MASONRY INSIGHTS

Masonry Partition Walls

Most building elements designed by a structural engineer are actually structural—they resist gravity or lateral loads (or both). One item, however, that is not structural is a masonry partition wall. The Masonry Society's TMS 402 code defines a partition wall as an interior wall without any structural function. It is a non-loadbearing wall that does not support a floor above, does not participate in the lateral system, and is not a wall that resists out-of-plane exterior wind or seismic loads. A structural engineer might think that if the wall serves no structural function, then it does not need to be included in their design considerations. This is not completely true, however.

Figure 1: Partition Wall Section
IMI Detailing Series

As a material, masonry has some advantages over other materials pertaining to partition walls. It offers durability, security, and a measure of fire and sound control. Masonry can provide energy savings due to its thermal mass, and it can require less maintenance than other building materials. There are also several finish options for masonry—it can be painted or burnished, rock-faced or set in a stack bond pattern. With these advantages, it is apparent why masonry partition walls are prevalently used. Now that we have reviewed the benefits of masonry partition walls, let's look closer at design and detailing practices to take into consideration to result in more cost-effective partition wall designs.

What are reinforcement requirements for partition walls?

The first design item we will explore are reinforcement requirements for partition walls. If detailed correctly, the only load that partition walls are to be designed for is an interior horizontal design pressure. IBC Code 2015, Section 1607.14 requires a minimum interior pressure of 5 psf service (8 psf ultimate) to be considered. Partition walls should not resist any gravity loading. Therefore, partition wall height, thickness, and reinforcement (if any) do need to be checked to resist loads, but only for a very light interior horizontal pressure. What does the TMS 402 Code mandate in terms of minimum reinforcement for partition walls? To understand TMS Code requirements, we first define partition walls as 'nonparticipating elements', which are masonry elements that are not part of the seismic (or lateral) force-resisting structural system. Per TMS 402-13 Section 7.4.1, partition walls in low seismic areas located in Seismic Design Category (SDC) A or B do not have minimum reinforcement area or maximum spacing requirements. Therefore, partition walls can be unreinforced in low seismic areas, if adequate to resist the service 5 psf pressure.

As an example, consider an 8" thick CMU partition wall with f'm = 2500 psi, Type S mortar, 18'-0 tall, simply supported, and located in Seismic Design Category (SDC) A or B. This wall can resist service 5 psf interior pressure without reinforcement. Refer to calculation per Figure 3. A partition wall constructed of 12" block can span up to 28 feet high as an unreinforced masonry wall. As we increase in height and/or reduce in wall thickness, light reinforcement is needed to resist the interior pressure of 5 psf. See Table 1 for guidance on partition wall reinforcement for low seismic loading, SDC A or B. It is important to note that such reinforcement is possible only with correct detailing and isolation of the wall, which will be discussed further. A useful complimentary tool in calculating partition wall reinforcement is developed by the International Masonry Institute called the Masonry Partition Wall Software, and can be found at http://imiweb.org/masonry-software/masonry-partition-wall-software/.

Partition Wall Guide
f'm=2500psi, Type S Mortar
IBC Code Min Interior Pressure 5psf Service, 8psf Ultimate
SDC A, B

	10 ft	12 ft	14 ft	16 ft	18 ft	20 ft	24 ft	28 ft	30 ft
6 inch	none	none	none	#4 @ 120	#4 @ 96	#4 @ 72	#4 @ 48	#4 @ 32	#4 @ 24
8 inch	none	none	none	none	none	#4 @ 120	#5 @ 120	#5 @ 80	#5 @ 64
10 inch	none	none	none	none	none	none	none	#5 @ 96	#5 @ 96
12 inch	none	none	none	none	none	none	none	none	#4 @ 96
16 inch	none	none	none	none	none	none	none	none	none

Table 1: Partition Wall Reinforcement Guide
for Seismic Design Category A or B

Higher seismic design categories, however, do require minimum prescriptive reinforcing per the TMS Code. Per TMS 402-13 Section 7.4.3.1, partition walls in SDC C require vertical reinforcement spaced at no more than 120 inches. Partition walls in SDC D require a maximum spacing of 48 inches per TMS 402-13 Section 7.4.4.1. SDC E or F require a maximum spacing of 24 inches in fully grouted partition walls, and additional reinforcement requirements per TMS 402-13 Section 7.4.4.2.3. Also, as seismic requirements increase, partition wall design will likely be controlled by seismic demands on nonstructural components rather than the minimum partition load. Table 2 provides guidance on partition wall reinforcement for SDC C. Overall, it is good to be aware of the prescriptive reinforcement requirements for partition walls. For projects in low seismic areas, we can avoid over-reinforcing, or even avoid providing any reinforcing at all, our partition walls that are not intended to resist gravity or high lateral loads.

Partition Wall Guide
f'm=2500psi, Type S Mortar
IBC Code Min Interior Pressure 5psf Service, 8psf Ultimate
SDC C

	10 ft	12 ft	14 ft	16 ft	18 ft	20 ft	24 ft	30 ft
6 inch	#4@120	#4@120	#5@120	#4 @ 72	#4 @ 56	#4 @ 40	#5 @ 40	#5 @ 24
8 inch	#4@120	#4@120	#4@120	#5@120	#5 @ 96	#5 @ 88	#5 @ 56	#5 @ 32
10 inch	#4@120	#4@120	#4@120	#4@120	#5@120	#5 @ 96	#5 @ 72	#5 @ 40
12 inch	#4@120	#4@120	#4@120	#4@120	#4@120	#5@120	#5 @ 88	#5 @ 48

Table 2: Partition Wall Reinforcement Guide
for Seismic Design Category C

At times, structural design for masonry shear walls are applied to partition walls as well in structural documents, inadvertently or not. A set of design drawings may contain a General Note stating that masonry walls shall have #4 vertical bars spaced at 48" typical, unless noted otherwise. Is it clear whether this note is applicable or necessary for nonstructural partition walls? As discussed above, it is possible for partition walls to extend tall story heights as unreinforced walls, if detailed correctly. Therefore, a General Note requiring reinforcement for all masonry walls - shear walls, load-bearing, and partition walls - may over-reinforce non-loadbearing partition walls on the project. It is cost effective to clearly communicate the reinforcement requirements for structural walls in wall schedules, in lieu of utilizing 'catch-all' statements in General Notes. There is the potential that a project will have more total volume of masonry partition walls than structural reinforced walls, and avoiding 'catch-all' general notes can lead to a significant cost savings on a project.

Detailing Tips for Partition Walls

Another way the cost of partition walls can be minimized is in considering the top of partition wall connection. TMS 402-13 Section 7.3.1 mandates that nonparticipating elements, or partition walls in our case, shall be isolated from the lateral force resisting system. It is important to isolate the partition wall from any adjacent structure, to ensure that no gravity forces from the floor above or lateral wind or seismic forces from beams or columns are inadvertently transferred to a nonstructural wall. This could result in damage to the nonstructural wall.

What are sound detailing tips to ensure isolation of the partition wall? Since the intent of a partition wall is to avoid structural loading, designers must pay special attention to the detailing of the wall's connections to the base structure. It is typical to detail the top of a partition wall with a vertical slip connection and a gap between the top of the wall and the bottom of the structure above. The depth of this vertical gap shall accommodate anticipated deflection of the floor framing structure above the wall. This detailing prevents the wall from being loaded due to differential movements between the level above the wall and the level on which the wall rests. Vertical gaps and compressible fillers should also be considered where partition walls abut structural walls or columns that are part of the lateral system, to ensure drifting of the main structure does not impose wind or seismic loads onto the partition walls. See Figure 1 for a sample detail at the top of a partition wall.

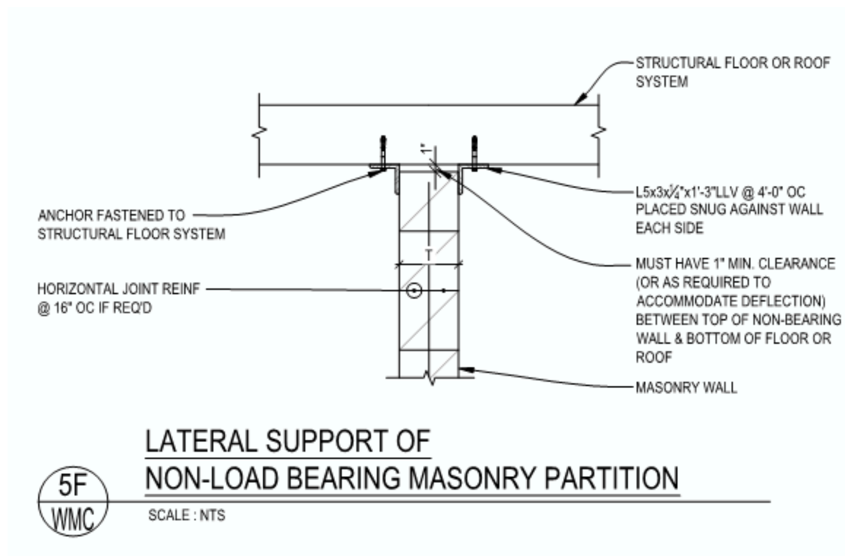


Figure 1: Top of Partition Wall Detail

It is true that a cantilevered wall that has a gap at the top and is not connected to any floor structure will not transfer any gravity or lateral loads, but the increase in the reinforcing that is required due to the fixed connection at the base of the wall could potentially offset any cost savings. Because of this, partition walls are typically designed as simply supported. This requires a connection at the top capable of resisting out-of-plane lateral loads to brace the wall, but does not transfer vertical or in-plane lateral loads. The preferred way to connect the top of a partition wall to the floor above is using a direct connection at the grouted cells. This connection consists of intermittent angles bracing the top of the wall and attached to the floor structure above. The angles are to align with any vertically grouted cells in the partition wall to ensure a load path for out-of-plane forces in the wall. This can be the simplest and cost-efficient option. The advantage to this detail is that it does not require a bond beam at the top of the wall as it relies on cells that are already grouted for any vertical reinforcing. The disadvantage to this connection is that the angle locations must be

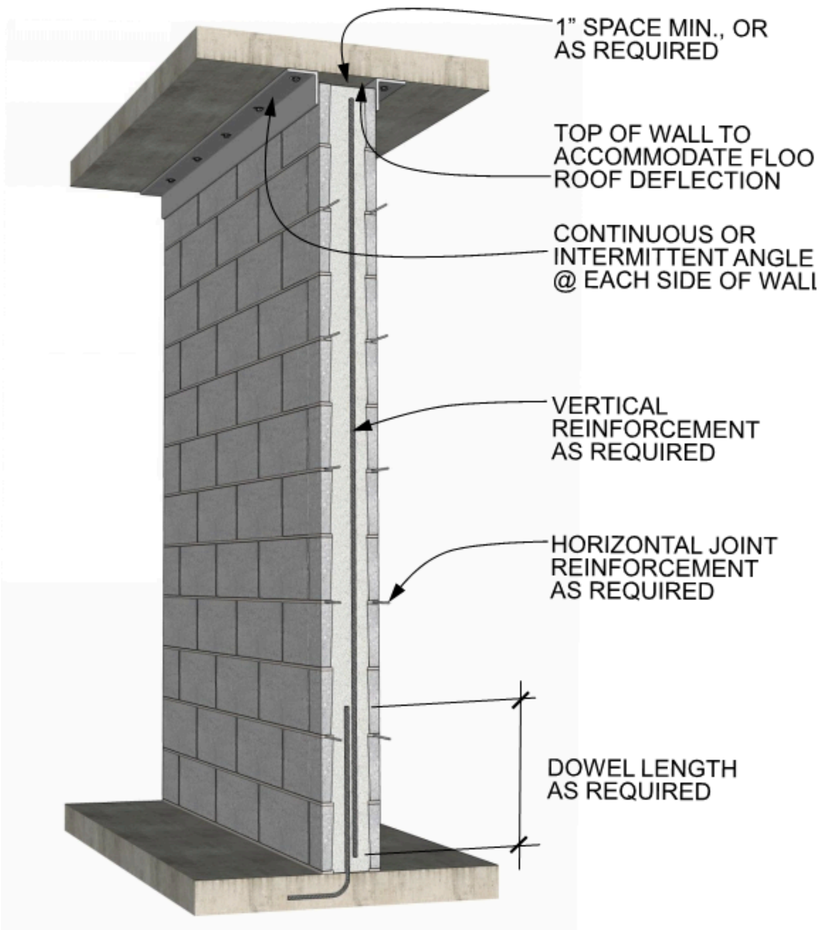


Figure 2: Partition Wall Detail with Top of Wall Bracing

coordinated with grouted cell locations. Another option is to provide a continuous angle at the top of the wall. Again, no bond beam is required since, with a continuous angle as the top connection, the wall does not have to span horizontally between connection points. This option will cost more than the first due to a continuous steel angle at each side of the top of the wall opposed to shorter, intermittent pieces. Lastly, one could detail a heavier intermittent angle that is not coordinated with the wall reinforcing—for instance, the angle could be specified at 6'-0 on center. The disadvantage is that since the angle is not coordinated with the grouted cells, a bond beam is now required at the top of the wall. The placement of this bond beam provides challenges for masons to install at the underside of the floor structure above.

While masonry is a popular material for partition walls, there is the potential they may be over-designed. Partition walls can expend a good portion of a project's budget due to the inclusion of unnecessary heavy reinforcement. In order to minimize cost overrun, it helps to consider good design and detailing practices. First, partition walls are not shear walls. The point of a shear wall is to participate in the main lateral force resisting system for the building, while a partition wall is not intended to resist any structural loads whatsoever. Partition walls, especially those in low seismic zones, do not have requirements for minimum reinforcing. Also, it is possible to make smarter connections at the top of partition walls by coordinating the location of the connection with cells that are already grouted. If things like this are considered during design, a project can have masonry partitions with all of their advantages and none of the drawbacks.

Masonry Partition Wall Design Results

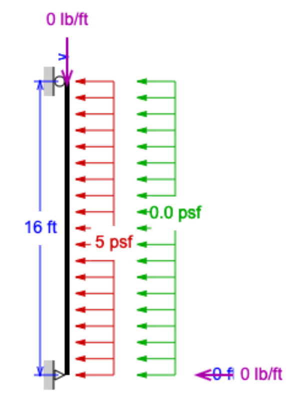
Masonry Partition Wall Design

Unreinforced Concrete Masonry
Non-Loadbearing Partition Wall

No external applied gravity loads
Interior pressure = 5 psf
Wall height = 18'-0"
Wall thickness = 8"
f'm = 2500 psi
Unreinforced wall is acceptable

Provided by:
team IMI INTERNATIONAL MASONRY INSTITUTE
EDUCATION PROVIDER

Project: Sample Partition Wall
Designer: FORSE Consulting, LLC
Notes:
Date: Wed Mar 20 2019 09:50:34 GMT-0500 (Central Daylight Time)
Masonry Type: ASTM C 90 CMU Medium weight
Mortar Type: ASTM C 270 Type S Portland Cement Lime or Mortar Cement
Bond Pattern: running
f'_m: 2500 psi
Wall Span: vertical
Wall Thickness (nominal): 8 inches
Wall Thickness (actual): 7.625 inches
Grout Spacing: none
Rebar Spacing: none
Wall Height: 18 ft
Wall Weight: 36 lb/ft^2
Net Wall area: 30 inches^2
Section Modulus: 81 ft^3
Horizontal Uniform Load: 5 lb/ft^2
Horizontal Concentrated Load: 0 lb/ft @ 0 ft
Vertical Load: 0 lb/ft, 0 inches eccentricity
Risk Category IV: No
Egress Stairway: No
S_{DS}: 0.33
S_{D1}: 0.133
Code Type: 2015 IBC/2013 TMS 402 ASD



Wall Side View
Concentrated Load
Uniform Load
Seismic Load

Design Status: **Good**

Load Combination	Status	x (ft)	Axial Force (lb)	Moment (ft-lb)	f_t/F_t (psi)	f_b/F_b (psi)	Unity	R_{top} lb/ft
A: 0.6D+w_L	OK	9.0	194	203	23.5 / 33.0	30 / 833	0.049	45.0

Unreinforced Design Results

Load Combinations: All passed

R_{top}: 45.0 lb/ft

Seismic load: 0.00 psf

Seismic Design Category B:

Grouting and Reinforcing: All masonry and grouting and reinforcing work shall be performed by masonry craftworkers who have successfully completed the International Masonry Institute (1-800-IMI-0988) training course for Grouting and Reinforced Masonry Construction, or equal.

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Figure 3: Partition Wall Sample Calculation
International Masonry Institute Masonry Partition Wall Software