A STUDY ON EFFECT OF HYDROCLORIC ACID ATTACK ON COMPRESSIVE STRENGTH OF CONCRETE BY REPLACING CEMENT WITH FLY ASH AND METAKAOLIN

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Abstract : ***Admixtures are using all over the world in concrete due to their low cost and echo-friendly nature. Hence Mineral admixtures such as fly ash, rice husk ash, silica fume etc. are more commonly used. This admixtures help in obtaining both higher performance and economical results. Metakaolin and Flyash are also such type of non - conventional material, which can be used in the construction industry to get more benefits. Metakaolin produced by calcinations and Fly ash is produced by coal combustion. The present work gives the results of compressive strength test to decide the suitability of Metakaolin and Fly ash in production of concrete. In the present work, the Compressive strength test carried out to study the effect of acid curing on M25 concrete in which Ordinary Portland cement is partially replaced by Metakaolin and Fly ash and acid curing is done by subjecting the concrete to different concentrations of Hydrochloric acid (HCl). The replacement of Metakaolin and Fly ash level were 0%,5%,10%,15%,20% separately and from this finding the optimum value. A separate mix of concrete was made by partial replacement of cement with optimum levels of Metakaolin and Fly ash. All mixes were tested for compressive strength at 7, 14 & 28 days of water curing. The final optimum levels mix was tested for compressive strength at the end of 7, 14 & 28 days under both water and HCL acid with concentrations of 3% & 5%.***

IndexTerms - Flyash,Metakaolin,Compressive strength,Compaction factor.

I. INTRODUCTION

Various researches and Experiments are conducting around the world to improve the properties of concrete. **YSV Ganesh and P Durgaiyya** carried out an experimental investigation to find the suitability of metakaolin in production of concrete. Mix with 15% metakaolin is superior to all other mixes. The result shows that the increase in metakaolin content improves the compressive strength up to 15% replacement and gradually decreases beyond that. **E.Arunakanthi** in 2012 an experimental investigation carried out to study the effect of aggressive chemical environment on High performance concrete with metakaolin in which Ordinary Portland cement is partially replaced by 20% of metakaolin. The results indicate that the compressive strength and split tensile strength decrease with the increase in concentration of HCl. **T.G.S.Kiran** in 2014 report the results of the tests carried out on Sulphate attack on concrete with use of fly-ash as cement replacement in water curing along with H2SO4solution. The test results indicate that at 10% replacement there is increase in strength and beyond that the strengths decreased, but at 20% replacement FA strength less than to normal concrete. **Nova John** in 2013 presented the results of an experimental investigation carried out to find the suitability of metakaolin in production of concrete. The replacement levels were 5%, 10%, 15% up to 20 %(by weight) for Metakaolin. Test results indicate that use of replacement cement by metakalion in concrete has improved performance of concrete up to 15%. **Avancha Sri Sowmya** in 2015 studied the effect of adding Metakaolin in concrete on its performance and its durability under H2SO4 and HCL acid curing. The compressive strength values of acid effected concrete decreases on comparison with of normal concrete, but the effect of acid on concrete decreases with the increase of percentage of metakaolin. At 20% replacement of cement by Metakaolin the concrete attained maximum compressive strength for both M20 and M40 grade of concrete. **Beulah M** in 2012 presented an experimental investigation on the effect of partial replacement of cement by metakalion by various percentages viz 0%, 10%, 20%, and 30% on the properties of high performance concrete, when it is subjected to hydrochloric acid attack. The concrete specimens were kept immersed in 5% concentrated hydrochloric acid solution for 30, 60 and 90 days for observation. Test results indicate that use of replacement cement by metakalion in HPC has improved performance of concrete up to 10%. **Aman Jatale** in 2013 conducted studies on the effect of partial replacement of cement by fly-ash on concrete mixes with 20%, 40%, 60% replacement levels. As the fly ash content increases there is reduction in the strength of concrete. Rate of strength development at various ages is related to the W/Cm and percentages of fly ash in the concrete mix.

Now a day, it is required to reduce the emission of CO2 associated with manufacture of cement. The construction industry is suggested to use admixtures to reduce cement consumption. Admixtures require less energy to manufacture as they are naturally occurring materials, industrial by products. The preset work gives a contribution to the efficient use of Metakaolin and Fly ash in concrete as admixtures. The Clay mineral kaolinite anhydrous calcined form is called Metakaolin. As it is not the by-product of an industrial process and not entirely natural, Metakaolin is unique. Fly ash is a coal combustion product that is the particulates (fine particles of fuel) composition that are driven out together with the flue gases of coal-fired boilers. Fly ash material solidifies while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. These admixtures can reduce the cement content in order to lower the effect of cement on the environment.

II. EXPERIMENTAL INVESTIGATION

Concrete Mix Design

Characteristic Compressive Strength at 28 days	25 N/mm^2
Cement	53 grade OPC
Coarse Aggregate	Angular, 20mm size

Fine Aggregate — Specific gravity- 2.63
River sand, Zone-IV
Specific gravity- 2.61

Maximum Water Cement Ratio — 0.45

Mix Proportion 1:1.33:2.96:0.45

Table 1: Composition of materials for $1m^3$ concrete with Fly ash or Metakaolin

Sl. No	The modified mix	Cement (kg)	Fly ash or Metakaolin (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Water (L)
1.	NC	413.300	0	1.860	4.128	0.627
2.	MC05 / FC05	392.350	20.665	1.860	4.128	0.627
3.	MC10 / FC10	371.970	41.330	1.860	4.128	0.627
4.	MC15 / FC15	351.305	61.995	1.860	4.128	0.627
5.	MC20 / FC20	330.640	82.660	1.860	4.128	0.627

Where, NC= Normal concrete
MC 05 = Modified Concrete of 5% replacement of Cement with Metakaolin
MC10 = Modified Concrete of 10% replacement of Cement with Metakaolin
MC 15 = Modified Concrete of 15% replacement of Cement with Metakaolin
MC20 = Modified Concrete of 20% replacement of Cement with Metakaolin
FC 05 = Modified Concrete of 5% replacement of Cement with Fly ash
FC10 = Modified Concrete of 10% replacement of Cement with Fly ash
FC 15 = Modified Concrete of 15% replacement of Cement with Fly ash
FC20 = Modified Concrete of 20% replacement of Cement with Fly ash
FMC = Combined Fly ash (10%) and Metakaolin (15%) concrete

III. LABORATORY TESTS

Workability

Slump Test

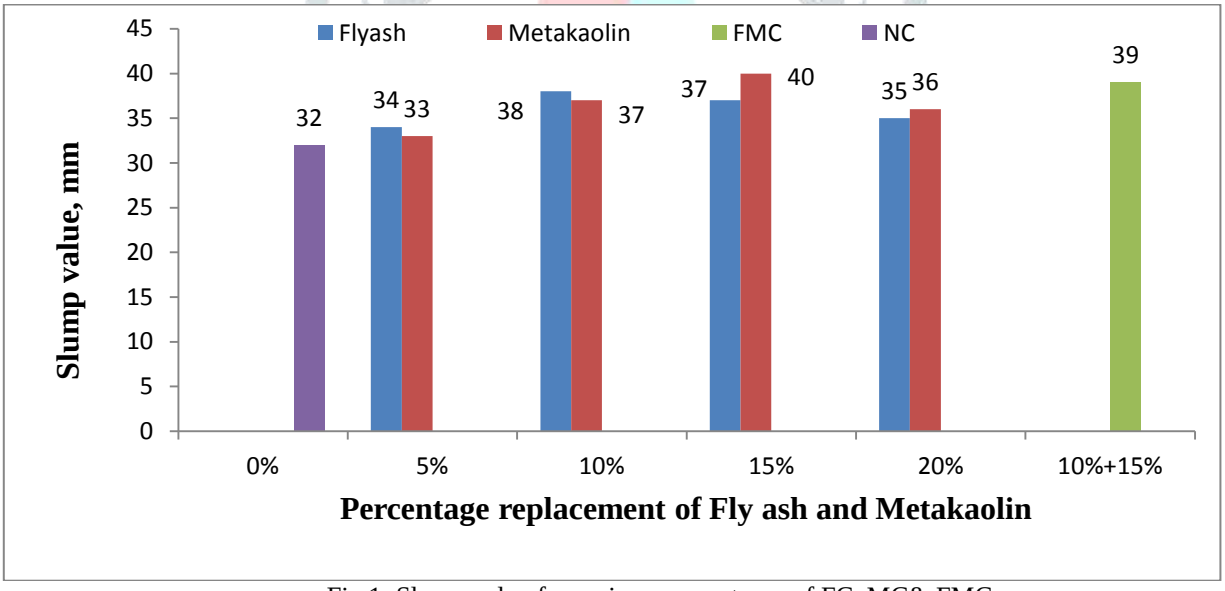

Fig 1: Slump value for various percentages of FC, MC& FMC

Compaction Factor (CF) Test

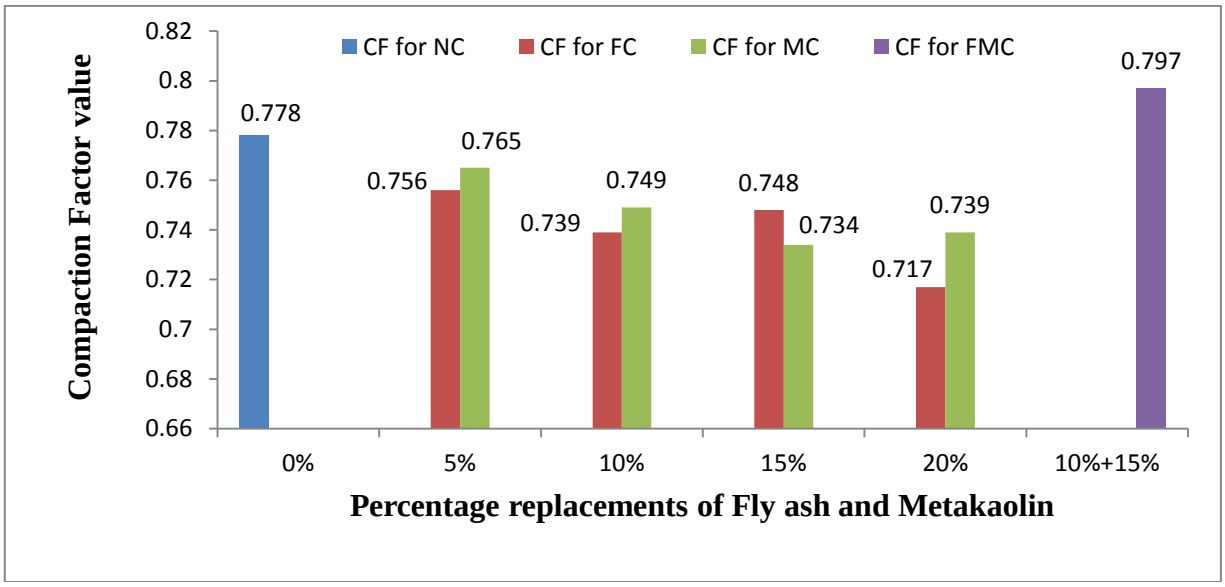

Fig 2: Compaction factor for various percentages of Fly ash

IV. RESULTS AND DISCUSSION

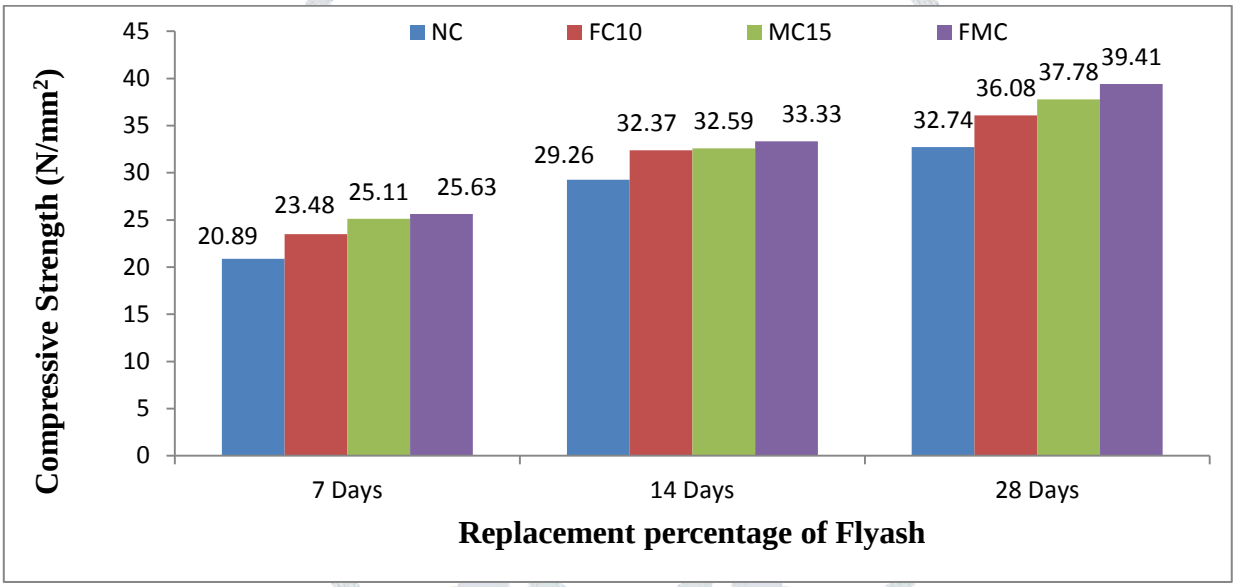

Fig 3: Compressive strength of NC, FC10, MC15, FMC for 7, 14, 28 days of water curing

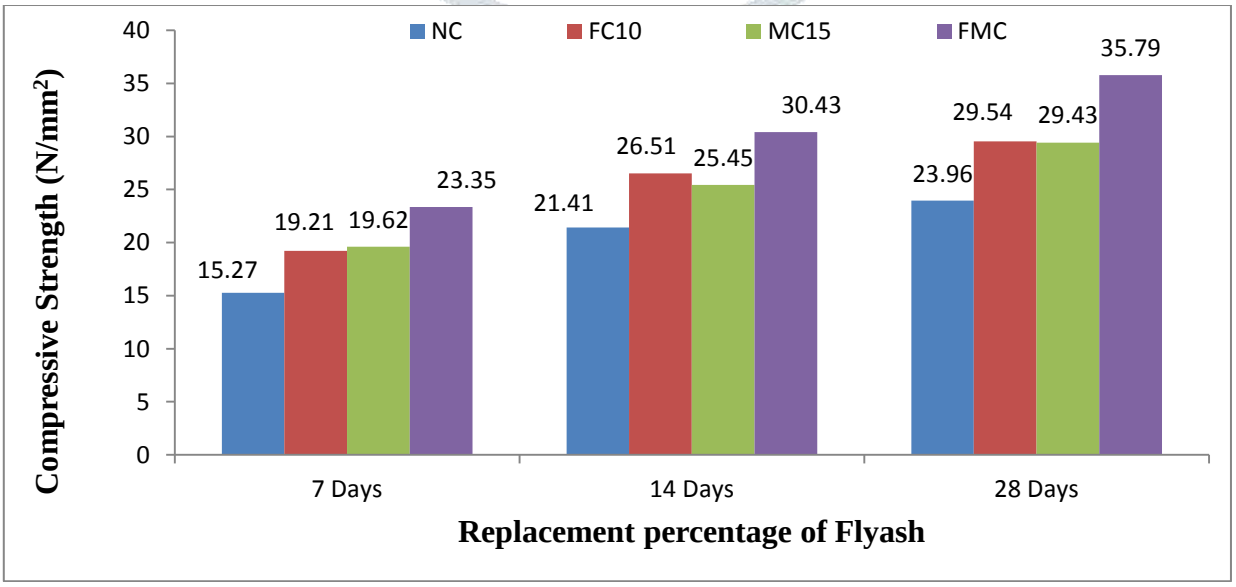

Fig 4: Compressive strength of NC, FC10, MC15, FMC for 7, 14, 28 days of 3% HCL acid curing

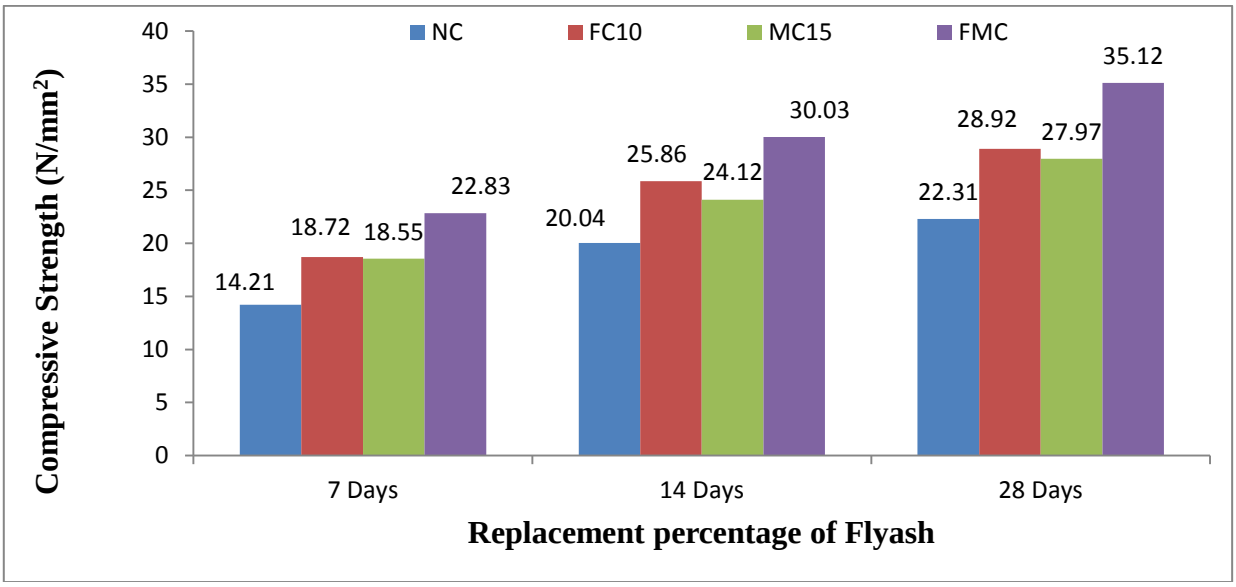

Fig 5: Compressive strength of NC, FC10, MC15, FMC for 7, 14, 28 days of 5% HCL acid curing

V. CONCLUSION

The following conclusions are drawn based on the laboratory studies carried out in this investigation.

- In compressive strength test results it shows that when compare to normal concrete the strength increases in Fly ash replaced, Metakaolin replaced and combined Fly ash - Metakaolin replaced concrete for 7, 14 and 28 days of water and HCL acid curing.
- The strength is optimum in FC10 and MC15 specimens. Thus we have to utilize Fly ash 10% and Metakaolin 15% by replacing cement in M25 grade of concrete to prepare new mix.
- In water curing, the compressive strength is increased by 10% for FC10, 15% for MC15 and 20% for FMC.
- In 3% HCL acid curing, the compressive strength is decreased by 27% for NC, 18% for FC10, 22% for MC15 and 9% for FMC.
- In 5% HCL acid curing, the compressive strength is decreased by 32% for NC, 20% for FC10, 26% for MC15 and 11% for FMC.
- The compressive strength of FMC is increased by 49% for 3% acid and 57% for 5% acid curing when compared with nominal mix in 3% and 5% acid curing.
- Thus from above results it shows, FMC is superior to all other mixes.
- The results encourage the use of combined Fly ash and Metakaolin, as pozzolanic material for partial cement replacement to reduce 25% of cement content in concrete.
- The utilization of admixtures like Fly ash and Metakaolin in concrete can compensate for environmental, technical and economic issues caused by the production of concrete.

VI. ACKNOWLEDGMENT

I wishes to place on record my sincere gratitude and indebtedness to my supervisor G S V KARUNA SRI, Assistant Professor, Department of Civil Engineering, B V C Engineering College, Odalarevu. His active supervision and guidance at every stage of my thesis work has been the cause of my success.

I am very much thankful to Dr D S V PRASAD, Professor and HOD, Department of Civil engineering, Principal, B V C Engineering College, Odalarevu. His constant encouragement and support has been the cause of my success, in completing this thesis in the college.

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