Seepage through a dam core with varying Ksat values

1 Introduction

The objective of this illustration is look at steady state flow through a dam core for different values of Ksat in the core. In particular, the objectives of this illustration are to:

- Investigate the seepage through a dam core when the saturated conductivity of the core is the same as or 100x less than the surround fill
- Show how this comparison can be carried out using two different analyses in a single project file
- Show how dynamic sketch text can be added to the project so that it changes automatically when the analysis changes

2 Feature highlights

GeoStudio feature highlights include:

- Multiple analyses in one project file
- Dynamic sketch text auto updating

3 Geometry and boundary conditions

The problem geometry and boundary conditions are illustrated below, in Figure 1. The dam is a simple cross section with similar fill material on the upstream and downstream sides, as well as a lower permeability core in the center. There is a blanket drain beneath the dam on the downstream side.

The upstream boundary nodes are designated as head boundaries with total head equal to the water level in the reservoir (40 feet). The nodes along the contact between the dam and the drain are designated as potential seepage review nodes, since the seepage exit point is unknown. With this review boundary applied, the solver will determine the appropriate nodes that have flow or no-flow. Default boundary conditions (no-flow) are assumed for all other boundaries.

The mesh illustrated in this figure shows a nicely formed pattern of unstructured quadrilateral and triangular elements. Notice how along the boundaries and the contacts between soils, there are evenly shaped quadrilateral elements. This is ideal for the contact between different soil types where there is a potential for higher seepage gradients to form.

Notice the text in the image. There is a main title and then below that, the phrase, “Core 100x reduced K Core.” The words “100x reduced K” are dynamic and will change as the analysis changes. This way, when the view is changed to the model with zero reduction in core Ksat, the text will update and be current with the view. The dynamic text is added using a “field” value, as shown in Figure 2. You can see that the field value refers to the material description for region 2.

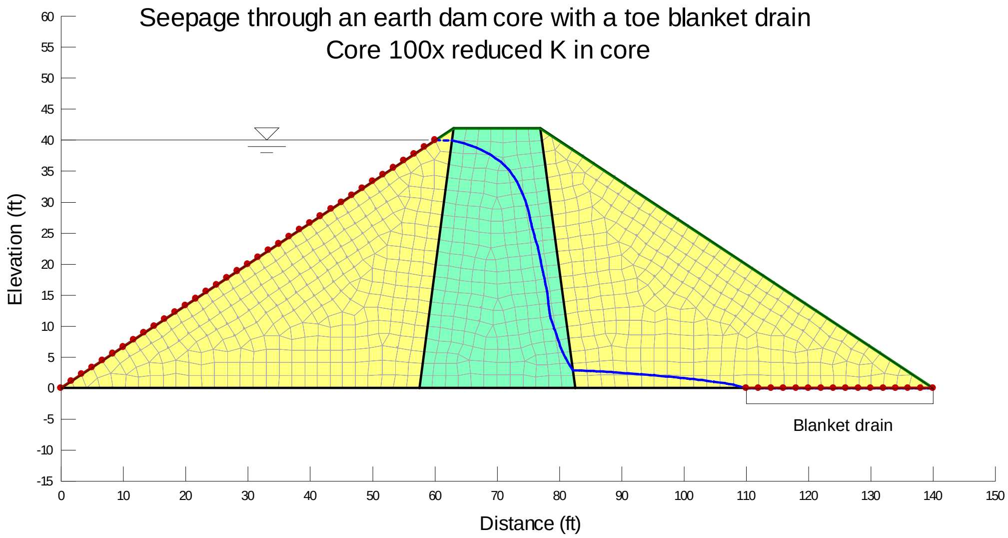

Figure 1 Seepage problem definition

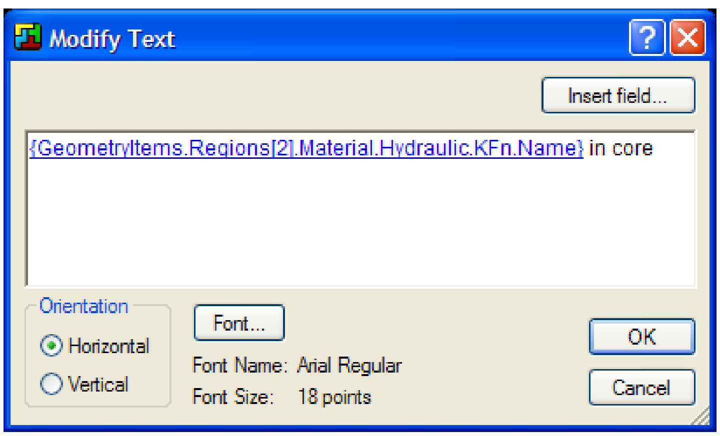

Figure 2 Dynamic sketch text field example

4 Material properties

The dam fill material is assumed to be a silty sand with a Ksat of 1e-5 ft/s. The core is assumed to be a silty clay material with conductivity Ksat values that vary, as shown in Table 1.

Table 1 Core conductivity values used in sensitivity study

Run #	Fill Ksat (ft/s)	Reduced By	Core Ksat (ft/s)
1	1×10^{-5}	0	1×10^{-5}
2	1×10^{-5}	100x	1×10^{-7}

The actual functions for these soils are illustrated in Figure 3. These functions were estimated within GeoStudio based on sample water content functions for silty sand and silty clay.

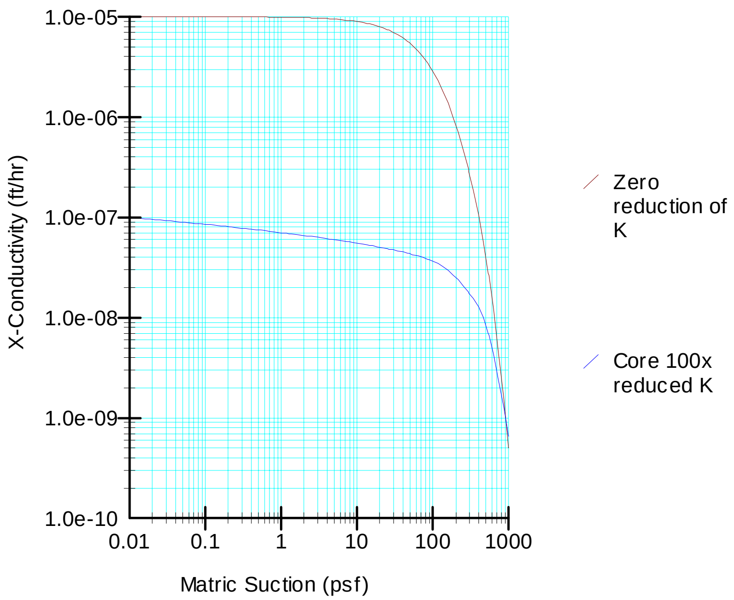

Figure 3 Hydraulic conductivity functions for dam soils

There are four analyses in the file, so region 2 can be assigned a different soil model in each one.

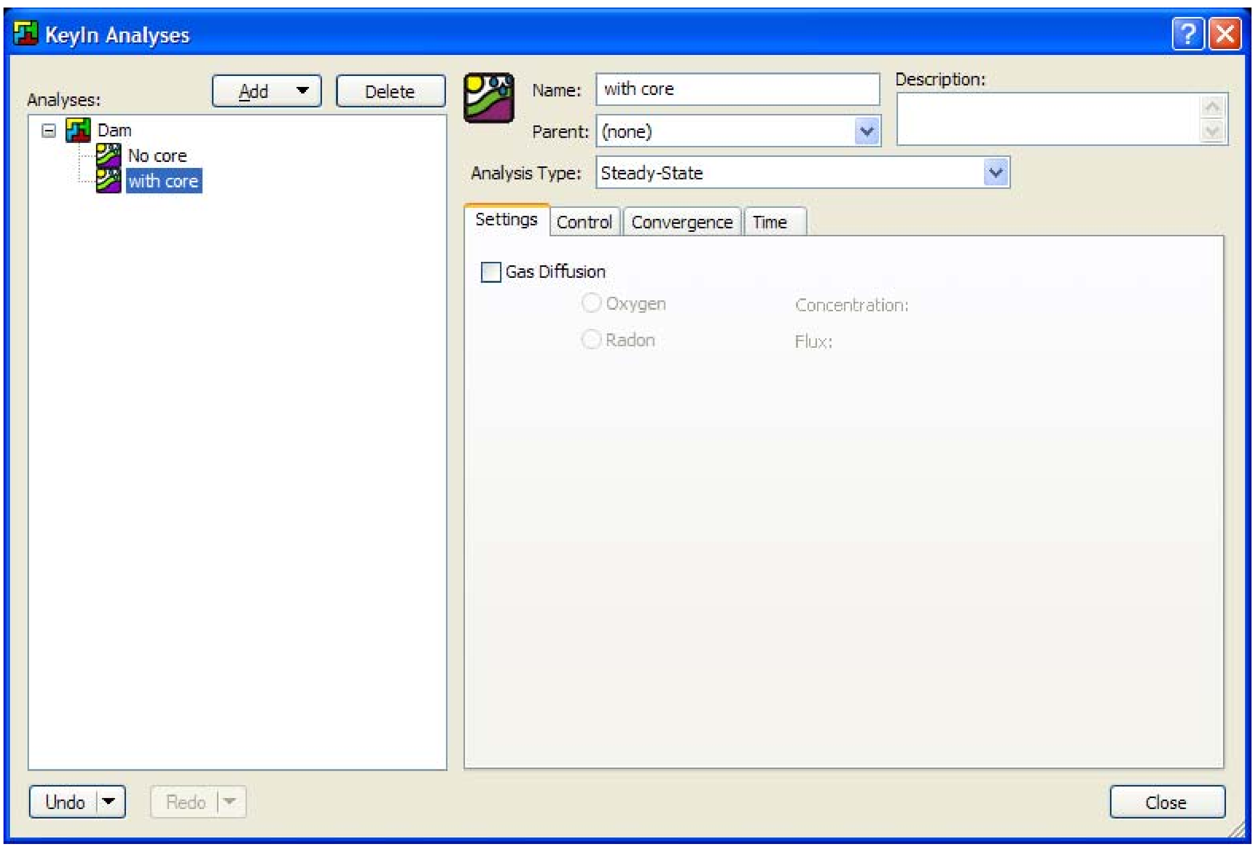

Figure 4 Two sibling analyses in the project

5 Comparison of results

The figures below show the change in phreatic surface line position and leakage through the core that result from reducing the hydraulic conductivity of the core relative to the surrounding fill. It is clear that reducing the core conductivity by only two orders of magnitude, reduces leakage through the core by almost two orders of magnitude. In addition, the pore pressures on the downstream face are greatly reduced, as most of the head loss occurs in the core material instead of on the downstream fill material. This may have implications when it comes to increased stability of the downstream dam face.

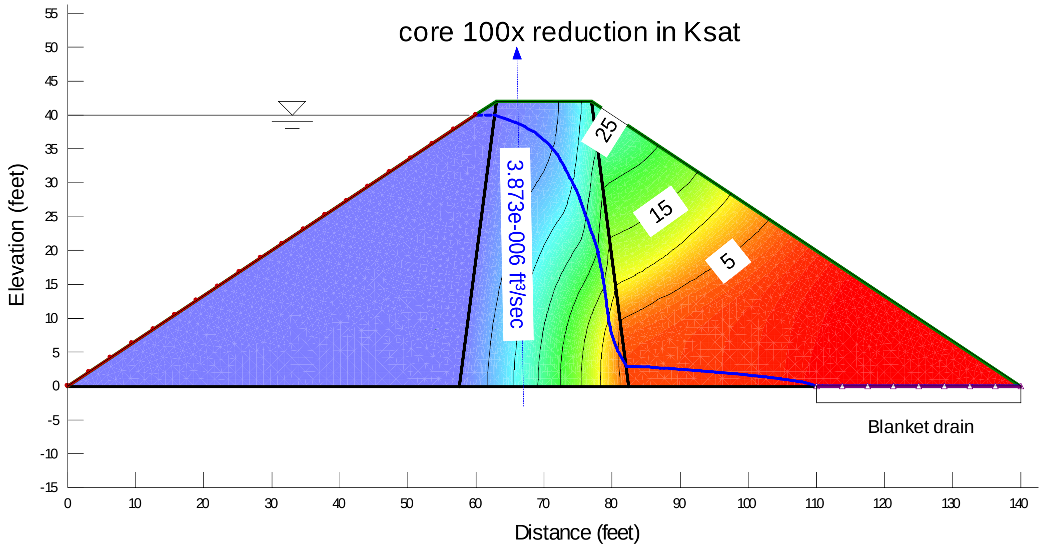

Figure 5 100x reduction of Ksat in core

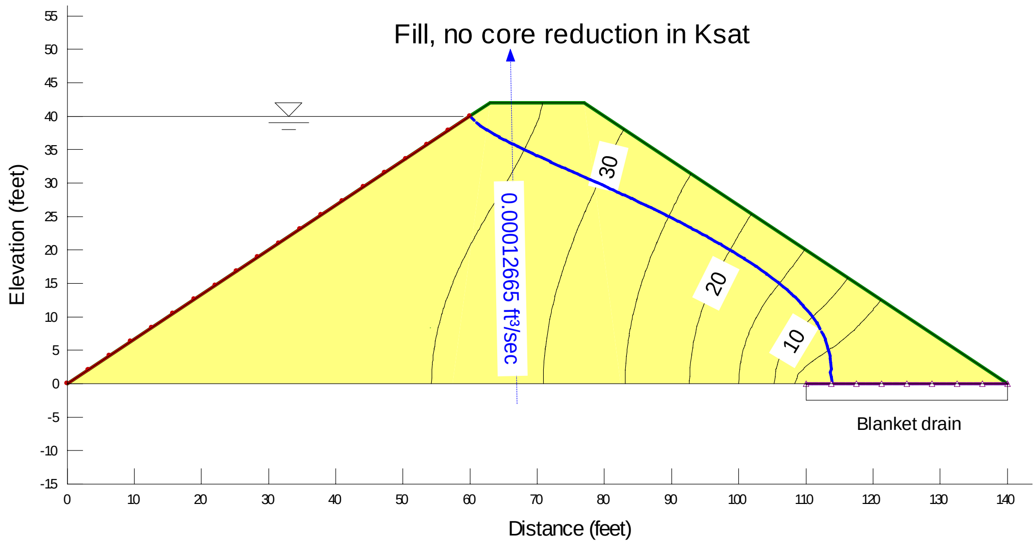

Figure 6 Flow through dam with NO core