EXPERIMENTAL STUDY ON HIGH STRENGTH CONCRETE FOR DURABILITY USING METAKAOLIN, COPPER SLAG AND SILICA FUME.

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ABSTRACT

The aim of present investigation is to evaluate the Durability of High Strength Concrete (HSC) containing Metakaolin (MK) as a partially replacement of cement, Copper Slag (CS) as a partially replacement of fine aggregate and Silica Fume (SF) as a mineral admixture. The experimental study will be divided into three Series, namely Series-1 MK-10%, CS-10% based mixers with Coarse Aggregate 60%, Series-2 MK-15%, CS-15% based mixers with Coarse Aggregate 50%, Series-3 MK-20%, CS-20% based mixers with Coarse Aggregate 40%. The Fine aggregate is 10% for all three Series and water binder ratio is 0.40,0.45,0.48 for all three Series. The Mix design for M60, M65 and M70 is done for these three Series. The changes in durability will investigate by the absorption and Volume of Permeable Voids, Sorptivity Test, Initial Surface Absorption Test (ISAT). Performs results shows that Metakaolin as a partially replacement of cement to enhance the durability performance, silica fume are the most abundantly used pozzolanic materials because of its potential to consume portlandite during the process of hydration for improves durability, copper slag the strength and durability of partial replaced concrete.to evaluate the strength and durability the various test were conducted. these resulted that the concrete strength is increased with addition of copper slag with concrete. focused on the durability aspects such as sorptivity, sulphate attack and advanced techniques such as rapid chloride ion penetration test to assess the chloride ion penetration into the concrete.

Keyword : - *Copper Slag, Silica Fume, Metakaolin, Durability.*

1. INTRODUCTION

High Strength Concrete (HSC) is specially used interaction of high-rise structures over 30 stories. HSC has been used in components such as columns (especially on lower floors where the loads will be greatest), shear walls and foundations. HSC has been used in Highway bridge, allowed for the reduction of column and beam dimensions, lower dead loads results reducing foundation design as owner benefits economically. HSC is for reducing weight, creep or the permeability issues, for improving the durability of the structures. HSC used for special architectural requirements were elements carry smaller loads. Also used in precast concrete elements. Aim to this research work is Experimental study on high strength concrete for durability using Metakaolin (MK), Copper Slag (CS) and Silica Fume (SF). Based on result we found that these combination for material gives good results on durability of concrete in long time.

Metakaolin

Use of Metakaolin in concrete decreases the chloride permeability. used to make a high strength concrete and which simultaneously increases the durability of the concrete. It also gives better resistance against the attack of

sulphates and other aggressive substances such as mineral and organic acid. Use of copper slag the strength and durability of HSC were generally improved with the increase of copper slag content in the concrete mixture. Use of

Silica Fume

silica fume as a mineral admixture to improve its properties, in particular its compressive strength, bond strength, and abrasion resistance.

The use of the materials with concrete to increase durability of concrete. The various experimental study is done with the different combinations with other researchers but these combinations with MK, SF, CS is shows good results for the durability and compressive strength, abrasion resistance for the High Strength concrete

Copper Slag

Copper slag (CS) is an industrial by-product produced from manufacturing copper (Sp. Gravity 4.12) substitute as fine aggregate (sand, Sp. Gravity 2.6) improves HSC strength and durability of HSC

The Mix design is prepared for M60, M65 and M70 as per IS code 10262-2019. For each Mix design nine cubes were casted and tested to measure compressive strength of concrete at 7 days, 14 days and for 28 days. The results shows that compressive stress will be increased. The slump workability test is done and result shows that workability will be improved if water binder ratio is maintained. For workability test measured with w/c 0.40,0.45.0.50. A large number of cube specimens were casted and subjected to normal curing at atmospheric temperature after demolding

High Strength Concrete is recognized as concrete with a 28-day cube/cylinder compressive strength greater than 60 Mpa to 80 Mpa (as per IS 456-. The compressive strength was determined at various ages up to 28 days. 2000 Cl-6.1 Table-2) have been used in different applications.

Experiments carried out in aspect to durability, first these materials combination is checked for the compression test for different days that is 7 days, 14 days, 28 days. Workability is measured through slump test and compaction test and slump test values for the M60: 35 mm, M65: 40 mm, M70: 43 mm. For Durability rest is on Acid Attacked, Acceleration corrosion test and softvity test.

2. DETAILS EXPERIMENTAL

Materials and Procedures Pozzolanic Binder used with cement is Metakaolin, It is combustion use in production of ceramics, its physical properties shown in Table-1 and its chemical properties shown in Table-2. The Copper Slag is partially replacement of sand which improve compressive strength, CS its physical properties shown in Table-3 and its chemical properties shown in Table-4. Silica Fume is produced during manufacturing of silicon by electric furnace. its physical properties shown in Table-5 and its chemical properties shown in Table-6.

Table1: Physical Properties of Metakaolin

Physical Properties	Metakaolin
Specific Gravity	2.40 – 2.60
Color	Off white
Physical form	Powder
Average plastic size	<2.5 µm
Brightness	80-82 Hunter L
Specific surface	8-15 m^2/g

Table 2: Chemical Properties of Metakaolin

Chemical constitution	Metakaolin
SIO_2	50-60%
Al_2O_3	30-40%
Fe_2O_3	0.5-5%
CaO	0-5%
K_2O	0.5-1.5%
Na_2O	0-1%
MgO	0-2%
TIO_2	1-2%
P_2O_5	0.03%

Table 3: Chemical Properties of Copper Slag

Chemical constitution	Copper Slag
Fe_2O_3	53-60%
SIO_2	32-37%
Al_2O_3	3-6%
CaO	1-3%
MgO	1-2%

Table 3: Chemical Properties of Silica Fume

Chemical constitution	Silica fume
SIO_2	92-94%
Fe_2O_3	0.1-0.5%
CaO	0.1-0.15%
Al_2O_3	0.2-0.3%
MgO	0.1-0.2%

Compression Test

For each mix of concrete, nine concrete cube specimens were cast each of size 100mm x 100mm x 100mm. To obtain a homogeneous mix, aggregates were mixed and binders (cement, Metakaolin, FA, Copper Slag, CA and

Silica Fume) were added to the system. After remixing, was added to the dry mix. Finally, Water added as a binder with mixture. In the fresh concrete slump cone test was performed to ensure the workability. Cube specimens were used to determine the compressive strength. The cubes were cast in three equal layers and each layer was compacted by After casting, the molded specimens were left in the casting room at 23 ± 1.7°C for 24 h. They were then demolded and cured. The cube specimens were cured for different ages like 7, 14, 28 to determine the compressive strength at these ages. Three number of specimens were tested and average was considered for analysis.

The results shows that compression test on M60, M65, M70 grade of concrete having good results. Compressive value is increased with % increased with MK, CS, SF. Results shows as bellow

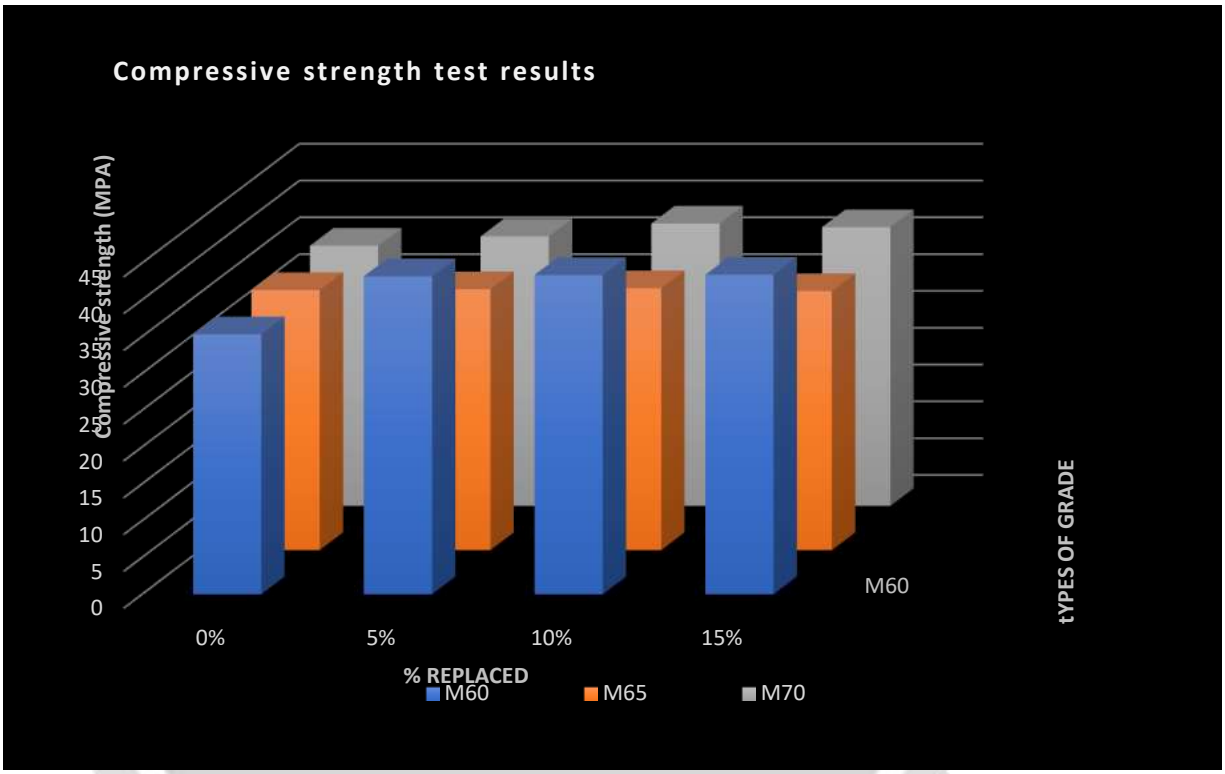

Chart -1: Compressive Strength Test Results

Acid Attack Test

Acid attack test plays an essential role in order to check durability of concrete against sever or harsh environmental effect. Acid penetration in concrete structure may leads to early corrosion of reinforcement which ultimately leads to complete failure of structure. Hence it is therefore become essential to check resistance of concrete against harsh chemical. For these concrete curing is done with normal curing and acid curing.

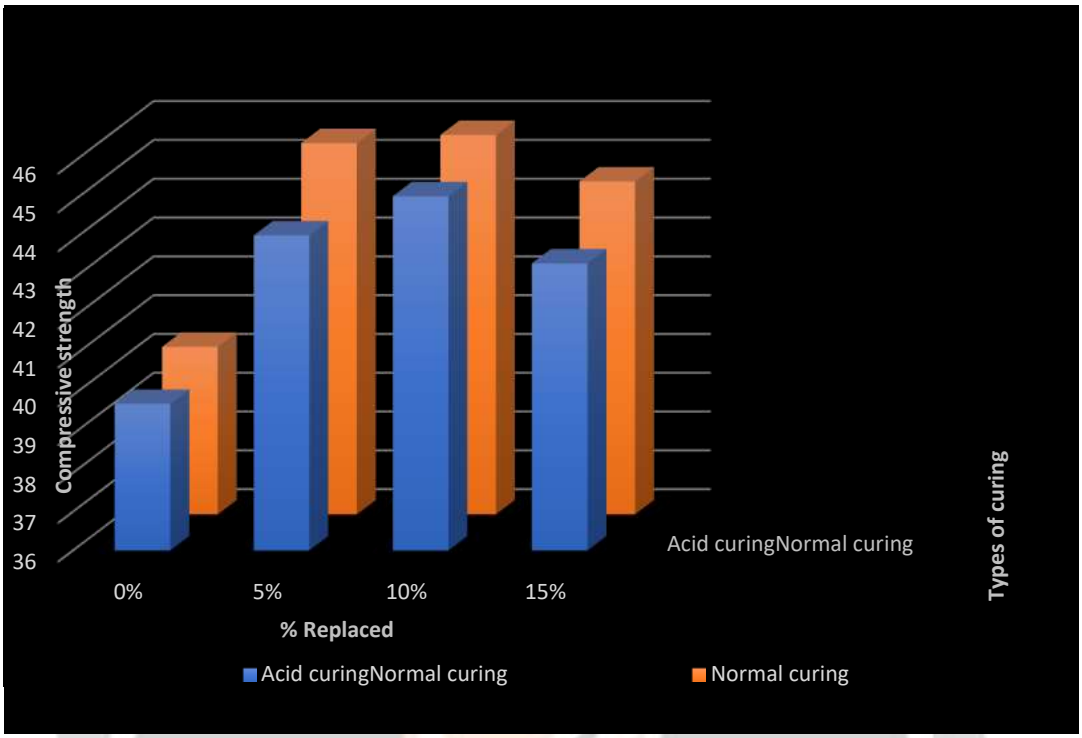

Chart -2: **Acid Attack Test**

3. CONCLUSIONS

The Results of compression strength of the concrete increases when the percentage of replacement up to 15%, then after compressive strength decreases. The acid attack test result show that it is good to resist for acid and corrosion relative to normal concrete.

From the experimental studied and major conclusions are as follows:

1. The incorporation of metakaolin, copper slag and silica fume is excellent improvement in compressive strength and durability.
2. The presence of silica fume as a mineral admixture shows excellent results to enhance mechanical and durability properties of concrete.
3. Use of copper slag as a partially replacement of fine aggregate gives good result on durability.

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