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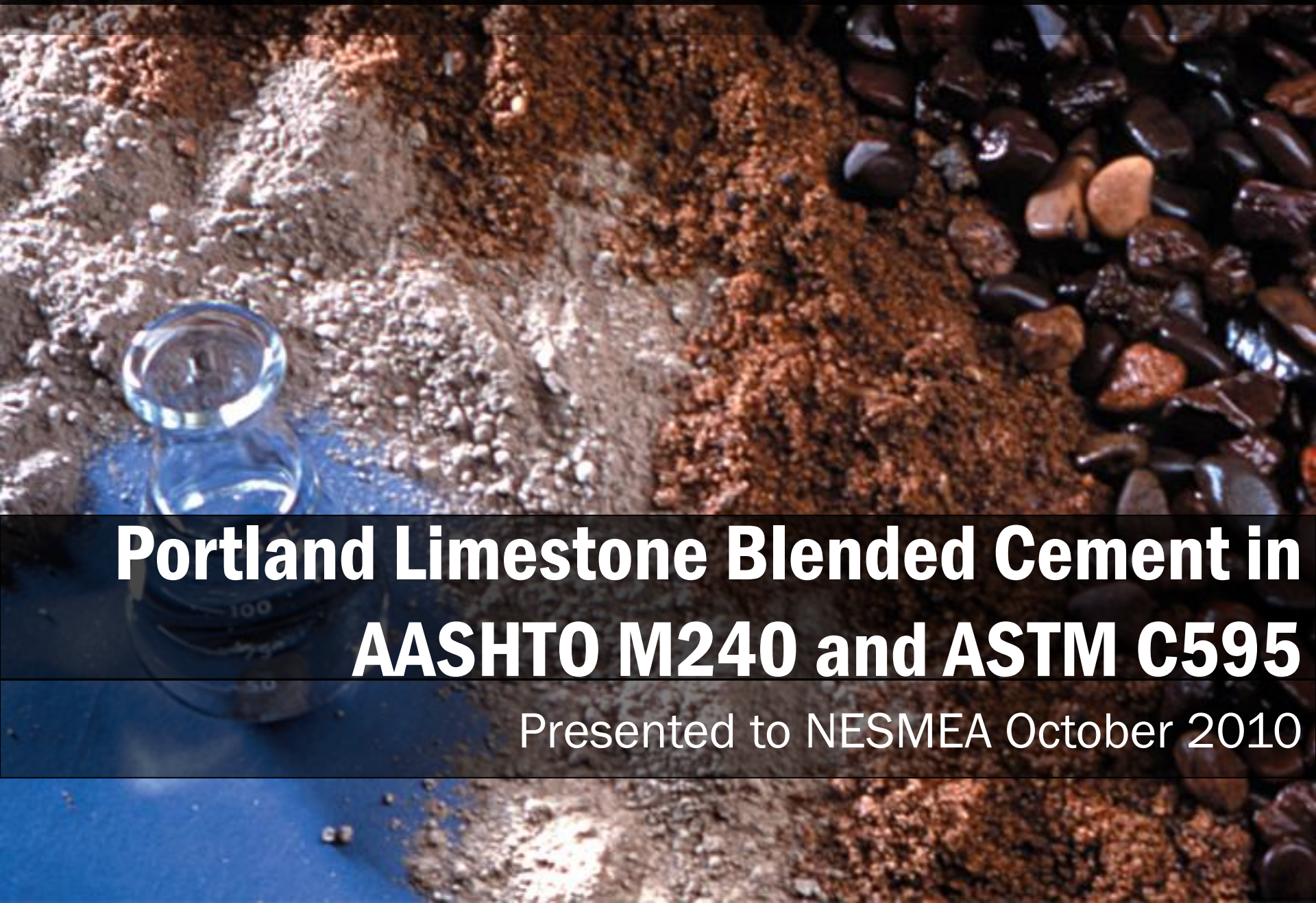


Portland Limestone Blended Cement in AASHTO M240 and ASTM C595

Presented to NESMEA October 2010

Objectives

- Why the proposed change?
- What would change?
- How do we propose to proceed?
- What do we know about portland limestone blended cements?
- What additional information is needed?

Reason for Proposal

- Provide option that can:
  - Help DOTs and industry meet sustainability initiatives
  - Implement proven technology
  - Reduce GHG emissions by up to 10%
  - Conserve energy and natural resources
  - Address legislative and regulatory challenges
  - Harmonize standards

Concept – Changes to M240/C595

- Include provisions for a new portland-limestone blended cement containing from 5% to 15% limestone
- Have same physical requirements as existing Type IS, IP, and IT cements

Development Procedure

- Consider cement standards development objectives
- Gather, review, and evaluate information
- Identify and address questions
- Develop and submit ballot item(s) with supporting rationale and documentation

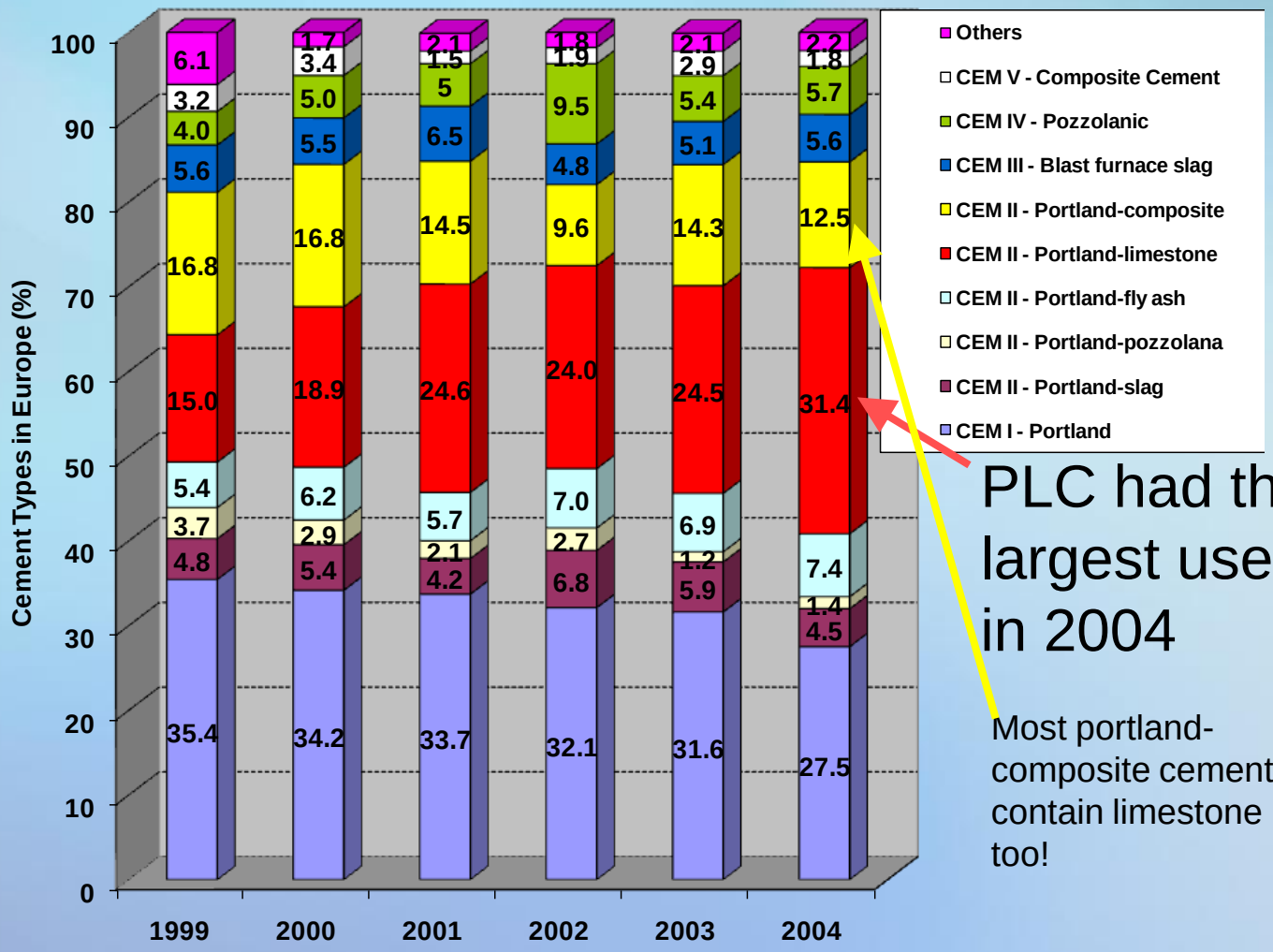
Known Use and Performance

- Experience in Europe and Canada
- Proven technology
- Fresh and hardened concrete properties
- Compatibility with admixtures and SCMs

Historical Use of Limestone in Cements

- 1965 Heidelberger produces 20% limestone cement in Germany for specialty applications (Schmidt 1992)
- 1979 French Cement Standards allows limestone additions.
- 1983 CSA A5 allows 5% in Type 10 (now GU) cement
- 1990, 15+/-5% limestone blended cements being used in Germany
- 1992, in UK, BS 7583 allows up to 20% in Limestone Cement
- 2000 EN 197-1 allows 5% MAC (Typ. Limestone) in all 27 common cements, as was commonly practiced in various European cement standards prior to that.
- 2000 EN 197-1 creates CEM II/A-L (6-20%) and CEM II/B-L (21-35%)
- 2006 CSA A3001 allows 5% in other Types than GU
- 2004 ASTM C 150 allows 5% in Types I-V
- 2007 AASHTO M85 allows 5% in Types I-V
- 2008 CSA A3001 includes PLC containing 5%-15% limestone

Cements Used in Europe



PLC had the largest use in 2004

Most portland-composite cements contain limestone too!

CSA A3001-08

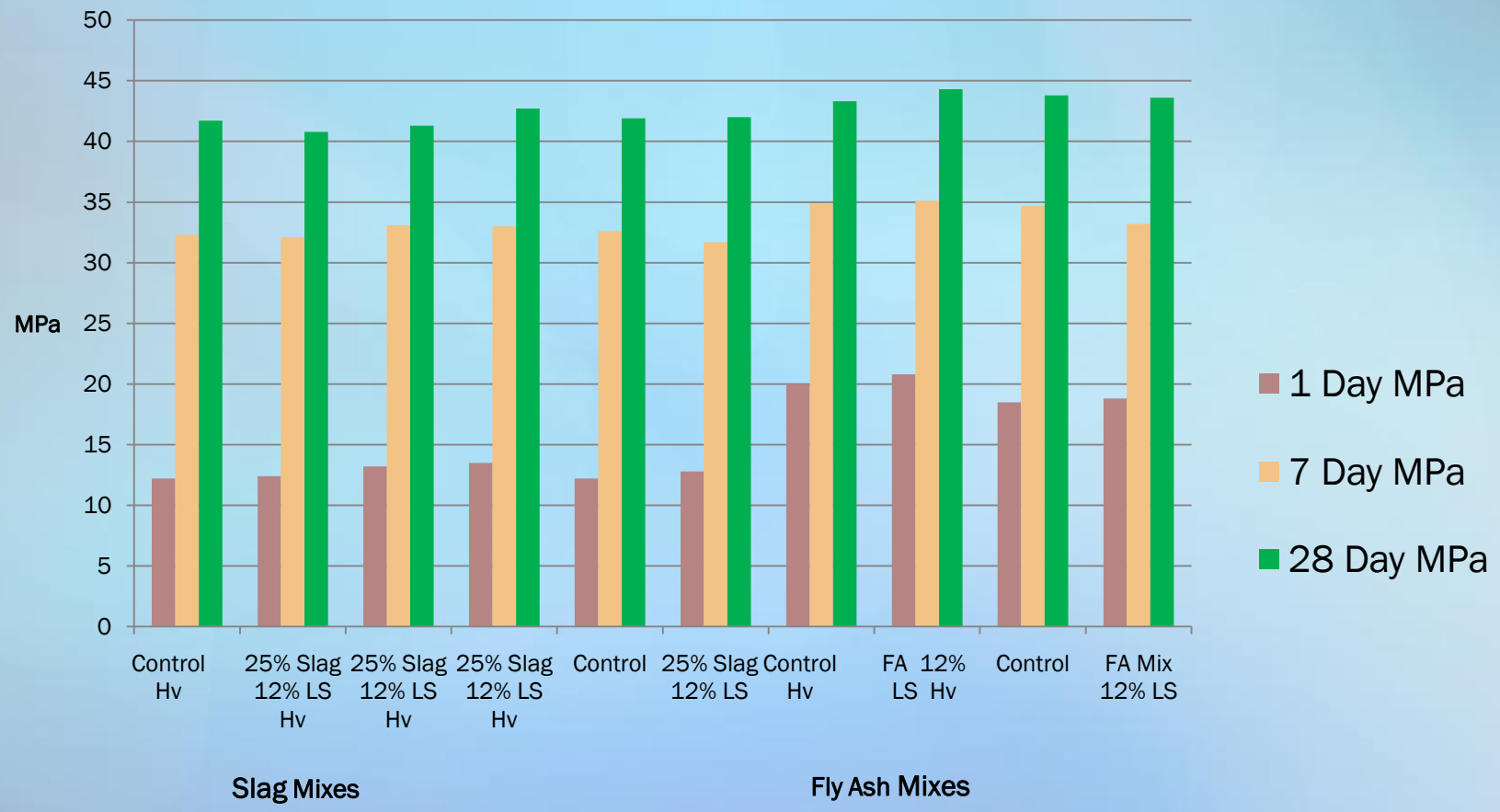
Portland cement	Blended cement	Portland-limestone cement	Application
GU	GUb	GUL	General use
MS	MSb	*-	Moderate sulfate resistant
MH	MHb	MHL	Moderate heat of hydration
HE	HEb	HEL	High early strength
LH	LHb	LHL	Low heat of hydration
HS	HSb	*-	High sulfate resistant

* CSA does not have provisions for sulfate resistant PLC cements

Concrete Tests

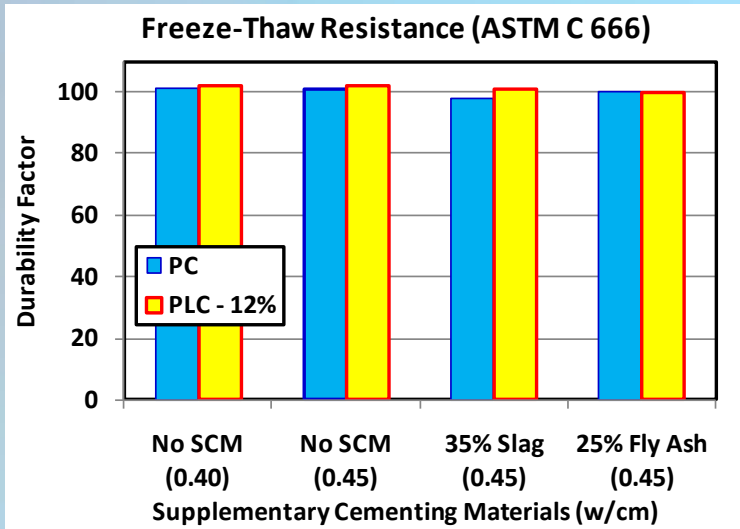
- Cements and SCMs
  - 10% to 15% PLC
  - Slag (15, 25, 30, 50%) and fly ash 25%
- Slump, slump retention and air were measured
- Strength and durability tests were performed

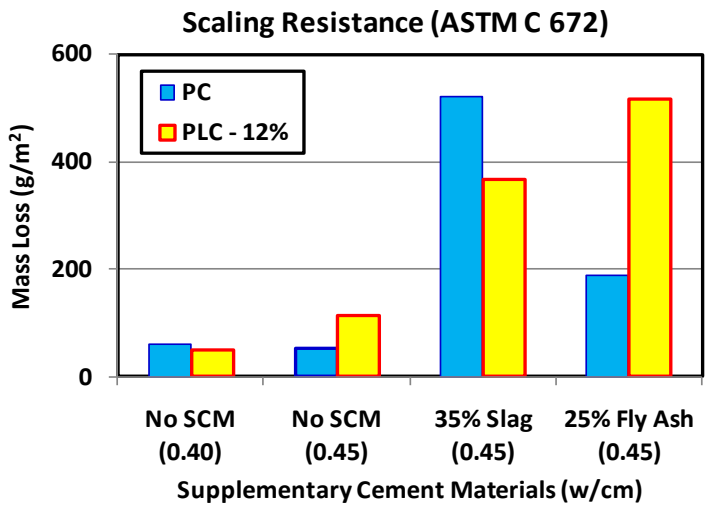
Concrete Strengths with Slag or Class C FA

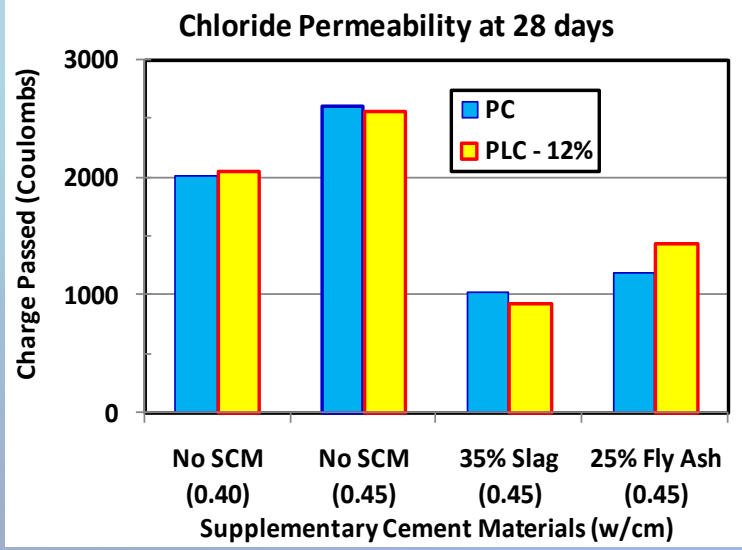


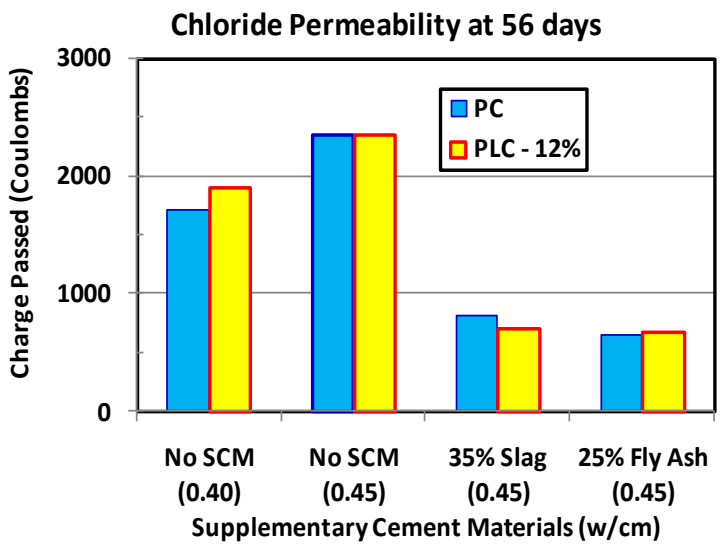
Almost no impact of 12% PLC on f'c at any age with 25% Slag or 20% Fly Ash

Durability Tests – w/cm = 0.40, 0.45 & SCM





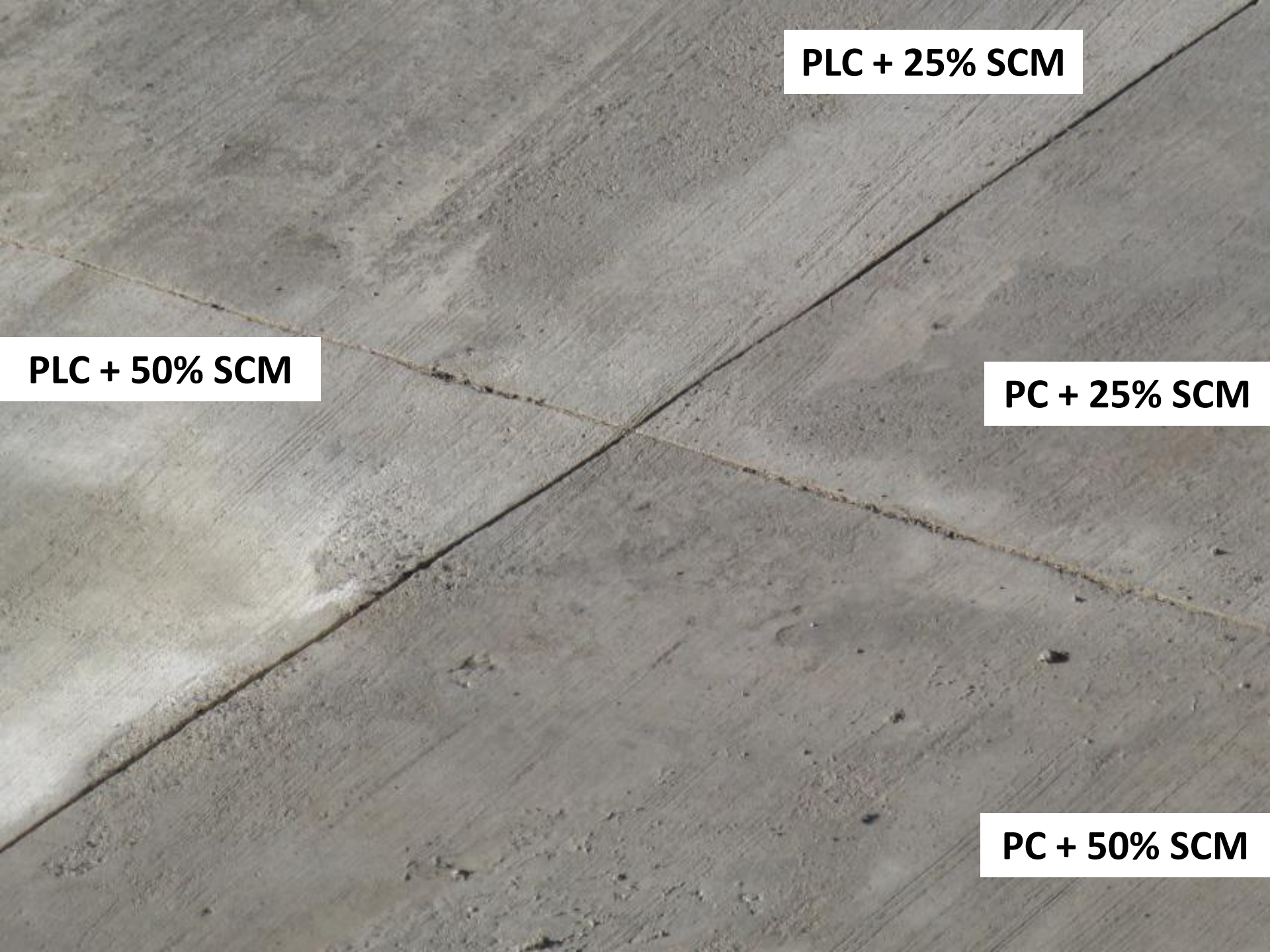




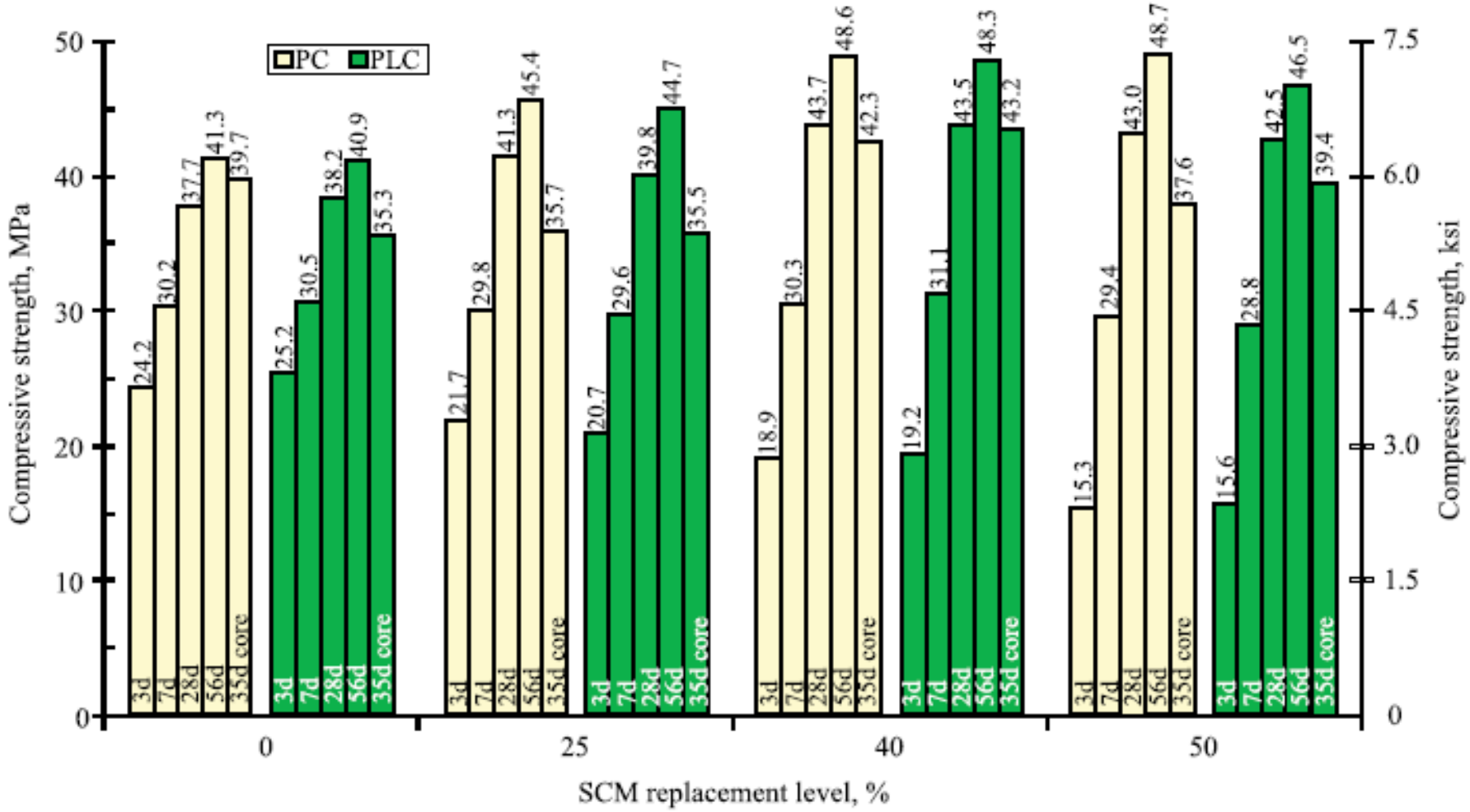
Field Trials – *Jan Cl*, 8 Concretes

Cements = CSA A3001 PC and PLC (12% limestone)

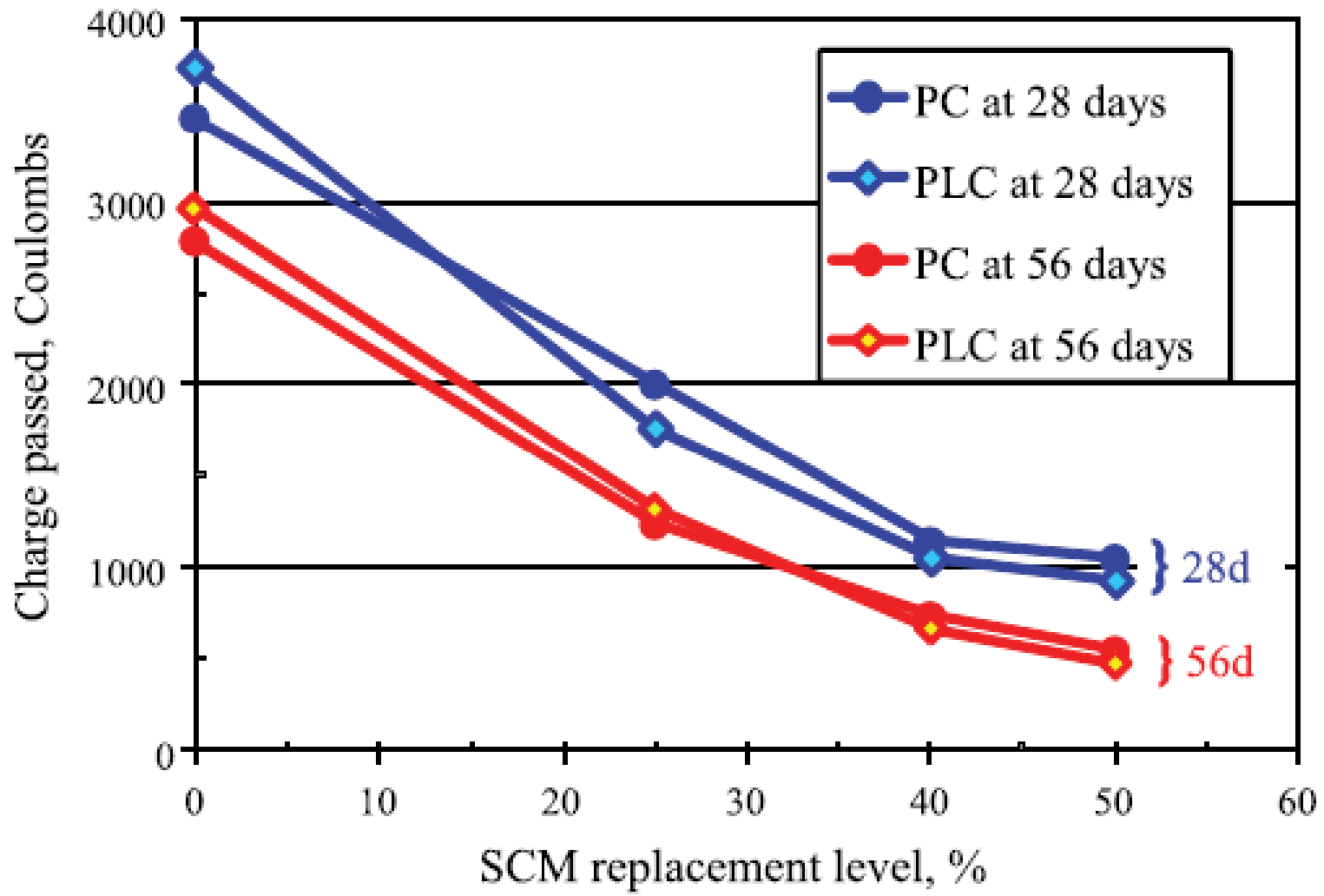
- Blended SCM = 33% FA, 67% Slag
  - Replacement levels =0, 25, 40, 50
- Tests
  - Cast specimens - compressive strength (ASTM C39), rapid chloride penetration (ASTM C1202), rapid freeze/thaw (ASTM C666), hardened air void analysis (ASTM C457), deicer scaling (C672),
  - Cored - strength (ASTM C42), chloride penetration (C1202), chloride diffusion (ASTM C1556)


PLC + 25% SCM
PLC + 50% SCM
PC + 25% SCM
PC + 50% SCM

Field Trials – Strength Results



Field Trials – RCPT Results



TRB Paper – Three Case Studies

All Used C1157 Cement Containing 10% Limestone

- 40th Avenue, Denver, 2007
  - Used with 20% Class C FA, Recycled Aggregate
- US HWY 287, Lamar, 2008-2009
  - Used with 20% Class F FA
- I-25, Castle Rock, 2008-2009
  - Used with 20% Class F FA

Summary

- Why the proposal?
  - Option to implement proven technology to obtain desired performance and improve sustainability of concrete
- What would change?
  - 5% to 15% limestone in ASTM C595/M240
  - Same physical requirements as IP, IS, IT
- How to proceed?
  - Remember standards development objectives
  - Gather, review, and evaluate information
  - Identify and address questions

Questions to Address

- Sulfate exposure
- Others?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Thank you!