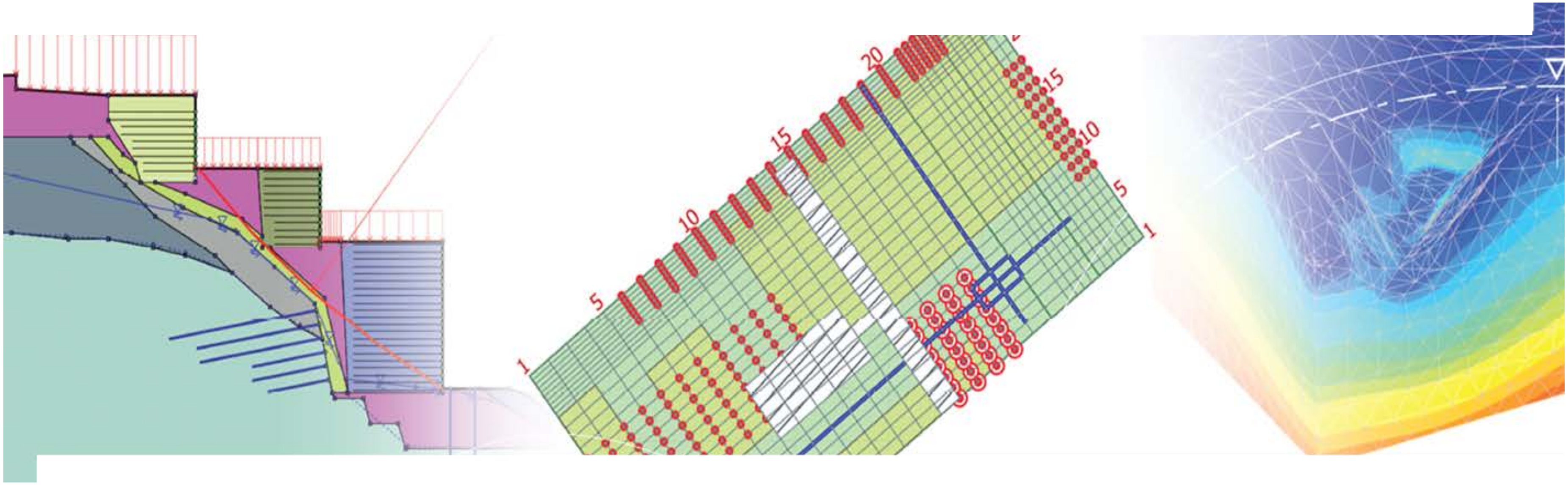
Talren v5

terrasol

setec

Software capabilities
Talren v5



2015

Introduction

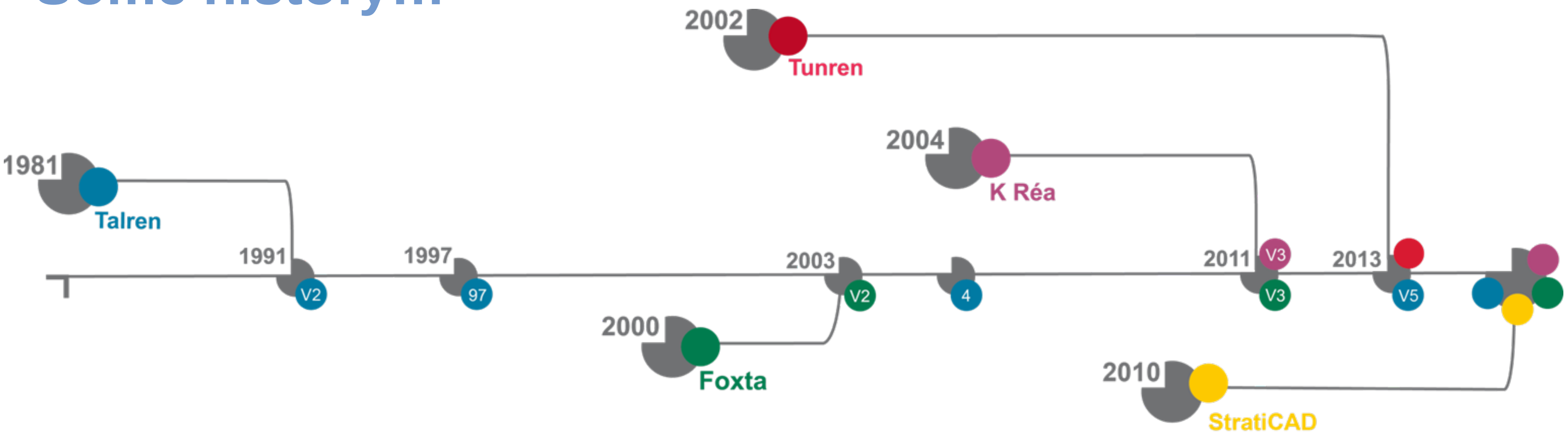
Talren is a software for slope stability analysis of geotechnical structures which enables the check of various types of works:

- natural slopes,
- cut or fill slopes,
- earth dams and dikes,

Taking into account various types of reinforcements:

- prestressed anchors,
- soil nails,
- piles and micropiles,
- struts,
- geotextiles,
- geogrids,
- steel and polymer strips.

Some history…



Last Windows version: Talren v5.1.4 December 2015

Pro active sales of TALREN software since1990.

More than 500 licences that 1/2 abroad in approximately 50 countries:

- Korea; UK; Turkey; Lebanon; Algeria; India; Morocco…

Talren: developed together with Clouterre 1991

The part of the French Clouterre recommendations dealing with the design of soil nailed walls is largely based on the concepts and theories used in the development of the TALREN software, which is recognized as one of the main design tools for reinforced soils.

Input data

Geometry

Soil characteristics

Loads

Reinforcements

Hydraulic conditions

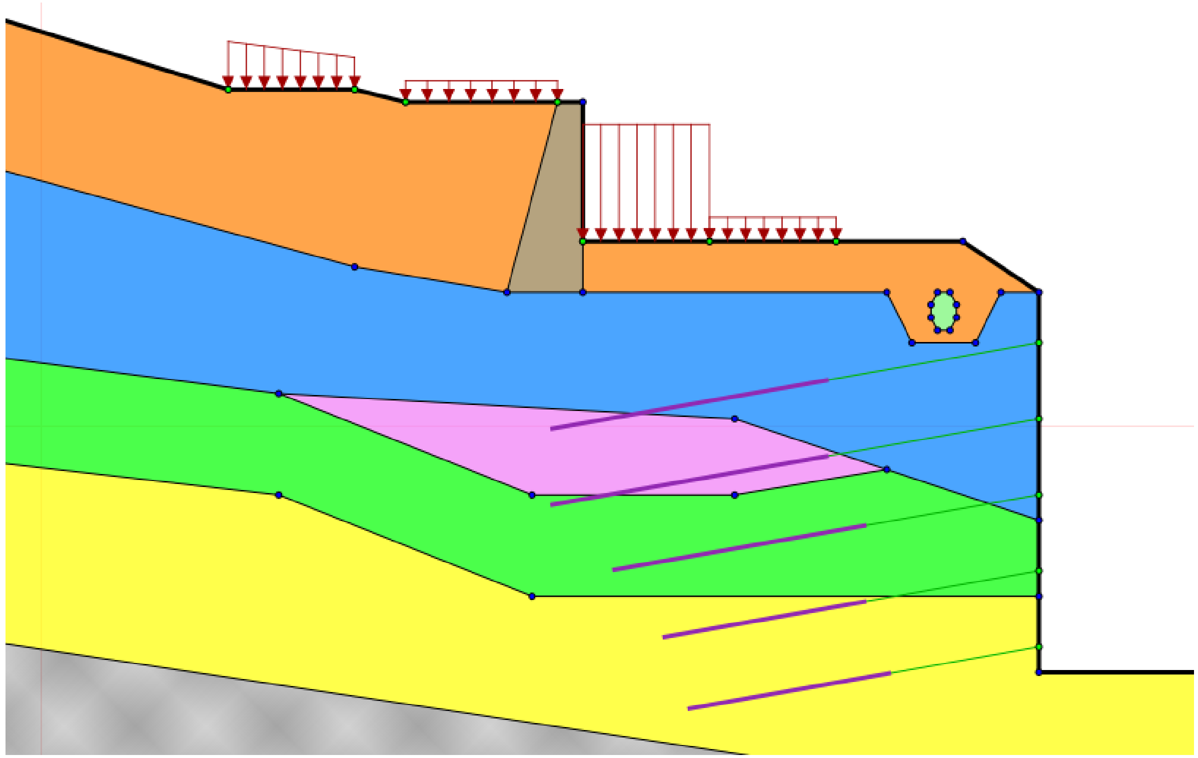
Seismic accelerations

Partial safety factors

Calculation options

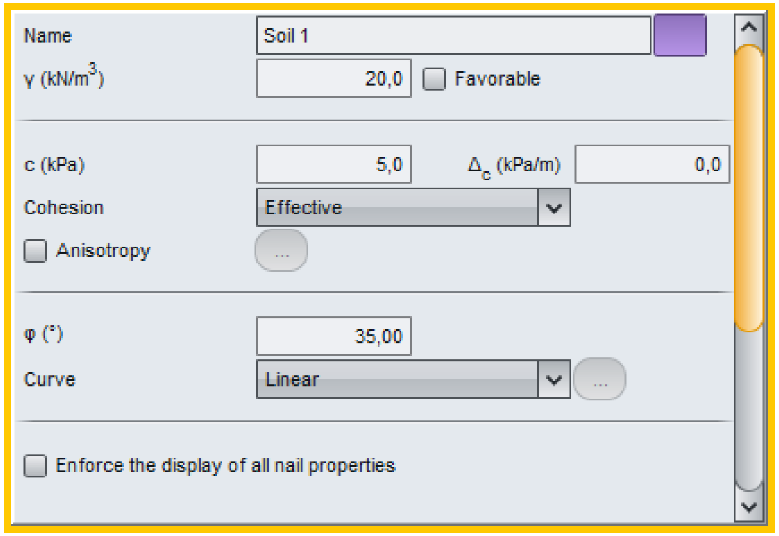
Project geometry

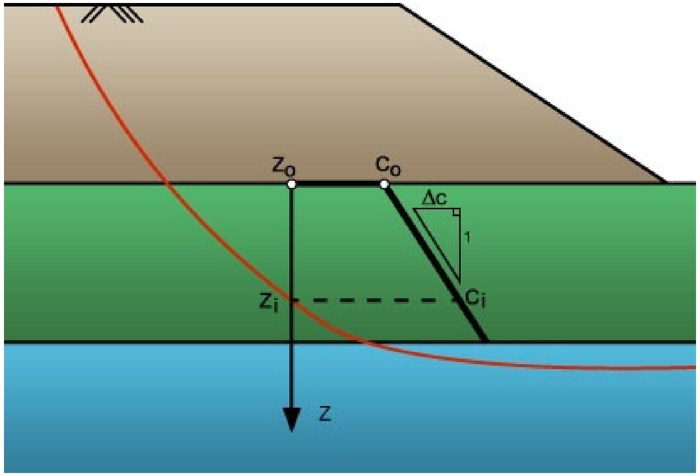
- Geometry can be complex.
- Model orientation: uphill on the left (failure from the left to the right).



Soil properties

Compulsory data: γ, φ, c, Δc.



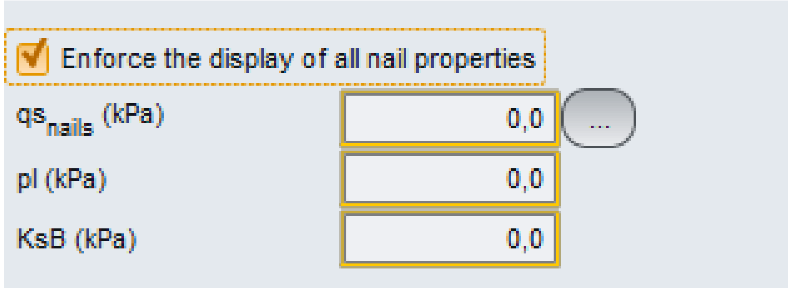


If nails are defined in this layer:

qs nails: unitary skin friction (traction)

pl: limit pressure (shear)

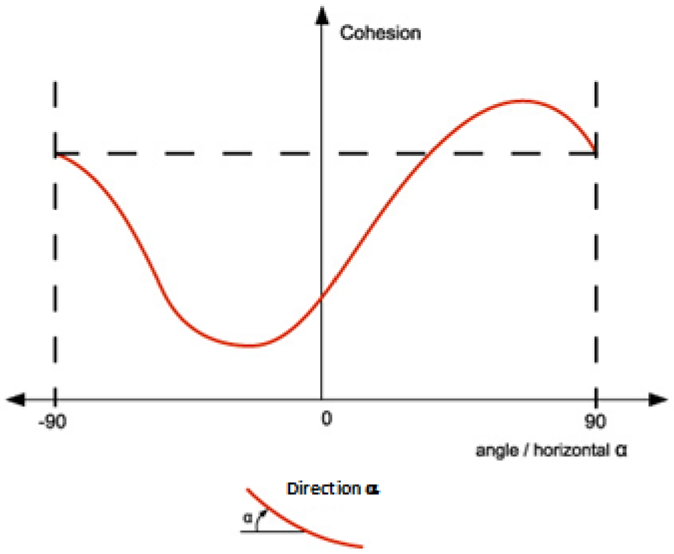
KsB (shear)



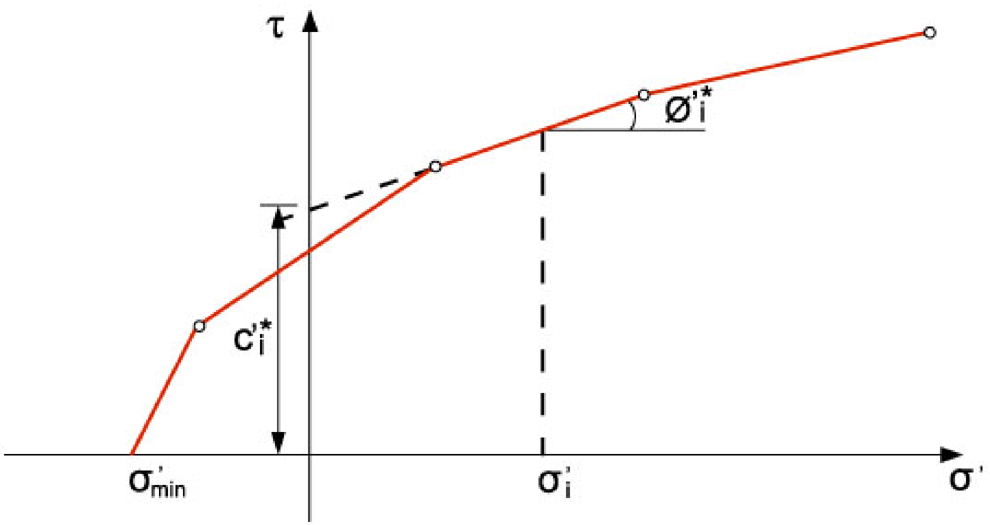
Soil properties

Options

- Cohesion anisotropy

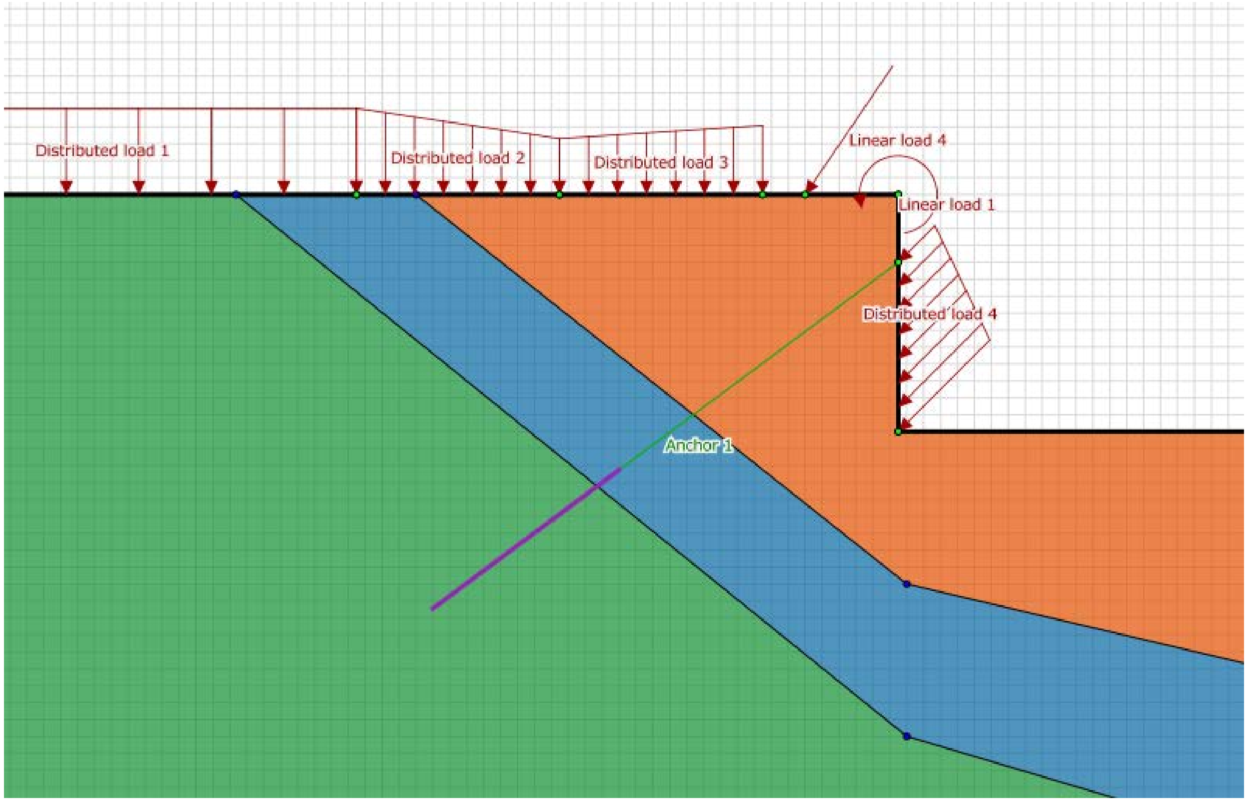


- Non-linear curve.



Loads

- Distributed loads (vertical)
- Linear loads (all angles possible)
- Additional moments



Reinforcements

4 types

Nails	Traction+Shear	Interaction soil / nail
Anchors	Traction	Interaction soil / anchor
Strips	Traction	Interaction soil / strip
Struts	Compression	No interaction

Hydraulic conditions

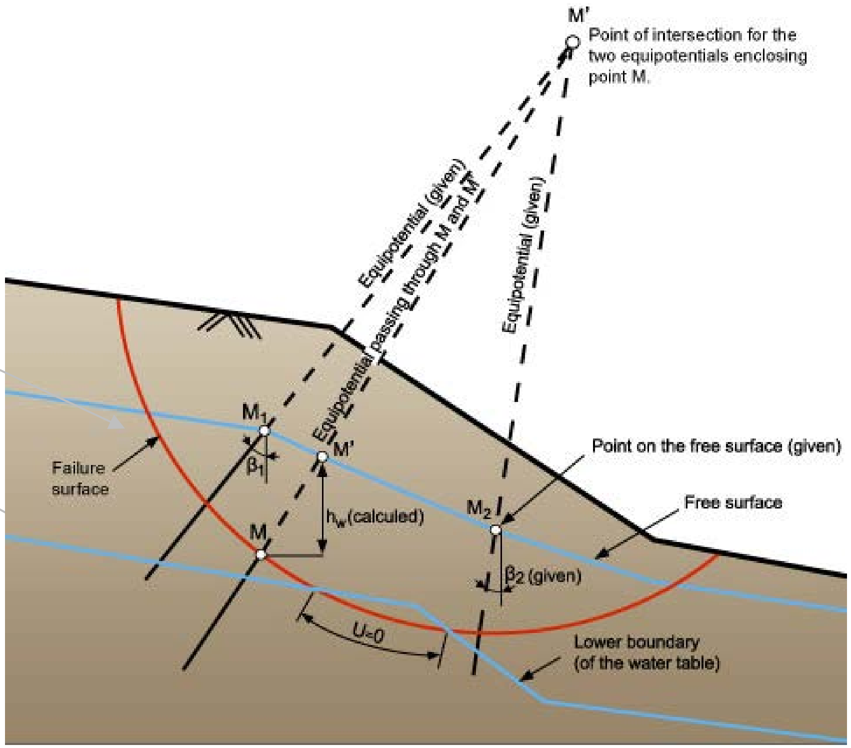
4 options

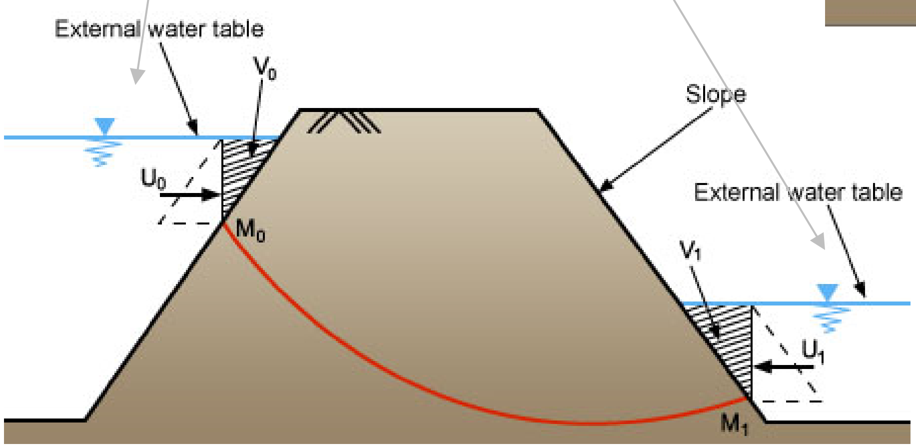
- **Phreatic line**
- **Pressures along polygonal failure surface**
- **Mesh of pore pressures**
- **ru coefficients**

Hydraulic conditions

Phreatic line:

- Water level
- Base of water table
- External water level





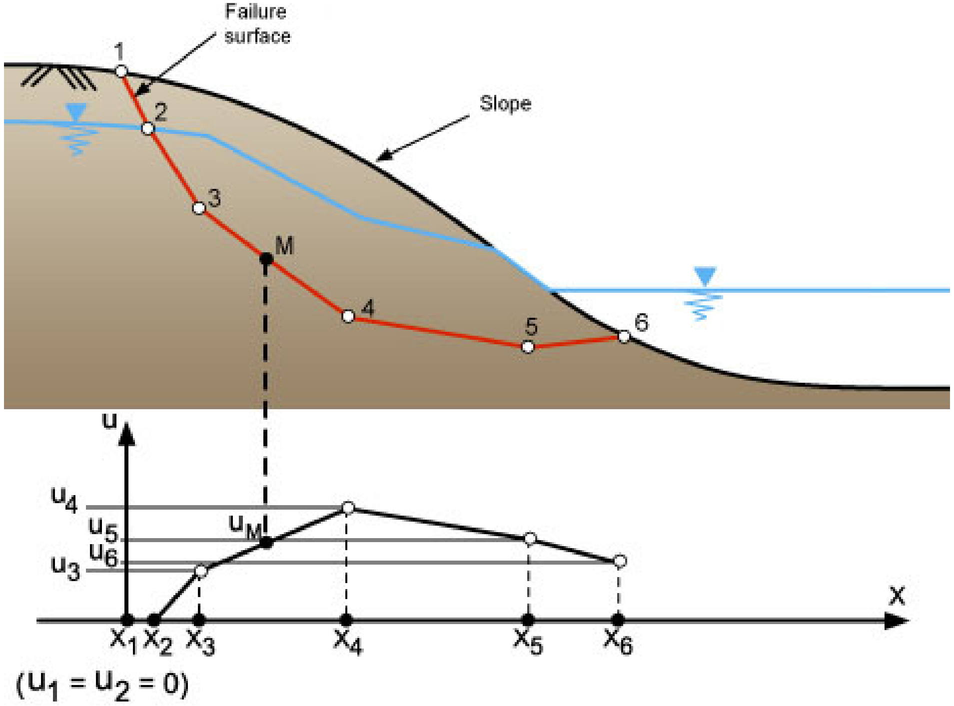
External water level: beware !

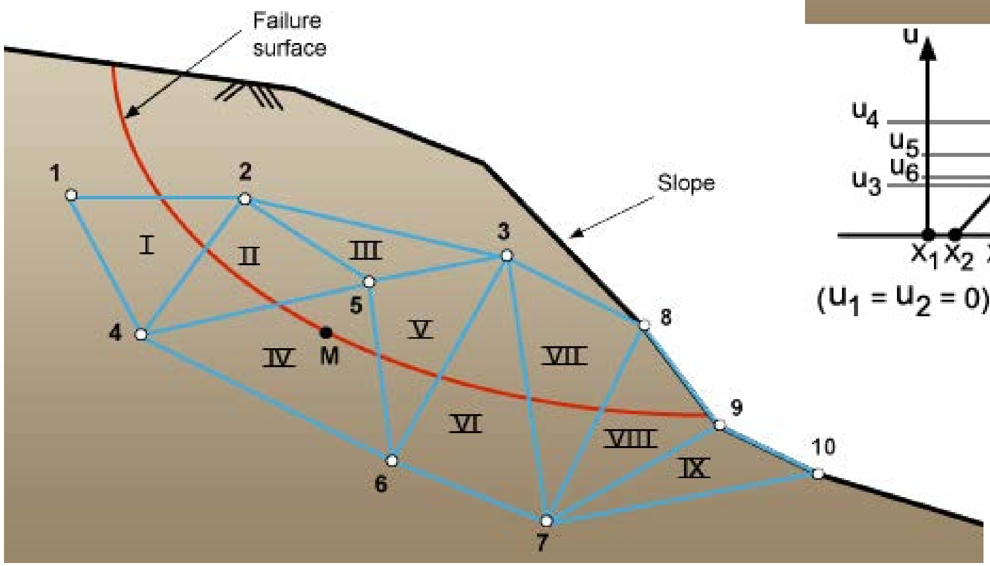
You should define first your water level for the whole width of the model, and then define also an external water level.

Hydraulic conditions

Pressures along polygonal failure surface

- Hydraulic conditions should be set on option « along non-circular failure surfaces »
- u values should be defined with the failure surface definition





- Mesh of pore pressures:

Defined manually

Imported from Plaxis

Hydraulic conditions

Coefficients ru

- Defined for each layer.
- Values can be different for each layer
- Values = 0 by default (no ru coefficient taken into account in any layer).

Reset all ru values to zero

N°	Soil layer name	ru
1	Soil layer 1	0,00
2	Soil layer 2	0,00
3	Soil layer 3	0,00

During calculations

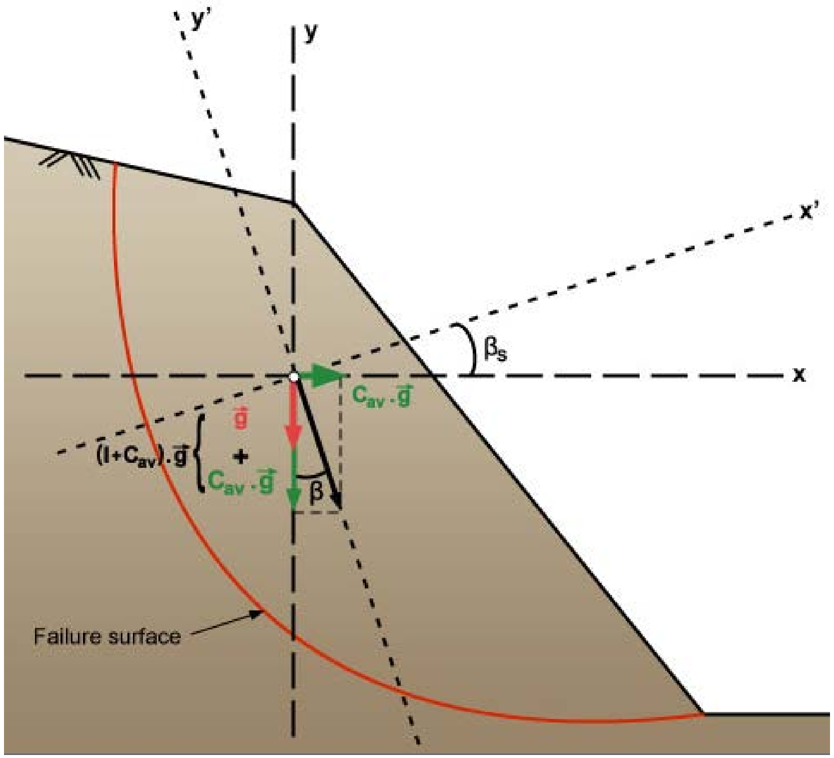
- In layers where ru ≠ 0: u = ru.g.h
- In layers where ru = 0: other existing hydraulic conditions are taken into account. For example, if a water table is defined, it will be taken into account to calculate u in layers with ru = 0.

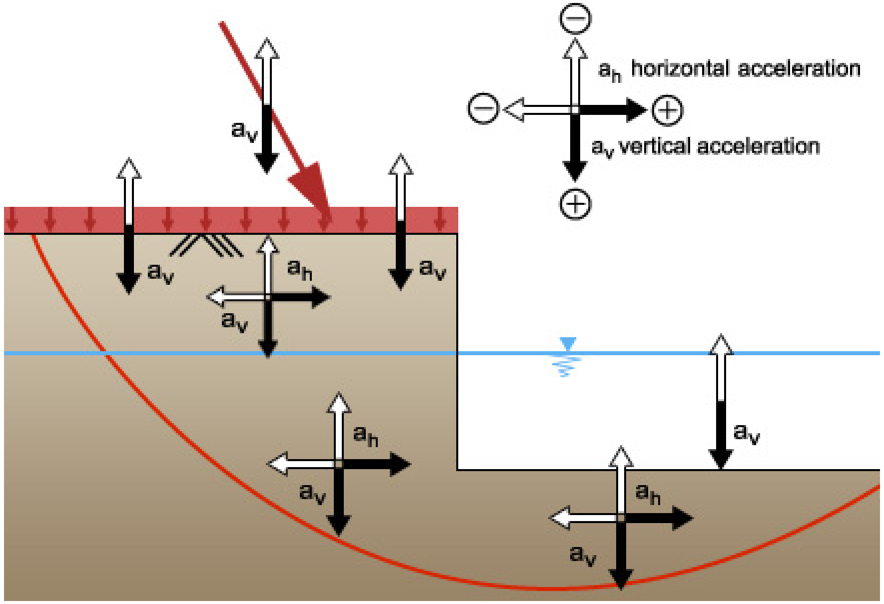
- Beware: ru cannot be combined with external water levels.

Seismic : pseudo-static method

Horizontal and vertical accelerations.

4 signs combinations should be tested.





Partial safety factors

Talren enables Ultimate Limit State analysis, taking into account partial safety factors.

Partial weighting factors

Method factor

Partial safety factors

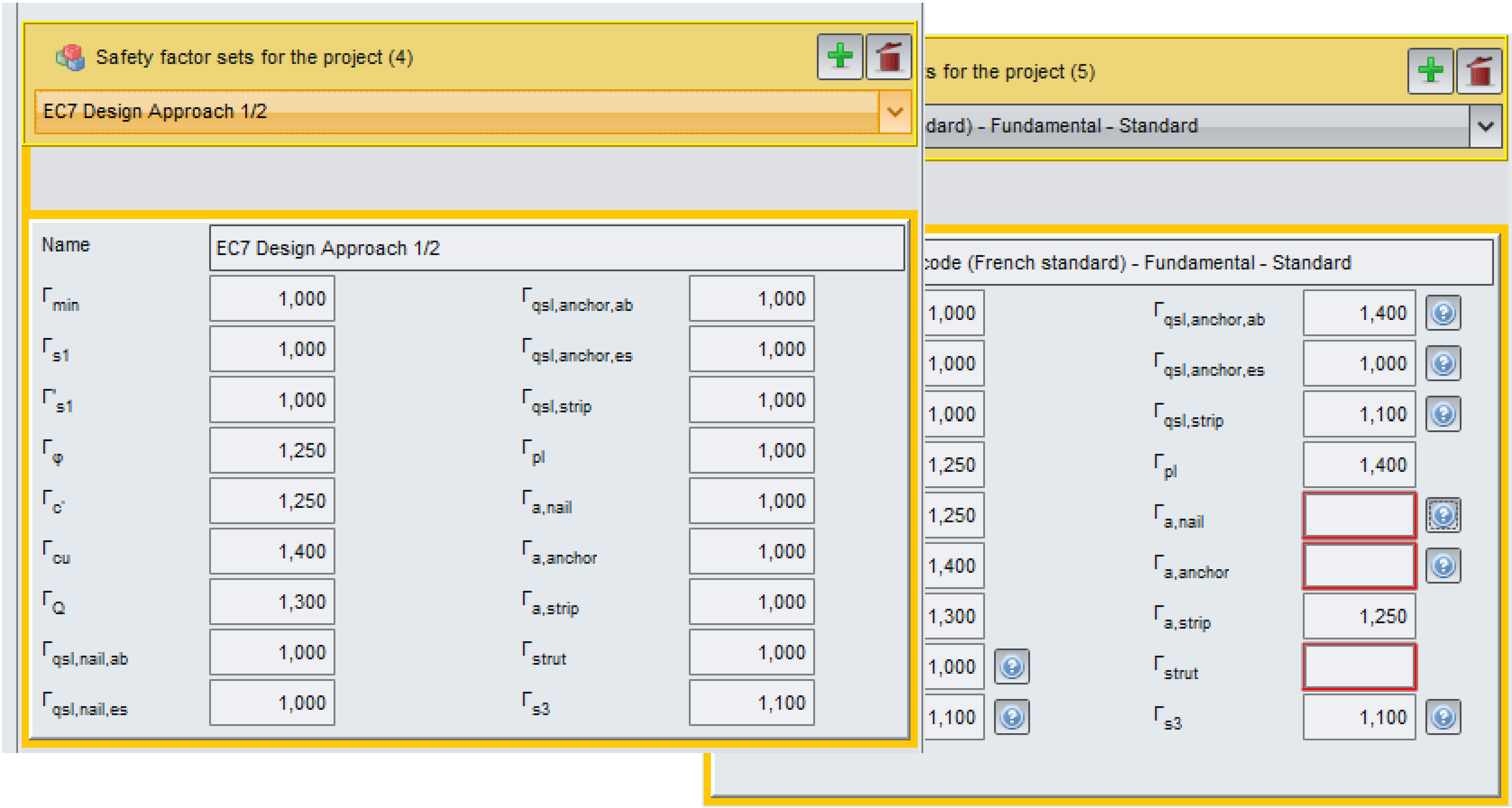
(0) $$\Gamma_{S3}\,\tau\,(\Gamma_{S1}\cdot G\ ,\ \Gamma_Q\cdot Q\ ,\ G_W) \leq \tau_{max}\left(\frac{\tan\phi}{\Gamma_\phi}\ ,\ \frac{c}{\Gamma_c}\right)$$

An additional coefficient Γ is included to establish the equality. This coefficient should be greater than or equal to 1 to ensure equilibrium.

(0a) $$\Gamma\,\Gamma_{S3}\,\tau = \tau_{max}$$

Calculation result: global safety factor

Partial safety factors



Tables issued from the EUROCODE and Clouterre recommendations
for nailed and mixed (nails+anchors) structures

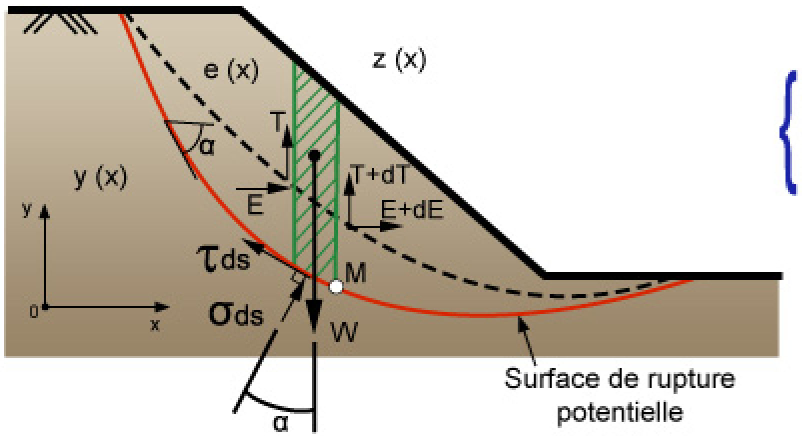
Calculation options

4 options

- Slice methods: Fellenius, Bishop.
- Global method: Perturbations.
- Yield design method (logarithmic spirals): detailed in a separate presentation.

Fellenius and Bishop calculation methods

Slice methods: Fellenius, Bishop



Equilibre d'une tranche :

$$\begin{cases} Ox : dE + \sigma \sin\alpha \, ds + \tau \cos\alpha \, ds = 0 & (1) \\ Oy : dT + \sigma \cos\alpha \, ds - \tau \sin\alpha \, ds = \gamma h \, dx & (2) \end{cases}$$

$$h = z - y(x)$$

$$ds = \frac{dx}{\cos\alpha}$$

Moment / M

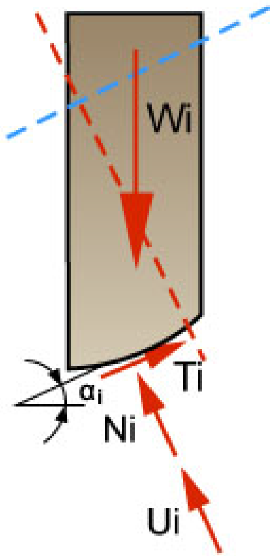
$$T + E\frac{de}{dx} + (e - y)\frac{dE}{dx} = 0 \qquad (3)$$

(1)
(2) + **Conditions aux limites** + $\left(\tau = \frac{c' + (\sigma - u) \operatorname{tg} \varnothing'}{F} \right)$ ⟷ σ (x), T (x), E (x), e (x), F **4 fonctions inconnues**

Fellenius and Bishop calculation methods

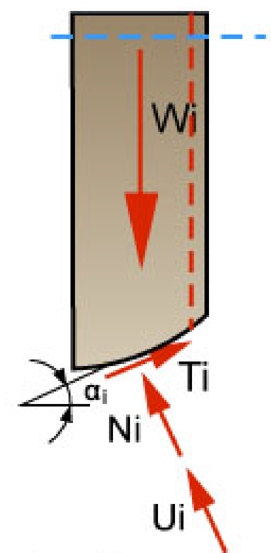
Additional assumptions necessary to solve the system:

Fellenius



$$\sigma' = \gamma h \cos^2\alpha + \frac{dU}{dx} \sin\alpha \cos\alpha - u$$

Bishop



$$\sigma' = \frac{\gamma h - u - \frac{C}{F} \mathrm{tg}\,\alpha}{\left(1 + \mathrm{tg}\alpha \frac{\tan\varphi}{F}\right)} = \frac{\gamma h - u - \frac{C}{F} \mathrm{tg}\,\alpha}{m(\alpha)}$$

F calculation based on moments →

$$F = \frac{M_{resisting}}{M_{driving}}$$

Perturbations calculation method

Global method: Perturbations (Raulin, Rouques, Toubol, LCPC 1974)

Global method: ≠ slice method

$$\sigma' = \overbrace{\left[\gamma h \cos^2\alpha + \frac{du}{dx} \sin\alpha \cos\alpha - u\right]}^{\sigma_{Fel}} \left[\lambda + \mu (tg\alpha)^n\right]$$

avec $n = 1$ ou 2

⇒ 3 équations

3 inconnues: λ, μ, F

⇒ $a_0 F^3 + a_1 F^2 + a_2 F + a_3 = 0$

⇒ F

$\lambda\,(-1)$

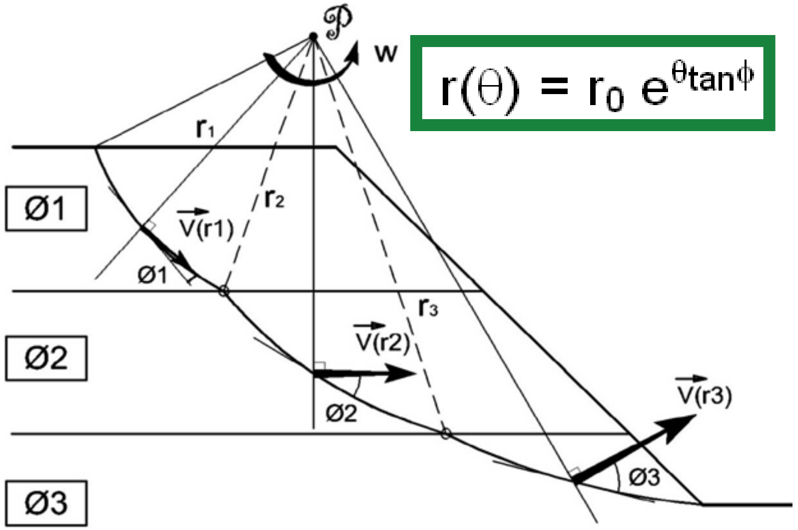
$\mu\,(-0)$

All equilibrium equations are satisfied.

Yield design method

- Developped by Jean Salençon, in the 1980s.
- Virtual velocity field (one block mechanism).
- Mohr-Coulomb criterion.
- Logarithmic spiral: leads to the **lowest upperbound value**.
  $F = P_{rm}/P_e = M_{rm}/M_e = M_{maximum\ resistance}/M_{external\ forces}$
  M_{rm} is maximum for logarithmic spirals ($\Rightarrow$ upperbound solution).
  F is called « failure coefficient » or « trust factor ».
  Upperbound value: $F < 1.0 \Rightarrow$ failure; $F \geq 1.0 \Rightarrow$??
- No « slide » surface: velocities are not tangent to the block boundary; they are perpendicular to the radius.

- The spiral radius depends on the friction angle: the spiral is indeed composed of several spiral « pieces » having the same pole. Discontinuities are possible when changing layer (if friction angles are different).



Yield design method

Comparaison with «classical » methods

Exemple

Talus H = 7 m, β = 49,4°

Couche unique ϕ = 20° , c = 10 kPa

Calcul à la rupture

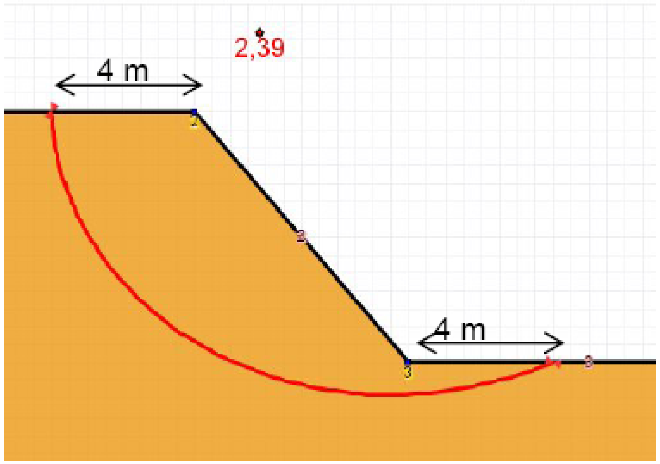
Spirale angle au centre 110°

Calcul sans pondération partielle

$\Gamma_\phi = 1, \Gamma_c = 1$

Résultat : F = 2,39

(coefficient de rupture
ou facteur de confiance)



Comparaison for F = 1

Calcul à la rupture

Introduction de la pondération supplémentaire XF sur tanϕ et c

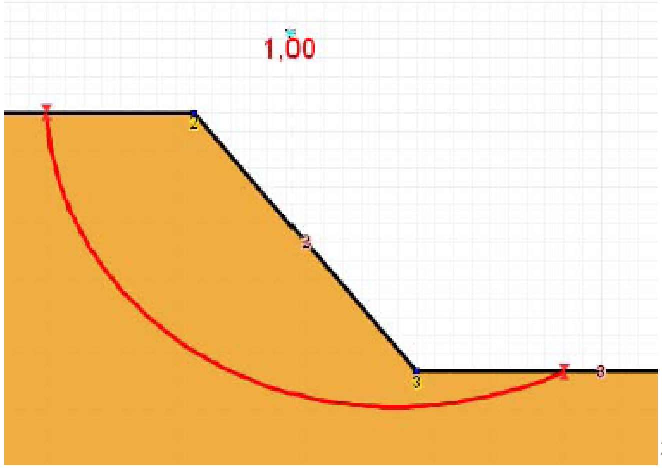
$\Gamma_\phi = XF, \Gamma_c = XF$

Recherche de XF pour obtenir F = 1

Introduction of XF coefficient

Résultat : XF = 1,27

(coefficient de sécurité "équivalent" à ceux calculés par les méthodes de Fellenius, Bishop ou des perturbations)



Yield design method

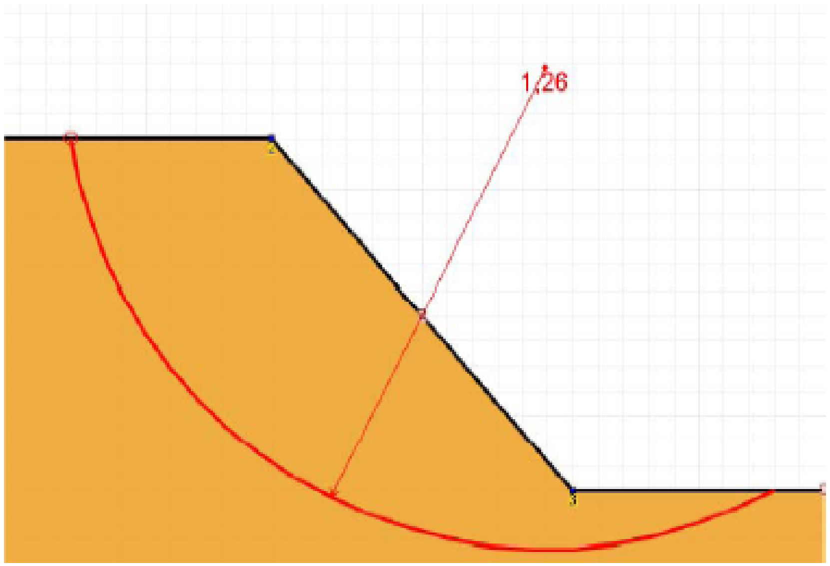
Comparaison à une méthode traditionnelle

Calcul Bishop

Cercle de mêmes extrémités et angle au centre 110 °

$\Gamma_{\phi} = 1$, $\Gamma_{c} = 1$

Résultat : F = 1,26



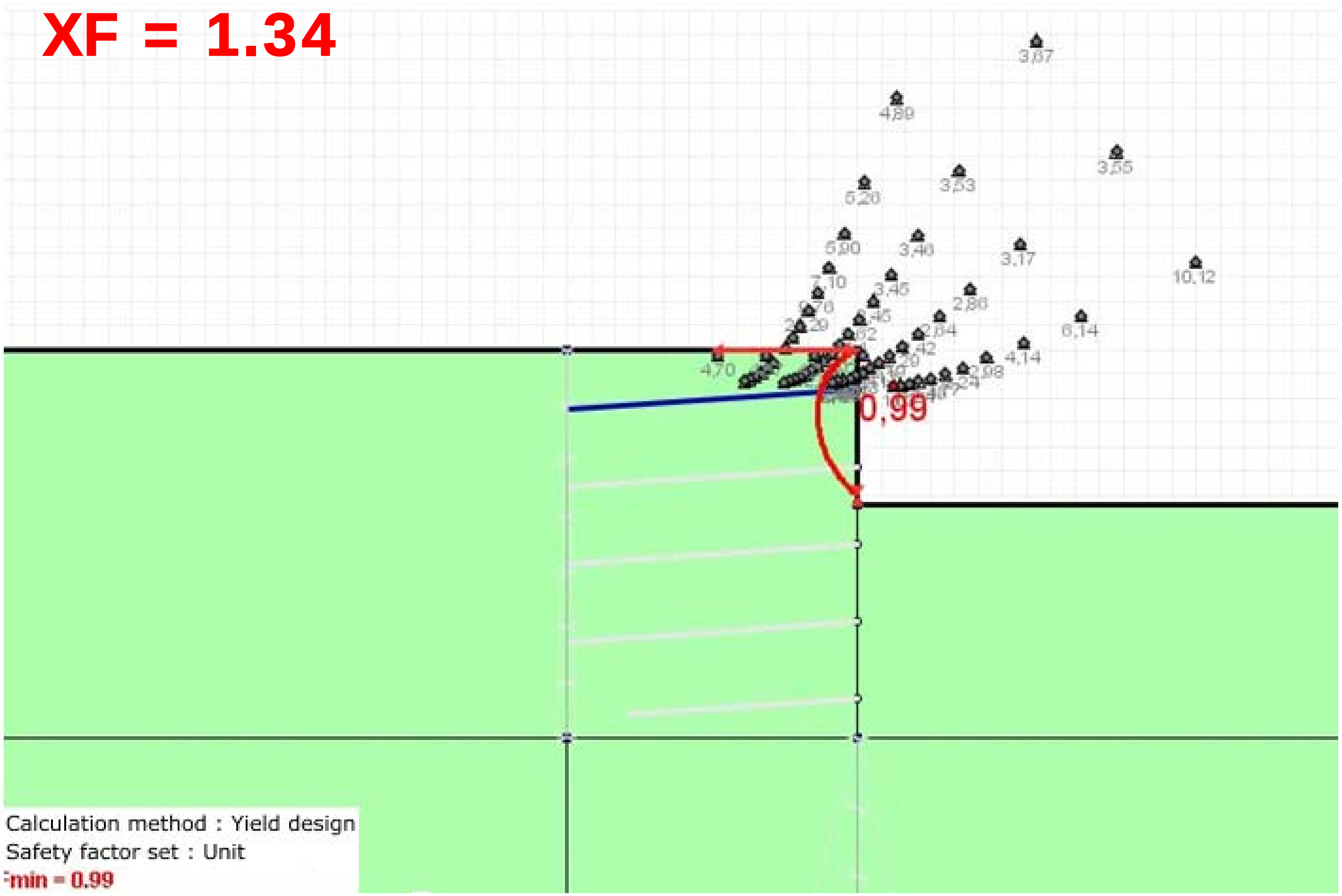
Publication

“Application du calcul à la rupture aux soutènements”, B. SIMON
ENPC – Symposium international ELU/ULS - Paris, Août 2006

Yield design method

Critical mechanism for 2^{nd} stage of excavation

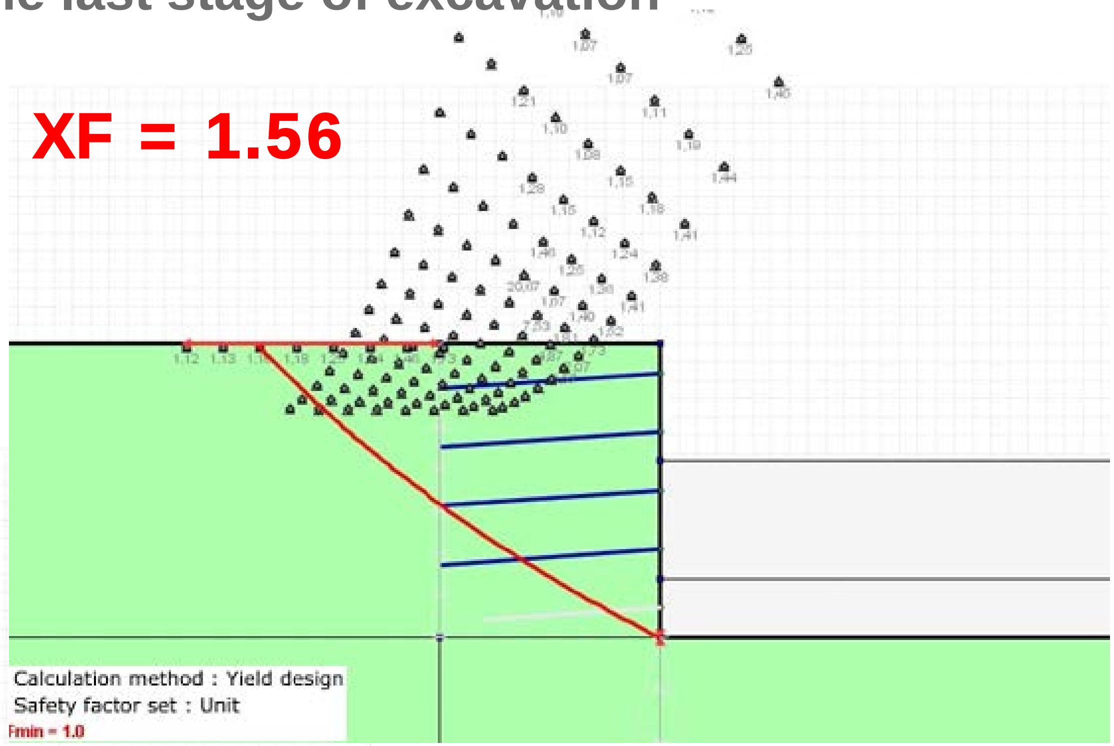
Fonctionnalités de recherche étendues



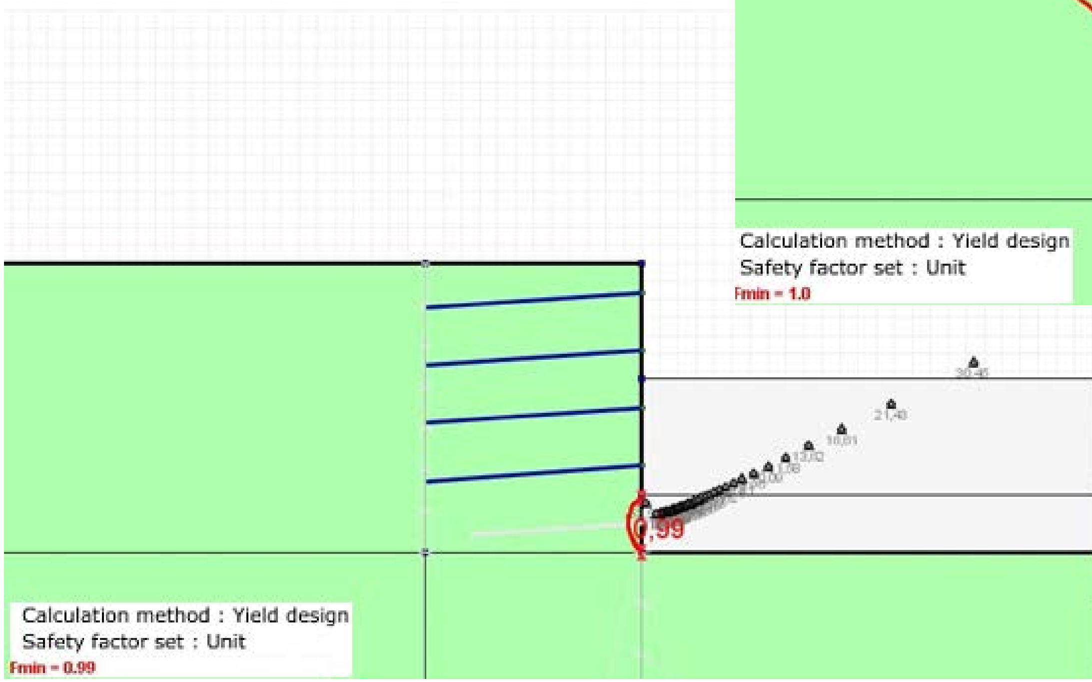
Yield design method

Critical mechanism for the last stage of excavation

XF = 1.56

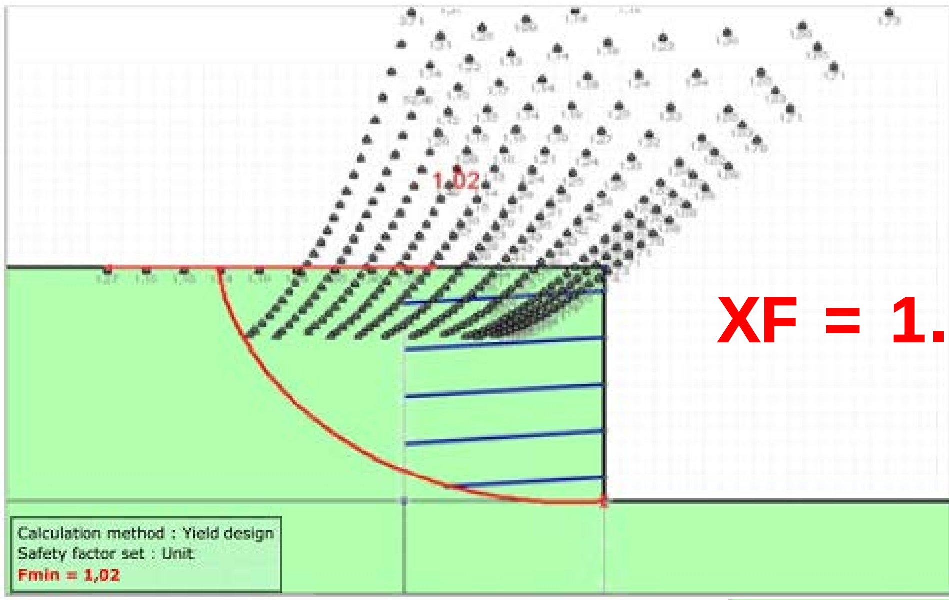


XF = 1.27

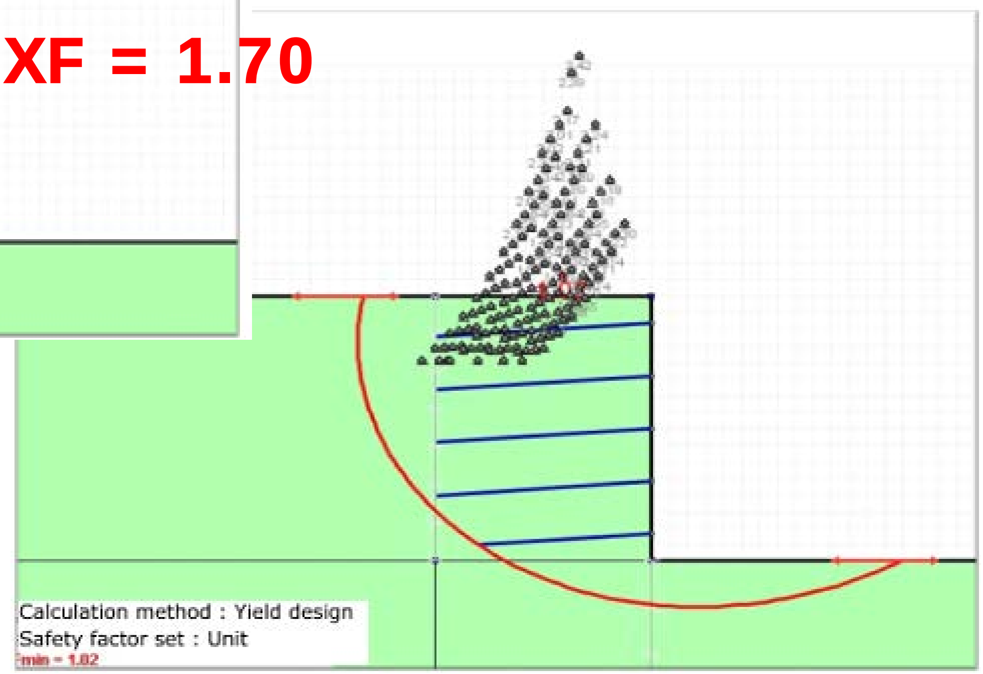


Yield design method

XF = 2.16



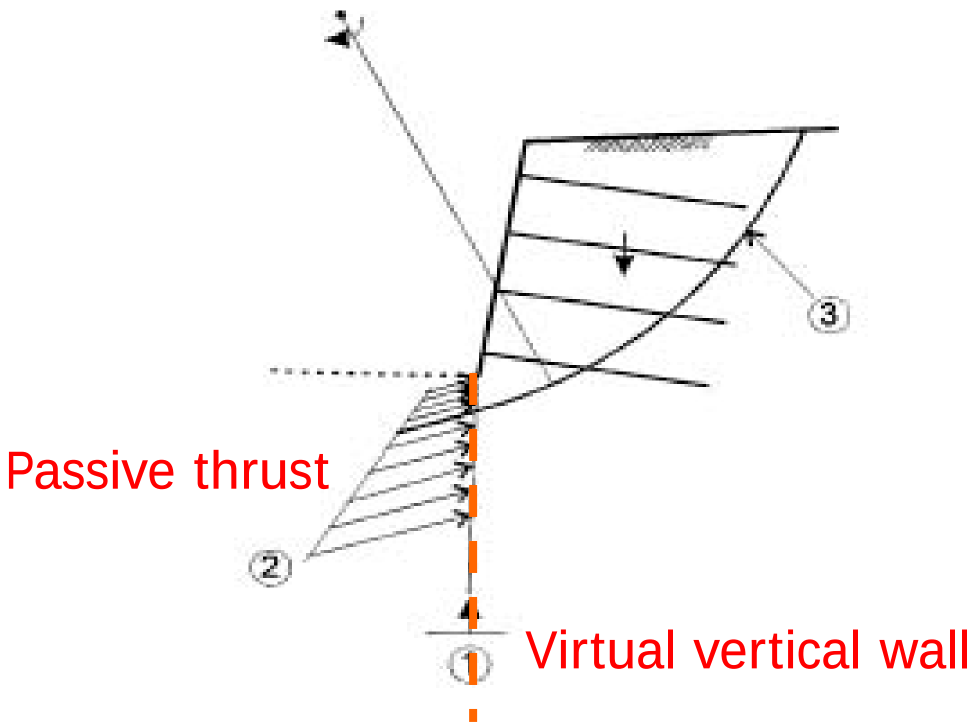
XF = 1.70

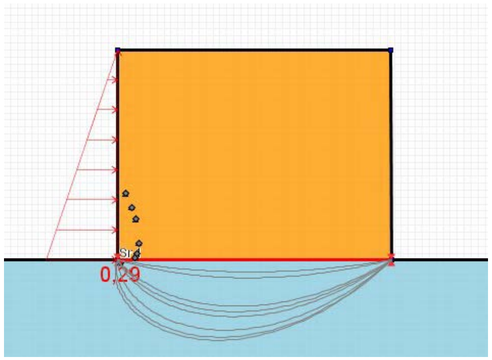


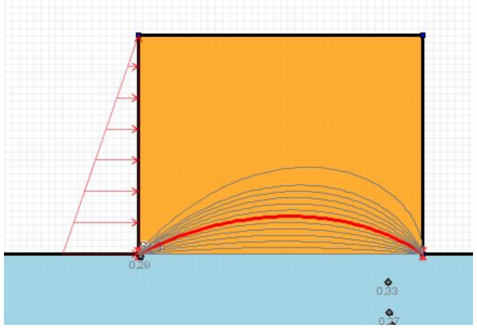
Yield design method

Options available with the Yield Design Method

- Inclined distributed loads can be taken into account.
- Active and passive earth pressures can be evaluated.
- Gabions can be calculated (concavity can be explored upwards and downwards to find the most unfavourable geometry).







Failure surfaces

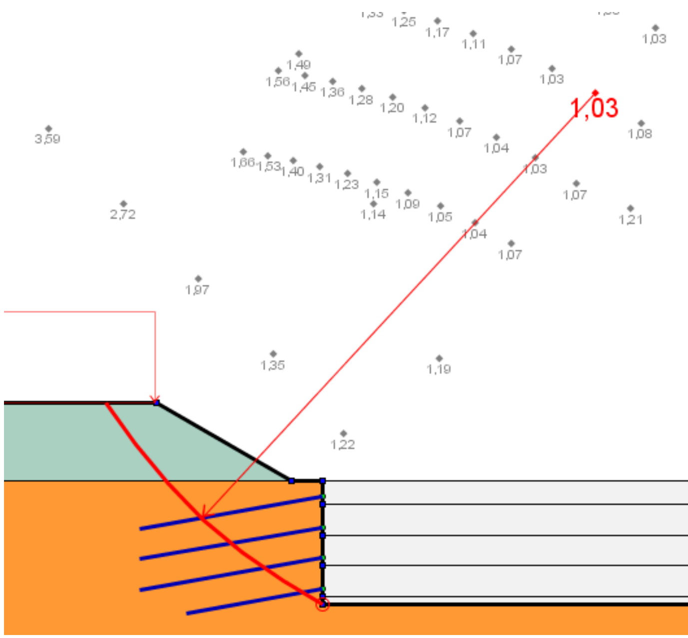
Failure surfaces: circular, polygonal or logarithmic spirals

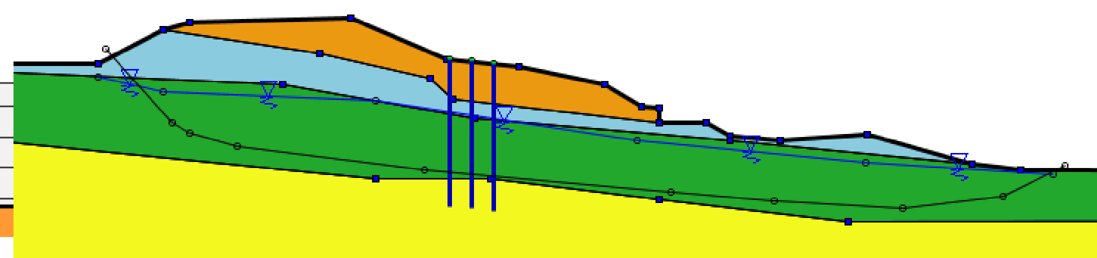
Search mode:

- **Manual search**
- **Automatic search**

1st circle for each centre:

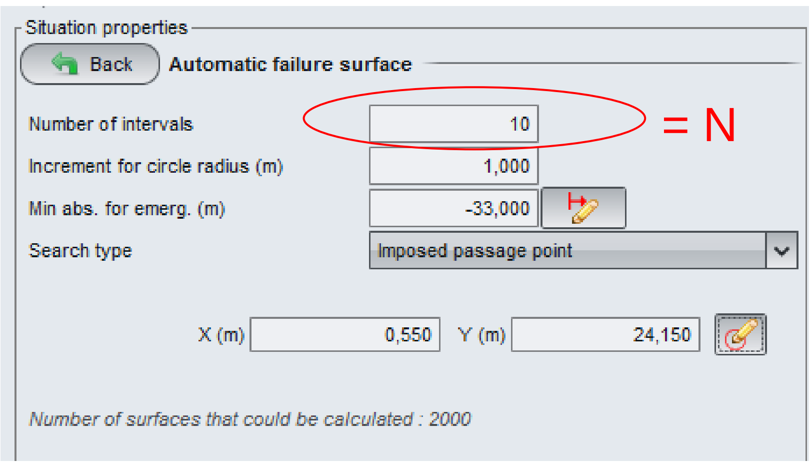
- Imposed passage point
- Smallest radius intercepting slope
- Tangent to a given soil layer

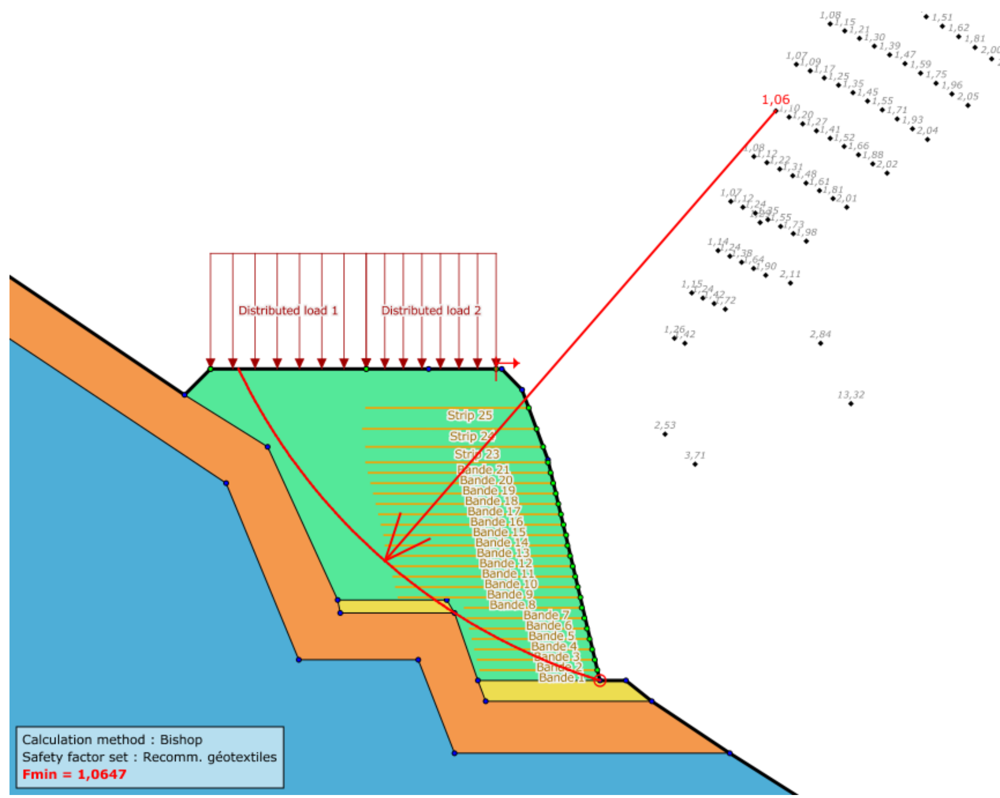




Automatic search

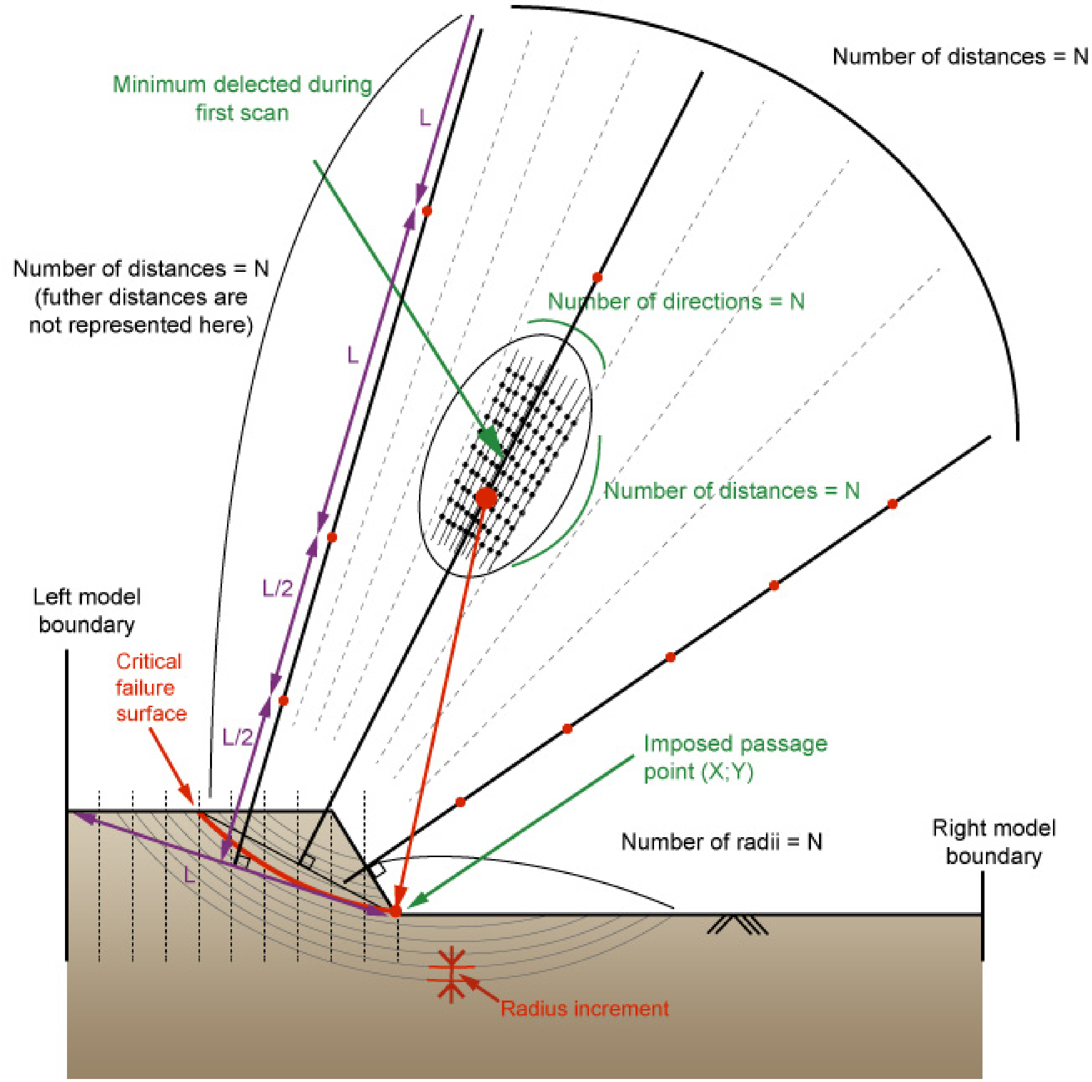
- Automatic search option for circular failure surfaces:
  Talren scans the area for possible circle centers.





Automatic search

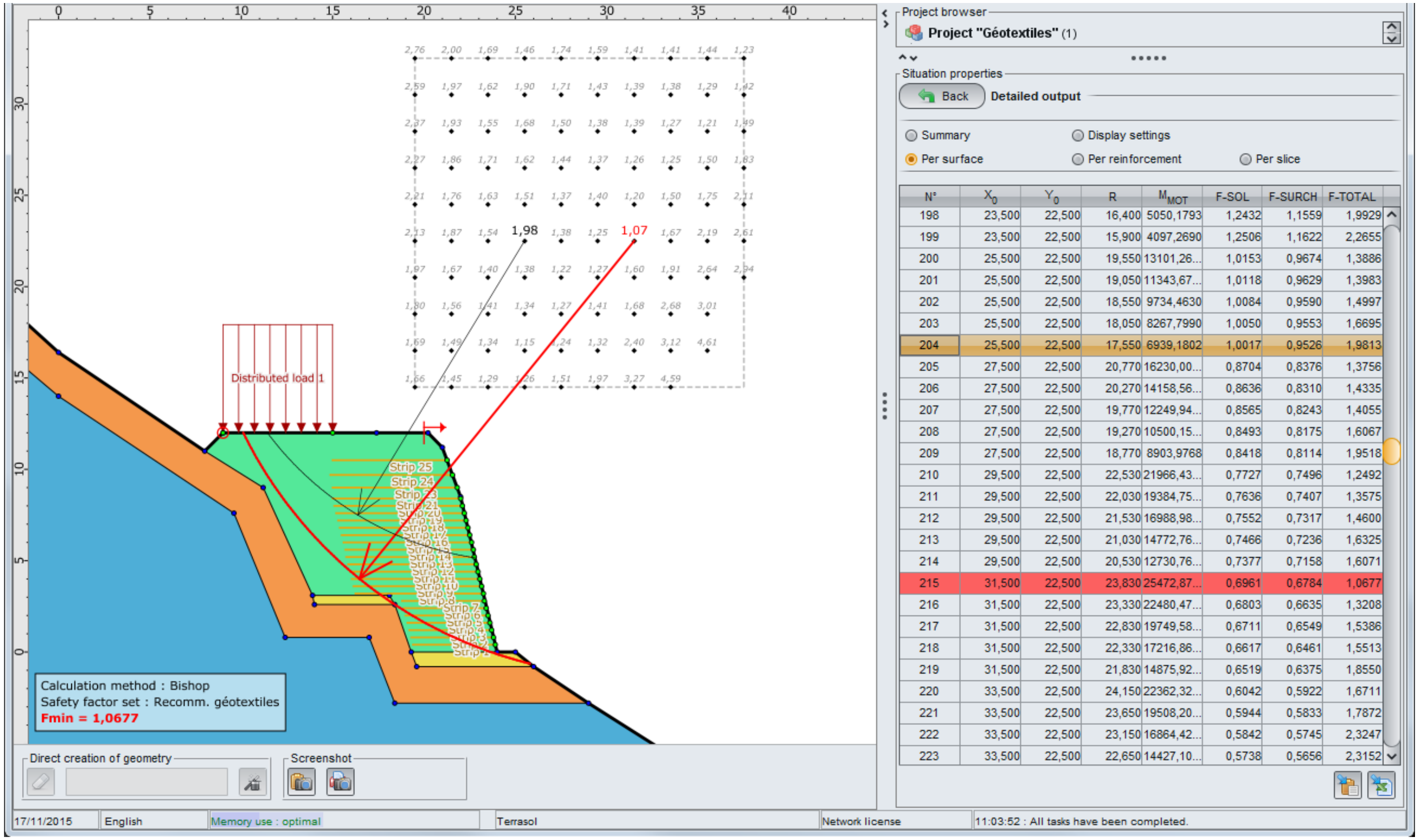
Automatic search of the critical circle with imposed point for the first calculated circle



Output

Default graphical display of results:

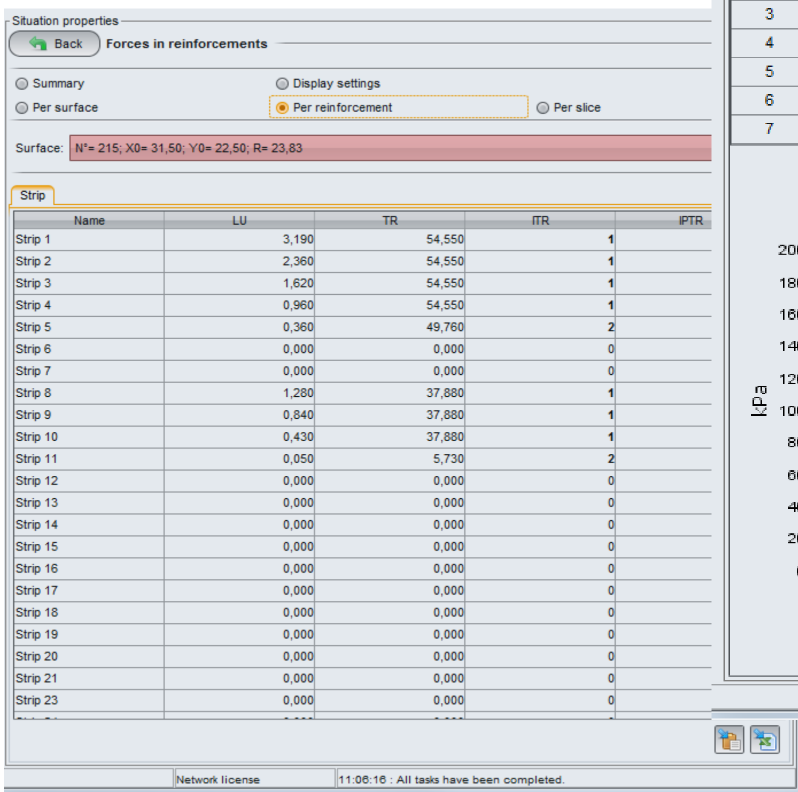
- Factor of safety and the most critical failure suface.
- Factor of safety for all calculated surfaces



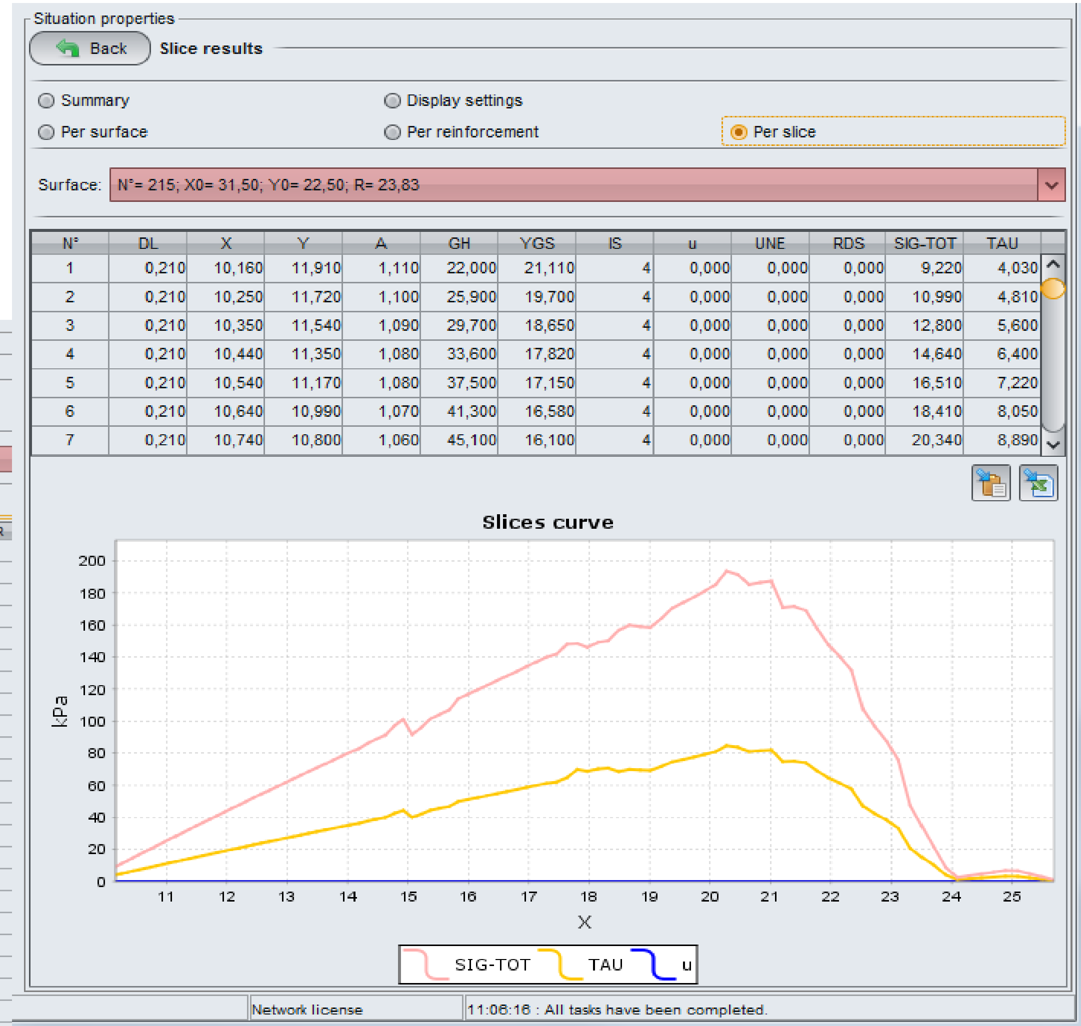
Detailed output

Complementary options

- Forces in reinforcements
- Detailed results per slices



Name	LU	TR	ITR	IPTR
Strip 1	3,190	54,550	1	
Strip 2	2,360	54,550	1	
Strip 3	1,620	54,550	1	
Strip 4	0,960	54,550	1	
Strip 5	0,360	49,760	2	
Strip 6	0,000	0,000	0	
Strip 7	0,000	0,000	0	
Strip 8	1,280	37,880	1	
Strip 9	0,840	37,880	1	
Strip 10	0,430	37,880	1	
Strip 11	0,050	5,730	2	
Strip 12	0,000	0,000	0	
Strip 13	0,000	0,000	0	
Strip 14	0,000	0,000	0	
Strip 15	0,000	0,000	0	
Strip 16	0,000	0,000	0	
Strip 17	0,000	0,000	0	
Strip 18	0,000	0,000	0	
Strip 19	0,000	0,000	0	
Strip 20	0,000	0,000	0	
Strip 21	0,000	0,000	0	
Strip 23	0,000	0,000	0	



N°	DL	X	Y	A	GH	YGS	IS	u	UNE	RDS	SIG-TOT	TAU
1	0,210	10,160	11,910	1,110	22,000	21,110	4	0,000	0,000	0,000	9,220	4,030
2	0,210	10,250	11,720	1,100	25,900	19,700	4	0,000	0,000	0,000	10,990	4,810
3	0,210	10,350	11,540	1,090	29,700	18,650	4	0,000	0,000	0,000	12,800	5,600
4	0,210	10,440	11,350	1,080	33,600	17,820	4	0,000	0,000	0,000	14,640	6,400
5	0,210	10,540	11,170	1,080	37,500	17,150	4	0,000	0,000	0,000	16,510	7,220
6	0,210	10,640	10,990	1,070	41,300	16,580	4	0,000	0,000	0,000	18,410	8,050
7	0,210	10,740	10,800	1,060	45,100	16,100	4	0,000	0,000	0,000	20,340	8,890