Bonded Concrete Resurfacing of Composite Pavements

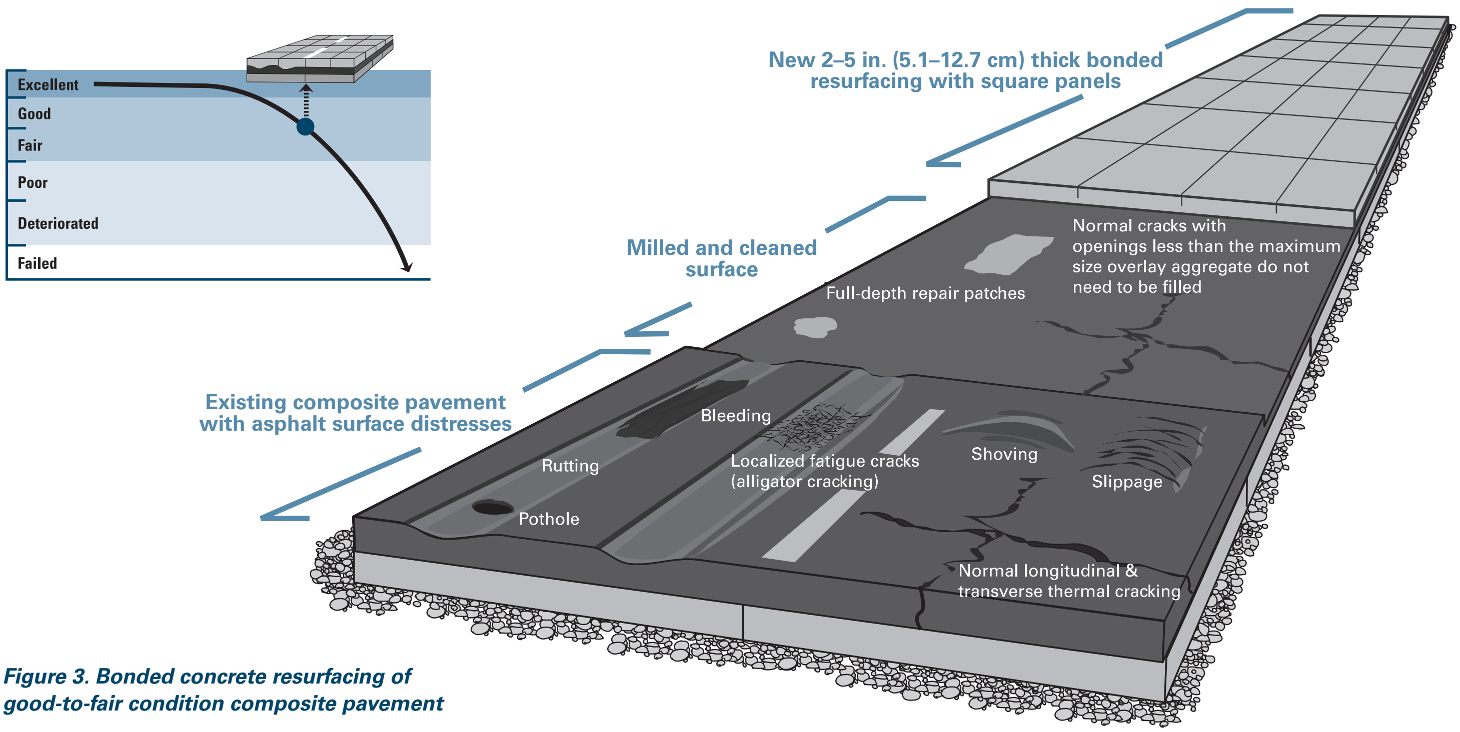

Figure 3. Bonded concrete resurfacing of good-to-fair condition composite pavement

Uses

Composite (concrete on asphalt) pavements that are in good-to-fair condition structurally but exhibit surface distresses such as rutting, shoving, slippage, and thermal cracking can be enhanced with a 2–5 in. (5.1–12.7 cm) bonded concrete resurfacing.

This type of concrete overlay is a bonded resurfacing that relies upon the existing composite pavement to carry some traffic loading.

Performance

Bonded concrete resurfacing has been successfully used in many states to maintain and rehabilitate composite pavements with surface defects. The condition of the underlying composite pavement and the uniformity of base support have a significant effect on the performance of bonded concrete resurfacing.

Resurfacing Process

STEP 1. PAVEMENT EVALUATION

An evaluation of the existing composite pavement is necessary to ensure it is structurally adequate to carry the anticipated traffic loads, to determine required milling depths, and to establish the bonded resurfacing design thickness. The structural adequacy of the existing composite pavement can be assessed through a visual examination of the type, severity, and extent of existing distresses and through analysis of cores taken from the existing pavement. Falling weight deflectometer (FWD) testing may be considered to aid in the analysis, depending on the design life and traffic volume.

The results can provide information on the stiffness of the asphalt pavement, subgrade support conditions, and variations of these properties over the length of the project, thereby identifying localized areas of weakness requiring strengthening. Composite pavements with significant structural deterioration, inadequate or uneven base/subbase support, poor drainage conditions, or stripping of asphalt layers are not good candidates for a bonded resurfacing of less than 5 in. (12.7 cm).

Consideration should be given to any deterioration of the asphalt surface course, as asphalt is a good reflector of structurally problematic areas such as subbase/subgrade problems, material-related distresses such as ASR and D-cracking, and other defects that result in vertical displacement of the profile and extensive fatigue cracking.

STEP 2. RESURFACING DESIGN

Resurfacing Thickness

The design thickness for bonded concrete resurfacing is typically 2–5 in. (5.1–12.7 cm) depending on the desired load-carrying capacity and service life and the structural capacity provided by the underlying pavement.

Newly developed (2006) design procedures for bonded concrete resurfacing of composite pavements are available from ACPA. The ACPA spreadsheet incorporates the latest thinking in methods to address the limitations of the previous design procedures. The procedures are consistent with the proposed **M-E PDG** in that the user evaluates a proposed section against anticipated traffic to determine if the section configuration, materials' thermal characteristics, and joint geometry are adequate to meet the demands.

Mixture Design

Conventional concrete mixtures have been successfully used for bonded concrete resurfacing. The concrete mixture can be proportioned for rapid strength gain, minimum thermal expansion and contraction, and minimum shrinkage.

Some states use rapid-strength concrete mixtures with a high cementitious material (cement and fly ash) content (though not to exceed 660 lb/yd^3 [299.4 kg/m^3]), low water-to-cementitious material ratio, and smaller top-size aggregate (typically ¾ in. [1.9 cm]). These mixtures can be used with accelerating admixtures to provide the early strength required to place traffic on the overlay within a short time. A water-reducing admixture is used to reduce the w/cm ratio. The slump range is typically 2–3 in. (5.1–7.6 cm), which provides good bonding grout. For bonded resurfacing, it is better to have a wet, sticky mixture than a dry one. The use of high-modulus structural fibers can improve the toughness and

Iowa State University
National Concrete Pavement Technology Center

post-cracking behavior of the concrete and help control plastic shrinkage cracking.

Joint Design

The recommended joint pattern for bonded resurfacing of composite pavements is small square panels, typically in the range of 3–8 ft (0.9–2.4 m), to reduce curling and warping stresses. It is recommended that the length and width of joint squares in feet be limited to 1–1.5 times the slab thickness in inches. In addition, if possible, longitudinal joints should be arranged so that they are not in the wheel path.

STEP 3. PRE-RESURFACING WORK

Pre-resurfacing Repairs

Most surface distresses can be removed through milling. See table 3. Areas with potholes; localized, moderate-to-severe alligator cracking; or loss of base/subgrade support may require partial or full-depth spot repairs to achieve the desired load-carrying capacity and long-term durability.

Panel tenting (early stages of blowups) may be an indication that a void exists under existing panels. Sections with significant tenting can be repaired to relieve the pressure and provide uniform support before construction of a bonded resurfacing. All patching should be completed prior to milling.

Milling

Milling may be used where surface distortions are 2 in. (5.1 cm) or greater. Milling should be minimized because it results in loss of structural support. The three main objectives of milling prior to a bonded resurfacing are (1) to remove significant surface distortions that contain soft asphaltic material, which would result in an inadequate bonding surface; (2) to roughen a portion of the surface to enhance bond development between the new concrete resurfacing and the existing asphalt; and (3) to reduce high spots to help ensure minimum resurfacing depth and reduce the quantity of concrete needed to fill low spots.

Table 3. Possible pre-resurfacing repairs for bonded resurfacing of composite pavements

Existing pavement distress	Spot repairs to consider
Fatigue cracking	Full-depth repair patch
Pothole	Full-depth repair patch
Deep rutting	Milling
Shoving, slippage	Milling
Thermal cracking	None
Tenting (early stages of blowups)	Full-depth repair

The amount of asphalt removal depends on the types and severity of distresses and the thickness of the asphalt pavement. The objective of removing material is not to obtain a perfect cross section. It is not necessary to completely remove ruts. A minimum of 3–4 in. (7.6–10.2 cm) of asphalt should be left after milling because of the reliance on the asphalt pavement to carry a significant portion of the load. Milling should leave at least half of the asphalt lift for optimum bonding since milling down to a point just above the tack line can lead to separation. The milled material may be used in constructing shoulders.

Further Repairs

After milling, the surface should be inspected for isolated pockets of deterioration that require further repairs. For isolated areas that have a high number of wide transverse thermal cracks, a decision needs to be made whether to bridge the cracks with the bonded resurfacing or to clean and fill the cracks. Concrete can span normal asphalt longitudinal and transverse cracks. Filling cracks with emulsion, fly ash slurry, or sand is necessary only for cracks that have an opening greater than the maximum size aggregate used in the bonded resurfacing.

If there is vertical movement of the underlying concrete pavement immediately adjacent to a crack, the joint should be replaced, fibers added to mixture, or rebar used over the joint in composite pavements. Typically, 36 in. (91 cm) long bars are stapled to the existing pavement at 30 in. (76.2 cm) spacings, perpendicular to the crack.

Surface Cleaning

Following repairs, the asphalt surface needs to be cleaned to ensure adequate bonding between the existing asphalt surface and the new concrete overlay. Adequate bonding is very important to the performance of this resurfacing technique. Cleaning may be accomplished by first sweeping the asphalt surface, followed by cleaning with compressed air. Pressure washing should only be considered when dust control is mandated or when mud has been tracked onto the milled surface. No standing water should remain on the surface at the time the overlay is placed. In order to prevent contamination, it is important to avoid a large lag time between final surface cleaning and paving.

STEP 4. CONSTRUCTION

Concrete Placement

When the surface temperature of the asphalt is at or above 120°F (48.9°C), surface watering can be used to reduce the temperature and minimize the chance of early-age shrinkage cracking. No standing water or moisture should remain on the surface at the time the bonded resurfacing is placed.

Once the surface of the existing asphalt pavement has been prepared, paving is accomplished using either conventional fixed-form or slip-form construction, the selection of which depends on the size of the project and any geometric constraints. Because of the variation of the concrete thickness, the concrete material is bid on a cubic-yard basis. Some states also include a bid item for placement on a square-yard basis.

Curing

Curing is especially critical to bonded resurfacing projects because their high surface area-to-volume ratio makes them more susceptible to rapid moisture loss. Curing is usually accomplished by applying a curing compound immediately after surface texturing (within 30 minutes of placement). In some states, the typical curing rate is increased by 1.5–2 times for bonded concrete resurfacing. The finished product should appear as a uniformly painted solid white surface, with the vertical faces along the edge of the bonded resurfacing also coated. Areas exhibiting a blotchy or spotty appearance should be recoated immediately. Be careful not to spill curing compound onto an area yet to be resurfaced, because it is a bond breaker.

Joint Sawing

Timely joint sawing is necessary to prevent random cracking. Joint sawing should commence as soon as the concrete has developed sufficient strength such that the joints can be cut without significant raveling or chipping, typically within 3–6 hours of concrete placement. Lightweight early-entry saws (⅛ in. [3.2 mm] wide blades) may be used to allow the sawing crew to get on the pavement as soon as possible. Extra saws will likely be needed. Transverse joints can be sawed with conventional saws to a depth of T/4. Transverse joint saw-cut depths for early-entry sawing should not be less than 1¼ in. (3.2 cm). Longitudinal joints should be sawed to a depth of T/3. Joint sealing is not required.

Future Repairs

Bonded concrete resurfacing may be easily repaired using full-panel replacement. Another option is simply to mill and fill. Do not patch with asphalt, because the adjacent concrete panels will move and break the bond. If a panel is distressed but the ride quality of the pavement is not compromised, the panel should be left in place. If a ride quality problem develops, the panel should be replaced before any pieces of concrete become loose from the resurfacing.

Key Resources

ACI Committee 325 (2006), Rasmussen and Rozycki (2004), and ACPA (1999a)