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Date:	September 20, 2013
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Report Number:	ESP012657P - 233
Client Reference:	2882

AC233 MECHANICAL TESTING OF FASTENERS

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INTRODUCTION

Ten (10) samples wood screw fasteners were received from Western Builders Supply, Inc located in Billings Montana. The samples were received for mechanical testing in accordance with ICC/ES AC233. The test samples were selected by an Element employee on February 20th, 2013 from inventory at Screw-Products, Inc. located at 9401 54th Avenue NW Building 1B in Gig Harbor, Washington 98332. Testing was conducted between June 1st 2013 and September 8th 2013. The following report documents this testing.

SAMPLE IDENTIFICATION

Sample Identification	Fastener Designation	Coating	Description	Part Drawing
CTX-14250	14 x 2-1/2	Bronze Star	Head suited for a star driver with built in washer.	Figure B-1 (Page 47)
CTX-14400	14 x 4	Bronze Star	Head suited for a star driver with built in washer.	
CTX-14600	14 x 6	Bronze Star	Head suited for a star driver with built in washer.	
CTX-516300	15 x 3	Bronze Star	Head suited for a star driver with built in washer.	Figure B-2 (Page 48)
CTX-516400	15 x 4	Bronze Star	Head suited for a star driver with built in washer.	
CTX-516600	15 x 6	Bronze Star	Head suited for a star driver with built in washer.	
CTX-38700	17 x 7	Bronze Star	Head suited for a star driver with built in washer.	Figure B-3 (Page 49)
CTX-381000	17 x 10	Bronze Star	Head suited for a star driver with built in washer.	
BL-14600	14 x 6	Black Log	Head suited for a hex driver	Figure B-4 (Page 50)
GL-38500	17 x 5	Gray Log	Head suited for a hex driver	Figure B-5 (Page 51)

SUMMAY OF MECHANICAL TESTING PERFORMED

Fastener Strength Tests (Bending Yield, Tensile and Single Shear)

- Performed on CTX-14400, CTX-516400, and CTX-381000 screws.

Withdrawal and Head Pull Through

- Performed on BL-14600 (head pull through only), GL-38500 (head pull through only), CTX-14400, CTX-516400, and CTX-381000 screws.
- Using wood with specific gravities of 0.42 and 0.55

Lateral Load Tests (Shear Tests for Wood to Wood Connections, Single Shear)

- Performed on all test samples, excluding BL-14600 and GL-38500.
- Using wood specific gravity of 0.42 and 0.55.
- Main and side members had the same specific gravity.
- Shear testing performed parallel to, and perpendicular to the grain.

SUMMAY OF TEST RESULTS

Fastener Strength Tests – Tested Load (Design Value)

Sample Identification	Bending Yield, lbf (psi)	Tensile, lbf	Shear, lbf	Tensile, psi	Shear, psi
CTX-14400	235 (141,400)	2,793 (931)	2,171 (724)	171,466 (57,155)	99,146 (33,049)
CTX-516400	363 (151,600)	4,430 (1,477)	3,057 (1,019)	174,072 (58,024)	95,531 (31,844)
CTX-381000	497 (170,500)	5,553 (1,851)	3,714 (1,238)	157,316 (52,439)	94,409 (31,470)

Withdrawal and Head Pull-Through Tests – Load (Reference Design Value)

Sample Identification	Withdrawal, lbf (lbf/in)		Pull-Through, lbf	
	0.42	0.55	0.42	0.55
CTX-14400	1,562 (156)	1,700 (170)	1,470 (294)	1,790 (358)
BL-14600	-	-	1,010 (202)	1,195 (239)
CTX-516400	1,415 (141)	1,835 (183)	1,490 (298)	2,015 (403)
GL-38500	-	-	1,360 (272)	1,615 (323)
CTX-381000	3,393 (170)	3,952 (198)	1,820 (364)	2,405 (481)

Lateral Load Tests – Load, lbf (Reference Design Value, lbf)

Sample Identification	Side Member Thickness (in)	Penetration into Main Member (in)	0.42		0.55	
			$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$
CTX-14250	3/4	1-3/4	750 (150)	625 (125)	900 (180)	768 (154)
CTX-14400	1-3/4	2-1/4	910 (182)	936 (187)	1,073 (215)	1,047 (209)
CTX-14600	3	3	1,201 (240)	1,108 (222)	1,674 (335)	1,202 (240)
CTX-516300	3/4	2-1/4	783 (157)	661 (132)	1,132 (226)	899 (180)
CTX-516400	1-1/2	2-1/2	1,208 (242)	1,216 (243)	1,401 (280)	1,294 (259)
CTX-516600	2	4	1,289 (258)	1,292 (258)	1,482 (296)	1,304 (261)
CTX-38700	2-3/4	4	1,922 (384)	1,327 (265)	2,196 (439)	1,431 (286)
CTX-381000	3-1/2	6-1/2	2,350 (470)	1,367 (273)	2805 (561)	1,512 (302)

DISCUSSION

Selection of Reference Design Values for Untested Sample Sizes

Testing was not conducted on all combinations of length and diameter for each screw. Rather, the reference design values from some sets of tests were used as the design values for multiple combinations of length and diameter. The table below shows which tests were conducted, and which results were inferred from other completed tests.

Test Type:	Performed on:		Also Applied to:
Tension, Shear, Bending, and Withdrawal	CTX	14 x 4	All CTX and BL 14 diameter sizes
		15 x 4	All CTX 15 diameter sizes
		17 x 10	All CTX and GL 17 diameter sizes
Head Pull Through	CTX	14 x 4	All CTX 14 diameter sizes
		15 x 4	All CTX 15 diameter sizes
		17 x 10	All CTX 17 diameter sizes
	BL	14 x 6	All Black Log 14 diameter sizes
	GL	17 x 5	All black log 17 diameter sizes
Lateral Load	CTX	14 x 2-1/2	CTX 14 x 3
		14 x 4	BL 14 x 4
		14 x 6	BL 14 x 6, 8, 10, and 12
		15 x 3	CTX 15 x 3-1/2
		15 x 4	CTX 15 x 5, GL 17 x 5
		15 x 6	-
		17 x 7	CTX 17 x 8, GL 17 x 7, GL 17 x 9
		17 x 10	CTX 17 x 12, GL 17 x 11

The tension, shear, and bending testing would have been performed exactly the same on all samples of a specified diameter. Therefore, one length of screw was selected for each diameter of screw, and applied to all lengths with that same diameter.

The Withdrawal testing would have been conducted with different depths of thread penetration into the main member for different lengths of screws. However, the design load to be reported for this test is in pounds per inch of thread depth, so the results may be extrapolated to any length of threads that are of the same design/diameter.

The head pull through tests were extrapolated to each length of screw with the same diameter as the tested sample, since the head design does not change with length. The threaded portion of each screw extended up well past the wood member, so that the only portion of the screw affecting the test was the head, which only varies with screw diameter and design, not length.

Lateral load testing results from each tested sample were used as results for multiple fasteners, with the exception of the 15 x 6 CTX screw. The results to use for an untested sample were determined in the following way. First, if there was a screw of the same diameter and length that was tested, this result was used. An example would be the GL 17 x 7 using the result from the CTX 17 x 7. If no exact diameter and length combination existed, a test with the same diameter and smaller screw length was used (assuming the side member thickness would be the same). An example would be the CTX 17 x 12 using the result from the CTX 17 x 10. Finally, if neither of the first two scenarios could be met, a result was taken from a smaller diameter screw and shorter length. An example would be the GL 17 x 5 using the result from the CTX 15 x 4, as no screw was tested with a diameter equal to the GL 17 x 5 and length as short as 5 inches.

TEST METHODS

Bending Yield Strength

Bending Yield Strength was determined in accordance with ICC/ES AC233 Section 4.1.2 "Bending Yield Strength" and ASTM F1575-03 "Standard Test Method for Determining Bending Yield Moment of Nails". Each specimen was placed on two supports, separated by a distance determined based on the diameter of the screw, per Table 1 "Length Between Nail Bearing Points" of ASTM F1575-03. The screw was arranged, so that the transition zone between shank and thread was as close as possible to the midpoint between the bearing points, with the load applied at the transition point, or in the threads. The specimen was loaded at a maximum constant rate of 0.25 inches per minute. The load deformation curve was used to determine the 5% offset yield load, which was used to calculate the bending yield strength of the specimen (F_{yb}). A minimum of 10 specimens were tested. A photograph of a tested specimen can be seen in Figure 1.

Shear and Tensile Strength

Shear and tensile testing was conducted in accordance with ICC/ES AC233 Section 4.1.1 "Shear and Tensile Strength" and also with AISI S904-08 "Standard Test Methods for Determining the Tensile and Shear Strength of Screws". A minimum of 10 fasteners were tested, however testing continued until precision of 5 percent at a 95 percent confidence interval was achieved, which was determined in accordance with ASTM D2915-10 "Practice for Sampling and Data-Analysis for Structural Wood and Wood-Based Products".

Tensile testing was conducted in accordance with AISI S904-08 Section 4.1 "Tensile Tests". The head and threads were gripped by the test machine, and separated at a rate of 0.1 inches per minute, or at a load rate of 500 pounds per minute, whichever was greater. The maximum load was recorded as the tensile strength of the screw. A photograph of a tested specimen can be seen in Figure 2.

Shear testing was conducted in accordance with AISI S904-08 Section 4.3 "Single Shear Tests". The specimen was tested using steel plates of sufficient thickness to preclude bearing failure and to ensure failure through the fully-threaded section. The plates created a single-lap joint connected with one fastener, and allowed for central loading across the lap joint. The plates were pulled apart at 0.1 inches per minute, or 500 pounds per minute, whichever was greater. The maximum load was recorded as the shear strength of the screw. A photograph of a tested specimen can be seen in Figure 3.

Withdrawal

Withdrawal Load testing was conducted in accordance with ICC/ES AC233 Section 4.2.3 "Withdrawal Load Test" and ASTM D1761-06 "Standard Test Method for Mechanical Fasteners in Wood" Sections 1-12 on "Nail, Staple, or Screw Withdrawal Test". Specific gravity and Moisture Content were determined as specified in the Test Methods section of this report, under the sub-headings Specific Gravity, and Moisture Content. Specimens were prepared in accordance with ASTM D1761-06 Section 8.2.3; sections of 4 x 4 nominal boards were cut, and a screw was installed near the middle, so that the minimum end and edge distances were maintained. Each screw was installed into the wood with an electric drill, with no pre-drilled lead hole, so that the threaded portion of the specimen was completely embedded into the wood, but the knurled shoulder was not. The wood was then placed into a square tube with a 3 inch diameter hole cut into the top, so that the screw head was protruding upwards through the hole. The head of the screw was then placed into a fastener pulling fixture, and pulled on at 0.1 in/min ± 25%. The maximum load was recorded for each test. A photograph of the test setup can be seen in Figure 4.

Head Pull-Through

Fastener head pull-through testing was conducted in accordance with ICC/ES AC233 Section 4.2.5 "Pull-through Test" and ASTM D1037-12 "Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Pales Materials" Section 15 "Nail Head Pull-Through". Specific gravity and Moisture Content were determined as specified in the Test Methods section of this report, under the sub-headings Specific Gravity, and Moisture Content. Sections of wood were cut at 3/4" thickness x 3-1/2" width x 6" length. A lead hole was drilled through the center of each wood member, with diameter equal to 70 percent of the root diameter of the test specimen. The specimen was then installed into the wood member, so that the head was flush with the surface of the wood, and all of the threads were exposed through the back. The wood was placed in a square tube with a three inch diameter hole cut out, and the threads on the fastener extended up through the hole, and were gripped by mechanical wedge grips on the test machine. A spacer with 1-1/2 inch diameter was placed between the wood and the square tube. The fastener head was then pulled through the wood at approximately 0.09 inches per minute. A photograph of the test setup can be seen in Figure 5.

Lateral Single Shear (Wood to Wood Connections)

Lateral shear testing was conducted in accordance with ICC/ES AC233 Section 4.2.4 "Lateral Load Testing" and ASTM D1761-12 "Standard Test Method for Mechanical Fasteners in Wood" Sections 13 – 20. Specific gravity and Moisture Content were determined as specified in the Test Methods section of this report, under the sub-headings Specific Gravity, and Moisture Content. A connection was created using the wood of the same specific gravity for the side member and main member, using the side member thickness and penetration shown in the "Lateral Load Tests" table in the Summary of Test Results section above. These thicknesses were achieved by buying wood with the correct thickness, planing or ripping to the correct thickness, or by gluing boards together (only for the main member). A pilot hole was drilled through the side member, with a diameter equal to 90% of the shank diameter of the screw to be tested. A pilot hole was also drilled to a depth of 1-5/8 inches into the main member with diameter equal to 70% of the root diameter of the test specimen. A friction reducing barrier was placed between the main and side members to minimize friction. The specimen was then installed using an electric drill, so that the head was flush with the surface of the side member.

Testing conducted parallel to the grain was performed in tension (as described in ASTM D1761-12). The screws were installed at 15 diameters maximum from the end of the wood side and main members. The wood specimens were pulled apart at approximately 0.1 inches per minute. The maximum load was reported. A minimum of 15 specimens were tested. A photograph of the test setup can be seen in Figure 6.

Testing conducted perpendicular to the grain was performed using a modified test setup that was performed in compression instead of tension. The fastener was installed approximately 1.5-2 inches from the edge, and was loaded away from the edge. The assembly was then loaded at approximately 0.1 inches per minute. The reported loads were taken from the first drop in load, or the ultimate load, as appropriate. Appendix 1 has detailed information regarding the setup, including a comparison data set taken parallel to the grain using sample CTX-381000 in tension and in compression. A photograph of the test setup can be seen in Figure 7.

Wood Members

All test series in wood members were performed in either 0.42 or 0.55 specific gravity. Southern Yellow Pine was used for the 0.55 Specific Gravity, which is its nominal value. Douglas Fir was used for tests with 0.42 specific gravity, the NDS reports the specific gravity of Douglas Fir to be 0.46. The average value of specific gravity for each set had to fall within 10 percent of the specified specific gravity (0.42 or 0.55) otherwise the wood was discarded. The average moisture content at test time was between 10 – 14 percent. Moisture content and specific gravity testing was conducted as specified below.

Specific Gravity
Specific gravity testing was conducted on each board in accordance with ICC/ES AC233 Section 4.2.1 "Wood Test Member Requirements" and ASTM D2395-07a "Standard Test Methods for Specific Gravity of Wood and Wood-Based Materials" Section 7 "Test Method A – Volume by Measurement". Two sections were taken from each board that was used as a test member. The volume of each section was found by measuring the dimensions with a digital caliper. The section was then weighed and oven-dried at 103 ± 2°C until the mass was no longer decreasing. Specific gravity was reported to the nearest 0.01 as an average of all test specimens in each set of tests. The average specific gravity of each set can be found, along with the results of each test, in the "Test Data" section of this report (see pages 8 – 32).

Moisture Content
Moisture content testing was conducted on each board in accordance with ICC/ES AC233 Section 4.2.1 "Wood Test Member Requirements" and ASTM D4442-07 "Direct Moisture Content Measurement of Wood and Wood-Based Materials" Section 6 "Method B – Oven-Drying (Secondary)". Two sections were taken from each board that was used as a test member. The mass of each section was found by measurement with a digital scale, capable of measuring 0.1% of the nominal oven-dry mass of each specimen. The section was then oven-dried at 103 ± 2°C until the mass was no longer decreasing. Moisture content was reported to the nearest 0.1% as an average of all test specimens at the time of testing. The average moisture content of each set can be found, along with the results of each test, in the "Test Data" section of this report (see pages 8 – 32).

TEST DATA

Bending Yield Testing

Sample Identification (Size)	Specimen	Root Diameter, in	Thread Length, in	Peak Load, lbf	P, lbf	F_{yb}, psi
CTX-14400 (1/4" x 4")	1	0.147	2	256	240	144254
	2	0.147	2	274	256	153871
	3	0.146	2	253	237	142451
	4	0.146	2	252	213	128026
	5	0.147	2	251	236	141850
	6	0.147	2	257	240	144254
	7	0.147	2	235	220	132233
	8	0.147	2	255	240	144254
	9	0.147	2	246	233	140047
	10	0.147	2	254	237	142451
Average				**253**	**235**	**141369**
Standard Deviation						**7048**
COV						**5.0%**
CTX-516400 (5/16" x 4")	1	0.181	2	401	374	154242
	2	0.181	2	395	366	153196
	3	0.182	2	374	353	147754
	4	0.182	2	374	351	146917
	5	0.182	2	374	356	149010
	6	0.181	2	376	346	144824
	7	0.182	2	409	393	164497
	8	0.182	2	382	363	151940
	9	0.181	2	398	369	154451
	10	0.182	2	382	357	149428
Average				**387**	**363**	**151626**
Standard Deviation						**5559**
COV						**3.7%**
CTX-381000 (3/8" x 10")	1	0.209	4	506	468	160237
	2	0.210	4	556	506	175578
	3	0.209	4	508	483	163187
	4	0.212	4	519	501	171536
	5	0.210	4	512	488	167085
	6	0.209	4	527	510	174617
	7	0.211	4	529	502	171878
	8	0.211	4	526	507	173590
	9	0.210	4	550	527	182865
	10	0.210	4	494	474	164475
Average				**523**	**497**	**170505**
Standard Deviation						**6790**
COV						**4.0%**

Tensile and Shear Testing

Sample	Specimen	Shear Diameter (in)	Shear Load (lbf)	shear stress (psi)	Tensile Diameter (in)	Tensile Load (lbf)	Tensile stress (psi)
CTX-14400	1	0.167	2141	97763	0.144	2,776	170453
	2		2144	97900		2,787	171128
	3		2188	99909		2,771	170146
	4		2189	99954		2,889	177391
	5		2155	98402		2,761	169532
	6		2183	99680		2,813	172725
	7		2188	99909		2,784	170944
	8		2171	99132		2,749	168795
	9		2176	99361		2,769	170023
	10		2178	99452		2,826	173523
	Average		2171	99146		2793	171466
	Standard Deviation		18	834		41	2517
	COV		0.8%	0.8%		1.5%	1.5%
CTX-516400	1	0.202	3,097	96,781	0.180	4,537	178293
	2		3,050	95,313		4,522	177703
	3		3,036	94,875		4,282	168272
	4		3,033	94,871		4,475	175856
	5		3,139	98,094		4,522	177703
	6		3,007	93,969		4,477	175935
	7		3,047	95,219		4,476	175896
	8		3,121	97,531		4,266	167643
	9		2,982	93,188		4,296	168822
	10		3,055	95,469		4,443	174599
	Average		3057	95531		4430	174072
	Standard Deviation		49	1530		106	4176
	COV		1.6%	1.6%		2.4%	2.4%
CTX-381000	1	0.224	3,676	93,299	0.212	5,876	166464
	2		3,683	93,477		5,493	155614
	3		3,891	98,756		5,468	154906
	4		3,571	90,635		5,508	156039
	5		3,683	93,477		5,511	156124
	6		3,828	97,157		5,409	153234
	7		3,768	95,635		5,670	160628
	8		3,780	95,939		5,539	156917
	9		3,640	92,386		5,529	156634
	10		3,677	93,325		5,528	156605
	Average		3,720	94,409		5,553	157,316
	Standard Deviation		95	2,421		131	3,715
	COV		2.6%	2.6%		2.4%	2.4%

Withdrawal Testing

Withdrawal, 0.42 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-14400	1	1511
	2	1572
	3	1665
	4	1433
	5	1482
	6	1502
	7	1625
	8	1605
	9	1565
	10	1615
	11	1529
	12	1495
	13	1732
	14	1526
	15	1541
	16	1594
Average		1562
Standard Deviation		76
COV		4.8%
Average Specific Gravity		0.42
Average Moisture Content		11.0%

Withdrawal, 0.42 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-516400	1	1282
	2	1366
	3	1422
	4	1616
	5	1648
	6	1407
	7	1365
	8	1365
	9	1362
	10	1335
	11	1407
	12	1333
	13	1271
	14	1285
	15	1417
	16	1475
	17	1868
	18	1307
	19	1367
	20	1238
	21	1331
	22	1885
	23	1406
	24	1383
	25	1317
	26	1301
	27	1442
	28	1334
	29	1316
	30	1376
	31	1331
	32	1327
	33	1415
	34	1487
	35	1392
	36	1445
	37	1500
	38	1472
	39	1527
	40	1460
Average		1415
Standard Deviation		138
COV		9.8%
Average Specific Gravity		0.38
Average Moisture Content		13.9%

Withdrawal, 0.42 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-381000	1	3710
	2	3535
	3	4401
	4	3918
	5	3939
	6	4102
	7	3587
	8	3428
	9	3544
	10	3538
	11	4117
	12	3837
	13	3748
	14	3393
	15	3652
	16	4271
	17	3966
	18	3491
	19	3791
	20	3744
	21	3821
	22	3287
	23	3805
	24	2696
	25	3563
	26	2793
	27	2650
	28	2753
	29	2609
	30	2850
	31	2601
	32	3133
	33	2841
	34	3015
	35	2730
	36	3082
	37	2507
	38	2668
	39	3751
	40	2846
Average		3393
Standard Deviation		534
COV		15.7%
Average Specific Gravity		0.42
Average Moisture Content		13.8%

Withdrawal, 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-14400	1	1600
	2	1769
	3	1716
	4	1753
	5	1434
	6	1720
	7	1718
	8	1705
	9	1657
	10	1906
	11	1555
	12	1873
	13	1812
	14	1739
	15	1767
	16	1644
	17	1459
	18	1443
	19	1560
	20	1595
	21	1644
	22	1567
	23	1778
	24	1730
	25	1733
	26	1527
	27	1640
	28	1637
	29	2054
	30	1799
	31	1870
	32	1969
	33	1583
	34	1706
	35	1517
	36	1565
	37	1687
	38	1701
	39	2052
	40	1821
Average		1700
Standard Deviation		149
COV		8.8%
Average Specific Gravity		0.54
Average Moisture Content		13.1%

Withdrawal, 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-516400	1	1583
	2	2012
	3	1670
	4	1659
	5	1778
	6	2105
	7	1732
	8	1945
	9	1930
	10	1681
	11	1765
	12	1636
	13	1850
	14	1597
	15	1673
	16	1636
	17	1707
	18	1742
	19	1861
	20	2091
	21	2095
	22	2134
	23	2123
	24	1888
	25	1839
	26	2078
	27	1730
	28	1594
	29	1877
	30	2067
	31	1764
	32	1906
	33	1942
	34	1967
	35	1749
	36	1885
	37	1800
	38	1736
	39	1890
	40	1682
Average		1835
Standard Deviation		165
COV		9.0%
Average Specific Gravity		0.53
Average Moisture Content		11.3%

Withdrawal, 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-381000	1	4504
	2	3629
	3	4503
	4	4052
	5	4376
	6	4497
	7	3862
	8	3937
	9	3347
	10	4081
	11	3537
	12	3432
	13	4685
	14	4431
	15	4535
	16	3753
	17	3841
	18	4313
	19	3522
	20	3556
	21	3455
	22	3490
	23	3421
	24	3244
	25	3394
	26	3947
	27	3449
	28	3847
	29	4962
	30	3908
	31	4876
	32	3483
	33	3473
	34	4680
	35	3799
	36	3873
	37	4302
	38	3996
	39	3933
	40	4160
Average		3952
Standard Deviation		468
COV		11.8%
Average Specific Gravity		0.51
Average Moisture Content		11.4%

Head Pull Through Testing

Head Pull Through, 0.42 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-14400	1	1558
	2	1694
	3	1209
	4	1287
	5	1666
	6	1154
	7	1893
	8	1269
	9	1583
	10	1257
	11	1396
	12	1277
	13	1314
	14	1313
	15	1342
	16	1477
	17	1595
	18	1585
	19	1503
	20	1512
	21	1534
	22	1653
	23	1496
	24	1459
	25	1633
	26	1651
	27	1915
	28	1857
	29	1495
	30	1351
	31	1406
	32	1312
	33	1508
	34	1328
	35	1398
	36	1389
	37	1438
	38	1263
	39	1495
	40	1398
Average		1472
Standard Deviation		182
COV		12.3%
Average Specific Gravity		0.44
Average Moisture Content		10.3%

Head Pull Through, 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-14400	1	1910
	2	1818
	3	1554
	4	2008
	5	1293
	6	1947
	7	1604
	8	1728
	9	1764
	10	2002
	11	1703
	12	1929
	13	1660
	14	1496
	15	1947
	16	1872
	17	2113
	18	1891
	19	1962
	20	1952
	21	1805
	22	2070
	23	1556
	24	2123
	25	1589
	26	2043
	27	2136
	28	1618
	29	1657
	30	2061
	31	1731
	32	1793
	33	1933
	34	1708
	35	1612
	36	1651
	37	1693
	38	1500
	39	1628
	40	1460
Average		1788
Standard Deviation		209
COV		11.7%
Average Specific Gravity		0.54
Average Moisture Content		11.6%

Head Pull Through, 0.42 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-516400	1	1287
	2	1666
	3	1154
	4	1287
	5	1666
	6	1154
	7	1269
	8	1583
	9	1257
	10	1396
	11	1277
	12	1314
	13	1313
	14	1342
	15	1477
	16	1595
	17	1585
	18	1503
	19	1512
	20	1534
	21	1653
	22	1496
	23	1459
	24	1633
	25	1651
	26	1857
	27	1495
	28	1735
	29	1685
	30	1631
	31	1837
	32	1917
	33	1257
	34	1390
	35	1347
	36	1147
	37	1657
	38	1463
	39	1584
	40	1622
Average		1492
Standard Deviation		198
COV		13.3%
Average Specific Gravity		0.44
Average Moisture Content		10.2%

Head Pull Through, 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-516400	1	1544
	2	1721
	3	2233
	4	1942
	5	1809
	6	2531
	7	2086
	8	1957
	9	2218
	10	2213
	11	994
	12	1835
	13	2346
	14	2182
	15	2153
	16	2291
	17	2209
	18	2700
	19	2437
	20	2106
	21	2091
	22	2087
	23	2050
	24	1947
	25	1917
	26	1877
	27	1572
	28	1895
	29	1960
	30	1939
	31	2094
	32	2104
	33	1915
	34	2064
	35	2081
	36	1987
	37	1873
	38	1995
	39	1709
	40	2013
Average		2017
Standard Deviation		285
COV		14.1%
Average Specific Gravity		0.55
Average Moisture Content		12.1%

Head Pull Through, 0.42 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-381000	1	1787
	2	1882
	3	1868
	4	2046
	5	1656
	6	2144
	7	1698
	8	1646
	9	1672
	10	1696
	11	2025
	12	2031
	13	1837
	14	1808
	15	2061
	16	1909
	17	1570
	18	1889
	19	1675
	20	1893
	21	1681
	22	1459
	23	1400
	24	2046
	25	2400
	26	1892
	27	1588
	28	1904
	29	1760
	30	1672
	31	2003
	32	1795
	33	1912
	34	1959
	35	1829
	36	1750
	37	1747
	38	1717
	39	1648
	40	1769
Average		1818
Standard Deviation		192
COV		10.6%
Average Specific Gravity		0.41
Average Moisture Content		10.7%

Head Pull Through, 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX-381000	1	2364
	2	2527
	3	1952
	4	2042
	5	2086
	6	2649
	7	1921
	8	2145
	9	1551
	10	2663
	11	2918
	12	2577
	13	2742
	14	2627
	15	2154
	16	1739
	17	1833
	18	2546
	19	2974
	20	2441
	21	2340
	22	2526
	23	2455
	24	2609
	25	2804
	26	2760
	27	2717
	28	3080
	29	2644
	30	2603
	31	3106
	32	2867
	33	2754
	34	2678
	35	2311
	36	1751
	37	1661
	38	1475
	39	1690
	40	2927
Average		2405
Standard Deviation		447
COV		18.6%
Average Specific Gravity		0.54
Average Moisture Content		11.1%

Head Pull Through, 0.42 Specific Gravity		
Sample ID	Specimen	Load (lbf)
BL 14400	1	854
	2	790
	3	768
	4	798
	5	866
	6	886
	7	812
	8	786
	9	671
	10	851
	11	961
	12	1133
	13	888
	14	858
	15	998
	16	1111
	17	1241
	18	1287
	19	984
	20	1058
	21	1214
	22	1126
	23	1029
	24	1270
	25	1226
	26	1030
	27	1119
	28	1208
	29	1211
	30	1092
	31	1214
	32	1282
	33	1085
	34	1052
	35	1049
	36	1050
	37	913
	38	897
	39	828
	40	968
Average		1012
Standard Deviation		167
COV		16.5
Average Specific Gravity		0.42
Average Moisture Content		10.4%

Head Pull Through, 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
BL 14400	1	1593
	2	1293
	3	1630
	4	1067
	5	1313
	6	1214
	7	1325
	8	997
	9	1043
	10	966
	11	933
	12	1203
	13	992
	14	1144
	15	1195
Average		1194
Standard Deviation		212
COV		17.8%
Average Specific Gravity		0.55
Average Moisture Content		12.2%

Head Pull Through, 0.42 Specific Gravity		
Sample ID	Specimen	Load (lbf)
GL 38500	1	1465
	2	1401
	3	1400
	4	1294
	5	1218
	6	1616
	7	1398
	8	1382
	9	1451
	10	1390
	11	1216
	12	1450
	13	1389
	14	1635
	15	1526
	16	1097
	17	1160
	18	1260
	19	1145
	20	1152
	21	1647
	22	1146
	23	1059
	24	912
	25	1046
	26	936
	27	1104
	28	1037
	29	858
	30	969
	31	1011
	32	952
	33	1954
	34	1702
	35	1859
	36	1951
	37	1652
	38	1964
	39	2250
	40	1411
Average		1362
Standard Deviation		333
COV		24.5%
Average Specific Gravity		0.42
Average Moisture Content		10.4%

Head Pull Through, 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
GL 38500	1	1465
	2	1350
	3	1202
	4	1343
	5	1868
	6	1513
	7	1615
	8	1843
	9	1730
	10	1820
	11	2131
	12	1485
	13	1501
	14	1605
	15	1786
Average		1617
Standard Deviation		246
COV		15.2%
Average Specific Gravity		0.52
Average Moisture Content		13.6%

Lateral Load Testing

Lateral Load, Parallel to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14250	1	1032	head pull through
	2	715	side member split
	3	855	head pull through
	4	696	head pull through
	5	653	side member split
	6	764	head pull through
	7	793	head pull through
	8	802	head pull through
	9	763	head pull through
	10	822	head pull through
	11	760	head pull through
	12	860	head pull through
	13	689	head pull through
	14	616	side member split
	15	617	head pull through
	16	565	side member split
Average		750	
Standard Deviation		115	
COV		15.4%	
Average Specific Gravity		0.42	
Average Moisture Content		11.9%	

Lateral Load, Parallel to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14250	1	832	head pull through
	2	1121	head pull through
	3	739	head pull through
	4	908	head pull through
	5	847	head pull through
	6	919	head pull through
	7	990	head pull through
	8	953	head pull through
	9	960	head pull through
	10	937	head pull through
	11	868	head pull through
	12	791	head pull through
	13	882	head pull through
	14	875	head pull through
	15	820	head pull through
	16	889	head pull through
Average		896	
Standard Deviation		89	
COV		9.9%	
Average Specific Gravity		0.55	
Average Moisture Content		12.3%	

Lateral Load, Perpendicular to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14250	1	630	head pull through
	2	606	head pull through
	3	709	head pull through
	4	516	head pull through
	5	646	head pull through
	6	667	head pull through
	7	646	head pull through
	8	687	head pull through
	9	608	head pull through
	10	601	head pull through
	11	550	head pull through
	12	632	head pull through
	13	648	head pull through
	14	583	head pull through
	15	681	head pull through
	16	589	head pull through
Average		625	
Standard Deviation		51	
COV		8.2%	
Average Specific Gravity		0.41	
Average Moisture Content		10.3%	

Lateral Load, Perpendicular to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14250	1	574	head pull through
	2	775	head pull through
	3	668	head pull through
	4	761	head pull through
	5	700	head pull through
	6	964	head pull through
	7	739	head pull through
	8	662	head pull through
	9	759	head pull through
	10	768	head pull through
	11	814	head pull through
	12	794	head pull through
	13	812	head pull through
	14	804	head pull through
	15	969	head pull through
	16	724	head pull through
Average		768	
Standard Deviation		100	
COV		13.1%	
Average Specific Gravity		0.54	
Average Moisture Content		13.6%	

Lateral Load, Parallel to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14400	1	843	head pull through
	2	847	head pull through
	3	811	head pull through
	4	924	head pull through
	5	1010	head pull through
	6	745	head pull through
	7	1013	head pull through
	8	931	head pull through
	9	976	head pull through
	10	964	head pull through
	11	860	head pull through
	12	824	head pull through
	13	919	head pull through
	14	1056	head pull through
	15	924	head pull through
Average		910	
Standard Deviation		87	
COV		9.5%	
Average Specific Gravity		0.42	
Average Moisture Content		12.7%	

Lateral Load, Parallel to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14400	1	1240	head pull through
	2	896	head pull through
	3	1066	head pull through
	4	1035	head pull through
	5	1030	head pull through
	6	1064	head pull through
	7	1149	head pull through
	8	1014	head pull through
	9	1114	head pull through
	10	1125	head pull through
	11	1141	head pull through
	12	1387	head pull through
	13	990	head pull through
	14	891	head pull through
	15	959	head pull through
Average		1073	
Standard Deviation		129	
COV		12.0%	
Average Specific Gravity		0.53	
Average Moisture Content		13.4%	

Lateral Load, Perpendicular to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14400	1	895	head pull through
	2	895	head pull through
	3	951	head pull through
	4	930	head pull through
	5	929	head pull through
	6	955	head pull through
	7	955	head pull through
	8	963	head pull through
	9	1099	head pull through
	10	1142	head pull through
	11	825	head pull through
	12	1028	head pull through
	13	788	head pull through
	14	898	head pull through
	15	943	head pull through
	16	783	head pull through
Average		936	
Standard Deviation		97	
COV		10.4%	
Average Specific Gravity		0.42	
Average Moisture Content		11.5%	

Lateral Load, Perpendicular to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14400	1	1112	head pull through
	2	987	head pull through
	3	1117	head pull through
	4	914	head pull through
	5	1103	head pull through
	6	970	head pull through
	7	1196	head pull through
	8	1065	head pull through
	9	839	screw fracture
	10	909	head pull through
	11	950	head pull through
	12	1235	head pull through
	13	1182	head pull through
	14	1050	head pull through
	15	901	head pull through
	16	1216	head pull through
Average		1047	
Standard Deviation		126	
COV		12.0%	
Average Specific Gravity		0.52	
Average Moisture Content		13.3%	

Lateral Load, Parallel to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14600	1	1286	Withdrawal
	2	1316	Withdrawal
	3	1093	Withdrawal
	4	1236	Withdrawal
	5	1184	Withdrawal
	6	1194	Withdrawal
	7	1239	Withdrawal
	8	1110	Withdrawal
	9	1304	Withdrawal
	10	1109	Withdrawal
	11	1263	Withdrawal
	12	1044	Withdrawal
	13	1292	Withdrawal
	14	1130	Withdrawal
	15	1219	Withdrawal
	16	1194	Withdrawal
Average		1201	
Standard Deviation		84	
COV		7.0%	
Average Specific Gravity		0.41	
Average Moisture Content		10.9%	

Lateral Load, Parallel to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14600	1	1682	Withdrawal
	2	1651	Withdrawal
	3	1759	Withdrawal
	4	1696	Withdrawal
	5	1987	Withdrawal
	6	1830	Withdrawal
	7	1585	Withdrawal
	8	1860	Withdrawal
	9	1425	Withdrawal
	10	1777	Withdrawal
	11	1495	Withdrawal
	12	1756	Withdrawal
	13	1588	Withdrawal
	14	1617	Withdrawal
	15	1556	Withdrawal
	16	1513	Withdrawal
Average		1674	
Standard Deviation		149	
COV		8.9%	
Average Specific Gravity		0.52	
Average Moisture Content		11.2%	

Lateral Load, Perpendicular to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14600	1	987	Withdrawal
	2	845	Withdrawal
	3	1209	Withdrawal
	4	1046	Withdrawal
	5	1070	Withdrawal
	6	1013	Withdrawal
	7	1249	Withdrawal
	8	1176	Withdrawal
	9	1150	Withdrawal
	10	1009	Withdrawal
	11	1254	Withdrawal
	12	1415	Withdrawal
	13	1078	Withdrawal
	14	987	Withdrawal
	15	1134	Withdrawal
	16	1100	Withdrawal
Average		1108	
Standard Deviation		136	
COV		12.3%	
Average Specific Gravity		0.42	
Average Moisture Content		11.2%	

Lateral Load, Perpendicular to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-14600	1	1461	Withdrawal
	2	1588	Withdrawal
	3	1118	Withdrawal
	4	1181	Withdrawal
	5	991	Withdrawal
	6	1035	Withdrawal
	7	1014	Withdrawal
	8	1061	Withdrawal
	9	1195	Withdrawal
	10	1038	Withdrawal
	11	1249	Withdrawal
	12	1148	Withdrawal
	13	1142	Withdrawal
	14	1506	Withdrawal
	15	1309	Withdrawal
Average		1202	
Standard Deviation		187	
COV		15.6%	
Average Specific Gravity		0.50	
Average Moisture Content		12.8%	

Lateral Load, Parallel to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516300	1	776	head pull through
	2	622	head pull through
	3	701	head pull through
	4	689	head pull through
	5	733	head pull through
	6	648	head pull through
	7	736	head pull through
	8	639	head pull through
	9	816	head pull through
	10	668	head pull through
	11	664	head pull through
	12	751	head pull through
	13	856	head pull through
	14	865	head pull through
	15	875	head pull through
	16	767	head pull through
	17	738	head pull through
	18	762	head pull through
	19	794	head pull through
	20	889	head pull through
	21	769	head pull through
	22	806	head pull through
	23	696	head pull through
	24	804	head pull through
Average		753	
Standard Deviation		77	
COV		10.2%	
Average Specific Gravity		0.38	
Average Moisture Content		11.1%	

Lateral Load, Parallel to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516300	1	1160	head pull through
	2	1146	head pull through
	3	1089	head pull through
	4	1151	head pull through
	5	1158	head pull through
	6	1111	head pull through
	7	1093	head pull through
	8	1278	head pull through
	9	968	head pull through
	10	1081	head pull through
	11	1239	head pull through
	12	1199	head pull through
	13	1166	head pull through
	14	1126	head pull through
	15	1192	head pull through
	16	954	head pull through
Average		1132	
Standard Deviation		85	
COV		7.5%	
Average Specific Gravity		0.53	
Average Moisture Content		12.5%	

Lateral Load, Perpendicular to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516300	1	563	head pull through
	2	704	head pull through
	3	751	head pull through
	4	668	head pull through
	5	532	head pull through
	6	676	head pull through
	7	639	head pull through
	8	723	head pull through
	9	598	head pull through
	10	737	head pull through
	11	560	head pull through
	12	624	head pull through
	13	676	head pull through
	14	691	head pull through
	15	696	head pull through
	16	732	head pull through
Average		661	
Standard Deviation		68	
COV		10.3%	
Average Specific Gravity		0.41	
Average Moisture Content		12.0%	

Lateral Load, Perpendicular to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516300	1	1005	head pull through
	2	930	head pull through
	3	1033	head pull through
	4	845	head pull through
	5	803	head pull through
	6	858	head pull through
	7	1236	withdrawal
	8	854	head pull through
	9	735	head pull through
	10	1062	head pull through
	11	956	head pull through
	12	740	head pull through
	13	809	head pull through
	14	739	head pull through
	15	878	head pull through
Average		899	
Standard Deviation		140	
COV		15.6%	
Average Specific Gravity		0.53	
Average Moisture Content		11.2%	

Lateral Load, Parallel to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516400	1	1088	head pull through
	2	1150	head pull through
	3	1184	head pull through
	4	1418	head pull through
	5	1238	head pull through
	6	1149	head pull through
	7	1559	head pull through
	8	1562	head pull through
	9	1081	head pull through
	10	1104	head pull through
	11	1171	head pull through
	12	950	side member split
	13	1269	head pull through
	14	1147	head pull through
	15	1275	head pull through
	16	977	head pull through
Average		1208	
Standard Deviation		178	
COV		14.7%	
Average Specific Gravity		0.42	
Average Moisture Content		11.8%	

Lateral Load, Parallel to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516400	1	1604	head pull through
	2	1360	head pull through
	3	1232	head pull through
	4	1823	head pull through
	5	1439	head pull through
	6	1455	head pull through
	7	1082	head pull through
	8	1780	head pull through
	9	1384	head pull through
	10	1105	head pull through
	11	1440	head pull through
	12	1215	head pull through
	13	1324	head pull through
	14	1358	head pull through
	15	1365	head pull through
	16	1442	head pull through
Average		1401	
Standard Deviation		206	
COV		14.7%	
Average Specific Gravity		0.51	
Average Moisture Content		12.3%	

Lateral Load, Perpendicular to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516400	1	1611	head pull through
	2	1214	head pull through
	3	1192	head pull through
	4	1308	head pull through
	5	974	head pull through
	6	1223	head pull through
	7	1152	head pull through
	8	1520	head pull through
	9	1342	head pull through
	10	911	head pull through
	11	1146	head pull through
	12	1274	head pull through
	13	1206	head pull through
	14	1316	head pull through
	15	1077	head pull through
	16	1127	head pull through
	17	1086	head pull through
Average		1216	
Standard Deviation		175	
COV		14.4%	
Average Specific Gravity		0.43	
Average Moisture Content		13.0%	

Lateral Load, Perpendicular to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516400	1	1357	head pull through
	2	1124	head pull through
	3	1366	head pull through
	4	1239	head pull through
	5	1245	head pull through
	6	1297	head pull through
	7	1352	head pull through
	8	1175	head pull through
	9	1123	head pull through
	10	1801	head pull through
	11	1269	head pull through
	12	1381	head pull through
	13	1351	head pull through
	14	1097	head pull through
	15	1229	head pull through
Average		1294	
Standard Deviation		169	
COV		13.1%	
Average Specific Gravity		0.55	
Average Moisture Content		13.0%	

Lateral Load, Parallel to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516600	1	1243	head pull through
	2	1381	head pull through
	3	1445	head pull through
	4	1295	head pull through
	5	1120	head pull through
	6	1224	head pull through
	7	1392	head pull through
	8	1470	head pull through
	9	1476	head pull through
	10	1391	head pull through
	11	1262	head pull through
	12	1058	head pull through
	13	1301	head pull through
	14	1226	head pull through
	15	1162	head pull through
	16	1178	head pull through
Average		1289	
Standard Deviation		127	
COV		9.9%	
Average Specific Gravity		0.41	
Average Moisture Content		12.0%	

Lateral Load, Parallel to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516600	1	1513	head pull through
	2	1394	head pull through
	3	1413	head pull through
	4	1534	head pull through
	5	1318	head pull through
	6	1400	head pull through
	7	1392	head pull through
	8	1234	head pull through
	9	1478	head pull through
	10	1368	head pull through
	11	1793	head pull through
	12	1912	head pull through
	13	1488	head pull through
	14	1608	head pull through
	15	1571	head pull through
	16	1302	head pull through
Average		1482	
Standard Deviation		177	
COV		11.9%	
Average Specific Gravity		0.50	
Average Moisture Content		11.1%	

Lateral Load, Perpendicular to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516600	1	1148	head pull through
	2	1303	head pull through
	3	1573	head pull through
	4	1578	head pull through
	5	1143	head pull through
	6	1616	head pull through
	7	1466	head pull through
	8	947	head pull through
	9	1301	head pull through
	10	1049	head pull through
	11	1258	head pull through
	12	1365	head pull through
	13	1083	head pull through
	14	1351	head pull through
	15	1044	head pull through
	16	1443	head pull through
Average		1292	
Standard Deviation		209	
COV		16.2%	
Average Specific Gravity		0.41	
Average Moisture Content		13.3%	

Lateral Load, Perpendicular to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-516600	1	1338	head pull through
	2	1338	head pull through
	3	1071	head pull through
	4	937	head pull through
	5	1113	head pull through
	6	1366	head pull through
	7	1386	head pull through
	8	1830	head pull through
	9	987	head pull through
	10	1244	head pull through
	11	1521	head pull through
	12	1446	head pull through
	13	1655	head pull through
	14	1324	head pull through
	15	1226	head pull through
	16	1089	head pull through
Average		1304	
Standard Deviation		240	
COV		18.4%	
Average Specific Gravity		0.50	
Average Moisture Content		12.9%	

Lateral Load, Parallel to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-38700	1	1491	head pull through
	2	1653	head pull through
	3	2310	head pull through
	4	1774	head pull through
	5	2406	head pull through
	6	2084	head pull through
	7	1911	head pull through
	8	1812	head pull through
	9	1913	head pull through
	10	2096	head pull through
	11	1574	head pull through
	12	1640	head pull through
	13	2285	head pull through
	14	1928	head pull through
	15	1892	head pull through
	16	1988	head pull through
Average		1922	
Standard Deviation		267	
COV		13.9%	
Average Specific Gravity		0.42	
Average Moisture Content		11.5%	

Lateral Load, Parallel to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-38700	1	2461	head pull through
	2	1637	head pull through
	3	1910	head pull through
	4	2018	head pull through
	5	1924	head pull through
	6	2198	head pull through
	7	2579	head pull through
	8	1969	head pull through
	9	2436	head pull through
	10	2446	head pull through
	11	2546	head pull through
	12	2583	head pull through
	13	1930	head pull through
	14	2085	head pull through
	15	2215	head pull through
Average		2196	
Standard Deviation		298	
COV		13.6%	
Average Specific Gravity		0.53	
Average Moisture Content		11.3%	

Lateral Load, Perpendicular to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-38700	1	1153	head pull through
	2	1259	head pull through
	3	1396	head pull through
	4	1157	head pull through
	5	1257	head pull through
	6	1097	head pull through
	7	1565	head pull through
	8	1229	head pull through
	9	1364	head pull through
	10	1167	head pull through
	11	1772	head pull through
	12	1561	head pull through
	13	1155	head pull through
	14	1454	head pull through
	15	1455	head pull through
	16	1186	head pull through
Average		1327	
Standard Deviation		192	
COV		14.5%	
Average Specific Gravity		0.40	
Average Moisture Content		10.9%	

Lateral Load, Perpendicular to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-38700	1	1664	head pull through
	2	1430	head pull through
	3	1735	head pull through
	4	1107	head pull through
	5	1260	head pull through
	6	1498	head pull through
	7	1652	head pull through
	8	1623	head pull through
	9	1163	head pull through
	10	1556	head pull through
	11	1136	head pull through
	12	1327	head pull through
	13	1556	head pull through
	14	1566	head pull through
	15	1104	head pull through
	16	1517	head pull through
Average		1431	
Standard Deviation		217	
COV		15.1%	
Average Specific Gravity		0.50	
Average Moisture Content		11.2%	

Lateral Load, Parallel to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-381000	1	2056	head pull through
	2	2354	head pull through
	3	2451	head pull through
	4	2020	head pull through
	5	2303	head pull through
	6	2603	head pull through
	7	2735	head pull through
	8	2884	head pull through
	9	2327	head pull through
	10	2400	head pull through
	11	2427	head pull through
	12	1515	head pull through
	13	2408	head pull through
	14	2492	head pull through
	15	2272	head pull through
Average		2350	
Standard Deviation		321	
COV		13.7%	
Average Specific Gravity		0.41	
Average Moisture Content		13.2%	

Lateral Load, Parallel to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-381000	1	2335	head pull through
	2	3359	head pull through
	3	2670	head pull through
	4	2611	head pull through
	5	2846	head pull through
	6	2628	head pull through
	7	2306	head pull through
	8	2746	head pull through
	9	2377	head pull through
	10	3304	head pull through
	11	2986	head pull through
	12	3344	head pull through
	13	2910	head pull through
	14	3078	head pull through
	15	2573	head pull through
Average		2805	
Standard Deviation		355	
COV		12.7%	
Average Specific Gravity		0.53	
Average Moisture Content		12.9%	

Lateral Load, Perpendicular to the Grain in 0.42 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-381000	1	1196	head pull through
	2	1099	head pull through
	3	1437	head pull through
	4	1810	head pull through
	5	1276	head pull through
	6	1275	head pull through
	7	1552	head pull through
	8	1461	head pull through
	9	1458	head pull through
	10	1133	head pull through
	11	1290	head pull through
	12	1305	head pull through
	13	1345	head pull through
	14	1495	head pull through
	15	1331	head pull through
	16	1414	head pull through
Average		1367	
Standard Deviation		174	
COV		12.7%	
Average Specific Gravity		0.42	
Average Moisture Content		12.6%	

Lateral Load, Perpendicular to the Grain in 0.55 Specific Gravity			
Sample ID	**Specimen**	**Load (lbf)**	**Failure Type**
CTX-381000	1	1339	head pull through
	2	1938	head pull through
	3	1306	head pull through
	4	1851	head pull through
	5	1602	head pull through
	6	1502	head pull through
	7	1645	head pull through
	8	1735	head pull through
	9	1305	head pull through
	10	1223	head pull through
	11	1584	head pull through
	12	1755	head pull through
	13	1150	head pull through
	14	1630	head pull through
	15	1276	head pull through
	16	1357	head pull through
Average		1512	
Standard Deviation		239	
COV		15.8%	
Average Specific Gravity		0.50	
Average Moisture Content		12.7%	

EVALUATION REPORT TABLES

Table 1 – Fastener Specifications

Fastener Designation		Minor Thread Diameter (in)	Shank Diameter (in)	Outside Thread Diameter (in)	Allowable Steel Strength		
					Bending Yield Strength, Fyb (psi)	Tensile (lbf) [psi]	Shear (lbf) [psi]
CTX	14 x 2-1/2	0.144	0.168	0.242	141,400	(931) [57,155]	(724) [33,049]
	14 x 3						
	14 x 4						
	14 x 6						
	15 x 3	0.180	0.201	0.275	151,600	(1,477) [58,024]	(1,019) [31,844]
	15 x 3-1/2						
	15 x 4						
	15 x 5						
	15 x 6						
	17 x 7	0.207	0.224	0.295	170,500	(1,851) [52,439]	(1,238) [31,470]
	17 x 8						
	17 x 10						
	17 x 12						
BL	14 x 4	0.171	0.189	0.258	141,400	(931) [57,155]	(724) [33,049]
	14 x 6						
	14 x 8						
	14 x 10						
	14 x 12						
	14 x 14						
GL	17 x 5	0.207	0.224	0.295	170,500	(1,851) [52,439]	(1,238) [31,470]
	17 x 7						
	17 x 9						
	17 x 11						

Table 2 – Reference Withdrawal (W) and Pull-Through (P) Design Values

Fastener Designation		Thread Length (in)	W (lbf/in)		P (lbf)	
			For Specific Gravities of:			
			0.42	0.55	0.42	0.55
CTX	14 x 2-1/2	1-1/2	156	170	294	358
	14 x 3	1-1/2				
	14 x 4	2				
	14 x 5	3				
	14 x 6	3				
	15 x 3	1-1/2	141	183	298	403
	15 x 3-1/2	2				
	15 x 4	2				
	15 x 5	3				
	15 x 6	3				
	17 x 7	3-1/2	170	198	364	481
	17 x 8	4				
	17 x 10	4				
	17 x 12	4				
BL	14 x 4	2	156	170	202	239
	14 x 6	2				
	14 x 8	2				
	14 x 10	2-1/2				
	14 x 12	2-1/2				
	14 x 14	2-1/2				
GL	17 x 5	2	170	198	272	323
	17 x 7	2				
	17 x 9	2				
	17 x 11	2-1/2				

Table 3 – Reference Lateral Design Values (Z) for Single Shear (Two-Member) Connections

Fastener Designation		Side Member Thickness (in)	Fastener Penetration into Main Member, p (in)	Reference Lateral Desing Value, Z (lbf) For Specific Gravities of:			
				0.42		0.55	
				Parallel to Grain, Z	Perpendicular to Grain, Z	Parallel to Grain, Z	Perpendicular to Grain, Z
CTX	14 x 2-1/2	3/4	1-3/4	150	125	180	154
	14 x 3		2-1/2				
	14 x 4	1-3/4	2-1/4	182	187	215	209
	14 x 6	3	3	240	222	335	240
	15 x 3	3/4	2-1/4	157	132	226	180
	15 x 3-1/2		2-3/4				
	15 x 4	1-1/2	2-1/2	240	243	280	259
	15 x 5		3-1/2				
	15 x 6	2	4	258	258	296	261
	17 x 7	2-3/4	4-1/4	384	265	439	286
	17 x 8		5-1/4				
	17 x 10	3-1/2	6-1/2	470	273	561	302
	17 x 12		8-1/2				
BL	14 x 4	3/4	3-1/4	182	187	215	209
	14 x 6	3	3	240	222	335	240
	14 x 8		5				
	14 x 10		7				
	14 x 12		9				
	14 x 14		11				
GL	17 x 5	1-1/2	3-1/2	240	243	280	259
	17 x 7	2-3/4	4-1/4	384	265	439	286
	17 x 9		6-1/4				
	17 x 11	3-1/2	7-1/2	470	273	561	302

Table 4 – Connection Geometry

Connection Geometry/Criteria	Diameters	CTX 14 Nominal Diameter (inches)	CTX 15 Nominal Diameter (inches)	CTX 17 Nominal Diameter (inches)	BL 14 Nominal Diameter (inches)	GL 15 Nominal Diameter (inches)
Minimum Edge Distance						
Loading Parallel to Grain	8	1.34	1.61	1.79	1.51	1.79
Loading Perpendicular to Grain, Loaded Edge	8	1.34	1.61	1.79	1.51	1.79
Loading Perpendicular to Grain, Unloaded Edge	8	1.34	1.61	1.79	1.51	1.79
Minimum End Distance						
Tension Load Parallel to Grain	15	2.52	3.02	3.36	2.84	3.36
Compression Load Parallel to Grain	10	1.68	2.01	2.24	1.89	2.24
Load Perpendicular to Grain	10	1.68	2.01	2.24	1.89	2.24
Spacing (Pitch) Between Fasteners in a Row						
Parallel to Grain	15	2.52	3.02	3.36	2.84	3.36
Perpendicular to Grain	10	1.68	2.01	2.24	1.89	2.24
Spacing (Gage) Between Rows of Fasteners						
In-Line	5	0.84	1.01	1.12	0.95	1.12
Staggered	2.5	0.42	0.50	0.56	0.47	0.56
Minimum Penetration into Main Member for Single Shear Connections	6	1.01	1.21	1.34	1.13	1.34

Table 5 – Exposure Conditions for Fasteners with Intended Use and Limitations of Recognition

Exposure Condition	Typical Applications	Recognition Limitations
Corrosion Resistance of Fasteners		
1	Treated wood in dry use applications	Limited to use where equilibrium moisture content of the chemically treated wood meets the dry service conditions as described in the NDS
3	General construction	Limited to freshwater and chemically treated wood exposure, e.g., no saltwater exposure

CALCULATIONS

Specific Gravity and Moisture Content

Specific gravity and moisture content were tested as described in the Test Methods section of this report. The following is a sample calculation to show how the specific gravity and moisture content of each wood member was calculated.

Measured Values

Board ID	Length (in)	Width (in)	Thickness (in)	Mass 1 (g)	Mass 2 (g)
1A	3.52	3.47	2.04	190.61	170.24
1B	3.51	3.47	1.54	137.25	122.01

Calculated Values

Board ID	Volume (in^3)	Moisture Content	Specific Gravity
1A	24.92	11.97%	0.417
1B	18.76	12.49%	0.397

Average Values

Board ID	Average Moisture Content	Average Specific Gravity
1	12.2%	0.41

Two sections were cut from board number “1” shown above. The dimensions (Length, Width, and Height) of each section were measured in inches with a digital caliper in three places and averaged to find the measured values shown in the table above. These three values were then multiplied together to find Volume, in cubic inches. Mass 1 was then taken in grams, using a digital scale for the purpose of determining the moisture content of each section of the board. The sections of the board were then placed into an oven at 103 degrees Celsius, and the mass was checked every couple of hours, until the mass was no longer decreasing significantly. The final mass (Mass 2), was used to determine the moisture content and specific gravity of the board.

Moisture content was calculated as the change in mass divided by the oven dry mass for each section. In this way, we have effectively taken the mass of the water that was inside the wood, and divided it by the actual mass of the oven dried specimen.

$$MC\ (\%) = 100 \times \frac{\text{Mass 1} - \text{Mass 2}}{\text{Mass 2}}$$

Specific Gravity was calculated by taking the oven dry mass of each section of wood, dividing by the volume of the section, and multiplying by a constant (0.061). The value of the constant was determined based on the units which were used to measure the specimen, in accordance with ASTM D2395-07a.

$$SG = 0.061 \times \frac{\text{Mass 2}}{\text{Volume}}$$

Finally, the two values calculated for moisture content and specific gravity for the board were averaged, and those values were reported as the specific gravity and moisture content for that specific board. If more than 1 board was used in a data set, the values of specific gravity and moisture content of each board were averaged, and those values were reported.

Tensile and Shear Testing
Tensile and shear testing were conducted on each set of specimens, and then reference design values were calculated based on the average reported load and stress for the data set. The average load and stress for each set was divided by a safety factor of 3, and those values were reported as the reference design values for the respective screw.

Bend Testing
The nominal fastener yield strength (F_{yb}) was determined by use of the following equation, based on the test results, as found in the Test Method section of this report. The value of F_{yb} is reported as the design value for this test.

$$F_{yb} = M_y/S$$

Where:

F_{yb} = nominal fastener yield strength, psi

S = effective plastic section modulus = $D^3/6$, in^3

D = root diameter, in

$M_y = P\ s_{bp}/4$, in-lbf

P = test load as determined from the load deformation curve (5% offset method), lbf

S_{bp} = cylindrical bearing point spacing, in

Withdrawal Reference Design Values
Withdrawal testing was conducted on each set of specimens, and then reference design values were calculated based on the average reported load for that data set. The average ultimate load (in pounds of force) was divided by 5, and that value was reported as the reference design value for the evaluation report tables.

Head Pull Through Reference Design Values
Head Pull Through testing was conducted on each set of specimens, and then reference design values were calculated based on the average reported load for that data set. The average ultimate load was divided by 5, and that value was reported as the reference design value for the evaluation report tables.

Lateral Reference Design Values
Lateral testing was conducted on each set of specimens, and then reference design values were calculated based on the average reported load for that data set. The load was divided by 5, and that value was reported as the reference design value for the evaluation report tables.

Number of Specimens Tested Per Data Set

The minimum number of specimens tested per set was calculated in accordance with ASTM D 2915 "Evaluating Allowable Properties for Grades of Structural Lumber", Section 3.4.2, Equation 1. The equation is shown as follows:

$$n = \frac{tt}{0.05} CCVV^2$$

Where:

n = the number of samples in a test series

t = A constant based on the number of samples in a test series, found in Table 1 of ASTM D 2915

CV = Coefficient of Variation, equal to the standard deviation divided by the average of a data set

First, the minimum numbers of samples (15) were tested in a series. Then the above equation was used to determine the required coefficient of variation. The actual coefficient of variation was calculated and compared to the required value. If the actual COV was less than or equal to the required COV, testing could be stopped. If the actual COV was greater than the required COV, testing continued until the actual COV was less than or equal to the calculated COV.

TEST EQUIPMENT

1. MTS Model 4501033 11,200 lbf load cell, MM210-009.2, S/N 105191, Calibrated 4/12/13, Calibration Due 4/12/14
2. MTS Model QTest/50LP Crosshead Displacement, MM210-009.6, S/N 1532, Calibrated 4/12/13, Calibration Due 4/12/14
3. Fischer Scientific Model 630F Isotemp Oven, MM190-015, S/N 256, Calibrated 8/7/13, Calibration Due 8/7/14
4. Mettler Model BB2400 2400 Gram Balance, PT-163-019, S/N M18988, Calibrated 7/10/13, Calibration Due 7/10/14
5. MTS Model 661.19 E-04 5.5 kip Load Cell, MTA-027.2, S/N V66160, Calibrated 12/3/12, Calibration Due 12/3/13
6. MTS Model 318.10 LVDT/Actuator, MTA-027.1, S/N 0175914P, Calibrated 12/3/12, Calibration Due 12/3/13
7. Mitutoyo Model 500-321 6 inch Digital Caliper, MM160-016, S/N 7141983, Calibrated 8/8/13, Calibration Due 8/8/14
8. Mitutoyo Model CD-6C 6 inch Digital Caliper, MM160-106, S/N 0080204, Calibrated 8/8/13, Calibration Due 8/8/14

REFERENCES

1. "AC233." *Acceptance Criteria for Alternate Dowel-Type Threaded Fastners*, ICC Evaluation Service.
2. "AISI S904." *Standard Test Method for Determiningthe Tensile and Shear Strength of Screws*, American Iron and Steel Institute.
3. "AC233." *Acceptance Criteria for Alternate Dowel-Type Threaded Fastners*, ICC Evaluation Service
4. "ANSI/AF&PA." *National Design Specification for Wood Construction (NDS),* American Forest & Paper Association.
5. "ASTM A370." *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*, ASTM International.
6. "ASTM D1037." *Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials*, ASTM International.
7. "ASTM D1761." *Test Method for Mechanical Fasteners in Wood*, ASTM International.
8. "ASTM D2395." *Standard Test Method for Specific Gravity of Wood and Wood-Based Materials*, ASTM International.
9. "ASTM D2915." *Standard Practice for Evaluating Allowable Properties for Grades of Structural Lumber*, ASTM International.
10. "ASTM D4442." *Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials*, ASTM International.
11. "ASTM F1575." *Standard Test Method for Determining Bending Yield Moment of Nails*, ASTM International.
12. "NASM1312-20." *National Aerospace Standard Practice for Fastener Test Methods, Method 20, Single Shear*, Aerospace Industries Association of America, Inc.

DIGITAL PHOTOGRAPHS

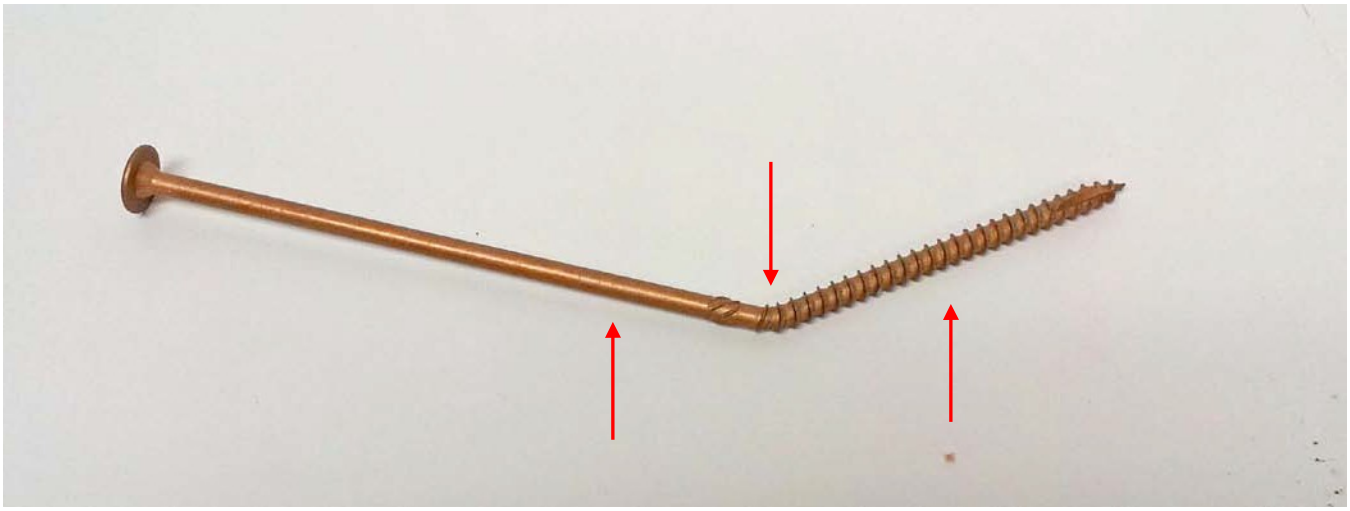


Figure 1 – A setup photograph for bend testing, in accordance with ASTM F1575-03. A CTX 381000 specimen is shown. The red arrows show the direction the force was applied.

Figure 2 – A setup photograph for tensile testing, in accordance with AISI S904-08. A CTX 381000 specimen is shown. The red arrows show the direction the force was applied.

Figure 3 – A setup photograph for shear testing, in accordance with AISI S904-08. A CTX 516400 specimen is shown. The red arrows show the direction the force was applied. The head was cut off of the specimen to allow for ease of loading into the fixtures.

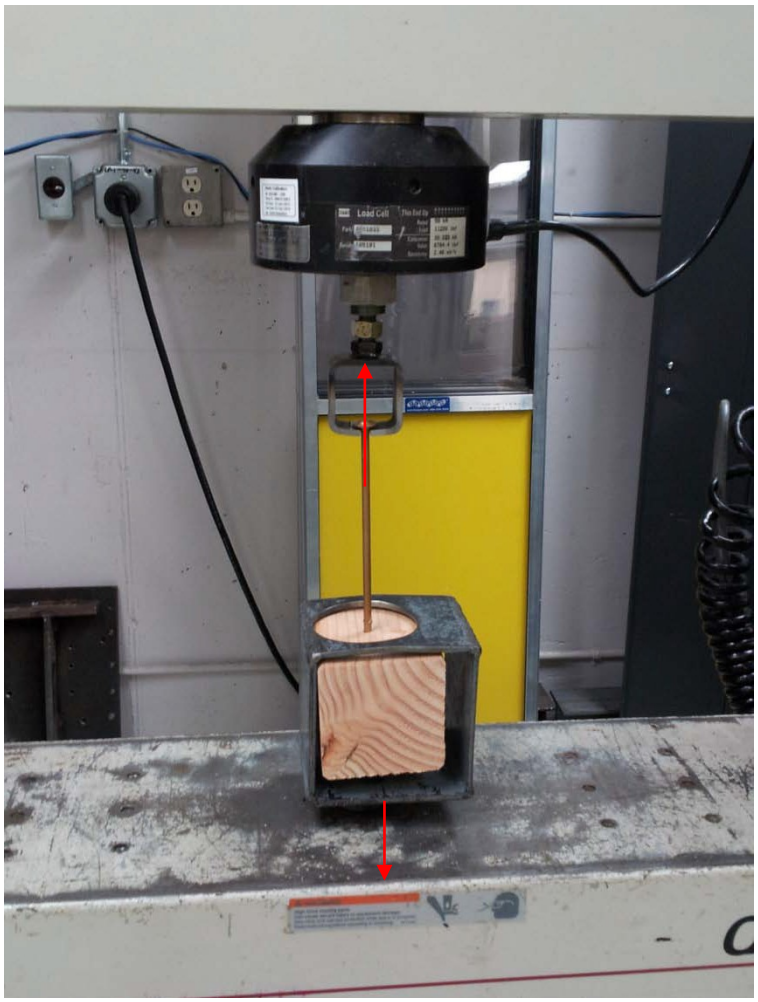


Figure 4 – A setup photograph for withdrawal testing, in accordance with ASTM D1761-06. A CTX 381000 specimen is shown. The red arrow shows the direction the force was applied.

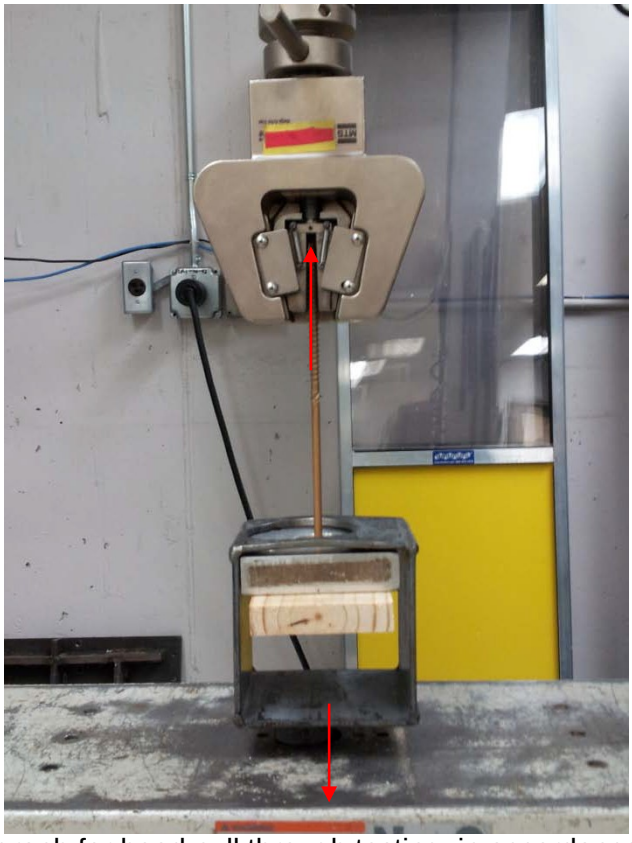


Figure 5 – A setup photograph for head pull through testing, in accordance with ASTM D1037-12. A CTX 381000 specimen is shown. The red arrows show the direction the force was applied.

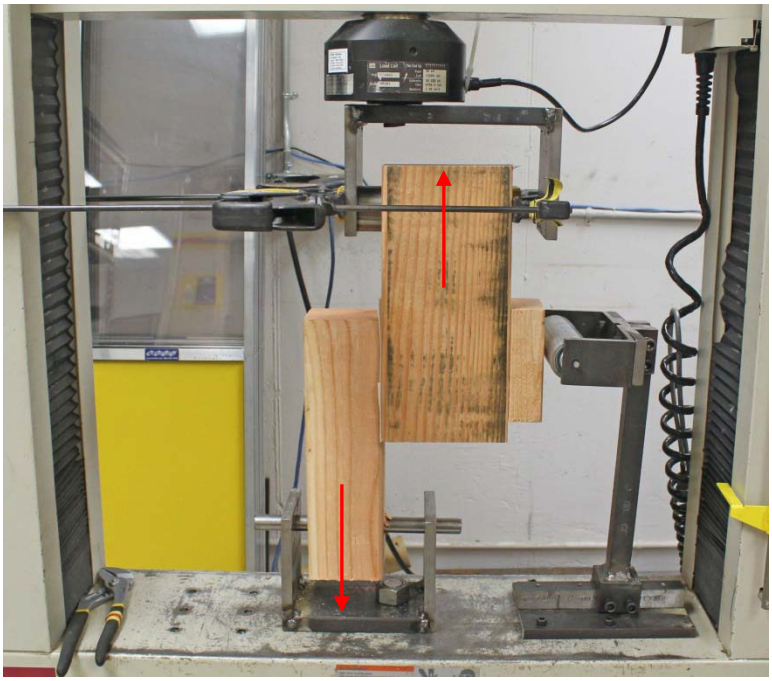


Figure 6 – A setup photograph for lateral single shear testing, in accordance with ASTM D1761-12. A CTX 381000 specimen is shown. The red arrows show the direction the force was applied.

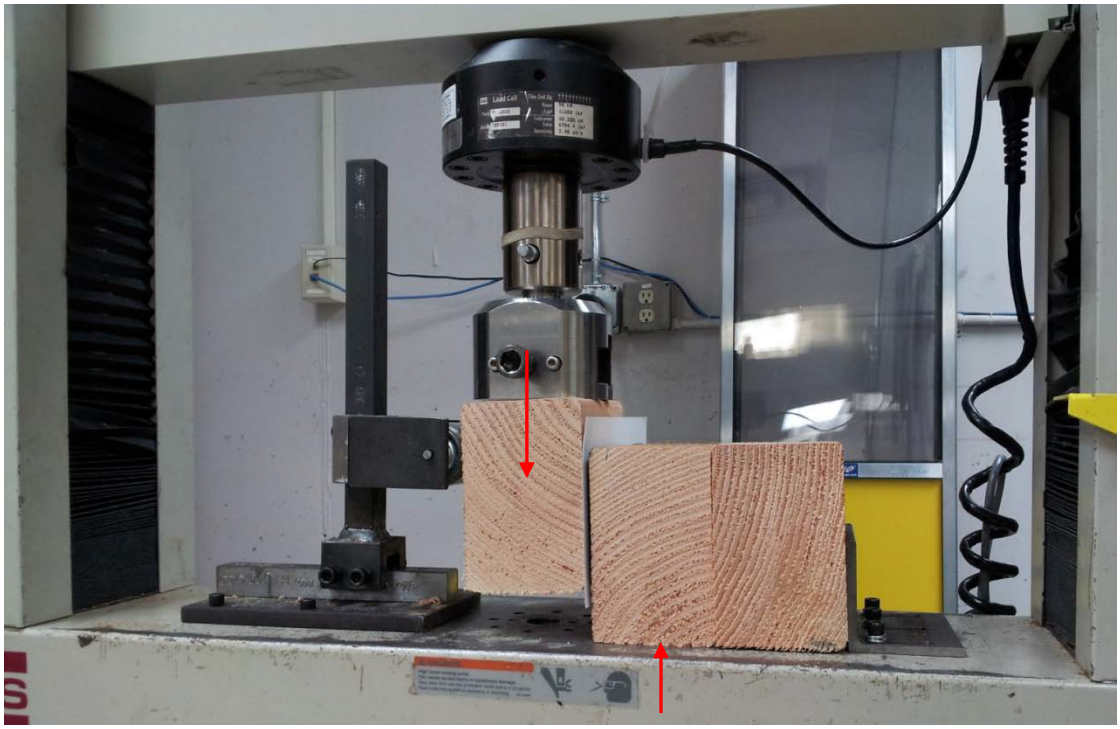


Figure 7 – A setup photograph for lateral single shear testing, perpendicular to the grain, modified setup based on ASTM D1761-12. A CTX 381000 specimen is shown. The red arrows show the direction the force was applied.

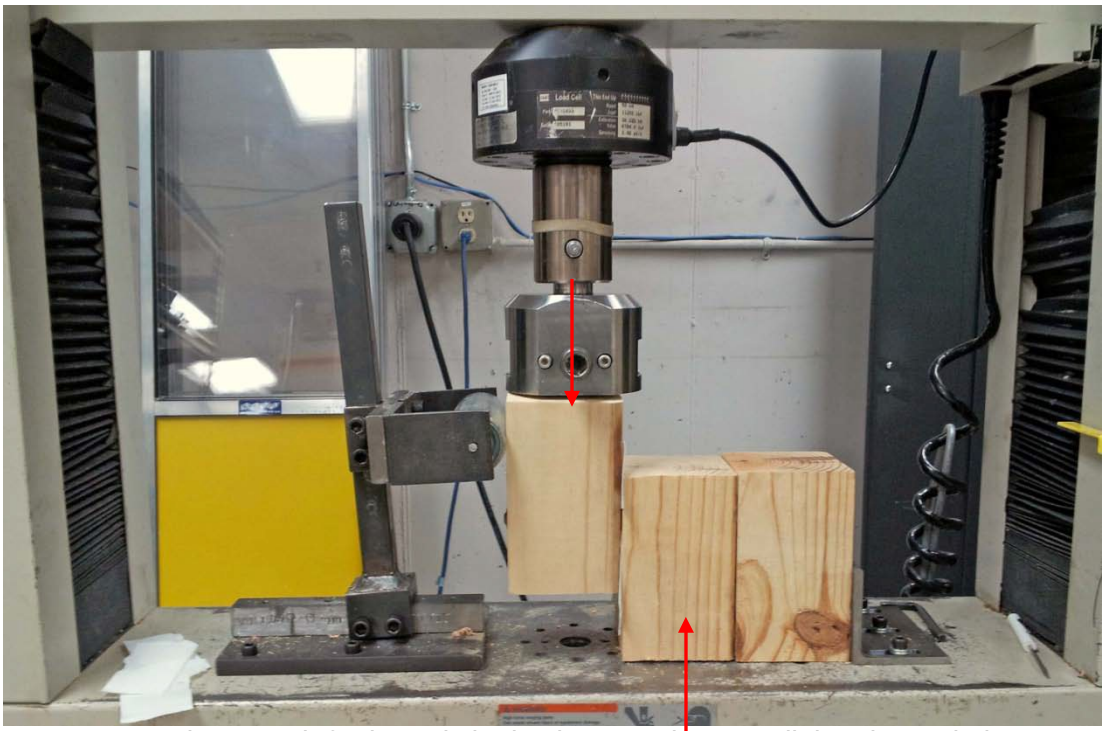


Figure 8 – A setup photograph for lateral single shear testing, parallel to the grain in compression, modified setup based on ASTM D1761-12. This setup was used to compare the tension and compression methods of testing lateral single shear. A CTX 381000 specimen is shown. The red arrows show the direction the force was applied.

APPENDIX A
Lateral Shear, Comparison of Tension Vs Compression

The lateral single shear testing was performed in tension (as specified in ASTM D1761-12) for the parallel to the grain tests, and in compression for the perpendicular to the grain tests. The test setups can be seen in Figures 6, and 7 for tension and compression, respectively.

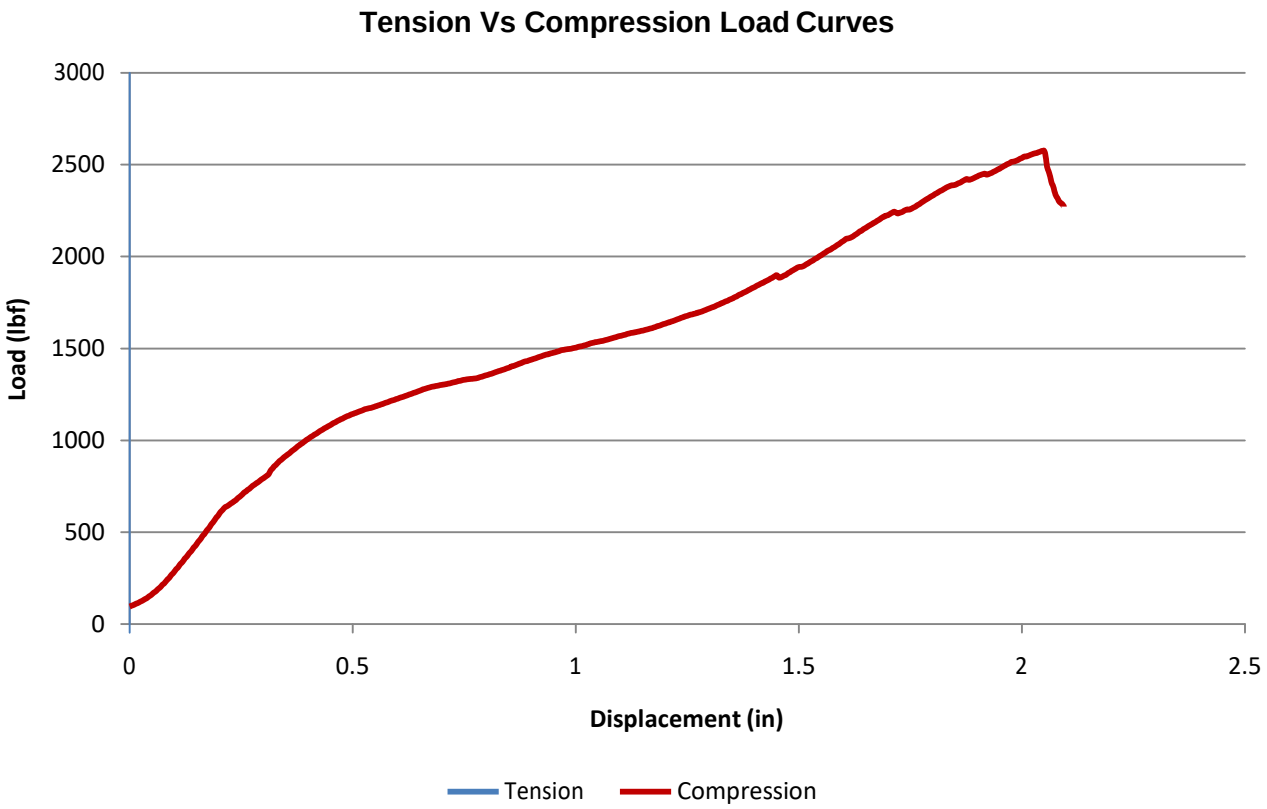
One set of comparison data was taken, to show that the results of the single shear testing were comparable whether the tests were performed in tension or in compression. This data set was taken with 15 tests from each tension in compression, in 0.55 specific gravity wood, using the largest screw diameter, side, and main member thicknesses. The side member was 3.5 inches, the main member was 7 inches (with 6.5 inches of penetration), and the screws used were the CTX 381000 (17 x 10). A picture of the test setup for compression can be seen in Figure 8. The setup for the tension test was the same as shown in Figure 6.

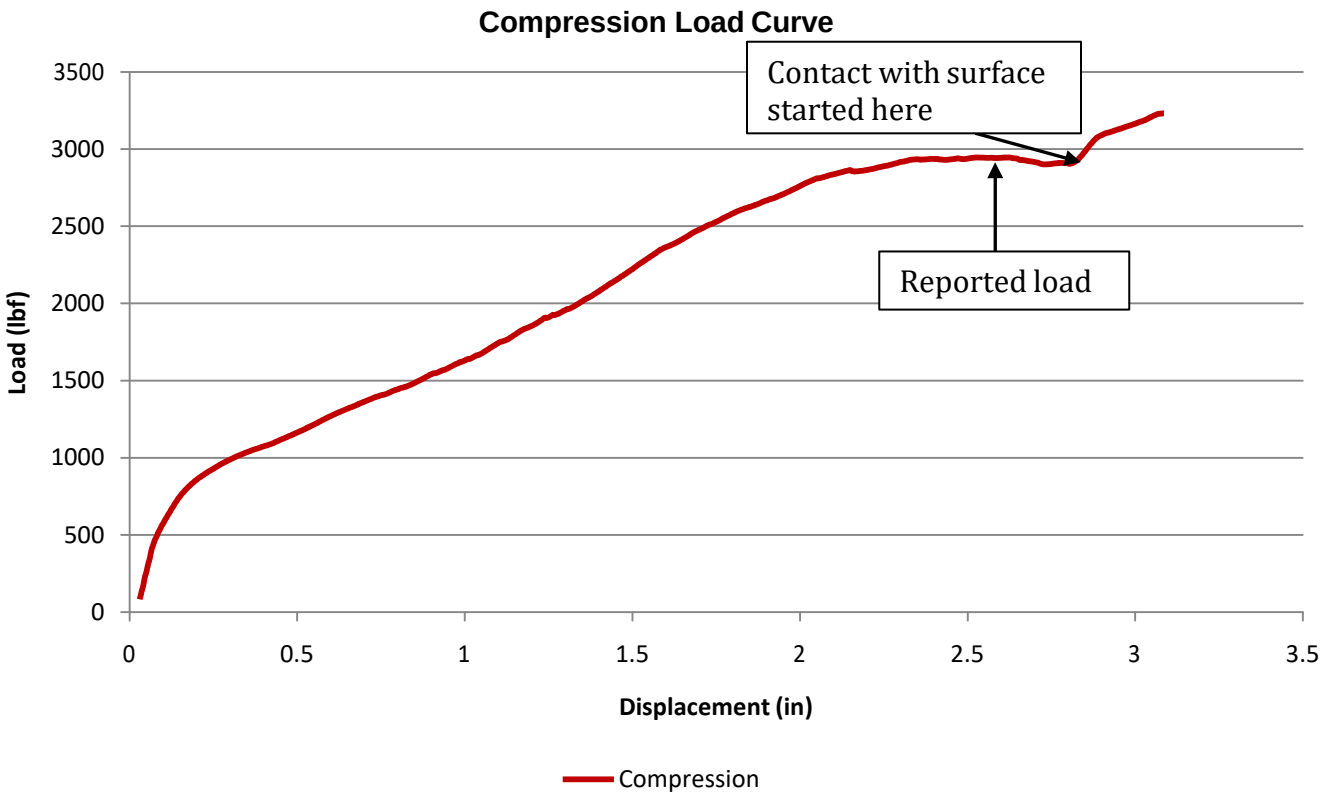
Test Data

Lateral Load Test (Tension), 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX 381000	1	2335
	2	3359
	3	2670
	4	2611
	5	2846
	6	2628
	7	2306
	8	2746
	9	2377
	10	3304
	11	2986
	12	3344
	13	2910
	14	3078
	15	2573
Average		2805
Standard Deviation		355
COV		12.7%
Average Specific Gravity		0.53
Average Moisture Content		12.9%

Lateral Load Test (Compression), 0.55 Specific Gravity		
Sample ID	Specimen	Load (lbf)
CTX 381000	1	2732
	2	2926
	3	2721
	4	3200
	5	2250
	6	2575
	7	2638
	8	2936
	9	2468
	10	2707
	11	2591
	12	2831
	13	2463
	14	3350
	15	2913
Average		2753
Standard Deviation		286
COV		10.4%
Average Specific Gravity		0.53
Average Moisture Content		12.9%

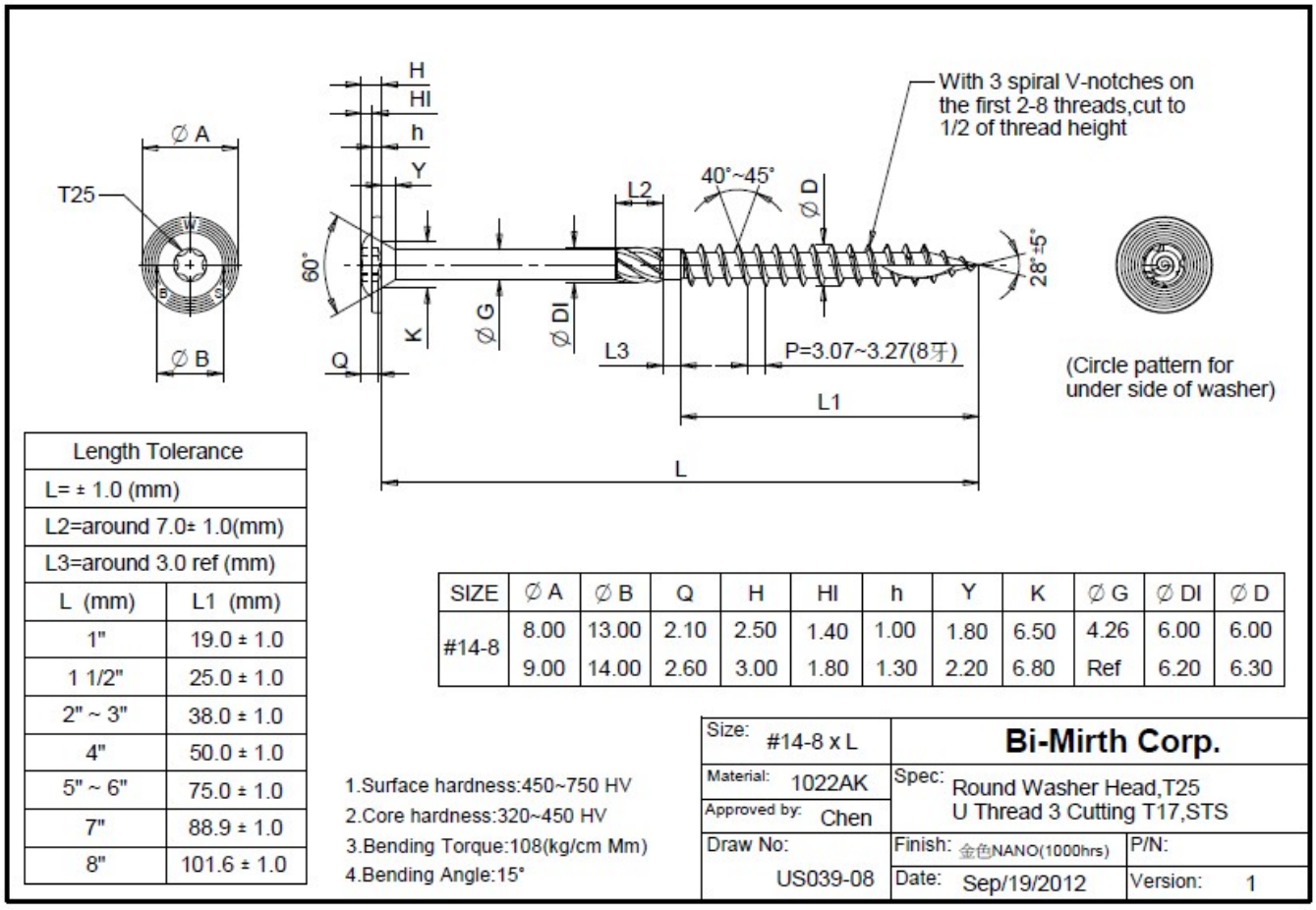
A sample of data from each the tension and compression sets can be seen below. It should be noted that on occasion the compression specimens would deflect to a point that the side member would come in contact with the surface that the main member was resting on, before ultimate failure had occurred. When this happened, the load was taken at the first drop in load. The first drop in load was determined by the test technician, generally as a point along the portion of the curve that had begun to flatten out (after yielding had occurred), as a significant drop in load. On the following page, the first plot shows a normal load curve of a sample in tension and in compression, while the second plot shows a sample that had used the first drop in load as its reported value.





APPENDIX B

Part Drawing for CTX 14 Fasteners



Length Tolerance	
L= ± 1.0 (mm)	
L2=around 7.0± 1.0(mm)	
L3=around 3.0 ref (mm)	
L (mm)	L1 (mm)
1"	19.0 ± 1.0
1 1/2"	25.0 ± 1.0
2" ~ 3"	38.0 ± 1.0
4"	50.0 ± 1.0
5" ~ 6"	75.0 ± 1.0
7"	88.9 ± 1.0
8"	101.6 ± 1.0

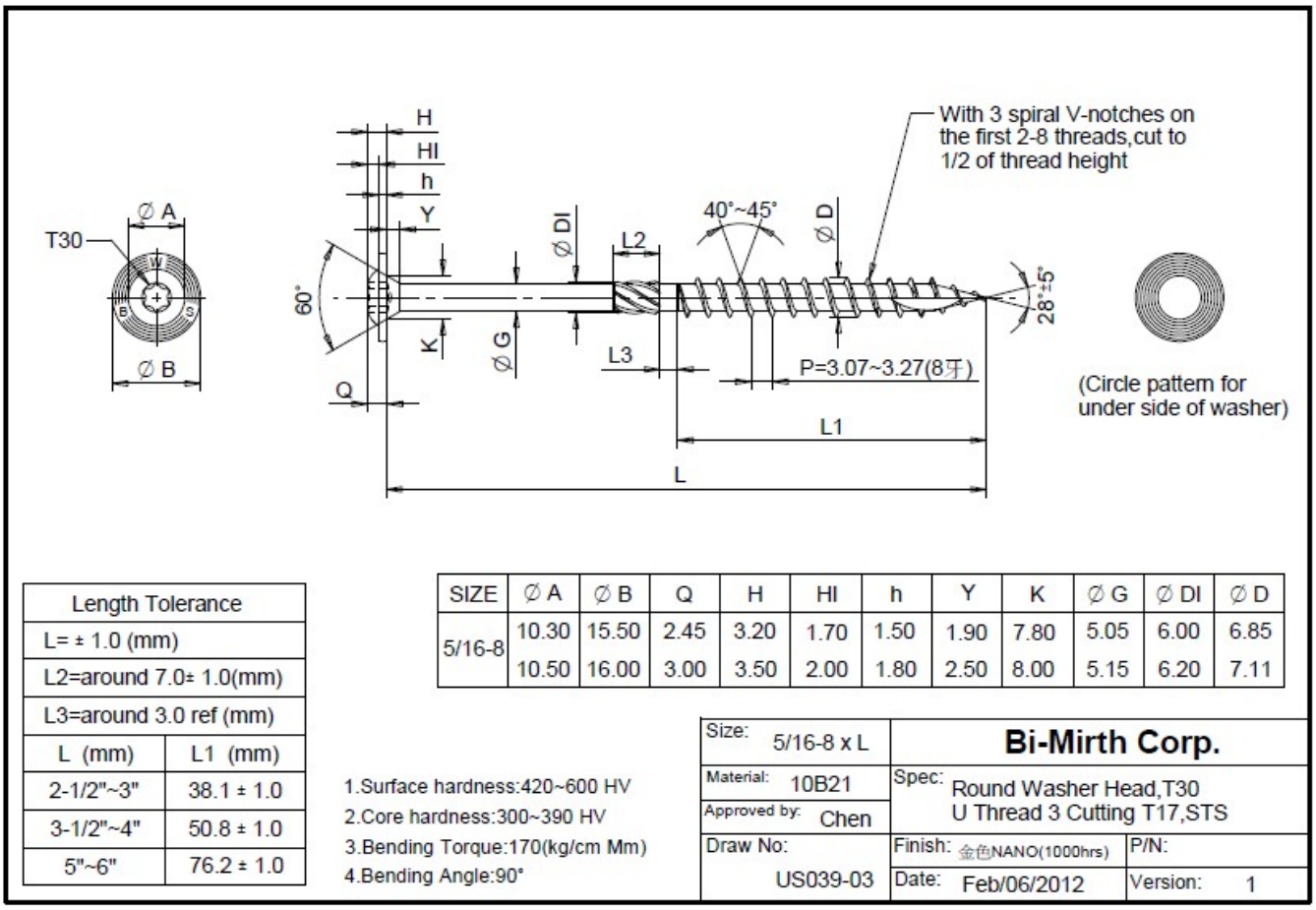
SIZE	∅ A	∅ B	Q	H	HI	h	Y	K	∅ G	∅ DI	∅ D
#14-8	8.00	13.00	2.10	2.50	1.40	1.00	1.80	6.50	4.26	6.00	6.00
	9.00	14.00	2.60	3.00	1.80	1.30	2.20	6.80	Ref	6.20	6.30

1.Surface hardness:450~750 HV
2.Core hardness:320~450 HV
3.Bending Torque:108(kg/cm Mm)
4.Bending Angle:15°

Size: #14-8 x L	**Bi-Mirth Corp.**		
Material: 1022AK	Spec: Round Washer Head,T25 U Thread 3 Cutting T17,STS		
Approved by: Chen			
Draw No: US039-08	Finish: 金色NANO(1000hrs)	P/N:	
	Date: Sep/19/2012	Version: 1	

Figure B-1 – A part level drawing for the CTX 14 fasteners, lengths from 2-1/2 to 8 inches. The six inch fastener does not have the knurled shoulder.

Part Drawing for CTX 15 Fasteners



Length Tolerance	
L= ± 1.0 (mm)	
L2=around 7.0± 1.0(mm)	
L3=around 3.0 ref (mm)	
L (mm)	L1 (mm)
2-1/2"~3"	38.1 ± 1.0
3-1/2"~4"	50.8 ± 1.0
5"~6"	76.2 ± 1.0

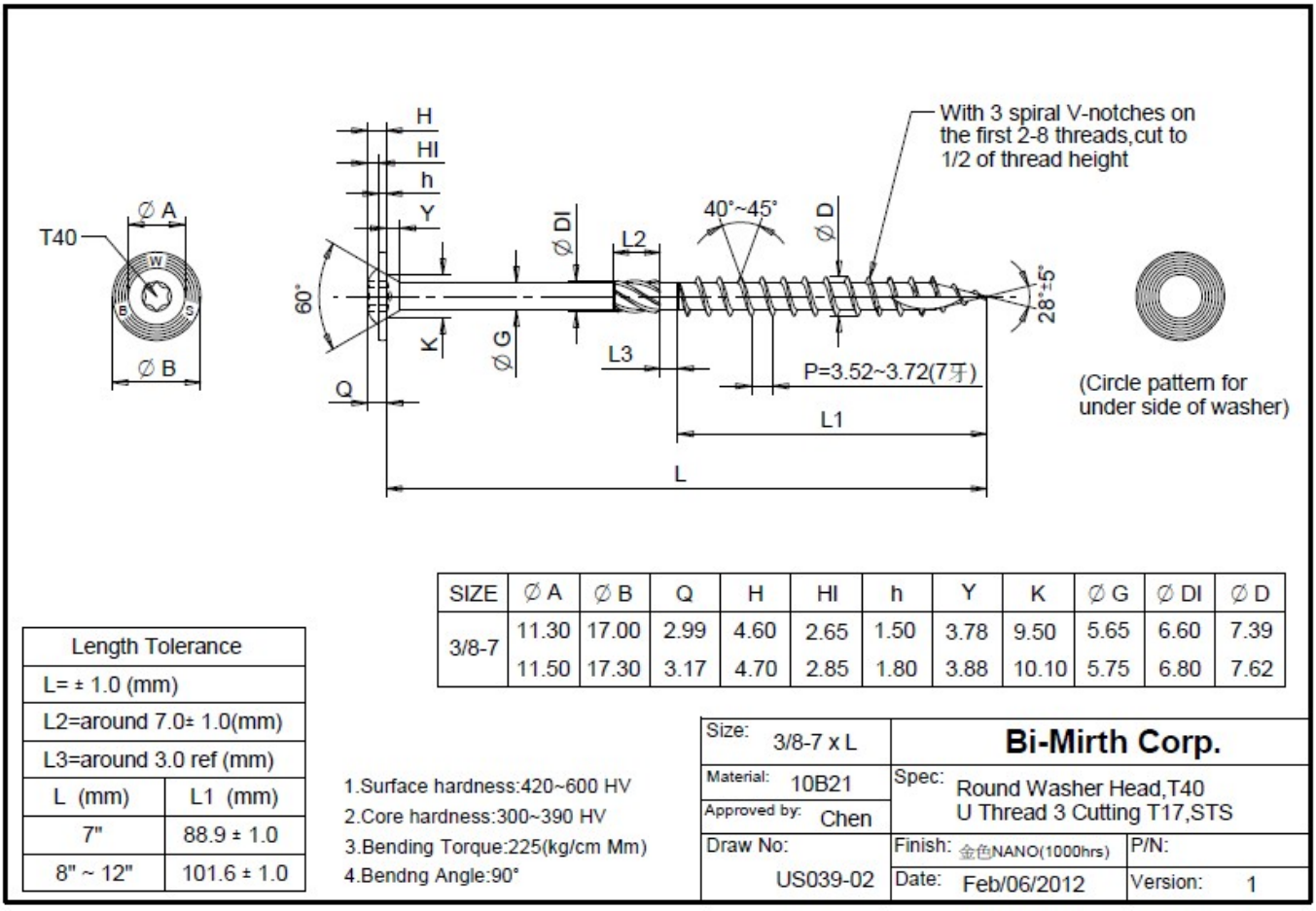
SIZE	Ø A	Ø B	Q	H	HI	h	Y	K	Ø G	Ø DI	Ø D
5/16-8	10.30	15.50	2.45	3.20	1.70	1.50	1.90	7.80	5.05	6.00	6.85
	10.50	16.00	3.00	3.50	2.00	1.80	2.50	8.00	5.15	6.20	7.11

1.Surface hardness:420~600 HV
2.Core hardness:300~390 HV
3.Bending Torque:170(kg/cm Mm)
4.Bending Angle:90°

Size: 5/16-8 x L	Bi-Mirth Corp.		
Material: 10B21	Spec: Round Washer Head,T30 U Thread 3 Cutting T17,STS		
Approved by: Chen			
Draw No: US039-03	Finish: 金色NANO(1000hrs)	P/N:	
	Date: Feb/06/2012	Version: 1	

Figure B-2 – A part level drawing for the CTX 15 fasteners, lengths from 3 to 6 inches. The six inch fastener does not have the knurled shoulder.

Part Drawing for CTX 17 Fasteners



SIZE	∅ A	∅ B	Q	H	HI	h	Y	K	∅ G	∅ DI	∅ D
3/8-7	11.30	17.00	2.99	4.60	2.65	1.50	3.78	9.50	5.65	6.60	7.39
	11.50	17.30	3.17	4.70	2.85	1.80	3.88	10.10	5.75	6.80	7.62

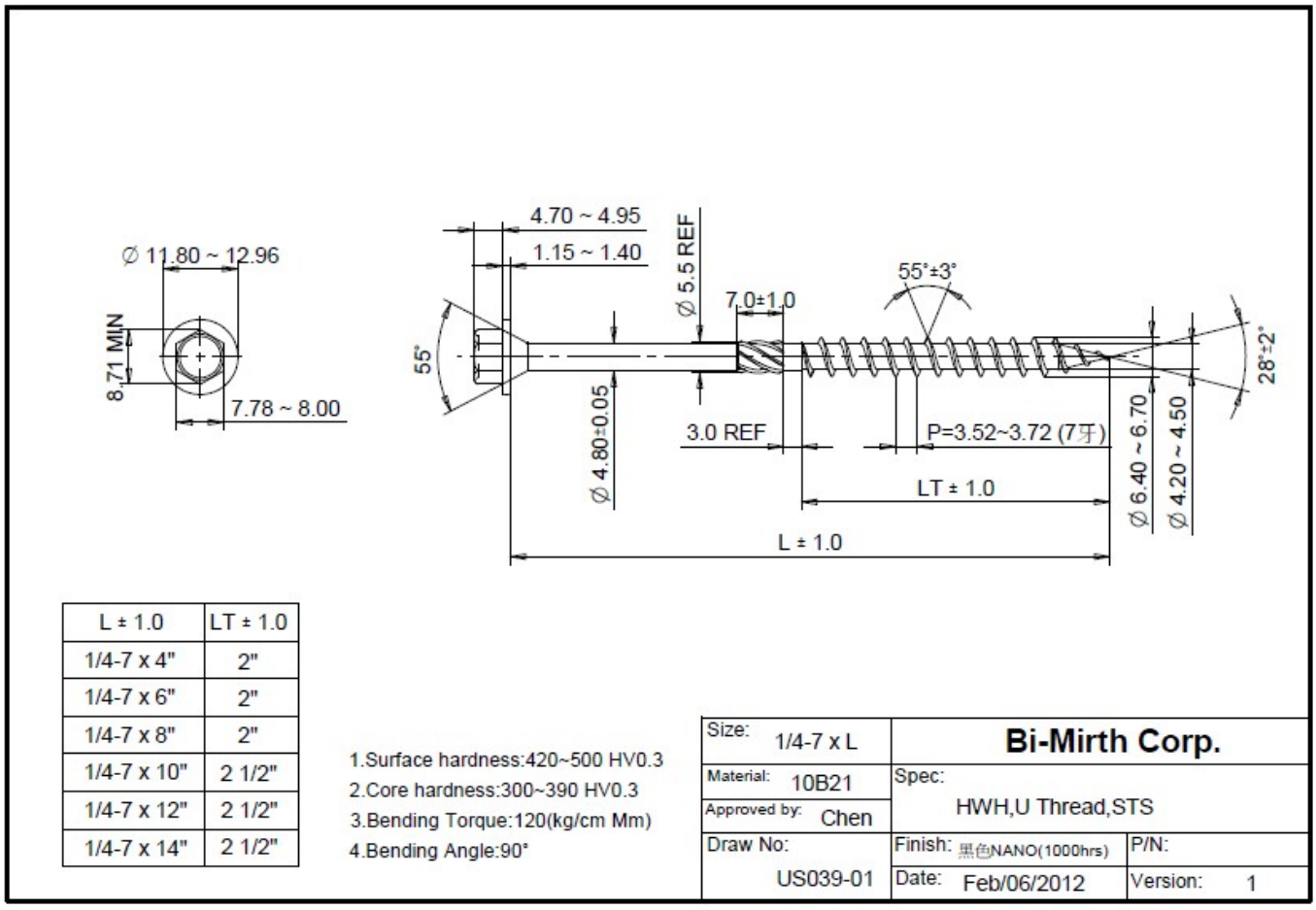
Length Tolerance	
L= ± 1.0 (mm)	
L2=around 7.0± 1.0(mm)	
L3=around 3.0 ref (mm)	
L (mm)	L1 (mm)
7"	88.9 ± 1.0
8" ~ 12"	101.6 ± 1.0

1.Surface hardness:420~600 HV
2.Core hardness:300~390 HV
3.Bending Torque:225(kg/cm Mm)
4.Bendng Angle:90°

Size: 3/8-7 x L	Bi-Mirth Corp.		
Material: 10B21	Spec: Round Washer Head,T40 U Thread 3 Cutting T17,STS		
Approved by: Chen			
Draw No: US039-02	Finish: 金色NANO(1000hrs)	P/N:	
	Date: Feb/06/2012	Version: 1	

Figure B-3 – A part level drawing for the CTX 17 fasteners, lengths from 7 to 12 inches.

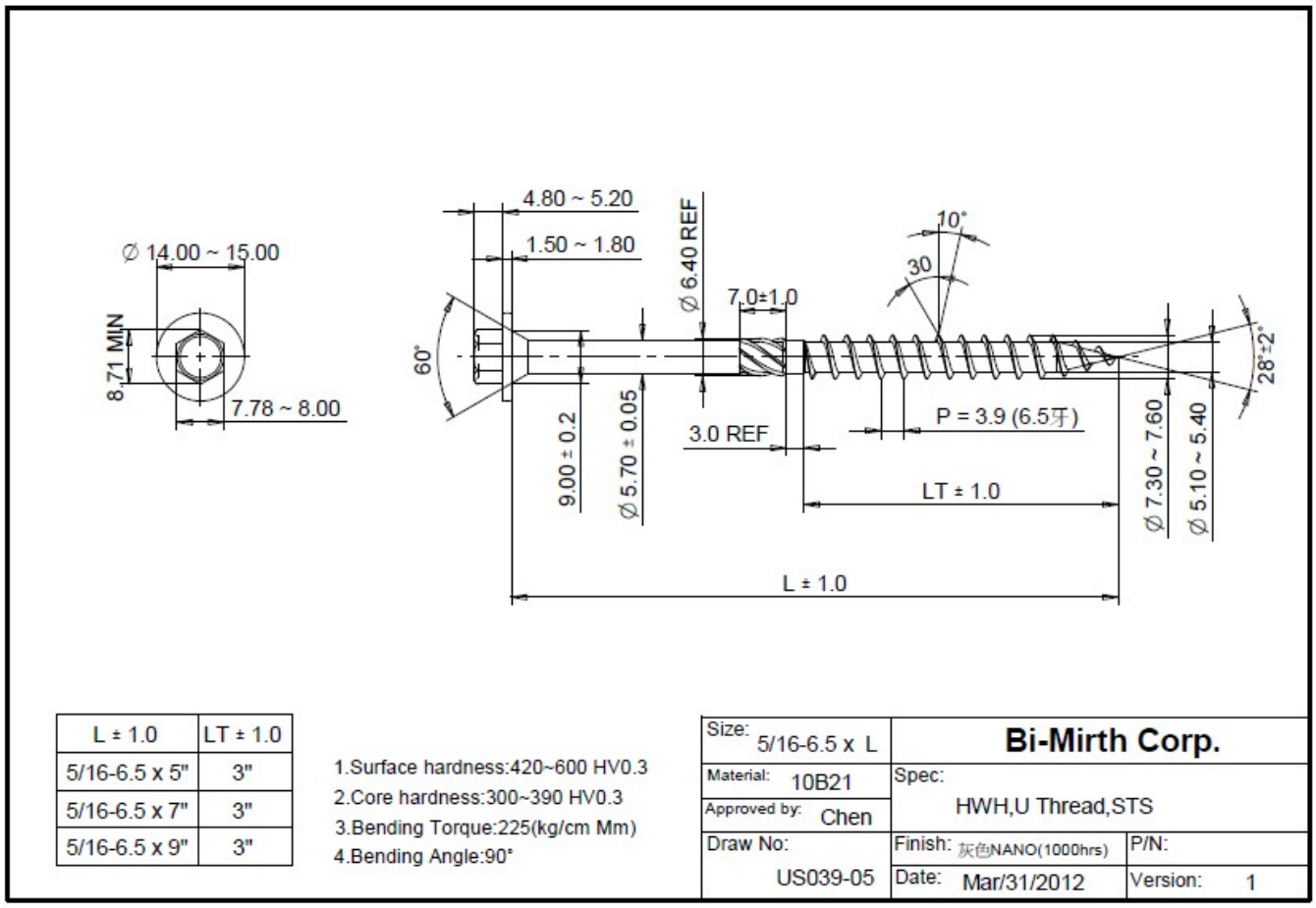
Part Drawing for Black Log 14 Fasteners



L ± 1.0	LT ± 1.0
1/4-7 x 4"	2"
1/4-7 x 6"	2"
1/4-7 x 8"	2"
1/4-7 x 10"	2 1/2"
1/4-7 x 12"	2 1/2"
1/4-7 x 14"	2 1/2"

Figure B-4 – A part level drawing for the Black Log 14 fasteners, lengths from 4 to 14 inches. The six inch and longer fasteners do not have the knurled shoulder.

Part Drawing for Gray Log 17 Fasteners



L ± 1.0	LT ± 1.0
5/16-6.5 x 5"	3"
5/16-6.5 x 7"	3"
5/16-6.5 x 9"	3"

1.Surface hardness:420~600 HV0.3
2.Core hardness:300~390 HV0.3
3.Bending Torque:225(kg/cm Mm)
4.Bending Angle:90°

Size: 5/16-6.5 x L	Bi-Mirth Corp.	
Material: 10B21	Spec: HWH,U Thread,STS	
Approved by: Chen		
Draw No: US039-05	Finish: 灰色NANO(1000hrs)	P/N:
	Date: Mar/31/2012	Version: 1

Figure B-4 – A part level drawing for the Gray Log 17 fasteners, lengths from 5 to 11 inches.