# Chloride penetration in ABS 410

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# Introduction

This test have been performed to a request by Rainer Ålgars, to investigate the chloride migration in ABS 410 in comparison with a reference concrete, C 35. Three samples of each material were submitted for testing.

# Chloride migration

Migration is defined as the movement of ions under the action of an external electric field, while as diffusion is defined as movement of ions under a concentration gradient. Normally, the value of the migration coefficient determined using this method is very comparable with the diffusion coefficient. A detailed investigation of the relationship between migration and diffusion is presented in [1].

# Materials

The materials tested were self-levelling screed ABS 410, delivered from Optiroc AB, Vingåker Sweden 2002-11 and a reference concrete C 35. The cement in reference concrete was OPC ("Anläggningscement", low alkali, high sulphate resistant, Portland cement for heavy constructions), delivered from Cementa AB, Degerhamn, Sweden 2002-06. The specimens were casted in a steel cylinder mould Ø 100 mm and hight 500 mm. During the first 24 hours the specimens was stored in the mould tightly covered. Thereafter the specimens were demoulded and cured under water until 28 days when testing was performed. For concrete composition, see below.

# Chloride migration test

One chloride migration test was performed, in accordance with the requirements of Nordtest method NT Build 492 [2], on each sample. The test results are shown in full details in the appendix.

The mean value of the chloride migration coefficients were found to be
$1.41 \times 10^{-12}$ [m$^2$/s] for ABS 410 and
$21.0 \times 10^{-12}$ [m$^2$/s] for reference concrete C 35.

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| Product | Sample No | Migration Coeff. [m$^2$/s] | Mean Migration Coeff. [m$^2$/s] |
|---------|-----------|---------------------------|--------------------------------|
| ABS 410 | 1 | $1.16 \times 10^{-12}$ | |
| ABS 410 | 2 | $1.83 \times 10^{-12}$ | $1.41 \times 10^{-12}$ |
| ABS 410 | 3 | $1.28 \times 10^{-12}$ | |

Table 1: Summary of Migration coefficient for ABS 410

| Product | Sample No | Migration Coeff. [m$^2$/s] | Mean Migration Coeff. [m$^2$/s] |
|---------|-----------|---------------------------|--------------------------------|
| Concrete C 35 | 1 | $21.42 \times 10^{-12}$ | |
| Concrete C 35 | 2 | $20.63 \times 10^{-12}$ | $21.0 \times 10^{-12}$ |
| Concrete C 35 | 3 | $20.81 \times 10^{-12}$ | |

Table 2: Summary of Migration coefficient for reference concrete

# References

[1] T. Luping. *Evaluation of the rapid test methods for measuring the chlotide diffusion coefficients of concrete.* SP Report 1998:42, SP Swedish National testing and Research Institute, Borås, 1998

[2] NT BUILD 492. *Concrete, Mortar and Cement-based Repair Materials: Chloride Migration Coefficient from Non-steady-state Migration Experiments.* Nordtest method 492, 1999

# Chloride Migration

| Namn: 410-030303 | |
|---|---|
| Performed | 01-04-2003 |
| Age | 28 days |
| Casting date | 03-03-2003 |

## Recipe

| Acoring to instruction from supplier |
|---|

|  | | Sample 1 | Sample 2 | Sample 3 | |
|---|---|---|---|---|---|
| Diameter | | 100 | 100 | 100 | mm |
| Thickness | | 52 | 52.5 | 52 | mm |
| Chloride concentration | | 10 | 10 | 10 | NaCl % |
| Voltage | | 30 | 30 | 30 | V |
| Electric current ($I_{30V}$) | | 14.3 | 9 | 9 | mA |
| **Start** | | | | | |
| Voltage (adjusted) | | 60 | 60 | 60 | V |
| Electric current | | 28.9 | 18 | 18 | mA |
| Temperature | | 21 | 21 | 21 | ° C |
| Duration of test | | 24 | 24 | 24 | h |
| | | | | | |
| | | | | | |
| **End** | | | | | |
| Time | | | | | |
| Electric current | | 85 | 81.5 | 68.8 | mA |
| Temperature | | 23 | 23 | 23 | ° C |
| | | | | | |
| Penetration depth | | | | | |
| $X_1$ | | 5.4 | 6.7 | 5.3 | mm |
| $X_2$ | | 5.3 | 6.0 | 6.9 | mm |
| $X_3$ | | 4.7 | 7.5 | 6.3 | mm |
| $X_4$ | | 4.4 | 8.7 | 5.4 | mm |
| $X_5$ | | 4.4 | 9.0 | 5.1 | mm |
| $X_6$ | | 5.7 | 9.7 | 5.5 | mm |
| $X_7$ | | 7.2 | 8.2 | 6.0 | mm |
| Average penetration depth | | 5.3 | 8.0 | 5.8 | mm |
| | | | | | |
| **Migration coefficient** | | **1.16** | **1.83** | **1.28** | **$x10^{-12}m^2/s$** |

## Chloride Migration

| Namn: Anl-030304 | |
|---|---|
| Performed | 02-04-2003 |
| Age | 28 days |
| Casting date | 04-03-2003 |

## Recipe

| | [kg/m$^3$] |
|---|---|
| Cement | 350 |
| Water | 205 |

| W/C | 0.59 |
|---|---|

| | | Sample 1 | Sample 2 | Sample 3 | |
|---|---|---|---|---|---|
| Diameter | | 100 | 100 | 100 | mm |
| Thickness | | 52.5 | 52.5 | 53 | mm |
| Chloride concentration | | 10 | 10 | 10 | NaCl % |
| Voltage | | 30 | 30 | 30 | V |
| Electric current ($I_{30V}$) | | 113.5 | 114 | 124 | mA |
| **Start** | | | | | |
| Voltage (adjusted) | | 20 | 20 | 15 | V |
| Electric current | | 78 | 78 | 61 | mA |
| Temperature | | 23 | 23 | 23 | ° C |
| Duration of test | | 24 | 24 | 24 | h |
| | | | | | |
| | | | | | |
| **End** | | | | | |
| Time | | | | | |
| Electric current | | 68 | 67 | 54 | mA |
| Temperature | | 23 | 23 | 23 | ° C |
| | | | | | |
| Penetration depth | | | | | |
| $X_1$ | | 29.4 | 30.2 | 22.4 | mm |
| $X_2$ | | 28.5 | 27.1 | 23.0 | mm |
| $X_3$ | | 28.7 | 29.4 | 20.3 | mm |
| $X_4$ | | 26.2 | 29.8 | 20.3 | mm |
| $X_5$ | | 30.3 | 25.7 | 20.2 | mm |
| $X_6$ | | 28.4 | 30.1 | 21.8 | mm |
| $X_7$ | | 29.1 | 21.4 | 19.8 | mm |
| Average penetration depth | | 28.7 | 27.7 | 21.1 | mm |
| | | | | | |
| **Migration coefficient** | | **21.42** | **20.63** | **20.81** | **x10$^{-12}$m$^2$/s** |

# Concrete recipe

| Location: | Lund University | | | Casting date: | | 04-03-2003 | |
|---|---|---|---|---|---|---|---|
| Name of recipe: | Anl-030304 | | | Sign: | | | |

| Basic recipe | | | | Actual volume (m$^3$) | | | 0.02 |
|---|---|---|---|---|---|---|---|
| | Weight kg/m$^3$ | Density kg/dm$^3$ | Moisture % | Volume l/m$^3$ | | | kg |
| Degerhamn Anl. OPC | 350 | 3.2 | | 109.375 | | | 7.000 |
| | | | | | | | |
| | | | | | | | |
| Water | 168 | 1 | | 168 | | | 3.360 |
| Total water | 205.2 | | | | | | |
| Air (%) | 2% | | | 20 | | | |
| | | | | | | | |
| Aggregate | | | | | | | |
| 0-8 mm | 931.008 | 2.65 | 4% | 351.324 | | | 18.620 |
| 8-11 mm | 465.504 | 2.65 | | 175.662 | | | 9.310 |
| 11-16 mm | 465.504 | 2.65 | | 175.662 | | | 9.310 |
| | | | | | | | |
| Sum (total weight kg) | 2585.2563 | Total volume (l) | | 1000.0 | | | 47.60 |

| W/C | 0.586 |
|---|---|