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Discussion

A reply to the discussion by M. Collepardi of the paper, "Influence of high temperature and low humidity curing on chloride penetration in blended cement concrete"☆

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The authors would like to thank Professor Collepardi for his comments regarding the paper. The discusser has made a substantial contribution to the topic of chloride penetration into concrete. The references quoted [1–3] in the discussion augment the literate review in the paper and serve to properly acknowledge contributions from previous early research in the field. Most of the references, however, are in Italian and not available to the authors.

The focus of the paper was on the effect of low humidity and high temperature curing on chloride penetration in concrete. This type of curing attempts to stimulate the curing conditions of concrete in hot dry countries and is different from the type of curing that the discusser investigated. The authors cured their specimens at high temperature and normal temperature. Also, the relative humidity varied from 25% to 100%. Details of the curing methods are presented in Table 1 below. For example, specimens that were cured at high temperature (curing MA and AH—Table 1) were subjected to this high temperature throughout the initial curing period of 28 days and during the exposure to chloride environment. In the case of the discusser, all paste and concrete specimens were initially subjected to curing at 25 °C for 3 months (2 months under wet sand plus month in air) before exposure to chloride solution at different temperatures of 10, 25 and 45 °C.

The chloride solution and concentration were not the same in each investigation. The discusser has used $CaCl_2$ solution (30 g/l), whereas the authors have used NaCl (175 g/l). Although the diffusion coefficient is a material property, different concentrations and different solution are not expected to yield similar results as reported in one of the discusser's paper [1].

In addition, the type and composition of pozzolan and the cement used are not the same. The alumina, iron and some other oxides (e.g., potassium, sodium) in salone pozzolana are different from those of fly ash and the silica fume used in the authors' work as shown in Table 2. The main compounds (e.g., C_2S, C_3A) of cement/clinker used in each investigation (Table 3) are also different. It is also anticipated that the specific surface area would be different for cement and pozzolan used in the investigation. These variations in composition are not expected to produce similar results.

The reference to Crank in the paper concerned the basic Fick's law of diffusion and the solution of the differential

Table 1
Details of curing methods before exposure to chloride environment

Curing (code)	After casting and before demoulding	After demoulding	
	Up to 24 hours	After 24 hours and up to 14 days	After 14 days and up to 28 days
Moist air (MA)	Covered with plastic sheeting and wet burlap at 37 °C and 25% RH	Covered with plastic sheeting and wet burlap at 37 °C and 25% RH	Exposed to air at 37 °C and 25% RH
Air (A)	Exposed to air at 37 °C and 25% RH	Exposed to air at 37 °C and 25% RH	Exposed to air at 37 °C and 25% RH
Air (AA)	Exposed to ambient conditions (20 ± 3 °C and 70 ± 10% RH)	Exposed to ambient conditions (20 ± 3 °C and 70 ± 10% RH)	Exposed to ambient conditions (20 ± 3 °C and 70 ± 10% RH)

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Table 2
Composition of the pozzolanic materials (%)

	Collepardi	Author
	Salone pozzolana	Fly ash
SiO_2	45.98	52.80
Al_2O_3	15.40	32.30
Fe_2O_3	10.64	5.80
CaO	9.13	3.40
MgO	5.00	1.20
Na_2O	2.09	0.40
K_2O	6.12	1.50

Table 3
Main compounds composition of cement and clinker (%)

	Collepardi	Authors
	Clinker	Cement
C_3S	61	47.82
C_2S	15	23.14
C_3A	3	7.56
C_4AF	11	9.69

equation. It was not cited in relation to chloride penetration in concrete. The discusser, in addition to many others, has shown that chloride penetration into concrete is a diffusion phenomena.

The other original information provided by the paper is data on the variation of chloride diffusion (D_c) and surface chloride concentration (C_0) with time for the curing regimes outlined in Table 1. The results on the variation of D_c with time agree with the results reported elsewhere (references included in the original paper). The authors [2,3] of this paper have made a contribution towards the prediction of chloride levels with the period of exposure. The variation C_0 depends upon the concrete exposure conditions. If concrete is submerged, C_0 tends to increase with the increase in chloride exposure times, whereas if concrete is subjected to frequent period of wetting and drying of chloride exposure, C_0 did not show great variation with the duration of exposure. Also, the paper attempts to relate the water absorption by total immersion and by capillary to the chloride penetration.

References

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