TMS Night School: Masonry Veneer Requirement Changes in TMS 402/602-22

Masonry Veneer Requirement Changes in TMS 402/602-22….

A Whole New Chapter

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

TMS Night School: Masonry Veneer Requirement Changes in TMS 402/602-22

Course Description

The chapter on masonry veneer has been extensively revised and updated for the 2022 edition of TMS 402/602. Prescriptive requirements for both anchored and adhered veneer have been simplified with many of the major requirements now found in a one or two tables. A tributary area method was added for engineered design of anchored veneer as well as guidance for modeling anchored veneer in a full engineered design. Both the prescriptive and engineered provisions for adhered veneer were enhanced.

Learn how to design masonry veneer with the new provisions and determine where your specifications need to be upgraded to meet the new requirements. Also learn about updated installation and inspection requirements and allowable tolerances for both types of veneer in construction. The updated requirements will simplify the design of your masonry veneer projects and assure the most efficient design methods are being used.

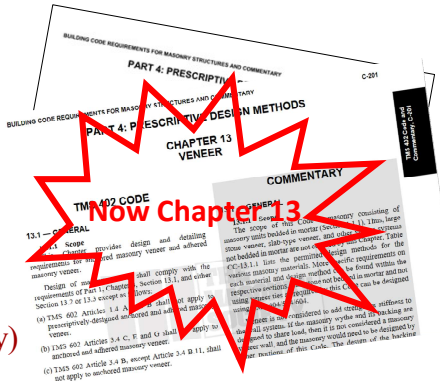
Learning Objectives

- Learn about the updated prescriptive requirements for anchored veneer including appropriate wind loading and deflection of backing requirements as well as requirements for veneer ties and their spacing.
- Review new rational design methods for anchored veneer using the Engineered Design Methods: Tributary Area Method and Engineering Analysis Method.
- Learn about the updated prescriptive requirements for adhered veneer including unit limitations, mortar material requirements and required system components.
- Discuss needed updates to project specifications with information from TMS 602 for both anchored and adhered veneer including material and installation requirements.

TMS Night School: Masonry Veneer Requirement Changes in TMS 402/602-22

Reorganized Entire Veneer Chapter

- Anchored Veneer
  - Engineered (2016) was 1/4 page
  - Engineered (2022) has dedicated Section (13.2.3)
    - Tie Strength & Stiffness
    - Tributary Area Method
    - Modeling Analysis Method
- Adhered Veneer
  - Prescriptive (2016) was 1 column on 1 page
  - Prescriptive (2022) is 4 pages (lots of Commentary)
  - Engineered (2022) has dedicated Section (13.3.3)
  - Tables for fasteners based on weight and cavity width



Veneer Chapter Updates

- New & Revised Definitions
- 'Veneer Anchor' changed to 'Veneer Tie'
- Many anchored veneer requirements are now in tables
  - Maximum cavity width & maximum veneer height
  - Tie spacing and tributary area
  - Tie requirements
  - Tie axial strength and stiffness
  - Deflection of veneer & backing
- New and Updated Recommendations on Adhered Veneer

Veneer Chapter Rewrite

- Veneer Subcommittee had a tough job
  - 24 (of 79) Holdover & TAC Comments from 2013 and 2016 Cycles
  - TMS Technical Advisory Committee (TAC) Directive to Review Entire Chapter
    - Review prescriptive requirements
    - Simple method to check for backing out-of-plane stability
    - 'Deemed to Comply' stiffness and strength values for common ties
    - Basic test criteria for other ties
  - 138 (of 430) TAC Comments came from veneer chapter (2022 Cycle)

Chapter 2 – New/Revised Definitions

- ***Veneer, adhered*** – Masonry veneer secured to and supported by the backing through direct bond to a masonry or concrete backing; or bond to either a scratch coat and lath or a cement backer unit that is fastened to the backing.
- ***Veneer, anchored*** – Masonry veneer secured to and supported laterally by the backing through veneer ties and supported vertically by the foundation or other structural members.
- ***Cavity Wall*** – A non-composite masonry wall consisting of two or more wythes, at least two of which are separated by a continuous air space; and separated wythes must be connected by wall ties.
- ***Cavity*** – The space between wythes of non-composite masonry or between a masonry veneer and its backing.
- ***Drainage space*** – A space within the cavity that allows for the drainage of water.

Chapter 2 – New/Revised Definitions

- ***Backing*** – Structural wall or surface to which veneer is attached.
- ***Cement Backer Unit*** – A rigid panel made of portland cement, aggregate, and glass mesh complying with ASTM C1325, Type A or B as applicable.
- ***Fastener*** – A device that attaches a veneer tie, lath, or cement backer unit to the backing or that attaches a glass unit panel anchor to its support.
- ***Scratch Coat*** – The first layer of mortar applied over lath or other substrate in an adhered veneer.
- ***Stone, dimension*** – Natural stone that has been selected and fabricated to specific sizes or shapes.
- ***Tie, veneer*** – Metal connector that attaches masonry veneer to backing.
- (not actually defined) ***Veneer wire reinforcement*** – Deformed wire or joint reinforcement used in 'other than running bond' (i.e. stack bond) veneer.

Veneer Chapter

- 13.1 General (for both anchored and adhered)
- 13.2 Anchored Veneer
- 13.3 Adhered Veneer

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Veneer Chapter

- 13.1 General (for both anchored and adhered)
  - 13.1.1 Scope
  - 13.1.2 General Design Requirements
- 13.2 Anchored Veneer
  - 13.2.1 General requirements for anchored veneer
  - 13.2.2 Prescriptive design of anchored masonry veneer
  - 13.2.3 Engineered design of anchored masonry veneer
- 13.3 Adhered Veneer
  - 13.3.1 General requirements for adhered veneer
  - 13.3.2 Prescriptive design of adhered masonry veneer
  - 13.3.3 Engineered design of adhered masonry veneer

Veneer Chapter

- Simplification of when to use Prescriptive or Engineered Design

Table CC-13.1.1: Permitted Materials for each Design Method [1]

Masonry Material	Anchored Veneer		Adhered Veneer	
	Prescriptive	Engineered	Prescriptive	Engineered
Clay and Concrete	X	X	X	X
Dimension Stone		X	X	X
Cast Stone	X	X	X	X
Manufactured Stone			X	X

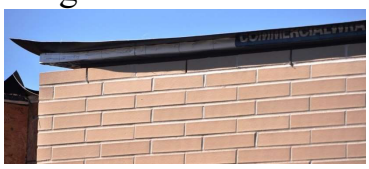
1 Specific requirements for each of these materials can be found in the respective design method sections.

All Veneer – General Requirements

- 13.1.2 General design requirements
  - 13.1.2.1 Design and detail wall systems to comply with the weather, structural, fire, and thermal resistance requirements of the legally adopted building code.
  - 13.1.2.2 Veneer shall be designed and detailed to accommodate deformations and differential movement.
  - 13.1.2.3 Deflection of horizontally spanning support members
  - 13.1.2.4 Limitations of applied vertical loads other than self-weight

All Veneer – General Requirements

- 13.1.2 General design requirements (differential movement)
  - 13.1.2.2.1 Veneer shall be designed and detailed to accommodate deformations and differential movement.
  - 13.1.2.2.2 *Wood Light Frame Backing* – exterior veneer connected to wood light frame construction exceeding 30' (38' at gable) in height above vertical support shall be designed and detailed to accommodate differential movement.
- Greater leeway on how to accommodate movement, but it must be done, with special emphasis on wood frame backings
  - Shelf angles
  - Greater gaps for expansion
  - Wood shrinkage strategies



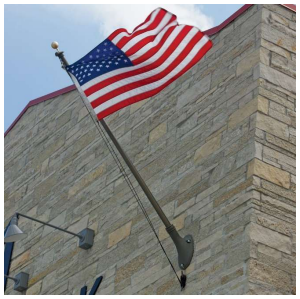
All Veneer – General Requirements

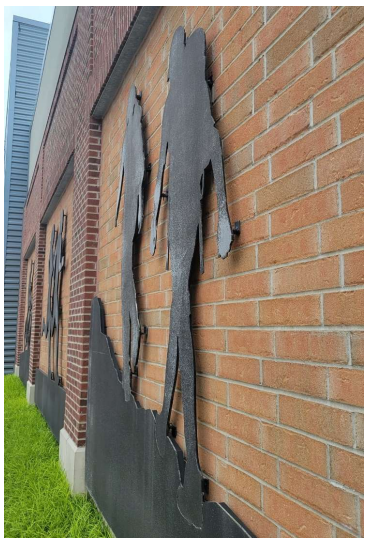
- 13.1.2 General design requirements (deflection of supports)
  - 13.1.2.3 Deflection of horizontally spanning support members
    - Vertical deflection due to allowable stress level dead plus live loads does not exceed l/600

For long spans over steel lintels, consider reinforcing the bed joints just above steel lintel to create a "reinforced masonry lintel".

All Veneer – General Requirements

- 13.1.2 General design requirements (applied loads)
  - 13.1.2.4 Limitations of applied vertical loads other than self-weight
    - Superimposed allowable stress level vertical loads on the face of veneer shall not exceed the following in any 5' x 5' area:
      - 20 lbs vertical load
      - 180 in-lb moment
    - Items that do not project more than 12" from face are deemed to comply





Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope
  - 13.2.1.2 Masonry units
  - 13.2.1.3 Veneer not laid in running bond
  - 13.2.1.4 Joint thickness for veneer ties
  - 13.2.1.5 Out-of-plane deflection
  - 13.2.1.6 Support above openings
  - 13.2.1.7 Seismic
  - 13.2.1.8 Water penetration resistance

Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope – permitted design methods
  - 13.2.1.2 Masonry units
  - 13.2.1.3 Veneer not laid in running bond
  - 13.2.1.4 Joint thickness for veneer ties
  - 13.2.1.5 Out-of-plane deflection
  - 13.2.1.6 Support above openings
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  - 13.2.1.8 Water penetration resistance

Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope – permitted design methods

Table 13.2.1.1: Permitted Design Methods for Anchored Veneer

p_{veneer}, psf (kPa) [1]	Permitted Design Method [2]	
	Seismic Design Category A, B, and C	Seismic Design Category D and higher
≤ 50 (2.39)	Prescriptive (Section 13.2.2 Basic) or Engineered (Section 13.2.3)	Prescriptive (Section 13.2.2 Enhanced) or Engineered (Section 13.2.3)
> 50 (2.39) and ≤ 75 (3.59)	Prescriptive (Section 13.2.2 Enhanced) or Engineered (Section 13.2.3)	
> 75 (3.59)	Engineered (Section 13.2.3)	

[1] p_{veneer} is determined from ASCE/SEI 7, Chapter 30.

[2] Section 13.2.2 Basic and Section 13.2.2 Enhanced refer to veneer tie spacing requirements in Table 13.2.2.5.

Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope
  - 13.2.1.2 Masonry units – at least 2 5/8 in. in specified thickness
  - 13.2.1.3 Veneer not laid in running bond
  - 13.2.1.4 Joint thickness for veneer ties
  - 13.2.1.5 Out-of-plane deflection
  - 13.2.1.6 Support above openings
  - 13.2.1.7 Seismic
  - 13.2.1.8 Water penetration resistance

Typical Queen size brick

Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope
  - 13.2.1.2 Masonry units
  - 13.2.1.3 Veneer not laid in running bond – veneer wire reinforcement req'd
  - 13.2.1.4 Joint thickness for veneer ties
  - 13.2.1.5 Out-of-plane deflection
  - 13.2.1.6 Support above openings
  - 13.2.1.7 Seismic
  - 13.2.1.8 Water penetration resistance

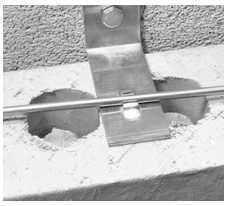
Single wire may be more common

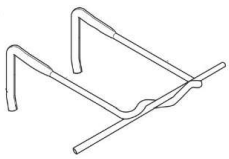
Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope
  - 13.2.1.2 Masonry units
  - 13.2.1.3 Veneer not laid in running bond
  - 13.2.1.4 Joint thickness for veneer ties – at least twice jt. thickness
  - 13.2.1.5 Out-of-plane deflection
  - 13.2.1.6 Support above openings
  - 13.2.1.7 Seismic
  - 13.2.1.8 Water penetration resistance

Anchored Veneer – General Requirements

- 13.2.1.4 Joint thickness for veneer ties –
  - 13.2.1.4.1 For specified veneer ties that rely on embedment in mortar for strength, the specified mortar bed joint thickness shall be at least twice the thickness of the veneer tie. If the joint also has veneer wire reinforcement stacked on the veneer tie, the specified mortar bed joint thickness shall be at least twice the combined thickness.
  - 13.2.1.4.2 For veneer ties that utilize a mechanical connector to engage veneer wire reinforcement for anchorage, the specified mortar joint thickness shall be greater than the combined thickness but no less than twice the thickness of the veneer wire reinforcement.





Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope
  - 13.2.1.2 Masonry units
  - 13.2.1.3 Veneer not laid in running bond
  - 13.2.1.4 Joint thickness for veneer ties
  - 13.2.1.5 Out-of-plane deflection – new h_b/t_{sp} ratio (Table 13.2.1.5)
  - 13.2.1.6 Support above openings
  - 13.2.1.7 Seismic
  - 13.2.1.8 Water penetration resistance

Anchored Veneer – General Requirements

- 13.2.1.5 Out-of-plane deflection – Out-of-plane deflection of the backing shall be limited to maintain veneer stability

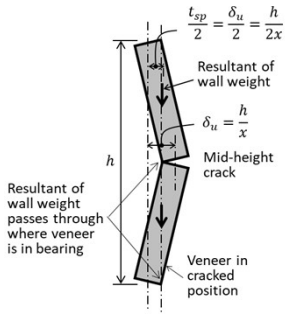
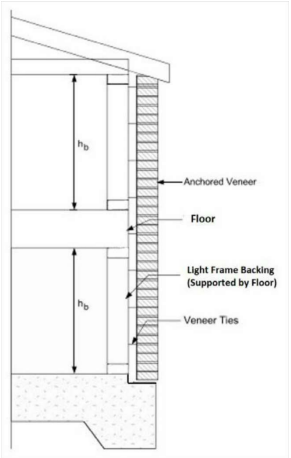


Table 13.2.1.5: Maximum deflection of the backing to provide out-of-plane stability

h_b/t_{sp}	Maximum Deflection of the Backing for Stability	
	Wind[1], δ_{ser}	Seismic[2], δ_u
67	$h_b/240$	$h_b/100$
100	$h_b/360$	$h_b/150$
133	$h_b/480$	$h_b/200$
167	$h_b/600$	$h_b/250$



Anchored Veneer – General Requirements

- 13.2.1.5 Out-of-plane deflection – Deemed to comply

Deflection of Backing		Maximum value for deemed to comply		
Wind[1]	Seismic[2]	h_b/t_{sp}	h_b for t_{sp} = 2-5/8 inch	h_b for t_{sp} = 3.5 inch
$h_b/240$	$h_b/100$	67	14.6 ft	19.5 ft
$h_b/360$	$h_b/150$	100	21.9 ft	29.2 ft
$h_b/480$	$h_b/200$	133	29.1 ft	38.8 ft
$h_b/600$	$h_b/250$	167	36.5 ft	48.7 ft

[1]Under application of 0.42 times the strength level wind load.

[2]Under application of the strength level seismic load.

Anchored Veneer – General Requirements

- 13.2.1.5 Out-of-plane deflection

Choose backup stiffness

Crack width $w_{cr} = \frac{4\delta t_{sp}}{h_b} = \frac{4t_{sp}}{x}$

Is $h_b \leq$ deemed to comply value?

YES → Out-of-plane stability satisfied

NO → Options:
A. Use stiffer backup
B. Design for additional tie force of $\frac{2P(\delta_u - t_{sp}/3)}{h_b}$

h_b = height of backing
P = weight of veneer
t_{sp} = specified thickness
w_{cr} = crack width
x = deflection is h_b/x
δ = deflection

Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope
  - 13.2.1.2 Masonry units
  - 13.2.1.3 Veneer not laid in running bond
  - 13.2.1.4 Joint thickness for veneer ties
  - 13.2.1.5 Out-of-plane deflection
  - 13.2.1.6 Support above openings – lintels, shelf angles or arches above openings
  - 13.2.1.7 Seismic
  - 13.2.1.8 Water penetration resistance

Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope
  - 13.2.1.2 Masonry units
  - 13.2.1.3 Veneer not laid in running bond
  - 13.2.1.4 Joint thickness for veneer ties
  - 13.2.1.5 Out-of-plane deflection
  - 13.2.1.6 Support above openings
  - 13.2.1.7 Seismic – SDC C, D, E and F => isolate the sides and top; SDC E & F support at floors
  - 13.2.1.8 Water penetration resistance

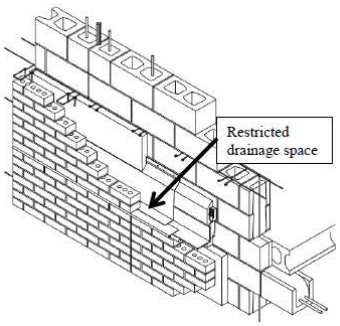
Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.1 Scope
  - 13.2.1.2 Masonry units
  - 13.2.1.3 Veneer not laid in running bond
  - 13.2.1.4 Joint thickness for veneer ties
  - 13.2.1.5 Out-of-plane deflection
  - 13.2.1.6 Support above openings
  - 13.2.1.7 Seismic
  - 13.2.1.8 Water penetration resistance – 1-in. min. drainage space, flashing, weeps < 33” o.c.

Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.8 Water penetration resistance – commentary on restricted drainage spaces

A drainage space, flashing system and weep holes are required to remove moisture from behind the veneer. The minimum drainage requirement is intended to provide drainage of the cavity and to allow the mason to grip and install the masonry veneer unit. Recognizing there will be localized restrictions within the cavity, the designer is cautioned to provide adequate drainage. Restrictions may occur at veneer ties, shelf angles and weep holes or may result from allowable tolerances as shown in Figure CC-13.2-3. Adequate drainage at restrictions can be achieved by increasing the drainage space width beyond the 1 in. (25.4 mm) minimum, adding a drainage device, or using alternative design and construction.



Anchored Veneer – General Requirements

- 13.2.1 General requirements
  - 13.2.1.8 Water penetration – commentary on rainscreens and vents

In addition to a drainage space, flashing and weeps, incorporating air movement in a masonry wall to create a rainscreen is a good design strategy. Weeps that permit airflow into the cavity can be used to assist in removing moisture from a veneer wall. Improved performance can be achieved by adding vents at the top of cavity compartments or near the top of the wall to further aid in evaporation and drying (BIA TN 27 (1994)).

Prescriptive Design of Anchored Veneer

- Permitted Units
- Unit limitations
- General requirements
- Veneer tie material requirements
- Prescriptive tie spacing

Prescriptive Design of Anchored Veneer

- Permitted Units
  - Concrete Masonry (C55, C73, C90, C129, C744, C1634, C1877)
  - Clay Units (C62, C126, C212, C216, C652)
  - Dimension Stone (C503, C568, C616, C629)
  - Cast Stone (C1364)
- Unit limitations
- General requirements
- Veneer tie material requirements
- Prescriptive tie spacing

Prescriptive Design of Anchored Veneer

- Permitted Units
- Unit limitations
  - Weight ≤ 50 psf
  - Height ≤ 16”
  - Thickness ≤ 5”
- General requirements
- Veneer tie material requirements
- Prescriptive tie spacing

Prescriptive Design of Anchored Veneer

- Permitted Units
- Unit limitations
- General requirements
  - Vertical applications/Corbelling limits
  - Pullout resistance of fasteners
  - Veneer tie type
  - Maximum cavity width
  - Height of veneer
  - Fastener requirements

} All in Table 13.2.2.3 for ease of use

- Veneer tie material requirements
- Prescriptive tie spacing

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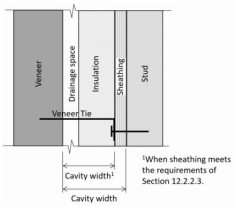
Prescriptive Design of Anchored Veneer

Table 13.2.2.3: General prescriptive anchored veneer requirements

Backing	Veneer Tie Type	Maximum Specified Cavity Width	Other requirements
Wood Light Frame	Corrugated Sheet-metal	1 in. (25.4 mm) [1]	Fastener: Minimum 2.5 in. (63.5 mm) x 0.131 in. (3.33 mm) ring-shank nail(s) with minimum 1 3/8 in. (34.9 mm) penetration into backing or No. 10 screw(s) with 5/8 in. (15.9 mm) penetration into backing. Locate fastener within ½ in. (12.7 mm) of the 90-degree bend in the veneer tie. The limiting p_{veneer} values for prescriptive design method shall be 75 percent of those listed in Table 13.2.1.1. Corrugated ties shall not be used on veneers greater than 30 ft (9.14 mm), or 38 ft (11.58 m) at a gable, in height.
	Sheet Metal	4 in. (101.6 mm) [1]	Fastener: Minimum No. 10 screw(s) with 1 3/8 in. (34.9 mm) penetration into backing. Exterior veneer exceeding 30 ft (9.1 m), or 38 ft (11.58 m) a gable, in height above the vertical support shall be design and detailed to provide for differential movement.
	Adjustable	6 in. (152 mm) [1]	Fastener: Minimum No. 10 screw(s) with 1 3/8 in. (34.9 mm) penetration into backing. Exterior veneer exceeding 30 ft (9.1 m), or 38 ft (11.58 m) at a gable, in height above the vertical support shall be designed and detailed to provide for differential movement.
Cold-formed Metal Framing	Adjustable	6 in. (152 mm) [1]	Fastener: Minimum corrosion resistant No. 10 screw(s) extending through the steel framing a minimum of three exposed threads. Steel framing shall be corrosion resistant and have a minimum base metal thickness of 0.043 in. (1.1 mm).. Exterior veneer exceeding 30 ft (9.1 m), or 38 ft (11.58 m) at a gable, in height above the vertical support shall be designed and detailed to provide for differential movement.
Concrete	Adjustable	6 in. (152 mm)	Fastener: Minimum 3/16 in. (4.76 mm) screw(s) with 1.5 in. (38.1 mm) embedment .
Clay or Concrete Masonry	Adjustable, Unit Wire, or Joint Reinforcement	6 in. (152 mm)	Fastener: When required, minimum 3/16 in. (4.76 mm) screw(s) with 1.5 in. (38.1 mm) embedment . Not applicable for joint reinforcement.

[1] The cavity width shall be permitted to be increased by the specified thickness of the sheathing up to 5/8 in. (15.9 mm) for sheathing or veneer ties meeting the requirements of Section 13.2.2.3.3.



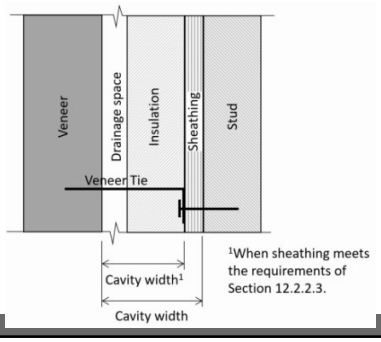
Depending on backing, Table specifies:

- Allowable veneer tie type
- Maximum cavity width
- Fastener requirements
- Height limitations of veneer

Prescriptive Design of Anchored Veneer

[1] The cavity width shall be permitted to be increased by the specified thickness of the sheathing up to 5/8 in. (15.9 mm) for sheathing or veneer ties meeting the requirements of Section 13.2.2.3.3.

- Cavity width
  - Maximum 6" cavity, but with OSB/ext. gyp board sheathing, cavity could be 6 5/8" wide; which is max. cavity width in the 2016 TMS 402
  - With thin insulative sheathing, max. cavity is 6 in. (measured to the stud) – i.e. distance < 6"



Prescriptive Design of Anchored Veneer

- Height limitations
  - What happened to the 30'height limitation for brick veneer???
  - Again, flexibility…

Veneers higher than 30 ft (9.1 m), or 38 ft (11.58 m) at a gable, are permitted with wood and cold-formed metal light frame backing provided a veneer tie other than corrugated sheet-metal is used, and detailing is provided to account for the differential movement. Support of veneer with a wood or cold-formed metal light frame backing typically occurs at grade level; however, it may also occur at the top of a noncombustible podium when podium-type construction is used. For flexible and taller structures, the differential lateral movement of the veneer and supporting structure must be addressed in the design, typically through appropriate detailing of movement joints. The height limitation is measured from the point of support wherever that may occur. For most structures, vertical differential movement is often accommodated by supporting the veneer at each story above 30 ft (9.1 m) with a shelf angle. See Commentary Section 13.1.2.2.2 for further information on brick veneer on wood light frame backing exceeding 30 ft (9.1 m) in height since shelf angles may not always be included in wood light frame backing structures.

Prescriptive Design of Anchored Veneer

Table 13.2.2.4: Veneer Tie Requirements

Tie type	Requirements
Corrugated sheet-metal	1) Minimum 7/8 in. (22.2 mm) wide, base metal thickness minimum of 0.03 in. (0.8 mm). 2) Corrugation wavelength: 0.3 to 0.5 in. (7.6 to 12.7 mm). 3) Corrugation amplitude: 0.06 to 0.10 in. (1.5 to 2.5 mm).
Sheet-metal	1) Minimum ⅞ in. (22.2 mm) wide, base metal thickness minimum of 0.06 in. (1.5 mm). 2) Shall have either: a. Corrugations with wavelength of 0.3 to 0.5 in. (7.6 to 12.7 mm) and amplitude of 0.06 to 0.10 in. (1.5 to 2.5 mm), or b. Bent, notched, or punched to provide equivalent performance in pull-out or push-through.
Unit wire	1) Minimum W1.7 (MW11) wire where the length of the wire that is parallel to and within the veneer is at least 2 in. (50.8 mm) long within the veneer for Z-ties. 2) Minimum W1.7 (MW11) wire with the total length of the wire within the veneer is at least 2 in. (50.8 mm) long for box and triangular unit ties. 3) Drips are not permitted.
	When cavity width exceeds 4 in. (101.6 mm): wires shall be minimum W2.8 (MW18).
Joint reinforcement	1) Ladder-type, truss-type or tab-type joint reinforcement is permitted. Truss-type joint reinforcement across the cavity is not permitted. 2) Longitudinal wires: minimum W1.7 (MW11) size. 3) Cross wires: minimum W1.7 (MW11) wire and spaced at maximum of 16 in. (406 mm) o.c. 4) Drips are not permitted in cross wires or tabs.
	When cavity width exceeds 4 in. (101.6 mm): cross and longitudinal wires shall be minimum W2.8 (MW18).
Adjustable	1) Sheet metal components shall conform to sheet-metal tie requirements. 2) Wire components shall conform to unit wire tie requirements. 3) Adjustable veneer ties with joint reinforcement shall also conform to joint reinforcement tie requirements. 4) Maximum clearance between connected parts of 1/16 in. (1.6 mm). 5) Detailed to prevent disengagement. 6) One or more pintle legs of minimum W2.8 (MW18), have two wires embedded in the veneer, and have a vertical wire offset not exceeding 1.25 in. (31.8 mm).
	1) Part of veneer tie attached to backing: a. For concrete, masonry, wood light framing or cold-formed metal light framing: (1) Barrel with minimum outside diameter of 3/16 in. (4.76 mm) and composed of solid metal. (2) Plate or prong at least 0.074 in. (1.88 mm) thick and 1-1/4 in. (31.8 mm) wide. b. For masonry backing: a tab or two eyes formed of minimum W2.8 (MW18) wire welded to joint reinforcement. 2) Where cavity width exceeds 4 in. (101.6 mm) a. Adjustable part: (1) Two or more pintle legs of minimum W2.8 (MW18) wire. (2) Distance from inside face of veneer to end of adjustable part: maximum 2 in. (51 mm).

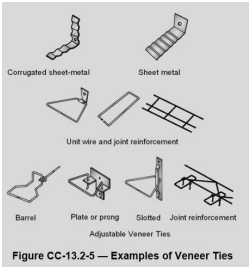


Figure CC-13.2-5 — Examples of Veneer Ties

Table specifies:

- Thickness & size
- No drips
- Maximum clearance between parts
- Requirements for veneer ties for large (> 4 in.) cavities

Prescriptive Design of Anchored Veneer

Table 13.2.2.5: Prescriptive anchored veneer tie spacing [1]

	Basic	Enhanced
Maximum tributary area per tie	2.67 ft^2 (0.248 m^2)	1.78 ft^2 (0.165 m^2)
Maximum spacing	24 in. (610 mm)	16 in. (406 mm)

[1] See Table 13.2.1.1 for when Basic and Enhanced are required.

24" x 16" = 2.67 sf
16" x 16" = 1.77 sf

Spacing of Veneer Ties:

- References to Basic and Enhanced are found in Table 13.2.1.1
- Veneer ties shall be located within 16 in. of supported edges and within 12 in. of unsupported edges, openings, and movement joints. The distance from the top of the veneer to the first row of veneer ties shall not exceed one-half the maximum spacing given in Table 13.2.2.5.

Engineered Design of Anchored Veneer

- Strength and stiffness of veneer ties
  - Determination of strength and stiffness by test (future ASTM test method)
  - Deemed to comply strength and stiffness (meet Table 13.2.2.5 and Table below)

Table 13.2.3.1: Veneer Tie Axial Strength and Stiffness Values

Veneer Tie	Design Strength	Allowable Load	Stiffness
Corrugated sheet-metal	125 lb (556 N)	75 lb (334 N)	500 lb/in. (87.6 N/mm)
Adjustable – slotted	330 lb (1468 N)	200 lb (890 N)	3000 lb/in. (525 N/mm)
Adjustable - two leg pintle	210 lb (934 N)	125 lb (556 N)	2500 lb/in. (438 N/mm)
Unit wire veneer ties and joint reinforcement	210 lb (934 N)	125 lb (556 N)	20000 lb/in. (3500 N/mm)

Values obtained from research: Choi and LaFave; Drysdale and Wilson; and Porter

Engineered Design of Anchored Veneer

- Tributary area method
- Modeling analysis method

Engineered Design of Anchored Veneer

- Tributary area method
  - Pseudo-nonlinear incremental analysis
  - Tie stiffness has greatest effect on tie force
    - As the stiffness of the tie decreases, the strength decreases, but the demand also decreases.
  - Factor times tie force provides good approximation of tie force
  - Veneer thickness limited to less than 5”

The strength level force in each veneer tie shall be determined as:

$2p_w A_t$ when $k_{tie} \le 2500$ lb/in. (350 N/mm)

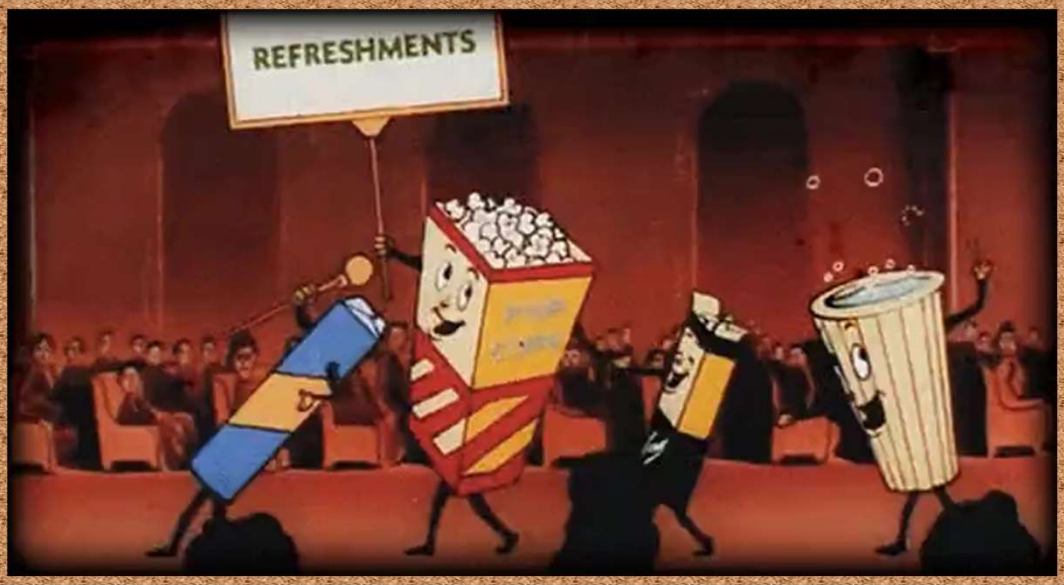
$2.5p_w A_t$ when 2500 lb/in. (350 N/mm) $< k_{tie} \le$ 5000 lb/in. (876 N/mm)

$3p_w A_t$ when 5000 lb/in. (876 N/mm) $< k_{tie} \le 8000$ lb/in. (1401 N/mm)

$4p_w A_t$ when $k_{tie} > 8000$ lb/in. (1401 N/mm)

- Modeling analysis method
  - Analysis shall consider relative stiffness of:
    - Veneer
    - Veneer tie
    - Backing
  - When flexural tension stress exceeds modulus of rupture:
    - Veneer is cracked
    - Permitted to be modeled as a hinge

INTERMISSION



Adhered Veneer – General Requirements

- 13.3.1 General requirements
  - 13.3.1.1 Scope
  - 13.3.1.2 Out-of-plane deflection
  - 13.3.1.3 Water Penetration Resistance

Adhered Veneer – General Requirements

- 13.3.1 General requirements for adhered veneer
  - 13.3.1.1 Scope – typical scoping requirements
  - 13.3.1.2 Out-of-plane deflection
  - 13.3.1.3 Water Penetration Resistance

Adhered Veneer – General Requirements

- 13.3.1 General requirements for adhered veneer
  - 13.3.1.1 Scope
  - 13.3.1.2 Out-of-plane deflection – h/360 (wind w/ 0.42); h/150 (seismic)
  - 13.3.1.3 Water Penetration Resistance

Adhered Veneer – General Requirements

- 13.3.1 General requirements for adhered veneer
  - 13.3.1.1 Scope
  - 13.3.1.2 Out-of-plane deflection
  - 13.3.1.3 Water Penetration Resistance – Design and detail exterior veneer to resist water penetration

> Since water penetration is a critical issue for adhered masonry veneer, consideration should be given to appropriate drainage layers within the adhered veneer system. Use of adhered masonry veneers with tight-fit joints (joints between adhered veneer units that are not purposely filled with mortar), also referred to as drystack veneer, should be carefully considered in wet climates that include freeze thaw conditions and should closely follow the installation requirements in TMS 602 Article 3.3 C.

Prescriptive Design of Adhered Veneer

- 13.3.2.1 Permitted Units
- 13.3.2.2 Unit Limitations
- 13.3.2.3 Mortar rqt's for scratch coat, setting bed, and joints between units
- 13.3.2.4 Installation requirements
- 13.3.2.5 General Requirements

Assumes:
Adhered veneers are bonded to either:
(a) a masonry or concrete backing or,
(b) a scratch coat and lath or,
(c) cement backer unit that is fastened to masonry, concrete, or light frame backing.

Prescriptive Design of Adhered Veneer

- 13.3.2.1 Permitted Units
  - ASTM C1088 Thin Veneer Brick Units (clay)
  - ASTM C1364 Architectural Cast Stone
  - ASTM C1670 Adhered Manufactured Stone Masonry Veneer Units
  - ASTM C1877 Adhered Concrete Masonry Units
  - Calcium silicate (C73) or dimension stone (must meet C482 shear bond req'ts)
- 13.3.2.2 Unit Limitations
- 13.3.2.3 Mortar rqt's for scratch coat, setting bed, and joints between units
- 13.3.2.4 Installation requirements
- 13.3.2.5 General Requirements

Prescriptive Design of Adhered Veneer

- 13.3.2.1 Permitted Units
- 13.3.2.2 Unit Limitations
  - Veneer units shall not exceed 2 5/8 in.
  - Maximum surface area of units < 720 in^2 (5 sf or 30" x 24"), but if over 360 in^2 (24" x 15"), then must have approved installation procedure
  - Maximum weight of units < 30 psf
- 13.3.2.3 Mortar rqt's for scratch coat, setting bed, and joints between units
- 13.3.2.4 Installation requirements
- 13.3.2.5 General Requirements

Past codes only allowed 15 psf for unit weight, but it's the assembly weight which is critical.

Prescriptive Design of Adhered Veneer

- 13.3.2.1 Permitted Units
- 13.3.2.2 Unit Limitations
- 13.3.2.3 Mortar rqt's for scratch coat, setting bed, and joints between units
  - Setting bed: ANSI A118.4 Modified Dry-Set Cement Mortar or ANSI A118.15 Improved Modified Dry-Set Cement Mortar
  - Scratch Coat and Jointing mortar: C270, ANSI A118.4 or ANSI A118.15
- 13.3.2.4 Installation requirements
- 13.3.2.5 General Requirements

Past codes allowed Type S mortar, but due to increased heights it was decided that polymer modified mortars were needed.

Prescriptive Design of Adhered Veneer

- 13.3.2.1 Permitted Units
- 13.3.2.2 Unit Limitations
- 13.3.2.3 Mortar rqt's for scratch coat, setting bed, and joints between units
- 13.3.2.4 Installation requirements
  - Lath and scratch coat not required when units are applied directly to concrete, unglazed clay or concrete masonry, or cement backer unit (and free of dirt, etc.)
- 13.3.2.5 General Requirements

Prescriptive Design of Adhered Veneer

- 13.3.2.1 Permitted Units
- 13.3.2.2 Unit Limitations
- 13.3.2.3 Mortar rqt's for scratch coat, setting bed, and joints between units
- 13.3.2.4 Installation requirements
- 13.3.2.5 General Requirements
  - Distance from exterior surface to back of scratch coat < 4 5/8"
  - Height above grade plane shall not exceed 60'
  - Backing installed in vertical application (i.e. not sloped)
  - Design and detail to consider differential movement
  - Prescriptive design comply with Tables 13.3.2.5 or 13.3.2.6
  - Sheathing is required for frame backing
  - Assembly weight < 50 psf

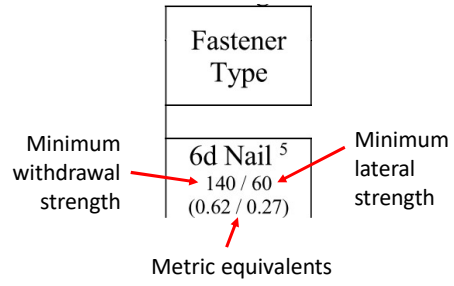
Prescriptive Design of Adhered Veneer

Table 12.3.2.5 Fastener Spacing Along Framing Member, $q_h \leq 60$ psf (2.87 kPa) (Wood Framing with 16 in. (406 mm) Spacing) [1, 2, 3, 4]

Fastener Type	Adhered Veneer Assembly Installed Weight, psf (kPa)							
	10 (0.48)	20 (0.96)	25 (1.2)	30 (1.4)	35 (1.7)	40 (1.9)	45 (2.2)	50 (2.4)
Cavity Width ≤ 0.5 in. (12.7 mm)								
6d Nail [5] 140 / 60 (0.62 / 0.27)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.5 in. (165 mm)	5.8 in. (148 mm)	5.3 in. (135 mm)	4.8 in. (123 mm)	4.5 in. (114 mm)
10d Nail [5] 300 / 90 (1.33 / 0.40)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)
0.5 in. (12.7 mm) ≤ Cavity Width ≤ 1.0 in. (25.4 mm)								
10d Nail [5] 240 / 90 (1.07 / 0.40)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.8 in. (174 mm)	6.1 in. (156 mm)	5.5 in. (140 mm)
16d Nail [5] 330 / 100 (1.47 / 0.44)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)
1.0 in. (25.4 mm) ≤ Cavity Width ≤ 1.5 in. (38.1 mm)								
10d Nail [5] 180 / 90 (0.80 / 0.40)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.2 in. (157 mm)	5.3 in. (136 mm)	4.6 in. (117 mm)	4.1 in. (105 mm)	3.7 in. (95 mm)
16d Nail [5] 260 / 100 (1.16 / 0.44)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.1 in. (156 mm)	5.4 in. (138 mm)	4.9 in. (124 mm)
1.5 in. (38.1 mm) ≤ Cavity Width ≤ 2.0 in. (50.8 mm)								
10d Nail [5] 120 / 90 (0.53 / 0.40)	7.0 in. (177 mm)	6.8 in. (174 mm)	5.6 in. (142 mm)	4.6 in. (117 mm)	4.0 in. (102 mm)	3.5 in. (89 mm)	3.1 in. (79 mm)	2.8 in. (71 mm)
16d Nail [5] 190 / 100 (0.85 / 0.44)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.1 in. (156 mm)	5.2 in. (133 mm)	4.6 in. (117 mm)	4.0 in. (104 mm)	3.6 in. (93 mm)
2.0 in. (50.8 mm) ≤ Cavity Width ≤ 2.5 in. (63.5 mm)								
16d Nail [5] 130 / 100 (0.58 / 0.44)	7.0 in. (177 mm)	7.0 in. (177 mm)	5.9 in. (149 mm)	4.9 in. (124 mm)	4.2 in. (107 mm)	3.6 in. (93 mm)	3.2 in. (83 mm)	2.9 in. (74 mm)
20d Nail [5] 230 / 130 (1.02 / 0.58)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.1 in. (156 mm)	5.4 in. (138 mm)	4.9 in. (124 mm)

Wood Framing

[1] Cavity width measured from face of stud to back of veneer assembly.
[2] Use 80% of listed fastener spacing for SDC D, E or F.
[3] Linear interpolation not permitted.
[4] Fastener placement tolerance +/- ¼ in. (6.4 mm).
[5] Equivalent diameter fastener strength with minimum withdrawal strength and lateral strength shown, respectively (lb on first line and kN on second line).



Prescriptive Design of Adhered Veneer

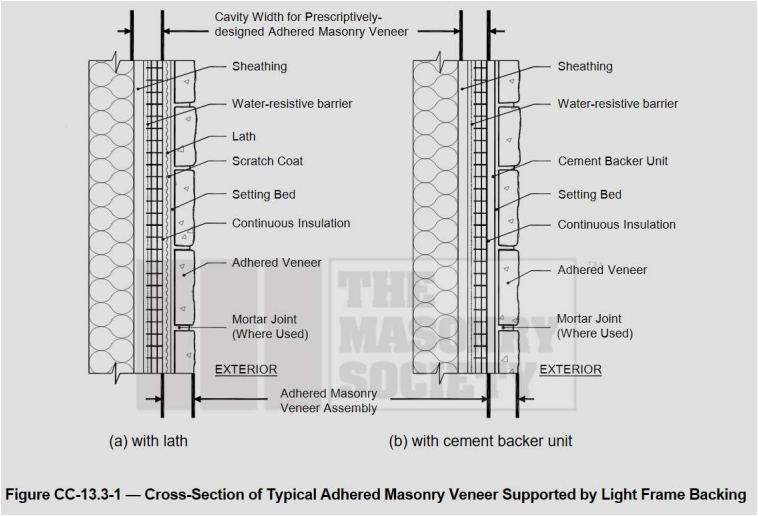


Figure CC-13.3-1 — Cross-Section of Typical Adhered Masonry Veneer Supported by Light Frame Backing

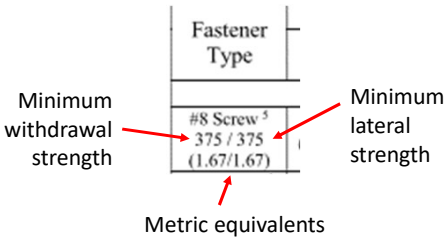
Prescriptive Design of Adhered Veneer

Table 12.3.2.6 Fastener Spacing Along Framing Member, $q_h \leq 60$ psf (2.87 kPa) (16 ga. (1.5 mm) Steel Framing with 16 in. (406 mm) Spacing) [1, 2, 3, 4]

Fastener Type	Adhered Veneer Assembly Installed Weight, psf (kPa)							
	10 (0.48)	20 (0.96)	25 (1.2)	30 (1.4)	35 (1.7)	40 (1.9)	45 (2.2)	50 (2.4)
Cavity Width ≤ 0.5 in. (12.7 mm)								
#8 Screw [5] 375 / 375 (1.67/1.67)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)
#10 Screw [5] 375 / 375 (1.67/1.67)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)
0.5 in. (12.7 mm) ≤ Cavity Width ≤ 1.0 in. (25.4 mm)								
#8 Screw [5] 375 / 375 (1.67/1.67)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.5 in. (165 mm)	5.7 in. (146 mm)	5.1 in. (131 mm)	4.6 in. (117 mm)	4.1 in. (105 mm)
#10 Screw [5] 375 / 375 (1.67/1.67)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.4 in. (164 mm)
1.0 in. (25.4 mm) ≤ Cavity Width ≤ 1.5 in. (38.1 mm)								
#8 Screw [5] 375 / 375 (1.67/1.67)	7.0 in. (177 mm)	6.5 in. (165 mm)	5.4 in. (138 mm)	4.6 in. (118 mm)	4.0 in. (102 mm)	3.5 in. (90 mm)	3.1 in. (80 mm)	2.8 in. (72 mm)
#10 Screw [5] 375 / 375 (1.67/1.67)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	7.0 in. (177 mm)	6.2 in. (159 mm)	5.5 in. (139 mm)	4.8 in. (124 mm)	4.4 in. (111 mm)
1.5 in. (38.1 mm) ≤ Cavity Width ≤ 2.0 in. (50.8 mm)								
#8 Screw [5] 375 / 375 (1.67/1.67)	7.0 in. (177 mm)	5.1 in. (131 mm)	4.5 in. (108 mm)	3.5 in. (90 mm)	3.0 in. (77 mm)	2.6 in. (67 mm)	2.3 in. (60 mm)	2.1 in. (54 mm)

Steel Framing

[1] Cavity width measured from face of stud to back of veneer assembly.
[2] Use 80% of listed fastener spacing for SDC D, E or F.
[3] Linear interpolation not permitted.
[4] Fastener placement tolerance +/- ¼ in. (6.4 mm).
[5] Equivalent diameter fastener strength with minimum withdrawal strength and lateral strength shown, respectively (lb on first line and kN on second line).



Engineered Design of Adhered Veneer

- Loads distributed through veneer to backing using principles of mechanics
- Design fastener system to limit vertical deflection of the veneer to 1/8 in. under strength level dead and seismic loads.
- Veneer shall not be subjected to the flexural tensile stress provisions of Section 8.2 or the nominal modulus of rupture provisions of Section 9.1.9.2.
- Installation shall comply with TMS 602; otherwise, the specific installation procedures and materials shall be tested to determine appropriate design properties.
- When installation complies with TMS 602, the flexural tension design strength of assembly components = 100 psi and design shear strength of assembly components = 50 psi. For ASD, allowable flexural tension stress = 60 psi and allowable shear stress = 30 psi.

PAUSE

TMS 602 Specification Changes

- Anchored Veneer
  - Modified veneer tie spacings to match TMS 402
  - Installation and corrosion protection similar to past versions
  - Added tolerance on veneer tie placement (+/- 1")
  - Fasteners conform to material standards (ACI, AISI, NDS)
- Adhered Veneer
  - New requirements for lath (conforms to C847, C1032, C933 or C1788)
  - Added accessory requirements for backer board, fasteners, weep screed
  - Updated installation requirements
  - Fog spray or dampen scratch coat prior to unit installation in hot weather
  - Added reference to ASTM C1780, MVMA and BIA

TMS 602 Specification Changes

- Added items to Section 1.6 Quality Assurance (Inspection), Table 4

Table 4: Minimum Special Inspection Requirements

MINIMUM SPECIAL INSPECTION					
Inspection Task	Frequency [a]			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 members	NR	P	P		Art. 3.3 G
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. Type, size, and location of veneer ties & movement joints	P[d]	P[d]	--	Sec. 13.2	Art. 3.4 E
f. Installation of adhered veneer	P[d]	P[d]	--	Sec. 13.3	Art. 3.3 D

TMS 602 Specification Changes

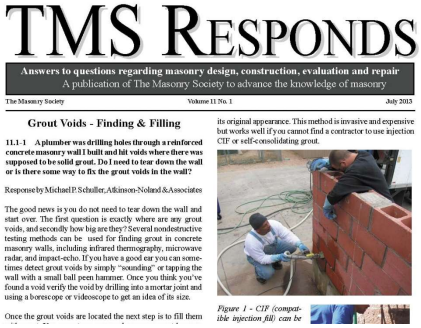
- Revised and added items to Mandatory & Optional Requirements Checklist

MANDATORY REQUIREMENTS CHECKLIST (Continued)

PART 3 — EXECUTION		
3.3 D.2-4	Pipes and conduits	Specify sleeve sizes and spacing.
3.3 D.5	Accessories	Specify accessories not indicated on the project drawings.
3.3 D.6	Movement joints	Indicate type and location of movement joints on the project drawings.
3.4	Reinforcement, tie and anchor installation	Specify type and location of reinforcement, ties and anchors on the project drawings
3.4 B.12	Placement tolerances	Indicate *d* distance for beams on drawings or as a schedule in the project specifications.
3.4 E	Veneer Ties	Specify the type of tie required.

Resources

- TMS Masonry Designers Guide 2022
- TMS Responds – changes to TMS 402/602


TMS RESPONDS

Answers to questions regarding masonry design, construction, evaluation and repair
A publication of The Masonry Society to advance the knowledge of masonry

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Grout Voids - Finding & Filling

11.1-1 A plumber was drilling holes through a reinforced concrete masonry wall I built and hit voids where there was supposed to be solid grout. Do I need to tear down the wall or is there some way to fix the grout voids in the wall?

Response by Michael P. Schuller, Atkinson-Noland & Associates

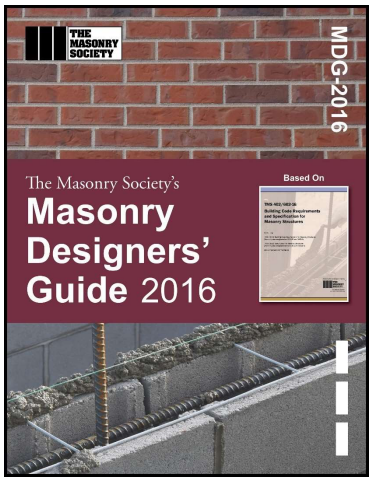
The good news is you do not need to tear down the wall and start over. The first question is exactly where are any grout voids, and secondly how big are they? Several nondestructive testing methods can be used for finding grout in concrete masonry walls, including infrared thermography, microwave radar, and impact-echo. If you have a good ear you can sometimes detect grout voids by simply "sounding" or tapping the wall with a small ball peen hammer. Once you think you've found a void verify the void by drilling into a mortar joint and using a borescope or videoscope to get an idea of its size.

Once the grout voids are located the next step is to fill them

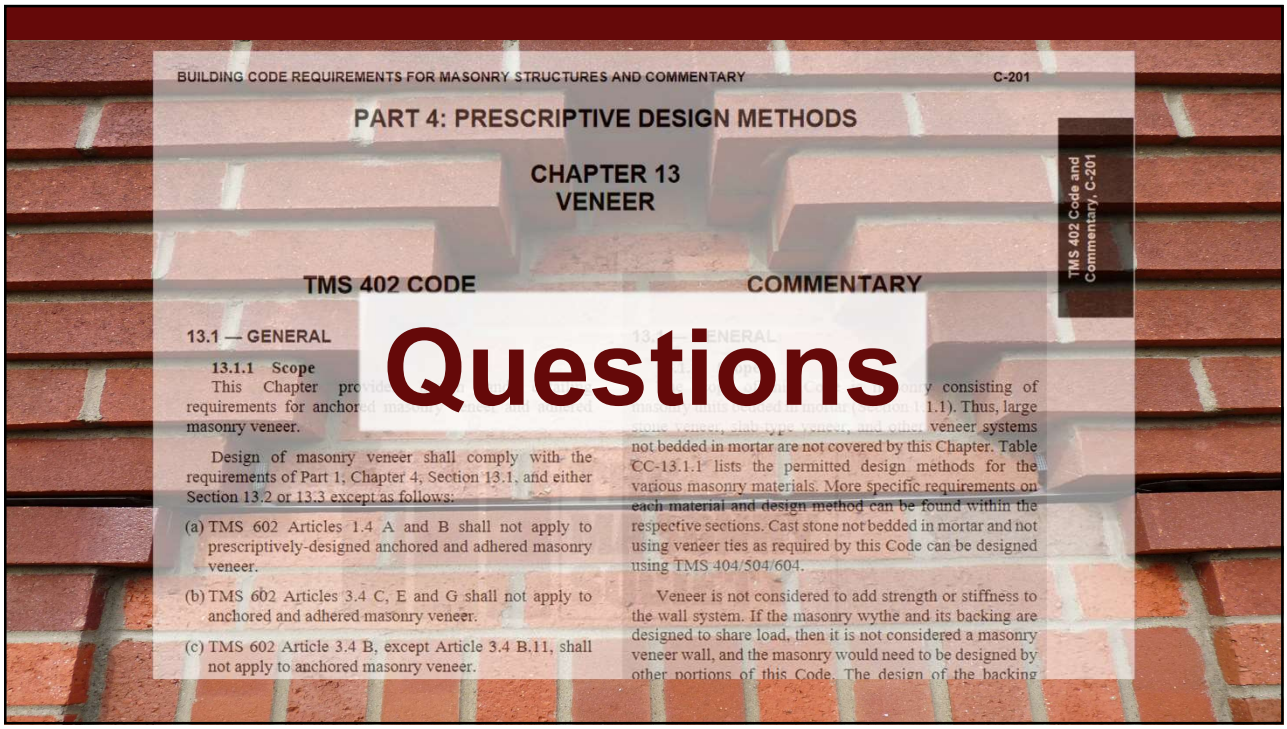
its original appearance. This method is invasive and expensive but works well if you cannot find a contractor to use injection CIF or self-consolidating grout.

Figure 1 - CIF (compatible injection fill) can be

Coming soon!



TMS Night School: Masonry Veneer Requirement Changes in TMS 402/602-22



This concludes The American Institute of Architects Continuing Education Systems Course

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The Masonry Society