

## EFFECT OF METAKAOLIN ON THE STRENGTH PROPERTIES OF CONCRETE

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**Abstract:** Concrete is the most commonly used material for construction. The worldwide production of cement has greatly increased since 1990. Supplementary cementitious materials have been widely used all over the world in concrete due to their economic and environmentally benefits. By addition of some pozzolanic materials, the various properties of concrete workability, durability, strength and resistance to crack can be removed. Various types of pozzolanic materials that improve the cement properties have been used in industries. Metakaolin is an amorphous non crystallized material, constituted of lamellar particles. It is also one of such non-conventional material which can be utilized beneficially in the construction industry. This paper presents the result of effect of metakaolin on strength of concrete. The concrete M 25 was made using 43 grades OPC and the rest mixes were prepared by replacing part of OPC with metakaolin. And the replacement levels were 5%, 10%, 15%, 20% (by weight) for Metakaolin.

**Keywords-** *Portland cement, concrete, Metakaolin, Compressive strength, Workability*

### 1 Introduction

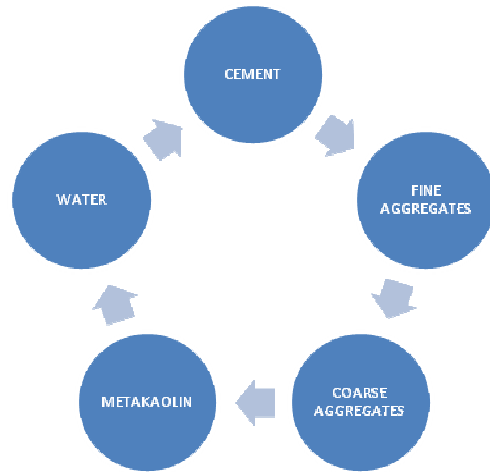
Performance of concrete is depends upon its mechanical and durability properties .The use of supplementary cementitious materials (SCM) is fundamental in developing low cost construction materials for use in developing countries. By addition of some pozzolanic materials, the various properties of concrete such as workability, durability, strength, resistance to cracks and permeability can be improved. Due to pozzolanic and filling effects of these certain mineral admixtures , They are capable of enhancing the durability through the pore refinement and the reduction in the calcium hydroxide of the cement paste , this cement

composites improves mechanical properties and life of the structure. The physical action of the pozzolanas provides a denser, more homogeneous and uniform paste.

Metakaolin is another pozzolanic material which is manufactured from selected kaolins, after refinement and calcinations under specific conditions. The particle size of metakaolin is less than 2 um. It is smaller than the cement particles. The chemical formula of Metakaolin is  $AL_2O_3.2SiO_2.2H_2O$ . It reduces the hardened cement permeability to liquid and gases. The utilization of this material is also environmentally friendly since it helps in reducing

the carbon di oxide (CO<sub>2</sub>) by decreasing the use of cement in the manufacturing of concrete

The primary objective of the paper is to evaluate the effect of metakaolin at various ratios on the



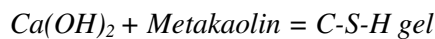
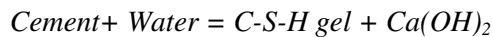
Properties	Standard Consistency	Specific Gravity	Setting Time	
			Initial time	Final time
Results	31.50 %	3.15	35 Minutes	540 Minutes
Permissible Values	27-35 %	3.1-3.5	Should not be less than 30 minutes.	Should not more than 600 Min.

**a) Cement:**

Ordinary Portland Cement (43 grade) is used . The different laboratory tests were conducted on cement to evaluate the standard consistency, initial and final setting time and specific gravity. The results are mentioned in Table 1 .

**Table 1 Physical Properties of ordinary Portland cement**

performance of concrete in terms of compressive strength, workability, water absorption. The various samples of concrete without metakaolin and with metakaolin were tested upto 28 days for a various characteristics. By the results of various tests, The various properties of the concrete are discussed. The chemical reactions are following:-



**2. Experimental Procedures**

**2.1 Materials**

**b) Fine Aggregates**

The fine aggregate used in the investigation from khizrabad (Yamunanagar, Haryana), Yamuna River. The properties of fine aggregate as per IS-383 are shown in Table 2 :

**Table 2 Properties of Fine Aggregates**

Properties	Results	Permissible Values
Fineness Modulus	2.54	2.55

Moisture Content	.57 %	Must be less than 2 %
Specific gravity	2.54	2.4-2.6

chemical properties of concrete is given in table 4 & 5 .



### c) Coarse Aggregates

The coarse aggregate of size 12.5 mm and taken from khizrabad (Yamunanagar, Haryana). The various properties of coarse aggregates are shown in Table 3

**Table 3 Properties of Coarse Aggregates**

Properties	Results	Permissible Values
Fineness Modulus	6.26	6.3
Flakiness index	23 %	Must be less than 40%
Moisture Content	.76 %	Must be less than 2 %
Crushing value	21.3 %	Must be less than 30 %
Specific gravity	2.73	2.6-2.8

**Table .4 Physical Properties of concrete**

Particulars	Values
Appearance	Red – orange Powder
pH	4.0-5.0
Bulk Density	.4-.5
Specific gravity	2.6
Loss on ignition (%)	1.5
D 50	1.5-2

**Table 5 Chemical Properties of concrete**

Chemical Composition	Mass (%)
SiO <sub>2</sub>	52-54
Al <sub>2</sub> O <sub>3</sub>	44-46
Fe <sub>2</sub> O <sub>3</sub>	.60-1.2
TiO <sub>2</sub>	.65
CaO	.09
MgO	.03
Na <sub>2</sub> O	.10

### d)Metakaolin

The admixture Metakaolin was obtained from the Karanwal Infratech materials Private limited , Faridabad , Haryana.. The various physical and

### d)Water

Ordinary potable water free from organic content, turbidity and salts is used for mixing.

## 2.2 Mix Design

The mix design for M25 grade of concrete having target strength of 31.5 MPa was prepared by using the above material. The proportion of material by weight was 1: 1.87: 2.19 (Cement : Fine Aggregates : Coarse Aggregates) .The water cement ratio is taken as .45. To evaluate the effect of the metakaolin combination, 150 mm cubes are cast at various ratios. The workability and the compressive strength of different mixes were tested at 7 and 28 days.

## 3. Results

The compressive strength of the cubes at different days and metakaolin combination are given in table 6

**Table 6 Compressive strength of the cubes**

Mix	Compressive strength	
	7 Days	28 days
Normal Concrete	16.7	25.4
M <sub>1</sub>	18.4	27.2
M <sub>2</sub>	20.6	28.7
M <sub>3</sub>	24.5	29.8
M <sub>4</sub>	22.1	27.6

The slump and the compaction factor are given in table 7

**Table 7 Factor**

Mix	Slump (mm)	Compaction Factor
Normal Concrete	60	.92
M <sub>1</sub>	61	.92
M <sub>2</sub>	58	.92
M <sub>3</sub>	54	.91

M <sub>4</sub>	50	.90
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## 4 Conclusions

The inclusion of metakaolin as a cement replacing material provides an excellent improvement in the compressive strength of the concrete. The utilization of supplementary cementitious material like Metakaolin concrete can compensate for environmental and technical issues. Mix with 15 % metakaolin is superior to all other mixes.

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