CHAPTER 2 – SNAP INPUT PARAMETERS

PROGRAM CONVENTIONS

SNAP Main Menus

The menu in SNAP consists of 4 options: *File, Units,* and *Help* (Figure 6.)

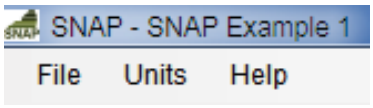


Figure 6. Screen Shot. SNAP main menus.

File Menu Items

The File menu contains standard operations found in other Windows-based computer programs: *New, Open, Save..., Save As…,* and *Exit* (Figure 7). The *Rename* operation allows the user to rename the current file, by right-clicking on the folder name. The *Clear Data* operation will erase all the inputs in the current file so the user can start over. The *Default Data* operation fills data fields with values for Example 1 (the complete Example work-through can be found in Chapter 4).

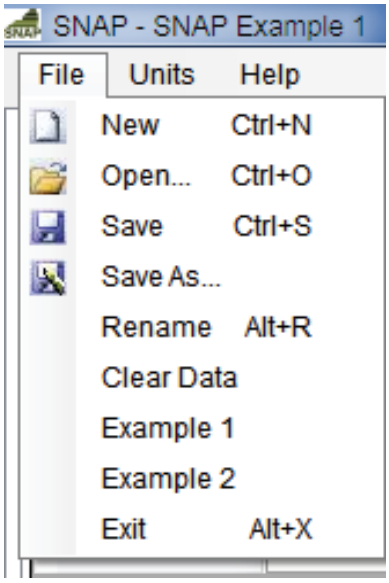


Figure 7. Screen Shot. File menu items.

Units Menu Items

The *Units* menu allows the user to enter project data in either Customary US units (i.e. ft, lbf, psi, etc.) or SI units (i.e. m, N, kPa, etc.) (Figure 8). The default setting for a new project is Customary US units. If the user has input data in SI units and accidentally enters those values while the units are set to US units, then the user can simply select *SI* from the units menu. The input values will remain the same, but the program will perform calculations in SI units.

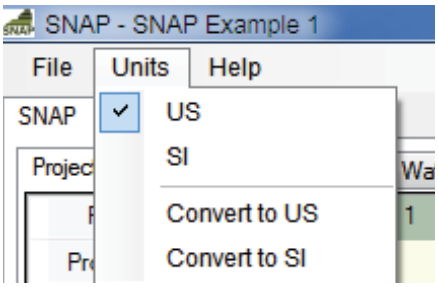


Figure 8. Screen Shot. Units menu items.

Convert to US and Convert to SI are used when the user has entered data in US units and now wants to see the equivalent problem in SI units. For example, after entering a unit weight of 110 lb/ft^3, when the user selects Convert to SI, this will be converted to 17.28 kN/m^3. The SI units designation in the top part of the menu will then be automatically checked. Please be aware that repeatedly converting back and forth between US and SI units will result in slight round-off errors.

Help Menu Items

On the *Help* menu, select *Topics* to open the Help file's *Table of Contents*.

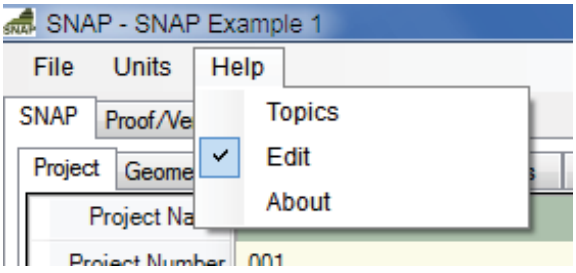


Figure 9. Screen Shot. Help menu items.

The *Help* function is navigated by clicking on links in the *Table of Contents* listing, and clicking on *Return to Table of Contents* and other links within each Help section. No Search function is currently available. To hide *Help*, drag the frame all the way to the right side of your screen (Figure 10)

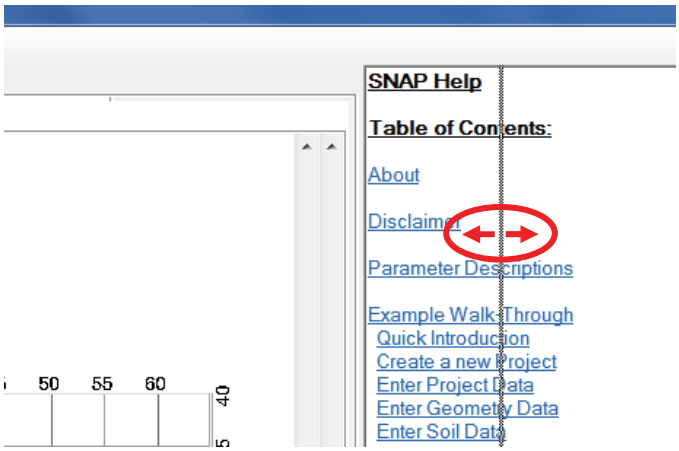


Figure 10. Screen Shot. Show/hide the Help frame.

At any time, selecting *Help* → *About* from the main menu provides version information.

Toolbar

The toolbar at the top of the screen (Figure 11) gives access to common menu commands, including:

- File →New Input File
- File →Open
- File →Save
- File →Save As
- Help →Help Topics

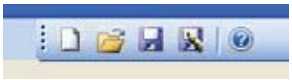


Figure 11. Screen Shot. Toolbar.

Tabs and Option Selection

Input parameters and output results in SNAP are organized into a series of tabs and sub-tabs. These tabs are used for organizing inputs and outputs (*outputs* are shown *shaded in green*). In addition to the tabs, some options can be changed by selecting radio buttons within the tabs (Figure 12). For example, under the *Wall Facing tab*, the user must select either *Shotcrete* or *Cast-in-Place* facing type. When *Shotcrete* is selected, two sub-tabs appear listing the inputs and outputs for that facing type. When *Cast-in-Place* is selected, two sub-tabs appear listing the inputs and outputs for the cast-in-place concrete and for the headed stud connection system.

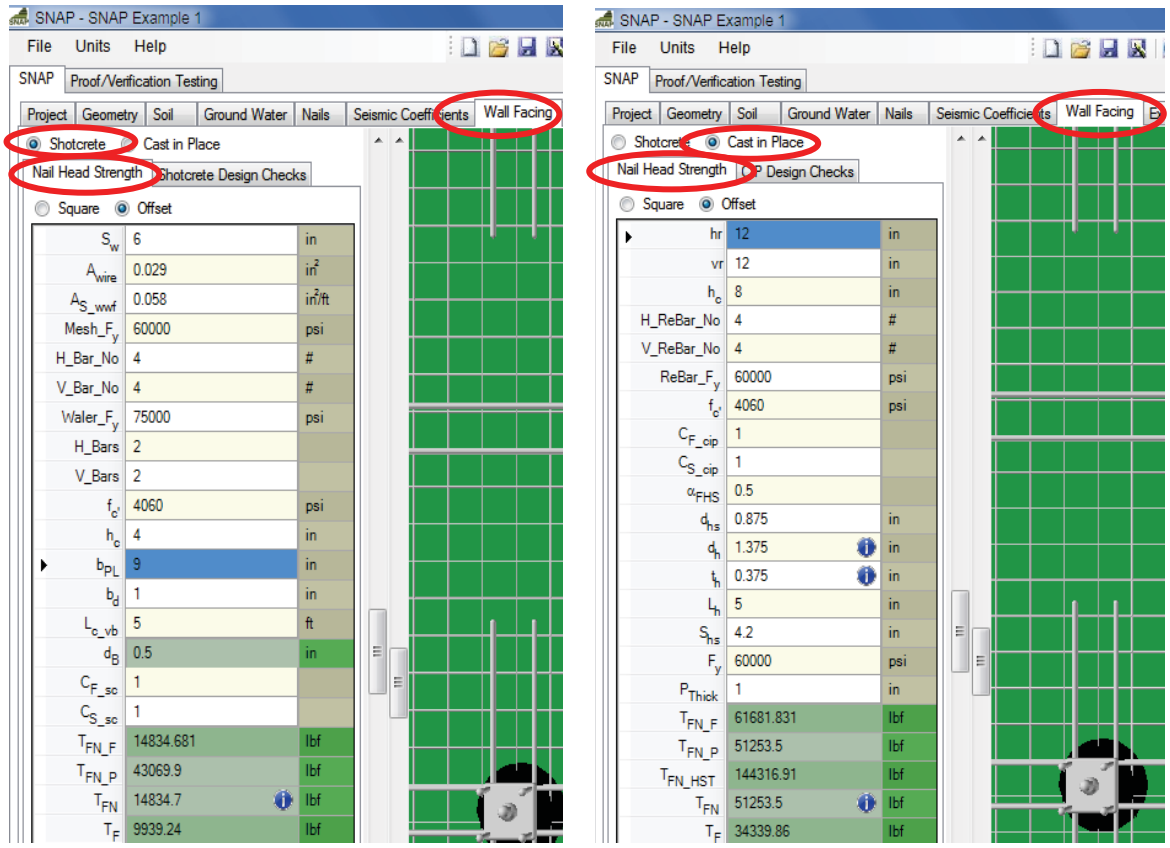


Figure 12. Screen Shot. Selecting tabs, radio buttons, and sub-tabs.

Problem Geometry

In SNAP, the soil nail wall face is on the left, with the global failure occurring from right to left on the screen. The coordinate system in SNAP is 3-dimensional so the user can view 3D graphics. However, a 2D view is always available by tilting or spinning the graphical wall representation until it returns to its original position on the screen. In 2D, the X-axis is along the bottom of the wall, and the Z axis is the vertical axis (Figure 13). The toe of the wall (at the ground surface) is always located at the origin point, (X, Z) = (0,0). Problem geometry is therefore entered in X,Z coordinates. The Y-axis forms the base of the wall in the 3D view; no problem geometry is entered for the Y-axis. See the Graphics section on page 24 for more information.

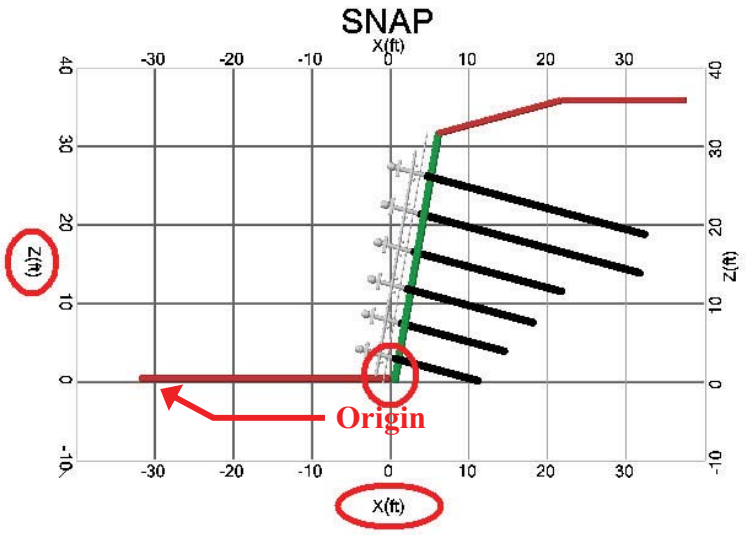


Figure 13. Schematic. Problem geometry in SNAP.

Additional Navigation Information

Many input parameters in SNAP are shown with a mathematical variable in the left column. When the mouse is placed over the box with the variable, a more detailed description of what the variable stands for will appear after a few seconds:

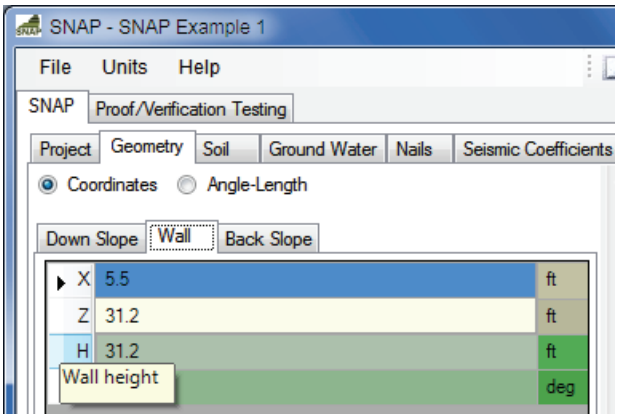


Figure 14. Screen Shot. Hovering over a variable will show its description.

Additionally there is a c*omplete list of parameter descriptions* used in SNAP under *Parameter Descriptions* in the Help section.

When more information is available about one of the output results, or a serviceability check does not pass minimum FHWA criteria, an icon will appear to the right of that result. This icon may be a blue "information" bubble or a yellow "caution" icon:

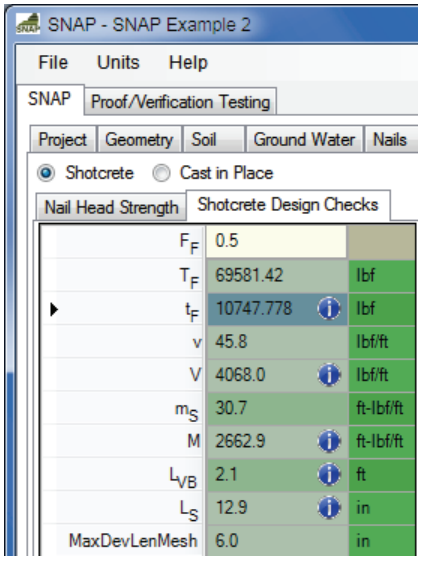


Figure 15. Screen Shot. Blue icons display additional information.

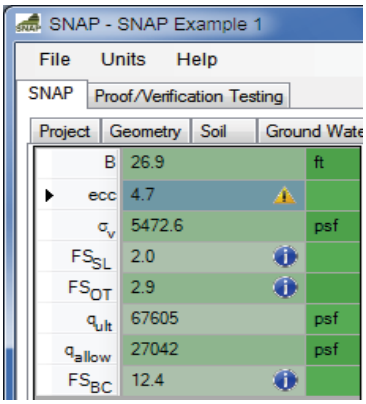


Figure 16. Screen Shot. Yellow icons display warnings for Factors of Safety or serviceability.

PROGRAM EXECUTION

Quick Introduction

Click on the desktop icon to start SNAP. The program will take several minutes to start up. A "splash screen" is displayed during program initialization each time the program runs; a "Loading" progress indicator is shown at the bottom:

Figure 17. Screen Shot. Splash screen shown on startup.

The program loads showing the *Project tab*. For an immediate example of how the program looks and works, select "Example 1" from the File menu for a sample data set like that shown in 8. This example is discussed in further detail in Chapter 4.

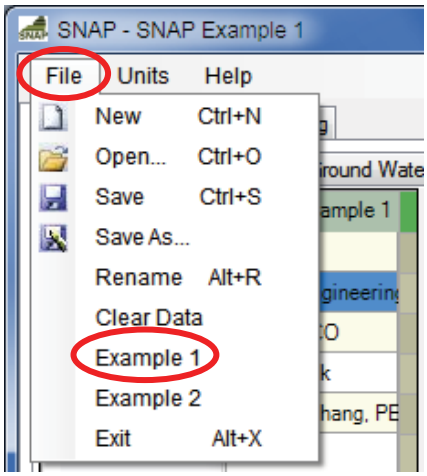


Figure 18. Screen Shot. Select "Example 1" to see how the program works using sample data.

You can now go through each tab to see what typical inputs and outputs might be. Select the *Report tab* to generate a sample report (Figure 19). Please wait until the report generation is complete. This may require up to a minute. A progress indicator will be displayed at the bottom of the screen. After clicking a different tab and then clicking the *Report tab* again, the program will re-generate the report, assuming some inputs or outputs may have changed.

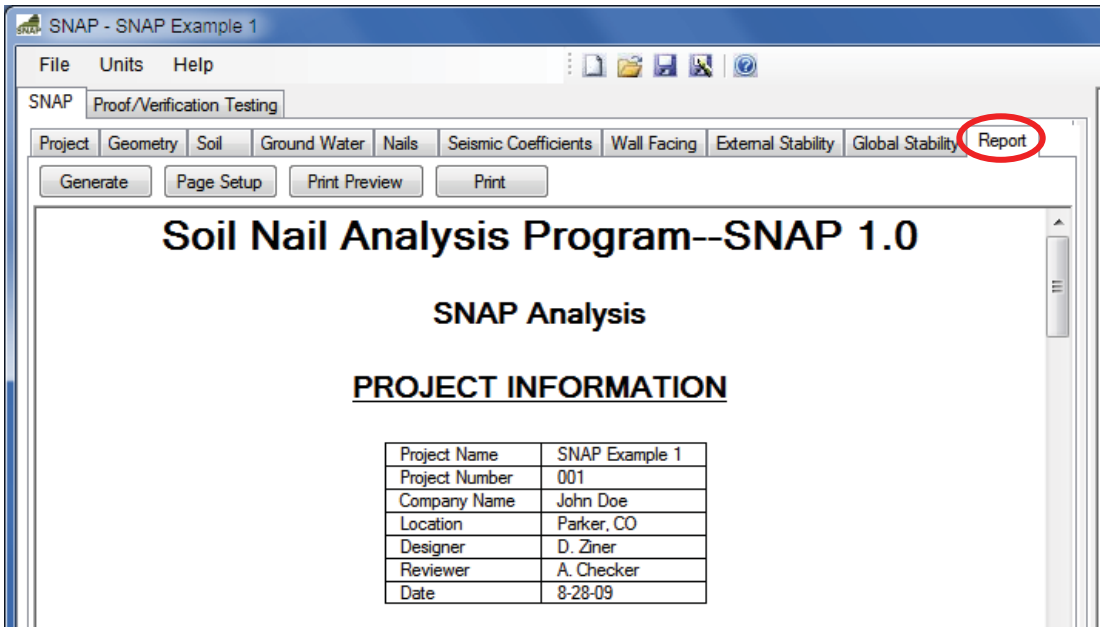


Figure 19. Screen Shot. Generate a sample report by clicking on the "Report" tab.

Create a New Project

To start from scratch and create a new project file, Select *File* → *New*:

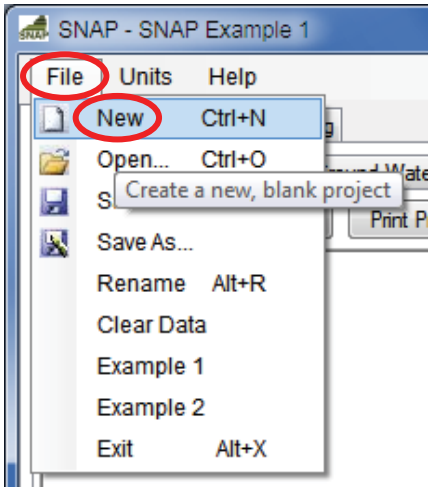


Figure 20. Screen Shot. Create a new project file from scratch.

You can browse to the location where you would like your new project to be stored, or just click on the default SNAP folder (located where you installed SNAP), and select *Make New Folder* to create a new project.

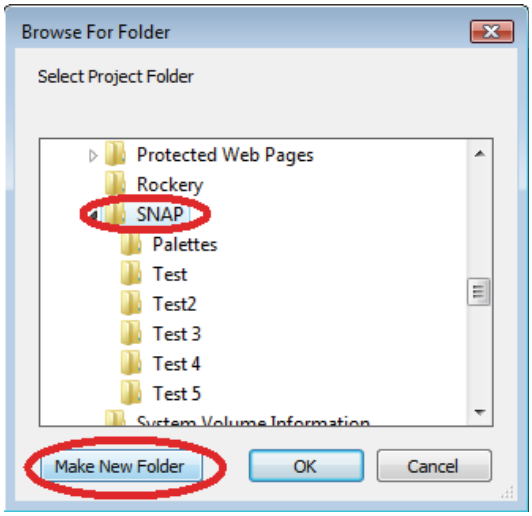


Figure 21. Screen Shot. Select "Make New Folder" to create a new project.

A new folder will appear:

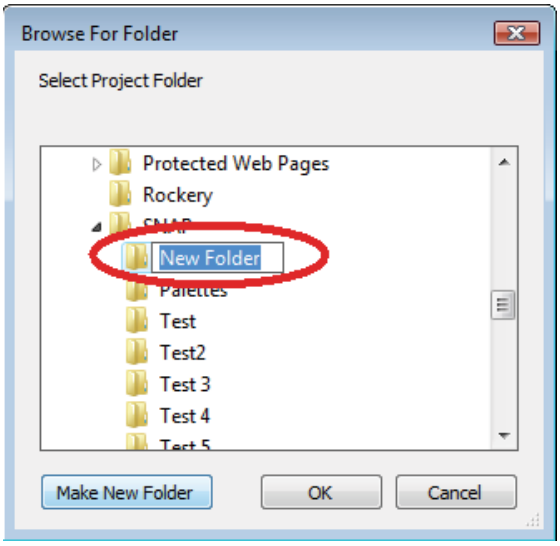


Figure 22. Screen Shot. A new project folder, ready to be renamed.

Type in a new project name, such as Rocky Mountain National Park, and click OK:

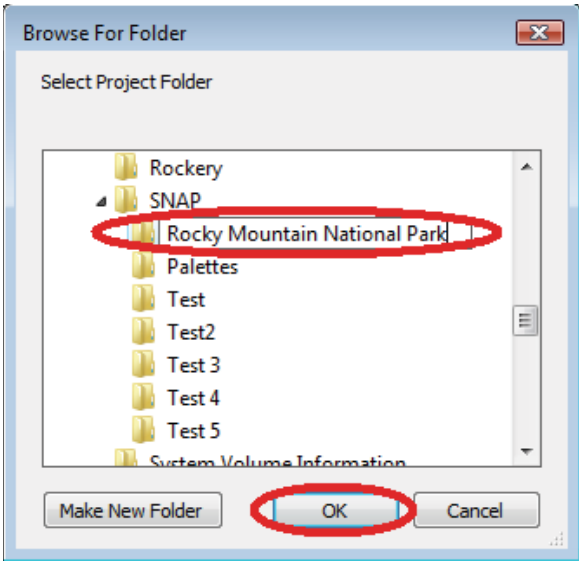


Figure 23. Screen Shot. Type a new name for your new project.

Now you can begin filling in the input data for your new project.

GRAPHICS

Summary of Graphical Presentation

SNAP displays the soil nail wall in three dimensions, but all analyses are done in two dimensions. Display capabilities can be useful for producing reports and presentations. Figure 24 summarizes how the various scroll bars surrounding the display area can be used to manipulate the image and see all aspects of a soil nail wall. The axes will automatically adjust as the image is manipulated. You can always go back to a 2D display by moving the Tilt and Spin scroll bars back to their original positions in the center.

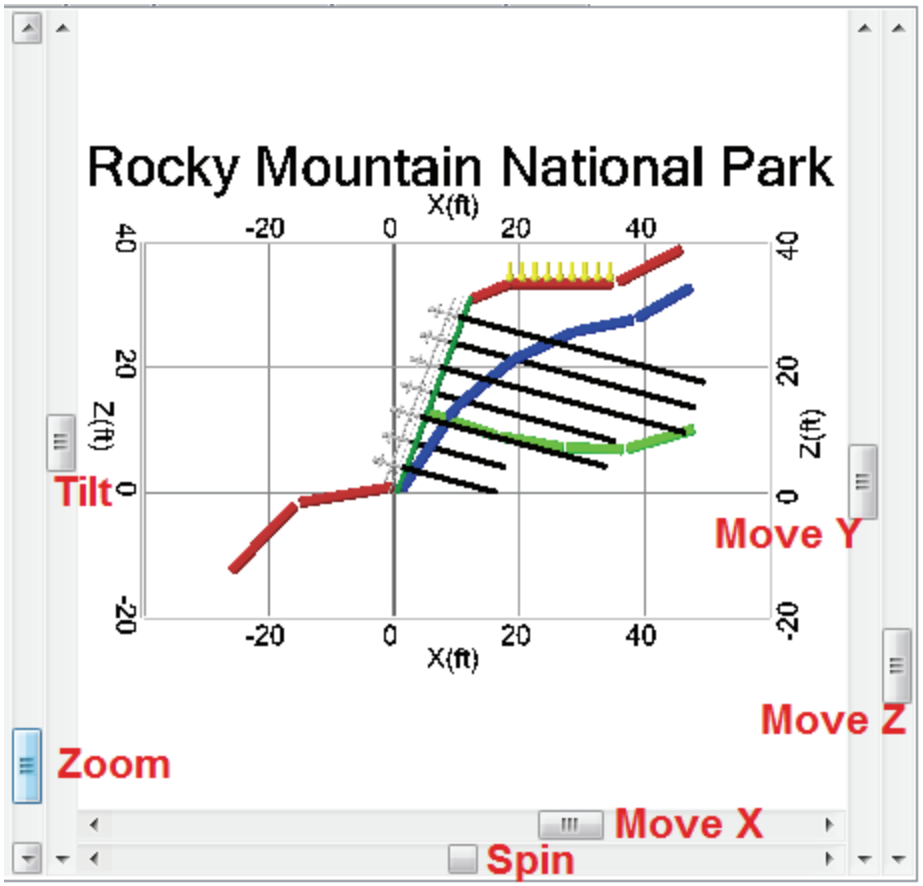


Figure 24. Screen Shot. Six scroll bars surrounding the display control the zoom, pan, tilt, and spin.

Zoom enlarges the image on your screen:

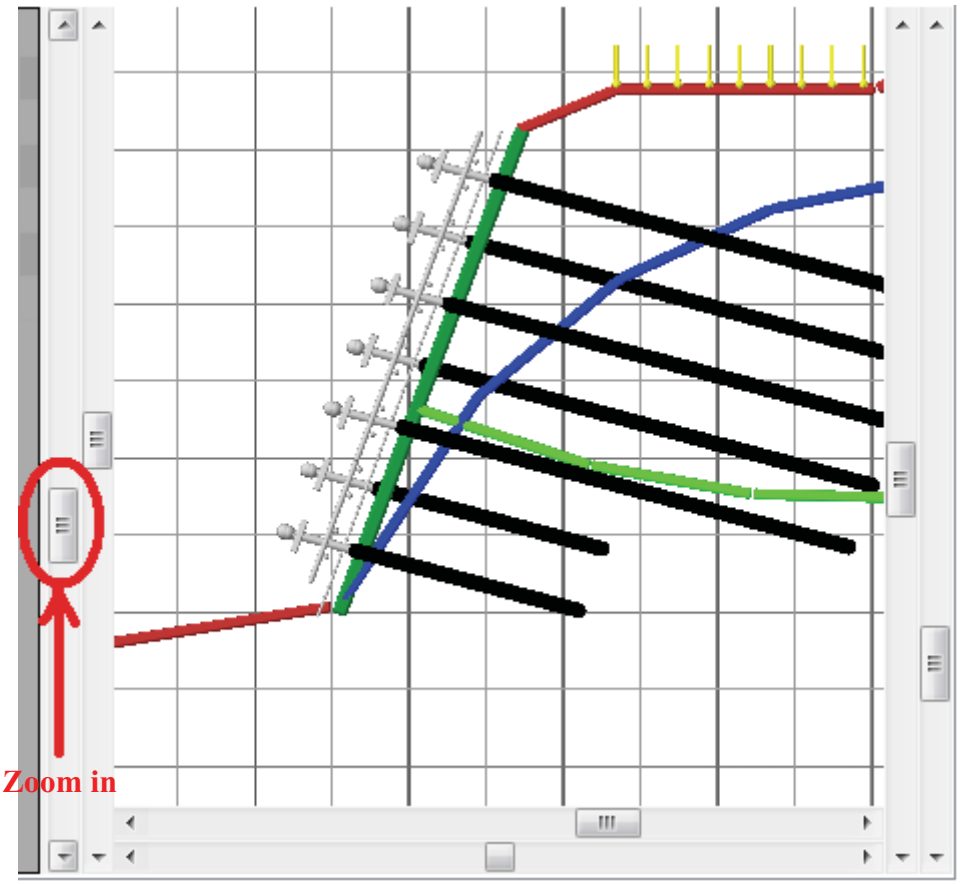


Figure 25. Screen Shot. Zoom in to see the problem geometry more easily.

Tilt rotates the image about the X-Axis:

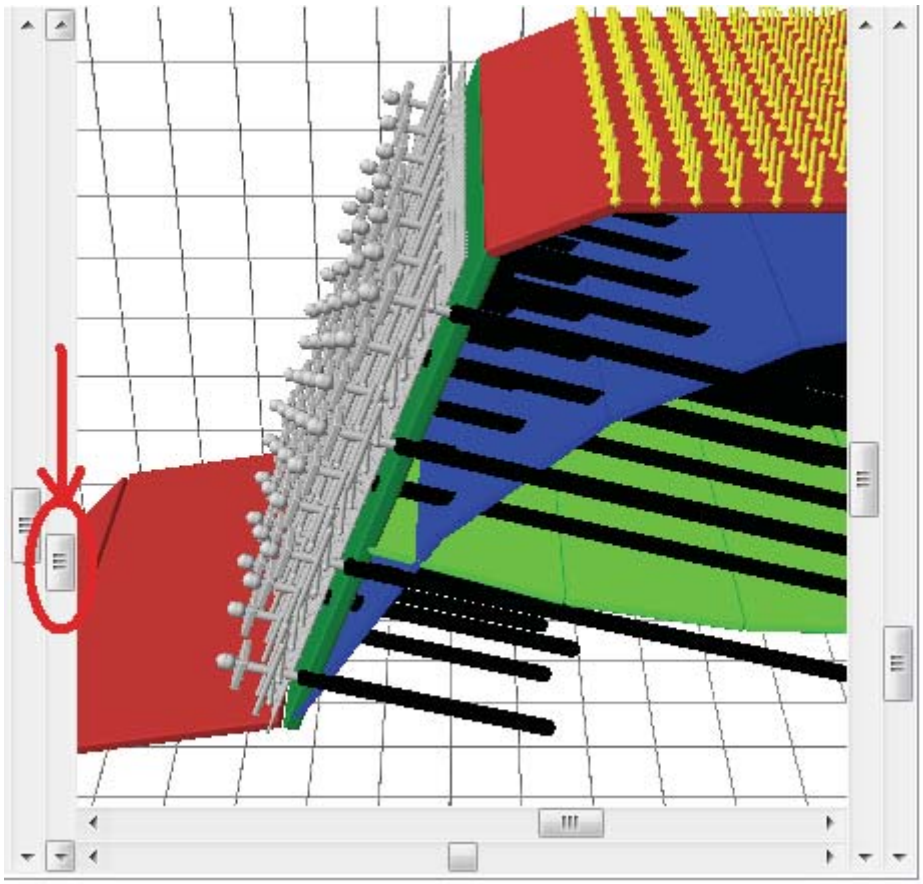


Figure 26. Screen Shot. Tilt will show the ground surface above the wall, or the view from below the wall.

Spin rotates the image about the Z-Axis:

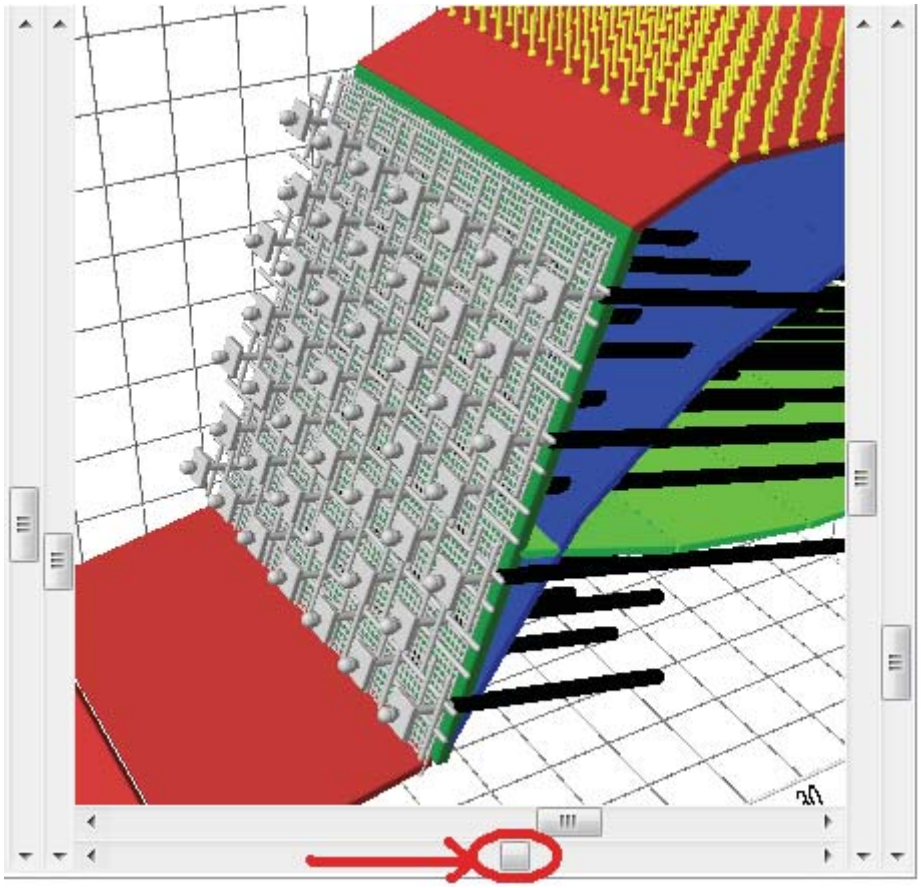


Figure 27. Screen Shot. You can "spin" the image to see the wall facing or view the stability analysis from left to right.

"Move X," "Move Y," and "Move Z" translate the image along the corresponding axis, without tilting, zooming, or spinning. This is similar to Pan commands in other programs (e.g. AutoCAD).

INPUT TABS

Project

The *Project tab* contains basic information about the project you are working on, such as the Name, Number, and Location. When the Report is generated, this information will be displayed on every page.

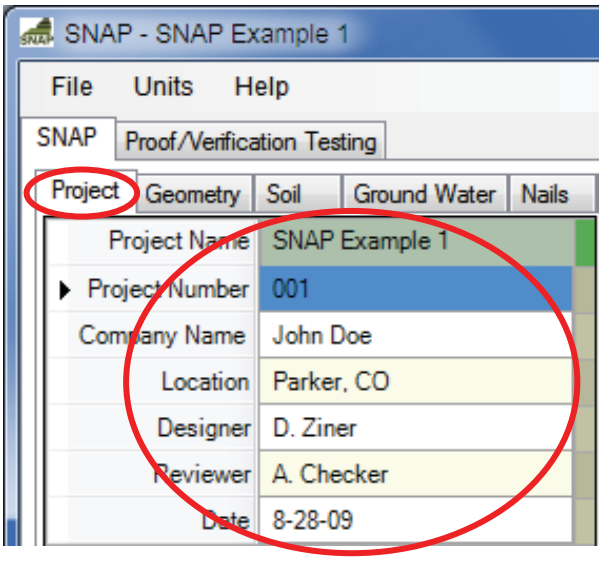


Figure 28. Screen Shot. Enter basic information about your problem on the Project tab.

Select the *Geometry tab* to enter data for the wall and backslope. Hold the mouse over any variable to see a description of that input parameter, such as *Wall height* for H (there is also a list of parameter descriptions used in SNAP under *Parameter Descriptions* in the Help section).

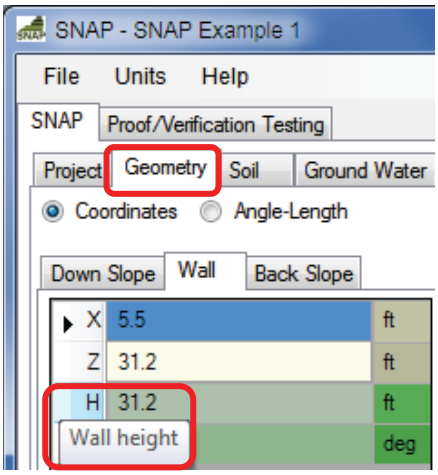


Figure 29. Screen Shot. Hold the mouse pointer over a variable to see its description.

The *Geometry tab* includes three sub-tabs: *Down Slope, Wall,* and *Back Slope*. For each of these geometry segments, the user must select one of two data entry methods: point-by-point using X,Z coordinates *(Coordinates* radio button) or by entering the horizontal distance and angle from horizontal for each segment (*Angle-Length* radio button (Figure 31). When *Coordinates* are chosen, the program will automatically fill in the *Angle-Length* numbers, and vice-versa. For any geometry segment, points may also be added by clicking in the display area at the location a point is desired, or deleted by right-clicking on the yellow dot at that point. Points may also be moved by clicking and dragging them around the display area.

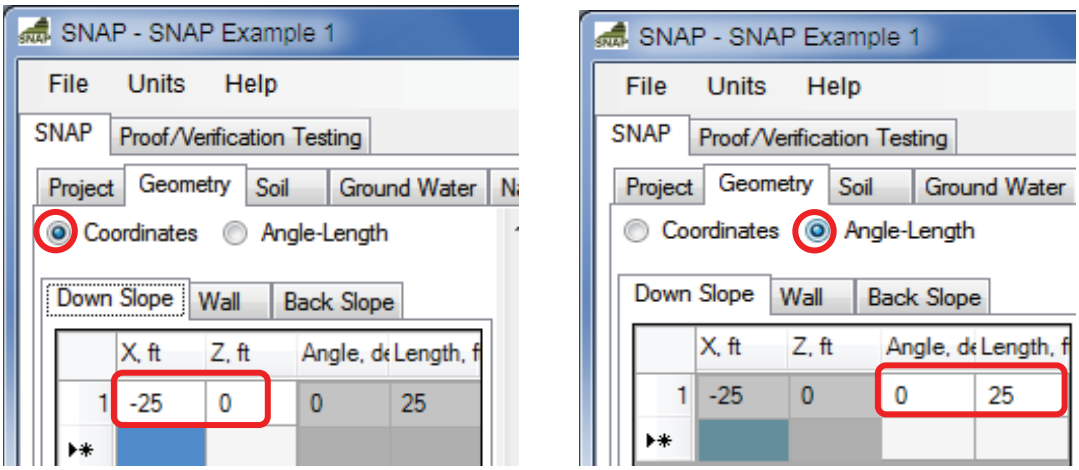


Figure 30. Screen Shot. The problem geometry can be entered using X,Z coordinates or a horizontal distance and angle from horizontal.

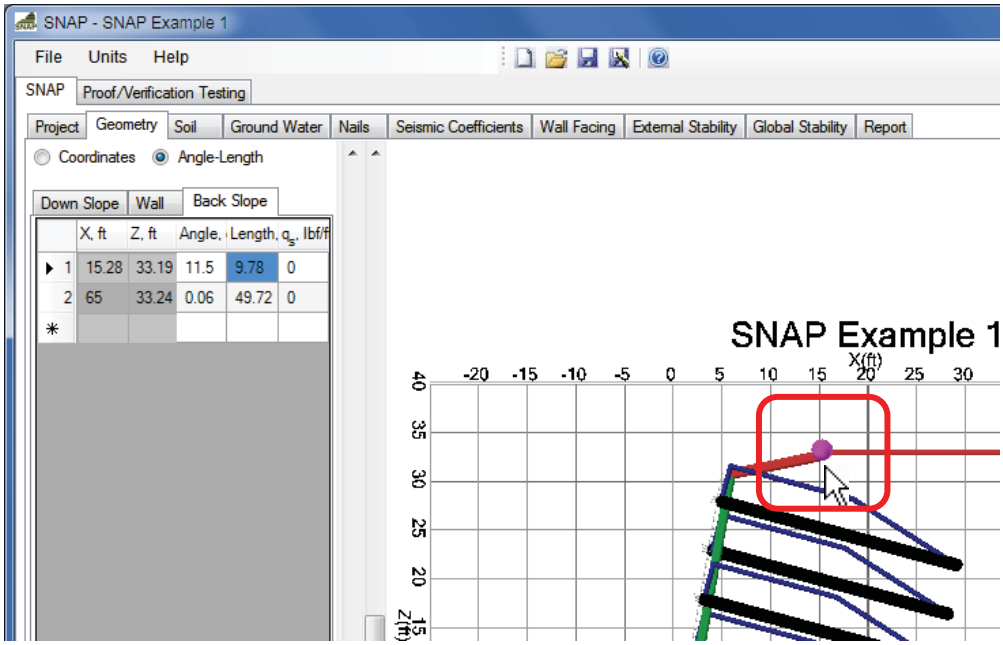


Figure 31. Screen Shot. You can also click and drag on the pink circles to adjust the problem geometry.

Complex slope geometry may be added in this way; however, only single-tier walls are available.

The program also allows a surcharge load to be specified for any ground segment behind the wall (in the back slope). The surcharge is displayed graphically by yellow arrows:

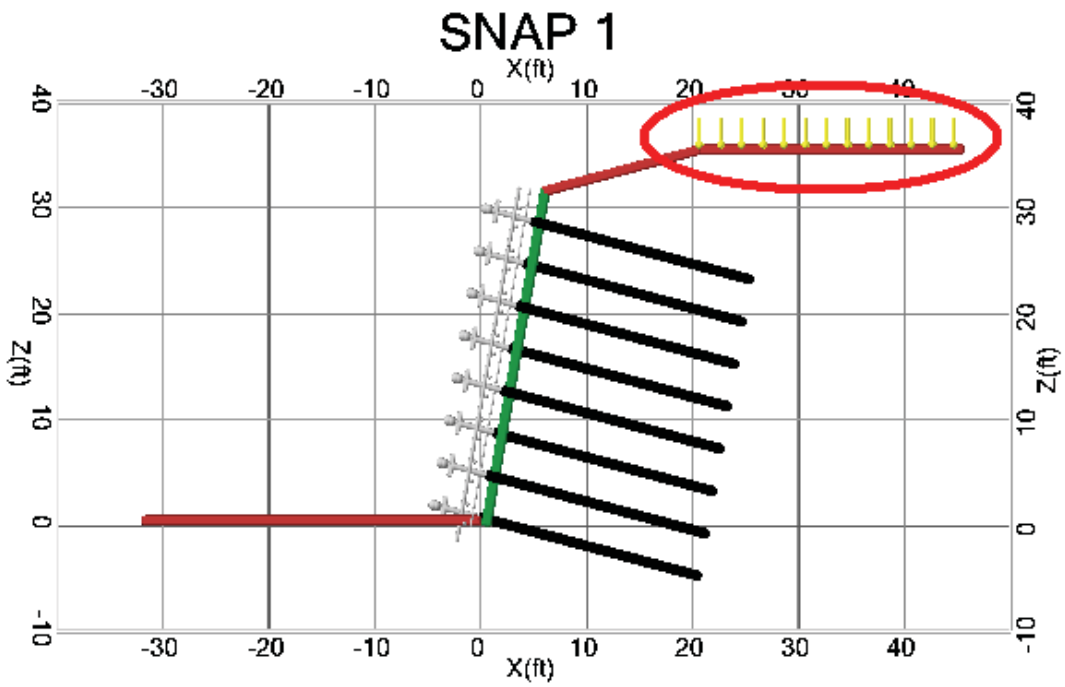


Figure 32. Screen Shot. Surcharge loading on the top of the wall is shown by yellow arrows.

Soil Layers

Select the *Soil tab* to enter soil strength data, pullout resistance (grout-ground bond) data, and bearing capacity factors.

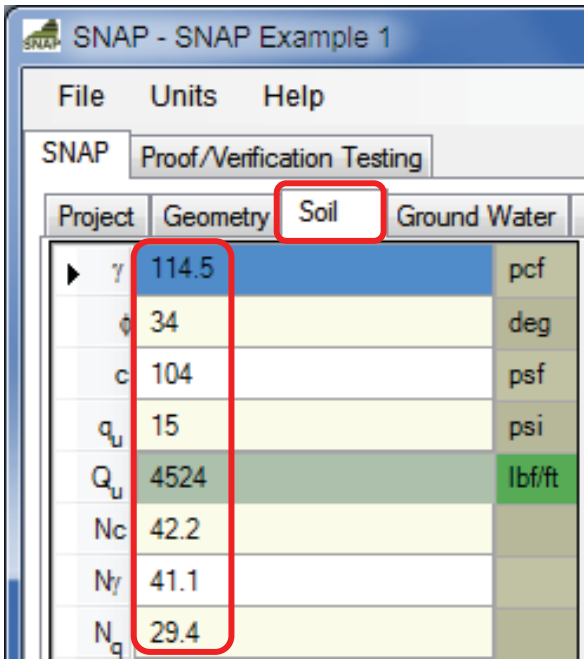


Figure 33. Screen Shot. Enter soil strength information, including pullout strength, on the Soil tab.

The ability to model *only one soil layer* is provided in this version of the program. Bearing capacity factors are entered by the user to allow for reductions due to an inclined toe slope, if required. Q_u is the ultimate pullout resistance *per unit of nail length*, and is calculated *based on the hole diameter entered* on the *Nails tab*.

Groundwater Data

Points specifying a phreatic surface may be entered by selecting the *Groundwater tab*:

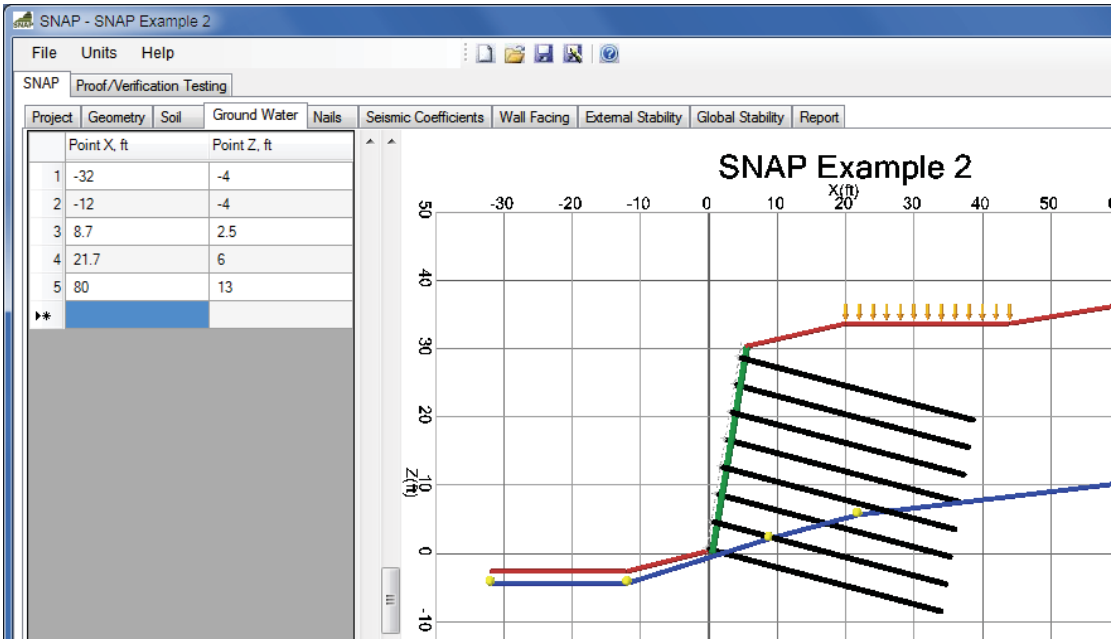


Figure 34. Screen Shot. Enter phreatic surface information on the Groundwater tab.

Points on the phreatic surface may be added either by entering X, Z coordinates into the table, or by clicking within the display area. Groundwater is not used in external stability or facing (internal) stability; it is used only in global stability.

Nail Data

Nail geometry and strength information is entered on the *Nails tab*. Nail lengths and vertical spacing can be either uniform or non-uniform, by selecting the radio button next to *Uniform* of *Non-Uniform*. When *Non-Uniform* is selected, only the nail lengths and vertical spacing can be non-uniform; other nail properties will still be uniform throughout the wall.

For both uniform and non-uniform nail geometries, a *Properties tab* allows the user to enter general data about the nails. This includes the nail length (for uniform nails only), horizontal nail spacing, vertical nail spacing (for uniform nails only), nail inclination, drill hole diameter, nail bar size, nail bar yield strength, nail bar shear strength, cantilever distance between the top of the wall and the top nail, and the strength factors for nail pullout, tendon tensile failure, and head strength. Both nail bar cross-sectional area and diameter must be entered, which *allows for the use of hollow-bar nails* in all subsequent calculations.

Please note: nail length in SNAP is defined from the back of the shotcrete facing to the end of the steel nail tendon, for both shotcrete and cast-in-place facing types. Nail length is measured in the direction of the nail inclination.

In the display area, the variation of allowable nail bar load along the length of the nail is shown as a blue line just above each nail (similar to Figure 2 in Chapter 1). Depending on the location, this line may correspond to the allowable nail head strength, the allowable nail bar tensile strength, or a reduction of the tensile strength based on the allowable pullout strength between the grout and the soil. This line is essentially a small graph, based on the nail and soil properties entered on the *Soil, Nail*, and *Wall Facing* tabs. (The nail head strength will be zero until wall facing information is entered on the Wall Facing tab.) When SNAP calculates global stability for the wall, these graphs are used to determine the resisting forces contributed by each nail.

For uniform nail geometry, the user may change the length or inclination of a nail by entering values into the Properties tab, or using the mouse to drag the end point of the top nail (displayed in bright purple) around the display area. The lengths and inclinations of all of the nails will automatically change.

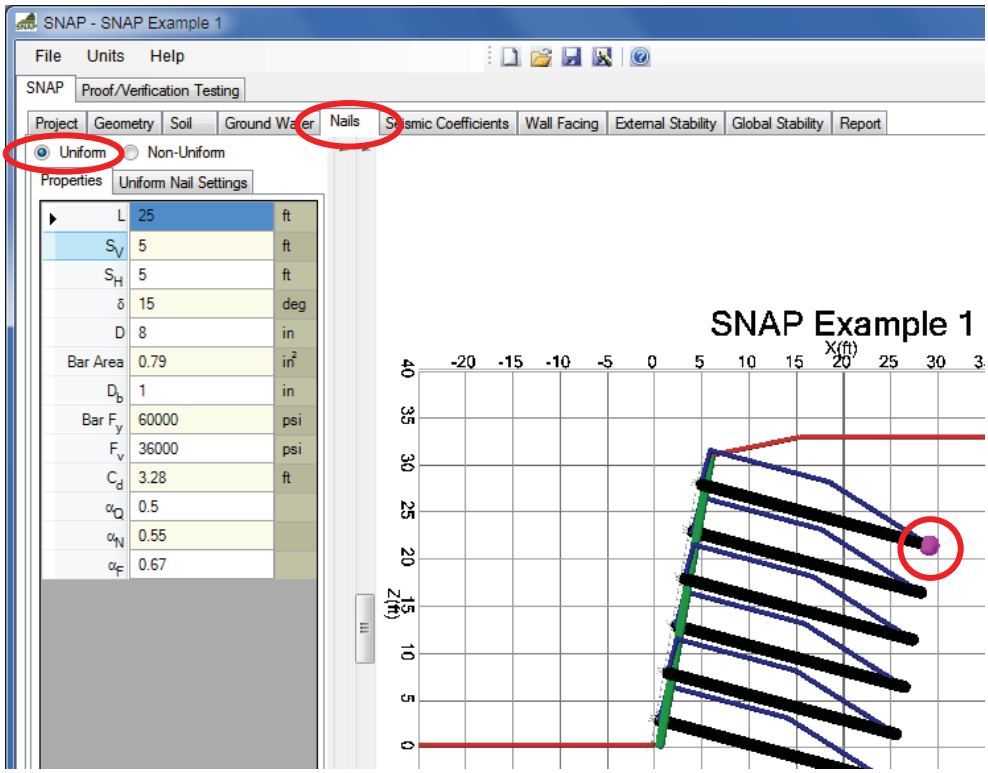


Figure 35. Screen Shot. Change uniform nail lengths by clicking and dragging the top nail around the display area.

For uniform nail geometry, the *Uniform Nail Settings tab* displays the height of each nail above the toe of the wall (the toe of the wall is by default Z = 0). When the user selects a nail in the table on the left, the allowable nail support load variation is summarized in a table in the lower portion of the frame. The nail support load diagrams are also shown in the display area, along the length of each nail.

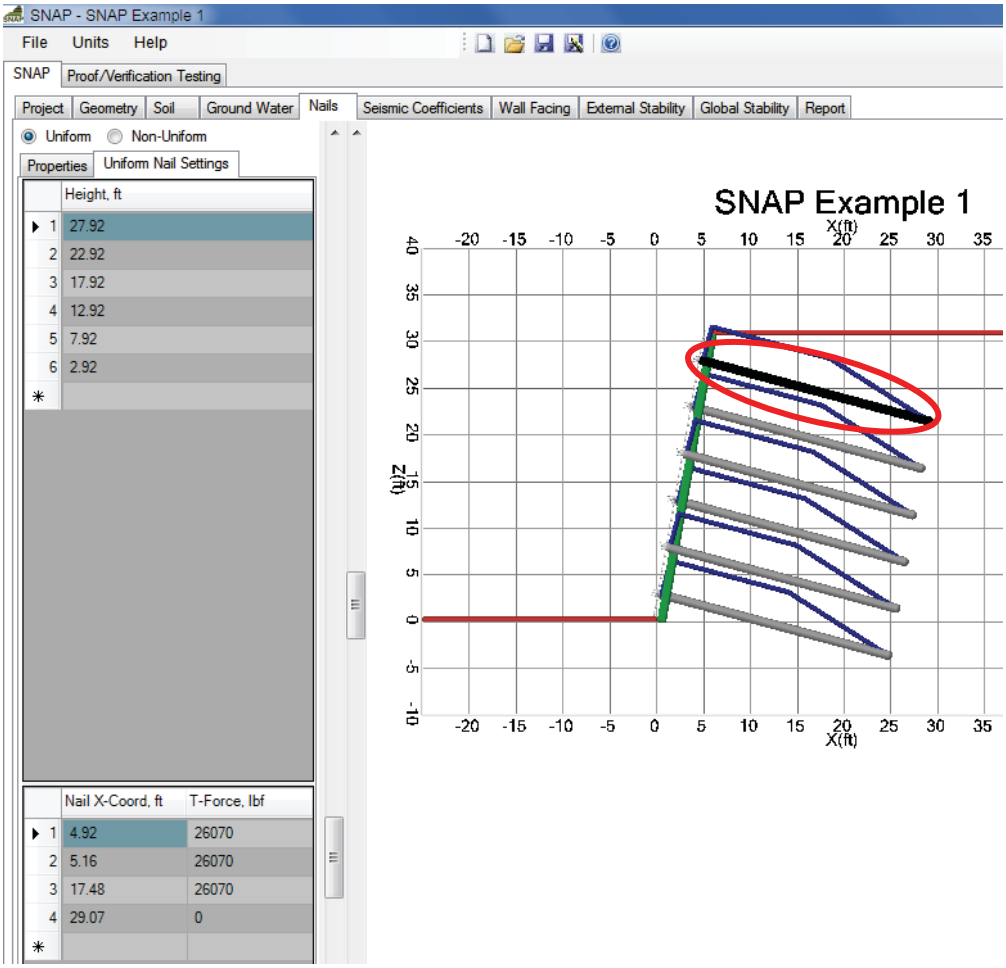


Figure 36. Screen Shot. The "Uniform Nail Settings" tab displays nail heights above the toe of the wall and support load diagrams.

For *non-uniform nail geometry*, the *Nail Settings tab* allows the user to change the length and height above the toe of the wall for each nail (the toe of the wall is by default Z = 0). Individual nail inclination may also be adjusted if a different orientation is required for any row of nails (e.g. in the case of an underground utility in conflict with wall construction). The overall nail inclination value on the Properties tab will show the minimum inclination value from the Nail Settings tab.

All settings values may be entered into the table or the user may click in the display area where the end point of a new nail should go, and a nail will be added. When a nail is selected in the table or when the user hovers over a nail in the display area with the mouse, the nail support load diagram for that nail is summarized in a table in the lower portion of the left frame. The nail support load diagrams are also shown in the display area along each nail.

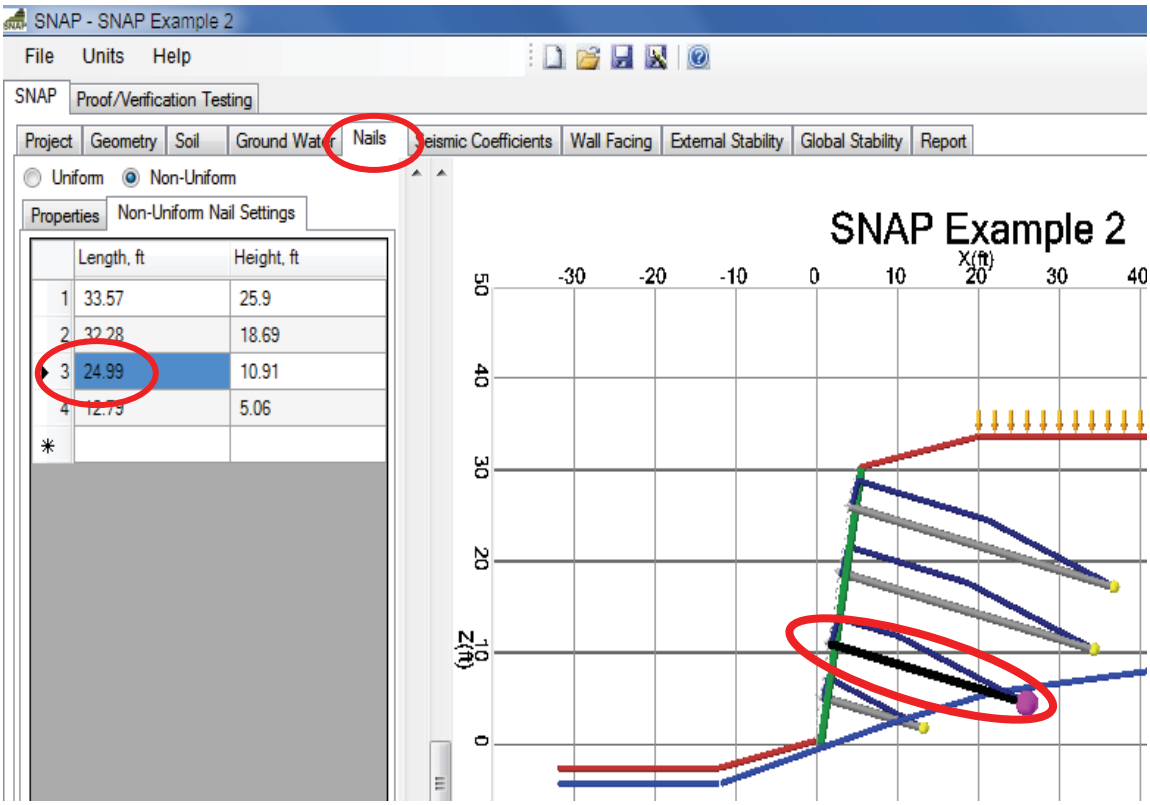


Figure 37. Screen Shot. The "Non-Uniform Nail Settings" tab displays nail lengths, heights, and inclinations, as well as support load diagrams.

Additional Information on Nail Support Load Diagrams

FHWA Publication No. FHWA-SA-96-069R includes a helpful example of a nail support load diagram, reproduced as Figure 2 on page 5 above. This diagram is used to visualize how a soil nail's contribution to global stability varies along the length of the nail. Where a potential slip circle intersects the nail along the nail's length determines how much additional strength will be

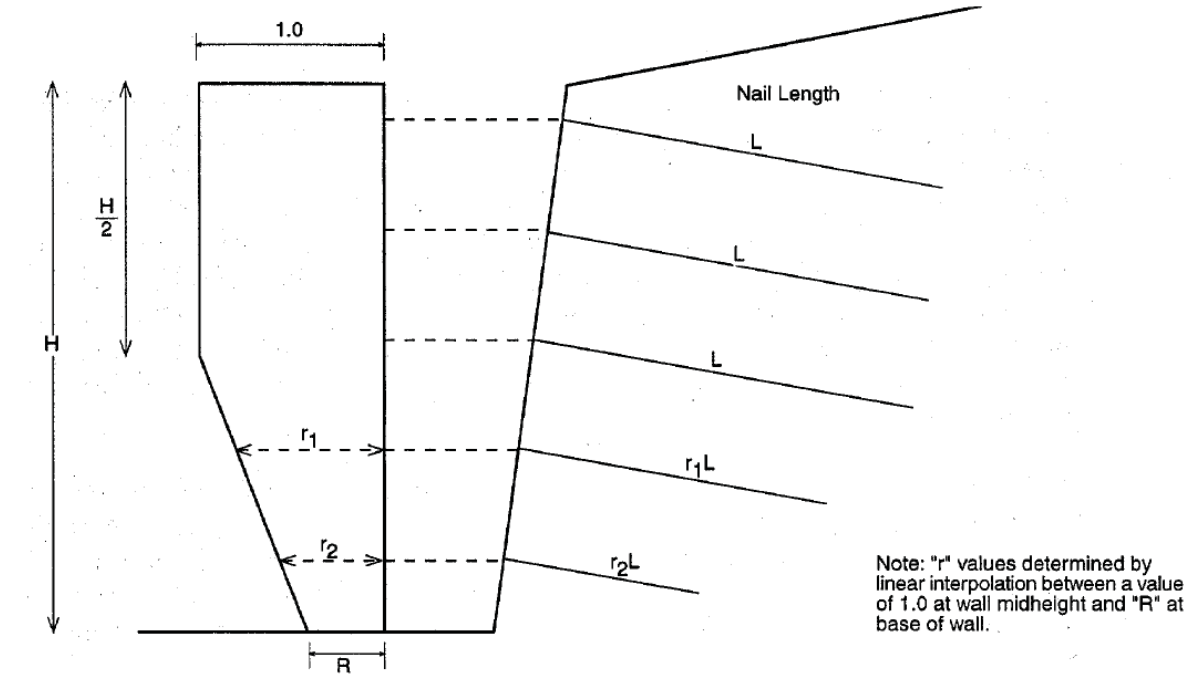
available to resist failure. The closer the intersection is to the front or the back, the more likely the nail is to fail in pullout. If the nail is long enough, then the nail's tendon tensile strength may be the contributing force at locations near the center of the nail tendon, rather than the pullout strength between the soil and the grout around the nail. The nail head also contributes some strength near the front of the nail.

Nail Length Handicapping in SNAP

FHWA-SA-96-069R outlines a procedure for "handicapping" or "shorting" soil nails near the bottom of a wall during design, in order to ensure that adequate nail reinforcement is installed in the upper portion of the wall. Performance monitoring of several instrumented soil nail walls has demonstrated that the top-down construction method of soil nail walls generally results in the nails in the upper part of the wall being more critical than the nails in the lower part of the wall in developing resisting loads and controlling wall deformation. If stability calculations overstate the contribution from the lower nails, then this can erroneously specify shorter nails or smaller tendon sizes should be used in the upper part of the wall. This is detrimental and could result in poor wall performance. The procedure given by FHWA (in Section 4.7.1) is summarized in Figure 38 below.

In SNAP, this can be done manually by the user, by using the Non-Uniform Nails feature in the Nails tab. The user can select appropriate lengths to analyze global stability based on artificially shortened nails.

Please note that this design procedure is only for use in designing the wall; it does not indicate that the installed nail pattern should correspond to this pattern. Soil nail walls are normally constructed with uniform nail lengths to simplify cost estimation and construction, although it is possible to install shorter nails in the lower part of the wall if external and global stability requirements are met.



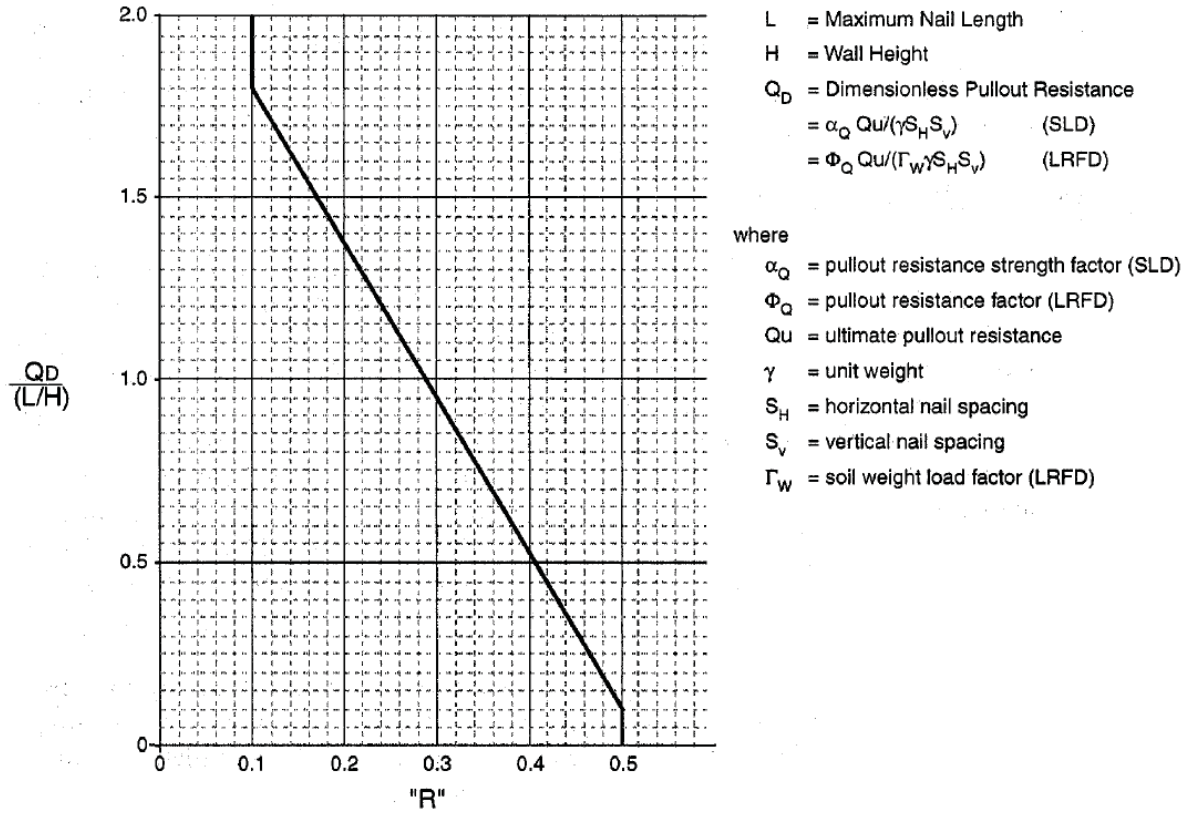


Figure 38. Schematic. SNAP uses the nail handicapping procedure outlined in FHWA-SA-96-069R.

Seismic Data

Seismic effects are ignored when "Include Seismic Loading in Analysis" on the *Seismic Coefficients tab* is not checked:

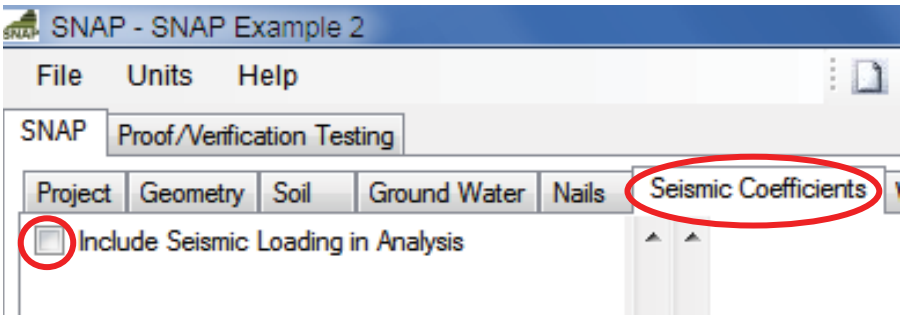


Figure 39. Screen Shot. Un-check this box to do a normal analysis without seismic effects.

To include seismic effects, check the box next to *Include Seismic Loading in Analysis*. Enter a value for the horizontal seismic coefficient K_h, or enter the peak ground acceleration, A, and obtain K_h from the *Calc Kh from A* button.

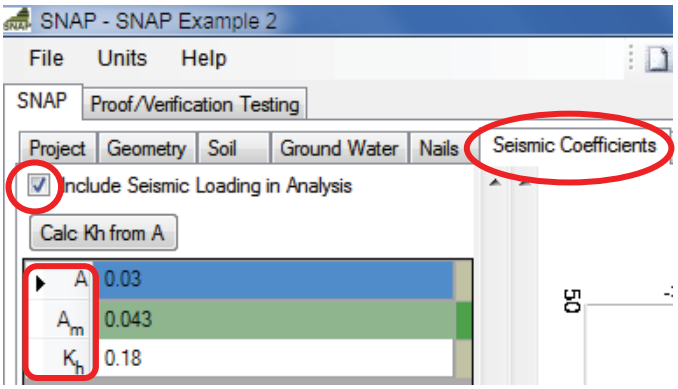


Figure 40. Screen Shot. You can enter two types of seismic coefficients: K_h or Peak Ground Acceleration.

This calculation is based on a tolerable seismically-induced lateral wall movement, as outlined by FHWA-IF-03-017, Section 5.4.5.3. Including seismic loading will affect results for external stability and global stability. For conservative calculations, SNAP always assumes that the vertical seismic coefficient, k_v, is zero, for both external and global stability calculations.

Facing Data

The *Wall Facing tab* provides the user with two options for facing types: Shotcrete and Cast-in-Place. When Cast-in-Place is selected, the strength of any shotcrete facing that would be constructed behind the cast-in-place facing is neglected. FHWA guidelines recommend this since a shotcrete facing is often only designed for a temporary loading condition.

Two common nail spacing patterns can be selected: Offset and Square. This *does not affect any calculations*, and is for display purposes only. Both nail patterns may be selected for either Shotcrete or Cast in Place facing types. An offset pattern is shown in Figure 41.

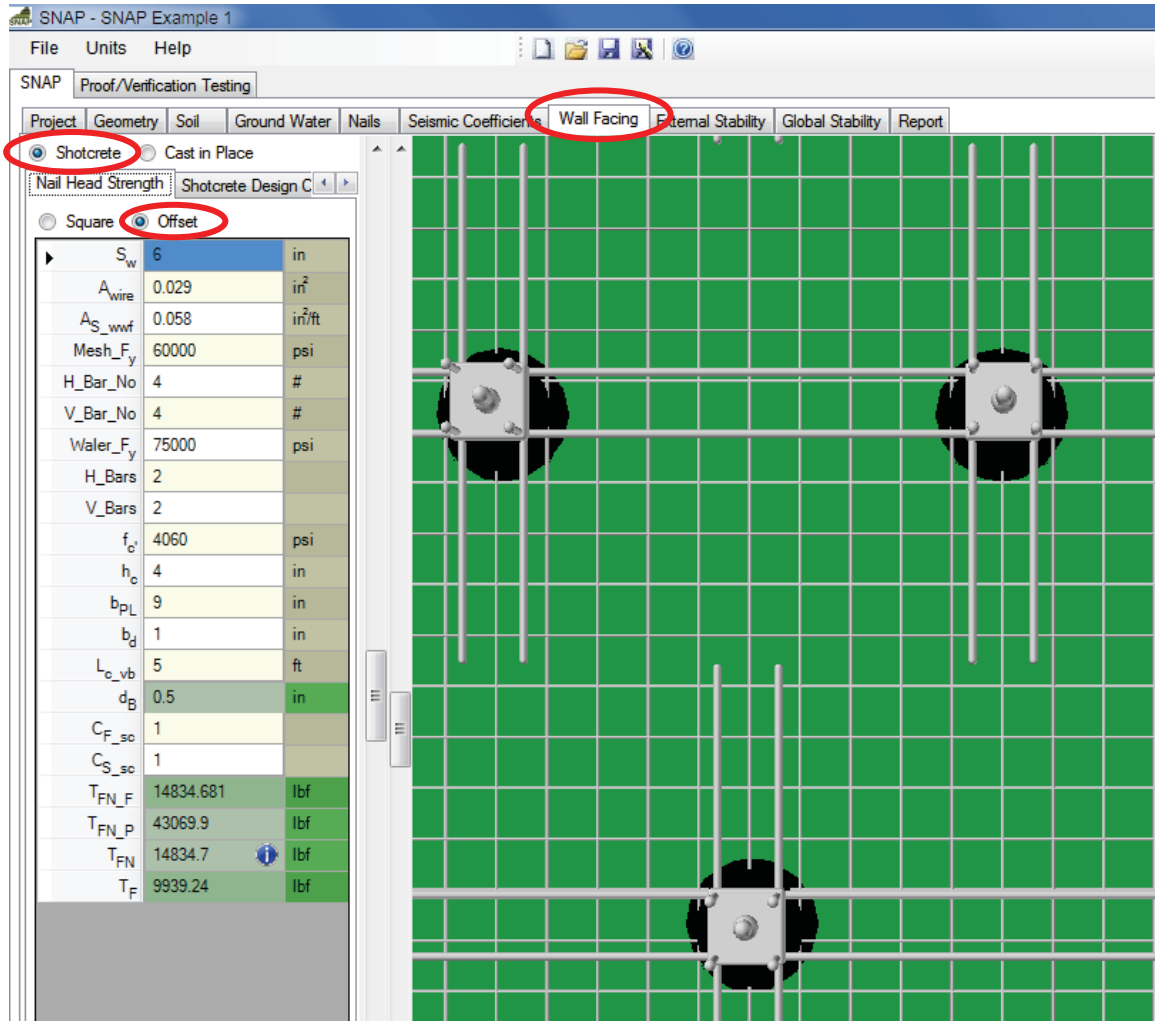


Figure 41. Screen Shot. An "Offset" nail installation pattern is selected on the Wall Facing tab.

Selecting a square pattern results in the following:

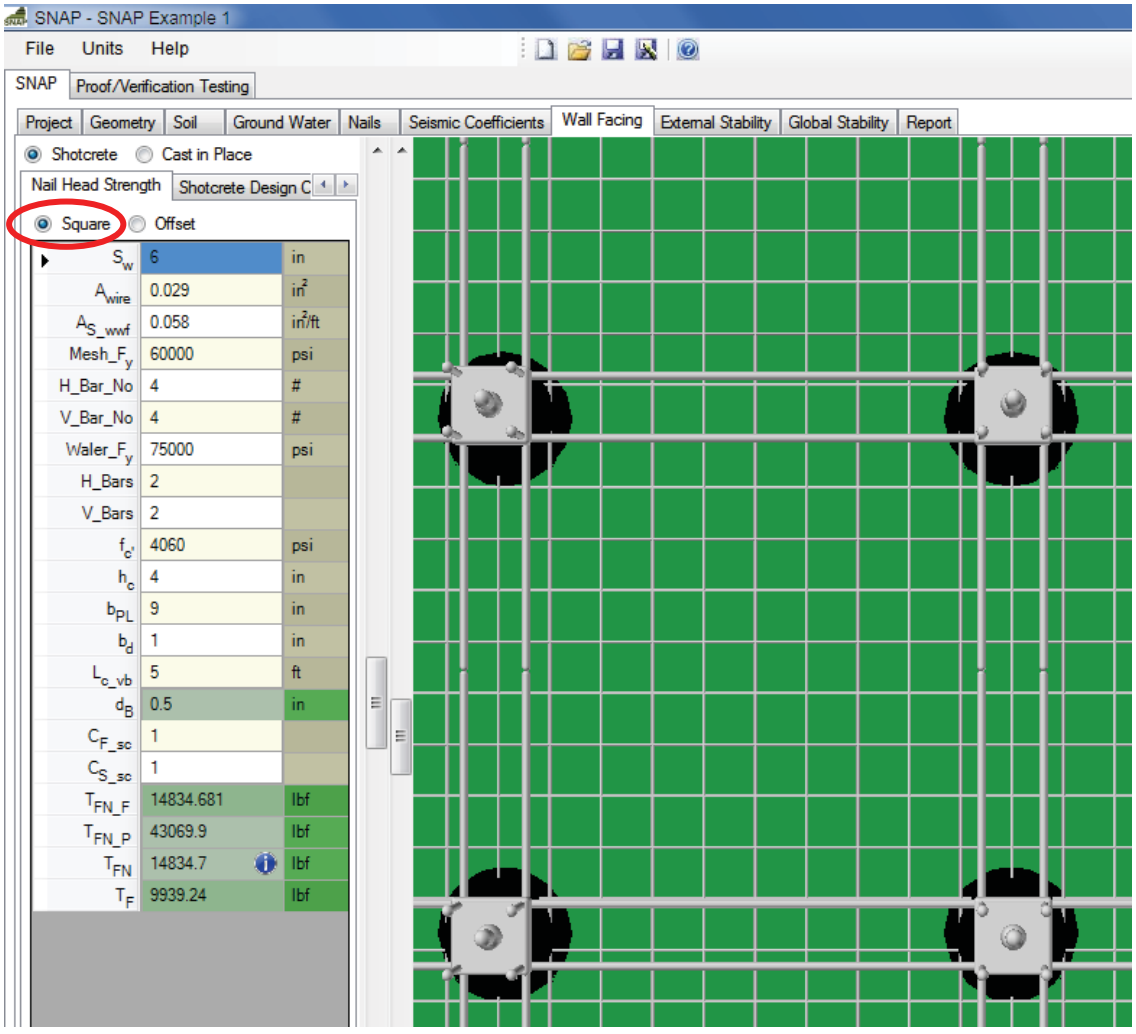


Figure 42. Screen Shot. A "Square" nail installation pattern is selected on the Wall Facing tab.

For a shotcrete facing, the user enters input information about the wire mesh, horizontal waler bars, vertical bearing bars, shotcrete, and bearing plate. SNAP calculates the nominal nail head strength for both punching and flexure, selects the controlling mode, and calculates the allowable nail head load based on this value. All of these are displayed at the bottom of the list.

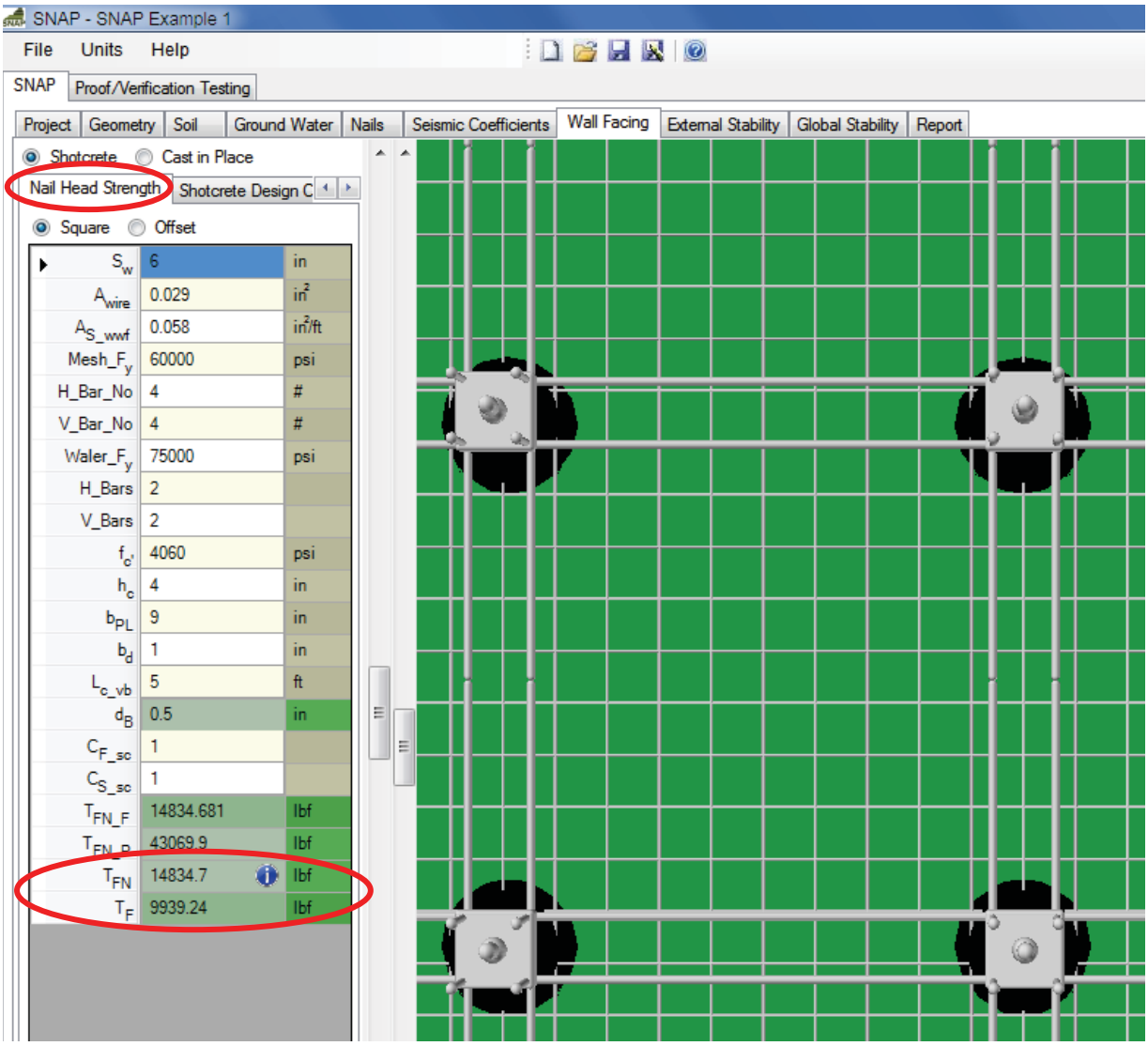


Figure 43. Screen Shot. The nominal nail head strength, T_{FN}, and allowable nail head load, T_F are displayed at the bottom of the list for a shotcrete facing.

Design checks for the shotcrete facing are included in a separate *Shotcrete Design Checks tab*, in the rows with small blue "information" icons. These can be viewed by holding the mouse over the icon for a few seconds:

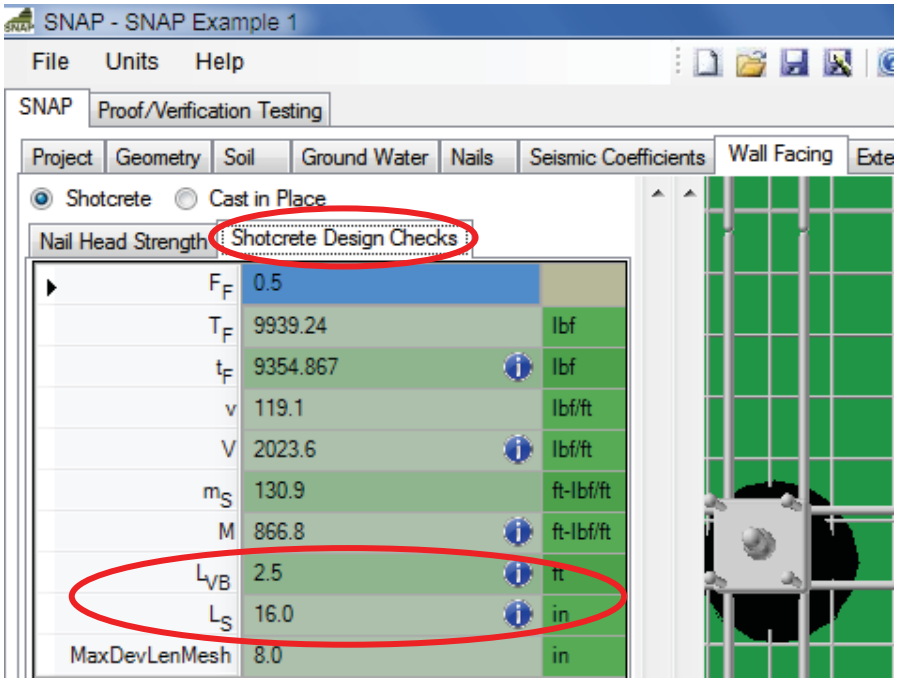


Figure 44. Screen Shot. Design checks for the shotcrete facing are viewed by holding the mouse over the blue icons.

For a cast-in-place concrete facing, the user enters input information about the horizontal and vertical concrete reinforcement, the concrete itself, and the headed-stud connection system between the concrete facing and the shotcrete facing. SNAP calculates the nominal and allowable nail head load and displays it at the bottom of the list under the *Cast-in-Place tab*.

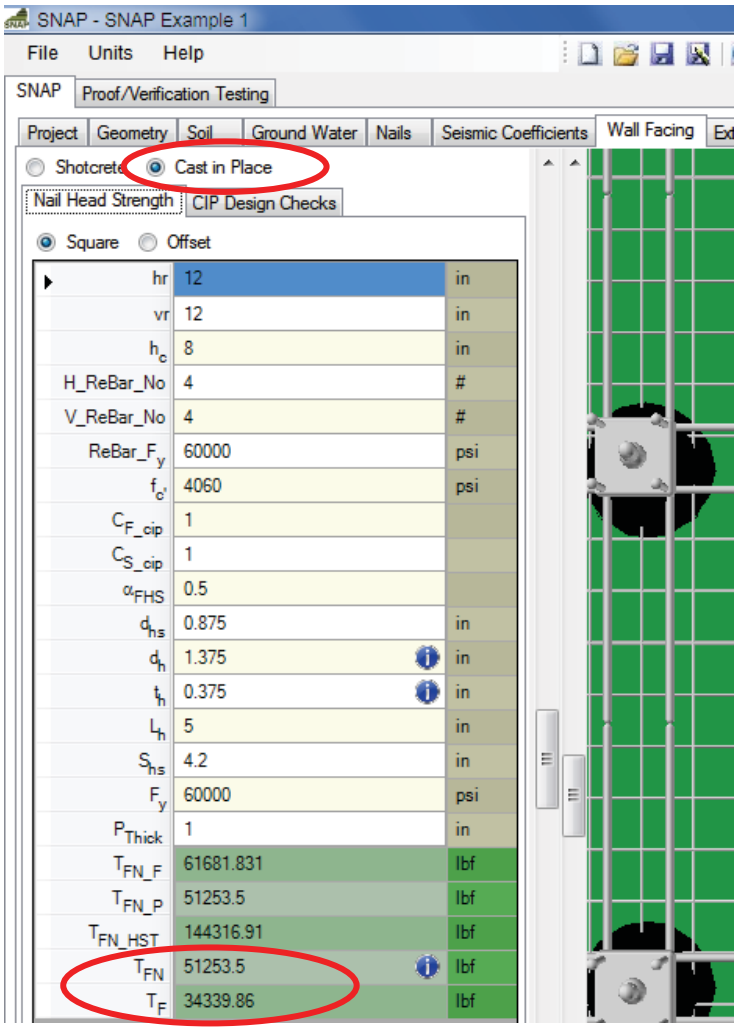


Figure 45. Screen Shot. The nominal nail head strength, T_{FN}, and allowable nail head load, T_F are displayed at the bottom of the list for a cast-in-place facing.

Design checks for a cast-in-place concrete facing are included in a separate *CIP design checks* tab, in the rows with small blue "information" icons. These can be viewed by holding the mouse over the icon for a few seconds:

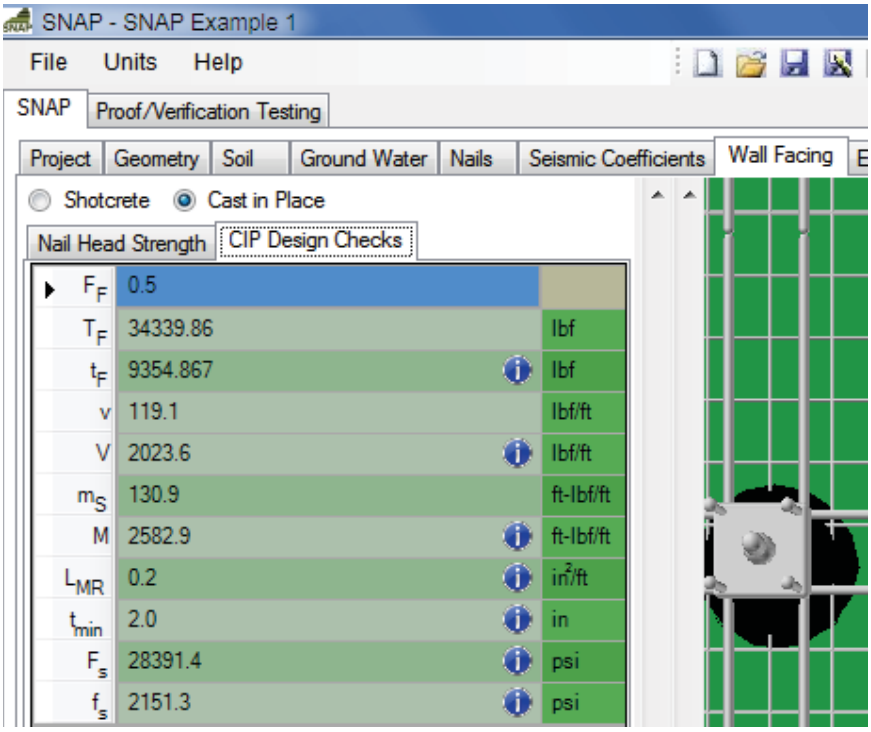


Figure 46. Screen Shot. Design checks for the cast-in-place facing are viewed by holding the mouse over the blue icons