

Bonded system - Friction length

calculations according to Design Manual chapter 3

Version: 1.0.4

26/9-2024

Conditions

Flow temperature, T _f	75	°C
Installation temperature, T _{ins}	10	°C
Insulation class	Series 2	

Steel material properties

Expansion coefficient, α	0.0000120	K ⁻¹
Modulus of elasticity, E	209,714	MPa

Soil parameters

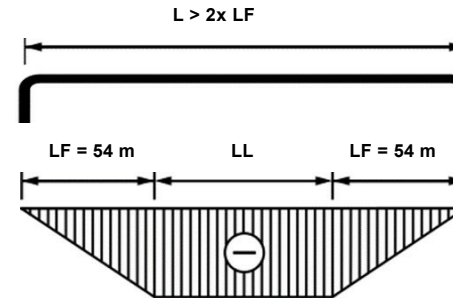
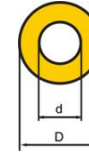
Density of soil, ρ	19.00	kN/m ³
Soil friction angle, φ	32.5	°
Friction coefficient, μ	0.40	

Results

Calculated max axial stress, σ_{max}	163	MPa
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Example

Nominal size	DN 125	
Steel pipe diameter, d	139.7	mm
Wall thickness, s	3.6	mm
Casing diameter, D	250	mm
Soil cover, H	1	m
Soil friction, F	4.63	kN/m



$\sigma_{max} = 163 \text{ Mpa}$

Multiple calculations

Pipe dimensions, Series 2					Soil cover, H (m)						Warnings
					0.5		1		1.5		
Nominal size	d mm	s mm	D mm	A mm ²	Soil friction F (kN/m)	Friction length LF (m)	Soil friction F (kN/m)	Friction length LF (m)	Soil friction F (kN/m)	Friction length LF (m)	
DN 20	26.9	2.6	110	198	1.00	32	1.95	17	2.91	11	
DN 25	33.7	2.6	110	254	1.00	41	1.96	21	2.91	14	
DN 32	42.4	2.6	125	325	1.15	46	2.23	24	3.32	16	
DN 40	48.3	2.6	125	373	1.15	53	2.23	27	3.32	18	
DN 50	60.3	2.9	140	523	1.30	66	2.51	34	3.73	23	
DN 65	76.1	2.9	160	667	1.50	73	2.89	38	4.28	26	
DN 80	88.9	3.2	180	862	1.71	82	3.27	43	4.83	29	
DN 100	114.3	3.6	225	1,252	2.18	94	4.13	50	6.08	34	
DN 125	139.7	3.6	250	1,539	2.46	102	4.63	54	6.79	37	
DN 150	168.3	4.0	280	2,065	2.81	120	5.23	64	7.66	44	
DN 200	219.1	4.5	355	3,034	3.68	135	6.76	73	9.84	50	
DN 250	273.0	5.0	450	4,210	4.85	142	8.75	79	12.65	54	
DN 300	323.9	5.6	500	5,600	5.55	165	9.89	93	14.22	64	
DN 350	355.6	5.6	560	6,158	6.34	159	11.20	90	16.05	63	
DN 400	406.4	6.3	630	7,919	7.36	176	12.82	101	18.28	71	
DN 450	457.0	6.3	710	8,920	8.53	171	14.68	99	20.84	70	
DN 500	508.0	6.3	800	9,930	9.89	164	16.82	96	23.76	68	
DN 600	610.0	7.1	900	13,448	11.69	188	19.50	113	27.30	81	

Bonded system - Installation length

calculations according to Design Manual chapter 3

LOGSTOR

Version: 1.0.4

26/9-2024

Conditions

Flow temperature, T _f	75	°C
Installation temperature, T _{ins}	10	°C
Insulation class	Series 2	
Allowable axial stress, σ_{all}	190	MPa

$\Delta T = 65 \text{ K} \Rightarrow \sigma_{max} = 163 \text{ Mpa} < \sigma_{all}$
No stress reduction required, use L_f!

Steel material properties

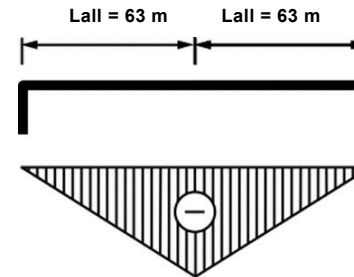
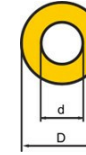
Expansion coefficient, α	0.0000120	°K ⁻¹
Modulus of elasticity, E	209,714	MPa

Soil parameters

Density of soil, ρ	19	kN/m ³
Soil friction angle, ϕ	32.5	°
Friction coefficient, μ	0.40	

Example

Nominal size	DN 125	
Steel pipe diameter, d	139.7	mm
Wall thickness, s	3.6	mm
Casing diameter, D	250	mm
Soil cover, H	1	m



$\sigma_{all} = 190.0 \text{ Mpa}$

Multiple calculations

Pipe dimensions, Series 2					Soil cover, H (m)						Warnings
					0.5		1		1.5		
Nominal size	d mm	s mm	D mm	A mm²	Soil friction F (kN/m)	Installation length Lall (m)	Soil friction F (kN/m)	Installation length Lall (m)	Soil friction F (kN/m)	Installation length Lall (m)	
DN 20	26.9	2.6	110	198	1.00	38	1.95	19	2.91	13	
DN 25	33.7	2.6	110	254	1.00	48	1.96	25	2.91	17	
DN 32	42.4	2.6	125	325	1.15	54	2.23	28	3.32	19	
DN 40	48.3	2.6	125	373	1.15	62	2.23	32	3.32	21	
DN 50	60.3	2.9	140	523	1.30	76	2.51	40	3.73	27	
DN 65	76.1	2.9	160	667	1.50	84	2.89	44	4.28	30	
DN 80	88.9	3.2	180	862	1.71	96	3.27	50	4.83	34	
DN 100	114.3	3.6	225	1,252	2.18	109	4.13	58	6.08	39	
DN 125	139.7	3.6	250	1,539	2.46	119	4.63	63	6.79	43	
DN 150	168.3	4.0	280	2,065	2.81	140	5.23	75	7.66	51	
DN 200	219.1	4.5	355	3,034	3.68	156	6.76	85	9.84	59	
DN 250	273.0	5.0	450	4,210	4.85	165	8.75	91	12.65	63	
DN 300	323.9	5.6	500	5,600	5.55	192	9.89	108	14.22	75	
DN 350	355.6	5.6	560	6,158	6.34	185	11.20	105	16.05	73	
DN 400	406.4	6.3	630	7,919	7.36	205	12.82	117	18.28	82	
DN 450	457.0	6.3	710	8,920	8.53	199	14.68	115	20.84	81	
DN 500	508.0	6.3	800	9,930	9.89	191	16.82	112	23.76	79	
DN 600	610.0	7.1	900	13,448	11.69	219	19.50	131	27.30	94	

See LOGSTOR Design Manual:

<https://www.logstor.com/documentation>

Bonded system - 10-80° L-bends with foam pads

calculations according to Design Manual chapter 4

Version: 1.0.4

3/9-2024

Conditions

Flow temperature, T _f	75	°C
Installation temperature, T _{ins}	10	°C
Soil cover, H	1	m

Insulation class **Series 2**

Soil parameters

Soil density, ρ	19	kN/m ³
Soil friction angle, φ	32.5	°
Friction coefficient, μ	0.40	

Important

The calculation only apply when L₂ ≥ 0,2*L₁

For preheated systems the expansion shall be calculated for the full temperature rise from installation to max operation.

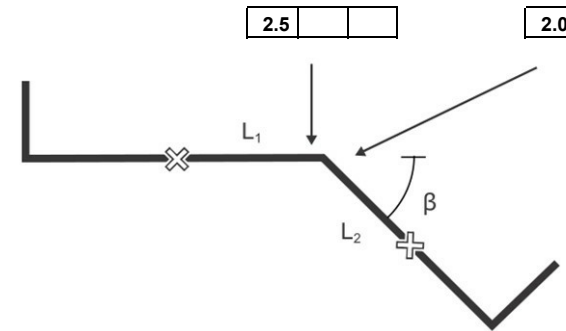
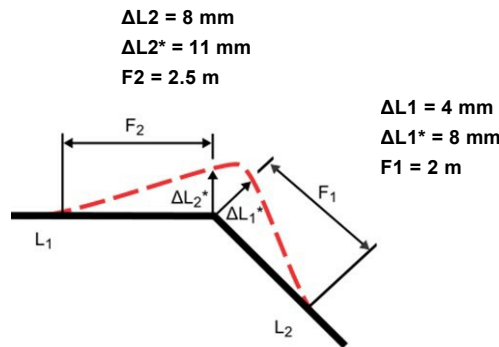
T_{ins} = installation temperature before preheating

T_f = max operating temperature

Example

Nominal size	DN 65	
Steel pipe diameter, d	76.1	mm
Wall thickness, s	2.9	mm
Casing diameter, D	160	mm

Dist. to anchor point, L ₁	5.5	m
Dist. to anchor point, L ₂	13	m
Bend angle, β	65	°
Max allowed ΔL ₁ +ΔL ₂	91	mm



Multiple calculations

Input					Output														
Node no.	β	L1	L2	Nominal size	d	D	Max allowed ΔL1+ΔL2	ΔL1	ΔL1*	ΔL2	ΔL2*	F1 min	Foam pads for ΔL1			F2 min	Foam pads forΔL2		
	°	m	m		mm	mm		mm	mm	mm	mm	mm	m	1	2	3	m	1	2
1	39	40	10	DN 65	76.1	160	38	15	32	7	29	2.7	3.0	1.5		2.7	3.0	1.5	
2	40	40	10	DN 65	76.1	160	40	15	31	7	28	2.7	3.0	1.5		2.6	3.0	1.5	
3	41	40	10	DN 65	76.1	160	41	15	30	7	27	2.7	3.0	1.5		2.6	3.0	1.5	
4	42	40	10	DN 65	76.1	160	43	15	29	7	26	2.7	3.0	1.5		2.6	3.0	1.5	
5	43	40	10	DN 65	76.1	160	45	15	29	7	26	2.7	3.0	1.5		2.6	3.0	1.5	
6	60	40	10	DN 65	76.1	160	80	15	21	7	16	2.5	2.5			2.3	2.5		
7	50	40	10	DN 65	76.1	160	58	15	25	7	21	2.6	3.0			2.5	2.5		
8	50	40	10	DN 65	76.1	160	58	15	25	7	21	2.6	3.0			2.5	2.5		
9	50	40	10	DN 65	76.1	160	58	15	25	7	21	2.6	3.0			2.5	2.5		
10	50	40	10	DN 65	76.1	160	58	15	25	7	21	2.6	3.0			2.5	2.5		

Bonded system - 80-90° L-bends with foam pads

calculations according to Design Manual chapter 4

Conditions

Flow temperature, T _f	75	°C
Installation temperature, T _{ins}	10	°C
Soil cover, H	0.9	m

Insulation class **Series 2**

Steel material properties

Expansion coefficient, α	0.0000120	°K ⁻¹
Modulus of elasticity, E	209,714	MPa

Soil parameters

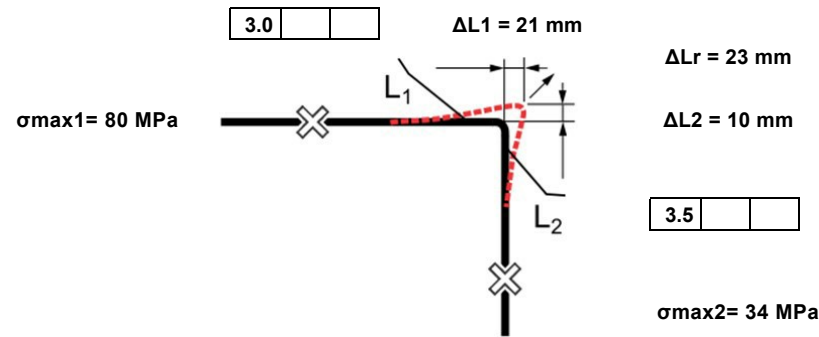
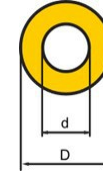
Soil density, ρ	19	kN/m ³
Soil friction angle, ϕ	32.5	°
Friction coefficient, μ	0.40	

Example

Nominal size	DN 150		
Steel pipe diameter, d	168.3	mm	
Wall thickness, s	4.0	mm	
Casing diameter, D	280	mm	

Dist. to anchor point, L1
Dist. to anchor point, L2

35
15



Multiple calculations

Input				Output													
Node no.	L1	L2	Nominal size	d	D	ΔL1	F1 min	Foam pads for ΔL1			ΔL2	F2 min	Foam pads for ΔL2			ΔLr	Number of layers
	m	m		mm	mm	mm	m	1	2	3	mm	m	1	2	3	mm	
1	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
2	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
3	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
4	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
5	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
6	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
7	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
8	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
9	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1
10	10	50	DN 65	76.1	160	6.9	1.9	2			16	2.3	2.5			18	1

Bonded system - Z-bends with foam pads

calculations according to Design Manual chapter 4

LOGSTOR

Version: 1.0.4

26/9-2024

Conditions

Flow temperature, T_f	75	°C
Installation temperature, T_{ins}	10	°C
Soil cover, H	1	m
Insulation class	Series 2	

Steel

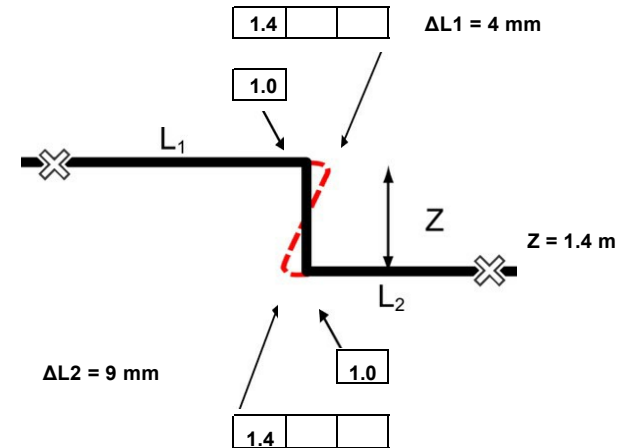
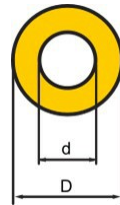
Expansion coefficient, α	0.0000120	°K ⁻¹
Modulus of elasticity, E	209,714	MPa

Soil parameters

Soil density, ρ	19	kN/m ³
Soil friction angle, ϕ	32.5	°
Friction coefficient, μ	0.40	

Example

Nominal size	DN 50		Dist. to anchor point, L_1	5.5	m
Steel pipe diameter, d	60.3	mm	Dist. to anchor point, L_2	15	m
Wall thickness, s	2.9	mm			
Casing diameter, D	140	mm			



Multiple calculations

Input					Output											
Node no.	L1 m	L2 m	Nominal size	d mm	D mm	ΔL1 mm	ΔL2 mm	Z m	Layers for ΔL1	Foam pads for ΔL1			Layers for ΔL2	Foam pads for ΔL2		
										1	2	3		1	2	3
1 2 3 4 5 6 7 8 9 10	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		
	50	100	DN 65	76.1	160	15	15	2.0	1	2.0			1	2.0		

See LOGSTOR Design Manual:

<https://www.logstor.com/documentation>

Bonded system - Perpendicular branches with foam pads

calculations according to Design Manual chapter 5

LOGSTOR

Version: 1.0.4

25/9-2024

Conditions

Flow temperature, T_f	75	°C
Installation temperature, T_{ins}	10	°C
Soil cover, H	0.7	m

Insulation class **Series 2**

Steel material properties

Expansion coefficient, α	0.0000120	°K ⁻¹
Modulus of elasticity, E	209,714	Mpa

Soil parameters

Soil density, ρ	19	kN/m ³
Soil friction angle, φ	32.5	°
Friction coefficient, μ	0.40	

Limitations

The calculations apply for branches under the following conditions:

Temperature:

$$T_f \leq 110^\circ\text{C}$$

$$\Delta T \leq 100^\circ\text{C}$$

Soil cover:

$$\text{Main pipe: } 0.6 \leq H \leq 1.0 \text{ m}$$

$$\text{Branch: } H \geq 0.5 \text{ m}$$

Important

For preheated systems the expansion shall be calculated for the full temperature rise from installation to max operation.

i.e.

T_{ins} = installation temperature before preheating

T_f = max operating temperature

Example

Main pipe

Nominal size	DN 150
Steel pipe diameter, d_1	168.3 mm
Wall thickness, s_1	4.0 mm
Casing diameter, D_1	280 mm

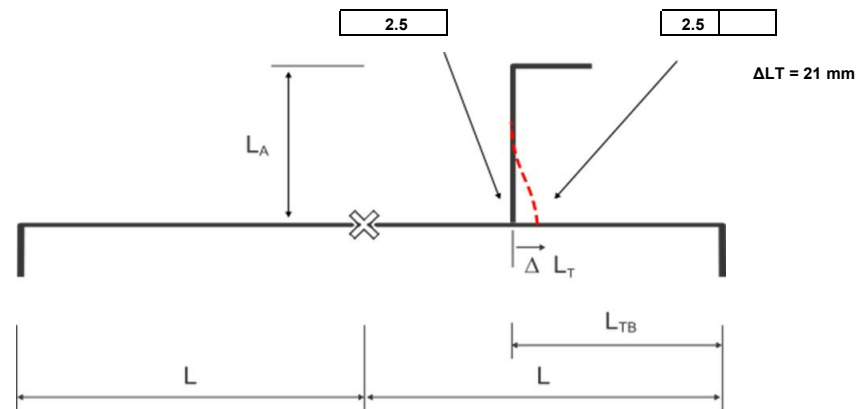
Pipe length, L	35 m
Dist. branch to bend, L_{TB}	1.5 m

Axial stress at branch, σ_{aT} 3 Mpa

Branch pipe

Nominal size	DN 65
Steel pipe diameter, d_2	76.1 mm
Wall thickness, s_2	2.9 mm
Casing diameter, D_2	160 mm

$L_{A,max}$	12 m
Branch length, L_A	12 m



Multiple calculations

Input

Output

Node no.	L		Branch length	Nominal size		Main pipe		Branch pipe		Main pipe stress at Tee σ_{aT}	ΔT	F_{min}	Foam pads for ΔT		Max branch length $L_{a,max}$	Warnings	
	m	m		Main	Branch	d_1	D_1	d_2	D_2				1	2		Main	Branch
1	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
2	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
3	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
4	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
5	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
6	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
7	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
8	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
9	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		
10	100	25	20	DN 80	DN 50	88.9	180	60.3	140	68	8	1.7	2.0		20		