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Assessment of the Concretes Mechanical Strengths from the Construction Elements Supposed on Dissolving - Levigation Corrosion

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Abstract

The proposed acceleration method represents a valuable work instrument that allows the obtaining of a great results volume in an acceptable time, taking into account that in exploitation, the buildings that are subjected to this type of corrosion are presenting visible degradations after a longer time. The realized device has been shown to be reliable and allows the testing of some series of 24 samples, so at the end of the experimental program, the obtained data after the results interpretation gave a clear image on the modification that are appearing in time in the concrete's structure subjected on dissolving – levigation corrosion.

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Keywords: concrete; corrosion; dissolving - levigation; mechanical strengths; methodology.

1. Introduction

During of a technical expertise of some cooling towers from S.C. Antibiotice S.A. Iassy can be notice that the structural concrete suffered two degradation types.

In the cooling towers access areas of the cold air from the inferior part and of the superior evacuation of the water vapours it was observed a degradation of the concrete due to gelivity. At the towers inferior part the aggresivity is

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stronger because the conditions that are created by the cooled water is leading, in winter when the temperatures are decreasing below 10^0C, to freeze – thaw cycle realization. From the performed measurements it results that in winter time, November – February, 3 – 4 freeze – thaw cycles will be realized instead 2 cycles in normal conditions.

At the superior part the degradation is less accentuated instead of a concrete which is working in normal environmental conditions.

In the central inflexion area of the cooling towers concrete structure has been noticed an observable degradation of the concrete highlighted by cracks and exfoliations [1]. Te pH determination on samples and in-situ of the concrete a reducing of the basic character can be observed [2] that allows to conclude that the concrete from the respective area was subjected to an accelerated dissolving – levigation corrosion due to a low recycled water hardness in the cooling process. The dissolving is stronger due to the water's character instead of calcium hydroxide dissolving process at high temperatures.

The modification of the concrete's basic character from the central area of the cooling towers has determined us to perform researches [3] on the structural modification from the concrete, especially of the mechanical strengths.

An original methodology was assessed for acceleration of the dissolving – levigation corrosion at temperatures above the average which can be found in cooling towers, heat exchangers, pipes [4].

2. Methodology for acceleration of the dissolving – levigation corrosion process

Because in-situ the modifications are manifesting after a big time duration (decades) [5] it was necessary a design of a device, which by realizing similar conditions as in exploitation to intensify these processes, so to obtain relevant results in a considerable reduced time interval.

The method presented in this paper supposes to maintain of some concrete samples in a steaming chamber, where they are subjected to dissolving – levigation corrosion. In this way the concrete was subjected to the dissolving – levigation attack under a liquid phase having a reduced hardness (soft water) and high temperature.

At significant time intervals 3, 6, 12, 18, 24, 30, 36 months the samples are subjected to some determinations to observe the variation in time of some certain characteristics. These are referring to volumic mass, water permeability and compression strength.

In this experimental study a concrete mixture was used and a great number of samples were realized, which were subjected to corrosion.

Device description

The device is made of a cylindrical chamber realised from steel sheet treated in the interior by priming and painting the device's dimensions (1,8 m heights and 0,9 m diameter) allow the samples placing on three grills made of welded mesh (fig. 1).

Fig. 1. Device

On the lateral wall at a half of the heights it is provided a door that allows an easy access to the three grills were the concrete samples are placed. In this case, cubic samples having a 14,2 cm side were realized. To obtain a uniform steaming / atomizing on the samples surfaces on each grill were placed a number of 8 samples having an enough space between them.

The device is producing a continuous atomizing on the samples surface of a water or steam spirt function on the selected temperature. The water is continuously recycled, being taken from the inferior part of the chamber, added by an aspiration pump and transmitted by an exterior circuit (rubber hose) at the superior part of the device. From there, by an extremely fine atomizing system, it is dispersed in the interior, all the samples coming into contact with the water and steam. The water's heating is realized with a resistance placed in the water's collecting tank. The device is provided with a thermostat that allows the desired temperature setting, in this case 65^0C. In the water tank zone there is a temperature sensor that is actioning the thermostat, so the resistance comes into operation automatically for a permanent maintaining of the water to the desired temperature (fig.2).

Fig. 2. Concrete samples position in the device

The operating of the entire device is automatically being controlled by an electronic system (control panel) because the continuous regime where it is working makes impossible the permanent surveillance by an operator.

The water used in this study is a soft water having the same composition with the water used in the cooling towers.

3. Experimental results

Cubic samples having 14,2 cm side [6, 7] were realized from a concrete having the following characteristics that are presented in the tables 1, 2, 3:

Table 1. Concrete receipt for 1m^3

Mixture	Cement	Water	Aggregate 1982 kg						
			0-0,25	0,25-0,5	0,5-1	1-2	2-4	4-8	8-16
A_0	260	130	160	240	240	201	279	392	470

Table 2. Fresh concrete characteristics [8]

Volumic mass (Kg/m^3)	Slump (cm)
2380	S3

Table 3. Hardened concrete characteristics [9, 10]

Volumic mass (Kg/m^3)	Permeability (mm)	Compression strength (N/mm^2)
2350	P_6^{10}	25,4

The samples were preserved in mixed conditions in water tanks for 7 days and in the climatic chamber up to 28 days.

After the concrete's ageing the samples were subjected to the accelerated corrosion performing physical and mechanical testings on the cubic samples at multiply of three months intervals.

The following experimental results were obtained as shown in tables 4, 5, 6:

Table 4. Volumic mass of the hardened concrete

Mixture	0 months	3 months	6 months	9 months	12 months	24 months	36 months
A_0	2380 kg/m^3	2380 kg/m^3	2378 kg/m^3	2375 kg/m^3	2374 kg/m^3	2372 kg/m^3	2370 kg/m^3

Table5. Water permeability. Determination of the penetration depth (cm)

Mixture	0 months	3 months	6 months	9 months	12 months	24 months	36 months
A_0	10,3	-	-	10,1	-	10,1	10,1

Table 6. Compression strength

mixture	0 months	3 months	6 months	9 months	12 months	24 months	36 months
A_0 (N/mm^2)	32,5	31,6	31,2	29,6	25,5	24,7	24,4

4. Experimental results processing

The processed results are synthesized as diagrams and graphs (Fig. 3, 4 5) and was estimated the variation of the concretes subjected to dissolving levigation mechanical strengths for 100 years life time (Fig.6).

The samples were subjected continuously to an accelerated dissolving – levigation process the exposure duration being used to appreciate in time of the structural modifications quantified by the physico – mechanical characteristics modifications (volumic mass, water absorption, water permeability, mechanical strengths etc.).

The water permeability and the mechanical strengths are decreasing because a part of the calcium oxide percent from the cement stone's structure that is bonded is reducing and another part remains unbounded in the structure.

The dissolving – levigation process depends on the crystalline calcium hydroxide percent from the cement stone that is subjected to a corrosion process whose effect is manifesting in the first life interval in greater percents and will decrease when the calcium hydroxide amount from the cement stone is reduced.

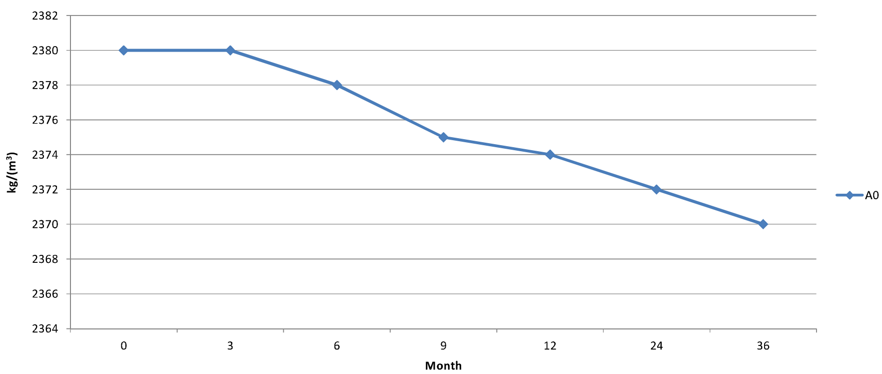

Fig. 3. Volumic mass variation

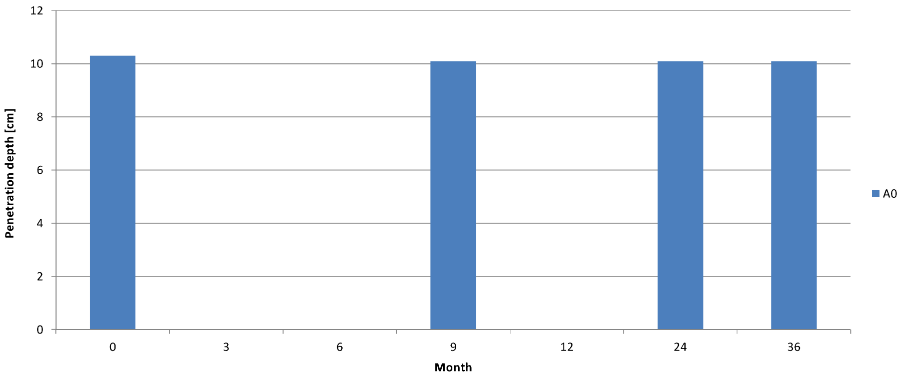

Fig. 4. Permeability variation

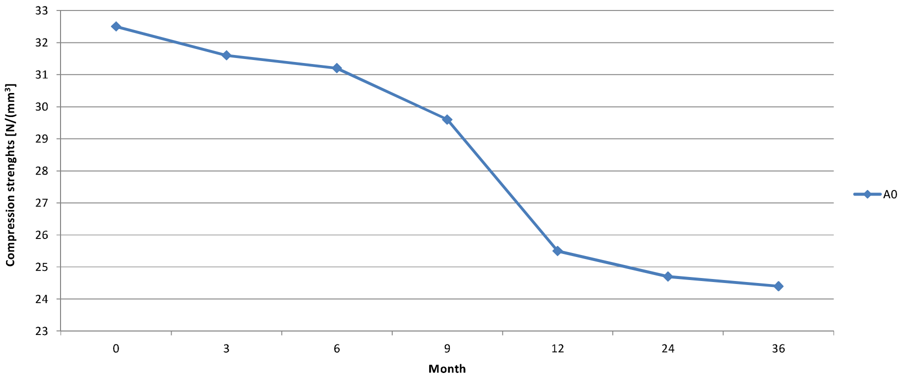

Fig. 5. Compression strengths variation during the testing

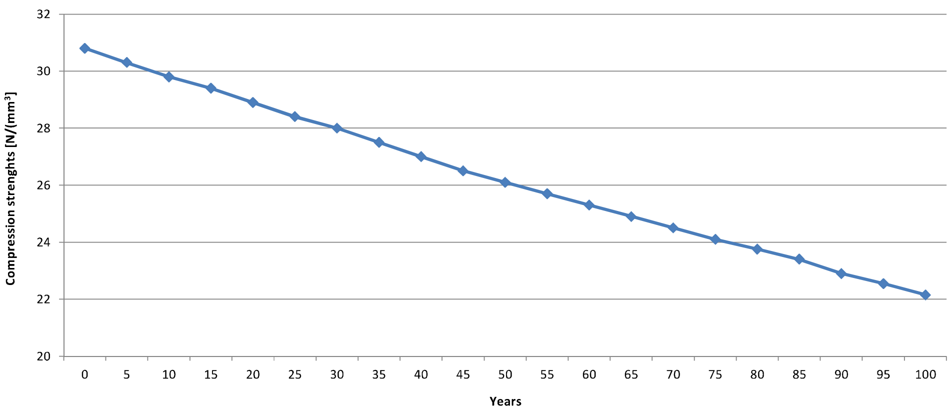

Fig. 6. Estimation of the variation of the concretes subjected to dissolving levigation
for 100 years life time mechanical strengths for 100 years life time

5. Conclusions

At the concretes subjected on dissolving levigation corrosion in the presence of the softened worm water evident degradations are appearing beginning with 7-8 exploitation years.

The pH is significantly modifying and will not ensure the reinforcement's protection.

The water permeability of the concrete is increasing.

The mechanical strengths are significantly and rapidly decreasing in the first period of the life cycle (15 years) a then, by the calcium hydroxide dissolving the strengths are continuously but in a reduced percent decreasing.

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