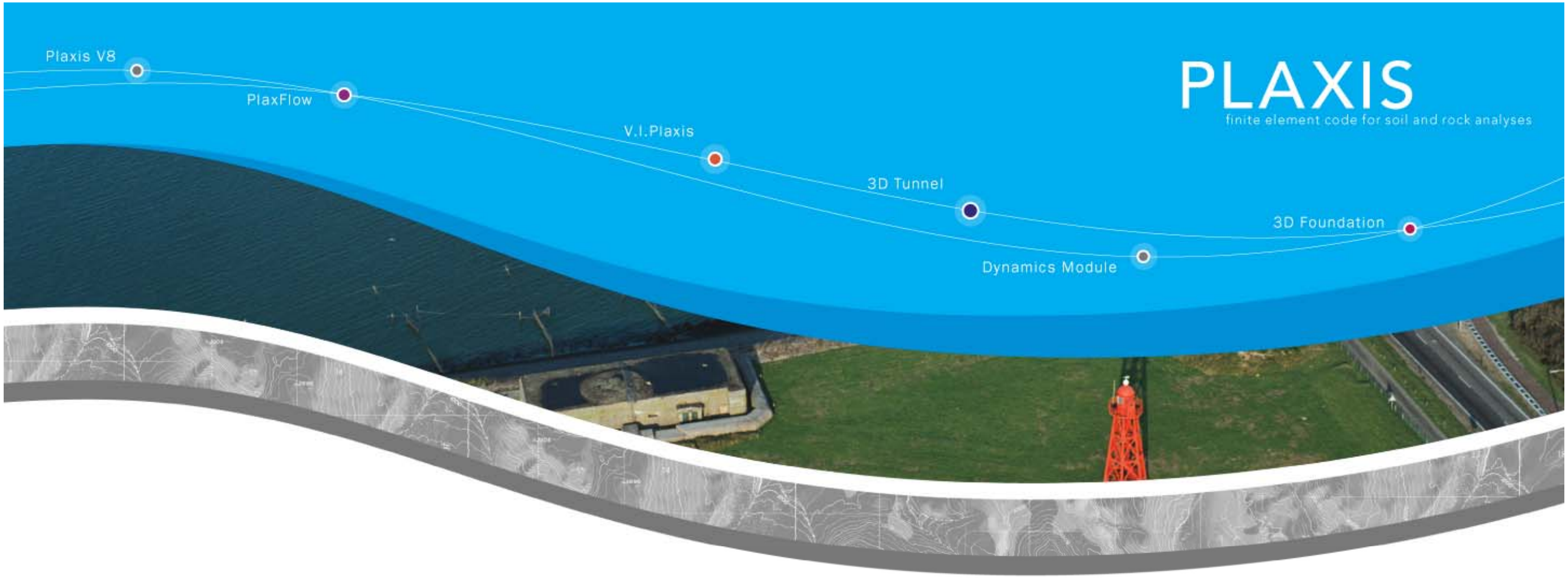


Initial Stresses

Dennis Waterman

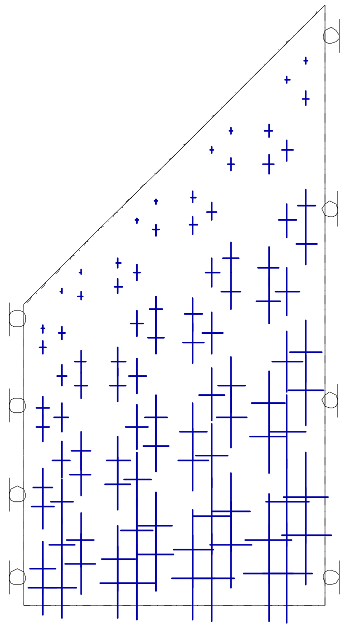
Plaxis BV

Initial stresses

- Initial stresses represent the equilibrium state of the undisturbed soil and consist of:
  - Soil weight
  - Loading history
- In Plaxis two possibilities exist:
  - K_0 procedure
  - Gravity loading

K_0-procedure

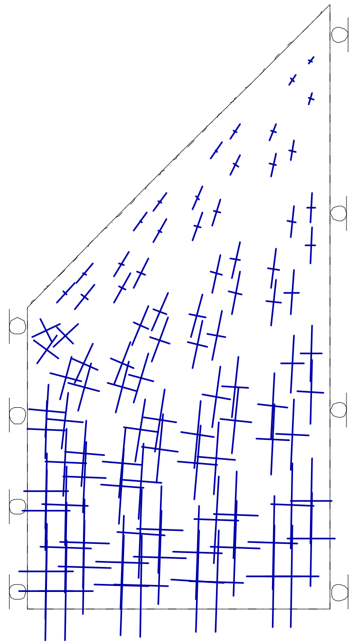
- Generation of initial stresses during input.
  - Needed:
    Coefficient for lateral earth pressure K0.
  - Disadvantage:
    No equilibrium for inclined surface
  - Advantage:
    No displacements are generated, only
    stresses.



$$\sigma'_h = \sigma'_v \bullet K_0$$

Gravity loading

- Calculation of initial stresses by weight loading.
  - Disadvantage:
    Non-physical displacements are created.
  - Advantage:
    Equilibrium satisfied in all cases.



For 1D compression: $\sigma'_n = \sigma'_v \bullet \frac{\nu}{1-\nu}$ so $K_0 = \frac{\nu}{(1-\nu)}$

Gravity loading

Procedure

- Initial phase
  - Skip K_0 procedure, ΣMweight remains zero
- Phase 1
  - Choose *Plastic calculation*, *Total multipliers*
  - Set weight multiplier ΣMweight = 1
- Phase 2
  - Select *Reset displacements to zero* to discard all displacements from raising the gravity

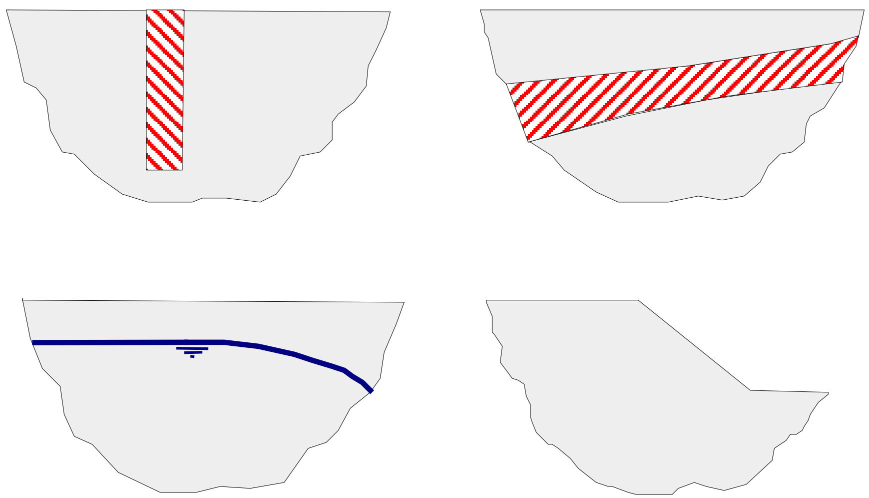
Gravity loading

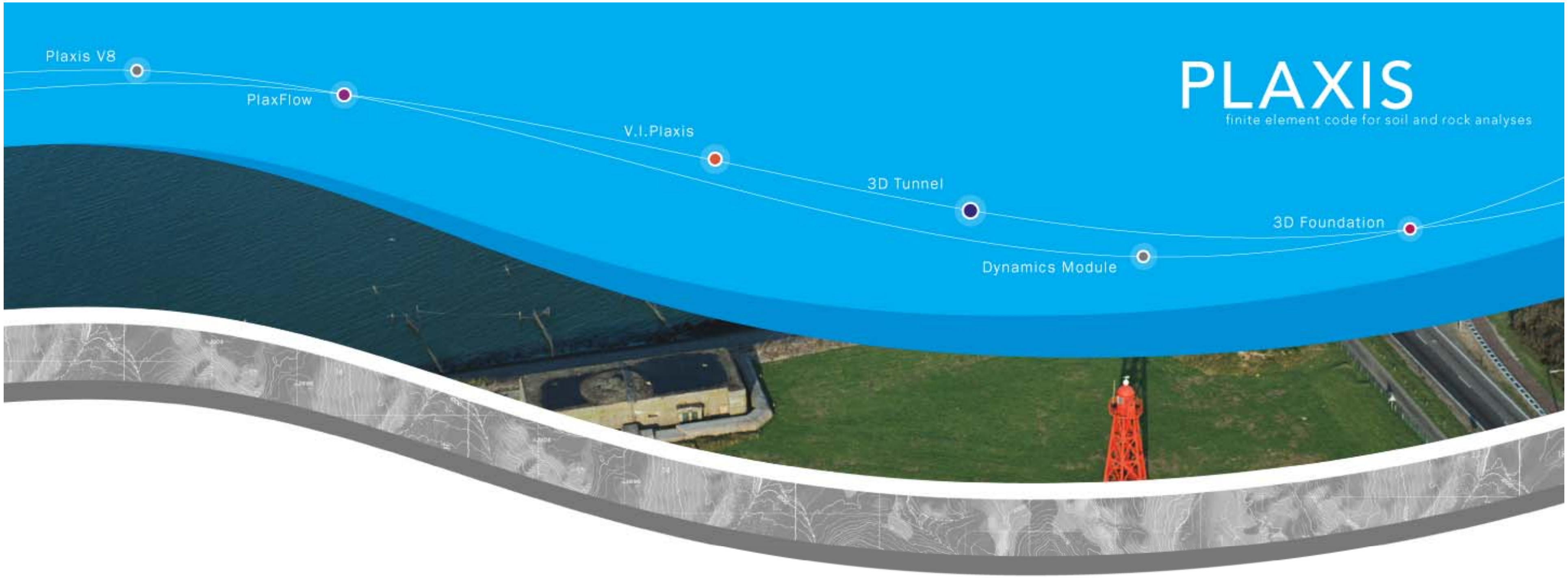
Notes

- Undrained material
  - Select *Ignore undrained behaviour* in Phase 1 to prevent the generation of unrealistic excess pore pressures
- K_0 procedure has been used first
  - In the Initial phase redo the K_0 procedure, but with ΣMweight = 0; this will reset all initial stresses to zero.

Gravity loading

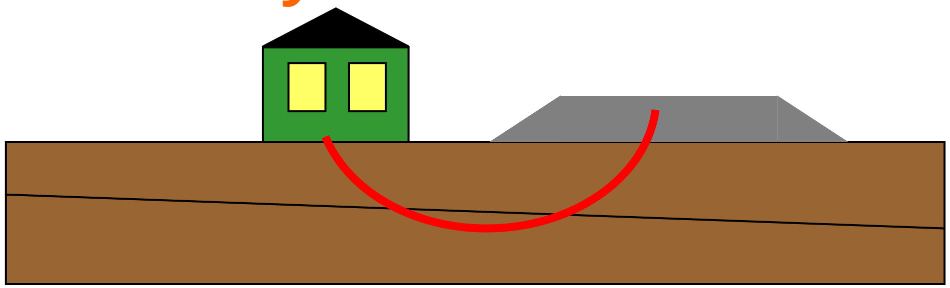
Cases where gravity loading should be used instead of K_0-procedure:





Safety Factor Analysis

Safety factor analysis

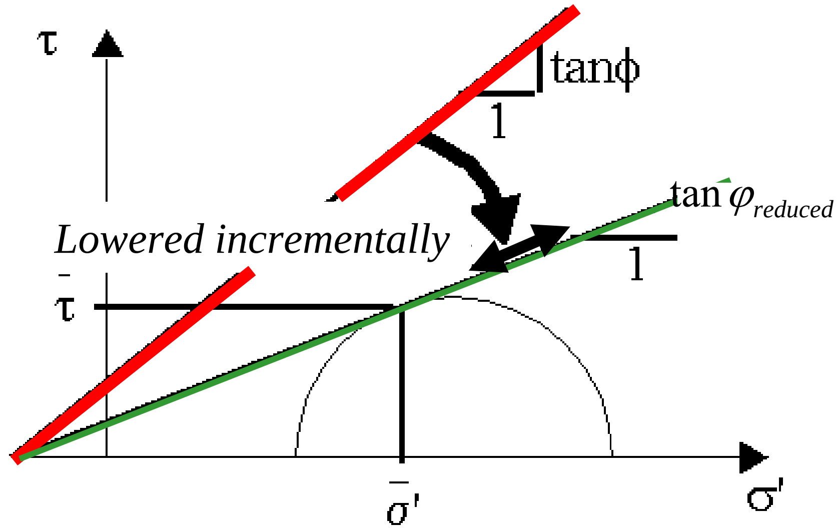


- Strength reduction method: Phi/c reduction
- Provides a “conventional” safety factor
- Same numerical tool as for serviceability design
- Automatically detects most critical failure mechanism

Safety factor analysis

- Phi/c reduction:
  - Reduction of strength parameters *c* and *tan(ϕ)* until failure is reached.
  - The factor of safety :

$$\Sigma Msf = \frac{c}{c_{reduced}} = \frac{\tan\varphi}{\tan\varphi_{reduced}}$$



Safety factor analysis

Calculation procedure:

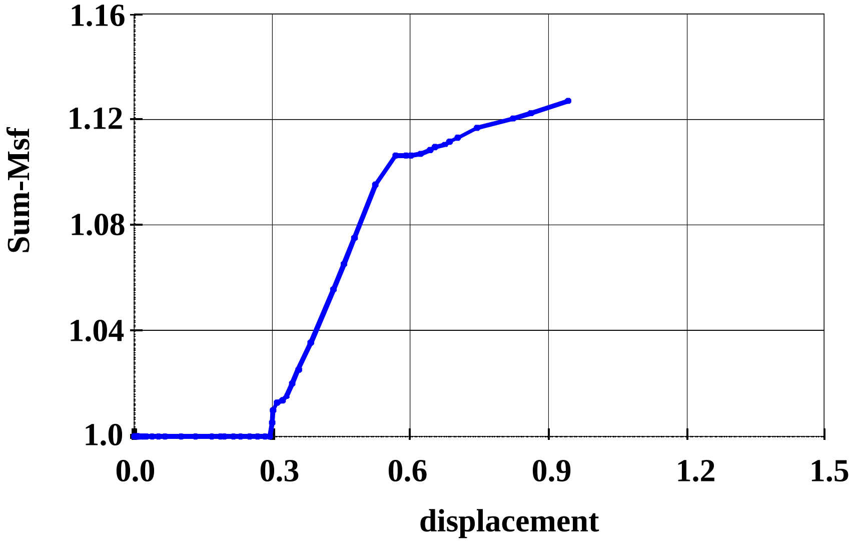
- Create a phi/c reduction phase
- Accept the default increment for Msf=0.1 from the multiplier tab-sheet.
- Calculate
- Carefully examine ΣMsf vs. displacement curve in Plaxis Curves

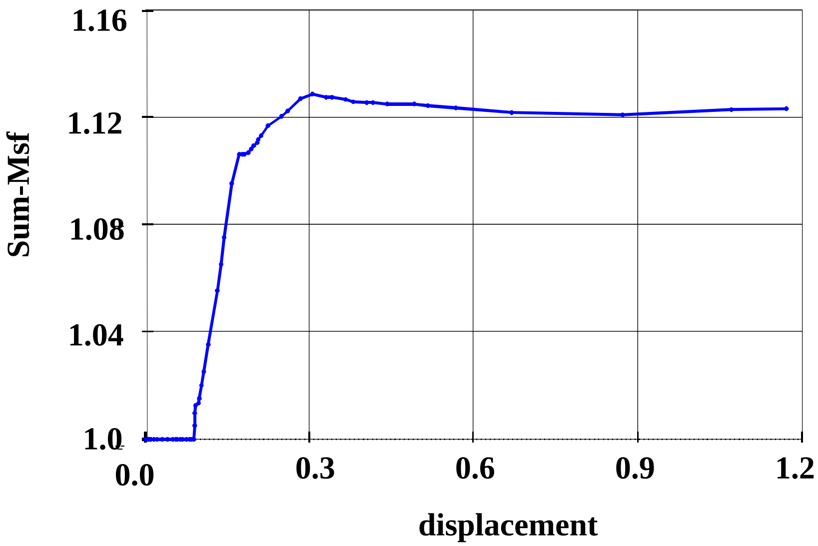
Safety factor analysis

- Notes:
  - Select control point within (expected) failing body
  - Use sufficient number of load steps
  - Use a sufficiently fine mesh
  - Limit the maximum structural forces by choosing elasto-plastic behaviour for walls, anchors and geotextiles.

Safety factor analysis

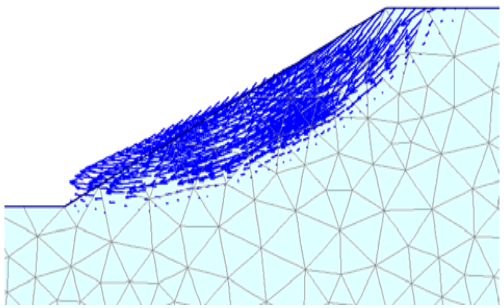
Number of load steps



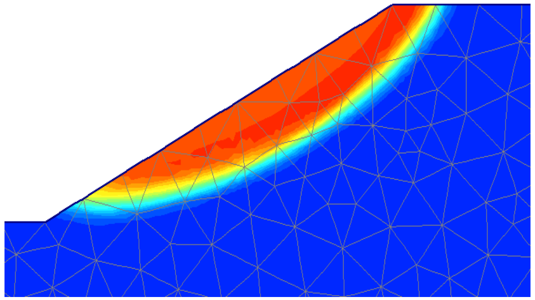


Safety factor analysis

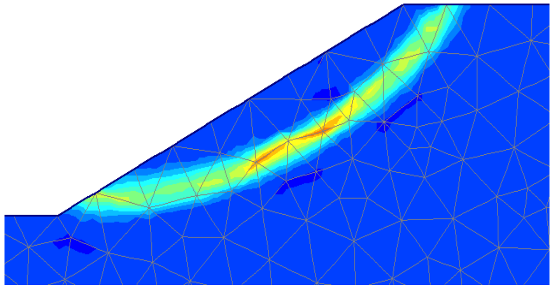
Use different plots to check failure mechanisme



1. *Arrows of incremental displacements*

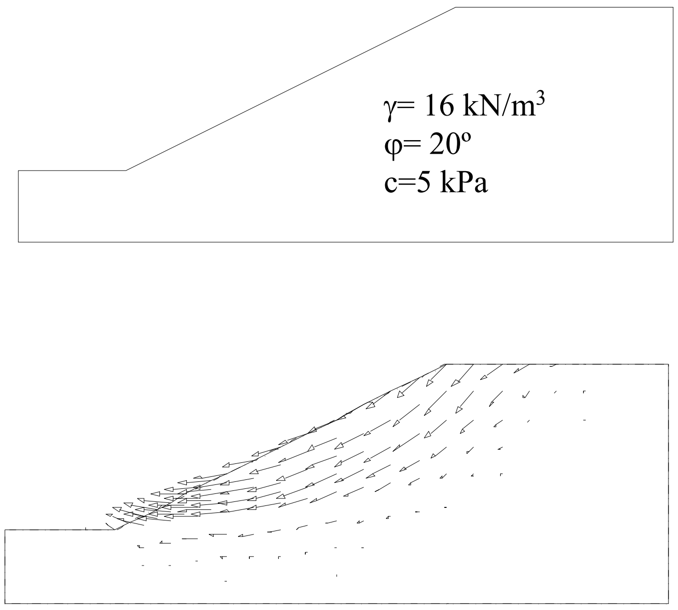


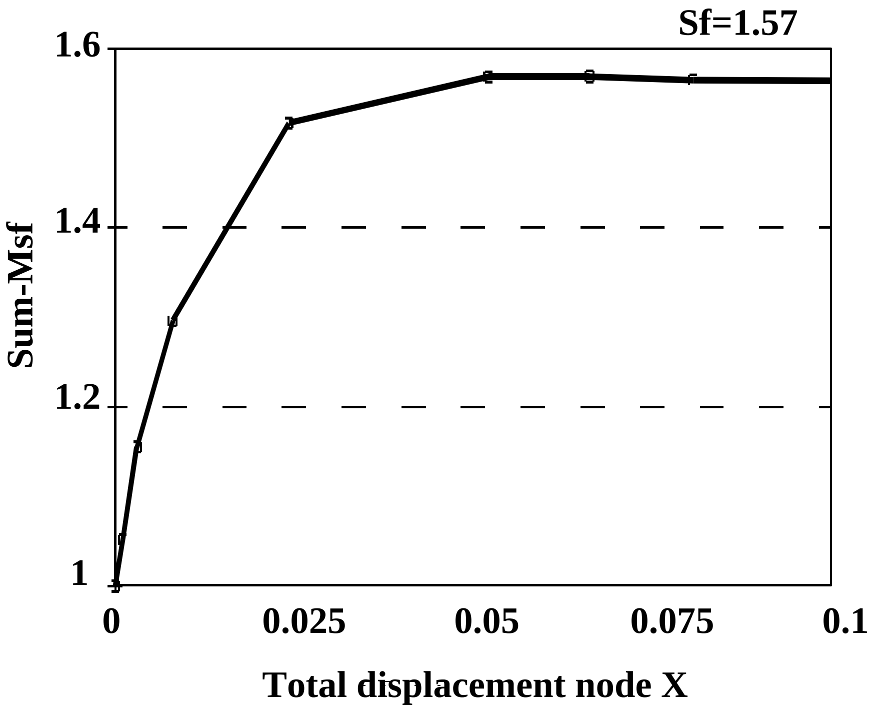
2. *Shadings of incremental displacements*



3. *Shadings of incremental shear strains*

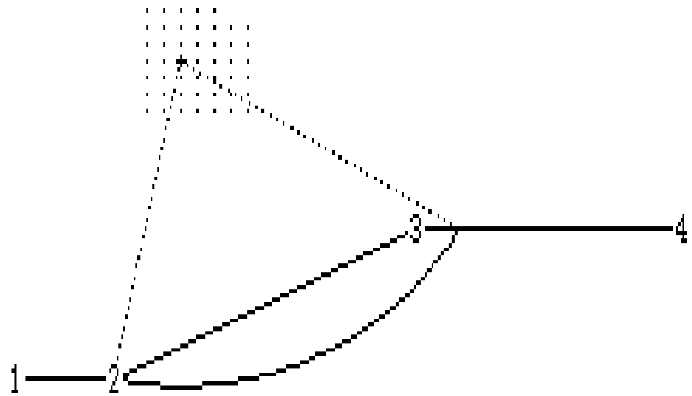
Example 1 – stability of a drained slope





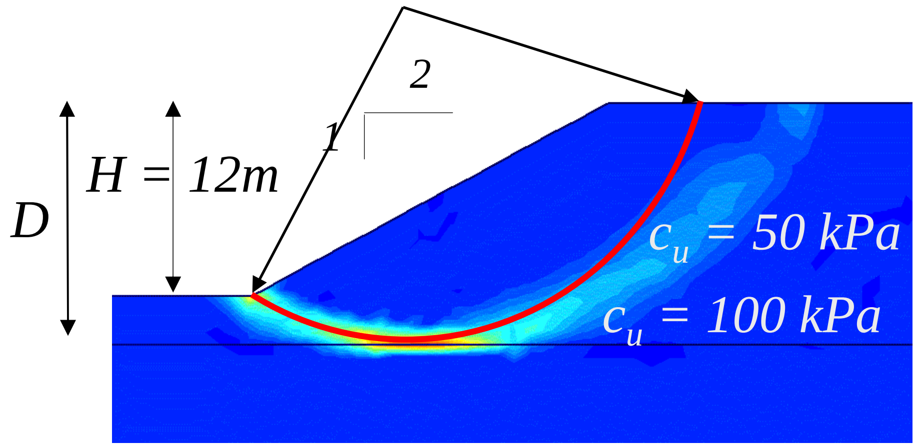
Example 1 – stability of a drained slope

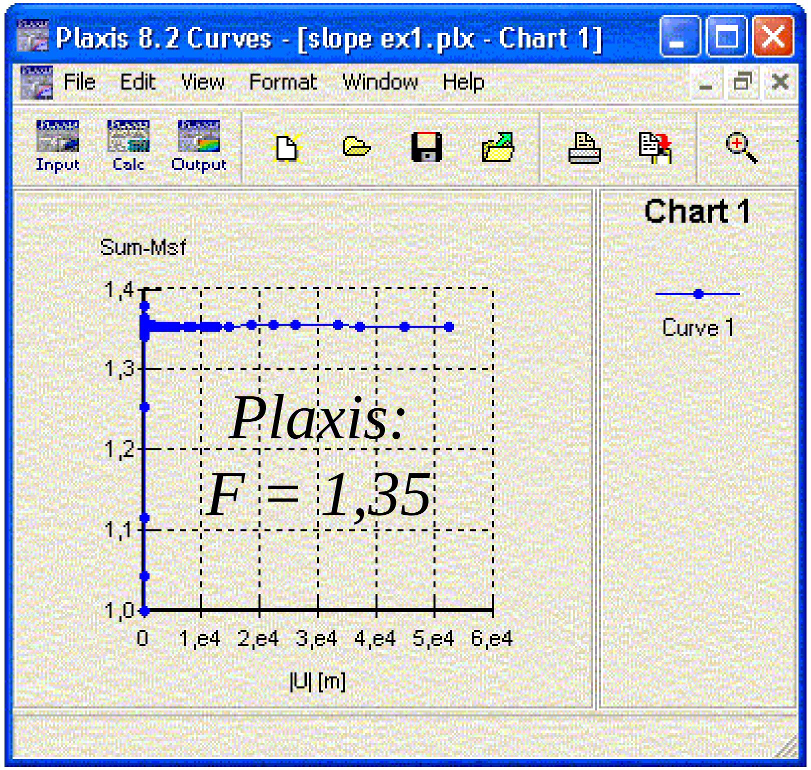
- Bischop analysis:



Bischop analysis: FoS = 1.54
Plaxis analysis: FoS = 1.57

Example 2, undrained stability of a slope:

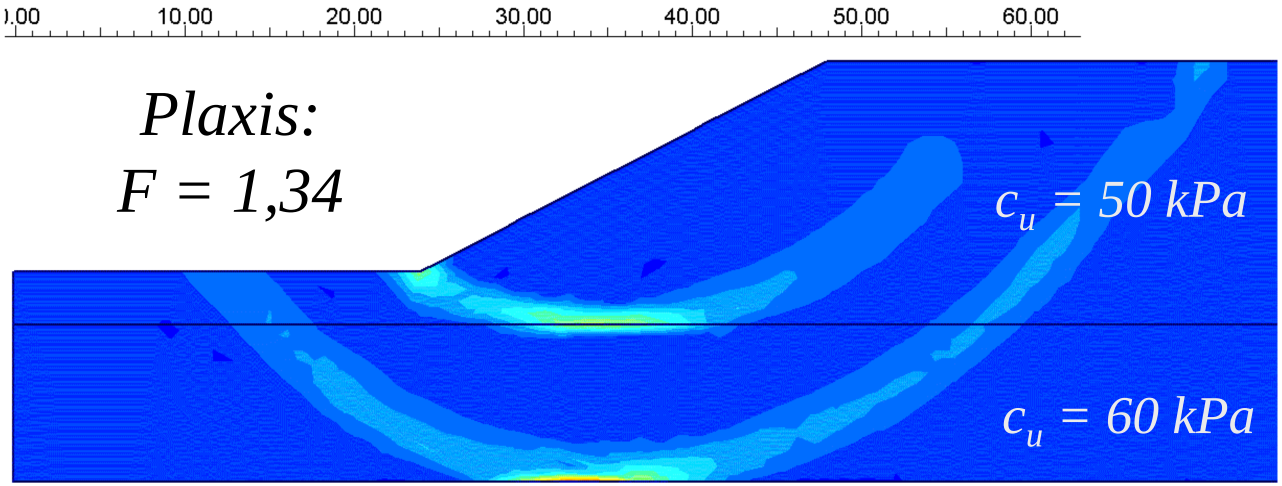




Stability charts: $F = N_0 \dfrac{c_u}{P_d} = 6.6 \dfrac{50}{12 \cdot 20} = 1.38 \;,\;\; N_0 = f(\theta, \dfrac{D}{H})$ (Taylor,1948)

Example 2, undrained stability of a slope:

Automatic detection of most critical shear surface:



Example 2, undrained stability of a slope:

Automatic detection of most critical shear surface: