

Concrete in Practice

What, why & how?

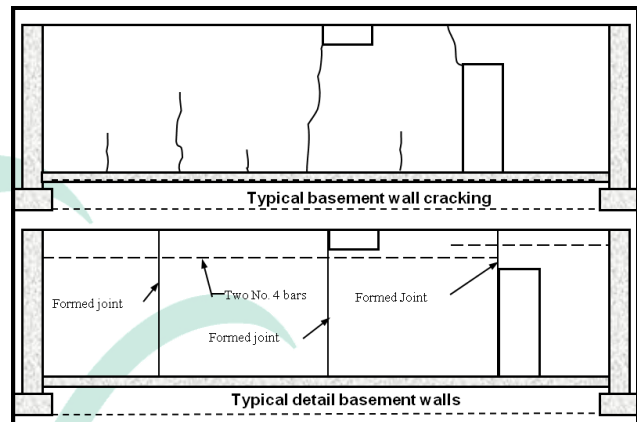


CIP 7 - Cracks in Residential Basement Walls

WHAT Types of Cracks May Occur?

Cast-in-place concrete basements provide durable, high quality living space. Cracking of concrete is a natural occurrence and at times can be undesirable. Most common causes of cracking include:

- a. Temperature and drying shrinkage cracks. Generally, newly placed concrete is at its largest volume. As concrete hardens it dries and starts to shrink. Temperature variations cause concrete to expand and contract. When these volume changes are restrained, cracking results.
- b. Re-entrant corner cracking occurs diagonally from the corners of windows, doors or openings in the concrete walls. These cracks result from shrinkage.
- c. Pour lines are visible demarcations between placement of two concrete loads, typically due to a delay in placing between the loads and if proper consolidation was not performed to homogenize the two portions across the separation. Pour lines are often perceived as cracks. In extreme cases they may perform as cracks if the first placement has partially hardened before the second placement. This is often referred to as a cold joint.
- d. Vertical form lines occur between form panels and can sometimes cause weak zones due to the use of form ties that support two layers of formwork during concrete placement. Cracks may initiate at form lines.
- e. Restraint cracks may form in some portions of walls where contact with footings restrains the shrinkage of the concrete wall.
- f. Cracking and surface cracking may occur due to a lack of adequate curing and protection if construction is during extreme cold or hot weather.
- g. Settlement cracks occur from non-uniform support of footings or occasionally from expansive soils.
- h. Structural cracks may occur during backfilling if concrete strength is not adequate or the walls are not adequately supported as the design intends. This is most likely to occur when heavy equipment gets too close to the walls during the backfill process or when pressure due to backfill material exceed that anticipated in the design, for example with liquefied soils.



WHY do Basement Cracks Occur?

Some cracking is normal in concrete basement walls. Volume changes and other movements at an early age result in different types of cracks, as discussed earlier. These cracks can grow if the walls are not properly designed, due to the continued horizontal pressures applied by soils, water and temperature. Cracking can be minimized and problems prevented if the design and construction practices that follow are implemented.

Most builders or third party providers offer limited warranties for basements. A typical warranty will require repair only when cracks leak, have measurable vertical displacement, or if the crack width exceeds 1/8-in. (3 mm). The National Association of Home Builders (NAHB) requires repair or corrective action when cracks in basement walls cause leaks into the basement.

HOW to Design & Construct Quality Basements?

Cast-in-place concrete basement walls are the strongest and most effective foundation for a residence. However, climate conditions, unusual or unforeseen loads, material quality and workmanship may impact the quality of the finished basement. Proper design and construction is important. The following steps should be followed:

- a. **Site conditions and excavation.** Soil type and conditions should be properly assessed for appropriate design and construction of foundations specific to the building site. The

excavation should be at least to the level of the bottom of the basement slab and can be to the bottom of the footing. Soil or granular fill beneath the entire area of the basement should be well compacted by rolling, vibrating or tamping. Footings must bear on undisturbed soil or well compacted fill. Uniform soil bearing capacity should be ensured or the design should accommodate any variation.

- b. **Formwork and reinforcement.** Formwork must be installed and braced to withstand the pressure of the fresh and flowing concrete. Reinforcement is used to control crack width. Wall thickness and reinforcement should be provided in accordance with International Residential Code (IRC), ACI 332, or locally adopted Code.
- c. **Joints.** Some cracks in basement walls can be controlled to occur in properly located formed joints.
- d. **Concrete.** Use concrete with adequate strength in accordance with the Code and project specifications. Excess water should not be added to concrete in the truck mixer. Water-reducing admixtures can be used to increase flow. Air-entrained concrete should be used for walls exposed to moisture and freezing temperatures.
- e. **Placement and curing.** Place concrete in a continuous operation to avoid cold joints and segregation. Adding excess water to concrete to facilitate placement will increase segregation, cause honeycombing or excessive cracking, and reduce strength. Consider placement points no greater than 20 or 30 feet around the perimeter of the wall to minimize segregation. Properly designed higher slump concretes with admixtures will flow horizontally for long distances and placement points can be spread out. Curing should begin after placement. Forms should be left in place 5 to 7 days or at least until concrete attains adequate strength to support itself. Forms removed too early can result in premature drying and may cause cracking. In cold weather, forms should be insulated with blankets or other materials to retain heat. During hot dry weather, forms should be covered with wet burlap to retain moisture. Liquid membrane-forming curing compounds can be sprayed at the required coverage after forms are removed to prevent excessive drying.
- f. **Waterproofing and drainage.** Waterproof membranes are best applied to the exterior of

foundation walls. These are spray-applied, painted, or mechanically fastened sheet systems. Positive side waterproofing (exterior) is generally better than negative side (inside) to keep water from leaking through cracks. Drainage systems should be designed to remove excessive soil moisture along the basement wall. Provide foundation drainage by installing drain tiles or plastic pipes around the exterior of the footing and properly connect them to a removal system or drain to daylight. Surface and roof drainage should direct water away from the residence. Water should be drained to lower elevations suitable to receive storm water run off.

- g. **Backfilling and final grading.** Backfilling should be done carefully to avoid damaging the walls. Brace the walls, if possible, or backfill after first floor or other structural systems are in place. Finish grade to slope ½ to 1-in. per foot (40 to 80-mm per m) for at least 8 to 10 feet (2.5 to 3 m) to drain water away from the foundation. Considering settlement, maintain this final grade to prevent water from standing along the foundation and exceeding the designed wall pressure.
- h. **Crack repair.** Cracking is not necessarily a sign of poor materials or workmanship or a structural problem with the concrete wall. If repair is necessary, epoxy injection, dry-packing, or routing and sealing techniques can be used to repair and stabilize cracks. Before repairing leaking cracks, the drainage around the structure should be checked and corrected if necessary. Details of these and other repair methods are provided in Ref. 1. Seek professional advice to evaluate and repair active cracks that are widening with time.

References

1. *Causes, Evaluation and Repair of Cracks*, ACI 224.1R, American Concrete Institute, Farmington Hills, MI. www.concrete.org
2. *Code Requirements for Residential Concrete*, ACI 332-14, American Concrete Institute, Farmington Hills, MI.
3. *International Residential Code*, International Code Council, Washington, DC, www.iccsafe.org
4. *Residential Concrete*, National Association of Home Builders, Washington, DC, www.nahb.org
5. *Residential Construction Performance Guidelines*, National Association of Home Builders, Washington, DC.
6. *Cast-in-Place Residential Foundation Walls in Cold Weather*, Concrete Foundations Association, Mount Vernon, IA, www.cfawalls.org.
7. *Backfilling Foundation Walls*, Concrete Foundations Association, Mount Vernon, IA.
8. *Cracking in Foundation Walls*, Concrete Foundations Association, Mount Vernon, IA.

1979, 2000, 2014

