SE INSIGHTS
FOR MASONRY DESIGN

Efficient Masonry Lintels for Masonry Walls

In recent years, there has been a renewed interest in using reinforced masonry lintels. There are several reasons to consider masonry lintels:

A) Previously it was thought the only way to reduce shoring was use another material. However, this is no longer true due to:

- New and innovative methods for shoring to build in-place masonry lintels.
- Availability of pre-fabricated masonry lintels.

B) Masonry lintels create an integral joint with vertical jamb reinforcement. This leads to a more robust design that has many design benefits and is less expensive . See Figure 1 below.

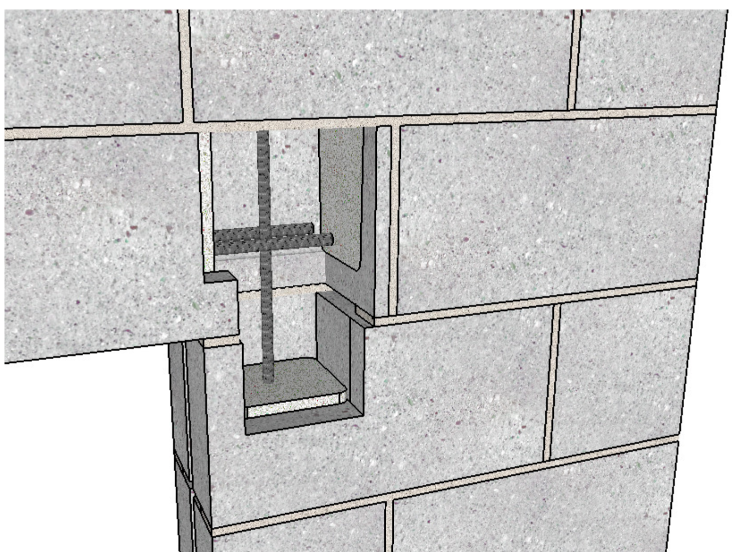


Figure 1: Masonry lintel intersection masonry jamb

C) Perhaps the most compelling reason to use masonry lintels is due to the ability to use arching action, which allows the design load to be much smaller. Arching action, which will be discussed later in the article, requires the lintel to be built integrally with the jamb and no control joints (CJ) at the edge or anywhere over the opening.

Below are tables indicating the required masonry lintels to support loads. By using different analysis methods, masonry lintels are able to be designed in various ways. The masonry lintels are designed in the first two tables without considering arching action, and simply designed for the load indicated in the table. The lintels were checked two different ways:

1. as a simply-supported, pinned-pinned beam with the specified loads applied directly to the lintel
2. as a beam with fixed ends (as it is built integrally with the rest of the wall) and the specified loads applied directly to the lintel

Lintel design criteria for all tables below:

- Masonry design is based on f'm = 2500 psi, strength design, and designed using NCMA software-SMDS for pin-pin and fix-fix designs, and RISA3D for finite element designs.

Table 1: 8" Masonry Wall Lintels, not considering arching action

length	8 feet		12 feet	
end fixity	pin-pin	fix-fix	pin-pin	fix-fix
to support 1.0 klf	16" deep, (2) #4 bottom	16" deep (1) #4 top& bottom	24" deep, (2) #6 bottom	16" deep (1) #6 top& bottom
to support 3.5 klf	32" deep, (2) #5 bottom	32" deep (1) #5 top& bottom	40" deep, (2) #7 bottom	40" deep (1) #6 top& bottom

Table 2: 12" Masonry Wall Lintels, not considering arching action

length	8 feet		12 feet	
end fixity	pin-pin	fix-fix	pin-pin	fix-fix
to support 1.0 klf	16" deep, (2) #4 bottom	16" deep (1) #4 top& bottom	24" deep, (2) #5 bottom	16" deep (1) #6 top& bottom
to support 3.5 klf	24" deep, (2) #5 bottom	24" deep (1) #5 top& bottom	40" deep, (2) #7 bottom	32" deep (1) #7 top& bottom

In Tables 3 and 4 below, arching action will be used to distribute all the load above the "arch" such as wall load, floor loads, or roof loads, and the only loads remaining for the masonry lintel will be the wall load below the arch. When considering arching action, only the load from the wall below the arch is considered to load the lintel. If point loads are on the wall above the opening, they need to be considered on the lintel as well. In these examples, we will assume all the loads on the wall are uniform loads.

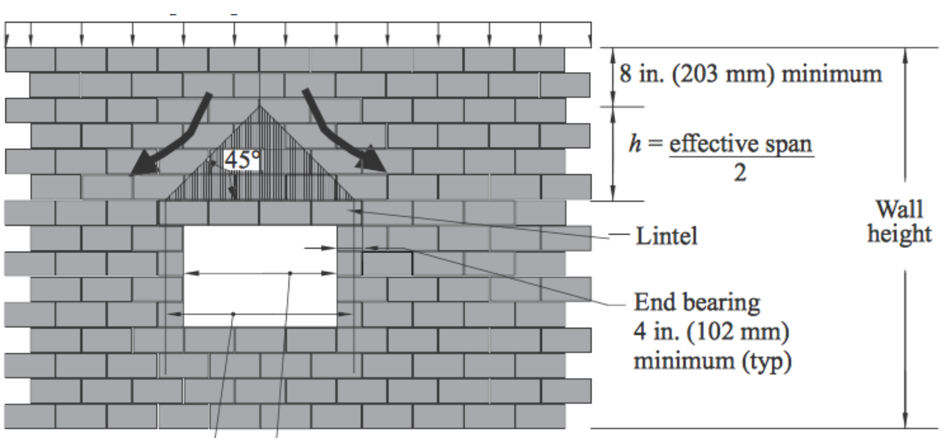


Figure 3: Arching Action Diagram from NCMA TEK 17-1D

Table 3: 8" Masonry Wall Lintels, considering arching action

length	4 feet		8 feet		12 feet	
end fixity	pin-pin	fix-fix	pin-pin	fix-fix	pin-pin	fix-fix
same for all uniform roof loads	8" deep, (1) #4 bottom	8" deep, (1) #4 top& bottom	8" deep, (1) #4 bottom	8" deep, (1) #4 top& bottom	16" deep, (2) #4 bottom	16" deep, (1) #4 top& bottom

Table 4: 12" Masonry Wall Lintels, considering arching action

length	4 feet		8 feet		12 feet	
end fixity	pin-pin	fix-fix	pin-pin	fix-fix	pin-pin	fix-fix
same for all uniform roof loads	8" deep, (1) #4 bottom	8" deep, (1) #4 top& bottom	8" deep, (1) #4 bottom	8" deep, (1) #4 top& bottom	16" deep, (2) #4 bottom	16" deep, (1) #4 top& bottom

Finally, we will consider the design of the masonry lintels using finite element analysis (FEA). For these tables, the wall height was assumed to be 14'-0, and the specified load was applied at the top of the wall. The finite element analysis is able to look at the entire wall panel as a unit and take advantage of the integral construction, and therefore yields a much more efficient design than looking at the lintel/beam individually. FEA uses plates elements with masonry properties to distribute the load based on the stiffness of the support elements below. The analysis from FEA may resemble the analysis considering arching action.

Table 5: 8" Masonry Wall Lintels, using Finite Element Analysis

length	8 feet	12 feet
	FEA	FEA
to support 1.0 klf	8" deep, (1) #4 bottom	8" deep, (2) #4 bottom
to support 3.5 klf	16" deep, (1) #4 bottom	24" deep, (1) #5 top & bottom

Table 6: 12" Masonry Wall Lintels, using Finite Element Analysis

length	8 feet	12 feet
	FEA	FEA
to support 1.0 klf	8" deep, (1) #4 bottom	8" deep, (2) #4 bottom
to support 3.5 klf	16" deep, (1) #6 bottom	24" deep, (1) #5 top & bottom

RAM Elements for Lintel Design

The images to the right are from a finite element program called RAM Elements, from Bentley Systems. On the center right, an image shows stresses from the FEA. On the far right, the geometry of the opening and reinforcement is shown.

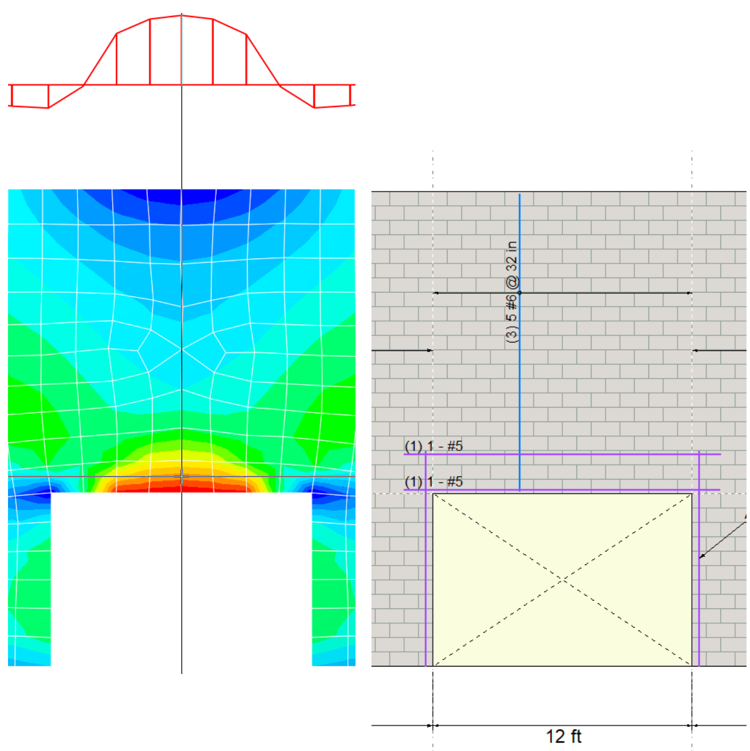
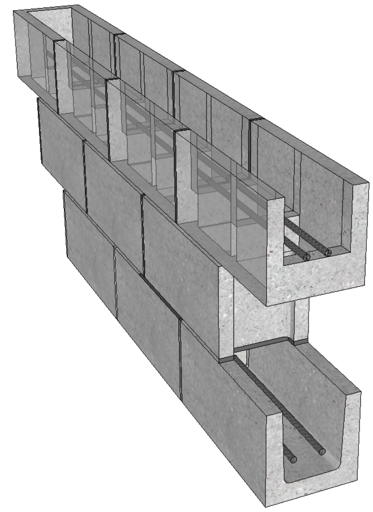


Figure 4 & 5 : Images from RAM Elements

High Strength Lintel

<u>Multi-Course Masonry Lintels</u>



In the design of masonry lintels, obtaining additional strength is easy to accomplish. Higher strength lintels are as simple as adding courses of solid grouted masonry to increase both shear and bending moment capacity of the lintel. In some cases with higher shear loads and positive bending moment, bottom reinforcement and several courses of masonry are sufficient. Other times, top and bottom reinforcement are required to resist positive and negative bending moment for the lintel.

There is typically no need for stirrups when additional courses can be used to resist shear loads. In situations when there is limited height above the opening, stirrups can be used. When the additional height is available, it is more cost-effective to use multi-course lintels.

Multi-course masonry lintels with top and bottom reinforcement are easy to build in the field or prefabricate. For example, a three course (or more) high masonry lintel with horizontal rebar in the first and third course would be built with a typical masonry bond beam unit (U-block) as the bottom course, a regular stretcher unit as the middle course(s), and a masonry flow-through unit as the top course.

Insight Summary

<u>Below is a summary of ways to increase the efficiency and capacity of Masonry Lintels:</u>

1. Use correct f'm, go to www.forsei.com/cmudata to get block strength in many areas of the country
2. Construction joints are to be placed away from openings; this will allow arching action to be considered in the analysis
3. Consider Finite Element Analysis (FEA) for a more accurate analysis of masonry lintels which generally leads to more efficient designs
4. If using a simple analysis, consider fixed end lintels; which reduces the maximum moment, has negative and positive moment, and requires top and bottom reinforcement

To increase Moment capacity:

5. Add more depth; simplest way to add more moment capacity
6. Add more reinforcement in single or double layers where necessary. More reinforcement with additional smaller bars is preferred over one large bar.

To increase Shear capacity:

7. Add more depth; generally the easiest and most cost effective is to add more courses and grout solid
8. If more depth is not possible, consider adding stirrups; this should be the last option, and only use single leg stirrups in 8" walls, double leg can be used in thicker walls

Alternate approach:

- Consider the full depth of the masonry above the opening and design lintels as deep beams. See current TMS code for more information on design and detailing of Deep Beam lintels.