6140-50/BRI/05

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Cowichan Valley Regional District
Parks and Trails Operations

Bright Angel Park
Cable Stayed Suspension Bridge
Condition Assessment

DRAFT – OCTOBER 16, 2013

- wicking grade of lockright.
- Plastidip for Tampering

Prepared By:

HEROLD
ENGINEERING LIMITED
Consulting Engineers

PROJECT 0635-019

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1 INTRODUCTION

For this project, Herold Engineering Limited has completed a condition assessment of the pedestrian suspension bridge at Bright Angel Park located in the Cowichan Valley Regional District. It is our understanding that this condition assessment has been requested as part of the routine preventative maintenance program utilized by the Parks and Trails Operations and is intended to determine whether any deficiencies exist in the structure due to environmental degradation, maintenance oversights, or vandalism, and what corrective actions may be required to ensure that the structure is acceptable for public usage.

2 DESCRIPTION OF STRUCTURE

The bridge is located within Bright Angel Park which is located off of Tigwell road at Cowichan Station, South of Duncan. The park encompasses areas on both sides of the Koksilah River and the bridge spans the river from West to East, connecting walking trails on each side of the river.

It is our understanding that the suspension bridge was originally constructed in 1967 and since that time has been continuously maintained, initially by the volunteer organization that managed the park and more recently by the CVRD.

The bridge is a typical cable suspension bridge with the walking surface of the bridge consisting of wooden planks supported by walkway cables which are then hung by hanger cables at short intervals from the suspension cables which are hung from towers at each end of the bridge. The suspension cables extend beyond the towers and are anchored to large cast in place concrete blocks buried at each end of the span.

The support towers are mounted on concrete piers on the riverbank at each side of the river and are spaced at 144' 6" according to the most recent survey of the bridge, performed in 2007. The anchorage for the suspension cables is located approximately 30' past the West pier and approximately 43' past the East pier. The approach span adjacent to the West tower is a short section (approximately 6') that is supported only by the walkway cables while the East approach is fully suspended by the main suspension cables and extends all the way from the East tower to the anchor block.

The West pier is located on the high bank above the river and is almost completely buried while the East pier is located on the shallow bank adjacent to the river and extends approximately 5' above grade.

On the West side of the bridge the anchor block is completely buried approximately 2' below grade with all cable terminations being buried as well. On the East side of the bridge the top of the anchor block is located at grade with all cable connections and terminations exposed.

It is our understanding that the maintenance of the bridge since it was constructed has included the replacement of the timber towers in 1981, the replacement of the main suspension cables in either 2002 or 2003, the replacement of the walkway cables in 2004 or 2005 and the replacement of the hanger cables and deck planks as required.

3 SCOPE OF ASSESSMENT

The condition assessment that has been performed was limited to visual and tactile methods utilizing manual probing, drilling and sounding to assess the condition of the cables, floor system and towers.

The bridge cables were observed from the either the bridge deck, from a ladder adjacent to the towers or from the ground beneath or adjacent to the spans where. Some areas such as the

walkway cables beneath the deck at mid-span are not readily accessible and were not viewed during this assessment.

Detailed strength calculations have not been performed as they are found in a previous assessment.

4 ASSESSMENT FINDINGS

4.1 Cables

The cables utilized on the bridge consist of 4 distinct sizes constructed of galvanized strand, each with a different application. The usage, construction and condition of these cables is detailed below.

4.1.1 Suspension Cables

The main suspension cables are used to carry the majority of the loads from the bridge deck, relying on the support of the towers at each end and deadweight and soil resistance at the anchor blocks. There are two main suspension cables with each being 1 1/8" in diameter.

The suspension cables are connected to the anchors at each end and utilizing a field assembled turn-back eye with a thimble and clips. The cables run continuously between the anchors and do not feature any simple means of adjustment.

At the West anchor the cables were exposed after hand excavating and were found to be wrapped in a combination of plastic wrap over burlap with the cable coated in grease inside of the wrapping. The layer of burlap was noted to be saturated with water.

The suspension cables were found to be in generally fair condition with a slight loss of galvanizing and the presence of corrosion between strands being found on the cable at easily accessible locations. At the turn-back eyes the cable ends were noted to be wrapped in plain electrical tape and some unraveling was found as a result.

4.1.2 Walkway Cables

The walkway cables are each located below a main suspension cable and run between the anchor blocks and over a lower support on each tower. The walkway cables are used to provide support to the bridge deck elements and to carry a portion of the bridge live load. There are 2 walkway cables with each being ¾" in diameter.

The walkway cables are connected to the anchors at each end utilizing a field assembled turn-back eye with a thimble and clips in the same manner as the suspension cables. Adjacent to the East anchor block there are turn-buckles in-line with the cables providing a means for adjustment of the cable tension. The turn-buckles were noted to have open hooks on one end and a capacity rating could not be seen on the turn-buckles in their current orientation. A cable splice made with clips was noted at the West end of the North cable immediately East of the West tower.

The walkway cables were found to be in generally fair condition similar to the suspension cables.

4.1.3 Hanger Cables

The hanger cables are used to transfer load from the walkway cables to the main suspension cables and each cable is ½" in diameter. There are a total of 46 hanger cables on the bridge with 23 between each pair of suspension and walkway cable. Of those cables 32 are located between the towers and 14 are located to the East of the East tower. It was noted that between the towers the 10 central hangers on each side are rigid fabricated units rather than cables.

The hanger cables are connected to the suspension and walkway cables by turn-back eyes with clips on each end, with the eyes wrapped around the large cables. No thimbles are used in the turn-back eyes. At the hanger locations on the suspension cable, 1 1/8" clips are used to stop the hanger cables from sliding down the suspension cable while at the walkway cable the eyes are located between sections of deck planking which are affixed to the walkway cable.

The hanger cables were generally in fair to good condition without signs of distress however it was noted that surface rust was present on some cables, despite the lack of any source of abrasion or additional moisture and that the corrosion was most prevalent at the bottom connection where the cables run between the deck planks. One hanger cable on the South side of the bridge, East of the East tower was noted to be in immediate need of replacement due to cable damage at the lower connection.

4.1.4 Walkway Hand Rail Cables

The walkway handrail cables are strung between the suspension and walkway cables and are used as handrails and to support chain-link fencing material used as a guard along the sides of the bridge. The handrail cables are connected to timber posts at each end of the bridge and are attached to the hanger cables using wire rope clips and links of chain along the length of the bridge. At mid span where the suspension cable is below the level of the top of the chain-ling material an additional cable has been added, although the purpose of the cable is not clear.

The connections of the handrail cable to the timber posts were noted to consist of a turn-back eye with no thimble and 2 clips at the South West post and loosely spliced eyes with no thimbles or clips at the other three locations.

The handrail cables were in generally good condition however the attachment and splicing of the cables appears deficient and the overall level of tension would be considered too low for usage as a "guard" despite being of sufficient height above the walking surface.

4.2 Decking

The walking surface of the bridge consists of 2"x10" planking bearing directly on the walkway cables and held in place by a top cap on ach side which is connected to the cable via eye-bolts that are installed between deck planks. The walking surface is approximately 36" wide with the deck planks typically measuring 48" wide.

The floor beams were noted to be in moderate to fair condition with some abrasion from cables and fittings noted, as well as some decay and softness at the ends of the planks.

4.3 Towers

The cable support towers each consist of a pair of braced 14" timber posts bearing on concrete piers. The towers have timber cross beams located on each side at the bottoms of the posts, immediately below the bridge deck, approximately 8' above the bridge deck and at the top of the posts. Timber cross braces are located between the two top levels of cross beams. Each tower has a pair of saddles fabricated from cable sheaves located atop the timber posts and a sheet metal cover over the top of the tower.

It was observed that some of the cross beams and the braces above the walking surface appear to have been replaced previously and these elements were found to be in good condition. The elements lower in the towers were found to be more saturated with moisture and were generally in moderate to poor condition.

A sounding of the tower posts indicated that some changes in density were evident in the bottom portion of the posts, immediately above the piers. Further probing of the posts with a drill revealed that the posts have significant decay throughout the core of the posts in the bottom 24"-36", with pockets of decay above that.

4.4 General Construction Notes

During the assessment of this structure a number of additional observations were made, that while not indicative of degradation or failure of components, are indicators of where potential problems may arise in the future or where maintenance practices could be improved. These observations are loosely grouped below.

4.4.1 Cable Construction and Configuration

The walking surface of the deck was noted to have a double crown, with a sag in the middle. This would appear to indicate that some areas of the deck are elevated higher than intended, possibly as a result of the routine replacement of hanger cables.

At turn-back eyes where thimbles are used the clips are typically too far from the thimble, allowing the cable eye to open and the thimbles to rotate in the eye.

The hanger cables are free to move on the suspension cable, potentially resulting in increased wear of the cables at these points.

The walkway handrail cables have virtually no tension in them, resulting in very large deflections of the "guards". Any person inadvertently leaning on one could become sufficiently off-balanced that they would fall against the guard.

4.4.2 Cable Clips

Most cable clips on the bridge that were checked were found to not be tightened adequately.

A mixture of branded (i.e. Crosby) cable clips and unbranded clips were found on the structure. The use of unbranded or poorly marked hardware is not recommended as the capacity of such items cannot readily be confirmed.

Most major structural cable connections are readily accessible and susceptible to opportunistic vandalism with simple hand tools. There is no simple method for detecting tampering at these connections.

4.4.3 Miscellaneous

A large number of "makeshift" cable connectors have been used to connect cables together. When used in this fashion, the capacity of these connectors cannot be readily determined and the long term effect of the use of these connectors on the cables is not known.

The fabricated hangers that have been used in place of cables at some locations utilize cable clamps in a non-standard application welded to flat-bar in a manner that would not typically be acceptable for this type of loading. The use of connections for which the capacity cannot be readily determined is not recommended.

14" - First 2' in the bases. Completely wrotten.

5 ASSESSMENT SUMMARY

In assessing this bridge structure it has been determined that while the cable elements are generally sound, the main timber posts in the towers supporting the cables have significant decay at their bases and should be replaced if continued future usage of the bridge is to be assured.

In addition it has been noted that there are a number of areas where maintenance practices could be improved or better documented and where the usage of non-rated or "makeshift" connections has occurred.

6 RECOMMENDED REPAIRS

It is recommended that the following repairs and maintenance items be performed to ensure continued availability and safe usage of the structure and to improve the long term reliability.

6.1 Short Term

- Replace posts in tower to address decay.
- Tighten all cable clips to recommended values. ✓ Parks Staff
- Provided proper connections at the ends of the walkway handrail cables and re-tension the cables.
- Apply thread-locker or apply other anti-tampering measures to cable clips at accessible locations. – Parks Staff
- Have solid hangers inspected and re-welded if required. –

6.2 Long Term

- Adjust hanger cables to level the bridge deck.
- Provide tamper-proof cable connections.
- Continue to replace deck planks and hanger cables as required.
- Ensure that the hanger cable material being used has sufficient corrosion protection.
- Implement maintenance policies that recognize the unique requirements of structural cable construction.

7 CONCLUSION

The suspension bridge at Bright Angel Park is in generally good condition with the exception of the support tower posts which have extensive decay at their bases. This type of decay is not unusual and is not unexpected given the location and configuration of the posts.

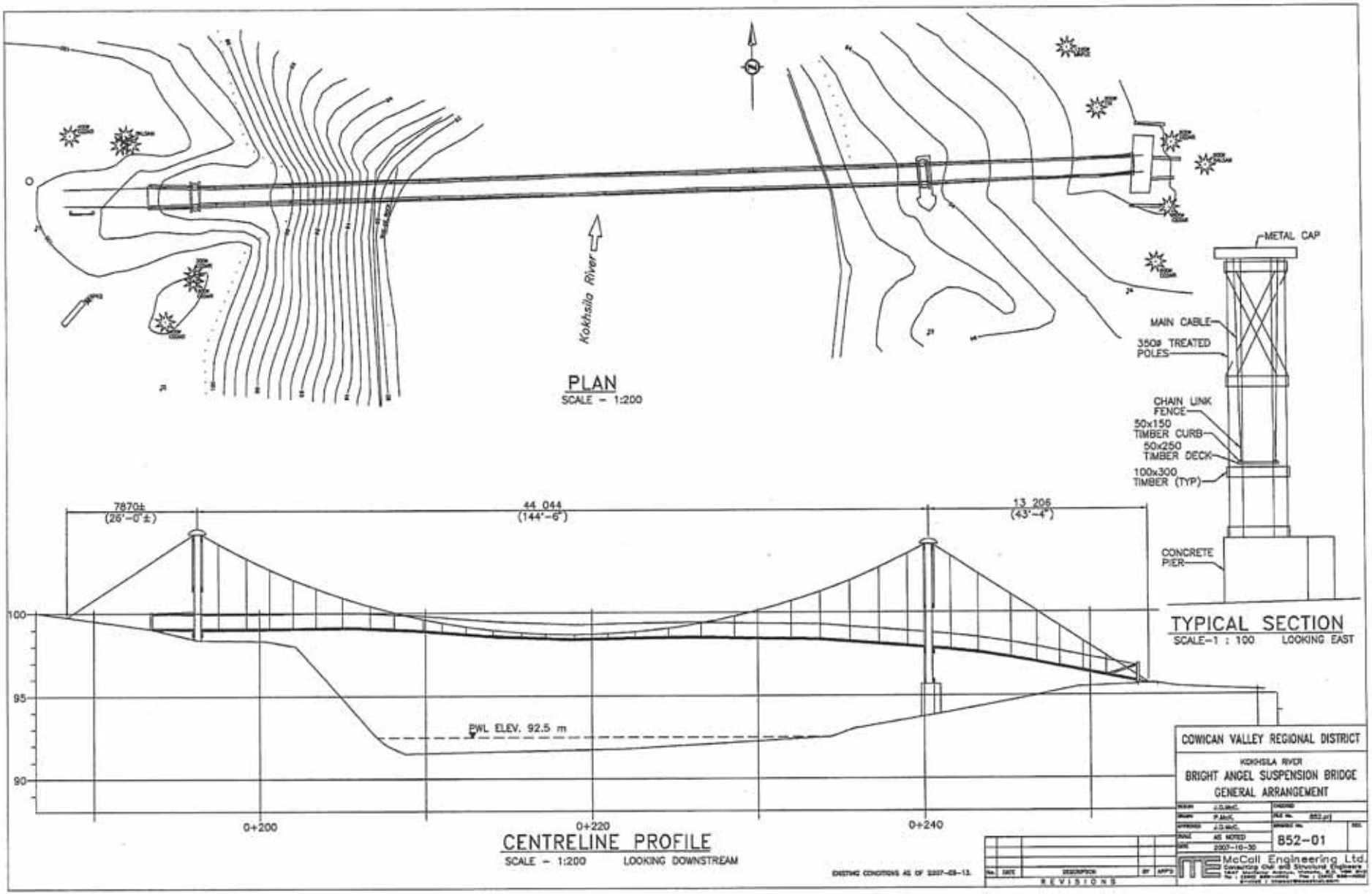
If the posts are replaced soon and the minor maintenance issues outlined above are addressed the bridge should continue to provide the current level of service in the future.

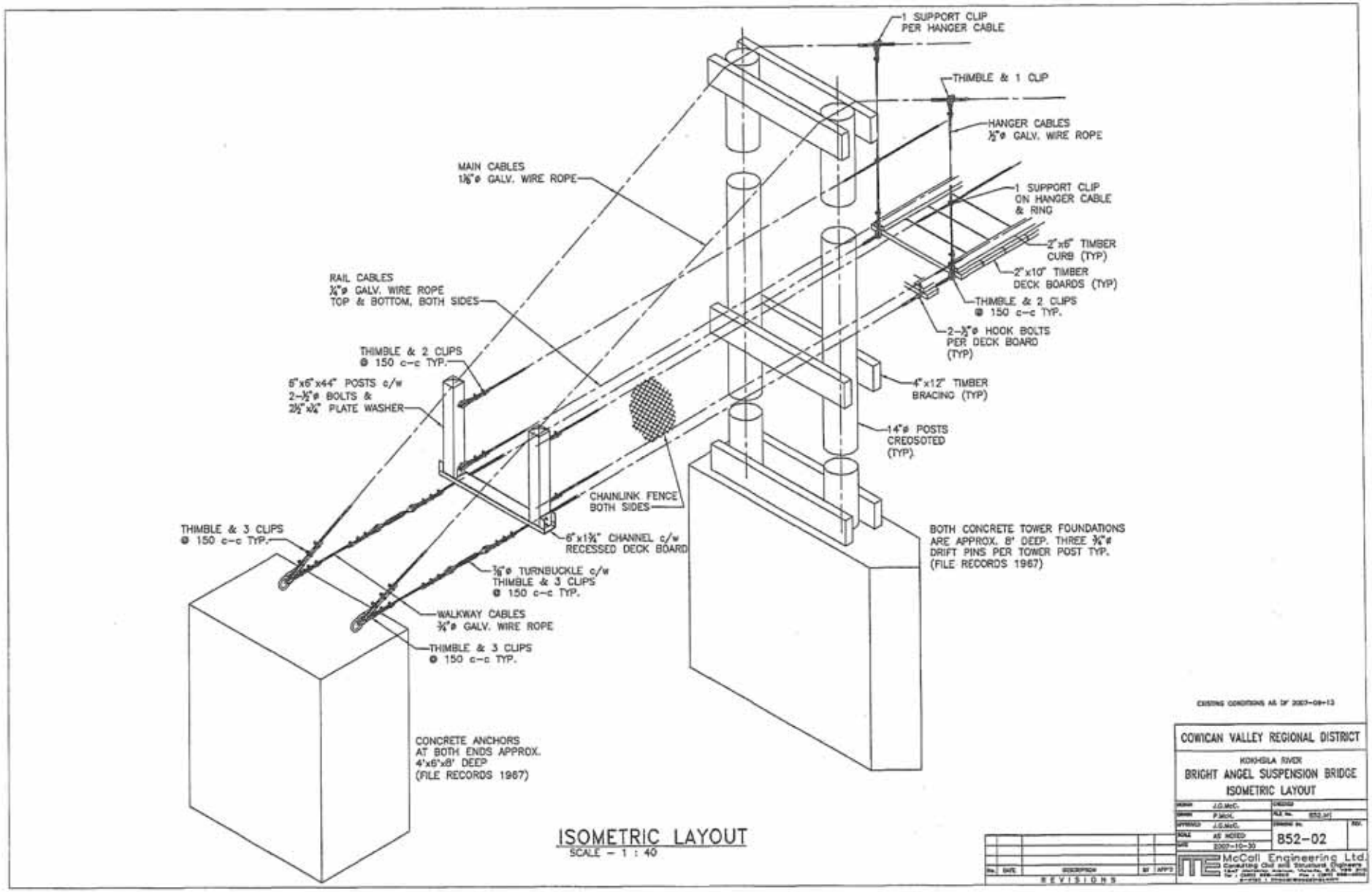
If you have any questions or comments about this report please feel free to contact the undersigned.

Sincerely,

Matt Seyd, P.Eng.
Project Engineer
Herold Engineering Limited

APPENDIX A – RECORD DRAWINGS


Kokhsilla River
PLAN
SCALE - 1:200
METAL CAP
MAIN CABLE
350ø TREATED POLES
CHAIN LINK FENCE
50x150 TIMBER CURB
50x250 TIMBER DECK
100x300 TIMBER (TYP)
CONCRETE PIER
TYPICAL SECTION
SCALE-1 : 100 LOOKING EAST
7870± (26'-0"±)
44 044 (144'-6")
13 205 (43'-4")
100
95
90
FWL ELEV. 92.5 m
0+200
0+220
0+240
CENTRELINE PROFILE
SCALE - 1:200 LOOKING DOWNSTREAM
EXISTING CONDITIONS AS OF 2007-09-13.
REVISIONS
COWICAN VALLEY REGIONAL DISTRICT
KOKHSILA RIVER
BRIGHT ANGEL SUSPENSION BRIDGE
GENERAL ARRANGEMENT
AS NOTED
2007-10-30
852-01
McCall Engineering Ltd.



ISOMETRIC LAYOUT
SCALE - 1 : 40

EXISTING CONDITIONS AS OF 2007-09-13

COWICAN VALLEY REGIONAL DISTRICT

KOKSILA RIVER
BRIGHT ANGEL SUSPENSION BRIDGE
ISOMETRIC LAYOUT

DRAWN	J.G.McC.	CHECKED	
DESIGN	P.McH.	FILE No.	B52.MT
APPROVED	J.G.McC.	DRAWING No.	B52-02
SCALE	AS NOTED		REV.
DATE	2007-10-30		

McCall Engineering Ltd.
Consulting Civil and Structural Engineers

No.	DATE	DESCRIPTION	BY	APP'D

REVISIONS

APPENDIX B – PHOTOGRAPHS

Figure 1: West Bridge Approach

Figure 2: View of Bridge from West Approach

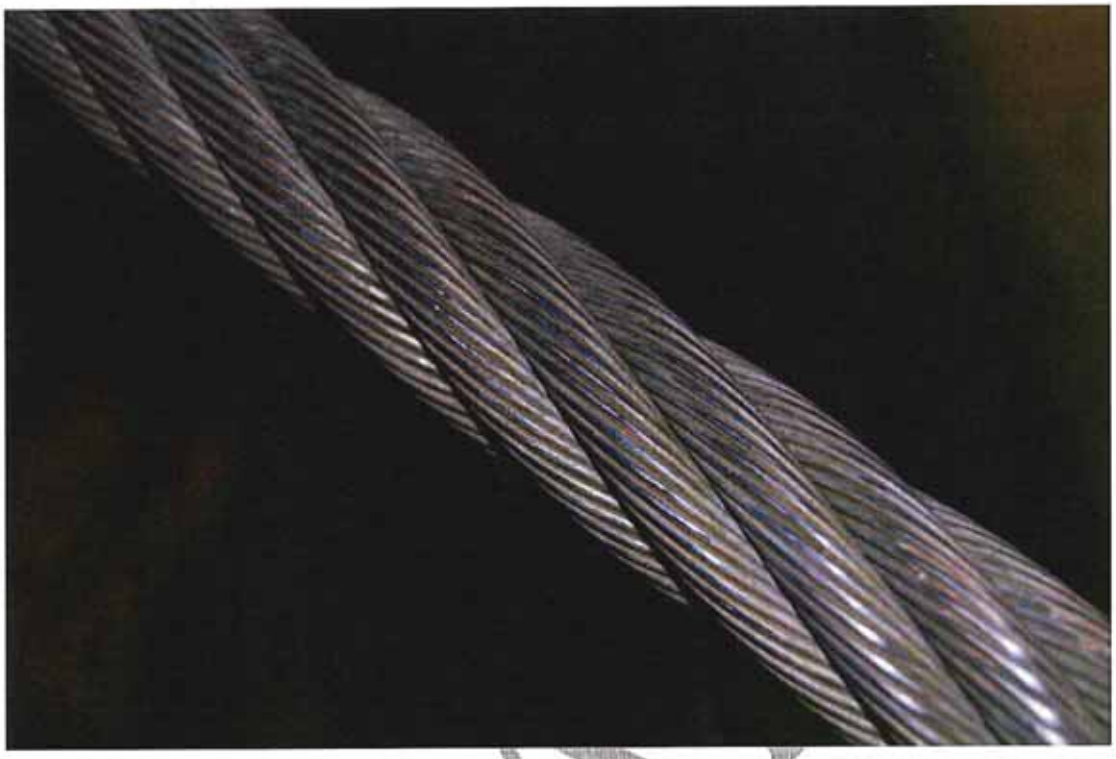


Figure 3: Main Suspension Cable Close-up

Figure 4: Cable Terminations at East Anchor

Figure 5: Wrapped Cable at West Anchor

Figure 6: Unwrapped Cables at West Anchor

Figure 7: Walkway Cable Turnbuckles

Figure 8: Walkway Cable Splice

Figure 9: Typical Top Hanger Connection

Figure 10: Typical Lower Hanger Connection

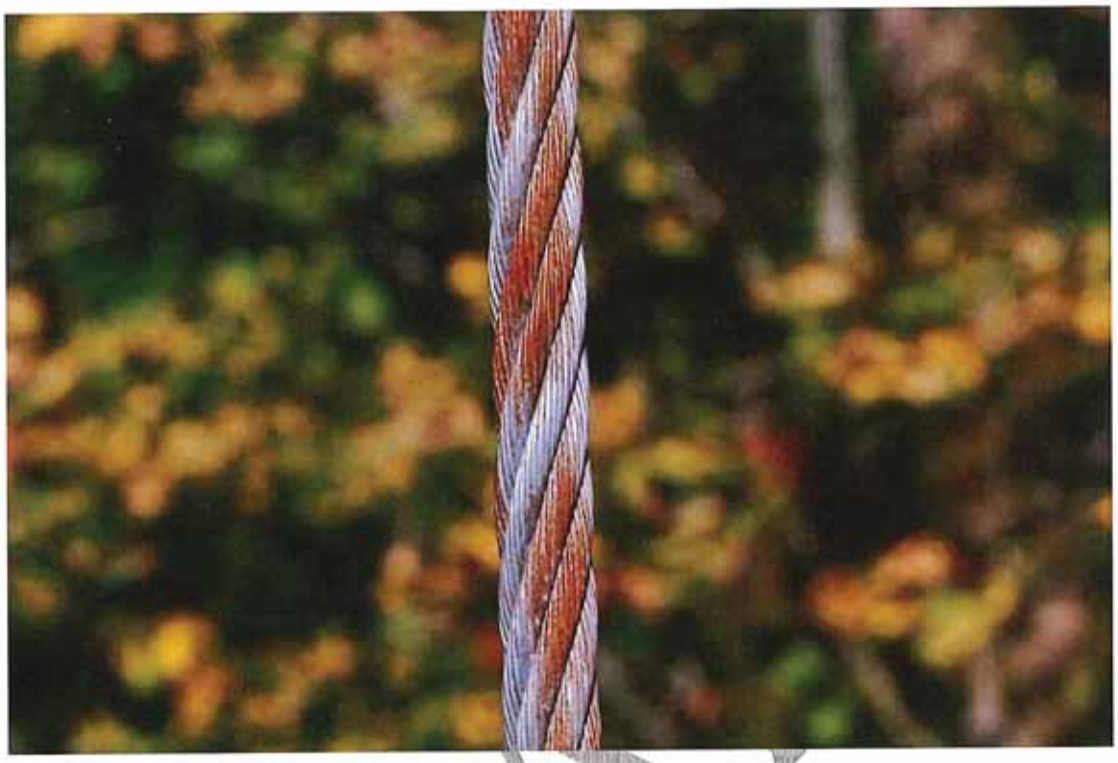


Figure 11: Surface Corrosion on Hanger Cable

Figure 12: Spliced End Connection At Hand Rail Cable

Figure 13: Typical Hand Rail Cable to Hanger Connection

Figure 13: Additional Hand Rail Cable Connection at Mid Span

Figure 15: Typical Decking Construction

Figure 14: Tower Post Base with Decay

Figure 15: Improperly Clipped Turn-Back Eye with Rotated Thimble

Figure 16: : Improperly Clipped Turn-Back Eye with Thimble

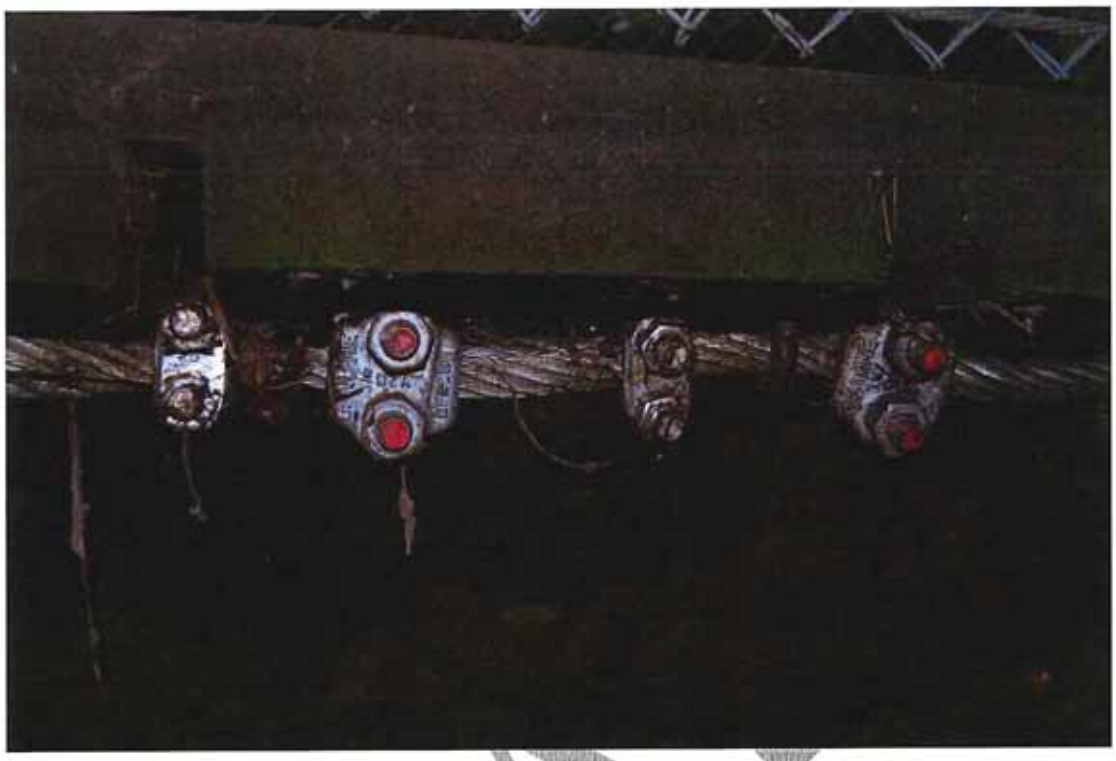


Figure 17: Cable Clips from Varying Suppliers

Figure 19: Makeshift Cable Connectors

APPENDIX C – SCHEDULE 1

Payment

The Client will pay Herold Engineering the fees as described in the proposal plus all applicable taxes and duties including without limitation the Harmonized Sales Tax (HST). In addition to the Services, the Client will also pay for any and all additional services requested of Herold Engineering even if those services are not listed as Services ("Additional Services").

Herold Engineering will submit invoices to the Client requesting payment for that portion of the Services and Additional Services completed to the date of the invoice. The Client agrees to pay the invoice within 30 days of the date of the invoice (the "Due Date"). Invoices unpaid by the Due Date will be charged interest at a rate of 18% per annum from the date of the invoice until paid.

Herold Engineering may, at its sole discretion, suspend the provision of any and all Services or Additional Services in respect to the Project if one or more invoices remain unpaid for more than 60 days from the Date of Invoice.

General Provisions

The Client shall not assign the whole or any part of this Agreement without the express written consent of Herold Engineering. Herold Engineering may assign to subcontractors and agents such part of the Services or Additional Services as Herold Engineering in its sole discretion shall determine. This proposal, if accepted, shall be governed by and construed in accordance with the laws of the Province of British Columbia.

Obligations of Client

The Client will assist Herold Engineering by providing all available and necessary information that Herold Engineering reasonably requires to provide the Services (or Additional Services). The Client will examine all requests, reports or other documents presented by Herold Engineering relating to the Services and Additional Services and will promptly provide in writing decisions or general instructions pertaining thereto so as not to delay the provision of the Services or Additional Services.

Termination

Herold Engineering may, without prejudice to any other right or remedy it may have, terminate this agreement if:

(a) the Client is in breach of any of its obligation under this Agreement; or

(b) the Client is insolvent or makes a general assignment for the benefit of creditors or if a receiver is appointed; or

(c) Herold Engineering is prevented from performing the Services (or Additional Services) for a period of thirty days or more as the result of an event which is unavoidable and beyond the control of Herold Engineering that includes without limitation an order of a Court or other public authority, a labour dispute, a communication line failure, power failure or any other natural disaster or Act of God.

If Herold Engineering terminates this Agreement under (a), (b) or (c) above, Herold Engineering shall be entitled to be paid for all Services or Additional Services performed to the date of termination. Further, if Herold Engineering terminates this Agreement under (a) or (b) then Herold Engineering is also entitled to receive from the Client an amount that Herold Engineering, acting reasonably, determines is equivalent to the profit that Herold Engineering has lost as a result of not completing all of its Services or Additional Services, as the case may be, under this Agreement.

If Herold Engineering terminates this Agreement under (a), (b) or (c) above the Client releases and discharges Herold Engineering of and from any and all of its obligations under this Agreement.

Confidentiality

Except as may be required to advance or protect the legal interests of the Client or Herold Engineering or as may be required by law, the parties will keep strictly confidential and will not, without the written consent of the other party, disclose to anyone, either before, during or after termination of this Agreement, the information which comes to the knowledge of a party as a result of this Agreement.

Ownership of Documents and Designs

All right, title and interest in and to any products, technology or other intellectual property developed by Herold Engineering in performing the Services or Additional Services pursuant to the terms of this Agreement including without limitation all drawings, designs, reports, working papers, computations, manuals, documentation and documents of every kind (the "Work Product") shall remain the property of Herold Engineering. Provided the Client has completed all of its obligations under the Agreement, the Client shall be entitled to receive copies of the Work Product at the Client's expense. No part of the Work Product may be reproduced or re-used without the express written consent of Herold Engineering.

Liability

Herold Engineering is only liable for loss and damage that is directly attributable to its negligent acts or omissions (the "Recoverable Loss and Damage") and in the event of a claim for Recoverable Loss and Damage, the parties agree that the maximum liability of Herold Engineering, whether in contract or tort, is limited to the amount of Herold Engineering's professional liability insurance in place at the time the claim is made and shall only be recoverable from Herold Engineering in respect of loss or damage which is directly attributable to negligent acts or omissions of Herold Engineering.

In no event will Herold Engineering be liable for any indirect, incidental, special, consequential or punitive damages as a consequence of any breach by Herold Engineering or the failure of Herold Engineering to satisfy and/or perform, any term or provision of this Agreement and without limiting the generality of the foregoing, Herold Engineering shall not, under any circumstances, be liable for loss or damage resulting from delays in the completion of the Project, or loss of earnings or loss of profits, howsoever caused.

Optional Dispute Resolution

(a) Either party may give notice in writing to the other with respect to any dispute between the parties under this Agreement (the "Mediation Notice") and, with the written consent of the other party, the dispute shall be referred to a mediator mutually agreed upon by the parties for the purposes of a non-binding mediation. The costs of such mediation shall be borne equally by the parties. Such mediation, if agreed to by the parties, shall be held within thirty (30) days from the date of the Mediation Notice.

(b) Notwithstanding (a) above, either party may give notice in writing to the other with respect to any dispute between the parties under this Agreement (the "Arbitration Notice") and, with the written consent of the other party, the dispute may be referred to and resolved by a single arbitrator (the "Arbitrator"). If the parties are unable to agree on the Arbitrator within 7 days, the Arbitrator shall be appointed under the Commercial Arbitration Act, R.S.B.C. 1996, c.55, as amended and the arbitration shall take place in Nanaimo. The decision of the Arbitrator shall be final and binding on the parties.