



0-6687: Minimize Premature Distresses in Continuously Reinforced Concrete Pavement

Background

The performance of continuously reinforced concrete pavement (CRCP) has been quite satisfactory in Texas, providing one of the most cost-effective pavement systems for the Texas Department of Transportation (TxDOT).

However, distresses do occur occasionally. Once distresses occur, they need to be repaired in a timely manner, and the repair cost is relatively high. Extensive field performance evaluations of CRCP in Texas conducted under the TxDOT rigid pavement database project indicate that the majority of the distresses are not necessarily due to the deficiencies in the structural capacity of CRCP. Rather, the majority of distresses are due to imperfections in materials and construction quality. These distresses normally occur earlier than structural distresses caused by fatigue failure of concrete. Accordingly, they are termed premature distresses (PMDs). Traditional ways of strengthening the pavement system, such as the use of increased concrete slab thickness, do not reduce the frequency of PMDs.

The repair cost of CRCP is higher than that of jointed concrete pavement (CPCD), and there is little difference in the repair cost between PMDs and normal structural failures. Also, repair of CRCP distress takes longer to complete than CPCD repairs, causing traffic delays and increasing user cost. It is desirable to identify the mechanisms of PMDs and develop means to prevent or minimize the occurrence of PMDs.

What the Researchers Did

Various types of PMDs in CRCP were identified by contacting districts and other states that use CRCP extensively. There are only a few types of PMDs in CRCP:

- PMDs at transverse construction joints (TCJs).
- Gores and longitudinal construction or warping joints.
- Y-cracks and short transverse cracks.
- PMDs due to slab expansions.

Among these, PMDs at TCJs are the most prevalent, followed by those at longitudinal construction or warping joints. The rest constitute a small portion. The remaining investigation was focused on identifying the mechanisms of PMDs at TCJs and developing means to prevent or minimize PMDs. Various gages were installed in new CRCP projects. Pavement behavior, in terms of strains in concrete and steel and concrete slab displacements, was investigated. Concrete cores were taken at various locations and evaluated for various material properties such as unit weight and modulus of elasticity. Nondestructive testing (NDT) devices such as MIRA were used to detect defects in concrete and to identify reinforcing steel locations. To evaluate long-term behavior of CRCP related to PMDs, data were downloaded from gages installed in previous research projects and analyzed.

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What They Found

A summary of the findings from the investigations of CRCP behavior that leads to PMDs at TCJs shows:

- Some CRCP responses that were considered distresses are not necessarily distresses, including Y-cracks and short crack spacing. Two different mechanisms exist for the two responses: one is environmental loading (temperature and moisture variations), and the other is deficient structural capacity of CRCP and an excessive loading condition.
- Among all PMDs, distresses at TCJs are the most frequent.
- At TCJs, steel stresses in longitudinal steel vary in accordance with temperature variations, but only on a daily basis. For longer-term temperature variations, steel stresses remain almost constant. The assumption of a good correlation between temperature variations and steel stresses at TCJ is not correct.
- The behavior of additional tie bars at TCJs is quite different from that of longitudinal steel. With concrete temperature above the setting temperature, stresses at additional tie bars could be in compression while those at longitudinal steel are in tension. The difference in stresses in longitudinal steel and additional tie bars could cause an uneven stress field, potentially leading to cracking and distresses in concrete.
- Steel stresses at TCJs decrease over time, potentially due to the creep of concrete and the development of transverse cracks, which might invalidate the benefit of additional tie bars at TCJs.
- The placement of additional tie bars at TCJs could interfere with concrete consolidation operations near TCJs, creating poor-quality concrete and potentially causing distresses in TCJs.

- The rate of concrete strain variation with temperature near a TCJ is higher during winter than during summer because the space available or joint widths at the TCJs differ with the seasons. In summer, joint widths get smaller, restricting the slab displacements when concrete temperature increases. On the other hand, joint widths get larger in winter, allowing slab displacements with less restriction. However, this seasonal effect lessens with pavement age.
- When there is a significant time difference between the placements of concrete on either side of the construction joint, the newly placed concrete seems to pull the slab placed earlier on the other side of the TCJ due to drying shrinkage of the newly placed concrete. Also, the old and new concrete slabs behave as a near-composite structure with quite a small joint width, at least at early ages.
- Due to the presence of additional steel at the TCJ, the compaction of concrete near the TCJ is hindered, resulting in formation of air voids and surface distresses near TCJs.

What This Means

The concrete placement operations, including concrete material quality and steel design details near TCJs, are different from other areas of CRCP. Concrete and steel behavior near TCJs is quite different from that in other areas. Based on the findings derived from the field testing and investigations conducted, it appears that additional tie bars at TCJs do not provide beneficial effects. Instead, they seem to interfere with concrete consolidation operations near TCJs, resulting in non-uniform concrete properties near TCJs. It appears that no additional tie bars at TCJs will improve the performance of CRCP at TCJs.

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