

**PAVEMENT TECHNOLOGY ADVISORY
-CONCRETE PAVEMENT JOINTS-
PTA-D3**

WHY ARE JOINTS NECESSARY?

Concrete is a material which is strong in compression, but relatively weak when placed in tension. Tensile stresses may build up in concrete pavements because of shrinkage during the hydration process, temperature and moisture changes, and/or traffic loadings. When the tensile stresses are great enough, cracks occur. Joints are often used as a means of relieving stresses to control cracking. Joints can also serve to protect adjacent structures, or to accommodate paving operations.

CONCRETE PAVEMENT TYPES

The purpose and location of joints depend largely on the type of concrete pavement in which the joints are found. There are three main concrete pavement types, each designed to accommodate cracking differently:

Jointed - plain Concrete Pavement (JPCP) utilizes short, un-reinforced slabs. Transverse contraction joints are spaced 10 to 20 feet apart to control cracking. Typically, devices such as dowels are placed at the joints to improve load transfer, and to prevent faulting of the slabs from occurring.

Jointed-reinforced Concrete Pavement (JRCP) features transverse contraction joints spaced 30 to 100 feet apart. Reinforcing steel is placed in the slab to hold cracks together that form between the joint locations. Load transfer devices are placed at the transverse joints.

Continuously - reinforced Concrete Pavement (CRCP) contains transverse joints, called "construction joints", only at paving stoppage locations. Longitudinal reinforcing steel is used to hold cracks tightly together and maintain load transfer.

Descriptions of the various concrete pavement joints are provided in the following sections.

LONGITUDINAL JOINTS

Longitudinal Joints run parallel to the pavement length (along the lane) and serve to control longitudinal cracking. All three major concrete pavement types use longitudinal joints. Typically, these joints are produced by either sawing the slab early in the curing process, or by placing an insert in the plastic concrete at the desired joint location. Longitudinal joints are normally placed at the edges of traffic lanes. Most Illinois Department of Transportation (IDOT) concrete pavement designs call for deformed tie bars at longitudinal joints to improve load transfer and prevent the joint from opening and/or faulting.

A second type of longitudinal joint can be used to separate through lanes from sideroad pavements at intersections. This non-standard design calls for a foundation ("sleeper") slab, to be poured under the joint location for support. A bond breaker is placed on the foundation slab to avoid transferring movement and stress from one paved area to the other. No tie bars are placed at these joints. This design may be useful for large intersections

where joint layout and function becomes very complex.

TRANSVERSE JOINTS

Transverse Joints run perpendicular to the pavement length (across the lane) and serve different functions depending on the pavement type.

A. Transverse Joints for Jointed Concrete Pavements (JPCP and JRCP):

Expansion Joints allow for expansion of the pavement due to temperature changes. Expansion joints are typically 2 inches wide, although widths up to 4 inches are sometimes used. Due to the width of the joint, load transfer devices are necessary. These are usually dowel bars with caps that allow the pavement and bar to move independently in the longitudinal direction.

Expansion joints are costly to construct and maintain. On mainline pavements, IDOT uses this type of joint mainly to protect features such as drainage castings and bridges, where concentrated stresses can cause expensive damage to the structure. Expansion joints are also used at intersections to isolate the intersection pavement from the adjacent mainline pavement. In such applications, the expansion joint width should be reduced to between $\frac{1}{2}$ inch and $\frac{3}{4}$ inch.

Contraction Joints provide crack control by relieving tensile stresses in the pavement slab. These joints are sawed to a depth of about one-third of the slab thickness at a regularly occurring interval. The specific joint spacing depends mainly on the slab thickness, slab reinforcement, and subgrade support conditions. The joint width is minimal (1/8 inch, min.), and sealant is not required. Dowel bars are typically used for load transfer across the joints.

Two variations of the normal contraction joint arrangement were commonly used in the past, but now are obsolete:

1. **Skewed Contraction Joints** were not perpendicular to the pavement length, but instead ran across the lane at a skewed angle. The skewed arrangement was intended to reduce slab faulting without using dowel bars; however, IDOT's experience with skewed joints indicates that faulting is not reduced. Further, skewed joints caused performance problems, as the slabs were prone to cracking at locations where the skewed joint made an acute angle with the pavement edge or longitudinal joint. Repairing failed skewed joints also proved to be difficult. As such, IDOT now discourages the use of skewed contraction joints in new concrete construction.
2. **Hinge Joints** formerly were placed at intermediate locations between doweled contraction joints to control slab warping. IDOT no longer constructs hinge-jointed pavements because of performance problems. Class B patches may be used at failed existing hinge joints. Designers should check plans of existing facilities to identify hinge joint locations.

B. Transverse Joints for CRCP:

Construction Joints allow for some kind of break in the continuous paving operation. All transverse joints for CRCP fall into the category of construction joints.

Transverse Construction Joints are the most common CRCP construction joints. These joints are used to extend the pavement in-kind on a subsequent working day. Transverse construction joints typically include increased longitudinal reinforcement to improve load transfer.

Terminal Joints are another kind of construction joint, which are placed at planned paving termini. They can be used to minimize the transfer of expansion forces into adjacent structures, or to allow for adjacent paving with differing designs.

Terminal joints can take one of the following forms:

1. **Lug System Joints** utilize a concrete anchorage tied to the end of the CRCP to resist expansive forces and movement of the pavement. In 7-inch and 8-inch CRCP, old versions of the lug systems were prone to rotating, causing a rough ride. This problem has not been evident in thicker pavements using shorter lug spacings.
2. **Wide-flange Beam Terminal Joints** allow the end of the CRCP slab to expand under the top flange of a steel beam embedded in the pavement. This type of joint requires great care in construction, and some top flanges of beams have detached in the past.

JOINT PLACEMENT

The placement of pavement joints can greatly affect the overall performance of a concrete pavement. This is especially true for jointed concrete pavements. If the joint layout is not properly designed, uncontrolled cracking can occur. IDOT has developed standard joint layouts, but special conditions may exist that require a site specific joint layout design.

When adjacent lanes are to be constructed in stages it is important to plan the layout of the joints before any pavement is placed. Sometimes new pavement is constructed adjacent to existing pavement. When this occurs the designer must make provisions in the plans to match the existing joints. A detailed joint survey prior to plan preparation can help to avoid problems.

Most IDOT standard joint layouts were developed for rural applications; therefore, extra care must be taken at urban locations. Common urban features such as turn lanes, drainage blockouts, medians, and intersecting side streets can affect joint placement, particularly at large urban intersections. Designers should provide individualized jointing details in the plans, and construction engineers should carefully follow the joint layout at these locations.

The American Concrete Pavement Association (ACPA) has published a bulletin entitled, "Intersection Joint Layout," available from the ACPA upon request at www.pavement.com. Although this bulletin should not be construed as an IDOT policy or standard, it does contain helpful information and can serve as a design reference.

For more information on pavement joints in general and variances in joint spacing in particular, please contact:

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