REPORT

# Rehabilitation of the Portage Avenue Twin Bridges over Sturgeon Creek

## Preliminary Engineering Study

Presented to:

**Matt Chislett, P.Eng.**
**Public Works Department**
**City of Winnipeg**
106-1155 Pacific Avenue
Winnipeg, MB  R3E 3P1


Report No. 1 07 1234.AB — April 2013

\\WIN01FP\DATA1\SHARED\PROJ\W12401300\4 DESIGN\STRUCTURE\REPORT\PORTAGEAVE REPORT FINAL_APRIL 8-2013.DOCX

# TABLE OF CONTENTS

# 1. INTRODUCTION

The City of Winnipeg retained Morrison Hershfield Limited (MH) to undertake a preliminary engineering study for the rehabilitation of the Portage Avenue Twin Bridges over Sturgeon Creek. The preliminary engineering services include a detailed bridge deck condition survey, detailed visual inspection, structural evaluation and pre-design for rehabilitation of the bridge.

The Portage Avenue Twin Bridges built in 1981 and 1982 provides an important crossing of Sturgeon Creek for the Trans-Canada Highway. It consists of a three-span semi-continuous precast pre-stressed concrete box girder structure over two pedestrian under-bridge walkways and Sturgeon Creek. The existing twin bridge carrying four lanes of traffic in each direction, eastbound and westbound, is separated by a median. The traffic in each direction has a left turning lane beyond the bridge. The bridge has sidewalks on each of the structures.

Corrosion potential measurements and extraction of cores for the detailed bridge deck condition survey were performed by Eng-Tech Consulting Limited between July 16 and 20, 2012. The detailed visual inspection was performed by MH on July 11, 2012 in conformance with the Ontario Structures Inspection Manual.

The bridge currently exhibits evidence of deterioration at the girder ends, ballast wall, traffic barriers and approach slabs. The expansion joints have corroded, lost expansion capacity, the seal is suspected to be leaking and cannot be replaced with the currently reduced expansion gap.

Based on the bridge deck condition survey, detailed visual inspection and structural evaluation findings, this Preliminary Engineering Report includes details to rehabilitate the structure, in order for the structure to have a minimum remaining useful service life of 50 years with a second bridge rehabilitation required in approximately 25 years identified as serving the City's needs.

## 2. DESCRIPTION OF THE STRUCTURE

The existing bridge is a twin structure carrying four lanes of traffic in each direction, eastbound and westbound, on Portage Avenue over Sturgeon Creek. The structure consists of a three-span (9m – 18m – 9m) semi-continuous precast pre-stressed concrete box cell structure. The bridge is post-tensioned transversely at mid-span in end spans and at two locations in center span. The bridge has a 29$^{o}$ 45' right hand forward skew.

All the existing information is obtained from As Built drawings B178-80-01 to B178-80-65. The existing structure, built in 1980, was designed as per AASHTO 1977 Standard Specifications for Highway Bridges for HS 30-44 (MS 27) Truck.

The total out to out width of the twin-structure is 38.694 m. A variable width median having a maximum width of 3.658 m separates the traffic in opposite directions. The median has a longitudinal joint separating the two structures. The bridge has a 2.438 m wide sidewalk on each structure. The sidewalk has a pedestrian rail at the outside edge and an epoxy-coated reinforced concrete barrier with a top rail on the traffic side. The sidewalk slopes transversely at 1% towards the outside edge and drains into the creek. The sidewalk and median has several embedded utility ducts.

The bridge deck consists of a 100 mm thick epoxy-coated reinforced concrete slab with a 50 mm thick high density concrete overlay.

The substructure consists of concrete abutments and piers on 305 dia. precast concrete piles. The abutment slope protection consists of 300 mm thick grouted rock riprap. There are pedestrian walkways under the bridge on each side of the creek.

The neoprene bearing pads are fixed at the west pier and expansion at the east pier and abutments. The expansion joints are Wabo Maurer strip seal joints.

Since original construction in 1980, there has been several small bridge maintenance contracts executed on the bridge structure involving:

- sidewalk surface concrete repairs on the south sidewalk near midspan,
- abutment seat concrete repairs at the north side of the east and west abutment,
- application of silane sealer to the roadway surface and roadway side and top of traffic barriers,

- installation of a flexible epoxy wearing surface at the curb lanes and shoulders of the bridge deck.

# 3. CONDITION ASSESSMENT

A detailed visual inspection and bridge deck condition survey was performed to assess the condition of the existing structure. The detailed visual inspection was carried out in conformance with the Ontario Structures Inspection Manual and the bridge deck condition survey consisted of corrosion potential survey and chloride ion testing. The condition assessment report is included in Appendix A.

## 3.1 VISUAL INSPECTION

This section summarizes the findings of the detailed visual inspection performed by MH on July 11, 2012 in conformance with the Ontario Structures Inspection Manual and follows below in sections that relate to the main structural components.

**Approaches:** The approach slabs have settled at the ends and have cracks and delaminations at the ballast wall ends. The approach slabs have wheel line rutting and pot holes. The south structure east approach sidewalk has settled and is a tripping hazard. The concrete in west approach sidewalk has delaminated at the expansion joint.

**Superstructure:** The cells in the box cell girders are inaccessible; therefore, the visible exteriors of the girders were inspected. The concrete in the bottom of a few girders in the north structure at abutment ends have delaminated. The spalled concrete on west abutment seat may be from the deteriorated cast-in-place concrete at girder end caps. Girder 15 from north has rotated south. The median soffit which carries encased conduits has spalled at west pier and has a wide crack at the midspan.

The high density concrete deck overlay has medium cracks over the piers in both structures. There are other minor longitudinal cracks in the overlay. The corrosion potential survey consisted of exposing the top layer of re-bar along the bridge deck by concrete coring. A visual inspection of the condition of the epoxy-coating and re-bar was made at each core hole location. The epoxy-coating and re-bar were all found to be in excellent condition with no sign of coating deterioration or corrosion.

The deck expansion joint at west abutment, north structure, has settled by 15 mm on the bridge deck side. This relative settlement is likely a result of the abutment repairs undertaken in 2008. The strip seal also appears to be leaking.

The sidewalk concrete has hairline cracks and delaminations. The sidewalk expansion joint at west abutment, north structure, has settled. The median has spalled concrete at expansion and construction joints. The traffic side face of concrete barrier in north structure has spalled and exposed re-bars at a few locations.

The existing galvanized handrail is in good condition, however, it does not meet current standards inasmuch as, the picket opening exceeds the current maximum size permitted by 40% and the handrail is not protected from potential snow clearing equipment damage by a concrete curb.

**Substructure**: The abutment and wingwalls are in good condition. The abutment ballast walls are inaccessible for inspection. However, based on the presence of gravel and soil on the seat of west abutment, north structure, it is suspected that the concrete in the ballast wall and/or girder ends have spalled and deteriorated. The pier shafts are in good condition.

The abutment bearings are in good condition except for a few bearings in the north structure. Bearing 15 from north on the west abutment has rotated in north-south direction and four bearings from north on east abutment have cracks and rust stains. The pier bearings are in good condition with a few hairline cracks.

The architectural end posts are in good condition except for some discoloration and staining on the surfaces.

The service box and wiring servicing the under-bridge pedestrian lighting has deteriorated.

A relatively small section of grouted rip rap on the east creek bank is missing.

## 3.2 DECK CONDITION SURVEY

The corrosion potential survey consisted of localized half-cell measurements and AC resistance measurements as per the Ontario Structural Rehabilitation Manual (OSRM) for bridges containing epoxy rebars. Calculated AC resistance at individual test locations along the bridge decks were found to be in the range of 0 ohm to 3500 ohms. According to the Ministry of Transportation of Ontario, a calculated AC resistance of less than 1000 ohm is considered to have a high probability of corrosion. Based on the calculated AC resistance results, the south bridge deck has greater resistance than the north bridge deck. This indicates that the resistance to an anodic and cathodic reaction, necessary for corrosion to occur, in the steel is less in the north bridge deck than the south bridge deck. In addition to the AC resistance measurements, a visual inspection of the condition of the epoxy coating and re-bar was made at each test location. Based on the visual inspection, the epoxy coating and re-bar at the test locations that had resistance less than 1000 ohms appeared to be in similar (excellent) condition to the test locations that had resistance greater than 1000 ohms. Hence, the calculated AC resistance should be interpreted as the likelihood of an anodic and cathodic reaction to occur, however the results bear no weight on the presence and degree of corrosion.

Ground penetrating radar survey results were to be incorporated into the deck condition assessment. The radar testing results of EBA Engineering Consultants Ltd. Report dated May 2012 provided by the City was reviewed for incorporation into this bridge deck condition survey. Regrettably, this could not be done as the radar cover to rebar findings could not be correlated to the actual cover observed in the field by coring and exposing the rebar. Radar results indicated a rebar cover range of 80mm to 200mm with an average of 140mm, whereas the field observed cover range is 75mm to 110mm with an average of 85mm.

The chloride ion test was conducted in accordance with the Canadian Standards Association A23.2-4B – Test Method for Sampling and Determination of Water-Soluble Chloride Ion Content in Hardened Grout or Concrete. Water-soluble chloride ion contents along bridge deck and fascia at the depth of rebar were found to be lower than the critical chloride ion threshold to initiate electrochemical corrosion in steel. The chloride ion content in traffic barriers, sidewalk, median and approach slabs were above or within the threshold limit.

# 4. STRUCTURAL EVALUATION

The evaluation of the bridge superstructure was carried out in accordance with CAN/ CSA S6-06, Section 14, Evaluation.

## 4.1 MATERIAL PROPERTIES

The following material properties from As Built drawing B178-80-02 were used in the evaluation of the structure,

Precast pre-stressed concrete box cell girder:

Concrete, $f'_c$: 35 MPa (5,075 psi)

Black Reinforcing Steel, $f_y$: 300 MPa (43,000 psi)

Prestressing Steel, $f_{pu}$: 1860 MPa (270,000 psi)

Structural concrete for deck slab, barrier, sidewalk, and median:

Concrete, $f'_c$: 30 MPa (4,350 psi)

Epoxy-coated Reinforcing Steel, $f_y$: 400 MPa (58,000 psi)

## 4.2 LOADS CONSIDERED

### 4.2.1 Live Load

The structural capacity of the pre-stressed box cell structure was evaluated for the normal traffic load, i.e., CL-625 truck and lane load for all the three evaluation levels. The structure was also evaluated for alternative loading, AASHTO HSS-25 Truck and other legal truck loads with gross vehicle weights of 36,500 kg, 56,500 kg and 62,500 kg, 81 090 kg Liebherr mobile crane, and overload vehicles with gross vehicle weights of 124,057 kg and 166,080 kg. See Appendix B for vehicle load and axle configuration provided by the City of Winnipeg.

The structure was also analyzed for the design truck load, HS 30 – 44, for the purpose of comparison. The axle loads for HS 30 – 44 were obtained by multiplying the axle loads of a HS-20 truck by 1.5.

The structure was evaluated for four lanes of traffic loads. The sidewalk load is not considered to occur coincident with the maximum traffic loading as per Clause 14.9.5.1.

As the clearance envelope required for the mobile crane and overload vehicles is greater than the normal traffic vehicles, it is assumed that these vehicles will travel in the middle lanes and will be escorted on the bridge one at a time with no other traffic on the bridge. The analysis of these vehicle loads was carried by applying live load factors for Permit Annual (PA) traffic at a speed of less than or equal to 10km/ hr.

#### 4.2.2 Dead Load

The dead load consists of the precast pre-stressed box cell girder, cast-in-place concrete deck, and the superimposed dead loads from high density concrete overlay, sidewalks, median, pedestrian rails, and concrete barrier. The superimposed dead loads were distributed equally to all the girders.

### 4.3 EVALUATION PARAMETER

#### 4.3.1 Target Reliability Index

The load factors applied to live and dead loads are based on reliability index, β, which is a measure of the level of safety of the structure. The bridge code requires that the new structures be designed for an annual reliability index, β = 3.75, which corresponds to a 75 year design life β = 3.5. The new structures are designed for system behavior S2, element behavior E2 and non-inspection level INSP0. However, the existing structures are evaluated using a lower reliability index, as the cost of rehabilitation is much higher than the additional cost incurred in new construction based on higher reliability index.

The existing structure is evaluated for,

| | |
|---|---|
| System behavior: | S2 |
| Element behavior: | E2 |
| Inspection level: | INSP1 |
| Target reliability index, β: | 3.50 |

The live and dead load factors are as follows;

| Traffic | Span | Load Factors | | |
|---|---|---|---|---|
| | | Dead Load, $\alpha_D$ | | Live Load, $\alpha_L$ |
| | | D1 | D2 | LL |
| Normal Traffic or Alternative Loading | Short | 1.09 | 1.18 | 2.20 |
| | Other | 1.09 | 1.18 | 1.63 |
| Permit Annual (PA) | Short | 1.09 | 1.18 | 1.78 |
| | Other | 1.09 | 1.18 | 1.53 |

D1 Factory produced concrete

D2 Cast-in-place concrete and other non-structural concrete

Short span load factors are used for moment effects in spans up to 10 m and for shear effects in spans up to 6 m.

### 4.3.2 Dynamic Load Allowance

A dynamic load of 0.30 was used for normal traffic and alternative loading and 0.09 (30% x 0.30) for permit annual traffic.

## 4.4 ANALYSIS

The structure was analyzed as a semi-continuous structure with girder and wet deck loads acting on simple spans and superimposed dead loads and live loads acting on continuous spans.

The structural analysis was based on CSA S6-06 Section 5 with the ULS load combination applied per meter width of the girder. The flexural and shear capacity of the box cell girders were calculated along the mid spans and ends in accordance with Section 8 and compared with the load effects. The girders were considered to be composite with bridge deck at the piers. The structure is adequate in flexure and shear for normal traffic and alternative loading and overload vehicles travelling under controlled supervision and speed. The results of the structural evaluation are included in Appendix C.

| Location | Moment | | | Shear | | |
|---|---|---|---|---|---|---|
| | Mf kN-m | Mr kN-m | Mr / Mf | Vf kN | Vr kN | Vr / Vf |
| Mid Span – Short Span | 472 | 798 | 1.69 | -- | -- | -- |
| Mid Span – Long Span | 1085 | 1314 | 1.21 | -- | -- | -- |
| Supports | -820 | -914 | 1.12 | 499 | 1013 | 2.032 |

# 5. RECOMMENDED REHABILITATIVE WORKS

## 5.1 Scope of Work

Considering the findings of the detailed visual inspection, structural evaluation and bridge deck condition survey the following rehabilitative work is recommended, in order for the structure to have a minimum remaining useful service life of 50 years with a second bridge rehabilitation required in approximately 25 years as has been identified as serving the City's needs:

- Demolish and remove approach slabs, pavement slabs, approach sidewalk, ballast wall, handrail, expansion joints, traffic barriers and deteriorated girder ends.
- Construct new girder ends, ballast wall, approach slabs, pavement slabs, expansion joints, and approach sidewalk.
- Construct new traffic barrier, aluminum handrail and handrail curb.
- Prepare sidewalk surface and pour concrete topping to reverse the transverse slope with 1% cross-fall towards the barrier.
- Prepare median surface and construct safety curb median.
- Remove remaining epoxy overlay, prepare surface and treat concrete bridge deck surface/cracks using Methacrylate (MMA) Technology.
- Construct roadway expansion joint.
- Modify utility conduit as required.
- Apply silane sealer to surface of traffic barriers, median, bridge sidewalk, end-posts and approach slabs.
- Miscellaneous works including, but not limited to; under-bridge lighting repair, rip rap repair, under-bridge sidewalk repair, etc.

Preliminary design drawings for the rehabilitative works can be found in Appendix D.

The long-term durability of the bridge is considered to be enhanced by not using expansion joints at the abutment ends, by converting the abutment into a semi-integral abutment. Changing the abutments to function as semi-integral was investigated. The investigation indicated that due to the presence of utility ducts in the median and sidewalk areas it was deemed impractical to convert the abutments to function as semi-integral. Therefore, it is recommended that the expansion joints be replaced at the current location in combination with a roadway expansion joint leading to both approaches to restore the bridge's expansion capacity and waterproofness.

The possibility of widening the bridge sidewalk utilizing the existing structure was investigated and determined to be feasible. However, the decorative bridge end posts attached to the abutment wingwalls would need to be removed in order to widen the sidewalk over the abutments. There is no desire to remove the bridge end posts and thus no advantage to only widen the sidewalk on the bridge so the notion of sidewalk widening was not pursued any further. Moreover, the bridge end-posts are in good condition, and not requiring any repair work.

No property acquisition or temporary construction easements are required to facilitate the recommended rehabilitative works. All work and construction access will take place on City owned property.

The recommended bridge rehabilitative design complies with the City of Winnipeg Universal Design Policy and Standards.

### 5.2 Regulatory Requirements

Regulatory body approvals are required for the proposed bridge rehabilitative works.

Approval by the Department of Fisheries and Oceans (DFO) consists of a submission of a Notification Form as the proposed rehabilitative works is considered "Bridge Maintenance" and therefore work can be performed under an Operational Statement and formal application is not required. The Notification Form should be submitted once the detailed design is completed. When the Notification Form has been completed, submitted to DFO and DFO has acknowledged receipt of the form, approval has been obtained.

A City of Winnipeg Waterways Bylaw Permit is required prior to commencing work on-site. The Application Form for the Waterways Bylaw Permit should be submitted once the detailed design is completed.

Detail design drawings should be submitted to Underground Structures allowing six (6) weeks for comments.

### 5.3 Traffic Management Plan

Portage Avenue at the Sturgeon Creek Bridge handles approximately 53,000 vehicles per day. The peak period occurs for westbound traffic from 4:00 to 5:00 p.m. with almost 2,900 vehicles crossing the bridge.

Pedestrian traffic will be maintained on at least one side at all times and the under-bridge sidewalks will be also be maintained at all times.

The following considerations will be analyzed for each of the vehicular traffic management options described below:

1) Traffic Service- How will traffic be impacted by the closure?
2) Cost- What will the cost implication be?
3) Safety- How is safety impacted?
4) Quality of Construction- How will the final product be affected?
5) Duration of Construction- How long will construction take?
6) Potential for Schedule Acceleration- Can the contract be accelerated to minimize disruption?
7) Risk- Is any additional risk added?

The following options will be discussed for staging the construction and accommodating traffic:

1) Half at-a-time Construction - This option involves closing four lanes of traffic and constructing one half of the bridge at a time. All traffic would use the 4 lanes on the opposite half of the bridge. Two sub-options include:
    a. Traffic using 2 lanes per direction 24 hours a day;
    b. Reversing one lane during peak periods (ie. 3 lanes in peak direction, 1 lane in the opposite direction);
2) Lane at-a-time Construction - This option involves closing two lanes of traffic in one direction and constructing the bridge one lane at a time. On the same half as construction is taking place, traffic would have 2 lanes while on the opposite half, traffic would still have 4 lanes. Two sub-options include:
    a. Two lanes in one direction, 4 lanes in the opposite direction 24 hours a day;
    b. Reversing one lane during peak periods (3 lanes in each direction).
3) Another option looked at is to construct a temporary widening to allow 5 lanes of traffic. This option has been deemed not possible for two reasons. One is because of the need to maintain pedestrian traffic on the open side. The other is for constructability reasons; the existing shoulder and median barriers on the bridge contain steel dowels that cannot be practically removed and replaced.

Temporary median crossovers would be constructed either side of the bridge wherever traffic is required to cross the median. Traffic in both directions would be returned to 4 lanes per direction prior to the next signalized intersection.

After analyzing the pros and cons of each option as shown in Table 1, the best method of staging construction will be to close one half at a time and accommodate 2 lanes in each direction on the other half. While traffic will be disrupted, this option provides for the shortest duration of disruption and also provides for the greatest opportunity for an accelerated completion schedule. Similar traffic management plans have been used successfully on Portage Avenue and Disraeli Freeway, for example, in the past.

**TABLE 1- Evaluation of Traffic Management Plans**
(0=Worst ; 3=Best)

| | OPTIONS | A. Traffic Service | Score | B. Cost | Score | C. Safety | Score | D. Quality of Construction | Score |
|---|---|---|---|---|---|---|---|---|---|
| 1a. | Half at-a-time Construction<br>2 lanes per direction | - Poor level of service during peak hours | 1 | - Least cost | 3 | - Safest; workers completely separated from traffic | 3 | - best potential for high quality finished product | 3 |
| 1b. | Half at-a-time Construction<br>Reversing one lane | - Improves peak direction<br>- Traffic in opposite direction fails with only 1 lane<br>**UNACCEPTABLE OPTION DUE TO FAILING LEVEL OF SERVICE** | 2 | | | | | | |
| 2a. | Lane at-a-time Construction<br>2 lanes in one direction, 4 lanes in opposite direction | - Poor level of service in peak direction for side<br>under construcion<br>- Traffic unaffected in opposite direction | 2 | - As much as a 50% increase in cost | 1 | - Less safe; workers crossing and working around traffic | 1 | - potential for poor quality increased due to many construction stages and resulting construction | 1 |
| 2b. | Lane at-a-time Construction<br>Reversing one lane | - Improves peak direction<br>- Traffic on both sides of bridge now affected | 3 | -Over 50% increase in cost | 0 | - Less safe; workers crossing and working around traffic | 1 | - potential for poor quality increased due to many construction stages and | 1 |

| | OPTIONS | E. Duration of Construction | Score | F. Potential for Schedule Acceleration | Score | G. Risk | Score | Total Score |
|---|---|---|---|---|---|---|---|---|
| 1a. | Half at-a-time Construction<br>2 lanes per direction | - shortest construction period (one construction season) | 3 | - provides for good potential to accelerate construction | 3 | - lowest overall project risk | 3 | **19** |
| 1b. | Half at-a-time Construction<br>Reversing one lane | | | | | | | **UNACCEPTABLE** |
| 2a. | Lane at-a-time Construction<br>2 lanes in one direction, 4 lanes in opposite direction | - construction period increased to two construction seasons | 1 | - unlikely to accelerate schedule due to concrete curing time between the many construction stages being the critial path | 1 | - increased risks due to multi-stage | 1 | **8** |
| 2b. | Lane at-a-time Construction<br>Reversing one lane | - construction period increased to two construction seasons | 1 | - unlikely to accelerate schedule due to concrete curing time between the many construction stages being the critial path | 1 | - increased risks due to multi-stage | 1 | **8** |

Steps to reduce the impact on traffic flow during construction shall be further developed and investigated during Detailed Design. These steps should include, but not be limited to:

- modification to signal timings;
- ensuring that no construction occurs along alternate routes at the same time (i.e. Ness Avenue);
- implementation of a communication plan to notify drivers of anticipated delays and alternate routes;

- incorporate into the construction contract documents incentives for the Contractor to lessen the impact to traffic by completing early or by other means.

### 5.4 Stakeholder Analysis

A number of stakeholders have been identified as having a role and/or being affected by/ interested in the Project. The following table summarizes the stakeholders, level of involvement, and how they are interested/affected.

***Stakeholder Analysis Table***

| **Stakeholder** | **Role in Decision Making** | **How Stakeholder is Affected By/Interested in the Project** |
|---|---|---|
| Public Works | I, C, PD, A, R, S | Project success; cost/quality/time; project deliverable accountability |
| DFO | R | Regulatory accountability |
| Manitoba Hydro | I, C, PD, S | Protection/Safety of electrical cable in bridge sidewalk |
| MTS | I, C, PD, S | Protection of communication cables in bridge sidewalk |
| Transit | I, C | Maintenance of Transit stops during lane closures |
| General Public | G | Pedestrian and vehicular traffic diversions |
| Local City Councilor | G | Project information |
| City Parks | G | Project information |
| City Waterways | C, S | Regulatory accountability |

**Legend:**

**NI: No Involvement**
**G: General Communication**
**I: Input Required**
**C: Consulted**
**PD: Participant in Planning & Decision Making**
**A: Accountable**
**R: Review Required**
**S: Sign-off/Approval Required**

### 5.5 Risk Assessment

For this Project, a risk response strategy for identified high probability/high impact risks is presented as follows:

| Key Risk | Potential Impact | Risk Response Strategy |
|---|---|---|
| 1. Existing conditions are not as expected | Schedule delay<br>Cost increase | Include flexibility into design details and develop a contingency plan to mitigate. |
| 2. Estimated cost of work too low | Schedule delay<br>Budget increase | Review estimates with experienced contractors and include appropriate contingencies. |
| 3. Working around MTS/ Hydro ducts proves to be not feasible | Schedule delay<br>Cost increase<br>Reduced quality | Communicate with utilities early in the design and develop contingency plan to leave ducts in place. |
| 4. Permitting not received or late | Schedule delay<br>Cost increase | Communicate with regulatory agencies early and maximize float time in schedule for permitting. |
| 5. Weather impacts construction | Schedule delay<br>Cost increase<br>Reduced quality | Commence construction early in spring and provide incentives for contractor to finish early. |

### 5.6 Utilities

Located within both sidewalks and the median on the bridge are conduits for use by MTS and Manitoba Hydro. Based on current discussions with MTS and MB Hydro, it is anticipated that during demolition and replacement of the sidewalk approach slab, complete with ducts, all cables contained within the ducts will be taken out of service. Following completion of construction the utilities will replace the cables on the bridge from the closest manholes and re-energize the system. Presently, MTS and MB Hydro are investigating options for facilitating construction around the sidewalk approach slabs. The strategy for dealing with the conduits will be finalized during detailed design.

Contact information is as follows:

MB Hydro: Terry McCarthy – Phone: 204-360-4127

MTS: Michael Janz – Phone: 204-941-4672

### 5.7 Schedule

We estimate the following time schedule for the project.

| Activity | Time Frame |
| --- | --- |
| Complete Detailed Design | November 2013 |
| Council Approval of Capital | December 2013 |
| Tender and Award | December 2013-January 2014 |
| Construction first structure | April 2014-July 2014 |
| Construction second structure | August 2014-October 2014 |

We anticipate the award of one Bid Opportunity package however, delivery of expansion joint materials could have an impact on the schedule if the period between award and start of construction is shortened.

### 5.8 Cost Estimate

The Class 3 estimated total project cost for the proposed bridge rehabilitative works is $4,000,000.00 as given in the following table. The cost estimate does not include GST, and has an allowance for contingencies, City overheads, engineering and testing and other project expenses.

| Item No. | Bid Item | Estimated Cost |
|---|---|---|
| 1 | Mobilization/Demob | $ 300,000.00 |
| 2 | Traffic Control | $ 50,000.00 |
| 3 | Structural Removals | $ 310,000.00 |
| 4 | Excavation | $ 30,000.00 |
| 5 | Backfill - granular | $ 60,000.00 |
| 6 | Structural Concrete | |
| | a) approach slabs | $ 200,000.00 |
| | b) traffic barriers | $ 75,000.00 |
| | c) median/sidewalk | $ 100,000.00 |
| | d) ballast wall | $ 100,000.00 |
| | e) girder ends | $ 50,000.00 |
| | f) approach sidewalk | $ 25,000.00 |
| | g) roadway pavement | $ 300,000.00 |
| 7 | Expansion Joints | $ 400,000.00 |
| 8 | Bridge Deck Sealing | $ 70,000.00 |
| 9 | Reinforcing - Black | $ 75,000.00 |
| 10 | Reinforcing - S/S | $ 200,000.00 |
| 11 | Galvanic Protection | $ 50,000.00 |
| 12 | Aluminum Pedestrian Handrail | $ 50,000.00 |
| 13 | Electrical | $ 25,000.00 |
| 14 | Rip Rap | $ 25,000.00 |
| 15 | Misc. Work | $ 200,000.00 |
| 16 | Repair Underbridge Sidewalk | $ 50,000.00 |
| 17 | Guardrail | $ 20,000.00 |
| | **Sub-Total** | **$ 2,765,000.00** |
| | **CONTINGENCY (15%)** | **$ 414,750.00** |
| | **TOTAL CONSTRUCTION** | **$ 3,179,750.00** |
| | | |
| City overheads, engineering, testing and other project expenses | | $ 820,250.00 |
| **TOTAL ESTIMATED PROJECT COST** | | **$ 4,000,000.00** |

It is estimated that the cash flow forecast for the total project cost would be $250,000 in 2013 and 3,750,000 in 2014.

# APPENDIX A: CONDITION ASSESSMENT REPORT

MORRISON HERSHFIELD

August 29, 2012

Project No.: W12401300

Matt Chislett, P.Eng
City of Winnipeg
Public Works Department
106-1155 Pacific Avenue
Winnipeg, MB R3E 3P1

Dear Mr. Chislett:

**Re: PORTAGE AVENUE TWIN BRIDGES OVER STURGEON CREEK
BRIDGE DECK CONDITION SURVEY AND DETAILED VISUAL INSPECTION**

We are pleased to present the following enclosed documents in relation to the bridge deck condition survey and detailed visual inspection conducted on the Portage Avenue Twin Bridges over Sturgeon Creek:

- ENG-TECH Consulting Limited report on the corrosion potential survey and chloride ion testing program.
- Ontario Bridge Management System Bridge Inspection Forms.

*Bridge Deck Condition Survey*

To summarize, the corrosion potential survey results bear no weight on the presence and degree of corrosion, based on the visual inspection of epoxy rebar at the test locations. Measured chloride ion content at the depth of rebar along the bridge deck and fascia are lower than the critical chloride ion threshold, while the traffic barriers, sidewalk, median and approach slabs are above the critical chloride ion threshold.

*Detailed Visual Inspection*

The detailed visual inspection was performed by Mr. Bill Ebenspanger and Mr. Hao Zhang on July 11, 2012 in conformance with the Ontario Structures Inspection Manual.

Performance deficiencies noted for the following elements include:

- Abutments, Ballast Walls – Suspected disintegration of concrete.
- Approaches, Approach Slabs – Rough riding surface, wheel rutting, potholes, wide cracks and surface delaminations.
- Barriers, Railing Systems – Inadequate gap to accommodate expansion.
- Girders, Ends – Suspected loss of concrete.
- Decks, Deck top – Loss of protection due to presence of medium cracks.

- Joints, Armouring – Loss of expansion capacity and seal replacement capability.
- Joints, Seals – suspected leaking seals.

*Recommended Bridge Rehabilitation Works*

Considering the results of the Bridge Deck Condition Survey and Detailed Visual Inspection and in order to achieve a 25 year service life before further rehabilitation can be expected, it is recommended that a preliminary design for rehabilitative works be developed to address deficiencies noted for the following bridge elements:

- Ballast walls
- Approach slabs
- Barriers
- Girder ends
- Deck top
- Median
- Joints
- Sidewalk

Please contact me at 204.977.8370 if you have any questions or require further information.

Yours truly,
Morrison Hershfield Limited

Bill Ebenspanger, P.Eng.

\\WIN01FP\DATA1\SHARED\PROJ\W12401300\6 CONTRACT ADMINISTRATION\CORRESPONDANCE\L-MCHISLETT_BRIDGE DECK SURVEY & VISUAL INSPECTION_120828.DOCX

## Element Data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Element Group:** | Abutments | | | | | **Length:** | -- |
| **Element Name:** | Abutment Walls | | | | | **Width:** | 43.54m |
| **Location:** | East & West Abutments | | | | | **Height:** | 1.75m |
| **Description:** | Abutment Seats | | | | | **Count:** | 2 |
| **Material:** | Concrete Finned Surface | | | | | **Total Quantity:** | 152 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | | | | | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ | Moderate ☒ | Severe ☐ | | | **Perform. Deficiencies** | **Maint. Needs** |
| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** | | |
| | Sq.m. | | 152 | | | | |
| **Comments:** | • Refer to Photo 1 | | | | | | |

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Element Group:** | Abutments | | | | | **Length:** | -- |
| **Element Name:** | Ballast Walls | | | | | **Width:** | 43.54m |
| **Location:** | East & West Abutments | | | | | **Height:** | .9m |
| **Description:** | Backwall | | | | | **Count:** | 2 |
| **Material:** | Concrete | | | | | **Total Quantity:** | 80 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | | | | | **Not Inspected:** | ☒ |
| **Environment:** | Benign ☐ | Moderate ☒ | Severe ☐ | | | **Perform. Deficiencies** | **Maint. Needs** |
| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** | | |
| | Sq.m. | | | | | | |
| **Comments:** | • Limited access – gravelly material noted on West abutment seat North structure.<br>• Refer to Photo 2. | | | | | | |

**Performance Deficiencies:**

- Suspected disintegration of concrete back wall and/or girder ends due to leaking expansion joints.

**Recommended Work:**

- Further investigation required.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☒ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Abutments | **Length:** | -- |
| **Element Name:** | Bearings | **Width:** | -- |
| **Location:** | East & West Abutments | **Height:** | -- |
| **Description:** | Expansion Bearing Pad | **Count:** | 60 |
| **Material:** | Neoprene | **Total Quantity:** | 60 |
| **Element type:** | Expansion Bearing Pad | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☒ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Each | | 51 | 6 | 3 |

**Comments:**

- Bearings 1 to 4 from North at East Abutment cracked and rusted. Refer to Photo 3.
- West Abutment - bearing 15 from North rotated N-S. Refer to Photo 4.

**Performance Deficiencies:**

- None-uniform contact of bearing with bearing seat.
- Excessive inclination of bearing.

**Recommended Work:**

- Regular monitoring of bearings.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☒ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Abutments | **Length:** | 6m |
| **Element Name:** | Wingwalls | **Width:** | -- |
| **Location:** | East & West Abutments | **Height:** | 1.5m |
| **Description:** | Four Wingwalls | **Count:** | 4 |
| **Material:** | Concrete | **Total Quantity:** | 18 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☒ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Sq.m. | | 18 | | |

**Comments:**

- Refer to Photo 5.

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Approaches | **Length:** | 8.66m |
| **Element Name:** | Approach Slabs | **Width:** | 14.63m |
| **Location:** | East & West Abutments | **Height:** | .25m |
| **Description:** | Cantilever Slab | **Count:** | 4 |
| **Material:** | Concrete | **Total Quantity:** | 500 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Sq.m. | | 484 | 8 | 8 |

**Comments:**

- Wheel Line Rutting - 4 routed cracks in all slabs.
- Westbound Slabs – asphalt filled potholes.
- Refer to Photo 6.
- Settlement at ends of all slabs and cracking and delamination observed at back wall ends.

**Performance Deficiencies:**

- Rough riding surface, wheel line rutting, potholes, wide cracks and surface delaminations.

**Recommended Work:**

- Replace approach slabs.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☒ Now < 1 Year ☐ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Approaches | **Length:** | 8.66m |
| **Element Name:** | Curb / Gutters | **Width:** | -- |
| **Location:** | East & West Approaches | **Height:** | -- |
| **Description:** | Traffic Barrier / Median Curb | **Count:** | 8 |
| **Material:** | Concrete | **Total Quantity:** | 70m |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| M | | 68 | 1 | 1 |

**Comments:**

- West Approach Slab – Eastbound curb spalled.
- Refer to Photo 7.

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Approaches | **Length:** | 6.4m |
| **Element Name:** | Sidewalk | **Width:** | 1.98m |
| **Location:** | East & West Abutments | **Height:** | 0 |
| **Description:** | Pedestrian Sidewalk | **Count:** | 4 |
| **Material:** | Concrete | **Total Quantity:** | 50 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Sq.m. | | 48 | 1 | 1 |

**Comments:**
- South Structure – West Slab delaminated near expansion joint.
- South Structure – East corner settled, tripping concern.
- Refer to Photos 8 & 9.

**Performance Deficiencies:**
- Excessive settlement and delaminations.

**Recommended Work:**
- Replace sidewalk approach slab.
- Urgently repair tripping concern.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☒ Now < 1 Year ☐ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Barriers | **Length:** | 51.5m |
| **Element Name:** | Interior Barrier / Parapet Walls | **Width:** | -- |
| **Location:** | Shoulders | **Height:** | .813m |
| **Description:** | Traffic Barrier | **Count:** | 2 |
| **Material:** | Concrete | **Total Quantity:** | 84 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Sq.m. | | 78 | 4 | 2 |

**Comments:**
- North Structure – Concrete spalling and exposed rebar.
- Refer to Photo 10.

**Performance Deficiencies:**

None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Barriers | **Length:** | 51.5m |
| **Element Name:** | Barrier Exterior | **Width:** | -- |
| **Location:** | Shoulders | **Height:** | .676m |
| **Description:** | Back of Barrier | **Count:** | 2 |
| **Material:** | Concrete | **Total Quantity:** | 70 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☒ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** |
|---|---|---|---|---|---|
| | Sq.m. | | 70 | | |

**Comments:**

- Refer to Photo 11.

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Barriers | **Length:** | 51.5m |
| **Element Name:** | Median Barrier | **Width:** | 4 |
| **Location:** | Median | **Height:** | -- |
| **Description:** | Median Curb | **Count:** | 1 |
| **Material:** | Concrete | **Total Quantity:** | 200 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** |
|---|---|---|---|---|---|
| | Sq.m. | | 198 | 1 | 1 |

**Comments:**

- Concrete spalls at Construction Joints and Expansion Joints.
- Refer to Photo 12.

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Barriers | **Length:** | 51.5m |
| **Element Name:** | Handrailing | **Width:** | -- |
| **Location:** | North & South Edges of Bridge | **Height:** | -- |
| **Description:** | Pedestrian Handrail | **Count:** | 2 |
| **Material:** | Galvanized Steel | **Total Quantity:** | 103m |
| **Element type:** | Picket & Post Railing | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☒ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| M | | 103 | | |

**Comments:**
- Refer to Photo 11.

**Performance Deficiencies:**
- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Barriers | **Length:** | 51.5m |
| **Element Name:** | Railing Systems | **Width:** | -- |
| **Location:** | Top of Shoulder Barriers | **Height:** | -- |
| **Description:** | Traffic Barrier Rail | **Count:** | 2 |
| **Material:** | Aluminum | **Total Quantity:** | 103m |
| **Element type:** | Barrier Rail | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| M | | 101 | 1 | 1 |

**Comments:**
- Expansion capacity exceeded at corners (typical).
- Refer to Photo 13.

**Performance Deficiencies:**
- Inadequate gap to accommodate expansion in railing.

**Recommended Work:**
- Restore expansion gap.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☒ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Girders | **Length:** | 2m |
| **Element Name:** | Ends | **Width:** | 1.219m |
| **Location:** | One Metre off Back Wall | **Height:** | .610m |
| **Description:** | Precast Box Girders | **Count:** | 30 |
| **Material:** | Precast Concrete | **Total Quantity:** | 146 sq.m. |
| **Element type:** | Pre-stressed Concrete | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☒ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** |
|---|---|---|---|---|---|
| | Sq.m. | | 136 | 6 | 4 |

**Comments:**
- End spalling and bottom delaminations – North Girders East & West Abutments.
- Refer to Photos 14 & 15.

### Performance Deficiencies:
- Suspected loss of concrete at girder ends.

### Recommended Work:
- Regular monitoring required.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☒ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Girders | **Length:** | 33.8m |
| **Element Name:** | Middle | **Width:** | 1.219m |
| **Location:** | Over Sturgeon Creek | **Height:** | .610 |
| **Description:** | Precast Box Girders | **Count:** | 30 |
| **Material:** | Precast Concrete | **Total Quantity:** | 2,473 sq.m. |
| **Element type:** | Pre-stressed Concrete | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☒ Moderate ☐ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** |
|---|---|---|---|---|---|
| | Sq.m. | | 2,473 | | |

**Comments:**
- Girder 15 from North - rotated South by 15 mm.
- Refer to Photo 16.

### Performance Deficiencies:
- Rotated girder.

### Recommended Work:
- Regular monitoring required.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☒ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Decks | **Length:** | 35.8m |
| **Element Name:** | Deck Top | **Width:** | 38.7m |
| **Location:** | Over Sturgeon Creek | **Height:** | .10m |
| **Description:** | Exposed Bridge Deck | **Count:** | -- |
| **Material:** | Concrete | **Total Quantity:** | 1,385 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Sq.m. | | 1,355 | 30 | 0 |

**Comments:**

- Medium cracks over piers westbound. Minor longitudinal cracks.
- Cannot inspect deck under barriers and sidewalk.
- Concrete scaling in gutter westbound.
- Refer to Photos 17 & 18.

**Performance Deficiencies:**

- Loss of protection due to medium cracks.

**Recommended Work:**

- Crack sealing.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☒ Now < 1 Year ☐ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Decks | **Length:** | 35.8m |
| **Element Name:** | Soffit Exterior | **Width:** | 1.71m |
| **Location:** | Cantilevered Overhang & Fascia | **Height:** | -- |
| **Description:** | | **Count:** | -- |
| **Material:** | | **Total Quantity:** | 60 sq.m. |
| **Element type:** | | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☒ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Sq.m. | | 57 | 2 | 1 |

**Comments:**

- South Structure – West-span wide crack, East-span spall, Mid-span abandoned electrical box rusted.
- North Structure – Mid-span 2 wide cracks. Hairline to narrow longitudinal cracks.
- Refer to Photo 19.

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

## Element Data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Element Group:** | Embankment & Streams | | | | | **Length:** | |
| **Element Name:** | Embankments | | | | | **Width:** | |
| **Location:** | East & West Embankments | | | | | **Height:** | |
| **Description:** | Grassed Slopes | | | | | **Count:** | |
| **Material:** | Sod | | | | | **Total Quantity:** | 4 |
| **Element type:** | Grassed Slopes | | | | | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☒ | Moderate ☐ | Severe ☐ | | | **Perform. Deficiencies** | **Maint. Needs** |
| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** | | |
| | End | | 4 | | | | |
| **Comments:** | • Refer to Photo 20. | | | | | | |

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Element Group:** | Embankments & Streams | | | | | **Length:** | |
| **Element Name:** | Slope Protection | | | | | **Width:** | |
| **Location:** | East & West Banks | | | | | **Height:** | |
| **Description:** | Rip Rap | | | | | **Count:** | |
| **Material:** | Grouted Rock | | | | | **Total Quantity:** | 2 |
| **Element type:** | Grouted Rip Rap | | | | | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☒ | Moderate ☐ | Severe ☐ | | | **Perform. Deficiencies** | **Maint. Needs** |
| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** | | |
| | Each | | 2 | | | | |
| **Comments:** | • Refer to Photo 21. | | | | | | |

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Embankments & Streams | **Length:** | |
| **Element Name:** | Streams & Waterways | **Width:** | |
| **Location:** | Sturgeon Creek | **Height:** | |
| **Description:** | Creek Bottom | **Count:** | |
| **Material:** | Random Rip Rap | **Total Quantity:** | 1 |
| **Element type:** | Rock Rip Rap | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☒ Moderate ☐ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Each | | 1 | | |

**Comments:**
- Refer to Photo 22.

**Performance Deficiencies:**
- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Foundations | **Length:** | |
| **Element Name:** | Below Ground | **Width:** | |
| **Location:** | Piers & Abutments | **Height:** | |
| **Description:** | Footing & Precast Piles | **Count:** | |
| **Material:** | Concrete | **Total Quantity:** | |
| **Element type:** | Cast-in-Place Reinforced & Precast | **Not Inspected:** | ☒ |
| **Environment:** | Benign ☒ Moderate ☐ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| -- | | | | |

**Comments:** Limited inspection – unremarkable.

**Performance Deficiencies:**
- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Joints | **Length:** | 40m |
| **Element Name:** | Armouring | **Width:** | -- |
| **Location:** | Median & East & West Abutments | **Height:** | -- |
| **Description:** | Single Strip Seal Joint | **Count:** | 6 |
| **Material:** | Steel | **Total Quantity:** | 240m |
| **Element type:** | Extrusion | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** |
|---|---|---|---|---|---|
| | M | | 240 | | |

**Comments:**
- North Structure – Expansion Joint settled 15 mm on Bridge's side, West Abutment.
- Refer to Photos 23, 24, & 25.

**Performance Deficiencies:**
- Loss of expansion capacity and seal replacement capability.

**Recommended Work:**
- Restore expansion capacity.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☒ Now < 1 Year ☐ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Joints | **Length:** | Each |
| **Element Name:** | Seals | **Width:** | -- |
| **Location:** | Median & East & West Abutments | **Height:** | -- |
| **Description:** | Single Strip Seal | **Count:** | 3 |
| **Material:** | Neoprene Rubber | **Total Quantity:** | |
| **Element type:** | Strip Seal | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** |
|---|---|---|---|---|---|
| | Each | | 3 | | |

**Comments:**
- Appears to be leaking at West Abutment, North Side.
- Refer to Photos 23, 24, & 25.

**Performance Deficiencies:**
- Suspected leaking seal.

**Recommended Work:**
- Regular monitoring.

None>10 Yrs ☐ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☒ Urgent ☐

## Element Data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Element Group:** | Piers | | | | | **Length:** | -- |
| **Element Name:** | Bearings | | | | | **Width:** | -- |
| **Location:** | Pier 2 and Pier 3 | | | | | **Height:** | -- |
| **Description:** | Bearing Pads | | | | | **Count:** | 120 |
| **Material:** | Neoprene Rubber | | | | | **Total Quantity:** | |
| **Element type:** | Bearing Pad | | | | | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☒ Moderate ☐ Severe ☐ | | | | | **Perform. Deficiencies** | **Maint. Needs** |
| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** | | |
| | Each | | 120 | | | | |

**Comments:**
- Hairline cracks observed.
- Refer to Photo 26.

**Performance Deficiencies:**
- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Element Group:** | Piers | | | | | **Length:** | -- |
| **Element Name:** | Shafts | | | | | **Width:** | -- |
| **Location:** | No. 2 and No. 3 | | | | | **Height:** | -- |
| **Description:** | Pier Shaft | | | | | **Count:** | 2 |
| **Material:** | Concrete | | | | | **Total Quantity:** | 130 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | | | | | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☒ Moderate ☐ Severe ☐ | | | | | **Perform. Deficiencies** | **Maint. Needs** |
| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** | | |
| | Sq.m. | | 128 | 1 | 1 | | |

**Comments:**
- Delamination on East Pier Cap, South End.
- Refer to Photo 27.

**Performance Deficiencies:**
- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

## Element Data

| | | | |
|---|---|---|---|
| **Element Group:** | Sidewalks / Curbs | **Length:** | 35.8m |
| **Element Name:** | Sidewalks and Medians | **Width:** | 2.438m |
| **Location:** | North & South Side of Bridge | **Height:** | 0 |
| **Description:** | Pedestrian Sidewalk | **Count:** | 2 |
| **Material:** | Concrete | **Total Quantity:** | 175 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ Moderate ☐ Severe ☒ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Sq.m. | | 171 | 2 | 2 |

**Comments:**

- South Structure – Delamination / hairline cracks / failed trial crack repairs.
- North Structure – Hairline cracks / Expansion Joint settled West Abutment.
- Refer to Photos 28 & 29.

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | |
|---|---|---|---|
| **Element Group:** | Sidewalks / Curbs | **Length:** | 45m |
| **Element Name:** | Sidewalks and Medians | **Width:** | 2.4m |
| **Location:** | East and West Banks | **Height:** | -- |
| **Description:** | Under-Bridge Sidewalk | **Count:** | 2 |
| **Material:** | Concrete | **Total Quantity:** | 108 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☒ Moderate ☐ Severe ☐ | **Perform. Deficiencies** | **Maint. Needs** |

**Condition Data:**

| Units | Exc. | Good | Fair | Poor |
|---|---|---|---|---|
| Sq.m. | | 90 | 12 | 6 |

**Comments:**

- Areas of delamination and spalling.
- Refer to Photos 30 & 31.

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | | | | |
|---|---|---|---|---|---|---|
| **Element Group:** | Barriers | | | | **Length:** | 6m |
| **Element Name:** | Posts | | | | **Width:** | .25m |
| **Location:** | Four Corners of Bridge | | | | **Height:** | 4.22m |
| **Description:** | Monument Wall End Post Extensions | | | | **Count:** | 2 |
| **Material:** | Concrete | | | | **Total Quantity:** | 150 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | | | | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ | Moderate ☒ | Severe ☐ | | **Perform. Deficiencies** | **Maint. Needs** |
| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** | |
| | | | 150 | | | |
| **Comments:** | • Refer to Photo 32. | | | | | |

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐

| | | | | | | |
|---|---|---|---|---|---|---|
| **Element Group:** | Decks | | | | **Length:** | 35.8m |
| **Element Name:** | Soffit – Inside Boxes | | | | **Width:** | 1.25m |
| **Location:** | Median | | | | **Height:** | -- |
| **Description:** | Encased Conduit / Med. Expansion Joint | | | | **Count:** | -- |
| **Material:** | Concrete | | | | **Total Quantity:** | 45 sq.m. |
| **Element type:** | Cast-in-Place Reinforced | | | | **Not Inspected:** | ☐ |
| **Environment:** | Benign ☐ | Moderate ☒ | Severe ☐ | | **Perform. Deficiencies** | **Maint. Needs** |
| **Condition Data:** | **Units** | **Exc.** | **Good** | **Fair** | **Poor** | |
| | Sq.m. | | 42 | 2 | 1 | |
| **Comments:** | • Spall at West Pier and wide crack at Midspan.<br>• Refer to Photos 33 & 34. | | | | | |

**Performance Deficiencies:**

- None

**Recommended Work:**

None>10 Yrs ☒ 6-10 Yrs ☐ 1-5 Yrs ☐ Now < 1 Year ☐ Urgent ☐


Photo 1 – west abutment


Photo 2 – west abutment gravelly material on seat


Photo 3 – east abutment bearing 4 from north


Photo 4 – west span girder 15 from north rotated


Photo 5 – wingwall


Photo 6 – east approach looking south

Photo 7 – west approach looking south

Photo 8 – south sidewalk west end

Photo 9 – south sidewalk east end trip hazard

Photo 10 – north barrier

Photo 11 – south sidewalk looking east

Photo 12- deck looking east

Photo 13 – north traffic back wall at west expansion joint

Photo 14 – NW bearing and delamination at bottom of girder

Photo 15 – NW bearing and delamination at bottom of girder

Photo 16 – middle span girders

Photo 17 – deck cracking

Photo 18 – deck scaling

Photo 19 – middle span south extension soffit

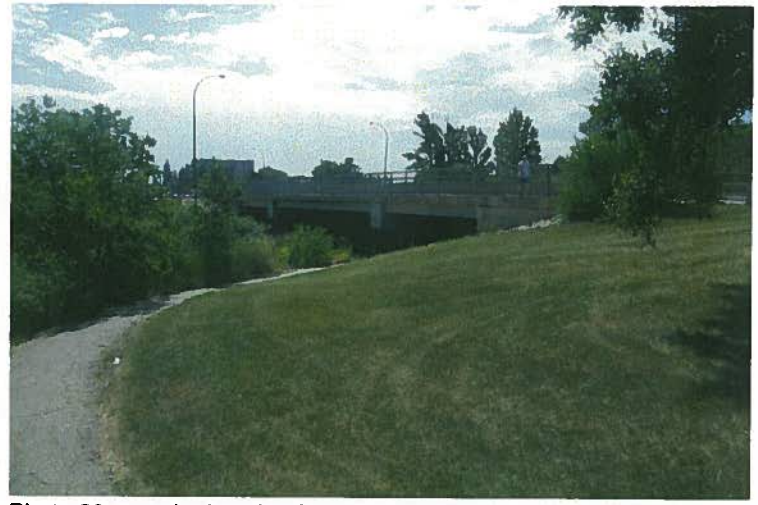


Photo 20 – north elevation from NW corner

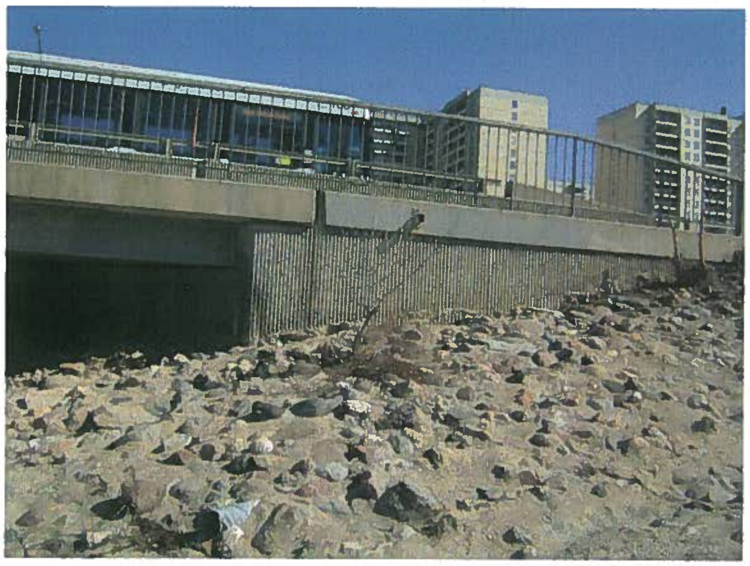


Photo 21- slope protection

Photo 22 – creek riprap

Photo 23 – west expansion joint looking south

Photo 24 – east expansion joint looking south

Photo 25 – median expansion joint

Photo 26 – east pier, east bearing 16 from north crack

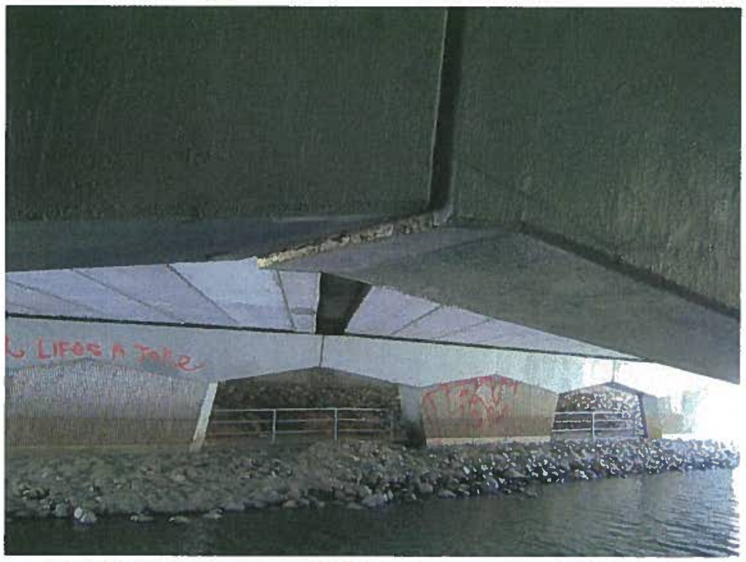


Photo 27 – piers

Photo 28 – north sidewalk west end minor settlement

Photo 29 – north sidewalk west end minor settlement

Photo 30 – under-bridge sidewalk

Photo 31 – under-bridge sidewalk delamination


Photo 32 - endpost

Photo 33 – middle soffit above west pier

Photo 34 – midspan crack

#6 - Marion Street, Winnipeg, Manitoba, R3J 0K4
Phone: (204) 233-1694 Fax: (204) 235-1579
E-mail: eng_tech@mts.net
www.eng-tech.ca

August 16, 2012

File No.: 11-087-01

Morrison Hershfield
Unit 1 – 25 Scurfield Blvd.
Winnipeg, MB
R3Y 1G4

**ATTENTION:** Bill Ebinspanger, P.Eng.

**RE:** Portage Avenue Twin Bridges Over Sturgeon Creek - Final Report

Dear Mr. Ebinspanger,

## 1.0 Introduction

ENG-TECH Consulting Limited (ENG-TECH) was retained by Morrison Hershfield to conduct localised half-cell, AC resistance and chloride ion testing on the Portage Avenue twin bridge structure passing over Sturgeon Creek. The information and data presented in this final report forms part of the condition survey to be reported in a structural rehabilitation recommendation to be presented to the City of Winnipeg by Morrison Hershfield.

## 2.0 Scope of Work

The work presented in this report consists of a corrosion potential survey and laboratory chloride ion testing program conducted on the Sturgeon Creek Bridge.

The corrosion potential survey consisted of exposing the top layer of reinforcing bars (re-bar) along, the bridge deck, traffic barriers, sidewalk, facia, and approach slabs in order to conduct localized half-cell and AC resistance measurements.

The chloride ion testing program consisted of extracting concrete cores from the bridge deck, traffic barriers, sidewalk, facia and approach slabs in order to determine the water-soluble chloride ion profile throughout the depth of the concrete.

Corrosion potential measurements and extraction of cores were conducted between July 16 and 20, 2012, along the north and south structures. The test locations are presented in Drawings 1 and 2 of Appendix A. Location and depth of cover at each test location was determined by Morrison Hershfield.

# 3.0 Methodology

## 3.1 Corrosion Potential Survey

Localized half-cell and AC resistance measurements, on the bridge structure, were carried out according to the *Ontario Structural Rehabilitation Manual* (OSRM) for bridges containing epoxy coated re-bar. Initially, the re-bar location and depth of cover was determined by the use of a cover meter instrument. Once located, the re-bar was exposed by cutting the concrete, with a coring machine, down to the depth of re-bar and then jackhammering the concrete within the cut area. After, a self-tapping screw was inserted into the re-bar in order to provide a connection for localized half-cell and AC resistance measurements.

### 3.1.1 Localized Half-Cell Measurements

Localized half-cell measurements were done using a half-cell instrument consisting of a copper sulphate reference electrode and portable voltmeter. The measurements were conducted at each test locations by connecting the voltmeter to the self-tapping screw and reference electrode. As such, localised half-cell measurements were done along the same re-bar segment.

### 3.1.2 AC Resistance Measurements

AC resistance measurements were done using a null balancing ohmmeter capable of measuring resistance from 0.01 ohm to 1.0 megaohm. The measurements were carried out by connecting the ohmmeter to two test locations. The complete set of AC resistance measurements were made between all possible combinations of test locations.

Due to the ability of only closing 2 lanes of traffic at a time, the AC resistance measurements covering all possible combinations was limited to the lane closure area.

## 3.2 Chloride Ion Testing Program

The chloride ion content of the bridge structure was conducted according to the Canadian Standards Association A23.2-4B: *Test Method for Sampling and Determination of Water-Soluble Chloride Ion Content in Hardened Grout or Concrete*. Drilled concrete cores of 100 mm in length or greater were extracted at selected test locations. Once extracted, the cores were brought to ENG-TECH's laboratory and slices were cut at depths of 10-20 mm, 30-40 mm, 50-60 mm, 70-80 mm and 90-100 mm from the top of core. The first 4 top slices were tested for chloride ion while the 5$^{th}$ bottom slice, of selected cores, was tested in order to provide background readings.

# 4.0 Results and Discussion

Localized half-cell measurements at the test locations revealed that the localised voltage drops had a range of -0.100 V to -0.600 V. Due to the presence of epoxy coating, the qualification of the potential for corrosion in the steel is not established by conventional practices. Notwithstanding, general observations can be made that provide insight into the potential for corrosion in the steel reinforcement.

Localized half-cell measurements were found to be higher long the south bridge deck than the north bridge deck. The average localized voltage drop along lanes 1, 2, 3 and 4 of the south bridge deck were -0.454 V, -0.400 V, -0.400 V and -0.401 V, respectively. The average localized voltage drop along lanes 1, 2, 3 and 4 of the north bridge deck were -0.196 V, -0.228V, -0.249 V and -0.260 V, respectively. Based on the localized voltage drop measurements, there is a higher potential for corrosion in the top re-bar of the south deck than the north deck.

Results of averaged localized voltage drop measurements along the approach slabs, sidewalk, facia and traffic barriers are summarized in Table 1.

| Table 1: Averaged Localised Voltage Drop (V) | | |
|---|---|---|
| Structural Element | South Structure | North Structure |
| Traffic barrier | -0.439 | -0.466 |
| Sidewalk | - | -0.395 |
| Facia | - | -0.331 |
| West approach slab | -0.467 | -0.412 |
| East approach slab | -0.391 | -0.375 |

Calculated AC resistance at individual test locations along the bridge decks were found to be in the range of 0 ohm to 3500 ohms. According to the Ministry of Transportation of Ontario, a calculated AC resistance of less than 1000 ohm is considered to have a high probability of corrosion. Based on the calculated AC resistance, presented in Table 2, the south bridge deck has greater resistance than the north bridge deck. This indicates that the resistance to an anodic and cathodic reaction, necessary for corrosion to occur, in the steel is less in the north bridge deck than the south bridge deck. In addition to the AC resistance measurements, a visual inspection of the condition of the epoxy coating and re-bar was made at each test location. Based on the visual inspection, the epoxy coating and re-bar at the test locations that had resistance less than 1000 ohms appeared to be in similar condition to the test locations that had resistance greater than 1000 ohms. Hence, the calculated AC resistance should be interpreted as the likelihood of an anodic and cathodic reaction to occur, however the results bear no weight on the presence and degree of corrosion.

A summary of AC resistance measurements between all possible test location combinations were calculated according to the OSRM and the individual readings are presented in Appendix D.

It is noted that test locations 15, 16, 17, 19 and 21 were provided for in the original corrosion potential survey proposal but not included in the final survey due to the presence of high voltage conduits inside the sidewalk.

| Table 2: Calculated AC Resistance | | | |
|---|---|---|---|
| Bridge Deck | Lane | Test Location | Calculated AC Resistance (ohm) |
| South | 1 | 2 | 0 |
| | 2 | 4 | 3495 |
| | | 5 | 115 |
| | 3 | 7 | 624 |
| | | 8 | 273 |
| | 4 | 11 | 1573 |
| | | 12 | 1123 |
| | | 13 | 1223 |
| North | 1 | 24 | 1193 |
| | 2 | 26 | 3 |
| | | 27 | 503 |
| | 3 | 29 | 0 |
| | | 30 | 1 |
| | 4 | 33 | 82 |
| | | 34 | 2 |
| | | 35 | 1 |

Water-soluble chloride ion contents were found to be lower along the bridge deck and facia than the traffic barriers, sidewalk, approach slabs and median. A summary of averaged water-soluble chloride ion contents are presented in Table 3. A literature review indicated that the onset of electrochemical corrosion of steel occurs when the water-soluble chloride ion content by mass of portland cement is in the range of 0.40% to 0.15%. This critical chloride ion threshold is dictated by the pH of the cement and carbonation of the concrete which makes a fixed threshold value not possible. By assuming that the concrete has a portland cement content of 300 kg/m$^3$ and density of 2350 kg/m$^3$, the critical chloride ion threshold to cause corrosion is between 0.050% and 0.019%.

Based on the water-soluble chloride ion test results, the bridge deck and facia on average contain concentrations that are below the critical chloride ion threshold while all other structural elements are above or within the critical chloride ion threshold. This indicates that the concrete on the bridge deck and facia have low prevalence on the electrochemical process required for corrosion while all other structural elements do.

The corrosion potential survey and chloride ion test results are summarized in Appendix B.

| Table 3: Averaged Water-Soluble Chloride Ion Profile | | | | | | |
|---|---|---|---|---|---|---|
| Structural Element | | Sample Depth (mm) | South Structure | | North Structure | |
| | | | Avg. Re-Bar Depth (mm) | Chloride Ion Content (%) | Avg. Re-Bar Depth (mm) | Chloride Ion Content (%) |
| Bridge deck | Lane 1 | 10-20 | 75 | 0.312 | 80 | 0.342 |
| | | 30-40 | | 0.115 | | 0.114 |
| | | 50-60 | | 0.021 | | 0.023 |
| | | 70-80 | | 0.017 | | 0.020 |
| | | 90-100 | | 0.015 | | 0.017 |
| | Lane 3 | 10-20 | 85 | 0.483 | 85 | 0.352 |
| | | 30-40 | | 0.271 | | 0.168 |
| | | 50-60 | | 0.075 | | 0.043 |
| | | 70-80 | | 0.042 | | 0.015 |
| | Lane 4 | 10-20 | 95 | 0.211 | 85 | 0.214 |
| | | 30-40 | | 0.089 | | 0.101 |
| | | 50-60 | | 0.034 | | 0.023 |
| | | 70-80 | | 0.023 | | 0.020 |
| | | 90-100 | | 0.019 | | 0.019 |
| Traffic barrier | | 10-20 | 50 | 0.321 | 40 | 0.477 |
| | | 30-40 | | 0.216 | | 0.374 |
| | | 50-60 | | 0.139 | | 0.228 |
| | | 70-80 | | 0.105 | | 0.237 |
| Sidewalk | | 10-20 | - | - | 50 | 0.321 |
| | | 30-40 | | | | 0.253 |
| | | 50-60 | | | | 0.162 |
| | | 70-80 | | | | 0.086 |
| Facia | | 10-20 | - | - | 60 | 0.184 |
| | | 30-40 | | | | 0.110 |
| | | 50-60 | | | | 0.051 |
| | | 70-80 | | | | 0.023 |
| West approach slab | | 10-20 | 50 | 0.503 | 70 | 0.445 |
| | | 30-40 | | 0.293 | | 0.315 |
| | | 50-60 | | 0.181 | | 0.226 |
| | | 70-80 | | 0.094 | | 0.206 |
| East approach slab | | 10-20 | 50 | 0.487 | 75 | 0.562 |
| | | 30-40 | | 0.335 | | 0.429 |
| | | 50-60 | | 0.239 | | 0.282 |
| | | 70-80 | | 0.177 | | 0.230 |
| Median | | 10-20 | - | - | 50 | 0.516 |
| | | 30-40 | | | | 0.349 |
| | | 50-60 | | | | 0.258 |
| | | 70-80 | | | | 0.215 |

## 5.0 Conclusion

A corrosion potential survey and laboratory chloride ion testing program was conducted on the Portage Avenue twin bridge structure passing over Sturgeon Creek.

The corrosion potential survey consisted of measuring localized voltage drops and AC resistance along the bridge deck, traffic barriers, sidewalk, facia, and approach slabs. Based on the localized voltage drop and AC resistance measurements it was observed that: 1) higher voltage drops are present along the south bridge deck than the north bridge deck, and 2) lower calculated AC resistances are present along the north bridge deck than the south bridge deck.

The chloride ion testing program consisted of measuring the water-soluble chloride ion profile on concrete cores extracted from the bridge deck, traffic barriers, sidewalk, facia and approach slabs. Based on the results, the water-soluble chloride ion content at the depth of re-bar along the bridge deck and facia are lower than the critical chloride ion threshold, while the traffic barriers, sidewalk, median and approach slabs are above or within the critical chloride ion threshold.

If there are any questions or comments, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

Jean-Luc Lambert, EIT
Materials Engineer

Reviewed by,
ENG-TECH Consulting Limited

Danny Holfeld, Principal
Manager of Operations

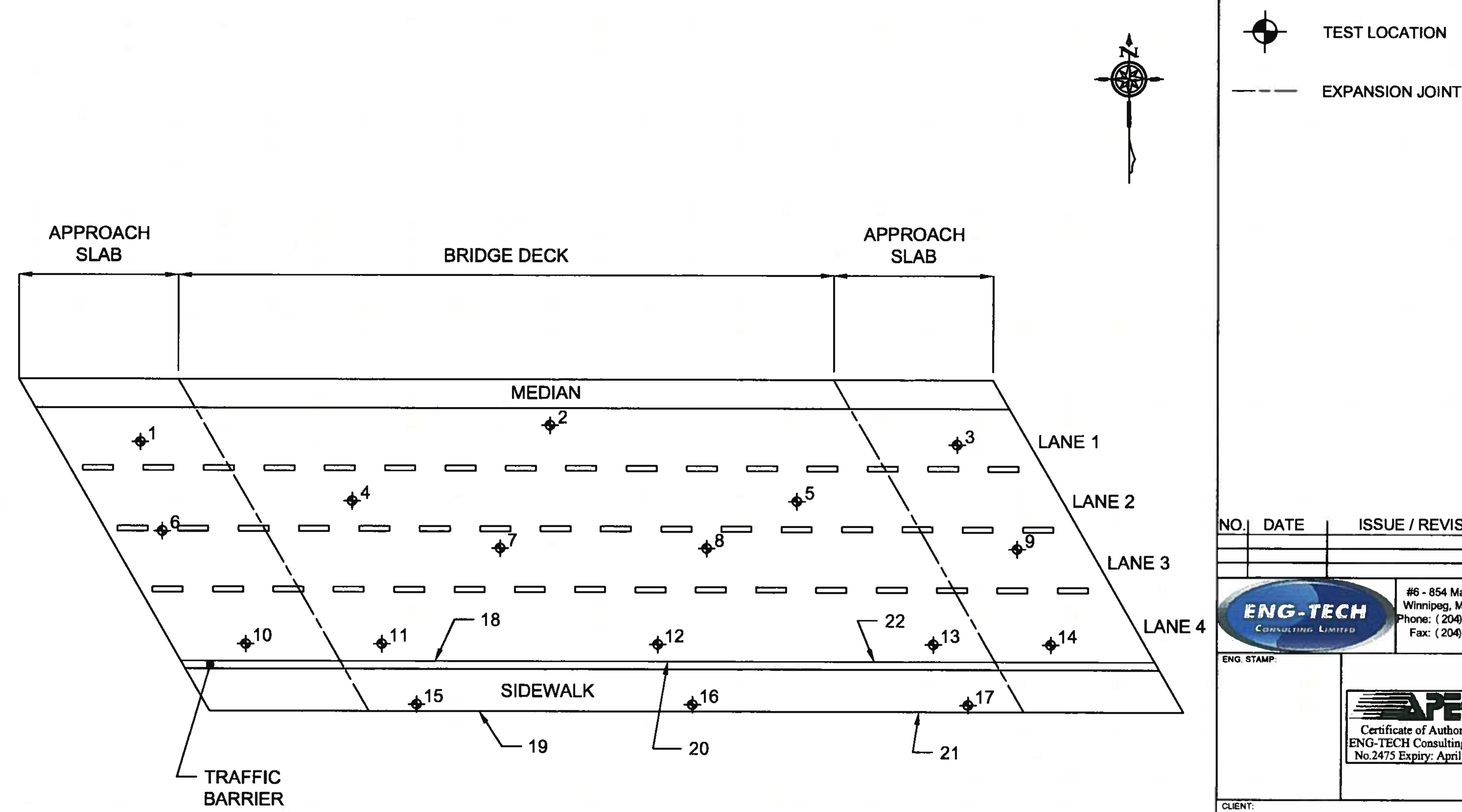
DH/jl

CC: Email: BEbenspanger@morrisonhershfield.com

Attachments:
Appendix A - Test Location Drawings
Appendix B - Corrosion Potential Survey and Laboratory Test Results
Appendix C - Concrete Core Pictures
Appendix D - Individual AC Resistance Measurements

# APPENDIX A

## Test Location Drawings




| NO. | DATE | ISSUE / REVISION |
|---|---|---|
| | | |

ENG-TECH Consulting Limited
#6 - 854 Marion Street
Winnipeg, MB R2J 0K4
Phone: (204) 233-1694
Fax: (204) 235-1579

ENG. STAMP:

APEGM
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475 Expiry: April 30, 2013

CLIENT: MORRISON HERSHFIELD

PROJECT: PORTAGE AVENUE TWIN BRIDGES OVER STURGEON CREEK

DWG DESCRIPTION: TEST LOCATIONS ALONG SOUTH STRUCTURE

SCALE: N.T.S.

DRAWN BY: JL

DATE: AUGUST 10, 2012

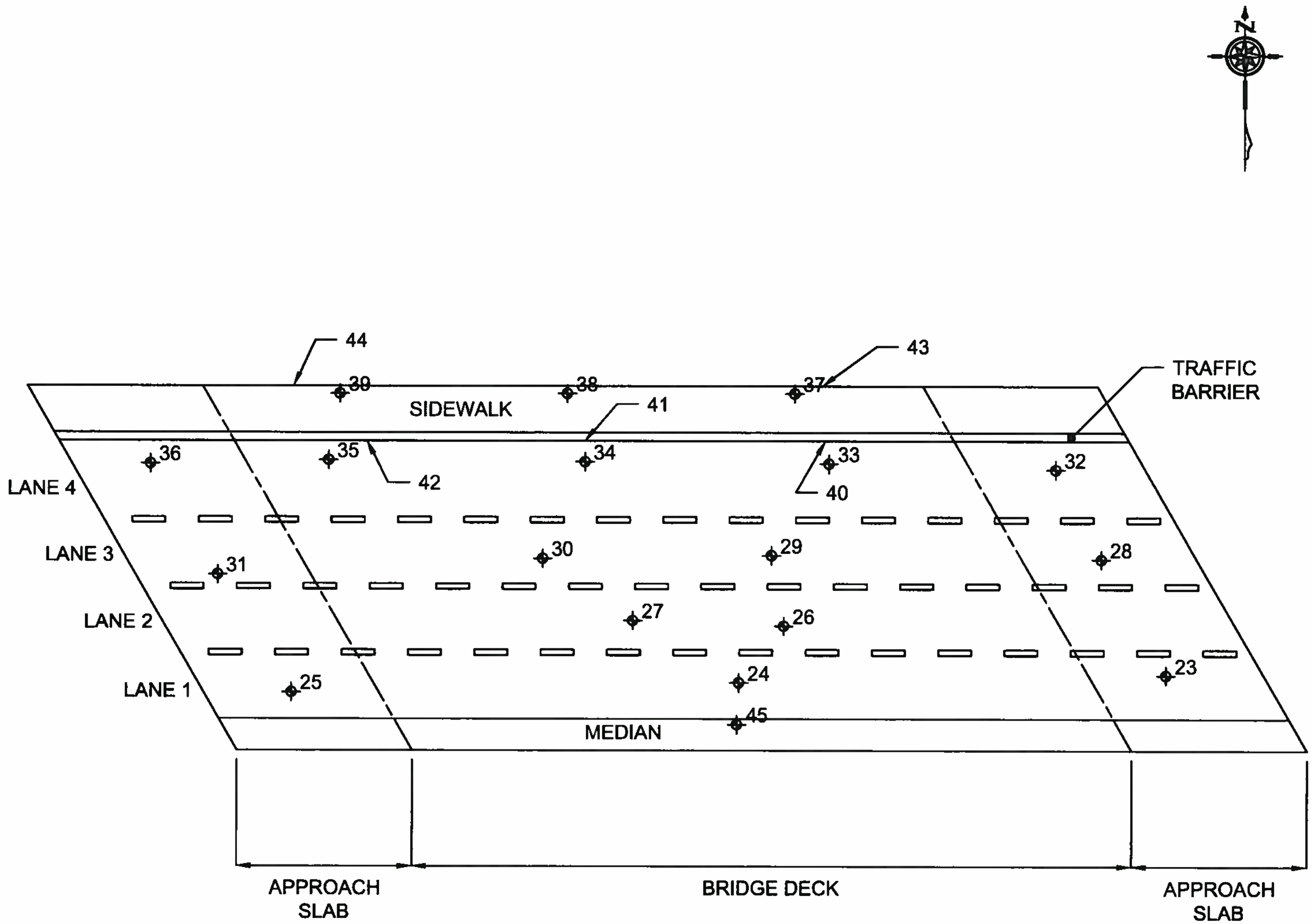
FILE No.: 12-087-01

CLIENT DWG/FIG. No.:

ENG-TECH DWG/FIG. No.: 1

NO.:

P:\2012\Projects\087 (Morrison Hersfield) \01 (Portage_Ave_Twin_Bridges) \Drawings\12-081-01_ Test locations.dwg




TEST LOCATION

EXPANSION JOINT

| NO. | DATE | ISSUE / REVISION |
|---|---|---|
| | | |
| | | |


ENG-TECH Consulting Limited
#6 - 854 Marion Street
Winnipeg, MB R2J 0K4
Phone: (204) 233-1694
Fax: (204) 235-1579


ENG. STAMP:

APEGM
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475 Expiry: April 30, 2013

CLIENT: MORRISON HERSHFIELD

PROJECT: PORTAGE AVENUE TWIN BRIDGES OVER STURGEON CREEK

DWG DESCRIPTION: TEST LOCATIONS ALONG NORTH STRUCTURE

SCALE: N.T.S.

DRAWN BY: JL

DATE: AUGUST 10, 2012

FILE No.: 12-087-01

CLIENT DWG/FIG. No.:

ENG-TECH DWG/FIG. No.: 2

NO.:

P:\2012\Projects\087 ( Morrison Hershfield) \01 ( Portage_Ave_Twin_Bridges) \Drawings\12-081-01__ Test locations.dwg

# APPENDIX B

## Corrosion Potential Survey and Laboratory Test Results

Table 1: Corrosion Potential Survey and Laboratory Test Results for South Structure

| Test Location | Location | Depth to Top Layer of Re-bar [mm] | Localized Half Cell Measur-ement [V] | Calculated AC Resistance [ohm] | Thickness of High Density Concrete [mm] | Core Length [mm] | Sample Depth [mm] | Water-Soluble Chloride Ion Content [%] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Eastbound lane 1 along west approach. 4.3 m west of west expansion joint and 2.0 m south of median curb. | 55 | -0.454 | - | - | - | - | - | |
| 2 | Eastbound lane 1 along bridge deck. 18.0 m west of east expansion joint and 2.0 m south of lane 1 curb. | 75 | -0.432 | 0 | 65 | 120 | 10-20<br>30-40<br>50-60<br>70-80<br>90-100 | 0.312<br>0.115<br>0.021<br>0.017<br>0.015 | |
| 3 | Eastbound lane 1 along east approach. 5.0 m east of east approach and 2.1 m south of median curb. | 95 | -0.397 | - | - | - | - | - | |
| 4 | Eastbound lane 2 along bridge deck. 6.0 m east of west expansion joint and 5.4 m south of median curb. | 80 | -0.333 | 3495 | - | - | - | - | |
| 5 | Eastbound lane 2 along bridge deck. 6.2 m west of east expansion joint and 5.4 m south of median curb. | 95 | -0.466 | 115 | - | - | - | - | |
| 6 | Eastbound lane 3 along west approach. 6.0 m west of west expansion joint and 7.5 m north of traffic barrier toe. | 60 | -0.391 | - | - | 140 | 10-20<br>30-40<br>50-60<br>70-80 | 0.527<br>0.289<br>0.188<br>0.086 | |
| 7 | Eastbound lane 3 along bridge deck. 13.0 m east of west expansion joint and 6.5 m north of traffic barrier toe. | 85 | -0.457 | 624 | 55 | 155 | 10-20<br>30-40<br>50-60<br>70-80 | 0.472<br>0.276<br>0.070<br>0.030 | |

Table 1: Corrosion Potential Survey and Laboratory Test Results for South Structure (Continued)

| Test Location | Location | Depth to Top Layer of Re-bar [mm] | Localized Half Cell Measurement [V] | Calculated AC Resistance [ohm] | Thickness of High Density Concrete [mm] | Core Length [mm] | Sample Depth [mm] | Water-Soluble Chloride Ion Content [%] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Eastbound lane 3 along bridge deck. 13.0 m west of east expansion joint and 6.5 m north of traffic barrier toe. | 90 | -0.342 | 273 | 55 | 140 | 10-20<br>30-40<br>50-60<br>70-80 | 0.493<br>0.266<br>0.083<br>0.053 | |
| 9 | Eastbound lane 3 along east approach. 5.0 m east of east expansion joint and 6.5 m north of lane 4 curb. | - | -0.299 | - | - | 145 | 10-20<br>30-40<br>50-60<br>70-80 | 0.582<br>0.421<br>0.285<br>0.230 | |
| 10 | Eastbound lane 4 along west approach. 4.9 m west of west expansion joint and 1.0 m north of traffic barrier toe. | 50 | -0.556 | - | - | 150 | 10-20<br>30-40<br>50-60<br>70-80 | 0.478<br>0.296<br>0.173<br>0.101 | |
| 11 | Eastbound lane 4 along bridge deck. 3.0 m east of west expansion joint and 1.0 m north of traffic barrier toe. | 85 | -0.501 | 1573 | 50 | 120 | 10-20<br>30-40<br>50-60<br>70-80<br>90-100 | 0.189<br>0.065<br>0.032<br>0.032<br>0.026 | |
| 12 | Eastbound lane 4 along bridge deck. 19.0 m east of west expansion joint and 1.0 m north of traffic barrier toe. | 110 | -0.355 | 1123 | 55 | 145 | 10-20<br>30-40<br>50-60<br>70-80<br>90-100 | 0.230<br>0.115<br>0.046<br>0.018<br>0.017 | |
| 13 | Eastbound lane 4 along bridge deck. 3.0 m west of east expansion joint and 1.0 m north of traffic barrier toe. | 90 | -0.346 | 1723 | 50 | 135 | 10-20<br>30-40<br>50-60<br>70-80<br>90-100 | 0.214<br>0.086<br>0.024<br>0.020<br>0.015 | |

Table 1: Corrosion Potential Survey and Laboratory Test Results for South Structure (Continued)

| Test Location | Location | Depth to Top Layer of Re-bar [mm] | Localized Half Cell Measurement [V] | Calculated AC Resistance [ohm] | Thickness of High Density Concrete [mm] | Core Length [mm] | Sample Depth [mm] | Water-Soluble Chloride Ion Content [%] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 14 | Eastbound lane 4 along east approach. 3.8 m east of east expansion joint and 1.0 m north of traffic barrier toe. | 50 | -0.476 | - | - | 150 | 10-20<br>30-40<br>50-60<br>70-80 | 0.391<br>0.249<br>0.192<br>0.123 | |
| 15 | South structure along west side of sidewalk. | - | - | - | - | - | - | - | No testing done due to high voltage conduits. |
| 16 | South structure along center of sidewalk. | - | - | - | - | - | - | - | No testing done due to high voltage conduits. |
| 17 | South structure along east side of sidewalk. | - | - | - | - | - | - | - | No testing done due to high voltage conduits. |
| 18 | South structure along north face of traffic barrier. 5.5 m east of west expansion joint and 0.6 m vertically up from traffic barrier toe. | 50 | -0.500 | - | - | 145 | 10-20<br>30-40<br>50-60<br>70-80 | 0.416<br>0.285<br>0.197<br>0.152 | Polymer with fiber topping approximately 1 mm thick |
| 19 | South structure along west facia. | - | - | - | - | - | - | - | No testing done due to high voltage conduits. |

Table 1: Corrosion Potential Survey and Laboratory Test Results for South Structure (Continued)

| Test Location | Location | Depth to Top Layer of Re-bar [mm] | Localized Half Cell Measur-ement [V] | Calculated AC Resistance [ohm] | Thickness of High Density Concrete [mm] | Core Length [mm] | Sample Depth [mm] | Water-Soluble Chloride Ion Content [%] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 20 | South structure along north face of traffic barrier. 19.0 m east of west expansion joint and 0.6 m vertically up from traffic barrier toe. | 50 | -0.270 | - | - | - | - | - | |
| 21 | South structure along east facia. | - | - | - | - | - | - | - | No testing done due to high voltage conduits. |
| 22 | South structure along north face of traffic barrier. 31.0 m east of west expansion joint and 0.6 m vertically up from traffic barrier toe. | 50 | -0.548 | - | 150 | - | 10-20<br>30-40<br>50-60<br>70-80 | 0.226<br>0.147<br>0.080<br>0.059 | Polymer with fiber topping approximately 1 mm thick |

Table 2: Corrosion Potential Survey and Laboratory Test Results for North Structure

| Test Location | Location | Depth to Top Layer of Re-bar [mm] | Localized Half Cell Measurement [V] | Calculated AC Resistance [ohm] | Thickness of High Density Concrete [mm] | Core Length [mm] | Sample Depth [mm] | Water-Soluble Chloride Ion Content [%] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 23 | Westbound lane 1 along east approach. 4.1 m east of east expansion joint and 2.3 m north of median curb. | 95 | -0.173 | - | - | - | - | - | |
| 24 | Westbound lane 1 along bridge deck. 18.7 m east of west expansion joint and 1.9 m north of median curb. | 80 | -0.196 | 1193 | 45 | 120 | 10-20<br>30-40<br>50-60<br>70-80<br>90-100 | 0.342<br>0.114<br>0.023<br>0.020<br>0.017 | |
| 25 | Westbound lane 1 along west approach. 4.6 m west of west expansion joint and 1.4 m north of median curb. | 80 | -0.368 | - | - | - | - | - | |
| 26 | Westbound land 2 along bridge deck. 14.6 m west of east expansion joint and 4.9 m north of median curb. | 80 | -0.214 | 3 | - | - | - | - | |
| 27 | Westbound lane 2 along bridge deck. 15.6 m east of west expansion joint and 5.2 m north of median curb. | 95 | -0.242 | 503 | - | - | - | - | |
| 28 | Westbound lane 3 along east approach. 4.2 m east of east expansion joint and 6.2 m south of traffic barrier toe. | 80 | -0.337 | - | - | 135 | 10-20<br>30-40<br>50-60<br>70-80 | 0.593<br>0.484<br>0.298<br>0.238 | |

Table 2: Corrosion Potential Survey and Laboratory Test Results for North Structure (Continued)

| Test Location | Location | Depth to Top Layer of Re-bar [mm] | Localized Half Cell Measurement [V] | Calculated AC Resistance [ohm] | Thickness of High Density Concrete [mm] | Core Length [mm] | Sample Depth [mm] | Water-Soluble Chloride Ion Content [%] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 29 | Westbound lane 3 along bridge deck. 13.1 m west of east expansion joint and 6.0 m south of traffic barrier toe. | 85 | -0.253 | 0 | 55 | 140 | 10-20<br>30-40<br>50-60<br>70-80 | 0.326<br>0.144<br>0.032<br>0.012 | |
| 30 | Westbound lane 3 along bridge deck. 12.7 m east of west expansion joint and 6.2 m south of traffic barrier toe. | 85 | -0.244 | 1 | 70 | 140 | 10-20<br>30-40<br>50-60<br>70-80 | 0.377<br>0.192<br>0.053<br>0.017 | |
| 31 | Westbound lane 3 along west approach. 4.9 m west of west expansion joint and 7.0 m south of traffic barrier toe. | 70 | -0.459 | - | - | 125 | 10-20<br>30-40<br>50-60<br>70-80 | 0.375<br>0.274<br>0.235<br>0.232 | Concrete delaminated at 20 mm from surface. |
| 32 | Westbound lane 4 along east approach. 4.5 m east of east expansion joint and 1.5 m south of traffic barrier toe. | 75 | -0.616 | - | - | 140 | 10-20<br>30-40<br>50-60<br>70-80 | 0.531<br>0.374<br>0.266<br>0.222 | Concrete delaminated at 40 mm from surface |
| 33 | Westbound lane 4 along bridge deck. 7.3 m west of east expansion joint and 1.2 m south of traffic barrier toe. | 95 | -0.422 | 82 | 60 | 100 | 10-20<br>30-40<br>50-60<br>70-80<br>90-100 | 0.232<br>0.108<br>0.024<br>0.020<br>0.018 | |
| 34 | Westbound lane 4 along bridge deck. 19.5 m west of east expansion joint and 1.1 m south of traffic barrier toe. | 80 | -0.172 | 2 | 50 | 135 | 10-20<br>30-40<br>50-60<br>70-80<br>90-100 | 0.224<br>0.085<br>0.020<br>0.020<br>0.020 | |

Table 2: Corrosion Potential Survey and Laboratory Test Results for North Structure (Continued)

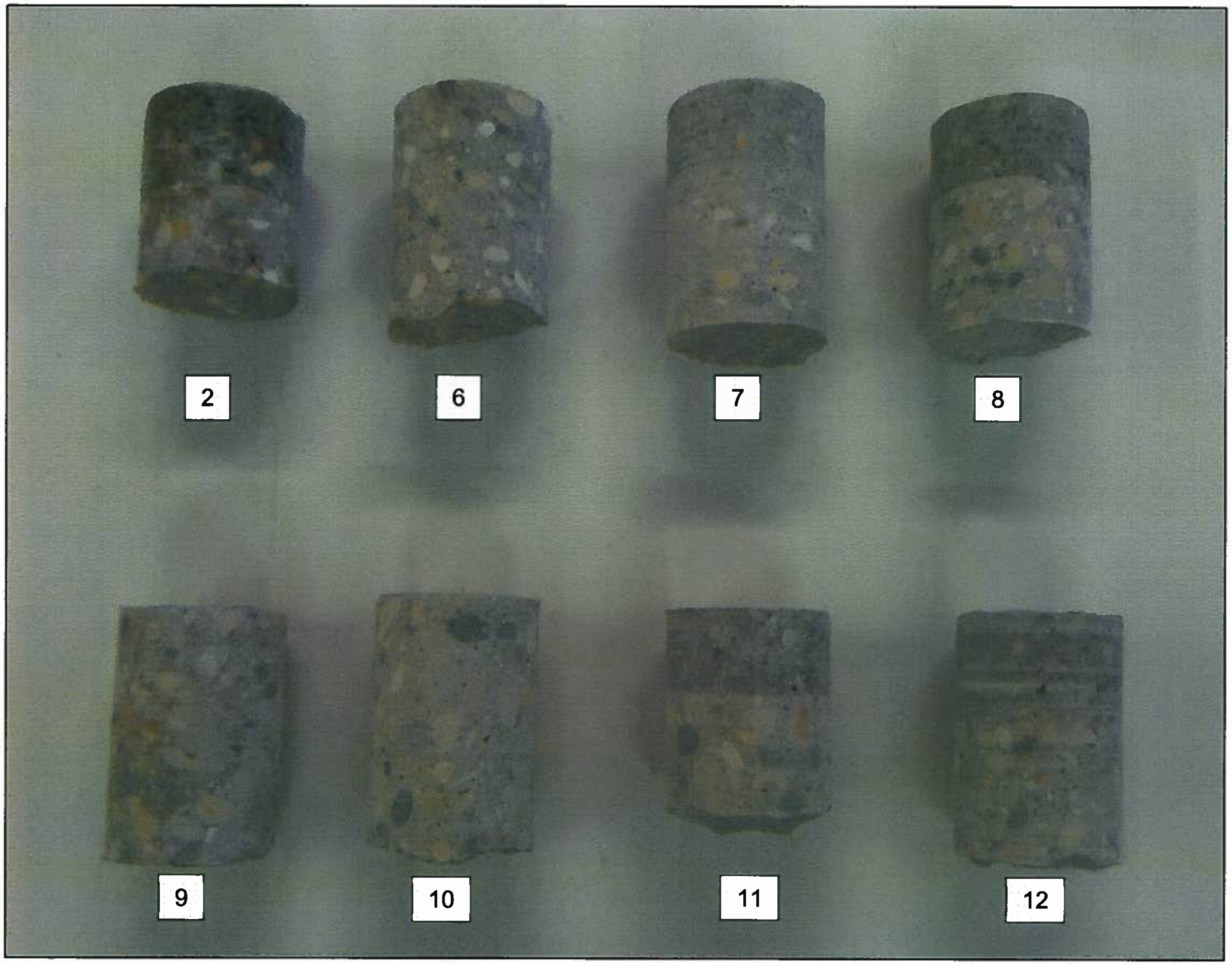
| Test Location | Location | Depth to Top Layer of Re-bar [mm] | Localized Half Cell Measurement [V] | Calculated AC Resistance [ohm] | Thickness of High Density Concrete [mm] | Core Length [mm] | Sample Depth [mm] | Water-Soluble Chloride Ion Content [%] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 35 | Westbound lane 4 along bridge deck. 4.4 m east of west expansion joint and 1.0 m south of traffic barrier toe. | 90 | -0.185 | 1 | 60 | 130 | 10-20<br>30-40<br>50-60<br>70-80<br>90-100 | 0.187<br>0.111<br>0.026<br>0.020<br>0.020 | |
| 36 | Westbound lane 4 along west approach. 5.1 m west of west expansion joint and 1.2 m south of traffic barrier toe. | 75 | -0.409 | - | - | 140 | 10-20<br>30-40<br>50-60<br>70-80 | 0.516<br>0.355<br>0.217<br>0.180 | |
| 37 | North structure along sidewalk. 7.0 m west of east expansion joint and 0.4 m from face of facia. | 60 | -0.394 | 234 | - | - | - | - | |
| 38 | North structure along sidewalk. 19.0 m west of east expansion joint and 0.4 m from face of facia. | 30 | -0.595 | 2913 | - | 100 | 10-20<br>30-40<br>50-60<br>70-80 | 0.321<br>0.253<br>0.162<br>0.086 | |
| 39 | North structure along sidewalk. 7.0 m east of west expansion joint and 0.4 m from face of facia. | 60 | -0.196 | 1763 | - | - | - | - | |
| 40 | North structure along south face of traffic barrier. 6.8 m west of east expansion joint and 0.6 m vertically up from traffic barrier toe.. | 50 | -0.436 | - | - | 140 | 10-20<br>30-40<br>50-60<br>70-80 | 0.572<br>0.449<br>0.232<br>0.226 | Concrete delaminated at 50 mm from surface. Polymer with fiber topping approximately 1 mm thick. |

Table 2: Corrosion Potential Survey and Laboratory Test Results for North Structure (Continued)

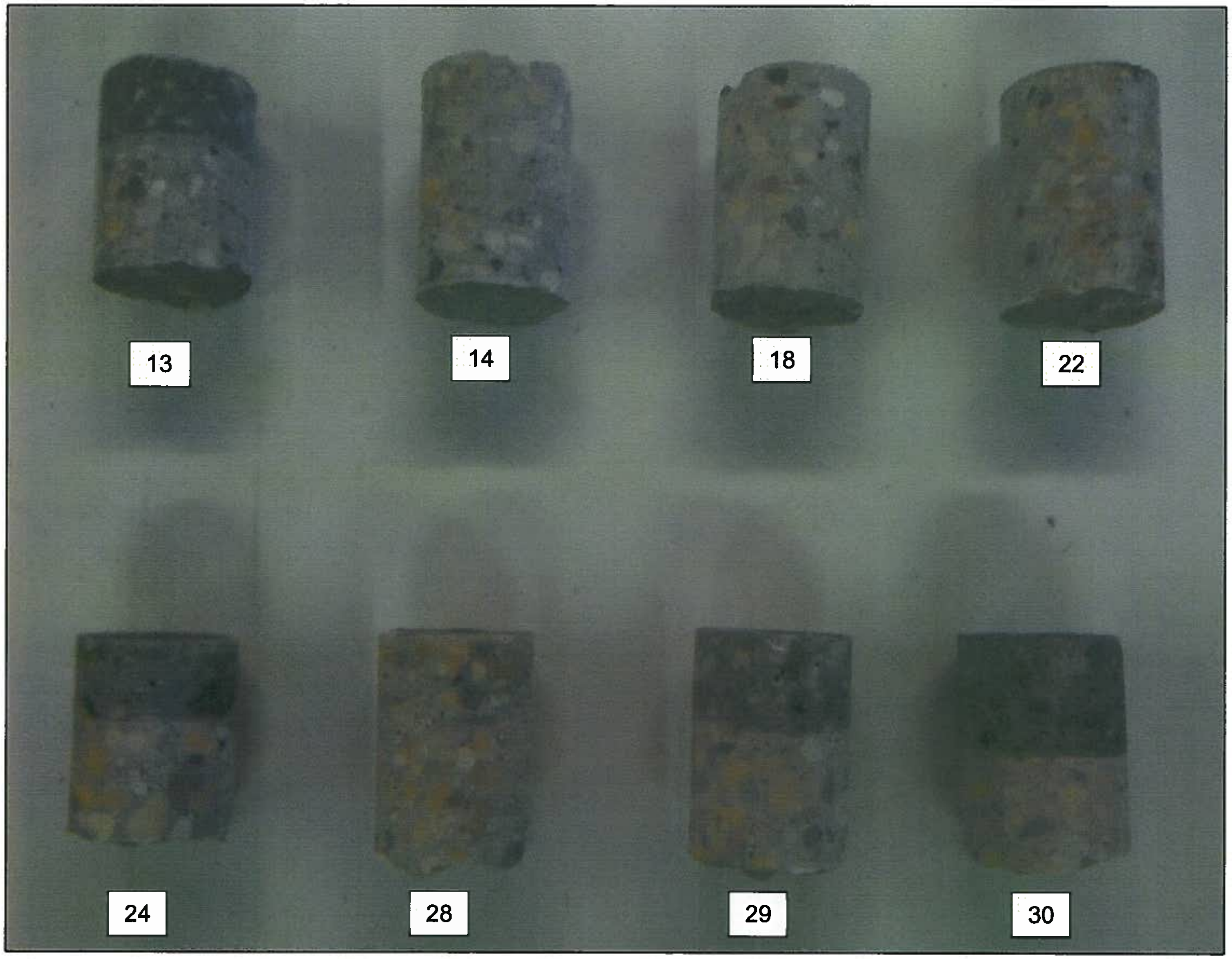
| Test Location | Location | Depth to Top Layer of Re-bar [mm] | Localized Half Cell Measurement [V] | Calculated AC Resistance [ohm] | Thickness of High Density Concrete [mm] | Core Length [mm] | Sample Depth [mm] | Water-Soluble Chloride Ion Content [%] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 41 | North structure along south face of traffic barrier. 19.5 m west of east expansion joint and 0.4 m vertically up from traffic barrier toe. | 40 | -0.399 | - | - | - | - | - | |
| 42 | North structure along south face of traffic barrier. 31.0 m west of east expansion joint and 0.6 m vertically up from traffic barrier toe. | 45 | -0.563 | - | - | 160 | 10-20<br>30-40<br>50-60<br>70-80 | 0.381<br>0.299<br>0.223<br>0.247 | Concrete delaminated at 40 mm from surface. Polymer with fiber topping approximately 1 mm thick. Slice 50-60 had some chunks with rust like colouration. |
| 43 | North structure along facia. 5.3 m west of east expansion joint and 0.2 m vertically down from surface of sidewalk. | 75 | -0.377 | - | - | 135 | 10-20<br>30-40<br>50-60<br>70-80 | 0.265<br>0.196<br>0.084<br>0.029 | Polymer with fiber topping approximately 1 mm thick. |
| 44 | North structure along facia. 4.8 m east of west expansion joint and 0.2 m vertically down from surface of sidewalk. | 60 | -0.285 | - | - | 150 | 10-20<br>30-40<br>50-60<br>70-80 | 0.103<br>0.023<br>0.018<br>0.017 | Polymer with fiber topping approximately 1 mm thick. |
| 45 | North structure along median. 18.1 m east of west expansion joint and 0.3 m south of median curb. | 50 | - | - | - | 145 | 10-20<br>30-40<br>50-60<br>70-80 | 0.516<br>0.349<br>0.258<br>0.215 | Polymer with fiber topping approximately 1 mm thick. |

# APPENDIX C

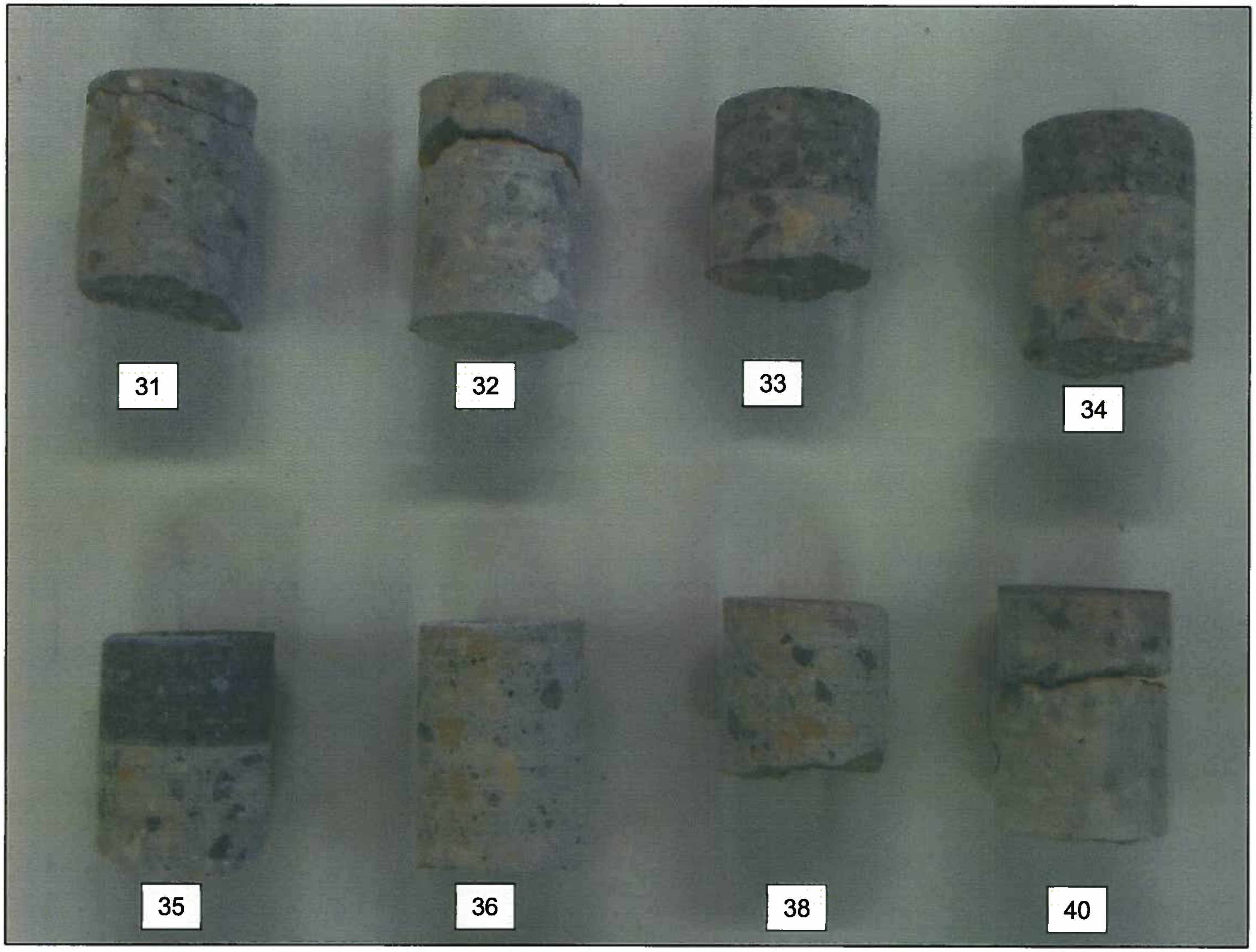
Concrete Core Pictures



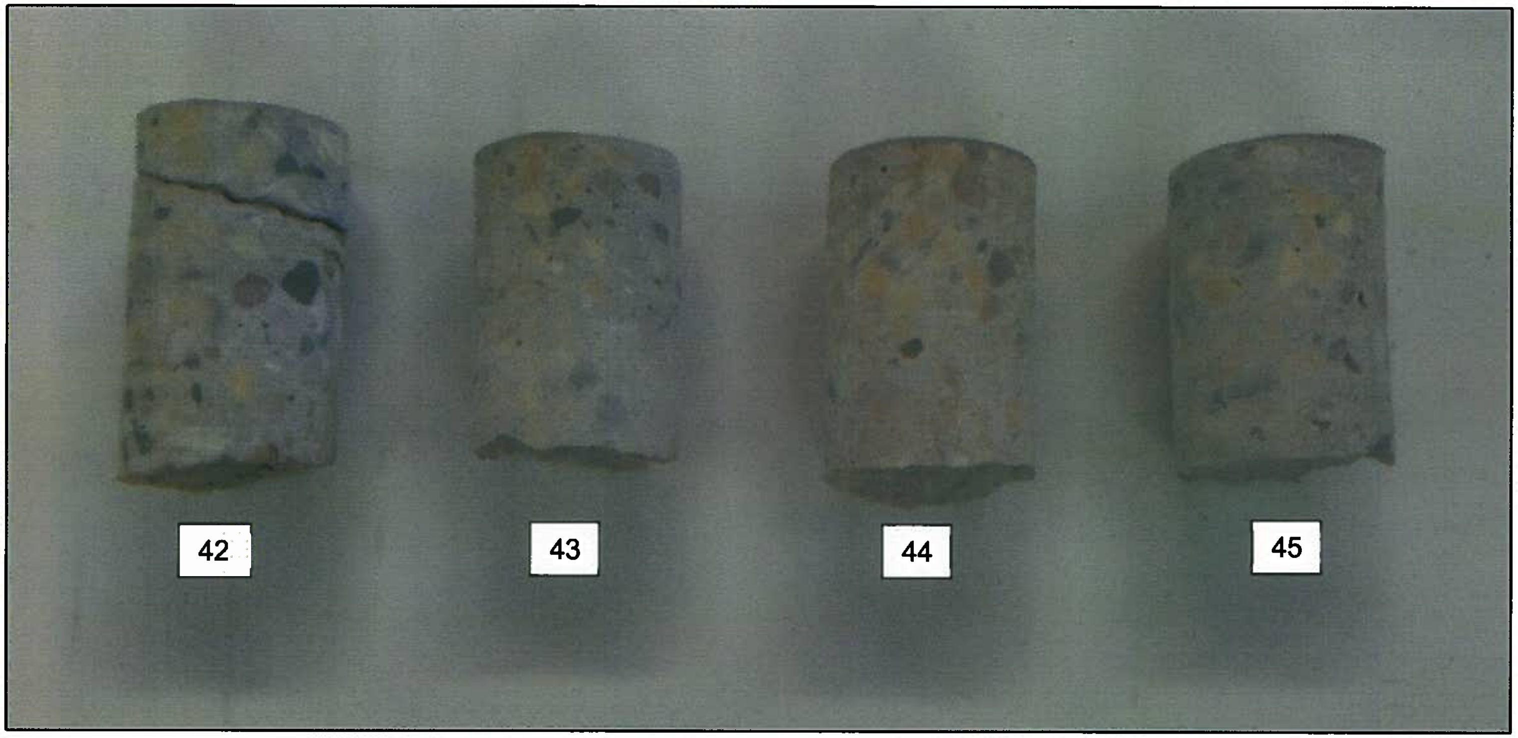

**Concrete Cores at Test Locations**




**Concrete Cores at Test Locations**




**Concrete Cores at Test Locations**




**Concrete Cores at Test Locations**

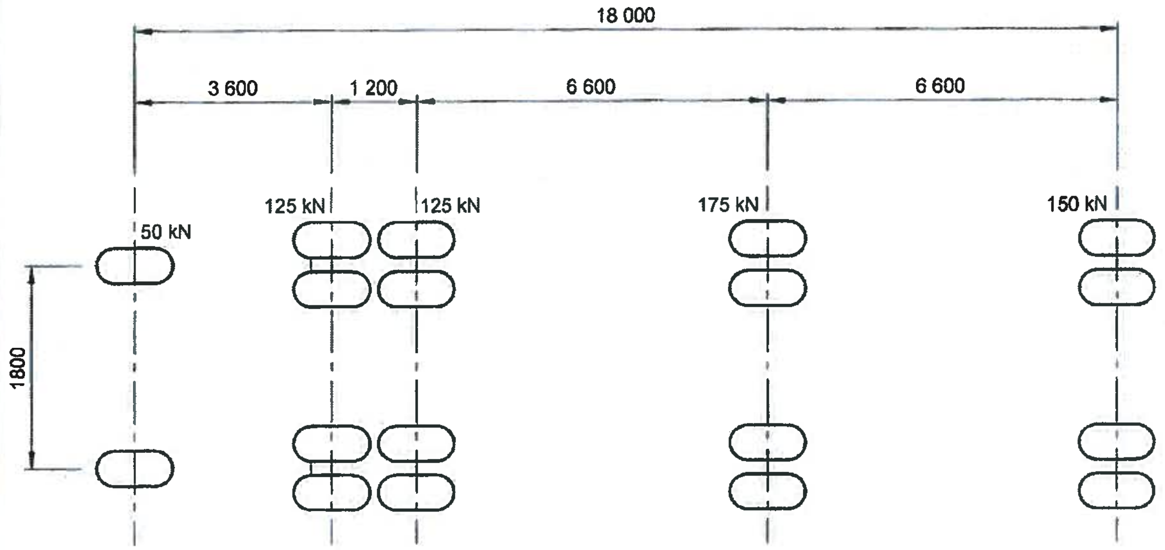
# APPENDIX D

Individual AC Resistance Measurements

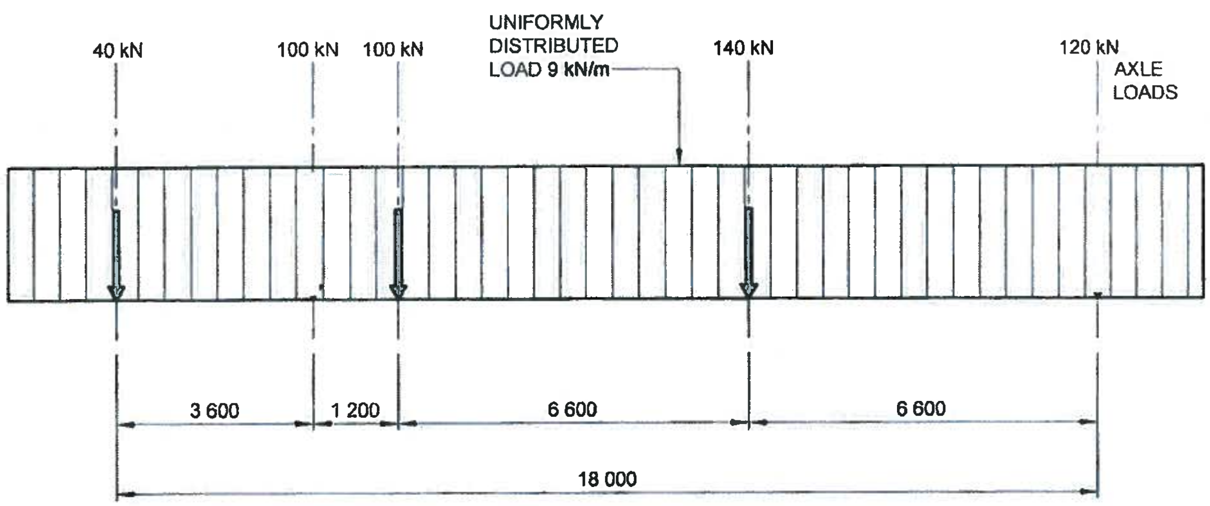
| Measured AC Resistance (ohm) Between Connection 1 and 2: South Structure | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Connection 2 | | | | | | | | | | | | |
| Connection 1 | 2 | 4 | 5 | 6 | 10 | 9 | 14 | 7 | 8 | 11 | 12 | 13 | Calculated AC Resistance |
| 2 | - | 3495 | 115 | | | | | | | | | | 0 |
| 4 | 4145 | - | 4045 | | | | | | | | | | 3495 |
| 5 | 125 | 3695 | - | | | | | | | | | | 115 |
| 6 | | | | - | 203 | | | | | | | | n.a. |
| 10 | | | | 199 | - | | | | | | | | n.a. |
| 9 | | | | | | - | 657 | | | | | | n.a. |
| 14 | | | | | | 657 | - | | | | | | n.a. |
| 7 | | | | | | | | - | 897 | 2197 | 1747 | 2347 | 624 |
| 8 | | | | | | | | 947 | - | 1847 | 1297 | 1747 | 273 |
| 11 | | | | | | | | 2147 | 1647 | - | 2547 | 3147 | 1573 |
| 12 | | | | | | | | 1747 | 1197 | 2547 | - | 2697 | 1123 |
| 13 | | | | | | | | 2447 | 1847 | 3347 | 2747 | - | 1723 |

| Measured AC Resistance (ohm) Between Connection 1 and 2: North Structure | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Connection 1 | Connection 2 | | | | | | | | | | | | | | | Calculated AC Resistance |
| | 24 | 26 | 27 | 28 | 32 | 31 | 36 | 29 | 30 | 33 | 34 | 35 | 37 | 38 | 39 | |
| 24 | - | 1196 | 1696 | | | | | | | | | | | | | 1193 |
| 26 | 896 | - | 506 | | | | | | | | | | | | | 3 |
| 27 | 1696 | 506 | - | | | | | | | | | | | | | 503 |
| 28 | | | | - | 1 | | | | | | | | | | | n.a. |
| 32 | | | | 1 | - | | | | | | | | | | | n.a. |
| 31 | | | | | | - | 43 | | | | | | | | | n.a. |
| 36 | | | | | | 47 | - | | | | | | | | | n.a. |
| 29 | | | | | | | | - | 1 | 82 | 2 | 1 | | | | 0 |
| 30 | | | | | | | | 1 | - | 83 | 2 | 1 | | | | 1 |
| 33 | | | | | | | | 85 | 84 | - | 86 | 85 | | | | 82 |
| 34 | | | | | | | | 2 | 1 | 82 | - | 2 | | | | 2 |
| 35 | | | | | | | | 1 | 1 | 82 | 2 | - | | | | 1 |
| 37 | | | | | | | | | | | | | - | 3147 | 1997 | 234 |
| 38 | | | | | | | | | | | | | 3097 | - | 4697 | 2913 |
| 39 | | | | | | | | | | | | | 2097 | 4147 | - | 1763 |

# APPENDIX B: LIVE LOAD VEHICLES

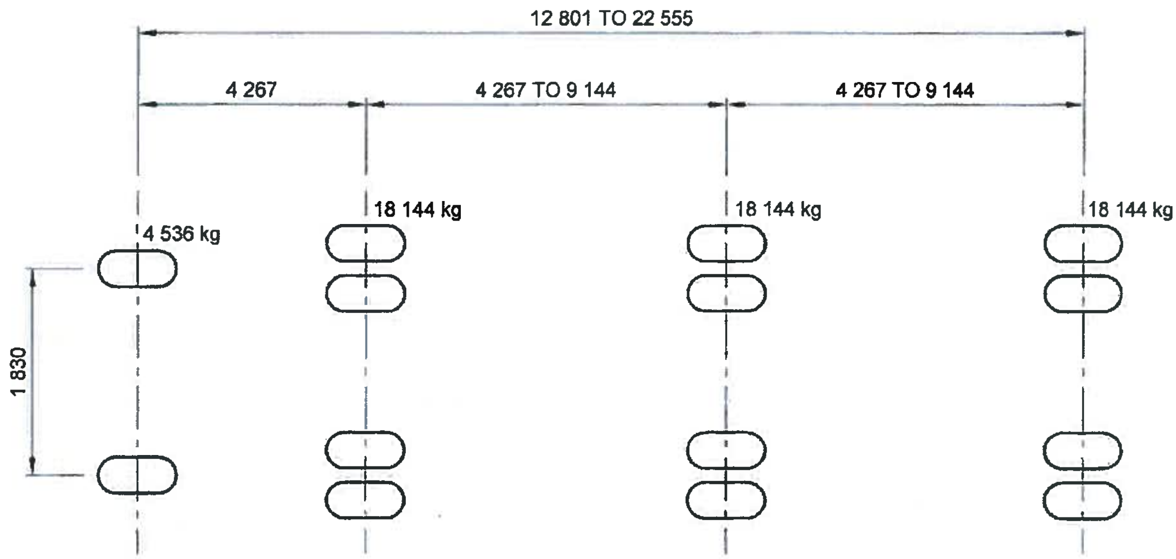



CL-625 TRUCK



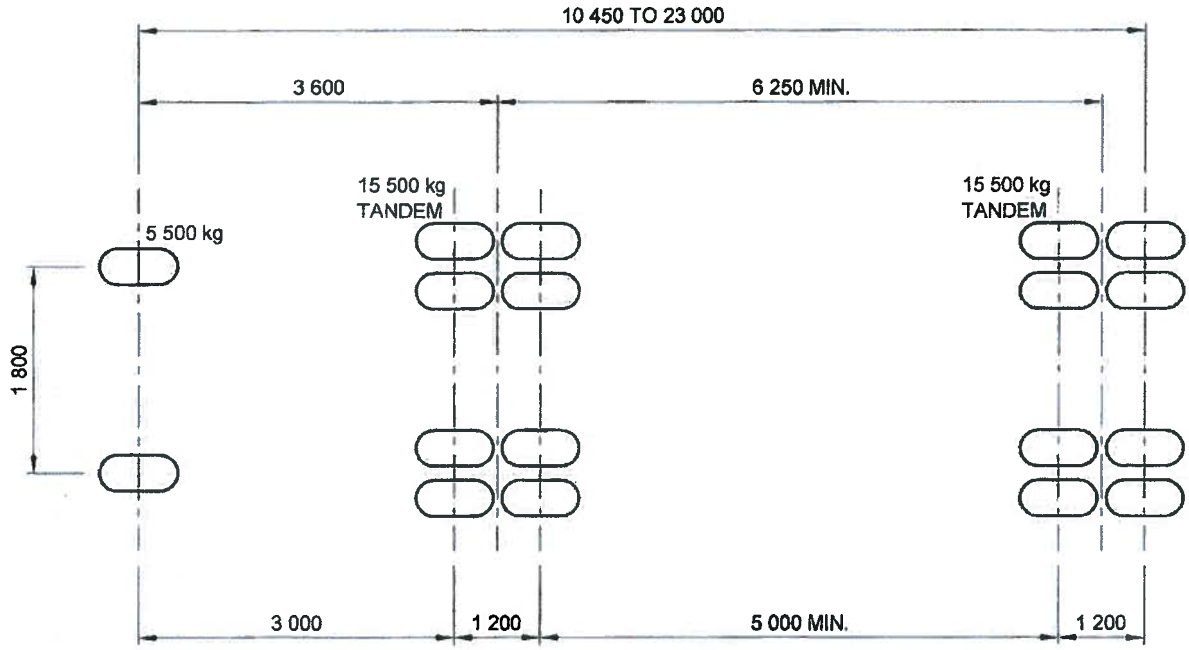

CSA CL-625 LANE LOAD

| | | |
|---|---|---|
| Winnipeg<br>THE CITY OF WINNIPEG<br>PUBLIC WORKS DEPARTMENT | LIVE LOAD VEHICLES | MORRISON HERSHFIELD |
| Portage Avenue<br>Twin Bridges<br>over<br>Sturgeon Creek | CSA S6-06 DESIGN LOADING<br>CL-625 TRUCK / LANE | PROJ. NO. 07-8164<br>SCALE: N.T.S.<br>DATE: MAY 2011<br>PLATE NO. 1 |



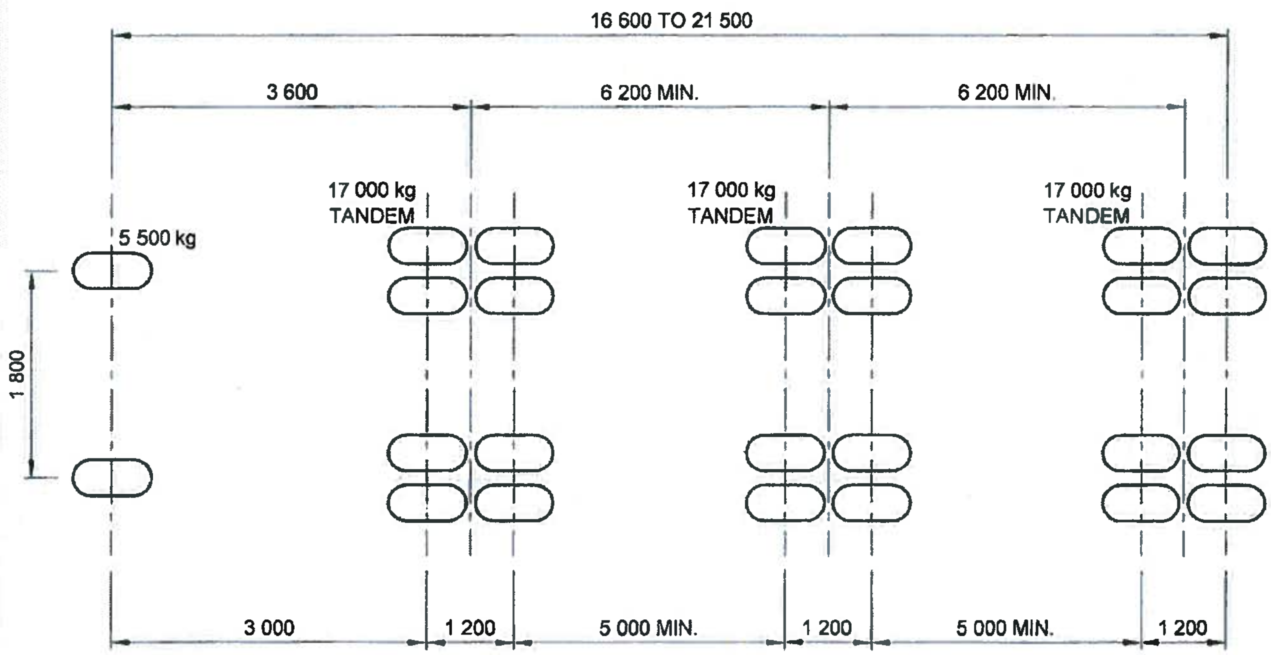

HSS - 25 TRUCK

| | | |
|---|---|---|
| THE CITY OF WINNIPEG<br>PUBLIC WORKS DEPARTMENT | LIVE LOAD VEHICLES | MORRISON HERSHFIELD |
| Portage Avenue<br>Twin Bridges<br>over<br>Sturgeon Creek | AASHTO HSS DESIGN TRUCK | PROJ. NO. 07-8164<br>SCALE: N.T.S.<br>DATE: MAY 2011<br><br>PLATE NO. 2 |



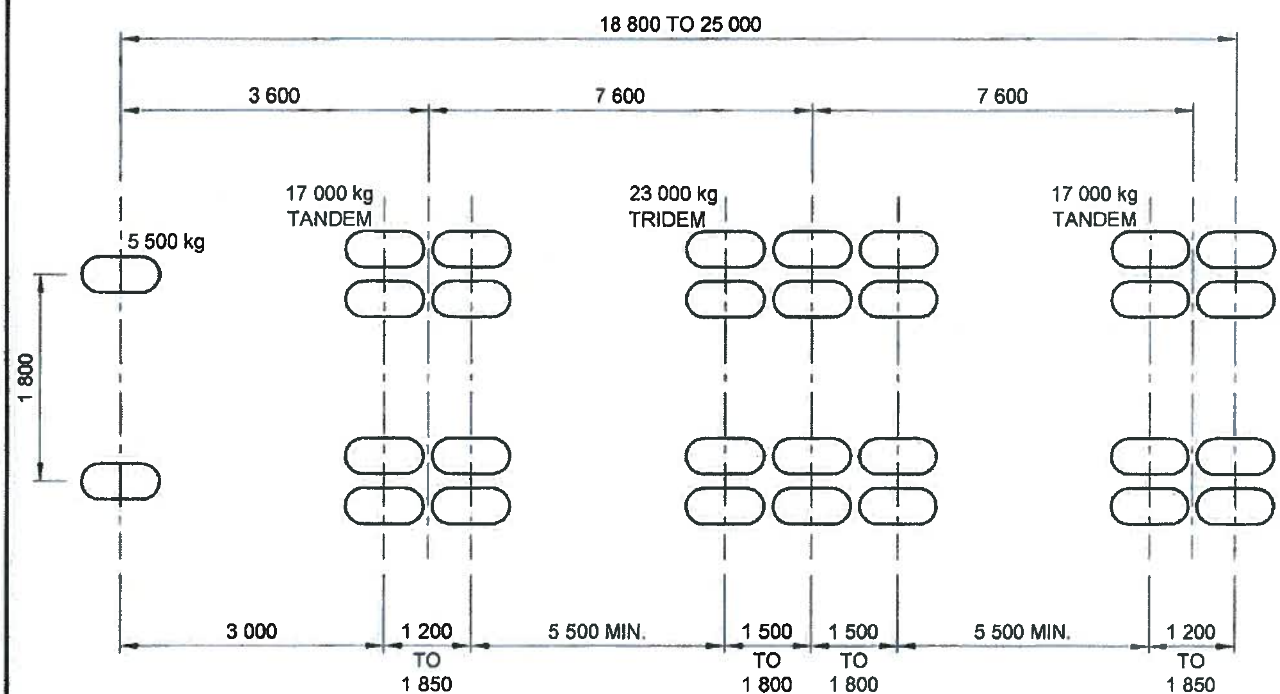

36 500 kg G.V.W. SEMI - TRAILER TRUCK

| | | |
|---|---|---|
| Winnipeg<br>THE CITY OF WINNIPEG<br>PUBLIC WORKS DEPARTMENT | LIVE LOAD VEHICLES | MORRISON HERSHFIELD |
| Portage Avenue<br>Twin Bridges<br>over<br>Sturgeon Creek | LEGAL TRUCK<br>36 500 kg G.V.W. | PROJ. NO. 07-8164<br>SCALE: N.T.S.<br>DATE: MAY 2011<br>PLATE NO. 3 |



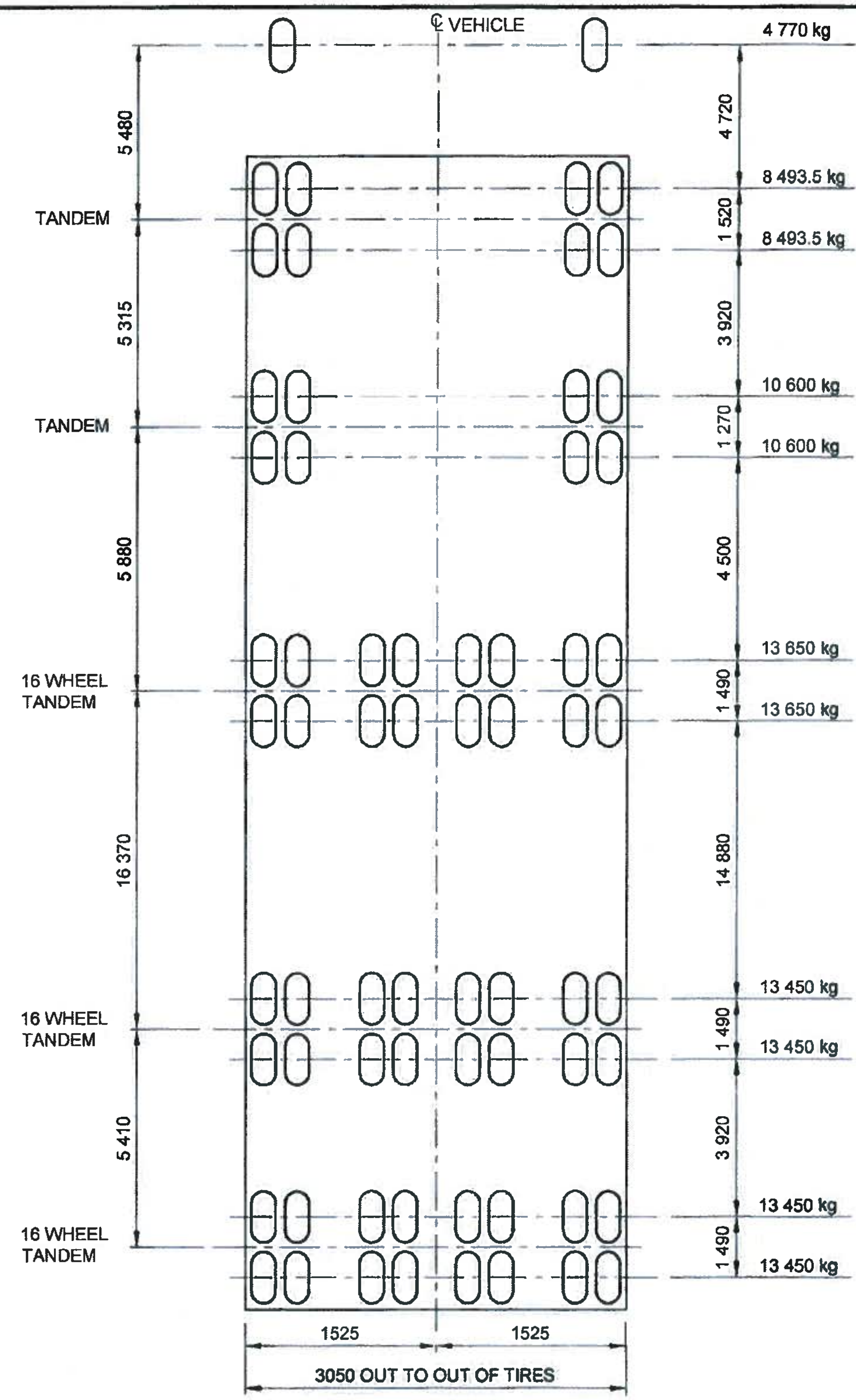

## 56 500 kg G.V.W. SEMI - TRAILER COMBINATION
## (B - TRAIN LEGAL TAC)

| | | |
|---|---|---|
| THE CITY OF WINNIPEG<br>PUBLIC WORKS DEPARTMENT | LIVE LOAD VEHICLES | MORRISON HERSHFIELD |
| Portage Avenue<br>Twin Bridges<br>over<br>Sturgeon Creek | LEGAL TRUCK<br>56 500 kg G.V.W. | PROJ. NO. 07-8164<br>SCALE: N.T.S.<br>DATE: MAY 2011<br>PLATE NO. 4 |



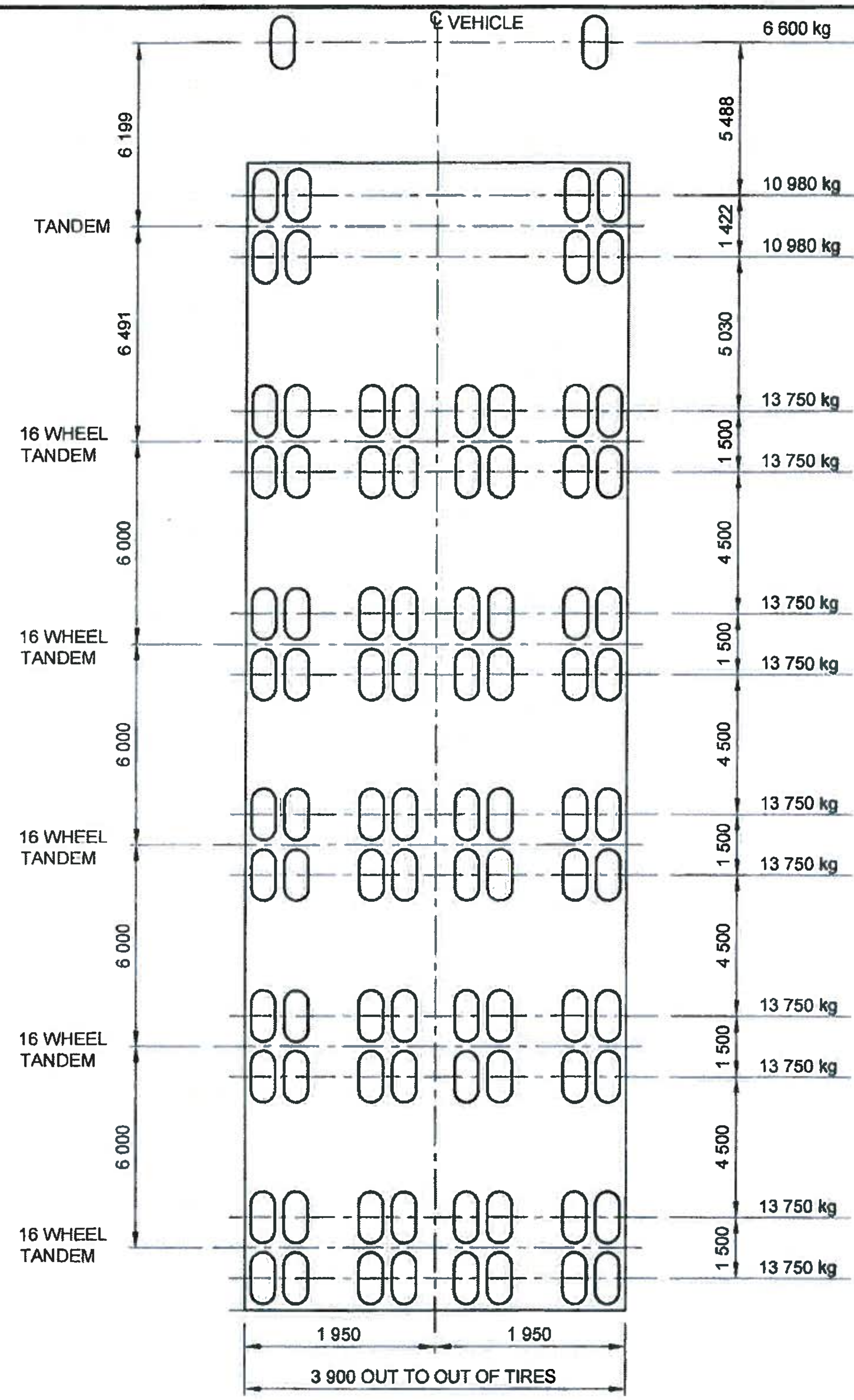

## 62 500 kg G.V.W. SEMI - TRAILER COMBINATION
## (B - TRAIN LEGAL TAC)

| | | |
|---|---|---|
| Winnipeg<br>THE CITY OF WINNIPEG<br>PUBLIC WORKS DEPARTMENT | LIVE LOAD VEHICLES | MORRISON HERSHFIELD |
| Portage Avenue<br>Twin Bridges<br>over<br>Sturgeon Creek | LEGAL TRUCK<br>62 500 kg G.V.W. | PROJ. NO. 07-8164<br>SCALE: N.T.S.<br>DATE: MAY 2011<br>PLATE NO. 5 |



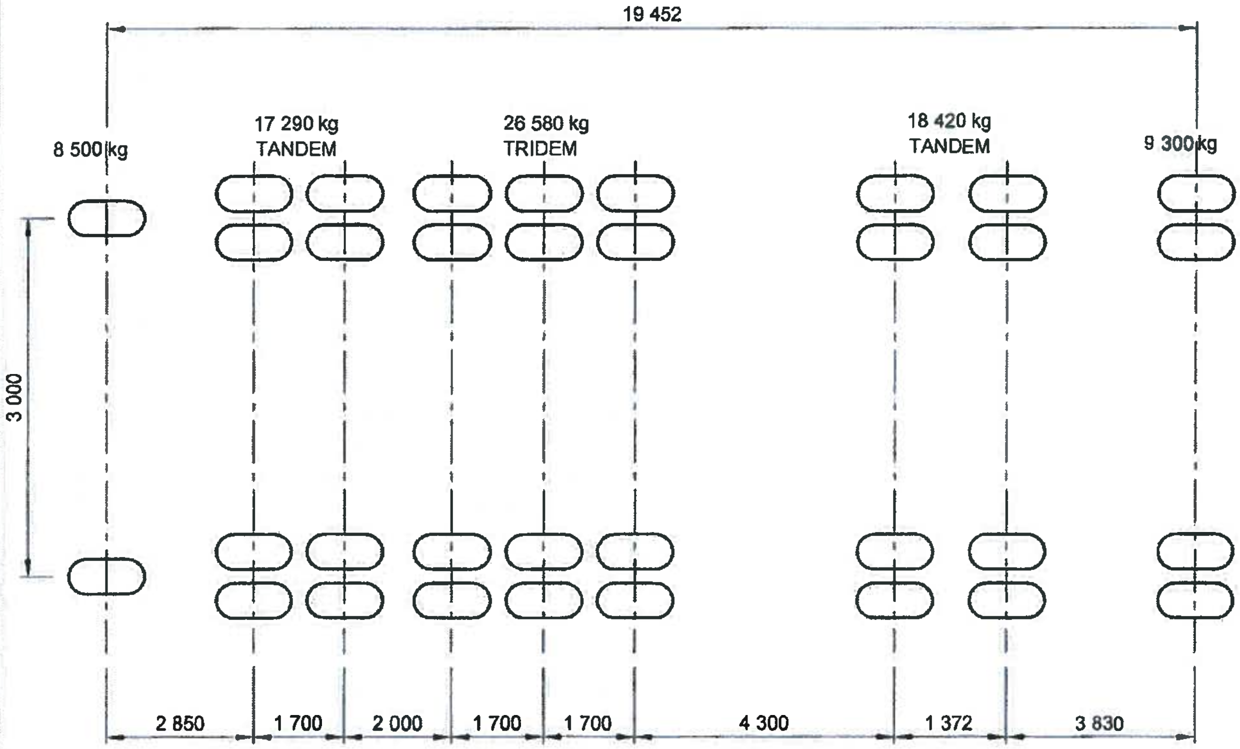

## 124 057 kg OVERLOAD VEHICLE

| | | |
|---|---|---|
| Winnipeg<br>THE CITY OF WINNIPEG<br>PUBLIC WORKS DEPARTMENT | LIVE LOAD VEHICLES | MORRISON HERSHFIELD |
| Portage Avenue<br>Twin Bridges<br>over<br>Sturgeon Creek | 124 057 kg OVERLOAD<br>VEHICLE | PROJ. NO. 07-8164<br>SCALE: N.T.S.<br>DATE: MAY 2011<br>PLATE NO. 6 |




## 124 057 kg OVERLOAD VEHICLE

| | | |
|---|---|---|
| Winnipeg<br>THE CITY OF WINNIPEG<br>PUBLIC WORKS DEPARTMENT | LIVE LOAD VEHICLES | MORRISON HERSHFIELD |
| Portage Avenue<br>Twin Bridges<br>over<br>Sturgeon Creek | 166 080 kg OVERLOAD VEHICLE<br>SCHEUERLE CONFIGURATION | PROJ. NO 07-8164<br>SCALE: N.T.S.<br>DATE: MAY 2011<br>PLATE NO. 7 |




## 81 090 kg MOBILE CRANE LIEBHERR 1160

| | | |
|---|---|---|
| THE CITY OF WINNIPEG<br>PUBLIC WORKS DEPARTMENT | LIVE LOAD VEHICLES | MORRISON HERSHFIELD |
| Portage Avenue<br>Twin Bridges<br>over<br>Sturgeon Creek | MOBILE CRANE<br>81 090 kg LIEBHERR 1160 | PROJ. NO. 07-8164<br>SCALE: N.T.S.<br>DATE: MAY 2011<br>PLATE NO. 8 |

# APPENDIX C: STRUCTURAL EVALUATION CALCULATIONS

**1. Design Criteria**

| | |
|---|---|
| Canadian Highway Bridge Design Code | S6-06 |

**2. Load Type**

| | |
|---|---|
| Dead Load (DL): | precast pre-stressed concrete box cell girder, cast-in-place concrete deck |
| Superimposed Dead Load (SDL): | high density concrete overlay, sidewalk and median, concrete barrier |
| Live Load (LL): | See Appendix B for normal and alternative live load vehicles, mobile crane and overload vehicles |

**3. Material Properties**

| | | | | |
|---|---|---|---|---|
| | | | | Contract Drawings B178-80-02 & 19 |
| Structural Concrete | $f_c$ | 12 | MPa | |
| | $f'_c$ | 30 | MPa | |
| Reinforcing Steel (hard grade) | $f_y$ | 400 | MPa | |
| Precast Prestressed Concrete | | | | |
| Concrete | $f'_{ci}$ | 30 | MPa | |
| | $f'_c$ | 35 | MPa | |
| Reinforcing Steel | $f_y$ | 300 | MPa | |
| Prestressing Steel | $f'_s$ | 1860 | MPa | |
| Dia of prestressing strand | | 13 | mm | |
| Intial force in prestressing strand | $p_i$ | 128.6 | kN | |

**4. Evaluation Parameter**

| | | | | |
|---|---|---|---|---|
| System Behaviour: | | S2 | | |
| Element Behaviour: | | E2 | | |
| Inspection Level: | | INSP1 | | |
| Target Reliability Index: | | $\beta$ | 3.5 | |
| ***Load Factors:*** | | | | |
| Dead Load: | | | | Table 14.7 |
| Factory produced concrete | | D1 | 1.09 | |
| Cast-in-place concrete and non-structural products | | D2 | 1.18 | |
| Live Load: | | | | |
| Normal Traffic or alternative loading | | | | Table 14.9 |
| Short Span | | $\alpha_{Ls}$ | 2.2 | |
| Other Span | | $\alpha_{Ll}$ | 1.63 | |
| Permit - Annual or project (PA) | | | | Table 14.10 |
| Short Span | | $\alpha_{Ls}$ | 1.78 | |
| Other Span | | $\alpha_{Ll}$ | 1.53 | |
| Short Span: Moment L < 10m, Shear L < 6m | | | | |
| Dynamic Load Factor | | | | |
| Normal traffic and alternative loading | | DLA | 0.3 | 3.8.4.5 & 14.9.3 (d) |
| Permit vehicle (Overload vehicles) | 0.3 | * DLA = $DLA_P$ | 0.09 | 14.9.3 (a) |

**5. Load Distribution Factor**

| Description | | Span 1 & 3 (L1) | | Pier 1 & 2 | | Span 2 (L2) | | |
|---|---|---|---|---|---|---|---|---|
| | | Exterior | Interior | Exterior | Interior | Exterior | Interior | |
| Total width of bridge (m) | B | 18.29 | 18.29 | 18.29 | 18.29 | 18.29 | 18.29 | |
| Total width of design lanes (m) | Wc | 14.02 | 14.02 | 14.02 | 14.02 | 14.02 | 14.02 | |
| Number of design lane | n | 4 | 4 | 4 | 4 | 4 | 4 | |
| Design lane width (m) | $W_e = W_c / n$ | 3.505 | 3.505 | 3.505 | 3.505 | 3.505 | 3.505 | |
| Multi-lane modification factor - normal traffic | $R_L$ | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | Table 3.5 |
| Lane width modification factor | μ = (We -3.3)/ 0.6 <= 1.0 | 0.34 | 0.34 | 0.34 | 0.34 | 0.34 | 0.34 | |
| Span length (m) | L1 or L2 | 9.966 | 9.966 | | | 18.000 | 18.000 | |
| Effective span length (m) | L | 7.97 | 7.97 | 6.99 | 6.99 | 10.80 | 10.80 | Fig A5.1.1 |
| ***Factors for longitudinal moments*** | | | | | | | | |
| Load distribution for width dimension | F | 12.17 | 11.86 | 11.92 | 11.32 | 12.82 | 13.37 | Table 5.3 |
| Correction factor to adjust F | $C_f$ | 12.24 | 12.24 | 11.71 | 11.71 | 13.22 | 13.22 | Table 5.3 |
| ***Moment Amplification Factor*** | **$F_m$ = B / [F * {1 + $\mu C_f$ / 100}] >= 1.05** | **1.44** | **1.48** | **1.48** | **1.55** | **1.37** | **1.31** | |
| ***Factors for longitudinal shear*** | | | | | | | | |
| Voided slab - c/c spacing of long web lines (S < 2.0m) | S | 1.219 | 1.219 | 1.219 | 1.219 | 1.219 | 1.219 | |
| Load distribution for width dimension (n <= 4) | F * (S/2)^0.25 | 8.66 | 8.66 | 8.66 | 8.66 | 8.66 | 8.66 | 5.7.1.4.1.2(b) |
| ***Shear Amplification Factor*** | **$F_v$ = B / F >= 1.05** | **2.11** | **2.11** | **2.11** | **2.11** | **2.11** | **2.11** | |
| **USL and SLS-1** | | | | | | | | |
| **Normal Traffic** | | | | | | | | |
| ***Truck Load / m width of voided slab for moment*** | **$F_m$ * n * $R_L$ / B** | **0.22** | **0.23** | **0.23** | **0.24** | **0.21** | **0.20** | |
| ***Truck Load / m width of voided slab for shear*** | **Fv * n * $R_L$ / B** | **0.32** | **0.32** | **0.32** | **0.32** | **0.32** | **0.32** | |

**6. Loads and Analysis Summary**

| | | |
|---|---|---|
| Unit weight of concrete | 24 | kN / $m^3$ |
| Unit weight of prestressed concrete | 24.5 | kN / $m^3$ |
| **Dead Loads** | | |
| Box Cell Girder | 10.4 | kN / m |
| CIP Concrete Deck | 1.95 | kN / m |
| **Superimposed Dead Loads** | | |
| Concrete Overlay | 0.98 | kN / m |
| Sidewalk | 1.45 | kN / m |
| Median | 1.02 | kN / m |
| Barrier | 0.47 | kN / m |
| | 3.91 | kN / m |

The spans are considered as semi-continuous with girders and wet deck loads acting as loads on simple spans and superimposed dead loads and live loads acting as loads on continuous span.

**Span 1 & 3** L1 = 9.966 m

| Dead Load | Load Factor | UDL | Unfactored / m width M | - M | V | Factored / m width $M_{ULS}$ | - $M_{ULS}$ | $V_{ULS}$ |
|---|---|---|---|---|---|---|---|---|
| | | kN / m | kN-m | kN-m | kN | kN-m | kN-m | kN |
| Box Cell Girder | 1.09 | 10.4 | 129 | 0 | 74 | 140.7 | 0.0 | 80.7 |
| CIP Concrete Deck | 1.18 | 1.95 | 24 | 0 | 12 | 26.4 | 0.0 | 13.1 |
| Overlay, barrier, median, sidewalk | 1.18 | 3.91 | 11 | -91 | 24 | 13.0 | -107.4 | 28.3 |

| Live Load | Load Factor Short Span | Other Span | Unfactored per lane (SAP2000 Analysis) M | - M | V | Factored per lane $M_{ULS}$ | - $M_{ULS}$ | $V_{ULS}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | $= \alpha_{Ls} * M$ | $= \alpha Ls * (- M)$ | $= \alpha_{Ll} * V$ |
| | $\alpha_{Ls}$ | $\alpha_{Ll}$ | kN-m | kN-m | kN | kN-m | kN-m | kN |
| **Design Truck** | | | | | | | | |
| HS - 30 Truck (AASHTO) | 2.2 | 1.63 | 486 | -761 | 360 | 1069 | -1674 | 587 |
| **Normal Traffic and alternative loading** | | | | | | | | |
| CL1-625 | 2.2 | 1.63 | 231 | -727 | 314 | 508 | -1599 | 512 |
| CL2-625 | 2.2 | 1.63 | 358 | -635 | 299 | 788 | -1397 | 487 |
| CL3-625 | 2.2 | 1.63 | 457 | -513 | 266 | 1005 | -1129 | 434 |
| CL1-625 Lane Load | 2.2 | 1.63 | 216 | -785 | 314 | 475 | -1727 | 512 |
| CL2-625 Lane Load | 2.2 | 1.63 | 364 | -704 | 293 | 801 | -1549 | 478 |
| CL3-625 Lane Load | 2.2 | 1.63 | 423 | -543 | 259 | 931 | -1195 | 422 |
| HSS - 25 Truck (AASHTO) | 2.2 | 1.63 | 393 | -801 | 333 | 865 | -1762 | 543 |
| 36 500 kg G.V.W. Legal Truck | 2.2 | 1.63 | 283 | -512 | 224 | 623 | -1126 | 365 |
| 56 500 kg G.V.W. Legal Truck | 2.2 | 1.63 | 213 | -664 | 279 | 469 | -1461 | 455 |
| 62 500 kg G.V.W. Legal Truck | 2.2 | 1.63 | 179 | -696 | 307 | 394 | -1531 | 500 |
| **Overload Vehicle** | | | | | | | | |
| 124 057 kg Overload vehicle | 1.78 | 1.53 | 360 | -668 | 315 | 641 | -1189 | 482 |
| 166 080 kg Overload vehicle | 1.78 | 1.53 | 69 | -1080 | 334 | 123 | -1922 | 511 |
| 81 090 kg Liebherr 1160 | 1.78 | 1.53 | 172 | -938 | 427 | 306 | -1670 | 653 |

| Live Load | | DLA | Distribution Factors / m width M | - M | V | Factored Truck Load / m width $M_{ULS}$ | - $M_{ULS}$ | $V_{ULS}$ |
|---|---|---|---|---|---|---|---|---|
| | | $\alpha_{Ll}$ | | | | kN-m | kN-m | kN |
| **Design Truck** | | | | | | | | |
| HSS - 30 Truck (AASHTO) | | 0.3 | 0.21 | 0.24 | 0.32 | **292** | -522 | 244 |
| **Normal Traffic and alternative loading** | | | | | | | | |
| CL1-625 | | 0.3 | 0.21 | 0.24 | 0.32 | 139 | -499 | 213 |
| CL2-625 | | 0.3 | 0.21 | 0.24 | 0.32 | 215 | -436 | 203 |
| CL3-625 | | 0.3 | 0.21 | 0.24 | 0.32 | 274 | -352 | 180 |
| CL1-625 Lane Load | | 0 | 0.21 | 0.24 | 0.32 | 100 | -414 | 164 |
| CL2-625 Lane Load | | 0 | 0.21 | 0.24 | 0.32 | 168 | -372 | 153 |
| CL3-625 Lane Load | | 0 | 0.21 | 0.24 | 0.32 | 195 | -287 | 135 |
| HSS - 25 Truck (AASHTO) | | 0.3 | 0.21 | 0.24 | 0.32 | 236 | -550 | 226 |
| 36 500 kg G.V.W. Legal Truck | | 0.3 | 0.21 | 0.24 | 0.32 | 170 | -351 | 152 |
| 56 500 kg G.V.W. Legal Truck | | 0.3 | 0.21 | 0.24 | 0.32 | 128 | -456 | 189 |
| 62 500 kg G.V.W. Legal Truck | | 0.3 | 0.21 | 0.24 | 0.32 | 108 | -478 | 208 |
| **Overload Vehicle** | | | | | | | | |
| 124 057 kg Overload vehicle | | 0.09 | 0.32 | 0.34 | 0.46 | 226 | -441 | 243 |
| 166 080 kg Overload vehicle | | 0.09 | 0.32 | 0.34 | 0.46 | 43 | **-712** | 257 |
| 81 090 kg Liebherr 1160 | | 0.09 | 0.32 | 0.34 | 0.46 | 108 | -619 | **329** |
| | | | | | Max Live Load | 292 | -712 | 329 |
| **Total DL1 + DL2 + LL (1+DLA)** | | | | | | **472** | **-820** | **451** |

**Span 2** L1 = 18 m

| Dead Load | Load Factor | UDL kN / m | Unfactored / m width M kN-m | - M kN-m | V kN | Factored / m width $M_{ULS}$ kN-m | $-M_{ULS}$ kN-m | $V_{ULS}$ kN |
|---|---|---|---|---|---|---|---|---|
| Box Cell Girder | 1.09 | 10.4 | 421 | 0 | 94 | 459.1 | 0.0 | 102.5 |
| CIP Concrete Deck | 1.18 | 1.95 | 79 | 0 | 18 | 86.1 | 0.0 | 19.6 |
| Overlay, barrier, median, sidewalk | 1.18 | 3.91 | 70 | -91 | 36 | 82.6 | -107.4 | 42.5 |

| Live Load | Load Factor Short Span $\alpha_{Ls}$ | Other Span $\alpha_{Ll}$ | Unfactored per lane M kN-m | - M kN-m | V kN | Factored per lane $M_{ULS} = \alpha_{Ls}$ * M kN-m | $-M_{ULS}$ = αLs * (- M) kN-m | $V_{ULS} = \alpha_{Ll}$ * V kN |
|---|---|---|---|---|---|---|---|---|
| **Design Truck** | | | | | | | | |
| HS - 30 Truck (AASHTO) | 2.2 | 1.63 | 921 | -761 | 422 | 1501 | -1240 | 688 |
| **Normal Traffic and alternative loading** | | | | | | | | |
| CL1-625 | 2.2 | 1.63 | 737 | -727 | 371 | 1201 | -1185 | 605 |
| CL2-625 | 2.2 | 1.63 | 770 | -635 | 348 | 1255 | -1035 | 567 |
| CL3-625 | 2.2 | 1.63 | 709 | -513 | 283 | 1156 | -836 | 461 |
| CL1-625 Lane Load | 2.2 | 1.63 | 761 | -758 | 378 | 1240 | -1236 | 616 |
| CL2-625 Lane Load | 2.2 | 1.63 | 789 | -704 | 356 | 1286 | -1148 | 580 |
| CL3-625 Lane Load | 2.2 | 1.63 | 678 | -543 | 304 | 1105 | -885 | 496 |
| HSS - 25 Truck (AASHTO) | 2.2 | 1.63 | 924 | -801 | 435 | 1506 | -1306 | 709 |
| 36 500 kg G.V.W. Legal Truck | 2.2 | 1.63 | 594 | -512 | 286 | 968 | -835 | 466 |
| 56 500 kg G.V.W. Legal Truck | 2.2 | 1.63 | 660 | -664 | 338 | 1076 | -1082 | 551 |
| 62 500 kg G.V.W. Legal Truck | 2.2 | 1.63 | 732 | -696 | 354 | 1193 | -1134 | 577 |
| **Overload Vehicle** | | | | | | | | |
| 124 057 kg Overload vehicle | 1.78 | 1.53 | 564 | -668 | 384 | 863 | -1022 | 588 |
| 166 080 kg Overload vehicle | 1.78 | 1.53 | 918 | -1080 | 430 | 1405 | -1652 | 658 |
| 81 090 kg Liebherr 1160 | 1.78 | 1.53 | 1007 | -938 | 459 | 1541 | -1435 | 702 |

| Live Load | | DLA $\alpha_{Ll}$ | Distribution Factors / m width M | - M | V | Factored Truck Load / m width $M_{ULS}$ kN-m | $-M_{ULS}$ kN-m | $V_{ULS}$ kN |
|---|---|---|---|---|---|---|---|---|
| **Design Truck** | | | | | | | | |
| HSS - 30 Truck (AASHTO) | | 0.3 | 0.23 | 0.24 | 0.32 | 449 | -387 | 286 |
| **Normal Traffic and alternative loading** | | | | | | | | |
| CL1-625 | | 0.3 | 0.23 | 0.24 | 0.32 | 359 | -370 | 252 |
| CL2-625 | | 0.3 | 0.23 | 0.24 | 0.32 | 375 | -323 | 236 |
| CL3-625 | | 0.3 | 0.23 | 0.24 | 0.32 | 346 | -261 | 192 |
| CL1-625 Lane Load | | 0 | 0.23 | 0.24 | 0.32 | 285 | -297 | 197 |
| CL2-625 Lane Load | | 0 | 0.23 | 0.24 | 0.32 | 296 | -275 | 186 |
| CL3-625 Lane Load | | 0 | 0.23 | 0.24 | 0.32 | 254 | -212 | 159 |
| HSS - 25 Truck (AASHTO) | | 0.3 | 0.23 | 0.24 | 0.32 | 450 | -407 | 295 |
| 36 500 kg G.V.W. Legal Truck | | 0.3 | 0.23 | 0.24 | 0.32 | 289 | -260 | 194 |
| 56 500 kg G.V.W. Legal Truck | | 0.3 | 0.23 | 0.24 | 0.32 | 322 | -338 | 229 |
| 62 500 kg G.V.W. Legal Truck | | 0.3 | 0.23 | 0.24 | 0.32 | 357 | -354 | 240 |
| **Overload Vehicle** | | | | | | | | |
| 124 057 kg Overload vehicle | | 0.09 | 0.32 | 0.34 | 0.46 | 304 | -379 | 296 |
| 166 080 kg Overload vehicle | | 0.09 | 0.32 | 0.34 | 0.46 | 495 | **-612** | 331 |
| 81 090 kg Liebherr 1160 | | 0.09 | 0.32 | 0.34 | 0.46 | **543** | -532 | **354** |
| | | | | | Max Live Load | 543 | -612 | 354 |

**Total DL1 + DL2 + LL (1+DLA)** **1171** **-720** **518**

**7. Summary**

| Location | | Flexure | | | Shear | | |
|---|---|---|---|---|---|---|---|
| | | $M_f$ kN-m | $M_r$ kN-m | $M_r / M_f$ | $V_f$ kN | $V_r$ kN | $V_{r / Vf}$ |
| At Mid Span | Span 1 & 3 | 472 | 798 | 1.691 | | | |
| | Span 2 | 1171 | 1314 | 1.122 | | | |
| At Supports | | -820 | -914 | 1.115 | 518 | 1013 | 1.955 |

**Material Properties**

| | | | | |
|---|---|---|---|---|
| Precast box cell concrete girder | | | | |
| Concrete | | $f'_c$ | 35 | MPa |
| Prestressed steel | | $f_{pu}$ | 1860 | MPa |
| Reinforcing steel | | $f_y$ | 300 | MPa |
| Type of prestressing steel | | | low relaxation | |
| Structural concrete (deck, barrier, etc.) | | | | |
| Concrete | | $f'_c$ | 30 | MPa |
| Reinforcing steel | | $f_y$ | 400 | MPa |

**Resistance factors** Table 8.1

| | | | |
|---|---|---|---|
| Concrete | $\phi_c$ | 0.75 | |
| Prestress steel | $\phi_p$ | 0.95 | |
| Reinforcing steel | $\phi_s$ | 0.9 | |

**Dimensions**

| | | | | |
|---|---|---|---|---|
| Top flange width | | $b_t$ | 1219 | mm |
| Top flange thickness | | $h_t$ | 153 | mm |
| Web thickness | | $b_w$ | 306 | mm |
| Bottom flange width | | $b_b$ | 1219 | mm |
| Bottom flange thickness | | $h_b$ | 153 | mm |
| Total depth | | d | 610 | mm |
| Prestressing strand | 13 mm dia | $A_{ps}$ | 98 | $mm^2$ |
| Total number of strands | | | 16 | |
| Reinforcing steel | | | | |
| | 10M | $A_{s10}$ | 100 | $mm^2$ |
| | 25M | $A_{s25}$ | 500 | $mm^2$ |

***Distance from top of concrete***

| | | | |
|---|---|---|---|
| Bottom prestress steel | | | |
| layer 1 | $d_{p1}$ | 559 | mm |
| layer 2 | $d_{p2}$ | 508 | mm |
| layer 3 | $d_{p3}$ | 457 | mm |
| Top prestressing steel | $d'_p$ | 101 | mm |
| Bottom reinforcing steel | $d_s$ | 565 | mm |
| Top reinforcing steel | | | |
| layer 1 | $d'_{s1}$ | 45 | mm |
| layer 2 | $d'_{s2}$ | 108 | mm |

***Area of steel***

| | | | | | |
|---|---|---|---|---|---|
| Bottom prestress steel | | | | | |
| layer 1 | 6 | strands | $A_{ps1}$ | 588 | $mm^2$ |
| layer 2 | 6 | strands | $A_{ps2}$ | 588 | $mm^2$ |
| layer 3 | 2 | strands | $A_{ps3}$ | 196 | $mm^2$ |
| Top prestressing steel | 2 | strands | $A'_{ps}$ | 196 | $mm^2$ |
| Bottom reinforcing steel | 3 | 10M | $A_s$ | 300 | $mm^2$ |
| Top reinforcing steel | | | | | |
| layer 1 | 5 | 10M | $A'_{s1}$ | 500 | $mm^2$ |
| layer 2 | 4 | 10M | $A'_{s2}$ | 400 | $mm^2$ |

**<u>Calculations</u>**

| | | | | |
|---|---|---|---|---|
| $\alpha_1$ | $=0.85 - 0.0015 * f'_c$ | 0.798 | | |
| $\beta_1$ | $= 0.97 - 0.0025 * f'_c$ | 0.883 | | |
| $c / d_p$ | <= 0.5 | | | 8.8.4.2 |
| $f_{ps}$ | $= f_{pu} * (1 - k_p * c / d_p)$ | 1,704 | MPa | |
| $k_p$ | = 0.3 for low-relaxation strand | 0.3 | | |
| | = 0.4 for smooth high-strength bars | | | |
| | = 0.5 for deformed high strength bars | | | |

$c / d_p$ = {φp * Aps * fpu + φs * As * fy - ϕp * A'ps * fpu - φs * A's * fy - α1 * φc * f'c * ht * (b - bw)} / {α1 * φc * β1 * f'c * bw * dp + φp * kp * Aps * fpu}

-0.280 **OK**

| | | | | |
|---|---|---|---|---|
| $f_{ps}$ | $= f_{pu} [1 - 0.5 * (\mu_p * f_{pu} / f_c)]$ | 1,581 | MPa | 14.14.1.2.4 |
| $\mu_p$ | $= A_{sp} / A_c$ | 0.006 | | |

a = {φp * Aps * fps + φs * As * fy - ϕp * A'ps * fps - φs * A's * fy - α1 * φc * f'c * ht * (b - bw)} / {α1 * φc * f'c * bw }

-185 mm

185 mm

Mr = φp * Aps * fps * (dp - a/2) + φs * As * fy * (ds - a/2) - ϕp * A'ps * fps (d'p- a/2) - φs * A's * fy * (d - d's) - α1 * φc * f'c * ht * (b - bw) * (ht - a/2)

| | | | | |
|---|---|---|---|---|
| $f_{ps} =$ 1,704 MPa | 1,042 | kN-m | | |
| | **855** | **kN-m / m width** | | |
| $f_{ps} =$ 1,581 MPa | 973 | kN-m | | |
| | **798** | **kN-m / m width** | **Use** | |

**Material Properties**

| | | | | |
|---|---|---|---|---|
| Precast box cell concrete girder | | | | |
| Concrete | | $f'_c$ | 35 | MPa |
| Prestressed steel | | $f_{pu}$ | 1860 | MPa |
| Reinforcing steel | | $f_y$ | 300 | MPa |
| Type of prestressing steel | | | low relaxation | |
| Structural concrete (deck, barrier, etc.) | | | | |
| Concrete | | $f'_c$ | 30 | MPa |
| Reinforcing steel | | $f_y$ | 400 | MPa |

**Resistance factors** — Table 8.1

| | | | | |
|---|---|---|---|---|
| Concrete | | $\phi_c$ | 0.75 | |
| Prestress steel | | $\phi_p$ | 0.95 | |
| Reinforcing steel | | $\phi_s$ | 0.9 | |

**Dimensions**

| | | | | |
|---|---|---|---|---|
| Top flange width | | $b_t$ | 1219 | mm |
| Top flange thickness | | $h_t$ | 153 | mm |
| Web thickness | | $b_w$ | 306 | mm |
| Bottom flange width | | $b_b$ | 1219 | mm |
| Bottom flange thickness | | $h_b$ | 153 | mm |
| Total depth | | d | 610 | mm |
| Prestressing strand | 13 mm dia | $A_{ps}$ | 98 | $mm^2$ |
| Total number of strands | | | 28 | |
| Reinforcing steel | | | | |
| | 10M | $A_{s10}$ | 100 | $mm^2$ |
| | 25M | $A_{s25}$ | 500 | $mm^2$ |

***Distance from top of concrete***

| | | | | |
|---|---|---|---|---|
| Bottom prestress steel | | | | |
| layer 1 | | $d_{p1}$ | 559 | mm |
| layer 2 | | $d_{p2}$ | 508 | mm |
| layer 3 | | $d_{p3}$ | 457 | mm |
| layer 4 | | $d_{p4}$ | 406 | mm |
| Bottom reinforcing steel | | $d_s$ | 565 | mm |
| Top reinforcing steel | | | | |
| layer 1 | | $d'_{s1}$ | 45 | mm |
| layer 2 | | $d'_{s2}$ | 108 | mm |

***Area of steel***

| | | | | | |
|---|---|---|---|---|---|
| Bottom prestress steel | | | | | |
| layer 1 | 12 | strands | $A_{ps1}$ | 1176 | $mm^2$ |
| layer 2 | 10 | strands | $A_{ps2}$ | 980 | $mm^2$ |
| layer 3 | 4 | strands | $A_{ps3}$ | 392 | $mm^2$ |
| layer 4 | 2 | | $A_{ps4}$ | 196 | $mm^2$ |
| Bottom reinforcing steel | 3 | 10M | $A_s$ | 300 | $mm^2$ |
| Top reinforcing steel | | | | | |
| layer 1 | 5 | 10M | $A'_{s1}$ | 500 | $mm^2$ |
| layer 2 | 4 | 10M | $A'_{s2}$ | 400 | $mm^2$ |

**Calculations**

| | | | | |
|---|---|---|---|---|
| $\alpha_1$ | =0.85 - 0.0015 * $f'_c$ | 0.798 | | |
| $\beta_1$ | = 0.97 - 0.0025 * $f'_c$ | 0.883 | | |
| $c / d_p$ | <= 0.5 | | | 8.8.4.2 |
| $f_{ps}$ | = $f_{pu}$ * (1 - $k_p$ * c / $d_p$) | 1,633 | MPa | |
| $k_p$ | = 0.3 for low-relaxation strand | 0.3 | | |
| | = 0.4 for smooth high-strength bars | | | |
| | = 0.5 for deformed high strength bars | | | |

$c / d_p$ = {φp * Aps * fpu + φs * As * fy - φs * A's * fy - α1 * φc * f'c * ht * (b - bw)} / {α1 * φc * β1 * f'c * bw * dp + φp * kp * Aps * fpu}

0.407 **OK**

| | | | | |
|---|---|---|---|---|
| $f_{ps}$ | = $f_{pu}$ [1 - 0.5 * ($\mu_p$ * $f_{pu}$ / $f'_c$)] | 1,371 | MPa | 14.14.1.2.4 |
| $\mu_p$ | = $A_{sp}$ / $A_c$ | 0.010 | | |

a = {φp * Aps * fps + φs * As * fy - φs * A's * fy - α1 * φc * f'c * ht * (b - bw)} / {α1 * φc * f'c * bw }

183 mm

183 mm

Mr = φp * Aps * fps * (dp - a/2) + φs * As * fy * (ds - a/2) - φs * A's * fy * (d - d's) - α1 * φc * f'c * ht * (b - bw) * (ht - a/2)

| | | | | | |
|---|---|---|---|---|---|
| $f_{ps}$ = | 1,633 MPa | 1,891 | kN-m | | |
| | | **1551** | **kN-m / m width** | | |
| $f_{ps}$ = | 1,371 MPa | 1,602 | kN-m | | |
| | | **1314** | **kN-m / m width** | **Use** | |

**Material Properties**

| | | | | |
|---|---|---|---|---|
| Prestressed concrete | | $f'_c$ | 35 | MPa |
| Prestressed steel | | $f_{pu}$ | 1860 | MPa |
| Reinforcing steel | | $f_y$ | 300 | MPa |
| Type of prestressing steel | | | low relaxation | |
| Structural concrete (deck, barrier, etc.) | | | | |
| Concrete | | $f'_c$ | 30 | MPa |
| Reinforcing steel | | $f_y$ | 400 | MPa |

**Resistance factors** Table 8.1

| | | | | |
|---|---|---|---|---|
| Concrete | | $\phi_c$ | 0.75 | |
| Prestress steel | | $\phi_p$ | 0.95 | |
| Reinforcing steel | | $\phi_s$ | 0.9 | |

**Dimensions**

| | | | | | |
|---|---|---|---|---|---|
| Width | | b | 1219 | mm | |
| Total depth | | h | 710 | mm | incld 100 mm thk deck |
| Prestressing strand | 13 mm dia | $A_{ps}$ | 98 | $mm^2$ | |
| Total number of strands | | | 16 | | |
| Reinforcing steel | | | | | |
| precast box cell girder | 10M | $A_{s10}$ | 100 | $mm^2$ | |
| cast-in-place concrete deck | 25M | $A_{s25}$ | 500 | $mm^2$ | |

***Distance from top of concrete***

| | | | | |
|---|---|---|---|---|
| Bottom prestress steel | | | | |
| layer 1 | | $d_{p1}$ | 509 | mm |
| layer 2 | | $d_{p2}$ | 458 | mm |
| layer 3 | | $d_{p3}$ | 407 | mm |
| Top prestressing steel | | | | |
| layer 1 | | $d'_{p1}$ | 102 | mm |
| layer 2 | | $d'_{p2}$ | 51 | mm |
| Bottom reinforcing steel | | | | |
| layer 1 | (deck concrete) | $d_{s1}$ | 686 | mm |
| layer 2 | | $d_{s2}$ | 640 | mm |
| layer 3 | | $d_{s3}$ | 487 | mm |
| Top reinforcing steel | | | | |
| layer 1 | | $d'_{s1}$ | 45 | mm |

***Area of steel***

| | | | | | |
|---|---|---|---|---|---|
| Bottom prestress steel | | | | | |
| layer 1 | 2 | strands | $A_{ps1}$ | 196 | $mm^2$ |
| layer 2 | 2 | strands | $A_{ps2}$ | 196 | $mm^2$ |
| layer 3 | 4 | strands | $A_{ps3}$ | 392 | $mm^2$ |
| Top prestressing steel | | | | | |
| layer 1 | 4 | strands | $A'_{ps1}$ | 392 | $mm^2$ |
| layer 2 | 4 | strands | $A'_{ps2}$ | 392 | $mm^2$ |
| Bottom reinforcing steel | | | | | |
| layer 1 | 5 | 25M | $A_{s1}$ | 2500 | $mm^2$ |
| layer 2 | 5 | 10M | $A_{s2}$ | 500 | $mm^2$ |
| layer 3 | 4 | 10M | $A_{s3}$ | 400 | $mm^2$ |
| Top reinforcing steel | | | | | |
| layer 1 | 3 | 10M | $A'_{s1}$ | 300 | $mm^2$ |

**Calculations**

| | | | | | |
|---|---|---|---|---|---|
| | $\alpha_1$ | $=0.85 - 0.0015 * f'_c$ | 0.798 | | |
| | $\beta_1$ | $= 0.97 - 0.0025 * f'_c$ | 0.883 | | |
| | $c / d_p$ | $<= 0.5$ | | | 8.8.4.2 |
| | $f_{ps}$ | $= f_{pu} * (1 - k_p * c / d_p)$ | 1,822 | MPa | |
| | $k_p$ | = 0.3 for low-relaxation strand | 0.3 | | |
| | | = 0.4 for smooth high-strength bars | | | |
| | | = 0.5 for deformed high strength bars | | | |
| | $c / d_p$ | = {φp * Aps * fpu + φs * As * fy - ϕp * A'ps * fpu } / {α1 * φc * β1 * f'c * b * dp + φp * kp * Aps * fpu} | 0.068 | **OK** | |
| OR | $f_{ps}$ | $= f_{pu} [1 - 0.5 * (\mu_p * f_{pu} / f'_c)]$ | 1,770 | MPa | 14.14.1.2.4 |
| | $\mu_p$ | $= A_{sp} / A_c$ | 0.002 | | |
| | a | = {φp * Aps * fps + φs * As * fy - ϕp * A'ps * fps } / {α1 * φc * f'c * b } | 29 | mm | |
| | | | 29 | mm | |
| | Mr | = φp * Aps * fps * (dp - a/2) + φs * As * fy * (ds - a/2) - ϕp * A'ps * fps (d'p- a/2) - φs * A's * fy * (d - d's) | | | |

| | | | | | |
|---|---|---|---|---|---|
| $f_{ps} =$ | 1,822 | MPa | 1,087 | kN-m | |
| | | | **891** | **kN-m / m width** | |
| $f_{ps} =$ | 1,770 | MPa | 1,154 | kN-m | |
| | | | **947** | **kN-m / m width** | **Use** |

**Shear Capacity of Box Cell Girder at h/2 from support**

| | | | | | | |
|---|---|---|---|---|---|---|
| $V_c$ | $= 2.5 * \beta * \phi_c * f_{cr} * b_v * d_v$ | | | | 8.9.3.4 | |
| $f_{cr}$ | $= 0.4 * sqrt (f'_c) <= 3.2$ MPa | | 2.4 | MPa | | |
| β | | | 0.18 | | | |
| $V_c$ | | | 245.3 | kN | | |
| Vs | $= \phi_s * f_y * A_v * d_v * cot(\theta) / s$ | | | | 8.9.3.5 | |
| θ | | | 42 | degrees = | 0.733 | rad |
| s | | | 300 | mm | | |
| Av | 6 | 15 M | 1200 | $mm^2$ | | |
| | | $A_{s15}$ 200 $mm^2$ | | | | |
| Vs | | | 767.7 | kN | | |
| Vp | | | | | | |
| $V_{total}$ | $= V_c + V_s + V_p$ | | **1013.0** | **kN** | $> V_f$ | |

**Material Properties**

| | | | | |
|---|---|---|---|---|
| Prestressed concrete | $f'_c$ | 35 | MPa | |
| Prestressed steel | $f_{pu}$ | 1860 | MPa | |
| Reinforcing steel | $f_y$ | 300 | MPa | |
| Type of prestressing steel | | low relaxation | | |
| Structural concrete (deck, barrier, etc.) | | | | |
| Concrete | $f'_c$ | 30 | MPa | |
| Reinforcing steel | $f_y$ | 400 | MPa | |

**Resistance factors** — Table 8.1

| | | |
|---|---|---|
| Concrete | $\phi_c$ | 0.75 |
| Prestress steel | $\phi_p$ | 0.95 |
| Reinforcing steel | $\phi_s$ | 0.9 |

**Dimensions**

| | | | | |
|---|---|---|---|---|
| Width | | $b$ | 1219 | mm |
| Total depth | | $h$ | 710 | mm |
| Prestressing strand | 13 mm dia | $A_{ps}$ | 98 | $mm^2$ |
| Total number of strands | | | 28 | |
| Reinforcing steel | | | | |
| precast box cell girder | 10M | $A_{s10}$ | 100 | $mm^2$ |
| cast-in-place concrete deck | 25M | $A_{s25}$ | 500 | $mm^2$ |

***Distance from top of concrete***

| | | | |
|---|---|---|---|
| Bottom prestress steel | | | |
| layer 1 | $d_{p1}$ | 509 | mm |
| layer 2 | $d_{p2}$ | 458 | mm |
| layer 3 | $d_{p3}$ | 407 | mm |
| layer 4 | $d_{p4}$ | 356 | mm |
| Top prestressing steel | | | |
| layer 1 | $d'_{p1}$ | 102 | mm |
| layer 2 | $d'_{p2}$ | 51 | mm |
| Bottom reinforcing steel | | | |
| layer 1 (deck concrete) | $d_{s1}$ | 686 | mm |
| layer 2 | $d_{s2}$ | 640 | mm |
| layer 3 | $d_{s3}$ | 487 | mm |
| Top reinforcing steel | | | |
| layer 1 | $d'_{s1}$ | 45 | mm |

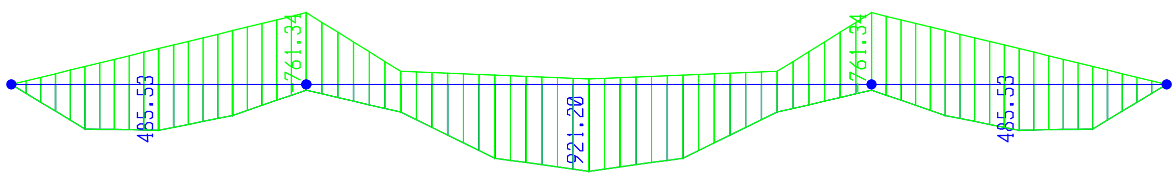
***Area of steel***

| | | | | | | |
|---|---|---|---|---|---|---|
| Bottom prestress steel | | | | | | |
| layer 1 | 2 | strands | $A_{ps1}$ | 196 | $mm^2$ | |
| layer 2 | 2 | strands | $A_{ps2}$ | 196 | $mm^2$ | |
| layer 3 | 2 | strands | $A_{ps3}$ | 196 | $mm^2$ | |
| layer 4 | 4 | strands | $A_{ps3}$ | 392 | $mm^2$ | |
| Top prestressing steel | | | | | | |
| layer 1 | 6 | strands | $A'_{ps1}$ | 588 | $mm^2$ | 4 debonded strands |
| layer 2 | 6 | strands | $A'_{ps2}$ | 588 | $mm^2$ | 2 debonded stands |
| Bottom reinforcing steel | | | | | | |
| layer 1 | 5 | 25M | $A_{s1}$ | 2500 | $mm^2$ | |
| layer 2 | 5 | 10M | $A_{s2}$ | 500 | $mm^2$ | |
| layer 3 | 4 | 10M | $A_{s3}$ | 400 | $mm^2$ | |
| Top reinforcing steel | | | | | | |
| layer 1 | 3 | 10M | $A'_{s1}$ | 300 | $mm^2$ | |

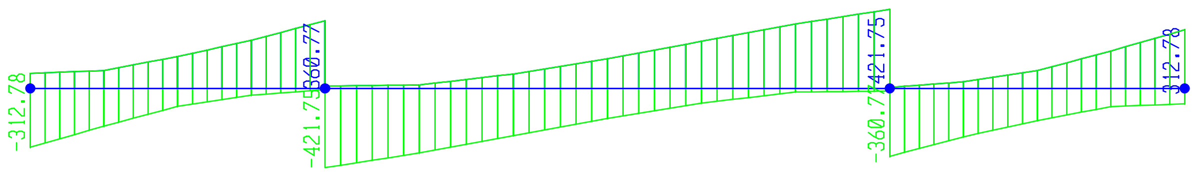
**Calculations**

| | | | | | |
|---|---|---|---|---|---|
| | $\alpha_1$ | $=0.85 - 0.0015 * f'_c$ | 0.798 | | |
| | $\beta_1$ | $= 0.97 - 0.0025 * f'_c$ | 0.883 | | |
| | $c / d_p$ | <= 0.5 | | | 8.8.4.2 |
| | $f_{ps}$ | $= f_{pu} * (1 - k_p * c / d_p)$ | 1,858 | MPa | |
| | $k_p$ | = 0.3 for low-relaxation strand | 0.3 | | |
| | | = 0.4 for smooth high-strength bars | | | |
| | | = 0.5 for deformed high strength bars | | | |
| | $c / d_p$ | = {φp * Aps * fpu + φs * As * fy - ϕp * A'ps * fpu } / {α1 * φc * β1 * f'c * b * dp + φp * kp * Aps * fpu} | | | |
| | | | 0.003 | **OK** | |
| OR | $f_{ps}$ | $= f_{pu} [1 - 0.5 * (\mu_p * f_{pu} / f_c)]$ | 1,703 | MPa | 14.14.1.2.4 |
| | $\mu_p$ | $= A_{sp} / A_c$ | 0.003 | | |
| | a | = {φp * Aps * fps + φs * As * fy - ϕp * A'ps * fps } / {α1 * φc * f'c * b } | | | |
| | | | 1 | mm | |
| | | | 1 | mm | |
| | Mr | = φp * Aps * fps * (dp - a/2) + φs * As * fy * (ds - a/2) -ϕp * A'ps * fps (d'p- a/2) - φs * A's1 * fy * (d - d's1) - φs * A's2 * fy * (d - d's2) | | | |

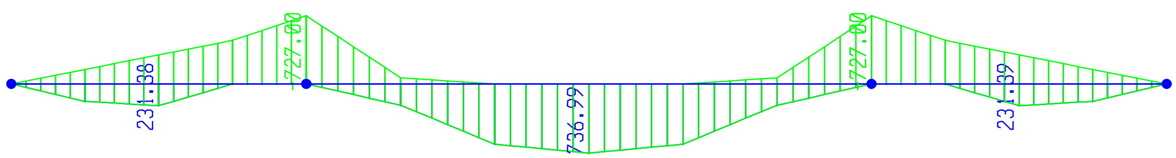
| | | | | |
|---|---|---|---|---|
| $f_{ps} =$ | 1,858 MPa | 1,161 | kN-m | |
| | | **952** | **kN-m / m width** | |
| $f_{ps} =$ | 1,703 MPa | 1,114 | kN-m | |
| | | **914** | **kN-m / m width** | **Use** |

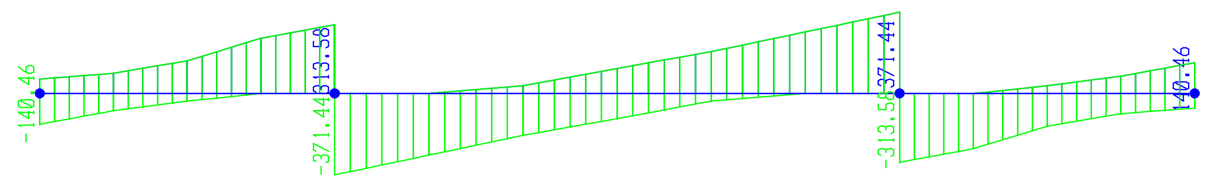



SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML HS-30) - KN, m, C Units



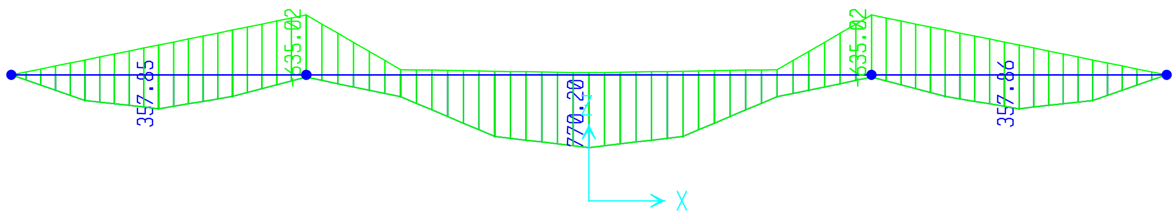

SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML HS-30) - KN, m, C Units


231.38
727.00
736.99
727.00
231.39


-140.46
313.58
-371.44
371.44
-313.58
140.46

SAP2000

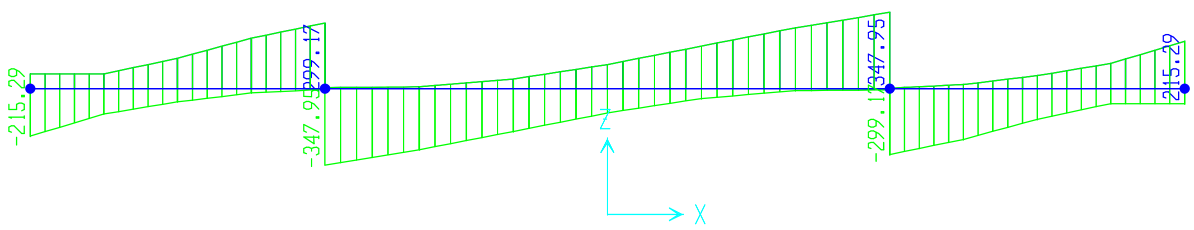
10/10/12 13:44:14




SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML CL2) - KN, m, C Units

# SAP2000

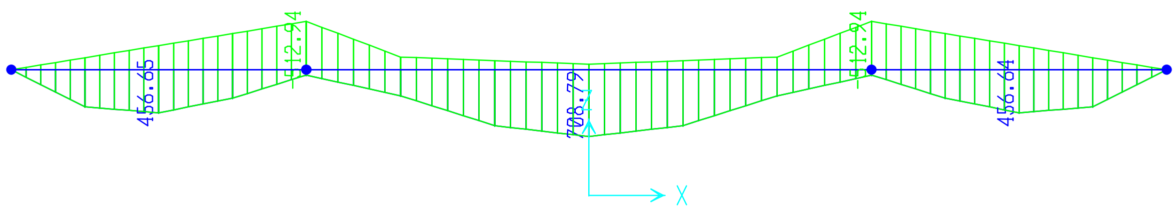
10/10/12 13:44:36



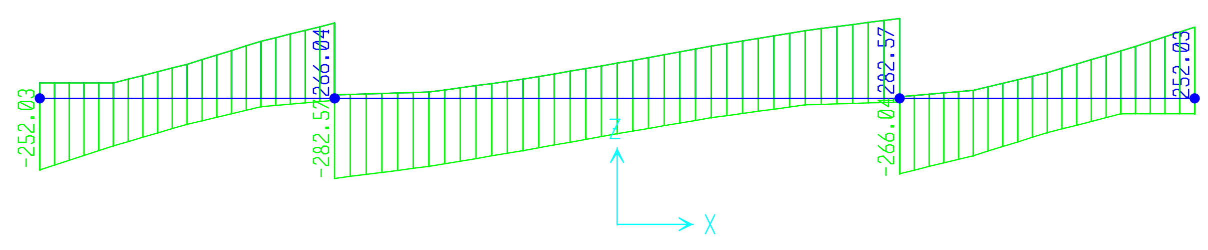

SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML CL2) - KN, m, C Units

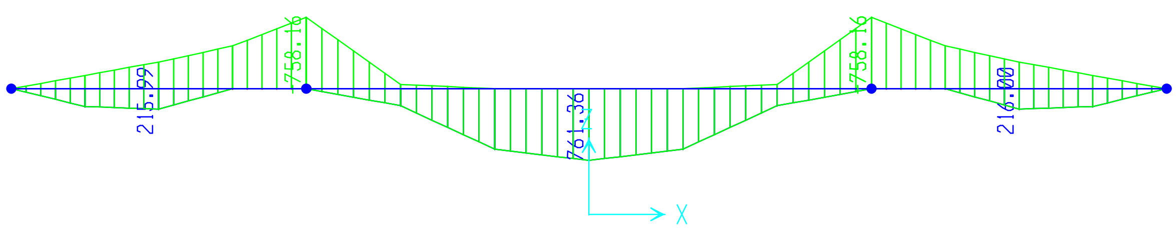
# SAP2000

10/10/12 13:44:59



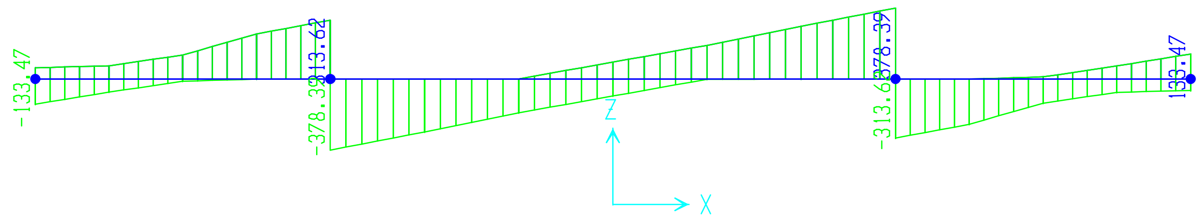

SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML CL3) - KN, m, C Units


-252.03
266.04
-282.57
282.57
-266.04
252.03
Z
X

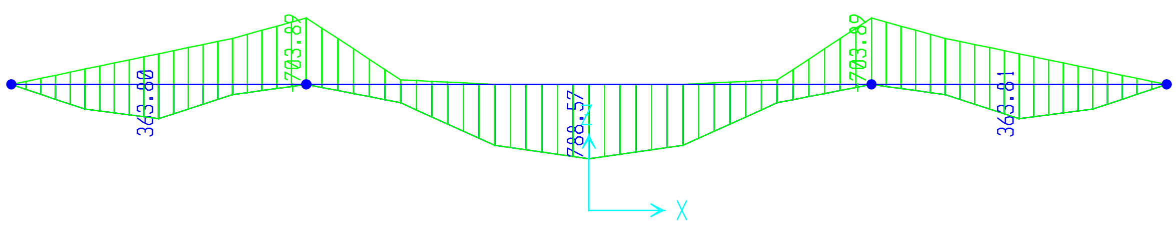

215.99
758.16
761.36
758.16
216.00
X

SAP2000

10/10/12 13:47:43



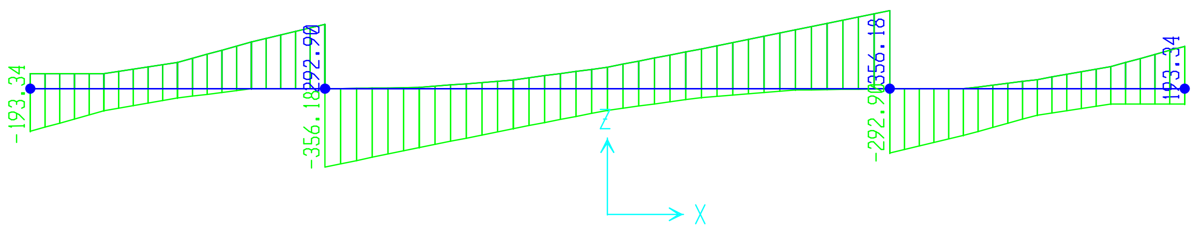

SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML LL CL1) - KN, m, C Units




SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML LL CL2) - KN, m, C Units

**SAP2000**

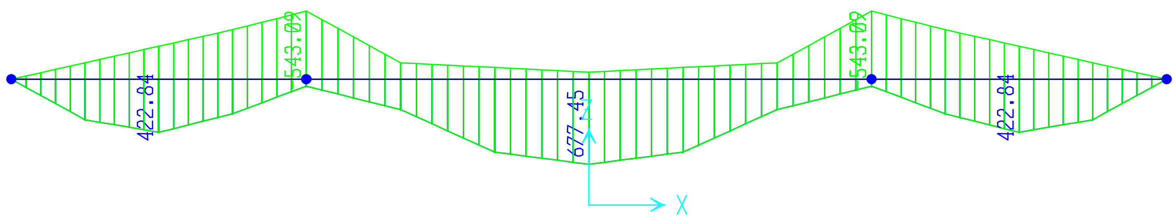
10/10/12 13:48:46




SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML LL CL2) - KN, m, C Units

SAP2000

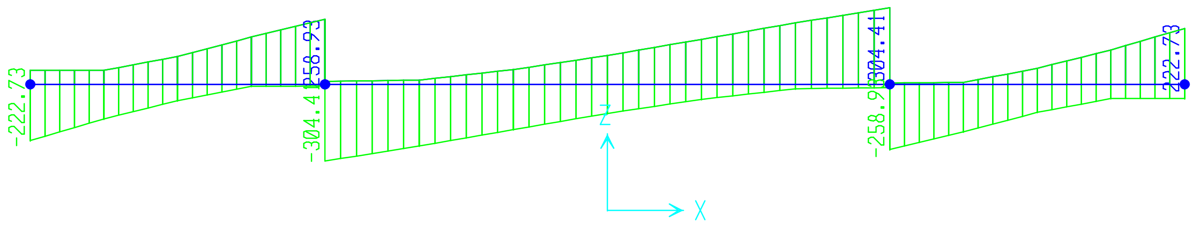
10/10/12 13:49:19




SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML LL CL3) - KN, m, C Units

# SAP2000

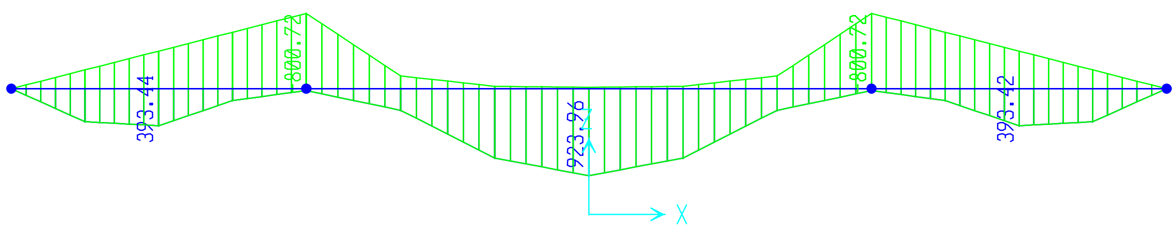
10/10/12 13:49:43




SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML LL CL3) - KN, m, C Units

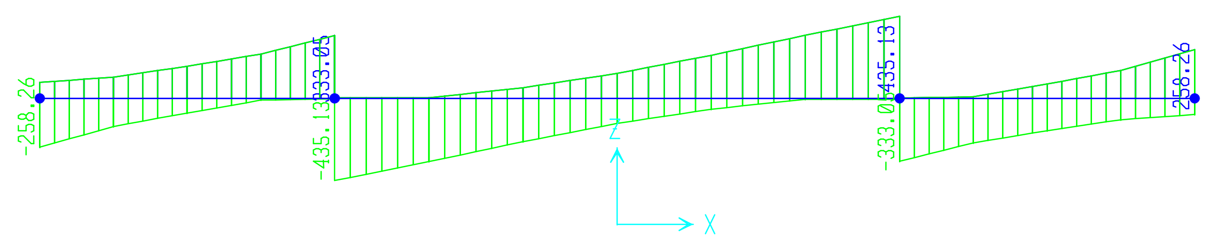
# SAP2000

10/10/12 13:51:28

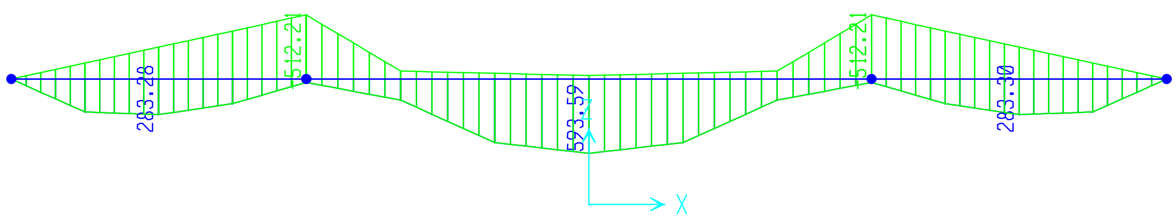


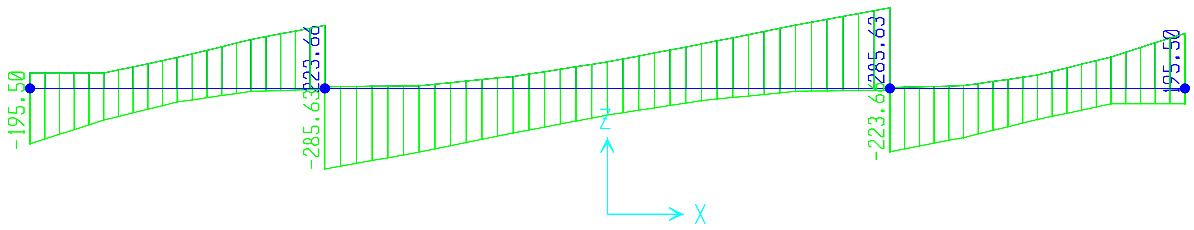

SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML HSS-25) - KN, m, C Units

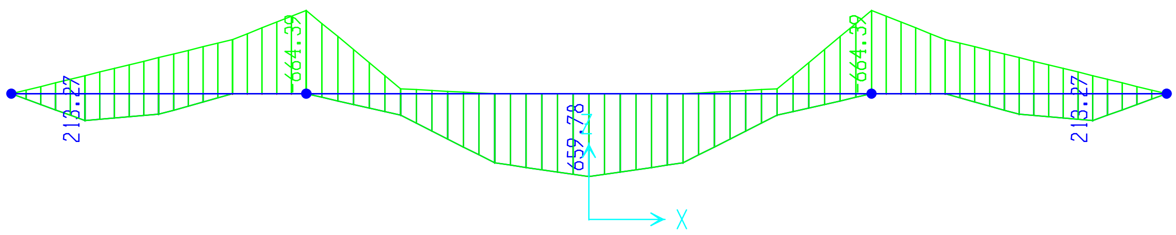
**SAP2000** 10/10/12 13:51:55




SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML HSS-25) - KN, m, C Units


512.21
283.28
593.59
512.21
283.30
X

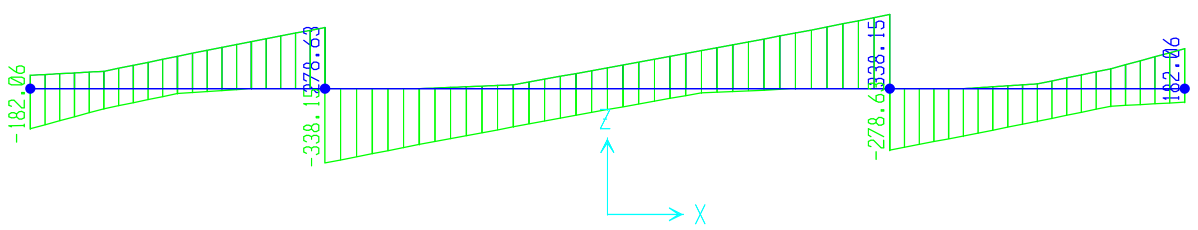

-195.50
223.66
-285.63
285.63
-223.66
195.50
Z
X



664.39
664.39
213.27
213.27
659.78
Z
X

# SAP2000

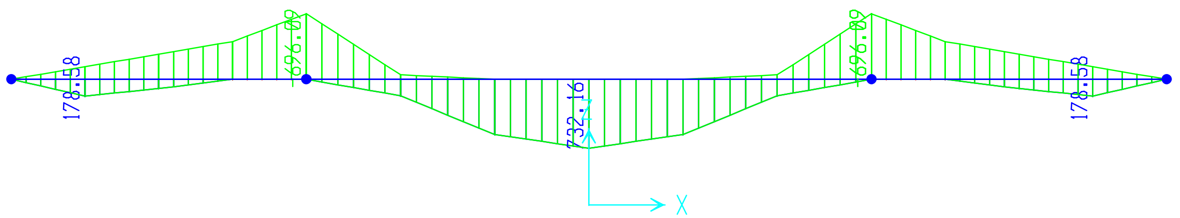
10/10/12 14:02:48




SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML 56 500) - KN, m, C Units

# SAP2000

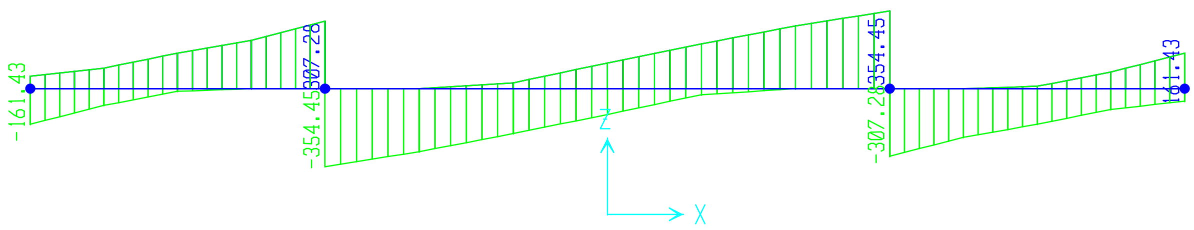
10/10/12 14:03:18



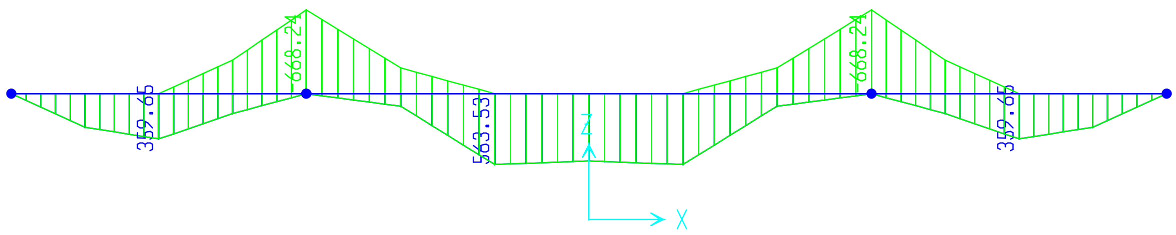

SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML 62 500) - KN, m, C Units

# SAP2000

10/10/12 14:03:41



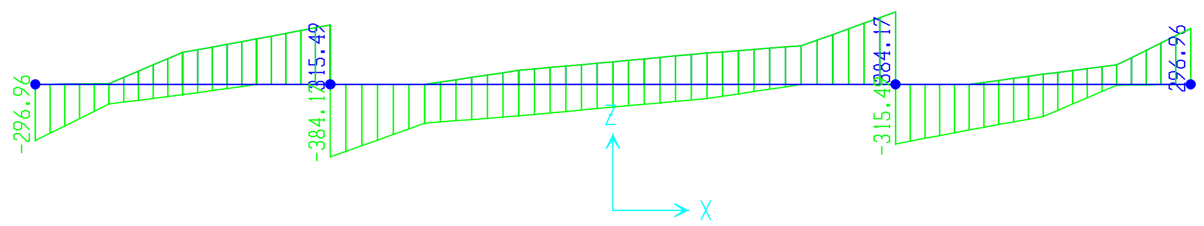

SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML 62 500) - KN, m, C Units




SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML 124 057) - KN, m, C Units

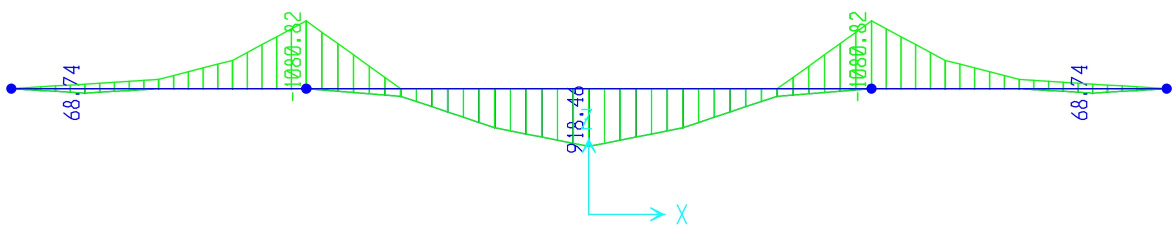
**SAP2000**

10/10/12 14:05:00




SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML 124 057) - KN, m, C Units

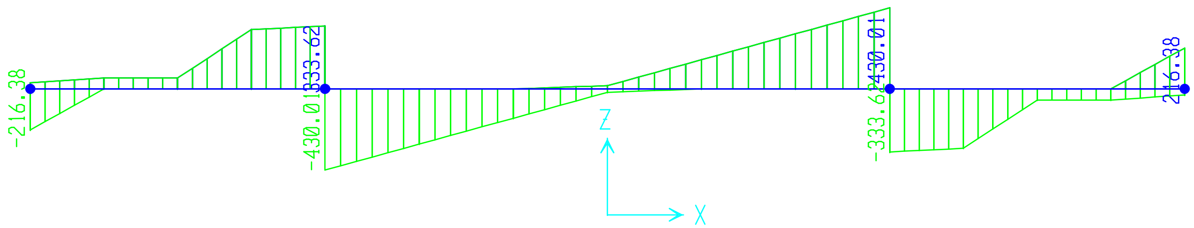
SAP2000 10/10/12 14:05:30



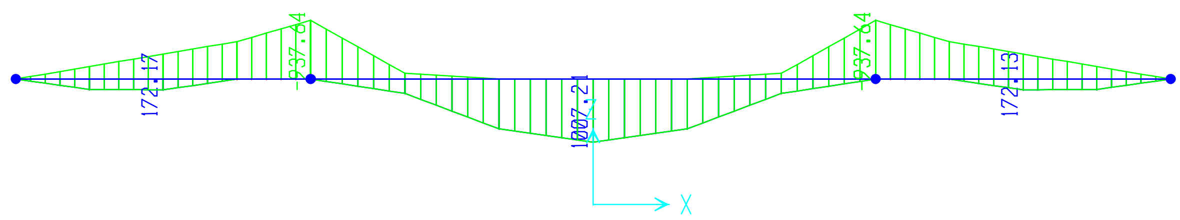

SAP2000 v15.1.0 - File:PortageAveBridge - Moment 3-3 Diagram (ML 166 080) - KN, m, C Units

# SAP2000

10/10/12 14:05:52

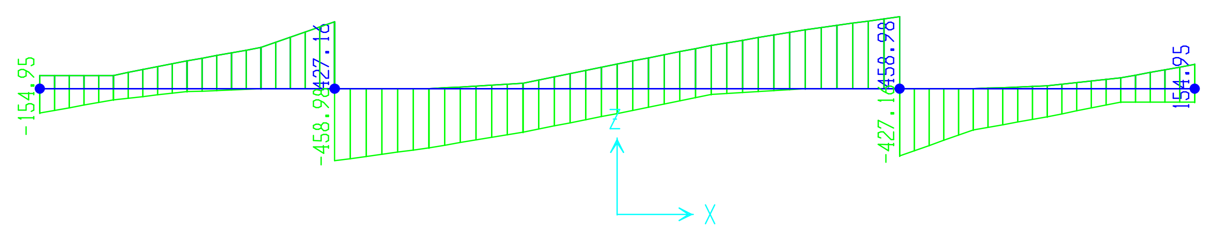



SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML 166 080) - KN, m, C Units

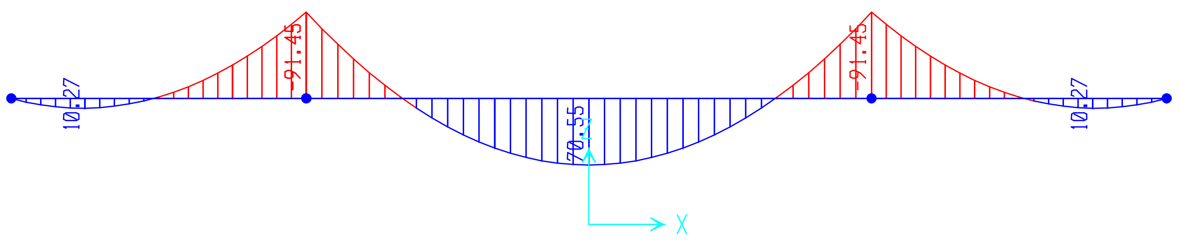


172.17
-937.64
1007.21
-937.64
172.13
X

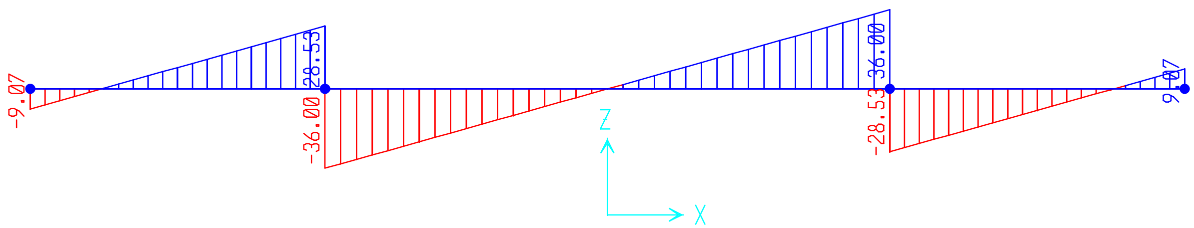
SAP2000 10/10/12 14:06:38




SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (ML MC) - KN, m, C Units

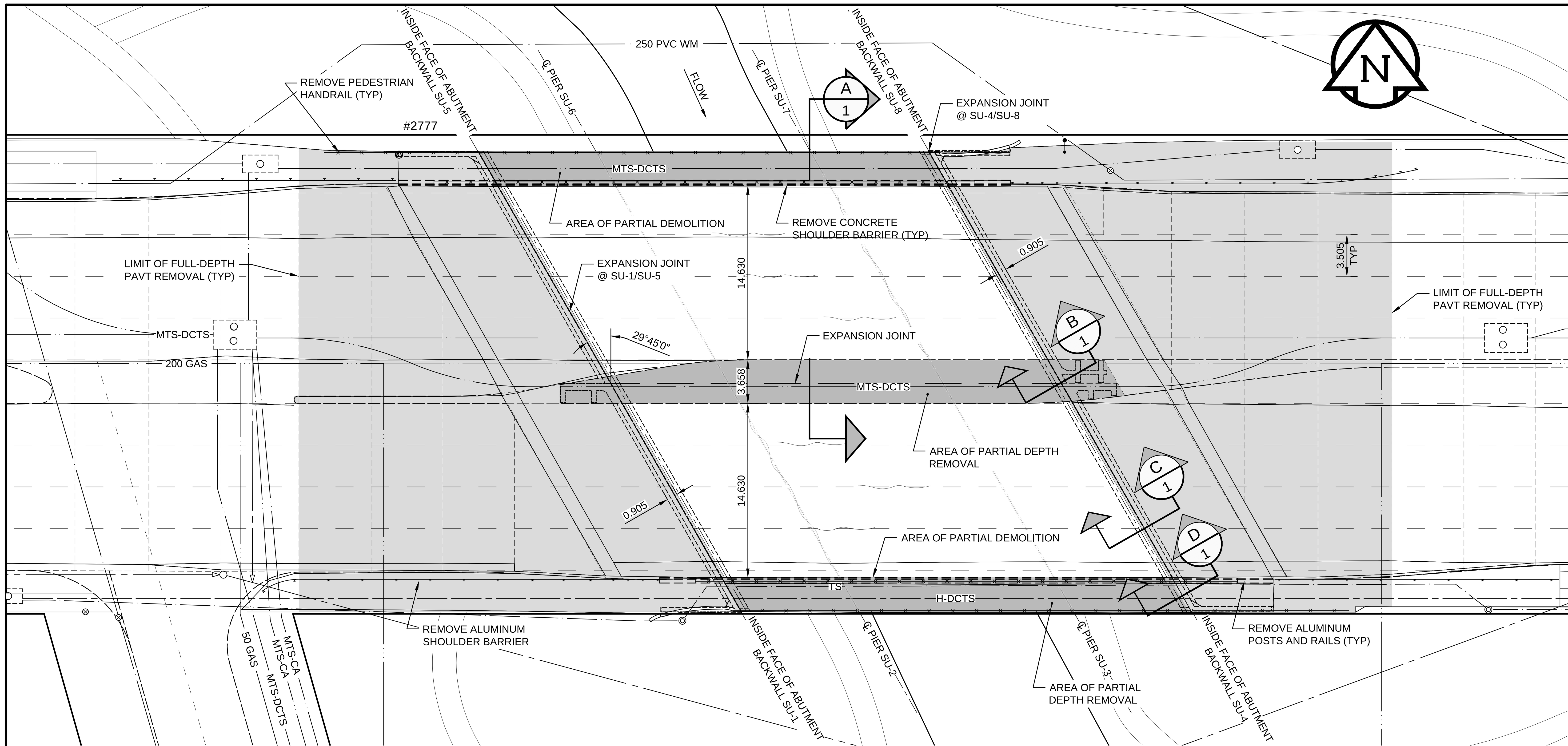

-91.45
-91.45
10.27
10.27
70.55
Z
X

SAP2000 10/10/12 14:07:27




SAP2000 v15.1.0 - File:PortageAveBridge - Shear Force 2-2 Diagram (SD) - KN, m, C Units

# APPENDIX D: DRAWINGS



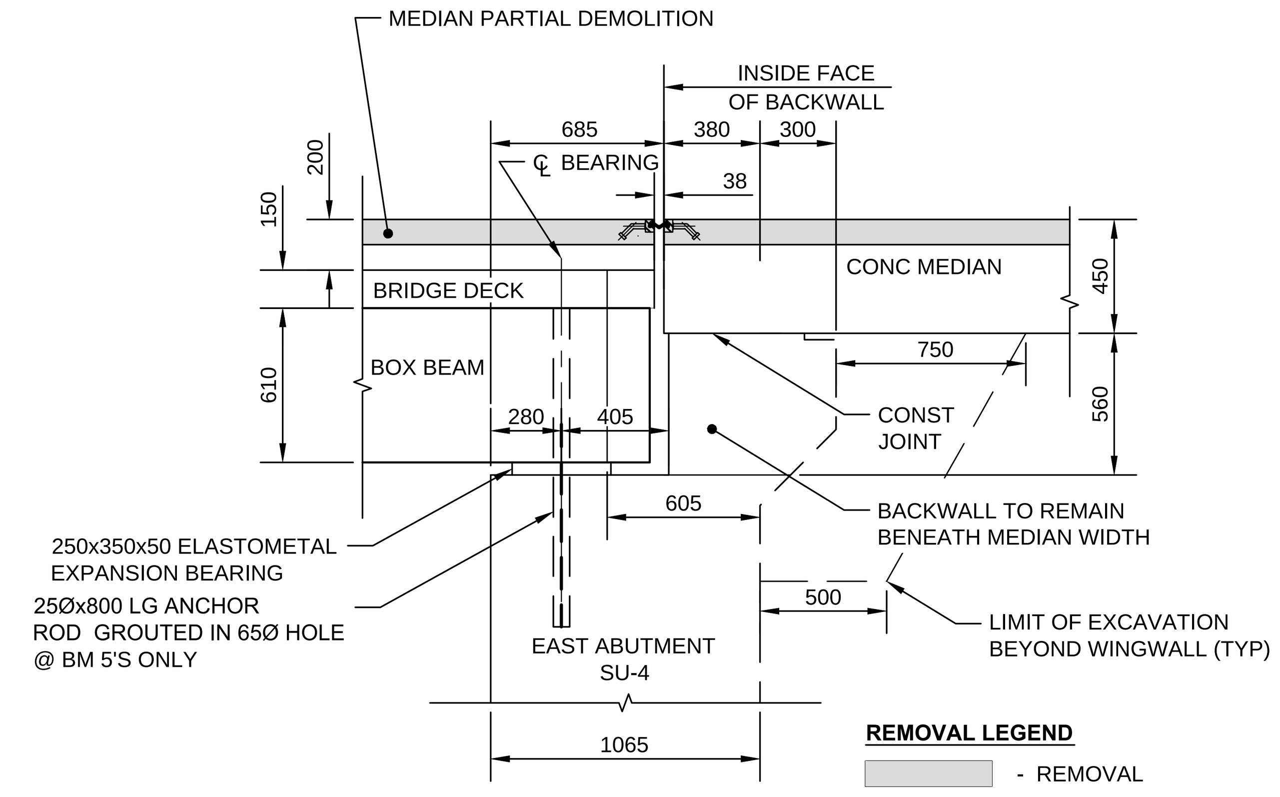

## REMOVALS PLAN

SCALE: 1:250

0 5 10 15m

**REMOVAL LEGEND**

- FULL DEPTH REMOVAL
- PARTIAL DEPTH REMOVAL

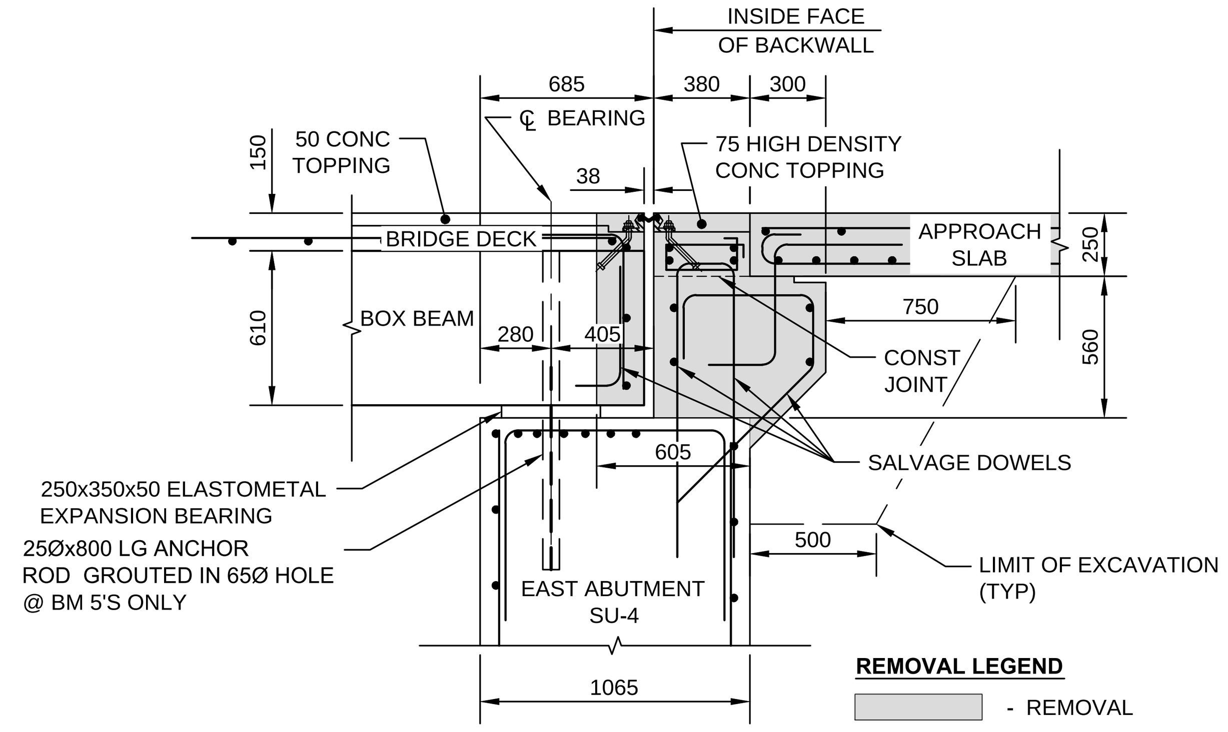



## SECTION "B" @ SU-4 EXP

**SIMILAR @ SU-1 EXP**

SCALE: 1:25

0 0.5 1.0 1.5m

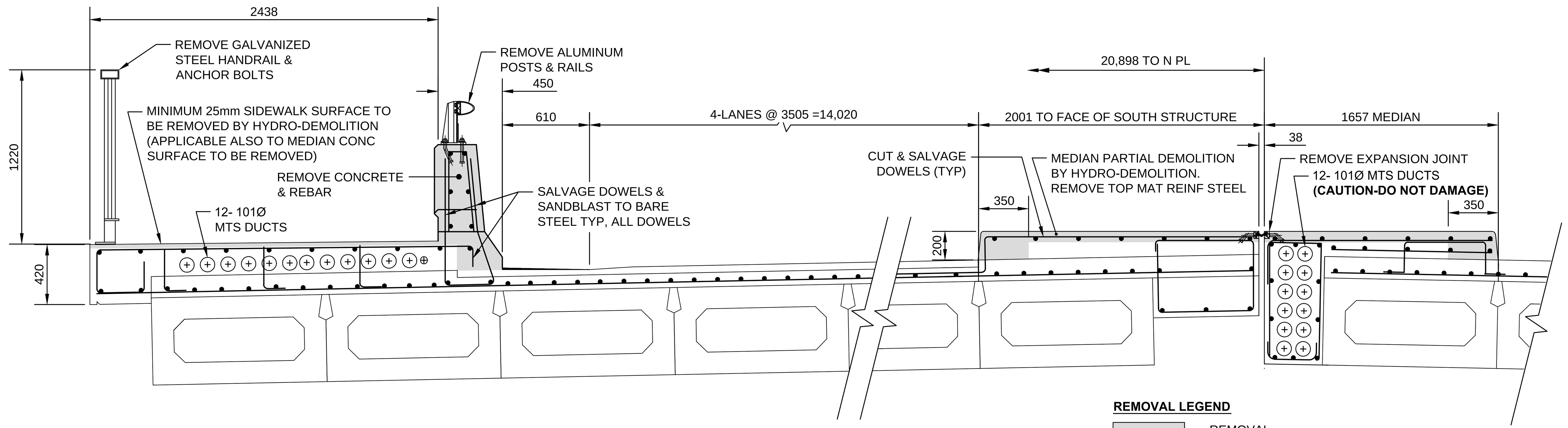



## SECTION "C" @ SU-4 EXP

**SIMILAR @ SU-1, SU-5 & SU-8 EXP**

SCALE: 1:25

0 0.5 1.0 1.5m

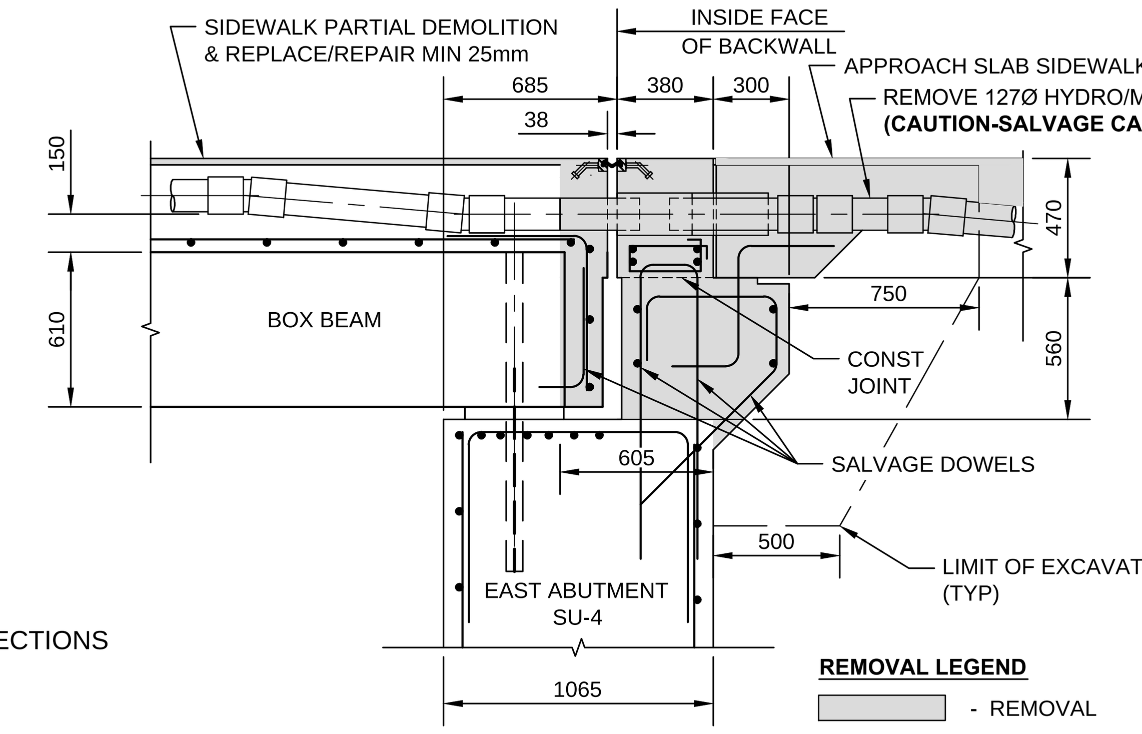



## SECTION "A" NORTH STRUCTURE

**SIMILAR @ SOUTH STRUCTURE**

SCALE: 1:25

0 0.5 1.0 1.5m




## SECTION "D" @ SU-4 EXP

**SIMILAR @ SU-1, SU-5 & SU-8 EXP**

SCALE: 1:25

0 0.5 1.0 1.5m

## DRAWING INDEX

1 DRAWING INDEX, REMOVALS PLAN & SECTIONS
2 GENERAL ARRANGEMENT & SECTIONS
3 EXPANSION JOINT DETAILS

# METRIC

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

### SURVEY BAR - HORIZONTAL CONTROL POINTS - PROJECT COORDINATES

| CONTROL POINT | LOCATION | NORTHING EASTING | ELEVATION | NAD 83 DATUM |
|---|---|---|---|---|
| #1 | SURVEY BAR @ S/W CRN PORTAGE AVE. & HARRIS BLVD. | N9961.972 E9926.527 | 234.512 | N5526586.997 E623766.098 |
| #2 | SURVEY BAR @ N/W CRN PORTAGE AVE & BOOTH DR. | N10002.288 E10158.351 | 233.912 | N5526550.165 E623998.527 |

### GEODETIC BENCHMARK - VERTICAL CONTROL POINTS

| GBM | LOCATION | ELEVATION |
|---|---|---|
| 39-044 (GSCM 83R498) | N side Portage Ave @ Harris Blvd, Tblt on top of 0.05m dia x 2.4m iron pipe, 6.5m N of N curb line of Portage Ave & 2.2m E of CL of Conc Pvmt of Harris Blvd produced from the South | 233.848 |

| EXISTING | LEGEND - PLAN | NEW | EXISTING | LEGEND - PLAN | NEW | EXISTING | LEGEND - PLAN | NEW |
|---|---|---|---|---|---|---|---|---|
| | GAS | | | MANHOLE | | | CONCRETE PAVEMENT | |
| | MTS | | | CATCH BASIN / CATCH PIT | | | CONC SIDEWALK / MEDIAN | |
| | HYDRO | | | CURB INLET WITH BOX | | | ASPHALT PAVEMENT | |
| | CATV / FIBRE OPTIC | | | TREE | | | PAVING STONE | |
| | TRAFFIC SIGNALS / PIT | | TH-12 | TEST HOLE | | | GRAVEL | |
| | LAND DRAINAGE SEWER | | | PROPERTY LINE | | | RAMP CURB | |
| | SANITARY/COMBINED SEWER | | | SURVEY BAR | | | PLANING / REMOVAL | |
| | SSP/DCP | | | FENCE | | | | |
| | WATERMAIN | | | BOC / EDGE OF PAVEMENT | | | | |
| | SUBDRAIN | | 33.000 | ELEVATION | 33.100 | | | |
| | DITCH | | | TRAFFIC SIGN | | | | |

**LOCATION APPROVED**
UNDERGROUND STRUCTURES

SUPR. U/G STRUCTURES COMMITTEE | DATE

NOTE:
LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE. BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

BM GBM No. 39-044 (GSCM-83R498)
ELEV 233.848m

| No. | REVISIONS | YY/MM/DD | BY |
|---|---|---|---|
| B | ISSUED FOR PRELIMINARY DESIGN REPORT | 13/03/28 | BE |
| A | ISSUED FOR CLIENT REVIEW | 13/03/11 | BE |

MORRISON HERSHFIELD

| | | | |
|---|---|---|---|
| DESIGNED BY | BE | CHECKED BY | RPB |
| DRAWN BY | DID | APPROVED BY | BWB |
| HOR. SCALE | AS SHOWN | RELEASED FOR CONSTRUCTION | |
| VERT. SCALE | AS SHOWN | | |
| DATE | 12/12/18 | DATE | |

PROFESSIONAL'S SEAL

CONSULTANT DRAWING No.
W12401300-T-001_RX.dwg

APEGM
Certificate of Authorization
MORRISON HERSHFIELD
No. 1736 Date: 13/03/01

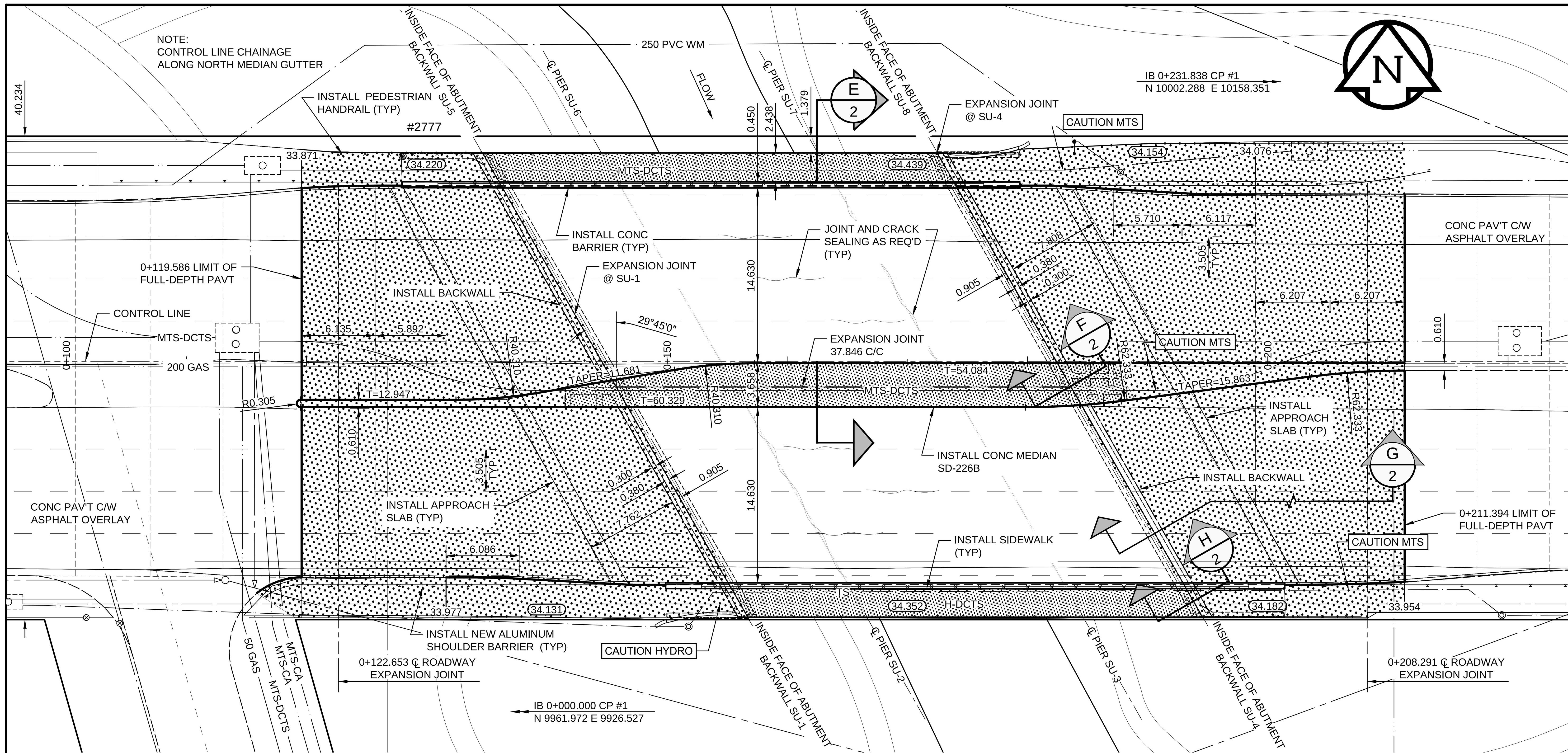
# THE CITY OF WINNIPEG
## PUBLIC WORKS DEPARTMENT
### ENGINEERING DIVISION

**REHABILITATION OF THE PORTAGE AVENUE TWIN BRIDGES OVER STURGEON CREEK AND RELATED WORKS**
PRELIMINARY ENGINEERING
DRAWING INDEX, REMOVALS PLAN & SECTIONS

CITY DRAWING NUMBER N/A
SHEET 1 OF 3
DRAWING No. 1 REV B

A1 SIZE 594mm x 841mm
PLOT: 3/28/2013 1:06:10 PM
FILE NAME: W12401300-T-001_RX.dwg Saved By: dlane

A1 SIZE 594mm x 841mm



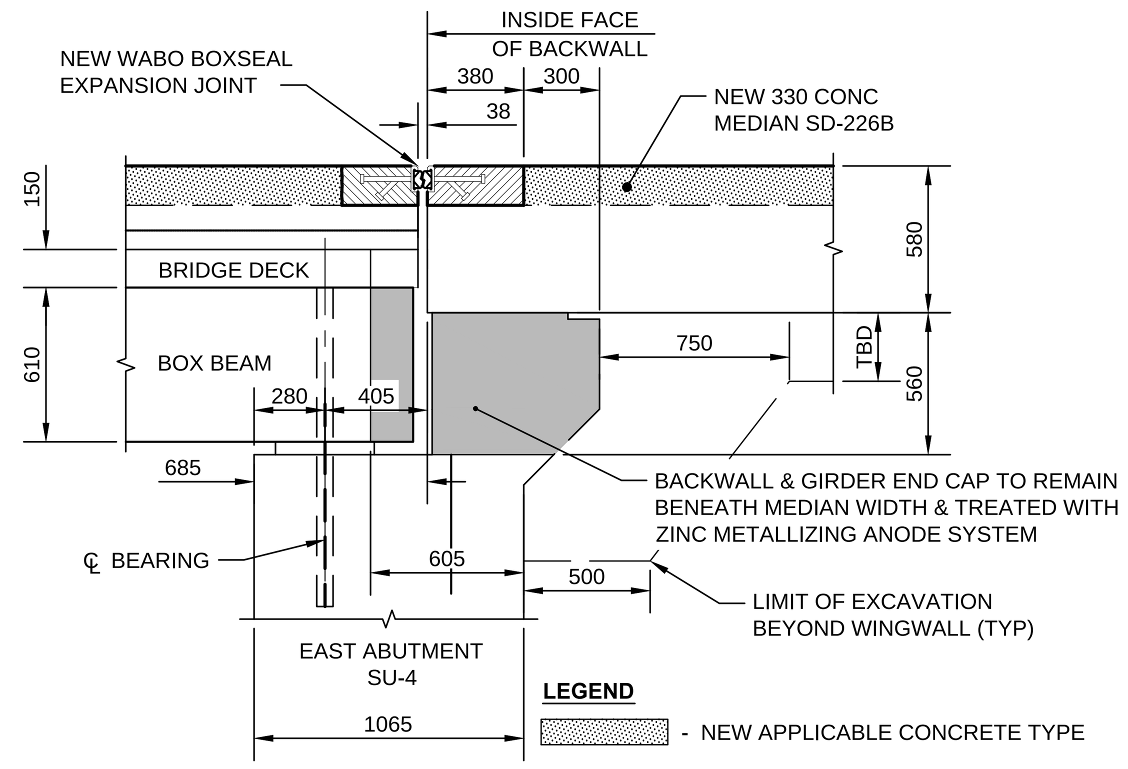

## GENERAL ARRANGEMENT

SCALE: 1:250

0 5 10 15m

**REPAIR LEGEND**

- FULL DEPTH REPAIR
- PARTIAL DEPTH REPAIR

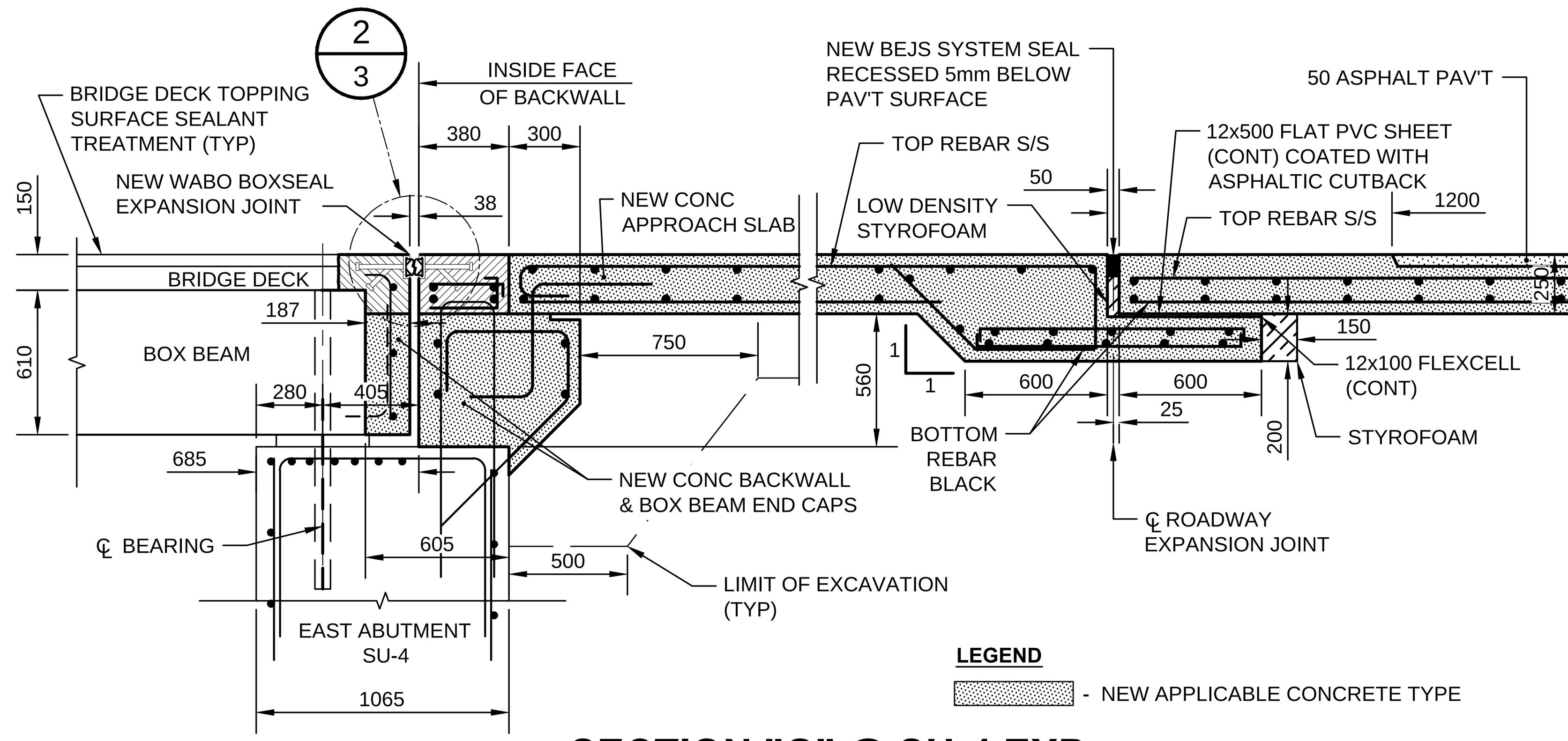



## SECTION "F" @ SU-4 EXP

**SIMILAR @ SU-1 EXP**

SCALE: 1:25

0 0.5 1.0 1.5m



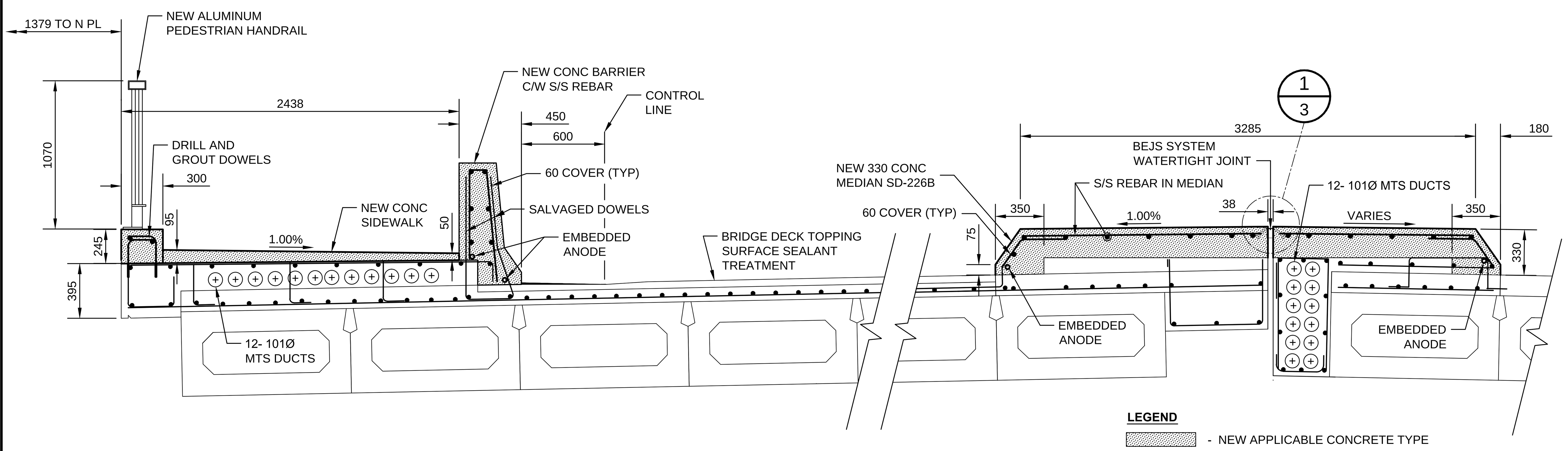

## SECTION "G" @ SU-4 EXP

**SIMILAR @ SU-1 EXP**

SCALE: 1:25

0 0.5 1.0 1.5m

PLOT: 3/28/2013 1:06:33 PM

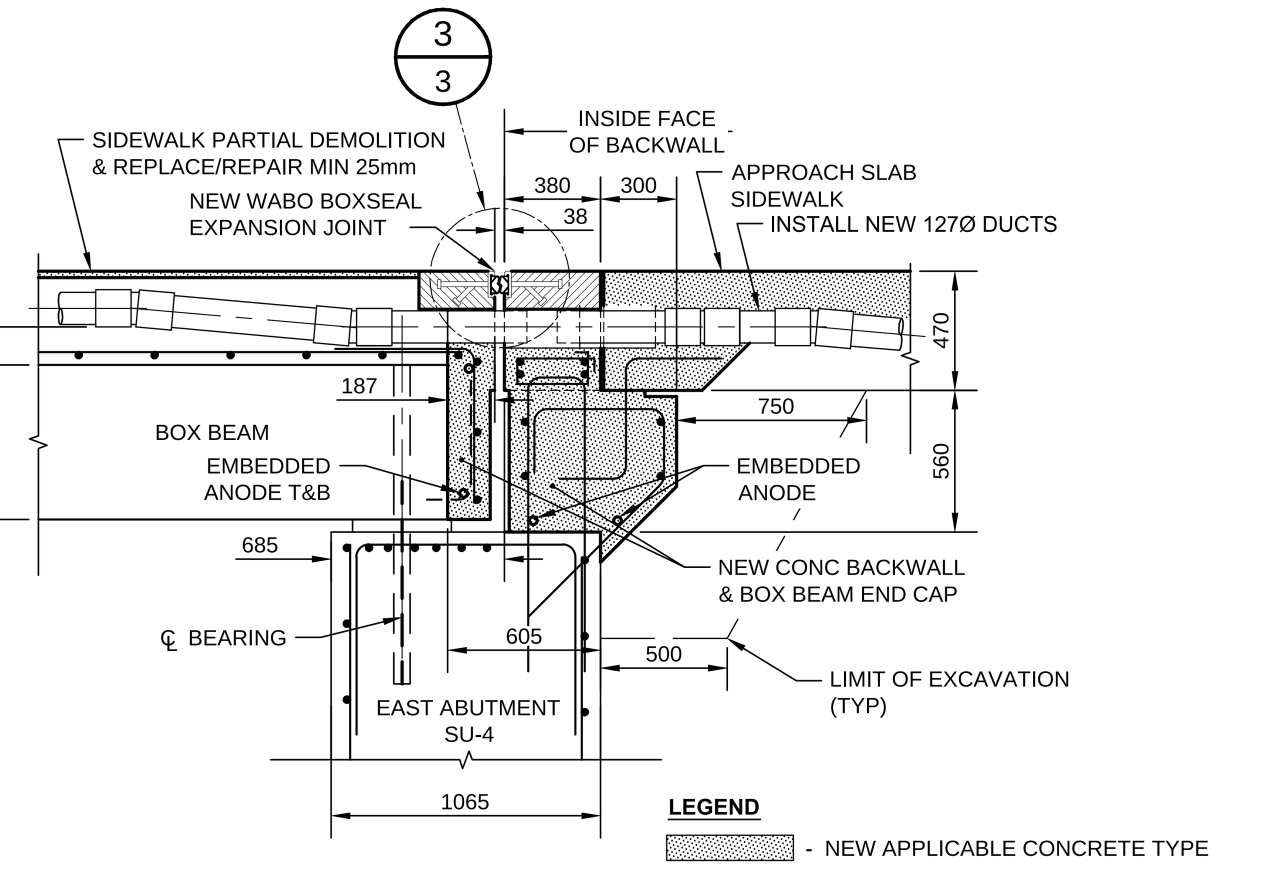



## SECTION "E" SIDEWALK @ NORTH STRUCTURE

**SIMILAR @ SOUTH STRUCTURE**

SCALE: 1:25

0 0.5 1.0 1.5m




## SECTION "H" @ SU-4 EXP

**SIMILAR @ SU-1, SU-5 & SU-8 EXP**

SCALE: 1:25

0 0.5 1.0 1.5m

APEGM
Certificate of Authorization
MORRISON HERSHFIELD
No. 1736 Date: 13/03/01

# METRIC

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

| EXISTING | LEGEND - PLAN | NEW | EXISTING | LEGEND - PLAN | NEW | EXISTING | LEGEND - PLAN | NEW |
|---|---|---|---|---|---|---|---|---|
| | GAS | | ○ | MANHOLE | ● | | CONCRETE PAVEMENT | |
| | MTS | | □ | CATCH BASIN / CATCH PIT | ■ | | CONC SIDEWALK / MEDIAN | |
| | HYDRO | | △ | CURB INLET WITH BOX | ▲ | | ASPHALT PAVEMENT | |
| | CATV / FIBRE OPTIC | | | TREE | | | PAVING STONE | |
| | TRAFFIC SIGNALS / PIT | | TH-12 | TEST HOLE | | | GRAVEL | |
| | LAND DRAINAGE SEWER | | | PROPERTY LINE | | | RAMP CURB | |
| | SANITARY/COMBINED SEWER | | | SURVEY BAR | | | PLANING / REMOVAL | |
| | SSP/DCP | | | FENCE | | | | |
| | WATERMAIN | | | BOC / EDGE OF PAVEMENT | | | | |
| | SUBDRAIN | | 33.000 | ELEVATION | 33.100 | | | |
| | DITCH | | | TRAFFIC SIGN | | | | |

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPR. U/G STRUCTURES COMMITTEE DATE

NOTE:
LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE. BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

BM GBM No. 39-044 (GSCM-83R498)
ELEV 233.848m

| No. | REVISIONS | YY/MM/DD | BY |
|---|---|---|---|
| B | ISSUED FOR PRELIMINARY DESIGN REPORT | 13/03/28 | BE |
| A | ISSUED FOR CLIENT REVIEW | 13/03/11 | BE |

MORRISON HERSHFIELD

| | | | |
|---|---|---|---|
| DESIGNED BY | BE | CHECKED BY | RPB |
| DRAWN BY | DID | APPROVED BY | BWB |
| HOR. SCALE | AS SHOWN | RELEASED FOR CONSTRUCTION | |
| VERT. SCALE | AS SHOWN | | |
| DATE | 12/12/18 | DATE | |

PROFESSIONAL'S SEAL

CONSULTANT DRAWING No.
W12401300-T-002_RX.dwg

# THE CITY OF WINNIPEG

## PUBLIC WORKS DEPARTMENT

ENGINEERING DIVISION

**REHABILITATION OF THE PORTAGE AVENUE TWIN BRIDGES OVER STURGEON CREEK AND RELATED WORKS**

**PRELIMINARY ENGINEERING**
**GENERAL ARRANGEMENT & SECTIONS**

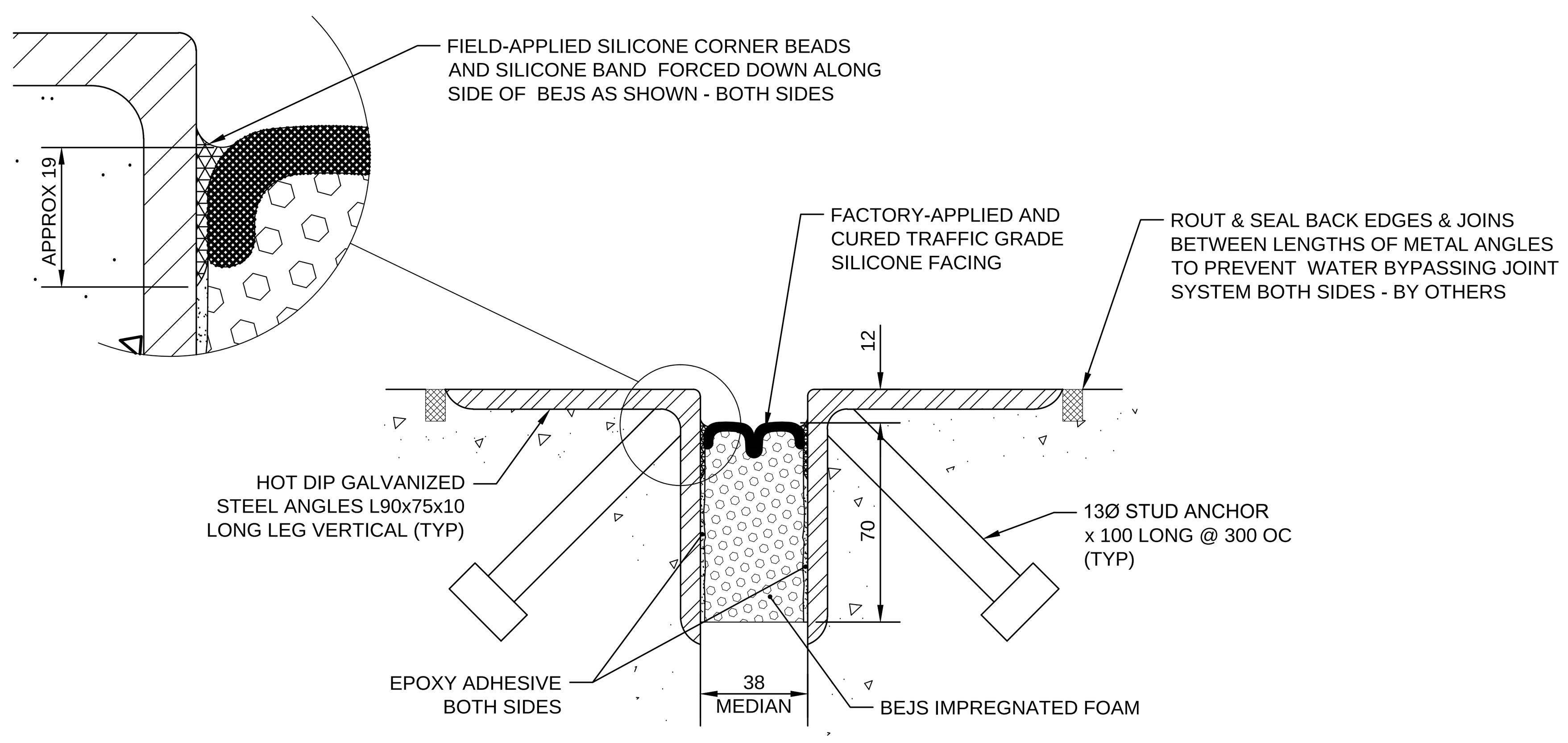
CITY DRAWING NUMBER N/A

SHEET 2 OF 3

DRAWING No. 2 REV B

FILE NAME: W12401300-T-002_RX.dwg Saved By: dlane

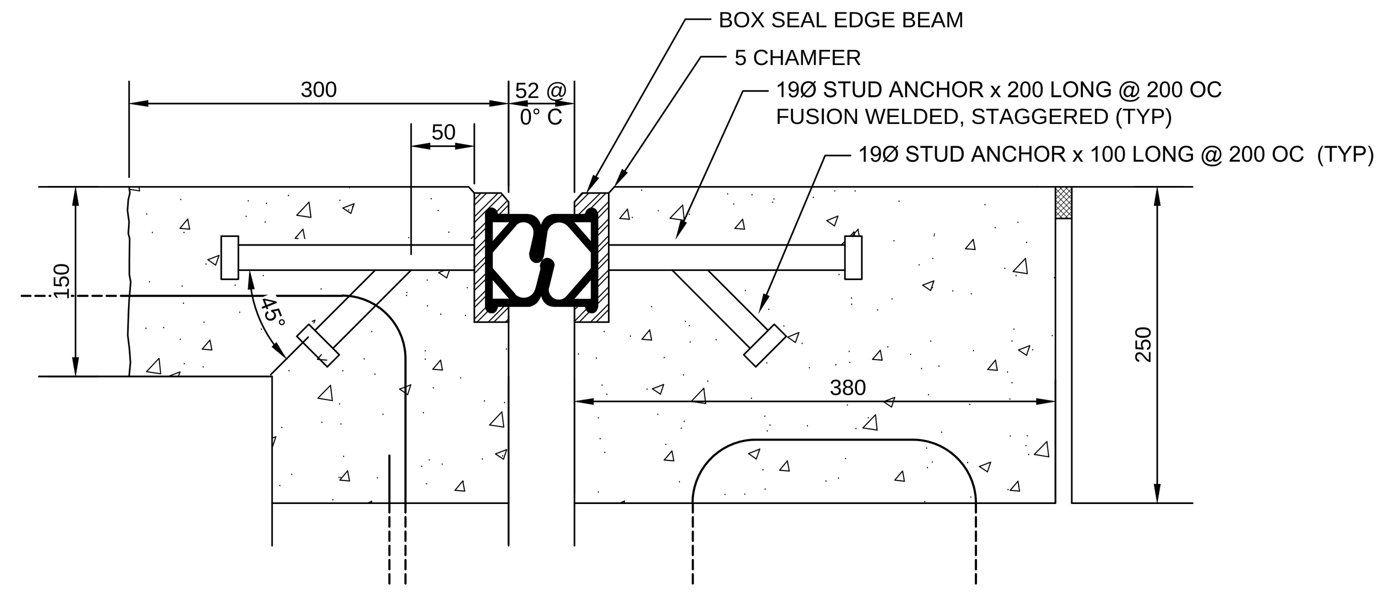
A1 SIZE 594mm x 841mm




## DETAIL "1" @ SU-4 EXP (MEDIAN)

**SIMILAR @ SU-1 EXP**

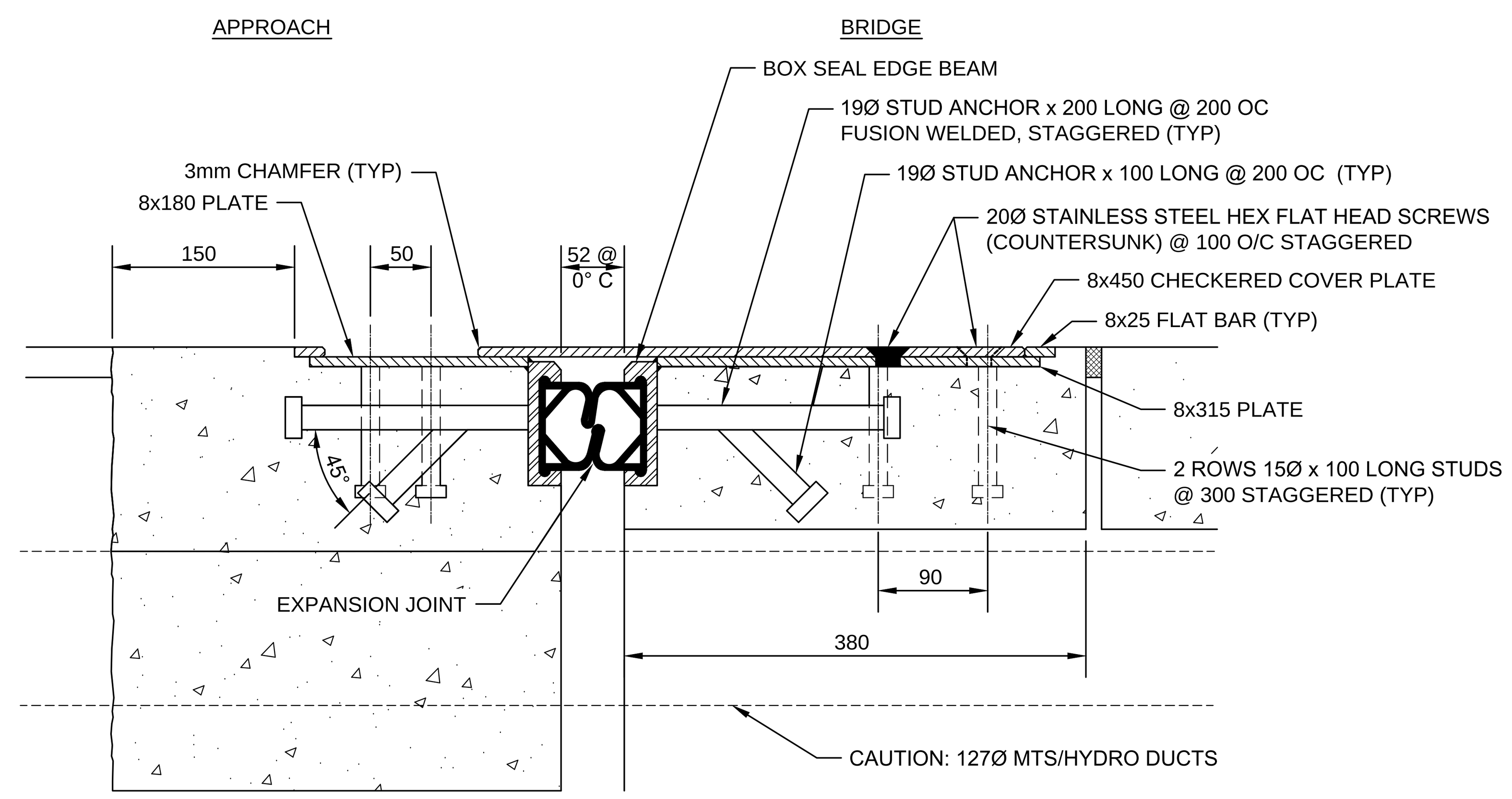
SCALE: 1:2
0 0.05 0.10m




## DETAIL "2" @ SU-4 EXP (ROADWAY)

**SIMILAR @ SU-1 EXP**

SCALE: 1:5
0 0.05 0.1 0.2 0.3m




## DETAIL "3" @ SU-4 EXP (SIDEWALK)

**SIMILAR @ SU-1, SU-5 & SU-8 EXP**

SCALE: 1:5
0 0.05 0.1 0.2 0.3m

PLOT: 3/28/2013 1:06:48 PM

FILE NAME: W12401300-T-003_RX.dwg Saved By: dlane

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

| EXISTING | LEGEND - PLAN | NEW | EXISTING | LEGEND - PLAN | NEW | EXISTING | LEGEND - PLAN | NEW |
|---|---|---|---|---|---|---|---|---|
| | GAS | | | MANHOLE | | | CONCRETE PAVEMENT | |
| | MTS | | | CATCH BASIN / CATCH PIT | | | CONC SIDEWALK / MEDIAN | |
| | HYDRO | | | CURB INLET WITH BOX | | | ASPHALT PAVEMENT | |
| | CATV / FIBRE OPTIC | | | TREE | | | PAVING STONE | |
| | TRAFFIC SIGNALS / PIT | | TH-12 | TEST HOLE | | | GRAVEL | |
| | LAND DRAINAGE SEWER | | | PROPERTY LINE | | | RAMP CURB | |
| | SANITARY/COMBINED SEWER | | | SURVEY BAR | | | PLANING / REMOVAL | |
| | SSP/DCP | | | FENCE | | | | |
| | WATERMAIN | | | BOC / EDGE OF PAVEMENT | | | | |
| | SUBDRAIN | | 33.000 | ELEVATION | 33.100 | | | |
| | DITCH | | | TRAFFIC SIGN | | | | |

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPR. U/G STRUCTURES COMMITTEE DATE

NOTE:
LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE. BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

BM GBM No. 39-044 (GSCM-83R498)
ELEV 233.848m

| No. | REVISIONS | YY/MM/DD | BY |
|---|---|---|---|
| B | ISSUED FOR PRELIMINARY DESIGN REPORT | 13/03/28 | BE |
| A | ISSUED FOR CLIENT REVIEW | 13/03/11 | BE |

MORRISON HERSHFIELD

| | | | |
|---|---|---|---|
| DESIGNED BY | BE | CHECKED BY | RPB |
| DRAWN BY | DID | APPROVED BY | BWB |
| HOR. SCALE | AS SHOWN | RELEASED FOR CONSTRUCTION | |
| VERT. SCALE | AS SHOWN | | |
| DATE | 12/12/18 | DATE | |

PROFESSIONAL'S SEAL

CONSULTANT DRAWING No.
W12401300-T-003_RX.dwg

APEGM
Certificate of Authorization
MORRISON HERSHFIELD
No. 1736 Date: 13/03/01

THE CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

REHABILITATION OF THE PORTAGE AVENUE TWIN BRIDGES OVER STURGEON CREEK AND RELATED WORKS
PRELIMINARY ENGINEERING
EXPANSION JOINT DETAILS

CITY DRAWING NUMBER N/A
SHEET 3 OF 3
DRAWING No. 3
REV B