INTEGRATING CONCRETE MASONRY WALLS WITH METAL BUILDINGS

TEK 5-5A
Details (1997)

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INTRODUCTION

Metal buildings are used extensively for warehouses and other structures requiring large, open floor spaces. This system can provide considerable design flexibility, long clear spans, and rapid construction. Part of the design flexibility comes from the ability to clad metal buildings with a variety of materials to provide different appearances or functions to the buildings. Concrete masonry walls are popular enclosure systems for metal buildings because of masonry's aesthetic appeal, impact resistance, strength, and fire resistance. The durability of concrete masonry resists incidental impacts from hand carts and forklifts, provides maximum protection in disasters such as earthquakes and hurricanes, as well as superior security, fire resistance, and noise control.

Concrete masonry walls used for metal buildings can include: exterior full-height walls, either with or without a parapet; exterior partial-height or wainscot walls; and interior bearing walls or nonbearing walls or partitions. This TEK addresses exterior full-height walls, where the concrete masonry is used as cladding over the steel frame.

Architectural concrete masonry units, such as colored, split faced, burnished, or scored units, can be used to provide an almost limitless array of textures and patterns to the walls. These units can be used for the entire facade or for banding courses to achieve specific patterns or highlight certain design aspects of the building.

A more detailed discussion of the system, along with structural design and construction considerations, is included in *Concrete Masonry Walls for Metal Buildings* (ref. 1).

DETAILS

A typical metal building clad with masonry is shown in Figure 1. Figures 2 through 6 show some typical details used for exterior concrete masonry cladding on a metal building. These details may need to be modified to meet individual design conditions.

Because of the inherent material differences between steel and masonry, careful consideration must be given to accommodating differential movement between the two materials. Typically, the masonry wall is stiff enough to transfer loads to the metal frame without deflecting significantly. Under the most extreme loading conditions, however, a lateral drift limit of $h/100$ for a ten year recurrence wind loading has been recommended for low-rise buildings with exterior reinforced masonry walls, provided that a "hinge" is detailed at the base of the wall. (ref. 2). This degree of movement in an unreinforced concrete masonry wall, however, will cause the masonry to crack. For this reason, connection details have been designed to allow the masonry to deflect without excessive cracking.

It should be noted that some designers recommend drift and deflection limits smaller than the $h/100$ criteria. For example, limits of $h/200$ for steel frame drift with a $h/600$ deflection limit for the girts have been used. These criteria should be reviewed for each design.

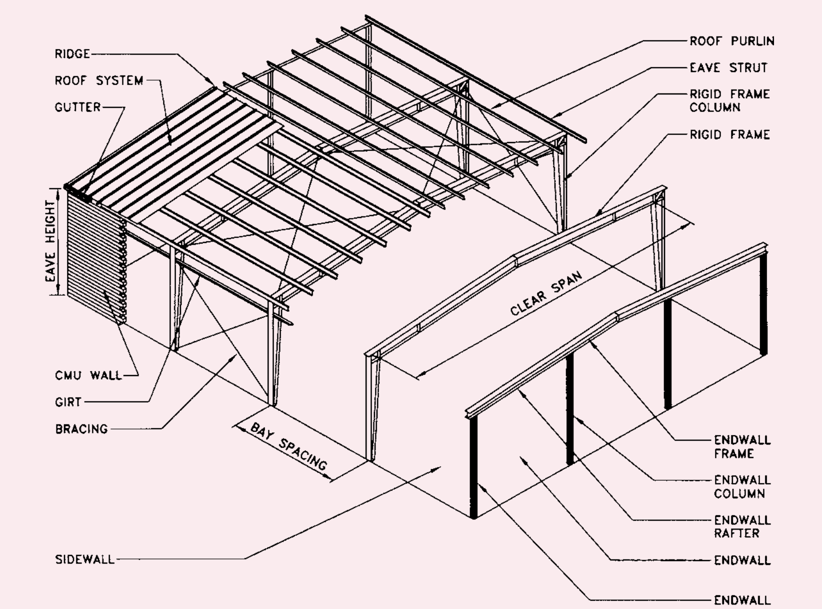

Figure 1—Typical Metal Building

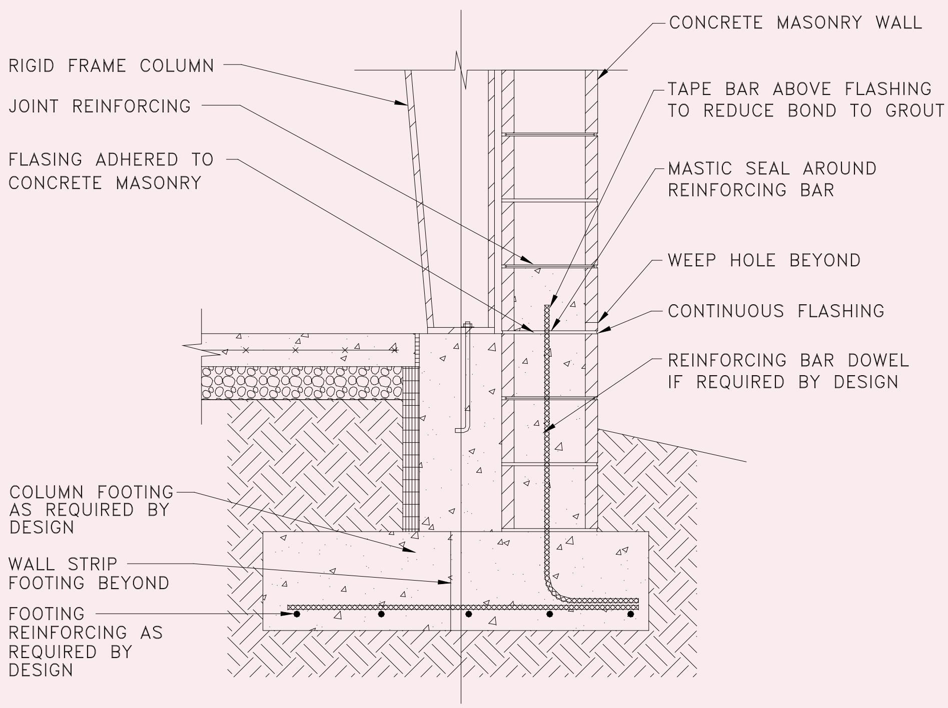

Figure 2—Base Hinge Detail, Flashing and Foundation Dowels

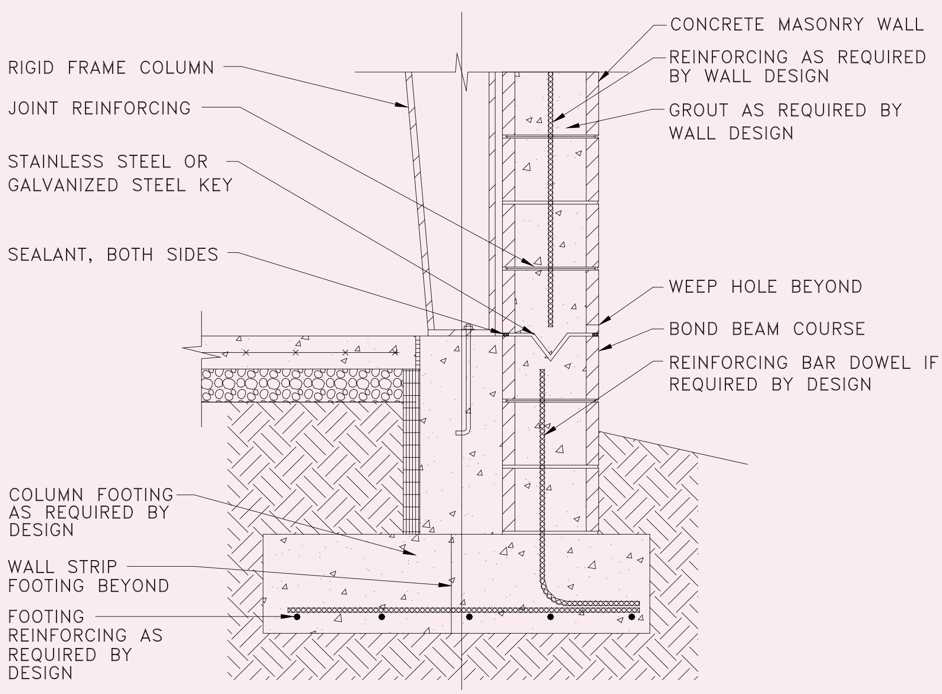

Figure 3—Base Hinge Detail, Steel Angle

Wall Base

A common method to allow for this deflection is to provide a "hinge" at the base of the masonry wall. The hinge connection allows the wall to rotate, with the metal building deflections, as a continuous panel. It is recommended that a positive shear connection be provided at the base to ensure shear loads are transferred through the joint.

Two such hinge connections are shown in Figures 2 and 3. The construction shown in Figure 2 uses through-wall flashing to break the bond at the base of the wall, and foundation dowels extended through the joint to provide shear transfer. It is recommended that the number of bars extended through the horizontal joint be minimized, and that the extension be limited to 4 in. (120 mm), to ensure that the joint will behave as assumed. Therefore, every bar does not necessarily need to be extended through the joint.

Figure 3 uses a steel key to break the bond and provide shear transfer. The key is formed by welding two plates on either side of a steel angle or by cold-forming light gage sheet steel. The use of galvanized or stainless steel is recommended for corrosion protection.

When the masonry wall is designed with a base hinge, it is important to properly detail the building corners to accommodate the movements. A vertical isolation joint should be placed near the building corner and proper consideration should be given to the masonry and steel connections at corner columns. Flexible anchors and/or slotted connections should be used.

Wainscot Walls

A partial height, or wainscot, wall is illustrated in Figure 4. These walls are commonly 6 to 8 ft (1.8 to 2.4 m) high with metal panel walls extending above them to the roof. The masonry provides strength and impact resistance for the portion of the building most susceptible

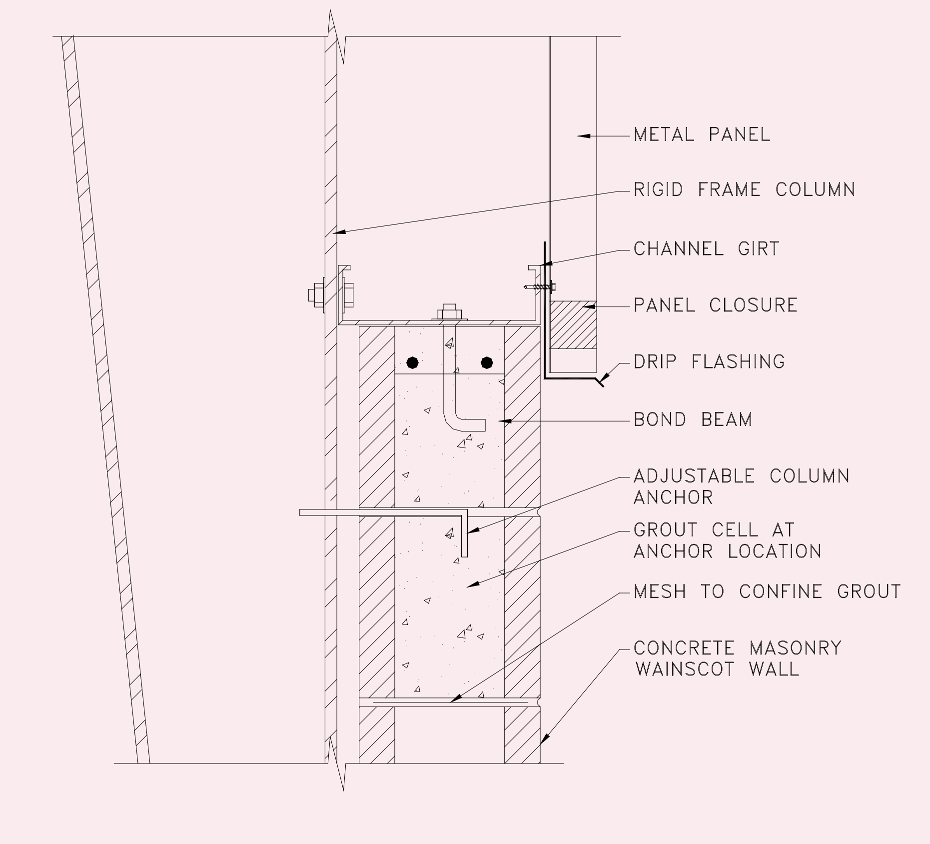

Figure 4—Wainscot Wall Detail

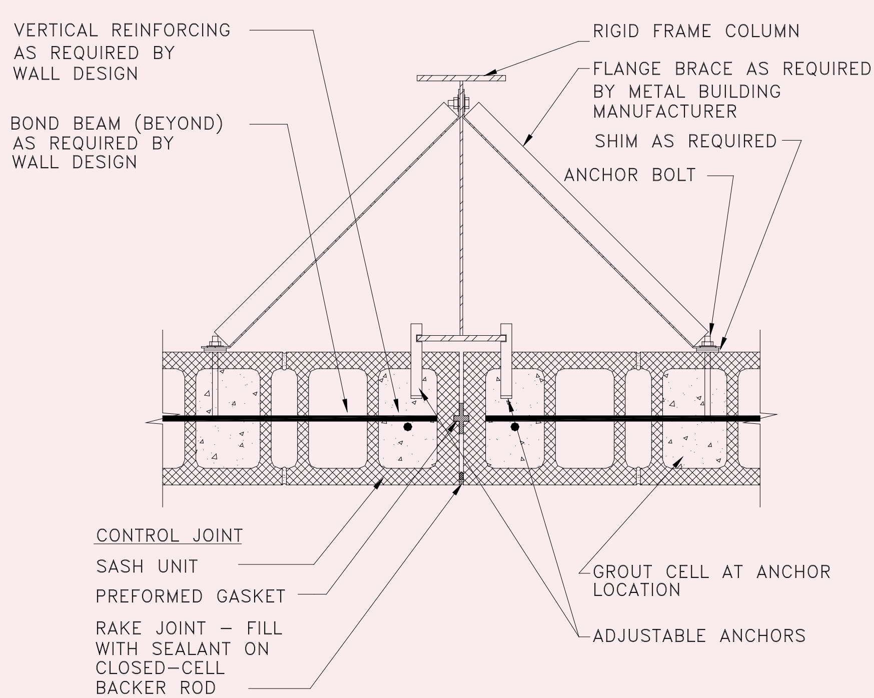

Figure 5—Column Detail

to damage. As shown, these walls span horizontally between the metal frame columns. The walls can also span as cantilevers, but significant moments may be induced by large building drifts.

Column Detail

Figure 5 shows the connection of a rigid frame column to concrete masonry sidewalls with a vertical control joint. The details show adjustable column anchors connecting the wall to the column. For walls designed to span vertically, it is good practice to provide a nominal number of anchors connecting the wall to the column to add stiffness and strength to the edge of the wall. If rigid enough, these anchors can assist in laterally bracing the outside column flange. For walls designed to span horizontally, such anchors may be adequate to transfer the lateral load reaction from the wall to the rigid frame. For larger lateral loads, more substantial connections may be required.

Girt Detail

A typical girt detail is shown in Figure 6. Girts should be placed as high as possible to reduce the masonry span above the girt, especially on walls with parapets. Depending on the rigid frame configuration used, rigid frame connection plates and diagonal stiffeners may restrict the girt location. In some cases, it may be possible to place the girt above the top flange of the rigid frame to reduce the overall height of the parapet.

Where it is not possible to place the girt high on the wall, vertical reinforcement may be required for the parapet wall. For walls spanning vertically, some or all of the reinforcing bars can be extended past the girt. For walls spanning horizontally, vertical reinforcement can be added into the parapet and should extend below the girt elevation by a length equal to the development length of the bar.

For walls designed to span vertically, a significant

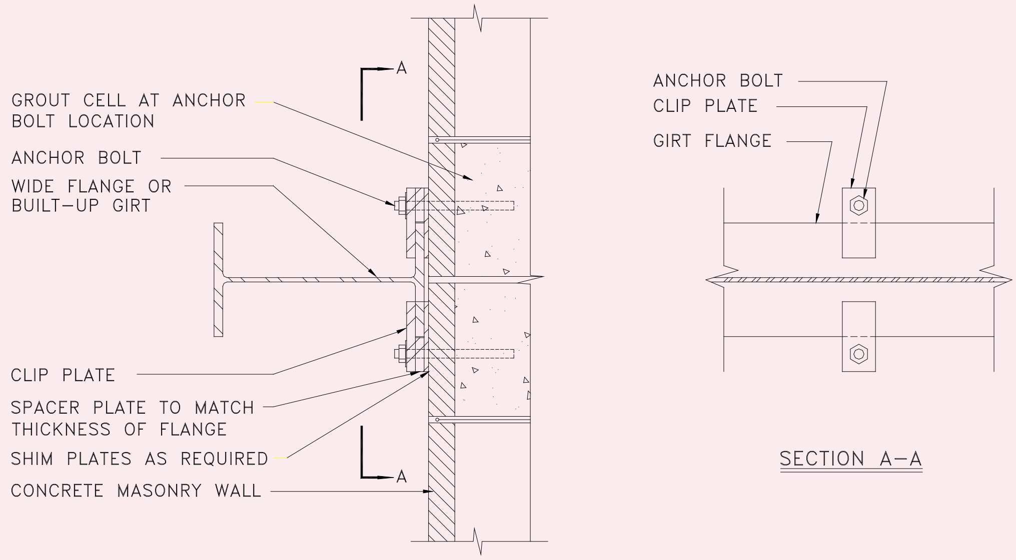

Figure 6—Girt Detail

structural steel girt consisting of a wide flange or built-up section will be required to transfer the lateral load reaction from the wall to the rigid frames. For horizontally spanning walls, a cold-formed channel or zee section can be used to add strength and stiffness to the top of the wall.

Shim plates should be used at connections between the girt and masonry to allow for camber in the girt and other construction tolerances (see Figure 6). The steel girt should never be pulled to the masonry wall by tightening the anchor bolts.

CONSTRUCTION SEQUENCE

Typically, construction of metal buildings with concrete masonry walls proceeds as follows: concrete footing placement; concrete masonry foundation wall construction to grade; concrete slab placement; steel erection; and concrete masonry wall construction.

Keep in mind, however, that this sequence may need to be modified to meet the needs of a particular project. For example, this construction sequence changes when loadbearing end walls are used. In this case, the steel supported by the masonry wall is erected after the masonry wall is in place.

Coordination between the various trades is essential for construction to proceed efficiently. Preconstruction conferences are an excellent way for the contractors and subcontractors to coordinate construction scheduling and to avoid conflicts and delays.

REFERENCES

1. *Concrete Masonry Walls for Metal Buildings*, TR 149. National Concrete Masonry Association, 1996.
2. Fisher, J. M., and West, M. A. *Serviceability Design Considerations for Low-Rise Buildings*, American Institute of Steel Construction, 1990.

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