International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.4, pp 213-218, 2017

Effect of Metakaolinon Strength Characteristics of Concrete

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Abstract : In day to day the construction field can build new mega structure like underground tunnel, palm island, metro train bridges. The ordinary concrete cannot fulfil the above construction work, So we go for high strength concrete. In this paper we have to partially replace the cement by Metakaolin(MK). Metakaolin is Supplementary cementitious material. It is a by product of clay. The clay contain High purity kaolin deposits, it should be calcinated by certain temperature to breed metakaolin.

The mix design of concrete should be calculated by material test results. The replacement percentage of metakaolin is 0%,5%,10%,15%. several number of specimen are casted for M25 grade of concrete. The specimen should be cured 7 days and 28 days. Finally they should be tested by compression test, split tensile test, flexural test. The maximum strength should be obtained in 10 to 12 % of replacement of metakaolin.

Keywords : *metakaolin, kaolin, Compressive strength Splitting strength, flexural strength*.

1. Introduction:

Metakaolin is a mineral admixture obtained from clay. The clay contain mineral of kaolin. it should be continuously calcinated at moderately high temperature (650-800°c) ,then MK should purchased. one of the prominent use of MK is mixing with concrete ,because it is highly reactive pozolanic material and chemical , physical properties are similar to the cement. It is in power form and fineness of MK 700 to 800m²/kg. MK is primarily consists of silicon dioxide(SiO_2) , aluminium oxide(Al_2O_3), ferric oxide(Fe_2O_3), calcium oxide (CaO) and potassium oxide(K_2O).

Table 1 Ingredients of Metakaolin

Ingredient	Percentage (%)
SiO2	62.62
Al2O3	28.63
Fe2O3	1.07
CaO	0.06
K2O	3.46
TiO2	0.36

MK is highly reactive with concrete ingredients like cement, aggregate to produce high strength concrete. Another important use of MK is reducing the CO2 emission. Portland cement production generate to major CO2 emissions, results from calcination of limestone (CaCO3). For one ton of cement production emitted

0.7 tons of CO_2.it leads to 5 to 6 % of the total CO2 world emissions. So we have to partially replace the cementitious material (MK) will reduce the carbon dioxide emissions.

In this paper, metakaolin is used, and the effect of these mineral admixture mechanical properties like compressive, flexural, splitting and bond strengths, different metakaolin content (0%, 5%, 10% and 15% by weight of cement) are determined at 7dayes and 28 days.

2. Materials and Mix Proportion:

2.1 Material

The Materials used are cement, fine aggregate, sand, coarse aggregate, water, metakaolin.

Cement:

Ultra-Tech 53 Grade, Ordinary Portland Cement (OPC) confirming to IS 12269: 1987 has been used throughout the investigation. Standard consistency is 27%. The initial and final setting times were 38 minutes and 570 minutes respectively. Specific gravity being 3.08.

Fine Aggregate:

The river sand should be used. The sand shall be of Quartz, light gray or whitish variety and shall be free from silt. The sand shall pass through 2.36 mm IS sieve and shall be retained 98 percent in 75 microns IS sieve. Specific gravity of F.A is 2.64, Fineness modulus of sand is 3.53%

Coarse Aggregates:

Hard granite broken stones of less than 20mm size were used as coarse aggregate. The Specific Gravity is 2.77, Fineness modulus 4.82%, impact value is 27.08% , unit weight is 1738.07 kg/m³ are tested in laboratory.

Water:

Potable water available in laboratory with pH value of of not less than 6 and conforming t the requirement of IS 456-2000 was used for mixing concrete and curing the specimen as well.

Admixtures:

metakaolin should be used as a admixtures. Specific gravity is 2.40 to 2.60. Colour is gray to buff, fineness of Mk 700 to 800 m²/kg,physical form as powder,Brightness is 80-82 Hunter L.

2.2 Mix Proportion

Table 2 Mix Ratio

CEMENT (Kg/m³)	F.A (Kg/m³)	C.A (Kg/m³)	WATER (lit/m³)
437	645	1227	197
1	1.437	2.81	0.45

3. Experimental Procedure

3.1 Mixing the materials

The materials shall be mixed by hand in such manner as to avoid loss of water or other materials. each batch of concrete shall be extra adding 10% materials The cement and fine aggregate shall be mixed dry until the mixture is thoroughly blended and is in uniform colour. The coarse aggregate shall be added and mixed with the cement and fine aggregate until the coarse aggregate is distributed throughout the batch.

Table 3 Concrete Mixture Proportions

Mixture	Cement(kg/m^3)	MK %	MK(kg/m^3)	F.A(kg/m^3)	C.A(kg/m^3)	Water(l/ m$^{3)}$
MK0	437	0	0	645	1227	197
MK5	415.2	5	21.85	645	1227	197
MK10	393.3	10	43.70	645	1227	197
MK15	371.3	15	65.75	645	1227	197

The water shall be added and the entire batch mixed until the concrete appears to be homogenous and has the desired consistency.

3.2 Pouring and compacting the concrete

After mixing, the concrete should be filled immediately in the mould. Concrete is filled in three layers; each layer is compacted well by using tamping rod, so as to avoid entrapped air inside the concrete cubes and honey combing effects on the sides. During pouring of concrete, it is better to avoid wasting of concrete. After the top layer has been compacted, a strike off bar is used to strike out the excess concrete.

3.3 Demoulding

The cube specimens are demould after 24 hours from the process of moulding.

3.4 Curing

The demould specimen immediately cured in water at room temperature. **.** The curing is spilt into 2 batch's. (7 days, 28 days).

Fig 1 curing of specimens

3.5 Testing

The following tests are done in the concrete specimen.

1. Compressive strength Test
2. Split tensile strength Test
3. Flexural strength test

4. Results

4.1 Compression test results

Compressive strength test was conducted in CTM to evaluate the strength development of concrete at the age of 7 days and 28 days respectively.

Table 4: Compressive strength results in N/mm^2

Mixture	7days(N/mm2)	28days(N/mm^2)
MK0	27	32
MK5	27.8	33.43
MK10	28.6	35.1
MK15	28.1	34.2

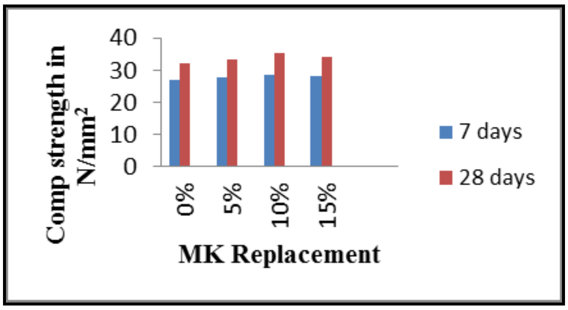

Fig. 2 Compressive strength result for M25 cubes

4.2 split tensile strength results

Split tensile strength test was conducted in CTM to evaluate the strength development of concrete at the age of 7 days and 28 days respectively.

Table 5: Split tensile strength results in N/mm^2

Mixture	7days(N/mm^2)	28days(N/mm^2)
MK0	1.8	2.21
MK5	1.9	2.33
MK10	2.32	2.49
MK15	1.95	2.41

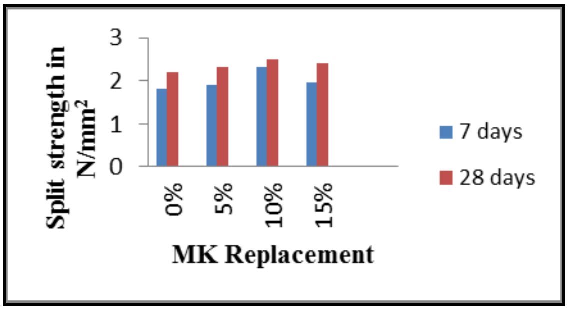

Fig. 3 Compressive strength result for M25 cylinder

4.3 Flexural strength results

Flexural strength test was conducted in UTM to evaluate the strength development of concrete at the age of 7 days and 28 days respectively.

Table 6: Flexural strength results in N/mm^2

Mixture	7days(N/mm^2)	28days(N/mm^2)
MK0	2.53	3.46
MK5	2.60	3.62
MK10	2.80	3.86
MK15	2.68	3.72

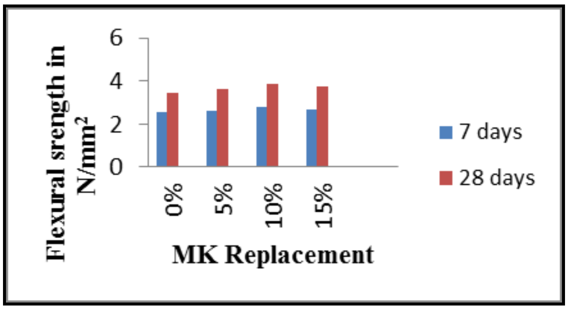

Fig. 4 flexural strength result for M25 prism

5. Discussions

A. Compressive Strength

The compressive strength results are shown in figure 3. If the percentage of MK from 0 to 10% in concrete, the compressive strength increases. Then again increase the percentage of MK the compressive strength decreases. The maximum strength attained in 10 to 12 percentage replacement of cement by MK, the strength increases up to 10% when compared to the normal concrete strength.

C. Flexural Strength

The Flexural strength results are shown in figure 5. If the percentage of MK from 0 to 10% in concrete the Flexural strength increases. Then adding 15% of MK of the concrete strength decreases. The optimum split tensile value is 3.86 N/mm^2 in MK10

6. Conclusion

From the above results, Optimum replacement of cement with silica fume is found to be: 10 to 12% for M25 grade of concrete as per IS method of design.

The increase in compressive strength of concrete of 5% (from10% to 15%), Split tensile and strength Flexural Strength of concrete increases of 4%(from 8% to 12%).

7.References

1. D.Anjali, S.S.Vivek and G.Dhinakaran(2015)," Compressive Strength Of Metakaolin Based Self-Compacting Concrete", International Journal of ChemTech research coden (usa): ijcrgg issn: 0974-4290 vol.8, no.2, pp 622-625,
2. F. Pacheco Torgal, Arman Shasavandi, Said Jalali , "Using metakaolin to improve the compressive strength and the durability of fly ash based concrete", innovation & valorization in civil engineering & construction materials N° : 1p-251
3. Xiaoqian Qian, Zongjin Li "The relationships between stress and strain for high-performance concrete with metakaolin" Cement and Concrete Research 31 (2001) 1607– 1611
4. Alaa M. Rashad , " A preliminary study on the effect of fine aggregate replacement with metakaolin on strength and abrasion resistance of concrete", Construction and Building Materials 44 (2013) 487–495

5. Aiswarya S, Prince Arulraj G, Dilip C, " Review On Use Of Metakaolin In Concrete", IRACST – Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-3498,Vol.3, No.3, June 2013.
6. Guang Jiang, Zhidan Rong , Wei Sun,"Effects of metakaolin on mechanical properties, pore structure and hydration heat of mortars at 0.17 w/b ratio", Construction and Building Materials 93 (2015) 564–572
7. Abid Nadeem a, Shazim Ali Memonb,, Tommy Yiu Lo " Mechanical performance, durability, qualitative and quantitative analysis ofmicrostructure of fly ash and Metakaolin mortar at elevated temperatures", Construction and Building Materials 38 (2013) 338–347
8. Rajkumar. R, Akkineni surya teja , Pandia rajan R " Experimental Investigation on the Mechanical and Durability Properties of concrete using Metakaolin and Copper slag ", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 02 Issue: 04 | July-2015
9. Okan Karahan a,b, Khandaker M.A. Hossain b, Erdogan Ozbay b,c, Mohamed Lachemi b, Emre Sancak d "Effect of metakaolin content on the properties self-consolidating lightweight concrete" Construction and Building Materials 31 (2012) 320–325
10. Sanjay N. Patil, Anil K. Gupta, Subhash S. Deshpande. "Metakaolin- Pozzolanic Material For Cement in High Strength Concrete ", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, PP: 46-49.

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