



Document Type:	TECHNICAL APPRAISAL FORM Tunnels
Submission Name:	T10B - Hearthwood Tunnel (Highway 3)
Document Number:	285380-03-127-0025

Design Consultant:		HMM
Date	Revision	Description
Mar. 15, 2012	0	Substructure IFC Submission

Issued by: Liang Guo
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Mar. 15, 2012
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Appendix A – Design Documentation

1 Project Description

This submission contains design drawings and geotechnical recommendations associated with Hearthwood Tunnel (Highway 3) T10B. This is the substructure IFC submission for the structure deliverables.

1.1 Name and location of tunnel

Hearthwood Tunnel (Highway 3) T10B is designed for the westbound and eastbound traffic along the below-grade section of Highway 3, Service Road 4 (HWY 3 SR4) from STA. 40+840 to STA. 41+000.

1.2 Permitted traffic speed

Highway Classification:	UAU 100 – HWY 3 (SR4)
Design Speed:	100 km/h under the structure
Posted Speed:	80 km/h under the structure
Laning:	Landscape and pedestrian trail over the structure 4 under the structure for HWY 3 (SR4)
Design Clearance:	Minimum 5.0 m vertical clearance
Bridge Design Vehicle:	CL-625-ONT

2 Tunnel Details

2.1 Basic layout

Hearthwood Tunnel (Highway 3) T10B is 160 m long with a clear roadway width of 21 m. The tunnel is centered at the tangent segment of Highway 3 with two 3.75 m westbound lanes and two 3.75 m eastbound lanes. 2.5 m wide shoulders are accommodated along the north and south side of the below-grade highway. No physical divider between the westbound and eastbound lanes.

Basic Layout Summary

Length:	160 m
Clear Roadway Width:	21 m
Alignment:	Highway 3 – tangent
Laning:	2 – 3.75 m westbound lanes under 2 – 3.75 m eastbound lanes under
Shoulder:	2.5 m wide each side
Median Barrier:	1m flush median
Road side Barrier:	Along shoulders

2.2 Restrictions to traffic

Not applicable.

3 Brief Description of Tunnel, Traffic and Tunnel Geometry

3.1 Structural form of Tunnel

Hearthwood Tunnel (Highway 3) T10B is a single span deck-on-girder structure designed along the below-grade section of Highway 3. Abutments are parallel to the tangent of Alignment of HWY 3 (SR4). Girders have no skew angle with the abutments. See summary below for general arrangement.

Structure Summary

Structural Type:	Prestressed concrete NU 1900 girders and semi-integral abutments with RSS return wall.
Span Arrangement:	Single span structure comprising NU 1900 girders spaced at 3.01 m except at expansion joint which is 2.46 m. Exterior girder's overhang is 1.06 m. Span length is 26.3 m perpendicular to Highway 3.
Foundation Type:	
North Abutment:	Semi-integral abutment supported on HP 310x110 steel piles.
South Abutment:	Semi-integral abutment supported on HP 310x110 steel piles.
Span Articulation:	Semi-integral support at abutments. Three expansion joints longitudinal to girders are provided on the deck along length of the tunnel with spacing of 38.41 m and 41.59 m.
Deck:	235 mm deck comprising 90 mm precast panels and cast-in-place concrete topping with minimum 30 mm haunch; 1.8 m high, 0.35-0.5 m wide parapet wall at each side.

3.2 Structural form of portal structures

Not applicable.

3.3 Traffic and geometry

3.3.1 Horizontal and vertical alignment of Tunnel and Tunnel approaches

Tunnel:

Horizontal alignment: Tangent from STA. 40+783.98 to STA. 41+146.86

Vertical alignment: -0.50% slope from STA. 40+839.33 to STA. 41+000.00

Above Tunnel: Pedestrian trail

3.3.2 Cross-section

Mechanical and electrical arrangements will be provided on next submission. Tunnel satisfied 5.0 m minimum vertical clearance. Minimum 5.09 m vertical clearance is provided.

3.3.3 Standards used

Design Criteria in accordance with Part 2 of Project Agreement – Schedule 15-2:
Article 1 – Highway Geometrics Design Criteria
Article 3 – Structural Design Criteria
Article 4 – Tunnel Design Criteria
Article 5 – Geotechnical and Foundation Design Criteria
Referenced Documents as specified in these Articles following the order of precedence as instructed.

No deviation from the standards used including design traffic flows and speeds.

3.3.4 Accommodation of mechanical and electrical services in Tunnel

Mechanical and electrical arrangements are as shown on drawings.

3.3.5 Minimum vertical clearance, horizontal clearances

Minimum vertical clearance is 5.09 m. Horizontal clearance between road side barriers is 21 m (including 1m flush median).

3.4 Proposed arrangements for inspection and maintenance

All exposed structure elements will be accessible for inspection and maintenance. Some elements may require use of an inspection platform.

3.5 Provision to be made in the Tunnel layout for emergency communication and escape facilities, fire, etc.

Emergency communication details are shown on ATMS New Construction drawings which is not included in this submission.

No escape facilities will be provided.

3.6 Landscaping above Tunnel and protection of Tunnel roof

Landscaping above tunnel is shown on Landscape Construction drawings which is not included in this submission. Tunnel has been designed with 1.0 m soil layer on top deck to accommodate the requirement for drainage and landscaping.

3.7 Finishes

Concrete finishes on interior of the parapet wall will have smooth finish. Concrete finishes of all other cast-in-place exposed surfaces will have rubbed finish.

4 Design Assessment Criteria

4.1 Live Loading

4.1.1 Loading relating to normal traffic under applicable code loading and regulation

Truck load of CL-625-ONT and pedestrian load used in the design of T10B is as per the Canadian Highway and Bridge Design Code (CHBDC) S6-06.

4.1.2 Design vehicle

There are no vehicular traffic lanes except 4 m wide trail over the structure. Therefore, only one CL-625-ONT truck was used in the design of T10B. Tunnel is on tangent alignment with no turning radius.

4.1.3 Provision for exceptional abnormal loads

Not applicable.

4.1.4 Any special loading not covered above

Not applicable.

4.1.5 Heavy or high load route requirements and arrangements being made to preserve the route and any provisions for future heavier loads or future widening

Not applicable.

4.1.6 Authorities consulted or any special conditions required

Not applicable.

5 Structural Analysis

5.1 Methods of analysis proposed

Hearthwood Tunnel (Highway 3) T10B has been analysed in accordance with Canadian Highway Bridge Design Code and S6S1-10 (Supplement No. 1 to CAN/CSA-S6-06). Software design aids including RM Bridge V8i version 08.09.90.01, STAAD Pro 2007 version 20.07.02.15 and Microsoft Office Excel 2007 were used.

5.2 Assumptions of structural elements

5.2.1 Cast-In-Place Concrete

Minimum compressive strength at 28 days: 30MPa (substructure and remainder)

Minimum compressive strength at 28 days: 40MPa (deck overlay)

5.2.2 Precast Prestressed Concrete

Minimum compressive strength at transfer: 42MPa (girders)

Minimum compressive strength at 28 days: 60MPa (girders)

Minimum compressive strength at 28 days: 40MPa (deck panels)

5.2.3 Precast Reinforced Concrete

Minimum compressive strength at 28 days: 40MPa (deck panels)

5.2.4 Reinforcing Steel

Plain and coated reinforcing steel bars: CAN/CSA G30.18-M92; Grade 400W

Stainless steel reinforcing bars: Type 316LN or Duplex 2205 or Type XM-28;
Grade 500

5.2.5 Prestressing Steel

Strands shall be low-relaxation, size designation 15, Grade 1860 in accordance with CSA Standard G279.

5.2.6 Structural Stiffness

Structural stiffness is calculated according to CAN/CSA S6-06.

5.3 Proposed earth pressure coefficient (K_a , K_o , or K_p)

Refer to Geotechnical Investigation and Design Report, Doc No. 285380-04-119-0004.

5.4 Proposed fire design including protection of structure and cable

All elements of the tunnel superstructure are designed to survive without failure a vehicle-based fire incident. 45 mm thick spray on fire protection will be applied to exposed surfaces including the underside of deck panels, underside and sides of girder top flange, both sides of girder web, and top, bottom and sides of girder bottom flange, after construction of tunnel superstructure is completed.

Only non-combustible materials are used in tunnel for electrical and ATMS works.

6 Ground Conditions**6.2 Ground Conditions**

Refer to Geotechnical Investigation and Design Report, Doc No. 285380-04-119-0004.

6.3 Geotechnical Design Parameters

Refer to Geotechnical Investigation and Design Report, Doc No. 285380-04-119-0004.

6.4 Differential Settlement

Refer to Geotechnical Investigation and Design Report, Doc No. 285380-04-119-0004.

6.5 Anticipated Ground Movements or Settlement

Refer to Geotechnical Investigation and Design Report, Doc No. 285380-04-119-0004.

6.6 Groundwater Conditions and Mitigative Measures

Refer to Geotechnical Investigation and Design Report, Doc No. 285380-04-119-0004.

6.7 Variance from Geotechnical Memo Recommendations

Not applicable.

7 Drainage and Waterproofing**7.2 Details of proposed/existing drainage**

Refer to Highway and Roadway Drainage Design Report, Doc No. 285380-70-119-0001 for Phase 1 and Phase 2

7.2.6 Ground water seepage and run off

Geotechnical comments to be provided.

Refer to Highway and Roadway Drainage Design Report, Doc No. 285380-70-119-0001 for Phase 1 and Phase 2.

7.2.7 Accidental spillage, water carried in by vehicles

Drainage structures have been placed along the tunnel to collect runoff from vehicles.

7.2.8 Fire main burst

Flow from a burst fire main would be less than the 100-year storm flow, which the storm system is designed for. The flow would be collected within two or three inlets.

7.2.9 Tunnel washing

Flow from a burst fire main would be less than the 100-year storm flow, which the storm system is designed for. The flow would be collected within two or three inlets.

7.3 Details of proposed waterproofing

Refer to Tunnel Watertightness, Doc No. 285380-03-126-0039.

7.4 List special requirements of local drainage authority

Not applicable.

8 Tunnel Support System and Method of Construction**8.2 Basis of the design of the Tunnel support system for temporary and permanent conditions and any proposals for ground treatment**

Structural form as described on Section 3.1 is one of the effective support systems commonly used to carry roadway above for highway underpass. This support system is

also capable of satisfying the design requirements for permanent conditions of the WEP tunnels.

Refer to Geotechnical Investigation and Design Report, Doc No. 285380-04-119-0004 for the basis of permanent ground treatment design.

Design for temporary conditions is not addressed in this submission.

- 8.3 Show how the proposed method of construction, i.e. excavation and applicable ground support, will ensure the continued safe use of the Parkway and prevent structural failure

Permanent design is based on the assumed Construction Sequence provided on the Foundation Plan, Abutment Layout and Ground Improvements Plan. (Construction methodology, staging and temporary works design are not addressed in this submission.)

- 8.4 Give details of predicted settlements on adjacent structures

Refer to Geotechnical Investigation and Design Report, Doc No. 285380-04-119-0004 for anticipated deformation of the ground around the structure.

- 8.5 State methods to be adopted to monitor and control the effects of tunnel construction to ensure compliance with any criteria imposed to limit surface movements or vibration (if applicable)

A program of site instrumentation and monitoring will be developed and implemented during construction, but is not part of this submission.

9 Checking

- 9.2 Independent Check

Independent check is required as per Project Agreement – Schedule 15-2, Part 2, Article 3 3.2 I (i).

Independent Checking Team: INTERNATIONAL BRIDGE TECHNOLOGIES.

- 9.3 Responsible Design Personnel

Originator: Liang Guo, P. Eng.

Checker: Matthias Yu, P. Eng.

Reviewer: Biljana Rajlic, P. Eng.

10 Drawings and Documents

10.2 List of Drawings (included in this submission):

Drawing No.	Revision	Drawing Name
285380-03-060-SEG1-3050	0	COVER SHEET, SITE PLAN AND KEY PLAN
285380-03-060-SEG1-3051	0	GENERAL ARRANGEMENT
285380-03-060-SEG1-3052	0	GENERAL NOTES
285380-04-090-SEG1-3053	0	BOREHOLE LOCATIONS & SOIL STRATA
285380-04-091-SEG1-3054	0	SOIL STRATIGRAPHY
285380-03-061-SEG1-3055	0	FOUNDATION LAYOUT
285380-03-060-SEG1-3056	0	GROUND IMPROVEMENTS - PLAN
285380-03-061-SEG1-3057	0	ABUTMENT LAYOUT & BEARINGS
285380-03-061-SEG1-3058	0	ABUTMENT REINFORCEMENT
285380-03-061-SEG1-3059	0	RSS WALLS LAYOUT
285380-03-061-SEG1-3060	0	RSS WALLS DETAILS
285380-03-066-SEG1-3071	0	STANDARD DETAILS
285380-03-060-SEG1-3077	0	GROUND IMPROVEMENTS – SECTIONS I
285380-03-060-SEG1-3078	0	GROUND IMPROVEMENTS – SECTIONS II
285380-03-060-SEG1-3079	0	GROUND IMPROVEMENTS – SECTIONS III
285380-03-060-SEG1-3080	0	GROUND IMPROVEMENTS – SECTIONS IV
285380-04-094-SEG1-3081	0	CONSTRUCTION NOTES – BACKFILL AT STRUCTURES
285380-04-094-SEG1-3082	0	CONSTRUCTION NOTES – LIGHTWEIGHT FILL MATERIAL
285380-04-094-SEG1-3083	0	CONSTRUCTION NOTES – EXPANDED POLYSTYRENE
285380-03-080-SEG1-3085	0	FIRE SUPPRESSION PLAN & CONNECTIONS
285380-03-080-SEG1-3086	0	FIRE SUPPRESSION PROFILE
285380-03-080-SEG1-3087	0	FIRE SUPPRESSION DETAILS

10.3 List of Documents (included in this submission):

Document No.	Revision	Document Name
285380-04-119-0004	0	Geotechnical Investigation and Design Report
285380-03-126-0039	C	Tunnel Watertightness Technical Memorandum
285380-03-127-0025	0	Technical Appraisal Form

10.4 List of Reference Drawings and Documents (not included in this submission)

See Appendix A.

The above design and construction proposals are submitted for review

Signed: *Biljana Rajlic*
Design Manager

Name: Biljana Rajlic

Engineering Qualifications: P.Eng

Date: March 15, 2012

Professional Registration Number: 100041385

Affix Professional Seal



Signed:

Project Co Representative

Name: *Janisore LISA*

Date: *March 30, 2012*

Professional Registration Number:

Affix Professional Seal

Appendix A – Referenced Drawings and Documents

Referenced Drawing(s)

Drawing No.	Revision	Drawing Name

Certificate(s)

Certificate No.	Revision	Certificate Name

Special Provision(s)

Document No.	Revision	Document Name
285380-70-119-0001	C	Highway and Roadway Drainage Design Report for Phase 1 and Phase 2