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"STUDY ON STRENGTH OF CONCRETE BY PARTIALLY REPLACEMENT OF CEMENT WITH METAKAOLIN, CALCIUM CARBIDE RESIDUE (CCR) AND FLY ASH"

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Abstract - *In the present work it has been explored to use the blended mix of Meta kaolin, Calcium Carbide Residue and Fly Ash by partial replacement of cement with appropriate % in concrete to develop concrete. Present study evaluates strength and durability parameters of the concrete containing the combination of above-mentioned materials. For durability analysis 5 % H_2SO_4 and 5 % HCL solutions prepared and sample were immersed in acid solution for 28 days, then % change loss in compressive strength with reference to control mix was observed. The experimental program consists of preparing concrete mixes with Meta kaolin as a partial replacement of cement (5%, 10% and15%) and similarly CCR and Fly ash also used as a partial replacement Cement with the same proportions. The performance of the concrete mixes for compressive strength at 7 days and 28 days, compressive strength after 28 days acid curing test were investigated.*

1. INTRODUCTION

The main aim of this study is to investigate combined use of Meta kaolin, Calcium carbide residue and fly ash in concrete by partial replacement of cement. Grade of concrete for the study has been chosen as M 30, as it offers good number of applications in the construction industry, ranging from pavement to buildings. Initially the study is done on the individual effects for all materials on concrete by replacing cement and then searching the optimum percentage replacement level for Meta kaolin, Calcium carbide residue and fly ash to investigate the combined effect of these replacing materials on blended concrete.

1.1 Literature Review

Karthiga et all (2018) have investigated the strength parameters for M35 grade of concrete. The experimental study is basically a combination of GGBS and CCR replacement by cement and got the test results for 28 days and following conclusions were made –

- 15% CCR and 20% GGBS combination provide better results, almost equal to the control mix.
- With the higher replacement ratio of CCR in the mix , resulting decrease in strength.

Saurav and Ashok Kumar Gupta (2014) have investigated on experimental study of strength relationship of concrete cube and concrete cylinder using ultrafine slag (Ground granulated blast-furnace slag) and have shown the comparison between cubical strength and cylindrical strength of normal concrete and with partial replacement of cement with ultra fine slag (Ground-granulated blast-furnace slag) and varies at 3%, 5%, 7%, 10%, 13%, 15% & 18.

- It was observed that higher compressive cube strength over compressive cylinder strength at 13% replacement of cement with ultra fine slag (GGBS) attained.

Aiswarya and Navaneetha (2016) have investigated the compressive strength, split tensile strength and flexural strength for the M 30 grade of concrete. In this study it used fly ash as partial replacement of cement and the replacement level was 5,10 and 15 percent. Similarly fine aggregated replaced by steel slag 30% and also add 1% glass fiber, then above mentioned test carried out for 7 and 28 days.

The following conclusion are reported –

- Mechanical properties of concrete increased by 10% comparative to control mix with 30% steel slag.
- Compressive and tensile strength increased with the addition of above mentioned replacing materials.

Rahul et. Al. (2015) have investigated on fresh and hardened properties of M-20 grade concrete with fly ash and steel fibres. Fly ash was used as a partial replacement of cement (5%, 10%, 15%, 20%, 25% by cement weight) with the addition of 0.5%, 1%, 1.5%, 2% by weight of cement and following conclusions are made on different strength parameters –

- With the addition of fly ash from 5 to 25 percent there was a reduction of compressive strength at the age of 28 days.
- Workability of mix increased with the fly ash.

- Optimum compressive and tensile strength reported at 1.5% replacement of steel fibers by weight of cement.

2. RAW MATERIALS

Cement: In present experimental study Ordinary Portland Cement of 43 Grade (Ambuja Cement) conforming to IS: 8112 - 1989 was used. The Specific gravity of cement was 3.15.

Ground-granulated blast-furnace slag (GGBS) - GGBS is obtained by quenching molten iron slag from a blast furnace in water or stream, to produce a glassy, granular product that is then dried and ground into a fine powder. GGBS is used to make durable concrete structures in combination with ordinary Portland cement or other pozzolanic materials. GGBS has been widely used in Europe, and increasingly in the United States and in Asia for its superiority in concrete durability, extending the life span of buildings from fifty to a hundred years. GGBS reacts like Portland cement when in contact with water.

Calcium Carbide Residue: - CCR is a by-product obtained from the acetylene gas (C_2H_2) Acetylene (C_2H_2) gas is widely used for welding in construction industries, while the by-product (CCR) is often dumped as waste in landfills and thus poses a threat to the environment. For example, in China, as much as 2500 tons of CCR is generated annually. CCR is highly alkaline in nature and it is mainly composed of calcium hydroxide with a mass fraction of above 92%

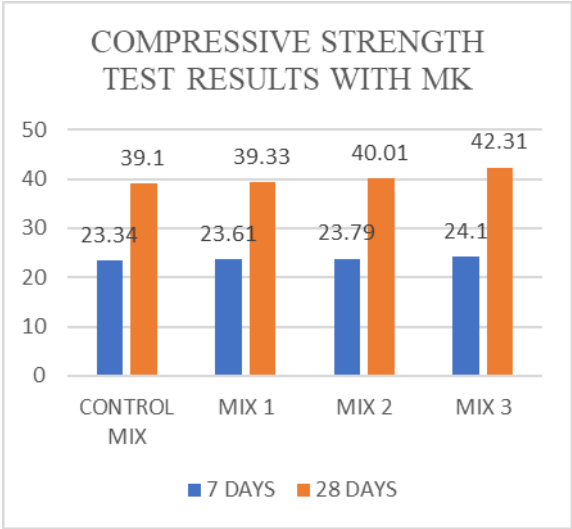
Fly ash – Fly ash is a wastage product basically generated from the combustion of coal. On behalf of its physical and chemical properties it is widely used in construction activities now days. Due to higher fineness and glassy spherical particles it also used as a partial replacing material for cement.

Super Plasticizer

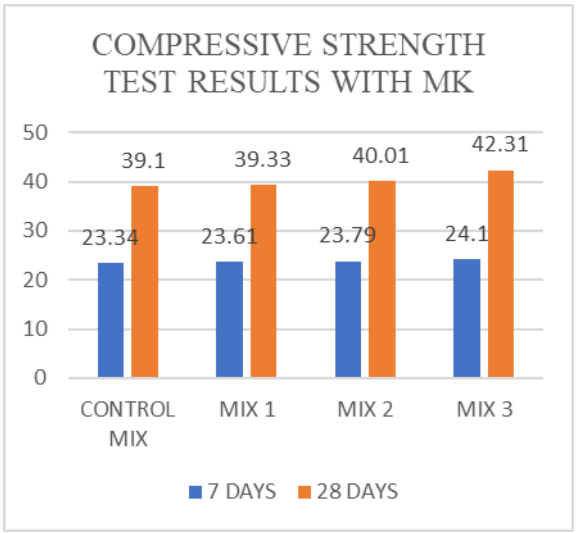
Super plasticizer (Sika-Plastiment) was used @ 1% by weight of cement. Specific gravity of Sika-Plastiment is 1.12 (as per manufacturer).

3. TEST RESULTS

The Compressive Strength test results of control mix and concrete prepared with 5%, 10% and 15% replacement of cement by Meta kaolin at the age of 7 and 28 days are presented-



The durability test results are shown in table below. The results represented in table specifically for the specimen which is prepared with Meta kaolin as a partial replacement of cement is cured for 28 days in the solution of 5% H_2SO_4 concentration and 5% HCL concentration. The strength affected with the acids represented.



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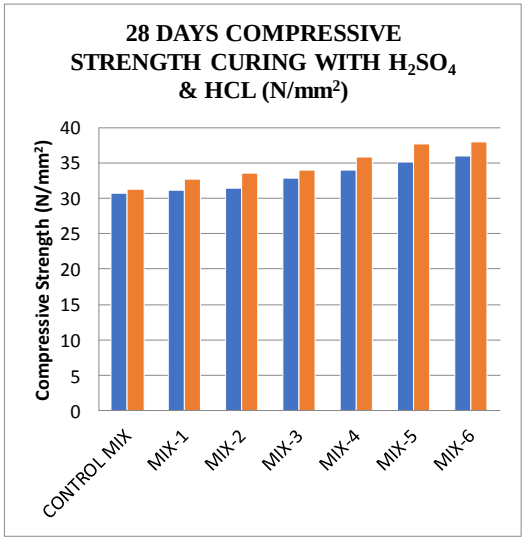
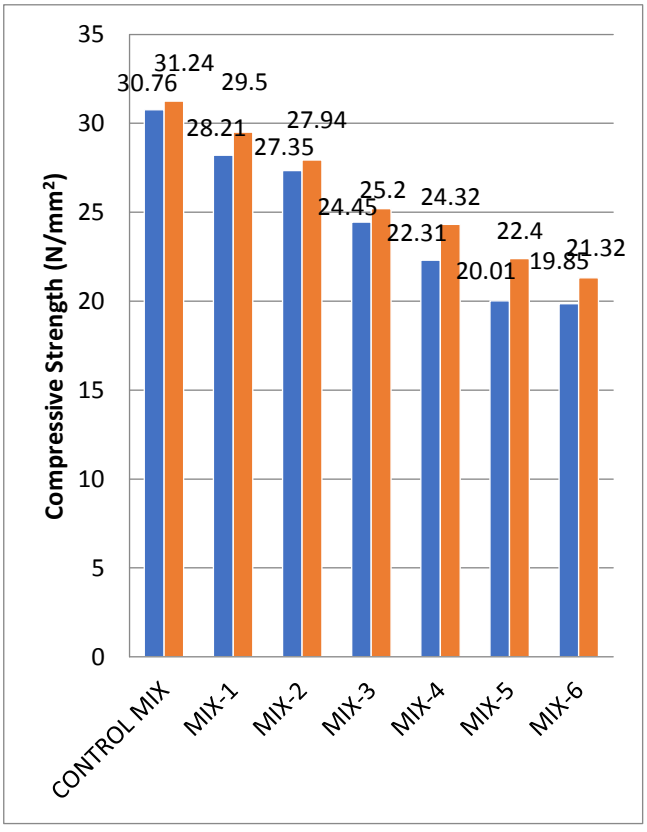
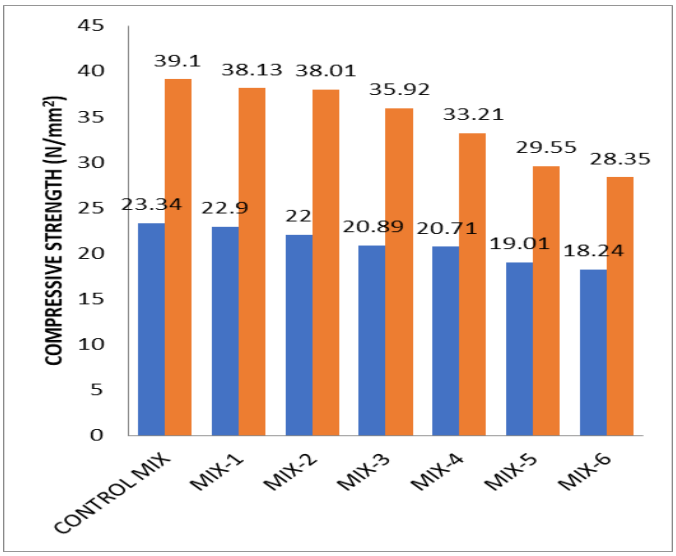


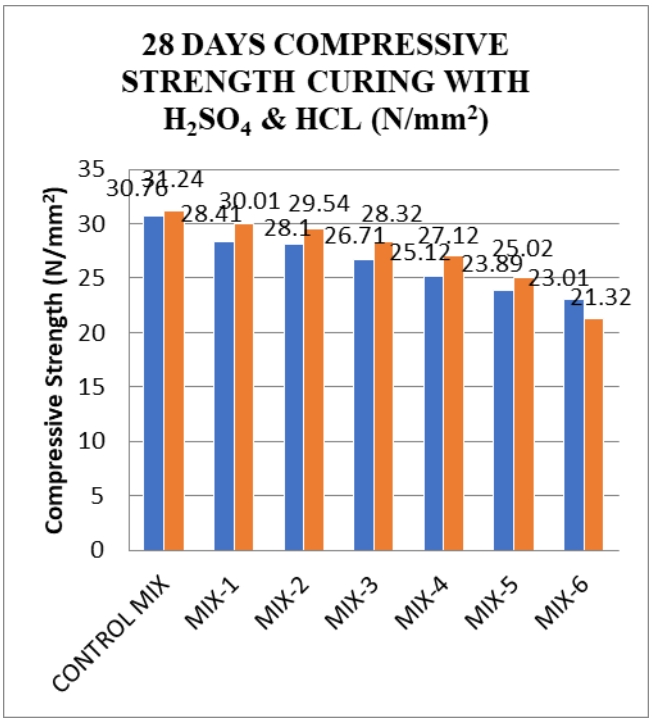
The Compressive Strength test results of control mix and concrete prepared with 5%, 10%, 15%, 20%, 25% and 30% replacement of cement by Calcium carbide residue at the age of 28 days curing in solution of 5% H_2SO_4 and 5% HCL are presented



The Compressive Strength test results of control mix and concrete prepared with 5%, 10%, 15%, 20%, 25% and 30% replacement of cement by fly ash at the age of 7 and 28 days are presented



For durability studies on the specimen, the specimen which is prepared with fly ash as a partial replacement of cement is cured for 28 days in the solution of 5% H_2SO_4 concentration and 5% HCL concentration. The normality of the solution checked time to time. The compressive strength of cubes in curing of H_2SO_4 and HCL or can say exposed to acid are tested and prepared the results which is shown below



3. CONCLUSIONS

Compressive Strength

GGBS : In the mixes with GGBS (varies from 5% to 30% as a cement replacement by weight) the compressive strength gives satisfactory results for all the ages (7 and 28 days) Compressive strength for the mix with 30% replacement level is around 7% more than the compressive strength of control mix.

CCR: Compressive strength of concrete mix for 5% replacement level with CCR was approximately same to the target mean strength of control mix. For more than 5% replacement of CCR compressive strength of mix start decreasing and for 30 % replacement it was reduced by 45% in comparison of control mix at 28 days.

Fly Ash: With the replacement of Fly ash (varies from 5% to 30% as a cement replacement by weight) the compressive strength reduces for the ages (7 and 28 days) but with 5% to 10% replacement level the reduction in strength noticed 1% to 2.5% comparing to Control mix, as considering the economical aspects 5% to 10% replacement of cement by fly ash can be acceptable.

The compressive strength of concrete prepared with Meta kaolin, CCR and Fly ash are less affected with the solution of 5% HCL compared to the solution of 5% H_2SO_4 however all the strength are lesser than the strength achieved by water curing for 28 days.

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