

Effect of PVA and Nano-Silica on Strength of Cement Mortar

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Abstract- Cement mortar is a very essential part of plastering and masonry work. Its strength affects the durability of the structure. Mortar with Nano materials and polymers has been tested by many of the researchers. In this experimental work cement mortar is tested for its strength with Nano silica and polyvinyl alcohol (PVA). It was found that compressive strength decreases up-to 43% with PVA and Nano Silica. An increment in the tensile strength up to 6% of the cement mortar was observed.

Keywords- Compressive strength, tensile strength, polymers, nano materials.

I. INTRODUCTION

In construction cement mortar is considered as essential part as it is used for plastering and masonry work. Durability

of mortar is one of the necessary part for longevity of the structure. Peoples are trying to increase the strength of mortar by using various Nano-materials and polymers. Many scientists are trying to use many other materials like fly ash, rice husk ash in the mortar and concrete.

A. Materials and methods

In this work Cement of 43 grade OPC was used and mortar was prepared with cement and sand 1:3 proportion by weight. Mix mixed in mixer for one minute and was vibrated for one minute. Water cement ratio was taken 0.5. Curing of sample done for 3, 7, 14 and 28 days at room temperature.

TABLE I. OBSERVATION TABLE FOR REFERENCE MORTAR CUBE (CONTROL MIX)

Admixture component	% of admixture	Strength in MPa			
		(3 days)	(7 days)	(14 days)	(28 days)
plain cement mortar	Nil	20.00	28.00	34.00	36.00
		18.00	28.00	34.00	36.00
		18.00	32.00	36.00	38.00
Average strength in MPa		18.66	29.33	34.66	36.66

The compressive strength of control mix results as shown in Table 1 show that after 3 days curing, the strength is 18.66 N/mm², 7 days curing strength is 29.33 N/mm², 14 days curing strength is 34.66- and 28-days curing strength is 36.66 N/mm². Hydration of C₃A, causes loss of plasticity and form cake within 24 hours.

Then hardening process starts, and C₄AF hydration takes place which gives initial strength. The C₃S hydration begins and contributes most of the strength 7-28 days. Lastly C₂S hydration begins which contributes in the final strength. Its hardening process completes 90-95 % in 28 days span.

B. *Compressive strength of cement mortar with combination of varying % of pva and nano SiO₂ for 28 days of curing.*

In control mortar nano PVA and nano SiO₂ is partially replaced by (0.5+0.5) to (2.0

+2.0) percent. Other parameters kept constant and compressive strength is determined, Table 2 makes comparison of the results.

TABLE II COMPARATIVE STATEMENT FOR EFFECT OF COMBINATION OF PVA+ NANO SIO₂ ON COMPRESSIVE STRENGTH OF CEMENT MORTAR AFTER 28 DAYS OF CURING

% of PVA + nano SiO ₂	Strength in MPa (28 days)	Variation in Strength with respect to control mix
0.00	36.66	
0.5+0.5	24.66	-32.73
1.0+1.0	22.33	-39.09
1.5+1.5	22.00	-39.99
2.0+2.0	20.66	-43.64

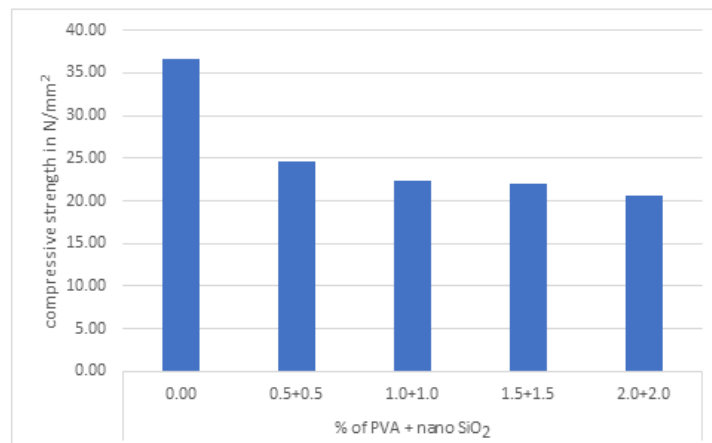


Fig. 1. Compressive strength of cement mortar with varying % of Nano Silica and PVA

C. *Results of compressive strength of cement mortar with nano silica and PVA after 28 days curing*

Figure 1 and Table 2 indicate the change of compressive strength with partial replacement of cement by PVA and nano SiO₂ showing that there is no improvement in compressive strength. The compressive

strength reduces by 32.73% to 43.64 % with respect to the control specimen. Hence this combination is not beneficial for compressive strength enhancement. Because nano material is not filling the CSH gel pores, it is trapped by PVA gel pores hence no improvement in compressive strength is found.

D. *Effect of (PVA + Nano SiO₂) on split tensile strength of cement mortar after 3, 7, 14 & 28 days of curing with varying % of (PVA + Nano SiO₂).*

In control mortar (PVA + nano SiO₂) is partially replaced by 0.5 to 2.0 %. Other parameters kept constant and split tensile strength is determined, Table 3 makes comparison of the results.

TABLE III COMPARATIVE TABLE FOR SPLIT TENSILE STRENGTH OF MORTAR WITH NANO SILICA + PVA

% of PVA+ nano SiO ₂	3 days Split tensile strength in MPa	% change in split tensile strength	7 days Split tensile strength in MPa	% change in split tensile strength	14 days Split tensile strength in MPa	% change in split tensile strength	28 days Split tensile strength in MPa	% change in split tensile strength
0.00	4.57		4.90		5.57		5.90	
0.5+0.5	4.57	0.00	4.90	0.00	5.57	0.00	6.23	5.93
1.0+1.0	4.90	9.40	5.23	6.73	5.57	0.00	6.23	5.93
1.5+1.5	4.23	-5.25	4.23	-13.67	4.90	-12.02	5.56	-5.76
2 +2	4.23	-5.25	4.23	-13.67	4.56	-18.13	5.23	-11.35

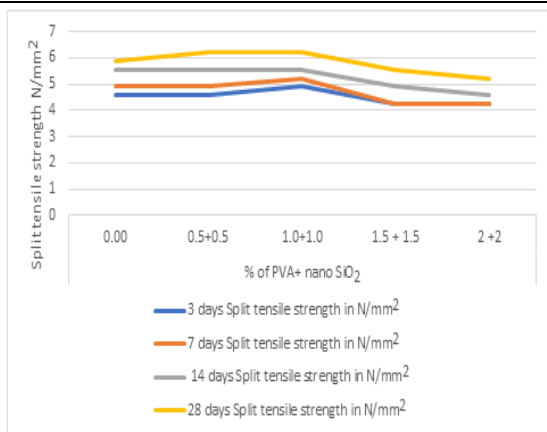


Fig. 2. Split tensile strength of cement mortar with varying % of Nano Silica and PVA

E. *Results of split tensile strength of cement mortar with nano SiO₂ and PVA, after 3, 7, 14 & 28 days of curing.*

Table 3 and Figure 2 depict the partial replacement of cement by PVA and nano SiO₂. It is found that after 28 days there is an increment in strength at 0.5+0.5 % PVA and nano SiO₂ replacement. Change in split tensile strength for content (1.0 +1.0) observed to be by 5.93 %. Increase in tensile strength for 3 days at 1% content is 9.4% and 6.73% increase for 7 days strength as shown in Table 3 and Figure 2. For this composite early strength (3 days + 7 days) is slightly appreciable. For other composites at 14 days reduction in strength up to 18.13% has been observed.

II. CONCLUSION

Cement mortar strength with nano silica and PVA was investigated in this work and found that when PVA and Nano Silica added in the cement mortar in the range of 0.5% to 2% the compressive strength decreases 33 to 43%. This may be due to nano material is not filling the CSH gel pores, it is trapped by PVA gel pores and

PVA produces small air bubbles. But it was found that there was an increment in tensile strength approx. 6% after adding the PVA and nano silica at 0.5% to 1.0%, but on increasing the percentage of admixtures the strength start decreasing. Hence for increasing tensile strength small percentage of PVA and nano silica is recommended.

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