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Self-Curing Assessment of Meta Kaolin Based High Strength Concrete

[1]Shibani Rani Samal, [2]Subhalaxmi Jena, [3]Bhabani Sankar Sahani

[1]Assistant Professor, Department of Civil Engineering, Raajdhani Engineering College, Bhubaneswar

[2, 3]Assistant Professor, Department of Civil Engineering, Templecity Institute of Technology and Engineering, Bhubaneswar

Abstract

The potential of metakaolin as a mineral addition to create high-strength concrete is discussed in this paper. This study examined the literature on self-curing compounds such as super absorbent polymers (SAP) and high strength concrete (HSC). Water-soluble polymers such as polyvinyl alcohol and polyacrylic acids have been tested as self-curing agents. Meta kaolin was substituted for regular Portland cement in different proportions, and the ideal amount of it to use to create high-strength concrete was discovered. Compressive strength and other mechanical characteristics were assessed. The purpose of this experimental study is to ascertain how polyvinyl alcohol and polyacrylic acid alone affect the compressive strength of concrete made of kaolin at a low water-to-cement ratio of 0.38

Keywords: High strength Concrete, Highly reactive Metakaolin, Polyvinyl alcohol, Poly acrylic acid, Self- curing, super absorbent polymers etc

1. Introduction

Higher strength, denser concrete is made with mineral admixtures such as micro silica and metakaolin. It may result in less water evaporating from the surface and prevent water from penetrating, or only very slowly and insufficiently. Therefore, the effect of cure can be disregarded. Numerous studies demonstrated that conventional HSC treatment approaches were ineffective. One method for adding more moisture to concrete for efficient cement hydration is self-curing, often known as internal curing. There are currently two methods for internal curing: the first uses saturated light weight aggregate (LWA), and the second uses super absorbent polymers (SAP), which assist retain water and decrease evaporation.

(De Sensual et al., Gemma Rodriguez, 2014).When compared to traditional concrete, the idea behind self-curing chemicals is to increase the concrete's water retention capacity by decreasing water evaporation. Water-soluble polymers have been discovered to be effective self-curing agents for concrete.

2. Materials and Methods

1. Metakaolin

Metakaolin is an amorphous alumino silicate that is reactive in concrete, made from refined kaolin clay that has been burned (calcined) under precisely regulated conditions. The calcium hydroxide (lime) byproducts created during cement hydration react with metakaolin, just like other pozzolans (fly ash and silica fume are two popular pozzolans).Even at young ages, the quick reaction rate of metakaolin greatly increases compressive strength, enabling an earlier formwork release. The presence of high reactive metakaolin speeds up the consumption of calcium (OH) 2, which modifies the concrete's microstructure and enhances the material's strength and durability. Fig.1 shows its physical form.

Figure 1 Meta kaolin

Polyvinyl Alcohol (PVA)

Granular and white, polyvinyl alcohol dissolves in hot water but is insoluble in cold water and typical organic solvents. Polyvinyl alcohol is made in aqueous solutions for a variety of uses. Transparent films with excellent tensile strength and tear resistance are created as water evaporates. Polyvinyl Alcohol's binder properties provide superior adherence to water-absorbing, porous surfaces. Commercial polyvinyl alcohol is made from polyvinyl acetate, typically in a continuous process. It can be used to concrete as an additive to reduce shrinkage.

Poly Acrylic Acid (PAA)

Dry polyacrylic acid dissolves in water and is a white, soft powder. Many of PAA's side chains will lose protons and become negatively charged when combined with water. This enables them to grow to several times their initial volume and absorb and hold onto water.

1. Methodology

According to reports, replacing 5% to 15% of the cement with HRM significantly increases the compressive strength of high-strength concrete, particularly in its early stages.(J.A. Kostuch et al., 1993).The current experimental research program was thoughtfully created to ascertain how met kaolin affects the characteristics of concrete. Therefore, only cement should be substituted with met kaolin in different proportions (5%, 7.5%, and 10% by the weight of cement) during the research.IS 10262:2000 was used to prepare the concrete mix design.The ideal proportion of met kaolin to provide the required strength was discovered. To create a practical mixture, water reducing additive (trade name: Sika) was utilized. The control mixture was made with the ideal dosage of Metakaolin. To test the control mix's capacity for self-curing, poly vinyl alcohol and poly acrylic acid were added individually in different amounts.

1. Mix design calculations as per(IS 10262:2009)

According to the Indian standard procedure, highly reactive Meta kaolin is used to manufacture high strength concrete. Table 1 displays the number of trial batches that were tried and the percentage that was finalized.It was determined that the target mean strength was 68.25 N/mm2.

Table 1 Design mix proportion

	Water	Cement	Fine aggregate	Coarse aggregate
By weight (kg)	192.370	506.21	522.8	1242.88
By volume	0.36	1	1.03	2.43

Table 2 Mix Proportions

Metakaolin %	W/C Ratio	Water* (kg /m3)	Chemical Admixture %	Cement (kg /m3)	Metakaolin (kg /m3)	Fine Aggregate (kg /m3)	Coarse aggregate (kg /m3)
5	0.38	173.14	1	480.90	25.34	522.6	1242.85
7.5	0.38	173.14	1	468.25	37.94	522.6	1242.85
10	0.38	173.14	1	455.60	50.60	522.6	1242.85

*10% reduction in water content due to addition of Chemical admixture

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Control mix

Using the mix proportions listed in Table 3, a control mix of several variations was created.

Each proportion was casted into three 150*150*150 mm cubes, which were then water cured for 28 days. Compressive strength was determined by testing under a compression testing equipment after 28 days

Addition of PVA and PAA in different percentages in control mix

PVA and PAA were added to the control mix in different percentages (0.02, 0.04, 0.06, 0.08, and 0.1 percent by the weight of cement) after the control mix was finished. A horizontal pan mixer was used to combine all of the components for two minutes. For 28 days, six cubes of each proportion were cast and stored at room temperature. Weight reduction was seen every day.

3.RESULTS AND DISCUSSIONS

Compressive strength of Control Mix

It was shown that the ideal degree of cement replacement by Meta kaolin in terms of compressive strength was 10%. The strength reduced but stayed higher than the control mixture after 10% replacement levels. At 10% replacement, a compressive strength of 106 MPa was attained.(P. Dinkar and others, 2013)

At 28 days, strength tests showed that concrete containing 5%, 7.5%, and 10% Meta kaolin added to it was stronger than the control mix. Over 10% additions result in an excess of high reactivity Meta kaolin in the concrete, which reacts with the hydrated calcium hydroxide to lower the concrete's compressive strength. When compared to the control mix specimen, the ideal percentage of high reactivity meta kaolin added to cement is 7.5%, which increases the compressive strength at 28 days by 7.73% (B.B. Patil et al., 2012).

Compressive strength testing was done on water-cured cubes for this investigation, and the findings are shown in Table 3.The results show that an optimal replacement of 7.5% by the weight of cement yields strength that is almost equal to the intended mean strength, making it an economical mix. Additionally, Fig. 2 displays the results graphically.

Table 3 Compressive Strength of concrete Mix for different variation of Metakaolin

Meta kaolin (%)	**Specimens (CUBES)**	**Compressive strength after 28 days N/ mm^2**	**Average compressive strength N/mm^2**
0	C1	61.50	61.50
	C2	62.44	
	C3	60.60	
5	C1	72.40	73.37
	C2	73.10	
	C3	74.55	
7.5	C1	66.34	66.

	C2	67.10	62
	C3	66.50	
10	C1	62.25	60.95
	C2	59.87	
	C3	60.81	

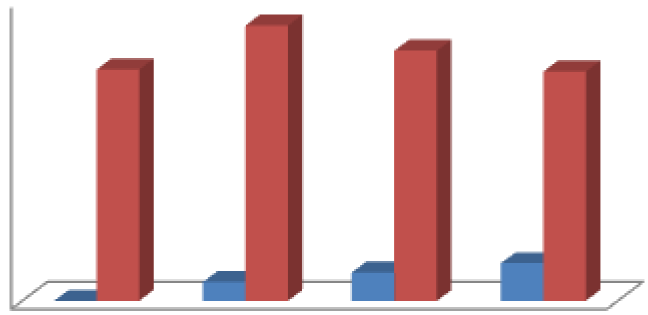

Figure 2 Compressive strength of control mix

Compressive strength of HSC based on meta kaolin combined with PVA and PAA The results in Table 4 show that 7.5% is the ideal percentage to replace cement with Metakaolin.PVA and PAA were added separately to this control mix at different amounts (0.02, 0.04, 0.06, 0.08, and 0.1 percent by the weight of cement). Weight loss was noted daily as the cast specimens air-cured at ambient temperature. Water lost just 1% of the weight, which is insignificant after 28 days, according to the weight loss observation. Specimens were then put through compression testing.

Concrete combined with 0.04% polyvinyl alcohol yields the highest strength of 65.40 N/mm2, while concrete combined with 0.02% polyacrylic acid yields the highest strength of 64.20 N/mm2.The two acquired strengths are almost equivalent to the control mix's strength. The results are displayed graphically in Fig. 3 and in Table 4.

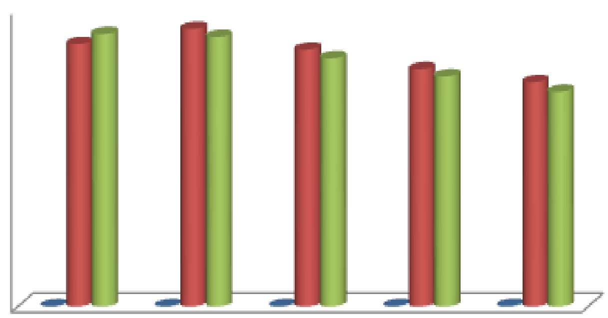

Figure 3 Compressive Strength of HSC unified by PVA and PAA

Table 4 Compressive Strength of HSC unified by PVA and PAA solely

	1	2	3	4	5
Series1	0.02	0.04	0.06	0.08	0.1
Series2	61.81	65.4	60.5	55.9	52.83
Series3	64.2	63.5	58.5	54.2	50.5

PVA/PAA in Percentages	0.02	0.04	0.06	0.08	0.1
Avg. compressive strength of PVA mixed cubes after 28 days, N/mm^2	61.81	65.40	60.5	55.9	52.88
Avg. compressive strength of PAA mixed cubes after 28 days, N/mm^2	64.20	63.5	58.5	54.2	50.4

Conclusions

Due of the high water demand, concrete with low water cement ratios that contain natural pozzolana, such that employed in this study, needs an effective curing application. Self-curing is therefore a possible substitute for meeting water needs. The results of this investigation indicate that adding 7.5% more Meta kaolin to cement and combining it with just poly vinyl alcohol and polyacrylic acid will greatly increase the concrete's capacity to retain water and boost its compressive strength. More thorough research is required to determine whether the commercially available polymers are suitable for use in construction projects. To create novel polymers that are best suited for construction projects alone, a variety of alterations can be done. It is obvious that more research is needed to determine the stability of SAP over time and in different exposure conditions, as well as the durability of concretes containing super absorbent po

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