TECHNICAL NOTE

Rehabilitation Strategies for Bonded Concrete Overlays of Asphalt Pavements

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1. Introduction

Bonded concrete overlays of asphalt pavements (BCOA) are becoming a widely accepted rehabilitation alternative in the United States. BCOAs are typically between 2 to 5 inches thick. Long term performance is obtained from these thin overlays by maintaining a good bond between the concrete overlay and the asphalt so load induced stresses are reduced. Additionally, the use of short joint spacings reduces the effect of curling and warping stresses from environmental loads as well as bending stresses from applied traffic loading [2].

Development of new design procedures for BCOA, such as BCOA-ME from the University of Pittsburgh, will only make this rehabilitation option more appealing in the future. As this form of pavement rehabilitation becomes more common, it is important to understand the types of distress that develop and best practices for repairing them. Below, the types of distress that can develop in a BCOA will be discussed as well as appropriate rehabilitation strategies that can be employed.

2. BCOA Distresses

Load related distresses that typically develop in BCOA are transverse cracking (larger slabs: 10 ft x 12 ft or large), longitudinal or diagonal cracks (medium panels: 6 ft x 6 ft or smaller) corner breaks (smaller slabs: 4.5 ft x 4.5 ft or smaller). Longitudinal cracking of the panel may also occur. Finally, reflective cracking of distress from the asphalt up into the overlay can occur. Examples of these distresses are provided in Figures 1 and 2.

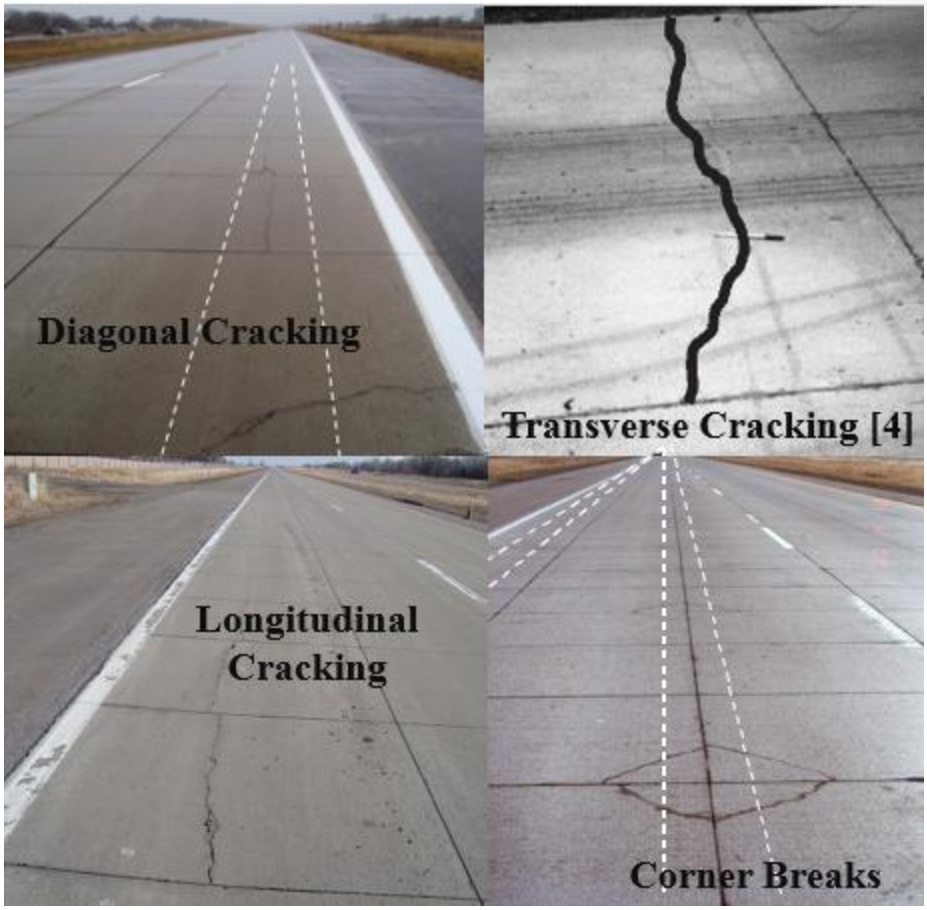

Figure 1. BCOA load-related distresses.

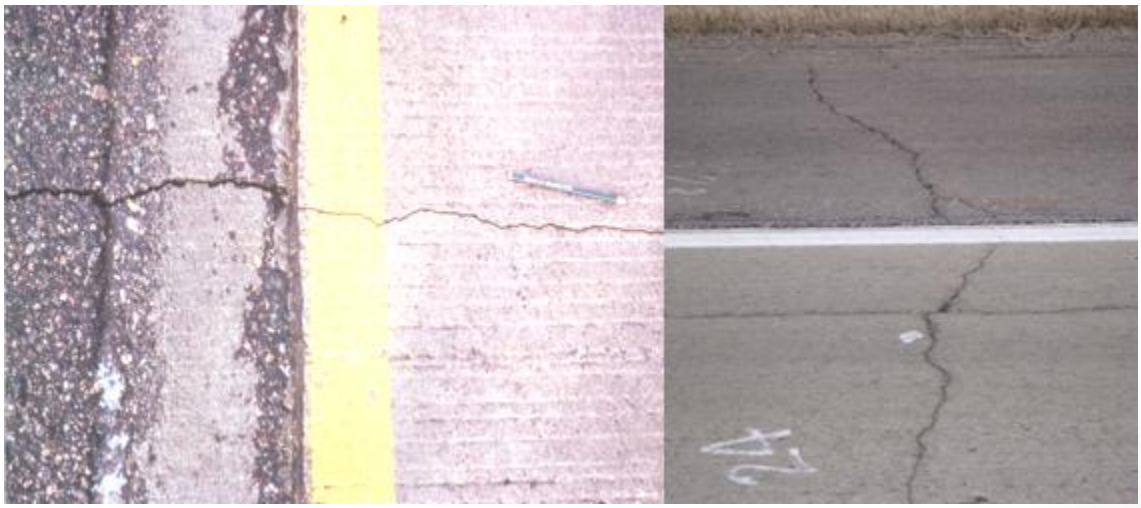

Figure 2. Reflective cracking in a BCOA

3. Repairs

There are several approaches to repairing BCOAs. The appropriate rehabilitation strategy should be selected based on if the distress is only present in isolated areas or if it uniform throughout the section. Patching can be performed if only isolated areas of distress are present. If the overlay is distressed throughout the section but sound HMA is still available under the BCOA, then the Portland cement concrete (PCC) can be milled and replaced with new PCC. An unbounded overlay can be placed on the BCOA if it is heavily distressed throughout with insufficient HMA remaining to place another BCOA after milling or if unstable support conditions are present under the BCOA throughout the section.

1) Isolated distress
   - Patching
2) Distressed throughout
   - Mill and fill with PCC
   - Unbonded overlay

A brief description of each of the three rehabilitation strategies is provided below.

Patching

Panels only need to be repaired if the distress has deteriorated to the point that ride quality of the pavement has been compromised; otherwise the panel should be left in place. These distressed slabs should not be replaced with asphalt because the adjacent concrete panels will move and potentially damage the bond [1]. Steps to be taken when performing a full-depth slab replacement are outlined below.

I. Pre-mill coring (optional)

- This optional step prior to milling is to estimate an appropriate milling depth on the basis of the integrity of the asphalt beneath the distressed panel. Also, the location of the lifts within the HMA layer can be identified and should be considered when establishing the depth of milling when performing the repair. An attempt should be made to keep the lift below 0.75 in to 1 in from the top of the milled surface if at all possible to maintain the integrity of the bond.

II. Mill the distressed panel

- Mark out the repair areas and mill out the slab interior leaving approximately a 4 in boundary between the milled region and the adjacent joints. This will help to insure that the joints are not inadvertently damaged during the milling process. There is no need to saw the perimeter if milling is performed, as shown in Figure 3.

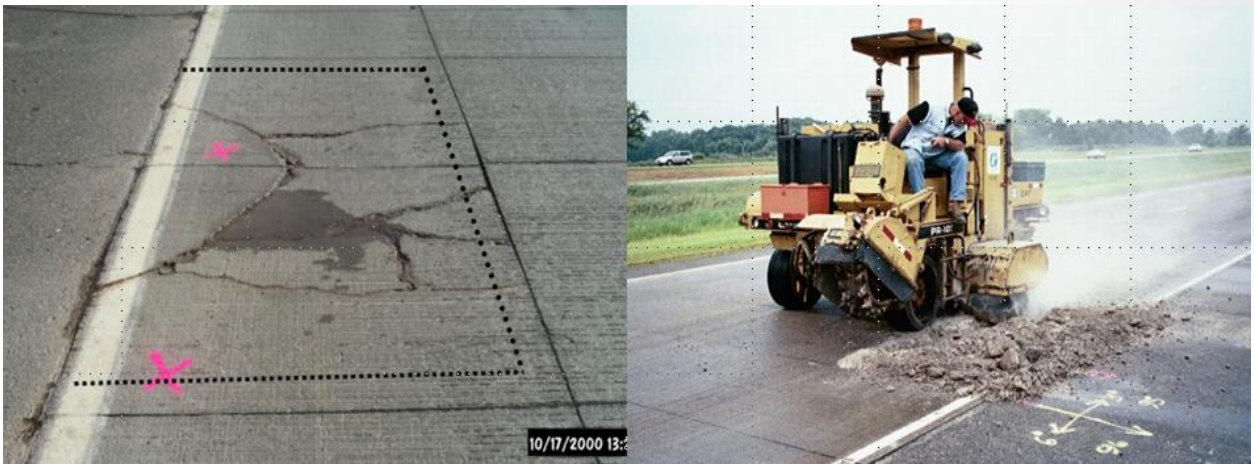

Figure 3. BCOA slab marked out and subsequent milling of the region within the boundary.

III. Jackhammer around the outer portion of the repair area to create a vertical edge

- Small jack hammers are used to remove the material between the milled area and the adjacent joints that was not removed during the milling process.
- Care should be taken create insure the depth of the patch area in uniform and that the milled areas are the same depth as the areas where the jack hammer was used. Otherwise, premature cracking will occur in the patch due to the non-uniform thickness of the patch. See Figure 4.
- Care should be taken to insure the edge is vertical and not sloped when jack hammering out the exterior edge of the repair area. See Figure 5.a.

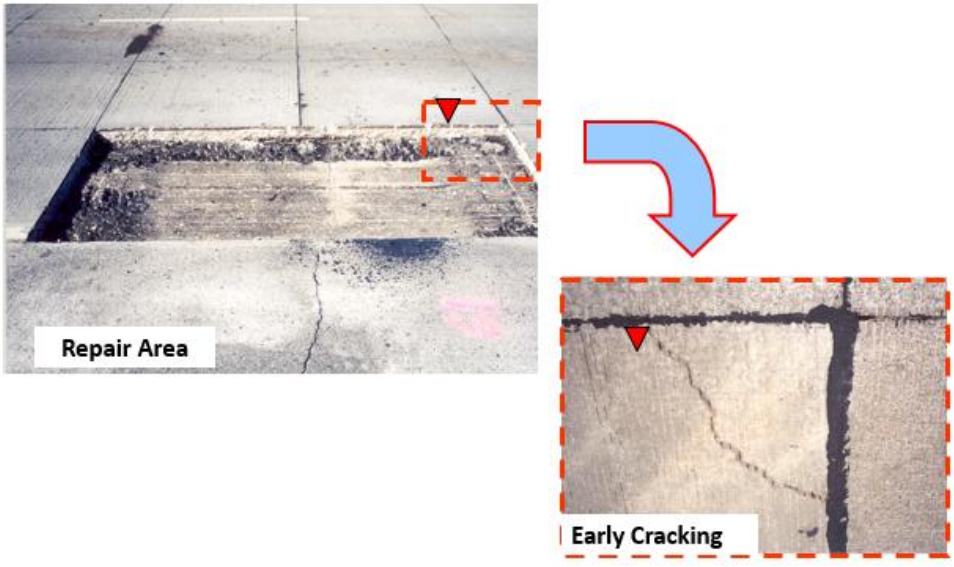

Figure 4. Example of early cracking in a patch due to a non-uniform surface in the repair area prior to placing the concrete.

IV. Clean repair area

- It is essential to thoroughly clean the repair area prior to placing the concrete in the patch so that a good bond between the asphalt surface and the patch material is obtained.
- Vacuums can be used to quickly remove debris from the repair area. See Figure 5.b.

(a) (b)

Figure 5. Material removal a.) jackhammering and removing the exterior edge and b.) removal of debris from the repair area.

V. Place, finish and cure the concrete

- Just prior to the placement of the concrete in the repair area, compressed air can be used to insure any debris remaining is removed.
- Mist the surface of the surface of the repair area prior to the placement of the patch to ensure moisture from the concrete is not absorbed by the asphalt surface and to cool the asphalt surface.
- Place concrete in the repair area and vibrate with a shaft vibrator.
- Strike off and finish the surface.
- Spray a curing compound on the finished surface. Blankets can be used if temperatures are low or to increase the rate of strength gain for earlier opening to traffic.

VI. Re-establish and seal joints

- Saw a ¼ in reservoir and seal with an asphalt sealant. A backer rod is not needed. See Figure 6.

- The joint should be sawed to a depth of 1/3 the thickness of the repair when reestablishing joints within the interior portion of the repair area.
- Prior to placing sealant material, compressed air should be used to clean the debris from the sawing operation.

Figure 6. Placing the concrete in the repair and sawing and sealing.

VII. Diamond grind

- Diamond grinding can be performed after the repairs are made if rideability is reduced due to differential elevations between the old concrete and the patch.

An additional step is required when repairing a reflective crack. When the asphalt is exposed after cleaning out the milled concrete, a debonding material must be placed over the crack in the asphalt. The debonding material can be any thin material that will break the bond, such as duct tape or roofing paper. After placing the concrete, joints are sawed as previously described accept for in the location of the transverse reflective crack. In this location, the joint is sawed directly above the crack in the existing asphalt, resulting in a joint that does not align with the transverse joint in the adjacent panels. The longitudinal joints should be sawed to the depth of the overlay and on both sides of the misaligned transverse joints to ensure that the

adjacent panels do not bond together. Cracks may develop from the misaligned transverse joints into the adjacent panels if the longitudinal joint is not sawed full depth. See Figure 7.

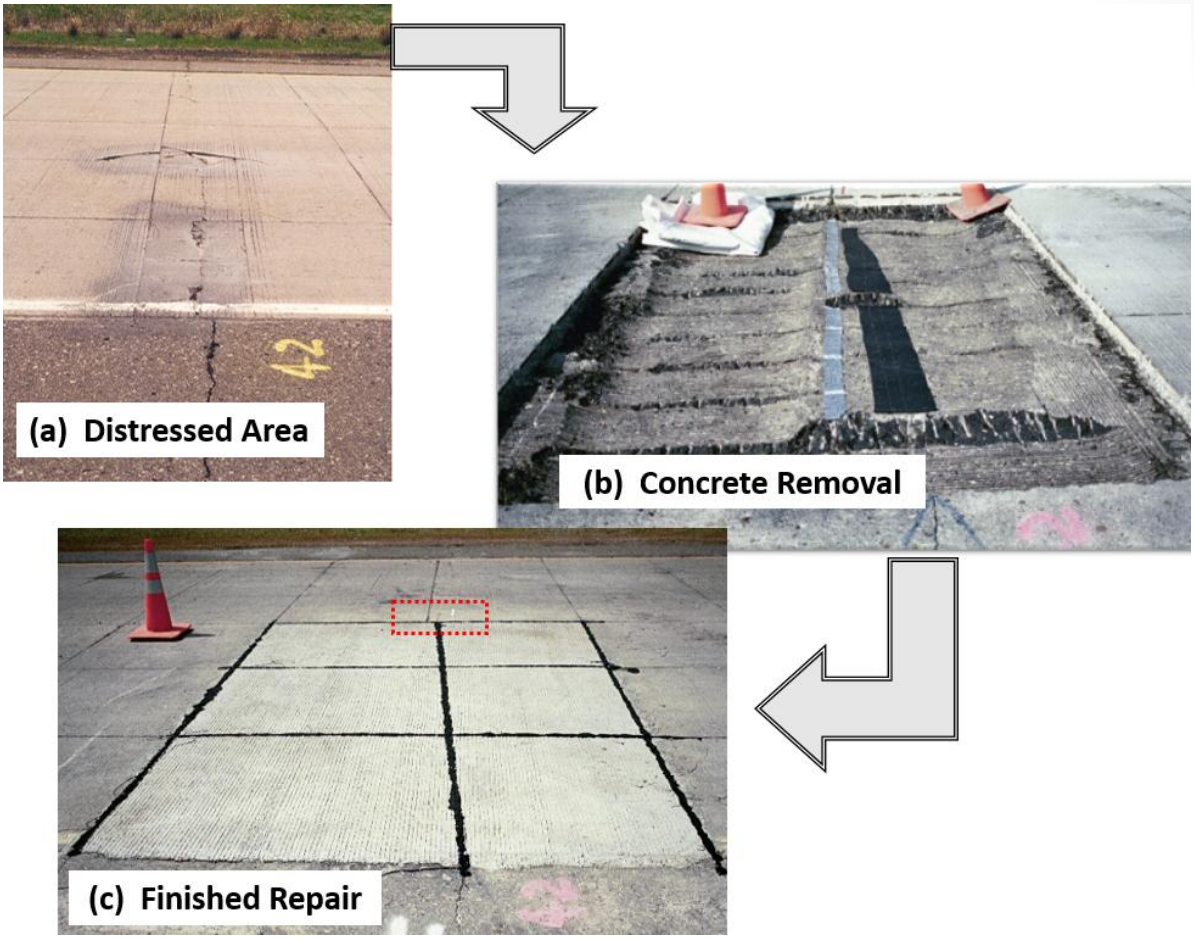

Figure 7. Repair of a reflective crack repair; a.) reflective crack needing repair, b.) duct tape used to debond the repair material from the HMA in the area of the HMA transverse crack and c.) longitudinal joint sawed full-at misaligned transverse joint.

Mill and Fill with PCC

A mill and fill with PCC is a good rehab alternative when the overlay is distressed throughout the section and sound asphalt is present under the BCOA. Steps to be taken when performing a mill and fill with PCC are outlined below.

I. Pre-mill coring

- Cores should be pulled prior to milling to establish the depth to mill.
- The extent of the deterioration into the asphalt below the BCOA should be established to that it can be considered when establishing the depth to mill.
- The location of the lifts within the asphalt layer needs to be identified. An attempt should be made to keep the lift below 0.75 in to 1 in from the top of the milled surface, if at all possible, to maintain the integrity of the bond.

II. Milling

- The milling depth will be dictated by the following:
  - Core information
  - Overlay design thickness
  - Vertical clearance restrictions, if any
  - Final grade elevation required based on existing structures, such as curb and gutter, manholes, etc.
- Standard milling operations, as shown in Figure 8, typically used for asphalt pavements can be used for milling the BCOA.

Figure 8. Milling prior to the placement of the PCC overlay.

III. Surface preparation

- Before placing the new concrete overlay, the asphalt surface needs to be cleaned to ensure proper bonding. Cleaning can be accomplished by sweeping (see Figure 9) the surface or with compressed air.

Figure 9. Sweeping the HMA surface after milling.

IV. Place and finish concrete

- It is imperative that the existing asphalt temperature be maintained at a temperature below 120 ^{o}F when placing the concrete overlay to decrease the potential of fast set

shrinkage cracking. The surface can be misted with water to reduce the temperature of the asphalt.

- Misting the surface is recommended even when the asphalt temperature is lower to bring the surface of the asphalt up to a saturated surface dry condition so that it is not pulling moisture from the concrete mixture.
- Water should not be puddled on the surface when placing the overlay or localized high water to cementicious ratios, and therefore reduced bond strengths, can develop at the interface.
- The use of forms is not necessary for this type of repair, as paving is accomplished through a mill and fill method as shown in Figure 10.
- Finish the surface and spray curing compound on all exposed edges as well as the surface of the overlay.

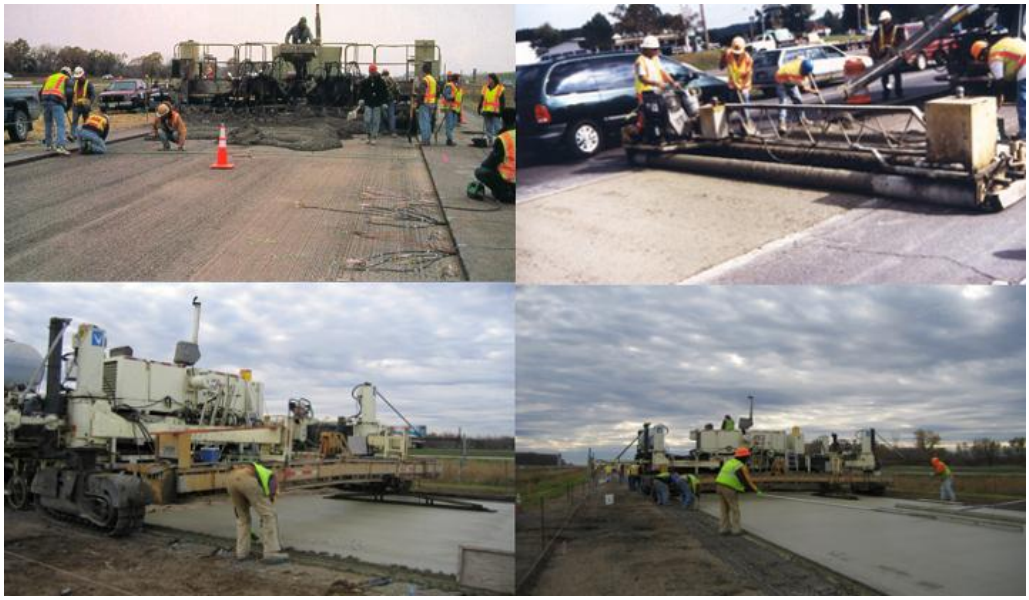

Figure 10. Placing and finishing the mill and fill BCOA.

V. Sawing and sealing joints

- Joints should be sawed to 1/3 the depth of the overlay. See Figure 11.
- A ¼ inch wide reservoir is sufficient if an asphalt sealant is to be used. Backer rod should not be used for these narrow joint widths.

Figure 11. Sawing joints

Unbonded Overlay

An unbonded concrete overlay is a good rehabilitation alternative, if the BCOA is severely cracked and deteriorated and unstable, overlay. With this type of overlay, an interlayer is placed between the existing distressed concrete pavement and the newly placed. The interlayer can be either an asphalt or a geotextile fabric. These types of structures are durable, mitigate reflective cracking, require minimal, if any, pre-overlay repairs and preparation, and can be placed with traditional concrete pavement paving methods. The interlayer allows for independent deformation between the concrete overlay and existing concrete slab creating a cushioning effect. This cushion helps to prevent reflective cracking from occurring up into the overlay. As a result, unbonded overlays can be used for severely deteriorated existing BCOA. One concern with these types of structures is geometric constraints, such as sight distances and vertical clearances.

I. Surface cleaning

- The existing BCOA surface must be cleaned prior to placing the interlayer by sweeping the surface or with compressed air.

II. Debonding interlayer

- The interlayer consists of either asphalt (Figure 12.a) or geotextile fabric (Figure 12.b)
- An asphalt overlay should be used if the differential deflections at the joints and/or cracks are larger than what can be absorbed by the fabric (the thickness of the fabric is less than the differential deflections at the joints and/or cracks).
- A asphalt the interlayer can be placed with conventional asphalt paving, while geotextile interlayers are rolled out over the surface and tacked onto the surface of the existing BCOA.

(a) (b)

Figure 12. Placement of a.) a HMA interlayer and b.) a fabric interlayer for debonding. (Photos courtesy of John Donahue of the Missouri Department of Transportation.)

III. Mist interlayer surface

- Misting the surface will bring the surface of the asphalt or fabric up to a saturated surface dry condition so that it is not pulling moisture from the concrete mixture. Be sure to mist the surface and not to saturate the fabric.
- The surface can be misted with water to reduce the temperature of the interlayer to decrease the potential of fast set shrinkage cracking, as shown in Figure 13.

Figure 13. Misting interlayer prior to paving the unbonded overlay. (Photo courtesy of John Donahue of the Missouri Department of Transportation.)

IV. Paving, finishing and curing

- The overlay can be placed, finished, and cured with traditional concrete paving operations See Figure 14..

Figure 14. Paving and finishing an unbonded overlay

V. Joint layout

- The transverse joints in the unbonded overlay should be misaligned from the existing pavement by a minimum of about 3 ft, if possible [3]. The intentional mismatching of joints will improve load transfer efficiency across joints in the overlay.
- Joint spacing for unbonded overlays are similar to those of traditional concrete pavements than a BCOA. For an unbounded overlay, the joint spacing in feet should be less than approximately 1.75 times the slab thickness in inches, for up to a maximum joint spacing of approximately 20 feet.
- Joints should be sawed to a depth of ¼ the thickness of the overlay.

References

1. National Concrete Pavement Technology Center. *Guide to Concrete Overlays: Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements.* 2nd Edition, September 2008.
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