Utilizing Slot Stitching for Longitudinal Joint Separation Repair

Background

Many miles of Continuously Reinforced Concrete Pavement (CRCP) in Texas suffer longitudinal joint separation. This undesirable joint separation at the longitudinal construction joint, shown in Figure 1, creates a safety hazard and often leads to further structural deterioration of the pavement. Tie bars are used to prevent longitudinal joint separation by keeping the concrete slabs together, but their ability to do so is diminished by improper placement, rupture, and corrosion, as shown in Figure 2.

Figure 1 - Typical examples of lane separation and ruptured tie bar

Figure 2 - Ruptured tie bar
Repair Methods

The repair of longitudinal joint separation is imperative for the safety of the traveling public and the ride quality of roadways. Although full-depth repair (FDR) can be used to repair wide lane separation, more cost-effective methods have the potential to yield very similar results. TxDOT Districts have used stapling, cross-stitching, and slot stitching to repair longitudinal cracks and longitudinal joint separation. Instead of removing and replacing the concrete slabs entirely, reinforcing the pavement with deformed bars has both economic and sustainable advantages. Far less material and labor are required for these repair techniques.

The Houston District has utilized stapling in many projects, and some of these repairs have lasted for over 8 years. This method includes the installation of U-shaped tie bars, or “staples.” When using U-shaped tie bars, vertical holes must be drilled at the ends of each horizontal slot to accommodate the small vertical sections of the bar. The vertical “legs” of the bar are then anchored into the vertical holes using a high-modulus epoxy in order to provide satisfactory mechanical anchorage.

The Construction Division’s Materials and Pavements Section conducted an in-house study to investigate cross-stitching. The study found that cross-stitching may be used to repair cracks that are fairly tight, but the technique is not suitable for wider joint separations.

Under Department Research Project 0-5444, the Center for Transportation Research conducted a lab study to compare these three repair methods and recommended slot stitching for the repair of longitudinal joint separations [Stringer et al. 2009]. The Department has since used slot stitching to restore load transfer along longitudinal joints and provide horizontal anchorage to prevent further lane separation. In addition, recent field data indicates that slot stitching may be more cost effective than stapling.

Slot Stitching

Slot stitching is similar to the dowel bar retrofit (DBR) technique commonly used to restore load transfer across joints. In slot stitching, rectangular cavities, or “slots,” are saw-cut perpendicular to and centered over the joint or crack at the specified depth and spacing in order to provide enough clearance for the tie bars and their underlying support devices to be placed at mid-depth of the concrete slab. Typically, three or more cuts are made 1-3/4 in. apart—1 in. deeper than mid-depth—to accommodate 48-in. No. 6 bars every 3 ft. along the longitudinal joint. Figure 3 shows the deformed bar arrangement.

![Figure 3 - Slot stitching cross section](image-url)
As shown in Figure 4, the area between the cuts is then chipped out with a small jackhammer or chisel to produce the slot.

Each slot is sandblasted and dried before insertion of a tie bar on two support chairs, usually installed 1 in. from the bottom of the slot in a centered position to keep the ends of the bar clear of the radiused ends of the slot. The slots are then filled with grout, as shown in Figure 5.

Slot stitching is generally used to repair wide longitudinal joint separation; the bars provide horizontal anchorage and restore load transfer across the joints. When there is presence of faulting, forensic study should be performed to determine the causes.
Case Study: IH-35

As shown in Figure 1A, a section of IH-35 in the Waco District was experiencing lane separation as wide as 2 in. caused by ruptured tie bars evident in Figure 1B. IH-35 is a major corridor; based on 2012 data, the 20-year design traffic (2012–2032) was 126.5 million equivalent single axle loads (ESALs) with an average daily traffic (ADT) of 53,660 vehicles. Falling weight deflectometer (FWD), Dynamic Cone Penetrometer (DCP), and ground penetrating radar (GPR) results indicated no major defects other than the lane separation. No other visible distress was observed, and the structural bearing capacity seemed to be sufficient.

In 2010 the District used slot stitching on the section to tie the lanes together for better load transfer and to minimize further lane separation. Sawing and chipping were used to create 6-in. deep slots, and No. 6 bars were installed at 3-ft. intervals. Class P concrete with a maximum aggregate size of 1/2 in. was used to fill the slots. The concrete mix was designed with maximum water to cement ratio of 0.38. The aggregate was siliceous, with no more than 15% gradation of any one size rock. Class P concrete generally must reach a compressive strength of at least 3,200 psi after a 7-day cure.

So far, District personnel are very pleased with the performance. Figure 6 shows the pavement condition after slot stitching and almost 2 years of heavy traffic. No cracking or spalling of the Class P concrete has been observed, and the concrete and tie bars have been performing well and have prevented any further movement. The repaired areas also provide a smooth ride to the traveling public. Total cost for installation of 741 bars was $118,560, or $160 per bar. The cost of full-depth repair was estimated at $247,000—more than twice that of slot stitching.

Figure 6 - Slot-stitched pavement condition after 2 years of heavy traffic (IH-35)
Summary

The repair of longitudinal joint separation is imperative for the safety of the traveling public and the ride quality of roadways. Slot stitching has proven to be an effective repair method, and its application brings significant cost savings over full-depth repair.

Contact

If you have any questions about the content of this article, please contact Dar Hao Chen, Ph.D., P.E., in the Materials and Pavements Section at 512-506-5983 or darhao.chen@txdot.gov.

References