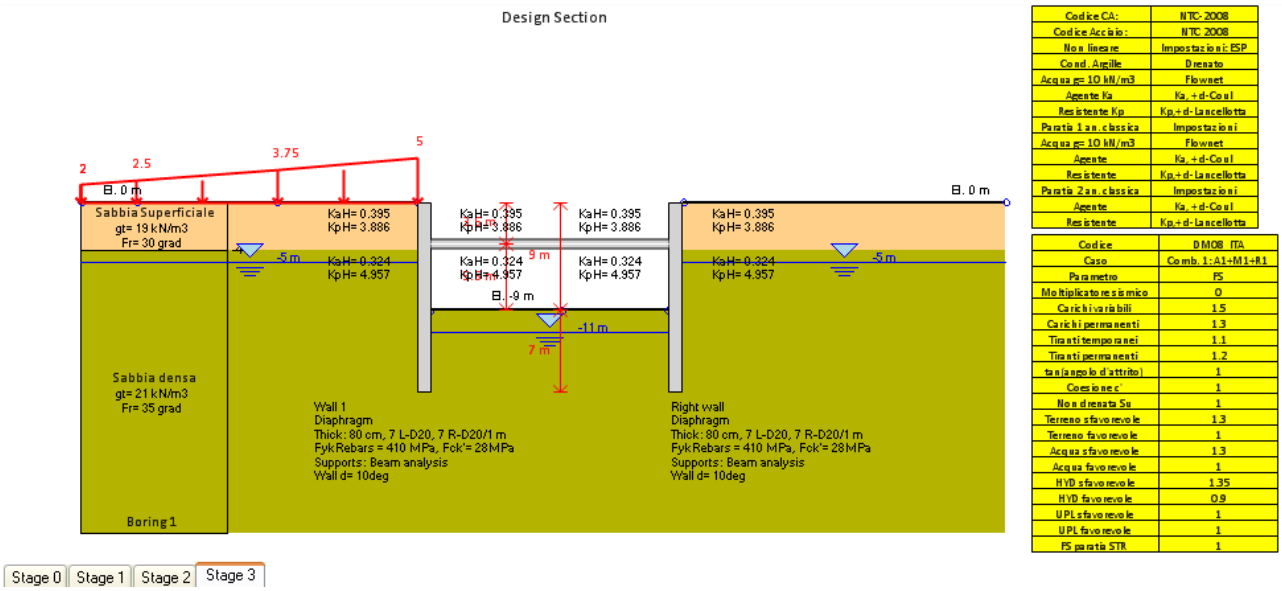
Verification of a double wall supported by a strut

The following model is given:



Codice CA:	NTC-2008
Codice Acciaio:	NTC 2008
Non lineare	Impostazioni: ESP
Cond. Argille	Drenato
Acqua g= 10 kN/m3	Flownet
Agente Ka	Ka, +d-Coul
Resistente Kp	Kp,+d-Lancellotta
Paratia 1 an. classica	Impostazioni
Acqua g= 10 kN/m3	Flownet
Agente	Ka, +d-Coul
Resistente	Kp,+d-Lancellotta
Paratia 2 an. classica	Impostazioni
Agente	Ka, +d-Coul
Resistente	Kp,+d-Lancellotta

Codice	DM08 ITA
Caso	Comb. 1: A1+M1+R1
Parametro	FS
Moltiplicatore sismico	0
Carichi variabili	1.5
Carichi permanenti	1.3
Tiranti temporanei	1.1
Tiranti permanenti	1.2
tan(angolo d'attrito)	1
Coesione c'	1
Non drenata Su	1
Terreno sfavorevole	1.3
Terreno favorevole	1
Acqua sfavorevole	1.3
Acqua favorevole	1
HYD sfavorevole	1.35
HYD favorevole	0.9
UPL sfavorevole	1
UPL favorevole	1
FS paratia STR	1

It concerns a double wall (concrete wall) model for which, during Stage 2, a strut support has been applied before realizing a further excavation. Aim of the following example is to lead the user through strut support check.

The soil properties are:

- *Superficial sand (from the surface to a depth of –4m)*

γ_{dry} = 19 kN/m^3

ϕ'= 30°

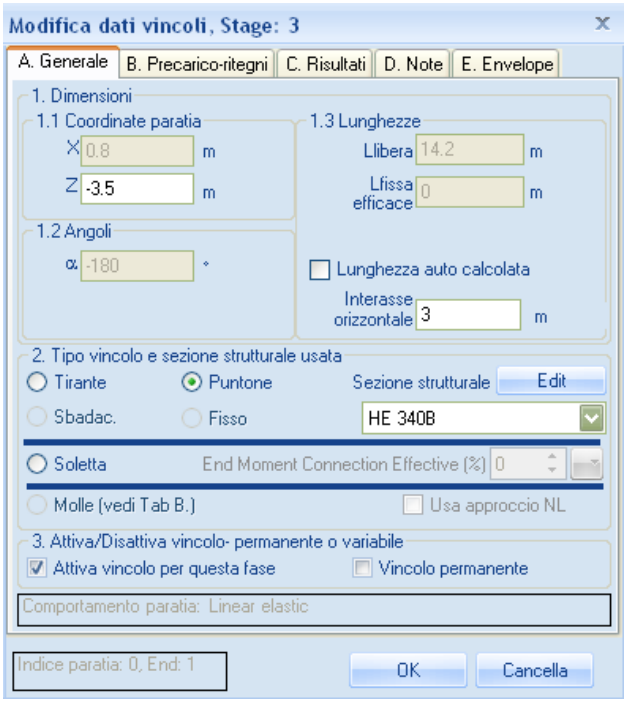
- *Dense sand*

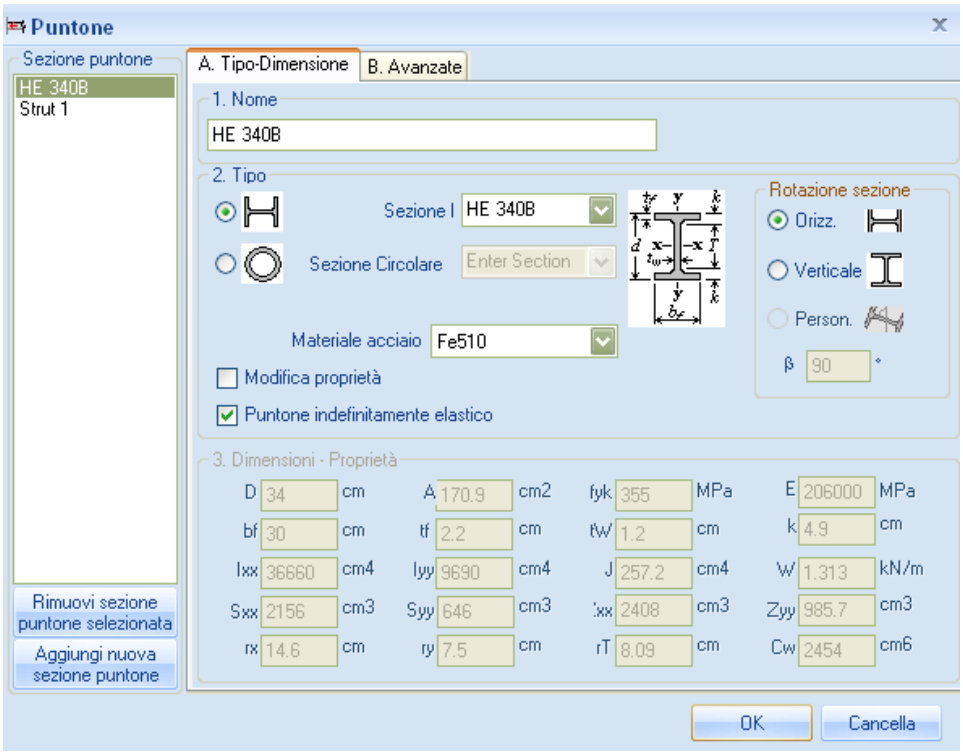
γ_{dry} = 18 kN/m^3

γ_t = 21 kN/m^3

ϕ'= 35°

As strut support, steel profiles HE300B with an horizontal spacing of 3m have been used.

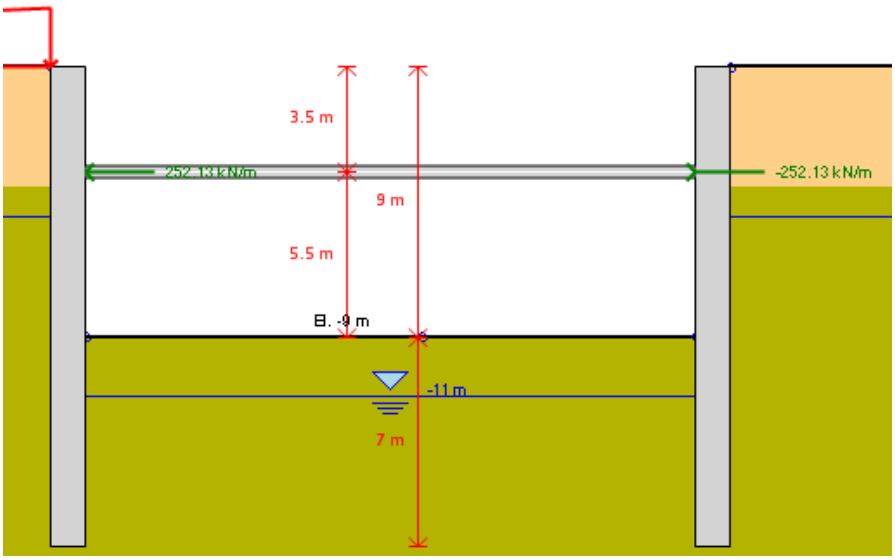




Apply the Comb.1 of DM2008 (A1+M1+R1), more unfavourable to structural design, and use UNI EN 1993 1-1:2005 and the coefficients provided by DM2008 for check.

Choosing then DM2008 under the *Design* menu, the software will run check in keeping with UNI EN 1993 1-1:2005 but using (gamma factors) prescribed by the Italian code.

When the analysis is over the following results (about the reaction on the struts in the last excavation step) will be retrieved:



The compression reaction on the strut is worth 252,13 kN/m.

The FS prescribed by DM2008 are:

gamma_0 = 1,05

gamma_1 = 1,05

An extract of the file . EXT (output file provided after the steel beams checking step) about Step 3 (last excavation) is given.

EC3: START RESISTANCE CHECKS

Section no. 1 at x= 0.000000 [mm]

selected class for current cross section = 1

6.2.4 Compression for class 1 cross sections

Ratio =-756.4 / 6061. =0.1248

max n= 0.9640

Paragraph 6.2.4 of UNI EN 1993 1-1:2005 is about compression.

The axial load on each strut is worth 252,13 kN/m * 3 m = 756,39 kN

So:

TSF = 756,39 / (A * fy/ gamma_m0) = 0,1248

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

Shape type H

NmaxMy= 600.5 NmaxMz= 1201.

yredMy= T yredMz= F

Interaction between M and N is account for

(for notation see paragraph 6.2.9.1)

aw =0.2637 af = 0.000

alfa = 2.000 beta = 1.000

MVNyRd= 814.1 MVNzRd= 333.3 ratio= 0.4065E-01 (eqn. 6.31)

5.5 Shear buckling resistance check

no shear buckling resistance is necessary

according to 5.1(2) EN 1993-1-5

Section no. 1 at x= 0.000000 [mm]

selected class for current cross section = 1

resist. ratio according to 6.2.3 = 0.000

resist. ratio according to 6.2.4 = 0.125

resist. ratio according to 6.2.6 (2) = 0.000

resist. ratio according to 6.2.6 (3) = 0.000

resist. ratio according to 6.2.7 = 0.000

resist. ratio according to 6.2.9.1 = 0.041 eqn. 6.31

resist. ratio according to 6.2.9.2 = 0.000 (not applicable)

resist. ratio according to 6.2.9.3 = 0.000 (not applicable)

max. resist. ratio (max. among above)= 0.125

web buckling ratio (section 5.6) = 0.000

Section no. 2 at x= 14200.00 [mm]

selected class for current cross section = 1

6.2.4 Compression for class 1 cross sections

Ratio =-756.4 / 6061. =0.1248

max n= 0.9640

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

Shape type H

NmaxMy= 600.5 NmaxMz= 1201.

yredMy= T yredMz= F

Interaction between M and N is account for

(for notation see paragraph 6.2.9.1)

aw =0.2637 af = 0.000

alfa = 2.000 beta = 1.000

MVNyRd= 814.1 MVNzRd= 333.3 ratio= 0.4065E-01

(eqn. 6.31)

5.5 Shear buckling resistance check

no shear buckling resistance is necessary

according to 5.1(2) EN 1993-1-5

Section no. 2 at x= 14200.00 [mm]
selected class for current cross section = 1
resist. ratio according to 6.2.3 = 0.000
resist. ratio according to 6.2.4 = 0.125
resist. ratio according to 6.2.6 (2) = 0.000
resist. ratio according to 6.2.6 (3) = 0.000
resist. ratio according to 6.2.7 = 0.000
resist. ratio according to 6.2.9.1 = 0.041 eqn. 6.31
resist. ratio according to 6.2.9.2 = 0.000 (not applicable)
resist. ratio according to 6.2.9.3 = 0.000 (not applicable)
max. resist. ratio (max. among above)= 0.125
web buckling ratio (section 5.6) = 0.000

Summary of resistance checks over all the sections
max salected class: 1, at station no. 2
maximum resistance ratio = 0.125
maximum web buckling ratio = 0.000

Besides the compression check, also a combined check bending-axial load in keeping with paragraph 6.2.9.1 (concerning class 1 and 2 sections) of UNI EN 1993 1-1:2005 has been made and it wasn't necessary to carry out an instability shear check, according to UNI EN 1993-1-5.

Buckling check:

Struts check is made accordino to paragraph 6.3.3 of UNI EN 1993 1-1:2005 (in particular formula number 6.61 and 6.62). Lateral instability is not consedered accroding to chapter 6.3.2.2 point (4).

A double pinned element is considered; pins are localized on the axis of the walls.

To calculate the critical moment, since in the new Eurocode there isn't a plain reference to the method that has to be used, the checker uses appendix F of ENV 1993 1-1: 1992.

Two ratio concerning equations 6.61 e 6.62 di UNI EN 1993 1-1:2005 are then calculated and the higher is considered.

EC3: START BUCKLING CHECKS

CSTVEREC3: STABILITY CHECKS FOR PARTIAL SPAN NO. 1

zstart = 0.000000 [mm] zend= 14200.00 [mm]

buckl. length about x-x = 14200.00 [mm]

buckl. length about y-y = 14200.00 [mm]

buckl. length about m-m = 14200.00 [mm] (only for angles)

buckl. length about n-n = 14200.00 [mm] (only for angles)

lateral torsion buckl. length= 14200.00 [mm]

warping buckling length = 14200.00 [mm]

CSTVEREC3: CRITICAL MOMENT CALCULATION (ANNEX F)

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

*M cr y = 479.579351927 [kN*m]*

L.T. LENGTH = 14200. [mm]

WARP LENGTH = 14200. [mm]

PATTERN MOM. =LINEAR

C1 = 1.0000

C2 = 0.0000

C3 = 1.0000

Zg (Za-Zs) = 0.0000 [mm]

Zj " = 0.0000 [mm]

Torsional Inertia = 0.28995E+07 [mm^4]

Warping constant = 0.24540E+10 [mm^6]

TABLE 6.6: Correction factor Kc

Axe = y Kc = 1.000

Member class (classification was made before)= 1

Tab 6.2 SHAPE TYPE=H

Axis =Y; Curve B

6.3.1.1: FOR BUCKLING ABOUT AXIS Y

SLENDERNESS (L/i) = 97.12778

LAMBDA sup = 1.283436

PHI = 1.507788

CHI = 0.4349478

NBRD = 2636.257 [kN] (max. buckling load)

Tab 6.2 SHAPE TYPE=H

Axis =Z; Curve C

6.3.1.1: FOR BUCKLING ABOUT AXIS Z

SLENDERNESS (L/i) = 190.8136

LAMBDA sup = 2.521390

PHI = 4.247445

CHI = 0.1304539

NBRD = 790.6928 [kN] (max. buckling load)

LAMBDA SUP < LAMBDA SUP 0 : 1.3351 < 0.40000

Med/Mcr < (LAMBDA SUP 0)^2: 0.33094E+08/ 0.47958E+09

= 0.69006E-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 = 1.2295

Interaction factor Kyz = 0.0000

Interaction factor Kzy = 0.73772

Interaction factor Kzz = 0.0000

E C 3 - SECTION 6.3.3

NSD (MAX COMPRESSION FORCE [KN]) -756.40

RATIOB (STABILTY WITHOUT LATERAL TORSION) EQ 6.61 0.33690

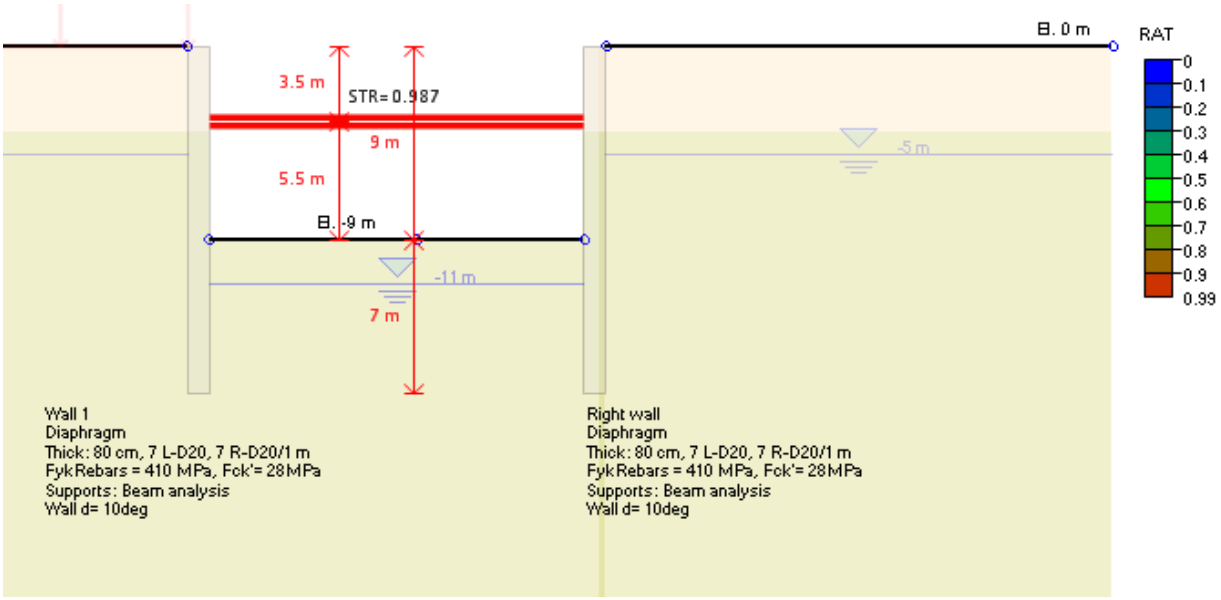
RATIOB1 (STABILTY WITHOUT LATERAL TORSION) EQ 6.62 0.98662

RATIO = max {RATIOB,RATIOB1} 0.98662

EC3_EN_1993-1-1: RESISTANCE RATIO 0.125

AXIAL BUCKLING RATIO 0.987

Grafico STR.:


B. 0 m
RAT
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0.99
3.5 m
STR= 0.987
9 m
5.5 m
B. -9 m
-11 m
7 m
-5 m
Wall 1
Diaphragm
Thick: 80 cm, 7 L-D20, 7 R-D20/1 m
FykRebars = 410 MPa, Fck'= 28MPa
Supports: Beam analysis
Wall d= 10deg
Right wall
Diaphragm
Thick: 80 cm, 7 L-D20, 7 R-D20/1 m
FykRebars = 410 MPa, Fck'= 28MPa
Supports: Beam analysis
Wall d= 10deg