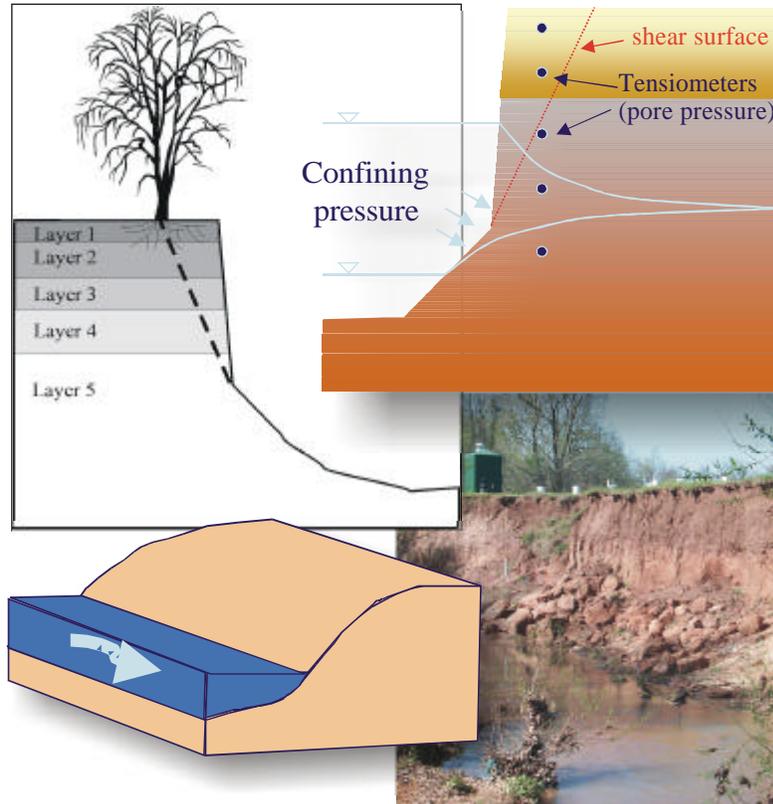


Bank-Stability and Toe Erosion Model

Version 3.4



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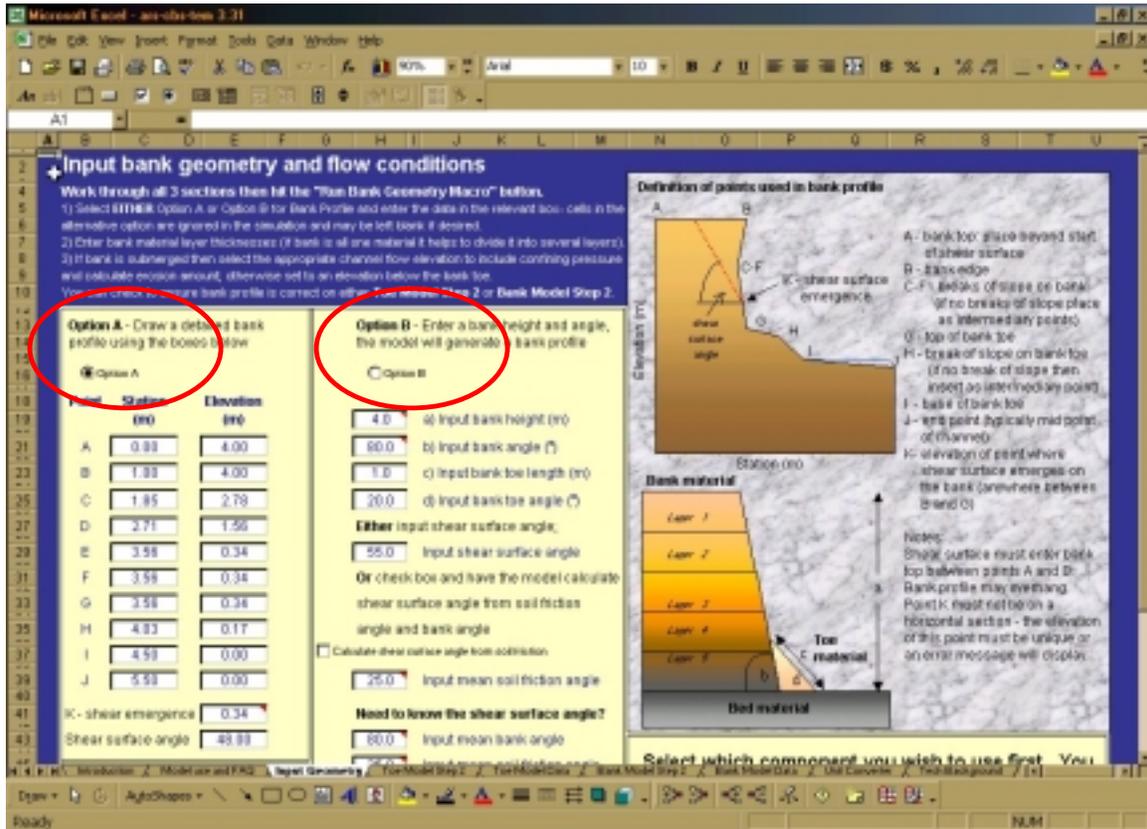
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Note: Additional information on model usage is available on each of the model worksheets.

1. Input Geometry Sheet



- Select EITHER Option A or Option B for Bank Profile and enter the data in the relevant box - cells in the alternative option are ignored in the simulation and may be left blank if desired.

Option A - Draw a detailed bank profile using the boxes below

Option A

Point	Station (m)	Elevation (m)
A	0.00	4.00
B	1.00	4.00
C	1.85	2.78
D	2.71	1.56
E	3.58	0.34
F	3.58	0.34
G	3.58	0.34
H	4.03	0.17
I	4.50	0.00
J	5.50	0.00

K- shear emergence

Shear surface angle

If Option A is selected remember to enter a K value and a shear surface angle.

The K value is the elevation of the point where the shear surface emerges on the bank. Point K must not be on a horizontal section - the elevation of this point must be unique or an error message will be displayed

Note the shear surface must enter bank top between points A and B.

Option B - Enter a bank height and angle, the model will generate a bank profile

Option B

a) Input bank height (m)

b) Input bank angle (°)

c) Input bank toe length (m)

d) Input bank toe angle (°)

Either input shear surface angle;

Input shear surface angle

Or check box and have the model calculate shear surface angle from soil friction angle and bank angle

Calculate shear surface angle from soil friction

Input mean soil friction angle

Need to know the shear surface angle?

Input mean bank angle

Input mean soil friction angle

Recommended shear surface angle

If Option B is selected remember to enter a shear surface angle.

The shear surface angle may be determined from mean bank angle and a soil friction angle.

- Enter bank layer thickness

2. Bank layer thickness (m)

	Bank layer thickness (m)	Elevation of layer base (m)
Layer 1	<input type="text" value="1.00"/>	3.00
Layer 2	<input type="text" value="1.00"/>	2.00
Layer 3	<input type="text" value="1.00"/>	1.00
Layer 4	<input type="text" value="0.50"/>	0.50
Layer 5	<input type="text" value="0.51"/>	-0.01

Top Layer

Bottom Layer

Parallel layers, starting from point B

If the bank is all one material it helps to divide it into several layers.

Layer 5 must end at or below the base of the bank toe. Therefore the basal elevation of layer 5 should be equal to or less than the elevation of point I (base of bank toe) if option A is selected, or 0 (zero) if option B is selected.

- Enter channel flow parameters

3. Channel flow parameters

<input type="text" value="1.00"/>	Input elevation of flow (m)
<input type="text" value="0.003"/>	Input slope of channel (m/m)
<input type="text" value="48"/>	Input duration of flow (hrs)

If bank is partially submerged then select the appropriate channel-flow elevation to provide a calculation of confining pressure and erosion amount; otherwise set to an elevation below the bank toe.

- Select which model (Bank toe or Bank stability) you wish to use first. You will be automatically redirected to the relevant worksheet after hitting the “Run Bank Geometry Macro” button

Select which component you wish to use first. You will be automatically redirected to the relevant worksheet after hitting the Run Bank Geometry Macro button

Bank Stability component	▼
Toe Erosion component	
Bank Stability component	

**Run Bank
Geometry Macro**

2. Input Bank Materials

Input bank materials

Specify the erodibility of the different materials. Use the drop-down boxes to select material type or select "Enter own data" and add values in the "Bank Model Data" worksheet. If you select a material, the values shown in the "Toe Model Data" worksheet will be used. Once you are satisfied that you have completed all necessary inputs, hit the "Run Shear Stress Macro" button (Center Right of this page).

Bank Material					Bank Toe Material	Bed material
Layer 1	Layer 2	Layer 3	Layer 4	Layer 5		
Erodible cohesive	Moderate cohesive	Resistant cohesive	Erodible cohesive	Resistant cohesive	Enter own data	Fixed bed
0.10	5.00	50.00	0.10	50.00	1.50	248.00
0.316	0.045	0.014	0.316	0.014	0.002	0.006

Bank Protection: No protection (Input bank protection)

Bank Toe Protection: No protection (Input toe protection)

Run Shear Stress Macro

Average applied boundary shear stress	7.76	Pa
Maximum Lateral Retreat	17.46	cm
Mean Eroded Area - Bank	0.01	m ²
Mean Eroded Area - Bank Toe	0.04	m ²
Mean Eroded Area - Bed	0.00	m ²
Mean Eroded Area - Total	0.05	m ²

Export Coordinates back into model

- Specify the erodibility of the different materials. Use the drop down boxes to select material

Bank Material

Layer 1: Erodible cohesive (dropdown menu open)

Layer 2: Moderate cohesive (dropdown menu)

5.00 (input field)

0.045 (input field)

Dropdown menu options: Boulders (256 mm), Cobbles (64 mm), Gravel (20 mm), Coarse sand (1 mm), Fine sand (0.125 mm), Resistant cohesive, Moderate cohesive, Erodible cohesive, Enter own data (highlighted)

- If "Enter own data" is selected add values in the "Toe model data" sheet

Erodibility Data

These data are used when selecting the different material types. Note that changing the values here will change the values in the drop down boxes of the Toe Erosion Model.

Bank Material				Bank Toe Material				Bed Material				
	Diameter (m)	c_c (Pa)	K (m^3/Ns)		Diameter (m)	c_c (Pa)	K (m^3/Ns)		Diameter (m)	c_c (Pa)	K (m^3/Ns)	
1	Boulders (256 mm)	0.256	248.83	0.006	Boulders (256 mm)	0.256	248.83	0.006	Boulders (256 mm)	0.256	248.83	0.0
2	Cobbles (64 mm)	0.064	62.21	0.013	Cobbles (64 mm)	0.064	62.21	0.013	Cobbles (64 mm)	0.064	62.21	0.0
3	Gravel (20 mm)	0.02	19.44	0.023	Gravel (20 mm)	0.02	19.44	0.023	Gravel (20 mm)	0.02	19.44	0.0
4	Coarse sand (1 mm)	0.001	0.71	0.118	Coarse sand (1mm)	0.001	0.71	0.118	Coarse sand (1mm)	0.001	0.71	0.1
5	Fine sand (0.125 mm)	0.00013	0.09	0.335	Fine sand (0.125 mm)	0.00013	0.09	0.335	Fine sand (0.125 mm)	0.00013	0.09	0.3
6	Resistant cohesive	-	50.00	0.014	Resistant cohesive	-	50.00	0.014	Resistant cohesive	-	50.00	0.0
7	Moderate cohesive	-	5.00	0.045	Moderate cohesive	-	5.00	0.045	Moderate cohesive	-	5.00	0.0
8	Erodible cohesive	-	0.10	0.216	Erodible cohesive	-	0.10	0.216	Erodible cohesive	-	0.10	0.2

Enter own data layer 1: [] [] [] Enter own data: 1.50 0.082 Enter own data: 1.50 0.0

Enter own data layer 2: [] [] []

Enter own data layer 3: [] [] []

Enter own data layer 4: [] [] []

Enter own data layer 5: [] [] []

Need to know the critical shear stress (τ_c) ?

0.13 Input non-cohesive particle diameter (mm)

0.08 Critical Shear Stress τ_c (Pa)

Need to know the erodibility coefficient (K) ?

1.50 Input critical shear stress τ_c (Pa)

0.082 Erodibility Coefficient (m^3/Ns)

Bank protection		Toe protection	
	Permissible shear stress		Permissible shear stress
1	No protection	-	-
2	Plant cuttings	100	100
3	Large Woody Debris	150	150
4	Rip Rap	150	150
5	Jute net	22	22
6	Coir fiber	100	100

- Once you are satisfied that you have completed all necessary inputs, hit the "Run Shear Stress Macro" button.

Layer 5

Material	Enter own data	Fixed bed
Resistant cohesive	50.00	248.83
	0.014	0.006

Bank Protection: No protection Input bank protection

Bank Toe Protection: No protection Input toe protection

Run Shear Stress Macro

Average applied boundary shear stress: 7.76 Pa

- To continue transfer the coordinates into the “Input geometry” sheet by clicking the “Export Coordinates back into model” button.



This will export coordinates into the “Option A” box on the “Input geometry” sheet.

Once the coordinates have been transferred two options are available. One may determine the stability of the new eroded bank profile or one may run another flow event. To run another flow event alter the relevant details in section 3 and hit the “Run bank geometry macro” button making sure the toe model component is selected.

To determine bank stability after a flow event select the bank stability model component and click the “Run bank geometry macro” button.

3. Bank Stability model

Select material types, vegetation cover and water table depth below bank top
(or select "own data" and add values in 'Bank Model Data' worksheet)

Layer 1: Rounded sand, Silt, Stiff clay, Soft clay, Own data
 Layer 2: Angular sand, Rounded sand, Silt, Stiff clay, Soft clay
 Layer 3: Gravel, Angular sand, Rounded sand, Silt, Stiff clay
 Layer 4: Rounded sand, Angular sand, Rounded sand, Silt, Stiff clay
 Layer 5: Rounded sand, Silt, Stiff clay, Own data

Bank top vegetation cover (age): None
 Vegetation safety margin: 50
 Reach Length (m): 100
 Constituent concentration (kg/kg): 0.001

Water table depth (m) below bank top: 1.50
 Use water table
 Input own pore pressures (kPa)

Own Pore Pressures	kPa	Pore Pressure From Water Table
	Layer 1	-9.83
	Layer 2	0.00
	Layer 3	9.83
	Layer 4	17.15
	Layer 5	15.88

Factor of Safety: **1.25** Conditionally stable

Failure width: 2.54 m
 Failure volume: 434 m³
 Sediment loading: 755737 kg
 Constituent load: 756 kg

47.5 Shear surface angle used
 Export Coordinates back into model

- Select material type from the menus

Layer 1: Rounded sand, **Silt**, Stiff clay, Soft clay, Own data
 Layer 2: Angular sand, Rounded sand, Silt, Stiff clay, **Soft clay**

- If “own data” is selected enter values in the “Bank Model data” sheet

Bank material type	Description	Friction angle ϕ'	Cohesion c' (kPa)	Saturated unit weight (kN/m^3)	ϕ_b (degrees)
1	Gravel	36	0	20	5
2	Angular sand	36	0	18	15
3	Rounded sand	27.0	0.0	18	15
4	Silt	25.0	5.0	18	15
5	Stiff clay	10.0	15.0	18	15
6	Soft clay	30	10	16	15
7	Own data layer 1	27.0	0.4	21.4	15.0
	Own data layer 2	0.0	79.0	21.6	15.0
	Own data layer 3	35.0	0.0	21.6	15.0
	Own data layer 4	15.0	10.0	16.0	12.0
	Own data layer 5	15.0	10.0	16.0	12.0

- Select pore water pressures to determine stability

Water table depth (m) below bank top
 Use water table
 Input own pore pressures (kPa)

Own Pore Pressures	kPa	Pore Pressure From Water Table
<input type="text"/>	Layer 1	-9.80
<input type="text"/>	Layer 2	0.00
<input type="text"/>	Layer 3	9.80
<input type="text"/>	Layer 4	17.15
<input type="text"/>	Layer 5	15.88

Stability is given as a factor of safety

Factor of Safety

Conditionally stable

Failure width	2.54	m
Failure volume	434	m^3
Sediment loading	755737	kg
Constituent load	756	kg

- Once stability has been determined the coordinates may be exported back into the model (“Initial Geometry” sheet) **IF** the modeler deems that the bank has failed. This is done by clicking the “Export Coordinates back into model” button. **IF** the bank remains stable, return to the “Initial Geometry” sheet to simulate another flow event or another pore-water pressure condition.

