



Part 2

Masonry Wall Bracing

Student Materials
MTI Level Two Construction Compliance Course
Consultation Education and Training Division
Michigan Occupational Safety and Health Administration
Michigan Department of Labor and Economic Opportunity
www.michigan.gov/miosha
517-284-7720



Construction Part 2. Masonry Wall Bracing and Restricted Zones

MTI Level Two Construction Compliance Course

Presented By:
 Consultation Education and Training (CET) Division
 Michigan Occupational Safety and Health Administration
 Michigan Department of Labor and Economic Opportunity
www.michigan.gov/miosha
 517-284-7720



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Objectives

- Discuss Scope and Definitions
- Compare Internal Bracing to External Bracing
- Identify Employer Responsibilities
- Explain Training Expectations
- Illustrate Restricted Zone Requirements
- Detail Signage Requirements
- Analyze Wind Speed Conditions
- Specify Initial Period and Intermediate Period Requirements
- Describe Wall Bracing Designs
- Depict Triangle Wall Bracing System
- Assess Walls and Bracing by Inspection

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Reason for the Standard in Michigan

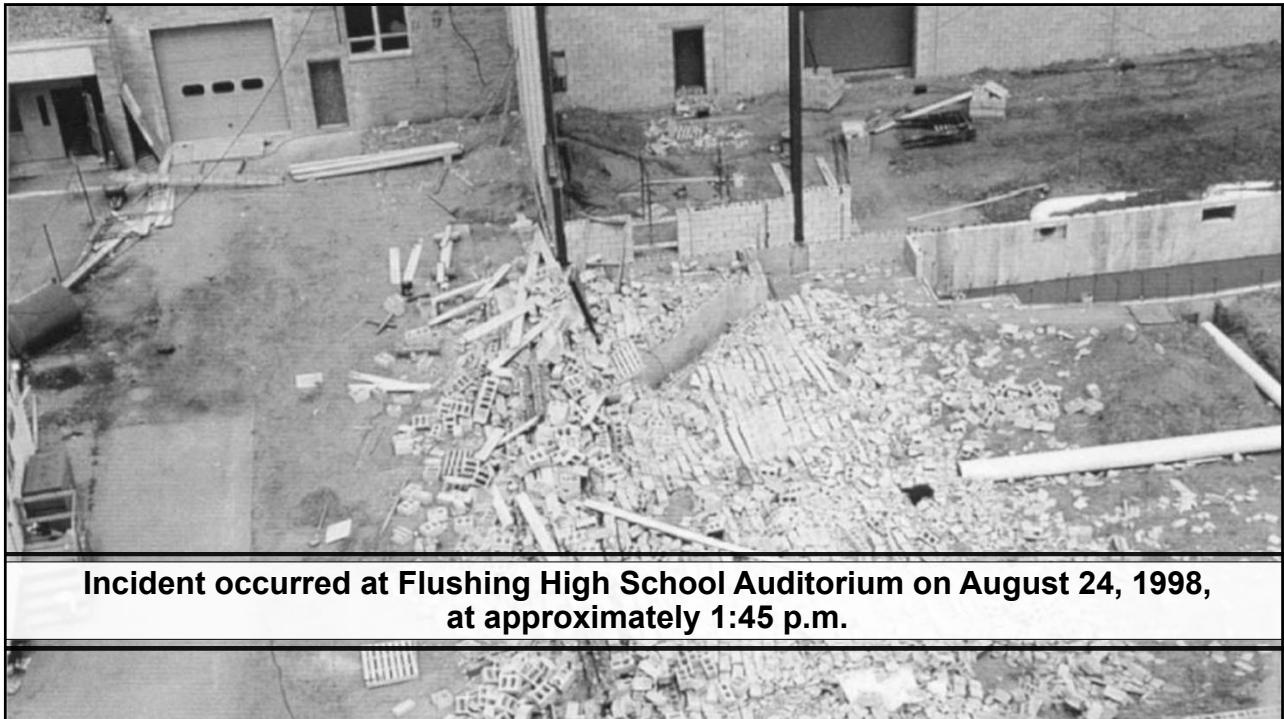
Masonry Wall Collapse Flushing, MI 1998

MIOSHA Citations

- Masonry Contractor: \$319,200
- General Contractor: \$157,000
- Electrical Contractor: \$8,600
- Sheet Metal Contractor: \$8,600

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The Standard: Part 2. Masonry Wall Bracing

As Amended May 14, 2010

MIOSHA-STD-1302 (05/10)
10 Pages



For further information
Ph: 517-264-7740
www.michigan.gov/miosha/standards

DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS

DIRECTOR'S OFFICE

CONSTRUCTION SAFETY STANDARDS

Filed with the Secretary of State on November 15, 1989 (as amended May 14, 2010)

These rules take effect 14 days after filing with the Secretary of State

(By authority conferred on the director of the department of energy, labor, and economic growth by sections 19 and 21 of 1974 PA 154, and Executive Reorganization Order Nos. 1996-2, 2003-18, and 2008-4, MCL 408.1019, 408.1021, 445.2001, 445.2011, and 445.2025)

R 408.40201, R 408.40202, R 408.40203, R 408.40204, R 408.40205, R 408.40206, R 408.40207, R 408.40208, R 408.40209, and R 408.40210 of the Michigan Administrative Code are amended and R 408.40211, R 408.40212, and R 408.40213 are added to the Michigan Administrative Code as follows:

CONSTRUCTION SAFETY AND HEALTH STANDARD PART 2. MASONRY WALL BRACING

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R 408.40201 Scope.

Rule 201. These rules pertain to the bracing of unsupported masonry walls exposed to wind during construction.

R 408.40202 Availability of referenced documents.

Rule 202. (1) The following Michigan occupational safety and health standards are referenced in these rules and shall be considered part of the requirements of these rules to the extent prescribed in each reference. Up to 5 copies of these standards may be obtained at no charge from the Michigan Department of Energy, Labor and Economic Growth, MIOSHA Standards Section, 7150 Harris Drive, P.O. Box 30643, Lansing, Michigan, 48909-8143 or via the internet at website: www.michigan.gov/miosha/standards. For quantities greater than 5, the cost, as of the time of adoption of these rules, is 4 cents per page.

(a) Construction safety standard part 1 general rules, R 408.40101 to R 408.40134.

(b) Construction safety standard part 22 signals, signs, tags, and barricades, R 408.42201 to R 408.42243.

(2) The following standards are referenced in these rules and shall be considered part of the requirements of these rules to the extent prescribed in each such reference. They are available from Mason Contractors Association of America, 33 South Roselle Road, Schaumburg, Illinois 60193, telephone number: 1-800-536-2225 or via the internet at website: www.masoncontractors.org; at a cost as of the time of adoption of these rules, as stated in this subrule:

(a) Standard practice for bracing masonry walls under construction, chapters 5 and 6 and their commentaries, July 2001 as referenced in R 408.40211(2)(b) as it relates to wall bracing design. Cost: \$50.00.

(b) Masonry wallbracing design handbook, March 2003. Cost: \$65.00.

R 408.40202 Scope

202 These rules pertain to the **bracing** of **unsupported** masonry walls **exposed to wind** during construction.



The masonry walls covered by this Standard are typically **BLOCK WALLS** (CMUs), not brick walls.

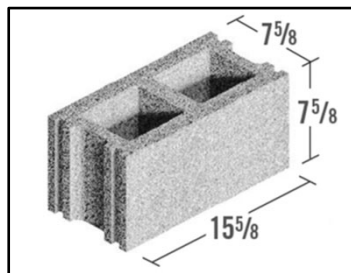


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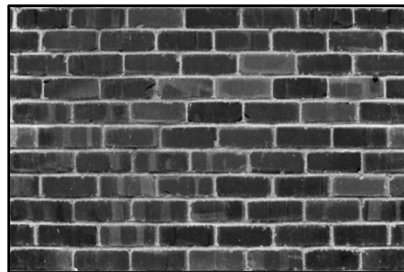
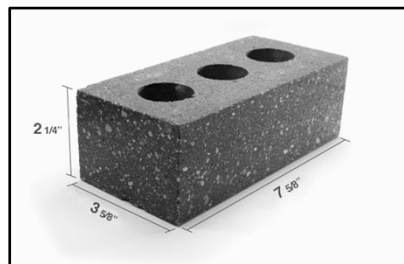
Block

(usually cement and aggregate)



Brick

(usually clay, sand, and lime)



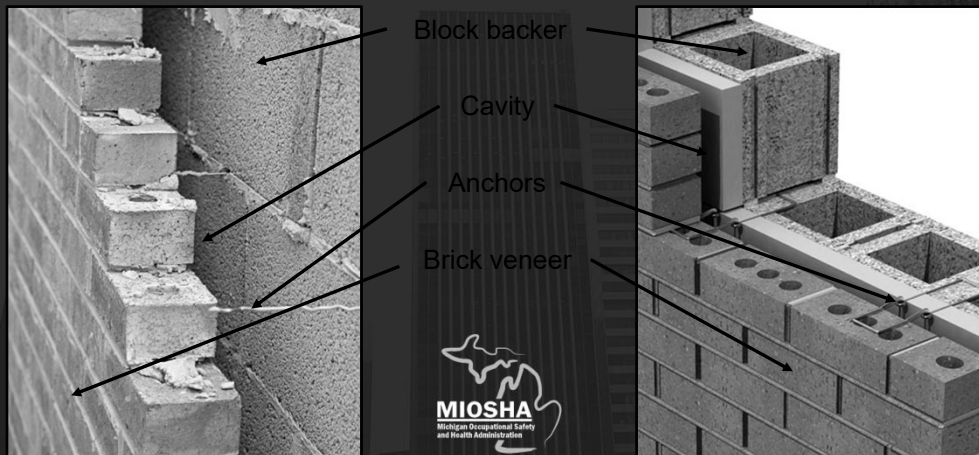
8

Occasionally, due to design/construction, brick walls may fall under the Standard.



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Most wall designs today are cavity walls designed with masonry veneer that **transfers out-of-plane loads directly to a backing** and is not considered to add load resisting capacity to the wall system.



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Reinforcing Walls Using Grout and Rebar

- Tensile strength resists tension (being pulled apart), therefore walls get reinforced with grout and rebar to boost tensile strength and resist wind loading.
- **Grout** is a cementitious fluid similar to concrete with smaller aggregate poured vertically (sometimes horizontally) in the hollow cores of block walls bonding the rebar and masonry for resisting loads.
- **Rebar** or reinforcing bar are lengths of steel rod placed along with grout vertically (sometimes horizontally) in the hollow cores of block walls to increase tensile strength.

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- **Reinforced Masonry**

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• Unreinforced Masonry

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Masonry Walls can be Braced Internally and/or Externally



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Internal Wall Bracing

- Internal wall bracing uses the inherent strength of reinforced masonry to resist wind loading and provide stability during construction.
- The objective of internal bracing design is to keep the wall standing during construction and to provide enough time for evacuation during a wind event.

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Internal Wall Bracing



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Internal Wall Bracing



Advantages

- No external hardware impeding movement onsite
- Reduced/no costs associated with bracing hardware purchase, storage, cartage, installation, training
- No additional mobilization to remove bracing
- No concentrated load at bracing point connection to the wall
- Predictable capacity with more direct path for load resistance
- Capacity that increases with time and curing
- Reinforcing walls typically integral work operation
- Safer site without external components

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External Wall Bracing



- External wall bracing has been used effectively for years by lending stability to masonry walls during construction through resistance to tensile stresses.
- External bracing can help provide appropriate capacity for certain wall configurations that cannot be adequately braced using the wall's internal capacity.

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External Wall Bracing



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External Wall'Bracing



Advantages

- Easily inspect/recognize external components
- More familiar to workers than internal bracing
- Numerous systems readily available
- Most systems' components are reusable
- Alternative to internal bracing limitations

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Wall Bracing Design Considerations

- Layout including wall locations, heights, openings
- Sequencing for walls, wall segments, buttressed walls, final lateral support
- Masonry unit's compressive strength, thickness, density
- Mortar type (N, S, M, mortar cement, masonry cement, Portland cement/lime)
- Low-lift vs high-lift grouting techniques
- Rebar size and grout spacing
- Lap splice (48 bar diameters = full capacity > 24 hrs)
- Foundation size and soil capacity analysis
- Fixed vs Pinned base – foundation dowel length

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R 408.40203 Definitions



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R 408.40203 Definitions



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R 408.40203 Definitions



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R 408.40203 Definitions



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✓ Knowledge Check #1 :

1. Masonry walls must be u_____ and e_____ t_ w____ to fall under the scope of Part 2.
2. Which of the following wall types is most likely to be covered by Part 2?
 - a) Brick walls
 - b) Block walls
 - c) Veneer walls
 - d) Cavity walls
3. On a masonry project, who has the ability to solve and resolve issues related to the blockwork?

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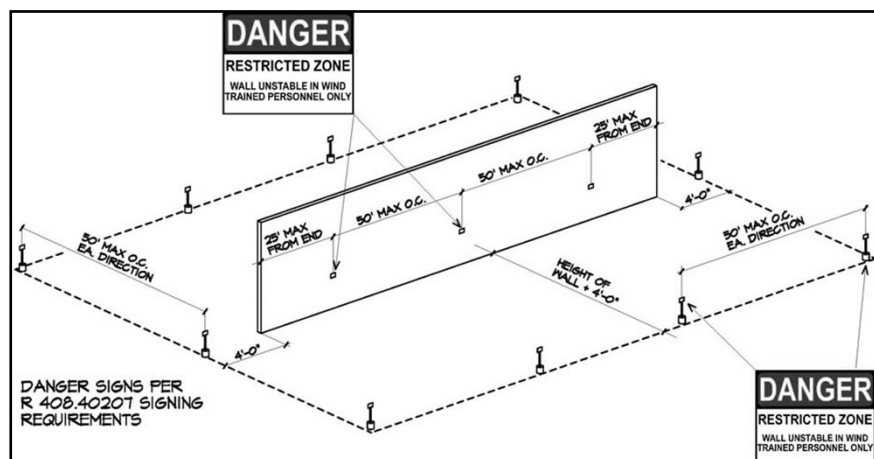
R 408.40204 Responsibilities; Restricted Zone, Wall Bracing System, and Signage

204(1) Prior to the start of masonry construction, the mason contractor shall notify in writing the controlling contractor where and when a restricted zone will exist. See Figure 1 for a sample restricted zone plan.

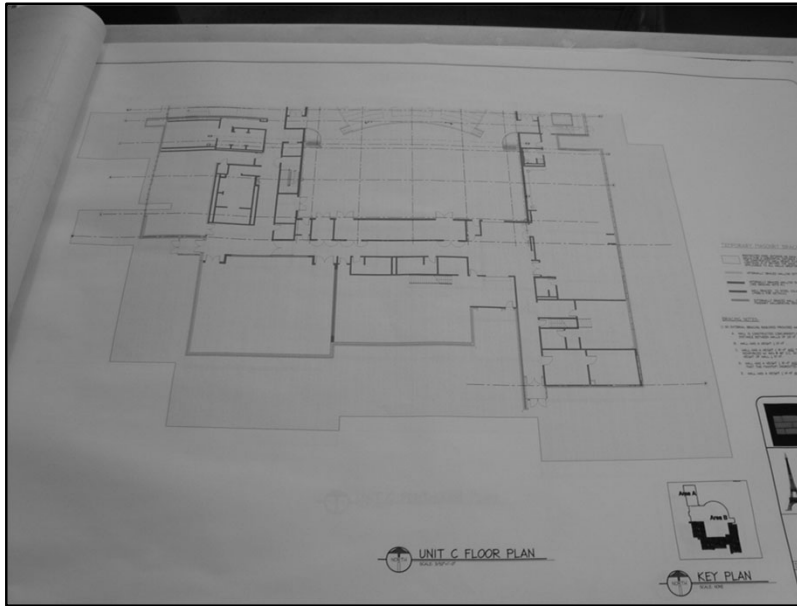


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**Figure 1 –
Restricted
Zone**



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• Restricted Zone Plan

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R 408.40204 Responsibilities; Restricted Zone, Wall Bracing System, and Signage

204(2) The mason contractor shall establish the restricted zone and the installation of the wall bracing system and danger signs. After the wall bracing system and danger signs have been installed in accordance with these rules, any person including, but not limited to, a construction manager, subcontractor, general contractor, or owner who alters or removes the wall bracing system or danger signs shall replace them in accordance with these rules.



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Wall Bracing System and Signage



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Danger Signs on Walls



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408.40204 Responsibilities; Restricted Zone, Wall Bracing System, and Signage

- **204(3)** Each employer having workers in the restricted zone shall monitor the wind speed and evacuate employees when the limitations of these rules have been exceeded.

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R 408.40205 Training Requirements

- **205(2)** An employer shall provide training by a qualified person to each **competent person or employee** who is **involved in installing, altering, repairing, maintaining, or inspecting** the wall bracing system and restricted zone. The training shall enable an employee to recognize hazards associated with the work.
- **205(3)** An employer shall provide training by a qualified person to **any employee who enters** a restricted zone of a masonry wall under construction.

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Training Requirements for Employees Entering the Restricted Zone

Includes both 205(2) and 205(3) workers:

- The nature of hazards involving masonry walls under construction
- Instruction in the general use and maintenance of wall bracing systems, signage, and restricted zone requirements as prescribed in these rules
- Procedures for monitoring wind speeds
- Procedures for vacating the restricted zone during windy conditions
- The nature of hazards involving electrical lines within the restricted zone
- The nature of hazards involving excavating within the restricted zone
- Any other pertinent requirements

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Training is Required to Enter a Restricted Zone



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Training Requirements for Employees Installing, Altering, Repairing, Maintaining, or Inspecting the _____ Bracing System and Restricted Zone

Includes 205(2) workers only, typically the masonry crew:

- Identifying unsupported masonry walls requiring bracing
- The procedures for installing, altering, repairing, inspecting, and maintaining the wall bracing system being used
- Proper installation and maintenance of a restricted zone and signage
- Inspecting the worksite for overhead and underground utilities and other hazards
- Inspecting the worksite for excavations in the restricted zone

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Restricted Zone and Wall Bracing Duties Require Extended Training



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R 408.40205 Training Requirements

205(4) Additional training is required in each of the following situations:

(a) When changes at the worksite present a hazard about which an employee has not been previously trained.

(b) When changes in the types of wall bracing systems present a hazard for which an employee has not been previously trained.



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R 408.40205 Training Requirements



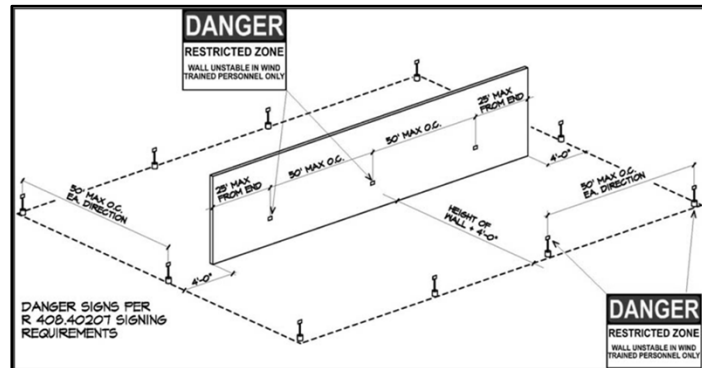
205(5) The employer shall verify compliance with this rule by preparing a **written certification record**. The written certification record shall contain the name or other identity of the employee trained, the date or dates of the training, and the signature of the person who conducted the training or the signature of the employer. If the employer relies on training conducted by another employer or completed prior to the effective date of this rule, the certification record shall indicate the date the employer determined the prior training was adequate rather than the date of actual training.

The latest training certification shall be maintained and available during the work shift.

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R 408.40206 Restricted Zone Requirements

206(1) For walls greater than eight feet in height, a restricted zone shall be established prior to the start of the construction of the wall. The restricted zone shall meet all the following requirements (see Figure 1):



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R 408.40206 Restricted Zone Requirements



206(1) CONTINUED

- (a) Be equal to the height of the constructed wall plus a minimum of four feet and run the entire length of the wall plus a minimum of four feet beyond the ends of the wall.
- (b) Be established on both sides and ends of the wall.
- (c) Be limited to entry by employees trained in accordance with R 408.40205.
- (d) Remain in place until the wall has obtained its final lateral support.
- (e) Be delineated by signing in accordance with R 408.40207.

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R 408.40206 Restricted Zone Requirements

- **206(2)** When a restricted zone extends onto or across roadways or other adjacent areas, protection shall be provided as prescribed in Construction Safety Standard Part 22 Signals, Signs, Tags, and Barricades, R 408.42223 Traffic control, or by other methods.



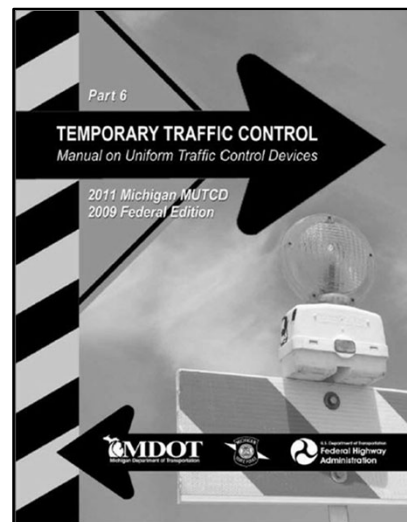
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Restricted Zones Requiring Traffic Control

R 408.402223 Traffic Control

2223(1) Traffic control devices shall be installed and maintained as prescribed in Part 6 of the 2011 **MMUTCD**, which is adopted by reference.



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R 408.40206 Restricted Zone Requirements

- **206(3)** If restricted zones **cannot be installed or maintained as prescribed** by these rules, **alternative protective methods** shall be provided. Drawings/plans or calculations shall be prepared by a qualified person and available at the jobsite.

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Alternative Protective Method

Eliminating the Restricted Zone

"This can be a great tool when the Restricted Zone extends into roadways or pedestrian walkways that cannot be closed or easily protected. It can also prove highly beneficial when the Restricted Zone extends over adjacent building spaces that must remain occupied during construction. The basic premise for eliminating the Restricted Zone is to **design the Internal Bracing for wind loads based on the full design level wind speed**....Higher design wind velocities and the resulting higher pressures will more frequently require modifications to the occupancy design requirements including reinforcement quantity and possibly foundation size."

"Internal Bracing Design Guide for
Masonry Walls Under Construction"
Copyright © 2013
International Masonry Institute
Author: Scott W. Walkowicz, PE, NCEES



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R 408.40206 Restricted Zone Requirements

206(4) For multi-story structures the restricted zone shall be determined by a qualified person.



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✓ Knowledge Check #2 : Restricted Zone Needed?

Yes or No?

Why?



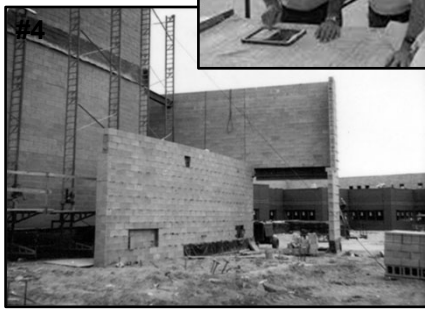
#1



#2



#3



#4

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R 408.40207 Signing Requirements



207(1) Each unsupported masonry wall that is **more than eight feet in height** shall be posted with a danger sign on each end and each side at intervals of not more than 50 feet as shown in Figure 1.

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R 408.40207 Signing Requirements

- **207(2)** The restricted zone shall be delineated by signs at each corner and spaced at intervals of not more than 50 feet along the perimeter.



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R 408.40207 Signing Requirements

207(3) The danger signs shall be maintained in readily visible, unobstructed locations and in a legible condition until the masonry wall has obtained its final lateral support.



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R 408.40207 Signing Requirements

- **207(5)** An illustration of a danger sign which complies with subrule (4) of this rule is shown in Figure 2.



- **207(6)** All signs must be removed after the walls have obtained their final lateral support.

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R 408.40208 Wind Speed; Determination by Competent Person

- **208** Wind speeds shall be determined by a **competent person** in the **vicinity of the masonry wall exposed to wind** and shall be monitored during the initial and intermediate periods. A wind-measuring device shall be used to determine wind speeds.

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Wind Speed Monitoring







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R 408.40209 Initial Period Requirements

209(1) Unbraced masonry walls shall not exceed the maximum height as shown in Table 1 during the initial period.

| TABLE 1 INITIAL PERIOD (LESS THAN 24 HOURS) Maximum Unbraced Height of Unreinforced Masonry Above its Base or Highest Line of Bracing for Resisting 20 mph Wind Unit Weight of Masonry | | | |
|--|---|---|--|
| Nominal Thickness | Light Weight ⁽¹⁾ (<105 pcf) | Medium Weight ⁽²⁾ (105 to <125 pcf) | Normal Weight ⁽³⁾ (≥125 pcf) |
| | Maximum Height | Maximum Height | Maximum Height |
| 4" | 8'-0" | 8'-0" | 8'-0" |
| 6" | 8'-0" | 8'-0" | 8'-0" |
| 8" | 9'-4" | 10'-0" | 12'-0" |
| 10" | 13'-4" | 14'-8" | 17'-4" |
| 12" | 18'-0" | 20'-0" | 24'-0" |

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R 408.40209 Initial Period Requirements

- **209(2)** No one shall be within the restricted zone of a masonry wall subjected to winds exceeding **20 miles per hour during the initial period.**



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R 408.40209 Initial Period Requirements

209(3) At the end of the initial period, the wall shall be braced on both sides if it exceeds the unbraced wall heights as shown in Table 2.



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R 408.40210 Intermediate Period Requirements

210(1) When the height of an unbraced masonry wall exceeds the maximum height as shown in Table 2 during the intermediate period, the masonry wall shall be braced on both sides.

| TABLE 2 ⁽⁵⁾ INTERMEDIATE PERIOD (GREATER THAN 24 HOURS) Maximum Unbraced Height of Unreinforced Masonry Above its Base or Highest Line of Bracing for Resisting 35 mph Wind | | | | |
|---|---|---|--|------------------------------------|
| Nominal Thickness | Unit Weight of Masonry | | | Unbonded Masonry ⁽⁴⁾ |
| | Light Weight ⁽¹⁾ (<105 pcf) | Medium Weight ⁽²⁾ (105 to <125 pcf) | Normal Weight ⁽³⁾ (≥125 pcf) | |
| | Maximum Height | Maximum Height | Maximum Height | |
| 4" | 8'-0" | 8'-0" | 8'-0" | 8'-0" |
| 6" | 8'-0" | 8'-0" | 8'-0" | 8'-0" |
| 8" | 8'-0" | 8'-0" | 8'-0" | 8'-0" |
| 10" | 8'-0" | 8'-0" | 8'-8" | 8'-0" |
| 12" | 9'-4" | 10'-0" | 10'-8" | 8'-0" |

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R 408.40210 Intermediate Period Requirements

- **210(2)** No one shall be within the restricted zone of a masonry wall subjected to winds exceeding **35 miles per hour** during the **intermediate period**.

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R 408.40210 Intermediate Period Requirements

210(3) When **bracing cannot be installed** because of work operations, no one shall be permitted within the restricted zone when the wind is more than **20 miles per hour** during the intermediate period as shown in Table 3.

| TABLE 3 ⁽⁵⁾ INTERMEDIATE PERIOD (GREATER THAN 24 HOURS) Maximum Unbraced Height of Unreinforced Masonry Above its Base or Highest Line of Bracing for Resisting 20 mph Wind | | | | |
|---|---|---|--|---------------------------------|
| Nominal Thickness | Unit Weight of Masonry | | | Unbonded Masonry ⁽⁴⁾ |
| | Light Weight ⁽¹⁾ (<105 pcf) | Medium Weight ⁽²⁾ (105 to <125 pcf) | Normal Weight ⁽³⁾ (≥125 pcf) | |
| | Maximum Height | Maximum Height | Maximum Height | Maximum Height |
| 4" | 8'-0" | 8'-0" | 8'-0" | 8'-0" |
| 6" | 9'-4" | 10'-0" | 10'-8" | 8'-0" |
| 8" | 14'-8" | 15'-4" | 16'-8" | 9'-4" |
| 10" | 18'-8" | 20'-0" | 22'-0" | 13'-4" |
| 12" | 23'-4" | 25'-4" | 28'-0" | 18'-0" |

⁽¹⁾ Light Weight Units at 95 pounds per cubic foot (pcf) unit weight.
⁽²⁾ Medium Weight Units at 105 pounds per cubic foot (pcf) unit weight.
⁽³⁾ Normal Weight Units at 125 pounds per cubic foot (pcf) unit weight.
⁽⁴⁾ Flashing or other
⁽⁵⁾ Tables 2 and 3 are based on Type N masonry cement mortar.

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R 408.40211 Wall Bracing Design



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- **211(1)** A wall bracing system shall be **designed by a qualified person** and capable of providing stability to the wall for a wind speed of **40 miles per hour**.

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R 408.40211 Wall Bracing Design

211(2) A wall bracing system shall be installed in accordance with **one of the following**:

a) A **triangle wall bracing system** as prescribed in R 408.40212.

OR



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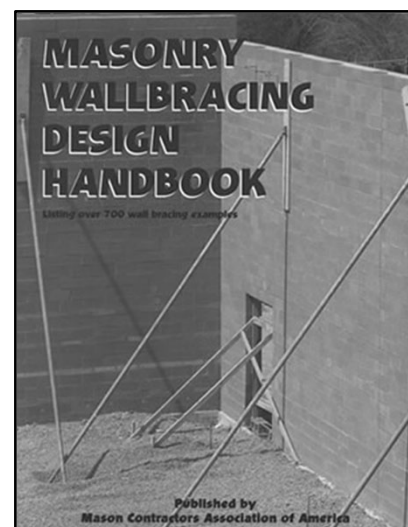
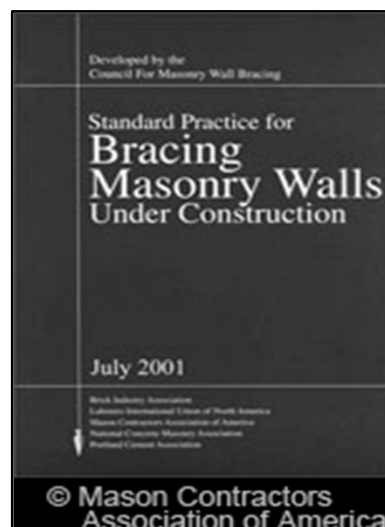
R 408.40211 Wall Bracing Design

211(2) CONTINUED

(b) A bracing plan that is designed using acceptable engineering practices and the engineering content of the Mason Contractors Association of America, Standard Practice for Bracing Masonry Walls Under Construction Chapters 5 and 6 and their commentaries, July 2001 Edition, adopted by reference in R 408.40202. Wall bracing erection drawings/plans or calculations and specifications shall be available at the jobsite. Bracing schemes for walls matching examples specifically outlined in the Mason Contractors Association of America, Masonry Wallbracing Design Handbook, March 2003 Edition, adopted by reference in R 408.40202, satisfy these requirements.

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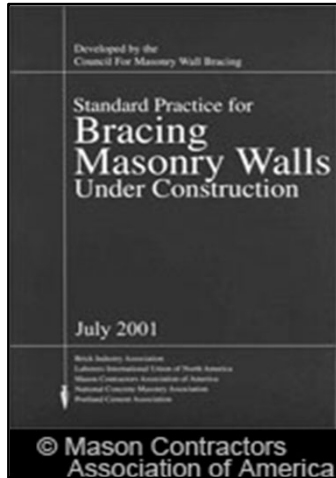
R 408.40211(2)(b) Wall Bracing Design



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R 408.40211(2)(b) Wall Bracing Design



- First industry-supported document giving specific procedures for bracing masonry walls during construction
- The primary goal is to provide life safety for masons and other workers onsite while masonry walls are being constructed

**Content to be used in conjunction with acceptable engineering practices*

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Standard Practice for Bracing Masonry Walls Under Construction

**CHAPTER 4
INITIAL PERIOD REQUIREMENTS**

4.1 - General
4.1.1 During the initial period, the requirements of this chapter shall apply.

4.2 - Unbraced Wall Height
4.2.1 The height of masonry above the support of its weight or above the highest line of lateral support shall not exceed that shown in Table 4.2.
4.2.2 For wind speeds over 20 mph but less than 35 mph, walls may be built 8 feet or less in height above grade.

4.3 - Evacuation
4.3.1 When wind speed during the initial period exceeds 20 miles per hour, evacuate the restricted zone. Exception: The restricted zone adjacent to walls less than 8 feet above grade is permitted to remain occupied for wind speeds up to 35 mph.

Table 4.2. Maximum Unbraced Height of Masonry Walls Above Grade or Highest Line of Lateral Support, (feet)^a

| Nominal Wall Thickness, (in) | Density of Masonry Units, (γ) (lb/ft ³) | | | | | |
|------------------------------|---|---|------------------------|---|------------------------|---|
| | 95 < γ < 115 | | 115 < γ < 125 | | 125 < γ | |
| | Ungrouted Hollow Units | Solid and Fully Grouted Hollow Units ^b | Ungrouted Hollow Units | Solid and Fully Grouted Hollow Units ^b | Ungrouted Hollow Units | Solid and Fully Grouted Hollow Units ^b |
| 4 | 8'0" | 8'0" | 8'0" | 8'0" | 8'0" | 8'0" |
| 6 | 8'0" | 8'0" | 8'0" | 8'0" | 8'0" | 8'0" |
| 8 | 10'8" | 12'4" | 12'8" | 18'0" | 14'0" | 16'6" |
| 10 | 16'8" | 24'2" | 20'0" | 29'2" | 21'8" | 20'0" |
| 12 | 23'0" | 35'0" | 28'0" | 35'0" | 30'0" | 35'0" |

^aFor partially grouted masonry, weight of masonry shall be determined on the basis of linear interpolation between hollow walls that are ungrouted and those that are fully grouted, based on the amount of grouting.
^bWalls may have up to 27% coreing.
^cThis table is for 20 miles per hour wind speeds. For wind speeds greater than 20 miles per hour, see Tables A2.1 - A2.5.

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**CHAPTER 6
BRACING SYSTEMS REQUIREMENTS**

6.1 - General
The design of bracing systems for masonry walls and the anchorage of bracing shall comply with the requirements of this chapter.

6.2 - Steel Components of Bracing Systems
Steel components of bracing systems shall be designed in accordance with the Allowable Stress Design and Plastic Design Specification of Structural Steel Buildings using the unfactored load combinations in Section 5.5.2, or shall be designed in accordance with the Load and Resistance Factor Design Specification for Structural Steel Buildings using the factored load combinations of Section 5.4.2.

6.3 - Wood Components of Bracing Systems
Wood components of bracing systems shall be designed in accordance with the National Design Specification for Wood Construction, using the unfactored load combinations in Section 5.5.2, or shall be designed in accordance with the Load and Resistance Factor Design Specification for Engineered Wood Construction, ASCE 16, using the factored load combinations of Section 5.4.2.

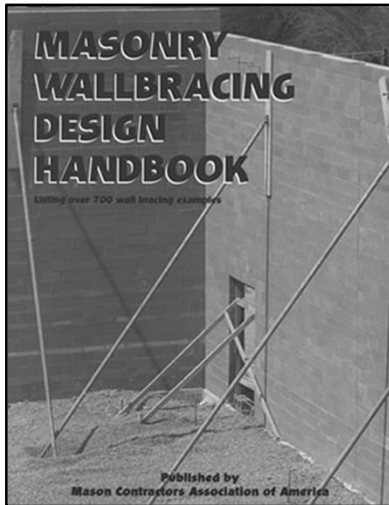
6.4 - Connections of Bracing Systems to Concrete
6.4.1 Concrete slabs and other concrete elements used to anchor masonry bracing systems shall comply with the requirements of Building Code Requirements for Concrete Structures, ACI 318.
6.4.2 Post-drilled and cast-in-place anchors are permitted for connecting braces to concrete slabs, dead men or foundations. Restricted working loads shall be as reported in manufacturers' literature.

6.5 - Design Requirements for Anchorage of Bracing Systems
1.4.3 - Ground Anchors
The nominal strength of ground anchors shall be based on the ground anchor manufacturer's load tests in soils comparable to those at the construction site. The design strength shall be the nominal strength multiplied by a strength reduction factor of 0.6 and the design based on factored loads. Where design is based on unfactored loads, the safety factor shall be 2.
6.5.2 - Dead Men
The nominal strength of dead man anchors shall be determined by considering dead load and soil resistance if any. The design strength of dead man anchors is the nominal strength multiplied by a strength reduction factor of 0.6. Where design is based on unfactored loads, the safety factor shall be 1.5.

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R 408.40211(2)(b) Wall Bracing Design

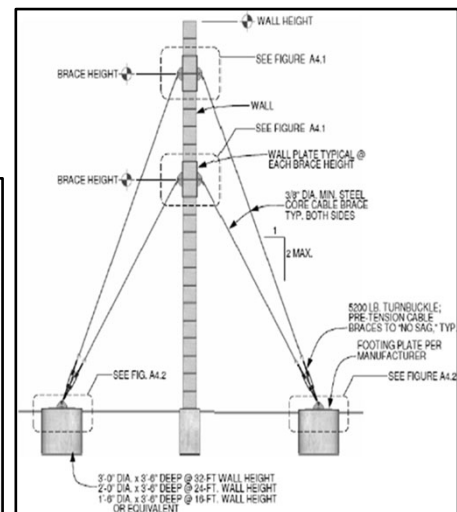
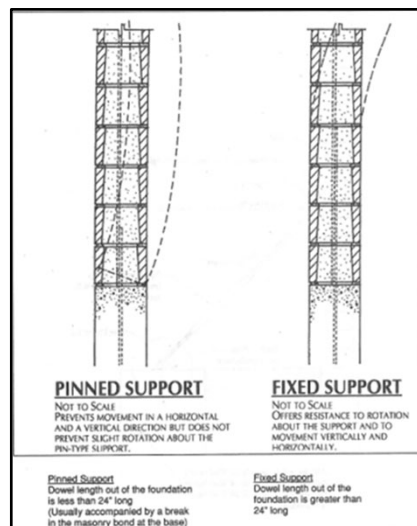


- Lists over 700 examples of masonry wallbracing
- Engineering design calculations adhering to Standard Practice for Bracing Masonry Walls Under Construction
- Step-by-step pictorial of wall bracing placement

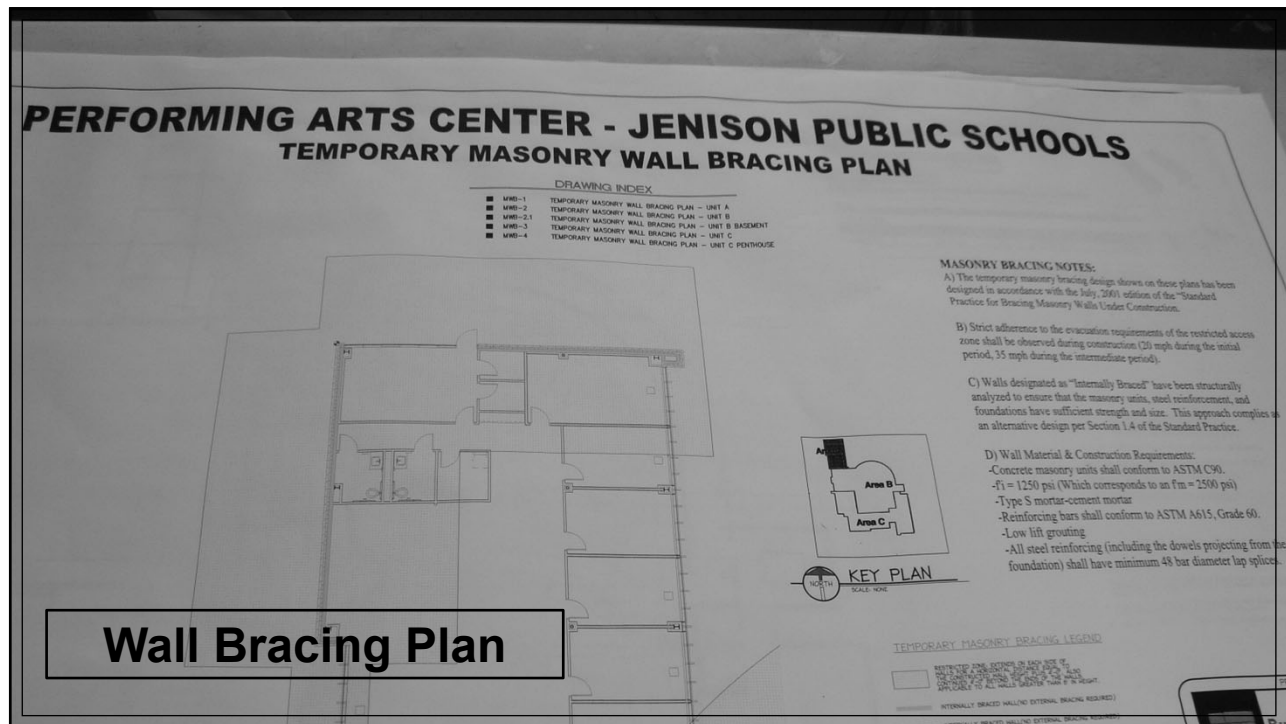
**Bracing schemes must match wall examples to satisfy requirements*

67

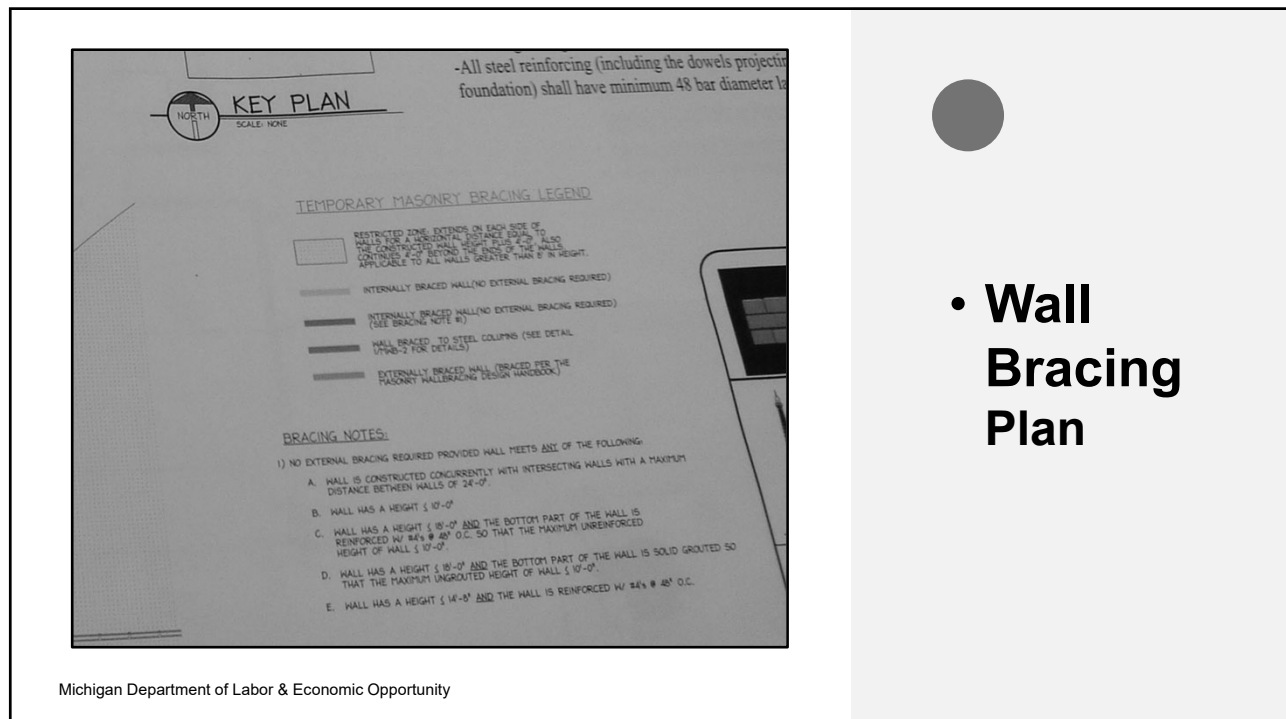
Masonry Wallbracing Design Handbook



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✓ Knowledge Check #3 :

1. What is required of masonry walls in order to remove danger signs from walls and restricted zones?
2. Match the wind speeds relevant to the following conditions:

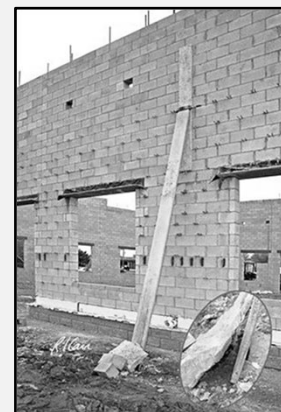
| | |
|---------------|---|
| a) Irrelevant | 1) Intermediate Period |
| b) 20 mph | 2) Wall bracing design speed |
| c) 35 mph | 3) Final lateral support |
| d) 40 mph | 4) Initial Period/bracing cannot be installed |
3. Per the Standard, wall bracing systems shall be designed by a _____.

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External Wall Bracing – Triangle

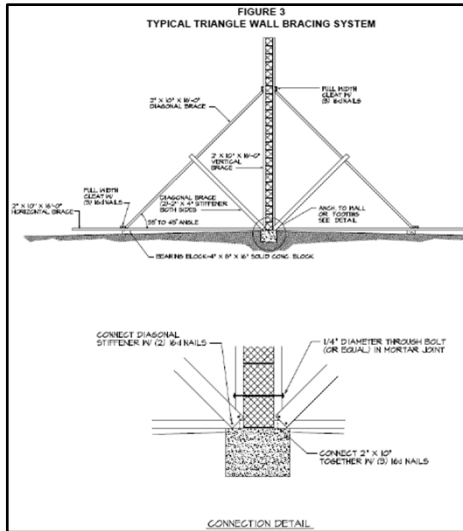


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R 408.40212 Triangle Wall Bracing System



212(1) A triangle wall bracing system shall consist of **all** the following elements assembled as shown in Figure 3:

(a) Scaffold grade lumber that is suitable for planking.

(i) A 16-foot, 2-inch by 10-inch vertical brace.

(ii) A 16-foot, 2-inch by 10-inch diagonal brace.

(iii) A 16-foot, 2-inch by 10-inch horizontal brace.

(b) Two nominal 2 x 4 wood stiffeners.

(c) Top wall anchor.

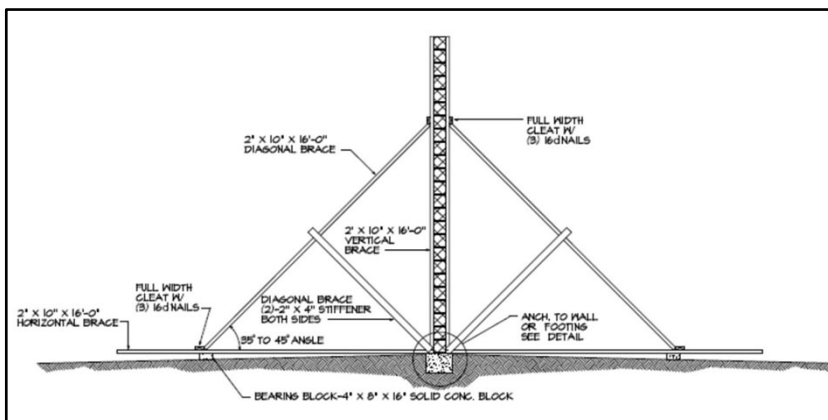
(d) Base of wall or footing anchor.

(e) Bearing block.

(f) Cleats.

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R 408.40212 Triangle Wall Bracing System

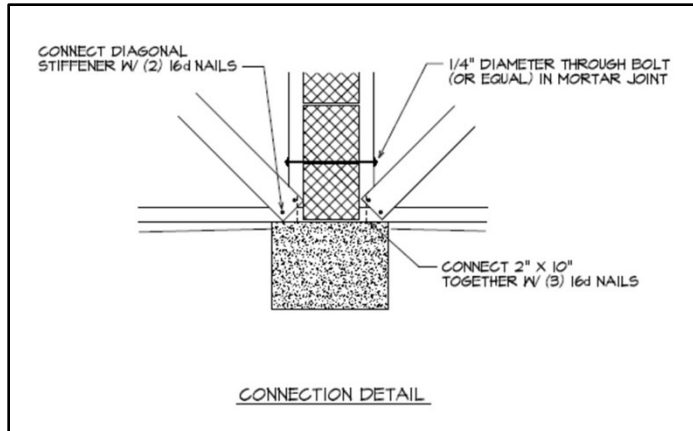


- **212(2)** The angle of intersection of the diagonal brace and the horizontal brace shall be between 35 and 45 degrees. The diagonal brace shall not intersect the vertical brace below the midpoint height of the masonry wall.

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R 408.40212 Triangle Wall Bracing System



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- **212(3)** The triangle wall bracing system shall be aligned on both sides of the wall when installed.

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R 408.40212 Triangle Wall Bracing System

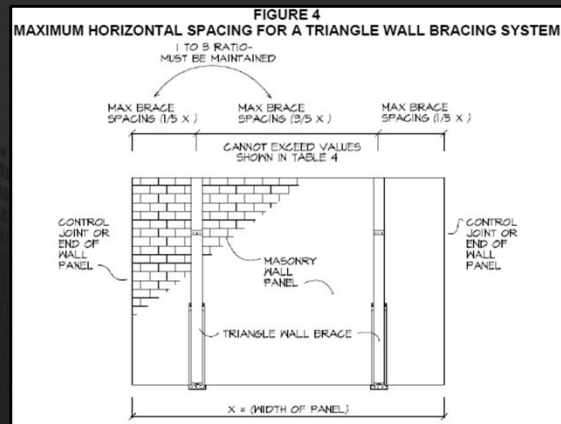
212(4) The maximum horizontal spacing for a triangle wall bracing system shall not exceed the values as shown in Table 4 for the corresponding maximum wall heights and as illustrated in Figure 4.

| TABLE 4 ⁽¹⁾ INTERMEDIATE PERIOD (GREATER THAN 24 HOURS) Maximum Horizontal Spacing for the Triangle Wall Bracing System for Resisting 40 mph Wind | | | |
|--|----------------------------|---------------------|---------------------------------------|
| Nominal Thickness | Maximum Horizontal Spacing | Maximum Wall Height | Maximum Panel Width ⁽²⁾⁽³⁾ |
| 4" | 9'-1" | 16' | 16'-0" |
| 6" | 13'-6" | 16' | 24'-0" |
| 8" | 17'-11" | 16' | 32'-0" |
| 10" | 20'-10" | 16' | 38'-0" |
| 12" | 23'-6" | 16' | 42'-8" |

⁽¹⁾ Table 4 is based on Type N masonry cement mortar.
⁽²⁾ Actual width of panel may not exceed design spacing of control joints or design panel widths.
Consult approved permit drawings for specified control joint locations or maximum spacing.
⁽³⁾ Panels shall not include control joints within width of panel.

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R 408.40212 Triangle Wall Bracing System



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Triangle Wall Bracing



System Fail

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✓ Knowledge Check #4 :

For the following, calculate the spacing for installing triangle braces using the formula from Figure 4. Then, determine applicability using the Table 4 values given:

1) 25 ft. long, 14 ft. 8 in. high, 8 in. concrete block wall panel needs bracing between control joints.

(Per Table 4: 8-inch block allows up to 32 ft panel width, up to 16 ft panel height, and up to 17 ft 11 in between braces)

2) 30 ft. long, 16 ft. high, 12 in. concrete block wall panel needs bracing between control joints.

(Per Table 4: 12-inch block allows up to 42 ft 8 in panel width, up to 16 ft panel height, and up to 23 ft 6 in between braces)

3) 40 ft. long, 17 ft. 4 in. high, 12 in. concrete block wall panel needs bracing between control joints.

(Per Table 4: 12-inch block allows up to 42 ft 8 in panel width, up to 16 ft panel height, and up to 23 ft 6 in between braces)

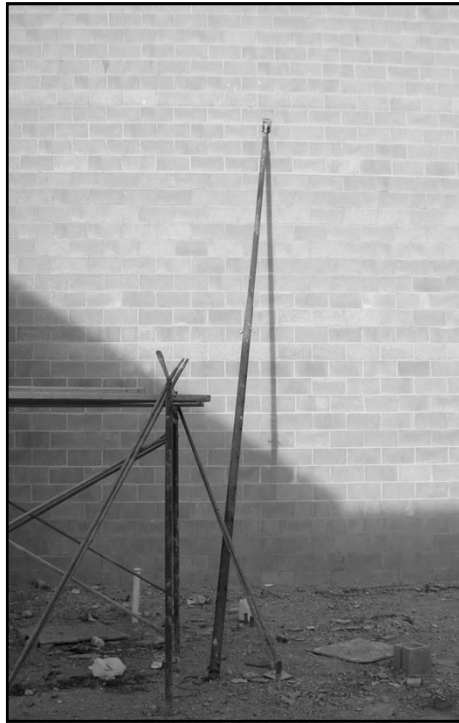
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Common External Bracing Issues



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Common External Bracing Issues



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Common External Bracing Issues



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R 408.40213 Inspections



- **213(1)** An unsupported masonry wall, including the wall bracing system, **shall be inspected** for visible defects by a **competent person** at the **beginning of each shift** and **after any occurrence** that could affect the structural integrity of the wall bracing system or the wall.

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- **(a)** Any bracing element that is damaged or weakened from any cause shall be immediately repaired or replaced. A **competent person** shall supervise the repairs.
- **(b)** Any bracing element that is repaired shall have at least the original designed strength for the wall brace system.
- **(c)** If any movement of the wall or physical damage to the wall occurs, the project structural designer of record shall be notified. Repairs to the wall shall be designed by a structural engineer and shall not be done without the approval of the project structural designer of record.
- **(d)** Only those persons repairing the wall or wall bracing system may work within the restricted zone until repairs have been made.

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408.40213 Inspections

213(1) CONTINUED

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203(5) “Intermediate period” means the period of time following the initial period until the masonry wall is connected to the structural elements that provide its **final lateral support**

203(11) “Unsupported masonry wall” means a masonry wall that has not obtained its **final lateral support** from structural elements, such as, but not limited to, roofs, floors, buttresses, crosswalls, and piers

203(1)(d) For walls greater than eight feet in height, a restricted zone shall be established prior to the start of the construction of the wall. The restricted zone shall remain in place until the wall has obtained its **final lateral support**

207(3) The danger signs shall be maintained in readily visible, unobstructed locations and in a legible condition until the masonry wall has obtained its **final lateral support**

207(6) All signs must be removed after the walls have obtained their **final lateral support**

Final Lateral Support



Not defined in the Standard though mentioned five times

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Final Lateral Support

“Final lateral support means that the wall and its final connections, i.e., trusses and decking, are capable of transferring the design level wind load to the structure as determined by a qualified person.”

MIOSHA Fact Sheet
Construction Safety & Health Division
Part 2 – Masonry Wall Bracing Questions and Answer

These Q & As are designed to provide information related to Construction Safety Standard Part 2 – Masonry Wall Bracing. The Michigan Occupational Safety and Health Act 154, as amended, require employers to comply with safety and health standards promulgated by MIOSHA. However, **this document is not itself a standard or regulation, and it creates no new legal obligations.**

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Final Lateral Support

- “The intent is that the wall be connected to a continuous lateral system. Bar joists or beams bearing on or connected to the wall, without connection to a deck or even when connected to a deck, without an effective shear wall or other bracing may not qualify as ‘final lateral support’ and each project condition should be evaluated independently to determine when the Intermediate Period ends.”

“Internal Bracing Design
Guide for Masonry Walls
Under Construction”

Copyright © 2013
International Masonry
Institute

Author: Scott W. Walkowicz,
PE, NCEES

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Bracing Masonry Walls – Federal OSHA

1926.706(a) A limited access zone shall be established whenever a masonry wall is being constructed. The limited access zone shall conform to the following:

Established prior to the start of construction of the wall; equal to the height of the wall to be constructed plus four feet, and shall run the entire length of the wall; established on the side of the wall which will be unscaffolded; restricted to entry by employees actively engaged in constructing the wall; no other employees shall be permitted to enter the zone; remain in place until the wall is adequately supported to prevent overturning and to prevent collapse unless the height of wall is over eight feet, in which case the limited access zone shall remain in place until the requirements of paragraph (b) of this section have been met.

1926.706(b) All masonry walls over eight feet in height shall be adequately braced to prevent overturning and to prevent collapse unless the wall is adequately supported so that it will not overturn or collapse. The bracing shall remain in place until permanent supporting elements of the structure are in place.

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Factors that Prevent Masonry Walls from Blowing Over:

1. Gravity – Initial Period (Design for 20 mph wind)
2. Time – Wall achieves one half masonry strength at 24 hours after laying and/or grouting
3. Mortar Strength
4. Wall Geometry & Sequence of Construction
5. Reinforced Wall Strength
6. Time – Reserve strength as wall develops from one half masonry strength to full masonry strength

- “Practical Design of Temporary Masonry Wall Bracing”
Author: Todd Dailey, Civil Engineer,
President and CEO Dailey Engineering Inc.

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Other Safety Standards Affecting Masonry

- Part 1. General Rules** – APPs, first aid cards, toilets, washing facilities
Part 6. Personal Protective Equipment – hard hats, safety glasses, face shields, boots, gloves
Part 7. Welding and Cutting – welding anchors to steel, cutting rerod to length
Part 8. Handling and Storage of Materials – brick, block, scaffold, water, mortar, grout, powerlines
Part 9. Excavation, Trenching, and Shoring – footing block, foundations, poured walls
Part 10. Cranes and Derricks – cannot reach with forklift, powerlines
Part 11. Fixed and Portable Ladders – access to scaffolds, egress from excavations, powerlines
Part 12. Scaffolds and Scaffold Platforms – fall protection, falling objects, powerlines
Part 13. Mobile Equipment – operator permits, forklifts, powered industrial trucks, powerlines
Part 17. Electrical Installations – electric saws, electric mixers, electric grinders, extension cords
Part 18. Fire Protection and Prevention – fire extinguishers with heaters, smoking, welding, fueling
Part 19. Tools – saws, grinders, hammers, trowels, shovels, tape measures, brick tongs
Part 20. Demolition – tearing-out, toothing, grinding, shoring, bracing, material chutes
Part 21. Guarding of Walking and Working Areas – stairways, ramps, catch platforms, guardrails
Part 22. Signals, Signs, Tags, and Barricades – traffic control, MMUTCD, traffic regulators
Part 25. Concrete Construction – forms, fall protection, rerod-impalement, rerod-powerlines
Part 32. Aerial Work Platforms – op permits, fall protection, powerlines
Part 35. Confined Spaces in Construction – limited access, bodily enter, not for occupancy
Part 42. Hazard Communication – mortar, cement, gas, diesel, kerosene, propane, sealants
Part 45. Fall Protection – training, inspection, PPE, hazard recognition

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**Many Health Standards Affect Masonry
the Most Prevalent of Which Are:
Part 451. Respiratory Protection
and
Part 690. Silica in Construction**



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DANGER! Catastrophic Consequences



Masonry Wall Collapse – Traverse City, MI 2020

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IN CONCLUSION:**Part 2.
Masonry
Wall Bracing
and
Restricted
Zones**

- Training
- Unsupported block walls
- Exposed to wind
- Over eight feet tall
- Restricted zone plan and signage
- Wind speed
- Evacuate 20/35 mph
- Internal wall bracing – grout and rebar
- External wall bracing – triangle or acceptable engineering practices
- Inspections
- Final lateral support

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Questions?

Keys to preventing injuries and fatalities related to masonry wall bracing are employee training and frequent/thorough inspections to identify and correct hazards.

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References

- Standard Practice for Bracing Masonry Walls Under Construction
- Masonry Wall Bracing Design Handbook
- Mason Contractors Association of America
- International Masonry Institute
- Walkowicz Consulting Engineers, Inc.
- Dailey Engineering Inc.
- MIOSHA Construction Safety Standard Part 2
- Internet

MIOSHA
Michigan Occupational Safety
and Health Administration

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Knowledge Assessment

- The purpose of this assessment is to validate the knowledge learned in class
- A passing score of 70% is required
- Class reference materials/notes are not allowed to be used during the assessment
- Collaboration or discussion with others is not allowed during the assessment
- Answers will be reviewed after everyone completes and submits their assessment

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Online Transcript

www.macomb.edu/webadvisor

- Choose NonCredit / Continuing Education
- Log In
- What?
- Check individual courses – Proficient / Not Proficient
- Track courses taken through the MTI
- Request a transcript to show certification
- Manage account information

MIOSHA
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How?

- Select What's My User ID?
- Key in the Last Name and SS# or Macomb ID
- Select Log In
- If you need help call 586-498-4106 or email mti@macomb.edu

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Thank You for Attending this Presentation

Michigan Occupational Safety and Health Administration
Consultation Education and Training Division
525 W Allegan Street, PO Box 30643
Lansing, Michigan 48909-8143

For more information or to request consultation,
education, and training services call (517) 284-7720
or visit our website at

www.michigan.gov/miosha



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Part 2. Masonry Wall Bracing

Student Resources

MIOSHA Standard:

[Part 2. Masonry Wall Bracing](#)

MIOSHA Fact Sheets:

[Masonry Wall Bracing \(CSHD-028\)](#)

[Part 2 – Masonry Wall Bracing Questions & Answers \(CSHD-031\)](#)

MIOSHA Publications:

[Danger Restricted Zone – Wall Unstable in Wind Poster \(CET-0319\)](#)

[Danger – Hard Hat Area \(CET-0324\)](#)

External Publications:

[IMI – Internal Bracing Design Guide for Masonry Walls Under Construction](#)

[Dailey Engineering – Practical Design of Temporary Masonry Wall Bracing](#)

MIOSHA Training Institute (MTI) Resources:

www.michigan.gov/mti

MIOSHA Training Calendar:

www.michigan.gov/mioshatraining

MIOSHA Homepage:

www.michigan.gov/miosha



Michigan Department of Labor and Economic Opportunity
Michigan Occupational Safety and Health Administration
Consultation Education and Training Division
525 W Allegan St, PO Box 30643
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www.michigan.gov/leo

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