BEARING CAPACITY OF STRIP FOOTING

This document describes an example that has been used to verify the bearing capacity of a strip footing in PLAXIS.

Figure 1 Problem geometry

Used version:
• PLAXIS 2D - 2015
• PLAXIS 3D - Anniversary Edition

Geometry: Calculations are carried out for a rough and a smooth footing. The geometry of the PLAXIS 2D model is shown in Figure 2. Because of symmetry, only half of the geometry is modeled using 15-node elements. A line prescribed displacement is used to simulate the footing. Its downward component in y-direction equals 0.05 m. For the smooth footing, the x-direction of the prescribed displacement is set to free whereas for the rough footing the x-direction of the prescribed displacement is set to fixed.

Figure 2 Model geometry (PLAXIS 2D)
The geometry of the PLAXIS 3D model is shown in Figure 3. The strip footing is defined as a surface prescribed displacement equal to 0.05 m in z-direction, pointing downwards. A soil cluster and a surface are defined underneath and at the right of the strip footing respectively to enable local control of the mesh.

**Materials:** The material properties are shown in Figure 1. The Mohr-Coulomb model is used to model the behavior of the soil in order to be consistent with the conventional foundation design (Potts & Zdravković (2001)). The soil unit weight $\gamma$ is selected to equal zero. The cohesion at the soil surface, $c_{\text{ref}}$, is taken 1 kN/m$^2$. In the Advanced settings, the Undrained C method is used with the cohesion gradient, $S_{u,\text{inc}}$, equal to 2 kN/m$^2$/m, using the top of layer as a reference level (PLAXIS 2D $y_{\text{ref}} = 0$ m, PLAXIS 3D $z_{\text{ref}} = 0$ m). The stiffness at the top is given by $E_u = 299$ kN/m$^2$ and the increase of stiffness with depth is defined by $E_{u,\text{inc}} = 598$ kN/m$^2$/m. The phreatic level is at the bottom of the model.

**Meshing:** In the 2D model the Medium option is selected for the Global coarseness. The point at the right end of the prescribed displacement is refined with a Coarseness factor of 0.05 and the prescribed displacement has a default Coarseness factor of 0.25. The resulting finite element mesh is shown in Figure 4.

In the 3D model the Coarse option is selected for the Global coarseness. The soil cluster below the footing and the surface prescribed displacement representing the footing are refined with a Coarseness factor of 0.25. The surface at the right of the footing is refined with a Coarseness factor of 0.1. The resulting finite element mesh is shown in Figure 5.

**Calculations:** In the Initial phase zero initial stresses are generated by using the K0 procedure ($\gamma = 0$). The prescribed displacement is activated in a separate phase. In the case of the smooth footing the horizontal prescribed displacement is set to Free. In the case of the rigid footing the horizontal prescribed displacement is fixed. The calculation type is Plastic analysis and a Tolerated error of 0.001 is defined. The Reset displacements to zero option is selected and the Max steps parameter is set to 500.

**Output:** To obtain the PLAXIS results a soil node is selected at the soil surface, at the left boundary of the models. In the PLAXIS 2D model the calculated maximum average
vertical stress under the smooth footing is 7.831 kN/m² and for the rough footing is 9.168 kN/m². In the PLAXIS 3D model the calculated maximum average vertical stress under the smooth footing is 8.076 kN/m² and for the rough footing is 9.737 kN/m². The computed load-displacement curves are shown in Figure 6 for both PLAXIS 2D and PLAXIS 3D.

**Verification:** The analytical solution derived by Davis & Booker (1973) for the mean ultimate vertical stress beneath the footing, $p_{\text{max}}$, is:

$$p_{\text{max}} = \frac{F}{B} = \beta \left[(2 + \pi)c_{\text{ref}} + \frac{B \times c_{\text{inc}}}{4}\right]$$

where $B$ is the footing width and $\beta$ is a factor that depends on the footing roughness and
the rate of increase of clay strength with depth. The appropriate values of $\beta$ in this case are 1.27 for the smooth footing and 1.48 for the rough footing. The analytical solution therefore gives average vertical stresses at collapse of 7.8 kN/m$^2$ for the smooth footing and 9.1 kN/m$^2$ for the rough footing. The errors in the PLAXIS 2D solution are $+0.4\%$ and $+0.7\%$ respectively. The errors in the PLAXIS 3D solution are $+3.5\%$ and $+7\%$ respectively.

REFERENCES
