NCMA TEK

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BUILDING CODE REQUIREMENTS FOR CONCRETE MASONRY

TEK 1-3C
Codes & Specs (2007)

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INTRODUCTION

The majority of jurisdictions in the United States adopt a national model code, most commonly the *International Building Code* (IBC) (refs. 1, 2), as the basis of their building code. The intent of the IBC is to reference and coordinate other standardized documents, rather than to develop design and construction provisions from scratch. With this in mind, the IBC masonry design and construction provisions are based primarily on *Building Code Requirements for Masonry Structures* (MSJC code) (refs. 3, 4) and *Specification for Masonry Structures* (MSJC specification) (refs. 5, 6).

The code adoption process is shown schematically in Figure 1. In adopting the MSJC code and specification, the IBC typically amends or modifies some provisions. Similarly, depending on state laws, modifications can be made to the IBC at the state or local level to better suit local building practices or design traditions. However, most state codes require that any modifications to the IBC be more stringent than the corresponding requirement in the IBC.

Because significant changes can be introduced into subsequent editions of both the MSJC and IBC, the edition referenced by the local building code can be an important consideration when determining the specific requirements to be met. Note that code officials will often accept more current design and construction standards than those referenced in the code, as they represent more state-of-the-art requirements for a specific material or system.

To help determine which code provisions apply and highlight changes of note, this TEK outlines the major modifications to the MSJC code and specification made in the 2003 and 2006 IBC, as well as the principal changes made between the 2002 and 2005 editions of the MSJC code and specification. Note that the scope of the MSJC code and specification covers structural design and construction. Hence, requirements for items such as fire resistance, sound insulation and energy efficiency are not addressed in the MSJC documents.

2003 INTERNATIONAL BUILDING CODE

The 2003 *International Building Code* (ref. 1) adopts by reference the 2002 editions of the MSJC code and MSJC specification (refs. 3, 5). The MSJC code covers the design of concrete masonry, clay masonry, glass unit masonry, stone masonry, as well as masonry veneer. The MSJC code requires compliance with the MSJC specification, which governs masonry construction requirements and quality assurance provisions (see also TEK 1-2B, ref. 7).

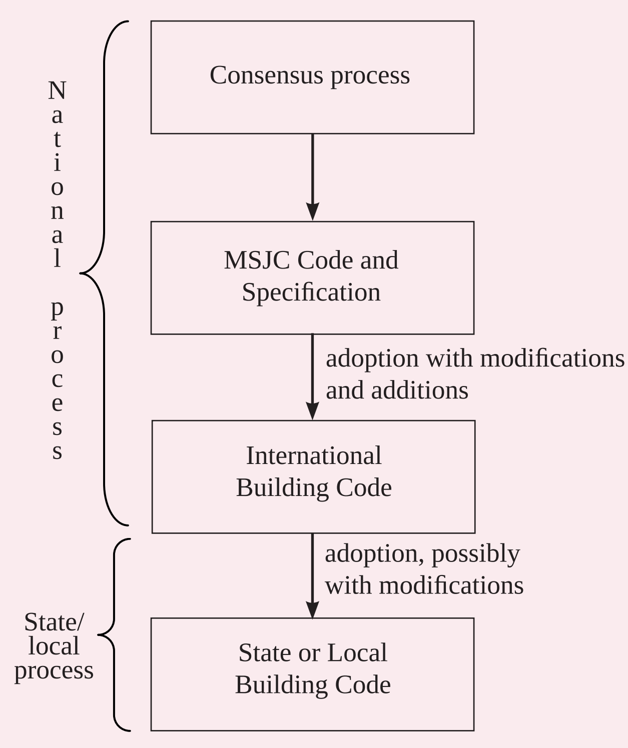

Figure 1—Masonry Structural Code Development Process

The 2002 MSJC Code and Specification

Compared to earlier editions of the MSJC code and specification, updates included in the 2002 edition are summarized below.

Masonry Design

Changes to masonry design provisions included:

- for the design of masonry structures, the 2002 MSJC code included new strength design provisions (see TEK 14-4A, ref. 8), offering a design method in addition to allowable stress design and empirical design,
- revised seismic design requirements, including prescriptive shear wall reinforcement (see TEK 14-18A, ref. 9) and transition from Seismic Performance Categories to Seismic Design Categories (SDCs) (see TEK 14-18A, ref. 9),
- for allowable stress design, revised allowable flexural tension values for unreinforced grouted masonry elements when subjected to flexural tension perpendicular to the bed joints,
- new prohibition on the use of wall ties with drips (bends intended to inhibit moisture migration from one masonry wythe to the other),
- for empirical design, revised wind speed threshold from a design wind pressure of 25 psf (1,197 MPa) to a wind speed of 110 mph (145 km/h) three-second gust,
- for empirical design, revised shear wall spacing requirements (see TEK 14-8A, ref. 10), and
- revisions to the types of masonry veneer permitted to be supported by wood construction (see TEK 3-6B, ref. 11).

Construction and Quality Assurance

Specification revisions included:

- new corrosion protection requirements for joint reinforcement, anchors and ties depending on their intended use or exposure conditions (see TEK 12-4D, ref. 12),
- new prestressed masonry quality assurance provisions for Level 2 (moderate) and Level 3 (rigorous) programs (see TEK 18-3B, ref. 13),
- the addition of grout demonstration panels as a means of meeting grout pour requirements (see TEK 3-2A, ref. 14),
- revised cold weather construction requirements, including new protection procedures for grouted masonry (see TEK 3-1C, ref. 15),
- new veneer anchor placement requirements (see TEK 3-6B, ref. 11), and
- updating of ASTM C 270 (ref. 16) mortar specification tables to include mortar cement.

Differences Between the 2003 IBC and the 2002 MSJC

The 2002 editions of the MSJC code and specification are included in their entirety (by reference) in the 2003 IBC. The IBC modifies several areas of the MSJC code and specification applicable to concrete masonry. The most significant of these are summarized below. In addition, quality assurance provisions are close, but not identical between the IBC and MSJC.

Seismic Design Requirements

- The IBC bases loads on ASCE 7-02 (ref. 17), rather than the 1998 edition (ref. 18) referenced by the MSJC,
- the IBC includes prescriptive seismic requirements for post-tensioned masonry shear walls, which are not included in the MSJC, and
- the IBC has some more stringent seismic requirements than the MSJC, applicable to SDCs B, C, D, E and F.

Allowable Stress Design

For masonry designed using allowable stress design procedures, the IBC:

- modifies load combinations to be based on IBC section 1605, rather than those in MSJC code section 2.1.2.1,
- modifies minimum inspections required during construction,
- includes separate design requirements for columns used only to support light-frame roofs of carports, porches, sheds or similar structures with a maximum area of 450 ft^2 (41.8 m^2) and assigned to Seismic Design category A, B or C,
- modifies the minimum required lap splice length for reinforcing bars (Note that development length and corresponding lap splice length requirements have changed frequently in recent years. NCMA recommends using the lap splice requirements published in the 2006 IBC. See TEK 12-4D (ref. 12) for more detailed information.),
- sets a maximum reinforcing bar size based on the size of the cell or collar joint where the reinforcement is placed (see ref. 12), and
- sets a limit on the amount of reinforcement permitted in the in-plane direction for special reinforced masonry shear walls.

Strength Design

For masonry designed using strength design procedures, the IBC:

- sets a maximum width for the equivalent stress block of six times the nominal thickness of the masonry wall or spacing between reinforcement (whichever is less), or six times the thickness of the flange for in-plane bending of flange walls,
- modifies welded and mechanical splice requirements (see ref. 12), and
- adds maximum reinforcement percentage for special post-tensioned masonry shear walls.

Empirical Design

The IBC includes empirical design procedures within the body of the code and references the MSJC code as an alternate means of compliance. However, the IBC and MSJC empirical requirements are essentially the same, except that the IBC also includes:

- an exception allowing shear walls of one-story buildings to be a minimum of 6 in. (152 mm) thick, rather than 8 in. (203 mm),
- provisions for empirically-designed surface-bonded masonry walls, and

- additional parapet wall requirements, covering flashing and copings.

2006 INTERNATIONAL BUILDING CODE

The 2006 *International Building Code* (ref. 2) adopts by reference the 2005 editions of the MSJC code and MSJC specification (refs. 4, 6). The first section below highlights the major changes between the 2002 and 2005 MSJC code and specification. The following section summarizes important changes between the 2005 MSJC and the 2006 IBC.

The 2005 MSJC Code and Specification

Compared to the 2002 edition of the MSJC code and specification, the 2005 edition includes the following changes and additions.

Allowable Stress Design

For masonry designed using allowable stress design procedures:

- the use of the one-third increase in allowable stresses has been tied to specific load combinations,
- the minimum required lap splice and development lengths for reinforcing bars are the same for allowable stress design and strength design (Note that development length and corresponding lap splice length requirements have changed frequently in recent years. NCMA recommends using the lap splice requirements published in the 2006 IBC. See TEK 12-4D (ref. 12) for more detailed information.), and
- in-plane allowable flexural tension has been changed from zero to be the same value as for out-of-plane flexural tension.

Strength Design

For masonry designed using strength design procedures:

- the 2005 MSJC code includes explicit bearing strength provisions,
- the modulus of rupture for in-plane bending is now the same as that for out-of-plane bending,
- the maximum reinforcement limits have been modified, based on less restrictive assumptions that are related directly to the expected seismic ductility demand,
- new provisions for noncontact splices have been added,
- the minimum required lap splice and development lengths for reinforcing bars are the same for allowable stress design and strength design (Note that development length and corresponding lap splice length requirements have changed frequently in recent years. NCMA recommends using the lap splice requirements published in the 2006 IBC. See TEK 12-4D (ref. 12) for more detailed information.), and
- provisions for computing effective compression width have been added, using the same requirements historically employed for allowable stress design.

Other Revisions

The post-tensioned masonry design provisions have been updated. The most significant change is that design is now based on strength design with serviceability checks, rather than on allowable stress design with strength checks, making the design procedures easier to use for those accustomed to strength design of prestressed concrete.

For grouted masonry, the maximum grout lift height has been increased from 5 ft to 12 ft-8 in (1.5 to 3.9 m) under controlled conditions, such as a consistent grout slump between 10 and 11 in. (254 and 279 mm), the absence of reinforced bond beams between the top and bottom of the grout pour, and a minimum masonry curing time of 4 hours prior to grouting. See TEK 3-2A (ref. 14) for further information.

Empirical design includes several revisions to the limitations that define where empirical design can be used.

In the 2002 MSJC documents, the three levels of quality assurance were designated Levels 1, 2 and 3, which were replaced by Levels A, B and C, respectively in the 2005 edition. This change in nomenclature is wholly editorial and does not affect the requirements specified for each level.

For masonry veneers, prescriptive seismic requirements have been modified (several requirements that previously applied in SDC D and higher now apply in SDC E and higher), and new prescriptive requirements have been introduced for areas with high winds (wind speeds between 110 and 130 mph (177 and 209 km/hr)).

Prescriptive requirements for corbelled masonry have been moved from the empirical design chapter to Chapter 1, making the corbel requirements independent of the design procedure used.

In addition, design and construction provisions for autoclaved aerated concrete (AAC) appear in the MSJC for the first time.

Differences Between the 2006 IBC and the 2005 MSJC

The 2005 editions of the MSJC code and specification are included in their entirety (by reference) in the 2006 IBC. In addition to the modifications listed under the 2003 IBC (which are also included in the 2006 IBC unless noted below), the 2006 IBC modifies several areas of the MSJC code and specification applicable to concrete masonry. The most significant of these are summarized below.

- Development length and minimum lap splice length for reinforcing bars has been updated to 48 bar diameters for Grade 60 steel, with some exceptions. See TEK 12-4D (ref. 12) for more detailed information.
- Design loads and load combinations are based on ASCE 7-05 (ref. 19), rather than ASCE 7-02.
- For grouted masonry, the IBC requires a "grout key" between grout pours, i.e. a horizontal construction joint formed by stopping the grout pour $1^1/_2$ in. (38 mm) below a mortar joint.
- For certain special reinforced masonry shear walls, the IBC prescribes a maximum reinforcement percentage, applicable in the in-plane direction.

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