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Utilisation Of Metakaolin and Copper Slag on Strength Characteristics of Concrete

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ABSTRACT

Production of the cement has greatly increased which results various of problems in environment as it produces the CO2 gas. Environmental concerns, ensuing from the high level expense and carbon dioxide emission associated with cement manufacture have brought about the concern to reduce cement consumption through the use of alternate materials. Materials like Metakaolin, fly ash and other ash powders have good pozzolanic behavior and are suitable material for the production of concrete which is getting popularity because of its good results on various properties of concrete. In this study mechanical properties of Metakaolin is used as a supplementary cementitious material are examined. Metakaolin can also use as a binder with the partial replacement of cement which take some part of reaction at the time of hydration reaction. Cement replacement by metakaolin in the range 5% to 25% with an interval of 5% and a waste byproduct copper slag of 30% constant rate is used and characterized along with the compression strength and flexural strength tests .

Key Words : CS (Copper Slag ,FA (Fine Aggregate).

INTRODUCTION

Metakaolin is one of the good clay products developed in recent years. It is produced by thermal treatment of kaolin under some controlled conditions and it can be used as a concrete constituent, replacing part of the cement content since it has pozzolanic properties. The use of metakaolin as a partial cement replacement material in mortar and concrete has been studied widely in recent years. Despite of the recent studies, there are still many unknowns with the use of metakaolin. Study is needed to determine the contribution of metakaolin to the performance of hardened concrete. There are great concerns on the strength and durability of metakaolin-concrete when used as construction materials in the construction industries. If it is proven that the concrete is durable and strong, this will lead to the use of metakaolin to replace part of the cement. Metakaolin is not a by-product which means its engineering values are well controlled. Copper slag is a by-product obtained during the matte smelting and refining of copper. Copper slag used in this work was brought from Universal Abrasives & Minerals (P) Ltd. It produces Copper slag during the manufacture of copper metal. Currently, about 2600 tons of Copper slag is produced per day and a total accumulation of around 1.5 million tons Copper slag, which is the waste material produced in the extraction process of copper metal in refinery plants, has low cost, and its application as a fine aggregate in concrete production reaps many environmental benefits, such as waste recycling, and also disposal problems. By analysing the mechanical properties of concrete using metakaolin and copper slag as a partial replacements has found to be effective and advantageous to the society as it can solve the scarcity of construction material to some extent.

MATERIAL USED

I. Cement: It is always desirable to use the best cement in constructions. Therefore, the properties of a cement must be investigated The cement used was 53 grade Ordinary Portland Cement with Specific Gravity 3.15is used .

II. Fine aggregate: Locally available sand confirming to zone II with specific gravity 2.66 was usedThe aggregate size is lesser than 4.75 mm is considered as fine aggregate. The sand particles should be free from any clay or inorganic materials and found to be hard and durable. It was stored in open space free from dust and water. Sand confirming IS 383 1970 comes under zone II is used.

III. Coarse aggregate: Coarse aggregate used was 20 mm and less size and specific gravity 2.70 It can be found from original bed rocks. Coarse aggregate are available in different shape like rounded, Irregular or partly rounded, Angular, Flaky. It should be free from any organic impurities and the dirt content was negligible.

IV. Metakaolin: In this experiments metakaolin having particle size less than 90 micron was used.

Fig 1 showing the image of metakaolin

Properties	Obtained values
Bulk density (g/cm^3)	0.3 5
Physical form	Powder
Color	Off-White
GE Brightness	80

Table 1 showing properties of Metakaolin

V Copper Slag: Copper slag is widely used as an abrasive media to remove rust, old coating and other impurities in dry abrasive blasting due to its high hardness (6-7 Mohs), high density (2.8-3.8 g/cm3) and low free silica content

Fig 2showing the image of copper slag :

Table 1 showing properties of Copper Slag

Properties	Obtained values
Bulk density (g/cm^3)	1.89
Physical form	Greasy
Color	Black
Hardnesss	6.5
Specific Gravity	2.8
Water Absorption	0.4%

EXPERIMENTAL WORK AND TEST

Mix Design: Mix design carried out for M20 grade of concrete by IS 10262:2009, resulting to a mix proportion of 1:1.45:2.8 with water cement ratio of 0.45. The replacement of cement by Metakaolin was 5% to 25% at increment of 5% each and addition of copper slag with a replacement of sand by 20% constant .

Compressive and Flexure test: Concrete prepared with different percentage replacement of cement by metakaolin at increment of 5% each up to 25% and 20% of copper slag was cured under normal condition and were tested for 28 days for determining the compressive and flexural strength and compared with the results of conventional concrete.

Compressive Strength Test Results

The table showing the results of test conducted on hardened concrete with 0-25% metakaolin for 28 days curing. From table 3, results shows that the compressive strength increases with the increase in Percentage of metakaolin upto 20% and with a costant rate of 20% of copper slag .

Table 3: Results of Compressive Strength of concrete with partial replacement of cement by metakaolin and copper slag

Grade of Concrete	Mix Proportion	W/C Ratio	% replacement of CS with FA	% replacement of Metakaolin with Cement	28 days Compression Strength (MPa)
M20	1:1.45:2.8	0.45	20	0	28.00
M20	1:1.45:2.8	0.45	20	5	30.50
M20	1:1.45:2.8	0.45	20	0	32.02
M20	1:1.45:2.8	0.45	20	15	34.90
M20	1:1.45:2.8	0.45	20	20	36.85
M20	1:1.45:2.8	0.45	20	25	33.50
M20	1:1.45:2.8	0.45	20	30	32.00

Flexural strength Test Results

Table 4 showing the variation of results for flexural strength of concrete with cement replacement by metakaolin for 28 days. It is clear that flexural strength of concrete with 20% cement replacement by metakaolin showed a higher value compared to all other proportions mentioned below for 28 days curing and a drastic decrease in the flexural strength with the increase in % of metakaolin beyond 20% with constant rate of 20% copper Slag .

Table 4: Results of Flexural Strength of concrete with partial replacement of cement by metakaolin and copper slag

Grade of Concrete	Mix Proportion	W/C Ratio	% replacement of CS with FA	% replacement of Metakaolin with Cement	28 days Compression Strength (MPa)
M20	1:1.45:2.8	0.45	20	0	3.2
M20	1:1.45:2.8	0.45	20	5	3.35
M20	1:1.45:2.8	0.45	20	0	3.42
M20	1:1.45:2.8	0.45	20	15	3.49
M20	1:1.45:2.8	0.45	20	20	3.55
M20	1:1.45:2.8	0.45	20	25	3.3
M20	1:1.45:2.8	0.45	20	30	3.2

Conclusion

Based on the Experimental results the following conclusions can be drawn

- Metakaolin and copper slag concrete imparts increases the compressive effectively as compared with conventional concrete .
- It can be conclude that metakaolin can be replaced with cement in M20concrete upto 20% for Compression Strength for 20 % replacement of copper slag .
- Metakaolin and copper slag also increases the Flexural Strength drastiacally for upto 20% replacement of metakaolin with cement .
- It can also be conclude that metakaolin can be replaced with cement in M20concrete upto 20% for 20 % replacement of copper slag .for Flexural Strength.
- Also the copper slag imparts good compressive strength to the concrete.

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