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EFFECT OF METAKAOLIN ON COMPRESSIVE STRENGTH OF CONCRETE: A REVIEW

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Abstract— ***This study presents the effect of incorporating metakaolin (MK) on the mechanical and durability properties of high strength concrete for a constant water/binder ratio of 0.3. MK mixtures with cement replacement of 5, 10 and 15 % were designed for target strength and slump of 90 MPa and 100 ± 25 mm. From the results, it was observed that 10 % replacement level was the optimum level in terms of compressive strength. Beyond 10 % replacement levels, the strength was decreased but remained higher than the control mixture. Compressive strength of 106 MPa was achieved at 10 % replacement. Splitting tensile strength and elastic modulus values have also followed the same trend. In durability tests MK concretes have exhibited high resistance compared to control and the resistance increases as the MK percentage increases. This investigation has shown that the local MK has the potential to produce high strength and high performance concrete.***

Keywords— ***Metakaolin, Compressive Strength, OPC, Durability, Replacement, Compressive strength***

INTRODUCTION

Metakaolin is pozzolanic materials manufactured from selected kaolins, after refinement and calcinations under specific condition. It is a highly efficient pozzolana and reacts rapidly with the excess calcium hydroxide resulting from OPC hydration by a pozzolanic reaction, to produce calcium silicate hydrate and calcium aluminosilicate hydrates. G.Murali and P.Sruthee (2012) studied that when metakaolin is used as a partial replacement for Portland cement, tends to improve the compressive strength of concrete.

Vikas kumar and Rakesh kumar (2012) investigated the effect of silica fume and metakaolin combination on concrete. They reported that the combination of these materials the compressive strength of concrete and the workability both are improved. P. Dinakar (2013) reported on the behaviour of a metakaolin on properties of high strength concrete. High-strength concrete is typically categorized as concrete with compressive strength greater than 40 Mpa after 28 days of curing. ACI (American Concrete institute) defined "high-strength concrete as a concrete meeting special collage of performance and uniformity requirements that cannot always be accomplished routinely using conventional constituents and normal mixing, placing, and curing practice". Generally construction industry needs rapid attainment of strength so that the projects can be completed in the scheduled time. This demand leads to high strength concrete, using mineral admixture and lower water cement ratio using super plasticizer.

LITERATURE REVIEW

Pdenakar et al (2013), conducted an experimental investigation in which the modulus of elasticity is mainly related to the compressive strength of concrete. However, due to the existence of non-linear relationship between them, the increase in the modulus of elasticity is not in proportion to the increase in compressive strength. The modulus values presented indicates that the rate of increase in the modulus is lower than the rate of increase in the compressive strength. The elastic modulus (*E*) values with respect to the MK contents were given. The trend is similar to that obtained for compressive strength; here the optimum MK percentage that gives maximum *E* is at 10% .

Razzak et al (2005), conducted an experimental investigation in which the strength of a concrete mixture made with metakaolin or silica fume can be related to the strength of an OPC control mixture. This relationship is described by using a linear equation in the form of S p =α Sc + β where α and β are factors related to the pozzolanic and dilution effects of the particular pozzolan. The pozzolanic factor α and the dilution factor β can be represented by a three-parameter hyperbolic function and a quadratic function of the pozzolan content, respectively. These relationships are based on mixtures designed with up to 15% mass replacement of OPC with metakaolin and silica fume, and mixtures with w/cm from 0.27 to 0.33. The proposed model was found to have good accuracy in estimating the strength of cement concrete at age 28 days and above, where 97% of the estimated values are within ± 5% of the actual values.

Siddique et al (2005), conducted an experimental investigation on the basis of which he conducted that partial replacement of cement with MK reduces the water penetration into concrete by capillary action and also improves the resistance of concrete to sulphate attack .Concrete containing 10% and 15% MK replacement showed excellent durability to sulphate attack.

Avancha et al (2015), conducted an experimental investigation in which the compressive strength of concrete increased when cement is replaced by Metakaolin for both M20 and M40 grade of concrete. At 20% replacement of cement by Metakaolin the concrete attained maximum compressive strength for both M20 and M40 grade of concrete. The split tensile strength of concrete is increased when cement is replaced with Metakaolin .The split tensile strength is maximum at 20% of replacement. The flexural strength of concrete is also increased when the cement is replaced by Metakaolin. At 20% replacement, the flexural strength is maximum. 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.

Ashik et al (2017), conducted an experimental investigation in which he concluded that 10% Metakaolin can be taken as the optimum dosage, which can be utilized by using super plasticizer mixed as a partial replacement to cement for giving maximum possible compressive strength at any stage. The optimum percentage of Metakaolin is again 10% in the case of Split Tensile Strength, Flexural Strength and Modulus of Elasticity. Metakaolin addition to concrete leads to decrease in workability which has to be compensated by adding Super plasticizers.

Subamma et al (2016), conducted an experimental investigation by introducing steel fibres in concrete which increased cube compressive strength and split tensile strength values. For 7 and 28 days the cube compressive strength was increased by 30% to 60%. For composite fibre (steel and polypropylene fibres) the strength was increased by 3% to 22% for 7 and 28 days when compared to normal concrete. The ductility properties of concrete specimen were also increased by use of fibres.

Pendyala et al (2016) conducted an experimental investigation in which both the physical and chemical properties of metakaolin and cement area unit in compliance with the quality. Cement replacement up with Metakaolin results in increase in compressive strength for M-35 grade of concrete. There is also decrease in compressive strength for three, seven and twenty eight days of solidifying amount.

- The optimum dose of metakaolin for achieving higher
- Metakaolin will increase the compressive strength of

CONCLUSIONS

Based on the study done it can be concluded that when metakaolin replaces cement for both grades i.e M20 and M40 of concrete the compressive strength increases by certain amount and its 10% of replacement not only increases its split tensile strength but its flexural strength and modulus of elasticity as well. But its addition in concrete can lead to decrease in its workability. In order to get over this disadvantage addition of super plasticizer is adopted. At 10% replacement of metakaolin the high strength concrete shows better strength than that of conventional concrete. The sole reason for the strength of concrete is that metakaolin accelerates the hydration of cement and forms C-S-H gel. Substitution of MK has shown to increase the chemical resistance of such mortars over those made with plain Portland cement. Mortars were relatively little affected by 1% hydrochloric acid, 1% sulphuric acid and 1% nitric acid environments, but those mortars made from all three series showed poor resistance to higher acid concentrations.

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