

BI-AXIAL SHEARING TEST WITH LINEAR ELASTIC MODEL

This document describes an example that has been used to verify the elastic deformation capabilities of PLAXIS, according to Hooke's law of isotropic elasticity. The problem involves shear loading under bi-axial test conditions.

Used version:

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

Geometry: A bi-axial test is conducted on the geometry displayed in Figure 1 for PLAXIS 2D and PLAXIS 3D. In PLAXIS 2D, a square specimen is used ($1 \times 1 \text{ m}^2$), subjected to shear loading equal to 1 kN/m/m . A *line displacement* is used to fix the bottom boundary in the vertical y-direction. The bottom left corner is fixed in both horizontal and vertical directions by use of a *point displacement*. Unit *line loads* are assigned to all four model boundaries. Their direction is presented in Figure 1.

In PLAXIS 3D, a cubic specimen is used ($1 \times 1 \times 1 \text{ m}^3$), subjected to shear loading equal to 1 kN/m^2 . A *surface displacement* is used to fix the bottom boundary in the vertical z-direction. The bottom left edge is fixed in all directions by use of a *line displacement*. Unit *surface loads* are assigned to all six model faces. Their direction is presented in Figure 1. Table 1 summarizes the applied loads per face.

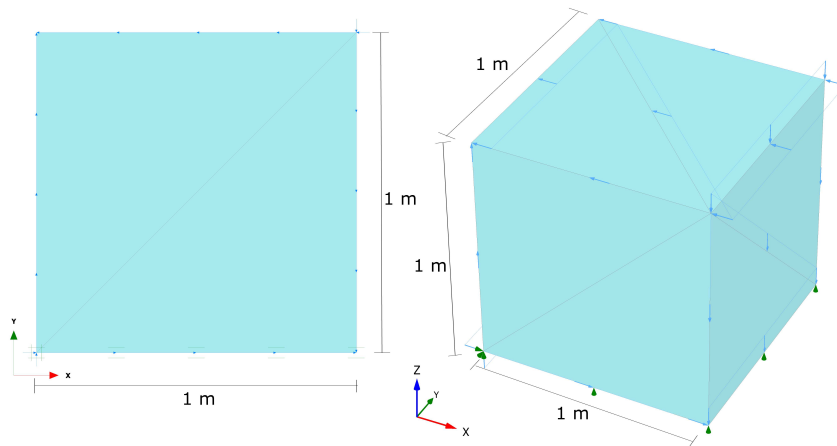


Figure 1 Bi-axial shearing test - loading conditions

Table 1 Loading condition in PLAXIS 3D

Face	$Load_x$ (kN/m^2)	$Load_y$ (kN/m^2)	$Load_z$ (kN/m^2)
Front	-	-	-
Rear	-	-	-
Left	-	-	1.0
Right	-	-	-1.0
Bottom	1.0	-	-
Top	-1.0	-	-

Material: The unit weight γ is set to zero. The remaining material properties are:

Linear elastic $E' = 1000 \text{ kN/m}^2$ $\nu' = 0.25$

Meshing: In order to create an very coarse mesh, the *Expert mesh* settings (without any local refinements) are used for the model in both PLAXIS 2D and PLAXIS 3D. The *Relative element size* is set to 20.00 and a *Coarseness factor* equal to 1.0 is used for the whole geometry. The generated mesh is illustrated in Figure 1.

Calculations: In the Initial phase, zero initial stresses are generated by using the K0 procedure ($\gamma = 0$). In a separate phase (Phase 1) the defined loads and fixed displacements are activated. Default fixities are deactivated. *Tolerated error* of 0.001 is used.

Output: The resulting deformed meshes are shown in Figure 2. The obtained shear strain in both PLAXIS 2D and PLAXIS 3D is 2.5×10^{-3} .

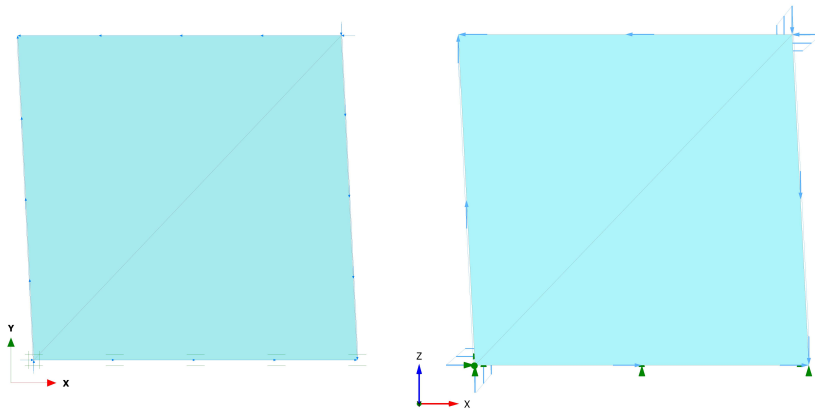


Figure 2 The resulting deformed mesh in PLAXIS 2D (left) and PLAXIS 3D (right)

Verification: The shear modulus G and the shear strain γ are calculated as:

$$G = \frac{E'}{2(1 + \nu')} = 400 \text{ kN/m}^2$$

$$\gamma = \frac{\tau}{G} = 2.5 \times 10^{-3}$$

PLAXIS results are in perfect agreement with the analytical solution.