Masonry-to-steel-joist CONNECTION

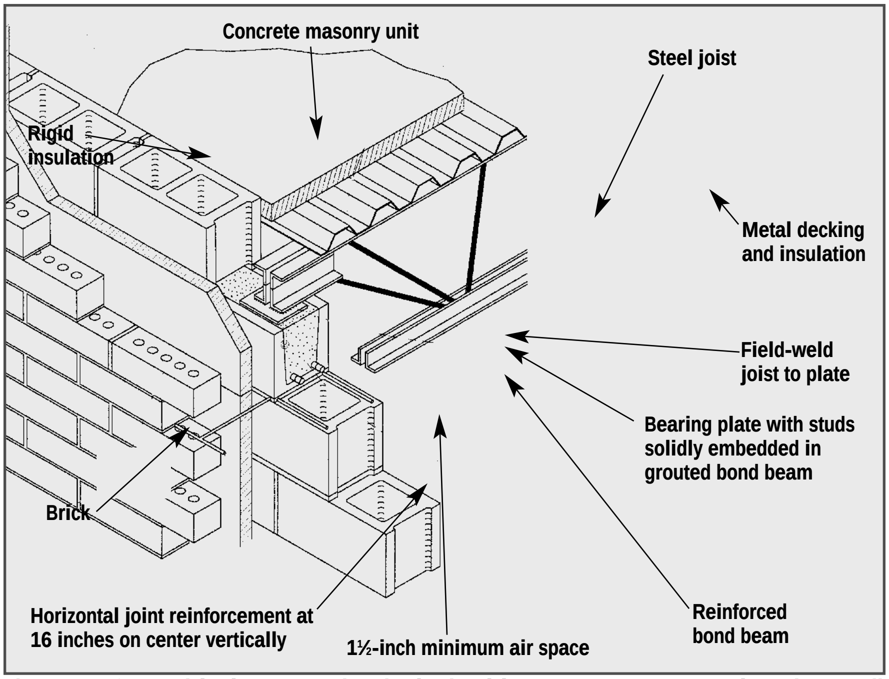

Figure 1. If a welded connection is desired between a masonry bearing wall and steel roof joist, you can specify a bearing plate with studs solidly embedded in a grouted bond beam.

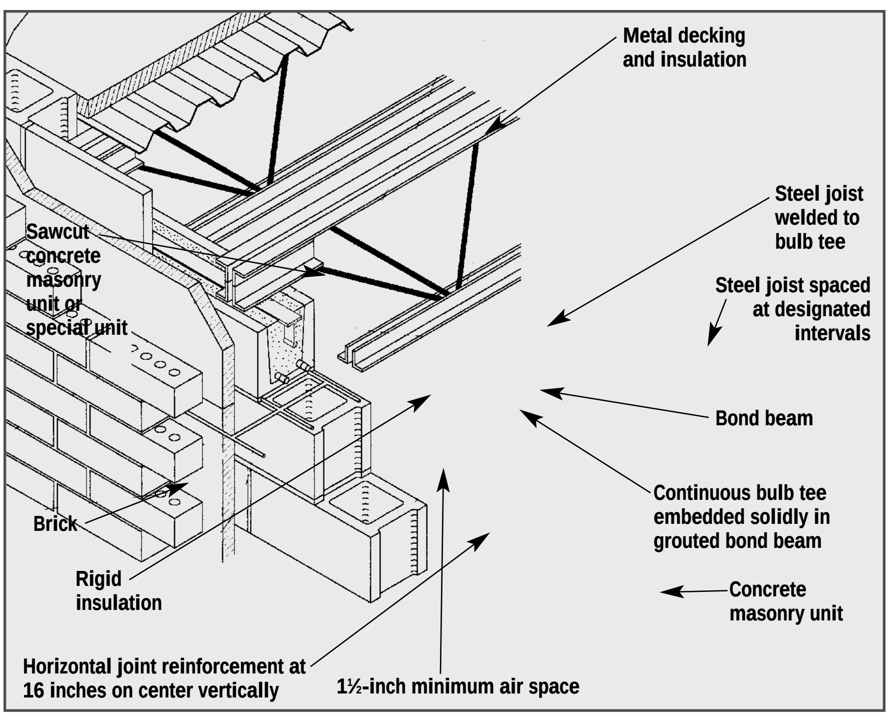

Figure 2. A continuous bulb tee embedded solidly in a grouted bond beam provides a welded connection between a masonry bearing wall and a steel roof joist.

Consider connection adjustability, potential differential movement, and lateral bracing of the masonry walls

By Walter Laska

The structural composition of a building often consists of masonry walls and steel joists. In this type of system, masonry walls perform as both bearing and nonbearing components. When detailing steel-joist-to-masonry connections, designers should take into account several factors, such as the adjustability of the connection, potential movement between the two systems, and lateral bracing of the masonry walls.

K-series and LH-series joists are most commonly used with masonry. The span and depth of these open-web joists determine their bearing requirements, as established by the Steel Joist Institute.

K-series joists range from 8 to 30 inches in depth, with a maximum span of 60 feet. The minimum bearing requirement on masonry for a K-series joist is 4 inches. If the joist is detailed to be anchored to a steel bearing plate, the plate must be at least 6 inches wide (parallel to the wall).

LH-series joists range from 18 to 48 inches in depth, with a maximum span of 96 feet. The minimum bearing requirement on masonry for an LH-series joist is 6 inches. If the joist is to be anchored to a steel bearing plate, the plate must be at least 9 inches wide (parallel to the wall).

It is sometimes necessary, however, for a steel joist to bear on masonry less than the required dimensions—when constructing tall, slender (single-wythe) reinforced masonry walls, for example. In such circumstances, the structural engineer should give special consideration to the design of the masonry and steel joist connection.

Movement

When a roof joist spans its maximum length and carries its maximum allowable load, the ends of the joist will rotate. This inward movement (joist shortening) is the result of deflection. If this condition is overlooked, the masonry can bow and crack.

One way to eliminate this problem is to specify joists stiff enough to resist maximum deflection. You also can minimize deflection by increasing the number of joists, thereby reducing the space between them.

Roofs should be insulated properly to prevent joist movement due to temperature variations. You should also consider the time of year the joists are erected and the type of enclosed environment they will be subjected to. If joists are erected in hot weather and subjected to heavy cooling or refrigeration upon completion, they will contract. Joists erected in cold weather and later subjected to heating will expand. To accommodate this thermal movement, you can specify that the steel fabricator modify the camber (upward bowing) of the top chord of the joist. A special slippage connection to accommodate joist lengthening may be required if the walls are braced laterally by steel joists.

In addition, do not design joists to be in direct contact with the outer face shell of concrete masonry units. Provide a clearance of ¾ inch. If the two materials are in contact, any structural movement of the joist can stress the concrete masonry, causing cracks. This clearance is especially critical in the design of single-wythe

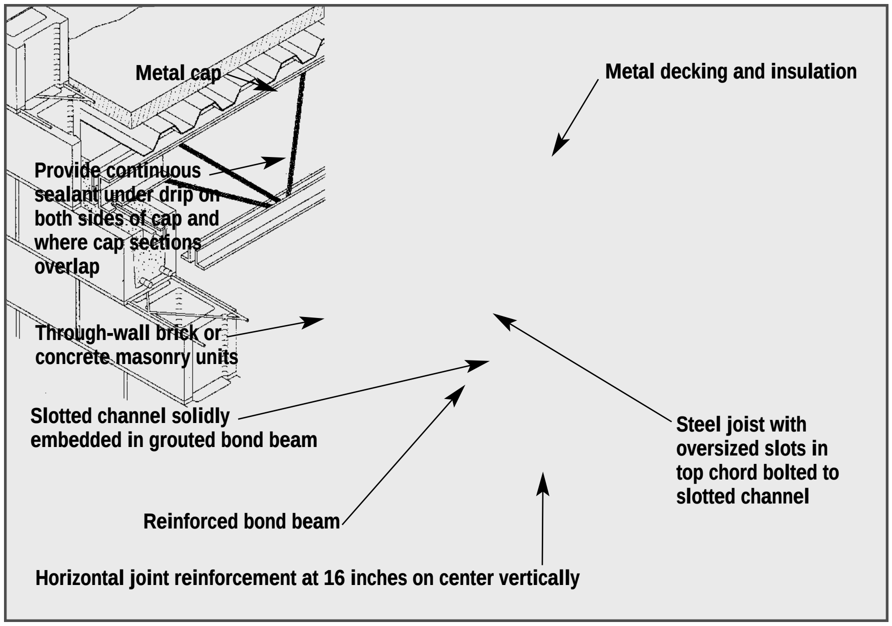

Figure 3. If a bolted connection is desired, specify a slotted channel solidly embedded in the masonry.

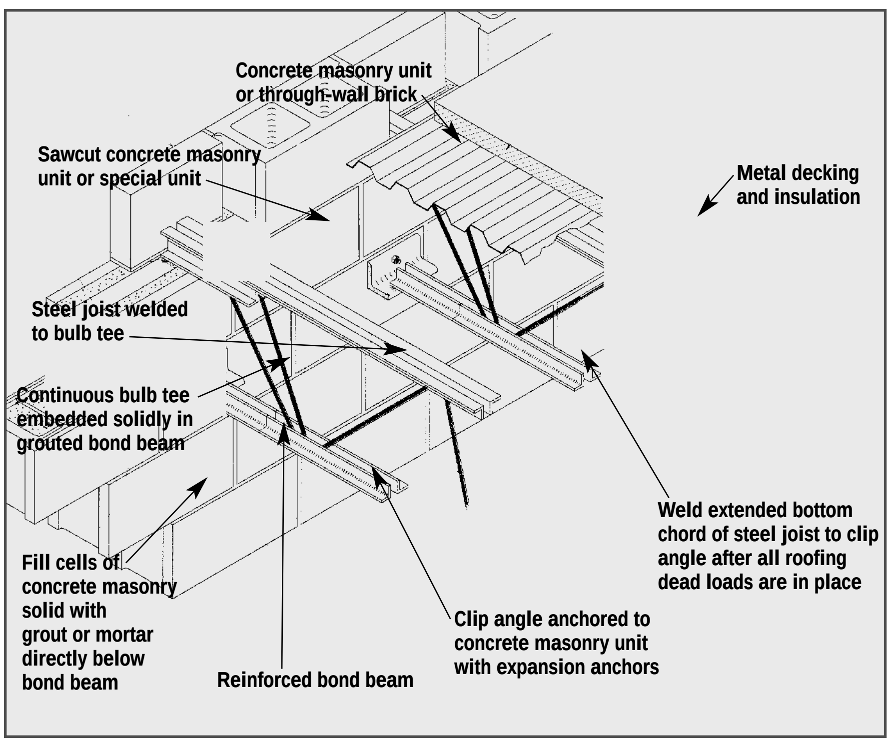

Figure 4. To increase the allowable height of the wall, one option is to extend the bottom chord of the joist and connect it to the wall—after all roof dead loads are in place.

walls, where any cracks that develop would be on the exterior and exposed; in double-wythe walls, in contrast, cracks would develop on the interior and wouldn't be exposed.

Bearing wall connections

A connection should be designed so that it can be installed easily. It needs to be adjustable since distances between bearing points can vary by an inch or more due to construction tolerances. In addition, the anchor bolts set in the masonry during construction can be misaligned.

Detail a connection that allows adjustment of the joist in two directions—north-south and east-west. If a welded connection is desired, then specify a bearing plate with studs (Figure 1) or a continuous bulb tee (Figure 2), which will provide adequate adjustment.The bearing plates should be fabricated and delivered to the jobsite prior to masonry construction to enable masons to embed the plates before the joists are delivered.

If a bolted connection is desired, then specify a slotted channel solidly embedded in the masonry. Also, specify the steel joist to be fabricated with oversized slots in the top chord. The channel enables the bolt to be adjusted from left to right, while the slotted joist allows for up-down adjustment (Figure 3).

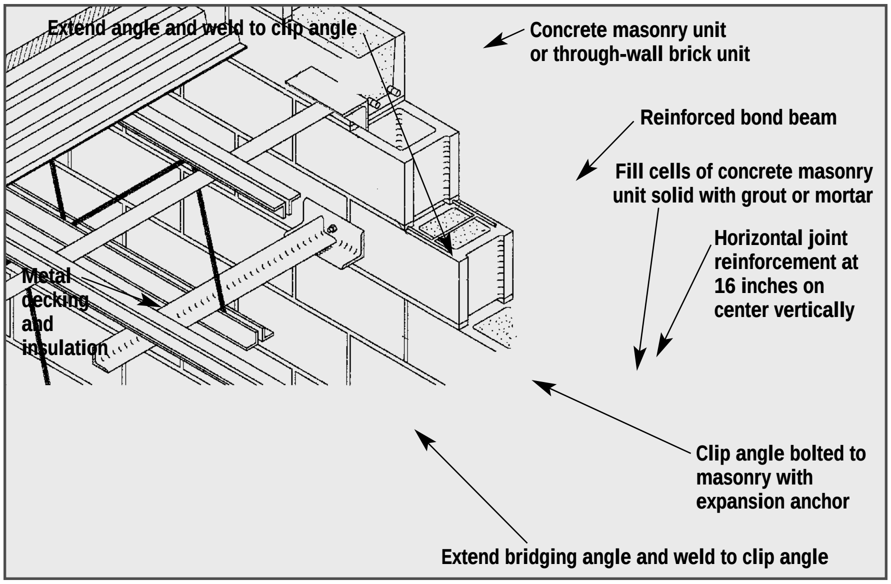

Figure 5. To brace the wall laterally, you can extend the horizontal bridging angles and weld them to clip angles embedded in the masonry wall. The extended section of each angle should align with the horizontal bridging. (Nonalignment could cause joist chords to crimp from wind pressure.)

Nonbearing wall connections

When connecting steel joists to nonbearing masonry walls, connection adjustability is not as critical, but you should still give special consideration to this connection. Two similar types of connection plates provide the best results.

For the most adjustability, specify a clip angle bolted to the masonry with either an expansion anchor or an anchor bolt. Alternatively, you can specify fabricated metal inserts, which are installed during construction. Clip angles and metal inserts should be fabricated and delivered to the jobsite prior to the beginning of masonry construction.

Lateral bracing of walls

Masonry walls must be braced laterally to resist wind loads (which govern in nonseismic areas). This bracing is commonly provided by a roof system constructed of steel joists. The steel joists (and metal decking) act as a diaphragm that continuously braces the wall against wind loads at the bearing connection. Columns, piers, pilasters, or crosswalls are not required for lateral bracing if the wall is built within height limitations allowed by code.

Bearing walls are braced at the masonry and steel joist connection. To increase the allowable height of a wall without increasing the wall thickness, adding more rebar, or constructing columns, piers, or pilasters, you can extend the bottom chord of the joist and connect it to the wall—but only after all roof dead loads are in place (Figure 4). The joist must be stiff enough to minimize deflection after live loads are applied. If ex-

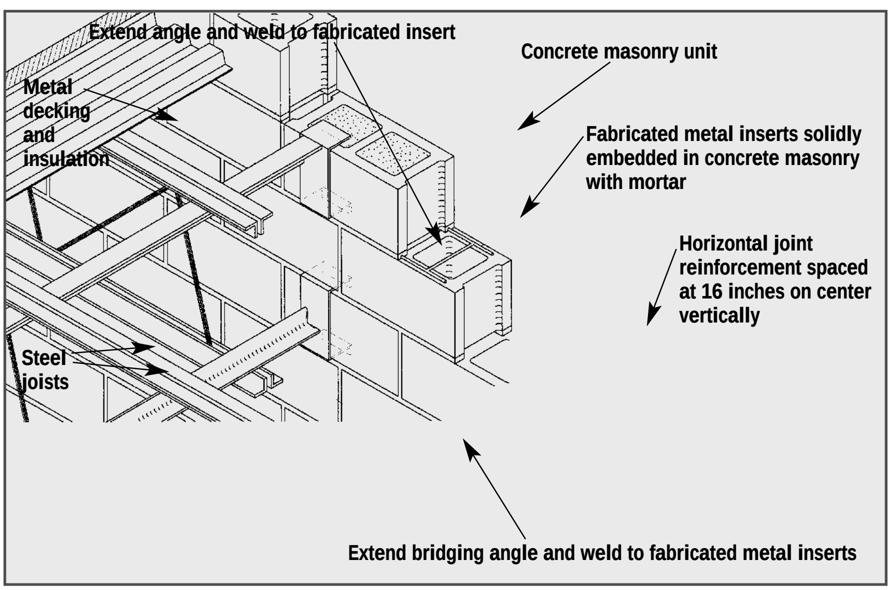

Figure 6. Another option for bracing a wall laterally is to extend the horizontal bridging angles and weld them to metal inserts embedded in the wall.

cessive deflection occurs, a horizontal crack can develop in the mortar joint immediately above or below the bottom chord connection.

Nonbearing walls also must be braced laterally by the steel joists. To brace these walls, you can extend the horizontal bridging angles and weld them to the metal plate or angle, which is connected to the wall (Figures 5 and 6). Align the extended angle with the horizontal bridging to prevent crimping in the joist chords due to wind pressure. However, if spacing between the bridging angles is in excess of 6 feet, bridging alone may not adequately transfer wind loads. In this case, you must increase the number of bracing angles.

If diagonal bridging is used for steel joists, specify a horizontal bridging connection at the end joists to brace the walls laterally. Cross-bracing these joists to the masonry is not recommended and may cause the walls to crack; when the joist deflects, loads would be induced into the cross-bracing, pulling the top connection inward while pushing the bottom connection outward, resulting in additional bonding stresses.

Conclusion

Successful design of masonry and steel requires a thorough understanding of the two materials. Numerous problems can be avoided—and successful construction can be assured—by providing well-developed and workable connection details.

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