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# Influence of Drying on Accelerated Carbonation Testing of Concrete

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## 1 Introduction

Accelerated tests are generally carried out to determine carbonation resistance of concrete and to assess the influence of various parameters of formulation, curing or ageing. Varying experimental conditions are used for the tests. In European level, there is not a consensus for accelerated carbonation tests (prTS 12390-12, NF XP P18-458). The $CO_2$ concentration and the drying conditions of specimens before $CO_2$ exposure vary influencing the carbonation kinetics. The aim of the present work is to better understand the influence of drying conditions and moisture content of concrete on its carbonation kinetics during accelerated test.

## 2 Materials and Methods

A formulation of concrete with 275 kg/m$^3$ of CEM II/A-LL 42.5 R cement (according to EN 197.1 standard), 0.7 water-cement ratio and siliceous aggregates was used for the tests. This formulation is representative of that used in France for building constructions in the 50's and the 60's presenting today many problems of corrosion of the reinforcement. Two types of cylindrical specimens were prepared and covered with aluminum sheet in order to expose only the free surface of concrete specimens or the lateral cast surface. Both types of specimens were exposed to different drying conditions before accelerated carbonation testing:

- 14 days at 80 ± 2°C plus 7 days at 20 ± 2°C and 65 ± 5% RH;
- 14 days at 45 ± 2°C plus 7 days at 20 ± 2°C and 65 ± 5% RH;
- 87 days at 20 ± 2°C and 50 ± 5% RH plus 7 days at 20 ± 2°C and 65 ± 5% RH in order to reach the same loss of weight than the drying at 45°C for 14 days.

The accelerated carbonation tests were carried out in 3% $CO_2$, 20 ± 2°C and 65 ± 5% RH for 70 days. The carbonation depth was measured with phenolphthalein at 0, 28, 56 and 70 days as well as the height of water capillary absorption after saturation of specimens with colored water.

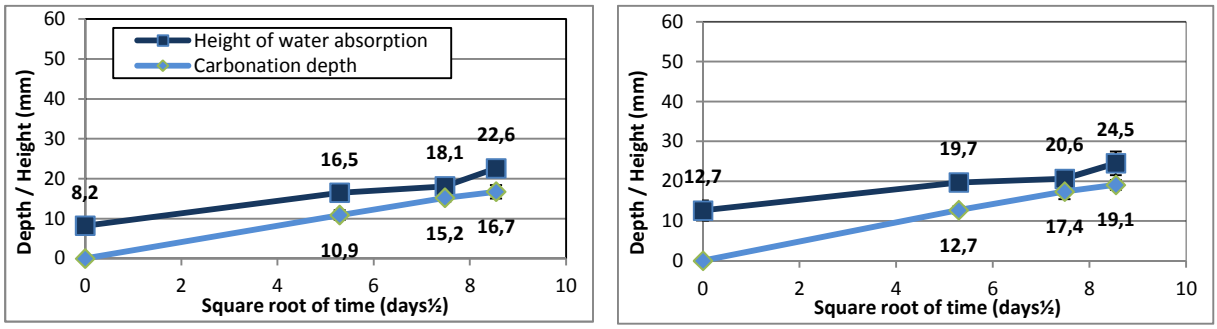
## 3 Results and Discussion

The loss of weight per unit of exposed surface through the free surface of concrete was between 2 and 2.5 times higher than that through the cast surface for the different drying conditions. 80°C drying eliminates also an amount of water between 2 and 2.5 times higher than that at 45°C. The height of water absorption at the end of drying presents reduced differences between the two types of exposed surfaces (free or cast) than the loss of weight

but stronger differences between the three drying conditions.

The carbonation depth progresses almost linearly with the square root of testing time (Figure 1), consequently a carbonation rate was calculated. The carbonation rate for different types of exposed surface and drying conditions is relatively close, nevertheless, the values are more influenced by the drying conditions than the type of exposed surface.

The height of water absorption increases during accelerated tests in spite of the fact that carbonation reaction releases water and that the specimens present during testing a gain of weight (Figure 1).




(a) (b)

**Figure 1**. Carbonation depth and height of water absorption as a function of square root of testing time after 45°C drying for 14 days, (a) through the cast surface, (b) through the free surface.

## 4 Conclusions

The results show that there is a significant difference in the loss of weight per unit of exposed surface through the cast and the free surface of specimens. The height of water absorption through the cast and the free surface is also significantly different. But, the drying condition before accelerated carbonation tests has more influence on the carbonation rate of concrete than the type of the exposed surface. However, the carbonation rates through both types of surfaces and for the three drying conditions are relatively close. The comparison of carbonation depth and height of water absorption during accelerated tests show that the height of water absorption was systematically higher than the carbonation depth. Moreover, the height of water absorption increases during testing while the carbonation releases water and the specimens present globally a gain of weight. The hypothesis of moisture redistribution in concrete during accelerated carbonation tests was advanced to explain the increase of the unsaturated layer thickness in concrete.

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