

FOUNDATIONS STRUCTURAL SLABS

Slab-on-grade foundations are one of the most common foundations in the U.S. because they can be adapted to perform well in a wide range of climate zones and difficult soil conditions.

Site Layout for Structural Slabs

SITE LAYOUT FOR STRUCTURAL SLABS

Site Layout for Slab Foundations

When framing a floor system, there is a little latitude in both the timing and installation of the utilities. But when building on a slab, the utilities must be defined precisely before any concrete is poured.

Plumbers First

When starting layout, make sure the plumber is the first trade on site. Let other subs work around him — it's a lot easier for an electrician to work around obstructions than it is for the plumber.

Before excavation begins, work through the plumbing plans to define all drain/waste and supply lines and vent stack locations, and review plans for all utilities running below the slab, such as electric, gas, and phone lines.

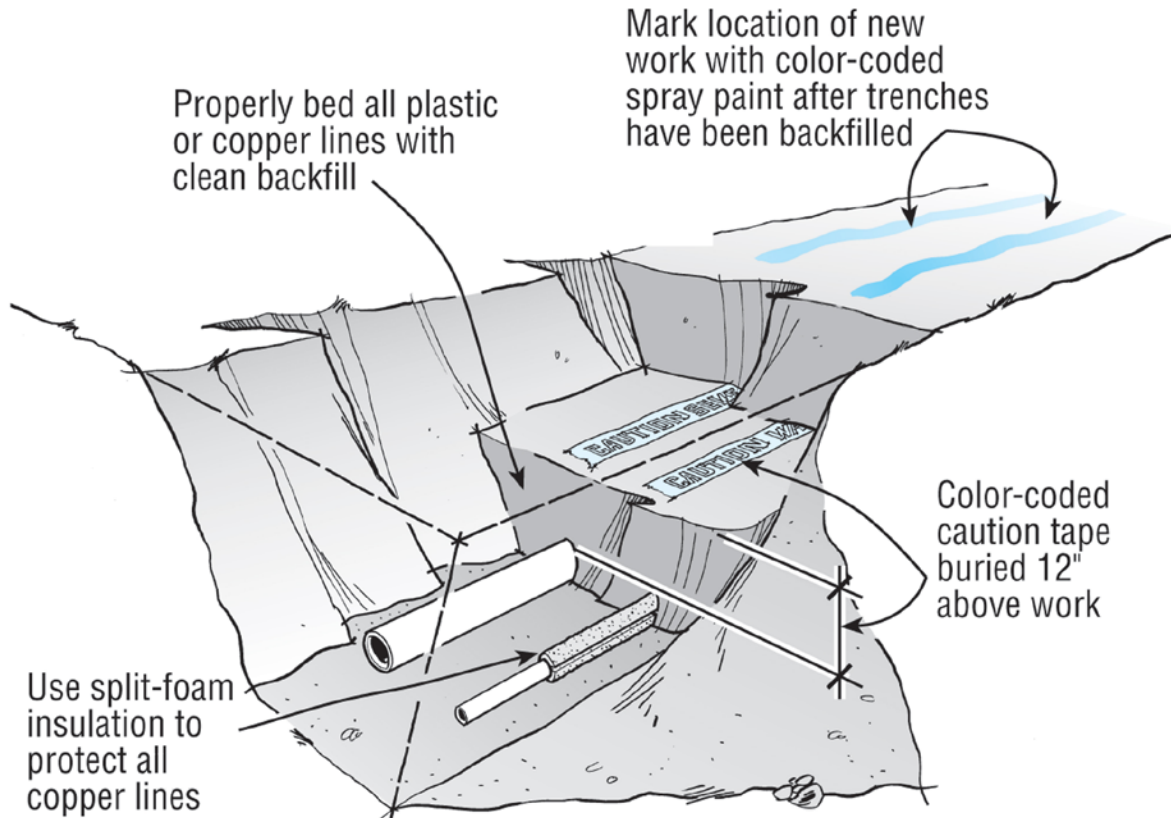
Subslab Utilities

After the service lines have been installed, all plastic or copper lines should be properly bedded (clean fill, no rocks) and tested for leaks prior to backfilling. All copper should be checked for dents or abrasions and wrapped in split-foam insulation, or something similar, to protect it.

Install caution tape: Make sure every trade buries color-coded caution tape 12 in. below grade and in line with their work (**Figure A**). These plastic caution tapes are color coded: red for electric, blue for water, green for sewer, yellow for gas, and orange for phone.

FIGURE A: UTILITY TRENCH INFILL

Site Layout for
Structural Slabs



Water supply lines must be below the frostline outside the foundation perimeter, and should be protected with split foam insulation throughout. Clearly mark all utility lines with caution tape 12 in. below grade, and transfer these markings to the surface with spray paint using color-coded caution tape: Red = Electric; Blue = Water; Green = Sewer; Yellow = Gas; Orange = Phone.

Mark location of new work: Use spray paint to color-code the location of new work after backfilling trenches. It's easy to forget where lines run a few days after a trench has been backfilled. Don't leave anything to memory: Before the concrete trucks show up, make notes either on the drawings or in a site log.

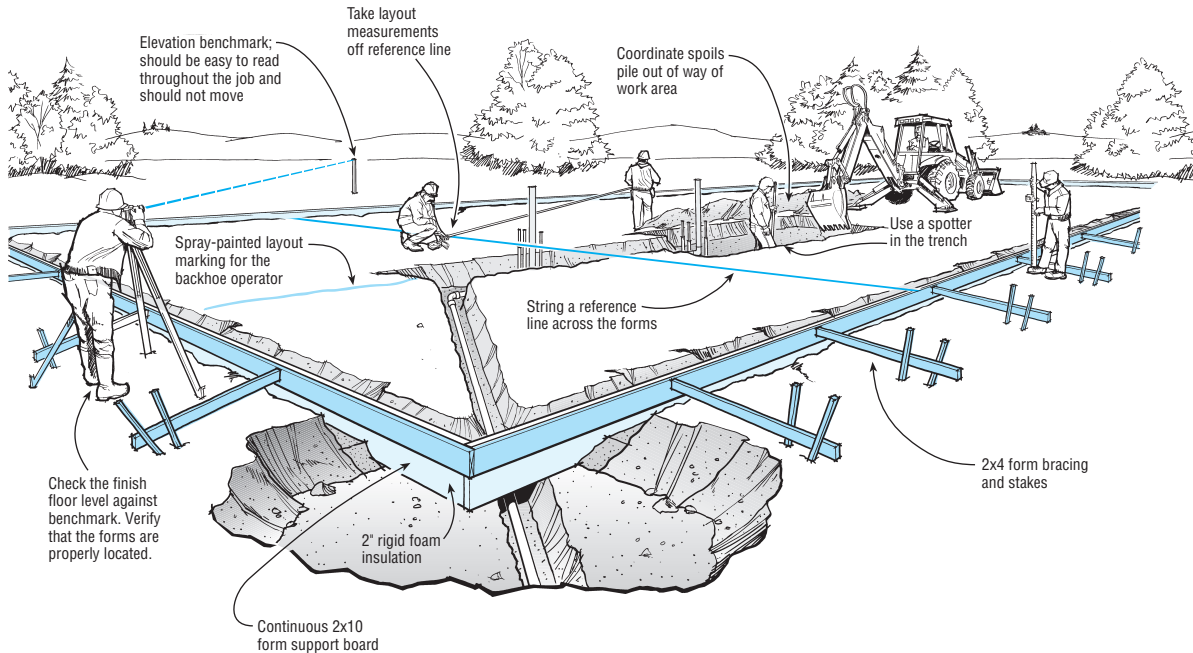
Slab Layout Checklist

Keep careful track of these critical layout details for structural slabs:

Benchmark: A slab excavation should be as level as possible. Set an elevation benchmark prior to excavation. Place the benchmark somewhere convenient and make sure everybody on the site knows where it is (**Figure B**).

FIGURE B: STRUCTURAL SLAB LAYOUT AND FORMWORK

Site Layout for Structural Slabs

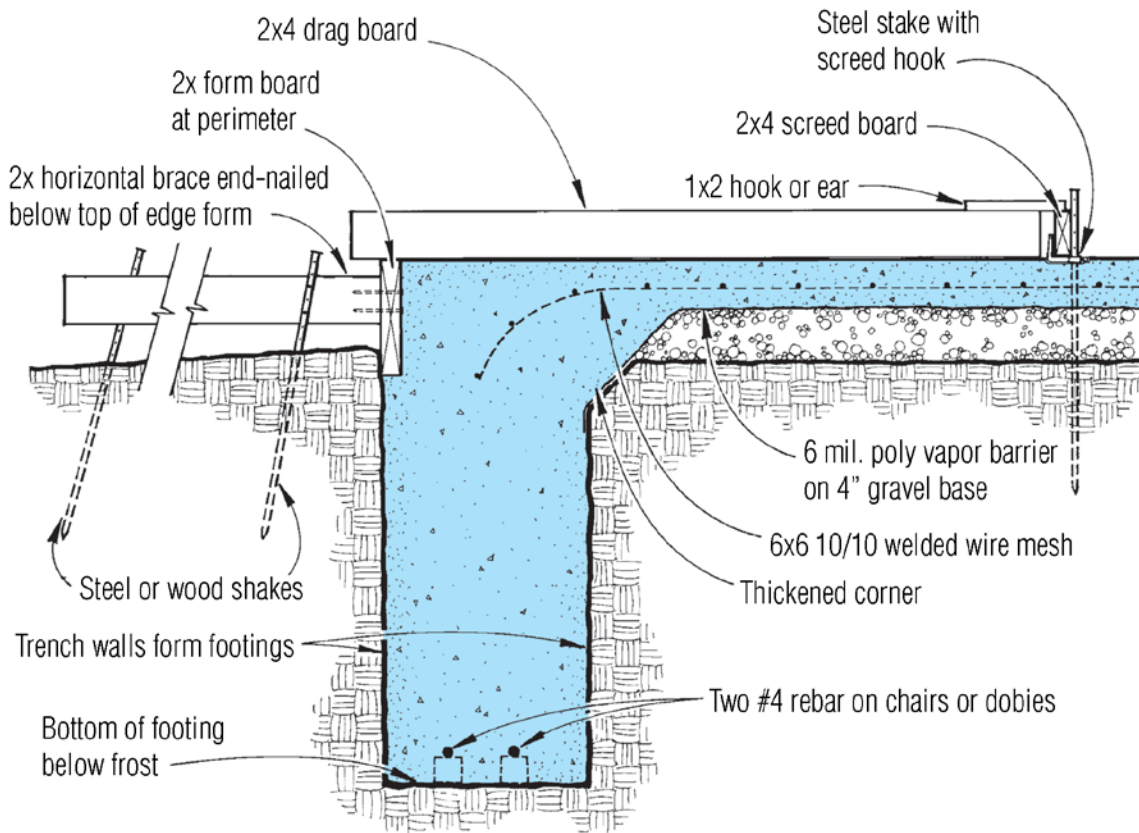


Check the elevation of forms against a benchmark. Layout lines for slabs should be clearly marked with spray paint for the excavator.

Concrete formwork: Form monolithic slabs as shown in **Figure C**. Double-check forms, verifying that they are located properly, both in relation to the corner points the surveyor set prior to excavation and in relation to the elevation benchmark.

FIGURE C: FORMING A STRUCTURAL SLAB

Site Layout for
Structural Slabs



In slab-on-grade construction, excavate accurately; the trench walls typically act as footing forms. The slab's subbase should be a minimum 4-in. compacted gravel base.

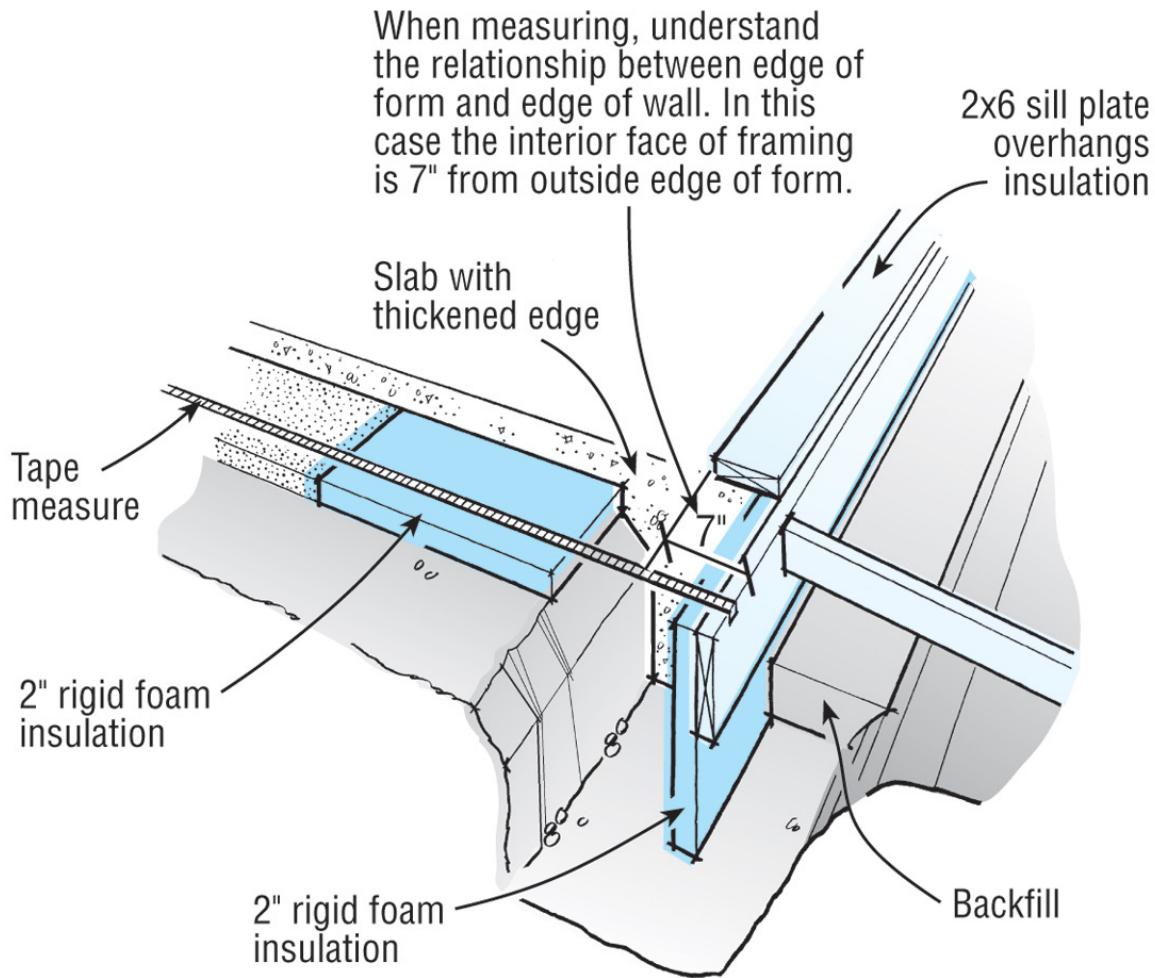
Reference lines: Mark on the edge of forms one reference point from which each subtrade can take dimensions and work. A string line across the forms is ideal. Locate this reference line at some feature of the building that cannot change, such as the longest bearing wall. Make sure that all trades clearly understand how this line corresponds to their work.

Edge of slab/wall: Take time to understand the -relationship between the edge of the form and the edge of the wall. Explain it to the plumber and other subs (**Figure D**).

FIGURE D: SLAB/WALL RELATIONSHIP

Site Layout for
Structural Slabs

Subgrade and
Subbase



When measuring formwork, the layout crew must understand the relationship between the edge of the form and the edge of the wall. In this case, the interior face of framing is 7 in. from the outside edge of the form.

Penetrations: Double-check all penetrations before the slab is poured. These include toilet flanges, drain boxes, turn-ups for water, electric, gas, phone, and floor drains.

SUBGRADE AND SUBBASE

Subgrade material should consist of well-drained native soil. If soils are not suitable, excavate and replace with a deep subbase layer of compacted gravel.

Granular fill, such as gravel or a mixture of sand and -gravel, works best as a subbase under a slab because it compacts well (**Figure C**). The fill should be completely thawed and free of organic material — melted ice and decomposed organic material will leave voids (see Soils).

Base Compaction

Residential slabs, even with steel reinforcement, cannot span over voids or soft spots (the amount of steel used is not enough for structural reinforcement unless designed for that purpose by an engineer). Compact subgrade and -subbase after utility trenching to prevent settlement, and under footings to provide even bearing strength.

Compaction is usually expressed as a percentage at -optimal moisture content — usually 95% or greater (see Compacting Soil). Run a plate tamper or- jumping jack until there is very little impression left with each successive pass.

All fill material should be reasonably free of moisture, but if it's too dry, you can pound on it all day and it won't compact much. In this case, spray it sparingly with water.

Level Base

The subbase must be graded to the same level across the full width of the slab. Level the subbase to within 1/2 in. (less than 12.4% of a 4-in. slab). Where subgrade elevation is inconsistent, the slab will vary in thickness. This variation will cause it to cure unevenly, which will stress the concrete, increasing the likelihood of cracking.

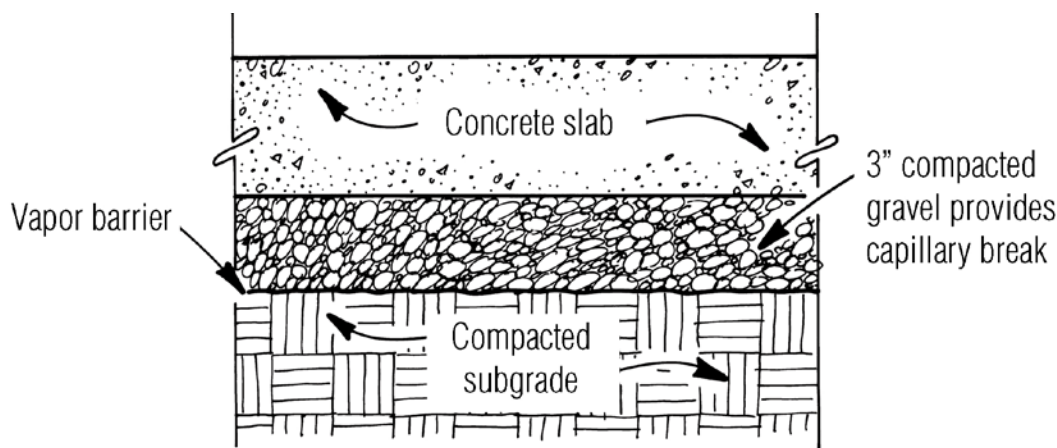
Subslab Vapor Barriers

Install a subslab vapor barrier on interior slabs to keep moisture and soil gases from entering the home. Use a minimum 4-mil to 6-mil poly. For best results, use a cross-woven poly. Lap seams by at least 6 in.

Capillary Break

An optional 3- to 4-in. layer of sand or gravel over the poly, directly under the slab, helps reduce concrete curling and cracking by allowing water to escape from the slab at the bottom as well as the top (**Figure E**). Damp sand is typical, but gravel or a sand-gravel mix can also be used.

FIGURE E: CAPILLARY BREAK BENEATH SLABS



To prevent a slab from curling, use a 3-in.-thick layer of sand or gravel over the poly vapor barrier. Compact the sand before pouring the slab. While sand is more commonly used, gravel works better than sand because it is less likely to mix with the concrete or to create thin spots in the slab.

Subgrade and
Subbase

CONCRETE FOR STRUCTURAL SLABS

Depending on the slab's purpose, use a 3,000-psi to 4,000-psi mix (**Figure F**) at a 4-in. slump (for increased workability, consider a water-reducing admixture). For a harder surface, use a 6-bag mix. For more information on concrete mixes, see Concrete.

Use air-entrained concrete for slabs exposed to freezing.

Concrete for
Structural Slabs

Bearing on Slabs

FIGURE F: CONCRETE FOR SLABS

Floor Class	Application	Minimum Thickness	28-day Strength	Slump
1	Residential or tile covered	4"	3,000 psi	4"
2	Offices, churches, hospitals, schools, ornamental residential	4"	3,500 psi	4"
3	Drives, sidewalks for residences, garage floors	4"	3,500 psi	4"
4	Business or commercial walks	5"	3,500 psi	4"
5	Light industrial and commercial	5"	4,000 psi	3"

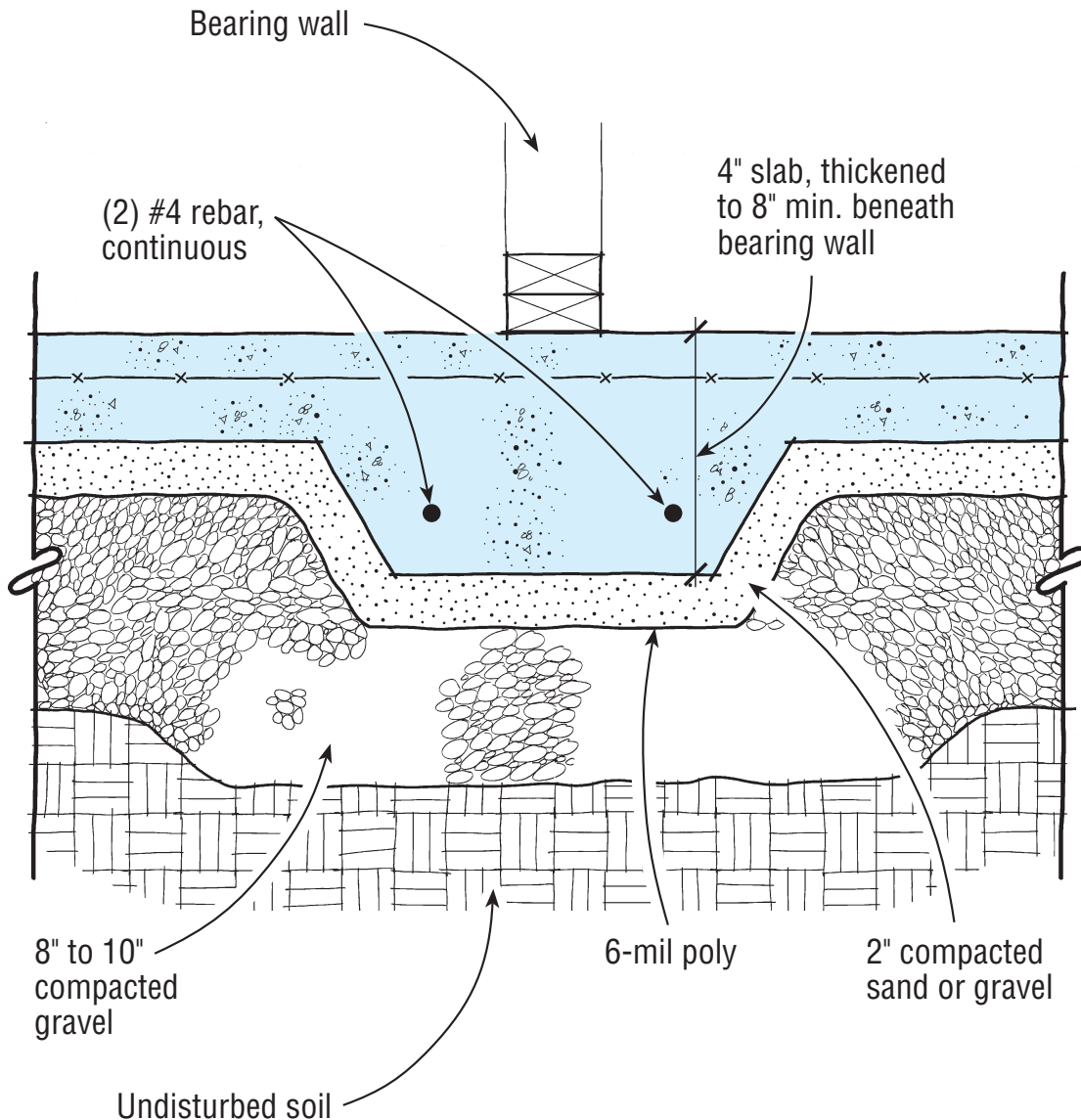
BEARING ON SLABS

Increase the thickness of a slab to 8 in. under bearing walls and structural columns (**Figure G**).

In thickened bearing pads and exterior wall footings, lay two #4 rebars (see Rebar).

Under a fireplace, thicken the slab to 12 in. and use #5 rein-forcing bars, placed 12 in. o.c. each way to form a grid-work.

FIGURE G: SLAB BEARING SUPPORT



Bearing on Slabs

Steel Reinforcing
for Slabs

Thicken slabs beneath interior bearing walls and columns to a minimum of 8 in., using two #4 rebar about 2 in. from the bottom surface. The bearing width of all footings varies according to soil strengths and loading conditions, as shown in **Figure: Footing Dimensions** in Footing Layout.

STEEL REINFORCING FOR SLABS

To limit cracking, residential slabs require steel reinforcement — either rebar or welded wire. This steel does not increase the load-carrying strength unless purposely engineered to do so.

Rebar

In the field of a slab, use #3 or #4 rebar at 16 in. o.c. Place rebar in the center of the slab section. Use dobies or wire chairs to hold the steel off the ground. Do not use brick to support rebar, because it will pull moisture out of the surrounding concrete too quickly, creating a stress point.

Pipe or conduit laid directly on the ground will dramatically weaken the slab by effectively creating a score line on the bottom (tension) surface.

Welded-Wire Mesh

To effectively limit cracks, 6x6 wire mesh in slabs should be placed in the upper part of the slab, where cracks are noticeable, but no closer than 2 in. to the top surface. Use dobies or wire chairs to hold the steel off the ground.

At slab edges, curve the mesh down into the perimeter footings (**Figure: Forming a Structural Slab** in Site Layout for Structural Slabs). Do not lap wire sections at joints. Instead, stop the mesh several inches back from the joint location.

If control joints are spaced close together, and a low-slump mix is used, wire mesh is probably not necessary.

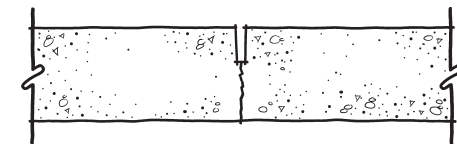
Steel Reinforcing
for Slabs

Control Joints
for Slabs

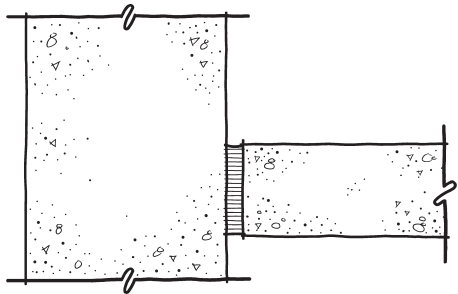
CONTROL JOINTS FOR SLABS

Three kinds of joints are used in concrete slabs (**Figure H**):

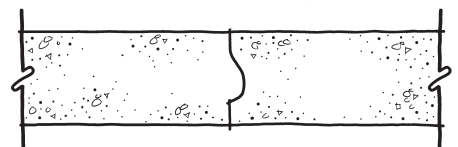
FIGURE H: CRACK CONTROL JOINTS



Control Joint



Isolation Joint



Cold Joint

Control joints (**center**) extend only partially into the slab surface and determine where cracks will form. Isolation, or expansion, joints (**top**) extend all the way through the slab and allow sections to slide back and forth without cracking. Cold joints (**bottom**) are necessary when a pour must be interrupted, and should coincide with control joints.

- **Control joints** confine cracks to intended locations
- **Isolation joints** allow structural and non-structural elements to move separately
- **Cold, or construction, joints** define where a concrete pour has been interrupted

Control Joints
for Slabs

CUTTING CONTROL JOINTS

Control joints can be tooled in the slab surface with a grooving trowel or cut with an abrasive or diamond circular-saw blade at recommended spacing and depths (**Figure I**). Make tooled joints during finishing, as soon as bleed water has evaporated. Cut sawn joints as soon as possible after finishing the slab. Random cracks may appear as rapidly as within six hours in hot weather.

Cutting Control
Joints

FIGURE I: CONTROL JOINTS FOR SLABS

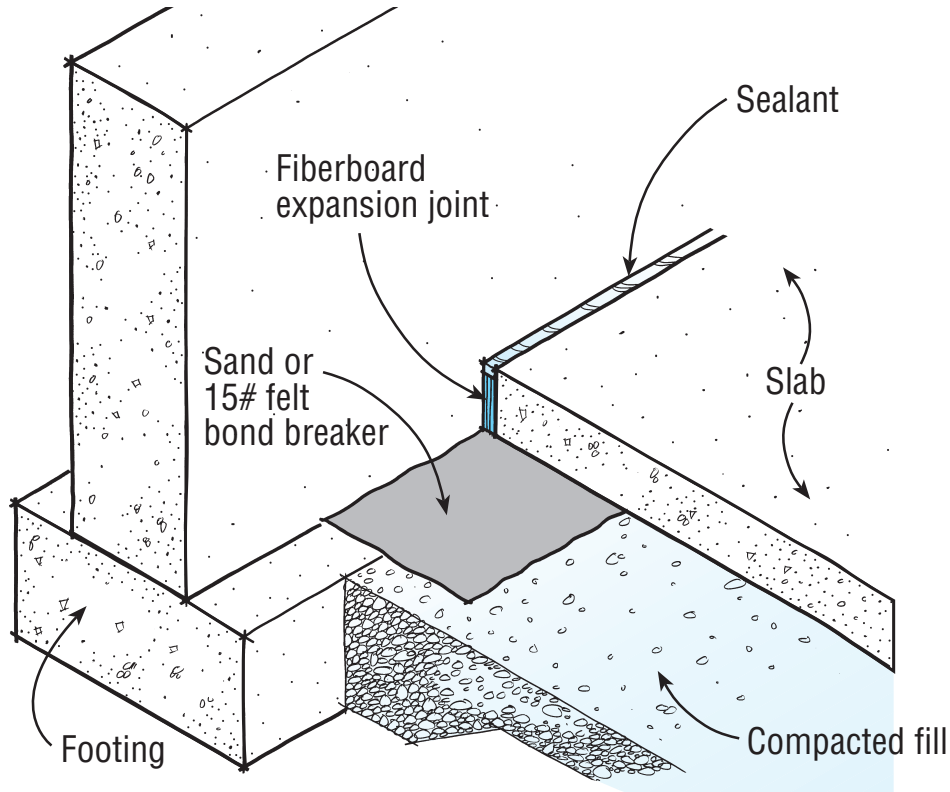
Slab Thickness (in.)	Joint Spacing (ft.)	Joint Depth (in.)
4	8-12	3/4 to 1
5	10-15	1 to 1 1/4
6	12-18	1 1/4 to 1 1/2
7	14-21	1 3/8 to 1 3/4
8	16-24	1 5/8 to 2
9	18-27	1 3/4 to 2 1/4

Isolation Joints

Provide isolation, or expansion, joints at garage and basement slab edges (**Figure J**) and at column footings (**Figure K**). This prevents movement of one element from damaging the other. Expansion joints can be made of asphalt-impregnated fiberboard or a plastic strip that can be zipped off after concrete is placed.

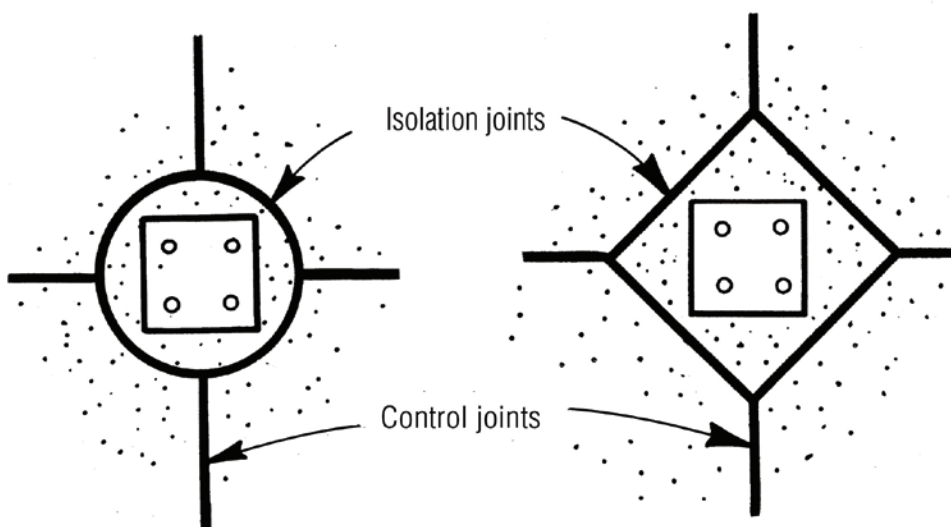
FIGURE J: ISOLATING BASEMENT SLABS

Cutting Control Joints



An expansion joint should be installed at the edges of a basement slab, and a bond breaker should be installed between the footing and the slab to help prevent cracking as the slab moves.

FIGURE K: ISOLATING COLUMN FOOTINGS



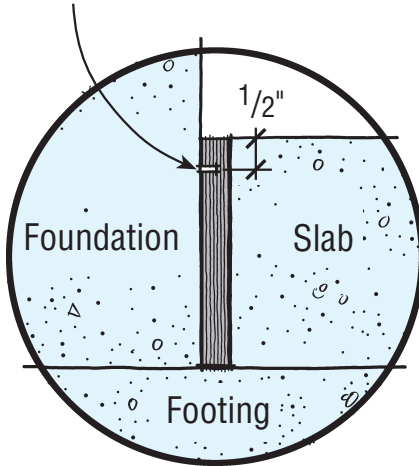
Structural columns must be isolated from the slab using block-outs that extend through the slab thickness (Figure C). When forming square block-outs, align the points of the square to meet control joints.

For a finished appearance in slabs, score fiberboard expansion material prior to placing, so it can be snapped out and the joint sealed with caulk (**Figure L**). This same detail should be employed with exterior driveway expansion joints; in this case, the caulk provides an important protection from potential freeze-thaw damage (see Concrete Drives).

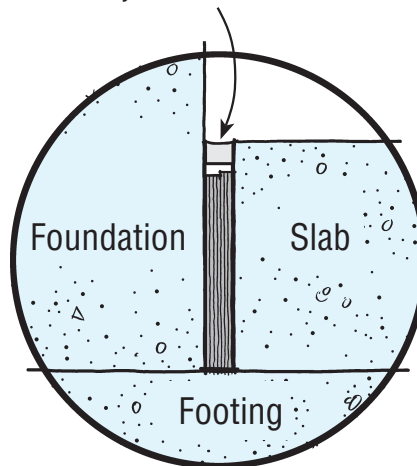
Cutting Control Joints

FIGURE L: FINISHED EXPANSION JOINT

- A. Fiberboard expansion joint, scored prior to installation



- B. Remove scored fiberboard, finish joint with sealant



For a finished appearance at the slab edge, score the fiberboard on a table saw so the top 1/2 in. can be easily snapped off after the pour. Then finish the joint with sealant.

Basement slabs must also be isolated from the footing, either with sand (**Figure: Parging for Concrete Block Foundation** in Dampproofing) or with 15# felt (**Figure J**).