

# Overview of Changes in TMS 402/602-22 and Review of the Specification for Masonry Structures

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

## Course Description

This webinar will review the major changes from the 2016 edition to the 2022 edition of TMS 402/602. The 2022 edition was created using the first six-year revision cycle, allowing more comprehensive consideration of significant changes and reorganization of these Masonry Standards. In addition to reviewing the changes to the standards, this presentation will review the Specification for Masonry Structures (TMS 602) and will discuss the importance of why designers should be aware of how masonry is constructed.

3

## Learning Objectives


- Evaluate and utilize Masonry Standard updates
- Specify documents that are consistent with the current code
- Organize construction documents to be consistent with current codes and standards
- Recognize issues related to masonry construction.

4

## Affected Chapters

Chapter	Name	Minor	Moderate	Major	Extreme
1	General Requirements	●			
2	Notations/Definitions	●			
3	Quality & Construction		●		
4	General Analysis & Design		●		
5	Structural Members		●		
6	Reinforcement, Metal Accessories & Anchor Bolts			●	
7	Seismic Design Requirements			●	
8	Allowable Stress Design		●		
9	Strength Design			●	
10	Prestressed Masonry	●			
11	Autoclaved Aerated Masonry	●			

## Affected Chapters

Chapter	Name	Minor	Moderate	Major	Extreme
12	Design of Masonry Infills (Prev App B)	●			
13	Veneer (Previously Chapter 12)				●
14	Glass Unit Masonry (Previously Ch 13)	●			
15	Partition Walls (Previously Chapter 14)	●			
App A	Empirical Masonry (Deleted)				●
App B	Masonry Infill (Moved to Chapter 12)				
App C	Limit Design	●			
App D	Glass Fiber Reinforced Polymer Reinf				
Spec 1	General	●			
Spec 2	Products			●	
Spec 3	Execution		●		

## Changed Covers



## Chapter 1-General Requirements

- Added commentary for control joints (1.2.1 (h))
- Clarification of mortar cement mortar (1.2.1 (j))
- Update of cited Standards (1.4)

## Chapter 2-Notations and Definitions

- Added notations, particularly for Composite Masonry and Veneer
- Deleted notations and definition (particularly related to Empirical)
- Update of terms
- Formatting changes



## Chapter 3-Quality and Construction

- Section 3.2 (Construction Considerations) deleted-Subsections either duplicative or more appropriately moved
  - Minimum grout space already in Specification (Article 3.5)
  - Pipes, conduits and sleeves more appropriately moved to Code Design (4.8)



## Chapter 4-General Analysis & Design

- Masonry Compressive Strength limitations moved from Strength Design and AAC Design to General Design, so it now applies to all masonry design (4.3)
- Table showing Net Shear Area for Partially and Fully Grouted members (including beams) added—Big clarification (4.4.5)
- Moved Section 5.2.1.4.1 to General Design to clarify deflection limitation for all beams supporting unreinforced masonry (4.6)
- Moved Section 3.2 (embedded pipes, conduits and sleeved) to new Section (4.8)

## Chapter 5-Structural Members

- Reorganized for Clarity

<b>2016 TMS 402</b>
5.1 Masonry Assemblies
5.2 Beams
5.3 Columns
5.4 Pilasters
5.5 Corbels

## Chapter 5-Structural Members

- Reorganized for Clarity

2016 TMS 402	2022 TMS 402
5.1 Masonry Assemblies	5.1 General
5.2 Beams	5.2 Walls
5.3 Columns	5.3 Beams
5.4 Pilasters	5.4 Columns
5.5 Corbels	5.5 Pilasters
	5.6 Corbels

## Chapter 6-Reinforcement, Metal Access.

- Scope Defined (6.1.1)
- Clarity of Deformed Wire Requirements (6.1 Various)
- Deformed Bar Size Consistent-ASD/SD (6.1.3.2.1)
- Gross Grout Space Introduced (6.1.3.2.5)
  - **Alternate Vertical Reinforcement Maximum**
- Added Placement Requirements for Mechanical Splices (6.1.7.2.3)
- General Shear Hook Requirements Deleted
  - **Seismic Shear Hook Requirements Maintained in Chapter 7**



## Chapter 7-Seismic Design Requirements

- Exemption for Isolating Non-Participating Elements (7.3.1)
- Modifications/Clarifications for SRMSW (7.3.2.5)
- Joint Reinforcement for Shear Requirements Moved from 9.3.3.4 (7.4.1.2.1/7.4.3.2.6)
  - Now Applies to All Design Methods
- Clarification of Prescriptive Non-Participating Seismic Steel (7.4.3.1)
- Clarification of Lateral Stiffness Requirements (7.4.3.2.1)



## Chapter 8-Allowable Stress Design

- Anchor Bolt Design changed from Yield to Specified Strength (8.1.4.3)
- Masonry Allowable Axial Compressive Force increased from 0.25 to 0.30 (8.3.4.2.1)
- Partially Grouted Shear Wall Factor Decreased 0.75 to 0.70 (8.2.5.1.2)
- Axial Load Masonry Shear Strength Reduced 0.25 to 0.20 (8.3.5.1.3)
- Beam Design Moved to Chapter 5 to Apply to All Beams
- Shear Friction Factor Changed from 0.6 to 0.75 (8.3.6)



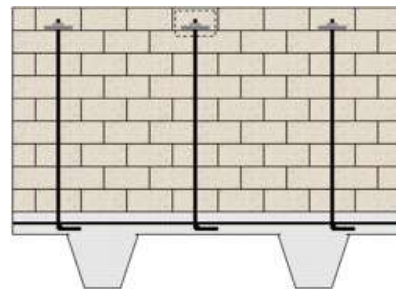
## Chapter 9-Strength Design



- Added Compression Controlled Sections for Combinations of Flexure and Axial Load (9.1.4.4)
  - Maximum Reinforcement (Except Beams, Intermediate and Special Reinforced Masonry Shear Walls) deferred to Chapter 6
- Anchor Bolt Design changed from Yield to Specified Strength (9.1.6.3)
- Partially Grouted Shear Wall Factor Decreased 0.75 to 0.70 (9.3.3.1.2)
- Modified Cracked Moment of Inertial Formula (Eq 9-28)
- Shear Friction Strength Formulas Simplified (9.3.5.5)

## Chapter 10-Prestressed Masonry

- New equation for laterally restrained and unrestrained walls (10-1)
- Added specific section for Design of Walls (10.5)
- Added section for Design of Beams and Lintels (10.6)



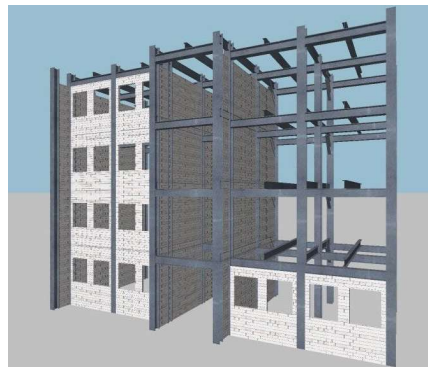
## Chapter 11-AAC Masonry

- Strength Reduction Factors moved into Table format (Table 11.1.5)
- No other significant changes



## Chapter 12-Masonry Infills

- Moved from Appendix B with virtually no changes



## Chapter 13-Masonry Veneer

- Chapter completely reorganized and enhanced
- Significant guidance for Engineered Veneer Design
- Anchored Veneer split into Basic and Enhanced Design
- Substantial design additions for Adhered Veneer
  - Polymer modified mortars recognized for setting bed
  - Major information added on backing



## Chapter 14-Glass Unit Masonry

- Thin Glass Unit limitations put into table format (Figure 14.2)
- Panel Size Limitations put into table format (Table 14.2)



## Chapter 15-Masonry Partition Walls

- Old Chapter 14 – No Change



## Appendix A-Empirical Design

- Gone



## Appendix B-Masonry Infills

- Moved to Chapter 12



## Appendix C-Limit Design Methods

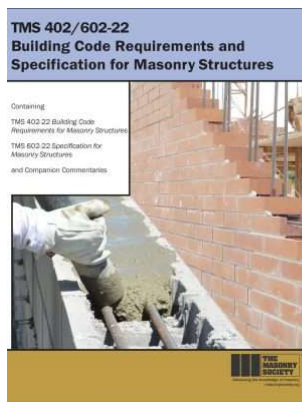
- Mechanism Deformation changed
  - From Strength Level Load,  $\delta_u$
  - To Maximum Considered Earthquake,  $\delta_{MCE}$

## Appendix D-GFRP Reinforced Masonry

- New Section (Appendix) recognizing Glass Fiber Reinforced Polymer as an acceptable masonry reinforcement in limited applications
  - Limited to Non-Participating elements
  - Limited to SDC C or lower



## TMS 602 – What Is It?



**Code – 402 (Designer)**

**Specification – 602 (Contractor)**

# Specification

## CSI Format

- Part 1 – General
- Part 2 – Products
- Part 3 – Execution

## TMS 602 Specification Format

- Part 1 – General
- Part 2 – Products
- Part 3 – Execution

# Specification Article 1-General

- Definitions-Minor modifications mostly format to be consistent with Code (Article 1.2)
- Standards-Updated and added Standards relating to GFRP and Veneer, deleted unused Standards (Article 1.3)
- Strength determination for Cast Stone Added (Article 1.4 B.2.d)
- Added submittal requirements for mechanical splices and veneer related items (Article 1.5 B.2)
- Added inspection requirements for adhered veneer (Table 4, Item 3.f)
- Added section on GFRP Reinforcing Bars (Article 1.7 F)

## Specification Article 2-Products

- Preblended mortars (ASTM C1714) added (Article 2.1 A)
- Adhered veneer setting mortar added (Article 2.1 B)
- Commentary cautions on provisions for lightweight grout (Article 2.2 C)
- Add Adhered Concrete Masonry Units, ASTM C1877 (Article 2.3 A)
- Added provision for GFRP Reinforcing Bars (Article 2.4 C)
- Add for Stainless Steel Joint Reinforcement (Article 2.4 D.1)
- Added a term for (single) wire reinforcement in veneer (Article 2.4 E)
- Added provision for stainless steel wire, ASTM A1022 (Article 2.4 F)

## Specification Article 2-Products

- Welded wire reinforcement must be deformed (Article 2.4 G)
- Added Mechanical Splice 125% requirement (Article 2.4 H)
- Put Anchor Bolts into own section, added ASTM F1554 (Article 2.4 J)
- Added Section for lath-adhered veneer (Article 2.4 O)
- Added Veneer-Related Sections for Veneer Tie Fasteners, Cementitious Backer Units, Lath Fasteners and Weep Screed (Articles 2.5 F, G, H, I)
- Standard Hook Table moved from Code to Spec (Article 2.7 A)
- Added Section for GFRP Fabrication (Article 2.7 B)



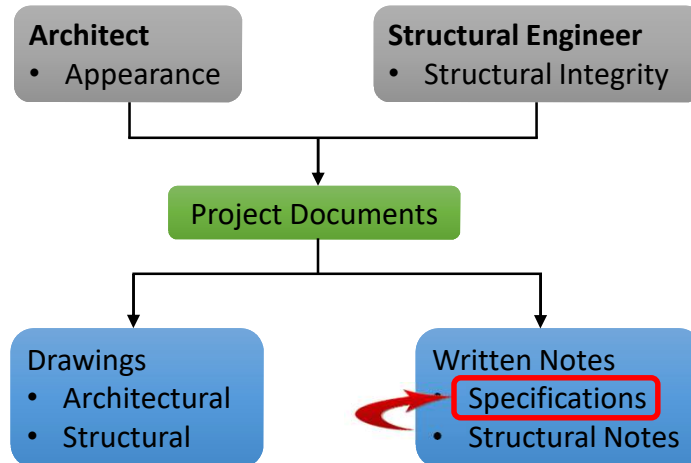
## Specification Article 3-Execution

- Moved Figure SC-8 to Tolerances Article (Article 3.1 A, 3.3 G)
- Expanded requirements for Adhered Veneer (Article 3.3 D)
- Clarify Mechanical Splice Cover to match Reinforcement (Article 3.4 B)
- Add Section for GFRP Reinforcement Fabrication (Article 3.4 B.10)
- Veneer Ties Clarified and Placement Tolerance Added (Article 3.4 D)
- Added Tolerance for Adhered Veneer Fasteners (Article 3.4 F)
- Added Glass Unit Masonry Requirements (Article 3.4 G)
- Added Figure to Clarify Grouting Procedures (Figure SC-20)

## Specification

- Why should Designer care?
  - Code reflects minimum design requirements (Quality Assurance)
  - Specification reflects minimum construction requirements (Quality Control)
  - Each needs to be NO LESS than Code/Specification requirements
- Designers want assurance that construction meets minimum the minimum Specification requirements
- **Aesthetics**
- **Structural Performance**

# Quality Assurance Relationship



# Specification

## Start with Specifications

- Reference current material standards
- Be consistent with material standards
  - TMS 602, Article 3.3 G reference for tolerances (consistent with ASTM C90)
  - Installation tolerance modified
- Don't over-specify
- Keep internally consistent
  - Part 1 Quality Assurance – Verify mortar compressive strength
  - Part 2 Products – Mortar specified by proportion (does not require testing)
  - Specifications need to be consistent with Structural Notes



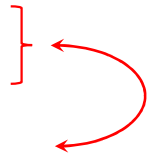
# Specification

- How about the Plans?
  - Clearly Show Intent
  - What is in the Designer's Mind?
  - 'Typical' should not be a word to reflect assumed industry practice
    - For example, spacing of Control Joints



# Proactive Communication

- Preconstruction Meeting
  - Architect
  - Engineer
  - General Contractor
  - Subcontractor
  - Testing Agency
  - Inspection Agency
  - Material Suppliers



## Quality Control

- What is the difference between Quality Assurance (from the Code) and Quality Control (from the Specification)?
- Why do we need either one?
- Assuming we do, how do we effectively implement a program?
- Will it cost?
- How does it help?

## Quality Assurance

- Code Requirements
  - (TMS 402 Code Section 2.2 and TMS 602 Specification, Article 1.2)  
*Quality Assurance*—The administrative and procedural requirements established by the Contract Documents to assure that constructed masonry is in compliance with the Contract Documents

*The Plan*



## Quality Control

- Code Requirements
  - ***Quality Control***—Not code-defined.
  - “A system for ensuring the maintenance of proper standards in manufactured goods, especially by periodic random inspection of the product.” (American Heritage Dictionary, 2006; [www.thefreedictionary.com](http://www.thefreedictionary.com) 2015)

### *Implementation of The Plan*

## TMS 402/602 Code & Specification

- And Where are QA/QC Provisions?
  - Code (TMS 402-22)
    - CHAPTER 3 — Quality and Construction
  - Specification (TMS 602-22)
    - ARTICLE 1.6 — Quality Assurance

## TMS 402/602 Code & Specification

- Assuming Design or Prescriptive Requirements are Satisfied, What is Important?
  - Materials (Quality/Conformance to Standards)
  - Proper Installation



**Location of Reinforcing Steel**

**Grouting Process**



## Masonry Materials

- Correct Material
  - Concrete Masonry Units
    - Conformance to ASTM C90



Normal Strength Unit



High Strength Unit

# Masonry Materials

- Correct Material
  - Mortar
    - Conformance to ASTM C270
    - Type M, S, N, or O
    - By Property or Proportion



Careful-Project Specifications often call for both Property and Proportion which conflicts with 3 ASTM Standards

# Masonry Materials

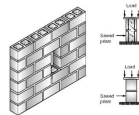
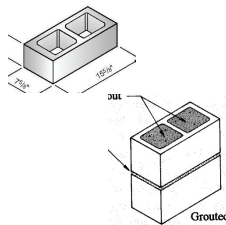
- Correct Material
  - Grout
    - Conformance to ASTM C476
    - Coarse or Fine
    - Traditional (8 to 11 inch slump)
    - Self-Consolidating (24 to 30 inch spread)



# VERIFICATION OF $f'_m$ Masonry Design STRENGTH

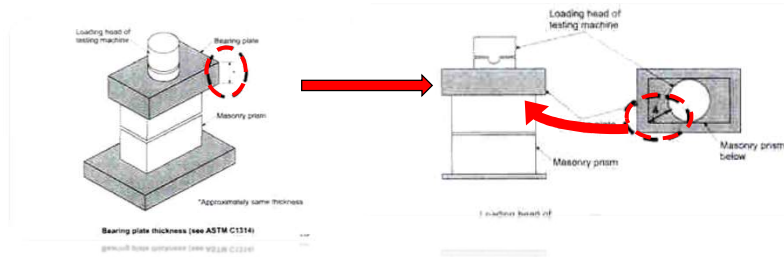
## Verify Compressive Strength

- Unit Strength Method
  - Test Strength of Unit/Use Table
- Prism Testing
  - Build and Test Wall Assemblage
- In Case of Emergency
  - Testing Prisms from Constructed Masonry





## Prism Test Method



## Tolerances

- Tolerances contained in TMS 602 Specification are based on structural requirements (eccentricities) for performance, not aesthetics. It is, however, reasonable to use these tolerance values for acceptance of the project. Consideration must also be given to the ASTM distance viewing requirements for aesthetic acceptance.

### **TMS 602 Specification, Article 3.3 G**

**3.3 G. Site Tolerances** – Erect masonry within the following tolerances from the specified dimensions.

1. Dimension of elements

a. In cross section or elevation

.....- $\frac{1}{4}$  in. (6.4 mm), + $\frac{1}{2}$  in. (12.7 mm)

# Tolerances

***TMS 602 Specification, Article 3.3 G***

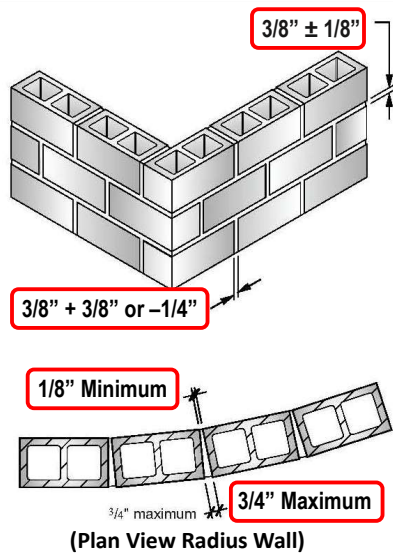
**3.3 G. Site Tolerances** – Erect masonry within the following tolerances from the specified dimensions.

1. Dimension of elements

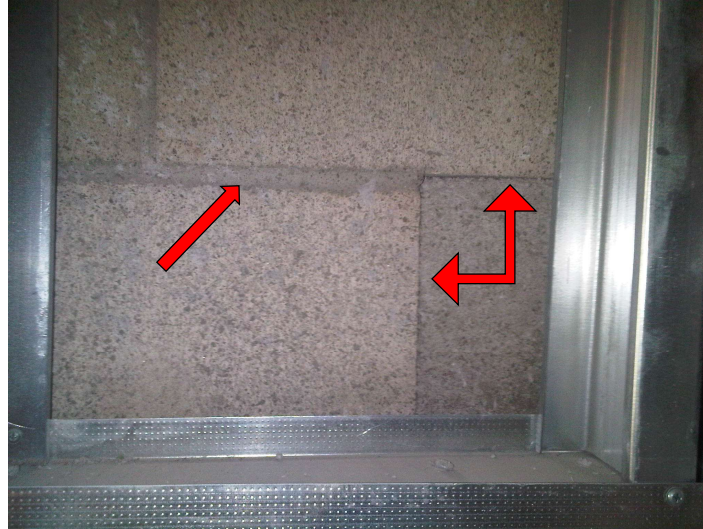
b. Mortar joint thickness

bed.....	$\pm 1/8$ in. (3.2 mm)
head.....	$-1/4$ in. (6.4 mm), $+ 3/8$ in. (9.5 mm)
collar.....	$-1/4$ in. (6.4 mm), $+ 3/8$ in. (9.5 mm)

# Tolerances

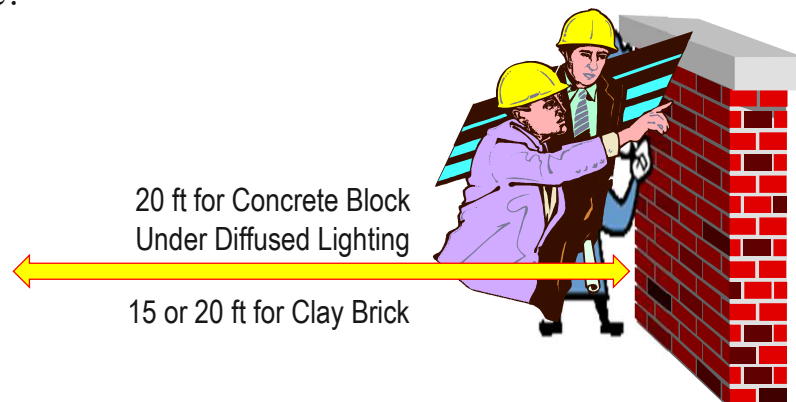


## Tolerances



## Tolerances

- Before we go on to Reinforcement tolerances, what about visual acceptance?



# Reinforcement Tolerances

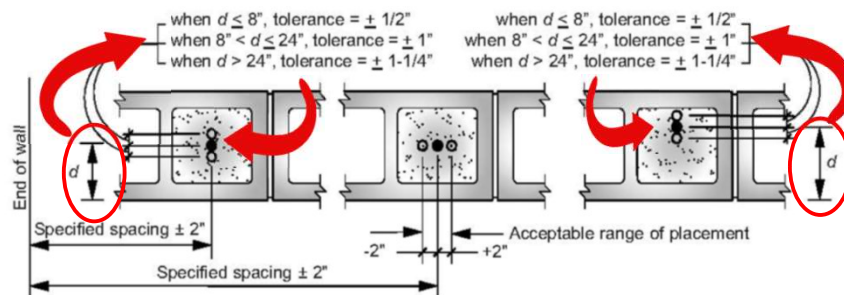
## TMS 602, Article 3.4 B

### 8. Placement tolerances

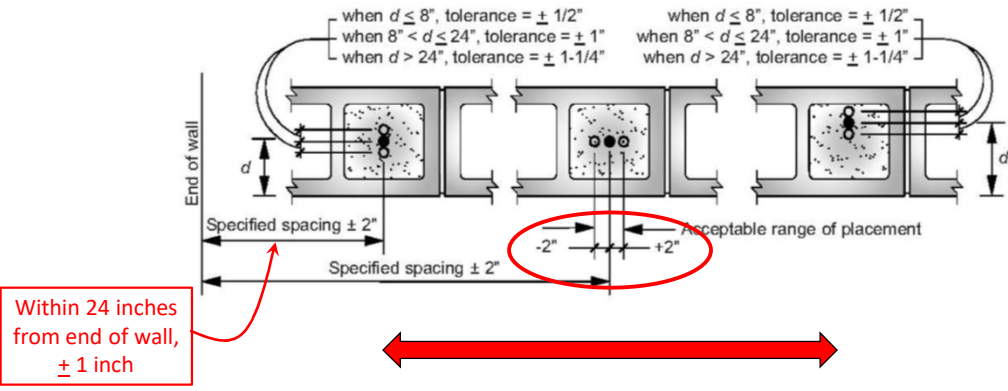
- a. Tolerances for the placement of reinforcing bars in walls and flexural elements shall be  $\pm 1/2$  in. (12.7 mm) when the distance from the centerline of reinforcing bars to the opposite face of masonry,  $d$ , is equal to 8 in. (203 mm) or less,  $\pm 1$  in. (25.4 mm) for  $d$  equal to 24 in. (610 mm) or less but greater than 8 in. (203 mm), and  $\pm 1 1/4$  in. (31.8 mm) for  $d$  greater than 24 in. (610 mm).
- b. Place vertical bars within 2 in. (50.8 mm) of the required location along the length of the wall.

# Reinforcement Tolerances

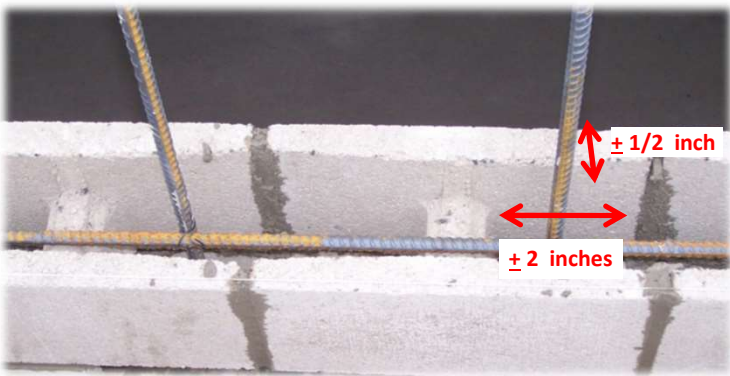
Distance ( $d$ ) from face of CMU to center of reinforcing (in)	Allowable Tolerance (in)
$d \leq 8$	$\pm 1/2$
$8 < d \leq 24$	$\pm 1$
$d > 24$	$\pm 1-1/4$



# Reinforcement Tolerances



# Reinforcement Tolerances



## Grouting

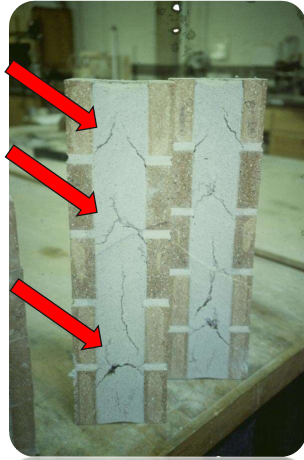


## Grouting

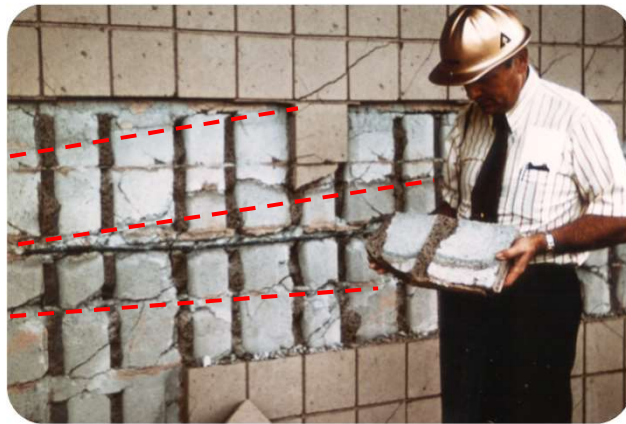
- Vibrate
  - ...to compact and solidify the grout
  - ...to compact the grout after the water is absorbed into the masonry
  - ...to consolidate any cracks or pull away from the unit due to settlement of the grout



## Grouting



## Grouting



# Some considerations for Guidelines and Resources to Develop a Plan

## Guidelines and Resources

- General
  - Specify the Quality Assurance Level Required
  - Provide site access to the Testing and Inspection Agency
  - Advise the Testing Agency in advance to facilitate the required sampling of materials
  - Cooperate with the Testing and Inspection Agency for the appropriate level of inspection (Level 1, Level 2 or Level 3)
  - Who will be responsible for this?



## Guidelines and Resources

- Materials
  - Certificates of Compliance for Masonry Units, Mortar and Grout
  - Any material required for sampling and testing
  - Comply with the applicable requirements of Specification for Masonry Structures, Part 2, Products
  - Who will be responsible for this?

## Guidelines and Resources

- Installation
  - Install masonry units within the tolerances of Specification for Masonry Structures Article 3.3 G
  - Install masonry reinforcement within the tolerances of Specification for Masonry Structures, Article 3.4 B
  - Comply with the applicable requirements of Specification for Masonry Structures, Part 3, Execution
  - Who will be responsible for this?

## Guidelines and Resources

- Where else to go?
  - The Masonry Society ([www.masonrysociety.org](http://www.masonrysociety.org))
    - Inspection Checklist
  - Masonry Institute of America ([www.masonry.pro](http://www.masonry.pro))
    - Concrete Masonry Inspectors Handbook
  - National Concrete Masonry Association ([www.ncma.org](http://www.ncma.org))
    - Technical Notes Series 3 and 18
  - Brick Industry Association ([www.bia.org](http://www.bia.org))
    - Technical Notes 39B

## Significant Issues

*Some final thoughts*

## Significant Issues

- What's Important?
  - Communicating the Intent of Contract Documents
  - Adequate Plans/Specifications
  - Correct Material
  - Reinforcement Placement
  - Reasonable Cleanliness of Cells
  - Grouting Process
  - Construction Extremes (Temperature)
  - Use these points to develop the QA Program

## Elements of a QC Program

- Materials
  - Provide Certificates of Compliance for masonry units, mortar, grout and any other required materials
  - Provide materials for sampling and testing
  - Comply with applicable requirements of Specification for Masonry Structures, Part 2

## Elements of a QC Program

- Installation
  - Install masonry units within tolerances of Specification for Masonry Structures, Article 3.3 F
  - Install masonry reinforcement within tolerances of Specification for Masonry Structures, Article 3.4 B
  - Comply with applicable requirements of Specification for Masonry Structures, Part 3, Execution

This concludes The American Institute of Architects Continuing Education  
Systems Course



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