How the Prominent Types of Deicers Affect Scaling

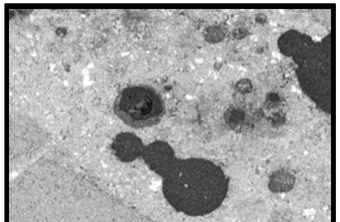
Jan Olek, PhD, PE
HyunGu Jeong, Mirian Velay-Lizancos,
Lyles School of Civil Engineering
Purdue University,
West Lafayette, IN, USA

Daniel K. Pannell, Robert Geiger
Compass Minerals, Overland Park, KS

Overview

1. Introduction
2. Aims of the study
3. Materials and methods
4. Results and discussion
5. Conclusions

1. Introduction



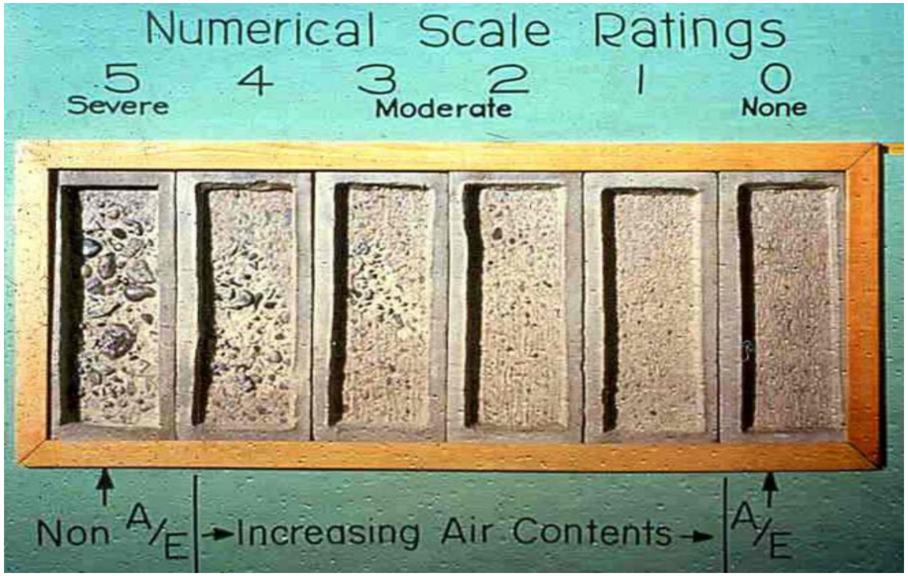
Poor quality air void system

Early deterioration
Local flaking of the surface

Scaling

2. Aims of the study

To evaluate the effect of **different types of deicers** on the **scaling resistance** of four commercial-grade concretes, with and without fly ashes



ASTM C 672

Scaling

3. Materials and methods

Concretes

Component	Concrete			
	A	B	C	D
Cement (kg/m^3)	335	335	234	234
Fly Ash (kg/m^3)	0	0	100	100
Water (kg/m^3)	141	151	141	151
Fine Aggregate (kg/m^3)	816	816	816	816
Coarse Aggregate (kg/m^3)	1,009	1,009	1,009	1,009
Air Entrainer (mL/m^3)	135	77	174	97
Water reducer (mL/m^3)	812	425	870	329

Plain concretes (A, B) | Fly ash Concretes (C, D)

3. Materials and methods

Concretes

Type	Concrete	w/cm	% Fly Ash (Class F)	Target air content (%)	Target Slump (in.)/(mm)
Plain	A	0.42	0	6.5	3-5/(76-127)
	B	0.45	0	4.5	3-5/(76-127)
Fly Ash	C	0.42	30	6.5	3-5/(76-127)
	D	0.45	30	4.5	3-5/(76-127)

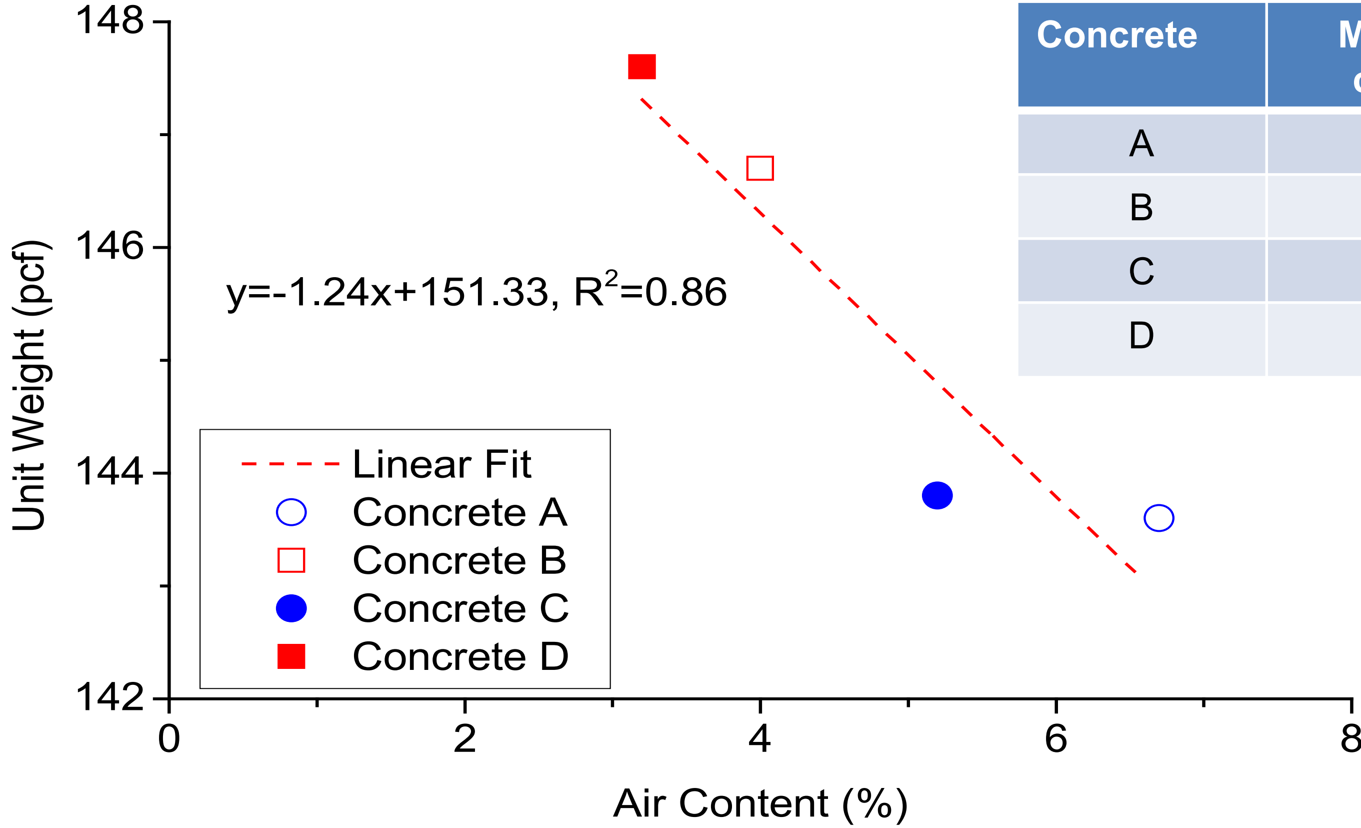
3. Materials and methods

Concretes

Concrete	Slump (in./(mm))		Air content (%)	
	Target	Measured	Target	Measured
A	3 – 5/(76-127)	3.75/(95)	6.5	6.7
B	3 – 5/(76-127)	4.25/(108)	4.0	4.0
C	3 – 5/(76-127)	3.50/(89)	6.5	5.2
D	3 – 5/(76-127)	4.50/(114)	4.0	3.2

3. Materials and methods

Concretes



Concrete	Measured air content (%)
A	6.7
B	4.0
C	5.2
D	3.2

3. Materials and methods

Deicers

$CaCl_2$

$MgCl_2$

NaCl

All deicers contained 4 grams of anhydrous salt per 100 mL of solution **(4%)**

3. Materials and methods

Tests

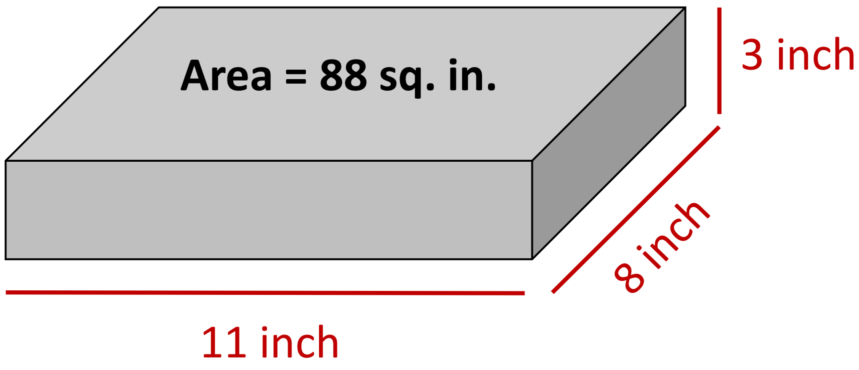
Concrete	Compressive strength (4”(d)×8”cylinders) [14, 28 and 56 days]	Chloride penetration depth (1 cylinder/solution)	RCP/CDC	Total # of cylinders (4”(d)×8”)
A	12	3	4 slices (2 Cylinders)	17
B	12	3	4 slices (2 Cylinders)	17
C	12	3	4 slices (2 Cylinders)	17
D	12	3	4 slices (2 Cylinders)	17
TOTAL	48	12	16 slices(8 cylinders)	68

+ 32 slabs (2 slabs x 4 deicers x 4 types of concrete) to evaluate the scaling resistance

3. Materials and methods

Tests

Slabs for scaling resistance evaluation (ASTM C 672)



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3. Materials and methods

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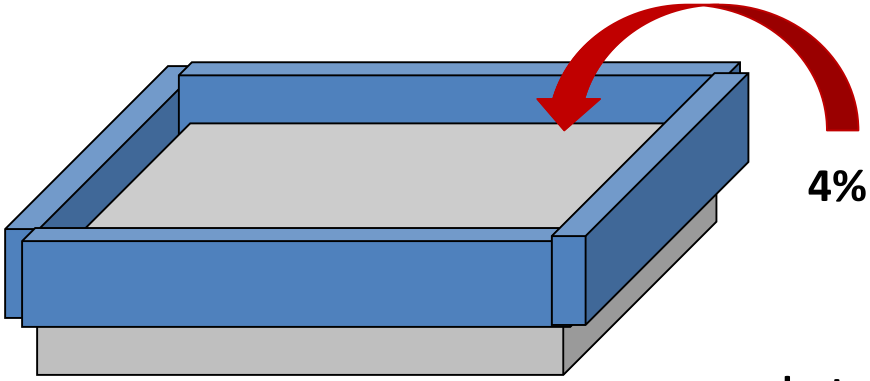
Slabs for scaling resistance evaluation (ASTM C 672)



4% deicer solution

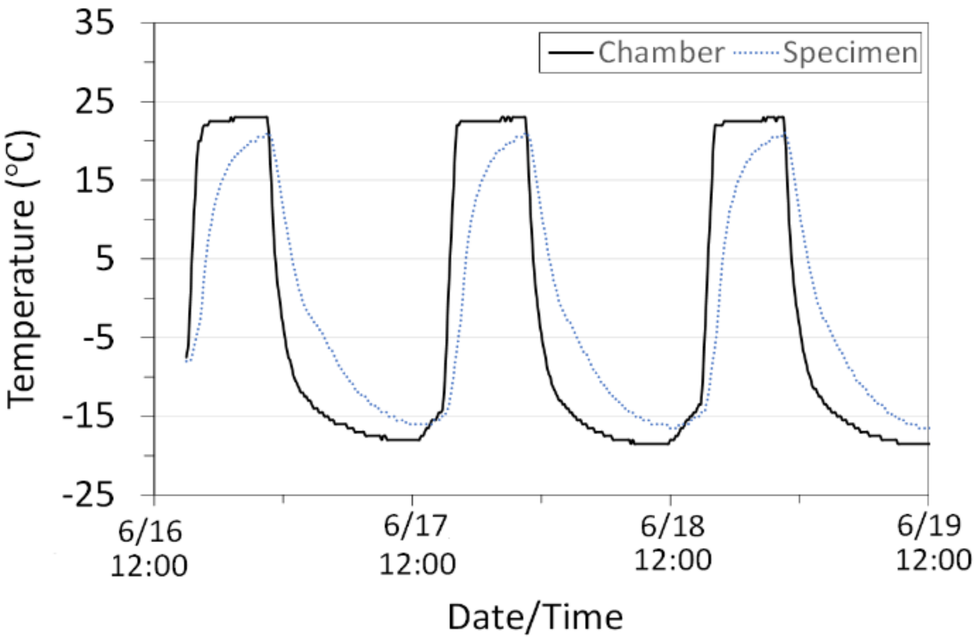
Into environmental chamber +
50 cycles of Freeze-thaw

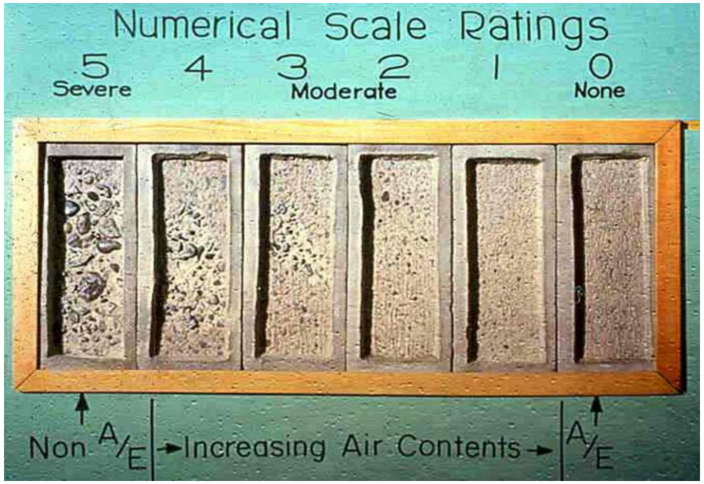
3. Materials and methods

Tests

Slabs for scaling resistance evaluation (ASTM C 672)

Into environmental chamber **+ 50 cycles of Freeze-thaw**





ASTM C 672

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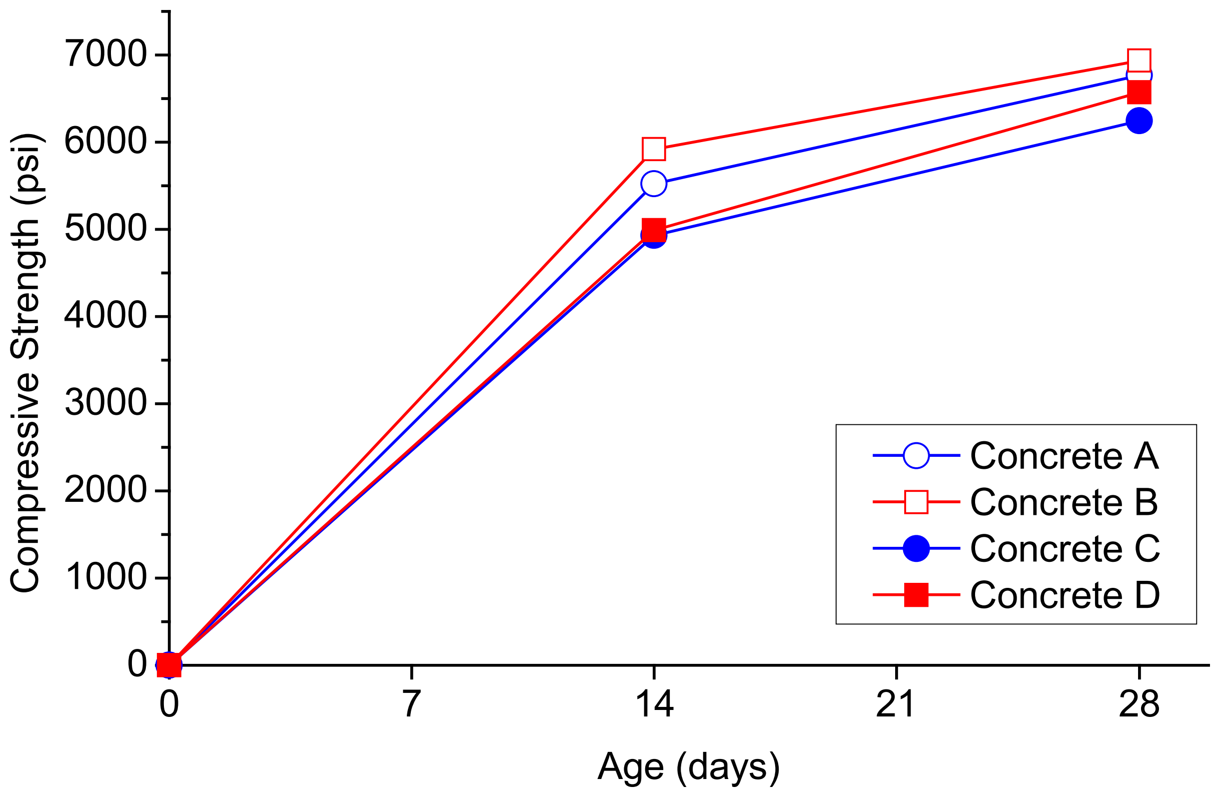
4. Results and discussion

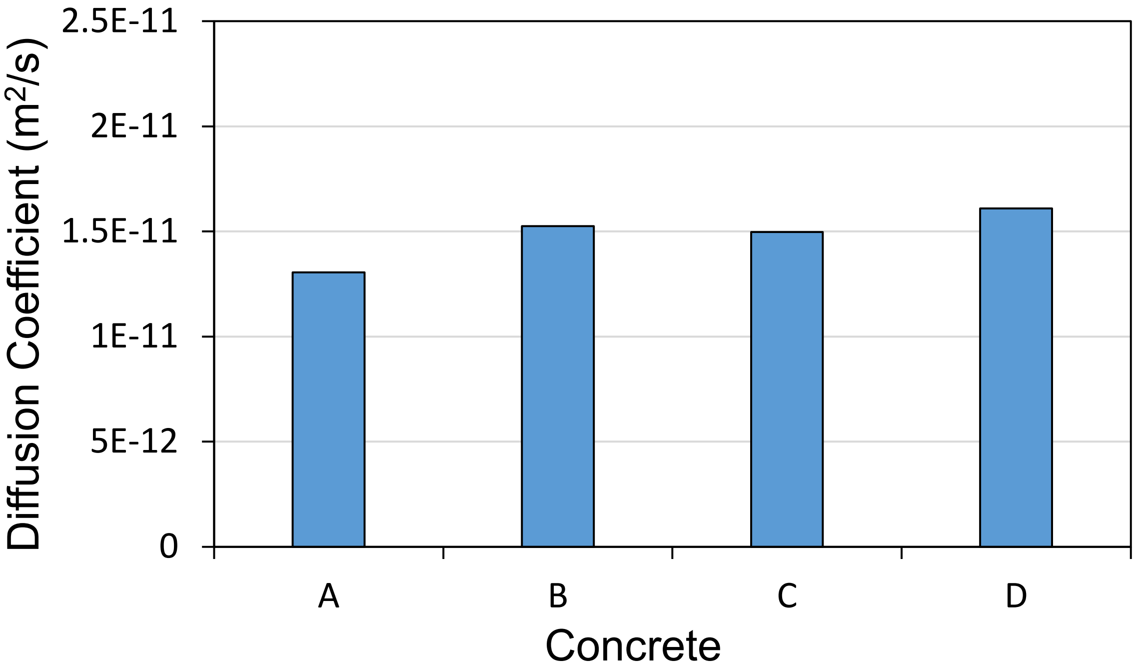
Compressive strength



Type	Concrete	w/cm
Plain	A	0.42
	B	0.45
Fly Ash	C	0.42
	D	0.45

4. Results and discussion

Chloride Diffusion



Type	Concrete	w/cm
Plain	A	0.42
	B	0.45
Fly Ash	C	0.42
	D	0.45

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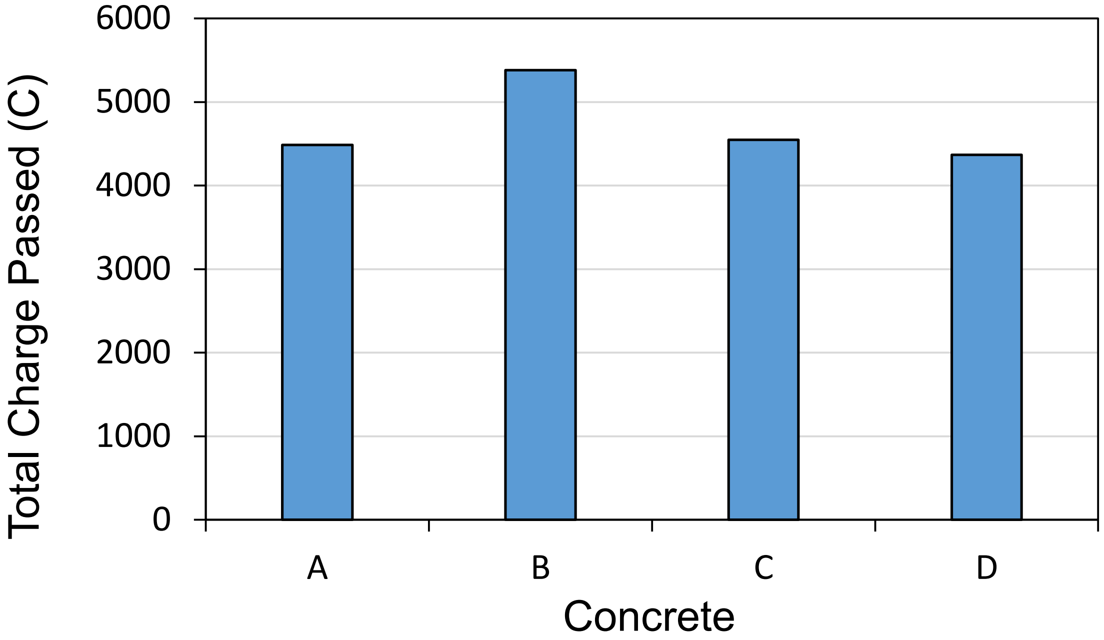
4. Results and discussion

Resistance to chloride penetration



Type	Concrete	w/cm
Plain	A	0.42
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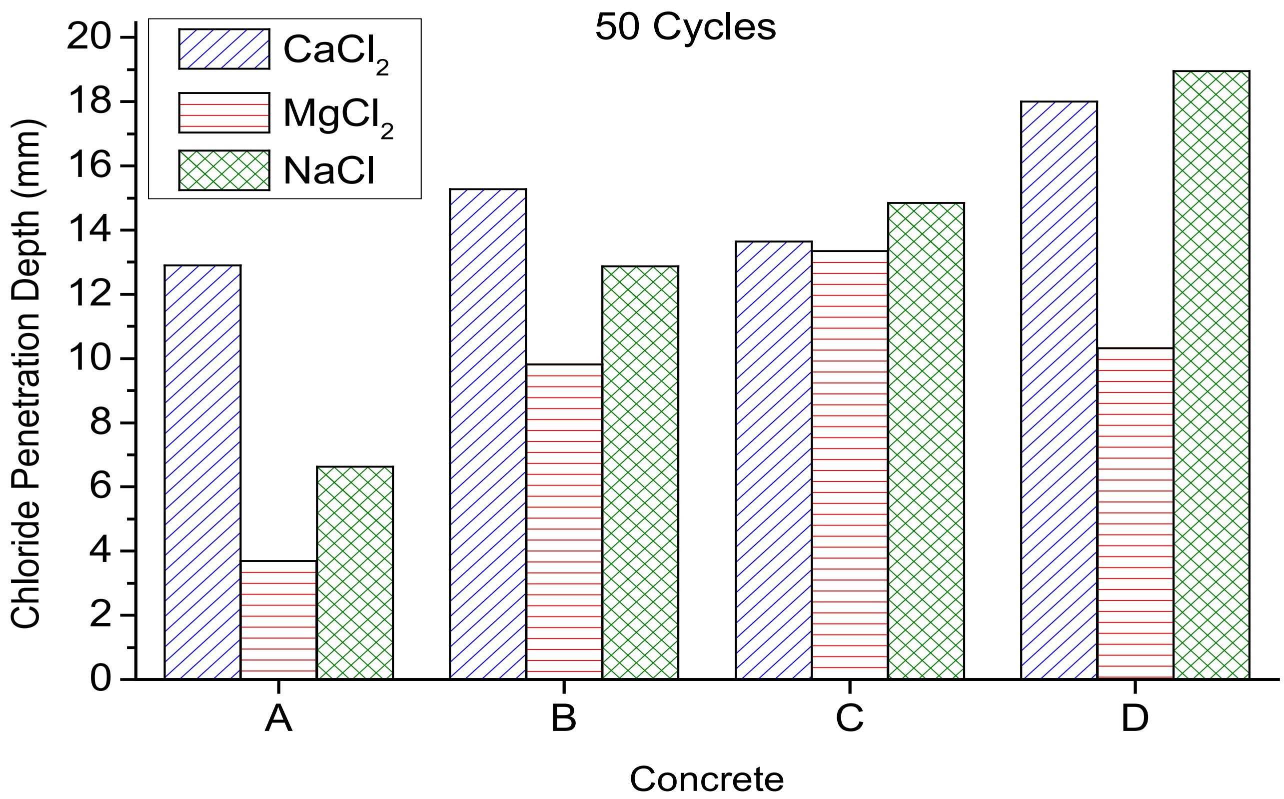
4. Results and discussion

Depth of Chloride Penetration



Type	Concrete	w/cm
Plain	A	0.42
	B	0.45
Fly Ash	C	0.42
	D	0.45

4. Results and discussion

Scaling resistance

	De-ionized water	$CaCl_2$	$MgCl_2$	NaCl
Concrete A (Plain, w/c=0.42)				
Concrete B (Plain, w/c=0.45)				

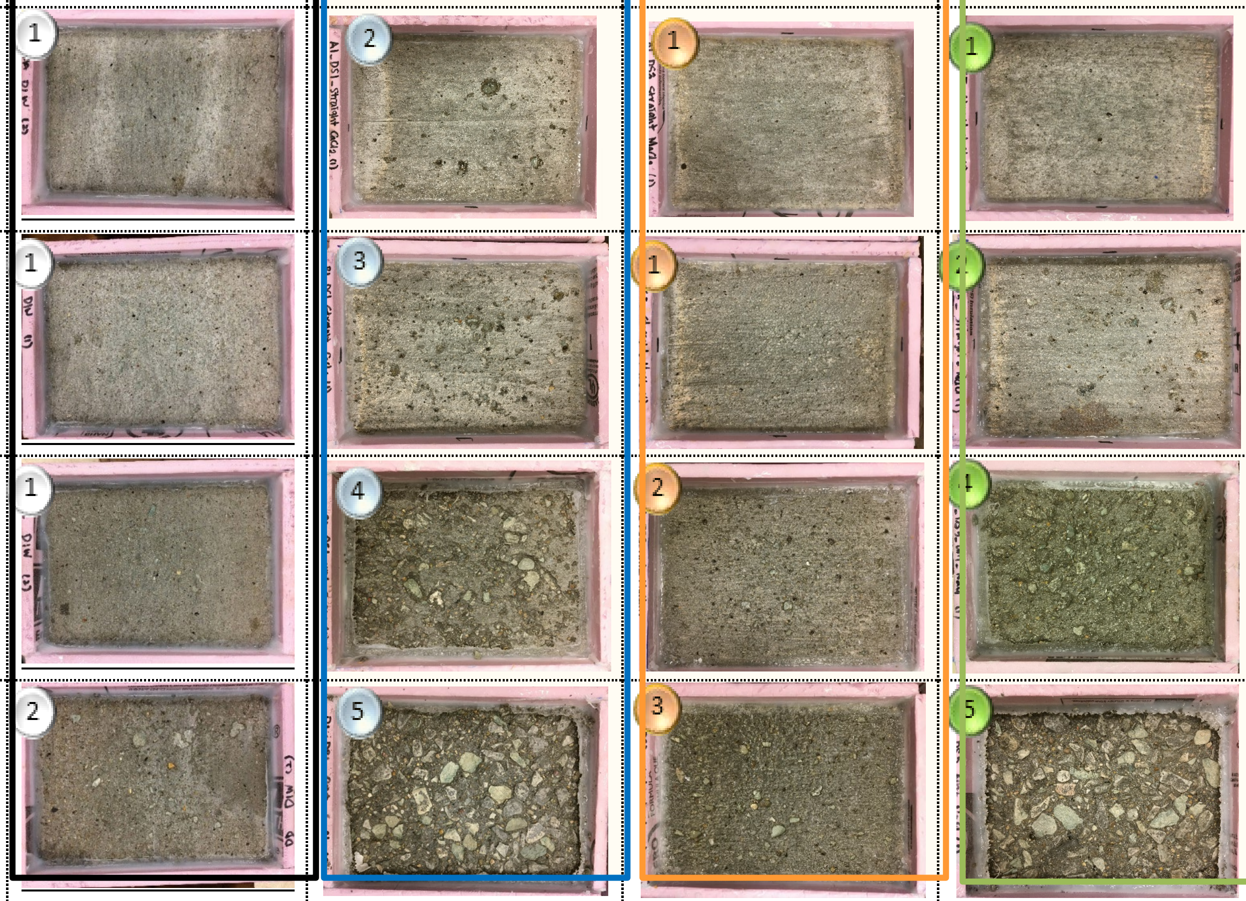
4. Results and discussion

Scaling resistance

	De-ionized water	$CaCl_2$	$MgCl_2$	NaCl
Concrete C (Fly ash, w/c=0.42)	1 	4 	2 	4 
Concrete D (Fly ash, w/c=0.45)	2 	5 	3 	5 

4. Results and discussion

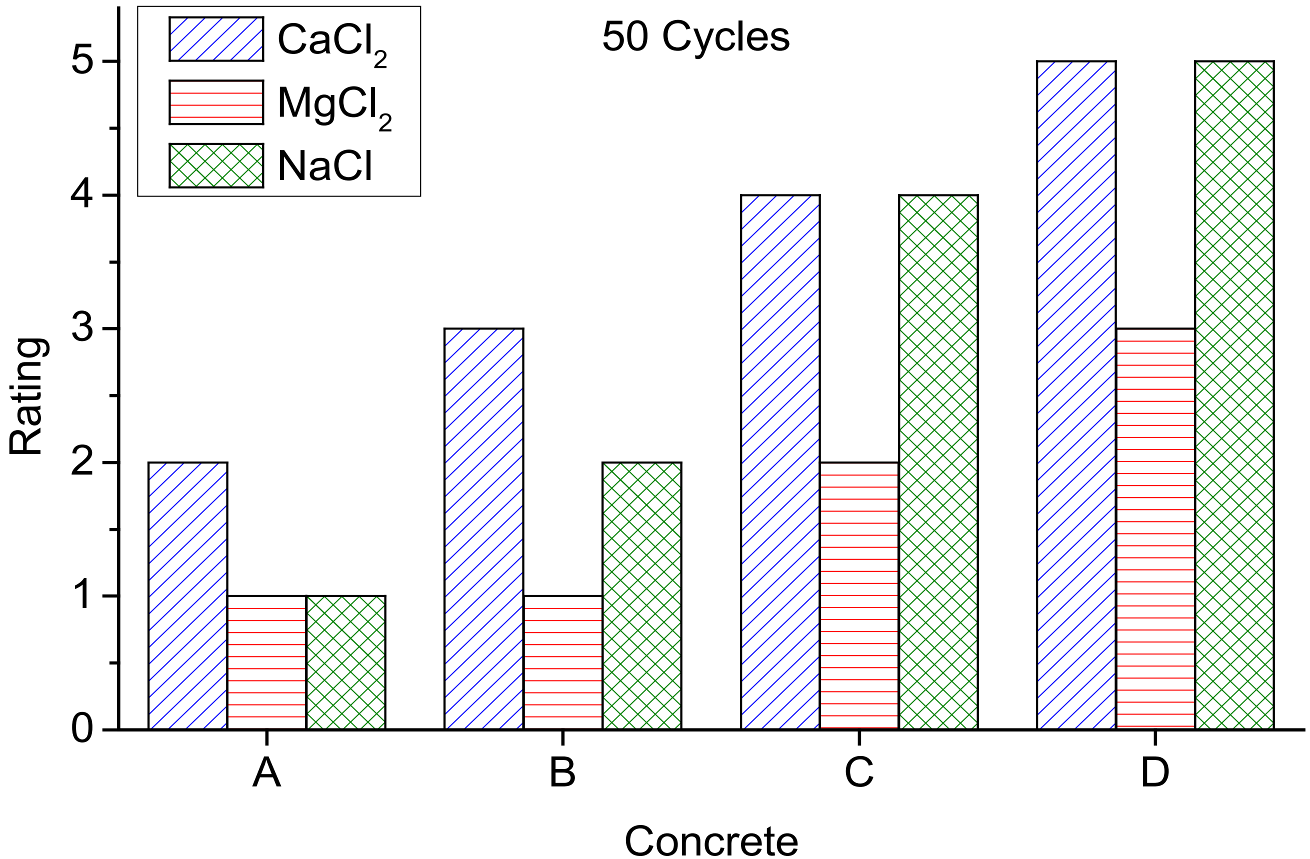
Scaling resistance



	De-ionized water	$CaCl_2$	$MgCl_2$	NaCl
Concrete A (Plain, w/c=0.42)	1	2	1	1
Concrete B (Plain, w/c=0.45)	1	3	1	1
Concrete C (Fly ash, w/c=0.42)	1	4	2	1
Concrete D (Fly ash, w/c=0.45)	2	5	3	5

4. Results and discussion

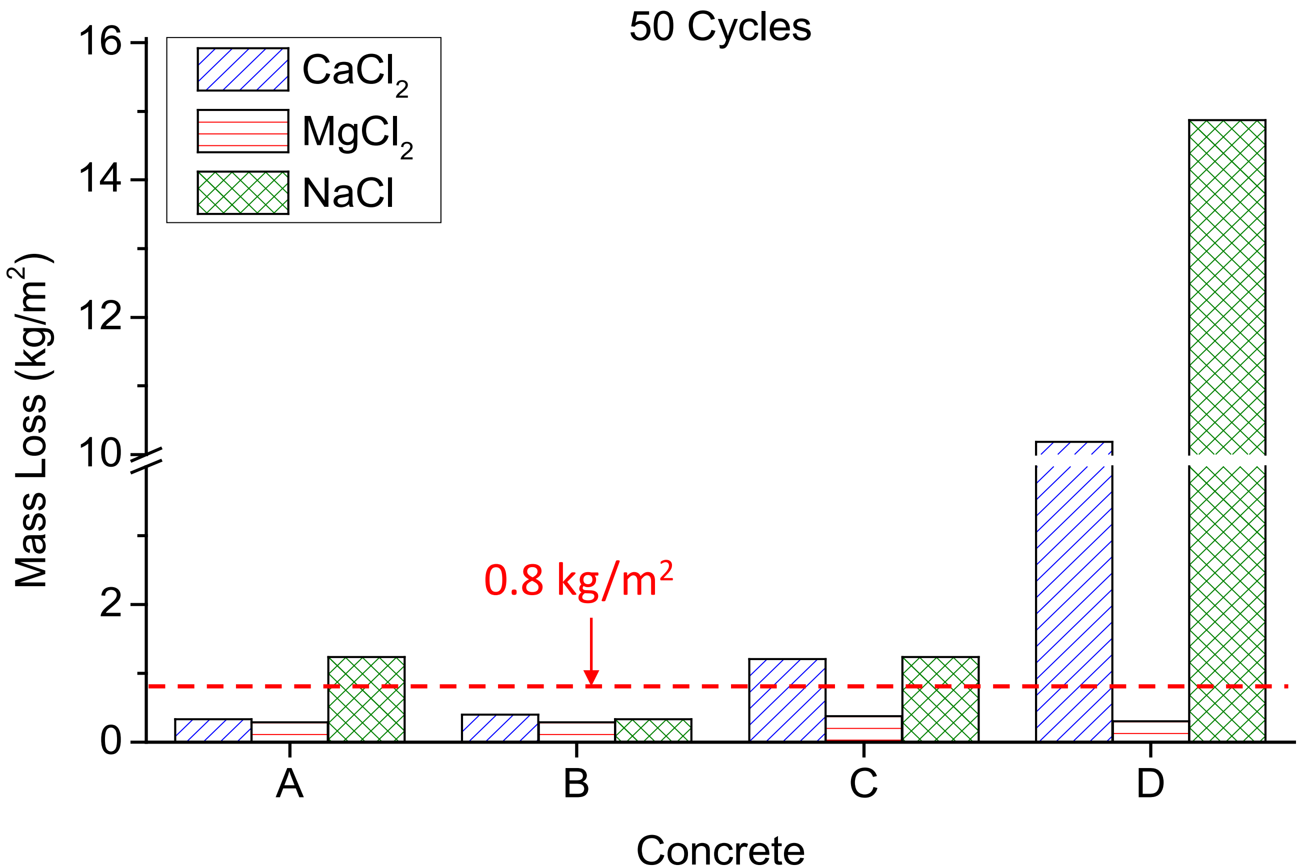
Scaling resistance



Type	Concrete	w/cm
Plain	A	0.42
	B	0.45
Fly Ash	C	0.42
	D	0.45

4. Results and discussion

Scaling resistance. **Mass loss**



Type	Concrete	w/cm
Plain	A	0.42
	B	0.45
Fly Ash	C	0.42
	D	0.45

5. Conclusions

- For all concretes studied in this paper…

  The highest chloride penetration depths were observed for cases associated with the use of **$CaCl_2$**, and the **lowest** chloride penetration depths for cases involving **$MgCl_2$**.

- The **effect of deicers** on **scaling resistance** of **plain concretes** used in this study was relatively **similar**.

- In contrast, the scaling resistance of concretes containing **fly ash** was **highly dependent on the type of deicer used.**

- In particular, the use of **$CaCl_2$ or NaCl** deicers resulted in **severe scaling**, whereas the use of **$MgCl_2$** resulted **only in slight to moderate scaling**.

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Jan Olek

Purdue University
(olek@purdue.edu)

Thank you !