Box-shaped beams offer thin floors, flat ceilings, long spans and quick erection.

Steel Support for a Slim Floor System

BY MARK JOHANSON

AN UNUSUAL STEEL BEAM SYSTEM recently had its first installation in the U.S., providing the solution to a headroom problem at the Dwell Bay View project being constructed in Milwaukee. Using Peikko's Deltabeam, the project team was able to increase the clearance in the vehicle pathway and enable access for extra-high "accessible" type vans without having to rework any footing elevations.

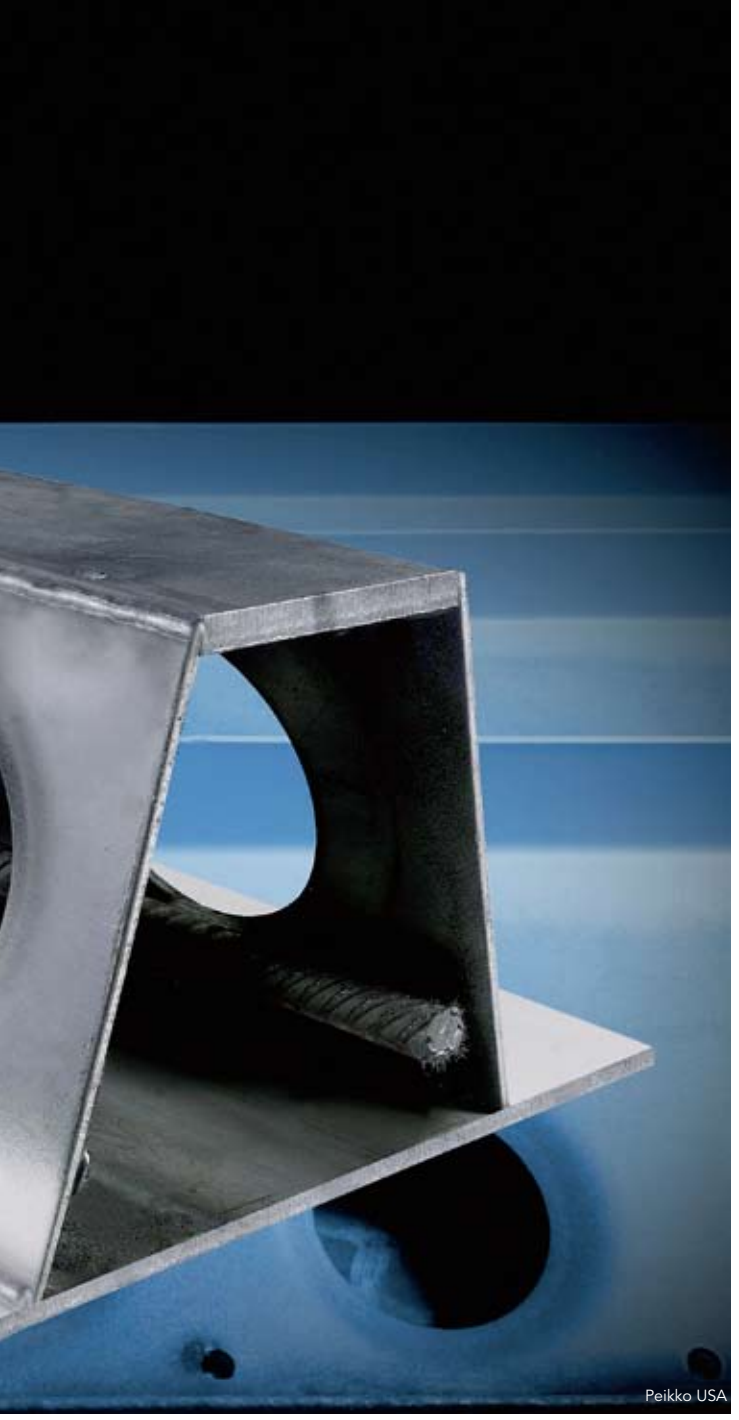
The five-story structure is largely precast concrete construction, but early in the preconstruction meetings the precast supplier, South Beloit, Ill.-based Mid-States Concrete Industries, realized there was a problem with the required van access. Mid-States recommended using the Deltabeam in the areas that required van access as the solution. The solution developed by SEOR Structural Dimension Inc., Brookfield, Wis., and accepted by project architect Engberg Anderson Architects, Milwaukee, was to use Deltabeams to support the hollow-core plank along the vehicle travel. Although it involved just five 11-in.-deep beams, the steel solution kept the project on track and blended seamlessly with the rest of the construction.

The Deltabeam does cost slightly more than a comparable precast beam, according to Mid-States' vice president of preconstruction Jeremy Olivotti. "It is a great system for the right project," he said.

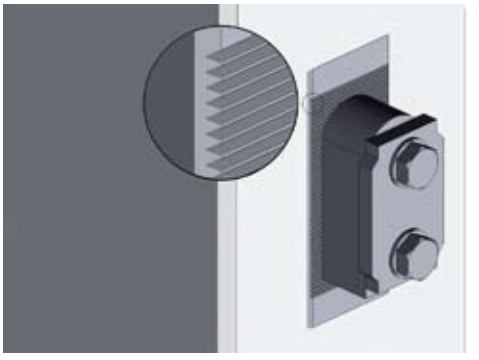
A Thin Floor

The system combines Deltabeams with precast hollow-core slabs of the same thickness to create a uniform slim floor that can be erected rapidly as well as offer long yet thin spans. It has been used throughout Europe and Canada for a number of years in a variety of structures.

Through the composite action of Deltabeam and precast slabs, the floor assembly can be as thin as 9 in. without a downstanding beam and span as much as 45 ft—all while being lighter than a cast-in-place concrete floor. After casting the grout infill,



Available in lengths up to 45 ft, Peikko's Deltabeam consists of four steel plates welded together and pre-cambered.



Three photos, above: The key to the Deltabeam's quick erection is the end connection. One piece of the corbel is welded to the steel column in the fabricator's shop. The second piece is bolted to the first and provides vertical adjustment. Grooves on the interfacing surfaces maintain the connection's high capacity. The slotted plate welded to the end of the Deltabeam slips over the corbel and the connection is done.

the Deltabeam becomes nearly invisible, hidden in the floor: only the bottom flange remains visible from the floor below. Having a thin floor means using minimal space on each floor, therefore minimizing the total height of a building or in some cases, having one additional floor for the same building height. Additionally, the integration of building services, especially for large ventilation ducts, becomes simpler and less costly thanks to the uniform, flat ceiling.

Beam Design

The Deltabeam consists of four steel plates—two side plates, one top plate and one bottom plate—of the same length, ranging from about 10 ft to 45 ft, that are welded together and pre-cambered. Rebar spans the full length of the beam. Forged steel studs are welded under the top plate, and end plates are welded at the two ends of the beam. The side plates are perforated every 12 in. with either 3-in. or 6-in. diameter holes.

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Peikko USA

▲ The uniform, flat ceiling achieved by using Deltabeams simplifies installation of building services, especially large ventilation ducts.

▼ In their first U.S. installation, using Deltabeams to support the hollow-core floor over the traffic lane solved a headroom problem at the Bay View Housing project in Milwaukee.

Structural Dimension Inc., Brookfield, Wis.

Engberg Anderson Architects, Milwaukee

▲ The Dwell Bay View Housing project being constructed in Milwaukee.

These holes enable the beam to be filled with grout and create the composite action between the steel beam and the concrete. The bottom plate, which projects approximately 5 in. on each side of the beam, serves as support for the hollow core. The top plate has air holes to ensure that the beam is entirely filled with concrete and hook holes for lifting and erection.

The rebar and steel studs reinforce the beam as well as enhance its fire rating. Through physical fire tests done according to ISO 834, the Deltabeam with its exposed bottom flange can withstand fire for up to three hours. Through the composite behavior developed between the steel and concrete, the Deltabeam's bottom flange is no longer load bearing when the concrete in the beam has cured. Physical fire tests are also being done with Underwriters Laboratories (UL) in the spring of 2012.

Last but not least, the steel plates welded at each end of the beam make for very fast erection. No onsite bolting or welding is required to install the Deltabeam. Typically a high shear capacity corbel is welded to the steel column as part of the steel fabrication. That provides the connection point for one of the beams enabling it to be simply supported between two columns. A similar corbel assembly can be embedded for attachment to concrete.

Fast Four-Step Erection

The four-step construction process involving this steel beam can bring erection speed to an average of 8,000 sq. ft per day. Four components are required to make the flat slab assembly: Deltabeams, precast slabs, rebar and minimum onsite grout.

First, Deltabeams are erected in place. Each beam erection can be done in less than a minute, depending on the size of the beam. Next, precast hollow-core slabs are placed on the projecting edges of the Deltabeam's bottom plate. Like the beam placement, this is a simple operation requiring no special trade workers onsite. Because the Deltabeam is a box-shaped beam, it has a high resistance to torsion. It therefore requires minimal shoring near the beam-to-column connections, though shoring can even be avoided altogether through special design of the corbel connection. This also allows different trades to have access to the site earlier, thus reducing the overall time of construction.

The assembly of the slabs also involves placing rebar through the beam and between slabs. Because both Deltabeams and hollow-core slabs are reinforced when produced, the quantity of rebar required to be placed at the job site is small. The only reinforcement needed is placed through the web holes of the Deltabeam and in hollow-core slab keyways every 4 ft.

Finally, the beam and keyways are entirely filled with grout to complete the composite action between steel and concrete. At this point, workers can walk freely on the Deltabeam/hollow-core assembly, making this last operation easy to do and safe. Due to the limited areas where grout is required, this step can be done with minimal heating and hoarding in case of winter conditions. The trapezoid shape of the steel beam leaves enough space between beam edges and precast slab extremities to grout without notching the top of each hollow core end, a practice often mandatory when using other slim floor systems.

If desired, a fourth step consisting of placing a leveling topping can be done to provide a better floor finish. This is typically done after most of the exterior cladding is installed, especially during winter to reduce heating and hoarding costs.

More information is available online at **www.peikousa.com**. MSC