Development of Concrete Water Absorption Testing for Quality Control

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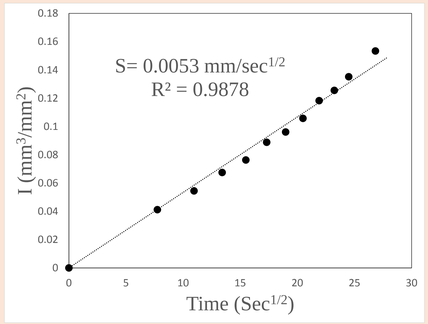
1. INTRODUCTION

- One of the basic and most important properties related to concrete durability is water absorption.
- Hall (1981) investigated that the cumulative amount of absorbed water by concrete material has a linear relationship with square root of absorption time. The slope of this trend is called sorptivity.

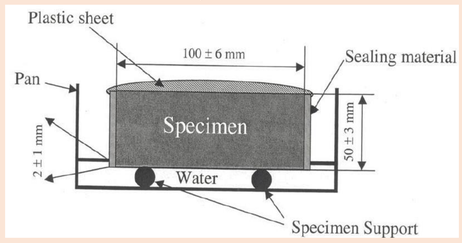
$$i = S.t^{-0.5}$$

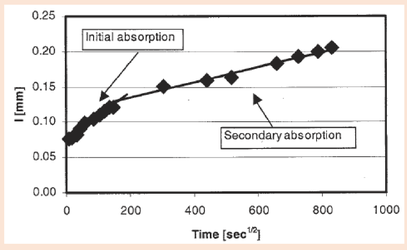
Where;

i: Cumulative volume of absorbed water per unit of area (mm^3/mm^2)
S: Sorptivity index ($mm/s^{0.5}$)

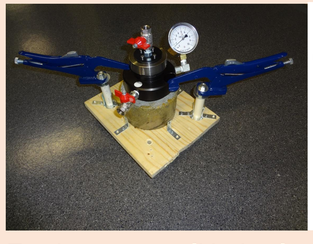


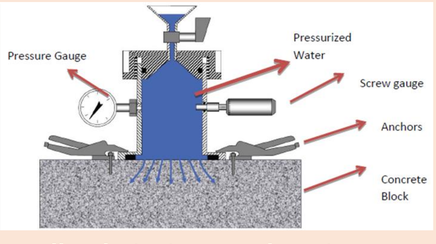
- There are some standard methods to perform this test in laboratory conditions; in North America, the most common is ASTM C 1585.





- There are also some methods for in-situ sorptivity measurements, like GWT-4000.





- Two important conditioning factors affect the in-situ water absorption test results. This may cause serious misleading in concrete durability evaluation.
  1.Conditioning Temperature
  2.Concrete Moisture Content

2.EXPERIMENTAL PROGRAM

❑Materials:

Test specimens were manufactured using concrete mixtures of two construction projects in Montreal, QC, Canada.

Contents (Kg/m^3)						Properties		
W/C	Cement	Supplementary Materials	Water	Gravel	Sand	Air (%)	Slump (mm)	Strength (MPa)
0.42	283	71 (Ternary Cement = 78% PC+22% Slag+5% Silica Fume)	149	1051	810	5-8	30±10	32
0.40	292 (with 5% SF)	73 (Class F fly ash)	131	975	819	5-8	140±40	35

❑Specimens Curing and Conditioning:

Twenty-seven 75mm height and 150mm diameter cylindrical size specimens were manufactured at each site using cardboard tube formwork.

Laboratory Trial:

1. Moist cured at project site **for one day to one week** (same as curing process of real concrete element).
2. Remained in the molds in an exposed weathering condition (similar to the project site) **for 3 to 4 weeks**.
3. Moved to the lab and unmolded. Side and bottom surfaces were painted with epoxy.
4. Saturated by immersing in water **for 3 days**.
5. Moved to oven for drying periods of **2, 3, 5, 7, 10 and 14 days** at **45˚C**.
6. Placed in sealed plastic bags **for one month**.

0.42 walkway with curing compound

0.40 bridge deck with wet covering

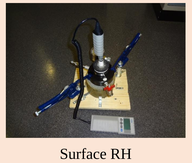
- ❖ In order to investigate the effect of temperature, sorptivity tests were performed at 3 different conditioning temperatures of 5, 23 and 40˚C at a constant moisture content.
- ❖ The outdoor exposure samples were placed in outdoor conditions after the initial curing of one month.

❑Testing:

➢Moisture content
Two indices were used to evaluate the concrete moisture content:
- Saturation degree
- Surface Relative Humidity

➢Temperature

➢Sorptivity
This measurement was carried out using a commercial apparatus, GWT 4000, developed by Germann Instruments.

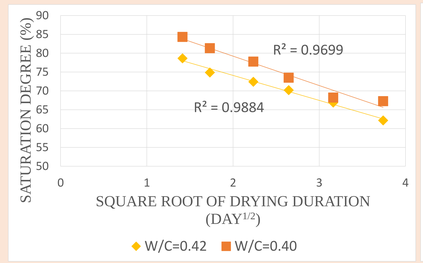


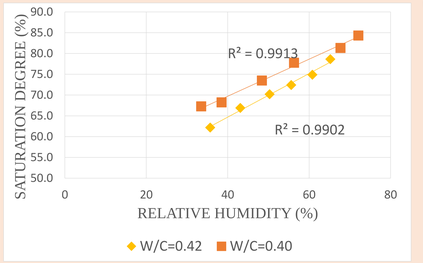
Surface RH measurement

Temperature measurement

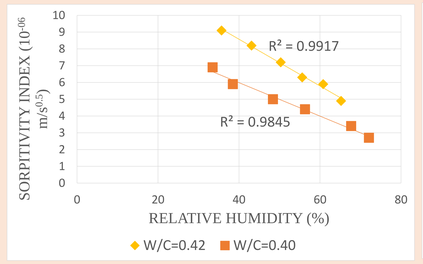
3. RESULTS AND CONCLUSIONS

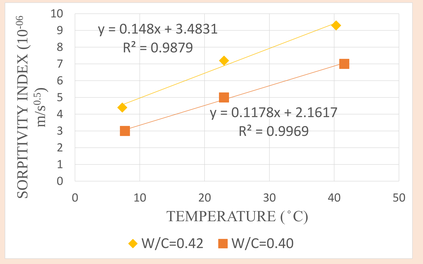
❑Laboratory Measurements





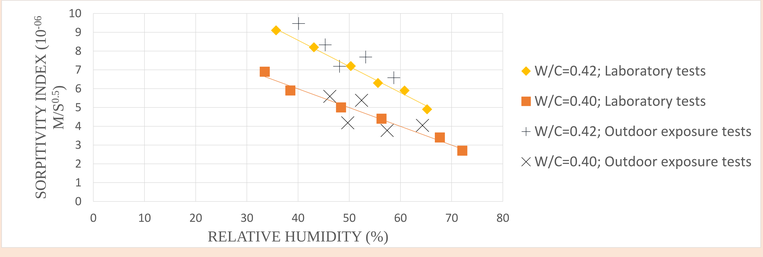
✓Moisture content decreases linearly by increasing of square root of drying duration.
✓Surface Relative Humidity has linear dependence on saturation degree.





✓ Sorptivity index decreases linearly with decreasing in surface RH.
✓ Sorptivity index increases linearly with increasing in conditioning temperature.

❑ Outdoor Exposure Measurements



✓ Outdoor measurements shows acceptable correlation with laboratory results.

4. OVERALL CONCLUSION

➢ **In-situ sorptivity measurements are fast and practicable methods for non-destructive concrete durability evaluation, but to avoid wrong data, test results should be calibrated to the standard laboratory conditions in the terms of concrete moisture content and temperature.**