Date: January 3rd, 2018
To: All Interested Parties in Masonry Production, Design and Installation
From: The Masonry Association of Florida
RE: Code Update on Increased Design Strength of Masonry Provided in the *2016 Building Code Requirements and Specification for Masonry Structures* (TMS 402/602-16)

The Building Code Requirements and Specification for Masonry Structures contains two standards and their commentaries: *Building Code Requirements for Masonry Structures* designated as TMS 402-16 (and formerly designated as TMS 402, ACI 530, ASCE 5) and *Specification for Masonry Structures* designated as TMS 602-16 (and formerly designated as TMS 602, ACI 530.1, ASCE 6). These standards are produced by The Masonry Society's Committee TMS 402/602 and were formerly developed through the joint sponsorship of The Masonry Society (TMS), the American Concrete Institute (ACI), and the Structural Engineering Institute of the American Society of Civil Engineers (SEI/ASCE) through the Masonry Standards Joint Committee (MSJC). In late 2013, ACI and ASCE relinquished their rights to these standards to TMS who has served as the lead sponsor of the Standard for a number of years. [1]

The mission of The Masonry Society's Committee TMS 402/602 is to develop and maintain design and construction standards for masonry for reference by, or incorporation into, model building codes regulating masonry construction.

For the purposes of this paper we will refer to *The Building Code Requirements and Specification for Masonry Structures* as TMS 402 and the *Specification for Masonry Structures* as TMS 602. These are the official designation for the code and specification starting with the 2016 Edition. TMS 402/602 form the basis for masonry design in both the ICC and FBC and have for many years. It is important to note that the latest edition available of TMS 402/602 is routinely adopted by the ICC and FBC. TMS 402/602 is considered as the authoritative base code for masonry design in the United States and in many other parts of the world.

The 2008 edition of TMS 402/602 formed the basis for Chapter 21 of the 2010 FBC. The 2011 edition of TMS 402/602 formed the basis for Chapter 21 of the FBC, 5th Edition. The 2011 edition of TMS 402/602 was used simply because it was the latest edition of TMS 402/602 available at the time the masonry Chapter 21 of the FBC, 5th Edition was locked into Florida's code development process. The 2016 edition of TMS 402/602 now forms the basis for Chapter 21 of the FBC, 6th Edition.

Significant changes to the allowable compressive strength of masonry were introduced in the 2013 edition of TMS 402/602. These changes were the result of extensive research conducted by NCMA (see Attachment 1). This research was not completed in time for inclusion in the 2011 edition of TMS 402/602 and thus was not able to be included in the FBC, 5th Edition.

This paper focuses on the increased code values of masonry compressive strength. These values can be utilized on projects immediately and are valuable provisions of the 2013, and current 2016, editions of TMS 402/602. These increases are summarized in Table 1 below and can be found in TMS 602-16 Section 1.4 B.2. Table 2 (see Attachment 1).

Table 1

FBC and TMS 402/602 Editions	Net Area Block Strength (psi)	Design Strength f'm (psi)
FBC, 5th Ed. and TMS 402/602-11	1900 psi – Min Block Strength per C90-11b	1500 psi – Historic f'm Design Value
FBC, 6th Ed. and TMS 402/602-16	2000 psi – Current Min Block Strength per C90-14	2000 psi - New Standard Min f'm Design Value

Additionally, the new FBC, 6th Edition adopts ASTM C90-14 which increases the minimum allowable net area strength of an individual block from the historic 1900 psi to 2000 psi.

ASTM C90 is the national standard that tells us what criteria a concrete masonry unit must meet. Historically, it required that all concrete masonry units must have an average net area compressive strength of 1900 psi. Again, this has increased to 2000 psi.

The Unit Strength Method outlined in TMS 602 Section 1.4 B.2 (see Attachment 1) allows us to determine what the f'm design strength is (the value used by engineers and architects in design) based on the C90 net area strength. As shown in Table 1 above, this f'm design value has increased from 1500 psi to 2000 psi.

We want to stress that there is nothing different that has to happen to take advantage of this increase in design strength of approx. 33%. Modern methods in the uniform production and testing of masonry units have simply resulted in a better understanding of the safe, allowable f'm design strength of concrete masonry materials. This is not something that is going to happen in the future – it is already part of the FBC and ICC. The Masonry Society, the American Concrete Institute and the American Society of Civil Engineers have determined that the allowable compressive design strength (f'm) of any standard concrete masonry unit, produced according to ASTM C90, is now 2000 psi.

Any architect or structural engineer wishing to design according to the criteria of the 2016 edition of TMS 402/602 is now free to do so. This approval is part of the current FBC, 6th Edition. The use of the standard should be specified on the plans along with wind loads and other critical and required structural information.

The increased design strength of a CMU is independent of any other provision of the FBC. An example of this would be if other safety factors and design equations in the 2016 TMS 402/602 and the FBC, 6th Edition were modified to work in conjunction with the increased design strengths. **This is NOT the case.** The increased design values are "stand alone". They are a true increase in allowable f'm design strength of block and can be applied to any design equation and procedures in the 2011 TMS 402/602 as well.

As can be seen in Table 2 on Attachment 1 the correlation between net area strength and the f'm design strength remains 1 to 1 up to 2000 psi. The designer should specify a net area block strength of 2000 psi thus attaining an f'm of 2000 psi rather than 1500 psi. All blocks manufactured in Florida now meet the 2000 psi minimum net area strength requirement with no modification to the production process[2]. There is no additional cost for 2000 psi block rather than 1900 psi block as it is now the minimum strength allowed by code. The block supplier should normally provide a certificate stating the net area strength of his block is 2000 psi in accordance with ASTM C90-14 and that the allowable design strength of the unit, f'm, is 2000 psi in accordance with TMS 602-16 Section 1.4 B.2. Table 2.

Again, the 2014 edition of ASTM C90 (currently referenced in the FBC, 6th Edition) has increased the minimum net area strength of an individual block from 1900 psi to 2000 psi (the Florida Building Code 5th Edition references the 2011 edition of ASTM C90 which sets the minimum strength at the historic 1900 psi).

Net area strengths greater than 2000 psi are readily available across the State from all manufactures. Increasing the strength can be a very cost effective alternative to decreasing steel spacing, increasing wall thicknesses or including pilasters in the design. The 2016 TMS 402/602 code allows for higher values of f'm for all net area strengths. Thus, we highly recommend immediate use of the 2016 TMS 402/602 Unit Strength Method for the determination of your f'm for high strength masonry also.

The current FBC, 6th Edition (like past editions) contain modifications to specific sections of the TMS 402/602. The sections modified by the current FBC, 6th Edition are unchanged from section modified by the FBC, 5th Edition. These modified sections are unaffected by the code allowed increase in f'm design strength. The most important of these modifications involves the gamma factor in the development length equations. These factors were modified to remove the effects of earthquakes from the Florida lap calculation as required by the Florida legislature. The lap equation, factors for calculations and use of this equation are unaltered in the FBC, 6th Edition.

Summary

Increasing your f'm design strength from 1500 psi to 2000 psi can have a significant impact on the cost and materials required for your masonry structure. It is the hope of the concrete masonry industry that all engineers and architects reading this paper will be encouraged to immediately begin using the best design values available in the new FBC, 6th Edition.

[1] Wording from 2016 *Building Code Requirements and Specification for Masonry Structures* – Abstract

[2] The strength of CMU is generally governed by the rate of breakage rather than a necessity to meet the requirements of ASTM C90. CMU are cubed and transported to the block yard via forklift usually within 16 hours of manufacturing. Within this 16 hour window the block must gain enough strength to survive this process. The strength required to keep the rate of breakage to an acceptable threshold during cubing and transport is generally what governs the ultimate 28 day strength. This strength is generally above 2000 psi.

TMS 602 SPECIFICATION

1.4 B.2. *Unit strength method* (Continued)

b. *Concrete masonry* - Use Table 2 to determine the compressive strength of concrete masoruy based on the strength of the unit and type of mortar specified, when masoruy complies with the following requirements:

1) Units are sampled and tested to verify conformance with, ASTM C90.

2) Thickness of bed joints does not exceed 5/8 in. (15.9 mm).

3) For grouted masonry, the grout conforms to Article 2.2.

COMMENTARY

b. *Concrete masonry* - Prior to the 2013 Specification, the standardized correlations between unit compressive strength, mortar type, and resulting assembly compressive strength of concrete masoruy were established using prism test results collected from the 1950s through the 1980s. The result was a database of prism compressive strengths with statistically high variability, which when introduced into the Specification, drove the lower bound desig n values between unit, mortar, and prism to very conservative values. The reasons for the inherent historical conservatism in the unit strength table are twofold: 1) When originally introduced, the testing procedures and equipment used to develop the prism test data were considerably less refined than they are today. Changes introduced into ASTM C1314, particularly requirements for stiffer/thicker bearing platens on testing equipment, produce more consistent, repeatable compressive strength results. 2) Previous testing procedures either did not control the construction, curing, and testing of masoruy prisms, or permitted many procedures for doing so. As a result, a single set of materials could produce prism test results that varied significantly depending upon how the prisms were constructed, cured, and tested. Often, a field-constructed and field-cured prism would test to a lower value than a laboratory-constructed and laboratory-cured prism. Consequently, the compressive-strength values for concrete masoruy prisms used to develop historical versions of the unit strength tables are not directly comparable to the compressive-strength values that would be obtained today.

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, psi (MPa)[1]	Net area compressive strength of ASTM C90 concrete masonry units, psi (MPa)	
	Type M or S mortar	Type N mortar
1,750 (12.07)	—	2,000 (13.79)
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)	—

1 For units ofless than 4 in. (102 mm) nominal height, use 85 percent of the values listed.