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Properties Of Ferro-Geopolymer Mortar Slab Panels

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Abstract*: The purpose of this experimental research is to study the flexural behavior of Ferro-Geopolymer slab panels. Initially the ratio of binder to fine aggregate (1:2, 1:2.5, 1:3) and the ratio of Na_2SiO_3/ NaOH solution (2.5) is considered. The different combination of Fly ash and GGBS were considered. Ratio of alkaline liquid to binder ratio is fixed as 0.45. The Geopolymer mortar mix that gives compressive strength nearly equal to M_{20} grade concrete target mean strength was used to cast Ferro-Geopolymer slab panels. A slab of size (1000X1000X30) mm were cast of both ferrocement and Ferro-Geopolymer slab panels with two types of mesh were used such as square woven and square welded with single and double layers. Based on the results of slab load vs deflection of both types of meshes were compared from the characteristics of such as first crack load and ultimate load.

Keywords: Ferro-Geopolymer slab, Ferrocement, Fly ash, GGBS.

I. INTRODUCTION

Extensive use of natural source massive amount production of industrial wastes and environmental pollution require new solutions for a more sustainable development. In the modern days cement using will contributes about two billion tones of (CO_2) evolution occurs in atmosphere annually. The manufacture of cement is responsible to produce one ton of CO_2 per ton of cement produced, and the cement manufacturing industry contribution of 7% of global CO_2 emission, which is one of the green house gas that cause climate change due to global warming. It is estimated that the production of cement will increase from about 300 million tons in 2010 to 550 billion tons in 2020, as per Cement Manufacturers Association (CMA).

There is require to develop alternative to Portland cement utilize the industrial waste such as, fly ash, ground granulated blast furnace slag (GGBS). To reduce the heat of hydration and due to cost-effective, now a day's cement is being replaced partially with the pozzolans which are usually industrial wastes such as metakaolin, silica fumes, fly ash, GGBS.

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Fly ash will gives positive effect and environment friendly, it could produce concrete of better quality. Geopolymer has possible to replace Portland cement with excellent physical and mechanical properties such as high early strength, low shrinkage, sulphate and corrosion resistance could become a viable alternative to conventional cement and hence Substantially reduce CO_2 emission caused by the cement industries.

Use of fly ash and GGBS to produce geopolymer is main strategy in making materials more environments friendly. Therefore fly ash and GGBS used as a base material.

II. LITERATURE REVIEW

2.1 General

This chapter includes that brief review of published literatures for Ferro-Geopolymer materials and investigation on Ferro-Geopolymer mortar, and durability properties.

2.2 Historical Overview

According to P.Sushma [1] trough shaped panels have high load carrying capacity than folded shaped panel with increasing in the number of layers of wire mesh. In this investigation two types of panels were considered namely, ferrocement trough and folded type panels with Geopolymer mortar and mesh has been carried out for one and two layers of Galvanized Iron (GI) and Mild Steel (MS) of size (1000 x 350 x 30) mm and (1000 x 400 x 30) mm. The slab panels are tested under flexure by applying single point load.

Suhail Hameed sheikh et.al [2] research work explains about compressive strength, load vs deflection behavior, crack width and stiffness of Ferro-Geopolymer slab of size (750 x 450 x 25) mm by replacing the cement completely by fly ash. Compressive strength of steam cured geopolymer mortar specimen of size (70 x 70 x 70) mm is higher than cement mortar specimens ranges up to 70.473Mpa.Load carrying capacity of Ferro-Geopolymer and ferrocement slab increases with increase in layers of wire meshes. Loading is done on Universal Testing Machine (UTM) by placing slab on simply supported condition and applied load as two symmetrically placed concentrated loads. Increases in number of mesh layers in both ferrocement and Ferro-Geopolymer flat slabs increases ductility and decrease in the crack width.

Mohan Rajendran et.al [3] research work explains about as the molarity of NaOH increases from (8M-14M) compressive strength increases as compared to cement mortar ranges about 9.015%, 36.09%, 58.95%, 83.43%.

M. Laxminarayan R Naik et.al [4] research work concluded that formulations used for ordinary reinforced concrete as per IS 456-2000 same concept can be used for Geopolymer concrete. Because, deflection measured after flexural behavior of conventional reinforced cement concrete and reinforced Geopolymer concrete are similar.

V. Sreevidya et.al [7] research work explains that load carrying capacity increases for square welded wire mesh as compared to square woven and expanded metal mesh. A slab of size (1000 x 1000 x 30) mm were cast and tested by applying load of 50Kg of cement bags on slab in layer wise. Compressive strength of fly ash based Geopolymer mortar was found to depend on the strength of the Geopolymer binder and good bonding between the Geopolymer binder and fine aggregate.

R. Kumutha et.al [8] research work explains that by replacing the percentage of GGBS increases in geopolymer. Compressive strength increases. Geopolymer mortar prepared with (Na_2SiO_3/NaOH) ratio of 2.5 and also binder to sand ratio of (1:2) produces maximum strength as compared to (1:3).

2.3 OBJECTIVES

1. Optimization of parameters for Ferro-Geopolymer such as alkaline liquid to fly ash ratio, sodium silicate to sodium hydroxide ratio, molarity of Ferro-geopolymer , fly ash and GGBS proportions.
2. Determine the flexural behavior of slab panels using square woven and square welded wire mesh with one and two layers.

III. MATERIALS AND THEIR PROPERTIERS

3.1 Cement

In this experimental work, Ultra tech cement of 53 grade is used. Physical properties of cement is presented in Table 1 as per IS code confirming 1489-1991.

Table 1. Physical properties of cement

Sl.no	Properties	Test results
1	Specific gravity	3.12
2	Normal consistency	33%
3	Initial setting time	50 min
4	Final setting time	280 min

3.2 Fly ash

In this experimental work, class F type fly ash used from Raichur thermal power station Karnataka. The physical properties and chemical composition of fly ash is presented in below Table 2 and 3 respectively.

Table 2. Physical properties of fly ash

Sl.no	Properties	Test results
1	Specific gravity	2.15
2	Fineness	520 m^2/kg

Table 3. Chemical composition of fly ash

Sl.no	Characteristics	Fly ash(% wt)
1	Silica	55-65
2	Aluminum oxide	22-25
3	Iron oxide	5-7
4	Calcium oxide	5-7
5	Magnesium oxide	< 1.5
6	Titanium oxide	< 1.5
7	Phosphorous	< 1.5
8	Sulphate	0.1
9	Alkali oxide	< 1.5
10	Loss of ignition	1-1.5

3.3 GGBS (Ground Granulated Blast Furnace Slag)

In this research work, GGBS was used from the JSW steel Ltd of Bellary, Karnataka state. The chemical composition of GGBS is presented in Table 4.

Table 4. Chemical composition of GGBS

Sl.no	Characteristics	Test results
1	Fineness	404 m^2/kg
2	Specific gravity	2.9
3	Moisture content	1.00%
4	Manganese content	2.00%
5	Chloride content	0.10%
6	Sulphide content	0.33%
7	Magnesia content	7.90%
8	Glass content	91%
9	Insoluble residue	0.40%
10	Loss of ignition	0.33%
11	Sulphite content	0.33%

3.4 Fine aggregate

Good quality fine aggregate belonging to zone-II was used. The physical property of fine aggregate confirming as per code IS: 383-1970 is given in Table 5.

Table 5. Physical properties of fine aggregate

Sl.no	Properties	Test results
1	Specific gravity	2.67
2	Fineness modulus	3.791
3	Water absorption	0.61%

3.5 Alkaline liquids (Sodium Hydroxide and Sodium Silicate)

3.5.1 Sodium hydroxide

Sodium hydroxide (NaOH) is also called caustic soda and is available in the form of pellets or flakes with 90% to 95% purity. It was purchased from suppliers in bulk quantity. According to the required concentration of NaOH solid pellets were dissolved in water to make the solution. Physical properties of sodium hydroxide are given below in Table 6.

Table 6. Physical properties of sodium hydroxide

Sl.no	Physical properties	values
1	Color	Color-less
2	PH	14

3.5.2 Sodium Silicate

The Sodium Silicate solution was purchased from suppliers in bulk quantity which is locally available.

Commercial grade of sodium silicate solution are used. Physical and chemical properties of sodium silicate are given below in Table 7.

Table 7. Physical and chemical properties of sodium silicate

chemicals	Na_2O	Sio_2	H_2O	Appearance	color
Values (%)	27.60	32.08	40.32	Liquid (Gel)	Light yellow liquid

3.6 Water

Portable water is used for mixing and curing process.

3.7 Wire mesh

Used two types of wire meshes such as square woven and square welded with single layer and double layer. Properties of both meshes are given below in Table 8 and 9.

Table 8.properties of square welded mesh

Sl.no	**Properties**	**values**
1	Shape of opening	square
2	Mesh opening	15mm*15mm
4	diameter	1.5mm
5	Available form	Roll

Table 9.properties of square woven mesh

Sl.no	**Properties**	**values**
1	Shape of opening	square
2	Mesh opening	15mm*15mm
4	diameter	1mm
5	Available form	Roll

IV. EXPERIMENTAL INVESTIGATION

This chapter represents the details of mix design, casting, curing and testing of both normal cement and Geopolymer mortar. In order to simplify the process the compressive strength test was selected as the benchmark parameter.

4.1 MIX DESIGN FOR NORMAL CEMENT MORTAR

In order to finalize the parameters for normal cement mortar number of trail cast are done on ratio of cement to fine aggregate taken as 1:2,1:2.5,1:3and Water to cement ratio as 0.4,0.45. Cubes of size (150 X 150 X 150) mm were cast and cured for 7 days under water and 1 day in accelerated heat curing. Compressive strength of cubes was determined and results are presented in the Table10.

Table 10. Trail casting results for cement mortar cubes to finalize the cement to fine aggregate ratio

Sl. no	**Mix proportions**	**Compressive strength in N/mm^2 7 days**	**Compressive strength in N/mm^2 Accelerated curing**
1	1:2	23.45	33.69
2	1:2.5	26.86	38.81
3	1:3	24.52	35.32

Based on the test results presented in Table 10. It is observed that the mix proportion ratio of 1:2.5 gives good compressive strength equivalent to target mean strength of M_{20} grade concrete compressive strength (26.6N/mm^2). Therefore 1:2.5 mix proportions was considered and Curing age is fixed as 7 days.

Table 11. Trail casting results for cement mortar cubes to finalize the water to cement ratio

Sl. no	**Water to cement ratio**	**Compressive strength in N/mm^2 7 days**	**Compressive strength in N/mm^2 Accelerated curing**
1	0.4	23.26	33.43
2	0.45	26.86	38.81

Based on the results of trail casting presented in Table 11.It is observed that water to cement ratio of 0.45 gives good compressive strength. Therefore Water to cement ratio 0.45 finalized for further casting of slab panels.

4.2 MIX DESIGN FOR GEOPOLYMER MORTAR

The various parameters considered for trail casting are, binder to fine aggregate ratio 1:2.5, molarity of NaOH (8M),(10M), Na_2SiO_3/NaOH ratio considered as 2, 2.5. Ratio of liquid to binder ratio taken as 0.45. Numbers of trail cast were carried out to finalize the following parameters.

- The percentage of binders used (Fly Ash + GGBS)
- Molarity of NaOH
- Ratio of Na_2SiO_3/ NaOH
- Ratio of liquid to binder ratio

Trail castings were carried out for the different combinations of binder (Fly ash + GGBS) to determine the percentage of fly ash to GGBS proportion. Compressive strength of cubes was determined and results are presented in the Table 12.

Table 12. Trail cast results for Geopolymer mortar cubes to determine the percentage of binder content

Sl. no	**(Fly ash : GGBS)**	**Compressive strength in 7 days ambient curing in N/mm^2**
1	S1 (20:80)	25.823
2	S2 (30:70)	28.748
3	S3 (40:60)	36.661
4	S4 (50:50)	39.471

Based on the trail test results fly ash:GGBS (30:70) its compressive strength is nearer to M_{20} grade concrete that is 26.6N/mm^2. Therefore (30:70) Geopolymer mix proportion is finalized.

Table 13. Trail cast results for Geopolymer mortar with different molarity

Sl. no	**Molarity**	**Compressive strength in 7 days ambient curing in N/mm^2**
1	8M	28.748
2	10M	31.663

Based on the test results, molarity of NaOH increases the compressive strength increases. Molarity of NaOH (8M) has resulted compressive strength nearly equal to the compressive strength of normal cement mortar (26.86N/mm^2). Hence (8M) of NaOH is finalized.

Table 14. Trail test results for determining the Na_2SiO_3/ NaOH ratio

Sl. no	Na_2SiO_3/NaOH	Compressive strength in 7 days ambient curing in N/mm^2
1	2	24
2	2.5	28.748

Based on trail test results Na_2SiO_3/NaOH of 2.5 is gives good compressive strength compared to Na_2SiO_3/NaOH of 2. Hence Na_2SiO_3/NaOH of 2.5 is finalized.

Table 15. The finalized parameters considered for further casting of slab

Sl.No	Ratio of (Fly ash : GGBS)	Molarity	Ratio of Na_2SiO_3/NaOH	Ratio of alkaline liquid to binder
1	30:70	8M	2.5	0.45

4.3 Casting and curing of cubes

In order to finalize the above parameters total of 90 cubes were cast. Normal mortar cubes were cured under water for 7 days and 1 day in accelerated heat curing. Geopolymer mortar cubes were kept under ambient curing at normal temperature 27-30^{0}Cfor 7 days. Five specimens were prepared to take average result of the specimen.

4.4 FINAL CASTING OF SLAB PANELS

For testing the flexural behavior of slab panels of size (1000*1000*30) mm of slab were cast for both ferrocement and Ferro-Geopolymer slab panels. Total of 12 slabs of ferrocement panels and 12 slabs of Ferro-Geopolymer mortar were cast with single and double layers of mesh provided.

In the single layer slab the mesh provided at distance of 4mm (cover) and in the double layer of slab both the layers are bundled with binding wires and placed at distance of 4mm cover from bottom of slab.

4.5 Curing of specimens

Slabs were demoulded after 24 hours casting. Ferrocement slab panels were kept curing under water for 28 days duration and Ferro-Geopolymer mortar slabs were kept under ambient curing at normal temperature 27-30^{0}C for 7 days.

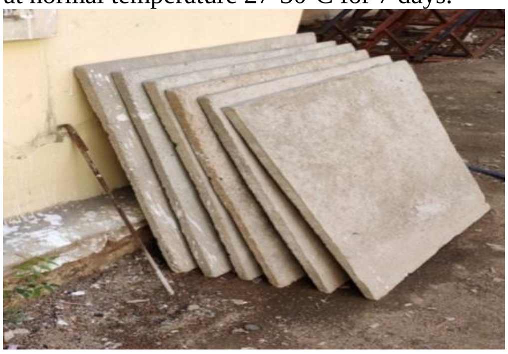

Fig.1 Ferro-Geopolymer slabs kept for curing

4.6 Test on hardened concrete

4.6.1 Compressive strength

The compressive strength test was carried out as per IS: 2250-1981code book. The rate of loading applied at uniform rate of 2 N/mm^2.

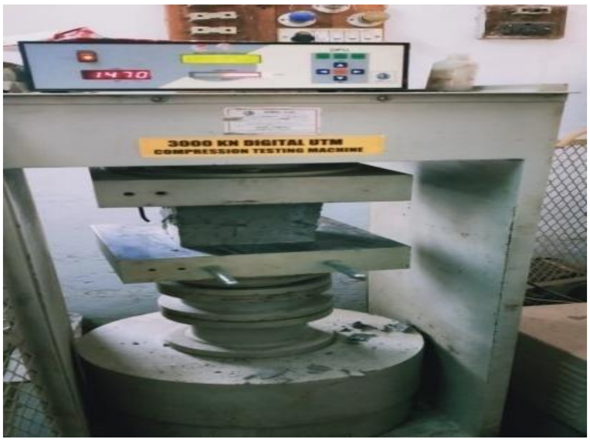

Fig.2 Compression Testing Machine

4.6.2 Flexural test under loading frame

Testing is done by a specially made frame of size (1m*1m). The slab is simply supported on frame and load is applied to the slab is uniformly distributed load. The loading is done by providing 1 to 2 layers of bricks to distribute load uniformly over a slab after this a loading 30Kg of sand bags were provided. The slab is kept on frame and Linear Variable Differential Transducer (LVDT). The LVDT is set below the centre part of the slab to measure the deflection in the slab by gradually applying the load. Electrical strain gauges were used in this test to measure strain occurs in the slab. For every layer corresponding reading should be taken through LVDT the load is gradually increased up to the failure occurs in the slab. The first crack is noted when continues load happened after that failure load is noted and corresponding deflections is also noted the slab failure due to flexure. The load deflection reading is taken and graph is plotted against load vs deflection.

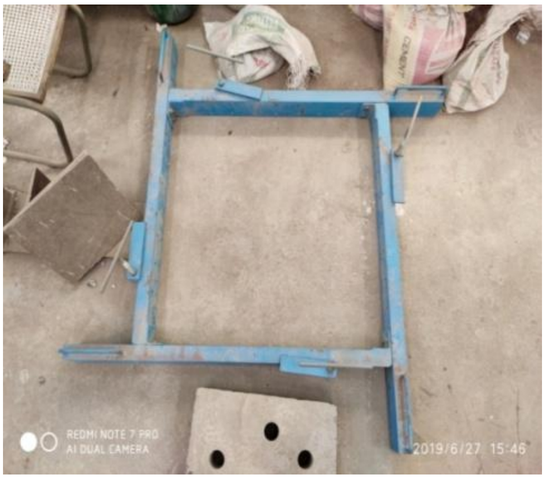

Fig .3 Frame of size (1m*1m)

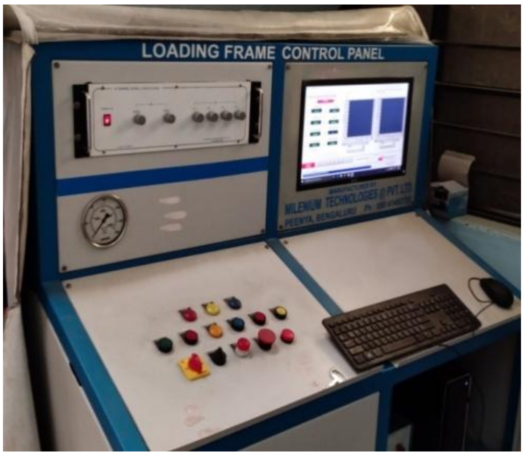

Fig.4 Loading Frame Control Panel

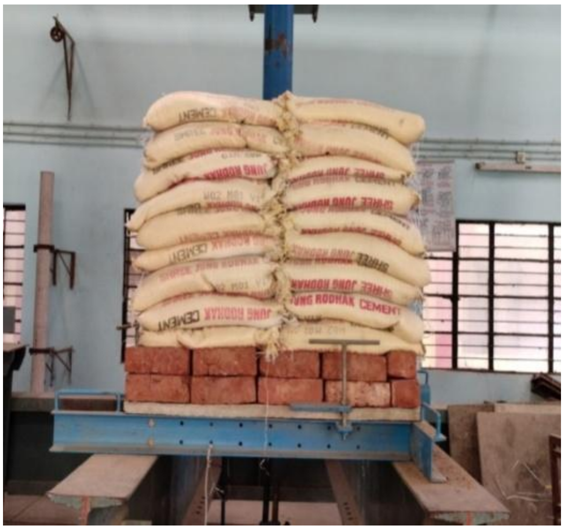

Fig.5 Layer wise load applied on slab

V. RESULTS AND DISCUSSION

5.1 Results of slabs

The ferrocement slabs and Ferro-geopolymer mortar slabs were tested under the loading frame and results of all the slabs are as shown below in the following tables:

Table 16: Load and deflection values for ferrocement slab (Square Woven Mesh)

Sl. no	Load (N)	Deflection in (mm)	
		1 Layer	2 Layer
1	0	0	0
2	870	0.05	0
3	1740	0.44	0.24
4	2940	2.15	1.84
5	4140	4.65	3.67
6	5340	6.19	5.08
7	7340	8.39	7.79
8	8540	9.09	8.72
9	9740	10.96	9.19
10	10940	-	11.08

Table 17: Load and deflection values for ferrocement slab (Square Welded Mesh)

Sl. no	Load (N)	Deflection in (mm)	
		1 Layer	2 Layer
1	0	0	0
2	870	0.01	0
3	1740	0.17	0.03
4	2940	1.01	0.43
5	4140	2.20	1.20
6	5340	4.12	2.15
7	7340	5.37	3.97
8	8540	6.77	5.34
9	9740	7.80	6.21
10	10940	8.35	6.87
11	12140	-	8.10

Table 18: Load and deflection values for Ferro-geopolymer slab (Square Woven Mesh)

Sl. no	Load (N)	Deflection in (mm)	
		1 Layer	2 Layer
1	0	0	0
2	870	0.02	0
3	1740	0.27	0.17
4	2940	1.75	0.85
5	4140	5.03	2.66
6	5340	5.72	4.29
7	7340	7.60	6.26
8	8540	8.68	7.48
9	9740	9.42	8.31
10	10940	10.83	9.84
11	12140	-	10.96

Table 19: Load and deflection values for Ferro-geopolymer slab (Square Welded Mesh)

Sl. no	Load (N)	Deflection in (mm)	
		1 Layer	2 Layer
1	0	0	0
2	870	0	0
3	1740	0.04	0
4	2940	0.57	0.20
5	4140	1. 64	0.73
6	5340	3.10	1.95
7	7340	4.72	2.62
8	8540	5.23	3.85
9	9740	6.56	4.66
10	10940	7.15	5.56
11	12140	8.21	6.97
12	13340	-	8.13

5.2 DISCUSSION OF THE RESULTS

Table 20: Results for Ferrocement slab and Ferro-Geopolymer slab (Square Woven)

Sl. no	Specimen	Type of wire mesh	No of layers of mesh	First crack (N)	Ultimate load (N)	Deflection (mm)
1	Ferro cement slab	Square Woven	1	4140	9740	10.97
			2	5340	10940	11.10
2	Ferro-Geopolymer slab	Square Woven	1	5340	10940	10.53
			2	7340	12140	10.96

From Table 20 It is observed that load carrying capacity of slab increases in Ferro-Geopolymer slab as compared to Ferro cement slab.

From Table 20 It is clear that as the number of layers of mesh increases load carrying capacity increases and deflection decreases for first crack load and ultimate load. This is due to the fact that percentage of reinforcement increases in the slab.

For square woven one layer wire mesh first crack load increases by (28.98%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square woven one layer wire mesh ultimate load increases by (12.32%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square woven one layer wire mesh deflection decreases by (4.17%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square woven two layer wire mesh first crack load increases by (37.45%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square woven two layer wire mesh ultimate load increases by (10.96%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square woven one layer wire mesh deflection decreases by (1.28%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

From the above Table it is concluded that as compared to Ferro cement slab Ferro-Geopolymer slab gives high flexural strength.

Table 21: Results for Ferrocement slab and Ferro-Geopolymer slab (Square Welded)

Sl.no	Specimen	Type of wire mesh	No of layers of mesh	First crack (N)	Ultimate load (N)	Deflection (mm)
1	Ferro cement slab	Square Welded	1	5340	10940	8.36
			2	7340	12140	8.10
2	Ferro-Geopolymer slab	Square Welded	1	7340	12140	8.22
			2	8540	13340	8.13

From Table 21 It is observed that load carrying capacity of slab increases in Ferro-Geopolymer slab as compared with the Ferro cement slab.

From Table 21 It is clear that as the number of layers of mesh increases load carrying capacity increases and deflection decreases for first crack load and ultimate load. This is due to the fact that percentage of reinforcement increases in the slab.

From the above Table it is concluded that as compared to Ferro cement slab Ferro-Geopolymer slab gives flexural strength high.

For square Welded one layer wire mesh ultimate load increases by (37.45%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square welded one layer wire mesh ultimate load increases by (10.96%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square welded one layer wire mesh deflection decreases by (1.70%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square welded two layer wire mesh first crack load increases by (16.35%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square welded two layer wire mesh ultimate load increases by (9.88%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

For square welded two layer wire mesh deflection increases by (0.37%) in case of Ferro-Geopolymer compared to ferrocement slab panels.

From the above table it is concluded that the use of two layer welded mesh in Ferro-geopolymer slab gives good flexural strength.

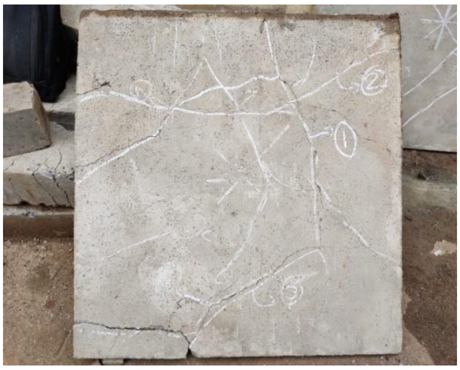

Fig. 6 Crack pattern for Ferro cement square welded mesh with 2 layers

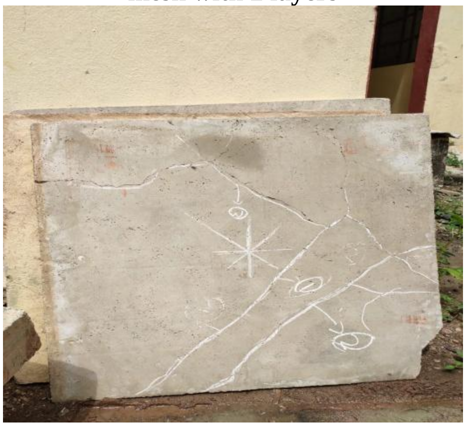

Fig. 7 Ferro-Geopolymer square welded mesh with 2 layers

VI. CONCLUSION

1. The binder ratio of (fly ash to GGBS) (30:70) results in high compressive strength.
2. As the molarity of NaOH increases the compressive strength also increases with respect to curing age.
3. It was observed that the ratio of Na_2SiO_3/NaOH of 2.5 resulted in good compressive strength as compared to ratio of Na_2SiO_3/NaOH of 2.
4. The liquid to binder ratio of 0.45 results higher compressive strength.
5. The load carrying capacity of both ferro-geopolymer as well as ferrocement slab panels increases with increases in number of layers of wire mesh.
6. Higher flexural strength is observed for two layer square welded meshes.
7. The flexural strength of two layer square welded mesh of Ferro-Geopolymer slab panels will give high strength as compared to ferrocement slab panels.
8. Delay in first crack load (8540 N) is observed on Ferro-Geopolymer slab square welded with two layer mesh as compared to ferrocement slab (7340 N).
9. Both slabs of ferrocement and Ferro-Geopolymer slabs are failed with multiple cracks occurs at bottom or tension face of the slab.

REFERENCES

1. P.Sushma "Experimental Study on Ferro-geopolymer Slab panels" vol.6 issue 1,2018 international Journal of innovative research in science and engineering ISSN(online) 2347-3207.
2. Suhail Hameed Shaikh, DR. J. B. Dafedar "An Experimental Investigation on Ferro-Geopolymer Flat panel" Vol. 6, Issue 7, July 2017 www.ijirset.com ISSN(Online): 2319-8753 ISSN (Print): 2347-6710.
3. Mohan Rajendran, NaganSoundarapandian "An Experimental Investigation on the Flexural Behavior of GeopolymerFerrocement Slabs" Vol. 3, Issue 2, Jul-Dec 2013 Journal of Engineering and Technology.
4. Mr.Laxminarayan R Naik, Prof .Mahantesh N B, Dr. Amarnath.K "Study on Flexural Behavior of Fly Ash based Reinforced Rectangular Geopolymer Concrete Slabs" IJERT, Vol.4,Issue 09, September 2015 ISSN: 2278-0181 PP 523-528.
5. Vinu P, dr. Ramesh Manoli, Dr. M T Prathap Kumar, Shiva Kumar KS "Flexural Behavior of Geopolymer Beam and Slab Elements Reinforced with Different Types of Wiremesh" Vol. 3, Issue 03, August 2016, ISSN (online): 2349-6010 PP 93-103.
6. SalmabanuLuhar ,UrvashiKhandelwal "Durability Studies of Fly Ash Based Geopolymer Concrete" Vol.5, Issue 8, (part-4) August 2015, PP 17-32.
7. V.Sreevidya , R. Anuradha, R. Venkatasubramani " Experimental study on geopolymerferro cement slab using various wire mesh" vol. 39, no. 4, October-November 2012 PP. 436-443.
8. R. Kumutha, K Vijay, P. Rajeswaran "Struturalbehaviour of ferrogeopolymer slabs under flexure" vol.866,,pp 109-113 ISSN 1662-9752.
9. A. sofi, PranavPhalpher and ManasPratap Singh " An experimental investigation on geopolymerferrocement slabs" ISSN: 0974-2115.
10. R. Padmavathy , S. Dharmar " Study On Flexural behavior of flat ferrocement panels" ISSN 2319-7064.
11. Sunil kumar M.V, N. Jayaramappa " modulus of elasticity of ferrocement slabs with varying layers of mesh subjected to flexure" vol. 5, issue 3, June-2018.
12. Code books reffered IS 456-2000, IS 1489-1991, IS 383-1970.
13. IS Code specifications for mortars 91-92.
14. Code practice for preparation and use of masonry mortars IS: 2250 – 1981.
15. Methods of tests for strength of concrete IS: 516-1959.
16. Methods of physical tests for hydraulic cement IS: 4031(PART 7)-1988.

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