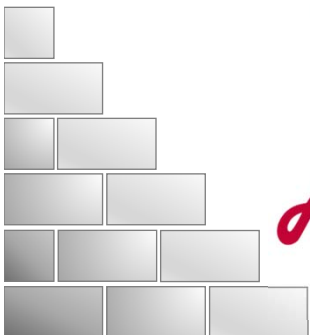
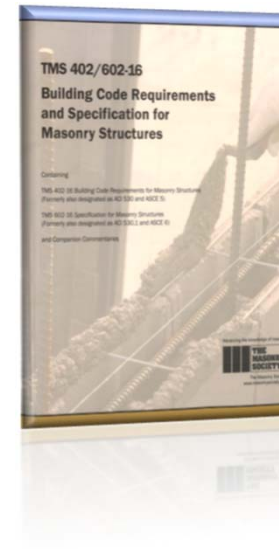
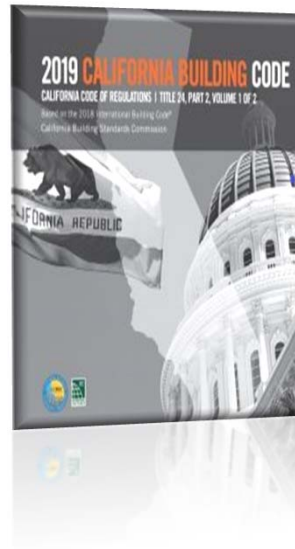
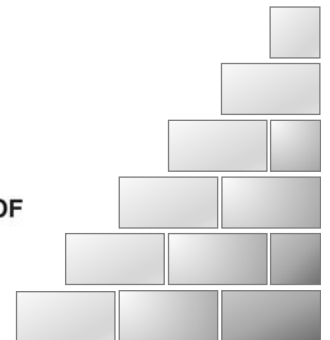


2019 MASONRY CODE UPDATE



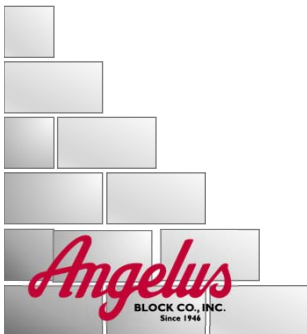
Angelus
BLOCK CO., INC.
Since 1946

MIA MASONRY
INSTITUTE OF
AMERICA
Established 1957



2019 Masonry Code Update

- Introduction
 - Understanding Which Code and Terminology
 - Masonry Changes in IBC/CBC Chapter 14-Veneer
 - Masonry Changes in IBC/CBC Chapter 17-Inspection
 - Changes in IBC/CBC Chapter 21-Masonry
 - Changes in Reference Standard
 - TMS 402 Building Code Requirements for Masonry Structures
 - TMS 602 Specification for Masonry Structures
 - The OSHPD Impact



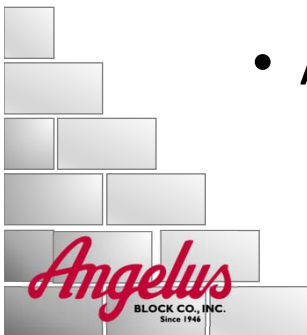
2019 Masonry Code Update

- Which is more effective?

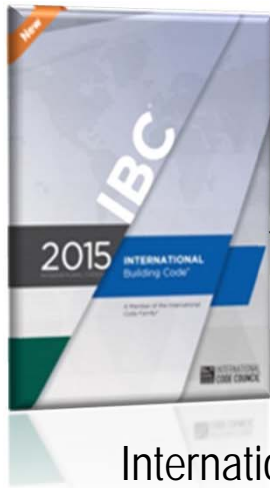
CBSC HS
Code §18930

- A long Code with
 - Conflicting, overlapping and duplicating provisions of referenced Material Standards
 - Provisions that are unreasonable, arbitrary, unfair or capricious
 - Requirements that make the cost unreasonable based on the overall benefit
 - Language that is unnecessarily ambiguous or vague

- A concise direct Code that is easy to understand



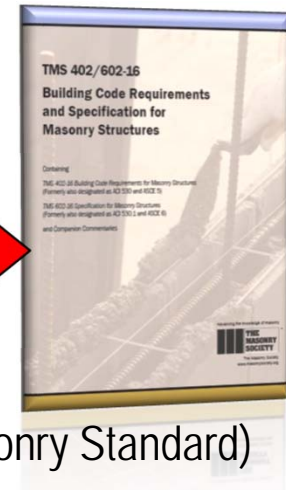
Which Code Applies?



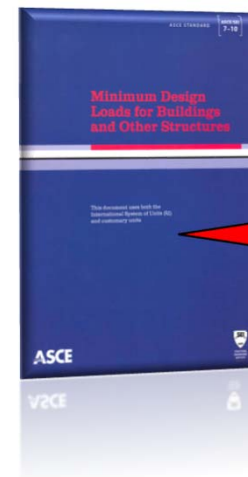
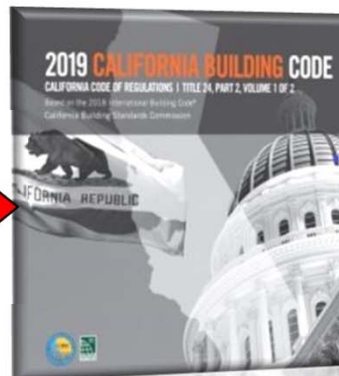
International Building Code



TMS 402/602 (Masonry Standard)



California Building Code



ASCE 7



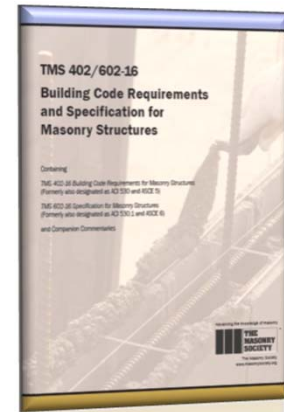
MASONRY INSTITUTE OF AMERICA

Angelus
BLOCK CO., INC.
Since 1946

Which Code Applies?



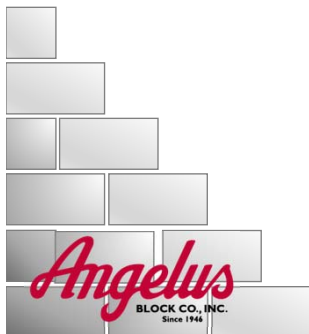
2018 International Building Code



2016 TMS 402/602 (Masonry Standard)



2019 California Building Code

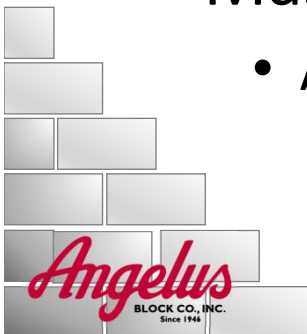


Sorting Out Terminology/History

- TMS
 - The Masonry Society
- ACI
 - American Concrete Institute
- ASCE
 - American Society of Civil Engineers

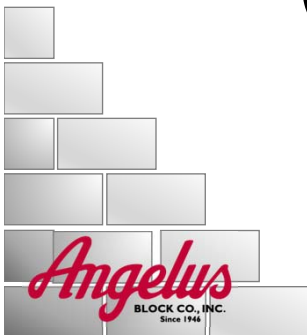
MSJC
Masonry Standards
Joint Committee

- Masonry Code-Referenced Standard
 - ACI 530/ACI 530.1



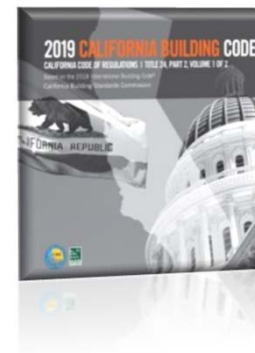
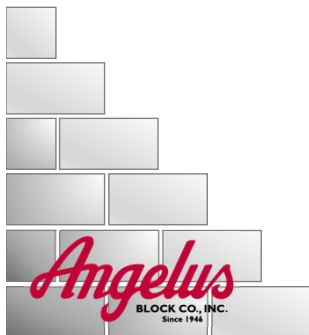
Sorting Out Terminology/History

- Building Code Requirements for Masonry Structures
 - (ACI 530-88/ASCE 5-88)
- Building Code Requirements for Masonry Structures
 - (ACI 530-92/ASCE 5-92/**TMS 402-92**)
- Building Code Requirements for Masonry Structures
 - (**TMS 402-08**/ACI 530-08/ASCE 5-08)
- Building Code Requirements for Masonry Structures
 - (**TMS 402-16**)



Chapter 14 – Exterior Walls

MASONRY VENEER



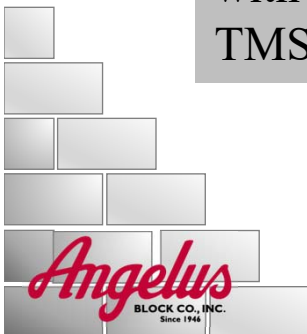
International Building Code



- Chapter 14
- Most of the Masonry Veneer Provisions are not in IBC/CBC Chapter 14, but in TMS 402, Chapter 12.

1404.6 Anchored masonry veneer. Anchored masonry veneer shall comply with the provisions of Sections 1404.6 through 1404.9 and Sections 12.1 and 12.2 of TMS 402.

1404.10 Adhered masonry veneer. Adhered masonry veneer shall comply with the applicable requirements in this section and Sections 12.1 and 12.3 of TMS 402.



International Building Code

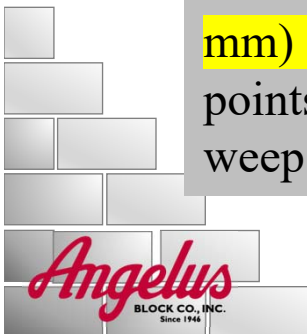


- Chapter 14 – Exterior Walls
 - Anchored Veneer Flashing - **2015**

1405.4.2 Masonry. Flashing and weep holes in anchored veneer shall be located in the first course of masonry above finished ground level above the foundation wall or slab, and other points of support, including structural floors, shelf angles and lintels where anchored veneers are designed in accordance with Section 1405.6.

- Anchored Veneer Flashing - **2018**

1404.4.2 Masonry. Flashing and weep holes in anchored veneer designed in accordance with Section 1404.6 shall be located not more than 10 inches (245 mm) above finished ground level above the foundation wall or slab. At other points of support including structural floors, shelf angles and lintels, flashing and weep holes shall be located in the first course of masonry above the support.



International Building Code

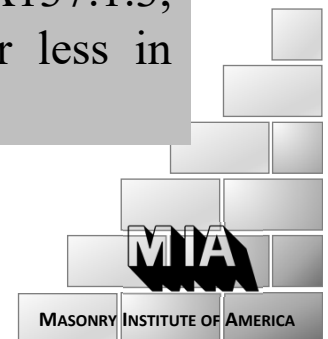
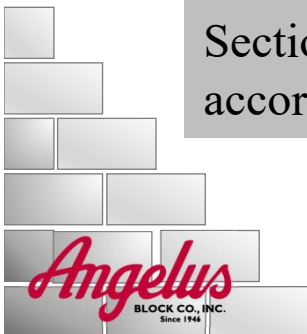


- Chapter 14 – Exterior Walls
 - Code Clarification

1405.10.2 Exterior adhered masonry veneers—porcelain tile. Adhered units shall not exceed 5/8 inch (15.8 mm) thickness and 24 inches (610 mm) in any face dimension nor more than 3 square feet (0.28 m²) in total face area and shall not weigh more than 9 pounds psf (0.43 kN/m²). Porcelain tile shall be adhered to an approved backing system.

Section 202 DEFINITIONS

PORCELAIN TILE. Tile that conforms to the requirements of ANSI A137.1.3, Section 3.0 for ceramic tile having an absorption of 0.5 percent or less in accordance with ANSI A137.1, Section 4.1 and Section 6.1 Table 10.



International Building Code

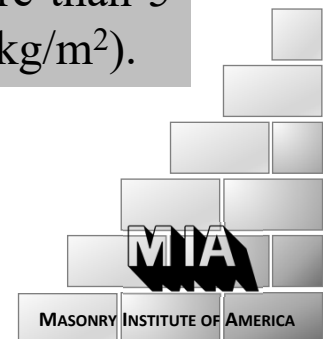
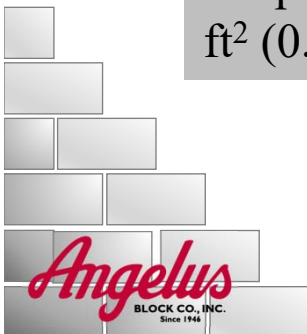


- Chapter 14 – Exterior Walls
 - Code Clarification

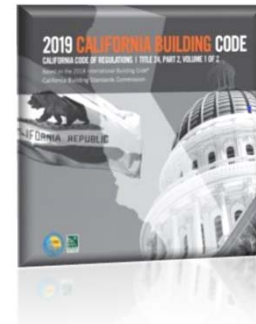
1404.10.3 Interior adhered masonry veneers. Interior adhered masonry veneers shall have a maximum weight of 20 psf (0.958 kg/m²) and shall be installed in accordance with Section 1404.10. Where the interior adhered masonry veneer is supported by wood construction, the supporting members shall be designed to limit deflection to 1/600 of the span of the supporting members.

- TMS 402

12.3.2.1 Unit sizes — Adhered veneer units shall not exceed 2-5/8 in. (66.7 mm) in specified thickness, 36 in. (914 mm) in any face dimension, nor more than 5 ft² (0.46 m²) in total face area, and shall not weigh more than 15 psf (73 kg/m²).



California Building Code



SECTION 1410

[DSA-SS & DSA-SS/CC, OSHPD 1, 1R, 2, 4 & 5]

ADDITIONAL REQUIREMENTS FOR ANCHORED AND ADHERED VENEER

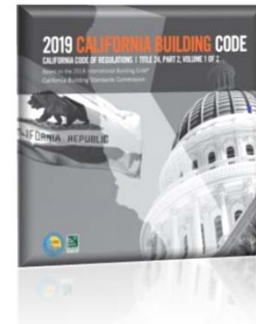
1410.1 General. In no case shall veneer be considered as part of the backing in computing strength or deflection nor shall it be considered a part of the required thickness of the backing.

Veneer shall be anchored in a manner which will not allow relative movement between the veneer and the wall.

Anchored or adhered veneer shall not be used on overhead horizontal surfaces.



California Building Code



SECTION 1410

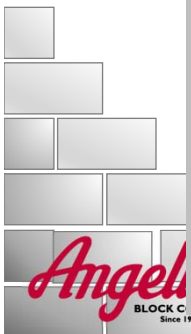
[DSA-SS & DSA-SS/CC, OSHPD 1, 1R, 2, 4 & 5]

ADDITIONAL REQUIREMENTS FOR ANCHORED AND ADHERED VENEER

1410.2 Adhered veneer. *Units of tile, masonry, stone or terra cotta which exceed 5/8 inch (16 mm) in thickness shall be applied as for anchored veneer where used over exit ways or more than 20 feet (6096 mm) in height above adjacent ground elevation.*

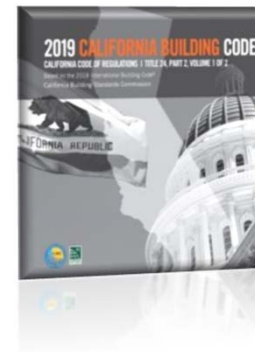
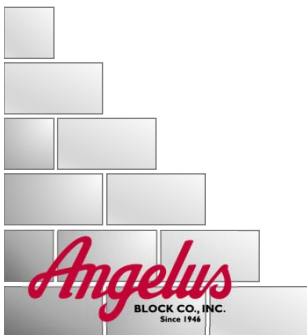
1410.2.1 Bond strength and tests. *Veneer shall develop a bond to the backing in accordance with TMS 402, Section 12.3.2.4.*

Not less than two shear tests shall be performed for the adhered veneer between the units and the supporting element. At least one shear test shall be performed at each building for each 5,000 square feet (465 m²) of floor area or fraction thereof.



Chapter 17

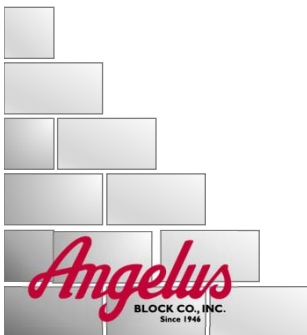
SPECIAL INSPECTIONS AND TESTS



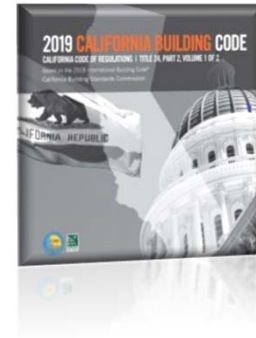
International Building Code



- Chapter 17
 - 1705.4 Masonry construction
 - No changes
 - One errata item, reference to QA Level B should be QA Level 2
 - Unlike other disciplines, QA Tables are in TMS 602



California Building Code

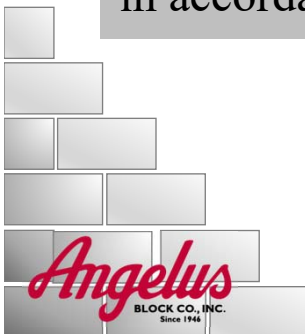


- Chapter 17 (2016)

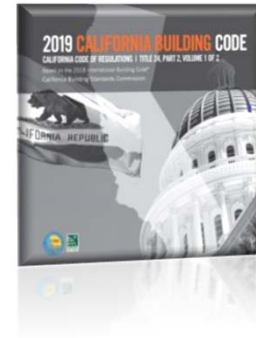
1705.4 Masonry construction. Special inspections and tests of masonry construction shall be performed in accordance with the quality assurance program requirements of TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530. 1/ASCE 6.

Exception: Special inspections and tests shall not be required for:

1. Empirically designed masonry, glass unit masonry or masonry veneer designed in accordance with Section 2109, 2110 or Chapter 14, respectively, where they are part of a structure classified as Risk Category I, II or III.
2. Masonry foundation walls constructed in accordance with Table 1807.1.6.3(1), 1807. 1.6.3(2), 1807.1.6.3(3) or 1807.1.6.3(4).
3. Masonry fireplaces, masonry heaters or masonry chimneys installed or constructed in accordance with Section 2111 , 2112 or 2113, respectively.



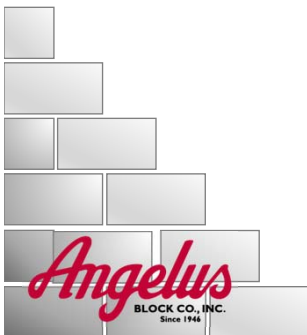
California Building Code



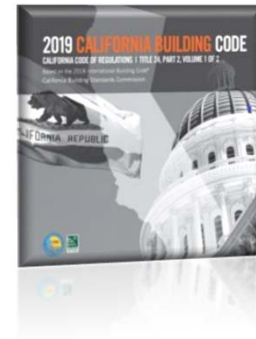
- Chapter 17 (2016)

1705.4.1 Empirically designed masonry, glass unit masonry and masonry veneer in Risk Category IV. Special inspections and tests for empirically designed masonry, glass unit masonry or masonry veneer designed in accordance with Section 2109, 2110 or Chapter 14, respectively, where they are part of a structure classified as Risk Category IV shall be performed in accordance with TMS 402/ACI 530/ASCE 5, Level B Quality Assurance.

1705.4.2 Vertical masonry foundation elements. Special inspections and tests of vertical masonry foundation elements shall be performed in accordance with Section 1705.4.



California Building Code



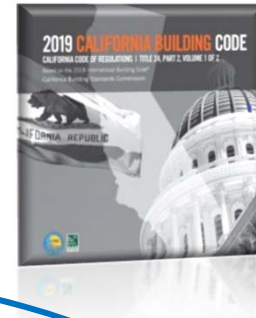
- Chapter 17 (2019)

1705.4 Masonry construction. Special inspections and tests of masonry construction shall be performed in accordance with the quality assurance program requirements of TMS 402 and TMS 602, *[OSHPD 1R, 2 & 5] as set forth in Tables 3 and 4, Level 3 requirements, and Chapter 21. Testing shall be performed in accordance with Section 2105. Special inspection and testing of post-installed anchors in masonry shall be required in accordance with requirements for concrete in Chapters 17 and 19.*

Exception: *[OSHPD 1R, 2 & 5] Not permitted by OSHPD.* Special inspections and tests shall not be required for:

1. Empirically designed masonry, glass unit masonry or masonry veneer designed in accordance with Section 2109, 2110 or Chapter 14, respectively, where they are part of a structure classified as Risk Category I, II or III.
2. Masonry foundation walls constructed in accordance with Table 1807.1.6.3(1), 1807.1.6.3(2), 1807.1.6.3(3) or 1807.1.6.3(4).
3. Masonry fireplaces, masonry heaters or masonry chimneys installed or constructed in accordance with Section 2111, 2112 or 2113, respectively.

California Building Code



- Chapter 17 (2019)

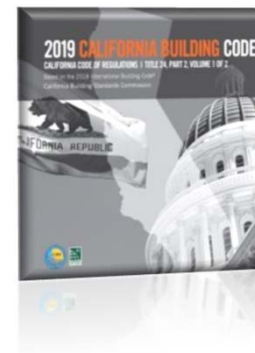
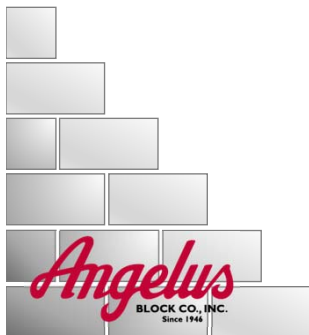
1705.4.1 Empirically designed masonry, glass unit masonry and masonry veneer in Risk Category IV. Special inspections and tests for empirically designed masonry, glass unit masonry or masonry veneer designed in accordance with Section 2109, 2110 or Chapter 14, respectively, where they are part of a structure classified as Risk Category IV shall be performed in accordance with TMS 402/ACI 530/ASCE 5, Level B Quality Assurance. *[OSHPD 1R, 2 & 5] Not permitted by OSHPD.*

[OSHPD 1R, 2 & 5] Glass unit masonry and masonry veneer in Risk Category II, III or IV. Special inspections and tests for glass unit masonry or masonry veneer designed by Section 2110 or Chapter 14, respectively, in structures classified as Risk Category II, III or IV, shall be performed in accordance with TMS 602 Tables 3 and 4, Level 2 Quality Assurance.

1705.4.2 Vertical masonry foundation elements. Special inspections and tests of vertical masonry foundation elements shall be performed in accordance with Section 1705.4.

Chapter 21

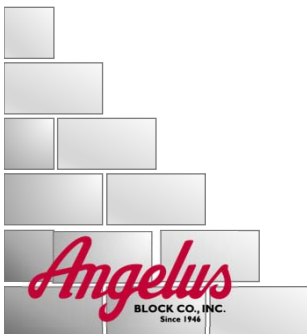
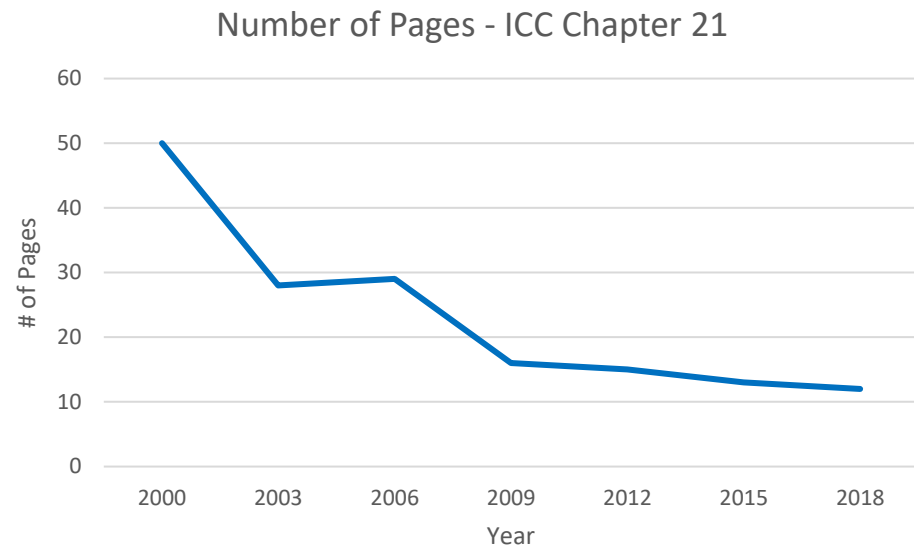
MASONRY



International Building Code



- Chapter 21 - Masonry
 - 2000 – 50 Pages
 - 2003 – 28 Pages
 - 2015 – 13 Pages
 - 2018 – 12 Pages

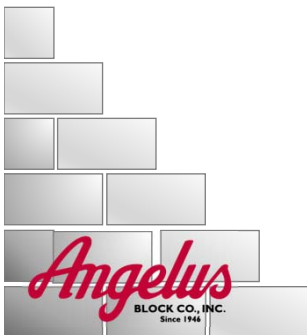


International Building Code



- Chapter 21 – 2018 Updates
 - Editorial-All references to ACI 530/ASCE 5 are gone
 - Definitions have been moved to Chapter 2
 - Architectural Cast Stone added
 - Adhered manufactured stone masonry units added
 - For ASD, lap splices need not be greater than $72 d_b$
 - Maximum bar size limitation for ASD eliminated
 - Empirical Design limited to Adobe Masonry

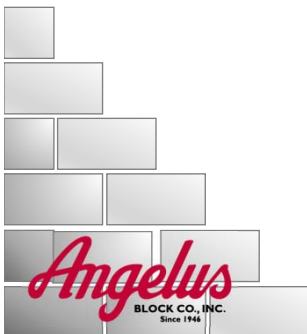
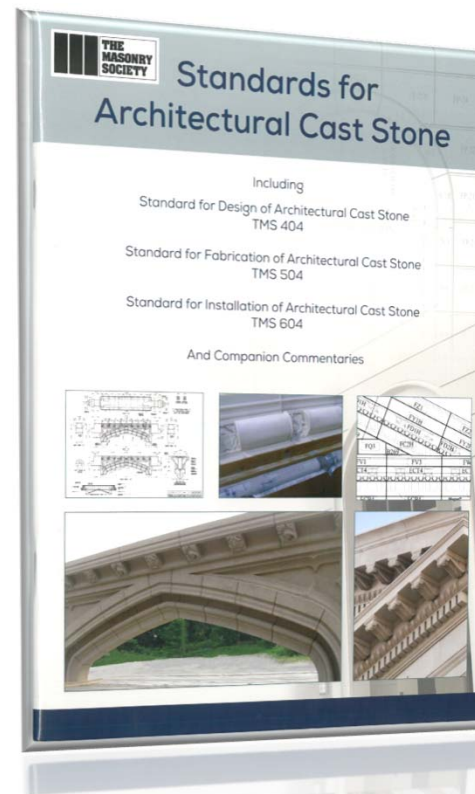
That's it



IBC-Architectural Cast Stone



- Standards for Architectural Cast Stone (TMS 404-16 / 504-16 / 604-16) are referenced in the IBC/CBC for design, fabrication and installation of the product.



IBC- ASD Lap Splice



- $72d_b$ cap on ASD lap splice length added to be consistent with Strength Design
- TMS 402 equation may require long lap lengths at small cover depths and/or large bar sizes. Some believe research was not consistent with actual loading and performance of lap splices.

Development (lap) length

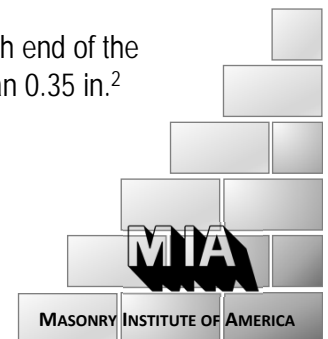
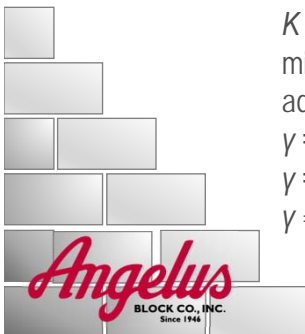
$$l_d = \frac{0.13d_b^2 f_y \gamma}{K \sqrt{f'_m}}$$

K shall not exceed the smallest of the following: the minimum masonry cover, the clear spacing between adjacent reinforcement splices, and $9d_b$.
 $\gamma = 1.0$ for No. 3 (M#10) through No. 5 (M#16) bars;
 $\gamma = 1.3$ for No. 6 (M#19) through No. 7 (M#22) bars; and
 $\gamma = 1.5$ for No. 8 (M#25) and larger bars.

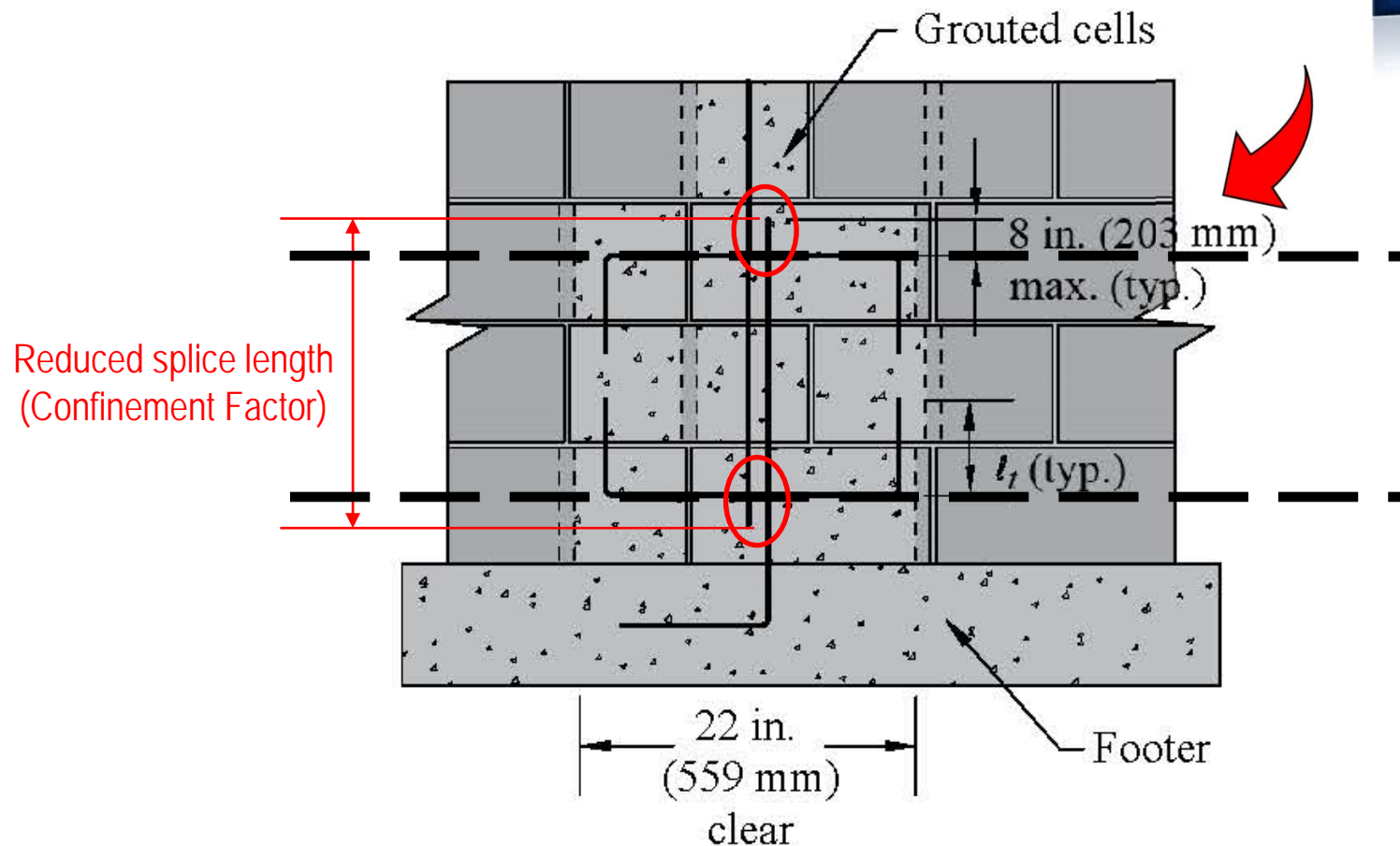
Confinement factor

$$\varepsilon = 1.0 - \frac{2.3A_{sc}}{d_b^{2.5}}, \text{ where } \frac{2.3A_{sc}}{d_b^{2.5}} \leq 1.0$$

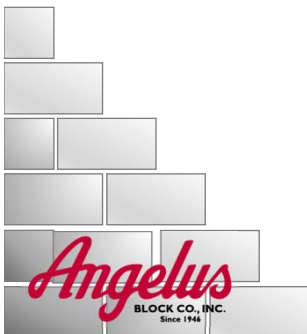
A_{sc} is the area of the transverse bars at each end of the lap splice and shall not be taken greater than 0.35 in.^2 (226 mm^2).



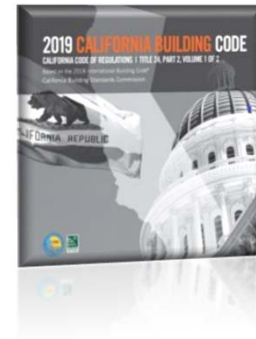
IBC- ASD Lap Splice



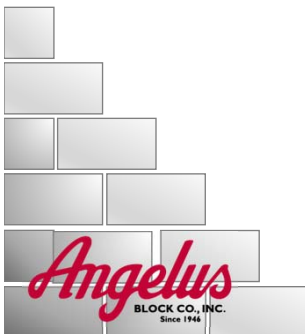
If continuous horizontal reinforcement is not otherwise provided within the end 8 in. (203 mm) of each end of the splice, confinement requirements may be satisfied by providing hooked reinforcement as detailed here



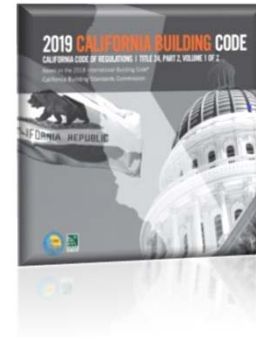
California Building Code



- Chapter 21A
 - **2104A.1.3.1.2.2** When using 10-inch or wider units grout lift (without cleanouts) may be increased from 4 ft-0 in. to 5 ft-4 in.
 - ALL of Chapter 21 by default to Reference Standard permits low lift grouting, without providing cleanouts, up to 5 ft-4 inches.



California Building Code



- Chapter 21A
 - OSHPD Wisdom – Core testing

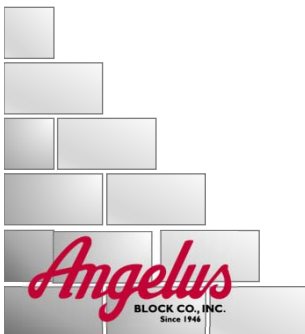
2105A.4 Masonry core testing

Exemptions

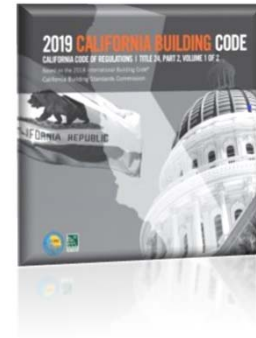
2. An infrared thermographic survey or other nondestructive test procedures, shall be permitted to be approved as an alternative system to detect voids or delamination in grouted masonry in-lieu of core sampling and testing.

[OSHPD 1 & 4] Infrared thermographic surveys or other nondestructive test procedures shall also include core tests with a minimum of two cores taken from each building for each 10,000 square feet (930m²) of the wall.

New in 2019



California Building Code

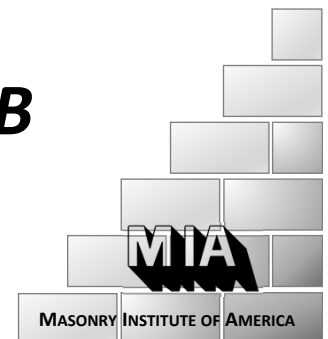
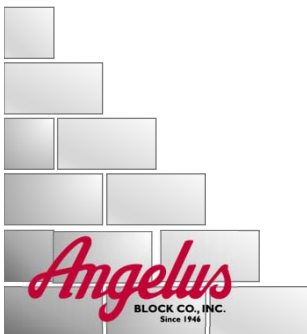


- Chapter 21A
 - Also New Duplicative Language for 2019

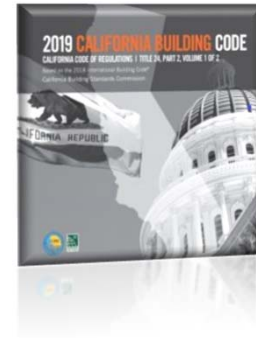
2105A.5 Masonry prism method testing. Prism test method performed prior to the start or during construction shall be in accordance with TMS 602 Section 1.4 B.3. Prism test method performed on constructed walls shall be in accordance with TMS 602 Section 1.4 B.4.

2105A.6 Unit strength method testing. Unit strength method testing shall be performed in accordance with TMS 602 Section 1.4 B.2.

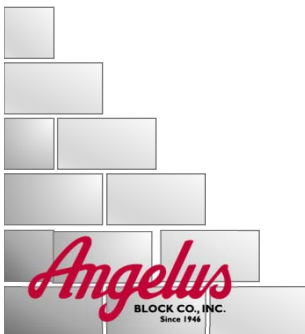
Already required by TMS 602, Article 1.4 B



California Building Code

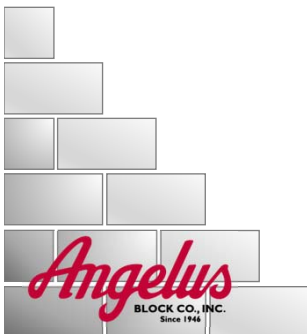
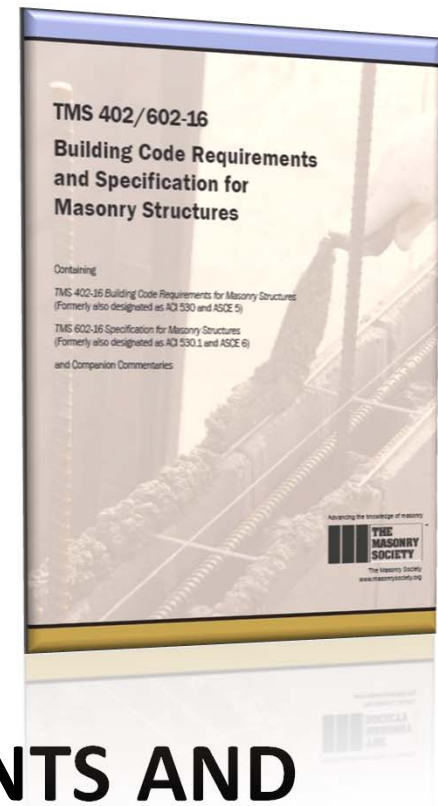


- Chapter 21
 - CBC Chapter 21 is unique
 - Mirrors IBC Chapter 21
 - Plus DSA Amendment Section 2115
 - Actual changes in 2019 Chapter 21 are minimal, but here comes OSHPD
 - Maintains OSHPD 2 (Skilled nursing facilities, intermediate care)
 - Adds OSHPD 1R (Nonconforming hospitals)
 - Adds OSHPD 5 (Acute psychiatric hospitals)
 - **Regulates to the level of Chapter 21A, but placed amendments interspersed throughout Chapter 21**



TMS 402/602

BUILDING CODE REQUIREMENTS AND SPECIFICATION FOR MASONRY STRUCTURES

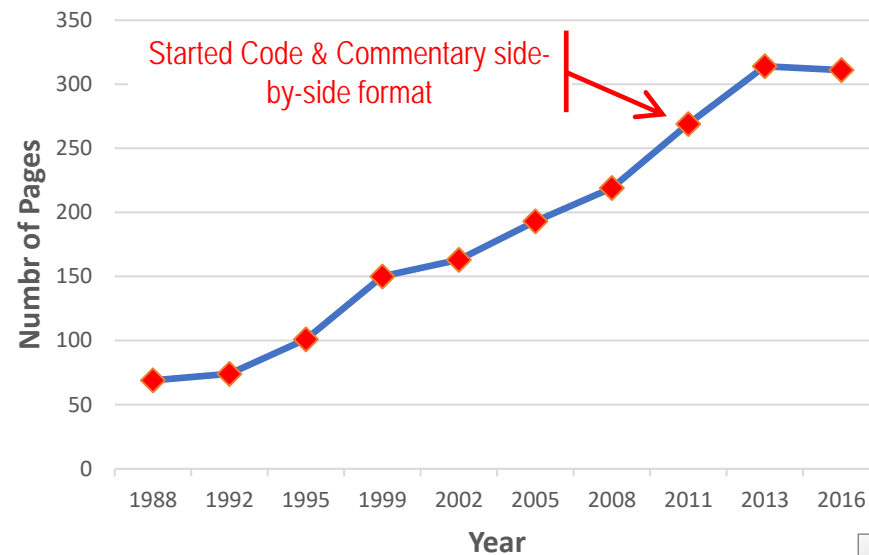


TMS 402/602

- Bigger is not necessarily Better



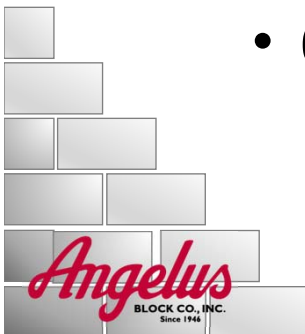
TMS 402/602



TMS 402/602

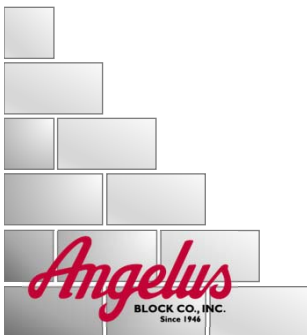


- Non-Technical Updates
 - Removed ACI and ASCE as Co-Sponsors
 - 2005 – ACI 530/TMS 402/ASCE 5/ACI 530.1...
 - 2008 – TMS 402/ACI 530/ASCE 6/TMS 602...
 - 2016 – TMS 402/TMS 602
 - Where possible, change text provisions into tables
 - Most reinforcement provisions moved to Chapter 6
 - Quality Assurance Tables combined and simplified
 - Page stabilization (6 fewer pages than previous cycle)
 - 6-Year cycle for subsequent (2022) edition



TMS 402

Part 1 – General (Chapters 1 – 3)



TMS 402 Text to Tables



- Text to Tables
 - 2013 TMS 402

3.1.1 *Level A Quality Assurance*

The minimum quality assurance program for masonry in Risk Category I, II, or III structures and designed in accordance with Part 4 or Appendix A shall comply with Table 3.1.1.

3.1.2 *Level B Quality Assurance*

3.1.2.1 The minimum quality assurance program for masonry in Risk Category IV structures and designed in accordance with Chapter 12 or 13 shall comply with Table 3.1.2.

3.1.2.2 The minimum quality assurance program for masonry in Risk Category I, II, or III structures and designed in accordance with chapters other than those in Part 4 or Appendix A shall comply with Table 3.1.2.

3.1.3 *Level C Quality Assurance*

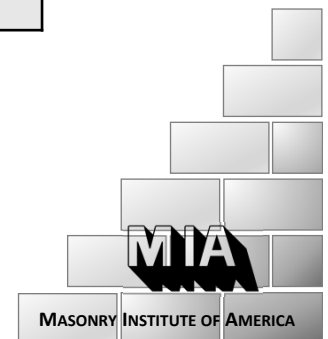
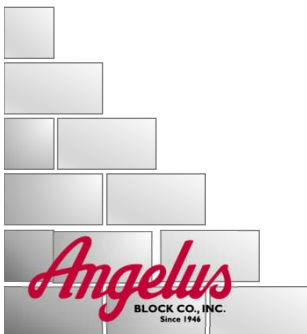
The minimum quality assurance program for masonry in Risk Category IV structures and designed in accordance with chapters other than those in Part 4 or Appendix A shall comply with Table 3.1.3.

TMS 402 Text to Tables



- Text to Tables
 - 2016 TMS 402

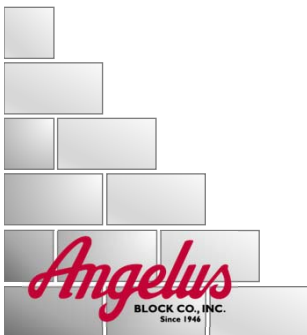
Table 3.1 Minimum Quality Assurance Level		
Designed in accordance with	Risk Category I, II or III	Risk Category IV
Part 3 or Appendix B or Appendix C	Level 2	Level 3
Part 4	Level 1	Level 2
Appendix A	Level 1	Not permitted



TMS 402

Part 2 – Design Requirements

(Chapters 4 – 7)



TMS 402 Text to Tables



- 2013 TMS 402

4.2.2 Elastic moduli

4.2.2.1 *Steel reinforcement* — Modulus of elasticity of steel reinforcement shall be taken as: $E_s = 29,000,000$ psi (200,000 MPa)

4.2.2.2 Clay and concrete masonry

4.2.2.2.1 The design of clay and concrete masonry shall be based on the following modulus of elasticity values:

$E_m = 700 f'_m$ for clay masonry;

$E_m = 900 f'_m$ for concrete masonry;

4.2.2.2.2 Modulus of rigidity of clay masonry and concrete masonry shall be taken as: $E_v = 0.4E_m$

4.2.2.3 AAC masonry

4.2.2.3.1 Modulus of elasticity of AAC masonry shall be taken as: $E_{AAC} = 6500 (f'_{AAC})^{0.6}$

4.2.2.3.2 Modulus of rigidity of AAC masonry shall be taken as: $E_v = 0.4 E_{AAC}$

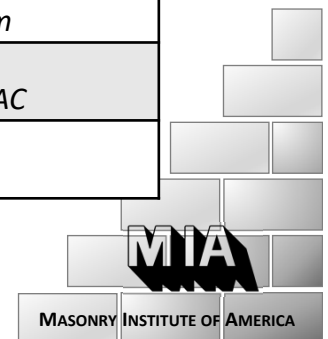
4.2.2.4 *Grout* — Modulus of elasticity of grout shall be taken as $500 f'_g$.

TMS 402 Text to Tables



- 2016 TMS 402

Table 4.2.2 Elastic Moduli		
Material	Modulus of Elasticity	Modulus of Rigidity
Steel Reinforcement	$E_s = 29,000,000\text{psi}$ (200,000MPa)	---
Prestressing Steel	E_{ps} shall be determined by tests or provided by manufacturer	---
Clay Masonry	$E_m = 700 f'_m$	$G = 0.4E_m$
Concrete Masonry	$E_m = 900 f'_m$	$G = 0.4E_m$
AAC Masonry	$E_{AAC} = 6500 (f'_{AAC})^{0.6}$	$G = 0.4E_{AAC}$
Grout	$E_g = 500 f'_g$	---



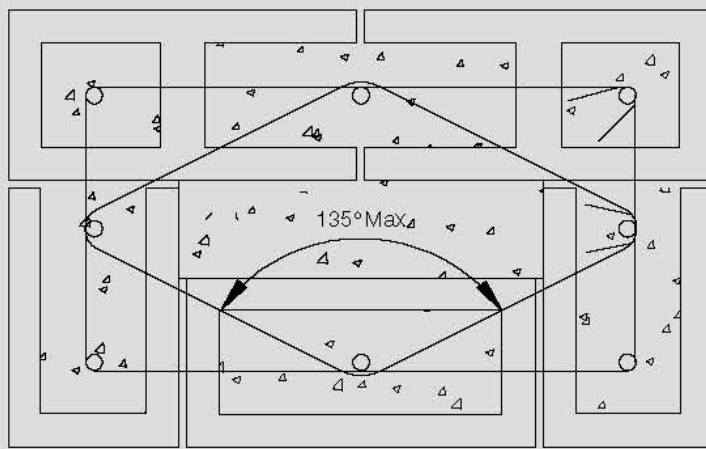
TMS 402 Structural Members



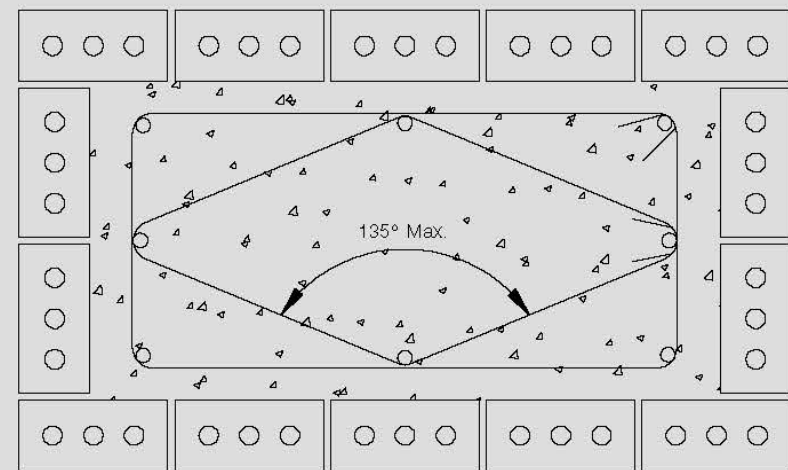
- Added Commentary Figure for Column Ties

5.3.1.4 *Lateral ties*

(c) Lateral ties shall be arranged so that every corner and alternate longitudinal bar shall have lateral support provided by the corner of a lateral tie with an included angle of not more than 135 degrees. No bar shall be farther than 6 in. (152 mm) clear on each side along the lateral tie from such a laterally supported bar. Lateral ties shall be placed in grout



Clear space between bars greater than 6 in.



Clear space between bars greater than 6 in.

Amg

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TMS 402 Structural Members



- Derived from ACI 318

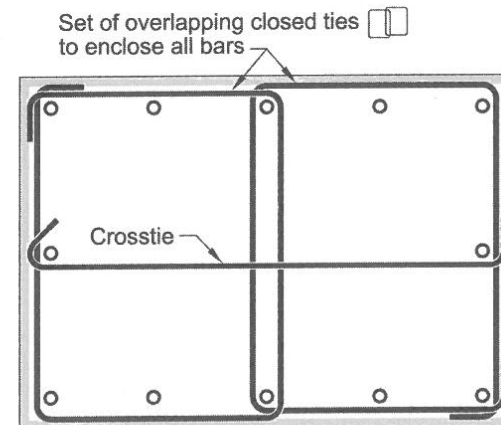
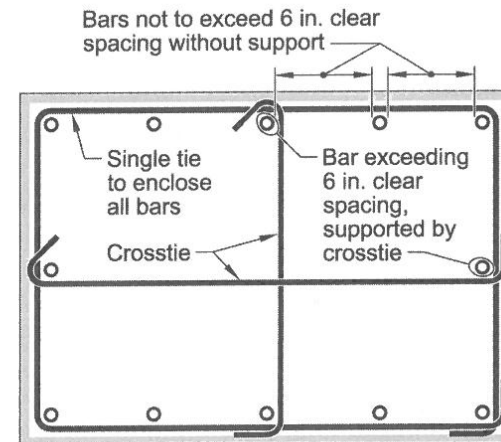
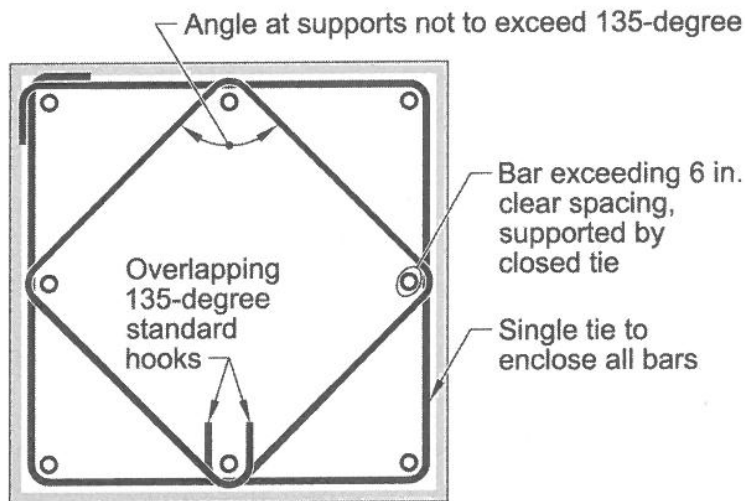
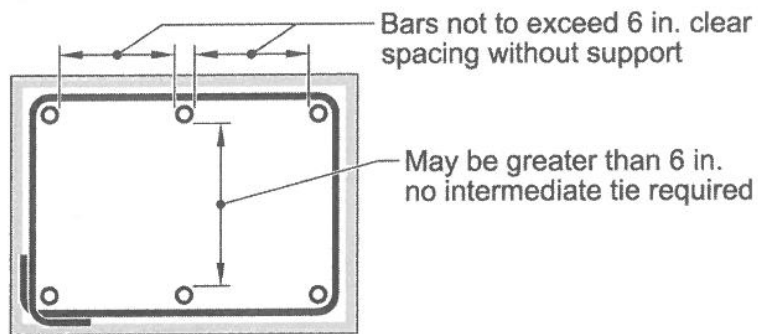
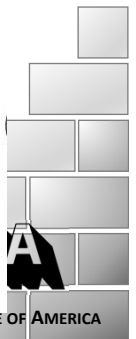


Fig. R25.7.2.3a—Illustrations to clarify measurements between laterally supported column bars and rectilinear tie



TMS 402 Reinforcement



2013 TMS 402

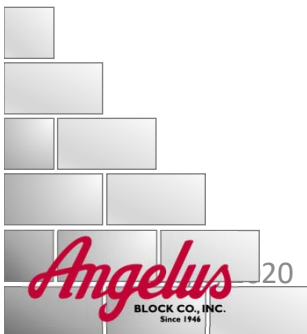
6.1 Details of reinforcement and metal accessories

- 6.1.1 Embedment
- 6.1.2 Size of reinforcement
- 6.1.3 Placement of reinforcement
- 6.1.4 Protection of reinforcement and metal accessories
- 6.1.5 Standard hooks
- 6.1.6 Minimum bend diameter for reinforcing bars

2016 TMS 402

6.1 Reinforcement

- 6.1.1 Embedment
- 6.1.2 Size of reinforcement
- 6.1.3 Placement of reinforcement
- 6.1.4 Protection of reinforcement
- 6.1.5 Development
 - 6.1.5.1 Development of bar reinforcement in tension or compression
 - 6.1.5.2 Development of wires in tension
- 6.1.6 Splices
 - 6.1.6.1 Splices of bar reinforcement
 - 6.1.6.1.1 Lap Splices
 - 6.1.6.1.2 Welded Splices
 - 6.1.6.1.3 Mechanical Splices
 - 6.1.6.1.4 End beating splices



TMS 402 Reinforcement



2013 TMS 402

6.1 Details of reinforcement and metal accessories

2016 TMS 402

6.1 Reinforcement

6.1.6.2 Splices of wires in tension

6.1.6.2.1 Lap Splices

6.1.6.2.2 Welded Splices

6.1.6.2.3 Mechanical Splices

6.1.6.1.4 End beating splices

6.1.7 Shear reinforcement

6.1.7.1 Horizontal shear reinforcement

6.1.7.2 Stirrups

6.1.7.3 Welded wire reinforcement

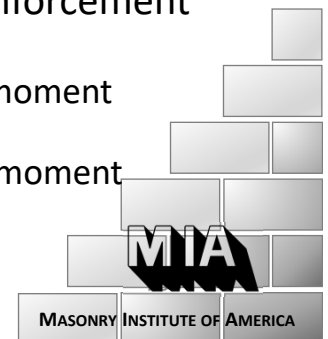
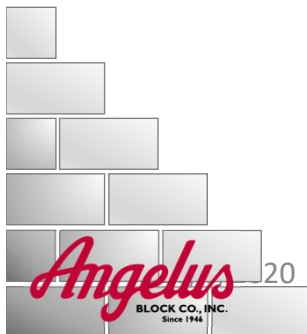
6.1.8 Standard hooks and bends for reinforcing bars, stirrups and ties

6.1.9 Embedment of flexural reinforcement

6.1.9.1 General

6.1.9.2 Development of positive moment reinforcement

6.1.9.3 Development of negative moment reinforcement



TMS 402 Reinforcement



2013 TMS 402

6.1 Details of reinforcement and metal accessories

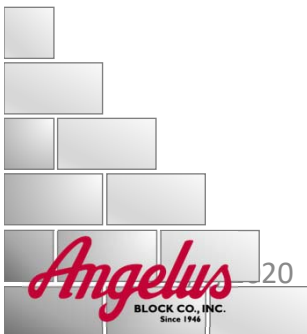
6.3 Anchor bolts

2016 TMS 402

6.2 Metal accessories

6.2.1 Protection of metal accessories

6.2 Anchor bolts



TMS 402-Reinforcement



- Harmonization of Reinforcement Requirements

6.1.2 *Size of reinforcement*

6.1.2.1 The maximum size of reinforcement used in masonry shall be No. 11 (M #36). *(#9 in Strength Design, 9.3.3.1)*

6.1.2.2 The diameter of reinforcement shall not exceed one-half the least clear dimension of the cell, bond beam, or collar joint in which it is placed. *(One-quarter least clear dimension in Strength Design, 9.3.3.1)*

6.1.2.3 Longitudinal and cross wires of joint reinforcement shall have a minimum wire size of W 1.1 (MW7) and a maximum wire size of one-half the joint thickness.

6.1.2.4 Area of vertical reinforcement shall not exceed 6 percent of the area of the grout space. *(4% in Strength Design, 9.3.3.1)*

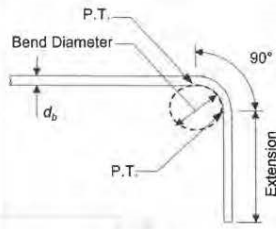
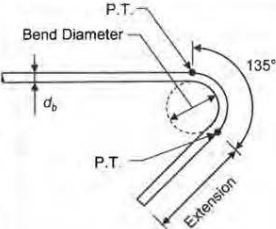
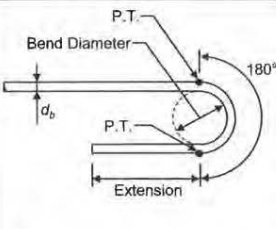

6.1.2.5 The nominal bar diameter shall not exceed one-eighth of the least nominal member dimension. *(Previously only in Strength Design)*

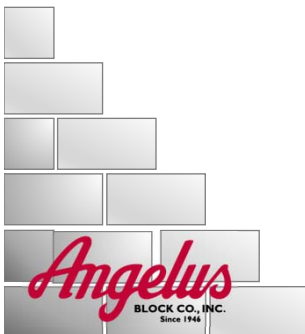


TMS 402

- Text to Tables
 - 2016 TMS 402

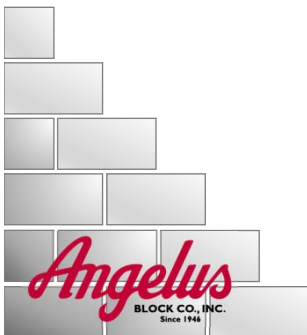
Table 6.1.8 Standard Hooks Geometry and Minimum Inside Bend Diameters for Reinforcing Bars, Stirrups & Ties

Standard Hook Type and Use	Bar Grade	Bar Size	Min. Inside Bend Diameter	Extension	Standard Hook Figures
90 Degree Hook – Reinforcing Bars	40 (M280)	No. 3 - No. 7 (M#10 - #22)	$5d_b$	$12d_b$	 <p>P.T. = Point of Tangency</p>
	50 or 60 (M350 or 420)	No. 3 - No. 8 (M#10 - #25)	$6d_b$	$12d_b$	
	50 or 60 (M350 or 420)	No. 9 - No. 11 (M#29 - #36)	$8d_b$	$12d_b$	
90 Degree Hook – Stirrups & Ties	40, 50, 60 (M280, 350 or 420)	No. 3 - No. 5 (M#10 - #16)	$4d_b$	$6d_b$ but not less than 2-1/2 in. (64 mm)	 <p>P.T. = Point of Tangency</p>
	40 (M280)	No. 6 and No. 7 (M#19 - #22)	$5d_b$	$6d_b$	
	50 or 60 (M350 or 420)	No. 6 - No. 8 (M#19 - #25)	$6d_b$	$6d_b$	
	50 or 60 (M350 or 420)	No. 9 - No. 11 (M#29 - #36)	$8d_b$	$6d_b$	
135 Degree Hook – Stirrups & Ties	40, 50, 60 (M280, 350 or 420)	No. 3 - No. 5 (M#10 - #16)	$4d_b$	$6d_b$	 <p>P.T. = Point of Tangency</p>
	40 (M280)	No. 6 and No. 7 (M#19 - #22)	$5d_b$	$6d_b$	
	50 or 60 (M350 or 420)	No. 6 - No. 8 (M#19 - #25)	$6d_b$	$6d_b$	
	50 or 60 (M350 or 420)	No. 9 - No. 11 (M#29 - #36)	$8d_b$	$6d_b$	
180 Degree Hook – Reinforcing Bars	40 (M280)	No. 3 - No. 7 (M#10 - #22)	$5d_b$	$4d_b$ but not less than 2-1/2 in. (64 mm)	 <p>P.T. = Point of Tangency</p>
	50 or 60 (M350 or 420)	No. 3 - No. 8 (M#10 - #25)	$6d_b$	$4d_b$ but not less than 2-1/2 in. (64 mm)	
	50 or 60 (M350 or 420)	No. 9 - No. 11 (M#29 - #36)	$8d_b$	$4d_b$	



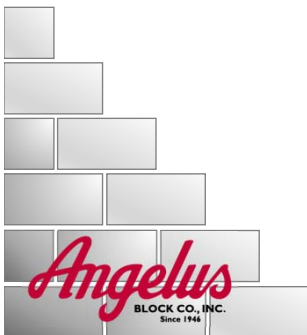
TMS 402

Part 3 – Engineered Design Methods *(Chapters 8 – 11)*



TMS 402

Part 4 – Prescriptive Design Methods *(Chapters 12 – 14)*



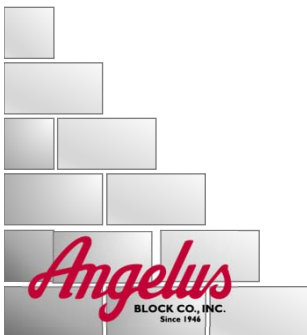
TMS 402-Veneer



- Change in Cavity Width
 - 2013 TMS 402 (Steel Stud Backing)

12.2.2.7 Masonry veneer anchored to steel backing

12.2.2.7.4 A 4½ in. (114-mm) maximum distance between the inside face of the veneer and the steel framing shall be specified. A 1 in. (25.4 mm) minimum air space shall be specified.



TMS 402-Veneer



- Change in Cavity Width
 - 2016 TMS 402 (Steel Stud Backing)

12.2.2.7 Masonry veneer anchored to steel backing

12.2.2.7.5 A $6\frac{5}{8}$ in. (168 mm) maximum distance between the inside face of the veneer and the steel framing shall be specified. A 1 in. (25.4 mm) minimum air space shall be specified.

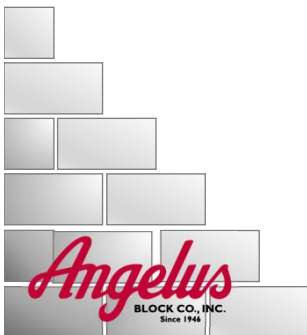
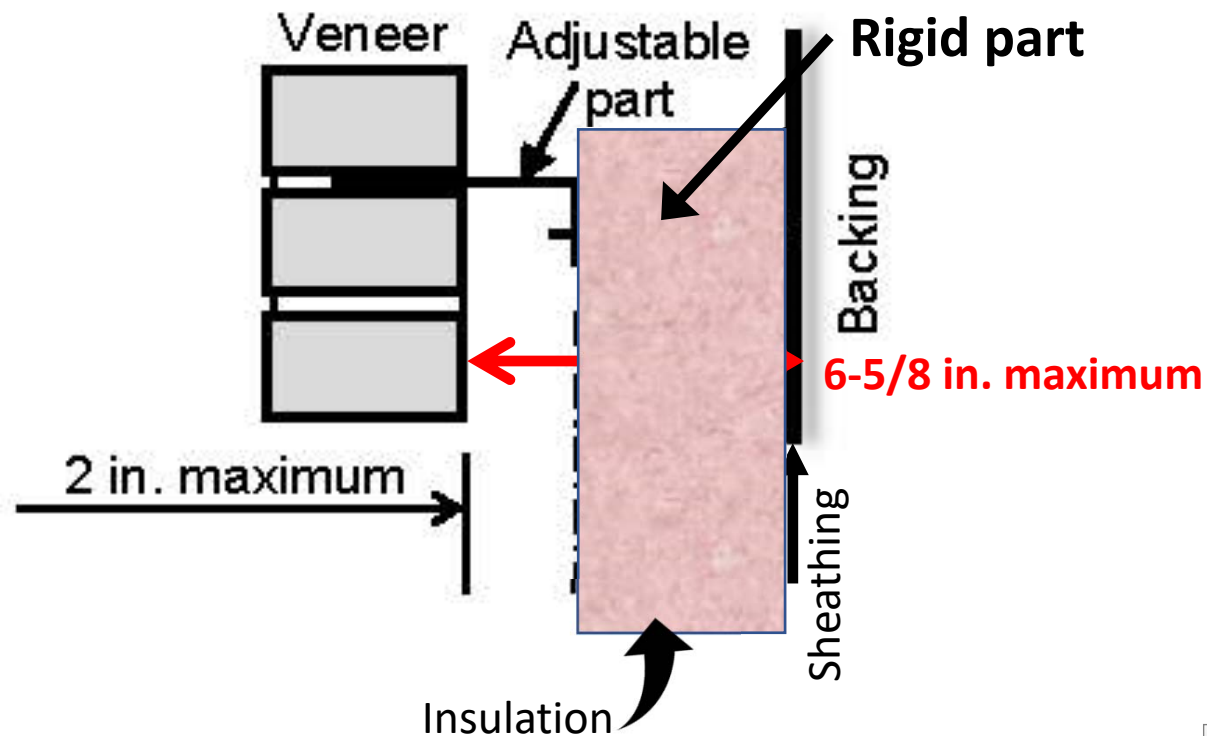
12.2.2.5.5.5 When the distance between the inside face of the veneer and the backing exceeds $4\frac{5}{8}$ in. (117 mm), adjustable anchors shall also conform to the requirements of Sections 12.2.2.5.5.5.1 and 12.2.2.5.5.5.2.

12.2.2.5.5.5.1 The adjustable part of the anchor shall consist of two or more wires of minimum size W2.8 (MW18). The distance from the inside face of the veneer to the end of the adjustable part shall be a maximum of 2 in. (51 mm).

TMS 402-Veneer



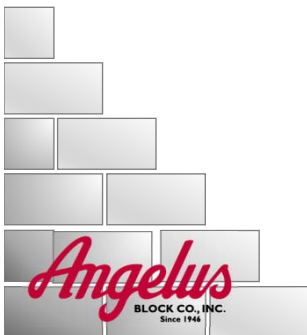
- Change in Cavity Width
 - Increased from 4-1/2 inches to 6-5/8 inches



TMS 402-Veneer

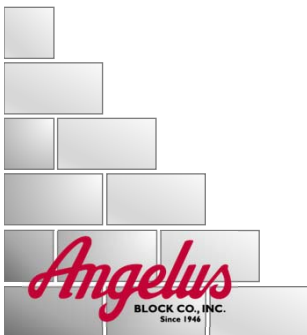


- Increase in Cavity Width
 - Must be adjustable anchor
 - Maximum span (airspace) of adjustable portion is 2 in.
 - (Rigid) Part attached to backing must be either 1/4-inch barrel anchor, a plate or prong anchor at least 0.074 in. thick and 1-1/4 in. wide or (for masonry backing) a tab of two eyes formed of minimum wire size W2.8 (3/16 in.) wire welded joint reinforcement



TMS 602

Specification for Masonry Structures



TMS 602-Cleanup



2013 Specification

1.1 C. This article addresses the furnishing and construction of masonry including the following:

1. Furnishing and placing masonry units, grout, mortar, masonry lintels, sills, copings, through-wall flashing, and connectors.
2. Furnishing, erecting and maintaining of bracing, forming, scaffolding, rigging, and shoring
3. Furnishing and installing other equipment for constructing masonry.
4. Cleaning masonry and removing surplus material and waste.
5. Installing lintels, nailing blocks, inserts, window and door frames, connectors, and construction items to be built into the masonry, and building in vent pipes, conduits and other items furnished and located by other trades.

2013 Commentary

1.1 C. The scope of the work is outlined in this article. All of these tasks and materials will not appear in every project.

TMS 602-Added Materials



- Added Cast and Manufactured Stone Materials

1.3 – Reference standards

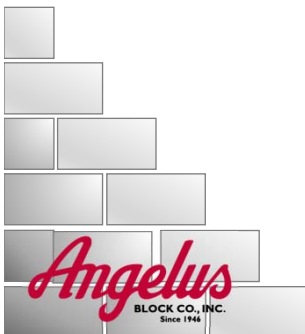
BG. ASTM C1364-16 Standard Specification for Architectural Cast Stone

BP. ASTM C1670-15 Standard Specification for Adhered Manufactured Stone Masonry Veneer Units

2.3 – Masonry unit materials

2.3 F. Provide cast stone that conforms to ASTM C1364 as specified.

2.3 G. Provide manufactured stone that conforms to ASTM C 1670 as specified.



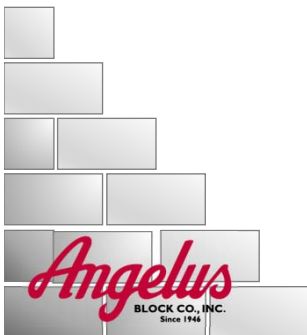
TMS 602-2013 QA Tables



Table 3.1.1/3-Level A Quality Assurance

MINIMUM VERIFICATION

Prior to construction, verify certificates of compliance used in masonry construction.



TMS 602-2013 QA Tables



Table 3.1.2/4-Level B Quality Assurance

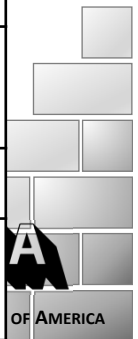
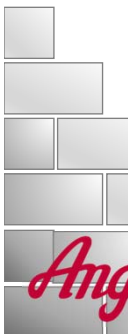
MINIMUM TESTS				
Verification of Slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with Article 1.5 B.1.b.3 for self-consolidating grout				
Verification of f'_m and f'_{AAC} in accordance with Article 1.4 B prior to construction, except where specifically exempted by the Code.				
MINIMUM SPECIAL INSPECTION				
Inspection Task	Frequency		Reference for Criteria	
	Continuous	Periodic	TMS 402	TMS 602
1. Verify compliance with the approved submittals		X		Art. 1.5
2. As masonry construction begins, verify the following are in compliance				
a. Proportions of site-prepared mortar		X		Art. 2.1 2.6

TMS 602-2013 QA Tables



Table 3.1.3/4-Level C Quality Assurance

MINIMUM TESTS				
Verification of f'_m and f'_{AAC} in accordance with Article 1.4 B prior to construction and for every 5,000 sq. ft (465 sq. m) during construction				
Verification of proportions of materials in premixed or preblended mortar, prestressing grout, and grout other than self-consolidating grout as delivered to the project site				
Verification of Slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with Article 1.5 B.1.b.3 for self-consolidating grout				
MINIMUM SPECIAL INSPECTION				
Inspection Task	Frequency		Reference for Criteria	
	Continuous	Periodic	TMS 402	TMS 602
1. Verify compliance with the approved submittals		X		Art. 1.5
2. Verify the following are in compliance				
a. Proportions of site-mixed mortar, grout, and prestressing grout for bonded tendons		X		Art. 2.1 2.6



TMS 602-QA Tables



- There Must be a Better Way
- Simplify by:
 - Going Back to Designations 1,2 and 3 (vs. A, B and C)
 - Consistent language of tasks
 - QA Level B – “As masonry construction begins, verify that the following are in compliance”
 - QA Level C – “Verify that the following are in compliance”
 - Combine the Tables into One
 - Delete the Duplicate Tables in Code and Use Reference Pointer to Specification Tables



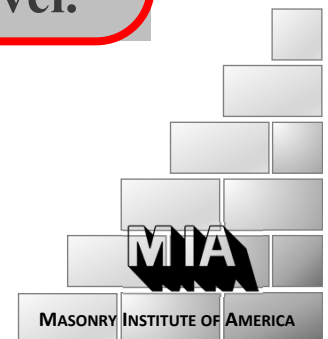
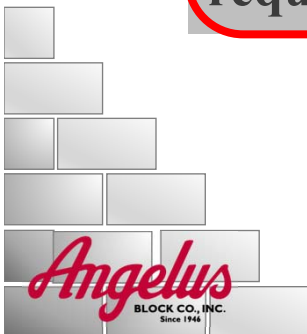
TMS 402/602-2016 QA Tables



- The Pointer

3.1 - Quality Assurance program

The quality assurance program shall comply with the Level defined in Table 3.1, depending on how the masonry was designed and the Risk Category, as defined in ASCE 7 or the legally adopted building code. **The quality assurance program shall itemize the requirements for verifying conformance of material composition, quality, storage, handling, preparation, and placement with the requirements of TMS 602, and shall comply with the minimum requirements of TMS 602, Tables 3 and 4, for the required Level.**



TMS 602-QA Tables



Table 3 – Minimum Verification Requirements				
Minimum Verification	Required for Quality Assurance ^(a)			Reference for Criteria
	Level 1	Level 2	Level 3	TMS 602
Prior to construction, verification of compliance of submittals	R	R	R	Art. 1.5
Prior to construction, verification of $f'm$ and f'_{AAC} , except where specifically exempted by the Code	NR	R	R	Art. 1.4 B
During construction, verification of Slump flow and Visual Stability Index (VSI) when self-consolidating grout is delivered to the project site.	NR	R	R	Art 1.5 & 1.6.3
During construction, verification of $f'm$ and f'_{AAC} for every 5,000 sq. ft. (465 sq. m).	NR	NR	R	Art. 1.4 B
During construction, verification of proportions of materials as delivered to the project site for premixed or preblended mortar, prestressing grout, and grout other than self-consolidating grout	NR	NR	R	Art. 1.4 B

(a) R=Required, NR=Not Required



TMS 602-QA Tables



Table 4 – Minimum Special Inspection Requirements					
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. Grade and size of prestressing tendons and anchorages	NR	P	P		Art. 2.4 B & 2.4 H
c. Grade, type and size of reinforcement, connectors, anchor bolts and prestressing tendons and anchorages	NR	P	P		Art. 3.4 & 3.6 A
d. Prestressing technique	NR	P	P		Art. 3.6 B
e. Properties of thin-bed mortar for AAC masonry	NR	C ^(b) /P ^(c)	C		Art. 2.1 C.1
f. Sample panel construction	NR	P	C		Art. 1.6 D

^(a) Frequency refers to the frequency of inspection, which may be continuous during the listed task or periodically during the listed task, as defined in the table.

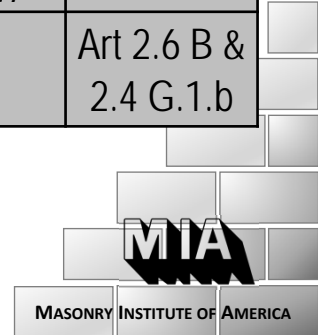
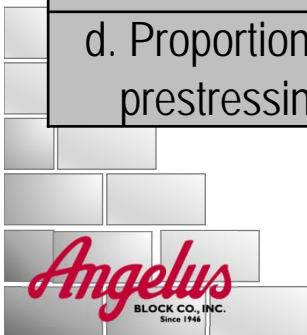
^(b) Required for the first 5000 square feet (465 square meters) of AAC masonry.

^(c) Required after the first 5000 square feet (465 square meters) of AAC masonry.

TMS 602-QA Tables



Table 4 – Minimum Special Inspection Requirements					
Inspection Task	Frequency			Reference for Criteria	
	Level 1	Level 2	Level 3	TMS 402	TMS 602
2. Prior to grouting, verify that the following are in compliance:					
a. Grout space	NR	P	C		Art. 3.2 D & 3.2 F
b. Placement of prestressing tendons and anchorages	NR	P	P	Sec. 10.8 & 10.9	Art. 2.4 & 3.6
c. Placement of reinforcement, connectors, and anchor bolts	NR	P	C	Sec. 6.1, 6.3.1, 6.3.6 & 6.3.7	Art. 3.2 E & 3.4
d. Proportions of site-prepared grout and prestressing grout for bonded tendons	NR	P	P		Art 2.6 B & 2.4 G.1.b



TMS 602-QA Tables



Table 4 – Minimum Special Inspection Requirements

Inspection Task	Frequency			Reference for Criteria	
	Level 1	Level 2	Level 3	TMS 402	TMS 602
3. Verify compliance of the following during construction:					
a. Materials and procedures with the approved submittals	NR	P	P		Art. 1.5
b. Placement of masonry units and mortar joint construction	NR	P	P		Art. 3.3 B
c. Size and location of structural elements	NR	P	P		Art. 3.3 F
d. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction	NR	P	C	Sec. 1.2.1(e), 6.2.1 & 6.3.1	
e. Welding of reinforcement	NR	C	C	Sec. 6.1.6.1.2	

TMS 602-QA Tables



Table 4 – Minimum Special Inspection Requirements					
Inspection Task	Frequency			Reference for Criteria	
	Level 1	Level 2	Level 3	TMS 402	TMS 602
3. Verify compliance of the following during construction:					
f. Preparation, construction, and protection of masonry during cold weather (temperature below 40°F (4.4°C)) or hot weather (temperature above 90°F (32.2°C))	NR	P	P		Art. 1.8 C & 1.8 D
g. Application and measurement of prestressing force	NR	C	C		Art. 3.6 B
h. Placement of grout and prestressing grout for bonded tendons is in compliance	NR	C	C		Art 3.5 & 3.6 C
i. Placement of AAC masonry units and construction of thin-bed mortar joints	NR	C ^(b) /P ^(c)	C		Art. 3.3 B.9 & 3.3 F.1b
4. Observe preparation of grout specimens, mortar specimens, and/or prisms	NR	P	C		Art.1.4 B.2.a.3, b.3, c.3, 1.4 B.3 & 1.4 B.4

TMS 602-QA Tables

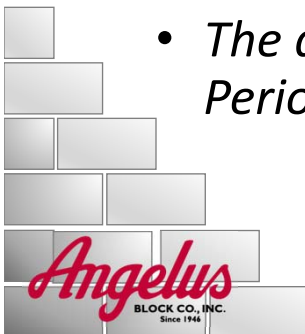


- In a Perfect World, Plan Sheet S-01 would be:

MASONRY NOTES

Verify and inspect masonry materials and installation in accordance with Quality Assurance Level (Choose one: 1, 2, 3) as listed in the following tables:

- *Cut-and-paste TMS 602 Tables 3 and 4 in their entirety. The note and tables can be used for every job providing the QA level is considered exclusively for the particular project.*
- *Advantage: The inspector, contractor and supplier will be using familiar provisions on each and every project, only the application (NR, P or C) will change.*
- *The designer can always increase inspection requirements (e.g. change Periodic to Continuous) as needed.*



TMS 602-Field & Lab Testing Technicians



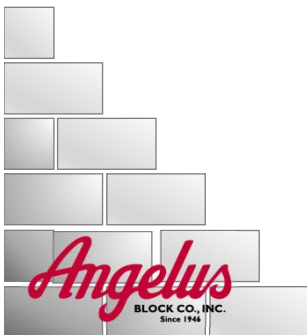
- ACI 318-14 Structural Concrete

26.12 Concrete evaluation and acceptance

26.12.1.1 Compliance requirements:

(c) Qualified field testing technicians shall perform tests of fresh concrete at the job site, prepare specimens for standard curing prepare specimens for field curing, if required, and record temperature of the fresh concrete when preparing specimens for strength tests.

(d) Qualified laboratory technicians shall perform required laboratory tests.

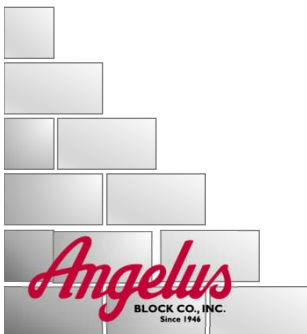


TMS 602-Field Testing Technicians



- TMS 602-16-Inspector Qualification-New Language

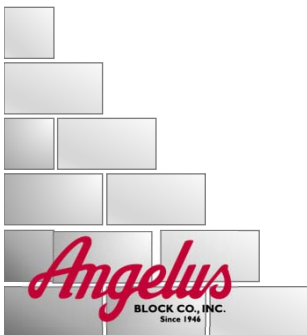
SPECIFICATION	COMMENTARY
<p>1.6 B <i>Inspection Agency's services and duties</i></p> <p>1. Utilize qualified field testing technicians to observe or perform the preparation and handling of grout specimens, mortar specimens and/or masonry prisms.</p>	<p>1.6 B <i>Inspection Agency's services and duties</i></p> <p>1. Field technicians who are certified in accordance with the requirements of ACI Masonry Field Testing Technician Certification Program, or an equivalent program, are qualified to observe and/or prepare masonry specimens.</p>



TMS 602-Field Testing Technicians



- Field Testing Technician Qualifications
 - One Hour Closed Book Test (60 questions, 70% Min.)
 - C67-Sampling and Testing Brick (60% Minimum)
 - C140-Sampling and Testing CMU (60% Minimum)
 - C780-Evaluation of Mortars for Masonry (60% Minimum)
 - C1019-Sampling and Testing Grout (60% Minimum)
 - C1314-Sampling and Testing Masonry Prisms (60% Minimum)
 - Closed Book Performance Evaluation Examination (Hands-on)
 - C140 Sampling CMU
 - C780 Sampling Mortar
 - C1019 Sampling Masonry Grout

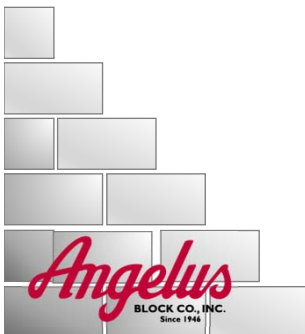


TMS 602-Inspection



- TMS 602-16-Special Inspector Qualification

SPECIFICATION	COMMENTARY
<p>1.6 B <i>Inspection Agency's services and duties</i></p> <p>2. Utilize qualified Special Inspectors to inspect and evaluate construction. Inspect and evaluate in accordance with Tables 3 and 4, as specified for the project.</p>	<p>1.6 B <i>Inspection Agency's services and duties</i></p> <p>2. Special inspectors who are certified for this service by International Code Council, or other acceptable agency, are qualified.</p>



TMS 602-Inspection



- Inspector Qualifications-3 Open Book Tests

- Special Inspector General Requirements

- 1 Hour, 25 Questions

- Structural Masonry Special Inspector – Codes

- 2 Hours, 60 Questions

- Knowledgeable on:

ASTM A615

ASTM A951

ASTM C90

ASTM C140

ASTM C216

ASTM C270

ASTM C476

ASTM C1019

ASTM C1314

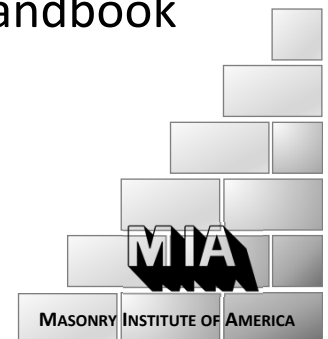
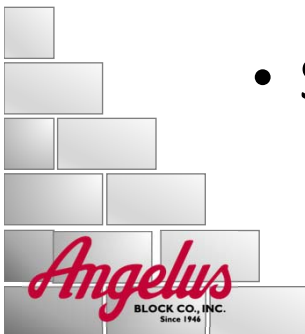
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TMS 402/602

Masonry Inspectors Handbook

- Structural Masonry Special Inspector – Plans

- 1-1/2 Hours, 30 Questions

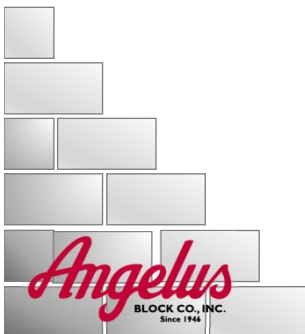


TMS 602-Lab Testing



- TMS 602-16-Lab Testing Technician-New

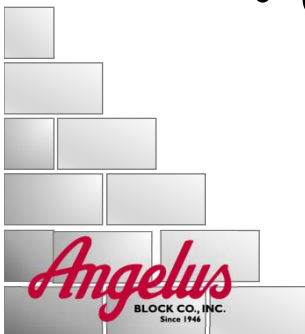
SPECIFICATION	COMMENTARY
<p>1.6 A <i>Testing Agency's services and duties</i></p> <p>1. Utilize qualified laboratory technicians to perform required laboratory tests.</p>	<p>1.6 B <i>Testing Agency's services and duties</i></p> <p>1. Masonry testing laboratory personnel who are certified in accordance with ACI Masonry Laboratory Testing Technician Certification Program, or equivalent program, are qualified.</p>



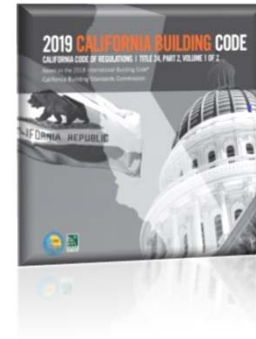
TMS 602-Lab Testing



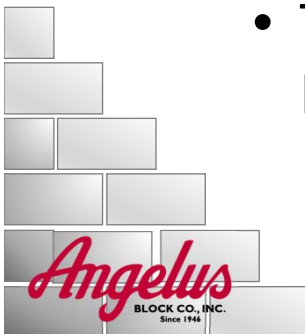
- Lab Testing Technician Qualifications
 - 1-1/2 Hour Open Book Test (70 questions, 70% Min.)
 - C90-Concrete Masonry Units (60% Minimum)
 - C140-Sampling and Testing CMU (60% Minimum)
 - C270-Mortar for Masonry (60% Minimum)
 - C780-Evaluation of Mortars for Masonry (60% Minimum)
 - C1019-Sampling and Testing Grout (60% Minimum)
 - C1314-Sampling and Testing Masonry Prisms (60% Minimum)
 - C1552-Capping Concrete Masonry Units (60% Minimum)
 - Closed Book Performance Evaluation Examination (Hands On)
 - C140-Testing CMU
 - C780-Testing Mortar
 - C1019-Testing Masonry Grout
 - C1552-Capping Masonry Units



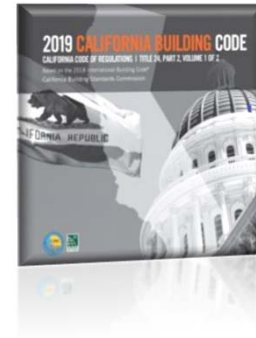
Chapter 21-OSHPD



- The OSHPD Approach
 - Tried to make Chapter 21 (OSHPD) provisions mirror Chapter 21A
 - Unnecessarily added duplicate provisions already contained in Reference Standard (TMS 402/602)
 - Did not seek assistance or review from Industry Stakeholders
 - Made some provisions less conservative than Reference Standard
 - There are references to irrelevant sections in the Material Standard



Chapter 21-OSHPD

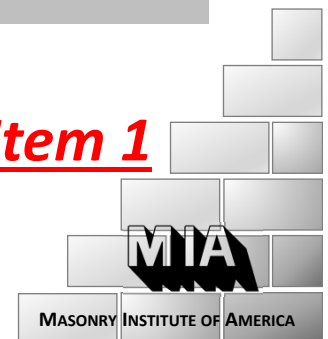
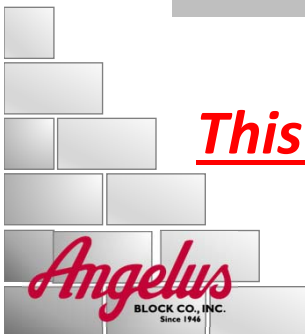


- The OSHPD Approach
 - Added to both Chapter 21 and 21A

2105.5 Masonry prism method testing [OSHPD 1R, 2 & 5] The prism test method performed prior to the start or during construction shall be in accordance with TMS 402 Section 1.4 B.3. The Prism test method performed on constructed walls shall be in accordance with TMS 602, Section 1.4 B.4.

2105.6 Unit strength method testing. [OSHPD 1R, 2 and 5] Unit strength method testing shall be performed in accordance with TMS 602 Section 1.4 B.2.

This provision totally violates CBSC HS Code §18930, Item 1



Chapter 21-OSHPD



- The OSHPD Approach
 - TMS 402/602 Provisions

TMS 402

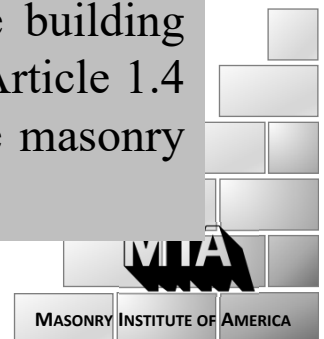
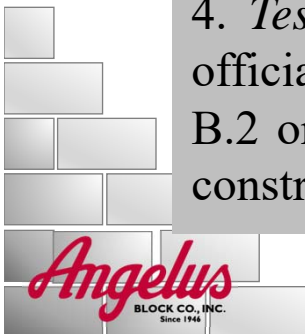
3.1.3.2 *Determination of compressive strength* – Compressive strength shall be determined in accordance with the provisions of TMS 602

TMS 602

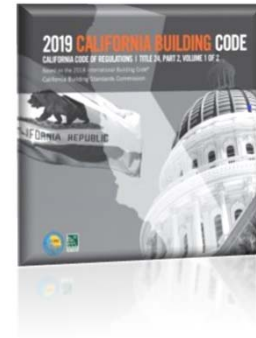
1.4 B. Compressive strength determination

1. Methods for determination of compressive strength - Determine the compressive strength for each wythe by the unit strength method or by the prism test method as specified here.

4. Testing prisms from constructed masonry – When approved by the building official, acceptance of masonry that does not meet the requirements of Article 1.4 B.2 or 1.4 B.3 is permitted to be based on tests of prisms cut from the masonry construction.



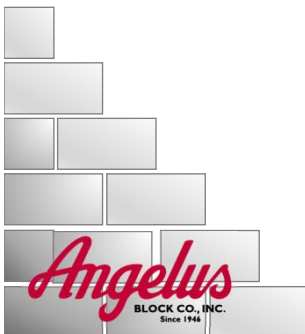
Chapter 21-OSHPD



- The OSHPD Approach
 - A provision LESS CONSERVATIVE than Material Standard

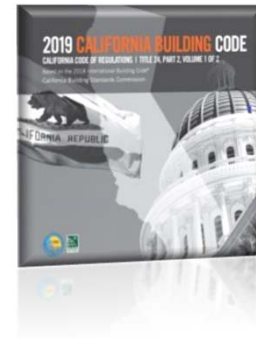
***CBC 2106.1.1.2 Minimum reinforcement for masonry columns.** The spacing of column ties shall be as follows: not greater than eight bar diameters, 24 tie diameters or one half the least dimension of the column for the full column height. Ties shall be at least 3/8 inch in diameter and shall be embedded in grout....*

***TMS 402 7.4.4.2.1 Minimum reinforcement for masonry columns** - Lateral ties in masonry columns shall be spaced not more than 8 in. (203 mm) on center and shall be at least 3/8 in. (9.5 mm) diameter. Lateral ties shall be embedded in grout.*



Chapter 21-OSHPD

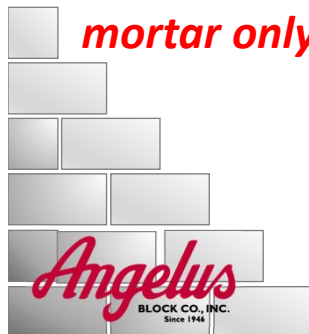
- The OSHPD Approach
 - Irrelevant References



***CBC 2105.3 Mortar and grout tests.
[OSHPD 1R, 2 & 5]***

...They shall meet the minimum strength requirement given in ASTM C270, Table 1 and TMS 402, Section 7.4.4.2.2 for mortar...

ASTM C270, Table 1 specifically states the application is for laboratory prepared mortar only.



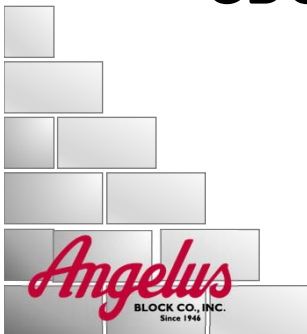
TMS 402 7.4.4.2.2 Material requirements –
Fully grouted participating elements shall be designed and specified with Type S or Type M cement-lime mortar, masonry cement mortar, or mortar cement mortar. Partially grouted participating elements shall be designed and specified with Type S or Type M cement-lime mortar or mortar cement mortar.

There is no reference to mortar strength.



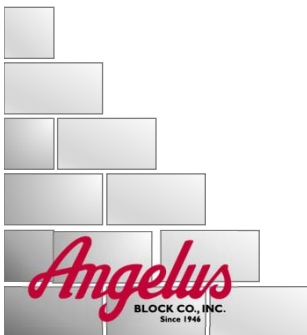
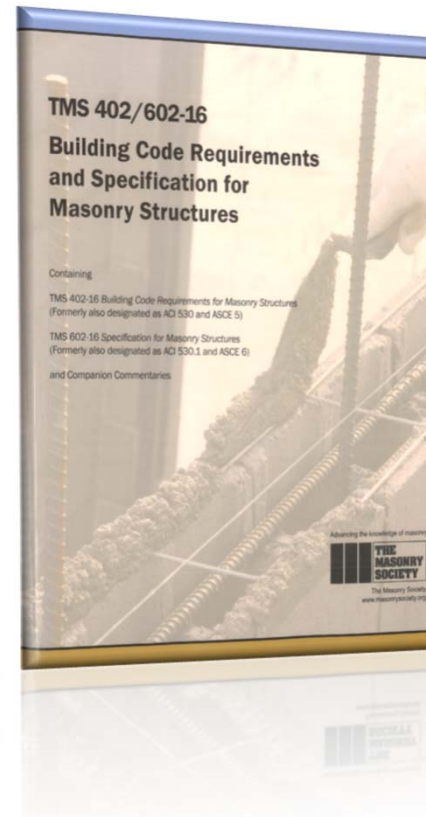
How to Use Chapter 21

- CBC Chapter 21 for NON-DSA and NON-OSHDPD
 - Ignore all italicized text
- CBC Chapter 21 for DSA [SS/CC]and NON-OSHDPD
 - Ignore all italicized text EXCEPT for Section 2115
- CBC Chapter 21 for OSHPD [1R, 2 and 5]
 - Ignore Section 2115
- CBC Chapter 21A For OSHPD [1 and 4] and DSA [SS]



The Good News!

- TMS 402/602-16 is on a 6-Year Cycle
 - Next Stop - 2022





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