STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL
Ten Franklin Square, New Britain, CT 06051
Phone: (860) 827-2935 Fax: (860) 827-2950A
E-Mail: siting.council@ct.gov
Web Site: portal.ct.gov/csc

VIA ELECTRONIC MAIL

February 10, 2021

Kristina Cottone
Real Estate Specialist
Smartlink, LLC
85 Rangeway Road
Building 3, Suite 102
North Billerica, MA 01862

RE: **EM-AT&T-050-210104** – AT&T Mobility, LLC notice of intent to modify an existing telecommunications facility located at 67 Main Street, Essex, Connecticut.

Dear Ms. Cottone:

The Connecticut Siting Council (Council) is in receipt of your correspondence of February 5, 2021 submitted in response to the Council's February 5, 2021 notification of an incomplete request for exempt modification with regard to the above-referenced matter.

The submission renders the request for exempt modification complete. Please be advised that as of January 25, 2021, the Council is not processing any request for an exempt modification from any carrier until compliance with the conditions of prior Council approvals is achieved.

Thank you for your attention and cooperation.

Sincerely,

s/ Melanie A. Bachman

Melanie A. Bachman
Executive Director

MAB/emr

From: Kristina Cottone <kristina.cottone@smartlinkgroup.com>
Sent: Friday, February 5, 2021 2:44 PM
To: Robidoux, Evan <Evan.Robidoux@ct.gov>
Cc: CSC-DL Siting Council <Siting.Council@ct.gov>
Subject: RE: Council Incomplete Letter for EM-AT&T-050-210104 (6 Main Street, Essex)

Hi Evan,

Sorry, this has happened before when combining the pdf's, the stamps/signatures disappear when combined in adobe. Please see stamped SA and MA as requested.

Thank you,

Kristina Cottone
Real Estate Specialist
Smartlink
c. 978-551-8627

From: Robidoux, Evan <Evan.Robidoux@ct.gov>
Sent: Friday, February 5, 2021 2:32 PM
To: Kristina Cottone <kristina.cottone@smartlinkgroup.com>
Cc: CSC-DL Siting Council <Siting.Council@ct.gov>
Subject: Council Incomplete Letter for EM-AT&T-050-210104 (6 Main Street, Essex)

Please see the attached correspondence.

STRUCTURAL ANALYSIS REPORT

Prepared for: Smartlink/AT&T

New Antenna Installation
on Existing Water Tank Structure

Site No.: CTL02163
Site Name: ESSEX CT
10 Main Street
Essex, CT 06426

August 13, 2020

Henry M. Bellagamba, P.E.

FULLERTON
ENGINEERING-DESIGN

Fullerton Engineering Consultants, LLC
1100 E. Woodfield Road, Suite 500
Schaumburg, IL 60173
Tel: 847.908.8400
www.fullertonengineering.com

Project Number: 2020.0032.0090

Summary

The structural analysis was performed by Fullerton Engineering Consultants, as requested by the client, to determine the conformance of the existing structure with the governing 2018 Connecticut Building Code (2015 International Building Code w/ Amendments) and the industry standards TIA-222-G (Structural Standards for Steel Antenna Towers and Antenna Supporting Structures) and AWWA D100-11 (Welded Carbon Steel Tanks for Water Storage). The analysis considers the structural properties, existing antennas and proposed antennas and the required loading criteria.

Scope

- Determine adequacy of the existing water tank structure to support the existing and proposed antenna and equipment installation.

Conclusion

- The existing water tank structure is **adequate** to support the existing and proposed antenna and equipment installation.

Analysis Data

The following is based on information provided by the client, field investigation, and other determination by Fullerton Engineering Consultants or third parties.

References:	Tower Mapping Report by HighTower Solutions Inc. dated 7/29/2020 RFDS by AT&T dated 05/27/2020

Appurtenance Loading Schedule

ELEV. (FT.=AGL)	APPURTENANCE
	Proposed
108’-0” (AT&T)	(2) Commscope NNHH-65C-R4 Antennas (1) Commscope NNHH-65A-R4 Antennas (2) CCI DMP65R-BU8DA Antennas (1) CCI DMP65R-BU4DA Antennas (3) Ericsson RRUS-4415 B30 RRH Units (3) Ericsson RRUS-4449 B5/B12 RRH Units (3) Ericsson RRUS-8843 B2/B66A RRH Units (3) Raycap DC9-48-60-24-PC16-EV Units Proposed antennas and equipment will be installed on existing catwalk handrail.
	Existing (To Remain)
117’-7”	(3) 7’ Antennas (3) Alcatel-Lucent TD-RRH8x20-25 RRH Units (3) Alcatel-Lucent RRH1900 4x45 RRH Units (6) Alcatel-Lucent RRH2x50-800 RRH Units Existing antennas and RRH units to remain attached to existing water tank.
108’-0” (AT&T)	(3) Powerwave 7770 Antennas (6) Powerwave LGP 21401 TMA Units Existing antennas and TMA units to remain on existing catwalk handrail.
107’-2”	(2) Amphenol LPA 80080/6CF E-DIN Antennas (3) Amphenol LPA 80063-6CF-EDIN Antennas (6) Commscope SBNHH-1D65B Antennas (3) Alcatel-Lucent RRH4x45 B66A RRH Units (3) Alcatel-Lucent RRH4x30 B13 RRH Units (12) RFS TMA Units (2) Raycap RRFDC-3315-PF-48 Units Existing antennas, RRH, TMA, Raycap units to remain on existing catwalk handrail.
	Existing (To be Removed)
108’-0” (AT&T)	(1) KMW AM-X-CD-17-65-00T-RET Antenna (1) Commscope SBNH-1D6565C Antenna (1) Commscope SBNH-1D4545A Antenna (3) Powerwave 7770 Antennas (3) Ericsson RRUS-11 B12 Units (3) Ericsson RRUS-12 Units (6) Powerwave LGP 21901 Diplexors (3) Raycap DC2 Units Existing antennas and equipment to be removed prior to the installation of new equipment.

Assumptions

This analysis is based on the theoretical capacity of the members and is not a condition assessment of the structure. The analysis is based solely on the information supplied, and the results, in turn, are only as accurate as data extracted from this information. Fullerton has been instructed by the client to assume the information supplied is accurate, and Fullerton has made no independent determination of its accuracy. The exception to the previous statement is if Fullerton has been contracted by the client to provide an independent structural mapping report of the structure and related appurtenances, in which case Fullerton has made an independent determination of the accuracy of the information resulting from the mapping report.

- The structural member sizes and geometry are considered accurate as supplied. The material grade is as per data supplied and/or as assumed and stated in the materials section.
- The existing structure is assumed to have been properly maintained. The existing structure is assumed to be in good condition with no structural defects and with no deterioration to its member capacities.
- The antenna configuration is as supplied and/or stated in the analysis section. It is assumed to be complete and accurate. All antennas, mounts, remote radios, cables and cable supports are assumed to be properly installed and supported as per the manufacturer's requirements.
- The antennas, mounts, remote radios, cables and cable supports stated in the appurtenance loading schedule represent Fullerton's understanding of the overall antenna configuration. If the actual configuration is different than above, then this analysis is invalid. Please refer to this report for the projected wind areas used in the calculations for antennas and mounts. If variations or discrepancies are identified, please inform Fullerton.
- Some assumptions are made regarding antenna and mount sizes and their projected areas based on a best interpretation of the data supplied and a best knowledge of antenna type and industry practice.
- All welds and connections are assumed to develop at least the member capacity, unless determined otherwise and explicitly stated in this report.
- All prior structural modifications, if any, are assumed to be as per date supplied/ available, to be properly installed and to be fully effective.

Scope and Limitations

The engineering services rendered by Fullerton Engineering Consultants, Inc. (Fullerton) in connection with this structural analysis are limited to an analysis of the structure, size and capacity of its members. Fullerton does not analyze the fabrication, including welding and connection capacities, except as included in this report.

The information and conclusions contained in this report were determined by application of the current engineering standards and analysis procedures and formulae, and Fullerton assumes no obligation to revise any of the information or conclusions contained in this report in the event such engineering and analysis procedures and formulae are hereafter modified or revised.

Fullerton makes no warranties, expressed or implied in connection with this report and disclaims any liability arising from original design, material, fabrication and erection deficiencies or the “as-built” condition of this structure.

Installation procedures and loading are not within the scope of this report and should be performed and evaluated by a competent contractor.

Section I

Structural Calculations

Analysis and Design Criteria

Type of structure		Water Tower	
Elevation of antenna centerline above ground		$z := 108ft$	
Structure height above grade		$h := 122.67ft$	
Ultimate Design 3-Second Gust Wind Speed		$V_{ult} := 131$ *mph*	*2018 Connecticut Building Code: Section 1609*
Equivalent Nominal Wind Speed		$V_{asd} := V_{ult} \cdot \sqrt{0.6} = 101.47$*mph*	*2018 Connecticut Building Code: Section 1609.3.1*
Basic Wind Speed: 3-second gust	*GOVERNS*	$V_{3sec.gust} := 116$ *mph*	*ANSI/TIA-222-G: ANNEX B*
Structure Class		II	*ANSI/TIA-222-G: Section 2.6.6.2*
Exposure Category		C	*ANSI/TIA-222-G: Section 2.6.6.2*
Topographic Category		1	*ANSI/TIA-222-G: Section 2.6.6.2*
Gust Effect Factor		$G_h := 0.85$	*ANSI/TIA-222-G, Section 2.6.9*
Height of crest above surrounding terrain		$H := 5ft$	
Importance Factor for Wind		$I_{wind} = 1$	*ANSI/TIA-222-G: Table 2-3*
Wind Direction Probability Factor		$K_d = 0.95$	*ANSI/TIA-222-G: Table 2-2*
Velocity Pressure Coefficient		$K_z = 1.29$	*ANSI/TIA-222-G: Section 2.6.5.2*
Topographic Factor		$K_{zt} = 1$	*ANSI/TIA-222-G: Section 2.6.6.4*
$q_z := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot I_{wind} \cdot V^2 \cdot psf$		$q_z = 42.09 \cdot psf$	*Velocity Pressure* *ANSI/TIA-222-G: Section 2.6.9.6.*

Tank Dimensions and Properties

$d_{tank} := 82ft$	*Diameter of tank*
$h_{tank} := 122.67ft$	*Overall height of structure*
$h_{main} := 11.083ft$	*Height of flat-sided cylindrical part of tank*
$h_{top} := 6.333ft$	*Height from top of cylindrical part to topmost part of tank.*
$h_{bottom} := 6.333ft$	*Height from bottom of cylindrical part to bottommost part of tank.*
$h_{balcony} := 108ft$	*Elevation of balcony*

Columns

$n_{legs} := 4$	*Number of perimeter columns*
$d_{col} := 17.1in$	*Diameter of column*
$Dist_{col} := 24.25ft$	*Distance between column feet*

LEG := ● Round ○ Flat

Center Riser

$d_{riser} := 3.1ft$	*Diameter of the riser*

Diagonal Rods

$n_{bays} := 3$	*Number of bays per side*
$n_{rods} := 2$	*Rods per bay*
$d_{rod} := 1.25in$	*Diameter of rods*

Horizontal Struts *(between tank legs)*

$H_{strut} := 8in$	*Height of individual strut*

Horizontal Rods *(between tank leg and riser)*

$d_{Hrod} := 1in$	*Diameter of horizontal rods*

Discrete Appurtenances

Antennas

Antenna name/model	*Number of antennas*	*Elevation of antennas*	*Flat antenna?* *1 = yes* *0 = no (round)*
"(N) Commscope NNHH-65C-R4 Antennas"	2	108	1
"(N) Commscope NNHH-65A-R4 Antennas "	1	108	1
"(N) CCI DMP65R-BU8DA Antennas "	2	108	1
"(N) CCI DMP65R-BU4DA Antennas "	1	108	1
"(N) Ericsson RRUS-4415 B30 RRH "	3	108	1
"(N) Ericsson RRUS-4449 B5/B12 RRH "	3	108	1
"(N) Ericsson RRUS-8843 B2/B66A RRH "	3	108	1
"(N) Raycap DC9-48-60-24-PC16-EV "	3	108	0
"(E) 7' Antennas "	3	117.583	1
"(E) Alcatel-Lucent TD-RRH8x20-25 RRH "	3	117.583	1
"(E) Alcatel-Lucent RRH1900 4x45 RRH "	$n_{ant} :=$ 3	$z_{ant} :=$ 117.583 ft	$shape_{ant} :=$ 1
"(E) Alcatel-Lucent RRH2x50-800 RRH "	6	117.583	1
"(E) Powerwave 7770 Antennas "	3	108	1
"(E) Powerwave LGP 21401 TMA "	6	108	1
"(E) Amphenol LPA 80080/6CF E-DIN Antennas "	2	107.167	1
"(E) Amphenol LPA 80063-6CF-EDIN Antennas "	3	107.167	1
"(E) Commscope SBNHH-1D65B Antennas "	6	107.167	1
"(E) Alcatel-Lucent RRH4x45 B66A RRH "	3	107.167	1
"(E) Alcatel-Lucent RRH4x30 B13 RRH "	3	107.167	1
"(E) RFS TMA Units "	12	107.167	1
"(E) Raycap RRFDC-3315-PF-48 "	2	107.167	1

Height of antennas

$$height_{ant} := \begin{pmatrix} 96 \\ 55.1 \\ 96 \\ 48 \\ 14.96 \\ 14.96 \\ 14.9 \\ 31.41 \\ 84 \\ 26 \\ 26 \\ 16 \\ 55 \\ 14.5 \\ 70 \\ 70 \\ 72 \\ 25 \\ 20 \\ 4.5 \\ 18 \end{pmatrix} in$$

Width of antennas

$$width_{ant} := \begin{pmatrix} 19.6 \\ 19.6 \\ 20.7 \\ 20.7 \\ 13.19 \\ 13.19 \\ 13.2 \\ 10.24 \\ 21 \\ 18 \\ 12.5 \\ 13 \\ 11 \\ 9.5 \\ 6 \\ 15 \\ 12 \\ 12 \\ 11.75 \\ 6.25 \\ 15 \end{pmatrix} in$$

Depth of antennas

$$depth_{ant} := \begin{pmatrix} 7.8 \\ 7.8 \\ 7.7 \\ 7.7 \\ 5.39 \\ 10.43 \\ 40.9 \\ 10.24 \\ 6 \\ 6.5 \\ 13 \\ 10 \\ 5.25 \\ 2.75 \\ 14 \\ 8 \\ 7.5 \\ 7 \\ 7.25 \\ 1 \\ 10 \end{pmatrix} in$$

Weight of antennas

$$weight_{ant} := \begin{pmatrix} 112.9 \\ 80.9 \\ 126.8 \\ 76.5 \\ 46 \\ 73 \\ 72 \\ 26.2 \\ 50 \\ 52.9 \\ 60 \\ 50 \\ 50 \\ 14 \\ 21 \\ 27 \\ 42.6 \\ 64 \\ 53 \\ 10 \\ 32 \end{pmatrix} lbf$$

$N_{antenna} := 21$

number of antenna groups

Note: Shielding is considered for the noted antennas. Shielding is detailed in TIA-222-G, Section 2.6.9.4.

Pipes

Length of pipes

$$length_{pipe} := \begin{pmatrix} 108 \\ 108 \\ 108 \end{pmatrix} \cdot in$$

Number of pipes

$$n_{pipe} := \begin{pmatrix} 9 \\ 12 \\ 6 \end{pmatrix}$$

Nominal pipe size

$$Pipe := \begin{pmatrix} 2 \\ 2 \\ 2 \end{pmatrix}$$

Elevation

$$z_{pipe} := \begin{pmatrix} 117.583 \\ 108 \\ 107.167 \end{pmatrix} \cdot ft$$

$N_{pipe} := 3$

number of pipe groups

Note: Shielding is considered for the noted pipes. Shielding is detailed in TIA-222-G, Section 2.6.9.4. The pipes are located closely enough to their respect antennas that they can also be considered shielded.

Dishes and Other Appurtenances (including Platforms and Others)

Number	*Type*	*CaAa*	*Elevation*	*Weight*
$n_{app} := (0)$	("(E) 1 ft Dish")	$CaAa\_app := (0) \cdot ft^2$	$z_{app} := (0) \cdot ft$	$weight_{app} := (0) \cdot lbf$

$N_{app} := 1$ *number of appurtenance groups*

Feedlines

The coax cables are tightly attached. In addition, the total weight of the coax cables is negligible.

	Type	*CaAa (side projection)*	*Weight*	*Elevation*
$n_{coax} := (0)$	("(E) Coax ")	$CaAa\_coax := (0.6) \cdot ft^2$	$weight_{coax} := (0) \cdot lbf$	$z_{coax} := (85) \cdot ft$

$N_{coax} := 1$

Antenna Loads - Per TIA-222-G

$$C := \left(I_{wind}\cdot K_{zt}\cdot K_z\right)^{0.5}\cdot V\cdot width_{ant}\cdot\frac{1}{ft}$$

Wind Flow Characteristic TIA-222-G Table 2-8

$C =$

	1
1	214.88
2	214.88
3	226.94
4	226.94
5	144.61
6	144.61
7	144.72
8	112.27
9	230.23
10	197.34
11	137.04
12	142.52
13	120.6
14	104.15
15	65.78
16	164.45
17	131.56
18	131.56
19	128.82
20	68.52
21	164.45

Force Coefficient for Appurtenances TIA-222-G Table 2-8

Aspect Ratio

```
$C_A :=$ for $n \in 1 .. N_{antenna}$
    $Aspect_n \leftarrow \frac{height_{ant_n}}{width_{ant_n}}$                              if $shape_{ant_n}$
    $p_n \leftarrow$ 1.2  if $Aspect_n \le 2.5$
          $1.2 + .2\cdot\frac{Aspect_n - 2.5}{7 - 2.5}$  if $2.5 \le Aspect_n \le 7$
          1.4  if $Aspect_n = 7$
          $1.4 + .6\cdot\frac{Aspect_n - 7}{25 - 7}$  if $7 \le Aspect_n \le 25$
          2.0  if $Aspect_n \ge 25$
    $Aspect_n \leftarrow \frac{height_{ant_n}}{width_{ant_n}}$                              otherwise
    $p_n \leftarrow$ if $C_n < 32$
```

continued...

cont.

$$.7 \;\; \text{if} \;\; \text{Aspect}_n \le 2.5$$

$$.7 + .1 \cdot \frac{\text{Aspect}_n - 2.5}{7 - 2.5} \;\; \text{if} \;\; 2.5 \le \text{Aspect}_n \le 7$$

$$.8 \;\; \text{if} \;\; \text{Aspect}_n = 7$$

$$.8 + .4 \cdot \frac{\text{Aspect}_n - 7}{25 - 7} \;\; \text{if} \;\; 7 \le \text{Aspect}_n \le 25$$

$$1.2 \;\; \text{if} \;\; \text{Aspect}_n \ge 25$$

$$\text{if} \;\; 32 \le C_n \le 64$$

$$\frac{3.76}{\left(C_n\right)^{.485}} \;\; \text{if} \;\; \text{Aspect}_n \le 2.5$$

$$\frac{3.76}{\left(C_n\right)^{.485}} + \left[\frac{3.37}{\left(C_n\right)^{.415}} - \frac{3.76}{\left(C_n\right)^{.485}}\right] \cdot \frac{\text{Aspect}_n - 2.5}{7 - 2.5} \;\; \text{if} \;\; 2.5 \le \text{Aspec}$$

$$\frac{3.37}{\left(C_n\right)^{.415}} \;\; \text{if} \;\; \text{Aspect}_n = 7$$

$$\frac{3.37}{\left(C_n\right)^{.415}} + \left[\frac{38.4}{C_n} - \frac{3.37}{\left(C_n\right)^{.415}}\right] \cdot \frac{\text{Aspect}_n - 7}{25 - 7} \;\; \text{if} \;\; 7 \le \text{Aspect}_n \le 25$$

$$\frac{38.4}{C_n} \;\; \text{if} \;\; \text{Aspect}_n \ge 25$$

$$\text{if} \;\; C_n > 64$$

$$.5 \;\; \text{if} \;\; \text{Aspect}_n \le 2.5$$

$$.5 + .1 \cdot \frac{\text{Aspect}_n - 2.5}{7 - 2.5} \;\; \text{if} \;\; 2.5 \le \text{Aspect}_n \le 7$$

$$.6 \;\; \text{if} \;\; \text{Aspect}_n \ge 7$$

p

$C_A =$

	1
1	1.307
2	1.214
3	1.295
4	1.2
5	1.2
6	1.2
7	1.2
8	0.513
9	1.267
10	1.2
11	1.2
12	1.2
13	1.311
14	1.2
15	1.556
16	1.296
17	1.356
18	1.2
19	1.2
20	1.2
21	1.2

$$A_A := \left|\begin{array}{l} \text{for } n \in 1\,..\,N_{antenna} \\ \quad p_n \leftarrow height_{ant_n} \cdot width_{ant_n} \\ p \end{array}\right.$$

$A_A =$

	1
1	13.067
2	7.5
3	13.8
4	6.9
5	1.37
6	1.37
7	1.366
8	2.234
9	12.25
10	3.25
11	2.257
12	1.444
13	4.201
14	0.957
15	2.917
16	7.292
17	6
18	2.083
19	1.632
20	0.195
21	1.875

$\cdot ft^2$

Area of Appurtenances

$$F_A := \left|\begin{array}{l} \text{for } n \in 1\,..\,N_{antenna} \\ \quad p_n \leftarrow n_{ant_n} \cdot G_h \cdot q_z \cdot C_{A_n} \cdot A_{A_n} \cdot SF_{ant_n} \\ p \end{array}\right.$$

$F_A =$

	1
1	818.544
2	218.231
3	856.829
4	198.492
5	70.602
6	70.602
7	70.372
8	49.16
9	1115.918
10	167.449
11	116.284
12	148.844
13	396.156
14	98.573
15	194.801
16	679.775
17	1169.856
18	107.339
19	84.083
20	40.252
21	64.404

$\cdot lbf$

Wind Force on Appurtenances

$$W_{ant} := \sum_{i=1}^{N_{antenna}} \left(n_{ant_i} weight_{ant_i} \right)$$

$$W_{ant} = 3224.7 \cdot lbf$$

Total Weight of Appurtenances

Pipes

```
$Aspect :=$ for $n \in 1 .. N_{pipe}$
    $Aspect_n \leftarrow \frac{length_{pipe_n}}{D_{pipe_n}}$
$Aspect$
```

$$Aspect = \begin{pmatrix} 45.38 \\ 45.38 \\ 45.38 \end{pmatrix}$$

$$C := \left(I_{wind} \cdot K_{zt} \cdot K_z\right)^{0.5} \cdot V \cdot D_{pipe} \cdot \frac{1}{ft} \qquad C = \begin{pmatrix} 26.09 \\ 26.09 \\ 26.09 \end{pmatrix}$$

$$W_{pipe} := \sum_{i=1}^{N_{pipe}} \left(n_{pipe_i} \cdot weight_{pipe_i} \cdot length_{pipe_i}\right) \qquad W_{pipe} = 889.38 \cdot lbf$$

Total Weight of Pipes

```
$A_{pipe} :=$ for $n \in 1 .. N_{pipe}$
    $a_n \leftarrow length_{pipe_n} \cdot D_{pipe_n}$
$a$
```

$$A_{pipe} = \begin{pmatrix} 1.78 \\ 1.78 \\ 1.78 \end{pmatrix} ft^2$$

$$C_{A.pipe} = \begin{pmatrix} 1.2 \\ 1.2 \\ 1.2 \end{pmatrix}$$

```
$C_{A.pipe} :=$ for $n \in 1 .. N_{pipe}$
    $Aspect_n \leftarrow \frac{length_{pipe_n}}{D_{pipe_n}}$
    $p_n \leftarrow$ if $C_n < 32$
            $.7$ if $Aspect_n \le 2.5$
            $.7 + .1 \cdot \frac{Aspect_n - 2.5}{7 - 2.5}$ if $2.5 \le Aspect_n \le 7$
            $.8$ if $Aspect_n = 7$
            $.8 + .4 \cdot \frac{Aspect_n - 7}{25 - 7}$ if $7 \le Aspect_n \le 25$
            $1.2$ if $Aspect_n \ge 25$
        if $32 \le C_n \le 64$
            $\frac{3.76}{\left(C_n\right)^{.485}}$ if $Aspect_n \le 2.5$
            $\frac{3.76}{\left(C_n\right)^{.485}} + \left[\frac{3.37}{\left(C_n\right)^{.415}} - \frac{3.76}{\left(C_n\right)^{.485}}\right] \cdot \frac{Aspect_n - 2.5}{7 - 2.5}$ if $2.5 \le Aspect_n \le 7$
            $\frac{3.37}{\;^{.415}}$ if $Aspect_n = 7$
```

continued...

cont.

$$\left(C_n\right)^{.415}$$

$$\frac{3.37}{\left(C_n\right)^{.415}} + \left[\frac{38.4}{C_n} - \frac{3.37}{\left(C_n\right)^{.415}}\right]\cdot\frac{Aspect_n - 7}{25 - 7} \text{ if } 7 \le Aspect_n \le 25$$

$$\frac{38.4}{C_n} \text{ if } Aspect_n \ge 25$$

$$\text{if } C_n > 64$$

$$.5 \text{ if } Aspect_n \le 2.5$$

$$.5 + .1\cdot\frac{Aspect_n - 2.5}{7 - 2.5} \text{ if } 2.5 \le Aspect_n \le 7$$

$$.6 \text{ if } Aspect_n \ge 7$$

$$p$$

$$F_{pipe} := \left| \begin{array}{l} \text{for } n \in 1 .. N_{pipe} \\ \quad p_n \leftarrow n_{pipe_n}\cdot C_{A.pipe_n}\cdot A_{pipe_n}\cdot q_z\cdot G_h\cdot SF_{pipe_n} \\ p \end{array} \right.$$

$$F_{pipe} = \begin{pmatrix} 137.95 \\ 183.94 \\ 91.97 \end{pmatrix}\cdot lbf$$

Wind Force on Pipes

Dishes and Other Appurtenances (including Platforms and Others)

$$F_{app} := \left| \begin{array}{l} \text{for } n \in 1 .. N_{app} \\ \quad p_n \leftarrow n_{app_n}\cdot G_h\cdot q_z\cdot CaAa\_app_n\cdot SF_{app_n} \\ p \end{array} \right.$$

$$F_{app} = (0)\cdot lbf$$

$$W_{app} := \sum_{i=1}^{N_{app}} \left(n_{app_i}\cdot weight_{app_i}\right)$$

$$W_{app} = 0\cdot lbf$$

Feedlines

$$F_{coax} := \left| \begin{array}{l} \text{for } n \in 1 .. N_{coax} \\ \quad p_n \leftarrow G_h\cdot q_z\cdot\frac{CaAa\_coax_n}{\left(z_{coax_n}\right)}\cdot SF_{coax_n} \\ p \end{array} \right.$$

$$F_{coax} = (0.17)\cdot\frac{lbf}{ft}$$

Linear wind load on coax cables

Wind Load for Water Tank

From ANSI/AWWA D100-11 (table 2)

$C_{d\_flat} := 1.0$	*Wind drag coefficient (flat)*
$C_{d\_cyl} := 0.6$	*Wind drag coefficient (cylindrical or conical with apex angle <15 deg)*
$C_{d\_sphere} := 0.5$	*Wind drag coefficient (double curved or conical with apex angle >15 deg)*
$G := 1$	*Gust-effect factor (per ANSI/AWWA D100-11 Section 3.1.4)*
$I := 1.15$	*Wind effect factor (per ANSI/AWWA D100-11 Section 3.1.4)*

Tank

Top dome

$h_{lower} := h_{tank} - \left(h_{top} + h_{main} + h_{bottom}\right)$ $h_{lower} = 98.92\ ft$ *Elevation of lowest point of tank (point of connection of main riser)*

$L_{top} := \frac{1}{2h_{top}} \cdot \left(\frac{d_{tank}}{2}\right)^2 - \frac{1}{2}h_{top}$ $L_{top} = 129.55\ ft$

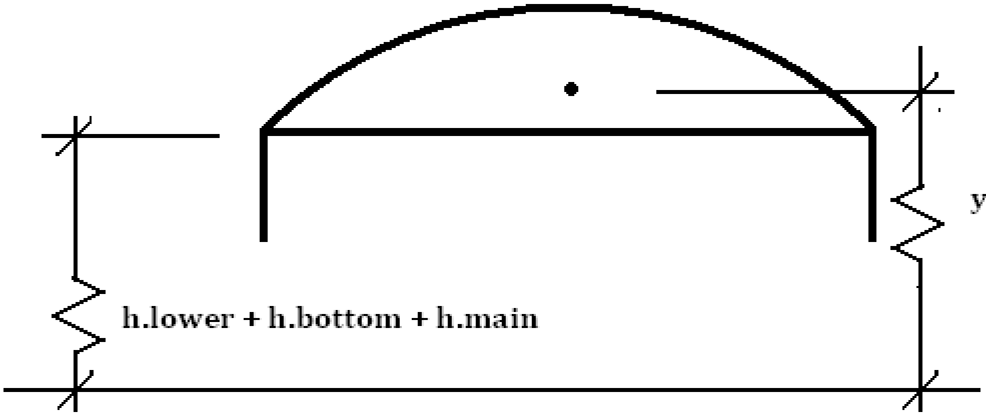
$R_{top} := \frac{1}{2h_{top}} \cdot \left(\frac{d_{tank}}{2}\right)^2 + \frac{1}{2}h_{top}$ $R_{top} = 135.88\ ft$ *Radius of curvature of top dome*

$\Theta_{top} := 2\,acos\left(\frac{L_{top}}{R_{top}}\right)$ $\Theta_{top} = 35.12 \cdot deg$ *Arc angle*

$A_{top} := \frac{\Theta_{top} \cdot R_{top}^{\ 2}}{2} - \frac{1}{2}L_{top} \cdot d_{tank}$ $A_{top} = 347.85\ ft^2$ *Projected top dome area*

$Y_{top} := \frac{4R_{top} \cdot \sin\left(\frac{\Theta_{top}}{2}\right)^3}{3\left(\Theta_{top} - \sin\left(\Theta_{top}\right)\right)} - L_{top}$ $Y_{top} = 2.54\ ft$ *Centroid of arc segment*

$y_{top} := h_{lower} + h_{bottom} + h_{main} + Y_{top}$ $y_{top} = 118.88\ ft$ *Centroid of top dome of tank*



Main body of tank

$A_{main} := d_{tank} \cdot h_{main}$ $A_{main} = 908.81\ ft^2$ *Projected area of main body*

$y_{main} := h_{lower} + h_{bottom} + \frac{1}{2} \cdot h_{main}$ $y_{main} = 110.8\ ft$ *Centroid of main body of tank*

Bottom dome

$L_{bottom} := \frac{1}{2h_{bottom}} \cdot \left(\frac{d_{tank}}{2}\right)^2 - \frac{1}{2}h_{bottom}$ $L_{bottom} = 129.55\ ft$

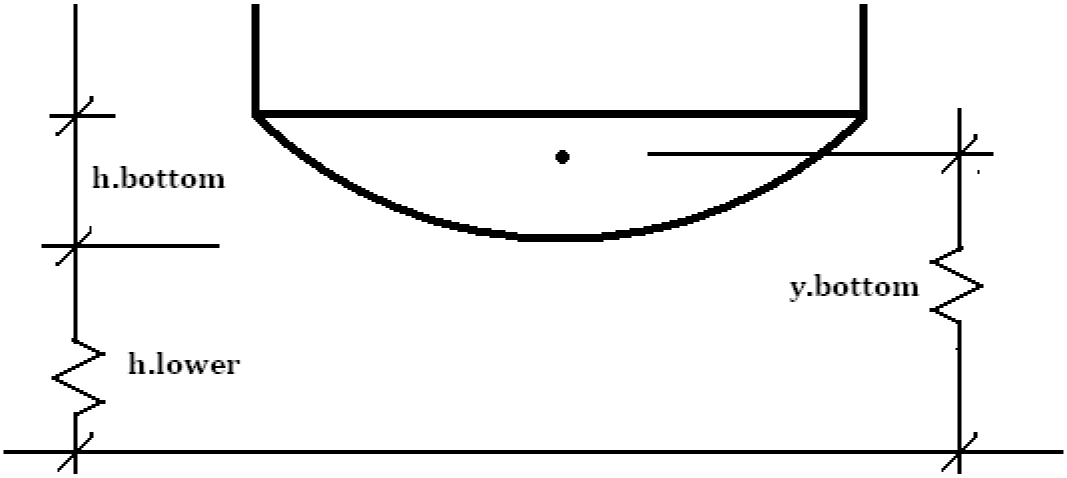
$R_{bottom} := \frac{1}{2h_{bottom}} \cdot \left(\frac{d_{tank}}{2}\right)^2 + \frac{1}{2}h_{bottom}$ $R_{bottom} = 135.88\ ft$ *Radius of curvature of bottom dome*

$\Theta_{bottom} := 2\ \mathrm{acos}\left(\frac{L_{bottom}}{R_{bottom}}\right)$ $\Theta_{bottom} = 35.12 \cdot deg$ *Arc angle*

$A_{bottom} := \frac{\Theta_{bottom} \cdot R_{bottom}^{\ 2}}{2} - \frac{1}{2}L_{bottom} \cdot d_{tank}$ $A_{bottom} = 347.85\ ft^2$ *Projected bottom dome area*

$Y_{bot} := R_{bottom} - \frac{4R_{bottom} \cdot \sin\left(\frac{\Theta_{bottom}}{2}\right)^3}{3\left(\Theta_{bottom} - \sin\left(\Theta_{bottom}\right)\right)}$ $Y_{bot} = 3.79\ ft$ *Centroid of arc segment (measured from curved side)*

$y_{bot} := h_{lower} + Y_{bot}$ $y_{bot} = 102.72\ ft$ *Centroid of bottom dome of tank*



Diagonal bracing and horizontal struts and rods

$D := Dist_{col}$ $\qquad$ $h_{leg} := h_{balcony}$

$\alpha := \dfrac{360deg}{n_{legs}}$ $\qquad$ $\alpha = 90 \cdot deg$

$\Theta := \dfrac{180deg - \alpha}{2}$ $\qquad$ $\Theta = 45 \cdot deg$

$r_{bottom} := D \cdot \dfrac{\sin(\Theta)}{\sin(\alpha)}$ $\qquad$ $r_{bottom} = 17.15\ ft$

$r_{tank} := \dfrac{d_{tank}}{2}$ $\qquad$ $r_{tank} = 41\ ft$

$d := r_{tank} \cdot \dfrac{\sin(\alpha)}{\sin(\Theta)}$ $\qquad$ $d = 57.98\ ft$

$g := \sqrt{h_{leg}{}^2 + \left(r_{bottom} - r_{tank}\right)^2}$ $\qquad$ $g = 110.6\ ft$

```
Z :=  | $Z_1 \leftarrow d$
      | for  $n \in 2 .. n_{bays}$
      |     $Z_n \leftarrow d + \dfrac{n-1}{n_{bays}} \cdot (D - d)$
      | $Z_{n_{bays}+1} \leftarrow D$
      | Z
```

$$Z = \begin{pmatrix} 57.98 \\ 46.74 \\ 35.49 \\ 24.25 \end{pmatrix} ft$$

Length of horizontal members per elevation. Note: the first and last members of the matrix do not physically exist, they are there for computations sake.

```
b :=  | for  $n \in 1 .. n_{bays}$
      |     $b_n \leftarrow \sqrt{\left(\dfrac{1}{n_{bays}} \cdot g\right)^2 + Z_n \cdot Z_{n+1}}$
      | b
```

$$b = \begin{pmatrix} 63.79 \\ 54.94 \\ 47.12 \end{pmatrix} ft$$

Length of diagonal rods per each bay

```
R :=  | for  $n \in 1 .. n_{bays} - 1$
      |     $r_n \leftarrow r_{tank} + \dfrac{n \cdot \left(r_{bottom} - r_{tank}\right)}{n_{bays}}$
      | r
```

$$R = \begin{pmatrix} 33.05 \\ 25.1 \end{pmatrix} ft$$

```
H :=  | for  $n \in 1 .. n_{bays} - 1$
      |     $h_n \leftarrow R_n - \left(\dfrac{d_{col}}{2} + \dfrac{d_{riser}}{2}\right)$
      | h
```

$$H = \begin{pmatrix} 30.79 \\ 22.84 \end{pmatrix} ft$$

Length of each horizontal rod per elevation

Wind on members

Diagonal rods

$$y_b := \left| \begin{array}{l} \text{for } n \in 1..n_{bays} \\ \quad y_n \leftarrow h_{leg} \cdot \left(\frac{n_{bays} - n}{n_{bays}} \right) + \frac{h_{leg}}{2n_{bays}} \\ y \end{array} \right.$$

$$y_b = \begin{pmatrix} 90 \\ 54 \\ 18 \end{pmatrix} \text{ft}$$

Centroid of each rod level

$$A_b := \left| \begin{array}{l} \text{for } n \in 1..n_{bays} \\ \quad a_n \leftarrow 2 \cdot d_{rod} \cdot b_n \\ a \end{array} \right.$$

$$A_b = \begin{pmatrix} 13.29 \\ 11.45 \\ 9.82 \end{pmatrix} \text{ft}^2$$

Projected area of each diagonal rod per elevation

Horizontal struts

$$y_Z := \left| \begin{array}{l} \text{for } n \in 1..n_{bays} - 1 \\ \quad y_n \leftarrow \left(\frac{n_{bays} - n}{n_{bays}} \right) \cdot h_{leg} \\ y \end{array} \right.$$

$$y_Z = \begin{pmatrix} 72 \\ 36 \end{pmatrix} \text{ft}$$

Centroid of each strut level

$$A_Z := \left| \begin{array}{l} \text{for } n \in 1..n_{bays} - 1 \\ \quad A_n \leftarrow Z_{n+1} \cdot H_{strut} \\ A \end{array} \right.$$

$$A_Z = \begin{pmatrix} 31.16 \\ 23.66 \end{pmatrix} \text{ft}^2$$

Projected area of each horizontal strut per elevation

Horizontal rods

$$y_H := \left| \begin{array}{l} \text{for } n \in 1..n_{bays} - 1 \\ \quad y_n \leftarrow \left(\frac{n_{bays} - n}{n_{bays}} \right) \cdot h_{leg} \\ y \end{array} \right.$$

$$y_H = \begin{pmatrix} 72 \\ 36 \end{pmatrix} \text{ft}$$

Centroid of each rod level

$$A_H := \left| \begin{array}{l} \text{for } n \in 1..n_{bays} - 1 \\ \quad A_n \leftarrow H_n \cdot d_{Hrod} \\ A \end{array} \right.$$

$$A_H = \begin{pmatrix} 2.57 \\ 1.9 \end{pmatrix} \text{ft}^2$$

Projected area of each horizontal rod per elevation

Columns

$A_{col} := d_{col} \cdot g$ $\quad A_{col} = 157.61\ ft^2$ *Projected area of one column*

$y_{col} := h_{leg} \cdot 0.5$ $\quad y_{col} = 54\ ft$ *The elevation of the centroids of the columns*

Center Riser

$H_{riser} := h_{lower}$

$A_{riser} := d_{riser} \cdot H_{riser}$ $\quad A_{riser} = 306.66\ ft^2$ *Projected area of riser*

$y_{riser} := H_{riser} \cdot 0.5$ $\quad y_{riser} = 49.46\ ft$ *The elevation of the centroid of the riser*

Balcony

$A_{balcony} := \left(d_{tank} + 2 \cdot 30in\right) \cdot 36in$ $\quad A_{balcony} = 261\ ft^2$ *Projected area of balcony*

Wind Load Determination

As per ANSI/AWWA D100-11, the wind loading is to be determined by the height of the individual centroid of each element.

$$KZ := \begin{pmatrix} y_{top} \\ y_{main} \\ y_{bot} \\ y_{col} \\ y_{riser} \\ h_{balcony} \end{pmatrix} \qquad KZ = \begin{pmatrix} 118.88 \\ 110.8 \\ 102.72 \\ 54 \\ 49.46 \\ 108 \end{pmatrix} ft$$

$$K_Z := \left| \begin{array}{l} \text{for } n \in 1..6 \\ \quad K_n \leftarrow \left| \begin{array}{l} 1.09 \ \text{ if } 0ft < KZ_n \le 50ft \\ 0.0036(KZ_n - 50ft)\cdot\frac{1}{ft} + 1.09 \ \text{ if } 50ft < KZ_n \le 100ft \\ 0.0022(KZ_n - 100ft)\cdot\frac{1}{ft} + 1.27 \ \text{ if } 100ft < KZ_n \le 150ft \\ 0.0016(KZ_n - 150ft)\cdot\frac{1}{ft} + 1.38 \ \text{ if } 150ft < KZ_n \le 200ft \\ 0.0014(KZ_n - 200ft)\cdot\frac{1}{ft} + 1.46 \ \text{ if } 200ft < KZ_n \le 250ft \\ 0.0014(KZ_n - 250ft)\cdot\frac{1}{ft} + 1.53 \ \text{ if } 250ft < KZ_n \le 300ft \\ 0.0010(KZ_n - 300ft)\cdot\frac{1}{ft} + 1.60 \ \text{ if } 300ft < KZ_n \le 350ft \end{array} \right. \\ K \end{array} \right. \qquad K_Z = \begin{pmatrix} 1.31 \\ 1.29 \\ 1.28 \\ 1.1 \\ 1.09 \\ 1.29 \end{pmatrix}$$

$$q_z := 0.00256 K_Z \cdot I \cdot V_{3sec.gust}{}^2 \cdot psf \qquad q_z = \begin{pmatrix} 51.96 \\ 51.25 \\ 50.55 \\ 43.75 \\ 43.18 \\ 51.01 \end{pmatrix} \cdot psf$$

$F_{top} := \max\left(q_{z_1} \cdot G \cdot C_{d\_sphere}, 30psf \cdot C_{d\_sphere}\right) \cdot A_{top}$ $\quad F_{top} = 9.04 \cdot kip$ *Total wind loading on top dome of tank*

$F_{main} := \max\left(q_{z_2} \cdot G \cdot C_{d\_cyl}, 30psf \cdot C_{d\_cyl}\right) \cdot A_{main}$ $\quad F_{main} = 27.95 \cdot kip$ *Total wind loading on main body of tank*

$F_{bottom} := \max\left(q_{z_3} \cdot G \cdot C_{d\_sphere}, 30psf \cdot C_{d\_sphere}\right) \cdot A_{bottom}$ $\quad F_{bottom} = 8.79 \cdot kip$ *Total wind loading on bottom dome of tank*

$F_{col} := \max\left(q_{z_4} \cdot G \cdot C_{d\_cyl}, 30psf \cdot C_{d\_flat}\right) \cdot n_{legs} \cdot A_{col}$ $\quad F_{col} = 18.91 \cdot kips$ *Total wind loads on the columns*

$F_{riser} := \max\left(q_{z_5} \cdot G \cdot C_{d\_cyl}, 30psf \cdot C_{d\_cyl}\right) \cdot A_{riser}$ $\quad F_{riser} = 7.94 \cdot kips$ *Wind load on the riser*

$F_{balcony} := \max\left(q_{z_6} \cdot G \cdot C_{d\_flat}, 30psf \cdot C_{d\_flat}\right) \cdot A_{balcony}$ $\quad F_{balcony} = 13.31 \cdot kips$ *Wind load on the balcony*

Diagonals, Struts, and Horizontal Rods

Diagonal Rods

$$K_{Z.b} := \left| \begin{array}{l} \text{for } \ n \in 1 .. n_{bays} - 1 \\ \quad K_n \leftarrow \left| \begin{array}{l} 1.09 \ \text{ if } \ 0\text{ft} < y_{b_n} \le 50\text{ft} \\ 0.0036\left(y_{b_n} - 50\text{ft}\right)\cdot\dfrac{1}{\text{ft}} + 1.09 \ \text{ if } \ 50\text{ft} < y_{b_n} \le 100\text{ft} \\ 0.0022\left(y_{b_n} - 100\text{ft}\right)\cdot\dfrac{1}{\text{ft}} + 1.27 \ \text{ if } \ 100\text{ft} < y_{b_n} \le 150\text{ft} \\ 0.0016\left(y_{b_n} - 150\text{ft}\right)\cdot\dfrac{1}{\text{ft}} + 1.38 \ \text{ if } \ 150\text{ft} < y_{b_n} \le 200\text{ft} \\ 0.0014\left(y_{b_n} - 200\text{ft}\right)\cdot\dfrac{1}{\text{ft}} + 1.46 \ \text{ if } \ 200\text{ft} < y_{b_n} \le 250\text{ft} \\ 0.0014\left(y_{b_n} - 250\text{ft}\right)\cdot\dfrac{1}{\text{ft}} + 1.53 \ \text{ if } \ 250\text{ft} < y_{b_n} \le 300\text{ft} \\ 0.0010\left(y_{b_n} - 300\text{ft}\right)\cdot\dfrac{1}{\text{ft}} + 1.60 \ \text{ if } \ 300\text{ft} < y_{b_n} \le 350\text{ft} \end{array} \right. \\ K \end{array} \right.$$

$$K_{Z.b} = \begin{pmatrix} 1.23 \\ 1.1 \end{pmatrix}$$

$$q_{z.b} := 0.00256 K_{Z.b}\cdot\left(I\cdot V_{3sec.gust}{}^{2}\right)\cdot\text{psf}$$

$$q_{z.b} = \begin{pmatrix} 48.88 \\ 43.75 \end{pmatrix}\cdot\text{psf}$$

$$P_b := \left| \begin{array}{l} \text{for } \ n \in 1 .. n_{bays} \\ \quad p_n \leftarrow \max\left(q_{z.b}\cdot G\cdot C_{d\_cyl}, 30\text{psf}\cdot C_{d\_cyl}\right)\cdot n_{legs}\cdot A_{b_n} \\ p \end{array} \right.$$

$$P_b = \begin{pmatrix} 1559.18 \\ 1342.8 \\ 1151.62 \end{pmatrix} \text{lbf}$$

Wind loading on all the horizontal rods per elevation

$$F_{brace} := \sum_{i=1}^{n_{bays}} \left(P_{b_i}\right)$$

$$F_{brace} = 4053.6\,\text{lbf}$$

Total wind force on diagonal rods (shielding is not considered)

$$M_B := \left| \begin{array}{l} \text{for } \ n \in 1 .. n_{bays} \\ \quad m_n \leftarrow P_{b_n}\cdot y_{b_n} \\ m \end{array} \right.$$

$$M_B = \begin{pmatrix} 140.33 \\ 72.51 \\ 20.73 \end{pmatrix}\cdot\text{kip}\cdot\text{ft}$$

Overturning moment for diagonal rods per elevation

$$M_{brace} := \sum_{n = n_{bays}}^{1} M_{B_n}$$

$$M_{brace} = 233.57\cdot\text{kip}\cdot\text{ft}$$

Total overturning moment due to diagonal rods

Horizontal struts

$$K_{Z.Z} := \left| \begin{array}{l} \text{for } n \in 1 .. n_{bays} - 1 \\ \quad K_n \leftarrow \left| \begin{array}{l} 1.09 \ \text{ if } \ 0ft < y_{Z_n} \le 50ft \\ 0.0036\left(y_{Z_n} - 50ft\right)\cdot\dfrac{1}{ft} + 1.09 \ \text{ if } \ 50ft < y_{Z_n} \le 100ft \\ 0.0022\left(y_{Z_n} - 100ft\right)\cdot\dfrac{1}{ft} + 1.27 \ \text{ if } \ 100ft < y_{Z_n} \le 150ft \\ 0.0016\left(y_{Z_n} - 150ft\right)\cdot\dfrac{1}{ft} + 1.38 \ \text{ if } \ 150ft < y_{Z_n} \le 200ft \\ 0.0014\left(y_{Z_n} - 200ft\right)\cdot\dfrac{1}{ft} + 1.46 \ \text{ if } \ 200ft < y_{Z_n} \le 250ft \\ 0.0014\left(y_{Z_n} - 250ft\right)\cdot\dfrac{1}{ft} + 1.53 \ \text{ if } \ 250ft < y_{Z_n} \le 300ft \\ 0.0010\left(y_{Z_n} - 300ft\right)\cdot\dfrac{1}{ft} + 1.60 \ \text{ if } \ 300ft < y_{Z_n} \le 350ft \end{array} \right. \\ K \end{array} \right.$$

$$K_{Z.Z} = \begin{pmatrix} 1.17 \\ 1.09 \end{pmatrix}$$

$$q_{z.Z} := 0.00256 K_{Z.Z}\cdot\left(I\cdot V_{3sec.gust}{}^{2}\right)\cdot psf$$

$$q_{z.Z} = \begin{pmatrix} 46.32 \\ 43.18 \end{pmatrix}\cdot psf$$

$$P_Z := \left| \begin{array}{l} \text{for } n \in 1 .. n_{bays} - 1 \\ \quad P_n \leftarrow \max\left(q_{z.Z}\cdot G\cdot C_{d\_flat}, 30psf\cdot C_{d\_flat}\right)\cdot n_{legs}\cdot A_{H_n} \\ P \end{array} \right.$$

$$P_Z = \begin{pmatrix} 475.32 \\ 352.56 \end{pmatrix} lbf$$

Wind loading on all of the rods per elevation

$$F_{strut} := \sum_{i=1}^{n_{bays}-1} \left(P_{Z_i}\right)$$

$$F_{strut} = 827.88\, lbf$$

Total wind force on horizontal struts (shielding is not considered)

$$M_Z := \left| \begin{array}{l} \text{for } n \in 1 .. n_{bays} - 1 \\ \quad M_n \leftarrow P_{Z_n}\cdot y_{Z_n} \\ M \end{array} \right.$$

$$M_Z = \begin{pmatrix} 34.22 \\ 12.69 \end{pmatrix}\cdot kip\cdot ft$$

Overturning moment for struts per elevation

$$M_{strut} := \sum_{n = n_{bays}-1}^{1} M_{Z_n}$$

$$M_{strut} = 46.92\cdot kip\cdot ft$$

Total overturning moment due to horizontal struts

Horizontal rods

$$K_{Z.Hrod} := \left| \begin{array}{l} \text{for } n \in 1 .. n_{bays} - 1 \\ \quad K_n \leftarrow \left| \begin{array}{l} 1.09 \ \text{ if } \ 0\text{ft} < y_{H_n} \le 50\text{ft} \\ 0.0036\left(y_{H_n} - 50\text{ft}\right)\cdot\frac{1}{\text{ft}} + 1.09 \ \text{ if } \ 50\text{ft} < y_{H_n} \le 100\text{ft} \\ 0.0022\left(y_{H_n} - 100\text{ft}\right)\cdot\frac{1}{\text{ft}} + 1.27 \ \text{ if } \ 100\text{ft} < y_{H_n} \le 150\text{ft} \\ 0.0016\left(y_{H_n} - 150\text{ft}\right)\cdot\frac{1}{\text{ft}} + 1.38 \ \text{ if } \ 150\text{ft} < y_{H_n} \le 200\text{ft} \\ 0.0014\left(y_{H_n} - 200\text{ft}\right)\cdot\frac{1}{\text{ft}} + 1.46 \ \text{ if } \ 200\text{ft} < y_{H_n} \le 250\text{ft} \\ 0.0014\left(y_{H_n} - 250\text{ft}\right)\cdot\frac{1}{\text{ft}} + 1.53 \ \text{ if } \ 250\text{ft} < y_{H_n} \le 300\text{ft} \\ 0.0010\left(y_{H_n} - 300\text{ft}\right)\cdot\frac{1}{\text{ft}} + 1.60 \ \text{ if } \ 300\text{ft} < y_{H_n} \le 350\text{ft} \end{array} \right. \\ K \end{array} \right.$$

$$K_{Z.Hrod} = \begin{pmatrix} 1.17 \\ 1.09 \end{pmatrix}$$

$$q_{z.Hrod} := 0.00256K_{Z.Hrod}\cdot\left(I\cdot V_{3sec.gust}{}^{2}\right)\cdot\text{psf} \qquad q_{z.Hrod} = \begin{pmatrix} 46.32 \\ 43.18 \end{pmatrix}\cdot\text{psf}$$

$$P_H := \left| \begin{array}{l} \text{for } n \in 1 .. n_{bays} - 1 \\ \quad P_n \leftarrow \max\left(q_{z.Hrod}\cdot G\cdot C_{d\_flat}, 30\text{psf}\cdot C_{d\_flat}\right)\cdot n_{legs}\cdot A_{H_n} \\ P \end{array} \right. \qquad P_H = \begin{pmatrix} 475.32 \\ 352.56 \end{pmatrix}\text{lbf}$$

Wind loading on all of the rods per elevation

$$F_{Horiz.Rod} := \sum_{i=1}^{n_{bays}-1} \left(P_{H_i}\right) \qquad F_{Horiz.Rod} = 827.88\,\text{lbf}$$

Total wind force on horizontal rod (shielding is not considered)

$$M_h := \left| \begin{array}{l} \text{for } n \in 1 .. n_{bays} - 1 \\ \quad M_n \leftarrow P_{H_n}\cdot y_{H_n} \\ M \end{array} \right. \qquad M_h = \begin{pmatrix} 34.22 \\ 12.69 \end{pmatrix}\cdot\text{kip}\cdot\text{ft}$$

Overturning moment for rods per elevation

$$M_{Hrod} := \sum_{n=n_{bays}-1}^{1} M_{h_n} \qquad M_{Hrod} = 46.92\cdot\text{kip}\cdot\text{ft}$$

Total overturning moment due to horizontal rods

Overturning Review

Shear at base of tank from the existing structure

$$V_{exist.base} := F_{top} + F_{main} + F_{bottom} + F_{col} + F_{riser} \cdots + F_{balcony} + F_{brace} + F_{strut} + F_{Horiz.Rod}$$

$$\boxed{V_{exist.base} = 91.65 \cdot kip}$$

Total shear due to original water tower structures and members

Shear from the antennas

$$V_{new.base} := \sum_{i=1}^{N_{antenna}} F_{A_i} + \sum_{j=1}^{N_{pipe}} \left(F_{pipe_j}\right) + \sum_{j=1}^{N_{app}} \left(F_{app_j}\right)$$

$$\boxed{V_{new.base} = 7.15 \cdot kip}$$

Total shear due to appurtenances

$$V_{total.base} := V_{exist.base} + V_{new.base}$$

$$\boxed{V_{total.base} = 98.8 \cdot kip}$$

Total shear at base

The overturning moment about the base from the water tank

$$M_{ot} := F_{top} \cdot y_{top} + F_{main} \cdot y_{main} + F_{bottom} \cdot y_{bot} + F_{col} \cdot y_{col} \cdots + F_{riser} \cdot y_{riser} + F_{balcony} \cdot h_{balcony} + M_{brace} + M_{strut} \cdots + M_{Hrod}$$

$$\boxed{M_{ot} = 8253.01 \cdot kips \cdot ft}$$

Overturning moment from original water tower structures and members

The overturning moment about the base from the antennas

done to the current AWWA design specifications

$$M_{app} := \sum_{j=1}^{N_{antenna}} \left[\left(F_A\right)_j \cdot z_{ant_j}\right] + \sum_{j=1}^{N_{pipe}} \left[\left(F_{pipe}\right)_j \cdot z_{pipe_j}\right] + \left[\sum_{j=1}^{N_{app}} \left[\left(F_{app}\right)_j \cdot z_{app_j}\right]\right] + \sum_{j=1}^{N_{coax}} \left[\frac{F_{coax_j} \cdot \left(z_{coax_j}\right)^2}{8}\right]$$

$$\boxed{M_{app} = 786.53 \cdot kips \cdot ft}$$

Overturning moment from all appurtenances

$$\boxed{\frac{M_{app}}{M_{ot}} = 9.53 \cdot \%}$$

****Note: The existing and proposed antennas have a 9.53 % increase on the overturning moment of the existing water tank. According to engineering judgment, the existing water tank will be adequate to support existing and proposed antennas.***

FULLERTON
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September 11, 2020

RE:	**AT&T LTE 3C/4C/4TXRX/5G NR/BWE**
Prepared For:	SMARTLINK/AT&T
Pace Number:	MRCTB047114/MRCTB047069/MRCTB047120/MRCTB047079/MRCTB047140
FA Code:	10035078
Site Number:	CTL02163
Site Name:	ESSEX CT
Site Address:	10 Main Street Essex, CT 06426

To Whom It May Concern,

This structural assessment is regarding to the adequacy of the existing catwalk handrail for the AT&T LTE 3C/4C/4TXRX/5G NR/BWE project. The analysis has been performed in accordance with the TIA-222-H Standard (Structural Standard for Antenna Supporting Structures, Antennas and Small Wind Turbine Support Structures). This analysis utilizes a basic wind speed of V= 124 mph as required by the latest adopted building code and local amendments. Exposure Category C and Risk Category II were used in this analysis.

Based on collected information via the tower mapping report by HighTower Solutions Inc. dated 7/29/2020, existing and proposed loading presented in the RFDS provided by AT&T dated 05/27/2020 Rev. 2.00, technical data of the proposed equipment and structural calculations, the existing catwalk handrail **is adequate to support the existing and proposed loading provided by the client, with a maximum catwalk handrail stress ratio of 99.9% provided that the following modifications are installed at each sector:**

- Removal of existing threaded rod connections at existing antenna mounting pipes.
- Addition of (2) sets of new water tower handrail antenna mounts (Perfect Vision P/N: PV-WT-HRM-U.)
- Addition of (2) new Pipes 2 ½ Std. x 9'-0".
- Addition of (2) new horizontal midrail members L2x2x3/8 x 2'-11" (V.I.F.) bolted to existing rail members.
- Addition of (2) new horizontal connection angles L2x2x3/8 x 1'-5" (V.I.F.) bolted to new midrail members.

For details regarding the modifications, see attached sketch and construction drawings (latest version) prepared by Fullerton Engineering.

This PE certification completed by Fullerton Engineering Consultants, LLC is inclusive of the existing antenna mounting structures that will support the existing and proposed loading provided by the client.

This certification assumes that all structural members of the existing antenna mounting structures are in good condition and have not been altered from the manufacturer's original design. Prior to installation of new equipment, contractor shall inspect the condition of all relevant members and connectors. The contractor shall be responsible for the means and methods of construction.

Respectfully,

Barbara T. Kotecki, P.E

B. Kotecki

Appurtenance Loading Schedule:

CARRIER	ELEVATION (FT)	QUANTITY	MANUFACTURER	MODEL	STATUS	POSITION	AZIMUTH	MOUNT
AT&T	108’-0”	2	Commscope	NNHH-65C-R4	Proposed	A3, B3	25°,150°	Existing Catwalk Handrail
		1	Commscope	NNHH-65A-R4		C3	275°	
		2	CCI	DMP65R-BU8DA		A4,B4	25°,150°	
		1	CCI	DMP65R-BU4DA		C4	275°	
		3	Ericsson	RRUS-4415 B30		A3,B3,C3	N/A	
		3	Ericsson	RRUS-8843 B2/B66A		A4,B4,C4	N/A	
		3	Ericsson	RRUS-4449 B5/B12		A4,B4,C4	N/A	
		3	Raycap	DC9-48-60-24-PC16-EV		A1,B1,C1	N/A	
		3	Powerwave	7770	Existing	A1,B1,C1	143°,263°,23°	
		6	Powerwave	LGP21401		A1,B1,C1	N/A	

Member Component Capacity Table:

Component	% Capacity	Pass / Fail
Face Horizontal	99.9%	Pass
Bracing Members	97.4%	Pass
Mounting Pipes	55.3%	Pass

Structural Rating (max from all components) =	**99.9%**

Site Number: **CTL02163**
Site Name: Essex CT
Created By: JM
Checked By: RKM
Date: 9/11/2020
Code: ANSI/TIA-222-H

Base Structure Type	**Type**	Water Tower	
Structure Height Above Grade (ft)	**Ht**	122.67	
RAD Center (ft)	**z**	108.00	
Windspeed no ice (mph, 3-sec gust)	**V**	124.00	see wind maps
Windspeed with ice (mph, 3-sec gust)	**Vi**	50.00	see ice maps
Windspeed for maintenance (mph, 3-sec gust)	**Vm**	30.00	Section 16.6
Ice Thickness	**ti**	1.00	see ice maps
Exposure Category (B/C/D)	**Exposure**	C	Section 2.6.5.1.2
Topographic Category (1,2,3,4)	**Topo**	1.00	Section 2.6.6.1
Risk Category (I,II,III, IV)	**Cat**	II	Table 2-1
Crest Height	**H**	0.00	Section 2.6.6.2.1
Height above sea level	**Zs**	39.00	
Exposure Category Coefficient	**zg**	900.00	Table 2-4
Mid-Point of Structure	**Ht.mid**	61.34	
Min Velocity Pressure Coefficient	**Kzmin**	0.85	Table 2-4
Exposure Category Coefficient	**α'**	9.50	Table 2-4
Velocity Pressure Coefficient	**Kz**	1.29	Section 2.6.5.2
Topographic Coefficient	**Kt**	1.00	Table 2-5
Terrain Constant	**Kc**	1.00	Table 2-4
Ground Elevation Factor	**Ke**	1.00	Section 2.6.8
Topographic Category Coefficient	**f**	0.00	Table 2-5
Height Reduction Factor	**Kh**	1.00	Section 2.6.6.2.1
Topographic Factor	**Kzt**	1.00	Section 2.6.6.2.1
Ice Load Importance Factor	**Iti**	1.00	Table 2-3
Wind Direction Probability Factor	**Kd**	0.95	Table 2-2
Height Escalation Factor	**Kiz**	1.13	Section 2.6.10
Gust Effect Factor	**Gh**	1.00	Section 16.6
Design Ice Thickness	**tiz**	1.13	Section 2.6.10
Ice Density	**ρ.ice**	56.00	lbf/ft^3
Velocity Pressure for Maintenance	**qzm**	2.81	Section 2.6.11.6
Velocity Pressure With Ice	**qzi**	7.81	Section 2.6.11.6
Velocity Pressure No Ice	**qz**	48.03	Section 2.6.11.6

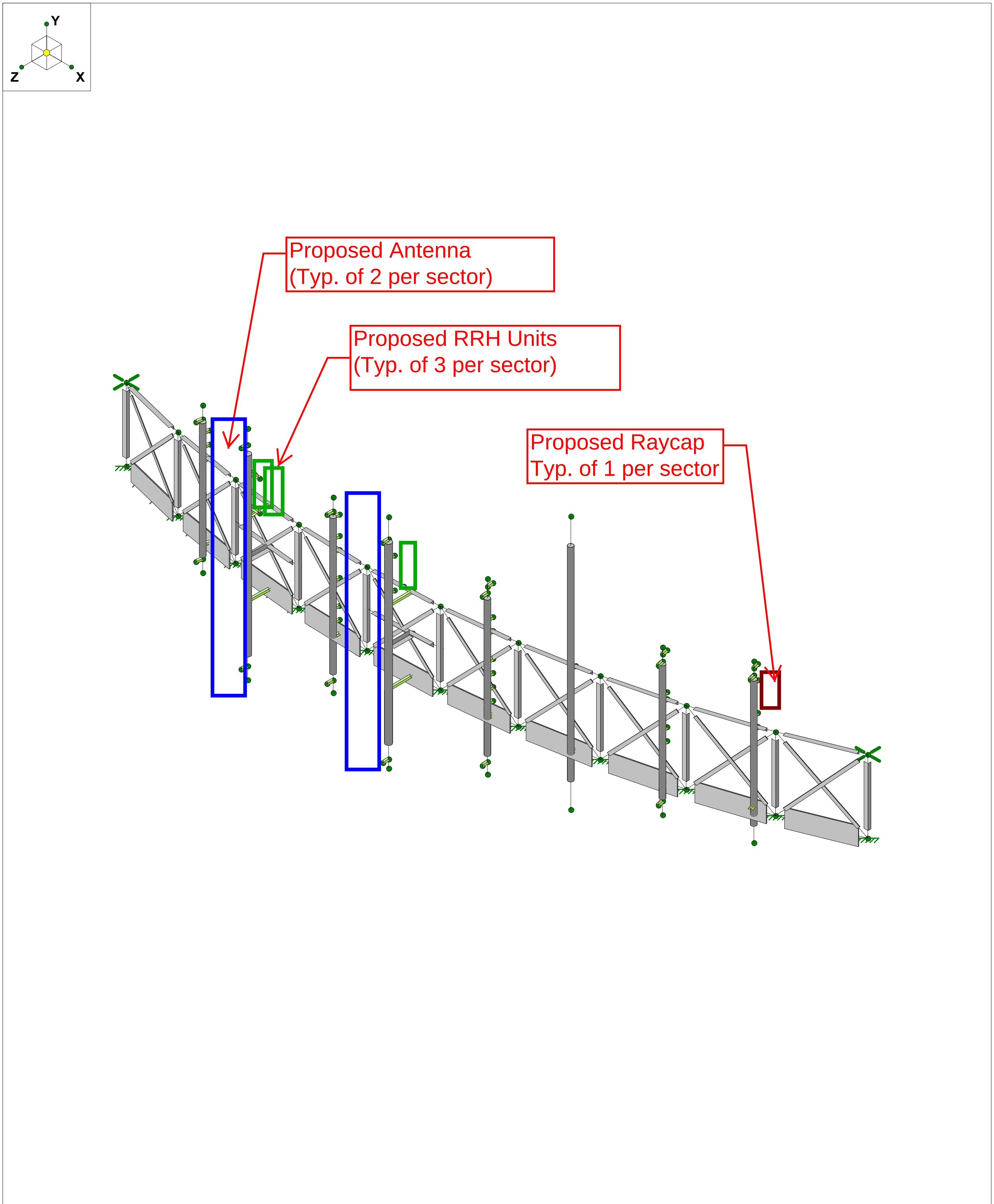
Ka=	0.9

Importance Factor (Earthquake)	**I_e**	1.00	Table 2-3
Site Class	**Class**	D - Stiff Soil	
Seismic Design Category	**Cat**	B	
MCE_R Ground Motion (period=0.2s)	**S_S**	0.207	
MCE_R Ground Motion (period=1.0s)	**S_1**	0.054	
Seismic Design Value at 0.2s	**S_{DS}**	0.22	
Long-Period Site Coefficient Fv	**Fv**	0.80	Table 2-12
Seismic Design Value at 1.0s	**S_{D1}**	0.044	Sec. 2.7.5
Long-period Transition Period (s)	**T_L**	6.000	

Sesimic Shear		
R	2.000	See 16.7
$C_{S\text{-}calc}$	0.111	See 2.7.7.1.1
$C_{S\text{-}min}$	0.010	See 2.7.7.1.1
C_S	0.111	See 2.7.7.1.1
A_S	1.000	See 16.7

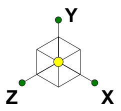
Appurtenance Properties								Loads (force per connection)										
Manufacturer	**Model**	**R/F**	**L**	**W**	**D**	**Weight**	**# Conn**	**Wt**	**Ice Wt**	**F no ice**	**S no ice**	**F ice**	**S ice**	**Fm**	**Sm**	**Eh**	**Ev**	**EPA.F**
Powerwave	7770	Flat	56	11	5	39	2	19.5	24.2	122	65	24	15	7	4	2	1	6
Amphenol	LPA-80080-6CF	Flat	70.9	5.5	13.2	21	2	10.5	32.1	93	186	20	36	5	11	1	0.5	4
Commscope	SBNHH-1D65B	Flat	72.6	11.9	7.1	50.6	2	25.3	40.0	176	117	34	24	10	7	3	1	8
Commscope	NNHH-65C-R4	Flat	96	19.6	7.8	112.9	2	56.5	57.1	369	177	68	36	22	10	6	2	17
CCIAntennas	DMP65R-BU8DA	Flat	96	20.7	7.7	126.8	2	63.4	56.7	386	176	70	36	23	10	7	3	18
AlcatelLucent	B66A-RRH4x45	Flat	26.6	12	6.8	64	2	32.0	15.7	57	34	12	8	3	2	4	1	3
Ericsson	RRUS 4415 B30	Flat	14.96	13.19	5.39	46	2	23.0	9.2	36	15	8	4	2	1	3	1	2
AlcatelLucent	B25 RRH4x30	Flat	21.2	12	7.2	53	2	26.5	13.8	46	28	10	6	3	2	3	1	2
Ericsson	4449 B5/12	Flat	14.96	13.19	10.43	73	2	36.5	15.3	36	28	8	6	2	2	4	2	2
Ericsson	8843 B2/B66A	Flat	14.9	13.2	10.9	72	2	36.0	15.9	35	29	8	7	2	2	4	2	2
CCIAntennas	DMP65R-BU8DA	Flat	96	20.7	7.7	126.8	2	63.4	56.7	386	176	70	36	23	10	7	3	18
Powerwave	LGP-21401	Flat	14.4	9.2	2.6	14.1	2	7.1	5.1	24	8	6	2	1	0.4	1	0.3	1
RFS	TMA	Flat	4.5	6.25	1	10	2	5.0	1.6	5	1	2	1	0.3	0.1	1	0.2	0
Raycap	DC9-48-60-24-8C-EV	Round	31.41	10.24	10.24	26.2	1	26.2	16.3	49	49	10	10	3	3	3	1	1
Raycap	RRFDC-3315-PF-48	Flat	18	15	10	32	2	16.0	17.2	49	32	10	7	2.8	1.9	2	0.7	2

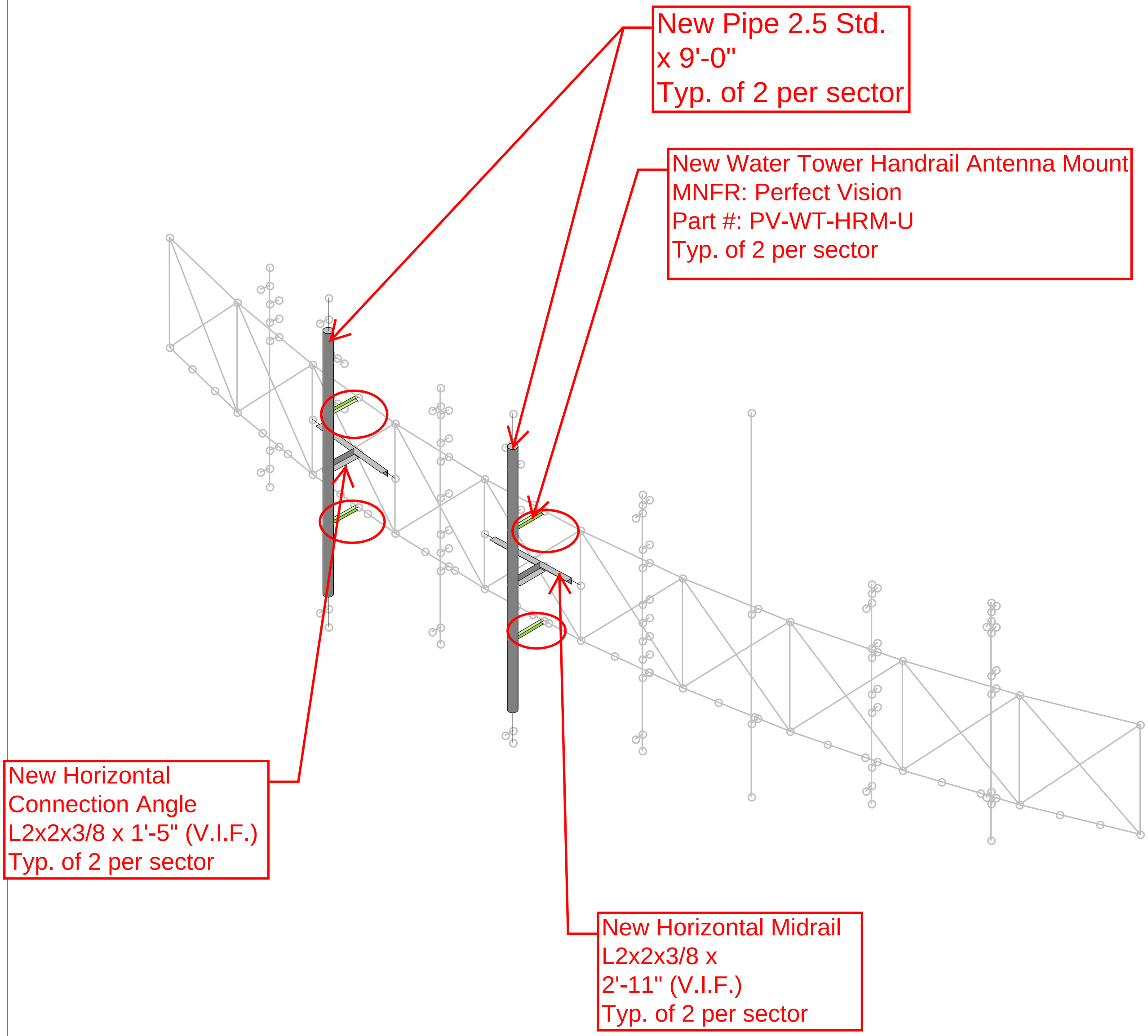
Shape Properties								Loads (force per connection)										
Shape Type	**Shape**	**R/F**	**L**	**W**	**D**	**Wt (plf)**	**# Conn**	**Wt**	**Ice Wt**	**F no ice**	**S no ice**	**F ice**	**S ice**	**Fm**	**Sm**	**Eh**	**Ev**	**EPA.F**
Angle	L2x1 1/2x1/4	Flat	35.144	2	1.5	2.77	2.92867	8.11	5.0	13	11	4	4	1	0.62	0.31	0.12	0.86
Plate	PL¼"x1½"	Flat	50.31	1.5	0.25	1.28	4.1925	5.35	3.6	11	2	4	3	1	0.11	0.14	0.06	1
Plate	PL7/16"x9"	Flat	35.144	9	0.4375	13.40	2.92867	39.24	13.9	41	3	9	3	2.40	0.18	1.48	0.6	2.77
Angle	L2x1 1/2x1/4	Flat	36	2	1.5	2.77	3	8.31	5.0	13	11	4	4	1	1	0.31	0.12	1
Pipe	Pipe 2 Std.	Round	72	2.38	2.38	3.66	6	21.96	4.8	10	10	3	3	1	1	0.40	0.16	1
Pipe	Pipe 2 Std.	Round	84	2.38	2.38	3.66	7	25.62	4.8	10	10	3	3	1	1	0.40	0.16	2
Pipe	Pipe 2 Std.	Round	126	2.38	2.38	3.66	10.5	38.43	4.8	10	10	3	3	1	1	0.40	0.16	2
Pipe	Pipe 2½ Std.	Round	120	2.88	2.88	5.80	10	58.00	5.5	12	12	4	4	1	1	0.64	0.26	3
Angle	L2X2X3/8	Flat	35.144	2	2	4.70	2.92867	13.76	5.4	13	13	4	4	1	0.74	0.52	0.21	0.86



Envelope Only Solution

Fullerton Engineering Con...		SK - 1
JM	Mount Analysis	Sept 11, 2020 at 1:27 PM
CTL02163	3D Render	CTL02163 - Mount Analysis.r3d





New Pipe 2.5 Std.
x 9'-0"
Typ. of 2 per sector

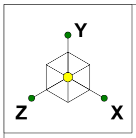
New Water Tower Handrail Antenna Mount
MNFR: Perfect Vision
Part #: PV-WT-HRM-U
Typ. of 2 per sector

New Horizontal
Connection Angle
L2x2x3/8 x 1'-5" (V.I.F.)
Typ. of 2 per sector

New Horizontal Midrail
L2x2x3/8 x
2'-11" (V.I.F.)
Typ. of 2 per sector

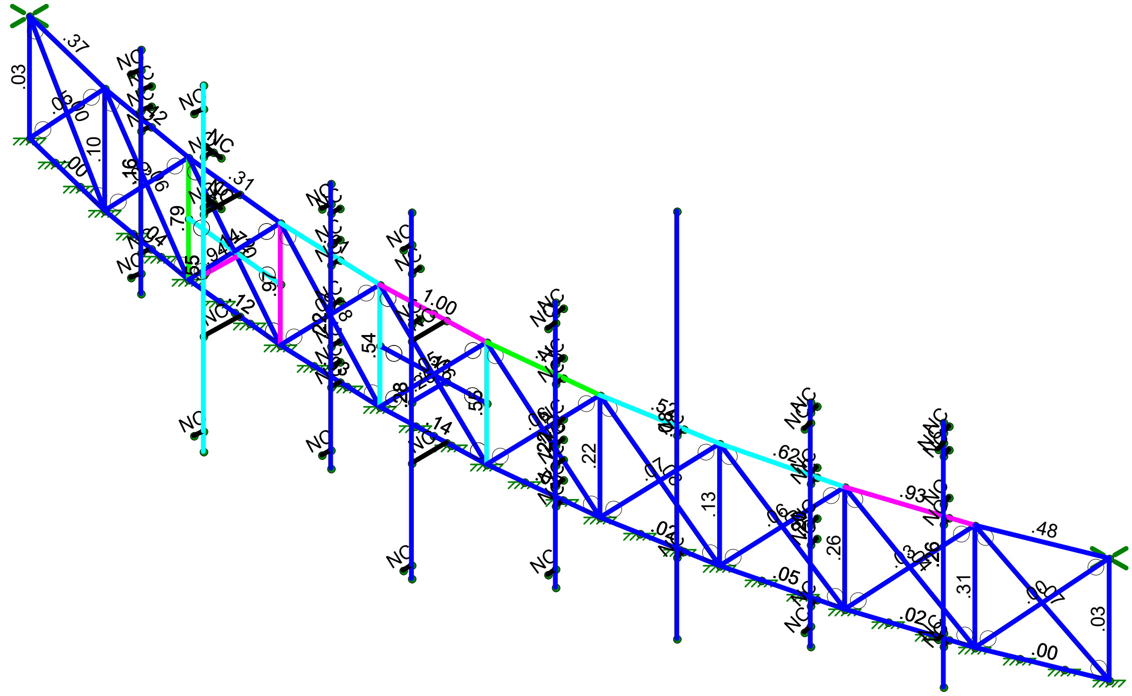
Loads: BLC 13, LM1
Envelope Only Solution

Fullerton Engineering Con...		SK - 15
JM	Mount Analysis	Sept 11, 2020 at 1:33 PM
CTL02163	Modification	CTL02163 - Mount Analysis.r3d



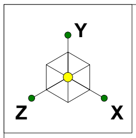
Code Check
(Env)

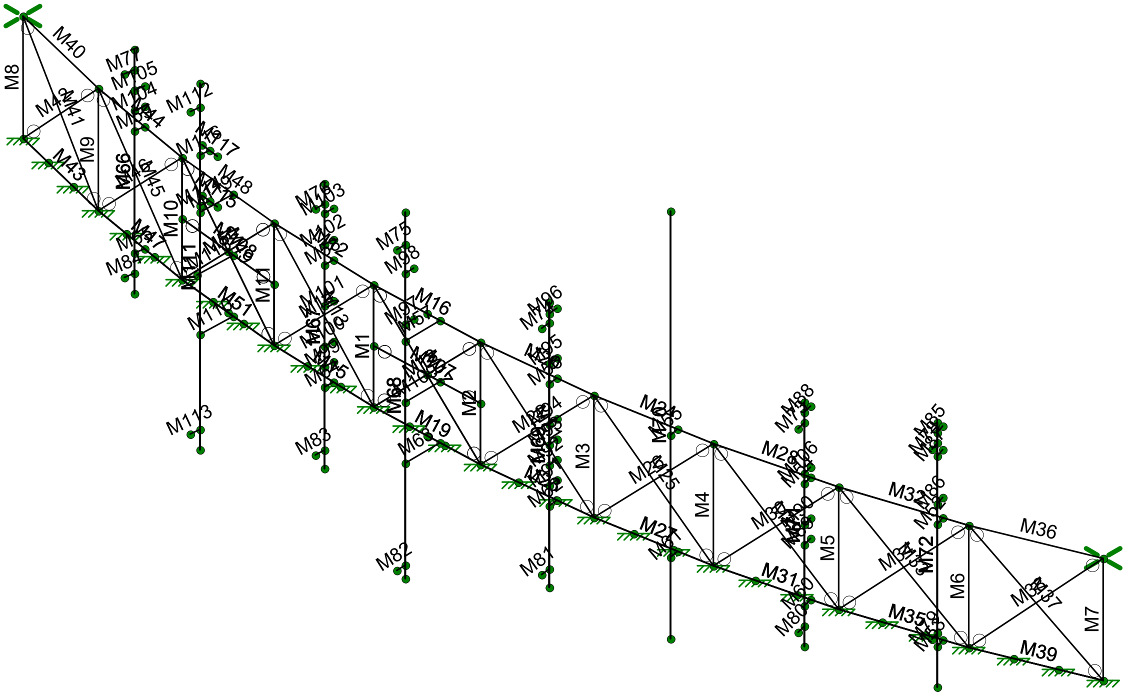
⬛	No Calc
🟥	> 1.0
🟪	.90-1.0
🟩	.75-.90
🟦	.50-.75
🟦	0.-.50



Member Code Checks Displayed (Enveloped)
Envelope Only Solution

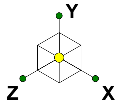
Fullerton Engineering Con...		SK - 2
JM	Mount Analysis	Sept 11, 2020 at 1:47 PM
CTL02163	Unity Graphic	CTL02163 - Mount Analysis.r3d

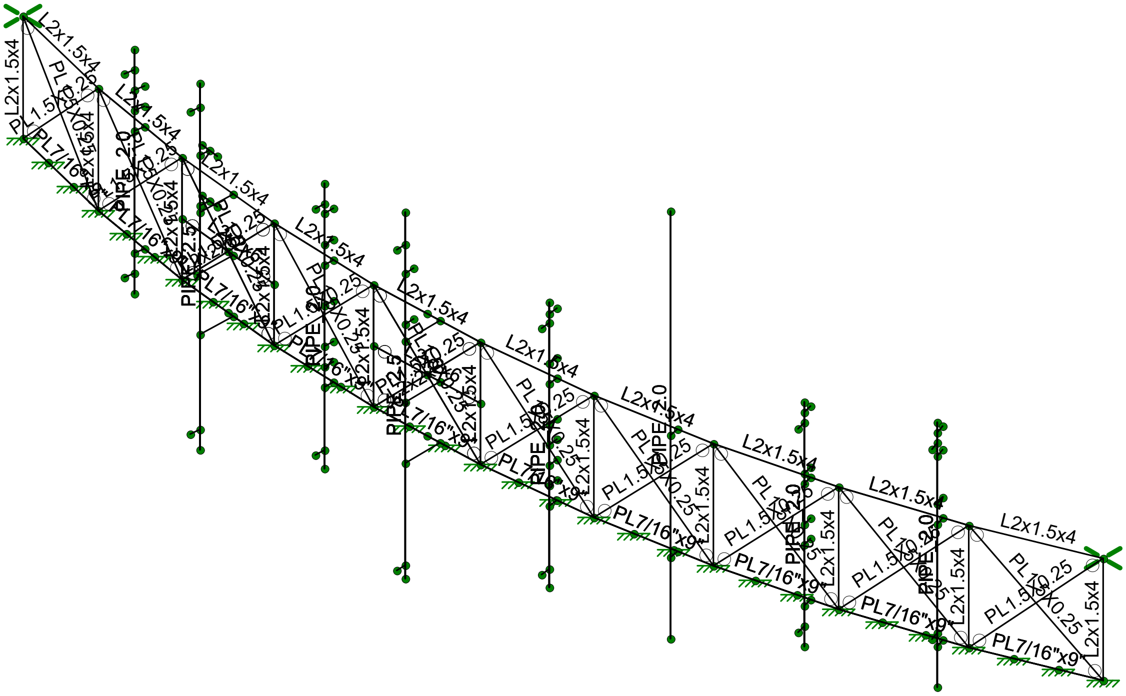




Envelope Only Solution

Fullerton Engineering Con...		SK - 3
JM	Mount Analysis	Sept 11, 2020 at 1:27 PM
CTL02163	Member Label	CTL02163 - Mount Analysis.r3d





Envelope Only Solution

Fullerton Engineering Con...

JM

CTL02163

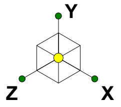
Mount Analysis

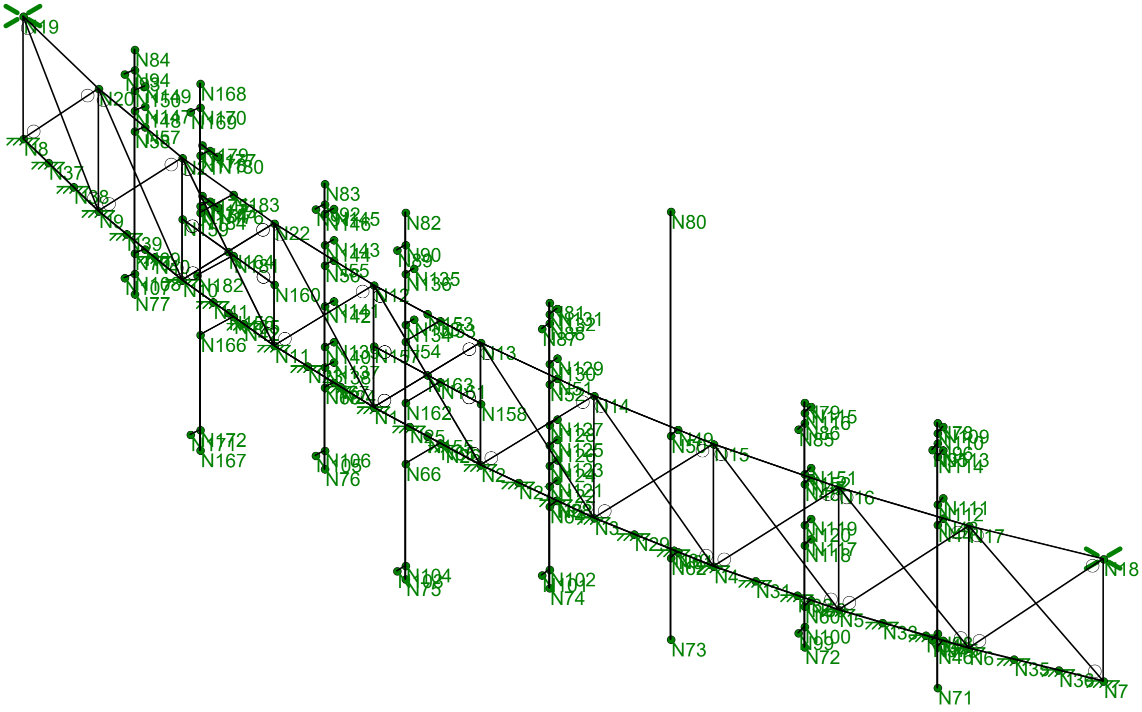
Shape

SK - 4

Sept 11, 2020 at 1:28 PM

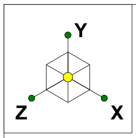
CTL02163 - Mount Analysis.r3d

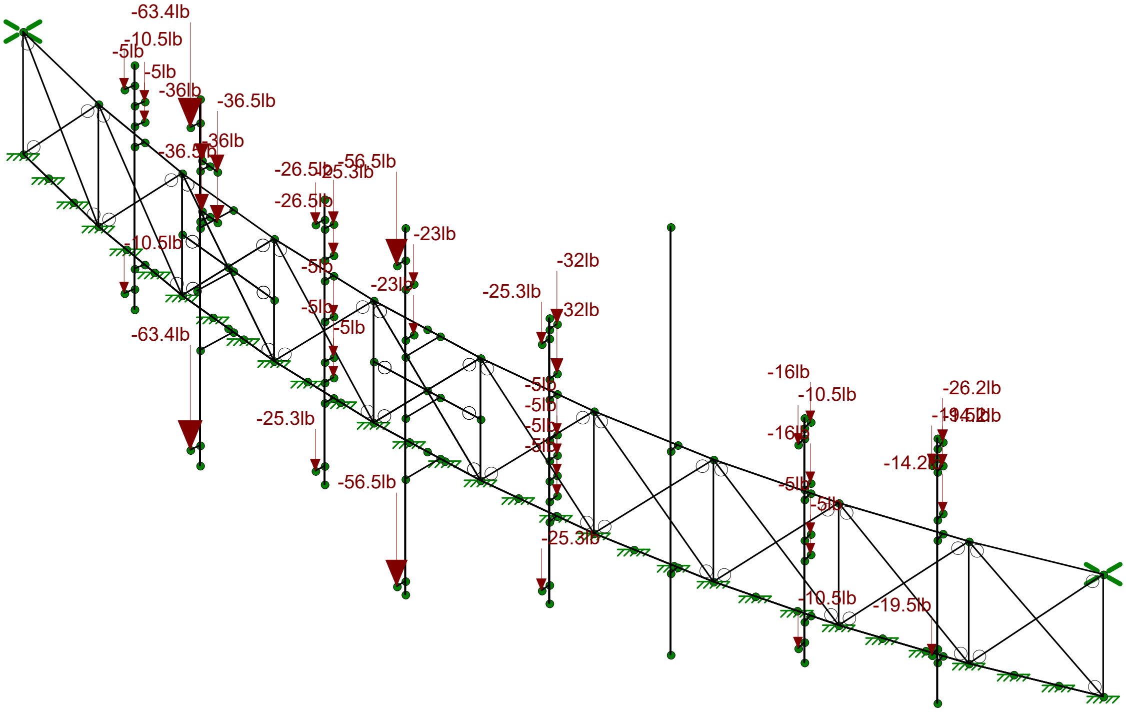




Envelope Only Solution

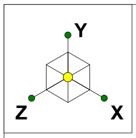
Fullerton Engineering Con...		SK - 5
JM	Mount Analysis	Sept 11, 2020 at 1:28 PM
CTL02163	Nodes	CTL02163 - Mount Analysis.r3d

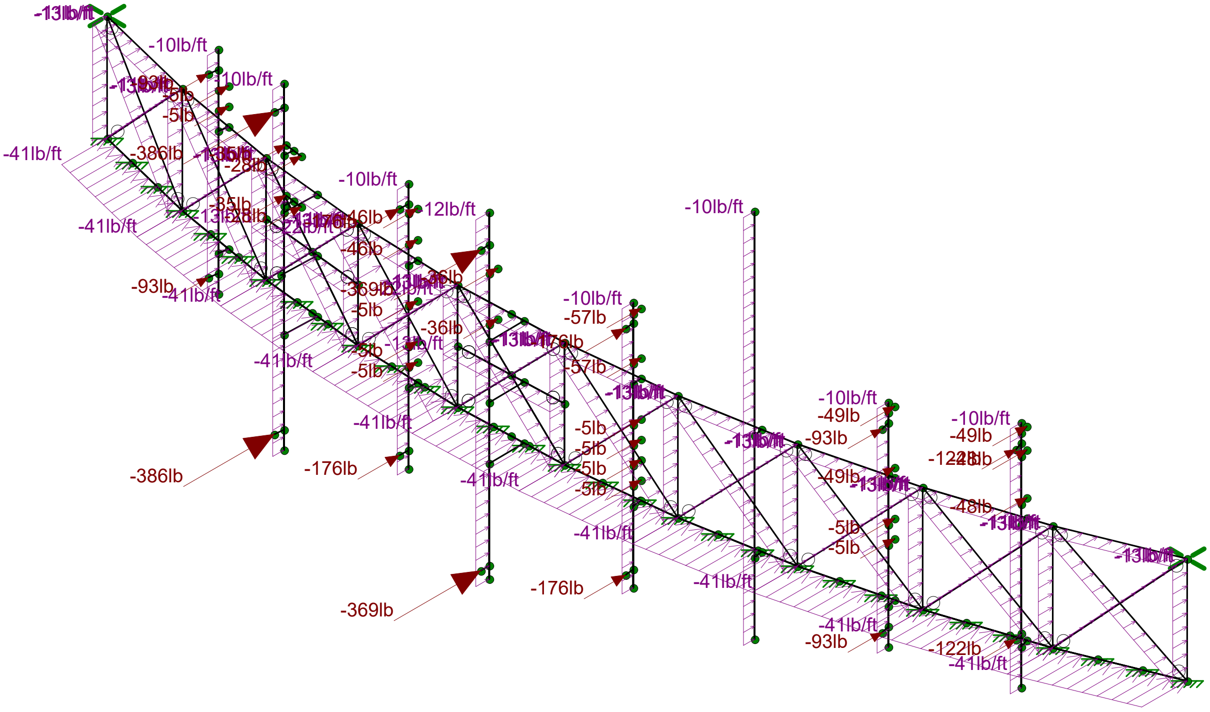




Loads: BLC 1, DL
Envelope Only Solution

Fullerton Engineering Con...		SK - 6
JM	Mount Analysis	Sept 11, 2020 at 1:28 PM
CTL02163	Dead Load	CTL02163 - Mount Analysis.r3d



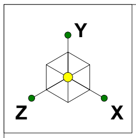


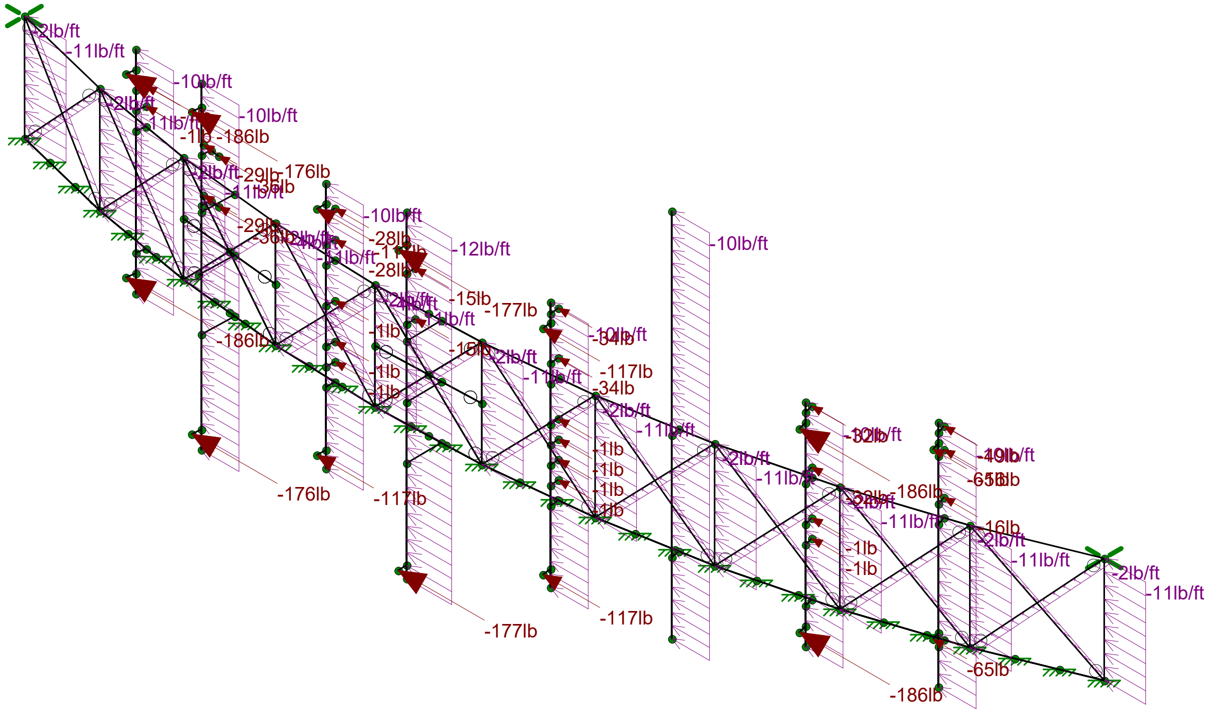
Loads: BLC 3, WL(0)
Envelope Only Solution

Fullerton Engineering Con...
JM
CTL02163

Mount Analysis
Wind Load (Z-Direction)

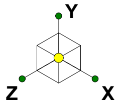
SK - 7
Sept 11, 2020 at 1:28 PM
CTL02163 - Mount Analysis.r3d

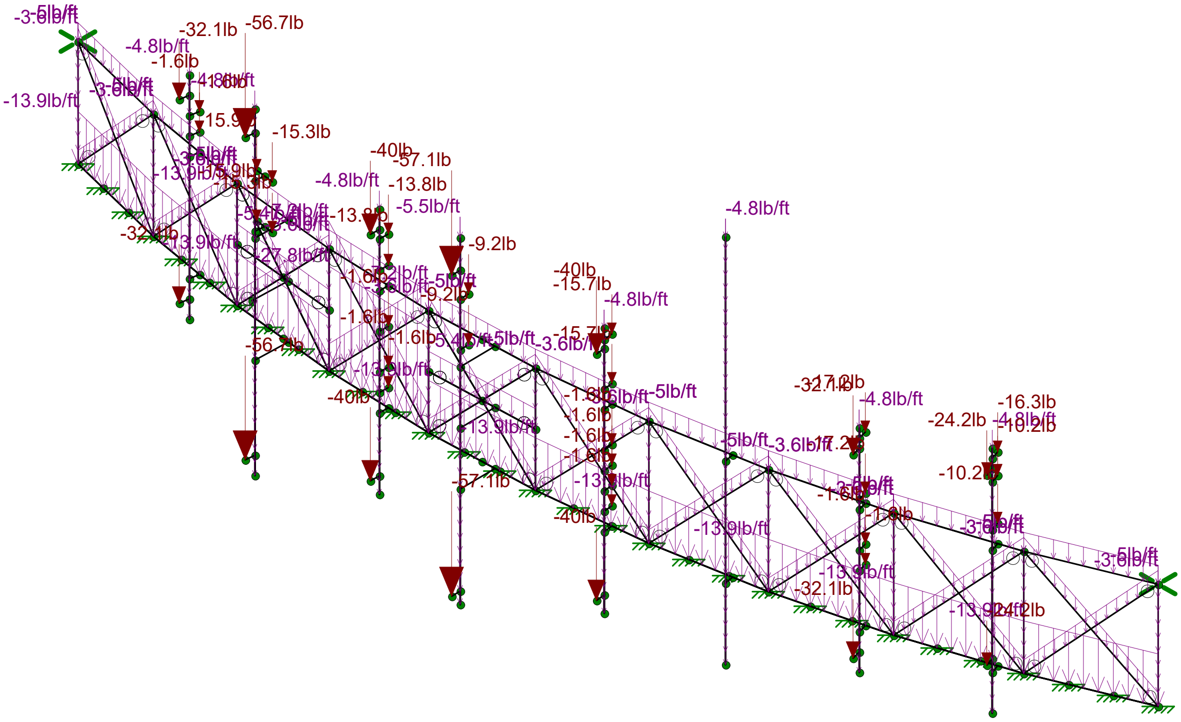




Loads: BLC 4, WL(90)
Envelope Only Solution

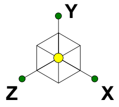
Fullerton Engineering Con...		SK - 8
JM	Mount Analysis	Sept 11, 2020 at 1:29 PM
CTL02163	Wind Load (X-Direction)	CTL02163 - Mount Analysis.r3d

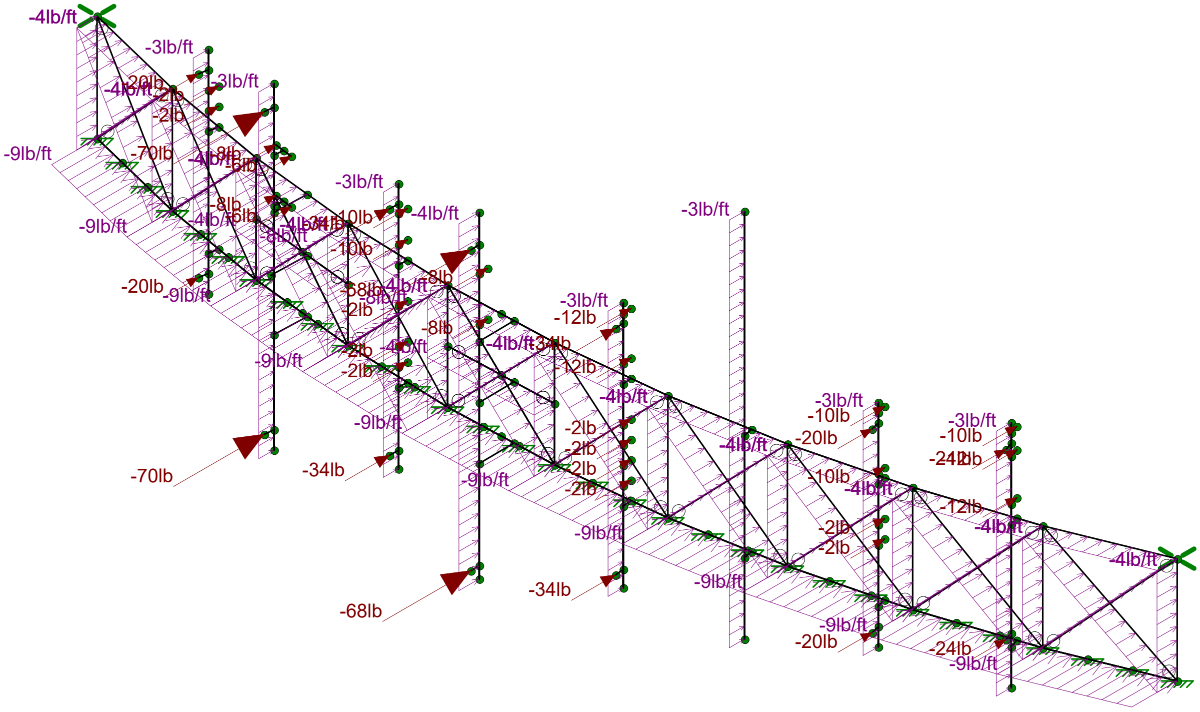




Loads: BLC 2, DLi
Envelope Only Solution

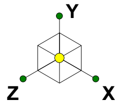
Fullerton Engineering Con...		SK - 9
JM	Mount Analysis	Sept 11, 2020 at 1:29 PM
CTL02163	Ice Load	CTL02163 - Mount Analysis.r3d

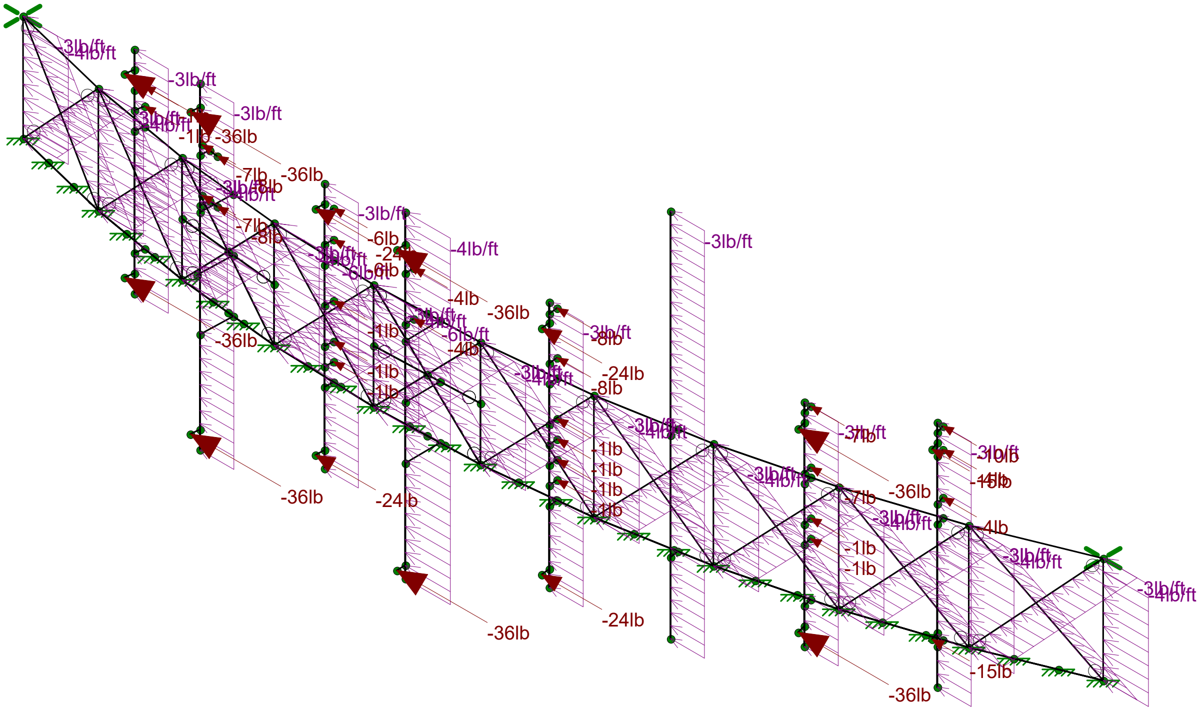




Loads: BLC 5, WL.i(0)
Envelope Only Solution

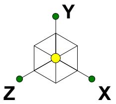
Fullerton Engineering Con...		SK - 10
JM	Mount Analysis	Sept 11, 2020 at 1:29 PM
CTL02163	Wind Load with Ice (Z-Direction)	CTL02163 - Mount Analysis.r3d

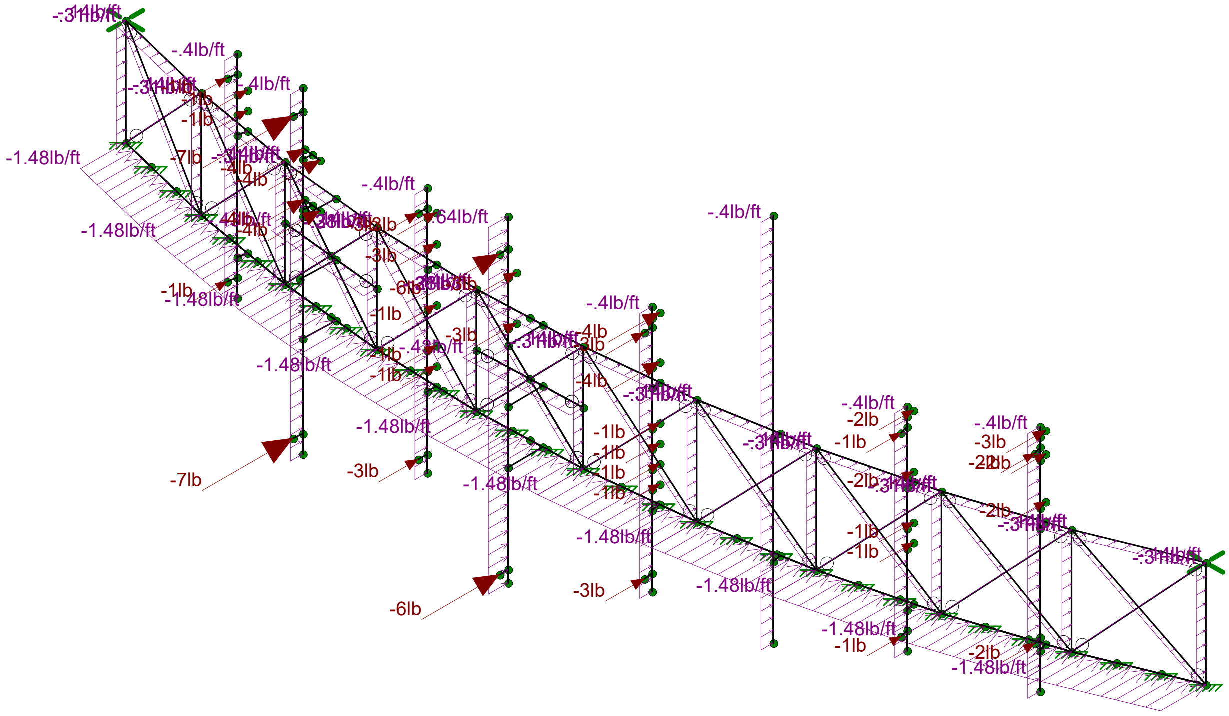




Loads: BLC 6, WL.i(90)
Envelope Only Solution

Fullerton Engineering Con...		SK - 11
JM	Mount Analysis	Sept 11, 2020 at 1:30 PM
CTL02163	Wind Load with Ice (X-Direction)	CTL02163 - Mount Analysis.r3d



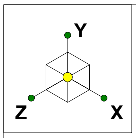


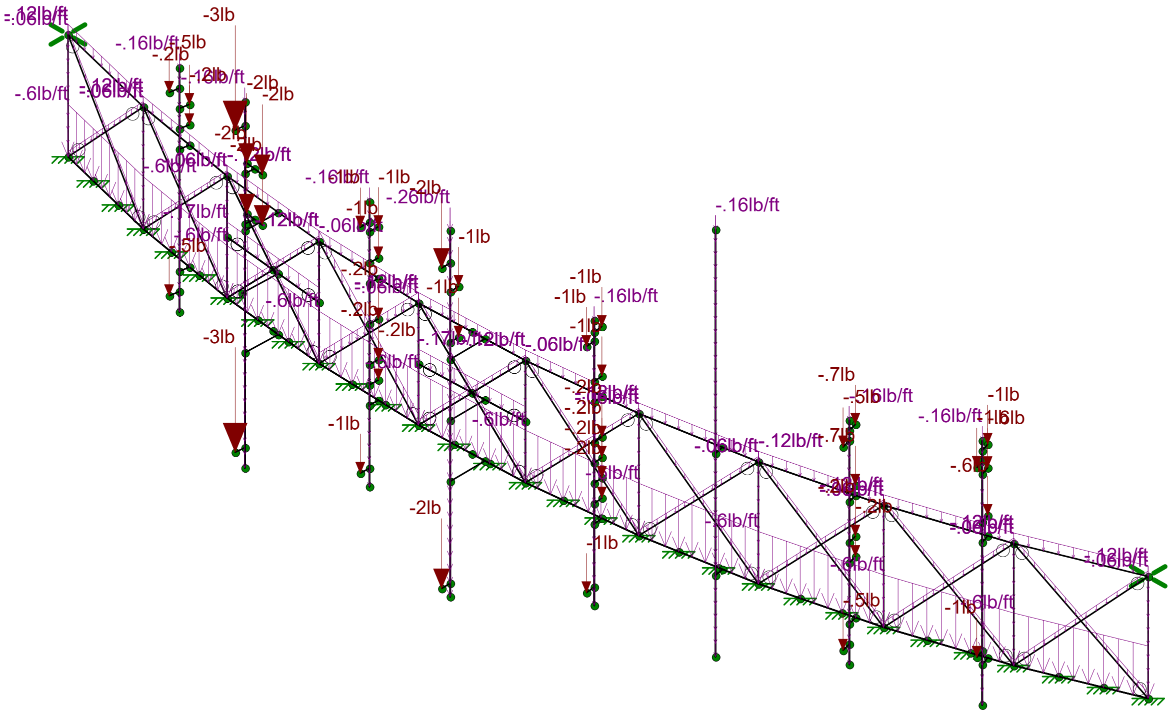
Loads: BLC 8, EH(0)
Envelope Only Solution

Fullerton Engineering Con...
JM
CTL02163

Mount Analysis
Seismic Load (Horizontal)

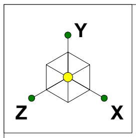
SK - 12
Sept 11, 2020 at 1:30 PM
CTL02163 - Mount Analysis.r3d

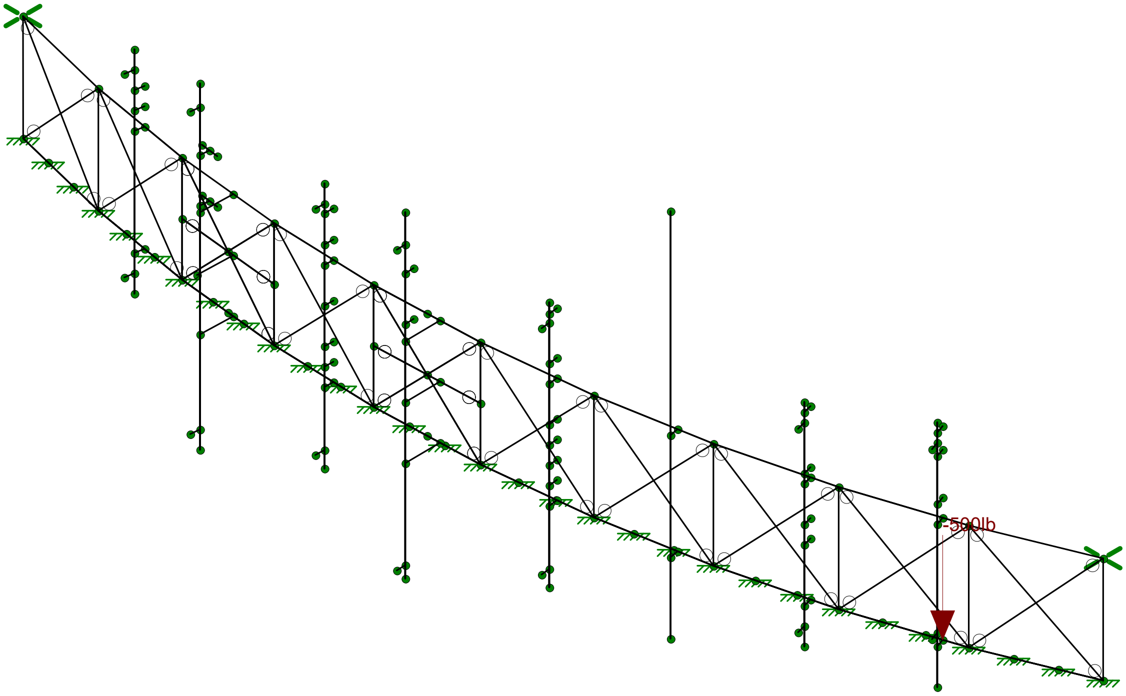




Loads: BLC 10, EV
Envelope Only Solution

Fullerton Engineering Con...		SK - 13
JM	Mount Analysis	Sept 11, 2020 at 1:30 PM
CTL02163	Seismic Load (Vertical)	CTL02163 - Mount Analysis.r3d





Loads: BLC 13, LM1
Envelope Only Solution

Fullerton Engineering Con...		SK - 14
JM	Mount Analysis	Sept 11, 2020 at 1:31 PM
CTL02163	500 Lb Live Load	CTL02163 - Mount Analysis.r3d

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (in^2)	144
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	No
Max Iterations for Wall Stiffness	3
Gravity Acceleration (in/sec^2)	386.4
Wall Mesh Size (in)	12
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Standard Skyline
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 15th(360-16): LRFD
Adjust Stiffness?	No
RISAConnection Code	AISC 15th(360-16): LRFD
Cold Formed Steel Code	None
Wood Code	None
Wood Temperature	< 100F
Concrete Code	None
Masonry Code	None
Aluminum Code	None - Building
Stainless Steel Code	None

Number of Shear Regions	4
Region Spacing Increment (in)	4
Biaxial Column Method	PCA Load Contour
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	Yes
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

(Global) Model Settings, Continued

Seismic Code	UBC 1997
Seismic Base Elevation (in)	Not Entered
Add Base Weight?	No
Ct X	.035
Ct Z	.035
T X (sec)	Not Entered
T Z (sec)	Not Entered
R X	8.5
R Z	8.5
Ca	.36
Cv	.54
Nv	1
Occupancy Category	4
Seismic Zone	3
Om Z	1
Om X	1
Rho Z	1
Rho X	1

Hot Rolled Steel Design Parameters

	Label	Shape	Length[in]	Lbyy[in]	Lbzz[in]	Lcomp top[in]	Lcomp bot[in]	L-torq...	Kyy	Kzz	Cb	Function
1	M1	L2x1.5x4	36									Lateral
2	M2	L2x1.5x4	36									Lateral
3	M3	L2x1.5x4	36									Lateral
4	M4	L2x1.5x4	36									Lateral
5	M5	L2x1.5x4	36									Lateral
6	M6	L2x1.5x4	36									Lateral
7	M7	L2x1.5x4	36									Lateral
8	M8	L2x1.5x4	36									Lateral
9	M9	L2x1.5x4	36									Lateral
10	M10	L2x1.5x4	36									Lateral
11	M11	L2x1.5x4	36	18	18	18	18	18				Lateral
12	M12	L2x1.5x4	35.144	0	0	0	0	0				Lateral
13	M13	PL1.5X0.25	50.31									Lateral
14	M14	PL1.5X0.25	50.31									Lateral
15	M15	PL7/16"x9"	35.144			Lbyy						Lateral
16	M16	L2x1.5x4	35.144	0	0	0	0	0				Lateral
17	M17	PL1.5X0.25	50.31									Lateral
18	M18	PL1.5X0.25	50.31									Lateral
19	M19	PL7/16"x9"	35.144			Lbyy						Lateral
20	M20	L2x1.5x4	35.144			Lbyy						Lateral
21	M21	PL1.5X0.25	50.31									Lateral
22	M22	PL1.5X0.25	50.31									Lateral
23	M23	PL7/16"x9"	35.144			Lbyy						Lateral
24	M24	L2x1.5x4	35.144			Lbyy						Lateral
25	M25	PL1.5X0.25	50.31									Lateral
26	M26	PL1.5X0.25	50.31									Lateral
27	M27	PL7/16"x9"	35.144			Lbyy						Lateral
28	M28	L2x1.5x4	35.144			Lbyy						Lateral
29	M29	PL1.5X0.25	50.31									Lateral
30	M30	PL1.5X0.25	50.31									Lateral
31	M31	PL7/16"x9"	35.144			Lbyy						Lateral
32	M32	L2x1.5x4	35.144			Lbyy						Lateral
33	M33	PL1.5X0.25	50.31									Lateral
34	M34	PL1.5X0.25	50.31									Lateral
35	M35	PL7/16"x9"	35.144			Lbyy						Lateral

Hot Rolled Steel Design Parameters (Continued)

	Label	Shape	Length[in]	Lbyy[in]	Lbzz[in]	Lcomp top[in]	Lcomp bot[in]	L-torq...	Kyy	Kzz	Cb	Function
36	M36	L2x1.5x4	35.144			Lbyy						Lateral
37	M37	PL1.5X0.25	50.31									Lateral
38	M38	PL1.5X0.25	50.31									Lateral
39	M39	PL7/16"x9"	35.144			Lbyy						Lateral
40	M40	L2x1.5x4	35.144			Lbyy						Lateral
41	M41	PL1.5X0.25	50.31									Lateral
42	M42	PL1.5X0.25	50.31									Lateral
43	M43	PL7/16"x9"	35.144			Lbyy						Lateral
44	M44	L2x1.5x4	35.144			Lbyy						Lateral
45	M45	PL1.5X0.25	50.31									Lateral
46	M46	PL1.5X0.25	50.31									Lateral
47	M47	PL7/16"x9"	35.144			Lbyy						Lateral
48	M48	L2x1.5x4	35.144	0	0	0	0	0				Lateral
49	M49	PL1.5X0.25	50.31									Lateral
50	M50	PL1.5X0.25	50.31									Lateral
51	M51	PL7/16"x9"	35.144			Lbyy						Lateral
52	M66	PIPE_2.0	72			Lbyy						Lateral
53	M67	PIPE_2.0	84			Lbyy						Lateral
54	M68	PIPE_2.5	108			Lbyy						Lateral
55	M69	PIPE_2.0	84			Lbyy						Lateral
56	M70	PIPE_2.0	126			Lbyy						Lateral
57	M71	PIPE_2.0	72			Lbyy						Lateral
58	M72	PIPE_2.0	78			Lbyy						Lateral
59	M107	L2x2x6	35.144	17	17	17	17	17				Lateral
60	M108	L2x2x6	35.144	17	17	17	17	17				Lateral
61	M109	L2x2x6	11.998									Lateral
62	M111	PIPE_2.5	108			Lbyy						Lateral
63	M118	L2x2x6	11.989									Lateral

Material Takeoff

	Material	Size	Pieces	Length[in]	Weight[K]
1	General				
2	RIGID_1		53	186.1	0
3	RIGID		3	24	0
4	Total General		56	210	0
5					
6	Hot Rolled Steel				
7	A36 Gr.36	L2x1.5x4	21	747.4	.172
8	A36 Gr.36	L2x2x6	4	94.3	.037
9	A36 Gr.36	PL1.5X0.25	20	1006.2	.107
10	A36 Gr.36	PL7/16"x9"	10	351.4	.392
11	A53 Gr.B	PIPE_2.0	6	516	.149
12	A53 Gr.B	PIPE_2.5	2	216	.099
13	Total HR Steel		63	2931.3	.956

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distribut...	Area(Me...	Surface...
1	DL	None				42				
2	DLi	None				42		64		
3	WL(0)	None				42		63		
4	WL(90)	None				42		41		
5	WL.i(0)	None				42		63		
6	WL.i(90)	None				42		41		
7	T	None								

Basic Load Cases (Continued)

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distribut...	Area(Me...	Surface...
8	EH(0)	None				42		63		
9	EH(90)	None				42		63		
10	EV	None				42		63		
11	WM(0)	None				44		63		
12	WM(90)	None				44		41		
13	LM1	None				1				
14	LM2	None				1				
15	LM3	None				1				
16	LM4	None				1				
17	LM5	None				1				
18	LM6	None				1				
19	LM7	None				1				
20	LM8	None								
21	LM9	None								
22	LM10	None								
23	LM11	None								
24	LM12	None								
25	LV1	None								
26	LV2	None								
27	LV3	None								
28	LV4	None								
29	LV5	None								
30	LV6	None								
31	LV7	None								
32	LV8	None								
33	LV9	None								
34	LV10	None								
35	LV11	None								
36	LV12	None								
37	LV13	None								
38	LV14	None								
39	LV15	None								
40	LV16	None								
41	LV17	None								
42	LV18	None								
43	LV19	None								
44	LV20	None								
45	LV21	None								

Load Combinations

	Description	S...	P...	S...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1	1.4*DL	Y...	Y		1	1.4																		
2	1.2*DL + 1.0* WL(0)	Y...	Y		1	1.2	3	1																
3	1.2*DL + 1.0* WL(30)	Y...	Y		1	1.2	3	.869	4	.5														
4	1.2*DL + 1.0* WL(60)	Y...	Y		1	1.2	3	.5	4	.869														
5	1.2*DL + 1.0*WL(90)	Y...	Y		1	1.2	4	1																
6	1.2*DL + 1.0*WL(120)	Y...	Y		1	1.2	3	-.5	4	.869														
7	1.2*DL +1.0*WL(150)	Y...	Y		1	1.2	3	-.8...	4	.5														
8	1.2*DL + 1.0 * WL(180)	Y...	Y		1	1.2	3	-1																
9	1.2*DL + 1.0* WL(210)	Y...	Y		1	1.2	3	-.8...	4	-.5														
10	1.2*DL + 1.0* WL(240)	Y...	Y		1	1.2	3	-.5	4	-.8...														
11	1.2*DL + 1.0*WL(270)	Y...	Y		1	1.2	4	-1																
12	1.2*DL + 1.0*WL(300)	Y...	Y		1	1.2	3	.5	4	-.8...														
13	1.2*DL +1.0*WL(330)	Y...	Y		1	1.2	3	.869	4	-.5														
14	1.2*DL+1.0*DLi+1.0*WL.i(0)+1.0*T	Y...	Y		1	1.2	2	1	5	1	7	1												

Load Combinations (Continued)

	Description	S...	P...	S...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
15	1.2*DL+1.0*DLi+1.0*WL.i(30)+1.0*T	Y...	Y		1	1.2	2	1	5	.866	6	.5	7	1										
16	1.2*DL+1.0*DLi+1.0*WL.i(60)+1.0*T	Y...	Y		1	1.2	2	1	5	.5	6	.866	7	1										
17	1.2*DL+1.0*DLi+1.0*WL.i(90)+1.0*T	Y...	Y		1	1.2	2	1	6	1	7	1												
18	1.2*DL+1.0*DLi+1.0*WL.i(120)+1.0*T	Y...	Y		1	1.2	2	1	5	-.5	6	.866	7	1										
19	1.2*DL+1.0*DLi+1.0*WL.i(150)+1.0*T	Y...	Y		1	1.2	2	1	5	-.8...	6	.5	7	1										
20	1.2*DL+1.0*DLi+1.0*WL.i(180)+1.0*T	Y...	Y		1	1.2	2	1	5	-1	7	1												
21	1.2*DL+1.0*DLi+1.0*WL.i(210)+1.0*T	Y...	Y		1	1.2	2	1	5	-.8...	6	-.5	7	1										
22	1.2*DL+1.0*DLi+1.0*WL.i(240)+1.0*T	Y...	Y		1	1.2	2	1	5	-.5	6	-.8...	7	1										
23	1.2*DL+1.0*DLi+1.0*WL.i(270)+1.0*T	Y...	Y		1	1.2	2	1	6	-1	7	1												
24	1.2*DL+1.0*DLi+1.0*WL.i(300)+1.0*T	Y...	Y		1	1.2	2	1	5	.5	6	-.8...	7	1										
25	1.2*DL+1.0*DLi+1.0*WL.i(330)+1.0*T	Y...	Y		1	1.2	2	1	5	.866	6	-.5	7	1										
26	1.2*DL+1.0*EH(0)+1.0*EV(+)	Y...	Y		1	1.2	8	1	10	1														
27	1.2*DL+1.0*EH(0)+1.0*EV(-)	Y...	Y		1	1.2	8	1	10	-1														
28	1.2*DL+1.0*EH(90)+1.0*EV(+)	Y...	Y		1	1.2	9	1	10	1														
29	1.2*DL+1.0*EH(90)+1.0*EV(-)	Y...	Y		1	1.2	9	1	10	-1														
30	1.2*DL+1.0*EH(180)+1.0*EV(+)	Y...	Y		1	1.2	8	-1	10	1														
31	1.2*DL+1.0*EH(180)+1.0*EV(-)	Y...	Y		1	1.2	8	-1	10	-1														
32	1.2*DL+1.0*EH(270)+1.0*EV(+)	Y...	Y		1	1.2	9	-1	10	1														
33	1.2*DL+1.0*EH(270)+1.0*EV(-)	Y...	Y		1	1.2	9	-1	10	-1														
34	0.9*DL+1.0*EH(0)-1.0*EV(+)	Y...	Y		1	.9	8	1	10	-1														
35	0.9*DL+1.0*EH(0)-1.0*EV(-)	Y...	Y		1	.9	8	1	10	1														
36	0.9*DL+1.0*EH(90)-1.0*EV(+)	Y...	Y		1	.9	9	1	10	-1														
37	0.9*DL+1.0*EH(90)-1.0*EV(-)	Y...	Y		1	.9	9	1	10	1														
38	0.9*DL+1.0*EH(180)-1.0*EV(+)	Y...	Y		1	.9	8	-1	10	-1														
39	0.9*DL+1.0*EH(180)-1.0*EV(-)	Y...	Y		1	.9	8	-1	10	1														
40	0.9*DL+1.0*EH(270)-1.0*EV(+)	Y...	Y		1	.9	9	-1	10	-1														
41	0.9*DL+1.0*EH(270)-1.0*EV(-)	Y...	Y		1	.9	9	-1	10	1														
42	1.2*DL+1.5*LM1+1.0*WM(0)	Y...	Y		1	1.2	13	1.5	11	1														
43	1.2*DL+1.5*LM1+1.0*WM(30)	Y...	Y		1	1.2	13	1.5	11	.866	12	.5												
44	1.2*DL+1.5*LM1+1.0*WM(60)	Y...	Y		1	1.2	13	1.5	11	.5	12	.866												
45	1.2*DL+1.5*LM1+1.0*WM(90)	Y...	Y		1	1.2	13	1.5	12	1														
46	1.2*DL+1.5*LM1+1.0*WM(120)	Y...	Y		1	1.2	13	1.5	11	-.5	12	.866												
47	1.2*DL+1.5*LM1+1.0*WM(150)	Y...	Y		1	1.2	13	1.5	11	-.8...	12	.5												
48	1.2*DL+1.5*LM1+1.0*WM(180)	Y...	Y		1	1.2	13	1.5	11	-1														
49	1.2*DL+1.5*LM1+1.0*WM(210)	Y...	Y		1	1.2	13	1.5	11	-.8...	12	-.5												
50	1.2*DL+1.5*LM1+1.0*WM(240)	Y...	Y		1	1.2	13	1.5	11	-.5	12	-.8...												
51	1.2*DL+1.5*LM1+1.0*WM(270)	Y...	Y		1	1.2	13	1.5	12	-1														
52	1.2*DL+1.5*LM1+1.0*WM(300)	Y...	Y		1	1.2	13	1.5	11	.5	12	-.8...												
53	1.2*DL+1.5*LM1+1.0*WM(330)	Y...	Y		1	1.2	13	1.5	11	.866	12	-.5												
54	1.2*DL+1.5*LM2+1.0*WM(0)	Y...	Y		1	1.2	14	1.5	11	1														
55	1.2*DL+1.5*LM2+1.0*WM(30)	Y...	Y		1	1.2	14	1.5	11	.866	12	.5												
56	1.2*DL+1.5*LM2+1.0*WM(60)	Y...	Y		1	1.2	14	1.5	11	.5	12	.866												
57	1.2*DL+1.5*LM2+1.0*WM(90)	Y...	Y		1	1.2	14	1.5	12	1														
58	1.2*DL+1.5*LM2+1.0*WM(120)	Y...	Y		1	1.2	14	1.5	11	-.5	12	.866												
59	1.2*DL+1.5*LM2+1.0*WM(150)	Y...	Y		1	1.2	14	1.5	11	-.8...	12	.5												
60	1.2*DL+1.5*LM2+1.0*WM(180)	Y...	Y		1	1.2	14	1.5	11	-1														
61	1.2*DL+1.5*LM2+1.0*WM(210)	Y...	Y		1	1.2	14	1.5	11	-.8...	12	-.5												
62	1.2*DL+1.5*LM2+1.0*WM(240)	Y...	Y		1	1.2	14	1.5	11	-.5	12	-.8...												
63	1.2*DL+1.5*LM2+1.0*WM(270)	Y...	Y		1	1.2	14	1.5	12	-1														
64	1.2*DL+1.5*LM2+1.0*WM(300)	Y...	Y		1	1.2	14	1.5	11	.5	12	-.8...												
65	1.2*DL+1.5*LM2+1.0*WM(330)	Y...	Y		1	1.2	14	1.5	11	.866	12	-.5												
66	1.2*DL+1.5*LM3+1.0*WM(0)	Y...	Y		1	1.2	15	1.5	11	1														
67	1.2*DL+1.5*LM3+1.0*WM(30)	Y...	Y		1	1.2	15	1.5	11	.866	12	.5												
68	1.2*DL+1.5*LM3+1.0*WM(60)	Y...	Y		1	1.2	15	1.5	11	.5	12	.866												
69	1.2*DL+1.5*LM3+1.0*WM(90)	Y...	Y		1	1.2	15	1.5	12	1														
70	1.2*DL+1.5*LM3+1.0*WM(120)	Y...	Y		1	1.2	15	1.5	11	-.5	12	.866												
71	1.2*DL+1.5*LM3+1.0*WM(150)	Y...	Y		1	1.2	15	1.5	11	-.8...	12	.5												

Load Combinations (Continued)

	Description	S...	P...	S...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
72	1.2*DL+1.5*LM3+1.0*WM(180)	Y...	Y		1	1.2	15	1.5	11	-1														
73	1.2*DL+1.5*LM3+1.0*WM(210)	Y...	Y		1	1.2	15	1.5	11	-.8...	12	-.5												
74	1.2*DL+1.5*LM3+1.0*WM(240)	Y...	Y		1	1.2	15	1.5	11	-.5	12	-.8...												
75	1.2*DL+1.5*LM3+1.0*WM(270)	Y...	Y		1	1.2	15	1.5	12	-1														
76	1.2*DL+1.5*LM3+1.0*WM(300)	Y...	Y		1	1.2	15	1.5	11	.5	12	-.8...												
77	1.2*DL+1.5*LM3+1.0*WM(330)	Y...	Y		1	1.2	15	1.5	11	.866	12	-.5												
78	1.2*DL+1.5*LM4+1.0*WM(0)	Y...	Y		1	1.2	16	1.5	11	1														
79	1.2*DL+1.5*LM4+1.0*WM(30)	Y...	Y		1	1.2	16	1.5	11	.866	12	.5												
80	1.2*DL+1.5*LM4+1.0*WM(60)	Y...	Y		1	1.2	16	1.5	11	.5	12	.866												
81	1.2*DL+1.5*LM4+1.0*WM(90)	Y...	Y		1	1.2	16	1.5	12	1														
82	1.2*DL+1.5*LM4+1.0*WM(120)	Y...	Y		1	1.2	16	1.5	11	-.5	12	.866												
83	1.2*DL+1.5*LM4+1.0*WM(150)	Y...	Y		1	1.2	16	1.5	11	-.8...	12	.5												
84	1.2*DL+1.5*LM4+1.0*WM(180)	Y...	Y		1	1.2	16	1.5	11	-1														
85	1.2*DL+1.5*LM4+1.0*WM(210)	Y...	Y		1	1.2	16	1.5	11	-.8...	12	-.5												
86	1.2*DL+1.5*LM4+1.0*WM(240)	Y...	Y		1	1.2	16	1.5	11	-.5	12	-.8...												
87	1.2*DL+1.5*LM4+1.0*WM(270)	Y...	Y		1	1.2	16	1.5	12	-1														
88	1.2*DL+1.5*LM4+1.0*WM(300)	Y...	Y		1	1.2	16	1.5	11	.5	12	-.8...												
89	1.2*DL+1.5*LM4+1.0*WM(330)	Y...	Y		1	1.2	16	1.5	11	.866	12	-.5												
90	1.2*DL+1.5*LV1	Y...	Y		1	1.2	17	1.5																
91	1.2*DL+1.5*LV2	Y...	Y		1	1.2	18	1.5																
92	1.2*DL+1.5*LV3	Y...	Y		1	1.2	19	1.5																
93	1.2*DL+1.5*LV4	Y...	Y		1	1.2	20	1.5																
94	1.2*DL+1.5*LV5	Y...	Y		1	1.2	21	1.5																
95	1.2*DL+1.5*LV6	Y...	Y		1	1.2	22	1.5																
96	1.2*DL+1.5*LV7	Y...	Y		1	1.2	23	1.5																
97	1.2*DL+1.5*LV8	Y...	Y		1	1.2	24	1.5																
98	1.2*DL+1.5*LV9	Y...	Y		1	1.2	25	1.5																
99	1.2*DL+1.5*LV10	Y...	Y		1	1.2	26	1.5																
100	1.2*DL+1.5*LV11	Y...	Y		1	1.2	27	1.5																
101	1.2*DL+1.5*LV12	Y...	Y		1	1.2	28	1.5																

Envelope Joint Reactions

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
1	N18	max	3717.208	8	0	101	1815.492	2	0	101	0	101	0	101
2		min	-4306.796	2	0	1	-1602.923	8	0	1	0	1	0	1
3	N1	max	654.316	4	528.758	13	252.224	2	.23	2	0	12	.178	2
4		min	-355.631	9	-353.388	4	-213.063	8	-.204	8	0	8	-.149	8
5	N2	max	565.303	7	887.523	2	240.609	13	.222	2	.001	2	.162	13
6		min	-608.316	12	-216.561	7	-231.982	8	-.202	8	0	10	-.141	8
7	N3	max	840.128	7	381.674	2	176.458	13	.085	2	.003	10	.094	13
8		min	-616.569	12	-564.121	8	-196.374	7	-.081	8	-.002	4	-.082	7
9	N4	max	688.661	6	494.195	13	101.534	2	.051	3	.006	6	.035	13
10		min	-429.006	10	-880.099	8	-162.75	7	-.049	9	-.006	13	-.031	7
11	N5	max	428.129	5	315.272	12	261.664	2	.162	3	.032	13	.06	2
12		min	-241.895	10	-167.402	6	-261.119	7	-.142	9	-.031	7	-.076	60
13	N6	max	354.152	8	377.773	2	168.674	2	.23	3	.008	12	.087	2
14		min	-63.062	2	-72.574	5	-247.041	8	-.21	8	-.007	5	-.098	8
15	N7	max	535.785	8	44.069	15	64.457	2	.012	2	.005	2	.012	10
16		min	-19.094	12	-598.995	8	-284.948	8	-.012	8	-.005	8	-.012	4
17	N8	max	22.684	5	45.07	24	66.653	2	.014	2	.003	8	.011	12
18		min	-397.627	8	-407.715	8	-166.644	8	-.013	8	-.003	2	-.011	6
19	N9	max	35.575	4	583.827	3	107.553	2	.027	12	0	8	.034	11
20		min	-788.82	8	-480.117	8	-252.791	8	-.026	7	0	13	-.036	4
21	N10	max	474.124	3	604.232	3	454.463	2	.276	2	0	5	.162	12
22		min	-1071.595	9	-637.486	8	-570.807	8	-.341	8	0	2	-.217	7

Envelope Joint Reactions (Continued)

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
23	N11	max	888.146	4	394.724	15	521.469	2	.382	2	0	9	.303	12
24		min	-720.531	10	-382.453	8	-560.681	8	-.439	8	-.002	2	-.377	7
25	N23	max	18.185	5	152.05	90	52.786	3	.032	2	.009	10	.055	90
26		min	-18.8	12	-77.305	4	-58.018	9	-.035	8	-.009	5	-.015	13
27	N24	max	74.717	5	725.344	90	297.944	2	.12	2	.026	3	.134	5
28		min	-79.479	12	-195.303	13	-270.61	8	-.128	8	-.027	9	-.174	10
29	N25	max	23.01	5	175.432	10	160.797	4	.064	2	.047	11	.053	8
30		min	-23.939	11	-135.63	4	-163.926	10	-.072	8	-.045	5	-.041	2
31	N26	max	113.247	5	1104.335	8	589.446	13	.429	2	.124	4	.355	5
32		min	-114.081	11	-847.957	2	-468.564	7	-.484	8	-.12	10	-.37	11
33	N27	max	1.445	37	13.569	25	40.025	2	0	101	0	101	0	101
34		min	-1.445	32	-.586	27	-40.025	8	0	1	0	1	0	1
35	N28	max	92.888	5	914.376	72	267.927	2	.078	13	.056	3	.24	5
36		min	-89.778	11	-311.084	2	-260.365	8	-.119	7	-.056	10	-.231	11
37	N29	max	1.445	37	13.569	25	40.025	2	0	101	0	101	0	101
38		min	-1.445	32	-.586	27	-40.025	8	0	1	0	1	0	1
39	N30	max	7.166	3	156.493	8	60.932	13	.075	4	.024	12	.034	7
40		min	-3.153	13	-135.007	2	-63.027	8	-.067	9	-.022	6	-.029	11
41	N31	max	1.445	37	13.569	25	40.025	2	0	101	0	101	0	101
42		min	-1.445	32	-.586	27	-40.025	8	0	1	0	1	0	1
43	N32	max	103.777	5	584.833	61	98.022	4	.106	3	.015	9	.101	59
44		min	-105.77	12	-244.576	3	-96.073	10	-.09	9	-.018	3	-.073	13
45	N33	max	1.445	37	13.569	25	40.025	2	0	101	0	101	0	101
46		min	-1.445	32	-.586	27	-40.025	8	0	1	0	1	0	1
47	N34	max	17.37	6	536.024	48	114.743	3	.121	3	.007	9	.133	8
48		min	-20.713	12	-343.837	2	-91.718	9	-.096	9	-.012	3	-.109	2
49	N35	max	1.445	37	13.569	25	40.025	2	0	101	0	101	0	101
50		min	-1.445	32	-.586	27	-40.025	8	0	1	0	1	0	1
51	N36	max	1.445	37	13.569	25	40.025	2	0	101	0	101	0	101
52		min	-1.445	32	-.586	27	-40.025	8	0	1	0	1	0	1
53	N37	max	1.445	37	13.569	25	40.025	2	0	101	0	101	0	101
54		min	-1.445	32	-.586	27	-40.025	8	0	1	0	1	0	1
55	N38	max	1.445	37	13.569	25	40.025	2	0	101	0	101	0	101
56		min	-1.445	32	-.586	27	-40.025	8	0	1	0	1	0	1
57	N39	max	28.704	4	252.434	92	117.556	5	.018	12	.024	12	.076	92
58		min	-28.994	10	-66.678	4	-105.523	11	-.023	7	-.026	5	-.017	13
59	N40	max	111.401	5	542.334	92	197.03	13	.037	12	.015	13	.052	5
60		min	-110.137	11	-113.268	13	-195.093	7	-.037	6	-.015	7	-.097	92
61	N41	max	96.948	13	280.861	91	336.53	4	.144	2	.078	11	.129	9
62		min	-85.926	7	-83.595	12	-318.295	11	-.241	8	-.083	5	-.068	2
63	N42	max	151.749	2	1052.286	8	447.4	12	.29	2	.033	15	.091	11
64		min	-141.274	8	-532.24	2	-206.194	5	-.463	8	.002	9	-.157	4
65	N19	max	3330.705	2	0	101	850.653	2	0	101	0	101	0	101
66		min	-2905.269	8	0	1	-750.778	8	0	1	0	1	0	1
67	Totals:	max	3663.233	5	3260.828	24	7260.947	2						
68		min	-3663.25	11	704.408	34	-7260.922	8						

Stress ratios are less than 1.0.
Therefore, adequate.

Envelope AISC 15th(360-16): LRFD Steel Code Checks

	Member	Shape	Code Check	Loc[...	LC	Shear..	Loc[in]	Dir	LC	phi*Pnc [lb]	phi*Pnt...	phi*Mn...	phi*Mn...	Cb	Eqn
1	M16	L2x1.5x4	.999	21.9...	13	.089	21.965	z	13	26325	26325	.565	.956	2...	H2-1
2	M11	L2x1.5x4	.974	36	8	.068	36	z	8	22275.909	26325	.443	1.134	1	H2-1
3	M118	L2x2x6	.945	11.9...	8	.124	0	y	11	42190.143	44388	.925	2.142	1...	H2-1
4	M32	L2x1.5x4	.928	28.1...	2	.095	32.947	z	2	13927.502	26325	.443	1.134	2...	H2-1
5	M10	L2x1.5x4	.795	36	8	.055	36	z	8	13496.981	26325	.443	1.134	1...	H2-1
6	M20	L2x1.5x4	.765	23.7...	13	.073	23.795	z	2	13927.502	26325	.443	1.134	2...	H2-1

Envelope AISC 15th(360-16): LRFD Steel Code Checks (Continued)

	Member	Shape	Code Check	Loc[...	LC	Shear...	Loc[in]	Dir	LC	phi*Pnc [lb]	phi*Pnt...	phi*Mn...	phi*Mn...	Cb	Eqn
7	M108	L2x2x6	.716	19.4...	9	.069	17.572	z	8	40079.197	44388	.925	2.142	1	H2-1
8	M28	L2x1.5x4	.617	27.4...	2	.058	27.456	z	2	13927.502	26325	.443	1.134	2...	H2-1
9	M12	L2x1.5x4	.607	21.2...	2	.060	0	y	2	26325	26325	.565	.956	1...	H2-1
10	M2	L2x1.5x4	.553	36	2	.026	36	z	2	13496.981	26325	.443	1.134	2...	H2-1
11	M111	PIPE 2.5	.553	55.1...	2	.136	56.25		13	26137.193	50715	3.596	3.596	4...	H1-1b
12	M1	L2x1.5x4	.544	36	2	.021	36	z	2	13496.981	26325	.443	1.134	2...	H2-1
13	M24	L2x1.5x4	.520	35.1...	2	.023	24.894	z	13	13927.502	26325	.443	1.134	1...	H2-1
14	M36	L2x1.5x4	.481	0	2	.030	35.144	y	3	13927.502	26325	.443	1.131	1...	H2-1
15	M44	L2x1.5x4	.424	35.1...	2	.040	19.768	z	8	13927.502	26325	.443	1.134	2...	H2-1
16	M40	L2x1.5x4	.372	35.1...	2	.007	35.144	y	3	13927.502	26325	.443	1.134	1...	H2-1
17	M6	L2x1.5x4	.312	36	3	.018	36	z	3	13496.981	26325	.443	1.134	2...	H2-1
18	M48	L2x1.5x4	.310	0	3	.017	0	z	4	26325	26325	.565	.956	1	H2-1
19	M68	PIPE 2.5	.275	37.1...	8	.055	38.25		10	26137.193	50715	3.596	3.596	3...	H1-1b
20	M5	L2x1.5x4	.265	36	3	.016	36	z	2	13496.981	26325	.443	1.134	2...	H2-1
21	M72	PIPE 2.0	.260	29.25	2	.031	29.25		2	19360.206	32130	1.872	1.872	1...	H1-1b
22	M109	L2x2x6	.252	11.9...	2	.025	0	z	9	42186.825	44388	.925	2.142	1...	H2-1
23	M69	PIPE 2.0	.224	23.6...	2	.051	24.5		2	17855.085	32130	1.872	1.872	2...	H1-1b
24	M3	L2x1.5x4	.217	36	13	.017	36	z	2	13496.981	26325	.443	1.134	2...	H2-1
25	M67	PIPE 2.0	.216	59.5	2	.033	23.625		9	17855.085	32130	1.872	1.872	3...	H1-1b
26	M71	PIPE_2.0	.197	24	5	.061	24		3	20866.733	32130	1.872	1.872	2...	H1-1b
27	M66	PIPE 2.0	.162	24	5	.049	24		11	20866.733	32130	1.872	1.872	2...	H1-1b
28	M107	L2x2x6	.150	21.9...	2	.033	17.572	z	8	40079.197	44388	.925	2.142	1	H2-1
29	M50	PL1.5X0.25	.141	50.31	9	.030	25.155	y	9	174.315	12150	.063	.38	1...	H1-1b*
30	M19	PL7/16"x9"	.139	21.9...	11	.557	21.965	y	8	11487.83	127575	1.163	23.92	3...	H1-1b
31	M4	L2x1.5x4	.135	36	3	.010	36	z	3	13496.981	26325	.443	1.134	1...	H2-1
32	M51	PL7/16"x9"	.118	19.4...	5	.535	19.768	y	8	11487.83	127575	1.163	23.92	2...	H1-1b
33	M9	L2x1.5x4	.098	36	3	.009	36	z	7	13496.981	26325	.443	1.134	2...	H2-1
34	M49	PL1.5X0.25	.095	50.31	3	.028	25.155	y	3	174.315	12150	.063	.38	1...	H1-1b*
35	M14	PL1.5X0.25	.094	50.31	9	.015	50.31	z	8	174.315	12150	.063	.319	1...	H1-1b*
36	M46	PL1.5X0.25	.094	50.31	8	.008	0	y	10	174.315	12150	.063	.319	1...	H1-1b*
37	M21	PL1.5X0.25	.093	50.31	7	.010	50.31	y	8	174.315	12150	.063	.319	1...	H1-1b*
38	M70	PIPE_2.0	.080	65.6...	13	.028	66.938		12	8922.084	32130	1.872	1.872	1...	H1-1b
39	M13	PL1.5X0.25	.080	50.31	4	.012	50.31	z	2	174.315	12150	.063	.319	1...	H1-1b*
40	M25	PL1.5X0.25	.080	50.31	7	.005	0	z	8	174.315	12150	.063	.319	1...	H1-1b*
41	M37	PL1.5X0.25	.069	50.31	8	.008	0	y	8	174.315	12150	.063	.319	1...	H1-1b*
42	M26	PL1.5X0.25	.066	50.31	12	.004	50.31	z	8	174.315	12150	.063	.319	1...	H1-1b*
43	M22	PL1.5X0.25	.062	50.31	12	.016	0	y	2	174.315	12150	.063	.319	1...	H1-1b*
44	M45	PL1.5X0.25	.057	50.31	3	.005	0	z	13	174.315	12150	.063	.319	1...	H1-1b*
45	M17	PL1.5X0.25	.057	50.31	7	.014	25.679	y	8	174.315	12150	.063	.38	1...	H1-1b*
46	M30	PL1.5X0.25	.056	0	9	.007	0	z	9	174.315	12150	.063	.319	1...	H1-1b*
47	M23	PL7/16"x9"	.055	23.4...	10	.162	23.429	y	7	11487.83	127575	1.163	23.92	4...	H1-1b
48	M18	PL1.5X0.25	.050	50.31	9	.017	0	y	8	174.315	12150	.063	.38	1...	H1-1b*
49	M42	PL1.5X0.25	.049	50.31	8	.005	0	z	8	174.315	12150	.063	.319	1...	H1-1b*
50	M31	PL7/16"x9"	.049	27.4...	13	.126	23.429	y	3	11487.83	127575	1.163	23.92	3...	H1-1b
51	M29	PL1.5X0.25	.047	50.31	4	.009	50.31	y	3	174.315	12150	.063	.319	1...	H1-1b*
52	M47	PL7/16"x9"	.044	19.7...	12	.042	19.768	y	7	11487.83	127575	1.163	23.92	2...	H1-1b
53	M33	PL1.5X0.25	.037	50.31	8	.014	50.31	y	8	174.315	12150	.063	.319	1...	H1-1b*
54	M7	L2x1.5x4	.033	36	9	.021	36	z	3	13496.981	26325	.443	1.134	2...	H2-1
55	M8	L2x1.5x4	.033	36	2	.006	36	z	3	13496.981	26325	.443	1.134	1...	H2-1
56	M34	PL1.5X0.25	.032	0	9	.016	50.31	y	8	174.315	12150	.063	.319	1...	H1-1b*
57	M15	PL7/16"x9"	.032	23.4...	9	.152	21.233	y	8	11487.83	127575	1.163	23.92	3...	H1-1b
58	M27	PL7/16"x9"	.022	24.5...	12	.085	23.429	y	3	11487.83	127575	1.163	23.92	3...	H1-1b
59	M35	PL7/16"x9"	.018	27.8...	4	.168	23.429	y	3	11487.83	127575	1.163	23.92	3...	H1-1b
60	M43	PL7/16"x9"	.003	35.1...	8	.000	0	z	8	11487.83	127575	1.163	14.77	1	H1-1b
61	M39	PL7/16"x9"	.003	23.4...	8	.000	35.144	z	8	11487.83	127575	1.163	14.77	1	H1-1b
62	M41	PL1.5X0.25	.001	50.31	2	.004	0	z	2	174.315	12150	.063	.319	1...	H1-1b*
63	M38	PL1.5X0.25	.000	50.31	33	.000	50.31	y	56	174.315	12150	.063	.319	1...	H1-1b*