Chapter 6
Dowel Bar Retrofit

From… Maintenance Technical Advisory Guide (MTAG)
Load Transfer Restoration Through Dowel Bar Retrofit
Learning Objectives

1. List benefits of load transfer restoration
2. Describe recommended materials and mixtures
3. Describe recommended construction procedures
4. List important quality control activities
5. Describe potential construction and performance problems
6. Identify associated solutions

Chapter 6 – Dowel Bar Retrofit
Presentation Outline

- Introduction
- Material selection
- Construction
- Quality control
- Troubleshooting

Chapter 6 – Dowel Bar Retrofit
Load Transfer

- Definition
  Mechanism of transferring wheel loads across a joint or crack

- Accomplished through:
  - Mechanical devices (dowel bars)
  - Aggregate interlock
  - Foundation support

- Load transfer efficiency (LTE)
Load Transfer (continued)

0% Load Transfer

Wheel Load

Direction of Traffic

Slab 1

Slab 2

100% Load Transfer

Wheel Load

Direction of Traffic

Slab 1

Slab 2
Causes of Poor Load Transfer

- Absence of load transfer devices
- Failed load transfer device
- Excessive crack/joint opening
- Poor pavement drainage
- Eroded base
Results of Poor Load Transfer
Pumping
Results of Poor Load Transfer
Transverse Joint Faulting
Results of Poor Load Transfer
Corner Breaks
Results of Poor Load Transfer
Deteriorated Mid-Panel Cracking
Load Transfer Restoration

- **Definition**
  Installation of mechanical devices in an existing pavement to restore load transfer

- **Suitable for transverse joints or cracks**
Retrofitted Dowel Bar

**End view**

- Temporary joint insert for sealant reservoir
- 2.5 in min.
- 6 in max.

**Side view**

- Full depth joint forming medium & dowel support
- Dowel bar cap (at least one side)
- 0.25 in expansion

- *18 in max.
- 18 in ± 0.2 in
- 1.5 in
- T/2
- T
Load Transfer Restoration

Benefits

- Reduced probability of pumping, faulting, and corner breaks
- Improved long-term rideability
- Increased service life

Chapter 6 – Dowel Bar Retrofit
Good Candidate Projects

- Relatively good condition but with:
  - Poor load transfer
  - Faulting between 0.125 and 0.5 in
  - <10% slabs with multiple cracks
- Medium to heavy truck traffic

Chapter 6 – Dowel Bar Retrofit
## Example Item Codes

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>074017</td>
<td>Prepare water pollution control program</td>
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<tr>
<td>074019</td>
<td>Prepare storm water pollution prevention plan</td>
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<td>074020</td>
<td>Water pollution control</td>
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<td>074042</td>
<td>Temporary concrete washout (portable)</td>
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<td>120090</td>
<td>Construction area signs</td>
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<td>120100</td>
<td>Traffic control system</td>
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<td>128650</td>
<td>Portable changeable message sign</td>
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<tr>
<td>406100</td>
<td>Dowel bar retrofit</td>
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<tr>
<td>413111</td>
<td>Repair spalled joints</td>
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<tr>
<td>414101</td>
<td>Seal transverse joint</td>
</tr>
<tr>
<td>420201</td>
<td>Grind existing concrete pavement</td>
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[http://i80.dot.ca.gov/hq/esc/oe/awards/#item_code](http://i80.dot.ca.gov/hq/esc/oe/awards/#item_code)
Module 6-1

Design, Materials & Specifications

From… Maintenance Technical Advisory Guide (MTAG)
Presentation Outline

- Introduction
- Material selection
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Chapter 6 – Dowel Bar Retrofit
Material Selection

- Load transfer devices
  - Retrofitted dowel bars
  - Other devices not recommended

- Repair (filler) materials
  - Portland cement concrete (PCC)
  - Rapid strength materials
  - Polymer concretes
  - Epoxy-resin adhesives
Load-Transfer Devices
Dowel Bars
Dowel Design and Layout

Existing longitudinal joint

18 in

3 dowels @12 in centers

18 in

Existing Shoulder

18 in

Truck Lane

1.5-in dia. dowels

4 dowels @12 in centers

18 in

Existing Shoulder

12 ft

Truck Lane
Repair Material Requirements

- Little or no shrinkage
- Good ultimate strength
- Thermal compatibility
- Freeze-thaw durability
- Good bond to existing concrete
- Non shrink
Selecting Repair Materials

- Partial-depth repair materials work well
- Required time until opening to traffic
- Laboratory testing
Module 6-2

Construction and Inspection

From… Maintenance Technical Advisory Guide (MTAG)
Presentation Outline

☑ Introduction
☑ Material selection
☐ Construction
☐ Quality control
☐ Troubleshooting
Construction

1. Slot construction
2. Slot preparation
3. Dowel bar placement
4. Repair material placement
5. Material consolidation and finishing
Slot Construction

- Parallel to longitudinal joints
- Diamond saw cutters vs. modified milling machines
- Slot dimensions
  - Length: 3 ft on surface
  - Width: 2.5 and 4 in
  - Depth: 0.5 in below dowel (mid-panel depth + half diameter of dowel + 0.5 inch)
Slot Construction
Slot Cutting Machine
Slot Construction
Close-Up of Sawblades
Slot Construction
Slot Cutting with Milling Machine
Slot Construction

Milled Slots
Slot Preparation
Material Removal
Slot Preparation
Material Removal
Slot Preparation
Material Removal
Slot Preparation
Sandblasting Slots
Slot Preparation
Cleaning Slots after Sandblasting
Slot Preparation
Caulking of the Joint or Crack
Dowel Bar Placement

- Apply bondbreaker to dowels
- Attach expansion caps
- Place dowel on chair at slab mid-depth
- Filler board placed at mid-point of dowel bar to maintain joint
- Proper alignment is critical
Dowel Bar Placement
Dowel Bar Placement
Repair Material Placement

- Mix material in small quantities
- Generally 3/8 in top size aggregate
- Totally encase dowel bar
- Consolidate with small 1 in pencil vibrator
- Apply curing compound
Repair Material Placement

Backfilling
Repair Material Placement
Consolidation and Finishing
Diamond Grinding after LTR
Retrofitted Dowel Project
Retrofitted Dowels at Cracks
Presentation Outline

- Introduction
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- Construction
- Quality control
- Troubleshooting

Chapter 6 – Dowel Bar Retrofit
Quality Control

- Preliminary responsibilities
- Inspection of equipment
- Weather requirements
- Traffic control
- Construction inspection
Presentation Outline

☑ Introduction
☑ Material selection
☑ Construction
☑ Quality control
☐ Troubleshooting

Chapter 6 – Dowel Bar Retrofit
Project Checklist

- Preliminary Responsibilities
  - Project Review
  - Document Review

- Materials Checks
  - Cementing grout
  - Dowel bars
  - Joint/crack materials
  - Other materials
  - General

Chapter 6 – Dowel Bar Retrofit
Project Checklist

- Equipment Inspections
  - Slot Cutting Equipment
  - Slot Cleaning and Preparation
  - Mixing and Testing Equipment
  - Other Equipment

- Others
  - Weather Requirements
  - Traffic Control
Project Checklist

• Project Inspection Responsibilities
  • Slot Cutting and Removal
  • Slot Cleaning and Preparation
  • Placement of Dowel Bars
  • Mixing, Placing, Finishing, and Curing Backfill Material
  • Cleanup
  • Diamond Grinding
  • Resealing Joints and Cracks

Chapter 6 – Dowel Bar Retrofit
Troubleshooting

- Construction and performance problems

Approach:

1. Identify Problem
2. Determine Cause
3. Identify Solution

Chapter 6 – Dowel Bar Retrofit
Troubleshooting
What is wrong here?

Misaligned joint forming material
Troubleshooting
Construction Problems

● Problem

Sawcuts are not cut parallel to the longitudinal joints

● Solution?
Troubleshooting
Construction Problems

● Problem
  *Dowel bar slots are cut too shallow*

● Solution?
Troubleshooting
Construction Problems

- Problem
  *Dowel bar slots are cut too deep*

- Solution?
Troubleshooting
Construction Problems

- Problem
  Concrete fin is not easily removed

- Solution?
Troubleshooting
Construction Problems

● Problem
  *Jackhammer punching through slot*

● Solution?
Troubleshooting
Performance Problems

- Problem
  *Cracking of in-place patch material*

- Causes?
Troubleshooting
Performance Problems

- Problem
  *Patch material pops out*

- Causes?
Troubleshooting
Performance Problems

- Problem
  Wearing off of patch material

- Causes?
Troubleshooting Guide – Causes and Solutions

- Slots are not parallel to pavement edge or longitudinal joint
- Dowel bar slots are too shallow
- Dowel bar slots are too deep
- Concrete fin not easily removed
- Jackhammer punches through bottom of slot
- Epoxy coating on dowel bar is chipped or missing

Chapter 6 – Dowel Bar Retrofit
Troubleshooting Guide – Causes and Solutions

- Joint/crack sealant does not fully seal joint/crack along entire length expose in slot
- Joint/crack sealant extends more than 0.5 in. into slot
- Backfill material cracks in place
- Backfill material pops out of slot
- Backfill material wears faster than adjacent pavement

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Thank You

Questions?

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