Concrete block is one of the most efficient and economical materials for constructing residential basements. It’s strong, fireproof, thermally efficient, termite-resistant, requires no formwork, and is available almost everywhere. Ribbed, split-face, slump, fluted, and other decorative block can give a basement interior an appealing look. And unless soil conditions or a high water table prohibit them, concrete block basements provide comfortable living or storage space at about half the cost of above-grade construction.

Designing the walls

Most block basement walls are designed according to empirical design standards. The wall thickness, amount of reinforcement, and the spacing between lateral supports are based on lateral earth pressures and vertical loads normally encountered in light construction. Concrete masonry wall thicknesses for various basement depths below grade are listed in the table (Ref. 1). They were proposed by a joint American Concrete Institute-American Society of Civil Engineers committee. Local building code requirements should be checked too.

A concrete masonry basement wall generally acts as a beam spanning from the slab and footing intersection to the first floor framing. Thus it transfers lateral earth pressures to the floor slabs. For this reason, the first floor framing should be installed before the walls are backfilled. Figure 1 shows how to connect block basement walls to the first floor wood framing. Every fourth joist (spaced at most 6 feet apart) should be anchored as shown. Joists running parallel to the wall should be anchored every 8 feet or less using anchors that are long enough to engage at least three joists.

Vertical stiffness of the wall can be increased by constructing solidly grouted pilasters or integral pilasters (Figure 2). The wall then spans hori-
zontally between pilasters. External pilasters should project from the wall a distance equal to about \( \frac{1}{2} \) the wall height. The width of each one should equal about \( \frac{1}{10} \) the horizontal span between supports. And they should be spaced no more than 18 feet apart in 10-inch-thick unreinforced walls, and no more than 15 feet apart in 8-inch-thick unreinforced walls. If integral pilasters are used, these spacings can be reduced by 3 feet. Integral pilasters are created by grouting steel reinforcement in the hollow cores of the block.

Horizontal stiffness can be increased by adding joint reinforcement every other course or by constructing continuous bond beams at or near the top of the wall. In fact, the Uniform Building Code (UBC) requires joint reinforcement in Zones 2, 3, and 4 (Ref. 2). Bond beams help distribute concentrated vertical loads, too, and they can act as lintels for window openings.

Bond beams and joint reinforcement also help reduce cracking. Thus they reduce the need for expansion and control joints, which reduce flexural strength and provide places for water to enter. Movement joints are seldom necessary in basement walls anyway because the earth fill minimizes thermal and moisture volume changes.

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### Reinforcing block basement walls

Generally, concrete block basement walls are built without reinforcing steel. Steel is required only if the soil exerts extreme lateral pressures, loads are unusually heavy, the basement is built more than 8 feet below grade, or there's seismic risk.

In Seismic Zones 2, 3, and 4, UBC requires fully reinforced construction. Reinforcing bars must be a minimum #3 and spaced no more than 4 feet on center. The sum of the areas of horizontal and vertical reinforcement must equal 0.002 times the gross cross-sectional area of the wall. The minimum amount of steel in either direction must be one-third the total required. Both steel rebar and joint reinforcement can be calculated as part of the horizontal reinforcement.

### Building the walls

Block basement walls should be built on concrete or concrete block footings placed on firm, undisturbed soil below the frost line. Excavations deeper than 5 feet must be constructed according to OSHA regulations. Soft or sandy soils must have at least a 1:1 slope. Hard or compact soil must have at least a 1:2 slope.

Before laying block, clean the top of the footing. Dirt, mud, water, and many other substances inhibit mortar bonding. Then locate the exact corners of the building and snap a chalk line to help keep the walls straight.

As with conventional above-grade construction, begin laying block at the corners and work toward the middle of the wall being careful to maintain correct modular coursing. Lay the first course of block in a full mortar bed. The rest of the wall can be laid with face-shell bedding only, except where cores will be grouted solid. At these locations, mortar the cross-webs too.

Use Type M or Type S mortar (ASTM C 270). And maintain a standard 3/8-inch-thick joint. Tool all the joints concave.

### Keeping the basement dry

Sidewalks, driveways, or finished grade next to basement walls should slope away from the building to drain surface water away. Gutters, downspouts, and troughs or lateral drain pipes should be used to carry away roof runoff.

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### Required Thickness of Foundation Walls

<table>
<thead>
<tr>
<th>Type of Foundation Wall</th>
<th>Nominal Thickness (inches)</th>
<th>Maximum Depth of Unbalance Fill (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masonry of hollow units, ungrouted</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Masonry of solid units</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Masonry of hollow units, fully grouted</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Masonry of hollow units, reinforced and grouted</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Masonry of solid units</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Masonry of hollow units, reinforced</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Masonry of solid units</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: ACI-ASCE 530 (Ref. 1).

1. Unbalanced fill is the height of the finish grade above the basement floor. This table is valid only where the unbalanced fill and the height of wall between lateral supports do not exceed 8 feet, and where the equivalent fluid weight of unbalanced fill does not exceed 30 pounds per cubic foot.

2. Vertical #4 bars installed 24” o.c. and not less than \( \frac{3}{4} \) from pressure side of wall.

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Figure 1. Anchor first floor joists to block basement walls as shown here.
Drainage tile with at least a 4-inch inside diameter should be installed above the bottom of the footing but below the slab level. Leave \( \frac{1}{4} \) -inch open joints between each tile and cover them with pieces of roofing felt, glass-fiber batts, or a porous filter fabric to prevent clogging during backfill. The drain should connect to an exposed surface outlet, sump, or storm sewer and should slope at least \( \frac{1}{2} \) inch in 12 feet. Backfill should be a free-draining, granular material such as coarse sand and pea gravel.

The wall itself should be damp-proofed by parging (or plastering), grout-coating, or asphalt-coating the outside surface. Dampproofing prevents the passage of water vapor, but not liquid water, especially if the wall is under hydrostatic pressure. If hydrostatic pressure can’t be avoided, waterproofing must be applied to the wall instead. Composite sheet membranes, synthetic rubber sheet membranes (butyl rubber, EPDM, or neoprene), fiber-reinforced cement surface bonding materials, and bentonite clay are waterproofing materials usually used in commercial below-grade construction. All dampproofing and waterproofing materials should be covered with protection board to protect them from punctures or tears during backfilling.

To expel trapped or leaded moisture or condensation, any interior coatings used on the wall must be permeable. Never use vinyl wall coverings or non-breathable paints.

Insulation
Concrete masonry basement walls can be insulated in many ways:

- Polyurethane foam, loose perlite, loose vermiculite, or expanded polystyrene inserts can be placed inside the block cores
- Rigid insulation boards can be applied to the outside of the wall (also serving as protection boards)
- Batts or boards can be installed between furring strips on the inside of the wall

Backfilling
Unless pilasters are used, be sure to install the first floor framing before backfilling the walls. If you don’t, the soil pressure may crack and possibly even collapse the wall.

Place and compact the backfill in shallow lifts with a tamper or vibratory plate. Never compact the fill by water soaking; it creates too much hydrostatic pressure on the wall. Also never backfill frozen earth or bury trash, lumber, or other debris in the backfill. If settlement is expected, build the backfill up above the adjacent grade. Remember to slope the grade away from the building.

After the wall is backfilled, don’t operate heavy equipment too close to it. This also can stress the wall and cause cracks in it. For this reason, always keep heavy equipment back a distance equal to the height of the fill.

—by Christine Beall

References
1. ACI-ASCE 530, Building Code Requirements for Masonry Structures, 1988, American Concrete Institute, P.O. Box 19150, Detroit, Michigan 48219.