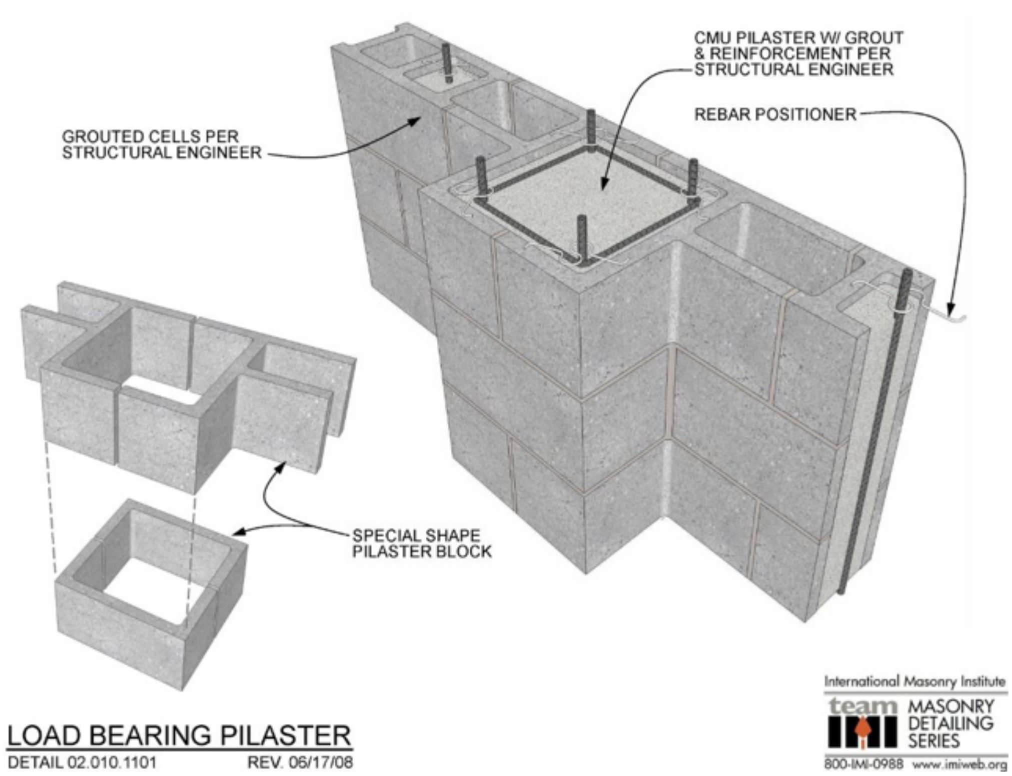
SE MASONRY INSIGHTS
written in conjunction with International Masonry Institute

Masonry Pilasters

When designing for large concentrated loads on a masonry wall, engineers may consider using a masonry pilaster, an isolated concrete column, or an isolated (and likely enclosed) steel column. Engineers must consider which element will have sufficient capacity to resist the large concentrated load. Below are comparisons of each of the members within common wall construction.

First, the requirements for a masonry pilaster or column are pretty similar to those for concrete. The area of longitudinal steel is required to be between 0.25 percent and 4 percent of the net area of the column. For typical columns, there must be 4 longitudinal bars, which are required to be enclosed by ties with a minimum size of #4, and maximum tie spacing is equal to the least of 16 longitudinal bar diameters, 48 tie bar diameters, or the least dimension of the column. There are also lightly loaded column provisions in TMS 402-16[1], but this paper will focus on general column and pilaster capacities.



Checking a masonry pilaster with an h/r ratio of 99 or less, the ultimate capacity is given by equation 9-15 in TMS 402 - 16:

$$P_n = 0.80\left[0.80f'_m(A_n - A_{st}) + f_yA_{st}\right]\left[1 - \left(\frac{h}{140r}\right)^2\right]$$

The strength reduction factor, ϕ, is 0.90 for reinforced masonry loaded axially. Looking at a 16x16 column with a height of 12 feet, (4)#7 longitudinal bars and a common masonry compressive strength of f'm = 2500 psi, the capacity is 445.6 kips. A similar column built with 4000 psi concrete has a capacity of 502 kips, for an increase of 17%. Doing the same check on a 24x24 column with (8)#8, the masonry column can resist 1043 kips, and the concrete column's capacity is 1172 kips (a 12% increase).

To increase the masonry capacity, consider a masonry pilaster instead of an isolated masonry column. As shown in the figure on page 1, masonry column can be built integrally with the masonry walls on each side (flanges). To consider the increased capacity and use these flanges, the requirements for intersecting walls must be met; see TMS 402-16[1], Section 5.4 Pilasters. Looking at a 16x16 pilaster with a height of 12 feet and (4)#7 longitudinal bars, and 8 inch ungrouted flanges, the capacity with f'm = 2500 psi is 677 kips. This is more than the concrete column. Checking the 24x24 pilaster with (8)#8 and #3 ties, and 8 inch ungrouted flanges, the capacity increases to 1418 kips, which is also more than the concrete column option.

Yes, the concrete has a higher strength, but less capacity than the masonry pilaster options. The concrete option also introduces another trade into the construction. This requires the masons to stop and allow a concrete crew to come in and build their pilaster before the masons can finish up. If the pilaster were designed as masonry, one trade - the masons - can build it in the way that is most efficient for them, which is probably also the most efficient for the project in general. It is also worth mentioning that a higher strength masonry block can be specified for masonry with a higher grout strength that could be equivalent to concrete. A different masonry material would be an extra effort, but it would be much better than an entirely different trade and new material.

Another option would be to use a steel column to carry the concentrated load. An HSS12x12x3/8 could be hidden inside a 16x16 masonry pilaster with no interruption in the wall's surface. However, such a member that is 12 feet tall and made from ASTM A1085 material has an ultimate capacity of 719 kips, which is more than the 16x16 masonry column or pilaster, but far less than any of the 24x24 masonry options. And again, is the additional capacity needed and worth the different trade and coordination efforts when the masonry piers have significant capacity?

In summary:

- 16"x16" masonry column, f'm = 4 ksi [2,4] : 626k
- 16"x16" concrete column, f'c = 4 ksi [3] : 502k
- 16"x16" masonry pilaster, f'm = 2.5 ksi [2] : 677k
- 24"x24" masonry column, f'm = 2.5 ksi [2,4] : 1043k
- 24"x24" concrete column, f'c = 4 ksi [3] : 1172k
- 24"x24" masonry pilaster, f'm = 4 ksi [2] : 1509k
- HSS 12 x 12 x 3/8: 719k

In a situation where a bump-out is not allowed, let us compare the capacity of a 24"x8" masonry non-projecting pilaster, 24"x8" concrete, and a HSS5x5x3/8:

- 24"x8" masonry pilaster, f'm = 2.5 ksi [4] : 242k
- 24"x8" masonry column, f'c = 4 ksi [3]: 363k
- 24"x8" concrete column, f'c = 4 ksi [3]: 248k
- HSS 5 x 5 x 3/8: 191k

It is also important to recognize the inherent redundancy that will be achieved when using a masonry pilaster that may be built integrally with the masonry wall.

Through these examples, it has been shown that a masonry column has only a slightly reduced capacity when compared to a similarly-sized concrete column. The masonry pilaster also has a significantly higher capacity than a steel column designed to fit inside the masonry wall. If space is not an issue (the pilaster can be thicker than the wall), or an element is needed that will be flush with the masonry wall, a masonry pilaster is likely the best choice to resist a concentrated load.

Footnotes:

1. TMS 402-16: Building Code Requirements for Masonry Structures from The Masonry Society
2. Capacity for masonry pilasters was found using TMS-402 and the Structural Masonry Design System.
3. Capacity for steel columns and concrete columns was found using ACI 318 and the Tekla TEDDS software.
4. If masonry with f'm = 4 ksi were used, the capacities would be as follows:

- 16"x16" masonry pilaster: 654 kips
- 24"x24" masonry pilaster: 1551 kips
- 24"x8" masonry pilaster: 403 kips

