Material Transfer Device Effect on Pavement Smoothness

Widening Joint Design & Construction

2016 FTBA Construction Conference
Factors Affecting Pavement Smoothness
Smooth Pavements

• Road users
  – Safe and comfortable driving
  – Better fuel efficiency
  – Reduced vehicle maintenance cost

• Highway agencies
  – Longer service life with less maintenance
  – Reduced maintenance costs
Potential Factors Affecting Smoothness

- Underlying layer smoothness
- Structural design
- Material properties
- Construction practices
Historical Use of MTD on Interstates

- MTD Use
- Partial MTD Use

% Lane Miles with MTD Use

Year

2005 to 2010 Interstate Data

- **With MTD**
  - Avg: 41 in/mile

- **Without MTD**
  - Avg: 54 in/mile

- **Statewide Avg:** 50 in/mile

**Graph Details:**
- 2005-2010 All (28,400 LOTs)
- 2005-2010 MTD-Yes (5,300 LOTs)
- 2005-2010 MTD-No (1,900 LOTs)
2011 to 2015 Interstate Data

- 2011-2015 All (16,200 LOTs)
- 2011-2015 MTD-Yes (11,200 LOTs)
- 2011-2015 MTD-No (2,300 LOTs)

With MTD
Avg: 43 in/mile

Without MTD
Avg: 49 in/mile

Statewide Avg: 45 in/mile
MTD Use Notes

- MTD use has increased and now approaches 90%
- MTD use leads to improved smoothness
  - 13 in/mile in 2005 to 2010
  - 6 in/mile in 2011 to 2015
- Gap has narrowed due to improved paving practices
Dev330SM Incentive/Disincentive

Incentive ($I$) =

\[ \begin{cases} 
  $260 & \text{if } IRI \leq 30 \\
  (43 - IRI) \times 20 & \text{if } 30 < IRI < 43 
\end{cases} \]

Incentive ($$) = (55 - IRI) \times 20$
Dev330SM Pilot Projects

**Incentive**

IRI < 43

Dev330SM
Avg: 39 in/mile

**Full Pay**

2005-2010 All (28,400 LOTs)
2011-2015 All (16,200 LOTs)
Dev330SM (3,600 LOTs)

2005-2010
Avg: 50 in/mile

2011-2015
Avg: 45 in/mile

**Disincentive**

55 < IRI < 95

Remove & Replace

% Frequency

IRI (inch/mile)
Dev330SM Pilot Projects

- Friction Course Avg: 39 in/mile
- Structural Avg: 51 in/mile
- Preconstruction Avg: 64 in/mile

% Frequency

IRI (inch/mile)

- Preconstruction (3,200 LOTs)
- Structural (3,300 LOTs)
- Friction Acceptance (3,600 LOTs)
# Pilot Project MTD Use

<table>
<thead>
<tr>
<th>Project ID</th>
<th>MTD Use</th>
<th>Structural IRI</th>
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<th>Differential IRI</th>
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Effect of MTD on Pilot Projects

MTD Use

- With MTD: 67%
- Partial MTD: 25%
- Without MTD: 8%

Acceptance Smoothness vs. MTD Usage

- Yes
- Partial
- No

Florida Department of Transportation
Regression Model Prediction of IRI

**“With MTD” Model**

\[ y = 0.406x + 15.927 \]

\[ R^2 = 0.45 \]

**“Without MTD” Model**

\[ y = 0.337x + 26.996 \]

\[ R^2 = 0.26 \]

Friction Layer IRI (in/mi) = \( IRI_F \)

Structural Layer IRI (in/mi) = \( IRI_s \)

\[ IRI_F = 0.406 \cdot IRI_s + 15.927 + \varepsilon \]

\[ IRI_F = 0.337 \cdot IRI_s + 26.996 + \varepsilon \]
Probability of Project Incentive

- Friction Layer IRI Prediction
- Lot Incentive Calculation
- Project Incentive Calculation
- Sum of Lot Incentives

Regression Model Prediction + Random Error

FDOT Dev. 330 SM Specification

Probability of Project Incentive

Florida Department of Transportation
Prediction Results

- **Projects “Without MTD”**
  - Average of $23K lost by not using an MTD
  - With MTD Model Simulation
  - Actual Incentive Paid
  - Without MTD Model Simulation

- **Projects “With MTD”**
  - Average of $20K gained by using an MTD

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Model Validation

✅ Project 11

![Graph showing probability distribution of project incentives with and without MTD model.]

- Actual Incentive: $31,520
- (Partial MTD Used for Friction Course Paving)
Model Validation

 ✓ Project 12

Actual Incentive: $14,100
(MTD Used for Friction Course Construction)
Smoothness Summary

- Dev330SM statewide implementation
- 15/25 pilot projects have been completed
- Long-term monitoring of pilot projects
  - Does localized roughness in structural layer eventually reflect through?
Smoothness Summary

- Smooth pavements can lead to significant incentives and long lasting pavements
- MTD use can improve the probability of obtaining incentives
- Good paving practices are most important
- More details on IRI prediction model:
  - TRB 2016 report by Kwon et. al
Improvement of Widening Joint Design & Construction Practices for Flexible Pavements
Widening Joint Design & Construction

- **Title**: Improvement of Widening Joint Design & Construction Practices for Flexible Pavements
- **Contract**: BDX93
- **Objectives**:
  - Design & construction guidelines
  - Effective rehabilitation strategies for deteriorated widening joints
Offset joints 6 to 12 inches laterally between successive layers

Friction course longitudinal joint
- Do not place in the wheel path
- Center of lane or near lane edge
Issues

• Reflection cracking of underlying joint
• Difficulties achieving density on narrow widening sections
• Accelerated deterioration of widening joints
• Poor drainage & structural failures due to incompatible base materials or when new & existing cross-sections do not match
Example 1: I-4 Volusia County

• 4 lane roadway widened to 6 lanes in 2008
  – New traffic lane & additional 2 ft of shoulder
• Widening joint located beneath right wheel path of L2 and R2
• Reflection crack appeared within 3 to 4 years
Example 2: I-4 Seminole County

- Widened from four to six lanes in 1998
- Widening started in the median & transitioned to outside
- Existing lanes were milled and resurfaced
Example 2: I-4 Seminole County
Example 3: Turnpike Trench Repair

- Full-depth saw cut widening joint
- Joint deteriorated significantly & became full-depth crack
- Repair plan
  - 2 ft. wide full-depth mill over crack, two lifts of structural asphalt (even with existing FC-5)
  - Regular milling & resurfacing of entire project
  - No issues to date
Example 3: Turnpike Trench Repair

• Lessons learned
  – Trench width changed to 26” to accommodate compaction equipment
  – Thinner lift thicknesses could have also been made to achieve density, but would have taken longer
Vertical Joint – Not Recommended

Existing HMA Surface
Existing Subbase
Existing Treated Subgrade
New HMA Overlay
New HMA Base Course
New HMA Base Course
Widened Subbase
Widened Section
Treated Subgrade

Widened Section
Tapered Joint

Diagram showing the layers of pavement materials in a widened section, including:
- New HMA Overlay
- New HMA Base Course
- Existing HMA Surface
- Existing Subbase
- Existing Treated Subgrade
- Widened Subbase
- Treated Subgrade
Stepped Joint - Recommended

- Existing HMA Surface
- Existing Subbase
- Existing Treated Subgrade
- New HMA Overlay
- New HMA Base Course
- New HMA Base Course
- Widened Subbase
- Treated Subgrade
- Widened Section
Stepped Joint

- Offset each successive layer a minimum of 6 inches
- Each step should not exceed 6 to 8 inches vertically
- Use additional steps for thick layers of a specific material type
Joint Location

- Do not place near wheel path
- Do not place near extreme edge of existing pavement
  - Cut back to sound material
- Eliminate shoulder joint by paving final layer with same material & thickness
- Overlay existing pavement & widened section to bridge widening joint
Joint Treatments

- Hot applied rubberized asphalt joint adhesives (recommended but costly)
- Double tack joint faces with an asphalt emulsion
- Apply a surface sealer product or overband joints with a PG binder
- Pay for tack as a separate bid item
- At a minimum tack with same material used to tack mat
Design & Construction Issues

- Joint steps should be offset 6 in minimum
- Ensure existing materials are not disturbed
- Treat existing vertical joint face with tack or joint adhesive
- Adequately compact new materials against existing materials
- Density measurements at 6, 12, & 18 inches from cut line in all materials
HMA Compaction

- Initial compaction of the joint should be performed before rolling the mat
  1. Vibratory roller on cold mat overlapping 6 in. on hot mat (static mode)
  2. Vibratory roller on hot mat overlapping 6 in. on cold mat (vibratory mode)
  3. Keep vibratory roller on hot mat 6 in. away from joint and roll this 6 in. on next pass

- Most important – meet density & smoothness requirements
HMA Compaction

- Don’t roll too fast (walking speed)
- General paving sequence
  - Vibratory compactor
  - Rubber tired roller
  - Finish with steel-wheel roller
- Lift thickness specifications should be enforced
Compacting Narrow Lanes

- Achieving density difficult due to insufficient compactor weight
- Narrow rollers readily available
- Decrease lift thickness
- If full-depth HMA is used, pay attention to drainage
Research Report

- Extensive literature review
- Questionnaire responses from 20 agencies
- Guidebook for Florida
- Online report:
Upcoming Research Projects

• Improving Safety in Pavement Testing
• High RAP mixes for Low Volume Roads
• Best Practices for Construction/Repair of Bridge Approaches & Leaves
• Structural Coefficient for High Polymer Modified Asphalt Mixtures
Questions?