Rapid Replay

By Gene Martin, P.E. and Beth S. Pollak, with David R. Simpson, P.E.

Trust, teamwork, and technology boost a quick switch from concrete to steel in the expansion of West Virginia University's Mountaineer Stadium in Morgantown, WV.

In less than a year, 18 luxury suites and 648 seats were to be added at the north end zone of West Virginia University's Mountaineer Stadium in time for the team's opening game on September 4, 2004.

The project design team initially chose concrete for the expansion. However, during the bidding process, the eventual general contractor, March-Westin Company, suggested to the owner that a steel option should be investigated because of the tight schedule, difficulties facing winter construction, and the possible costs savings of steel versus concrete. March-Westin was the successful bidder on the original design, but after receiving the contract they worked with Allegheny Design Services and AISC-member fabricator Contracting Engineering Consultants (CEC) to investigate the steel option. By early November, they submitted a proposal for the steel-framed option that gave the owner a 5% total project savings. The steel option also lowered the risk of schedule overruns with winter approaching and a December 1, 2003 start-of-construction date. The owner accepted, and March-Westin, Allegheny and CEC worked as a team to design and build the project.

"We like to bring the fabricator and the engineer on at the same time," said Jamie Ridgeway, project manager for March-Westin. "We do it all the time on projects, because it can save time and money."

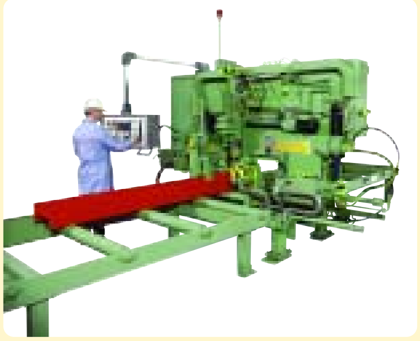
The transition from concrete to steel went smoothly, said structural engineer David R. Simpson, P.E. "We worked directly for March-Westin while maintaining coordination with HOK and Thornton-Tomasetti. To complete the design in a three-month period, we had to feed information to the fabricator as we were going along so that they could meet the mill schedules to order steel—while maintaining communication with HOK and their architectural requirements—and while communicating with Thornton-Tomasetti to determine what

Six Secrets of Success at WVU

1. The contractor's experience in construction methods and materials equaled an opportunity for cost savings on a tight schedule through the use of steel.
2. The owner was willing to entertain design options.
3. Working relationships that were cultivated on past projects helped the contractor assemble a unified team with design and construction expertise.
4. Excellent communication between the architect, engineers, and contractors facilitated the redesign process.
5. Excellent communication between the engineer, detailer and fabricator helped expedite the detailing and drawing-approval process.
6. The fabricator's use of technology helped move seamlessly between detailing software, production control software and CNC-controlled equipment. This saved weeks on the schedule and greatly reduced the chance of shop errors.

Machinery Makes a Difference

The Peddinghaus Beam Drill Line BDL 760 used on this project is a compact structural drilling machine suited for short or long production runs of sections 30” wide or less. It is a computer-numerically controlled (CNC) machine—and fabrication information could be directly imported into the machine from Xsteel, the detailing software program used for the WVU project. The combined use of Xsteel and the BDL 760 shaved as many as three weeks from the project schedule. “The Peddinghaus machine is pretty impressive,” said Tanner Johnson, project detailer for fabricator Contracting Engineering Consultants. “Depending on the difficulty of the pieces that we have to run, and how much work gets done to them, with some projects we can squeeze in as many as 45 tons a day. It’ll chew up beams and columns as fast as you can keep it running. It’s a great piece of machinery.” The drill line’s carbide marking system, Signoscript, is used for fast part identification.



their foundations could and could not take.” Simpson also worked carefully with HOK to make sure that frame layout and geometry would work well with fascia and curtain-wall attachments.

Allegheny had worked with the contractor and the fabricator on many projects before, some of which were design-build projects. “Because of our relationship with the builder and the fabricator, we were able to provide a quick response,” Simpson said. “A lot of barriers that we might have faced were already out of the way.”

Tanner Johnson, CEC’s project detailer, gathered information daily from Allegheny Design Services and detailed areas using Tekla Xsteel as soon as sections and layout were available.

“The fabricator is two miles down the road from us,” Simpson said. “So sometimes we were able to sit at their desk as they were doing their detailing.”

Johnson agreed that the proximity and trust between team members facilitated the quick design and detailing process. “We’ve worked together a lot before, and our companies have a good flow of information when we work together. Even if there were RFIs, there was a quick response, usually just a phone call away. With other engineers, it might take days or weeks to send an RFI out and receive a response, which can make the project excruciating. We were on the phone daily with each other—we all have the same cell phone service, so it’s as if we were on walkie-talkies.”

Working closely with the engineer and general contractor also meant that the team members could consider each other’s input in the design, fabrication and construction process. “One of the greatest assets of the relationship between CEC, Allegheny Design, and the general contractor is that everyone is open to suggestions that will make the project faster to build, quicker to ship, or easier to erect,” Johnson said. “As fast as we’re doing this project, it’s good to have a lot of trust. There’s no one pointing fingers. There’s no haggling back and forth about who owes what. Everyone’s focused on the main goal.”

Johnson started detailing December 2, 2003. Working closely with Simpson on submittals and approvals, he was able to complete the detailing and approval process by January 22, 2004. As soon as material lengths were available, steel was ordered from various steel service centers, including AISC-members Infra-Metals (Baltimore) and Metals USA (Pittsburgh). Fabrication began a few days later.

Using the Xsteel software, Johnson converted the connection information to computer-numerically controlled (CNC) files that were sent directly to a Peddinghaus BDL 760 drill line—which he says saved up to three weeks on the delivery schedule. “What one person can do in two days with Xsteel would take a person two or three weeks to program by hand. It’s quite a lifesaver. Plus, it eliminates most human error. As compared to a job where you would have to hand-program each and every file—Xsteel is seamless.”

Johnson also used FabTrol fabrication and project management software to manage pieces, layouts and parts necessary for the project. “FabTrol manages our ordering, shipping and receiving. It keeps track of our specs, and just about anything else you’d want to do with it,” he said. “We also use Master Builder, an accounting software, to keeps track of our billing.”

The first load of material was shipped to the job site on March 1, three weeks ahead of foundation completion.

Steel Stadium

The steel-framed expansion used W-shape columns and beams with knee-braced, back–to-back double angles for lateral stability. The roof is a steel-beam and metal-deck system, and the floor is composed of 8” hollow-core pre-cast concrete with structural stopping. The second level of the facility houses the private luxury suites with general seating and concessions on the lower levels. All suites are enclosed with motorized windows that rise for warm weather games. The motorized windows required tight construction tolerances. Close attention and coordination had to be paid to the fascia and curtain-wall attachments due to the change in structural frames.

A cantilever, primarily composed of a W27×94 with an end-plate connection to the W27×94 columns, accommodates the allowable deflection limits imposed by the curtain-wall system and a motorized

Project Timeline

October 2003: March-Westin wins the bid for the project; organizes a team to consider design in structural steel.

November, 2003: March-Westin submits a proposal for the steel-framed option that offers the owner a 5% total project savings.

December 1, 2003: Construction begins.

December 2, 2003: Structural steel detailing begins.

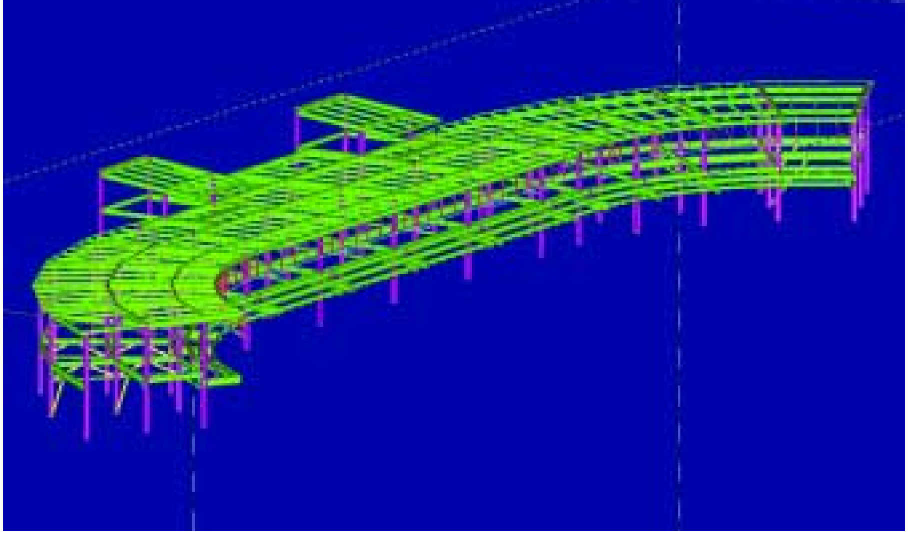
January 22, 2004: Detailing and shop-drawing approval process is complete.

March 1, 2004: The first load of structural steel is shipped to the job site.

March 22, 2004: Foundations are complete.

May 20, 2004: Structural steel erection complete.

September 4, 2004: Kick-off!



Tekla Xsteel software was used to created CNC files for use by the fabrication equipment. FabTrol fabrication and project management software helped out in the shop.

window-operating system. The driving frequencies of excited football fans in the stadium also were taken into consideration. For the cantilevers, Simpson designed a bolted moment connection with 1½″ ASTM A325N bolts, for ease of erection.

"As opposed to concrete, the appearance as you're walking underneath the cantilevered sections is really impressive," Johnson said. "Especially to see those W27×94 beams that are cantilevered out with bolts on them."

An error in the soils report was discovered, and the expected differential settlement was increased from 1″ to 2″-3″. The solution was to temporarily brace the frame with cables and install the angle knee bracing after most of the dead loads were applied. Under temporary bracing, the frames were allowed to rotate at the beam-column connections during settlement. After an approximately 1.5″ settlement and no sign of significant further settlement, the knee braces were secured, thus greatly reducing any residual stresses.

At the ends of the building, where it joins the existing stadium, considerations were made to provide underpinning to the existing stadium structure. Due to poor soil conditions, it was not advisable or economical to use soil nailing for this area. This led to the use of the superstructure as support for the 20′-high retaining walls. HSS 8×8s were used to direct the top-of-wall reactions into the Thornton-Tomasetti-designed foundations.

The project contained 325 tons of structural steel members. A spray-applied fire-protective vermiculite coating was used on the interior structural members of the steel frame. The exterior steel was coated with a Tnemec SSPC-SP6 system, with zinc-rich shop-applied primer and a two-coat system of field-applied paint.

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Owner
West Virginia University, Morgantown, WV

General Contractor
March-Westin Company, Inc., Morgantown, WV

Architect
HOK, Inc., Kansas City, MO

Structural Engineer
Thornton-Tomasetti Engineers, New York City (Original Concrete Design)

Allegheny Design Services, Star City, WV (For the Steel Design Option)

Steel Fabricator/Detailer
Contracting Engineering Consultants (CEC) (AISC member), Maidsville, WV

Structural Engineering Software
RAM Structural System

Detailing Software
Tekla Xsteel

Project Management Software
FabTrol, Intuit Master Builder

Coating Supplier
Tnemec