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LOWER CHURCHILL PROJECT
GENERAL REPORT – SITE INSPECTION OF DRAFT TUBE UNIT 1 FORMWORK AND FALSEWORK

Purpose of Document:

The purpose of this report is to document deficiencies observed during a visual inspection performed on August 1, 2016. The inspection focused on the installed formwork and falsework in Draft Tube 1 elbow.

Overview:

Following the collapse of the wooden formwork supporting Draft Tube 2, NL OH&S issued stop work orders pertaining to all concrete pours on all four Draft Tubes and associated works. As part of the phased approach to release and continue work on Draft Tube 1, an inspection of the existing formwork and falsework was conducted. The observations made during the inspection will aid in the investigation of the root cause of the failure.

Due to limited visibility and access in some areas inside Draft Tube 1, not all portions of the formwork and falsework were able to be visually inspected.

Summary of findings:

The inspection revealed deficiencies pertaining to the quality of materials and the quality of fabrication and construction of the formwork and falsework.

The inspection revealed various issues pertaining to the quality of materials and the quality of fabrication and installation of the formwork and shoring towers. Observations made on the formwork and shoring towers are described below. The naming convention used for identifying the shoring towers throughout this report is shown in Figure 1.



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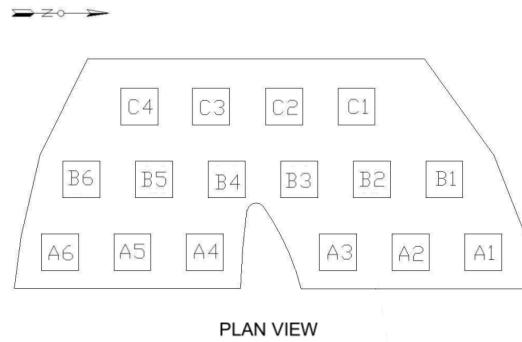


Figure 1: Shoring tower naming convention

Quality of Material – Shoring towers

The material used for the shoring tower legs showed signs of extensive weathering and rot as seen in Figures 2 to 5. All shoring towers throughout Draft Tube 1 have some degree of weathering, with varying degrees of intensity. Instances of biological attack (mold, fungi, insect) were also observed.



Figure 2: Highly weathered column member with extensive rot and damage due to overstress

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Figure 3: Highly weathered column member with extensive rot and damage due to overstress



Figure 4: Highly weathered column member with mold growth

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Figure 5: Weathered column member with fungal growth

The bases of the tower legs on all towers were generally in very poor condition, with obvious indications of moisture damage and weathering as see in Figure 6.



Figure 6: Highly weathered column base with moisture damage

All towers in Row B were overstressed and showed some indication of compression failure as shown Figures 7, 8 and 9.

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Figure 7: Compression failure of column member in tower B2



Figure 8: Compression failure of column member in tower B6

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Figure 9: Buckling of column in tower B4

Quality of Fabrication and Construction – Shoring towers

Fabrication and construction issues observed during the inspection were quite extensive. These observations are summarized as follows:

Butt joints in column members were not staggered as seen in Figure 10.

Approximately 90% of the shims between the shoring tower columns and the steel beams were not installed. Shim plates that were installed do not cover the bearing surface of the columns resulting in unevenly distributed loads to the column (Figure 11 and 12). It was noted that a combination of softwood and steel shims were used.

Buckling of column legs was observed in Row B as seen in Figures 7, 8 and 9.

Column members were observed to be inadequately nailed together, as large gaps between column laminations were visible in Figure 13. Figure 14 shows an extreme example of inadequate nailing of tower legs (nails should penetrate all column laminations).

Evidence of termite damage was found on one of the shoring tower legs (see Figure 15).

14 of the 16 shoring towers were not anchored to the concrete base slab as indicated on drawing MFA-AT-SD-3310-CS-D04-0066-01 to MFA-AT-SD-3310-CS-D04-0066-06. Figure 16 shows Tower A6 with no anchors installed and uninstalled anchors off to the side.

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Some shoring towers color coded green (meant for Draft Tube 3) were installed in Draft Tube 1 as seen in Figure 17.

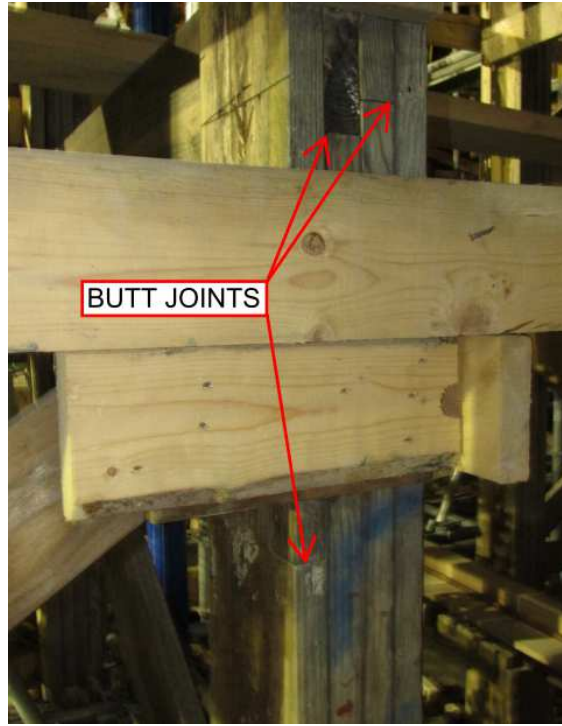


Figure 10: Butt joints not staggered (tower C1)



Figure 11: Inadequate shim plate (shifted plate)

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Figure 12: Localized end-grain compression due to lack of shim plate



Figure 13: Inadequate nailing of column panels

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Figure 14: Inadequate nailing of column leg (tower B1)



Figure 15: Termite damage on shoring tower leg with wood filler added

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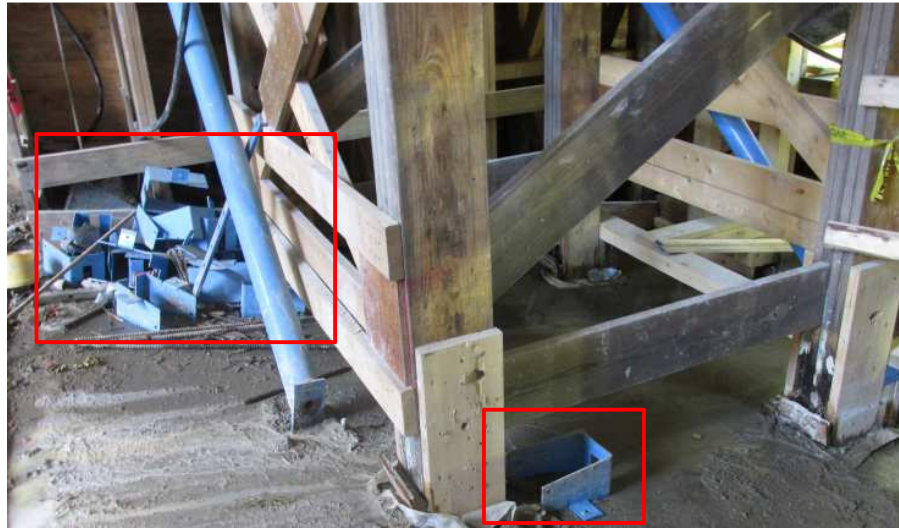


Figure 16: Uninstalled tower base anchors



Figure 17: Shoring towers for Draft Tube 3 (green paint) found in Draft Tube 1

Quality of Formwork Panels

It was observed that the installed formwork panels in Draft Tube 1 had similar deficiencies as those identified in Draft Tube 3 and 4. Refer to Draft Tube 3 and 4 reports; MFA-AT-SD-331A-EN-A99-0011-01 and MFA-AT-SD-331A-EN-A99-0018-01.

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The observed deficiencies in Draft Tube 1 were primarily insufficient nailing and inadequate splice plates, as shown in Figure 18 and 19. OSB splice plates were not observed in Draft Tube 1. Signs of weathered wood and mold were also seen in the formwork panels (Figure 20). A summary of observed deficiencies in the formwork is found in Table 1.



Figure 18: Inadequate splice plate coverage of structural member and insufficient nailing

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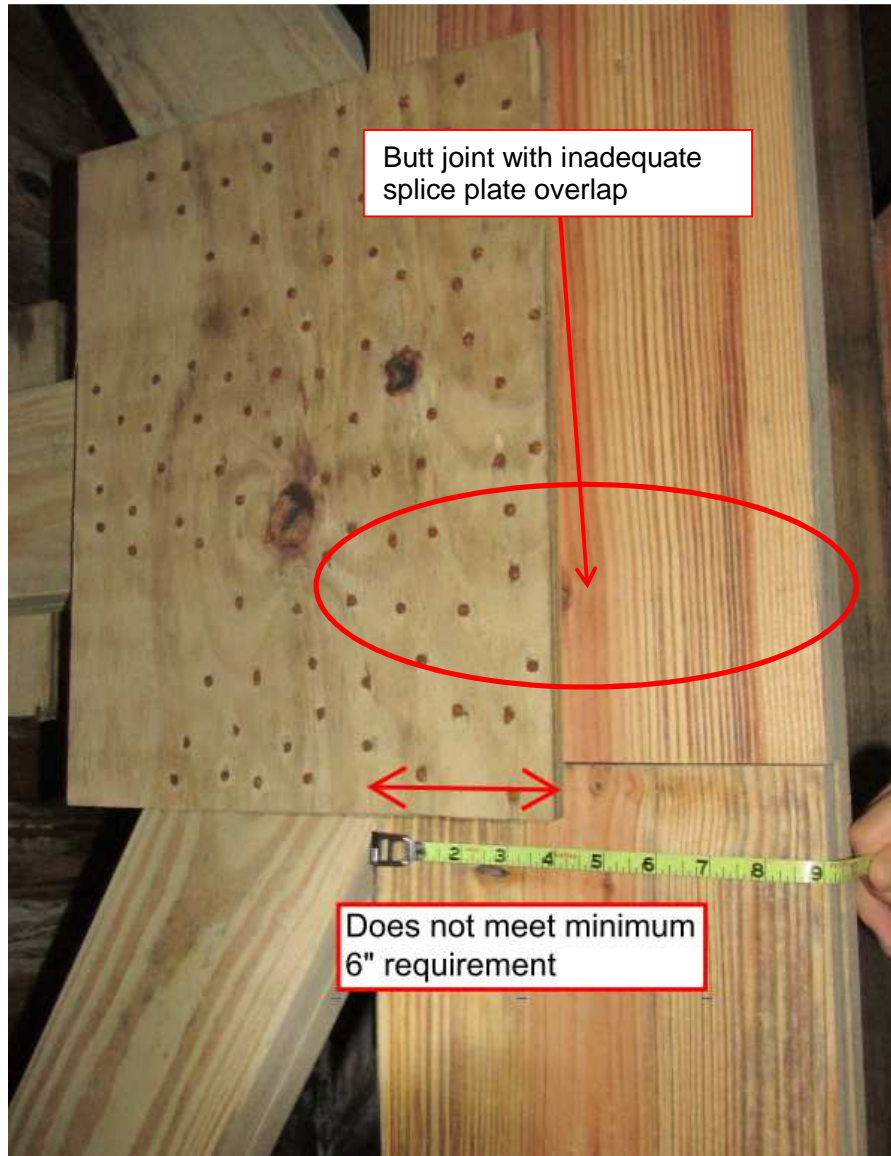


Figure 19: Incorrect size and installation of splice plate

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Figure 20: Weathered formwork

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Table 1: Summary of formwork deficiencies in Draft Tube 1 Elbow

Panel	OSB	No. 2 Grade	Deficiency					
			Inadequate splice plate	Missing coil rod	Inadequate nailing	Damaged member	Incorrect geometry	
A1			20%		1%			
A2			20%					
A3			5%					
A4			5%					
A5			5%					
A6			10%					
A7			10%		1%			
A8			20%					
A9			5%					
A10			15%					
A11			30%					
A12			30%					
A13								
A14								
A15			5%					
A16			15%					
A17			20%					
A18			30%					
A19								
A20			2%					
A21			10%					
A22			25%		1%			
A23			10%	3				
A24			40%		10%			
A25			40%		10%			
A26			40%		5%			
A27			40%		10%			
A28			*Could not see/access*					
A29			30%		2%			
A30			5%					
A31			15%					
A32			10%					
A33			30%					
A34			3%		2%			
A35								
A36			10%	2				
B36			25%	2				
A37			25%					
A38			25%					
A39			25%					
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A42								
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Conclusion:

A visual inspection of Draft Tube 1 formwork and falsework was required to assess material quality and fabrication and construction deficiencies. A summary of deficiencies is noted below.

Material quality issues observed are as follows:

- varying degree of weathering and rot (minor to severe)
- mold growth
- termite damage
- saturated wood

Fabrication and construction issues as observed are as follows:

- inadequate nailing of column members and splice plates
- improper use, size and placement of shim plates
- uninstalled tower base anchors
- inadequate staggering of butt joints within the columns
- placement of the shoring towers in the wrong draft tube
- insufficient splice plates for formwork panels

With best regards,

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