

## BOUNDARY CONDITIONS IN FEM IN 3D WITH SVOFFICE 2009

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### Introduction

Hi, my name is Murray Fredlund. Welcome to the session How to Assign Boundary Conditions within a 3D finite element numerical model within the *SVOffice 2009 Next Generation* geotechnical software suite.

In this example we've loaded an example model called **EarthDam>Irregular EarthDams**. This is a good example of a fairly typical 3D model which might be created using our software. We are only going to be looking at SVFlux in this example, because the similarity between all of the finite element software packages is reasonable enough so that once the user learns to create boundary conditions and assign them in one package, the methodologies apply to all of our software packages.

### Applying Boundary Conditions

What we have here is an EarthDam which we can spin around to see all sides of it. We have an upstream boundary condition to the left of the model and we have water flowing through the EarthDam and exiting downstream of the model. This model would be made up of (given the current paradigm of geometry in SVFlux) a series of surfaces and regions. Regions are like cookie-cutter objects which cut vertically through the model (which can be viewed both in 2D and 3D to see regions). Boundary conditions can be applied in a 3D model to either surfaces or sidewalls. As each of these shapes cuts down through the model, sidewalls are created both internally and externally and it's important to note that we can apply boundary conditions internally and externally in the software. If we wanted to (in the example) provide a boundary condition which puts a head boundary condition on the left side of the numerical model, we could go to **Model>Boundaries>Boundary Conditions**. In this case, you can see the entire shape is selected because the entire shape is selected in the Boundary Conditions dialog. As we click on the various starting line segments, each of those lines is highlighted on the model. Next we will select a head expression (same conditions are available in both 2D and 3D except in the 3D model the dimensions may change because z is in the vertical direction in a 3D model). If you set the expression to 45 metres and the change is represented by a blue line around the numerical model. When boundary conditions are implied, they continue around the entire model until they are changed or turned off. Because we don't want the head boundary condition to be applied to all sidewalls of that region so we can turn it off by selecting **No BC** and then the blue line (head boundary condition) only applies to the one sidewall.

Now we have applied a boundary condition to Surface One (at the bottom of the model as shown in the video). Boundary conditions are always extruded up to the next surface so this boundary condition has been extruded vertically up to the next surface and the blue indicates where it has been applied in the 3D model. Boundary conditions can be applied to any sidewalls in the numerical model.

If we want to apply a boundary condition to a surface, we can select a surface (the upstream side of the top face of the model): Surface Three. The Surfaces are always sorted with the highest

number being the top of the model. In this case, we're going to right click on the object, select Boundary Conditions and we receive a note that "segment boundary conditions do not apply to the top surface". This is because there is no need for applying a boundary condition to the sidewalls because they will be extruded to thin air. We can, however, apply a surface boundary condition to this object by selecting the **Surface Boundary Conditions** tab in the **Boundary Conditions** dialog. By applying a **Head Expression** of 45 metres to the surface of the model, you will see that surface is covered in blue to indicate that the boundary conditions are represented on that surface and have been applied there. This covers the basics of how to apply boundary conditions in a 3D model.

### **Of Note**

Boundary conditions should represent and coincide with applied initial conditions. In this example model, we have violated this rule by applying the boundary condition on the downstream side of the EarthDam and the initial condition was applied to the upstream. By viewing the Initial Conditions (**Model>Initial Conditions**) we see the defined initial water table (z value = 27 ½ metres) will conflict with the existing boundary conditions and will create numerical instability in the model. As in 2D, users must ensure initial conditions match the model's boundary conditions or there will be a high probability of convergence problems with the model.

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