



1.0 INPUT

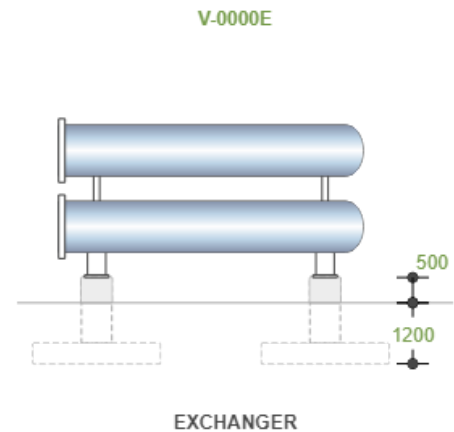
1.1 Design Options

Tag No	V-0000E
Foundation Type	Soil Supported
Equipment Type	EXCHANGER
Design Code	British Standard
Unit	SI Unit

1.2 Equipment Data

1.2.1 Exchanger Geometry

No of Exchangers	N_e	= Double
Exchanger Diameter (Lower)	D_1	= 1000 mm
Exchanger Diameter (Higher)	D_2	= 1000 mm
Spacing between Stacked Exchangers	S_e	= 1500 mm
Spacing between Saddles	S_s	= 4500 mm
Length of the Exchanger	L	= 6000 mm
TOG to C/L of Exchanger	H_{cl}	= 1000 mm
FGL to Saddle Base	H_{ag}	= 500 mm
Corrosion Allowance	C_{af}	= 0 %
Coefficient of Friction	μ_{slide}	= 0.3
Co-efficient of Thermal Expansion	α	= $12 \times 10^{-6} / ^\circ C$



1.2.2 Exchanger Temperature (Operating / Sustained Conditions)

Positive Differential (Expansion)	Δ_{ps}	= $173^\circ C$
Negative Differential (Contraction)	Δ_{ns}	= $0^\circ C$

1.2.3 Exchanger Temperature Test / Temporary Conditions)

Positive Differential (Expansion)	Δ_{pt}	= $173^\circ C$
Negative Differential (Contraction)	Δ_{nt}	= $0^\circ C$

1.3 Foundation

Footing Type	Isolated
Reduction in Soil Cover	S_{cr} = 100 mm

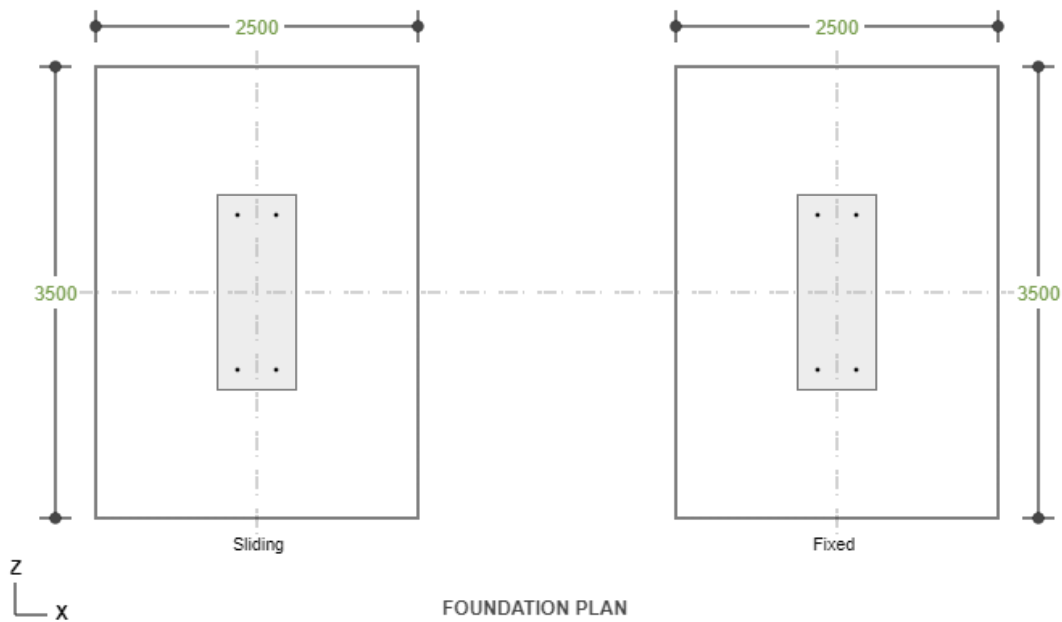
1.3.1 Isolated Footing data - Fixed End

Foundation Depth	D_f	= 1200 mm
Footing Thickness	T_f	= 400 mm
Length of Footing	L_f	= 2500 mm
Breadth of Footing	B_f	= 3500 mm
Pedestal Location in X Direction	X	= 1250 mm
Pedestal Location in Z Direction	Z	= 1750 mm

1.3.2 Isolated Footing data - Sliding End

Foundation Depth	D_f	= 1200mm
Footing Thickness	T_f	= 400 mm
Length of Footing	L_f	= 2500 mm
Breadth of Footing	B_f	= 3500 mm
Pedestal Location in X Direction	X	= 1250 mm
Pedestal Location in Z Direction	Z	= 1750 mm

1.4 Foundation Plan



1.5 Foundation Elevation



1.6 Soil

Allowable Net Bearing Pressure	SBC	= 200 kN/m ²
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Allowable Increase of SBC in Test	$SBC_t = 0 \%$
Allowable Increase of SBC in Wind	$SBC_w = 33 \%$
Allowable Increase of SBC in Seismic	$SBC_s = 33 \%$
Contact Percentage	$C_p = 60 \%$
Density of Soil	$\gamma_{soil} = 18.5 \text{ kN/m}^3$
Density of Ground Water	$\gamma_w = 9.81 \text{ kN/m}^3$
Angle of Internal Friction	$\Phi = 30 \text{ deg}$
Co-efficient of Friction	$\mu = 0.35$
Consider Ground Water Level	Yes
Ground Water Table depth below ground	$H_{wt} = 350 \text{ mm}$

1.7 Reinforced Concrete Properties

Density of Concrete	$\gamma_{conc} = 24 \text{ kN/m}^3$
Modulus of Elasticity of Steel	$E_s = 200 \text{ kN/mm}^2$
Strength of Concrete	$f_{cu} = 35 \text{ N/mm}^2$
Strength of Reinforcement	$f_y = 500 \text{ N/mm}^2$
Strength of Links	$f_{yv} = 500 \text{ N/mm}^2$

1.8 Passive Resistance

Include Passive Resistance	Yes
Pedestal Resistance	All Pedestals

1.9 Material Partial Safety Factors

Concrete in Flexure/Compression	$\gamma_{mc} = 1.5$
Concrete in Shear	$\gamma_{mcs} = 1.25$
Reinforcement	$\gamma_{mc} = 1.15$

1.10 Stability Safety Factors

F.O.S against Sliding	$\gamma_{slide} = 1.5$
F.O.S against Overturning	$\gamma_{over} = 1.5$
F.O.S against Uplift	$\gamma_{up} = 1.2$

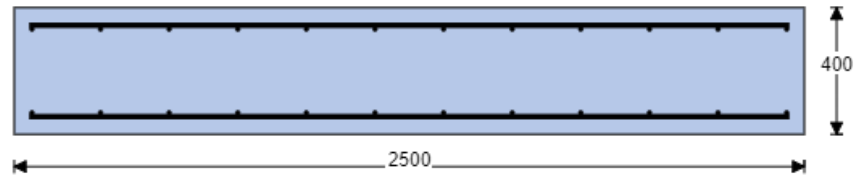
1.11 Crack Width

Check for Crack Width	Yes
Crack Width for	All Load Combinations (SLS)
Allowable Crack Width	$W_c = 0.2 \text{ mm}$

1.12 Reinforcement

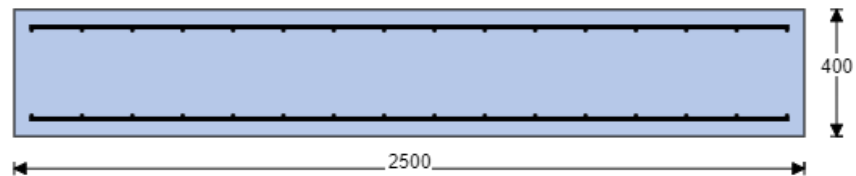
Clear Cover for Pedestal	$C_p = 50 \text{ mm}$
Clear Cover for Footing	$C_f = 50 \text{ mm}$

1.12.1 Pad Reinforcement Details (Fixed End)



X - Direction - Bottom : #12 @ 200 mm C/C (565.5 mm² - 0.14 %)
Top : #12 @ 200 mm C/C (565.5 mm² - 0.14 %)
Z - Direction - Bottom : #12 @ 200 mm C/C (565.5 mm² - 0.14 %)
Top : #12 @ 200 mm C/C (565.5 mm² - 0.14 %)

1.12.2 Pad Reinforcement Details (Sliding End)



X - Direction - Bottom : #10 @ 150 mm C/C (523.6 mm² - 0.13 %)
Top : #10 @ 150 mm C/C (523.6 mm² - 0.13 %)
Z - Direction - Bottom : #10 @ 150 mm C/C (523.6 mm² - 0.13 %)
Top : #10 @ 150 mm C/C (523.6 mm² - 0.13 %)

1.13 Pedestal Details

1.13.1 Pedestal Size at Fixed End

Size in X Direction	P_{fx}	= 600 mm
Size in Z Direction	P_{fz}	= 1500 mm

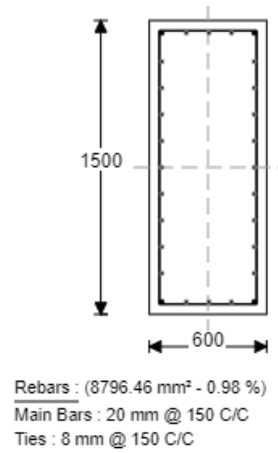
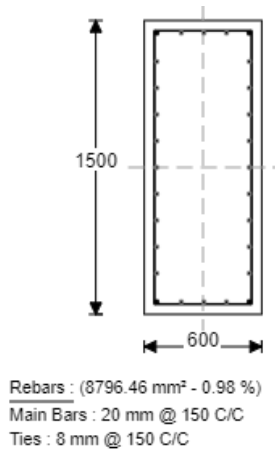
1.13.2 Pedestal Size at Sliding End

Size in X Direction	P_{sx}	= 600 mm
Size in Z Direction	P_{sz}	= 1500 mm

1.13.3 Pedestal Reinforcement Details

Sliding End

Fixed End



1.14 Anchor Bolts Details

Anchorage Tension Capacity	C_t	= 50 kN
Anchorage Shear Capacity	C_s	= 50 kN
Bolt Grade	f_b	= 4.6
Bolt Yield Strength	Y_b	= 240 N/mm ²
Bolt Ultimate Strength	U_b	= 400 N/mm ²
Bolt Size	d	= 24 mm
No of Anchor Bolts per pedestal	N_{ab}	= 4
Spacing in X - Direction	S_x	= 300 mm
Spacing in Z - Direction	S_z	= 1200 mm

1.15 Load Distribution

Vertical Load on Fixed End (FI)	= 60 %
Vertical Load on Sliding End (SI)	= 40 %
Bundle Weight as Pull Force (BI)	= 100 %
Bundle Weight Direction	= BP Sliding to Fixed
Piping Thermal Load in Fixed End	= 50 %

1.16 Load Case / Load Data

Load Case	Notation	F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN)	M_z (kN)
Fabricated Erection Weight	Df		80			
Empty Weight	De		60			
Operating Weight	Do		150			
Test Weight	Dt					
Live Load	L		20			
Snow Load	S					
Thermal Load by Piping	Tsp			25	10	
Bundle Weight	Bp		20			
Exchanger Head (Channel) Weight	Bhead		25			
Wind Load in Transverse (Z) Dir.	WT					
Wind Load in Longitudinal (X) Dir.	WL					
Seismic Load in Transverse (Z) Dir.	EoT					
Seismic Load in Longitudinal (X) Dir.	EoL					

1.17 Serviceability Load Combinations (BS 8110)

Comb No	Combination
SLS1	Dead + Do + Tsp
SLS2	Dead + Do + Tsp + Tse
SLS3	Dead + Do + Tsp + Tsc
SLS4	Dead + Tte
SLS5	Dead + Ttc
SLS6	Dead + Do + Tsp + Tse + L
SLS7	Dead + Do + Tsp + Tsc + L
SLS8	Dead + Tte + L
SLS9	Dead + Ttc + L
SLS10	Dead + Do + Tsp + Tse + 0.8L
SLS11	Dead + Do + Tsp + Tsc + 0.8L
SLS12	Dead + Tte + 0.8L
SLS13	Dead + Ttc + 0.8L
SLS14	0.6Dead + 0.6Df
SLS15	0.6Dead + 0.6De + Tte
SLS16	0.6Dead + 0.6De + Ttc
SLS17	0.6Dead + 0.6Do + Tsp + Tsc
SLS18	0.6Dead + 0.6Do + Tsp + Tse
SLS19	0.6Dead + 0.6De + Tsp + Tsc
SLS20	Dead + De + Bp
SLS21	0.6Dead + 0.6De + Bp

1.18 Ultimate Load Combinations (BS 8110)

Comb No	Combination
ULS1	1.4Dead + 1.4Do + 1.2Tsp
ULS2	1.4Dead + 1.4Do + 1.2Tsp + 1.2Tse
ULS3	1.4Dead + 1.4Do + 1.2Tsp + 1.2Tsc
ULS4	1.4Dead + 1.2Tte
ULS5	1.4Dead + 1.2Ttc
ULS6	1.2Dead + 1.2Do + 1.2Tsp + 1.2Tse + 1.6L
ULS7	1.2Dead + 1.2Do + 1.2Tsp + 1.2Tsc + 1.6L
ULS8	1.2Dead + 1.2Tte + 1.6L
ULS9	1.2Dead + 1.2Ttc + 1.6L
ULS10	1.2Dead + 1.2Do + 1.2Tsp + 1.2Tse + 0.5L
ULS11	1.2Dead + 1.2Do + 1.2Tsp + 1.2Tsc + 0.5L
ULS12	Dead + 1.2Do + 1.2Tsp + 1.2Tse
ULS13	Dead + 1.2Do + 1.2Tsp + 1.2Tsc
ULS14	1.2Dead + 1.2Tte + 0.5L
ULS15	1.2Dead + 1.2Ttc + 0.5L
ULS16	1.2Dead + 1.2Tte
ULS17	1.2Dead + 1.2Ttc
ULS18	0.9Dead + 0.9Df
ULS19	0.9Dead + 0.9De + 1.2Tte
ULS20	0.9Dead + 0.9De + 1.2Ttc
ULS21	0.9Dead + 0.9Do + 1.2Tsp + 1.2Tse
ULS22	0.9Dead + 0.9Do + 1.2Tsp + 1.2Tsc
ULS23	1.2Dead + 1.2De + 1.6Bp
ULS24	0.9Dead + 0.9De + 1.6Bp

2.0 OUTPUT

2.1 Thermal Load Calculation

Modulus of Elasticity of Concrete	$E_c = 20000 + 200 * f_{cu}$	$E_c = 27000 \text{ N/mm}^2$
Moment of Inertia - Fixed End	$I_f = \frac{P_{fz} * P_{fx}^3}{12}$	$I_f = 0.027 \text{ m}^4$
Moment of Inertia - Sliding End	$I_s = \frac{P_{sz} * P_{sx}^3}{12}$	$I_s = 0.027 \text{ m}^4$
Pedestal free height - Fixed End		$H_f = 1200 \text{ mm}$
Pedestal free height - Sliding End		$H_s = 1200 \text{ mm}$

Load due to Deflection

Fixed End	$F_{df} = \frac{3 * \Delta * E_c * I_f}{2 * H_f^3}$
Sliding End	$F_{ds} = \frac{3 * \Delta * E_c * I_s}{2 * H_s^3}$

Description	Expansion/Contraction (mm)	Load due to (kN)		Thermal Load (kN)
	$\Delta = \alpha \cdot S_s \cdot \Delta_t$	Deflection	Friction	
		$F_d = \min(F_{df}, F_{ds})$	$F_r = \mu_{\text{slide}} \cdot D_o$	$F_t = \min(F_d, F_r)$
At Operating conditions / Sustained conditions				
Expansion	9.342	5911.7	18	18
Contraction	0	0	18	0
At Test conditions / Temporary conditions				
Expansion	9.342	5911.7	18	18
Contraction	0	0	18	0

2.2 Bundle Pull Load

Total Bundle Pull load	$B_{pt} = (BI / 100) * B_p = 20.000 \text{ kN}$
Bundle Friction Load	$B_{pf} = \mu_{\text{slide}} * (SI / 100) * (D_e - B_{\text{head}}) = 4.200 \text{ kN}$

2.2.1 Sliding End

Lateral Load	$B_{pls} = \min(B_{pf}, 0.5 * B_{pt}) = 4.200 \text{ kN}$
Axial Load	$B_{pas} = -B_{pls} * (H_{cl} + S_e) / S_s = -2.333 \text{ kN}$

2.2.2 Fixed End

Lateral Load	$B_{plf} = B_{pt} - B_{pls} = 15.800 \text{ kN}$
Axial Load	$B_{baf} = B_{plf} * (H_{cl} + S_e) / S_s = 8.778 \text{ kN}$

2.3 Loads on Pedestal

Load Cases	Fixed End (60 % of Total Load)				
	Horizontal F_x (kN)	Vertical F_y (kN)	Horizontal F_z (kN)	Moment M_x (kN.m)	Moment M_z (kN.m)
Erection	0	48	0	0	0
Empty	0	36	0	0	0
Operating	0	90	0	0	0
Test	0	0	0	0	0

Load Cases	Fixed End (60 % of Total Load)				
	Horizontal F _x (kN)	Vertical F _y (kN)	Horizontal F _z (kN)	Moment M _x (kN.m)	Moment M _z (kN.m)
Piping Thermal	0	0	12.5	5	0
Temp. Sustained - Exp	18	0	25	0	0
Temp. Sustained - Cont	0	0	25	0	0
Temp. Test - Exp	18	0	25	0	0
Temp. Test - Cont	0	0	25	0	0
Live	0	12	0	0	0
Snow	0	0	0	0	0
Wind - trans	0	0	0	0	0
Wind - Long	0	0	0	0	0
Seismic - Trans (Oper)	0	0	0	0	0
Seismic - Long (Oper)	0	0	0	0	0
Seismic - Trans (Emp)	0	0	0	0	0
Seismic - Long (Emp)	0	0	0	0	0
Bundle pull	15.8	8.778	0	0	0

Load Cases	Sliding End (40 % of Total Load)				
	Horizontal F _x (kN)	Vertical F _y (kN)	Horizontal F _z (kN)	Moment M _x (kN.m)	Moment M _z (kN.m)
Erection	0	32	0	0	0
Empty	0	24	0	0	0
Operating	0	60	0	0	0
Test	0	0	0	0	0
Piping Thermal	0	0	12.5	5	0
Temp. Sustained - Exp	-18	0	25	0	0
Temp. Sustained - Cont	0	0	25	0	0
Temp. Test - Exp	-18	0	25	0	0
Temp. Test - Cont	0	0	25	0	0
Live	0	8	0	0	0
Snow	0	0	0	0	0
Wind - trans	0	0	0	0	0
Wind - Long	0	0	0	0	0
Seismic - Trans (Oper)	0	0	0	0	0
Seismic - Long (Oper)	0	0	0	0	0
Seismic - Trans (Emp)	0	0	0	0	0
Seismic - Long (Emp)	0	0	0	0	0
Bundle pull	4.2	-2.333	0	0	0

2.4 Service Loads on Pedestal - Fixed End

SLS Comb	Horizontal F _x (kN)	Vertical F _y (kN)	Horizontal F _z (kN)	Moment M _x (kN.m)	Moment M _y (kN.m)	Moment M _z (kN.m)
SLS1	0.000	90.000	12.500	5.000	0.000	0.000
SLS2	18.000	90.000	37.500	5.000	0.000	0.000
SLS3	0.000	90.000	37.500	5.000	0.000	0.000
SLS4	18.000	0.000	25.000	0.000	0.000	0.000
SLS5	0.000	0.000	25.000	0.000	0.000	0.000
SLS6	18.000	102.000	37.500	5.000	0.000	0.000
SLS7	0.000	102.000	37.500	5.000	0.000	0.000

SLS Comb	Horizontal F _x (kN)	Vertical F _y (kN)	Horizontal F _z (kN)	Moment M _x (kN.m)	Moment M _y (kN.m)	Moment M _z (kN.m)
SLS8	18.000	12.000	25.000	0.000	0.000	0.000
SLS9	0.000	12.000	25.000	0.000	0.000	0.000
SLS10	18.000	99.000	37.500	5.000	0.000	0.000
SLS11	0.000	99.000	37.500	5.000	0.000	0.000
SLS12	18.000	9.000	25.000	0.000	0.000	0.000
SLS13	0.000	9.000	25.000	0.000	0.000	0.000
SLS14	0.000	28.800	0.000	0.000	0.000	0.000
SLS15	18.000	21.600	25.000	0.000	0.000	0.000
SLS16	0.000	21.600	25.000	0.000	0.000	0.000
SLS17	0.000	54.000	37.500	5.000	0.000	0.000
SLS18	18.000	54.000	37.500	5.000	0.000	0.000
SLS19	0.000	21.600	37.500	5.000	0.000	0.000
SLS20	15.800	44.778	0.000	0.000	0.000	0.000
SLS21	15.800	30.378	0.000	0.000	0.000	0.000

2.5 Factored Loads on Pedestal - Fixed End

ULS Comb	Horizontal F _x (kN)	Vertical F _y (kN)	Horizontal F _z (kN)	Moment M _x (kN.m)	Moment M _y (kN.m)	Moment M _z (kN.m)
ULS1	0.000	126.000	15.000	6.000	0.000	0.000
ULS2	21.600	126.000	45.000	6.000	0.000	0.000
ULS3	0.000	126.000	45.000	6.000	0.000	0.000
ULS4	21.600	0.000	30.000	0.000	0.000	0.000
ULS5	0.000	0.000	30.000	0.000	0.000	0.000
ULS6	21.600	127.200	45.000	6.000	0.000	0.000
ULS7	0.000	127.200	45.000	6.000	0.000	0.000
ULS8	21.600	19.200	30.000	0.000	0.000	0.000
ULS9	0.000	19.200	30.000	0.000	0.000	0.000
ULS10	21.600	114.000	45.000	6.000	0.000	0.000
ULS11	0.000	114.000	45.000	6.000	0.000	0.000
ULS12	21.600	108.000	45.000	6.000	0.000	0.000
ULS13	0.000	108.000	45.000	6.000	0.000	0.000
ULS14	21.600	6.000	30.000	0.000	0.000	0.000
ULS15	0.000	6.000	30.000	0.000	0.000	0.000
ULS16	21.600	0.000	30.000	0.000	0.000	0.000
ULS17	0.000	0.000	30.000	0.000	0.000	0.000
ULS18	0.000	43.200	0.000	0.000	0.000	0.000
ULS19	21.600	32.400	30.000	0.000	0.000	0.000
ULS20	0.000	32.400	30.000	0.000	0.000	0.000
ULS21	21.600	81.000	45.000	6.000	0.000	0.000
ULS22	0.000	81.000	45.000	6.000	0.000	0.000
ULS23	25.280	57.244	0.000	0.000	0.000	0.000
ULS24	25.280	46.444	0.000	0.000	0.000	0.000

2.6 Soil and Self Weight of Foundation - Fixed End

Self Weight of Pad	S _{wf} = 84.0 kN
Self Weight of Pedestals	S _{wpd} = 28.1 kN
Minimum Soil Overburden	SIM _{nWt} = 116.2 kN
Maximum Soil Overburden	SIM _{xWt} = 116.2 kN

Water Weight above Pad	$W_{rfp} = 34.7$ kN
Deduction Weight of Suspended Soil	$SID_{nWt} = 34.7$ kN
Buoyancy Deduction Load	$B_{fuf} = 73.0$ kN
Total Weight under Min.Soil Condition	$M_{nCwt} = S_{wf} + S_{wpd} + W_{rfp} + SIM_{nWt} - SID_{nWt} - B_{fuf} = 155.3$ kN
Total Weight under Max.Soil Condition	$M_{xCwt} = S_{wf} + S_{wpd} + SIM_{xWt} = 228.3$ kN

2.7 Serviceability Check for SLS combinations - Fixed End

2.7.1 Stability Resistance - Fixed End

Comb	Sliding Resistance (kN)			Overturning Resisting Moment (kN.m)					
	Frictional	Passive	Total	Self - X	Self - Z	Passive - X	Passive - Z	Total - X	Total-Z
SLS1	85.9	59.8	145.6	429.3	306.6	0.0	0.0	429.3	306.6
SLS2	85.9	79.2	165.1	429.3	306.6	0.0	0.0	429.3	306.6
SLS3	85.9	59.8	145.6	429.3	306.6	0.0	0.0	429.3	306.6
SLS4	54.4	82.7	137.1	271.8	194.1	0.0	0.0	271.8	194.1
SLS5	54.4	59.8	114.1	271.8	194.1	0.0	0.0	271.8	194.1
SLS6	90.1	79.2	169.3	450.3	321.6	0.0	0.0	450.3	321.6
SLS7	90.1	59.8	149.8	450.3	321.6	0.0	0.0	450.3	321.6
SLS8	58.6	82.7	141.3	292.8	209.1	0.0	0.0	292.8	209.1
SLS9	58.6	59.8	118.3	292.8	209.1	0.0	0.0	292.8	209.1
SLS10	89.0	79.2	168.2	445.0	317.9	0.0	0.0	445.0	317.9
SLS11	89.0	59.8	148.8	445.0	317.9	0.0	0.0	445.0	317.9
SLS12	57.5	82.7	140.2	287.5	205.4	0.0	0.0	287.5	205.4
SLS13	57.5	59.8	117.3	287.5	205.4	0.0	0.0	287.5	205.4
SLS14	42.7	35.9	78.6	213.5	152.5	0.0	0.0	213.5	152.5
SLS15	40.2	49.6	89.8	200.9	143.5	0.0	0.0	200.9	143.5
SLS16	40.2	35.9	76.0	200.9	143.5	0.0	0.0	200.9	143.5
SLS17	51.5	35.9	87.4	257.6	184.0	0.0	0.0	257.6	184.0
SLS18	51.5	47.5	99.1	257.6	184.0	0.0	0.0	257.6	184.0
SLS19	40.2	35.9	76.0	200.9	143.5	0.0	0.0	200.9	143.5
SLS20	70.0	58.5	128.6	350.1	250.1	0.0	0.0	350.1	250.1
SLS21	43.2	35.1	78.4	216.2	154.4	0.0	0.0	216.2	154.4

2.7.2 Overturning Check - Fixed End

SLS Comb	Overturning(kN.m)		Resisting(kN.m)		FOS Overturning		
	Moment X	Moment Z	Moment X	Moment Z	Actual X	Actual Z	Allowable
SLS1	26.3	0.0	429.3	306.6	16.35	100.00	1.50
SLS2	68.8	-30.6	429.3	306.6	6.24	10.02	1.50
SLS3	68.8	0.0	429.3	306.6	6.24	100.00	1.50
SLS4	42.5	-30.6	271.8	194.1	6.40	6.34	1.50
SLS5	42.5	0.0	271.8	194.1	6.40	100.00	1.50
SLS6	68.8	-30.6	450.3	321.6	6.55	10.51	1.50
SLS7	68.8	0.0	450.3	321.6	6.55	100.00	1.50
SLS8	42.5	-30.6	292.8	209.1	6.89	6.83	1.50
SLS9	42.5	0.0	292.8	209.1	6.89	100.00	1.50
SLS10	68.8	-30.6	445.0	317.9	6.47	10.39	1.50
SLS11	68.8	0.0	445.0	317.9	6.47	100.00	1.50
SLS12	42.5	-30.6	287.5	205.4	6.77	6.71	1.50
SLS13	42.5	0.0	287.5	205.4	6.77	100.00	1.50
SLS14	0.0	0.0	213.5	152.5	100.00	100.00	1.50

SLS Comb	Overturning(kN.m)		Resisting(kN.m)		FOS Overturning		
	Moment X	Moment Z	Moment X	Moment Z	Actual X	Actual Z	Allowable
SLS15	42.5	-30.6	200.9	143.5	4.73	4.69	1.50
SLS16	42.5	0.0	200.9	143.5	4.73	100.00	1.50
SLS17	68.8	0.0	257.6	184.0	3.75	100.00	1.50
SLS18	68.8	-30.6	257.6	184.0	3.75	6.01	1.50
SLS19	68.8	0.0	200.9	143.5	2.92	100.00	1.50
SLS20	0.0	-26.9	350.1	250.1	100.00	9.31	1.50
SLS21	0.0	-26.9	216.2	154.4	100.00	5.75	1.50

2.7.3 Sliding and Uplift Check - Fixed End

SLS Comb	Resultant Shear (kN)	Resisting Force (kN)	FOS Sliding		FOS Uplift			
			Actual	Allowable	Uplift Force (kN)	Resisting Force (kN)	Actual	Allowable
SLS1	12.5	145.6	11.65	1.50	0.0	155.3	100.00	1.2
SLS2	41.6	165.1	3.97	1.50	0.0	155.3	100.00	1.2
SLS3	37.5	145.6	3.88	1.50	0.0	155.3	100.00	1.2
SLS4	30.8	137.1	4.45	1.50	0.0	155.3	100.00	1.2
SLS5	25.0	114.1	4.57	1.50	0.0	155.3	100.00	1.2
SLS6	41.6	169.3	4.07	1.50	0.0	155.3	100.00	1.2
SLS7	37.5	149.8	4.00	1.50	0.0	155.3	100.00	1.2
SLS8	30.8	141.3	4.59	1.50	0.0	155.3	100.00	1.2
SLS9	25.0	118.3	4.73	1.50	0.0	155.3	100.00	1.2
SLS10	41.6	168.2	4.04	1.50	0.0	155.3	100.00	1.2
SLS11	37.5	148.8	3.97	1.50	0.0	155.3	100.00	1.2
SLS12	30.8	140.2	4.55	1.50	0.0	155.3	100.00	1.2
SLS13	25.0	117.3	4.69	1.50	0.0	155.3	100.00	1.2
SLS14	0.0	78.6	100.00	1.50	0.0	93.2	100.00	1.2
SLS15	30.8	89.8	2.92	1.50	0.0	93.2	100.00	1.2
SLS16	25.0	76.0	3.04	1.50	0.0	93.2	100.00	1.2
SLS17	37.5	87.4	2.33	1.50	0.0	93.2	100.00	1.2
SLS18	41.6	99.1	2.38	1.50	0.0	93.2	100.00	1.2
SLS19	37.5	76.0	2.03	1.50	0.0	93.2	100.00	1.2
SLS20	15.8	128.6	8.14	1.50	0.0	155.3	100.00	1.2
SLS21	15.8	78.4	4.96	1.50	0.0	93.2	100.00	1.2

2.7.4 Bearing Pressure Check - Fixed End

SLS Comb	Minimum Soil Condition			Maximum Soil Condition			Bearing Pressure		
	Axial Force (kN)	Moment X (kN.m)	Moment Z (kN.m)	Axial Force (kN)	Moment X (kN.m)	Moment Z (kN.m)	Actual(kN/m²)	Allowable(kN/m²)	Contact %
SLS1	245.3	26.3	0.0	318.3	26.3	0.0	41.52	222.20	100.0
SLS2	245.3	68.8	-30.6	318.3	68.8	-30.6	58.24	222.20	100.0
SLS3	245.3	68.8	0.0	318.3	68.8	0.0	49.84	222.20	100.0
SLS4	155.3	42.5	-30.6	228.3	42.5	-30.6	42.81	222.20	100.0
SLS5	155.3	42.5	0.0	228.3	42.5	0.0	34.41	222.20	100.0
SLS6	257.3	68.8	-30.6	330.3	68.8	-30.6	59.61	222.20	100.0
SLS7	257.3	68.8	0.0	330.3	68.8	0.0	51.21	222.20	100.0

SLS Comb	Minimum Soil Condition			Maximum Soil Condition			Bearing Pressure		
	Axial Force (kN)	Moment X (kN.m)	Moment Z (kN.m)	Axial Force (kN)	Moment X (kN.m)	Moment Z (kN.m)	Actual(kN/m ²)	Allowable(kN/m ²)	Contact %
SLS8	167.3	42.5	-30.6	240.3	42.5	-30.6	44.18	222.20	100.0
SLS9	167.3	42.5	0.0	240.3	42.5	0.0	35.79	222.20	100.0
SLS10	254.3	68.8	-30.6	327.3	68.8	-30.6	59.26	222.20	100.0
SLS11	254.3	68.8	0.0	327.3	68.8	0.0	50.87	222.20	100.0
SLS12	164.3	42.5	-30.6	237.3	42.5	-30.6	43.84	222.20	100.0
SLS13	164.3	42.5	0.0	237.3	42.5	0.0	35.44	222.20	100.0
SLS14	122.0	0.0	0.0	165.8	0.0	0.0	18.94	222.20	100.0
SLS15	114.8	42.5	-30.6	158.6	42.5	-30.6	34.84	222.20	97.5
SLS16	114.8	42.5	0.0	158.6	42.5	0.0	26.45	222.20	100.0
SLS17	147.2	68.8	0.0	191.0	68.8	0.0	35.29	222.20	100.0
SLS18	147.2	68.8	-30.6	191.0	68.8	-30.6	43.69	222.20	96.9
SLS19	114.8	68.8	0.0	158.6	68.8	0.0	31.59	222.20	98.7
SLS20	200.1	0.0	-26.9	273.0	0.0	-26.9	38.57	222.20	100.0
SLS21	123.6	0.0	-26.9	167.3	0.0	-26.9	26.49	222.20	100.0

2.7.5 Crack Width Check - Fixed End

Position	Combination	Location (m)	Moment (kN.m/m)	Crack Width (mm)	
				Actual	Allowable
Bottom - X	SLS6	1.55	8.85	0.0000	0.2
Top - X	SLS4	0.95	2.07	0.0000	0.2
Bottom - Z	SLS6	1.00	12.12	0.0000	0.20
Top - Z	SLS19	2.50	3.71	0.0000	0.20

2.8 Ultimate Design - Fixed End

2.8.1 Pad - Check for Bending Moment - Fixed End

- X Direction - Bottom -----

Critical Ultimate Load Combination = **ULS2**
 Critical Moment Location = **1.55 m**
 Design Moment = **11.0 kN.m**
 Moment Capacity(for given Reinforcement) = **90.4 kN.m**
 Reinforcement Provided = **0.14 %**
 Min Reinforcement Required = **0.00 %**
 Provided Rebar Spacing = **200 mm**
 Allowed Maximum Rebar Spacing = **300.0 mm**

- X Direction - Top -----

Critical Ultimate Load Combination = **ULS16**
 Critical Moment Location = **0.95 m**
 Design Moment = **2.5 kN.m**
 Moment Capacity(for given Reinforcement) = **90.4 kN.m**
 Reinforcement Provided = **0.14 %**
 Min Reinforcement Required = **0.00 %**
 Provided Rebar Spacing = **150 mm**
 Allowed Maximum Rebar Spacing = **300.0 mm**

- Z Direction - Bottom -----

Critical Ultimate Load Combination = **ULS2**
 Critical Moment Location = **1.00 m**
 Design Moment = **14.9 kN.m**

Moment Capacity(for given Reinforcement) = **90.6 kN.m**
 Reinforcement Provided = **0.14 %**
 Min Reinforcement Required = **0.00 %**
 Provided Rebar Spacing = **200 mm**
 Allowed Maximum Rebar Spacing = **300.0 mm**
 • Z Direction - Top -----
 Critical Ultimate Load Combination = **ULS16**
 Critical Moment Location = **2.50 m**
 Design Moment = **3.0 kN.m**
 Moment Capacity(for given Reinforcement) = **90.6 kN.m**
 Reinforcement Provided = **0.14 %**
 Min Reinforcement Required = **0.00 %**
 Provided Rebar Spacing = **200 mm**
 Allowed Maximum Rebar Spacing = **300.0 mm**

2.8.2 Pad - Check for Shear - Fixed End

Position	Critical Combination	Location (m)	Shear Force (kN/m)	Design Stress (N/mm ²)	Strength (N/mm ²)
Bottom - X	ULS2	1.89	14.9	0.043	0.402
Top - X	ULS16	0.61	3.4	0.010	0.402
Bottom - Z	ULS2	0.66	19.8	0.060	0.411
Top - Z	ULS16	2.84	4.0	0.012	0.411

2.9 Check for Punching Shear - Fixed End

Pedestal	ULS Comb	Punching at	Punch.Force (kN)	Tension Face	Punch.Stress (N/mm ²)	Strength (N/mm ²)
Fixed	ULS2	Face	131.6	Bottom	0.093	4.733
	ULS2	1.5 d	78.7	Bottom	0.028	0.392

2.9.1 Pedestal Design - Fixed End

○ Pedestal - PT1 (1500x600 Size Wall) Design Check {Fixed}

• Design Check - Bending Moment
 Design Pedestal Location = **Fixed**
 Design Load Combination = **ULS24**
 Design Axial Load(+ve Compression) = **71.7 kN**
 Design Moment(Resultant) = **32.9 kN.m**
 - Axial Compression Load Capacity = **17757.0 kN**
 - Axial Tension Load Capacity = **3824.5 kN**
 - Moment Capacity = **956.0 kN.m**
 - Design Ratio for Bending Moment = **0.034**
 - Reinforcement Provided = **1.0 %**
 - Min Reinforcement Required = **0.4 %**
 - Vertical Rebar Spacing = **150.0 mm**
 • Design Check for Shear
 Design Pedestal Location = **Fixed**
 Design Load Combination = **ULS2**
 Design Axial Load(+ve Compression) = **165.3 kN**
 Design Moment(Resultant) = **28.1 kN.m**
 Design Shear(Resultant) = **45.0 kN**
 - Maximum Shear Stress = **0.052 N/mm²**

- Maximum Allowable Shear Stress	= 4.733 N/mm ²
- Design Ties Spacing	= Not Required
- Provided Ties Spacing	= 150 mm
- Maximum Allowed Ties Spacing	= 320 mm

2.9.2 Steel Material Strength - Fixed End

Effective Cross Sectional Area of Anchor	$A_{se} = \pi / 4 * (d - 0.9743 / 8)^2 = 343.286 \text{ mm}^2$	ASME B1.1
Bolt Tension Strength	$P_t = 160 \text{ N/mm}^2$	Table 34
Bolt Shear Strength	$P_s = 240 \text{ N/mm}^2$	Table 30
Design Steel Tension Strength of Bolt	$P_b = P_t * A_{se} = 82.389 \text{ kN}$	cl 6.3.4.3
Design Steel Shear Strength of Bolt	$P_v = P_s * A_{se} = 54.926 \text{ kN}$	cl 6.3.2.1
Anchorage Tension Capacity	$T_c = \min(P_b, C_t) = 50 \text{ kN}$	
Anchorage Shear Capacity	$S_c = \min(P_v, C_s) = 50 \text{ kN}$	

2.9.3 Anchor Bolt Check - Fixed End

Sl. No	Tension in Anchor Bolt T_{ab} (kN)	Bolt Tension Capacity T_c (kN)	Shear per bolt V_{ab} (kN)	Bolt Shear Capacity S_c (kN)	Anchorage Interaction $(T_{ab} / T_c) + (V_{ab} / S_c)$	Status
ULS 1	No Tension	50	3.75	50	0.075	Pass
ULS 2	No Tension	50	12.479	50	0.25	Pass
ULS 3	No Tension	50	11.25	50	0.225	Pass
ULS 4	No Tension	50	9.242	50	0.185	Pass
ULS 5	No Tension	50	7.5	50	0.15	Pass
ULS 6	No Tension	50	12.479	50	0.25	Pass
ULS 7	No Tension	50	11.25	50	0.225	Pass
ULS 8	No Tension	50	9.242	50	0.185	Pass
ULS 9	No Tension	50	7.5	50	0.15	Pass
ULS 10	No Tension	50	12.479	50	0.25	Pass
ULS 11	No Tension	50	11.25	50	0.225	Pass
ULS 12	No Tension	50	12.479	50	0.25	Pass
ULS 13	No Tension	50	11.25	50	0.225	Pass
ULS 14	No Tension	50	9.242	50	0.185	Pass
ULS 15	No Tension	50	7.5	50	0.15	Pass
ULS 16	No Tension	50	9.242	50	0.185	Pass
ULS 17	No Tension	50	7.5	50	0.15	Pass
ULS 18	No Tension	50	0	50	0	Pass
ULS 19	No Tension	50	9.242	50	0.185	Pass
ULS 20	No Tension	50	7.5	50	0.15	Pass
ULS 21	No Tension	50	12.479	50	0.25	Pass
ULS 22	No Tension	50	11.25	50	0.225	Pass
ULS 23	No Tension	50	6.32	50	0.126	Pass
ULS 24	No Tension	50	6.32	50	0.126	Pass

2.10 Service Loads on Pedestal - Sliding End

SLS Comb	Horizontal F_x (kN)	Vertical F_y (kN)	Horizontal F_z (kN)	Moment M_x (kN.m)	Moment M_y (kN.m)	Moment M_z (kN.m)
SLS1	0.000	60.000	12.500	5.000	0.000	0.000
SLS2	-18.000	60.000	37.500	5.000	0.000	0.000
SLS3	0.000	60.000	37.500	5.000	0.000	0.000

SLS Comb	Horizontal F _x (kN)	Vertical F _y (kN)	Horizontal F _z (kN)	Moment M _x (kN.m)	Moment M _y (kN.m)	Moment M _z (kN.m)
SLS4	-18.000	0.000	25.000	0.000	0.000	0.000
SLS5	0.000	0.000	25.000	0.000	0.000	0.000
SLS6	-18.000	68.000	37.500	5.000	0.000	0.000
SLS7	0.000	68.000	37.500	5.000	0.000	0.000
SLS8	-18.000	8.000	25.000	0.000	0.000	0.000
SLS9	0.000	8.000	25.000	0.000	0.000	0.000
SLS10	-18.000	66.000	37.500	5.000	0.000	0.000
SLS11	0.000	66.000	37.500	5.000	0.000	0.000
SLS12	-18.000	6.000	25.000	0.000	0.000	0.000
SLS13	0.000	6.000	25.000	0.000	0.000	0.000
SLS14	0.000	19.200	0.000	0.000	0.000	0.000
SLS15	-18.000	14.400	25.000	0.000	0.000	0.000
SLS16	0.000	14.400	25.000	0.000	0.000	0.000
SLS17	0.000	36.000	37.500	5.000	0.000	0.000
SLS18	-18.000	36.000	37.500	5.000	0.000	0.000
SLS19	0.000	14.400	37.500	5.000	0.000	0.000
SLS20	4.200	21.667	0.000	0.000	0.000	0.000
SLS21	4.200	12.067	0.000	0.000	0.000	0.000

2.11 Factored Loads on Pedestal - Sliding End

ULS Comb	Horizontal F _x (kN)	Vertical F _y (kN)	Horizontal F _z (kN)	Moment M _x (kN.m)	Moment M _y (kN.m)	Moment M _z (kN.m)
ULS1	0.000	84.000	15.000	6.000	0.000	0.000
ULS2	-21.600	84.000	45.000	6.000	0.000	0.000
ULS3	0.000	84.000	45.000	6.000	0.000	0.000
ULS4	-21.600	0.000	30.000	0.000	0.000	0.000
ULS5	0.000	0.000	30.000	0.000	0.000	0.000
ULS6	-21.600	84.800	45.000	6.000	0.000	0.000
ULS7	0.000	84.800	45.000	6.000	0.000	0.000
ULS8	-21.600	12.800	30.000	0.000	0.000	0.000
ULS9	0.000	12.800	30.000	0.000	0.000	0.000
ULS10	-21.600	76.000	45.000	6.000	0.000	0.000
ULS11	0.000	76.000	45.000	6.000	0.000	0.000
ULS12	-21.600	72.000	45.000	6.000	0.000	0.000
ULS13	0.000	72.000	45.000	6.000	0.000	0.000
ULS14	-21.600	4.000	30.000	0.000	0.000	0.000
ULS15	0.000	4.000	30.000	0.000	0.000	0.000
ULS16	-21.600	0.000	30.000	0.000	0.000	0.000
ULS17	0.000	0.000	30.000	0.000	0.000	0.000
ULS18	0.000	28.800	0.000	0.000	0.000	0.000
ULS19	-21.600	21.600	30.000	0.000	0.000	0.000
ULS20	0.000	21.600	30.000	0.000	0.000	0.000
ULS21	-21.600	54.000	45.000	6.000	0.000	0.000
ULS22	0.000	54.000	45.000	6.000	0.000	0.000
ULS23	6.720	25.067	0.000	0.000	0.000	0.000
ULS24	6.720	17.867	0.000	0.000	0.000	0.000

2.12 Soil and Self Weight of Foundation - Sliding End

Self Weight of Pad	$S_{wf} = 84.0 \text{ kN}$
Self Weight of Pedestals	$S_{wpd} = 28.1 \text{ kN}$
Minimum Soil Overburden	$SIM_{nWt} = 116.2 \text{ kN}$
Maximum Soil Overburden	$SIM_{xWt} = 116.2 \text{ kN}$
Water Weight above Pad	$W_{rfp} = 34.7 \text{ kN}$
Deduction Weight of Suspended Soil	$SID_{nWt} = 34.7 \text{ kN}$
Buoyancy Deduction Load	$B_{fuf} = 73.0 \text{ kN}$
Total Weight under Min.Soil Condition	$M_{nCwt} = S_{wf} + S_{wpd} + W_{rfp} + SIM_{nWt} - SID_{nWt} - B_{fuf} = 155.3 \text{ kN}$
Total Weight under Max.Soil Condition	$M_{xCwt} = S_{wf} + S_{wpd} + SIM_{xWt} = 228.3 \text{ kN}$

2.13 Serviceability Check for SLS combinations - Sliding End

2.13.1 Stability Resistance - Sliding End

Comb	Sliding Resistance (kN)			Overturning Resisting Moment (kN.m)					
	Frictional	Passive	Total	Self - X	Self - Z	Passive - X	Passive - Z	Total - X	Total-Z
SLS1	75.4	59.8	135.1	376.8	269.1	0.0	0.0	376.8	269.1
SLS2	75.4	79.2	154.6	376.8	269.1	0.0	0.0	376.8	269.1
SLS3	75.4	59.8	135.1	376.8	269.1	0.0	0.0	376.8	269.1
SLS4	54.4	82.7	137.1	271.8	194.1	0.0	0.0	271.8	194.1
SLS5	54.4	59.8	114.1	271.8	194.1	0.0	0.0	271.8	194.1
SLS6	78.2	79.2	157.4	390.8	279.1	0.0	0.0	390.8	279.1
SLS7	78.2	59.8	137.9	390.8	279.1	0.0	0.0	390.8	279.1
SLS8	57.2	82.7	139.9	285.8	204.1	0.0	0.0	285.8	204.1
SLS9	57.2	59.8	116.9	285.8	204.1	0.0	0.0	285.8	204.1
SLS10	77.5	79.2	156.7	387.3	276.6	0.0	0.0	387.3	276.6
SLS11	77.5	59.8	137.2	387.3	276.6	0.0	0.0	387.3	276.6
SLS12	56.5	82.7	139.2	282.3	201.6	0.0	0.0	282.3	201.6
SLS13	56.5	59.8	116.2	282.3	201.6	0.0	0.0	282.3	201.6
SLS14	39.3	35.9	75.2	196.7	140.5	0.0	0.0	196.7	140.5
SLS15	37.7	49.6	87.3	188.3	134.5	0.0	0.0	188.3	134.5
SLS16	37.7	35.9	73.5	188.3	134.5	0.0	0.0	188.3	134.5
SLS17	45.2	35.9	81.1	226.1	161.5	0.0	0.0	226.1	161.5
SLS18	45.2	47.5	92.8	226.1	161.5	0.0	0.0	226.1	161.5
SLS19	37.7	35.9	73.5	188.3	134.5	0.0	0.0	188.3	134.5
SLS20	61.9	58.5	120.5	309.7	221.2	0.0	0.0	309.7	221.2
SLS21	36.8	35.1	72.0	184.2	131.6	0.0	0.0	184.2	131.6

2.13.2 Overturning Check - Sliding End

SLS Comb	Overturning(kN.m)		Resisting(kN.m)		FOS Overturning		
	Moment X	Moment Z	Moment X	Moment Z	Actual X	Actual Z	Allowable
SLS1	26.3	0.0	376.8	269.1	14.35	100.00	1.50
SLS2	68.8	30.6	376.8	269.1	5.48	8.80	1.50
SLS3	68.8	0.0	376.8	269.1	5.48	100.00	1.50
SLS4	42.5	30.6	271.8	194.1	6.40	6.34	1.50
SLS5	42.5	0.0	271.8	194.1	6.40	100.00	1.50
SLS6	68.8	30.6	390.8	279.1	5.68	9.12	1.50
SLS7	68.8	0.0	390.8	279.1	5.68	100.00	1.50
SLS8	42.5	30.6	285.8	204.1	6.72	6.67	1.50
SLS9	42.5	0.0	285.8	204.1	6.72	100.00	1.50
SLS10	68.8	30.6	387.3	276.6	5.63	9.04	1.50

SLS Comb	Overturning(kN.m)		Resisting(kN.m)		FOS Overturning		
	Moment X	Moment Z	Moment X	Moment Z	Actual X	Actual Z	Allowable
SLS11	68.8	0.0	387.3	276.6	5.63	100.00	1.50
SLS12	42.5	30.6	282.3	201.6	6.64	6.59	1.50
SLS13	42.5	0.0	282.3	201.6	6.64	100.00	1.50
SLS14	0.0	0.0	196.7	140.5	100.00	100.00	1.50
SLS15	42.5	30.6	188.3	134.5	4.43	4.40	1.50
SLS16	42.5	0.0	188.3	134.5	4.43	100.00	1.50
SLS17	68.8	0.0	226.1	161.5	3.29	100.00	1.50
SLS18	68.8	30.6	226.1	161.5	3.29	5.28	1.50
SLS19	68.8	0.0	188.3	134.5	2.74	100.00	1.50
SLS20	0.0	-7.1	309.7	221.2	100.00	30.98	1.50
SLS21	0.0	-7.1	184.2	131.6	100.00	18.43	1.50

2.13.3 Sliding and Uplift Check - Sliding End

SLS Comb	Resultant Shear (kN)	Resisting Force (kN)	FOS Sliding		FOS Uplift			
			Actual	Allowable	Uplift Force (kN)	Resisting Force (kN)	Actual	Allowable
SLS1	12.5	135.1	10.81	1.50	0.0	155.3	100.00	1.2
SLS2	41.6	154.6	3.72	1.50	0.0	155.3	100.00	1.2
SLS3	37.5	135.1	3.60	1.50	0.0	155.3	100.00	1.2
SLS4	30.8	137.1	4.45	1.50	0.0	155.3	100.00	1.2
SLS5	25.0	114.1	4.57	1.50	0.0	155.3	100.00	1.2
SLS6	41.6	157.4	3.78	1.50	0.0	155.3	100.00	1.2
SLS7	37.5	137.9	3.68	1.50	0.0	155.3	100.00	1.2
SLS8	30.8	139.9	4.54	1.50	0.0	155.3	100.00	1.2
SLS9	25.0	116.9	4.68	1.50	0.0	155.3	100.00	1.2
SLS10	41.6	156.7	3.77	1.50	0.0	155.3	100.00	1.2
SLS11	37.5	137.2	3.66	1.50	0.0	155.3	100.00	1.2
SLS12	30.8	139.2	4.52	1.50	0.0	155.3	100.00	1.2
SLS13	25.0	116.2	4.65	1.50	0.0	155.3	100.00	1.2
SLS14	0.0	75.2	100.00	1.50	0.0	93.2	100.00	1.2
SLS15	30.8	87.3	2.83	1.50	0.0	93.2	100.00	1.2
SLS16	25.0	73.5	2.94	1.50	0.0	93.2	100.00	1.2
SLS17	37.5	81.1	2.16	1.50	0.0	93.2	100.00	1.2
SLS18	41.6	92.8	2.23	1.50	0.0	93.2	100.00	1.2
SLS19	37.5	73.5	1.96	1.50	0.0	93.2	100.00	1.2
SLS20	4.2	120.5	28.69	1.50	0.0	155.3	100.00	1.2
SLS21	4.2	72.0	17.13	1.50	0.0	93.2	100.00	1.2

2.13.4 Bearing Pressure Check - Sliding End

SLS Comb	Minimum Soil Condition			Maximum Soil Condition			Bearing Pressure		
	Axial Force (kN)	Moment X (kN.m)	Moment Z (kN.m)	Axial Force (kN)	Moment X (kN.m)	Moment Z (kN.m)	Actual(kN/m ²)	Allowable(kN/m ²)	Contact %
SLS1	215.3	26.3	0.0	288.3	26.3	0.0	38.09	222.20	100.0
SLS2	215.3	68.8	30.6	288.3	68.8	30.6	54.81	222.20	100.0
SLS3	215.3	68.8	0.0	288.3	68.8	0.0	46.41	222.20	100.0
SLS4	155.3	42.5	30.6	228.3	42.5	30.6	42.81	222.20	100.0
SLS5	155.3	42.5	0.0	228.3	42.5	0.0	34.41	222.20	100.0
SLS6	223.3	68.8	30.6	296.3	68.8	30.6	55.72	222.20	100.0

SLS Comb	Minimum Soil Condition			Maximum Soil Condition			Bearing Pressure		
	Axial Force (kN)	Moment X (kN.m)	Moment Z (kN.m)	Axial Force (kN)	Moment X (kN.m)	Moment Z (kN.m)	Actual(kN/m ²)	Allowable(kN/m ²)	Contact %
SLS7	223.3	68.8	0.0	296.3	68.8	0.0	47.33	222.20	100.0
SLS8	163.3	42.5	30.6	236.3	42.5	30.6	43.72	222.20	100.0
SLS9	163.3	42.5	0.0	236.3	42.5	0.0	35.33	222.20	100.0
SLS10	221.3	68.8	30.6	294.3	68.8	30.6	55.49	222.20	100.0
SLS11	221.3	68.8	0.0	294.3	68.8	0.0	47.10	222.20	100.0
SLS12	161.3	42.5	30.6	234.3	42.5	30.6	43.49	222.20	100.0
SLS13	161.3	42.5	0.0	234.3	42.5	0.0	35.10	222.20	100.0
SLS14	112.4	0.0	0.0	156.2	0.0	0.0	17.85	222.20	100.0
SLS15	107.6	42.5	30.6	151.4	42.5	30.6	34.02	222.20	96.0
SLS16	107.6	42.5	0.0	151.4	42.5	0.0	25.62	222.20	100.0
SLS17	129.2	68.8	0.0	173.0	68.8	0.0	33.24	222.20	100.0
SLS18	129.2	68.8	30.6	173.0	68.8	30.6	41.65	222.20	93.2
SLS19	107.6	68.8	0.0	151.4	68.8	0.0	30.77	222.20	95.2
SLS20	177.0	0.0	-7.1	249.9	0.0	-7.1	30.52	222.20	100.0
SLS21	105.2	0.0	-7.1	149.0	0.0	-7.1	18.99	222.20	100.0

2.13.5 Crack Width Check - Sliding End

Position	Combination	Location (m)	Moment (kN.m/m)	Crack Width (mm)	
				Actual	Allowable
Bottom - X	SLS6	0.95	7.10	0.0000	0.2
Top - X	SLS4	1.55	2.07	0.0000	0.2
Bottom - Z	SLS6	1.00	10.18	0.0000	0.20
Top - Z	SLS19	2.50	4.12	0.0000	0.20

2.14 Ultimate Design - Sliding End

2.14.1 Pad - Check for Bending Moment - Sliding End

- X Direction - Bottom -----
 - Critical Ultimate Load Combination = **ULS2**
 - Critical Moment Location = **0.95 m**
 - Design Moment = **8.8 kN.m**
 - Moment Capacity(for given Reinforcement) = **84.4 kN.m**
 - Reinforcement Provided = **0.13 %**
 - Min Reinforcement Required = **0.24 %**
 - Provided Rebar Spacing = **150 mm**
 - Allowed Maximum Rebar Spacing = **300.0 mm**
- X Direction - Top -----
 - Critical Ultimate Load Combination = **ULS16**
 - Critical Moment Location = **1.55 m**
 - Design Moment = **2.5 kN.m**
 - Moment Capacity(for given Reinforcement) = **84.4 kN.m**
 - Reinforcement Provided = **0.13 %**
 - Min Reinforcement Required = **0.24 %**
 - Provided Rebar Spacing = **150 mm**
 - Allowed Maximum Rebar Spacing = **300.0 mm**
- Z Direction - Bottom -----
 - Critical Ultimate Load Combination = **ULS2**
 - Critical Moment Location = **1.00 m**

Design Moment = **12.5 kN.m**
 Moment Capacity(for given Reinforcement) = **84.4 kN.m**
 Reinforcement Provided = **0.13 %**
 Min Reinforcement Required = **0.24 %**
 Provided Rebar Spacing = **150 mm**
 Allowed Maximum Rebar Spacing = **300.0 mm**
 • Z Direction - Top -----
 Critical Ultimate Load Combination = **ULS16**
 Critical Moment Location = **2.50 m**
 Design Moment = **3.0 kN.m**
 Moment Capacity(for given Reinforcement) = **84.4 kN.m**
 Reinforcement Provided = **0.13 %**
 Min Reinforcement Required = **0.24 %**
 Provided Rebar Spacing = **200 mm**
 Allowed Maximum Rebar Spacing = **300.0 mm**

2.14.2 Pad - Check for Shear - Sliding End

Position	Critical Combination	Location (m)	Shear Force (kN/m)	Design Stress (N/mm ²)	Strength (N/mm ²)
Bottom - X	ULS2	0.61	11.9	0.035	0.391
Top - X	ULS16	1.89	3.4	0.010	0.391
Bottom - Z	ULS2	0.66	16.6	0.049	0.398
Top - Z	ULS16	2.84	4.0	0.012	0.398

2.15 Check for Punching Shear - Sliding End

Pedestal	ULS Comb	Punching at	Punch.Force (kN)	Tension Face	Punch.Stress (N/mm ²)	Strength (N/mm ²)
Sliding	ULS1	Face	93.9	Bottom	0.066	4.733
	ULS3	1.5 d	55.8	Bottom	0.020	0.391

2.15.1 Pedestal Design

○ Pedestal - PT2 (1500x600 Size Wall) Design Check {Sliding}

• Design Check - Bending Moment
 Design Pedestal Location = **Sliding**
 Design Load Combination = **ULS21**
 Design Axial Load(+ve Compression) = **79.3 kN**
 Design Moment(Resultant) = **28.1 kN.m**
 - Axial Compression Load Capacity = **17757.0 kN**
 - Axial Tension Load Capacity = **3824.5 kN**
 - Moment Capacity = **28.1 kN.m**
 - Design Ratio for Bending Moment = **0.026**
 - Reinforcement Provided = **1.0 %**
 - Min Reinforcement Required = **0.4 %**
 - Vertical Rebar Spacing = **150.0 mm**
 • Design Check for Shear
 Design Pedestal Location = **Sliding**
 Design Load Combination = **ULS2**
 Design Axial Load(+ve Compression) = **123.3 kN**
 Design Moment(Resultant) = **28.1 kN.m**
 Design Shear(Resultant) = **45.0 kN**
 - Maximum Shear Stress = **0.052 N/mm²**

- Maximum Allowable Shear Stress	= 4.733 N/mm ²
- Design Ties Spacing	= Not Required
- Provided Ties Spacing	= 150 mm
- Maximum Allowed Ties Spacing	= 320 mm

3.0 SUMMARY

3.1 Fixed End

3.1.1 Stability Checks(SLS)

Stability Condition	Critical Condition	Actual	Allowable	Status
FOS Overturning X	SLS19	2.922	1.500	Pass
FOS Overturning Z	SLS15	4.689	1.500	Pass
FOS Sliding (Resultant)	SLS19	2.028	1.500	Pass
FOS Uplift	SLS1	100.0	1.200	Pass
Bearing Pressure (kN/m ²)	SLS6	59.6	222.2	Pass
Contact (%)	SLS18	96.9	60.0	Pass

3.1.2 Crack Width Check

Stability Condition	Critical Condition	Actual(mm)	Allowable(mm)	Status
Bottom - X	SLS6	0.0000	0.200	Pass
Top - X	SLS4	0.0000	0.200	Pass
Bottom - Z	SLS6	0.0000	0.200	Pass
Top - Z	SLS19	0.0000	0.200	Pass

3.1.3 Pad Design

3.1.3.1 Pad Minimum Reinforcement

Position	Provided	Min Percentage	Max.Spacing	Status
Bottom - X	12Φ at 200 c/c (0.14%)	0.13 %	300.0	Pass
Bottom - Z	12Φ at 200 c/c (0.14%)	0.13 %	300.0	Pass
Top - X	12Φ at 200 c/c (0.14%)	0.13 %	300.0	Pass
Top - Z	12Φ at 200 c/c (0.14%)	0.13 %	300.0	Pass

3.1.3.2 Pad Moment Capacity

Position	Combination	Required(kN.m/m)	Capacity(kN.m/m)	Status
Bottom - X	ULS2	10.96	90.38	Pass
Top - X	ULS16	2.48	90.38	Pass
Bottom - Z	ULS2	14.92	90.55	Pass
Top - Z	ULS16	3.03	90.55	Pass

3.1.3.3 Pad Shear Capacity

Position	Combination	Required(kN/m)	Capacity(kN/m)	Status
Bottom - X	ULS2	14.9	138.4	Pass
Top - X	ULS16	3.4	138.4	Pass
Bottom - Z	ULS2	19.8	136.3	Pass

Position	Combination	Required(kN/m)	Capacity(kN/m)	Status
Top - Z	ULS16	4.0	136.3	Pass

3.1.3.4 Punching Shear

Location	Combination	Punching at	Face	Actual(N/mm ²)	Strength(N/mm ²)	Status
Fixed	ULS2	Face	Bottom	0.093	4.733	Pass
Fixed	ULS2	1.5d	Bottom	0.028	0.392	Pass

3.1.4 Pedestal Design

3.1.4.1 Pedestal Bending Moment

Type	Applicable Locations	Critical Location	Combination	Design Ratio	Status
PT1	Fixed	Fixed	ULS24	0.034	Pass

3.1.4.2 Pedestal Shear

Type	Applicable Locations	Critical Location	Combination	Provided Spacing(mm)	Max.Spacing(mm)	Status
PT1	Fixed	Fixed	ULS2	150.0	320.0	Pass

3.1.5 Anchorage in Tension and Shear

Description	Combination	Actual (kN)	Capacity(kN)	Status
Tension	ULS1	0	50	Pass
Shear	ULS2	12.479	50	Pass

3.1.6 Interaction in Tension and Shear

Description	Combination	Actual Tension (kN)	Tension Capacity (kN)	Actual Shear (kN)	Shear Capacity (kN)	Interaction	Status
Anchorage	ULS2	0	50	12.479	50	0.25	Pass

3.2 Sliding End

3.2.1 Stability Checks(SLS)

Stability Condition	Critical Condition	Actual	Allowable	Status
FOS Overturning X	SLS19	2.738	1.500	Pass
FOS Overturning Z	SLS15	4.395	1.500	Pass
FOS Sliding (Resultant)	SLS19	1.961	1.500	Pass
FOS Uplift	SLS1	100.0	1.200	Pass
Bearing Pressure (kN/m ²)	SLS6	55.7	222.2	Pass
Contact (%)	SLS18	93.2	60.0	Pass

3.2.2 Crack Width Check

Stability Condition	Critical Condition	Actual(mm)	Allowable(mm)	Status
Bottom - X	SLS6	0.0000	0.200	Pass
Top - X	SLS4	0.0000	0.200	Pass
Bottom - Z	SLS6	0.0000	0.200	Pass
Top - Z	SLS19	0.0000	0.200	Pass

3.2.3 Pad Design

3.2.3.1 Pad Minimum Reinforcement

Position	Provided	Min Percentage	Max.Spacing	Status
Bottom - X	10Φ at 150 c/c (0.13%)	0.13 %	300.0	Pass
Bottom - Z	10Φ at 150 c/c (0.13%)	0.13 %	300.0	Pass
Top - X	10Φ at 150 c/c (0.13%)	0.13 %	300.0	Pass
Top - Z	10Φ at 150 c/c (0.13%)	0.13 %	300.0	Pass

3.2.3.2 Pad Moment Capacity

Position	Combination	Required(kN.m/m)	Capacity(kN.m/m)	Status
Bottom - X	ULS2	8.79	84.38	Pass
Top - X	ULS16	2.48	84.38	Pass
Bottom - Z	ULS2	12.52	84.38	Pass
Top - Z	ULS16	3.03	84.38	Pass

3.2.3.3 Pad Shear Capacity

Position	Combination	Required(kN/m)	Capacity(kN/m)	Status
Bottom - X	ULS2	11.9	135.0	Pass
Top - X	ULS16	3.4	135.0	Pass
Bottom - Z	ULS2	16.6	133.4	Pass
Top - Z	ULS16	4.0	133.4	Pass

3.2.3.4 Punching Shear

Location	Combination	Punching at	Face	Actual(N/mm ²)	Strength(N/mm ²)	Status
Sliding	ULS1	Face	Bottom	0.066	4.733	Pass
Sliding	ULS3	1.5d	Bottom	0.020	0.391	Pass

3.2.4 Pedestal Design

3.2.4.1 Pedestal Bending Moment

Type	Applicable Locations	Critical Location	Combination	Design Ratio	Status
PT2	Sliding	Sliding	ULS21	0.026	Pass

3.2.4.2 Pedestal Shear

Type	Applicable Locations	Critical Location	Combination	Provided Spacing(mm)	Max.Spacing(mm)	Status
PT2	Sliding	Sliding	ULS2	150.0	320.0	Pass