MASONRY
Institute of Michigan

Masonry Partition Guide

Minimum Reinforcement Requirements

As it relates to masonry construction, partition wall requirements are covered under Chapter 14 of the *2016 TMS 402 Building Code Requirements for Masonry Structures* (TMS 402). Partition walls are typically designed as 'nonparticipating elements' in accordance with the requirements of Section 7.3.1. As such, partition walls are not part of the seismic-force-resisting system and are isolated in their own plane from the seismic-force-resisting system except as required for gravity support. Isolation joints and connectors are designed to accommodate the design story drift.

Participating walls also have minimum reinforcement requirements based on the Seismic Design Category (SDC), as determined by ASCE 7 *Minimum Design Loads for Buildings and Other Structures* (ASCE 7). These requirements are included in TMS 402 Section 7.4.1.1 (SDC A), 7.4.1.1 (SDC B), 7.4.3.1 (SDC C), and 7.4.4.1 (SDC D+). For convenience, these minimum reinforcement requirements are presented below in Table 1 and Table 2.

This guide will focus on SDCs A, B, and C since these are the SDCs that apply to Michigan.

<table>
<tr><th colspan="5">Minimum Seismic Reinforcement
Vertically Spanning Partitions</th></tr>
<tr><th>SDC</th><th>Allowable Design Method</th><th colspan="2">Minimum Horizontal Reinforcement (H)</th><th>Minimum Vertical Reinforcement (V)</th></tr>
<tr><td>A</td><td rowspan="2">Chapters 8, 9, 10, 11, Appendix A, or Appendix B</td><td colspan="2" rowspan="2">None</td><td rowspan="2">None</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td><td>Chapters 8, 9, 10, 11, Appendix A, or Appendix B</td><td colspan="2">None</td><td>#4 at 120 in.</td></tr>
<tr><td>D</td><td>Chapters 8, 9, 10, 11, or Appendix A</td><td colspan="2">None</td><td>#4 at 48 in.</td></tr>
<tr><td rowspan="2">E or F</td><td rowspan="2">Chapters 8, 9, 10, 11, or Appendix A</td><td>Walls Laid in Running Bond</td><td>None</td><td>#4 at 48 in.</td></tr>
<tr><td>Walls not Laid in Running Bond</td><td>Cross sectional area of at least 0.0015 times the gross section area; Maximum Spacing = 24 in.</td><td>#4 at 48 in.

These elements shall be fully grouted and shall be constructed of hollow open-end units or two wythes of solid units (TMS 402 Section 7.4.5.1).</td></tr>
</table>

Table 1: Vertically Spanning Partitions

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Minimum Seismic Reinforcement Horizontally Spanning Partitions					
SDC	**Allowable Design Method**	**Minimum Horizontal Reinforcement (H)**			**Minimum Vertical Reinforcement (V)**
A B	Chapters 8, 9, 10, 11, Appendix A, or Appendix B	None			None
C	Chapters 8, 9, 10, 11, Appendix A, or Appendix B	≤ 4" Walls	(1) W1.7 wire at 16 in. on center		None
		> 4" Walls	(2) W1.7 wire bed joint reinforcement at 16 in. on center		None
D	Chapters 8, 9, 10, 11, or Appendix A	≤ 4" Walls	(1) W1.7 wire at 16 in. on center		None
		> 4" Walls	(2) W1.7 wire bed joint reinforcement at 16 in. on center		None
E or F			Walls Laid in Running Bond	Same as SDC D	None
			Walls not Laid in Running Bond	Cross sectional area of at least 0.0015 times the gross section area; Maximum Spacing = 24 in.	None

Table 2: Horizontally Spanning Partitions

General Design Practices

Horizontally spanning partition walls typically span between intersecting walls (or columns), and they cannot include openings as the openings would create a discontinuity in the load path. The load path could be resolved by including vertical reinforcement at the jambs and reinforced masonry lintel. Connections are provided between the partition wall and intersecting walls (or columns) along with vertical isolation joints, as shown in Figure 1 below:

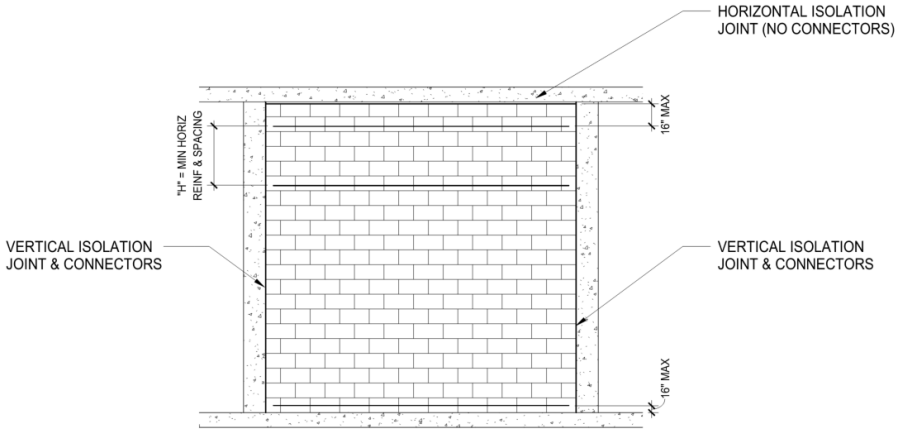


Figure 1: Horizontally Spanning Partition

Vertically spanning partition walls typically span between a base (slab or foundation) and a diaphragm (roof or floor). Vertically spanning partition walls can include openings if vertical reinforcement is provided on both sides of the opening to resist the applied loads. Thus, connections are provided between the base and the diaphragm along with horizontal isolation joints, as shown below in Figures 2 and 3:

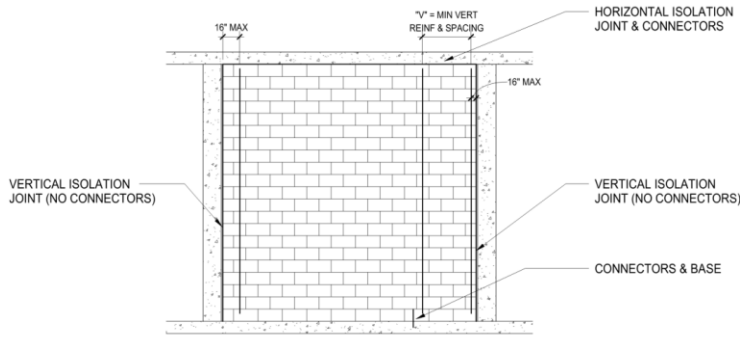


Figure 2: Vertically Spanning Partition without Openings

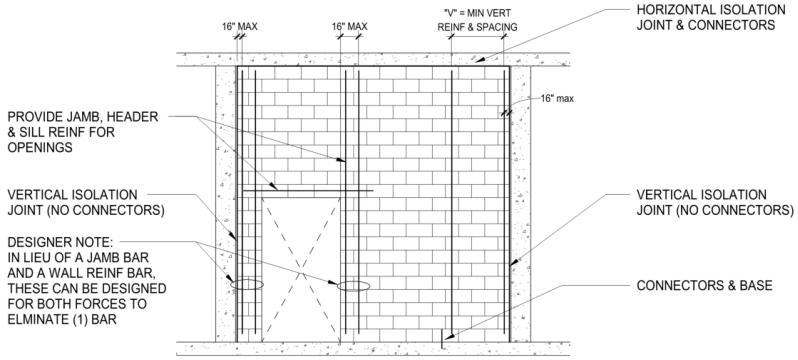


Figure 3: Vertically Spanning Partition with Openings

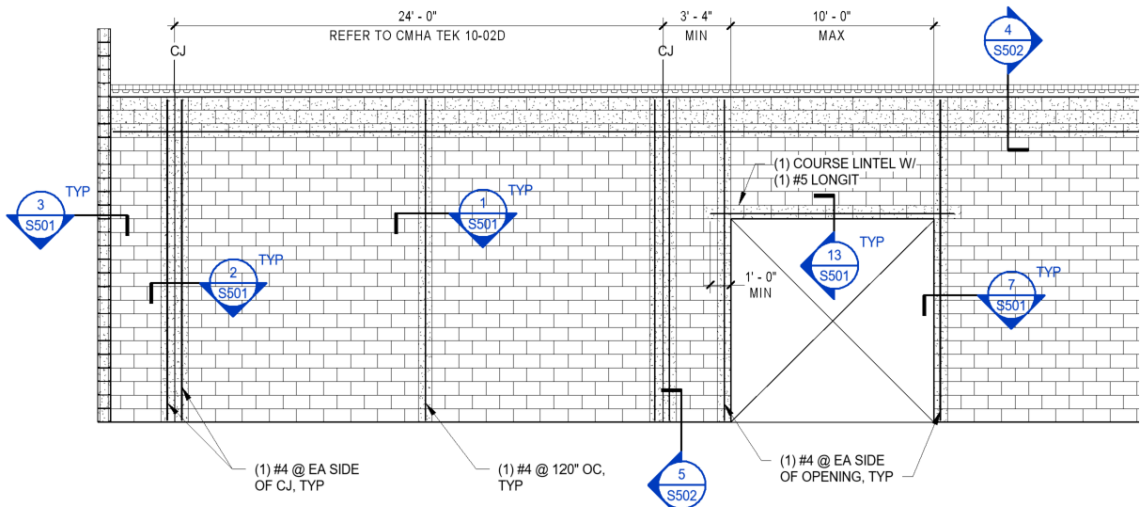
Since partition walls are typically nonparticipating elements, it is essential that they are detailed such that they are not part of the seismic-force-resisting system. For example, if the top of a vertically spanning partition wall is connected to a roof deck with an angle and an anchor, the wall will be participating and will resist lateral loads.

MIM Recommendations

A full discussion of unreinforced masonry (URM), which is permitted in SDCs A and B, and reinforced masonry, that is required in SDC C and greater, is provided below these recommendations. These recommendations relate to the most economical means of designing and constructing partition walls in Michigan:

- Maximum horizontal load is limited to 5 psf, as required by IBC Section 1607.15.
- In terms of the enclosure classification defined by ASCE 7, the building can be considered an enclosed building.
- Design partition walls vertically spanning from the base to a floor/roof level. Wall height is limited to the following:
    - 15’-4” for 6-inch CMU
    - 18’-0” for 8-inch CMU
    - 22’-8” for 12-inch CMU
- Provide (1) #4 vertical reinforcing bar at the following locations:
    - At a spacing of 120 in. on center.
    - In the jamb on each side of openings in the first core.
    - On both sides of control joints.
    - At wall ends and corners.
- Provide 9 ga. horizontal joint reinforcement at a spacing of 16 in. on center, vertically. For half-high CMUs, reduce spacing to 12 in. on center.
- Provide control joints at a minimum spacing of 1.5 multiplied by the wall height or 24’-8” on center in accordance with CMHA TEK 10-02D.
- Limit the maximum width of openings to 10’-0” to prevent interrupting the vertical reinforcement spaced at 120 in. on center.
- Provide one course CMU lintels over openings with (1) #5 longitudinal bar located 3 in. from bottom of closed bottom lintel unit.

A typical wall elevation is provided below in Figure 4:



Unreinforced Masonry (SDC A and B)

In SDC A and B, there are no minimum reinforcement requirements for either vertical or horizontal reinforcement. As such, the masonry partition walls could be designed as unreinforced masonry using either strength design (TMS 402 Section 9.2) or allowable stress design (TMS 402 Section 8.2). If openings are present in the partition wall, then nominal reinforcement is required at the opening locations.

The *International Building Code* (IBC) has a minimum horizontal load of 5 psf for interior walls and partitions that exceed 6 ft. in height in Section 1607.15. If the seismic design spectral response acceleration parameter (S_{DS}) is less than 0.30, then typically the minimum horizontal load from IBC Section 1607.15 will control. For the purposes of this guide, a load factor of 1.6 was used which is consistent with a live load to determine allowable spans.

For simplicity, Tables 3 and 4 below provide maximum spans for ungrouted CMU partitions spanning vertically and horizontally, respectively:

Maximum Wall Height Vertically Spanning CMU Partition				
Unit Density	**Mortar Type**	**Maximum Height**		
		6-inch CMU	**8-inch CMU**	**12-inch CMU**
NW (135 pcf)	Type N Masonry Cement	9’ – 4”	12’ – 8”	19’ – 4”
	Type S Masonry Cement	12’ – 0”	16’ – 0”	23’ – 4”
	Type N PCL/Mortar Cement	12’ – 8”	18’ – 0”	25’ – 4”
	Type S PCL/Mortar Cement	14’ – 8”	20’ – 0”	28’ – 0”
MW (125 pcf)	Type N Masonry Cement	9’ – 4”	12’ –8”	18’ – 8”
	Type S Masonry Cement	11’ – 4”	16’ – 0”	22’ – 8”
	Type N PCL/Mortar Cement	12’ – 8”	17’ – 4”	24’ – 8”
	Type S PCL/Mortar Cement	14’ – 8”	20’ – 0”	27’ – 4”
LW (115 pcf)	Type N Masonry Cement	9’ – 4”	12’ – 8”	18’ – 0”
	Type S Masonry Cement	11’ – 4”	15’ – 4”	22’ – 0”
	Type N PCL/Mortar Cement	12’ – 8”	17’ – 4”	24’ – 8”
	Type S PCL/Mortar Cement	14’ – 8”	20’ – 0”	27’ – 4”

Table 3: CMU Maximum Vertical Spans

Maximum Wall Length Horizontally Spanning CMU Partition			
Mortar Type	**Maximum Height**		
	6-inch CMU	**8-inch CMU**	**12-inch CMU**
Type N Masonry Cement	12’ – 0”	16’ – 0”	20’ – 8”
Type S Masonry Cement	14’ – 8”	20’ – 0”	26’ – 0”
Type N PCL/Mortar Cement	16’ – 8”	22’ – 8”	29’ – 4”
Type S PCL/Mortar Cement	19’ – 4”	26’ – 0”	33’ – 4”

Table 4: CMU Maximum Horizontal Spans

Reinforced Masonry (SDC C)

In SDC C, there are minimum reinforcement requirements as shown in Tables 1 and 2. Therefore, the masonry partitions are typically designed as reinforced masonry using either strength design (TMS 402 Section 9.3) or allowable stress design (TMS 402 Section 8.3). Like SDC A and B, the minimum 5 psf horizontal load specified in IBC Section 1607.15 applies and will typically control if the S_{DS} is less than 0.30.

A sample calculation is provided below for determining the flexural capacity of an 8-inch CMU wall with the minimum required reinforcing of (1) centered #4 reinforcing bar at 120 in. on center.

Step 1: Determine the actual area of steel (A_s) per foot of wall:

$$A_s = (0.20\text{ in})\frac{12\text{ in/ft}}{120\text{ in}} = 0.02\text{ in}^2/\text{ft}$$

Step 2: Solve for the effective compression width per bar:

As stated in TMS 402 Section 5.2.1, the effective compression width per bar is the minimum of the center-to-center bar spacing, six multiplied by the nominal wall thickness, and 72 in. Thus, for our case, the effective compression width per bar would be the minimum of 120 in., 48 in. [(6)(8-in)], or 72 in., where 48 in. will control.

Step 3: Calculate moment capacity:

Since the reinforcement spacing is greater than the effective compression width per bar, we must verify that we have sufficient capacity. The simplest way to accomplish this is by factoring down the unit width (b) to account for the larger spacing.

$$b_{mod} = \frac{(48\text{ in})(12\text{ in/ft})}{120\text{ in}} = 4.8\text{ in/ft}$$

Now we can solve for the modified factored moment capacity (ϕM_n),

$$\varphi M_n = \varphi A_s F_y(d - \frac{a}{2}) = \varphi A_s F_y(d - \frac{1}{2} * \frac{(A_s)(f_y)}{(0.80)(f'_m)(b_{mod})}$$

$$\varphi M_n = (0.90)(0.02\text{ in}^2/\text{ft})(60{,}000\text{ psi})(3.8125\text{ in} - \frac{1}{2}\frac{(0.02\text{ in}^2/\text{ft})(60{,}000\text{ psi})}{(0.80)(2000\text{ psi})(4.8\text{ in/ft})}$$

$$\varphi M_n = 4{,}033.12\text{ in} - \text{lb/ft}$$

Step 4: Calculate permitted wall height:

$$M_u = \frac{wL^2}{8} = 4{,}033.12\text{ in} - \text{lb/ft} = \frac{1.6(5\text{ psf})(L)^2}{8} = 336.1\text{ ft} - \text{lb/ft}$$

L = 18.33 ft.

Thus, an 8-inch CMU wall with the minimum required reinforcing of (1) centered #4 bar at 120 in. on center can resist the minimum 5 psf applied load of 5 psf and spanning vertically 18’ – 0”. The values for 6-inch, 8-inch, and 12-inch CMU walls are provided below in Table 5:

Factored Moment Capacity and Wall Height for Minimum Required Reinforcement			
	6-inch CMU	**8-inch CMU**	**12-inch CMU**
Factored Moment Capacity (ϕM_n)	2,925 in-lb/ft	4,033 in-lb/ft	6,221 in-lb/ft
Allowable Wall Height	15’ – 4”	18’ – 0”	22’ – 8”

Table 5: Factored Moment Capacity and Wall Height

Cantilevered Partition Walls

Partition walls are not required to be supported at the top of the wall in SDC A, B, or C. If a partition wall is designed as a cantilevered partition wall, then the base of the wall needs to be detailed to achieve a sufficient level of base fixity to resist the applied loads which is outside of the scope of this guide.

ASCE 7 Section 13.5.8.1 requires partitions that are tied to the ceiling and all partitions greater than 6 ft. in height to be laterally braced to the building structure. ASCE 7 Section 13.1.4 exempts architectural components in SDC B, provided that the component Importance Factor is equal to 1.0. In most cases, the component Importance Factor is equal to 1.0 for partition walls constructed in SDC A or B.

In ASCE 7 Table 13.5-1, interior nonstructural walls and partitions have an amplification factor (a_p) equal to 1.0. In higher SDCs, the structural engineer of record is permitted to use a higher amplification factor, which is listed in Table 13.5-1 as 2.50 for cantilever interior nonstructural walls. Thus, in SDCs greater than B, a cantilevered partition wall is permitted to be used if it is designed for higher seismic forces. For SDC A and B, Table 6 provides the required reinforcement spacing of a centered #5 reinforcing bar for a cantilevered partition wall, based on wall height:

Wall Height	**Required Spacing of (1) #5 Centered Rebar**		
	6-inch	**8-inch**	**12-inch**
8’ – 0”	120 in.	120 in.	120 in.
10’ – 0”	104 in.	120 in.	120 in.
12’ – 0”	72 in.	96 in.	120 in.
14’ – 0”	48 in.	72 in.	104 in.
16’ – 0”	40 in.	56 in.	80 in.

Table 6: Required Reinforcement Spacing