TO STUDY THE EFFECT OF METAKAOLIN- POZZOLANIC MATERIAL IN CONCRETE STRUCTURE

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ABSTRACT
Metakaolin pozzolanic powder is used in many civil engineering constructions in world. Metakaolin powder is act or work as binding material in concrete available in many different varieties and qualities. The purity of Metakaolin will show its binding capacity or free lime. Some of them also provide special reactivity. Metakaolin is a valuable admixture for concrete and or cement applications. Usually we add from 5% - 20% (by weight) of Portland cement replaced by Metakaolin in concrete. Such a concrete exhibits favourable engineering properties. The pozzolanic reaction starts from 7 to 28 days. For the preliminary investigation, Metakaolin and cement was subjected to physical and chemical analyses to determine whether they are in compliance with the standard use. The experimental analysis will be designed to study Metakaolin as a partial replacement with cement will done at 5%, 10%, 15% , 20% in concrete.

KEYWORDS- Met kaolin, Concrete mix, Compressive strength, spilt tensile strength.

1 INTRODUCTION
The demand for Portland cement is increasing dramatically in developing countries. Portland cement production is one of the major reasons for CO2 emissions into atmosphere. It is due to the use of fossil fuels, including the fuels required to generate electricity during cement manufacturing process. The use of pozzolanas for making concrete is considered efficient, as it allows the reduction of the cement consumption while improving the strength and durability properties of the concrete. Metakaolin when used as a partial replacement substance for cement in concrete, it reacts with Ca(OH)2 one of the by-products of hydration reaction of cement and results in additional C-S-H gel which results in increased strength. Metakaolin is obtained by thermal activation of kaolin clay. This activation will cause a substantial loss of water in its constitution Causing a rearrangement of its structure. To obtain an adequate thermal activation, the temperature range should be established between 600 to 750ºC. Metakaolin is used in oil well cementing to improve the compressive and flexural strength of the hardened cement. Metakaolin also reduces the hardened cement permeability to liquids and gases. Hence by partially replacing Portland cement with Metakaolin not only reduces carbon dioxide emissions but also increases the service life of buildings.as well as it is economically available in world wide.

3.0 LITERATURE REVIEW

Jian-Tong Ding et al (2002) experimentally found out the effects of Metakaolin and Silica Fume on the properties of Concrete. Experimental investigation with seven concrete mixtures of 0, 5, 10, and 15% by mass replacement of cement with high-reactivity Metakaolin or Silica fume, at a water cement ratio of 0.35 and a sand-to-aggregate ratio of 40% was carried out. The effect of Metakaolin or Silica fume on the workability, strength, shrinkage, and resistance to chloride penetration of concrete was investigated. The Incorporation of both Metakaolin and Silica fume in concrete was found to reduce the free drying shrinkage and restrained shrinkage cracking width. It is also reported that the incorporation of Metakaolin or Silica fume in concrete can reduce the chloride diffusion rate significantly. The performance of Silica fume was found to be better than Metakaolin.

Badogiannis.E et al (2004) evaluated the effect of Metakaolin on concrete. Eight mix proportions were used to produce high-performance concrete, where Metakaolin replaced either cement or sand of 10% or 20% by weight of the control cement content. The strength development of Metakaolin concrete was evaluated using the efficiency factor (k value). With regard to strength development the poor Greek Metakaolin and commercially obtained Metakaolin yielded the same results. The replacement with cement gave better results than that of sand. When Metakaolin replaced cement, its positive effect on concrete strength generally started after 2 days where as in case of sand it

Started only after 90 days. Both Metakaolin exhibited very high k-values (close to 3.0 at 28 days) and are characterized as highly reactive pozzolanic materials that can lead to concrete production with excellent performance.

Justice.J.M et al (2005) made a comparative study by replacing 8% by weight of cement with Metakaolin and Silica fume. Metakaolin addition proved to be beneficial, resulting in concrete with considerably higher strengths and greater. durability than the normal mixes. The use of finer Metakaolin was more effective in improving concrete properties than the coarser Metakaolin. Addition of Metakaolin increased the use of super

Plasticizers. Addition of Metakaolin exhibited improvements in shrinkage, durability and other strength aspects.

Nabil M. Al-Akhras (2005) carried out an investigation by replacing cement with Metakaolin to find out the durability of concrete against sulphate attack. Three replacements of cement with Metakaolin (5, 10 and 15% by weight) were done with water cement ratio of 0.5 and 0.6. After the specified days, the samples were immersed in 5% sodium sulphate solution for 18

months. The effect of metakaolin addition proved to be beneficial in improving the resistance of concrete to sulphate attack. Metakaolin with water cement ratio of 0.5 exhibited better results in sulphate resistance than 0.6. Autoclaved cured specimens had better resistance against sulphate than moist cured specimens.

Abid Nadeem et al (2008) made an investigation on the chloride permeability of high strength concrete and mortar specimens containing varying proportions of Metakaolin (MK) and Fly ash at elevated temperatures. A total of seven concrete and three mortar mixes were tested after exposing each mix to 200, 400, 600 and 800°C. In concrete, the dosage levels of MK were 5, 10 and 20% and for Fly ash the dosage levels were 20, 40 and 60%. In mortar, the dosage level of Metakaolin

and Fly ash was 20%. All concrete specimens investigated in this study had a minimum compressive strength of 85 MPa. At normal temperatures, concrete and mortar specimens had very low chloride ion Penetrability. At normal temperature, metakaolin mixes had lower chloride permeability than Fly ash and Portland cement B mixes. At normal temperatures, mortar specimens were more chloride permeable than concrete specimens. At 200°C and 400°C, mortar was still more chloride permeable than concrete but the ratio of mortar to concrete chloride permeability was less than that at normal temperature.

Jiping Bai and Albinas Gailius (2009) developed statistical models for predicting the consistency of concrete incorporating Portland cement, Fly ash and Metakaolin from the experimental results of standard consistency tests. The effect of variations of pozzolanic replacement materials including Fly ash and Metakaolin replacement levels up to 40% and 50% respectively were tried. ConsistencyParameters were found out from the best fit models. Values of consistency were calculated by the proposed models and gave a good agreement with observed experimental data. It indicated that the models were reliable, accurate and can be used in practice to predict the consistency of Portland cement-Fly ash-Metakaolin blends.

4. MATERIALS

4.1 Cement:- The most common type of cement is 53 Grade ordinary Portland cement. confirming to 12269-1987 was used in the investigation. The specific gravity of cement was 3.10

4.2 Coarse Aggregate: The crushed coarse aggregates of size 20mm and 10mm maximum size obtained from the local crushing plants are use in this project. The physical properties of coarse aggregate such as specific gravity, water absorption are tested as per IS: 2386

4.3 Fine Aggregate: Natural sand available with local market is used as fine aggregate confirming to zone II of IS 383-1983.The maximum size of fine aggregate used is 4.75mm. The specific gravity of fine aggregate was 2.52.

4.4 Meta kaolin Meta kaolin is not a by-product. I t is obtained by the calcinations of pure or refined Kaolinite clay at a temperature between 6500 C and 8500 C, followed by grinding to achieve a finesse of 700-900 m2/kg. It is a high quality pozzolonic material, which is blended with cement in order to improve the durability of concrete. When used in concrete it will fill the void space between cement particles resulting in a more impermeable concrete. Metakaolin is a relatively new material in the concrete industry, is effective in increasing strength, reducing sulphate attack and improving air-void network. Pozzolanic reactions change the microstructure of concrete and chemistry of hydration products by consuming the released calcium hydroxide (CH) and production of additional calcium silicate hydrate (C-S-H), resulting in an increased strength and reduced porosity and therefore improved durability. The formation and properties of Meta kaolin are shown in below. The specimen kept immerse in water for 7 and 28days.The chemical content of meta kaolin presented in Table 1.

Table 1 Property of Cement and Metakaolin

Chemical composition	Cement %	Metakaolin %
Silica (SiO2)	34	54.3
Calcium oxide CaO	63	0.39
Ferric oxide Calcium oxide (Fe2O3)	4.4	4.28
Magnesium oxide (MgO)	1.26	0.08
Potassium oxide (K2O)	0.48	0.50
Sulphuric anhydride (SO4)	1.92	0.22
LOI	1.3	0.68
Specific gravity	3.15	2.5

4.5 Super Plasticizer- Poly-carboxylate Ether Super plasticizer obtained from Chemcon tech SYS was used .It conforms to IS 9103 – 1999 and its specific gravity of 1.2.

4.6 Water- Fresh portable water is free from concentration of acid and organic substance is used for mixing the concrete and curing.

5. EXPERIMENTAL PROGRAMME

Test on Compressive strength of concrete

According to IS 516-1959, determining compressive strength of concrete. The specimens of size are 150mmX150mmX150mm. (according to IS: 10086-1982) the cube casted for 7 days, 14 days and 28 days and immersed in water.

Table 5.1 Compressive Strength at MK0% add in concrete

Sr .No	No of days for curing	Compressive stress in Mpa	Avg. Compressive stress in Mpa
1	7 days	30.08	29.667
2	7 days	29.37	
3	7 days	30.45	
4	14 days	38.55	38.024
5	14 days	37.65	
6	14 days	39.03	
7	28 days	42.36	41.785
8	28 days	41.37	
9	28 days	42.89	

Table 5.2 Compressive Strength at MK5% add in concrete

Sr .No	No of days for curing	Compressive stress in Mpa	Avg. Compressive stress in Mpa
1	7 days	31.58	31.15
2	7 days	30.84	
3	7 days	31.97	
4	14 days	40.48	39.93
5	14 days	39.53	
6	14 days	40.98	
7	28 days	44.48	43.87
8	28 days	43.44	
9	28 days	45.03	

Table 5.3 Compressive Strength at MK10% add in concrete.

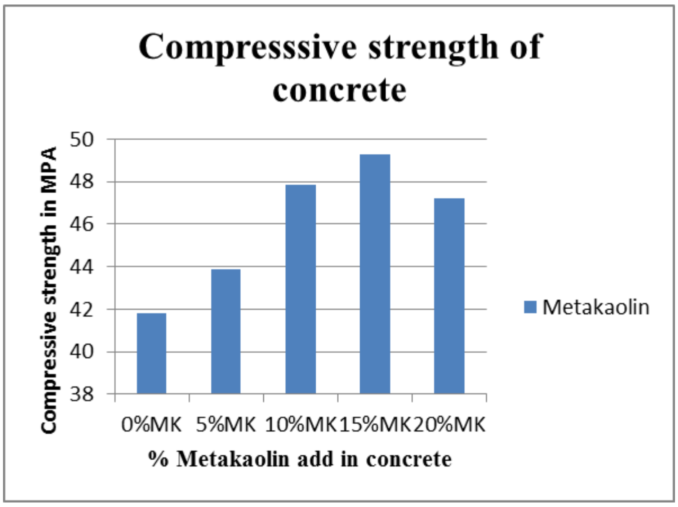
Sr .No	No of days for curing	Compressive stress in Mpa	Avg. Compressive stress in Mpa
1	7 days	34.44	33.97
2	7 days	33.63	
3	7 days	34.87	
4	14 days	44.14	43.54
5	14 days	43.11	
6	14 days	44.69	
7	28 days	48.50	47.84
8	28 days	47.37	
9	28 days	49.11	

Table 5.4 Compressive Strength at MK15% add in concrete.

Sr .No	No of days for curing	Compressive stress in Mpa	Avg. Compressive stress in Mpa
1	7 days	35.49	35.01
2	7 days	34.66	
3	7 days	35.93	
4	14 days	45.49	44.87
5	14 days	44.43	
6	14 days	46.06	
7	28 days	49.98	49.31
8	28 days	48.82	
9	28 days	50.61	

Table 5.4 Compressive Strength at MK20% add in concrete.

Sr .No	No of days for curing	Compressive stress in Mpa	Avg. Compressive stress in Mpa
1	7 days	33.99	33.52
2	7 days	33.19	
3	7 days	34.41	
4	14 days	43.56	42.97
5	14 days	42.54	
6	14 days	44.10	
7	28 days	47.87	47.22
8	28 days	46.75	
9	28 days	48.47	



Graph 5.1 Variation of Compressive Strength

6. CONCLUSIONS

On the basis of the result obtained during experimental investigation following conclusion were drawn,

a) The Compressive strength of OPC is less as comparatively to Metakaolin powder when added in concrete from 0% to 20 % cement replacement by Metakaolin

b) The Compressive strength of concrete is gradually increased from 0% to 15% , after that strength was decresed at 20%.

c) 15% cement replacement by Metakaolin is good for to all other mixes.

d) The results show that the use of Metakaolin, material for partial replacement in cement producing high strength concrete.

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