



PUTTING RESEARCH TO WORK

# BRIEF

## Cutting the Guesswork Out of Full-Depth Concrete Repair

When concrete pavement suffers substantial cracking, spalling at joints or other serious failures, crews resort to full-depth repair (FDR): Sections are cut out or full slabs are removed, and the concrete is replaced down to the base course.

Concrete pavements are designed to last 20 to 25 years, after which most roadways undergo one or two significant rehabilitations before full reconstruction. The first typically includes FDR with dowel-bar retrofitting or shoulder replacement, and is followed by diamond grinding or asphalt overlay to improve ride quality. This repair should last 12 to 15 years.

Methods used for the second repair vary. For overlaid concrete, the overlay is milled off and FDR is performed; then another asphalt overlay is placed. For pavements that were not overlaid during the first rehabilitation, FDR and other repairs are completed, followed by diamond grinding or asphalt overlay. Designers expect to gain another eight to 10 years from the second repair.

### What's the Problem?

WisDOT leaves the decisions of how and when to perform FDR to the discretion of county maintenance staff. Crews follow the design guidelines in WisDOT's Facilities Development Manual, but the manual does not specify construction techniques and practices, so FDR techniques may vary from county to county or project to project. Overall, FDR sections seem to perform well in Wisconsin, but early distress occasionally occurs.

### Research Objectives and Methodology

This research sought to develop guidelines for improving FDR practices statewide based on experience in Wisconsin and effective practices and techniques from around the country. To develop FDR guidelines that would supplement the Facilities Development Manual, researchers:

- Reviewed national literature and WisDOT standards.
- Examined four Wisconsin highway projects with hundreds of individual FDR sections.
- Analyzed data and published FDR best practice guidelines as a final report.

### Results

The literature review and performance evaluation confirmed that full-depth repairs in Wisconsin are performing well compared to those in other states. Guidelines were created in four areas:

**Background and general guidance.** This section describes FDR and conditions that require it, including linear (longitudinal and transverse) cracking and corner breaks, alkali-silica reaction cracking and joint spalling.

**Design.** FDR is effective in conjunction with joint sealing, drainage work or diamond grinding. Designers should anticipate heavy truck traffic, lane closure time, environmental conditions and existing pavement design. Additional considerations are:

- *Boundaries of FDR sections.* Repairs should be made across the entire lane (12 feet) and from 6 feet long to slab length or 15 feet, whichever is shorter. Sections must start at least 6 inches from the location of distress. A buffer of existing sound concrete of 6 feet or longer must stand between nonadjacent repaired sections.
- *Joints.* Dowel bars must be replaced, and repairs that are longer than 10 feet should use tie bars at the longitudinal joints.
- *Thickness.* Repaired sections should match the thickness of the adjoining pavement. Thicker FDR sections may be used for heavy truck traffic or when early pavement opening is planned if previous FDR sections performed poorly or if base material must be replaced.

#### Investigator



*"Our research found that the layout of repairs and load transfer are the most critical factors in proper full-depth repair."*

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*“Researchers found that Wisconsin’s full-depth repairs are performing better than most other states’. These guidelines will help make pavements more uniform around the state.”*

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Using retention disks on newly inserted tie bars, above, and dowel bars keeps fresh epoxy from oozing out and coating exposed dowels, tie bars and joint faces (Fig. 23c of the final report).

**Construction.** Effective construction will consider:

- *Mix design.* High early strength must be 3,000 psi or greater for 10-inch or thicker slabs, and higher for thinner layers. The guidelines match current practice in Wisconsin in terms of mix types, cementitious content and use of admixtures.
- *Cutting boundaries.* Single, full-depth saw cuts are recommended at repair boundaries.
- *Concrete removal.* Lifting slabs or breaking and removing concrete can reduce damage to adjoining pavement or bases. Loose or damaged base materials must be replaced with concrete.
- *Load transfer device placement.* Holes for new dowels must be free of debris and moisture. The inserted half of dowels must be thoroughly covered with epoxy and carefully inserted. Retention disks will keep epoxy in holes.
- *Concrete placement and finishing.* Air temperature should remain at 40 degrees Fahrenheit or higher within 24 hours of placement. High temperatures should also be avoided. Multiple batches must be placed within 20 minutes of one another. Finish level and texture should match adjoining concrete.
- *Joint forming.* Joints should be formed, and cutting must follow new pavement standards.
- *Curing and opening to traffic.* Curing temperature specifications must be followed closely; curing compounds, insulation covers and sprinklers may be necessary.

**Checklist.** A five-page checklist addresses preliminary responsibilities, materials, equipment inspection, weather requirements, project inspection, and common problems and solutions.

## Benefits and Implementation

This supplement to the Facilities Development Manual informs county maintenance crews about using and performing FDR. Its use will establish uniform pavement quality around the state and better ensure the 10- to 15-year life WisDOT expects from FDR projects. An industry-based workshop will use the guidelines to train county maintenance personnel around the state.

## Further Research

The investigators suggest that future research should investigate how well the guidelines suit local situations and traffic, and should evaluate the impact of FDR section dimensions on transverse and longitudinal cracking. In addition, FDR practices should evolve to reflect changes in concrete pavement design and construction, such as dowel size and placement adjustments, new curing practices, and the use of early-opening mixes.

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