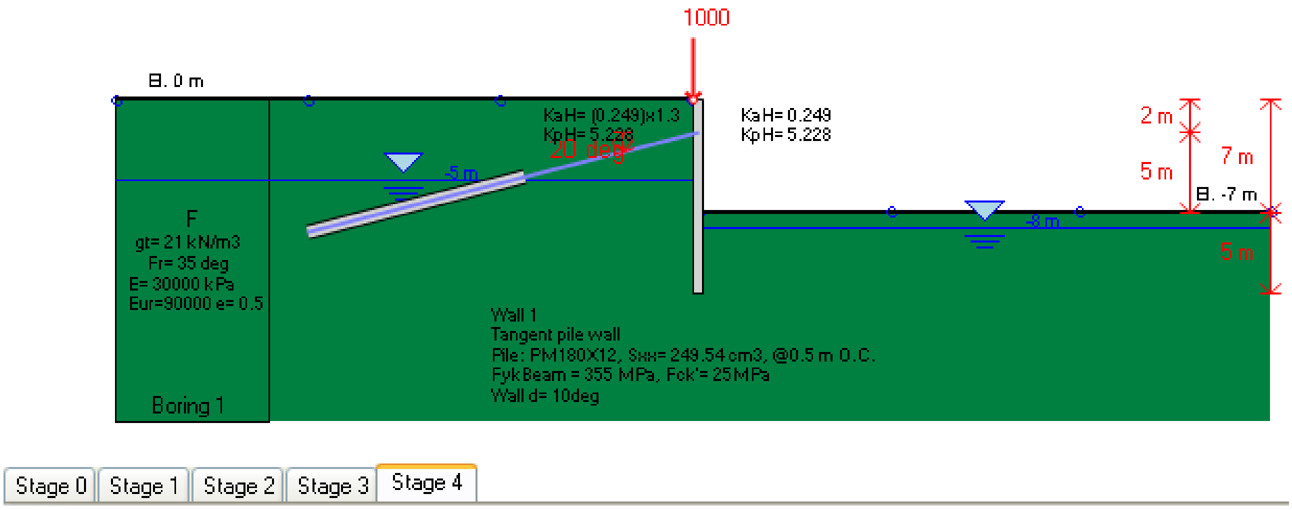
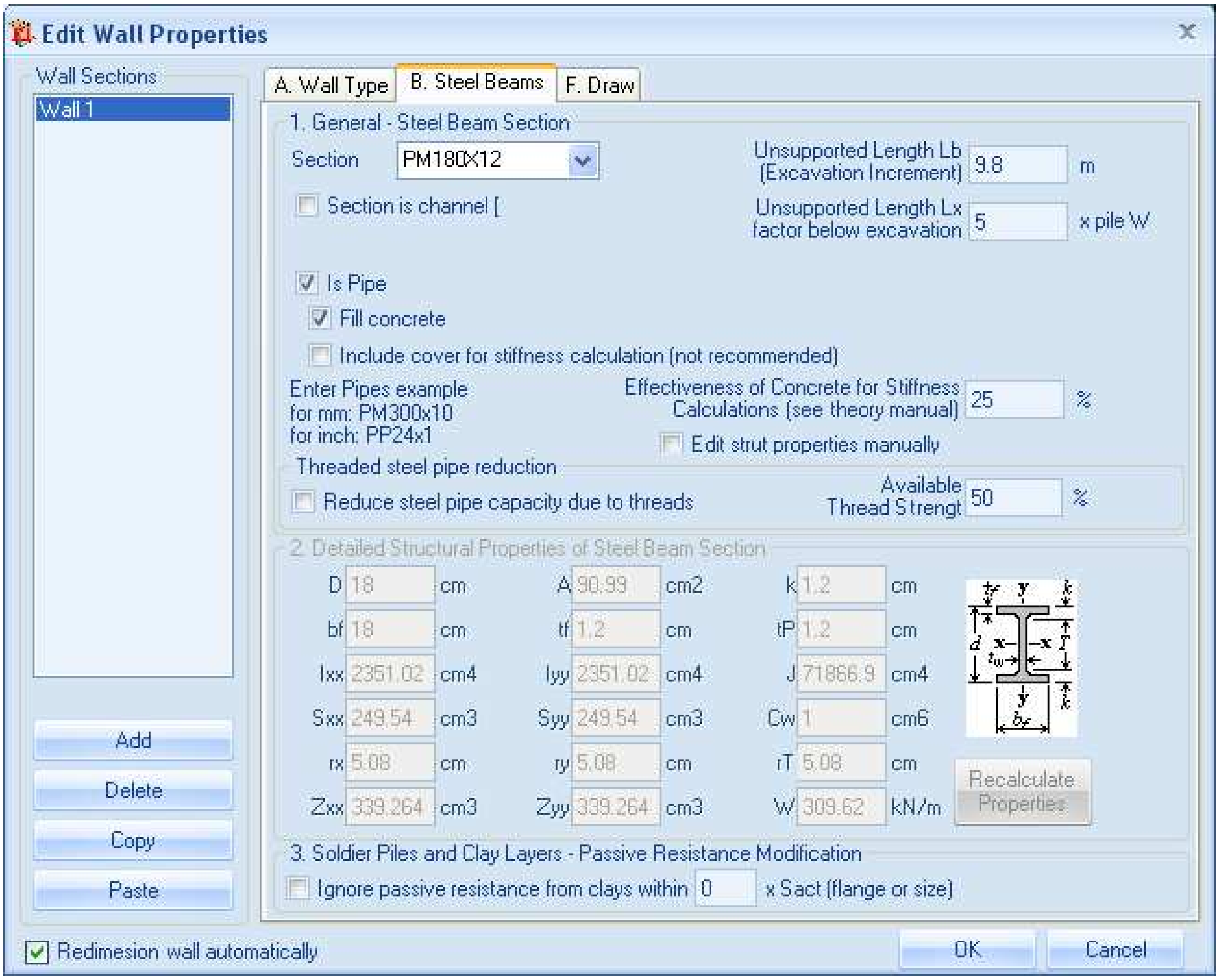
Tangent pile wall check in Paratie Plus



Consider the example shown in the window above.

It concerns a wall made up of pails featured this way:

- Section: 180 x 10 mm
- Material: Fe510
- Horizontal space: 0,5 m



Choosing to fill, or not, the pail with concrete and to include, or not, the cover for stiffness calculation affects the equivalent thickness calculation and, then, the structural analysis.

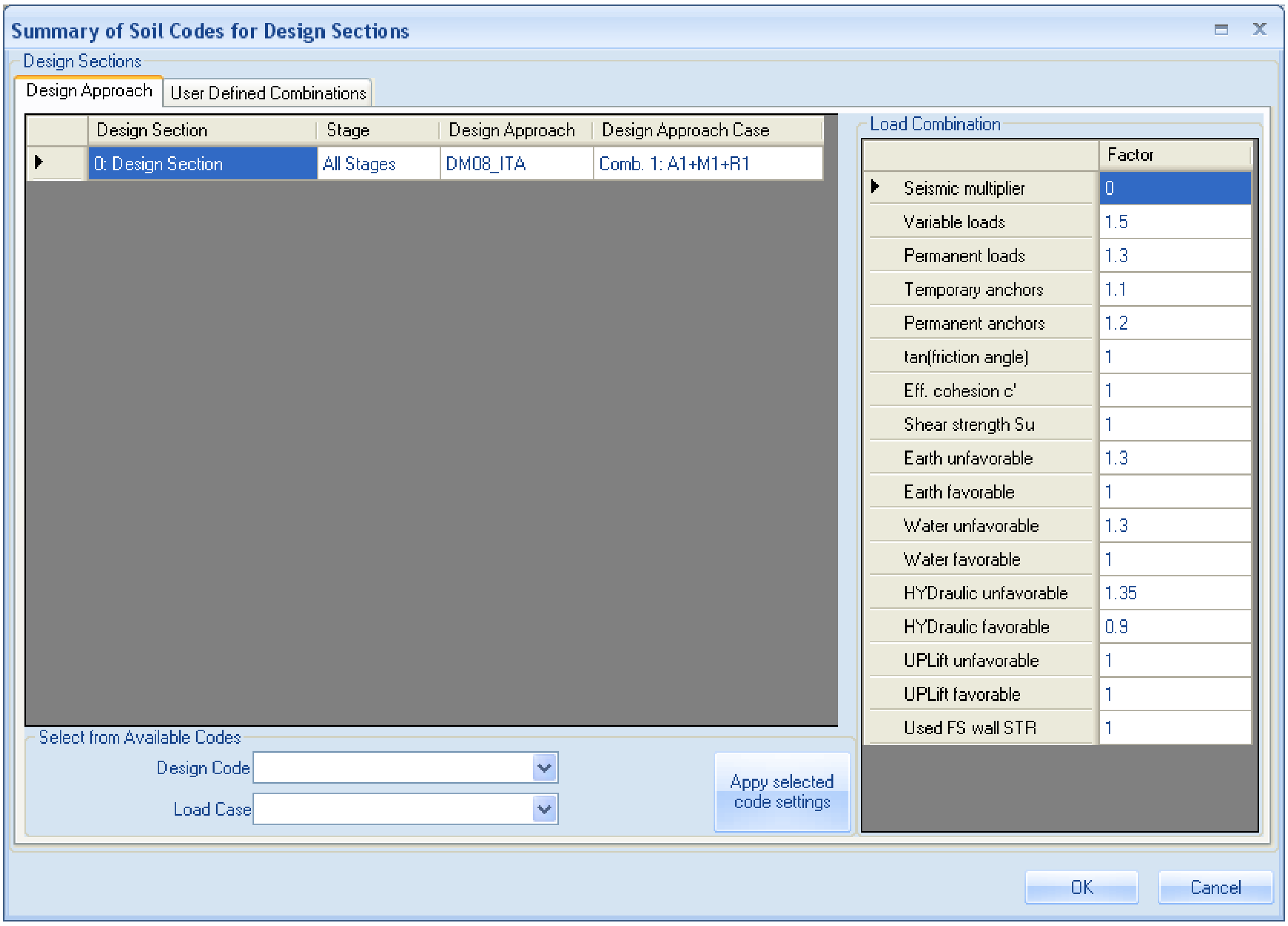
During the check *only* the pail is considered as resistant.

The Paratie Plus checker doesn't make SLS checks, but only ULS checks.

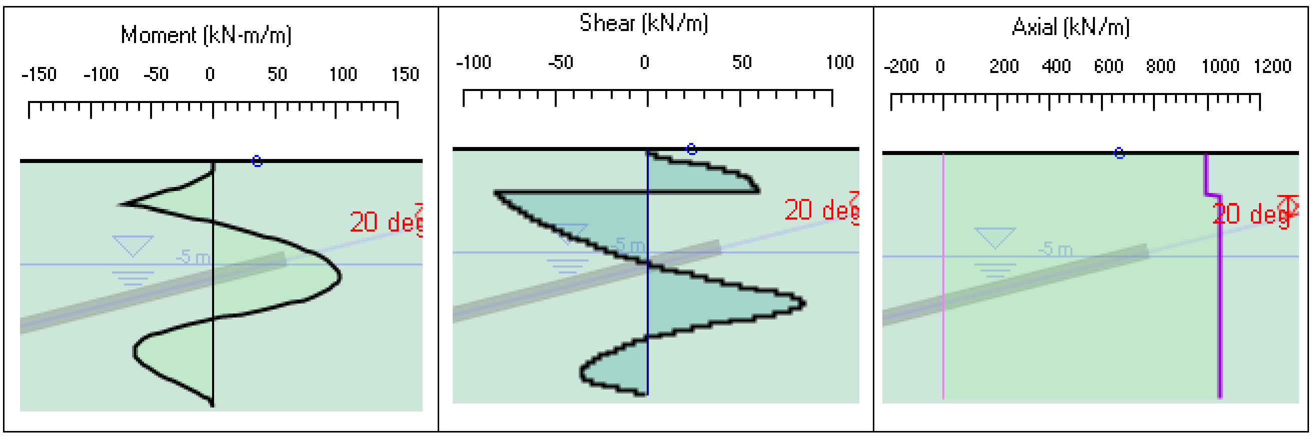
Checks are made up according to UNI EN 1993 1-1:2005.

If DM2008 under *Design/Structural design code* is selected, the Italian Code gamma safety coefficients are considered.

The model has been calculated according to the approach A1 + M1 + R1 (DM2008).



The following results are shown after the analysis:



- *Traction/Compression check*

The traction/compression check is made by the checker but can't be printed as output. The user can read it in the file .EXT (in the folder Documents/DeepXcavtemporaryfiles/steel).

In this extended file all the resistance checks, for each wall section and step, are reported.

Checks are made according to paragraph 6.2.4 of UNI EN 1993 1-1:2005.

The safety factors are concerning to DM2008 as written in the extended file:

EC3: CSTVEREC3 MODULE: START

****

Partial safety factors as used in this code

Gamma M0 = 1.050

Gamma M1 = 1.050

Gamma M2 = 1.250

Compression check:

Section no. 66 at x= 5501.000 [mm]

selected class for current cross section = 1

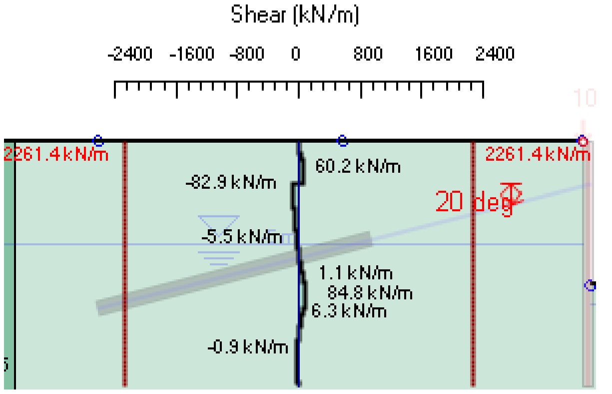
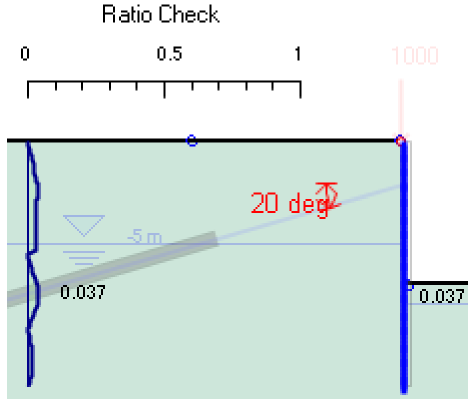
6.2.4 Compression for class 1 cross sections

Ratio =-526.3 / 2141. =0.2458

- *Shear check*

It's made according to paragraph 6.2.6 of UNI EN 1993 1-1:2005.

Results can be shown both as resistant shear and as STR, for each step.

SHEAR + CAP S. key	RAT S. key
	

The user can refer to the output file .EXT of the checker, in the foldere Douments/DeepXcavTemporaryFiles/steel.

6.2.6 Shear resistance check

Z direction : Shear Area Av = 4032. mm2

Vsd = -41.43 kN , VplRd = 787.0 kN, ratio = 0.5264E-01

- *Bending moment and bending moment/compression check*

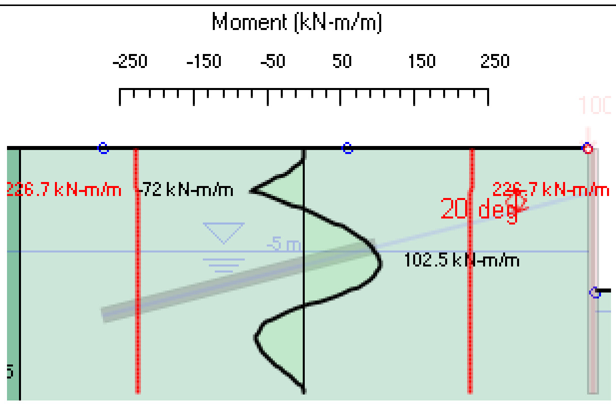
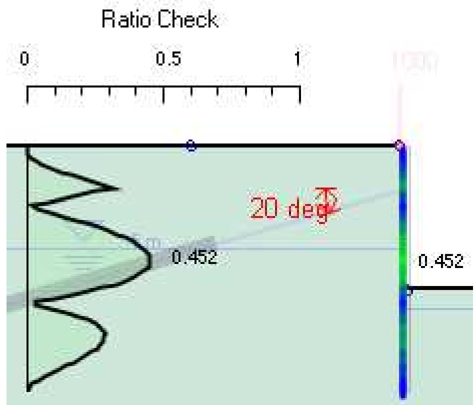
It's made according to paragraph 6.2.9 of UNI EN 1993 1-1:2005 (when there is also compression) or paragraph 6.2.5. when there is only bending moment.

The checker makes a classification of the section, as can be seen in the output file:

Section no. 66 at x= 5501.000 [mm]

selected class for current cross section = 1

Results can be shown both as resistant moment and as STR, for each step.

MOMENT + CAP M. key	RAT M. key
	

Besides, the maximum STR results for each stage are reported in the extended summary at the end of the analysis.

STR moment wall ratio corresponds to RAT.M value shown on the model.

Extended vs Stage

	Moment)	Wall Shear (kN/m)	Wall Shear (kN)	STR Combine Wall Ratio	STR Moment Wall Ratio	STR Shear Wall Ratio	Concrete Service Stress Wall Ratio FIC	Reinforcement Service Stress Ratio FIS	M Su Re (k
Stage 0		0	0	0	0	0	N/A	N/A	0
Stage 1		29.12	14.56	0.207	0.207	0.013	N/A	N/A	0
Stage 2		40.83	20.41	0.176	0.176	0.018	N/A	N/A	72
Stage 3		84.78	42.39	0.447	0.447	0.037	N/A	N/A	15
Stage 4		84.78	42.39	1.128	0.452	0.037	N/A	N/A	15

The user can refer to the output file .EXT in the folder Douments/DeepXcavTemporaryFiles/steel.

The following is an extract of the output file concerning the most bending-stressed element in the last stage.

6.2.9.1 Bending and axial force check for Class 1 and 2 sections

Shape type TUBO

Interaction between M and N is account for

(for notation see paragraph 6.2.9.1)

aw = 0.000 af = 0.000

alfa = 2.000 beta = 2.000

MVNyRd= 108.3 MVNzRd= 108.3 ratio= 0.4732 (eqn. 6.31)

- *Buckling check*

Buckling check in made according to paragraph 6.3.3. of UNI EN 1993 1-1:2005 (particularly formulas 6.61 and 6.62 concerning combined bending-compression buckling).

The paragraph 6.3.3 refers, in order to calculate some factors, to paragraphs 6.3.1; 6.3.2 and 6.2.9.3.

(4) Members which are subjected to combined bending and axial compression should satisfy:

$$\frac{N_{Ed}}{\frac{\chi_y N_{Rk}}{\gamma_{M1}}} + k_{yy}\frac{M_{y,Ed} + \Delta M_{y,Ed}}{\chi_{LT}\frac{M_{y,Rk}}{\gamma_{M1}}} + k_{yz}\frac{M_{z,Ed} + \Delta M_{z,Ed}}{\frac{M_{z,Rk}}{\gamma_{M1}}} \leq 1 \qquad (6.61)$$

$$\frac{N_{Ed}}{\frac{\chi_z N_{Rk}}{\gamma_{M1}}} + k_{zy}\frac{M_{y,Ed} + \Delta M_{y,Ed}}{\chi_{LT}\frac{M_{y,Rk}}{\gamma_{M1}}} + k_{zz}\frac{M_{z,Ed} + \Delta M_{z,Ed}}{\frac{M_{z,Rk}}{\gamma_{M1}}} \leq 1 \qquad (6.62)$$

To calculate the critical moment M_{cr} refer to appendix F of UNI EN 1993 1-1: 1992.

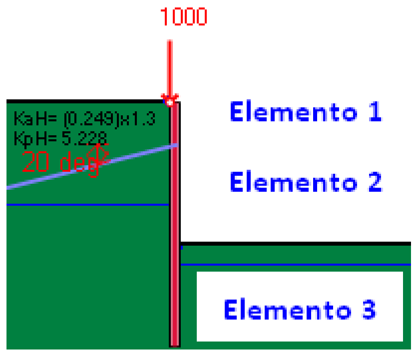
The pile is divided into elements by te checker; the presence of supports, the elevetion of excavation and the bottom elevation of the wall are gathered.

Under the elevation of excavation, in order to simulate the hydraulic heave, the wall is divided into smaller elements.

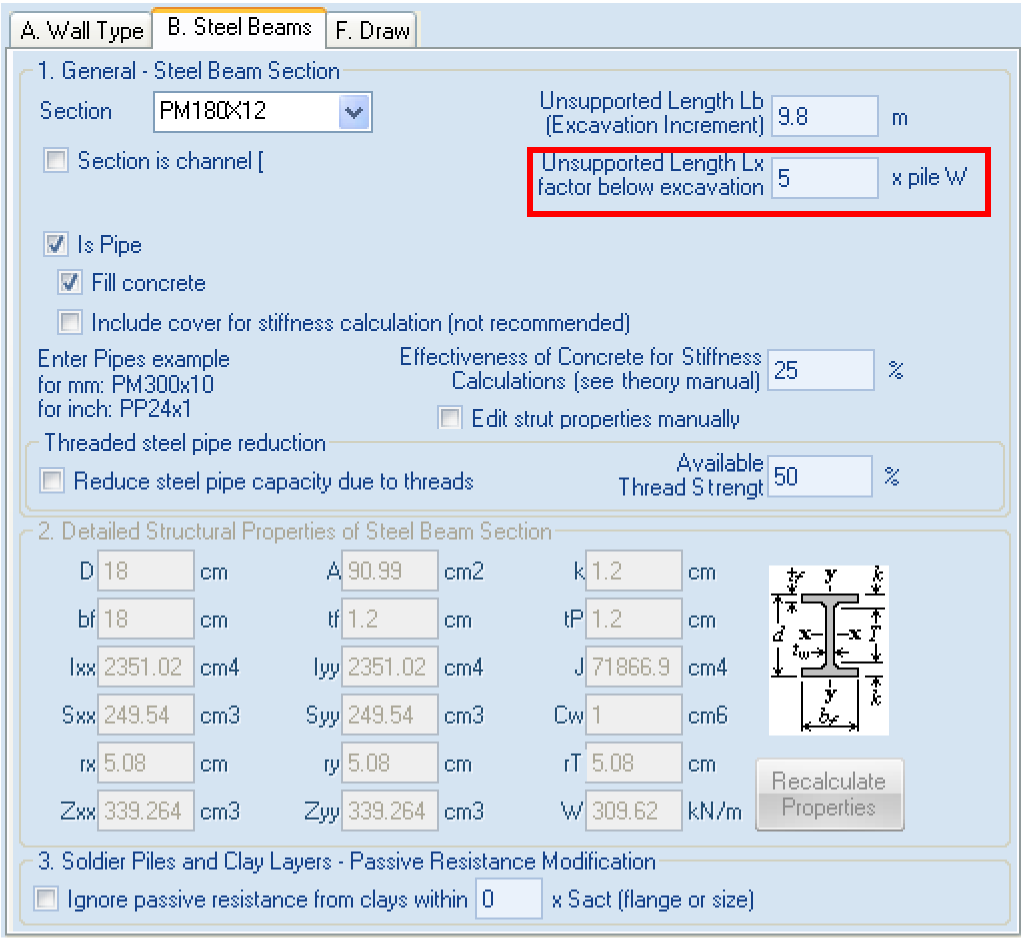
In the current model, then, the checker gathers:

	From elevation	To elevation	Beta

elemento 1	Surface	Tieback application	2
elemento 2	Tieback application	Excavation depht	1
elemento 3	Excavation depht	Wall bottom	little

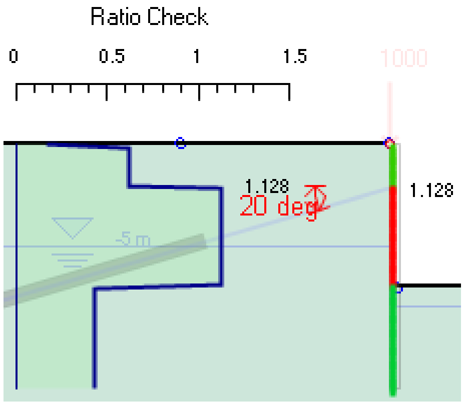


In Paratie Plus it’s possible to simulate the situation when the excavation depth support forms a bit lower than the excavation depth .



The default value is 5 time the total wall width. In this case the total width is like the boring diameter.

The buckling check results can be shown both using the COMB. Key and in the extended summary at the end of the analysis, for each excavation stage.



Extended vs Stage

	nt	Wall Shear (kN/m)	Wall Shear (kN)	STR Combine Wall Ratio	STR Moment Wall Ratio	STR Shear Wall Ratio	Concrete Service Stress Wall Ratio FIC	Reinforcement Service Stress Ratio FIS	Max Support Reactio (kN/m)
Stage 0		0	0	0	[illegible]	0	N/A	N/A	0
Stage 1		29.12	14.56	0.207	.207	0.013	N/A	N/A	0
Stage 2		40.83	20.41	0.176	.176	0.018	N/A	N/A	72.23
Stage 3		84.78	42.39	0.447	.447	0.037	N/A	N/A	153.86
Stage 4		84.78	42.39	1.128	.452	0.037	N/A	N/A	153.86

The results say that during the fifth stage the buckling check is not satisfied; the critical part of the wall is the one that starts from the elevation of the tieback application to the excavation depth,

It is possible to refer to the . EXT output file (folder Documents/DeepXcavTemporaryFiles/steel); it shows the buckling check for each element and step.

CSTVEREC3: STABILITY CHECKS FOR PARTIAL SPAN NO. 1

zstart   = 0.000000   [mm] zend=   2000.000   [mm]

buckl. length about x-x   = 4000.000   [mm]

CSTVEREC3: STABILITY CHECKS FOR PARTIAL SPAN NO. 2

zstart = 2000.000 [mm] zend= 7000.000 [mm]

buckl. length about x-x = 6250.000 [mm]

As for the second part of the wall, considering the unsupported lenght like 5*W (W= boring hole= 250mm)=1,25m, the buckling lenght is:

$l = l_0 * Beta = 6,25\ m * 1 = 6,25m.$

CSTVEREC3: STABILITY CHECKS FOR PARTIAL SPAN NO. 3

zstart = 7000.000 [mm] zend= 12000.00 [mm]

buckl. length about x-x = 1000.000 [mm]

buckl. length about y-y = 1000.000 [mm]

As for the third part of the wall, Beta value is:

$Beta = l / l_0 = 1\ m / 5\ m = 0,2$

Finally here is an extract of the output file concrening he first element check, the critical one:

CSTVEREC3: EQUIVALENT MOMENTS CALCULATION

Start calculation - Moment:Y Bracing:Z

TABLE B.3 : XMIN = 2001.0 XMAX = 7000.0

BXMIN= 0.35984E+08 BXMAX= -0.27753E+08

X(1) = 0.0000 X(N) = 12000.

M(1) = 0.0000 M(N) = 0.0000

Table B.3 : ERR Q M - BILINEAR 0.71647E+16

" " : ERR Q M - PARABOLA CENTR. 0.11856E+16

Table B.3 : PSI -0.77125

" " ALPHA -0.86265

" " Cm unif. 0.97340

" " Cm conc. 0.85320

" " Cm avrg. 0.95633

" " Cm . 0.97340

Table B.3 : sway buck. mode = YES

" " Cm set to 0.90000

Annex B: TABLE B.3

Moment about axis: Y

Bracing in direction: Z

Equiv. uniform moment factor Cm = 0.90000

Max. bending moment (abs value) [kNm]= 51.251

End calculation - Moment:Y Bracing:Z

Start calculation - Moment:Z Bracing:Y

TABLE B.3 : XMIN = 2001.0 XMAX = 7000.0

BXMIN= 0.0000 BXMAX= 0.0000

X(1) = 0.0000 X(N) = 12000.

M(1) = 0.0000 M(N) = 0.0000

Table B.3 : PSI 0.0000

" " Cm 0.0000

" " MQ 0.0000

" " Mmax 0.0000

" " MQ/Mmax<1/50 -> LINEAR

Annex B: TABLE B.3

Moment about axis: Z

Bracing in direction: Y

Equiv. uniform moment factor Cm = 0.0000

Max. bending moment (abs value) [kNm]= 0.0000

End calculation - Moment:Z Bracing:Y

Start calculation - Moment:Y Bracing:Y

TABLE B.3 : XMIN = 2001.0 XMAX = 7000.0

BXMIN= 0.35984E+08 BXMAX= -0.27753E+08

X(1) = 0.0000 X(N) = 12000.

M(1) = 0.0000 M(N) = 0.0000

Table B.3 : ERR Q M - BILINEAR 0.71647E+16

" " : ERR Q M - PARABOLA CENTR. 0.11856E+16

Table B.3 : PSI -0.77125

" " ALPHA -0.86265

" " Cm unif. 0.97340

" " Cm conc. 0.85320

" " Cm avrg. 0.95633

" " Cm . 0.97340

Annex B: TABLE B.3

Moment about axis: Y

Bracing in direction: Y

Equiv. uniform moment factor Cm = 0.97340

Max. bending moment (abs value) [kNm]= 51.251

End calculation - Moment:Y Bracing:Y

CSTVEREC3: CRITICAL MOMENT CALCULATION (ANNEX F)

SUBROUTINE CSEC3BMASPECT - DIFFERENCE'S DIAGRAMS

NO. OF SAMPLE (NSAMPLE) 142

MINIMUM NO. OF SAMPLE (NSAM) 142

FIRST INTERNAL POINT (KSIN1) 26

LAST INTERNAL POINT (KSIN2) 82

X CASE 1 CASE 2 CASE 3 CASE 4 CASE 5 LINEAR

2001. 0.3598E+08-0.4744E+08 0.3598E+08-0.5729E+07 0.3598E+08 0.000

2174. 0.3431E+08-0.3797E+08 0.3162E+08-0.7206E+07 0.3451E+08-0.5045E+07

....

ANNEX F: GENERAL FORMULA F.1.2 - (EQN F 2)

M cr y = 4956.22296671 [kN*m]

L.T. LENGTH = 2500.0 [mm]

WARP LENGTH = 5000.0 [mm]

PATTERN MOM. =F.1.2 1

C1 = 0.97200

C2 = 0.30400

C3 = 0.98000

Zg (Za-Zs) = 0.0000 [mm]

Zj " = 0.0000 [mm]

Torsional Inertia = 0.44917E+08 [mm^4]

Warping constant = 0.0000 [mm^6]

AREE -> 0.935E+11 0.648E+11 0.143E+12 0.936E+11 0.218E+12 0.134E+12 0.774E+11

TABLE 6.6: Correction factor Kc

Axe = y Kc = 0.910

************ STABILITY CHECK ********

************ EUROCODE 3 - 1993 ********

USER WORK AUTOMATIC

SELECTED WORK 633

**** E C 3 SECTION 6.3.3 ****

Member class (classification was made before)= 1

Tab 6.2 SHAPE TYPE=TUBO

Axis =Y; Curve A

6.3.1.1: FOR BUCKLING ABOUT AXIS Y

SLENDERNESS (L/i) = 104.9568

LAMBDA sup = 1.386888

PHI = 1.586352

CHI = 0.4243666

NBRD = 908.7004 [kN] (max. buckling load)

Tab 6.2 SHAPE TYPE=TUBO

Axis =Z; Curve A

6.3.1.1: FOR BUCKLING ABOUT AXIS Z

SLENDERNESS (L/i) = 0.1679309

LAMBDA sup = 0.2219021E-02

PHI = 0.4792355

CHI = 1.000000

NBRD = 2141.310 [kN] (max. buckling load)

LAMBDA SUP < LAMBDA SUP 0 : 0.15589 < 0.40000

Med/Mcr < (LAMBDA SUP 0)^2: 0.51251E+08/ 0.49562E+10

= 0.10341E-01 < 0.16000

Lateral buckling can be neglected due to

clause (4) of item 6.3.2.2

Annex B: TABLE B.1

Interaction factor Kyy = 1.3170

Interaction factor Kyz = 0.0000

Interaction factor Kzy = 0.79021

Interaction factor Kzz = 0.0000

SECTION 6.3.3 - BUCKLING RATIO (4) EQ. 6.61

Contribution from NEd : 526.3 / 908.7 = 0.579 +

Contribution from MyEd : 67.50 / 114.7 = 0.588 +

Contribution from MzEd : 0.000 / 114.7 = 0.000 =

Sum of above contributions = 1.168

SECTION 6.3.3 - BUCKLING RATIO (4) EQ. 6.62

Contribution from NEd : 526.3 / 2141. = 0.246 +

Contribution from MyEd : 40.50 / 114.7 = 0.353 +

Contribution from MzEd : 0.000 / 114.7 = 0.000 =

Sum of above contributions = 0.599

E C 3 - SECTION 6.3.3

NSD (MAX COMPRESSION FORCE [KN]) -526.31

RATIOB (STABILTY WITHOUT LATERAL TORSION) EQ 6.61 1.1677

RATIOB1 (STABILTY WITHOUT LATERAL TORSION) EQ 6.62 0.59887

RATIO = max {RATIOB,RATIOB1} 1.1677