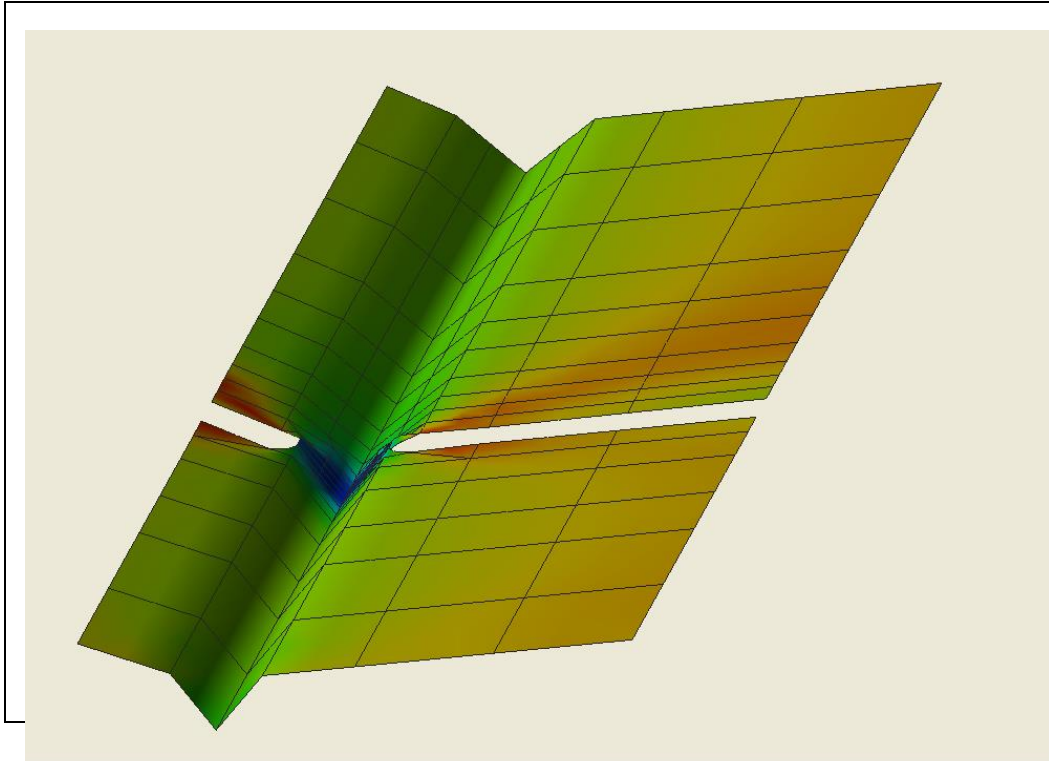


SMS 12.3 Tutorial

FESWMS Analysis with Weirs



Objectives

This tutorial demonstrates how to prepare a FESWMS simulation using of weirs.

Prerequisites

- Overview Tutorial
- FESWMS Tutorial

Requirements

- FESWMS
- FST2DH
- Mesh Module

Time

- 15–30 minutes

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1 Introduction

This tutorial uses the project file “suecreek.sms”, which contains a mesh created and renumbered specifically for this tutorial.

To open the mesh data:

1. Select *File* / **Open...** to bring up the *Open* dialog.
2. Browse to the *data files* folder for this tutorial and select “suecreek.sms”.
3. Click **Open** to import the project and exit the *Open* dialog.
4. If geometry is still open from a previous tutorial, a dialog will ask if existing data should be deleted. If this happens, click **Yes** .

The project should appear similar to Figure 1.

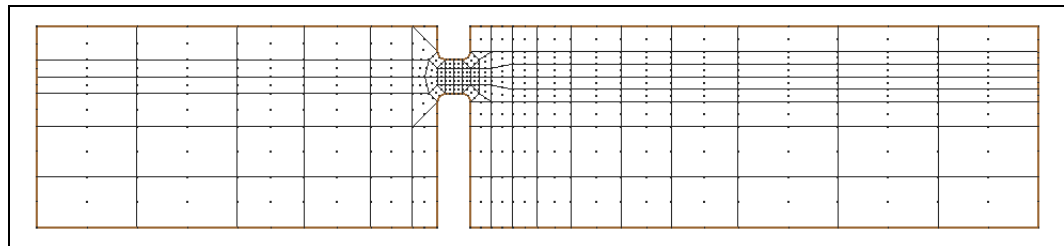


Figure 1 The “suecreek.sms” geometry

2 Defining Material Properties

Each element of the mesh is assigned a material ID. The material ID tells FESWMS which material properties should be assigned to the element.

To view the materials used in the mesh:

1. Select *Display* | **Display Options...** to open the *Display Options* dialog.
2. Select “2D Mesh” from the list on the left.
3. On the *2D Mesh* tab, turn off *Nodes* and *Elements* and turn on *Materials*.
4. Click **OK** to close the *Display Options* dialog.

The mesh should appear similar to Figure 2.

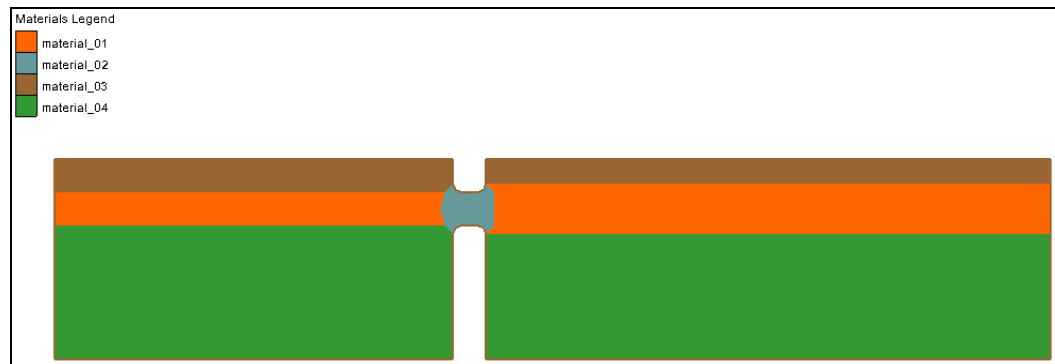


Figure 2 The mesh with only Materials being displayed

There are four different material types in this mesh, but the material properties have not yet been defined. When SMS opens a mesh with undefined materials, the materials are assigned default properties. See the FESWMS documentation for a definition of individual material parameters.

To change the material values:

1. Select *FESWMS* / **Material Properties...** to bring up the *FESWMS Material Properties* dialog.


A graphical image at the top of the *Roughness Parameters* tab shows the Manning's n value as a function of water depth.

2. Select "material_01" from the list on the left.
3. Enter values shown in the table below for $n1$ and $n2$ on the *Roughness Parameters* tab, and for Vo and $Cu1$ on the *Turbulence Parameters* tab.
4. Repeat steps 2–3 for "material_02", "material_03", and "material_04".
5. Click the **OK** to close the *FESWMS Material Properties* dialog.

Material	Roughness Parameters		Turbulence Parameters	
	$n1$	$n2$	Vo	$Cu1$
material_01	0.035		20.0	0.6
material_02				
material_03	0.055			
material_04				

Values have now been assigned for the four materials in this mesh. Notice in the table above that there are only two distinct material regions because materials 1 and 2 have the same values, as do materials 3 and 4.

Now that the material values have been assigned, turn off their display:

1. Click **Display Options**  to open the *Display Options* dialog.
2. Select "2D Mesh" from the list on the left.
3. On the *2D Mesh* tab, turn off *Materials* and turn on *Nodes* and *Elements*.



- Click **OK** to close the *Display Options* dialog.

2.1 Assigning Boundary Conditions

Boundary conditions—such as flow and head—define how water enters and leaves the finite element network. Improper boundary conditions result in model instability and inaccurate solutions.

A steady state model such as this can only have constant boundary conditions. The flow and head boundary conditions will be defined at nodestrings on opposite sides of the model.


To create the two boundary nodestrings:

- Select “ suecreek” to make it active.
- Using the **Create Nodestrings**  tool, click on the lower node of the left boundary.
- Hold the *Shift* key and double-click on the upper node of the left boundary.

This creates the nodestring all the way across the left boundary of the mesh. If the *Shift* key is not held down when this is done, a valid boundary nodestring is not created because it does not include all nodes across the boundary.

- Repeat steps 2–3 to create a nodestring across the right boundary.

Boundary conditions can now be assigned to the left nodestring by doing the following:

- Using the **Select Nodestrings**  tool, select the left boundary nodestring.
- Select *FESWMS / Assign BC...* to bring up the *FESWMS Nodestring Boundary Conditions* dialog.
- Turn on *Flow* and select “Constant” and “Normal” from the two drop-downs.
- Enter “9000.0” as the *Flow rate*.
- Click **OK** to close the *FESWMS Nodestring Boundary Conditions* dialog.

The selected nodestring is now defined as a flow nodestring. To reflect this, the nodestring color has changed. An arrow appears at the center of the nodestring to indicate the flow direction and the flow value is shown next to the arrow (Figure 3).

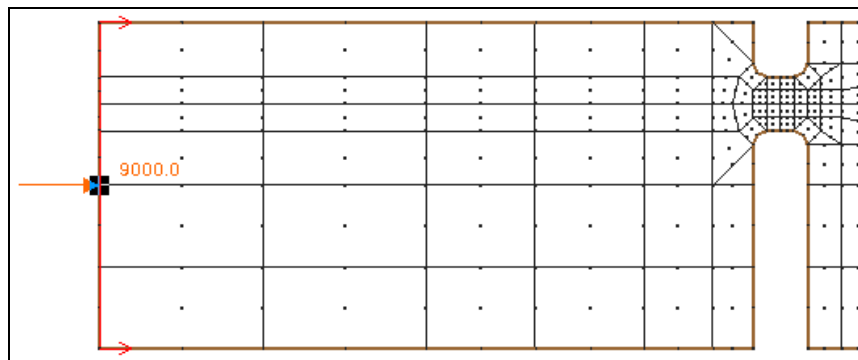



Figure 3 The inflow boundary condition

To assign the head to the right boundary:

1. Using the **Select Nodestrings**  tool, select the right nodestring.
2. Right-click and select **Assign BC...** to bring up the *FESWMS Nodestring Boundary Conditions* dialog.
3. Turn on *Water surface elevation* and select “Constant” and “Essential” from the two drop-downs.
4. Enter “812.9” as the *WSE*.
5. Click **OK** to close the *FESWMS Nodestring Boundary Conditions* dialog.

The selected nodestring is now defined as a head nodestring. A head symbol appears at the center of the nodestring and the head value is shown next to the symbol (Figure 4).

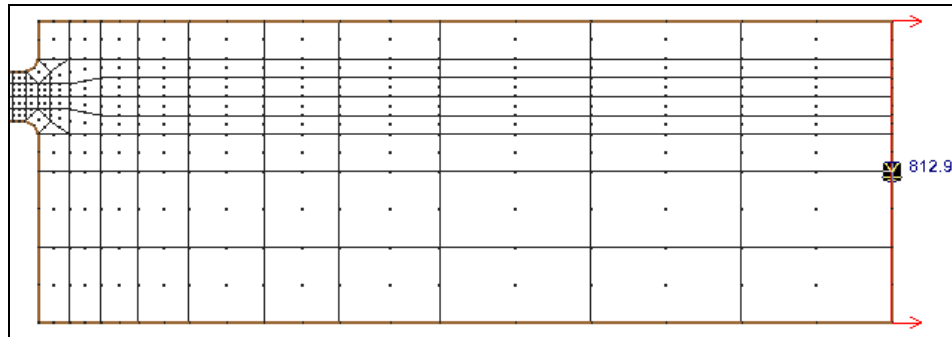


Figure 4 The outflow boundary condition

3 Creating Weirs

With FESWMS, flow control structures—such as weirs, piers, culverts, and drop inlets—are easily added to the mesh. Weirs, culverts, and drop inlets are created between pairs of nodes. Wide structures can be created between strings of node pairs.

For this model, a weir will be defined along seven node pairs across the abutment at the bottom middle of the mesh, as shown in Figure 5. This image highlights the nodes across which weir segments will be created.

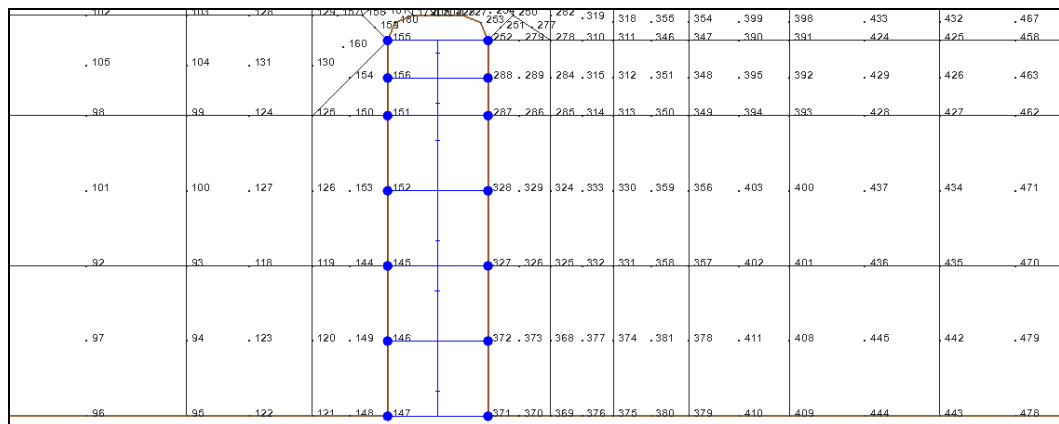




Figure 5 Area with weirs

The seven node pairs for the weir are:



- 155↔252.

- 156↔288.
- 151↔287.
- 152↔328.
- 145↔327.
- 146↔372.
- 147↔371.

To make node numbers visible, do the following:

1. **Zoom**  in to the area shown in Figure 5.
2. Click the **Display Options**  macro to open the *Display Options* dialog.
3. Select “2D Mesh” from the list on the left.
4. Turn on *Node Numbers*.
5. Click **OK** to close the *Display Options* dialog.

A set of weir segments can be created across pairs of adjacent nodes by using nodestrings by doing the following:

1. Using the **Create Nodestrings**  tool, create a nodestring by clicking on node 147, then holding *Shift* while double-clicking on node 155 (right to left, as if facing downstream).
2. Repeat step 1 for nodes 371 to 252.
3. Using the **Select Nodestrings**  tool, select both nodestrings by selecting one, and holding down the *Shift* key while selecting the other.
4. Select *FESWMS / Weir...* to bring up the *FESWMS Weir* dialog (Figure 6).

Note that each nodestring is labeled: one is “B” and the other is “A”.

5. If the value to the right of *Upstream* does not match the letter corresponding to the nodestring going from node 147 to 155, click **Switch**.
6. In the *Weir Coefficients* section, select “Paved roadway” from the *Weir type* drop-down.
7. In the *Weir Geometry* section, enter “825.0” as the *Zc – Crest Elevation*.
8. Click **OK** to close the *FESWMS Weir* dialog.

A set of five consecutive weir segments spanning the two bottom elements has just been defined (Figure 5). Together, these segments define a 300-foot-long broad crested weir with a crest elevation of 825 feet, and discharge coefficient of 0.544. SMS displays tick marks along the centerline of the weir to show the breaks between weir segments.

There is a specific formula for determining the length of each pair of nodes. Each midside node has two-thirds of the element width in its crest length while each corner node has one-sixth of each element width that is involved in the weir. See *SMS Help* for more information on weirs and other flow control structures.

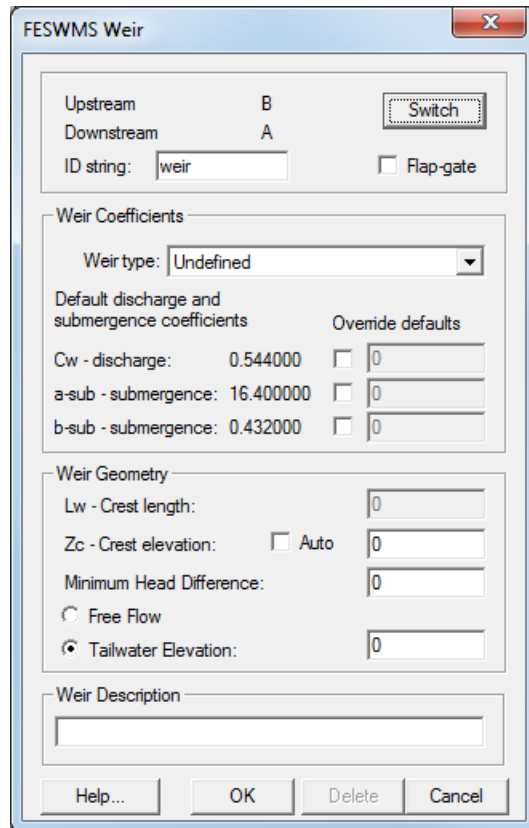




Figure 6 FESWMS Weir dialog

After creating the weir, turn off node numbers by doing the following:

1. Click **Display Options**  to open the *Display Options* dialog.
2. Select “2D Mesh” from the list on the left
3. On the 2D Mesh tab, turn off *Node Numbers*.
4. Click **OK** to close the *Display Options* dialog..
5. **Frame**  the project.

The project should appear similar to Figure 7.

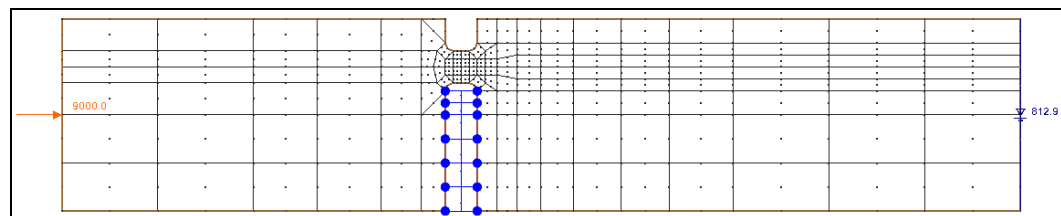



Figure 7 The bridge geometry with weirs

4 Assigning Model Parameters

The remaining FESMWS model parameters now need to be modified:

1. Select *FESWMS* / **Model Control...** to bring up the *FESWMS Model Control* dialog.
2. On the *Parameters* tab, in the *General Parameters* section, turn on *Element drying / wetting*.
3. Click **OK** to close the *FESWMS Model Control* dialog.
4. Right-click on “ suecreek” and select **Rename**.
5. Enter “suecreek2” and press *Enter* to set the new name.

5 Saving the Data

The data is now ready to be saved by doing the following:

1. Select *File* | **Save As...** to bring the *Save As* dialog.
2. Select “Project Files (*.sms)” from the *Save as type* drop-down.
3. Enter “suecreek2.sms” as the *File name*.
4. Click **Save** to save the project and close the *Save As* dialog.

6 Using FST2DH

The analysis module of FESWMS is called FST2DH. It uses either default values or data from a previous solution as initial conditions to compute the solution. The default conditions correspond to still water at the *Water surface elevation* specified in the *Parameters* section of the *FESWMS Model Control* dialog. In this tutorial, the default conditions are used.

To run FST2DH:

1. Select *FESWMS* | **Run FST2DH** to launch the *FESWMS* model wrapper dialog.

The model wrapper displays the progress of the iterations.


2. When the model run finishes, turn on *Load solution* and click **Exit** to close the *FESWMS* model wrapper dialog.

The solution is stored in a file named “suecreek2.flo”. This file contains the velocity and water surface elevation for each node in the mesh. SMS automatically loads the solution by following the directions above. The solution file is also provided in the *data files\output* folder.

7 Editing Weir Data

In the solution just computed, there is no flow over the weir. The water surface at the weir is much lower than the weir crest elevation so no overtopping occurred. This was purposely done to add model stability.


With an initial solution, the weir’s crest elevation can be lowered to allow overtopping by doing the following:

1. Using the **Select Nodestrings**  tool, select the two weir nodestrings by using the *Shift* key.
2. Select *FESWMS / Weir...* to open the *FESWMS Weir* dialog.
3. In the *Weir Geometry* section, enter “812.5” as the *Zc – Crest Elevation*.
4. Click **OK** to close the *FESWMS Weir* dialog.

7.1 Using the Hot Start File

SMS needs to tell FST2DH to use the previous solution file as an input “hot start”—or “initial condition”—file.

To do this:


1. Select *FESWMS / Model Control...* to bring up the *FESWMS Model Control* dialog.
2. In the *FST2DH Input* section on the *General* tab, turn on *INI file*.
3. Click  to bring up an *Open* dialog.
4. Select “FESWMS Initial Conditions (*.ini;*.flo)” from the *Files of type* drop-down.
5. Browse to the *data files\suecreek2\FESWMS\suecreek2* folder and select “suecreek2.flo”.

If unable to run the model using this file, use the “suecreek2.flo” solution file provided in the *data files\output* directory.

6. Click **Open** to close the *Open* dialog.
7. Click **OK** to close the *FESWMS Model Control* dialog.

7.2 Computing a New Solution File Using a Hot Start File

To run the new simulation:

1. Right-click “ suecreek2” and select **Rename**.
2. Enter “suecreek3” and press *Enter* to set the new name.
3. Select *File | Save As...* to bring up the *Save As* dialog.
4. Select “Project Files (*.sms)” from the *Save as type* drop-down.
5. Enter “suecreek3.sms” as the *File name*.
6. Click **Save** to save the project under the new name and close the *Save As* dialog.
7. Select *FESWMS / Run FST2DH* to open the *FESWMS* model wrapper dialog.
8. When the model run finishes, turn on *Load solution* and click **Exit** to close the *FESWMS* model wrapper dialog.

The solution is stored in a file named “suecreek3.flo”. This file contains the velocity and water surface elevation for each node in the mesh. SMS automatically loads the solution by following the directions above. The solution file is also provided in the *data files\output* folder. See the *Data Visualization* tutorial for post-processing operations.

8 Checking Flow over Weirs

When FST2DH runs, it saves information for each weir segment. To view this:

1. Select *File* | **View Data File** to bring up the *Open* dialog.
2. Browse to the *data files\suecreek3\FESWMS\suecreek3* folder and select “suecreek3.prt”.
3. Click **Open** to exit the *Open* dialog and bring up the *View Data File* dialog. If the *Never ask this again* option was previously checked, this dialog will not appear. In that case, skip to step 5.
4. Select the desired text editor from the *Open with* drop-down and click **OK** to close the *View Data File* dialog and open the text file in the selected text editor.
5. Scroll to the bottom of the file and find the “SUMMARY WEIR REPORT” section near the end.

The final weir report should appear similar to Figure 8. The second-to-last column shows the flowrate over each weir segment. To see which segment corresponds with which pair of nodes, turn on node numbers inside SMS.

*** SUMMARY WEIR REPORT ***									
Weir id	Node 1			Node 2			Flow		
	Node no.	WS elev (ft)	Energy (ft)	Node no.	WS elev (ft)	Energy (ft)	Flow rate (ft ³ /sec)	Submerge factor	
weir-7	155	813.914	813.999	252	813.089	813.092	64.879	1.000	
weir-6	156	813.949	813.990	288	813.116	813.132	269.167	1.000	
weir-5	151	813.984	814.005	287	813.143	813.156	209.188	1.000	
weir-4	152	813.990	814.002	328	813.148	813.161	561.073	1.000	
weir-3	145	813.996	814.008	327	813.153	813.169	282.176	1.000	
weir-2	146	813.986	814.001	372	813.162	813.182	559.006	1.000	
weir-1	147	813.977	813.995	371	813.171	813.194	138.428	1.000	

Note - An asterisk after flow rate denotes flow from the network.

Figure 8 Final weir report

9 Conclusion

This concludes the “FESWMS Analysis with Weirs” tutorial. Continue experimenting with FESWMS weirs or exit the program.