Steel Stud Brick Veneer Wall Design

By Helen Chen and Thomas Trestain

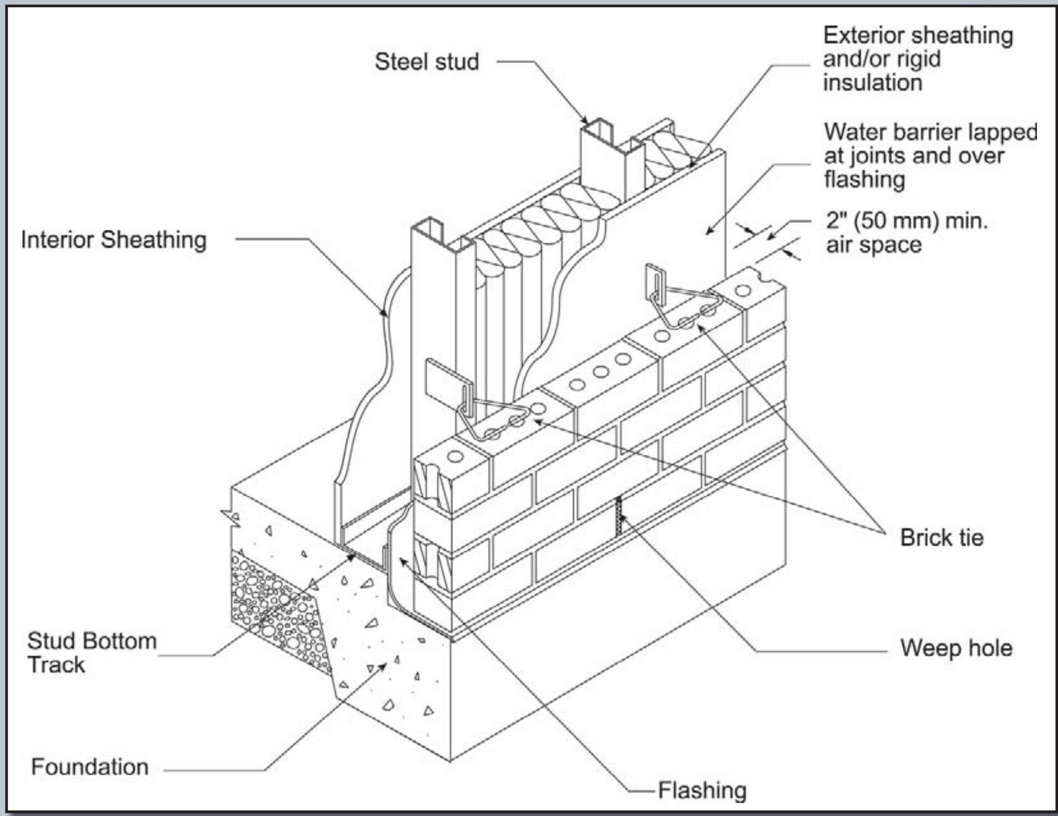

Figure 1: Steel Stud Brick Veneer Wall System

This article introduces the design and detailing recommendations provided in the recently published AISI *Steel Stud Brick Veneer Wall Design Guide* (Design Guide).

The Steel Stud Brick Veneer (SSBV) wall system provides a separation between the interior and exterior environment on low or high-rise buildings. The primary structural function is to withstand the effects of wind and earthquake, with only those loads applied perpendicular to the plane of the wall considered in the Design Guide. In addition to structural requirements, SSBV wall systems should also be capable of minimizing heat transfer and at the same time preventing moisture accumulation within the wall.

Since the SSBV wall system was introduced, a considerable body of research has accumulated which in turn has helped define good design and construction practice. The Brick Industry Association (BIA) published its Tech Notes 28B – *Brick Veneer/Steel Stud Walls in 1980*, with the latest revision in 1999. Canada Mortgage and Housing Corporation (CMHC) has sponsored a long-term research program on SSBV walls culminating in the publication of *Exterior Wall Construction in High-Rise Buildings, Brick Veneer on Concrete Masonry or Steel Stud Wall Systems in 1991*, and the more recent *Best Practice Guide Brick Veneer Steel Stud in 1996*. Based primarily on the research findings of CMHC, including the relevant structural and building science issues, AISI published the *Steel Stud Brick Veneer Design Guide* in 2003, which provides general design and detailing guidelines for SSBV wall systems.

Steel Stud Back-Up System

A steel stud back-up system typically includes steel stud framing, interior and exterior sheathing, air barrier, vapor/moisture barrier and insulation. The system provides structural support, and resists air and moisture intrusion.

Steel Stud Framing

Due to a significant difference in flexural stiffness of brick veneer and the steel stud, the brick veneer is likely to crack under the design load. As a result of this cracking, the steel stud back up system should be designed to resist the full wind and/or seismic load, with any flexural contribution from the brick veneer ignored. Note that the steel stud is usually not designed to carry the weight of brick veneer, even if the steel stud wall is designed as a gravity load-bearing wall. The brick wall normally bears its weight directly on the concrete slab/foundation wall, or on the steel shelf angles at each story level connected directly to the building frame.

As a structural system, the steel stud framing should be designed in accordance with the *North American Specification for the Design of Cold-Formed Steel Structural Members* (NA Specification) published by AISI. Two design approaches are used in steel stud wall design: (1) all steel design, and (2) sheathing braced design. The all steel design approach ignores the structural contribution of wall sheathings (such as drywall), and requires that the stud walls be laterally and torsionally braced by either channel or strap bridging. The necessary design requirements are provided in the NA Specification Section D4, *Wall Studs and Wall Stud Assemblies*. The sheathing braced design approach relies instead on the attached sheathings to provide lateral and torsional bracing to the studs. The sheathing braced design approach should follow the soon to be published AISI Standard, *Cold-Formed Steel Framing – Wall Stud Design*. A review paper on this standard has been published on April 2004 edition of this magazine.

Flexural cracking of the brick veneer is treated as a serviceability limit state. To control the brick veneer crack size, the lateral deflection of the steel stud under the wind or seismic load should be limited to L/600 as per Brick Industry Association's Technical Notes 28B – *Brick Veneer /Steel Stud Walls*.

From the durability standpoint, all exterior structural steel stud supporting brick veneer should be protected with a minimum of G60 galvanized coating or equivalent, and the base metal thickness should be at least 0.0451-inches (43 mil). For more information on the structural design of steel stud framing, readers may refer to AISI *Cold-Formed Steel Framing Design Guide*, which provides a number of practical design examples for typical stud wall framing.

Brick Ties

Brick ties should be designed to transfer the lateral load between the brick veneer and the steel studs. Based on research studies and the relative stiffness of the steel stud and the brick veneer (see the Design Guide for details), it is recommended that each tie be designed to resist the lateral load on 40% of the stud tributary area, but not less than twice the tributary load for an individual tie. For example, the tie design load = the larger of { (40%)(25psf)(1.33 ft)(12 ft), or (2 times)(25 psf)(1.33 ft)(2.00 ft) }= 160 pounds for the following condition:

Design wind load=25 psf
Stud spacing = 16-inches
Stud span=12-feet
Tie horizontal and vertical spacing=16-inches and 24-inches, respectively

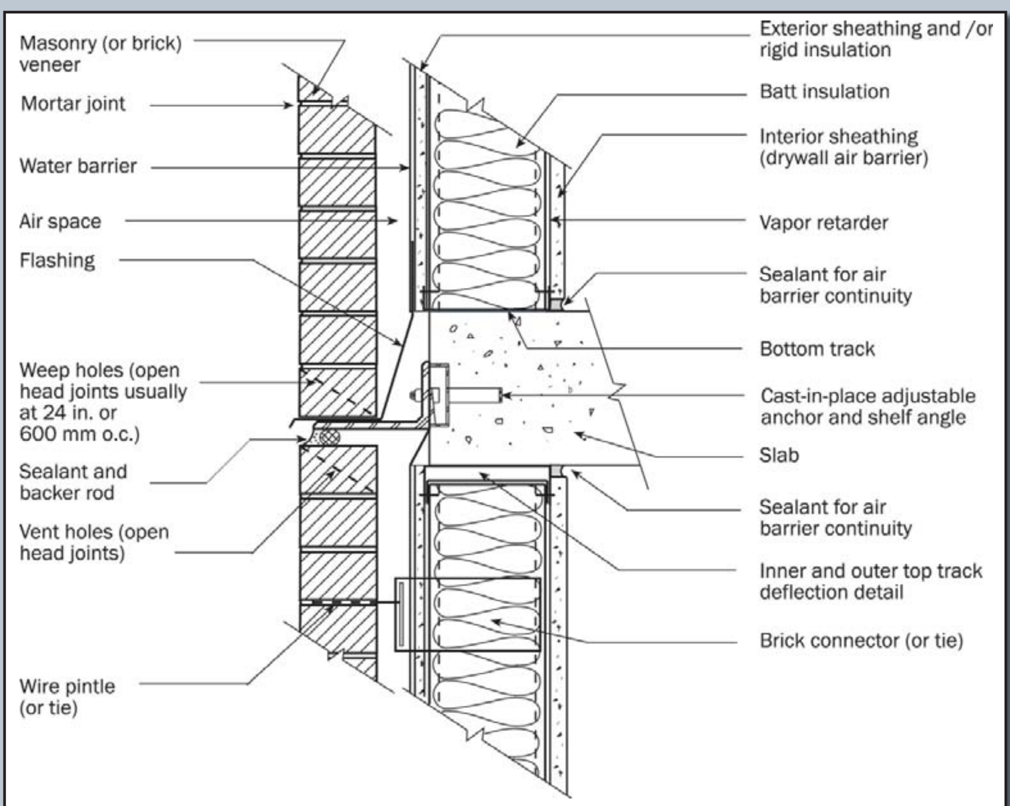

Figure 2: Typical Detail with Drywall Air Barrier in Cold Climate Construction

To control brick veneer crack size (in addition to the L/600 deflection limit), the maximum total free play for ties should be limited to 0.05-inches, and the tie deflection should not exceed 0.05-inches under a 100-lb load (tension or compression). For corrosion protection, the ties should be hot-dip galvanized after fabrication, as a minimum. To avoid mortar and moisture accumulations, ties with small horizontal projection area are preferred. In addition, it is preferred to connect the ties directly to the steel studs without relying on the compressive strength of the exterior sheathings – particularly those sheathings that do not have adequate long-term compressive strength and stiffness. Lastly, for connection of the tie to the stud, it is preferred to avoid sheet metal screws in pull-out in the outside flange of the stud since this type of connection may be susceptible to failure through corrosion.

For additional information about tie selection, readers may refer to Brick Industry Association's Tech Notes 44B – *Wall Ties for Brick Masonry*, to the CMHC documents referenced above and to the Design Guide.

Wall Detailing

The Design Guide provides detailed explanations on the causes of water penetration, the functionality of air barriers and vapor barriers, and the different building science requirements for buildings in cold and warm climates. This knowledge is very helpful for providing wall details that function properly and effectively over the long-term.

Water Penetration

Brick veneer walls leak, and they leak more in the presence of a positive pressure difference between the exterior and the air space behind the brick veneer. This pressure difference has the effect of driving rainwater from the outside surface of the brick through any cracks and construction defects in the veneer into the air space. To help control this leakage, the Design Guide proposes the adoption of the rainscreen design principal. The goal of this approach is to minimize the air pressure differential across the brick veneer, and to this end a number of design and detailing recommendations are provided in the Design Guide. As noted in the Design Guide, even with perfect pressure equalization, some leakage through the brick veneer should be anticipated and effective flashings, weep holes and water barriers on the exterior of the stud wall are required. Steel parts also require corrosion protection.

Air Barriers and Vapor Retarders

An essential element of rainscreen design is an effective air barrier. The air barrier is the element in the wall that resists the pressure difference between the outside and the inside of the building, and thus controls air flow through the entire wall assembly. This pressure difference is due to wind, mechanical pressurization and the stack effect in higher buildings. The interior drywall is commonly used, and is both an economical and effective air barrier.

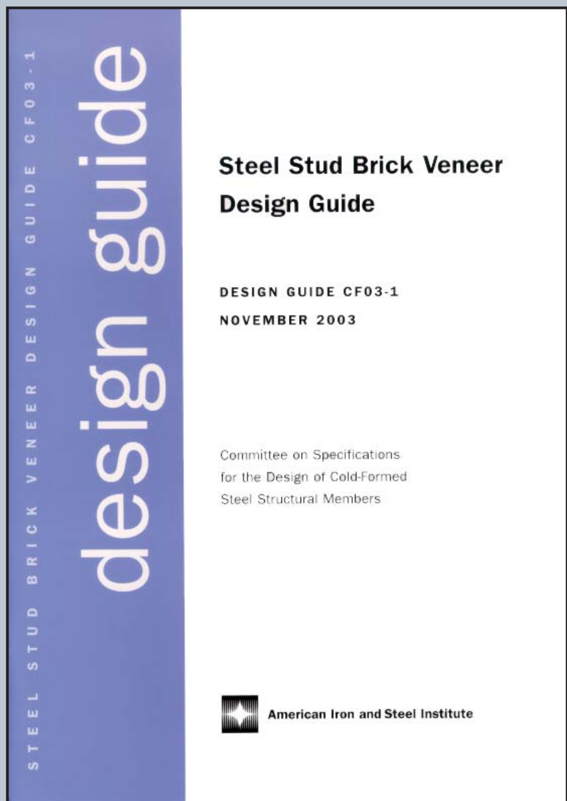

Figure 3: AISI Cold-Formed Steel Stud Brick Veneer Design Guide

In contrast, a vapor retarder (or barrier) is only used to control the diffusion of water vapor. The vapor retarder should be installed on the warm side of the stud wall to minimize moisture diffusion into the steel stud space. It should be noted that although the air barrier and the vapor barrier function differently, some materials could be used for both. The placement of the air and vapor barriers depends on the direction of the air and moisture flow through the wall system. Further discussion is provided in the next section.

Climate Consideration

Sound wall detailing should also consider the affects of climate on the SSBV wall system. During the winter period in cold climate, the transfer of warm, humid interior air through the SSBV wall system is a particular concern, and locating both the air barrier and the vapor retarder on the inside face of the stud wall is preferred. Further, to minimize the potential for condensation in the stud space (due to exfiltrating air), it is recommended that a minimum of 1-inch rigid insulation be installed on the outside face of steel stud wall. In any case, moisture accumulation in the stud space should be anticipated and drying potential though the outside face of the stud back-up wall should be maintained with adequate vapor permeability through the exterior sheathing.

In warm climate, the design concern is essentially the reverse of the one in the cold climate situation. During summer months in an air-conditioned building, the warm and humid air flows from the air space behind the veneer to the inside of the building through the steel stud back-up. In this case, the air barrier and the vapor retarder should be installed on the outside face of the steel stud wall, with drying potential via vapor diffusion though the interior sheathing. Any vapor retarder installed on the inside face of the stud wall would, therefore, be undesirable. *Figure 2* shows a recommended typical wall cross-section in cold climate.

Other Information

The article summarizes the design recommendations provided in the recently published AISI *Steel Stud Brick Veneer Wall Design Guide*. For structural design requirements of steel stud walls, readers may refer to a companion document, *Cold-Formed Steel Framing Design Guide*, published by AISI. All AISI publications can be ordered via AISI website **www.steel.org**.▪

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