North Avenue Bridge Reconstruction Over Chicago River

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Summary

This $21.4 million project involved the removal of an inoperable bascule bridge carrying North Avenue over the Chicago River and constructing a wider, fixed span structure at the same location. The new bridge has a 252-ft main span and two 84-ft back spans. A hybrid structural system was selected for the new structure in order to meet various geometric and clearance constraints, to provide for future utilization of the river banks adjacent to the structure, and to provide for an aesthetic structure. The hybrid structural system consists of a combination of a self-anchored suspension bridge and cable-stayed bridge. The design will serve as a good opportunity to study the behavior of such a unique structural system and provide valuable knowledge for its future applications in long span bridges. The construction of this bridge was completed in December 2007.

Keywords: hybrid; cable-stayed; self-anchored suspension bridge; post-tensioned HPC deck; reconstruction.

1. Project Description

This $21.4 million project consisted of removing the existing, inoperable bascule bridge, located at approximately 3 miles northwest of Chicago's Central Business District, and constructing a wider, fixed span bridge in the same location. Portions of the east and west roadway approaches were reconstructed, and street appurtenances were upgraded. The project improved four major deficiencies: bridge condition, roadway geometrics, traffic flow, and safety considerations. The new bridge also provides pleasing aesthetics in this highly urbanized location.

2. New Bridge Structure

The new bridge structure is 81-feet wide and 420-feet long. The structure has a 252-feet long main span over the Chicago River and two 84-foot long back-spans. The bridge has a 50-feet wide roadway, measured curb-to-curb, matching the existing roadway width along North Avenue, and carries two lanes of traffic in each direction. Sidewalks are provided along each side of the new bridge.

The selected structural form for the new bridge is a hybrid system, a combination of a self-anchored suspension bridge and a cable- stayed bridge. Between the quarter points of the center span, the

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bridge is supported by a suspension system comprised of a catenary cable and pairs of vertical hangers. The remainder of the center span is supported by both the suspension system and inclined cable stays. The back-spans are supported only by cable stays.

The construction of the new bridge is completed in December 2007, and opened to traffic (Figure 1).

Fig. 1: New North Avenue Bridge. (Courtesy of J. McHugh Construction, Chicago, IL)

The following factors played a role in the adoption of such a structural form:

- The City of Chicago decided to replace the existing structure with an aesthetically pleasing signature bridge for the community.
- Vertical navigational clearance requirements and site constraints limit the superstructure depth to no more than 3'-10", which translates to a span-to-depth ratio of 66.
- One of the ultimate goals is to achieve harmony with the surroundings. Pylons of a pure cable-stayed bridge would be too high for this location based on aesthetic concerns. The use of a hybrid structural system enabled a reduced pylon height.
- The weak mechanical properties of the existing soil and the high number of utilities at both banks of the river favored a self-anchored suspension system.

The new deck consists of cast-in-place High Performance Concrete (HPC) that is longitudinally post-tensioned, providing a crack free deck design and reducing long-term maintenance costs. The deck is supported by tapered, transverse steel box beams, spaced 21-feet on center to match the hanger and stay spacing.

The pylons supporting the suspension cables and cable stays are elliptical steel.

In order to speed up the construction, the center part of the main span deck was built on a barge in the Chicago River. This enabled all superstructure to be built on falsework simultaneously without interfering with river traffic. The 850ton, pre-cast center span was lifted from the barge, and integrated to the rest of the superstructure.

Despite the tight schedule, and unexpected site conditions this was a successful project and resulted in a new landmark structure for the City of Chicago.

This project is a pioneer effort in applying the innovative cable stayed – suspension hybrid system. The design will serve as a good opportunity to study the behavior of such a unique structural system and provide valuable knowledge for its future applications in various bridge structures.