Construction Issues

discussion of construction issues and techniques

Innovative Mid Rise Construction

Steel Stud Walls with Hollowcore Plank Floor System – Revisited

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The August 2006 issue of STRUCTURE® magazine included an article titled *Innovative Mid Rise Construction – Steel Stud Walls with Hollowcore Plank Floor System.* The authors received several excellent questions regarding the subject of the article, and share both the questions and answers in this follow-up article.

Q Point loading of cold-formed steel (CFS) studs with minimal load distribution from the thin tracks that are commonly used appears to create high bearing stresses on precast hollowcore planks. How is the point load at each stud considered in the design, and what are the recommendations to evenly distribute this load on the hollowcore slab?

A With the use of precast hollowcore planks as a rigid floor system, the studs can be assumed to be equally loaded. CFS studs supporting hollowcore planks can be subjected to axial compression loads up to 20,000 lbs per stud at the ground floor of a 5 story building. Careful procedures need to be considered to ensure that this point load does not crush the plank underneath. One important procedure is to grout the core of the hollowcore planks at the bearing wall locations with a grout mix that has sufficient compressive strength. In addition, the top and bottom runner tracks of the wall have to be thick enough to distribute the stud point load to an area larger than the footprint of the stud cross-section. The slight bending resistance of the track around its weak axis can provide a significant increase in the bearing area of the stud. The *Cold-Formed Steel Framing Design Guide* (AISI Design Guide CF02-1) provides a method to calculate the bearing area and bearing stresses between the track and the slab for axial load bearing studs.

CFS designers typically require that the thickness of the wall tracks at least match the thickness of the stud at every floor level. A minimum of 54 mils for the thickness of the tracks is recommended.

Q How important is aligning CFS studs vertically from floor to floor? When the studs don't align, the precast hollowcore planks perform as a short beam between the studs which they are not designed to do?

A Vertical alignment of the axial load bearing CFS studs from the roof level down to the first floor level is always preferred (*Figure 1*). The *AISI General Provisions Standard for Cold-Formed Steel Framing* (AISI/COFS/GP-2004) requires that wall studs be aligned vertically (within a tolerance limit), unless a structural load distribution member is specified in accordance with an approved design or a recognized design standard.

Misalignment may occur due to the change of stud spacing from 16 inches o.c. at lower floors to 24 inches o.c at upper floors to reduce the cost of steel. It may also occur at a location of punched opening. It is always recommended that a fixed stud spacing (typically 16 inches o.c.) is used for all floors. Lighter studs (33 or 43 mils, with standard 1.625-inch flange) can be used at top floors, and gradually increase the thickness and flange size at lower floors. The designer may end up with 97 mils, 2.5-inch flange studs or double studs (back to back studs) of the same thickness and smaller flange size at the first floor depending on the design loads.

Figure 1: Vertical Alignment of Load Bearing Studs.

In the case that vertical alignment of the studs can not be reserved at one location, the design professional must address the load path from the stud above to the stud below through a design check of the hollowcore plank, or the use of a distribution lintel between the hollowcore planks and the stud wall.

Q How are the lateral stiffness of the tracks of exterior walls are evaluated when they are welded to cast-in plates in the bottom of precast hollowcore planks and subjected to lateral wind loads? The welded plates do not often align close to a CFS stud, and this has the potential to load the track in bending between cast-in plates.

A If the top and bottom tracks of exterior walls are connected to the floor diaphragm only through the cast-in plates, the design professional should evaluate the strength and stiffness of the wall tracks to span between cast-in plates where wind loads are transferred from the wall to the floor diaphragm through the tracks. However, it is a common practice to use pin fasteners to attach the top and bottom tracks to the hollowcore planks at every stud location. This attachment ensures direct transfer of the shear force from the stud to floor diaphragm without loading the tracks in bending.

The top and bottom tracks participate in transferring the shear force back from the floor diaphragm to the shear walls parallel to the direction of the shear force. The load path for this force may run through the cast-in plates, pin fasteners and/or through-floor bolts. The tracks will then transfer a force to the shear wall in its longitudinal direction only, and not in its lateral direction.

Q In-plane racking of CFS stud walls without adequate diagonal bracing during erection of the precast hollowcore planks may create a potential for instability for individual wall panels. Who is responsible for erection loads from the precast planks?

A The CFS stud walls must be braced with temporary (construction) bracing to prevent in-plane and out-of-plane instability during the installation of the precast hollowcore planks (*Figure 2*). This is a shared responsibility between the hollowcore contractor and the CFS contractor. There is no current standard that addresses the construction bracing for CFS stud walls. However, if the shear wall system for the building is composed of X-brace flat strap panels, part of these X-brace panels can be secured before the installation of the planks to act as in-plane construction bracing against any in-plane racking.

Q Is there a standard that the CFS stud wall industry uses to define the tolerance on shimming requirements between the stud and the track, and between the hollow core plank surface and the track?

A The *AISI General Provisions Standard for Cold-Formed Steel Framing* (AISI/COFS/GP-2004) requires that CFS wall studs to have square end cuts and be seated tight against the wall tracks. The Standard requires that the gap tolerance between the load bearing stud and the track not to exceed ⅛ inch. A recent experimental study at the University of Missouri-Rolla recommended that this maximum gap tolerance to be limited to 1/16 inch for studs and tracks having a thickness greater than 54 mils, to prevent possible shear failure of the screw connection between the stud and the track. If the gap is within the specified tolerance by the standard, no shimming is required.

For shimming between the hollow core plank surface and the track, the hollow core industry has a plank thickness tolerance of +/- ¼ inch. Some plank manufacturers make a continuous top recess at the bearing ends of the planks and then level with grout in the field. Shimming would not be required in this case. If the top recess is not available, the gap has to be shimmed to ensure full bearing across the depth of the track.

Q What are the grout strength requirements for field grouting operations in the CFS stud wall-precast hollowcore plank framing system?

A The minimum compressive strength of the grout used to seal the joints between hollowcore planks needs to be selected based on the maximum design axial compression load and the bearing area of a single CFS stud at the first floor level of the building. Calculation of the bearing area must take into consideration the factors discussed in answering Question #1. If the service axial load supported by an individual stud (such as 8-inch, 97 mils single stud sitting inside 97 mils track) is 19,000 pounds, and the bearing area at the surface of the hollowcore plank (also at the surface of the grout) is 20 square inches, then the bearing stress would be equal to 950 psi. The *AISC-05 Steel Construction Manual* provides the allowable bearing stress for a concrete mix as $0.85f'_c / \Omega$, where $\Omega = 2.5$. This results in a minimum compressive strength of the grout (f'_c) for this design case of 2800 psi.▪


Figure 2: Construction Bracing during Installation.

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