Precision
Structural
Engineering, Inc.

STRUCTURAL ENGINEERING CALCULATIONS

PROJECT: Stainless Cable & Railing

PROJECT LOCATION: Washington & California

PSE PROJECT NUMBER: Stainless Cable & Railing
216-1 Railing

DATE: January 16, 2017

BY: Nabil Taha, Ph.D., P.E.

1-16-17

REGISTERED PROFESSIONAL ENGINEER
NABIL M. TAHA
C60802
EXP. 12-31-18
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1-16-17

NABIL M. TAHA
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EXPIRES 7-26-17

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PROJECT NO. Stainless Cable 216-1 SHEET ______ OF ______

PROJECT NAME Guard rail DESIGNED BY AF DATE 10/06/16

SUBJECT Conclusion CHECKED BY ______ DATE ______

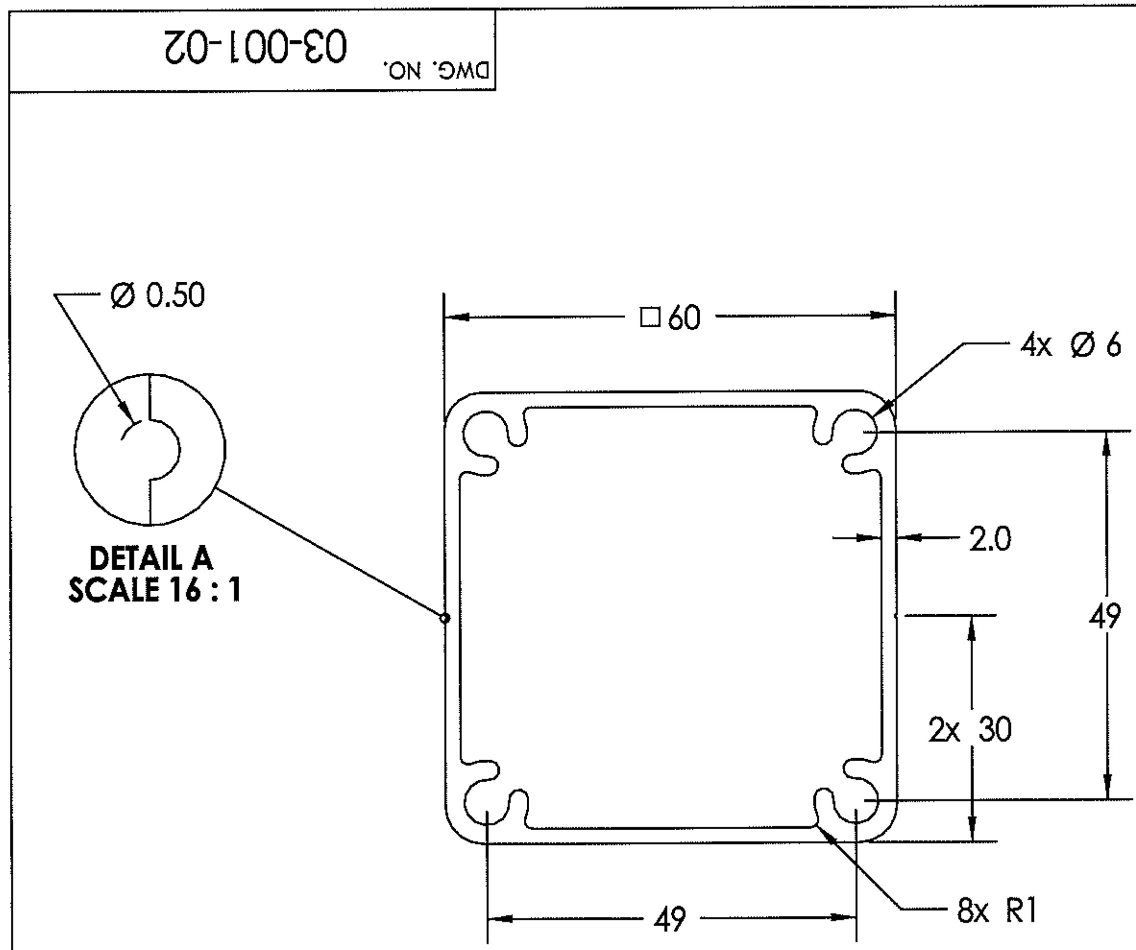
Conclusion

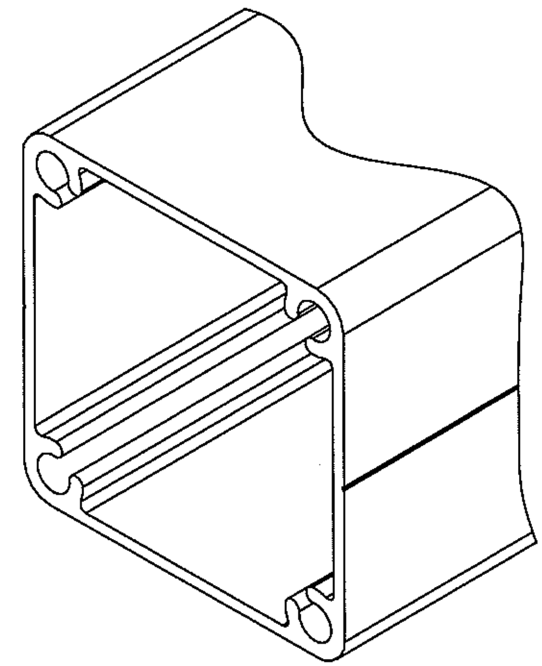
1- Base plate minimum size is 5.25" * 5.25" * 0.35"

2- Minimum Anchor bolt size as follows:

- $\frac{3}{8}$"ϕ w/min 4" Embed, Redhead ITW wedge
- $\frac{3}{8}$"ϕ w/min 4" Embed, Red head LDT (SLDT-3816)
- $\frac{1}{2}$"ϕ w/min 4" Embed, Redhead SRM-38 or similar

3- Cable size $\frac{1}{8}$"ϕ or $\frac{3}{16}$"ϕ

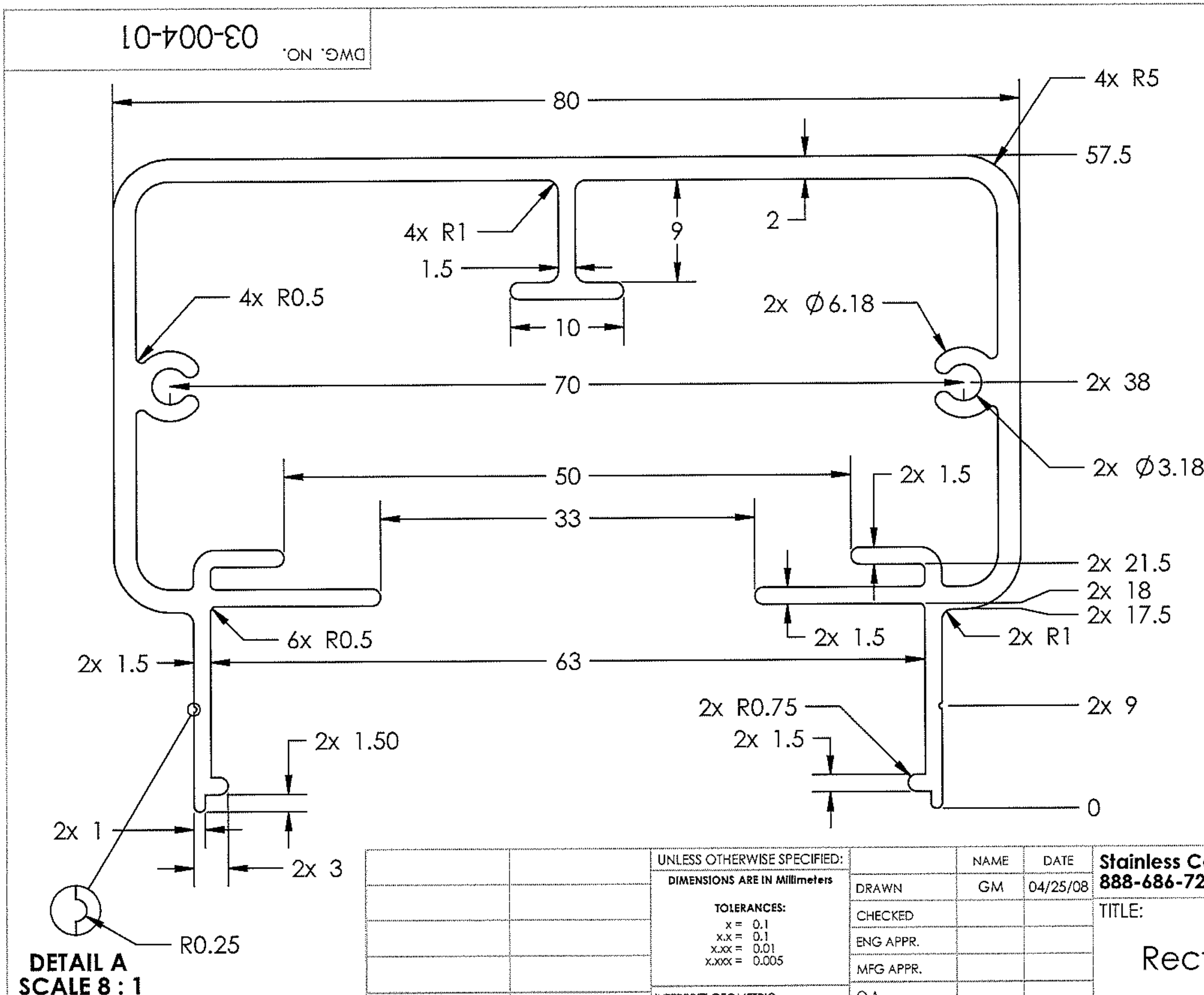




		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	Stainless Cable & Railing, Inc. 888-686-7245 (RAIL)
		DIMENSIONS ARE IN Millimeters TOLERANCES: x = 0.1 x.x = 0.1 x.xx = 0.01 x.xxx = 0.005	DRAWN	GM	04/30/08	TITLE:
			CHECKED			Intermediate Post
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL 6082 T6 Alu	COMMENTS: Powdercoating to meet or exceed AAMA2604 Salt Spray Resistance			SIZE A · DWG. NO. 03-001-02 · REV PR1
NEXT ASSY	USED ON	FINISH Powdercoat				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:1 · WEIGHT: · SHEET 1 OF 1

PROPRIETARY AND CONFIDENTIAL

5 4 3 2 1



PROPRIETARY AND CONFIDENTIAL

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NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN Millimeters

TOLERANCES:
x = 0.1
x.x = 0.1
x.xx = 0.01
x.xxx = 0.005

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL: 6082 T6 Alu

FINISH: Powdercoat 6 Mil Min.

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	GM	04/25/08
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:
Powdercoating to meet or exceed AAMA2604 Salt Spray Resistance

Stainless Cable & Railing, Inc.
888-686-7245 (RAIL)

TITLE:

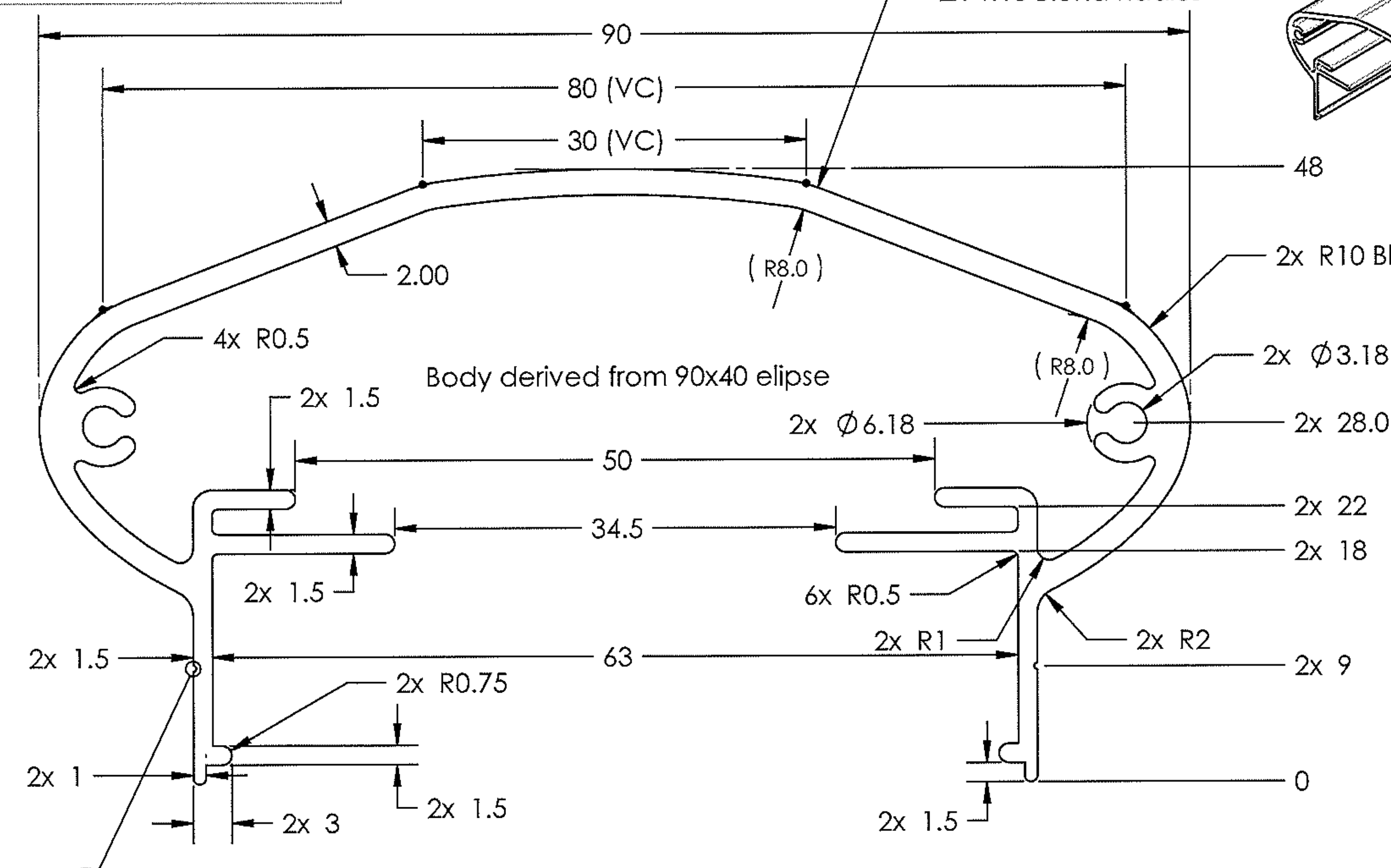
Rectangular Top Rail

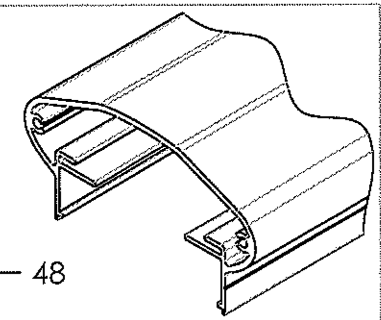
SIZE	DWG. NO.	REV
A	03-004-01	PR1

SCALE: 2:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1

DWG. NO. 03-002-01





DETAIL A
SCALE 8 : 1

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN Millimeters

TOLERANCES:
x = 0.1
x.x = 0.1
x.xx = 0.01
x.xxx = 0.005

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL: 6082 T6 Alu

FINISH: Powdercoat 6 Mil Min.

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	GM	04/25/08
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:
Powdercoating to meet or exceed AAMA2604 Salt Spray Resistance

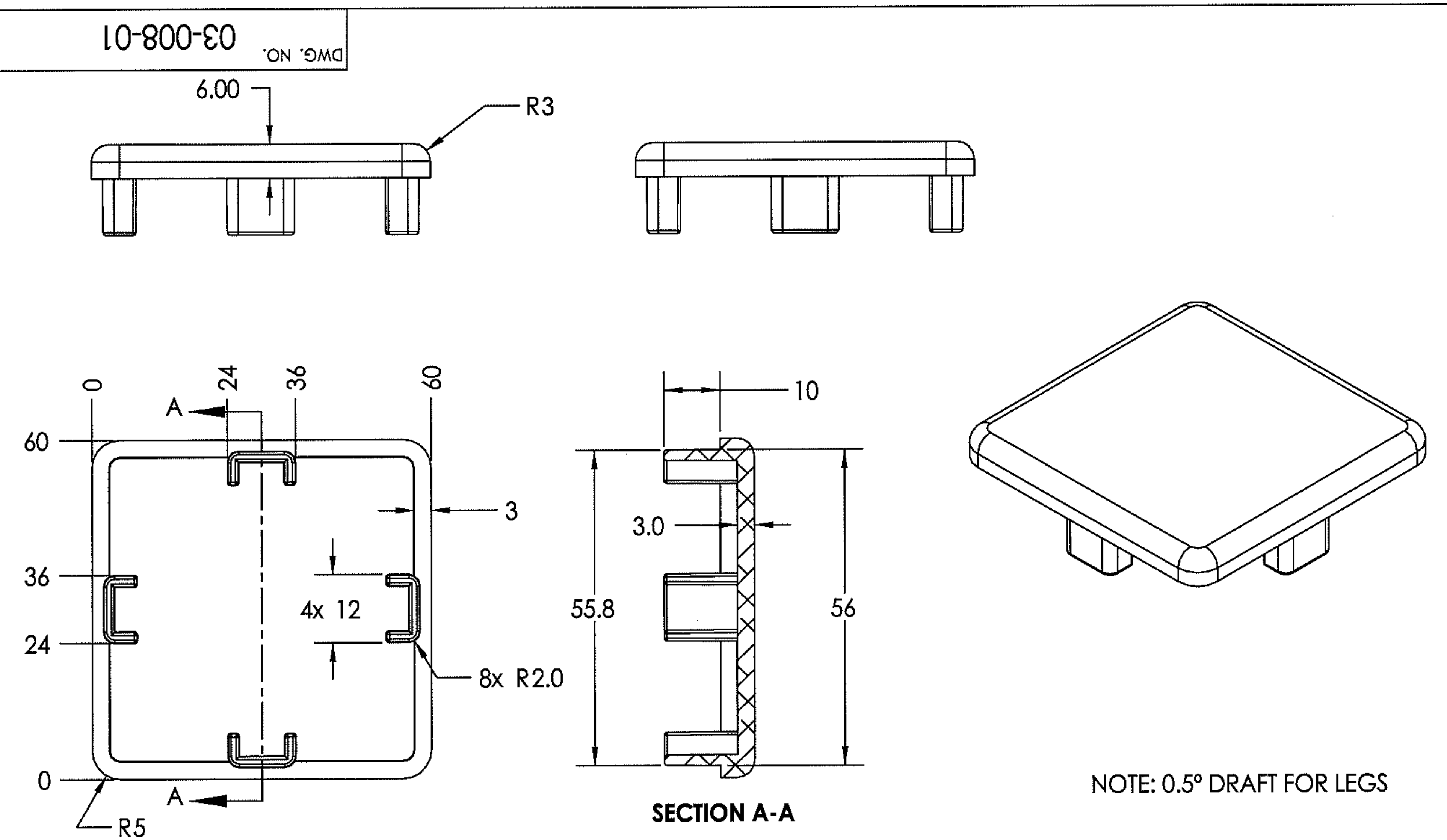
Stainless Cable & Railing, Inc.
888-686-7245 (RAIL)

TITLE:
Eliptical Top Rail

SIZE	DWG. NO.	REV
A	03-002-01	PR1

SCALE: 2:1 WEIGHT: SHEET 1 OF 1

5 4 3 2 1



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	Stainless Cable & Railing, Inc. 888-686-7245 (RAIL)
DIMENSIONS ARE IN Millimeters TOLERANCES: x = 0.1 x.x = 0.1 x.xx = 0.01 x.xxx = 0.005	DRAWN	GM	04/27/08	TITLE: Post Cap
	CHECKED			
	ENG APPR.			
	MFG APPR.			
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
MATERIAL 6082 T6 Alu	COMMENTS: Powdercoating to meet or exceed AAMA2604 Salt Spray Resistance			SIZE A · DWG. NO. 03-008-01 · REV PR2
FINISH				SCALE: 1:1 · WEIGHT: · SHEET 1 OF 1
DO NOT SCALE DRAWING				

NEXT ASSY	USED ON
APPLICATION	

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5 4 3 2 1

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Table of Contents:

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References:

1- Literature:

a. 2015 International Building Code (IBC)

b. 2016 California Building Code based on 2015 International Building Code (IBC)

c. Aluminum Design Manual ADMI-15, The Aluminum Association.

2- Software:

a. RISA 3D Version 14.0.1
RISA Technologies,
26212 Dimension Dr. Suite 200

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Design Criteria:

1- Location: Washington & California

2- Live Load on Handrail & guards:

a. Uniform Distributed load 50 p/f
b. Single Concentrated load 200 lbs

**Other criteria assumed as stated in design calculations.

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Precision
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GUARD RAIL ANALYSIS & DESIGN:

Pages 1,000 - 1,999

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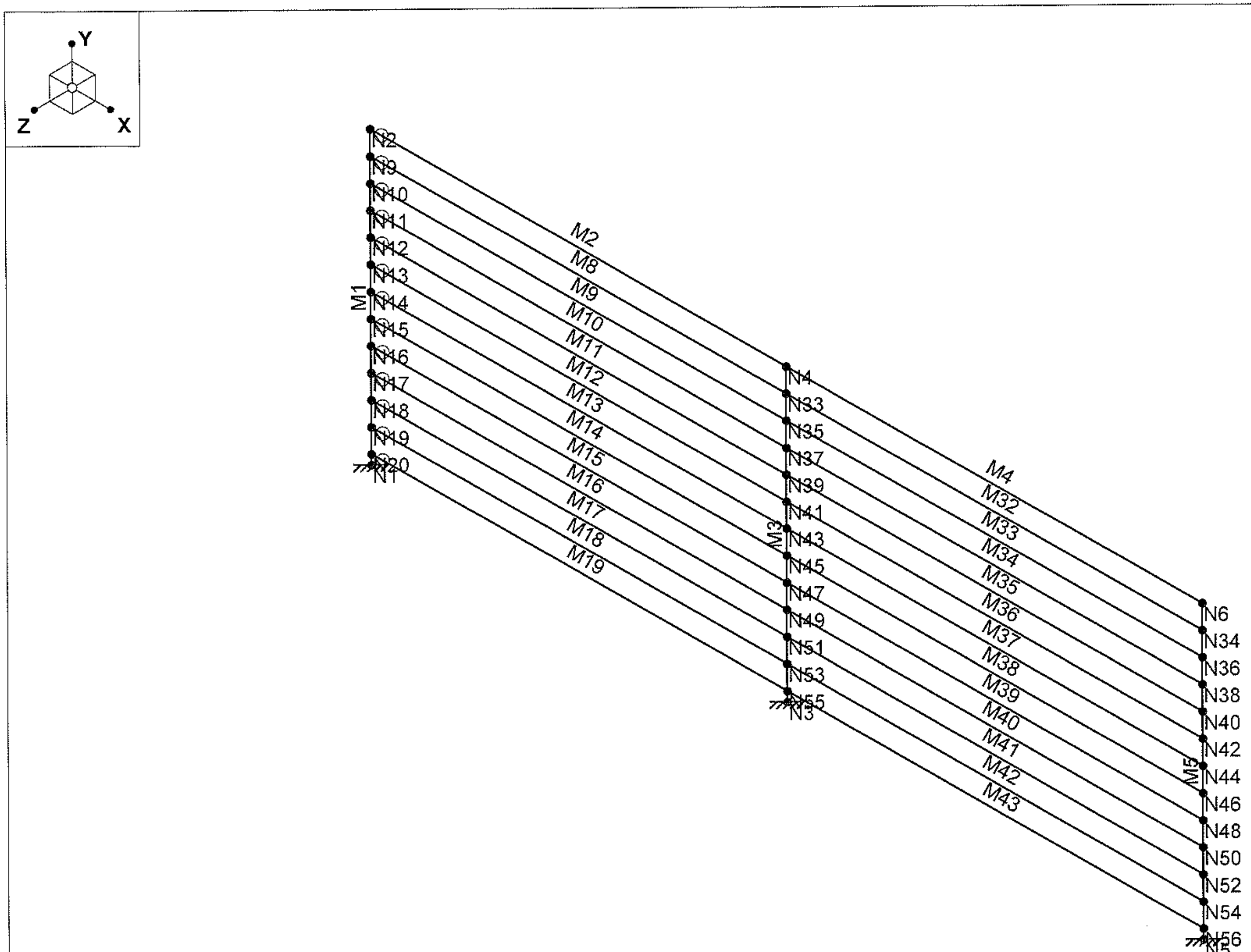
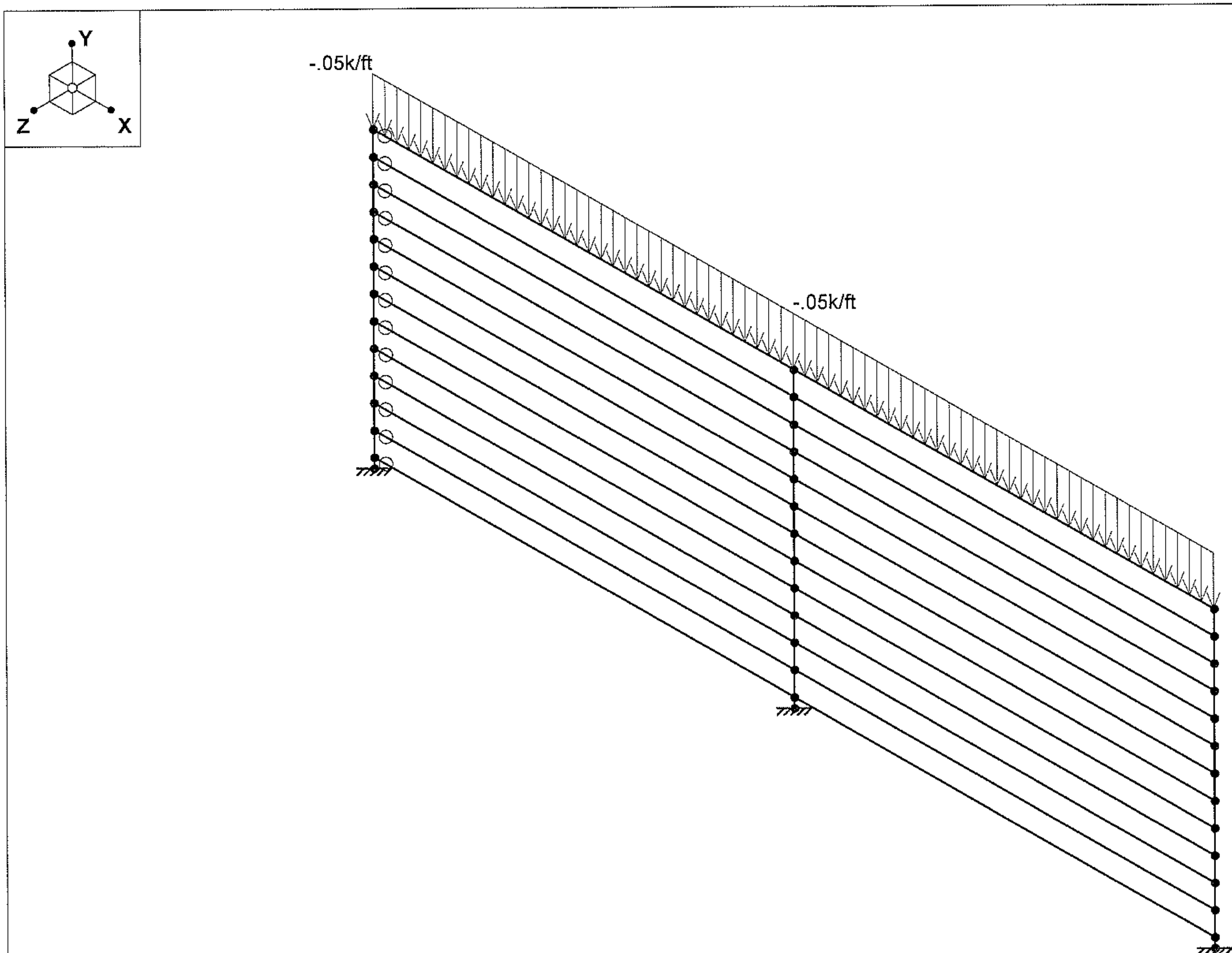


1000

Envelope Only Solution

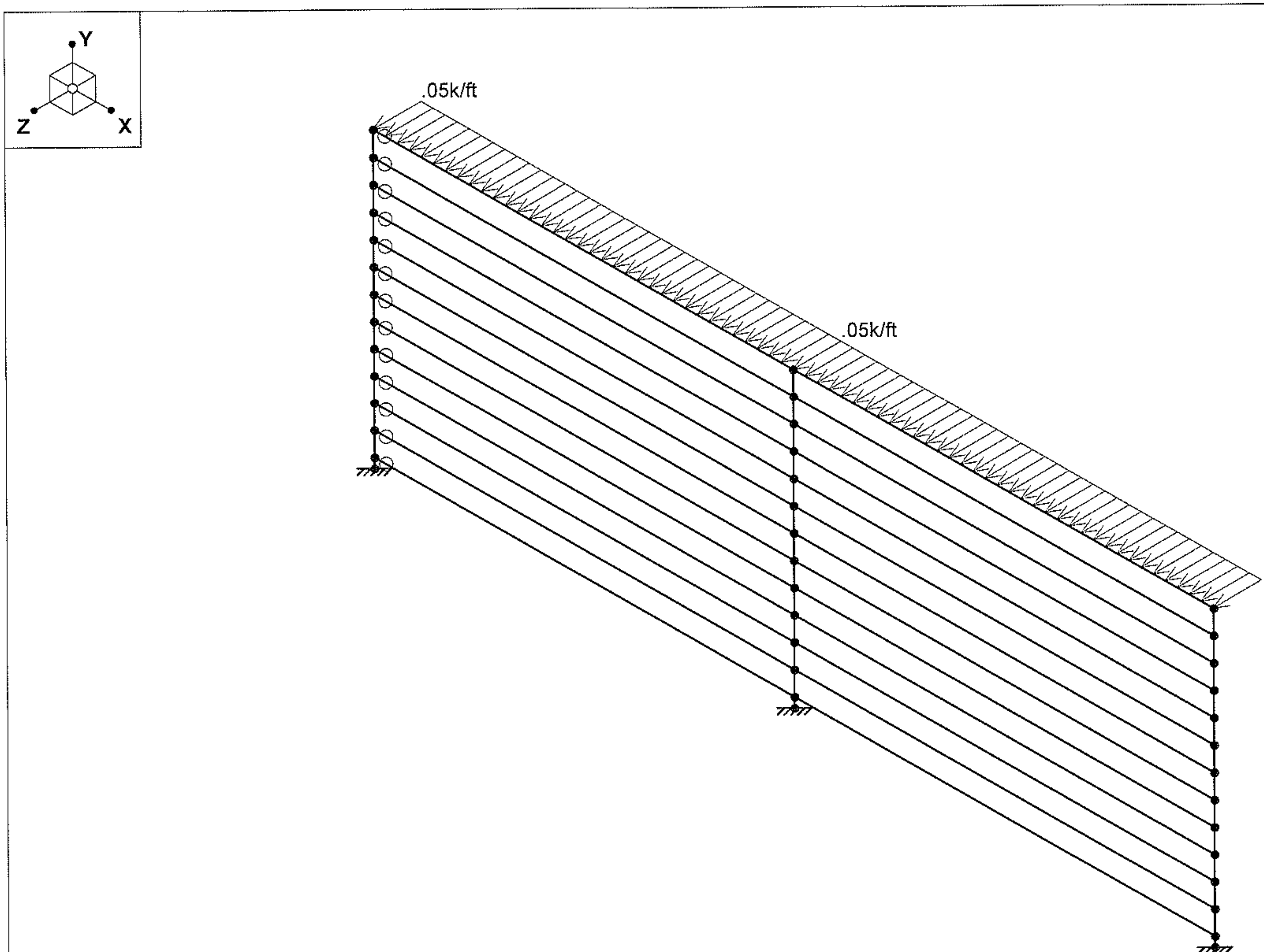
PSEI	GUARD RAIL SYSTEM WITH CABLES	SK - 1
AF		Oct 5, 2016 at 1:04 PM
Stainless Cable & Railing 216-1		5' SPACING GUARD RAIL WITH CABLES.r3d



Loads: BLC 1, Distributed load-y at the top of
Envelope Only Solution

PSEI	GUARD RAIL SYSTEM WITH CABLES	SK - 2
AF		Oct 5, 2016 at 1:04 PM
Stainless Cable & Railing 216-1		5' SPACING GUARD RAIL WITH CABLES.r3d

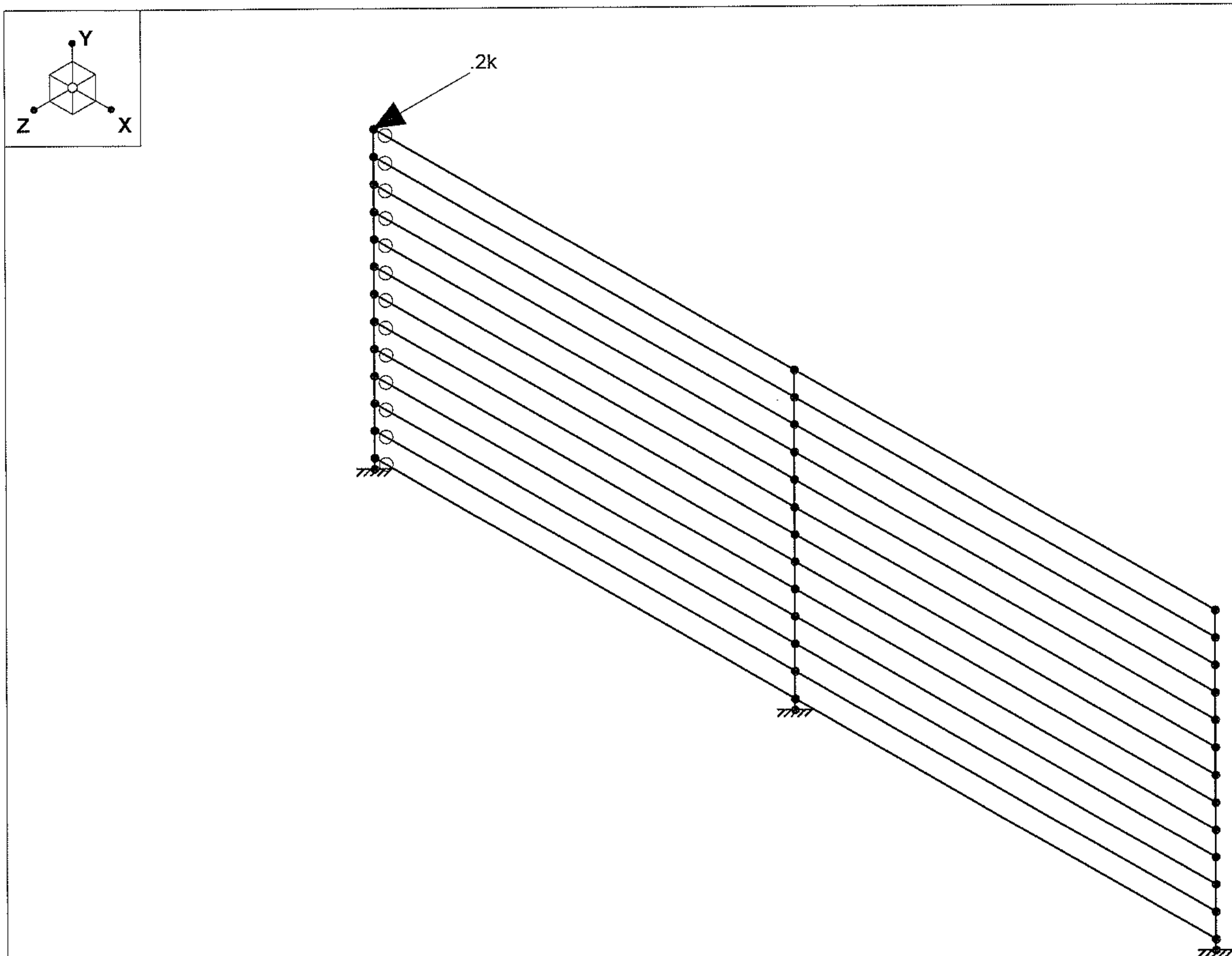
1001



1002

Loads: BLC 2, Distributed load-X at the side o
Envelope Only Solution

PSEI	GUARD RAIL SYSTEM WITH CABLES	SK - 3
AF		Oct 5, 2016 at 1:04 PM
Stainless Cable & Railing 216-1		5' SPACING GUARD RAIL WITH CABLES.r3d

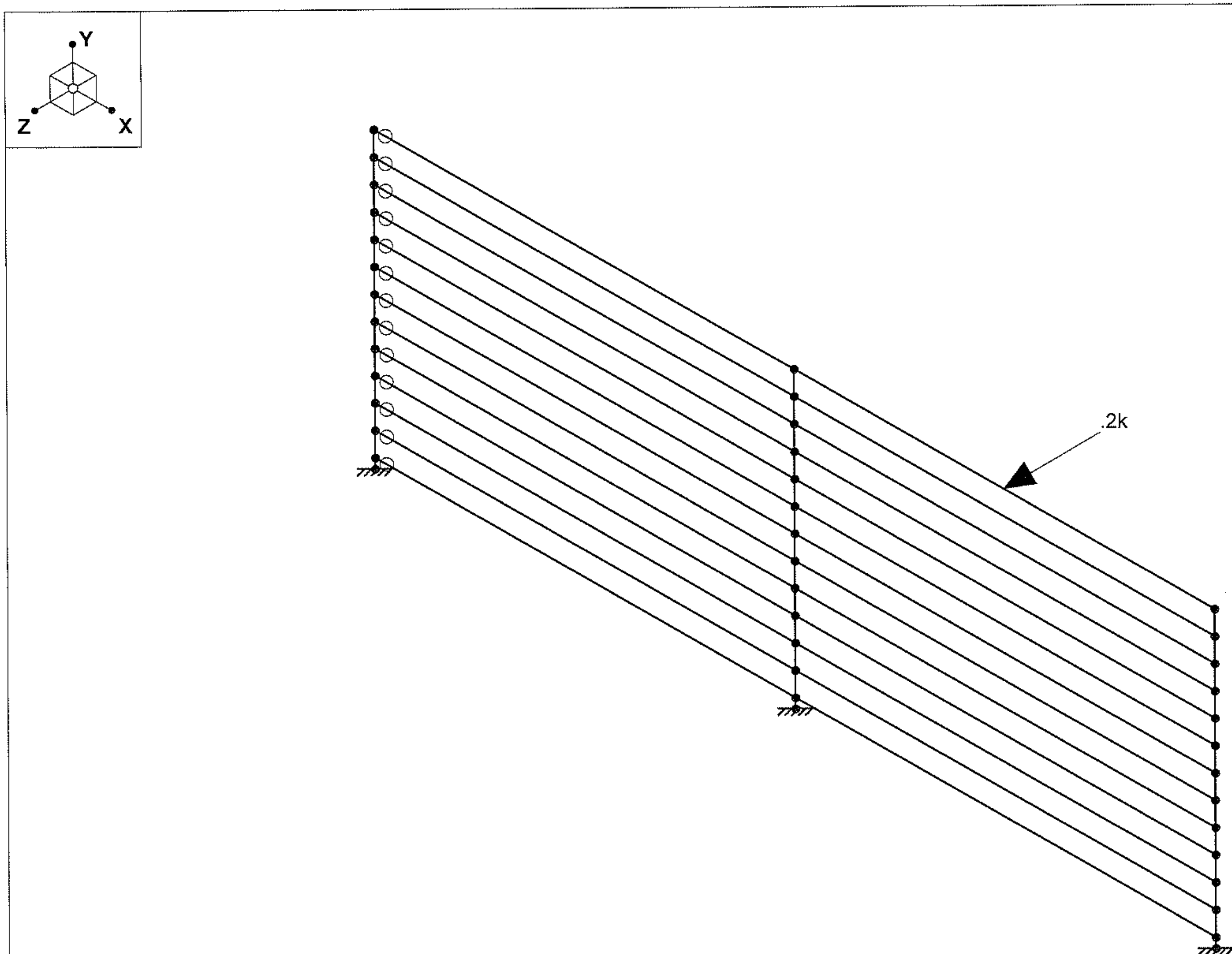


1003

Loads: BLC 3, Point load applied at the corner
Envelope Only Solution

PSEI	GUARD RAIL SYSTEM WITH CABLES	SK - 4
AF		Oct 5, 2016 at 1:04 PM
Stainless Cable & Railing 216-1		5' SPACING GUARD RAIL WITH CABLES.r3d

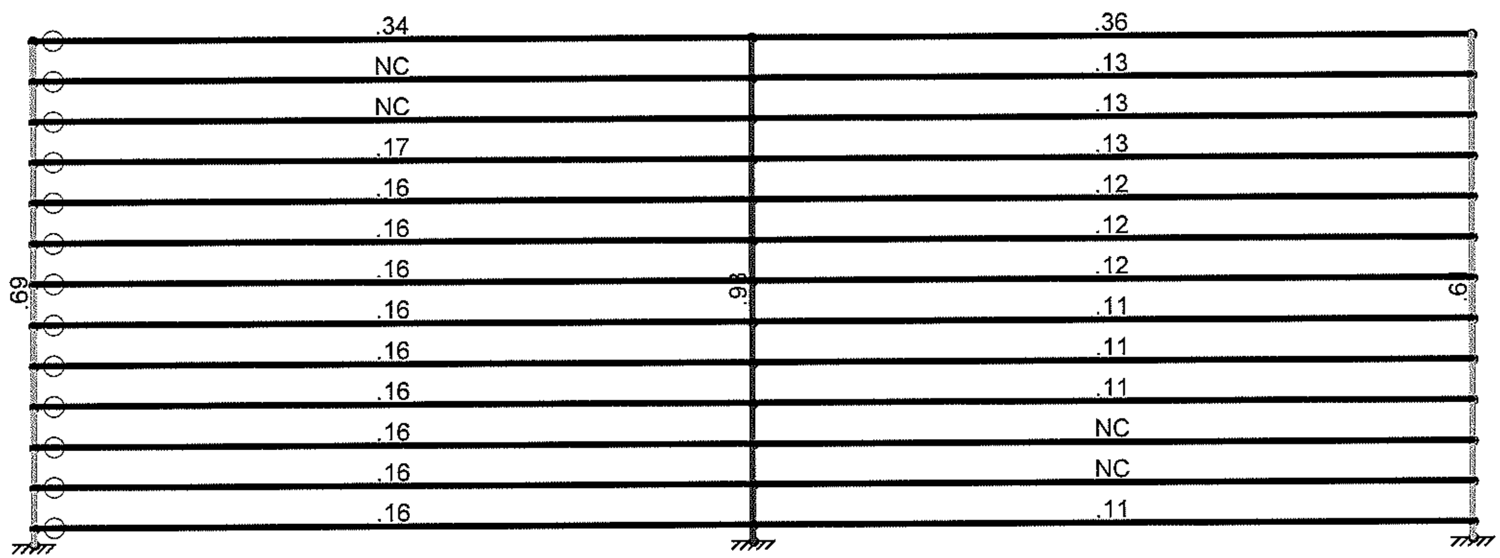
1004



Loads: BLC 4, Point load applied at the middle
Envelope Only Solution

PSEI	GUARD RAIL SYSTEM WITH CABLES	SK - 5
AF		Oct 5, 2016 at 1:04 PM
Stainless Cable & Railing 216-1		5' SPACING GUARD RAIL WITH CABLES.r3d

Code Check
(Env)
No Calc
> 1.0
.90-1.0
.75-.90
.50-.75
0.-.50



1005

Member Code Checks Displayed (Enveloped)
Envelope Only Solution

PSEI	GUARD RAIL SYSTEM WITH CABLES	SK - 6
AF		Oct 5, 2016 at 1:05 PM
Stainless Cable & Railing 216-1		5' SPACING GUARD RAIL WITH CABLES.r3d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1...	Density[k/ft^3]	Yield[ksi]	Ry	Fu[ksi]	Rt
1	A36 Gr.36	29000	11154	.3	.65	.49	36	1.5	58	1.2
2	A572 Gr.50	29000	11154	.3	.65	.49	50	1.1	65	1.1
3	A992	29000	11154	.3	.65	.49	50	1.1	65	1.1
4	A500 Gr.42	29000	11154	.3	.65	.49	42	1.4	58	1.3
5	A500 Gr.46	29000	11154	.3	.65	.49	46	1.4	58	1.3

Aluminum Properties

	Label	E [ksi]	G [ksi]	Nu	Therm ...	Density...	Table B.4	kt	Ftu[ksi]	Fty[ksi]	Fcy[ksi]	Fsu[ksi]	Ct
1	3003-H14	10100	3787.5	.33	1.3	.173	Table B.4-1	1	19	16	13	12	141
2	6061-T6	10100	3787.5	.33	1.3	.173	Table B.4-2	1	38	35	35	24	141
3	6063-T5	10100	3787.5	.33	1.3	.173	Table B.4-2	1	22	16	16	13	141
4	6063-T6	10100	3787.5	.33	1.3	.173	Table B.4-2	1	30	25	25	19	141
5	5052-H34	10200	3787.5	.33	1.3	.173	Table B.4-1	1	34	26	24	20	141
6	6061-T6 W	10100	3787.5	.33	1.3	.173	Table B.4-1	1	24	15	15	15	141

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	CABLE	3/16" Rod	HBrace	None	A36 Gr.36	Typical	.027	6e-5	6e-5	.00012

Aluminum Section Sets

	Label	Shape	Type	Design List	Material	Design Ru...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	POST	2.375x2.375x.100	Beam	Rectangular Tub...	6063-T6	Typical	.91	.786	.786	1.177
2	TOP RAIL	3.15x1.575x0.078	Beam	Rectangular Tub...	6063-T6	Typical	.713	.313	.929	.722
3	BOTTOM RAIL	.735x2.125x.07	Beam	Rectangular Tub...	6063-T6	Typical	.381	.035	.2	.096

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Z [ft]	Temp [F]	Detach From Diap...
1	N1	0	0	0	0	
2	N2	0	3.5	0	0	
3	N3	5	0	0	0	
4	N4	5	3.5	0	0	
5	N5	10	0	0	0	
6	N6	10	3.5	0	0	
7	N9	0	3.217708	0	0	
8	N10	0	2.935417	0	0	
9	N11	0	2.653125	0	0	
10	N12	0	2.370833	0	0	
11	N13	0	2.088542	0	0	
12	N14	0	1.80625	0	0	
13	N15	0	1.523958	0	0	
14	N16	0	1.241667	0	0	
15	N17	0	0.959375	0	0	
16	N18	0	0.677083	0	0	
17	N19	0	0.394792	0	0	
18	N20	0	0.1125	0	0	
19	N33	5	3.217708	0	0	
20	N34	10	3.217708	0	0	
21	N35	5	2.935417	0	0	
22	N36	10	2.935417	0	0	
23	N37	5	2.653125	0	0	

Joint Coordinates and Temperatures (Continued)

	Label	X [ft]	Y [ft]	Z [ft]	Temp [F]	Detach From Diap...
24	N38	10	2.653125	0	0	
25	N39	5	2.370833	0	0	
26	N40	10	2.370833	0	0	
27	N41	5	2.088542	0	0	
28	N42	10	2.088542	0	0	
29	N43	5	1.80625	0	0	
30	N44	10	1.80625	0	0	
31	N45	5	1.523958	0	0	
32	N46	10	1.523958	0	0	
33	N47	5	1.241667	0	0	
34	N48	10	1.241667	0	0	
35	N49	5	0.959375	0	0	
36	N50	10	0.959375	0	0	
37	N51	5	0.677083	0	0	
38	N52	10	0.677083	0	0	
39	N53	5	0.394792	0	0	
40	N54	10	0.394792	0	0	
41	N55	5	0.1125	0	0	
42	N56	10	0.1125	0	0	

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]
1	N1	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
2	N3	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
3	N5	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Hot Rolled Steel Design Parameters

	Label	Shape	Length[ft]	Lbyy[ft]	Lbzz[ft]	Lcomp top[ft]	Lcomp bot[ft]	L-torqu...	Kyy	Kzz	Cb	Function
1	M8	CABLE	5			Lbyy						Lateral
2	M9	CABLE	5			Lbyy						Lateral
3	M10	CABLE	5			Lbyy						Lateral
4	M11	CABLE	5			Lbyy						Lateral
5	M12	CABLE	5			Lbyy						Lateral
6	M13	CABLE	5			Lbyy						Lateral
7	M14	CABLE	5			Lbyy						Lateral
8	M15	CABLE	5			Lbyy						Lateral
9	M16	CABLE	5			Lbyy						Lateral
10	M17	CABLE	5			Lbyy						Lateral
11	M18	CABLE	5			Lbyy						Lateral
12	M19	CABLE	5			Lbyy						Lateral
13	M32	CABLE	5			Lbyy						Lateral
14	M33	CABLE	5			Lbyy						Lateral
15	M34	CABLE	5			Lbyy						Lateral
16	M35	CABLE	5			Lbyy						Lateral
17	M36	CABLE	5			Lbyy						Lateral
18	M37	CABLE	5			Lbyy						Lateral
19	M38	CABLE	5			Lbyy						Lateral
20	M39	CABLE	5			Lbyy						Lateral
21	M40	CABLE	5			Lbyy						Lateral
22	M41	CABLE	5			Lbyy						Lateral
23	M42	CABLE	5			Lbyy						Lateral
24	M43	CABLE	5			Lbyy						Lateral

1008

Aluminum Design Parameters

	Label	Shape	Length[ft]	Lbyy[ft]	Lbzz[ft]	Lcomp top[ft]	Lcomp bot[ft]	L-torq...	Kyy	Kzz	Cb	Welde...	Functi...
1	M1	POST	3.5			Lbyy							Lateral
2	M2	TOP RAIL	5			Lbyy							Lateral
3	M3	POST	3.5			Lbyy							Lateral
4	M4	TOP RAIL	5			Lbyy							Lateral
5	M5	POST	3.5			Lbyy							Lateral

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distribu...	Area(M...	Surface...
1	Distributed load-y at the top of	None		-1				2		
2	Distributed load-X at the side o	None		-1				2		
3	Point load applied at the corner	None		-1		1				
4	Point load applied at the middle	None		-1			1			

Load Combinations

	Description	Solve	PDelta	S...	BLC	Fa...	BLC	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1	Distributed load-y a...	Yes	Y		1	1																		
2	Distributed load-X ...	Yes	Y		2	1																		
3	Point load applied ...	Yes	Y		3	1																		
4	Point load applied ...	Yes	Y		4	1																		

Load Combination Design

	Description	ASIF	CD	ABIF	Service	Hot Rolled	Cold For...	Wood	Concrete	Masonry	Footings	Aluminum	Connecti...
1	Distributed l...					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Distributed l...					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Point load a...					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	Point load a...					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Joint Loads and Enforced Displacements (BLC 3 : Point load applied at the corner)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Z	.2

Envelope Joint Reactions

	Joint		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
1	N1	max	0	3	.105	1	0	1	0	1	0	1	-.001	2
2		min	-.001	1	.008	2	-.181	3	-.579	3	0	1	-.023	1
3	N3	max	0	2	.309	1	0	1	0	1	.042	4	-.001	2
4		min	0	1	.015	2	-.238	2	-.773	2	-.04	3	-.023	1
5	N5	max	.001	1	.118	1	.008	3	.007	3	0	1	-.001	2
6		min	0	2	.008	3	-.138	2	-.509	2	-.063	2	-.023	1
7	Totals:	max	0	2	.531	1	0	1						
8		min	0	1	.031	3	-.5	2						

Envelope Member Section Forces

	Member	Sec		Axial[k]	LC	y Shear[k]	LC	z Shear[k]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
1	M1	1	max	.105	1	.001	1	0	1	0	1	.579	3	-.001	2
2			min	.008	2	0	3	-.181	3	0	1	0	1	-.023	1
3		2	max	.103	1	0	1	0	1	0	1	.421	3	0	2

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[k]	LC	y Shear[k]	LC	z Shear[k]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
4			min	.006	2	0	3	-.181	3	0	1	0	1	-.024	1
5		3	max	.102	1	0	2	0	1	0	1	.262	3	0	2
6			min	.005	2	-.002	1	-.181	3	0	1	0	1	-.023	1
7		4	max	.1	1	0	2	0	1	0	1	.141	2	0	3
8			min	.003	2	-.013	1	-.181	3	0	1	0	1	-.016	1
9		5	max	.099	1	0	3	0	1	0	1	.034	4	0	1
10			min	.002	2	-.02	1	-.181	3	0	1	-.055	3	0	1
11	M2	1	max	.02	1	.019	3	-.002	2	.055	3	0	1	0	1
12			min	0	3	-.125	2	-.099	1	-.034	4	0	1	0	1
13		2	max	.02	1	.019	3	0	2	.055	3	-.001	2	.117	2
14			min	0	3	-.062	2	-.035	1	-.034	4	-.084	1	-.024	3
15		3	max	.02	1	.019	3	.028	1	.055	3	-.002	2	.156	2
16			min	0	3	0	4	0	3	-.034	4	-.088	1	-.047	3
17		4	max	.02	1	.063	2	.092	1	.055	3	0	2	.116	2
18			min	0	3	0	4	.002	3	-.034	4	-.013	1	-.071	3
19		5	max	.02	1	.125	2	.156	1	.055	3	.142	1	.003	4
20			min	0	3	0	4	.003	3	-.034	4	.002	3	-.095	3
21	M3	1	max	.298	1	.033	1	0	1	.042	4	.059	2	0	1
22			min	.005	2	0	2	-.238	2	-.04	3	-.033	3	0	2
23		2	max	.301	1	.008	1	0	1	.042	4	0	1	0	3
24			min	.008	2	0	2	-.238	2	-.04	3	-.149	2	-.02	1
25		3	max	.303	1	0	3	0	1	.042	4	0	1	0	2
26			min	.01	2	0	1	-.238	2	-.04	3	-.357	2	-.023	1
27		4	max	.306	1	0	3	0	1	.042	4	0	1	0	2
28			min	.013	2	0	1	-.238	2	-.04	3	-.565	2	-.023	1
29		5	max	.309	1	0	2	0	1	.042	4	0	1	-.001	2
30			min	.015	2	0	1	-.238	2	-.04	3	-.773	2	-.023	1
31	M4	1	max	.052	1	0	1	-.003	2	.027	2	.143	1	0	2
32			min	.001	3	-.112	2	-.143	1	-.006	4	.003	2	-.054	3
33		2	max	.052	1	0	1	-.001	2	.027	2	.004	1	.102	2
34			min	.001	3	-.101	4	-.079	1	-.006	4	0	2	-.044	3
35		3	max	.052	1	.099	4	0	2	.027	2	0	2	.214	4
36			min	.001	3	-.008	3	-.016	1	-.006	4	-.055	1	-.033	3
37		4	max	.052	1	.099	4	.048	1	.027	2	0	2	.09	4
38			min	.001	3	-.008	3	0	3	-.006	4	-.035	1	-.023	3
39		5	max	.052	1	.138	2	.111	1	.027	2	.065	1	0	1
40			min	.001	3	-.008	3	.002	3	-.006	4	0	3	-.063	2
41	M5	1	max	.111	1	-.001	3	.008	3	0	1	.006	4	0	3
42			min	.002	3	-.051	1	-.138	2	-.063	2	-.027	2	-.065	1
43		2	max	.113	1	0	3	.008	3	0	1	0	1	0	3
44			min	.003	3	-.019	1	-.138	2	-.063	2	-.147	2	-.029	1
45		3	max	.115	1	0	3	.008	3	0	1	0	1	0	2
46			min	.005	3	0	1	-.138	2	-.063	2	-.268	2	-.021	1
47		4	max	.116	1	.002	1	.008	3	0	1	0	1	0	2
48			min	.007	3	0	2	-.138	2	-.063	2	-.389	2	-.022	1
49		5	max	.118	1	.001	1	.008	3	0	1	.007	3	-.001	2
50			min	.008	3	0	2	-.138	2	-.063	2	-.509	2	-.023	1
51	M8	1	max	0	3	0	1	0	3	0	3	0	1	0	1
52			min	0	1	0	2	0	2	0	4	0	1	0	1
53		2	max	0	3	0	1	0	3	0	3	0	3	0	2
54			min	0	1	0	2	0	2	0	4	0	2	0	1
55		3	max	0	3	0	1	0	3	0	3	0	3	0	2
56			min	0	1	0	2	0	2	0	4	0	2	0	1
57		4	max	0	3	0	1	0	3	0	3	0	3	0	2
58			min	0	1	0	2	0	2	0	4	0	2	0	1
59		5	max	0	3	0	1	0	3	0	3	0	3	0	2
60			min	0	1	0	2	0	2	0	4	0	2	0	1

1010

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[k]	LC	y Shear[k]	LC	z Shear[k]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
61	M9	1	max	0	3	0	1	0	3	0	3	0	1	0	1
62			min	-.003	1	0	2	0	2	0	4	0	1	0	1
63		2	max	0	3	0	1	0	3	0	3	0	3	0	2
64			min	-.003	1	0	2	0	2	0	4	0	2	0	1
65		3	max	0	3	0	1	0	3	0	3	0	3	0	2
66			min	-.003	1	0	2	0	2	0	4	0	2	0	1
67		4	max	0	3	0	1	0	3	0	3	0	3	0	2
68			min	-.003	1	0	2	0	2	0	4	0	2	0	1
69		5	max	0	3	0	1	0	3	0	3	0	3	0	2
70			min	-.003	1	0	2	0	2	0	4	0	2	0	1
71	M10	1	max	0	3	0	1	0	3	0	3	0	1	0	1
72			min	-.004	1	0	2	0	2	0	4	0	1	0	1
73		2	max	0	3	0	1	0	3	0	3	0	3	0	2
74			min	-.004	1	0	2	0	2	0	4	0	2	0	1
75		3	max	0	3	0	1	0	3	0	3	0	3	0	2
76			min	-.004	1	0	2	0	2	0	4	0	2	0	1
77		4	max	0	3	0	1	0	3	0	3	0	3	0	2
78			min	-.004	1	0	2	0	2	0	4	0	2	0	1
79		5	max	0	3	0	1	0	3	0	3	0	3	0	2
80			min	-.004	1	0	2	0	2	0	4	0	2	0	1
81	M11	1	max	0	3	0	1	0	3	0	3	0	1	0	1
82			min	-.004	1	0	2	0	2	0	2	0	1	0	1
83		2	max	0	3	0	1	0	3	0	3	0	3	0	2
84			min	-.004	1	0	2	0	2	0	2	0	2	0	1
85		3	max	0	3	0	1	0	3	0	3	0	3	0	2
86			min	-.004	1	0	2	0	2	0	2	0	2	0	1
87		4	max	0	3	0	1	0	3	0	3	0	3	0	2
88			min	-.004	1	0	2	0	2	0	2	0	2	0	1
89		5	max	0	3	0	1	0	3	0	3	0	3	0	2
90			min	-.004	1	0	2	0	2	0	2	0	2	0	1
91	M12	1	max	0	3	0	1	0	3	0	3	0	1	0	1
92			min	-.003	1	0	2	0	2	0	2	0	1	0	1
93		2	max	0	3	0	1	0	3	0	3	0	3	0	2
94			min	-.003	1	0	2	0	2	0	2	0	2	0	1
95		3	max	0	3	0	1	0	3	0	3	0	3	0	2
96			min	-.003	1	0	2	0	2	0	2	0	2	0	1
97		4	max	0	3	0	1	0	3	0	3	0	3	0	2
98			min	-.003	1	0	2	0	2	0	2	0	2	0	1
99		5	max	0	3	0	1	0	3	0	3	0	3	0	2
100			min	-.003	1	0	2	0	2	0	2	0	2	0	1
101	M13	1	max	0	3	0	1	0	4	0	3	0	1	0	1
102			min	-.003	1	0	2	0	2	0	2	0	1	0	1
103		2	max	0	3	0	1	0	4	0	3	0	4	0	2
104			min	-.003	1	0	2	0	2	0	2	0	2	0	1
105		3	max	0	3	0	1	0	4	0	3	0	4	0	2
106			min	-.003	1	0	2	0	2	0	2	0	2	0	1
107		4	max	0	3	0	1	0	4	0	3	0	4	0	2
108			min	-.003	1	0	2	0	2	0	2	0	2	0	1
109		5	max	0	3	0	1	0	4	0	3	0	4	0	2
110			min	-.003	1	0	2	0	2	0	2	0	2	0	1
111	M14	1	max	0	3	0	1	0	4	0	3	0	1	0	1
112			min	-.002	1	0	2	0	2	0	2	0	1	0	1
113		2	max	0	3	0	1	0	4	0	3	0	4	0	2
114			min	-.002	1	0	2	0	2	0	2	0	2	0	1
115		3	max	0	3	0	1	0	4	0	3	0	4	0	2
116			min	-.002	1	0	2	0	2	0	2	0	2	0	1
117		4	max	0	3	0	1	0	4	0	3	0	4	0	2

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[k]	LC	y Shear[k]	LC	z Shear[k]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
118			min	-.002	1	0	2	0	2	0	2	0	2	0	1
119		5	max	0	3	0	1	0	4	0	3	0	4	0	2
120			min	-.002	1	0	2	0	2	0	2	0	2	0	1
121	M15	1	max	0	2	0	1	0	4	0	3	0	1	0	1
122			min	0	1	0	2	0	2	0	2	0	1	0	1
123		2	max	0	2	0	1	0	4	0	3	0	4	0	2
124			min	0	1	0	2	0	2	0	2	0	2	0	1
125		3	max	0	2	0	1	0	4	0	3	0	4	0	2
126			min	0	1	0	2	0	2	0	2	0	2	0	1
127		4	max	0	2	0	1	0	4	0	3	0	4	0	2
128			min	0	1	0	2	0	2	0	2	0	2	0	1
129		5	max	0	2	0	1	0	4	0	3	0	4	0	2
130			min	0	1	0	2	0	2	0	2	0	2	0	1
131	M16	1	max	0	2	0	1	0	4	0	3	0	1	0	1
132			min	0	1	0	2	0	2	0	2	0	1	0	1
133		2	max	0	2	0	1	0	4	0	3	0	4	0	2
134			min	0	1	0	2	0	2	0	2	0	2	0	1
135		3	max	0	2	0	1	0	4	0	3	0	4	0	2
136			min	0	1	0	2	0	2	0	2	0	2	0	1
137		4	max	0	2	0	1	0	4	0	3	0	4	0	2
138			min	0	1	0	2	0	2	0	2	0	2	0	1
139		5	max	0	2	0	1	0	4	0	3	0	4	0	2
140			min	0	1	0	2	0	2	0	2	0	2	0	1
141	M17	1	max	0	2	0	1	0	4	0	3	0	1	0	1
142			min	0	1	0	2	0	3	0	2	0	1	0	1
143		2	max	0	2	0	1	0	4	0	3	0	4	0	2
144			min	0	1	0	2	0	3	0	2	0	3	0	1
145		3	max	0	2	0	1	0	4	0	3	0	4	0	2
146			min	0	1	0	2	0	3	0	2	0	3	0	1
147		4	max	0	2	0	1	0	4	0	3	0	4	0	2
148			min	0	1	0	2	0	3	0	2	0	3	0	1
149		5	max	0	2	0	1	0	4	0	3	0	4	0	2
150			min	0	1	0	2	0	3	0	2	0	3	0	1
151	M18	1	max	0	2	0	1	0	4	0	3	0	1	0	1
152			min	0	1	0	2	0	3	0	2	0	1	0	1
153		2	max	0	2	0	1	0	4	0	3	0	4	0	2
154			min	0	1	0	2	0	3	0	2	0	3	0	1
155		3	max	0	2	0	1	0	4	0	3	0	4	0	2
156			min	0	1	0	2	0	3	0	2	0	3	0	1
157		4	max	0	2	0	1	0	4	0	3	0	4	0	2
158			min	0	1	0	2	0	3	0	2	0	3	0	1
159		5	max	0	2	0	1	0	4	0	3	0	4	0	2
160			min	0	1	0	2	0	3	0	2	0	3	0	1
161	M19	1	max	0	1	0	1	0	4	0	3	0	1	0	1
162			min	0	3	0	2	0	3	0	2	0	1	0	1
163		2	max	0	1	0	1	0	4	0	3	0	4	0	2
164			min	0	3	0	2	0	3	0	2	0	3	0	1
165		3	max	0	1	0	1	0	4	0	3	0	4	0	2
166			min	0	3	0	2	0	3	0	2	0	3	0	1
167		4	max	0	1	0	1	0	4	0	3	0	4	0	2
168			min	0	3	0	2	0	3	0	2	0	3	0	1
169		5	max	0	1	0	1	0	4	0	3	0	4	0	2
170			min	0	3	0	2	0	3	0	2	0	3	0	1
171	M32	1	max	0	2	0	1	0	2	0	2	0	3	0	1
172			min	-.008	1	0	2	0	3	0	4	0	2	0	2
173		2	max	0	2	0	1	0	2	0	2	0	3	0	1
174			min	-.008	1	0	2	0	3	0	4	0	4	0	2

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[k]	LC	y Shear[k]	LC	z Shear[k]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
175		3	max	0	2	0	1	0	2	0	2	0	3	0	2
176			min	-.008	1	0	2	0	3	0	4	0	4	0	1
177		4	max	0	2	0	1	0	2	0	2	0	3	0	2
178			min	-.008	1	0	2	0	3	0	4	0	4	0	1
179		5	max	0	2	0	1	0	2	0	2	0	3	0	2
180			min	-.008	1	0	2	0	3	0	4	0	4	0	1
181	M33	1	max	0	2	0	1	0	2	0	2	0	3	0	1
182			min	-.012	1	0	2	0	3	0	4	0	4	0	2
183		2	max	0	2	0	1	0	2	0	2	0	3	0	1
184			min	-.012	1	0	2	0	3	0	4	0	4	0	2
185		3	max	0	2	0	1	0	2	0	2	0	3	0	3
186			min	-.012	1	0	2	0	3	0	4	0	4	0	1
187		4	max	0	2	0	1	0	2	0	2	0	3	0	2
188			min	-.012	1	0	2	0	3	0	4	0	4	0	1
189		5	max	0	2	0	1	0	2	0	2	0	1	0	2
190			min	-.012	1	0	2	0	3	0	4	0	4	0	1
191	M34	1	max	0	2	0	1	0	2	0	2	0	3	0	1
192			min	-.012	1	0	2	0	3	0	4	0	4	0	2
193		2	max	0	2	0	1	0	2	0	2	0	3	0	1
194			min	-.012	1	0	2	0	3	0	4	0	4	0	2
195		3	max	0	2	0	1	0	2	0	2	0	3	0	1
196			min	-.012	1	0	2	0	3	0	4	0	4	0	2
197		4	max	0	2	0	1	0	2	0	2	0	3	0	2
198			min	-.012	1	0	2	0	3	0	4	0	4	0	1
199		5	max	0	2	0	1	0	2	0	2	0	1	0	2
200			min	-.012	1	0	2	0	3	0	4	0	4	0	1
201	M35	1	max	0	3	0	1	0	4	0	2	0	3	0	1
202			min	-.009	1	0	2	0	3	0	4	0	4	0	2
203		2	max	0	3	0	1	0	4	0	2	0	3	0	1
204			min	-.009	1	0	2	0	3	0	4	0	4	0	2
205		3	max	0	3	0	1	0	4	0	2	0	3	0	1
206			min	-.009	1	0	2	0	3	0	4	0	4	0	2
207		4	max	0	3	0	1	0	4	0	2	0	3	0	2
208			min	-.009	1	0	2	0	3	0	4	0	4	0	1
209		5	max	0	3	0	1	0	4	0	2	0	1	0	2
210			min	-.009	1	0	2	0	3	0	4	0	4	0	1
211	M36	1	max	0	3	0	1	0	4	0	2	0	3	0	1
212			min	-.006	1	0	2	0	3	0	4	0	4	0	2
213		2	max	0	3	0	1	0	4	0	2	0	3	0	1
214			min	-.006	1	0	2	0	3	0	4	0	4	0	2
215		3	max	0	3	0	1	0	4	0	2	0	3	0	1
216			min	-.006	1	0	2	0	3	0	4	0	4	0	2
217		4	max	0	3	0	1	0	4	0	2	0	1	0	2
218			min	-.006	1	0	2	0	3	0	4	0	2	0	1
219		5	max	0	3	0	1	0	4	0	2	0	1	0	2
220			min	-.006	1	0	2	0	3	0	4	0	2	0	1
221	M37	1	max	0	3	0	1	0	4	0	2	0	3	0	1
222			min	-.004	1	0	2	0	3	0	4	0	4	0	2
223		2	max	0	3	0	1	0	4	0	2	0	3	0	1
224			min	-.004	1	0	2	0	3	0	4	0	4	0	2
225		3	max	0	3	0	1	0	4	0	2	0	3	0	1
226			min	-.004	1	0	2	0	3	0	4	0	4	0	2
227		4	max	0	3	0	1	0	4	0	2	0	1	0	2
228			min	-.004	1	0	2	0	3	0	4	0	2	0	1
229		5	max	0	3	0	1	0	4	0	2	0	1	0	2
230			min	-.004	1	0	2	0	3	0	4	0	2	0	1
231	M38	1	max	0	3	0	1	0	4	0	2	0	3	0	1

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[k]	LC	y Shear[k]	LC	z Shear[k]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
232			min	-.002	1	0	2	0	3	0	4	0	4	0	2
233		2	max	0	3	0	1	0	4	0	2	0	3	0	1
234			min	-.002	1	0	2	0	3	0	4	0	4	0	2
235		3	max	0	3	0	1	0	4	0	2	0	3	0	1
236			min	-.002	1	0	2	0	3	0	4	0	4	0	2
237		4	max	0	3	0	1	0	4	0	2	0	1	0	2
238			min	-.002	1	0	2	0	3	0	4	0	2	0	1
239		5	max	0	3	0	1	0	4	0	2	0	1	0	2
240			min	-.002	1	0	2	0	3	0	4	0	2	0	1
241	M39	1	max	0	3	0	1	0	4	0	2	0	3	0	1
242			min	0	1	0	2	0	3	0	4	0	4	0	2
243		2	max	0	3	0	1	0	4	0	2	0	3	0	1
244			min	0	1	0	2	0	3	0	4	0	4	0	2
245		3	max	0	3	0	1	0	4	0	2	0	3	0	1
246			min	0	1	0	2	0	3	0	4	0	4	0	3
247		4	max	0	3	0	1	0	4	0	2	0	1	0	2
248			min	0	1	0	2	0	3	0	4	0	2	0	1
249		5	max	0	3	0	1	0	4	0	2	0	1	0	2
250			min	0	1	0	2	0	3	0	4	0	2	0	1
251	M40	1	max	0	3	0	1	0	4	0	2	0	3	0	1
252			min	0	1	0	2	0	3	0	4	0	4	0	2
253		2	max	0	3	0	1	0	4	0	2	0	3	0	1
254			min	0	1	0	2	0	3	0	4	0	4	0	2
255		3	max	0	3	0	1	0	4	0	2	0	3	0	1
256			min	0	1	0	2	0	3	0	4	0	4	0	3
257		4	max	0	3	0	1	0	4	0	2	0	1	0	2
258			min	0	1	0	2	0	3	0	4	0	2	0	1
259		5	max	0	3	0	1	0	4	0	2	0	1	0	2
260			min	0	1	0	2	0	3	0	4	0	2	0	1
261	M41	1	max	0	1	0	1	0	4	0	2	0	3	0	1
262			min	0	2	0	2	0	2	0	4	0	4	0	2
263		2	max	0	1	0	1	0	4	0	2	0	3	0	1
264			min	0	2	0	2	0	2	0	4	0	4	0	2
265		3	max	0	1	0	1	0	4	0	2	0	3	0	1
266			min	0	2	0	2	0	2	0	4	0	4	0	3
267		4	max	0	1	0	1	0	4	0	2	0	1	0	2
268			min	0	2	0	2	0	2	0	4	0	2	0	1
269		5	max	0	1	0	1	0	4	0	2	0	1	0	2
270			min	0	2	0	2	0	2	0	4	0	2	0	1
271	M42	1	max	0	1	0	1	0	4	0	2	0	3	0	1
272			min	0	2	0	2	0	2	0	4	0	4	0	2
273		2	max	0	1	0	1	0	4	0	2	0	3	0	1
274			min	0	2	0	2	0	2	0	4	0	4	0	2
275		3	max	0	1	0	1	0	4	0	2	0	3	0	2
276			min	0	2	0	2	0	2	0	4	0	4	0	1
277		4	max	0	1	0	1	0	4	0	2	0	1	0	2
278			min	0	2	0	2	0	2	0	4	0	2	0	1
279		5	max	0	1	0	1	0	4	0	2	0	1	0	2
280			min	0	2	0	2	0	2	0	4	0	2	0	1
281	M43	1	max	0	1	0	1	0	4	0	2	0	3	0	1
282			min	0	2	0	2	0	2	0	4	0	4	0	2
283		2	max	0	1	0	1	0	4	0	2	0	3	0	1
284			min	0	2	0	2	0	2	0	4	0	4	0	2
285		3	max	0	1	0	1	0	4	0	2	0	3	0	2
286			min	0	2	0	2	0	2	0	4	0	4	0	1
287		4	max	0	1	0	1	0	4	0	2	0	1	0	2
288			min	0	2	0	2	0	2	0	4	0	2	0	1

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[k]	LC	y Shear[k]	LC	z Shear[k]	LC	Torque[k...	LC	y-y Mom...	LC	z-z Mom...	LC
289		5	max	0	1	0	1	0	4	0	2	0	1	0	2
290			min	0	2	0	2	0	2	0	4	0	2	0	1

Envelope Member Section Deflections

	Member	Sec		x [in]	LC	y [in]	LC	z [in]	LC	x Rotate [r...	LC	(n) L/y Ratio	LC	(n) L/z Ratio	LC
1	M1	1	max	0	1	0	1	0	1	0	1	NC	1	NC	1
2			min	0	1	0	1	0	1	0	1	NC	1	NC	1
3		2	max	0	2	.002	1	.056	3	0	1	NC	1	NC	1
4			min	0	1	0	2	0	1	0	1	NC	1	750.186	3
5		3	max	0	2	.01	1	.2	3	0	1	NC	2	NC	1
6			min	0	1	0	2	0	1	0	1	4283.386	1	210.465	3
7		4	max	0	2	.022	1	.398	3	0	1	NC	2	NC	1
8			min	0	1	0	2	0	1	0	1	1910.93	1	105.602	3
9		5	max	0	2	.037	1	.617	3	0	1	NC	2	NC	1
10			min	0	1	.001	2	0	1	0	1	1122.702	1	68.018	3
11	M2	1	max	-.001	2	.617	3	0	1	2.08e-2	3	NC	1	NC	1
12			min	-.037	1	0	1	0	2	0	1	131.641	3	NC	1
13		2	max	-.001	2	.681	2	.108	1	2.199e-2	2	NC	1	NC	2
14			min	-.037	1	0	1	.002	2	0	1	187.165	3	561.805	1
15		3	max	-.001	2	.78	2	.132	1	2.411e-2	2	NC	1	NC	2
16			min	-.038	1	0	1	.002	2	0	1	309.487	3	457.139	1
17		4	max	-.001	2	.826	2	.07	1	2.622e-2	2	NC	1	NC	2
18			min	-.038	1	0	1	.001	2	0	1	712.791	3	871.464	1
19		5	max	-.001	2	.832	2	.002	1	2.833e-2	2	NC	1	NC	1
20			min	-.038	1	0	1	0	2	0	1	NC	1	NC	1
21	M3	1	max	.002	1	.038	1	0	1	4.715e-3	4	NC	2	NC	1
22			min	0	2	.001	2	-.832	2	-4.561e-3	3	1116.516	1	50.465	2
23		2	max	.001	1	.022	1	0	1	3.534e-3	4	NC	2	NC	1
24			min	0	2	0	2	-.534	2	-3.42e-3	3	1944.421	1	78.606	2
25		3	max	0	1	.01	1	0	1	2.355e-3	4	NC	2	NC	1
26			min	0	2	0	2	-.267	2	-2.279e-3	3	4385.414	1	157.07	2
27		4	max	0	1	.002	1	0	1	1.177e-3	4	NC	1	NC	1
28			min	0	2	0	2	-.075	2	-1.139e-3	3	NC	1	561.108	2
29		5	max	0	1	0	1	0	1	0	1	NC	1	NC	1
30			min	0	1	0	1	0	1	0	1	NC	1	NC	1
31	M4	1	max	-.001	2	.832	2	.002	1	2.833e-2	2	NC	1	NC	1
32			min	-.038	1	0	1	0	2	0	1	380.368	3	NC	1
33		2	max	-.001	2	.823	2	.026	1	2.656e-2	2	NC	1	NC	2
34			min	-.038	1	0	1	0	3	0	1	609.086	3	2411.818	1
35		3	max	-.001	2	.779	2	.062	1	2.479e-2	2	NC	1	NC	2
36			min	-.038	1	0	1	.001	2	0	1	639.944	4	979.543	1
37		4	max	-.001	2	.693	2	.047	1	2.302e-2	2	NC	1	NC	2
38			min	-.038	1	0	1	0	2	0	1	951.274	4	1310.801	1
39		5	max	-.001	2	.584	2	0	1	2.125e-2	2	NC	1	NC	1
40			min	-.038	1	0	1	0	3	0	1	NC	1	NC	1
41	M5	1	max	0	1	.038	1	0	1	0	1	NC	2	NC	1
42			min	0	3	.001	2	-.584	2	-7.117e-3	2	1100.772	1	71.944	2
43		2	max	0	1	.021	1	0	3	0	1	NC	2	NC	1
44			min	0	3	0	2	-.367	2	-5.336e-3	2	2046.625	1	114.533	2
45		3	max	0	1	.009	1	.001	3	0	1	NC	2	NC	1
46			min	0	3	0	2	-.18	2	-3.556e-3	2	4524.971	1	232.925	2
47		4	max	0	1	.002	1	0	3	0	1	NC	1	NC	1
48			min	0	3	0	2	-.05	2	-1.778e-3	2	NC	1	844.831	2
49		5	max	0	1	0	1	0	1	0	1	NC	1	NC	1
50			min	0	1	0	1	0	1	0	1	NC	1	NC	1

Envelope Member Section Deflections (Continued)

	Member	Sec		x [in]	LC	y [in]	LC	z [in]	LC	x Rotate [r...	LC	(n) L/y Ratio	LC	(n) L/z Ratio	LC
51	M8	1	max	-.001	2	0	2	.546	3	2.098e-2	3	NC	1	NC	1
52			min	-.032	1	0	1	0	1	0	1	NC	1	147.826	3
53		2	max	-.001	2	-.255	2	.572	2	2.18e-2	2	235.066	2	NC	1
54			min	-.032	1	-.267	1	0	1	0	1	225.527	1	209.547	3
55		3	max	-.001	2	-.303	2	.655	2	2.403e-2	2	198.248	2	NC	1
56			min	-.032	1	-.321	1	0	1	0	1	187.544	1	344.803	3
57		4	max	-.001	2	-.142	2	.714	2	2.626e-2	2	422.292	2	NC	1
58			min	-.032	1	-.159	1	0	1	0	1	381.688	1	312.295	4
59		5	max	-.001	2	0	2	.735	2	2.849e-2	2	NC	1	NC	1
60			min	-.032	1	-.002	1	0	1	0	1	NC	1	233.592	4
61	M9	1	max	-.001	2	0	2	.475	3	2.084e-2	3	NC	1	NC	1
62			min	-.027	1	0	1	0	1	0	1	NC	1	169	3
63		2	max	-.001	2	-.255	2	.494	2	2.132e-2	2	235.062	2	NC	1
64			min	-.027	1	-.266	1	0	1	0	1	225.993	1	238.51	3
65		3	max	-.001	2	-.303	2	.568	2	2.362e-2	2	198.243	2	NC	1
66			min	-.027	1	-.32	1	0	1	0	1	188.06	1	389.664	3
67		4	max	-.001	2	-.142	2	.62	2	2.592e-2	2	422.273	2	NC	1
68			min	-.027	1	-.158	1	0	1	0	1	383.561	1	359.815	4
69		5	max	-.001	2	0	2	.639	2	2.823e-2	2	NC	1	NC	1
70			min	-.027	1	-.001	1	0	1	0	1	NC	1	266.672	4
71	M10	1	max	0	2	0	2	.405	3	2.038e-2	3	NC	1	NC	1
72			min	-.022	1	0	1	0	1	0	1	NC	1	197.262	3
73		2	max	0	2	-.255	2	.419	2	2.057e-2	2	235.068	2	NC	1
74			min	-.022	1	-.265	1	0	1	0	1	226.685	1	276.772	3
75		3	max	0	2	-.303	2	.483	2	2.289e-2	2	198.25	2	NC	1
76			min	-.022	1	-.319	1	0	1	0	1	188.827	1	447.959	3
77		4	max	0	2	-.142	2	.528	2	2.521e-2	2	422.301	2	NC	1
78			min	-.022	1	-.156	1	0	1	0	1	386.363	1	424.738	4
79		5	max	0	2	0	2	.544	2	2.753e-2	2	NC	1	NC	1
80			min	-.022	1	-.001	1	0	1	0	1	NC	1	310.866	4
81	M11	1	max	0	2	0	2	.336	3	1.958e-2	3	NC	1	NC	1
82			min	-.018	1	0	1	0	1	0	1	NC	1	236.011	3
83		2	max	0	2	-.255	2	.347	2	1.954e-2	2	235.082	2	NC	1
84			min	-.018	1	-.264	1	0	1	0	1	227.512	1	328.597	3
85		3	max	0	2	-.303	2	.401	2	2.183e-2	2	198.266	2	NC	1
86			min	-.018	1	-.317	1	0	1	0	1	189.746	1	525.427	3
87		4	max	0	2	-.142	2	.438	2	2.412e-2	2	422.363	2	NC	1
88			min	-.018	1	-.155	1	0	1	0	1	389.745	1	516.265	4
89		5	max	0	2	0	2	.452	2	2.64e-2	2	NC	1	NC	1
90			min	-.018	1	-.001	1	0	1	0	1	NC	1	371.491	4
91	M12	1	max	0	2	0	2	.272	3	1.846e-2	3	NC	1	NC	1
92			min	-.014	1	0	1	0	1	0	1	NC	1	291.044	3
93		2	max	0	2	-.255	2	.279	2	1.824e-2	2	235.102	2	NC	1
94			min	-.014	1	-.263	1	0	1	0	1	228.408	1	401.108	3
95		3	max	0	2	-.303	2	.323	2	2.044e-2	2	198.288	2	NC	1
96			min	-.014	1	-.315	1	0	1	0	1	190.745	1	631.386	3
97		4	max	0	2	-.142	2	.353	2	2.265e-2	2	422.451	2	NC	1
98			min	-.014	1	-.153	1	0	1	0	1	393.445	1	650.906	4
99		5	max	0	2	0	2	.364	2	2.485e-2	2	NC	1	NC	1
100			min	-.014	1	-.001	1	0	1	0	1	NC	1	457.618	4
101	M13	1	max	0	2	0	2	.211	3	1.701e-2	3	NC	1	NC	1
102			min	-.01	1	0	1	0	1	0	1	NC	1	372.924	3
103		2	max	0	2	-.255	2	.216	2	1.666e-2	2	235.126	2	NC	1
104			min	-.01	1	-.262	1	0	1	0	1	229.332	1	506.953	3
105		3	max	0	2	-.303	2	.25	2	1.873e-2	2	198.315	2	NC	1
106			min	-.01	1	-.313	1	0	1	0	1	191.777	1	781.827	3
107		4	max	0	2	-.142	2	.274	2	2.08e-2	2	422.56	2	NC	1

Envelope Member Section Deflections (Continued)

	Member	Sec		x [in]	LC	y [in]	LC	z [in]	LC	x Rotate [r...	LC	(n) L/y Ratio	LC	(n) L/z Ratio	LC
108			min	-.01	1	-.152	1	0	1	0	1	397.305	1	860.796	4
109		5	max	0	2	0	2	.283	2	2.286e-2	2	NC	1	NC	1
110			min	-.01	1	0	1	0	1	0	1	NC	1	585.774	4
111	M14	1	max	0	2	0	2	.156	3	1.523e-2	3	NC	1	NC	1
112			min	-.007	1	0	1	0	1	0	1	NC	1	502.623	3
113		2	max	0	2	-.255	2	.159	2	1.48e-2	2	235.153	2	NC	1
114			min	-.007	1	-.261	1	0	1	0	1	230.264	1	670.432	3
115		3	max	0	2	-.303	2	.185	2	1.668e-2	2	198.347	2	NC	1
116			min	-.007	1	-.312	1	0	1	0	1	192.821	1	1006.209	3
117		4	max	0	2	-.142	2	.203	2	1.857e-2	2	422.685	2	NC	1
118			min	-.007	1	-.15	1	0	1	0	1	401.245	1	1215.803	4
119		5	max	0	2	0	2	.209	2	2.045e-2	2	NC	1	NC	1
120			min	-.007	1	0	1	0	1	0	1	NC	1	788.764	4
121	M15	1	max	0	2	0	2	.107	3	1.313e-2	3	NC	1	NC	1
122			min	-.005	1	0	1	0	1	0	1	NC	1	NC	1
123		2	max	0	2	-.255	2	.109	2	1.267e-2	2	235.185	2	NC	1
124			min	-.005	1	-.26	1	0	1	0	1	231.198	1	7907.757	4
125		3	max	0	2	-.302	2	.127	2	1.431e-2	2	198.383	2	NC	1
126			min	-.005	1	-.31	1	0	1	0	1	193.871	1	3447.38	4
127		4	max	0	2	-.142	2	.139	2	1.596e-2	2	422.828	2	NC	1
128			min	-.005	1	-.149	1	0	1	0	1	405.24	1	1893.9	4
129		5	max	0	2	0	2	.144	2	1.761e-2	2	NC	1	NC	1
130			min	-.005	1	0	1	0	1	0	1	NC	1	1139.7	4
131	M16	1	max	0	2	0	2	.067	3	1.07e-2	3	NC	1	NC	1
132			min	-.003	1	0	1	0	1	0	1	NC	1	NC	1
133		2	max	0	2	-.255	2	.068	2	1.026e-2	2	235.22	2	NC	1
134			min	-.003	1	-.259	1	0	1	0	1	232.135	1	NC	1
135		3	max	0	2	-.302	2	.079	2	1.162e-2	2	198.423	2	NC	1
136			min	-.003	1	-.308	1	0	1	0	1	194.927	1	7485.878	4
137		4	max	0	2	-.142	2	.086	2	1.297e-2	2	422.988	2	NC	1
138			min	-.003	1	-.147	1	0	1	0	1	409.294	1	3477.352	4
139		5	max	0	2	0	2	.089	2	1.433e-2	2	NC	1	NC	1
140			min	-.003	1	0	1	0	1	0	1	NC	1	1830.822	4
141	M17	1	max	0	2	0	2	.034	3	7.945e-3	3	NC	1	NC	1
142			min	-.001	1	0	1	0	1	0	1	NC	1	NC	1
143		2	max	0	2	-.255	2	.035	2	7.571e-3	2	235.259	2	NC	1
144			min	-.001	1	-.258	1	0	1	0	1	233.077	1	NC	1
145		3	max	0	2	-.302	2	.041	2	8.591e-3	2	198.468	2	NC	1
146			min	-.001	1	-.306	1	0	1	0	1	195.991	1	NC	1
147		4	max	0	2	-.142	2	.045	2	9.611e-3	2	423.165	2	NC	1
148			min	-.001	1	-.145	1	0	1	0	1	413.418	1	9047.557	4
149		5	max	0	2	0	2	.046	2	1.063e-2	2	NC	1	NC	1
150			min	-.001	1	0	1	0	1	0	1	NC	1	3516.804	4
151	M18	1	max	0	2	0	2	.012	3	4.862e-3	3	NC	1	NC	1
152			min	0	1	0	1	0	1	0	1	NC	1	NC	1
153		2	max	0	2	-.255	2	.012	2	4.608e-3	2	235.303	2	NC	1
154			min	0	1	-.256	1	0	4	0	1	234.027	1	NC	1
155		3	max	0	2	-.302	2	.015	2	5.238e-3	2	198.517	2	NC	1
156			min	0	1	-.305	1	0	4	0	1	197.066	1	NC	1
157		4	max	0	2	-.142	2	.016	2	5.868e-3	2	423.36	2	NC	1
158			min	0	1	-.144	1	0	1	0	1	417.626	1	NC	1
159		5	max	0	2	0	2	.016	2	6.498e-3	2	NC	1	NC	1
160			min	0	1	0	1	0	1	0	1	NC	1	9797.233	4
161	M19	1	max	0	2	0	2	.001	3	1.45e-3	3	NC	1	NC	1
162			min	0	1	0	1	0	1	0	1	NC	1	NC	1
163		2	max	0	2	-.255	2	.002	3	1.368e-3	2	235.35	2	NC	1
164			min	0	1	-.255	1	0	4	0	1	234.985	1	NC	1

Envelope Member Section Deflections (Continued)

	Member	Sec		x [in]	LC	y [in]	LC	z [in]	LC	x Rotate [r...	LC	(n) L/y Ratio	LC	(n) L/z Ratio	LC
165		3	max	0	2	-.302	2	.002	3	1.558e-3	2	198.57	2	NC	1
166			min	0	1	-.303	1	-.001	4	0	1	198.155	1	NC	1
167		4	max	0	2	-.142	2	.002	3	1.748e-3	2	423.574	2	NC	1
168			min	0	1	-.142	1	0	4	0	1	421.924	1	NC	1
169		5	max	0	2	0	2	.002	2	1.937e-3	2	NC	1	NC	1
170			min	0	1	0	1	0	1	0	1	NC	1	NC	1
171	M32	1	max	-.001	2	0	2	.735	2	2.849e-2	2	NC	1	NC	1
172			min	-.032	1	-.002	1	0	1	0	1	NC	1	434.345	3
173		2	max	-.001	2	-.078	1	.718	2	2.661e-2	2	778.811	1	NC	1
174			min	-.032	1	-.085	2	0	1	0	1	708.14	2	708.091	3
175		3	max	-.001	2	-.151	2	.672	2	2.472e-2	2	397.086	2	NC	1
176			min	-.032	1	-.154	1	0	1	0	1	391.821	1	1023.564	4
177		4	max	-.001	2	-.085	2	.602	2	2.284e-2	2	703.618	2	NC	1
178			min	-.032	1	-.097	1	0	1	0	1	624.95	1	1364.727	4
179		5	max	-.001	2	0	3	.512	2	2.096e-2	2	NC	1	NC	1
180			min	-.031	1	0	1	0	1	0	1	NC	1	NC	1
181	M33	1	max	-.001	2	0	2	.639	2	2.823e-2	2	NC	1	NC	1
182			min	-.027	1	-.001	1	0	1	0	1	NC	1	504.27	3
183		2	max	-.001	2	-.078	1	.624	2	2.627e-2	2	780.422	1	NC	1
184			min	-.027	1	-.085	2	0	1	0	1	708.261	2	840.731	3
185		3	max	-.001	2	-.151	3	.584	2	2.432e-2	2	397.159	3	NC	1
186			min	-.026	1	-.153	1	0	1	0	1	395.826	1	1122.206	4
187		4	max	-.001	2	-.085	2	.522	2	2.236e-2	2	703.843	2	NC	1
188			min	-.026	1	-.095	1	0	1	0	1	639.367	1	1504.085	4
189		5	max	-.001	2	0	3	.442	2	2.041e-2	2	NC	1	NC	1
190			min	-.026	1	0	1	0	1	0	1	NC	1	NC	1
191	M34	1	max	0	2	0	2	.544	2	2.753e-2	2	NC	1	NC	1
192			min	-.022	1	-.001	1	0	1	0	1	NC	1	597.042	3
193		2	max	0	2	-.078	1	.531	2	2.555e-2	2	776.978	1	NC	1
194			min	-.022	1	-.085	2	0	1	0	1	708.26	2	1024.576	3
195		3	max	0	2	-.151	3	.498	2	2.357e-2	2	397.86	1	NC	1
196			min	-.022	1	-.152	1	0	1	0	1	397.194	2	1241.825	4
197		4	max	0	2	-.085	2	.445	2	2.16e-2	2	704.006	2	NC	1
198			min	-.021	1	-.093	1	0	1	0	1	649.776	1	1673.028	4
199		5	max	0	2	0	3	.373	2	1.962e-2	2	NC	1	NC	1
200			min	-.021	1	0	1	0	3	0	1	NC	1	NC	1
201	M35	1	max	0	2	0	2	.452	2	2.64e-2	2	NC	1	NC	1
202			min	-.018	1	-.001	1	0	1	0	1	NC	1	723.827	3
203		2	max	0	2	-.079	1	.442	2	2.445e-2	2	770.508	1	NC	1
204			min	-.017	1	-.085	2	0	1	0	1	708.176	2	1290.255	3
205		3	max	0	2	-.151	3	.415	2	2.249e-2	2	398.599	1	NC	1
206			min	-.017	1	-.151	1	0	1	0	1	397.205	2	1389.912	4
207		4	max	0	2	-.085	2	.371	2	2.053e-2	2	704.141	2	NC	1
208			min	-.017	1	-.092	1	0	1	0	1	657.376	1	1882.12	4
209		5	max	0	2	0	3	.308	2	1.858e-2	2	NC	1	NC	1
210			min	-.017	1	0	1	0	3	0	1	NC	1	NC	1
211	M36	1	max	0	2	0	2	.364	2	2.485e-2	2	NC	1	NC	1
212			min	-.014	1	-.001	1	0	1	0	1	NC	1	903.682	3
213		2	max	0	2	-.08	1	.357	2	2.296e-2	2	762.603	1	NC	1
214			min	-.014	1	-.085	2	0	1	0	1	708.036	2	1696.069	3
215		3	max	0	2	-.151	3	.337	2	2.107e-2	2	398.623	1	NC	1
216			min	-.013	1	-.151	1	0	1	0	1	397.204	2	1578.012	4
217		4	max	0	2	-.085	2	.301	2	1.917e-2	2	704.273	2	NC	1
218			min	-.013	1	-.091	1	0	1	0	1	663.343	1	2147.635	4
219		5	max	0	2	0	3	.247	2	1.728e-2	2	NC	1	NC	1
220			min	-.013	1	0	1	0	3	0	1	NC	1	NC	1
221	M37	1	max	0	2	0	2	.283	2	2.286e-2	2	NC	1	NC	1

Envelope Member Section Deflections (Continued)

	Member	Sec		x [in]	LC	y [in]	LC	z [in]	LC	x Rotate [r...	LC	(n) L/y Ratio	LC	(n) L/z Ratio	LC
222			min	-.01	1	0	1	0	1	0	1	NC	1	1171.387	3
223		2	max	0	2	-.08	1	.278	2	2.108e-2	2	754.259	1	NC	1
224			min	-.01	1	-.085	2	0	1	0	1	707.859	2	2365.368	3
225		3	max	0	2	-.151	3	.264	2	1.93e-2	2	398.336	1	NC	1
226			min	-.01	1	-.151	1	0	1	0	1	397.198	2	1824.881	4
227		4	max	0	2	-.085	2	.236	2	1.752e-2	2	704.421	2	NC	1
228			min	-.01	1	-.09	1	0	1	0	1	668.574	1	2496.022	4
229		5	max	0	2	0	3	.191	2	1.574e-2	2	NC	1	NC	1
230			min	-.01	1	0	1	-.001	3	0	1	NC	1	NC	1
231	M38	1	max	0	2	0	2	.209	2	2.045e-2	2	NC	1	NC	1
232			min	-.007	1	0	1	0	1	0	1	NC	1	1596.129	3
233		2	max	0	2	-.081	1	.206	2	1.883e-2	2	745.989	1	NC	1
234			min	-.007	1	-.085	2	0	1	0	1	707.654	2	2800.329	4
235		3	max	0	2	-.151	3	.197	2	1.72e-2	2	397.974	1	NC	1
236			min	-.007	1	-.151	1	0	1	0	1	397.192	2	2163.177	4
237		4	max	0	2	-.085	2	.177	2	1.558e-2	2	704.596	2	NC	1
238			min	-.007	1	-.089	1	0	1	0	1	673.65	1	2973.326	4
239		5	max	0	2	0	3	.14	2	1.395e-2	2	NC	1	NC	1
240			min	-.007	1	0	1	-.001	3	-3.063e-5	3	NC	1	NC	1
241	M39	1	max	0	2	0	2	.144	2	1.761e-2	2	NC	1	NC	1
242			min	-.005	1	0	1	0	1	0	1	NC	1	2332.533	3
243		2	max	0	2	-.082	1	.143	2	1.618e-2	2	737.992	1	NC	1
244			min	-.005	1	-.085	2	0	1	0	1	707.424	2	3421.725	4
245		3	max	0	2	-.151	2	.138	2	1.476e-2	2	397.65	1	NC	1
246			min	-.005	1	-.151	1	0	1	0	1	397.187	3	2655.252	4
247		4	max	0	2	-.085	2	.125	2	1.334e-2	2	704.8	2	NC	1
248			min	-.005	1	-.089	1	0	1	0	1	678.892	1	3597.001	2
249		5	max	0	2	0	3	.096	2	1.192e-2	2	NC	1	NC	1
250			min	-.005	1	0	1	0	3	-5.835e-5	3	NC	1	NC	1
251	M40	1	max	0	2	0	2	.089	2	1.433e-2	2	NC	1	NC	1
252			min	-.003	1	0	1	0	1	0	1	NC	1	3788.579	3
253		2	max	0	2	-.083	1	.089	2	1.316e-2	2	730.308	1	NC	1
254			min	-.003	1	-.085	2	0	1	0	1	707.169	2	4409.259	4
255		3	max	0	2	-.151	2	.088	2	1.198e-2	2	397.408	1	NC	1
256			min	-.003	1	-.151	1	0	1	0	1	397.184	3	3436.848	4
257		4	max	0	2	-.085	2	.08	2	1.081e-2	2	705.038	2	NC	1
258			min	-.003	1	-.088	1	0	1	0	1	684.449	1	4429.257	2
259		5	max	0	2	0	3	.059	2	9.63e-3	2	NC	1	NC	1
260			min	-.003	1	0	1	0	3	-7.09e-5	3	NC	1	NC	1
261	M41	1	max	0	2	0	2	.046	2	1.063e-2	2	NC	1	NC	1
262			min	-.001	1	0	1	0	1	0	1	NC	1	7360.08	3
263		2	max	0	2	-.083	1	.047	2	9.746e-3	2	722.909	1	NC	1
264			min	-.001	1	-.085	2	0	3	0	1	706.889	2	6220.853	4
265		3	max	0	2	-.151	2	.048	2	8.862e-3	2	397.253	1	NC	1
266			min	-.001	1	-.151	1	0	3	0	1	397.182	3	4870.081	4
267		4	max	0	2	-.085	2	.044	2	7.979e-3	2	705.31	2	NC	1
268			min	-.001	1	-.087	1	0	1	0	1	690.372	1	5957.84	2
269		5	max	0	2	0	3	.03	2	7.095e-3	2	NC	1	NC	1
270			min	-.001	1	0	1	0	3	-6.827e-5	3	NC	1	NC	1
271	M42	1	max	0	2	0	2	.016	2	6.498e-3	2	NC	1	NC	1
272			min	0	1	0	1	0	1	0	1	NC	1	NC	1
273		2	max	0	2	-.084	1	.018	2	5.951e-3	2	715.755	1	NC	1
274			min	0	1	-.085	2	-.002	3	0	1	706.583	2	NC	1
275		3	max	0	2	-.151	2	.02	2	5.404e-3	2	397.182	2	NC	1
276			min	0	1	-.151	1	-.001	3	0	1	397.175	1	8352.771	4
277		4	max	0	2	-.085	2	.018	2	4.858e-3	2	705.616	2	NC	1
278			min	0	1	-.086	1	0	1	0	1	696.669	1	9682.919	2

Envelope Member Section Deflections (Continued)

	Member	Sec		x [in]	LC	y [in]	LC	z [in]	LC	x Rotate [r...	LC	(n) L/y Ratio	LC	(n) L/z Ratio	LC
279		5	max	0	2	0	3	.011	2	4.311e-3	2	NC	1	NC	1
280			min	0	1	0	1	0	3	-5.044e-5	3	NC	1	NC	1
281	M43	1	max	0	2	0	2	.002	2	1.937e-3	2	NC	1	NC	1
282			min	0	1	0	1	0	1	0	1	NC	1	NC	1
283		2	max	0	2	-.085	1	.002	4	1.772e-3	2	708.818	1	NC	1
284			min	0	1	-.085	2	0	3	0	1	706.251	2	NC	1
285		3	max	0	2	-.151	2	.003	2	1.608e-3	2	397.184	2	NC	1
286			min	0	1	-.151	1	0	3	0	1	397.169	1	NC	1
287		4	max	0	2	-.085	2	.003	2	1.443e-3	2	705.956	2	NC	1
288			min	0	1	-.085	1	0	3	0	1	703.338	1	NC	1
289		5	max	0	2	0	3	0	2	1.278e-3	2	NC	1	NC	1
290			min	0	1	0	1	0	3	-1.741e-5	3	NC	1	NC	1

Envelope AA ADM1-10: ASD - Building Aluminum Code Checks

	Member	Shape	Code C...	Loc[ft]	LC	Shear ...	Loc[ft]	Dir	LC	Pnc/O...	Pnt/Om...	Mny/O...	Mnz/O...	Vny/O...	Vnz/O...	Cb	Eqn
1	M1	2.375x2.3...	.694	0	3	.048	1.531	z	3	9.894	13.788	.836	.836	3.773	3.773	1...	H.1-1
2	M2	3.15x1.57...	.343	5	1	.120	5	z	3	4.46	10.799	.414	.739	4.135	1.902	1	H.1-1
3	M3	2.375x2.3...	.926	3.5	2	.088	0	z	4	9.894	13.788	.836	.836	3.773	3.773	1...	H.1-1
4	M4	3.15x1.57...	.357	0	1	.087	5	y	2	4.46	10.799	.414	.739	4.135	1.902	1	H.1-1
5	M5	2.375x2.3...	.610	3.5	2	.129	0	z	2	9.894	13.788	.836	.836	3.773	3.773	1...	H.1-1

Precision
Structural
Engineering, Inc.

BASE PLATE & ANCHORAGE DESIGN:

Pages 2,000 - 2,999

250-A Main Street
Klamath Falls, OR. 97601

E-Mail: info@structure1.com
Web: www.structure1.com

ph. (541) 850-6300
fax (541) 850-6233

Precision Structural Engineering, Inc.
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Medford Office
836 Mason Way (off Sage Road) • Medford, OR 97501
Tel (541) 858-8500

www.structure1.com • Email: info@structure1.com

PROJECT NO. Stainless Cable 216. SHEET 2000 OF ______

PROJECT NAME Guard rail DESIGNED BY AF DATE ______

SUBJECT Base plate CHECKED BY ______ DATE ______

Base plate Design

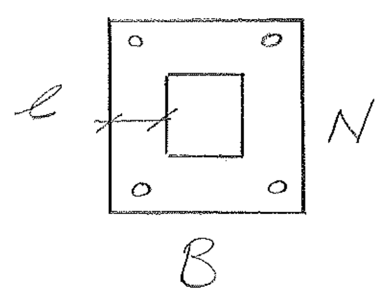
$$t \geq e\sqrt{\frac{2P_u}{0.9BN.F_y}}$$

$t = 0.315"$, $e = (4.52 - 2.37)/2 = 1.075"$

$B = N = 4.52"$

$P_u = 310$ lb , $F_y = 30$ Ksi

$$0.315 \geq 1.075\left(\frac{2*}{0.9*4.52*4.52*30}\right) \qquad (oK)$$



use [5.25" * 5.25" * 0.35"]

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PROJECT NO. Stainless Cable 216- SHEET 2001 OF

PROJECT NAME Guard rail DESIGNED BY AF DATE

SUBJECT Base plate CHECKED BY DATE

* Connection Design

post height = 42"

applied load = 200 lb (Concentrated

$\therefore$ Moment = 200 lb * 42 in = 8400 lb·in

applied load = 50 lb/ft (distributed), 5' spacing

$\therefore$ Moment = 50 lb/ft * 5 ft * $\frac{42"}{12 \frac{in}{ft}}$ = 875 lb·ft

$\therefore$ 875 lb·ft > $\frac{8400 \text{ lb·in}}{12}$ = 700 lb·ft

$\therefore$ Design moment = 875 lb·ft

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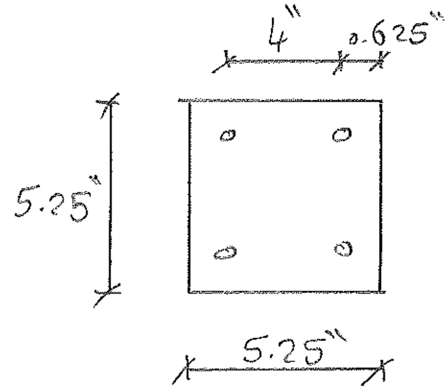
PROJECT NO. Stainless Cable 216. SHEET 2002 OF ______

PROJECT NAME guard rail DESIGNED BY AF DATE ______

SUBJECT Base plate CHECKED BY ______ DATE ______

1) Base plate to Concrete

use ITW Red head Trubolt wedge



Applied moment = 875 lb.ft

Tension = $\frac{M}{d}$

$= \frac{875^{\,lb.ft}}{4.65/12} = 2258\ lb$

For Concrete > 3000 psi

$\frac{3}{8}$" ϕ bolt w/ 4" Embedment Tension Capacity = 4800 lb (page 2005)

Allowable Tensile strength = $\frac{4800^{\,lb}}{4}$ = 1200 lb

F.O.S → 4

T = 2258 lb is resisted by 2-Anchors

∴ 2 bolts capacity (tension) = $2 * 1200^{\,lb} = 2400^{\,lb} > 2258^{\,lb}$

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PROJECT NO. Stainless Cable 216- SHEET 2003 OF

PROJECT NAME DESIGNED BY AF DATE

SUBJECT Base plate CHECKED BY DATE

* check for shear

Applied shear = 250 lb

ult. shear capacity of $\frac{3}{8}$" ⌀ bolt = 4000 lb (Page 2005)

Allowable shear capacity = $\frac{4000 \text{ lb}}{4}$ = 1000 lb

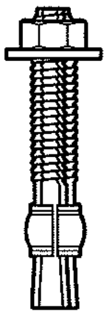
Total shear capacity of 4 bolts = 4 * 1000 lb = 4000 lb
> 250 lb
OK

* check critical spacing

Min. Allowable spacing = 3" < 4" spacing

∴ use [4 - $\frac{3}{8}$" ⌀ w/ min. 4" Embed.
ITW Red head Trubolt wedge]

Trubolt Wedge



SPECIFIED FOR ANCHORAGE INTO CONCRETE

Trubolt Wedge anchors feature a stainless steel expansion clip, threaded stud body, nut and washer. Anchor bodies are made of plated carbon steel, hot-dipped galvanized carbon steel, type 304 stainless steel or type 316 stainless steel as identified in the drawings or other notations.

The exposed end of the anchor is stamped to identify anchor length. Stampings should be preserved during installation for any subsequent embedment verification.

Use carbide tipped hammer drill bits made in accordance with ANSI B212.15-1994 to install anchors.

Anchors are tested to ACI 355.2 and ICC-ES AC193. Anchors are listed by the following agencies as required by the local building code: ICC-ES, UL, FM, City of Los Angeles, California State Fire Marshal and Caltrans.

See pages 42-43 for performance values in accordance to 2006 IBC.

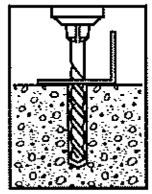
APPROVALS/LISTINGS

Trubolt®
Wedge Anchors

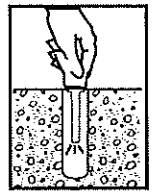
ICC Evaluation Service, Inc. # ESR-2251
- Category 1 performance rating
- 2006 IBC compliant
- Meets ACI 318 ductility requirements
- Tested in accordance with ACI 355.2 and ICC-ES AC193
- For use in seismic zones A & B
- 1/4", 3/8" & 1/2" diameter anchors listed in ESR-2251

Underwriters Laboratories
Factory Mutual
City of Los Angeles - #RR2748
California State Fire Marshall
Caltrans
Meets or exceeds U.S. Government G.S.A. Specification A-A-1923A Type 4 (formerlyGSA: FF-S-325 Group II, Type 4, Class 1)

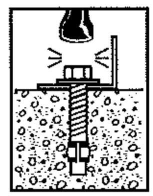
INSTALLATION STEPS



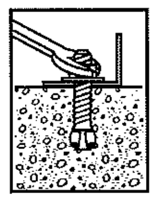
1. Select a carbide drill bit with a diameter equal to the anchor diameter. Drill hole to any depth exceeding the desired embedment. See chart for minimum recommended embedment.



2. Clean hole or continue drilling additional depth to accommodate drill fines.



3. Assemble washer and nut, leaving nut flush with end of anchor to protect threads. Drive anchor through material to be fastened until washer is flush to surface of material.



4. Expand anchor by tightening nut 3-5 turns past the hand tight position, or to the specified torque requirement.

**** ONLY FOR USE IN CONCRETRE****

LENGTH INDICATION CODE *

CODE	LENGTH OF ANCHOR		CODE	LENGTH OF ANCHOR	
A	1-1/2 < 2	(38.1 < 50.8)	K	6-1/2 < 7	(165.1 < 177.8)
B	2 < 2-1/2	(50.8 < 63.5)	L	7 < 7-1/2	(177.8 < 190.5)
C	2-1/2 < 3	(63.5 < 76.2)	M	7-1/2 < 8	(190.5 < 203.2)
D	3 < 3-1/2	(76.2 < 88.9)	N	8 < 8-1/2	(203.2 < 215.9)
E	3-1/2 < 4	(88.9 < 101.6)	O	8-1/2 < 9	(215.9 < 228.6)
F	4 < 4-1/2	(101.6 < 114.3)	P	9 < 9-1/2	(228.6 < 241.3)
G	4-1/2 < 5	(114.3 < 127.0)	Q	9-1/2 < 10	(241.3 < 254.0)
H	5 < 5-1/2	(127.0 < 139.7)	R	10 < 11	(254.0 < 279.4)
I	5-1/2 < 6	(139.7 < 152.4)	S	11 < 12	(279.4 < 304.8)
J	6 < 6-1/2	(152.4 < 165.1)	T	12 < 13	(304.8 < 330.2)

*Located on top of anchor for easy inspection.

2005

RED HEAD®
CONCRETE ANCHORING SPECIALISTS

Submittal Information

PERFORMANCE TABLE

Trubolt Wedge Anchors — Ultimate Tension and Shear Values (Lbs/kN) in Concrete*

ANCHOR DIA. In. (mm)	INSTALLATION TORQUE Ft. Lbs. (Nm)	EMBEDMENT DEPTH In. (mm)	ANCHOR TYPE	f'c = 2000 PSI (13.8 MPa) TENSION Lbs. (kN)	f'c = 2000 PSI (13.8 MPa) SHEAR Lbs. (kN)	f'c = 4000 PSI (27.6 MPa) TENSION Lbs. (kN)	f'c = 4000 PSI (27.6 MPa) SHEAR Lbs. (kN)	f'c = 6000 PSI (41.4 MPa) TENSION Lbs. (kN)	f'c = 6000 PSI (41.4 MPa) SHEAR Lbs. (kN)
1/4 (6.4)	4 (5.4)	1-1/8 (28.6)	WS-Carbon or WS-G Hot-Dipped Galvanized or WW-304 S.S. or SWW-316 S.S.	1,180 (5.2)	1,400 (6.2)	1,780 (7.9)	1,400 (6.2)	1,900 (8.5)	1,400 (6.2)
		1-15/16 (49.2)		2,100 (9.3)	1,680 (7.5)	3,300 (14.7)	1,680 (7.5)	3,300 (14.7)	1,680 (7.5)
		2-1/8 (54.0)		2,260 (10.1)	1,680 (7.5)	3,300 (14.7)	1,680 (7.5)	3,300 (14.7)	1,680 (7.5)
3/8 (9.5)	25 (33.9)	1-1/2 (38.1)		1,680 (7.5)	2,320 (10.3)	2,240 (10.0)	2,620 (11.7)	2,840 (12.6)	3,160 (14.1)
		3 (76.2)		3,480 (15.5)	4,000 (17.8)	5,940 (26.4)	4,140 (18.4)	6,120 (27.2)	4,500 (20.0)
		4 (101.6)		4,800 (21.4)	4,000 (17.8)	5,940 (26.4)	4,140 (18.4)	6,120 (27.2)	4,500 (20.0)
1/2 (12.7)	55 (74.6)	2-1/4 (57.2)		4,660 (20.7)	4,760 (21.2)	5,100 (22.7)	4,760 (21.2)	7,040 (31.3)	7,040 (31.3)
		4-1/8 (104.8)		4,660 (20.7)	7,240 (32.2)	9,640 (42.9)	7,240 (32.2)	10,820 (48.1)	8,160 (36.3)
		6 (152.4)		5,340 (23.8)	7,240 (32.2)	9,640 (42.9)	7,240 (32.2)	10,820 (48.1)	8,160 (36.3)
5/8 (15.9)	90 (122.0)	2-3/4 (69.9)		6,580 (29.3)	7,120 (31.7)	7,180 (31.9)	7,120 (31.7)	9,720 (43.2)	9,616 (42.8
		5-1/8 (130.2)		6,580 (29.3)	9,600 (42.7)	14,920 (66.4)	11,900 (52.9)	16,380 (72.9)	12,520 (55.7)
		7-1/2 (190.5)		7,060 (31.4)	9,600 (42.7)	15,020 (66.8)	11,900 (52.9)	16,380 (72.9)	12,520 (55.7)
3/4 (19.1)	110 (149.2)	3-1/4 (82.6)		7,120 (31.7)	10,120 (45.0)	10,840 (48.2)	13,720 (61.0)	13,300 (59.2)	15,980 (71.1)
		6-5/8 (168.3)		10,980 (48.8)	20,320 (90.4)	17,700 (78.7)	23,740 (105.6)	20,260 (90.1)	23,740 (105.6)
		10 (254.0)		10,980 (48.8)	20,320 (90.4)	17,880 (79.5)	23,740 (105.6)	23,580 (104.9)	23,740 (105.6)
7/8 (22.2)	250 (339.0)	3-3/4 (95.3)		9,520 (42.3)	13,160 (58.5)	14,740 (65.6)	16,580 (73.8)	17,420 (77.5)	19,160 (85.2)
		6-1/4 (158.8)		14,660 (65.2)	20,880 (92.9)	20,940 (93.1)	28,800 (128.1)	24,360 (108.4)	28,800 (128.1)
		8 (203.2)		14,660 (65.2)	20,880 (92.9)	20,940 (93.1)	28,800 (128.1)	24,360 (108.4)	28,800 (128.1)
1 (25.4)	300 (406.7)	4-1/2 (114.3)		13,940 (62.0)	16,080 (71.5)	20,180 (89.8)	22,820 (101.5)	21,180 (94.2)	24,480 (108.9)
		7-3/8 (187.3)		14,600 (64.9)	28,680 (127.6)	23,980 (106.7)	37,940 (168.8)	33,260 (148.0)	38,080 (169.4)
		9-1/2 (241.3)		18,700 (83.2)	28,680 (127.6)	26,540 (118.1)	37,940 (168.8)	33,260 (148.0)	38,080 (169.4)

*Allowable values are based upon a 4 to 1 safety factor. Divide by 4 for allowable load values.

* For Tie-Wire Wedge Anchor, TW-1400, use tension data from 1/4" diameter with 1-1/8" embedment.

*For continuous extreme low temperature applications, use stainless steel.

PERFORMANCE TABLE

Trubolt Wedge Anchors — Ultimate Tension and Shear Values (Lbs/kN) in Lightweight Concrete*

ANCHOR DIA. In. (mm)	INSTALLATION TORQUE Ft. Lbs. (Nm)	EMBEDMENT DEPTH In. (mm)	ANCHOR TYPE	LIGHTWEIGHT CONCRETE f'c = 3000 PSI (20.7 MPa) TENSION Lbs. (kN)	LIGHTWEIGHT CONCRETE f'c = 3000 PSI (20.7 MPa) SHEAR Lbs. (kN)	LOWER FLUTE OF STEEL DECK WITH LIGHTWEIGHT CONCRETE FILL f'c = 3000 PSI (20.7 MPa) TENSION Lbs. (kN)	LOWER FLUTE OF STEEL DECK WITH LIGHTWEIGHT CONCRETE FILL f'c = 3000 PSI (20.7 MPa) SHEAR Lbs. (kN)
3/8 (9.5)	25 (33.9)	1-1/2 (38.1)	WS-Carbon or WS-G Hot-Dipped Galvanized or WW-304 S.S. or SWW-316 S.S.	1,175 (5.2)	1,480 (6.6)	1,900 (8.5)	3,160 (14.1)
		3 (76.2)		2,825 (12.6)	2,440 (10.9)	2,840 (12.6)	4,000 (17.8)
1/2 (12.7)	55 (74.6)	2-1/4 (57.2)		2,925 (13.0)	2,855 (12.7)	3,400 (15.1)	5,380 (23.9)
		3 (76.2)		3,470 (15.4)	3,450 (15.3)	4,480 (19.9)	6,620 (29.4)
		4 (101.6)		4,290 (19.1)	3,450 (15.3)	4,800 (21.4)	6,440 (28.6)
5/8 (15.9)	90 (122.0)	3 (76.2)		4,375 (19.5)	4,360 (19.4)	4,720 (21.0)	5,500 (24.5)
		5 (127.0)		6,350 (28.2)	6,335 (28.2)	6,580 (29.3)	9,140 (40.7)
3/4 (19.1)	110 (149.2)	3-1/4 (82.6)		5,390 (24.0)	7,150 (31.8)	5,840 (26.0)	8,880 (39.5)
		5-1/4 (133.4)		7,295 (32.5)	10,750 (47.8)	7,040 (31.3)	N/A

*Allowable values are based upon a 4 to 1 safety factor. Divide by 4 for allowable load values.

2006

PERFORMANCE TABLE

Trubolt Wedge Anchors — Recommended Edge and Spacing Distance Requirements for Shear Loads*

ANCHOR DIA. In. (mm)	EMBEDMENT DEPTH In. (mm)	ANCHOR TYPE	EDGE DISTANCE REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	MIN. EDGE DISTANCE AT WHICH THE LOAD FACTOR APPLIED = .60 In. (mm)	MIN. EDGE DISTANCE AT WHICH THE LOAD FACTOR APPLIED = .20 In. (mm)	SPACING REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	MIN. ALLOWABLE SPACING BETWEEN ANCHORS In. (mm) LOAD FACTOR APPLIED = .40
1/4 (6.4)	1-1/8 (28.6)	WS-Carbon or WS-G Hot-Dipped Galvanized or WW-304 S.S. or SWW-316 S.S.	2 (50.8)	1-5/16 (33.3)	N/A	3-15/16 (100.0)	2 (50.8)
	1-15/16 (49.2)		1-15/16 (49.2)	1 (25.4)	N/A	3-7/8 (98.4)	1-15/16 (49.2)
3/8 (9.5)	1-1/2 (38.1)		2-5/8 (66.7)	1-3/4 (44.5)	N/A	5-1/4 (133.4)	2-5/8 (66.7)
	3 (76.2)		3-3/4 (95.3)	3 (76.2)	1-1/2 (38.1)	6 (152.4)	3 (76.2)
1/2 (12.7)	2-1/4 (57.2)		3-15/16 (100.0)	2-9/16 (65.1)	N/A	7-7/8 (200.0)	3-15/16 (100.0)
	4-1/8 (104.8)		5-3/16 (131.8)	3-1/8 (79.4)	1-9/16 (39.7)	6-3/16 (157.2)	3-1/8 (79.4)
5/8 (15.9)	2-3/4 (69.9)		4-13/16 (122.2)	3-1/8 (79.4)	N/A	9-5/8 (244.5)	4-13/16 (122.2)
	5-1/8 (130.2)		6-7/16 (163.5)	3-7/8 (98.4)	1-15/16 (49.2)	7-11/16 (195.3)	3-7/8 (98.4)
3/4 (19.1)	3-1/4 (82.6)		5-11/16 (144.5)	3-3/4 (95.3)	N/A	11-3/8 (288.9)	5-11/16 (144.5)
	6-5/8 (168.3)		6-5/16 (160.3)	5 (127.0)	2-1/2 (63.5)	9-15/16 (252.4)	5 (127.0)
7/8 (22.2)	3-3/4 (95.3)		6-9/16 (166.7)	4-5/16 (109.5)	N/A	13-1/8 (333.4)	6-9/16 (166.7)
	6-1/4 (158.8)		8-1/2 (215.9)	6-1/4 (158.8)	3-1/8 (79.4)	12-1/2 (317.5)	6-1/4 (158.8)
1 (25.4)	4-1/4 (108.0)		7-7/8 (200.0)	5-1/8 (130.2)	N/A	15-3/4 (400.1)	7-7/8 (200.0)
	7-3/8 (187.3)		10-1/16 (255.6)	7-3/8 (187.3)	3-11/16 (93.7)	14-3/4 (374.7)	7-3/8 (187.3)

*Spacing and edge distances shall be divided by 0.75 when anchors are placed in structural lightweight concrete. Linear interpolation may be used for intermediate spacing and edge distances.

PERFORMANCE TABLE

Trubolt Wedge Anchors — Recommended Edge and Spacing Distance Requirements for Tension Loads*

ANCHOR DIA. In. (mm)	EMBEDMENT DEPTH In. (mm)	ANCHOR TYPE	EDGE DISTANCE REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	MIN. ALLOWABLE EDGE DISTANCE AT WHICH THE LOAD FACTOR APPLIED = .65 In. (mm)	SPACING REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	MIN. ALLOWABLE SPACING AT WHICH THE LOAD FACTOR APPLIED = .70 In. (mm)
1/4 (6.4)	1-1/8 (28.6)	WS-Carbon or WS-G Hot-Dipped Galvanized or WW-304 S.S. or SWW-316 S.S.	2 (50.8)	1 (25.4)	3-15/16 (100.0)	2 (50.8)
	1-15/16 (49.2)		1-15/16 (49.2)	1 (25.4)	3-7/8 (98.4)	1-15/16 (49.2)
	2-1/8 (54.0)		1-5/8 (41.3)	13/16 (20.6)	3-3/16 (81.0)	1-5/8 (41.3)
3/8 (9.5)	1-1/2 (38.1)		2-5/8 (66.7)	1-5/16 (33.3)	5-1/4 (133.4)	2-5/8 (66.7)
	3 (76.2)		3 (76.2)	1-1/2 (38.1)	6 (152.4)	3 (76.2)
	4 (101.6)		3 (76.2)	1-1/2 (38.1)	6 (152.4)	3 (76.2)
1/2 (12.7)	2-1/4 (57.2)		3-15/16 (100.0)	2 (50.8)	7-7/8 (200.0)	3-15/16 (100.0)
	4-1/8 (104.8)		3-1/8 (79.4)	1-9/16 (39.7)	6-3/16 (157.2)	3-1/8 (79.4)
	6 (152.4)		4-1/2 (114.3)	2-1/4 (57.2)	9 (228.6)	4-1/2 (114.3)
5/8 (15.9)	2-3/4 (69.9)		4-13/16 (122.2)	2-7/16 (61.9)	9-5/8 (244.5)	4-13/16 (122.2)
	5-1/8 (130.2)		3-7/8 (98.4)	1-15/16 (49.2)	7-1/16 (195.3)	3-7/8 (98.4)
	7-1/2 (190.5)		5-5/8 (142.9)	2-13/16 (71.4)	11-1/4 (285.8)	5-5/8 (142.9)
3/4 (19.1)	3-1/4 (82.6)		5-11/16 (144.5)	2-7/8 (73.0)	11-3/8 (288.9)	5-11/16 (144.5)
	6-5/8 (168.3)		5 (127.0)	2-1/2 (63.5)	9-15/16 (252.4)	5 (127.0)
	10 (254.0)		7-1/2 (190.5)	3-3/4 (95.3)	15 (381.0)	7-1/2 (190.5)
7/8 (22.2)	3-3/4 (95.3)		6-9/16 (166.7)	3-5/16 (84.1)	13-1/8 (333.4)	6-9/16 (166.7)
	6-1/4 (158.8)		6-1/4 (158.8)	3-1/8 (79.4)	12-1/2 (317.5)	6-1/4 (158.8)
	8 (203.2)		6 (152.4)	3 (76.2)	12 (304.8)	6 (152.4)
1 (25.4)	4-1/2 (114.3)		7-7/8 (200.0)	3-15/16 (100.0)	15-3/4 (400.1)	7-7/8 (200.0)
	7-3/8 (187.3)		7-3/8 (187.3)	3-11/16 (93.7)	14-3/4 (374.7)	7-3/8 (187.3)
	9-1/2 (241.3)		7-1/8 (181.0)	3-9/16 (90.5)	14-1/4 (362.0)	7-1/8 (181.0)

*Spacing and edge distances shall be divided by 0.75 when anchors are placed in structural lightweight concrete. Linear interpolation may be used for intermediate spacing and edge distances.

Combined Tension and Shear Loading—for Trubolt Anchors

Allowable loads for anchors subjected to combined shear and tension forces are determined by the following equation:

$$(Ps/Pt)^{5/3} + (Vs/Vt)^{5/3} \leq 1$$

Ps = Applied tension load Vs = Applied shear load Pt = Allowable tension load Vt = Allowable shear load

2007

Trubolt Strength Design Performance values in accordance to 2006 IBC

ITW RED HEAD TRUBOLT WEDGE ANCHOR

DESIGN INFORMATION TESTED TO ICC-ES AC193 AND ACI 355.2, IN ACCORDANCE WITH 2006 IBC

Trubolt® Wedge Anchors

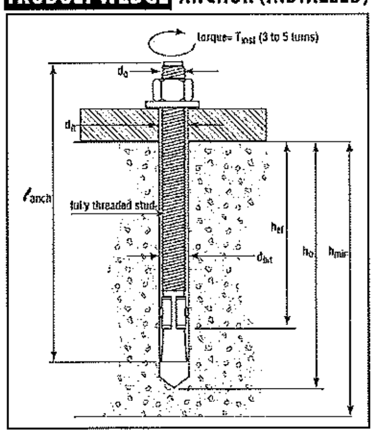
TRUBOLT WEDGE ANCHOR DESIGN INFORMATION[1,2,3]

DESIGN INFORMATION	Symbol	Units	Nominal Anchor Diameter									
			1/4		3/8		1/2		5/8		3/4	
Anchor O.D.	d_o	in	0.250		0.375		0.500		0.625		0.750	
Effective embedment	h_{ef}	in	1-1/2	2	1-3/4	2-5/8	1-7/8	3-3/8	2-1/2	4	3-1/2	4-3/4
Minimum member thickness	h_{min}	in	4	4	4	5	5	6	5	8	6	8
Critical edge distance	c_{ac}	in	2-5/8	3	2-5/8	5-1/4	3-3/4	6-3/4	5	8	7	9
Minimum edge distance	c_{min}	in	1-3/4	1-1/2	2-1/4	2	3-3/4	3-3/4	4-1/4	3-1/4	3-3/4	3-1/2
Minimum anchor spacing	s_{min}	in	1-3/4	1-1/2	2-1/4	2	3-3/4	3-3/4	4-1/4	3-1/4	3-3/4	3-1/2
Min. Specified Yield Strength	f_y	lb/in^2	55,000									
Min. Specified Ultimate Strength	f_{uta}	lb/in^2	75,000									
Effective tensile stress area	A_{se}	in^2	0.032		0.078		0.142		0.226		0.334	
Steel strength in tension	N_s	lb	2,385		5,815		10,645		16,950		25,050	
Steel strength in shear	V_s	lb	1,430		2,975	3,490	4,450	6,385	6,045	10,170	10,990	15,030
Pullout strength, uncracked concrete	$N_{p,uncr}$	lb	1,392	1,706	2,198	3,469	2,400	4,168	4,155	6,638	8,031	10,561
Anchor Category (All anchors are ductile)			1									
Effectiveness factor k_{uncr} uncracked concrete			24									
Axial stiffness in service load range	β	lb/in	14,651	9,385	17,515	26,424	32,483	26,136	42,899	21,749	43,576	28,697
Coefficient for variation for axial stiffness in service load range			34	47	28	45	17	33	55	22	63	28
Strength reduction factor ϕ for tension, steel failure modes			0.75									
Strength reduction factor ϕ for shear, steel failure modes			0.65									
Strength reduction factor ϕ for tension, concrete failure modes, Condition B			0.65									
Strength reduction factor ϕ for shear, concrete failure modes, Condition B			0.70									

[1] Trubolt+ Anchor Design Strengths must be determined in accordance with ACI 318-05 Appendix D and this table
[2] The Trubolt+ Wedge Anchor is a ductile steel element as defined by ACI 318 D.1
[3] 1/4", 3/8", & 1/2" diameter data is listed in ICC-ES ESR-2251.

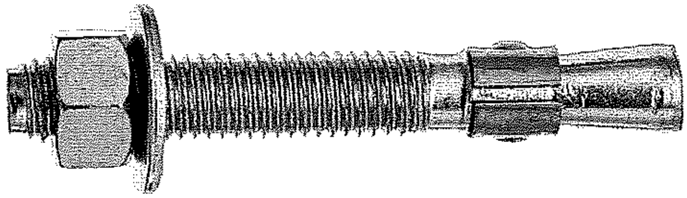
Trubolt® Wedge Anchors

TRUBOLT WEDGE ANCHOR (INSTALLED)



TRUBOLT WEDGE INSTALLATION INFORMATION

	Symbol	Units	Nominal Anchor Diameter (in.)									
			1/4		3/8		1/2		5/8		3/4	
Anchor outer diameter	d_0	in	0.25		0.375		0.5		0.625		0.750	
Nominal carbide bit diameter	d_{bit}	in	1/4		3/8		1/2		5/8		3/4	
Effective embedment depth	h_{ef}	in	1-1/2	2	1-3/4	2-5/8	1-7/8	3-3/8	2-1/2	4	3-1/2	4-3/4
Min hole depth	h_0	in	2	2-1/2	2-1/2	3-3/8	2-3/4	4-1/4	3-3/4	5-1/4	4-3/4	6
Min slab thickness	h_{min}	in	4		4	5	5	6	5	8	6	8
Installation torque	T_{inst}	ft-lb	4		25		55		90		110	
Min hole diameter in fixture	d_h	in	5/16		7/16		9/16		11/16		13/16	



2008

Trubolt Strength Design Performance values in accordance to 2006 IBC

Trubolt®
Wedge Anchors

TRUBOLT WEDGE PULLOUT STRENGTH ($N_{p,unc}$) (POUNDS) [1]

Nominal Anchor Diameter (in.)	Effective Embedment Depth (in.)	Concrete Compressive Strength			
		f'c = 2,500 psi	f'c = 3,000 psi	f'c = 4,000 psi	f'c = 6,500 psi
1/4	1-1/2	1,392	1,525	1,610	1,822
	2	1,706	1,869	1,947	2,151
3/8	1-3/4	2,198	2,408	2,621	3,153
	2-5/8	3,469	3,800	3,936	4,275
1/2	1-7/8	2,400	2,629	3,172	4,520
	3-3/8	4,168	4,520	4,520	4,520
5/8	2-1/2	4,155	4,155	4,376	5,578
	4	6,638	6,900	7,968	10,157
3/4	3-1/2	8,031	8,322	9,610	12,251
	4-3/4	10,561	10,561	10,561	12,251

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 Mpa
1 Values are for single anchors with no edge distance or spacing reduction.

TRUBOLT WEDGE ANCHOR ALLOWABLE STATIC TENSION (ASD), NORMAL-WEIGHT UNCRACKED CONCRETE [1-6]

Nominal Anchor Diameter (in.)	Effective Embedment Depth (in.)	Concrete Compressive Strength			
		f'c = 2,500 psi	f'c = 3,000 psi	f'c = 4,000 psi	f'c = 6,500 psi
1/4	1-1/2	611	670	707	800
	2	749	821	855	945
3/8	1-3/4	965	1,058	1,151	1,385
	2-5/8	1,524	1,669	1,729	1,878
1/2	1-7/8	1,054	1,155	1,393	1,985
	3-3/8	1,831	1,985	1,985	1,985
5/8	2-1/2	1,825	1,825	1,922	2,450
	4	2,915	3,030	3,499	4,461
3/4	3-1/2	3,527	3,655	4,221	5,381
	4-3/4	4,638	4,638	4,638	5,381

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 Mpa
Design Assumptions:
1 Single anchor with static tension load only.
2 Concrete determined to remain uncracked for the life of the anchorage.
3 Load combinations from 2006 IBC, Sections 1605.2.1 and 1605.3.1 (no seismic loading).
4 Thirty percent dead load and 70 percent live load, controlling load combination 1.2D + 1.6L
5 Calculation of weighted average: 1.2D + 1.6L = 1.2 (0.3) + 1.6 (0.7) = 1.48
6 Values do not include edge distance or spacing reductions.

2006 IBC Compliant

TRUBOLT WEDGE ANCHOR ALLOWABLE STATIC SHEAR (ASD), STEEL (POUNDS) [1-5]

Nominal Anchor Diameter (in.)	Effective Embedment Depth (in.)	Allowable Steel Capacity, Static Shear
1/4	1-1/2	628
	2	
3/8	1-3/4	1,307
	2-5/8	1,533
1/2	1-7/8	1,954
	3-3/8	2,804
5/8	2-1/2	2,655
	4	4,467
3/4	3-1/2	4,827
	4-3/4	6,601

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 Mpa
Design Assumptions:
1 Single anchor with static shear load only.
3 Load combinations from 2006 IBC, Sections 1605.2.1 and 1605.3.1 (no seismic loading).
3 Thirty percent dead load and 70 percent live load, controlling load combination 1.2D + 1.6L
4 Calculation of weighted average: 1.2D + 1.6L = 1.2 (0.3) + 1.6 (0.7) = 1.48
5 Values do not include edge distance or spacing reductions.

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PROJECT NO. Stainless Cable 216. SHEET 2009 OF

PROJECT NAME DESIGNED BY AF DATE

SUBJECT CHECKED BY DATE

* Red head LDT (SLDT-3816

For Concrete > 3000 psi

$\frac{3}{8}$" ϕ bolt :

Allowable Tension Capacity = 1656 lb (page

∴ 2 bolts Capacity = 2 * 1656 lb = 3312 lb > 2258 lb

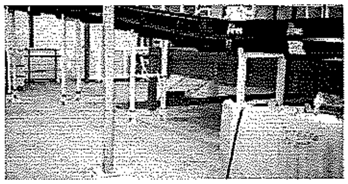
Allowable shear Capacity = 842 lb (page

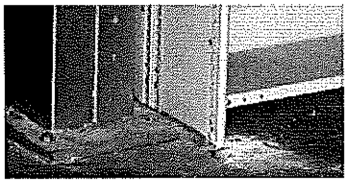
∴ 4 bolts Capacity = 4 * 842 lb = 3368 lb > 250 lb

Use [$\frac{3}{8}$" ϕ w/min 4" Embed Redhead LDT (SLDT-3816)]

2010

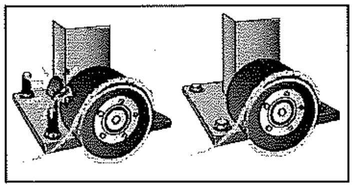
APPLICATIONS





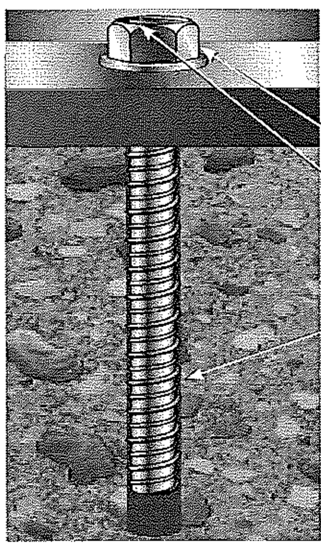
Racking, shelving and conveyors are just a few high volume applications ideal for Large Diameter Tapcon (LDT™). The ease and speed of installation of the LDT can reduce installation time to less than half the time of typical systems used today.

For installation speed, high performance and easy removability, LDT is the anchor of choice.



The LDT's finished head and lack of exposed threads virtually eliminates tire damage on fork lift trucks.

FEATURES



Easy Installation
Installs into concrete by hand or impact wrench

Anti-rotation Serrated Washer
—Prevents anchor back-out

Extra Large Hex Washer Head
—With increased bearing surface

Length Identification Head Stamp
—For embedment inspection after installation

Hi-Lo Threads
—Cuts its own threads into concrete for greater pull-out resistance

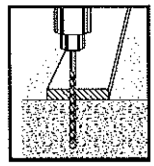
LDT 3/8" and 1/2" are available with *EnvireX* coating

1,000 hours salt spray ASTM B117. Approved for use in ACQ and MCQ lumber*

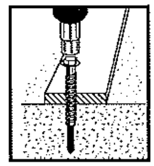
*Excessive content of copper in the ACQ and MCQ lumber may affect the anchor finish.

INSTALLATION STEPS

Installation Steps for Concrete, Lightweight Concrete and Metal Deck

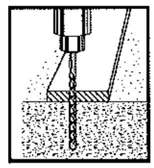


1. Using the proper size carbide bit (see chart) drill "a pilot hole at least 1" deeper than anchor embedment. "'

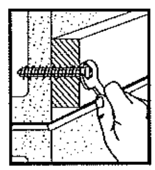


2. Using an **electric impact wrench**, or socket wrench (hand install) insert anchor into hole and tighten anchor until fully seated. (see chart for socket size) (do not over tighten).

Installation Steps for Hollow or Grout-Filled CMU
(3/8" and 1/2" diameter)



1. Using a 5/16" (for 3/8" LDT) or 7/16" (for 1/2" LDT) carbide tipped bit, drill a pilot hole at least 1" deeper than anchor embedment. "'



2. Using a socket wrench insert anchor into hole and hand tighten anchor until fully seated. (9/16" socket for 3/8" and 3/4" socket for 1/2") (do not over tighten).

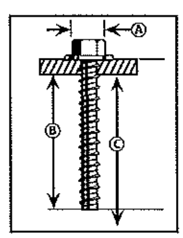
LDT's can be installed by hand or with an impact wrench

Installation by hand—is easy, simply using a socket wrench

Installation by impact wrench—is recommended for faster installations or for high volume projects. Installation with impact wrench—is ***not*** recommended for hollow block.

Selection Chart

LDT Size	ANSI Standard Drill Bit Diameter	Ⓐ Anchor Head (Socket Size) Diameter	Washer Diameter	Ⓑ Minimum Embedment	Ⓒ Hole Depth	USE IN Concrete	USE IN CMU Hollow	USE IN CMU Grout-filled
LDT 3/8"	5/16"	9/16"	13/16"	1-1/2"	2-1/2"	YES	YES	YES
LDT 1/2"	7/16"	3/4"	1"	2-1/2"	3-1/2"	YES	NO	YES
LDT 5/8"	1/2"	13/16"	1-3/16"	2-3/4"	3-3/4"	YES	NO	YES
LDT 3/4"	5/8"	15/16"	1-5/16"	3-1/4"	4-1/4"	YES	NO	YES



See catalog for effective lengths and length indication code.

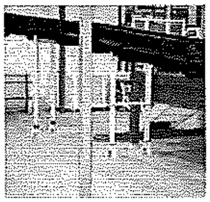
2011

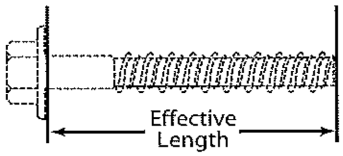
SELECTION CHART

LDT Carbon and Stainless Steel

Carbon Steel with Zinc Plating: Meets ASTM B695 and B633 specifications for zinc plating of 5um = .0002" thickness. This coating is well suited for non-corrosive interior environments.

Carbon Steel with EnvireX Coating: Provides additional corrosion protection for outdoor applications.





PART NUMBER CARBON STEEL ZINC PLATED	PART NUMBER CARBON STEEL EnvireX COATING	PART NUMBER FOR 410 STAINLESS STEEL	ANCHOR DIA. In. (mm)	DRILL BIT DIA. In. (mm)	EFFECTIVE LENGTH In. (mm) (see detail on left)	MAX. THICKNESS OF MATERIAL TO BE FASTENED In. (mm)	QTY/WT PER BOX lbs.	QTY/WT PER MASTER CARTON lbs.
LDT-3816	—	SLDT-3816	3/8 (9.5)	5/16 (7.9)	1-3/4 (44.5)	1/4 (6.4)	50/ 3.0	400/ 24.0
LDT-3824	—	SLDT-3824	3/8 (9.5)	5/16 (7.9)	2-1/2 (63.5)	1 (25.4)	50/ 4.5	400/ 34.0
LDT-3830	LDT-3830X	SLDT-3830	3/8 (9.5)	5/16 (7.9)	3 (76.2)	1-1/2 (38.1)	50/ 5.0	400/ 40.0
LDT-3840	LDT-3840X	SLDT-3840	3/8 (9.5)	5/16 (7.9)	4 (101.6)	2-1/2 (63.5)	50/ 6.5	400/ 52.0
LDT-3850	LDT-3850X	SLDT-3850	3/8 (9.5)	5/16 (7.9)	5 (127.0)	3-1/2 (89.0)	40/ 7.5	320/ 60.0
LDT-1230	LDT-1230X	SLDT-1230	1/2 (12.7)	7/16 (11.1)	3 (76.2)	1/2 (12.7)	25/ 4.5	150/ 27.0
LDT-1240	LDT-1240X	SLDT-1240	1/2 (12.7)	7/16 (11.1)	4 (101.6)	1-1/2 (38.1)	25/ 6.0	150/ 36.6
LDT-1250	LDT-1250X	SLDT-1250	1/2 (12.7)	7/16 (11.1)	5 (127.0)	2-1/2 (63.5)	25/ 7.6	150/ 45.6
LDT-1260	—	—	1/2 (12.7)	7/16 (11.1)	6 (152.4)	4 (101.6)	20/ 9.0	120/ 54.0
LDT-5830	—	—	5/8 (15.9)	1/2 (12.7)	3 (76.2)	1/4 (6.4)	10 / 3.5	100 / 35.0
LDT-5840	—	—	5/8 (15.9)	1/2 (12.7)	4 (101.6)	1-1/4 (31.8)	10 / 4.0	100 / 40.0
LDT-5850	—	—	5/8 (15.9)	1/2 (12.7)	5 (127.0)	2-1/4 (57.1)	10 / 4.7	100 / 47.0
LDT-5860	—	—	5/8 (15.9)	1/2 (12.7)	6 (152.4)	3-1/4 (82.6)	10 / 5.4	50 / 27.0
LDT-3444	—	—	3/4 (19.1)	5/8 (15.9)	4-1/2 (114.3)	1-1/4 (31.8)	10 / 7.4	50 / 37.0
LDT-3454	—	—	3/4 (19.1)	5/8 (15.9)	5-1/2 (139.7)	2-1/4 (57.1)	10 / 8.1	50 / 40.5
LDT-3462	—	—	3/4 (19.1)	5/8 (15.9)	6-1/4 (158.8)	3 (76.2)	10 / 9.1	30 / 27.3

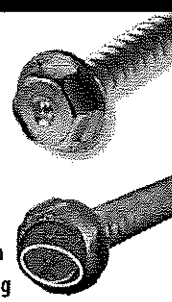
* The stainless steel LDT's will be gold in color in order to differentiate them from the carbon steel anchors.

DESIGN GUIDE

For proper selection of anchor diameters based upon predrilled holes in base plates and fixtures.

HOLE DIAMETER IN FIXTURE In. (mm)	SUGGESTED LDT DIAMETER In. (mm)
7/16 (11.1)	3/8 (9.5)
1/2 (12.7)	3/8 (9.5)
9/16 (14.3)	1/2 (12.7)
5/8 (15.9)	1/2 (12.7)
3/4 (19.1)	5/8 (15.9)
7/8 (22.2)	3/4 (19.1)

LENGTH INDICATION CODE*



X denotes available with EnvireX coating

CODE	LENGTH OF ANCHOR In. (mm)
A	1-1/2 < 2 (38.1 < 50.8)
B	2 < 2-1/2 (50.8 < 63.5)
C	2-1/2 < 3 (63.5 < 76.2)
D	3 < 3-1/2 (76.2 < 88.9)
E	3-1/2 < 4 (88.9 < 101.6)
F	4 < 4-1/2 (101.6 < 114.3)
G	4-1/2 < 5 (114.3 < 127.0)
H	5 < 5-1/2 (127.0 < 139.7)
I	5-1/2 < 6 (139.7 < 152.4)
J	6 < 6-1/2 (152.4 < 165.1)

* Located on top of anchor for easy inspection.

PERFORMANCE TABLE

LDT Anchors *Ultimate Tension and Shear Values (Lbs/kN) in Concrete*

ANCHOR DIA. In. (mm)	EMBEDMENT DEPTH In. (mm)	f'c = 2000 PSI (13.8 MPa) TENSION Lbs. (kN)	f'c = 2000 PSI (13.8 MPa) SHEAR Lbs. (kN)	f'c = 3000 PSI (20.7 MPa) TENSION Lbs. (kN)	f'c = 3000 PSI (20.7 MPa) SHEAR Lbs. (kN)	f'c = 4000 PSI (27.6 MPa) TENSION Lbs. (kN)	f'c = 4000 PSI (27.6 MPa) SHEAR Lbs. (kN)
3/8 (9.5)	1-1/2 (38.1)	1,336 (5.9)	2,108 (9.4)	1,652 (7.3)	2,764 (12.3)	1,968 (8.8)	3,416 (15.2)
	2 (50.8)	1,492 (6.6)	3,036 (13.5)	2,024 (9.0)	3,228 (14.4)	2,552 (11.4)	3,420 (15.2)
	2-1/2 (63.5)	3,732 (16.6)	3,312 (14.7)	3,748 (16.7)	3,364 (15.0)	3,760 (16.7)	3,424 (15.2)
	3-1/2 (88.9)	5,396 (24.0)	3,312 (14.7)	6,624 (29.5)	3,368 (15.0)	7,852 (34.9)	3,428 (15.2)
1/2 (12.7)	2 (50.8)	3,580 (15.9)	5,644 (25.1)	3,908 (17.4)	6,512 (29.0)	4,236 (18.8)	7,380 (32.8)
	3-1/2 (88.9)	7,252 (32.3)	6,436 (28.6)	8,044 (35.8)	7,288 (32.4)	8,836 (39.3)	8,140 (36.2)
	4-1/2 (114.3)	10,176 (45.3)	7,384 (32.8)	10,332 (46.0)	7,968 (35.4)	10,488 (46.7)	8,552 (38.0)
5/8 (15.9)	2-3/4 (69.9)	5,276 (23.5)	8,656 (38.5)	6,560 (29.2)	11,064 (49.2)	7,844 (34.8)	13,476 (59.9)
	3-1/2 (88.9)	7,972 (35.5)	10,224 (45.5)	9,848 (43.8)	12,144 (54.0)	11,724 (52.2)	14,060 (62.5)
	4-1/2 (114.3)	11,568 (51.5)	12,316 (54.8)	13,432 (59.8)	13,580 (60.4)	16,892 (75.1)	14,840 (66.0)
3/4 (19.1)	3-1/4 (82.6)	6,876 (30.6)	7,140 (31.8)	9,756 (43.4)	10,728 (47.7)	12,636 (56.2)	14,316 (63.6)
	4-1/2 (114.3)	10,304 (45.8)	13,120 (58.4)	14,424 (64.2)	16,868 (75.0)	18,540 (82.5)	20,612 (91.7)
	5-1/2 (139.7)	13,048 (58.0)	17,908 (79.7)	18,156 (80.8)	21,718 (96.9)	23,268 (130.5)	25,652 (114.1)

2012

PERFORMANCE TABLE

LDT Anchors — *Allowable Tension and Shear Values* (Lbs/kN) in Concrete Carbon and Stainless Steel*

ANCHOR DIA. In. (mm)	EMBEDMENT DEPTH In. (mm)	f'c = 2000 PSI (13.8 MPa) TENSION Lbs. (kN)	f'c = 2000 PSI (13.8 MPa) SHEAR Lbs. (kN)	f'c = 3000 PSI (20.7 MPa) TENSION Lbs. (kN)	f'c = 3000 PSI (20.7 MPa) SHEAR Lbs. (kN)	f'c = 4000 PSI (27.6 MPa) TENSION Lbs. (kN)	f'c = 4000 PSI (27.6 MPa) SHEAR Lbs. (kN)
3/8 (9.5)	1-1/2 (38.1)	334 (1.5)	527 (2.3)	413 (1.8)	691 (3.1)	492 (2.1)	854 (3.8)
	2 (50.8)	373 (1.7)	759 (3.4)	506 (2.2)	807 (3.6)	638 (2.8)	855 (3.8)
	2-1/2 (63.5)	933 (4.2)	828 (3.7)	937 (4.2)	841 (3.7)	940 (4.2)	856 (3.8)
	3-1/2 (88.9)	1,349 (6.0)	828 (3.7)	1,656 (7.4)	842 (3.7)	1,963 (8.7)	857 (3.8)
1/2 (12.7)	2 (50.8)	895 (4.0)	1,411 (6.3)	977 (4.3)	1,628 (7.2)	1,059 (4.7)	1,845 (8.2)
	3-1/2 (88.9)	1,813 (8.0)	1,609 (7.2)	2,011 (8.9)	1,822 (8.1)	2,209 (9.8)	2,035 (9.0)
	4-1/2 (114.3)	2,544 (11.3)	1,846 (8.2)	2,583 (11.5)	1,992 (8.9)	2,622 (11.7)	2,138 (9.5)
5/8 (15.9)	2-3/4 (69.9)	1,319 (5.9)	2,164 (9.7)	1,640 (7.3)	2,766 (12.3)	1,961 (8.7)	3,369 (15.0)
	3-1/2 (88.9)	1,993 (8.9)	2,556 (11.4)	2,462 (10.9)	3,036 (13.5)	2,931 (13.0)	3,515 (15.6)
	4-1/2 (114.3)	2,892 (12.9)	3,079 (13.7)	3,358 (14.9)	3,395 (15.1)	4,223 (18.8)	3,710 (16.5)
3/4 (19.1)	3-1/4 (82.6)	1,719 (7.6)	1,785 (7.9)	2,439 (10.8)	2,682 (11.9)	3,159 (14.0)	3,579 (15.9)
	4-1/2 (114.3)	2,576 (11.5)	3,280 (14.6)	3,606 (16.0)	4,217 (18.7)	4,635 (20.6)	5,153 (22.9)
	5-1/2 (139.7)	3,262 (14.5)	4,477 (19.9)	4,539 (20.2)	5,445 (24.2)	5,817 (25.9)	6,413 (28.5)

* Allowable values are based upon a 4 to 1 safety factor. (Ultimate/4)

PERFORMANCE TABLE

LDT Anchors — *Recommended Edge & Spacing Requirements for Tension Loads* Carbon and Stainless Steel*

ANCHOR DIA. In. (mm)	EMBEDMENT DEPTH In. (mm)	EDGE DISTANCE REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	LOAD FACTOR APPLIED AT MIN. EDGE DISTANCE 1-3/4 Inches (44mm)	SPACING DISTANCE REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	LOAD FACTOR APPLIED AT MIN. SPACING DISTANCE 3 Inches (76mm)
3/8 (9.5)	1-1/2 (38.1)	2 (50.8)	70%	6 (152.4)	44%
	2 (50.8)	2 (50.8)	70%	6 (152.4)	44%
	2-1/2 (63.5)	3 (76.2)	70%	6 (152.4)	44%
	3-1/2 (88.9)	4 (101.6)	70%	6 (152.4)	44%
1/2 (12.7)	2 (50.8)	2-1/4 (57.2)	65%	8 (203.2)	27%
	3-1/2 (88.9)	3 (76.2)	65%	8 (203.2)	27%
	4-1/2 (114.3)	4 (101.6)	65%	8 (203.2)	27%

* Edge and spacing distance shall be divided by .75 when anchors are placed in structural lightweight concrete. Linear interpolation may be used for intermediate spacing and edge distances.

For 5/8" and 3/4" LDT Anchors, the critical edge distance for these anchors is 10 times the anchor diameter. The edge distance of these anchors may be reduced to 1-3/4" provided a 0.65 load factor is used for tension loads, a 0.15 load factor is used for shear loads applied perpendicular to the edge, or a 0.60 load factor is used for shear loads applied parallel to the edge. Linear interpolation may be used for intermediate edge distances.

PERFORMANCE TABLE

LDT Anchors — *Recommended Edge & Spacing Requirements for Shear Loads* Carbon and Stainless Steel*

ANCHOR DIA. In. (mm)	EMBEDMENT DEPTH In. (mm)	EDGE DISTANCE REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	LOAD FACTOR APPLIED AT MIN. EDGE DISTANCE 1-3/4 Inches (44mm)	SPACING DISTANCE REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	LOAD FACTOR APPLIED AT MIN. SPACING DISTANCE 3 Inches (76mm)
3/8 (9.5)	1-1/2 (38.1)	3 (76.2)	25%	6 (152.4)	57%
	2 (50.8)	4 (101.6)	25%	6 (152.4)	57%
	2-1/2 (63.5)	5 (127.0)	25%	6 (152.4)	57%
	3-1/2 (88.9)	5 (127.0)	25%	6 (152.4)	57%
1/2 (12.7)	2 (50.8)	5 (127.0)	25%	8 (203.2)	60%
	3-1/2 (88.9)	5 (127.0)	25%	8 (203.2)	60%
	4-1/2 (114.3)	5-1/2 (139.7)	25%	8 (203.2)	60%

* Edge and spacing distances shall be divided by .75 when anchors are placed in structural lightweight concrete. Linear interpolation may be used for intermediate spacing and edge distances.

2013

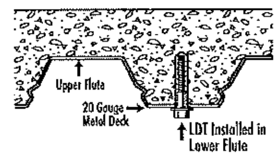
LDT Anchors — *Ultimate Tension Load (Lbs/kN) in Concrete Block (anchors should be installed by hand in hollow block)*

ANCHOR DIA. In. (mm)	EMBEDMENT DEPTH In. (mm)	HOLLOW CONCRETE BLOCK		GROUT FILLED CONCRETE BLOCK	
		TENSION Lbs. (kN)	SHEAR Lbs. (kN)	TENSION Lbs. (kN)	SHEAR Lbs. (kN)
3/8 (9.5)	1-1/2 (38.1)	916 (4.1)	3,176 (14.1)	1,592 (7.1)	3,900 (17.3)
1/2 (12.7)	2-1/2 (63.5)	N/A	N/A	5,924 (26.4)	6,680 (29.7)

LDT Anchors — *Allowable Tension and Shear* (Lbs/kN) in Concrete Block (anchors should be installed by hand in hollow block)*

ANCHOR DIA. In. (mm)	EMBEDMENT DEPTH In. (mm)	HOLLOW CONCRETE BLOCK		GROUT FILLED CONCRETE BLOCK	
		TENSION Lbs. (kN)	SHEAR Lbs. (kN)	TENSION Lbs. (kN)	SHEAR Lbs. (kN)
3/8 (9.5)	1-1/2 (38.1)	229 (1.0)	794 (3.5)	398 (1.8)	975 (4.3)
1/2 (12.7)	2-1/2 (63.5)	N/A	N/A	1,481 (6.6)	1,670 (7.4)

* Allowable values are based upon a 4 to 1 safety factor. (Ultimate/4)

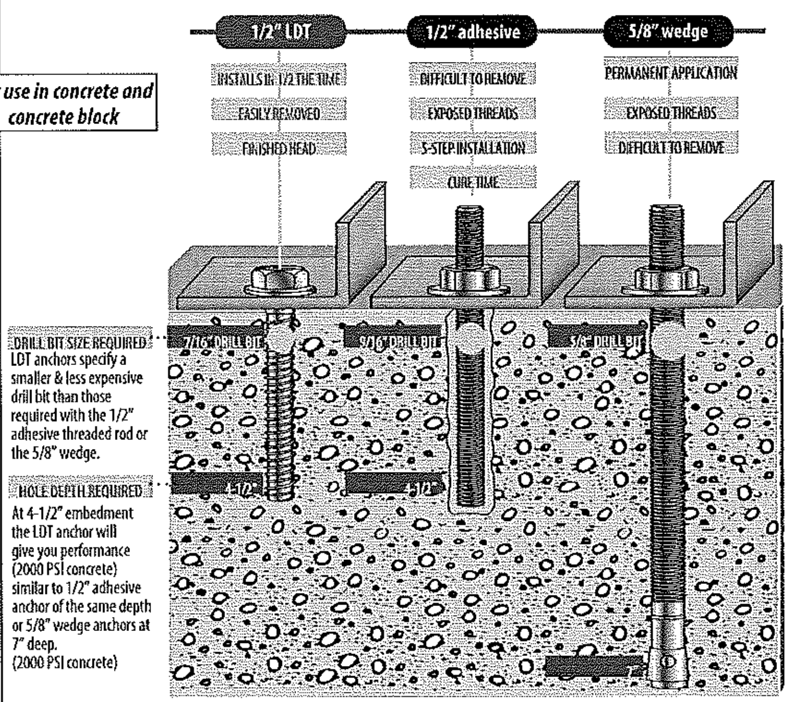


LDT Anchors — *Anchoring Overhead in 3000 PSI Lightweight Concrete On Metal Deck*

ANCHOR	DRILL HOLE DIAMETER In. (mm)	EMBEDMENT In. (mm)	3000PSI (20.7 MPa) CONCRETE		
			ULTIMATE TENSION LOAD Lbs. (kN)		ALLOWABLE WORKING LOAD Lbs. (kN)
3/8" LDT	5/16 (7.9)	1-1/2 (38.1)	Upper Flute	2,889 (12.9)	722 (3.2)
			Lower Flute	1,862 (8.3)	465 (2.1)

The Easy, Fast, High Performing, Removable Tapcon Anchor, Now Available in 3/8" and 1/2" Diameter

For use in concrete and concrete block



Precision Structural Engineering, Inc.
250 Main Street, Suite A • Klamath Falls, OR 97601
Tel (541) 850-6300 • FAX (541) 850-6233

Medford Office
836 Mason Way (off Sage Road) • Medford, OR 97501
Tel (541) 858-8500

www.structure1.com • Email: info@structure1.com

PROJECT NO. ______ SHEET 2014 OF ______

PROJECT NAME ______ DESIGNED BY AF DATE ______

SUBJECT ______ CHECKED BY ______ DATE ______

* Red head SRM-38 bolt

For Concrete > 3000 psi

$\frac{1}{2}$" ϕ bolt:

ultimate tension capacity = 5840 lb (page 2018)

allowable tension capacity = $\frac{5840^{lb}}{4}$ = 1460 lb

F.o.S

∴ 2 bolts tension capacity = 2*1460^{lb} = 2920 lb > 2425 lb

ultimate shear capacity = 4580 lb (page 2018)

allowable shear capacity = $\frac{4580}{4}$ = 2290 lb

∴ 4 bolts shear capacity = 4*2290^{lb} = 4580 lb > 250 lb

use [$\frac{1}{2}$" ϕ w/min 4" Embed, Red head SRM-38]

2018

PERFORMANCE TABLE

Multi-Set II Drop-In Anchors — Ultimate Tension and Shear Values (Lbs/kN) in Concrete*

BOLT DIA. In. (mm)	DRILL BIT SIZE In. (mm)	MIN. EMBEDMENT DEPTH In. (mm)	ANCHOR TYPE	TENSION Lbs. (kN) f'c = 2000 PSI (13.8 MPa)	TENSION Lbs. (kN) f'c = 4000 PSI (27.6 MPa)	TENSION Lbs. (kN) f'c = 6000 PSI (41.4 MPa)	SHEAR Lbs. (kN) f'c >2000 PSI (13.8 MPa)
1/4 (6.4)	3/8 (9.5)	1 (25.4)	RM, RL or CL-Carbon or SRM-18-8 S.S. or SSRM-316 S.S.	1,680 (7.5)	2,360 (10.5)	2,980 (13.3)	1,080 (4.8)
3/8 (9.5)	1/2 (12.7)	1-5/8 (41.3)		2,980 (13.3)	3,800 (16.9)	6,240 (27.8)	3,160 (14.1)
1/2 (12.7)	5/8 (15.9)	2 (50.8)		3,300 (14.7)	5,840 (26.0)	8,300 (36.9)	4,580 (20.4)
5/8 (15.9)	7/8 (22.2)	2-1/2 (63.5)		5,500 (24.5)	8,640 (38.4)	11,020 (49.0)	7,440 (33.1)
3/4 (19.1)	1 (25.4)	3-3/16 (81.0)		8,280 (36.8)	9,480 (42.2)	12,260 (54.5)	10,480 (46.6)

* Allowable values are based upon a 4 to 1 safety factor. Divide by 4 for allowable load values.

* For continuous extreme low temperature applications, use stainless steel.

Multi-Set II Drop-In Anchors — Ultimate Tension and Shear Values (Lbs/kN) in Lightweight Concrete*

BOLT DIA. In. (mm)	DRILL BIT SIZE In. (mm)	MINIMUM EMBEDMENT DEPTH In. (mm)	ANCHOR TYPE	LIGHTWEIGHT CONCRETE f'c = 3000 PSI (20.7 MPa) TENSION Lbs. (kN)	LIGHTWEIGHT CONCRETE f'c = 3000 PSI (20.7 MPa) SHEAR Lbs. (kN)	LOWER FLUTE OF STEEL DECK WITH LIGHTWEIGHT CONCRETE FILL f'c = 3000 PSI (20.7 MPa) TENSION Lbs. (kN)	LOWER FLUTE OF STEEL DECK WITH LIGHTWEIGHT CONCRETE FILL f'c = 3000 PSI (20.7 MPa) SHEAR Lbs. (kN)
3/8 (9.5)	1/2 (12.7)	1-5/8 (39.7)	RM, RL or CL-Carbon or SRM-18-8 S.S. or SSRM-316 S.S.	2,035 (9.1)	1,895 (8.4)	3,340 (14.9)	4,420 (19.6)
1/2 (12.7)	5/8 (15.9)	2 (50.8)		2,740 (12.2)	2,750 (12.2)	3,200 (14.2)	4,940 (22.0)
5/8 (15.9)	7/8 (22.2)	2-1/2 (63.5)		4,240 (18.9)	4,465 (19.9)	5,960 (26.5)	5,840 (26.0)
3/4 (19.1)	1 (25.4)	3-3/16 (81.0)		5,330 (23.7)	6,290 (28.0)	8,180 (36.4)	9,120 (40.6)

* Allowable values are based upon a 4 to 1 safety factor. Divide by 4 for allowable load values.

Multi-Set II Drop-In Anchors — Recommended Edge and Spacing Distance Requirements*

BOLT DIA. In. (mm)	DRILL BIT SIZE In. (mm)	EMBEDMENT DEPTH In. (mm)	ANCHOR TYPE	EDGE DISTANCE REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	MIN. EDGE DISTANCE AT WHICH LOAD FACTOR APPLIED =.80 FOR TENSION =.70 FOR SHEAR In. (mm)	SPACING REQUIRED TO OBTAIN MAX. WORKING LOAD In. (mm)	MIN. ALLOWABLE SPACING BETWEEN ANCHORS LOAD FACTOR APPLIED =.80 FOR TENSION =.55 FOR SHEAR In. (mm)
1/4 (6.4)	3/8 (9.5)	1 (25.4)	RM, RL or CL-Carbon or SRM-18-8 S.S. or SSRM-316 S.S.	1-3/4 (44.5)	7/8 (22.2)	3-1/2 (88.9)	1-3/4 (44.5)
3/8 (9.5)	1/2 (12.7)	1-5/8 (41.3)		2-7/8 (73.0)	1-7/16 (36.5)	5-11/16 (144.5)	2-7/8 (73.0)
1/2(12.7)	5/8 (15.9)	2 (50.8)		3-1/2 (88.9)	1-3/4 (44.5)	7 (177.8)	3-1/2 (88.9)
5/8(15.9)	7/8 (22.2)	2-1/2 (63.5)		4-3/8 (111.1)	2-3/16 (55.6)	8-3/4 (222.3)	4-3/8 (111.1)
3/4(19.1)	1 (25.4)	3-3/16 (81.0)		5-5/8 (142.9)	2-13/16 (71.4)	11-3/16 (284.2)	5-5/8 (142.9)

* Spacing and edge distances shall be divided by 0.75 when anchors are placed in structural lightweight concrete. Linear interpolation may be used for intermediate spacing and edge distances.

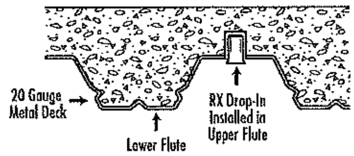
Multi-Set II Drop-In Anchors — Ultimate Tension and Shear Values (Lbs/kN) for RX-series (3/4" and 1" Embedment)*

BOLT DIA. In. (mm)	DRILL BIT SIZE In. (mm)	EMBEDMENT In. (mm)	2500 PSI (17.2 MPa) CONCRETE		4000 PSI (27.6 MPa) CONCRETE		HOLLOW CORE	
			TENSION Lbs. (kN)	SHEAR Lbs. (kN)	TENSION Lbs. (kN)	SHEAR Lbs. (kN)	TENSION Lbs. (kN)	SHEAR Lbs. (kN)
3/8 (9.5)	1/2 (12.7)	3/4 (19.1)	1,571 (7.0)	2,295 (10.2)	1,987 (8.8)	2,903 (12.9)	1,908 (8.5)	2,401 (10.7)
1/2 (12.7)	5/8 (15.9)	1 (25.4)	2,113 (9.4)	2,585 (11.5)	2,673 (11.9)	3,270 (14.5)	2,462 (11.0)	2,401 (10.7)

* The tabulated values are for RX anchors installed at a minimum of 12 diameters on center and minimum edge distance of 6 diameters for 100 percent anchor efficiency. Spacing and edge distance may be reduced to 6 diameters spacing and 3 diameter edge distance provided the values are reduced 50 percent. Linear Interpolation may be used for intermediate spacings and edge margins.

* Allowable values are based upon a 4 to 1 safety factor. Divide by 4 for allowable load values.

Multi-Set II Drop-In Anchors — Anchoring Overhead in 3000 PSI Lightweight Concrete On Metal Deck



ANCHOR	DRILL HOLE DIAMETER In. (mm)	EMBEDMENT In. (mm)	3000PSI (20.7 MPa) CONCRETE		
			ULTIMATE TENSION LOAD Lbs. (kN)		ALLOWABLE WORKING LOAD Lbs. (kN)
RX-38 Drop-In	1/2 (12.7)	3/4 (19.1)	Upper Flute	1,410 (6.3)	353 (1.6)
			Lower Flute	1,206 (5.4)	301 (1.3)

* Allowable values are based upon a 4 to 1 safety factor. Divide by 4 for allowable load values.

Combined Tension and Shear Loading—for Multi-Set Anchors

Allowable loads for anchors subjected to combined shear and tension forces are determined by the following equation:

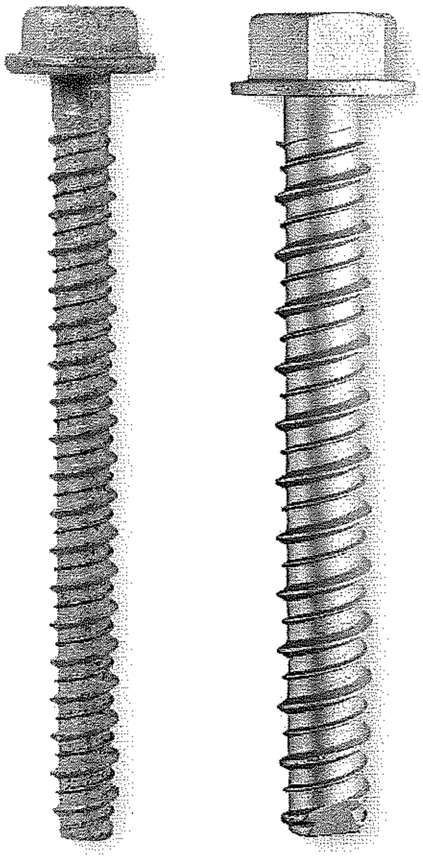
$$(Ps/Pt)^{5/3} + (Vs/Vt)^{5/3} \leq 1$$

Ps = Applied tension load Vs = Applied shear load Pt = Allowable tension load Vt = Allowable shear load

RED HEAD
CONCRETE ANCHORING SPECIALISTS

Large Diameter Tapcon (LDT) Anchors

Finished head, Removable Anchor



LDT

(3/8" & 1/2")   (5/8" & 3/4") Sawtooth™

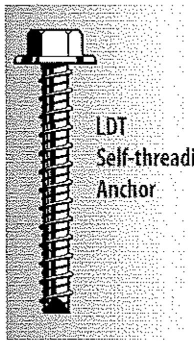
3/8" and 1/2" are available with *EnvireX* coating

Uses standard drill bits— no special drill bits to purchase or lose!

DESCRIPTION/SUGGESTED SPECIFICATIONS

Self-threading Anchors—

SPECIFIED FOR ANCHORAGE INTO CONCRETE



The LDT anchor is a high performance anchor that cuts its own threads into concrete.

Anchor bodies are made of hardened carbon steel and zinc plated, **Grade 5.**

The anchors shall have a finished hex washer head with anti-rotation serrations to prevent anchor back-out. The head of the anchor is stamped with a length identification code for easy inspection.

The anchor shall be installed with carbide tipped hammer drill bits made in accordance to ANSI B212.15-1994.

ADVANTAGES

SAVE TIME

EASILY INSTALLED

- Installs in less than half the time of wedge anchors or adhesive anchors
- Simply drill a pilot hole and drive the LDT anchor by hand or impact

EASILY REMOVED

- No torching or grinding required to remove anchors

SAVE MONEY

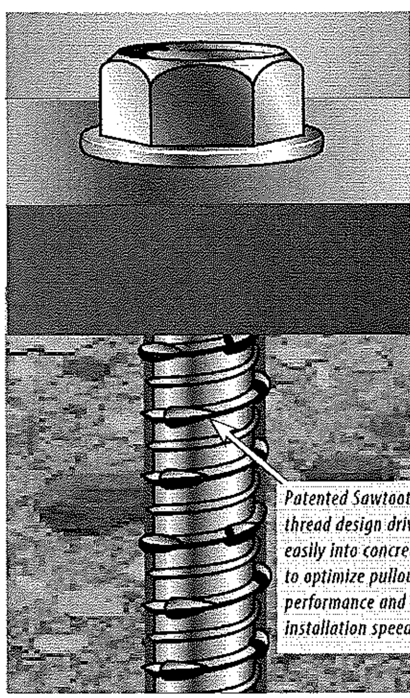
LOWER DRILL BIT COSTS

- Use standard ANSI bits instead of proprietary bits
- Single piece design, no nut and washer to assemble

USE STANDARD ANSI BITS

- No special proprietary bits to purchase or lose
- Reduce chances for anchor failure due to incorrect bit usage

Sawtooth Threads™, now available on 5/8" and 3/4"



IMPROVED PERFORMANCE IN LARGE DIAMETER HOLES

- Superior performance to wedge anchor
- Higher loads in shallow embedments
- Closer edge/spacing distance than mechanical anchors
- More threads for better thread engagement and higher pullout resistance
- Durable induction-hardened tip

EASY INSTALLATION

- Easy 2-step installation, simply drill a pilot hole and drive
- Installs in less than half the time of a wedge anchor
- Efficient thread cutting
- Use standard drill bit sizes
- Single piece design—no nut and washer assembly
- Easily removed

2015

RED HEAD
CONCRETE ANCHORING SPECIALISTS

Multi-Set II® Drop-In Anchors

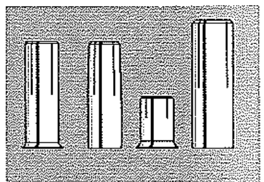
Internally Threaded Heavy-Duty Anchoring Systems

DESCRIPTION/SUGGESTED SPECIFICATIONS

Drop-In, Shell-Type Anchors—

SPECIFIED FOR ANCHORAGE INTO CONCRETE

Drop-In, shell-type anchors feature an internally threaded, all-steel shell with expansion cone insert and flush embedment lip. Anchors are manufactured from zinc-plated carbon steel, 18-8 stainless steel and 316 stainless steel.


Multi-Set II Drop-In Anchors

Anchors should be installed with carbide tipped hammer drill bits made in accordance to ANSI B212.15-1994 specifications.

Anchors should be tested to ASTM E488 criteria and listed by ICC-ES. Anchors should also be listed by the following agencies as required by the local building code: UL, FM, City of Los Angeles, California State Fire Marshal and Caltrans.

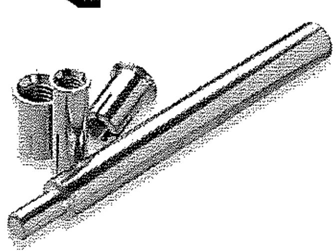
ADVANTAGES

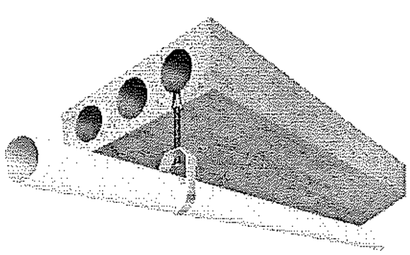
Depth Charge Stop Drill and RX Drop-In Anchors

Ideal for Hollow-Core, Pre-Cast Plank and Post Tension Slabs

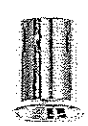
DepthCharge™ Stop Drill

- Optimized for use in hollow-core, pre-cast plank and post-tension slabs
- Lip keeps anchor flush during installation
- Shallow drilling—fast installation



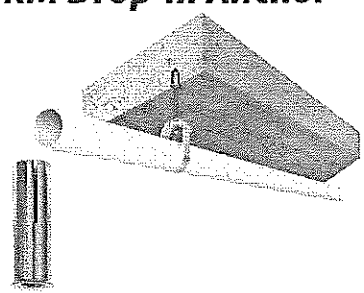


RX Drop-In Anchor



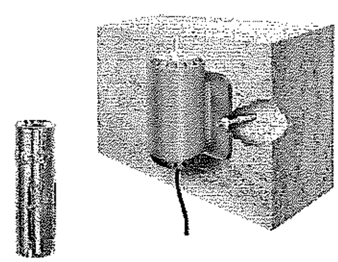
See page 81 for kits

RM Drop-In Anchor



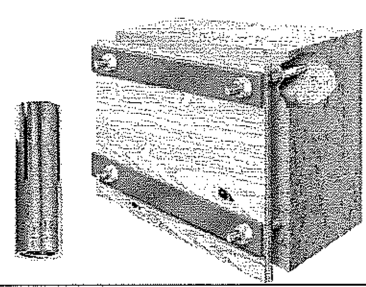
- Lipped anchor body keeps anchor flush
- Easy installation
- Keeps all rods same length
- Easy inspection
- Available in carbon steel, 18-8 and 316 stainless steel

RL Drop-In Anchor



- Below surface setting for easy patch work

Coil Thread Anchor

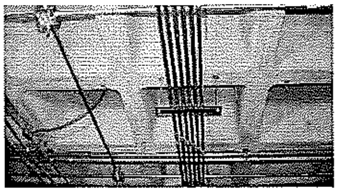


- Quick thread attachment—ideal for 1 sided forming
- Use coil rod on job
- 2 diameters (1/2" and 3/4")

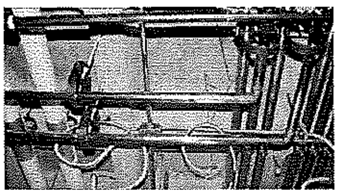
2016

APPLICATIONS

Pumps and heavy piping are common applications for larger diameter Multi-Set Drop-In Anchors.

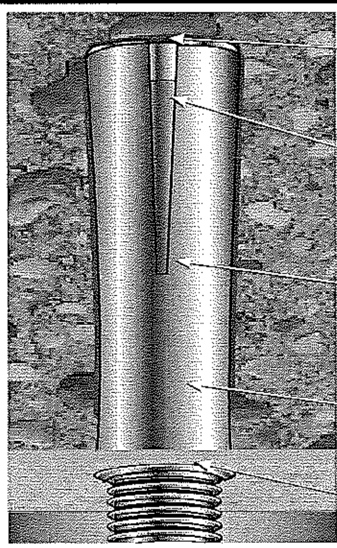


Cable tray and strut suspended from concrete ceilings are ideal Multi-Set applications. In post-tension or hollow-core slabs use the RX-38.



The Multi-Set Anchor is the standard for pipe-hanging. The RM version has a retainer lip to keep all anchors flush at the surface, keeping all your threaded rod the same length.

FEATURES



For use with threaded rods or headed bolts (supplied by contractor)

Expander Slots—allow for easy setting and superior performance

Cone Insert—that expands the anchor when driven with setting tool and hammer

Body—available in zinc-plated steel, 18-8 stainless steel, and 316 stainless steel

Easy Depth Inspection—keeps threaded rod drop lengths consistent

Retainer Lip—to keep anchor flush with surface

APPROVALS/LISTINGS

Meets or exceeds U.S. Government G.S.A. Specification A-A-55614 Type 1 (Formerly GSA: FF-S-325 Group VIII)

Underwriters Laboratories

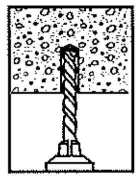
Factory Mutual

Caltrans

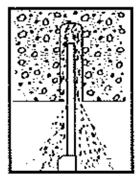
For the most current approvals/listings visit: www.itw-redhead.com

INSTALLATION STEPS

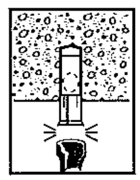
To set anchor flush with surface:



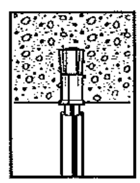
1. Drill hole to required embedment (see Table on page 69).



2. Clean hole with pressurized air.



3. Drive anchor flush with surface of concrete.



4. Expand anchor with setting tool provided (see chart on page 69). Anchor is properly expanded when shoulder of setting tool is flush with top of anchor.

SELECTION CHART

Multi-Set II
Depth Charge Bits

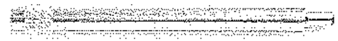
PART NUMBER	DESCRIPTION FEATURE BENEFITS	DRILLING DEPTH
DCX-138	3/8" Depth Charge Stop Drill	3/4"
DCX-112	1/2" Depth Charge Stop Drill	1"

DepthCharge™ *Stop Drill*

- Shoulder prevents over drilling. Less likely to hit reinforcing steel or post-tension cable in concrete
- No wasted time or energy drilling deeper than necessary
- Prevents anchor from dropping too far into hole below work surface

2017

SELECTION CHARTS

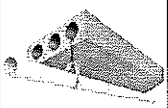
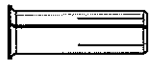
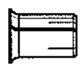
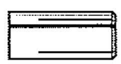
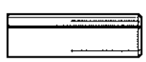
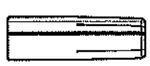


PART NUMBER RT-138
1 setting tool per master carton
(See above for part numbers.)

PART NUMBER RTX-138
For use with RX-38 only.

PART NUMBER RTX-112
For use with RX-12 only.

Multi-Set II
Drop-In Anchors

USER TYPE / APPLICATION	BASE MATERIAL	CORROSION RESISTANCE LEVEL	DROP-IN ANCHOR TYPE	PART NUMBER	SETTING TOOL PART NUMBER*	BOLT SIZE-THREADS PER INCH	DRILL BIT DIA. In. (mm)	THREAD DEPTH In. (mm)	EMBEDMENT MIN. HOLE DEPTH In. (mm)	QTY/WT PER BOX lbs.	QTY/WT PER MASTER CTN lbs. *
HVAC/Fire Sprinkler Plumber (Pipe-fitter) 	Solid concrete/ lightweight fill deck	Low	RM 	RM-14	RT-114	1/4" - 20	3/8 (9.5)	3/8 (9.5)	1 (25.4)	100/ 2.6	1000/ 28
				RM-38	RT-138	3/8" - 16	1/2 (12.7)	1/2 (12.7)	1-5/8 (41.3)	50/ 3.4	500/ 36
				RM-12	RT-112	1/2" - 13	5/8 (15.9)	3/4 (19.1)	2 (50.8)	50/ 5.8	400/ 49
				RM-58	RT-158	5/8" - 11	7/8 (22.2)	1 (25.4)	2-1/2 (63.5)	25/ 7.8	125/ 41
				RM-34	RT-134	3/4" - 10	1 (25.4)	1-1/4 (31.8)	3-3/16 (81.0)	25/11.9	100/ 49
	Hollow-core pre-cast or Post-tension	Low	RX 	RX-38	RTX-138	3/8" - 16	1/2 (12.7)	3/8 (9.5)	3/4 (19.1)	100/ 3.5	1000/ 36
				RX-12	RTX-112	1/2" - 13	5/8 (15.9)	1/2 (12.7)	1 (25.4)	50/ 3.0	500/ 31
	Solid concrete/ lightweight fill deck	Medium	SRM** 18-8 S.S. 	SRM-14	RT-114	1/4" - 20	3/8 (9.5)	3/8 (9.5)	1 (25.4)	100/ 2.7	1000/ 28
				SRM-38	RT-138	3/8" - 16	1/2 (12.7)	1/2 (12.7)	1-5/8 (41.3)	50/ 3.4	500/ 36
				SRM-12	RT-112	1/2" - 13	5/8 (15.9)	3/4 (19.1)	2 (50.8)	50/ 6.0	400/ 50
				SRM-58	RT-158	5/8" - 11	7/8 (22.2)	1 (25.4)	2-1/2 (63.5)	25/ 7.9	125/ 42
				SRM-34	RT-134	3/4" - 10	1 (25.4)	1-1/4 (31.8)	3-3/16 (81.0)	25/12.0	100/ 50
	Solid concrete	High	SSRM** 316 S.S.	SSRM-38	RT-138	3/8" - 16	1/2 (12.7)	1/2 (12.7)	1-5/8 (41.3)	50/ 3.4	500/ 36
				SSRM-12	RT-112	1/2" - 13	5/8 (15.9)	3/4 (19.1)	2 (50.8)	50/ 6.0	400/ 50
Concrete Contractor, General Contractor, Highway	Solid concrete	Low	CL-Coil Threaded 	CL-12	RT-112	1/2" - 6	5/8 (15.9)	3/4 (19.1)	2 (50.8)	50/ 5.7	400/ 47
				CL-34	RT-134	3/4" - 4.5	1 (25.4)	1-1/4 (31.8)	3-3/16 (81.0)	25/11.9	100/ 49
Concrete Cutting/ Sawing Contractor/ Misc. Metal	Solid concrete/ lightweight fill deck	Low	RL (w/o lip) 	RL-14	RT-114	1/4" - 20	3/8 (9.5)	3/8 (9.5)	1 (25.4)	100/ 2.6	1000/ 28
				RL-38	RT-138	3/8" - 16	1/2 (12.7)	1/2 (12.7)	1-5/8 (41.3)	50/ 3.4	500/ 36
				RL-12	RT-112	1/2" - 13	5/8 (15.9)	3/4 (19.1)	2 (50.8)	50/ 5.8	400/ 49
				RL-58	RT-158	5/8" - 11	7/8 (22.2)	1 (25.4)	2-1/2 (63.5)	25/ 7.8	125/ 41
				RL-34	RT-134	3/4" - 10	1 (25.4)	1-1/4 (31.8)	3-3/16 (81.0)	25/11.9	100/ 49

* 1 setting tool per master carton. ** For continuous extreme low temperature, use stainless steel.

Multi-Set II
RX Drop-In Kits

Part No.	Description
RX-38	3/8" drop-in using 1/2" drill bit
RTX-138	Setting Tool
DCX-138	Depth Charge Stop Drill
RX-38KIT	Contains: 1,000 RX-38 Anchors, 5 RTX-138 Setting Tools and 2 DCX-138 Depth Charge Stop Drills

Part No.	Description
RX-12	1/2" drop-in using 5/8" drill bit
RTX-112	Setting Tool
DCX-112	Depth Charge Stop Drill

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PROJECT NO. Stainless Cable 216- SHEET 2018 OF

PROJECT NAME DESIGNED BY AF DATE

SUBJECT Base plate CHECKED BY DATE

2) Base plate to wood , wood specific weight = 0.43

$$\text{Tension} = \frac{M}{d} = \frac{875^{\text{lb}}}{4.65/12} = 2258 \text{ lb}$$

Adjustment for wood bearing

$$C_b = (5.25'' + 0.375'')/5.25'' = 1.071 \quad (3.10\text{-}2$$

$$a = \frac{2258^{\text{lb}}}{(1.071 * 625\text{psi} * 5.25\text{in}} = 0.64''$$

$$\text{Tension} = T = \frac{875^{\text{lb.ft}} * 12^{\frac{\text{ft}}{\text{in}}}}{\left(4.65 - \frac{0.64}{2}\right)} = 2425 \text{ lb}$$

$\frac{3}{8}''$ ϕ lag screw w/5'' min Embed tension capacity $= 243^{\text{lb}} * 5^{\text{in}} = 1215$ lb (page 2019.)

2- lag screws capacity $= 2 * 1215^{\text{lb}} = 2430 \text{ lb} > 2425^{\text{lb}}$

use [4- $\frac{3}{8}''$ lag screws w/min 5'' Embed]

2019

Table 12.2A Lag Screw Reference Withdrawal Design Values, W[1]

Tabulated withdrawal design values (W) are in pounds per inch of thread penetration into side grain of wood member. Length of thread penetration in main member shall not include the length of the tapered tip (see 12.2.1.1).

Specific Gravity, G[2]	Lag Screw Diameter, D										
	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"
0.73	397	469	538	604	668	789	905	1016	1123	1226	1327
0.71	381	450	516	579	640	757	868	974	1077	1176	1273
0.68	357	422	484	543	600	709	813	913	1009	1103	1193
0.67	349	413	473	531	587	694	796	893	987	1078	1167
0.58	281	332	381	428	473	559	641	719	795	869	940
0.55	260	307	352	395	437	516	592	664	734	802	868
0.51	232	274	314	353	390	461	528	593	656	716	775
0.50	225	266	305	342	378	447	513	576	636	695	752
0.49	218	258	296	332	367	434	498	559	617	674	730
0.47	205	242	278	312	345	408	467	525	580	634	686
0.46	199	235	269	302	334	395	453	508	562	613	664
0.44	186	220	252	283	312	369	423	475	525	574	621
0.43	179	212	243	273	302	357	409	459	508	554	600
0.42	173	205	235	264	291	344	395	443	490	535	579
0.41	167	198	226	254	281	332	381	428	473	516	559
0.40	161	190	218	245	271	320	367	412	455	497	538
0.39	155	183	210	236	261	308	353	397	438	479	518
0.38	149	176	202	227	251	296	340	381	422	461	498
0.37	143	169	194	218	241	285	326	367	405	443	479
0.36	137	163	186	209	231	273	313	352	389	425	460
0.35	132	156	179	200	222	262	300	337	373	407	441
0.31	110	130	149	167	185	218	250	281	311	339	367

1. Tabulated withdrawal design values, W, for lag screw connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Specific gravity, G, shall be determined in accordance with Table 12.3.3A.

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PROJECT NO. Stainless Cable 216-1 SHEET 2020 OF

PROJECT NAME guard rail DESIGNED BY AF DATE

SUBJECT Cable CHECKED BY DATE

Cable Design

Max Tension = 310 lb (page 1009)

$S_g \geq 2.2T$ per 3.2.1 Structural applications of steel cables

$2.2T = 679.8$ lb

$\frac{1}{8}$" ϕ Cable nominal strength = 2000 lb

$S_n = 2000$ lb

$\phi_f = 0.8$ per table 3.2.1

$S_g = \phi_f \cdot S_n$

$= 0.8 * 2000 = 1600 \text{ lb} > 679.8 \text{ lb}$

use [1/8" ϕ cable]

2071

Precision Structural Engineering, Inc.

Project No.	Stainless Cable & Railing 216-1	Sheet No.	
Project Name:	Guard Rail W/ Cables	Date:	
Subject:	Cable design		
Designed By:		Checked By:	

Cable Design

Tension, T =	309	+	0	=	309	lb
$S_g \geq 2.2$ T	Per 3.2.1 Structural Applications of Steel Cables					
2.2T =	679.8 lb					

Allowable Load on " Cable

Nominal Strength, Sn =	2000	lb			
# of Cables =	1				
Sn =	2000	lb			
$\Phi_f =$	0.8	Per Table 3.2.1			
$S_g = \Phi_f * S_n$	1600	lb	>	679.8	lb

Safe

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dynamic analysis or through wind tunnel tests; wind-induced structural vibration and fatigue effects; and earthquake effects.

3.1.2 Load combinations. Cable tensions shall be calculated for the following load combinations:

T_1 = Cable tension due to $D + P$

T_2 = Cable tension due to $D + P + L + (L_r$ or S or $R)$.

T_3 = Cable tension due to $D + P + (W$ or $E)$

T_4 = Cable tension due to $D + P + L + (L_r$ or S or $R) + (W$ or $E)$

T_5 = Cable tension due to C + erection components of D, L, P, and W.

3.2 Cable Strength

3.2.1 Design strength. The design strength S_d of each cable shall be equal to or greater than:

(a) 2.2 T_1

(b) 2.2 T_2

(c) 2.0 T_3

(d) 2.0 T_4

(e) 2.0 T_5

The above criteria shall be satisfied for the full range of temperatures to which the structure will be subjected.

Except for designs in which fatigue and/or elevated temperature control, the design strength S_d of the cable shall be taken as the smaller of:

$$S_d = S_n \times \phi_f \quad \text{or} \quad S_d = S_n \times \phi_d$$

in which

S_n = specified nominal strength of the cable,

ϕ_f = fitting reduction factor, and

ϕ_d = deflector reduction factor ($\phi_d = 1$ for no deflector).

3.2.1.1 Fitting reduction factor. The factor to be applied due to the action of the end fitting in transferring tension from the cable to the fitting is given in Table 3.2.1.

3.2.1.2 Deflector reduction factor. The factor to be applied due to curvature over a saddle is given in Table 3.2.2.

Table 3.2.2 applies to saddles for which the live load changes the deflector angle of the cable less than 2 degrees for strand and 4 degrees for rope, per saddle end. For greater anticipated deflector angle changes, the deflector reduction factor shall be determined by an approved method. Table 3.2.2 is limited to curvature induced by saddles.

3.2.1.3 Elevated temperature effect. The effect of elevated temperature on the physical properties of cable and end fittings shall be considered during design.

3.2.1.4 Fatigue effect. The reduction in cable strength due to fatigue effects shall be considered.

Table 3.2.1
Fitting reduction factor.

Type of Termination	Fitting Reduction Factor ϕ_f	
	Rope	Strand
Poured socket (Zinc or resin)	1.00	1.00
Swaged socket	1.00 (Note #1)	(Note #2)
Mechanical loop splice with sleeve and thimble		
0 < dia ≤ 1 inch	0.95	N/A
1 < dia ≤ 2 inch	0.925	N/A
2 < dia ≤ 3-1/2 inch	0.90	N/A
Loop or thimble splice (Hand splice)		
(Carbon steel rope)		
1/4 inch size	0.90	N/A
1/2	0.86	N/A
3/4	0.82	N/A
7/8 thru 2-1/2	0.80	N/A
(Stainless steel rope)		
1/4 inch size	0.80	N/A
1/2	0.76	N/A
3/4	0.72	N/A
7/8	0.70	N/A
Wedge socket (Note #3)	0.75 to 0.80	N/A
Clip (Note #4)	0.80	N/A

Notes:
1 in. = 25.4 mm
Note #1 – Regular lay ropes only. Consult manufacturer for sizes over 2 inches.
Note #2 – Consult manufacturer.
Note #3 – Value depends on fitting design. Typical range given. Consult fitting manufacturer for a more precise value.
Note #4 – Number of clips varies with size and construction of rope.

2024

3.2.2 End fittings. Fittings shall develop an ultimate strength of at least 110 percent of the specified nominal cable strength. Moreover, fittings shall be designed such that the computed average stresses across the fitting body are less than the yield stress of the fitting material under a static tension force equal to the specified nominal strength of the rope or strand for which the fitting is designed to be attached. Localized yielding at stress concentrations, such as at the line contact of pins and the roots of screw threads, is permitted at the cable working tension.

Under special circumstances, over-designed cables may terminate with undersize fittings, or conventionally designed cables with oversize fittings. Such designs shall be based on data supplied by an assembler or a fitting manufacturer regarding fit of the cable in the fitting and the stresses in the fitting.

3.3 Structural Analysis

3.3.1 General considerations. The structural analysis shall be based on the following considerations in addition to those mentioned elsewhere in this Standard:

(a) Elastic stretch of the cables and deformation of the supporting structure shall be taken into account in the design.

(b) Nonlinear analyses shall be performed if it is determined that the magnitudes of the cable displacements are such that the equilibrium equations should be based on the geometry of the displaced structure.

3.3.2 Vibrations. The effect of dynamic loading on cable stresses, fatigue, and deflections of the individual cable and the entire structure shall be considered in the design.

3.3.3 Deflections. Cables supporting floors and roofs shall be so proportioned that the maximum deflection under the combined action of applied loads and cable stretch will not damage the supported or adjacent structure.

Table 3.2.2
Deflector reduction factor.

Ratio: Saddle Radius to Rope Diameter	Ratio: Saddle Radius to Strand Diameter	Deflector Reduction Factor ϕ_d
15 and over	20 and over	1.0
14	19	0.95
13	18	0.90
12	17	0.85
11	16	0.80
10 min.	15 min.	0.75

3.3.4 Erection analyses. A structural analysis shall be performed for the suggested or mandatory erection procedure including the items listed in Section 3.3.1.

4.0 Cable Materials

4.1 Cable Specifications

This Standard applies to cables conforming to the following standard specifications:

ASTM A416-90A, *Steel Strand, Uncoated Seven-Wire Stress-Relieved Steel Strand for Prestressed Concrete.*

ASTM A474-86, *Aluminum-Coated Steel Wire Strand.*

ASTM A475-89, *Zinc-Coated Steel Wire Strand.*

ASTM A492-92, *Stainless and Heat-Resisting Steel Wire Rope.*

ASTM A586, *Zinc-Coated Parallel and Helical Steel Wire Structural Strand.*

ASTM A603-88, *Zinc-Coated Steel Structural Wire Rope.*

ASTM A779-90, *Steel Strand, Seven-Wire, Uncoated, Compacted, Stress-Relieved for Prestressed Concrete.*

ASTM A855/855M-89, *Zinc—5% Aluminum-Mischmetal Alloy-Coated Steel Wire Strand.*

ASTM A882/882M-91, *Epoxy-Coated Seven-Wire Prestressing Steel Strand.*

Some of the above cable specifications apply to cables of a specific construction. This Standard does not exclude cables of other construction provided that the chemical and mechanical properties of the wires constituting the cables conform to the requirements of one of the above specifications.

4.2 Prestretching

For each type and construction of cables specified in the contract documents, the prestretching requirements shall be explicitly stated. For prestretched cables, the minimum value of the modulus of elasticity of the cable after prestretching shall be specified. Prestretch force shall be not less than 50% of the nominal cable strength of cables that are 2-1/2 in. (63 mm) in diameter or less, except if it can be physically demonstrated by the manufacturer that