SEEPAGE LENGTH

This document verifies that groundwater flow principles are correctly implemented in PLAXIS. The purpose of this example is to determine the length of the seepage face *l* in an inclined river bank with slope α. The problem geometry is presented in Figure 1. Assuming a point P on the phreatic surface, with known location determined by length L and height H, the seepage face *l* and the phreatic surface are found through a set of nonlinear equations.

Used version:

- PLAXIS 2D - Version 2018.0
- PLAXIS 3D - Version 2018.0

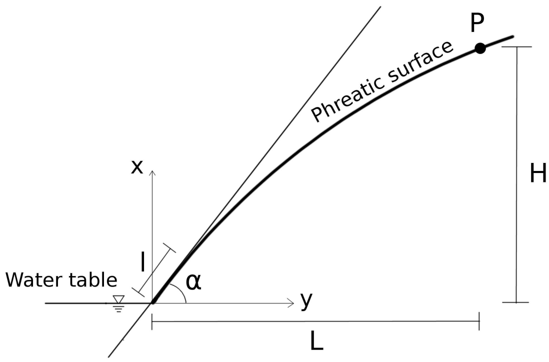

Figure 1 Problem geometry

Geometry: The model geometry in PLAXIS 2D is presented in Figure 2. A plane-strain model with 15-noded elements is used. The top part of the trapezium represents the model geometry introduced in Figure 1. Length L equals 100 m and and height H equals 50 m. Point P is located at the right upper corner of the model. On the left model side, the groundwater head is prescribed at 50 m, while at the right side at 100 m. A triangular mesh refinement zone (ABC) is generated in the vicinity of the expected seepage face.

In PLAXIS 3D, the same model as described above is used, extended by 1 m in y-direction. Both groundwater flow boundaries in y-direction are set to be closed. Figure 3 illustrates the model geometry.

An inclined water level is used to generate hydraulic head of 50 m at the left side and 100 m at the right side. The internal part of this water level has no meaning and it will be overwritten by the results of the groundwater flow analysis.

Materials: The soil is modeled as *Drained*, *Linear elastic*. The *Standard* hydraulic model (*Van Genuchten*) for *Coarse* material is used to model the unsaturated flow conditions above the phreatic level. Permeability *k* equals 1 m/day in every direction. The adopted material parameters are:

Soil: Linear elastic Drained E' = 1 kN/m^2 k = 1 m/day

Meshing: In both PLAXIS 2D and PLAXIS 3D models, a *Coarseness factor* of 0.2 is

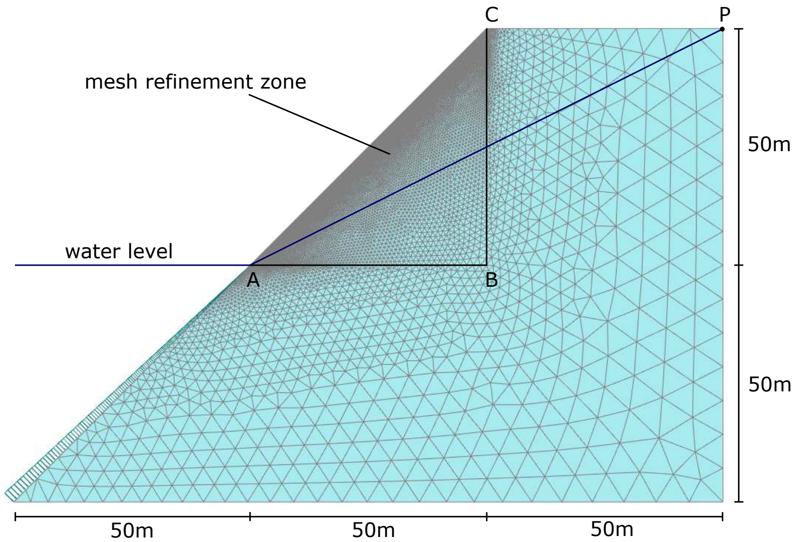

Figure 2 Problem geometry and generated mesh (PLAXIS 2D)

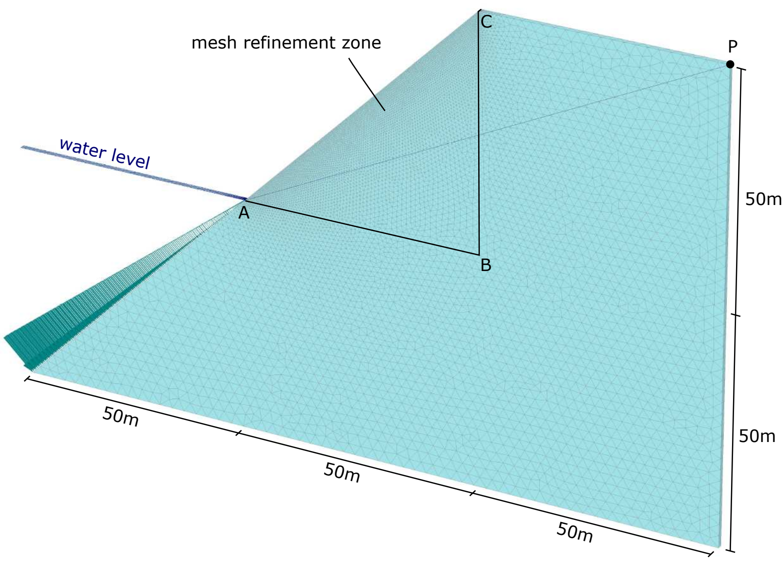

Figure 3 Problem geometry and generated mesh (PLAXIS 3D)

used for the triangular mesh refinement zone, while its left side (AC) is further refined with a *Coarseness factor* equal to 0.03125. In PLAXIS 2D, the *Fine* option is selected for the *Element distribution*. In PLAXIS 3D, the *Medium* option is selected for the *Element distribution*. The generated mesh is illustrated in Figures 2 and 3 for PLAXIS 2D and PLAXIS 3D respectively.

Calculations: The calculations are performed using the *Flow only* calculation type in the Initial Phase.

Output: The groundwater flow field and the computed phreatic line are presented in Figure 4 for PLAXIS 2D. The active pore pressures and the seepage face at the end of the analysis are illustrated as well in Figure 5. In Figures 6 and 7 the corresponding results are plotted for PLAXIS 3D.

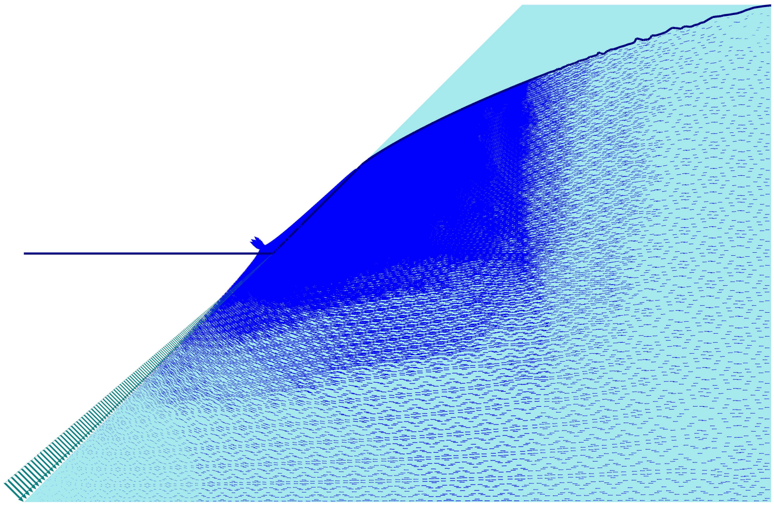

Figure 4 Flow field obtained in PLAXIS 2D

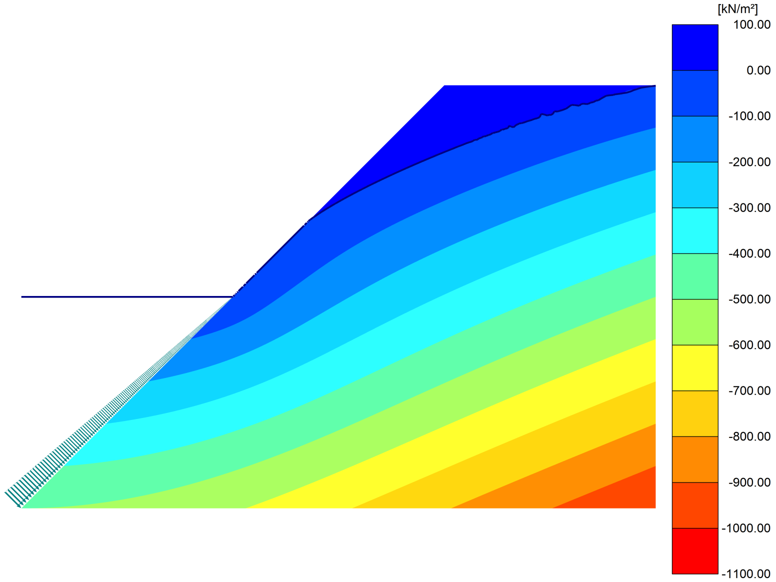

Figure 5 Active pore pressures obtained in PLAXIS 2D

Verification: A closed form solution of this problem is given by Strack & Asgian (1978), based on the following assumptions:

- The river bank is presented as an infinite slope with inclination angle equal to α
- Unconfined ground water flows from far away towards the river bank

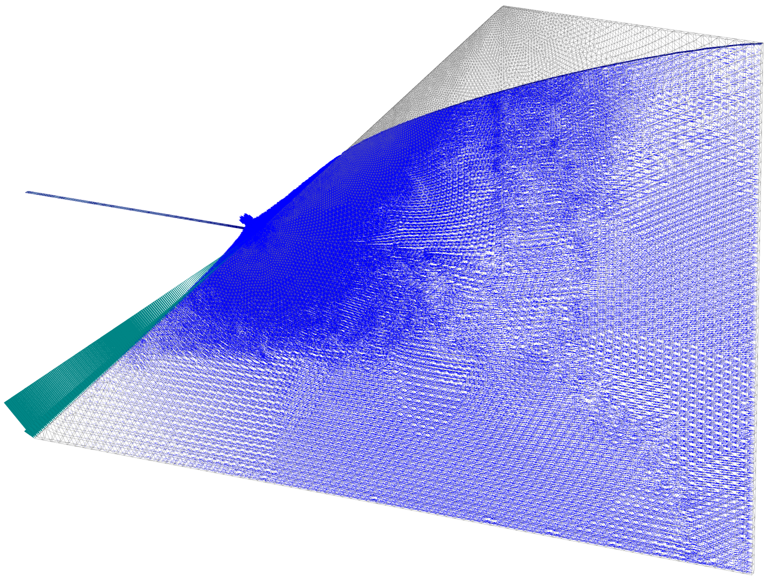

Figure 6 Flow field obtained in PLAXIS 3D

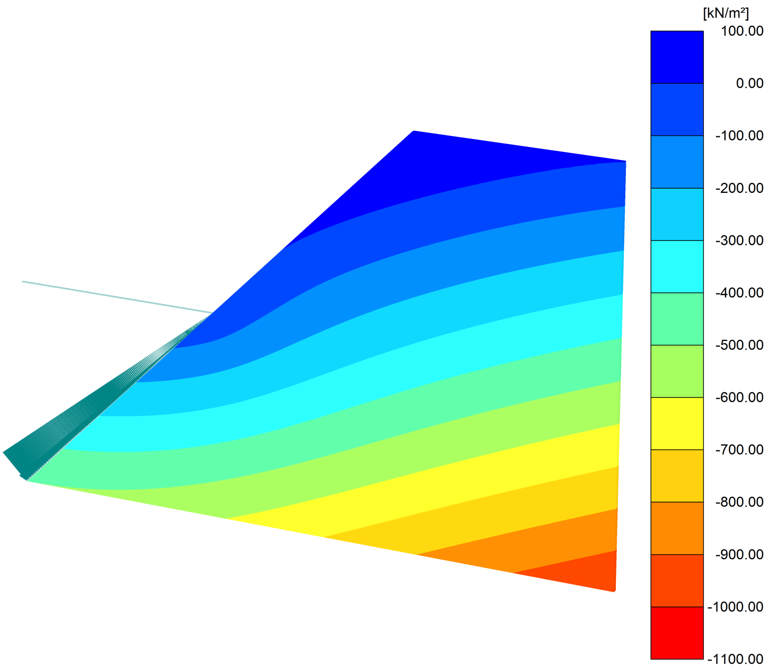

Figure 7 Active pore pressures obtained in PLAXIS 3D

- Water flow is two dimensional, i.e. no flow occurs in the direction parallel to the river
- Permeability is homogeneous and isotropic

- Water flow is steady
- Soil is saturated below the phreatic surface and dry above

The solution is presented in graphical form. The normalized seepage length l/L is plot as a function of H/L for various values of α. For the selected model geometry, the following applies:

$$\frac{H}{L} = 0.5 \quad \text{and} \quad \alpha = 45°, \quad \text{thus} \quad \frac{l}{L} = 0.255 \tag{1}$$

The calculation results for the seepage length *l* obtained from the closed form solution and PLAXIS are compared in Table 1. It is concluded that PLAXIS approaches well the analytical formulation.

Table 1 Comparison between analytical solution and PLAXIS results

Seepage length *l* (m)			Error	
Analytical	PLAXIS 2D	PLAXIS 3D	PLAXIS 2D	PLAXIS 3D
25.50	25.35	25.59	0.60 %	0.35 %

REFERENCES

[1] Strack, O., Asgian, M. (1978). A new function for use in the hodograph method. Water Resources Research, 14(6), 1045–1058.