Just the FAQs

questions we made up about … MASONRY

Changing Masonry Standards

Masonry Infills

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Question

The 2011 Building Code Requirements for Masonry Structures (TMS 402-11/ACI 530-11/ASCE 5-11) added Appendix B–Design of Masonry Infill.

What is masonry infill and what are the limitations on its use in seismic regions?

Answer

As the name indicates, masonry infill completely fills in the portal space inside a bounding frame, usually made of steel or reinforced concrete (*Figure 1*). Masonry infills create a composite structural system composed of the bounding frame with the portal space masonry, which can be reinforced or unreinforced.

Unreinforced masonry infills have been constructed worldwide for decades. They have been experimentally investigated since the 1950s and have just recently been added to the masonry standard for the United States. Experimental results, as well as field performance, indicate that infills provide significant strength and ductility for resisting various types of lateral loads – even after considerable cracking. The composite behavior results in higher ductility than the unreinforced masonry alone, as well as increases in both the strength and stiffness of the system when compared to the bare frame.

Unreinforced masonry infills are easy and economical to construct; the construction process is relatively simple. The masonry panels must completely infill the frame; no openings are permitted. In most cases, the bounding frame is constructed first, allowing for the installation of floor or roof framing. After the bounding frames are constructed, the masonry infill is laid in the interior portal space. Masonry infills provide a strong, ductile system for resisting lateral loads, in-plane and out-of-plane.

Several stages of in-plane loading response occur with a masonry infill system. Initially, the system acts as a monolithic cantilever wall whereby slight stress concentrations occur at the four corners, while the middle of the panel develops an approximately pure shear stress state.

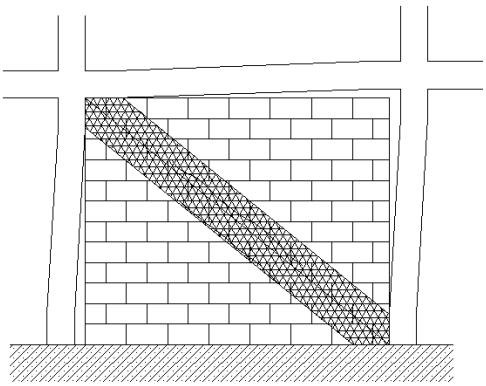

Figure 2: Diagonal strut.

Figure 1: Clay masonry infill with concrete frame.

As loading continues, separation occurs at the interface of the masonry and the frame members at the off-diagonal corners. Once a gap is formed, the stresses at the tensile corners are relieved while those near the compressive corners are increased.

As the loading continues, further separation between the masonry panel and the frame occurs, resulting in contact only near the loaded corners of the frame. This results in the composite system behaving as a braced frame, which leads to the concept of replacing the masonry infill with an equivalent diagonal strut (*Figure 2*). These conditions are addressed in the masonry standard.

Masonry infills resist out-of-plane loads by an arching mechanism. As out-of-plane loads increase beyond the elastic limit, cracking occurs in the masonry panel. This cracking allows for arching action to resist the applied loads, provided the infill is constructed tight to the bounding frame and the infill is not too slender.

The second part to the question addresses the limitations of masonry infill use in seismic regions. As indicated by the question, the 2011 *Building Code Requirements for Masonry Structures* added Appendix B to address the design of masonry infills. Masonry infill designs must comply with the requirement of Chapter 1, with the exception of Sections 1.12 – 1.15. However, infill masonry is not included in ASCE 7, Table 12.2-1; to use the system in seismic design requires that the system be treated as a special structure and then receive the approval of the building official.

For use as a special structure, the Commentary of Section B.1.1 gives a recommendation that includes:

> *"When participating infills are used to resist in-plane loads as part of a concrete or steel frame structure, a hybrid system is effectively created that may not otherwise be defined in Table 12.2-1 of ASCE 7 for seismic force-resistance. Until further research is completed, the Committee recommends using the smallest R and Cd value for the combination of the frame and masonry infill be used to design the system."* ▪