Klohn Crippen Berger

MAYERTHORPE RAIL BRIDGE REPLACEMENT

MAYERTHORPE, ALBERTA

CN

CANADIAN CONSULTING engineer

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KLOHN CRIPPEN BERGER

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PROJECT NAME	Mayerthorpe Rail Bridge Replacement
LOCATION	Mayerthorpe, Alberta
COMPLETED BY	2016
CATEGORY OF ENTRY	B. Transportation
ENTERING FIRM	Klohn Crippen Berger Ltd.
ROLE IN THE PROJECT:	Prime Consultant
PROJECT OWNER	CN Rail
PROJECT CLIENT	CN Rail
SUMMARY DESCRIPTION OF PROJECT	Klohn Crippen Berger (KCB) was retained by CN to complete a site investigation, design and supervision construction for a rail bridge replacement near Mayerthorpe, Alberta destroyed by fire on April 26, 2016. The goal was to restore service to Whitecourt and beyond within 3 weeks, which was achieved and service was restored on May 15, 2016. KCB worked in close collaboration with CN and other contractors to facilitate the fast-tracked construction.
NAMES OF CONTRACTORS INVOLVED	Challenger Geomatics Mobile Augers and Research ConeTec Journeaux Assoc.

Innovation

KCB was retained by CN to redesign the grade, track, and bridge layout, conduct a site investigation, design and monitor construction of the approach fills for a replacement of a 335 m long timber bridge that was destroyed by fire.

Service from Edmonton to Whitecourt was disrupted, impacting the oil, lumber, and gravel supply industries. This bridge is a critical link and CN was committed to have the line back in service within three weeks. Contractors were mobilized the day of the fire. A drone was used to capture photogrammetry and generate ground surface topography to provide a basis for design.

KCB worked in collaboration with CN Engineering and other contractors to complete the investigation, design and construction monitoring to achieve the timeline and manage the substantial risks associated with the execution of this type of project. Together, the team restored rail service in 20 days.

Given the compressed timeline for the design and construction, it was key to observe the performance of the foundation in response to construction and modify the design as the construction progressed. An observational design approach was implemented through installation and monitoring of both construction induced pore pressures through vibrating wire piezometers and foundation movements through inclinometers. Monitoring was implemented round-the-clock to help manage the risk of slope instability during and after construction, and to add confidence in the design assumptions and design criteria.

Along the toe of the western approach fill, a shear key and a toe berm was constructed due to ground conditions. The stability assessment conducted was based on assumed pore pressure response in foundation soils and it was key to monitor those pressures to be in line with design assumptions. Vibrating wire piezometers were installed in the surficial clays and deeper till layer along key stability sections, and were read three times per day to record changes in pore pressure in response to increased fill. Slope inclinometers were installed to monitor for movements in the approach fills.

Readings from the inclinometers were used to determine if these measures were sufficient. Inclinometers were read twice daily during construction and periodically after construction to confirm movements observed had slowed. Movements were also monitored with survey pins installed on the toe berm.

Complexity

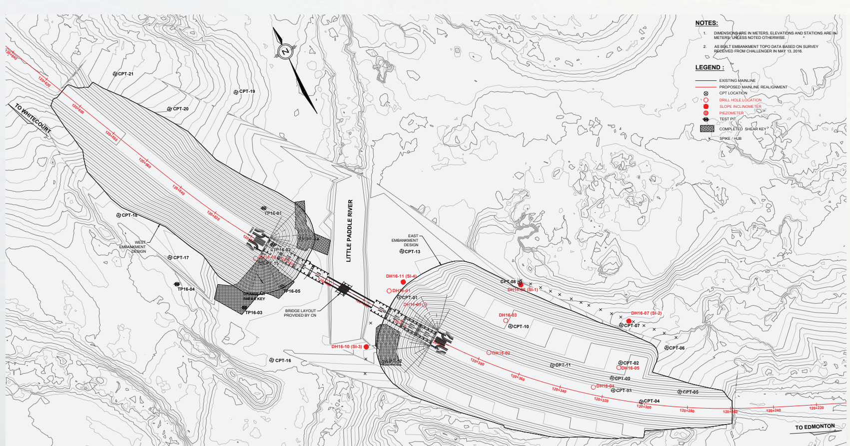
Suspected weak foundation soils under the proposed embankments required the design to utilize the observational approach, to allow adjustment of the design and construction based on performance of the fill. Previous movements of the track in the area had required stabilization measures.

To initiate the early start of the embankment fills prior to the results of the test drilling, a general slope configuration utilizing 2H:1V slopes was adopted. A granular shear key was designed under the north slope toe of the east embankment and a 5m berm was constructed to ½ the embankment height to mitigate against inferred weak soils.

Construction continued 24 hours a day and the engineering had to be completed at a similar pace. KCB and Journeaux Associates worked simultaneously to complete the pile design for the new bridge and stability analysis of the embankments. Simultaneous and independent methods were used to review, validate, and confirm the design results.

The bridge needed to be built and service restored within three weeks

The headslope of the approach fills had to maintain a minimum setback from the Little Paddle River due to environmental constraints. Shear keys were the only stabilization measure that implemented as it would stay within the footprint of the approach slope. The headslopes were founded on deep deposits of alluvial materials. Under the centre of the headslope there is rows of piles that were constructed to support the original bridge and new piles installed for the replacement span. These piles provide additional shear resistance through the centre of the headslope.



OVERALL PROJECT LAYOUT

Economic Benefits

The new bridge was constructed within 20 days, re-establishing rail service for the communities and resource industries affected by the disruption. Industries rely on the delivery of materials to manufacturing centers and the loss of rail service can have significant impacts on a wide variety of businesses and communities.

Environmental Benefits

CN elected to use a steel bridge span salvaged from a bridge abandonment project in BC reducing the requirement for new raw materials for the project. CN actively look for opportunities to reuse materials when appropriate. The saving of materials reduces the use of raw materials and also provides a supply of bridge components that are available at short notice.

The environmental impact of the project was reduced by use of the nearest available borrow source for the approach fills, and utilizing the organic stripping from the footprint as part of the stabilizing berm. Contaminated materials and soil was managed and disposed of in strict adherence to the applicable regulations. Baseline aquatic and terrestrial habitat was surveyed, protected and monitored during and after construction.

Meeting Client's Needs

CN's main goal was to have the line back in service within three weeks. This goal was met. KCB and contractors Challenger Geomatics, Mobile Augers and Research, ConeTec, and Journeaux Associates provided timely coordination of design and construction activities to maximize the efficiency of the schedule.

The final fill placement in the approach was completed on May 11 and the first train crossed the new bridge on May 15, only 20 days after the original bridge was destroyed by fire. The continuous monitoring of construction, design revisions in response to field observations, and close coordination between all the contractors, CN and the various other team members lead to a safe and timely completion of the project and resumption of rail service to all customers that had been without service since the fire.

In addition, follow up monitoring of the instrumentation has shown that pore pressures were dissipating and movements have stopped. CN observations have also showed no significant movement of the rail after months of being back in regular service.

The project required management of risk through independent reviews, coordination meetings, construction observations and communication of findings throughout the project. Experienced based design which was confirmed through analysis allowed for the fast-tracked construction to proceed even before the site investigation started. The project was very challenging but was managed through aggressive design, observations during construction, and, most importantly through collaboration.

DISPLAY BOARD

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MAYERTHORPE, ALBERTA

APRIL 26

Trestle bridge on CN rail line between Edmonton and Whitecourt is destroyed by fire, causing several million dollars worth of damage and impacting service to nearby communities.

APRIL 27

As soon as the fire was extinguished, teams were mobilized to remove the debris and begin preparation for the new approach fill embankments and bridge.

APRIL 30

To expedite construction, earthfill activities, installation of piles and bridge piers, installation of monitoring instrumentation, and fabrication of the bridge sections took place simultaneously on site.

MAY 9

As construction nears completion, the final instrumentation is installed, new piers were welded together and backfill of the bridge approaches is completed.

MAY 13

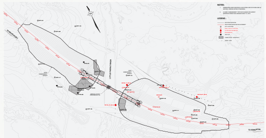
The last of the earthfill has been placed around the bridge piers and the concrete bridge deck has been installed. Final cleanup being completed prior to reactivation of the rail service.

MAY 15

Rail service is restored and the site cleanup is complete. More than 190,000 metric tonnes of material was used to build the new bridge constructed of steel, concrete and fill. The completed structure stands about 14m tall and 335m long.

Klohn Crippen Berger was retained by CN Rail to complete the redesign of the grade, track, and bridge layout and, concurrent with the construction, complete a site investigation; implement observational approach design; and monitor construction of the approach fills for an emergency bridge replacement near Mayerthorpe, Alberta that was destroyed by fire on April 26, 2016.

Service to Whitecourt and beyond was disrupted by the fire impacting business, particularly the oil and lumber industries. A critical link in the rail infrastructure, the goal was to have the line back in service within three weeks. KCB worked in close collaboration with CN Rail and other contractors to complete the investigation, design and construction monitoring to facilitate the fast tracked construction. Suspected weak foundation soils prompted the design of the embankment fills using the observational approach to adjust the design during the build. Decision made to replace the original 335m long timber trestle with approximately 50m of steel and concrete bridge and two 150m long approach fills. Together the team restored rail service on May 15, 2016.



OVERALL PROJECT LAYOUT

CPT AND DRILL HOLE LOCATIONS

CLIENT

CN

CONTRACTORS

MobileAugers and Research Ltd

Challenger Geomatics Ltd.

Journeaux Assoc

ConeTec

AERIAL PHOTOGRAPHY

Pipistrel Aircraft Canada

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