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The Use of GPS-Based Distress Mapping to Improve Pavement Management

Peter-Paul Dzwilewski, P.E.

Genevieve Long, P.E., LEED AP

Monty Wade, P.E.

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VDOT

Introduction

- **Goal: Enhancement of long-term pavement management practices**
- **Method: Distress mapping using GPS-referenced tablets**

- **Presented here are examples from recent surveys of portland cement concrete (PCC) pavements**

Survey Process

- Additional mapping required prior to surveying
- A reference grade GPS unit tracks the location
- Distress type, severity, quantity are recorded like traditional PCI survey
  - Includes location within a slab
  - Also represents the physical characteristics of each distress

Distress Mapping Legend

LOW	MED	HIGH	DISTRESS	DESCRIPTION
			61	BLOWUP
			62	CORNER BREAK
			63	CRACK - LONGITUDINAL, TRANSVERSE & DIAGONAL
			66/67	PATCHING
			68	POPOUTS
			69	PUMPING
			70	SCALING

Distress Mapping Legend (cont.)

LOW	MED	HIGH	DISTRESS	DESCRIPTION
			71	SETTLEMENT
			72	SHATTERED SLAB
			73	SHRINKAGE CRACKS
			74	SPALLING - JOINT
			75	SPALLING - CORNER
			76	ASR

Distress Mapping Benefits

- **Distress pattern identification**
- **Quality control during survey is substantially easier**
- **Section re-segmentation after survey**
- **Track distresses and repairs over time**
- **Determine localized maintenance repair quantities**

Distress Mapping Benefits (cont.)

- **Locate repairs within section**
- **Evaluate impact of repairs**
- **Choose appropriate rehabilitation methods**
- **Apply identified deficiencies to future construction projects**

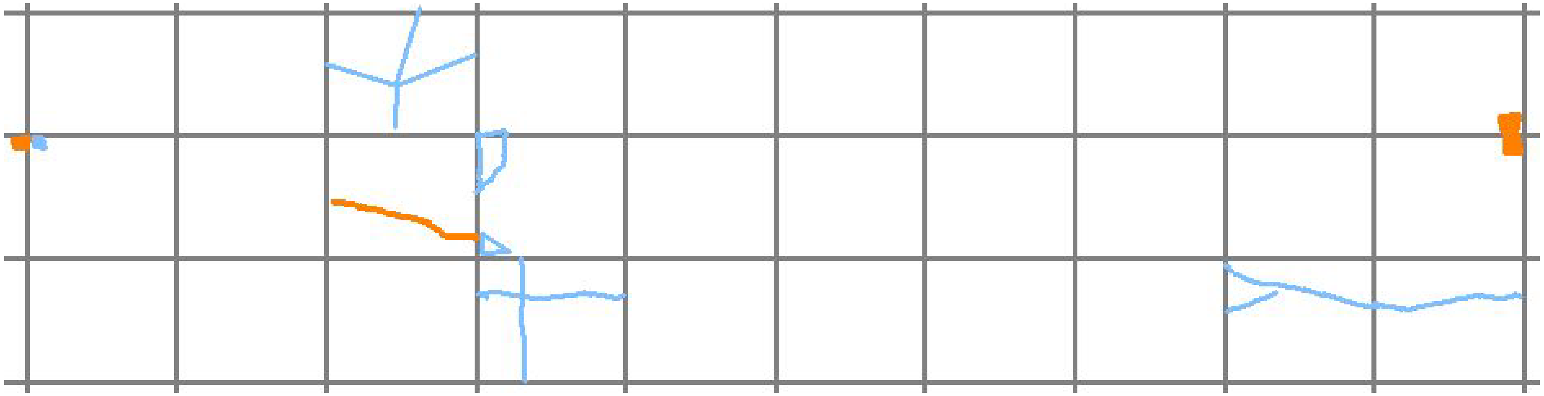
DISTRESS PATTERN IDENTIFICATION

Case Study 1 Overview

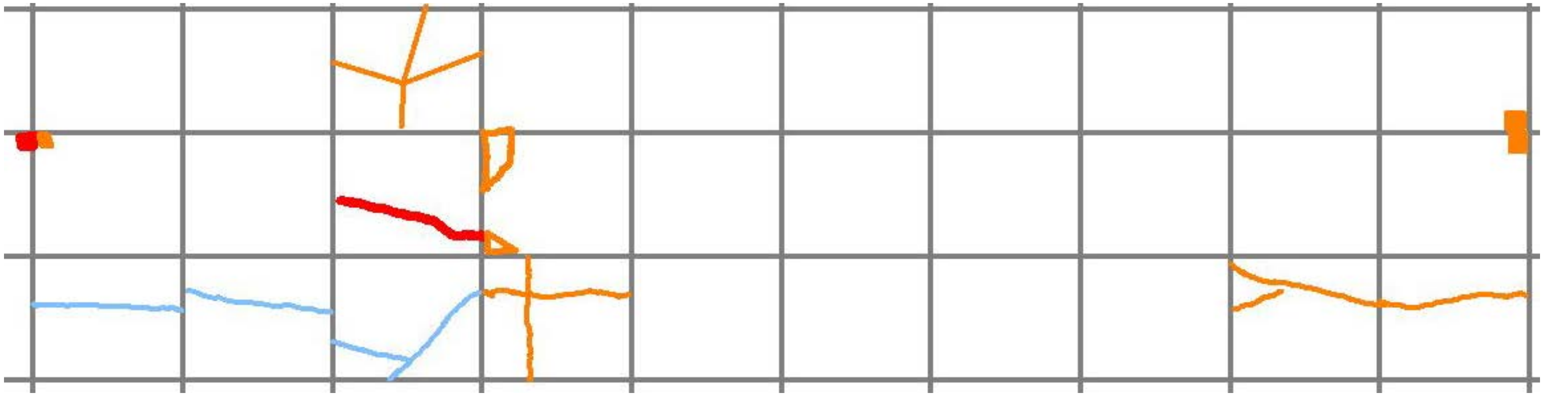
- **Pavement overloaded in late fall**
- **Distresses mapped soon after overloading**
- **Pavement re-mapped 6 months later**
  - Significant freeze-thaw and daily temperature cycling between inspections
- **Would distresses from overloading propagate between inspections?**

Distress Maps

Initial



Follow-up



Case Study 1 Benefits

- **Possible to see change in general condition and specific distresses**
- **Track progression of distresses**
- **Illustrate relationships between distresses within and across slabs**
- **Depicts deterioration versus stabilization of pavement over time**

CHOOSING APPROPRIATE REHABILITATION METHODS

Case Study 2 Overview

- **Distress mapping allows for:**
  - **Localization of maintenance needs**
  - **Improved accuracy of cost estimates**
  - **Tracking the effectiveness of repairs**
  - **Greater insight for selecting the proper rehabilitation method**

Repair Options

- **Weigh rehabilitation and reconstruction options for best combination of:**
  - **Future pavement condition**
  - **Cost**
  - **Operational requirements**

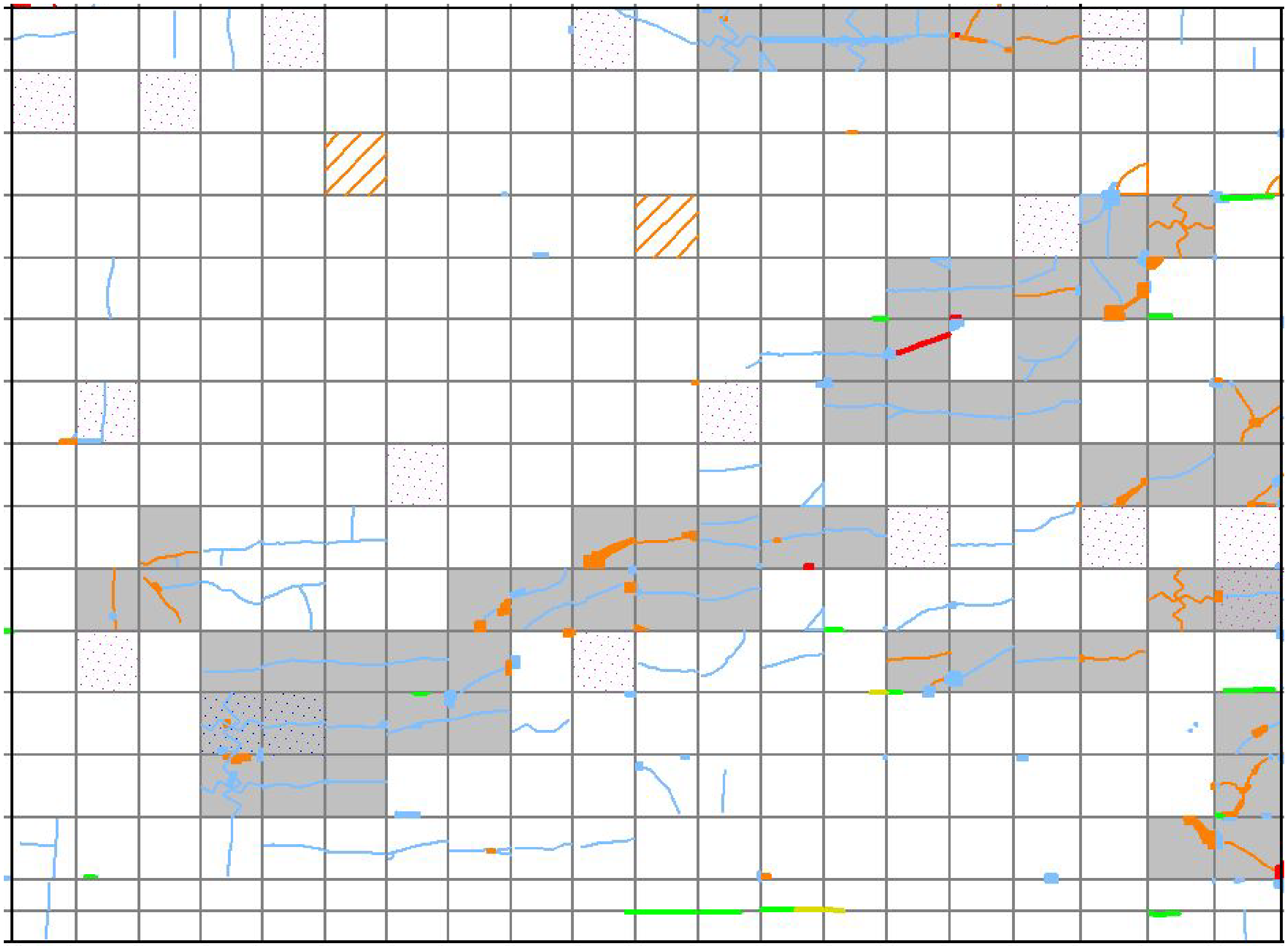
Slab Replacement Alternatives

- Create multiple repair maps with varying quantities of slab replacements
- Repair maps depict slabs replaced
- PCI increase calculated for each map
- Repair maps and PCI increase weighed against the estimated costs

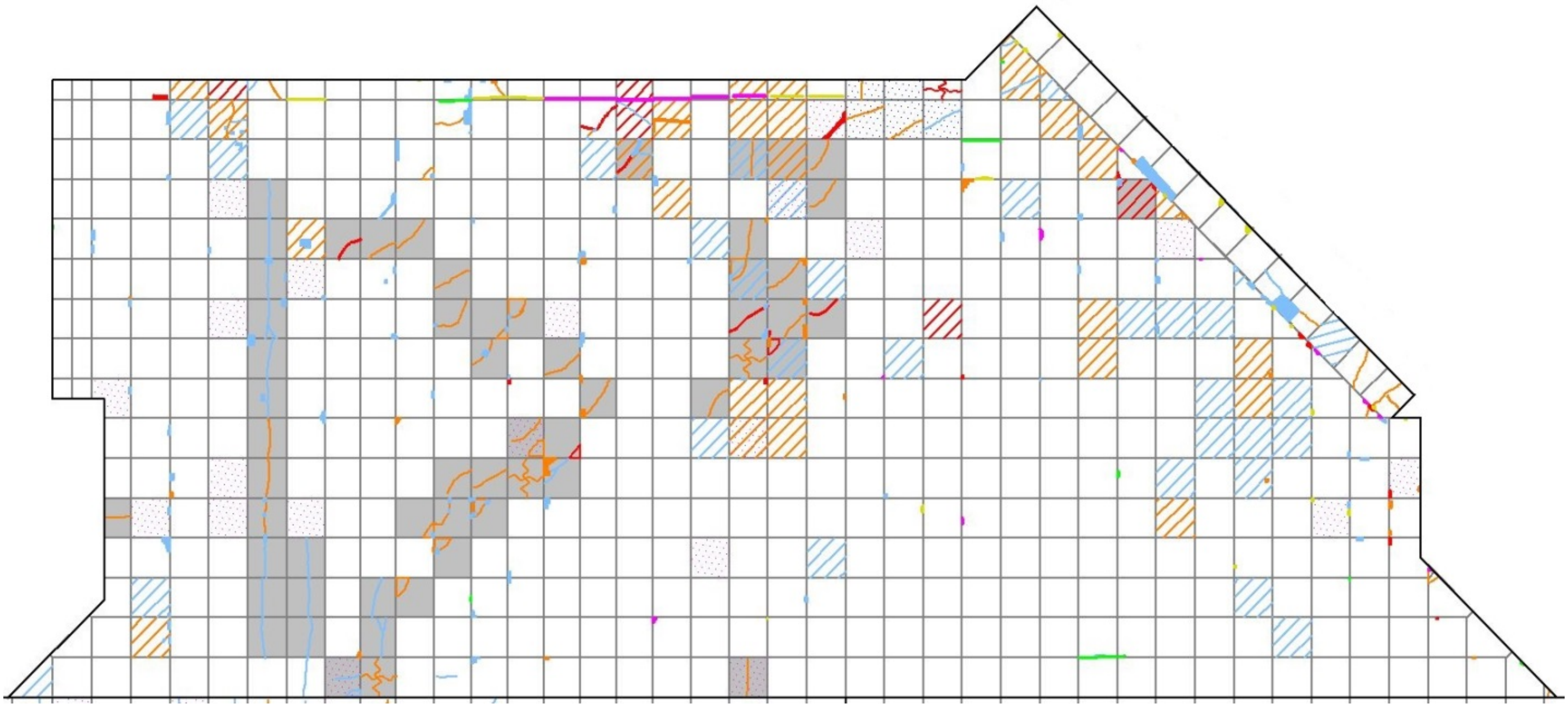
Examples of Slab Replacement Differences

- **Two sections in same network with:**
  - **Same PCI (58)**
  - **Same age**
  - **Same cross section (11-inch PCC)**
  - **Similar traffic patterns**

Section A



Section B



Case Study 2 Summary

- **Slab replacement recommendations and resulting PCIs differ**
  - **18% of slabs replaced and 21-point PCI increase**
  - **10% of slabs replaced and 10-point PCI increase**

LOCALIZED MAINTENANCE REPAIR QUANTITIES

Case Study 3 Overview

- **Localized repair needs determined during pavement management projects**
- **Repair quantities and costs calculated using traditional PCI survey methods**
- **Distress mapping improves:**
  - **Accuracy of calculated repair quantities for localized maintenance needs**
  - **Identification of specific locations where repairs are needed**

Maintenance and Repair Quantities from Traditional PCI

- **Only provides number of affected slabs of each distress/severity combination for a sample unit**
- **Only one distress of each type at highest severity per slab recorded**
- **Maintenance quantities computed via conversion factors**
- **May or may not be an appropriate repair quantity depending on specific pavement conditions**

Maintenance and Repair Quantities from Distress Mapping

- **Customized conversion factors used to calculate repair quantities**
- **Conversion factors adjusted and are based on actual distress size and pattern**
- **If repairs are mapped, no conversion factors are needed**

Repair Quantity Example I

Distress	Severity	PAVER™ Repairs	Distress Map Repairs	Units	Difference (%)
Corner Break	M	41	58.7	ft^2	-30.2%
Joint Spall	M	19.4	50.6	ft^2	-62.5%
	H	5.4	7.5	ft^2	-24.9%
Large Patch	M	293	1,477	ft^2	-80.2%
	H	1,465	7,385	ft^2	-80.2%
Linear Crack	M	683	668	ft	2.3%
	H	15.1	6.2	ft	137.6%
Small Patch	M	5.4	4.3	ft^2	39.5%
	H	3.2	4.3	ft^2	-41.0%

Repair Quantity Example II

Distress	Severity	PAVER™ Repairs	Distress Map Repairs	Units	Difference (%)
Corner Break	M	80.7	69.9	ft^2	15.4%
Joint Spall	M	80.7	107.6	ft^2	-25.0%
Large Patch	M	1,495	175	ft^2	752.1%
	H	197	37.7	ft^2	422.9%
Linear Crack	M	288.4	111.2	ft	159.3%
Small Patch	M	73.2	67.8	ft^2	7.9%
	H	24.8	9.7	ft^2	155.6%

Case Study 3 Summary

- **Repair quantities and costs can impact localized maintenance planning**
- **Recognition of the actual repair quantities allow for proper allocation of funding across the network**

APPLYING IDENTIFED DEFICIENCIES TO FUTURE CONSTRUCTION PROJECTS

Case Study 4 Overview

- **Factors impacting pavement condition:**
  - **Pavement structure/design**
  - **Climate**
  - **Traffic**
  - **Construction techniques**
  - **Materials**
- **Using distress mapping, it is possible to consider these factors, along with actual distresses, to improve future projects**

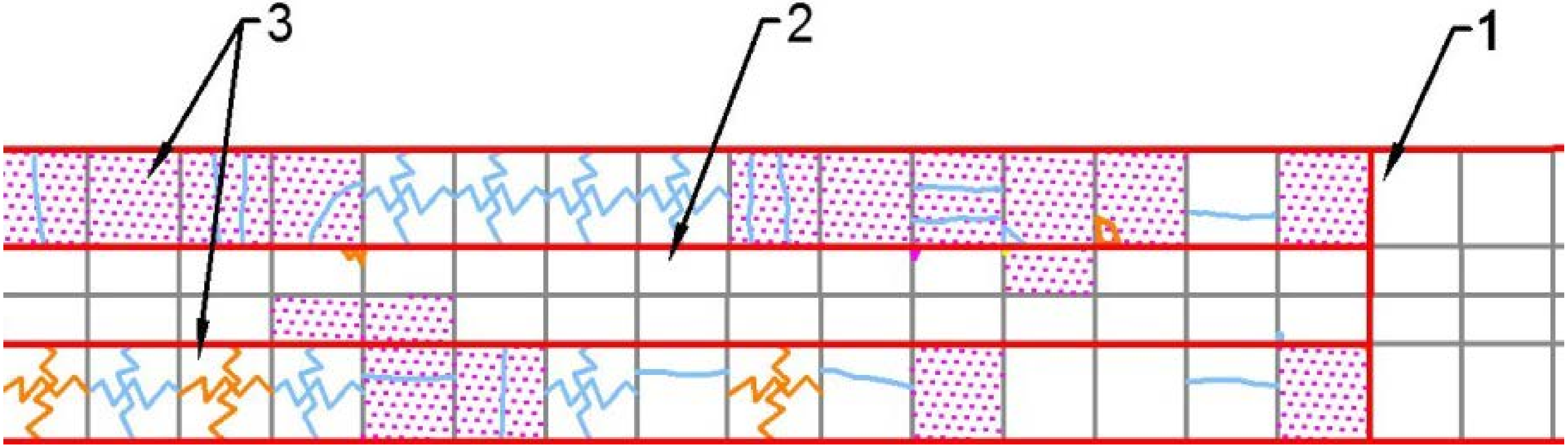
Possible Improvements

- **Existing distresses can assist in identifying the need to modify:**
  - **Design practices**
  - **Construction techniques**
  - **Repair methods**

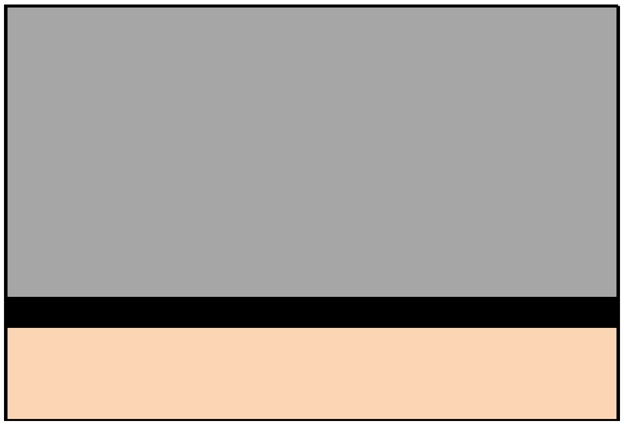
Taxiway Rehabilitated

- **Parallel taxiway recently rehabilitated**
  - **Used by wide-body aircraft**
- **Cross section and slab size vary**
- **Section 1, PCI = 98**
- **Section 2, PCI = 95**
- **Section 3, PCI = 52**
  - **85% of distresses are load-related**

Taxiway Distress Map

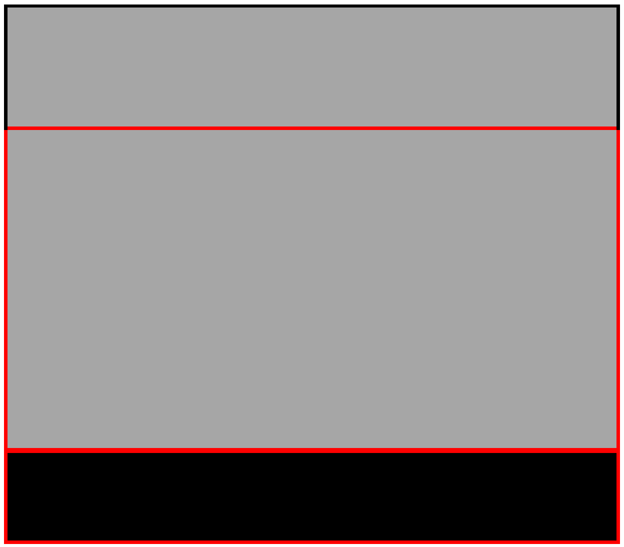


Cross Sections



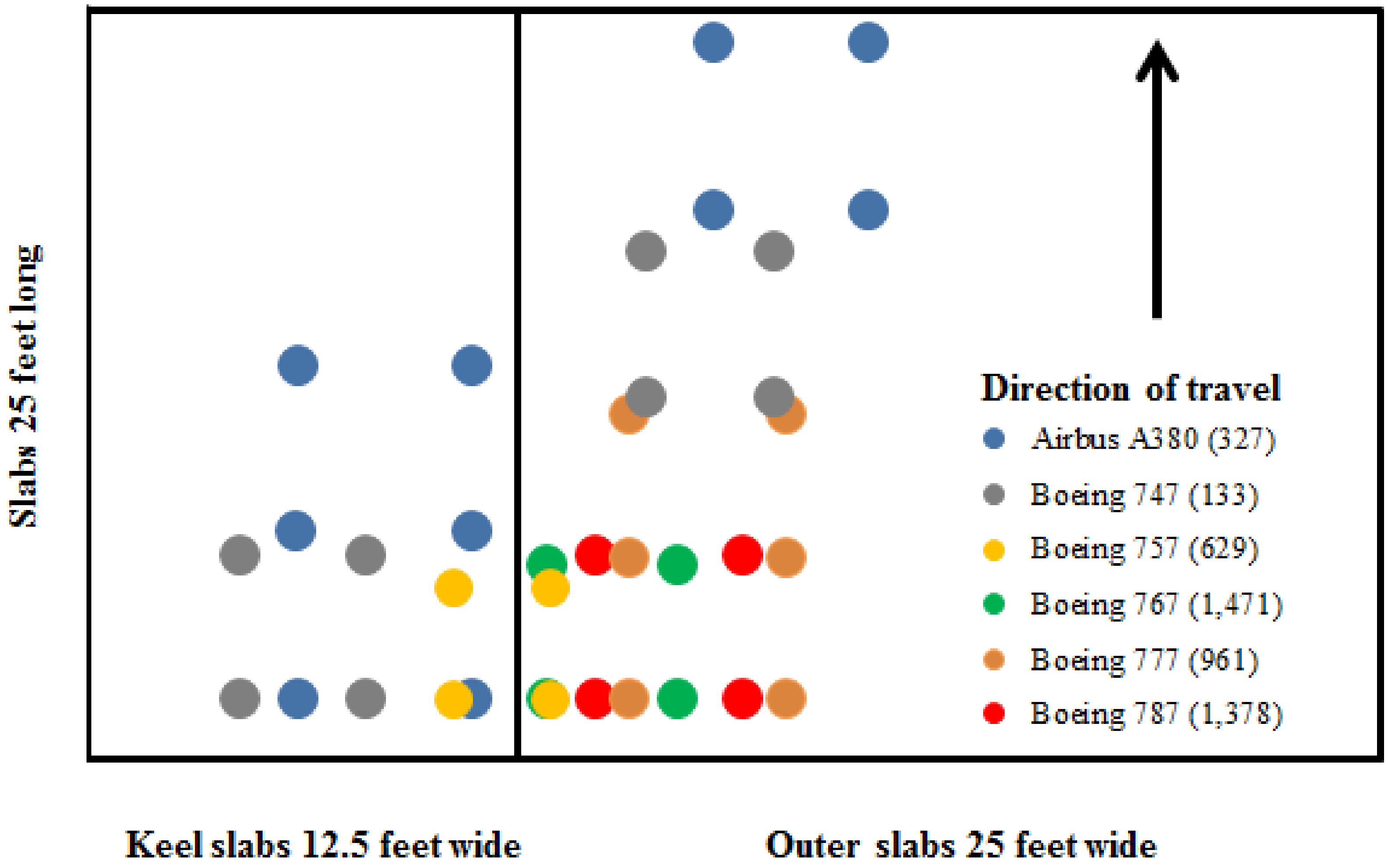
Section 1 Cross Section
19-inch PCC
2-inch HMA bond breaker
6-inch RCA

Section 2 Cross Section
21-inch PCC
2-inch HMA bond breaker
6-inch RCA
6-inch HMA (existing)



Section 3 Cross Section
8-inch bonded PCC Overlay
21-inch PCC (existing)
6-inch HMA (existing)

Wheel Loading



Case Study 4 Conclusions

- Theorized that the top layer of PCC in Section 3 did not bond properly
  - Acts as if independent rather than monolithic
  - Top layer not able to withstand wide-body aircraft loading
- Cross section and paving practices
  - Additional analysis needed for Section 3
  - Section 1 and 2 designs have performed well

CONCLUSIONS

Distress Mapping Considerations

- Slight increase in time to evaluate each sample unit
- 100% sample coverage recommended for distress mapping
- Benefits include a more efficient and robust pavement management program

Distress Mapping Benefits

- Analyze distress patterns
- Identify specific repair locations
- Track performance over time
- Determine accurate maintenance and repair quantities
- Identify issues in design, construction, or repair methods

Thank You!

Peter-Paul Dzwilewski, P.E.

217-398-3977

pdzwilewski@appliedpavement.com

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