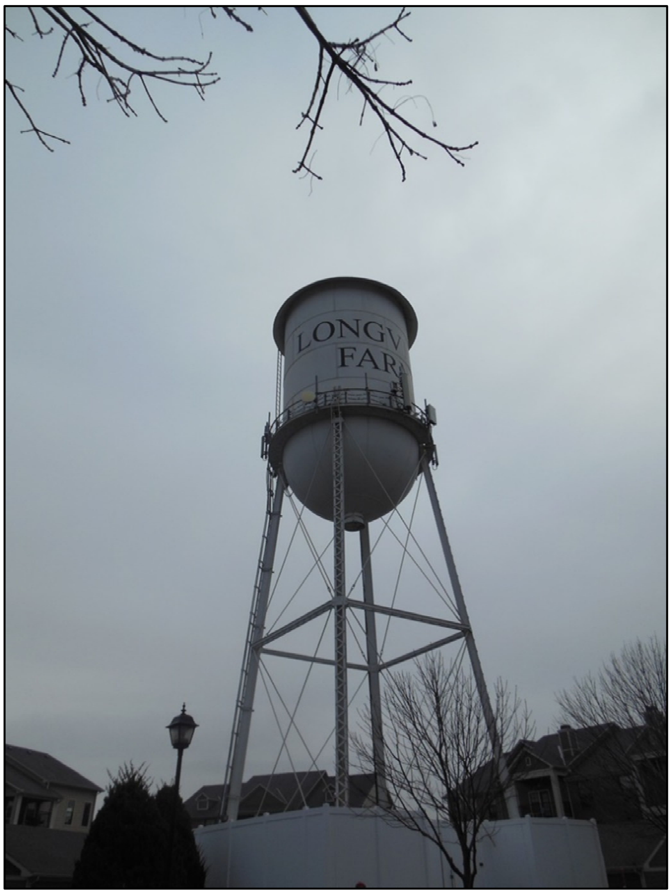
STRUCTURAL ANALYSIS REPORT
WATER TANK

Prepared For:
KGI Wireless, Inc.
Building Three, Suite 370
805 Las Cimas Parkway
Austin, TX 78746



Structure Rating:	
Handrail:	**Pass**
Water Tank:	**Pass**

Sincerely,
EFI Global, Inc.

3/1/2021

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Missouri Professional Engineer
License No: PE-2011011126

T-Mobile Site Name: Longview Farm Tank
T-Mobile Site ID: A5C0335A
548 SW Tower Park Road
Lee's Summit, MO 64081

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APPENDIX

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1.0 SUBJECT AND REFERENCES

The purpose of this analysis is to evaluate the structural capacity of the existing telecommunication installation at 548 SW Tower Park Road, Lee's Summit, MO 64081 for the additions and alterations proposed by T-Mobile.

The structural analysis is based on the following documentation provided to EFI Global, Inc. (EFI):

- Construction Drawings prepared by KGI, dated 02/23/2021.
- Mount Mapping Report & Site Photos prepared by Engineering Tower Solutions, PLLC, dated 02/16/2021.
- Field Audit Form & Site Photos prepared by KGI, dated 10/29/2020.
- RFDS provided by T-Mobile, dated 09/30/2020.
- Structural Analysis Report prepared by SSC, Inc., dated 11/09/2018.

1.1 STRUCTURE

The subject structure is 98 ft. water tank. T-Mobile currently has six (6) antennas, with two (2) antennas per sector. The antennas are attached pipe mounts on the handrail around the water tank. The RAD centers of the appurtenances are 63'-6'' and 63'-0'' above grade level (AGL). Please refer to the calculations in Appendix A for additional details.

2.0 EXISTING AND PROPOSED APPURTENANCES

T-Mobile is proposing the following appurtenance changes on the water tank:

Existing Configuration of T-Mobile Appurtenances:

Sector	Rad Center (ft.)	Antennas & Equipment	Coax	Mount
Alpha, Beta & Gamma	63'-6''	(3) RFS APXVSPP18 (3) Ericsson RRUS 11 B26A (3) Ericsson RRUS 31 B25	(3) 1/2'' Coax (3) 7/8'' Coax	(6) Existing Pipe Mounts on Handrail
	63'-0''	(3) Ericsson IP 65		

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Proposed and Final Configuration of T-Mobile Appurtenances:

Sector	Rad Center (ft.)	Antennas & Equipment	Coax	Mount
Alpha, Beta & Gamma	63-6’’	(3) Commscope FFV4-65C-R3-V1 (3) Nokia AEHC (3) Nokia AHLOA* (3) Nokia AHFIG* (3) Ericsson RRUS 31 B25	(3) 7/8” Coax (2) 1.8” HCS2.0 Coax	(6) Existing Pipe Mounts on Handrail

***To be mounted behind antennas.**

3.0 CODES AND LOADING

The analysis is in accordance with:

- 2018 International Building Code.
- 2018 International Existing Building Code.
- ASCE 7-16, Minimum Design Loads for Buildings and Other Structures.
- AISC, Steel Construction Manual, 15th Edition.
- AWWA D100-11, Welded Carbon Tanks for Water Storage

The following loading parameters were used:

- Ultimate Wind Speed: V = 122 mph (3-Second gust)
- Exposure Category: C
- Risk Category: IV
- S_S = 0.099
- S_1 = 0.068
- Seismic Site Class: D

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4.0 STANDARD CONDITIONS FOR ENGINEERING SERVICES ON EXISTING STRUCTURES

The analysis is based on the information provided to EFI and is assumed to be current and correct. Unless otherwise noted, the structure and the foundation system are assumed to be in good condition, free of defects, and can achieve theoretical strength.

It is assumed that the structure has been maintained and shall be maintained during its service lifespan. The superstructure and the foundation system are assumed to be designed with proper engineering practice and fabricated, constructed, and erected in accordance with the design documents. EFI will accept no liability which may arise due to any existing deficiency in design, material, fabrication, erection, construction, etc., or lack of maintenance.

The analysis results presented in this report are only applicable for the previously mentioned existing and proposed additions and alterations. Any deviation of the proposed equipment and placement, etc., will require EFI to generate an additional structural analysis.

5.0 ANALYSIS AND ASSUMPTIONS

This structural analysis and qualification of the subject structure is based on the following criteria:

Pursuant to 2018 International Existing Building Code Sections 1103.1 and 1103.2, any existing gravity load-carrying structural element for which additions and/or alterations cause an increase in design gravity load of no more than 5 percent, shall be permitted to remain unaltered, thus considered to be Code-compliant and adequate. Any existing gravity load-carrying structural element for which additions and/or alterations cause an increase in design gravity loads exceeding 5 percent is checked against the applicable Code criteria for new structures.

Pursuant to 2018 International Existing Building Code Sections 1103.1 and 1103.2, any existing lateral load-carrying structural element whose demand-capacity ratio with the addition and/or alteration considered is no more than 10 percent greater than its demand-capacity ratio with the addition and/or alteration ignored shall be permitted to remain unaltered, thus considered to be Code-compliant and adequate. If the demand-capacity ratio increase is more than 10 percent, the subject structural element is checked against the applicable Code criteria for new structures.

This analysis was performed by utilizing Risa 3-D, a commercially available structural engineering software package by Risa Technologies, as applicable.

6.0 RESULTS AND CONCLUSION

Handrail: The existing water tank handrail has **adequate** structural capacity for the proposed additions by T-Mobile. For the code specified load combinations and as a maximum, the handrail members are stressed to **104.7%** of their structural capacity; lower than industry wide accepted stress level of 105%.

Water Tank: The existing water tank is found to have **adequate** structural capacity for the proposed additions by T-Mobile. Utilizing a conservative approach, the tank structural design is determined to be governed by seismic loads. The additional lateral loads on the tank due to T-Mobile additions is approximately 1.98%, less than the 10% given by the 2018 IEBC. Therefore, further analysis of the tank is not required, and the structure is considered to have adequate capacity.

Therefore, the proposed additions and alterations by T-Mobile **can** be implemented as intended and with the conditions outlined in this report.

Should you need any clarifications or have any questions about this report, please contact EFI at telecom@efiglobal.com.

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APPENDIX A
PICTURES & CALCULATIONS

Existing T-Mobile Antennas on Handrail (Typ.)

CALCULATION SHEET

PURPOSE

The purpose of this analysis is to evaluate the structural capacity of the existing water tank at 548 SW Tower Park Road, Lee's Summit, MO 64081 for the proposed changes by T-Mobile.
All calculations in accordance with 2018 International Building Code.

1. Antenna Support

Wind Load (reference ASCE 7-16)

Input:

Location:	Lee's Summit, MO	Reference, ASCE-7-16
Classification:	IV	Table 1.5-1 pg 4
Equipment height (RAD):	$z := 63.5$ ft	
Exposure category:	$Exp := "C"$	Section 26.7.4.1 pg 266

$$z_g := \begin{cases} 1200 & \text{if } Exp = "B" \\ 900 & \text{if } Exp = "C" \\ 700 & \text{if } Exp = "D" \end{cases} = 900 \qquad \alpha := \begin{cases} 7.0 & \text{if } Exp = "B" \\ 9.5 & \text{if } Exp = "C" \\ 11.5 & \text{if } Exp = "D" \end{cases} = 9.5$$

Velocity pressure exposure coefficient:	$K_z := 2.01 \cdot \left(\frac{z}{z_g}\right)^{\frac{2}{\alpha}} = 1.15$	Table 26.10-1 pg. 268
Ground Elevation:	$z_s := 1011$ ft	Ground elevation above sea level
Ground Elevation factor:	$K_e := e^{-0.0000362 \cdot z_s} = 0.96$	Table 26.9-1 pg. 268
Topographic factor:	$K_{zt} := 1.0$	Section 26.8.2 pg 268
Wind directional factor:	$K_d := 1.0$	Table 26.6.1 pg 266
Ultimate wind speed:	$V := 122$ mph	Figure 26.5-1B pg.253
Gust factor:	$G := 0.85$	Section 26.11.1 pg 269
Velocity pressure:	$q_z := 0.00256 \cdot K_z \cdot K_e \cdot K_{zt} \cdot K_d \cdot V^2 \cdot psf$ $q_z = 42.25 \cdot psf$	Equation 26.10-1 pg 268
Force Coeifficients:		Figure 29.4-1, pg 325

for Flat surface — for D*sqrt(qz) >2.5 — for D*sqrt(qz) < 2.5

$$C_{F\_flat} := \begin{pmatrix} 1 & 1.3 \\ 7 & 1.4 \\ 25 & 2 \end{pmatrix} \quad C_{F\_round\_1} := \begin{pmatrix} 1 & 0.5 \\ 7 & 0.6 \\ 25 & 0.7 \end{pmatrix} \quad C_{F\_round\_2} := \begin{pmatrix} 1 & 0.7 \\ 7 & 0.8 \\ 25 & 1.2 \end{pmatrix}$$

Loads on Antennas (Commscope FFV4-65C-R3-V1):

Dimensions: $H := 96in$ $W := 25.2in$ $D := 9.3in$ $W_{ant1} := 131.8lbf$

$C_{f\_F} := linterp\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{W}\right) = 1.35$ Figure 29.4-1, pg 325

$C_{f\_S} := linterp\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{D}\right) = 1.51$ Figure 29.4-1, pg 325

$F_{ant1} := q_z \cdot G \cdot C_{f\_F} \cdot H \cdot W = 812.62\ lbf$ Equation (29.4-1) Pg 322

$S_{ant1} := q_z \cdot G \cdot C_{f\_S} \cdot H \cdot D = 336.4\ lbf$ Equation (29.4-1) Pg 322

Loads on Antennas (Nokia AEHC):

Dimensions: $H := 35.4in$ $W := 22.8in$ $D := 8.3in$ $W_{ant2} := 99.2lbf$

$C_{f\_F} := linterp\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{W}\right) = 1.31$ Figure 29.4-1, pg 325

$C_{f\_S} := linterp\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{D}\right) = 1.35$ Figure 29.4-1, pg 325

$F_{ant2} := q_z \cdot G \cdot C_{f\_F} \cdot H \cdot W = 263.54\ lbf$ Equation (29.4-1) Pg 322

$S_{ant2} := q_z \cdot G \cdot C_{f\_S} \cdot H \cdot D = 99.25\ lbf$ Equation (29.4-1) Pg 322

Loads on RRUs (Nokia AHFIG):

Dimensions : $H := 27.6in$ $W := 13.4in$ $D := 5.6in$ $W_{rrh1} := 79.4lbf$

$C_{f\_F} := linterp\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{W}\right) = 1.32$ Figure 29.4-1, pg 325

$C_{f\_S} := linterp\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{D}\right) = 1.37$

$F_{rrh1} := q_z \cdot G \cdot C_{f\_F} \cdot H \cdot W = 121.54\ lbf$ Equation (29.4-1) Pg 322

$S_{rrh1} := q_z \cdot G \cdot C_{f\_S} \cdot H \cdot D = 52.64\ lbf$ Equation (29.4-1) Pg 322

Loads on RRUs (Nokia AHLOA):

Dimensions : $H := 26.6in$ $W := 12.9in$ $D := 8.1in$ $W_{rrh2} := 83.8lbf$

$C_{f\_F} := linterp\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{W}\right) = 1.32$ Figure 29.4-1, pg 325

$C_{f\_S} := linterp\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{D}\right) = 1.34$

$F_{rrh2} := q_z \cdot G \cdot C_{f\_F} \cdot H \cdot W = 112.77\ lbf$ Equation (29.4-1) Pg 322

$S_{rrh2} := q_z \cdot G \cdot C_{f\_S} \cdot H \cdot D = 71.9\ lbf$ Equation (29.4-1) Pg 322

CALCULATION SHEET

Loads on RRUs (Ericsson RRUS 31 B25):

Dimensions : $H := 16.5in$ $W := 11.8in$ $D := 9.3in$ $W_{rrh3} := 56.1lbf$

$Cf_{\_F} := \text{linterp}\left(C_{F\_flat}^{\langle 0\rangle}, C_{F\_flat}^{\langle 1\rangle}, \frac{H}{W}\right) = 1.31$ Figure 29.4-1, pg 325

$Cf_{\_S} := \text{linterp}\left(C_{F\_flat}^{\langle 0\rangle}, C_{F\_flat}^{\langle 1\rangle}, \frac{H}{D}\right) = 1.31$

$F_{rrh3} := q_z \cdot G \cdot Cf_{\_F} \cdot H \cdot W = 63.45\ lbf$ Equation (29.4-1) Pg 322

$S_{rrh3} := q_z \cdot G \cdot Cf_{\_S} \cdot H \cdot D = 50.25\ lbf$ Equation (29.4-1) Pg 322

Loads on Antennas (Argus LLPX310R-V1) - Other Carrier:

Dimensions: $H := 42.13in$ $W := 11.81in$ $D := 4.53in$ $W_{ant3} := 41.9lbf$

$Cf_{\_F} := \text{linterp}\left(C_{F\_flat}^{\langle 0\rangle}, C_{F\_flat}^{\langle 1\rangle}, \frac{H}{W}\right) = 1.34$ Figure 29.4-1, pg 325

$Cf_{\_S} := \text{linterp}\left(C_{F\_flat}^{\langle 0\rangle}, C_{F\_flat}^{\langle 1\rangle}, \frac{H}{D}\right) = 1.48$ Figure 29.4-1, pg 325

$F_{ant3} := q_z \cdot G \cdot Cf_{\_F} \cdot H \cdot W = 166.63\ lbf$ Equation (29.4-1) Pg 322

$S_{ant3} := q_z \cdot G \cdot Cf_{\_S} \cdot H \cdot D = 70.29\ lbf$ Equation (29.4-1) Pg 322

Loads on Dish (VHLP2-11) - Other Carrier:

Dimensions : $H := 26.1\text{in}$ $W := 26.1\text{in}$ $D := 12.3\text{in}$ $W_{dish1} := 31\text{lbf}$

$C_{f\_F} := \text{linterp}\left(C_{F\_flat}^{\langle 0\rangle}, C_{F\_flat}^{\langle 1\rangle}, \frac{H}{W}\right) = 1.3$ Figure 29.4-1, pg 325

$C_{f\_S} := \text{linterp}\left(C_{F\_flat}^{\langle 0\rangle}, C_{F\_flat}^{\langle 1\rangle}, \frac{H}{D}\right) = 1.32$

$F_{dish1} := q_z \cdot G \cdot C_{f\_F} \cdot H \cdot W = 220.87\ \text{lbf}$ Equation (29.4-1) Pg 322

$S_{dish1} := q_z \cdot G \cdot C_{f\_S} \cdot H \cdot D = 105.58\ \text{lbf}$ Equation (29.4-1) Pg 322

Loads on Dish (32"Øx12" Dish) - Other Carrier:

Dimensions : $H := 32\text{in}$ $W := 32\text{in}$ $D := 12\text{in}$ $W_{dish2} := 50\text{lbf}$

$C_{f\_F} := \text{linterp}\left(C_{F\_flat}^{\langle 0\rangle}, C_{F\_flat}^{\langle 1\rangle}, \frac{H}{W}\right) = 1.3$ Figure 29.4-1, pg 325

$C_{f\_S} := \text{linterp}\left(C_{F\_flat}^{\langle 0\rangle}, C_{F\_flat}^{\langle 1\rangle}, \frac{H}{D}\right) = 1.33$

$F_{dish2} := q_z \cdot G \cdot C_{f\_F} \cdot H \cdot W = 332.01\ \text{lbf}$ Equation (29.4-1) Pg 322

$S_{dish2} := q_z \cdot G \cdot C_{f\_S} \cdot H \cdot D = 127.16\ \text{lbf}$ Equation (29.4-1) Pg 322

Loads on Pipe Mount (2.5 STD):

Dimensions: $Dia := 2.875\text{in}$ $H := 96\text{in}$

$C_f := \text{linterp}\left(C_{F\_round\_2}^{\langle 0\rangle}, C_{F\_round\_2}^{\langle 1\rangle}, \frac{H}{Dia}\right) = 1.39$ Figure 29.4-1, pg 325

$C_f := \begin{cases} C_f & \text{if } C_f \le 1.2 \\ 1.2 & \text{otherwise} \end{cases} = 1.2$

$F_{pipe1} := q_z \cdot G \cdot C_f \cdot Dia = 10.33 \cdot \text{plf}$ Equation (29.4-1) Pg 322

Loads on Pipe Mount (2.0 STD):

Dimensions: $Dia := 2.375\text{in}$ $H := 84\text{in}$

$C_f := \text{linterp}\left(C_{F\_round\_2}^{\langle 0\rangle}, C_{F\_round\_2}^{\langle 1\rangle}, \frac{H}{Dia}\right) = 1.43$ Figure 29.4-1, pg 325

$C_f := \begin{cases} C_f & \text{if } C_f \le 1.2 \\ 1.2 & \text{otherwise} \end{cases} = 1.2$

$F_{pipe2} := q_z \cdot G \cdot C_f \cdot Dia = 8.53 \cdot \text{plf}$ Equation (29.4-1) Pg 322

Loads on Channel (C6x8.2):

Dimensions: $D := 6in$ $H := 41.5in$

$C_f := \text{linterp}\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{D}\right) = 1.4$ Figure 29.5-1, pg 312

$C_f := \begin{cases} C_f & \text{if } C_f \le 2.0 \\ 2.0 & \text{otherwise} \end{cases} = 1.4$

$F_{ch} := q_z \cdot G \cdot C_f \cdot D = 25.11 \cdot plf$ Equation 29.5-1, pg 308

Loads on Angle (L2x1.5):

Dimensions: $D := 2in$ $H := 41.5in$

$C_f := \text{linterp}\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{D}\right) = 1.86$ Figure 29.5-1, pg 312

$C_f := \begin{cases} C_f & \text{if } C_f \le 2.0 \\ 2.0 & \text{otherwise} \end{cases} = 1.86$

$F_{angle} := q_z \cdot G \cdot C_f \cdot D = 11.12 \cdot plf$ Equation 29.5-1, pg 308

Loads on Plate (PL1.5x3/16):

Dimensions: $D := 1.5in$ $H := 51in$

$C_f := \text{linterp}\left(C_{F\_flat}^{\langle 0 \rangle}, C_{F\_flat}^{\langle 1 \rangle}, \frac{H}{D}\right) = 2.3$ Figure 29.5-1, pg 312

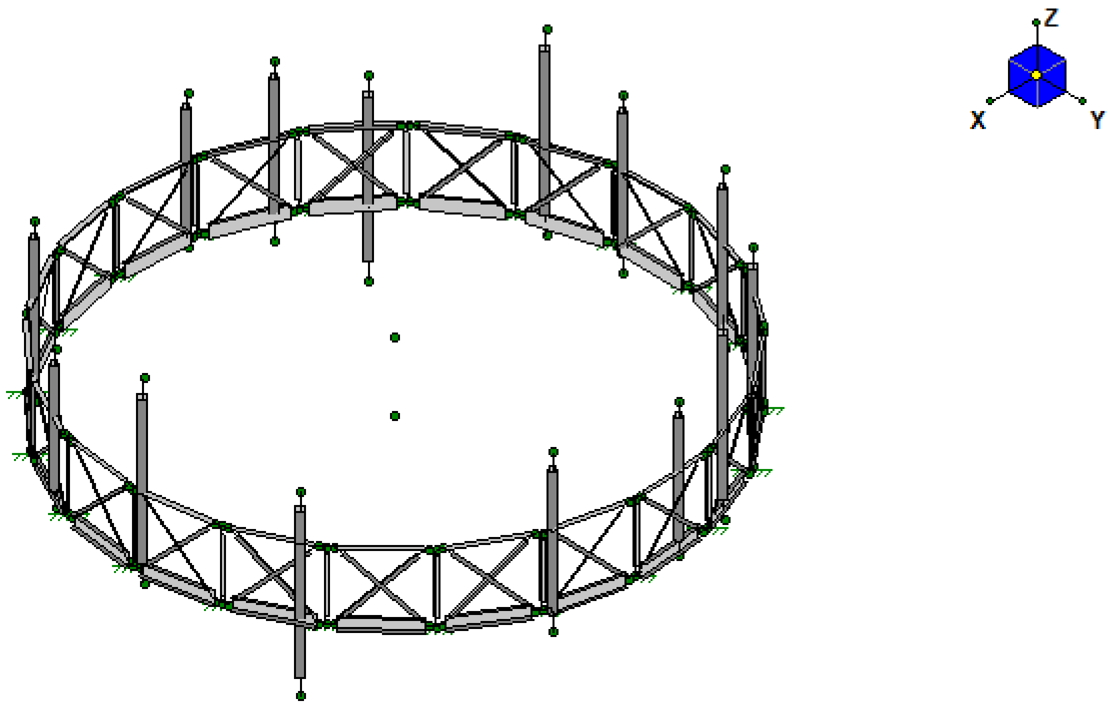
$C_f := \begin{cases} C_f & \text{if } C_f \le 2.0 \\ 2.0 & \text{otherwise} \end{cases} = 2$

$F_{plate} := q_z \cdot G \cdot C_f \cdot D = 8.98 \cdot plf$ Equation 29.5-1, pg 308

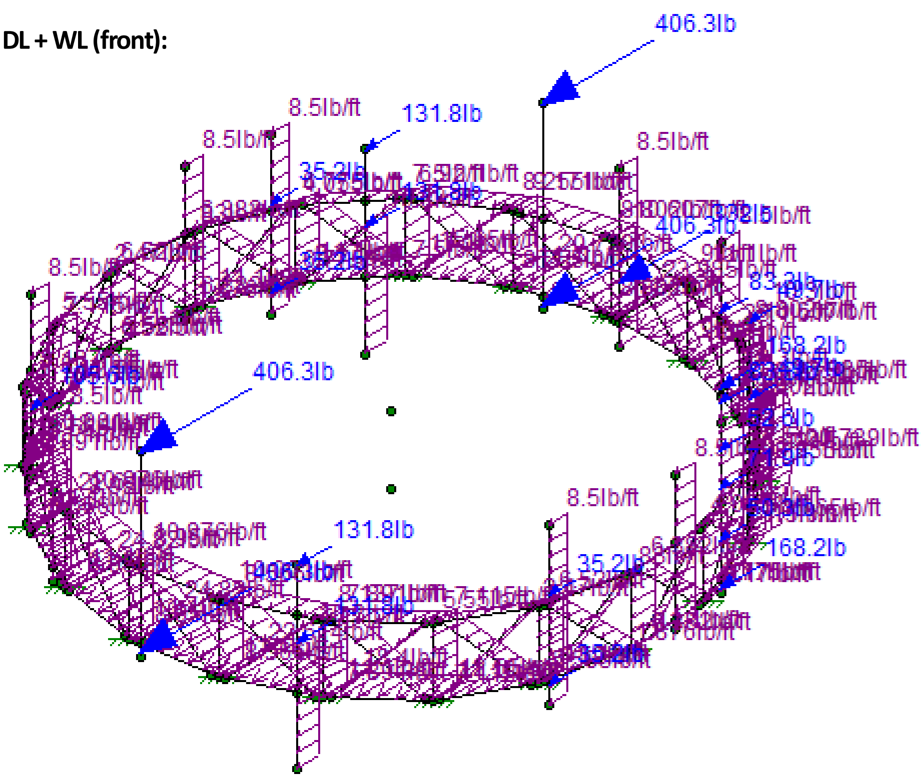
CALCULATION SHEET

Existing Handrail Mount:

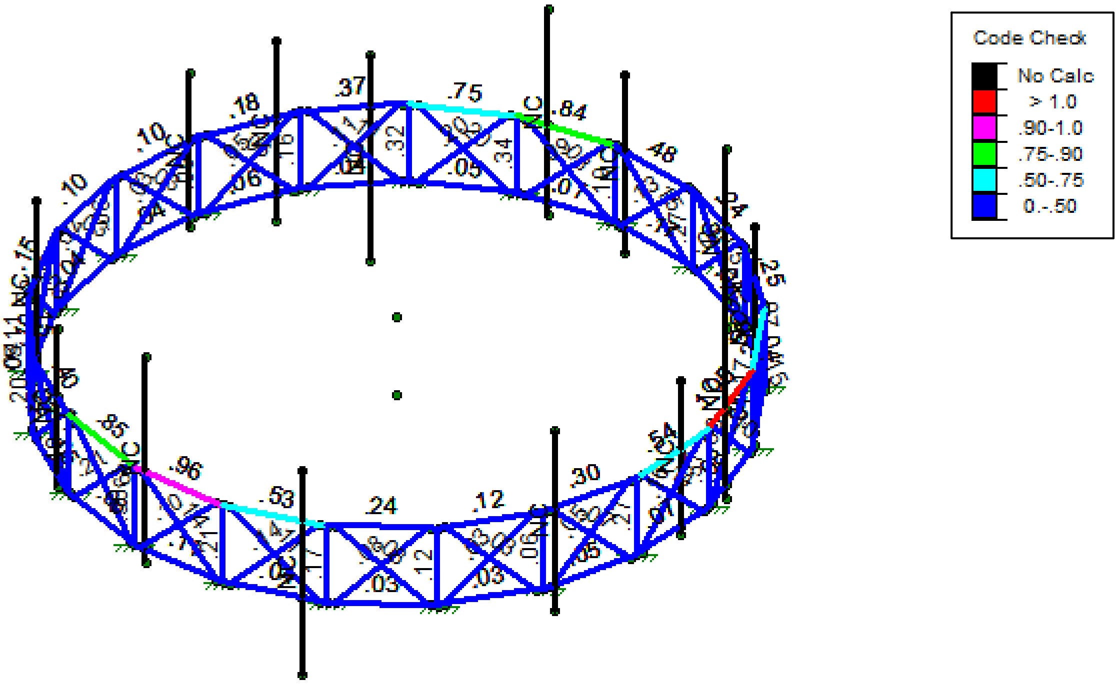
Render:



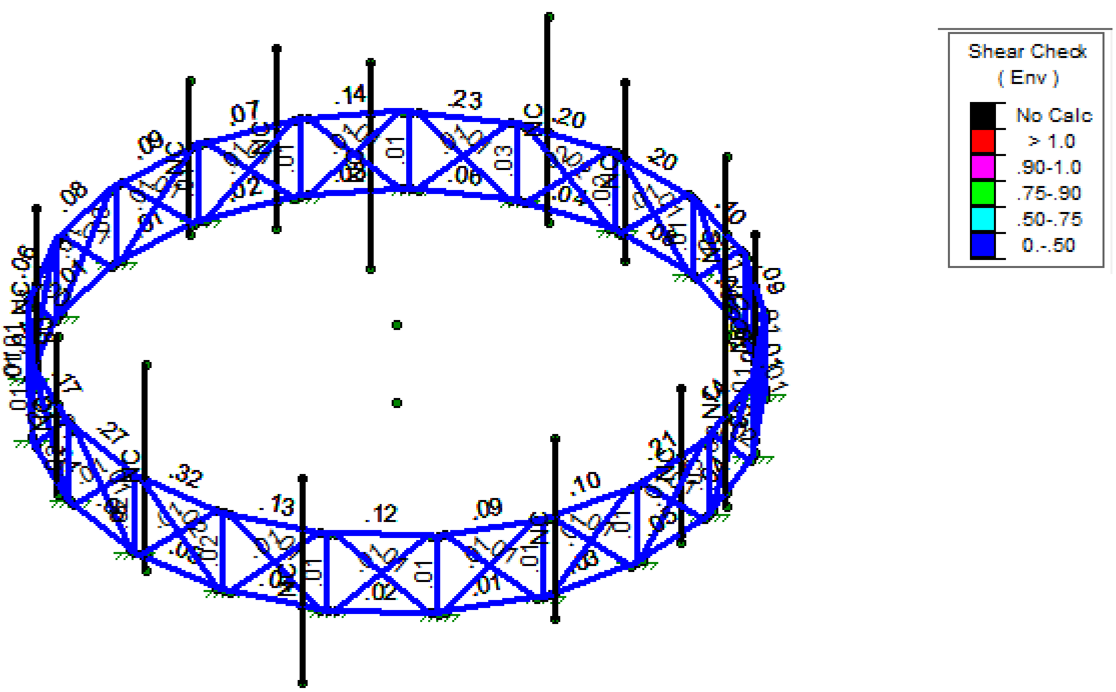
DL + WL (front):



Code Check:



Shear Check:



As a maximum, mount members are stressed to 104.7% of capacity.

2. Tank Structure

By inspection, the existing and proposed telecommuncation installations do not increase the lateral loads resulting from wind by more than 10%. Thus, check the increase in lateral loads to the water tank resulting from seismic loads to ensure those additions are within prescribed building code limits.

Approximate Total Height of water tank $H_{tank} := 98ft$

Approximate Diameter of water tank $D_{tank} := 19ft$

Approximate Height of water tank $L_{tank} := 38ft$

Approximate Volume of water tank $Volume := \pi \cdot \left(\frac{D_{tank}}{2}\right)^2 \cdot L_{tank} = 80596\,gal$ OR $Volume = 10774.09 \cdot ft^3$

$Capacity := 0.75 Volume$

$\gamma_{water} := \frac{8.34}{gal}$ lbs per gallon

$W_{water} := Capacity \cdot \frac{\gamma_{water}}{1000} = 504$ kips — this is also conservatively used as the effective seismic weight (neglects weight of tank's steel shell)

$C_{s\_min} := 0.03$ — seismic response coefficient - value used based upon experience

$W_{allcarriers} := 10$ kips — Weight of all carrier equipment installed, conservatively estimated

Input

ASCE 7-16 Reference

Seismic Base Shear: $V_s := C_{s\_min} \cdot W_{water} = 15.1$ .kips — Equation 12.8-1, pg. 101

Compare added loads to design seismic loads

$Addition := \frac{(W_{allcarriers} + W_{water}) \cdot C_{s\_min}}{V_s} - 100\% = 1.98 \cdot \%$ < 10%, no additional checks required per IBC requirements