TEST REPORT

REPORT NUMBER: 100390597TOR-003b
ISSUE DATE: February 29, 2012

EVALUATION CENTER

Intertek Testing Services NA Ltd.
6225 Kenway Drive
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RENDERED TO
Titan Building Products
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Ottawa, Ontario K1J 9G6

PRODUCT EVALUATED:
Primus 4×4 post anchors

EVALUATION PROPERTY:
Load Tests on Guards

Report of load testing for Titan Building Products of a guard rail system utilizing 4×4 Primus post anchors for compliance with the applicable requirements of 2006 Ontario Building Code and 2010 National Building Code of Canada, Section 9.8.8.2 sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units."

1 Table of Contents

2 Introduction

This test report covers load tests performed on a guard (rail) system utilizing 4×4 Primus post anchors anchored to an SPF (spruce, pine, fir) substrate. Based on the guard rail construction as noted in this report, it serves to qualify the 4×4 Primus post anchor as a method of securement to the SPF substrate.

The test loads applied were as set forth in the following:

- 2006 Ontario Building Code (OBC) Section 9.8.8.2, Sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units.
- 2010 National Building Code of Canada (NBC), Section 9.8.8.2, Sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units.

In addition, factored loads (based on the appropriate resistance factors) were applied to the load specifications. This evaluation began on December 5, 2011 and was completed on December 7, 2011.

3 Test Sample

The Primus post anchors were submitted by the client on July 21, 2011.

In order to qualify the 4×4 Primus post anchors as a suitable component in a guard rail system, it is required that the guard system (assembled with 4×4 Primus post anchors) satisfy the requirements set out in the 2006 OBC and 2010 NBC. The description below outlines the components and construction of the guard rail system assembled with 4×4 Primus post anchors.

3.1. Sample and Assembly Description

A guard rail assembly measuring 5.49 m (18′) long was tested. This system represents a guard rail system that has the following characteristics:

- the posts at either end of the assembly was fixed at the top and bottom (not cantilevered)
- centre-to-centre post spacing is no longer than 1829 mm (72″)
- entire guard rail assembly is no longer than 10.97 m (36′). The guard rail system described is not qualified for an infinite run of railing)

Two separate guard rail assemblies were tested for concentrated load. Each assembly is noted described below as Option 1 and Option 2. The guard rail assembly is qualified constructed in the following two manners:

Top Rail and Hand Rail:

The top rail length measured 1740 mm (68-1/2″). A plastic mount was fastened to each end of the top rail using two #8×2-1/2″ screws. Each mount was subsequently fastened to the post with three #8×2-1/2″ screws.

In addition, for the balusters, fifteen 13/16” diameter holes were drilled into the bottom side of the top rail, spaced 114 mm (4-1/2″) apart, 1 inch deep.

Top Railing Option 1:

The hand rail measured 1829 mm (72″) in length and was fastened at either side to the 4×4 post with three #10×3-1/2″ flat-head screws. The hand rail was also fastened onto the upper surface of the top rail with five #10×3-1/2″ screws, equally spaced approximately 13” apart. The end of each hand rail was butted against the end of the next adjacent handrail. The top of the hand rail was 1070 mm (42-1/8″) from the floor.

Top Railing Option 2:

The hand rail measured 1740 mm (68-1/2″) in length and was fastened to either side to the 4×4 post with three #10×3-1/2″ flat-head screws “toenailed” from the top of the handrail into the post. The hand rail was also fastened onto the upper surface of the top rail with five #10×3-1/2″ screws, equally spaced approximately 13″ apart. The top of the hand rail was 1070 mm (42-1/8″) from the floor.

Bottom Rail

The bottom rail length measured 1740 mm (68-1/2″). A plastic mount was fastened to each end of the bottom rail using two #8×2-1/2″ screws. Each mount was subsequently fastened to the post with three #8×2-1/2″ screws

In addition, for the balusters, fifteen 13/16” diameter holes were drilled into the top side of the bottom rail, spaced 114 mm (4-1/2″) apart, 1 inch deep.

Posts

Each post was assembled with a 4×4 Primus post anchor. Each post anchor was assembled to the post as per the packaging instructions. Each pressure-treated SPF post measured 89 mm by 89 mm by 1003 mm (3.5″ × 3.5″ by 39.5″) long.

4×4 SPF lumber was cut to 1016 mm (40″) lengths. A 1-1/4” diameter hole saw was used to cut a circular pilot cut identical to the diameter of the tube in the centre of the 4×4 post about 42-48 mm (1-5/8" to 1-7/8") deep. The inner wood core of the cut remained and the sharp edge of the tube was aligned and set into the pilot cut at a vertical attitude and driven with force into the solid core of the post until the base of the anchor was flush against the post bottom. Four pilot holes measuring 1/4" diameter were drilled a minimum of 50mm (2") deep into the post. Then, four 3/8″×5″ lags screws fastened the anchor to the post.

Each post was fastened into an SPF base that measured 76 mm (3″) thick (fastened perpendicular to the wood grain) with eight #14×3″ screws.

Balusters

Each rail section was outfitted with fifteen balusters each measuring 19 mm (3/4″) diameter and 940 mm (37″) in length. Each baluster was capped with a small plastic cover that was inserted into the top and bottom rail sections.

3.2. Drawings

Post Anchor Drawing: Titan Post Anchor System – Titan 4X4 01, dated Feb 24, 08. (3 pages)

4 Test and Evaluation Methods

4.1. SPECIMEN PREPARATION

The post anchor specimens were shipped to the Intertek laboratory in Mississauga, Ontario. The guard system was assembled by the client.

4.2. CONDITIONING

The guard specimens were tested in the laboratory under ambient conditions. No specific conditioning parameters were required before testing. After purchase, the SPF wood was allowed to be accustomed to the test environment for a minimum of two weeks.

4.3. TEST PROCEDURES

Since the guard system was symmetrical, it is Intertek's professional opinion that the loads applied from one side would achieve results that are equal to loads applied to the other side.

The end post (that was not fixed at the top) was evaluated for the following tests:

- concentrated horizontal load at top of end post (to qualify tributary load requirement for a guard system with 1.83 m (6′) post spacing and qualify the horizontal concentrated load on the post). This setup served to qualify a maximum rail length with fixed end posts

A simple two-post guard rail system (with cantilevered end posts) was also evaluated for the following tests:

- concentrated horizontal load at top rail at midspan (to qualify the requirement for a guard system with 1.83 m (6′) post spacing.
- concentrated horizontal load at top rail end connector (to qualify the requirement on the end connector).
- concentrated horizontal load on balusters (to qualify the requirement for elements within the guard). This was evaluated only for its effect on the post anchor.
- distributed horizontal load at top rail (to qualify the requirement for a guard system with 1.83 m (6′) post spacing.
- distributed vertical load at top rail (to qualify the requirement for a guard system with 1.83 m (6′) post spacing.

The test loads applied were as set forth in the following:

- 2006 Ontario Building Code Section 9.8.8.2, Sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units.
- 2010 National Building Code of Canada Section 9.8.8.2, Sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units.

Appropriate factored loads were applied to the load specifications. Due to the limited number of samples, the guard rail was tested at a higher safety factor than what was required based on calculations from Limit States Design (section 4.1.3. of the 2006 OBC and 2010 NBC) and Resistance Factors listed in CSA S16-09, "*Design of steel structures*", Section 13.1 and CSA O86-09, "*Engineering design in wood*".

4.3.1 Tributary Load Requirements - Horizontal Concentrated Load on Post

The tributary load requirement of the guard rail system is based on the assembly information in Section 3 qualifying a centre-to-centre post spacing of 1.83 m (6 ft. 0 in.). The end post of the test assembly representing the middle post of a guard rail system measuring 10.97 m (36′) anchored in SPF was tested to ultimate failure to determine a mode of failure and subsequently an appropriate material resistance factor (and a combined factor of safety). Based on this testing, the guard rail posts are required to sustain a concentrated horizontal load of 1.67 kN (343 lbf) applied to the top of rail.

4.3.2 Horizontal Concentrated Load on Post

The post was tested for horizontal concentrated load applied at the top rail for a guard rail system anchored in SPF. The tributary load results on the posts as reported in Section 5.1 serve to qualify the guard rail system in SPF.

Basic Load (2006 OBC and 2010 NBC)

The initial position of the top of the post was measured. A concentrated load of 1.0 kN (delivered with a 100 mm by 100 mm platen) was applied at the top of the post by means of a calibrated load cell/single ram/pump system and held for 1 minute. The position of the post was measured. The load was then released and the residual position of the post was again measured.

1.67 Factored Load

A test load of 1.67 kN (factored load of 1.67) was applied to the top of the post rail and the post movement was measured at full load and after removal of the test load. After release of the load, the system was evaluated for failure, evidence of disengagement of any component and visible cracks in any component.

4.3.3 Horizontal Concentrated Load at Top Rail at Midspan

Basic Load (2006 OBC and 2010 NBC)

The initial position of the top rail (at mid-span) was measured. A concentrated horizontal load of 1.0 kN (delivered with a 100 mm by 100 mm platen) was applied to mid span of the top rail by means of a calibrated load cell/single ram/pump system and held for 1 minute. The position of the top railing was measured. The load was then released and the residual position of the top rail was again measured.

2.5 Factored Load

A test load of 2.5 kN (factored load of 2.5) was applied to mid span of the top rail and the rail movement was measured at full load and after removal of the test load. After release of the load, the system was evaluated for failure, evidence of disengagement of any component and visible cracks in any component.

4.3.4 Horizontal Concentrated Load at Top Rail End Connector

Basic Load (2006 OBC and 2010 NBC)

The horizontal concentrated load at top rail end connector was conducted only to evaluate its effect on the post anchor. A concentrated horizontal load of 1.0 kN (delivered with a 100 mm by 100 mm platen) was applied to the top rail adjacent the post by means of a calibrated load cell/single ram/pump system and held for 1 minute. The load was then released and the residual position of the top rail was again measured.

1.67 Factored Load

A test load of 1.67 kN (factored load of 1.67) was applied to top rail adjacent the post. After release of the load, the system was evaluated for failure, evidence of disengagement of any component and visible cracks in any component.

4.3.5 Horizontal Uniform Load at Top Rail

Basic Load (2006 OBC and 2010 NBC)

Quarter-point loading (deemed by Intertek to be equivalent to uniform loading) was applied to the top rail in a horizontal direction by means of the loading system comprised of a calibrated load cell/single ram/pump system and load distributing steel bar. A test load of 0.50 kN/m was applied to the rail. The initial position of the top of the rail at midspan was measured. A total load of 0.92 kN was applied to the rail and held for 1 minute and then released. The load was based on a rail length of 1.83 m on centre.

2.5 Factored Load

A test load of 2.29 kN (factored load of 2.5) was applied to the railing system. The top rail movement was measured at full load and after removal of the test load. After release of the load, the system was evaluated for failure, evidence of disengagement of any component and visible cracks in any component.

4.3.6 Horizontal Load on Balusters

Basic Load (2006 OBC and 2010 NBC)

The horizontal load on the balusters was conducted only to evaluate its effect on the post anchor. A concentrated load of 0.5 kN (delivered with a 300 mm by 300 mm platen) was applied to the baluster at top, mid, and bottom height by means of a calibrated load cell/single ram/pump system and held for 1 minute. The load was then released. After release of the load, the system was evaluated for failure, evidence of disengagement of any component and visible cracks in any component.

2.5 Factored Load

A test load of 1.25 kN (factored load of 2.5) was applied to the baluster at the aforementioned location. After release of the load, the system was evaluated for failure, evidence of disengagement of any component and visible cracks in any component.

4.3.7 Vertical Uniform Load on Top Rail

Basic Load (2006 OBC)

Quarter-point loading (deemed by Intertek to be equivalent to uniform loading) was applied to the top rail in a vertical direction by means of the loading system comprised of a calibrated load cell/single ram/pump system and load distributing steel bar. A test load of 1.5 kN/m was applied to the rail. A total load of 2.75 kN was applied to the rail and held for 1 minute. After release of the load, the system was evaluated for failure, evidence of disengagement of any component and visible cracks in any component. The load was based on a rail length of 1.83 m on centre.

2.5 Factored Load

A test load of 6.86 kN (factored load of 2.5) was applied to the top rail. After release of the load, the system was evaluated for failure, evidence of disengagement of any component and visible cracks in any component.

5 Test and Evaluation Results

5.1. Tributary Load Results - Horizontal Concentrated Load on Post

Table 1. – Ultimate Failure Mode on Horizontal Concentrated Load on Post anchored to SPF substrate

Failure Mode at Ultimate Load	Combined Factor of Safety
Yielding of post anchor steel	1.67

Based on the failure mode of the load of the post system (anchored to SPF substrate), a combined resistance factor of 1.67 was calculated based on calculations from Limit States Design (section 4.1.3. of the 2006 OBC and 2010 NBC) and Resistance Factors listed in CSA S16-09, *"Design of steel structures*", Section 13.1 and CSA O86-09, "*Engineering design in wood*".

Since the post-to-post spacing is less than 2.0 m, the requirements for tributary load (Horizontal Concentrated Load on Post) are less than the requirements for the horizontal concentrated load on the post. The results for horizontal concentrated load on the post are reported below.

5.2. Horizontal Concentrated Load on Post

Table 2. - Horizontal Concentrated Load on Post anchored to SPF substrate

	Load		Net Deflection (mm)	Residual Deflection (mm)	Test Result
Option 1	Basic	1.0 kN (225 lbf)	60	17	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system
	Factored 1.67 X	1.67 kN (375 lbf)	--	--	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system
Option 2	Basic	1.0 kN (225 lbf)	77	22	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system
	Factored 1.67 X	1.67 kN (375 lbf)	--	--	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system

Based on the appropriate resistance factor applied, both railing systems tested (Option 1 and Option 2) satisfied the requirements specified in the 2006 Ontario Building Code and 2010 National Building Code of Canada, Section 9.8.8.2 sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units for Horizontal concentrated load (load on post).

5.3. Horizontal Concentrated Load at Top Rail at Midspan

Table 3. - Horizontal Concentrated Load at Top Rail at Midspan

Load		Net Deflection (mm)	Residual Deflection (mm)	Test Result
Basic	1.0 kN (225 lbf)	33	1	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system
Factored 2.5 X	2.5 kN (562 lbf)	--	--	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system

Based on the appropriate resistance factor applied, the guard system satisfied the requirements specified in the 2006 Ontario Building Code and 2010 National Building Code of Canada, Section 9.8.8.2 sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units for Horizontal concentrated load (load at top rail midspan).

5.4. Horizontal Concentrated Load at Top Rail End Connector

Table 4. - Horizontal Concentrated Load at Top Rail End Connector (adjacent to post)

Load		Test Result
Factored 2.5 X	2.5 kN (562 lbf)	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system

Based on the appropriate resistance factor applied, the guard system (anchored to SPF substrate) satisfied the requirements specified in the 2006 Ontario Building Code and 2010 National Building Code of Canada, Section 9.8.8.2 sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units for Horizontal concentrated load (load at top rail end connector).

5.5. Horizontal Uniform Load at Top Rail

Table 5. - Horizontal Uniform Load at Top Rail

Load		Net Deflection (mm)	Residual Deflection (mm)	Test Result
Basic	0.50 kN/m (34.3 lbf/ft)	29	2	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system
Factored 2.5 X	1.25 kN/m (85.7 lbf/ft)	--	--	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system

Based on the resistance factor applied, the guard system (anchored to SPF substrate) satisfied the requirements specified in the 2006 Ontario Building Code and 2010 National Building Code of Canada, Section 9.8.8.2 sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units for Horizontal uniform load.

5.6. Horizontal Load on Balusters

Table 6. - Horizontal Load on Balusters

Load		Test Result
Factored 2.5 X	1.25 kN (281 lbf)	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system

Based on the appropriate resistance factor applied, the guard system (anchored to SPF substrate) satisfied the requirements specified in the 2006 Ontario Building Code and 2010 National Building Code of Canada, Section 9.8.8.2 sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units for Horizontal load on the balusters.

5.7. Vertical Uniform Load on Top Rail

Table 7. – Vertical Uniform Load on Top Rail

Load		Test Result
Factored 2.5 X	3.75 kN/m (257 lbf/ft)	After release of the load there was no evidence of disengagement or visible cracks in any component of the post anchor system

Based on the appropriate resistance factor applied, the guard system (anchored to SPF substrate) satisfied the requirements specified in the 2006 Ontario Building Code and 2010 National Building Code of Canada, Section 9.8.8.2 sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units for Vertical uniform load on the top rail.

6 Test Equipment

Description	Inventory Number
24″ hydraulic ram	-
Electric Hydraulic Pump	-
Artech Load Cell	280-01-0713 Cal Due Dec 1, 2012
Admet Read Out	280-01-0696 Cal Due Dec 1, 2012
Husky Tape Measure	300-01-0956 Cal Due March 12, 2012
Stop Watch	273 01 0923 Cal Due February 7, 2012

7 Conclusion

The subject guard system utilizing 4×4 Primus post anchors described herein satisfied the basic and factored horizontal and vertical loads (including tributary loads) as set forth in the 2006 Ontario Building Code and 2010 National Building Code of Canada, Section 9.8.8.2 sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units.

The guard rail is qualified for installation of the posts anchored to a SPF wood substrate.

Tested by Claudio Sacilotto and Gabriel Fernandes

INTERTEK TESTING SERVICES NA LTD

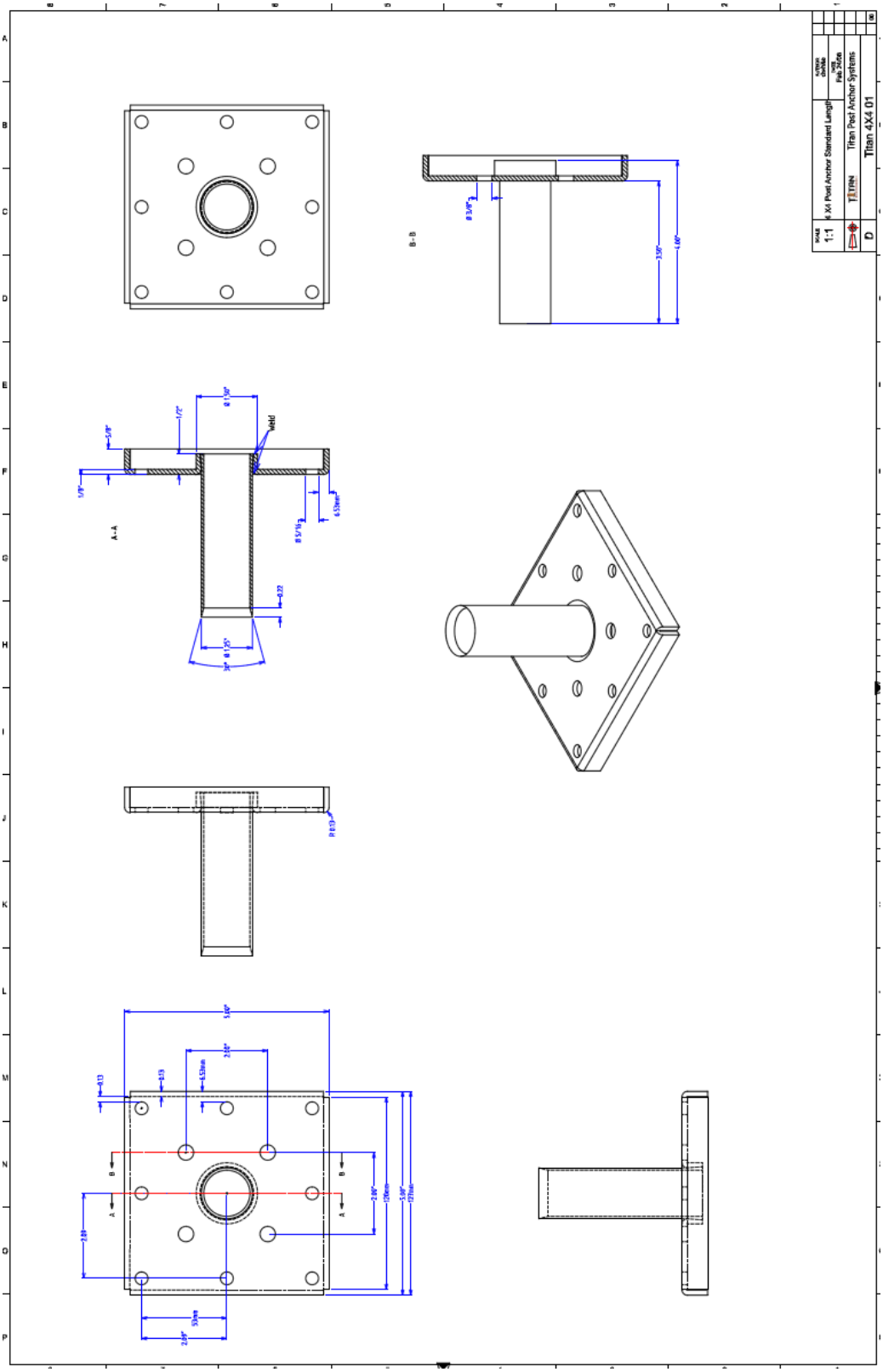
Reported by:
Claudio Sacilotto, P.Eng
Senior Project Engineer

Reviewed by:
Vern W. Jones, C.E.T.
Laboratory Technologist

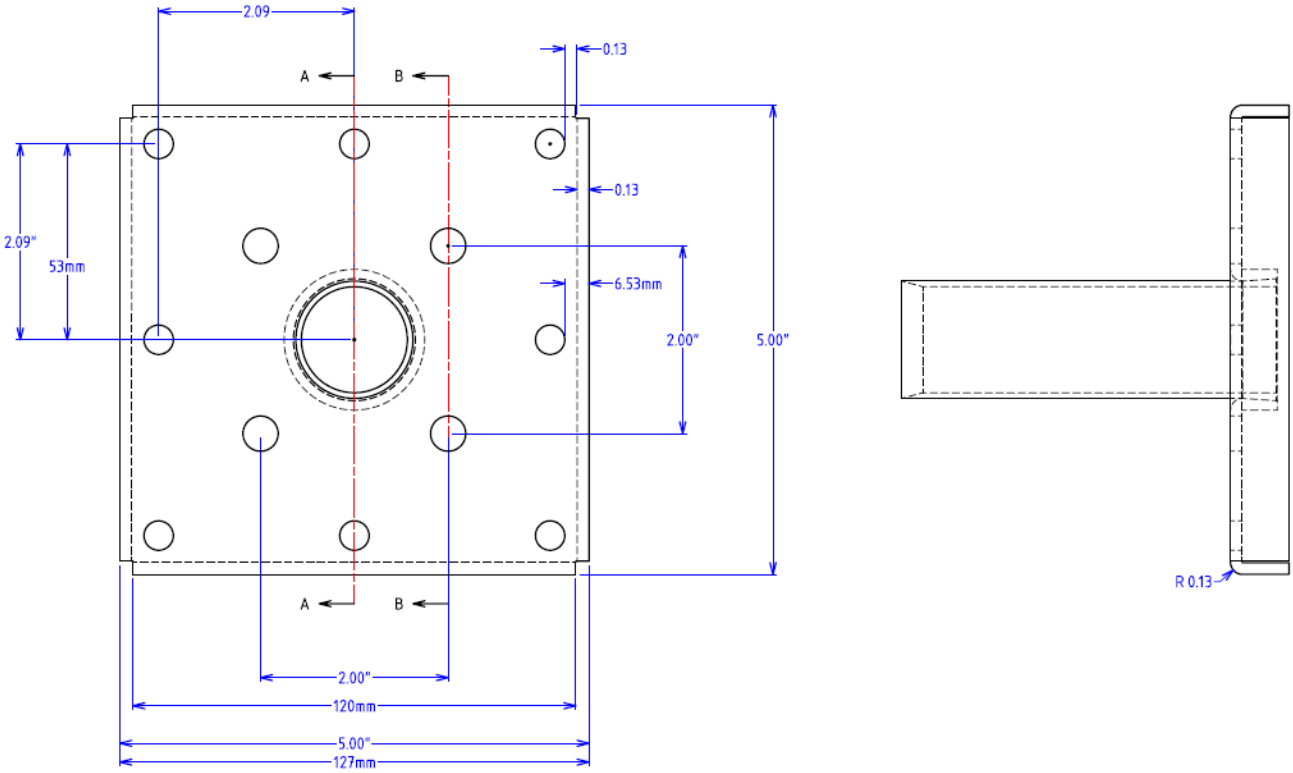
8 Appendix A – Drawings

APPENDIX A

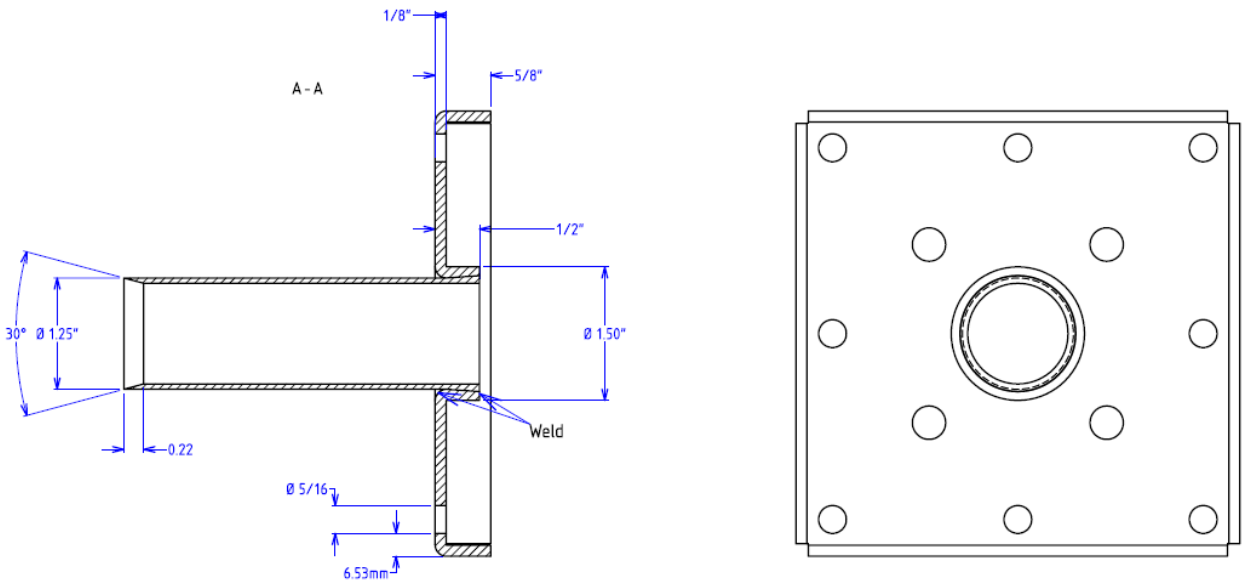
(Drawings – 3 pages)


Titan 4X4 01
Titan Post Anchor Systems
4 X 4 Post Anchor Standard Lamp
1:1
D
B-B
A-A
Weld

Drawing 2. – Zoomed in drawing of 4x4 Primus post anchor (top-view)



Drawing 3. – Zoomed in drawing of 4x4 Primus post anchor (side-view)



9 Appendix B – Photographs

Photo 1. Guard Rail system (Top Railing Option 1) being tested. The post on the left side is completely fixed to the forklift. All the other posts are cantilevered from the ground.

Photo 2. Guard Rail System post under load.

10 Appendix B – Revision Page

Revision No.	Date	Changes	Author	Reviewer
0	February 29, 2011	First issue	Claudio Sacilotto	Vern Jones

END OF DOCUMENT

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July 9, 2014

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This letter serves as a response to a request for clarification of the minimum specified loads listed in Article 9.8.8.2 of the 2012 Ontario Building Code.

Intertek has conducted load testing for Titan Building Products on the following:

- Primus 4×4 post anchors anchored to a wood substrate
- Primus 4×4 post anchors (with Chicago Bolt) anchored to a wood substrate
- Primus 6×6 post anchors anchored to a wood substrate

In addition to load testing on the posts, a guardrail system incorporating the posts was also constructed and tested. Details of the post load testing, guardrail construction, test method and test results can be found in the following Intertek Reports:

- 100390597TOR-003a, dated January 30, 2012
- 100390597TOR-003b, dated February 29, 2012
- 100390597TOR-003c, dated February 29, 2012
- 100604363TOR-004b, dated March 27, 2012
- 100604363TOR-004c, dated March 27, 2012

The test loads applied were as set forth in the following:

- 2006 Ontario Building Code Article 9.8.8.2, Sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units.
- 2010 National Building Code of Canada, Article 9.8.8.2, Sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units.

On January 1, 2014, the 2012 Ontario Building Code came into effect. Upon review of the 2012 Ontario Building Code it was determined that there were no changes to the minimum specified loads in Article 9.8.8.2, specifically Sentence 1 in conjunction with Table 9.8.8.2 for guards within dwelling units and for exterior guards serving not more than 2 dwelling units.

Please let us know if you have any questions.

Claudio Saciotto, P. Eng
Senior Project Engineer