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Concrete Pavements Containing PLC & SCM – A Review after 3 & 4 years

by

Ashlee Hossack, Ph.D. Candidate, University of Brunswick, Frederickton, NB, Canada

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Concrete Pavements Containing PLC & SCM – A Review after 3 & 4 years

Michael Thomas, Ashlee Hossack, Kevin Cail, Anik Delagrave, Laurent Barcelo, Bruce Blair, Ken Kazanis

UNB EST. 1785

LAFARGE

Concrete Pavements Containing PLC & SCM – A Review after 3 & 4 years

- In 2008 CSA allowed the replacement of up to 15% Portland cement with limestone
- Replacement of Portland cement with interground limestone can reduce CO_2 by 10%
- Extensive laboratory research has been conducted; this project demonstrates the field performance of concretes with varying limestone and SCM replacement levels

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Pavements

PLC-SCM pours using 3 different Lafarge cements from plants across Canada

- Bath, Ontario
  - Pavement placed in Gatineau, Quebec
  - October 2008
- Exshaw, Alberta
  - September 2009
- Brookfield, Nova Scotia
  - October 2009

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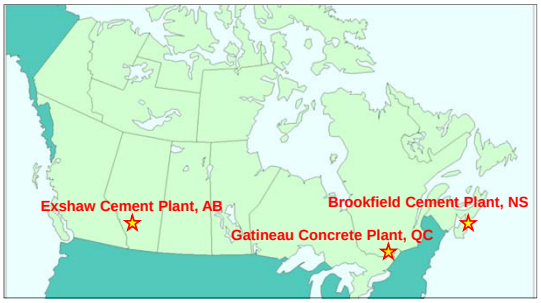
Pavement Locations



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Limestone and SCM Replacement

Brookfield Cement Plant, NS

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Limestone and SCM Replacement

Brookfield, NS

				Clinker Content (%)		
	Gypsum (%)	Limestone (%)	Slag (%)	0 Fly ash	15% FA	20% FA
PC	5	4	0	91	76	71
PC-slag	5	0	15	80	65	60
PLC-slag	5	12	15	68	53	48

- Slag was interground
  - Fly ash added at plant (0%, 15%, 20%)
- W/CM from 0.42-0.44
- Slump: 60-80mm (2 ¼ - 3 ¼ in.)
- Air: 5.8-6.6%

Field samples with PC-slag and PLC-slag only, lab samples with all 3 cements

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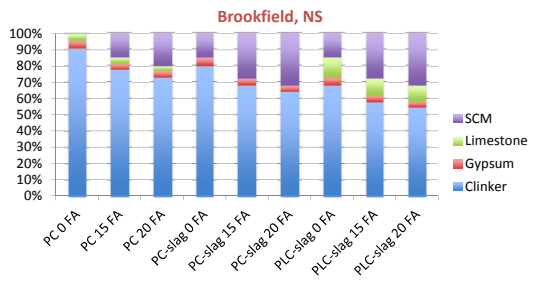
Limestone and SCM Replacement



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Limestone and SCM Replacement

Gatineau Ready-mix Plant, QC

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Limestone and SCM Replacement

Gatineau, QC

		Clinker Content (%)			
		SCM Replacement Levels (%)			
	Limestone (%)	0	25	40	50
GU	3.5%	92	69	55	46
GUL	12%	84	63	50	42

- SCM blend of 2/3 slag + 1/3 fly ash
- W/CM from 0.44-0.45
- Slump: 75-100mm (3-4 in.)
- Air: 6.0-6.8%

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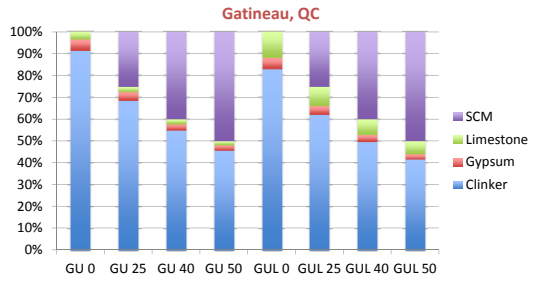
Limestone and SCM Replacement



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Limestone and SCM Replacement

Exshaw Cement Plant, AB

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Limestone and SCM Replacement

Exshaw, AB

		Clinker Content (%)			
		Fly ash Content (%)			
	Limestone (%)	0	15	25	30
PC	4	91	76	66	61
PLC	12	83	68	58	53

- Fly ash added at plant
- W/CM = 0.37-0.42

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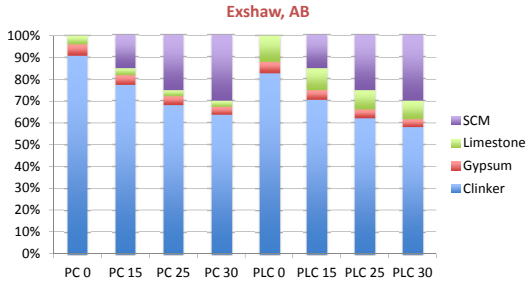
Limestone and SCM Replacement



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Results from Field samples after 3 & 4 years

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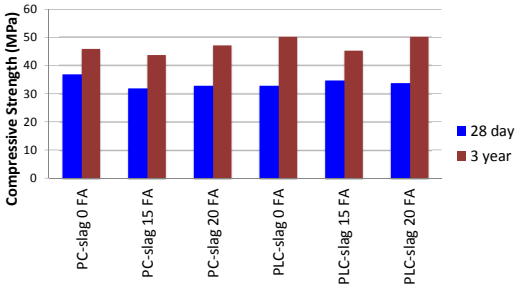
Brookfield

Compressive Strength



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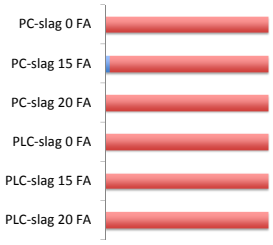
Brookfield
Carbonation

Depth of carbonation after 3yr

	Depth of carbonation after 3 years (mm)
PC-slag 0 FA	0.1
PC-slag 15 FA	1.5
PC-slag 20 FA	0.1
PLC-slag 0 FA	0.1
PLC-slag 15 FA	0
PLC-slag 20 FA	0



Carbonation with assumed 50mm (2 in.) cover

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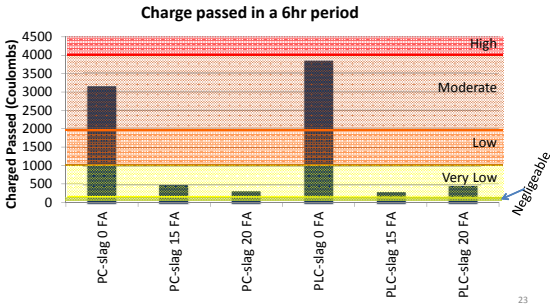
Brookfield
Chloride Permeability



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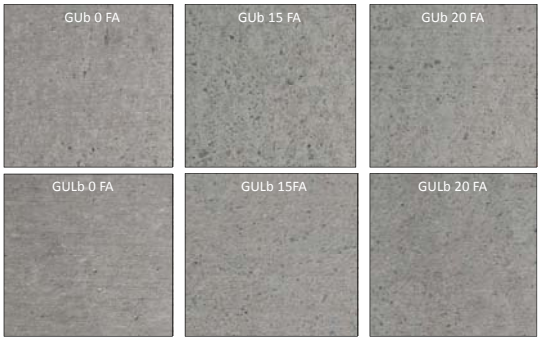
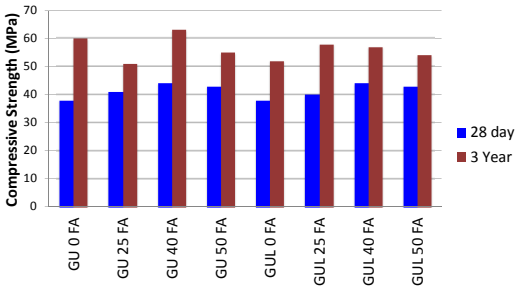
Brookfield
Scaling performance of field samples



Gatineau
Compressive Strength



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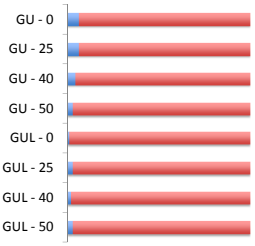
Gatineau
Carbonation

Depth of Carbonation after 4yr

	Depth of Carbonation after 4 years (mm)
GU - 0	3
GU - 25	3
GU - 40	2
GU - 50	1.5
GUL - 0	0.5
GUL - 25	1.5
GUL - 40	1
GUL – 50	1.5



Carbonation with assumed 50mm (2 in.) cover

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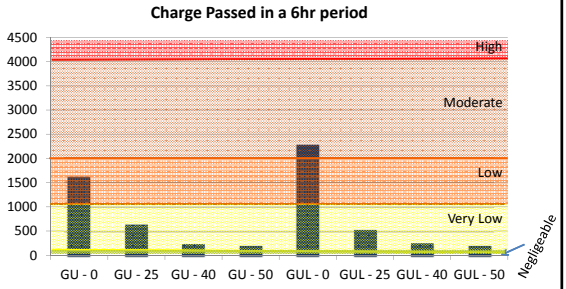
Gatineau
Chloride Permeability



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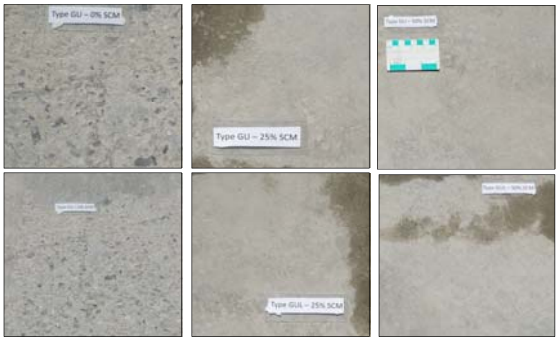
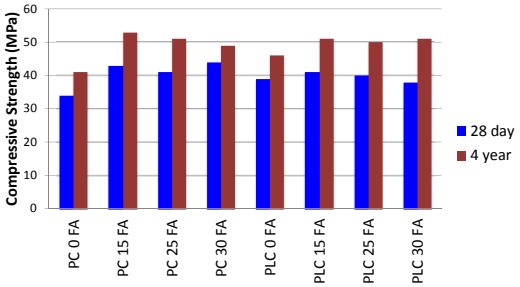
Gatineau

Scaling performance of field samples



Exshaw

Compressive Strength



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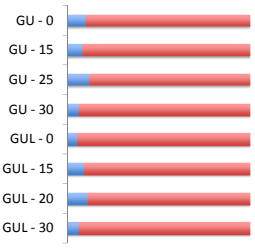
Exshaw

Carbonation

Depth of Carbonation after 3yr

	Depth of Carbonation after 3 years (mm)
GU - 0	5
GU - 15	4
GU - 25	6
GU - 30	3
GUL - 0	2.5
GUL - 15	4.5
GUL - 25	5.5
GUL - 30	3



Carbonation with assumed 50mm (2in.) cover

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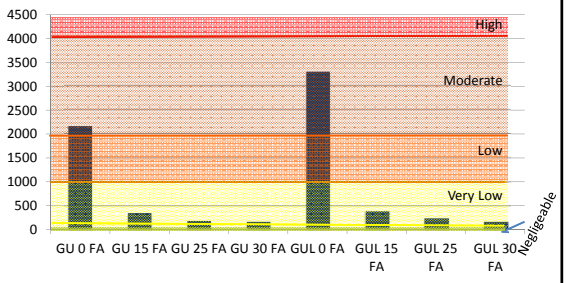
Exshaw

Chloride Permeability

Charge Passed in a 6hr period



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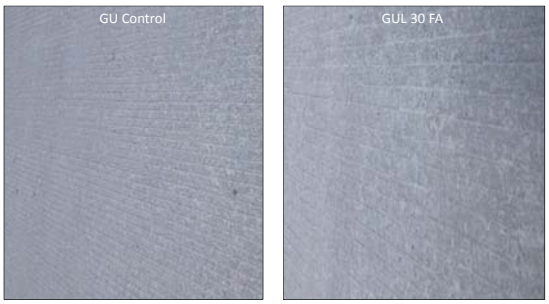
Exshaw

Scaling performance of field samples



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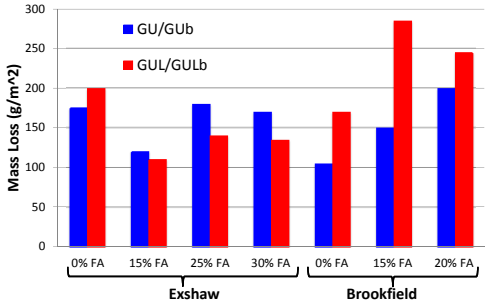
Exshaw and Brookfield

Salt scaling laboratory results



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Conclusions of Study

- The addition of SCMs had a significant impact on the performance of PC and PLC concretes
- PC and PLC blend concretes displayed very similar performance in all cases
  - Compressive strength within 10MPa for companion mixes
  - All SCM blend concrete had very low chloride permeability regardless of limestone content
- The PLC with up to 12% interground limestone achieved equal performance to PC
- The limestone content did not alter the effect that SCMs had on concrete performance

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