STRUCTURAL ANALYSIS

PROJECT

Tank

CLIENT

CREATED BY

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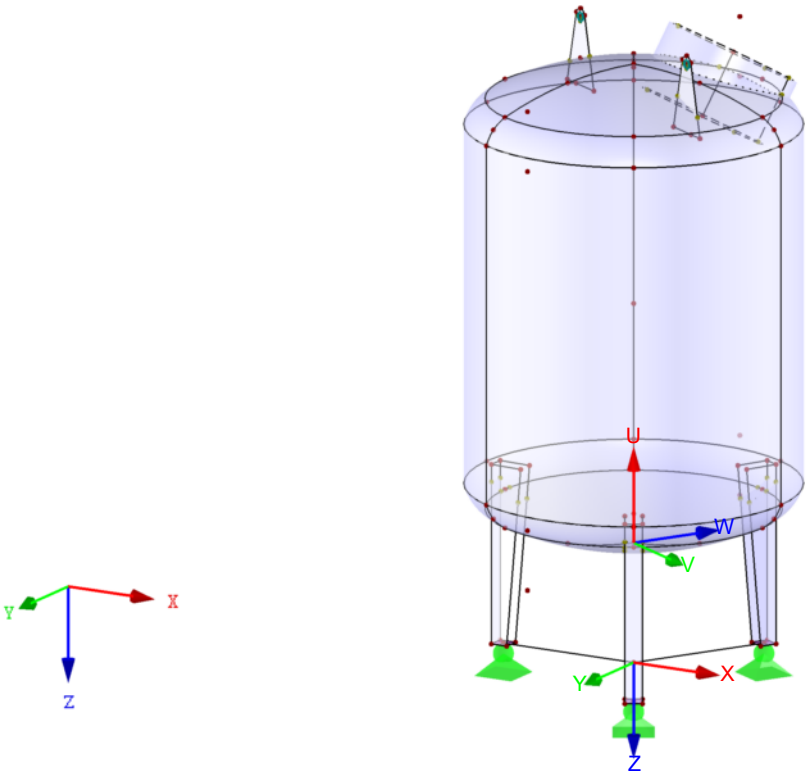
Isometric



CONTENTS

1.3 MATERIALS

Matl. No.	Modulus E [ksi]	Modulus G [ksi]	Poisson's Ratio ν [-]	Spec. Weight γ [lbf/ft³]	Coeff. of Th. Exp. α [1/°F]	Partial Factor γ_M [-]	Material Model
1	Stainless Steel (Plates and Sheets) A 240, Grade 304, 18Cr-8Ni | ASME B31.3-2010						
	29198.50	11230.20	0.300	499.72	9.11E-06	1.00	Isotropic Linear Elastic

2.1 LOAD CASES

Load Case	Load Case Description	ASCE 7-16 Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	Self Weight	Dead	☒	0.000	0.000	1.000
LC2	Fill	Live	☐			
LC3	Wind	Wind	☐			

2.5 LOAD COMBINATIONS

Load Combin.	DS	Load Combination Description	No.	Factor	Load Case	
CO1		1.4*LC1	1	1.40	LC1	Self Weight
CO2		1.2*LC1 + 1.6*LC2	1	1.20	LC1	Self Weight
			2	1.60	LC2	Fill
CO3		1.2*LC1 + LC2 + LC3	1	1.20	LC1	Self Weight
			2	1.00	LC2	Fill
			3	1.00	LC3	Wind
CO4		1.2*LC1 + LC3	1	1.20	LC1	Self Weight
			2	1.00	LC3	Wind
CO5		0.9*LC1 + LC3	1	0.90	LC1	Self Weight
			2	1.00	LC3	Wind
CO6		LC1	1	1.00	LC1	Self Weight
CO7		LC1 + LC2	1	1.00	LC1	Self Weight
			2	1.00	LC2	Fill
CO8		LC1 + 0.6*LC3	1	1.00	LC1	Self Weight
			2	0.60	LC3	Wind
CO9		LC1 + 0.75*LC2 + 0.45*LC3	1	1.00	LC1	Self Weight
			2	0.75	LC2	Fill
			3	0.45	LC3	Wind
CO10		0.6*LC1 + 0.6*LC3	1	0.60	LC1	Self Weight
			2	0.60	LC3	Wind
CO11		1,2D+L2+W+Imp	1	1.20	LC1	Self Weight
			2	1.00	LC2	Fill
			3	1.00	LC3	Wind

2.5.7 LOAD COMBINATIONS

Load Combin.	CO-Description	Applied Imperfection from Module RF-IMP	Applied Imperfection
CO11	1,2D+L2+W+Imp	☒	CA1

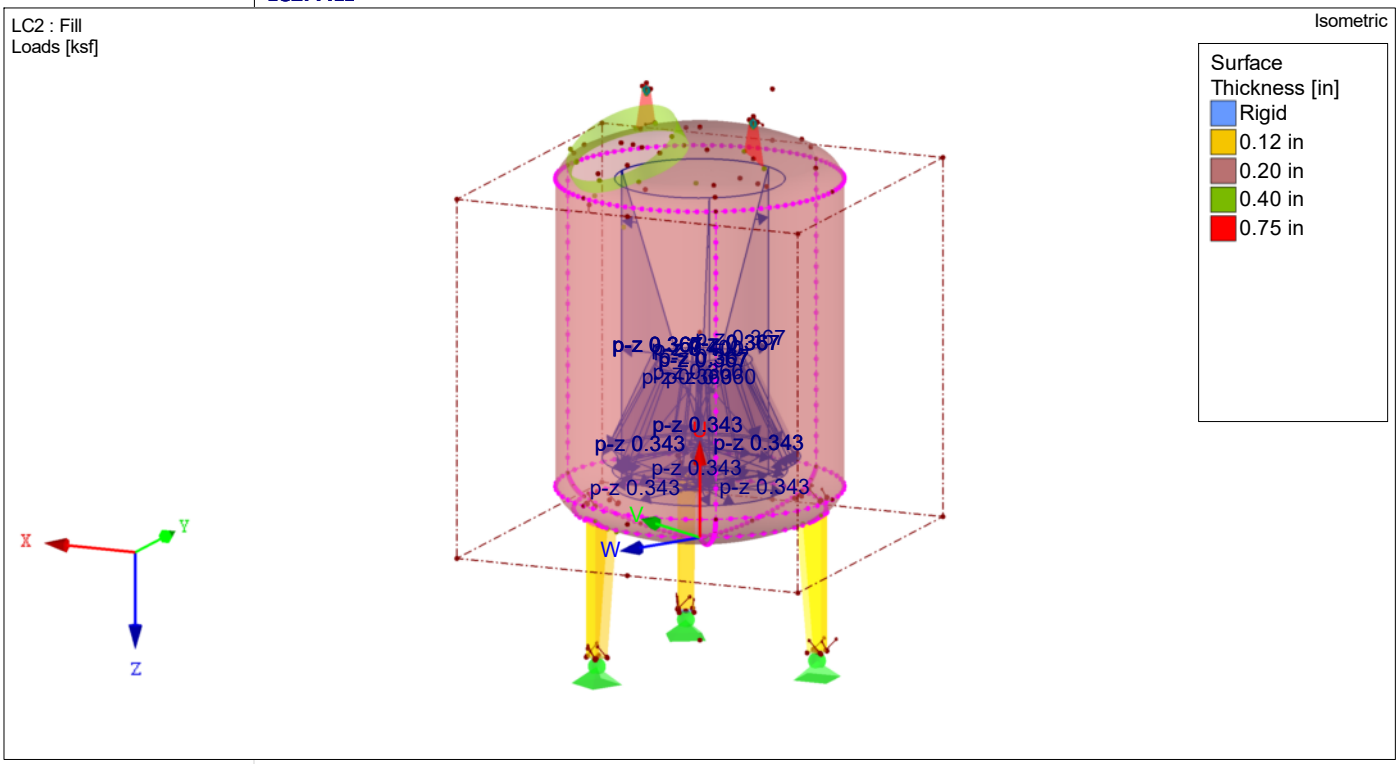
3.8 FREE RECTANGULAR LOADS

LC2: Fill

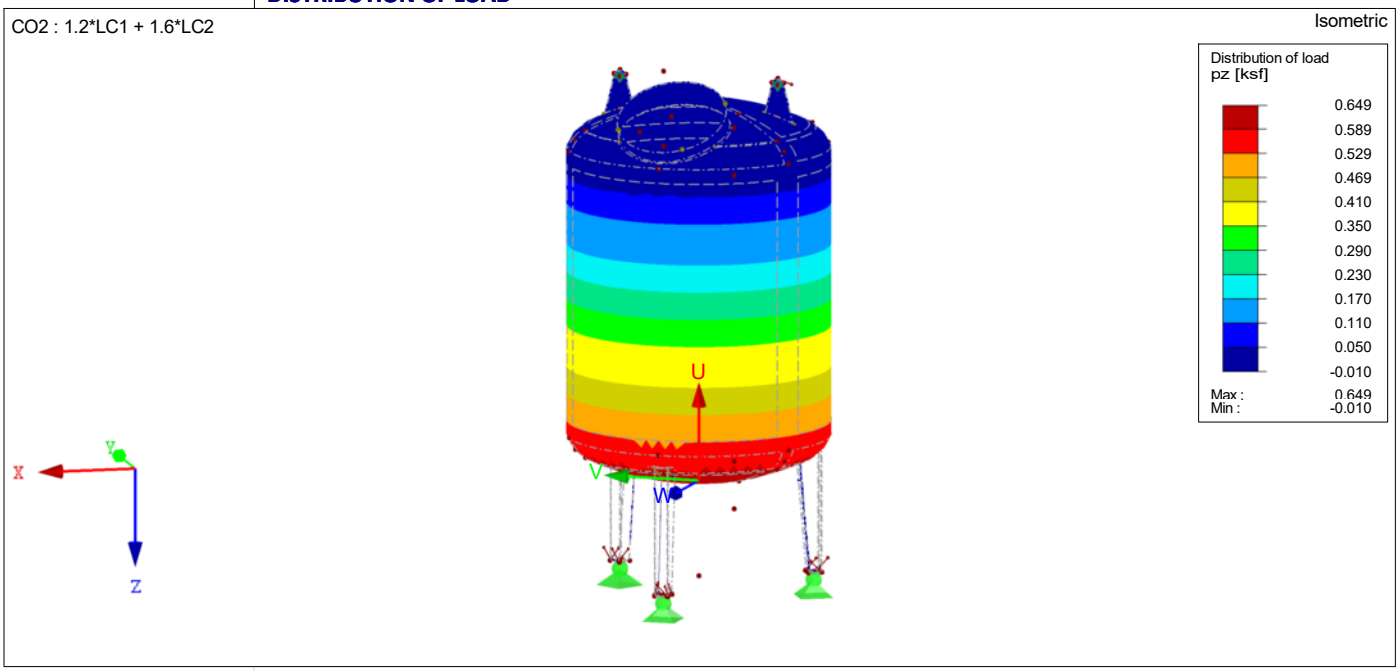
LC2
Fill

No.	On Surfaces No.	Project.	Load Distribution	Load Direction	Magnitude Symbol	Magnitude Value	Magnitude Unit	Load Position X [in]	Load Position Y [in]	Load Position Z [in]
1	1-3,6-8,11-13, 42-47	YZ	Linear Z	z	p_1	0.000	ksf		-24.00	-63.00
					p_2	0.400	ksf		24.00	-14.00

LC2: FILL



DISTRIBUTION OF LOAD



3.8 FREE RECTANGULAR LOADS

LC3: Wind

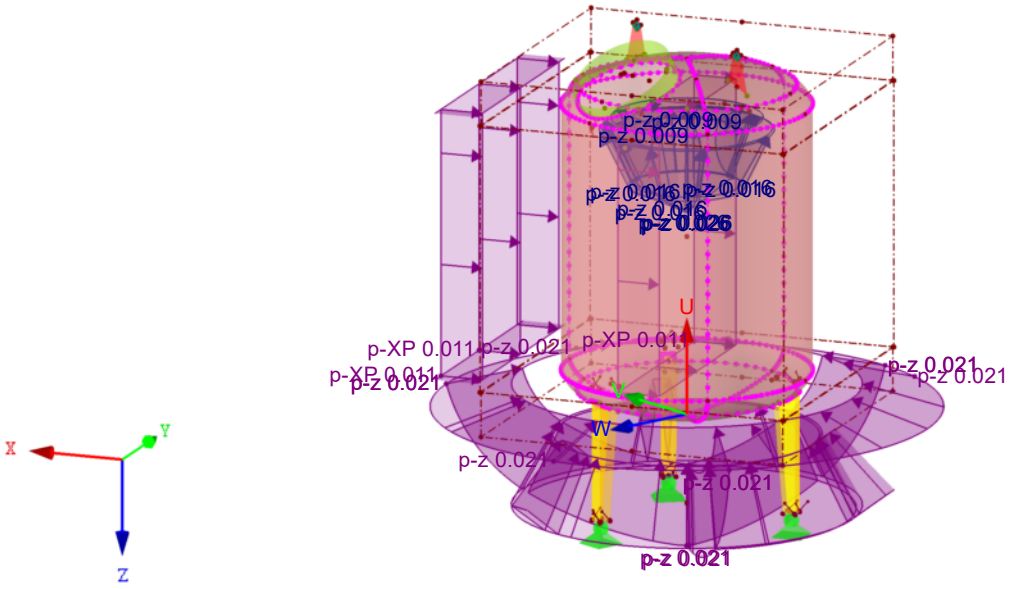
LC3
Wind

No.	On Surfaces No.	Project.	Load Distribution	Load Direction	Magnitude Symbol	Magnitude Value	Magnitude Unit	Load Position X [in]	Load Position Y [in]	Load Position Z [in]
1	3,8,13	YZ	Uniform	XP	p	-0.011	ksf		-24.00	-63.00
									24.00	-21.00
2	4,5,9,10,17,19	YZ	Linear Z	z	p_1	0.026	ksf		-24.00	-70.00
					p_2	0.009	ksf		24.00	-63.00
3	1,2,6,7,11,12, 42-47	YZ	Uniform	z	p	-0.021	ksf		-24.00	-21.00
									24.00	-14.00

LC3: WIND

LC3 : Wind
Loads [ksf]

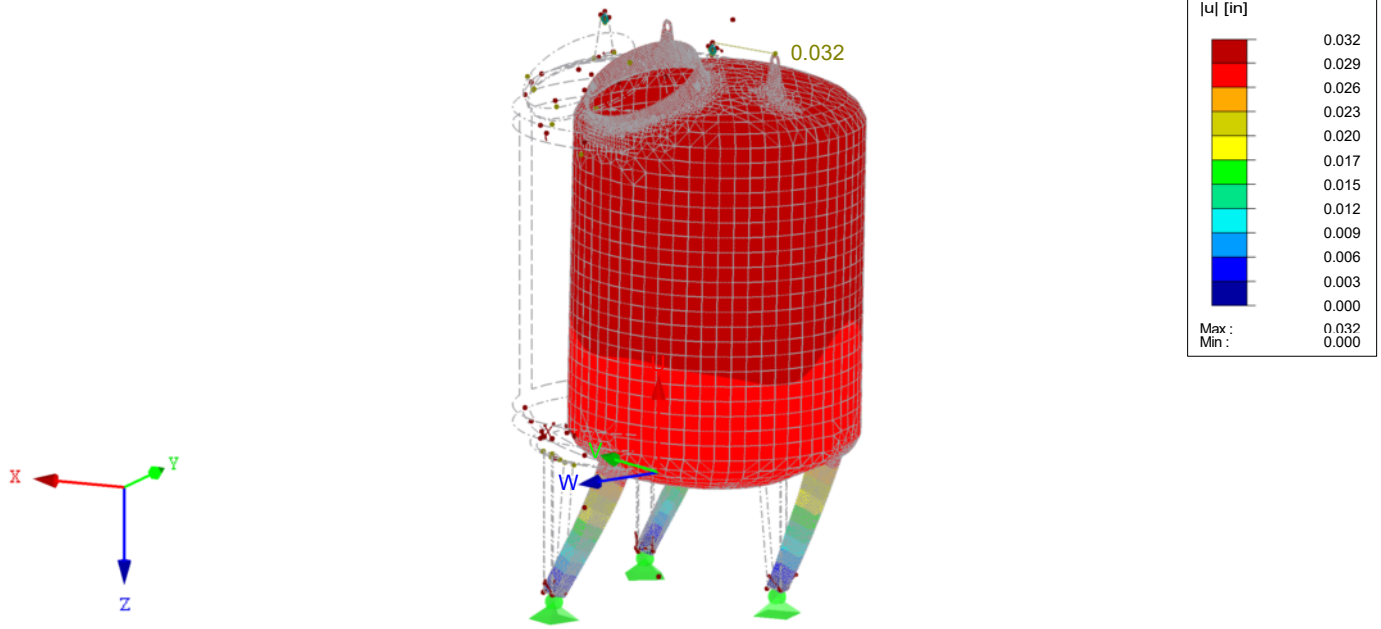
Isometric



GLOBAL DEFORMATIONS u

CO11 : 1,2D+L2+W+Imp

Isometric

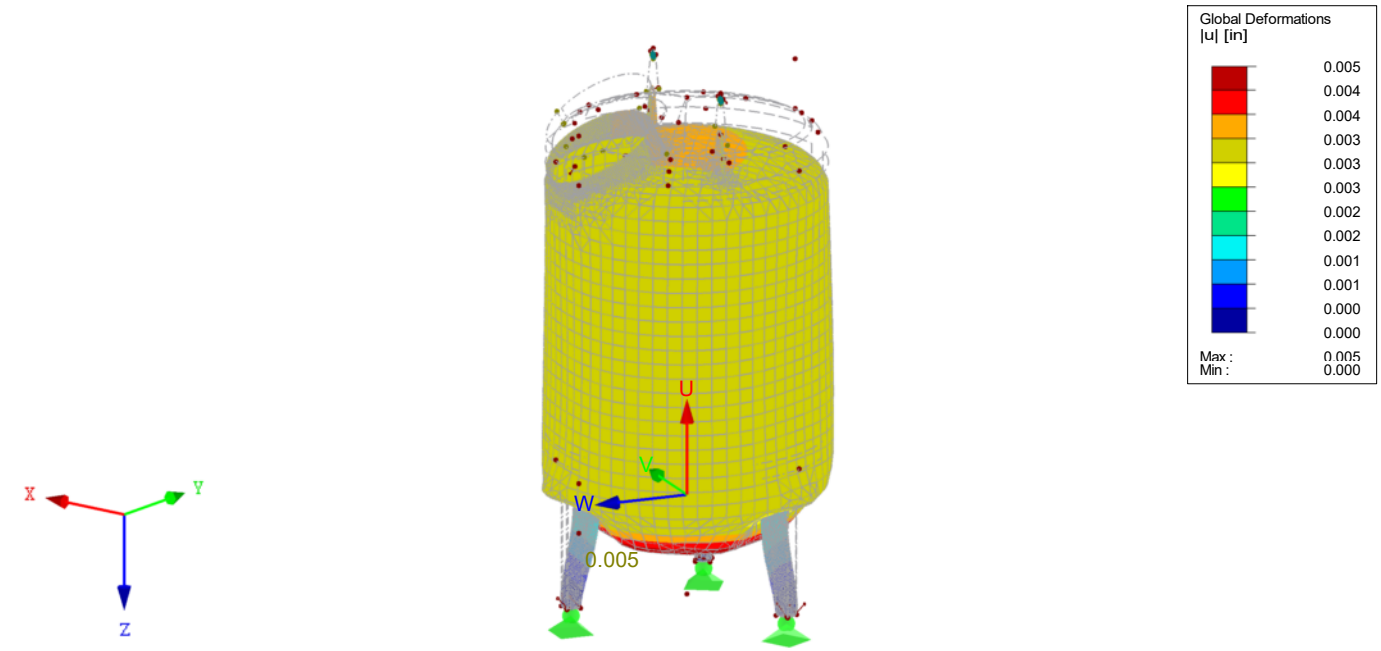


Factor of deformations: 280.00
Max u: - Min u: -

GLOBAL DEFORMATIONS u

CO2 : 1.2*LC1 + 1.6*LC2

Isometric

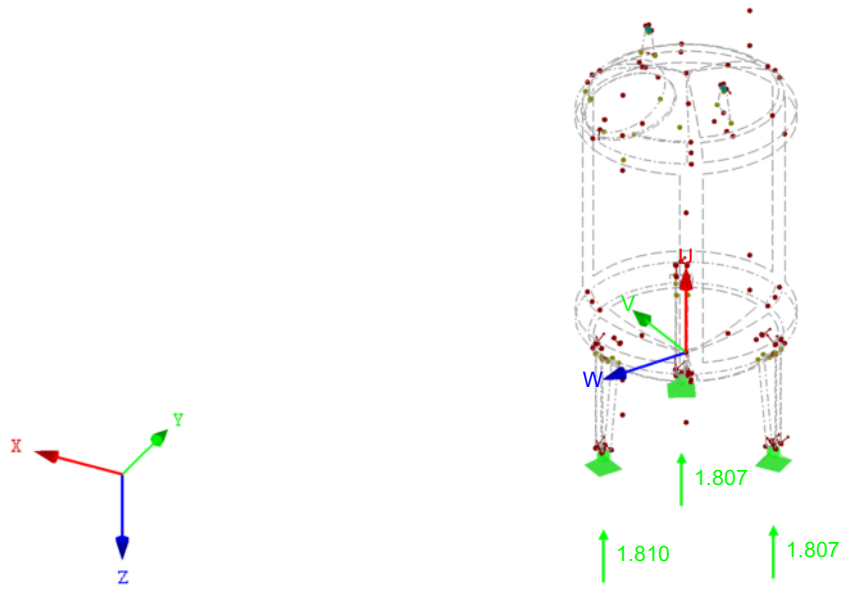


Factor of deformations: 1500.00
Max u: - Min u: -

SUPPORT REACTIONS

CO2 : 1.2*LC1 + 1.6*LC2
Support Reactions[kip]

Isometric



Max P-Z': 1.810, Min P-Z': 1.807 kip

RF-STEEL
Surfaces
with selection
General stress
analysis of
steel surfaces

1.1 GENERAL DATA

Surfaces to design	2-5,7-10,12,13,17,19,42-48,50,52,54,56,58,60,62,64	
Load combinations to design:	CO1	1.4*LC1
	CO2	1.2*LC1 + 1.6*LC2
	CO3	1.2*LC1 + LC2 + LC3
	CO4	1.2*LC1 + LC3
	CO5	0.9*LC1 + LC3

1.1.1 DETAILS

	Mindlin Equivalent stresses according to: Von Mises Distribution of internal forces: Constant on Elements	
Serviceability Limits		Cantilevers
- CH Characteristic:	L / 300	Lc / 150
- FR Frequent:	L / 200	Lc / 100
- QP Quasi-permanent:	L / 200	Lc / 100

1.2 MATERIALS

Material No.	Material Description	Safety Factor γ_M [-]	Yield Strength f_{yk} [ksi]	Limit Stresses [ksi] Manually	Limit σ_x	Limit τ	Limit σ_{eqv}	limit $\sigma_{eqv,m}$
1	Stainless Steel (Plates and Sheets) A 240, Grade 304, 18Cr-8Ni	1.00	30.000	☐	30.000	17.321	30.000	30.000

2.2 STRESSES BY MATERIAL

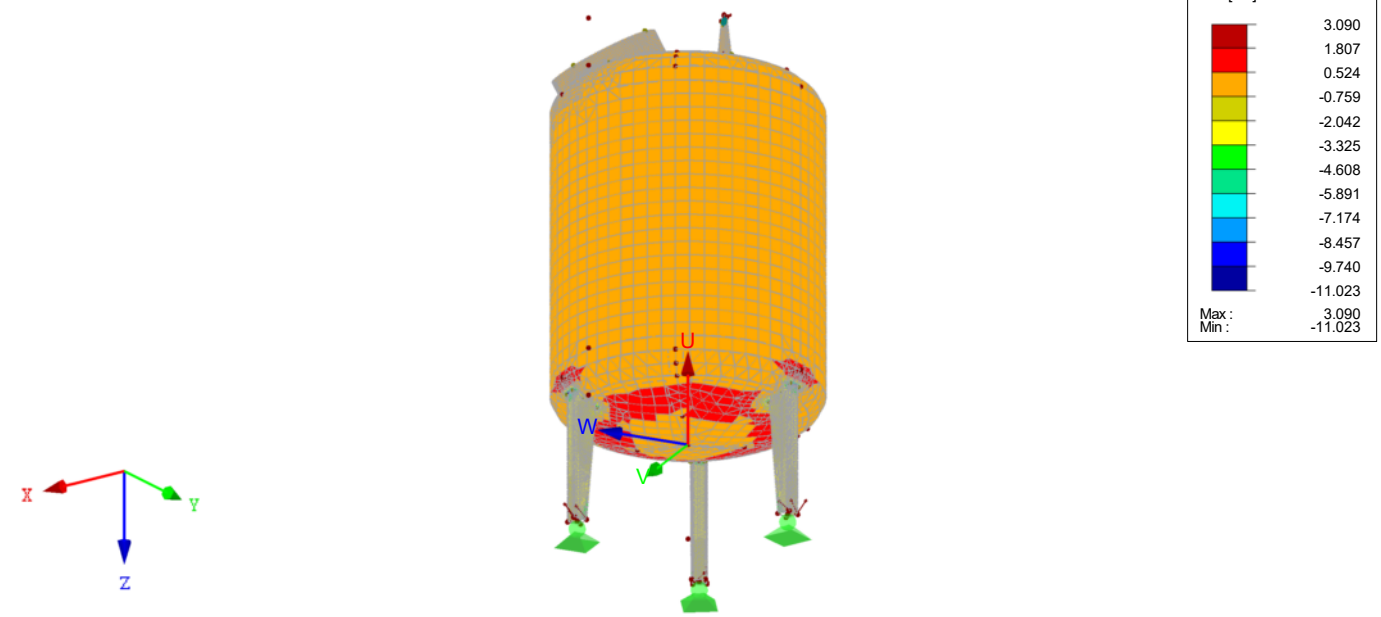
RF-STEEL
Surfaces
with selection
General stress
analysis of
steel
surfacesRESULTS

Material No.	Surface No.	FE Mesh Point No.	Point Coordinates [in] X	Y	Z	Loading	Stress [ksi] Symbol	Existing	Limit	Stress Ratio [-]
1	Stainless Steel (Plates and Sheets) A 240, Grade 304, 18Cr-8Ni									
	52	126	9.87	-15.09	-18.95	CO3	τ_{max}	4.774	17.321	0.28
	7	123	-14.51	-1.00	-16.99	CO3	$\sigma_{1,+}$	-13.043	30.000	0.43
	52	126	9.87	-15.09	-18.95	CO3	$\sigma_{2,+}$	-18.452	30.000	0.62
	7	122	-14.51	1.00	-16.99	CO3	$\sigma_{1,-}$	11.613	30.000	0.39
	7	122	-14.51	1.00	-16.99	CO3	$\sigma_{2,-}$	8.502	30.000	0.28
	48	128	6.39	-13.07	-16.99	CO5	$\sigma_{1,m}$	6.351	30.000	0.21
	52	126	9.87	-15.09	-18.95	CO3	$\sigma_{2,m}$	-11.457	30.000	0.38
	52	126	9.87	-15.09	-18.95	CO3	$\sigma_{eqv,max}$	16.448	30.000	0.55
	52	126	9.87	-15.09	-18.95	CO3	$\sigma_{eqv,m}$	10.697	30.000	0.36

STRESSES $\sigma_{x,+}$

CO2 : 1.2*LC1 + 1.6*LC2

Isometric

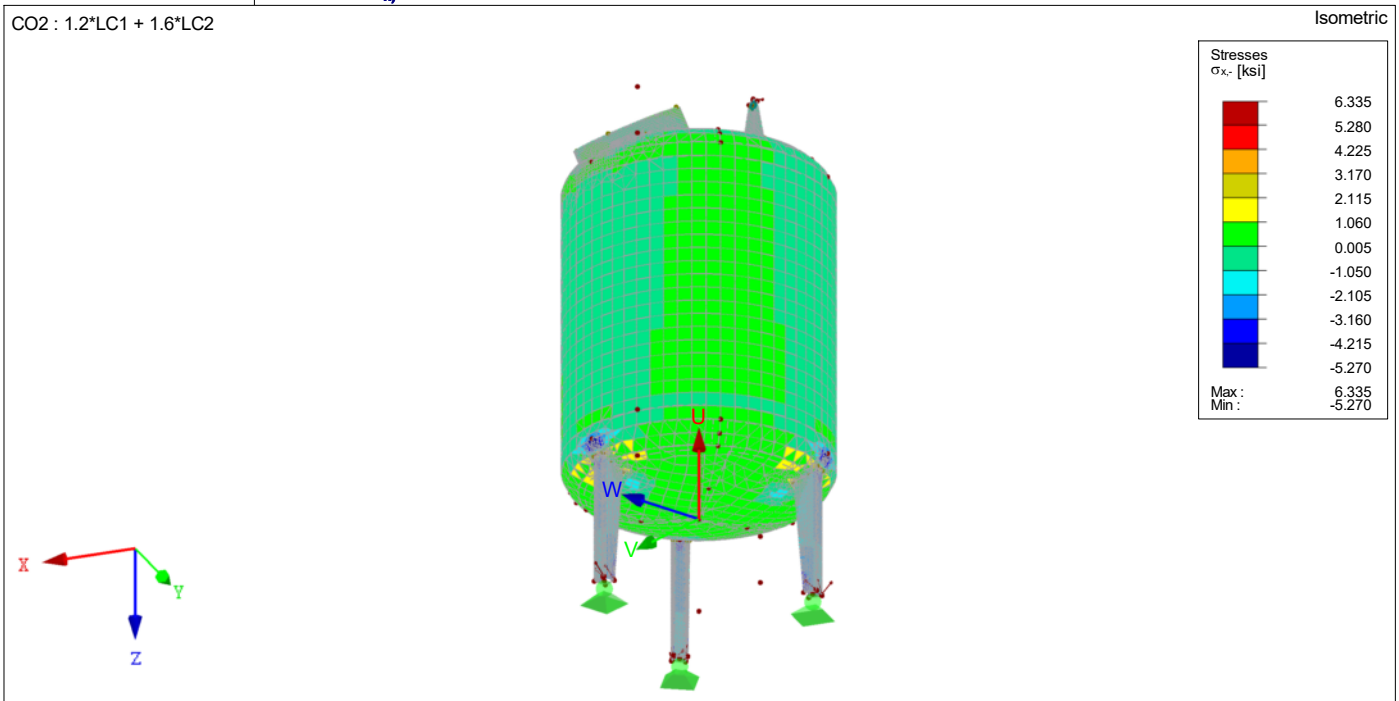


Max Sigma-x,+: 3.090, Min Sigma-x,+: -11.023 ksi

STRESSES $\sigma_{x,-}$

CO2 : 1.2*LC1 + 1.6*LC2

Isometric

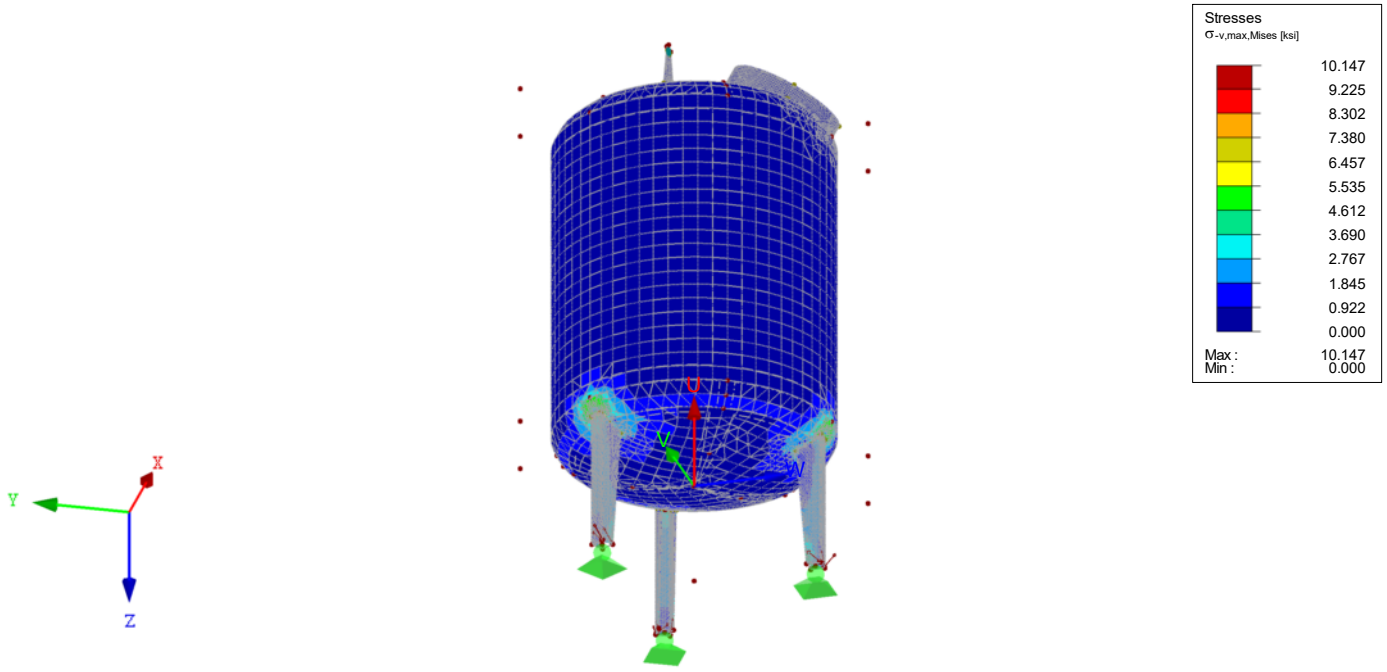


Max Sigma-x,-: 6.335, Min Sigma-x,-: -5.270 ksi

STRESSES $\sigma_{eqv,Mises,Max}$

CO2 : 1.2*LC1 + 1.6*LC2

Isometric



Max Sigma-eqv,Mises,max: 10.147, Min Sigma-eqv,Mises,max: 0.000 ksi

4.1 PARTS LIST

Part No.	Material	Thickness Type	Thickness d [in]	Area [ft²]	Coating [ft²]	Volume [ft³]	Weight [kip]
48	Stainless Steel (Plates and Sheets) A 240, Grade 304, 18Cr-8Ni	Constant	0.12	0.34	0.69	0.00	0.00
50		Constant	0.12	0.26	0.53	0.00	0.00
52		Constant	0.12	0.34	0.69	0.00	0.00
54		Constant	0.12	0.34	0.69	0.00	0.00
56		Constant	0.12	0.26	0.53	0.00	0.00
58		Constant	0.12	0.34	0.69	0.00	0.00
60		Constant	0.12	0.34	0.69	0.00	0.00
62		Constant	0.12	0.26	0.53	0.00	0.00
64		Constant	0.12	0.34	0.69	0.00	0.00
2		Constant	0.20	2.16	4.32	0.04	0.02
3		Constant	0.20	11.72	23.45	0.20	0.10
4		Constant	0.20	1.03	2.07	0.02	0.01
5		Constant	0.20	2.16	4.32	0.04	0.02
7		Constant	0.20	2.16	4.32	0.04	0.02
8		Constant	0.20	11.72	23.45	0.20	0.10
9		Constant	0.20	1.03	2.07	0.02	0.01
10		Constant	0.20	2.16	4.32	0.04	0.02
12		Constant	0.20	2.16	4.32	0.04	0.02
13		Constant	0.20	11.72	23.45	0.20	0.10
17		Constant	0.20	0.83	1.65	0.01	0.01
19		Constant	0.20	0.93	1.85	0.02	0.01
42		Constant	0.20	1.01	2.03	0.02	0.01
43		Constant	0.20	0.02	0.04	0.00	0.00
44		Constant	0.20	1.01	2.03	0.02	0.01
45		Constant	0.20	0.02	0.04	0.00	0.00
46		Constant	0.20	1.01	2.03	0.02	0.01
47		Constant	0.20	0.02	0.04	0.00	0.00
Sum				55.74	111.48	0.91	0.45

RF-STABILITY
with selection
Stability
analysis

1.1 GENERAL DATA

Number of lowest eigenvalues (eigenvectors for buckling):	4
Normalization of eigenvectors:	Such that |u|=1
Import axial forces from RFEM from:	CO3 - 1.2*LC1 + LC2 + LC3
Consider favorable effect due to tension:	☒
Consider axial forces as prestress:	☐
Eigenvalue calculation method:	☒ Method by Lanczos ☐ Roots of the characteristic polynomial ☐ Subspace Iteration Method ☐ ICG Iteration Method
Stability analysis of LC/CO results	☒
Stability analysis for load increased to structural failure:	☐
Type of matrix:	Standard
Activate Stiffness Modification from RFEM	☒

2.1 CRITICAL LOAD FACTORS

E-Value No.	Critical Load Factor f	Magnification Factor α	
1	19.776	1.053	
2	20.734	1.051	
3	21.966	1.048	
4	22.792	1.046	