



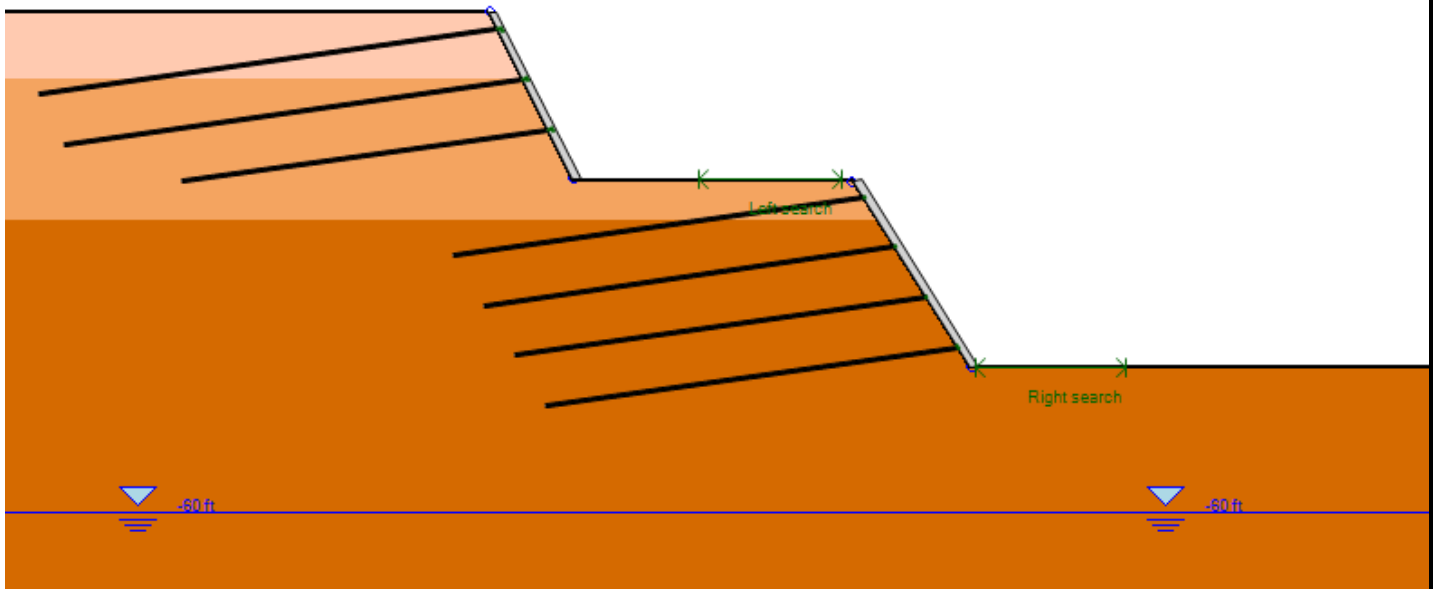
# DEEP EXCAVATION

GEOTECHNICAL SOFTWARE & ENGINEERING

## Stepped Soil Nail Wall Design Example - SnailPlus

Model Wizard – Manual Options: Excavation / Facing And Soil Nails Installation

+ Morgenstern-Price  
Automatic search procedure



SnailPlus  
Soil Nail Wall Design  
Software

Document Version: 1.2.2.5

Released: April 22, 2020

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**INTRODUCTION: SNAILPLUS – SOIL NAIL WALL DESIGN SOFTWARE**

SnailPlus is a powerful software program for the slope stability analysis, and the design and evaluation of soil nail wall systems.

SnailPlus can be used for the calculation of the global stability safety factor, and it can also design all soil nail wall structural members (soil nails, shotcrete facing, head plates)

**Slope Stability Methods:** Bishop, Morgenstern-Price (General Limit Equilibrium), Spencer.

**Shotcrete Facing:** Temporary, Permanent, Two-Stage (Temporary and Permanent in different construction stages).

**Design Conditions:** Temporary Structure, Permanent Structure, Extreme Events (Seismic and High Water).

**Seismic Pressures Methods:** Semirigid, Mononobe-Okabe, Wood, User-Defined.

**Water Pressures Methods:** Hydrostatic, Simplified Flow, Full 2D Flownet Analysis.

**Soil Properties:** User-Defined, Estimation Tools (Test Data), SPT and CPT logs.

**Structural Design:** ACI, FHWA (ASD), FHWA (LRFD).

**Analysis - Combinations:** Allowable Design (ASD), LRFD GEC-7, EUROCODE 7 (ULS).

**Printed Reports:** Reports Exported in PDF and Word.

**Model Creation:** Graphical (Interactive Interface), Model Wizard.

**SnailPlus – Software Capabilities and Examples**

SnailPlus is a robust software for the design of soil nail wall systems. It can locate the most critical slope surfaces, the slope stability FS and it can fully design all structural items (soil nails, head plates, shotcrete facings).

[Click here to learn more: SnailPlus: Features and Examples](#)

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**A. PROJECT DESCRIPTION – MODEL DATA**

In this example we will design a 75 deg slope surface, supported by a soil nail wall (5 rows of #9 bar soil nails, with a 6in permanent shotcrete facing).

Figure: 2D Section Model

Table: Soil Properties and Soil Layer Elevations

Soil Layer Elev. (ft)	Soil (-)	Soil Type (-)	Friction Angle (deg)	Cohesion (psf)	Total Unit Weight (pcf)	Skin Friction (psi)
0	F	Sand (Fill)	30	10	120	17
-8	S1	Medium Sand	34	20	125	22
-25	S2	Dense Sand	36	200	130	28

Table: Shotcrete Facing Properties

Wall Type	Shotcrete Wall
Wall Thickness	6 in
Reinforcement	2 rows / #6 Bars Horizontal And Vertical
Steel Grade	Grade 60
Concrete	3 ksi

Table: Soil Nails and Head Plates Properties

Elevation	Varies (5 rows)
Support Type	1#9 Rebar Soil Nails
Grout Diameter	4 in
Head Plate Section	Rectangular – 10in x 10in
Head Plate Thickness	1.5 in
Steel Grade	Grade 60
Concrete	5 ksi
Horizontal Spacing	6 ft
Vertical Spacing	6 ft

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**B. SNAILPLUS SOFTWARE – SOIL TYPES AND BORINGS**

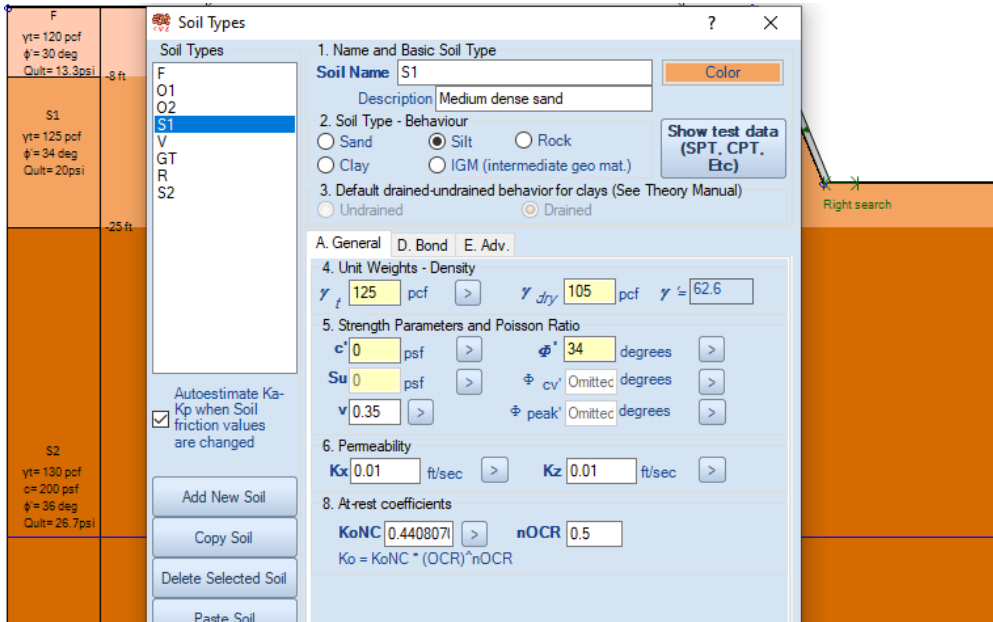


Figure: General soil properties – Sand S1

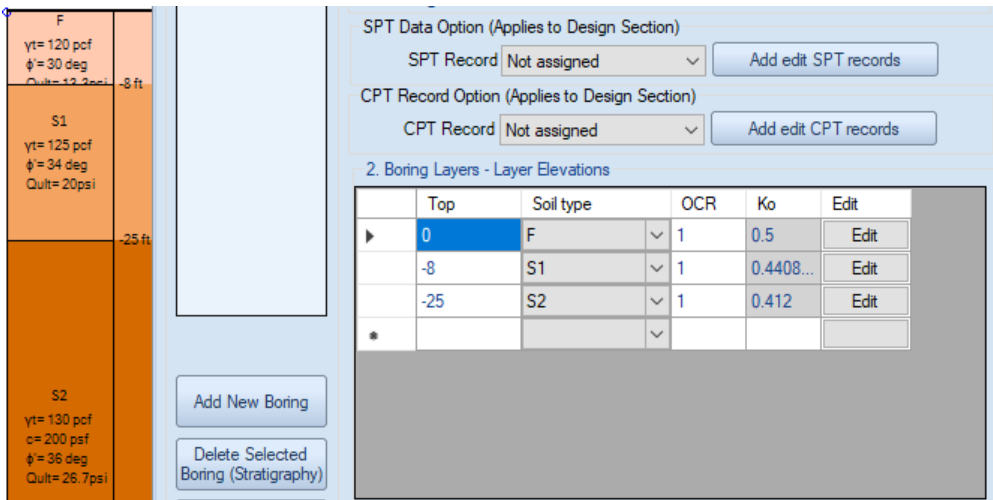


Figure: Soil Layers

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C. SNAILPLUS SOFTWARE – SOIL NAILS AND FACING PROPERTIES

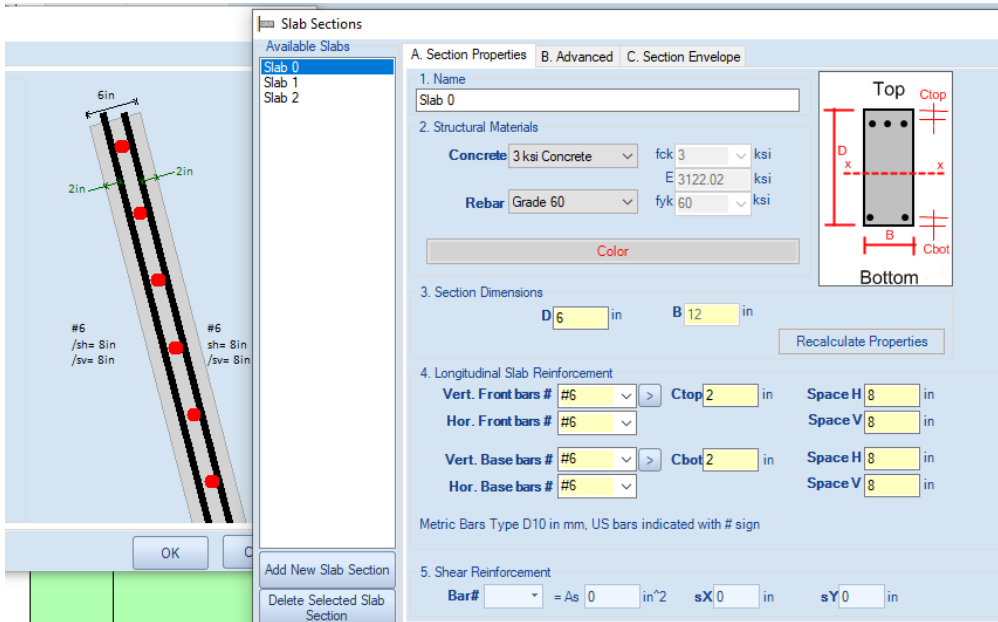


Figure: SnailPlus – Shotcrete Facing – Section Properties

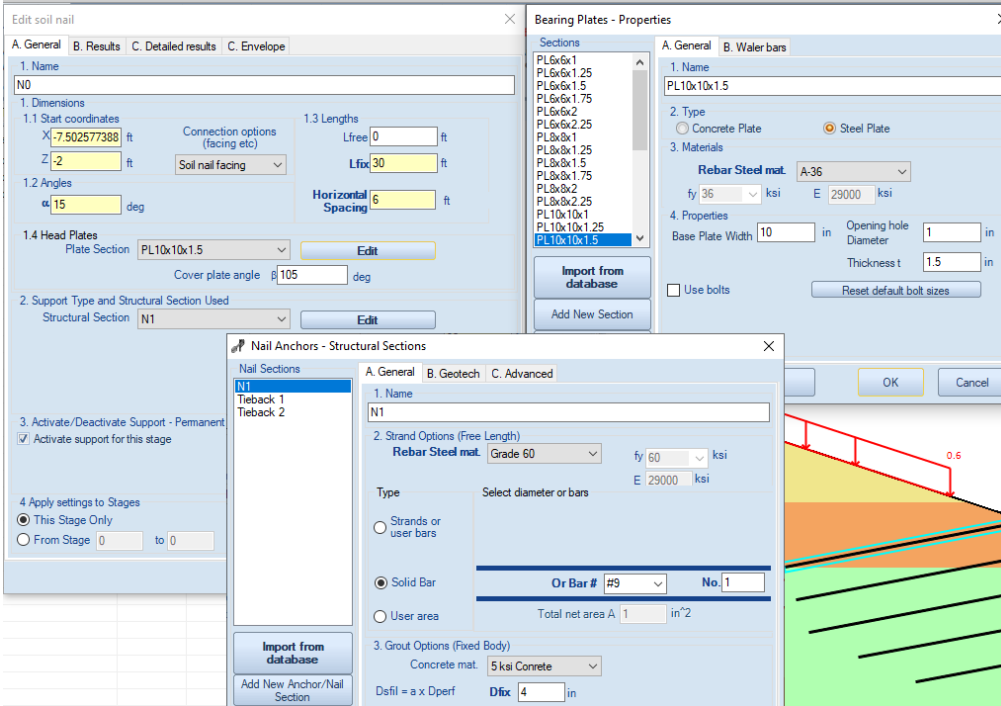


Figure: SnailPlus – Soil Nail and Head Plate Properties

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**D.1. SNAILPLUS MODEL WIZARD – MODEL DIMENSIONS AND SOIL NAILS LAYOUT**

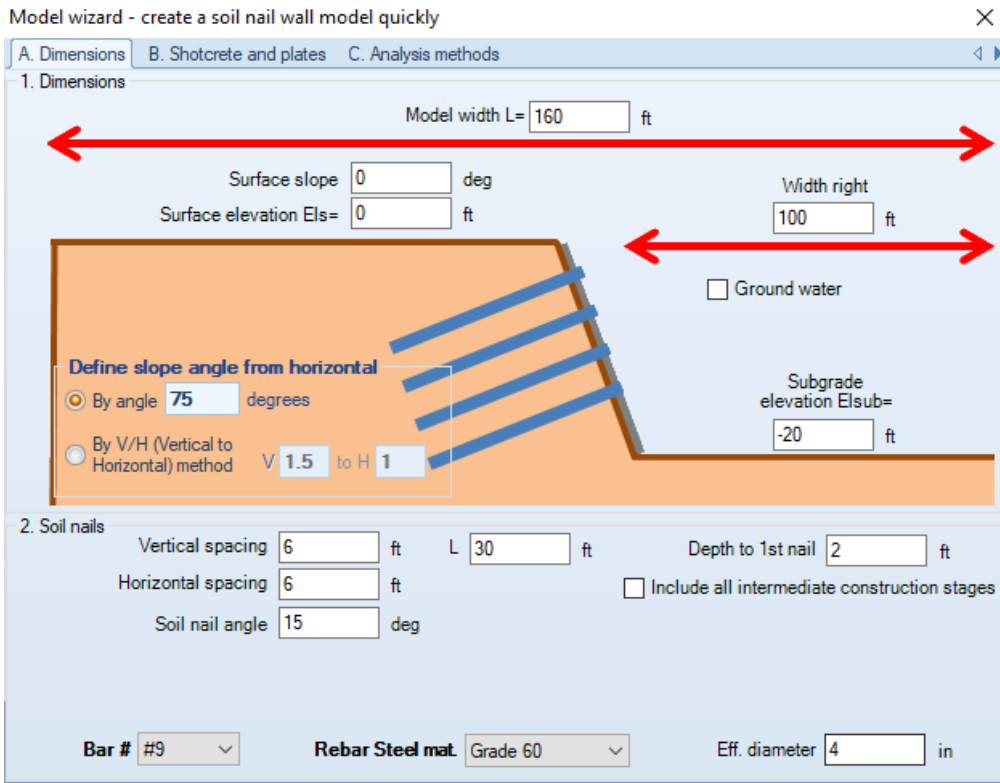


Figure: Model Wizard – Model Dimensions and Soil Nails Layout

- Define Top and Subgrade Surface Elevations (First Soil Nail Wall)
- Define Total Model Width, and Width of the Right Model Side (After the wall)
- Define the Slope Angle (First Soil Nail Wall)
- Define the Soil Nail Structural Section
- Define the Soil Nails Horizontal and Vertical Spacing
- Select Option to include all Intermediate Construction Stages (Not Selected in this example)

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D.2. SNAILPLUS MODEL WIZARD – FACING AND HEAD PLATES OPTIONS

The screenshot shows the 'Model wizard - create a soil nail wall model quickly' window. It has three tabs: 'A. Dimensions', 'B. Shotcrete and plates', and 'C. Analysis methods'. The 'Shotcrete properties' section includes a dropdown for 'Select from available sections' (Slab 0), checkboxes for 'Define new shotcrete section' (checked), 'Use two stage facing (temporary and permanent)', and 'Use only one layer of mesh reinforcement'. Input fields include 'Final facing thickness D' (6 in), 'Concrete' (3 ksi Concrete), 'Top bars #' (#6), 'Clear. Ctop' (2 in), 'Rebar' (Grade 60), 'Bottom bars #' (#6), 'Clear. Cbot' (2 in), 'Mesh spacing Sv' (8 in), 'Mesh spacing Sh' (8 in), and 'Horizontal Bottom bars #' (#6). The 'Plate data' section includes a dropdown for 'Select head plate' (PL8x8x1.25), checkboxes for 'Use plate studs' (checked) and 'Use waler bars', a dropdown for '#3/Diam. = 0.375in', a 'Reset default bolt sizes' button, and a 'Stud length' field (6 in).

Figure: Model Wizard – Shotcrete Facing and Head Plates Sections

- Define Facing Type (Permanent/Two-Stage): Permanent Facing Only in this example
- Select Facing Thickness and Reinforcement
- Select the Head Plate Section to be applied on all soil nails
- Option to use Plate Studs (Use #3 Rebar Diameter in this example)
- Option to use Waler Bars (Not selected in this example)

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**D.3. SNAILPLUS MODEL WIZARD – SLOPE SURFACE SEARCH AND DESIGN METHODS**

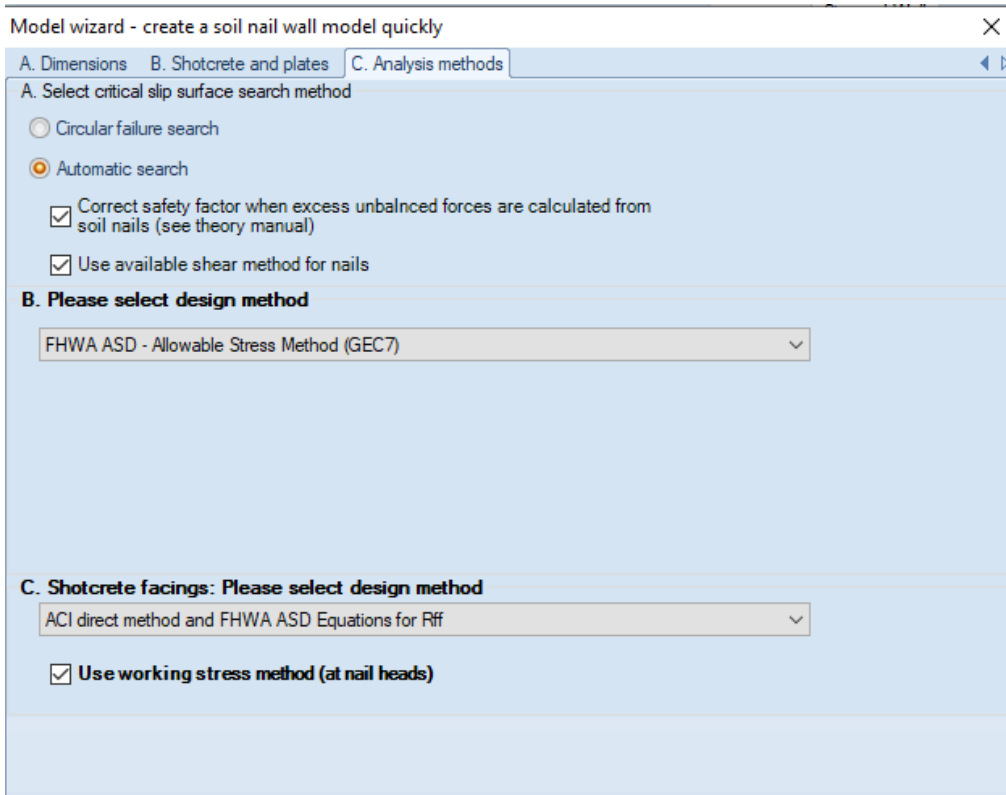


Figure: Model Wizard – Slope Surface Search Method and Structural Design Methods

- Define Slope Surface Search Method (Automatic Search in this example)
- Define Design Method (Allowable Stress Method (FHWA ASD GEC-7 in this example)
- Select Method for the Design of the Shotcrete Facing (ACI Method in this example).

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**E. MANUAL OPTIONS: EXCAVATION AND SOIL NAIL WALL INSTALLATION**

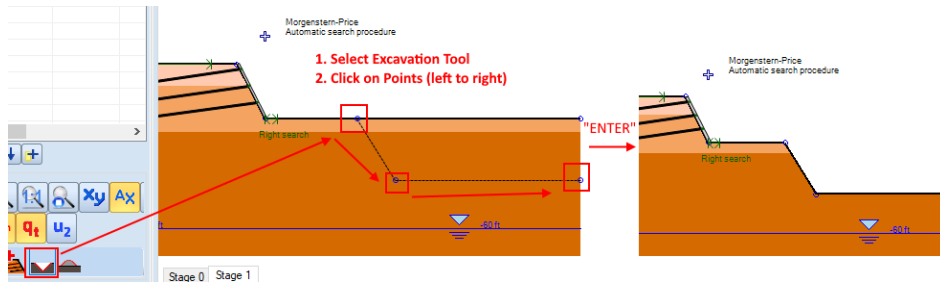


Figure: Manual Excavation Procedure

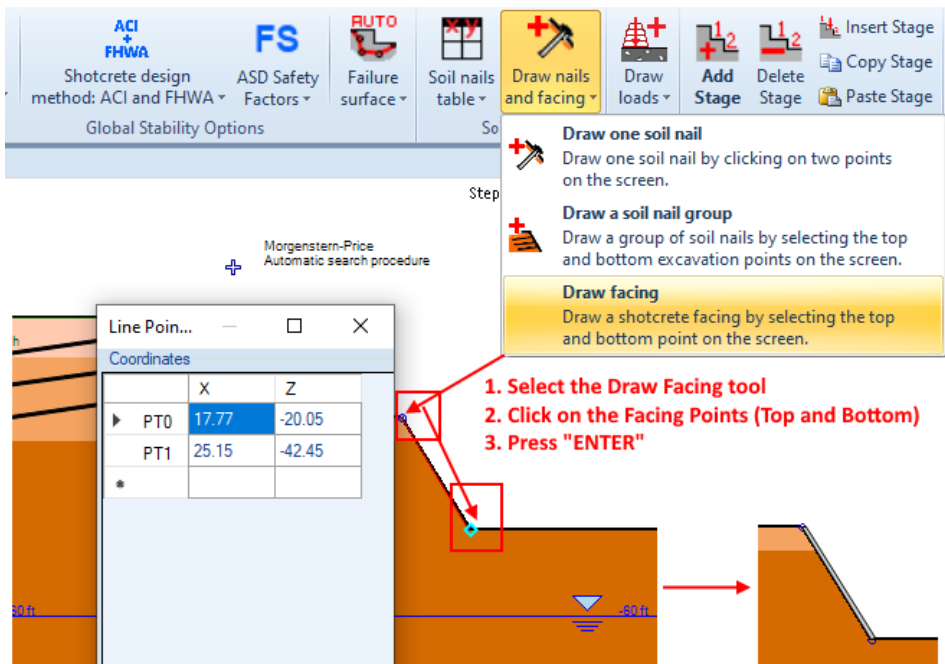


Figure: Manual Facing Installation Procedure

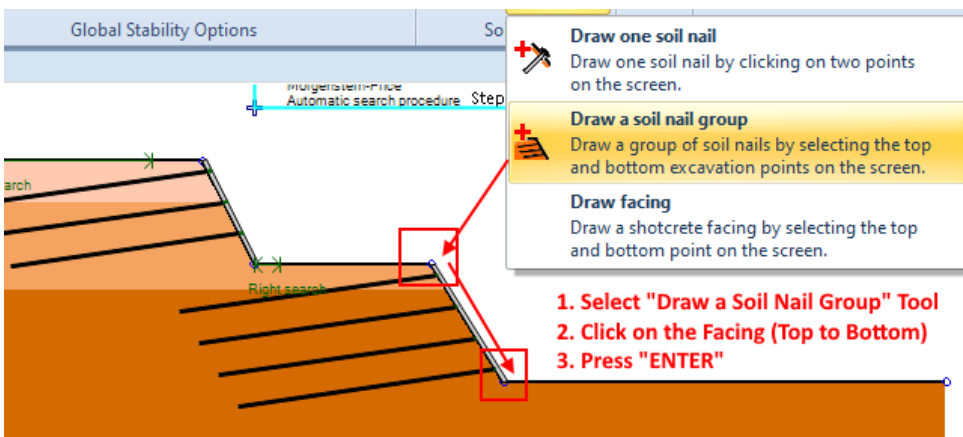


Figure: Manual Soil Nail Rows Installation Procedure

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### F. AUTOMATIC SLOPE SEARCH OPTIONS (BOTH WALLS)

The **Automatic Sliding Surface Search** solution uses a genetic evolution algorithm to examine several surfaces that pass from user-defined left and right search limits. In this example we will edit the left and right search limits on each construction stage, so will check each of the stepped soil nail walls in a stage.

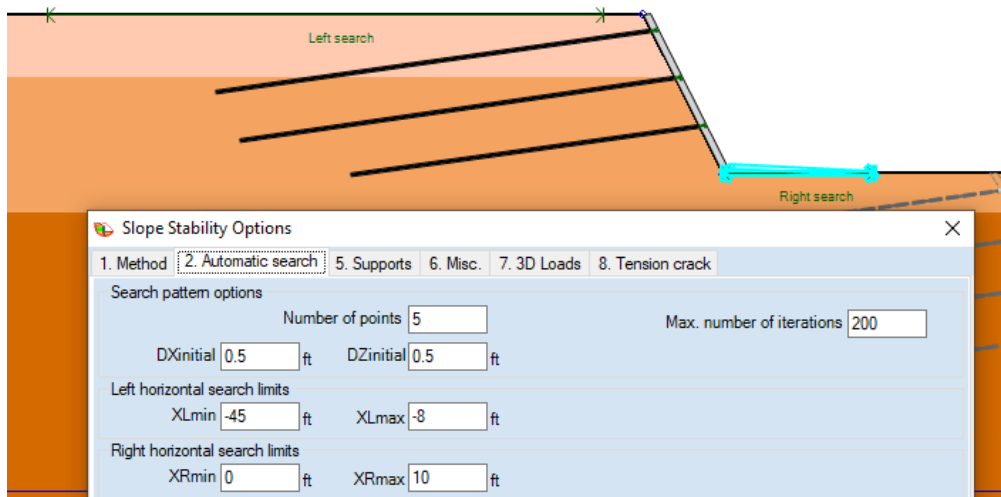


Figure: Automatic Failure Surface Search Options – Left and Right Search Limits for Left Wall (Stage 0)

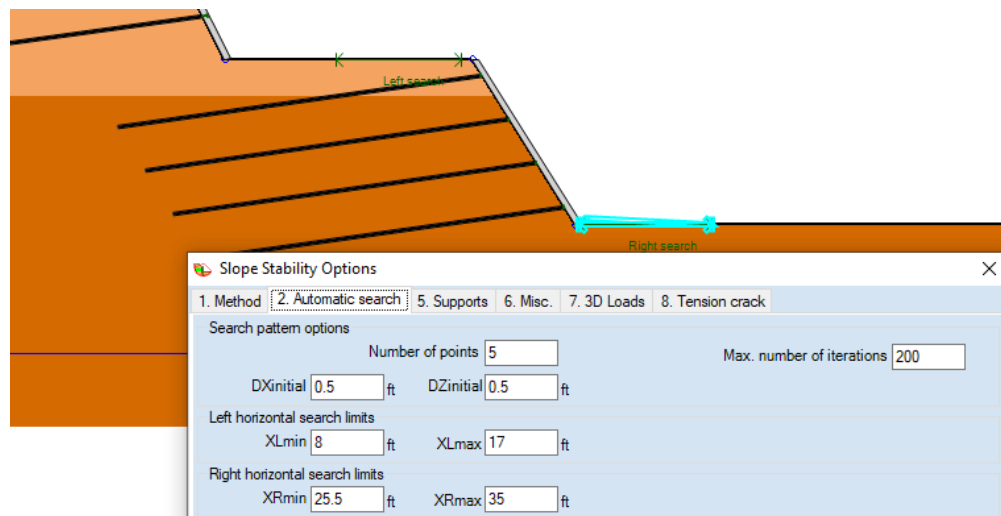


Figure: Automatic Failure Surface Search Options – Left and Right Search Limits for Right Wall (Stage 1)

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G.1. SNAIL PLUS ANALYSIS RESULTS – LEFT SOIL NAIL WALL

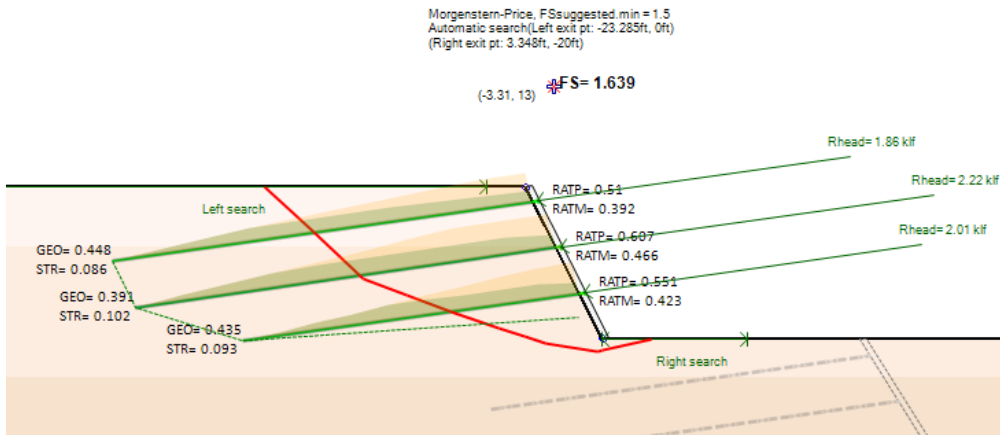


Figure: Slope Stability FS, Critical Slope Surface, Soil Nail and Head Plates Check Ratios (Left Wall – Stage 0)

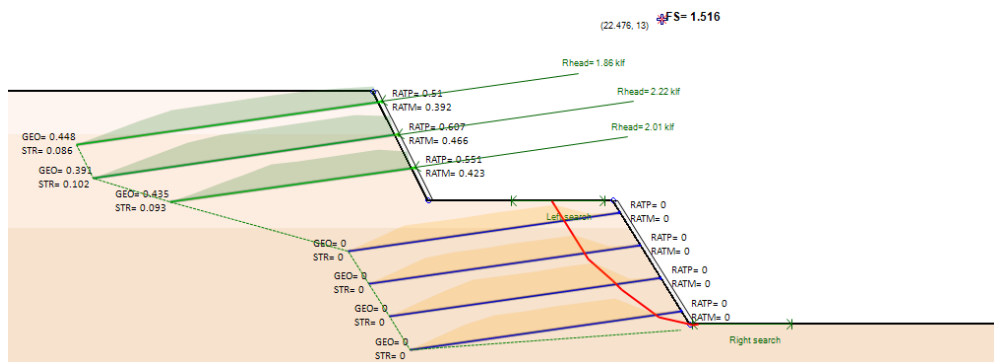


Figure: Slope Stability FS, Critical Slope Surface, Soil Nail and Head Plates Check Ratios (Right Wall – Stage 1)

Soil nails											
	Tension	Tension max. stage Stage 1	Tension capacity STR	Design Tension cap GEO	Crit. shear GEO	Shear cap STR	boxCalc	SxxCalc	Thickness loss	% STR loss	Mode
▶ Nail name /Units	k	k	k	k	k	k	in4	in3	in	%	crit.
0: N0	0	0	274.59	32.62	0	137.29	0.08	0.14	N/A	N/A	N/A
1: N1	0	0	274.59	44.4	0	137.29	0.08	0.14	N/A	N/A	N/A
2: N2	0	0	274.59	36.19	0	137.29	0.08	0.14	N/A	N/A	N/A
3: N4	8.4	11.58	274.59	49.05	0	137.29	0.08	0.14	N/A	N/A	FACE
4: N5	8.18	13.36	274.59	51.33	0	137.29	0.08	0.14	N/A	N/A	FACE
5: N6	8.89	16.91	274.59	54.35	0	137.29	0.08	0.14	N/A	N/A	FACE
6: N7	4.96	15.11	274.59	54.35	0	137.29	0.08	0.14	N/A	N/A	FACE

Figure: Soil Nails Results and Check Ratios (All Nails)

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