

# Prosheet

## C. Examples

<b>1. Cantilever wall.....</b>	<b>2</b>
1.1. Description .....	2
1.2. Classical method .....	3
1.3. Eurocode method .....	7
<b>2. Anchored wall .....</b>	<b>9</b>
2.1. Description .....	9
2.2. Classical method .....	10
<b>3. Head wall and anchor wall system .....</b>	<b>14</b>
3.1. Description .....	14
3.2. Eurocode method .....	15

## 1. Cantilever wall

### 1.1. Description

This example shows a cantilever wall in a multilayer soil (gravel – sand – clays). An excavation is planned on the front side of the wall over a height of 4.0 m. Top level of the sheet pile is considered at 30.0 m, so excavation level is at 26.00 m. The water table is at 22.50 m. Constant permanent load (20 kPa) must be taken into account at the top level of the back side. PU 32 section has been chosen in the design.

Prosheets may help to deduce minimum embedment required to ensure global wall equilibrium.

Calculation will be done according to Classical and Eurocode 7-1 methods.

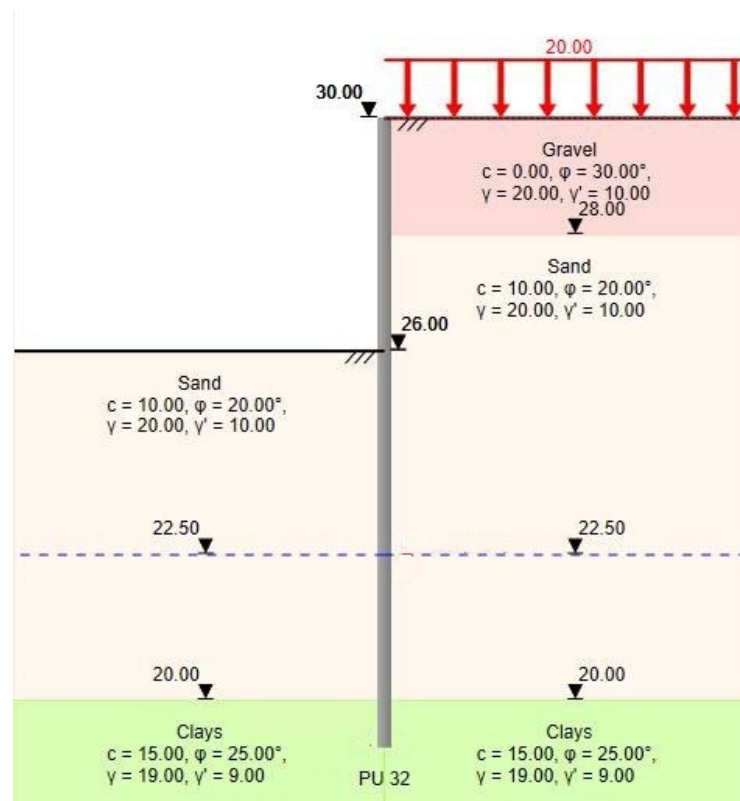


Figure 1. Cross-section

## 1.2. Classical method

The classical method aims to get the wall equilibrium with no ponderation on actions but with possible global safety on passive earth pressure ( $S_f$  factor). No local standard is used in this method.

The screenshot displays the Prosheets software interface with two tabs: 'Project' and 'Sheet pile'. The 'Project' tab is active, showing a description of 'Cantilever wall (Classical)' and various project options. The 'Sheet pile' tab is also visible, showing a cross-section diagram and calculation parameters.

**Project Tab:**

- Description:** Cantilever wall (Classical)
- Type of project:** Cantilever wall (selected), Anchored wall, Propped wall, Anchor wall, Head wall and anchor wall.
- Calculation method:** Classical (selected), Eurocode 7-1.
- Options:** Elevation definition: Levels, Calculation step: 0.50 m, Seismic calculation: unchecked.

**Sheet pile Tab:**

- Head wall:** (selected)
- Sheet pile section:** Type: All, Name: PU 32, Sort by: Catalogue.
- Geometry:** Z top: 30.00 m,  $\lambda$ : 0.00°.
- Reduction factors (U-piles):**  $\beta_D$ : 1.00.

Figure 2. Project and Sheet pile tabs

First, one has to choose type of project: Cantilever wall for this project. Our calculation will be made with Classical method. We choose to define the cross-section with levels (depths option is also available). Calculation step is defined equal to 0.50 m, it means that results will be provided every 0.50 m without no impact on the bottom level of the sheet pile.

In this project, we aim for a global safety on passive earth pressure of at least 1.90. No over-length for the moment.

The screenshot shows the 'Factors' dialog box in the Prosheets software. It has a title bar 'Factors' and a close button. The 'Factors on...' section is expanded, showing 'Soil' as the selected category. Under 'Soil', 'Passive earth pressure' is selected, and the value 'S<sub>f, min</sub>' is set to 1.90. There is an 'Ok' button at the bottom right.

Figure 3. Global safety on passive earth pressure

Then, soil geometry and materials must be defined in both sides of the wall. Natural ground level (NGL) may be horizontal, inclined or berm. According to the cross section, we choose horizontal and define  $z_0 = 25.50$  m for the front side. At the back, we also define a horizontal soil at  $z_0 = 30.0$  m.

Please, input following soil parameters. Active and passive earth pressures coefficients may be calculated automatically by Prosheets according to Kérisel-Absi tables. They may be also defined by the user with "Custom" mode.

**Head wall**

Natural ground level (NGL)

**Front**

☒ Horizontal

☐ Inclined  $Z_0$  26.00 m

☐ Berm

**Back**

☒ Horizontal

☐ Inclined  $Z_0$  30.00 m

☐ Embankment

**Soil layers**

$K_{ay}$ ,  $K_{py}$ ,  $K_{ac}$ ,  $K_{pc}$  : ☒ Automatic (Kerisel-Absi tables) ☐ Custom

**Front**

+	Z top [m]	Name	Color	Y [kN/m <sup>3</sup> ]	Y' [kN/m <sup>3</sup> ]	C <sub>k</sub> [kN/m <sup>2</sup> ]	C <sub>d</sub> [kN/m <sup>2</sup> ]	$\phi_k$ [°]	$\phi_d$ [°]	$\delta p / \phi$	$k_{py}$ , k	$k_{pc}$ , k	Drained
x	30.00	Gravel		20.00	10.00	0.00	0.00	30.00	30.00	-0.500	4.443	5.694	<input checked="" type="checkbox"/>
x	28.00	Sand		20.00	10.00	10.00	10.00	20.00	20.00	-0.500	2.511	4.058	<input checked="" type="checkbox"/>
x	20.00	Clays		19.00	9.00	15.00	15.00	25.00	25.00	-0.500	3.319	4.764	<input checked="" type="checkbox"/>

**Back**

+	Z top [m]	Name	Color	Y [kN/m <sup>3</sup> ]	Y' [kN/m <sup>3</sup> ]	C <sub>k</sub> [kN/m <sup>2</sup> ]	C <sub>d</sub> [kN/m <sup>2</sup> ]	$\phi_k$ [°]	$\phi_d$ [°]	$\delta a / \phi$	$K_{ay}$ , k	$K_{ac}$ , k	$K_{ay,min}$	$\delta p / \phi$	$k_{py}$ , k	$k_{pc}$ , k	Drained
x	30.00	Gravel		20.00	10.00	0.00	0.00	30.00	30.00	0.660	0.283	1.237	0.000	0.000	3.000	3.464	<input checked="" type="checkbox"/>
x	28.00	Sand		20.00	10.00	10.00	10.00	20.00	20.00	0.660	0.431	1.553	0.000	0.000	2.050	2.856	<input checked="" type="checkbox"/>
x	20.00	Clays		19.00	9.00	15.00	15.00	25.00	25.00	0.660	0.349	1.387	0.000	0.100	2.289	2.773	<input checked="" type="checkbox"/>

Soil database

Figure 4. Soil tab

After that, one must define hydraulic conditions. Two possibilities exist: phreatic level and custom pore pressure diagram. In this project, we define the same condition and the same level for both sides: phreatic level at  $z_w=22.60$ m.

Several loads may be defined in the same project: Caquot and Boussinesq loads applied on the soil, linear and distributed loads and wave load applied on the wall.

Uniform permanent load will be modelled as Caquot load: 20 kPa at  $z = 30.0$ m.

Project Sheet pile Soil **Hydraulic** Loads Seismic Results Scenario synthesis

**Head wall**

Hydraulic conditions

**Front**

☒ Phreatic level  $Z_w$  22.50 m

☐ Custom pore pressure diagram

**Back**

☒ Phreatic level  $Z_w$  22.50 m

☐ Custom pore pressure diagram

Project Sheet pile Soil Hydraulic **Loads** Seismic Results Scenario synthesis

**Head wall**

Loads on the soil

**Caquot**

Side	q [kN/m <sup>2</sup> ]
Front	0.00
Back	20.00

**Boussinesq**

N°	Side	z [m]	a [m]	L [m]	q [kN/m <sup>2</sup> ]	$\alpha_e$	+
----	------	-------	-------	-------	------------------------	------------	---

Loads on the wall

**Linear loads**

z [m]	F [kN/m]	$\alpha$ [°]	+
-------	----------	--------------	---

Figure 5. Hydraulic tab (left) and Loads tab (right)

Prosheet launch calculation automatically every time new input data is available.

In Results tab we can find following information:

- Graphs : displacement, bending moment, shear, earth and water pressures diagrams.
- Tables: numerical values of every diagram.
- Details: intermediate and final results and some checks.

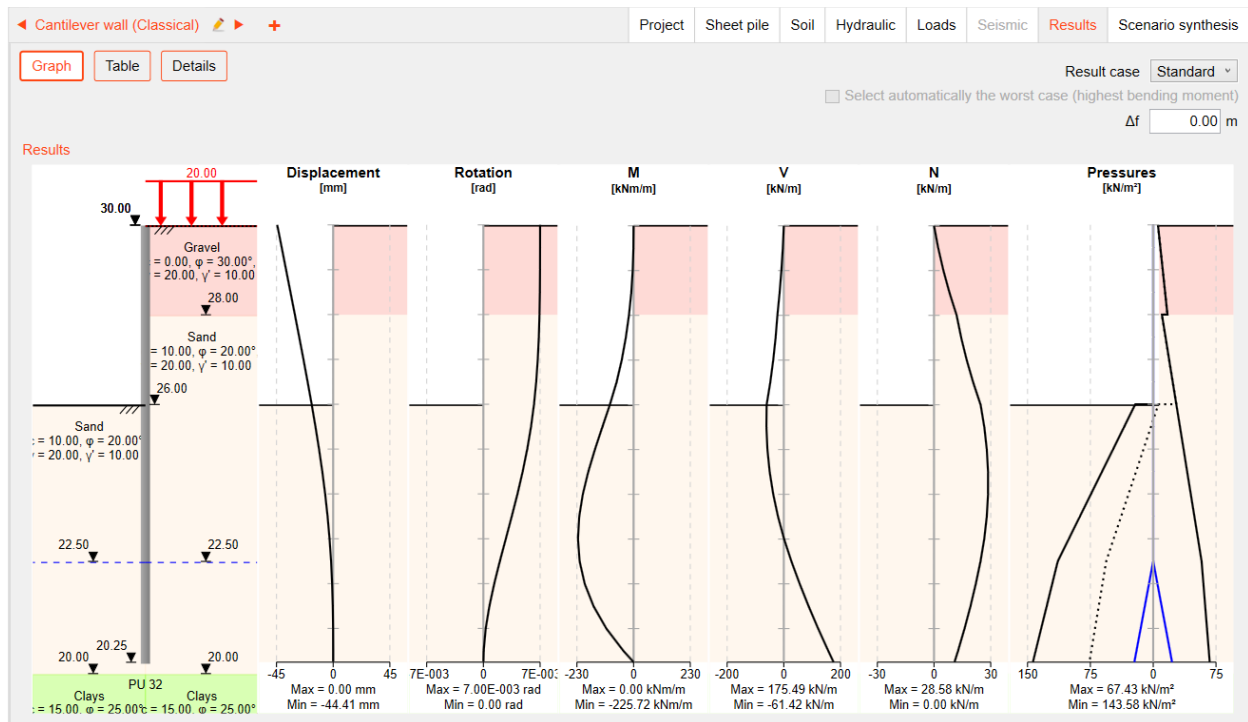


Figure 6. Results tab (graph)

◀ Cantilever wall (Classical) ▶ +

Project Sheet pile Soil Hydraulic Loads Seismic **Results** Scenario synthesis

Graph Table Details

Result case Standard ▾

☐ Select automatically the worst case (highest bending moment)

Δf 0.00 m

**Results**

z [m]	Displacement [mm]	Rotation [rad]	M [kNm/m]	V [kN/m]	N [kN/m]	Differential pressure [kN/m²]	Passive earth pressure Left [kN/m²]	Active earth pressure Right [kN/m²]	Water pressure Left [kN/m²]	Water pressure Right [kN/m²]
30.00	-44.41	7.00E-003	0	0	0	5.7	0	5.66	0	0
29.50	-40.91	7.00E-003	0	0	2	8.5	0	8.49	0	0
29.00	-37.41	6.99E-003	-4	-8	5	11.3	0	11.32	0	0
28.50	-33.92	6.97E-003	-10	-15	8	14.2	0	14.15	0	0
28.00	-30.44	6.93E-003	-19	-23	12	17.0	0	16.98	0	0
27.50	-26.99	6.85E-003	-32	-29	14	14.6	0	14.64	0	0
27.00	-23.60	6.72E-003	-48	-37	17	19.0	0	18.95	0	0
26.50	-20.29	6.52E-003	-69	-48	21	23.3	0	23.26	0	0
26.00	-17.09	6.25E-003	-96	-61	25	27.6	0	27.57	0	0
25.50	-14.05	5.89E-003	-127	-81	27	6.2	21.36	27.57	0	0
25.00	-11.22	5.42E-003	-157	-58	28	-11.6	47.79	36.19	0	0
24.50	0	4.85E-003	-184	-50	29	-20.5	61.01	40.50	0	0
24.00	0	4.21E-003	-206	-37	29	-29.4	74.22	44.81	0	0
23.50	0	3.51E-003	-221	-20	28	-38.3	87.44	49.12	0	0
23.00	0	2.77E-003	-226	0.98	27	-47.2	100.65	53.43	0	0
22.50	0	2.03E-003	-219	27	25	-56.1	113.87	57.74	0	0
22.00	0	1.34E-003	-198	56	22	-60.6	120.48	59.90	5.00	5.00
21.50	0	7.43E-004	-163	87	19	-65.0	127.08	62.05	10.00	10.00
21.00	0	2.89E-004	-111	121	16	-69.5	133.69	64.21	15.00	15.00
20.50	0	3.43E-005	-41	157	13	-73.9	140.30	66.36	20.00	20.00
20.25	0	0.00	0	0	11	-76.1	143.58	67.43	22.48	22.48

Figure 7. Results tab (table)

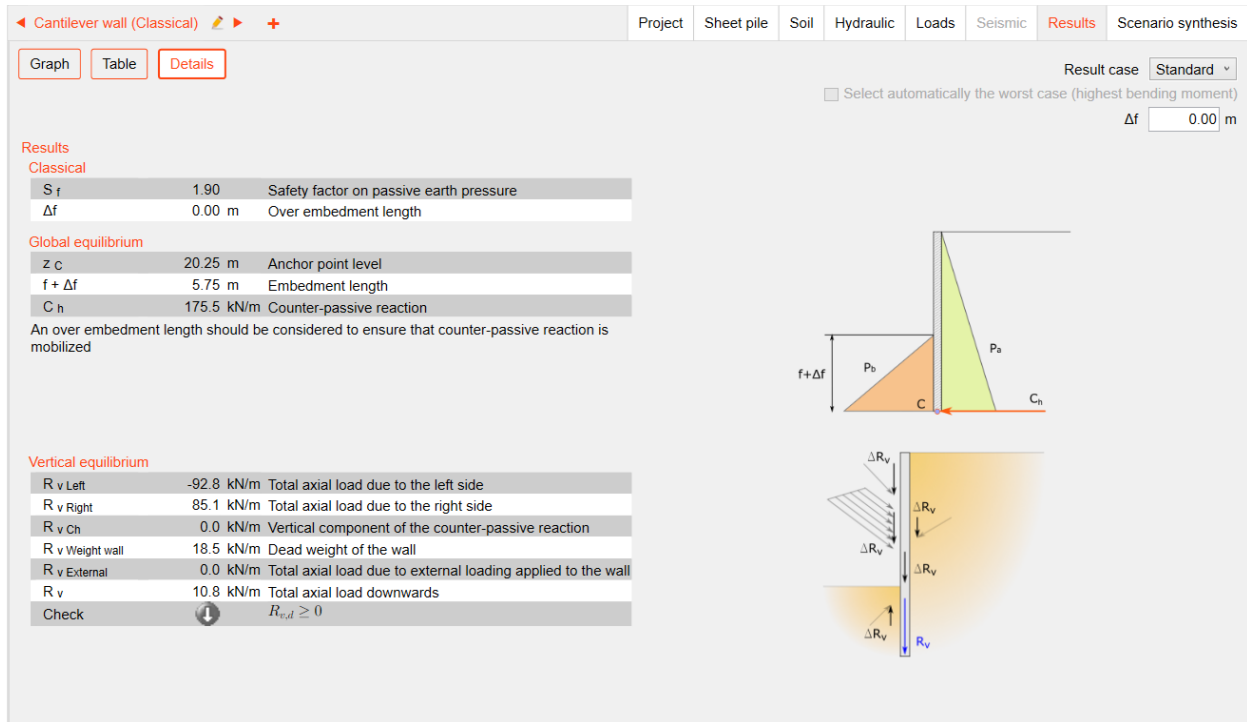


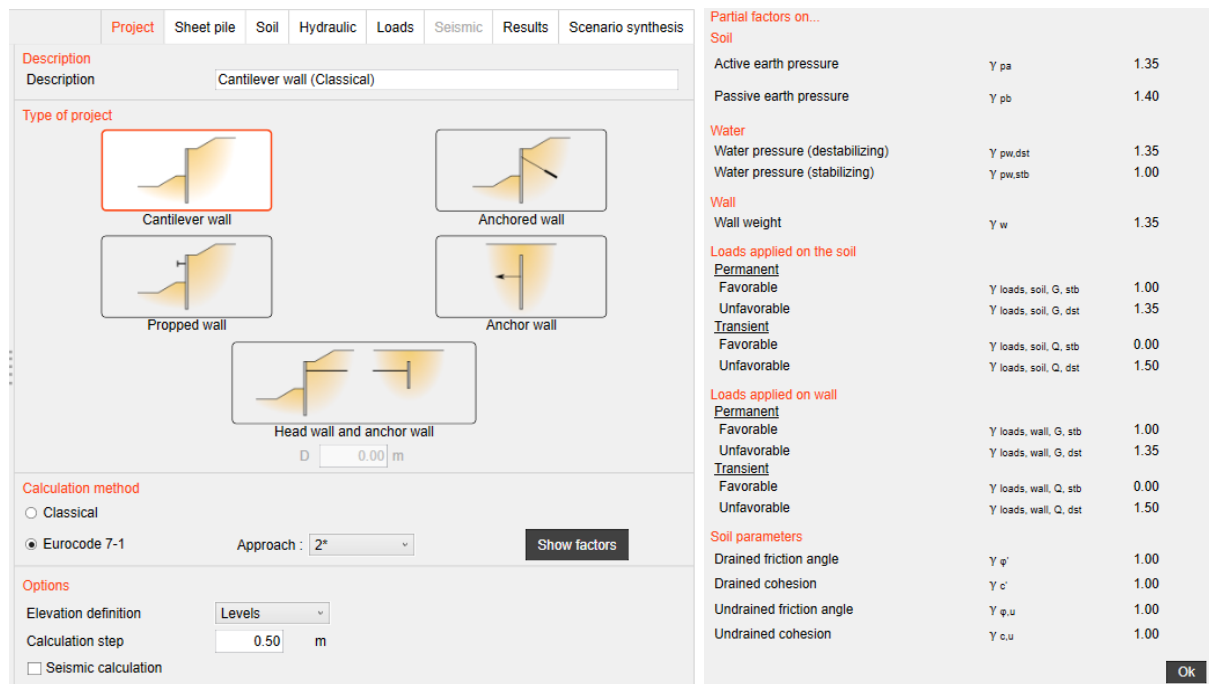
Figure 8. Results tab (details)

Required embedment to ensure global wall equilibrium with global safety on passive earth pressure equal to 1.90 is 5.75 m, that is bottom level at 20.25 m. Required counter-passive earth reaction is 175.5 kN/m to ensure global equilibrium. An overlength should be considered to ensure that counter-passive reaction is mobilized.

Finally, vertical resultant force is downwards (positive value) so vertical equilibrium is coherent. Bearing capacity has to be checked with 10.8 kN/m at the bottom level of the sheet pile wall.

### 1.3. Eurocode method

Prosheets allows to switch quickly from one calculation method to another one. Please, choose Eurocode method in the Project tab and take a look to the partial factors set for Approach 2\*



Partial factors on...		
<b>Soil</b>		
Active earth pressure	$\gamma_{pa}$	1.35
Passive earth pressure	$\gamma_{pb}$	1.40
<b>Water</b>		
Water pressure (destabilizing)	$\gamma_{pw,dst}$	1.35
Water pressure (stabilizing)	$\gamma_{pw,stab}$	1.00
<b>Wall</b>		
Wall weight	$\gamma_w$	1.35
<b>Loads applied on the soil</b>		
<u>Permanent</u>		
Favorable	$\gamma_{loads, soil, G, stb}$	1.00
Unfavorable	$\gamma_{loads, soil, G, dst}$	1.35
<u>Transient</u>		
Favorable	$\gamma_{loads, soil, Q, stb}$	0.00
Unfavorable	$\gamma_{loads, soil, Q, dst}$	1.50
<b>Loads applied on wall</b>		
<u>Permanent</u>		
Favorable	$\gamma_{loads, wall, G, stb}$	1.00
Unfavorable	$\gamma_{loads, wall, G, dst}$	1.35
<u>Transient</u>		
Favorable	$\gamma_{loads, wall, Q, stb}$	0.00
Unfavorable	$\gamma_{loads, wall, Q, dst}$	1.50
<b>Soil parameters</b>		
Drained friction angle	$\gamma_{\varphi'}$	1.00
Drained cohesion	$\gamma_{c'}$	1.00
Undrained friction angle	$\gamma_{\varphi_u}$	1.00
Undrained cohesion	$\gamma_{c_u}$	1.00

Figure 9. Sheet pile tab and partial factors for Approach 2\*

Results are immediately available in Results tab in ULS and SLS.

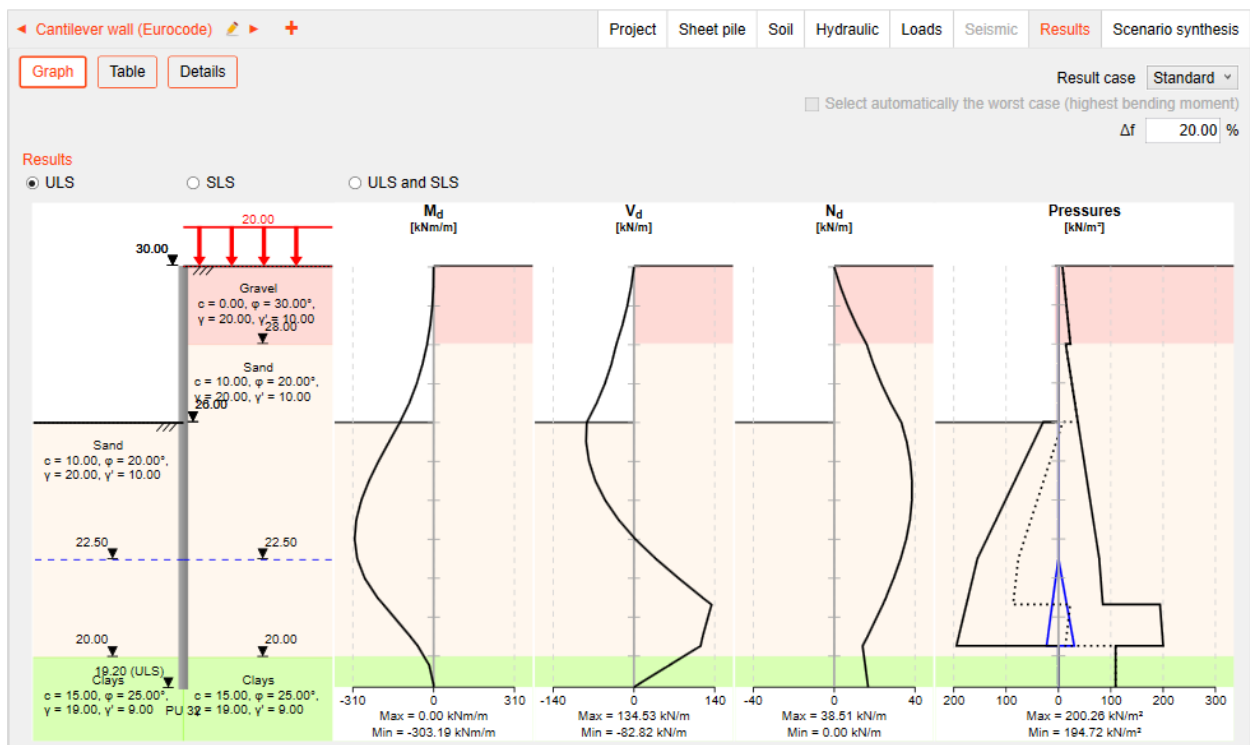


Figure 10. Results tab (ULS results graphs)

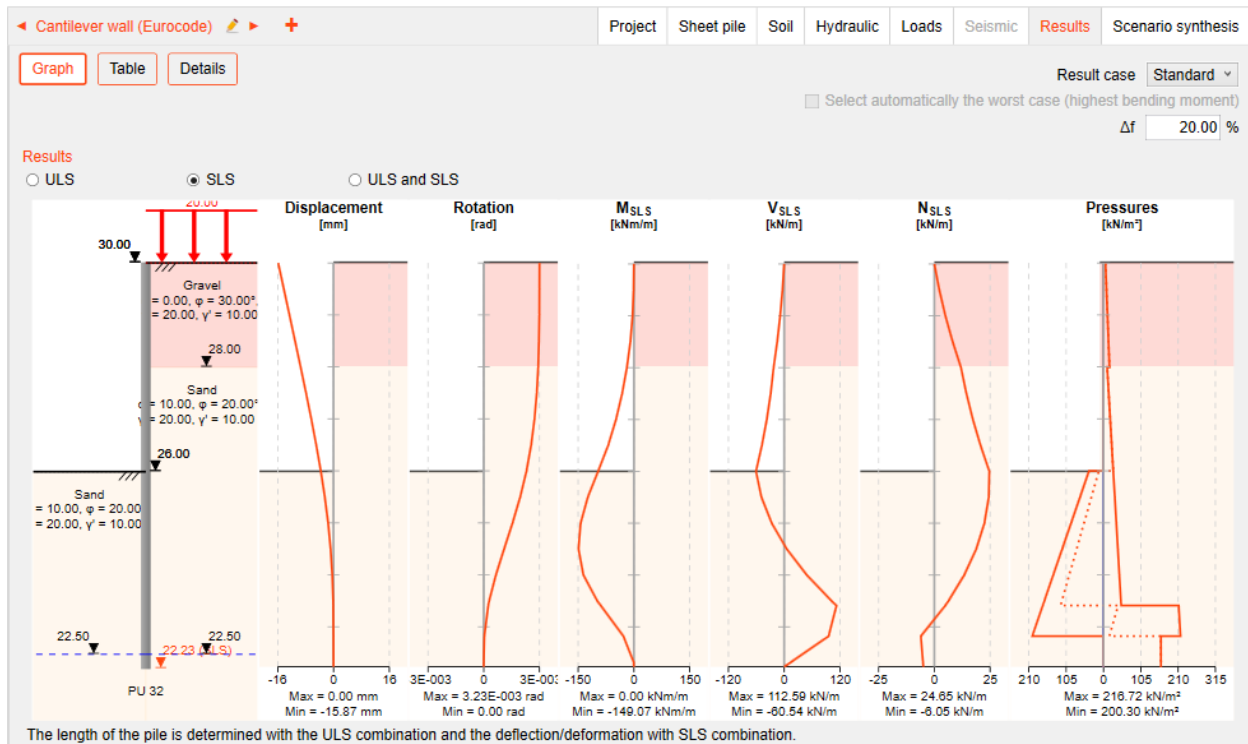


Figure 11. Results tab (SLS results graph)

According to Eurocode 7-1, embedment is calculated from ULS calculation considering partial factors, active and passive earth pressure. Eurocode 7-1 (NF P94-282) requires to check embedment length and counter-passive reaction). An overlength of  $\Delta f = 20\%$  of the embedment length has been considered to ensure the mobilization of the counter-passive earth pressure

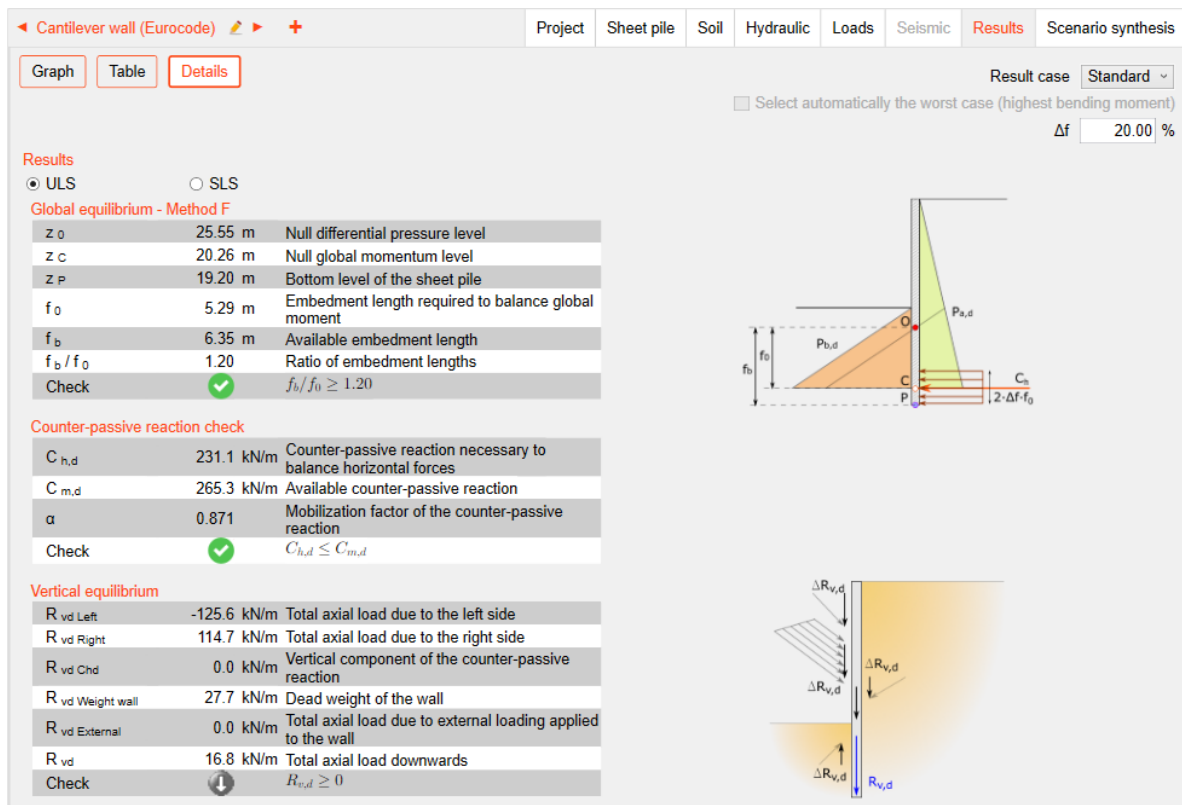


Figure 12. Results tab (ULS Details)



## 2. Anchored wall

### 2.1. Description

This example shows an anchored wall in a multilayer soil. An excavation is planned on the front side of the wall over a height of 12.0 m. Top level of the sheet pile is considered at 30.0 m, so excavation level is at 18.0 m. The water table is assumed to be very deep in relation to the project. Uniform permanent load (20 kPa) must be considered at the top level of the back side. AZ 32-750 section has been chosen in the design.

Anchors level is at 25.0 m, inclined of 30° with 10.0 m of free length and 7.0 m of embedment length.

Calculation will be done according to Classical method considering a fixed earth support. In this case, Prosheets ensures global equilibrium horizontal forces as well as global momentum equilibrium using Blum assumption, which consists of to assume that null differential pressure level matches with null bending moment level.

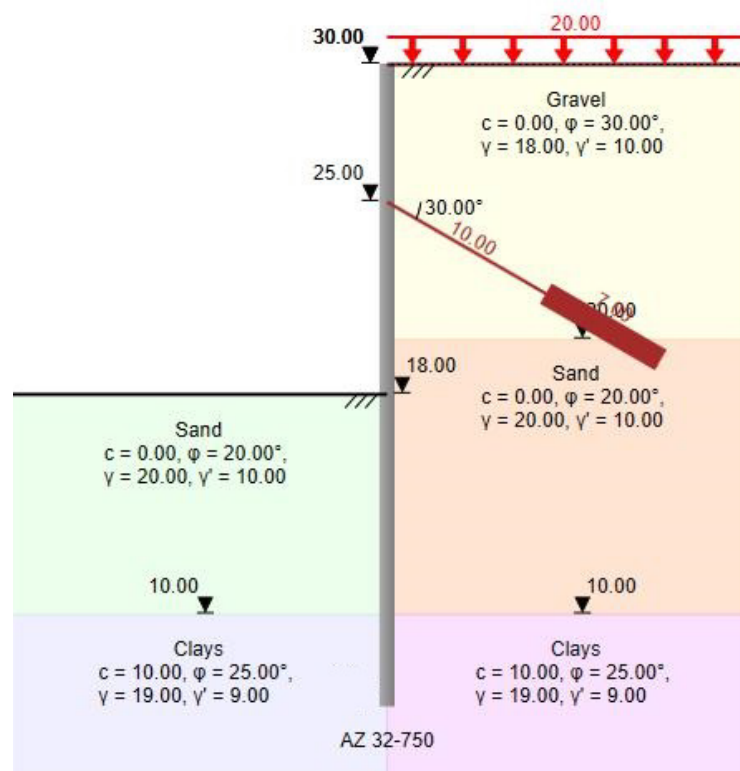


Figure 13. Cross-section

## 2.2. Classical method

Project Sheet pile Soil Hydraulic Loads Seismic Results Scenario synthesis

Description

Description

Type of project

Cantilever wall

Anchored wall

Propped wall

Anchor wall

Head wall and anchor wall

D 0.00 m

Calculation method

Classical

Eurocode 7-1

Show factors

Options

Elevation definition Levels

Calculation step 0.50 m

Seismic calculation

Project Sheet pile Soil Hydraulic Loads Seismic Results Scenario synthesis

Head wall

Sheet pile section

Type All

Name AZ 32-750

Sort by Catalogue

Solution 12

HZM Section HZ 680M LT

L HZM/AZ 100.00 %

Sort by Catalogue

Geometry

Z top 30.00 m

$\lambda$  0.00 °

Earth support

Free earth support

Fixed earth support

Active anchor

Z 25.00 m

$\alpha$  30.00 °

L Free 10.00 m

L Embedded 7.00 m

Figure 14. Project tab (left) and sheet pile tab (right)

In this project, we aim for a global safety on passive earth pressure of at least 1.50.

Factors

Factors on...

Soil

Passive earth pressure

$S_{f, min}$

1.50

Ok

Figure 15. Project tab and global safety factor on passive earth pressure

Soil definition is given on the following figure:

Project Sheet pile **Soil** Hydraulic Loads Seismic Results Scenario synthesis

Head wall

Natural ground level (NGL)

**Front**

☒ Horizontal

☐ Inclined  $Z_0$  18.00 m

☐ Berm

**Back**

☒ Horizontal

☐ Inclined  $Z_0$  30.00 m

☐ Embankment

**Soil layers**

$k_{ay}, k_{py}, k_{ac}, k_{pc}$  : ☒ Automatic (Kerisel-Absi tables) ☐ Custom

**Front**

	$Z_{top}$ [m]	Name	Color	$Y$ [kN/m <sup>2</sup> ]	$Y'$ [kN/m <sup>2</sup> ]	$C_k$ [kN/m <sup>2</sup> ]	$C_d$ [kN/m <sup>2</sup> ]	$\varphi_k$ [°]	$\varphi_d$ [°]	$\delta p / \varphi$	$k_{py}, k$	$k_{pc}, k$	Drained
x	30.00	Gravel		18.00	10.00	0.00	0.00	30.00	30.00	-0.330	3.932	4.985	<input checked="" type="checkbox"/>
x	20.00	Sand		20.00	10.00	0.00	0.00	20.00	20.00	-0.330	2.381	3.699	<input checked="" type="checkbox"/>
x	10.00	Clays		19.00	9.00	10.00	10.00	25.00	25.00	-0.330	3.062	4.264	<input checked="" type="checkbox"/>

**Back**

	$Z_{top}$ [m]	Name	Color	$Y$ [kN/m <sup>2</sup> ]	$Y'$ [kN/m <sup>2</sup> ]	$C_k$ [kN/m <sup>2</sup> ]	$C_d$ [kN/m <sup>2</sup> ]	$\varphi_k$ [°]	$\varphi_d$ [°]	$\delta a / \varphi$	$k_{ay}, k$	$k_{ac}, k$	$k_{ay,min}$	$\delta p / \varphi$	$k_{py}, k$	$k_{pc}, k$	Drained
x	30.00	Gravel		18.00	10.00	0.00	0.00	30.00	30.00	0.660	0.283	1.237	0.000	-0.660	4.959	6.271	<input checked="" type="checkbox"/>
x	20.00	Sand		20.00	10.00	0.00	0.00	20.00	20.00	0.660	0.431	1.553	0.000	-0.660	2.669	4.337	<input checked="" type="checkbox"/>
x	10.00	Clays		19.00	9.00	10.00	10.00	25.00	25.00	0.660	0.349	1.387	0.000	-0.660	3.536	5.160	<input checked="" type="checkbox"/>

Soil database

Figure 16. Soil tab

Loads definition is given in the following figure:

Project Sheet pile Soil Hydraulic **Loads** Seismic Results Scenario synthesis

Head wall

Loads on the soil

Caquot ?

Side	$q$ [kN/m <sup>2</sup> ]
Front	0.00
Back	20.00

Figure 17. Loads tab

Results tab provides all results we need, in particular:

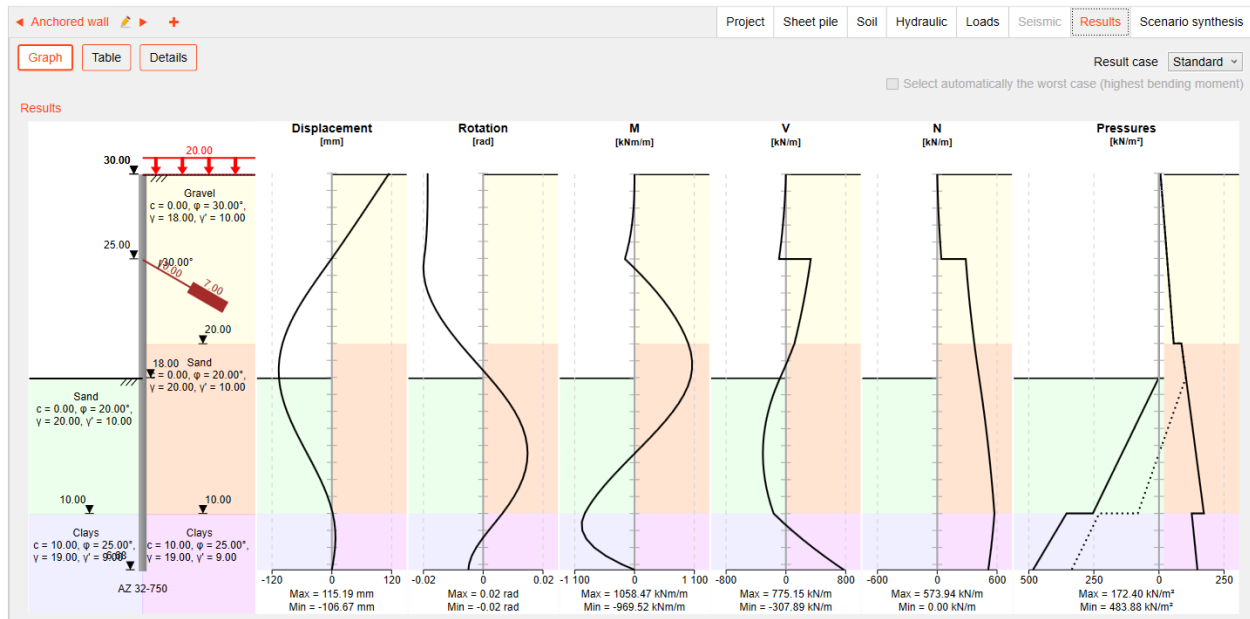


Figure 18. Results tab (graph)

z [m]	Displacement [mm]	Rotation [rad]	M [kNm/m]	V [kN/m]	N [kN/m]	Differential pressure [kN/m²]	Passive earth pressure Left [kN/m²]	Active earth pressure Right [kN/m²]	Water pressure Left [kN/m²]	Water pressure Right [kN/m²]
30.00	115.19	-0.02	0	0	0	5.7	0	5.66	0	0
29.50	103.83	-0.02	0	0	2	8.2	0	8.21	0	0
29.00	92.47	-0.02	-4	-8	5	10.8	0	10.75	0	0
28.50	81.11	-0.02	-9	-14	7	13.3	0	13.30	0	0
28.00	69.73	-0.02	-18	-22	11	15.8	0	15.85	0	0
27.50	58.33	-0.02	-31	-30	15	18.4	0	18.40	0	0
27.00	46.88	-0.02	-48	-40	19	20.9	0	20.94	0	0
26.50	35.36	-0.02	-71	-51	24	23.5	0	23.49	0	0
26.00	23.74	-0.02	-100	-63	29	26.0	0	26.04	0	0
25.50	11.97	-0.02	-135	-77	35	28.6	0	28.58	0	0
25.00	0	-0.02	-177	-92	41	31.1	0	31.13	0	0
25.00	0	-0.02	-177	332	286	31.1	0	31.13	0	0
24.50	-12.17	-0.02	-15	316	293	33.7	0	33.68	0	0
24.00	-24.37	-0.02	139	299	300	36.2	0	36.22	0	0
23.50	-36.36	-0.02	284	280	307	38.8	0	38.77	0	0
23.00	-47.95	-0.02	419	260	315	41.3	0	41.32	0	0
22.50	-58.92	-0.02	544	239	324	43.9	0	43.87	0	0
22.00	-69.11	-0.02	657	216	332	46.4	0	46.41	0	0
21.50	-78.34	-0.02	759	192	342	49.0	0	48.96	0	0
21.00	-86.46	-0.02	849	167	352	51.5	0	51.51	0	0
20.50	-93.35	-0.01	926	141	362	54.1	0	54.05	0	0
20.00	-98.90	-9.68E-003	990	113	373	56.6	0	56.60	0	0
20.00	-98.90	-9.68E-003	990	113	373	86.2	0	86.20	0	0
19.50	-103.00	-6.72E-003	1 036	69	384	90.5	0	90.51	0	0
19.00	-105.60	-3.67E-003	1 058	23	395	94.8	0	94.82	0	0
18.50	-106.67	-5.85E-004	1 058	-26	408	99.1	0	99.13	0	0
18.00	-106.19	2.46E-003	1 032	-77	420	103.4	0	103.44	0	0
17.50	-104.22	5.40E-003	981	-125	433	91.9	15.87	107.75	0	0

Figure 19. Results tab (table)

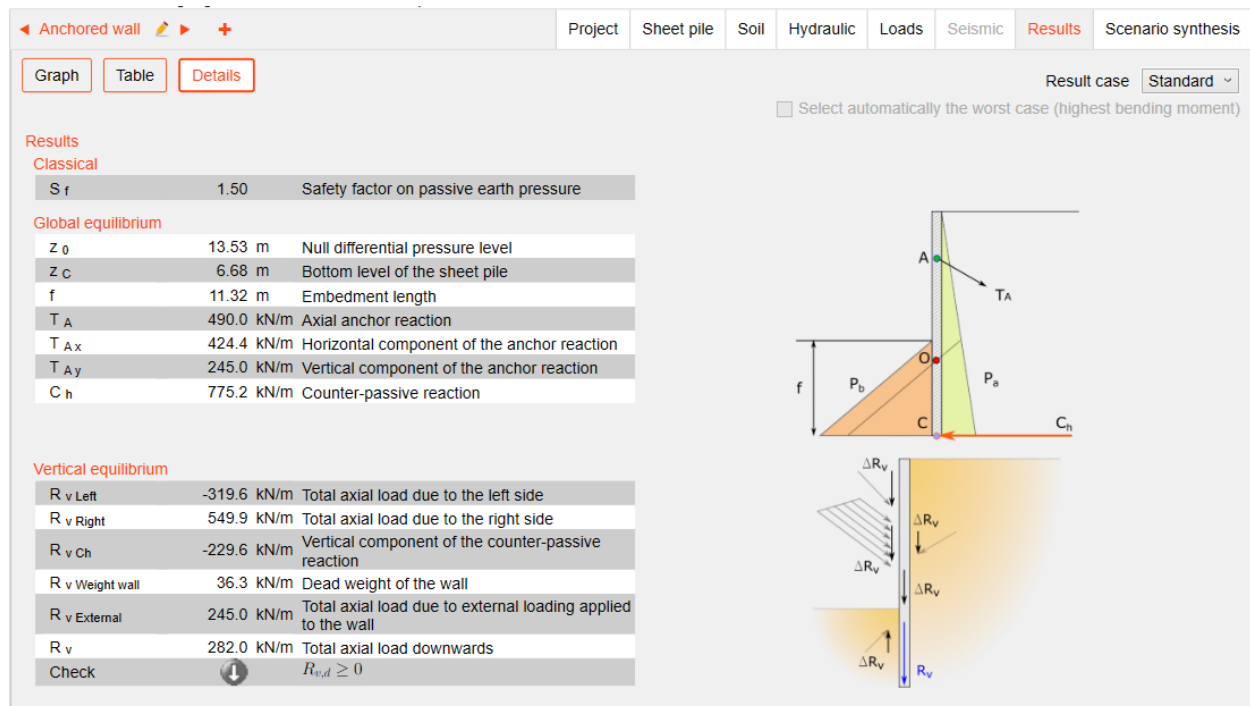


Figure 20. Results tab (details)

Null differential pressure level and null bending level is  $z=13.53\text{m}$  (Blum's assumption).

Required embedment to ensure global wall equilibrium with global safety on passive earth pressure equal to 1.50 is 11.32 m, that is bottom level at  $z = 6.68\text{ m}$ . Required counter-passive earth reaction is 775.2 kN/m to ensure global equilibrium. An overlength should be considered to ensure that counter-passive reaction is mobilized.

Finally, vertical resultant force is downwards (positive value) so vertical equilibrium is coherent. Bearing capacity has to be checked with 282.0 kN/m at the bottom level of the sheet pile wall.

### 3. Head wall and anchor wall system

#### 3.1. Description

This example shows a head wall and anchor wall system in a multilayer soil. An excavation is planned on the front side of the wall over a height of 16.0 m. Top level of the sheet pile is considered at 30.0 m, so excavation level is at 14.0 m. The water table is assumed to be very deep in relation to the project. Uniform permanent load (20 kPa) must be taken into account only at the top level of the head wall back side. AZ 52-700 section has been chosen in the design for the head wall and AZ 32-750 for the anchor wall, separated by 21 m. The tie rods are inclined between levels 26.0 m (at the head wall) and 25.0 m (at the anchor wall).

Calculation will be done according to Eurocode method (approach 2\*) considering a free earth support for the head wall as well as anchor wall.

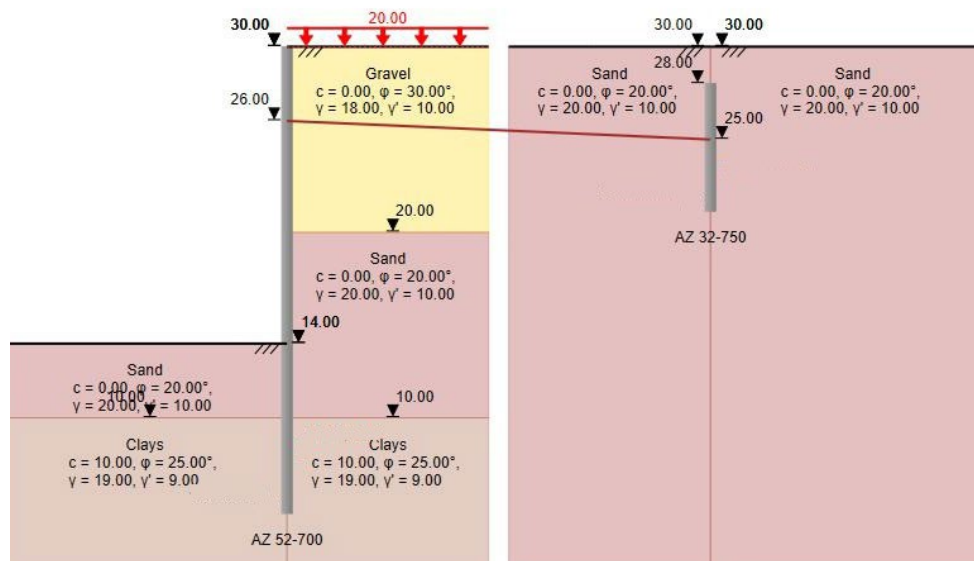


Figure 21. Cross section

### 3.2. Eurocode method

Project	Sheet pile	Soil	Hydraulic	Loads	Seismic	Results	Scenario synthesis
<b>Description</b> Description: <input type="text"/>							
<b>Type of project</b> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%; text-align: center;">             Cantilever wall         </div> <div style="width: 50%; text-align: center;">             Anchored wall         </div> <div style="width: 50%; text-align: center;">             Propped wall         </div> <div style="width: 50%; text-align: center;">             Anchor wall         </div> <div style="width: 100%; text-align: center; border: 2px solid red; padding: 5px;">             Head wall and anchor wall            D: 21.00 m         </div> </div>							
<b>Calculation method</b> <input type="radio"/> Classical <input checked="" type="radio"/> Eurocode 7-1    Approach: 2* <span>Show factors</span>							
<b>Options</b> Elevation definition: Levels Calculation step: 0.50 m <input type="checkbox"/> Seismic calculation							
<b>Partial factors on...</b> <input checked="" type="checkbox"/> Distinguish between the stabilizing and destabilizing parts of the active earth and water pressure diagrams							
<b>Soil</b> Active earth pressure (destabilizing) $\gamma_{pa.dst}$ 1.35 Active earth pressure (stabilizing) $\gamma_{pa.stb}$ 1.00 Passive earth pressure $\gamma_{pb}$ 1.40							
<b>Water</b> Water pressure (destabilizing) $\gamma_{pw.dst}$ 1.35 Water pressure (stabilizing) $\gamma_{pw.stb}$ 1.00							
<b>Wall</b> Wall weight $\gamma_w$ 1.35							
<b>Loads applied on the soil</b> <b>Permanent</b> Favorable $\gamma_{loads, soil, G, stb}$ 1.00 Unfavorable $\gamma_{loads, soil, G, dst}$ 1.35 <b>Transient</b> Favorable $\gamma_{loads, soil, Q, stb}$ 0.00 Unfavorable $\gamma_{loads, soil, Q, dst}$ 1.50							
<b>Loads applied on wall</b> <b>Permanent</b> Favorable $\gamma_{loads, wall, G, stb}$ 1.00 Unfavorable $\gamma_{loads, wall, G, dst}$ 1.35 <b>Transient</b> Favorable $\gamma_{loads, wall, Q, stb}$ 0.00 Unfavorable $\gamma_{loads, wall, Q, dst}$ 1.50							
<b>Soil parameters</b> Drained friction angle $\gamma_{\phi'}$ 1.00 Drained cohesion $\gamma_{c'}$ 1.00 Undrained friction angle $\gamma_{\phi_u}$ 1.00 Undrained cohesion $\gamma_{c_u}$ 1.00							
<b>Anchor</b> Anchor reaction $\gamma_{anc}$ 1.35 Destabilizing force on the anchor block (Kranz) $\gamma_{krz}$ 1.10							
<span>Ok</span>							

Figure 22. Project tab and partial safety factors

Project	Sheet pile	Soil	Hydraulic	Loads	Seismic	Results	Scenario synthesis
<b>Head wall</b> <b>Anchor wall</b>							
<b>Sheet pile section</b> Type: All    Solution: 12 Name: AZ 52-700    HZM Section: Sort by: Catalogue    L HZM/AZ: 100.00 % Sort by: Catalogue							
<b>Geometry</b> Z top: 30.00 m $\lambda$ : 0.00°							
<b>Tie-rods</b> Z head wall: 26.00 m Z anchor wall: 25.00 m L: 21.02 m $\alpha$ : 2.73°							
<b>Head wall</b> <b>Anchor wall</b>							
<b>Sheet pile section</b> Type: All    Solution: 12 Name: AZ 32-750    HZM Section: HZ 680M LT Sort by: Catalogue    L HZM/AZ: 100.00 % Sort by: Catalogue							
<b>Geometry</b> Z top: 28.00 m $\lambda$ : 0.00°							
<b>Earth support</b> <input checked="" type="radio"/> Free earth support <input type="radio"/> Fixed earth support							
<b>Tie-rods</b> Z head wall: 26.00 m Z anchor wall: 25.00 m L: 21.02 m $\alpha$ : 2.73°							

Figure 23. Sheet pile tab (head wall on the left and anchor wall on the right)

Project Sheet pile **Soil** Hydraulic Loads Seismic Results Scenario synthesis

Head wall Anchor wall

Natural ground level (NGL)

**Front**

☒ Horizontal  $Z_0$  14.00 m

☐ Inclined  $\Delta a$  0.00 m

☐ Berm

**Back**

☒ Horizontal  $Z_0$  30.00 m

☐ Inclined

☐ Embankment

**Soil layers**

$k_{ay}$ ,  $k_{py}$ ,  $k_{ac}$ ,  $k_{pc}$ : ☒ Automatic (Kerisel-Absi tables) ☐ Custom

**Front**

+	Z top [m]	Name	Color	Y [kN/m <sup>2</sup> ]	Y' [kN/m <sup>2</sup> ]	C <sub>k</sub> [kN/m <sup>2</sup> ]	C <sub>d</sub> [kN/m <sup>2</sup> ]	$\phi_k$ [°]	$\phi_d$ [°]	$\delta p / \phi$	$k_{py}$ , k	$k_{pc}$ , k	Drained
x	30.00	Gravel		20.00	10.00	0.00	0.00	30.00	30.00	-0.660	4.959	6.271	<input checked="" type="checkbox"/>
x	20.00	Sand		20.00	10.00	0.00	0.00	20.00	20.00	-0.660	2.669	4.337	<input checked="" type="checkbox"/>
x	10.00	Clays		19.00	9.00	10.00	10.00	25.00	25.00	-0.660	3.536	5.160	<input checked="" type="checkbox"/>

**Back**

+	Z top [m]	Name	Color	Y [kN/m <sup>2</sup> ]	Y' [kN/m <sup>2</sup> ]	C <sub>k</sub> [kN/m <sup>2</sup> ]	C <sub>d</sub> [kN/m <sup>2</sup> ]	$\phi_k$ [°]	$\phi_d$ [°]	$\delta a / \phi$	$k_{ay}$ , k	$k_{ac}$ , k	$k_{ay,min}$	$\delta p / \phi$	$k_{py}$ , k	$k_{pc}$ , k	Drained
x	30.00	Gravel		18.00	10.00	0.00	0.00	30.00	30.00	0.660	0.283	1.237	0.000	-0.660	4.959	6.271	<input checked="" type="checkbox"/>
x	20.00	Sand		20.00	10.00	0.00	0.00	20.00	20.00	0.660	0.431	1.553	0.000	-0.660	2.669	4.337	<input checked="" type="checkbox"/>
x	10.00	Clays		19.00	9.00	10.00	10.00	25.00	25.00	0.660	0.349	1.387	0.000	-0.660	3.536	5.160	<input checked="" type="checkbox"/>

Soil database

Figure 24. Soil tab (head wall)

Project Sheet pile **Soil** Hydraulic Loads Seismic Results Scenario synthesis

Head wall Anchor wall

Natural ground level (NGL)

**Front**

☒ Horizontal  $Z_0$  30.00 m

☐ Inclined  $\Delta a$  0.00 m

**Back**

☒ Horizontal  $Z_0$  30.00 m

☐ Inclined

**Soil layers**

$k_{ay}$ ,  $k_{py}$ ,  $k_{ac}$ ,  $k_{pc}$ : ☒ Automatic (Kerisel-Absi tables) ☐ Custom

**Front**

+	Z top [m]	Name	Color	Y [kN/m <sup>2</sup> ]	Y' [kN/m <sup>2</sup> ]	C <sub>k</sub> [kN/m <sup>2</sup> ]	C <sub>d</sub> [kN/m <sup>2</sup> ]	$\phi_k$ [°]	$\phi_d$ [°]	$\delta p / \phi$	$k_{py}$ , k	$k_{pc}$ , k	Drained
x	30.00	Sand		20.00	10.00	0.00	0.00	20.00	20.00	-0.330	2.381	3.699	<input checked="" type="checkbox"/>

**Back**

+	Z top [m]	Name	Color	Y [kN/m <sup>2</sup> ]	Y' [kN/m <sup>2</sup> ]	C <sub>k</sub> [kN/m <sup>2</sup> ]	C <sub>d</sub> [kN/m <sup>2</sup> ]	$\phi_k$ [°]	$\phi_d$ [°]	$\delta a / \phi$	$k_{ay}$ , k	$k_{ac}$ , k	$k_{ay,min}$	$\delta p / \phi$	$k_{py}$ , k	$k_{pc}$ , k	Drained
x	30.00	Sand		20.00	10.00	0.00	0.00	20.00	20.00	0.660	0.431	1.553	0.000	-0.660	2.669	4.337	<input checked="" type="checkbox"/>

Soil database

Figure 25. Soil tab (anchor wall)

Project Sheet pile Soil Hydraulic **Loads** Seismic Results Scenario synthesis

Head wall Anchor wall

Loads on the soil

Caquot

Side	q [kN/m <sup>2</sup> ]	Type	Nature
Front	0.00	Permanent	Favorable
Back	20.00	Permanent	Unfavorable

Figure 26. Loads tab



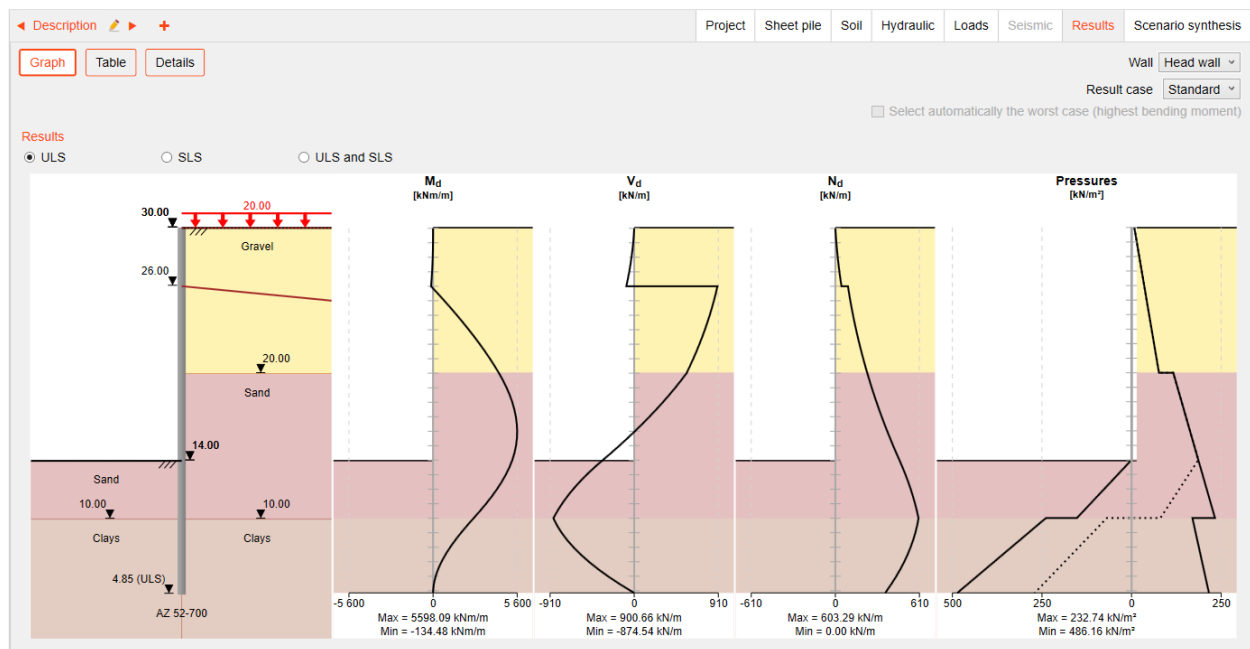


Figure 27. ULS results (graphs for head wall)



Figure 28. ULS results (graphs for anchor wall)

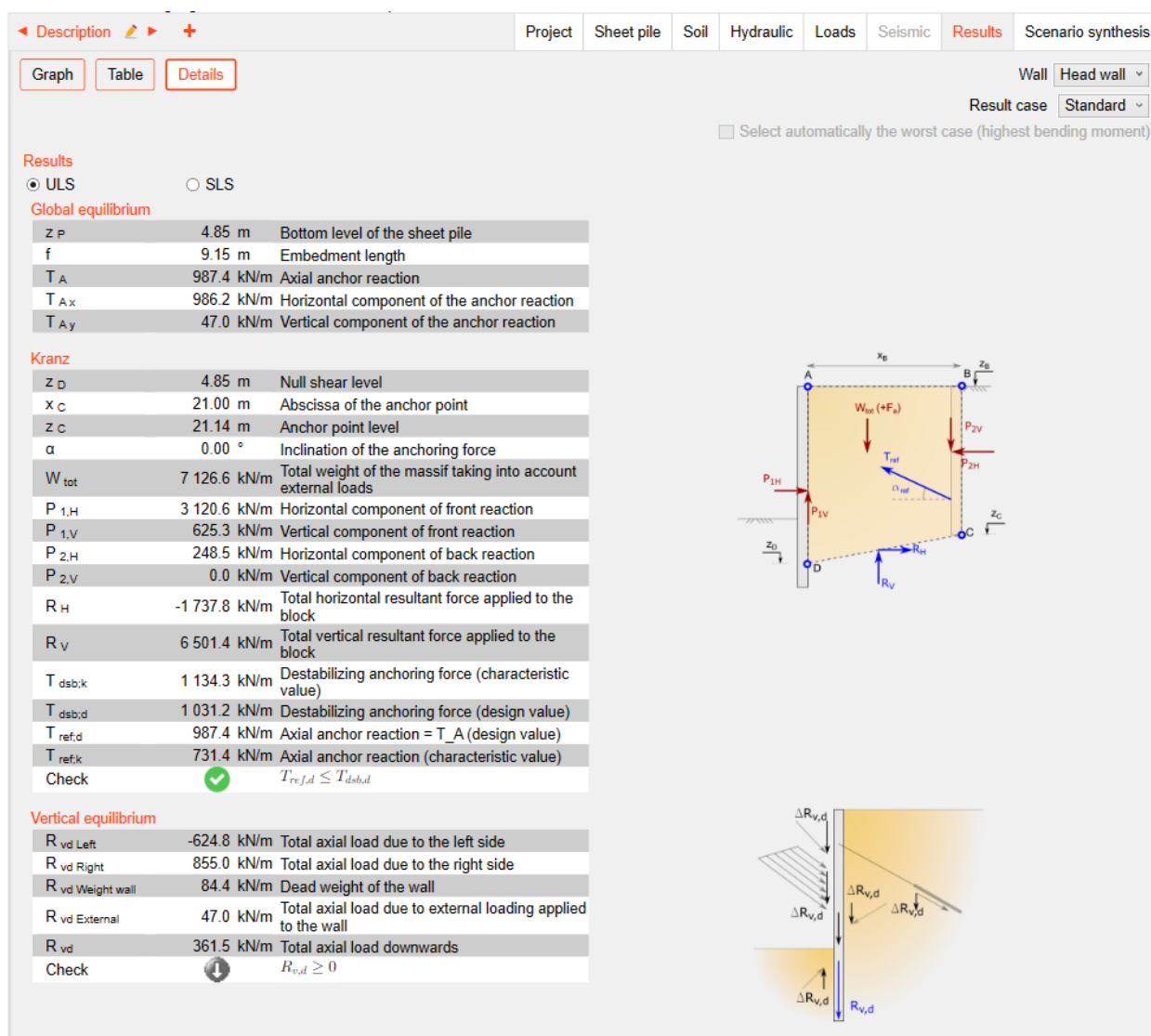


Figure 29. ULS results (details for head wall)

### Head wall

Required embedment to ensure global wall equilibrium is 9.15 m, that is bottom level at  $z = 4.85$  m. Anchor reaction is 987.4 kN/m (ULS design value).

According to Eurocode (NF P94-282), Prosheet has performed Kranz check automatically considered C level at the bottom level of the anchor wall. Reference effort (design value) is 987.4 kN/m (anchor reaction), which is less than 1031.2 kN/m (destabilizing effort, design value).

Finally, vertical resultant force is downwards (positive value) so vertical equilibrium is coherent. Bearing capacity must be checked with 361.5 kN/m at the bottom level of the sheet pile wall.

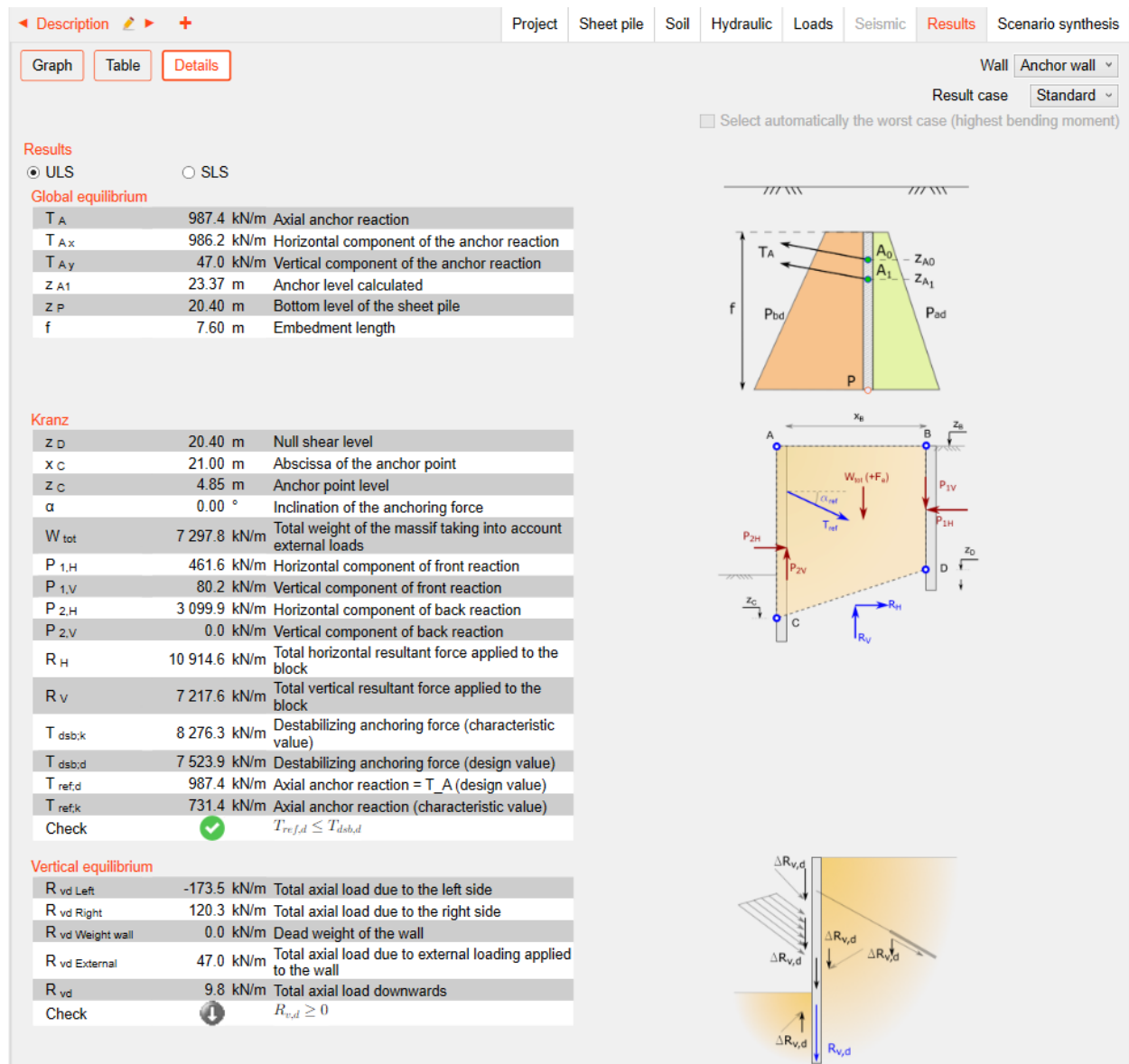


Figure 30. ULS results (details for anchor wall)

## Anchor wall

Input anchor reaction is 987.4 kN/m (ULS design value). Initially, anchor level was defined at 25.00 m. After calculation, anchor level has been recalculated to ensure momentum equilibrium, that is  $z_{A1} = 23.37$  m.

Required embedment to ensure global wall equilibrium is 7.60 m that is bottom level at  $z = 20.40$  m.

Finally, vertical resultant force is downwards (positive value) so vertical equilibrium is coherent. Bearing capacity must be checked with 9.8 kN/m at the bottom level of the sheet pile wall.