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Masonry Inspection Update

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Masonry, as an industry, has the regrettable reputation of being stagnant.Unfortunately, this is a bad rap since there have been a number of significant changes in masonry design, materials, and construction methods. As inspectors, we need to be aware of these changes and keep up to date on the items to independently observe in an effective Quality Assurance program.

When the International Building Code (IBC) came onto the scene fifteen years ago, there was a significant, although not immediate, shift in inspection practices. The previous Uniform Building Code (UBC) required masonry to be continuously inspected, otherwise there would be a half stress penalty which, in many cases, resulted in over design of structural masonry. The Standard Building Code and BOCA National Building Code were marginal on inspection provisions and as a result, the masonry inspection provisions of all three codes were considered and compromise provided new levels of inspection.

Masonry Inspection Tables

In preparation for the transition to the 2000 IBC, the masonry industry developed code inspection tables and through a consensus process, published the Quality Assurance Inspection Tables in the 1999 Specification for Masonry Structures (ACI 530.199/ ASCE 699/TMS 60299). Subsequently, the tabled information was expanded and included in Chapter 17 of the 2000 IBC.

Over the next few code cycles, these tables were continually modified in content and format in both the IBC and Specification for Masonry Structures (MSJC Specification) through the 2009 IBC. Since the masonry inspection tables in both the IBC and MSJC Specification were virtually identical by this time, the Chapter 17 masonry inspection tables were deleted from the 2012 IBC in favor of referencing the Industry Standard, Specification for Masonry Structures.

The format of masonry inspection tables in both the IBC and MSJC Specification has been awkward so in the 2016 MSJC Specification development cycle, the tables have been combined, simplified and reformatted through a consensus process. These user friendly tables will be available when the 2016 MSJC Specification is published later this year.

New tables will combine Quality Assurance Levels into a single table so that the same tasks are identified for any of the three QA levels and the table indicates what kind of inspection (Not Required, Periodic, Continuous) is required. Table 1 partially shows the existing QA Level C requirements and Table 2 partially shows the simplified and combined QA Inspection tables. Note that the A, B and C designations will revert back to the 1, 2, and 3 levels as previously designated in the IBC.

Table 1—TMS 602 (2013) Level C Quality Assurance (Partial)

MINIMUM INSPECTION				
Inspection Task	Frequency(a)		Reference for Criteria	
	Continuous	Periodic	TMS 402/ ACI 530/ ASCE 5	TMS 602/ ACI 530.1/ ASCE 6
1. Verify compliance with the approved submittals		X		Art. 1.5
2. Verify that the following are in compliance:				
a. Proportions of site-mixed mortar, grout and prestressing grout for bonded tendons		X		Art. 2.1, 2.6 A, 2.6 B, 2.6 C, 2.4 G.1 b
b. Grade, type, and size of reinforcement and anchor bolts, and prestressing tendons and anchorages		X	Sec. 6.1	Art. 2.4, 3.4
c. Placement of masonry units and construction of mortar joints		X		Art. 3.3 B

The 2016 Specification for Masonry Structures redesignated the levels from A, B and C to 1, 2 and 3 and combined the levels into a single QA Table.

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Table 2—TMS 602 (2016) Quality Assurance (Partial)

MINIMUM INSPECTION					
Inspection Task	Frequency (a)			Reference for Criteria	
	Level 1	Level 2	Level 3	TMS 402	TMS 602
1. As masonry construction begins, verify that the following are in compliance:					
a. Proportions of site-prepared mortar	NR	P	P		Art. 2.1, 2.6 A, 2.6 C
b. Construction of mortar joints	NR	P	P		Art. 3.3 B
c. Grade and size of prestressing tendons and anchorages	NR	P	P		Art. 2.4 B, 2.4 H

(a) Frequency refers to the frequency of inspection, which may be continuous during the task listed or periodically during the listed task, as defined in the table. NR=Not Required, P=Periodic, C=Continuous

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Part of the difficulty with the tables is the requirement for 'Continuous' and 'Periodic' inspection. Continuous is pretty clear since it means that the inspector needs to be present during the listed activity. Period inspection is another issue. An MSJC

Subcommittee was asked to quantify the appropriate amount of periodic inspection, but determined that the design professional must make this call. The UBC (since 1943) and IBC provided for periodic inspection, but neither quantified it, and for good reason. A convenience store constructed of masonry would not require the same level of periodic inspection as a large commercial masonry building. In an effort to provide guidance, the Subcommittee developed MSJC Specification Commentary language which was approved by consensus. Although the language does not quantify an amount of periodic' inspection, it gives the design professional guidance on issues related to determining an appropriate amount of 'periodic' inspection.

The Architect/Engineer should define the required timing of periodic inspections so that they are sufficient to verify a representative sample of the materials and workmanship. The frequency of periodic inspection varies depending on the size and complexity of the project.

Unit Strength Tables

The National Concrete Masonry Association (NCMA) conducts a significant amount of research which often leads to Code changes. Industry proposed changes in ASTM C90, Standard Specification for Loadbearing Concrete Masonry Units, raising the minimum average compressive strength from 1,900 psi to 2,000 psi. The increased strength requirement for Concrete Masonry Units was published in ASTM C9014. Along with this material change, NCMA proposed raising the values in the Unit Strength Tables which is one way to verify the compressive strength of masonry assemblages. Unit strength tables were introduced into the UBC in 1973 for clay brick masonry and subsequently developed for hollow unit masonry into the familiar format of Table 3. The unit strength of 1,900 psi, the minimum average required by ASTM C90, with Type S mortar by proportion and grout of at least 2,000 psi, verified a system strength of 1,500 psi

Table 3—TMS 602 (2011) Unit Strength Table, Hollow Unit Masonry

Table 2 – Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction		
Net area compressive strength of concrete masonry units, psi (MPa)		Net area compressive strength of masonry, psi[1] (MPa)
Type M or S Mortar	Type N Mortar	
----	1,900 (13.10)	1,350 (9.31)
1,900 (13.10)	2,150 (14.82)	1,500 (10.34)
2,800 (19.31)	3,050 (21.03)	2,000 (13.79)
3,750 (25.86)	4,050 (27.92)	2,500 (17.24)
4,800 (33.10)	5,250 (36.20)	3,000 (20.69)

With NCMA research and thorough evaluation and compromise by the Masonry Standards Joint Committee, the Unit Strength table was recalibrated to the values contained in Table 4. Significant changes include a base design of 2,000 psi based on the new unit design requirements of ASTM C9014. Mortar and grout requirements are the same. The third column of the old table was moved to the first column in an effort to convey the message to the designer that design increments of 250 psi may be in order.

Table 4—TMS 602 (2013) Unit Strength Table, Hollow Unit Masonry

Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction		
Net area compressive strength of concrete masonry, psi (MPa)[1]	Net area compressive strength of ASTM C90 concrete masonry units, psi (MPa)	
	Type M or S Mortar	Type N Mortar
1,700 (11.72)	---	1,900 (13.10)
1,900 (13.10)	1,900 (13.10)	2,350 (14.82)
2,000 (13.79)	2,000 (13.79)	2,650 (18.27)
2,250 (15.51)	2,600 (17.93)	3,400 (23.44)
2,500 (17.24)	3,250 (22.41)	4,350 (28.96)
2,750 (18;96)	3,900 (26.89)	-----
3,000 (20.69)	4,500 (31.03)	-----

When reading Table 4, it is important to understand that the second and third columns relate to the strength of the masonry unit only. Some designers have interspersed the values to also apply to mortar and grout, which is not the intent. Mortar and grout requirements are contained within the text of the code.

Coring Masonry Walls

Certain applications of the California Building Code (CBC) require coring of masonry walls for quality verification. This provision was a result of the 1933 Long Beach Earthquake and unquestionably applied only to double wythe clay brick masonry walls.

This provision did not encompass single wythe hollow unit masonry walls until publication of the 2010 CBC. Without research, the single wythe 'face shell' requirement was inserted into the 2010 CBC. Making matters worse, the coring provision required that half the specimens be tested in shear and may or may not have required the other half of the specimens to be compression tested. Additionally, there was, and continues to be, no published Standard to follow for the extraction, handling or testing of masonry prisms. Without a published Standard, core test results will vary widely for the same masonry wall.

In the 2013 CBC, the California Division of the State Architect (DSA) significantly revised coring requirements stating that all core specimens be tested in shear and that the total average be used for shear compliance. If there is a separated face shell, it is included in the average as a zero value. There are a number of exceptions to coring masonry walls, such as nonbuilding elements, such as site walls, trash enclosures, and planters; and when vertical reinforcement is placed such that the coring process would cut the vertical reinforcement, core testing may be waived by the design professional.

The California Office of Statewide Health Planning and Development (OSHPD) did not adopt the 2013 coring modifications so there is still confusion on the coring process for hospitals and health care facilities.

Conclusion

These are but a few of the recent changes in masonry materials and construction. Code requirements are dynamic, even for masonry, and the industry is taking advantage of improved technology and quality control provisions. The masonry industry is also integrally involved in the development of Building Information Modeling for

Masonry which will revolutionize design and construction of the oldest building material which as anything but stagnant.

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