

DeepEX 2D and 3D FEM Verification Part 2

Berlin Excavation case study- Schweiger et al (2002)

In the current example, the DeepEX software is benchmarked with a well monitored, anchored deep excavation in Berlin Sand. The specific problem was utilized by Schweiger and the working AK 1.6 of the German Society for Geotechnics in 2002 [2] as a benchmarking blind test with multiple expert consulting companies and university institutes as participants in the study. In the current benchmarking case, the monitored response along with a reference model prepared by the authors of [2] with the finite element software PLAXIS are compared with the nonlinear spring and FEM analysis modules of the DeepEX software. The geometrical properties of the site in question and the structural properties of the tiebacks are illustrated in Figure 1.

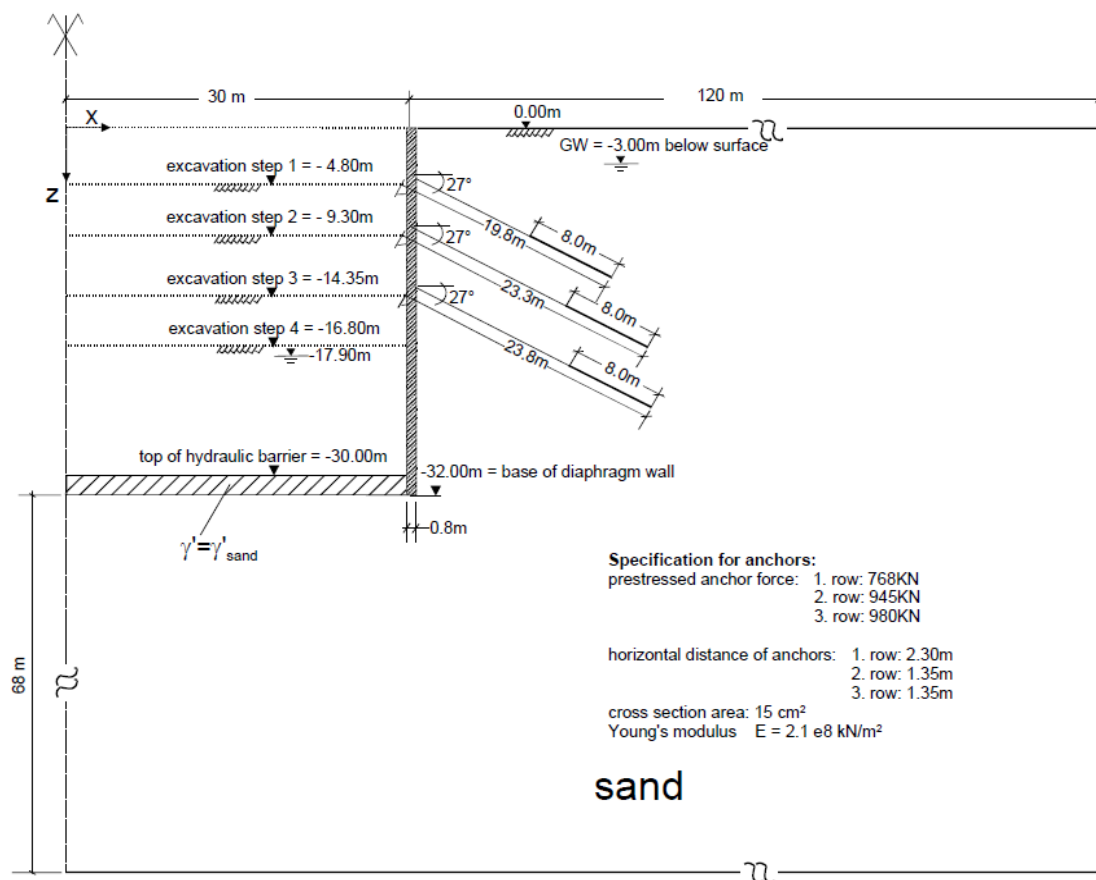


Figure 1: Geometry and stages of excavation as presented in [Schweiger et al 2002]

The soil material and wall diaphragm properties are the ones used by Schweiger in the PLAXIS reference model as reported in "BENCHMARKING IN GEOTECHNICS, part II: REFERENCE SOLUTION AND PARAMETRIC STUDY" (figure 2). As the main goal of the specific study is the comparison with both the generated PLAXIS model and available measurements, no additional alteration was done to the reported properties in the DeepEX model.

depth of layer	E_{50}^{ref}	E_{ur}^{ref}	E_{oed}^{ref}	ν	p	c	ϕ_{ur}	p_{ref}	m	R_f	R_{inter}
m	kPa	kPa	kPa	°	°	kPa	-	kPa	-	-	-
0 - 20	45 000	180 000	45 000	35	5	1.0	0.2	100	0.55	0.9	0.8
20 - 40	75 000	300 000	75 000	38	6	1.0	0.2	100	0.55	0.9	0.8
> 40	105 000	315 000	105 000	38	6	1.0	0.2	100	0.55	0.9	-

Figure 2: Table of soil properties as presented in [Schweiger et al 2002]

2D Finite Element model in DeepEX

The FEM model constructed in DeepEX is illustrated in Figure 3. A strict decomposition of the excavation process in single action stages is accomplished in accordance to the guidelines presented in (Schweiger et al 2002):

Stage GF: Greenfield conditions (Ko based imposed stress field)

Stage 0: activation of diaphragm wall (wished in place)

Stage 1: excavation at level -4.8m and dewatering

Stage 2: activation of anchor 1 and prestressing and groundwater lowering to -9.4m

Stage 3: excavation at level -9.3m

Stage 4: activation of anchor 2 and prestressing

Stage 5: groundwater lowering to -14.5m

Stage 6: excavation at level -14.35m

Stage 7: activation of anchor 3 and prestressing

Stage 8: groundwater lowering to -17.9m

Stage 9: final excavation at level -16.8m

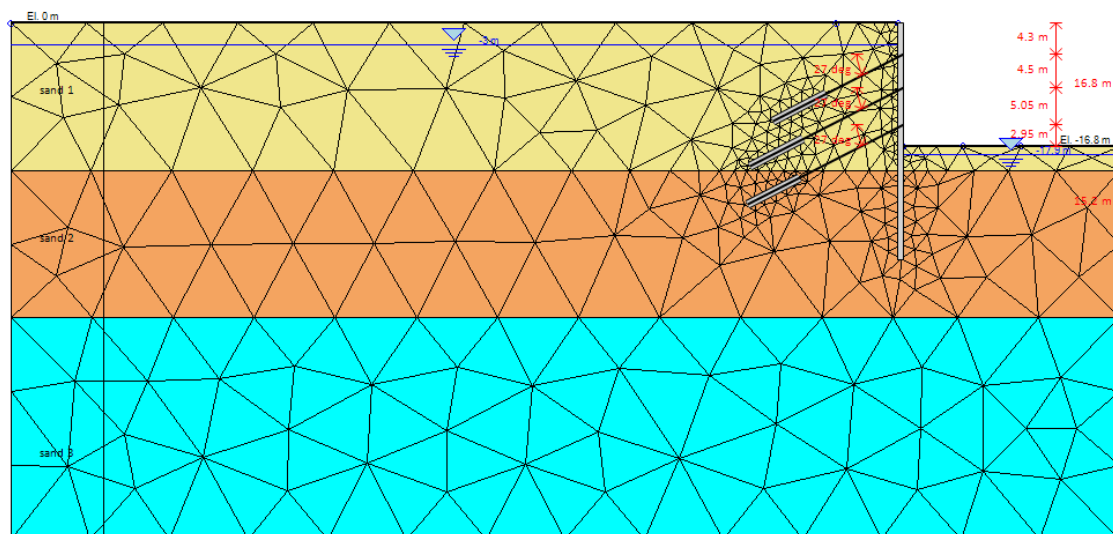


Figure 3: 2D model constructed in DeepEX – final construction stage

Measured results included the deflection of the diaphragm wall for the initial excavation stage (stage 1) and final stage of the excavation process (stage 9). In the following results we compare the DeepEX 2D FEM model with Schweiger's reference model developed in PLAXIS and the in-site measurements when available. The comparison of the wall displacements and moments for stage 1 and stage 9 are illustrated in Figures 4 and 5 respectively.

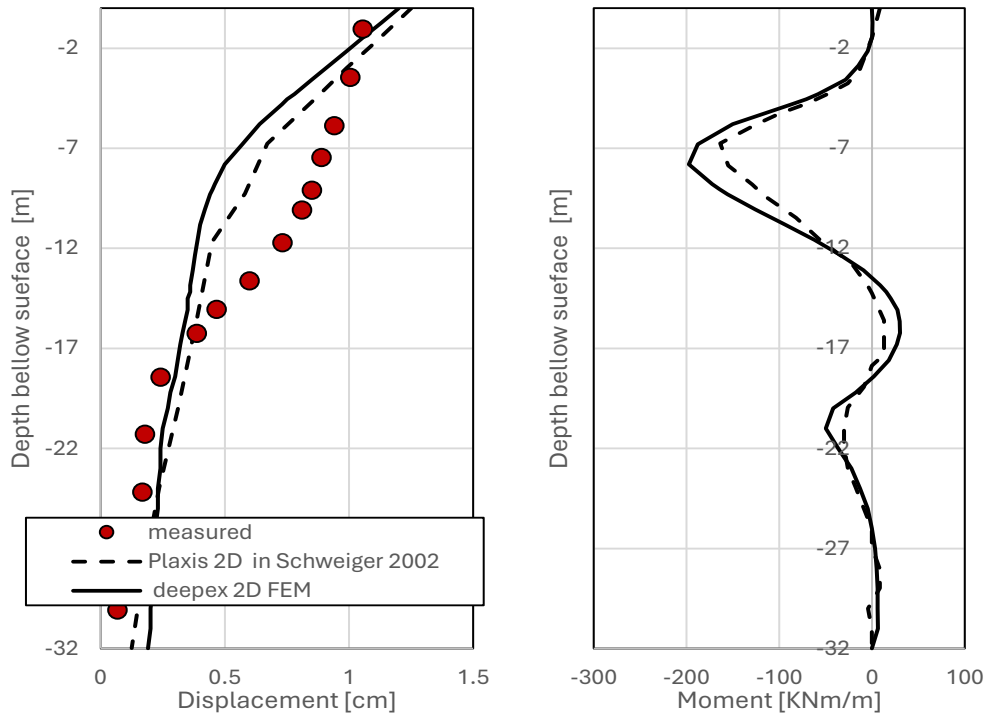


Figure 4: Comparison of a) displacement and b) moments for stage 1

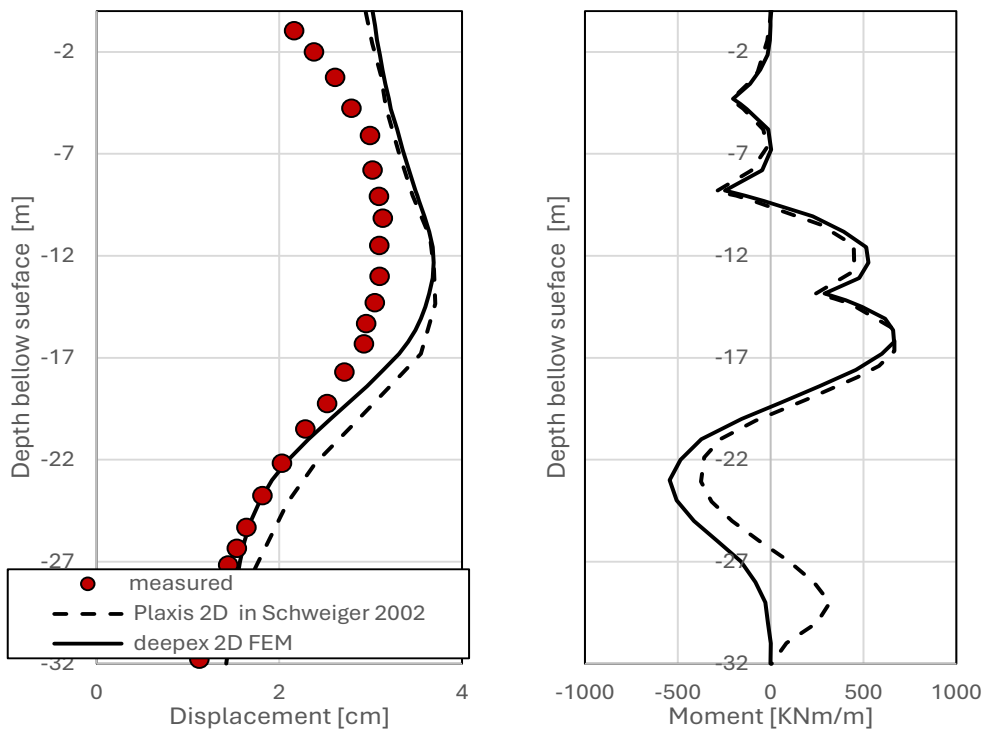


Figure 5: Comparison of a) displacement and b) moments for final stage

The surface settlement for the stage 1 and stage 9 is illustrated in Figure 6.

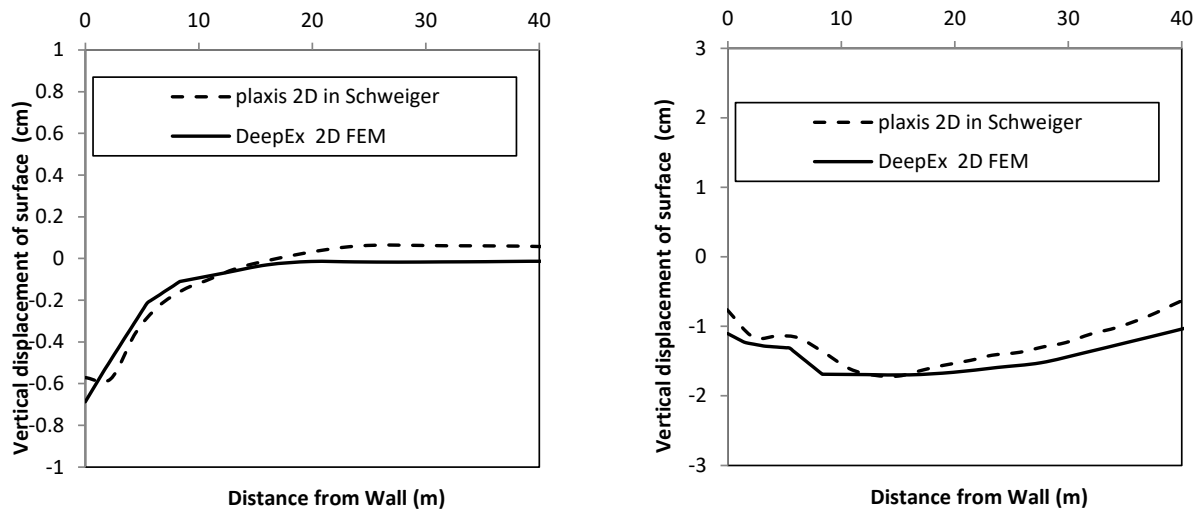


Figure 6: surface settlement comparison for a) Stage 1 and b) Final stage

8.2.3 3D Finite Element model in Deepex

Finally, a 3D finite element model (FEM) has been developed to simulate the excavation. As the exact properties of the 3D excavation are not available in the published documentation, a 30m length cut section of the 60m span excavation is created as illustrated in Figure 7. The Finite element model is illustrated bellow.

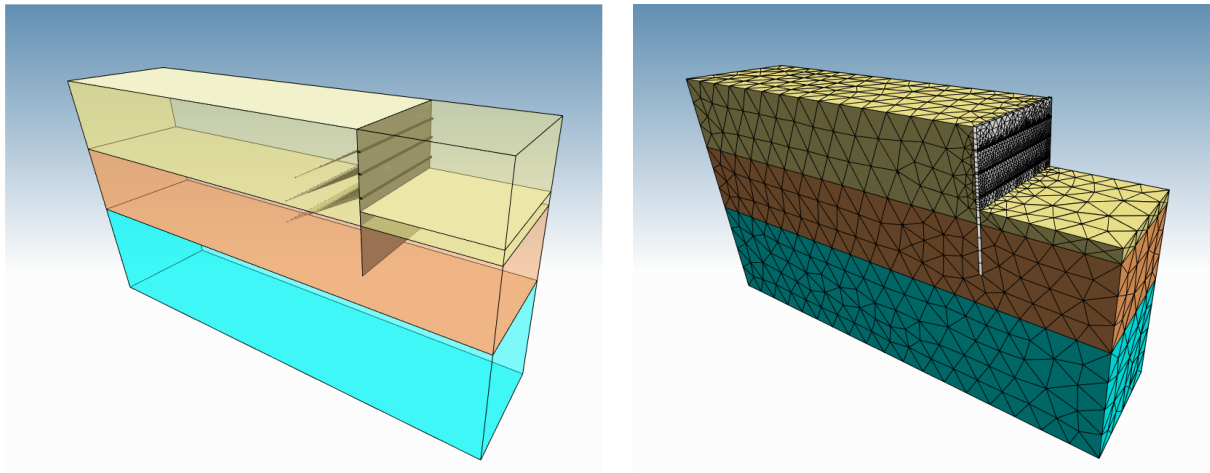


Figure 7: 3D FEM model of berlin anchored excavation

A comparison of the measured lateral displacement of the wall and the 3D model prediction is illustrated in Figure 8a. Also, the moment comparison between 3D and 2D FEM for the final stage of the wall can be seen in Figure 8.

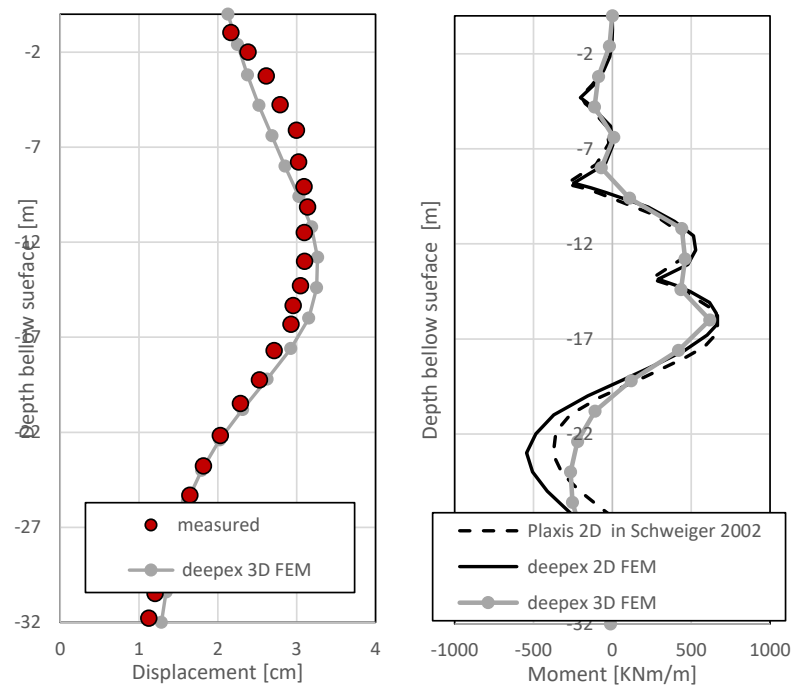


Figure 8: 3D FEM Comparison of a) displacement and b) moments for final stage