SLIDE. FREEZE. LAUNCH.

The Fort Nelson Bridge

Prepared for the Canadian Consulting Engineering Awards 2019

Submitted by: McElhanney

Category: B — Transportation

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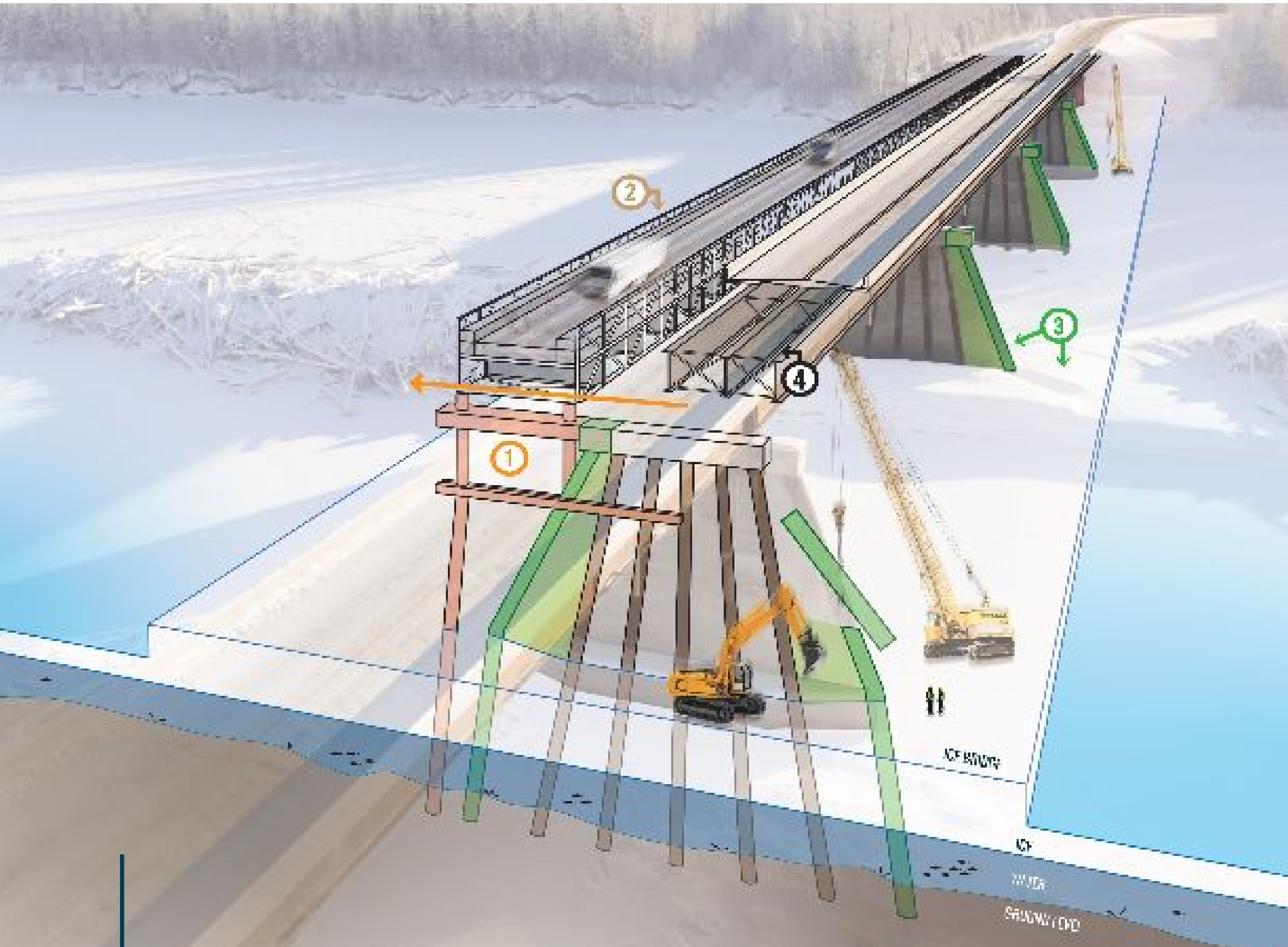
Contents

Project Outline

1. 75-Word Summary

The 430m long Fort Nelson River Bridge, which supports the natural gas, oil, forestry, and tourism industries in northern BC, and connects BC to the Northwest Territories, needed a superstructure replacement and substructure retrofit. McElhanney's innovative, cost-effective, and sustainable design included an ice bridge construction platform and sliding the superstructure onto piers for use as a detour. This $35-million project, completed for BC's Ministry of Transportation and Infrastructure, demonstrates a conventional bridge requiring unconventional engineering.



1 Transverse slide. 2 Existing superstructure used as traffic detour.

3 Ice bridge used for construction. 4 Incremental launching of steel girders.

McElhanney devised a traffic staging scheme whereby the existing superstructure was slid 10.5m onto temporary pier extensions to serve as a traffic detour.

2. Project Highlights

Q1. INNOVATION

When the Fort Nelson River Bridge was built in 1984 in northern British Columbia, the project only had funding for the substructures (foundations and piers), so a temporary single-lane Acrow superstructure was installed on top. Eventually, the superstructure (steel truss with a timber deck) was not meeting the needs of local industrial traffic. Vehicles had to queue up at either end of the bridge and wait to cross due to the single lane. McElhanney was retained to design the replacement of the existing superstructure with a permanent two-lane deck and to retrofit the substructures. What made this project unique was the need to work with northern BC's extreme weather conditions, an environmentally-sensitive river, pre-built substructures, and the need to maintain traffic during construction.

INNOVATIONS

To maintain traffic flow, the Acrow superstructure was transversely slid 10.5m onto temporary pier extensions for use as a traffic detour. Slides are risky, because the bridge could become jammed or damaged if the pulling operations do not operate within a narrow tolerance. However, guided by McElhanney's specifications, the contractor achieved the slide within 17 hours during an unexpected snowstorm. This solution prevented the expensive labour of a new bridge, used existing materials, and kept the highway open.

For the substructure piers retrofit, an ice bridge was used as a platform for workers to access the bridge and store construction equipment. Workers drilled through the ice to the water level, then sprayed water onto the river surface and graded it flat. Constructing from an ice bridge is relatively rare, as highway bridges are generally in warmer climates, and in-river works are usually conducted from temporary berms or trestles. This sustainable and cost-effective solution required no additional materials but necessitated the completion of retrofit activities during the winter.

RELATIVE COMPARISONS

McElhanney's design had to enhance durability and reduce life-cycle maintenance costs — not a typical requirement on similar projects. To achieve this, full superstructure continuity was provided over the entire 430m length, with expansion joints limited to abutments only. This solution means the deck protects the structural steel underneath it, and fewer expansion joints means there are fewer bridge components to maintain. However, this required an inventive articulation scheme to ensure the retrofitted substructures could accommodate thermal forces. The girder depth was transitioned by about 2m from the longer 76-58m river spans to the shorter 35m land spans using tapering segments, which achieved girder continuity and structural efficiency.

The ice bridge is a sustainable construction methodology. The platform allowed workers to access the substructure for the retrofit, and to store cranes and equipment.

Q2. COMPLEXITY

UPGRADES & UPDATES

As a long river crossing in a remote northern setting, the bridge was more complex to engineer than a typical girder bridge. Geometric and structural compatibility between the new superstructure and existing substructure was needed, a constraint not typical on rural projects. The original bridge was designed using standards from 1977, and since modern trucks are heavier, additional piles had to be driven into land piers and the north abutment was replaced to accommodate modern loads. It was critical to ensure compatibility, because if the substructure is not compatible with the superstructure, the bridge could be damaged or structurally fail. The girders were detailed to suit the existing geometry, which avoided major modifications to the pier cap and bearing seats.

REMOTE SITE

The project was complicated by northern BC's relatively short construction seasons. At 68km away from the nearest town, Fort Nelson, access to further materials and crews was challenging. Therefore, the design was configured with easy-to-follow details for on-site assembly and faster installation. McElhanney designed the steel girders to accommodate incremental launching, which allowed them to be erected more quickly than a conventional crane would have allowed. This technique also avoided disruption of the river ecology. To speed up deck casting, a linear pour sequence was developed. Simple lock blocks were used to preload mid-span regions of the bridge prior to casting the preceding above-the-pier region. In a typical deck pour sequence, all midspan deck regions are cast first, but this would have taken more time.

Q3. SOCIAL & ECONOMIC BENEFITS

FEDERAL & PROVINCIAL INITIATIVES

The replacement and rehabilitation of the Fort Nelson River Bridge was funded as part of British Columbia's provincial initiative *On the Move*, which contributed approximately $19.6M, and by the Canadian federal government's *New Building Canada Plan*, which contributed approximately $15.4M. These commitments recognized the social and economic value in upgrading the bridge.

SUPPORTING LOCAL INDUSTRY

BC's economy has grown in the past decade and so too has its need to safely connect people and cargo. Fort Nelson is in the Northern Rockies Regional Municipality (NRRM), which lists oil and gas, forestry, and tourism as its strongest economic pillars. The bridge is part of a vital route for natural gas (including access to the Fort Liard natural gas basin, one of the largest of its kind in BC), forestry, and mining activities. The bridge permits industrial vehicles to transport goods and supplies, while also servicing tourism. The bridge is near the Alaska Highway, which the NRMM estimates is used by more than 300,000 tourists annually, and forms part of Highway 77, which leads to the Northwest Territories, Nahanni Park, and Fort Simpson – all of which are tourist destinations.

The upgrade of the bridge from a single lane to two has eliminated the transportation bottleneck at the site, as vehicles previously had to queue up at each end of the bridge in order to cross. This has improved overall safety for industrial, residential, and tourist use.

The original bridge was built in 1984 to support local industries including forestry, mining, natural gas, and tourism. The continued economic importance of these industries today made the bridge's rehabilitation critical.

The overhead incremental launch of the steel girders meant no interference with the river below.

Q4. ENVIRONMENTAL BENEFITS

A SENSITIVE ECOSYSTEM

River crossings always pose challenges in terms of disruption to local ecology and the bridge was no exception, as it crosses a sensitive ecosystem. The Fort Nelson River is connected to the Liard River, which originates in the Yukon and hosts Pacific salmon, among other species. Downstream from the bridge is the Fort Nelson River Ecological Reserve.

SUSTAINABILITY

Using an ice bridge to complete retrofit works is a sustainable methodology that works with the environment, rather than against it. This approach also prevented the need for additional materials and costs. While an ice bridge is a cost-effective solution, it can be risky if not done well. The bridge had to maintain a minimum required ice thickness to ensure stability and safe accommodation of the workers and equipment for the duration of the works. The ice bridge, combined with the overhead launching of the steel girders, were solutions that minimized interference with the river.

REDUCED MATERIAL USE

McElhanney's design reduced the need for new materials. Existing materials, such as the piers, were rehabilitated and upgraded rather than discarded, and the use of the existing superstructure as a traffic detour was a sustainable solution requiring only temporary pier extensions. The Acrow bridge was salvaged, distributed in smaller spans, and stockpiled by the Ministry in various regions of the province for use in emergency situations such as flood or earthquake damage. The steel used in the temporary works was taken to the contractor's yard for reuse on other projects.

Q5. MEETING CLIENT'S NEEDS

ENHANCING INFRASTRUCTURE

The Ministry's project priorities were to keep traffic open during construction, ensure compatibility between the substructures and the superstructure, engineer a design with low life-cycle costs given maintenance concerns, and complete work within two construction seasons. The Ministry also wanted to increase safety, capacity, mobility, and reliability, support a reliable transportation network, and enhance the movement of goods and services to the community for an economic benefit.

McElhanney successfully met the Ministry's needs. The existing superstructure detour allowed traffic to flow unimpeded, subject only to a one-day closure while the transverse slide was completed. Compatibility between the superstructure and substructure was achieved through strengthening the piers and other substructure modifications. The gradual transition of the girder depth, achieving overall superstructure continuity, promoted durability and will reduce maintenance needs. To complete the works in the short construction seasons, McElhanney's design incorporated accelerated bridge construction techniques, such as incremental launching of girders and linear deck casting operations.

DELIVERING TO BUDGET & SCHEDULE

The new lane has increased capacity and mobility in support of the local industries (forestry, mining, natural gas, and tourism) and the replacement of the temporary timber superstructure has delivered a reliable, safe, and long-term infrastructure solution.

Of the project, the Ministry's Regional Project Manager Brian Taylor said:

"McElhanney's design accounted for the importance of the highway to the users, both public, and the industry. The remote location, a short construction season, difficult weather, and changes to the design scope posed challenges, however the project was completed within budget."

The new bridge is longer than three soccer fields and has five spans that are each 50-76m long, as well as approach land spans about 35m each.