

Diffusion and Durability Studies of Cement Mortar

S.Manivel, A.Arokia prakash, G.Senthil Kumar

Abstract: Viscosity Modifying Admixtures (VMA), chemical based admixtures, used to increase the viscosity of cement based grouts. Usage of natural materials as admixtures in VMA is much needed in current scenario. Present work aims in using *Moringa pterygosperma* (gum of drumstick tree) as an admixture. Studies were conducted by adding 1-10g of *Moringa pterygosperma* with the mass of water and maintaining water-cement ratio (w/c) of 0.4 with 1:3 mix ratios. The resultant cement mortar is studied for Compressive strength, Split tensile and rapid chloride penetration test. Tests conducted were compared with 28-days cured conventional specimen which evidentially proved that use of natural VMA increased compressive and tensile strength by 11.2% and 47.42% respectively. Appreciable improvement in penetration values were found out in the experiment.

Keywords: VMA, *Moringa pterygosperma*, Diffusion, Durability, VERDiCT

I. INTRODUCTION

Reinforced concrete structural elements and members are susceptible to attack by chloride and sulphate ions that are present in environment, which decreases the service life. Past studies include the usage of super plasticizers and silica fume to increase the service life of the structures^{1,2}. But the addition of those additive admixtures eventually increases the temperature and shrinkage of grouts which initiates early age cracking.

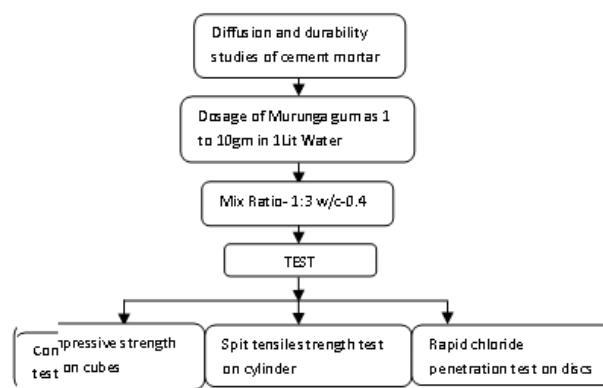
VERDiCT (Viscosity Enhancing Reducing Diffusion in Concrete Technology) is a new concept that is being used to increase the service life of the structure by increasing the viscosity of the cement grouts/concrete^{3,4,5}. This Viscosity Modifying Admixtures (VMA) may be in the form chemical or natural gums.

In this research study natural gum *Moringa Pterygosperma* is used as a VMA which in turn increases the viscosity of cement grout⁶. The objective of this study is to evaluate the performance of natural gum in cement grouts with 1-10% addition of VMA by weight of water in cement mortar grouts which was maintained consistently with w/c ratio of 0.40 with ration 1:3 in order to compare the difference of conventional specimens^{7,8,9}.

II. OBJECTIVE OF THE PROJECT

- To examine the performance of mortars with and without the VERDiCT admixture.
- To evaluate the performance of the viscosity modifier in actual concrete mixtures containing natural gum i.e. moringa pterygosperma.

Methodology



Need For The Research

- The structure is needs some desired durability. But due to some reasons like workability and material selection, durability of structure may decrease.
- To increase the durability of the structure we need to use some durability increasing materials like viscosity modifying admixtures.
- Viscosity modifying admixtures may be in natural or some chemicals.
- The purpose of this VMA is to increase durability and initial setting cracks will be resisted.

III. EXPERIMENTAL WORK

Mortar specimens were casted using 1:3 mix with w/c ratio of 0.4 and the Viscosity modifiers were added in various concentrations by water. The various concentrations of solutions kept in separate beakers. Then the fine aggregate and cement were weighted and mixed thoroughly. The moulds were cleaned and oil was applied throughout the mould. The mortar prepared above was placed in three layers in the mould. For each layer, compaction was done using table vibrator to fill the voids. At last finishing is done and excess mortar is removed. After 24 hours the specimen were removed, from the mould and subjected to water curing for 28 days.

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The control specimen was designated as 'C' and all other specimens consisting of viscosity modifiers were designated as I₁, I₂, I₃, I₄, I₅, I₆, I₇, I₈, I₉ and I₁₀.

Compression strength Test

For the determination of compression strength of cube mortar specimens, 70.7 x 70.7 x 70.7 mm size specimens were casted and dried in open air after 3, 7 and 28 days of water curing and subjected to compression test as per ASTM standards and the cube compressive strength (f_{cy}) was computed. Figure 1 shows the compressive strength test of cube conducted for sample I₆.



Fig.1 Compression strength test of cube

The Compressive Strength of Specimen were computed for conventional and VMA added samples and the result are shown graphically in Figure 2

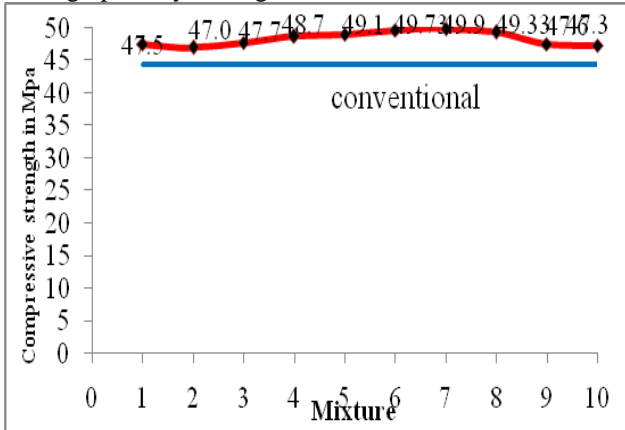


Fig.2 Compression strength test

Cylinder split tensile strength test

For the determination of splitting tensile strength of mortar, 50mm diameter and 100 mm height cylinder specimens were casted and dried in open air after 3, 7 and 28 days water curing and subjected to splitting tensile test. Figure 3 shows the split tensile strength test of cylinder conducted for sample I₆.



Fig.3 Split tensile strength test of cylinder

The tensile strengths of specimen were computed for conventional and VMA added samples and the result is shown graphically in Figure 4

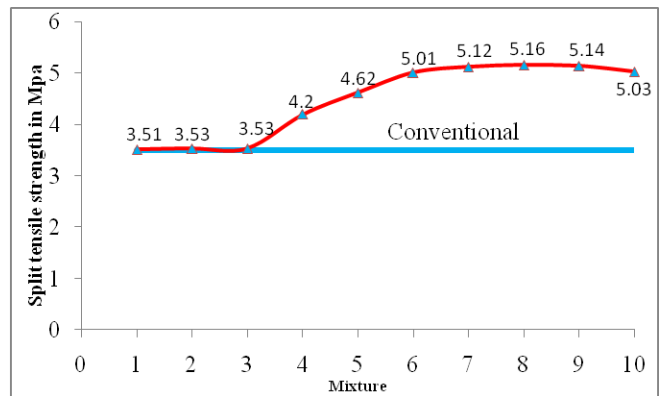


Fig.4 Split tensile test

Rapid Chloride Penetration Test

In this study, RCPT test method covers the determination of the electrical conductance of specimens. This test is conducted as per ASTM C1202. This test method consists of monitoring the amount of electrical current passed through 50mm thick slices and 100 mm diameter cylinder specimens during 6 hours period. A potential difference of 60 volts direct current is maintained and the current passed was noted at every 30 minutes over a period of 6 hours. Following formulae is used to calculate the diffusion values in coulombs.

$$Q = 900[I_{0+2}(I_{30}+I_{60}+\dots\dots\dots I_{300}) + I_{360}]$$



Fig .5 RCPT test of cube specimen

Table.2 Compression strength, Split tensile strength and RCPT test results

Specimen details	Compression strength in N/mm ²			Split tensile strength in N/mm ²			RCPT values in coulombs		
	3 days	7 days	28 days	3 days	7 days	28 days	3 days	7 days	28 days
Conventional	18	28.72	44.5	2.28	2.48	3.5	8825.4	6809.4	3765.6
I ₁	13.52	28.5	47.5	1.44	2.37	3.51	8660.7	6187.5	3157.2
I ₂	18.3	29.73	47	1.78	2.42	3.53	7911	5655.6	2611.8
I ₃	18.7	29.93	47.7	2.48	2.99	3.53	6943.5	4940.1	2501.1
I ₄	19.02	30.22	48.7	2.72	3.44	4.2	6912	4644	2402.1
I ₅	19.72	35.13	49.1	3.27	3.76	4.46	6841.8	4575.6	2243.7
I ₆	24.22	40.9	49.73	3.35	4.14	5.01	6848.8	4440.6	2164.5
I ₇	25.13	43.8	49.9	2.93	4.63	5.12	6913.8	4750.2	1799.1
I ₈	23.7	41.13	49.33	3.57	4.39	5.16	7359.3	5949	1305.9
I ₉	24.1	37	47.6	3.06	4.12	5.14	8757.9	6239.7	1187.1
I ₁₀	23.7	37.4	47.3	3.06	3.84	5.03	8254.8	6255.9	1010.7

The RCPT results of specimen were computed for conventional and VMA added samples and the result is shown graphically in Figure 6

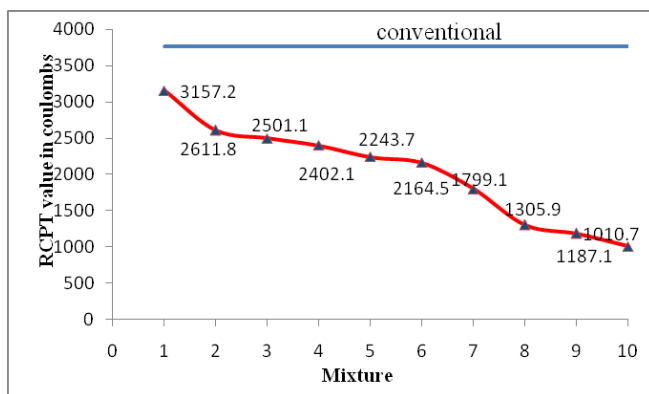


Fig.6 RCPT test of cube specimen

The limitations of the RCPT values are shown in below table.1 and with reference to that, the chloride permeability is decided.

Table.1 Limitations of the RCPT test

Additional Advantages of VMA (Natural Gum)

Charge passed in coulombs	Chloride permeability
> 4000	High
2000 to 4000	Moderate
1000 to 2000	Low
100 to 1000	Very low
< 100	Negligible

Natural resins are used to reduce the diffusion ingress rate of chloride and sulfates. VMA solution is used to produce better

quality against to various concrete constituents. By increasing the dosages pore structure of the concrete which make denser and since is possible to increase the service life time of the structures against to corrosion effect.

Results that are computed for Compressive strength, Split tensile strength and RCPT tests are tabulated in below Table.2

IV. CONCLUSION

The performance of mortars with and without the VERDiCT admixture is examined and the following conclusions are arrived from this study.

- The comparative study of conventional specimen and specimens with VMA shows the increasing pattern in its compressive strength values after 28 days of curing.
- This study shows that the compressive strength is increased from I₁ to I₇ specimens. An optimized value was obtained for Specimen I₇ which shows the increase in strength by 11.2%.
- The tensile strength of conventional and VMA added samples are examined and the results obtained are highly satisfactory for VMA.
- It is to be noted that the specimen I₈ yield optimized results because increase in VMA quantity which increased the tensile strength value up to 47.42 % than the conventional specimen.
- The results obtained were also proved that the increase in VMA tends to decrease the RCPT value which is a positive result that encourages the use of VMA in cement mortar.
- At the outset, this research study is a proof that addition of VMA increases the service life of concrete structures.

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