Often, the joint layout for a concrete pavement is determined while developing project plans to aid in bidding procedures. By doing so, the designer produces bird's-eye views of the joint layout for the whole process. Even with such plans, however, it can be difficult to visualize the entire project layout during construction.

Making this even more of a challenge, an engineer or designer usually develops the joint layout plan without knowledge of the specific contractor, equipment or process that will be used to place the pavement. For this reason, some agencies do not provide a pre-developed jointing plan, instead requiring the contractor to submit a proposed joint plan prior to the initiation of the paving. The contractor then has full flexibility with the joint layout, along with the ability to customize the construction process, phasing and equipment used to optimize construction and minimize costs.

It is important to make (and allow) field adjustments for complex projects. Factors such as islands, medians, ramps and turning lanes complicate joint layout. Those complications require some forethought before construction, although some tweaking of the joint layout is typically acceptable in the field, provided the contractor understands the ramifications.

It also is important to consider location changes that will be necessary for some joints. Planning ensures that joints can pass through embedded fixtures, such as manholes and drainage inlets. It is common for the actual location of manholes or drainage inlets to vary from the location shown on the plans. As such, the construction crew may have to adjust the location of the joints to coincide with the actual location of any in-pavement object. The designer should consider including a note on the plan to give the field engineer and contractor the latitude to make appropriate adjustments in the field for situations like in-pavement objects.

Understanding joint types

There are three basic joint types for concrete pavements: contraction, construction and isolation. Specific design requirements for each type depend upon orientation to the direction of the roadway (transverse or longitudinal). The joint types that are typical to streets, roads and highways are illustrated in Figure 1.

Transverse contraction joints (Type A-1 or A-2)

Joints that run transversely to the pavement centerline are essential to controlling cracking from stresses caused by shrinkage, thermal contraction and moisture or thermal gradients. Typically, transverse joints are at a right angle to the pavement centerline and edges, but some agencies do specify that transverse joints be skewed.

The need for dowels (smooth round bars) in transverse contraction joints depends upon the roadway or street classification. If included, dowels are usually spaced at 12 in. on-center in doweled transverse joints.
Undoweled transverse contraction joints (Type A-1) typically are sufficient for light residential, residential or collector pavements, but if the traffic requires that the concrete pavement be thicker than about 7 in., doweled joints might be required. Industrial and arterial streets that will carry heavy truck traffic for long periods almost always require doweled contraction joints (Type A-2).

**Transverse construction joints (Type B-1 or C-1)**

Transverse construction joints are necessary at the end of a paving segment or at a placement interruption for a driveway or crossroad. A doweled butt joint (Type B-1) is preferable and should be used whenever the construction joint will correspond to the location of a contraction joint or construction joint in an adjacent lane. Again, dowels are usually placed at 12 in. on-center.

Sometimes it is not feasible to match the location of a transverse joint in the adjacent lane, which necessitates use of a tied construction joint (Type C-1). The deformed tie bars in a Type C-1 joint prevent the joint from opening, causing sympathy cracking in adjacent lane(s).

**Longitudinal contraction joints**

Longitudinal contraction joints (Type A-3 or A-4) also are necessary to control cracking from stresses caused by concrete volume changes and moisture or thermal gradients. These joints run parallel to the pavement centerline and usually correspond to the edge of a driving lane. On two-lane and multilane pavements, spacing of 10 to 13 ft, depending on the concrete pavement thickness and the subgrade/sub-base type, serves the dual purpose of crack control and lane delineation.

The need to tie longitudinal contraction joints will depend upon the degree of lateral restraint available to prevent the joints from opening permanently. Most longitudinal contraction joints on roadway sections contain No. 4 or No. 5 deformed reinforcing bars. The deformed bars are usually about 24-30 in. long and are spaced at 30-40-in. intervals. Where there are curbs or a concrete shoulder on both sides of the pavement, it may not be necessary to tie the joints unless local experience indicates otherwise.

**Longitudinal construction joints**

(Longitudinal construction joints (Type B-2 or C-2)

Longitudinal construction joints join pavement lanes that are paved at different times.

If the longitudinal construction joint does not include a keyway then it must be tied; if a keyway is used, however, the tie bar may be optional. A keyed longitudinal construction joint can be difficult to construct correctly in thin pavements. Therefore, some agencies avoid placing keyways in slabs less than 10 in. thick. Keyway shear failures can occur in thin slabs when keyways are too large or too close to the slab surface, causing some agencies to avoid the use of keyways altogether. Regardless, some contrac-
tors report that half-round keyways are easier to construct than trapezoidal keyways, and field performance shows that they are less prone to long-term problems as well.

**Isolation joints (Type D-1, D-2, D-3 or D-4)**

Isolation joints are needed where the pavement abuts certain manholes, drainage fixtures, sidewalks, aprons or other structures. Certain agencies and contractors also prefer to use isolation joints at crossroad intersections. Where used, the isolation joint will allow independent movement of the pavement and the structure, without any connection that could cause damage.

The thickened-edge (Type D-1) and sleeper-slab (Type D-3) designs each provide improved support to compensate for the absence of dowel bars. For a thickened-edge joint, the abutting edges of the concrete slabs should be 20% thicker at the joint and then taper back to the nominal thickness over at least 4.5 ft. Rather than providing a means of load transfer across a joint as is done with dowels or the sleeper slab, the thickened edge provides increased fatigue capacity. Doweled isolation joints (Type D-2) might be used where two sections of pavement need to be isolated but load transfer is still essential, and undoweled longitudinal isolation joints (Type D-4) might be used where a pavement abuts a building and little traffic is expected to traverse the edge of the pavement.

Understanding the basics of joint design is not only a key to accurate bidding, but also can prevent problems on the grade.

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