

Description

Calculation method: Eurocode 3 - Part 5

Head wall

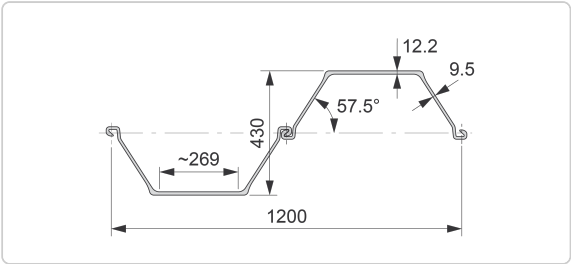
Geometry

Z _{top}	4.00	m
Z _{w front}	1.50	m
Z _{w back}	-4.00	m
Buckling length	12.00	m

Partial safety factors

Project specific	
γ _{M0}	1.50
γ _{M1}	1.50
γ _{M2}	1.00
γ _{Mt,ser}	1.00

GU 20N / S 355 GP



Sheet pile properties (initial values)

W _{el,y} [cm³/m]	W _{pl,y} [cm³/m]	I _y [cm⁴/m]	A [cm²/m]	t _f [mm]	t _w [mm]	h [mm]	α [°]
1,920	2,280	41,320	172.3	12.20	9.50	430.0	57.5

b [mm]	c [mm]	A _v [cm²/m]	S _y [cm³/m]	r ₀ [mm]	mass [kg/m²]	B [mm]
288.5	247.7	66.2	1,125	15.0	135.2	1,200

Steel grade

f _{y ini}	355.0	MPa
ε	0.814	
(b/t _f)/ε	29	
Class ini.	2	

Steel quantities

L _{wall}	60.0	m
L _{SSP}	0.00	m
Steel weight	0.00	t

Reduction factors (U-piles)

β _B	1.00
β _D	1.00

Service life

100 years

Actions

Position	Z [m]	M _{Ed} [kNm/m]	V _{Ed} [kN/m]	N _{Ed} [kN/m]	e [mm]
1	1.50	10	-7	20	0
2	0.00	17	-13	40	0
3	-3.00	53	22	60	0
4	-8.00	-3	-10	80	0

Corrosion

Approach : Eurocode 3 - Part 5. Table 4.1 and 4.2

Zone	Z _{bottom} [m]	Loss of steel Front [mm]	Loss of steel Back [mm]	Protection Front [years]	Protection Back [years]	Total loss Front [mm]	Total loss Back [mm]
1	4.00	WATER_4 3.50	WATER_4 3.50	0	0	3.50	3.50
2	-8.00	WATER_4 3.50	WATER_4 3.50	0	0	3.50	3.50

Legend

WATER_4 Water. Sea water in temperate climate in the zone of permanent immersion or in the intertidal zone

Results

N°	Z [m]	Bending	Bending & shear	Web shear buckling	Buckling	Bending & axial	Bending & shear & axial	Uf
1	1.50	✓	✓	✓	✓	✓	-	0.10
2	0.00	✓	✓	✓	✓	✓	-	0.17
3	-3.00	✓	✓	✓	✓	✓	-	0.53
4	-8.00	✓	✓	✓	✓	✓	-	0.10

Numerical details : level n°1 (z = 1.50 m)

Section classification

Property	Ini.	Red.	Red. class 3
f_y	355.0	355.0	187.0
ϵ	0.814	0.814	1.121
$(b/t_f)/\epsilon$	29	68	49
Class	2	4	3

Selected section properties

Property	Ini.	Red.	Unit
$W_{el,y}$	1,920	805	cm ³ /m
$W_{pl,y}$	2,280	...	cm ³ /m
I_y	41,320	17,260	cm ⁴ /m
A	172.3	73.8	cm ² /m
t_f	12.20	5.20	mm
t_w	9.50	2.50	mm
h	430.0	423.0	mm
α	57.5	-	°
b	288.5	-	mm
c	247.7	-	mm
A_v	66.2	17.4	cm ² /m
S_y	1,125	-	cm ³ /m
r_0	15.0	-	mm
mass	135.2	-	kg/m ²
B	1,200	-	mm

Bending

$$M_{Ed} = 10 \text{ kNm/m} \leq M_{c,Rd} = \frac{\beta_B W_{el} f_y}{\gamma_{M0}} = 100 \text{ kNm/m}$$

$$W_{el} = 805 \text{ cm}^3/\text{m}$$

Bending & shear

$$V_{Ed} = 7 \text{ kN/m} \leq V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3} \gamma_{M0}} = 125 \text{ kN/m}$$

$$V_{Ed} = 7 \text{ kN/m} \leq 0.50 V_{pl,Rd} = 63 \text{ kN/m}$$

No further verification needed

Web shear buckling

$$\frac{c}{t_w \cdot \epsilon} = 88.4 > 72$$

$$\bar{\lambda} = 0.346 \frac{c}{t_w} \sqrt{\frac{f_y}{E}} = 1.023$$

$$f_{bv} = 87.7 \text{ MPa}$$

$$V_{Ed} = 7 \text{ kN/m} \leq V_{b,Rd} = \frac{2(h - t_f)t_w f_{bv}}{B \cdot \gamma_{M0}} = 102 \text{ kN/m}$$

Buckling

$$N_{Ed} = 20 \text{ kN/m} \leq N_{pl,Rd} = \frac{A f_y}{\gamma_{M0}} = 920 \text{ kN/m}$$

$$N_{cr} = \frac{EI \beta_D \pi^2}{l^2} = 2484 \text{ kN/m}$$

$$0.04 \cdot N_{cr} = 99 \text{ kN/m} \geq N_{Ed} = 20 \text{ kN/m}$$

No further verification needed

Bending & axial

$$N_{Ed} = 20 \text{ kN/m} \leq k_1 N_{pl,Rd} = k_1 \frac{A f_y}{\gamma_{M0}} = 92 \text{ kN/m with } k_1 = 0.10$$

✓ Correct sheet pile selected

Numerical details : level n°2 (z = 0.00 m)

Section classification

Property	Ini.	Red.	Red. class 3
f_y	355.0	355.0	187.0
ε	0.814	0.814	1.121
$(b/t_f)/\varepsilon$	29	68	49
Class	2	4	3

Selected section properties

Property	Ini.	Red. Unit
$W_{el,y}$	1,920	805 cm ³ /m
$W_{pl,y}$	2,280	... cm ³ /m
I_y	41,320	17,260 cm ⁴ /m
A	172.3	73.8 cm ² /m
t_f	12.20	5.20 mm
t_w	9.50	2.50 mm
h	430.0	423.0 mm
α	57.5	- °
b	288.5	- mm
c	247.7	- mm
A_v	66.2	17.4 cm ² /m
S_y	1,125	- cm ³ /m
r_0	15.0	- mm
mass	135.2	- kg/m ²
B	1,200	- mm

Bending

$$M_{Ed} = 17 \text{ kNm/m} \leq M_{c,Rd} = \frac{\beta_B W_{el} f_y}{\gamma_{M0}} = 100 \text{ kNm/m}$$

$$W_{el} = 805 \text{ cm}^3/\text{m}$$

Bending & shear

$$V_{Ed} = 13 \text{ kN/m} \leq V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3} \gamma_{M0}} = 125 \text{ kN/m}$$

$$V_{Ed} = 13 \text{ kN/m} \leq 0.50 V_{pl,Rd} = 63 \text{ kN/m}$$

No further verification needed

Web shear buckling

$$\frac{c}{t_w \cdot \varepsilon} = 88.4 > 72$$

$$\bar{\lambda} = 0.346 \frac{c}{t_w} \sqrt{\frac{f_y}{E}} = 1.023$$

$$f_{bv} = 87.7 \text{ MPa}$$

$$V_{Ed} = 13 \text{ kN/m} \leq V_{b,Rd} = \frac{2(h - t_f)t_w f_{bv}}{B \cdot \gamma_{M0}} = 102 \text{ kN/m}$$

Buckling

$$N_{Ed} = 40 \text{ kN/m} \leq N_{pl,Rd} = \frac{A f_y}{\gamma_{M0}} = 920 \text{ kN/m}$$

$$N_{cr} = \frac{EI \beta_D \pi^2}{l^2} = 2484 \text{ kN/m}$$

$$0.04 \cdot N_{cr} = 99 \text{ kN/m} \geq N_{Ed} = 40 \text{ kN/m}$$

No further verification needed

Bending & axial

$$N_{Ed} = 40 \text{ kN/m} \leq k_1 N_{pl,Rd} = k_1 \frac{A f_y}{\gamma_{M0}} = 92 \text{ kN/m with } k_1 = 0.10$$

✓ Correct sheet pile selected

Numerical details : level n°3 (z = -3.00 m)

Section classification

Property	Ini.	Red.	Red. class 3
f_y	355.0	355.0	187.0
ε	0.814	0.814	1.121
$(b/t_f)/\varepsilon$	29	68	49
Class	2	4	3

Selected section properties

Property	Ini.	Red. Unit
$W_{el,y}$	1,920	805 cm ³ /m
$W_{pl,y}$	2,280	... cm ³ /m
I_y	41,320	17,260 cm ⁴ /m
A	172.3	73.8 cm ² /m
t_f	12.20	5.20 mm
t_w	9.50	2.50 mm
h	430.0	423.0 mm
α	57.5	- °
b	288.5	- mm
c	247.7	- mm
A_v	66.2	17.4 cm ² /m
S_y	1,125	- cm ³ /m
r_0	15.0	- mm
mass	135.2	- kg/m ²
B	1,200	- mm

Bending

$$M_{Ed} = 53 \text{ kNm/m} \leq M_{c,Rd} = \frac{\beta_B W_{el} f_y}{\gamma_{M0}} = 100 \text{ kNm/m}$$

$$W_{el} = 805 \text{ cm}^3/\text{m}$$

Bending & shear

$$V_{Ed} = 22 \text{ kN/m} \leq V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3} \gamma_{M0}} = 125 \text{ kN/m}$$

$$V_{Ed} = 22 \text{ kN/m} \leq 0.50 V_{pl,Rd} = 63 \text{ kN/m}$$

No further verification needed

Web shear buckling

$$\frac{c}{t_w \cdot \varepsilon} = 88.4 > 72$$

$$\bar{\lambda} = 0.346 \frac{c}{t_w} \sqrt{\frac{f_y}{E}} = 1.023$$

$$f_{bv} = 87.7 \text{ MPa}$$

$$V_{Ed} = 22 \text{ kN/m} \leq V_{b,Rd} = \frac{2(h - t_f)t_w f_{bv}}{B \cdot \gamma_{M0}} = 102 \text{ kN/m}$$

Buckling

$$N_{Ed} = 60 \text{ kN/m} \leq N_{pl,Rd} = \frac{A f_y}{\gamma_{M0}} = 920 \text{ kN/m}$$

$$N_{cr} = \frac{EI \beta_D \pi^2}{l^2} = 2484 \text{ kN/m}$$

$$0.04 \cdot N_{cr} = 99 \text{ kN/m} \geq N_{Ed} = 60 \text{ kN/m}$$

No further verification needed

Bending & axial

$$N_{Ed} = 60 \text{ kN/m} \leq k_1 N_{pl,Rd} = k_1 \frac{A f_y}{\gamma_{M0}} = 92 \text{ kN/m with } k_1 = 0.10$$

✓ Correct sheet pile selected

Numerical details : level n°4 (z = -8.00 m)

Section classification

Property	Ini.	Red.	Red. class 3
f_y	355.0	355.0	187.0
ε	0.814	0.814	1.121
$(b/t_f)/\varepsilon$	29	68	49
Class	2	4	3

Selected section properties

Property	Ini.	Red. Unit
$W_{el,y}$	1,920	805 cm ³ /m
$W_{pl,y}$	2,280	... cm ³ /m
I_y	41,320	17,260 cm ⁴ /m
A	172.3	73.8 cm ² /m
t_f	12.20	5.20 mm
t_w	9.50	2.50 mm
h	430.0	423.0 mm
α	57.5	- °
b	288.5	- mm
c	247.7	- mm
A_v	66.2	17.4 cm ² /m
S_y	1,125	- cm ³ /m
r_0	15.0	- mm
mass	135.2	- kg/m ²
B	1,200	- mm

Bending

$$M_{Ed} = 3 \text{ kNm/m} \leq M_{c,Rd} = \frac{\beta_B W_{el} f_y}{\gamma_{M0}} = 100 \text{ kNm/m}$$

$$W_{el} = 805 \text{ cm}^3/\text{m}$$

Bending & shear

$$V_{Ed} = 10 \text{ kN/m} \leq V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3} \gamma_{M0}} = 125 \text{ kN/m}$$

$$V_{Ed} = 10 \text{ kN/m} \leq 0.50 V_{pl,Rd} = 63 \text{ kN/m}$$

No further verification needed

Web shear buckling

$$\frac{c}{t_w \cdot \varepsilon} = 88.4 > 72$$

$$\bar{\lambda} = 0.346 \frac{c}{t_w} \sqrt{\frac{f_y}{E}} = 1.023$$

$$f_{bv} = 87.7 \text{ MPa}$$

$$V_{Ed} = 10 \text{ kN/m} \leq V_{b,Rd} = \frac{2(h - t_f)t_w f_{bv}}{B \cdot \gamma_{M0}} = 102 \text{ kN/m}$$

Buckling

$$N_{Ed} = 80 \text{ kN/m} \leq N_{pl,Rd} = \frac{A f_y}{\gamma_{M0}} = 920 \text{ kN/m}$$

$$N_{cr} = \frac{EI \beta_D \pi^2}{l^2} = 2484 \text{ kN/m}$$

$$0.04 \cdot N_{cr} = 99 \text{ kN/m} \geq N_{Ed} = 80 \text{ kN/m}$$

No further verification needed

Bending & axial

$$N_{Ed} = 80 \text{ kN/m} \leq k_1 N_{pl,Rd} = k_1 \frac{A f_y}{\gamma_{M0}} = 92 \text{ kN/m with } k_1 = 0.10$$

✓ Correct sheet pile selected