Load Transfer Restoration – A Survey of Current Practice and Experience

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Outline

- Load transfer restoration techniques
- Practices and specifications
- Dowel bar retrofit performance
- Estimated future use of dowel bar retrofit
- Summary
Restoration Techniques

- Early 1980’s – research began on restoring load transfer at concrete joints and cracks
  - Figure Eight
  - Vee
  - Double Vee
  - Miniature I-Beam
  - Georgia Split Pipe
  - Freyssinet Connector
  - Dowel Bar Retrofit
Restoration Techniques

- Figure Eight

- Vee
Restoration Techniques

- Double Vee

- Miniature I-beam
Restoration Techniques

- Georgia Split Pipe
- Freyssinet Connector
Restoration Techniques

• Dowel Bar Retrofit
  – 1 to 1½ inch diameter by 18 inch in length epoxy coated smooth, round steel dowel bar
  – Two to four per wheelpath
Summary of Performance

- **Double Vee**
  - Load transfer initially restored
  - Polymer concrete debonding and consolidation failures typically occurred within two years

- **Dowel Bar Retrofit**
  - Effective in restoring load transfer
  - In-service 10 or more years in several states
  - Patching material consolidation and debonding due to slot cleanliness
PRACTICES & SPECIFICATIONS
Nationwide Use

- < 40 k
- 100 – 400 k
- 400 – 800 k
Dowel Bar

**Number of Dowel Bars per Wheelpath**

- 4 bars per wheelpath – CA, NY, OK, PA

**Dowel Bar Diameter**

- 1¼” diameter bar – IN, MN, MS
- PA (allows both)
Bond Breaker

![Bar chart showing percent of states for different materials and specifications. The chart has categories for Oil or Grease, Liquid Membrane, Engineer, Manufacturer, QPL, Bond Breaking Material, Graphite Type B, and Pull-Out Test. The Oil or Grease category has the highest bar, indicating a significant percentage of states use it as a bond breaker material or specification.]
Caulking Material

The graph shows the percent of states using different caulking materials or specifications. Silicone is the most commonly used, followed by compatible material and non-sag sealant. Sealant material, multiple products, and as shown on plans are the least used options.
Curing Compound

- Curing Compound
- Multiple Products
- White Pigmented
- Supplier
- Methylstyrene
- Modified Membrane
- Wax Based
Patching Material – General

Percent of States

Approved Product | ASTM C 928 | Not specified | Mg-phosphate; high alumina; PCC

Patching Material Product or Specification
Patching Material - Aggregate

Manufacturer's Recommendation

Percent of States

Extender Aggregate Size or Specification

- Manufacturer's Recommendation
- <\frac{3}{8}''
- <\frac{1}{2}''
- Multiple gradations
- <\frac{1}{4}''
- <\frac{3}{8}'' or \frac{1}{2}''
Patching Material – Compressive Strength

Compressive Strength Specification

Percent of States

Not Specified; > 3000 @ 3 hrs; > 5000 @ 24 hrs
> 4000 @ 6 hrs
> 3000 @ 3 hrs
> 4000 @ 24 hrs
> 3000 @ 4 hrs; > 4500 @ 24 hrs
> 2000 @ 6 hrs
> 2000 @ 2 hrs; > 2500 @ 4 hrs; > 4500 @ 28 day
Patching Material - Shrinkage

![Bar Graph]

- Not specified
- < 0.13% @ 4 days
- < 0.15% @ 28 days
- < 0.03% @ 28 days

Percent of States

Shrinkage Specification
DOWEL BAR RETROFIT PERFORMANCE
Summary of Performance

- Puerto Rico DOT
  - One of the first to routinely use DBR
  - First project in 1980
  - Report excellent load transfer
  - Less than 0.5 percent slot failure
Summary of Performance

• Minnesota DOT
  – After 6 years, load transfer has remained above 80 percent
  – No visible patching material failures
  – Very little additional faulting
  – 15 inch bar length provides equivalent performance
  – Three bars per wheelpath is appropriate
Summary of Performance

- North Dakota DOT
  - DBR effective in restoring load transfer
  - Slot distress appears to be due to
    - Shrinkage cracking
    - Lack of bond
    - Movement of foam core board
  - Require use of notched foam core board
    - Also used in CA, ID, OK, WI
Summary of Performance

• Michigan DOT
  – Evaluation of 7 projects
  – All performing as expected
  – Limited spalling of patching material
  – Few locations of patching material cracking
Summary of Performance

• Wisconsin DOT
  – Noted good load transfer results
  – Significant patching material failure
    ➢ Enforced moratorium in 2001
    ➢ Removed in 2002 after determining failure due to freeze/thaw durability issues
  – Require 3 year warranty
    ➢ Also included in Nevada, Michigan and Wisconsin
Summary of Performance

- California DOT
  - HVS evaluation by UC Davis
    - DBR improved load transfer efficiencies
    - Promising rehabilitation strategy
  - Constructed ~100 lane miles
    - Misaligned dowel bars
    - Less adhesion and lower bond strength with magnesium phosphate materials
    - Variation of distress within a given project
    - Installation not according to specification
Summary of Performance

- Washington State DOT
  - DBR of approximately 280 lane-miles
  - In-service age: 2 to 14 years
  - Detailed review of approximately
    - 180 lane-miles or
    - 380,000 dowel bar retrofit slots
Summary of Performance
Summary of Performance

Contract Number, Direction (Age)
Estimated Future Use of DBR
Conclusions

• DBR has gained widespread use in recent years

• Effective rehabilitation treatment for faulted concrete pavements
  – Improved load transfer efficiencies
  – Reduced potential for fault return

• Importance of quality control during construction
QUESTIONS