

Concrete in Practice

What, why & how?



CIP 6 - Joints in Concrete Slabs on Grade

WHAT are Joints?

Concrete expands and shrinks with changes in moisture and temperature. The overall tendency is to shrink and this can cause cracking at an early age. Irregular cracks are unsightly and difficult to maintain but generally do not affect the integrity of concrete. Joints are simply pre-planned cracks. Joints in concrete slabs can be created by forming, tooling, sawing, and placement of joint formers.

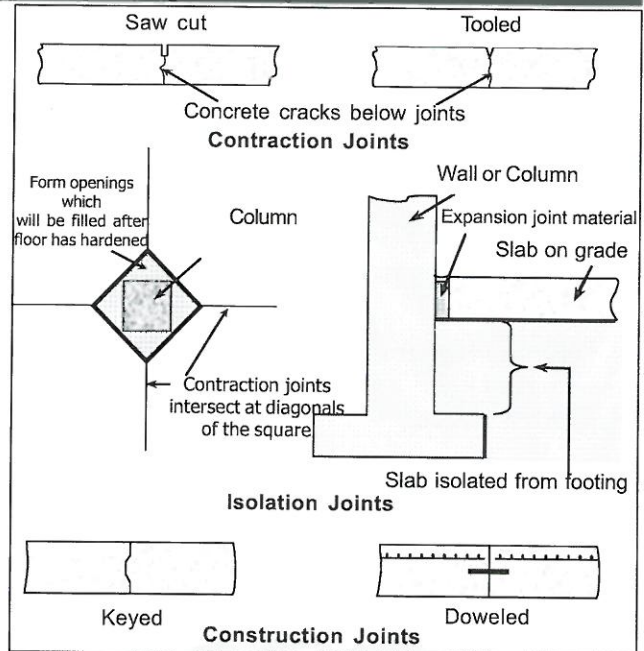
Some forms of joints are:

- Contraction joints – are intended to create weakened planes in the concrete and regulate the location where cracks, resulting from dimensional changes, will occur.
- Isolation or expansion joints – separate or isolate slabs from other parts of the structure, such as walls, footings, or columns; and driveways and patios from sidewalks, garage slabs, stairs, lightpoles and other points of restraint. They permit independent vertical and horizontal movement between adjoining parts of the structure and help minimize cracking when such movements are restrained.
- Construction joints – are surfaces where two successive placements of concrete meet. They are typically placed at the end of a day's work but may be required when concrete placement is stopped for longer than the initial setting time of concrete. In slabs they may be designed to permit movement and/or to transfer load. The location of construction joints should be planned. It may be desirable to achieve bond and continue reinforcement through a construction joint.

WHY are Joints Constructed?

Cracks in concrete cannot be prevented entirely, but they can be controlled and minimized by properly designed joints. Concrete cracks because:

- Concrete is weak in tension and, therefore, if its



natural tendency to shrink is restrained, tensile stresses that exceed its tensile strength can develop, resulting in cracking.

- At early ages, before the concrete dries out, most cracking is caused by temperature changes or by the slight contraction that takes place as the concrete sets and hardens. Later, as the concrete dries, it will shrink further and either additional cracks may form or preexisting cracks may become wider.

Joints provide relief from the tensile stresses, are easy to maintain and are less objectionable than uncontrolled or irregular cracks.

How to Construct Joints?

Joints must be carefully designed and properly constructed if uncontrolled cracking of concrete flatwork is to be avoided. The following recommended practices should be observed:

- The maximum joint spacing should be 24 to 36 times the thickness of the slab. For example, in a 4-inch [100 mm] thick slab the joint spacing should be about

- 10 feet [3 m]. It is further recommended that joint spacing be limited to a maximum of 15 feet [4.5 m].
- b. All panels should be square or nearly so. The length should not exceed 1.5 times the width. Avoid L-shaped panels.
 - c. For contraction joints, the joint groove should have a minimum depth of $\frac{1}{4}$ the thickness of the slab, but not less than 1 inch [25 mm]. Timing of jointing operations depends on the method used:
 - Performed plastic or hard board joint strips are inserted into the concrete surface to the required depth before finishing.
 - Tooled joints must be run early in the finishing process and rerun later to ensure groove bond has not occurred.
 - Early-entry dry-cut joints are generally run 1 to 4 hours after completion of finishing, depending on the concrete's setting characteristics. These joints are typically not as deep as those obtained by the conventional saw-cut process, but should be a minimum of 1 inch [25 mm] in depth.
 - Conventional saw-cut joints should be run within 4 to 12 hours after the concrete has been finished.
 - d. Raveling during saw cutting is affected by the strength of the concrete and aggregate characteristics. If the joint edges ravel during sawing, it must be delayed. However, if delayed too long, sawing can become difficult and uncontrolled cracking may occur.
 - e. Use premolded joint filler such as asphalt-impregnated fiber sheeting, compressible foam strips, or similar materials for isolation joints to separate slabs from building walls or footings. At least 2 inches [50 mm] of sand over the top of a footing will also prevent bond to the footing.
 - f. To isolate columns from slabs, form circular or square openings, which will not be filled until after the floor has hardened. Slab contraction joints should intersect at the openings for columns. If square openings are used around columns, the square should be turned at 45 degrees so the contraction joints intersect at the diagonals of the square.
 - g. If the slab contains wire mesh, cut out alternate wires, or preferably discontinue the mesh, across contraction joints. Note that wire mesh will not prevent cracking. Mesh tends to keep the cracks and joints tightly closed.
 - h. Construction joints key the two edges of the slab together either to provide transfer of loads or to help prevent curling or warping of the two adjacent edges. Galvanized metal keys are sometimes used for interior slabs, however, a beveled 1 by 2 inch [25 by 50 mm] strip, nailed to bulkheads or form boards, can be used in slabs that are at least 5 inches [125 mm] thick to form a key which will resist vertical loads and movements. Keyed joints are not recommended for industrial floors. Metal dowels should be used in slabs that will carry heavy loads. Dowels must be carefully lined up and parallel or they may induce restraint and cause random cracking at the end of the dowel.
 - i. Joints in industrial floors subject to heavy traffic require special attention to avoid spalling of joint edges. Such joints should be filled with a material capable of supporting joint edges. Manufacturer's recommendations and performance records should be checked before use.

References

1. *Joints in Concrete Construction*, ACI 224.3R, American Concrete Institute, Farmington Hills, MI.
 2. *Guide for Concrete Floor and Slab Construction*, ACI 302.1R, American Concrete Institute, Farmington Hills, MI.
 3. *Slabs on Grade*, ACI Concrete Craftsman Series CCS-1, American Concrete Institute, Farmington Hills, MI.
 4. *Joint Planning Primer*, Concrete Construction, August 1997.
 5. Bruce A. Suprenant, *Sawcutting Joints in Concrete*, Concrete Construction, January 1995.
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Follow These Rules for Proper Jointing

1. Plan exact location of all joints, including timing of contraction joint sawing before construction.
2. Provide isolation joints between slabs and columns, walls and footings, and at junctions of driveways with walks, curbs or other obstructions.
3. Provide contraction joints and joint filling materials as outlined in specifications.

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