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Effect of Metakaolin on the Properties of Concrete

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Abstract - *Concrete is widely used construction materials. However, the production of Portland cement releases significant amount of CO_2 (carbon dioxide), a greenhouse gas. One ton of Portland cement clinker production releases approximately one ton of CO_2 and other gases. Environmental issues are playing essential role in the sustainable development of concrete industry.*

Today many researches are ongoing for the replacement of Portland cement, using many waste materials like fly ash and GGBS. Like Fly ash and GGBS a 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 glass powder in the range 5% to 25% with an interval of 5% is to be study.

It was tested for compressive strength, Split tensile strength and flexural strength at the age of 7, 28 days and compared with the results of conventional concrete. The overall test results shows that Metakaolin could be used in concrete as a partial replacement of cement.

Key Words*: *Concrete, Metakaolin, Strength, carbon dioxide.

1. INTRODUCTION

Metakaolin is a cementitious material used as admixture to produce high strength concrete. In Korea, the utilization of this material remained mainly limited to fireproof walls but began recently to find applications as a replacement for silica fume in the manufacture of high performance concrete. In order to evaluate and compare the mechanical properties and durability of concrete using metakaolin, the following tests were conducted on concrete specimens using various replacements of metakaolin; mechanical tests such as compressive, tensile and flexural strength tests. Strength tests revealed that the most appropriate strength was obtained for a substitution rate of metakaolin to binder ranging between 10% and 15%. The filler effect resulting from the fine powder of binders was seen to ameliorate substantially the resistance to chemical attacks in comparison with ordinary concrete The tests implemented in this study confirmed that metakaolin constitutes a promising material as a substitute for the cost prohibitive silica fume.

Metakaolin is one of the innovative clay products developed in recent years. It is produced by controlled thermal treatment of kaolin. Metakaolin 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 wellcontrolled. Therefore, using metakaolin should promise some advantages compared to other cement replacement materials. In this case, studies are needed to study the performance of concrete using metakaolin.

Metakaolin is produced by burning kaolin at a temperature of 600°C-800°C. The main constituent, kaolinite is a hydrous aluminium silicate of the approximate composition 2H2O.Al2O3.2SiO2.

2. MATERIAL USED

2.1 Cement: The cement used was 53 grade Ordinary Portland Cement.

2.2 Fine aggregate: Locally available sand confirming to zone II with specific gravity 2.66 was used.

2.3 Coarse aggregate: Coarse aggregate used was 20 mm and less size and specific gravity 2.70.

2.4 Metakaolin: In this experiments metakaolin having particle size less than 90 micron was used. Chemical composition of glass powder is as follows:

Table 1: Chemical composition of Metakaolin

Chemical	Composition
SiO	50% - 55%
Al2O3	38% - 42%
CaO	1%-3%
TiO2	0.8-1.2
Na2O	<1%
Fe2O3	0.2-0.5
K2O	<1%
MnO	<0.5%
MgO	<0.1%
Loss on Ignition	Max 1.5%
Physical	**Properties**
Bulk Density (g/cc)	0.5461 (When packed)
Color	White
Specific Gravity	2.30

3. EXPERIMENTAL WORK AND TEST

3.1 Mix Design: Mix design carried out for M35 grade of concrete by IS 10262:2009, resulting to a mix proportion of 1:1.69:2.28 with water cement ratio of 0.42. The replacement of cement by Metakaolin was 5% to 25% at increment of 5% each.

3.2 Compressive and Flexure test: Concrete prepared with different percentage replacement of cement by metakaolin at increment of 5% each up to 25% was cured under normal condition and were tested at 7 days and 28 days for determining the compressive and flexural strength and compared those with the results of conventional concrete.

3.3 Workability test: The slump is a measure representing the workability of concrete. In this experimental work, the slump value of fresh concrete was in the range of 40 mm to 63 mm.

4. TEST RESULTS

4.1 Workability

Table 2 shows the results of workability of concrete with partial replacement of cement by metakaolinr in various percentages ranging from 5% to 25% in increments of 5%.

Table 2: Results of workability of concrete with partial replacement of cement by metakaolin

Mix Designation	% replacement of cement by metakaolin	Slump (mm)
A1	0	63
A2	5	61
A3	10	56
A4	15	52
A5	20	45
A6	25	40

4.2 Compressive Strength

The table gives the results of test conducted on hardened concrete with 0-25% metakaolin for 7, 28. From table 3, results shows that the compressive strength increases with increasing curing time.

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

Mix Designation	% replacement of cement by metakaolin	7 days Compressive Strength	28 days Compressive Strength
A1	0	27.26	43.14
A2	5	29.64	45.34
A3	10	34.59	48.07
A4	15	33.90	50.29
A5	20	29.77	42.01
A6	25	26.20	41.25

4.3 Flexural strength

Table 4 shows the variation of results for flexural strength of concrete with cement replacement by metakaolin for 7 and 28 days. It is clear that flexural strength of concrete with 15% cement replacement by metakaolin showed a higher value compared to control concrete for 7 days and 28 days respectively.

Table 4: Results of Flexural Strength of concrete with partial replacement of cement by metakaolin.

Mix Designation	% replacement of cement by metakaolin	7 days Flexural Strength	28 days Flexural Strength
A1	0	2.43	4.04
A2	5	2.46	4.30
A3	10	2.68	4.64
A4	15	2.83	4.84
A5	20	2.64	4.44
A6	25	2.50	4.12

5. DISCUSSION ON TEST RESULTS

5.1 Workability

As the metakaolin in concrete increases workability decreases. As there is a reduction in fineness modulus of cementatious material, quantity of cement paste available for providing lubricating effect is less per unit surface area of aggregate.

5.2 Strength

As the percentage replacement of cement with metakaolin increases strength of concrete increases up to 15%.

6. CONCLUSIONS

Based on experimental observations, following conclusions can be drawn:

1) Metakaolin concrete increases the compressive and flexural strength effectively as compared with conventional concrete.
2) Workability decreases as percentage of metakaolin in concrete increases.
3) The strength of concrete increases with increase in metakaolin content upto 15% replacement of cement.
4) As the Percentage of metakaolin powder in concrete increases, workability of concrete decreases.

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REFERENCES

[1] Dr. Richard Parnas et al., Basalt FIBRE Reinforced Polymer Composites, August 2007.PP 5.

[2] Van De Velde K. ,et al., Basalt fibres as reinforcement for composites , March 2006

[3] Eythor Thorhallsson et al., Reykjavik University & Iceland GeoSurvey, November 2013, PP 2.

[4] Kunal Singh, A Short Review on Basalt FIBRE, 2012, pp. 20, 23.

[5] Matthews, F.L., Rawlings, R. D., Composite Materials: Engineering and Science.1994.

[6] Akovali, G., Handbook of Composite Fabrication. 2001.

[7] Chou, T.-W., and Ko, Frank K., Textile Structural Composites. 1988, Amsterdam,The Netherlands: Elsevier Science Publishing Company Inc.

[8] Gajanan Deshmukh; Basalt - The Technical Fibre; Man-made Textiles in India; July 2007; 258-261.

[9] Davidovits J. Properties of geopolymer cements. In: Proceedings of the 1st International Conference on Alkaline Cements and Concretes. Kiev, Ukraine, 1994. p. 131–49; Ph.D. Thesis, Instituto Militar de Engenharia, Rio de Janeiro, Brasil, 1999.