CEPA Surface Loading Calculation - Buried Pipeline *ver 0.0*

https://pipeeng.com/CEPA_calc.html

Project	*ANGP 1.5', 30 deg., E'=100*		Developer	*GRL*
Date	*2021-10-03*		Approver	
Revision	*1*		Reviewer	

This calculation tool was developed using equations and methods contained in the final report of "Development of a Pipeline Surface Loading Screening Process & Assessment of Surface Load Dispersing Methods" published by David J. Warman, etc. This report was developed by Kiefner & Associates, Inc for Canadian Energy Pipeline Association (CEPA) to provide a practical method which can determine the potential loading effects of the temporary crossing by vehicles and equipment in locations without established roads. It is also very useful to verify pipe stresses when cover depths or surface load exceeds limits embodied in API RP 1102.

Input Data

Pipe Outside Diameter, D	inch	12.75
Pipe Wall Thickness, t	inch	0.312
Pipe Specified Minimum Yield Strength, SMYS	psi	65,000
Maximum Allowable Operating Pressure, MAOP	psi	1440.0
Temperature Differential, ΔT	°F	50.0
Dry unit weight of Soil, γ	lb/ft³	120.0
Pipe Buried Depth, C	ft	1.50
Pipe Bedding Angle, θ	°	30
Type of Soil : Coarse-grained soils with little or no fines (SP, SW, GP, GW)		
Soil Standard AASHTO Relative Compaction	%	85

Reference Data

Soil Load on Pipe, Pv	psi	1.25
Live Load on Pipe, P_Live	psi	40.67
Moment Parameter, Kb	-	0.235
Deflection Parameter, Kz	-	0.108
Modulus of Soil Reaction, E'	psi	100.0
Impact Factor, F	-	1.50

Output Data

Hoop Stress Internal Pressure, σ *H_internal*	psi	29,423
Hoop Stress Live Load, σ *H_Live*	psi	22,998
Hoop Stress Soil Load, σ *H_Soil*	psi	707
Longitudinal Interal Pressure, σ *L_Internal*	psi	8,827
Longitudinal Soil Load, σ *L_Soil*	psi	212
Longitudinal Local Bending Stress, σ *L_Local*	psi	7,454
Longitudinal Thermal Stress, σ *L_Thermal*	psi	9,750
Hoop Stress Total, σ *H_Total*	psi	53,128
Longitudinal Total, σ *L_Total*	psi	26,243
Combined Stress per Max Shear Stress Theory, σ *E*	psi	53,128
Combined Stress per Von Mises Theory, σ *E*	psi	46,011

Girth Weld Fatigue Check

	Hoop Stress	Allowable [1]	Pass/ Fail
Hoop Stress Caused by Live Load, psi	22,998	12,000	Fail

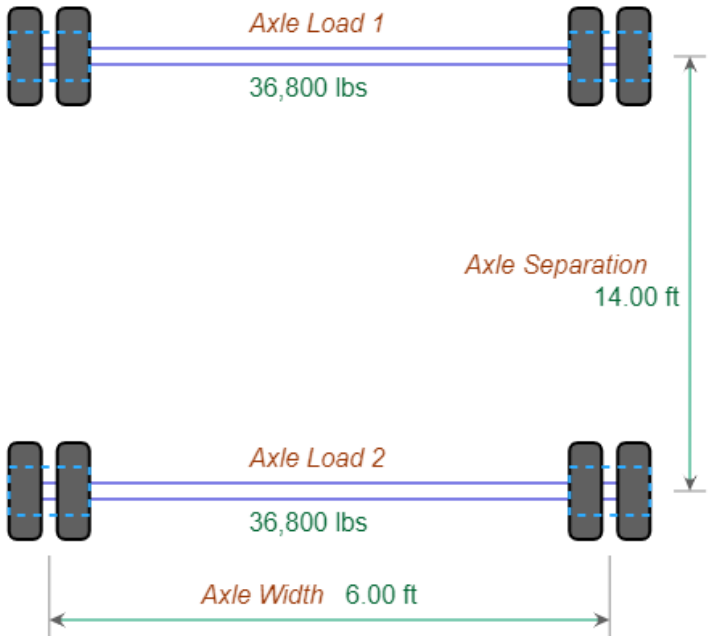
Stress Check

	SMYS %	Allowable [1]	Pass/ Fail
Hoop Stress Total	81.7	90.0	Pass
Longitudinal Total	40.4	90.0	Pass
Combined Stress per Max Shear Stress Theory	81.7	90.0	Pass
Combined Stress per Von Mises Theory	70.8	90.0	Pass

Notes :

1. Allowable limits are default. Users shall confirm allowable limits based upon applicable codes and standards.
2. Fatigue check is only required for long term or high cycle implementation.

Vehicle Configuration



CEPA Surface Loading Calculation - Buried Pipeline *ver 0.0*

https://pipeeng.com/CEPA_calc.html

Project	*ANGP 1.5', 0 deg., E'=100*		Developer	*GRL*
Date	*2021-10-03*		Approver	
Revision	*1*		Reviewer	

This calculation tool was developed using equations and methods contained in the final report of "Development of a Pipeline Surface Loading Screening Process & Assessment of Surface Load Dispersing Methods" published by David J. Warman, etc. This report was developed by Kiefner & Associates, Inc for Canadian Energy Pipeline Association (CEPA) to provide a practical method which can determine the potential loading effects of the temporary crossing by vehicles and equipment in locations without established roads. It is also very useful to verify pipe stresses when cover depths or surface load exceeds limits embodied in API RP 1102.

Input Data

Pipe Outside Diameter, D	inch	12.75
Pipe Wall Thickness, t	inch	0.312
Pipe Specified Minimum Yield Strength, SMYS	psi	65,000
Maximum Allowable Operating Pressure, MAOP	psi	1440.0
Temperature Differential, ΔT	°F	50.0
Dry unit weight of Soil, γ	lb/ft³	120.0
Pipe Buried Depth, C	ft	1.50
Pipe Bedding Angle, θ	°	0
Type of Soil : Coarse-grained soils with little or no fines (SP, SW, GP, GW)		
Soil Standard AASHTO Relative Compaction	%	85

Reference Data

Soil Load on Pipe, Pv	psi	1.25
Live Load on Pipe, P_Live	psi	40.67
Moment Parameter, Kb	-	0.294
Deflection Parameter, Kz	-	0.110
Modulus of Soil Reaction, E'	psi	100.0
Impact Factor, F	-	1.50

Output Data

Hoop Stress Internal Pressure, σ *H_internal*	psi	29,423
Hoop Stress Live Load, σ *H_Live*	psi	28,503
Hoop Stress Soil Load, σ *H_Soil*	psi	876
Longitudinal Interal Pressure, σ *L_Internal*	psi	8,827
Longitudinal Soil Load, σ *L_Soil*	psi	263
Longitudinal Local Bending Stress, σ *L_Local*	psi	9,238
Longitudinal Thermal Stress, σ *L_Thermal*	psi	9,750
Hoop Stress Total, σ *H_Total*	psi	58,802
Longitudinal Total, σ *L_Total*	psi	28,078
Combined Stress per Max Shear Stress Theory, σ *E*	psi	58,802
Combined Stress per Von Mises Theory, σ *E*	psi	50,941

Girth Weld Fatigue Check

	Hoop Stress	Allowable [1]	Pass/ Fail
Hoop Stress Caused by Live Load, psi	28,503	12,000	Fail

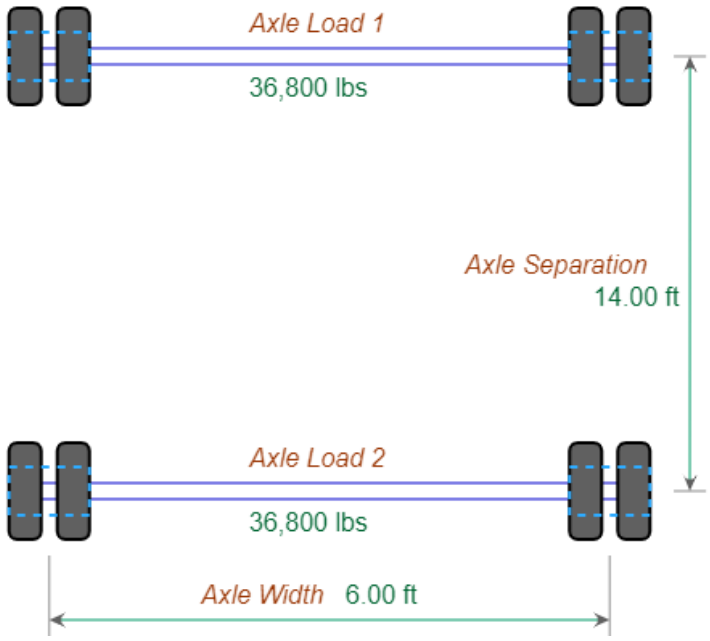
Stress Check

	SMYS %	Allowable [1]	Pass/ Fail
Hoop Stress Total	90.5	90.0	Fail
Longitudinal Total	43.2	90.0	Pass
Combined Stress per Max Shear Stress Theory	90.5	90.0	Fail
Combined Stress per Von Mises Theory	78.4	90.0	Pass

Notes :

1. Allowable limits are default. Users shall confirm allowable limits based upon applicable codes and standards.
2. Fatigue check is only required for long term or high cycle implementation.

Vehicle Configuration



CEPA Surface Loading Calculation - Buried Pipeline *ver 0.0*

https://pipeeng.com/CEPA_calc.html

Project	*ANGP 2.0', 30 deg., E'=100*		Developer	*GRL*
Date	*2021-10-03*		Approver	
Revision	*1*		Reviewer	

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Input Data

Pipe Outside Diameter, D	inch	12.75
Pipe Wall Thickness, t	inch	0.312
Pipe Specified Minimum Yield Strength, SMYS	psi	65,000
Maximum Allowable Operating Pressure, MAOP	psi	1440.0
Temperature Differential, ΔT	°F	50.0
Dry unit weight of Soil, γ	lb/ft³	120.0
Pipe Buried Depth, C	ft	2.00
Pipe Bedding Angle, θ	°	30
Type of Soil : Coarse-grained soils with little or no fines (SP, SW, GP, GW)		
Soil Standard AASHTO Relative Compaction	%	85

Reference Data

Soil Load on Pipe, Pv	psi	1.67
Live Load on Pipe, P_Live	psi	22.88
Moment Parameter, Kb	-	0.235
Deflection Parameter, Kz	-	0.108
Modulus of Soil Reaction, E'	psi	100.0
Impact Factor, F	-	1.50

Output Data

Hoop Stress Internal Pressure, σ *H_internal*	psi	29,423
Hoop Stress Live Load, σ *H_Live*	psi	12,936
Hoop Stress Soil Load, σ *H_Soil*	psi	942
Longitudinal Interal Pressure, σ *L_Internal*	psi	8,827
Longitudinal Soil Load, σ *L_Soil*	psi	283
Longitudinal Local Bending Stress, σ *L_Local*	psi	4,193
Longitudinal Thermal Stress, σ *L_Thermal*	psi	9,750
Hoop Stress Total, σ *H_Total*	psi	43,302
Longitudinal Total, σ *L_Total*	psi	23,052
Combined Stress per Max Shear Stress Theory, σ *E*	psi	43,302
Combined Stress per Von Mises Theory, σ *E*	psi	37,527

Girth Weld Fatigue Check

	Hoop Stress	Allowable [1]	Pass/ Fail
Hoop Stress Caused by Live Load, psi	12,936	12,000	Fail

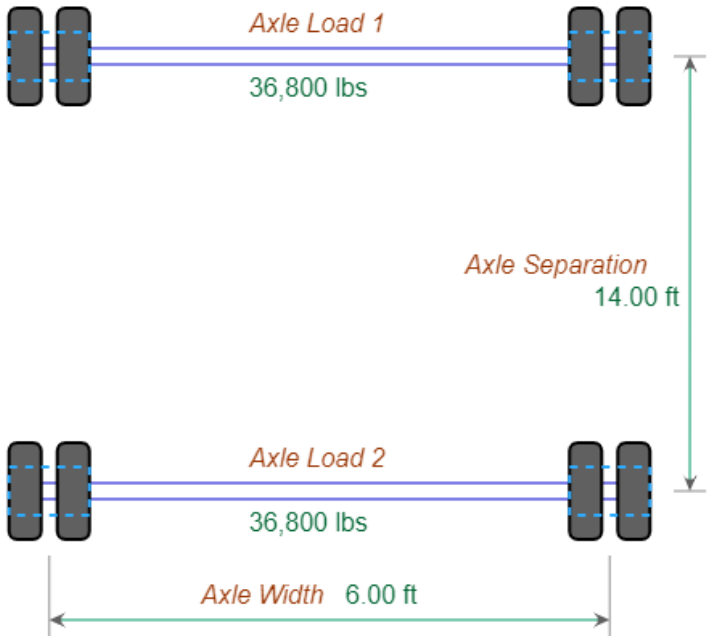
Stress Check

	SMYS %	Allowable [1]	Pass/ Fail
Hoop Stress Total	66.6	90.0	Pass
Longitudinal Total	35.5	90.0	Pass
Combined Stress per Max Shear Stress Theory	66.6	90.0	Pass
Combined Stress per Von Mises Theory	57.7	90.0	Pass

Notes :

1. Allowable limits are default. Users shall confirm allowable limits based upon applicable codes and standards.
2. Fatigue check is only required for long term or high cycle implementation.

Vehicle Configuration



CEPA Surface Loading Calculation - Buried Pipeline *ver 0.0*

https://pipeeng.com/CEPA_calc.html

Project	*ANGP 2.0', 0 deg., E'=100*		Developer	*GRL*
Date	*2021-10-03*		Approver	
Revision	*1*		Reviewer	

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Input Data

Pipe Outside Diameter, D	inch	12.75
Pipe Wall Thickness, t	inch	0.312
Pipe Specified Minimum Yield Strength, SMYS	psi	65,000
Maximum Allowable Operating Pressure, MAOP	psi	1440.0
Temperature Differential, ΔT	°F	50.0
Dry unit weight of Soil, γ	lb/ft³	120.0
Pipe Buried Depth, C	ft	2.00
Pipe Bedding Angle, θ	°	0
Type of Soil : Coarse-grained soils with little or no fines (SP, SW, GP, GW)		
Soil Standard AASHTO Relative Compaction	%	85

Reference Data

Soil Load on Pipe, Pv	psi	1.67
Live Load on Pipe, P_Live	psi	22.88
Moment Parameter, Kb	-	0.294
Deflection Parameter, Kz	-	0.110
Modulus of Soil Reaction, E'	psi	100.0
Impact Factor, F	-	1.50

Output Data

Hoop Stress Internal Pressure, σ *H_internal*	psi	29,423
Hoop Stress Live Load, σ *H_Live*	psi	16,033
Hoop Stress Soil Load, σ *H_Soil*	psi	1,168
Longitudinal Interal Pressure, σ *L_Internal*	psi	8,827
Longitudinal Soil Load, σ *L_Soil*	psi	350
Longitudinal Local Bending Stress, σ *L_Local*	psi	5,196
Longitudinal Thermal Stress, σ *L_Thermal*	psi	9,750
Hoop Stress Total, σ *H_Total*	psi	46,624
Longitudinal Total, σ *L_Total*	psi	24,124
Combined Stress per Max Shear Stress Theory, σ *E*	psi	46,624
Combined Stress per Von Mises Theory, σ *E*	psi	40,386

Girth Weld Fatigue Check

	Hoop Stress	Allowable [1]	Pass/ Fail
Hoop Stress Caused by Live Load, psi	16,033	12,000	Fail

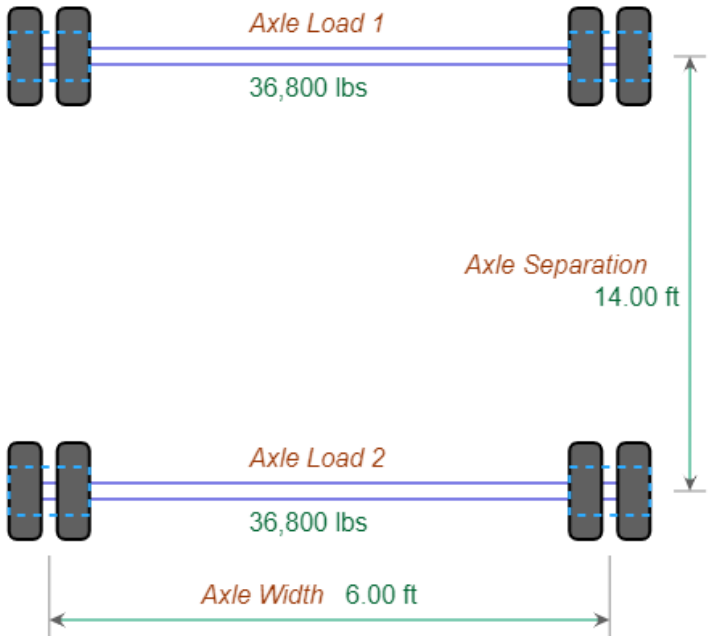
Stress Check

	SMYS %	Allowable [1]	Pass/ Fail
Hoop Stress Total	71.7	90.0	Pass
Longitudinal Total	37.1	90.0	Pass
Combined Stress per Max Shear Stress Theory	71.7	90.0	Pass
Combined Stress per Von Mises Theory	62.1	90.0	Pass

Notes :

1. Allowable limits are default. Users shall confirm allowable limits based upon applicable codes and standards.
2. Fatigue check is only required for long term or high cycle implementation.

Vehicle Configuration



Project:ANGP GPTC 1.5", 3" W, 30 deg, 18,400_Copy_Copy	
Location:Clay Swamp	Date:10/3/2021

TECHNICAL TOOLBOXES

GPTC Guide Appendix G192-15- Design of Uncased (Gas)

Pipe Description	
Pipe Type	Pipe Line - API Specification 5L
Select Nominal Pipe Diameter	12-3/4 inch
Outside Diameter [inch]	12.750
Wall Thickness [inch]	0.312
Pipe Grade	X65
SMYS [psi]	65000
Location Class	3
Design Factor	0.50
Steel Pipe and Location Data	
Soil Type	Extreme Maximum For Clay(Completely Saturated)
Uniform Support Under Pipe [°] and Crossing Conditions	30* Open Trench
Pipe Class:	
Joint Type	Electric Resistance Welded and Flash Welded
Longitudinal Joint Factor	1.0
Youngs Modulus of Elasticity [psi]	30000000.00
T - Temperature Derating Factor:	
Temperature [deg F]	250.0 or less
Temperature Derating Factor	1.000
Impact Factor:	Non-Rigid Pavement
Pipe and Operational Data:	
Average Unit Weight of Soil [lb/ft3]	120.00
Deflection Parameter	0.108
Bending Parameter	0.235
Impact Factor	1.5
Pipeline Internal Pressure [psig]	1440.00
Wheel Load	18400
Width of Pipe Trench or Diameter of Bore [ft]	3.000
Height of Soil Over Pipe [ft]	1.500

Results:

Load Coefficient	0.474
Total External Load [lbf/in]	560.39
Hoop Stress due to Internal Pressure [psi]	29423.09
Hoop Stress due to External Loading [psi]	25103.49
Total Calculated Combined Stress [psi]	54526.58

Note: The total calculated combined stress should not exceed 100% of SMYS

Notes:

Reference:GPTC - Guide for Gas Transmission and Distribution Systems, Appendix G-192-15, A.G.A.

Prepared By:Gregory Liebert	Approved By:	Prepared Using: Pipeline Toolbox

Project:ANGP GPTC 1.5", 3" W, 0 deg, 18,400_Copy_Copy_Copy	
Location:Clay Swamp	Date:10/3/2021

TECHNICAL TOOLBOXES

GPTC Guide Appendix G192-15- Design of Uncased (Gas)

Pipe Description	
Pipe Type	Pipe Line - API Specification 5L
Select Nominal Pipe Diameter	12-3/4 inch
Outside Diameter [inch]	12.750
Wall Thickness [inch]	0.312
Pipe Grade	X65
SMYS [psi]	65000
Location Class	3
Design Factor	0.50
Steel Pipe and Location Data	
Soil Type	Extreme Maximum For Clay(Completely Saturated)
Uniform Support Under Pipe [°] and Crossing Conditions	0* Consolidate Rock
Pipe Class:	
Joint Type	Electric Resistance Welded and Flash Welded
Longitudinal Joint Factor	1.0
Youngs Modulus of Elasticity [psi]	30000000.00
T - Temperature Derating Factor:	
Temperature [deg F]	250.0 or less
Temperature Derating Factor	1.000
Impact Factor:	Non-Rigid Pavement
Pipe and Operational Data:	
Average Unit Weight of Soil [lb/ft3]	120.00
Deflection Parameter	0.110
Bending Parameter	0.294
Impact Factor	1.5
Pipeline Internal Pressure [psig]	1440.00
Wheel Load	18400
Width of Pipe Trench or Diameter of Bore [ft]	3.000
Height of Soil Over Pipe [ft]	1.500

Results:

Load Coefficient	0.474
Total External Load [lbf/in]	560.39
Hoop Stress due to Internal Pressure [psi]	29423.09
Hoop Stress due to External Loading [psi]	31109.45
Total Calculated Combined Stress [psi]	60532.54

Note: The total calculated combined stress should not exceed 100% of SMYS

Notes:

Reference:GPTC - Guide for Gas Transmission and Distribution Systems, Appendix G-192-15, A.G.A.

Prepared By:Gregory Liebert	Approved By:	Prepared Using: Pipeline Toolbox

Project:ANGP GPTC 2.0", 3" W, 30 deg, 18,400_Copy_Copy_Copy_Copy	
Location:Clay Swamp	Date:10/3/2021

TECHNICAL TOOLBOXES

GPTC Guide Appendix G192-15- Design of Uncased (Gas)

Pipe Description	
Pipe Type	Pipe Line - API Specification 5L
Select Nominal Pipe Diameter	12-3/4 inch
Outside Diameter [inch]	12.750
Wall Thickness [inch]	0.312
Pipe Grade	X65
SMYS [psi]	65000
Location Class	3
Design Factor	0.50
Steel Pipe and Location Data	
Soil Type	Extreme Maximum For Clay(Completely Saturated)
Uniform Support Under Pipe [°] and Crossing Conditions	30* Open Trench
Pipe Class:	
Joint Type	Electric Resistance Welded and Flash Welded
Longitudinal Joint Factor	1.0
Youngs Modulus of Elasticity [psi]	30000000.00
T - Temperature Derating Factor:	
Temperature [deg F]	250.0 or less
Temperature Derating Factor	1.000
Impact Factor:	Non-Rigid Pavement
Pipe and Operational Data:	
Average Unit Weight of Soil [lb/ft3]	120.00
Deflection Parameter	0.108
Bending Parameter	0.235
Impact Factor	1.5
Pipeline Internal Pressure [psig]	1440.00
Wheel Load	18400
Width of Pipe Trench or Diameter of Bore [ft]	3.000
Height of Soil Over Pipe [ft]	2.000

Results:

Load Coefficient	0.615
Total External Load [lbf/in]	346.59
Hoop Stress due to Internal Pressure [psi]	29423.09
Hoop Stress due to External Loading [psi]	15526.02
Total Calculated Combined Stress [psi]	44949.11

Note: The total calculated combined stress should not exceed 100% of SMYS

Notes:

Reference:GPTC - Guide for Gas Transmission and Distribution Systems, Appendix G-192-15, A.G.A.

Prepared By:Gregory Liebert	Approved By:	Prepared Using: Pipeline Toolbox

Project:ANGP GPTC 2.0", 3" W, 0 deg, 18,400_Copy_Copy_Copy_Copy_Copy	
Location:Clay Swamp	Date:10/3/2021

TECHNICAL TOOLBOXES

GPTC Guide Appendix G192-15- Design of Uncased (Gas)

Pipe Description	
Pipe Type	Pipe Line - API Specification 5L
Select Nominal Pipe Diameter	12-3/4 inch
Outside Diameter [inch]	12.750
Wall Thickness [inch]	0.312
Pipe Grade	X65
SMYS [psi]	65000
Location Class	3
Design Factor	0.50
Steel Pipe and Location Data	
Soil Type	Extreme Maximum For Clay(Completely Saturated)
Uniform Support Under Pipe [°] and Crossing Conditions	0* Consolidate Rock
Pipe Class:	
Joint Type	Electric Resistance Welded and Flash Welded
Longitudinal Joint Factor	1.0
Youngs Modulus of Elasticity [psi]	30000000.00
T - Temperature Derating Factor:	
Temperature [deg F]	250.0 or less
Temperature Derating Factor	1.000
Impact Factor:	Non-Rigid Pavement
Pipe and Operational Data:	
Average Unit Weight of Soil [lb/ft3]	120.00
Deflection Parameter	0.110
Bending Parameter	0.294
Impact Factor	1.5
Pipeline Internal Pressure [psig]	1440.00
Wheel Load	18400
Width of Pipe Trench or Diameter of Bore [ft]	3.000
Height of Soil Over Pipe [ft]	2.000

Results:

Load Coefficient	0.615
Total External Load [lbf/in]	346.59
Hoop Stress due to Internal Pressure [psi]	29423.09
Hoop Stress due to External Loading [psi]	19240.59
Total Calculated Combined Stress [psi]	48663.68

Note: The total calculated combined stress should not exceed 100% of SMYS

Notes:

Reference: GPTC - Guide for Gas Transmission and Distribution Systems, Appendix G-192-15, A.G.A.

Prepared By: Gregory Liebert	Approved By:	Prepared Using: Pipeline Toolbox

Project:ANGP GPTC 1.7", 3" W, 0 deg, 18,400_Copy_Copy_Copy_Copy_Copy_Copy	
Location:Clay Swamp	Date:10/3/2021

TECHNICAL TOOLBOXES

GPTC Guide Appendix G192-15- Design of Uncased (Gas)

Pipe Description	
Pipe Type	Pipe Line - API Specification 5L
Select Nominal Pipe Diameter	12-3/4 inch
Outside Diameter [inch]	12.750
Wall Thickness [inch]	0.312
Pipe Grade	X65
SMYS [psi]	65000
Location Class	3
Design Factor	0.50
Steel Pipe and Location Data	
Soil Type	Extreme Maximum For Clay(Completely Saturated)
Uniform Support Under Pipe [°] and Crossing Conditions	0* Consolidate Rock
Pipe Class:	
Joint Type	Electric Resistance Welded and Flash Welded
Longitudinal Joint Factor	1.0
Youngs Modulus of Elasticity [psi]	30000000.00
T - Temperature Derating Factor:	
Temperature [deg F]	250.0 or less
Temperature Derating Factor	1.000
Impact Factor:	Non-Rigid Pavement
Pipe and Operational Data:	
Average Unit Weight of Soil [lb/ft3]	120.00
Deflection Parameter	0.110
Bending Parameter	0.294
Impact Factor	1.5
Pipeline Internal Pressure [psig]	1440.00
Wheel Load	18400
Width of Pipe Trench or Diameter of Bore [ft]	3.000
Height of Soil Over Pipe [ft]	1.700

Results:

Load Coefficient	0.531
Total External Load [lbf/in]	450.82
Hoop Stress due to Internal Pressure [psi]	29423.09
Hoop Stress due to External Loading [psi]	25026.74
Total Calculated Combined Stress [psi]	54449.83

Note: The total calculated combined stress should not exceed 100% of SMYS

Notes:

Reference: GPTC - Guide for Gas Transmission and Distribution Systems, Appendix G-192-15, A.G.A.

Prepared By: Gregory Liebert	Approved By:	Prepared Using: Pipeline Toolbox

Project:Wheel Loading 4' H, 5' W_Copy	
Location:ANGP	Date:08/17/2018

TECHNICAL TOOLBOXES

Wheel Load Analysis (Gas)

Pipe Description	
Pipe Type	Pipe Line - API Specification 5L
Select Nominal Pipe Diameter	12-3/4 inch
Outside Diameter [inch]	12.750
Wall Thickness [inch]	0.312
Pipe Grade	X65
SMYS [psi]	65000
Soil Type	Saturated Clay
Top Layers/Pavement Type &Material	No Pavement
Crossing Construction Type	Open Cut
Operating Class	3
Pipe and Operational Data	
Maximum Allowable Internal Stress [%]	50
Maximum Allowable Combined Stress [%]	60
Kμ Friction Force Coefficient	0.110
Weight per Unit of Backfill [lb/ft3]	120.00
Impact Factor	1.5
Modulus of Elasticity of the Top Layers [psi]	15000.00
Modulus of Elasticity of the Soil Cover [psi]	15000.00
Poisson's Ratio of the Top Layers	0.35
Poisson's Ratio of the Soil Cover	0.35
Kb Bending Coefficient	0.235
Kz Deflection Coefficient	0.108
Pipe Internal Pressure [psi]	1440.00
Concentrated Surface Load [lbf]	18400.00
H - Vertical Depth of the Soil Cover [ft]	4.00
HI Thickness of the Pavement Layers [inch]	0
B - Trench Width [ft]	5.00
Include Longitudinal Bending Stress In Calculation:	No
X - Longitudinal Distance [ft]	0
Y - Vertical Deflection [inch]	0

Results:

Cd Load Coefficient	0.734
Wc Load due to Overburden [lbf/in]	183.32
Wv Average Vehicular Load [lbf/in]	72.81
WT Total Load [lbf/in]	256.12
Sb Longitudinal Bending Stress [psi]	0
Sc Circumferential Stress [psi]	11273.24
Sh Hoop Stress [psi]	29423.09
St Total Circumferential Stress [psi]	40696.32
S Total Combined Stress [psi]	40696.32
Percent of SMYS = S 100 / SMYS	62.610
Above Maximum Combined Stress	

Notes:

Reference:ASME B31.8 and "Evaluation of Buried Pipe Encroachments", Battelle Petroleum Technology "

Prepared By:Gregory Liebert	Approved By:	Prepared Using: Pipeline Toolbox

Project:Wheel Loading 3' H, 4' W_Copy_Copy	
Location:ANGP	Date:08/17/2018

TECHNICAL TOOLBOXES

Wheel Load Analysis (Gas)

Pipe Description	
Pipe Type	Pipe Line - API Specification 5L
Select Nominal Pipe Diameter	12-3/4 inch
Outside Diameter [inch]	12.750
Wall Thickness [inch]	0.312
Pipe Grade	X65
SMYS [psi]	65000
Soil Type	Saturated Clay
Top Layers/Pavement Type &Material	No Pavement
Crossing Construction Type	Open Cut
Operating Class	3
Pipe and Operational Data	
Maximum Allowable Internal Stress [%]	50
Maximum Allowable Combined Stress [%]	60
Kμ Friction Force Coefficient	0.110
Weight per Unit of Backfill [lb/ft3]	120.00
Impact Factor	1.5
Modulus of Elasticity of the Top Layers [psi]	15000.00
Modulus of Elasticity of the Soil Cover [psi]	15000.00
Poisson's Ratio of the Top Layers	0.35
Poisson's Ratio of the Soil Cover	0.35
Kb Bending Coefficient	0.235
Kz Deflection Coefficient	0.108
Pipe Internal Pressure [psi]	1440.00
Concentrated Surface Load [lbf]	18400.00
H - Vertical Depth of the Soil Cover [ft]	3.00
HI Thickness of the Pavement Layers [inch]	0
B - Trench Width [ft]	4.00
Include Longitudinal Bending Stress In Calculation:	No
X - Longitudinal Distance [ft]	0
Y - Vertical Deflection [inch]	0

Results:

Cd Load Coefficient	0.691
Wc Load due to Overburden [lbf/in]	110.58
Wv Average Vehicular Load [lbf/in]	129.44
WT Total Load [lbf/in]	240.02
Sb Longitudinal Bending Stress [psi]	0
Sc Circumferential Stress [psi]	10564.25
Sh Hoop Stress [psi]	29423.09
St Total Circumferential Stress [psi]	39987.34
S Total Combined Stress [psi]	39987.34
Percent of SMYS = S 100 / SMYS	61.519
Above Maximum Combined Stress	

Notes:

Reference:ASME B31.8 and "Evaluation of Buried Pipe Encroachments", Battelle Petroleum Technology "

Prepared By:Gregory Liebert	Approved By:	Prepared Using: Pipeline Toolbox

Project:Wheel Loading 2' H, 3' W_Copy_Copy_Copy	
Location:ANGP	Date:08/17/2018

TECHNICAL TOOLBOXES

Wheel Load Analysis (Gas)

Pipe Description	
Pipe Type	Pipe Line - API Specification 5L
Select Nominal Pipe Diameter	12-3/4 inch
Outside Diameter [inch]	12.750
Wall Thickness [inch]	0.312
Pipe Grade	X65
SMYS [psi]	65000
Soil Type	Saturated Clay
Top Layers/Pavement Type &Material	No Pavement
Crossing Construction Type	Open Cut
Operating Class	3
Pipe and Operational Data	
Maximum Allowable Internal Stress [%]	50
Maximum Allowable Combined Stress [%]	60
Kμ Friction Force Coefficient	0.110
Weight per Unit of Backfill [lb/ft3]	120.00
Impact Factor	1.5
Modulus of Elasticity of the Top Layers [psi]	15000.00
Modulus of Elasticity of the Soil Cover [psi]	15000.00
Poisson's Ratio of the Top Layers	0.35
Poisson's Ratio of the Soil Cover	0.35
Kb Bending Coefficient	0.235
Kz Deflection Coefficient	0.108
Pipe Internal Pressure [psi]	1440.00
Concentrated Surface Load [lbf]	18400.00
H - Vertical Depth of the Soil Cover [ft]	2.00
HI Thickness of the Pavement Layers [inch]	0
B - Trench Width [ft]	3.00
Include Longitudinal Bending Stress In Calculation:	No
X - Longitudinal Distance [ft]	0
Y - Vertical Deflection [inch]	0

Results:

Cd Load Coefficient	0.473
Wc Load due to Overburden [lbf/in]	75.73
Wv Average Vehicular Load [lbf/in]	291.23
WT Total Load [lbf/in]	366.96
Sb Longitudinal Bending Stress [psi]	0
Sc Circumferential Stress [psi]	16151.72
Sh Hoop Stress [psi]	29423.09
St Total Circumferential Stress [psi]	45574.81
S Total Combined Stress [psi]	45574.81
Percent of SMYS = S 100 / SMYS	70.115

Above Maximum Combined Stress

Notes:

Reference:ASME B31.8 and "Evaluation of Buried Pipe Encroachments", Battelle Petroleum Technology "

Prepared By:Gregory Liebert	Approved By:	Prepared Using: Pipeline Toolbox