Building Code Requirements for Masonry Structures (Code) and Specification for Masonry Structures (Specification) are documents written and maintained by the Masonry Standards Joint Committee (MSJC). These documents are adopted by reference in the International Building Code (IBC), which is a model building code. Conformance to the IBC model building code is required by law when a jurisdiction adopts the model building code, and it becomes law in that jurisdiction. For example, Michigan has adopted and packed the IBC (with minor alterations) as the Michigan Building Code.

The Code, Specification and IBC are all updated on a three-year cycle. The Code and Specification, other documents adopted by reference in the IBC, are typically published one year earlier than the year of the updated IBC publication. Thus, the 2009 edition of the IBC references the 2008 editions of the Code and Specification.

This article will review some of the significant changes in the 2008 Code and Specification, relative to the 2005 editions of those documents. Knowledge of these changes will be vital as jurisdictions adopt the 2009 IBC, expected by early 2011.

Learning Objectives
Upon reading the article you will be able to:
1. Explain the general reasoning behind changes to the numerous sections of Code and Specification
2. Summarize changes to the 2008 Code and Specification made, including those to Empirical Design provisions
3. Name the parties involved in writing and maintaining the Code, organizations who sponsor the writing and maintenance and how the MSJC Code and Specification is applied to the larger context of building codes

Changes in the 2008 MSJC Code and Specification

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Change in Document Designation
The MSJC is so named because it is sponsored by three professional organizations: American Concrete Institute (ACI), American Society of Civil Engineers (ASCE) and The Masonry Society (TMS). Since the 1992 editions of the Code and Specification, the documents authored by MSJC have been designated as ACI 530/ASCE 5/TMS 602 and ACI 530.1/ASCE 6/TMS 602, respectively. ACI was listed first in the document designations because ACI was the organization that took the lead in administering the activities of the MSJC. Both ACI and ASCE were American National Standards Institute (ANSI) accredited organizations, but TMS was not. The ANSI accreditation signifies that the organization operates its committees that produce documents in such a way that meets the ANSI requirements for generating consensus standards. Some of the ANSI requirements include balance of committee membership among producers, users, general interest and regulatory representation; a formal process for reviewing and processing proposed documents as well as changes to those documents; an internal technical review of proposed documents; and a process by which the public can review and comment on proposed consensus documents.

TMS recently received ANSI accreditation and took over the lead in administering the activities of the MSJC. In recognition of the change in the way the three professional organizations sponsor the MSJC, the designations of the documents authored by the MSJC were revised to TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530.1/ASCE 6. The document designation change gives credit to TMS as the lead organization and gives the masonry industry recognition of their self-sufficiency.

Self-Consolidating Grout
One of the most exciting changes to the MSJC Specification is the provision that permits the use of self-consolidating grout (SCG) to fill unit cores and to surround steel reinforcing bars. Use of SCG will have a significant impact on the industry because, unlike conventional grout, SCG does NOT have to be consolidated (by vibration) and reconsolidated. It has remarkable flow characteristics that permit filling of remote and small spaces, even those “around the corner” from the point of grout placement.

At the time of publication of the 2008 MSJC Code and Specification, an ASTM standard for SCG did not exist. Therefore, the MSJC had to develop material requirements for SCG, as well as installation requirements. Whereas conventional grout may be specified by either proportions or by strength, SCG is only specified by strength. Per the Specification, properties that must be evaluated include compressive strength, slump flow and visual stability index. Materials used in SCG must conform to ASTM C476, the standard for conventional masonry grout.

SCG is not permitted to be proportioned at the project site. It is typically provided...
as a ready-mix, but the dry materials may be delivered (pre-blended) to the site, where water is added. When delivered as a ready-mix, water should not be added at the site except in accordance with the manufacturer’s instructions.

SCG, in combination with aerated autoclaved masonry (AAC), has not been researched. Therefore, if SCG is to be used with AAC, a grout demonstration panel is required to prove that satisfactory filling of spaces will result.

If the masonry into which SCG will be poured has cured for a minimum of four hours, the lift height for placing SCG is unlimited, except by the pour height (of the erected masonry to be grouted). For shorter masonry cure periods, SCG placement is limited to 5’ lifts.

**Anchor Bolt Design by Allowable Stress Provisions**

Requirements for designing anchor bolts in accordance with the allowable stress provisions (Chapter 2) of the MSJC Code were harmonized (buzz word for the 2008 cycle) with strength design provisions (Chapter 3). As a result of this change, the number of anchor bolts required for a particular connection should be the same regardless of whether the designer uses allowable stress provisions or strength design provisions. Specific Code changes include:

- Previously, plate anchors, headed anchors and bent bar anchors were all designed by the same equations. Now separate requirements are provided for the three types of anchors.
- The capacity of plate anchor bolts is required to be established by testing.
- Two failure modes are checked for tension capacity of headed anchor bolts (same number of failure modes as the 2005 Code).
- Three failure modes are checked for tension capacity of bent bar anchor bolts (only two failure modes were checked in the 2005 Code).
- Four failure modes are checked for shear capacity of headed and bent bar anchor bolts (only two failure modes were checked in the 2005 Code).

Although more equations and calculations are required to determine the capacity of anchor bolts by allowable stress design, Code changes provide a significant benefit. The calculated capacity of headed and bent bar anchor bolts, per the 2008 Code, is on the order of 2.5 to 3 times the capacity calculated per the 2005 Code. Thus, fewer anchors will be required for the same connection designed under the 2005 Code.

**Reinforcement Placement**

Several provisions were added to the Specification to clarify reinforcement placement requirements. The first addresses reinforcing bar dowels that project out of the concrete foundation for embedment into the masonry. When the foundation dowels would interfere with placement of unit webs, the dowels may be bent at a rate up to 1” horizontally for each 6” of vertical height. Permitting bending of foundation dowels is expected to reduce the number of dowels that have to be reinstalled after construction of the foundation.

Reinforcing bars are permitted to be lapped without contact. Maximum space between lapped bars is one-fifth of the required lap splice length, but no more than 8”. Thus, lapped lengths of reinforcing bars could be placed in adjacent cores of concrete masonry units and need not be in the same vertical core. This provision existed in Chapter 2 (allowable stress design) and in Chapter 3 (strength design) of the Code, but was not previously included in the Specification. Consequently, contractors were likely unaware that noncontact lap splices were permitted.

Horizontal joint reinforcement is required to be overlapped a minimum of 6” at splices. The purpose of this requirement is to have continuity of reinforcement against shrinkage cracking in concrete masonry. The required lap length is fairly short because joint reinforcement develops by mechanical interlock of mortar against the cross wires and not by bond along the length of the wires (which is the bond mechanism for deformed reinforcing bars). Additional changes to this provision may be made in future editions of the MSJC documents because this lap splice length may be inadequate to assure development of joint reinforcement used as structural reinforcement.

**Corbels**

A corbel is a projection of successive courses of masonry, upward and outward, from the outside face of the masonry wall. Two changes were made to the code provisions for the design of corbels:

- Non-loadbearing corbels are permitted to be engineered in accordance with the allowable stress (Chapter 2), strength (Chapter 3) or prestressed masonry (Chapter 4) design requirements of the Code, or may be detailed in accordance with the prescriptive requirements of Chapter 1 (General Design Requirements). In the 2005 Code, only the prescriptive detailing was permitted.
- Masonry units used to construct corbels may be solid units or hollow units filled with mortar or grout. In the 2005 Code, only solid units were permitted.

**Deflections**

Deflection of beams and lintels used to support unreinforced masonry has traditionally been limited to avoid cracking of the supported masonry. In the 2008 Code, two changes were made to clarify the deflection limitations:

- Deflection is limited to L/600 under unfactored dead plus live loads. In the 2005 Code, the deflection was additionally limited to 0.3”. This additional limitation was deleted because it was unnecessarily restrictive, especially for long span beams.
2008 MSJC Code Changes

- The deflection limitation was clarified to apply to the support of masonry designed by Section 2.2 (unreinforced masonry designed by allowable stress), Section 3.2 (unreinforced masonry designed by strength), Chapter 5 (unreinforced masonry designed by empirical provisions) and Section A.2 (unreinforced AAC masonry). In the 2005 Code, only Section 2.2 and Chapter 5 were listed as the applicable types of masonry for which the deflection of the support was limited.

A time limit of 1 1/2 hours is waived for transit-mixed grout as long as it meets the specified slump

Lightly Loaded Columns

Masonry columns are vertically oriented members that support vertical loads and may also support lateral loads. Masonry columns have traditionally been required to have a minimum of four vertical reinforcing bars that are enclosed by reinforcing bar ties.

In the 2008 Code, added provisions permit the use of lightly loaded columns which are limited to Seismic Design Categories A, B, or C and an unfactored gravity load of no more than 2,000 lbs. The gravity load must be applied within the cross-sectional dimensions of the column to limit bending of the column. Columns that meet these requirements only need to have one number four bar centered in the column. Lateral ties are not required.

Provisions for lightly loaded columns are taken from the 2006 edition of the IBC. By adding these provisions to the MSJC Code, the provisions can be deleted from IBC and the MSJC Code is closer to reaching its goal of containing all masonry design requirements.

Flexural Capacity of Stack Bond Masonry

Table of allowable flexural tensile stresses (Chapter 2) and the table of modulus of rupture values (Chapter 3) were both revised for the condition where the flexural tension is parallel to bed joints in grouted stack bond masonry. In this type of construction, the flexural tensile capacity of the masonry is not affected by mortar type. A uniform value of 100 psi (allowable flexural tension) or 250 psi (modulus of rupture) is listed in the respective tables, regardless of mortar type, and is applicable to the grout section only.

This provision permits unreinforced, stack bond masonry to be used to resist lateral loading. Previously, stack bond masonry was assumed to have no capacity to resist flexural tension parallel to bed joints, whether or not it was grouted, and reinforcement was required. Stack bond masonry that is not grouted is still assumed to have no capacity to resist flexural tension parallel to the bed joints.

The Grout Placement

Grout is required to be placed within 1 1/2 hours from introducing water in the mixture and prior to initial set. The 1 1/2 hour time limit may be too long in hot weather, when initial set may occur earlier, and may be unduly restrictive in cooler weather. Additional provisions were added to the Specification to give guidance as to when grout should be rejected and to extend the time limit for transit-mixed (ready mix) grout, when appropriate.

- Water is permitted to be added to transit-mixed grout at the time of initial discharge to adjust slump to the specified range.
- Grout should be discarded when it does not meet the specified slump without adding water after the initial mixing for field-mixed grout or after initial discharge for transit-mixed grout.
- The time limit of 1 1/2 hours is waived for transit-mixed grout as long as it meets the specified slump.

These clarification provisions are expected to prevent unnecessary discarding of transit-mixed grout and to provide guidance to the inspector as to when grout is acceptable for use.

Grout Keys

A key should be formed in grout when it is placed to provide mechanical interlock between piers or lifts and to avoid forming a cold joint entirely through the masonry thickness. The 2005 Specification had no specific requirements for grout keys. The following guidance was added to the 2008 Specification:

- Form a grout key by stopping the grout a minimum of 1/2" below a mortar joint.
- Do not form grout keys within beams.
- Terminate the grout pour at the bottom of beams and lintels with closed bottom units and do not form a grout key.

Empirical Design of Masonry

Several changes were made to Chapter 5, Empirical Design, in the Code. Those changes address openings in the masonry, the change in the material standard for hollow concrete masonry and provide additional guidance for anchorage of masonry walls to floor and roof diaphragms.

Empirical design of masonry is based on rules of thumb that were developed over years of successful (and unsuccessful) construction. Historically, masonry bearing walls were massive with relatively small window openings. The empirical guidelines that were developed neglected the effect of these small openings. However, the proportion of window openings to masonry mass has grown substantially over the years until the effect of openings dominates the behavior of the masonry wall.

To provide guidance to the designer who does not want to perform an engineered design of masonry, provisions were added to Chapter 5 (empirical design) of the Code to address the effect of openings. The table of wall lateral support requirements (Table 5.5.1) still applies to masonry without openings, but the design of masonry with openings must now consider the masonry strips, both horizontally and vertically located between window or door openings. For each strip, the tributary width of lateral load supported by that strip is calculated. Masonry walls must be laterally supported in either the vertical or horizontal direction at a spacing that does not exceed the value in Table 5.5.1 divided by the square root of the ratio of tributary width divided by the masonry strip width.

Another change that was made in the empirical design chapter of the Code was in Table 5.4.2, Allowable Compressive Stresses. Previously, the table did not distinguish between masonry constructed of hollow clay units and masonry constructed of hollow concrete units. Changes were made to the ASTM standard that governs the manufacture of hollow...
Concrete units; those changes decreased the minimum thickness of face shells in units greater than 8" in nominal thickness. As a result of the changes in the material standard, new construction that utilizes the thinner shelled units will have less capacity in empirical design because empirical design is based on gross area. Consequently, the allowable values in Table 5.4.2 are slightly decreased for hollow concrete unit masonry thicker than 8" nominal.

The third set of changes to the Empirical provisions relates to floor and roof anchorage. Where the floor or roof system consists of steel joists that bear on the walls, joists are required to be connected to steel bearing plates. The minimum number and size of anchor bolts used for that purpose are given. In the 2005 Code, only the roof diaphragm was required to be anchored to the masonry walls, using a minimum of 3/8" diameter anchors bolts at a maximum spacing of 6'. In the 2008 Code, this requirement was expanded to include floor diaphragms. The Code goes on to give specific requirements for embedment of the bolts and anchors required to attach steel joists, floor and roof diaphragms to the walls. These anchorage-related changes were developed to address what has been observed to be a weak link in masonry bearing wall buildings. When masonry walls fail under high winds, cause of the failure is usually blowing off of the roof, which results in loss of lateral support for the walls. By assuring that a positive mechanical connection exists between the diaphragm and wall, both components perform better under lateral loading.

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