7.4 SINGLE-WYTHE MASONRY

7.4.1 A Popular Choice

Walls made of single-wythe CMU are popular in pre-engineered buildings because of their fire and sound resistance, hardness, and other masonry benefits. Exposed CMU walls need not be gray and nondescript: a wide variety of split-face, ground-face, and scored-block units is available in attractive colors. The units are typically 8 to 12 in thick. As any hard walls, the exterior masonry can be designed as loadbearing, shear, or enclosure-only walls. The concrete masonry blocks used in loadbearing walls and in exterior applications where a possibility of freezing is present should conform to ASTM C90.[6]

Since masonry is brittle and very weak in tension, CMU walls in seismic regions are required by codes to be reinforced in two directions. Steel reinforcement improves the wall's strength and ductility. A reinforced wall deflects gradually under load and tends to form a multitude of very narrow cracks, rather than a few wide ones that might appear in an unreinforced masonry wall.

Vertical reinforcement is placed in grouted cells and is spliced as needed to extend the full height of the wall. Many masonry designers avoid using more than one layer of vertical reinforcement, because the bar placement techniques in masonry are far less precise than in concrete construction. On the West Coast, however, two layers of bars are often used, because of the traditionally high levels of inspection in those earthquake-prone areas. Horizontal reinforcement may include deformed bars or joint reinforcement of fabricated wire. The bars are placed in special units, either U-shaped bond beams or blocks with notched webs. Joint reinforcement is placed in horizontal joints between the blocks.

The amount of reinforcement is determined by analysis based on the governing building code. Most building codes recognize ACI 530[7] as an authoritative source. There are plenty of computer program and design tables for masonry, one helpful source being *Concrete Masonry Design Tables* by the National Concrete Masonry Association (NCMA).[8] The maximum spacing of vertical and horizontal wall reinforcement and the minimum reinforcement percentage depends on a number of factors, such as the governing building code, the Seismic Performance Category of the building, and whether the wall is a shear wall or not.

For example, for Seismic Performance Category D, representing areas of high seismicity, ACI 530 stipulates that the CMU walls be reinforced in two directions, with the sum of the vertical and horizontal rebar cross-sectional areas being at least 0.002 times the gross area of the wall. The minimum area of the bars in either direction must not be less than 0.0007 times the gross area of the wall. The reinforcement must be uniformly distributed; the maximum spacing in either direction is 48 in, except for masonry laid in stack bond. For CMU laid in stack bond, the maximum reinforcement spacing is reduced to 24 in, and the units must be fully grouted. Additional provisions deal with shear wall reinforcement. For other, lower seismic performance categories, requirements that are more lenient apply.

There are some issues worth keeping in mind when specifying CMU walls in metal buildings. Not easily removed and reused, masonry is poorly suited for buildings where future expansion is likely. Also, masonry is heavy and requires continuous foundations for support. The insulation value of CMU walls is small; to increase it, furred interior walls containing insulation and finished with drywall or metal liner panels are needed. The blocks absorb moisture unless treated with a water-repellant admixture at the time of production or covered with a waterproof coating which needs to be periodically reapplied.

To reduce moisture penetration through mortar joints, the joints should be properly tooled, preferably to a concave shape. Adding a water-repelling admixture to the mortar may also be beneficial. Like any exposed masonry, CMU requires control joints at close intervals such as 20 to 25 ft. Fortunately, this joint spacing coincides with the popular building bay sizes. With all the precautions taken, single-leaf CMU still does not enjoy the benefits of cavity construction, and any wall crack or missing mortar will allow moisture into the interior (Fig. 7.25).

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WALL MATERIALS

FIGURE 7.25 Watertightness of this single-layer stack-bond CMU wall is compromised by missing mortar. Daylight can be seen through the head joints.

7.4.2 Vertically Spanning CMU Walls

The main discussion of vertically spanning hard walls takes place in Sec. 7.3. Here, we examine some design issues that are germane specifically to CMU walls, still the most common form of hard walls, and provide some design examples.

Whenever the wide-flange girt of Fig. 7.23 is used behind the wall, its elevation must be determined with care. Quite often, the girt cannot be placed at the very top of the wall, where the grouted bond beam normally exists, because some manufacturers provide diagonal stiffeners in the frame knees. This makes impractical any girt connection to the knee area and necessitates placing the girt below the knee.

The CMU wall must now be fully grouted at the height of the girt location, where the anchor bolts are. To avoid placing the anchor bolts near the edges of grout, at least two block courses nearest the bolts should be grouted. This requirement must be transmitted to the masons and the grouting properly supervised, so that the anchors are not placed into empty block cells. A simple and foolproof but more expensive solution is to specify solid grouting in *all* exterior walls. A solidly grouted wall is of course stronger than a partly grouted wall.

7.4.3 Bracing CMU Walls by Intermediate Girts?

At some combination of wall span and loading, the strength of a standard 8-in CMU wall spanning vertically becomes insufficient, or the wall may require very large amount of steel reinforcement. To

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