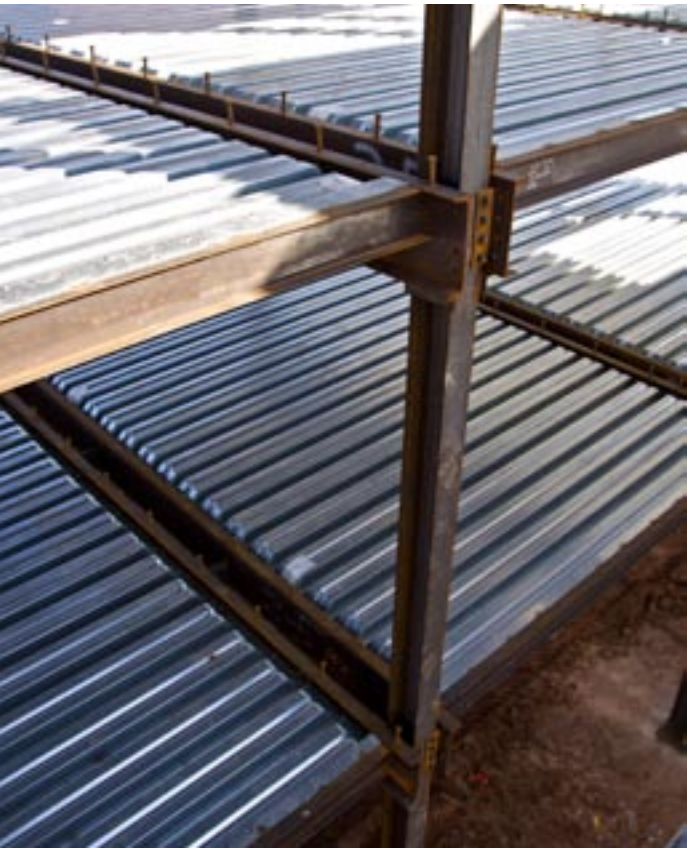
Prefabricating units on the ground, then erecting them, improves both schedule and safety.

Versa-Floor [HR] panel lifted to multi-story columns.

Panelized Units Speed Construction

BY BILL LINDLEY, P.E., MARTIN R. WILLIAMS, AND C. ERIC JACOBSON | PHOTOS BY CSI - METAL DEK GROUP



SHORTENING THE CONSTRUCTION SCHEDULE was a critical issue when general contractor Naylor Construction elected to convert Southern Nazarene University's new A.M. Hills Residence Hall from a precast plank system to a groundbreaking panelized steel-framed structure. With student move-in scheduled to begin before the start of the second semester in January 2011, the $8.5 million, four-story dormitory was on a tight schedule.

Speed of construction drove the decision to make the change to using Versa-Floor [HR]. Jointly developed and patented by W&W Steel and CSi's Metal Dek Group, the system employs prefabricated floor panels combining three elements: composite channel beams, long-span composite floor deck and an integrated, low-profile spandrel beam. The panels are fabricated at grade, lifted by crane and slid between multi-story columns readied for their bolted attachment. By taking advantage of a long-span approach, this system is also cost-competitive on the basis of time and materials alone, providing a viable alternative even when shortening the construction schedule is not a prime concern.

In addition to installing quickly, the panel diaphragm helps plumb the structure. Its composite construction promotes stability of the structure while also making it more flexible and adaptable to M/E/P services.

When the project was released for construction to the fabricator in October, 2009, time was of the essence. To support their claim the system would shorten the construction schedule by at least six weeks, engineers from W&W Steel and the Metal Dek Group provided design assistance to the project engineer, L.A. Fuess Partners. The redesign, completed in

The chase formed between side-by-side panels provides freedom for placement of M/E/P risers. Unused chase is decked before the concrete pour.

about a month, released both suppliers to process materials for on time shipment to the job site in early January 2010.

The redesign took advantage of the system's lighter dead weight in several ways. Placed over poor soil bearing conditions, Versa-Floor [HR] incorporated a low density concrete topping helping to lighten the structure. "Switching to the new system allowed us to get a 30% reduction in foundation loads by using lightweight concrete, and we were able to get rid of three vertical braces," said L.A. Fuess associate principal Aaron Ford, P.E.

Another advantage of the system, one which couldn't be utilized because of the quick pace of the redesign, is the creation of an aligned, vertical chase formed between adjacent panels. The panel's channel beams mount to the sides of the columns to form the opening.

"The built-in chase-way is an innovative solution to M/E/P challenges," said Troy Downing, AIA, associate principal with RBA Architects. "I look forward to an opportunity of working with this feature from conception. It lends itself to the development of 'intelligent' system placement."

Built on the Ground

With guidance of W&W and the Metal Dek Group, Bennett Steel, orchestrated the on-site panel assembly and erection phases. With a crew of six including, crane and forklift operators, panel construction commenced January 11 and multi-level columns were installed within a week.

Floor panel fabrication involved a six-step process including: collecting materials; bolting the structural steel framework; setting the deck; welding the deck; connecting the deck side-laps; and stacking the panels. With routine established, the panels, most in sizes up to 750 sq. ft, were assembled in less than 45 minutes. On average, 15 panels of various sizes were constructed over the course of a typical workday. A 20-panel day,

Panel fabrication and erection phases occur simultaneously.


Site-fabricated Versa-Floor [HR] floor panels installed in only 18 days.

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Photos this page: Versa-Floor [HR] before and after concrete

The Birth of the Idea

The genesis of the Versa-Floor [HR] system lies in a lost opportunity, namely a 40,000-ton, 67-story casino-hotel tower placed along the Las Vegas strip initially designed with a "beam-in-wall" system. With commitment in hand, W&W Steel placed mill orders and plunged into design and modeling activities.

Shortly thereafter, the architects gave the development team a visual "walk through" of the residence units. They took immediate exception to the ensuing bulkhead formed by the spandrel beam. Wanting an unobstructed view of "The Strip" through their expensive glass curtain wall, they promptly ordered the designers to switch to a post-tensioned concrete frame.

About the same time, CSi's Metal Dek Group was making the rounds touting its just released long-span composite floor system, Deep-Dek Composite. With span capacities up to 35 ft, the ability to prefabricate single sections into panels and the reduction or elimination of filler beams, the product is geared for multi-story residences.

Designers from both companies gathered to respond to the challenges of the lost casino-hotel opportunity. In the process they addressed a second issue. The steel-framed option required placement of the M/E/P chase-ways off the column lines, effectively decreasing the usable square footage of the residence units.

The resulting solution was Versa-Floor [HR]. The system integrates a low-profile spandrel beam matching the overall depth of the Deep-Dek Composite floor system while the pre-fabricated panels connecting to the sides of the columns formed an aligned, vertical chase to facilitate installation of M/E/P risers.

accounting for about 15,000 sq. ft of panel, topped daily production.

The benefits of prefabrication were significant. Regulated, efficient production, quality control and ease of inspection were obtainable. On-grade prefabrication also recouped time usually lost in moving workers, tools and equipment from floor to floor.

Appreciable reductions in worker's compensation insurance costs could also be realized. "With 75% of the work performed on the ground, exposure to hazardous conditions could be reduced at least 50%. This translates to a 40% reduction in premiums," said Bennett Steel's president Dave Bennett.

Safer conditions were also assured after the panels were fixed to the columns. In place, they provided an immediate working platform. Fall protection was installed immediately after placement.

The rigidity developed in the bolted panel-to-column connections promoted frame stability during the erection phase. Additionally, the panel's inherent diaphragm stiffness helped to plumb the structure. "We were quite impressed with the stiffness of the system during the construction phase. It's very stable and doesn't vibrate," said Larry Jacobson, Naylor Construction's project superintendent. "We were absolutely delighted with the performance of the system."

Second floor panel installation, commencing on January 19, matched the pace of the panel construction. The final fourth floor panel was set on February 23. With eight days lost due to an abnormally harsh Oklahoma winter, Bennett assembled and installed all the floor panels in just 18 days. "The ice and snow created a challenging site," said Floyd Smalley, Bennett's project superintendent. "We kept pace because all the materials and equipment were in the same area, on the ground. Actually, we could have shaved another three to four days off the schedule if other trades had kept pace. We were less impacted by the weather."

Long-Span Composite System

Deep-Dek Composite panels, furnished in 18 ga. (0.0478-in.) thickness and 4½-in. depths, were topped with a 5-in., 4,000-psi lightweight concrete. The combination provided the required strength to span more than 28 ft while exceeding the cover needed to achieve a UL two-hour unprotected fire rating.

The deck's side-lap construction "locks" the concrete to prohibit vertical separation. The formation works in conjunction with

an intermittent, folded sidelap connection, that transfers horizontal shear, allowing spans up to 35 ft.

The deck ends rest on a ledger angle shop attached to the webs of 12-in. or 15-in. deep composite channel beams. The ledger's projecting leg was placed 4½-in. below the top flange of the channel so the top of deck and channel were flush. That ensured concrete encasement of the beam's compression flange to enhance its composite strength while helping to control the structure's overall and floor-to-floor height.

The composite panels' factory-closed ends serve two purposes. They eliminate the need for field installation of closure angle to block wet concrete from passing through the flutes and act as stiffeners to keep the web ends from crushing under load.

Long-span decks and beams can negatively influence floor vibration. However, extensive studies by Thomas Murray from Virginia Tech confirmed that the Versa Floor [HR] system meets AISC criteria found in its *Steel Design Guide 11*, *Floor Vibrations Due to Human Activity*.

Span length and concrete cover dictate shoring requirements when using the Deep-Dek Composite. On this project, each predominant span condition required a single row of adjustable post and beam shores placed at mid-span. "Minimal shoring interference helped streamline site activities," said Naylor's Jacobson. "Traffic through the structure was far less cluttered than post-tensioned buildings I've worked on in the past."

Even more importantly, the deck didn't budge after shoring was removed. "That same level of ceiling flatness is not obtainable with plank," said Jacobson. MSC

Factory closed ends of the Deep-Dek Composite floor panels rest on a dropped ledger angle shop-attached to composite channel beams.

Owner
Southern Nazarene University, Bethany, Okla.

Developer
Cornerstone Development, Edmond, Okla.

Architect
RBA Architects, Oklahoma City

Structural Engineer
L.A. Fuess Partners, Inc., Dallas and Boston (AISC Member)

General Contractor
Naylor Construction, Olive Branch, Miss.

Steel Fabricator
W&W/AFCO Steel, Oklahoma City and Little Rock, Ark. (AISC Member)

Steel Erector
Bennett Steel, Inc., Sapulpa, Okla. (AISC Member, IMPACT Member)

Deck Supplier
Metal Dek Group, a unit of CSi, Columbia, S.C. (AISC Member)