TEK NOTE

December 2000

Design of Concrete Masonry Veneer for Crack Control

This technical bulletin discusses the application of concrete masonry units in anchored veneer construction in the Pacific Northwest. Concrete masonry can provide a durable aesthetically pleasing exterior facade for a variety of building types. This bulletin focuses on the control of non-structural cracking of concrete masonry veneer to maintain the appearance and water resistance designed.

Cracking in buildings and building materials results from restrained movement. The two primary causes of movement of concrete masonry are temperature change and change in moisture content. In most cases, movement of building materials is inevitable, and must be controlled if cracking is to be prevented.

Temperature change causes all commonly used building materials to expand and contract. Veneer construction is more susceptible to large temperature differentials due to its isolation from the conditioned space. Where materials of different thermal characteristics are used together in construction, the design should account for potential differential movement.

Concrete masonry, as any concrete product, is subject to shrinkage due to drying. Linear shrinkage of block is controlled by ASTM Standard Specification C-90 (ref.1), which places a limit on the maximum drying shrinkage percentage permitted. In the Pacific Northwest, it is recommended for block veneer that the block density be medium weight. A partially cored unit is preferable to a solid unit.

Keeping the concrete masonry veneer as dry as possible will minimize moisture movement. During construction, in inclement weather, walls should be covered at the end of the workday. A mortar providing good bond strength and workability should be specified. Portland cement-lime mortar, Type N by proportion, is adequate for veneer and aids in water resistance. Use tooled mortar joints when possible.

The wall should be sealed when completed with either a clear siloxane sealer or an opaque elastomeric coating. If a clear sealer is used, an integral water-repellent admixture should be specified for both the block and the mortar when designing a project in Western Oregon or Washington. Specifying proper veneer details including flashing and weep holes will ensure that any water penetrating the veneer will be diverted back to the exterior.
Control joints should be designed into the block veneer system to relieve tensile stresses by reducing restraint and permitting longitudinal movement. A panel length to height (aspect) ratio of 1.5 is recommended for spacing of control joints. (See Figure 1.) The maximum panel length (control joint spacing) recommended for concrete masonry veneer is 26 feet.

Brick has different movement properties than concrete masonry. Where bands of clay brick are included in the veneer design they should be considered as restraints, changing the aspect ratio. (See Figure 2.) If H_1 is less than 10′, place joint reinforcement in every course and use a modular spacing of control joints near 16′.

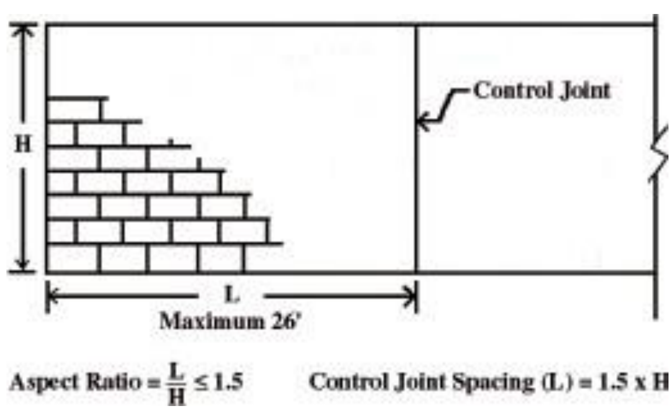

Figure 1. Control Joint Spacing
(for walls without openings or elevation changes)

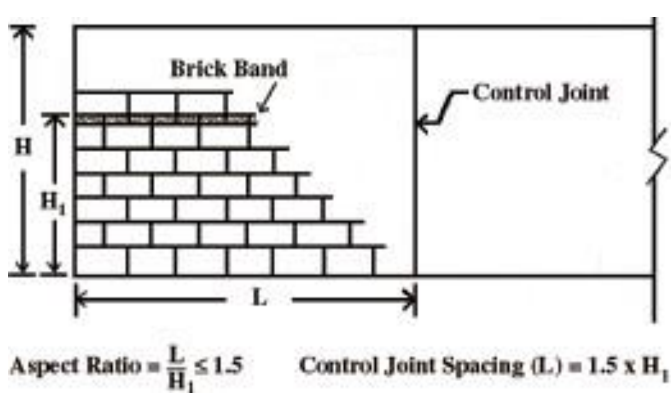

Figure 2. Control Joint Spacing
(for walls with clay brick accent bands)

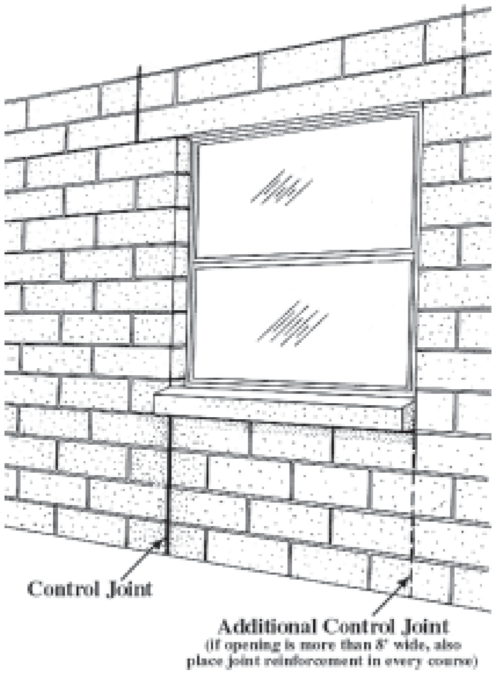

Figure 3. Control Joint at Window Opening

In addition to spacing control joints based upon wall aspect ratio as discussed previously, it is recommended to provide joints at locations of stress concentration such as:

1. At wall openings (see Figure 3);
2. At changes in wall height;
3. At movement joints of foundations or other structural support elements; and
4. Adjacent to wall corners or intersections within a distance qual to half the control joint spacing.

Horizontal joint reinforcement embedded in mortar aids in the control of cracking by increasing the tensile strength of a wall. It is recommended in Control Joints for Concrete Masonry Walls (Ref. 2) that the minimum equivalent area of reinforcement be 0.25 in^2/ft. of height. This reinforcement area equates to 9 gauge ladder-type joint reinforcement at 16 in. on center. In high seismic areas, the use of joint reinforcement can be combined with the requirement for the wall tie/anchor to "engage" a horizontal joint reinforcement wire. Joint reinforcement should be discontinuous at a control joint as illustrated in Figure 4.

The criteria for structural design and code compliance of concrete masonry veneer systems needs to be considered and is found in the Uniform Building Code (Ref. 3). The veneer ties should be corrosion resistant, and capable of transferring horizontal loads to the structural system. Corrugated metal ties are not recommended. All ties should be securely attached to the backup. The structural backup should be designed to provide adequate stiffness.

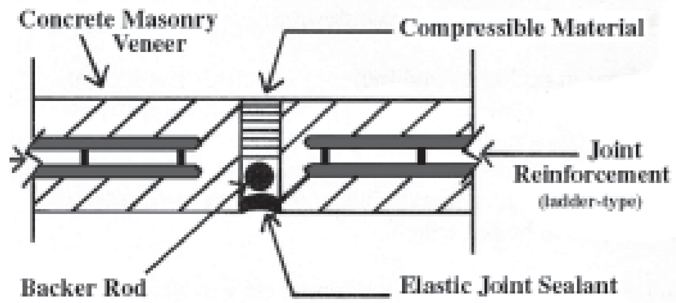

Figure 4. Typical Control Joint

The maximum deflection that should be permitted for the backup when considered alone at full lateral design load is recommended to be L/600 to L/720. Reinforced concrete masonry is an excellent backup wall for veneer. Its physical properties are identical to the concrete masonry veneer thereby eliminating differential movement. In addition, it provides a stiff backup with deflection amounts well below the recommended maximum limits. Two National Concrete Masonry Association technical bulletins (Ref. 4 and 5) provide additional design information.

The information and recommendations contained in this technical note are based upon available data and on the experience of the masonry industry. This material is intended for use by professional personnel competent to evaluate the significance of limitations of the recommendations, and who will accept responsibility for its application.

REFERENCES:

1. *Standard Specification for Loadbearing Concrete Masonry Units*, ASTM C-90-00. American Society for Testing Materials, 2000.
2. *Control Joints for Concrete Masonry Walls*, TEK 10-2A. National Concrete Masonry Association., 1998.
3. *Uniform Building Code*, Chapter 14. International Conference of Building Officials, 1997.
4. *Concrete Masonry Veneers*, TEK 3-6A. National Concrete Masonry Association, 1995.
5. *Structural Backup Systems for Masonry Veneer*, TEK 16-3A. National Concrete Masonry Association

Guide Specification

Concrete masonry units shall conform to ASTM C-90-00. Linear Shrinkage shall not exceed 0.065 percent. Unit density to be 115 pcf or greater.

Joint reinforcement shall conform to ASTM A-951 with wire conforming to ASTM A-82. Coating shall be in conformance with ASTM A-153, Class B-2 for exterior walls.

Northwest Concrete Masonry Association
19109 36th Avenue West, Suite 211
Lynnwood, WA 98036-5767
(425) 697-5298
www.nwcma.org