Seepage Through Dam

For LUSAS version:	21.0
For software product(s):	LUSAS Bridge plus or LUSAS Civil&Structural plus
With product option(s):	Geotechnical, Nonlinear

Problem Description

In this problem, we are examining the transient seepage that occurs when the water level in a reservoir on one side of an earth fill dam is raised. The base of the earth fill dam is 52 m wide. The initial steady-state reservoir level is 4 m. The flow is unconfined, with the dam built on an impermeable foundation.

Keywords

Seepage, Pore Pressure, Two Phase Material.

Associated Files

Associated files can be downloaded from the user area of the LUSAS website.

- ❑ **transient_seepage.lvb** carries out automated modelling of the example.

- Use **File > New** to create a new model of a suitable name in a chosen location.
- Use **File > Script > Run Script** to open the lvb file named above that was downloaded and placed in a folder of your choosing.

Objectives

The required output from the analysis consists of:

- ❑ Plotting pore pressure contours.
- ❑ Plotting settlement contours when the reservoir is full.

- Plotting displacement on the downstream face of the dam during filling.

Preparing the Model Features

We create a new model, set the Analysis category as 2D, and specify the model units as kN,m,t,s,C. Timescale is set to **Days**

Feature Geometry

The dam model is created by entering point coordinates that define the dam's shape, as shown in figure 1, and then drawing lines between these points to form the surface.

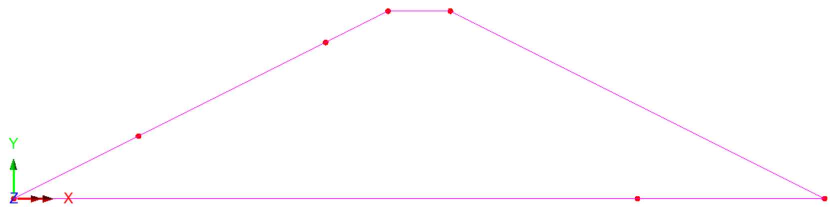

Figure 1: Model geometry

Preparing the Model Attributes

Model attributes (mesh, material, geometric properties, etc.) are defined and assigned to the model. (Figure 2).

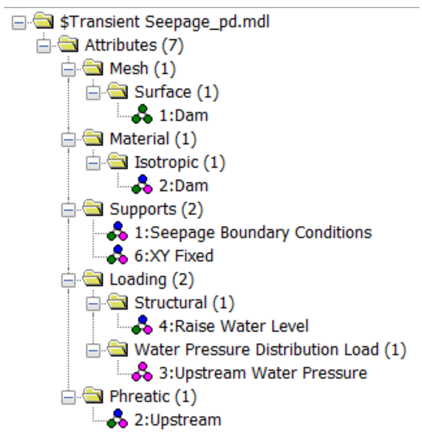

Figure 2: Model Attributes

Defining the Mesh

The surface feature is meshed using plane strain, two phase, quadrilateral, quadratic elements (QPN8P) as illustrated in figure 3. Figure 4 shows the mesh assigned to the model, a regular mesh with an elements size of 1 m.

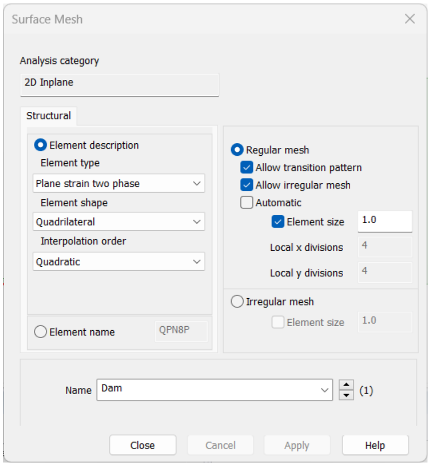

Figure 3: Surface mesh

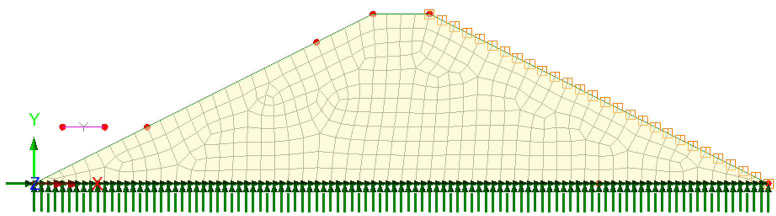

Figure 4: Mesh and boundary conditions

Defining the Materials

An isotropic nonlinear material utilizing the Modified Mohr-Coulomb failure surface will be used for the sandy soil.

Table 1 gives the material properties for this example.

Table 1: material properties

Layer	Mass Density	Young's modulus, E	Poisson's ratio, ν	Angle of friction, φ	Dilation	Cohesion, c
Sand	2.0 t/m^3	50.0E3 kPa	0.4	35°	35°	5 kPa

Two-phase material properties are required as well. Figure 5 gives the adopted properties and selected options. It is to be noted that hydraulic conductivity is entered in units of m/day.

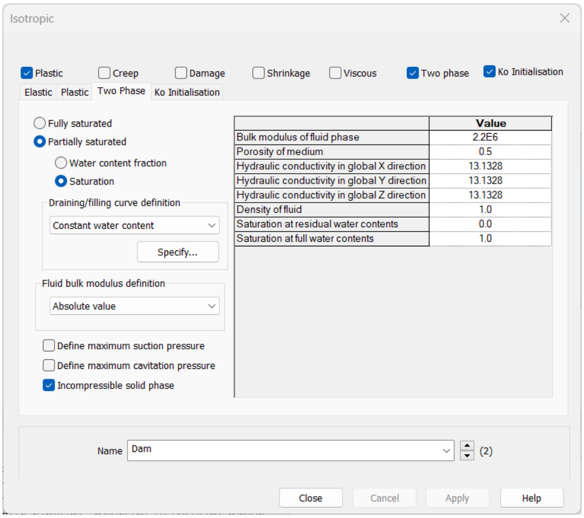

Figure 5: Two-Phase properties

Defining the Supports

Fully fixed supports are assigned for the base of the dam (Figure 4). Seepage boundary conditions are required on the downstream slope of the dam which are defined by selecting the **Seepage** radio button on the **Structural Supports** dialog (figure 6).

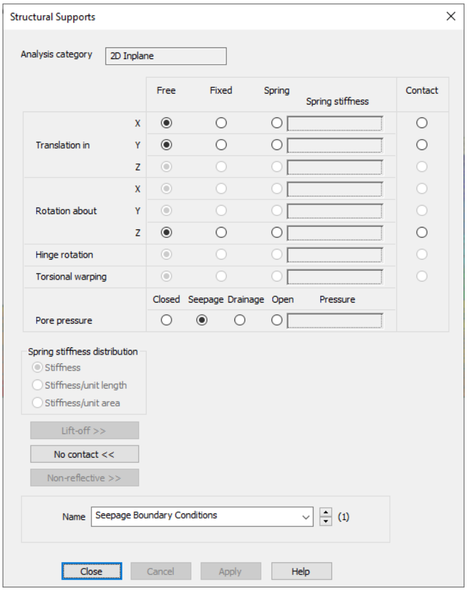

Figure 6: Seepage boundary conditions

Defining Loads and Phreatic Surface

To simulate changes in the water level in the reservoir, we establish the phreatic surface using the command: **Attributes > Pore Water Pressures > Phreatic Surface**. This attribute is then applied to a line feature as depicted in figure 7. As the water level rises, this line will move upward. To achieve this, we apply a displacement of 6 m in the Y direction to the line using the command **Attributes > Loading > Prescribed Displacement** (Figure 6). Finally, to calculate and obtain the water pressure distribution from the established phreatic surface, we create a water pressure distribution attribute using the command **Attributes > Loading > Water Pressure Distribution** and link it to the previously established Phreatic Surface attribute (Figure 8).

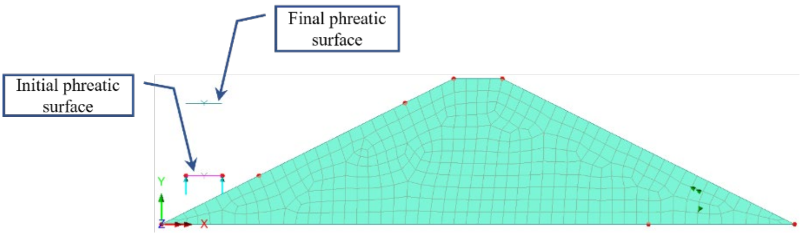

Figure 7: Assigning phreatic surface

Self-weight is to consider by right-clicking on the load case in the Treeview and selecting the **Gravity**.

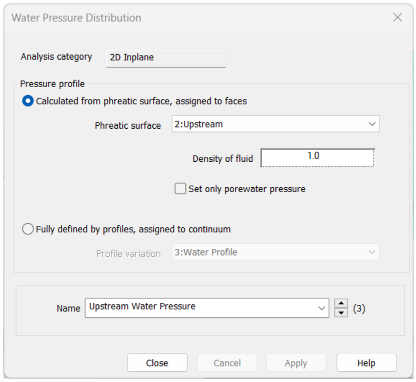

Figure 8: Water pressure distribution

Running the Analysis

We consider two construction stages.

Initial Phase

This stage simulates the initial conditions where we have the initial level of water level of 4 m. Nonlinear analysis control properties are defined for this phase, the number of iterations which is increased to 20 as the initial stage takes longer to convergence than normal and line searches are switched off (figure 9).

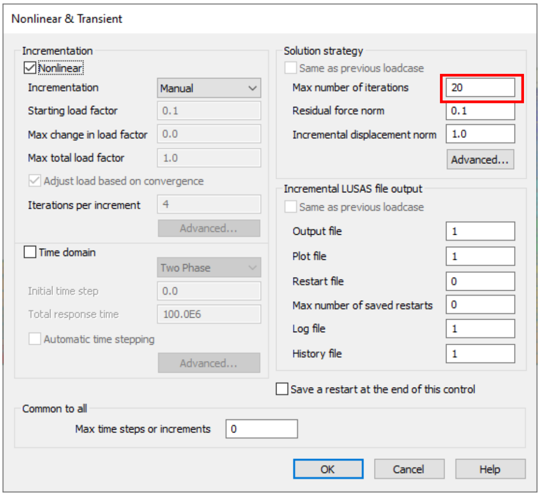

Figure 9: Increase maximum number of iterations

Rising Water Level

Using the **Prescribed Displacement,** we raise the water level in the reservoir up to 10m.

Viewing the Analysis

Analysis loadcase results are present in the Treeview.

Pore Pressure

Pore pressure contours for the final phase are drawn in figure 10.

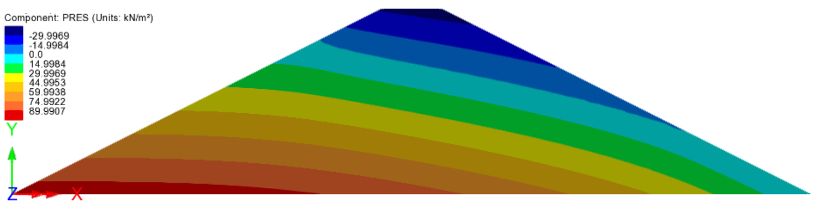

Figure 10: Pore pressure contour (water level at 10 m)

Downstream Displacement

Figure 11 shows the resultant displacement when the reservoir is full whilst the displacement at point A is plotted in figure 12.

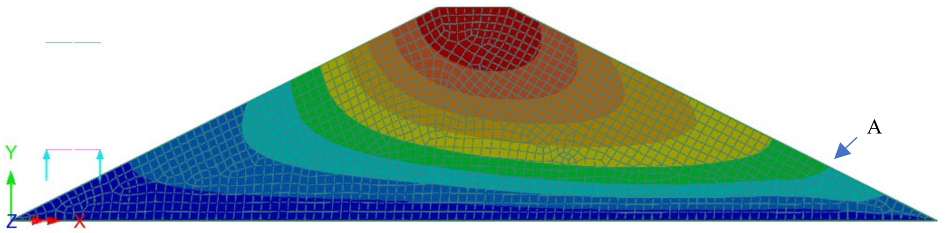

Figure 11: Resultant displacement (water level at 10 m)

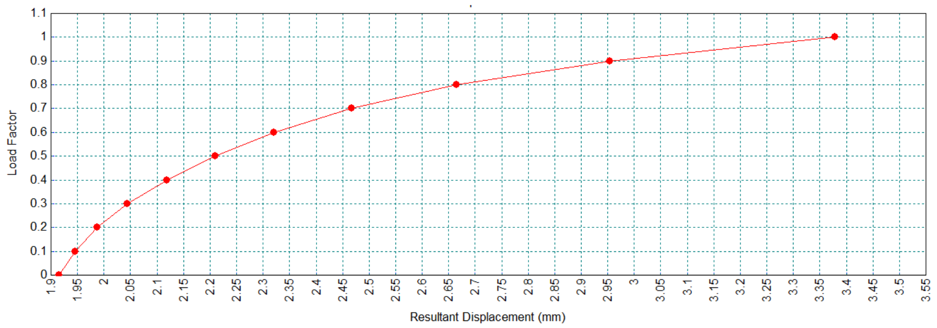

Figure 12: Resultant displacement in function of water level at point A