
To:	Ontario Ministry of Transportation J.P.Perron, P.Eng.	Date:	August 8, 2024
Attn:	Minkyung Kwak, P.Eng. Alisha Suthakaran, EIT Kashif Razzaq	File:	50000
From:	Nina Warriar, P.Eng., P.Geo.		
Reviewer:	Mehdi Mostakhdemi, M.Sc., P.Eng.		

**WOLFDAL CREEK CULVERT
USE OF LIGHTWEIGHT FILL
HIGHWAY 403, MISSISSAUGA, ONTARIO
AGREEMENT # 5021-E-0021, WORK ITEM NO. 14
GEOCRES NO. 30M12-534**

Dear Mr. Perron,

Thurber Engineering Ltd. (Thurber) has been retained by the Ontario Ministry of Transportation (MTO) to provide engineering design services in support of the detail design for Group Work Project (GWP) 2067-17-00. The scope of work under this GWP included the rehabilitation of the Woldale Creek Culvert, Site No. 24X-0571, located on Highway 403, in Mississauga, ON.

A 9 m high noise barrier composed of earth fill is currently present on the south side of Highway 403 (HWY) above the existing culvert and its extension. The existing culvert is a box culvert with a width of about 4.3 m and a height of about 1.8 m. Based on correspondences with MTO's Foundations office, it is understood that the weight of the existing earth fill berm above the culvert currently exceeds the culvert's structural shear capacity. This memorandum provides a geotechnical assessment of feasible solutions to reduce the weight of the fill materials above the culvert, so that the shear capacity is met. Additionally, this memo provides recommendations regarding the constructability, feasibility, and type of lightweight fills and relevant specifications for the proposed lightweight fill.

Thurber's scope of work for this assignment does not include an assessment of the foundations of the existing culvert, as currently signs of distress have not been observed and that the future loads will be smaller than the existing ones.

This memo is intended for the use of the Ministry of Transportation and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractors. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project.

It is a condition of this memorandum that the performance of Thurber's professional services is subject to the attached Statement of Limitations and Conditions.

1. BACKGROUND

The existing Wolfdale Creek culvert is located under the HWY between Creditview Road and Mavis Road, crossing the HWY in a northwest-southeast direction. A noise barrier berm is located on the culvert, towards the southeast opening of the culvert parallel to the alignment of the HWY. The approximate locations and dimensions of the culvert and the berm are included in the General Arrangement Drawing, following the text of this memo.

A structural analysis conducted during the detail design phase found that the top slab of the culvert, at the location of the noise barrier wall, does not have sufficient shear capacity. Therefore, there is a need to remove some of the existing earth fill of the berm and replace it with lightweight fill material to reduce the shear forces to an acceptable level. The height, side slope and other geometry configurations of the berm are required to be maintained due to its sustained functionality as a noise barrier.

2. DISCUSSION AND ENGINEERING RECCOMENDATIONS

2.1 General

The existing noise barrier berm is approximately 33.0 m wide (at its base just above the culvert) and has a maximum height of approximately 9.0 m above the culvert obvert. The crest of the berm is approximately 5.0 m wide, with side slopes of approximately 1.5 horizontal to 1 vertical (1.5H:1V). There is an existing gabion wall located on the southeast end of the culvert. The crest elevation of the existing embankment is approximately 173 m and is assumed to be fairly uniform parallel to the HWY alignment within the project area. The culvert obvert elevation is at about 164 m.

The berm is assumed to be composed of local earth fill material with an assumed unit weight of 21 kN/m³. Currently, the vertical pressure at the culvert obvert elevation is approximately 190 kPa at the location of the southeast opening.

It is understood that the maximum acceptable (unfactored) vertical pressure on top of the culvert is estimated to be 110 kPa, and the maximum height of the noise barrier berm must be maintained at 9 m.

2.2 Design Options

The following design options were considered in order to maintain the maximum height of the berm while reducing the weight above the culvert.

- **Lightweight Cellular Concrete (LCC)**

LCC is a lightweight fill alternative that can reduce the weight above the culvert when compared to the existing earth fill. A unit weight of 5 kN/m^3 was assumed for the LCC for design purposes. This option requires at least 1.5 m thick cover of earth fill to be placed above the LCC to protect against wind loads. The Non-Standard Special Provision (NSSP) for LCC is provided in Appendix A.

- **Expanded Polystyrene (EPS)**

EPS is the lightest alternative, with an assumed unit weight of 0.5 kN/m^3 . The EPS requires a protective cover with a thickness of at least 2 m (both above and on the sides of the EPS). Due to the low unit weight, the required depth of excavation is minimized. The NSSP for EPS is provided in Appendix B.

- **Blast Furnace Slag (BFS)**

Ultra lightweight blast furnace slag was considered as an option; however, it was found that with an assumed unit weight of approximately 12.5 kN/m^3 , 8.8 m of BFS corresponds to a vertical pressure of 110 kPa at the culvert obvert elevation. BFS with lower unit weights cannot reliably be obtained.

2.3 Design Configurations

A summary of the required thickness of lightweight fill for each design option is provided in Table 2.1.

Table 2.1: Comparison of Design Options

Parameters	LCC	EPS	BFS
Unit Weight (kN/m^3)	5.0	0.5	12.5
Maximum Thickness of Soil Cover (m)	1.5	2.0	0.0
Required Thickness of Lightweight Fill (m)	5.0	4.0	8.8
Maximum Excavation Depth (m)	6.5	6.0	9.0

In evaluating BFS, the vertical pressure requirement cannot be satisfied while maintaining the required 9.0 m berm height. Consequently, BFS is not considered a feasible solution, hence not further discussed in this memo.

Both LCC and EPS are feasible solutions, and both require 1.5 m to 2 m thick of soil cover with side slopes matching the existing, approximately 1.5H:1V slope. Considering these options, the total excavation required if using EPS is slightly lower than that required for LCC.

2.4 Cost Estimate

Considering that both LCC and EPS satisfy the design requirements and require a similar depth of excavation, a comparison of cost is provided in Table 2.2 to evaluate the design options. The estimates provided below only describe the costs for material supply and installation of the lightweight fill. Associated costs for disposal of excess soil, placement of soil cover and/or granular material are not included.

Table 2.2: Approximate Costs of EPS and LCC

Cost Items	LCC	EPS
Depth of Excavation (m)	6.5	6.0
Approximate Width (m), parallel to HWY	14.4	15.4
Approximate Length (m), along the culvert centerline	19.7	16.7
Total Volume	872 m ³	652 m ³
Approximate Total Cost	\$250,000	\$180,000

2.5 Preferred Solution

The recommended design requires an excavation of the existing berm to a depth of 6.0 m, followed by placement of 4.0 m of Expanded Polystyrene (EPS). A protective layer of soil cover with a vertical thickness of 2.0 m should be placed above the EPS while maintaining side slopes of 1.5H:1V slope, with a final berm height of 9.0 m. A general sketch showing a cross section of the preferred solution, perpendicular to the HWY, is shown in Figure 2-1.

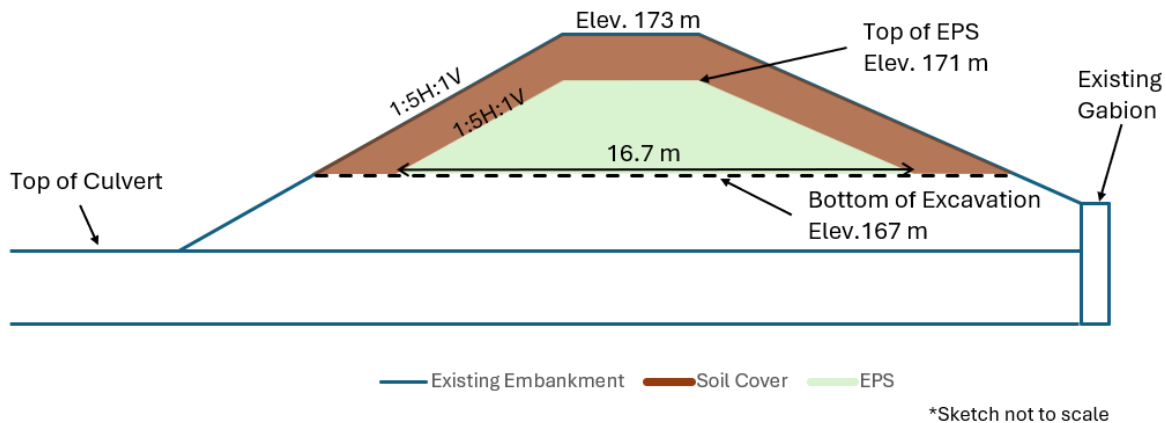


Figure 2-1: Sketch of Preferred Solution, Perpendicular to HWY

It is understood that the detailed design of the berm replacement will be conducted by the prime consultant.

3. EXCAVATION SUBGRADE PREPARATION AND INSTALLATION

Excavation of the existing berm shall be completed in accordance with OPSD 208.010. Additionally, all excavations must comply with the current O.Reg. 213/91 of the Occupational Health & Safety Act (OSHA) requirements. It is assumed that the existing berm earth fill material can be classified as Type 3 soils, for which temporary excavations can have side slopes of 1H:1V or flatter. During excavation, the side slopes should be reevaluated and flattened if necessary following visual inspection, in accordance with OPSD 208.010 and O.Reg. 213/91.

Heavy construction equipment (e.g. excavators, etc.) should not get closer than 5 m to the existing gabion wall. Heavy construction equipment and/or stockpile of materials should not get closer than 5 m to the crest of the slope.

The composition of the existing fill materials above the culvert is not known. As such, it is recommended that all excavated materials be hauled away from the site, and not used for backfilling.

Any softened, loosened or deleterious materials at the EPS founding elevation must be sub-excavated and replaced with OPSS.PROV 1010 Granular A material. The EPS subgrade must be free from deleterious, loose, or otherwise unsuitable soils. Embankment subgrade preparation must be carried out in accordance with OPSS.PROV 206.

Prior to placing the EPS blocks, it is recommended that a levelling pad be constructed on the existing fill subgrade by placing, levelling, and compacting a 150 mm thick layer of OPSS.PROV 1010 Granular A material to 95% Standard Proctor Maximum Dry Density (SPMDD). Any granular fill placed above the EPS blocks must also consist of Granular A compacted in accordance with OPSS.PROV 501. The compaction efforts must not damage the EPS blocks.

Where LCC or EPS are used, placement of such materials should be conducted such that the transition from one composition of materials to another (e.g., LCC to existing embankment fill) be conducted at an inclination of 1.5H:1V or flatter. Suppliers of lightweight fill should be consulted to ascertain the requirements for placement of such materials and the transition from one to another). The lightweight fill must be placed by an experienced supplier in accordance with their specifications, and in accordance with the NSSPs provided in Appendix A and B.

4. CLOSURE

A site reconnaissance was conducted on June 26th, 2024, to assess the existing conditions and gauge constructability methods for the proposed design options. No further considerations were identified during the site visit.

We trust this information meets your present needs. If you have any questions, please contact the undersigned at your convenience.

Yours truly,
Thurber Engineering Ltd.



Nina Warriar, P.Eng.
Geotechnical Engineer



Mehdi Mostakhdemi, M.Sc., P.Eng.
Senior Foundation Engineer



P.K. Chatterji, Ph.D., P.Eng.
Designated Foundation Contact

Attachments

Statement of Limitations and Conditions

General Arrangement Drawing

- Appendix A – Example Non-Standard Special Provision (NSSP) for Construction of LCC
- Appendix B – Example Non-Standard Special Provision (NSSP) for Construction of EPS

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

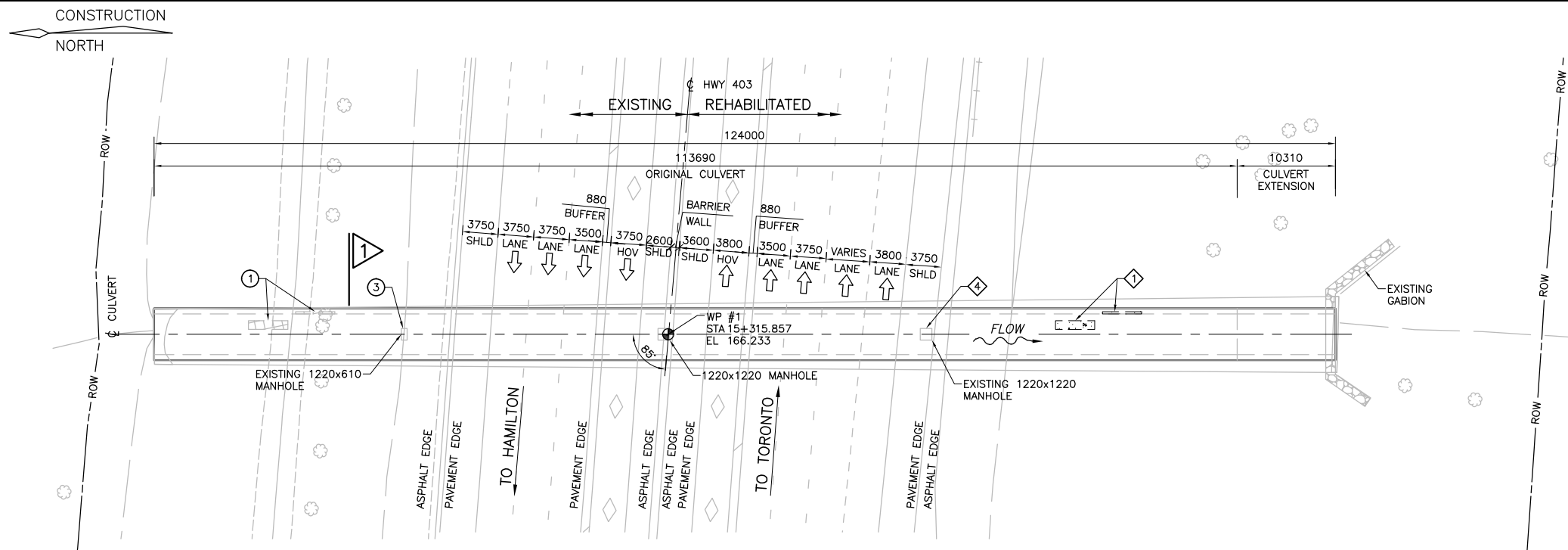
Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

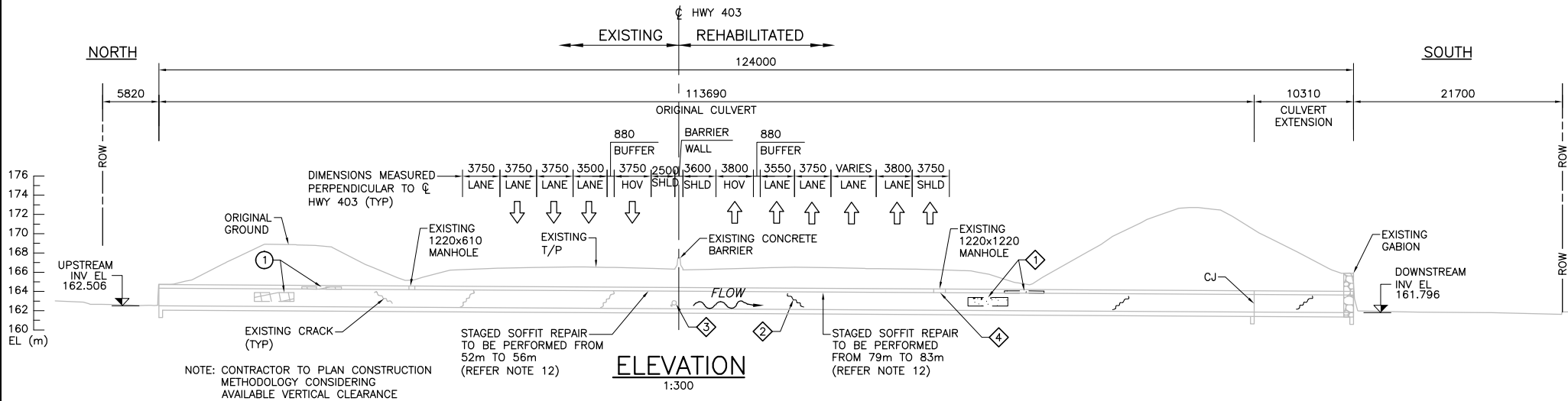
The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

CAD FILE LOCATION AND NAME: p:_TPD\Projects\CA\Projects\CAN7034\4--drafting\structural\drawings\24X-0571--C-001GA.dwg
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DATE PLOTTED: 3/15/2023 5:07:48 PM BY: WAHEED AKHTAR

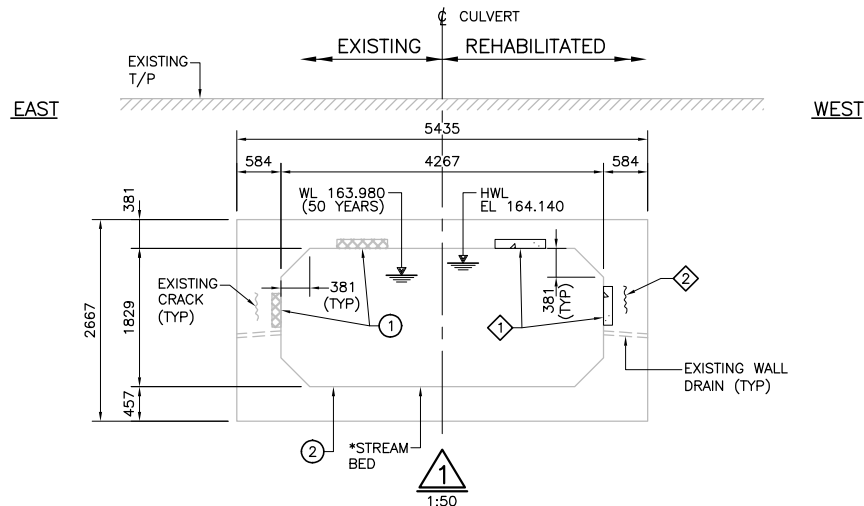
MINISTRY OF TRANSPORTATION, ONTARIO
PR-D-707 88-05



PLAN
1:300



ELEVATION
1:300



*STREAM BED LEVEL MAY VARY OVER THE LENGTH OF THE CULVERT

1:50

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT
CONT. NO.
GWP 2067-17-00



REHABILITATION OF
WOLFDALE CREEK CULVERT
GENERAL ARRANGEMENT

SHEET
109



LIST OF DRAWINGS:

- R1-1 GENERAL ARRANGEMENT
R2-2 MISCELLANEOUS DETAILS

LEGEND:

- REMOVALS
NEW CONCRETE
CRACK

LIST OF ABBREVIATIONS:

- CL CENTRE LINE
EL ELEVATION
HWY HIGHWAY
INV INVERT
STA STATION
T/P TOP OF PAVEMENT
ROW RIGHT OF WAY
TYP TYPICAL
WP WORKING POINT

SCOPE OF WORK:

THE GENERAL SCOPE OF THE REHABILITATION WORK OUTLINED BELOW AND DESIGNATED ON THIS DRAWING SHALL BE CONSIDERED SIMILAR ON EACH SIDE OF THE CENTERLINE OF THE CULVERT, UNLESS NOTED OTHERWISE. THIS IS NOT MEANT TO BE AN EXHAUSTIVE LIST OR INDICATE THE ORDER IN WHICH OPERATIONS SHOULD TAKE PLACE.

- INSTALL TRAFFIC CONTROL MEASURES.
- INSTALL ENVIRONMENTAL CONTROL MEASURES.
- CONSTRUCT TEMPORARY FLOW PASSAGE/DEWATERING SYSTEM.

A. LIST OF REMOVALS:

- REMOVE DELAMINATED AND DETERIORATED CONCRETE FROM SOFFIT, SIDE WALLS, AND FASCIA.
- REMOVE DEBRIS AND SILT DEPOSITED OVER THE BOTTOM SLAB.
- REMOVE DELAMINATED CONCRETE FROM SOFFIT AROUND MANHOLE

B. NEW CONSTRUCTION:

- PATCH REPAIR CONCRETE OF SOFFIT, SIDE WALLS, AND FASCIA.
- REPAIR EXISTING CRACKS IN CONCRETE AT SOFFIT, SIDEWALLS AND FASCIA.
- REPAIR SIDEWALL AT DRAIN OUTLET PIPE.
- REPAIR SOFFIT AT MH LOCATIONS.
- REMOVE ENVIRONMENTAL CONTROL MEASURES
- REMOVE TEMPORARY FLOW PASSAGE/DEWATERING SYSTEM.
- REMOVE TRAFFIC CONTROL MEASURES
- OTHER AS SHOWN/SPECIFIED IN THE CONTRACT.

GENERAL NOTES:

CLASS OF CONCRETE:

ALL CONCRETE UNLESS OTHERWISE NOTED 30 MPa.

CLEAR COVER:

REINFORCING STEEL 75mm
NEW CONCRETE MATCH EXISTING EXCEPT AS NOTED.

REINFORCING:

- REINFORCEMENT STEEL SHALL BE GRADE 400, UNLESS OTHERWISE NOTED.

CONSTRUCTION NOTES:

- THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, DETAILS AND ELEVATIONS OF THE EXISTING STRUCTURE THAT ARE RELEVANT TO THE WORK SHOWN ON THE DRAWINGS PRIOR TO COMMENCEMENT OF THE WORK. ANY DISCREPANCIES SHALL BE REPORTED TO THE CONTRACT ADMINISTRATOR AND THE PROPOSED ADJUSTMENT OF THE WORK REQUIRED TO MATCH THE EXISTING STRUCTURE SHALL BE SUBMITTED FOR APPROVAL. TYPICAL AREAS OF REPAIRS ARE INDICATED ON THE DRAWINGS. WHERE REPAIRS LIMITS ARE NOT SHOWN, LIMITS SHALL BE INDICATED BY THE CONTRACT ADMINISTRATOR.
- SAWCUT IN CONCRETE, WHERE DESIGNATED, SHALL BE 25mm DEEP OR TO THE FIRST LAYER OF REINFORCING STEEL WHICHEVER IS LESSER. SAWCUT SURFACE AGAINST WHICH NEW CONCRETE WILL BE PLACED SHALL BE ABRASIVE BLAST CLEANED AND ROUGHENED.
- ABRASIVE BLAST CLEAN ALL EXISTING REINFORCING STEEL TO REMAIN. ALL EXISTING EPOXY COATED REINFORCING STEEL THAT IS EXPOSED DURING CONCRETE REMOVAL IS ALSO TO BE ABRASIVE BLAST CLEANED TO REMOVE EPOXY COATING.
- ALL CONCRETE SURFACES AGAINST WHICH NEW CONCRETE IS TO BE PLACED SHALL BE ABRASIVE BLAST CLEANED AND ROUGHENED.
- ALL ELEVATIONS ARE GEODETIC ELEVATIONS.
- ANY PROPRIETARY REPAIR MATERIALS SHALL BE SELECTED FROM THE DESIGNATED SOURCES FOR MATERIALS LIST, AND SHALL BE USED IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS.
- THE CONTRACTOR IS FULLY RESPONSIBLE FOR ADEQUATE PROTECTION OF ALL UTILITIES, SERVICES, ROADWAYS, ETC. DURING CONSTRUCTION OPERATIONS. ANY DAMAGE DONE TO THE EXISTING STRUCTURE OR UTILITIES SHALL BE REPAIRED BY THE CONTRACTOR TO THE SATISFACTION OF THE CONTRACT ADMINISTRATOR AT NO COST TO THE OWNER.
- THE CONTRACTOR IS ADVISED NOT TO RELY ON THE WATER LEVEL SHOWN ON THE DRAWINGS. THE WATER LEVEL IS SUBJECT TO VARIATIONS.
- ALL DISTURBED EARTH SLOPES SHALL BE TREATED WITH 50mm TOPSOIL, EROSION CONTROL BLANKET, AND SEED IN ACCORDANCE WITH OPSS 804.
- ALL EXPOSED CORNERS TO BE CHAMFERED 20mm.
- MAXIMUM AREA OF SOFFIT CONCRETE REMOVAL AT ONE LOCATION SHALL NOT EXCEED 1.00m². IF REMOVAL AREA AT ONE LOCATION EXCEEDS 1.00m², REMOVAL AND REPAIR SHALL BE STAGED. REMOVALS SHALL NOT COMMENCE UNTIL CONCRETE REPAIR PLACED IN PREVIOUSLY REPAIRED AREA HAS REACHED A MINIMUM STRENGTH OF 20 MPa. IF STAGED REPAIR IS REQUIRED, LAP REMOVAL AND REPAIR BY 100mm.
- ALL WORK IS TO BE COMPLETED IN DRY.
- EROSION AND SEDIMENT CONTROL (ESC) SHALL BE INSTALLED PRIOR TO CONSTRUCTION. ALL ESC MEASURES SHALL BE MAINTAINED TO ENSURE PROPER FUNCTION AND SHALL BE INSPECTED AFTER ALL STORM EVENTS AND PREPARED/REPLACED IF NECESSARY.
- SILT FENCE CONFIGURATION/LOCATIONS TO BE CONFIRMED AND RELOCATED BY THE CONTRACTOR IN COORDINATION WITH ACCESS PIT AND SITE ACCESS LOCATIONS AND CONSTRUCTION SEQUENCING.
- CONTRACTOR SHALL COMPLY WITH ENVIRONMENTAL PROTECTION REQUIREMENTS AND ALL ENVIRONMENTAL CONSTRAINTS TO PREVENT CONTAMINATION.
- CONTRACTOR IS FULLY RESPONSIBLE FOR DESIGN AND MAINTAIN DEWATERING SYSTEM.
- IN-WATER WORK WILL ONLY BE IMPLEMENTED DURING THE APPROVED IN-WATER WORK WINDOW OF JULY 1 TO MARCH 31.

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS		DATE		BY		DESCRIPTION	
09/02/23	VY					60% TEAM SUBMISSION	
DESIGN	VY	CHK	NK	CODE	CHBDC 06	LOAD CL 625-ONT	DATE MAR/20
DRAWN	WA	CHK	VY	SITE	24X-0571/CD	STRUCT	SCHEME DWG R1-1

**APPENDIX A : EXAMPLE NON-STANDARD SPECIAL PROVISION (NSSP) FOR
CONSTRUCTION OF LCC**

CELLULAR CONCRETE - Item No.

Special Provision

December 11, 2023

1.0 SCOPE

This specification covers the requirements for the supply and placement of cellular concrete for use as lightweight fill at the locations and in accordance with the details shown in the Contract Documents.

2.0 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction:

OPSS 517	Dewatering
OPSS 539	Temporary Protection System
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material:

OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1303	Admixtures for Concrete

CSA Standards

A23.2-17C	Temperature of Freshly Mixed Hydraulic Cement Concrete
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ASTM Standards

ASTM C869	Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete
ASTM C796	Standard Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam
ASTM C495	Standard Test Method for Compressive Strength of Lightweight Insulating Concrete

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

MTO Forms:
PH-CC-433A Concrete Mix Design Submission Form A

3.0 DEFINITIONS

For the purpose of this specification the following definitions apply:

Cellular Concrete means a lightweight cement-based material containing cement, water and foaming agent. The foaming agent is used to create stable and uniformly distributed air cells (voids) in the cellular concrete.

Plastic Density means the density of fresh cellular concrete at the point of placement measured according to ASTM C796.

4.0 DESIGN AND SUBMISSION REQUIREMENTS

4.1 Submission of Working Drawings and Placement Procedures

The working drawings and the proposed placement procedures shall be submitted to the Contract Administrator.

The working drawings shall be signed and sealed by the design Engineer and the design-check Engineer.

The submission of the working drawing and proposed method of placement shall include a description of the proposed method of installation including, as a minimum, the following:

- a) A work plan outlining the schedule, procedures and work site details
- b) Proposed dewatering procedure (in accordance with OPSS 517)
- c) Environmental protection strategy
- d) Method for sealing cracks (if any) in formwork, underlying earth, and between precast wall panels to prevent leakage of cellular concrete
- e) Method for bulkhead construction
- f) List of equipment to be used
- g) Calibration records for the dry mix equipment (not more than 12 months old at the time of submission)
- h) List of all materials to be used in the cellular concrete, using MTO Form PH-CC-433A – Concrete Mix Design Submission Form A
- i) Target plastic density (kg/m^3)
- j) Identification of how the placement procedure will be monitored.
- k) A currently valid Certificate of Ready Mixed Concrete Production Facilities as issued by the Ready Mixed Concrete Association of Ontario (RMCAO) for any plant to be used on the Contract in conjunction with the “wet mix” process.

A Request to Proceed shall be submitted to the Contract Administrator, with the submission of the working drawings and proposed placement procedures, at least fifteen (15) Business Days prior to commencement of the work.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

4.2 Submission of Environmental Protection Strategy

At least fifteen (15) Business Days before the commencement of work, six copies of an environmental protection strategy shall be submitted to the Contract Administrator as specified under the Environmental Protection Strategy Subsection.

4.3 As-Built Drawings

As-built drawings shall be submitted to the Contract Administrator in a reproducible format

The as-built drawings shall be dated and bear the seal and signature of the design Engineer and design-check Engineer.

5.0 MATERIAL

5.1 Cementing Materials

Cementing materials shall be according to OPSS 1301.

5.2 Water

Water used for production shall be according to OPSS 1302.

5.3 Admixtures

Admixtures shall be according to OPSS 1303.

5.4 Foaming Agents

Foaming agents shall conform to the requirements of ASTM C869 when tested according to ASTM C796.

5.5 Cellular Concrete Properties

The cellular concrete product used in the work shall be on the DSM list #2.35.30 for Lightweight Fill Material.

Cellular concrete shall have the following properties:

- a) Minimum unconfined compressive strength at 28 days shall be 0.4 MPa (to be specified by the designer).
- b) The design wet cast density shall be 475 kg/m³ (to be specified by the designer)
- c) Temperature of the plastic cellular concrete at the time of discharge shall be between 5°C and 40°C.
- d) Plastic density at the time of discharge shall be within ±10% of the target design wet cast density noted in (b)
- Designer Fill-in: 28-day compressive strength (a) and design wet cast density (b) to be specified on a project specific basis.

6.0 EQUIPMENT

Cellular concrete shall be produced utilizing automated proportioning, mixing, and foam producing equipment, which can produce cellular concrete meeting the specified properties.

Dry-mix equipment must be able to receive bulk cement and process it continuously from one piece of equipment, and pump through hoses or pipes up to a flat lineal distance of 800 m.

Wet-mix equipment must be able to receive slurry on-site into the equipment and process it continuously during ready-mix supply, and pump through hoses or pipes up to a flat lineal distance of 200 m. When wet-mix equipment is used the batching plant and equipment used to batch the slurry shall be certified by the RMCAO prior to producing slurry for the work and shall meet the requirements for certification throughout the production of concrete. All truck mixers used to deliver the slurry shall be certified by RMCAO and shall display valid certification stickers.

Cellular concrete must be pumped by a positive displacement pump. A foam generator shall be used to continuously produce pre-formed foam, which shall be injected and mixed with the cementitious slurry downstream of the positive displacement slurry pump. The equipment shall be calibrated to produce a precise, consistent and predictable volumetric rate of foam with stable uniform bubbles.

7.0 CONSTRUCTION

7.1 Excavation and Subgrade Preparation

Foundation excavation shall be carried out to the design elevations and the horizontal and vertical limits shown in the Contract Drawings. Any softened, loosened or deleterious materials at the foundation footing elevation shall be sub excavated.

The prepared subgrade shall be good competent ground and snow and ice must be removed from the area prior to placement.

7.2 Dewatering

The prepared subgrade shall be free of standing water during placement of cellular concrete and until backfill is placed on top of the cellular concrete. If necessary, dewatering shall be continuous during placement of materials.

Dewatering shall be according to OPSS 517.

7.3 Roadway Protection System

The construction of all protection schemes shall be according to OPSS 539 and paid for under the appropriate tender item. Where the stability, safety or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided.

7.4 Placement

The placement of cellular concrete shall be under the direct supervision of the Contractor's Engineer or designated quality control representative.

The Contractor's Engineer or designated quality control representative shall be on site to oversee the placement of the cellular concrete and to verify that the cellular concrete is being supplied and placed in accordance with the Contract Documents.

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the placement of the cellular concrete.

The maximum lift thickness shall be determined based on density and any other considerations that may impact placement. The depth of the cellular concrete lifts shall be designed to prevent any thermal damage to the cellular concrete caused by heat of hydration. Cellular concrete placement duration, within a formed area, shall not exceed 2 hours.

Any items to be fully or partially encased in the cellular concrete shall be properly set and stable prior to the installation of the cellular concrete.

Where required, formwork should be designed and installed to withhold cellular concrete. When working near surface water, formworks shall be lined with an impermeable liner to prevent any leakage.

Cellular concrete shall not be placed on frozen ground. Cellular concrete may be placed during freezing conditions, provided measures are taken to prevent damage to the cellular concrete until sufficient strength has been attained. Cellular concrete shall not freeze before initial set. Cold weather protection shall be provided in accordance with OPSS 904.

Fresh cellular concrete shall be protected from contact with rain or snow. The cellular concrete shall be placed in the dry condition and above any groundwater table. All surfaces against which cellular concrete is placed shall be free of standing water. Cellular concrete shall be placed above any groundwater table.

Once mixed, the cellular concrete shall be conveyed promptly to the location of placement without excessive handling.

Finished surface elevation shall be within ± 25 mm of the design grades shown in the Contract Drawings. Cellular concrete with a design wet cast density of 475 kg/m^3 or less can be placed with a maximum slope of 1% when placed in a maximum 250 mm thick lift. Heavier densities and thicker lifts will reduce the ability of the cellular concrete to hold a slope. Slopes that cannot be created by the cellular concrete will require profiling by creating steps for the cellular concrete with formwork.

Vehicles, equipment, backfills, successive lifts of cellular concrete or other loadings on the cellular concrete shall be prevented until the material has attained sufficient strength to withstand the loads with no damage. Backfill can commence on the cellular concrete when the cellular concrete has attained sufficient strength such that foot traffic can be supported without leaving an indentation.

7.5 Environmental Protection Strategy

Materials and conduct of the work shall be handled in a manner that will ensure protection of the natural environment and prohibit cellular concrete from entering surface or ground water. Measures shall be taken as necessary to prevent the material from entering the natural environment and/or leaking outside of the intended placement location and shall have established methods for stopping flow of the product as required, and for prompt remediation of any leaks or spills. These measures and any other contingency planning requirements shall be documented in an environmental protection strategy.

7.6 Material Sampling and Testing

7.6.1 Testing of Plastic Cellular Concrete for Temperature and Density

The plastic cellular concrete shall be sampled and tested for temperature and density once for each placement, or once for every 50 m^3 , or once every 30 minutes, whichever is more frequent. Samples of the cellular concrete shall be taken at the point of discharge into the work. Temperature shall be measured according to CSA A23.2-17C. Plastic density shall be measured according to ASTM C796.

Cellular concrete which does not meet the specified requirements for temperature and plastic density shall be rejected and not used in the work.

7.6.2 Sampling of Cellular Concrete for 28-Day Compressive Strength Testing

Cylinders shall be cast for testing by the Owner for 28-day compressive strength. Cylinders shall be cast and cured according to ASTM C495. Cylinders shall be provided to the Contract Administrator along with a transmittal form including the date of casting of the cylinders, and the lot number.

One set of four 75 mm diameter by 150 mm long cylinders shall be cast for each lot of cellular concrete for determination of 28-day compressive strength. The lot size shall be according to the Quality Assurance Section.

7.7 Submission of Daily Summary for Plastic Cellular Concrete

After each Day's work, a daily summary shall be submitted to the Contract Administrator. The daily summary shall include the following:

- a) Date and time of placement
- b) Ambient air temperature
- c) Temperature of cement slurry
- d) Batch quantities
- e) Location of the backfilling application
- f) Total volume placed
- g) Plastic temperature and density test results

8.0 QUALITY ASSURANCE

8.1 Testing of 28-Day Compressive Strength

8.1.1 Lot Size

The lot shall consist of all the cellular concrete placed within 2 hours of continuous production, up to a maximum of 150 m³. If more than 150 m³ is placed in 2 hours, the cellular concrete lightweight fill shall be divided into the smallest number of equal sized lots not exceeding 150 m³.

8.1.2 Acceptance of 28-Day Compressive Strength

The set of four cylinders representing the lot shall be tested for compressive strength according to ASTM C495.

Compressive strength shall be considered acceptable when the average compressive strength of the set of four cylinders is equal to or greater than the specified strength.

Unacceptable cellular concrete shall be subject to removal and replacement.

9.0 MEASUREMENT FOR PAYMENT

Measurement will be Plan Quantity as may be revised by adjusted Plan Quantity of the cellular concrete

in cubic meters.

10.0 BASIS OF PAYMENT

Payment at the contract price for the cellular concrete shall be full compensation for all labor, equipment, and material to do the work.

NOTES TO DESIGNER

Designer Fill Ins

1. Subsection 5.5 – 28-day compressive strength and design density to be determined on a project specific basis.

**APPENDIX B : EXAMPLE NON-STANDARD SPECIAL PROVISION (NSSP) FOR
CONSTRUCTION OF EPS**

RIGID EXPANDED POLYSTYRENE EMBANKMENT FILL– Item No.

Special Provision

1.0 SCOPE

This Special Provision covers the requirements for the supply and installation of the Rigid Expanded Polystyrene embankment fill and associated works as shown on the Contract Drawings.

2.0 REFERENCES

This Special Provision refers to the following standards, specifications or publications.

Ontario Provincial Standard Specifications, Construction

OPSS.PROV 212	Earth Borrow
OPSS.PROV 501	Compacting
OPSS.PROV 517	Dewatering
OPSS.PROV 904	Concrete Structures

Ontario Provincial Standard Specifications, Materials

OPSS.PROV 1010	Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
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National Standards of Canada

CAN/ULC-S102-10	Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
CAN/ULC-S701-97	Thermal Insulation, Polystyrene, Boards and Pipe Covering

ASTM International

ASTM C177	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus
ASTM C203	Standard Test Method for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
ASTM C518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM D1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D2842	Standard Test Method for Water Absorption by Rigid Cellular Plastics
ASTM D2863	Standard Test Method for Measuring the Minimum Oxygen Content
ASTM D6817	Standard Specification for Rigid Cellular Polystyrene Geofoam

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

3.0 DEFINITIONS

For the purpose of this special provision, the following definitions apply:

Production Lot: means the quantity of rigid polystyrene blocks produced in a continuous period of manufacturing the same grade and thickness of product within the same production day.

Manufacturer: means the firm who supplies the Rigid Expanded Polystyrene

Rigid Expanded Polystyrene: means moulded rigid blocks listed on the DSM and produced by a process of pre-expansion, aging and forming of petroleum based raw material.

4.0 DESIGN AND SUBMISSION REQUIREMENTS

4.01 Design

4.01.01 Foundation Investigation Report

The subsurface conditions at the site are described in the Foundation Investigation Report for this Contract.

The Owner warrants the data in the Foundation Investigation Report, except that interpretations of the data and opinions expressed in the Foundation Investigation Report are not warranted.

4.02 Submissions

4.02.01 Working Drawings

At least three (3) weeks before the commencement of work, the Contractor shall submit to the Contract Administrator six copies of the Working Drawings and method statement signed and sealed by the Contractors Engineer that provides full details of materials and construction procedure.

The contractor shall submit full details of the following.

- a) The method of foundation excavation and preparation.
- b) The method of construction of the levelling pad.
- c) The method of placement of Rigid Expanded Polystyrene blocks including temporary ballasting and protection of blocks during installation. The shop drawings shall indicate laying pattern and block dimensions on a layer-by-layer basis.
- d) The method and limits of placement of polyethylene sheeting.
- e) The method of placement of reinforced concrete top slab.
- f) The method of placement of subbase material.
- g) The method of placement of side slope cover.

4.02.02 Delivery, Storage, Handling, and Protection Procedure

At least three (3) weeks before the commencement of work, the Contractor shall submit to the Contract Administrator the method of delivery, storage, handling and protection from damage by weather, traffic, construction staging and other causes as per the Rigid Expanded Polystyrene manufacturers requirement.

4.02.06 Rigid Expanded Polystyrene

At least two (2) weeks prior to commencement of the installation of the Rigid Expanded Polystyrene blocks, the following details shall be submitted in writing to the Contract Administrator:

1. A general statement as to the type, composition, and method of production of the material.
2. The manufacturer's name, address, phone number, identification of a contact person and description of experience background in the manufacturing of the Rigid Expanded Polystyrene.
3. An identification of the laboratory accredited by the Standards Council of Canada to conduct the testing of the physical and mechanical properties of the Rigid Expanded Polystyrene.
4. The physical and mechanical properties of the Rigid Expanded Polystyrene including:
 - a) Geometry
 - b) Nominal Density
 - c) Compressive Strength
 - d) Flexural Strength
 - e) Thermal Resistance
 - f) Flammability
 - g) Water Absorption
5. Aging and durability characteristics of the Rigid Expanded Polystyrene including the chemical, biological and ultra-violet degradation resistance of the rigid polystyrene.
6. A sample of the Rigid Expanded Polystyrene material.

4.02.07 Quality Test Certificates

Prior to installation of the Rigid Expanded Polystyrene, the Contractor shall submit Quality test certification for each production lot supplied from a laboratory accredited by the Standards Council. The Quality test certificates shall demonstrate compliance with all requirements of this special provision.

4.02.08 Rigid Expanded Polystyrene embankment

For each Rigid Expanded Polystyrene embankment, a Request to Proceed shall be submitted to the Contract Administrator at each of the following milestones:

- a) Following submission of the Quality Test Certificate and prior to construction.
- b) Following foundation excavation and preparation and prior to installation of the leveling pad;
- c) Following placement of Rigid Expanded Polystyrene blocks and prior to construction of the polyethylene sheeting and concrete top slab;

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

4.02.09 As-Built Drawings

As-built drawings shall be submitted to the Contract Administrator in a reproducible format prior to final acceptance of work.

The as-built drawings shall be signed and sealed by the design Engineer and design check Engineer

5.0 MATERIALS

5.01 Granular Levelling Pad

The levelling pad shall be as specified elsewhere in the contract documents and consist of a Granular “A” material with gradation and physical requirements as specified in OPSS 1010.

5.02 Rigid Expanded Polystyrene

5.02.01 Production Lots

Each block of the same production lot shall be stamped with the same production code showing plant identification, type and date of production. The Rigid Expanded Polystyrene shall be free from defects affecting serviceability.

5.02.02 Detail Requirements

The Rigid Expanded Polystyrene shall be listed on the DSM and meet the physical and mechanical properties requirements shown in Table 1 and as described below.

Table 1 – Material Properties

PROPERTY	UNIT	REQUIREMENTS	TEST PROCEDURE
Geometry - Linear Dimensions - Flatness - Squareness	mm (min)	1200 x 600 x 300 ± 1%10 mm in 3 m ± 0.5%	--
Compressive Strength at 5% Deformation	kPa (min)	115	ASTM D1621 (Procedure A)
Flexural Strength	kPa (min)	240	ASTM C203 (Method 1, Procedure B.2.7.4)

Thermal Resistance	m ² .°C/W (min for 25 mm thickness)	0.7	ASTM C177 or C518
Flammability	Limiting Oxygen Index (min)	24	ASTM D2863
Water Absorption	% by Volume (max)	4	ASTM D2842

5.03 Polyethylene Sheeting

The protective sheeting shall be at a minimum 6 mil polyethylene sheeting or better if specified elsewhere in the Contract Package.

5.04 Concrete Top Slab

The reinforced concrete top slab shall be as specified elsewhere in the contract documents.

6.0 EQUIPMENT

All cutting of Rigid Expanded Polystyrene materials shall be by electric equipment or by hand.

Heavy equipment shall be limited in weight and size and restricted in operation to avoid damaging the Rigid Expanded Polystyrene as per the manufacturer's requirement.

7.0 CONSTRUCTION

7.01 General

7.01.01 Rigid Expanded Polystyrene Installation

The installation of the Rigid Expanded Polystyrene shall be undertaken under the supervision of the Contractor's Engineer.

The Contractor inspection of the Rigid Expanded Polystyrene full-time.

The Contractor's manufacturer representative shall be on site to oversee installation of the Rigid Expanded Polystyrene blocks at the commencement of the installation.

7.02 Delivery, Storage and Handling

The product shall be suitably marked to identify its type, number and the manufacturer's name or trademark.

The Contractor shall protect the Rigid Expanded Polystyrene from exposure to sunlight to avoid ultraviolet degradation as per manufacturer's recommendation.

Protection of materials and works from damage by weather, traffic, construction staging, fire or vandalism and other causes shall be the responsibility of the Contractor.

Rigid Expanded Polystyrene shall not be exposed to open flame or other ignition source. The contractor shall protect the Rigid Expanded Polystyrene blocks from petroleum-based products such as gasoline and diesel fuel and organic solvents such as acetone, benzene, and paint thinner.

7.02 Foundation Excavation

Foundation excavation shall be carried out to the design elevations shown on the drawings. Any softened, loosened or deleterious materials at the foundation footing elevation shall be sub-excavated and replaced with Granular 'A' or Granular 'B' material.

7.03 Leveling Pad

The Contractor shall place, level and compact a layer of Granular 'A' or Granular 'B' material in accordance with OPSS PROV 501 to within ± 30 mm of the design elevation. The leveling pad shall not deviate by more than 10 mm at any place on a 3 m straight edge over the limits of the bottom course of blocks. The levelling pad shall not be placed on standing water, accumulated snow or ice or frozen ground. The levelling pad must be placed in-the-dry.

7.04 Installation of Blocks

The Contractor shall have on site at the commencement of the work, a representative of the supplier of the Rigid Expanded Polystyrene to advise on recommended construction procedure.

The Contractor shall maintain liaison with the supplier throughout the construction of the embankment for advice and guidance as required. Periodic site visits by the supplier should be coordinated as required.

The Rigid Expanded Polystyrene embankment shall be installed to ensure that:

1. The individually marked blocks shall be placed on the prepared leveling pad. The top surface of the first layer of blocks is to be set plane and level. Local trimming of the blocks may be necessary.
2. Subsequent successive layers shall be oriented with the long axis of blocks positioned at 90° to the previous layer in order to avoid continuous joints. Block joints shall be offset and staggered between layers.
3. A continuous check shall be kept to ensure the evenness of the blocks is satisfactory in each layer. Blocks shall be laid with joints with maximum opening of 10 mm between blocks. Differences in heights between adjacent blocks in the same layer shall not exceed 5 mm.
4. Sloping end adjustments at the abutments shall be accomplished by leveling terraces in the subsoil in accordance with the block thickness.
5. Temporary ballast shall be provided as necessary to prevent movement of Rigid Expanded Polystyrene both in storage and as placed due to windy conditions. Timber fasteners or equivalent shall be used as necessary.
6. The Rigid Expanded Polystyrene embankment shall be protected from accidental ignition due to welding, smoking, grinding or cutting tools, etc. The Contractor shall take all necessary precautions to prevent ignition of the Rigid Expanded Polystyrene.

7. The Rigid Expanded Polystyrene shall be protected from organic solvents and other aggressive, harmful chemicals during construction.
8. Exposed blocks shall be covered immediately to avoid possible burrowing by animals.
9. Individually marked blocks shall be fabricated and placed to ensure the top surface matches the elevation and crossfall shown on the drawings.
10. The top surface and side surfaces of the Rigid Expanded Polystyrene shall be covered with 6 mil polyethylene sheeting extending onto adjacent work at the longitudinal ends of the embankment. All joints shall be lapped a minimum of 300 mm to provide a fully sealed enclosure.

7.05 Side Slope Cover

The side slopes of the Rigid Expanded Polystyrene embankment shall be covered with granular fill as detailed elsewhere in the Contract drawings.

8.0 MEASUREMENT FOR PAYMENT

Actual Measurement

Measurement will be by volume in cubic metres measured in its original position and based on cross-sections.

9.0 BASIS OF PAYMENT

The Concrete top slab and granular leveling pad shall be paid for with the appropriate tender items as detailed elsewhere in the contract.

Payment at the contract price for the above tender item shall be full compensation for all labour, materials and equipment to do the work as described above and no extra payments will be made.