Appendix F. Proposal

Design of a Sustainable Transmission Building

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Abstract

To be added at a later date.

Capstone Design Statement

As part of the Accreditation Board for Engineering and Technology (ABET) requirement, a Capstone Design Experience must be completed by all students seeking a degree in Civil Engineering. The capstone design addresses eight, realistic constraints of a project of which include: economic, sustainability, environmental, constructability or manufacturability, ethical, health and safety, political and social aspects. The project will include all of these aspects in the final report that is submitted to both Stantec and WPI.

a. Economic

To address the aspect of economic feasibility the project will determine multiple general cost estimates for the varied design ideas and one specific one for the final design.

b. Sustainability & Environmental

Sustainability will be addressed through the alternate structural design and green materials that are proposed. The environmental aspect will be dealt within the analysis of the property.

c. Constructability & Manufacturability

The constructability constraint for the project will be reflected in the structural design of the transmission station and the multitude of design options implemented.

d. Health & Safety

Health and Safety will be considered through following the set standards of Canada, such as the National Building Code of Canada (2010).

e. Social & Political

The social needs of the community will be addressed through this project bringing electricity to the area.

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Introduction

The Maritime Link Transmission Project from Newfoundland to Cape Breton, Nova Scotia is to be a link designed to connect communities to the supply of sustainable electrical power. The three main components of the Project are to implement a new transmission line in Newfoundland, a second transmission line in Nova Scotia and add two subsea cables spanning the stretch between the two. In the proposed Major Qualifying Project, students are to design and form a proposal for one of the two converter stations that house the diffusion of the transmission line's alternating currents. The team will document multiple project design options and cost estimations for the structure. The proposal will discuss fiscal responsibilities and sustainable options as to discern the most effective option that uses both traditional and green building options. (Emera, 2012)

The project will use a multitude of materials to research the many options for design and cost of the building. Including, Canadian and local Nova Scotia codes that will be used to meet all structural requirements. One national code the group will use, yet will not be limited to, is the National Building Code of Canada (2010) specifically for the structural design work. For the sustainable and green options Canadian LEED requirements will be analyzed and implemented.

In addition to the Design Team's efforts a second project team from WPI will be proposing a document on the construction management for the same structure being designed. Quality assurance for both projects will be provided through weekly meetings with the Worcester Polytechnic Advisors and daily meetings with both the Management Major Qualifying Project Team and the Stantec Consulting limited (Stantec) Project Mentor Team.

The project will aim to complete a full design of these structures from foundation to roof and to discuss the many benefits of building green. The Design MQP Team aims to provide multiple options for these designs to incorporate sustainable building, such as use of innovative materials, new economic systems encompassing the mechanical, electrical and plumbing. Going beyond the required sustainable building requirements, the team plans to propose a final product that will be the most fiscally and environmentally responsible.

As the Design Team develops the structure the cost estimates for the designs will be composed. These cost estimates will look at components including, sustainability, functionality, cost efficiency, return on investment and any added value for innovative practices. Once the financial aspects are compiled, the designs and cost estimates will be compared and reviewed to find the most viable project.

With the collaboration between student groups, the Management Team and Design Team, Stantec's mentorship and the advisors from Worcester Polytechnic Institute, the Major Qualifying Project will prepare a construction report discussing the options for structures along a transmission line's path including the design and cost estimate.

Background

Traditional & Sustainable Build Design Options

The traditional build option is a Design/Bid/Build process, where there are three parties involved. The owner of the project hires a designer, and all the design work is done prior to the bidding or involvement of contractors. When the design is complete, contractors are invited to bid on the expected cost for to complete the project. Based on the owner's criteria, a subcontractor is chosen to complete the job. This process can be time consuming if the design is complex. If a design is complex, it is more likely changes will be made to the design during the construction phase. However, design is a significant fraction of the total project cost, and having it completed independently can cut costs. This project also allows the owner to keep a tighter rein on the project progress and decisions. Deciding to use Design/Bid/Build process would allow the owner to be more involved in building sustainably.

Building sustainably pertains to both the decisions made in the design phase and the construction phase. In design, there are many different components to consider including longevity, additions, and efficiency. The least expensive material may not be the best material for the job if it doesn't last as long. Wood beams would not be a good choice for a large multiple story building, as the strain would eventually cause the wood to break. Additions to the project are things added to reduce energy demand or impacts on the environment. Examples include an enhanced ventilation system, extra insulation, motion sensors, and solar water heaters. These pose an additional cost to the project, but may have a return on investment or preserve an invaluable natural resource. Efficiency is closely related to the materials chosen. Glass windows, for example, relate to the efficiency through their quality. If the window leaks, it means more heating is required in the colder months. If it is thin, the window can break more easily and also loses heat more easily. There are windows designed to retain heat through the use of thicker panes and pockets of air. The type of window is just one choice in the world of building efficiently and sustainably. Sustainability in construction has a lasting impact by reducing demands on natural resources & using local ones.

Structural Materials: Concrete

Concrete is commonly employed in construction due to its ability to fit a number of different shapes and durability. Concrete is also typically reinforced with steel frames within the cast. Concrete has many different types, three of which include slab, reinforced, and pre-stressed. Slab concrete is a thicker concrete, and used for foundations. It is reinforced with steel or metal framework along with precast concrete. The extra thickness allows for it to support the weight of the building. Reinforced concrete is designed to deal with higher levels of tensile stress. Accordingly it has steel bars placed inside it to allow it additional flexibility. Without the bars, the concrete might crack extensively. Some cracks in concrete are permissible, but too many is a cause for concern. Pre-stressed concrete is similar to reinforced concrete, but uses wires instead of bars to deal with active loads.

Structural Materials: Structural Steel

Structural steel is rated and prepared for a specific purpose. Solid bars are not always the best way to build. Based on stress analysis, reinforcement bars in certain shapes makes building more effective and more efficient. One common shape is the I-beam. As the name suggests, it looks like an "I" and is used to build the frame and skeleton. The skeleton is the framework of the building. It includes columns and supports, but no walls. Essentially, it looks like a birdcage with supports inside.

Component & Product Information

This proposal will contain and details materials chosen or recommended for the completion of the transmission building. These details discuss why each item was chosen and the purpose it is to fulfill. Different parts of the building face different demands, and thus some components must face more scrutiny.

LEED

Leadership in Energy and Environmental Design is relatively new, but becoming more common in the building world after its creation in 1998. LEED certification is based on numerous categories and the categories vary from whether the building is for commercial, residential, health care, military, or other purposes. These categories include efficiency in water, heat, and light use. Anything that saves resources saves money also. Buildings need to be healthy places to live, whether this means protecting of the water sources in a home or mold prevention in a school. There are numerous other categories, and points are earned in each category. Based on the total number of points, a LEED rating is given. The possible rankings are below.

Certified	40-49 Points
Silver	50-59 Points
Gold	60-79 Points
Platinum	80+ Points

Figure 1: LEED Ratings (LEED 2009, 2009)

Cost Estimate

Estimating the cost of a project accounts for in design, materials, labor, and delays. The design component is the rate charged by the design firm. This could be a lump sum, or a sum based on hours of work. Material costs are based on the market cost and transportation. Some materials are better to be purchased in another location, providing the cost of transportation does not outweigh buying closer. Labor costs are determined by the contractor and amount of work to be done. Delays are also a factor. Every day behind completion, the owner loses money. With regards to all these factors, the method of payment is important. Lump sum is paying one large amount all at once. Hourly work is paying a set rate, regardless of completion. There are also other payment methods including covering expenses with a guaranteed maximum price.

Methodology

Task: Project Statement

The team researched the project and other design projects. Based on the information and the research, the team made identified key components and questions to answer in the design project. After discussing the components and research, the team decided what the goal of the project would be. This goal is reflected in the project statement, outlined tasks and task chart see Figure 2: 7-Week Schedule.

Task: Designs

Design of the transmission building included code familiarization, interviews with the Stantec staff, on-site research when permitted, and use of design software. The interviews with the Stantec team allowed for the WPI crew to get a basic understanding about starting points. The design had to comply with all the codes, and thus the design had to be cross-checked by all listed specifications and codes. The completion of these designs was aided through the use of computer software.

Task: Sustainable Design

During the process of the original design, the team identified components that could be made sustainable. The team then analyzed each of these possibilities based on criteria including local impacts and resources, return on investment, and complying with future regulations. This design has as many sustainable ideas as were conceived in the design process. The team also identified the cost and materials used in this design.

Task: Traditional Design

This design is the result of the design previously discussed. The team chose the most cost-effective material for the climate and codes of the present day.

Task: Combined Designs

The team took the sustainable and traditional designs and used components from each to create a hybrid design. This allows for a less expensive building, while still considering impacts on the environment.

Task: Evaluation – Sustainability (Green)

The team reviewed all the designs and made decisions about using components based on their social and environmental impact. These decisions were based on available codes, environmental impact studies, availability of resources, return on investment, and future demands.

Task: Evaluation – Functionality

The team reviewed the building to ensure its durability in the environment. The team ran simulations when possible and researched how similarly constructed building or components fared in adverse conditions. Based on the research, the team made estimates as to the life expectation and maintenance of the building.

Task: Evaluation –Building Codes

The team reviewed the designs and all available building specifications & codes. All designs were revised when there was conflict.

Task: Evaluation – Cost Efficiency

Using some of the calculations from other evaluations, the team estimated when the building would need to be replaced in part or in total for each design.

Task: Evaluation – Investment

The team prepared a return on investment for applicable components. The team also considered the yearly maintenance costs in these calculations.

Task: Evaluation – Innovation

The team considered any additional value to add aesthetically pleasing or other components to the building. The criteria included return on investment, esthetic value, and future needs.

Task: Proposal Paper

The team prepared the paper to explain why the project is needed and how it was completed. This paper was written on a week-by-week basis in order to allow for revision. The team explained all relevant details to the process so it could be duplicated and understood.

Task: Presentation

The team prepared an oral presentation, supplemented with a poster and slide show when needed, to explain the design project to the Stantec and WPI community. The team summarized the project and brought out key components. These points were decided on by internal discussion among the WPI teams as well as discussion with the Stantec teams.

Goals Listed Chronologically

a. Pre-Qualifying Project: Design: Problem Statement

Before arriving in Halifax, the team will have an approach for designing a transmission building. This approach will include scheduling, structural research, and proposed design.

b. Week 1: Background Research

The week of January 14, the team will continue researching any details needed before solidifying designs by becoming familiar with codes & specifications, site visits, interviews with staff, design research, and other preparations.

c. Week 2&3: Designs

The weeks of January 21 & 28 will be devoted to the actual designing of all the plans. The WPI team will share their work with the Stantec members on the project to verify the project being done correctly.

i. Sustainable Designs

This design will be crafted with the intent of reducing the impacts and demands on the earth and supporting the local area where reasonably possible.

ii. Traditional Designs

This design will be crafted to meet codes & basic criteria.

iii. Joint Designs

These designs will be crafted as hybrids between the traditional & sustainable designs to offer more economical alternatives.

d. Week 4&5 Evaluation Criteria

The weeks of February 4 & 11 will be spent reviewing and revising the designs. The WPI team will be meeting with Stantec team members for in-depth feedback.

iv. Sustainability (Green)

The building will be evaluated to see if there are components which could be altered to make the project less taxing on the environment.

v. Functionality

The building must act as a transmission station and be reliable in the conditions in Halifax.

vi. Building Codes

The building must be in accordance with all relevant codes set by Canada's Government.

vii. Cost Efficiency

The building cannot be high maintenance & must have a long lifespan.

viii. Investment

The building must have a reasonable return on investment. The term reasonable will be defined in the section.

ix. Added value for innovation

The analysis of the building will also consider the benefit of having other components added to improve it at an elevated cost.

e. Week 6: Finalize Designs & Deliverables

The week of February 18 will be spent finishing the designs based on the feedback given by the Stantec team.

x. Designs and Evaluations

Based on the changes to the project, criteria will be reapplied.

xi. Presentation & Paper

The team will finish the written proposal and supporting documentation for the project along with preparing a presentation to accompany this proposal.

f. Week 7: Formal Presentation - Written & Oral

The week of February 25 will be spent reviewing & revising the final report along with preparing to present all findings to Stantec.

Figure 2: 7-Week Schedule

Deliverables

At the end of the time with Stantec the team aims to present two documents, one for the Capstone Design Requirement of the university and one for the final design of the Transmission Station for Stantec, and a final presentation summarizing the team's conclusions. The documents will cover the design requirements and cost estimate for the Transmission Station. A formal presentation will be made to detail the methodology, design aspects and final conclusions. For Worcester Polytechnic Institute the students will also present the findings in a poster presentation. The following chart categorizes these deliverables.

Figure 3: Deliverables

Results

Conclusions

Works Cited

LEED 2009. (2009). Retrieved December 14 2012, from United States Green Building Council: http://www.usgbc.org/ShowFile.aspx?DocumentID=5546

Emera. (2012). *The Maritime Link*. Retrieved December 14, 2012, from Emera Newfoundland & Labrador Maritime Link Inc: http://www.emeranl.com/en/home/ourbusiness/aboutthemaritimelink/default.aspx

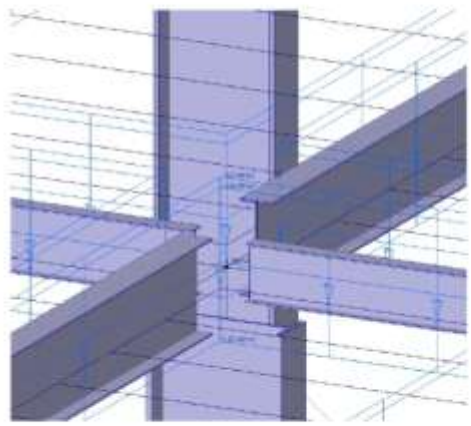
Appendix G. Presentation

Abstract

- The MQP proposed a sustainable structural design
  - Complete design analysis
  - Sustainable materials
  - Provides a set of criteria for the deliverables to be held to for Stantec & WPI

Structural Design

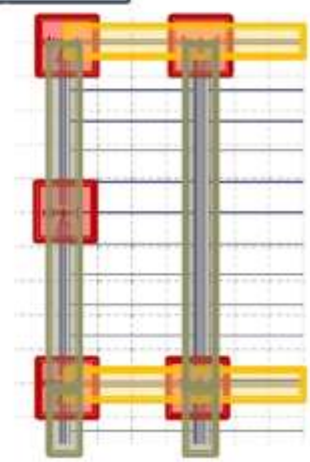
- Methodology
  - Load Development
  - Codes
  - Structural Components
- Results
  - Excel
  - Stantec QAP
- Conclusions



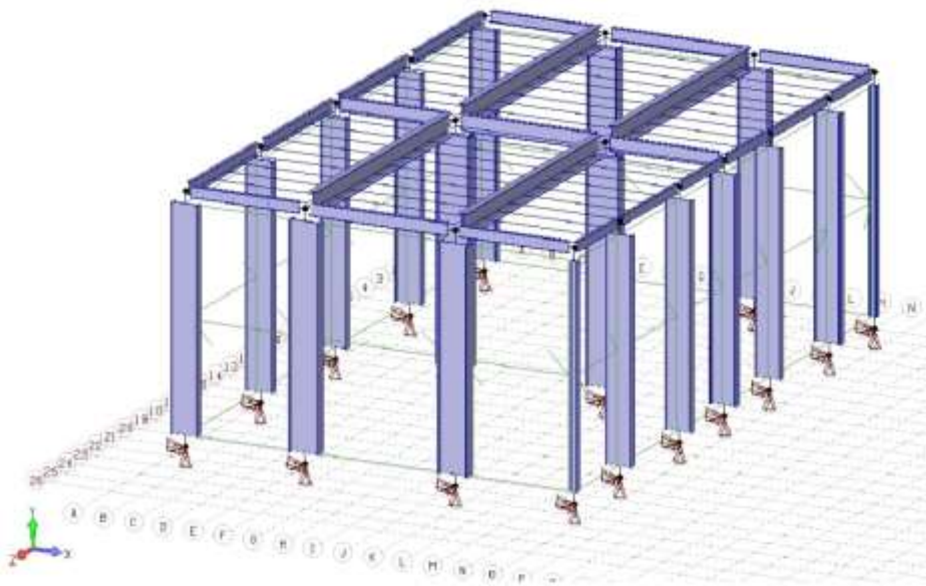
Steel

Beam			Spandrel Beam		
Length	Size	Trib. Width	Length	Size	Trib. Width
10.0	W760x134	10.0	4.0	W360x33	5.0
5.0	W410x39	2.0	5.0	W410x46	5.0
4.0	W310x28	2.0	4.0	W460x52	10.0
3.0	W310x28	2.0	5.0	W530x66	10.0

Column					
Location	Size	Type	Location	Size	Type
1A	W8400x193	4	3C	W1100x499	1
1B	W1000x321	2	3D	W8400x193	4
1C	W1000x321	2	3.5D	W8400x193	4
1D	W610x113	5	4A	W8400x193	4
1.5D	W8400x193	4	4.5D	W8400x193	4
2A	W8400x193	4	5A	W8400x193	4
2.5D	W8400x193	4	5B	W1000x321	2
3A	W8400x193	4	5C	W1000x321	2
3B	W1100x499	1	5D	W610x113	5



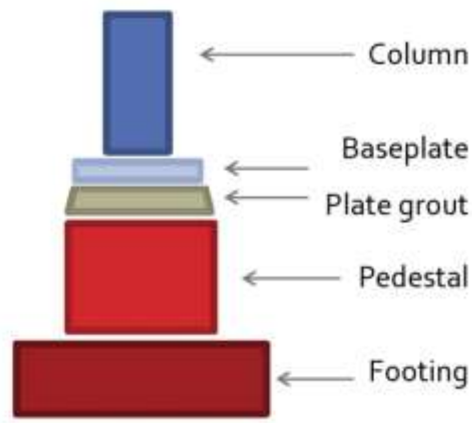
SAFI 3D Model



Foundation

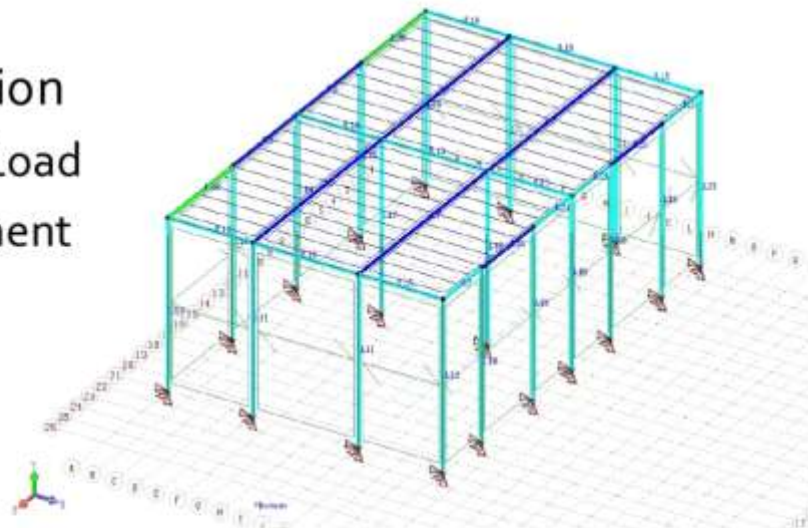
Footing	Ac m^2	b mm	d mm	t mm	As (min) mm^2	bar type	# of bars	spacing mm
1	2.89	1700	150	300	1530	20M	8.0	200
2	1.44	1200	75	200	1611	20M	6	190
4	1	1	75	200	503	20M	6	150
7	1	1	75	200	400	20M	6	150

Pedestal	Ag m^2	b mm	d mm	H mm
All	0.25	500	150	1000
	Rebar		Ties	
	Bar Type	#	Bar Type	#
	20M	4	10M	2



Structural Design

- Simplified Structural Design
- Optimization
  - Extreme Load Development



Sustainable Design

- Materials
  - Concrete Masonry Unit
  - Cast-in Place
  - Precast Concrete
  - Insulated Concrete Form
  - Structural Steel
  - Vulcraft Structural Steel
  - EcoSmart Concrete
  - Ductal
  - FasWall ICF

Environmental Scoring

(Scoring, (0-1, 1 is best))						
Environmental Breakdown						
Material	Resources required	LCA	Recycle	Toxic or Hazardous to make?	Lifespan	Data
Cast in Place Concrete	0.25	0	0.25	0.5	1	2
Pre-Cast Concrete	0.25	0.25	0.25	0.5	1	2.25
Structural Steel	0.5	0.75	0.75	0.5	1	3.5
Insulated Concrete Form	0.5	0.75	0	0.5	1	2.75
Concrete Masonry Unit	0.25	0	0	0.5	1	1.75

(Scoring, (0-1, 1 is best))						
Environmental Breakdown						
Sustainable Material	Resources required	LCA	Recycle	Toxic or Hazardous to make?	Lifespan	Data
Ductal (UHPC)	0.25	0	0.25	0.5	1	2
Ecosmart Concrete (CIP)	0.5	0	0.25	1	0.5	2.25
Vulcraft (SS)	1	0	1	1	0.75	3.75
Faswall (ICF)	1	0	0.5	1	0.75	3.25

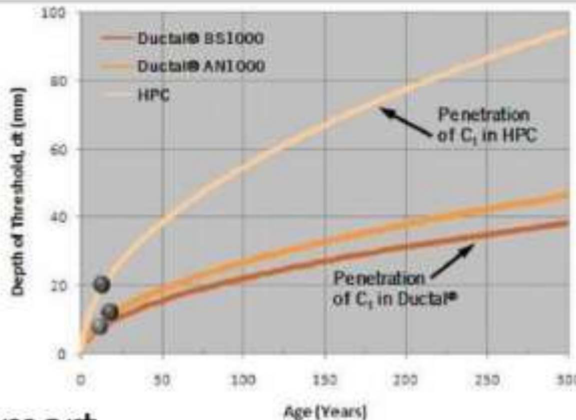
Sustainable Design

Please note: Industry scores and sustainable scores were determined independently of each other. Compare data when comparing the two

	Durability & Lifespan		Required Maintenance		Environmental Impact		
Industry Material	Data	Score	Data	Score	Data	Score	**Total (of 15)**
Cast in Place Concrete	100+	5	N/A	4	2	2	11
Pre-Cast Concrete	50-75	2	N/A	4	2.25	3	9
Structural Steel	50-100+	4	10-15 years	3	3.5	5	12
Insulated Concrete Form	75+	3	N/A	5	2.75	4	12
Concrete Masonry Unit	75+	3	N/A	4	1.75	1	8
Sustainable Material							**Total (of 14)**
Ductal (UHPC)	1000	5	Very low, sel	5	2	2	12
Ecosmart Concrete (CIP)	Default, unknown	2	Default inspe	4	2.25	3	9
Vulcraft (SS)	50-100+	3	10-15 years	4	3.75	5	12
Faswall (ICF)	200	4	Default inspe	4	3.25	4	12

Sustainable Design

- Ductal
  - 1,000 year lifespan
  - Low Maintenance
  - 30% of concrete is cement



- EcoSmart
  - 50% cement replaced by fly ash
  - Low Maintenance
  - Used by Stantec for Capilano Pumping Station
  - Difficult to recycle

Sustainable Design

ShelterWorks Ltd
Healthful and Sustainable Building Products

Manufacturer of
FASWALL
Insulated Wood Chip-Cement Forms

- FasWall
  - 85% wood product, 15% cement
  - 30% of cement replaced by clinker
  - Low maintenance & good insulation
  - 10% recycled material
- Vulcraft
  - No water toxicity,
    constant water recycling
  - Low production CO_2
  - High percentage recycled
  - Maintenance 10-15 years

Sustainable Design

- Choosing a material
  - Both FasWall & Vulcraft recycle, but is it practical?
  - Distance factors with construction
  - FasWall requires less maintenance and insulation
  - Vulcraft is well established in building
- Vulcraft is chosen as primary material

Sustainable Design

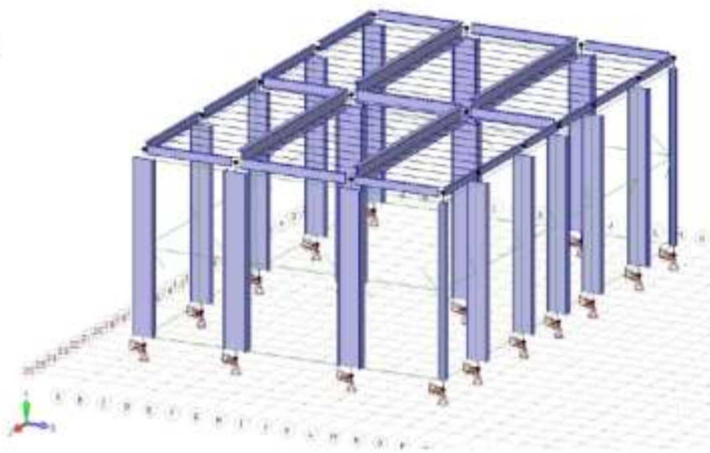
- Additional material
  - Carlisle SynTec Sure-White EPDM Roofing
  - Precast paneling by EcoSmart
  - Insulation with Foamglas

Final Proposed Design

SUSTAINABLE MATERIALS

- Vulcraft Structural Steel
- Carlisle EPDM
- Foamglas insulation
- EcoSmart walls

TRANSITION BUILDING

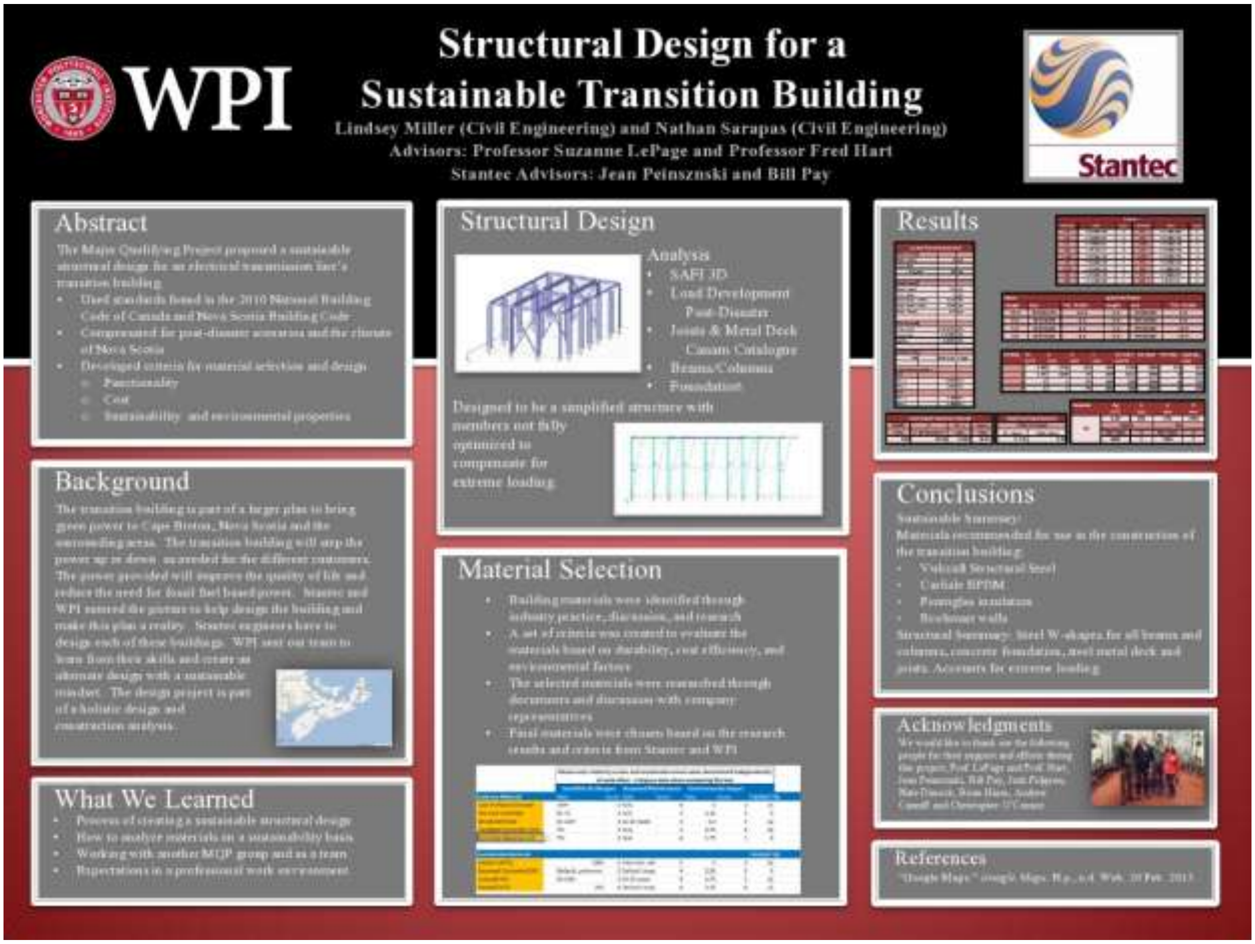


Thanks to:

Stantec

WPI

Questions?


WPI
Structural Design for a Sustainable Transition Building
Lindsey Miller (Civil Engineering) and Nathan Sarapas (Civil Engineering)
Advisors: Professor Suzanne LePage and Professor Fred Hart
Stantec Advisors: Jean Peinsznski and Bill Pay
Stantec
Abstract
The Major Qualifying Project proposed a sustainable structural design for an electrical transmission line's transition building
Used standards found in the 2010 National Building Code of Canada and Nova Scotia Building Code
Compensated for post-disaster scenarios and the climate of Nova Scotia
Developed criteria for material selection and design
Functionality
Cost
Sustainability and environmental properties
Background
What We Learned
Process of creating a sustainable structural design
How to analyze materials on a sustainability basis
Working with another MQP group and as a team
Expectations in a professional work environment
Structural Design
Analysis
SAFI 3D
Load Development
Post-Disaster
Joists & Metal Deck
Canam Catalogue
Beams/Columns
Foundation
Designed to be a simplified structure with members not fully optimized to compensate for extreme loading.
Material Selection
Results
Conclusions
Sustainable Summary:
Materials recommended for use in the construction of the transition building:
Structural Summary: Steel W-shapes for all beams and columns, concrete foundation, steel metal deck and joists. Accounts for extreme loading.
Acknowledgments
References

Appendix H. Design Criteria

Design Criteria - Overhead Transmission Line to Underground Cable Transition Compounds

Table of Contents

1. Scope

This document outlines the design criteria assumptions associated with the HVDC overhead transmission lines to the underground cables at the transition compound in Nova Scotia.

The transition compounds will be located approximately 1 to 2 km inland. The grounding overhead wire used as protection against lightning strikes on the land-based transmission and will terminate at the transition compound. Similar to the converter stations, the transition compounds will be constructed over a grounding grid to ensure safety of utility workers against a fault condition.

The transition compounds will be completely enclosed. This decision was also made to allow for maintenance to be carried out during all times of the year without difficulty.

2. Major Equipment

The transition compounds will include the following major equipment:

- Line dead end structures
- Surge arresters (it is anticipated that this will be included in the cable suppliers' scope of works)
- Cable potheads (dry type)
- Disconnect switches
- Current transformers
- Fibre optic communications interface
- Vertical roof bushing (dry type)
- A salt monitoring and provision for an insulator washing system (for the vertical, external roof bushing)

A conceptual transition compound design, including a conceptual electrical single line diagram, is provided in Figure 2-1.

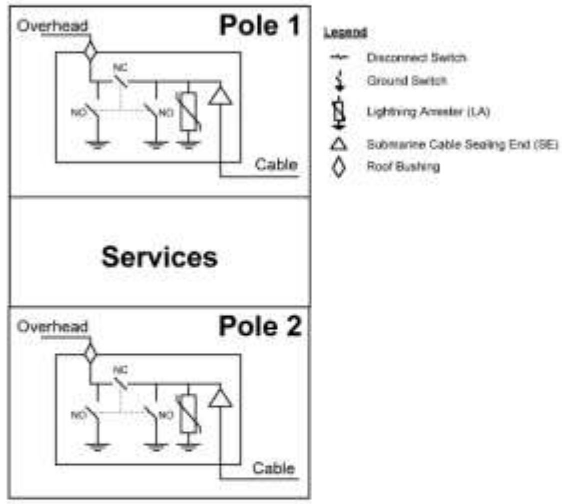


Figure 2-1: Conceptual Transition Compound Design

The cable transition electrical equipment will be confirmed when the HVDC converter station equipment is ordered, as the selected HVDC Contractor will have specific equipment requirements. The clearances in the building will be determined once the insulation levels are known.

Access to the roof will be incorporated into the design for maintenance of the external, vertical roof bushing. Maintenance and repair of the roof bushing will be performed using standard site lifting equipment.

The roof will include a gantry type structure to permit connection of the roof bushing to the dc transmission line without significant stresses on the vertical roof bushing. Roof top design shall provide for: 1) for access to the roof and 2) maintenance and replacement of the cable terminator with standard site lifting equipment.

The cable will be supplied up to the building in trenches. In the event of a failure, easy access to the underground cable via the cable trench, outside of the cable termination building, will be required.

Spare cable for the project will be stored separately from the transition building, as it would not then be possible for a single event to damage both the cable that is in-service and the spare cable.

The pole rooms in the transition compound building will be interlocked to prevent access if the line is energized.

The transition compound building will be designed to have positive pressure to ensure contaminants do not enter the building. The internal temperature of the building will be monitored to ensure tolerable levels are met.

The site must meet all NERC requirements for exterior building security including security fencing.

The transition stations will be unmanned. Personnel will occupy the station only when necessary (washing insulators, repairing cables, maintenance, etc.). The transition station will be equipped with the basic amenities.

Rooms, hallways and doors must be sized to allow movement of equipment for installation, removal, operation and maintenance.

3. Units of Measure

Units of measure, both layout and design, shall be SI units.

4. Codes

4.1 Occupational Health and Safety

The following provincial legislation applies to the work:

4.1.1 Nova Scotia

- Occupational Health and Safety Act, 1996 as amended to date.

4.2 Building Codes

The following provincial building codes shall apply:

4.2.1 Nova Scotia

.1 Nova Scotia Building Code, effective June 1, 2011.

The Nova Scotia Building Code adopts the NBC 2010 and NPCC 2010, including all revision, errata and corrections made by that body on or before June 1, 2011, as amended by the Nova Scotia Building Code Regulations 2011, effective June 1, 2011.

.2 NFCC 2010

4.3 Importance Category for Buildings

The building shall be designed with a Post-disaster Importance Category as noted in Table 4.1.2.1 "Importance Categories for Buildings" of Division B of NBC 2010. The following importance factors shall be used.

	ULS	SLS	
Snow	1.25	0.90	(NBC Table 4.1.6.2)
Wind	1.25	0.75	(NBC Table 4.1.7.1)
Seismic	1.50	-	(NBC Table 4.1.8.5)

Where ULS refers to ultimate limit states and SLS refers to serviceability limit states.

5. Climatic and Seismic Information

5.1 General

Climatic and seismic information shall be as listed in Appendix C "Climatic and Seismic Information for Building Design in Canada" of Division B of NBC 2010, unless noted otherwise.

For the design study the maximum values of the climatic data and seismic information listed below shall be used.

5.2 NS

Information listed in Schedule "B" "Design Data for Selected Locations in Nova Scotia" of the Nova Scotia Building Code Regulations, effective October 1, 2011, for, NS shall be used.

5.3 Information Summary

	NS
Snow Load (kPa)	
S_s	2.4
S_r	0.6
Hourly Wind Pressures (kPa)	
1/10	0.47
1/50	0.59
Driving rain (1/5)	0.30
Seismic Data	
Sa(0.2)	0.19
Sa(0.5)	0.11
Sa(1.0)	0.061
Sa(2.0)	0.016
PGA	0.098
Precipitation (mm)	
15 minute rain	13
One day (1/50) rain	123
Annual rain	1200
Annual total	1475

Moist index	1.36

Design Temperature (°C)

January 2.5%	-16
January 1%	-18
July dry 2.5%	+27
July wet 2.5%	+21
Degree days Below 18 °C	4600

Radial Ice

Thickness (mm)	50.4

6. Geotechnical Design Parameters

6.1 Design Frost Depths

NS 1.2 m

6.2 Seismic Site Classification (NBC Table 4.1.8.4.A.)

NS C*

* - assumed values based on very dense soil or soft rock. To be confirmed by a geotechnical investigation.

6.3 Soil Bearing Capacities

NS

Factored ultimate resistance (HP 310x110) 1000 KN

6.4 Groundwater Level

The groundwater level at both sites is assumed to be 1 meter below finished grade.

6.5 Backfill Properties

Backfill assumed to be granular material having the following unit weights:

.1 Compacted 21 kN/m^3

.2 Submerged 11 kN/m^3

Compacted unit weight shall be used for downward loads and, where applicable, submerged unit weight shall be used to resist upward loads.

7. Materials of Construction

The following subsections describe the major materials of construction.

7.1 Structural Steel

Plate	CSA G40.214 Grade 300W
Wide Flanges and Tees Cut from Wide Flange Shapes	CSA G40.21 Grade 350W ASTM A992 ASTM A572 Grade 50
S-Shapes	ASTM A992 ASTM A572 Grade 50
Channels	CSA G40.21 Grade 300W
Angles	CSA G40.21 Grade 300W
Hollow Structural Shapes (HSS)	CSA G40.21 Grade 350W, Class C
Steel Pipe	ASTM A53/A53M Grade B
High Strength Bolts, Nuts, and	20 mm diameter, ASTM A325, Type 1, bolts, ASTM A563/A563M Grade DH heavy hex nuts, and ASTM F436/F436M Type 1 steel washers with a hardness of 38 to 45 H. C. Bolts, nuts and washers shall be mechanically galvanized in accordance with ASTM A325. Use Slip-Critical connections for members subjected to axial tension and/or compressions forces, members where oversized holes are used for erection tolerances and for bolted moment connections (A325SC). Slip-Critical connections shall be designed based on Class A clean mill scale faying surface conditions. Other connections not specified as Slip-Critical shall be designed as bearing-type with threads included in the shear plane (A325N).
Direct Tension Indicating Washers	ASTM F959/F959M, mechanically galvanized. Use DTI's only in Slip-Critical connections and for connections subjected to direct tension.
Unfinished Bolts for Stairs, etc.	ASTM A307, galvanized per ASTM A153 Grade B
Weld Filler Material	E49XX rod meeting the requirements of CSA W48.1
Checkered Floor Plate	6 mm thick plate meeting the requirements of ASTM A36 and having a symmetrical, raised diamond pattern
Pipe Guardrail	DN40 pipe conforming to the requirements of ASTM A53 Grade B, STD weight class for horizontal rails and XXS weight class for posts. Maximum post

	spacing shall be determined on design load requirements.
Pipe Handrail	DN32 pipe conforming to the requirements of ASTM A53 Grade B, STD weight class.
Floor Grating and Stair Treads	38.1 mm galvanized serrated welded steel grating having 38.1 mm deep by 4.76 mm bearing bars spaced at 30.2 mm centers. Grating shall be fastened with galvanized saddle clips and fasteners. 31.8 mm plain grating properties shall be used for design.
Anchor Rods	ASTM F1554 Grade 36, unless noted otherwise. Minimum diameter shall be 25 mm.
Roof Deck	38.1 mm profile non-cellular steel roof deck, with 152 mm flute spacing and interlocking side laps, manufactured from zinc-iron alloy coated sheet steel, with a Z275 coating, conforming to ASTM A653/A653M Grade 230 having a minimum yield strength of 230 MPa and a tensile strength of 310 MPa. Minimum thickness shall be 0.91 mm thick

7.2 Reinforced Concrete

7.2.1 Concrete

Concrete shall meet the following requirements in accordance with CSA A23.1/A23.2 Alternative 1 - Performance Method for specifying concrete:

.1 Foundations: footings, grade walls and piers.
  - .1 Durability and class of exposure: F-2.
  - .2 Compressive strength at 28 days: 30 MPa.
  - .3 Aggregate size (maximum): 19 mm.
  - .4 Air content: 4-7 percent.
  - .5 Admixtures: As approved by the Owner's Representative.
  - .6 Curing: Type 1 Basic.

.2 Slab-on-Grade.
  - .1 Durability and class of exposure: N.
  - .2 Compressive strength at 28 days: 30 MPa.
  - .3 Aggregate size (maximum): 19 mm.
  - .4 Air content: None.
  - .5 Admixtures: As approved by the Owner's Representative.
  - .6 Curing: Type 3 – Extended.

7.2.2 Reinforcing Steel

Reinforcing shall conform to CAN/CSA-G30.18, Grade 400.

7.2.3 Grout

Grout shall be flowable non-shrink cementitious grout conforming to the requirements of ASTM C1107 Grade C.

Grout shall develop a minimum compressive strength of 24 MPa at 24 hours, and 48 MPa at 28 days when tested in accordance with ASTM C109.

7.3 Masonry Walls and Partitions

Concrete Masonry Blocks	Two cell hollow blocks that conform to CSA A165 and have a minimum compressive strength of 15 MPa based on the net area of the unit. Units shall have a H/15/A/M classification.
Horizontal Joint Reinforcement	Heavy duty truss type galvanized reinforcement conforming to CSA G30.3.
Connectors	Galvanized connectors conforming to CSA A370.
Cement	Masonry cement conforming to CSA A8.
Mortar	Mortar conforming to CSA A179 Type S.
Grout Cement	Cement conforming to CSA A3001 GU(Type 10).

7.4 Exterior Wall Cladding

Barrier Series PVC finished exterior and liner sheets shall be used.

Exterior wall cladding shall be designed to resist the maximum wind loads determined in accordance with Factory Mutual "Property Loss Data Sheet 1-28" and the provincial building codes.

Exterior Sheet	Fabricated from zinc-iron coated sheet steel, with a Z275 coating and a minimum thickness of 0.91 mm, conforming to ASTM A924/A924M Grade 230 having a minimum yield strength of 230 MPa and a tensile strength of 310 MPa. Steel sheet shall have a Barrier Series PVC finish, 0.305 mm thick coating on the exterior side and 0.203 mm thick coating on the interior side. Profile shall be 38.1 mm with 152 mm flute spacing.
Sub-girts	Fabricated from zinc-iron coated sheet steel, with a Z275 coating and a minimum thickness of 1.22 mm, conforming to ASTM A924/A924M Grade 230 having a minimum yield strength of 230 MPa and a tensile strength of 310 MPa.
Insulation	Semi-rigid inorganic fiber insulation conforming to ASTM C533, Type III and ASTM C665, Type 1.
Liner Sheet	Fabricated from zinc-iron coated sheet steel, with a Z275 coating and a minimum thickness of 0.91 mm, conforming to ASTM A924/A924M Grade 230 having a minimum yield strength of 230 MPa and a tensile strength of 310 MPa.

Steel sheet shall have a Barrier Series PVC finish, 0.203 mm thick coating on the exterior side and 0.203 mm thick coating on the interior side.

7.5 Roofing

7.5.1 General

For the CBoD phase the roofing system shall be a two ply modified roofing system. The proposed roofing system will be revisited during the FBoD phase.

Roofing and sheet metal work shall be performed in accordance with the roofing manufacturer's written recommendations, as well as the requirements of the ULC laboratories Class A, Factory Mutual "Property Loss Data Sheet 1-28", provincial building codes, and the CRCA specifications manual.

Roofing system shall be designed to resist the maximum wind loads determined in accordance with Factory Mutual "Property Loss Data Sheet 1-28" and the provincial building codes.

7.5.2 Two Ply Modified Roofing System

The roofing system shall consist of the following components (bottom to top):

.1 Steel roof deck fastened to structural steel roof members.

.2 15.9 mm thick fiberglass-mat faced gypsum roof covering.

3 (SBS) elastomeric polymer vapour retarder (95 g/m^2).

.4 Polyisocyanurate Insulation, thickness to be determined, minimum 2 layers.

.5 15.9 mm thick fiberglass-mat faced gypsum overlay board mechanically fastened to the steel roof deck.

.6 (SBS) elastomeric polymer base sheet and base sheet flashing (180 g/m^2).

.7 (SBS) elastomeric polymer cap sheet and cap sheet flashing with granular surface (250 g/m^2).

8. Civil

8.1 General

The site arrangement shall conform to applicable laws, regulations, and environmental standards. The principle elements in the selection of site arrangement criteria are physical space requirements and relationships dictated the National Building Code and/or other local, provincial and federal standards. Distances between various systems shall be minimized for economy. However, adequate clearance between various systems shall be provided as needed for construction, operations, and maintenance.

8.2 Site Preparation

Areas to be graded shall be cleared and grubbed of all vegetation. Waste from clearing and grubbing operations shall be disposed of off-site in accordance with provincial regulatory requirements. All topsoil and other organic materials shall be stripped from the areas to be graded prior to starting earthwork. Topsoil shall be kept for re-use where possible while excess material shall be disposed of in an off-site disposal area in accordance with provincial regulatory requirements.

Excavation and fill shall be balanced to the maximum extent possible. In areas requiring excavation, material shall be removed to the required lines and grades. Any undesirable material shall be removed and disposed of in accordance with Provincial regulations. The remaining in-situ material shall be graded and compacted. Excavated (common) material that meets the design requirements shall be re-used as general site fill where possible. Compacted fill material shall be obtained from on-site excavations to the maximum extent possible. Imported fill shall only be used when common fill is limited or does not meet the project standards. Imported fill shall be taken from a local borrow pit or quarry. Material types, depths and compaction requirements shall be confirmed through a geotechnical study.

8.3 Erosion and Sediment Control

Erosion and sediment control measures (both temporary and permanent) shall be designed and implemented to retain sediment on-site, prevent violations of provincial water quality standards and limit adverse effects to the environment during and after construction. Erosion and Sediment Control measures shall take into account any phased construction and shall integrate with any stormwater infrastructure proposed for the site. The design shall adhere to the Erosion and Sedimentation Control Handbook for Construction Sites (NS) and Environmental Guidelines for General Construction Practices (NL).

8.4 Design Vehicle and Vehicular Movements

The design vehicle for the site shall be the WB-19 tractor-semitrailer as defined by the Transportation Association of Canada (TAC) Guidelines. The site shall be designed so that the design vehicle can make a full turning circle to enter and exit the site.

8.5 Access Roads and Parking

Access Roads shall be designed to accommodate the design vehicle. Single lane roads shall be a minimum 4.0 m wide. Double lane roads shall be a minimum 7.0m wide. Longitudinal roadway slopes shall typically be between 0.5% (minimum) and 8% (maximum). Unpaved access roads and parking areas shall be finished with a 350 mm thick layer of 75 mm (NLDTW Class B/NSTIR Type 2) crushed aggregate sub-base material topped with a 200 mm thick layer of 20mm (NLDTW Class A/NSTIR Type 1) crushed aggregate base material. Material types, depths and compaction requirements shall be confirmed through a geotechnical study.

8.6 Site Grading and Finished Surfaces

Grade sites to match the existing contours where possible to limit cut and fills. Sites shall contain smooth grade transitions and eliminate ponding areas. Sites shall be graded to direct stormwater away from above ground structures. Typical grades should range from 1% to 3% where possible. Unpaved sites shall be finished with a 350 mm thick layer of 75 mm (NLDTW Class B/NSTIR Type 2) crushed aggregate sub-base material topped with a 200 mm thick layer of 20 mm (NLDTW Class A/NSTIR Type 1) crushed aggregate base material. Exposed slopes shall be a minimum of 2H:1V and shall be stabilized with grass or rock to limit erosion potential. Material types, depths and compaction requirements shall be confirmed through a geotechnical study.

8.7 Stormwater

A stormwater assessment shall be prepared to ensure post-development peak flows do not exceed pre-development peak flows. Design events shall be for the 1:5 and 1:100 year storm. Where the development of the site increases the rate and quantity of stormwater runoff, the design of the site shall include a stormwater management plan which may include such items as retention ponds, drainage channels, piping and outfalls to control and limit the post development runoff. The design shall also address factors such as watercourse protection, erosion and sediment control, and maintenance. Where upstream drainage areas discharge on to the site development area, control measures shall be designed to divert the incoming "clean" water. Where stormwater may contain oil, the system shall contain a separation treatment unit. The design of all stormwater management infrastructure shall include Best Management Practice's, as applicable.

8.8 Water Supply

Water supply to the site shall be for potable use and/or fire protection. Where possible, a connection to the municipal system shall be made. If a municipal supply is unavailable, the design shall consider the use of a drilled well and/or an above ground water storage tank(s). Potable water systems shall be designed to the Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution and Operation of Drinking Water Supply Systems.

8.9 Sanitary Sewage

Where possible, sanitary sewage shall be discharged to a municipal system. If a municipal connection is not available, an on-site sewage treatment system shall be designed. On-site treatment systems and sanitary system works shall be designed to the Atlantic Canada Wastewater Guidelines Manual, the Private Sewage Disposal and Water Supply Standards (NL) and/or the On-site Sewage Disposal Systems Technical Guidelines (NS).

8.10 Fencing and Security

The site shall be a fenced compound. Fencing shall be galvanized chain link, with a minimum height of 2100 mm above the finished grade. Three strands of galvanized barbed wire shall also be installed, for an additional height of 305 mm. Galvanized double swinging chain link gates shall be provided for vehicular access to the site. Gates shall be wide enough to suit the design vehicle. The fencing system shall also contain a grounding system. Design of fencing shall conform to ASTM F2611 – Guide for Design and Construction of Chain Link Security Fencing and ASTM F900 – Standard Specification for Industrial and Commercial Swing Gates.

Fencing shall be equipped with an alarm system.

9. Structural

9.1 General

The structural portion of the design criteria deals primarily with the design and construction of the transition building and associated foundations.

9.2 Design Loads

9.2.1 General

Design loads shall be as defined in NBC Section 4.1 "Structural Loads and Procedures.

Design loads for the electrical equipment will be provided by the equipment suppliers.

9.2.2 *Dead Loads*

Dead loads shall be determined in accordance with NBC Subsection 4.1.4 "Dead Loads".

Dead loads shall include the self-weight of the structural steel and all construction materials permanently fastened to it or supported by it.

An additional 10 kN point load shall be applied to all steel beams and girders. The point load shall be located to result in the maximum moment and shear in the member. Point loads shall not be additive.

An additional 50 kN point load shall be applied to the top of every column.

The following uniformly distributed loads shall be applied to the various roof and floor levels. The dead loads include the weight of the columns, beams, girders, horizontal and vertical bracing, connections, gusset plates, and handrail.

.1	Roofs	
	Steel deck and roofing	0.75 kPa
	Structural steel	1.20 kPa
	Total	1.95 kPa
.2	Girts and Cladding	0.75 kPa
.3	Concrete Masonry Wall	
	(grouted cells @ 800 c/c)	
	200 mm nominal thickness	2.80 kPa
	250 mm nominal thickness	3.60 kPa
	300 mm nominal thickness	4.30 kPa
.4	Reinforced Concrete	23.5 kN/m^3

The following uniformly distributed dead loads shall be applied to account for miscellaneous electrical and mechanical services supported beneath the roof. These loads shall not be used to resist uplift or load reversal.

.1	Roofs	1.2 kPa

9.2.3 *Live Loads*

Live loads shall be determined in accordance with NBC Subsection 4.1.5 "Live Loads Due to Use and Occupancy".

Live load reduction factors determined in accordance with NBC Article 4.5.1.8 "Variation with Tributary Area" shall not be used.

The following uniformly distributed live loads or point live loads, whichever produces the most critical effect shall be used for structural design.

	UDL	Point Ld.
.1 Roofs	1.0 kPa	1.3 kPa (200 mm x 200 mm area)
.2 Exits	4.8 kPa	9.0 kPa (750 mm x 750 mm area)
.3 Floors at Grade	25.0 kPa	

9.2.4 *Snow and Rain Loads*

Snow and rain loads shall be determined in accordance with NBC Subsection 4.1.6 "Loads Due to Snow and Rain" and Commentary G "Snow Loads" of the User's Guide – NBC 2010 Structural Commentaries and local conditions.

9.2.5 *Wind Loads*

Wind loads, external and internal, shall be determined in accordance with NBC Subsection 4.1.7 "Wind Load" and Commentary I "Wind Loads and Effects" of the User's Guide – NBC 2010 Structural Commentaries and local conditions.

External pressure coefficients for low-rise buildings shall be used.

Internal pressure coefficients for buildings with large or significant building, C_{pi} = -0.7 to +0.7, shall be used.

The exposure factor for open terrain, $C_e = (h/10)^{0.2}$, shall be used.

9.2.6 *Earthquake Loads*

Earthquake loads shall be determined in accordance with NBC Subsection 4.1.8 "Earthquake Load and Effects".

Additional system restrictions for post-disaster buildings as noted in NBC Article 4.1.8.10 shall apply. In particular the seismic force resisting system, SFRS, shall have a ductility-related force modification factor, R_d, of 2.0 or greater.

Analysis shall be carried out in accordance with the Equivalent Static Force Procedure described in NBC Article 4.1.8.11.

The dead load, W, shall be the structure dead load, plus permanent equipment loads, minimum partition loads (0.5 kPa), 25% of the design snow load, 60% of storage loads and the full contents of any tanks.

9.3 Design Methodology

9.3.1 *General*

Buildings and structural components shall be designed to have adequate strength and stability so that the factored resistance, ϕR, is greater than or equal to the effect of the factored loads in accordance with NBC Subsection 4.1.3 "Limit States Design".

9.3.2 *Load Factors and Load Combinations*

Load factors and load combinations shall be as described in NBC Article 4.1.3.2 "Strength and Stability", Table 4.1.3.2A. "Load Combinations Without Crane Loads for Ultimate Limit States", and Table 4.1.3.2.B. Load Combinations With Crane Loads for Ultimate Limit States".

9.3.3 *Lateral Deflection*

The largest lateral interstorey deflection of all buildings due to service wind and gravity loads shall not exceed 1/500 in accordance with NBC Article 4.1.3.5 "Deflection".

The largest lateral interstorey deflection of all buildings due to seismic loads shall be 0.01 h_s in accordance with NBC Article 4.1.8.13 "Deflections and Drift Limits".

9.3.4 *Structural Separation*

Adjacent structures shall be separated by the square root of the sum of the squares of their individual deflections.

9.3.5 *Serviceability*

Building and its structural components shall be checked for serviceability limit states in accordance with NBC Article 4.1.3.4 "Serviceability".

9.4 Structural Steel Design

9.4.1 *General*

Steel structures shall be designed in accordance with CAN/CSA-S16 "Limit States Design of Steel Structures".

To suit the requirements of Subsection 8.1.7 the type of SFRS shall be "Limited ductility concentrically braced frames, Tension only braces" having an R_d = 2.0 and R_o = 1.3 as described in NBC Table 4.1.8.9 "SFRS Ductility-Related Force Modification Factors, R_d, Overstrength-related Force Modification Factors, Ro, and General Restrictions".

Steel structures shall be founded at grade on reinforced concrete foundations.

For design purposes all members shall be assumed to be pinned, except at locations specifically requiring rigid connections.

Work points shall be assumed to be located at: 1) the intersection of beam/column centerlines and 2) at the underside of the column base plate.

9.4.2 *Base Plates*

Grout thickness between underside of baseplate and top of concrete foundation shall be maximum 50 mm.

Small horizontal shear loads shall be resisted by the anchor rods in bearing.

Large horizontal shear shall be resisted by shear lugs. Shear lugs shall be 50 mm thick by 150 mm deep.

Base plates shall have a minimum thickness of 25 mm.

Base plates having shear lugs shall be a minimum thickness of 50 mm.

Small uplifts shall be resisted by the base plate in bending and shear.

Large uplifts shall be resisted by chair type structures welded to the column and base plate.

Load factors and load combinations shall be as described in NBC Article 4.1.3.2 "Strength and Stability", Table 4.1.3.2A. "Load Combinations Without Crane Loads for Ultimate Limit States", and Table 4.1.3.2.B. Load Combinations With Crane Loads for Ultimate Limit States".

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The largest lateral interstorey deflection of all buildings due to service wind and gravity loads shall not exceed 1/500 in accordance with NBC Article 4.1.3.5 "Deflection".

The largest lateral interstorey deflection of all buildings due to seismic loads shall be 0.01 h_s in accordance with NBC Article 4.1.8.13 "Deflections and Drift Limits".

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Building and its structural components shall be checked for serviceability limit states in accordance with NBC Article 4.1.3.4 "Serviceability".

9.4 Structural Steel Design

9.4.1 General

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To suit the requirements of Subsection 8.1.7 the type of SFRS shall be "Limited ductility concentrically braced frames, Tension only braces" having an R_d = 2.0 and R_o = 1.3 as described in NBC Table 4.1.8.9 "SFRS Ductility-Related Force Modification Factors, R_d, Overstrength-related Force Modification Factors, Ro, and General Restrictions".

Steel structures shall be founded at grade on reinforced concrete foundations.

For design purposes all members shall be assumed to be pinned, except at locations specifically requiring rigid connections.

Work points shall be assumed to be located at: 1) the intersection of beam/column centerlines and 2) at the underside of the column base plate.

9.4.2 Base Plates

Grout thickness between underside of baseplate and top of concrete foundation shall be maximum 50 mm.

Small horizontal shear loads shall be resisted by the anchor rods in bearing.

Large horizontal shear shall be resisted by shear lugs. Shear lugs shall be 50 mm thick by 150 mm deep.

Base plates shall have a minimum thickness of 25 mm.

Base plates having shear lugs shall be a minimum thickness of 50 mm.

Small uplifts shall be resisted by the base plate in bending and shear.

Large uplifts shall be resisted by chair type structures welded to the column and base plate.

Where base plate dimensions exceed 610 mm, two 50 mm diameter grout holes shall be placed as close as possible to the centre of the plate.

9.4.3 Steel Framing Design

Beams shall frame into beams of equal or greater depth.

Minimum column size shall be W310.

WT-shapes if used for horizontal bracing members and connected by their flanges only shall be designed considering the effects of connection eccentricity.

Beams spanning between columns and located above the apex of a chevron-type brace shall be designed for the full span between columns. A lateral brace system shall be provided at the beam level to brace the top of the chevron.

Columns shall be designed using a K equal to 1.0 and an unbraced length equal to the distance between centerlines of the effective column stability bracing. Columns shall be designed taking into consideration all applied moments, including applied point loads between bracing points and the effects of knee-braced platforms.

Platform grating spans shall not exceed 1.7 m. Span is defined from centre-to-centre of the support beams.

Beams shall be designed as simple span beams.

Structural members shall be arranged to minimize pocketing of dust and moisture.

Exterior welded connections shall be seal welded to prevent entrance of water.

9.4.4 Connections

Simply supported beam-to-beam and beam-to-column connections shall be double clip angle type connections.

Bolted connections shall be designed as bearing connections with threads in the shear plane condition. except where slip-critical connections are required.

Design of slip-critical connections shall be based on Class A surface condition.

All bolts shall be pretensioned.

All axial loads shall be shown on the drawings. Pass-through axial loads shall be shown on the drawings.

Each beam end connection shall be designed for the larger of the following:

.1 Shear load shown on the drawings.

.2 50% of the total uniform capacity from "Beam Load Tables", tabulated in the CISC "Handbook of Steel Construction", for given shape, span and steel specified assuming the beam is fully-laterally supported.

Hanger and diagonal bracing member connections shall be designed for shear, axial tension and compression forces.

End connections of horizontal members in braced vertical frames and horizontal trusses shall be designed for combination of axial force and beam shear reaction.

Moment connections shall be designed as follows:

.1 Assume that moment connection angles, structural tees, or plates above the top flange and below the bottom flange do not carry any portion of the shear load.

.2 Where moment connections occur at grating platforms, arrange the top plate of the moment connection flush with the grating surface. Edge support for the grating shall be provided at moment connections.

.3 Where required, stiffeners plates between the column flanges opposite the beam flange moment connection points shall be provided to prevent column web crippling or column flange buckling.

.4 If required, column web doublers plates shall be provided.

Field connections shall be bolted. Field welding shall be kept to a minimum.

Column splice plates shall be a minimum thickness of 13 mm (0.50 in) and shall have a minimum of 4 bolts per connecting element on either side of the splice

Column finishes at base plates and splices shall meet a surface roughness coefficient tolerance of 500 in accordance with ANSI B46.1 by milling, saw cutting, or other suitable means.

9.5 Reinforced Concrete Design

9.5.1 General

Reinforced concrete design shall be in accordance with CSA A23.3 "Design of Concrete Structures".

9.5.2 Foundations

At the NS transition site pile supported foundations shall be used to support the building structural steel framework and wall systems, and the electrical equipment foundations. This is due to potential of the transition site being situated on open pit mine workings that have been backfilled with uncontrolled materials. The open pit mine workings could be to 30 meters in depth. Prior to detailed design, a geotechnical investigation shall be carried out to determine the required foundation type.

Exterior foundations shall be founded below the design frost depth unless founded on rock. Exterior foundations not be founded below design frost depth shall be insulated.

Uplift loads shall be resisted by anchor rods.

Where additional uplift resistance is required the base of the foundation shall be lowered or rock anchors used.

Small horizontal shear loads shall be resisted by the anchor rods in bearing. Large horizontal shear shall be resisted by shear lugs.

9.6 Masonry Design

Masonry shall be in accordance with CSA S304.1 "Design of Masonry Structures"

9.7 Roof System Design

The roofing system shall be designed to provide weather-tight exterior roofs for the buildings.

The roofing system shall be designed to resist the algebraic sum of the external and internal wind pressures calculated in accordance with NBC or FM Global 1-28, Wind Design, whichever results in the higher design pressures.

For the NBC calculation, exterior wind pressures shall be calculated using the composite pressure-gust coefficients, C_pC_g, given in Figure I-9 "External peak pressure-gust coefficients, C_pC_g, on roofs with a slope of 7° or less for the design of structural components and cladding" of Commentary I of the NBC "User's Guide – NBC 2010 Structural Commentaries (Part 4 of Division B)".

Securement of the steel roof deck to the structural steel and the above-deck components shall be in accordance with FM Global 1-29, Above-Deck Roof Components.

Perimeter flashing shall be designed in accordance with FM Global 1-49, Perimeter Flashing

9.8 Wall Cladding System Design

The wall cladding system shall provide a weather-tight insulated exterior wall skin for the buildings.

Wall cladding system shall be designed to resist the algebraic sum of the external and internal wind pressures calculated in accordance with NBC or FM Global 1-28, Wind Design, whichever results in the higher design pressures. The wall cladding system shall be designed to resist the algebraic sum of the external and internal wind pressures.

For the NBC calculation, exterior wind pressures shall be calculated using the composite pressure-gust coefficients, CpCg, given in Figure I-8 "External peak pressure-gust coefficients, CpCg, on individual walls for the design of structural components and cladding" of Commentary I of the NBC "User's Guide – NBC 2010 Structural Commentaries (Part 4 of Division B)".