Steady state flux under a cutoff wall

1 Introduction

The objective of this illustration is look at steady state flow under a cutoff and to compare it with a published solution. In particular, the objectives of this illustration are to:

- Compare a SEEP/W solution with a published "flow net" solution
- Show how an interface element can be used to model a no-flow thin barrier
- See how the uplift pressure beneath the dam and exit gradients can be obtained

2 Feature highlights

GeoStudio feature highlights include:

- Head and pressure boundary conditions
- Interface elements on a line
- Exit gradients
- Uplift pressures

3 Geometry and boundary conditions

Figure 1 presents the SEEP/W model definition of a cutoff example published by Lambe and Whitman (1969). The original flow net solution for seepage flow in the foundation of a concrete dam with a cutoff wall as presented by Lambe and Whitman, is given in Figure 2.

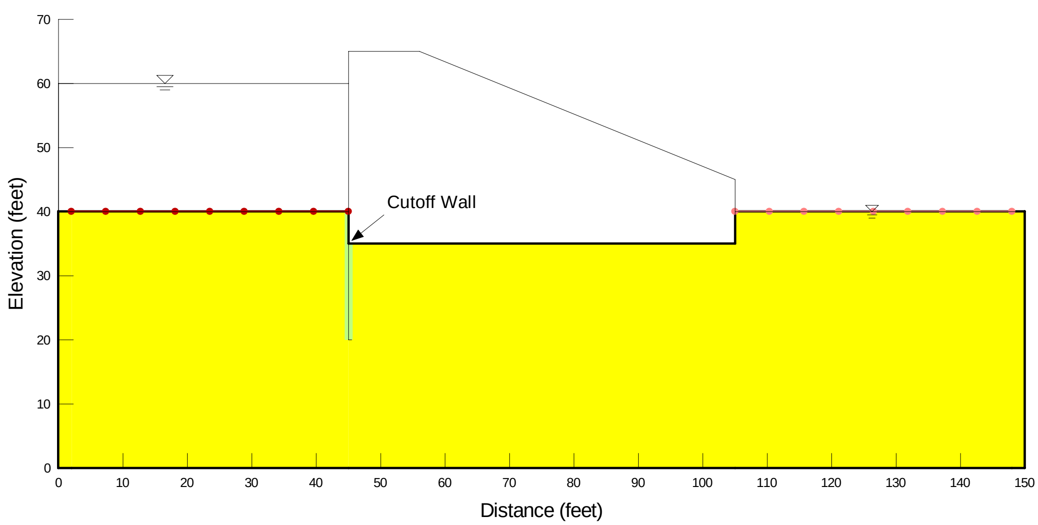
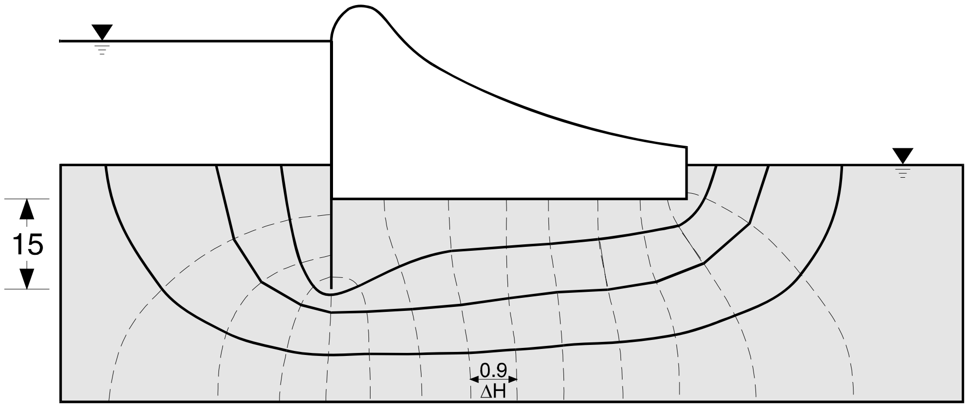


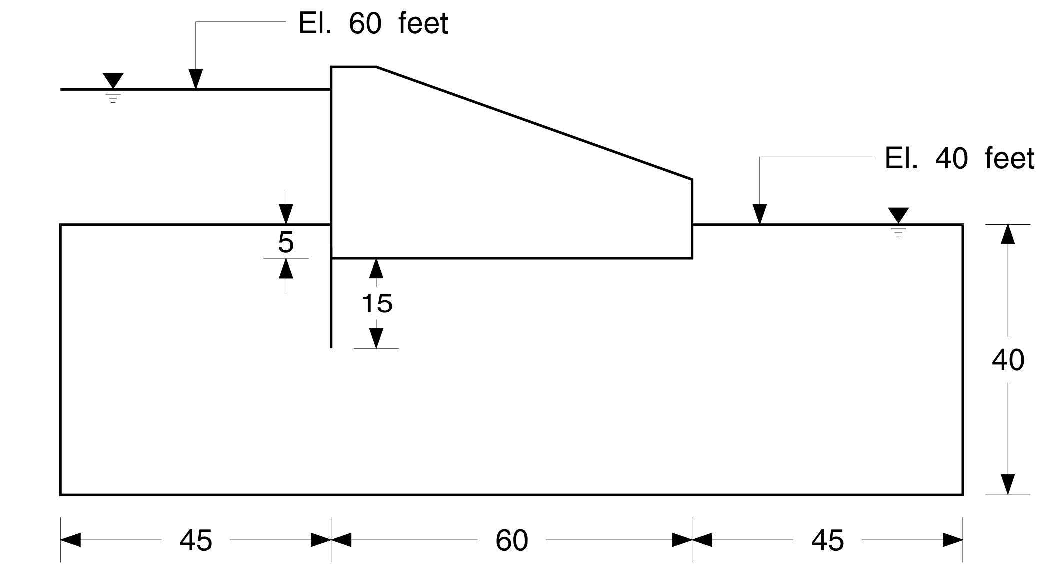
Figure 1 SEEP/W model definition

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.



(a) Flow Net Solution



(b) Problem Dimensions

Figure 2 Seepage problem definition and flow net solution

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 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 3 and Figure 4 respectively.

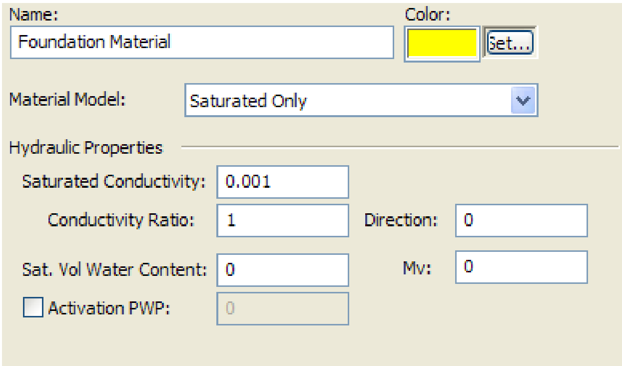


Figure 3 Saturated Only soil seepage model

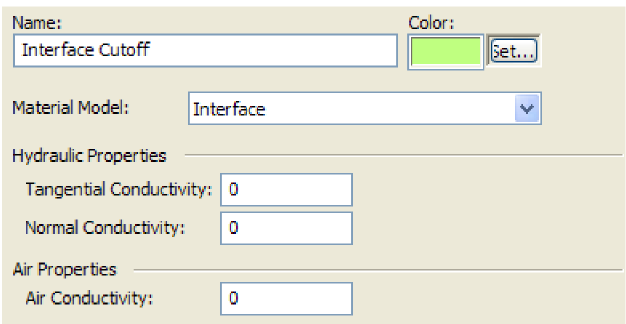


Figure 4 Interface element "no flow" model

5 Results and discussion

The SEEP/W solution with drawn flow paths and head contours is shown in Figure 1.

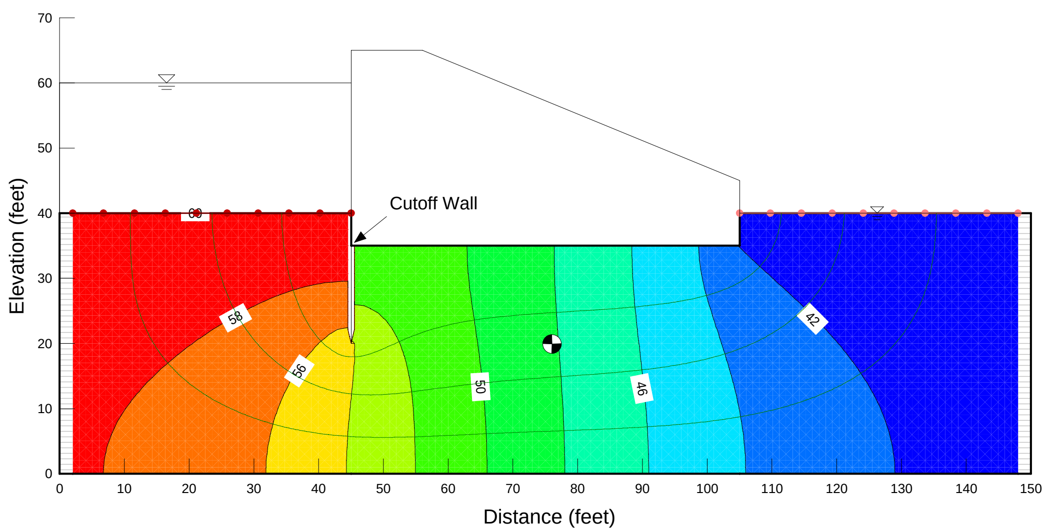


Figure 1 Seepage problem definition and computed heads and flow lines

Based on the flow net solution computed by hand and illustrated above, the seepage under the dam is $5.76x10^{-3}$ ft^3/min/ft, the uplift pressure at the downstream toe is 7.1 feet, and the exit gradient is 0.34. The

SEEP/W results are summarized in Table 1 with data obtained from Figure 2 and Figure 3 respectively. There is very good agreement with the flow net solution.

Table 1 Comparison of flow net and SEEP/W results

Item	Flow Net	SEEP/W
Total Seepage (ft^3/min/ft)	5.76×10^{-3}	5.62×10^{-3}
Uplift Pressure Head at toe base (ft)	7.1	6.93
Exit Gradient at Downstream Toe	0.34	0.32

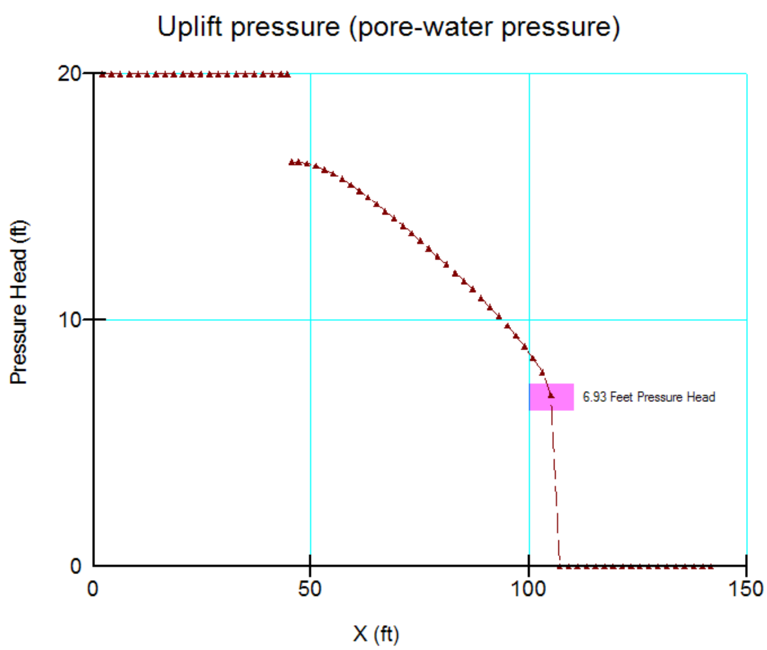


Figure 2 Pressures along ground surface and beneath dam

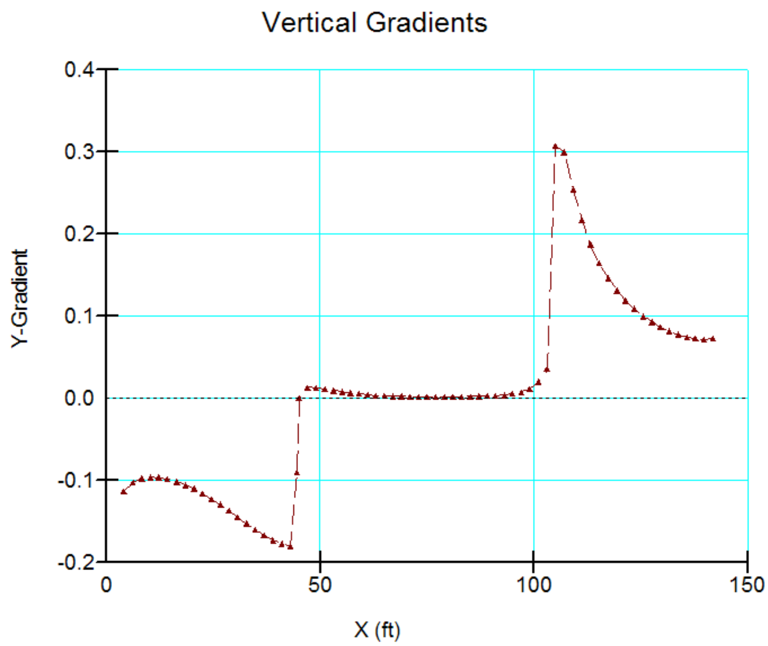


Figure 3 Vertical gradients along ground surface and beneath dam