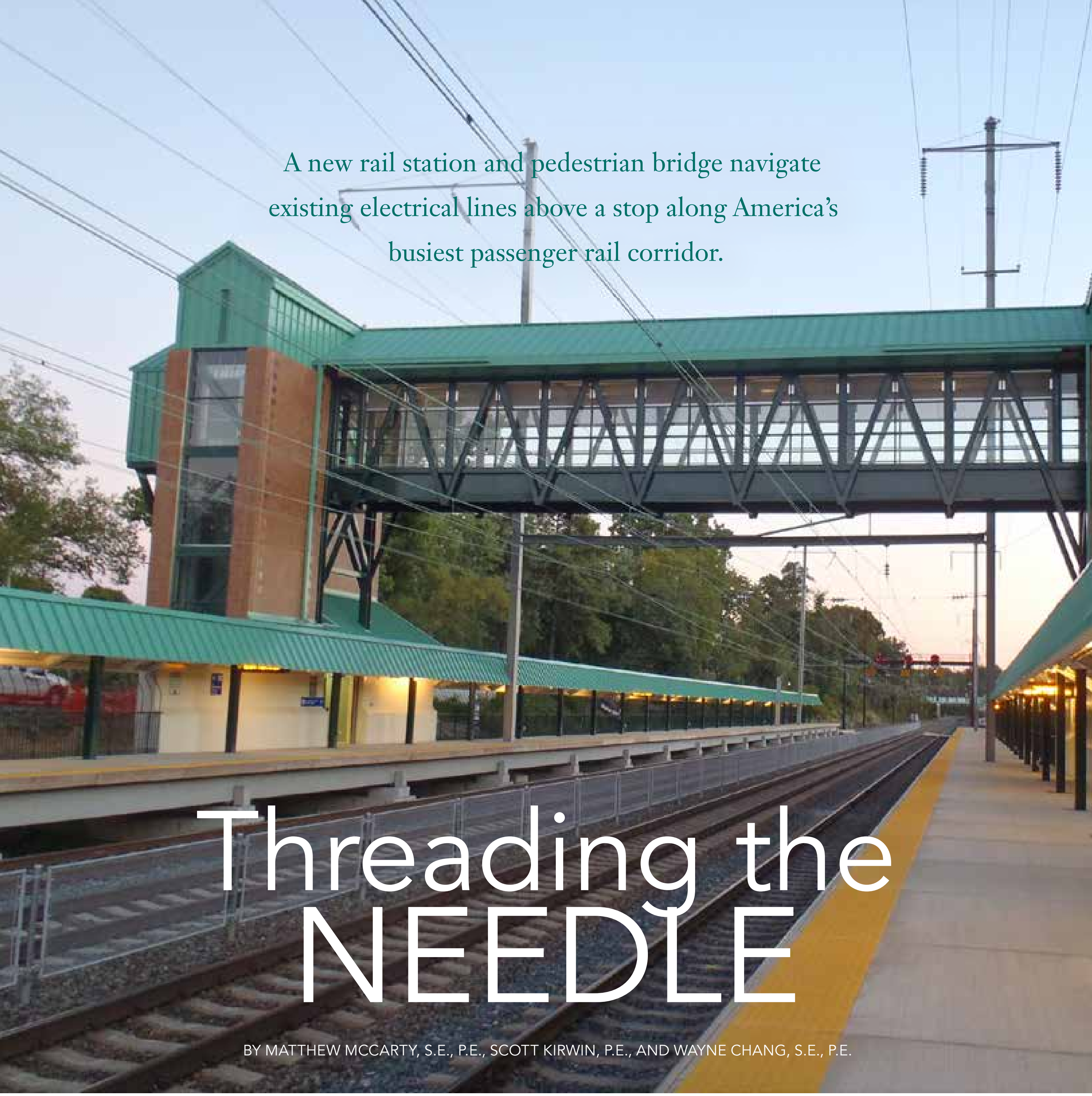
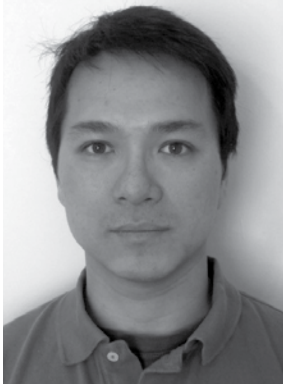


A new rail station and pedestrian bridge navigate existing electrical lines above a stop along America's busiest passenger rail corridor.

Threading the NEEDLE

BY MATTHEW MCCARTY, S.E., P.E., SCOTT KIRWIN, P.E., AND WAYNE CHANG, S.E., P.E.



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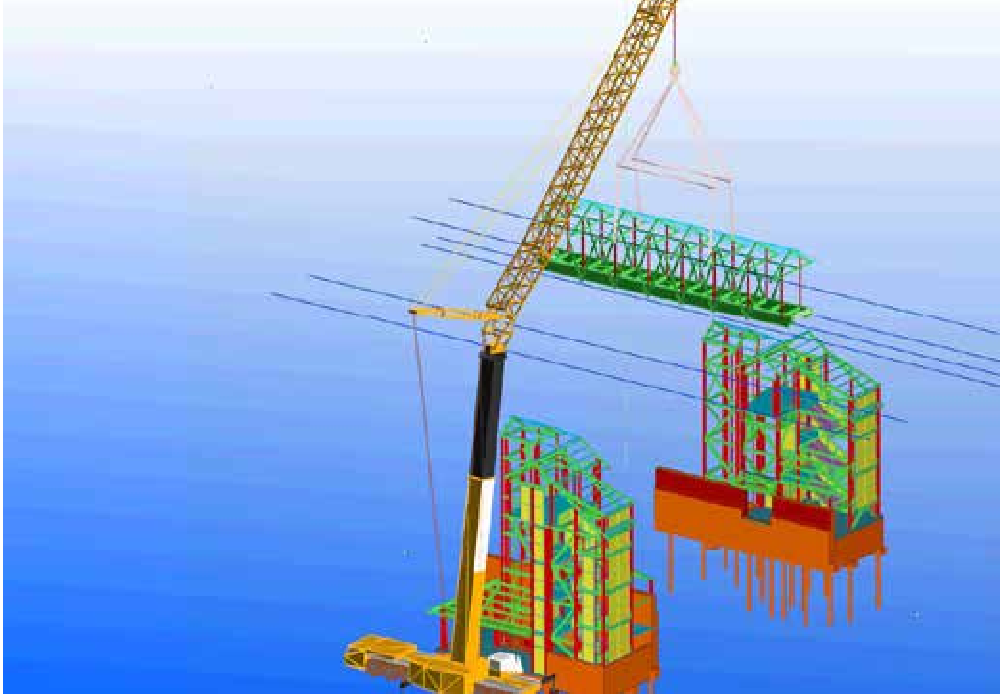
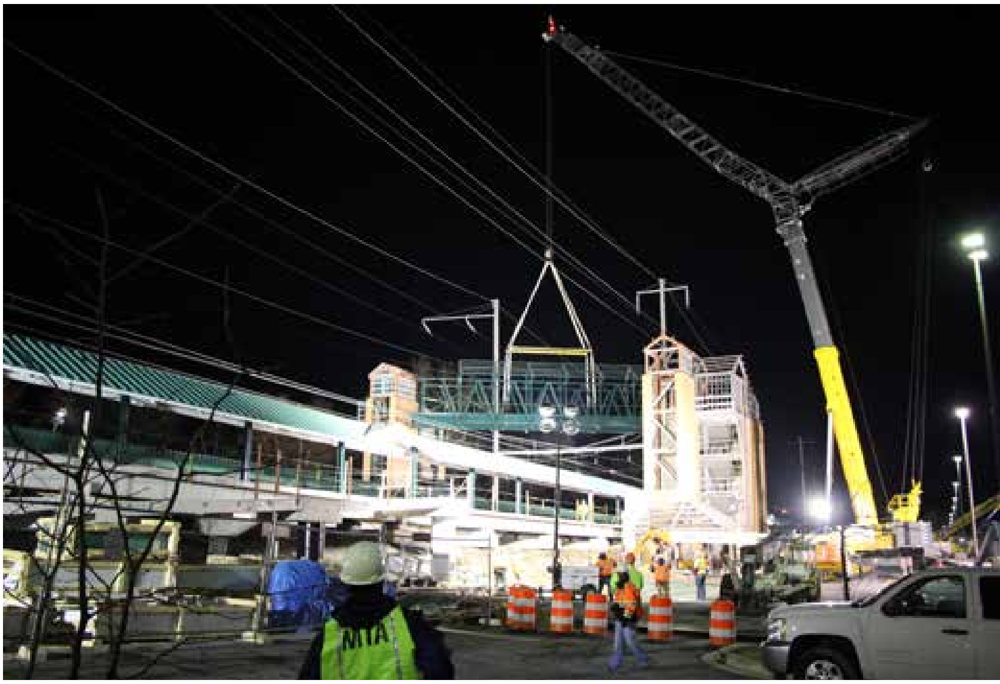


▲ A detailing model of the pedestrian bridge erection process.

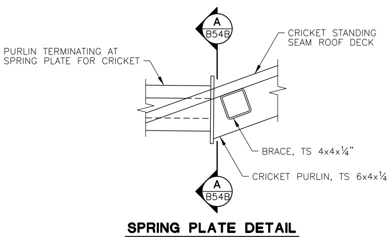
◄ The project uses 245 tons of structural steel in all.

▼ Erection of the bridge at night. For a time-lapse video of the bridge's erection, visit: vimeo.com/82219115.



THE HALETHORPE STATION is a key link in a long and crucial chain.

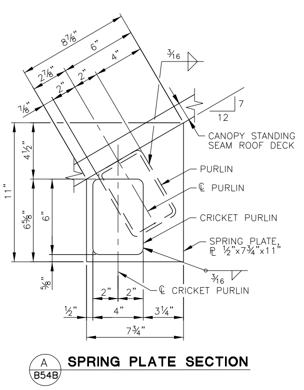
Each day, the station (in Halethorpe, Md.) accommodates 1,300 of the 39,000 passengers served by the Maryland Rail Commuter Service (MARC), making it one of the five busiest stations in the system and a key point along Amtrak's Northeast Corridor (NEC), the busiest passenger rail corridor in the U.S. However, the station didn't meet Americans with Disabilities Act (ADA) requirements, so in 2002, the Maryland Transit Administration (MTA) engaged Whitman, Requardt and Associates (WRA) to study and subsequently design a new station that would be both ADA-compliant and able to accommodate current and potentially larger future passenger capacity. In addition, MTA requested that the station be unmanned and require minimal maintenance. It is also intended to serve as a prototype for future new and upgraded MARC stations. Finally, the facility needed to be constructed without interrupting MARC rail service and that of the NEC. WRA completed design contract documents in 2008, Amtrak electric traction modifications began in January 2010, the general contractor's construction was underway by March 2011 and the ribbon cutting for the new station took place in August 2013.



▲ Welding the canopy steel.

◄ Spring plate details.

▼ HSS field-welded connections.



Old and New

The previous Halethorpe Station consisted of two 150-ft-long at-grade platforms: one for trains bound for Washington, D.C., and the other for Baltimore. These pre-ADA, low-level platforms required conductors to assist patrons with the use of a small stepstool while boarding or alighting trains. Only the platform for Washington-bound trains provided any relief from the elements, in the form of two 33-ft-long shelters. The ticketing building was located 100 ft from the Washington-bound platform and even farther from the Baltimore service. In addition, patrons were required to walk up two flights of steep, open stairs to the sidewalk of the Francis Avenue Bridge then descend another two flights of stairs to get from one platform to the other, all while exposed to the elements.

The replacement station provides two 700-ft-long, high-level platforms that allow patrons to board and alight from trains at any point along the platform, thereby improving safety, accessibility and reducing dwell time for trains. Full-length platform canopies provide protection to commuters from the weather, and the new station is fully ADA-accessible, with elevators, ramps, stairwells and doorways that lead to a covered pedestrian bridge to provide easy access to and from each platform. The ticketing area is located at the main parking level entrance, which is near the middle of the Washington-bound platform. The style of the station echoes transportation architecture of the late Victorian/Industrial Revolution era; iron spot brick with accent bands, sloping metal roof components and an exposed structure evoke a historic flavor. These elements combine with the modern landscaping to provide a pleasant environment for the patrons to await their train's arrival. In all, the project uses 245 tons of structural steel (131 for the station building and 114 for the canopy).

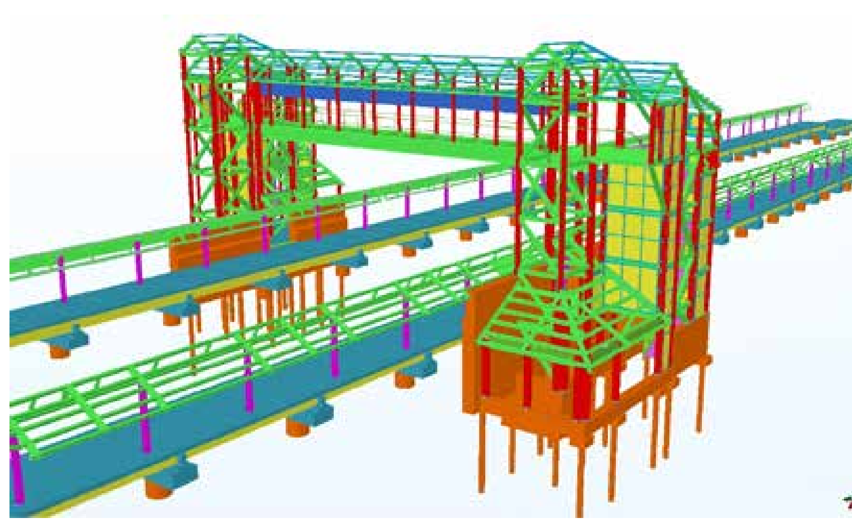
Limited Flexibility

The project site's location along the NEC placed severe limitations on the overall construction. During construction, the daily operations of 122 passenger trains and the existing MARC station were required to be unimpeded, resulting in extremely restricted work schedules with limited flexibility. On the east side of the site, the contractor, W.M. Schlosser, had approximately 12,500 sq. ft of MTA property available for construction trailers and staging during construction; on the west side, it was limited to a small area of existing parking spaces immediately adjacent to the new construction. Finding parking around the MARC station during peak times was already very difficult, and MTA deemed it unacceptable for Schlosser to use any more than the bare minimum amount of parking lot for construction laydown. For temporary activities, which absolutely required more laydown area (e.g., prep for the bridge lift) Schlosser had to arrange to perform the work during lower commuter days or off-peak times of day.

The preassembled pedestrian bridge before erection.

Finished pedestrian bridge interior.

East tower framing with interior precast panels.



A steel detail model, from AIW, used for review.

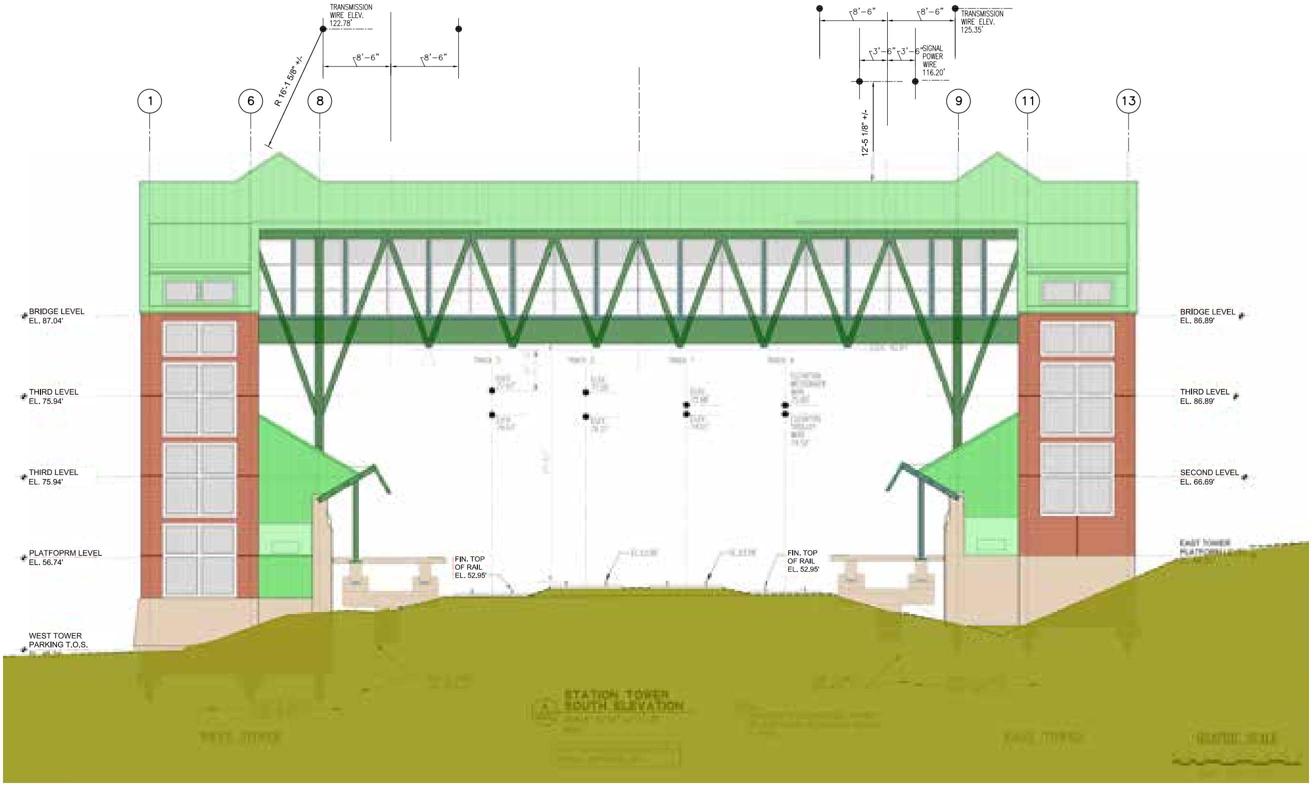
The completed station.

Schlosser was limited to a six-hour nighttime work window allowing track closure for all activities adjacent to the southbound platform track and only a two-hour nighttime work window for activities affecting all tracks. As such, most foundation, concrete and structural steel work required at least one track closure. In addition, the overhead catenary power system and overhead transmission lines posed further constraints because they could only be de-energized within similar work windows. The overhead transmission lines run parallel to and are directly overhead of the entire platform and canopy structures. These lines limited the height of the equipment that could be used to install the drilled shafts for the platform foundations as well as the height of the cranes setting precast platform panels and canopy steel. On top of that, other Amtrak projects on the corridor upstream and downstream of Halethorpe Station occasionally removed these work windows entirely. These unexpected and unpredictable removals had a significant impact on the originally estimated construction duration. Schlosser was granted additional contract calendar days when they could prove that the delay was due to Amtrak requirements/limitations. For the most part, the company requested work windows and Amtrak approved or declined them as necessary for its own work needs. However, on occasion, Schlosser was told daily before close of business whether or not they would be working that night.

Platform Canopy

Each platform is protected by a steel-framed gable roof canopy using wide-flange columns and rectangular hollow steel structural sections (HSS) beams and purlins. The canopy columns and attached main sloped beams are W8×31s, and the canopy purlins are HSS6×4×¼. HSS were selected over open structural sections to eliminate a bottom flange where debris and wildlife can collect, as well as for its ability to better accommodate irregular connection geometry.

A standing-seam metal roof is applied directly over the structural steel purlins. Given the canopy's length, the designers selected a scheme where numerous short, structurally independent sections comprise each canopy. Each run of canopy is made up of 19 independent framing sections of lengths between 27 ft and 50 ft. This scheme was favored because it allowed nearly all steel connections to be performed off-site to speed on-site construction and minimize required track outages. The frequent joints between the framing sections also provide all necessary room for thermal expansion and contraction of the canopy. At the request of the fabricator, AIW, keeper bars were added to each joint in the framing to keep the independent canopy steel framing sections appropriately aligned to accept the standing-seam roof. These series of keeper bars, which slide past one another when the canopy thermally expands and contracts, hold the abutting cantilevered spans of canopy framing in vertical and horizontal



The south elevation of the station building.

alignment. All canopy steel was shop primed and given final field coats of high-performance forest green or white Tnemec paint.

Towers

Steel columns for the east and west towers are launched from the tops of 30-in.-thick reinforced concrete crash walls and surrounding grade beams. The gravity load resisting system of the towers consists of HSS beams and columns with non-composite concrete on metal deck, and the lateral load resisting system is a series of braced and moment frames. Multiple braced frames tie into the tops and sides of the crash walls and engage them as part of the lateral system. The designers chose steel HSS sections for the same reason as the canopy: The aesthetic and geometry of the buildings also required irregular member connection geometry, which was more easily accomplished with HSS rather than open sections. All exposed HSS sections were shop primed and given final field coats of high-performance forest green Tnemec paint.

The station building is clad in a combination of precast concrete panels, metal panels and wire mesh, and is designed to be an open structure. The use of exposed HSS in an open structure necessitated that the connections between elements be seal welded all-around for aesthetic and corrosion reasons. These connections are used as moment resisting connections in multiple locations and participate in the towers' vertical lateral load resisting system. Moment connections in the horizontal plane are also used to create a frame in some areas as a substitute for a traditional building diaphragm. During construction, AIW welded together complete building frames in the shop and erected them in one piece as much as possible. In cases where the seal-welded connections did not accommodate field fit-up tolerances in member length, the tolerances were achieved by either cutting off slivers of member ends where pieces ran long or by building up a sufficient weld width to bridge the resulting gap where pieces ran short.

Due to the towers' open nature, the precast panels were mostly placed around the elevator and stair shafts and below steel roof beams, which necessitated very close coordination between the steel and concrete panel erectors and fabricators. During construction, steel framing was advanced up until the roof beams were to be set, then paused while the interior precast panels were set. Once all the internal panels were set, roof framing was completed.

The structural steel shop drawings were produced by AIW via Tekla. During the steel shop drawing review period, WRA requested and was sent "for information only" copies of the Tekla detailing model. Due to the complexity and irregularity of the stair/elevator towers, this model was incredibly helpful in verifying the shop drawings and visualizing the structure. A number of issues, which had been hardly noticeable in the printed shop drawings, were readily identified in the model and were quickly resolved. For instance, the initial set of shop drawings was missing several rows of short cantilevered purlins on top of the stair tower. Using 2D drawings, this omission was easy to overlook, as the purlins only extend 1 ft outwards and support a small section of roof and gutter. However, comparing the shop model to contract drawings and architectural renderings made the missing purlins blatant. Additionally, the initial shop drawings misplaced a number of the steel channels required for attaching wire mesh panel cladding. Reviewing the model made verifying proper placment of the various cladding system elements much more intuitive.

Pedestrian Bridge

The pedestrian bridge provided perhaps the biggest erection challenge because it could only fit within a narrow vertical window. The elevation and height were restricted in order to maintain effective viewing time to Amtrak's signals coupled with maintaining vertical clearances from power cables above and below the bridge. Just below the bridge are electrical trolley lines; just above the bridge are electrical transmission and signal lines. These physical constraints were the driver of most design decisions related to the bridge. Given the need to shut down all four tracks and trolley wires to install the bridge, ease and speed of erection were of paramount concern. The vertical load-resisting structure of the bridge consists of a pair of 80-ft-long W36×194 girders laced together with horizontal angle bracing. HSS frames are launched from atop the girders and are used to support the bridge's roof and glazed and wire mesh cladding.

The bridge was designed to give Schlosser the flexibility to either erect the girders first and then build the HSS frames atop or fully preassemble the bridge and set it in one piece. Schlosser ultimately decided to set the bridge almost completely assembled, as this allowed them to perform the maximum amount of work while still on the ground, without track outages and during the day. A few of the HSS frames at the end of the bridge were left off during the bridge pick to allow it to fit between the already constructed stair and elevator towers and to reduce pick weight. Although the bridge assembly weighed 40 tons when set, it required a 550-ton-capacity Grove GMK 7550 crane to erect. To clear the electrical transmission lines, Amtrak tracks and already constructed west stair tower, the pick radius was an impressive 90 ft.

Unfortunately, not all of Amtrak's electrical lines could be shut down during the bridge pick. At least one set of transmission lines is required to remain energized at all times to maintain proper phasing between all the electrical substations along the NEC. To provide an adequate clearance around all electrified lines, the eastern set of transmission lines were permanently relocated approximately 10 ft further away from the tracks by installing new steel tower armatures in the weeks preceding the bridge lift.

Schlosser further leveraged the steel detailing model to fully model the surveyed locations of the bridge bearings, electrical lines, bridge pick rigging and crane to be used. AIW then created a series of animations to show that the entire bridge lift could be performed successfully and demonstrate that every contingency had been evaluated; the entire project team recognized the potential for a prolonged and very costly closure of the NEC if something went wrong with the lift. Thanks to the months of planning and preparation, the night of the bridge erection went off without a hitch. The bridge went from sitting on the ground to being lifted over 120 ft in the air to clear the de-energized transmission wires to sitting on its bearings with connections bolted within two hours—which was just in time to let a 3:30 a.m. diesel train pass through the site. ■

Owner
Maryland Transit Administration

Operator
Maryland Rail Commuter Service

Architect and Structural Engineer
Whitman, Requardt and Associates, LLP, Baltimore

General Contractor
W.M. Schlosser Company, Inc., Hyattsville, Md.

Steel Fabricator, Erector and Detailer
AIW, Inc., Hyattsville, Md.