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Canadian Consulting Engineering Awards 2019
Project: QEW Seventh St. Interchange Improvements
Category: B Transportation

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1.0 Full Project Description

Wood and EllisDon Corp. were the successful bidders on a Ministry of Transportation Ontario (MTO) design-build contract to replace the QEW and Seventh St. Interchange. The existing interchange had to be replaced to enhance operations at the interchange ramp terminals, accommodate the ultimate QEW lane configuration and replace the existing deteriorated structure.

The existing structure, a four-span post-tensioned deck with round voids on piled foundations, is being replaced with a four-span concrete deck on Nebraska University (NU) girders.

The QEW and Seventh Street Interchange Reconstruction Design-Build project is the first of its kind for MTO. The design-build project was successful in providing the MTO and the residents of St. Catharines with an innovative and durable replacement structure to accommodate the widening of the QEW. The interchange roundabouts will reduce the number of accident incident points for drivers, improving the overall safety on the high-volume Ontario highway.

1.1 Innovation

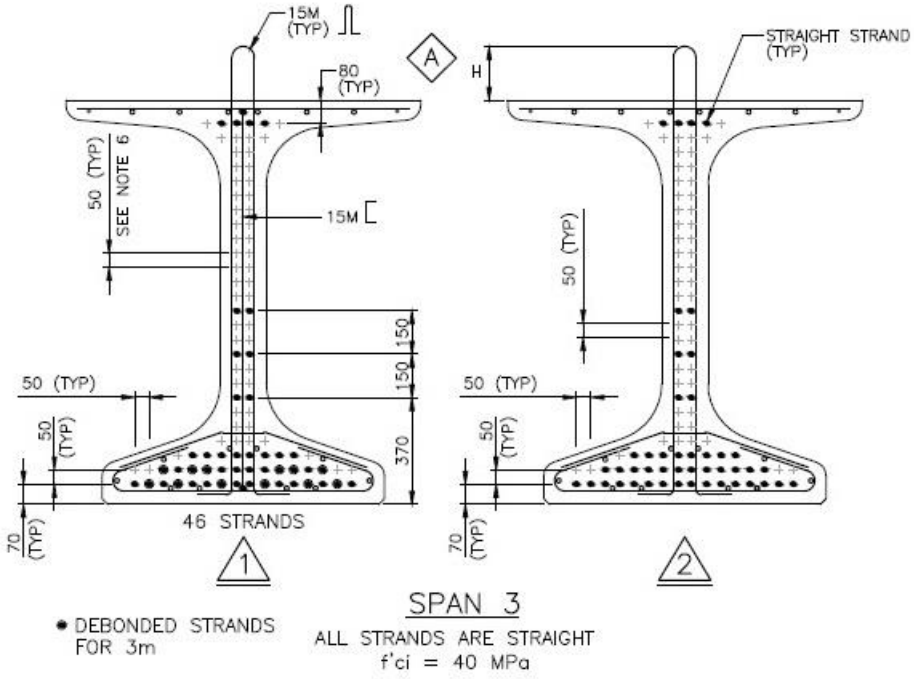
The existing interchange had to be replaced to enhance operations at the interchange ramp terminals, improve geometric conditions and replace the existing deteriorating structure. The project involved the realignment of Seventh Street Interchange (N/S-E, E-N/S, N/W, and W-N/S Ramps), resurfacing of the existing ramps, staging detours where the inner and outer shoulders were used as detours during construction, and realignment of the Seventh Street with two (2) new roundabouts.

The existing structure, a four-span post-tensioned deck with round voids on piled foundations, was replaced with a four-span concrete deck on Nebraska University (NU) girders. The new structure with integral abutments supported on piles, is narrower than the previously existing structure, and aligns with the north fascia of the structure and accommodates the ultimate QEW lane configuration.

The design life of the new structure is 75 years and in accordance with the Canadian Highway Bridge Design Code (CHBDC). To ensure the long-term durability of the structure we followed the requirements of the MTO Structural Manual and specified premium corrosion protection materials such as stainless steel and Glass Fibre Reinforced Polymer (GFRP) reinforcing bars where required.

The structure has been articulate to have fully integral abutments, eliminating the need for expansion joints between the deck and the ballast wall. The longitudinal movement of the structure, due to time dependent and thermal effects, is accommodated at the ends of the approach slabs where a sleeper slab and class C joint were specified. These changes have been incorporated to ensure that the new structure will be much more resilient than the existing structure.

In the detailing of the prestressed girders, only straight strands are specified, eliminating the need for hold down devices and permitting the simultaneous stressing and releasing of all the strands. Straight strands are also specified, possibly for the first time in Ontario, in the web below the center of gravity of the girder to transition, together with debonding, the concrete stresses from the highly stressed bottom flange to the web and reduce the possibility of horizontal cracking of the webs.



It is very important for the economical production of precast and prestressed components that the designer specifies the minimum concrete strength at transfer, (f'ci), rounded to the nearest MPa, which the Code SLS requirements will permit. Specifying the minimum concrete strength required ensured that the girders can be poured, cured and stripped on a 24-hour cycle.

1.2 Complexity

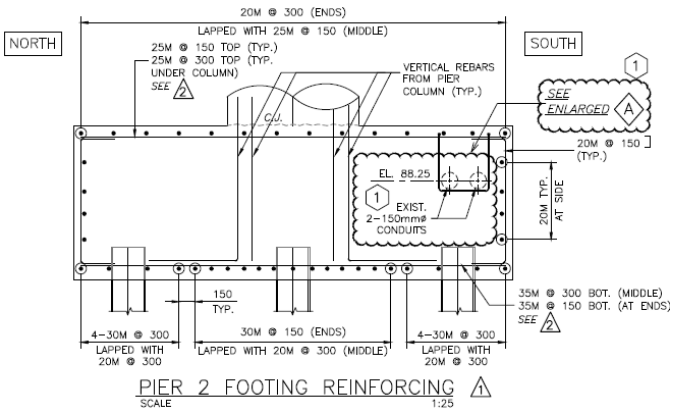
Demolition of the existing post-tensioned structure on this very busy highway needed to be completed within a very tight 12-hour closure window. This required the very careful development of the detour plans in partnership with various stake holders such as MTO, Region of Niagara, City of St. Catharines, OPP and other Emergency Services.

It also required proper staging, the simultaneous use of multiple pieces of equipment as well as the use of adjacent areas to temporarily store spoils to ensure that the highway can be open to normal traffic immediately after the allocated closure time.

The spans for the new structure were determined based on horizontal clearance requirements and the need to accommodate the future QEW Ultimate Lane Configuration. This requirement placed the new piled foundations in close proximity to the existing piles and a deeply seated box culvert. To minimize the risk of pile interference and possible damage to the existing infrastructure, three-dimensional (3-D) modeling and unconventional pile cap design with pile spacings specifically designed to eliminate

conflicts was utilized.

During the excavation for the central pier pile installation, the Contractor encountered a couple of 150 mm diameter conduits that were not previously identified. Under the design-build program delivery model used on this project by MTO, we were able to respond quickly and adjust the design to ensure that there were no delays to the contractor's plan to complete this project well ahead of schedule.



1.3 Social and / or Economic Benefits

This project involved realignment of the Seventh Street Interchange (N/S-E, E-N/S, N/W, and W-N/S Ramps), resurfacing of the existing ramps, staging detours where the inner and outer shoulders were used as detour during construction, realignment of the Seventh Street with two (2) new roundabouts and the replacement of the existing deteriorated structure which interfered with the plans for the Ultimate QEW Lane Configuration.

The new roundabouts enhance the traffic capacity of the ramps and ensure unhindered movement of traffic in every direction while minimizing delays to the travelling public.

The long-term plans for this stretch of the QEW include a widening of the highway. The opening beneath the new structure has been sized to accommodate the future QEW Ultimate Lane Configuration which will increase the capacity of the Hwy, ease congestion and reduce travel time.

1.4 Environmental Benefits

The structure has been designed to be more resilient than the one it replaced, and to blend well with the environment with certain aesthetic features consistent with other structures on this stretch of the highway (barrier wall patterns, open features etc.).

The entire interchange has been designed to efficiently move traffic without delays in order to reduce user costs as well as impacts to the environment during idling of vehicles. The landscaping of the islands within the roundabouts and around the interchange enhance the appearance of the interchange and augment the natural beauty of the surrounding gardens and orchards.

1.5 Meeting Client's Needs

The MTO needed to replace the existing QEW and Seventh St. Interchange in order to enhance operations at the interchange ramp terminals, improve geometric conditions, provide an opening that accommodates the ultimate QEW lane configuration and replace the existing deteriorating structure.

The project involved realignment of Seventh Street Interchange (N/S-E, E-N/S, N/W, and W-N/S Ramps), resurfacing of the existing ramps, staging detours where the inner and outer shoulders were used as detour during construction and realignment of the Seventh Street with two (2) new roundabouts.

To construct the new structure the existing had to be demolished within a 12-hour highway closure window while traffic on this very busy southern Ontario highway was detoured. The existing structure was demolished within the closure window by careful staging the demolition, using simultaneously numerous pieces of equipment and temporarily storing the spoils in adjacent areas.

The entire project was completed on budget and ahead of schedule. The new structure meets all the requirements of the CHBDC, the MTO structural Manual, the Project Agreement and accommodates the planned future widening of the QEW. The new ramp configuration with the roundabouts provides efficient movement of traffic in all directions minimizing delays to the travelling public.