APPENDIX F2

CNR OVERHEAD BRIDGE DECK CONDITION SURVEY REPORT 2009

Halton REGION

Dundas Street (Reg. Rd. 5) Class EA Study Brant Street (Reg. Rd. 18) to Proudfoot Trail

Dundas Street - CNR Overhead Structure Site Number 010-0175

BRIDGE DECK CONDITION SURVEY REPORT

September 2009

MRC

A member of MMM GROUP

Global Transportation Engineering

Regional Municipality of Halton

Dundas Street - CNR Overhead Structure
Site Number 010-0175

Bridge Deck Condition Survey Report

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MRC

A member of MMM GROUP

McCormick Rankin Corporation
September 2009

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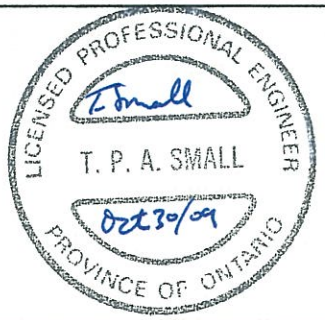
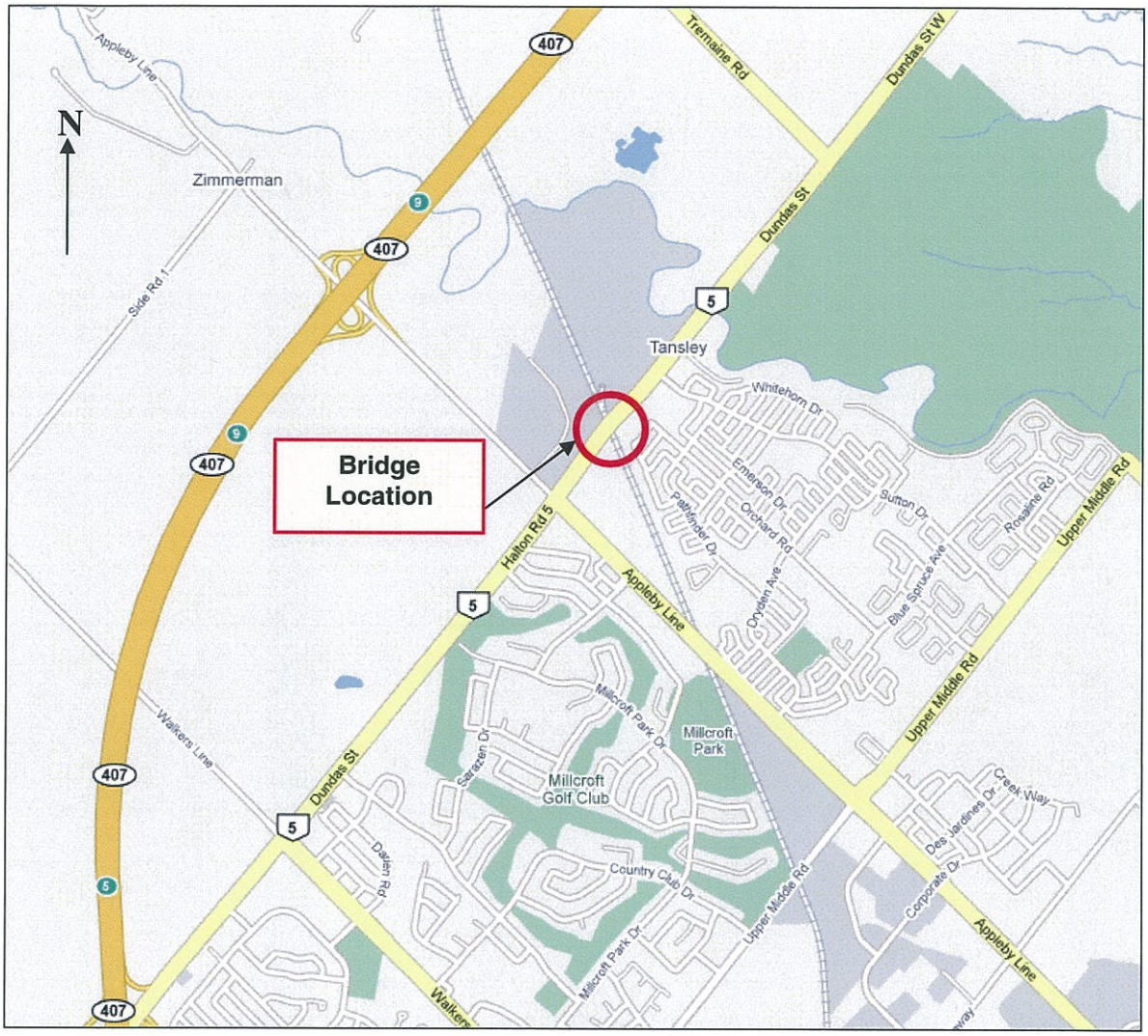
STRUCTURE IDENTIFICATION SHEET

GENERAL INFORMATION

STRUCTURE NAME	Dundas Street – CNR Overhead Structure		
BRIDGE NUMBER	05-1144380 BR01	**DISTRICT NUMBER**	14000
HIGHWAY	**Above** -	**Below**	CNR
TYPE OF STRUCTURE	Reinforced Concrete Slab on Precast Concrete Girders		
NUMBER OF SPANS	3	**SPAN LENGTHS**	12.192 m, 17.831 m, 12.192 m
ROADWAY WIDTH	20.422 m	**YEAR BUILT**	1964
DIRECTION OF STRUCTURE	East-West		
SEQUENCE NUMBER	N/A	**TOWNSHIP NUMBER**	N/A
LHRS NUMBER	N/A	**MTO SITE No.**	010-0175
LOCATION	0.5 km east of Appleby Line	**JURISDICTION**	Municipality of Halton
INSPECTOR'S NAME	Gideon Tjandra, E.I.T.		
PARTY MEMBERS	Christopher Fulton, E.I.T., Laura Ballios, On Track Safety Ltd., Craftsman Cutting Company		
DATE OF INSPECTION	July 7th and 8th, 2009		
TEMPERATURE	22-28 °C	**WEATHER**	Sunny
MTO REGION	Southwest	**AADT**	35 000
DECK RIDING SURFACE	Asphalt		
YEAR LAST REHABILITATED	2003		

ENGINEERS STAMP





Dundas Street CNR Overhead Structure
0.5 km east of Appleby Line

KEY PLAN
N.T.S.

1. INTRODUCTION

McCormick Rankin Corporation (MRC), a member of MMM Group, was retained by the Regional Municipality of Halton to undertake a bridge deck condition survey and a visual inspection of the Dundas Street - CNR Overhead Structure (MTO Site Number 010-0175). This work was completed over a two day period in July 2009.

The report includes the following:

- A summary of significant findings; and,
- Discussions of findings and the results of the laboratory testing.

The Dundas Street - CNR Overhead Structure was constructed in 1964 and accommodates four (4) lanes of traffic over two (2) CNR tracks that run in the north to south direction. The bridge is located on Dundas Street, 0.5 km east of Appleby Line in the Regional Municipality of Halton (see key plan). For the purpose of this report, the bridge runs in the east to west direction.

The bridge consists of a three (3) span reinforced concrete deck with ten (10) precast prestressed concrete girders in each span. The east and west approach spans are each 12.192 m in length and the main span is 17.831 m in length. The total span length of the bridge is 42.215 m. Two (2), 10.211 m wide, travelled roadways accommodate two (2) lanes in both the eastbound and westbound direction. The roadway cross-section in both directions comprise a 0.455 m barrier wall, 2.589 m side clearance, two (2) 3.660 m lanes, 0.457 m shoulder, and 0.610 m centre concrete median. Concrete barrier walls with railings are provided on both sides and measure 1.009 m in height, from top of pavement to centre of railing. The substructure consists of concrete abutments, wingwalls, and piers with crashwalls supported on spread footings. The pier footings were founded on native stiff clay while the abutment footings were perched and constructed on compacted granular fill. The bridge was constructed at approximately 26° skew to the road alignment, which has an 873 m horizontal curve to the south.

The superstructure is superelevated at +4.1 % to the north, to accommodate the horizontal curve.

General views of the bridge are shown in Photographs 1 to 5 in Appendix D.

The bridge was last rehabilitated in 2004 under contract number R-1853B-2003. The work included; resurfacing 40 mm of the asphalt wearing surface, installing a seal in the longitudinal expansion joint, removal of the original railings and curbs, construction of new PL-2 concrete barriers with railing, installing asphaltic plug seals over abutment and pier expansion joints, and local patching of the concrete deck at the curb face.

One (1) previous condition survey was undertaken for the Regional Municipality of Halton, in 1999 by Totten Sims Hubicki Associates. The 1999 *Bridge Inspection Report* included the results of inspection of sawn asphalt samples and concrete cores. In addition, two (2) municipal bridge appraisal inspections were completed in 1999 and 2006.

This condition survey was undertaken as part of an environmental assessment (EA) for the planned widening of Dundas Street. The condition survey was completed in accordance with the *Structure Rehabilitation Manual* (MTO, April 2007) for update surveys on one lane in each direction. Based on the age and existing condition of the structure, some investigation methods were modified.

Half of the bridge deck was assessed to obtain a reasonable representation of the deck's overall condition for the EA. The right lane and right shoulder of the eastbound direction were investigated. Similarly, the left lane and left shoulder of the westbound direction were investigated.

Throughout the following report, reference is made to photographs included in Appendix D.

The soffit and substructure was visually inspected by MRC on May 28, 2009. See the MRC report for details, *"Dundas Street – CNR OHD Bridge Inspection Soffit and Substructure"*, which is included in Appendix G.

2. SUMMARY OF SIGNIFICANT FINDINGS

2.1 Bituminous Surface and Waterproofing

The asphalt wearing surface on the Dundas Street - CNR Bridge was partially replaced during the 2004 rehabilitation and appears to be in fair condition. There are several sealed and unsealed longitudinal and transverse cracks (see photograph 10). There are transverse sealed cracks spanning the width of the bridge at the edge of the east and west approach slabs. In total, approximately 60 m of longitudinal light and medium cracks were noted on the deck surface.

The thickness of the asphalt and bituminous waterproofing system on the deck, measured from the core and sawn sample locations, varied from 66 mm to 185 mm and averaged 132 mm. The thickness of the asphalt on the approaches measured 152 mm (east) and 130 mm (west) at approach core locations.

Based on field observations, a bituminous type waterproofing was observed at sample locations. Waterproofing thickness ranged from 5 mm to 10 mm with an average thickness of 6 mm.

In addition, an epoxy resin was applied to the concrete deck surface extending 457 mm to both sides of the centre median (before pouring curb and median). This material is believed to have been encountered at several core and sawn asphalt sample locations.

2.2 Concrete Deck

The deck consists of a reinforced concrete slab built as part of the original construction contract. During the 2004 rehabilitation, patching of the deck along the curb face was completed where delaminated and spalled concrete was found. In general, the concrete deck is in fair condition.

2.2.1 Sawn Asphalt Samples

A total of five (5) sawn asphalt samples were removed from the asphalt wearing surface. Several qualitative and quantitative observations were made at each sawn asphalt sample location. The bond of the asphalt to the waterproofing was observed, as well as the bond of the waterproofing to the concrete deck. The condition of the deck was inspected for delaminations, scaling and cracks. The concrete cover and asphalt thickness were also measured. Descriptions and photographs of the sawn asphalt samples are included in Appendix C.

At three (3) of the five (5) sample locations, no defects or deterioration were noted in the concrete. At sawn sample S4, the concrete deck appeared to be in good condition (see photograph 12). However, a core taken at this location revealed a void within the concrete deck (see Section 2.2.2 for details). At sawn sample S5, scaling was noted on the concrete surface after the asphalt had been removed (see photograph 14).

The asphalt at the sawn asphalt sample locations was in good condition. The asphalt thickness ranged from 80 mm to 140 mm with an average thickness of 120 mm based on sawn samples.

The thickness of the bituminous waterproofing system ranged from 5 mm to 13 mm with an average thickness of 9 mm. The waterproofing system was noted in good to fair condition overall.

The bond of waterproofing to the underlying concrete surface was noted to be in good to fair condition at all sample locations. Upon removal of the asphalt wearing surface and waterproofing, the deck was found dry, indicating that the waterproofing system is performing adequately.

The concrete cover readings, taken on the exposed concrete deck surface, ranged from 65 mm to 77 mm for the longitudinal reinforcing steel bars and 62 mm to 78 mm for the transverse reinforcing steel bars. The average cover to the top layer of reinforcing steel was 71 mm (transverse).

2.2.2 Core Samples

Cores were removed from the deck for several purposes. Upon removal, a visual inspection was completed on the concrete deck and any reinforcing steel that may have been intercepted. The cores were also used to verify the depth of concrete cover.

Twenty-four (24) cores were retrieved from the structure, which includes two (2) approach slab cores (one from each slab). All cores were 100 mm in diameter. The depth of the concrete in the cores varied from 30 mm to 180 mm (average depth of 110mm).

Transverse and longitudinal reinforcing steel bars (#5) were exposed at sixteen (16) core locations. At core location C11, which was located at the east approach slab, a #6 longitudinal reinforcing bar was exposed. On average, concrete cover measured 58 mm and ranged from 30 mm to 80 mm. The exposed rebar showed light corrosion at eight (8) core locations. The other eight (8) locations showed no signs of deterioration.

In summary, twenty-one (21) of the core samples were found in good condition.

Light corrosion was noted on the reinforcing steel intercepted at core C17. Vertical cracking, in the transverse direction, was also observed in the core. The cracks extended from the top of the concrete deck surface to below the level of the reinforcing steel. Rust stains were observed within the adjacent areas of the concrete (see photograph 16).

A horizontal construction joint was noted in cores C16 and C24 (see photograph 15). Both cores were retrieved from the westbound structure within the main span. Both cores were taken within 300 mm of the centre concrete median. Upon inspection of the cores, a horizontal construction joint was observed in both cores approximately 70 mm below the concrete surface. An unknown substance (powder) was noted within the concrete interface (see photographs 12 and 13). Based on the original contract drawings, the concrete joint encountered is believed to be the concrete gutter and deck joint interface. The material in the joint may be a bonding agent and / or debris build-up.

We note that the epoxy resin protective membrane was encountered at these two core locations.

2.2.3 Core Testing

MRC retained the services of Golder Associates to provide destructive testing services. Cores were tested in accordance to the *Structure Rehabilitation Manual* (MTO, April 2007). Three (3) testing procedures were undertaken to determine the chloride content, air void system, and compressive strength. In total, six (6) cores were selected for destructive testing purposes.

The chloride ion content of the deck was determined by testing two (2) core samples for acid soluble chloride ion content. The core samples, C1 and C14, were retrieved from areas of the deck with higher corrosion potentials and tested for chloride ion content.

The chloride content profile was measured from successive 10 mm thick slices to a depth of 90 mm. Testing procedures and review of the cores were in accordance with Cores for Total Soluble Chloride Ion Content (MTO LS-417).

The *Structure Rehabilitation Manual* states that a chloride content of 0.20% or greater by mass of cement is necessary to react with embedded steel and permit corrosion. For a typical cement factor of 300 kg/m^3 this corresponds to a chloride content of 0.025% by mass of concrete.

In determining the chloride content profile, it is necessary to establish a background chloride content value. The value is taken as the lowest measured reading from all the cores to set a benchmark. This value represents the chloride content which may have already been in place at the time of construction, and does not contribute to the corrosion. The actual chloride content reading is subtracted by the background value to obtain a corrected measurement.

The background chloride ion content was 0.065% and was found in the 80-90 mm horizon of core number C14.

Table 2.3.1 – Chloride Ion Content Testing Summary

Core Sample Tested for Chloride Ion Content	Depth at Which Chloride Ion Content of 0.025% is Exceeded*
C1	80-90 mm
C14	none
** A chloride content of 0.025% by mass of concrete is the minimum required to permit corrosion of embedded reinforcing steel.*	

It should be noted that C1 contained only one (1) layer, 80 mm to 90 mm horizon, which exceeded a chloride content of 0.025 %. All the other layers, 0 mm to 70 mm depth, had a corrected chloride content level less than 0.013 %. Observations in the field do not indicate a cause of this occurrence. A higher chloride level is typically expected at the deck surface where the ingress of chloride ions is expected.

Cover meter readings at the sawn asphalt sample locations and the cover measured at core locations show that the reinforcing steel is located approximately 60 mm below the concrete surface. We note that light corrosion was observed in half of the core samples where reinforcing steel was exposed.

As noted in the core logs, of all the ten (10) layers tested for chloride ion content, only one (1) layer exceeds a content of 0.025 %.

The *MTO Structure Rehabilitation Manual* classifies concrete as properly entrained with air if the following parameters are met:

(1) Air content > 3 %;
(2) Spacing factor < 0.20 mm; and
(3) Specific surface > 24 mm^2/mm^3.

Core C10 and C19 was tested for hardened air void system parameters in accordance to ASTM C457. The results indicated adequate air content, specific surface, and spacing factors in C19. Specific surface and spacing factor limits were not met in core C10.

Core C3 and C18 were tested for compressive strength in accordance to CSA A23.2-00-14C. Results indicated a corrected compressive strength of 58.1 MPa and 63.1 MPa for C3 and C18, respectively.

Indication of which cores have been tested is given in the condition survey drawings included in Appendix E.

A summary of the test results is included for each core log within Appendix B. In addition, the test reports are included in Appendix F.

2.2.4 Corrosion Potential Survey

The corrosion potential readings are grouped into three ranges as follows:

- ***Low Range***: If potentials over an area are numerically less than -0.20V, there is a greater than 90% probability that no reinforcing steel corrosion is occurring in that area at the time of measurement;
- ***Mid Range***: If potentials over an area are within the range of -0.20V to -0.35V, corrosion activity of the reinforcing steel in that area is uncertain; and
- ***High Range***: If potentials over an area are numerically greater than -0.35V, there is a greater than 90% probability that reinforcing steel corrosion is occurring in that area at the time of measurement.

Table 2.1 below provides a summary of the corrosion potential readings recorded during testing.

Table 2.1 – Corrosion potential reading summary

Corrosion Potential (V)	% of Surveyed Deck Area
0.000 to -0.200	60
-0.200 to -0.350	34
Less than -0.350	6

Based upon the above results, the reinforcing steel in 6 % of the deck area has a high probability of active corrosion. The highest corrosion potential readings were found adjacent to centre median. Areas of high corrosion potential were confirmed, with three (3) core samples, where light corrosion was noted in the reinforcing steel. Furthermore, 34 % of the deck area is identified as having an uncertain corrosion activity.

The above readings do not include corrosion potential readings taken directly on the centre median. All twenty-seven (27) readings indicate a corrosion potential value less than -0.350 V.

The corrosion potential readings are presented in Appendix E.

2.3 Other Components

2.3.1 Expansion Joints

A longitudinal expansion joint is used to separate the eastbound superstructure and westbound superstructure. The original joint was replaced with a Jeene 25 mm type "W" joint seal during the rehabilitation work completed in 2004. The existing 150 mm wide waterstop was part of the original construction and has not been modified since. Condition from the above surface indicates that the joint is brittle and has little ductility. A visual inspection from below the structure confirms that the longitudinal joint is leaking (see photographs 18 and 19).

Transverse expansion joints are used at abutments and piers due to the simply supported superstructure arrangement. Based on the original contract drawings, joints consist of a Thiokol sealer between concrete interfaces. In addition to the sealer, the joints at the piers consist of a waterstop across the width of the bridge. Joints were paved over with an asphaltic plug seal during the 2004 rehabilitation contract (see photograph 11). The asphalt material is in poor condition and has depressed below the bridge deck wearing surface since the time of placement, causing an uneven riding surface. Visual inspection from below the structure indicates leaking joints at the abutments and piers.

2.3.2 Drainage

The eastbound and westbound roadway is superelevated +4.1% from the south to north. In the westbound direction, water drains towards and is collected by the centre median. In the eastbound direction, water drains towards the concrete barrier wall.

The structure lies on a vertical crest curve on the Dundas Street road alignment. Based on the original structure contract drawings, the roadway at the bridge allows water to runoff in both the east and west direction (towards the abutments). A 5% roadway grade exists on the west approach. Similarly, a 4% roadway grade exists on the east approach.

Catch basins were noted on the on the curb face of the eastbound lanes, at the east and west approach.

2.3.3 Barrier Walls and Railings

Concrete barrier walls with railing were constructed as part of the 2004 rehabilitation work. The walls are generally in fair condition. A delamination survey was completed on the south wall only. The south wall contained thirty-five (35) vertical medium cracks, most of which were noted stained (see photograph 20). A 50 x 700 mm area of spalling was noted.

The north wall was generally in the same condition as the south wall. However, medium concrete scaling was noted on top of the concrete wall at the east end.

Railing consists of a single galvanized steel tube, 90 mm in diameter. The railing is in good condition and was noted with small local areas of light corrosion.

2.3.4 Approaches

The asphalt wearing surface on the approaches is in fair condition with a medium transverse crack at the ends of the approach slabs.

Cores C11 and C22 confirmed that approach slabs exists on the east and west approach. C11 was taken at full depth through the 145 mm thick east approach slab, and was found underlying a 152 mm thick layer of asphalt. Core C22 revealed the west approach slab underlying 130 mm of asphalt. Reinforcing steel within the approach slab is in good condition as observed from core C11.

There are steel beam guide rails (SBGR) at all four corners of the bridge. Based on the applicable standard drawings listed on the rehabilitation contract drawings, the connection of the rails to the barrier walls and assembly is in accordance with current standards.

Concrete curbs exist beyond the ends of barrier walls, at all four corners. Settlement of the underlying fill contributes to the observed cracking of the curbs.

2.3.5 Utilities and Signage

Four (4) utility ducts were originally located within the concrete curbs as part of the original construction. When the structure was rehabilitated, the ducts were removed at the same time as the curbs.

No utilities or light standards are presently located on the structure. A utility aerial line runs parallel to the bridge on the south side. Light standards are located along the westbound lanes at both approaches.

The eastbound roadway is posted with an "80 km/h maximum speed limit" sign and a "bridge ices" sign, southwest of the bridge. A "traffic light ahead" sign was observed on the south side of the east approach.

2.4 Discussions and Conclusions

Test results are similar to those obtained in 1999, indicated in the bridge inspection report. The chloride ion content range, in two cores, was measured from 0.065% to 0.091%. Similarly, in the previous bridge inspection report, the chloride ion content measured between 0.065 % and 0.086%. This slight difference in value indicates a slightly higher level of chloride ion content in the bridge deck since the last inspection (ten (10) years ago). Corrosion potential readings have increased in severity as well. Previously the bridge deck contained no areas of high range corrosion potential, whereas now 6 % is noted. Compressive strength results (58.1 MPa and 63.1 MPa) correspond to approximately the same values as previously noted (59.2 MPa and 62.9 MPa).

The wearing surface appears to be in fair condition based on visual inspection at core and sawn asphalt sample locations. Few areas of narrow and medium cracking in the asphalt were noted. However, the asphaltic plug seals appeared depressed below the deck wearing surface causing an uneven riding surface. In several areas, the asphaltic plug seals appeared to have been previously patched with cold mix asphalt. Some of these areas contained voids or missing material. This may contribute to the leaking joints by allowing water to penetrate the expansion joints.

The average thickness of the asphalt wearing surface measured 132 mm at core and sawn sample locations. Asphalt thicknesses were measured at half cell reading locations and are shown in Drawing 3 of Appendix E. Asphalt was milled and replaced in the last rehabilitation and should have a thickness of 90 mm ± as specified in the rehabilitation drawings. In addition, the asphalt plug seals were placed at the same height as the asphalt wearing surface. It is unknown whether this asphaltic plug seal height is able to provide acceptable resistance to compressive forces (i.e. traffic loads). The observed depressions in the plug seals may indicate inadequate resistance to loads. The material may be too flexible given the height.

The core and sawn asphalt samples retrieved were generally in good condition with the exception of two (2) cores. Horizontal voids were noted in adjacent cores, C16 and C24. We note that these cores were taken at the construction joint of the gutter and deck interface. An unknown substance was observed between the concrete interfaces of the voids.

Reinforcing steel generally appeared to be in good and fair condition. In half of the cores, light corrosion was noted in a small portion of the exposed reinforcing steel. We note that one (1) of the two (2) cores exceeded the chloride ion content level required for a high possibility of active corrosion. However, out of both cores, only one slice contained a chloride ion content level greater than 0.025 % by mass of concrete. All

other slices contained very low levels of chloride content. The high probability of corrosion in the bridge deck was confirmed with a corrosion potential survey. Six (6) percent of the bridge deck, that was inspected, is within the high range of corrosion potential (< -0.350 V).

The existing concrete barrier walls with steel railings, constructed in 2004, meet code requirements at this time. The existing barrier system meets current Canadian Highway Bridge Design Code (CHBDC) requirements. We note that the barriers are in good condition.

We also note that, similar to the barriers mentioned above, the steel beam guiderail connection to the concrete barriers also meet the requirements of current standards for post spacing and anchorage to the concrete barrier. This is based on field measurements and standards listed in the contract and rehabilitation drawings.

There are approach slabs; however there is notable settlement at the east and west approaches, which has contributed to a slight settlement of concrete roadside curbs.

APPENDIX A
DECK CONDITION SURVEY FORMS

SURVEY EQUIPMENT AND CALIBRATION PROCEDURES

Component Type: Deck **Site No.** 010-0175

1. Delaminations:

Weight of Chain: 2.2 **Kg/m**
Other Equipment: Mason's hammer

2. Concrete Cover:

Covermeter Make and Model: Elcometer Protovale 331, Model T
Battery Check: **Reading at Start of Test:** O.K.
Reading at End of Test: O.K.
Concrete Cover Check: **Location of Check:** Concrete block with reinforcing steel
Actual Depth & Rebar Dia.: Cover: 75 mm & Size: 15M
Reading Before Test: 75 mm
Readings Each 30 min During Test: 75 mm
Readings End of Test: 75 mm

3.0 Corrosion Activity

3.1 Corrosion Activity (July 7th, 2009 – West exterior span of EBL structure):

Half Cell Make & Model: Cupric Sulphate, MCM RE-5
Multimeter Make & Model: Radio Shack CAT NO. 22-813
Length and Gauge of Lead Wires: 120m - #16
Deck Temp: **Start of Test:** 24.5 ^{0}C **End of Test:** 25.0 ^{0}C
Ambient Temp: **Start of Test:** 20.0 ^{0}C **End of Test:** 29.5 ^{0}C
Battery Check: O.K.
Ground Check: **Method of Connection:** Compression clamp

Ground Location:	K1 100 S 200 E	**Check Location:**	N7 600 N 600 E
Lead Resistance:	1.4Ω	**Voltage Drop (mV's):**	0.2 mV
Resistance:	3.6Ω	**Resistance Reversed:**	3.8Ω

Grid Point Potential Readings Check - See Table Below

Location	Initial Reading	Check Reading*	Check Reading - Latex Concrete Overlay**
L3	-0.197 V	-0.206 V	N/A
L4	-0.176 V	-0.199 V	N/A
L5	-0.184 V	-0.180 V	N/A
L6	-0.167 V	-0.170 V	N/A
L7	-0.158 V	-0.159 V	N/A

3.2 Corrosion Activity (July 7th, 2009 – Interior spans of EBL structure):

Half Cell Make & Model: Cupric Sulphate, MCM RE-5
Multimeter Make & Model: Radio Shack CAT NO. 22-813
Length and Gauge of Lead Wires: 120m - #16
Deck Temp: **Start of Test:** 24.5 ^{0}C **End of Test:** 25.0 ^{0}C
Ambient Temp: **Start of Test:** 20.0 ^{0}C **End of Test:** 29.5 ^{0}C
Battery Check: O.K.
Ground Check: **Method of Connection:** Compression clamp

Ground Location:	K10 350 N 140 W	**Check Location:**	N20 250 N 1050 E
Lead Resistance:	0.9Ω	**Voltage Drop (mV's):**	0.4mV
Resistance:	1.1Ω	**Resistance Reversed:**	1.5Ω

Grid Point Potential Readings Check - See Table Below

Location	Initial Reading	Check Reading*	Check Reading - Latex Concrete Overlay**
K13	-0.110 V	-0.103 V	N/A
K14	-0.111 V	-0.101 V	N/A
K15	-0.144 V	-0.142 V	N/A
K16	-0.125 V	-0.104 V	N/A
K17	-0.114 V	-0.100 V	N/A

4.3 Corrosion Activity (July 7th, 2009 – East exterior span of EBL structure):

Half Cell Make & Model: Cupric Sulphate, MCM RE-5
Multimeter Make & Model: Radio Shack CAT NO. 22-813
Length and Gauge of Lead Wires: 120m - #16

Deck Temp:	**Start of Test:**	24.5 ^{0}C	**End of Test:**	25.0 ^{0}C
Ambient Temp:	**Start of Test:**	20.0 ^{0}C	**End of Test:**	29.5 ^{0}C

Battery Check: O.K.

Ground Check: **Method of Connection:** Compression clamp

Ground Location:	K22 300 S 600 W	**Check Location:**	N29 600 N 250 W
Lead Resistance:	0.8Ω	**Voltage Drop (mV's):**	0.3mV
Resistance:	0.7Ω	**Resistance Reversed:**	0.9Ω

Grid Point Potential Readings Check - See Table Below

Location	Initial Reading	Check Reading*	Check Reading - Latex Concrete Overlay**
N22	-0.334 V	-0.335 V	N/A
N23	-0.212 V	-0.215 V	N/A
N24	-0.314 V	-0.330 V	N/A
N25	-0.372 V	-0.375 V	N/A
N26	-0.385 V	-0.381 V	N/A

3.4 Corrosion Activity (July 8th, 2009 – West exterior span of WBL structure):

Half Cell Make & Model: Cupric Sulphate, MCM RE-5
Multimeter Make & Model: Radio Shack CAT NO. 22-813
Length and Gauge of Lead Wires: 120m - #16

Deck Temp:	**Start of Test:**	20.0 °C	**End of Test:**	23.5 °C
Ambient Temp:	**Start of Test:**	22.0 °C	**End of Test:**	27.0 °C

Battery Check: O.K.

Ground Check: **Method of Connection:** Compression clamp

Ground Location:	E1 100 N 100 E	**Check Location:**	G8 500 N 300 E
Lead Resistance:	7.9Ω	**Voltage Drop (mV's):**	0.3mV
Resistance:	4.5Ω	**Resistance Reversed:**	5.2Ω

Grid Point Potential Readings Check - See Table Below

Location	Initial Reading	Check Reading*	Check Reading - Latex Concrete Overlay**
F1	-0.227 V	-0.234 V	N/A
F2	-0.178 V	-0.185 V	N/A
F3	-0.130 V	-0.170 V	N/A
F4	-0.144 V	-0.154 V	N/A
F5	-0.130 V	-0.138 V	N/A

3.5 Corrosion Activity (July 8th, 2009 – Interior spans of WBL structure):

Half Cell Make & Model: Cupric Sulphate, MCM RE-5
Multimeter Make & Model: Radio Shack CAT NO. 22-813
Length and Gauge of Lead Wires: 120m - #16

Deck Temp:	**Start of Test:**	20.0 ^{0}C	**End of Test:**	23.5 ^{0}C
Ambient Temp:	**Start of Test:**	22.0 ^{0}C	**End of Test:**	27.0 ^{0}C

Battery Check: O.K.

Ground Check: **Method of Connection:** Compression clamp

Ground Location:	E10 750 W	**Chéck Location:**	G20 450 N 600 E
Lead Resistance:	2.3Ω	**Voltage Drop (mV's):**	10.5mV
Resistance:	10.1Ω	**Resistance Reversed:**	9.5Ω

Grid Point Potential Readings Check - See Table Below

Location	Initial Reading	Check Reading*	Check Reading - Latex Concrete Overlay**
G10	-0.362 V	-0.366 V	N/A
G11	-0.310 V	-0.318 V	N/A
G12	-0.216 V	-0.224 V	N/A
G13	-0.221 V	-0.238 V	N/A
G14	-0.326 V	-0.330 V	N/A

3.6 Corrosion Activity (July 8th, 2009 – East exterior span of WBL structure):

Half Cell Make & Model: Cupric Sulphate, MCM RE-5
Multimeter Make & Model: Radio Shack CAT NO. 22-813
Length and Gauge of Lead Wires: 120m - #16

Deck Temp:	**Start of Test:**	20.0 ^{0}C	**End of Test:**	23.5 ^{0}C
Ambient Temp:	**Start of Test:**	22.0 ^{0}C	**End of Test:**	27.0 ^{0}C

Battery Check: O.K.

Ground Check: **Method of Connection:** Compression clamp

Ground Location:	E22 200 N 850 W	**Check Location:**	G29 300 N 400 W
Lead Resistance:	6.1Ω	**Voltage Drop (mV's):**	0.1mV
Resistance:	1.4Ω	**Resistance Reversed:**	3.5Ω

Grid Point Potential Readings Check - See Table Below

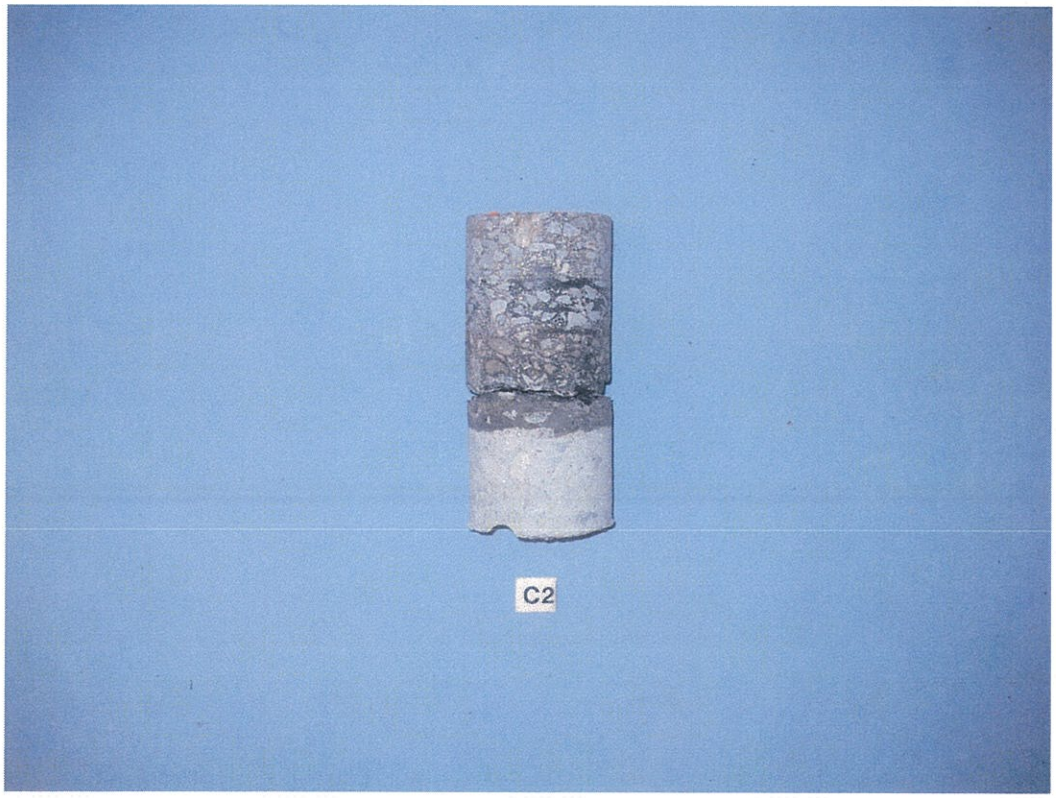
Location	Initial Reading	Check Reading*	Check Reading - Latex Concrete Overlay**
F24	-0.114 V	-0.110 V	N/A
F25	-0.125 V	-0.122 V	N/A
F26	-0.196 V	-0.201 V	N/A
F27	-0.226 V	-0.239 V	N/A
F28	-0.232 V	-0.236 V	N/A

* Check at least 5 readings at beginning of test and each change in ground.

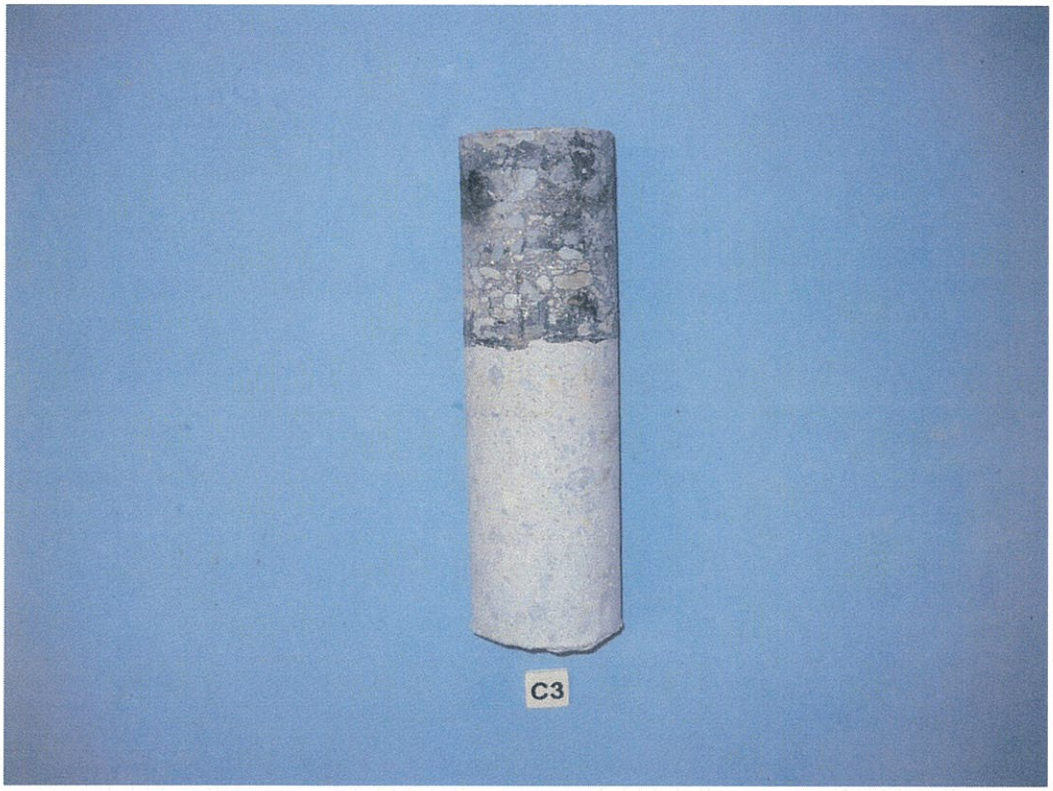
** On decks with latex modified concrete overlay, check at least 5 locations by drilling holes through the latex concrete overlay into the original concrete substrate.

APPENDIX B
CORE PHOTOGRAPHS, SKETCHES, AND LOGS

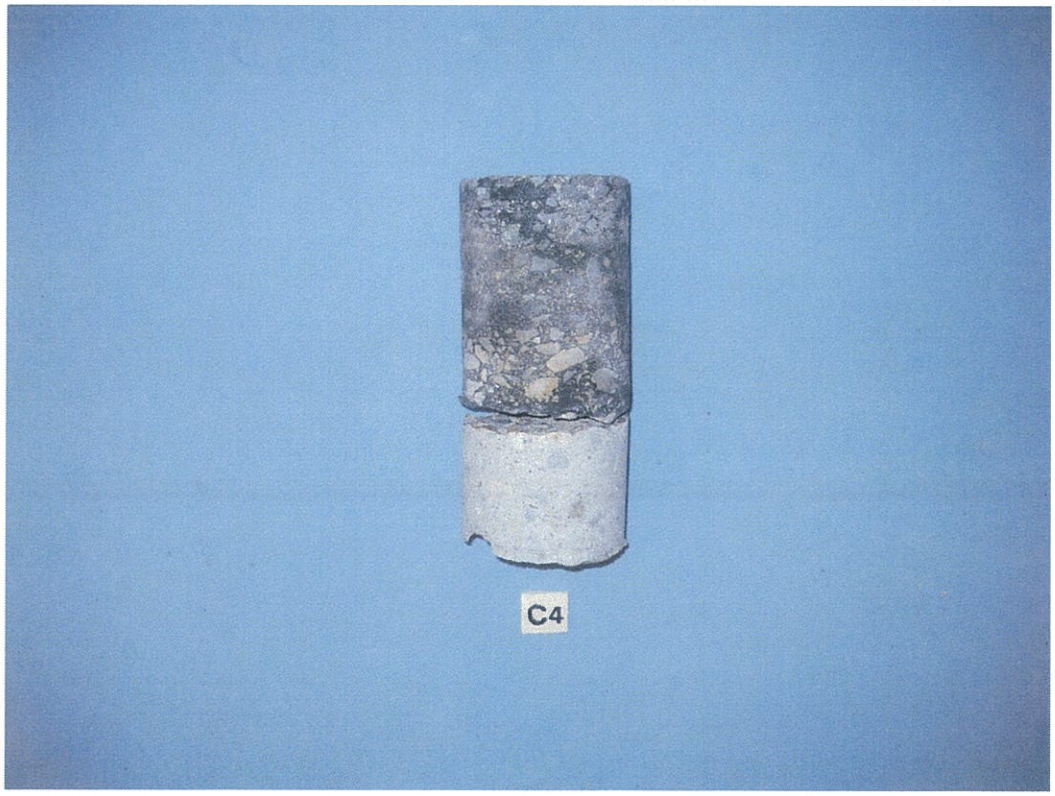
CORE C1



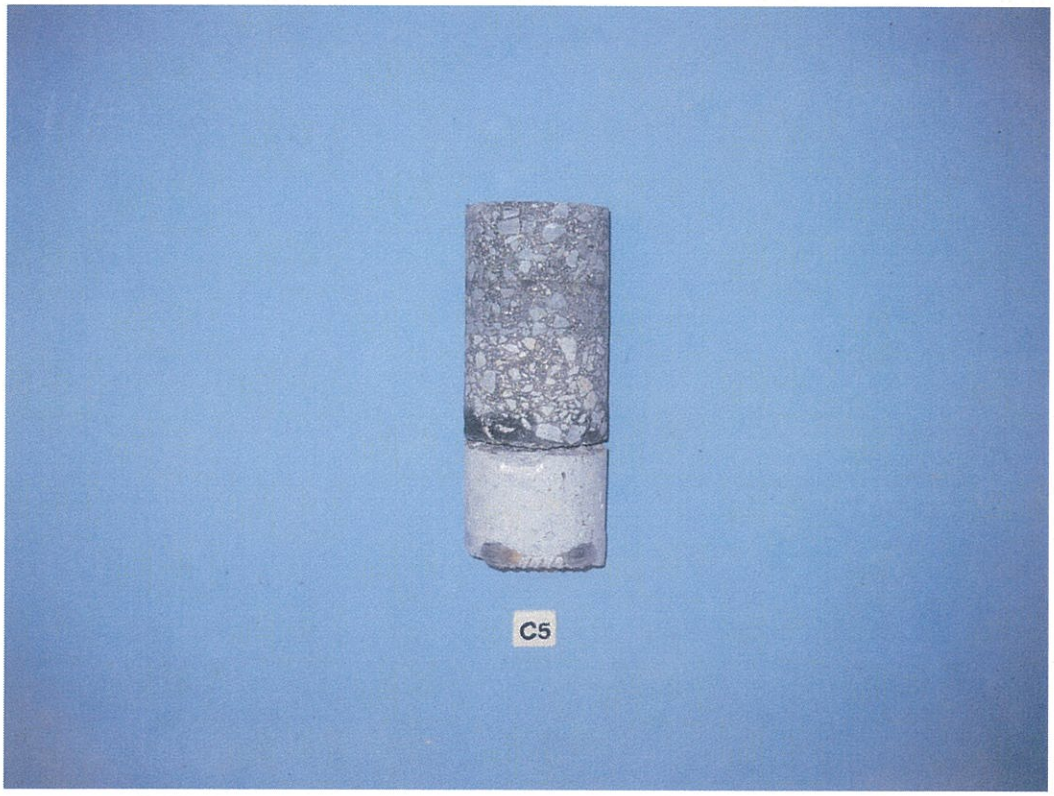
CORE C2



CORE C3



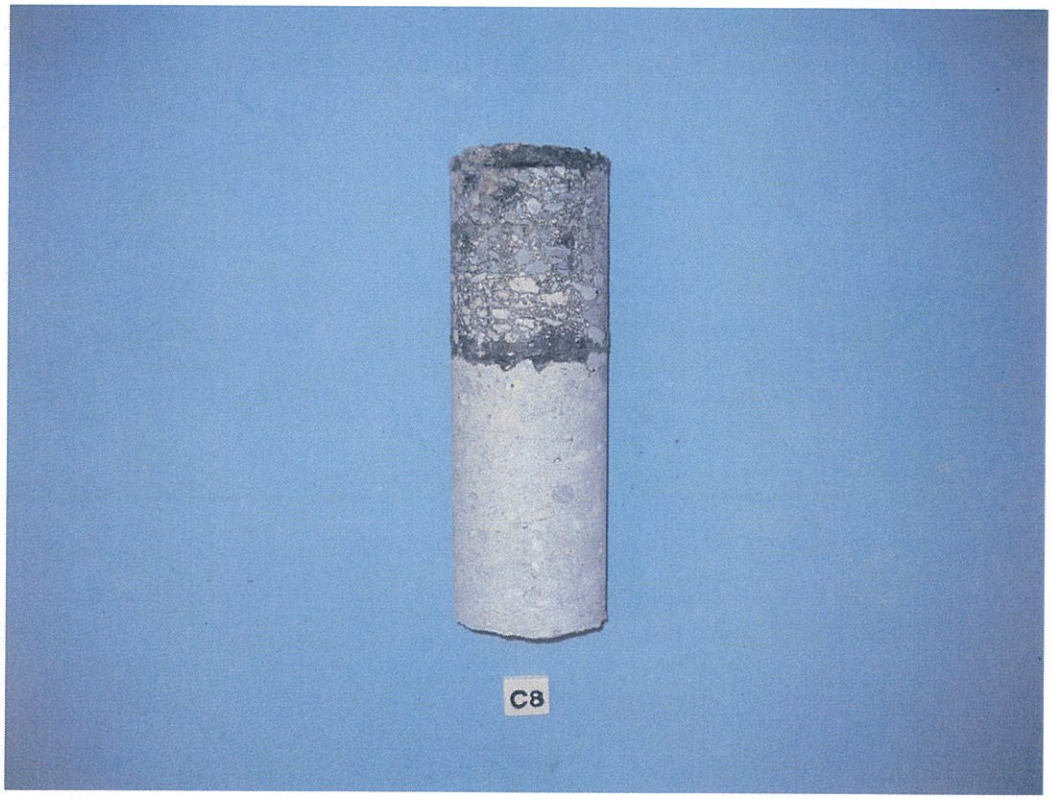
CORE C4



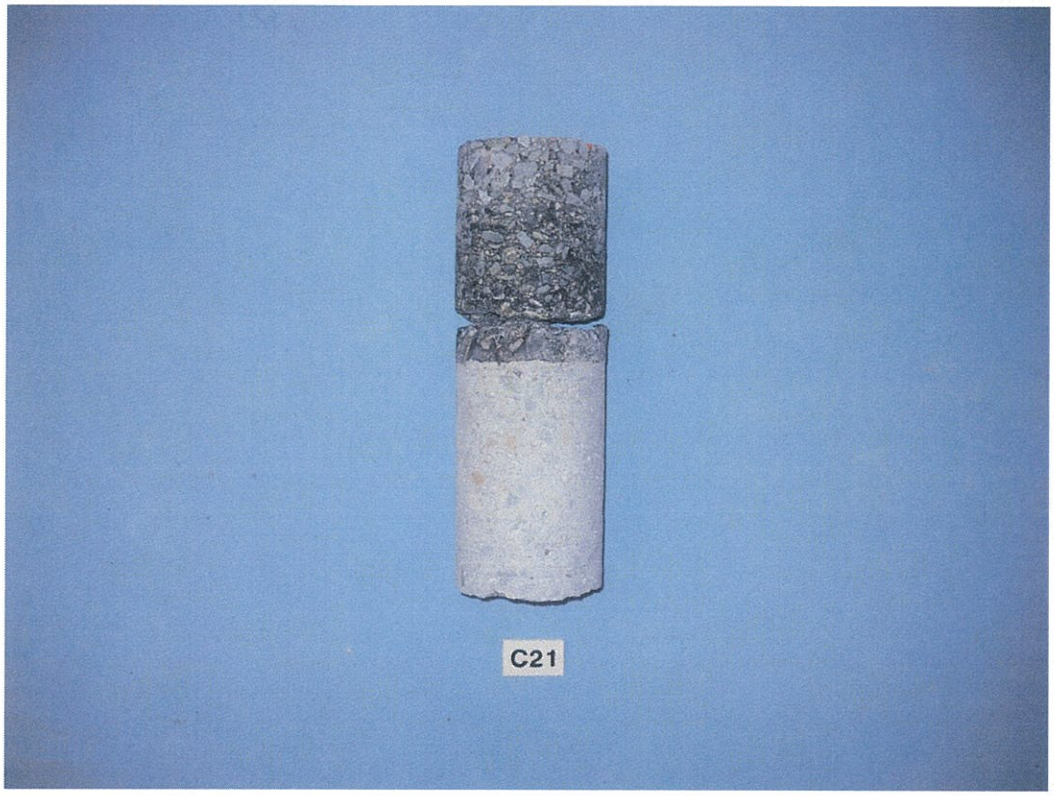
CORE C5

CORE C6

CORE C7

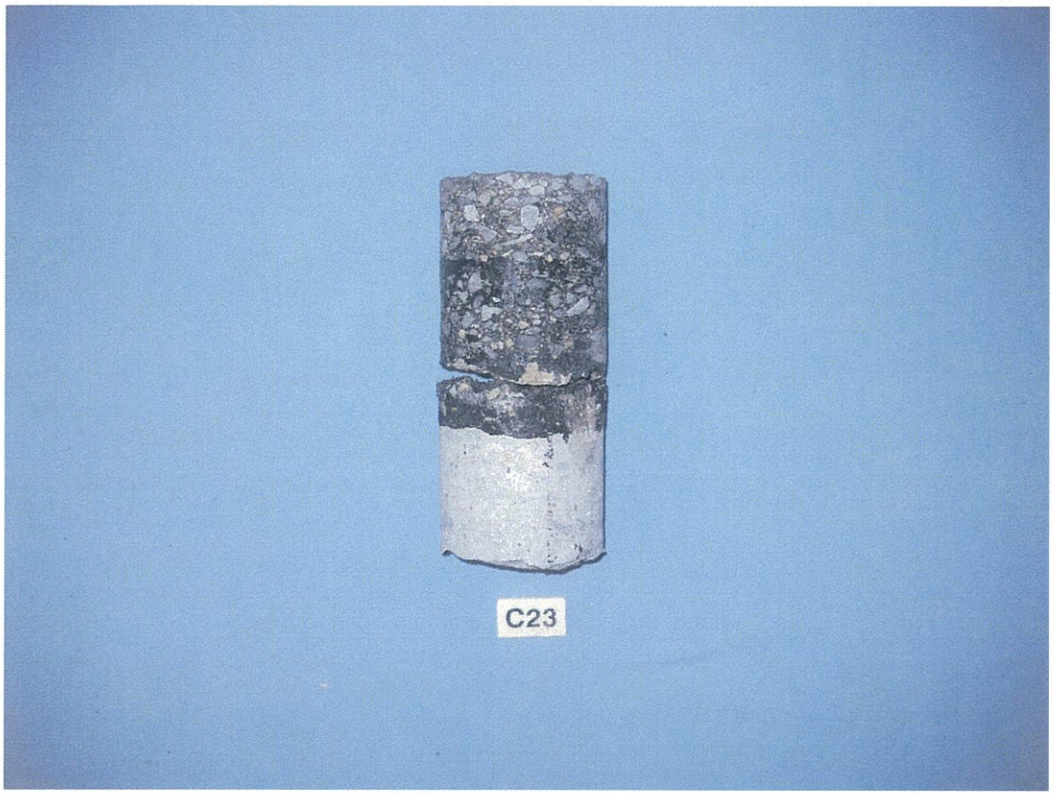


CORE C8



CORE C21

CORE C22



CORE C23

CORE C24

CORE LOG ASPHALT COVERED BRIDGE DECKS

Core No.		C1		C2		C3	
Location		K1 200 E 100 S		N8 900 W 600 N		K10 140 W 480 N	
Diameter, mm		100		100		100	
Thickness of asphalt, mm		126		60		180	
Asphalt Thickness at Nearest Grid Point, mm		120		100		140	
Thickness of Concrete, mm		125		60		180	
Full Depth, (Yes/No)		No		No		No	
Condition of Asphalt[1]		G		G		G	
Waterproofing (W/P) Type		Bituminous		Bituminous		Bituminous	
Condition of W/P[1]		G		G		G	
W/P Thickness, mm		5		6		5	
Bond of Asphalt or W/P to Concrete		G		G		G	
Defects in Concrete[2]		None		None		None	
Condition Rebar[3]		G		LR		N/A	
Corrosion Potential, V		-0.364		-0.205		-0.157	
Compressive Strength, MPa		-		-		58.1	
		Total	Corrected	Total	Corrected	Total	Corrected
Chloride Content % Chloride by weight of concrete	0 - 10 mm	0.067	0.002	-	-	-	-
	20 – 30 mm	0.073	0.008	-	-	-	-
	40 – 50 mm	0.078	0.013	-	-	-	-
	60 – 70 mm	0.074	0.009	-	-	-	-
	80 – 90 mm	0.091	0.026	-	-	-	-
Air Voids	Air Content, %	-		-		-	
	Spec. surf., mm^2/mm^3	-		-		-	
	Spacing factor, mm	-		-		-	
Testing Laboratory		Golder Associates		-		Golder Associates	
Remarks - Orientation of rebars and cover (L=Longitudinal, T=Transverse) - Presence of overlay, patch, and thickness - Other observed defects		• #5 Transverse – 125 mm cover • #5 Transverse – 125 mm cover • Ground location		• #5 Transverse – 60 mm cover • Ground check			

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed

CORE LOG ASPHALT COVERED BRIDGE DECKS

Core No.		C4		C5		C6	
Location		K10 140 W 350 N		L17 350 W 450 N		N20 1050 E 250 N	
Diameter, mm		100		100		100	
Thickness of asphalt, mm		130		150		140	
Asphalt Thickness at Nearest Grid Point, mm		140		140		95	
Thickness of Concrete, mm		70		90		30	
Full Depth, (Yes/No)		No		No		No	
Condition of Asphalt[1]		G		G		G	
Waterproofing (W/P) Type		Bituminous		Bituminous		Bituminous	
Condition of W/P[1]		G		G		G	
W/P Thickness, mm		5		5		5	
Bond of Asphalt or W/P to Concrete		G		G		P	
Defects in Concrete[2]		None		None		None	
Condition Rebar[3]		LR		G		LR	
Corrosion Potential, V		-0.157		-0.105		-0.204	
Compressive Strength, MPa		-		-		-	
Chloride Content % Chloride by weight of concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0 - 10 mm	-	-	-	-	-	-
	20 – 30 mm	-	-	-	-	-	-
	40 – 50 mm	-	-	-	-	-	-
	60 – 70 mm	-	-	-	-	-	-
	80 – 90 mm	-	-	-	-	-	-
Air Voids	Air Content, %	-		-		-	
	Spec. surf., mm^2/mm^3	-		-		-	
	Spacing factor, mm	-		-		-	
Testing Laboratory		-		-		-	
Remarks - Orientation of rebars and cover (L=Longitudinal, T=Transverse) - Presence of overlay, patch, and thickness - Other observed defects		• #5 Transverse – 70 mm cover • Ground location		• #5 Transverse – 60 mm cover		• #5 Transverse – 30 mm cover • Ground check	

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed

CORE LOG ASPHALT COVERED BRIDGE DECKS

Core No.		C7		C8		C9	
Location		N20 1000 E 150 N		K22 600 W 150 S		K22 600 W 300 S	
Diameter, mm		100		100		100	
Thickness of asphalt, mm		140		110		110	
Asphalt Thickness at Nearest Grid Point, mm		95		150		150	
Thickness of Concrete, mm		130		160		80	
Full Depth, (Yes/No)		No		No		No	
Condition of Asphalt[1]		G		G		G	
Waterproofing (W/P) Type		Bituminous		Bituminous		Bituminous	
Condition of W/P[1]		G		G		G	
W/P Thickness, mm		7		5		5	
Bond of Asphalt or W/P to Concrete		P		G		G	
Defects in Concrete[2]		None		None		None	
Condition Rebar[3]		G		N/A		G	
Corrosion Potential, V		-0.204		-0.155		-0.155	
Compressive Strength, MPa		-		-		-	
Chloride Content % Chloride by weight of concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0 - 10 mm	-	-	-	-	-	-
	20 – 30 mm	-	-	-	-	-	-
	40 – 50 mm	-	-	-	-	-	-
	60 – 70 mm	-	-	-	-	-	-
	80 – 90 mm	-	-	-	-	-	-
Air Voids	Air Content, %	-		-		-	
	Spec. surf., mm^2/mm^3	-		-		-	
	Spacing factor, mm	-		-		-	
Testing Laboratory		-		-		-	
Remarks - Orientation of rebars and cover (L=Longitudinal, T=Transverse) - Presence of overlay, patch, and thickness - Other observed defects		• #5 Transverse – 30 mm cover				• #5 Transverse – 80 mm cover • Ground location	

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed

CORE LOG ASPHALT COVERED BRIDGE DECKS

Core No.		C10		C11		C12	
Location		N29 250 W 600 N		L29 2100 E		E1 100 E 100 N	
Diameter, mm		100		100		100	
Thickness of asphalt, mm		140		152		130	
Asphalt Thickness at Nearest Grid Point, mm		140		-		160	
Thickness of Concrete, mm		60		145		50	
Full Depth, (Yes/No)		No		Yes		No	
Condition of Asphalt[1]		G		G		G	
Waterproofing (W/P) Type		Bituminous		-		Bituminous	
Condition of W/P[1]		G		-		G	
W/P Thickness, mm		5		-		7	
Bond of Asphalt or W/P to Concrete		G		F		G	
Defects in Concrete[2]		None		None		None	
Condition Rebar[3]		LR		G		G	
Corrosion Potential, V		-0.442		-		-0.263	
Compressive Strength, MPa		-		-		-	
Chloride Content % Chloride by weight of concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0 - 10 mm	-	-	-	-	-	-
	20 – 30 mm	-	-	-	-	-	-
	40 – 50 mm	-	-	-	-	-	-
	60 – 70 mm	-	-	-	-	-	-
	80 – 90 mm	-	-	-	-	-	-
Air Voids	Air Content, %	6.4		-		-	
	Spec. surf., mm^2/mm^3	20.83		-		-	
	Spacing factor, mm	0.177		-		-	
Testing Laboratory		Golder Associates		-		-	
Remarks - Orientation of rebars and cover (L=Longitudinal, T=Transverse) - Presence of overlay, patch, and thickness - Other observed defects		• #5 Transverse – 60 mm cover • Ground check		• East approach slab • #6 Longitudinal – 145 mm cover • #5 Transverse BLL bar – 165 mm cover		• #5 Transverse – 50 mm cover • Ground location	

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed

CORE LOG ASPHALT COVERED BRIDGE DECKS

Core No.		C13		C14		C15	
Location		G8 300 E 500 N		G8 300 E 300 N		E10 750 W	
Diameter, mm		100		100		100	
Thickness of asphalt, mm		110		120		120	
Asphalt Thickness at Nearest Grid Point, mm		150		150		150	
Thickness of Concrete, mm		70		180		60	
Full Depth, (Yes/No)		No		No		No	
Condition of Asphalt[1]		G		G		G	
Waterproofing (W/P) Type		Bituminous		Bituminous		Bituminous	
Condition of W/P[1]		G		G		G	
W/P Thickness, mm		7		5		5	
Bond of Asphalt or W/P to Concrete		G		G		G	
Defects in Concrete[2]		None		None		None	
Condition Rebar[3]		LR		N/A		LR	
Corrosion Potential, V		-0.374		-0.374		-0.082	
Compressive Strength, MPa		-		-		-	
		Total	Corrected	Total	Corrected	Total	Corrected
Chloride Content % Chloride by weight of concrete	0 - 10 mm	-	-	0.073	0.008	-	-
	20 – 30 mm	-	-	0.070	0.005	-	-
	40 – 50 mm	-	-	0.070	0.005	-	-
	60 – 70 mm	-	-	0.066	0.001	-	-
	80 – 90 mm	-	-	0.065	0.000	-	-
Air Voids	Air Content, %	-		-		-	
	Spec. surf., mm^2/mm^3	-		-		-	
	Spacing factor, mm	-		-		-	
Testing Laboratory		-		Golder Associates		-	
Remarks - Orientation of rebars and cover (L=Longitudinal, T=Transverse) - Presence of overlay, patch, and thickness - Other observed defects		• #5 Transverse – 70 mm cover • Ground check				• #5 Transverse – 60 mm cover • Ground location	

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed

CORE LOG ASPHALT COVERED BRIDGE DECKS

Core No.		C16		C17		C18	
Location		G14 600 E 450 S		G20 600 E 450 N		G20 700 E 300 N	
Diameter, mm		100		100		100	
Thickness of asphalt, mm		85		140		140	
Asphalt Thickness at Nearest Grid Point, mm		160		150		150	
Thickness of Concrete, mm		165		155		130	
Full Depth, (Yes/No)		No		No		No	
Condition of Asphalt[1]		G		G		G	
Waterproofing (W/P) Type		Epoxy Resin		Bituminous		Bituminous	
Condition of W/P[1]		-		G		G	
W/P Thickness, mm		-		10		7	
Bond of Asphalt or W/P to Concrete		-		G		G	
Defects in Concrete[2]		C		C		None	
Condition Rebar[3]		N/A		LR		N/A	
Corrosion Potential, V		-0.465		-0.394		-0.394	
Compressive Strength, MPa		-		-		63.1	
Chloride Content % Chloride by weight of concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0 - 10 mm	-	-	-	-	-	-
	20 - 30 mm	-	-	-	-	-	-
	40 - 50 mm	-	-	-	-	-	-
	60 - 70 mm	-	-	-	-	-	-
	80 - 90 mm	-	-	-	-	-	-
Air Voids	Air Content, %	-		-		-	
	Spec. surf., mm^2/mm^3	-		-		-	
	Spacing factor, mm	-		-		-	
Testing Laboratory		-		-		Golder Associates	
Remarks - Orientation of rebars and cover (L=Longitudinal, T=Transverse) - Presence of overlay, patch, and thickness - Other observed defects		• Horizontal void 70 mm below the concrete surface, void extends into deck • Unknown solid substance at void interface; bonding agent construction joint?		• #5 Transverse – 55 mm cover • Ground check • Vertical crack extending from the reinforcing steel to the concrete surface			

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed

CORE LOG ASPHALT COVERED BRIDGE DECKS

Core No.		C19		C20		C21	
Location		E22 850 W 200 N		G29 350 W 250 N		G29 200 W 250 N	
Diameter, mm		100		100		100	
Thickness of asphalt, mm		130		120		120	
Asphalt Thickness at Nearest Grid Point, mm		70		120		120	
Thickness of Concrete, mm		110		170		145	
Full Depth, (Yes/No)		No		No		No	
Condition of Asphalt[1]		G		G		G	
Waterproofing (W/P) Type		Bituminous		Bituminous		Bituminous	
Condition of W/P[1]		G		G		G	
W/P Thickness, mm		7		5		10	
Bond of Asphalt or W/P to Concrete		G		G		G	
Defects in Concrete[2]		None		None		None	
Condition Rebar[3]		G		LR		N/A	
Corrosion Potential, V		-0.115		-0.314		-0.314	
Compressive Strength, MPa		-		-		-	
Chloride Content % Chloride by weight of concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0 - 10 mm	-	-	-	-	-	-
	20 – 30 mm	-	-	-	-	-	-
	40 – 50 mm	-	-	-	-	-	-
	60 – 70 mm	-	-	-	-	-	-
	80 – 90 mm	-	-	-	-	-	-
Air Voids	Air Content, %	4.1		-		-	
	Spec. surf., mm^2/mm^3	18.13		-		-	
	Spacing factor, mm	0.294		-		-	
Testing Laboratory		Golder Associates		-		-	
Remarks - Orientation of rebars and cover (L=Longitudinal, T=Transverse) - Presence of overlay, patch, and thickness - Other observed defects		• #5 Longitudinal BLL bar – 110 mm cover • Ground location		• #5 Transverse BLL bar – 170 mm cover			

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed

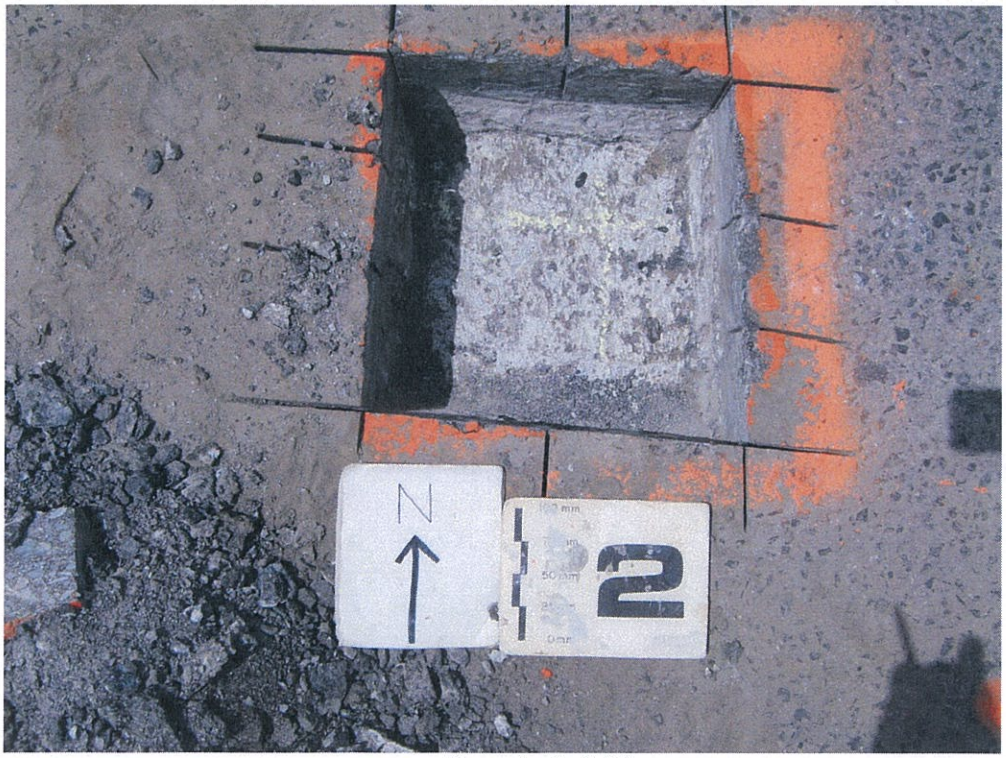
CORE LOG ASPHALT COVERED BRIDGE DECKS

Core No.		C22		C23		C24	
Location		G1 3100 W		G29 750 N 750 W		G14 300 E 400 S	
Diameter, mm		100		100		100	
Thickness of asphalt, mm		130		130			
Asphalt Thickness at Nearest Grid Point, mm		-		130		160	
Thickness of Concrete, mm		-		75		80	
Full Depth, (Yes/No)		No		No		No	
Condition of Asphalt[1]		G		G		-	
Waterproofing (W/P) Type		None		Bituminous		Unknown	
Condition of W/P[1]		-		G		-	
W/P Thickness, mm		-		7		nominal	
Bond of Asphalt or W/P to Concrete		F		G		-	
Defects in Concrete[2]		-		None		C	
Condition Rebar[3]		-		G		N/A	
Corrosion Potential, V		-		-0.314		-0.465	
Compressive Strength, MPa		-		-		-	
Chloride Content % Chloride by weight of concrete		Total	Corrected	Total	Corrected	Total	Corrected
	0 - 10 mm	-	-	-	-	-	-
	20 – 30 mm	-	-	-	-	-	-
	40 – 50 mm	-	-	-	-	-	-
	60 – 70 mm	-	-	-	-	-	-
	80 – 90 mm	-	-	-	-	-	-
Air Voids	Air Content, %	-		-		-	
	Spec. surf., mm^2/mm^3	-		-		-	
	Spacing factor, mm	-		-		-	
Testing Laboratory		-		-		-	
Remarks - Orientation of rebars and cover (L=Longitudinal, T=Transverse) - Presence of overlay, patch, and thickness - Other observed defects		• West approach slab		• #5 Transverse – 75 mm cover • Ground check		• Core taken at sawn sample #4 • See sawn sample log for asphalt conditions • Horizontal void 70 mm below the concrete surface, void extends into deck • Unknown solid substance at void interface; bonding agent at construction joint?	

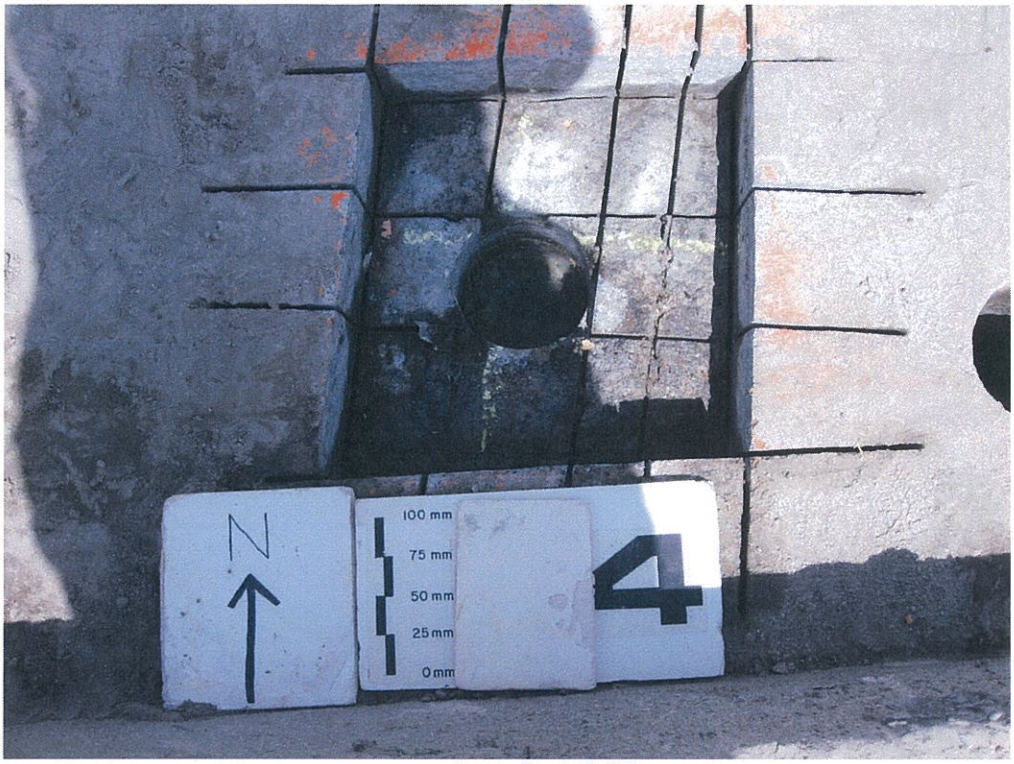
1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A = No rebar exposed

APPENDIX C
SAWN ASPHALT SAMPLE PHOTOGRAPHS AND LOGS

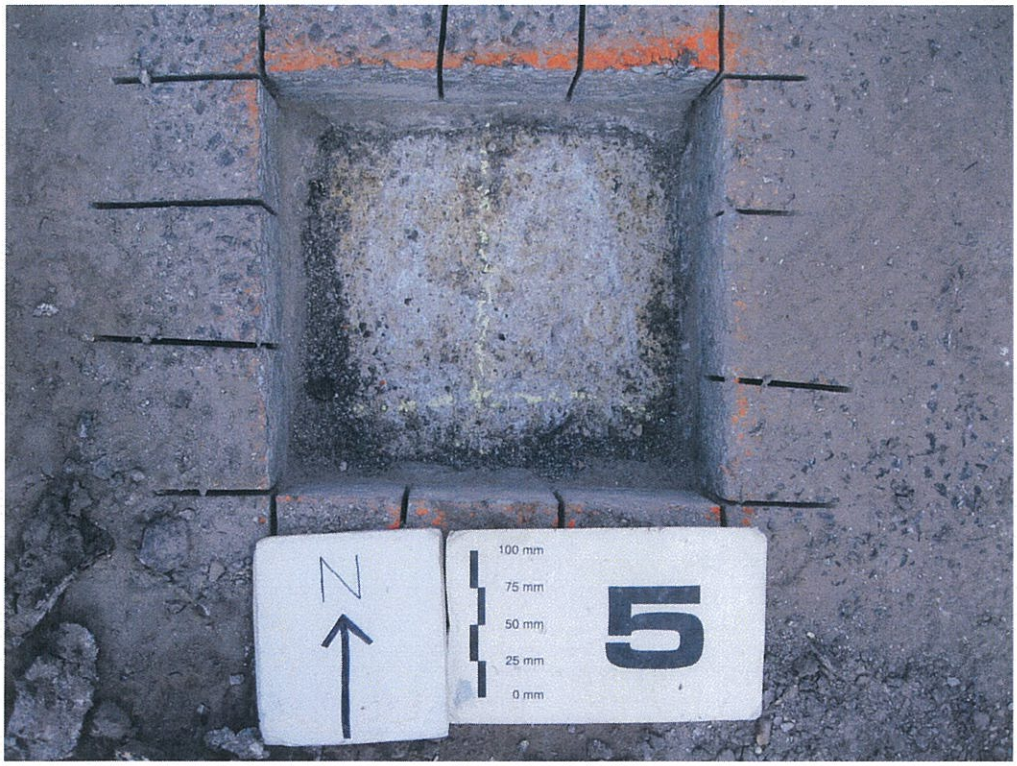
Sawn Asphalt S1



Sawn Asphalt S2



Sawn Asphalt S4



Sawn Asphalt S5

SAWN ASPHALT SAMPLE LOG

 Site Number 010-0175

Sample No.	S1	S2	S3
Location	M27 300 W 800 S	L14 500 W 300 N	N6 700 W 100 S
Size, mm x mm	305 x 305	290 x 295	305 x 300
Thickness of Asphalt, mm	130	140	126
Thickness of Asphalt at Nearest Grid Point, mm	115	100	100
Condition of Asphalt	G	G	G
Waterproofing (W/P) Type	Bituminous	Bituminous	Bituminous
W/P Thickness, mm	7	10	13
Condition of W/P[1]	G	F	G
Bond of W/P to Asphalt	G	G	G
Bond of Asphalt or W/P to Concrete	G	G	G
Concrete Cover to Reinforcing, mm (Note orientation of rebar)	75 – Long. 78 – Trans.	65 – Long. 62 – Trans	70 – Long. 71 – Trans.
Defects in Concrete Surface[2]	None	None	None
Corrosion Potential @ Nearest Grid Point	-0.206	-0.097	-0.190
Remarks	• Concrete surface scaled due to W/P removal	• Concrete surface scaled due to W/P removal	• Concrete surface scaled due to W/P removal

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Rebar orientation – L = Longitudinal, T = Transverse

SAWN ASPHALT SAMPLE LOG

Sample No.	S4	S5	
Location	G14 300 E 400 S	E3 750 E	
Size, mm x mm	285 x 280	295 x 315	
Thickness of Asphalt, mm	80	125	
Thickness of Asphalt at Nearest Grid Point, mm	160	120	
Condition of Asphalt	G	G	
Waterproofing (W/P) Type	Unknown	Bituminous	
W/P Thickness, mm	nominal	5	
Condition of W/P[1]	-	F	
Bond of W/P to Asphalt	-	G	
Bond of Asphalt or W/P to Concrete	F	F	
Concrete Cover to Reinforcing, mm (Note orientation of rebar)	131 – Long. 120 – Trans.	77 – Long. 73 – Trans.	
Defects in Concrete Surface[2]	C	Sc	
Corrosion Potential @ Nearest Grid Point	-0.326	-0.097	
Remarks	• Concrete is sound • Core C24 taken at this location • See core log for comments regarding underlying concrete condition	• Concrete is sound • Concrete surface is discoloured and scaled	

1. Condition - G = Good, F = Fair, P = Poor.
2. Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling
3. Rebar orientation – L = Longitudinal, T = Transverse

APPENDIX D
SITE PHOTOGRAPHS

Photograph 1 – South elevation

Photograph 2 – North elevation

Photograph 3 – Southwest pier, looking west

Photograph 4 – Northwest pier, looking west

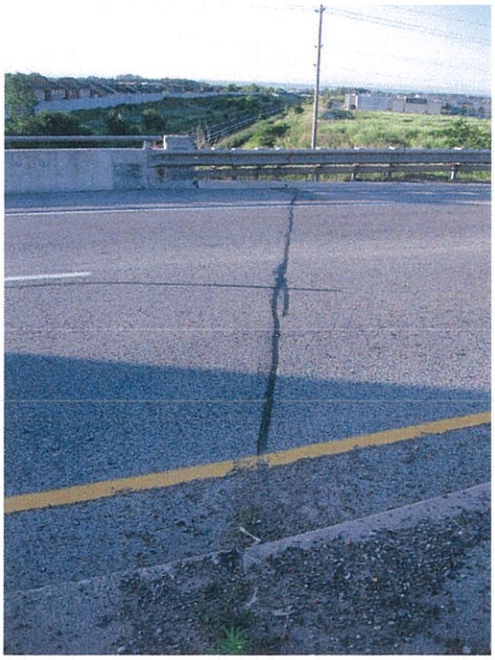
Photograph 5 – East piers, looking northeast

Photograph 6 – East approach, looking east

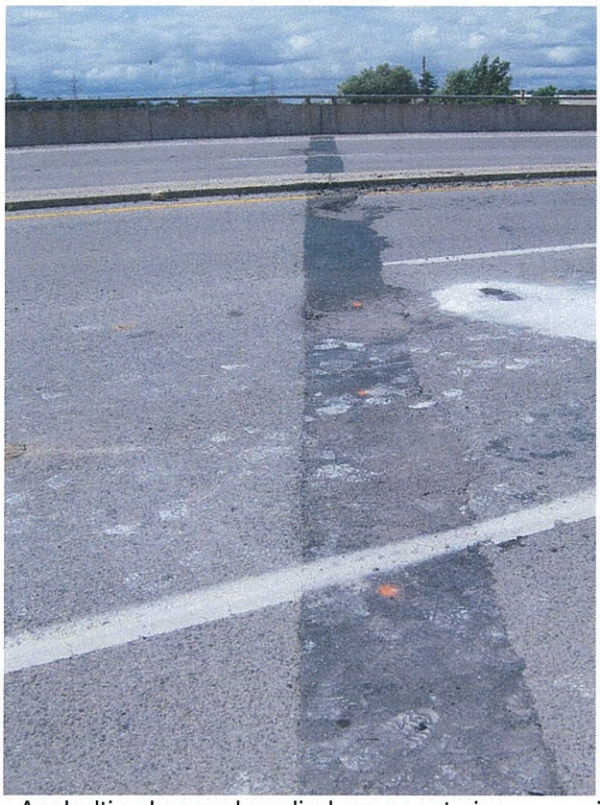
Photograph 7 – West approach, looking west

Photograph 8 – Looking south along CN rails

Photograph 9 – Looking north



Photograph 10 – Transverse sealed crack at west approach (typical)

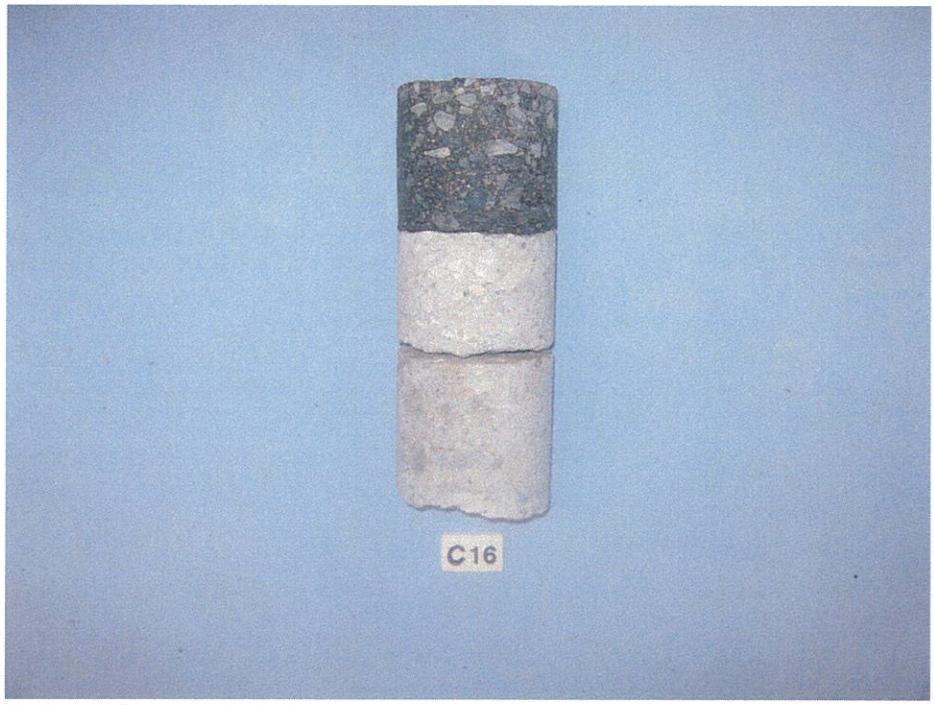


Photograph 11 – Asphaltic plug seal applied over east pier expansion joint, looking north (typical); Note the patched areas and voids in the plug seal

Photograph 12 – Horizontal void found within the concrete deck at sawn asphalt sample S4 (Core C24 taken at this location); construction joint between gutter and deck

Photograph 13 – Unknown solid substance found in the void of core C24, 70 mm below the concrete surface

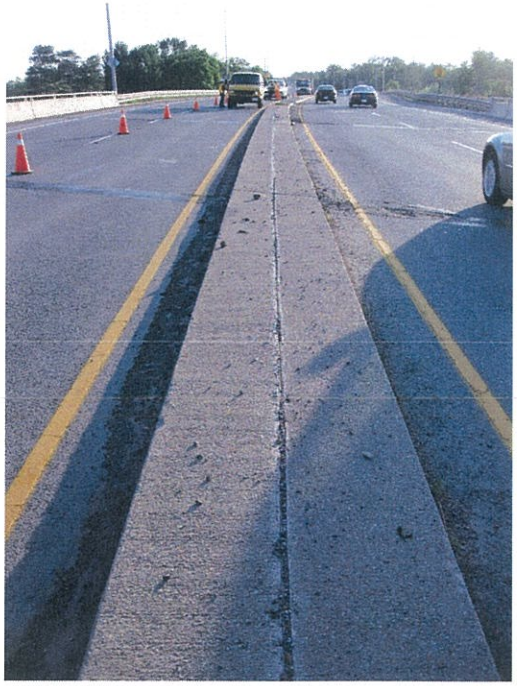
Photograph 14 – Scaling noted on concrete surface at sawn asphalt sample S5



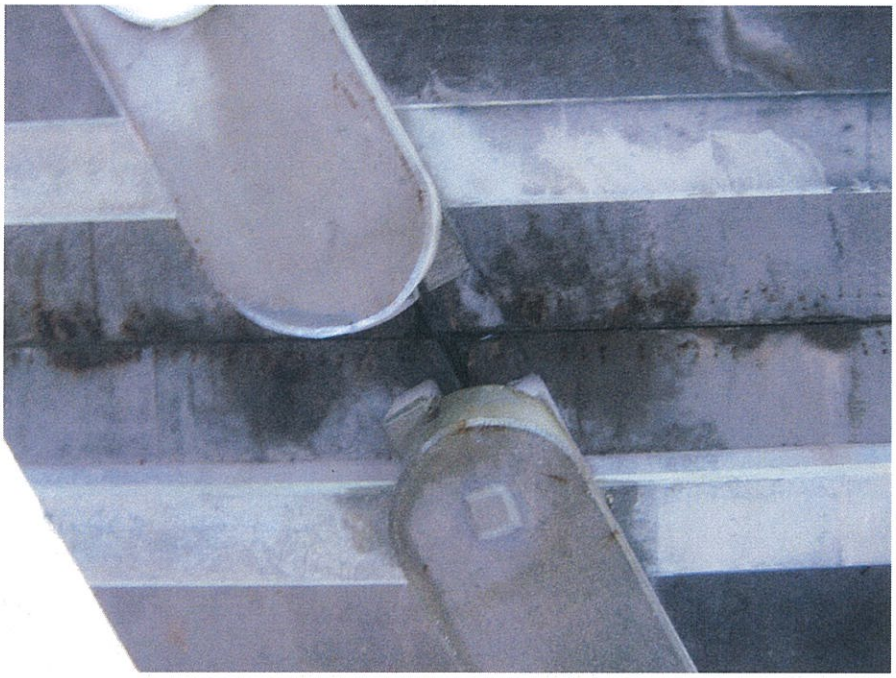
Photograph 15 – Horizontal void in core C16, Core C24 contained similar horizontal void at approximately the same depth below the concrete surface (refer to photograph 13)

Photograph 16 – Vertical crack in core C17

Photograph 17 – Light rust noted on reinforcing steel at eight (8) core sample locations (Core C15 shown)



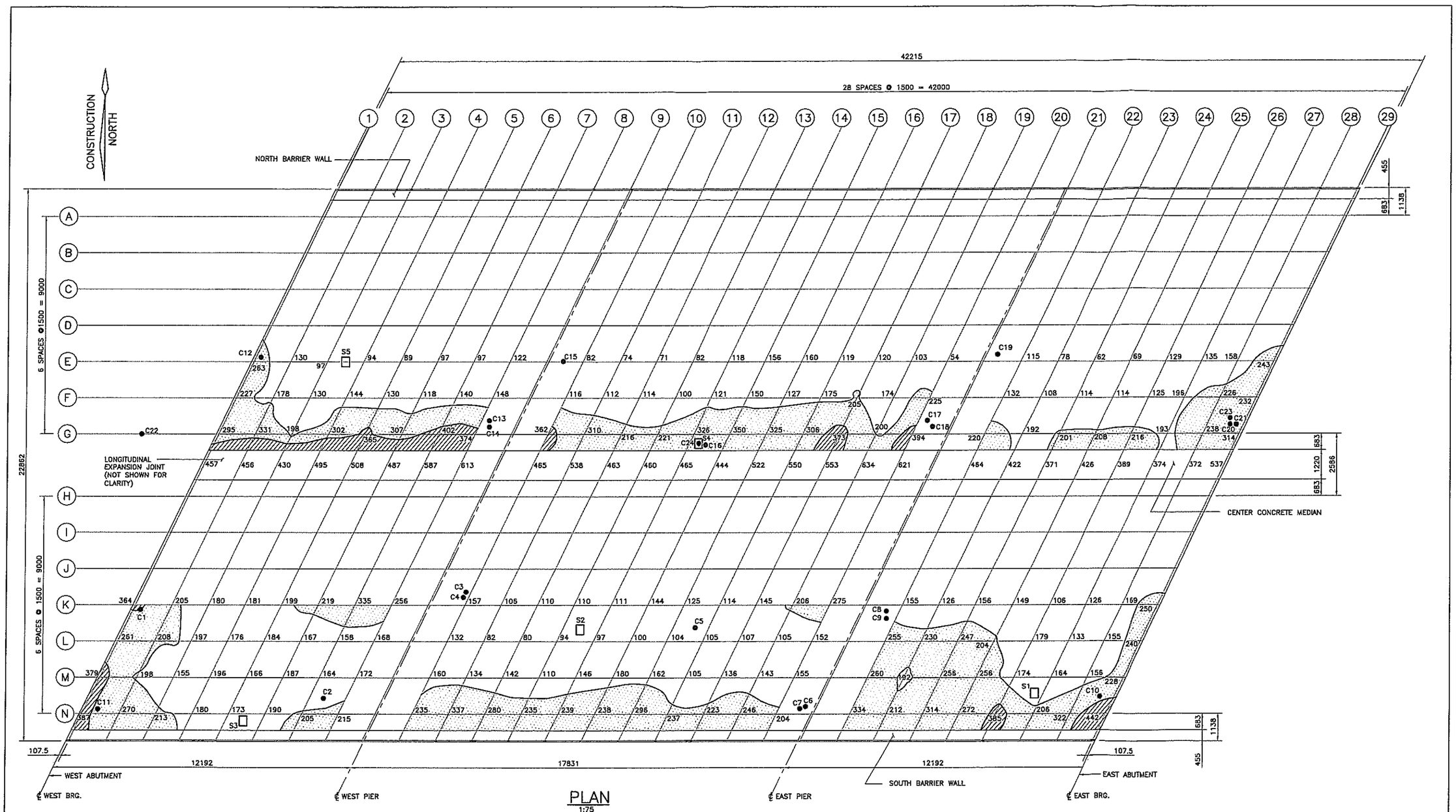
Photograph 18 – Longitudinal joint along the raised median (installed during 2004 rehabilitation contract)



Photograph 19 – Leaking and staining underneath the longitudinal expansion joint at the west piers (typical)

Photograph 20 – Vertical medium cracking in concrete parapet walls (typical)

APPENDIX E
DECK CONDITION SURVEY DRAWINGS



Notes

Field Notes

Nº	Date	By	REVISIONS	MANU	CAD
Design	GT	Ch'kd	TS	Date	
Drawn	CA	Ch'kd	GT		
Scale			References		

APPROVALS

Municipal

Regional

Director, Engineering Services

Manager, Design Services

McCORMICK RANKIN CORPORATION

Halton

TITLE

GENERAL ARRANGEMENT
DUNDAS STREET
CNR OVERHEAD
CORE & SAWN ASPHALT SAMPLE LOCATIONS

Consultant File Nº	Regional Drawing Nº
CONTRACT Nº	Drawing Nº SHEET 1 OF 3

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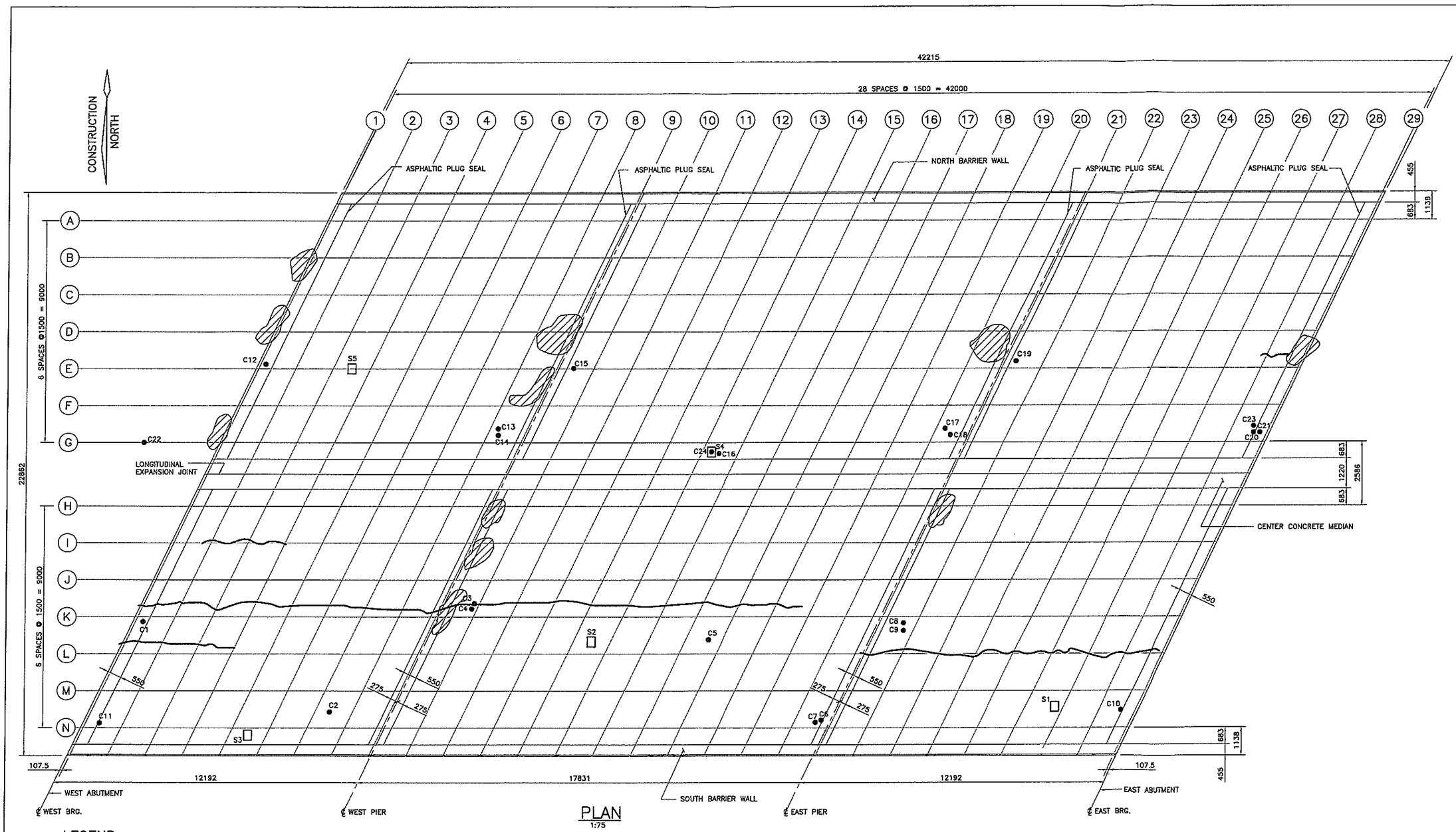
DRAWN BY: CLAIR A.
DATE PLOTTED: 09/10/23 11:38:39
MODIFIED: 09/10/23 11:38:39



PLAN
1:75

LEGEND:

C1● CORE SAMPLE LOCATION & IDENTIFICATION

S1 □ SAWN SAMPLE LOCATION & IDENTIFICATION

LEGEND FOR ASPHALT SURFACE DETERIORATION:

CRACKS (WIDTH GREATER THAN 3mm)

SC SEALED CRACKS

COLD-PATCH ASPHALT REPAIRS

Notes

Field Notes

Nº	Date	By	REVISIONS	MANU CAD
Design	GT	Ch'kd	TS	Date
Drawn	CA	Ch'kd	GT	
Scale				References

APPROVALS

Municipal

Regional

Director, Engineering Services

Manager, Design Services

McCORMICK RANKIN CORPORATION

Halton

TITLE

GENERAL ARRANGEMENT
DUNDAS STREET
CNR OVERHEAD
ASPHALT WEARING SURFACE CONDITION

Consultant File Nº | Regional Drawing Nº

CONTRACT Nº | Drawing Nº SHEET 2 OF 3

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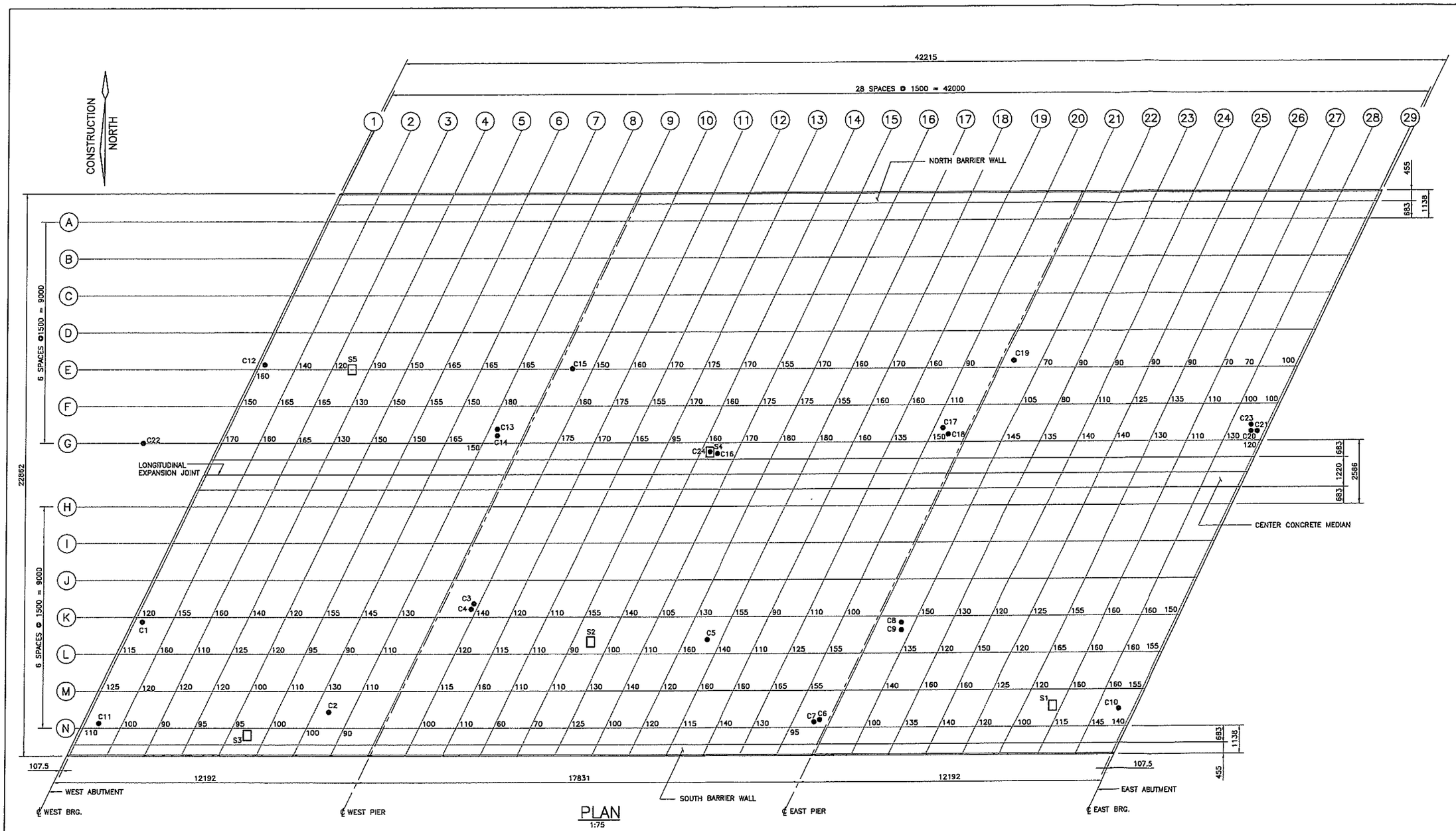

PLAN
1:75

LEGEND:

C1● CORE SAMPLE LOCATION & IDENTIFICATION

S1□ SAWN SAMPLE LOCATION & IDENTIFICATION

110 ASPHALT THICKNESS MEASUREMENT

Notes

Field Notes

Nº	Date	By	REVISIONS	MANU	CAD
Design	GT	Ch'kd	TS	Date	
Drawn	CA	Ch'kd	GT		
Scale				References	

APPROVALS

Municipal

Regional

Director, Engineering Services

Manager, Design Services

McCORMICK RANKIN CORPORATION

Halton

TITLE

GENERAL ARRANGEMENT
DUNDAS STREET
CNR OVERHEAD
ASPHALT THICKNESS

Consultant File Nº	Regional Drawing Nº
CONTRACT Nº	Drawing Nº SHEET 3 OF 3

FILE LOCATION: S:\7108\CNR BRIDGE\
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DRAWN BY: CLAIR A.
MODIFIED: 09/10/23 11:33:16
DATE PLOTTED: 09/10/23 11:33:16

APPENDIX F
LABORATORY TESTING RESULTS

Golder Associates

August 4, 2009

09-1175-0021

Client: McCormick Rankin Corporation
2655 North Sheridan Way
Mississauga, ON L5K 2P8

Attention: Mr. Gideon Tjandra

RE: SUMMARY OF CONCRETE CORE TESTING
DUNDAS STREET – CNR OVERHEAD STRUCTURE BDCS
MRC FILE NO.: 7108.300

Core Number **Golder Lab Number**	C1 C-09-826	C14 C-09-827
Acid Soluble Chloride Ion Content *(% Cl by Weight of Concrete)*		
0 – 10 mm	0.067	0.073
20 – 30 mm	0.073	0.070
40 – 50 mm	0.078	0.070
60 – 70 mm	0.074	0.066
80 – 90 mm	0.091	0.065
Remarks:		

Note:
1. Acid soluble chloride ion content was determined according to MTO Test Method LS-417, Rev.16.

Issued by: _____
John A. Watkins, Laboratory Services Manager

TS/JR/JAW/aj

09-1175-0021 TBL 2009'08'04 Dundas Street C-09-826-831

Golder Associates Ltd.
100 Scotia Court, Whitby, Ontario Canada L1N 8Y6
Tel: (905) 723 2727 Fax: (905) 723 2182 www.golder.com
Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

Golder Associates

August 4, 2009

09-1175-0021

Client: McCormick Rankin Corporation
2655 North Sheridan Way
Mississauga, ON L5K 2P8

Attention: Mr. Gideon Tjandra

RE: SUMMARY OF CONCRETE CORE TESTING
DUNDAS STREET – CNR OVERHEAD STRUCTURE BDCS
MRC FILE NO.: 7108.300

Core Number	C3	C18
Golder Lab Number	C-09-830	C-09-831
Compressive Strength		
Capped Height (mm)	170.1	121.0
Average Diameter (mm)	93.0	93.0
Density (Mg/m^3)	2.394	2.358
Capping Materials	End Grinder	End Grinder
Load (kN)	400.3	457.7
Compressive Strength (MPa)	58.9	67.4
Corrected Compressive Strength (MPa)	58.1	63.1
Moisture Condition at time of Test	Moist	Moist
Remarks		

Note:
1. Compressive strength testing was carried out according to CSA A23.2-00-14C.

Issued by:
John A. Watkins, Laboratory Services Manager

TB/JR/JAW/aj

09-1175-0021 TBL 2009'08'04 Dundas Street C-09-826-831

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Golder Associates

August 4, 2009 09-1175-0021

Client: McCormick Rankin Corporation
2655 North Sheridan Way
Mississauga, ON L5K 2P8

Attention: Mr. Gideon Tjandra

RE: SUMMARY OF CONCRETE CORE TESTING
DUNDAS STREET – CNR OVERHEAD STRUCTURE BDCS
MRC FILE NO.: 7108.300

Core Number	C10	C19
Golder Lab Number	C-09-828	C-09-829
Air Voids Parameters		
Total Air Content (%)	6.4	4.1
Specific Surface (mm^2/mm^3)	20.83	18.13
Spacing Factor (mm)	0.177	0.294
Remarks		

Note:
1. Air void content and parameters were determined according to ASTM C457 using a modified point count method.

Issued by: _____
John A. Watkins, Laboratory Services Manager

TS/JR/JAW/aj

09-1175-0021 TBL 2009'08'04 Dundas Street C-09-826-831

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APPENDIX G
SOFFIT AND SUBSTRUCTURE REPORT

Introduction:

Widening of Dundas Street to six lanes is the subject of the Dundas Street (Reg. Rd. 5) Class EA Study – Appleby Line to Proudfoot Trail. The four lane CNR OHD bridge is within the study limits, which will also need to widened. As part of the study, the condition of the CNR OHD bridge needs to be determined to evaluate the feasibility of widening the structure and assess the existing structure needs.

The condition of the structure was determined based on a detailed bridge deck condition survey, which investigated the bridge deck, barriers, and surface elements of the structure, and a separate investigation of the soffit and substructure. This report presents the results of the investigation of the condition of the soffit and substructure.

Background Data:

The Dundas Street - CNR Overhead Structure was constructed in 1964 and accommodates four (4) lanes of traffic over two (2) CNR tracks that run in the north to south direction. The bridge is located on Dundas Street, 0.5 km east of Appleby Line in the Regional Municipality of Halton. For the purpose of this report, the bridge runs in the east to west direction.

The bridge consists of a three (3) span (12.912m, 17.831m, 12.192m) reinforced concrete deck with ten (10) precast prestressed concrete girders in each span. The bridge was constructed at approximately 26° skew to the road alignment, which is on a horizontal curve (see photo 1 for general elevation of the bridge). As a result of the curve, the bridge is superelevated +4.1% to the north.

The bridge comprises two independent superstructures, four independent reinforced concrete piers (two per superstructure) and common reinforced concrete abutments founded on spread footings. Each pier comprises a reinforced concrete bent with three columns supported by reinforced concrete footings bearing on native stiff clays. The abutment footings are perched on compacted granular fill, for the approach road embankments, to provide the vertical separation between the road and railway.

In each direction, the original structure cross-section comprised the following:

- 0.915 m curb including steel handrail panels and posts;
- 9.75 m asphalt paved travel width; and
- 0.46 m concrete gutter integral with;
- 0.61 m wide concrete median.

The original longitudinal expansion joint at the centreline of road, between two superstructure medians, comprised a 13 mm joint gap filled with asphalt impregnated fibre board, which was sealed at the surface with caulking, and horizontal waterstop strip at mid-thickness of the concrete deck. Similar details were provided at the transverse expansion joints at the piers and abutments, except the horizontal waterstop was not provided at the abutment.

The original structure drawings indicate the superstructure was fixed at the piers. The drawings show that the girder bearings at the piers comprised 558 x 279 x 13 mm thick neoprene bearing pad. Fixity was provided by a 25 mm diameter anchor grouted into the pier and rubber sleeve inset into the girders at the centre of the bearings. The drawings also show that the reinforced concrete diaphragms at the piers were to have been constructed from the top of pier to underside of deck. Actual construction of the pier diaphragms was found to differ from the original drawings as discussed later in this report.

Thermal expansion/contraction of the superstructure end spans was provided by the transverse expansion joints at the abutments and 558 x 279 x 52 mm thick laminated neoprene bearing pads with pintels. It should be noted that due to the fixed anchor bolts between the centre span girders and piers, the thermal expansion/contraction of the centre span is accommodated solely the rubber sleeve over the anchor bolt and deflection of the pier. In addition, it is interesting to note that the girders were not provided with bevel shoe plates nor were the girder concrete beveled at the bearing locations to accommodate the vertical curve (slope) of the superstructure.

The original drawings show that the superstructure comprises AASHTO Type III prestressed concrete "I" girders and composite 178 mm thick concrete deck slab. The wearing surface originally comprised 76 mm of asphalt paving over a protective membrane (waterproofing).

The structure was originally designed according to AASHTO specifications for an H20-S16 design vehicle.

2004 Rehabilitation

The bridge was rehabilitated in 2004 under contract number R-1853B-2003. The work included; partial depth removal and resurfacing of 40 mm of the asphalt wearing surface, widening of the longitudinal joint gap and installation of a 25 mm wide compression seal in the longitudinal expansion joint, removal of the curb and railing, new PL-2 concrete barrier with railing, local concrete patching of the deck between the limits of the original curb and new concrete barrier, new asphaltic plug seals over the abutment and pier expansion joints, new railway crash walls between the columns on the piers, miscellaneous concrete patch repairs, and new approach SBGR systems. Excavation

required for the construction of the new crash walls resulted in partial replacement of the existing grouted rip-rap embankment slope with concrete slope paving below the end spans.

The rehabilitation maintained the existing concrete gutters at the median except at the new asphalt plug expansion joints, where they were removed. The transverse joint in the median at the piers and abutments was provided by foam backer road and caulking. Similar foam and caulking details were provided at the expansion joints in the new concrete barriers.

Inspection Findings:

The structure was inspected by Nicole Khalvati, P.Eng. of MRC on the morning of May 28, 2009 under light rain conditions. MRC's engineer, Nicole Khalvati, P. Eng. accessed the bridge from CN property. Two CN representatives accompanied her to ensure that the inspection was in accordance with CN safety standards.

The inspection comprised a visual appraisal of the bridge deck soffit, girders, and substructure. Photographs of poor areas of condition were noted in accordance with the Ontario Structure Inspection Manual.

The results of the inspection are as follows:

Wearing Surface

The wearing surface of the bridge is generally in good condition, except for some sealed and unsealed cracks in the asphalt paving, and the asphalt plug expansion joints. The asphalt plug expansion joints exhibited severe rutting and have numerous small asphalt patches. Details on the condition of the wearing surface may be found in the detailed deck condition survey report, "Dundas Street - CNR Overhead Bridge Condition Survey Report", by MRC.

Barriers

The barrier walls, constructed as part of the 2004 bridge rehabilitation are in good condition. SBGR connections at all four corners are in also in good condition with no noticeable defects.

Deck Soffit

The deck soffit is generally in good condition except at the longitudinal expansion joint, where numerous isolated delaminations and spalls were observed. Several of these spalls have rust stains (see photo 2). On the day of the inspection it was raining and some leaks

were observed at isolated areas along the longitudinal expansion joint. No drip details were found at the fascia or at the median. (Note: The original drawings indicated drip details at the curb fascia, which were subsequently removed when the curb was removed.)

The deck cantilever at the northwest corner was jammed at the west abutment ballast wall. Similarly, the deck cantilever was jammed against the ballast wall at the southwest corner.

Girders

In general girders were in good condition, except at the ends of some of the girders at the abutments, which were typically delaminated (see photo 3). Delaminations were found at the ends of the following girders:

- East End, East Span, South Interior Girder of EBL;
- West End, West Span, North Interior Girder of EBL;
- West End, West Span, North Exterior Girder of WBL; and
- West End, West Span, South Exterior Girder of EBL.

Access to the top of the piers at the time of the inspection was not available. Accordingly, the girder ends at the piers were not inspected.

No shear cracks were observed in the girders at the time of the inspection.

Abutments

The abutment bearing seats showed signs of water staining, and were covered with dirt and concrete debris (from the girder delaminations) at isolated locations. A wide crack was found in the west abutment stem near the centreline of road (see photo 4). The crack width suggests differential settlement of the abutment may have occurred, but no differential displacement of the two halves of the abutment was found.

The ballast walls were in good condition, except for some small delaminations and rust stains at the centreline of road.

Wingwalls

The wingwalls were in good condition.

Piers

The piers are in good condition. Some construction debris was found on the pier bents.

The pier bents were wet due to the rain at the exposed exterior ends, and interior ends below the longitudinal expansion joint. Some additional stains were found on the east pier between the middle and south interior girder of the WBL.

The crash walls were covered in graffiti, but are in good condition.

Diaphragms

The diaphragms at the piers and abutments were generally in good condition. The unexposed faces of the diaphragms were not accessible for inspection but are probably in poorer condition than the exposed face due to the expansion joint leaks (see photo 5).

We found the pier diaphragms were not constructed according to the original drawings. On the original drawings the pier diaphragms extend to the top of pier. The as-constructed diaphragms only extend to soffit of girders, except for a small area of diaphragm adjacent to the bearing seats. We speculate that these shear blocks were provided to prevent sliding of the deck to the south, to counteract the superelevation. Some of the shear blocks exhibited narrow cracks. Based on our observations, the performance and reliability of the shear blocks is questionable. However, the shear blocks are probably not needed for structural reasons, provided the anchor dowels at the ends of the girders were constructed.

Bearings

The bearings at the abutments are in good condition. Despite not having a bevel and shoe plate at the end of the girders to accommodate the prestress camber and vertical curve in the road, no signs of excessive deformation or uplift at the bearing was observed. Some of the bearings overhang the chamfer on the bearing seat. However the overhanging area is very small and structurally insignificant (see photo 6).

Slope Paving

The original slope paving comprised grouted rip-rap, which has minor cracking and some vegetation growth in the cracks (see photo 7). The bottom 2 meter of the grouted rip rap was replaced with concrete slope paving as part of the 2004 rehabilitation, which is in good condition.

Recommendations:

Based solely on our observations, the following repairs are recommended:

- Replace the longitudinal and transverse expansion joints or, preferably, convert the bridge to a jointless structure;
- Patch delaminations and spalls on the soffit of the deck at the centreline of road; and
- Repair the ends of the girders at the abutments.

For additional recommendations, the reader is referred to the ESR for the Dundas Street (Reg. Rd. 5) Class EA Study – Appleby Line to Proudfoot Trail.

Yours very truly
McCormick Rankin Corporation

Trevor Small, M.Sc., P. Eng.
Senior Project Manager

Nicole Khalvati, P.Eng.
Project Engineer

file: W:\7k\7108 Dundas St, EA Guelph Line to Appleby\7108-08.300 Structural\304 Reports\Dundas Street CNR Bridge\7108 tps CNR Soffit and Substructure Report 1-Sep-09

Photo 1 – South Elevation

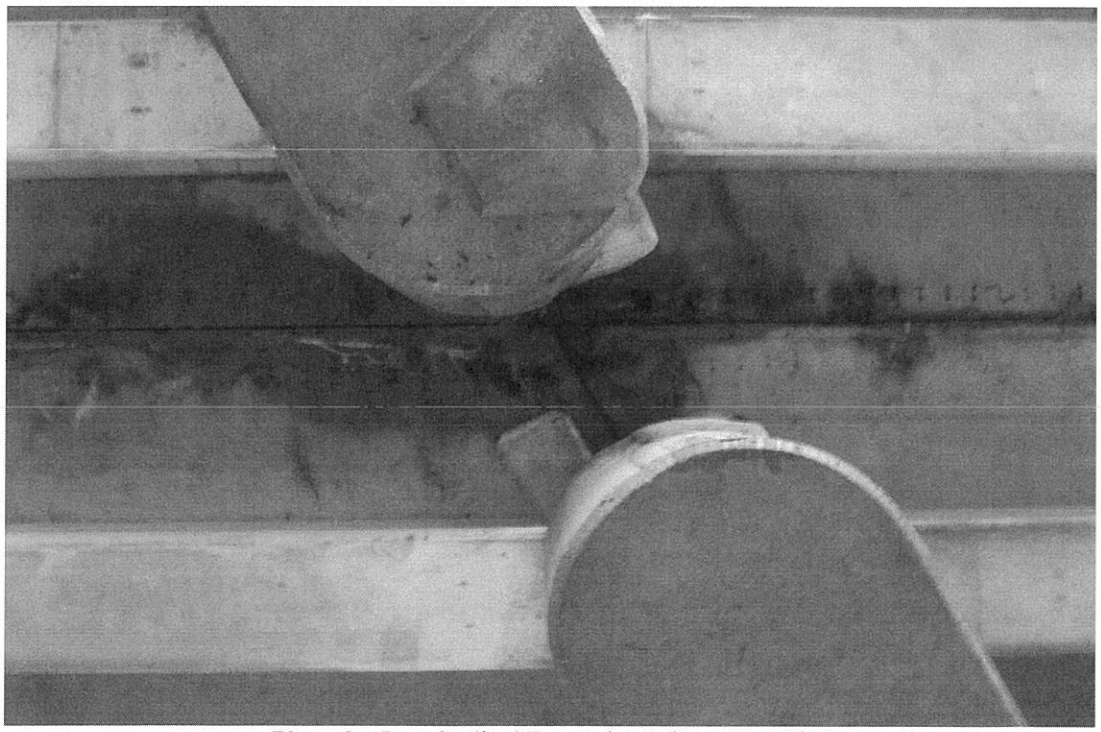

Photo 2 – Longitudinal Expansion Joint at East Pier

Photo 3 – South Girder at West Abutment

Photo 4 – Crack at West Abutment

Photo 5 – East Abutment below the Longitudinal Expansion Joint

Photo 6 – Bearing at East Abutment

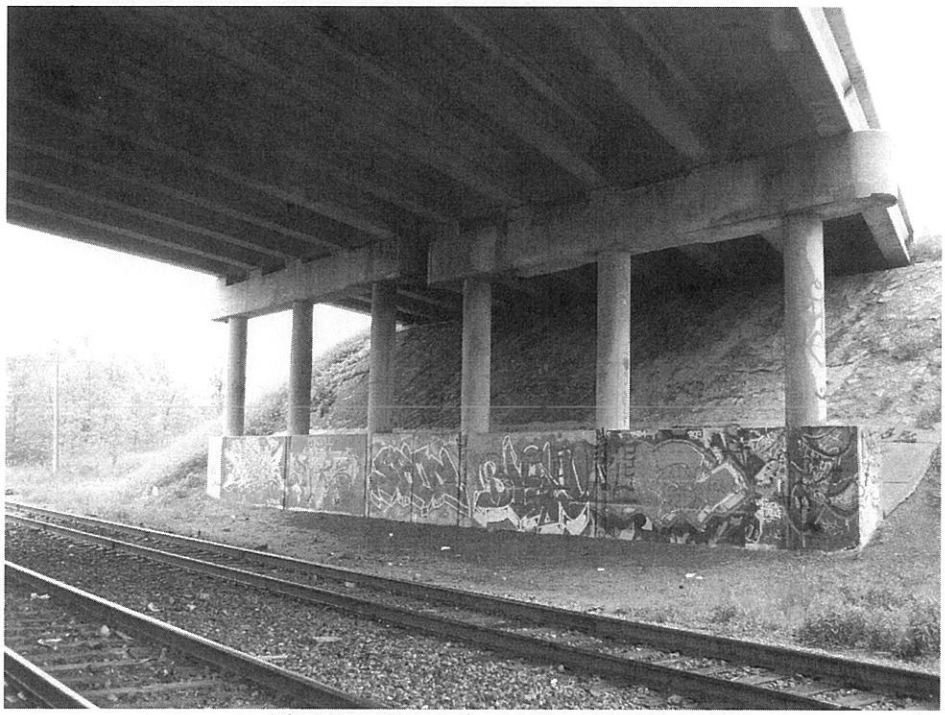

Photo 7 – Vegetation at Slope Paving