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What Contractors Need to Know about Lateral-Force Resisting Systems

Meeting the 2006 International Building Code

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With the widespread adoption and enforcement of the 2006 International Building Code (IBC), there has been much more talk about lateral-force resisting systems among designers and contractors. While lateral forces may seem like a complicated topic, they are simply the forces caused by wind and/or seismic activity that try to push a structure over.

We've all seen the damage caused by Mother Nature with events like Hurricane Katrina and the Northridge Earthquake. As we experience these types of natural disasters, engineers are learning more about building performance. As a result, new codes are being developed for light-frame construction that require additional resistance to lateral forces. In response, manufacturers are spending countless hours testing and seeking code listings for products that will help satisfy the new requirements. These products need to resist the loads that specifiers are looking for, and at the same time, they need to be cost effective for contractors.

Resisting Lateral Forces – Site-Built Shearwalls and “X” Bracing

In order to resist lateral forces, also known as “shear”, elements need to be installed in a wall to keep the wall from racking over. Historically in cold-formed steel framing, shearwalls are built with either structural sheathing material like OSB over the steel studs or with coil strap “X” bracing (diagonal bracing). Plywood or OSB panel sheathing helps keep a wall from racking, as long as the wall doesn't contain large or numerous openings.

When lateral (wind or seismic) forces act on a structure, it's easy to visualize the force pushing horizontally on the top of the shearwall. The sheathing transfers the shear from the top of the wall to the bottom of the wall while holding the wall together to resist racking. If the bottom track of the wall is anchored to the foundation to resist sliding, the far end of the wall will press down (compression force) and the near side of the wall will lift up (tension force)—this is overturning. There are prescriptive requirements for this type of bracing found in the ANSI AISI Standard for Cold-Formed Steel Framing – Lateral Design standard (S213), available at www.steel framingalliance.com.

“X” bracing is popular for cold-formed steel framed structures in termite-prone areas or where wood structural sheathing is not commonly used. “X” bracing is typically designed by an engineer who specifies how many screws are needed at the end of each brace. Recent testing at McGill University in Montreal has helped the industry better understand the performance of “X” bracing and identify its strengths and

weaknesses. In general, the wider the wall section to be braced, the better the performance. Narrow wall “X” bracing does not perform as well.

Whether you are using structural sheathing or “X” braced walls, you will need a holdown to transfer the overturning force to the concrete foundation. A strap style holdown, which is embedded in the concrete, is one option. The strap portion of the holdown screws into the exterior side of the end studs of the shear wall (commonly called chord studs). Another option is using a holdown that’s installed to the chord studs inside the wall cavity. An anchor bolt is embedded into the concrete either by casting it in place or by drilling and using an adhesive (*see photo below*). Whichever holdown is used, it’s critical that they are installed in the right place. Quite often the bolts, which are supposed to secure the shearwalls, are placed several inches away from where they are required for optimum load transfer. This will defeat the purpose of a shearwall.



Other methods used for shearwall construction include sheet metal shearwalls. Instead of installing wood structural panels, steel sheet sheathing is installed with the required number of screw fasteners for the edge and the field. Some products are available that have the sheet metal pre-attached to the drywall or DensGlass.

Narrow Walls and High-Wind/Seismic Loads

Lessons learned from Katrina and Northridge have influenced the building code. The IBC now limits shearwalls to a maximum height to width (h/w) ratio of 2:1. (A higher aspect ratio of 3 1/2:1 or 4:1 may be permitted, but a reduction in shearwall strength must be taken.) The concern is based on past events where narrow shearwalls have failed due to excessive deflection. Walls that are typically eight feet high now require a minimum shearwall width of four feet to meet the 2:1 aspect ratio. This restriction has implications throughout a building, including the front of a garage where narrow shearwalls are typically two-to-

three feet wide. Narrower sheathed shearwalls often are desired because they allow more openings in a wall for windows and doors; however, the ratio makes it impractical to build site-built shearwalls.

For areas of the country that experience high-wind and seismic loads, the traditional site-built lateral-force resisting methods mentioned above often do not provide the sufficient strength required to resist the design forces. For these situations, several manufacturers have developed prefabricated shearwalls. Prefabricated shearwalls (*see photo on page 3*) save contractors time because they typically install with a few anchor bolts and screws rather than the large number of screws that are required for installing structural panels or “X” bracing. With prefabricated shearwalls, it’s important to follow the manufacturer’s recommendations for proper installation. A foundation bolt placement template needs to be used to locate and support the foundation bolts during the pouring of the slab. Otherwise, a retrofit may have to be performed for the mis-installed bolts.



Multi-story Construction

For resisting even higher loads and for multi-story structures, manufacturers have started developing prefabricated ordinary and special moment frames. These are typically made out of structural steel and are more expensive than shearwalls, but they can resist greater forces in a minimal amount of space. In multi-story construction, anchor tiedown systems are another popular choice. These tend to consist of anchor rods that extend the height of each story and secure the structure's shearwall from the top down.

It's important to note that lateral-force resisting systems usually do not consist of just the shearwalls and "X" bracing. Connections to both the roof and floor diaphragms also must be considered along with the strength and stiffness of these elements.

Lateral-force resisting systems don't need to be complicated. Today there are many solutions specifiers and contractors can choose from to resist the forces of Mother Nature. Be sure to evaluate all the options so you find the solution that works best for your project.

Remember to look for code-listed, third-party tested and reviewed products with lower installed costs as these will contribute to the integrity of your structure as well as your bottom line.

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