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Behaviour of Surface Chloride Concentration in Concretes Subjected to Field Exposure in Marine Atmosphere Zone

Gibson R. Meira[1], Pablo R. R. Ferreira[2], Maria S. Freitas[3] and Carmen Andrade[4]

[1] Paraíba Federal Institute, Civil and Environmental Eng. Post-graduate Program of UFPB, Av. João da Mata, 256, 58015-020, João Pessoa, Brazil, gibsonmeira@yahoo.com, gibson.meira@ifpb.edu.br

[2] Paraíba Federal Institute, Civil and Environmental Eng. Post-graduate Program of UFPB, Av. João da Mata, 256, 58015-020, João Pessoa, Brazil, pablo.r06@hotmail.com, pablo.ferreira@ifpb.edu.br

[3] Civil and Environmental Engineering Post-graduate Program of UFPB, Av. João da Mata, 256, 58015-020, João Pessoa, Brazil, mariasilvajn@gmail.com

[4] International Centre for Numerical Methods in Engineering (CIMNE), Campus Nord UPC C/ Gran Capità, S/N 08034, Barcelona, Spain, candrade@cimne.upc.edu

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1 Introduction

Surface chloride concentration (*Cs*) is one of the main parameters to feed models used to simulate chloride penetration into concrete structures. It has been observed that *Cs* tends to increase over the years (Costa and Appleton, 1999; Yang *et al.*, 2017). However, this increase tendency weakens along the time reaching a stabilisation, which can be observed after ten years of exposure time in some cases (Andrade *et al.*, 2000). This behaviour can be represented by some mathematical models, which are, in general, power or exponential functions, with a predominance of first one. This work analyses the behaviour of *Cs* in concretes exposed along 12.5 years at a marine atmosphere zone located in northeast of Brazil.

2 Experimental Work

Experimental work was based on environmental characterisation and chloride concentration measurements in concrete surface. The environmental characterization was done on temperature, relative humidity, rainfall, wind characteristics and sea-salt data. This last one was collected at places 10, 100, 200 and 500 m far from the shoreline using wet candle device. Concrete specimens, which used three different water to binder ratios, were exposed at the same places.

3 Results and Analysis

Climatic results show that temperature ranged between 16 and 33.6 ºC along this period, with an average value of 27 ºC. The relative humidity presented a fluctuation between 55 and 99 %, with an average value of 76.6 %. Higher values were reached during the winter (rainy season) that takes place mainly between May and August. Wind speed data ranged between 1.5 and 7.6 m/s, with average value in this period around 3 m/s. Predominant wind directions were south (S), southeast (SE) and East (E), with a preponderance of SE winds.

Average chloride deposition data ranged between 520 mg/m^2.day to 15 mg/m^2.day for distances from 10 m to 500 m from the shoreline, respectively.

Results of the surface chloride concentration presented some fluctuation in the first exposure months, followed by a period of significant increase and afterwards a tendency of increase at lower rates, which suggests a tendency of reaching a maximum along time but that was not possible to be observed in these 12.5 years of exposure. Considering that the time is not the main variable that influences *Cs* increase, but the availability of chlorides in atmosphere, the relationship between *Cs* and the accumulated deposition of chlorides on the wet candle (*Dac*) was analysed and it was observed that this relationship could be represented by a power function (Figure 1), which has the advantage of taking into account the direct relation between the chlorides present in atmosphere and those captured in concrete surface.

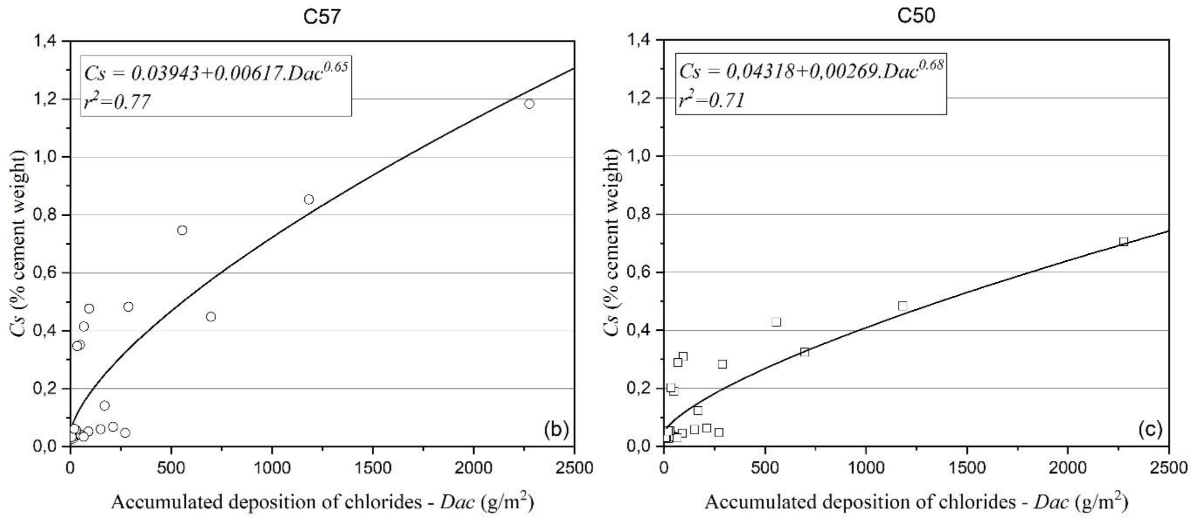

Figure 1. Relationship between *Cs* and *Dac* for concretes C57 (b) and C50 (c).

4 Conclusion

As the availability of chlorides in atmosphere plays an important role in *Cs* behaviour, the best function to represent the relationship between *Cs* and the availability of chlorides in atmosphere is $Cs = C_0 + k_{cs}.(Dac)^n$, where *Cs* is the surface chloride concentration, C_0 is the initial chloride concentration in concrete, k_{cs} is a coefficient associated to the concrete ability in capturing chlorides from atmosphere, *Dac* is the accumulated deposition of chlorides and *n* is a coefficient associated to the rate of *Dac* increase along the exposure time.

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