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# Chloride transport on partially saturated Concrete media: the influence of the hydric state

Hayet Chalabi[a,*], Abdelillah Bezzar[a], Abdelhafid Khelidj[b]

[a] *Department of civil engineering, faculty of technology, university of Tlemcen, Algeria*
[b]*LUNAM, GeM, IUT of Saint-Nazaire, university of Nantes,France*

**Abstract**

Transport of chloride in unsaturated concrete media is largely controlled by various phenomena occurring during the kinetics of the penetration of the ions chlorides within this media. This article studies the influence of the hydric rate of cementitious material on the penetration of chlorides. This transfer test was performed which insures an optimal contact of the material with a chloride solution without perturbing the hydric state of the material during these tests and by taking into account the fixation of chlorides on the matrix materiel. The results showed the important effect of the rate of saturation on the chlorides transfer and fixation.


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*Keywords:* diffusion; transport; convection; chloride; humidity; degree of saturation

## 1. Introduction

Reinforced concrete structures in seaboard are exposed to aggressive environments, chloride transfer within concrete is often responsible on corrosion of structural steel [1]. This parameter, was frequently studied in saturated cementitious media in this case the movement of chloride ions occur by diffusion under a concentration gradient, but in reality, the construction is not always saturated; e.g. of a structure subjected de-icing agent or a construction in

* Corresponding author. Tel.: +213-696-390-573.
E-mail address: hayet.cha@hotmail.com

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marine environment which can have various rate of saturation (tidal zone), inside this media the transport of chlorides arises by other mechanisms. Few experimental approaches are used in this purpose. [2] Use an innovative method which consists to insure a limited rate of chloride in the form of gas on the surface of the sample the chloride of hydrogen HCl gaz obtained by the combustion of the PVC. [3] Studied the effect of drying and moistening on the transfer of chlorides in a concrete partially saturated by means of a device which feigns the cycles of drying / moistening automatically. [4] test samples already immersing in a salt solution after that conditioned in 65 and 85 % humidity a duration of 2 hours follow-up by a drying to take back the same initial conditions. In the works [5,6] to avoid perturbing the state of saturation, the sample is submitted to chlorides under a solid state. All the experimental approaches used in the works quoted previously showed the strong dependence between the state of saturation of the material and the transfer of chlorides in spite of the difficulty controlling the hydric state of the material during the test.

In this present work, we proceeded to the study of the effect of the hydric state on the transfer of chlorides within a disk of the ordinary concrete (W/C=0. 5) conditioned in various hydric states. The evolution of the concentration of chlorides within the material was presented by chlorides concentration profiles.

**Nomenclature**

| | | | |
|---|---|---|---|
| WS | water saturation | W | water |
| $M_h$ | mass at natural water contents | C | cement |
| $M_d$ | mass after oven dry (at 65 °C) | $C_B$ | bound chloride |
| $M_s$ | mass in water saturation | $C_F$ | free chloride |
| | | A,B | constants |

## 2. Materials and methods

### *2.1. Materials:*

A CEMII 42.5 cement is used, and calcareous sand 0/4 fraction. Three fractions of calcareous gravel are used 3/8, 8/16 and 16/20.

### *2.2. Concrete mixtures:*

The composition of concrete and the mechanical characteristics obtained cylindrical specimens (22*11) cm are presented in the table 1. The specimens were exposed 24 hours in the ambient air then they are immersed in the water during 3 months in an ambient temperature to assure a complete hydration of cement.

Table 1. Concrete mixtures and properties

| Concrete mixtures (Kg/m3) | |
|---|---|
| Gravel 16-20 mm | 533 |
| Gravel 8-16 mm | 432 |
| Gravel 3-8 mm | 144 |
| Sand | 660 |
| Cement | 350 |
| Water | 175 |
| W/C | 0.5 |
| **Concrete properties** | |
| 28 Day water porosity (%) | 11.3 |
| 90 Day water porosity (%) | 10.90 |
| 28 Day compressive strength (MPa) | 39.14 |
| 90 Day compressive strength (MPa) | 44 |

A disk of 5 cm height is sliced in the middle of the specimen, this thickness often used as coatings applied reinforced concrete structures in marine environment. Two layers of epoxy resin covered the surface sample for to