Building Codes for Masonry Veneer

By J. Gregg Borchelt, P.E.

One of the most popular uses of masonry is as a veneer. This application takes advantage of the design flexibility, color, texture, and durability inherent with masonry (*Figure 1*). Building codes provide the basic requirements for this construction. Since it seems like a straightforward approach, the veneer "design" is often accomplished by the architect with little input from the structural engineer. There are several conditions that require the input of the structural engineer.

Figure 1: Train station with brick veneer (courtesy Ryan-Biggs Associates/James J. Shaughnessy)

Veneer or Not Veneer?

The backing of veneer may be concrete, masonry, or framing made from wood or steel studs. Examples of several of these wall systems are shown in *Figures 2* through *4*. According to code definitions, the masonry portion of the assembly that is the veneer does not contribute to the structural capacity of the wall (*see Sidebar on page 57*). This article covers only anchored veneer, the most common type.

A wall with brick exterior wythe and a concrete masonry (cmu) interior wythe separated by an air space may be either of two wall types. It may be an anchored masonry veneer with a masonry backing or a non-composite multi-wythe masonry wall (cavity wall). While there is no apparent difference in materials or construction, there is a difference in the design used. If the designer intends a veneer with cmu backing, loads and stresses must be considered in just the concrete masonry wythe. If the designer intends this assembly to be a cavity wall, the designer must assign loads to and consider the stresses developed in both wythes. It is the choice of the designer as to how such a wall is classified.

If the wall is a cavity wall there is an additional requirement. The designer must specify a compressive strength for the exterior wythe. The contractor must provide data to show that the specified compressive strength of both wythes is met.

In most instances, it is more conservative to assume that this is a veneer wall. For design purposes, all lateral loads are then resisted by the concrete masonry. In fact some of the load will be resisted by the veneer, reducing the flexural stress in the cmu. The cmu wythe is typically thicker and stiffer than the brick wythe, and thus attracts more of the load. Concrete masonry is typically made of hollow units, which have a lower design flexural tensile stress than solid brick with the same mortar type. The brick wythe will typically have a higher compressive strength, and thus a higher shear strength than the cmu. Thus, the cmu wythe is the critical element in design in both wall systems.

Building Code Requirements for Anchored Veneer

Building Code Requirements for Masonry Structures (MSJC)

This national building code introduced its veneer chapter in the 1995 edition. The assumptions, design methods and content have remained nearly the same, but with minor changes introduced as the MSJC code was updated in 2002 and 2005.

Chapter 6, *Veneer*, of the MSJC contains several requirements that must be met for all veneers:

1. The exterior of the backing must provide resistance to water penetration.
2. Flashing and weep holes in the exterior veneer wythe must be present to drain water.
3. The veneer must be designed to accommodate differential movement.

There are two methods by which to design anchored veneer: prescriptive and rational.

The prescriptive requirements are limited to use in locations where the basic wind speed does not exceed 130 mph (209 km/hr) as given in ASCE 7-02. The remainder of the prescriptive requirements for anchored veneer is just that, a series of requirements that provide limits on:

- Vertical support of the veneer,
- Veneer height,
- Support of veneer over openings,
- Anchor materials and sizes,
- Anchor spacing,
- Maximum wall area per anchor,
- Anchor embedment in mortar,
- Types of anchors to be used with the various backing materials, including the distance between the inside face of the veneer and structural surface of the backing,
- More stringent requirements in Seismic Design Categories C through F, and
- More stringent requirements in locations with basic wind speed from 110 to 130 mph (177 to 209 km/hr).

The rational design method, identified as the Alternative Design of Anchored Masonry Veneer, provides engineering principles that must be followed. There is little specific information on the design procedure to be used. The Code requires that:

1. Loads shall be distributed through the veneer to the anchors and the backing using principles of mechanics.
2. Out-of-plane deflection of the backing shall be limited to maintain veneer stability.
3. All masonry in the wall system, other than veneer, shall be designed by one of the other design chapters in the MSJC Code.

continued on next page

Figure 2: Anchored brick veneer with concrete masonry backing and insulation

4. The veneer is not subject to the flexural tensile stress limits of Allowable Stress Design or the nominal flexural tensile strength limit of Strength Design.
5. Compressive strength of the masonry in the veneer is not specified.
6. The scope of Chapter 6 applies.
7. Veneer laid in other than running bond must have joint reinforcement of at least one wire, of size W1.7 (MW11), spaced at a maximum of 18 inches (457 mm) on center vertically.
8. The additional seismic provisions for veneer apply.

International Building Code

The MSJC Code is included by reference in the International Building Code, beginning with the 2000 version. The IBC does make some changes and additions to the MSJC veneer chapter. Fortunately for structural engineers, none are of a structural nature. The IBC exempts anchored masonry veneers from the dimensional tolerances of the MSJC specification.

The IBC also includes requirements for anchored veneer made from stone laid in mortar, slab-type stone and terra cotta.

Recent Code Changes

Changes to the Veneer chapter of the *Building Code Requirements for Masonry Structures* from the 2002 to the 2005 edition are of interest to designers. In this transition, the following changes were made.

MSJC Veneer Code Changes

Several Seismic Design Provisions were moved up to one higher level of seismic activity. Supporting the weight of anchored veneer for each story independent of other stories, and the inclusion of continuous single wire joint reinforcement of wire size W1.7 (MW11) at a maximum spacing of 18 inches (457 mm) on center vertically, were instituted in SDC E, not SDC D.

A new section that permits the use of prescriptive design of anchored veneer in locations where basic wind speed is from 110 to 130 mph (177 to 209 km/hr) was added. This provision increases the frequency of the anchors by reducing the wall area per anchor to 70% of that in lower wind speed areas. The reduction in anchor frequency was based on the square of the ratio of basic wind speeds (110/130). Further, the maximum horizontal and vertical spacing of the anchors is 18 inches (457 mm). In lower wind areas, the horizontal spacing is 32 inches (813 mm). Also, the anchors required around opening are spaced at 24 inches (610 mm), not 36 inches (0.91 m), on center.

IBC Veneer Code Changes

Not all of these changes were accepted by the International Code Council. The change to move the seismic design requirements from SDC D to SDC E were not approved. When this change to the MSJC was not accepted the result in the 2006 IBC will be that, in SDC D, veneer anchors will have to be mechanically attached to the joint reinforcement and the weight of the veneer will have to be supported at each floor.

Anchored Veneer Design Tips

- Use the prescriptive requirement for the design of anchored masonry veneer where the basic wind speed is less than 130 mph (209 km/hr).
- Design the backing for the full lateral load.
- Design steel stud backing to a maximum deflection of its span length divided by 600. This will not preclude flexural cracking of the veneer.
- Investigate the deflection of the shelf angle and its support. The MSJC Code limits the deflection of the floor supporting anchored veneer to its span length divided by 600 or 0.3 inches (7.6 mm).
- Shelf angles to carry the weight of the veneer are not always required or recommended. Shelf angles are only required if the backing is wood or steel stud framing and over 30 feet (14.1 m) tall. If the backing is concrete masonry or

Figure 3: Concrete backing with dovetail slots to receive brick veneer anchors

concrete, consider supporting the weight of the veneer on the foundation rather than on shelf angles. Differential movement between the frame and the veneer, between the veneer and elements that are attached to it, and between elements that are attached to the frame and pass through the veneer must be considered.

- If shelf angles are used, include them to carry the weight of the veneer for each floor. This does not mean that the support must be at the floor line.

Summary

Anchored masonry veneers constructed to the prescriptive requirements of the MSJC have performed well. The inclusion of these requirements to areas with wind speeds up to 130 mph (209 km/hr) makes them more useful.▪

Mr. Borchelt is the Vice President, Engineering and Research, for the Brick Industry Association in Reston Virginia and serves as the chairman of the subcommittee that has charge of the veneer chapter of Building Code Requirements for Masonry Structures.

Figure 4: Steel stud backing for anchored brick veneer

Masonry Definitions

Virtually all codes define masonry veneers in a similar manner. The MSJC Code uses the following:

Veneer, adhered – Masonry veneer secured to and supported by the backing through adhesion.
Veneer, anchored – Masonry veneer secured to and supported lateally by the backing through anchors and suported vertically by the foundation or other structural elements.
Veneer, masonry – A masonry wythe that provides the exterior finish of a wall system and transfers out-of plane load directly to a backing, but is not considered to add load resisting capacity to the wall system.

The 2003 International Building Code uses:

Adhered Masonry Veneer – Veneer secured to and supported through the adhesion of an approved bonding material applied to an approved backing.
Anchored Masonry Veneer – Veneer secured with approved mechancal fasteners to an approved backing.
Veneer – A facing attached to a wall for the purpose of providing ornamentation, protection, or insulation, but not counted as adding strength to the wall.

References

Building Code Requirements for Masonry Structures, ACI 530-05/ASCE 5-05/TMS 402-05, The Masonry Society, Boulder, CO, 2005.

Specifications for Masonry Structures, ACI 530.1-05/ASCE 6-05/TMS 602-05, The Masonry Society, Boulder, CO, 2005.

International Building Code, 2000 and 2003 editions, International Code Council, Country Club Hills, IL, 2002.