Rhomberg Avenue Bridge

Upper Bee Branch Creek Restoration Project bridges community, creativity, and collaboration

by Michael A. Jansen, IIW P.C.

When the city of Dubuque, Iowa, launched its flood mitigation project—the largest capital improvement project in the city's history—residents and the city focused on how a watershed solution could also serve as a catalyst for neighborhood reinvestment and revitalization. Through many public meetings, it became clear residents were not only concerned about eliminating devastating flooding, but they wanted amenities that would support a sustainable neighborhood with enhanced quality of life. This flood mitigation project will protect over 1300 homes and businesses. The project has the added value of improving water quality and property values, stimulating investment, and enhancing quality of life.

The Bee Branch Creek Restoration project takes former industrial, commercial, and residential properties and creates an open waterway with a linear park—complemented by a highly visible bridge, culvert, and overlook structures, recreation green space and trail, outdoor amphitheater, community orchard, and playground equipment.

The Lower Bee Branch Creek segment includes a channel connected to a large expanse of open water that wraps around a former industrial site. Construction of the Lower Bee Branch Creek started in the fall of 2010 and was completed in November of 2011. The Upper Bee Branch Creek segment, currently under construction, will have a 2300-ft-long landscaped creek and green space that accommodates low intensity recreational use.

Community Expectations

In August 2003, the Dubuque City Council formed a committee to study the flooding issues in the North End and Washington Street neighborhoods. To help the committee evaluate solutions, they established six criteria, including preservation of local businesses and services, minimization of property acquisitions, affordability, preservation of neighborhood access and connectivity, minimize health and safety risks, and minimize impacts to quality of life and the environment. The city council moved forward with the recommendation to create an open channel by day-lighting the Bee Branch Creek.

In the fall of 2008, the design for the Bee Branch Creek Restoration was initiated. In order to understand the community's vision for the project, the design team held a series of

Completed Rhomberg Avenue Bridge. All Photos and Figures: IIW P.C.

profile

RHOMBERG AVENUE BRIDGE / DUBUQUE, IOWA

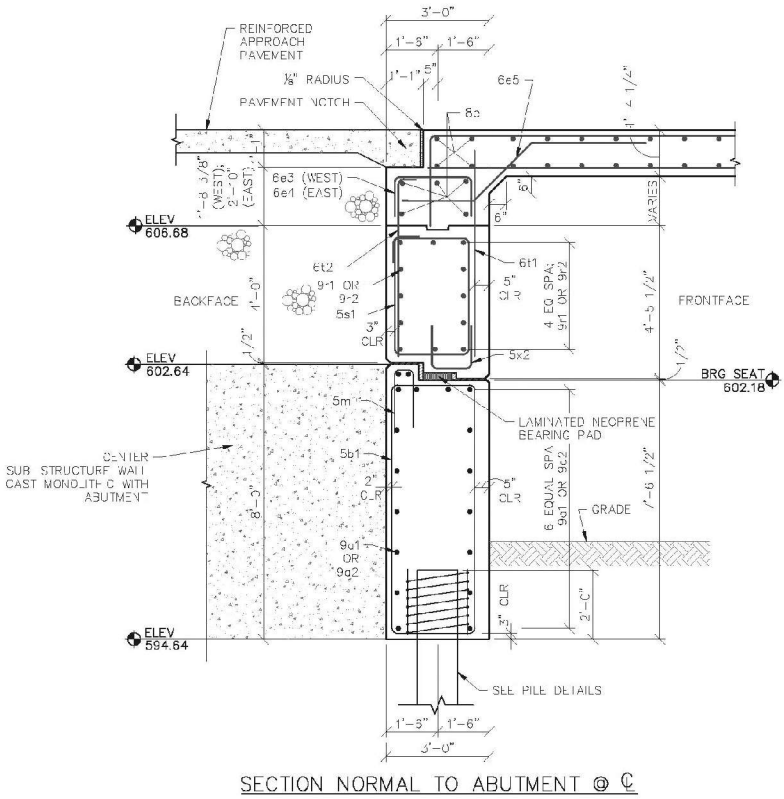
BRIDGE DESIGN ENGINEER: IIW P.C., Dubuque, Iowa

PRIME CONTRACTOR: Tricon Construction, Dubuque, Iowa

BRIDGE SUBCONTRACTOR: Jim Schroeder Construction, Bellevue, Iowa

STAMPING SUBCONTRACTOR: D&D Superior Concrete Construction, Dubuque, Iowa

PRECASTER: Crest Precast Inc., LaCrescent, Minn.—a PCI-certified producer



Rhomberg Avenue Bridge abutment detail.

three public workshops. The public workshops included visual preference exercises using photographs to illustrate bridge structure types, shapes, and materials. The Keystone Bridge, a historic stone arch bridge in Elkader, Iowa, was overwhelmingly recommended by the public.

As the design was developed, three-dimensional modeling and animation were utilized to help residents and the city visualize several alternatives, and detail the various project components. This provided an authentic understanding of the project's impact, allowing for important input prior to finalizing the design.

Design Aspects

The geometry of the bridges for the Bee Branch Creek Restoration project was driven by their core purpose to provide vehicular and pedestrian passage over the waterway and storm water conveyance. The bridges over the Upper Bee Branch Creek span the flowing creek with approximately 16 ft of water surface elevation change while providing horizontal and vertical clearance for a multi-use recreational trail beneath one of the end spans. The bridge profile was based on the existing street profile due to limited approach lengths.

The superstructure cross section was influenced by multi-transportation modes and provided a gradual transition and fit to the two lane urban street.

The Rhomberg Avenue Bridge, one of four bridges making up the Bee Branch Creek Restoration project, is a 90- by 45-ft, 3-span (27.5-35-27.5 ft), 0° skew, continuous cast-in-place concrete slab bridge. The superstructure cross section was influenced by multi-transportation modes and provided a gradual transition and fit to the two lane urban street. A raised, cantilevered sidewalk was incorporated with an 8-in. curb adjacent to the bike lane and traffic corridor.

The gravity and lateral design parameters were based on the sixth edition of American Association of State Highway and Transportation Officials' *AASHTO LRFD Bridge Design Specifications*, including HL-93 criteria and a future wearing surface. Flowing water velocities were relatively low at about 7 ft/s, primarily due to the low stream slope (0.5%).

Driven concrete-filled steel pipe (14 in. diameter by 0.375 in. thickness) displacement piles were utilized due to the depth to bedrock of

CITY OF DUBUQUE, OWNER

PRIME CONSULTANT: Strand & Associates, Madison, Wis.

LANDSCAPE ARCHITECT: Ken Saiki Design, Madison, Wis.

GEOTECHNICAL ENGINEER: Allender Butzke Engineers, Urbandale, Iowa

BRIDGE DESCRIPTION: A 90- by 45-ft, 3-span (27.5-35-27.5 ft) 0° skew, continuous cast-in-place concrete slab

STRUCTURAL COMPONENTS: A 16¼-in.-thick reinforced cast-in-place concrete slab with 3-ft-thick abutments with expansion bearings, and pile bent fixed bearing piers with fully encased piles; six precast concrete arch façade panels coupled with cast-in-place decorative piers and curved planters incorporating formliners and multi-color stain; Texas classic crash tested barrier rail system and custom railing panels/light pole bases.

BRIDGE CONSTRUCTION COST: $1,426,040 (includes substructure, superstructure, arch surface treatment, precast panels, railing, planters, and approaches)

Rhomberg Avenue Bridge creates a gateway experience.

approximately 200 ft, and presence of fine to coarse sands with standard penetration test (SPT) blows per foot ranging from about 10 to 15 through the majority of the driven pile length. The nominal axial bearing resistance for construction control was determined from a noncohesive soil classification and a geotechnical resistance factor of 0.55. The required nominal axial bearing resistance was 127 tons for the abutment piles, and 120 tons for the pier piles at the end of pile driving, which required a wave equation analysis for pile driving (WEAP) with bearing graph.

Pile bent fixed bearing piers (45 ft wide, 19 ft high, and 2 ft thick) with fully encased piles and a 3-ft-high pier cap were utilized to minimize debris accumulation and provide superior in-plane lateral load resistance. The pier height was driven by the "low flow" channel beneath the center span and calculated scour depths, placing the bottom of pier approximately 3.5 ft below the channel bottom.

High abutments were provided for stormwater conveyance and underpass trail clearance requiring a unique application of an integral slab/abutment with expansion bearing for the upper portion and creating cells integral with the planter substructure for the lower 8 ft of the abutment to resist lateral forces similar to a deadman. An analysis was performed of the slab/abutment load transfer as well as a soil-structure interaction analysis on the deadman cells to determine reinforcing requirements.

The Upper Bee Branch Creek bridges were seen as an opportunity to create a gateway experience for travelers.

The Upper Bee Branch Creek bridges were seen as an opportunity to create a gateway experience for travelers at the street level and to send a message that they were entering something unique and special. This was the driving force behind incorporating planters with pedestrian viewing and seating areas and open railings. The bridge elevations required a high attention to detail, heavily influenced by strong, predominantly horizontal lines while recognizing the longitudinal street profile and adapting to the level lines of the formliners.

Creative application of a Texas Classic open barrier rail system and custom railing panels embossed with the street name were incorporated. A Test Level Two (TL-2) crash tested railing was selected based on a local street, vehicle type/frequency, and design speed. Innovative precast concrete façade panel enhancements, to give the illusion of a series of limestone arches, were important features to satisfy the public workshop visual preferences. The precast concrete panels have gravity and lateral support at the substructure. Lateral support at the top is provided by the sidewalk, which cantilevers over the precast concrete panels to conceal and protect the top connection while maintaining independence for deflection and expansion/contraction.

Formliner selection and color were critical to emulate native Dubuque limestone. A 12 in. cut limestone pattern was used for support/base elements, while a smaller random ashlar pattern was selected for the precast concrete panels compatible with the massing. Since both cast-in-place and precast concrete elements were used, field application of a custom water-based multi-color stain was used to provide a consistent appearance. The barrier railing was coated with a solvent-based, single-color stain due to more aggressive service conditions of salt, moisture, and sunlight on the horizontal and vertical surfaces.

It was recognized the stain will require periodic maintenance. However the bridge service life will likely extend into the next century due to the durability of continuous concrete slabs, incorporation of Iowa Department of Transportation (IowaDOT) concrete mixtures, and utilization of epoxy-coated reinforcement.

Construction Sequencing

The Rhomberg Avenue Bridge was located within 50 ft of a historic structure. Therefore, vibration due to pile driving was a concern. A preconstruction analysis based on information from the National Highway Institute and the IowaDOT revealed peak particle velocities with the potential for damage to the existing structures to warrant a heightened monitoring protocol. This included a condition assessment, real-time vibration monitors, crack gauges, and survey monitoring. At completion of the bridge construction in the summer

Superstructure under construction.

Formliner used on inside and outside corners.

of 2016, no movements were detected nor any other adverse effects to the existing buildings.

The majority of the structure was designed and constructed as a typical IowaDOT continuous concrete slab bridge. The contractor was able to utilize their standard forms and falsework and complete the core substructure and superstructure elements efficiently.

Just as attention to detail was important in the design, it was even more important during construction. Careful selection of construction joint locations in the design were important to recognize the expansion/contraction requirements. Constructability, coupled with aesthetic considerations, influenced the field-approved construction joint locations. Irregular formliner surfaces required close attention to the quality of outside corners, and especially inside corners, which were more difficult.

The Rhomberg Avenue Bridge was completed in the summer of 2016. This bridge, along with this entire urban revitalization project, is a superb example of understanding expectations, paying attention to detail, and collaborating to meet performance criteria and contribute to quality of life with the built environment.

Michael A. Jansen is chief executive officer and principal civil & structural engineer at IIW P.C. in Dubuque, Iowa.