Concrete: Full Depth Repair

An Online Continuing Education Course for Engineers

Course Number: C-1023

Credit: 1 Hour / 1 PDH / 1 CPD

1.0 Introduction

Full-depth repair (FDR) is a concrete pavement restoration technique that restores isolated slab structural integrity and rideability and deters further deterioration, thus extending the pavement's service life. FDR is suitable for a wide variety of distresses that are beyond partial-depth repair, such as transverse & longitudinal cracks, corner breaks, deteriorated joints, D-Cracking, blowups, and punch-outs. FDR involves making lane-width, full-depth saw cuts to remove the deteriorated concrete down to the base; repairing the disturbed base; installing load-transfer devices; and refilling the excavated area with new concrete. The cost of FDR is largely dependent upon the size, number, and location of repair areas, as well as the type of concrete mix used.

2.0 Project Selection

2.1 FDR Limitations

- Use partial-depth repair instead of FDR for spalls limited to the top one-third of the slab.
- Full depth repairs should be used for rigid pavements with deterioration limited to isolated slabs, not widespread over the entire project length.
- Structurally deficient pavements may require a structural enhancement, such as an overlay or tied rigid shoulders, instead of one or more isolated, full depth repairs.
- If the pavement has a severe material problem, such as reactive aggregate or alkali-silica reaction (ASR), FDR will only provide temporary relief from roughness and further deterioration caused by spalling. Continued deterioration of the original pavement is likely to result in the redevelopment of spalling and roughness.
- Pavements with base course or subgrade problems, as indicated by differential settlements or load-deflection tests, are not good candidates for isolated full depth concrete repairs.

2.2 Distress Types

Transverse cracking of medium and high severity are recommended for FDR. Some cracks that extend through the depth of a slab can begin moving and functioning as joints. Transverse cracks that function as joints are often called "working cracks" and are subject to about the same range of movement as transverse joints. Working cracks develop and deteriorate from one or more of these causes:

- Lock-up of the dowel bars in a nearby joint
- Rupture or corrosion of steel in jointed-reinforced slab
- Poor joint spacing
- Loss of aggregate interlock along the crack face
- Inadequate joint sawing
- Excessive curling and warping of slabs
- Lack of subgrade support

Transverse cracks that remain tight (hairline cracks) and do not extend to the bottom of a slab do not require any special treatment, (e.g., plastic shrinkage cracks). Most plastic shrinkage cracks remain very tight and extend into the slab about 25-50 mm (1-2 inch). These hairline cracks do not allow much water to penetrate the pavement substructure and rarely deteriorate or influence the serviceability of a concrete pavement. Low severity working cracks with poor load transfer may be repaired by restoring the load transfer using dowel bars (See Publication FHWA-SA-97-103 for details). Medium to high severity distress working cracks are good candidates for FDR.

Figure 1. Transverse crack

Longitudinal cracking of high severity warrants FDR. A high severity condition indicates that a crack is greater than 12 mm (0.5 inch) wide, spalling extends more than 150 mm (6 inch) from the crack, and faulting is greater than 12 mm (0.5 inch). If the condition is less severe, other CPR procedures, such as partial depth repairs, cross-stitching, retrofit dowel bars, or sawing and sealing are sufficient.

Figure 2. Longitudinal crack

"D" cracking is a pattern of cracks caused by the freeze-thaw expansive pressures of certain coarse aggregates. The disintegration and spalling associated with these stresses normally begins near the joints as a result of the higher moisture levels necessary for the course aggregates to expand in volume during freezing. Medium and high severity "D" cracking could warrant full depth repair. However, like for any other materials related distress, FDR only provides a temporary treatment.

Figure 3. "D" cracking

Shattered Slabs & corner breaks develop in slabs receiving marginal support from the subbase or subgrade. Any heavy loads that pass over these slabs cause large vertical deflections and high tensile stresses in the concrete. Over time the unsupported slab will pump subbase or subgrade fines out from beneath the slab, leading to voids and eventual cracking over the uneven support. Shattered slabs also may result from frost heave or swelling soil problems. Shattered slabs and corner breaks are good candidates for using FDR.

Punchouts in continuously reinforced concrete pavements (CRCP) are candidates for FDR as they represent a structural failure of the pavement. They form after many load cycles when the longitudinal steel ruptures along the faces of two closely spaced cracks, usually less than 0.6 m (2 ft) apart.

Figure 4. Punchout

Blowups occur in hot weather at transverse joints or cracks which do not allow sufficient expansion of the concrete slabs. The insufficient expansion width of joints is usually caused by infiltration of incompressible material into the joint. Blowups of any severity warrant FDR due to the localized disruption to pavement integrity and the potential safety hazard.

Figure 5. Blowup

Distress	Severity
Jointed Concrete Pavement (JCP)	
Blowup	Low
Corner Break	Low
D-Cracking	Medium
Deterioration	Adjacent to Existing Repair Medium
Joint Deterioration	Medium (with faulting 6mm (0.25 in))
Spalling	Medium
Reactive Aggregate	Medium
Transverse Cracking	Medium (with faulting 6mm (0.25 in))
Longitudinal Cracking	High (with faulting 12mm (0.5 inch)
Continuously Reinforced Concrete Pavement (CRCP)	
Blowup	Low
Punchout	Medium (with faulting 6mm (0.25 in))
Transverse Cracking (Steel Rupture)	Medium (with faulting 6mm (0.25 in))
Localized Distress	Medium
Construction Joint Distress	Medium
D-cracking	High
Longitudinal Cracking	High (with faulting 12 mm (0.5 in))
Repair Deterioration	High

Table 1. General distress criteria for full-depth repair

2.3 Pavement Type

2.3.1 Jointed Concrete Pavement (JCP)

JCP has transverse joints spaced at regular intervals to control temperature-induced contraction and expansion in the concrete. Smooth dowel bars are used at the transverse joints for load transfer between slabs. JCP also has longitudinal joints to control random longitudinal cracking; these joints are connected with tie bars.

JCP typically requires far more rep   them. Some
pavements devel   affic loading.
Lock   open the mid-
pane   heavy traffic
loadi   or more mid-
pane   es of JCP
distre   ble 1.

For mo   ad transfer.
The de   and spacing
of the   ed closely
togethe   ower dowel
bearing   ential for
faulting.   d in the
wheel pa   s) diameter
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is expect   equate
performa

2.3.2 Con

CRCP is a   steel
reinforcem   ement is
allowed to
together by

Most full-de   exhibiting punchouts and other
localized dis   quired at medium and high severity transverse cracks
in which the st   ruptured. The type of CRCP distresses that can be addressed through FDR are listed in Table 1.

For full-depth patching in continuously reinforced pavements, new steel bars are necessary to maintain the continuity of the reinforcing bars that run longitudinally through the pavement. The reinforcing bars provide load transfer at the closely spaced cracks by keeping the cracks from opening. Reliable methods to attach the new bars to the salvaged lengths of the old bars