4 DRY EXCAVATION USING A TIE BACK WALL - ULS

In this tutorial an Ultimate Limit State (ULS) calculation will be defined and performed for the dry excavation using a tie back wall (Chapter 3). The geometry model of Chapter 3 will be used. The *Design approaches* feature is introduced in this example. This feature allows for the use of partial factors for loads and model parameters after a serviceability calculation has already been performed.

Objectives:

- Using *Design approaches*

4.1 INPUT

In order to define a design approach:

- Open the project created in Chapter 3 and save it under a different name.
- Select the *Design approaches* option in the *Soil* or *Structures* menu. The corresponding window is displayed.
- Click the *Add* button. A new design approach is added in the list.
- In this example the design approach 3 of the Eurocode 7 will be used. This design approach involves partial factors for loads and partial factors for materials (strength). Click the design approach in the list and specify a representative name (ex: 'Eurocode 7 - DA 3').
- In the lower part of the window the partial factors can be defined for loads and materials. Set the partial factor for *Variable unfavourable* 1.3.

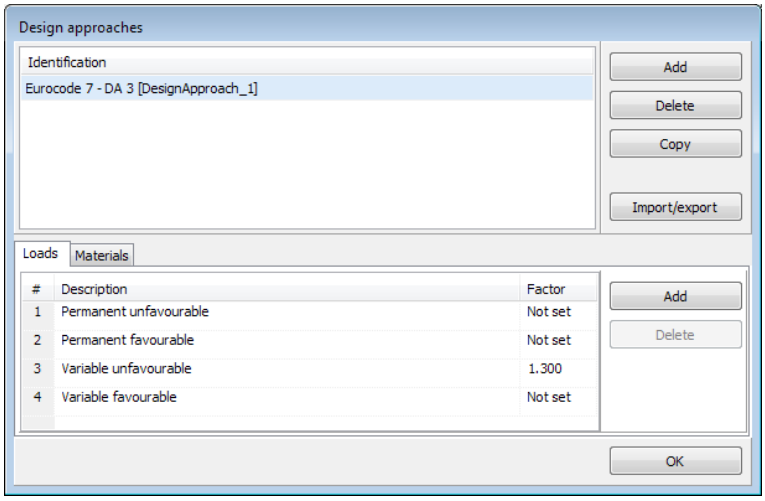

Figure 4.1 Partial factors for loads

- Click the *Materials* tab.
- Assign a value of 1.25 to *Effective friction angle* and *Effective cohesion*.

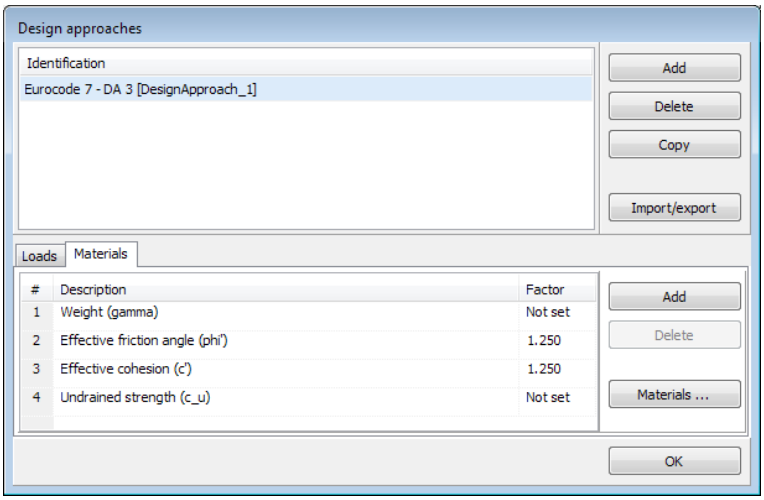

Figure 4.2 Partial factors for materials

- Click the *Materials...* button. The *Material sets* window pops up.
- Open the *Loam* material data set. Note that the view has changed. In the current view it is possible to assign factors to different soil parameters, as well as to see the effect of these factors on the soil parameters.
- Click the *Parameters* tab. In the *Parameters* tabsheet select the corresponding labels for c'_{ref} and φ' (Figure 4.3)
- Do the same for the remaining soil data sets.
- Close the *Design approaches* window.

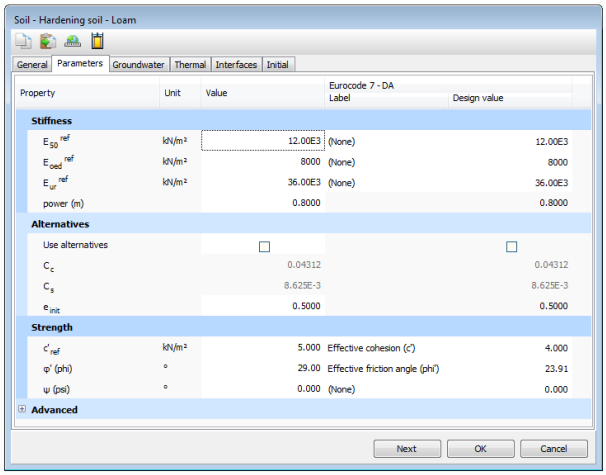

Figure 4.3 Assignment of partial factors to material parameters

Hint: Note that a partial factor for ϕ and ψ applies to the tangent of ϕ and ψ respectively.

4.2 CALCULATIONS

There are two main schemes to perform design calculations in relation to serviceability calculations (Section 5.9 of the Reference Manual). The first approach is used in this tutorial.

- Proceed to the *Staged construction* mode.
- Click *Phase_1* in the *Phases explorer*.
- Add a new phase.
- Double-click the newly added phase to open the *Phases* window.
- In the *General* subtree of the *Phases* window select the defined design approach in the corresponding drop-down menu.
- In the *Model explorer* expand the *Line loads* and all the subtrees under it.
- Select the *Variable unfavourable* option in the *LoadFactorLabel* drop-down menu of the static component of the load (Figure 4.4).

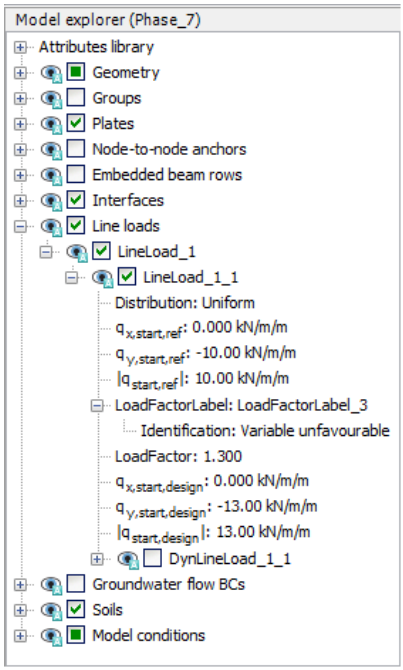

Figure 4.4 Assignment of factor label to loads in the *Selection explorer*

- Follow the same steps to define ULS phases for all the remaining SLS phases. Make sure that the Phase 7 starts from Phase 1, Phase 8 from Phase 2, Phase 9 from Phase 3 and so on.

Select some characteristic points for curves (for example the connection points of the ground anchors on the diaphragm wall, such as (40.0 27.0) and (40.0 23.0)).

Calculate the project.

Save the project after the calculation has finished.

4.3 RESULTS

The results obtained for the design approach phases can be evaluated in Output. Figure 4.5 displays the Σ*Mstage* - |*u*| plot for the node located at (40.0 27.0).

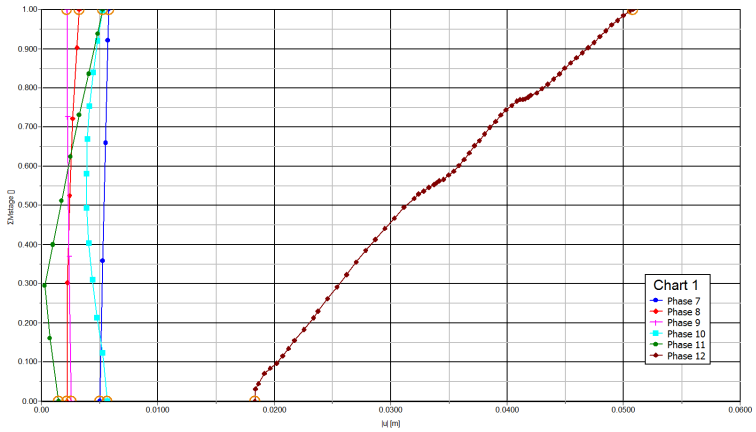

Figure 4.5 Σ – *Mstage* - |*u*| plot for the ULS phases

If the ULS calculations have successfully finished, the model complies with the corresponding design approach. If there are doubts about this due to excessive deformations, an additional *Safety* calculation may be considered using the same design approach, which should then result in a stable ΣM_{sf} value larger than 1.0. Note that if partial factors have been used it is not necessary that ΣM_{sf} also includes a safety margin. Hence, in this case Σ*Msf* just larger that 1.0 is enough. Figure 4.6 displays the Σ*Msf* - |*u*| plot for the *Safety* calculations of the Phase 6 and the corresponding ULS phase (Phase 12). It can be concluded that the situation complies with the design requirements.

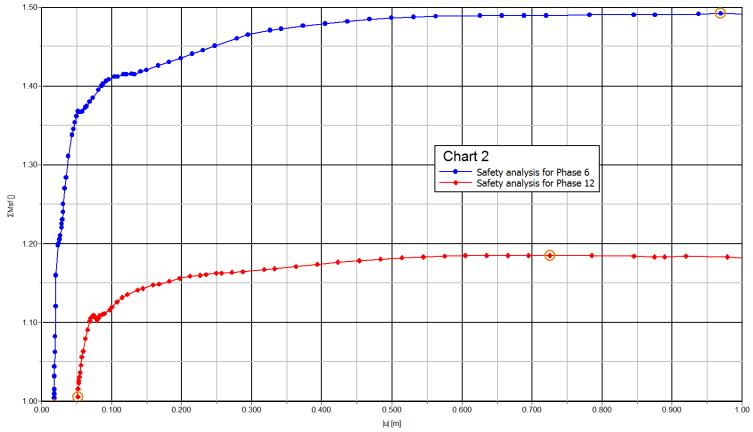

Figure 4.6 ΣMsf - $|u|$ plot for the last calculation phase and the corresponding ULS phase