A new elevated pathway provides safe passage for pedestrians and cyclists near one of the Windy City's premier tourist destinations.

The BACKBONE of the Lakefront Trail

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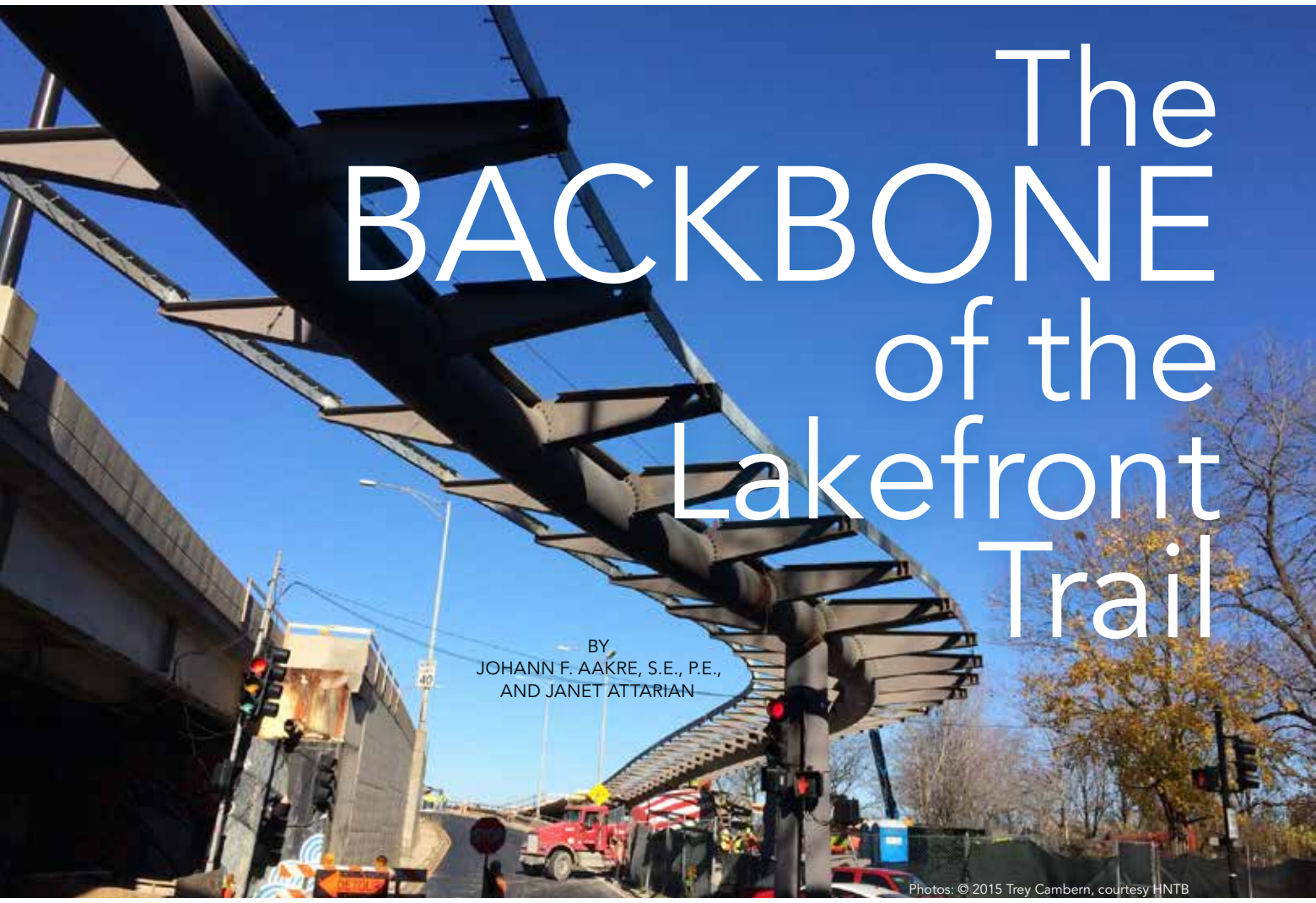

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CHICAGO'S LAKEFRONT TRAIL is a popular cycling, walking and running venue for residents and tourists alike.

The 1,750-ft-long, $60 million "Navy Pier Flyover" now under construction as part of Mayor Rahm Emanuel's "Building a New Chicago" program will eventually relieve congestion along the most heavily used section of the 18.5-mile trail.

Site constraints and limited clearances created by a parking garage, a residential high-rise, local streets, highway access ramps and several parks, a serpentine alignment was essentially the only option for the grade-separated pathway. Aesthetics were equally as important as functionality because the flyover will be visible from every angle in a highly visible part of the city. A dramatic steel spine-rib superstructure support system became the essential component that helped the team achieve objectives of both form and function.

Construction is being executed in three phases: The first, northern phase is between Jane Addams Park and Ogden Slip; the second stretches from this slip to the Chicago River; and the third phase will span the river by modifying the path on the Lake Shore Drive bridge. Construction of the supporting steel superstructure for phase 1 is now finished as the $27.9 million first segment nears completion.

Eliminating a Bottleneck

With 60,000 users traversing this segment of the Lakefront Trail during peak use, in the late 1990s the Chicago Department of Transportation (CDOT) began looking at ways to alleviate the bottleneck created when trail users crossed paths with pedestrians on city streets, local vehicle traffic and highway entrance ramps. All of this congestion, combined with missing or deteriorated pavement markings, lack of way-finding signage and poor trail surface conditions were contributing to frequent accidents.

In 2003, HNTB began working with CDOT and Muller and Muller Architects to develop a bridge configuration that was functional, aesthetically pleasing and contextually appropriate. The overriding objective for the new path was to separate shared crossing points between pedestrians and vehicles at Illinois Street and Grand Avenue, the heavily congested (not to

mention only) entry and exit streets to the Navy Pier facilities.

Initially, finding a viable path for the structure was the most formidable challenge. In one area, the partial removal of the east shoulder of upper Lake Shore Drive was deemed necessary to squeeze the elevated path between it and Lake Point Tower, an iconic residential high-rise. Given the proximity of the path to the 70-story condominium tower—there will be only 9 in. separating them—concessions were made with residents to erect a mesh screen wall between the structures for added security.

In another section, the path alignment had to be shifted across the currently undeveloped DuSable Park, designated as a Superfund site by the U.S. Environmental Protection Agency because of radioactive thorium nitrate present in fill material placed in the early 1900s. To minimize the need for soil remediation at flyover support columns, HNTB used minimally invasive steel H-pile foundations.

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A Flexible Spine

Tasked with designing a serpentine structure that would be practical, structurally sound and visually appealing, HNTB incorporated the use of an easily manipulated, central steel spine. The longitudinal spine-rib support system accommodates the complex bridge's need to curve both horizontally and vertically and provides the desired aesthetics.

The bridge's central spine is fabricated from 30-in.-diameter steel pipe, either 1¼ in. or 1¾ in. thick depending upon span and strength requirements. A T-shaped web and flange are welded on top of the pipe to provide added strength and a surface for shear studs, which enable composite action between the steel and the path's 6-in.-thick, 17-ft, 10-in.-wide concrete deck. For Phases 1 and 2, nearly 350 tons of API 2B steel pipe will be used in the spine.

The size of the pipe combined with the serpentine alignment did come with a challenge. Since the project is federally funded, the steel needed to meet Buy America provisions and most pipe of this size and thickness is produced overseas. In discussions with fabricators and the steel industry, it was determined that the pipe could be produced domestically in accordance with API 2B specifications, which is for pipe manufactured from plate that is rolled into cans and then longitudinally welded.

Rib elements, fabricated from steel plates, are connected to each side of the steel spine on 8-ft centers, tapering in

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depth from approximately 2 ft, 2 in. at the central spine to less than 5 in. at the outer deck edge to create a sleek, graceful appearance. A longitudinal steel channel, running parallel to the steel pipe spine, is bolted to the ends of the steel ribs to facilitate construction of the deck and to support the path railing.

The design uses the frame action created by the spine-column rigid connection. This not only controls in-plane bending, but also resists out of plan bending and torsion in the spine. As such, the analysis considered the column supports of the structure, rather than treating the superstructure as a continuous beam supported atop various piers. Thermal range was also factored into the design, requiring the development of unique expansion bearing and column connections. In one location, where the spine is supported on Lake Shore Drive itself, a dapped connection was inserted into the spine so that its thermal displacements would act in conjunction with the Lake Shore Drive Bridge. At this location and at the expansion piers, the spine is supported by low-profile disc bearings, serving to maximize the amount of steel pipe available to carry the forces at the bridge supports.

Connections between the steel elements of this unique structure also came with a set of challenges. The connections needed to fit within the aesthetic constraints of the project and custom details were developed. Where possible, AISC design guidelines for HSS connections and CIDECT publications were used as resources. In some cases, however, refined 3D finite element models were relied upon where the details did not fit entirely within the context of the code.

Steel Substructure and Foundation

The steel spine is supported by steel columns created from 1¼-in. steel plate bent into a 30-in. by 22-in. elliptical shape along the main alignment and by cantilevered concrete abutments at its ends. At three locations, the path is supported directly from the existing bents of Lake Shore Drive. The elliptical column extends 2 ft below the bottom of the spine before separating into two half-elliptical column legs that splay apart to create a wider base for additional stability. This arrangement was devised to provide an aesthetically continuous and pleasing transition between the bridge elements.

The foundation system is primarily comprised of steel piles driven to 50-ton capacity and embedded into a 3-ft, 3-inch-thick rein-

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▲ ▼ The bridge's central spine is fabricated from 30-in.-diameter steel pipe, either 1¼ in. or 1¾ in. thick depending upon span and strength requirements.

▲ A full-scale mockup of the spine, deck and railings was constructed on-site to refine the details.

▼ The path will come as close as 9 in. to an adjacent 70-story residential high-rise.

Steel plate rib elements are connected to each side of the steel spine on 8-ft centers, tapering in depth from approximately 2 ft, 2 in. at the central spine to less than 5 in. at the outer deck edge.

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forced concrete cap. Steel piling was selected as the preferred foundation type since it minimized the amount of excavation and spoils, especially necessary when working at the Superfund site.

Attention to Detail

All details were highly scrutinized to ensure that the desired function and look would be achieved. Architectural cable steel railings and panels and custom steel deck nosings were incorporated into the design. In addition, the paint system is not the typical zinc/epoxy/urethane system used on highway bridges, but rather a three-coat system comprised of a primer, an intermediate coat and a fluoropolymer finish coat. Typically used on building applications, this system is highly durable and provides enhanced color and finish retention.

Highlighting these details is a comprehensive LED lighting system that will illuminate the ribs, spine and columns from below and will shine down from the cable railing posts above. Most conduits for lighting power supply are embedded in the concrete curb or are enclosed within the steel elliptical column sections. Drainage downspouts were custom detailed to follow the path of the ribs and columns to integrate with the structure. A ⅜-in.-thick stainless steel curb cover plate extends along the deck edges to provide a uniform shape and enhanced appearance. To ensure that all details were worked out during construction, the contractor created a full-scale mock-up before starting full production.

When all three phases are complete in 2018, the elevated pathway will significantly improve this key segment of the Lakefront Trail, safely guiding pedestrians and cyclists through one of the most heavily trafficked regions of the city. By maneuvering the path through a 3D obstacle course of existing structures, the pathway's steel spine system has proven itself to be up to the challenge. ■

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Chicago Department of Transportation (primary), Chicago Park District, Illinois Department of Transportation

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Erection Engineer
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Steel Fabricator
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