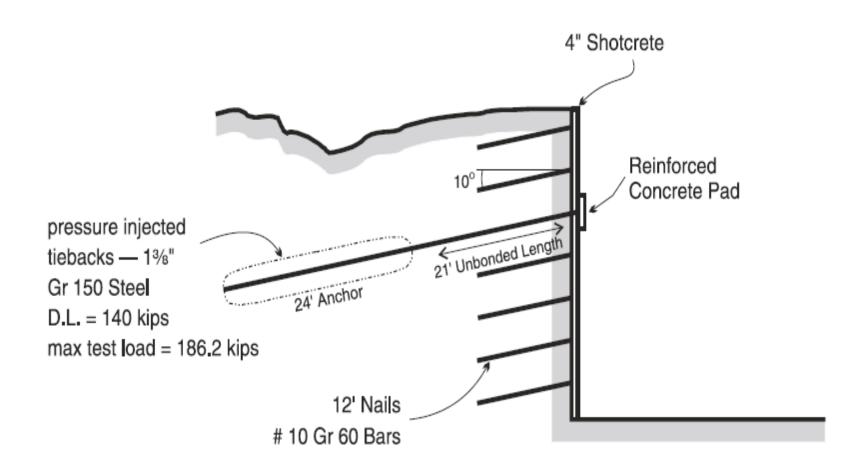
Example Application 6

Full-Scale Test Wall In Sand



Cross section through test wall

Sand Properties – Mohr-Coulomb Model

density 3.63 slugs/ft³

bulk modulus 1.33×10^6 psf

shear modulus 0.8x10⁶ psf

friction angle 36°

dilation angle 7.5°

cohesion 0.0

Shotcrete Properties

Young's modulus $4.80 \times 10^8 \text{ psf}$

Poisson's ratio 0.2

moment of inertia $3.00 \times 10^{-3} \text{ ft}^4$

area 0.333 ft²

Soil Nails and Tiebacks Properties

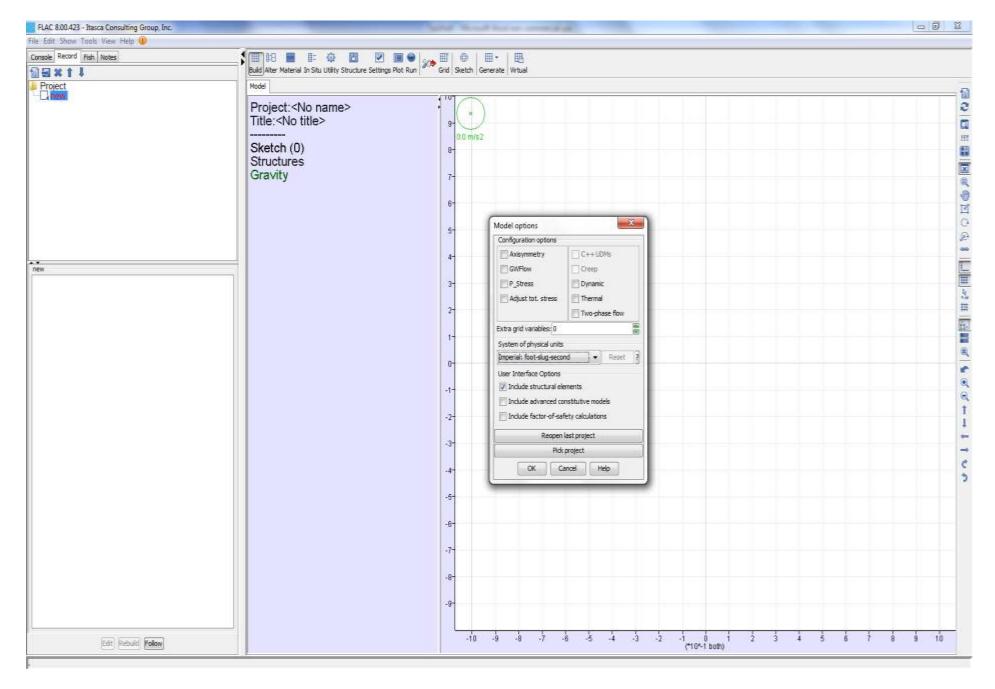
Property	Row 1 Nails	Row 2 Nails	Row 3 Nails	Grouted Tieback	Ungrouted Portion	Row 4-7 Nails
Young's modulus (psf)	4.2 x 10 ⁹	4.2 x 10 ⁹	4.2 x 10 ⁹	4.2 x 10 ⁹	4.2 x 10 ⁹	4.2 x 10 ⁹
Area (ft²)	8.5 x 10 ⁻³	8.5 x 10 ⁻³	8.5 x 10 ⁻³	0.0103	0.0103	8.5 x 10 ⁻³
Bond Stiffness (lb _f /ft/ft)	6.3 x 10 ⁷	6.3 x 10 ⁷	6.3×10^7	6.3 x 10 ⁷	0.0	6.3×10^7
Bond Strength (lb _f /ft)	5000	5000	6000	9000	0.0	6000
Yield Strength (lb _f)	73620	73620	73620	222750	222750	73620

Reinforcement Spacing

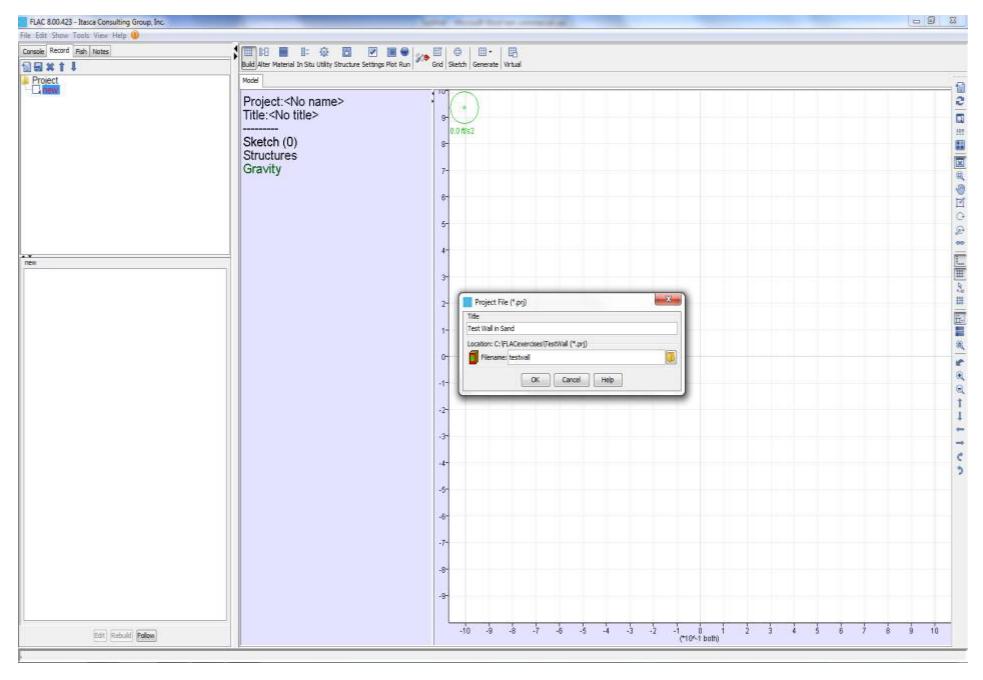
Row	Spacing (feet)
1	4.5
2	3.5
3	9.0
4	4.5
5	4.5
6	4.5
7	4.5

Modeling Procedure

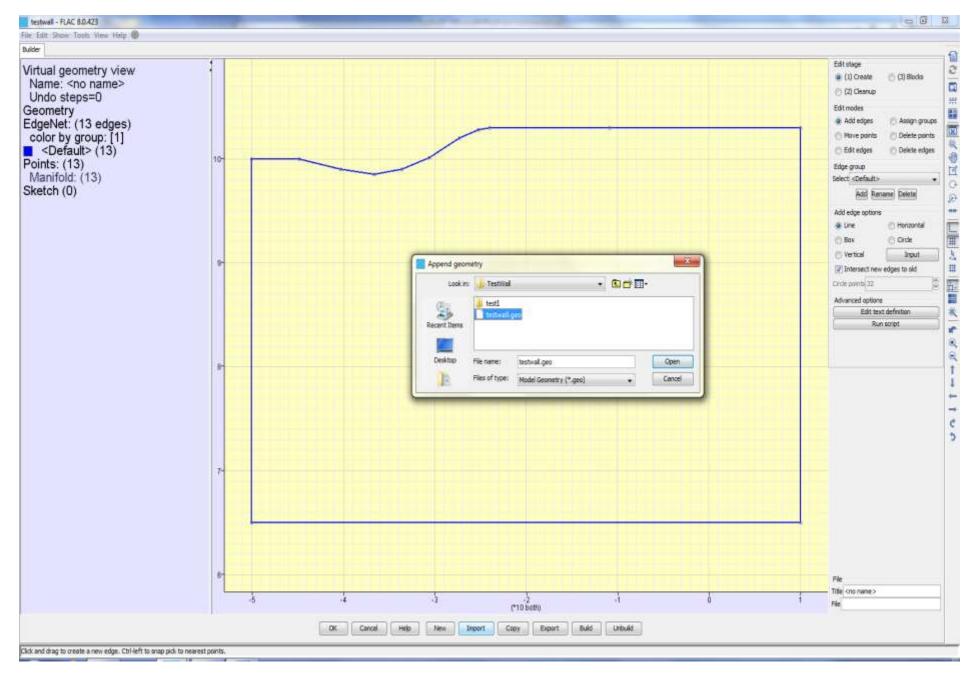
Step 1	Generate the model grid and assign the material model and boundary conditions to represent the physical system prior to construction of the test wall.
Step 2	Solve for the initial equilibrium state prior to construction.
Step 3	Excavation Stage I – excavate to elevation 98 and install shotcrete lining and Row I soil nails.
Step 4	Excavation Stage II – excavate to elevation 96 and install shotcrete lining and Row 2 soil nails.
Step 5	Excavation Stage III – excavate to elevation 91 and install shotcrete lining and Row 3 soil nails. Install tieback and pretension.
Step 6	Excavation Stage IV – excavate to elevation 87 and install shotcrete lining and Row 4 soil nails.
Step 7	$Excavation \ Stage \ V-excavate \ to \ elevation \ 82 \ and \ install \ shotcrete \ lining \ and \ Row \ 5 \ soil \ nails.$
Step 8	Excavation Stage VI – excavate to elevation 78 and install shotcrete lining and Row 6 soil nails.
Step 9	Excavation Stage VII – excavate to elevation 73 and install shotcrete lining and Row 7 soil nails.
Step 10	Excavation Stage VIII – excavate to elevation 72 and install shotcrete lining.
Step 11	Show axial forces along tieback and soil nails. Plot displacements in soil.



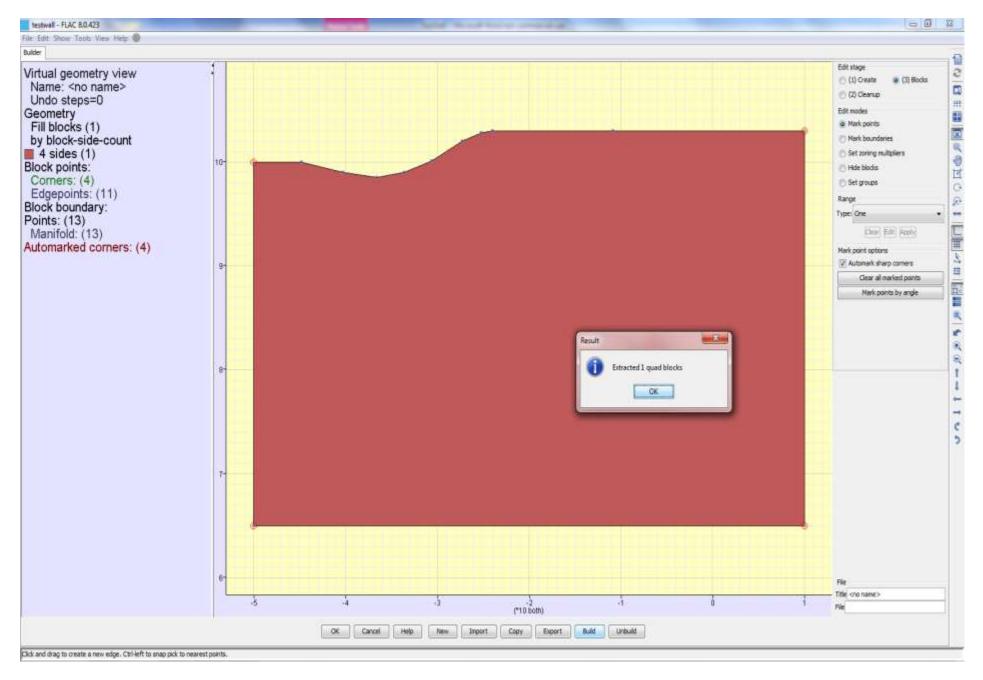
The [Include structural elements] User Interface option will be used for this exercise. The system of units are [Imperial: foot-slug-second].



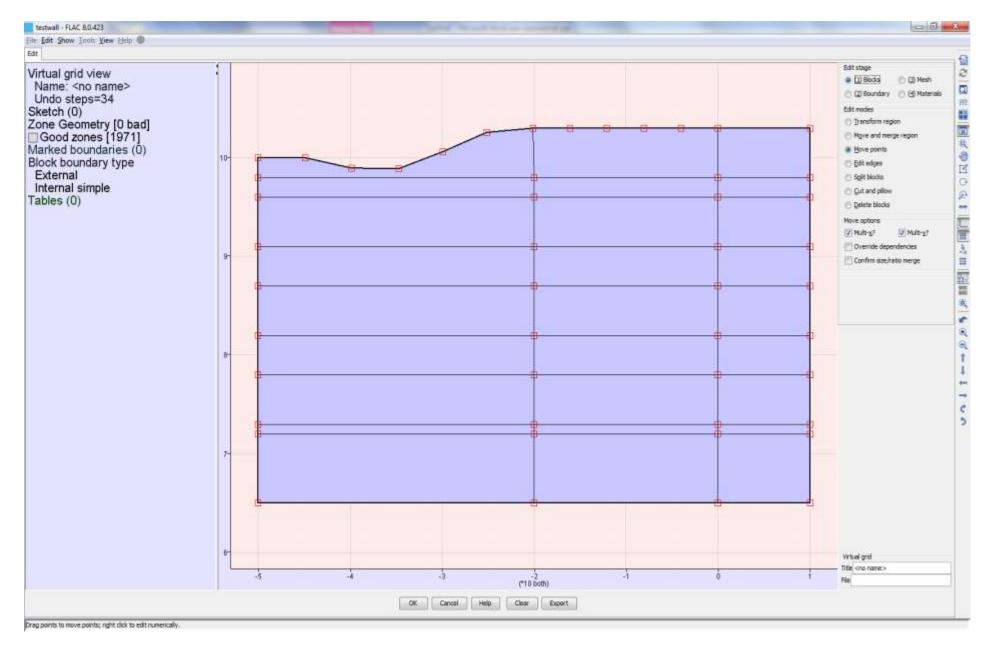
A project title is assigned, and a project file **testwall.prj** is created and stored in a working directory.



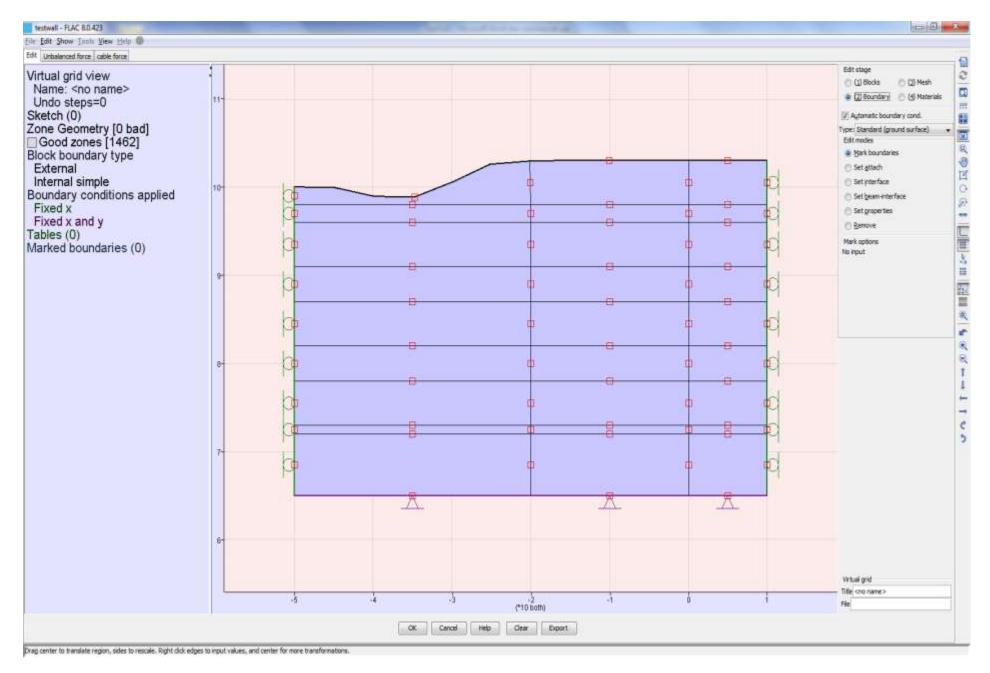
Step 1-1 In the [Geometry Builder] import the boundary geometry file testwall.geo. (This geometry can be obtained from a dxf or drawn in the [Sketch] tool.)



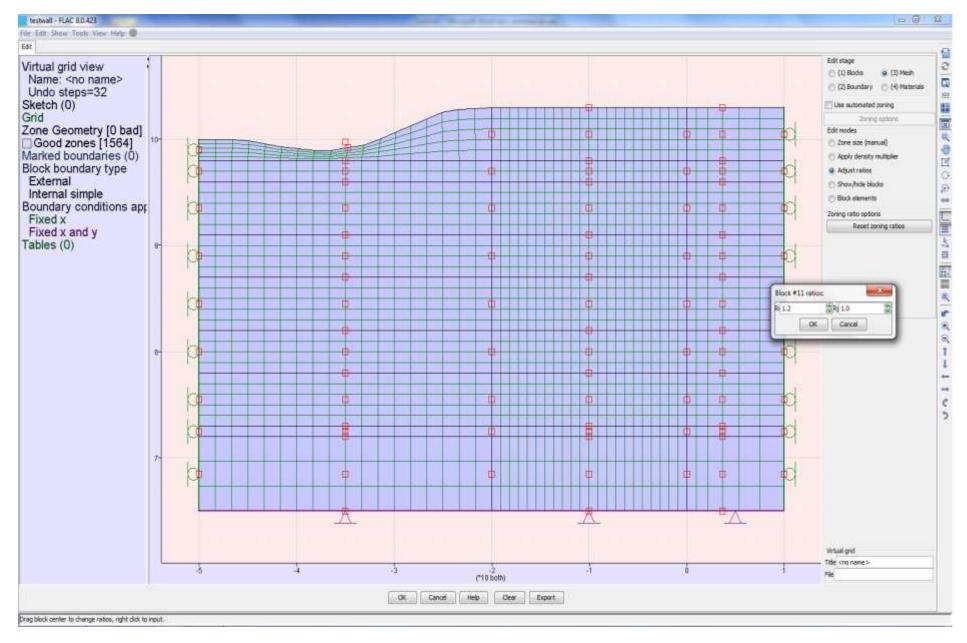
Step 1-2 Check the [Blocks] edit stage and press [Build] to extract one quad block. Press [OK] and exit the [Geometry Builder].



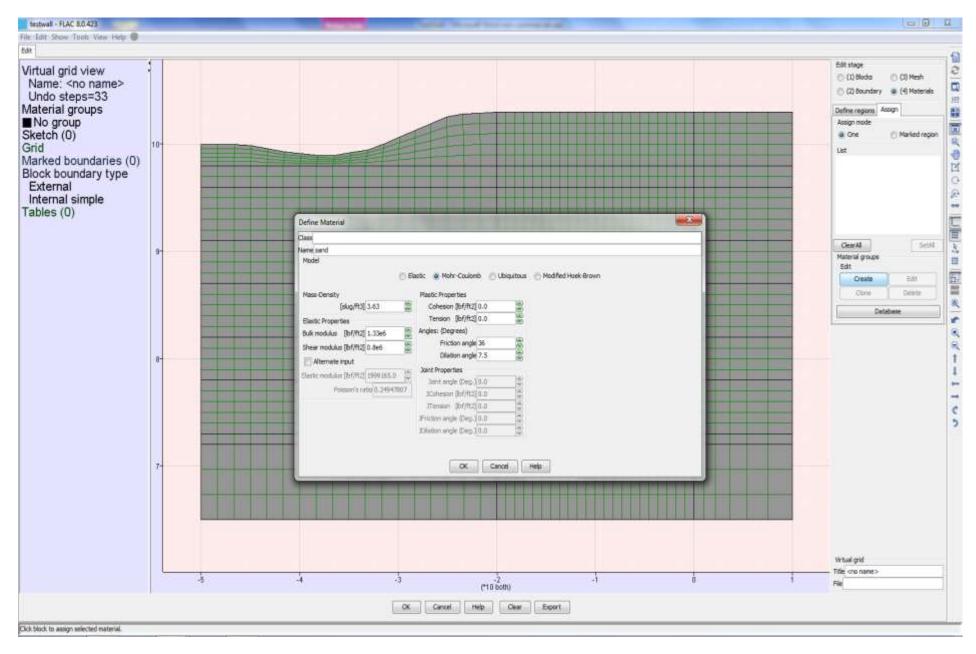
Step 1-3 In the [Blocks] edit stage of the [Edit] tool, add horizontal lines at elevation y = 72, 73, 78, 82, 87, 91, 96 and 98, which correspond to excavation stages. Also, add vertical lines at x = -20 and 0.0. This creates separate blocks in the model to control zoning.



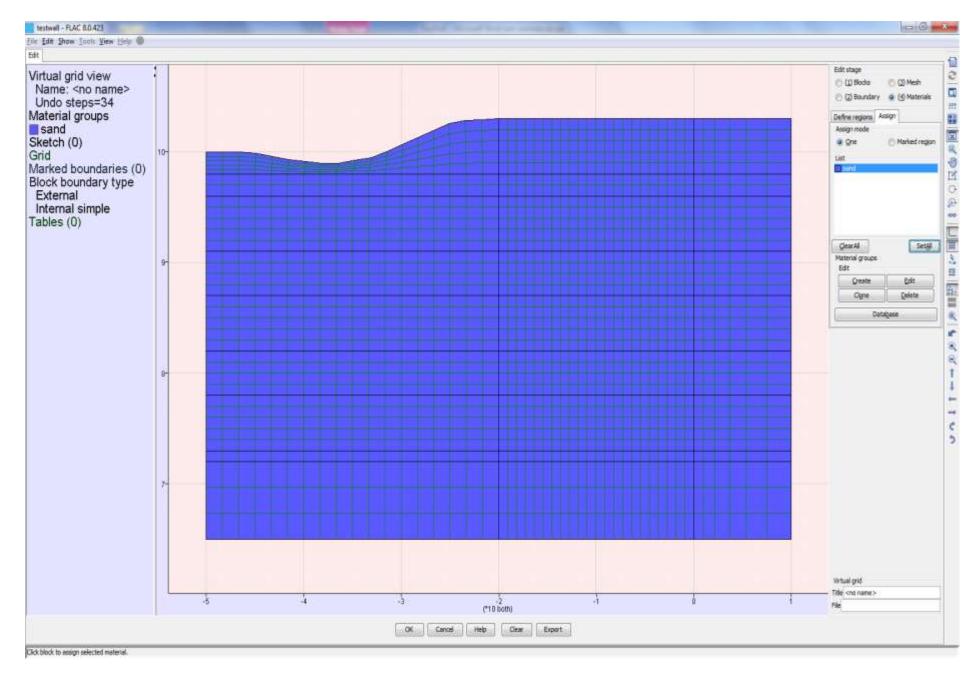
Step 1-4 In the [Boundary] edit stage, set boundary conditions by checking [Automatic boundary cond.].



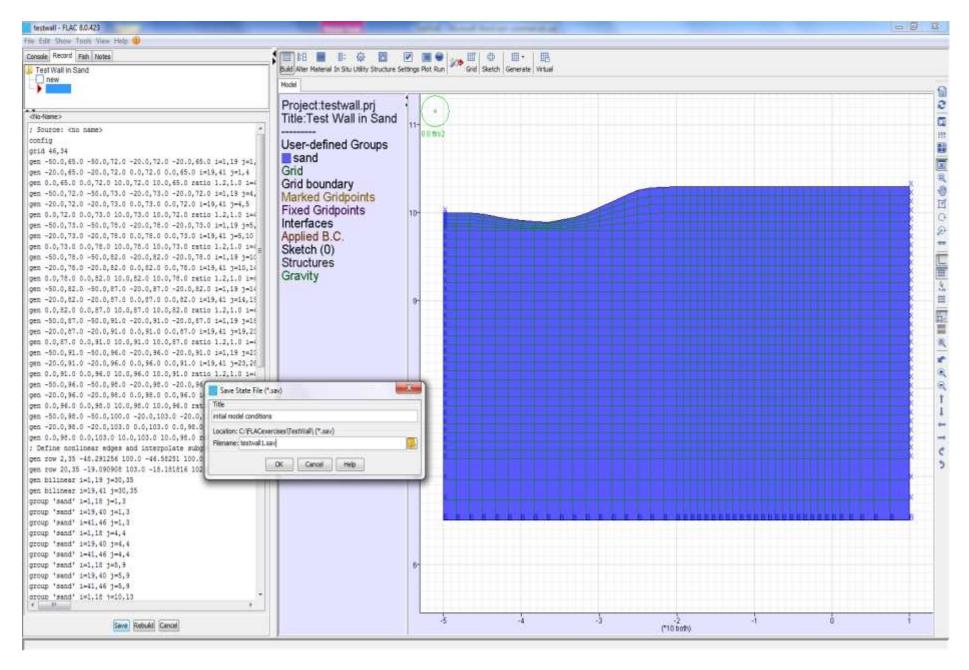
Step 1-5 In the [Mesh] edit stage, uncheck [Use automated zoning] mode and specify zoning manually as shown. Select [Adjust ratios] to adjust zone ratio for the region of zones to be excavated.



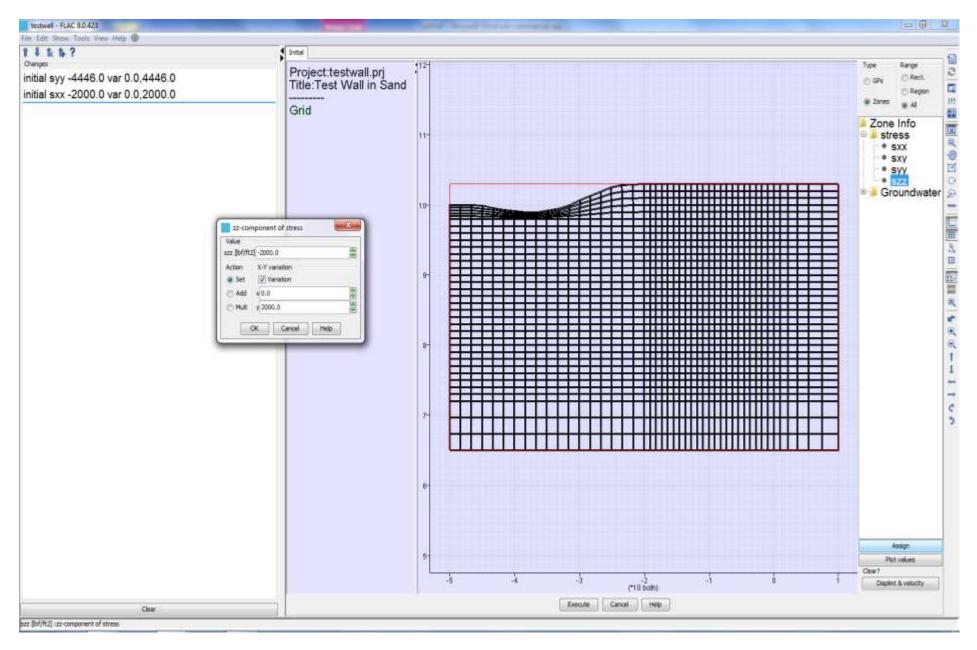
Step 1-6 In the [Materials] edit stage, check [Create] and create the material **sand** with Mohr-Coulomb properties as shown.



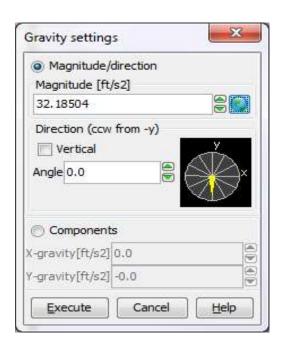
Step 1-7 Press [SetAll] to assign the **sand** material to all zones in the model. Click [OK] to exit the [Edit] tool.



Step 1-8 Press [Execute] to create the commands to send to FLAC, and press [Save] to save the model state (testwall1.sav).

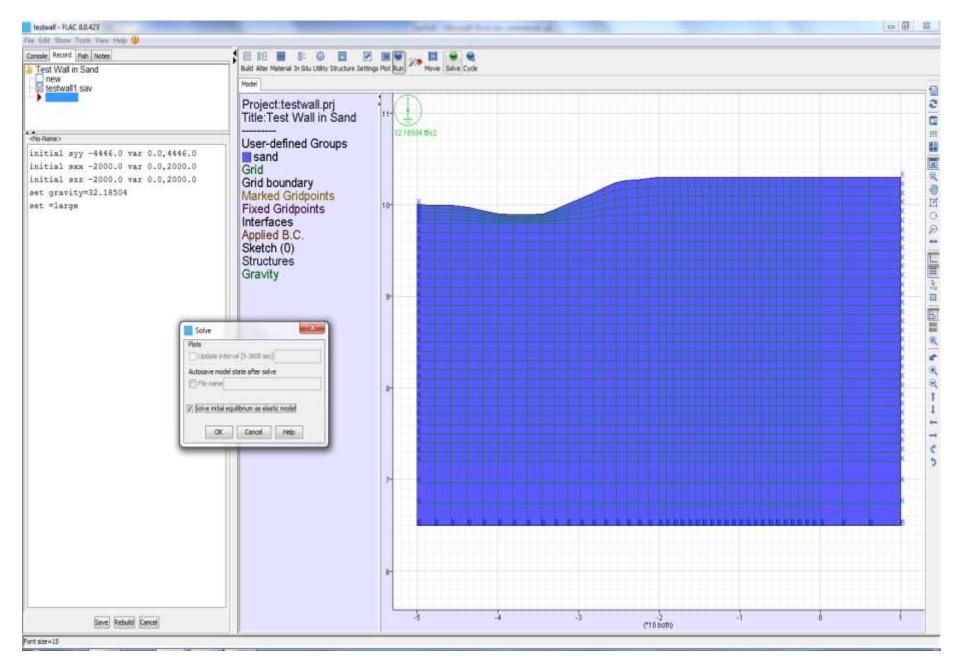


Step 2-1 Initialize the stress state using the [In Situ]/[Initial] tool. The stresses vary linearly from 0.0 at the top of the model to syy = -4446.0, sxx = -2000.0 and szz = -2000.0 at the bottom of the model.

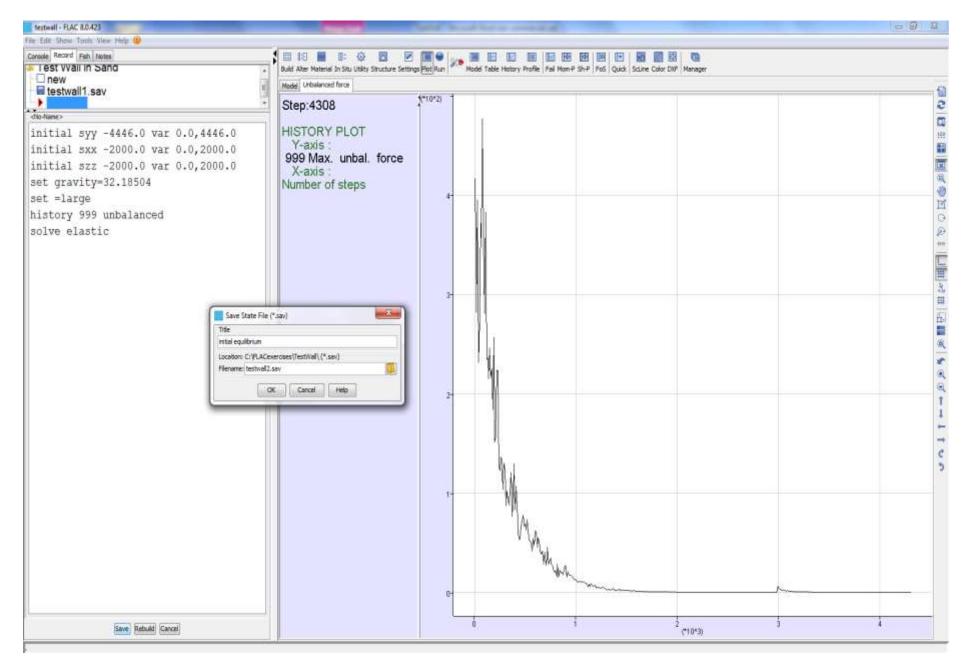


Mechanical settings Perform mechanical calculation	oc.	
Grid static damping	SE static damping	
Local 0.8	⊚ Local 0.8	
Combined 0.8	Combined 0.8	
Coordinate update		
Small-strain	Large-strain	
Bad <geometry> [ratio] 0.19</geometry>		
<update> geometry frequency [</update>	steps] 10	
	Execute Cancel <u>H</u> elp	

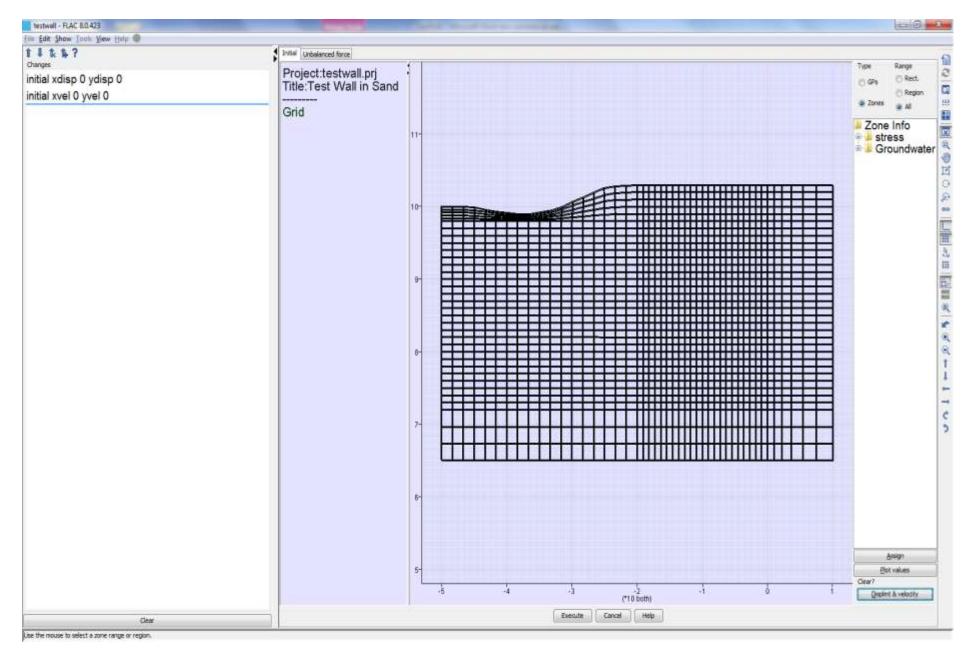
Step 2-2 Assign gravity in the [Settings] /[Gravity] tool, and turn on the large-strain calculation mode in the [Settings]/[Mech] tool.



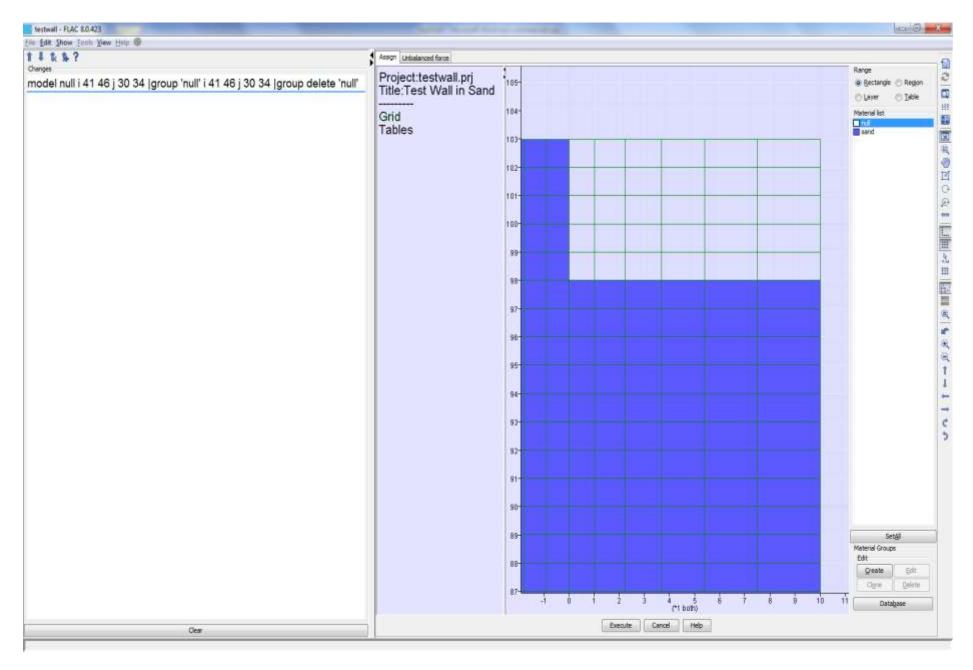
Step 2-3 Solve for the initial equilibrium state using the [Run]/[Solve] tool, with [Solve initial equilibrium as elastic model] checked.



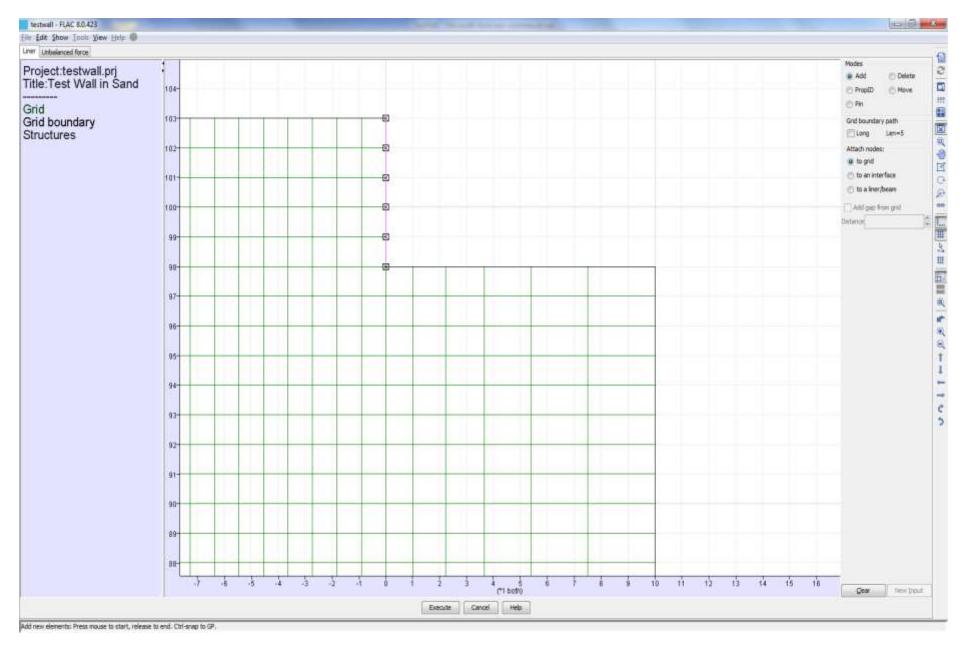
Step 2-4 Plot the maximum unbalanced force history, using the [Plot]/[Quick] tool, to check that equilibrium is reached. Save the state as testwall2.sav.



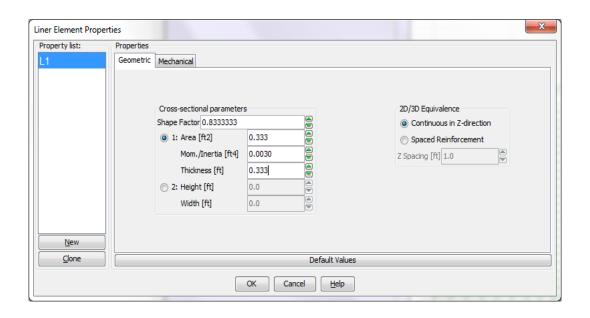
Step 3-1 Initialize displacements to zero in the [In Situ]/[Initial] tool by pressing the Clear? [Displmt & velocity] button. Press [Execute] to send the commands to *FLAC*.

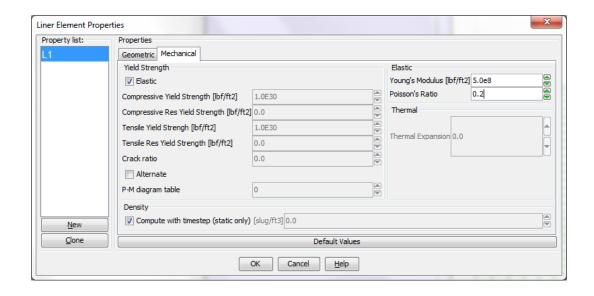


Step 3-2 Stage I excavation – use the [Material]/[Assign] tool and select [null] material to excavate zones to the depth y=98. Press [Execute] to send the commands to *FLAC*.

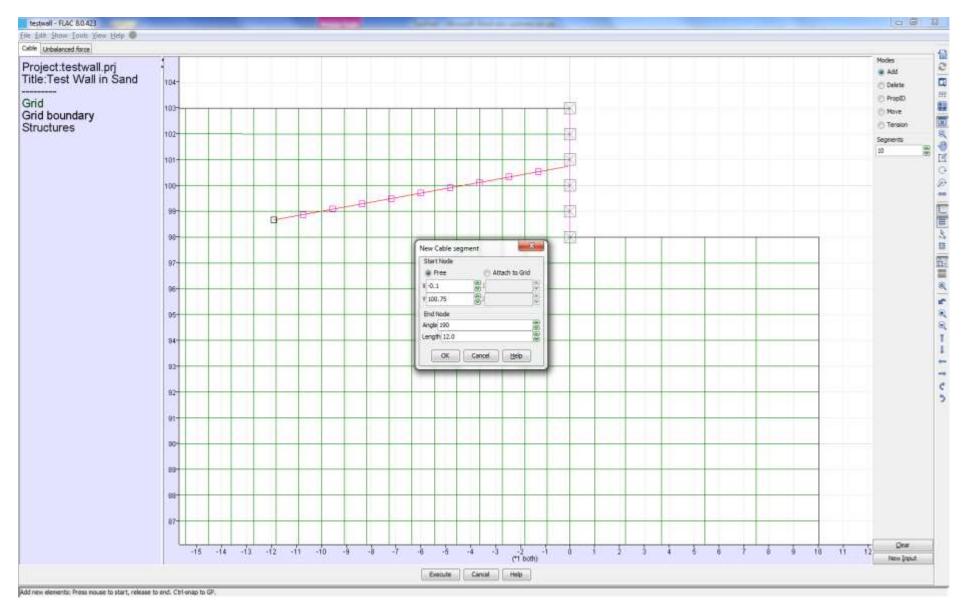


Step 3-3 In the [Structure]/[Liner] tool, check [Add] and drag the mouse along the boundary as shown to attach liner nodes to gridpoints in the excavation region. Press [Execute] to send the commands to *FLAC*.

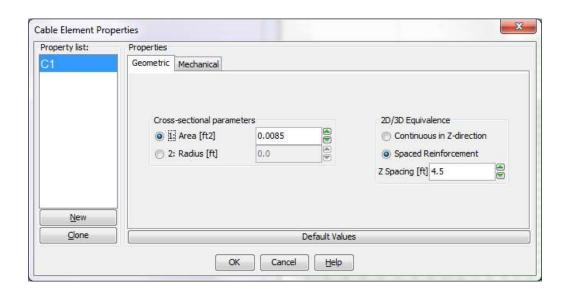


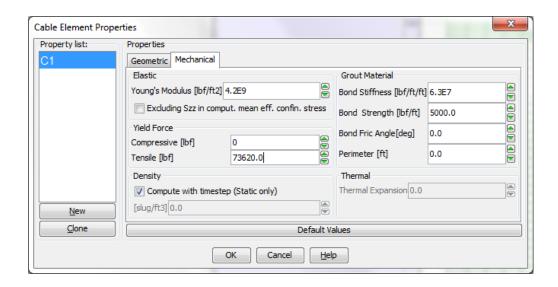


Step 3-4 In the [Structure]/[SEProp] tool, assign liner properties as shown.

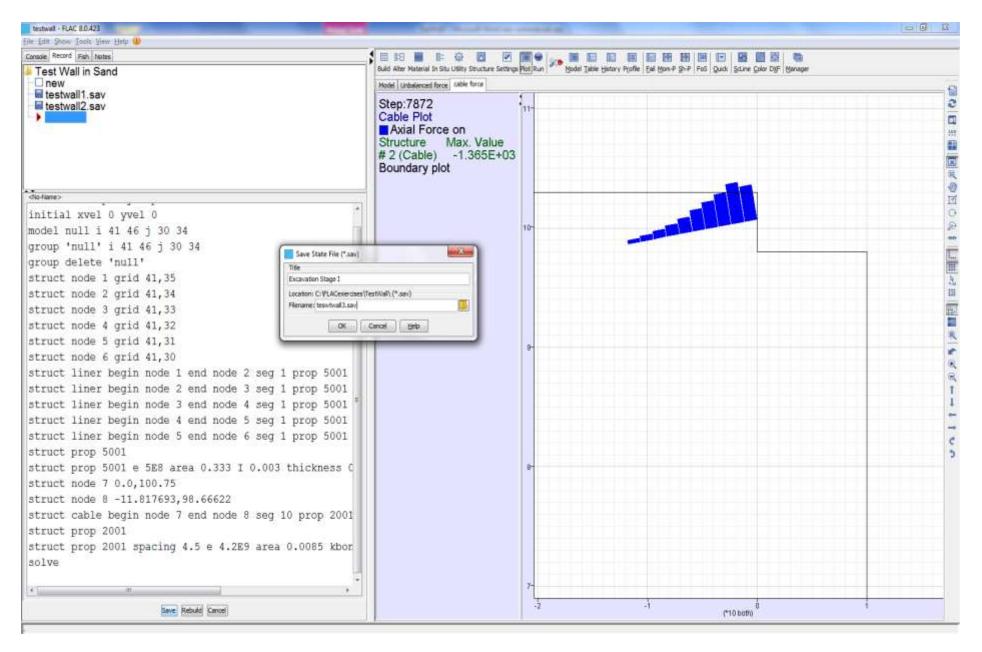


Step 3-5 In the [Structure]/[Cable] tool, check [Add], select 10 segments, and left click the mouse at a point inside the grid. This opens a *New Cable segment* dialog. Input a starting point at x=-0.1, y=100.75, and specify an angle of 190° and length of 12.0. The cable, composed of 10 segments, is created as shown. Press [Execute] to send the commands to *FLAC*.

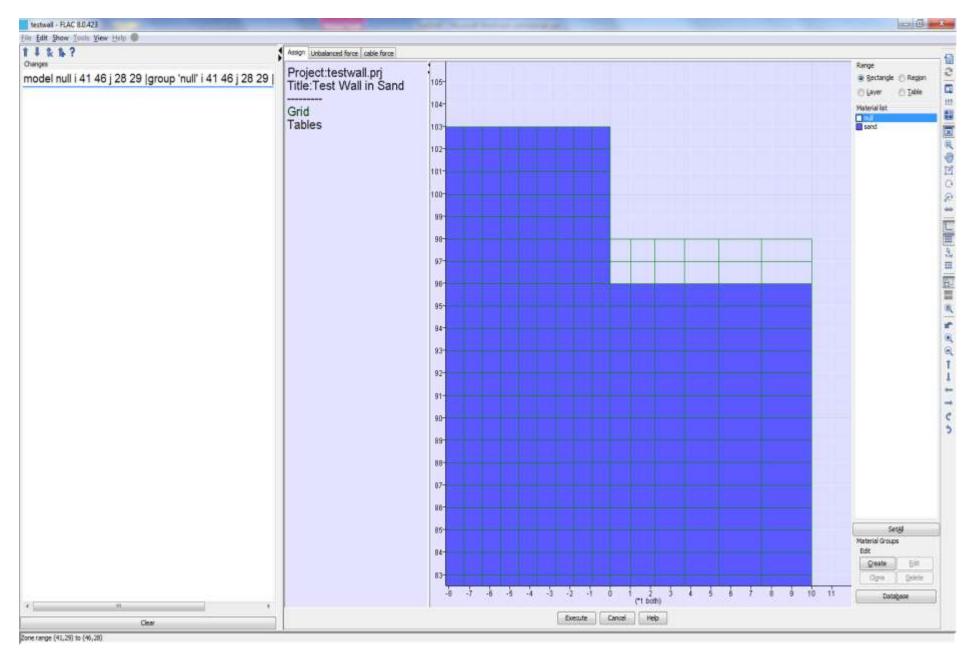




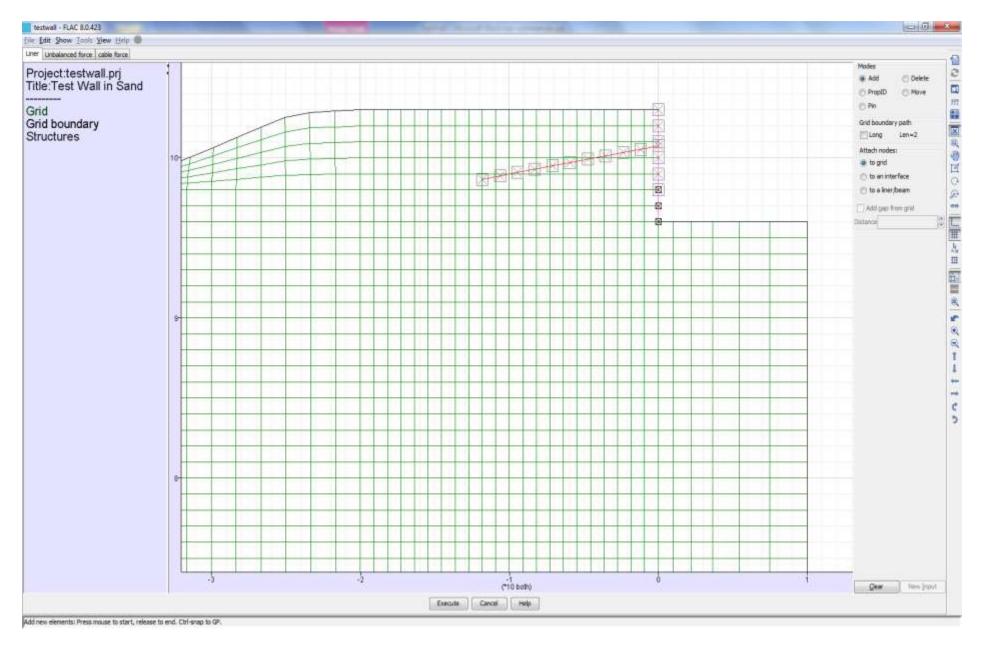
Step 3-6 In the [Structure]/[SEProp] tool, assign cable properties as shown. Note that cable spacing for the Row 1 cables is 4.5 ft.



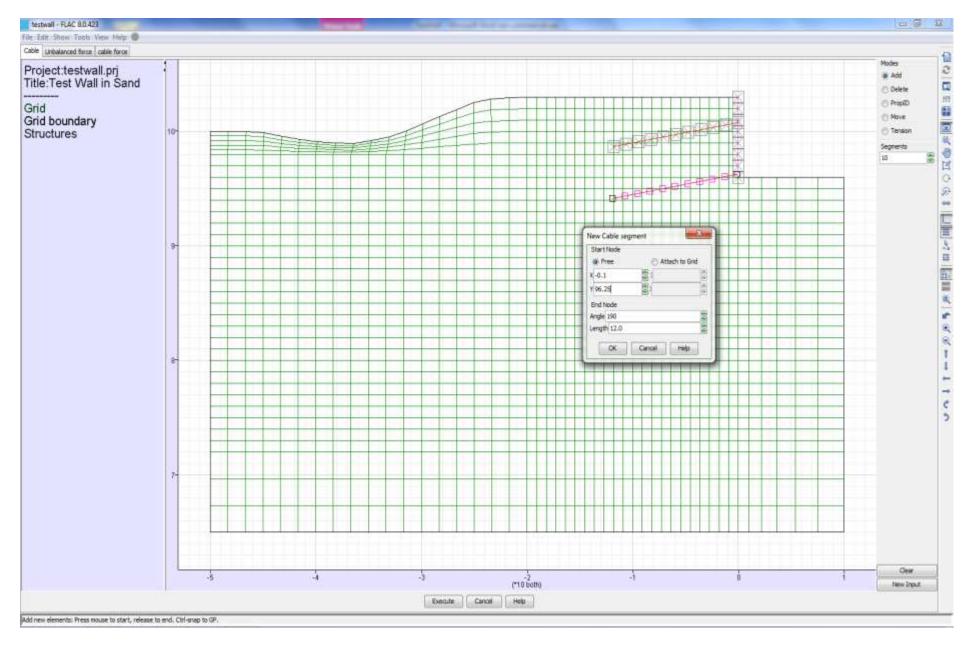
Step 3-7 Solve for the equilibrium state using the [Run]/[Solve] tool. Plot cable forces in the [Plot]/[Model] tool. Press [Save] to save the state as testwall3.sav.



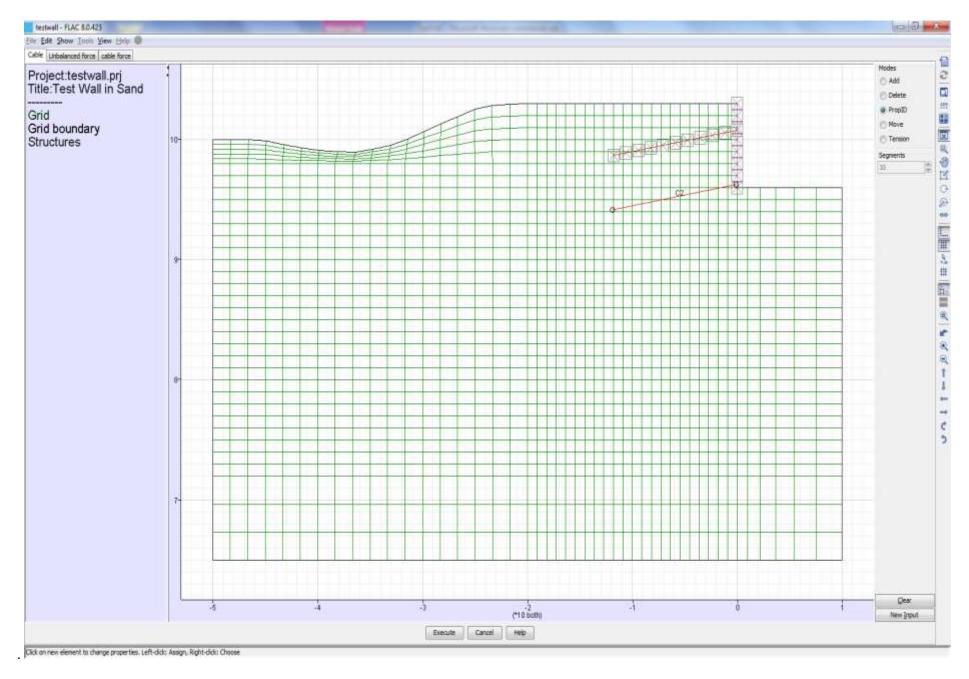
Step 4-1 Stage II excavation – use the [Material]/[Assign] tool and select [null] material to excavate zones to the depth y=96.



Step 4-2 In the [Structure]/[Liner] tool, check [Add] and drag the mouse along the boundary as shown to attach liner nodes to gridpoints in the excavation region. Press [Execute] to send the commands to *FLAC*



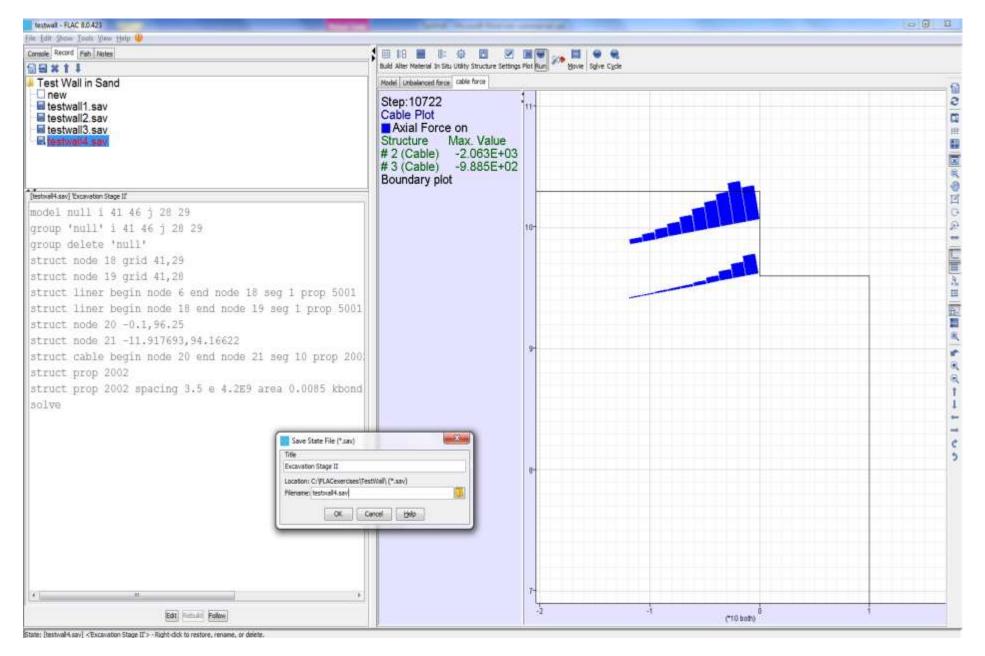
Step 4-3 In the [Structure]/[Cable] tool, check [Add], select 10 segments, and left click the mouse at a point inside the grid. This opens a *New Cable segment* dialog. Input a starting point at x=-0.1, y=96.25, and specify an angle of 190° and length of 12.0. The cable, composed of 10 segments, is created as shown.



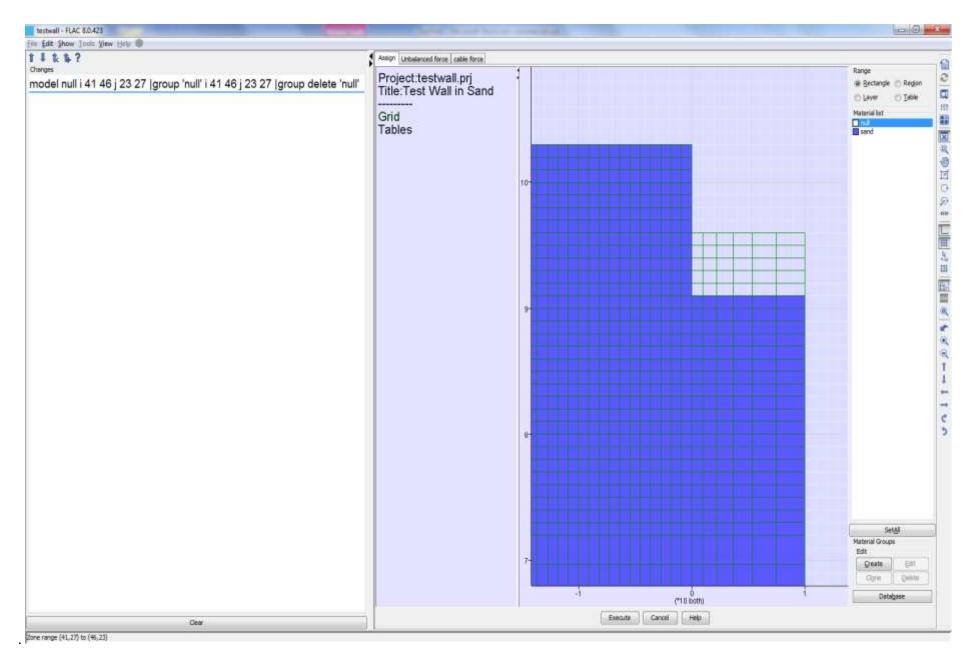
Step 4-4 Press [PropID] to change the property ID number for the new cable. Press [Execute] to send the commands to FLAC.

roperty list:	Properties			
2 2	Geometric Mechanical			
	Cross-sectional parameters (a) 1: Area [ft2] 0.0085 (b) 2: Radius [ft] 0.0		us in Z-direction einforcement	
<u>N</u> ew Clone	Default Values			
2000 (SA)	Deliane values			
3 57 200 h	OK Cancel Help			
ble Element Pro	OK Cancel <u>H</u> elp			(—X
roperty list:	OK Cancel Help			×
roperty list: C1	OK Cancel Help perties Properties Geometric Mechanical Elastic Grou	ıt Material		
roperty list: C1	OK Cancel Help perties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4.2e9 Bond	it Material Stiffness [lbf/ft/ft]	6.3e7	
roperty list: C1	OK Cancel Help perties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4.2e9 Founding Sex in compate mean office space above.		6.3e7 5000.0	
roperty list: C1	OK Cancel Help perties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4.2e9 Excluding Szz in comput, mean eff, confin, stress Bond Yield Force	Stiffness [lbf/ft/ft]		
roperty list: 01	OK Cancel Help perties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4.2e9 Excluding Szz in comput, mean eff, confin, stress Bond Yield Force	Stiffness [lbf/ft/ft] Strength [lbf/ft] Fric Angle[deg]	5000.0	
roperty list: C1	Properties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4.2e9 Excluding Szz in comput. mean eff. confin. stress Yield Force Compressive [lbf] Tensile [lbf] O Tensile [lbf] O Tensile [lbf] O Tensile Perim	Stiffness [lbf/ft/ft] Strength [lbf/ft] Fric Angle[deg] eter [ft]	5000.0	
Section and the section of the secti	Properties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4.2e9 Excluding Szz in comput. mean eff. confin. stress Yield Force Compressive [lbf] Tensile [lbf] Density Ther	Stiffness [lbf/ft/ft] Strength [lbf/ft] Fric Angle[deg] leter [ft] mal	5000.0	
roperty list: C1	Properties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4.2e9 Excluding Szz in comput. mean eff. confin. stress Bond Yield Force Compressive [lbf] Tensile [lbf] Density Compute with timestep (Static only)	Stiffness [lbf/ft/ft] Strength [lbf/ft] Fric Angle[deg] eter [ft]	5000.0	
roperty list: C1	Properties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4.2e9 Excluding Szz in comput. mean eff. confin. stress Yield Force Compressive [lbf] Tensile [lbf] Density Ther	Stiffness [lbf/ft/ft] Strength [lbf/ft] Fric Angle[deg] leter [ft] mal	5000.0	

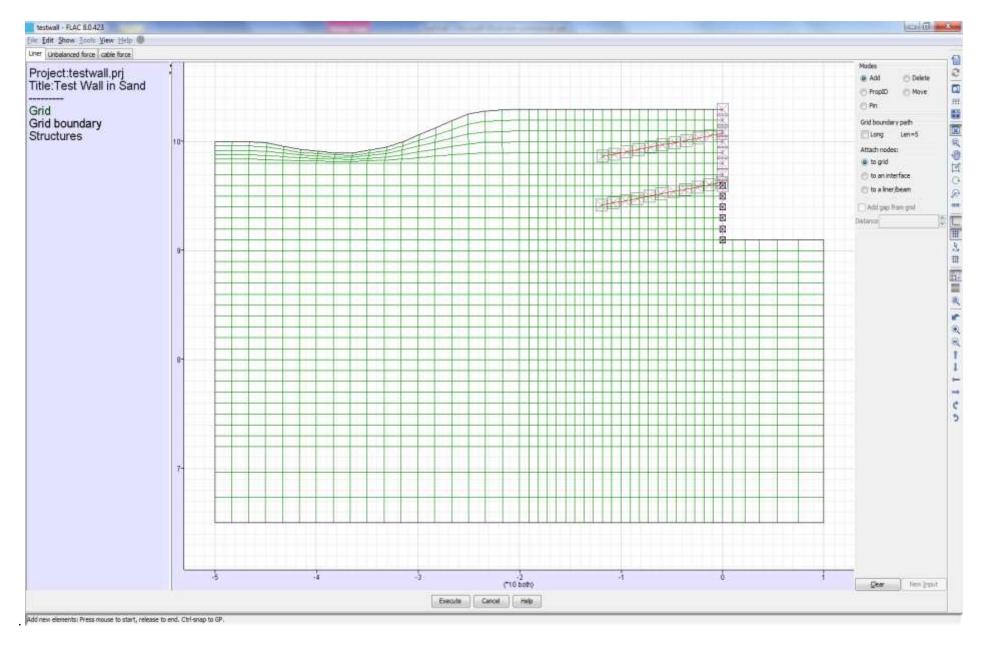
Step 4-5 In the [Structure]/[SEProp] tool, assign cable properties as shown. Note that cable spacing for the Row 2 cables is 3.5 ft.



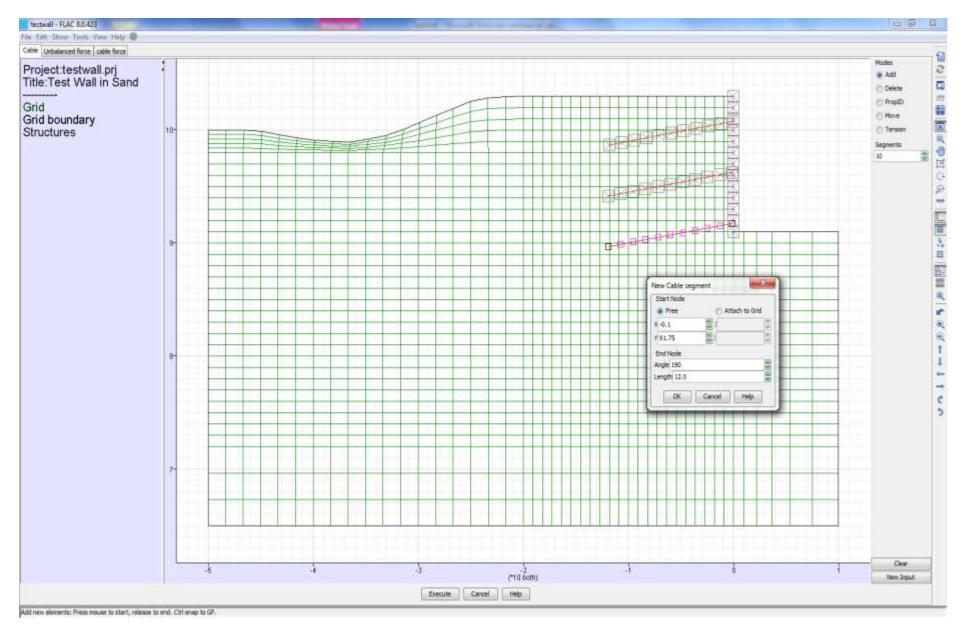
Step 4-6 Solve for the equilibrium state using the [Run]/[Solve] tool. Plot cable forces in the [Plot]/[Model] tool. Press [Save] to save the state as testwall4.sav.



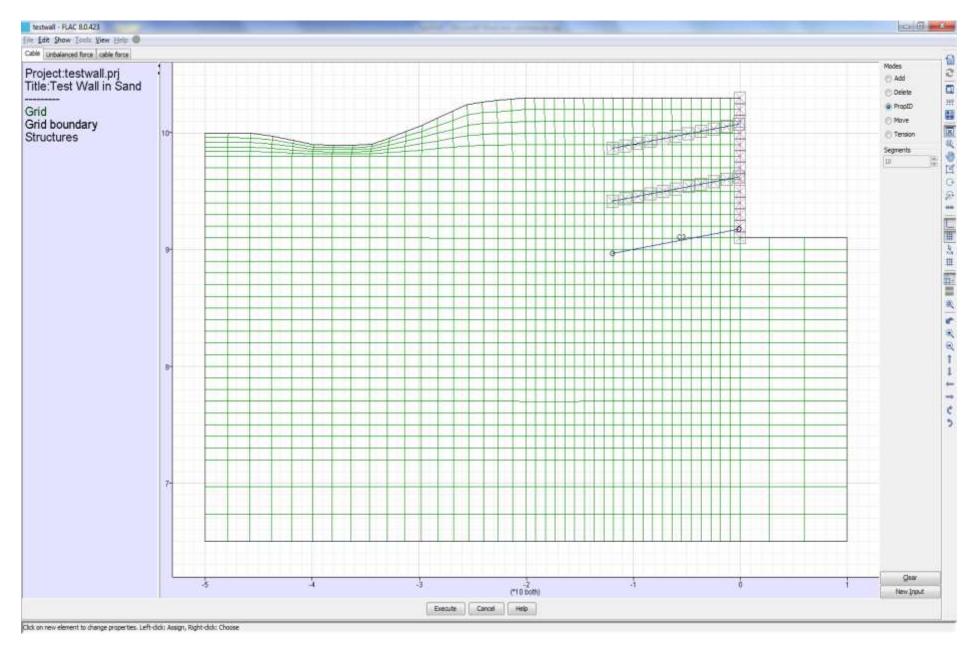
Step 5-1 Stage III excavation – use the [Material]/[Assign] tool and select [null] material to excavate zones to the depth y=91.



Step 5-2 In the [Structure]/[Liner] tool, check [Add] and drag the mouse along the boundary as shown to attach liner nodes to gridpoints in the excavation region. Press [Execute] to send the commands to *FLAC*



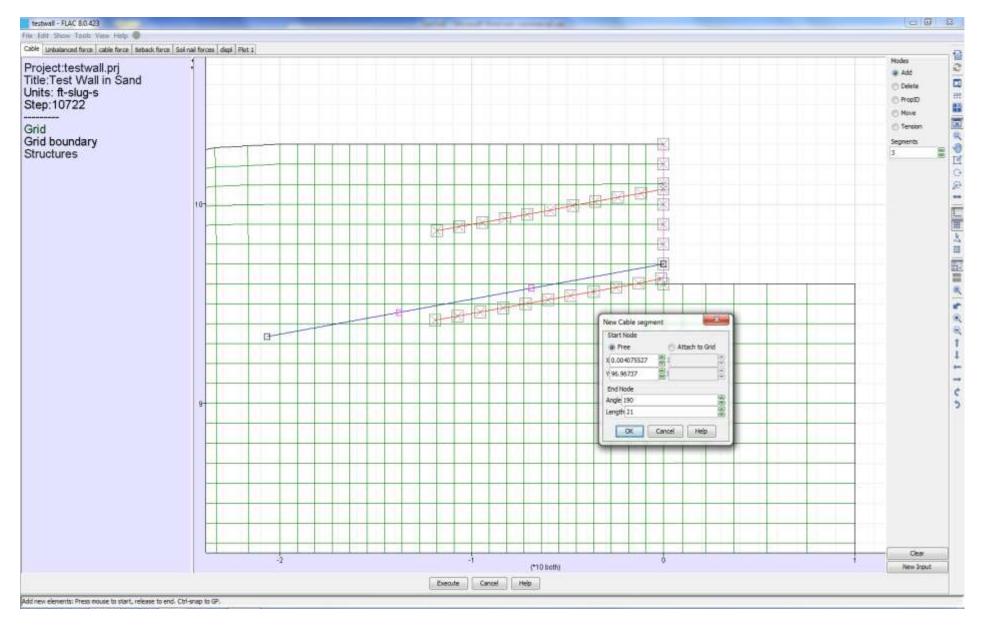
Step 5-3 In the [Structure]/[Cable] tool, check [Add], select 10 segments, and left click the mouse at a point inside the grid. This opens a *New Cable segment* dialog. Input a starting point at x=-0.1, y=91.25, and specify an angle of 190° and length of 12.0. The cable, composed of 10 segments, is created as shown.



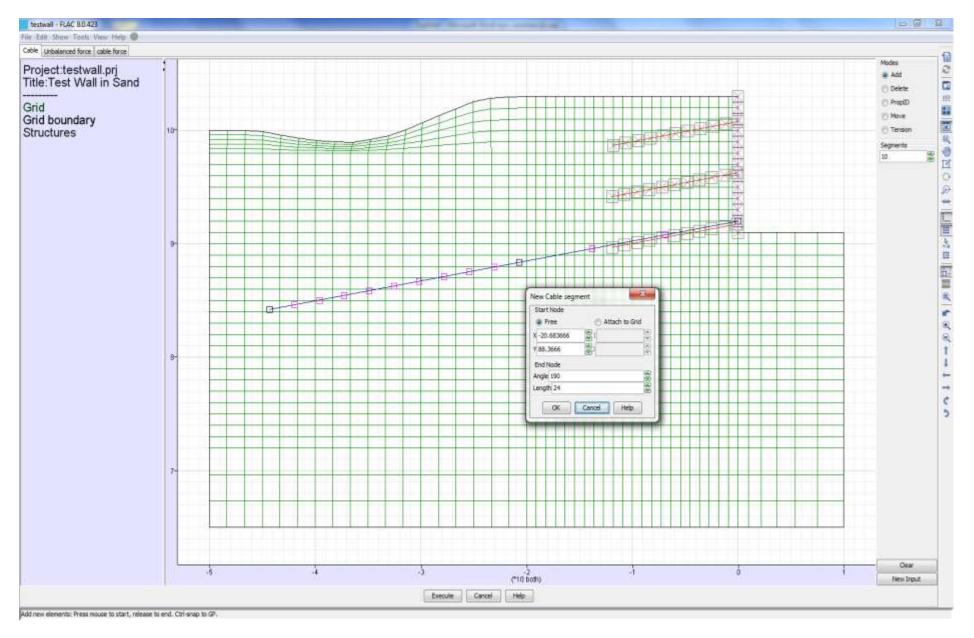
Step 5-4 Press [PropID] to change the property ID number for the new cable. Press [Execute] to send the commands to FLAC.

roperty list:	Properties				
1	Geometric Mechanical				
2					
3					
<i>1</i> 0					
	Cross-sectional par	rameters	2D/3D Equi	valence	
	1: Area [ft2]	0.0085		ous in Z-direction	
	2: Radius [ft]	0.0	Spaced	Reinforcement	
	ATTO A REPORT OF THE PARTY OF T	1000	Z Spacing [f	9.0	
			z spacing (i	212	
•	7				
<u>N</u> ew					
<u>C</u> lone		Defa	ault Values		
		OK Cancel	<u>H</u> elp		~
AND THE PROPERTY OF THE PROPER	***************************************	OK Cancel	<u>H</u> elp	412	×
roperty list:	Properties	OK Cancel	<u>H</u> elp		×
roperty list:	Properties Geometric Mechanical	OK Cancel		II.	x
roperty list: C1 C2	Properties Geometric Mechanical Elastic		Grout Material	(6) 6 2-7	
roperty list: C1 C2	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4. 2e9	Grout Material Bond Stiffness [lbf/ft,	/ft] 6.3e7	
roperty list: C1 C2	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2		Grout Material Bond Stiffness [lbf/ft,		46
roperty list: C1 C2	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4. 2e9	Grout Material Bond Stiffness [lbf/ft,	6000.0	
roperty list: C1 C2	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] 4. 2e9	Grout Material Bond Stiffness [lbf/ft,	6000.0 0.0	
roperty list: C1 C2	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2 Excluding Szz in com] 4.2e9 put. mean eff. confin. str	Grout Material Bond Stiffness [lbf/ft] Bond Strength [lbf/ft]	6000.0	
ble Element Pro roperty list: C1 C2	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2 Excluding Szz in com Yield Force Compressive [lbf] Tensile [lbf]] 4.2e9 hput, mean eff, confin. str	Grout Material Bond Stiffness [lbf/ft, Bond Strength [lbf/ft] Bond Fric Angle[deg] Perimeter [ft]	0.0	
roperty list: C1 C2	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2 Excluding Szz in com Yield Force Compressive [lbf] Tensile [lbf] Density	0 73620.0	Grout Material Bond Stiffness [lbf/ft, Bond Strength [lbf/ft] Bond Fric Angle[deg] Perimeter [ft]	0.0	
roperty list: C1 C2 C3	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2 Excluding Szz in com Yield Force Compressive [lbf] Tensile [lbf] Density Compute with times	0 73620.0	Grout Material Bond Stiffness [lbf/ft] Bond Strength [lbf/ft] Bond Fric Angle[deg] Perimeter [ft] Thermal step down	0.0	
roperty list: C1 C2	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2 Excluding Szz in com Yield Force Compressive [lbf] Tensile [lbf] Density	0 73620.0 tep (Static only)	Grout Material Bond Stiffness [lbf/ft, Bond Strength [lbf/ft] Bond Fric Angle[deg] Perimeter [ft]	0.0	

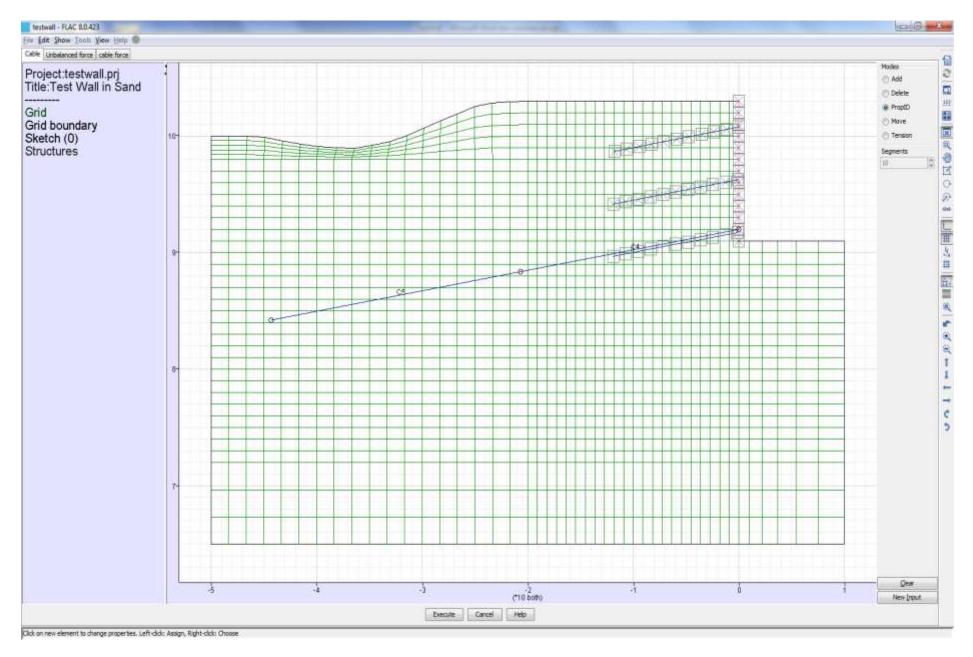
Step 5-5 In the [Structure]/[SEProp] tool, assign cable properties as shown. Note that cable spacing for the Row 3 cables is 9 ft. Press [OK] to send the commands to *FLAC*.



Step 5-6 In the [Structures]/[Cables] tool, check [Add], select 3 segments, and left click the mouse directly on the shotcrete liner node, as shown above. This opens a New Cable segment dialog. The starting point for the ungrouted portion of the tieback will be connected to the shotcrete liner. The tieback angle is 190° and the ungrouted length is 21 ft.

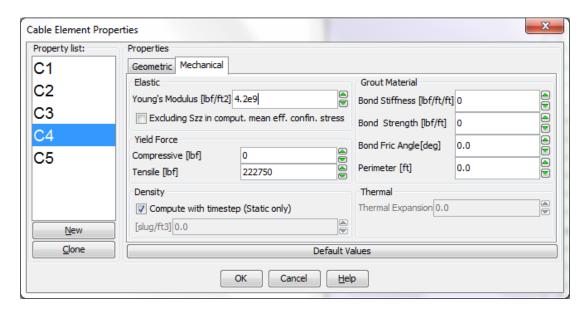


Step 5-7 In the [Structures]/[Cables] tool, check [Add], select 10 segments, and left click the mouse on the ending node of the ungrouted portion of the tieback. When the *New Cable segment* dialog opens, check [Free] and specify an angle of 190° and length of 24 ft. The grouted portion of the tieback is created.

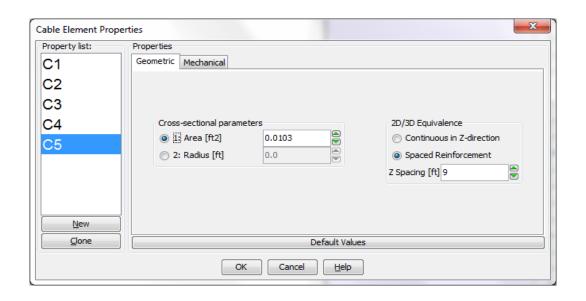


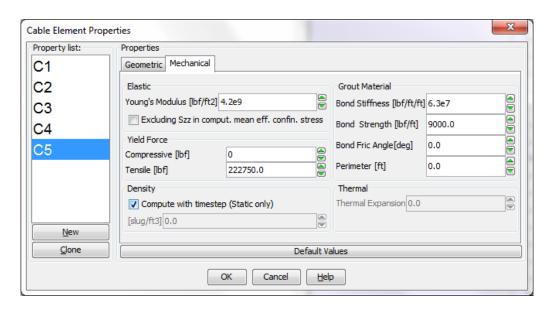
Step 5-8 Press [PropID] to change the property ID number for the tieback. The ungrouted portion and grouted portion are assigned different property ID numbers. Press [Execute] to send the commands to *FLAC*.

Property list:	Properties	
C1 C2 C3 C4 C5	Cross-sectional parameters Area [ft2] 2: Radius [ft] 0.0103	2D/3D Equivalence Continuous in Z-direction Spaced Reinforcement Z Spacing [ft] 9.0
<u>C</u> lone	De	fault Values

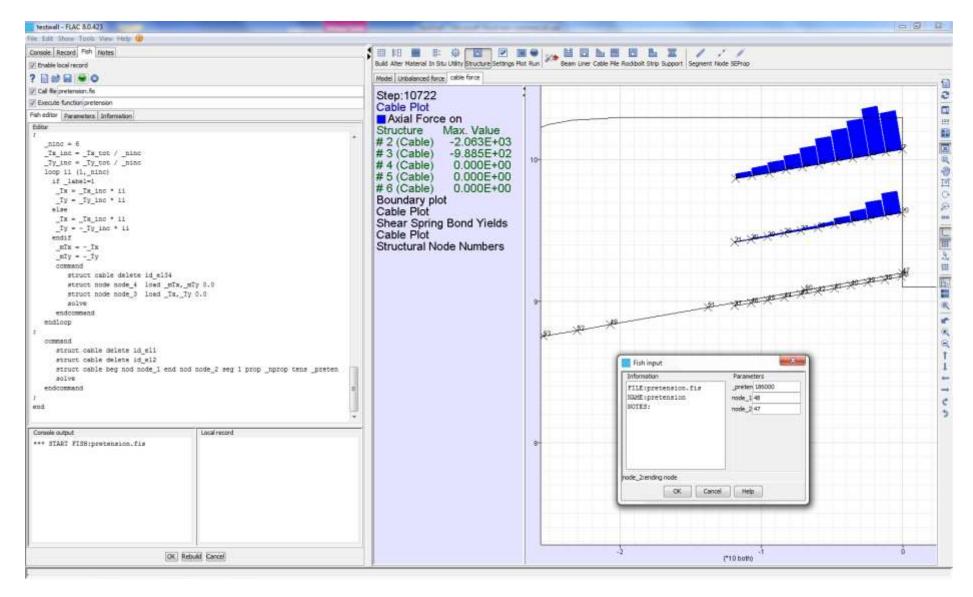


Step 5-9 In the [Structure]/[SEProp] tool, assign properties for the ungrouted portion of the tieback as shown. Note that tieback spacing is 9 ft. Press [OK] to send the commands to *FLAC*.

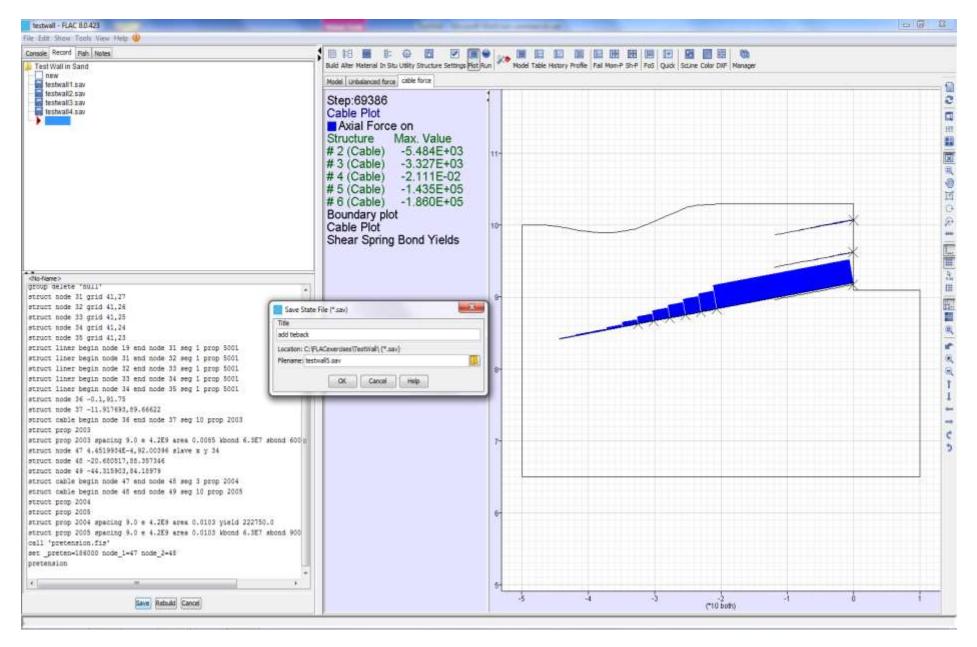




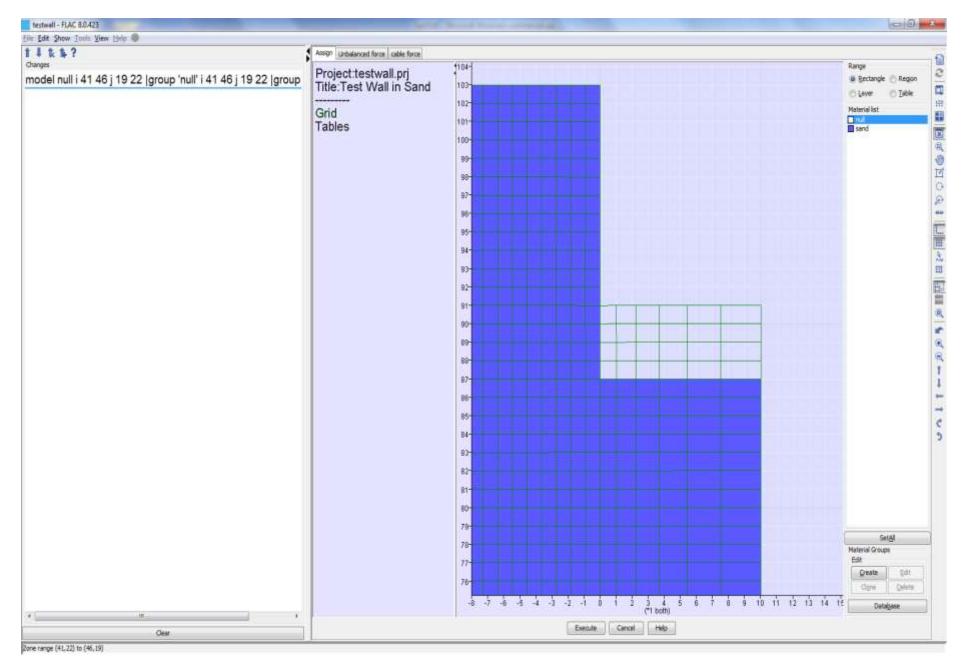
Step 5-10 In the [Structure]/[SEProp] tool, assign properties for the grouted portion of the tieback as shown. Note that tieback spacing is 9 ft. Press [OK] to send the commands to *FLAC*.



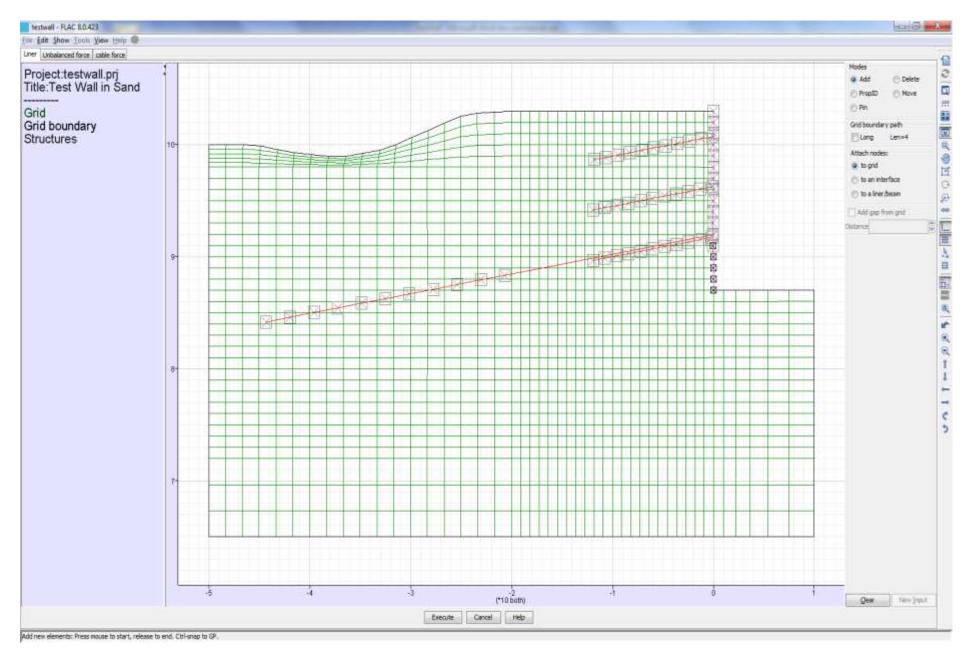
Step 5-11 Open pretension.fis in the [Fish editor] tool. Click on the execute button to open the *Fish input* dialog. The FISH function is described in Section 1.10.5 of the **Structural Elements** volume. The pretension value of 186,000 lb is assigned, and the starting and ending nodes of the ungrouted portion of the tieback (**node_1** = 48 and **node_2** = 47) are input. (Note that the starting node, **node_1**, must be the node with the lowest x-coordinate.) Press [OK] to execute the function.



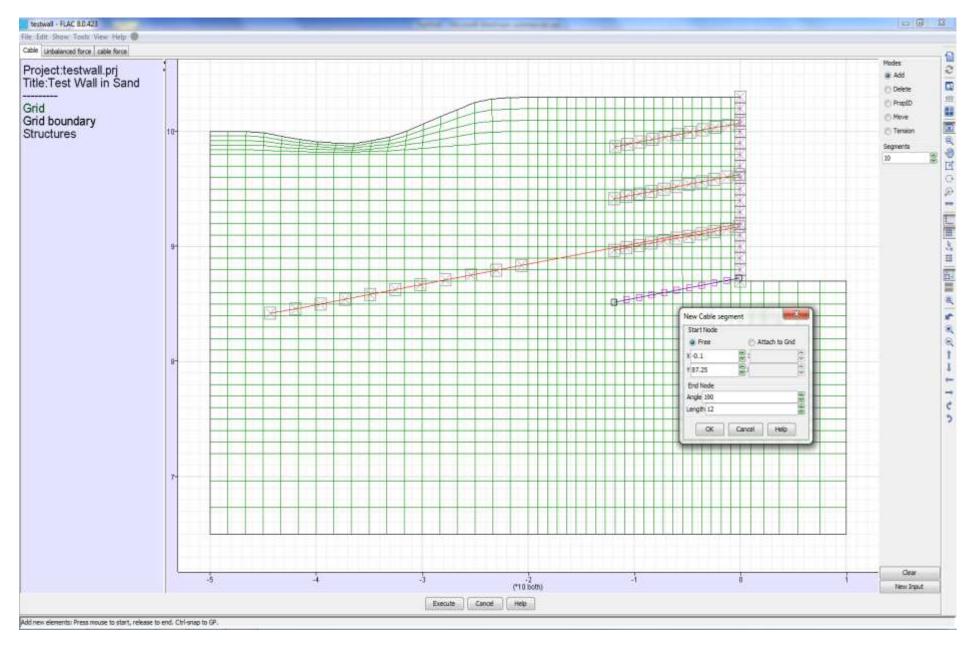
Step 5-12 When the calculation stops, return to the [Project] pane and check that the axial load in the cable is at the pretension value of 186,000 lb. Save the state as testwall5.sav.



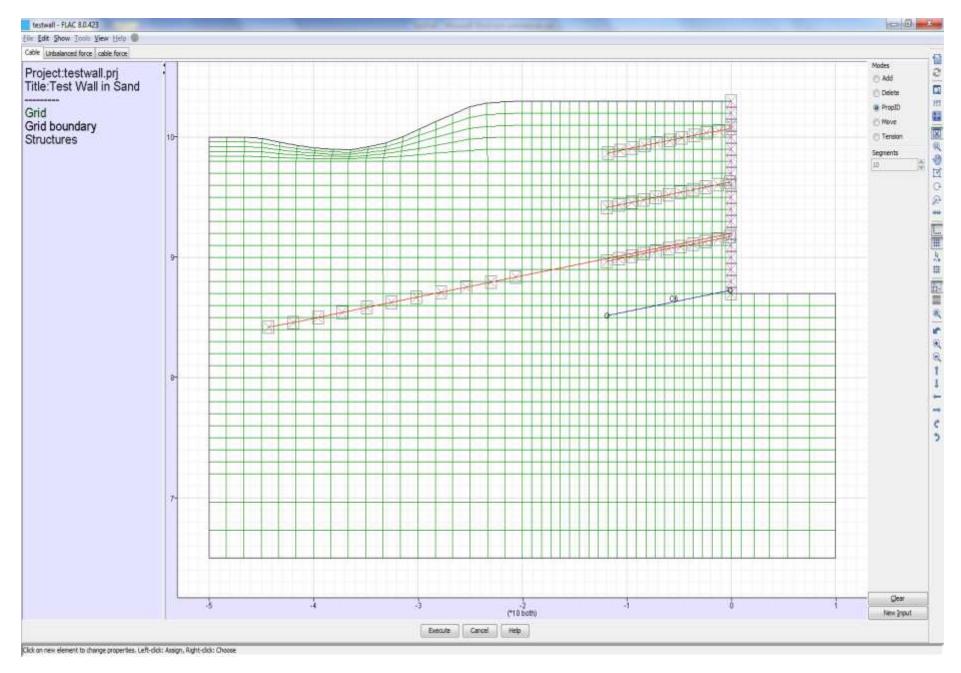
Step 6-1 Stage IV excavation – use the [Material]/[Assign] tool and select [null] material to excavate zones to the depth y=87.



Step 6-2 In the [Structure]/[Liner] tool, check [Add] and drag the mouse along the boundary as shown to attach liner nodes to gridpoints in the excavation region. Press [Execute] to send the commands to *FLAC*.



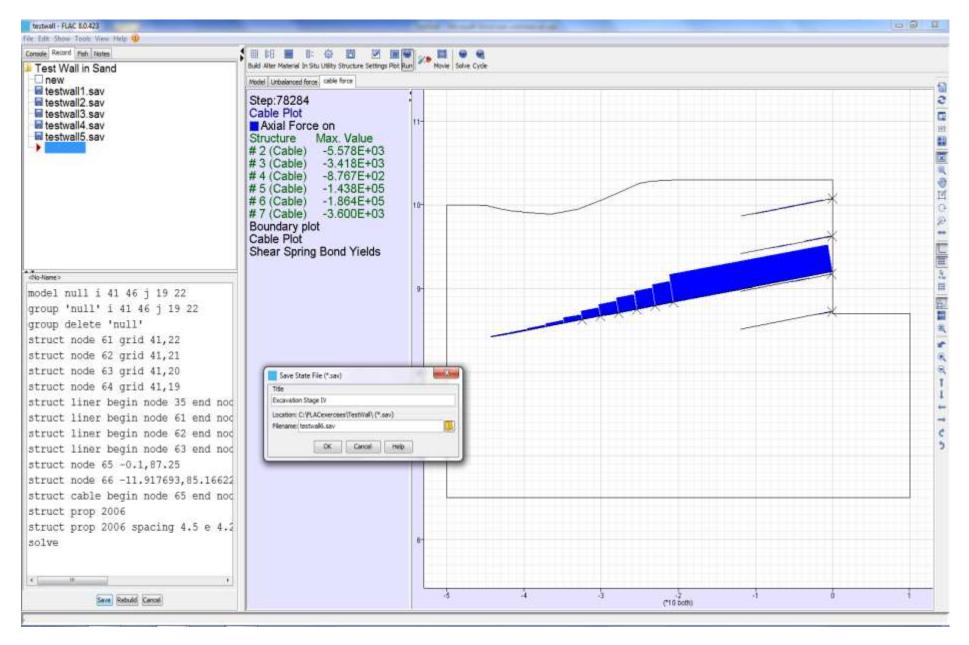
Step 6-3 In the [Structure]/[Cable] tool, check [Add], select 10 segments, and left click the mouse at a point inside the grid. This opens a *New Cable segment* dialog. Input a starting point at x=-0.1, y=87.25, and specify an angle of 190° and length of 12.0. The cable, composed of 10 segments, is created as shown.



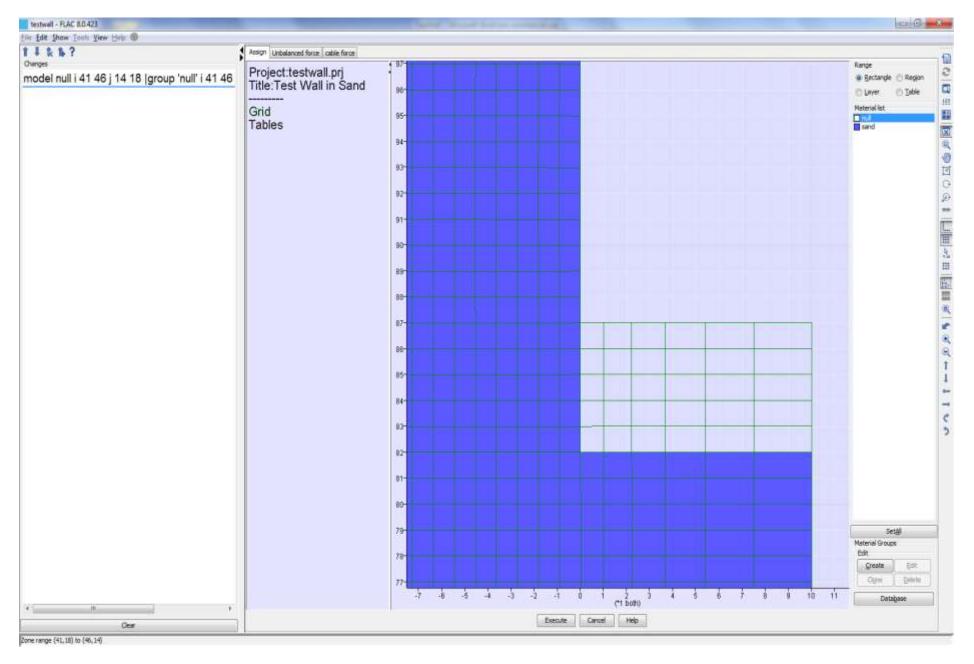
Step 6-4 Press [PropID] to change the property ID number for the new cable. Press [Execute] to send the commands to FLAC.

	Properties					
C1	Geometric Mechanical					
C2						
C3	Cross-sectional para	meters		2D/3D Equival	lence	
C4	(i) 1: Area [ft2]	0.0085			is in Z-directio	n
C5	② 2: Radius [ft]	0.0		Spaced Re		
C6	0.0000000	1500		Z Spacing [ft]		
5 0				2 Spacing [rd]	11.5	
<u>N</u> ew	Ī					
Clone	ī 	D	efault Values	s		
5500000000						
		OK Cancel	<u>H</u> elp			[6-2-4
		OK Cancel	<u>H</u> elp	<u> </u>		<u></u> x
Property list:	perties	OK Cancel	<u>H</u> elp			<u> </u>
Property list:	perties Properties	OK Cancel	G	out Material		
Property list: C1 C2	perties Properties Geometric Mechanical		G	out Material nd Stiffness [lbf/ft/ft] 6.3e7	
Property list: C1 C2 C3	perties Properties Geometric Mechanical Elastic	4. 2e9	Gi 🚳 Bo		6.3e7	
Property list: C1 C2 C3	perties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2]	4. 2e9	Gi Bo stress Bo	nd Stiffness [lbf/ft/ft] nd Strength [lbf/ft]	6000	
Property list: C1 C2 C3 C4	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] Excluding Szz in composition Yield Force Compressive [lbf]	4. 2e9	Gram Bo	nd Stiffness [lbf/ft/ft] nd Strength [lbf/ft] nd Fric Angle[deg]	6000	
Property list: C1 C2 C3 C4 C5	perties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] Excluding Szz in compo	4.2e9 ut. mean eff. confin.	Gram Bo	nd Stiffness [lbf/ft/ft] nd Strength [lbf/ft]	6000	
Property list: C1 C2 C3 C4	Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] Excluding Szz in composition Yield Force Compressive [lbf]	4.2e9 ut. mean eff. confin.	Grand Book Book Book Book Book Book Book Boo	nd Stiffness [lbf/ft/ft] nd Strength [lbf/ft] nd Fric Angle[deg] rimeter [ft] nermal	6000	
able Element Pro Property list: C1 C2 C3 C4 C5	Properties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] Excluding Szz in compound of the compound of	4.2e9 ut. mean eff. confin. 0 73620	Gr Bo Stress Bo Bo Pe	nd Stiffness [lbf/ft/ft] nd Strength [lbf/ft] nd Fric Angle[deg] rimeter [ft]	6000	
Property list: C1 C2 C3 C4 C5	Properties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] Excluding Szz in composition Yield Force Compressive [lbf] Tensile [lbf] Density	4.2e9 ut. mean eff. confin. 0 73620	Grand Book Book Book Book Book Book Book Boo	nd Stiffness [lbf/ft/ft] nd Strength [lbf/ft] nd Fric Angle[deg] rimeter [ft] nermal	6000	
Property list: C1 C2 C3 C4 C5	Properties Properties Geometric Mechanical Elastic Young's Modulus [lbf/ft2] Excluding Szz in composition Yield Force Compressive [lbf] Tensile [lbf] Density Compute with timeste	4.2e9 ut. mean eff. confin. 0 73620 p (Static only)	Gr Bo Stress Bo Bo Pe	nd Stiffness [lbf/ft/ft] nd Strength [lbf/ft] nd Fric Angle[deg] rimeter [ft] nermal ermal Expansion 0.0	6000	

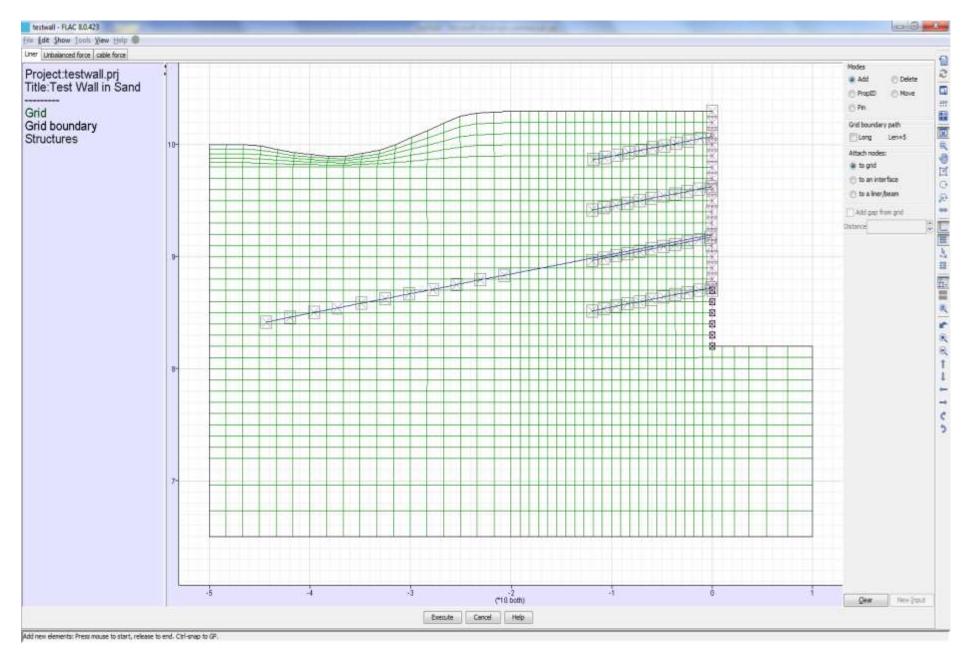
Step 6-5 In the [Structure]/[SEProp] tool, assign cable properties as shown. Note that cable spacing for the Row 4 cables is 4.5 ft. Press [OK] to send the commands to *FLAC*.



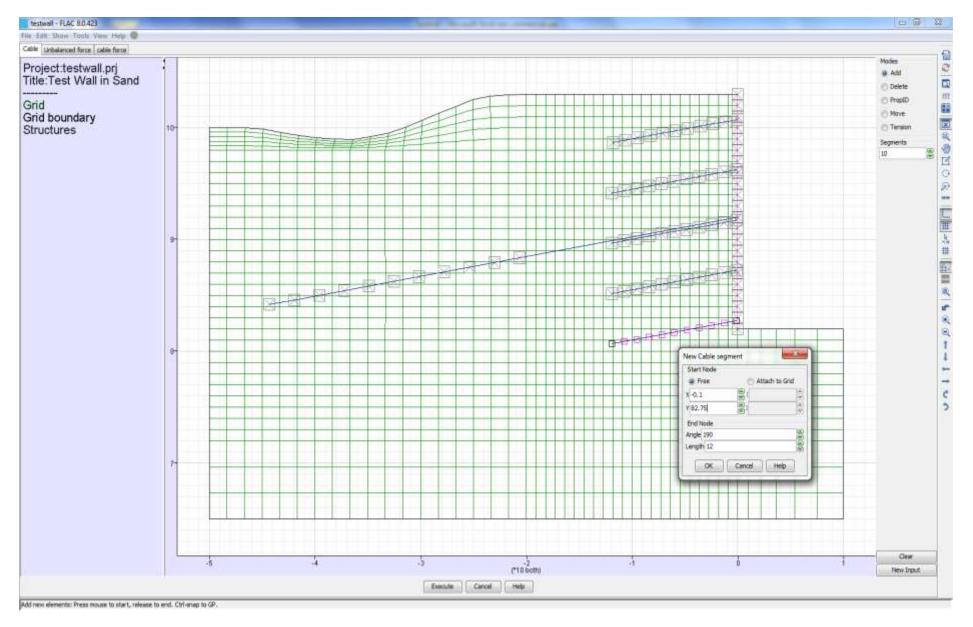
Step 6-6 Solve for the equilibrium state using the [Run]/[Solve] tool. Plot cable forces in the [Plot]/[Model] tool. Press [Save] to save the state as testwall6.sav.



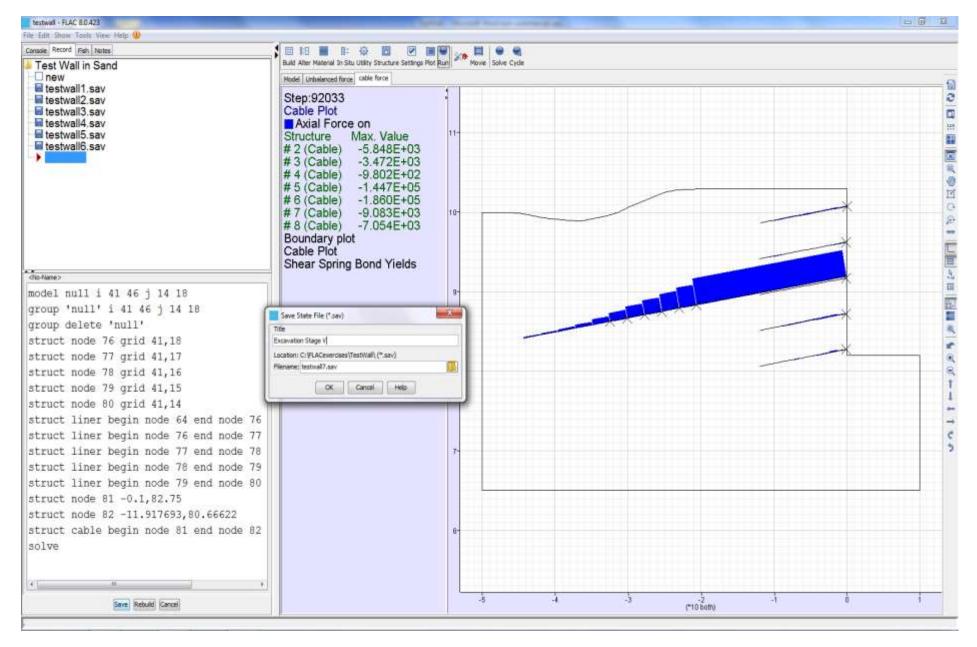
Step 7-1 Stage V excavation – use the [Material]/[Assign] tool and select [null] material to excavate zones to the depth y=82.



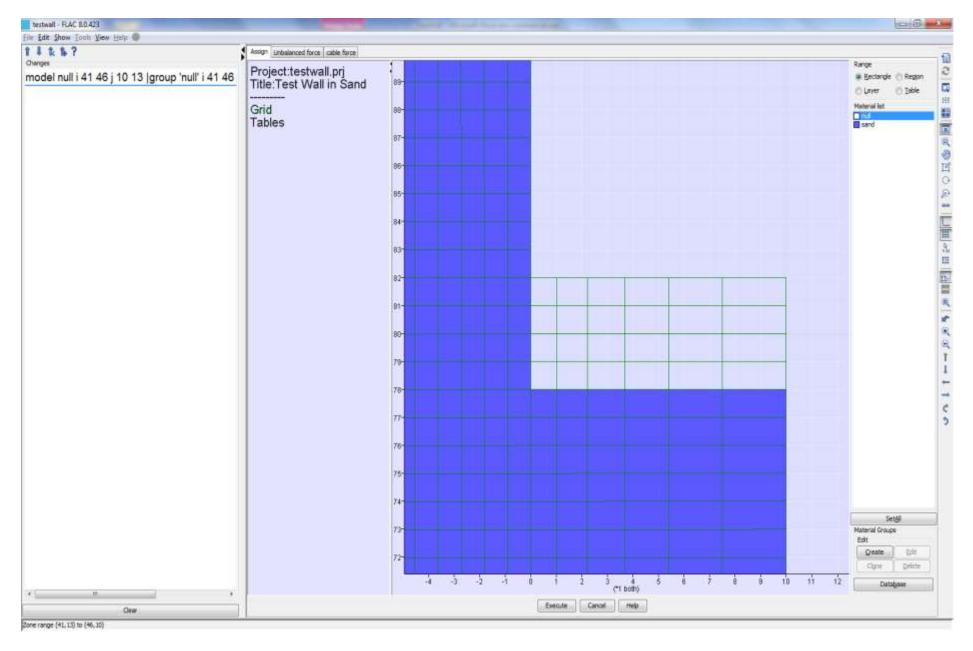
Step 7-2 In the [Structure]/[Liner] tool, check [Add] and drag the mouse along the boundary as shown to attach liner nodes to gridpoints in the excavation region. Press [Execute] to send the commands to *FLAC*.



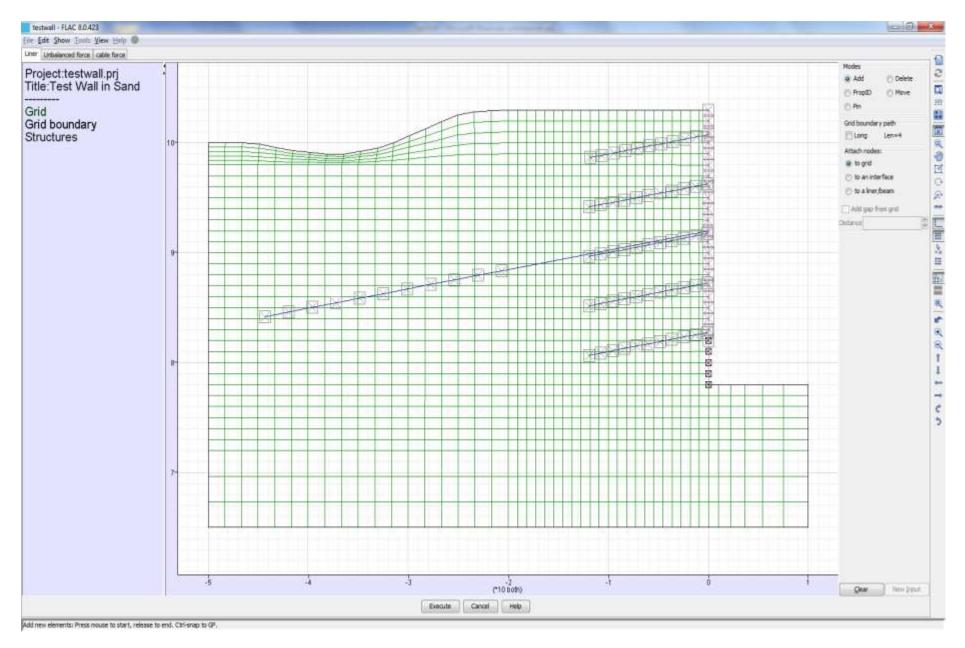
Step 7-3 In the [Structure]/[Cable] tool, check [Add], select 10 segments, and left click the mouse at a point inside the grid. This opens a *New Cable segment* dialog. Input a starting point at x=-0.1, y=82.25, and specify an angle of 190° and length of 12.0. The cable, composed of 10 segments, is created as shown.



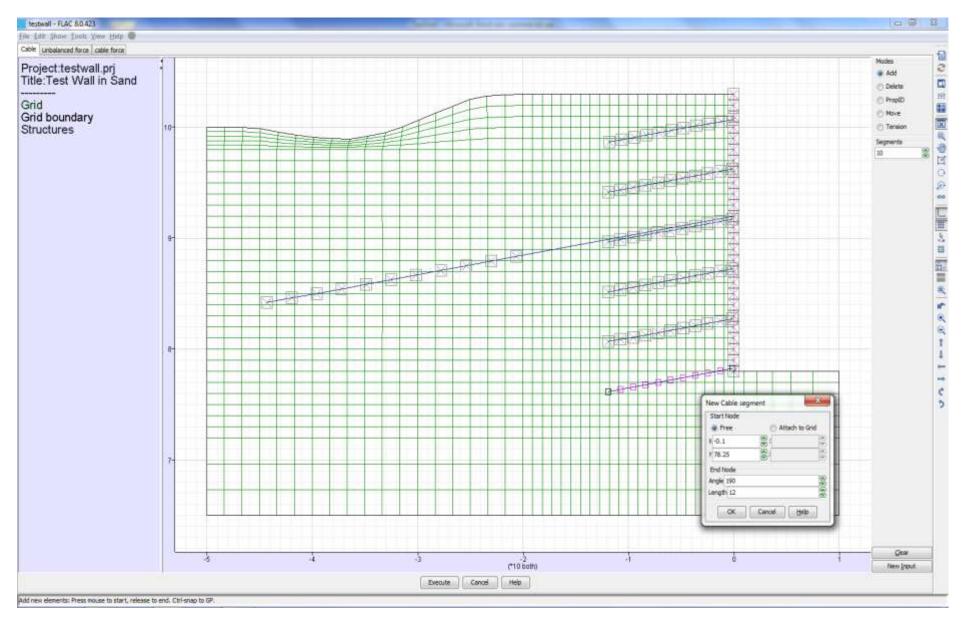
Step 7-4 Solve for the equilibrium state using the [Run]/[Solve] tool. Plot cable forces in the [Plot]/[Model] tool. Press [Save] to save the state as testwall7.sav.



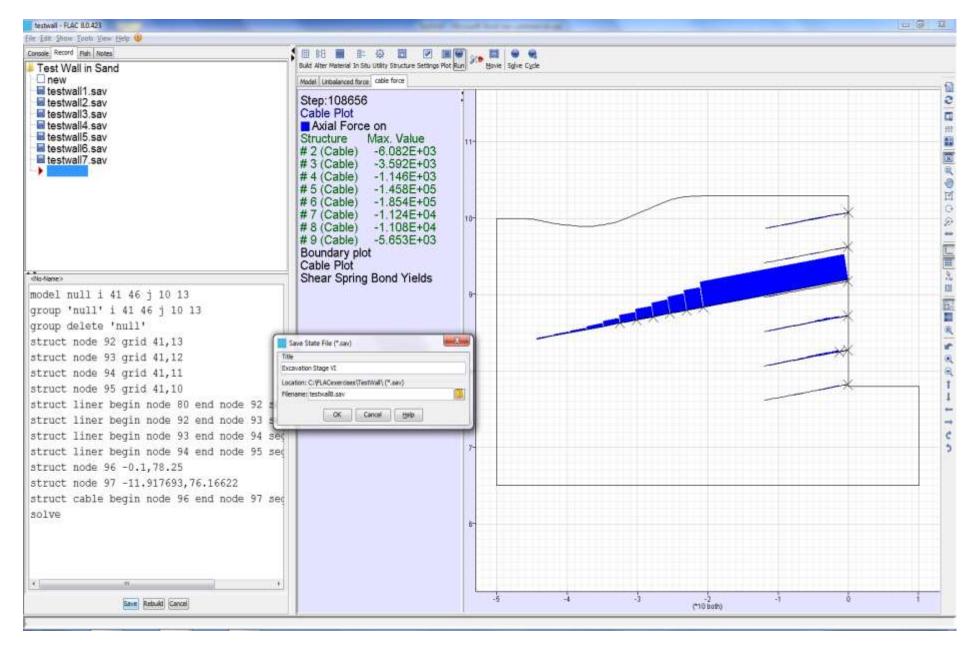
Step 8-1 Stage VI excavation – use the [Material]/[Assign] tool and select [null] material to excavate zones to the depth y=78.



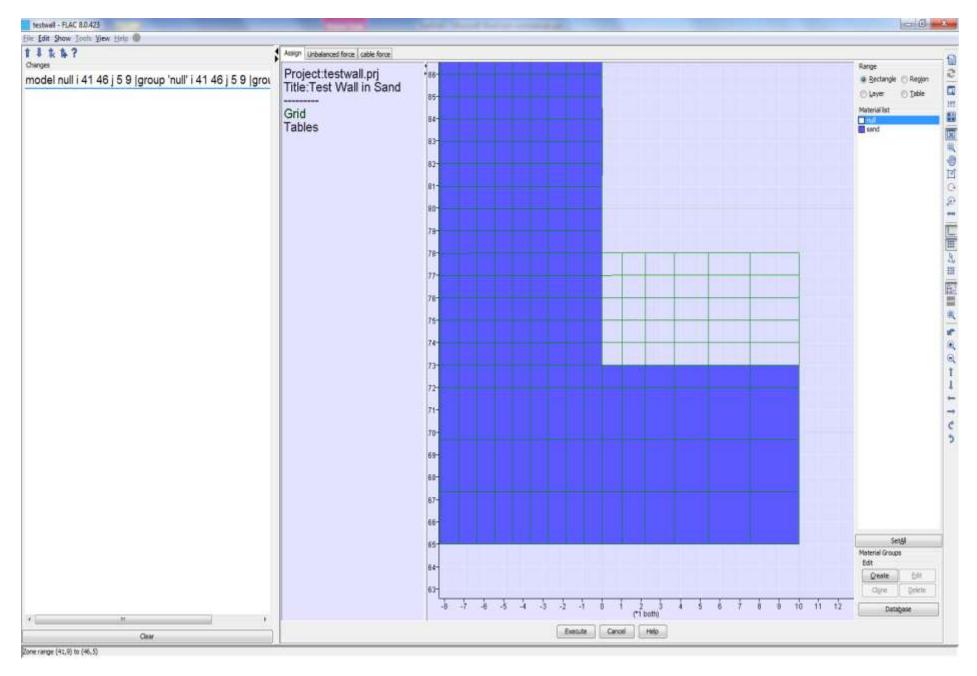
Step 8-2 In the [Structure]/[Liner] tool, check [Add] and drag the mouse along the boundary as shown to attach liner nodes to gridpoints in the excavation region. Press [Execute] to send the commands to *FLAC*.



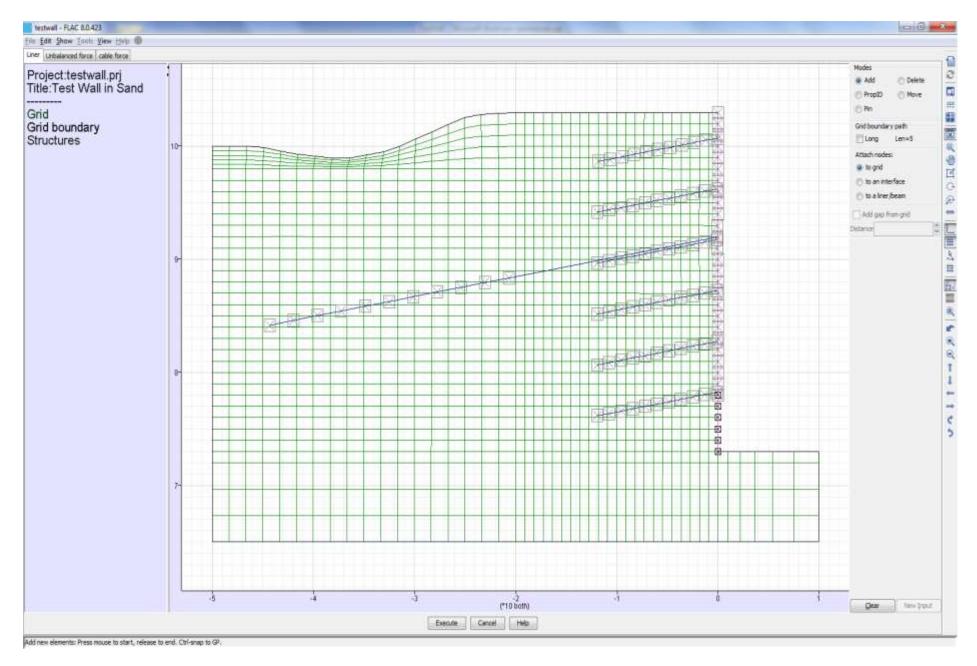
Step 8-3 In the [Structure]/[Cable] tool, check [Add], select 10 segments, and left click the mouse at a point inside the grid. This opens a *New Cable segment* dialog. Input a starting point at x=-0.1, y=78.25, and specify an angle of 190° and length of 12.0. The cable, composed of 10 segments, is created as shown.



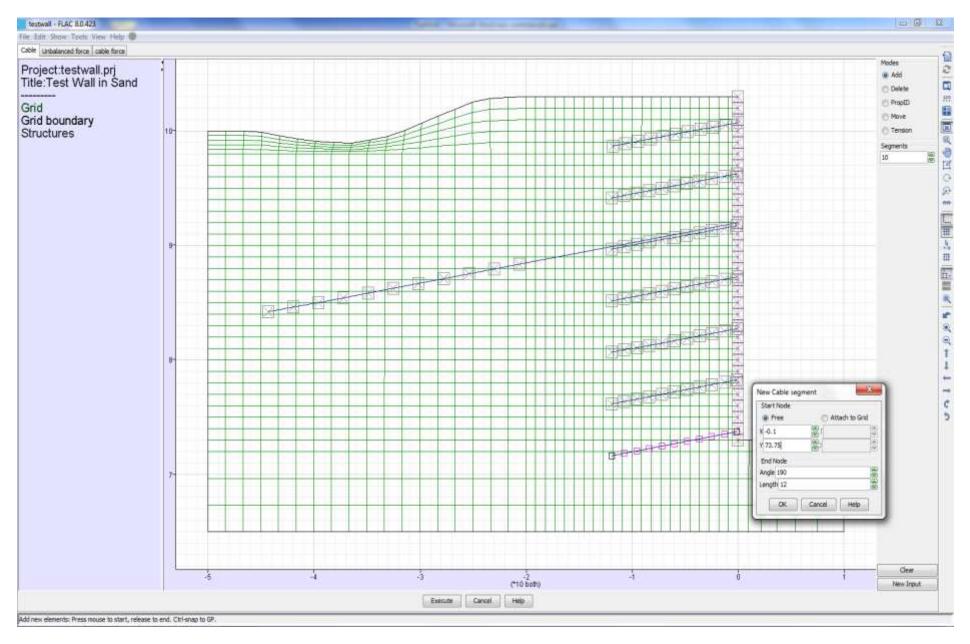
Step 8-4 Solve for the equilibrium state using the [Run]/[Solve] tool. Plot cable forces in the [Plot]/[Model] tool. Press [Save] to save the state as testwall8.sav.



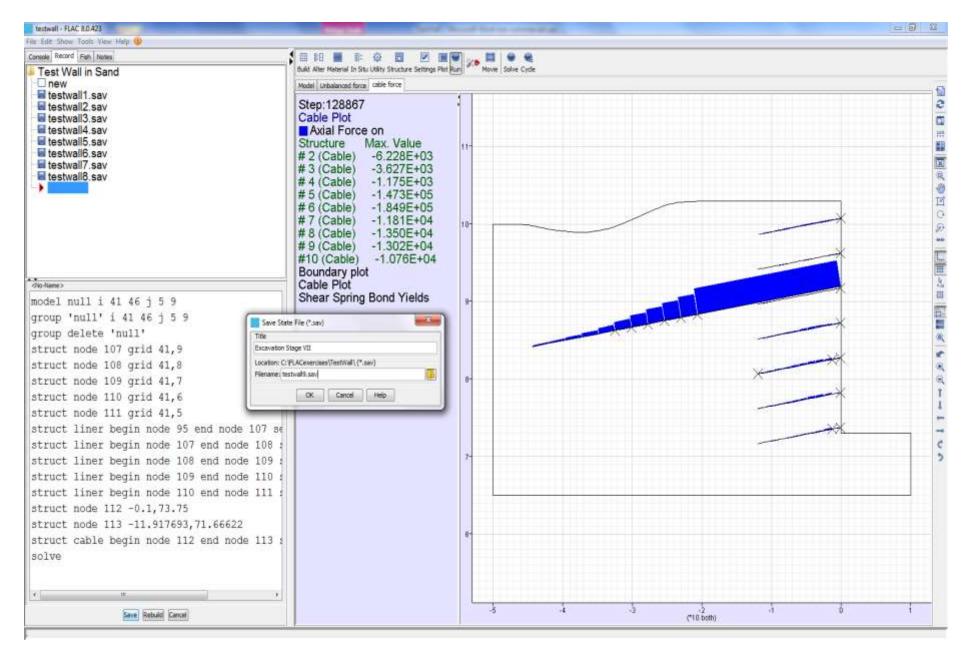
Step 9-1 Stage VII excavation – use the [Material]/[Assign] tool and select [null] material to excavate zones to the depth y=73.



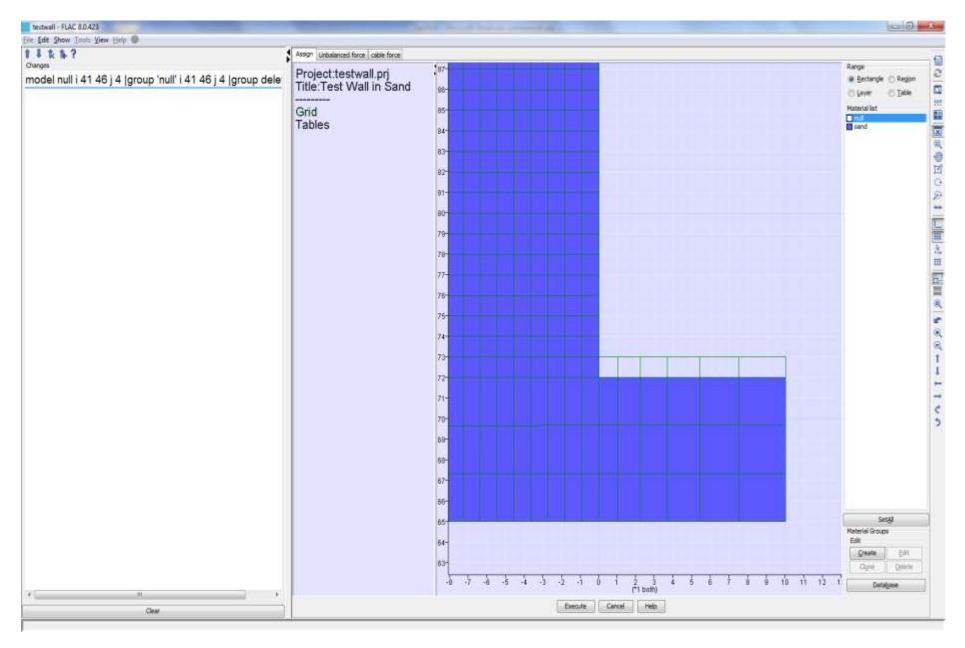
Step 9-2 In the [Structure]/[Liner] tool, check [Add] and drag the mouse along the boundary as shown to attach liner nodes to gridpoints in the excavation region. Press [Execute] to send the commands to *FLAC*.



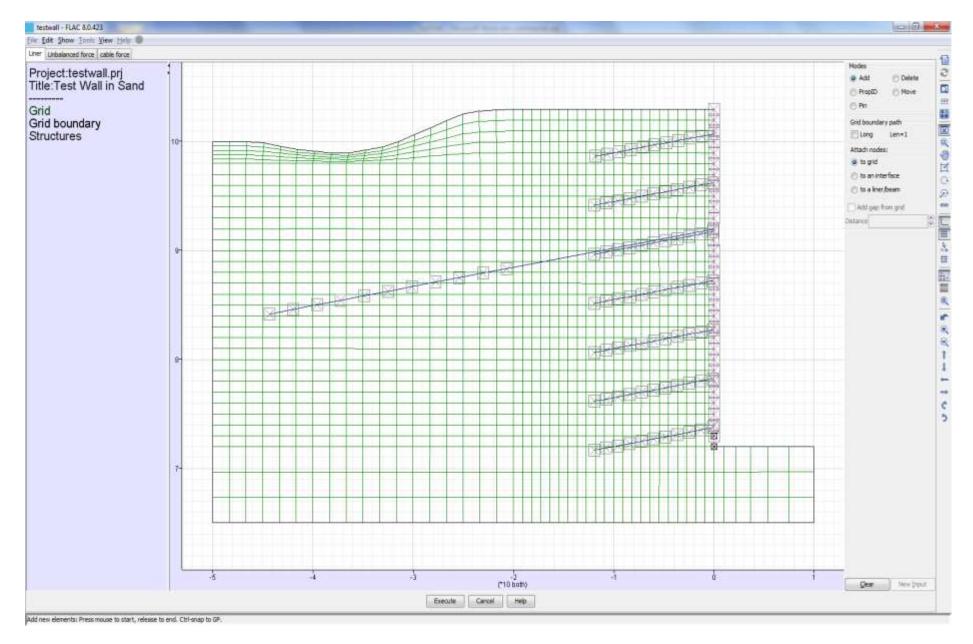
Step 9-3 In the [Structure]/[Cable] tool, check [Add], select 10 segments, and left click the mouse at a point inside the grid. This opens a *New Cable segment* dialog. Input a starting point at x=-0.1, y=73.75, and specify an angle of 190° and length of 12.0. The cable, composed of 10 segments, is created as shown.



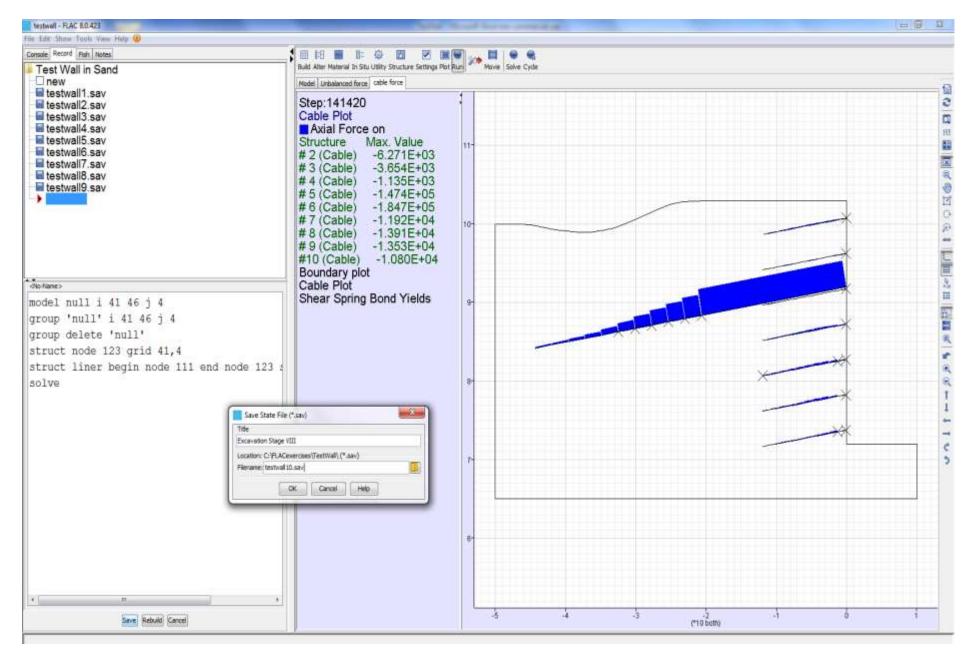
Step 9-4 Solve for the equilibrium state using the [Run]/[Solve] tool. Plot cable forces in the [Plot]/[Model] tool. Press [Save] to save the state as testwall9.sav.



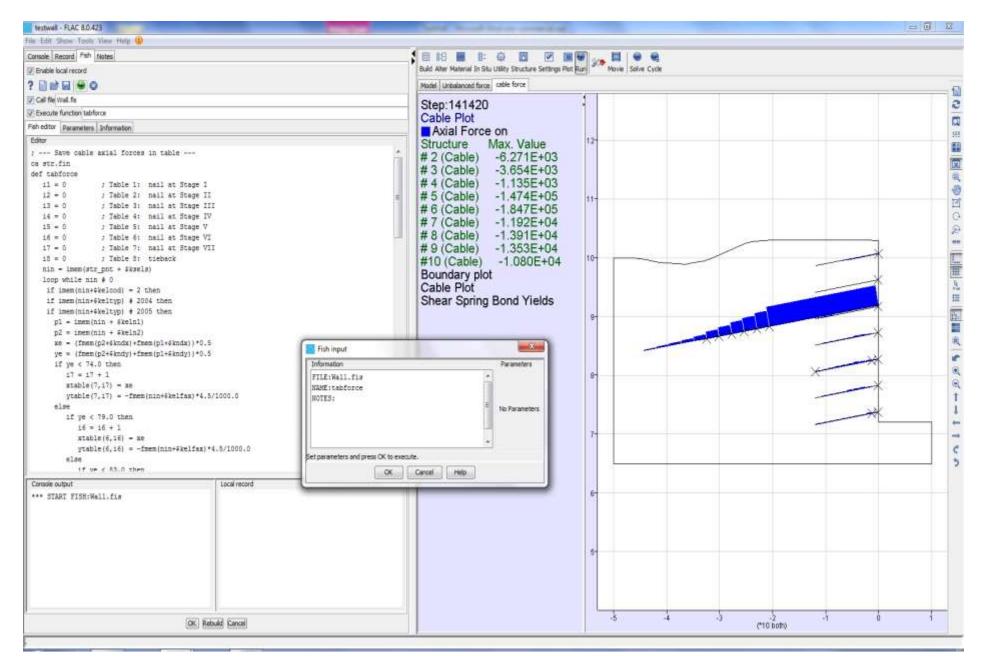
Step 10-1 Stage VIII excavation – use the [Material]/[Assign] tool and select [null] material to excavate zones to the depth y=72.



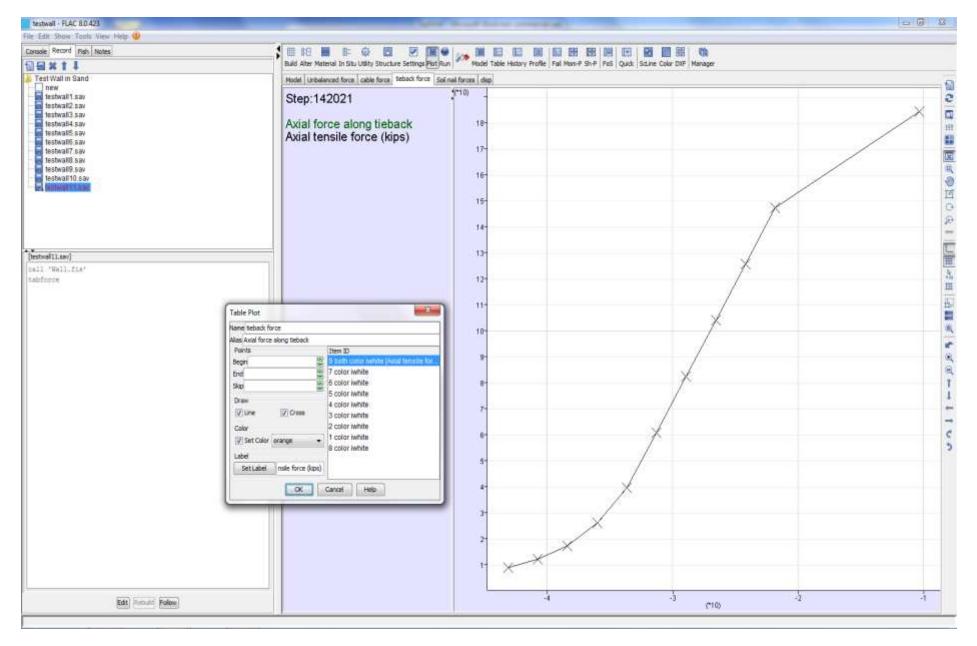
Step 10-2 In the [Structure]/[Liner] tool, check [Add] and drag the mouse along the boundary as shown to attach liner nodes to gridpoints in the excavation region. Press [Execute] to send the commands to *FLAC*.



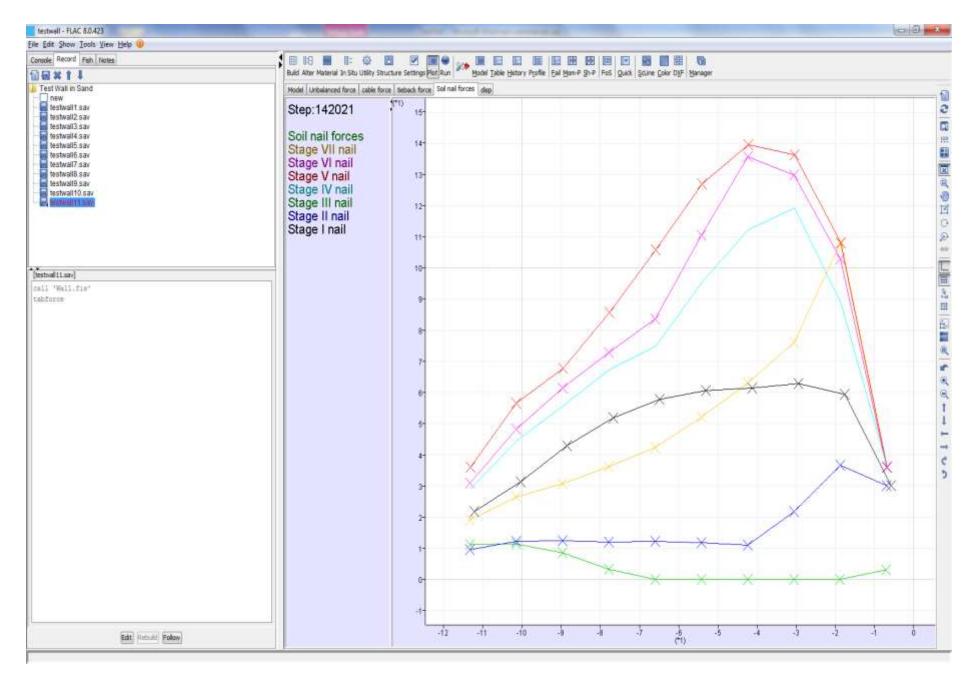
Step 10-3 Solve for the equilibrium state using the [Run]/[Solve] tool. Plot cable forces in the [Plot]/[Model] tool. Press [Save] to save the state as testwall9.sav.



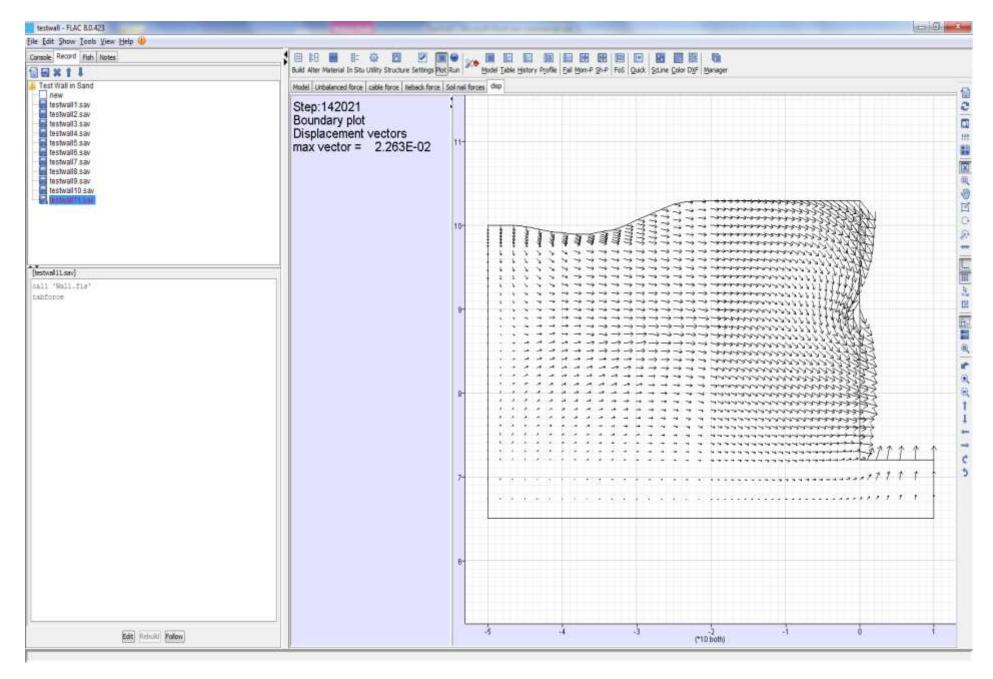
Step 11-1 FISH function, wall.fis, plots actual values in the tieback and soil nails. Enter the [Fish Editor] and open and execute wall.fis.



Step 11-2 Use the [Plot]/[Table] tool to plot tieback forces. Table 9 contains the axial force along the tieback. (Note that forces are first stored in table 8 and then reordered along the length of the tieback and stored in table 9.)



Step 11-3 Use the [Plot]/[Table] tool to plot soil nail forces. Tables 1 through 7 contain the axial forces along the soil nails.



Step 11-4 Use the [Plot]/[Model] tool to plot displacement vectors.