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FLEXURAL PERFORMANCE OF FERROCEMENT CONTAINING METAKAOLIN AND FLY ASH REINFORCED WITH CHICKEN MESH

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ABSTRACT

Ferrocement is one of the structural materials, widely used due to its advantage from its particular behavior such as mechanical properties. ferrocement structural elements involved in this study are having a simple cross section and it can be fabricated easily with the help of simple formwork The main aim of this work was to investigate the behavior of ferrocement by using metakaolin and fly ash as a partial replacement of cement. A total of 63 ferrocement panels with dimensions of (500×100×10 mm) were constructed and tested. . In this present investigation replacement of cement with Metakaolin and Fly Ash at 0%, 10%, 20% and 30%. From the experimental results flexural strength will be maximum at 20% fly ash and 10% metakaolin replacement with cement.
P6

KEYWORDS: *FERRO CEMENT, WATER, SAND, WIRE MESH.*

I. INTRODUCTION

The inventors of Ferro cement are Frenchmen **JOSEPH_MONIER** who dubbed it "ciment armé" (armored cement) and **JOSEPH-LOUIS_LAMBOT** who constructed a batteau with the system in 1848. Lambot exhibited the vessel at the **EXPOSITION UNIVERSELLE** in 1855 and his name for the material "ferciment" stuck. Lambot patented his batteau in 1855 but the patent was granted in Belgium and only applied to that country. At the time of Monier's first patent, July 1867, he planned to use his material to create urns, planters, and cisterns. These implements were traditionally made from **CERAMICS**, but large-scale, kiln-fired projects were expensive and prone to failure. In 1875, Monier expanded his patents to include bridges and designed his first steel-and-concrete bridge. The outer layer was sculpted to mimic rustic logs and timbers, thereby also ushering **FAUX BOIS** (wood grain) concrete. In the first half of the twentieth century Italian **PIER LUIGI NERVI** was noted for his use of Ferro-cement, in Italian called ferro-cement.

"Ferro cement" being referred to as Ferro-concrete or **REINFORCED CEMENT** to better describes the end product instead of its components.

Induced corrosion of steel can be effectively improved by the use of the mineral admixtures in cement mortar such as fly ash, blast furnace slag and metakaolin.The mineral admixtures such as fly ash, blast furnace slag and metakaolin help the formation of finer and discontinuous pore structures as a consequence of pozzolanic reaction. The successful application of the ferrocement boats and roofing element is an indication that ferrocement is relatively resistant to the ingress of water.

It is apparent that the ternary cementations blends of Portland cement, metakaolin and fly ash offer significant advantages over binary blends and even greater enhancements over ordinary Portland cement. In some cases, price differences between the individual components may allow the ternary blend to compete with the ordinary Portland cement on the basis of material costs.

The availability of materials in most developing countries, and skilled labour required and for both prefabrication and self help construction could make ferrocement become one of the most inexpensive and attractive techniques to strengthen and rehabilitate the existing and damaged ferrocement structures.

Limited data exist in the literature on the flexural behavior of ferrocement with modified cement matrix. The significant contributions of our paper to the ferrocement work are as follows.

To explore the effects of adding metakaolin and fly ash with super plasticizer to ferrocement laminates. Tests were conducted to study the flexural characteristics of the ferrocement laminates of low water binder ratio with the metakaolin and fly ash in various proportions in the presence of a super plasticizer. Ferrocement works demand cement mortars of good workability and high strength. It has to be done by including the optimum dosages of MA, FA and super plasticizer. Furthermore, this paper speaks of the ferrocement panels reinforced with chicken mesh of volume fraction fly ash 1.86%,2.321%,2.532% and metakaolin 1.36%,1.97%,2.1% their flexural performance was compared with that of the referred ferrocement panel. It considers the minimization of the manufacturing cost.

II. EXPERIMENTAL PROGRAMME

MATERIALS

Concrete was made of ordinary Portland cement 53 grade, Fine aggregate, Metakaolin, fly ash as mineral admixtures and Super plasticizer as chemical admixture.

WIRE MESH

The wire mesh is usually of 0.5 to 1.0 mm dia wire at 5 mm to 10 mm spacing and cement mortar.

CEMENT

Cement may be defined as the adhesive substance capable of uniting fragments or masses of solid matter to a lumped whole Lea *et al.* (1970). Various types of cements can be used in the concrete production. It should be fresh, free from foreign matters and of uniform consistency.

FINE AGGREGATE

The most common fine aggregate used in the concrete is river sand. River sand is a vital ingredient in making the two most normally used construction material viz. cement concrete and mortar. The sand should be clean, hard, strong and free from the organic impurities and deleterious substances. It should be capable of producing a sufficiently workable mix with minimum water-cement ratio.

WATER

Mixing water should be clean, fresh and potable. Water should be free from impurities like clay, loam, soluble salts which leads to deterioration in properties of concrete. Potable water is fit for mixing and curing of concrete.

TABLE-1 CHEMICAL PROPERTIES OF FLY ASH

Properties	Test results	Chemical requirement as per IS 3812-1:2003
Moisture	0.20%	-
Loss on ignition	4.00%	5.0 Max
Sio2+Al2o3+Fe2o3	89.82%	70.0 Min
Silicon dioxide(sio2)	60.70%	35.0 Min
Reactive silica	52.35%	20.0 Min
Magnesium Oxide(Mgo)	0.64%	5.0 Max
CaO	9.02%	<20% for Class-F fly ash >20% for Class-C fly ash
Total Sulphur as Sulphur Trioxide(So3)	0.18%	3.0 Max
Available Alkalis as Sodium Oxide(Na2o)	0.34%	1.5 Max
Total Chlorides	<0.01%	0.05 Max
Specific gravity	2.2	-

Table-2 TEST RESULTS ON FINE AGGREGATE (IS 383-1970)

Properties	Results obtained	Range
Specific Gravity	2.7	2.5-3.0
Fineness Modulus Test	2.89	2.6-3.2
Bulking Of sand	4%	-

TABLE-3 CHEMICAL PROPERTIES OF METAKAOLIN

S.NO	CONSTITUENTS (MASS %)	M.K
1	Silica (Sio2)	52. 86%
2	Alumina (Al2O3)	**44.10%**
3	Ferric Oxide (Fe2O3)	**0. 45%**
4	Calcium Oxide (Cao)	0. 28%
5	Total Alkalies (Na2O+K2O)	0.45%

Physical & chemical properties of Fly ash

Specific gravity = 2.45

bulk density = 1.1gm/cc

TABLE-4

S.n0	Constituent	Percent by wt
1	silica	62.63
2	Iron oxide	3.93
3	Alumina	32.35
4	Calcium oxide	2.04
5	Magnesium oxide	0.46
6	Total sulphur	0.53
7	Loss on ignition	0.39
8	Sodium oxide	1.35

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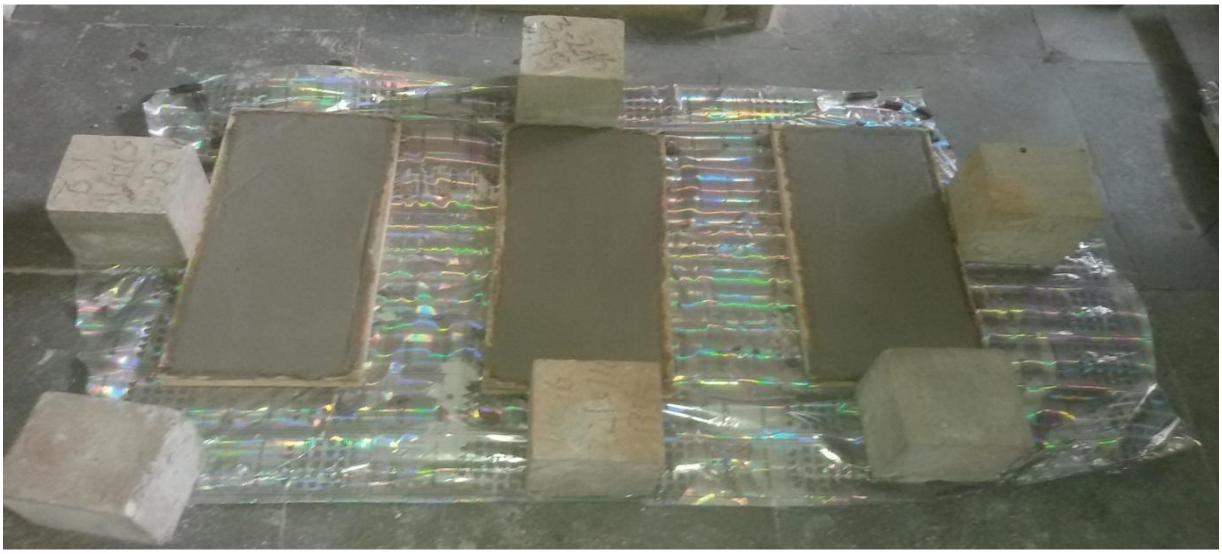
9	Total chlorides	0.06

Methodology

- Casting of the slabs specimen
- Curing
- Preparation for test specimens
- Flexural test on Ferro cement slab.

Specimen placed in closed mould



Casting of the slabs specimen

TEST METHOD

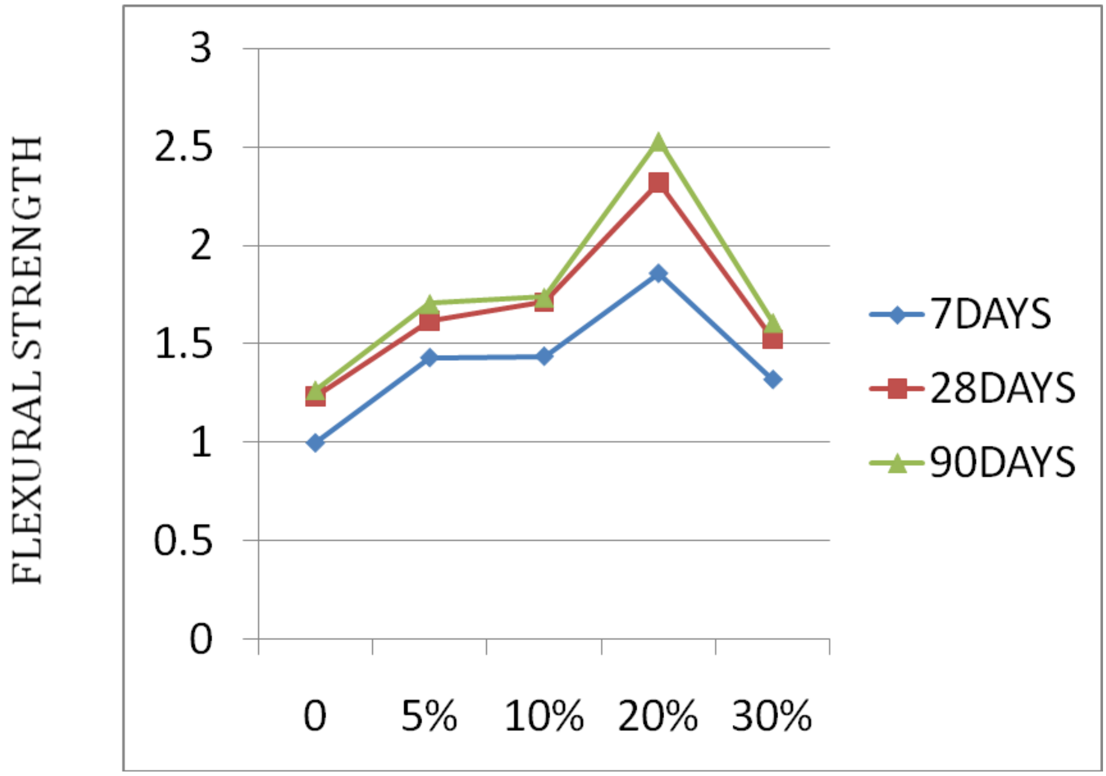
The flexural strengths of various mortar mixtures were determined on 500x100x100mm Ferro slab.

RESULTS AND DISCUSSION

Table-5,6 shows development for MK20, FA20 and reference concrete at different ages up to 90 days. From the results it can be seen that in both cases flexural strength increased with age.

TABLE-5 FLEXURAL STRENGTH OF MORTAR SPECIMENS (N/mm^2)

s.no	Fly Ash(%)	7 DAYS	28DAYS	90DAYS
0	REF.MIX	0.999	1.231	1.267
1	5 %	1.432	1.615	1.706
2	10 %	1.439	1.712	1.738
3	20 %	1.86	2.321	2.532
4	30 %	1.321	1.523	1.609



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PROPORTION

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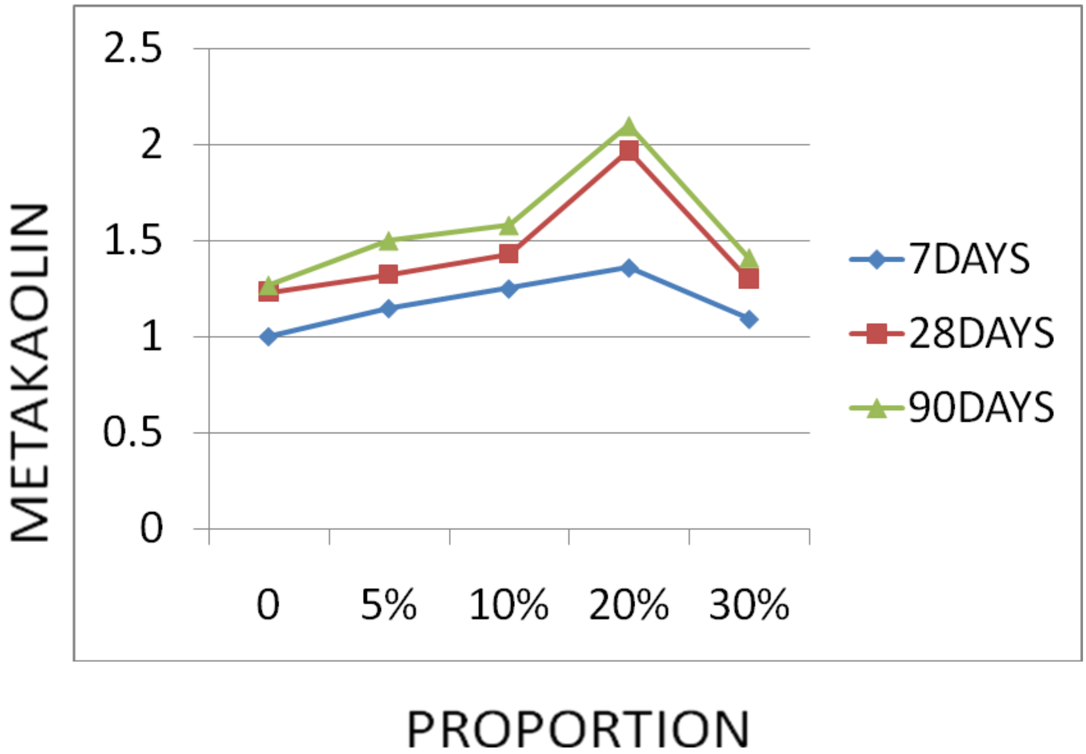
TABLE-6 FLEXURAL STRENGTH (N/mm^2)

s.no	Metakaolin(%)	7 DAYS	28DAYS	90DAYS
0	REF.MIX	0.999	1.231	1.267
1	5%	1.147	1.324	1.5
2	10%	1.25	1.43	1.58
3	20%	1.36	1.97	2.1
4	30%	1.09	1.300	1.41



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APPLICATIONS OF FERRO CEMENT:

1. **Marine Applications:**

- Boats, fishing vessels, barges, cargo tugs.
- Key criteria for marine applications: light weight, impact resistance, thickness and water tightness.

2. **Water supply and sanitation:**

- Water tanks, sedimentation tanks, swimming pool linings, well casings, septic tanks etc.

3. **Agricultural:**

- Grain storage bins, silos, canal linings, pipes, shells.

4. **Residential Buildings:**

- Houses, community centers, precast housing elements, corrugated roofing sheets, wall panels etc.

5. **Rural Energy:**

- Biogas digesters, biogas holders, incinerators, panels for solar energy collectors etc.

CONCLUSION

The addition of **FLY ASH** and **METAKAOLIN** has a significant effect on the Flexure strength of Ferro cement slab.

Flexural strength of Ferro cement increases with the addition of **FLY ASH** and **METAKAOLIN** up to 20% of cement after which it decreases.

Flexural strength will be more for fly ash Ferro cement compare normal Ferro cement.

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