STRIP LOAD ON ELASTIC GIBSON SOIL

This document describes an example that has been used to verify the beahaviour of a strip load on elastic Gibson soil in PLAXIS.

Used version:

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

Input: Gibson soil is an elastic layer in which the shear modulus increases linearly with depth. Using y to denote depth, the shear modulus, G, used in the calculation is given by:

$G = \alpha \cdot y$

Here α = 100 is used. With a Poisson's ratio of 0.499, the Young's modulus varies by:

$E = 299.8 \cdot y$

Figure 1 shows the project geometry in PLAXIS 2D and the soil data for a plane strain calculation of the settlement of a strip load on Gibson soil. Geometry lines to be used for local refinement are introduced at 1 m distance around the load.
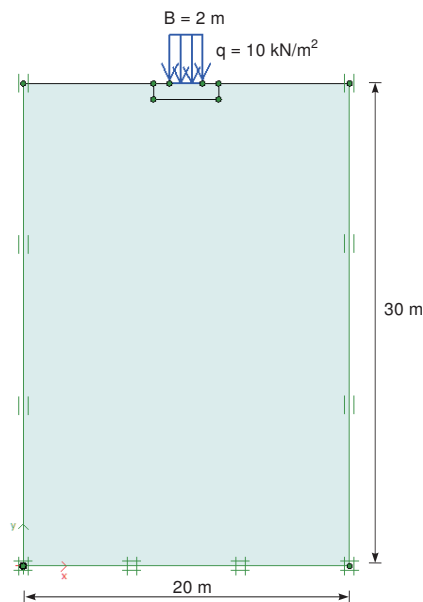

Figure 1 Problem geometry (PLAXIS 2D)

Figure 2 shows the project geometry in PLAXIS 3D. Due to the symmetry of the problem, it is sufficient to consider half of the model without compromising on accuracy and save calculation time. A 1 m long vertical surface is introduced at 1 m distance to the right of the surface load. This surface will be used to locally refine the mesh.

Material: In order to prescribe this variation of Young's modulus in the *Material properties* window the reference value of Young's modulus, E_{ref}, is taken very small. In the Advanced part of the *Parameters* tabsheet the increase of Young's modulus E_{inc} is
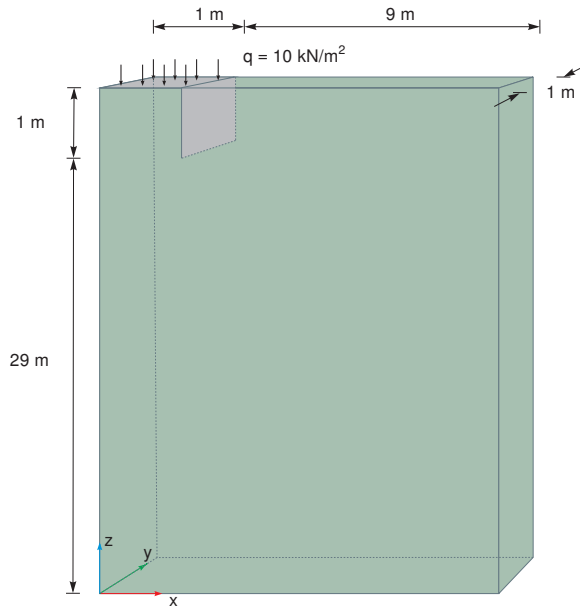
Figure 2 Problem geometry (PLAXIS 3D)

set to 299.8 and the reference level y_{ref} corresponds to the top of the geometry.

Meshing: The *Fine* option is selected for the *Global coarseness*. In PLAXIS 2D the geometry lines around the load are refined with a *Local element size factor* of 0.1. In PLAXIS 3D the surface load and the vertical surface are refined with a fineness factor of 0.0625.

Calculations: In the Initial phase zero initial stresses are generated by using the K0 procedure with Σ -*Mweight* equal to zero. The footing is activated in a separate phase (Phase 1). The calculation type is *Plastic analysis* and a *Tolerated error* of 0.001 is defined.

Output: An exact solution to this problem is only available for the case of a Poisson's ratio of 0.5; in the PLAXIS calculation a value of 0.499 is used for the Poisson's ratio in order to approximate this incompressibility condition.

The numerical results show an almost uniform settlement of the soil surface underneath the strip load as can be seen from the vertical displacement distribution plots in Figures 3 and 4. The computed settlement is 0.04845 m and 0.04776 m at the centre of the strip load for PLAXIS 2D and PLAXIS 3D respectively.

Verification: The analytic solution is exact only for an infinite half-space, whereas the PLAXIS solution is obtained for a layer of finite depth. However, the effect of a shear modulus that increases linearly with depth is to localise the deformations near the surface; it would therefore be expected that the finite thickness of the layer will only have a small effect on the results. The exact solution for this particular problem, as given by Gibson (1967), gives a uniform settlement beneath the load of magnitude:

$$\text{Settlement} = \frac{q}{2\alpha}$$

In this case the exact solution gives a settlement of 0.05 m. The numerical solution is
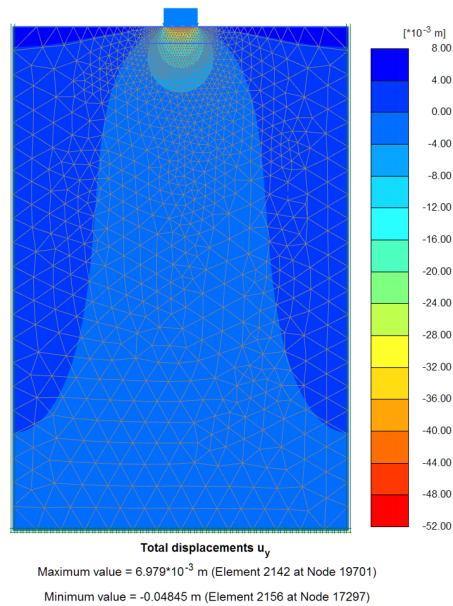
Total displacements u$_y$

Maximum value = 6.979*10^{-3} m (Element 2142 at Node 19701)

Minimum value = -0.04845 m (Element 2156 at Node 17297)

Figure 3 Vertical displacement distribution (PLAXIS 2D)

Total displacements u$_z$

Maximum value = 8.547*10^{-3} m (Element 2599 at Node 15793)
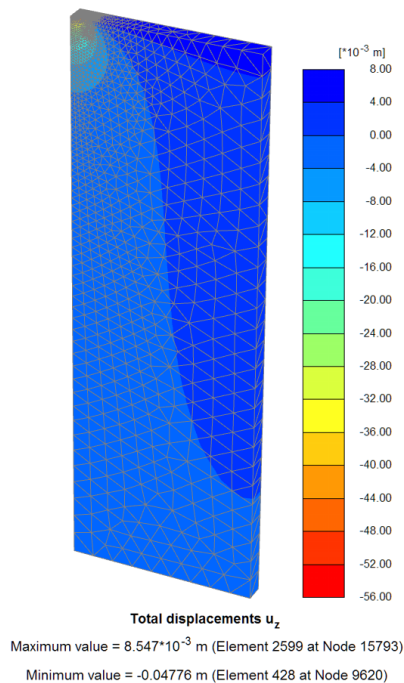
Minimum value = -0.04776 m (Element 428 at Node 9620)

Figure 4 Vertical displacement distribution (PLAXIS 3D)

3.1% and 4.5% lower in PLAXIS 2D and PLAXIS 3D respectively.

REFERENCES

[1] Gibson, R.E. (1967). Some results concerning displacements and stresses in a non-homogeneous elastic half-space. Geotechnique, 17, 58–64.