Glazed clay masonry units are the most precisely sized masonry products, and are often used to provide easily cleanable surfaces in hospitals and food handling or preparation areas. Since mortar absorbs stains, odors, and bacteria more easily than the glazed unit surface, joint widths must be kept to a minimum, which means that unit sizes must be closely controlled.

Concrete block dimensional variations are covered in ASTM C90 and C129 for loadbearing and non-loadbearing units, respectively. For both types, the standards permit a maximum size variation of $\pm^1/_8$ in. from the specified standard dimensions (defined as the "manufacturer's designated dimensions").

Although there are no industry-wide standards for dimensional variation of cut and dressed limestone, the Indiana Limestone Institute publishes dimensional tolerances for several different types of finishes (refer to Chapter 5). For granite, the National Building Granite Quarries Association publishes recommended tolerances (refer to Chapter 5). For marble, the Marble Institute of America recommends fabrication tolerances based on the thickness of the panels (refer to Chapter 5). For thin stone curtain walls constructed with sealant joints instead of mortar, dimensional variations are critical to the proper performance of the sealant.

15.5.2 Mortar Joints

Unit masonry size tolerances are accommodated by varying the thickness of the mortar joints. Modular units are designed to be laid with standard $^3/_8$-in. joints. The Masonry Standards Joint Committee (MSJC) *Specifications for Masonry Structures* (ACI 530.1/ASCE 6/TMS 602) sets allowable variation in joint thickness based on the structural performance of the masonry (*Fig. 15-61*).

Aesthetic rather than structural requirements govern tolerances for non-loadbearing masonry veneers. These tolerances will vary according to the type of units specified and the dexterity and skill of the mason. For example, Type FBX brick can be laid with the most uniform joint thickness because the unit size tolerances are very tight. This characteristic lends itself to stack bond patterns where alignment of the head joints is critical to appearance. Usually, all of the units in a shipment are either over- or undersized, but not both, so the *range* of variation will be smaller and the joint width more consistent. Type FBA brick will require considerable variation in joint thickness because of the greater unit size variations, but this is part of the charm and the reason for the popularity of this brick type.

15.5.3 Sealant Joints

The proper extension and compression of sealants and the performance of sealant joints in maintaining a weather seal are dependent on correct joint

Joint	Allowable Tolerance (in.)
Bed joint	± 1/8
Head joint	- 1/4 to + 3/8
Collar joint	- 1/4 to + 3/8

Figure 15-61 Field tolerances permitted by code for masonry mortar joints.

size and shape. Stone panel size tolerances are accommodated by variations in the width of the sealant joints, and expansion and control joints in unit masonry construction are affected by unit size tolerances. ASTM C1472, *Guide for Calculating Movement and Other Effects When Establishing Sealant Joint Width,* contains a complete set of tables for calculating sealant joint sizes. Once you have calculated combined thermal and moisture movement and added a factor of safety for construction tolerances, you can adjust joint size to change joint spacing, or adjust joint spacing to change joint size. The fewer joints you provide in a building facade, the wider they must be to equal or exceed the total calculated movement. The more joints you provide, the narrower they may be—up to a point.

Elastomeric sealants require a minimum joint width of $^1/_4$ in. for proper extension and compression. While $^1/_4$-in. joints are achievable in some types of stone panel construction, allowable tolerances in masonry unit and joint sizes make narrow joints impractical to achieve in the field. A more realistic minimum for sealant joints in unit masonry construction is $^3/_8$ in. to match the width of the mortar joints.

15.5.4 Connections

Structural frame tolerances are based on structural performance, accidental eccentricities, and member-to-member connection methods. Tolerances for cladding such as masonry veneers are based on stability, method of anchorage, and aesthetic perceptions. Allowable tolerances for concrete and steel structural frames are much greater than for the masonry panels, curtain walls, or veneers attached to them.

Allowable construction tolerances are much greater for concealed concrete and steel structural frames than for exposed cladding systems such as masonry veneer. *Figure 15-62* shows the differences in out-of-plumb tolerances for steel frame, concrete frame, and brick veneer. Where exposed veneer is permitted only $^1/_2$-in. latitude in either direction, the frames to which it must be connected may vary 2 to 4 times that much. Although the cast-in-place concrete tolerances shown are much more restrictive than those for steel, the few field studies that have been done indicate that the steel tolerances are more realistic in their relationship to actual field construction (*see Fig. 15-63*). Conflicts between structural frame and masonry veneer tolerances affect anchor embedment, support at shelf angles, and flashing details.

When a masonry veneer or curtain wall is attached to a structural frame that is alternately recessed or projected, the adjustments necessary to maintain a plumb line across the facade must be taken up in the anchorages. Different anchor lengths, however, create variable conditions of stiffness, deflection, and load transfer across a building elevation or throughout its height. Varying clearances between the edge of a slab or beam and the back of a curtain wall or veneer also affect the size and placement of thermal insulation, sprayed fireproofing, and fire-safing insulation.

A steel shelf angle with a 5-in. horizontal leg is usually adequate to span a 2-in. cavity width and support a single wythe of 4-in. modular brick veneer. If vertical and/or lateral displacement of the slab or beam to which the shelf angle is attached causes misalignment of the veneer surface, extreme measures are sometimes taken in an attempt to maintain the veneer alignment within its tolerances (*see Fig. 15-64*). Some contractors have been known to cut the brick or the shelf angle leg, or even to chip back