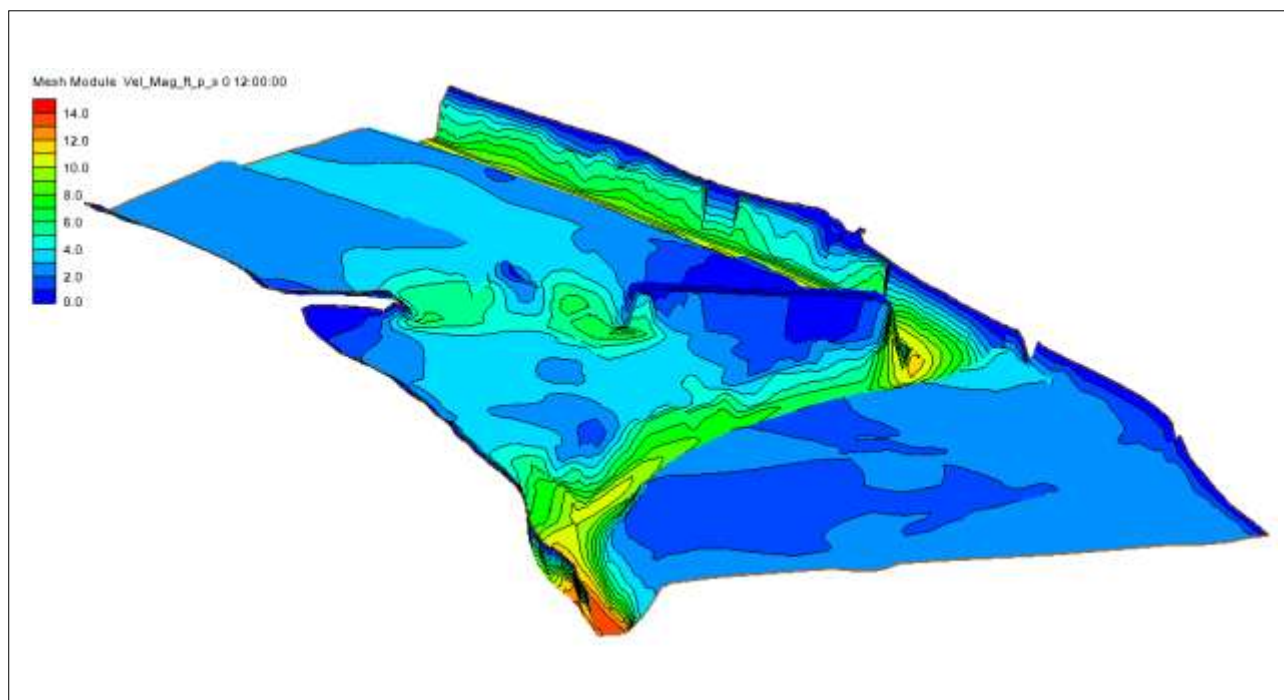## SRH-2D Tutorial
Cohesive Sediment Transport Modeling

Objectives

This tutorial demonstrates how to perform cohesive sediment transport simulations in SRH-2D.

Prerequisites

- SMS Overview tutorial
- SRH-2D
- SRH-2D Sediment Transport

Requirements

- SRH-2D Model
- Map Module
- Mesh Module
- Data files

Time

- 15–30 minutes model setup
- Up to 3 hours model run

1   Introduction

The Sedimentation and River Hydraulics – Two-Dimensional (SRH-2D) model is a hydraulic, sediment, temperature, and vegetation model for river systems developed by the United States Bureau of Reclamation (USBR) and sponsored by the United States Federal Highway Administration (FHWA).

For this tutorial, a previously developed SRH-2D sediment transport simulation with steady state flow will be modified to include cohesion materials. The primary interest for FHWA is in relation to bridge scour, and SRH-2D sediment transport simulations can be very informative for estimating contraction scour, which is essentially an erosion and sediment transport problem. SRH-2D also provides detailed hydraulic output that can be used to estimate pier and abutment scour potential.

1.1   Background

The Cimarron River example used in the SMS "SRH-2D Sediment Transport" tutorial will be used in this tutorial. If needed, review the "SRH-2D Sediment Transport" tutorial before proceeding with this tutorial.

This tutorial will cover defining sediment parameters and properties including sediment material types, boundary conditions, transport equation, and other input parameters. This tutorial is for instruction purposes and is not intended as an analysis of actual conditions at this bridge crossing.

2   Getting Started

To start this tutorial:

1. Launch the SMS application.

2. If SMS is already running, press *Ctrl-N* or select *File* | **New** to ensure that the program settings are restored to their default state.

3. Select *File* | **Open…** to bring up the *Open* dialog.

4. Browse to the file "Cimarron_Sed_Cohesive.sms" located in the *data files* folder for this tutorial.

5. Click **Open** to import the project file and close the *Open* dialog.

This file opens the existing steady state sediment transport model as shown in Figure 1. To perform cohesive sediment transport modeling under steady-state conditions, this tutorial will demonstrate making a copy of the steady-state sediment transport simulation, then adjusting the sediment materials in the vicinity of the secondary bridge to represent cohesive materials.
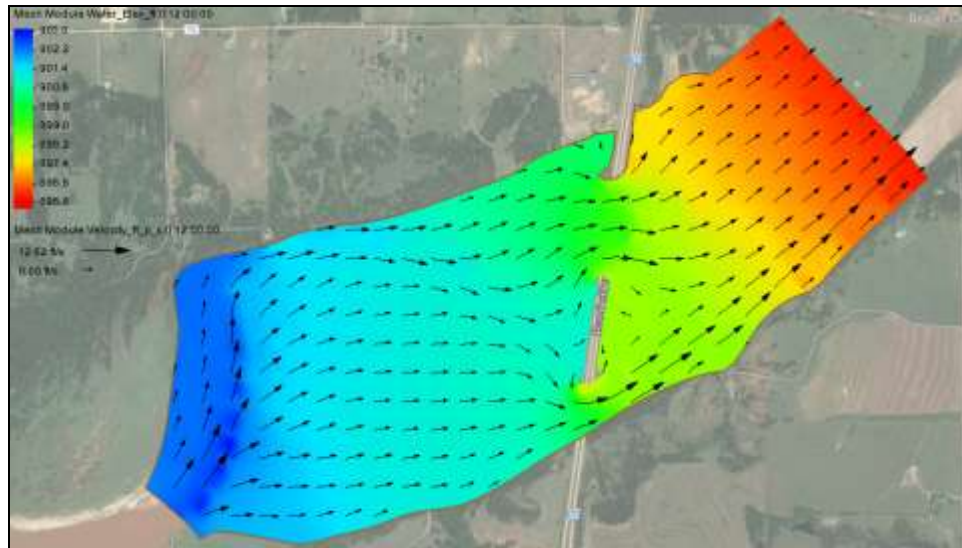

Figure 1   The hydraulic model of the Cimarron River

3   Sediment Materials Properties

Now adjust the bed material to show cohesive sediment in the vicinity of the secondary bridge opening:

1. Right-click on the " Sed_Mat" coverage and select **Duplicate**. This will create a new coverage named " Sed_Mat (2)".

2. Right-click on the " Sed_Mat (2)" coverage and select **Rename**. Then enter the name "Sed_Mat_Cohesive" for this coverage.

3. Select " Sed_Mat_Cohesive" to make it active and make sure it is turned on.

4. Right-click on the " Sed_Mat_Cohesive" coverage and select **Material List and Properties** to open the *Material List and Properties* dialog.
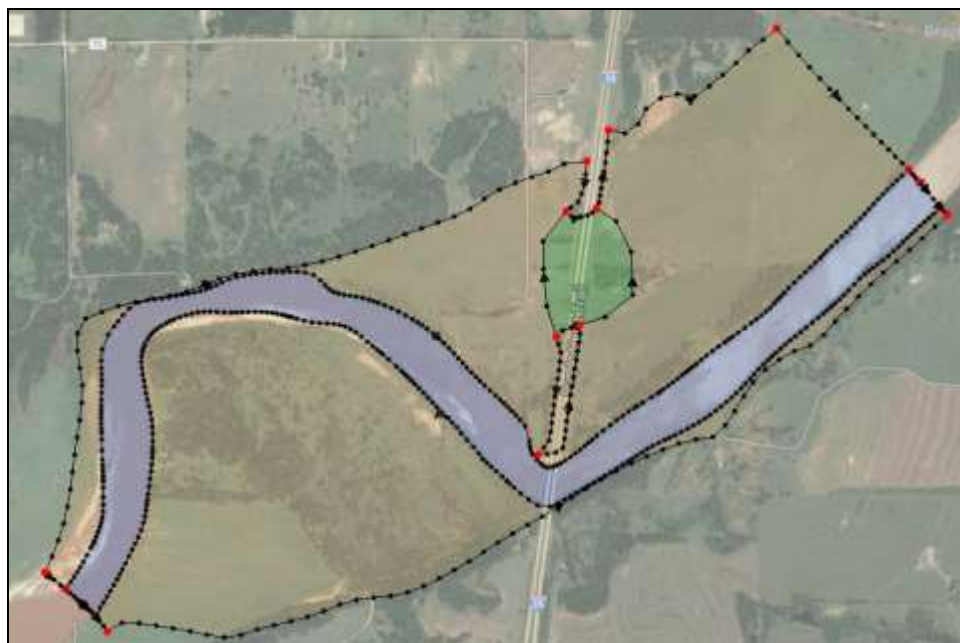
Figure 2   Cohesive sediment material located near the secondary bridge opening (shown in green)

5. Click the **Add Material** ✚ button to create a "new material".

6. Double-click on "new material" and rename it as "Cohesive"

7. On the right side of the dialog, click on the **Add Material Attribute Row** ✚ button.

8. Set the *Thickness* to "1" ft and the *Units* to "English" (double-click the drop-down).

9. Scroll to the right and click on the **Edit Curve…** button under *Gradation Curve* to bring up the *Gradation Curve* dialog.

10. Change the *Number of rows* to be "7" and enter the sediment gradation parameters as shown in Table 1 below.

Table 1: Sediment Gradation Parameters

Particle size, di (mm)	% finer
0.0025	0.0
0.0625	80.0
0.125	87.0
0.25	94.0
0.5	98.0
1.0	99.0
2.0	100.0

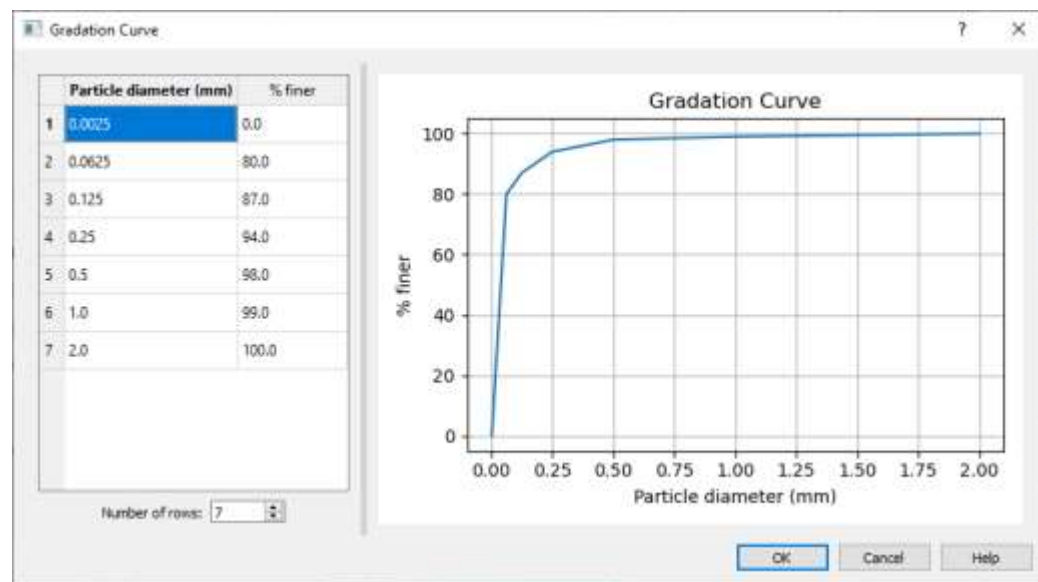When done, the *Gradation Curve* dialog should resemble Figure 3.

Figure 3   Sediment gradation curve for cohesive material

11. Click **OK** to close the *Gradation Curve* dialog and return to the *Material List and Properties* dialog.

Now add a second layer to the "Cohesive" material. SRH-2D guidance indicates that a minimum of two layers is recommended even if the bed material is vertically uniform.

12. On the right side of the dialog, click on the **Add Material Attribute Row** ➕ button.

13. Set the *Thickness* to "20" ft and *Units* to "English" (double-click the drop-down).

14. Click on the **Edit Curve…** button under *Gradation Curve* to bring up the *Gradation Curve* dialog.

15. Enter the sediment gradation parameters as shown in Table 1 above.

16. Click **OK** to close the *Gradation Curve* dialog.

17. Click **OK** to close the *Material List and Properties* dialog.

18. Using the **Select Feature Polygon** tool, double-click on the relief bridge area (as shown in Figure 2) to bring up the *Assign Material* dialog.

19. Select the "Cohesive" material to assign it to the polygon.

20. Click **OK** to close the *Assign Material* dialog.

4   Defining the SRH-2D Simulation

Many of the properties and components that were used in the " Sed_Steady" simulation can be used for the cohesive sediment transport simulation. To save time, the steady state simulation can be copied and modified.

To copy a simulation:

1. Right-click on the " Sed_Steady" simulation and select the **Duplicate** command. This creates a copy of the simulation with its model parameters and components.

2. Right-click in the " Sed_Steady (2)" simulation and select the **Rename** command. Enter "Sed_Cohesive" as the new name.

4.1   Linking Components

Most of the components needed for the simulation are already linked since they were copied from the original simulation. However, the boundary condition coverage and material coverage components need to be changed.

Change the component by:

1. Right-click on the " Sed_Mat" item under the " Sed_Cohesive" simulation and select **Remove**.

2. Right-click on the " Sed_Mat_Cohesive" coverage and select the *Apply To |* **SRH-2D Simulations → Sed_Cohesive** command.

All the necessary components are now linked to the simulation.

4.2   Assigning SRH-2D Parameters

The steady state model parameters were also copied. Most of these parameters will work for the model run, but a few of the parameters must be changed.

To do this:

1. Right-click on the " Sed_Cohesive" simulation and select **Model Control…** to bring up the *SRH2D Model Control* dialog.

2. Select the *General* tab and define the data:

   a. Set *Simulation description* to "Cohesive Sediment Transport".

   b. Set *Case name* to "Sed_Cohesive".

   c. Set *Initial condition* to "Restart File".

   d. Click the **Select File…** button to bring up the *Select File* browser.

   e. Navigate to the data files folder for this tutorial and select the "I35_RST1.dat" file, then click **Select** to set the file as the restart file.

3. Leave all the parameters under the *Output* tab as currently set.

4. Leave all the parameters under the *Advanced* tab as currently set.

5. Leave the *SRH2D Model Control* dialog open and continue to the next section.

4.3   Defining Cohesive Sediment Parameters

The sediment parameters now should be changed to model cohesive sediment.

1. Select the *Sediment* tab of the *SRH2D Model Control* dialog.

2. At the bottom of the dialog, turn on *Enable cohesive sediment modeling*.

The smallest size faction is considered as cohesive, which in this case is the 0.0025 mm to 0.0625 mm bin.

Note that the values for cohesive sediments entered below are highly variable depending on material properties. Values should be determined through laboratory testing. See also the HEC-18 (FHWA 2012)[1] section on Contraction Scour for Cohesive Sediments for background information on the range of erosion properties. Also, pay particular attention to the units and the form of the equation as described at www.xmswiki.com in the section on cohesive sediment modeling.

3. Set *Fall velocity* to "Kaolinite Properties".

4. Set *Erosion rate* to "Parameters".

5. Set *Critical shear stress for surface erosion* to "0.10" (lb/ft^2).

6. Set *Critical shear stress for mass erosion* to "0.7" (lb/ft^2).

7. Set *Surface erosion constant* to "10" (lb/ft^2/hr).

8. Set *Mass erosion constant* to "20" (lb/ft^2/hr).

9. Set *Erosion units* to "English".

10. Set *Critical shear stress for full deposition* to "0.005" (lb/ft^2).

11. Set *Critical shear stress for partial deposition* to "0.021" (lb/ft^2).

12. Set *Equilibrium concentration* to "3.0" (g/l or kg/m3, note 1 g/l is approximately 1000 ppm-wt).

13. Set *Deposition units* to "English".

14. Click **OK** to close the *SRH2D Model Control* dialog.

15. Save (**Ctrl + S**) the project.

4.4   Running SRH-2D

Since running sediment transport models is a long process, this section can be skipped to save time. The solution files have been provided for the next section.

> *Note:* Sediment transport simulations require significant computation power. Any computer system with hardware less than the recommended system for

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[1] Richardson, E.V. and Davis, S.R., 1995. *Evaluating scour at bridges: Federal Highway Administration Hydraulic Engineering Circular No. 18.* Publication FHWA-IP-90-017.

running SMS will not be able to complete an SRH-2D sediment transport simulation.

To run the model:

1. Right-click on the "⬚ Sed_Cohesive" simulation and select **Save Project, Simulation and Run**.

This command will save the SMS project, export all necessary files for PreSRH-2D, run the preprocessor and then run SRH-2D.

This model can take up to 1–2 hours to run.

Once the run is complete, the *Simulation Run Queue* will show all completed processes in green.

2. Click **Load Solution** to load the solution from the model run into the project.

3. Click **Close** to exit the *Simulation Run Queue*.

4.5   Viewing SRH-2D Output

Use the visualization tools in SMS to evaluate the results.

If the model run was skipped to save time, import the solution file by doing the following:

1. Select *File | **Open…** to bring up the *Open* dialog.

2. Browse to *data files\Cimarron_Sed_Cohesive\SRH-2D\Sed_Cohesive* in the *data files* folder for this tutorial and select the "Sed_Cohesive_XMDF.h5" file.

3. Click **Open** to close the *Open* dialog and import the solutions file.

See the visualization tools in SMS, as described in the "Data Visualization" tutorial, to evaluate the solution created by the SRH-2D model.

5   Conclusion

This concludes the "SRH-2D Cohesive Sediment Transport Modeling"[2] tutorial. This tutorial demonstrated:

- Setting the SRH-2D boundary condition coverage for use in cohesive sediment transport.

- Setting the SRH-2D sediment materials coverage for cohesive sediment transport.

- Defining the SRH-2D simulation for cohesive sediment transport.

Continue to experiment with the sediment transport options for SRH-2D in SMS or exit the program.

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[2] This tutorial was developed by Aquaveo, LLC under contract with the Federal Highway Administration.