BRIDGE BROS Engineering Inc.

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PENHORN LAKE PEDESTRIAN ARCH BRIDGE

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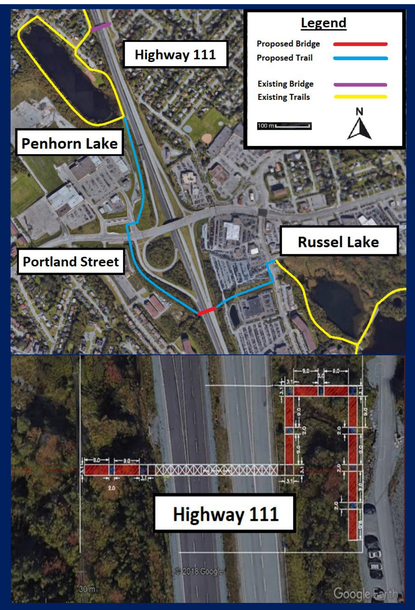
INTRODUCTION

The Penhorn Lake Area Trail Association has a long-term greenway plan to upgrade their trail located in Dartmouth, Nova Scotia. Integral to this long-term greenway plan is a connection crossing NS Highway 111 to the Russell Lake area. The solution is a pedestrian arch bridge that will span over the highway and connect the two trails.

The project scope involves:

- Establishing bridge dimensions.
- Selecting structural materials.
- Completing a detailed design of all structural components of the bridge.
- Class D cost estimate; construction schedule.

PROJECT LOCATION



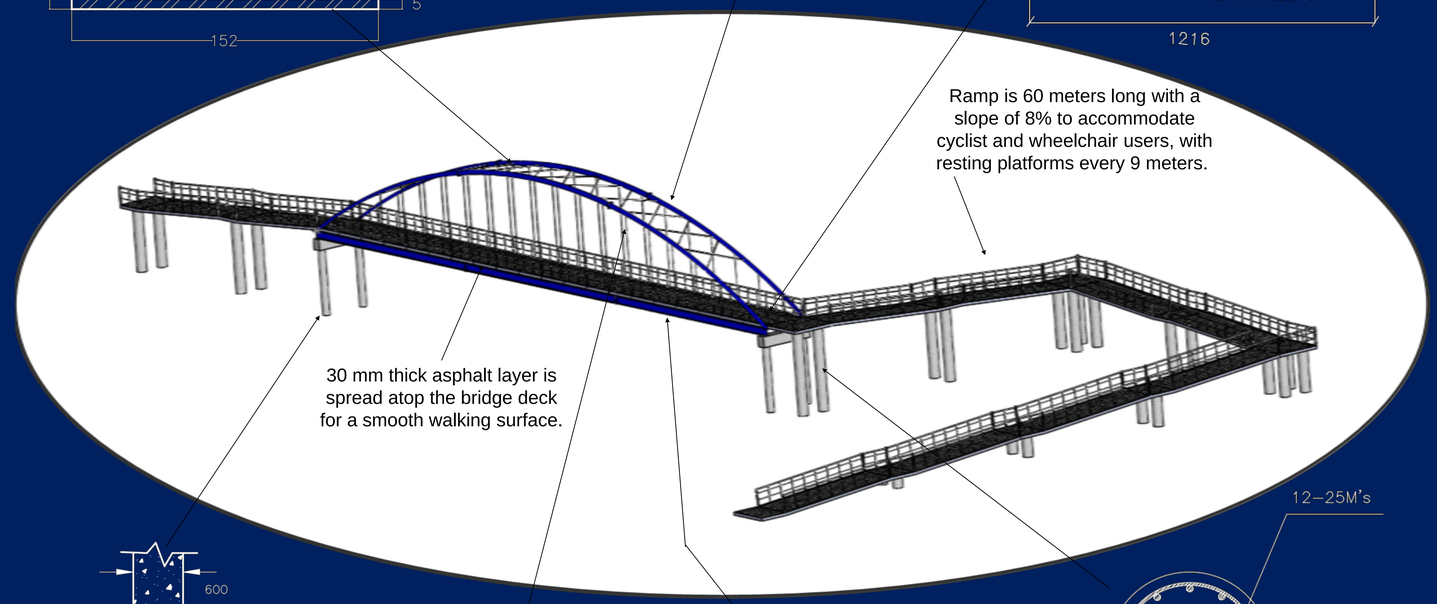
CONSTRAINTS

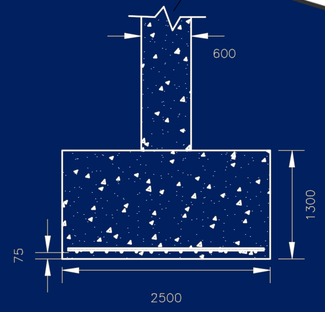
Bridge was designed such that it accommodates pedestrians and bicycle riders, and is wheelchair accessible.

Bridge must include a structural arch element for aesthetic purposes.

Top 4 meters of soil is unsuitable for supporting foundations.

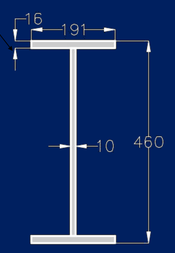
DETAILS OF FINAL DESIGN



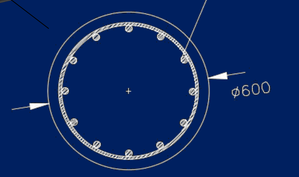


Bridge footings will be buried 4 meters underground. Footing dimensions satisfy shear and soil bearing capacity.

Cables spaced every 2.5 meters transfer force in pure tension from the girder to the arch.

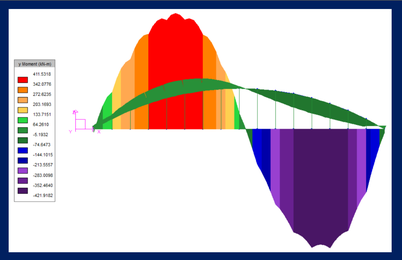


W460x82 wide flange beams are used for the girders. W shapes have the best geometry for resisting bending.

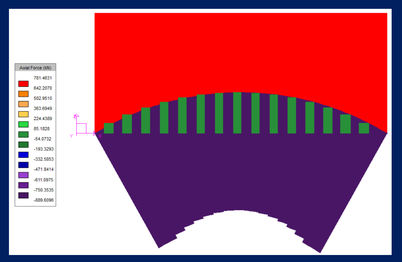


600 millimeters was determined for the column diameter taking slenderness effects into account, due to the column's length.

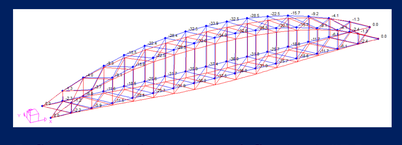
S-FRAME MODEL



Moment diagram for 1.25D+1.5L+1.0S loaded on half the span (worst case).



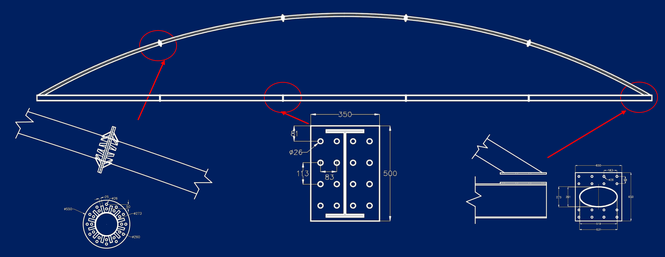
Axial force diagram for 1.25D+1.5L+1.0S loaded on entire span (worst case).



Deflection model. Maximum deflection is 37.5 mm under specified live load.

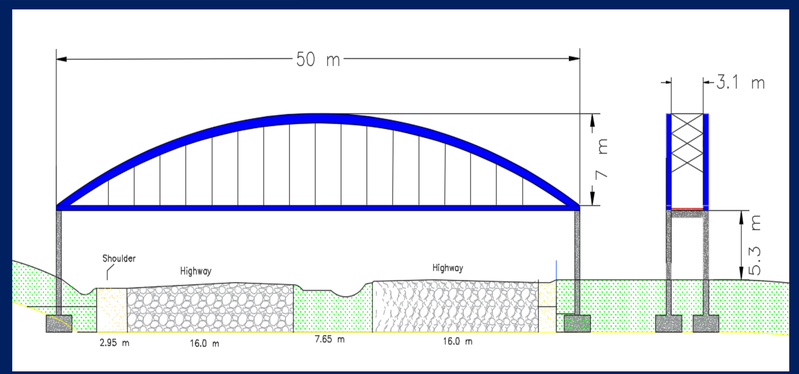
CONNECTION DETAILS

The arch and girder will be split into 5 segments, as circular HSS is only available in lengths up to 12 meters.



BRIDGE DIMENSIONS

- **50 meter span** was required to cross the four-lane, two-way divided highway.
- **3.1 meter deck width** was chosen to match width of Penhorn Lake trail.
- **5.3 meter deck height** accommodates large vehicles passing under deck on highway.
- **7 meter arch height** was chosen by modeling various arch heights in S-frame and choosing one that resulted in lowest self weight of steel members.



CLOSING SUMMARY

A tied arch bridge configuration was chosen to reduce the lateral loads transferred to the earth, thus reducing size of piers. The arch superstructure was modeled in S-Frame, where the calculated design loads were applied to the model to determine which steel members were strong enough to resist all load effects.

The steel arch members of the bridge will be fabricated in shop and transported to site by truck. They will be assembled on the side of the highway and then installed atop the concrete piers by crane. NS Highway 111 will be closed at night while bridge elements are installed using a crane. All concrete footings and columns will be cast-in-place. Hollow-core slabs will be used for the deck. The ramp will be precast and installed on-site.

PROJECT COST = $2.38 Million (CLASS D ESTIMATE)
ESTIMATED CONSTRUCTION TIME = 3 – 6 months

REFERENCES

- Autodesk AutoCAD (2016)
- CSA A23.3 - Concrete Design Handbook
- CSA B651-12 Accessible Design for the Built Environment
- CSA S6-14 Canadian Highway Bridge Design Code
- CSA S16-14 – Handbook of Steel Construction
- Geometric Design Guide for Canadian Roads, Chapter 5: Bicycle Integrated Design. Transportation Association of Canada
- National Building Code of Canada 2015
- S-Frame Software Version 2017.0.8