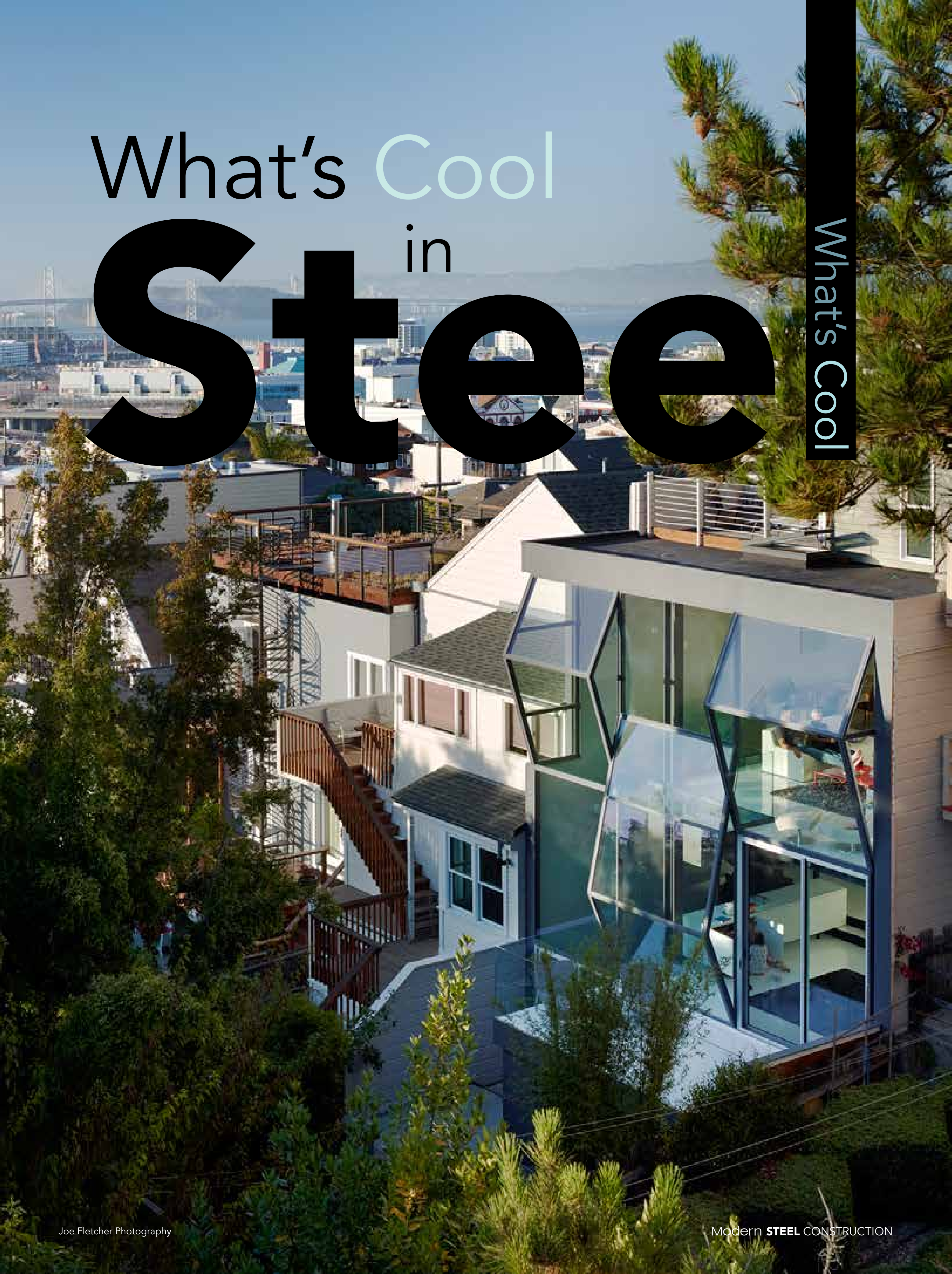
# What's Cool in Steel





Joe Fletcher Photography

COOL CONVERSION

# Flipping for the Better

BY ANNE FOUGERON, FOUGERON ARCHITECTURE

Some buildings just don't jibe with their surroundings.

Like many San Francisco homes, the Potrero Hill home that eventually became the Flip House poorly integrated its many levels with each other and failed to do justice to its sloping topography. The floor plan felt enclosed despite its size. Not only that, but a bedroom blocked the unbelievable city view and there was only one miniscule deck (hardly enough for even the most modest of grills).

The challenge was redesigning this disjointed home with a new modern aesthetic, but doing so without completely tearing down the existing envelope. Light was the driving motivation for the project, which was designed by Fougeron Architecture. In order for the interior's potential to be maximized, its exposure to the outside had to be completely reconsidered. This meant recasting the solar orientation of the home and reconnecting it to its striking landscape. The new primary façade has faceted,


Photos: Joe Fletcher Photography

custom-built glass walls divided into three vertical panels made of HSS. These sections push in and out, creating a dynamic prism, exploiting and animating natural light as well as the spectacular views. The HSS, measuring only 2 in. × 3 in., were custom-made for the project, cut and welded into one-story pieces in the shop, then assembled on-site. Glazing was applied over the HSS and custom steel stops to cover the joints and provide complete waterproofing.

The interior of the home also needed functional circulation, not only for the homeowners but also for natural light. While creating an open floor plan was intrinsic to making a more useable, more flowing space, design cannot forget how floors interact with each other. The pivot point had to be the transition from the various floors, which meant creating one rear staircase that smoothly linked all three levels and the garden below. The staircase uses a central piece of round steel as the stringer, giving the stairs an almost floating quality. The treads and risers were made of perforated steel, which provides a great deal of transparency by allowing light from the back of the home to shine through.

Above all, what steel offered in this home was flexibility—flexibility to design a façade that can harness available and abundant natural light, and flexibility to create a structured staircase that does not dominate the space but instead blends in with it.


Photos: Genie


COOL RIDE

## Capital Idea

The idea of an observation wheel as a tourist draw dates back to 1893 when the first wheel, designed and built by George Ferris, Jr., wowed attendees at the Chicago World's Fair. Since that time, the scale and sophistication of observation wheels have steadily grown, with landmark structures in London (London Eye), China (Star of Nanchang), Singapore (Singapore Flyer) and Las Vegas (High Roller).

And now Washington, D.C., has a wheel of its own. At 175 ft, the Capital Wheel boasts some of the most iconic vantage points imaginable, offering views of the White House, the U.S. Capitol, the National Mall and Arlington National Cemetery. Its location, in National Harbor—a 300-acre multi-use waterfront development in Prince George's County, Md., just south of Washington—was a large part of the reason AISC member fabricator Cianbro headed up the project, according to Aric Dreher, the company's project manager.

Work on the Capital Wheel started with the installation of a 150-ton steel grid base structure. Fabricated by Cianbro at its Baltimore yard, the individual components for the base were sent by barge to the Potomac River site. While that ultimately proved to be the best method for transporting the assemblies, there was a point when the decision to do so looked sketchy at best, said Dreher.

"Shortly after kicking off the project in January, we had everything for the base loaded onto the barges and ready to go," he recalled. "We were only waiting for a few beams to arrive from the galvanizer. But right after we loaded them, the temperatures plummeted, Chesapeake Bay froze over and the Coast Guard put shipping restrictions in place. It was three weeks before we were allowed to transport again, which threw a wrench in the schedule. But as soon as the weather broke, we were moving again and attacked the schedule aggressively."

With construction of the base completed, the structure's tower legs were erected, followed by installation of other ride components such as the axle, spokes, ring beams and lights. That predetermined construction sequence—as well as being located at the end of a 600-ft pier—essentially dictated the manner in which the balance of the project could proceed. While the actual height of the tower legs and components to be assembled could typically be reached using one of Cianbro's existing standard-sized booms, access at this site was another matter entirely, said Dreher.

"If we were putting this up on land under normal circumstances, we'd have no issues accessing the axle and spoke connections with a standard 85-ft boom lift," he explained. "But because we are on a pier and had to first install the base steel structure, we were left with only two spots from which a boom could operate in order to have access to both sides of the wheel. And on one of those sides, we were set back more than 85 ft and needed to reach 90 ft into the air over the top and in between the tower legs."

"What we call the 'Monster Lift' [a Genie lift with a 180-ft boom] has nicely filled that gap between what our 135-ft lift can and can't reach," Dreher said. "It was instrumental in the assembly of the tower legs themselves, but one of the most crucial areas of the construction involves setting the wheel's 'spokes' into the hub or axle. The lift allowed us to get up and over the tower legs and then reach in to the axle area to do each connection."

The Capital Wheel opened in time for Memorial Day weekend of this year.

COOL PAVILION

# Made in the Shade

BY MELL LAWRENCE, FAIA, MELL LAWRENCE ARCHITECTS, AND CHUCK NAEVE, P.E., ARCHITECTURAL ENGINEERS COLLABORATIVE

Cotillion Park in Dallas now has a clear-cut focal point.

Commissioned by the Dallas Parks and Recreation Department, the new Cotillion Pavilion shade structure appears to float in the middle of the park, bridging the gap between two groups of trees at a natural gathering place. The composition of steel components abstracts and mimics the surrounding trees to produce similar dappled shade. The sun's movement animates the structure, catching direct light, casting shadows and creating dynamic figure-ground shapes against the sky. Long concrete benches not only define the outdoor room under the translucent roof, but also stretch out beyond to extend the usable area into and under the surrounding shade trees.

The program called for a 650-sq.-ft pavilion that would be maintenance-free, immune to vandals and protected from sun and rain. The design and construction team was able to deliver an even larger area of usable space, and within the budget (the total project cost was $277,785). Designed by architect Mell Lawrence Architects, structural engineer Architectural Engineers Collaborative and artisan Lars Stanley Metalworks, the steel and polycarbonate roof structure covers 1,200 sq. ft of tables, benches and open space, and the concrete benches that extend into the landscape provide an additional 2,600 sq.-ft of seating area.

When viewed from a distance, the pavilion has a lightweight, ephemeral quality. At times it appears to merge with the surrounding tree canopy, but a closer inspection of the structure reveals a delicate screen wall of horizontal steel angles suspended outside of a steel frame. Eight steel columns support the canopy above a concrete slab, and board-formed concrete benches define the edges.

Not only does the weathered steel composition provide shelter, it also creates a sense of playfulness through the use of shape and pattern in concert with the sun. Throughout the day, a series of shadows project onto the ground tracking the sun's motion silhouetted against a bright sky. After sunset, discreetly placed energy efficient LED light fixtures transform the structure into a glowing lantern within the park, a feature that allows the pavilion to also be used in the evening.

Steel was the natural choice as a building material for a structure that was aesthetically driven, crisp in delineation and minimal in form. Hollow structural sections (HSS), structural tees and angles comprise the vocabulary of shapes used in the pavilion. Small HSS5×5 columns and beams are welded at all intersections to form the moment frame of the primary structure. The integrity of the frame, fixed to the foundation, enables columns that seem impossibly small to delicately support the rectangular form of the canopy above.

The canopy is composed of horizontally spaced 1¼-in.-by-1¼-in. angles supported on a framework of HSS3×1½ members. The rectangular form elegantly drapes the primary frame. A roof structure made of structural tees supports the translucent roof. The tees frame to a central spine, a built-up shape with a suspended L6×6 angle. Rainwater is channeled to the spine beam and into the trough of the angle below. The angle leaves the spine to cantilever beyond the structure, allowing rainwater to freefall to a basin in the pavement.

The structure is left unpainted and allowed to rust to a natural patina in the Texas environment. Originally, weathering steel was specified to limit deterioration of the structure from rust. However, a minimal budget and multiple steel shapes led to the practical decision to use standard steel materials, increasing each member's thickness sufficiently to allow for reasonable deterioration.

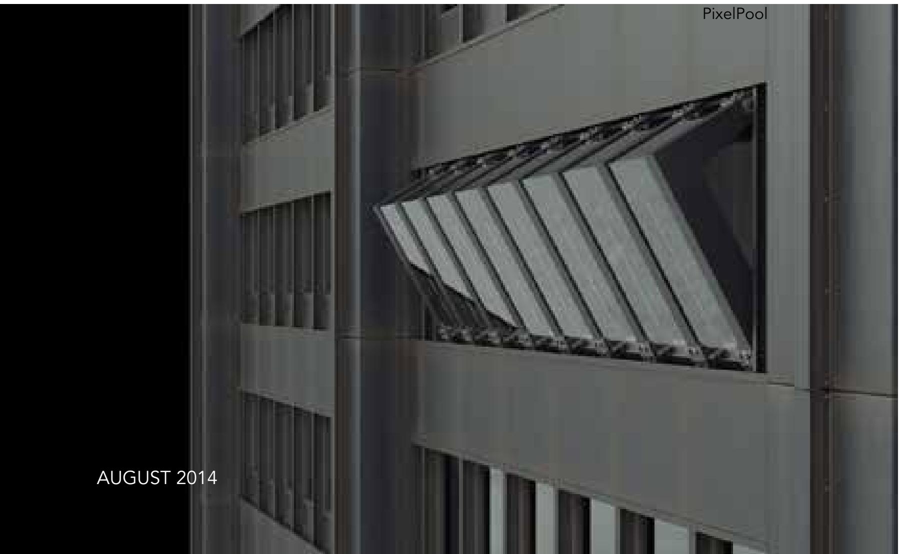
The suspended mobile is also an exceptional piece of steelwork. Architect and artisan Lars Stanley constructed the elliptical mobile from matching forged steel discs that were welded together and finished at the perimeter. The mobile, hung from a single spindle, turns slowly with the wind, belying its true size and mass.

Photos: Mell Lawrence


Thornton Tomasetti


PixelPool


PixelPool


PixelPool

COOL ANGLE

# Hanging Out

BY JOHN PERONTO, S.E., P.E., AND CHRISTIAN DEFAZIO, P.E., THORNTON TOMASETTI

On a clear day you can see forever.

Located on the 94th floor of the John Hancock Center, 360 CHICAGO (formerly the John Hancock Observatory) provides visitors with a panoramic view of Lake Michigan and four Midwestern states. To enhance their experience, the owner, Montparnasse 56 Group, hired Thornton Tomasetti to design Tilt, an operable steel and glass structure that inclines out of the south side of the building and allows patrons to hover 1,000 ft above the ground, providing a bird's-eye view of the cityscape. Up to eight people are able to stand in partitions along the platform and look down through the structural glass panels. Thornton Tomasetti designed the steel mechanism and retrofitted the steel framing of the 1960s building to support it.

An earlier concept design by Lawrence Allen, S.E., P.E., at ASE ENGINEERING was used as the basis of the project, but was modified to be more sympathetic to the iconic John Hancock tower. Thornton Tomasetti engineers engaged the Boundary Layer Wind Tunnel Laboratory to conduct a wind tunnel test of the steel-framed Tilt mechanism in both the open and closed position. The findings of this investigation were used to better understand the design loads on the framing and glass, accounting for the


high elevation in the tower. Such an operable steel structure in a high-rise is unique, and all steel and glass materials were under high scrutiny, especially the fatigue-life design considerations of the steel elements.

Tilt's mechanism is a two-part system composed of a stationary base structure and a movable viewing platform constructed of standard and custom built-up steel sections. The stationary base is supported and directly connected to the existing steel structure. The 26-ft-wide platform rotates on one axis and is supported at three primary locations by the fixed structure. Three overhead hydraulic actuators extend to rotate the platform 30° beyond the face of the building. Tilt uses roughly 15 tons of steel in all and is composed of W6×25, W8×28 and built-up sections using mostly ¾-in.-thick A572 Grade 50 plates.

The viewing windows are composed of three layers of reinforced, fully tempered, laminated glass panels. All loads can be safely supported by just two layers of laminate glass, with the third layer added as a redundancy. A similar system of layered reinforced glass forms a partial roof to prevent weather and debris from entering and exiting the space. Patrons stand in one of eight individual partitions along the length of the platform, and handrails on each side and a waistband provide additional support.

Jim Watkins

Demiurge

COOL TREE

# Growing Ideas

BY ADRIAN CROWTHER, P.E., C.ENG., ARUP

Some sculptures are thought-provoking by chance, others by design.

In the latter category is the Idea Tree, an interactive sculpture commissioned by the City of San Jose Public Art Program to reside outside of the recently renovated San Jose Convention Center. It was conceived by architect and public artist Soo-in Yang, principal of Lifethings, with Arup acting as the structural engineer of record.

A competition was held seeking an artist to design an artwork that would reflect the bold thinking and vision that characterizes San Jose's place as the "Capital of Silicon Valley" and hub of one of the world's most innovative regions. Based on his past work, Yang was commissioned to develop a site-specific design. The project that developed, the Idea Tree, is an energetic and multifaceted concept that combines a shading canopy with an interactive auditory experience described as a "self-sustaining ecology of ideas."

The interactive aspect comprises two parts. As visitors pass the 8-ft cast bronze pod or "Seed," audible questions encourage them to record their thoughts into the Seed. These messages are coalesced and played back through a directional speaker and evolves based on their reaction. Messages that garner a positive response are built upon in the "ecology of ideas" while messages that are ignored lose their literal content and transform into ambient soundscape.

Structurally, the 40-ft-wide canopy consists of three pairs of interconnected steel hoops fabricated from rolled 4.5-in.-diameter A500 Grade B round HSS. Each pair of hoops is laced together with $\frac{3}{8}$-in.-diameter stainless cables (240 total) supporting translucent polycarbonate leaves. Preloading in each cable removes unsightly sag but results in significant compressive load in the perimeter hoops. This added complication warranted careful consideration of the installation sequence to ensure the canopy's strength was not exceeded by unanticipated loading conditions.

The canopy is supported 20 ft above ground by three column "trees" each comprising three doubly curved 4.5-in.-diameter circular HSS. The lower column sections are stiffened with interconnecting tubes inspired by the tropical strangler fig tree.

The complex geometry resulted in atypical connections at the canopy nodes where multiple hoops would partially overlap and pass through one another. These nodes were justified using detailed localized finite element models, which were incrementally loaded until their capacity was reached. Once the node "strength" was determined, this could be compared to the demands seen in the global analytical model.

As San Jose is a seismically active area, the team undertook a response spectra analysis, which also captured the vertical excitation of the "cantilevering" rings. We also determined it was conceivable that dedicated guests could climb the structure and find themselves hanging from the outer rings, so we considered "vandal" loads in addition to the standard load combinations defined in ASCE 7.

Before being shipped to San Jose, Demiurge undertook a trial assembly of the completed canopy and columns to ensure that the tight tolerances could be assured at the connections to be site welded. The completed sections were then separated into smaller sections to allow for transportation. Once on-site the columns were installed on their reinforced concrete pad footings, and the canopy was reassembled and lifted into its final position with a single lift, with the cables installed with a nominal preload. After completion of the steel superstructure the cables were given their final prestress and the interactive aspect was commissioned. The Idea Tree officially opened to the public last October during a Community Day Celebration.

# What's Cool in Steel


COOL TOWER

## Building Blocks

BY RICHARD D. ROBERTS, P.E., PENNONI ASSOCIATES

Each year the Red Clay School District in Wilmington, Del., challenges its students to work together on a common project.

Their message to students is that when you work together on a common goal, you can achieve much more than one can individually. For 2013's project, 16,000 students used approximately 500,000 Legos to construct a tower over 100 ft tall, which was funded by private donations of $15,000.

Structural engineers from Pennoni volunteered their time and developed the design of an internal steel mast that would provide the lateral support required to prevent the tower from toppling over. The tower was required to be freestanding and therefore could not be supported vertically from the steel mast. However, lateral support of the tower was required due to wind forces that could easily cause it to collapse. The steel mast was designed as a series of steel pipes ranging in size from a 6-in.-diameter pipe at the base to a 3-in.-diameter pipe at the top. The steel pipes were built in 20-ft sections and were engineered to slide into one another to make erection and disassembly easy. At each section of pipe, four ¼-in.-diameter tensioned guy-wires were attached to gusset plates welded to the steel pipes to provide the support for the steel spine. The steel was fabricated by AISC member fabricator R.C. Fabricators, Inc., in Wilmington.

Six levels of guy-wires were installed at quarter points to brace the steel for wind loads in any direction, for a total of 24 guy-wires in all. Four concrete mass anchors were cast into the ground 60 ft from the tower base to anchor the guy-wires. A concrete foundation was also cast at the base of the tower to support both the steel mast and 1,400 lb of Legos and provided the level surface on which to construct the tower. The tower was built in sections and placed around the steel mast so that it did not touch the mast at any location. Voids were left in the tower at the gusset plate locations to allow the guy-wires to connect to the steel mast without touching the tower. As wind blows on the tower, the structure will deflect until it makes contact with the steel pipes inside. These in turn resist the loads caused by the wind and prevent the tower from toppling. As the wind calms, the tower will restore to its original shape. The system was designed to withstand hurricane winds up to 90 miles per hour.

A representative with Guinness World Records certified the district's 112-ft, 11¾-in.-high tower as the tallest tower constructed of interlocking toy bricks in 2013, defeating the previous record of 106 ft, 7 in., which was achieved in Prague, Czech Republic.


Photos: Pennoni Associates

## COOL RING

# Elevating the Roundabout

BY CHRISTA VAN DEN BERG, IPV DELFT

Sprucing up a dull intersection is one thing. Turning it into an iconic gateway is a whole other story.

Such was the case with a typical four-point intersection on the outskirts of Eindhoven, Netherlands, which was transformed with the arrival of the Hovenring, a hovering cyclist roundabout with a 70-m-high (230 ft) steel pylon and 72-m-diameter (236 ft) deck.

The initial idea for the Hovenring came about when the city council realized that the existing intersection wouldn't be able to cope with the severe increase in traffic as a result of nearby urban housing developments. Eindhoven decided a grade-separated intersection was needed and asked us to look into possible options. Whatever the solution, it had to clearly portray the intersection as an important entrance to Eindhoven, Veldhoven and the new Meerhoven estate. Furthermore, the intersection needed to become a new landmark for the city, befitting both its identity as the City of Light (a title Eindhoven gained from the presence of the Philips company) and its motto "Leading in technology."

As soon as we came up with the design concept of a suspended cyclist roundabout, we had a very clear view of what the bridge should look like: little more than a thin circular bridge deck and a powerfully shaped pylon. During the engineering phase, we made it our goal to stay true to the concept and ensure every detail would enhance the total appearance of the Hovenring.

The bridge is comprised of a 230-ft-high steel pylon, 24 steel cables, a circular steel deck and a circular counterweight. The cables are attached to the inner side of the cyclist deck, right where it connects to the circular counterweight. Concrete inside both deck and counterweight ensure that the bridge is balanced.

The slimness of the deck is mainly the result of two things. First, the bridge deck has a multi-cell box structure; with ribs welded onto both upper and bottom steel plate every 332 mm (13 in.). This allows for the structure to be as slim as possible, and enables the deck to successfully withstand forces and deformation caused by nonuniform moving loads. This type of deck does require a large amount of welding but has significant structural benefits.

Helibeeld.nl

Henk Snaterse

## COOL PAD

# Tight Quarters

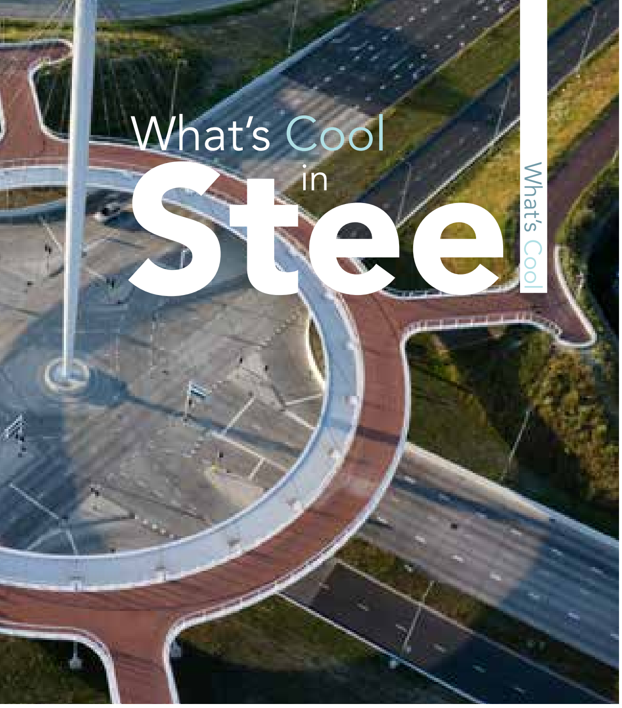
BY CEM SORGUÇ, CM ARCHITECTURE

Sometimes it's a matter of building where there's room. NoXX Apartment is located in a narrow dead end in Cihangir, Istanbul,Turkey. Due to the project's tight location on a 128-sq.-m site (1,378-sq.-ft) and the short construction time frame, steel was used to bring it to life. The seven-unit building evokes an industrial sensibility and pays homage to the early 20th century buildings that are typical of the area; the flats are 66 to 70 sq. m (646 to 753 sq. ft) each.

The underground levels of the building use reinforced concrete while the upper levels are framed with steel. The framing is left visible on purpose, and no plaster, paint or any cladding materials are used on the inside or the exterior. The primary beams and columns are HEA 300 and HEB 360, respectively; the secondary beams are IPE 300-IPE 240 and the cross-system members are 200×200×10. The project uses 80 tons of steel.

The building is immediately adjacent to an existing building on one side, and the façade on the other side had to be a blind wall as well, according to local regulations. This blind façade is composed of steel framing with insulation materials in between and brick walls on both sides. The custom-made bricks are designed to be placed unevenly on the façade in a natural pattern, giving different linear shades at different times of day. The front and rear façades were designed to be as wide as possible to maximize daylighting.

Photos: Cemal Emden



Second, we designed a freestanding steel structure to support overhead road signs and also function as a series of anti-collision portals. In case of an accidental collision, these portals are much easier to replace or repair than the bridge itself, and at a much lower cost.

To be structurally sound, the bridge needed stabilizing supports. We wanted those to be as subtle as possible and therefore designed custom-made M-shaped supports, comprising two slender cigar-shaped compression rods placed in a V shape and two prestressed tension rods on the outside. The compression rods are solid steel because of the significant forces they have to withstand and also because of their relatively greater length. Their shape is similar to that of the much larger central pylon.

The cable anchorage is another element that we didn't want to detract from the bridge's iconic appearance. At the pylon top, we used conical sockets, which are partially inside the pylon. As room was limited on the pylon surface, the stay cables have been attached in two separate rows, allowing room for anchorage inspection inside the pylon. A similar method was used to attach the cables to the bridge deck, where a tailor-made cover ensures watertight anchorage.

Both the counterweight and bridge deck were constructed at the Victor Buyck Steel Construction factory in Belgium in 12 different 16-m (52.5-m) sections, then transported to Eindhoven by boat; the same went for the four approach spans. On-site, all sections were assembled on temporary supports and then welded together. To save time, all sections were welded simultaneously by several groups of steelworkers.

The pylon was transported to the Hovenring site in two sections, which were welded together whilst lying horizontally underneath the circular deck. At that time, the deck was already fully assembled, which meant the pylon could be anchored to the circular deck and onto its M-shaped supports right away, after which the temporary supports could be removed.

The appearance of the Hovenring is further enhanced by an integrated lighting design. There is LED lighting inside the railings, which illuminates both deck and cyclists. The pylon is carefully illuminated by various uplighters, and the main lighting element is within the circular deck, in between the bridge deck and counterweight. Both the top and bottom of this in-between space are fitted with aluminium lamellas and translucent sheeting, and the tube lighting inside creates a surface of light.

COOL BELLS

# Ringing True

BY MARK BRAEKEVELT, P.E., IDEAL CONTRACTING

Photos courtesy of Mark Braekevelt

Oakland University in Rochester, Mich., recently received a musical new centerpiece. Paid for entirely with a donation from prominent alumni the Elliot Family, a new Carillon tower—complete with 49 bells cast in the Netherlands, clocks on four faces and a titanium roof—now anchors the campus.

AISC member erector Ideal Contracting was brought in early to work directly with construction manager Barton Malow, architect Niagara-Murano and structural engineer Desai-Nasr. Multiple aspects were taken into consideration including constructability, modular construction capability and future bell installation and maintenance. After working through each of these concerns, the final framing plans and elevations met all of these considerations, and within the original budget.

While the footprint is only 25 ft square, the structure is 150 ft tall; if ever a project wanted to be modular-built on the ground, this was it. Working hand in hand with the design team, the steel framing plans and elevations were all designed with preassembly in mind. With four different steel floor levels, each was designed accordingly and completely shop assembled. While each level was delivered on low-boy trailers at a sloping angle, making for over-wide shipments, the strategy turned out to be very cost-effective.

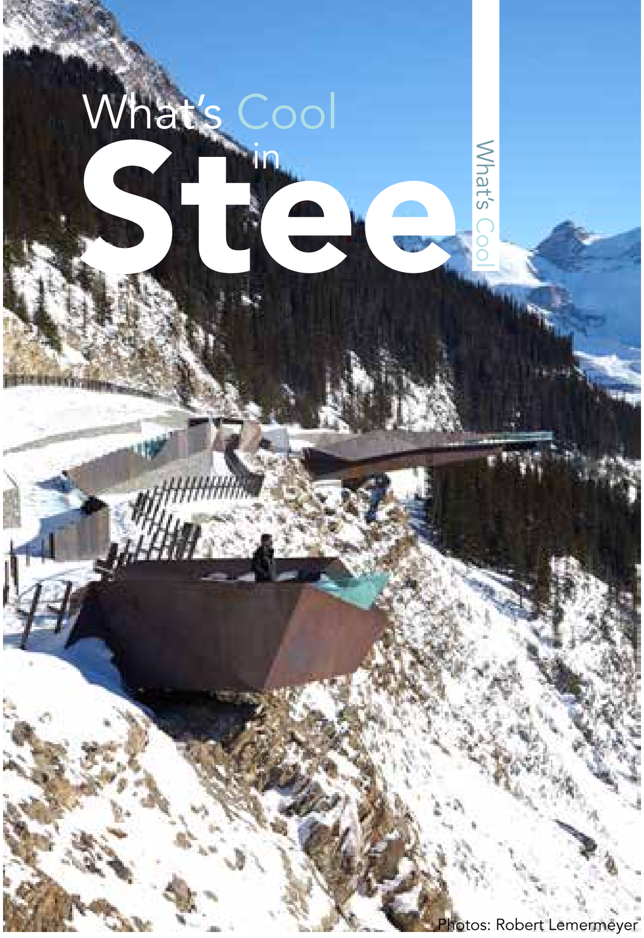
For the top third of the structure, Ideal assembled posts and vertical bracing to the floors before hoisting. Installing the bells after the structure was erected was of major concern to the owner. Install them too early and later construction damage becomes an issue. Install them too late and the means-methods become cost-prohibitive; the largest bell weighs 2.5 tons and is 5 ft in diameter! (The total weight of all the bells is over 15 tons.)

With Ideal's participation, the steel elevation bracing design took this into consideration and used a diamond-shaped vertical bracing layout as opposed to a traditional X-bracing layout. This made plumbing the structure a little trickier but allowed for a larger open wall space at the bell chamber area. Without this consideration taking place in the first stages of the project design, bell installation would not have been possible.

The architect and owner really wanted to use something dramatic for the roof finishes and decided on titanium shingles. Not only is the material itself expensive, but the installation labor is very time-consuming. Add in the fact that it all ends up 150 ft off the ground on a very steep sloped roof, and ground assembly clearly became the best choice. With Ideal's input, the design team came up with a roof structure that could be a standalone, preassembled rigid structure, which allowed all the shingles to be attached on the ground.

The final lifting procedure for the roof was also taken into consideration in the early design stages. A few options were considered, including leaving a small hole through the top peak for rigging attachments or setting it in halves. Ultimately we all decided that lifting from the bottom was the way to go. Typically it's best to rig an object from above its center of gravity for obvious reasons, so lifting from the bottom becomes an immediate safety concern. In this case, given that the titanium shingles were $150 per sq. ft and extremely labor-intensive, doing whatever we could to eliminate all shingle work in the air was very important.

Ideal assembled the steel structure on the ground earlier than needed so that the specialty roof contractor could install the titanium shingles and finishes (which took about six weeks). Temporary outrigger attachments at the bottom of the roof were part of the basic design from the start of the shop drawing phase. The means-methods of the outrigger removals was as much of a consideration as anything, to ensure that the shingles wouldn't be damaged.



Photos: Robert Lemermeyer

COOL WALKWAY

# Living on the Edge

BY TANYA KENNEDY FLOOD, READ JONES CHRISTOFFERSEN

Glacier Skywalk is one of those engineering feats that takes your breath away—mostly because it places you 280 m (919 ft) above Jasper National Park's (Canada) Sunwapta Valley.

The 30-m (98-ft) curved glass walkway extends 35 m (115 ft) from the cliff face and features interpretive stations to engage and educate visitors about the Skywalk's glacial home in the mountains. By cantilevering the structure, prime consultant and structural engineer Read Jones Christoffersen, Ltd. (RJC), was able to give owner Brewster Travel Canada (Brewster) the thrilling experience it wanted for visitors.

Brewster wanted to create an experience that would connect guests with the natural environment and provide them with an opportunity to view the Sunwapta Falls in Canada's Rocky Mountains and enjoy the beauty of Jasper National Park. The site that they provided was the side of a cliff along the side of a highway, and it was important for the design to maximize the impact of the site while respecting the natural environment.

The project team—RJC, Sturgess Architecture and PCL Construction Management—wanted to push the sense of exposure and therefore decided that the best way to approach this would be to construct a glass-floored walk area.

When considering the best structural system to use, it was critical that it could respond to the surrounding environment, and as such the team opted not to go with a high-tech cable-stayed system, but rather to cantilever the structure. This offered the advantage of not having to perform work down the face of the cliff and also minimized the amount of visible structure.

When contemplating which materials and construction methods would be most appropriate, RJC considered the local site restrictions, the importance of blending the structure into the natural surroundings, long-term durability and ongoing maintenance requirements, budgetary considerations and a rapid construction schedule.

Structural steel was identified as the best option, provided that durability and maintenance concerns could be addressed. Weathering steel was selected because as it rusts, it forms a protective layer over itself, preventing further corrosion of the steel. The result is a steel product that can be left exposed to the elements—and in the case of this project the color of the weathering steel would blend in naturally with the surrounding geology.

The steel for the main structure is further enhanced by the sensitive addition of a weathering steel plate. These plates give an irregular, angular appearance to the platform and disguise the more pragmatic-looking structural girders. The steel sheets serve to further promote the Skywalk as an extension of the existing landscape as opposed to an imposition. This theme is carried along the project length and incorporated into elements along the cliff-edge walkway and throughout the interpretive stations.

Glacier Skywalk opened to the public on May 1. Visitors say that the view through the glass floor is amazing and a little scary—exactly as it was intended to be.



COOL ENCLOSURE

## Behind the Wall

BY KRISTOFER NONN AND DAVID EWANOWSKI, AIA, KEE ARCHITECTURE

The Capitol Heating and Power Plant in Madison, Wisc., is a typical plant with an atypical enclosure.

Originally built in 1908 to provide steam and electricity to the State Capitol, it has undergone numerous renovations and additions over the past century to increase its capacity and output as other buildings were brought onto the system. The most recent renovation converted the plant solely to natural gas, eliminating coal as a fuel source, and included the addition of a one-million-gallon thermal energy storage (TES) water tank that stores chilled water generated by electric chillers during off-peak hours for subsequent distribution and use during peak hours.

Enclosing the TES tank is a 35-ft-tall weathering steel and sand-blasted concrete wall. In addition to protecting the tank, it also presents a more attractive appearance to its neighbors than the bare tank would have provided—a major concern to the state, city and adjacent property owners, all of whom anticipate further development in the area. The wall was designed by KEE Architecture, Inc., with Miron Construction acting as the general contractor.

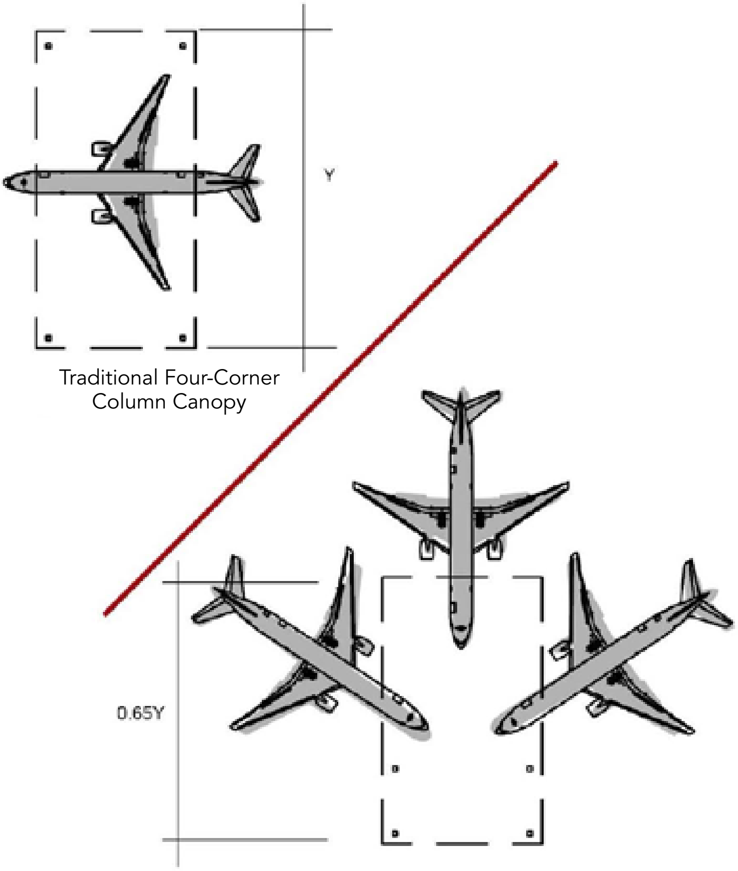
The shape and configuration of the screen wall respond to the strong round form of the massive TES tank. Its design considers the history and context of the power plant as well as the surrounding industrial downtown neighborhood, with visceral and self-finishing materials being used in all cases. The design references and echoes the proportions, composition and materials of the original power plant to which it is attached. It was also inspired by the rhythmic repetition of piano keys.

Vertical weathering steel "ribbons" are supported on a structure of W21×111 columns on the primary radial grid lines, with intermediate W8×28 columns carrying the horizontal girts. The girts are rolled curved W6×9s at 5-ft vertical spacing. Made from A588 weathering steel—an authentic no-maintenance material—the wall will grow in depth and character over time to integrate itself into its industrial context; the naturally rusting metal will develop a patina and color that relate to the brick and terra cotta materials of the original plant.

Photos: Kristofer Nonn – KEE Architecture

The ribbon pattern consists of nine unique profiles repeated around the structure. Each of the 270 ribbons is a 10-in.-wide by 24-ft-long strip, cut from ¼-in.-thick coil stock, with shop-welded stand-offs of prescribed lengths fastened back to the curved horizontal girts. Fabricated as flat panels, ribbons were warped as they were erected by hanging each one individually and progressively bolting the stand-offs to tabs on the wide-flange girts from the bottom to the top. This allowed all of the ribbons to be installed in five days and required no special rolling or other custom fabrication techniques. The top of the concrete wall has an inward-pitched profile that directs any rust-containing runoff from the weathering steel to the interior face of the wall, preventing staining of the visible exterior face.

Photos: Nina Lauren Photography




Traditional Four-Corner Column Canopy

Cable-Stayed Canopy

COOL CANOPY

# Grounded in Miami

BY WILL BRASWELL, S.E., P.E., BBM STRUCTURAL ENGINEERS, AND DANIEL C. LAGGAN, AIA, SCHENKELSHULTZ ARCHITECTURE

The nearly century-old Opa-Locka Airport has a rather exciting history. It is the place where Amelia Earhart began her quest to circle the world before her disappearance and also where Barrington Irving, the first and youngest African American pilot to complete the circumnavigation, began and ended his journey. From there it has served as a U.S. Naval Base as well as the CIA headquarters for covert operations in Latin America.

Today, it is currently known as the Opa-Locka Executive Airport. Its historic value has been preserved with the designation of a historic district within the confines of the property. The airport has seen a recent upgrade (designed by SchenkelShultz Architecture and built by Moss and Associates), which includes a new fixed-based operator (FBO) terminal, two 40,000-sq.-ft hangars, 20,000 sq. ft of tenant shops and offices and new landside parking and landscaping to support the new buildings.

One of the project's key elements is the new airside canopy for the FBO terminal. The design team proposed a cable-stayed design, instead of the traditional four-column configuration, that reduced the canopy size by 35% while increasing operational efficiency to allow three aircrafts to be serviced (all nose-in) at once rather than one at a time. This simple concept also allowed increased circulation around the canopy to maximize aircraft staging.

The design team turned to the bridge industry, which commonly uses cables for suspension and cable-stayed bridge spans, to provide support for the 85-ft-by-85-ft cable-stayed canopy (designed by BBM Structural Engineers, with VSL providing the cables). This presented a challenge in harmoniously tying ultra-high-strength bridge cables to traditional building steel within the horizontal canopy plate. The cables are composed of (19) 0.6-in.-diameter, seven-wire steel strands that have a tensile strength of 270 ksi. Combined, they provide an ultimate tensile capacity for each cable of over 1,100,000 lb. The back-span is made of concrete and the main span is steel, and these were designed as such to both maximize overturning resistance and minimize overturning forces respectively. The clevis plates were fabricated from 4-in.-thick 90-ksi steel that was shop welded to 50-ksi steel beams (steel was fabricated by AISC member Steel Fabricators, LLC).

The disparity between the two steel strengths precluded using standard welding procedures—as joining these two types is a relatively new practice—and required the fabricator's welders to obtain a Procedure Qualification Record (PQR) certification. They were required to perform test welds under the scrutiny of an examiner, and not until passing the exam were the welders allowed to work on the actual pieces required to connect the cables.

COOL ENTRANCE

# Urban Waterfall

BY MARTIN DESPANG, DIPL.ING., UNIVERSITY OF HAWAII

Since the beginning of urban mass transit, a major emphasis has been put on entrances—especially to subways.

According to New York's Museum of Modern Art, "The Parisian architect and designer Hector Guimard was commissioned to make the 1899 Entrance Gate to Paris Subway (Métropolitain) Station not only to mark an entry to the new Paris Métro, but also to help make this new mode of transportation appealing to Parisians…the Art Nouveau aesthetic was unfamiliar to the masses, yet they soon grew to appreciate this new style previously known only by the wealthy."

The city of Bochum, Germany, situated in a large population center that includes Dortmund, had its subway exits/entrances equipped with escalators that, due to being open to the elements, ended up causing immense maintenance costs. As such, the city decided to invest in rain-sheltering canopies. In the above-mentioned tradition of Paris and other cities with artistic, enticing subway entrances, Bochum decided to have architects (as opposed to engineers) come up with design concepts for the canopies and launched a national competition—which architect Despang Architekten won. The two matching canopies are at the city's Schauspielhaus Station.

The city's main design factor was of a very pragmatic nature; the structure would need to be able to withstand the impact of a truck crashing into the canopies. In investigating the best options for meeting this criteria, the architect, as well as the structural engineer and steel contractor, concluded that instead of using several large columns, the requirements could be equally met by using several smaller steel members—a route that also allowed for a lighter design that offers a smooth transition when emerging from underground. The traveler's eye, coming out of the dark underground, gradually adjusts to the bright outside by the 50% opacity of the 60-mm-wide (2.36-in.) HSS lattice and equally sized voids in between. The main intent of the structure, to shelter the escalators and stairs from rain and snow, is provided by glass on top of the horizontal, and inside of the vertical, lattice.

In addition, the white final finishing powder coating over the galvanized steel serves as a reflector and diffuser for the daylight and light trough at the bottom of the structure. With the flanks of the wall and roof lattice being coated in blue (the color of the city and the area's public transport system), way-finding is enhanced. And the subtle glow created by the light bouncing off the blue and white surfaces, under the curtain of rain running off the roof glass edge, creates the image of an urban waterfall. ■

Photos: Olaf Baumann/Hannover