Verification of the Berlin type walls in DeepXcav.

DeepXcav software program (Version 2011)

(ParatiePlus within Italy)

Version 1.0

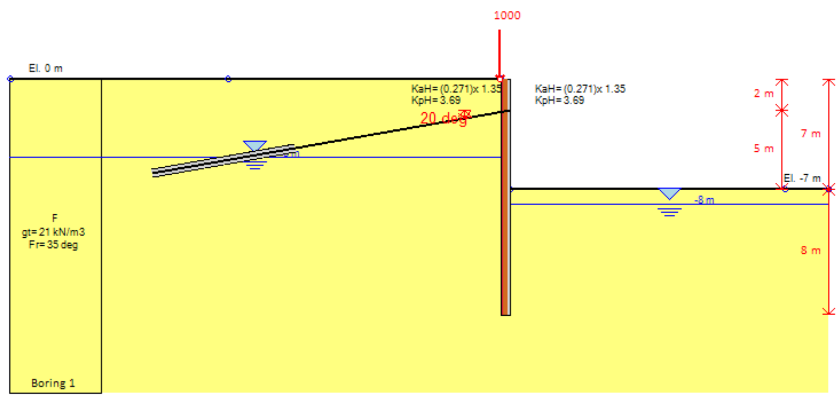
Issued: 5-Nov-2010

Deep Excavation LLC

www.deepexcavation.com

Object: **Verification of the Berlin type walls in DeepXcav.**

0: EC7, 2007: DA-1, Comb. 1: A1 + M1 + R1(LINK: Base model)

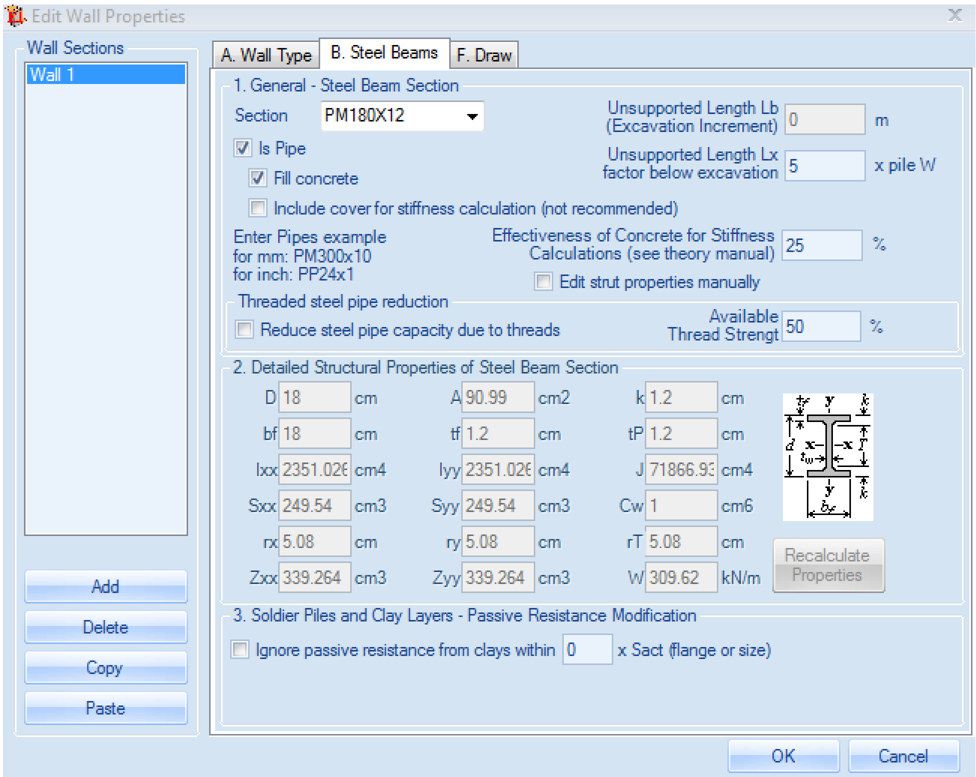


Code	EC7, 2007
Case	DA-1, Comb. 1: A1 + M1 + R1
Parameter	Safety Factor
Seismic multiplier	0
Variable loads	1.5
Permanent loads	1.35
Temporary anchors	1.1
Permanent anchors	1.1
tan(friction angle)	1
Eff. cohesion c'	1
Shear strength Su	1
Earth unfavorable	1.35
Earth favorable	1
Water unfavorable	1.35
Water favorable	1
HYDraulic unfavorable	1.35
HYDraulic favorable	0.9
UPLift unfavorable	1.1
UPLift favorable	0.9
Used FS wall STR	1

Let's consider the example presented in the previous figure.

This example includes a tangent pile wall with the following properties:

- Section: 180 x 10 mm
- Material: Fe510
- Wall spacing: 0,5 m



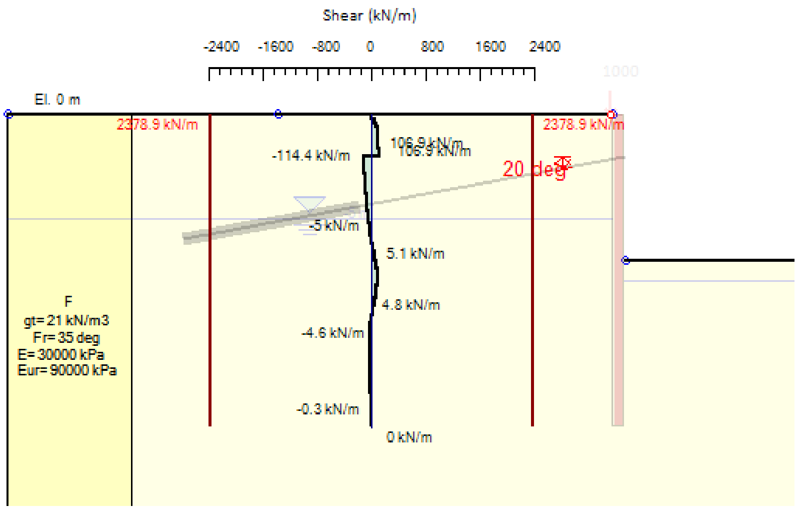
The choice to include the filling concrete to the pile, refers only to the calculation of the equivalent thickness and therefore the analysis of the structure.

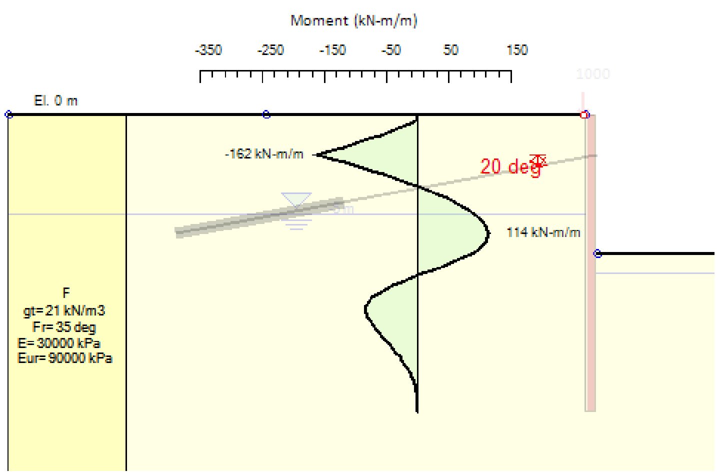
During structural verification only the steel tangent pile wall resistance is included.

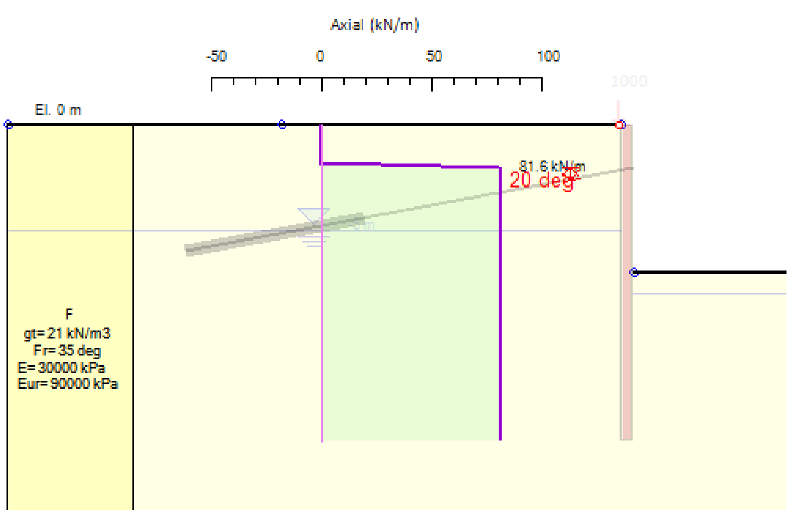
The verification has been made in agreement with the Eurocode cases.

The model was calculated according to the approach A1 + M1 + R1 (EC7, 2007: DA-1).

Next, lateral result diagrams are presented:







- *Verification of compression / traction*

The verification of the compression / traction verifies compression / traction which is calculated from the program but not included in the output.

This can be seen in file .EXT (in the folder Documents/DeepXcavtemporaryfiles/steel).

In this file are presented all the verification checks for every wal section and for every Stage.

The verification took place according to the paragraph (EC7, 2007: DA-1).

The factors of safety are relevant to the Eurocode 2 and 3:

EC3: CSTVEREC3 MODULE: START

****

Partial safety factors as used in this code

Gamma M0 = 1.000

Gamma M1 = 1.000

Gamma M2 = 1.250

Verification to compression:

Section no. 66 at x= 6401.000 [mm]

selected class for current cross section = 1

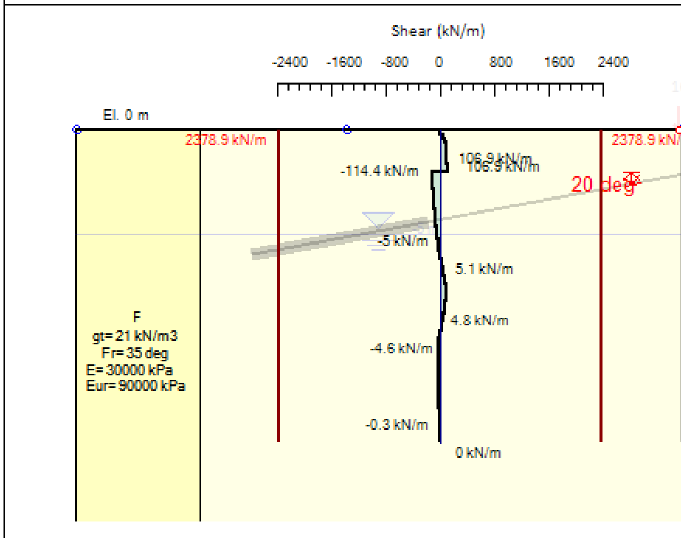
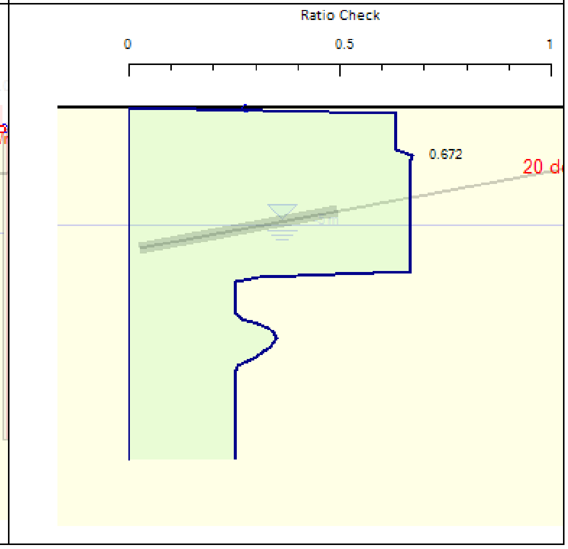
6.2.4 Compression for class 1 cross sections

Ratio =-26.57 / 3236. =0.8210E-02

- *Shear Verification*

According to the paragraph 6.2.6 of UNI EN 1993 1-1:2005:

The results are visible in the form of Shear resistance.

Shear	Ratio
	

This can be seen in file .EXT (in the folder Documents/DeepXcavtemporaryfiles/steel).

6.2.6 Shear resistance check

6.2.6 Shear resistance check

Z direction : Shear Area Av = 5803. mm2

Vsd = -7.767 kN , VplRd = 1189. kN, ratio = 0.6530E-02

- *Verification of bending moment / bending moment and Axial force*

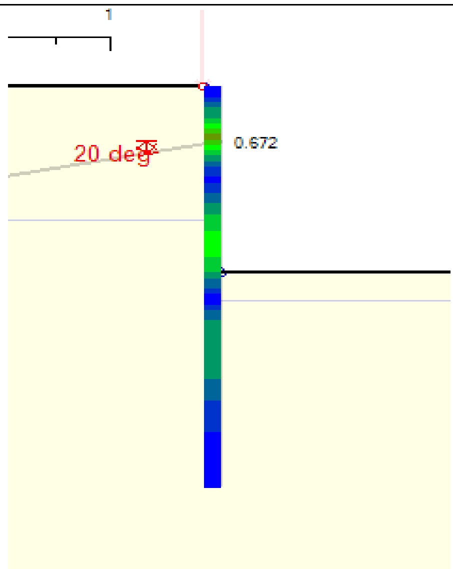
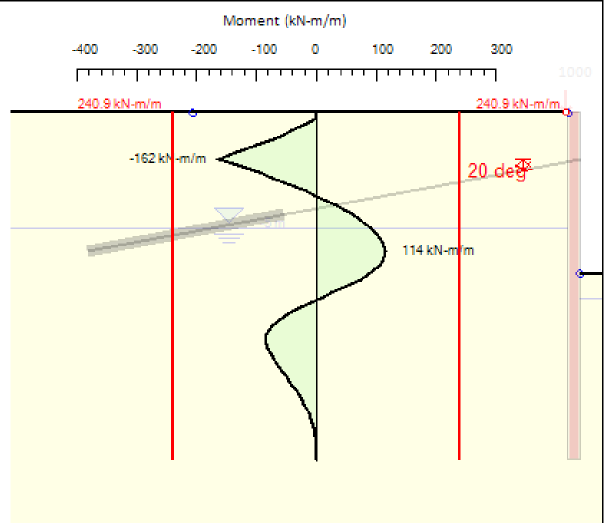
According to the paragraph 6.2.9 of UNI EN 1993 1-1:2005 (in the case that also axial force is present on the bulkhead) or to the paragraph 6.2.5 in the case that only bending moment is present.

The includes carries out a classification of the section, as it can be seen in the output file.

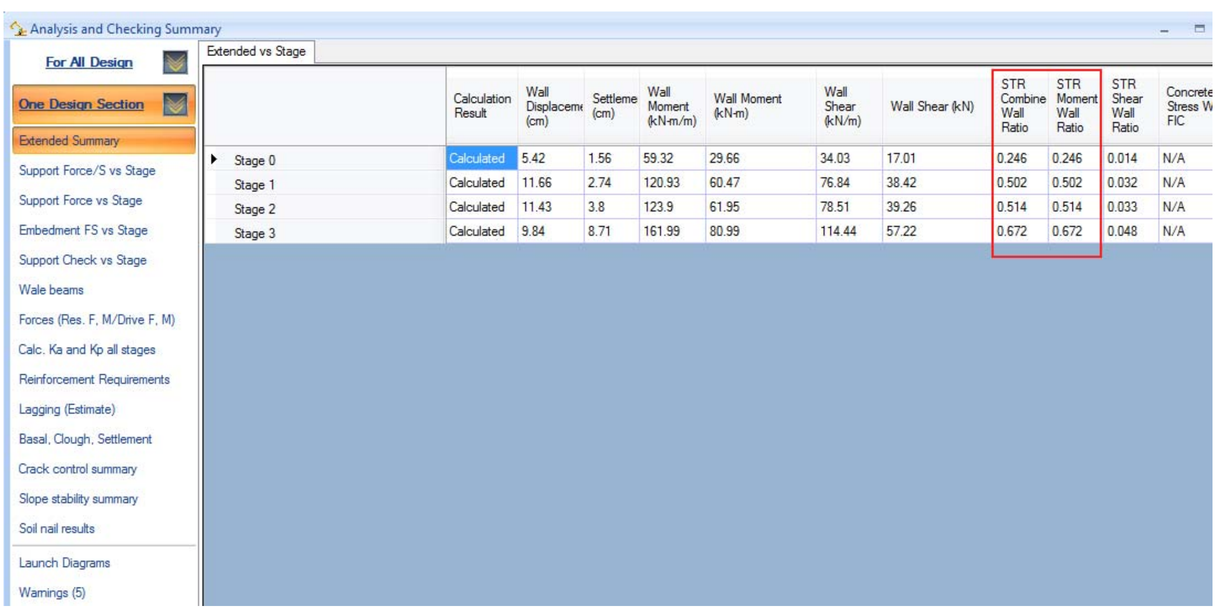
Section no. 66 at x= 6401.000 [mm]

selected class for current cross section = 1

The results are presented in exploitation of rates of limits in limits of resisting moment.

RATIO M	Moment + CAP.M
	

The extensive summary results are reported at the end of analysis with the greatest rates of exploitation for every stage. The values TSF M + N are coinciding to the values RAT. M as seen on the model.



	Calculation Result	Wall Displaceme (cm)	Settleme (cm)	Wall Moment (kN-m/m)	Wall Moment (kN-m)	Wall Shear (kN/m)	Wall Shear (kN)	STR Combine Wall Ratio	STR Moment Wall Ratio	STR Shear Wall Ratio	Concrete Stress W FIC
Stage 0	Calculated	5.42	1.56	59.32	29.66	34.03	17.01	0.246	0.246	0.014	N/A
Stage 1	Calculated	11.66	2.74	120.93	60.47	76.84	38.42	0.502	0.502	0.032	N/A
Stage 2	Calculated	11.43	3.8	123.9	61.95	78.51	39.26	0.514	0.514	0.033	N/A
Stage 3	Calculated	9.84	8.71	161.99	80.99	114.44	57.22	0.672	0.672	0.048	N/A

This can be seen in file .EXT (in the folder Documents/DeepXcavtemporaryfiles/steel).

The verification is performed for the most critical element in the final 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= 120.5 MVNzRd= 120.5 ratio= 0.4116

(eqn. 6.31)

- *Instability verification*

The instability verification is performed according to the paragraph 6.3.3. of UNI EN 1993 1-1:2005 .

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

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

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

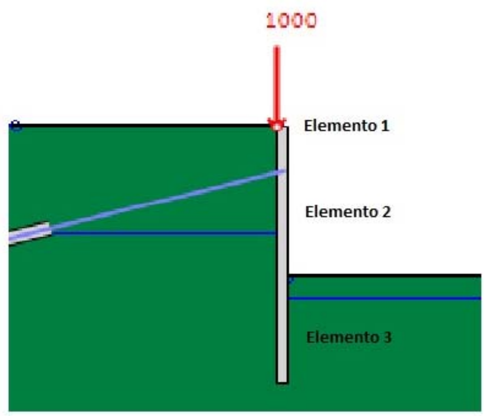
The calculation of the critical moment M_{cr} is done using the appendix F of UNI EN 1993 1-1: 1992.

The pile comes subdivided automatic from the program in elements; it points out the eventual presence of ties, the contribution of excavation and the back contribution of the bulkhead.

Regarding the contribution of excavation, to simulate the effect of trespass of the ground, the bulkhead comes subdivided in small elements.

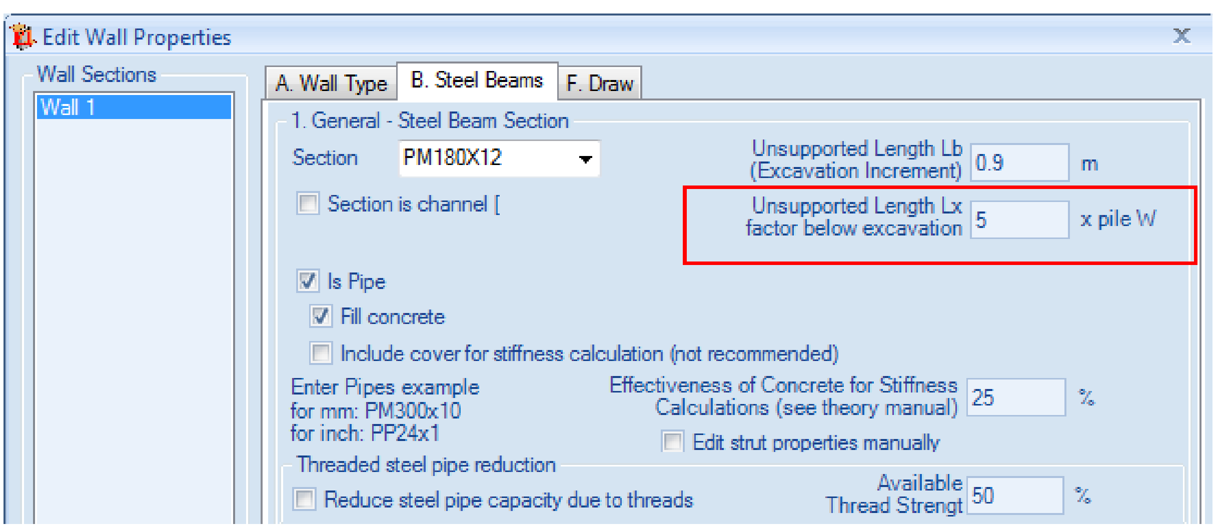
In the model that is beeing studied, therefore, it guilts::

	From contribution	To contribution	Beta
element 1	Slow camp.	Apllied Tiebacks	2
Element 2	Apllied Tiebacks	Bellow excavation	1
element 3	Bellow excavation	Bellow bulkhead	small

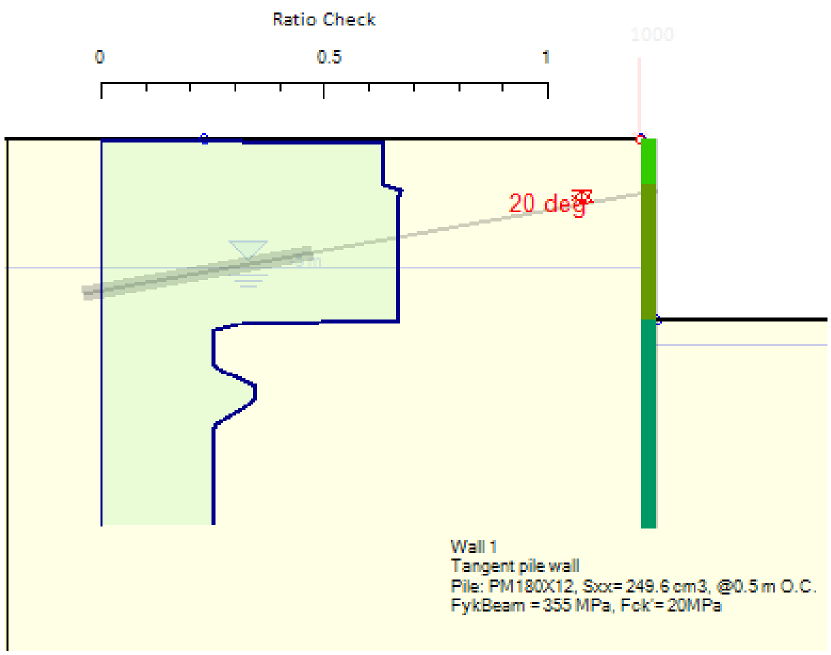


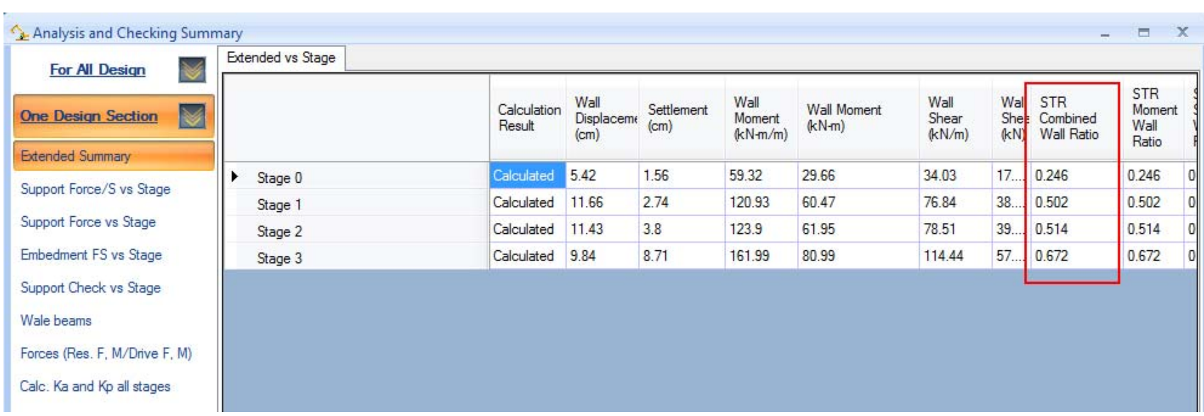
It is possible, in DeepXcav, to simulate the fact that the tieback contributes to the excavation less than the deep excavation itself.

On default, this development is equal to 5 times the total thickness of the pile. In this case the total thickness of the bulkhead is equal to the value of the diameter of perforation.



The results of the instability verification are presented by pressing the COMB. button. There is an extensive summary at the end of analysis, for each Stage of excavation.





	Calculation Result	Wall Displaceme (cm)	Settlement (cm)	Wall Moment (kN-m/m)	Wall Moment (kN-m)	Wall Shear (kN/m)	Wal She (kN)	STR Combined Wall Ratio	STR Moment Wall Ratio
Stage 0	Calculated	5.42	1.56	59.32	29.66	34.03	17....	0.246	0.246
Stage 1	Calculated	11.66	2.74	120.93	60.47	76.84	38....	0.502	0.502
Stage 2	Calculated	11.43	3.8	123.9	61.95	78.51	39....	0.514	0.514
Stage 3	Calculated	9.84	8.71	161.99	80.99	114.44	57....	0.672	0.672

From the results it seems that the piles, in Stage 3, are self instabilized, and the critical part is where the tiebacks are set.

It is possible to consult also the file .EXT (folder Document/DeepXcavTemporaryFiles/steel) of output to show, for each element and for each stage the instability verification.

EC3: START BUCKLING CHECKS

CSTVEREC3: STABILITY CHECKS FOR PARTIAL SPAN NO. 1

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

CSTVEREC3: STABILITY CHECKS FOR PARTIAL SPAN NO. 2

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

buckl. length about x-x = 6400.000 [mm]

Regarding to the second excavation, having considered the not supported length of the excavation equal to 5*W (W = sp. hole perforation = 250 mm) = 1.25 m, the length of free inflection results is:

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

CSTVEREC3: STABILITY CHECKS FOR PARTIAL SPAN NO. 3

zstart = 7000.000 [mm] zend= 15000.00 [mm]

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

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

Finally it comes restored the piece of the file of relevant output to verify the second element, that is critical:

CSTVEREC3: EQUIVALENT MOMENTS CALCULATION

Start calculation - Moment:Y Bracing:Z

TABLE B.3 : XMIN = 2001.0 XMAX = 6999.0

BXMIN= 0.80993E+08 BXMAX= -0.43099E+08

X(1) = 0.0000 X(N) = 15000.

M(1) = 1000.0 M(N) = 0.0000

Table B.3 : ERR Q M - BILINEAR 0.20069E+17

" " : ERR Q M - PARABOLA CENTR. 0.10708E+17

Table B.3 : PSI -0.53213

" " ALPHA -0.40527

" " Cm unif. 0.47743

" " Cm conc. 0.43064

" " Cm avrg. 0.46115

" " Cm . 0.47743

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]= 80.993

End calculation - Moment:Y Bracing:Z

Start calculation - Moment:Z Bracing:Y

TABLE B.3 : XMIN = 2001.0 XMAX = 6999.0

BXMIN= 0.0000 BXMAX= 0.0000

X(1) = 0.0000 X(N) = 15000.

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

STEEL-WORLD 4.3 Ce.A.S. s.r.l. PAG. 593

4 November 2010 15:45:53

DEFAULT TITLE FOR STEEL-WORLD

CHECK OF DIRECTLY INPUT MEMBER WL0_3

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:T

TABLE B.3 : XMIN = 2001.0 XMAX = 6999.0

BXMIN= 0.80993E+08 BXMAX= -0.43099E+08

X(1) = 0.0000 X(N) = 15000.

M(1) = 1000.0 M(N) = 0.0000

Table B.3 : ERR Q M - BILINEAR 0.20069E+17

" " : ERR Q M - PARABOLA CENTR. 0.10708E+17

Table B.3 : PSI -0.53213

" " ALPHA -0.40527

"   "   Cm unif.   0.47743

"   "   Cm conc.   0.43064

"   "   Cm avrg.   0.46115

"   "   Cm   . 0.47743

Annex B: TABLE   B.3

Moment about axis: Y

Bracing in direction: T

Equiv. uniform moment factor Cm   = 0.47743

Max. bending moment (abs value) [kNm]= 80.993

End calculation - Moment:Y Bracing:T

CSTVEREC3: CRITICAL MOMENT CALCULATION (ANNEX F)

SUBROUTINE CSEC3BMASPECT - DIFFERENCE'S DIAGRAMS

NO. OF SAMPLE   (NSAMPLE)   152

MINIMUM NO. OF SAMPLE (NSAM)   152

FIRST INTERNAL POINT (KSIN1)   22

LAST INTERNAL POINT (KSIN2)   71

X	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	LINEAR
2001.	0.8099E+08	0.1535E+08	0.8099E+08	0.4817E+08	0.8099E+08	0.000
2199.	0.7455E+08	0.1889E+08	0.7215E+08	0.4193E+08	0.7475E+08	-0.6525E+07

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

M cr y   =   20599.9489401   [kN*m]

L.T. LENGTH   = 2500.0   [mm]

WARP LENGTH   = 5000.0   [mm]

PATTERN MOM. =F.1.2 5

C1 = 1.0100

C2 = 0.41000

C3 = 1.8900

Zg (Za-Zs) = 0.0000 [mm]

Zj " = 0.0000 [mm]

Torsional Inertia = 0.71867E+09 [mm^4]

Warping constant = 0.0000 [mm^6]

AREE -> 0.171E+12 0.885E+11 0.171E+12 0.171E+12 0.146E+12 0.171E+12 0.873E+11

TABLE 6.6: Correction factor Kc

Axe = y Kc = 0.664

************ 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

**** 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) = 128.9415

LAMBDA sup = 1.703818

PHI = 2.109399

CHI = 0.2982395

NBRD = 965.1567 [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) = 0.2014710

LAMBDA sup = 0.2662216E-02

PHI = 0.4792831

CHI = 1.000000

NBRD = 3236.180 [kN] (max. buckling load)

LAMBDA SUP < LAMBDA SUP 0 : 0.76467E-01 < 0.40000

Med/Mcr < (LAMBDA SUP 0)^2: 0.80993E+08/ 0.20600E+11

= 0.39317E-02 < 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 = 0.93043

Interaction factor Kyz = 0.0000

Interaction factor Kzy = 0.55826

Interaction factor Kzz = 0.0000

SECTION 6.3.3 - BUCKLING RATIO (4) EQ. 6.61

Contribution from NEd : 40.80 / 965.2 = 0.042 +

Contribution from MyEd : 75.36 / 120.5 = 0.626 +

Contribution from MzEd : 0.000 / 120.5 = 0.000 =

Sum of above contributions = 0.668

SECTION 6.3.3 - BUCKLING RATIO (4) EQ. 6.62

Contribution from NEd : 40.80 / 3236. = 0.013 +

Contribution from MyEd : 45.22 / 120.5 = 0.375 +

Contribution from MzEd : 0.000 / 120.5 = 0.000 =

Sum of above contributions = 0.388

E C 3 - SECTION 6.3.3

NSD (MAX COMPRESSION FORCE [KN]) -40.798

RATIOB (STABILTY WITHOUT LATERAL TORSION) EQ 6.61 0.66791

RATIOB1 (STABILTY WITHOUT LATERAL TORSION) EQ 6.62 0.38799

RATIO = max {RATIOB,RATIOB1} 0.66791