Modeling the Effect of a Drain

1 Introduction

This example illustrates how to model the effect of a drain in a seepage analysis.

2 Background

It is useful to recall the fundamental finite element equation for a seepage analysis.

$$[K]\{H\} = \{Q\}$$

Remember that if *H* is specified, the solution computes *Q*, and if *Q* is specified then the solution computes *H*.

Physically it means that if *H* is specified, sufficient *Q* has to be extracted or injected to satisfy the specified *H*. This is true anywhere in the flow domain whether it is on the perimeter or inside the domain.

The implication here is that the effect of a drain can be modeled by specify *H* at a point inside the domain.

3 Illustrative example

Consider the case illustrated in Figure 1. This could be, for example, the situation along an irrigation canal or a water storage facility.

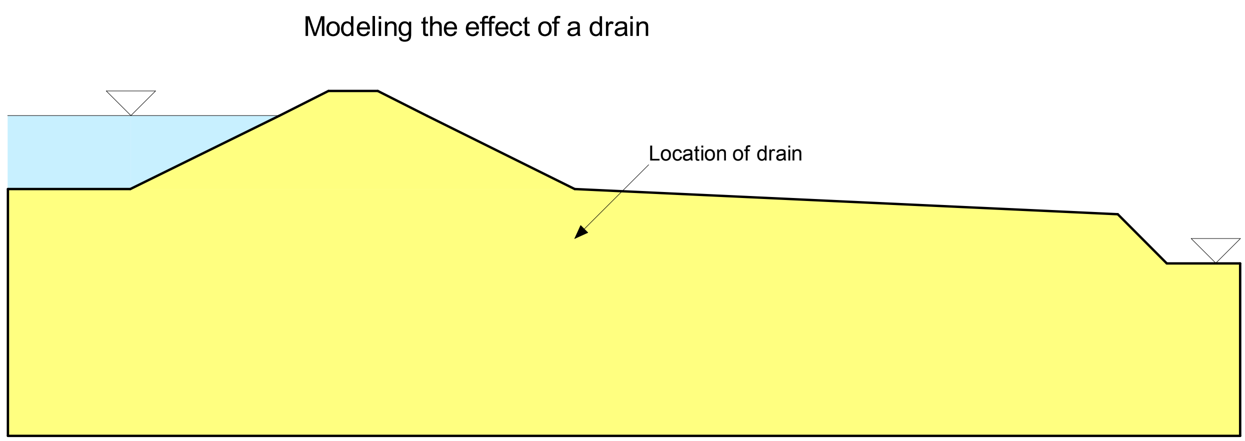

Figure 1 Illustrative problem

Under long term steady-state conditions a seepage face will develop along the outside toe of the embankment as shown in Figure 2. This is undesirable as it can lead to salinization and destroy the productive value of the land. One possible solution is to install a perforated drain to collect the seepage.

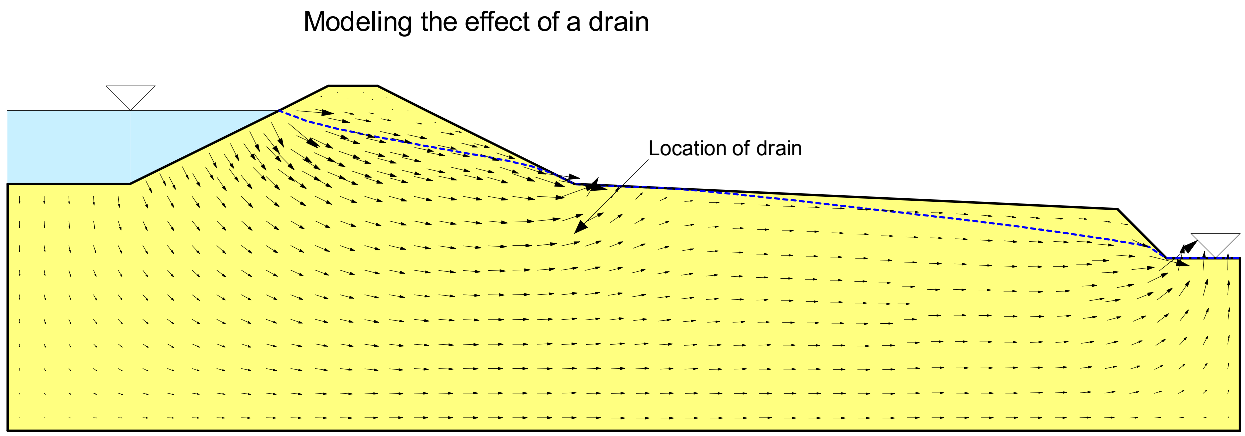

Figure 2 Long term steady-state seepage conditions

4 Drain behavior

Typically perforated drains in a case like this are small – about 4 inches or 100 mm in diameter. From a modeling perspective they are small compared to the overall size of the seepage domain. In a case like this, the effect of the drain can be simulated by simply specifying an *H* boundary condition at a Point.

If we make the assumption that the drain will remain unclogged and any seepage arriving in the drain can run freely along the drain, the drain will remain unpressurized. Stated another way, the drain will have the capacity to carry away all the seepage water without positive pressure building up in the drain.

This condition can be specified by setting H = to the y-coordinate or setting the pressure head to zero.

5 Seepage with the drain

The first step is to Draw a Point at the proposed location. The second step is to define a head-type boundary condition at the Point. In the associated data file, the boundary condition is specified as Pressure Head equal to zero.

Figure 3 shows the flow regime when the drain is present. As intended, the drain prevents ground surface seepage in the outside toe area.

Since we specified an H type boundary condition, SEEP/W will compute a Q. Using the View Results Information command reveals a water flux of -2.113 x 10^{-6} m^3/sec. The negative sign means flow out of the domain.

Total Head (m)	8
Pore-Water Pressure (kPa)	0
Pressure Head (m)	0
Water Flux (m^3/sec)	-2.1121828e-006
Cumulative Water Flux (m^3)	0

It is important to remember that this is the flow per unit distance into the section. If a drain has a collection point every 20 m, for example this value would need to be multiplied by 20 to get the total flow at the collection point.

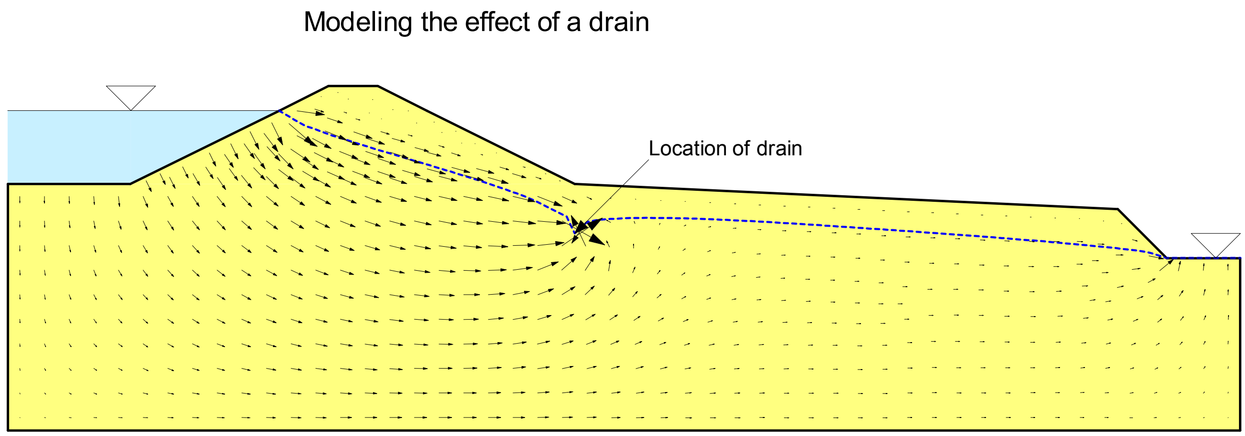

Figure 3 Flow regime with drain in place

6 Large drains

If the drain is large in the context of the flow domain, the drain can be modeled as a circular open in the mesh as illustrated in Figure 4. The boundary condition on the perimeter of the pipe can then be specified as a potential seepage face.

A typical result might be as shown in Figure 4. The implication is that seepage will enter the drain only along that portion of the perimeter where the water pressure is zero or positive.

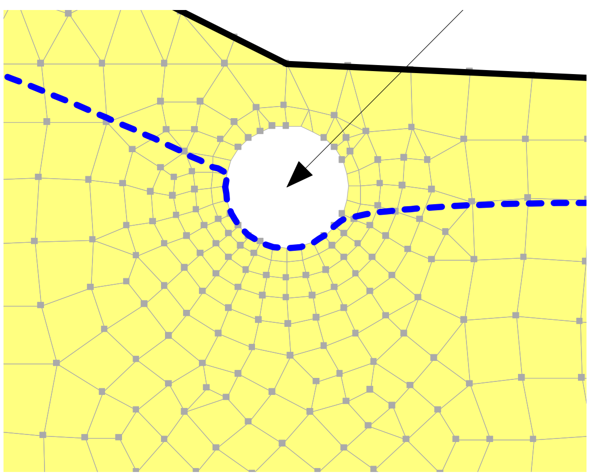

Figure 4 Illustration of a large size drain

7 Commentary

Modeling the effect of a drain with the specification of an H-type boundary condition at a Point is more than adequate for small drains, and is a useful approach to get a first estimate of the flow quantities one might expect. Usually the seepage collected is relatively small, and selecting the drain size is not based flow quantities but is based on practical maintenance considerations regarding the possible clogging of the drain.

If the drain is large in the context of the seepage domain, then a circular opening can be used to model the drain. As a general rule, the opening should be readily visible at a zoom factor of 100% for the size of the opening to have a significant influence on the results.