THE NEW CHAMPLAIN BRIDGE – TECHNICAL REQUIREMENTS AND DELIVERY STATUS REPORT

Guy Mailhot
Infrastructure Canada, Canada

ABSTRACT

In June 2015, the Government of Canada awarded a 3.98 billion dollar contract to the consortium Signature on the Saint Lawrence Group to design, build, operate, maintain and finance the undertaking of the new Champlain Bridge Corridor Project. Procured as a public-private partnership, this new project entails a new replacement crossing over the St. Lawrence River in Montreal and represents one of the largest bridge projects currently underway in North America. This new major transportation infrastructure, extending over a length of some 3.3 km will provide six vehicular traffic lanes, two lanes dedicated to a mass transit corridor and a multiple-use pathway. With reconstruction of its companion crossing over the western arm of the river along Nuns’ Island, a combined deck surface of some 193,000 m² will be constructed, making the new Champlain Bridge Canada’s largest bridge. This paper summarizes the technical requirements imposed by the Government of Canada to guide the bridge design and material selection. It also explains the approach used to develop the architectural features of the bridge and the technical requirements so as to ultimately endow Montreal with an elegant and highly durable structure (125-year design life). The paper also highlights some of the major construction techniques that have been selected and developed by the Private Partner to meet the demanding technical requirements and to ensure that the new bridge will be delivered on time. Finally, the paper summarizes the status of the bridge construction and presents a glimpse of the challenging and impressive works to come.

Keywords: Bridge, Champlain, NBSL, design, construction, durability

1. INTRODUCTION

The existing 3.5 km long Champlain Bridge shown in Figure 1 spans the St. Lawrence River and connects the city of Brossard to Nuns’ Island which forms part of the city of Montreal. A companion structure, 468 metres long and referred to as the Nuns’ Island Bridge (recently demolished) crosses the western arm of the St. Lawrence and connects the southern shore of the St. Lawrence River to the Island of Montreal. Both structures were constructed at the same time and opened to traffic in 1962.

The project and its schedule are driven by the condition of the existing bridge. As reported elsewhere “…the bridge is quickly approaching the end of its useful life. As such, replacement of the bridge must be expedited to ensure continuous use of the crossing” (Mailhot et al, 2014). In light of its condition, in December 2013 the Government of Canada announced that it would strive to replace the existing bridge under an accelerated timeframe by the year 2018. Because of its condition and importance, the existing bridge has undergone extensive major structural repairs over the years by The Jacques Cartier and Champlain Bridges Incorporated, the owner and operator of the existing crossing. Pending the bridge’s replacement, monitoring, inspection and major
structural interventions over the past few years have increased substantially in order to maintain the bridge in a safe operating condition.

Under the context described above, the Government of Canada issued a Request for Proposal on July 18, 2014 and awarded a contract on June 19, 2015 to the consortium Signature on the Saint Lawrence Group to design, build, operate, maintain and finance the undertaking of the new Champlain Bridge Corridor Project. Procured as a Public-Private Partnership (PPP), this new project entails a new replacement crossing over the St. Lawrence River in Montreal and represents one of the largest bridge projects currently underway in North America. Despite its accelerated schedule and delivery method, the Government of Canada has committed to delivering a modern and highly durable structure that would meet the transportation requirements of the Greater Montreal region while meeting the expectations of the community with respect to its architectural quality and visual impact. A number of the technical requirements prescribed by the Government of Canada to define its expectations and principal objectives and the Private Partner’s approach to satisfy these are described in the pages below. Figure 2 below provides a rendering developed on the basis of the Government of Canada’s reference design which also serves to illustrate the West Approach, the East Approach, the Main Span Tower and Cable Stayed Bridge spanning the Saint Lawrence River. In this figure, Montreal and Nuns’ Island are located on the left of the figure whereas the City of Brossard is shown on the right.

Figure 2: Aerial View Rendering of New Champlain Bridge (Existing Bridge Removed)

2. ARCHITECTURAL REQUIREMENTS

An important facet of the project for which the Government of Canada endeavored to devote proper attention early in the development stage was architectural quality. The new Champlain Bridge involves one of the largest pieces of infrastructure in the Montreal area and is considered to be the gateway to Montreal. Accordingly, the Government of Canada wanted to integrate measures to ensure that the architectural quality expectations for the new Champlain Bridge would be met. Although various potential schemes were explored to incorporate architectural quality within a PPP procurement framework (international competition, architectural directives process, competitive dialogue, etc.), the accelerated timelines and concerns about the ability to preserve the requisite architectural quality elements and enhancements throughout the delivery process led the Government of Canada to adopt a directives approach resulting in a precise definition of the most prominent and visually significant features of the main span over the St. Lawrence Seaway and the approaches of the bridge over the remainder of this major river.

Under this approach, architectural guidelines were developed regarding structural form, architectural lighting and lighting scenes including highly realistic views from and of the bridge. These guidelines were framed by a “definition design” such that the government could guarantee to the community that what it displayed during its public announcements would in fact be delivered, or in other words “What you see is what you get” (WYSIWYG). As part of its mandate to assist the Government of Canada in the development of procurement documentation, Arup Canada Inc. retained the services of a world renowned architect (Poul Ove Jensen from Dissing+Weitling) who has contributed to several notable bridge projects including several cable stayed bridges (Svensson, 2012). The process of determining the architectural shape of the bridge involved the collaboration of distinguished professionals and members of the community, a local architectural firm and Government of Canada professionals in order to clearly establish the rules and expectations in matters of architectural quality and aesthetic enhancement. Measures were incorporated in the Request for Proposal as well as the Project Agreement’s technical requirements to ensure that the
The architectural vision set out in the development phase would be preserved in the delivered bridge. This was a key requirement of the tendering process.

3. STRUCTURAL DESIGN REQUIREMENTS

Considering the importance of the bridge and its extended design life, a number of special structural requirements were specified by the Government of Canada in addition to the architectural requirements identified above. Some of these requirements, which generally exceed or expand upon the minimum design requirements prescribed in the Canadian Highway Bridge Design Code (06 or 14 versions), are briefly discussed below.

3.1 Highway Live Loading

To account for the extended design life, the standard truck load and lane models defined in CAN/CSA S6-06 were augmented by 10% (i.e. CL-625 increased by 10% equally to all axles to give a CL-685 truck load model). A special truck load, identified as NBSL-15 was also specified. This vehicle (inspired from a Caltrans P-15 special truck) represents a total load of 1,796 kN (mass of 183 metric tonnes) distributed over 15 axles as shown in Fig. 3 below. Considering that the potential passage of a truck of this size and magnitude over the new Champlain Bridge is expected to be a rare event (based on historical special permit requests on the existing Champlain Bridge), the project requirements allow that this vehicle could travel in a single lane at a reduced speed of 10 km/h or alternatively, it could straddle two adjacent marked lanes while travelling at 25 km/h. Dynamic load allowances are permitted to be reduced by the factors identified in Section 14 of CAN/CSA S6-06 and the live load factors for the special truck are those generally identified in Section 3, Table 3.2 of CAN/CSA S6-14.

The specifications required that the new bridge have three separate corridors (see Fig. 6), with the upstream and downstream corridors dedicated to highway loading and the central corridor dedicated to a mass transit system, which could consist of either busses or a light rail system. When operated with buses, the applicable highway loading would consist of the standard CL-625 load model. However, to accommodate the eventual transition from a bus system to a light rail system, the highway carriageways were widened to safely accommodate buses running temporarily within the shoulders. Accordingly, the highway corridors are designed to accommodate 4 lanes of highway traffic. The north corridor (downstream corridor) was also required to accommodate a multiple-use path with a net width of 3.5 metres with pedestrian and maintenance vehicle loading as prescribed in CAN/CSA S6-06.

![Figure 3 – NBSL-15 Special Truck Loading](image)

3.2 Rail Loading Requirements

Provisions in the Project Agreement (the PPP contract) required that the bridge be designed so that it could eventually accommodate a light-rail transit system (LRT) or as designated in this project a “Système léger sur rail (SLR)”. Because the exact type of light-rail transit system was not known at the time the project was tendered (and is still not confirmed), discussion with the promoter of the eventual light-rail transit system namely, the Agence métropolitaine de Transport (the promoter is now the Caisse de dépôt et de placement du Québec/CDPQ), it was decided to adopt Eurocode rail loading meeting the following two train load models (classified LM71 and SW0 models) below.
3.3 Seismic Design Requirements

At the time the Government of Canada (the Authority) was drafting its technical specification in 2014 with the assistance of its consultant Arup Canada Inc., the applicable Canadian Highway Bridge Design Code in force was CAN/CSA S6-06 (R2013). Well aware however of the fact that a newer version of the upcoming code would include major revisions to its seismic design provisions, notably an evolution towards a performance based design approach, the Authority obtained a draft version of the newer code via CSA International as well as edits to its draft version via Dr. Denis Mitchell, McGill University, chairman of the seismic design section of the code. Furthermore, in collaboration with Geological Survey of Canada/Natural Resources Canada and in particular Dr. John Adams a prominent Canadian seismologist, the Authority was also able to obtain the most recent spectral values available at the time for the Montreal region (Table 1), which were essential in establishing the basic design parameters for seismic design. Essentially, the design requirements for seismic design included as a minimum most of the relevant sections of the draft version of CAN/CSA S6-14, ensuring that the new bridge would meet state-of-the-art requirements for seismic design. The new Champlain Bridge is designated as a lifeline bridge, and this designation fits very well the newer definition of such a bridge as defined in CAN/CSA S6-14 which reads “a large, unique, iconic, and/or complex structure that is vital to the integrity of the regional transportation network, the ongoing economy, and the security of the region and represents significant investment and would be time-consuming to repair or replace”. Such a designation requires that the bridge shall be fully serviceable for normal traffic and have sustained minimal damage under a seismic event having a 975-yr return period and provide limited service for emergency traffic and be repairable without bridge closure under a large seismic event having a 2475-yr return period (i.e. 2% probability of exceedance in 50 years).

Table 1: Horizontal Spectral Acceleration for Seismic Design (Site Class C 5% damping)

<table>
<thead>
<tr>
<th>Period (s)</th>
<th>475-yr.</th>
<th>975-yr.</th>
<th>2475-yr.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10% 50 yr</td>
<td>5% 50 yr</td>
<td>2% 50 yr</td>
</tr>
<tr>
<td>.2</td>
<td>.2040</td>
<td>.3370</td>
<td>.5915</td>
</tr>
<tr>
<td>.5</td>
<td>.1065</td>
<td>.1740</td>
<td>.3090</td>
</tr>
<tr>
<td>1</td>
<td>.0520</td>
<td>.0835</td>
<td>.1470</td>
</tr>
<tr>
<td>2</td>
<td>.0240</td>
<td>.0385</td>
<td>.0675</td>
</tr>
<tr>
<td>5</td>
<td>.0055</td>
<td>.0095</td>
<td>.0175</td>
</tr>
<tr>
<td>10</td>
<td>.0020</td>
<td>.0040</td>
<td>.0060</td>
</tr>
</tbody>
</table>

Recognizing the need to ensure that damage to the bridge under a large seismic event could be repaired (i.e. limit on concrete strains and limit on excessive inelastic behaviour), the project requirements included the opportunity for the designer to pursue an “Essentially Elastic Design” approach. If such an approach were adopted, the seismic demands had to be augmented by 30%. Consistent with requirements for modern seismic design of important bridges, the specifications required that the designer carry out non-linear time history analysis using a minimum of five sets or more of relevant time-histories. If less than eleven sets of time histories were used, the maximum response quantity had to be used, however, if eleven or more sets are used, the mean response quantity can be used. To further ensure that the design for seismic approach would follow recognized best-practices in the area of modern seismic design of important bridges, the project requirements also required that the seismic design of the new bridge be peer reviewed by an independent seismic expert.
3.4 Wind Loading

Incorporating an asymmetrical cable stayed bridge with a main span of 240 m, a back span of 124 m and a single slender tower extending some 158 m above high water level, the project requirements incorporated modern best practice requirements for wind engineering for the design of the new bridge. These requirements included among others: i) sectional model testing of the deck cross-section with and without traffic at 1:50 scale, ii) stability and buffeting analyses for completed bridge and critical construction stages, iii) full aeroelastic modelling at 1:150 scale in both smooth and turbulent flows of the final bridge (with and without the presence of the existing Champlain Bridge) and iv) full aeroelastic modelling of the bridge at 1:150 scale in both smooth and turbulent flows at critical erection stages. The Mean Return Interval (MRI) and corresponding design wind speed and averaging times at the bridge deck level, based on a review of historic wind speeds at the site (including in-situ measurements on the existing Champlain Bridge) are reported in Table 2 below.

Table 2: Design Wind Speeds (at Deck Elevation)

<table>
<thead>
<tr>
<th>Condition</th>
<th>MRI</th>
<th>Averaging Time</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction design</td>
<td>20</td>
<td>3600</td>
<td>27.5</td>
</tr>
<tr>
<td>Final design</td>
<td>125</td>
<td>3600</td>
<td>31.0</td>
</tr>
<tr>
<td>Aeroelastic Stability - construction</td>
<td>1000</td>
<td>600</td>
<td>41.0</td>
</tr>
<tr>
<td>Aeroelastic Stability - final bridge</td>
<td>10000</td>
<td>600</td>
<td>48.0</td>
</tr>
</tbody>
</table>

The analysis for wind loads were carried out by two highly specialised wind engineering specialty firms, namely WES WIND Laboratories for the sectional modelling and The Boundary Layer Wind Tunnel Laboratory at Western University for the full aeroelastic wind tunnel testing. With the unexpected passing of Dr. Raggett (WES WIND Laboratories) in September 2015, Dr. Peter King, P.Eng. of Western University oversaw the entire wind study investigations.

Wind tunnel testing showing in the foreground the full aeroelastic model of the new bridge in its final configuration and the existing bridge in the background is presented in Fig. 5. In this figure, it is interesting to note the height of the new main span tower in comparison to the existing steel through-truss cantilever bridge. The height of the new bridge is in fact limited by the zone of no obstruction for aircraft landing at the nearby Saint Hubert Airport.

4. DURABILITY OBJECTIVES

One of the Government of Canada’s principal objectives for the project as noted above was to ensure the delivery of a new bridge of a very high quality and endowed with an extended design life of 125-years. To this end, the project specifications and performance objectives imposed by the Authority included among others the following design criteria or design features:

- Design life of 125-years for all non-replaceable elements (refer to Table 3 below).
- Mandatory use of stainless steel reinforcement in strategic locations as detailed below.
- Incorporation of a deck waterproofing membrane and high performance asphalt overlay with enhanced thickness (90 mm vs 65 mm standard thickness in the province of Québec).
• Good deck drainage system including longitudinal carrier pipes and vertical drain pipes extended so as to discharge close to water level.

• Requirement that the Private Partner develop a Durability Plan that demonstrates that the durability objectives set out in the Project Agreement can be met.

• Requirement that the Private Partner undertake time-to-corrosion modelling for concrete components using state-of-the-art modelling techniques.

• Fatigue resistance of components to be considered over the extended design life.

• Reserve capacity for structure design which allows for the replacement of a cable stay with traffic and which also accounts for the potential loss of multiple stays in an extreme event.

• Limitation on the number of expansion joints; a maximum of only 8 expansion joints is permitted, including the expansion joints at the abutments. This is in strong contrast to the existing bridge which incorporates 57 expansion joints.

• Incorporation of an efficient system for maintenance access and inspection, for example shuttles within box girders, elevators within the main span tower shafts, supply of under-bridge-inspection-vehicle and access devices within the interior of all hollow pier columns as well as maintenance travellers for the main span and back span for the cable stayed bridge.

• Remote controlled inspection system for cable stays.

• Stainless steel anchors installed in bridge components to facilitate inspection of the structure using rope climbing techniques.

• Incorporation of a Structural Health Monitoring System including corrosion sensors for concrete.

• Requirements to mitigate stray currents and induced currents, particularly in light of the eventual implementation of an electrified mass transit system.

• High performance three-coat paint system for exterior surfaces of structural steel elements and a two-coat system for all interior surfaces of box girders.

• Specific and detailed requirements governing handback conditions of the structure (after the 35 year concession period), including a detailed assessment of the condition of the cable stays.

• Special requirements governing the design of reinforced and prestressed concrete components, including specific requirements on maximum crack widths and conditions for injection of specific cracks.

With respect to the design and fabrication of concrete components, of special concern given the owner’s challenges encountered with respect to the maintenance of the existing bridge’s prestressed concrete girders along approach spans, the project specifications required the use of stainless steel reinforcement meeting the requirements of British Standard BS 1.4301, 1.4162 or 1.4362 (similar to ASTM A955/A995M) at the following strategic locations:

• 100% of all reinforcement in deck slab.

• Starter bars for barriers and appurtenances (other bars in barriers consist of galvanized reinforcement).

• Outer layer of all external faces of horizontal tie beams at the top of all piers (not applicable in the Private Partner’s design since the pier cap will be made of steel).

• Outer layers of all external faces of superstructure, piers and abutments at and below roadway joints.

• Outer layers of all external faces in piers and abutments within 10 metres horizontally of at-grade roadways up to a height of at least 8 m above the at-grade roadway.

• Outer layer of all external faces of tower columns and lower cross-beam from 8 m above the roadway to the soffit level of the superstructure.
Table 3 - Specified Design Life for Various Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Design Life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-replaceable components</strong></td>
<td></td>
</tr>
<tr>
<td>Foundations (piles, pile caps, footings)</td>
<td>125</td>
</tr>
<tr>
<td>Substructure (piers, abutments, tower)</td>
<td>125</td>
</tr>
<tr>
<td>Superstructure (including deck slab)</td>
<td>125</td>
</tr>
<tr>
<td><strong>Replaceable components</strong></td>
<td></td>
</tr>
<tr>
<td>Bearings</td>
<td>40</td>
</tr>
<tr>
<td>Expansion joints</td>
<td>30</td>
</tr>
<tr>
<td>Barriers</td>
<td>50</td>
</tr>
<tr>
<td>Drainage system</td>
<td>40</td>
</tr>
<tr>
<td>Bridge cables/stays</td>
<td>65</td>
</tr>
</tbody>
</table>

* Partial list

5. SUMMARY OF PRIVATE PARTNER’S ADOPTED DESIGN

Although the project requirements and in particular the definition design dictated the overall shape of the piers, approach spans as well as the main span crossing over the seaway, the Private Partner was free to establish the internal configuration of box girders and to select the specific material type for deck slab, superstructure, and pier caps. The Private Partner was also offered the flexibility of determining the most appropriate span length for approach spans, provided that spans would be equal to or greater than 65 metres in length and provided that the bridge would comprise a maximum of eight expansion joints (including the two expansion joints at the East and West abutments). In its planned final form, the Private Partner’s adopted design which was developed following close collaboration between the design and construction teams consists of:

For typical approach spans

- three independent steel box girders (East bound and West bound highway corridors and central mass transit corridor) having constant depth of 4 m and typical spans of 80.4 m centre-to-centre of piers.
- precast deck panels with wide closure strips reinforced with looped stainless steel reinforcing bars.
- W-shaped plated steel pier caps which are secured to the pier shafts by way of post-tensioning (PT anchors are located inside the steel pier caps and within a cast-in-place concrete bulk head). All post-tensioning is also internal to the precast pier segments and footings.
- hollow precast post-tensioned match-cast pier legs for approach spans.
- precast gravity footings (generally 11 m x 11 m x 2 m thick) resting on sound (unaltered) bedrock. Looped ducts in the footings allow the footings to be connected to the pier shafts by way of internal post-tensioning. A system of pucks, levelling bolts and tremie pipes allows the footings to be levelled and uniformly supported by the bedrock.

For cable stayed bridge

- asymmetrical cable stayed bridge having a 240 m main span and 124 m backspan. Cable planes are essentially vertical (as dictated by the definition design) and spaced roughly 12 m on centres.
- three steel box girders 4 m deep interconnected with rectangular steel cross-beams.
- 154.5 m high main span tower (measured from the top of pier cap to top of tower). The main span tower legs consist of hollow precast segments inclined below the upper cross beam (bow-tie) and cast-in-place hollow concrete sections for the region located between the bow-tie and the tower tops (refer to Fig. 8).
- drilled shaft foundations for back span piers (W01 and W02) as well as main span tower (MST) foundation. Tower is supported by two 4 m thick pile caps connected with tie beams, each supported by twenty-one 1.2 m dia. drilled shafts per tower leg. The most heavily loaded drilled shafts are socketed some 12 m into sound (unaltered) Utica-shale rock.
Figure 6 illustrates the typical arrangement for approach spans decks and Figure 7 the typical arrangement for the substructure. With respect to the main span, Figure 9 shows the general configuration of the asymmetrical cable-stayed bridge whereas the main span tower is illustrated in Fig. 8. An architectural rendering of the new bridge, seen from below the deck, is also shown in Fig. 10.

![Figure 6: Typical Approach Span Deck Configuration](image)

![Figure 7: Typical Approach Span Pier](image)

![Figure 8: Main Span Tower](image)

6. PRIVATE PARTNER’S CONSTRUCTION METHODOLOGY

In order to meet the challenging construction schedule, the Private Partner opted for extensive on-site and off-site precast concrete operations as well as off-site steel fabrication by Quebec based steel fabricators as well as steel fabricators based in Spain. Pre-assembly of steel components will occur on site at the West Jetty described below.
6.1 Temporary Concrete Precasting and Steel Preassembly Facilities

One of the key strategies behind the Private Partner’s construction approach is the installation of three rock-filled jetties, the principal one having dimensions of roughly 500 m in length by 100 m in width and which has been constructed along the western end of the new Champlain Bridge along Nuns’ Island as shown in Fig. 15a. This large jetty (West Jetty), which incorporates three fish passages, is used to install a temporary precasting plant certified to the requirements of CSA A23.4 Precast concrete – materials and construction. This precast plant is used to fabricate precast footings, pier starter stems and to preassemble the first off-site fabricated precast starter segments. The jetty is also used to preassemble superstructure segments and steel pier caps. The jetty is equipped with marine load-out and docking facilities required to transfer prefabricated concrete and steel bridge components for transport by barge to their final position along the St. Lawrence River. A custom-built Self Propelled Mobile Transporter (SPMT) with a capacity of some 1000 tonnes (see Fig. 12) will be used to move precast foundation units (footing, pier stem and starter segment) to various fabrication positions within the West Jetty. Lastly, once all bridge components have been precasted or preassembled on the jetty, the rock filled structure will be used to facilitate the construction of 6 piers in dry conditions (on rock-fill).

The West Jetty is complemented by two other jetties, namely the Main Span Tower Jetty (MST Jetty) and the East Jetty as shown in Fig. 1. The MST Jetty is currently being used to construct the main span tower footing and will be used to erect a temporary bent to construct the backspan superstructure on land for eventual hoisting into position by
way of strand jacks (Fig. 16). The East jetty, on the other hand is used to erect piers in the dry along the fingers of the East Jetty. The total length of jetties (West, MST, East) represents approximately one-third of the width of the St. Lawrence River at the location of the bridge.

6.2 Approach Span Fabrication

Fabrication of the west approach spans substructure includes the following principal activities, namely; i) prefabrication of footings and pier stems, ii) transport of heavy prefabricated segments using the SPMT to load-out marine facilities, iii) marine excavation using an excavator mounted on a barge (Fig. 13), iv) water transport of footings and pier stems from the jetty to final destination using a large gantry supported by catamaran (Fig. 14), v) final excavation and verification of bedrock, vi) unloading of the precast concrete pier components to their intended final position, vii) levelling of pier footings using three-point support pucks installed on the underside of the footing and levelling devices, viii) placement of tremie concrete to fill the cavity between the bedrock and the underside of the footing elements, ix) adjustment of geometry facilitated by a cast-in-place joint (below water level) made between the pier stem and the first off-site prefabricated pier starter segment, x) installation of match-cast pier segments making use of a combination of post-tensioning bars and post-tensioning cables, xi) installation of a temporary horizontal tie beam at the top of the pier legs, xii) installation of steel pier caps which are composed of two large preassembled pieces (roughly 25.6 m x 11.4 m each) by way of a large barge mounted crane and xiii) post-tensioning of the steel pier caps to the precast segmented pier legs. East approach work although similar, involves several spans located on land or accessible by the temporary East Jetty (see Fig. 1) which simplifies works to some degree.

West approach steel-concrete composite superstructure erection includes the following main activities, namely; i) installation of a segment of the steel superstructure on a pier which is temporarily supported by steel struts connecting the superstructure segment to the pier, ii) load out of a preassembled box-girder section, iii) erection of the preassembled superstructure segment using a large barge mounted crane, iv) making of the splice with the previously installed steel segment installed over the pier, v) installation of precast deck panels, vi) placement of closure strip concrete (deck stitches), and vii) deck finishing works.

6.3 Main Span Erection

Main span erection methodology is currently being developed by the Private Partner in close collaboration with the St. Lawrence Seaway Management Corporation (SLSMC) to ensure that the main span can be safely erected with minimal impact to navigation within the St. Lawrence Seaway navigational channel.
The erection method developed by the Private Partner contemplates the construction of a temporary bent on the MST Jetty. The jetty and the temporary bent will enable the preassembled backspan to be erected at ground level and then hoisted into position using strand jacks as shown in Fig. 16. For erection of the main span, steel segments will be delivered at the base of the Main Span Tower and then shuttled along the underside of the cantilevered superstructure for pick-up by a gantry mounted at the tip of the cantilever (see Fig. 11). This sequence will be repeated, with the installation of both temporary stays and permanent stays, until closure can be made with a segment of superstructure installed at pier E01. It is expected that the free end of the superstructure will be cantilevered out approximately 203 m from the tower erection of the main span. This most critical erection condition has been verified for aerodynamic stability through wind tunnel testing.

7. CHALLENGES AND OVERALL PROJECT STATUS

Given the fast-track nature of the project, one of the major challenges encountered involved the need to ensure that the advancement of the design would be able to meet the aggressive project construction schedule considering the elaborate design review process which was integrated into the Project Agreement and which includes reviews by the independent design checker, the Authority and its Owner’s Engineer, reviews by various stakeholders as well as reviews and the issue of certificates by the Independent Engineer.

Furthermore, in light of the condition of the existing Champlain Bridge, the Project Agreement (which governs all aspects of the construction and delivery of the new Champlain Bridge) imposes strong incentives so as to ensure that the new Champlain Bridge will be delivered by the required target substantial completion date which is set as December 1, 2018. Very important liquidated damages in the amount of $100,000 per day and $400,000 per day are set for late delivery after Dec. 1 and Dec. 8, 2018 respectively. The construction status of the new Champlain Bridge proper, the most important component of the project is summarized below.

7.1 Current Status

New Champlain Bridge Construction Status as of April 18, 2016:

- Design of the overall bridge (West and East approaches and Cable Stayed Bridge) is approaching 100%.
- The West Jetty, MST Jetty and East Jetty are completed.
- Eight footings have been completed at the West Jetty and the temporary precast plant used to fabricate them has received CSA certification.
- All drilled shafts (42 in total) for the MST have been completed and the South and North pile caps have been cast.
- Marine excavation has begun at the location of two piers (W10 & W18).
- Drilled shaft foundations at the West Abutment and East Abutment have been completed.
- Drilled Shaft for two piers along the East Approach (E07 & E10) have been completed.
- Offsite fabrication for the pier segments of the main span tower and steel superstructure has begun.
Additional information regarding the project and its status can be found at Infrastructure Canada’s web site (www.infrastructure.gc.ca/nbsl-npsl/index-eng.html) and the Private Partner’s web site (www.newchamplain.ca). Real-time cameras monitoring the construction activities can also be viewed at: http://www.nouveauchamplain.ca/chantier/chantier-en-direct/.

7.2 Upcoming Works

It is expected that by the summer of 2016, the main span tower will be constructed to a height of some 35 metres above water level. It is also expected that a number of piers will have been constructed and would be ready to receive superstructure components. By the end of 2016, it is expected that erection of the steel superstructure for the west approach would have begun, the main span tower will have reached a height of some 45 metres above water level and the first segments of the Cable-Stayed Bridge back span will have been erected.

In summary, almost all key construction activities would have been initiated, thus serving to confirm that the new Champlain Bridge can be delivered as planned.

ACKNOWLEDGEMENTS

A project of this size and complexities requires the contribution of a number dedicated organizations, firms and individuals. The author takes this opportunity to acknowledge the participation of the following companies and firms acting in various capacities:

- Owner: Government of Canada
- Private Partner: Signature on the Saint Lawrence Group
- Designer: SNC-LAVALIN, TY LIN International, IBT (International Bridge Technologies)
- Owner’s Engineer: Arup Canada Inc.
- Architect: Poul Ove Jensen/Provencher et Roy
- Independent Engineer: Stantec/Ramboll Joint Venture

REFERENCES


