Steady state flux under a cutoff wall with anisotropy

1 Introduction

The objective of this illustration is look at steady state flow under a cutoff when the soil exhibits anisotropic behavior. In particular, the objectives of this illustration are to:

- Compare two SEEP/W solutions where anisotropy is specified. In one case the Ky:Kx ratio is less than 1.0 and in the other it is more than 1.0.
- Illustrate how the two cases can be modeled using two seepage analyses within the same project file.

2 Feature highlights

GeoStudio feature highlights include:

- Head and pressure boundary conditions
- Interface elements on a line
- Anisotropic flow beneath a cutoff wall

3 Geometry and boundary conditions

Figure 1 presents the SEEP/W model definition where there is an inclined impermeable barrier to flow beneath a dam and cutoff barrier.

The boundary condition on the upstream side of the dam is a total head value equal to the elevation of the water in the reservoir. On the downstream side, the boundary condition is set to a value of pressure equal to zero – which indicates full saturation downstream with no tail water elevation.

The cutoff is installed to a depth of 15 feet beneath the dam foundation and is modeled using interface elements along a line. In the past, the cutoff had to be modeled as a no-soil region, which required a hole to be made in the mesh. The interface element approach is much more intuitive.

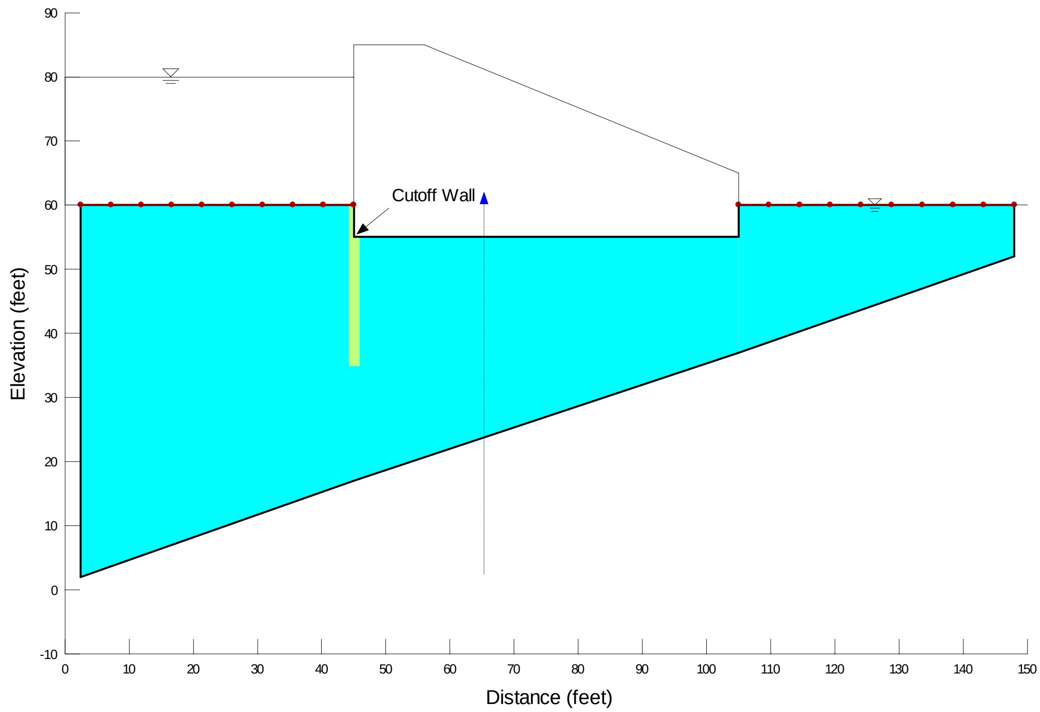

Figure 1 SEEP/W model definition

4 Material properties

The hydraulic conductivity of the homogeneous foundation material is 1x10^{-3} feet/min. Because the soil always remains saturated, the Saturated Only soil model type was assigned to the region. It is not necessary to create functions for the soil properties, as all values are constant for all pressures. The soil has a conductivity ratio Ky:Kx of 10 and an orientation of 26.5 degrees counter clockwise from horizontal in this case. In the second case, the ratio will be Ky:Kx of 0.1 at the same direction.

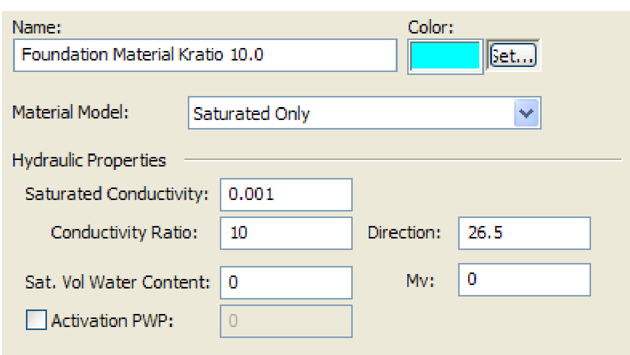

Figure 2 Saturated Only soil seepage model

The interface model in this case must be a no-flow model and this is achieved by setting the tangential and normal conductivity along the interface elements to have a value of zero. The material set-up for the soil and interface elements are given in Figure 2 and Figure 3 respectively.

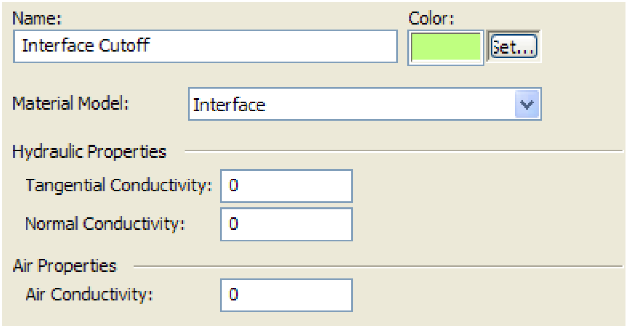

Figure 3 Interface element "no flow" model

5 Results and discussion

Figure 4 and Figure 5 show the head contours, flow paths and flow quantity beneath the cutoff for the two K-ratio models. With a K-ratio less than 1.0 there is more vertical infiltration. The flow paths are shown to drop down deeper into the profile before they flow laterally to the lower head right-side exit point. With a K-ratio greater than 1.0, there is more rapid flow in the lateral direction before the water has a chance to reach deeper into the soil profile.

Comparison of the total flow under the cutoff reveals that with a K-ratio of less than 1.0 there is much less flow through the system than for the high K-ratio case. This is due to the fact that for the high K-ratio case, the water must flow over a much longer distance from its entrance to exit point and over this longer distance there is a much lower gradient given the equal head loss applied for both cases. When the gradient is lower, the rate of flow is reduced. The magnitude of the gradient is observed by the closeness of the head contours relative to each other.

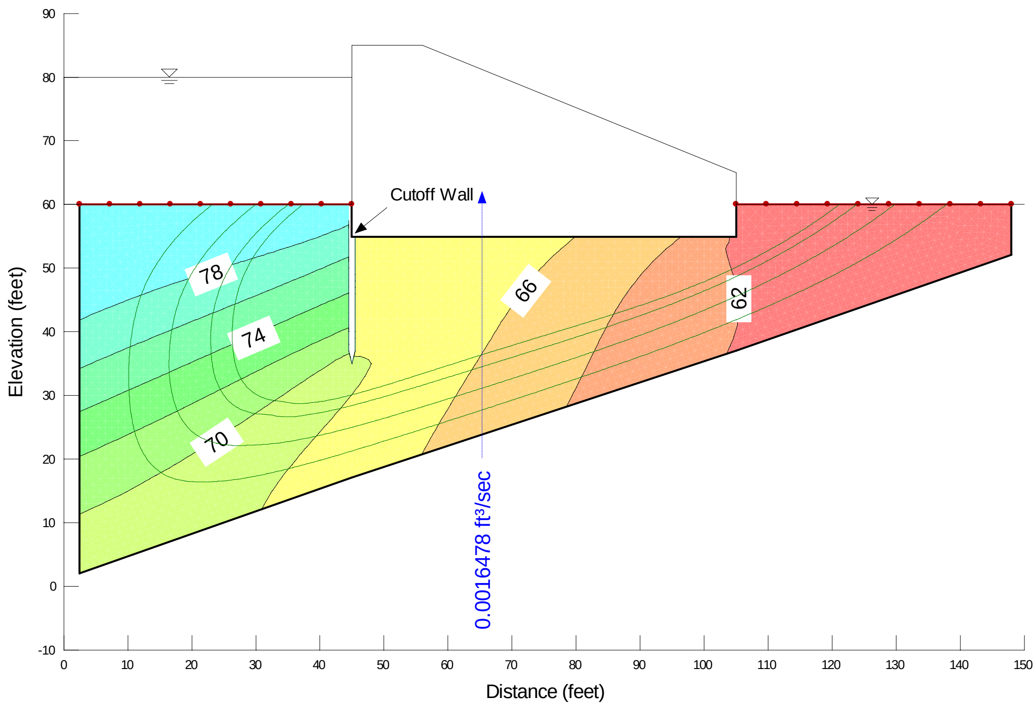

Figure 4 Flow system with Kratio = 0.1

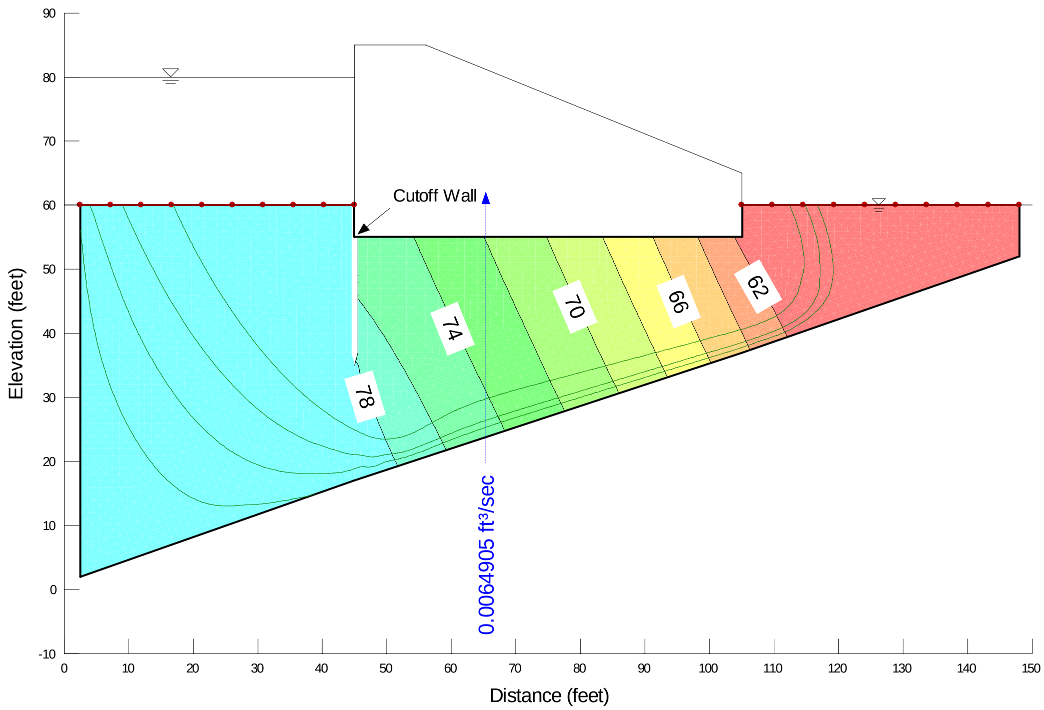

Figure 5 Flow system with Kratio = 10.0

Figure 6 shows the Key In Analyses settings for this GeoStudio project. You can see that within the single project file there are two sibling analyses. They share the same geometry but each will have unique material models assigned to them. This allows for simple comparison, and if the geometry were to change, both models can be re-solved with no additional effort.

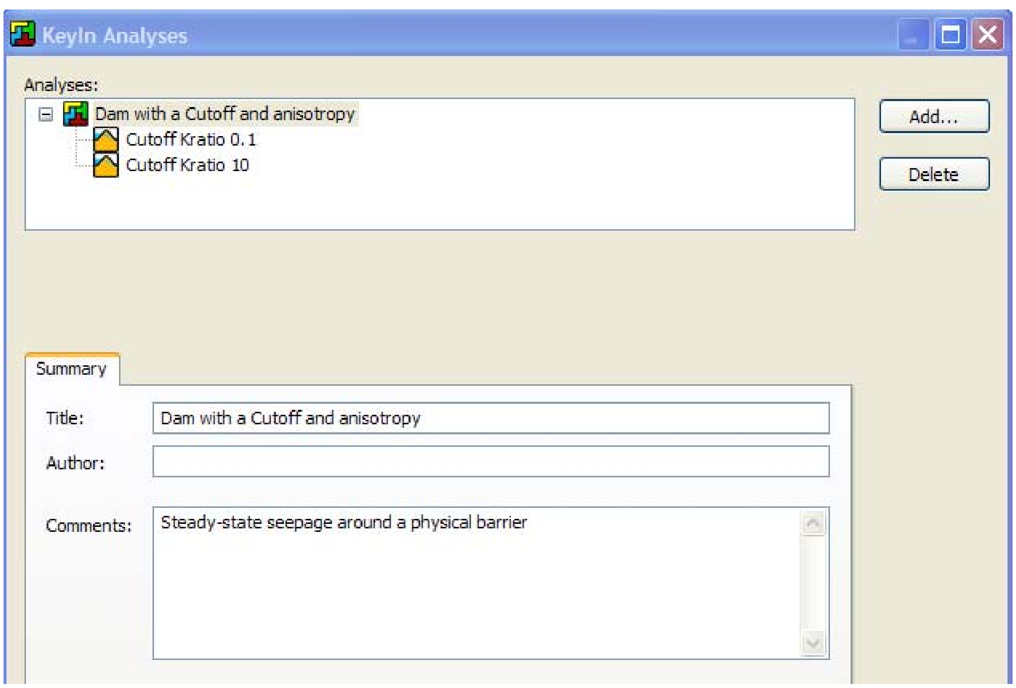

Figure 6 Analysis settings for both cases within one project file