Session 8: Load Transfer Restoration (Dowel Bar Retrofit, Cross-Stitching, and Slot Stitching)
Learning Outcomes

1. List benefits and applications of dowel bar retrofit (DBR), cross stitching, and slot stitching
2. Describe recommended materials and mixtures used for DBR
3. Describe recommended construction procedures for DBR
4. Identify typical construction problems and remedies for DBR
Load Transfer

- Ability of a joint or crack to transfer a wheel load from one side to the other
- Accomplished through:
  - Mechanical devices (dowel bars)
  - Aggregate interlock
  - Foundation support
- Expressed in terms of load transfer efficiency (LTE)
Load Transfer Efficiency

0% Load Transfer

Wheel Load → Direction of Traffic

Approach Slab   Leave Slab

100% Load Transfer

Wheel Load → Direction of Traffic

Approach Slab   Leave Slab

LT = \frac{Unloaded}{Loaded}

Fig. 8.1 on p. 8.2
Typical Causes of Poor Load Transfer

- Absence of load transfer devices
- Failed load transfer devices
- Poor aggregate interlock
- Poor pavement drainage
- Erodible base
Results of Poor Load Transfer
Results of Poor Load Transfer
Dowel Bar Retrofit

• Definition

Installation of dowel bars at existing transverse joints or cracks in order to effectively transfer wheel loads across slabs and reduce deflections

• Effective in preventing faulting
Schematic of Dowel Bar Retrofit Installation

END VIEW

- Varies

SIDE VIEW

- As required
- Compressible insert
- Mid-depth of slab
- Chair
- Joint or crack
- Endcap

See Fig. 8.5 on p. 8.8
Good Candidate Projects

• Relatively good structural condition but:
  – Poor load transfer (< 50–60%)
  – Differential deflections > 0.25 mm (0.01 in)
  – Faulting: 3 to 13 mm (0.12 to 0.5 in)
  – <10% slabs with multiple cracks

• Medium to heavy truck traffic
Patching Material

• Common patching materials:
  – Portland cement concrete (PCC)
  – Fast-setting proprietary materials

• Recommended characteristics
  – Little or no shrinkage
  – Thermal compatibility
  – Good bond strength
  – Rapid strength gain
Dowel Bar Design

• Round, smooth steel bars with corrosion resistance

• Recommended dowel bar dimension and spacing

<table>
<thead>
<tr>
<th>Pavement Thickness, mm (in)</th>
<th>Diameter, mm (in)</th>
<th>Minimum Length, mm (in)</th>
<th>Spacing, mm (in)</th>
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<td>&lt; 200 (8)</td>
<td>25 (1.0)</td>
<td>350 (14)</td>
<td>300 (12)</td>
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<tr>
<td>200 to 240 (8 to 9.5)</td>
<td>32 (1.25)</td>
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<td>300 (12)</td>
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<td>&gt; 250 (10)</td>
<td>38 (1.5)</td>
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<td>300 (12)</td>
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</table>

Table. 8.2 on p. 8.7
Dowel Bar Assembly

Fig. 8.3 on p. 8.5
Dowel Layout

Centerline

12 to 18 in (300 to 450 mm)

24 in (600 mm)

2 groups of 3 bars on 12-in (300-mm) centers

Direction of Travel

Fig. 8.4 on p. 8.7
Slot Creation
Slot Sawcuts
Slot Preparation

Material Removal
Slot Preparation

Material Removal
Slot Preparation
Sandblasting Slots
Slot Preparation
Cleaning Slots after Sandblasting

Airblasting

Cleaned Slot
Slot Preparation

Caulking of the Joint or Crack
Dowel Bar Placement

• Apply bondbreaker to dowels
• Slip filler board onto dowel bar
• Attach non-metallic expansion caps to both dowel ends
• Place dowel on non-metallic chairs
• Place dowel bar assembly into the dowel bar slot
• Adjust filler board to align with joint/crack
Dowel Bar Placement
Patching Material Placement

• Mix material in small quantities
  – Generally 10-mm (3/8-in) top size aggregate
  – Do not retemper mix
• Totally encase dowel bar with material
• Provide effective consolidation
  – Small 25-mm (1-in) spud vibrator
  – Do not contact dowel bar assembly
Patching Material Placement
Consolidation and Finishing
Patching Material Placement

Curing
Re-Establish Joint/Crack
Final Steps

- Diamond grinding
- Joint sealing
Key Factors For Success

- Selection of proper candidates
- Proper dowel bar design and layout
- Cutting of dowel bar slots
- Proper preparation of dowel bar slots
- Proper placement of dowel bar assembly
- Selection of appropriate material
- Careful material placement and curing
Troubleshooting

What is wrong here?

Misaligned Joint Forming Material
Troubleshooting
What is wrong here?

Jackhammer Angle Too Great

< 45°
Troubleshooting
What is wrong here?

Sawcuts Not Parallel to Centerline
Troubleshooting
What is wrong here?

Nonuniform Sawcuts
Troubleshooting
What is wrong here?

Poor Consolidation
Cross Stitching

- **Definition**
  
  *Grouting of tiebars in holes drilled across nonworking longitudinal joints and cracks at an angle to the pavement surface*

- **Used to strengthen nonworking longitudinal joints and nonworking longitudinal cracks (in relatively good condition)**
Cross Stitching
Applications and Benefits

• Prevent slab migration and to maintain aggregate interlock
• Mitigate the effects of tie bars omitted during construction
• Tying roadway lanes or shoulders that are separating
• Tying centerline longitudinal joints that are starting to fault
Cross Stitching Schematic

Fig. 8.18 on p. 8.23
## Cross Stitching

### Bar Dimensions, Angles, and Locations

<table>
<thead>
<tr>
<th>Angle</th>
<th>Slab Thickness, mm (in)</th>
<th>Distance from Crack to Hole, mm (in)</th>
<th>Length of Bar, mm (in)</th>
<th>Diameter of Bar, mm (in)</th>
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<td>165 (6.50)</td>
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<td>45°</td>
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<td>19 (0.75)</td>
<td>19 (0.75)</td>
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</tbody>
</table>

Table 8.5 on p. 8.24
Cross Stitching
Drilling Holes
Cross Stitching

Inserting Epoxy
Cross Stitching

Bar Insertion
Cross Stitching

Completed Project
Slot Stitching

- **Definition**

  *Repair technique for longitudinal cracks and joints that grew out of the dowel bar retrofit technique*

- Utilize deformed tie bars at longitudinal joints and cracks
Slot Stitching
Applications and Benefits

• Hold together adjoining concrete slabs
• Maintain aggregate interlock
• Provide reinforcement/strength to the longitudinal joint or crack
Slot Stitching Schematic

Fig. 8.21 on p. 8.26
Slot Stitching

Finished Crack
Review: Learning Outcomes

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4. Identify typical construction problems and remedies for DBR
Thank You For Your Attention!

Questions?