Walterdale Bridge Erection Engineering Project Brief

Allnorth

About Us

Allnorth is a multidisciplinary engineering and technical services consulting company serving clients in the oil and gas, mining, power, chemical, infrastructure and pulp and paper sectors.

With offices across Canada, we provide a single point of contact for clients looking for smart and practical solutions to their project needs.

We are focused on serving our clients and have developed extensive experience and strong client relationships in the sectors we serve.

At Allnorth we strongly believe that providing successful client relationships is the reason we are in business, and delivering the best service in our industry is how we will grow.

The Walterdale Bridge

The team

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The project

The Walterdale Bridge Replacement Project was commissioned by the **City of Edmonton in 2013.** The detailed architectural design of the bridge was carried out by COWI International (Buckland and Taylor) and Dialog Design. ACCIONA-Pacer Joint Venture (APJV) was contracted to build the structure and **Allnorth Consultants Limited (Allnorth)** was hired by APJV as the Erection Engineer of Record for the project.

To this point, the installation of this bridge proved technically challenging as it entailed:

- Navigation of 1000 tonne assembly up the icy North Saskatchewan River.
- Heavy lifts of 1000 and 2000 tonnes using strand jacks and lifting towers.
- Low tolerance alignment of large, stiff arch connections.
- Fine tuning of the deck elevation using hanger turnbuckles.

Figure 1 - Walterdale Bridge Rendering

Figure 2 - Walterdale Bridge Rendering

As the Erection Engineer of Record, Allnorth was responsible for the development of the erection procedures for the entire **permanent structure**, plus detailed designs for all temporary structures and equipment used in the installation. Allnorth also provided **ongoing site support** for the construction team and resolved construction issues as they arose.

The design for the Walterdale Bridge consists of **two steel arches with a span of 206m.** The arches incline towards each other at an angle of **13.5 degrees.** Sixteen top struts and two deck support beams connect the two arches, giving the structure lateral stability. The composite deck has a length of **230m** from abutment to abutment. The bridge deck is suspended from the arches by 32 steel hanger cables, and also bears on the arch deck support beams and abutments. Adjacent to the deck, the Shared Use Pathway (SUP), (a steel box girder with a trapezoidal section and a crescent shaped alignment), is suspended from the arch by fourteen additional hanger cables, and is connected to the deck by eight floor beam extensions. The overall bridge design is shown in Figure 1 and 2.

The three main objectives for the development of the procedures used to install the permanent structure were:

- Safety and structural stability at every stage of construction.
- Completion of the permanent structure within the constraints established by the design drawings and contract documents.
  - Final geometry.
  - Hanger cable tensions.
  - Minimizing locked in stresses in bridge components.
- Minimizing all potential risks to both schedule and budget.

The construction of the bridge was performed in three main phases.

ARCH INSTALLATION

TRAFFIC DECK INSTALLATION

SUP INSTALLATION

Figure 3

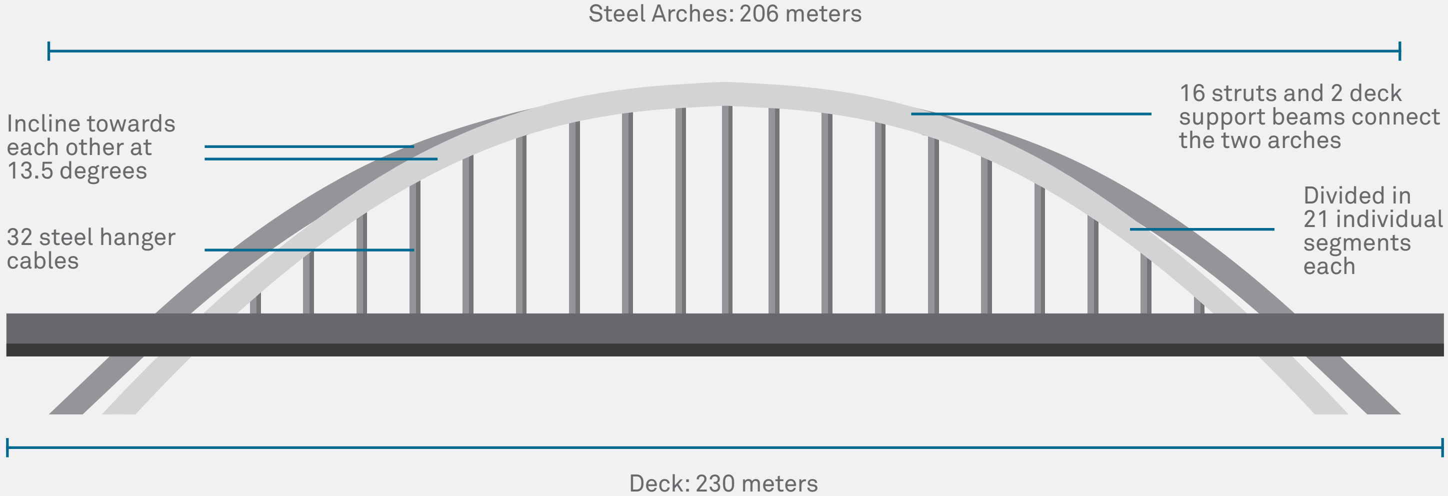
Phase 1 - Arch Installation

The procedure developed for the first phase of construction was moderately technically challenging. **Each arch was fabricated in 21 individual segments. Each segment had a length of around 10m, and the heaviest weighed 120 tonnes.** Joints with higher final elevations were designed to be bolted, while those closer to the roadway were designed to be fully welded for aesthetic reasons.

Initially, the midspan of the arch was assembled downstream from the final bridge location. **This midspan was 86m in length, and weighed approximately 1,000 tonnes.** During assembly it was fully supported by temporary towers. Once assembly was completed, bowstrings running the length of the midspan were tensioned until an arching action resulted in the entire midspan being supported by skid shoes located at each end of each arch.

When the load was transferred to the skid shoes, the assembly towers were removed from the area beneath the arch. Two barges with modular flexifloat

Graphic explanation of the bridge



systems were gathered and arranged at the end of the assembly area. The barges, plus the skid shoes and bowstrings were operated by a highly experienced team from ALE Heavylift.

The next step was to skid the assembly down the rails and onto the barges. **A tower was installed at the centre of each of the barges.** Each tower was connected to the arch by a moment connection and the bottom of the tower was a pinned connection to the barge. This configuration minimized the potential of the barge overturning, and allowed for more efficient barge dimensions. The transfer of the load onto the barges is shown in Figure 3.

Once the assembly was fully supported by the two barges, a system of winches attached to each barge was activated to pull the assembly upriver. Each barge was fitted with two main winches, with a capacity of 20 tonnes each, and two auxiliary winches of 5 tonnes each for stability. The procedure to move the arch from its initial assembled location to the final crossing alignment took approximately one week.

Substantial sized barges were required for buoyancy to accommodate the 1,000 tonnes. Due to changes in the construction schedule, challenges associated with the water depth and ice on the river were encountered during navigation. These challenges were mitigated by trial runs and the presence of a dredging machine throughout the operation. When the assembly reached its final location, it was lowered onto pilecap supports at the ends of each arch.

Stump arches on the berms at the final crossing location were also being assembled during the midspan assembly. Four lifting towers were located at each of the four corners of the first midpan. These towers supported the stump arches plus lifting strand jacks with a capacity of 860 tonnes each.

Two heavy lifts were required to complete the arch. The first midspan, with a weight of 1,000 tonnes was lifted 20m. At that height each end of each arch was bolted to the adjacent, previously assembled 30m long stump arches. The first heavy lift is shown in Figure 3.

At the time of the first heavy lift, the first upper bowstring was still in place. To maintain the geometry of the arch throughout construction, a second, lower bowstring was also required along the full length of the second midspan. The tension was traded from the upper to the lower bowstrings to prevent the permanent structure from being overstressed, and to keep the arch within the geometric limits established by the temporary structures.

The lift of the second assembled midspan involved the lift of 2,000 tonnes with a height of 20m. When the lift was complete, adjacent segments were temporarily connected using an internal bolted splice. The baseplate connection to the foundation was left incomplete to this point to allow for precise alignment of the connection. A rocker plate was installed beneath the baseplate to allow for adjustments in alignment of the stump arches with the second midspan.

Jacks were used to adjust the slope of the lower section and to facilitate installation of the connection. Smaller jacks and strongbacks were also used to bring the splice into torsional alignment locally.

Once this connection was complete, the permanent welded connection was applied. While the splice was being completed, the baseplate of the arches were grouted, and the anchor rods were tensioned.

The permanent structure of the arch was completed with the baseplate connection and the last splices. The lifting strand jacks and bowstrings were then removed, ending the first phase of construction.

Walterdale Bridge Rendering

Figure 4 - First Heavy Lift- 1000 tonnes, 86m Length

Phase 2 - Traffic Deck Installation

During the second phase of construction, the deck was installed in two parts:

- **In the first part,** the steel substructure of the deck was installed on towers on the berms where possible. Once the installation was completed, the assembly was elevated to be attached to pre-cut cables suspended from the arch. The hanger cable pins were then installed, the support from the towers beneath was removed, and the deck was suspended from the arch.
- **In the second part** of the installation of the deck, cranes located on the berms lifted steel components into place for cantilevered installation over the river. After each cantilevered bay was assembled, a cable stressing assembly, (designed and provided by Freyssinet), pulled the deck and the lower hanger fork towards each other to install the hanger pin. As each bay was completed, the erection fronts from the north and south side approached each other at the centre.

In its final condition, lateral stability of the bridge deck is provided by the concrete slab. Until the concrete could be placed, the deck was laterally supported at quarter points, and a temporary lateral bracing system was provided beneath the deck.

At each stage of construction, the geometry of the permanent structure was checked. This check involved a survey of the location of each of the hanger pins and the profile of the edge girders of the deck. This geometry was compared to the anticipated geometry of the structure based on a non-linear staged model, which was constantly adjusted to match the conditions on site.

The north assembly was initially installed 40mm north of its design position to ensure simple installation of the key segments. To complete the final connections of the key segment, jacks at the north abutment pushed the north half of the deck south to align properly.

All formwork and rebar for the concrete deck was placed simultaneously with steel installation, behind the construction front. When the steel installation was complete, all remaining formwork and rebar was installed. The alignment of the deck in the vertical direction was confirmed to be within the previously established project tolerances. The lateral alignment of the deck was adjusted slightly by applying jacks at the lateral supports at the edges of the berms, as well as at the deck support beams. The concrete of the deck was placed once the deck alignment had been determined as acceptable. **The completed bridge deck** is shown in Figure 4.

Figure 5 - Completed Steel Arch and Traffic Deck with Hangers Tuned

Phase 3 - Shared Used Pathway (SUP) Installation

The crescent shaped, trapezoidal steel box girder will be assembled adjacent to the deck in the third and final phase of construction will occur in the spring of 2017.

Using the same approach as the steel arch, **the SUP girders were fabricated in 25 individual segments.** These will be welded together prior to completion. The fabrication was complicated due to the complex geometry of the girders.

The SUP will be initially assembled on temporary towers above the berm, a similar process as that was used for the traffic deck. Once the portion of the SUP structure above the berms is complete, it will be jacked up to connect to the floor beam extensions of the deck and the hangers.

High capacity cranes will then lift portions of the pathway into place above the river. Floor beam extensions, hangers, and the splice to the previously installed structure will be completed prior to releasing the segments from the crane at the end of each lift.

When the full length of the SUP is installed, handrails, asphalt on the deck, and bituminous coating on the SUP will be installed on the bridge deck and SUP.

Once all permanent weight has been installed on the structure, the fine tuning of the cables can commence. The turnbuckles will be adjusted to change the unstressed length of the cables using cable tensioning equipment similar to that used for the installation of the hangers during deck installation. This adjustment will bring the geometry within the tolerances established by the design drawings and contract documents. In addition, changes to the unstressed lengths of the cables will change the tension distribution between cables. This will allow for the cable tension tolerances to be met.

The bridge is anticipated to be completed in 2017.

Owner – City of Edmonton
Owner's Representative – ISL Engineering
Arch Designer – COWI International
Deck and SUP Designer – Dialog Design
General Contractor – ACCIONA Pacer Joint Venture
Erection Engineer – Allnorth Consultants Limited
Heavy Lifting Subcontractor – ALE Heavy Lift

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