8 Dry excavation using a tie back wall - ULS [ADV]

8.1 Introduction

In this tutorial an Ultimate Limit State (ULS) calculation will be defined and performed for the dry excavation using a tie back wall (7 Dry excavation using a tie back wall [ADV] (p. 121)). The same geometry model 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.

Objective

- Using **Design approaches**

8.2 Define the geometry

In order to define a design approach:

1. Open the project created in 7 Dry excavation using a tie back wall [ADV] (p. 121) and save it under a different name.
2. Select the menu **Soil** > **Design approaches** or **Structures** > **Design approaches**.

   The corresponding window is displayed .
3. Click the **Add** button.

   A new design approach is added in the list .
4. 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').

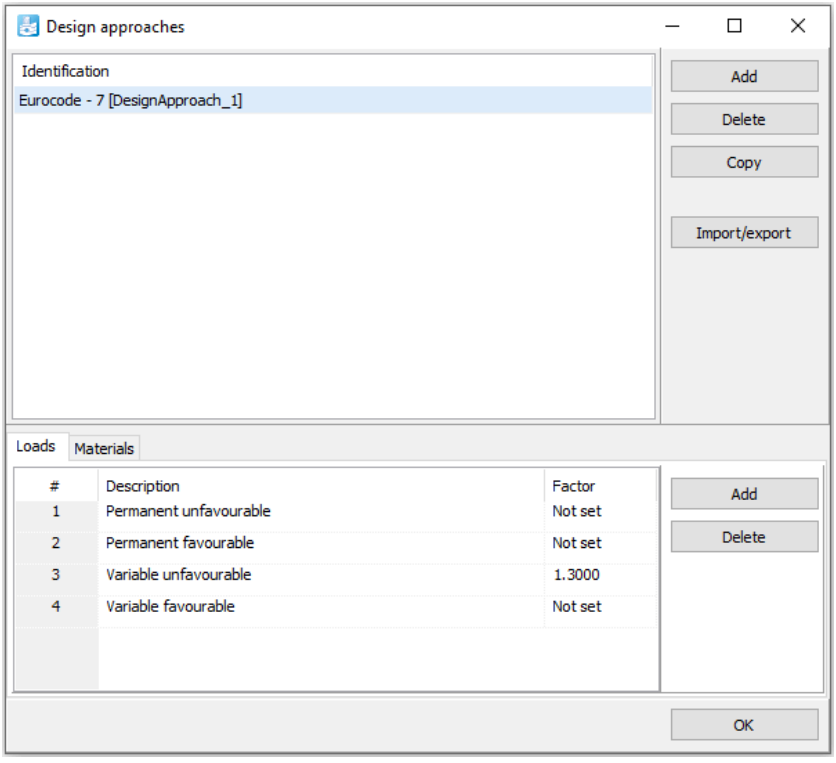

Figure 8–1: Partial factors for loads

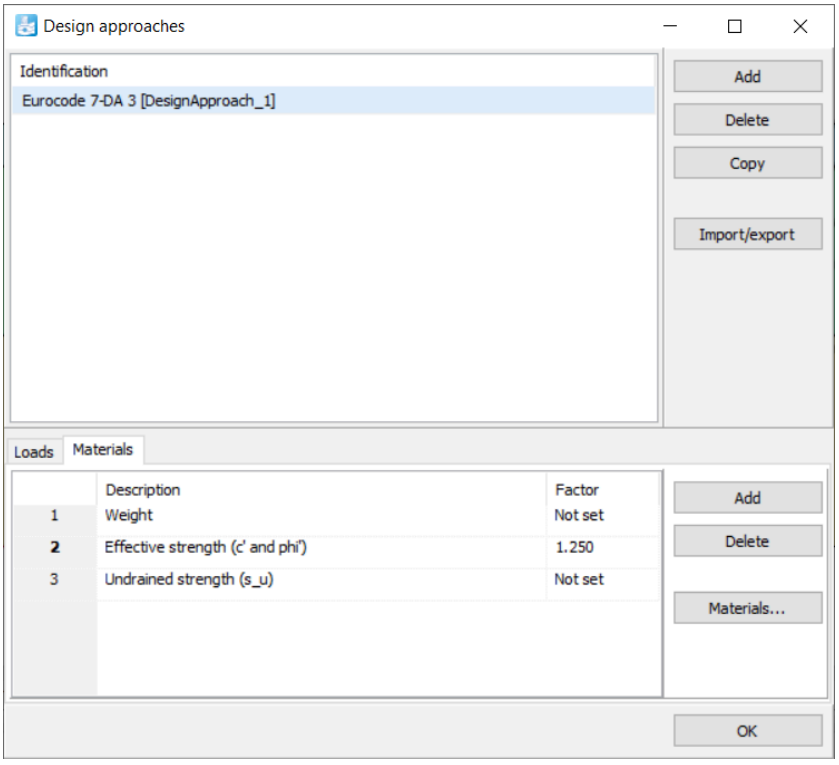

Figure 8–2: Partial factors for materials

5. In the lower part of the window the partial factors can be defined for loads and materials as shown in Figure 8–1 (p. 139). Set the partial factor for **Variable unfavourable** to 1.3.
6. Click the **Materials** tab.
7. Assign a value of 1.25 to **Effective strength (c' and phi')** as shown in Figure 8–2 (p. 140).
8. Click the **Materials...** button. The **Material sets** window pops up.
9. 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.
10. Click the **Mechanical** tab. In the **Mechanical** tabsheet select the **Label** > **Effective strength (c' and phi') [MaterialFactorLabel_2]** from the drop down list for c'_{ref} and φ' respectively. The new values will be updated for the strength parameters as shown in Figure 8–3 (p. 141).
11. Repeat the step for the remaining soil data sets.
12. Close the **Design approaches** window.

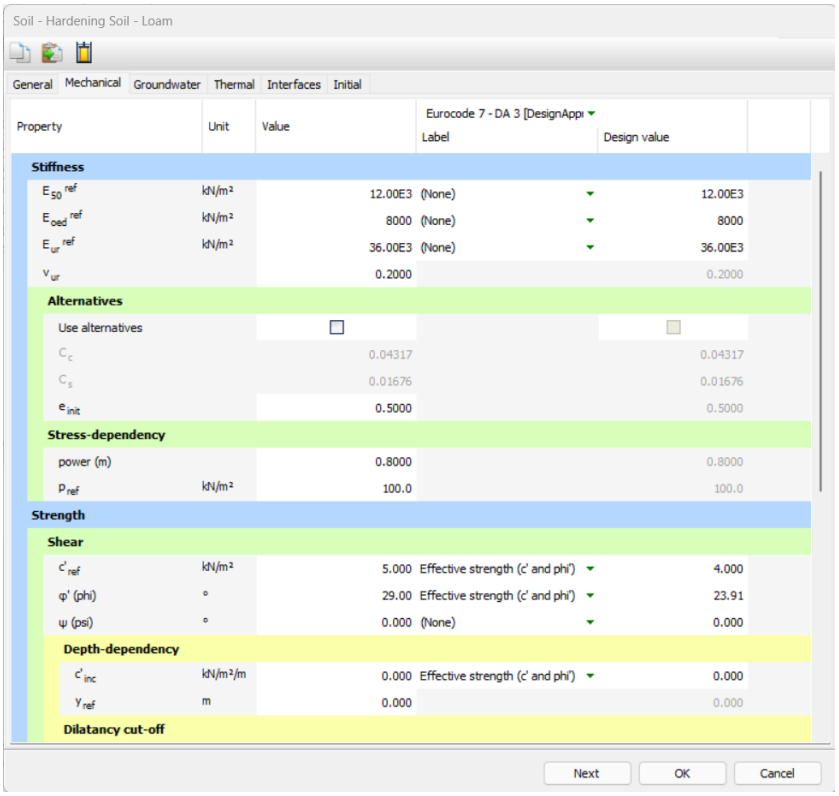

Figure 8–3: Mechanical tabsheet for Loam showing effective strength parameter after assigning partial factors for material

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

8.3 Define and perform the calculation

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

8.3.1 Changes to all phases

1. Proceed to the **Staged construction mode**.
2. In the **Phases explorer** click the phase Phase_1.
3. Add a new phase.
4. Double-click the newly added phase to open the **Phases** window.
5. In the **General** subtree of the **Phases** window select the defined design approach in the corresponding drop-down menu.

6. In the **Model explorer** expand the **Line loads** and all the subtrees under it.
7. Select the **Variable unfavourable** option in the **LoadFactorLabel** drop-down menu of the static component of the load.

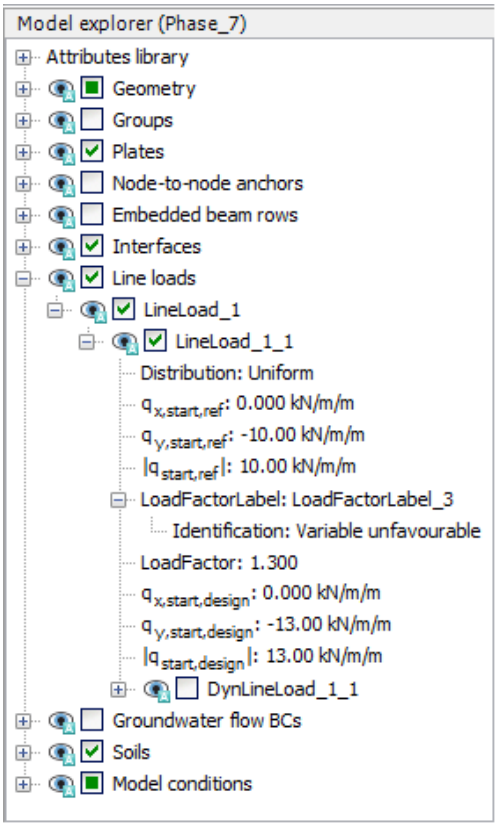

Figure 8–4: Assignment of factor label to loads in the Selection explorer

8. 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.

8.3.2 Execute the calculation

1. Click the **Select points for curves** button in the side toolbar.
2. Select some characteristic points for curves (for example the connection points of the ground anchors on the diaphragm wall, such as (40 27) and (40 23)).
3. Click the **Calculate** button to calculate the project.
4. After the calculation has finished, save the project by clicking the Save button.

8.4 Results

The results obtained for the design approach phases can be evaluated in Output. Figure 8–5 (p. 143) displays the ΣMstage - |u| plot for the node located at (40.0 27.0).

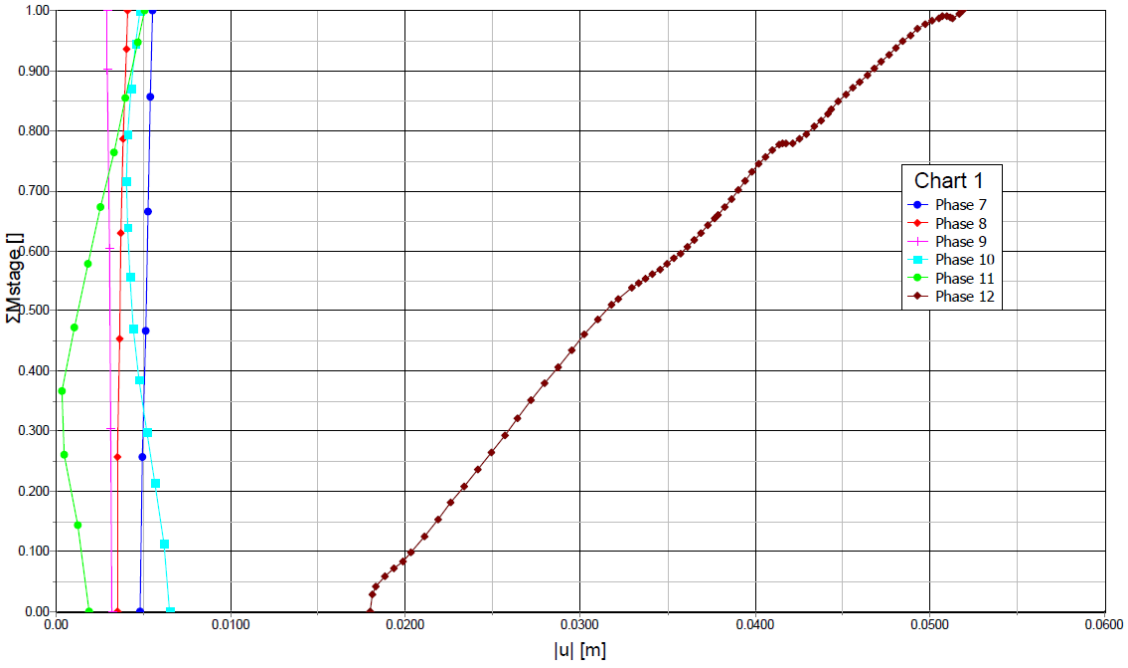

Figure 8–5: ΣMstage - |u| plot for the ULS phases

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 ΣM_{sf} just larger that 1.0 is enough.

Figure 8–6 (p. 144) displays the ΣMsf - |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.

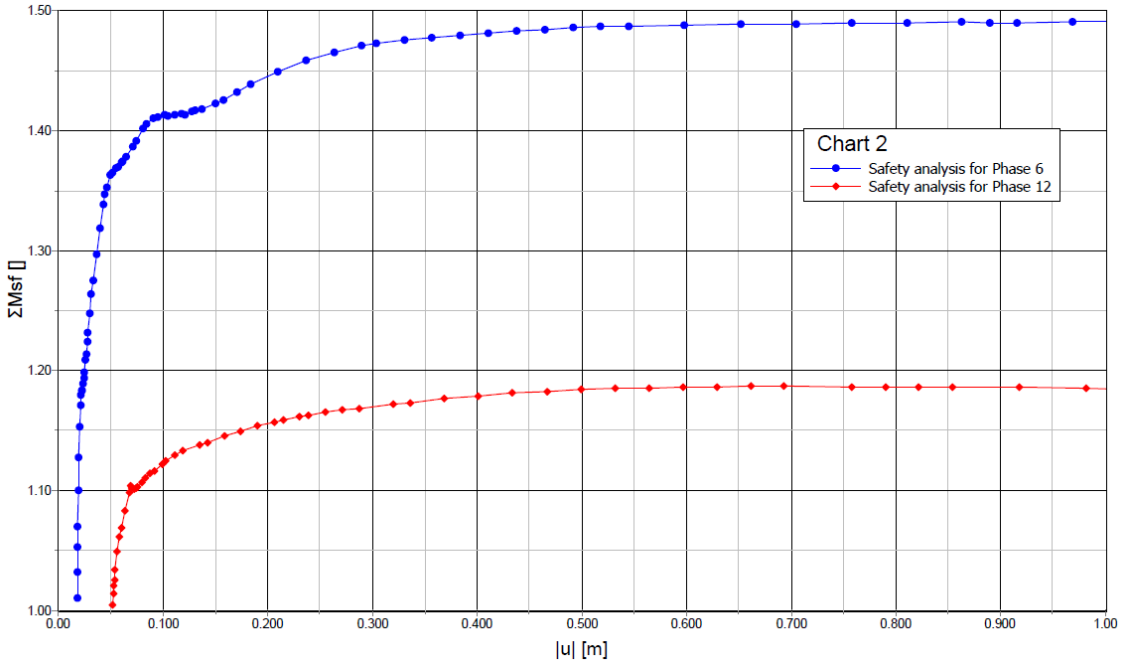

Figure 8–6: ΣMsf - |u| plot for the last calculation phase and the corresponding ULS phase