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Compressive strength of M40 and M50 grade concrete using metakaolin as admixture

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ABSTRACT- *In this research program, high volume ultra-fine fly ash concrete mixes produced with OPC 53 grade cement for higher grade M40 and M50. Initially control mix was produced with 100 % OPC cement. Further cement content was reduced by ultra-fine fly ash and Metakaolin and properties were found. The Metakaolin were used in, 10%, 15% and 20 % to enhance the concrete properties and. In such a way overall cement content was reduced up to 60 %. Replacement of cement by UFFA with Metakaolin results in more improved and economical concrete.*

Keywords - Ultra-fine fly ash, metakaolin, ordinary portland cement, concrete, compressive strength

INTRODUCTION

Christy et al. [1] investigated the effect of class-F fly ash for partial replacement of cement and fine aggregate in cement mortar for three different ratios 1:3, 1:4.5 and 1:6. Result showed increase in compressive strength for cement replacement for 1:3 and 1:4.5 mortars and for sand replacement to 1:6 mortar. **Satish H. Sathawane** et al. [2] conducted experimental study to investigate combined effect rice husk ash and fly ash for cement replacement up to 30 %. Result shows that compressive strength increases by 30.15% in compared with targeted strength and reduces by 8.73% compared with control concrete. **Guoqiang Xu** et al. [3] investigated the influence of combined admixture of super-fine lime stone powder and low quality fly ash on mortar. Test result indicated that the mortar fluidity increases with increase in the super-fine stone powder. The maximum flexural strength and compressive strength was found 9.8 MPa and 42.2 MPa respectively with 33.3% of limestone powder. **Ravande Kishore** al. [4] conducted experimental study to investigate the mechanical properties of high strength concrete by replacing ordinary portland cement by 5%, 10% and 15% Rice Husk Ash for grade M40 and M50 The optimum replacement of rice husk ash found to be 10% in both the grades of the concrete**. Papayianniet** al. [5] produced high-strength using high volumes of industrial by-products in laboratory mixtures. The by-products used are high-calcium (HC) fly ash and ladle furnace (LF) slag as binders and electric arc furnace slag as aggregates. Investigation reported mixtures containing both supplementary cementitious materials and slag aggregates the produced concrete shows high-strength (>70 MPa), good abrasion resistance and fracture toughness. **Krishna Murthy N** et al. [6] designed a simple tool for SCC with high reactive metakaolin and fly ash as an admixture for cement replacement. They provide detailed steps for mix design with 29% of coarse aggregate with three cement replacement ratio 5-20%(by MK), 10-30% (by FA) and different % combination of MK+FA. Authors developed a user friendly mix design tool which is capable of calculating all quantities required in the mix design.

II OBJECTIVE OF THE STUDY

The research was aimed to investigate effect of metakaolin on 7, 28, 56 and 90 days compressive strength for grade M40 and M50

III MATERIALS AND THEIR PROPERTIES

Cement

OPC 53 grade cement of Ultra tech was used for this research program.

Natural Sand

Locally procured natural sand was used as fine aggregate in concrete. Locally available Narmada sand (zone-II) was used

Aggregate

A combination of 20mm nominal size aggregate and 10mm nominal size aggregate is used as coarse aggregate in this experimental program. Both types of coarse aggregate were locally procured.

Water

The water used was ordinary tap water from the Bhopal city.

Ultra-Fine Fly ash

Fly ash used in this study was collected from Sarni thermal power plant.

Metakaolin

Commercially available Bags of Metakaolin were used in various proportions in this study.

IV. EXPERIMENTAL PROGRAM

To conduct experimental program various trials were prepared using metakaoline and ultrafine-fly ash for grade M40, M50 and M60.

V. RESULTS AND DISCUSSION

Fig. (5.1 and 5.2) shows compressive strength of concrete containing metakaolin combined with ultra. Fine fly ash as admixture for grade M40 and M50 Respectively.

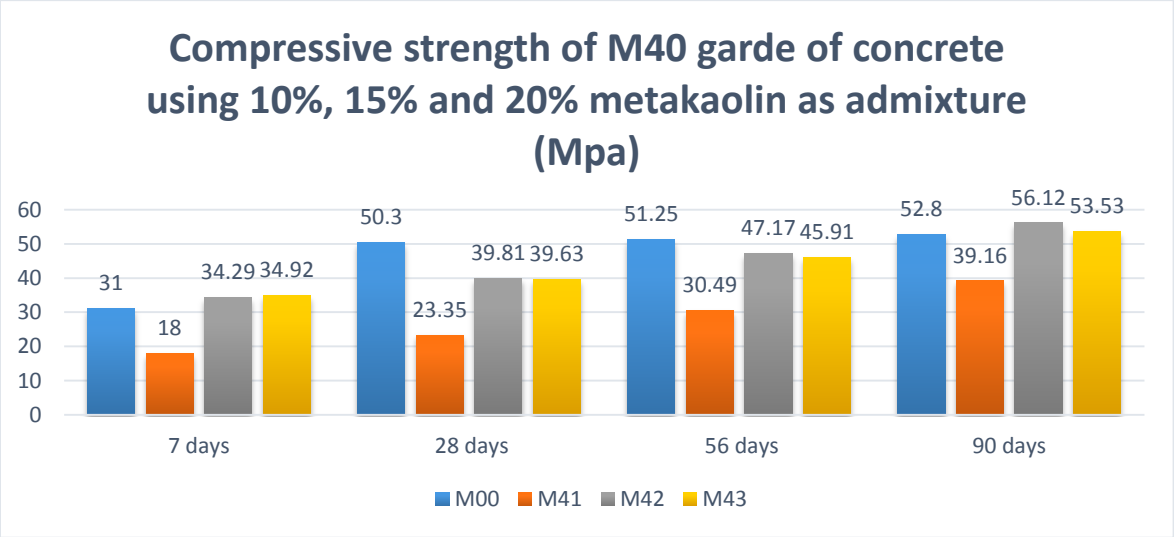

Fig. 5.1 Compressive strength at 7 days, 28 days, 56days and 90 days for grade M40 with10%,15% and 20% metakaolin

It is observed from the fig.1.1 that replacement of cement using UFFA with metakaolin results in reduction in compressive strength initially. But thereafter there is significant improvement in performance of compressive strength. Compressive

strength for control mix (M00) were found 31.00, 50.30, 51.25 and 52.80 N/mm2 at the age of 7 days, 28 days, 56 days and 90 days. It was found that compressive strength of concrete mix M41with 40%FA and 10%M was lower as compared to M42 with 45%FA and15%M and M43 with 40%FA and20%M) %. Maximum percentage of increment in compressive strength for mix M42 and M43 was found 6.28 % and 1.42 % at the age of 90 days as compared to control mix.

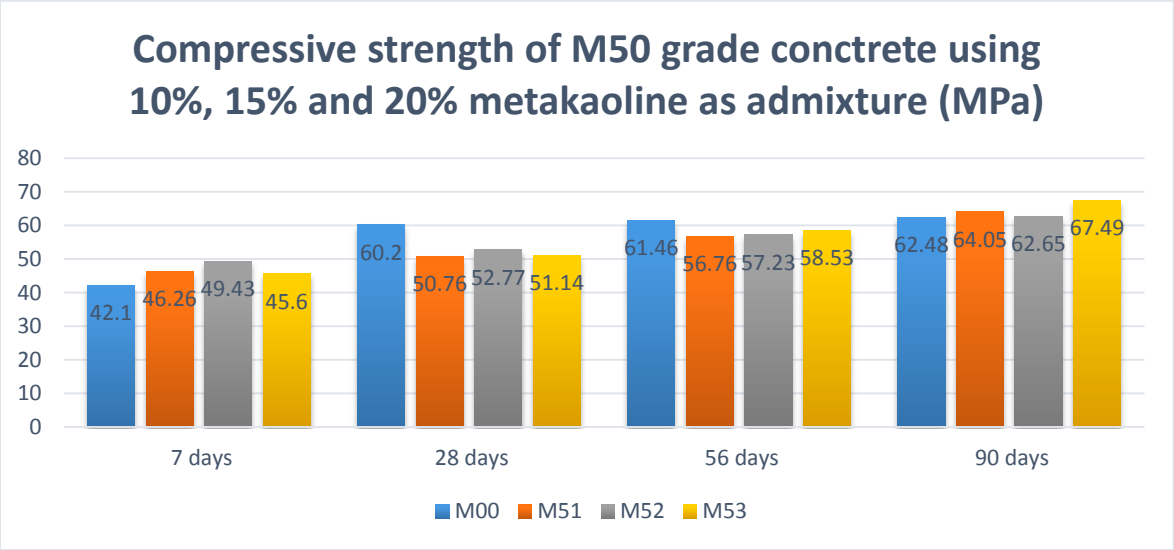

Fig. 5.2 Compressive strength at 7 days, 28 days, 56days and 90 days for grade M50 with10%,15% and 20% metakaolin

Compressive strength for control mix (M00) were found 42.10, 60.20, 61.46 and 62.48 N/mm2 at the age of 7 days, 28 days, 56 days and 90 days. It is indicated from the fig.5.2 that compressive strength at the age of 7 days and 90 days shows excellent improvement for grade 50. Maximum percentage of increment in compressive strength for mix M51, M52, and M53 were found 2.51%, 0.27% and 8.01% respectively at the age of 90 days when compared with control mix.

VI CONCLUSION

Various concrete mixes were produced in the lab using ultra-fine fly ash (40 to 45 %) in combination with metakaolin (10 %, 15% and 20%) for M40 and M50. Control mix with 100 % OPC were caste and tested in the laboratory. Combination of UFFA and Metakaolin shows excellent improvement in compressive strength for both grade. Maximum percentage of increment in compressive strength was found 6.28 % and 8.01% as compared to control mix at 90 days for M40 and M50 grade respectively. Concrete produced with combination of UFFA and Metakaolin can be used in different civil engineering structures, beam, column, foundations and other construction work. It can be also used in high-rise building, tall structure, road pavement etc.

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