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TSOLUM RIVER CABLE-STAYED ACTIVE TRANSPORTATION BRIDGE

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ABSTRACT: The One Spot Trail near Courtenay, British Columbia has been severed at the Tsolum River since the removal of the original rail bridge in 1954, interrupting a nearly 20 km active transportation corridor serving pedestrians, cyclists, and equestrians. The new Tsolum River Bridge, designed in 2026, restores this connection with an innovative cable-stayed configuration driven by a unique set of constraints. Two prefabricated MABEY C200 truss segments from a previous detour project were incorporated as side spans in a three-span arrangement suited to the natural valley topography. The new main span was designed to match the truss geometry of the reused segments, with a cable-stayed system added to achieve the vertical stiffness required for equestrian comfort. Stay cables run from anchor beams near each abutment, over saddles on A-frame tower pylons, and down to a central structural steel cradle suspended below the main span. The cradle transfers cable forces into the structure while carrying tension between the opposing bank anchorages. A widened octagonal viewing platform above the cradle provides passing room for mixed trail users and a scenic overlook of the river. A staged construction analysis informed the erection sequence, cable stressing operations, and final force distribution used as the basis for design.

1. INTRODUCTION

The One Spot Trail follows a historic rail corridor of the former Comox Logging and Railway Company near Courtenay, British Columbia. The trail currently exists as two disconnected segments, an 8.8 km northern section and a 7.0 km southern section, separated by the Tsolum River. The removal of the original rail bridge in 1954 interrupted what would otherwise be a nearly 20 km continuous active transportation corridor connecting rural communities to downtown Courtenay.

To restore this connection, the Comox Valley Regional District initiated the design of a new bridge crossing, spanning approximately 125 m across the river valley. The bridge is intended to accommodate pedestrians, cyclists, equestrians, and occasional maintenance vehicles while minimizing impacts to the environmentally sensitive river corridor. Unlike a conventional pedestrian bridge project, the design was shaped by a unique combination of requirements and constraints that together narrowed the viable range of solutions.

These constraints included a narrow former railway right-of-way, a river channel with a history of migration and bank erosion, and the availability of two prefabricated truss segments from a previous bridge project that the owner wished to incorporate into the permanent crossing. The two available MABEY C200 truss segments became primary drivers of the bridge configuration, influencing the span arrangement, deck geometry, and ultimately the development of the structural system. Their fixed lengths and cross-sectional geometry established boundaries within which the remainder of the design had to be resolved. A further constraint arose from the need to accommodate equestrian traffic, which placed demands on structural stiffness beyond what a conventional truss solution could efficiently provide.

The final design combines the reused truss spans with a new cable-supported main span and a suspended structural cradle at the centre of the bridge. Above the cradle, an octagonal viewing platform provides a passing area for trail users and offers a scenic overlook of the river. Detailed design was completed in 2026, with the project advancing toward tender in the following year. This paper presents the Tsolum River Bridge as a case study in constraint-driven bridge design, describing how site conditions, environmental requirements, functional demands, and the reused components together shaped the final structure. The structural behaviour of the bridge evolves throughout construction, and staged construction analysis formed an integral part of the design process, informing both the proposed sequence and the final force distribution.

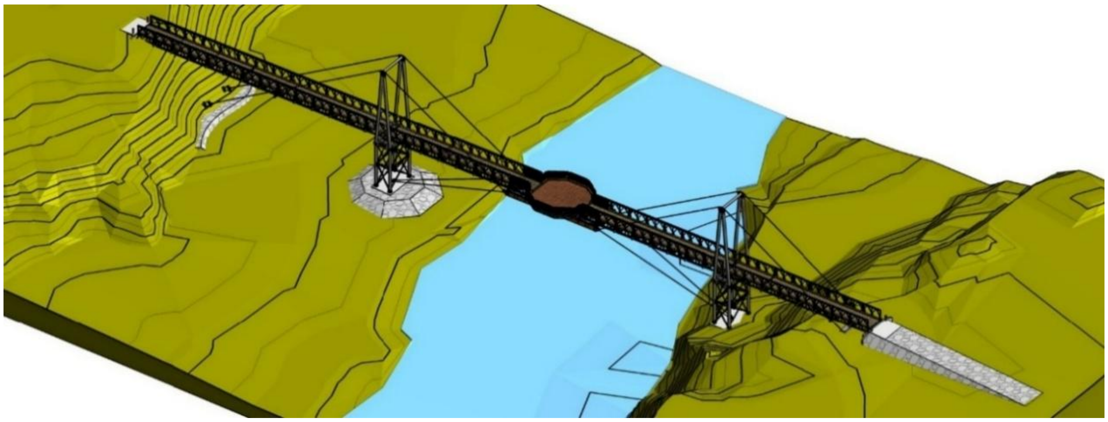

Figure 1: Isometric rendering of the Tsolum River Bridge showing the three-span configuration.

2. PROJECT CONSTRAINTS

The final form of the Tsolum River Bridge emerged from the interaction of several constraints that were present from the earliest stages of the project. While any one of these constraints could have been accommodated independently, their combined influence significantly narrowed the range of viable structural solutions.

2.1 Site Access and Right-of-Way

The bridge site lies within the former Comox Logging and Railway Company right of way, a corridor approximately 30.5 m wide that traverses the Tsolum River valley, as shown in Figure 2. Although the river valley itself is relatively broad, the available construction and bridge footprint is constrained by the historic railway corridor boundaries. To the north, the alignment passes adjacent to Tsolum Spirit Park, an environmentally sensitive area where disturbance was to be minimized wherever practicable. To the south, portions of the right-of-way have been informally utilized by neighbouring landowners during the decades following the removal of rail service. These adjacent uses introduced additional considerations for access, surveying, and construction staging. Remnants of the original railway bridge remain at the site, including concrete pier foundations and isolated timber pile elements, though these were not suitable for incorporation into the new structure and did not influence the permanent structural arrangement.

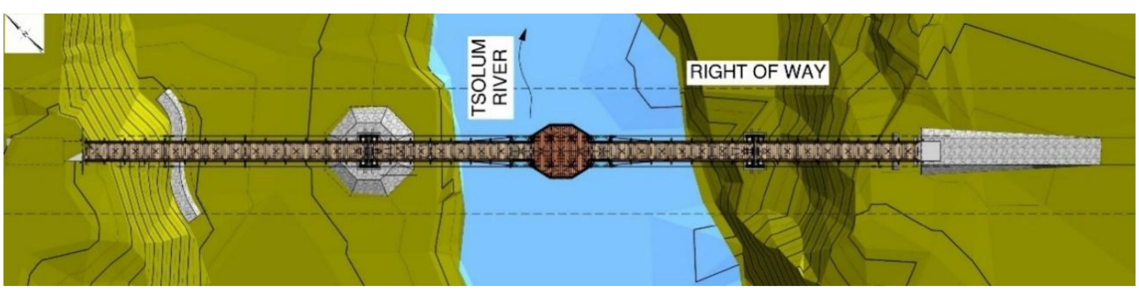

Figure 2: Plan view of the Tsolum River Bridge within the former Comox Logging and Railway Company right of way.

2.2 River and Environmental Considerations

The Tsolum River is an active and dynamic watercourse characterized by ongoing channel migration and bank erosion. Historical imagery and field observations indicate that the river has occupied multiple alignments within the valley over time, demonstrating its capacity for significant lateral movement. Flood events observed during the design process reinforced the importance of accounting for hydraulic forces, scour potential, and future channel migration. A significant event in early 2026, shown in Figure 3, captured elevated flow velocities and active bank erosion at the crossing location, confirming the hydraulic assumptions that shaped the design. These considerations strongly favoured a bridge configuration that avoided permanent substructure within the active river channel wherever possible. Eliminating in-stream piers reduced hydraulic impacts, minimized environmental disturbance, simplified permitting requirements, and reduced long-term scour vulnerability.

Figure 3: Ground-level view of the Tsolum River during a 2026 flood event.

As a result, a clear-span solution across the active channel was pursued, with tower foundations positioned on the riverbanks where foundation conditions and scour protection measures could be more effectively managed.

2.3 Reuse of Existing Truss Segments

A defining constraint of the project was the availability of two prefabricated MABEY C200 truss segments from a previous temporary bridge installation associated with the Admirals-McKenzie Interchange Project. The two segments, measuring 43.1 m and 24.8 m in length, were acquired by the Comox Valley Regional District with the intention that they be incorporated into the permanent crossing. Figure 4 shows the segments in their previous deployment at the Admirals-McKenzie Interchange Project. Their inclusion offered both economic and sustainability benefits through the reuse of existing structural materials and the reduction of new steel fabrication requirements.

Figure 4: MABEY C200 truss segments in their previous deployment at the Admirals-McKenzie Interchange Project, prior to acquisition for reuse at the Tsolum River Bridge (BC MoTT, Jacob Bros Construction).

Because the segments were fixed in length and geometry, they became primary drivers of the bridge configuration. The differing span lengths naturally suggested an asymmetric arrangement that aligned well with the valley topography, while the MABEY C200 cross section established the deck width and overall truss geometry for the remainder of the bridge.

The existing trusses had originally been deployed as simply supported spans, with peak force demands occurring near midspan. The longer segment had therefore been reinforced during its previous service life, whereas the shorter segment remained unmodified. Both segments required evaluation under their proposed permanent loading conditions, as the support arrangements and force distributions in their new roles differed significantly from their original deployment.

2.4 User Group and Functional Requirements

The bridge is intended to accommodate pedestrians, cyclists, equestrians, and occasional maintenance vehicles. While each user group introduces specific design considerations, equestrian traffic proved particularly influential in the development of the structural system. Unlike conventional pedestrian bridges, equestrian crossings require careful consideration of perceived movement and user comfort. Excessive deck flexibility can negatively affect rider confidence and may create an uncomfortable environment for horses. Consequently, a structural solution capable of providing enhanced vertical stiffness while maintaining a practical and economical bridge form was required.

This requirement became particularly important for the 58.6 m main span. Preliminary evaluations indicated that a conventional truss solution spanning this distance would likely require substantially increased section sizes to achieve the desired performance characteristics. The need for improved stiffness therefore became a key factor in the development of the final cable-supported configuration.

3. CONCEPT DEVELOPMENT AND STRUCTURAL DESIGN

Developing a structural system for the Tsolum River Bridge required satisfying several constraints simultaneously. Clear spans with minimal in-stream works, fixed geometry dictated by the available truss segments, and equestrian-appropriate stiffness were all requirements that had to be resolved together within a practical and constructible form. The cable-stayed configuration described in the following sections emerged as the solution that addressed all of these requirements.

3.1 Span Arrangement and Truss

The two prefabricated MABEY C200 truss segments form the north and south side spans, with the 43.1 m segment placed on the north side and the 24.8 m segment on the south. This arrangement fits naturally with the valley topography, as the longer span suits the flatter, lower-elevation north approach while the shorter span aligns with the south bank where the valley crest is closer to the river. This keeps both side spans entirely on the bank, avoiding in-stream foundations. A general arrangement of the bridge is shown in Figure 5.

With the side span positions established, the remaining crossing distance over the channel defined a main span of 58.6 m. The main span is new construction but is designed to match the MABEY C200 cross-sectional geometry to maintain consistent deck width, bay spacing, and member geometry across all three spans. This compatibility requirement governed the deck design for the full bridge length, with the contractor required to source new truss components matching the C200 section for the main span. The two prefabricated side spans required assessment and preparation for reuse in their new permanent roles.

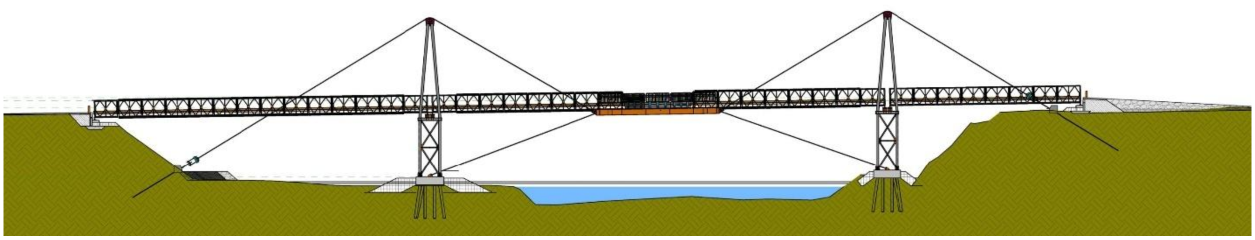

Figure 5: General arrangement elevation of the Tsolum River Bridge showing the three-span configuration, tower locations, and cable geometry.

The deck surface across all three spans is consistent in form. Timber stringers support timber deck planks running transversely across the full bridge width, with expansion joint plates provided at deck joints to accommodate thermal movement while maintaining a smooth riding surface for all user groups. The deck is set at a 1.5% longitudinal slope toward the north to provide drainage across the full bridge length.

3.2 Cable System

The cable system consists of two pairs of cables, main cables and wind cables, running on each side of the bridge. The main cables run continuously from a reinforced concrete anchor beam near each abutment, over a curved saddle at the top of the tower pylon, and down to a connection point on the midspan cradle. As shown in Figure 6, the saddle at the tower head guides the main cable over the pylon and transfers the cable deviation force smoothly into the tower structure. Cable stressing is performed from the anchor beam end using a threaded bar stressing assembly, allowing the cable force to be set and fine-tuned at this location.

Figure 6: Rendered view of the curved cable saddle at the A-frame tower head, showing the main cables passing over the pylon and the saddle connection detail.

The wind cables connect from anchor blocks at the tower foundation to a connection point on the midspan cradle. Their primary role is to provide lateral and torsional restraint to the main span and viewing platform against wind loading, complementing the vertical load resistance provided by the main cables. The connection of both cable types to the cradle at midspan integrates the lateral and vertical restraint systems. The addition of the cable system to the main span truss meaningfully increases the vertical stiffness of the structure relative to an equivalent unassisted truss, making it suitable for equestrian use. This was a primary driver of the cable-stayed configuration and a key performance requirement for the bridge.

The addition of the cable system to the main span truss provides the vertical stiffness that a conventional truss of this length could not efficiently achieve, directly addressing the performance requirements associated with equestrian use.

3.3 Midspan Cradle and Viewing Platform

The midspan cradle is a structural steel tension frame suspended below the main span deck at the centre of the bridge. It serves two structural roles simultaneously. In addition to connecting the stay cables that support the main span dead loads and the wind cables for lateral resistance, the cradle carries the tension forces running between the opposing cable anchorages on each bank.

The viewing platform sits above the cradle at midspan, widening the usable deck from the standard bridge width to an octagonal plan form approximately 8.3 m across at its widest point. The platform was incorporated in response to an owner request for a passing bay, recognizing that the bridge serves a diverse mix of trail users on a structure too narrow for comfortable passing along its full length. Figure 7 shows the midspan viewing platform and the cradle structure below.

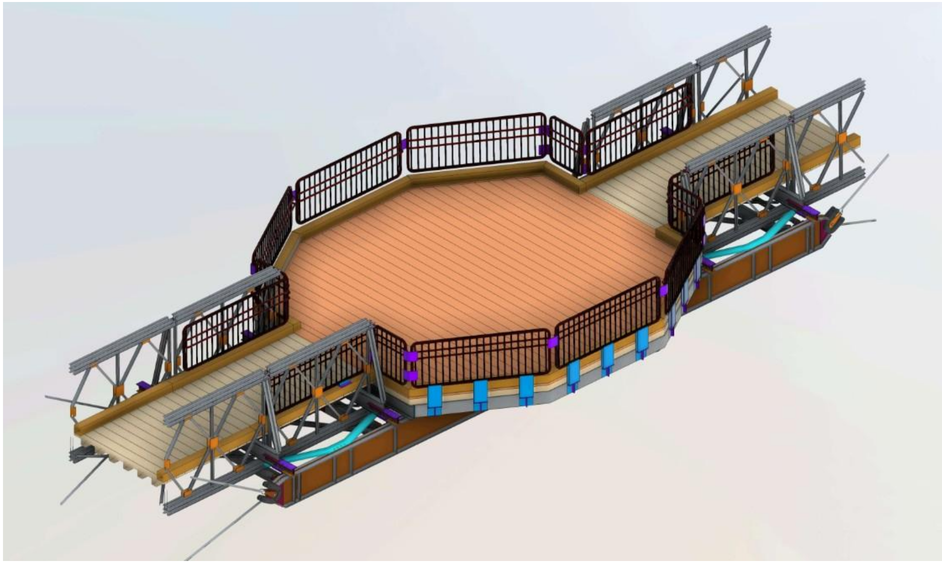

Figure 7: Isometric rendering of the midspan viewing platform and underlying structural steel cradle, showing the timber deck, railing panels, and cable connections.

3.4 Tower Configuration

The towers are A-frame pylons rising approximately 12 m above the deck, with the pylon height governed by the geometry needed to achieve adequate cable inclination over the main span. The A-frame geometry provides longitudinal stiffness through its triangulated leg arrangement, resisting the horizontal forces imposed by the stay cables. As shown in Figure 8, tower columns are hollow structural section members, braced transversely by a crossbeam and diagonally to form a rigid frame capable of resisting both longitudinal cable forces and transverse wind loads. A curved cable saddle is mounted at the tower head to guide the main cable over the pylon.

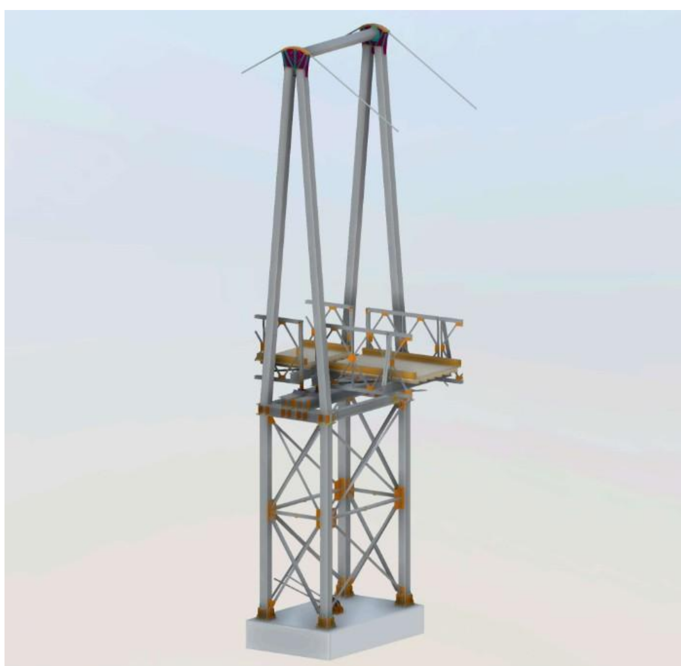

Figure 8: Rendered view of the A-frame tower pylon showing the HSS column legs, transverse crossbeam, diagonal bracing, and curved cable saddle at the tower head.

3.5 Abutments and Foundations

The bridge abutments are precast concrete units, a choice that offers meaningful practical benefits at a remote site with limited access. Fabricating the units off-site reduces the amount of formwork, wet concrete work, and curing time required in the field, and the units can be delivered and installed rapidly once foundation preparation is complete. As shown in Figure 9, each abutment is split into two precast units joined at the centreline to form the full bearing seat width. This two-piece arrangement was necessary to keep each unit within a manageable size and weight for transportation and installation at the site. A ballast wall provides the connection between the bearing shelf and the approach fill behind.

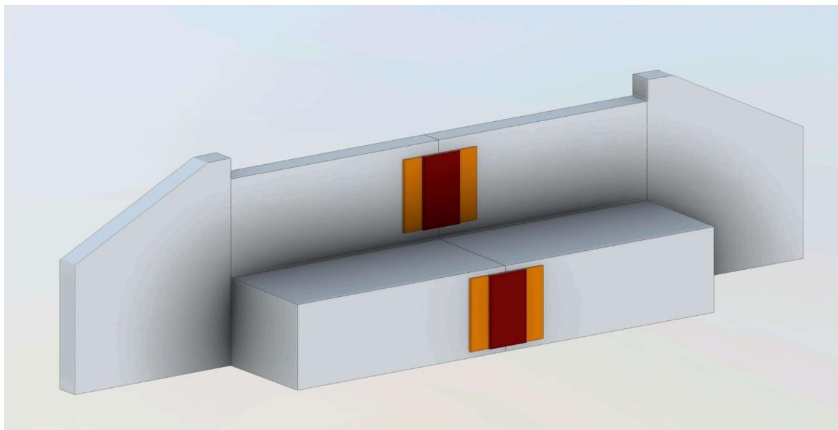

Figure 9: Rendered view of the precast concrete abutment showing the two-piece split arrangement, centreline joint, bearing seats, and ballast wall.

The tower foundations consist of reinforced concrete pile caps supported by groups of small diameter micropiles. The pile caps transfer the combined vertical and horizontal loads from the tower columns into the micropile group below, with the cap geometry accounting for the battered pile arrangement used to resist lateral forces. Scour protection in the form of riprap armouring is provided around the tower foundations, recognizing the river's capacity for rapid bank erosion.

4. STRUCTURAL ANALYSIS

The unique characteristics of the Tsolum River Bridge required the structural analysis and construction planning to be developed together. The bridge relies on a cable-supported system whose structural behaviour develops progressively as components are erected and cable forces are introduced. As a result, the load paths, member forces, and overall stiffness of the structure change throughout construction before reaching their final configuration. Understanding these conditions was therefore essential to establishing a reliable basis for design.

4.1 Global Model and Loading Cases

The bridge was analyzed using a three-dimensional finite element model developed in CSiBridge. The model included the complete structural system, incorporating the truss spans, towers, cable elements, midspan cradle, abutments, and foundation supports.

The model, shown in Figure 10, was used to evaluate the response of the structure under dead load, pedestrian, equestrian and maintenance vehicle loading, wind loading, thermal effects, and seismic loading. Particular attention was given to the interaction between the truss system and the cable-supported components, as the distribution of forces between these elements governs both the global stiffness and overall behaviour of the bridge.

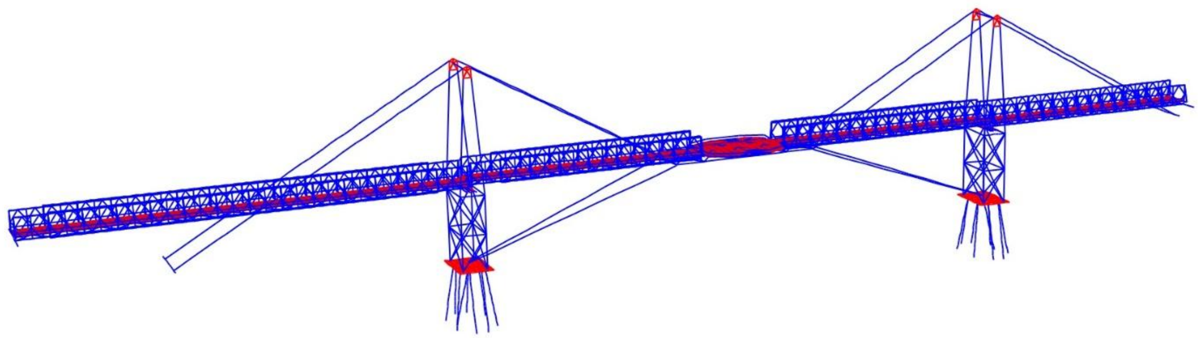

Figure 10: Three-dimensional finite element model of the Tsolum River Bridge developed in CSiBridge, showing the full structural system including truss spans, towers, cables, and midspan cradle.

4.2 Staged Construction Model

Because the bridge derives part of its stiffness and load-carrying behaviour from the cable system, the completed structure cannot be accurately represented by considering only its final configuration. The sequence in which components are erected influences cable forces, tower rotations, deck elevations, and member stresses throughout construction. A staged construction analysis was therefore performed to simulate the proposed erection sequence and evaluate the structure at each stage, verifying that acceptable force levels and deformations were maintained while confirming the viability of the proposed methodology.

The staged model was also used to establish target deck elevations, tower positions, and cable forces at key construction milestones. These values provide reference targets for field verification during erection and inform the final cable stressing operation.

The final stage of the construction sequence was used as the basis for the ultimate limit states (ULS) analysis of the completed bridge. By carrying forward the effects of staged construction, cable stressing, and accumulated deformations, the model captures the final force distribution, structural geometry, and stiffness upon which the design checks were performed.

5. PROPOSED CONSTRUCTION SEQUENCE

The proposed construction sequence was developed in conjunction with the staged construction analysis. The order of operations was selected to simplify erection, maintain stability throughout construction, and allow cable forces to be introduced in a controlled manner.

Construction begins with installation of the abutments, cable anchor beams, tower micropiles, and pile caps, followed by erection of the A-frame towers. With the towers in place, the main cables are strung from the anchor beams over the saddles at the tower heads and connected to the midspan cradle, holding it in its suspended position. Initial cable stressing is then performed, establishing the suspended cradle and creating the primary load path required to receive the main span. The reused north and south truss spans are subsequently lifted into position and installed onto their permanent bearings.

Following completion of the side spans, the main span truss and viewing platform are assembled and lifted into place as a single unit. Once connected, the dead load of the main span is transferred through the cradle and into the cable system, activating the primary structural behaviour of the bridge for the first time. The wind cables are installed, providing the completed structure with its intended lateral and torsional restraint. A final round of cable stressing is performed to achieve the target geometry established through the staged construction analysis.

The bridge is completed through installation of the railing system and approach works. The resulting sequence minimizes temporary works, avoids the need for construction activities within the river channel, and allows the bridge to be assembled in a logical progression that supports the structural load path.

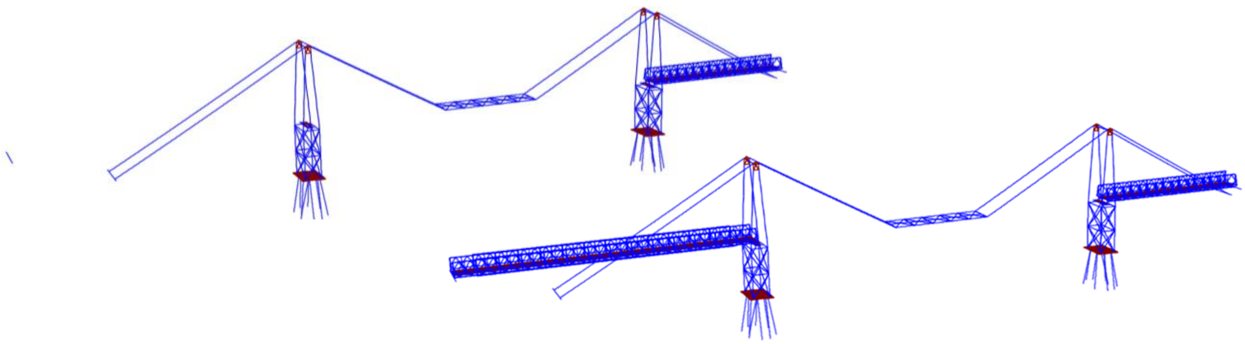

Figure 11: Mid-erection construction stages evaluated in the detailed erection analysis used in the development of the bridge design.

6. CONCLUSION

The Tsolum River Bridge restores a connection within the One Spot Trail that has been missing for over seventy years, while responding to a demanding combination of structural, environmental, and functional constraints. The final design achieves a 126.4 m crossing that avoids permanent substructure within the active river channel and accommodates the full range of intended trail users. Detailed design and independent review were completed in early 2026. With the project advancing toward tender in the coming year, the bridge is close to becoming a physical reality on the Tsolum River.

What distinguishes the project is not any single design decision but the relationship between them. The reused truss segments established the deck geometry, span arrangement, and main span length. This in turn exposed the stiffness demands that drove the cable-stayed configuration and ultimately created the opportunity for the suspended cradle and viewing platform at midspan. Staged construction analysis tied these elements together, providing confidence in both the proposed sequence and the final force distribution used as the basis for design.

The Tsolum River Bridge demonstrates that when constraints are embraced as design inputs rather than limitations, they can lead to solutions that are efficient, constructible, visually distinctive, and responsive to the needs of the communities they serve.

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