INTRODUCTION

The Dalewood Bridge is a $4 million project located in the relatively small City of St. Thomas, Ontario. The bridge was built to provide access to the City, while providing community access to the surrounding Dalewood Conservation Area.

The bridge is an extradosed steel bridge that has a total length of 50m, consisting of two 25m spans and a central pier. It has a total width of 11.85m that carries two traffic lanes and a 3.35m multi-use path. It replaced an existing modular (Baily) bridge that was in poor condition and enhanced the bridge's function by increasing space for vehicular traffic and providing a safe way for pedestrians to cross the bridge while providing access to the park setting within the Dalewood Conservation Area.

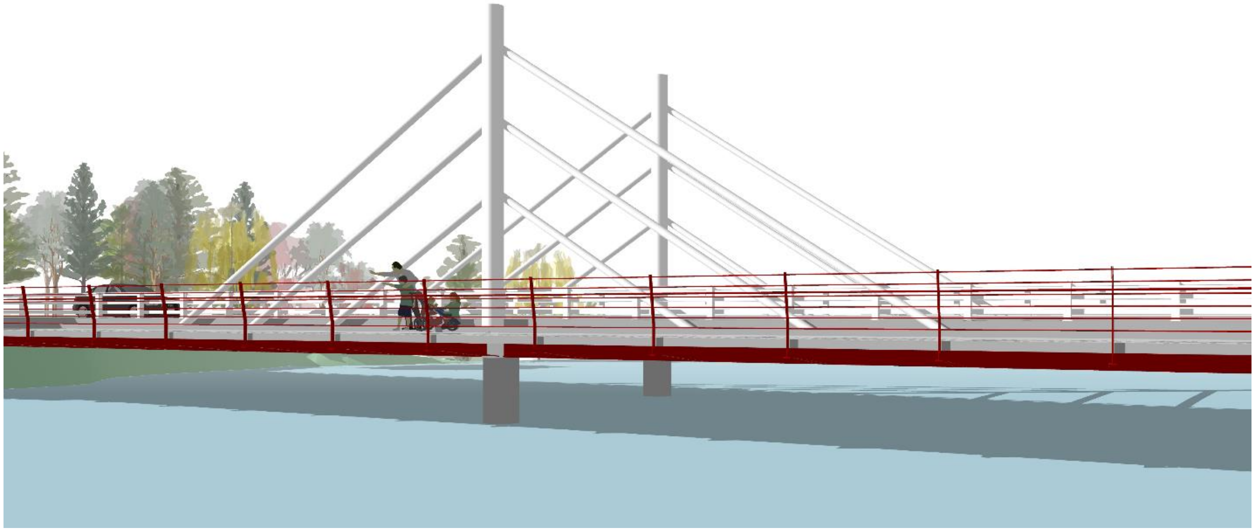
DOING THINGS DIFFERENTLY FOR A UNIQUE CLIENT

The City of St. Thomas is a relatively small city of 42,000 inhabitants and it had a relatively small $4 million budget for the type of bridge it was looking to construct. We knew we could do the work but we also understood that before we could get started, we had to get a firm grasp of our client – who they are, what they are looking for and how best to meet their needs.

VALUE ENGINEERING SESSIONS

During design development, we held a value engineering session, something not typically done for a project of this magnitude. We did it because we understood the uniqueness of the project, the City and their expectations.

We learned that the City wanted a unique, signature structure that could serve as a landmark feature. The structure needed to be more than a "bridge in a box" and accommodate concerns like building for both pedestrian and vehicular traffic and connecting the community to the natural park and surroundings. But, we also learned that budget was of the essence and so we would have to keep innovation up while keeping costs down. The next section on "Design and Innovation" addresses how we accomplished this to deliver ultimate value to our client.



Rendering of Dalewood Bridge developed from the first Value Engineering Session

COLLABORATION & LOCAL EMPLOYMENT

Post-tender, we held a subsequent value engineering session with the successful contractor, where we were able to shave an additional 10% off the project cost. This was incredibly important to the City, as their budget was small to begin with and we wanted to ensure we stayed true to that.

We also had to work through challenges related to public and agency issues, such as concerns related to nearby and affected fish habitat (which we managed to preserve working with the Kettle Creek Conservation Authority). We also had to seek MOECC, KKCA, and DFO permits and authorizations.

Finally, we worked closely with locals not just during design review and the value engineering sessions but as a team constructing the bridge. We hired a local general contractor and a local steel fabricator/erector, ensuring locals worked on the project and helping bring employment opportunities to the area.

Dalewood Bridge and the surrounding natural environment

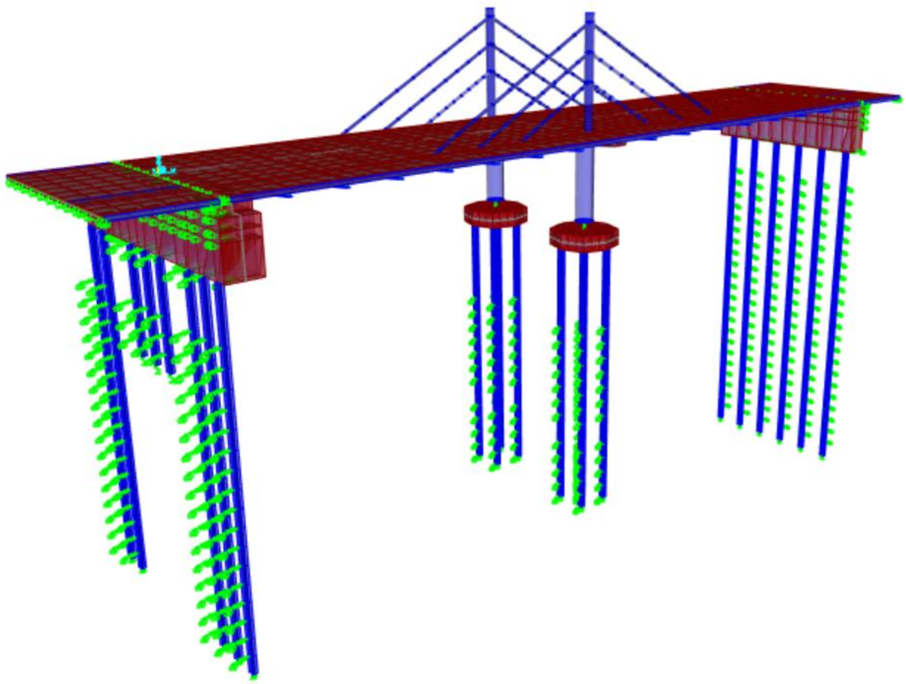
DESIGN & INNOVATION

There were many complexities and challenges to overcome in designing the Dalewood Bridge. From constructing over an existing Bailey Bridge, to unique challenges related to water depth, the Entuitive team worked hard and in collaboration to overcome these challenges and keep cost low to adhere to the City's small budget.

DESIGNING WITH NO COMPARABLES

We knew the City of St. Thomas wanted a unique design for their bridge to help in achieving the goal of creating a place maker.

Thus, another challenge was related to constructing a design with no known comparables. The technical design of the "extradosed steel bridge" was completed using a time-dependent staged construction analysis with careful consideration of the construction sequence and service life but using conventional analysis tools. Reviews by alternate methods and hand calculations were used to prove that the design was safe, durable, and comfortable as both a pedestrian and vehicle bridge.



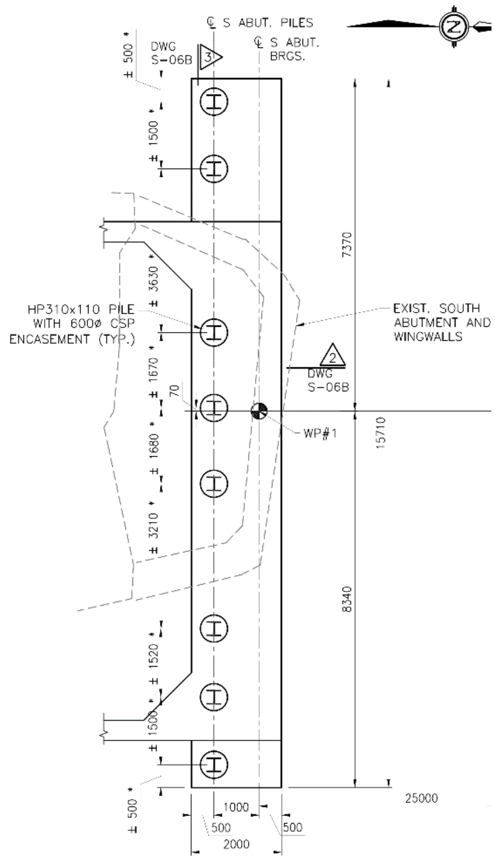
3-D Finite Element Model of Bridge Using CSiBridge Structural Analysis Software

DESIGNING OVER AN EXISTING BAILEY BRIDGE

The site already had a bridge – the "Dalewood Drive Over Reservoir Bridge", which was a Baily bridge built in 1983 and set up to accommodate one lane of vehicular traffic. The existing bridge had no record of rehabilitation and was in very poor condition and it was clear the City needed a replacement to help carry vehicular traffic over the reservoir. Given the poor history of upkeep, it was clear to us that we would need a design that required minimal maintenance in the years following construction.

Aside from the poor state of the bridge, the original design had no dedicated pedestrian area, presenting conflict between pedestrians and vehicles.

Designing over the bridge was difficult because the existing structure was about half the span of the new bridge. The pier foundation also had to be built just off the existing causeway, presenting a further challenge. As we began to build, we found that the existing south abutment was directly in the way of the new south abutment. To overcome this challenge, the new south abutment was designed as a transfer beam to bridge the existing abutment, without having to create a large cofferdam to remove the existing abutment.



Plan View of the New South Abutment Showing New Piles Spaced to Avoid Existing Abutment

The abutment wasn't the only challenge presented during construction of the foundations. Poor ground conditions and variable water depths necessitated the design of a circular corrugated steel pipe cofferdam that could be installed with the same equipment that would install the piles. The cofferdam could be sealed with a tremie plug anchored to the piles, thereby allowing the rest of the pier foundation to be constructed in the dry.

Installation of the circular corrugated steel pipe pier cofferdam off the end of the existing causeway

New pier column projecting from pier cofferdam

The solutions to both these problems were resolved in consort with the successful bidder in a design optimization process.

THE PIER – BOX GIRDERS & STEEL TUBE STAYS

The superstructure consists of two slender steel box girders with a composite concrete deck slab. Unlike typical U-shaped steel box girders that are common in North America, the box girders of the Dalewood Bridge were designed with full-width top flanges to significantly increase their flexural and torsional capacities. This innovation allowed the girders to be erected without falsework or bracing, thereby reducing cost and environmental impact. It also allowed them to be very slender. Typical box girders for a 25m span would be at least 1m deep. The Dalewood Bridge box girders are only 0.5m deep, resulting in the girders disappearing into the shadows under the bridge and presenting a pleasant visual appearance.

Slender box girders shortly after erection

A traditional bridge design would have featured a pier cap beam to land the girders on. A second beam, known as a pier diaphragm, would connect the girders to provide stability and to share lateral loads. To keep the Dalewood Bridge slender, it was decided to combine the pier cap beam and the pier diaphragm into a single beam that was in the same plane as the girders. This beam was erected with knife plates that were fitted into slots field cut into the tops of the steel pier columns. Field welds were used to complete the connection. This unconventional but simple and innovative approach allowed for a “field fit” that gave the contractor increased tolerance in constructing the pier. It also kept the superstructure as slender and aesthetically pleasing as possible.

Erection of the pier cap beam with knife plates projecting downward for connection to pier columns

Pier cap beam with knife plate fitted into vertical slot at top of pier column before welding

The design is also innovative in its use of steel tube stays and pylons to support the girders, like the design of extradosed concrete bridges. The stays were designed to be erected after the girders and before the casting of the deck slab. The weight of the deck slab acted to sufficiently tension the stays, such that they would not experience compression under combined dead and live loads. This innovation precluded a deliberate tensioning procedure, which would have added cost and complexity.

Steel tube stays and pylons before casting the deck

Finally, casting the deck slab integral with the abutments resulted in a jointless bridge without permanent bearings, features that have likely never been used before for an extradosed bridge. The absence of permanent bearings will preclude future maintenance. And the lack of joints between the ends of the bridge should reduce the volume of future concrete repairs, as there will be less pathways for de-icing chemicals to reach concrete surfaces.

PROVIDING LASTING VALUE

As we've emphasized, one of the defining challenges of this project was designing a signature bridge on a small budget.

We think we did just that. We provided value and met the clients' needs by designing an interesting and appropriate structure at a price they could afford. We even considered long-term impacts related to maintenance – since St. Thomas is a small City, they needed a bridge that they could feasibly maintain in the future and we gave them that.

A lot was taken into consideration during construction to minimize upkeep and the cost of upkeep to the City in the years to come.

Ultimately, we delivered on the main goals heard during the design phase – providing much more than a "bridge in a box", maximizing the budget and creating a landmark for the City.

Completed bridge after opening