PHI-C REDUCTION AND COMPARISON WITH BISHOP'S METHOD

This document describes an example that has been used to verify the ultimate limit state capabilities of PLAXIS 2D and PLAXIS 3D. The problem involves the stability of an embankment. The 2D results are compared with Bishop's method of slices. The influence of 3D load distribution is analysed.

Used version:

- PLAXIS 2D - Version 2011
- PLAXIS 3D - Version 2012

Input: In this validation the stability of an embankment is calculated by means of phi-c reduction. The situation is compared with a 2D calculation and with Bishop's slip circle method (see for example Verruijt (2001)). In PLAXIS 2D, the 6-noded model option is used. The embankment has a slope of 1:2, a height of 4.5 m and a width of 9.0 m. A load is applied to an area of 3.0 x 1.0 m on top of the embankment (Figure 1).

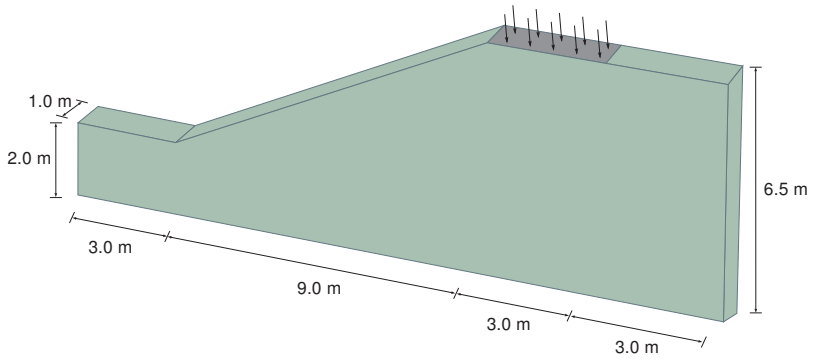


Figure 1 Geometry of the embankment

Material: The Mohr-Coulomb model is used and the unit weight γ is set to 16 kN/m^3. The remaining properties of the soil are:

E = 2600 kN/m^2	c = 5 kN/m^2	ν = 0.3
φ = 20°	ψ = 20°	

Meshing: In PLAXIS 2D the *Fine* option is used for the *Global coarseness* to generate the mesh. In PLAXIS 3D the *Fine* option is used for the *Element distribution* to generate the mesh and the surface load is locally refined with a *Fineness factor* of 0.5.

Calculations: The initial stresses are generated using gravity loading. Then the embankment is subjected to the following analyses:

- Phi-c reduction without additional loading
- Phi-c reduction after external loading of 30 kN/m^2
- Applying an external load of 100 kN/m^2 to simulate failure

Output: The initial safety factor without external loading is 1.57, the safety factor with external loading to 30 kN/m^2 is found to be 1.25 (Figure 2).

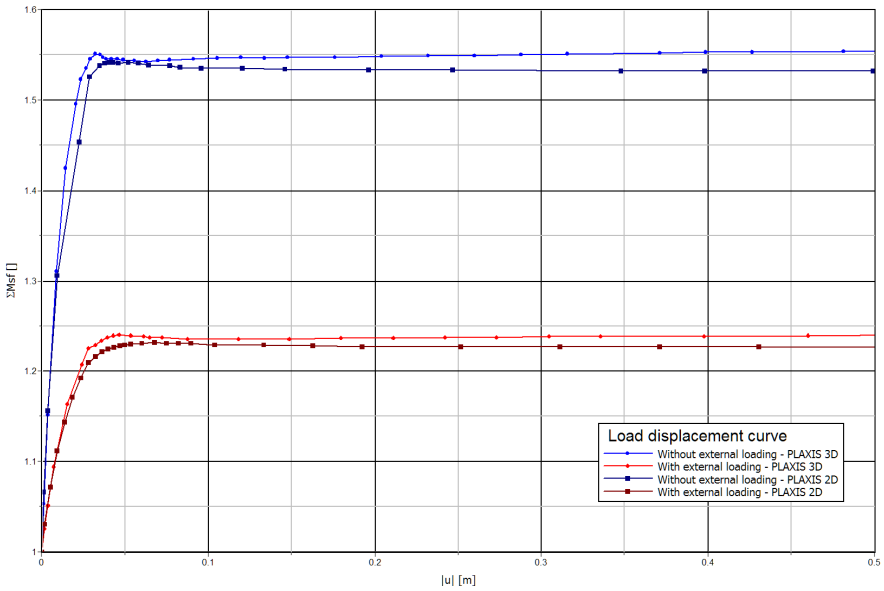


Figure 2 Load displacement curve

Verification: From the Bishop's slip circle method a safety factor of 1.56 is obtained for the initial situation. This value agrees with the PLAXIS calculation.

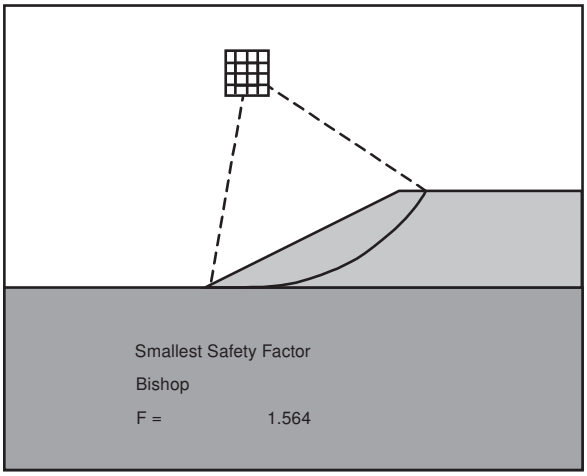
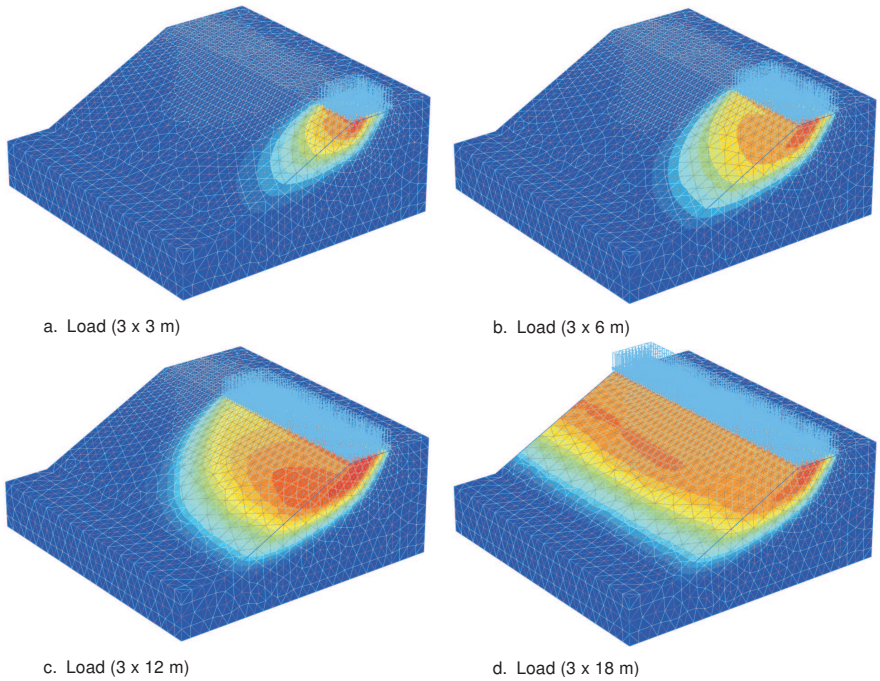


Figure 3 Bishop's slip circle method result

Influence of 3D effects: In addition safety factors are calculated for different situations where the load is only applied partially in order to see the influence of 3D effects. The following areas have been subsequently loaded to 30 kN/m^2: 3 x 3 m, 3 x 6 m, 3 x 12 m and 3 x 18 m (Figure 4).

The safety factor decreases with increasing load as expected (see Figure 5). The



a. Load (3 x 3 m)

b. Load (3 x 6 m)

c. Load (3 x 12 m)

d. Load (3 x 18 m)

Figure 4 Incremental displacements after Phi-c reduction for the different loading areas

situation in which an area of 3 x 18 m is loaded is comparable to the situations as considered in the first part of this validation.

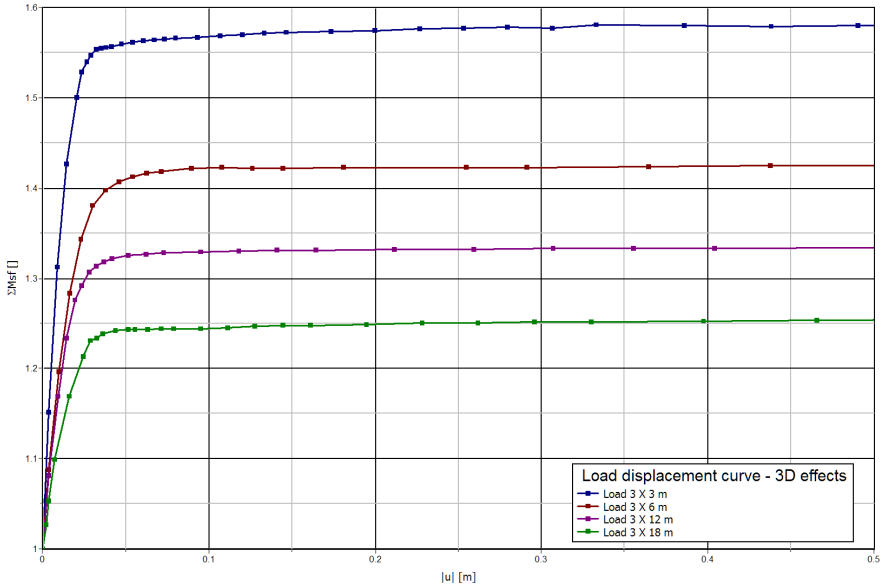


Figure 5 Load-displacement curve - Influence of 3D effects

REFERENCES

[1] Verruijt, A. (2001). Soil mechanics. Delft University of Technology.