Experimental Investigation of Ferrocement Panels in Different Casting Conditions

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Abstract:- **The main objective of this investigation is to study the performance of ferrocement panels in various different casting conditions such as normal and saline casting. These casting conditions are created by using potable and saline water for casting. Fly ash which is a waste material is also used in this investigation as partial replacement of cement. The ferrocement slab panels are casted by using both normal and saline water with partial replacement of cement by fly ash and tested. The load carrying capacity of these panels under flexure with and without fly ash at different casting conditions is investigated. The basic physical properties test for the materials has been conducted. The following percentages ferrocement panels are made by partially replacing cement by fly ash as 0%, 10% & 20% respectively. The flexural strength of control panels are compared with the flexural strength of partially replaced cement with fly ash panels at corresponding casting conditions. The addition of fly ash in different casting condition affects the flexural strength of panel with hexagonal wire fabric. In addition, the acid test was conducted to find out the acid resistance of ferrocement samples in acid circumferences. The samples for acid test are prepared in that manner such that, after the completion of 28 days normal curing period, the core portion of the ferrocement slab panels were cut out and fully immersed in acid solution for 28 days. The variation of percentage of weight loss is calculated by using each weight of the samples after 7 days, 14 days, 21 days, and 28 days respectively. The final outcome of this study is to bring out the performance of ferrocement panels against different casting conditions.**

1. INTRODUCTION

Any structure or component is made in the field of construction is to serve a purpose, must be capable of taking the entire expected load throughout its life span without any damage. Ferro cement can be made for this purpose to last for many years, but this depends on many factors such as mortar composition, corrosion of reinforcement, permeability, construction practices, and environmental conditions and etc. The casting condition is one of the major concerns because it affects the life, maintenance costs, and user convenience and safety of the structures. Several researchers have investigated the durability and performance of ferrocement structures. In this investigation the ferrocement slab panels are casted with hexagonal wire mesh layer and tested under strength and durability aspects.

2. EXPERIMENTAL PROGRAMME

The experimental programme was designed to check the flexural behaviour of ferrocement panels under different casting conditions. For this purpose, a total of 36 ferrocement slab panels are casted of size 450mm×450mm×20mm with single layer of hexagonal wire mesh. The load will be applied incrementally up to failure and for each increment of load, the deflection will be measured. In this investigation fly ash used as mineral admixture as partial replacement of cement with 0%, 10%, and 20% under two different casting conditions (NC-normal casting, SC- saline casting) the first crack load, ultimate load and deflection at first crack load, and at ultimate load were observed.

2.1 Materials:

2.1.1 Cement:

Ordinary Portland cement (53 Grade) was used in mix. The physical properties of cement were determined in the laboratory as per IS: 269-1989. The fineness of cement is 2%, specific gravity of cement is 3.15, Standard consistency of given cement is 35%, Initial setting time of cement is 35%.

2.1.2 Fine aggregate:

Locally available sand conforming to grading zone was used for this investigation. The sand is sieved using 4.75 mm sieve to remove all the pebbles. The specific gravity of Fine aggregate is 2.65 and Fines modules of sand is 3.25

2.1.3 Coarse aggregate:

Locally available well graded aggregate of normal size greater than 4.75 mm and less than 10mm is used. Specific gravity of coarse aggregate is 2.65, fines modulus of course aggregate is 4.51

2.1.4 Fly ash:

Fly ash (Class F) was collected from National Thermal Power Corporation (NTPC) Thoothukkudi, (Tamilnadu) India.

2.1.5 Wire mesh:

The hexagonal sized steel wire meshes are used in this project.

4. Mix design:

The mix design has been done based on Indian standard recommended method for M20 grade of concrete. The obtained mix ratio is 1:1.42:3.0007 with the water cement ratio of 0.50.

Casting of panels:

The ferrocement slab panels which are comes under the normal casting condition are casted by using normal potable water with the partial replacement of cement with fly ash as 0%, 10%, 20% respectively. The ferrocement slab panels which are comes under the saline condition are casted by using saline water which is prepared by adding 2.5% of sodium chloride with the normal potable water with the partial replacement of cement by fly ash as 0%, 10%, 20% respectively. For casting of the test panels, 450mm×450mm ×20mm size steel mould is used. This mould is placed on flat base sheet. Lubricating oil was applied on the base sheet and along the inner portions of the mould. While casting, initially the first layer of the concrete mix was spread over the base sheet within the mould and compacted. The wire mesh reinforcement was laid over the concrete layer. The second layer of the concrete was spread over the wire mesh reinforcement and compacted. And finally the well finishing was made. The panels were demoulded after 24 h and cured under moist gunny bags for 28 days. The cured panels were air-dried for 4 days before the actual testing.

3.7 Testing of panels:

3.7.1 Flexural strength test:

The ferrocement panels are tested under flexure with its one side (450 mm) resting on simple support and the other side (450 mm) free leaving and 1.5 cm overhang on each support. Mechanical dial gauges are mounted on the base of the panels having least count of 0.01 mm are used to obtain deflection at various stages of loading. The dial gauges were placed at the mid-span of the panel. The two point loads applied through a universal testing machine capacity of 100 tonne. The loads were gradually increased over the specimen. The first crack load, ultimate load, and deflection at various stages are recorded. For all the test specimens, three replications are used and an average value of ultimate load and deflection were calculated.

The ferrocement slab panels which are casted under both normal and saline condition tested under flexure and following parameters are considered while calculating the results which are the first crack load, deflection at first crack load, ultimate load, Deflection at ultimate load.

Fig 3.5: flexural strength test

3.7.2 Acid test:

The acid test is conducted to find out the acid resistance of ferrocement samples in acid solution. That acid resistance is calculated in terms of percentage of weight loss of the same ferrocement samples compared with the initial weight of the respective sample. The hydro chloric acid solution has been prepared for this test. The samples were cut out from the core portion the ferrocement slab panels after the completion of its total curing period of 28 days. The size of the samples is 100mm ×100mm×20mm.Those specimens are immersed in HCL solution for 28 days. The initial weight (before immersion) and final weight (after 28 days of immersion) of ferrocement samples are recorded after each 7 days of immersion in acid solution the weight of the samples are recorded. These weights are compared with the initial weight of the corresponding specimens. The final result of percentage of weight loss of ferrocement slab panel samples are obtained by using these individual weights of the respective specimens.

Acid solution of HCL having the normality of 0.5% is made and the solution is replenished regularly by checking the normality of the acid. And the normality is maintained that normality throughout the experiment. Ferrocement samples of size 100mmX100mmX20mm are used for this testing.

4. COMPARISON OF LOADS AND DEFLECTIONS FOR FERROCEMENT PANELS AGAINST DIFFERENT CASTING CONDITIONS:

Slab panel designation	First crack load (Kn)	Deflection at first crack load (mm)	Ultimate load (Kn)	Deflection at ultimate load (mm)	Ratio of ultimate to first crack load	Ratio of deflection at ultimate load to deflection at first crack load	% variation in first crack load due to saline casting	% variation in ultimate load due to saline casting
NC 00 FA	2.1	2.22	3.1	4.76	1.47	2.14	-	-
NC 10 FA	2.4	0.31	3.5	5.36	1.45	17.29	-	-
NC 20 FA	2.5	0.85	3.7	7.40	1.48	8.70	-	-
SC 00 FA	1.7	0.19	2.1	4.26	1.23	22.42	-19.05	-32.26
SC 10 FA	2	1.97	2.7	5.29	1.35	2.68	-16.67	-22.86
SC 20 FA	2.2	2.02	2.9	6.28	1.32	3.1	-12.01	-21.62

Table 4.11: Comparison of loads and deflections for ferrocement panels against different casting condition

5. COMPARISON OF LOADS AND DEFLECTIONS FOR FERROCEMENT PANELS AGAINST THE FLY ASH REPLACEMENT:

Slab panel designation	First crack load (Kn)	Deflection at first crack load (mm)	Ultimate load (Kn)	Deflection at ultimate load (mm)	Ratio of ultimate to first crack load	Ratio of deflection at ultimate load to deflection at first crack load	% variation in first crack load due to fly ash replacement	% variation in ultimate load due to fly ash replacement
NC 00 FA	2.1	2.22	3.1	4.76	1.48	2.14	-	-
NC 10 FA	2.4	0.31	3.5	5.36	1.45	17.29	+14.28	+12.90
NC 20 FA	2.5	0.85	3.7	7.40	1.48	8.70	+4.17	+5.71
SC 00 FA	1.7	0.19	2.1	4.26	1.23	22.42	-	-
SC 10 FA	2	1.97	2.7	5.29	1.35	2.69	+17.64	+28.57
SC 20 FA	2.2	2.02	2.9	6.28	1.32	3.1	+10	+7.41

Table 4.12: Comparison of loads and deflections for ferrocement panels against replacement of fly ash

6. RESULT OF ACID TEST:

6.1 CALCULATION OF % OF VARIATION OF WEIGHT LOSS:

Slab panel designation	Initial weight	Weight after 7 days	Weight after 14 days	Weight after 21 days	Weight after 28 days	% of variation after 7 days	% of variation after 14 days	% of variation after 21 days	% of variation after 28 days
NC 00 FA	801.75	800.83	799.72	798.17	797.35	0.11	0.25	0.44	0.54
NC 10 FA	624.69	624.13	623.53	622.98	621.79	0.09	0.18	0.27	0.46
NC 20 FA	834.83	834.17	833.75	832.97	831.75	0.07	0.12	0.22	0.37
SC 00 FA	779.51	778.67	777.17	775.62	774.35	0.10	0.30	0.49	0.67
SC 10 FA	824.59	823.83	822.91	822.27	821.53	0.08	0.20	0.28	0.37
SC 20 FA	570.16	569.97	569.13	568.71	568.23	0.03	0.18	0.25	0.33

Table 4.13: calculation of % of variation of weight loss of ferrocement samples

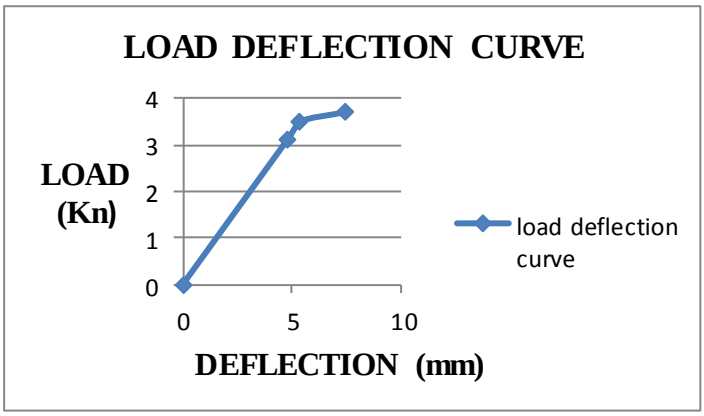

FIG 4.1: load deflection curve for varying percentage of fly ash in normal casting condition.

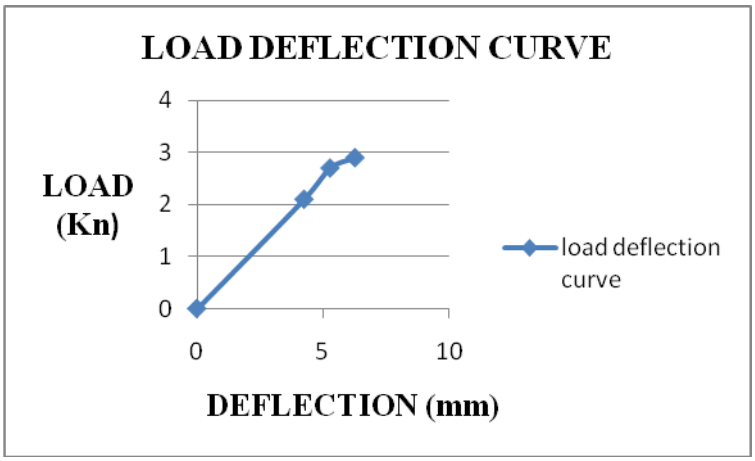

Fig 4.2: load deflection curve for varying percentage of fly ash in saline casting condition.

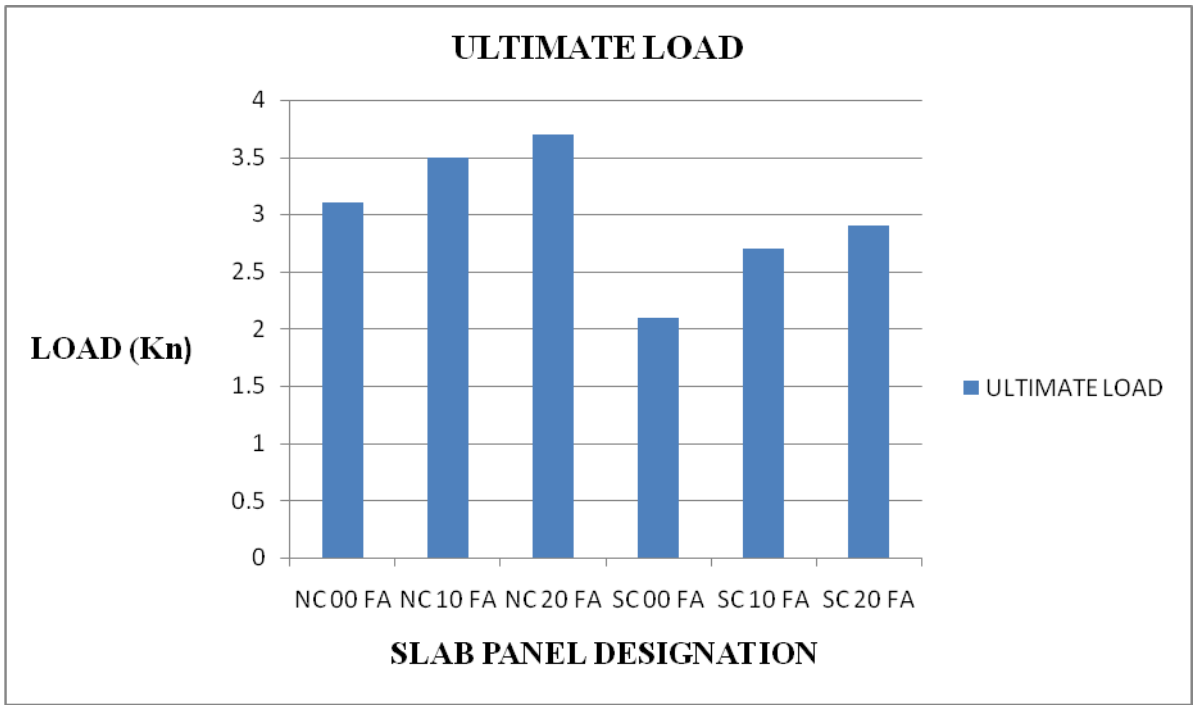

Fig 4.3: variation of ultimate load under different casting condition corresponding to replacement of fly ash.

ACID TEST:

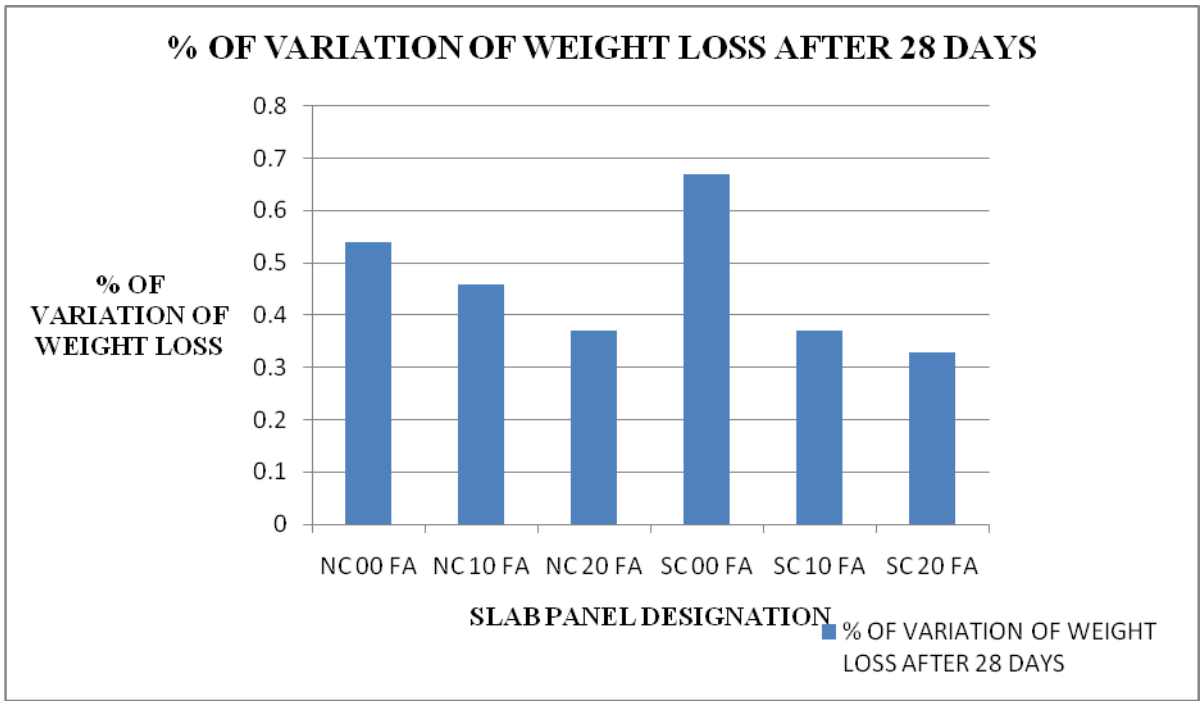

Fig 4.7: % of variation of weight loss of ferrocement samples after 28 days.

7. SUMMARY AND DISCUSSIONS:

A comparison of first crack load and ultimate load under flexure for the panels is given in table. The variation in the strength for the normal and saline casting condition under flexure is also given in table. The load deflection curves for both normal and saline casting condition under flexure corresponding to its fly ash replacement has been plotted. In saline casting condition with 10 and 20% replacement of cement by fly ash the load carrying capacity of the panels under flexure decreases by22.86% and 21.62% respectively as compared to panel with same percentage replacement of fly ash under normal casting condition. Due to the presence of fly ash the load carrying capacity is increases in both normal and saline casting. In saline casting with 10 and 20 % replacement of cement by fly ash the load carrying capacity of the panels under flexure increases by 28.57% and 7.41% respectively is greatly enhanced by the fly ash replacement. In normal casting condition the load carrying capacity is increased by 12.90% and 5.71% due to presence of fly ash. Both first crack load and ultimate load increases with increase in percentage replacement of cement by fly ash up to 20% in both normal and saline casting condition.

The action of acid on hardened concrete is the conversion of calcium compounds into the calcium salts of the attacking acid. Hydrochloric acid with concrete produces calcium chloride which leads to affecting the gypsum in concrete and leached out by the acid solution. It increases the porosity. As a result of these reactions, the structure of concrete gets destroyed. From the test results the concrete containing fly ash was found to be more resistant to HCl solution than that of control concrete. The weight loss is given in the table. It is found that there is a continuous increase in resistance up to 20 % replacement of cement with fly ash.

8. CONCLUSION

The usage of saline water while casting the ferrocement structures affects the load bearing capacity under flexure. Addition of fly ash in different casting condition affects the load carrying capacity under flexure for panel with hexagonal wire fabric. The strength of panel increases with fly ash dosage in saline casting condition. However the strength of panels under normal casting condition with 10 and 20% replacement of cement by fly ash is more as compared with the panels under saline casting with same percentage of fly ash replacements due to the presence of saline water during casting. In acid test the percentage of variation of weight loss of ferrocement samples for up to 28 days of immersion is calculated. The variation graph is plotted for each after 7 days, 14days, 21 days, and 28 days for the corresponding replacement of cement with fly ash by 0%, 10%, and 20% respectively. The percentage of weight loss of ferrocement samples increases with increase in the curing period of the samples in acid solution. The dosage of fly ash affecting the ferrocement samples under normally casted and saline casted samples. The replacement of fly ash up to 20%, reduces the increase in percentage of variation of weight loss in both normally casted and saline casted ferrocement samples.

9. REFERENCES:

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