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DESIGN-BUILD AND LAUNCHING OF A REMOTE, LONG-SPAN STEEL GIRDER BRIDGE

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ABSTRACT: The Ksi Gingolx (Gingolx River) Bridge on the North Coast of BC near the Village of Gingolx is a three-span steel I-girder bridge with an 80 m clear span over the tidal and environmentally sensitive Ksi Gingolx. The remoteness of the site necessitated all elements to be prefabricated off site and erected with a minimized construction schedule. Due to access limitations with full road access only available from the south side, the bridge was designed to be launched from one side of the river to the other, making use of the two smaller jump spans in a temporary lowered configuration as a pseudo launch nose. Upon completion of the launch, the nose was split into the two jump span segments and positioned in their final configuration. The jump spans were designed to rotate with the anticipated settlement of the approach fills required to bring the existing road to the new abutments. During a seismic event triggering liquefaction, the abutments and jump spans are permitted to translate without imposing critical kinematic loading on the main span piers. Freeboard constraints forced the use of shallower girders with span-to-depth ratios of 35, creating vibrational sensitivity that required additional consideration. The bridge utilizes weathering steel girders, galvanized piles where exposed to sea water, and semi-integral abutments to maximize longevity. The detailed planning of the design permitted a high-quality, rapidly constructed, and economical bridge that effectively serves the needs of the local community with minimal maintenance requirements.

1. INTRODUCTION

Nisga'a Construction Inc. (NCI) initiated the design and construction of a new bridge crossing over the Ksi Gingolx, located immediately to the northwest of the Village of Gingolx on British Columbia's North Coast. The Village of Gingolx is a Nisga'a community accessible by a single road corridor, making reliable bridge infrastructure essential to the community's connectivity, safety, and long-term development. The existing 3-span, simply supported, 77.4 m long Acrow-style bridge at approximately the same location was constructed in 1976 for a single alternating traffic lane and had been identified as no longer meeting current performance demands, with deterioration observed in its substructure. A new bridge was recommended to provide improved safety while accommodating standard BCL-625 / CL-800 vehicle loading as well as intermittent heavy L-100 vehicle loading. This capacity was required to support nearby work associated with the Gingolx Harbour breakwater project and a future adjacent residential development, while also serving the community's broader and long-term infrastructure goals. The existing Acrow bridge is to be removed.

The project presented several challenges that collectively shaped the design from an early stage. Road access to the site is limited to the south bank, with the north bank reachable only by marine transport, making conventional construction methods involving falsework or in-river craning impractical. The Ksi Gingolx is an environmentally sensitive tidal river with active debris transport, hydraulic restrictions on channel obstruction, and limited available structural depth due to freeboard requirements. The site geology introduces the potential for soil liquefaction during seismic events, a condition that imposes significant kinematic demands on substructure elements if resisted directly.

These constraints drove the development of a highly prefabricated bridge system in which the construction methodology, structural behaviour, and seismic design philosophy were shaped together from the outset. An incremental launching strategy eliminates the need for in-stream falsework entirely, while the jump spans serve a dual role as a temporary launch nose before being repositioned into permanent service. The seismic design accommodates rather than resists liquefaction-induced ground movement, protecting the main span piers from demands that would have been impractical to resist directly. The final design is a 110 m long, three-span steel plate girder bridge with a precast concrete composite deck, an 80 m main span over the active channel, and two 15 m jump spans connecting the main structure to the approaches on each bank.

This paper presents the Ksi Gingolx Bridge as a case study in design-build delivery under remote and technically demanding conditions. Emphasis is placed on how the site constraints shaped the structural arrangement and construction methodology, how the seismic design philosophy was tailored to the geotechnical realities of the site, and how the launching strategy was developed and analyzed.

2. PROJECT CONSTRAINTS

The design of the Ksi Gingolx Bridge was governed by a combination of logistical, environmental, hydraulic, and geotechnical constraints. These constraints significantly influenced the bridge alignment, structural arrangement, construction methodology, and seismic design.

2.1 Site Access and Right-of-Way

The remote location of the project created significant construction challenges. The Village of Gingolx is accessible by a single road corridor from the south, and as shown in Figure 1, the Ksi Gingolx separates the village from the harbour and future development areas to the northwest. Full road access to the bridge site is available only from the south side of the river, while the north bank can only be reached by marine transport. Delivery of heavy equipment and construction materials to the north side therefore requires barge transportation, increasing construction complexity and cost. Although the existing bridge could potentially be used to transport some materials, its load-carrying capacity limits the size and weight of equipment that can be moved across the river.

Figure 1: Aerial view of the Village of Gingolx showing the Ksi Gingolx River, the existing bridge crossing, Gingolx Harbour, and surrounding development areas referenced in the project scope.

2.2 Environmental Constraints

The Ksi Gingolx River provides important fish habitat and is subject to environmental regulations that restrict in-stream construction activities. Obtaining permits for temporary works within the active channel can be challenging and may impose seasonal construction windows that significantly affect project schedules. Environmental considerations also influenced the location of the bridge piers and approach embankments. Attention was given to minimizing impacts on the high-value fish habitat located along the west approach of the crossing. Reducing the footprint of permanent works within environmentally sensitive areas was therefore an important consideration during concept development.

2.3 Hydraulic Constraints

The bridge crossing is located within a tidal reach of the Ksi Gingolx River where hydraulic conditions are influenced by both river flows and tidal fluctuations. The river channel experiences significant debris transport, particularly during high-flow events and high tides, creating challenges for bridge pier placement and long-term maintenance.

Hydraulic performance requirements limited the acceptable obstruction of the channel and required consideration of scour and backwatering. In addition, the potential for debris accumulation around substructure elements had to be minimized to reduce maintenance requirements and avoid adverse hydraulic effects during extreme events.

Hydraulic design considerations also extended beyond the bridge footprint. The channel geometry upstream of the crossing was identified as an important factor influencing flow distribution and debris transport through the bridge opening. As a result, modifications to portions of the stream channel adjacent to the crossing were identified as a potential requirement to improve hydraulic performance and reduce the risk of debris accumulation.

Finally, freeboard requirements associated with the hydraulic design of the crossing limited the available structural depth for the bridge superstructure. These restrictions constrained the vertical geometry of the bridge.

2.4 Geotechnical and Seismic Constraints

The site geology introduced a further constraint with significant structural implications. Given the geological environment of the site, liquefiable soils are expected to be encountered on site, which can cause lateral flow issues that are very challenging and costs to resist directly due to the high kinematic loading on the piles.

3. CONCEPT DEVELOPMENT AND STRUCTURAL SYSTEM

The bridge concept was developed to address the combination of constraints present at the site. The resulting structure combines a highly prefabricated steel girder and concrete deck composite superstructure with precast substructure elements and minimal in-stream work. Attention was given to accommodating potential liquefaction-induced ground movements, maintaining hydraulic performance within the tidal river environment, and facilitating rapid construction in a remote location where access to one side of the river is limited.

3.1 Bridge Alignment

The bridge alignment was established upstream of the existing bridge, primarily to avoid culturally sensitive areas located downstream of the crossing. A downstream alignment would have been preferred from a roadway geometry standpoint, as the upstream location requires tighter approach curves and the river is wider in this direction. However, the upstream position offers meaningful practical advantages, as shown in Figure 2. The overhead powerlines on the downstream side would have complicated crane operations, and connection of the existing waterline is more straightforward at the upstream location.

Figure 2: Aerial view looking south showing the approximate upstream alignment of the new bridge highlighted in red, relative to the existing Ksi Gingolx Bridge and surrounding site features.

3.2 Overall Arrangement

The new bridge consists of three simply supported spans: a central main span of 80 m between the two piers and two 15 m jump spans, as shown in Figure 3. The piers are positioned to stay out of the active river channel due to environmental restrictions, while also aiming to minimize the environmental impact of the approach fills on the west approach to the bridge, which passes through high-value fish habitat.

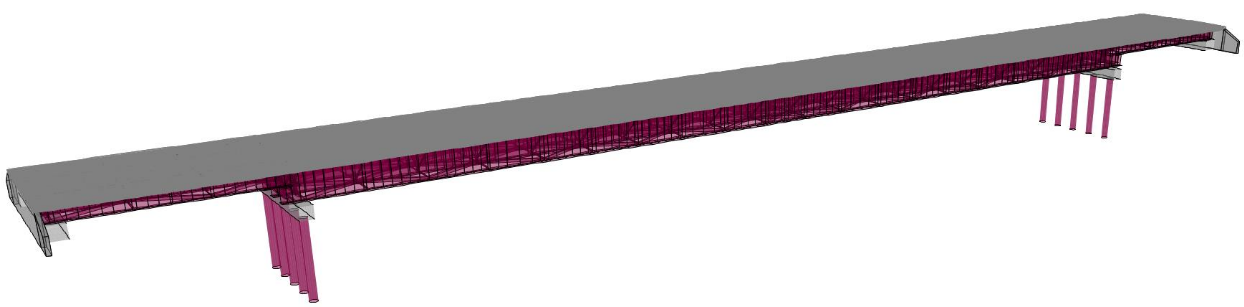


Figure 3: Perspective rendering of the Ksi Gingolx Bridge CSiBridge model showing the steel superstructure, precast concrete deck, piers, and jump spans at each abutment.

The bridge deck is 11.12 m wide, providing an 8.20 m clear roadway and 1.95 m clear sidewalk on west side. The bridge is designed for two lanes of traffic and accommodates CL-800 loading per CSA S6:25 and has been pre-evaluated for the occasional passage of L-100 off-highway vehicles under permit. The design speed is 50 km/h.

3.3 Substructure

The two main span piers are supported on groups of 610 mm diameter steel pipe piles. The piles are hot-dip galvanized at the top 6 m and where exposed, providing long-term corrosion protection in the aggressive marine environment. The piles at the North pier are expected to be driven to bedrock, and South pier driven to a deeper tip elevation.

The pier caps are comprised of precast concrete units seated on the pile group and detailed with embedded steel plates and anchor rods for connection to the girder bearing assemblies, as shown in Figure 4. The abutments are similar precast concrete units with wingwall units installed on each side of the abutment bearing shelves. The precast units are fabricated off-site and delivered to site for ease of handling and assembly, consistent with the rapid construction philosophy employed throughout the project.

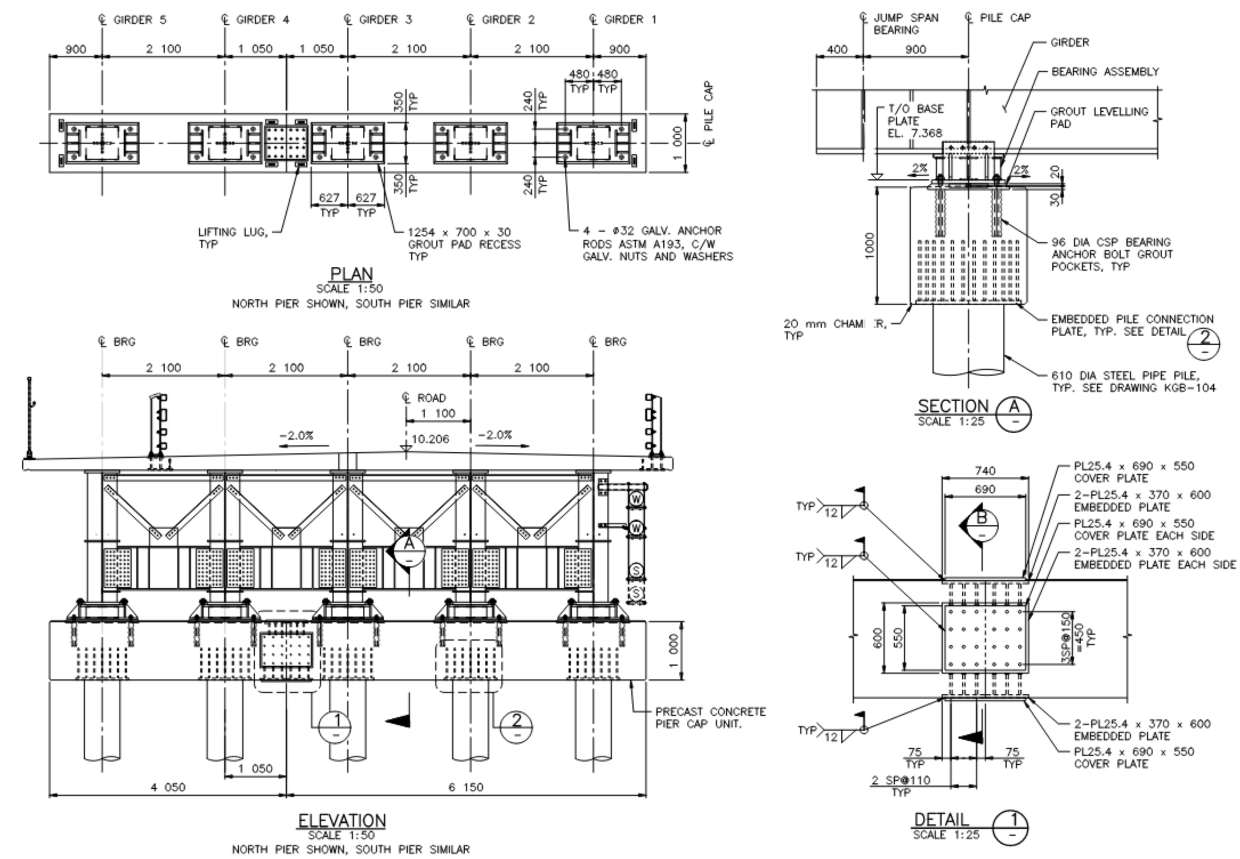


Figure 4: Precast pier unit details.

3.4 Jump Spans

The east and west jump spans are symmetric and equal in length to simplify the design and reduce fabrication costs. They serve a dual purpose. During normal service, they bridge the gap between the outer pier caps and the abutment seats. The jump spans were designed to rotate with the anticipated settlement of the considerable approach fills that were required to bring the existing road to the new abutments. During a seismic event that could trigger liquefaction of the underlying soils, the abutments and jump spans would be permitted to translate longitudinally without imposing critical levels of kinematic loading on the main span piers. Additionally, these jump spans were carefully detailed to be temporarily connected together near the bottom of the mainspan girders on the north side of the bridge to act as the launch nose in the staged launching required for the erection of the bridge, as will be subsequently discussed later in the paper.

3.5 Steel Superstructure

The main span and jump spans are composed of five parallel weathering steel I-shaped plate girders, fabricated from segments with varying flange thicknesses and widths to suit the flexural demands across the bridge length. Deeper, wider flanges are used at midspan segments where bending demands are greatest, while narrower flanges are employed over the piers where moment demands are reduced. The web plates are held constant in depth across all segments to reduce fabrication complexity, with additional vertical stiffeners provided at pier locations to address the elevated shear demands at these points. Both the main span and jump span girders are fabricated with camber to accommodate deflections under self-weight of the structure.

The main span girders have a span-to-depth ratio of approximately 35, making the bridge relatively slender for its span. This was required by the available freeboard at the crossing. Concerns regarding vibrational sensitivity due to the high span-to-depth ratio were checked following the static deflection limits for superstructure with occasional pedestrian use using CSA S6:25 vibrational performance provisions. Field splices between girder segments were strategically placed considering ease of fabrication and construction, and detailed relative to the demands across the span using high-strength bolted connections. Girders are cambered to lead to a longitudinal grade of 0% across the main span.

The girders are braced transversely at regular intervals using cross frames composed of angle members, providing stability against lateral torsional buckling of the compression flanges and ensuring adequate stiffness during the early stages of construction before the deck is in place. Plan bracing using WT sections is provided throughout the bridge.

The jump spans are shorter, shallower plate girder sections, detailed to accommodate the expected settlement of the approach fills and the lateral translation associated with a liquefaction event. The jump span girders are connected to the main structure only through the bearing assemblies at the connection to the main span girders, allowing them to move independently under seismic conditions.

3.6 Deck

The bridge deck consists of full-depth precast concrete deck panels placed across both the main span and jump spans. The panels are compositely connected to the steel girders through groups of Nelson studs installed in circular patterns within pockets in the panels. The stud pockets are created using galvanized corrugated steel blockouts cast into the panels during fabrication. Once all panels are positioned, high-strength non-shrink grout is poured into the stud pockets to complete the composite connection with the firders. A pair of deck panels are connected together at the centre girder at every cross-section of the bridge to accommodate camber differences among the bridge’s 5-girder system, as shown in Figure 5. This approach eliminates formwork and significant wet concrete work over the river, reduces on-site construction time, and delivers consistent panel quality through shop fabrication.

Link slabs are used above the joint of the main span and jump span girders. Due to the rotation of the simply supported span ends, particularly with the movement of jump spans allowed under approach settlement, high seismic loading, and liquefaction, cracks are expected to develop in the link slab panels. The links span panels are designed using cracked section properties and minimal stud groups to reduce composite action with the girders.

The deck surface is detailed with a crossfall of 2.0% transversely to both sides of the roadway centerline for drainage. Embedded anchor bolt assemblies are cast within the deck panels for rapid installation of accessories on site. A steel post-and-guardrail system is installed along the full length of the bridge. A standard steel bicycle fence and guardrail with timber top rail is provided on the downstream side to accommodate pedestrian and cycling use, consistent with the bridge's role as a community connection.

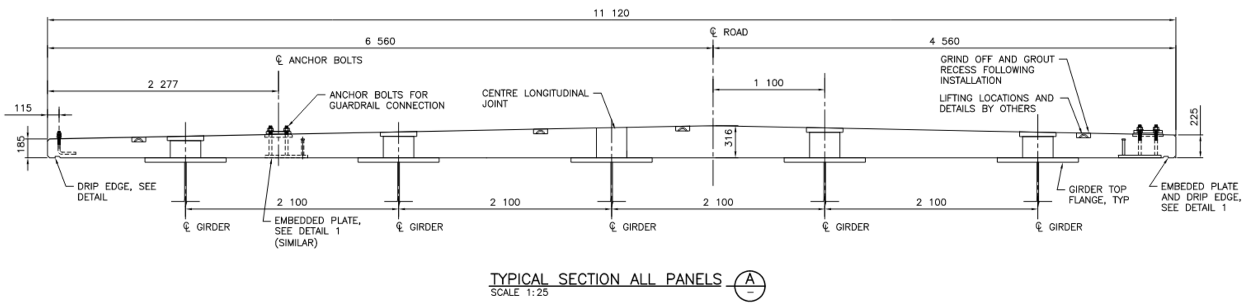


Figure 5: Typical deck panel section over mainspan and jump spans of the bridge.

3.7 Utilities

An existing waterline located upstream of the existing bridge is relocated onto the new structure. The utility is hung beneath the deck panels on the upstream side of the main span and side spans using a galvanized HSS system with hanger rods and lateral bracing. A side-mounted arrangement is used, with the line transitioned into the approach embankments at each end of the bridge.

4. PROPOSED CONSTRUCTION STAGING

The construction sequence for the Ksi Gingolx Bridge was developed in direct response to the access constraints of the site. With full road access available only from the south abutment, heavy equipment and materials on the north bank must be delivered by barge. This limitation, combined with the environmental sensitivity of the river corridor, made a conventional erection approach involving falsework or in-river cranes impractical. Instead, the bridge was designed to be launched from south to north, with all major structural components prefabricated off-site. The superstructure components are able to be assembled in segments and incrementally launched without the need to assemble the full bridge length in advance on the limited space for staging on the south bank.

4.1 Construction Sequence

Construction begins with installation of the bridge substructure. The 610 mm diameter steel pipe piles for the north and south piers are driven from crane positions located on the existing approach embankments, avoiding the need for equipment access within the active river channel. Once the piles are cut off at the correct elevation, the precast concrete pier cap units are placed onto the pile tops and connected using field welds to the embedded steel plates. In parallel, the precast concrete abutment bearing shelf units and wingwalls are similarly assembled and installed on both banks. The approach embankments are constructed and compacted to bring the existing road up to the new bridge deck elevation.

The girder launching sequence is illustrated with six key steps in Figure 5. A sloped launch bed is set up at the south bank and rocker beams with rollers are installed on the pier caps to facilitate sliding movement of the girders. Construction of the steel superstructure begins on the launch bed with the first main span segment assembly of girders and diaphragms. As discussed earlier, two jump span girder segments are spliced together and connected to the north end of the main span segment in a temporary lowered configuration to form a pseudo launch nose (Step 01).

Launching proceeds incrementally from south to north. Launch winches are positioned at the south pier and connected to the rear of the advancing girder assembly. Several precast deck panels are also temporarily placed on top of the rear as counterweight. The launch winch pulls the assembly forward in stages while the temporary counterweight is adjusted as required to control cantilever deflections (Step 02). As the assembly advances, next main span segments are spliced onto the rear and pull point of the launch winch is moved to the rear of the extended assembly (Step 03).

The governing launch condition occurs after the last main span segment is connected and is pulled forward to immediately prior to the launch nose reaching the north pier (Step 04). At this stage, the launch nose and girder assembly experiences its maximum unsupported cantilever length and corresponding downward deflection.

Once the leading end of the launch nose contact the north pier cap, the temporary props at the south pier are removed (Step 05). Launching continues until the main span girders reach their final longitudinal position relative to the permanent supports. The temporary launch configuration is then dismantled, and girders are lowered onto the final pier bearings. The jump span girders are repositioned into their permanent configuration, forming the north and south approach spans (Step 06).

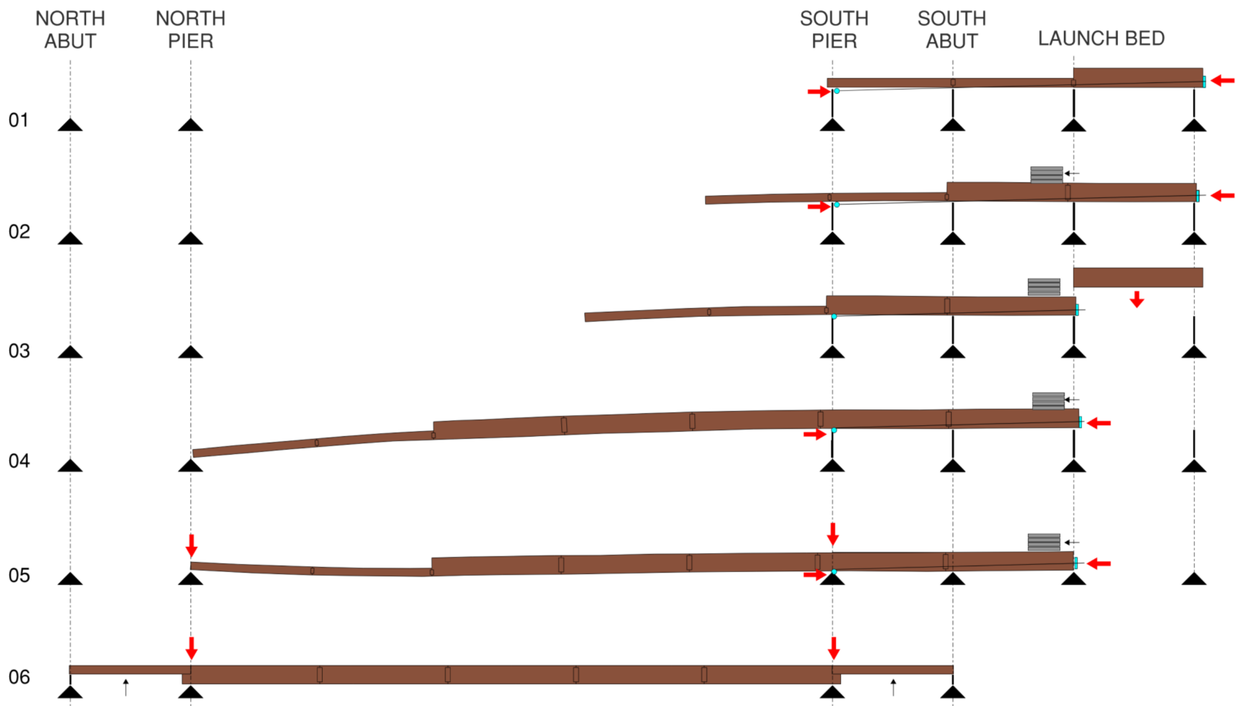


Figure 5: Girder launching sequence progressing from assembly on south bank launch bed (Step 01) to final girder position (Step 06).

Following the steel superstructure erection, the precast concrete deck panels are placed and connected to the girders using high-strength non-shrink grout placed within the shear stud pockets and closure joints between panels. The steel post-and-guardrail system, pedestrian fencing, and the utility waterline suspended beneath the deck are installed. Final roadway tie-ins and approach works are then completed.

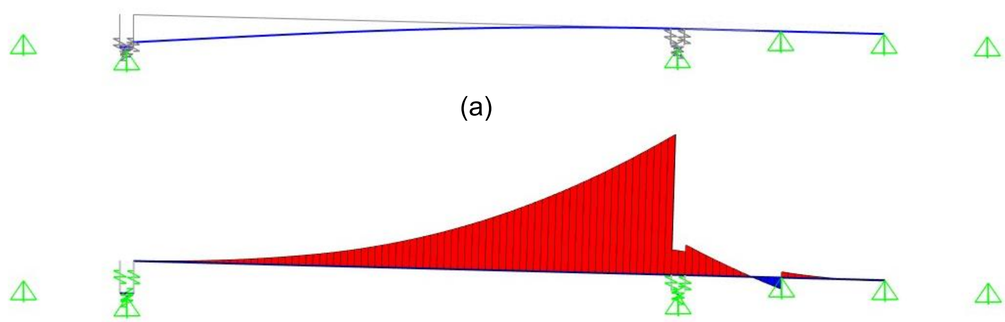
The selected construction methodology minimizes in-stream work, eliminates the need for temporary falsework within the river channel, and takes advantage of prefabricated bridge components to reduce field construction activities. By combining incremental launching with precast substructure and deck elements, the bridge can be erected efficiently within a remote location while minimizing environmental impacts and construction duration.

4.2 Analysis

Construction staging analysis was completed in CSiBridge to evaluate the feasibility of the launching operation and predict structural demands throughout erection and lauching sequence. The staged construction model was used to assess launch nose deflections, girder forces, and splice demands at each stage of the launch. The analysis also informed the selection of the launch angle and the design of the temporary launching system, including the rocker beam arrangement at the piers.

The launching sequence was simulated using a staged construction load case in which the steel superstructure was advanced from the south bank toward the north bank in 1 m increments. The model included the permanent and temporary support conditions present during launching, including the pier supports, rocker beams and rollers, abutment, and temporary launch bed supports. To ensure newly launched segments entered the analysis at the correct tangent orientation, the entire girder assembly was initially represented using massless, artificially stiff guide frame elements. As the launch progressed, individual segments were "activated" by converting the frame element properties to those of the corresponding permanent steel sections. This allows self-weight effects and structural response to develop progressively as the launch assembly advance with a deflected shape.

Attention was given to the maximum cantilever length condition immediately prior to the launch nose reaching the north pier (Step 04), as the launch nose deflections and girder demands reach their greatest values, as shown in Figure 6. Results from the staged construction analysis were used to confirm that the selected launch angle provided feasible deflections to meet touchdown conditions at the north pier, and to verify girder and splice capacities throughout the launch sequence.



(a)

(b)

Figure 6: Girder (a) deflected shape and (b) bending moment diagram at immediately prior to launch nose reaching the north pier (Step 04).

5. CONCLUSIONS

The Ksi Gingolx Bridge was designed to address a challenging combination of site constraints, including remote access, environmental sensitivity, tidal hydraulics, and liquefiable foundation soils, while delivering a durable, high-capacity crossing that meets the long-term infrastructure needs of the Village of Gingolx.

A defining aspect of the project was the development of a construction methodology suited to a site where conventional erection approaches were not viable. By designing the bridge to be launched from the accessible south bank, with the jump spans functioning as a temporary launch nose before being repositioned into their permanent configuration, the team eliminated the need for in-stream falsework and minimized reliance on barge-delivered equipment and extended construction windows.

The seismic design philosophy reflects a deliberate response to site conditions. Rather than designing substructure elements to resist the full kinematic demands of liquefaction-induced ground movement, the jump spans and abutments were detailed to accommodate lateral translation, protecting the main span piers from loads that would have been expensive to resist directly.

Throughout the project, prefabrication was employed as a consistent strategy rather than a convenience. Precast substructure elements, shop-fabricated girders, and full-depth precast deck panels reduced field construction time, improved component quality, and compressed the construction schedule in an environment where mobilization costs are high and working seasons are constrained.

The Ksi Gingolx Bridge demonstrates that remote and technically complex sites reward early investment in integrated design thinking, where construction methodology, structural behaviour, and long-term performance are developed together rather than in sequence.

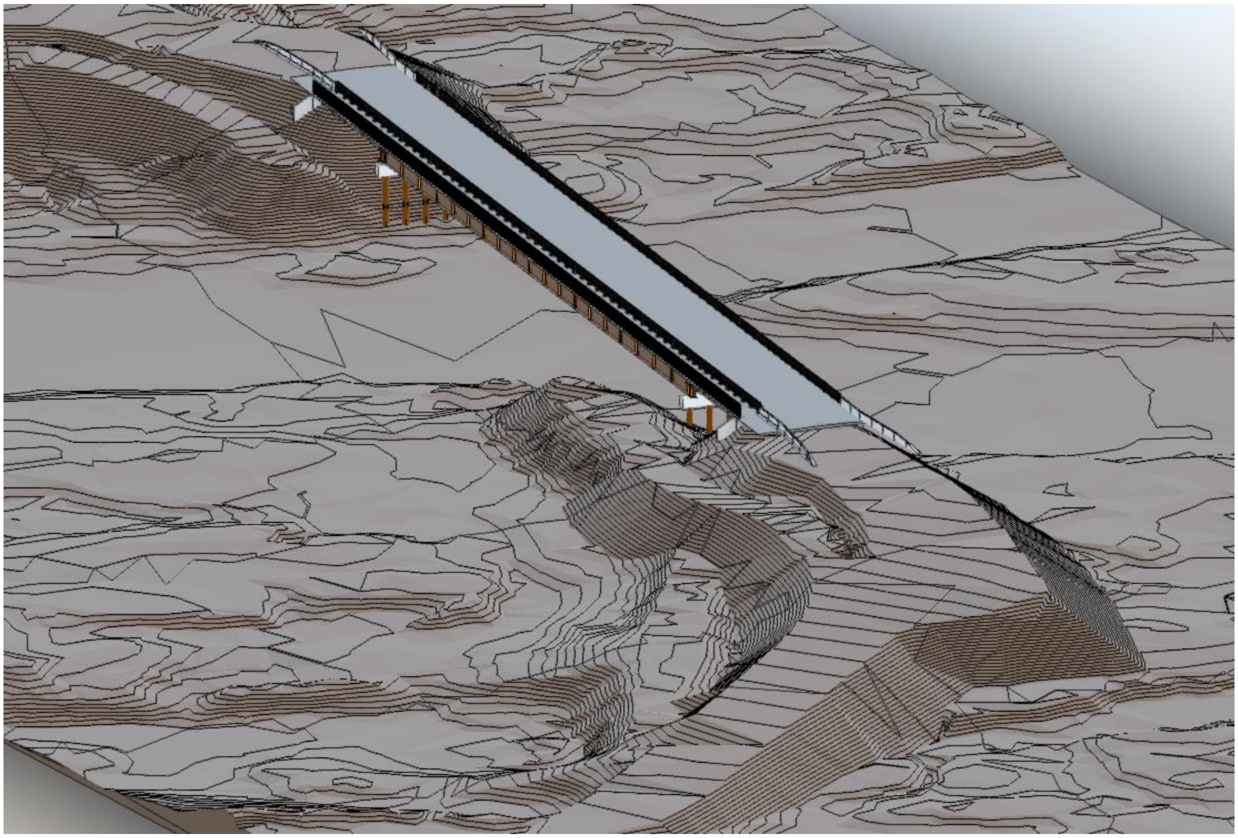


Figure 7: Isometric rendering of the Ksi Gingolx Bridge Revit model, showing the launch bed on right/south side of the bridge span.

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REFERENCES

Computers and Structures Inc. 2025. *CSI Analysis Reference Manual*. Computers and Structures Inc., Berkeley, CA, USA.

CSA Group. 2025. *Canadian Highway Bridge Design Code*. CSA Standard S6:25, CSA Group, Toronto, ON, Canada.

CSA Group. 2023. *Canadian Pedestrian, Cycling, and Multi-Use Bridge Design Guideline*. CSA Standard S7:23, CSA Group, Toronto, ON, Canada.