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LA GRANDE ALLIANCE

CREE DEVELOPMENT CORPORATION

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ENGINEERING CONSULTING SERVICES

VOLUME 6 - APPENDIX

SECTION 6.10 – RAILWAY BRIDGE LOAD RATING REPORTS

Feasibility Study Final Report Phase I

Consultant Reference: LGA-1-GN-F-FRN-RT-0006_00_LGA Final Technical Report

2023-02-24

Vision Eeyou Istchee

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with subconsultant KPMG

CREE DEVELOPMENT CORPORATION
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Grande alliance feasibility study phase I

Assessment report for the railway bridge located on mileage point 91.00 of the chapais subdivision

2023-03-23

VEI Document Number: **LGA-1-GN-F-FRN-RT-0006_00**

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Version	A
Date	2023-03-23
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Assessment report for the railway bridge located on mileage point 91.00 of the chapais subdivision

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1. INTRODUCTION

The Vision Eeyou Istchee (VEI) consortium formed by Stantec, Systra and Desfor was retained by the Cree Development Corporation (CDC) to complete the feasibility study of Phase I of the Grand Alliance project. One of the purposes of the project is to restore the service on the 99.4 miles long, abandoned Chapais subdivision.

This report presents the load rating capacity of the PK 91.0 bridge that is part of the Chapais subdivision. The structure is a railway bridge crossing the O'sullivan river, and is located in the West-Northern territory of Jasmie, Quebec.

2. STRUCTURE DESCRIPTION

The bridge consists of three simply supported deck plate girder spans with a total length of 186 feet. The main and approach spans are 90' and 45' long, respectively. The three spans sit on two abutments and two concrete piers. According to the original drawings, the bridge was built in 1955. Figure 2-1 and Figure 2-2 show the location as well as the plan and elevation views of the existing bridge.

Figure 2-1: PK 91.0 - Structure location

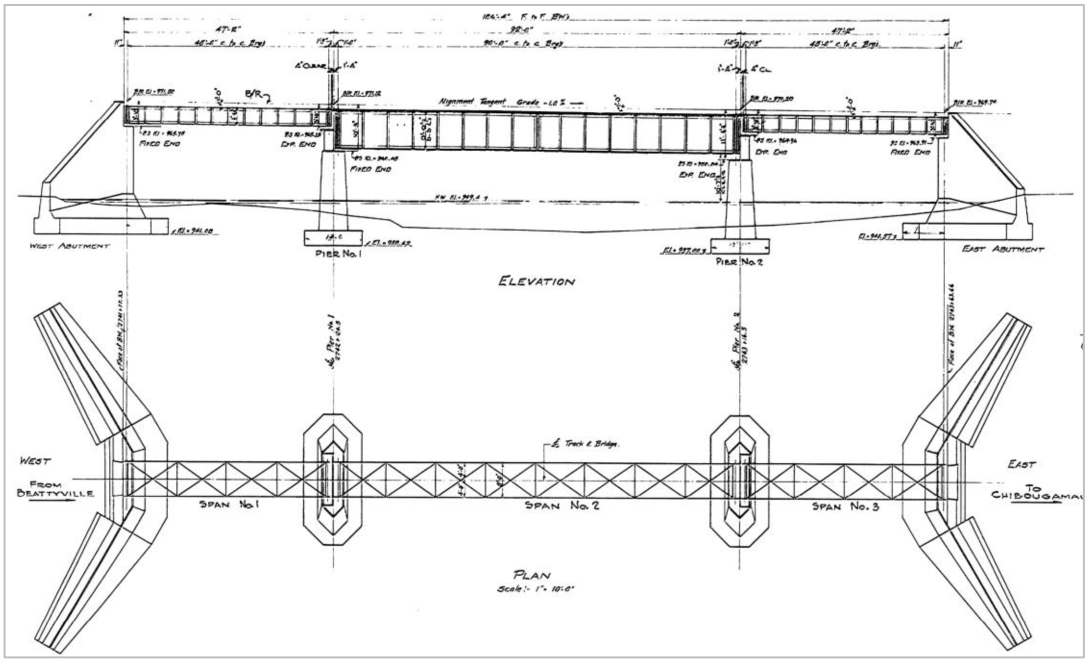

Figure 2-2:Plan and elevation views of the PK 91.0 Chapais bridge

The spans consist of two steel built-up plate girders, composed of web plate and flange angles with vertical stiffeners. The lateral load resisting system consists of cross frames and horizontal bracings. Figure 2-3 shows the plan, elevation and cross-sectional views of the main DPG span. The bridge deck consists of a wooden dekck on top of the original ties, while the other track components (rail, fasteners, tie plates, etc.) are missing.

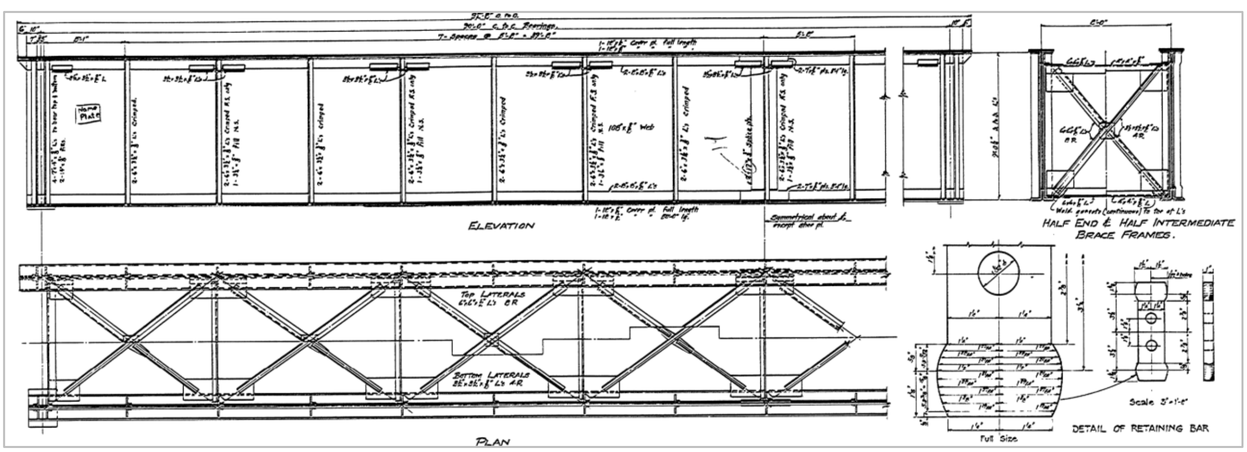

Figure 2-3 : 90’ DPG span

3. LOAD RATING ANALYSIS

3.1 SCOPE

The load rating assessment was carried out only on the plate griders and conducted in accordance with the AREMA manual for the normal and maximum ratings, considering the Cooper E80 loading. The purpose of this study is to assess the capacity of the bridge under the loads of the passenger (Via Rail) and freight cars (263k, 286k and 315k) at a speed varying between 10 and 60 mph.

3.2 REFERENCE DOCUMENTS

Reference was given to the following documents to complete the load rating of the PK 91.0 bridge:

- Original design drawings of the bridge under study;
- AREMA, 2021 Edition;
- AREMA – Structure Loading Seminar – Student Manual;
- Site visit photos - PK91.0 Chapais bridge, produced by Stantec, September, 2021;

3.3 SITE VISIT

A site visit to the PK 91.0 bridge at Chapais subdivision was conducted on September 14, 2021. During the site visit a visual inspection of the structure was completed from the deck, approcahes and the shores of the O'sullivan river.

It is important to note that the purpose of the site visit was to assess the overall condition of the bridge and was not to inspect in details the structure's main members.

Given that no detailed inspection was conducted on the existing bridge, the load rating assessment of the structure was completed based on its as-constructed condition, obtained from the original design drawings attached in Appendix A. Figure 3-1 shows general views of the existing bridge.

Figure 3-1 : General views of the PK 91.0 bridge

3.4 LOADS

Chapters 7 and 15 of AREMA were used to determine the loads to which the existing structure is subjected. The following loads / combinations were considered:

- Primary load combination including dead loads (DL), live loads (LL) and impact (IM). The impact was reduced, based on the speed, in accordance with AREMA 15-7.3.2.3a.
-
- Secondary load combination including the lateral forces from equipment and the wind loads (W) both on the bridge and the rail cars, in addition to the primary loads. For this combination, the allowable stresses are increased by 25% for the normal rating.

Based on the original drawings, the structure's dead load as well as the distribution of the transverse wind load on the truss members were calculated in two Excel files named "Calcul_Poids-mort_acier_PM91.0_Travee-90" and "Calcul_Poids-mort_acier_PM91.0_Travee-45".

The maximum bending moment and shear for the Cooper E80 live load, in the built-up plate girders, were determined by interpolation of the values presented in AREMA, table 15-1-15.

The bending moment and shear values were reported in MathCad calculation sheets, where the different stresses and "E-rating" were determined based on the normal and maximum allowable stresses.

3.5 CROSS-SECTIONAL PROPERTIES

The cross-sectional properties of the built-up plate girders were determined, by modelling the critical gross and net sections using "ShapeBuilder" software. Figure 3-2 shows the gross built-up sections of the 45' and 90' long plate girders.

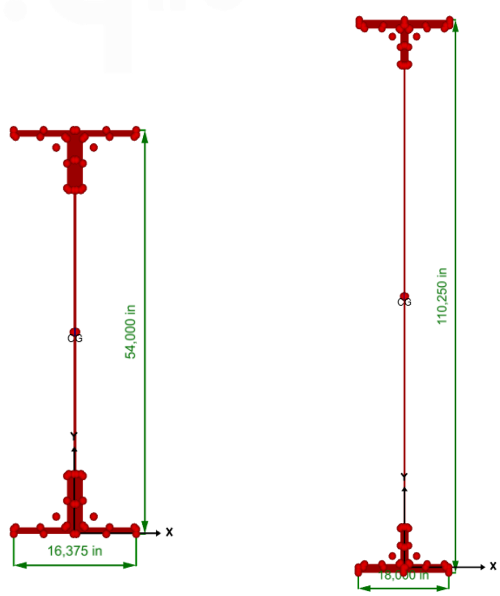

Figure 3-2 : Cross sections of the 45’ (left) and 90’ long (right) plate girders

3.6 Assumptions

The following different assumptions were taken into account during the load rating of the PK 91.0 bridge:

- Given that the steel’s yield and ultimate strengths are missing on the original drawings, a value of 33 ksi and 60 ksi for the yield and ultimate strengths respectively were estimated based on the year of construction from the CSA S6, Canadian Highway Bridge Design Code.
- A 10” x 12” x 15’ tie and a 136RE rail were considered in the calculation of the deck dead load.
- The girders dead load was estimated based on each component weight and was increased by 20% to consider the weight of the rivets, gussets and splices.

4. LOAD RATING SUMMARY

The load rating of the PK 91.0 railway bridge is summarized in a table attached in appendix B.

5. CONCLUSION

In order to support the projected live loads due to freight cars (268K, 286K and 315K), the plate girders need to be strenghthened.

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Grande Alliance Feasibility Study Phase I

Assessment Report for the Railway Bridge Located on Mileage Point 101.80 of the Chapais Subdivision

2023-03-23

VEI Document Number: **LGA-1-GN-F-FRN-RT-0006_00**

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Assessment Report for the Railway Bridge Located on Mileage Point 101.80 of the Chapais Subdivision

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1. INTRODUCTION

The Vision Eeyou Istchee (VEI) consortium formed by Stantec, Systra and Desfor was retained by the Cree Development Corporation (CDC) to complete the feasibility study of Phase I of the Grand Alliance project. One of the purposes of the project is to restore the service on the 99.4 miles long, abandoned Chapais subdivision.

This report presents the load rating capacity of the PK 101.8 bridge that is part of the Chapais subdivision. The structure is a railway bridge crossing the Bachelor River and is located in the West-Northern territory of Jasmie, Quebec.

2. STRUCTURE DESCRIPTION

The bridge consists of five simply supported spans with a total length of 152 feet. The three central spans consist of deck plate girders while the two approach spans are timber spans. The DPG spans sit on four steel trestle bents while the timber spans sit on two wooden abutments and trestle bents. According to the original drawings, the bridge was built in 1974. Figure 2-1 and Figure 2-2 show the location as well as the plan and elevation views of the existing bridge. It should be noted that the two timber spans shall be replaced and hence were not included in the present load rating assessment.

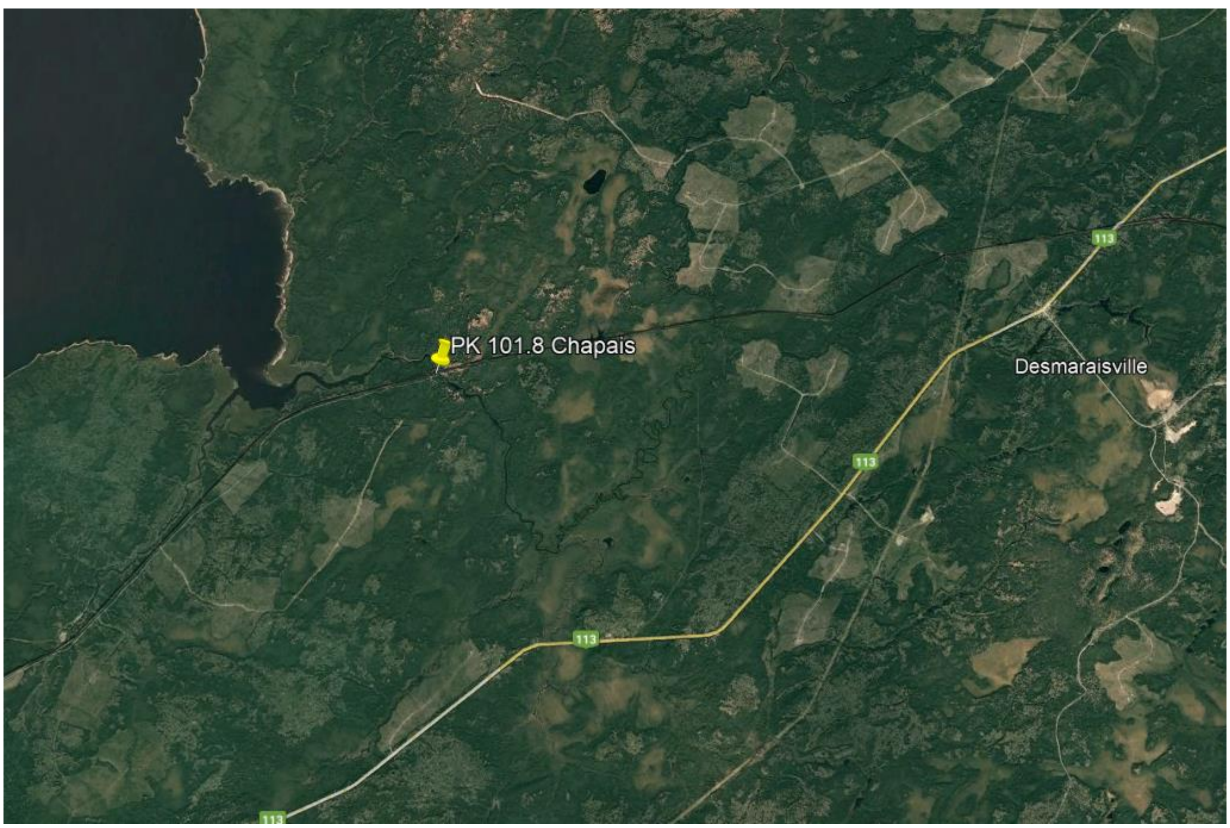

Figure 2-1: PK 101.8 structure location

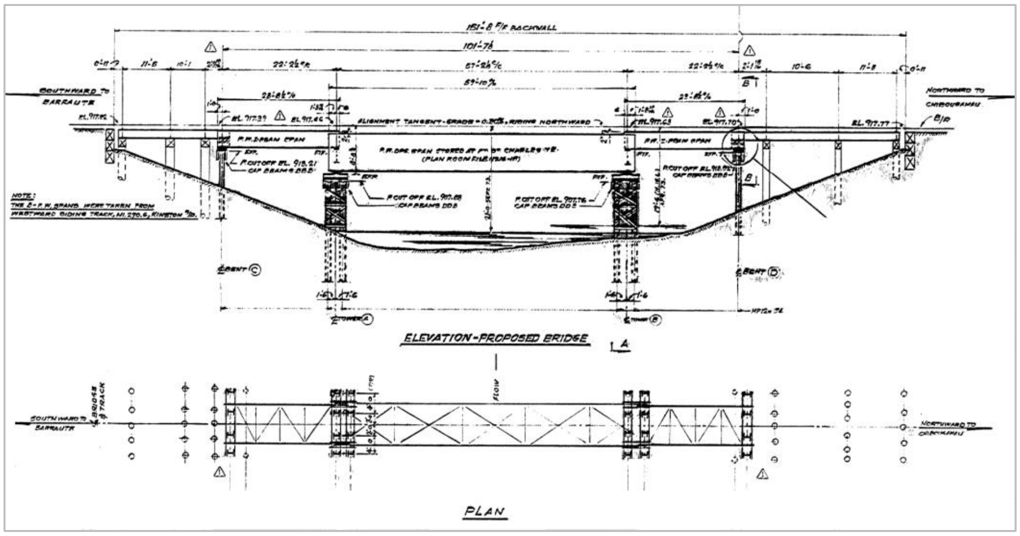

Figure 2-2:Plan and elevation views of the PK 101.8 Chapais bridge

The three central spans consist of two steel girders. The main span built-up girders are composed of web plate and flange angles with vertical stiffeners, while the adjacent spans are composed of I rolled girders. The lateral load resisting system consists of cross frames and horizontal bracings. Figure 2-3shows cross-sectional views of the DPG span. The bridge deck consist of a wooden deck on top of the original ties, while the other track components (rail, fasteners, tie plates, etc.) are missing.

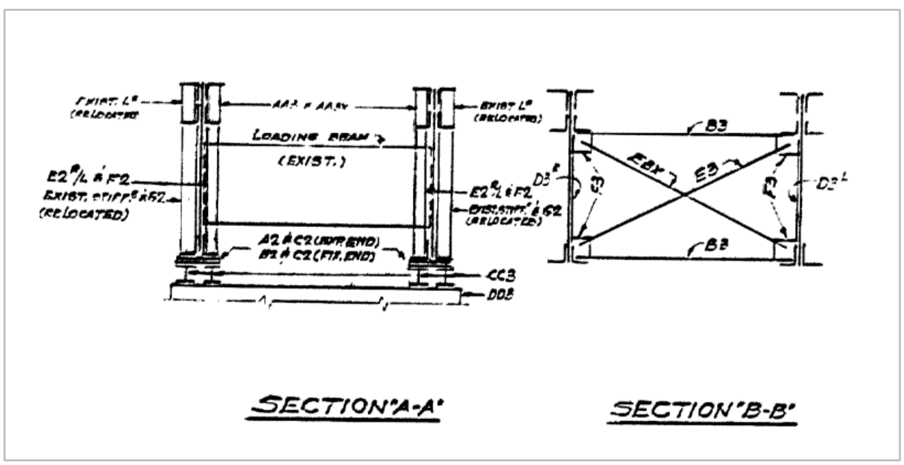

Figure 2-3 : Cross sections of the 57 DPG span

3. LOAD RATING ANALYSIS

3.1 SCOPE

The load rating assessment was carried out only on the main plate girders in accordance with AREMA manual for the normal and maximum ratings, considering the Cooper E80 loading. The purpose of this study is to assess the capacity of the bridge under the loads of the passenger (Via Rail) and freight cars (263k, 286k and 315k) at a speed varying between 10 and 60 mph.

3.2 REFERENCE DOCUMENTS

Reference was given to the following documents to complete the load rating of the PK 101.8 bridge:

- Original design drawings of the bridge under study;
- AREMA, 2021 Edition;
- AREMA – Structure Loading Seminar – Student Manual;
- Site visit photos - PK101.8 Chapais bridge, produced by Stantec, September, 2021.

3.3 SITE VISIT

A site visit to the PK 101.8 bridge at Chapais subdivision was conducted on September 14, 2021. During the site visit a visual inspection of the structure was completed from the deck, approaches and the shores of the Bachelor river.

It is important to note that the purpose of the site visit was to assess the overall condition of the bridge and was not to inspect in details the structure's main members.

Given that no detailed inspection was conducted on the existing bridge, the load rating assessment of the structure was completed based on its as-constructed condition, obtained from the original design drawings attached in Appendix A. Figure 3-1 shows general views of the existing bridge.

Figure 3-1 : General views of the PK 101.8 bridge

3.4 LOADS

Chapters 7 and 15 of AREMA were used to determine the loads to which the existing structure is subjected. The following loads / combinations were considered:

- Primary load combination including dead loads (DL), live loads (LL) and impact (IM). The impact was reduced, based on the speed, in accordance with AREMA 15-7.3.2.3a.

- Secondary load combination including the lateral and longitudinal (LF) forces from equipment and the wind loads (W) both on the bridge and the rail cars, in addition to the primary loads. For this combination, the allowable stresses are increased by 25% for the normal rating.

The maximum bending moment and shear for the Cooper E80 live load, in the built-up plate girders, were determined by interpolation of the values presented in AREMA, table 15-1-15.

The bending moment and shear values were reported in MathCad calculation sheets, where the different stresses and "E-rating" were determined based on the normal and maximum allowable stresses.

3.5 MODELLING AND CROSS-SECTIONAL PROPERTIES

In order to determine the bending moment, shear and axial forces in the trestle bent columns, a 2D model of the trestle bent was prepared using Advance Design America (ADA) software. The obtained forces from the model were reported in MathCad calculation sheets, where the different stresses and "E-ratings" were determined based on the normal and maximum allowable stresses. Figure 3-2 shows the 2D model of the trestle bent.

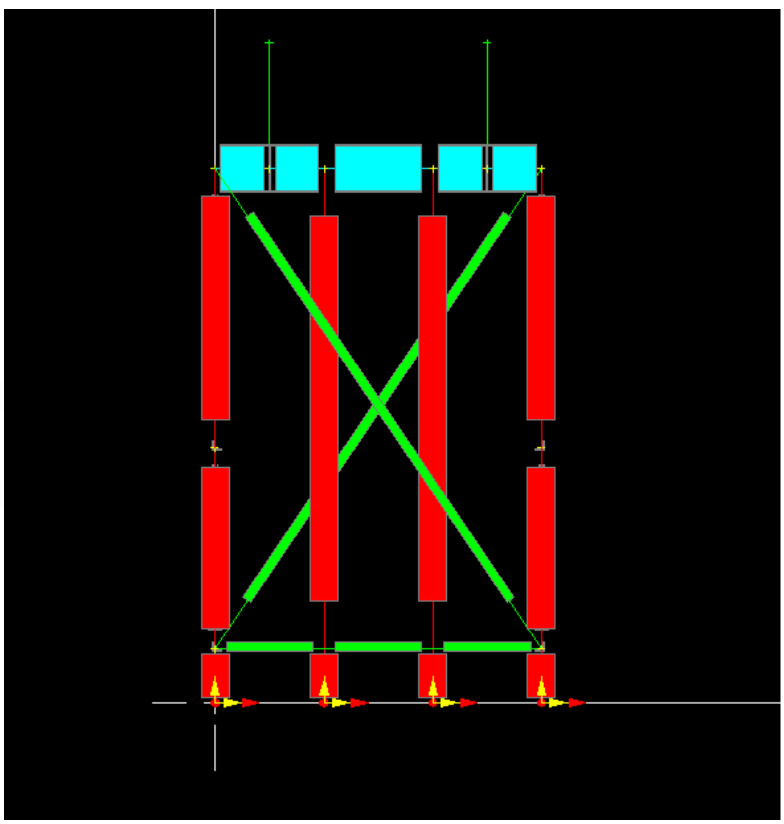

Figure 3-2 : Steel trestle bent model

The vertical force applied to the bents, due to the E80 Cooper live load, was determined by interpolation of the "maximum pier reactions" values presented in AREMA, table 15-1-15.

The cross-sectional properties of the built-up and I rolled girders were determined, by modelling the critical gross and net sections using “ShapeBuilder” software. Figure 3-3 shows the gross sections of the 57ft and 23ft long girders.

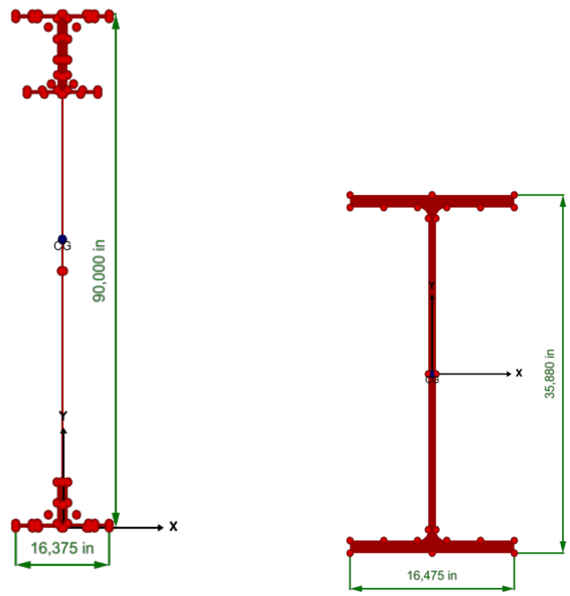

Figure 3-3 : Cross sections of the 57’ (left) and 23’ long (right) girders

3.6 Assumptions

The following different assumptions were considered during the load rating of the PK 101.8 bridge:

- Given that the steel’s yield and ultimate strengths are missing on the original drawings, a value of 33 ksi and 60 ksi for the yield and ultimate strengths respectively were estimated based on the year of construction from the CSA S6, Canadian Highway Bridge Design Code.
- A 10” x 12” x 15’ tie and a 136RE rail were considered in the calculation of the deck dead load.
- The girders dead load was estimated based on each component weight and was increased by 20% to consider the weight of the rivets, gussets and splices.
- In order to assess the steel trestle bents, the height of the columns was scaled from the original drawings to be 6m due to lack of information.
- The steel bents were assessed considering 2 load combinations, with the longitudinal forces and without the longitudinal forces.
- Steel pier cap was not assessed due to lack of information on the original drawings.

4. LOAD RATING SUMMARY

The load rating of the PK 101.8 railway bridge is summarized in a table attached in appendix B.

5. CONCLUSION

The rating of the deck plate girders confirms that they are adequate for the projected live loads. The steel bents have sufficient capacity for the load combinations without the longitudinal forces. However, the bents are not adequate to resist the longitudinal forces.

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Grande Alliance Feasibility Study Phase I

Assessment Report for the Railway Bridge Located at Mileage Point 118.80 of the Chapais Subdivision

2023-03-23

VEI Document Number: **LGA-1-GN-F-FRN-RT-0006_00**

Vision Eeyou Istchee

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Assessment Report for the Railway Bridge Located at Mileage Point 118.80 of the Chapais Subdivision

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1. INTRODUCTION

The Vision Eeyou Istchee (VEI) consortium formed by Stantec, Systra and Desfor was retained by the Cree Development Corporation (CDC) to complete the feasibility study of Phase I of the Grand Alliance project. One of the purposes of the project is to restore the service on the 99.4 miles long, abandoned Chapais subdivision.

This report presents the load rating capacity of the PK 118.8 railway bridge that is part of the Chapais subdivision. The structure is a railway bridge crossing a creek, and is located in the West-Northern territory of Jasmie, Quebec.

2. STRUCTURE DESCRIPTION

The bridge consists of three simply supported through plate girder (TPG) spans with a total length of 75 feet (25 feet each). According to the original drawings, the bridge was built in 1976. Figure 1 shows the location of the existing structure, while Figure 2-1 and Figure 2-2 show the elevation ans cross section views of the TPG spans.

Figure 2-1: PK 118.8 structure location

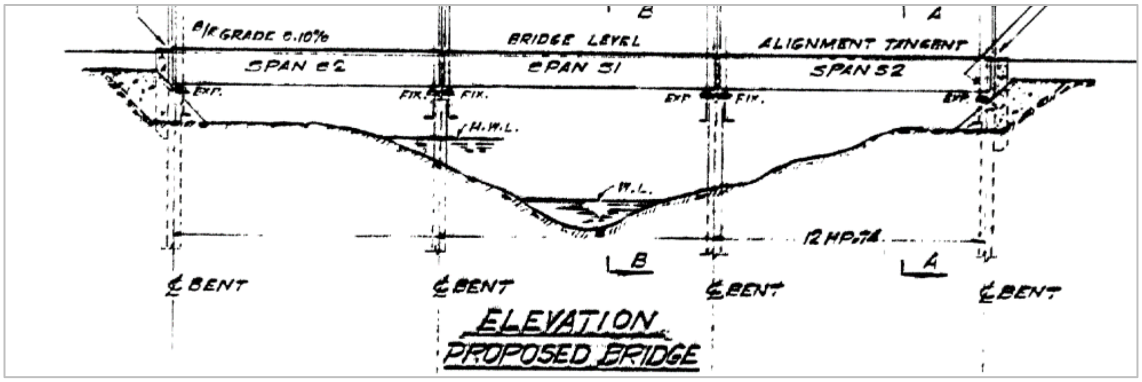

Figure 2-2: Elevation view of the PK 118.8 Chapais bridge

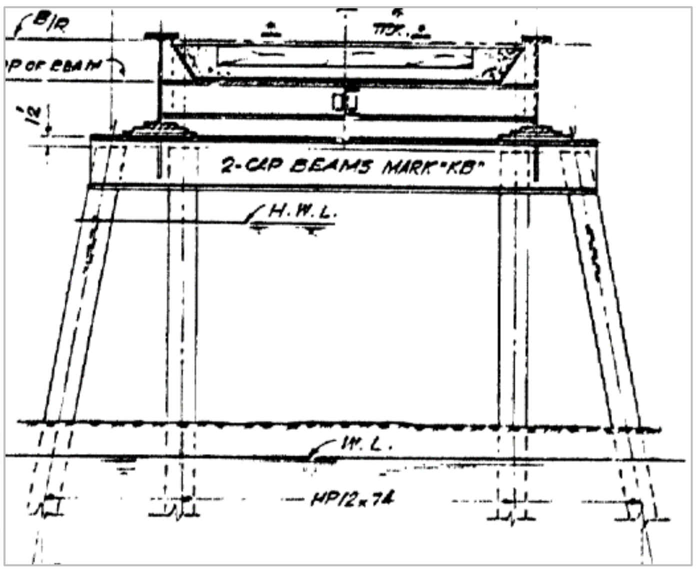

Figure 2-3:Cross section view of the PK 118.8 Chapais bridge

Each span consists of two steel I rolled girders, with vertical knee braces. The floor system consists of I rolled floorbeams that are connected to the main girders. The three spans sit on two precast concrete abutments and four steel trestle bents, each composed of four H profile columns and a steel cap beam. Figure 2-4shows half elevation view of the TPG span. It is noted that the track components (rail, fasteners, tie plates, etc.) are missing.

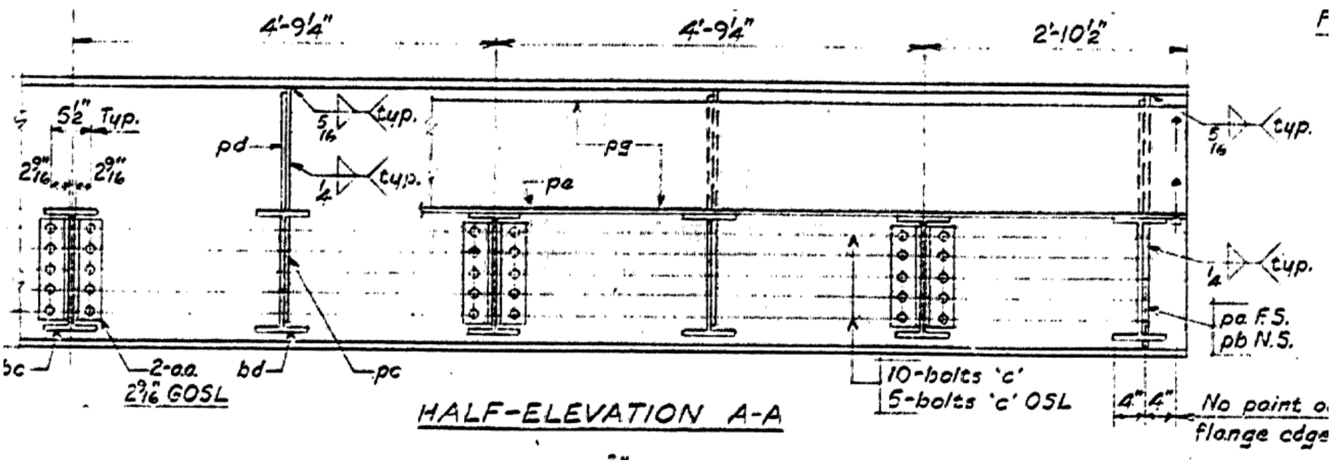

Figure 2-4 : Half elevation - TPG span

3. LOAD RATING ANALYSIS

3.1 SCOPE

The load rating assessment was carried out only on the plate griders and conducted in accordance with AREMA manual for the normal and maximum ratings, considering the Cooper E80 loading. The purpose of this study is to assess the capacity of the bridge under the loads of the passenger (Via Rail) and freight cars (263k, 286k and 315k) at a speed varying between 10 and 60 mph.

3.2 REFERENCE DOCUMENTS

Reference was given to the following documents to complete the load rating of the PK 118.8 bridge:

- Original design drawings of the bridge under study;
- AREMA, 2021 Edition;
- AREMA – Structure Loading Seminar – Student Manual;
- CN cars rating. Office of the System Engineer Structure Design. CNR October 1994;
- Site visit photos - PK118.8 Chapais bridge, produced by Stantec, September, 2021.

3.3 SITE VISIT

A site visit to the PK 118.8 bridge at Chapais subdivision was conducted on September 14, 2021. During the site visit a visual inspection of the structure was completed from the deck, approcahes and the shores of the creek.

It is important to note that the purpose of the site visit was to assess the overall condition of the bridge and was not to complete a detailed inspection of the structure's main members.

Given that no detailed inspection was conducted on the existing bridge, the load rating assessment of the structure was completed based on its as-constructed condition, obtained from the original design drawings attached in Appendix A. Figure 3-1 shows general views of the existing bridge.

Figure 3-1 : General views of the PK 118.8 bridge

3.4 LOADS

Chapters 7 and 15 of AREMA wer used to determine the loads to which the existing structure is subjected. The following loads / combinations were considered:

- Primary load combination including dead loads (DL), live loads (LL) and impact (IM). The impact was reduced, based on the speed, in accordance with AREMA 15-7.3.2.3a.
- Secondary load combination including the longitudinal (LF) and lateral forces from equipment and the wind loads (W) both on the bridge and the rail cars, in addition to the primary loads. For this combination, the allowable stresses are increased by 25% for the normal rating.

The maximum bending moment and shear for the Cooper E80 live load, in the built-up plate girders, were determined by interpolation of the values presented in AREMA, table 15-1-15.

The bending moment and shear values were reported in MathCad calculation sheets, where the different stresses and “E-rating” were determined based on the normal and maximum allowable stresses.

3.5 MODELLING AND CROSS-SECTIONAL PROPERTIES

In order to determine the bending moment, shear and axial forces in the trestle bent members (column and beam cap), a 2D model of the trestle bent was prepared using Advance Design America (ADA) software. The obtained forces from the model were reported in MathCad calculation sheets, where the different stresses and “E-ratings” were determined based on the normal and maximum allowable stresses. Figure 3-2shows the 2D model of the trestle bent of the PK 118.8 Chapais bridge.

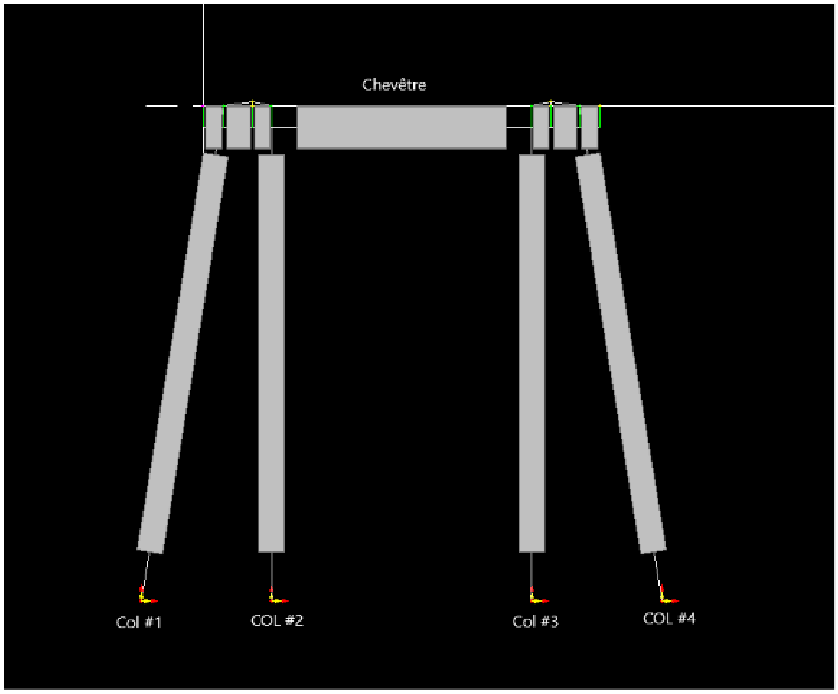

Figure 3-2 : Bent model in ADA

The vertical force applied to the bents, due to the E80 Cooper live load, was determined by interpolation of the "maximum pier reactions" values presented in AREMA, table 15-1-15.

The cross-sectional properties of the girders and columns were determined, by modelling the critical gross and net sections using "ShapeBuilder" software. Figure 3-3shows the gross sections of the column and girder.

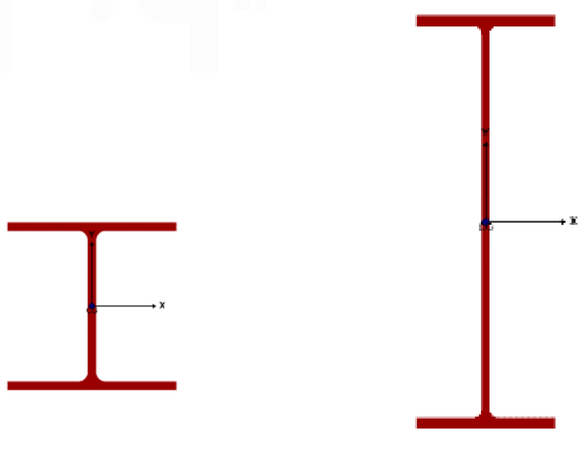

Figure 3-3 : Cross sections of the I rolled column (left) and through plate girder (right)

3.6 ASSUMPTIONS

The following different assumptions were taken into account during the load rating of the PK 118.8 bridge:

- Given that the steel's yield and ultimate strengths are missing on the original drawings, a value of 44 ksi and 60 ksi for the yield and ultimate strengths respectively were estimated based on the year of construction from the CSA S6, Canadian Highway Bridge Design Code.
- A 136RE rail was considered in the calculation of the deck dead load.
- An additional 8 inches of ballast thickness has been considered in the calculation of the deck dead load.
- Given that the bent columns length are missing on the original drawings and without any geotechnical information, the bent columns has been considered fixed in moments and shear at 1.5m below the estimated natural ground from the drawings.

4. LOAD RATING SUMMARY

The load rating of the PK 118.8 railway bridge is summarized in a table attached in appendix B.

5. CONCLUSION

The rating of the through plate girders confirms that they are adequate for the projected live loads. On the other hand, the bent columns are not adequate for the projected longitudinal loads coming from the braking and traction of the train.

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Grande Alliance Feasibility Study Phase I

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1. INTRODUCTION

The Vision Eeyou Istchee (VEI) consortium formed by Stantec, Systra and Desfor was retained by the Cree Development Corporation (CDC) to complete the feasibility study of Phase I of the Grand Alliance project. One of the purposes of the project is to restore the service on the 99.4 miles long, abandoned Chapais subdivision.

This report presents the load rating capacity of the PK 122.3 bridge that is part of the Chapais subdivision. The structure is a railway bridge crossing a section of the Opawika lake and is located in the West-Northern territory of Jasmie, Quebec.

2. STRUCTURE DESCRIPTION

The bridge consists of two simply supported deck plate girder spans with a total length of 135 feet (face to face of backwalls). The main and secondary spans are 90 and 45 feet long, respectively. The two spans sit on two abutments and one concrete pier. According to the original drawings, the bridge was built in 1956. Figure 2-1 and Figure 2-2 show the location as well as the plan and elevation views of the existing bridge.

Figure 2-1: PK 122.3 structure location

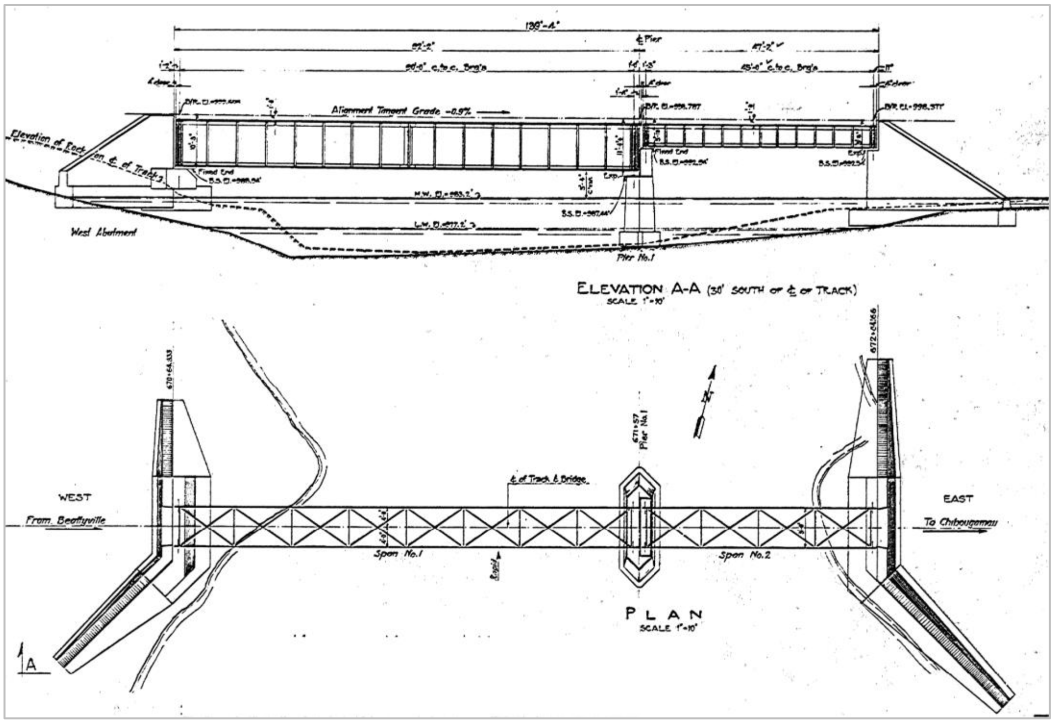

Figure 2-2:Plan and elevation views of the PK 122.3 Chapais bridge

The spans consist of two steel built-up plate girders, composed of web plate and flange angles with vertical stiffeners. The lateral load resisting system consists of cross frames and horizontal bracings. Figure 2-3shows the plan, elevation and cross-sectional views of the main DPG span. The bridge deck consist of a wooden deck on top of the original ties, while the other track components (rail, fasteners, tie plates, etc.) are missing.

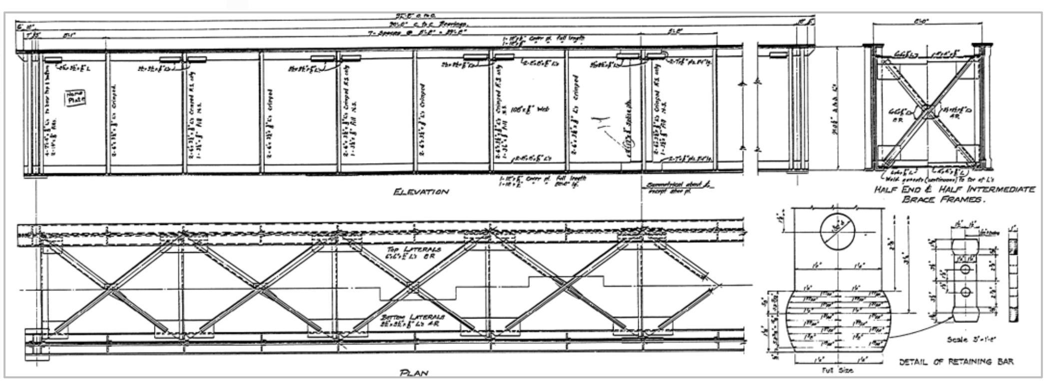

Figure 2-3 : 90’ DPG span

3. LOAD RATING ANALYSIS

3.1 Scope

The lod rating assessment was carried out only on the plate griders and conducted in accordance with AREMA manual for the normal and maximum ratings, considering the Cooper E80 loading. The purpose of this study is to assess the capacity of the bridge under the loads of the passenger (Via Rail) and freight cars (263k, 286k and 315k) at a speed varying between 10 and 60 mph.

3.2 Reference documents

Reference was given to the following documents to complete the load rating of the PK 122.3 bridge:

- Original design drawings of the bridge under study;
- AREMA, 2021 Edition;
- AREMA – Structure Loading Seminar – Student Manual;
- Site visit photos - PK122.3 Chapais bridge, produced by Stantec, September, 2021.

3.3 Site visit

A site visit to the PK 122.3 bridge at Chapais subdivision was conducted on September 14, 2021. During the site visit a visual inspection of the structure was completed from the deck, approaches and the shores of the O'sullivan river.

It is important to note that the purpose of the site visit was to assess the overall condition of the bridge and was not to inspect in details the structure's main members.

Given that no detailed inspection was conducted on the existing bridge, the load rating assessment of the structure was completed based on its as-constructed condition, obtained from the original design drawings attached in Appendix A. Figure 3-1shows general views of the existing bridge.

Figure 3-1 : General views of the PK 122.3 bridge

3.4 Loads

Chapters 7 and 15 of the AREMA were used to determine the loads to which the existing structure is subjected. The following loads / combinations were considered:

- Primary load combination including dead loads (DL), live loads (LL) and impact (IM). The impact was reduced, based on the speed, in accordance with AREMA 15-7.3.2.3a.

- Secondary load combination including the lateral forces from equipment and the wind loads (W) both on the bridge and the rail cars, in addition to the primary loads. For this combination, the allowable stresses are increased by 25% for the normal rating.

The maximum bending moment and shear for the Cooper E80 live load, in the built-up plate girders, were determined by interpolation of the values presented in AREMA, table 15-1-15.

The bending moment and shear values were reported in MathCad calculation sheets, where the different stresses and "E-rating" were determined based on the normal and maximum allowable stresses.

3.5 CROSS-SECTIONAL PROPERTIES

The cross-sectional properties of the built-up plate girders were determined, by modelling the critical gross and net sections using "ShapeBuilder" software. Figure 3-2shows the gross built-up sections of the 45' and 90' long plate girders.

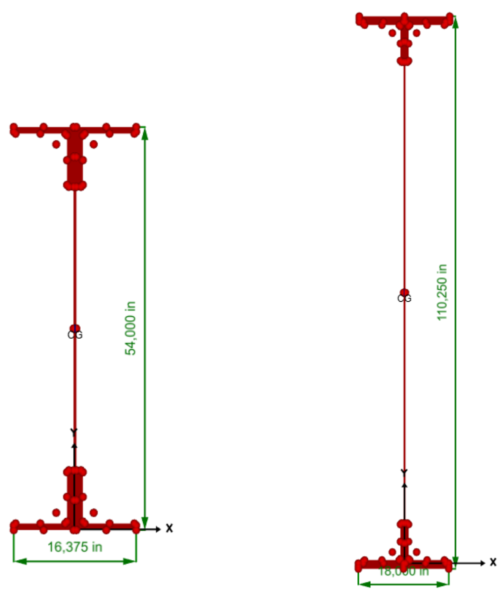

Figure 3-2 : Cross sections of the 45' (left) and 90' long (right) plate girders

3.6 ASSUMPTIONS

The following different assumptions were considered during the load rating of the PK 122.3 bridge:

- Given that the steel's yield and ultimate strengths are missing on the original drawings, a value of 33 ksi and 60 ksi for the yield and ultimate strengths respectively were estimated based on the year of construction from the CSA S6, Canadian Highway Bridge Design Code.
- A 10" x 12" x 15' tie and a 136RE rail were considered in the calculation of the deck dead load.
- The girders dead load was estimated based on each component weight and was increased by 20% to consider the weight of the rivets, gussets and splices.

4. LOAD RATING SUMMARY

The load rating of the PK 122.3 railway bridge is summarized in a table attached in appendix B.

5. CONCLUSION

The rating of the deck plate girders confirms that they are adequate for the projected live loads.

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Grande Alliance Feasibility Study Phase I

Assessment Report for the Railway Bridge Located at Mileage Point 125.30 of the Chapais Subdivision

2023-03-23

VEI Document Number: **LGA-1-GN-F-FRN-RT-0006_00**

Stantec DESFOR SYSTRA

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1. INTRODUCTION

The Vision Eeyou Istchee (VEI) consortium formed by Stantec, Systra and Desfor was retained by the Cree Development Corporation (CDC) to complete the feasibility study of Phase I of the Grand Alliance project. One of the purposes of the project is to restore the service on the 99.4 miles long, abandoned Chapais subdivision.

This report presents the load rating capacity of the PK 125.30 bridge that is part of the Chapais subdivision. The structure is a railway bridge crossing a narrow section of the Opawika Lake and is located in the West-Northern territory of Jasmie, Quebec.

2. STRUCTURE DESCRIPTION

The bridge consists of three simply supported spans with a total length of 293 feet. The central span is a 196.8 feet long Through Truss, while each of the two approach spans is 45 feet long braced deck-plate girder (DPG) span. The three spans sit on two concrete abutments and two concrete piers. According to the original drawings, the bridge was built in 1956. Figure 2-1 and Figure 2-2 show the location as well as the plan and elevation views of the existing bridge.

Figure 2-1: PK125.30 structure location

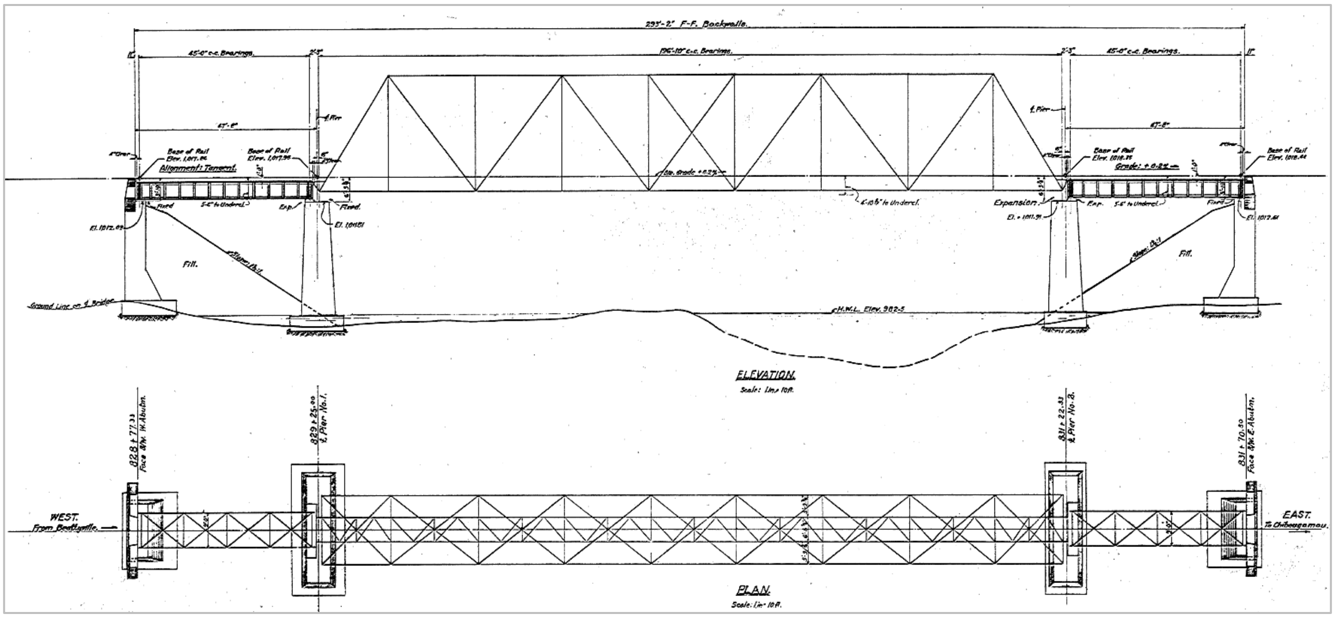

Figure 2-2:Plan and elevation views of the PK 125.30 Chapais bridge

Each of the DPG spans consists of two steel built-up girders, composed of web plate and flange angles with vertical stiffeners. The lateral load resisting system consists of cross frames and top horizontal bracings. Figure 2-3shows the plan, elevation and cross-sectional views of the DPG span. The bridge deck includes only original ties, since the other track components (rails, fasteners, tie plates, etc.) are missing.

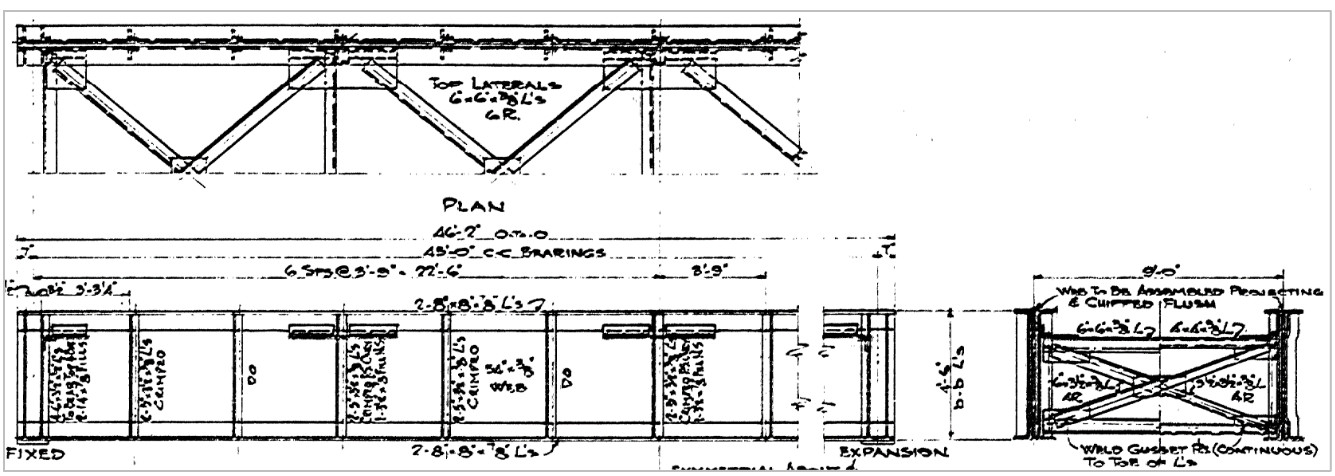

Figure 2-3 : 45’ DPG span

The through truss superstructure consists of riveted built-up truss members (top/bottom chords, verticals, diagonals and end posts). The floor system is composed of built-up floor beams and braced I-rolled stringers.

3. LOAD RATING ANALYSIS

3.1 SCOPE

The load rating assessment was carried out only on main members of the superstructure, which include the following:

- Top and bottom chords of the trusses.
- Diagonals, verticals, and end posts of the trusses.
- Floor system (stringers and floorbeams) of the truss span.
- Plate girders of the DPG spans.

Furthermore, the load rating was conducted in accordance with AREMA manual for the normal and maximum ratings, considering the Cooper E80 loading. The purpose of this study is to assess the capacity of the bridge under the loads of the passenger (Via Rail) and freight cars (263k, 286k and 315k) at a speed varying between 10 and 60 mph.

3.2 REFERENCE DOCUMENTS

Reference was given to the following documents to complete the load rating of the PK 125.30 bridge:

- Original design drawings of the bridge under study.
- AREMA, 2021 Edition.
- AREMA – Structure Loading Seminar – Student Manual.
- Inspection sheets and photos - PK125.30 Chapais bridge, produced by Stantec, June 2022.

3.3 INSPECTION REPORT

The inspection of the PK 125.30 bridge at Chapais subdivision was carried out by Stantec's inspection team, from June 15 to 18, 2022. Most of the structural systems were inspected using rope access techniques.

Based on the detailed visual inspection, the steel structure is considered to be in good condition. Hence, the load rating assessment of the existing structure was completed based on its as-constructed condition, obtained from the original design drawings attached in Appendix A. Figure 3-1shows a general view of the existing bridge.

Figure 3-1 : General view of the PK 125.30 bridge

3.4 LOADS

Chapters 7 and 15 of AREMA were used to determine the loads to which the existing structure is subjected. The following loads / combinations were considered:

- Primary load combination including dead loads (DL), live loads (LL) and impact (IM). The impact was reduced, based on the speed, in accordance with AREMA 15-7.3.2.3a.
- Secondary load combination including the longitudinal and lateral forces from equipment
- (LF) and the wind loads (W) both on the bridge and the rail cars, in addition to the primary loads. For this combination, the allowable stresses are increased by 25% for the normal rating.

Based on the original drawings, the structure's dead load as well as the distribution of the transverse wind load on the truss members were calculated in an Excel file named "125.30_Chapais_Dead&WindLoad_TT-197ft".

The truss stability was also checked under both, primary and secondary load combinations.

3.5 MODELING AND CROSS-SECTIONAL PROPERTIES

In order to determine the axial forces (compression and tension) in the main truss members, a 2D model of the truss was prepared using Advance Design America (ADA) software. The obtained forces from the model were reported in MathCad calculation sheets, where the different stresses and "E-rating" were determined based on the normal and maximum allowable stresses. Figure 3-2shows the 2D model of the truss span of the PK 125.30 bridge.

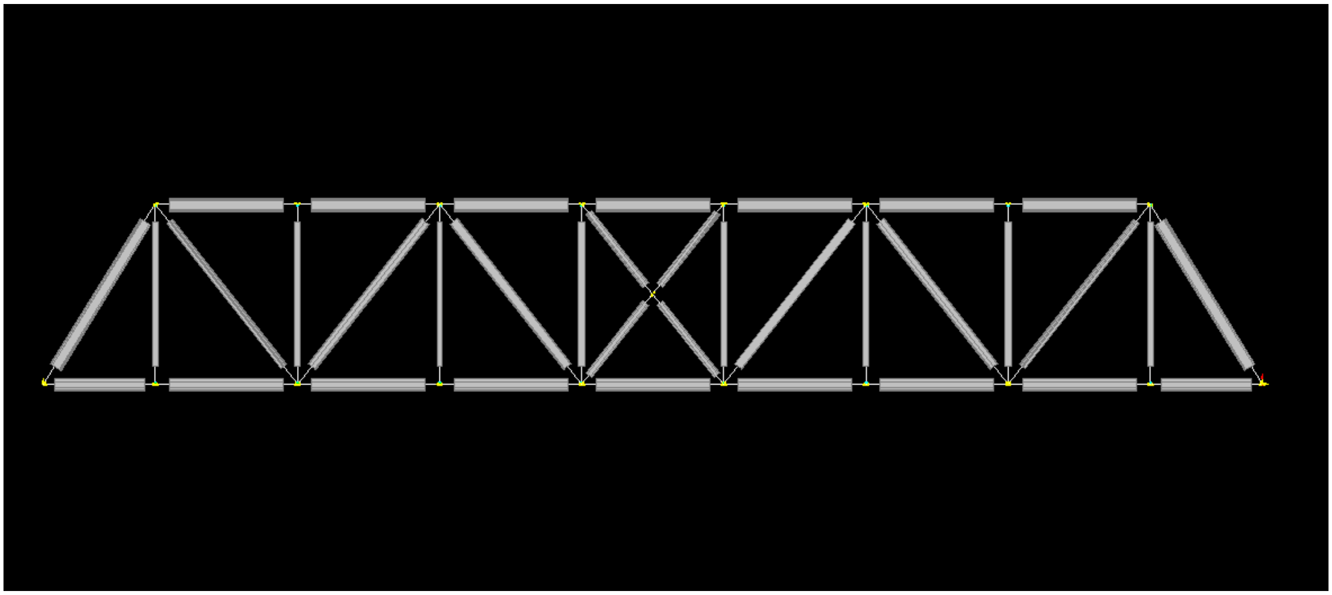

Figure 3-2 : 2D Through truss model

The maximum bending moments and shears in the girders, floor beams and stringers were determined using ADA software in conjunction with MathCad calculations. It is important to note that floorbeams and stringers were considered as simply supported beams.

Furthermore, the maximum bending moment and shear for the Cooper E80 live load, in the built-up deck plate girders, were determined by interpolation of the values presented in AREMA, table 15-1-15

The cross-sectional properties of the built-up truss members and plate girders were determined, by modelling the critical gross and net sections using "ShapeBuilder" software. Figure 3-3shows the gross built-up sections of the bottom chord members and the deck plate girder.

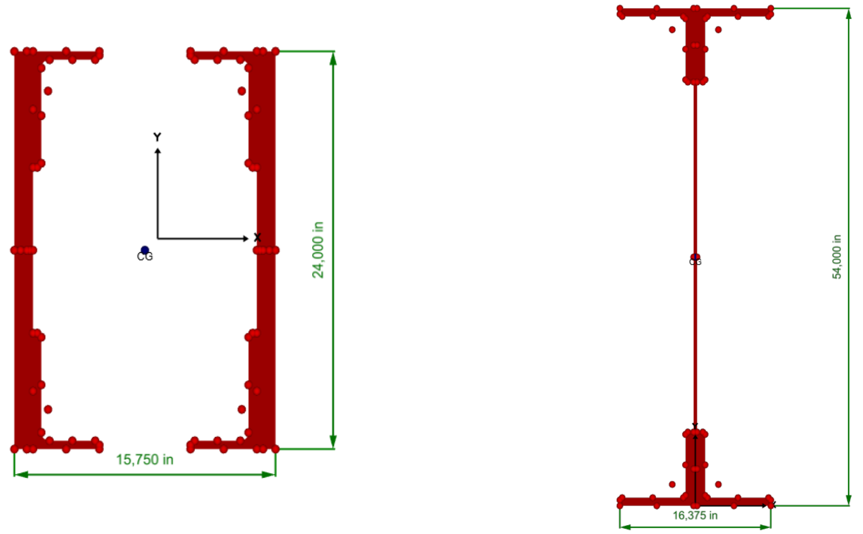

Figure 3-3 : Cross sections of the truss bottom-chord (left) and plate girder (right)

3.6 Assumptions

The following different assumptions were considered during the load rating of the PK 125.30 bridge:

- Given that the rail is missing throughout the bridge and due to the bad condition of the existing ties, a 10" x 12" x 15' tie and a 136RE rail were considered in the calculation of the deck dead load.
- The girders dead load was estimated based on each component weight and was increased by 20% to consider the weight of the rivets, gussets and splices.
- The original drawings indicate Open hearth steel (ASTM A7-42) as the construction material. Yield and ultimate strengths of 30 ksi and 60 ksi respectively were used to carry out the load rating of the Through truss members as well as the deck plate girders, the stringers and floor beams;
- It was assumed that the longitudinal forces in the truss span are resisted by the floorbeams and the bottom chord. The longitudinal force was assumed to be uniformly distributed on the bottom chord of the through truss.
- Both the local (member) and global (truss) effects of the wind loads on the structure were determined.
- An equivalent inertia of the two stringers were calculated and used to determine the stress due to the transverse wind loads on the stringers.
- In order to check the global lateral stability of the through truss bridge, 2.5% of the maximum compression force in the top chord (AREMA article 15-1.3.11) was applied to the verticals and end posts.

4. LOAD RATING SUMMARY

The load rating of the PK 125.30 railway bridge is summarized in a table attached in appendix B.

5. CONCLUSION

According to the load rating assessment carried out, the Trough Truss span is not adequate to support the projected passenger and freight cars traffic. In order to increase the load carrying capacity of the Trough Truss, the following principal members need structural strengthening:

- Top chord.
- Hangers.
- Diagonals.

Furthermore, the floor system consisting of stringers and floor beams needs to be replaced so that the structure can resist the significantly important longitudinal forces.

The rating of the deck plate girders confirms that they are adequate for the projected live loads.

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