It's discouraging to have the hard work that goes into building concrete walls spoiled by unsightly, random cracking. These cracks not only mar the wall's architectural appearance, they also can affect its structural integrity. Though concrete has a tendency to crack and does crack in most cases, cracks can be controlled by joints, or planned separations in concrete.

Cast-in-place concrete walls use three types of joints: contraction, expansion (or isolation), and construction:

Contraction joints are weakened planes built into walls to control the location of cracking caused by volume changes, especially those related to shrinkage and temperature changes.

Expansion joints are separations between adjoining parts of a structure to allow movement. Expansion joints also work as contraction joints and may have smooth dowels to maintain the plane of the wall. Expansion joints that allow completely independent movement between adjoining components are sometimes called isolation joints.

Construction joints separate adjacent placements of concrete to make large pours manageable. Construction joints are commonly located to coincide with contraction or expansion joints.

**Contraction joints**

Wall contraction joints often are made by fastening projecting strips inside forms to create narrow grooves in the concrete (Figure 1). Projecting strips are made of wood, premolded plastic, or metal. When using wood strips, a sawcut on the form side of the strip reduces swelling that might damage concrete near the joint area. Grooves should reduce the wall thickness by at least one-fourth and the sum of the inside and outside groove depths should be at least 2 inches (Ref. 1). Place the inside and outside grooves so the weakened plane is square to the wall. Also, maintain true alignment when installing the strips. Deviation from a straight line will be noticeable in the concrete surface.

Use special care when removing strips, especially when removing them with the wall form, to avoid concrete damage around the joint. For a watertight joint, caulk the outside groove with a weather-resistant sealant, such as a polysulfide, polyurethane, or silicone, that will remain flexible after placement. Where leakage is a concern, plan to use a waterstop for extra protection. For below-grade joints, use a protective cover, such as a 12-inch-wide asphalt-treated felt strip held in place with waterproof adhesive.

For engineered walls, vertical contraction joint spacing and horizontal steel details should be shown on the

![Figure 1. Use projecting strips to reduce wall thickness by at least one-fourth (Ref. 2).](image)

| Table 1 Recommended Spacing of Vertical Contraction Joints (modified from Ref. 2) |
|---------------------------------|-----------------|
| Wall Height                     | Spacing         |
| 8 feet or less                  | 3 times wall height |
| Between 8 and 12 feet           | 2 times wall height |
| 12 feet or greater              | 1 times wall height |
drawings. In general, the spacing of vertical contraction joints should not exceed 30 feet unless specified temperature and shrinkage reinforcement exceed minimum requirements. Spacings up to 60 feet are feasible for engineered walls.

Spacings recommended in Table 1 are useful when engineered plans are not available. For a residential unreinforced basement wall that is 8 feet high, Table 1 suggests that vertical joints be spaced approximately 24 feet (3 x 8 feet) apart. ACI 332R (Ref. 3) recommends a maximum 30-foot contraction joint spacing in residential basement walls, and the National Ready Mixed Concrete Association (Ref. 4) recommends a contraction joint spacing of 30 times the wall thickness, or 20 feet for an 8-inch-thick wall (30 x 8 = 240 inches = 20 feet). Some designers recommend reducing joint spacings by about 20% in walls with frequent openings, such as doors and windows. Generally, closer joint spacings decrease the width of cracks that form at the joint.

Figure 2 shows recommended joint locations for a typical concrete wall with window and door openings. Place joints in line with window and door jambs. Scuppers or other openings should align with openings where contraction joints are located. If possible, locate contraction joints within 10 to 15 feet of corners. Contraction joints often can be located to enhance or become an integral part of the structure's appearance.

Except where required for structural purposes, horizontal reinforcement (every other bar) is normally cut or terminated at wall contraction joints. These are sometimes called partial contraction joints, since there is still reinforcement to restrain a crack forming at the weakened plane. Verify that cuts are in line with the joint, and don't lap-splice continuous bars through contraction joints.

In some cases, full contraction joints are built at construction joints. Steel is terminated 2 or 3 inches from the joint and the joint face placed first is coated with a bond breaker. These joints often have watertops and may also have smooth dowels.

### Expansion Joints

Install expansion or isolation joints to separate independent wall construction. Expansion joints can be complex mechanical systems with overlapping slide plates. However, they usually are just 9/16- to 1-inch-thick compressible asphalt-impregnated fiber boards installed between adjacent placements. Use isolation joints as shown in Figure 3 at locations where a wall meets a slab or an independent wall. Bonded reinforcement should not pass through wall expansion or isolation joints.

True expansion joints in cast-in-place walls are not common. If plans call for expansion joints, verify the type of joint intended and execute the details carefully so the joint works properly.

### Construction Joints

Use construction joints when the concrete placement cannot be done at one time. Residential basement walls usually are placed without construction joints.

Unplanned joints also occur on many jobs when equipment breaks down or concrete supply is interrupted. A complete, or monolithic, construction joint restricts wall movements and should be as strong as the wall without joints. Other construction joints coincide with, or function as, contraction or expansion joints.

The simplest vertical construction joint is formed using a bulkhead board. Details of this butt-type construction joint are shown in Figure 4 with and without a keyway. Make the joint square to the line of the member and use chamfered edges where appearance is important.

For strong, watertight, monolithic construction joints,
use sufficient steel reinforcement to tie placements together and follow proper joint surface preparation and concreting procedures. Use deformed bars to supplement the reinforcement crossing the joint. For unreinforced walls, ACI 332R recommends at least three #4 bars at each vertical construction joint. Place these bars at the top, bottom, and middle portions of the wall and extend at least 15 inches in each direction beyond the joint.

Keyways are designed to increase the joint’s shear resistance. However, keyways in vertical or horizontal construction joints are less effective than reinforcement. Keyway construction is more difficult where reinforcement continues through the joint. Keyways can contribute to spalling of the joint and interfere with obtaining a tight bond between the old and new concrete.

Despite their limitations, keyways are useful if no reinforcement crosses the construction joint. Form vertical keyways by fastening metal, wood, or premolded key material to bulkhead boards. Horizontal keyways usually are made by pressing a beveled 2x4 into the fresh concrete and removing the wood after concrete hardens.

Figure 5 shows a typical horizontal construction joint. Form ties located within 4 inches below the joint can support the forms for the upper lift. Forms for the upper lift should overlap the hardened concrete about 1 inch and use a thin, compressible gasket to minimize leakage at irregularities in the wall surface. To help avoid bulges and offsets, the first row of form ties should be less than 6 inches above the joint. Accent or rustication strips, such as V-strips and beveled and rectangular grooves, can improve joint appearance by preventing ragged and irregular edges.

Locations of construction joints may be indicated on the plans or established during the prepour conference. Locate joints so as to least impair wall strength and to simplify form construction and concrete placement. Vertical joints at re-entrant corners of walls, and along columns or pilasters, become part of the structure’s appearance. Align horizontal construction joints with window sills, window and door headers, story increments, grooves, or similar features. In general, conceal construction joints or accentuate them to become an integral part of the wall’s appearance.

References
2. “Cast-in-Place Walls,” Concrete Craftsman Series 2, American Concrete Institute, Detroit, 1984.
3. “Guide to Residential Cast-in-Place Concrete Construction,” ACI 332R-84, American Concrete Institute.

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