STUDY OF STRUCTURAL STRENGTH INTO MORTARS OF PORTLAND CEMENT BY CONTROLLED ADDING OF INDOLE NANOSTRUCTURES

XXIV INTERNATIONAL MATERIALS RESEARCH CONGRESS

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ABSTRACT

A bicyclical biopolymer compound was added to cementitious materials in order to evaluate the strength behavior as an important characteristic in the construction of buildings in seismic areas. Mortar specimens were prepared Portland cement with different percentages of indole, replacing the water content partial and completely of a solution containing the biopolymer to constant concentration. Morphological changes brought about by hydration processes were monitored for 7, 14, 28 and 90 days using scanning electron microscopy and X-ray diffraction. It was observed, that the samples with combinations water/Biopolymer (W, Q) (0 12) and (3, 9) reached the highest strength values for water/cement ratio (A / C) of 0.8, showing an increase up to 18% over the reference nominal value. The behaviors of strength values have been associated with the uniform development of Tobermorite and inhibition of the formation of secondary Ettringite as a function of content and dispersion of the Biopolymer.

INTRODUCTION

Nowadays, there have been studies in which polymers are incorporated to cement, as a result, has improved the porosity of the cement and therefore the mechanical strength, however, the agglomeration of polymer and the passage of time, the polymer tends to degrade allowing the formation of crystalline phases as ettringite secondary affecting cement structure, therefore, it´s necesary evaluate a biopolymer in aqueous medium at nanoscale incorporated in cement to define their behavior over time [1,2]

MATERIALS

The basic commodities were: Ordinary portland cement trade, dry river sand, each with a size of particle less than 75µm , bidistilled water containing total chloride dissolved in 1 part per million (PPM) T.BAKER and the biopolymer added with patent application number PCT / MX2006 / 000043.

METHODS

Mortars were designed according to the NOM-C-021ONNCEE-2004 with a grit-cement ratio 1: 1 for the greatest possible resistance [3,4], the biopolymer (Q) is incorporated in substitution of water in a matrix composition as shown in the table 1.

W/Q		Q					
		0%	20%	40%	60%	80%	100%
W	0	-	-	+	+	+	+
	20%	-	+	+	+	+	-
	40%	+	+	+	+	-	-
	60%	+	+	+	-	-	-
	80%	+	+	-	-	-	-
	100%	+	-	-	-	-	-

Table 1

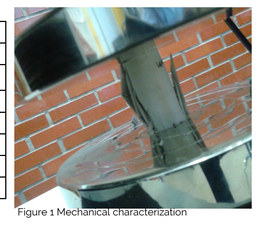


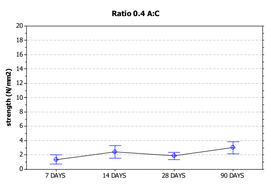
Figure 1 Mechanical characterization

The mechanical characterization was performed with a universal machine SHIMADZU 100K, the compression test was an interval of 10 ms, the morphological characterization was analyzed by X-ray diffraction (XRD) from the angle 5 to 50 2-theta with a pitch of 0.020 degrees every 43.2 seconds at 25 ° C with a copper anode, the microstructural analysis was performed on a scanning electron microscope (SEM) JEOL brand JBM-6610LV with an intensity of 20kV.

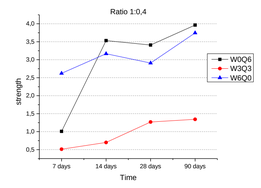
RESULTS

RATIO 1:0,4 A:C

Hydration process in the ratio 0.4 has been deficient due to lack free water which helps to CSH gel formation that contributes to the mechanical strength.



Graphic 1 Ratio 0,4 A:C

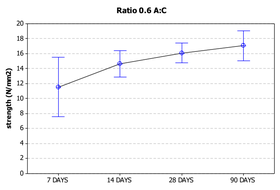


Graphic 2 Mixes 0,4 A:C

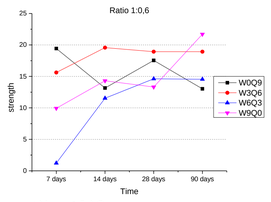
It is observed that mortar with a greater presence of Indole (W0Q6) has better mechanical performance than the reference (W6Q0) at 14, 28 and 90 days

RATIO 1:0,6 A:C

the ratio shown An increase in the mechanical strength , however, the intervals in each prove are extensive



Graphic 3 Ratio 0,6 A:C

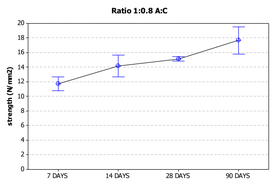


Graphic 4 Mixes 0,6 A:C

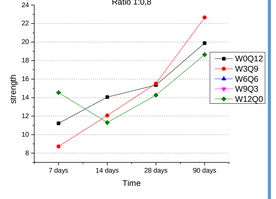
W0Q9 W3Q6 mixes shown better performance at 7, 14 and 28 days, but at 90 days of curing were overcome by the reference mortar (W9Q0).

RATIO 1:0,8 A:C

This ratio reached highest values of resistance over time compared to the 0.4, 0.6 and 0.8



Graphic 5 Ratio 0,8 A:C

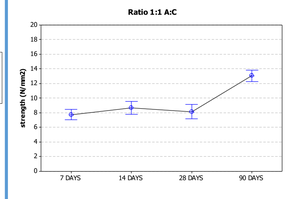


Graphic 6 Mixes 0,8 A:C

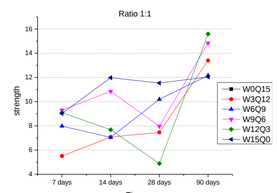
Mortars with W0Q12, W3Q9 combinations showed better performance than the reference mortar at 14, 28 and 90 days of curing, the mortar with combination W3Q9 presented the best results with increasing resistance over time, therefore proceeded to analyze the morphology of mortars with and compare them with reference to analyze the structural changes arising.

RATIO 1:1 A:C

Excess water in the ratio 1: 1 produces a low resistance for the high capillary pore formation due to water evaporation during the curing process, generating a permeable network that allow air ingress. [5,6]



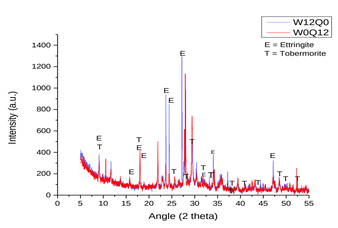
Graphic 7 Ratio 1:1 A:C



Graphic 8 Mixes 1:1 A:C

Compared to the reference (W15Q0), mortars with combinations W6Q0, W3Q12, W9Q6 and W12Q3 showed better performance at 90 days, however, at 14 and 28 days were overcome by reference.

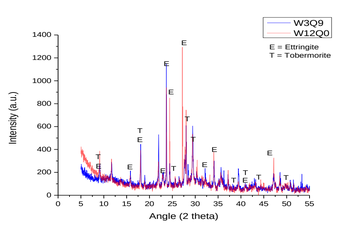
MIX Q0W12



Graphic 9 Mix Q0W12

Tobermorite crystalline phase has not significant changes in intensity but the ettringite decrease in mortar modificated in 2theta angle 23, 24, 27 34 and 47, demonstrating that this is not generating secondary ettringite that causes the cement cracking.

MIX W3Q9



Graphic 10 Mix W3Q9

The crystalline phase ettringite is reduced compared to the reference mortar in the angles 24, 27, 34 and 47 (2Theta) denoting the decrease of secondary ettringite in the mortar with the addition of indole while tobermorita intensity increase.

Morphology

Microstructure

MICROSTRUCTURAL ANALYSIS

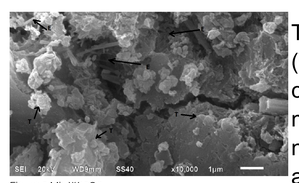


Figure 2 Mix W12Q0

The reference (W12Q0) shows secondary ettringite formation (E) as well defined needle[7] as result a crack in cement, likewise, the formation of dense arrays observed belonging to tobermorite phase in form of flakes, in the figure X the mix W3Q9 mortar presents dense arrays of highly compressed tobermoritas each other and no large formations of ettringite

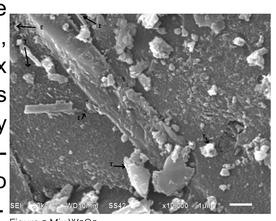


Figure 3 Mix W3Q9

CONCLUSION

Mortars with the addition of indole with ratio "1: 0.4", "1: 0.8" and "1: 1" water: cement showed greater strength than corresponding reference mortars demonstrating that the incorporation of indole optimizes demonstrating that the incorporation of indole improves compressive stress.

The morphological analysis showed that the presence of indole in the cementitious structure favors a uniform crystalline tobermorite phase, growth likewise, it decreases the growth of secondary ettringite which causes cracking of the structure.

Microstructural analysis shows in decreasing of secundary ettringite in the ratio 1: 0.8 water: cement ratio W3Q9.

The ratio 0.6 is functional to increase the strength at early ages and maintain the resistance over time in specific with the combination W3Q6.

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