DESIGN AND CONSTRUCTION OF A 160-METRE-LONG WOOD BRIDGE IN MISTISSINI, QUEBEC

Denis Lefebvre¹, Grégoire Richard²

ABSTRACT: This article outlines the process and challenges involved in designing and building a new structure to span the Uupaachikus Pass in Mistissini, Quebec. The 160-metre-long bridge was designed using semi-continuous arches made of glued laminated wood (glulam) girders. The bridge is 9.25 metres wide and has spans of 37, 43, 43 and 37 metres. The glulam bridge features straight girders with a maximum length of 24 metres attached to 15-metre arched girders by means of steel plate assemblies. The arches are connected to the piers and abutments using pins.

KEYWORDS: Bridge, Mistissini, Glulam, Arch, Curved girders

1 INTRODUCTION

This article deals with the various challenges faced by the engineers during the design and construction phases and provides details of how the glulam structure was designed and built. The project was completed on behalf of the Cree community of Mistissini.

2 DESIGN

The design of the Mistissini glulam bridge itself is innovative. The glulam girder and arch assembly creates a series of semi-continuous arches. The connectors between the arched girders and the piers and abutments are designed to provide a pivot-type connection. The connectors between glulam girder segments are designed to transfer shear, compression and bending forces. The properties of glulam make it possible to eliminate expansion joints over the 160-metre bridge, giving the structure greater durability. All of the bridge bearings are fixed which distributes the seismic effects over all foundation units, thus reducing their cost.

The wood structure is protected by waterproof decking, including different layers of plywood and a waterproof membrane. The bridge has a steel guardrail and a steel plate covered with Bimagrip to cover the wood CLT walkway. The wood curb is also covered with a steel plate.

2.1 ARCHITECTURAL DESIGN

In order to span the 160 metres of the Uupaachikus pass, we chose four (4) spans of 37, 43, 43 and 37 metres. The arches had been added in order to minimise the effects of the interior spans and adding an architectural feature, key aspect to our concept.

2.2 GEOMETRICAL DESIGN

As shown in Figure 2, the division of the spans (37/43 m) has been set in order to balance the efforts and deflections of the bridge in each span.

The Mistissini bridge features straight girders with a maximum length of 24 metres attached to 15-metre arched girders by means of steel plate assemblies.

---

¹ Denis Lefebvre, Dessau, 375 boul. Rolland-Therrien, Longueuil, Qc, Canada. Email: denis.lefebvre@dessau.com
² Grégoire Richard, Dessau, 375 boul. Rolland-Therrien, Longueuil, Qc, Canada. Email: gregoire.richard@dessau.com
2.3 MAIN FEATURES

2.3.1 Arches
Due to the shape and placement of the arched girders with the continuous girders, bending moment is always negative in the arches, meaning that bending reduces the intrados bending radius. Even if the girder is curved, the bending effect does not penalize the bending resistance. In fact, this effect probably increases the value of the shear resistance because moments increase the perpendicular compression between the lams.

However, Canadian standards [1] do not consider this effect to increase shear resistance.

2.3.2 Steel plate assemblies

![Figure 3: Steel plate assembly and arch](image)

The design of the steel plate assemblies is based on [1] and uses $\Phi 6x60$mm annularly threaded nails. Each plate uses 38 nails. This assembly allows developing 70 kN in every direction. We have designed this assembly so it could be used in every connection, using more or less assemblies depending on the required resistance in bending and shear at the interface of the girders.

2.3.3 Waterproofing deck

Water is the main enemy of wood structures. For this reason we have to take extra measures in the details of the bridge in order to minimize water infiltration. We combined several construction details to obtain a waterproofing deck.

The longitudinal slope of the bridge is on average 2.5%, favouring a fast flow to a drain on the west side of the bridge, in the abutment. Drains are known to leak and cause infiltration problems. Therefore, having no drains on the bridge reduces the possibility of infiltration.

The deck is composed of several layers of materials detailed in Figure 4. Using a bituminous coating, several sheets of membrane, a plywood, a steel plate and flashing, we are able to reduce to a maximum the possibility of water penetration and stagnation in the wood.

![Figure 4: Detail of the waterproofing deck](image)

3 CONSTRUCTION

At the time of submission of the extended abstract, the bridge is under construction. The wood structure is still not installed, so there is no feedback at the moment. Therefore, this section will be developed in full in the paper.

Because of the remote location of the project, in Northern Quebec, the design favoured the use of local materials. Chantier Chibougamau, located 90 km from the construction site, was awarded the contract for the wood structure, ensuring that the wood used on this project comes from sustainable forests in the surrounding area.

The materials used in this project are Nordic Lam for glulam girders and panels, and Nordic X-lam for CLT panels.

4 CONCLUSIONS

The use of glulam gave us the opportunity to conceive a 160-metre-long bridge across Uupaachikus pass in Mistissini, with great aesthetic features. The cost of the bridge is affordable; it is even less than an equivalent steel-concrete bridge.

ACKNOWLEDGEMENT

First, we would like to acknowledge our client the Cree Nation of Mistissini for his confidence in our capacity to conceive such an innovative project.

Also we would like to acknowledge the work and help of everyone included in the project: Nordic and Chantier Chibougamau for their insights in the design of the wood structure, and all the engineers and technicians of Dessau who worked hard on the project.

REFERENCES

[1] CAN/CSA-S6-06 – Chapter 9
[2] CSA O86-9 – Article 10.9.4.2