Fast-track Patching of Concrete Pavements

Midwest PPP

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Daniel P. Frentress, P.E.

International Grooving & Grinding Association

David C. Sethre, P.E.

ND Chapter, Inc. - ACPA

Count on Concrete

Focus of this Presentation

- General Information about Patching Concrete Pavement
  - Partial Depth Patches
  - Full Depth Patches
- Fast-track Capabilities for Opening to Traffic
- New techniques for Partial Depth Repairs
- Success Story for Extreme Early Opening
- Discussions on Specifications & Durability

Technological Terms

- High Range Water Reducer (Superplasticizer)
- Accelerator – Non-Chloride Based
- Hydration Stabilizer
- Slump Extender
- Well Graded Aggregate (3 bins max.)
- High Early
- Fast-track
- Flexural Strength/Compressive Strength

Specifying Mixes as per Needs

- Use the Mix that meets your minimum needs
  - Don't use a 4 hour mix for a 24 hour need for traffic
  - Economize with less sophisticated mixes with slower strength gain
- Mix Performance - Strength Gain
  - Automobiles & Pickups – Need 150 psi flex
  - Trucks – Need 300 psi flex to 500 psi
    - Few trucks &/or thicker - less strength
    - More trucks &/or less thickness – more strength

Duty of the Engineer

- Specify performance:
  - Strength Required for Opening
  - Time Required for Opening
  - Durability Consideration (Permeability Goals)
    - **Not** a factor – Allow 100% cement
    - **Is** a factor – Require up to 20% flyash, but remember strength achievement is delayed to 10 hours or so

Nominal Mixes

- Conventional (with High Cement) – High Early
  - 7.2 to 9.0 bag mixes
  - Action: Generates heat to accelerate strength gain
  - 4 to 12 hour strength
- Modern – Normal Cementitious – Fast-track
  - 6 bag with 20% replacement with fly ash
  - Action: Use well-graded aggregates and package of admixtures including accelerators
  - 10 to 14 hour strength

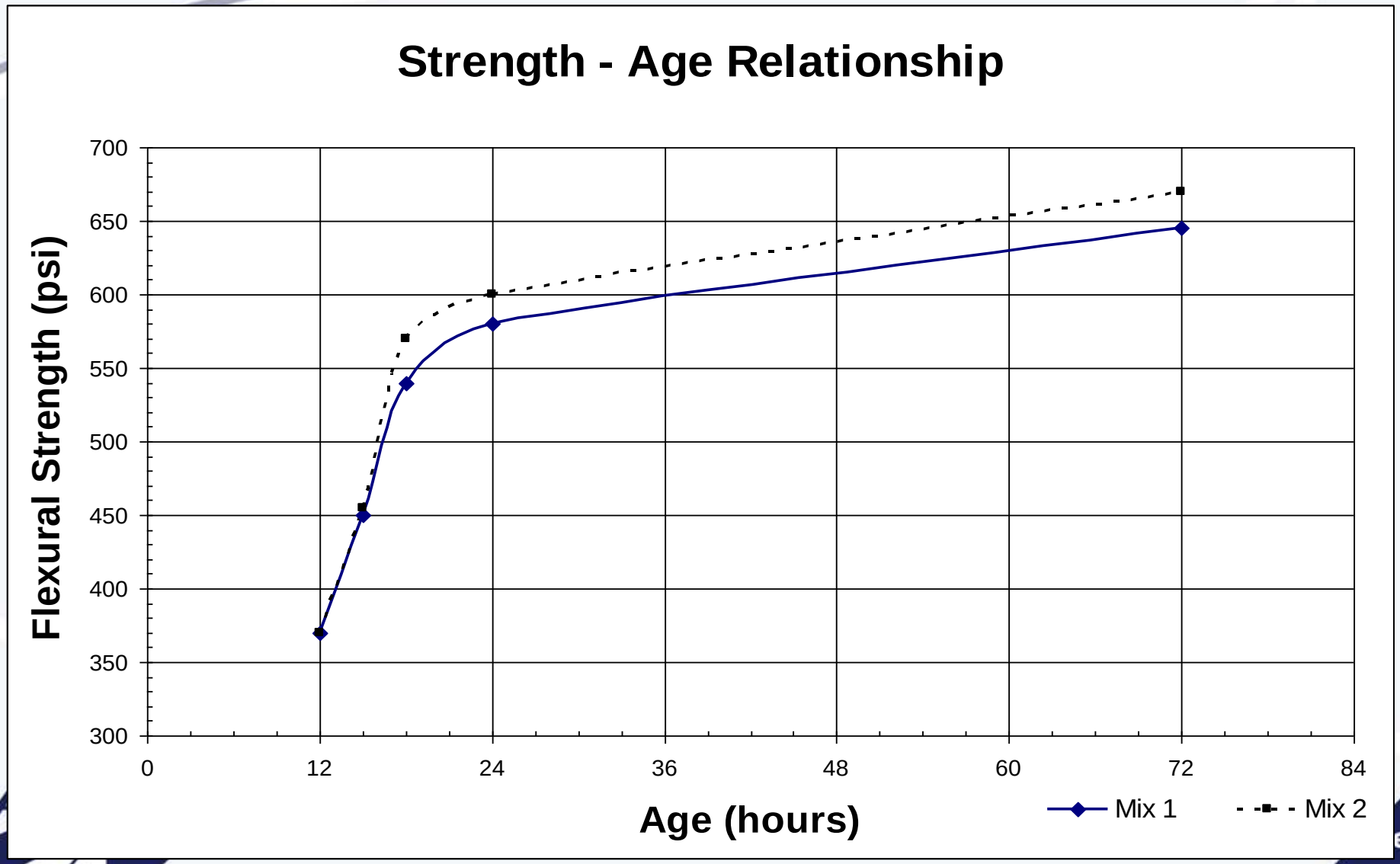
Fast-Track Mix Design

- Two cementitious content trials
  - ✓564 lbs./ CY - 20% Fly Ash
  - ✓611 lbs./ CY - 20% Fly Ash

Low Cementitious Content

- Target W/C ratio = 0.38
- Initial concrete temperature target - 75° F minimum
- Take advantage of chemical technologies
  - ✓ Polycarboxylate WR & New Slump Extenders
  - ✓ Non-Chloride Accelerator

Results...


Strength - Age Relationship
Flexural Strength (psi)
700
650
600
550
500
450
400
350
300
0
12
24
36
48
60
72
84
Age (hours)
Mix 1
Mix 2

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CONCRETE
INFORMATION

Maturity Testing of Concrete Pavements: Applications and Benefits

Maturity testing provides a reliable technique for continuous monitoring of concrete strength gain. The technology offers several advantages over traditional testing methods. Most importantly, maturity testing enables any pavement to be opened to traffic without delay, whether or not it is a fast-track project.

The purpose of this publication is to describe the maturity concept and its applications and, by explaining the benefits, encourage widespread implementation by agencies and contractors. Detailed procedures for maturity testing are given in the Appendix of this report.

According to a recent survey,[1] concrete maturity concepts are being applied or researched by 32 state Departments of Transportation (DOTs). The survey also

zone area to traffic. Iowa Department of Transportation has concluded that maturity testing reduces construction time and traffic delays, and improves public relations during construction.[2] Also, quality assurance costs can be reduced because the number of beams or cylinders required for the maturity method is less than that needed for quality assurance testing with destructive testing methods.

The use of maturity testing can reduce construction costs. Ansari et al[3] estimated that construction time for highway projects could be reduced by as much as 50%. The authors also concluded that the number of test specimens cast during construction could be reduced by about 75%. Hunt and Mihm[4] state that the savings

ACPA Support

	Slab Thickness mm (in.)	Foundation Support, k MPa/m (psi/in.)	REQUIRED FLEXURAL STRENGTH FOR OPENING, MPa (psi) To Support Estimated ESAL's Applied Before Achieving Specified Strength[b]				
			100	500	1000	2000	5000
MUNICIPAL	150 (6.0)	27.2 (100)	3.4 (490)	3.7 (540)	3.9 (570)	4.1 (590)	4.3 (630)
		54.3 (200)	2.8 (410)	3.1 (450)	3.2 (470)	3.4 (490)	3.6 (520)
		135 (500)	2.3 (340)	2.6 (370)	2.6 (370)	2.8 (400)	3.0 (430)
	165 (6.5)	27.2 (100)	3.0 (430)	3.2 (470)	3.4 (490)	3.6 (520)	3.8 (550)
		54.3 (200)	2.4 (350)	2.7 (390)	2.8 (410)	3.0 (430)	3.1 (450)
		135 (500)	2.1 (300)	2.2 (320)	2.3 (330)	2.4 (350)	2.6 (370)
	175 (7.0)	27.2 (100)	2.6 (370)	2.8 (410)	3.0 (430)	3.1 (450)	3.3 (480)
		54.3 (200)	2.1 (310)	2.3 (340)	2.5 (360)	2.6 (370)	2.8 (400)
		135 (500)	2.1 (300)	2.1 (300)	2.1 (300)	2.1 (300)	2.2 (320)
	190 (7.5)	27.2 (100)	2.3 (330)	2.6 (370)	2.6 (380)	2.8 (400)	3.0 (430)
		54.3 (200)	2.1 (300)	2.1 (300)	2.2 (320)	2.3 (330)	2.4 (350)
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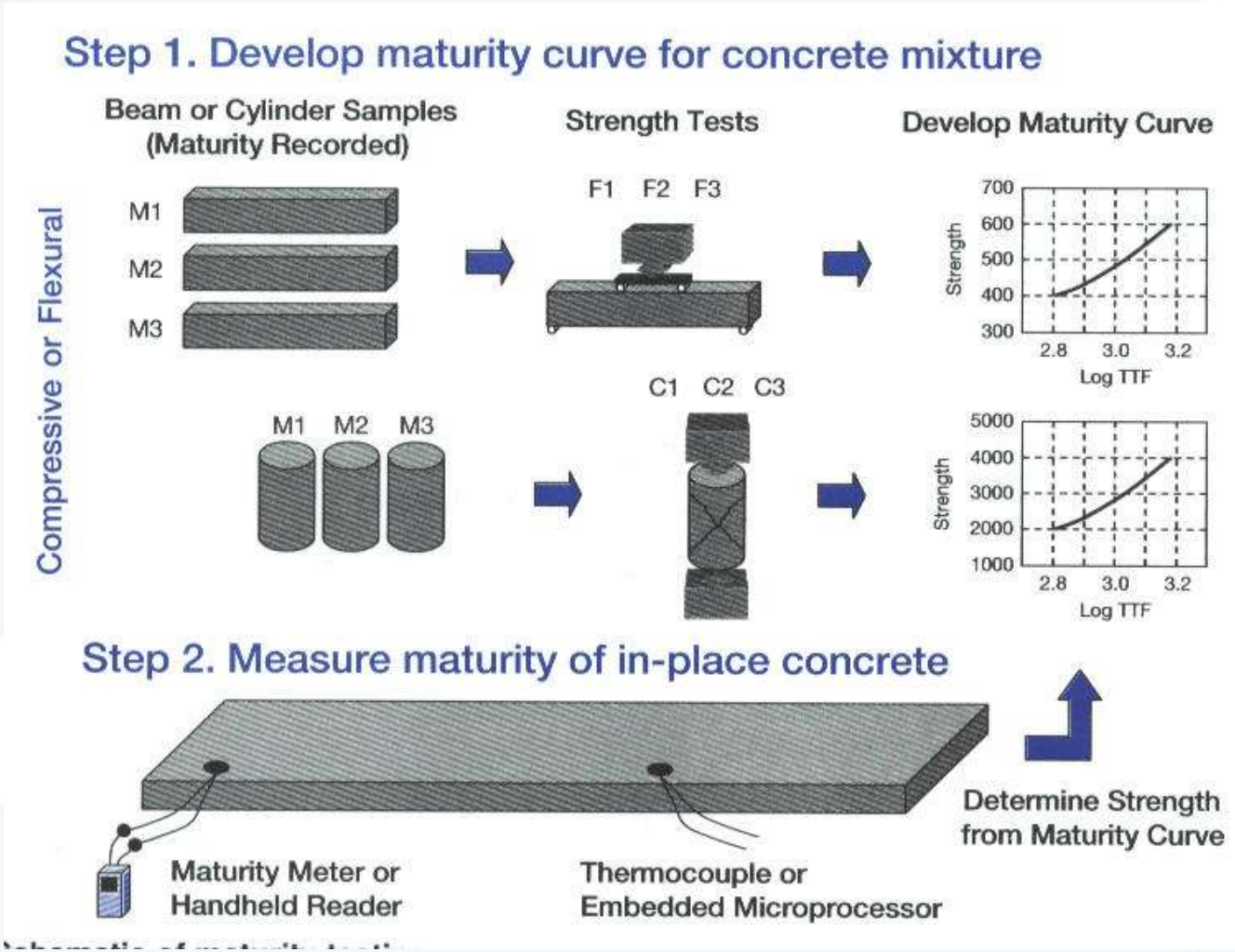
Non-Destructive Testing



How much strength is enough?

- Opening Traffic to Trucks
  - Kansas DOT – 2000 psi Compressive Strength
  - Michigan DOT – 300 psi Flexural Strength
  - Georgia Story
  - Minnesota Story

Durability Factor

Engineer Your Durability

- High Early Permeability
  - 3500 Coulombs (Moderate Permeability)
- Fast-track with 20% Flyash
  - 1000 coulombs (Low Permeability)

Permeability Measured using Rapid Chloride Ion Test for NDDOT

10 Year Old "High Early"

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Let's look at a

CASE STUDY – I-94 IN MINNESOTA

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Mn/RD I-94 Monticello

Traffic

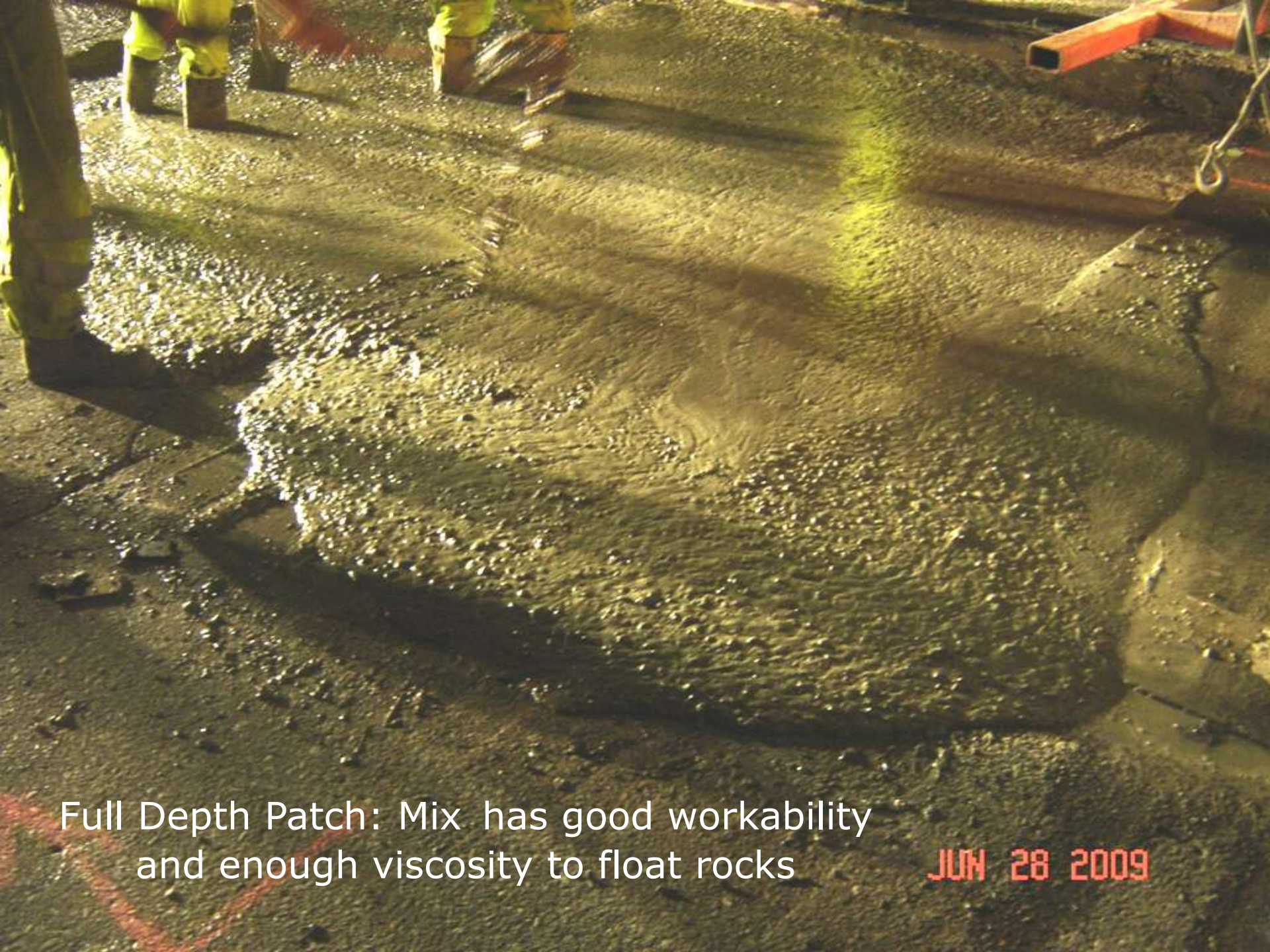
- Approximately 53,000 vehicles travel on this stretch of I-94 daily. The two main considerations for traffic restrictions were as follows:
  - Ultra-High Early Mix - Needed very early opening to traffic, i.e. 4 hours
  - Needed sufficient workability to get from RM plant to job site for placement in multiple locations
  - Workability for a 45 minute placement window

Mix Design – I-94 CPR Project

- Ultra High Early (UHE) concrete had to remain workable long enough to mix, transport, place, and finish the concrete
- No off the shelf mix design was available to meet the needs of the project.
- Due to the short turnaround period imposed by ARRA requirements, an advanced mix design was developed quickly

Requirements with UHE Mix

- High initial slump
- Sufficient workability life to allow consolidation and finishing
- Need for use of admixtures to secure workable solution
  - Superplasticizers – Workability & Low W/C ratios
  - Hydration Stabilizers – Puts concrete to sleep
  - Accelerators – Rapid hydration



Full Depth Patch: Mix has good workability and enough viscosity to float rocks

Ready Mix Truck Mixing with Roller Screed Finishing

Problem: Concrete lost workability as it was placed as admixture package wore out

Temporarily allowed to remain in place

Section was ultimately removed and replaced

Grout for Partial Depth Repair

- Most failures stemmed from issues with the grout; either the grout drying or curing.
- Best to mix small batches of grout, and to not get too far ahead when applying grout.

Restore Ride on Patched Pavement

DIAMOND GRINDING

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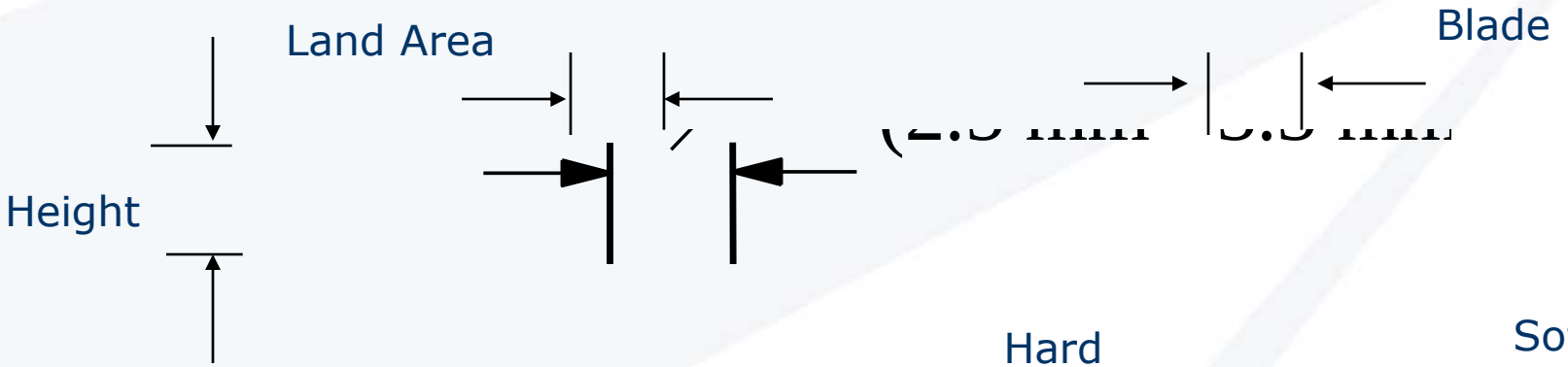
Diamond Grinding Dimensions



	Range	Hard Aggregate	Soft Aggregate
Blades	0.125 inches	0.125 inches	0.125 inches
Land Area	0.060-0.110 inches	0.060 – 0.090 inches	0.090 – 0.110 inches
Avg Height	0.06 inches	0.06 inches	0.06 inches
Blades/ft	50 – 60	53 - 60	49 - 54

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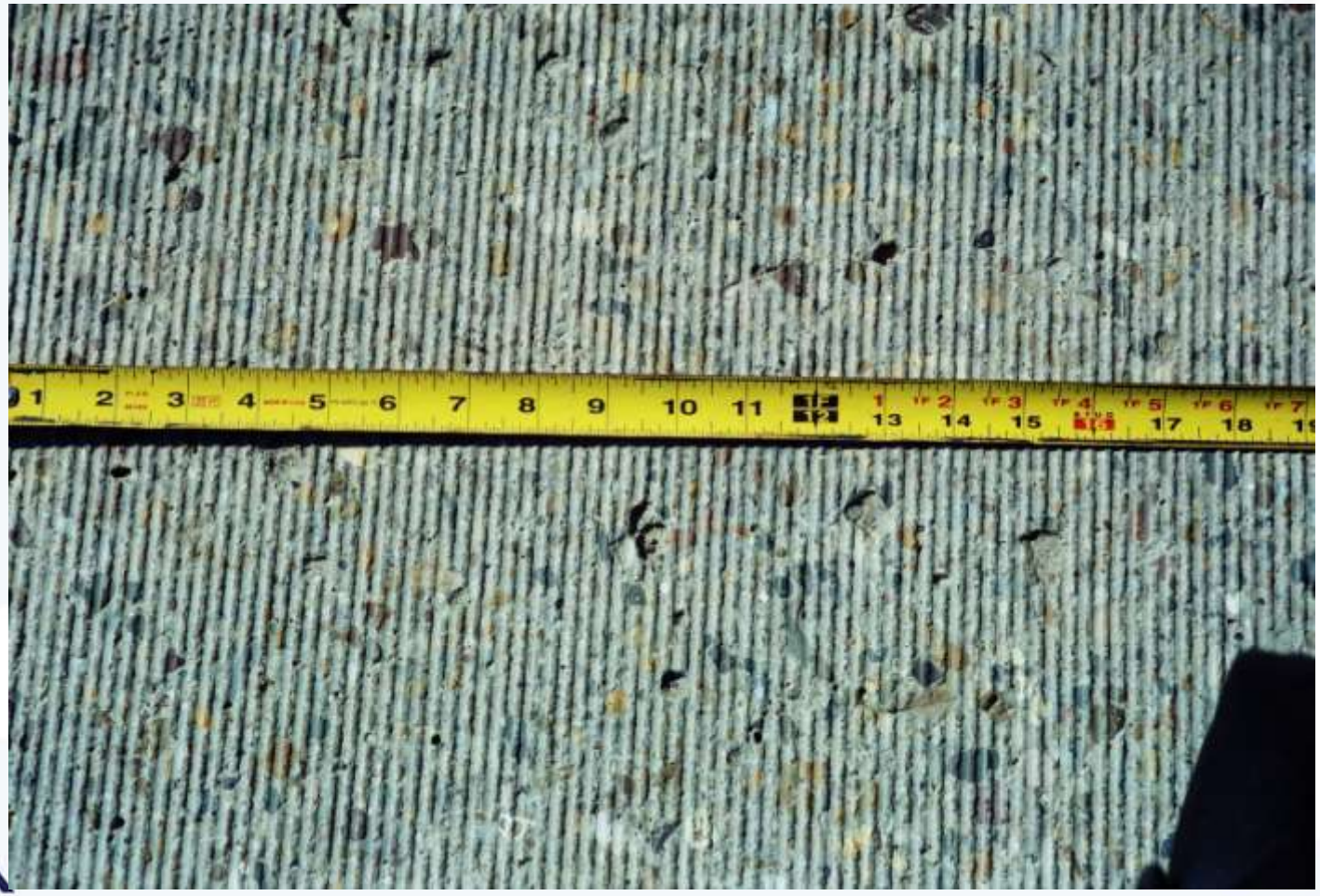
Method to Measure Texture Blades/Foot 49-54 per ft. for Limestone and 53-60/ft. for Hard Rock



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Blade Spacing Affects Fin Height

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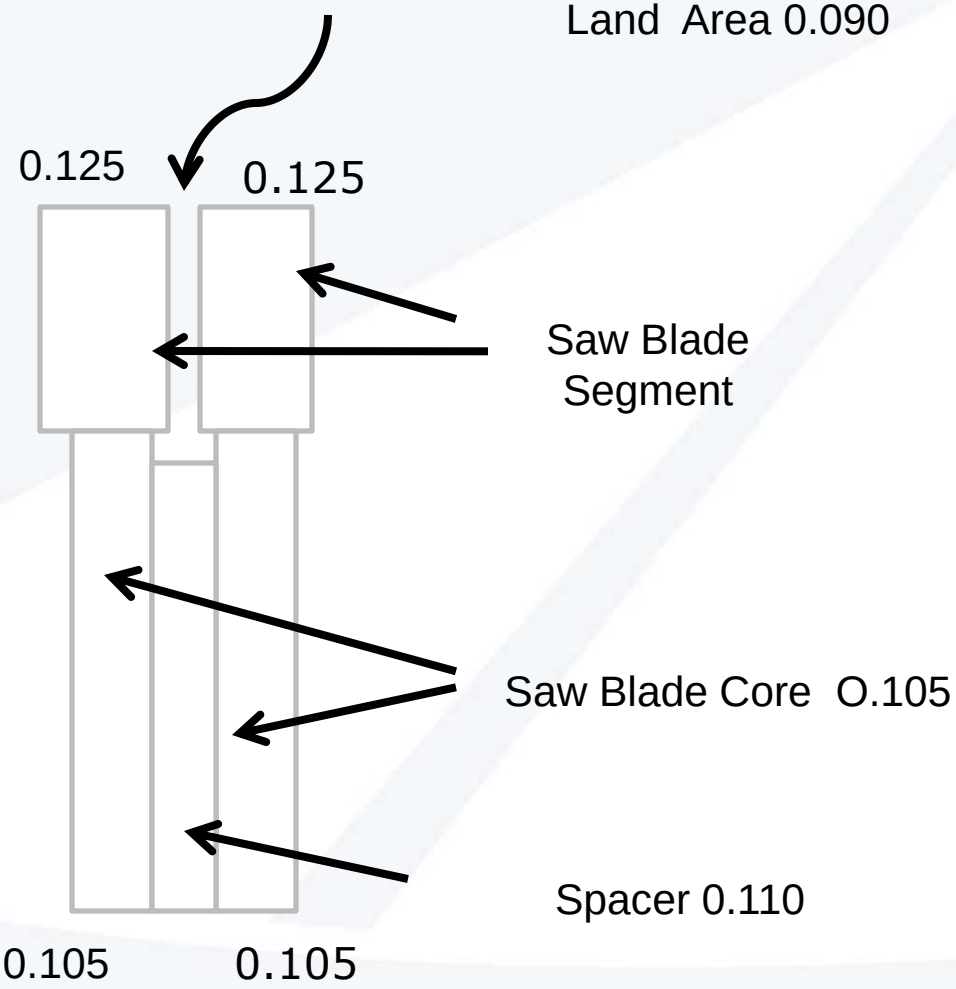
Saw Blades and Spacers
Typical Configuration



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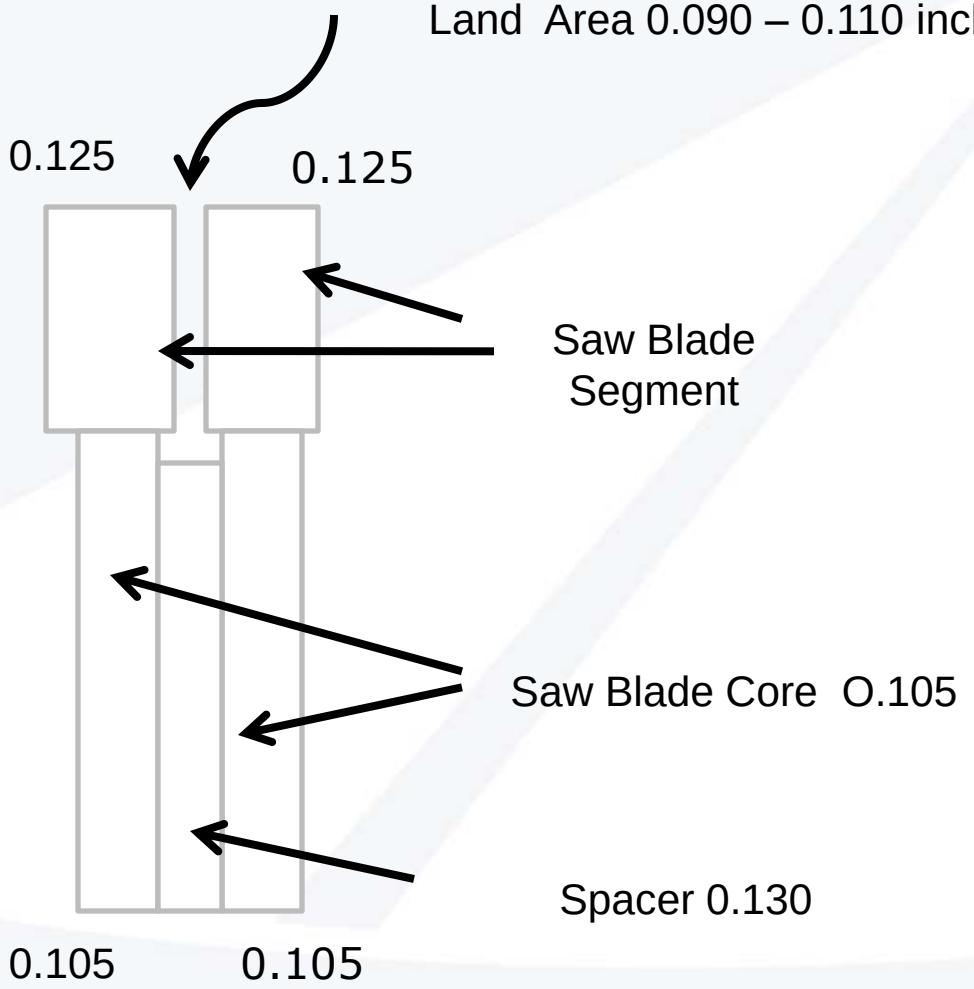
Saw Blades and Spacers
Spec I-94 Mn



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Urban Concrete Slurry Rules

- Designated washout areas
- All slurry needed to be contained
- Stringent disposal pit requirements

Summary

- Match your mix to your time to opening requirements
  - Not everyone needs 4 hours to opening
  - Durability can be engineered in a patch
- Don’t over specify strength to opening
- Modern concrete technology will meet just about every need for opening to traffic

David C. Sethre, P.E.
Executive Director
ND Chapter, Inc. – ACPA
dsethre@ndconcrete.com
Cell 701-371-4497

Daniel P. Frentress, P.E.
IGGA
56800 194 Street
Park Rapids, Mn 56470

for
Terry Kraemer

Copies of this presentation are available from Dave or Dan.

QUESTIONS?
COMMENTS?

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