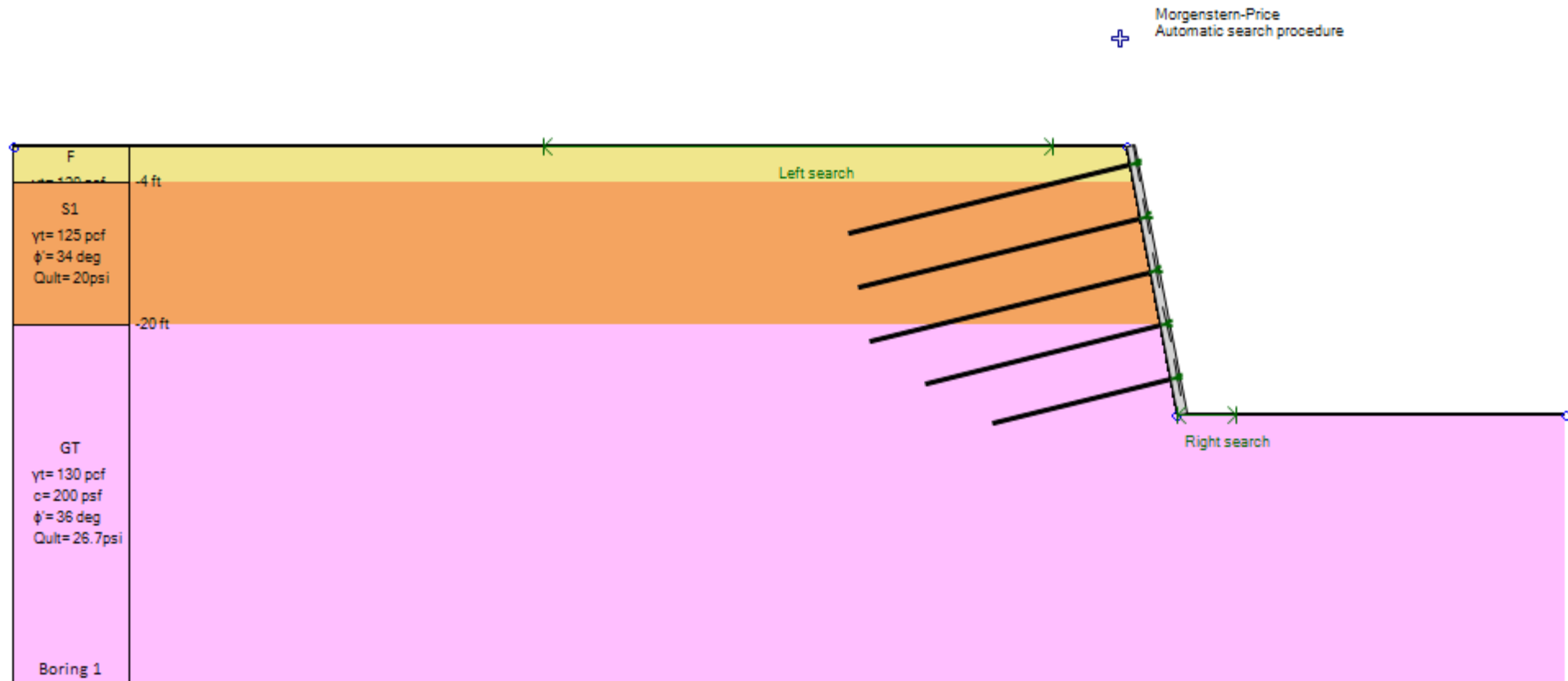
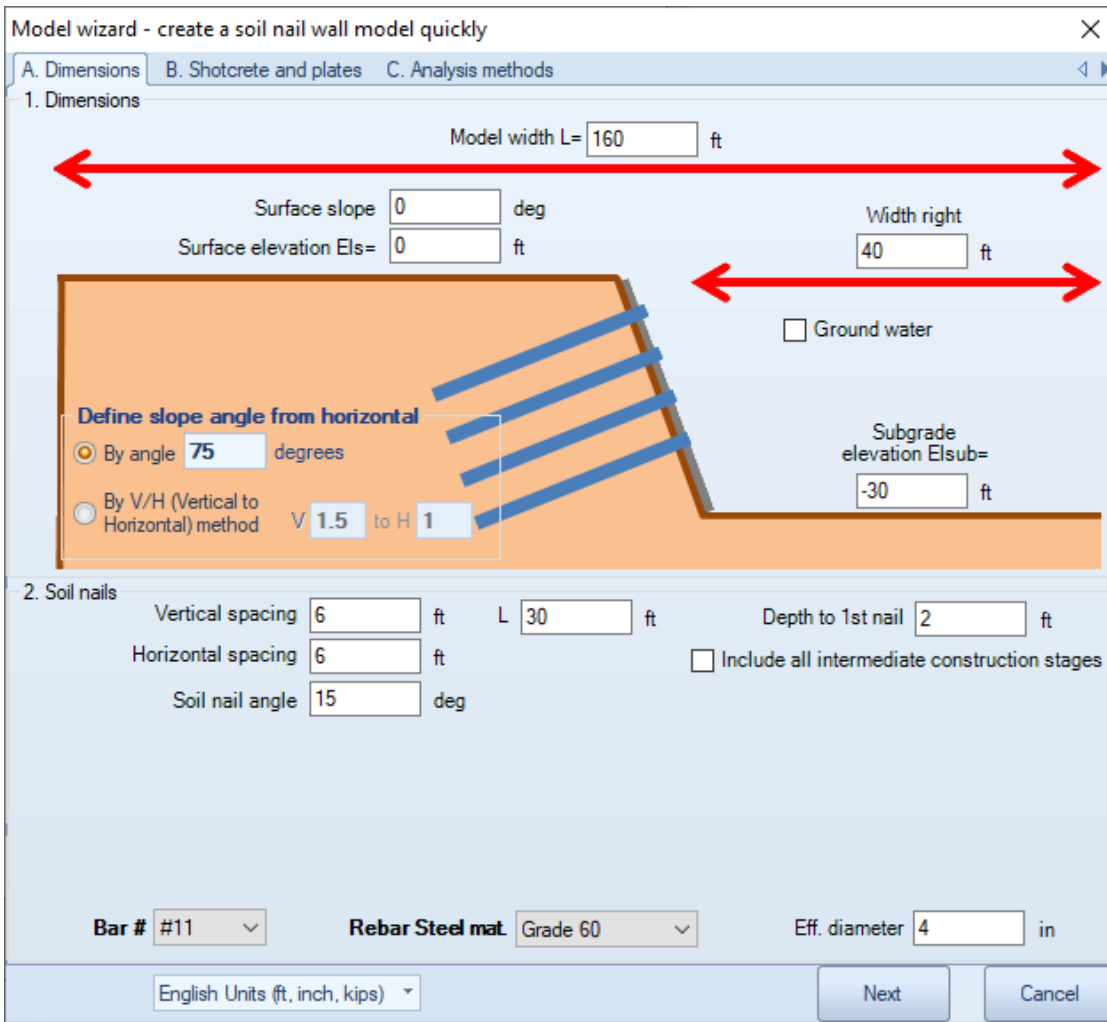


Example 1: Critical Slope Surface Methods in SnailPlus Global Stability Safety Factors Comparison



A1. Model Wizard - Project Geometry & Soil Nails Layout



Model wizard - create a soil nail wall model quickly

A. Dimensions B. Shotcrete and plates C. Analysis methods

1. Dimensions

Model width L= 160 ft

Surface slope 0 deg

Surface elevation Els= 0 ft

Width right 40 ft

Ground water

Subgrade elevation Elsub= -30 ft

Define slope angle from horizontal

By angle 75 degrees

By V/H (Vertical to Horizontal) method V 1.5 to H 1

2. Soil nails

Vertical spacing 6 ft L 30 ft Depth to 1st nail 2 ft

Horizontal spacing 6 ft Include all intermediate construction stages

Soil nail angle 15 deg

Bar # #11 Rebar Steel mat Grade 60 Eff. diameter 4 in

English Units (ft, inch, kips) Next Cancel

Geometry:

- 30ft Excavation
- 160ft Model Width
- 40ft Distance from the Base of the Wall to the right
- 75deg Slope Angle from Horizontal

Soil Nails Layout:

- 6ft Vertical Spacing
- 6ft Horizontal Spacing
- 30ft Fixed Length for the Soil Nails
- 15deg Inclined from Horizontal
- Do not include all Construction Stages

Soil Nails Section:

- #11 Rebar Steel
- Grade 60 Steel Material
- 4inches Hole Diameter

A2. Model Wizard - Shotcrete Facing & Head Plate Sections

Model wizard - create a soil nail wall model quickly

A. Dimensions | **B. Shotcrete and plates** | C. Analysis methods

Shotcrete properties

Select from available sections: Slab 0

Define new shotcrete section
 Use two stage facing (temporary and permanent) Use only one layer of mesh reinforcement

Final facing thickness D: 12 in Concrete: 3 ksi Concrete

Top bars #: #6 Clear. Ctop: 2 in Rebar: Grade 60

Bottom bars #: #6 Clear. Cbot: 3 in

Mesh spacing Sv: 8 in Mesh spacing Sh: 8 in
Horizontal Bottom bars #: #6

Plate data

Select head plate: PL8x8x1.25

Use plate studs #3/Diam. = 0.375in Stud length: 6 in [Reset default bolt sizes](#)

Use waler bars #4

Pressures on facing

Pressure on facing as ratio active: 0.75 (Ranges from 0.5 to 1.0 of active (standard 0.75))

English Units (ft, inch, kips) Next Cancel

Shotcrete Facing Section:

- Permanent Facing with 2 Rows of Rebars
- 12in Thick Facing
- #6 Bars @ 8in Spacing Horizontal & Vertical
- 3 ksi Concrete, Grade 60 Rebar Steel Materials

Head Plate Section:

- Plate 8in x 8in x 1.25in
- 6in Long #3 Rebar Studs
- #4 Waler Rebars

A3. Model Wizard - Analysis Methods & Codes

Model wizard - create a soil nail wall model quickly

A. Dimensions B. Shotcrete and plates C. Analysis methods

A. Select critical slip surface search method

Circular failure search

Automatic search Tri-linear search

Correct safety factor when excess unbalanced forces are calculated from soil nails (see theory manual)

Use available shear method for nails

B. Please select design method

FHWA ASD - Allowable Stress Method (GEC7)

C. Shotcrete facings: Please select design method

ACI direct method and FHWA ASD Equations for Rff

Use working stress method (at nail heads)

D. Please select if this wall is temporary or permanent

Permanent wall

English Units (ft, inch, kips)

Ok Cancel

← Initial Slope Surface Search Method:
- Automatic Search Approach

← Geotechnical Design Method:
- FHWA Allowable Stress Method (GEC 7)

← Structural Design Codes:
- ACI direct Method for the Shotcrete Facing
- FHWA Allowable Stress Design Equations for Steel Members

B. Soil Properties and Stratigraphy (Soil Layers)

The screenshot shows a software interface with a soil stratigraphy diagram on the left and a dialog box for 'Boring 1' on the right.

Soil Layers:

- F:** 0 to -4 ft, $\gamma_t = 120$ pcf
- S1:** -4 to -20 ft, $\gamma_t = 125$ pcf, $\phi' = 34$ deg, $q_{ult} = 20$ psi
- GT:** -20 to -26.7 ft, $\gamma_t = 130$ pcf, $c = 200$ psf, $\phi' = 36$ deg, $q_{ult} = 26.7$ psi

1. General Boring Information - Coordinates

N Boring 1

Coordinates X: 50 ft, Y: 0 ft

The x coordinate controls where the boring is shown in your design section view. Each design section uses one boring (soil strata). You can use a different boring on each design section.

SPT Data Option (Applies to Design Section)

SPT Record: Not assigned [Add edit SPT records]

CPT Record Option (Applies to Design Section)

CPT Record: Not assigned [Add edit CPT records]

2. Boring Layers - Layer Elevations

	Top	Soil type	OCR	Ko	Edit
▶	0	F	1	0.5	Edit
	-4	S1	1	0.441	Edit
	-20	GT	1	0.412	Edit
*					

Elev. (ft)	Soil (-)	γ_t (pcf)	C' or Su (psf)	ϕ' (deg)
0	F - Sand	120	0	30
-4	S1 - Sand	125	0	34
-20	GT - Till	130	200	36

A. General B. Elasto-plastic Lateral E. Adv.

4. Unit Weights - Density

γ_t 120 pcf γ_{dry} 120 pcf γ_w 57.6

5. Strength Parameters and Poisson Ratio

Drained strength properties

c' 0 psf ϕ' 30 degrees

ν 0.35

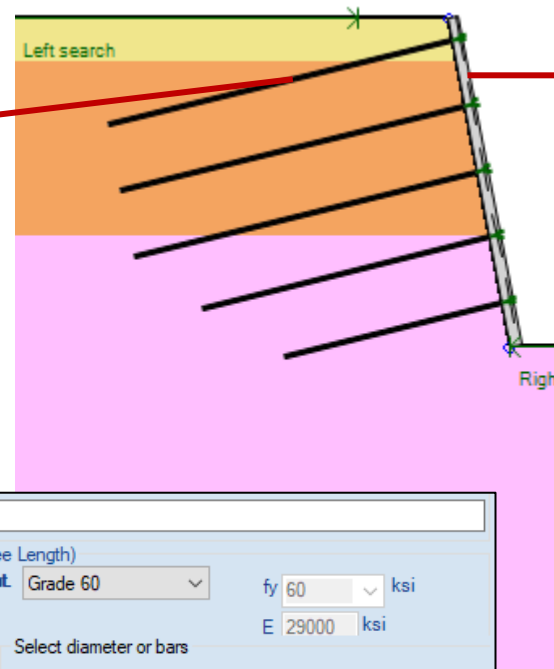
5. At-rest coefficients

KoNC 0.5 nOCR 0.5
 $Ko = KoNC * (OCR)^{nOCR}$

6. Ultimate bond (grouted piles when bond option is selected)

$q_{skin,u}$ 20 psi

C. Structural Sections - Manual Review/Input



Facing for soil nails (shotcrete or other)

A. Data B. Results C. Results for this stage D. Advanced

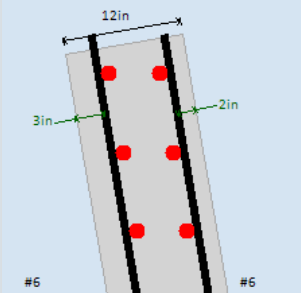
1. Name: Soil nail facing

2. Facing type: Shotcrete (uses concrete slab sections)

3. Slab section used for facing: Slab 0

4. Activate/Deactivate: Activate facing for this stage

6. Options for staged excavation: Enable activation of individual stages



Edit soil nail

A. General B. Results C. Detailed results C. Envelope

1. Name: N0

1.1 Start coordinates: X: -4.937155459 ft, Z: -2 ft

1.2 Angles: α : 15 deg

1.3 Lengths: Lfree: 0 ft, Lfix: 30 ft

1.4 Head Plates: Plate Section: PL8x8x1.25, Cover plate angle: 100 deg

2. Support Type and Structural Section Used: Structural Section: N1

3. Activate/Deactivate Support - Permanent or Temporary: Activate support for this stage

4. Apply settings to Stages: This Stage Only

N1

2. Strand Options (Free Length)

Rebar Steel mat: Grade 60, fy: 60 ksi, E: 29000 ksi

Type: Solid Bar

Or Bar #: #11, No.: 1

Total net area A: 1.56 in²

3. Grout Options (Fixed Body)

Concrete mat: 5 ksi Concrete

Dfsil = a x Dperf, Dfix: 4 in

Slab 0

2. Structural Materials

Concrete: 3 ksi Concrete, fck: 3 ksi, E: 3122.02 ksi

Rebar: Grade 60, fyk: 60 ksi

3. Section Dimensions: D: 12 in, B: 12 in

4. Longitudinal Slab Reinforcement

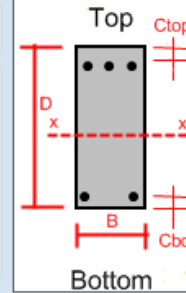
Vert. Front bars #: #6, Ctop: 2 in, Space H: 8 in

Hor. Front bars #: #6, Space V: 8 in

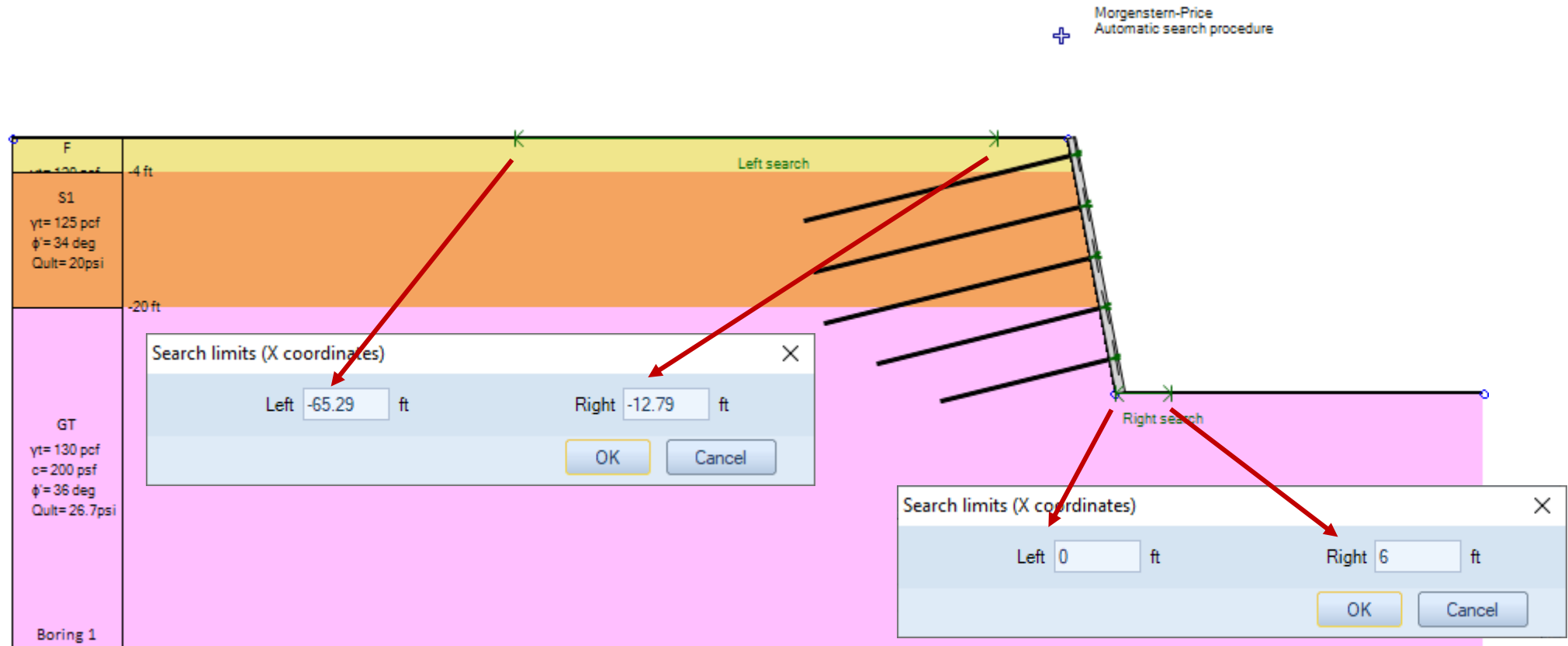
Vert. Base bars #: #6, Cbot: 3 in, Space H: 8 in

Hor. Base bars #: #6, Space V: 8 in

Recalculate Properties



D1. Automatic Surface Search Method - Input

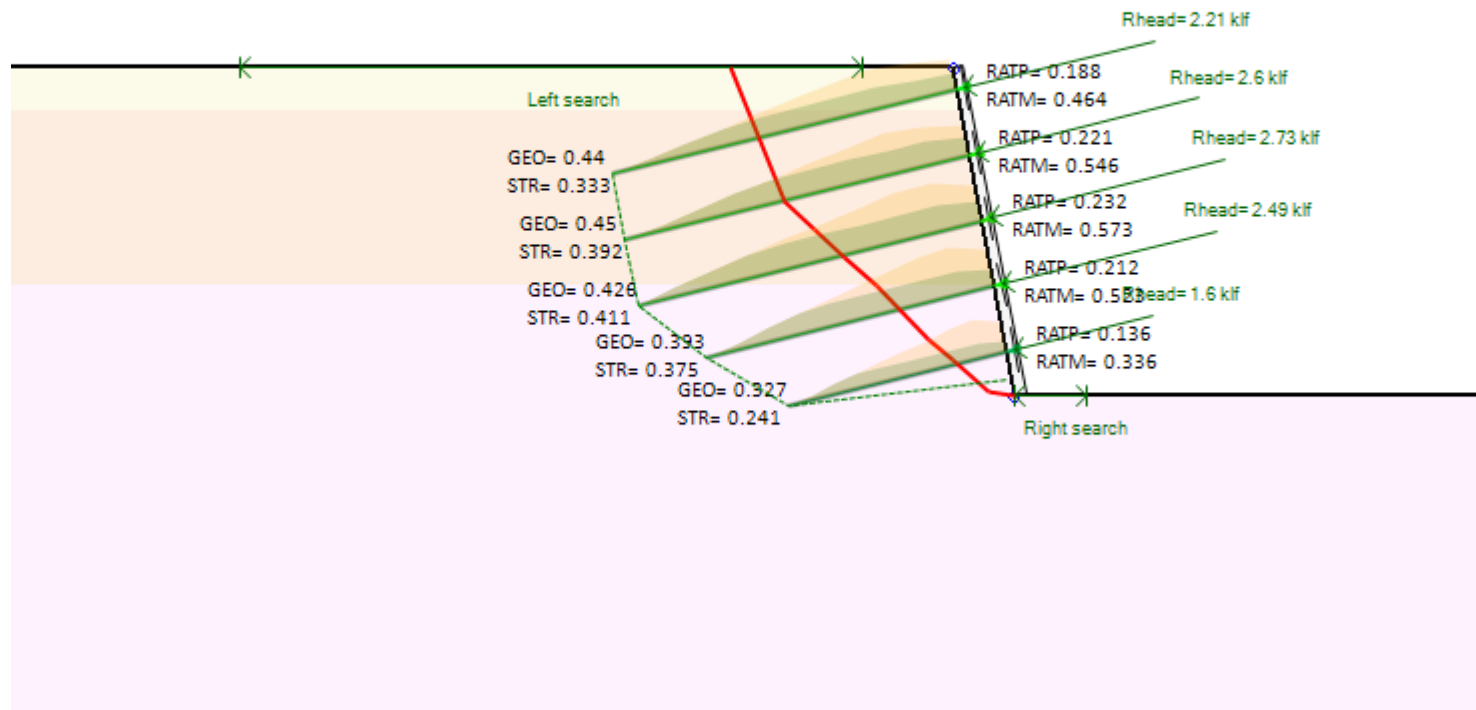


Automatic Surface Search Method:
 SnailPlus checks non circular slope surfaces that pass from 2 predefined limits (left and right)

D2. Automatic Surface Search Method - Slope Stability FS

Morgenstern-Price, FSsuggested.min = 1.5
 Automatic search(Left exit pt: -23.932ft, 0ft)
 (Right exit pt: 0ft, -30ft)

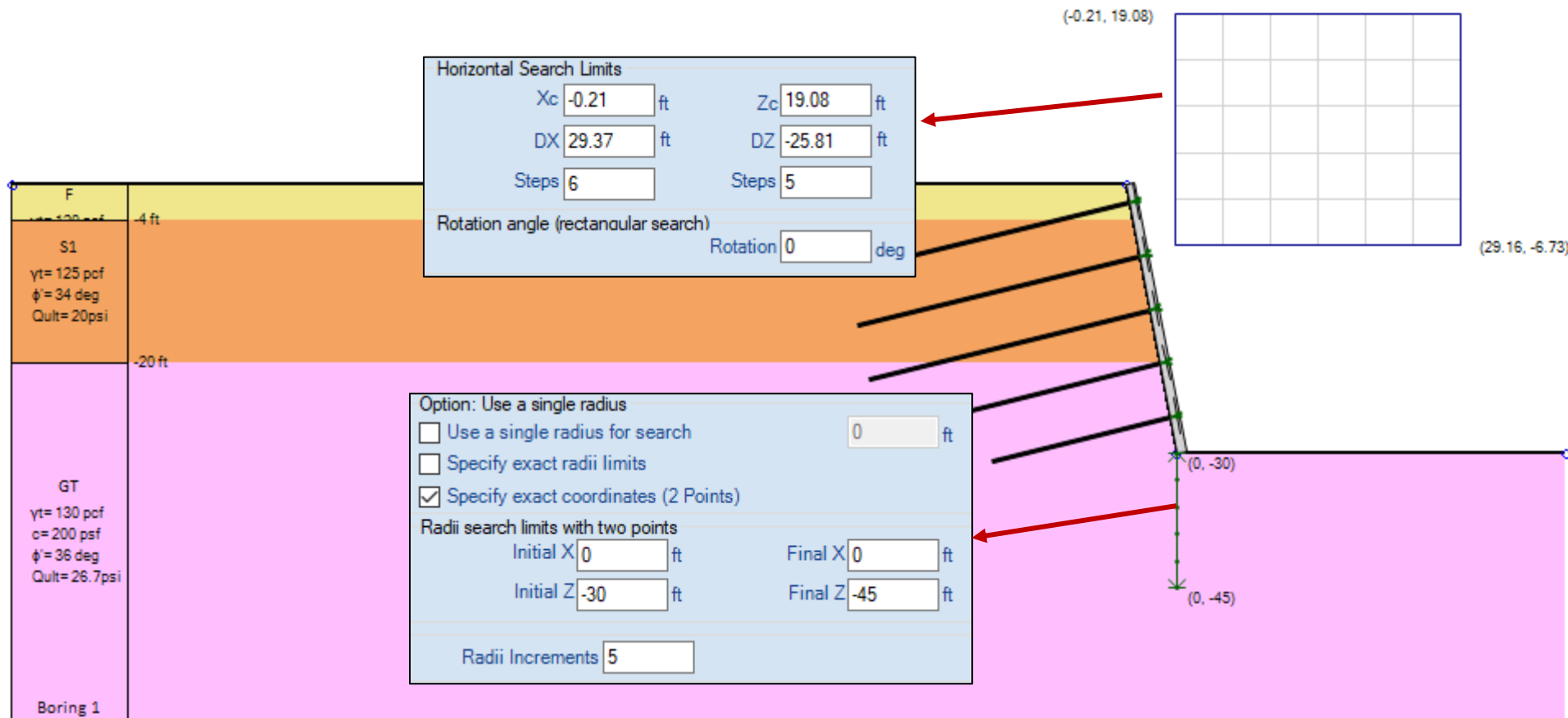
(-5.983, 12) **FS= 1.561**



Presented Results:

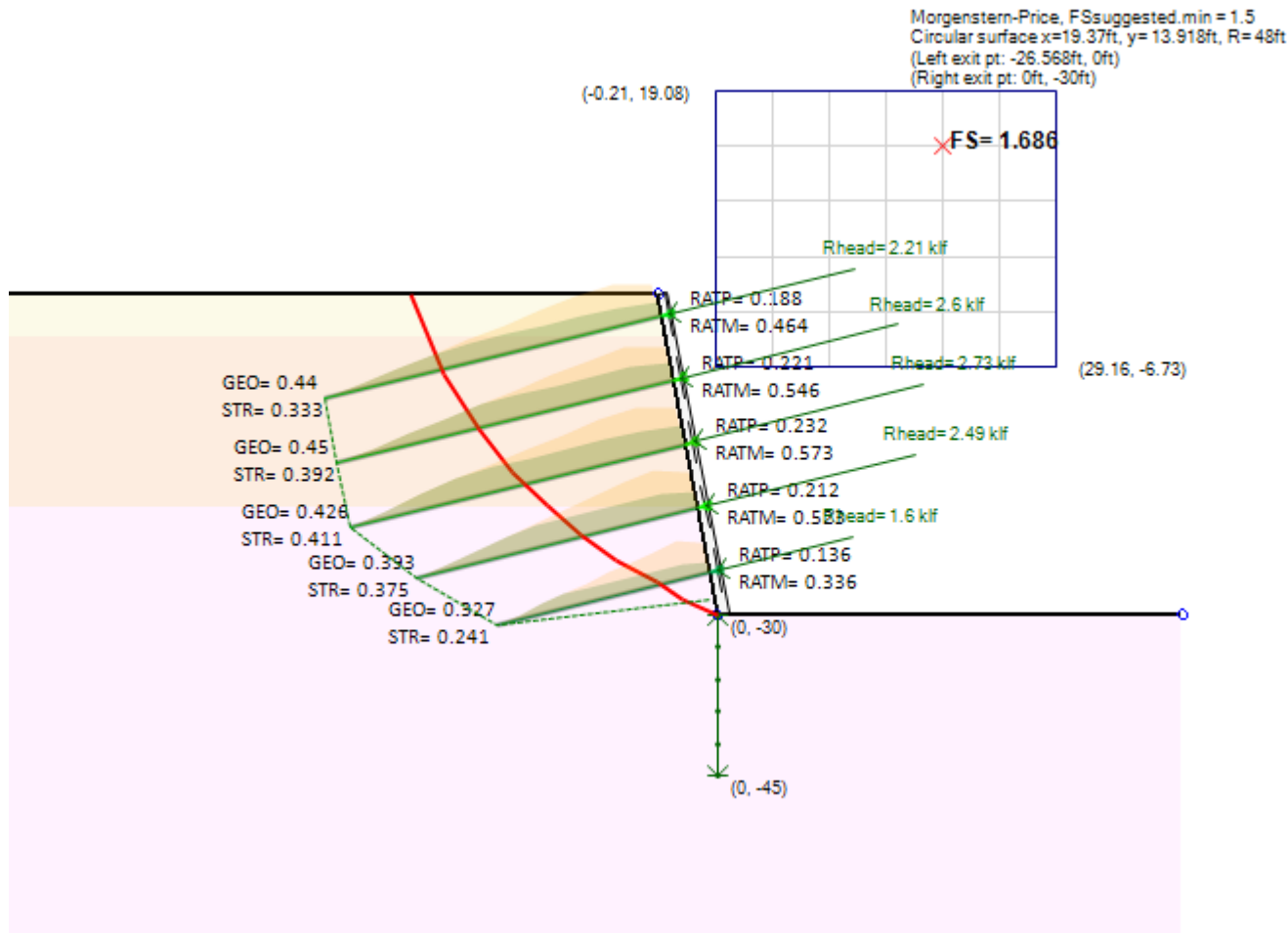
- Critical Slope Surface
- Slope Stability FS (GLE Method)
- Soil Nail Head Reactions
- Plate Punching & Moment Check Ratios
- Soil Nail Structural & Geotechnical Check Ratios

E1. Circular Surface Search Method - Input



Circular Surface Search Method:
 SnailPlus checks circular slope surfaces with predefined centers and radii search limits

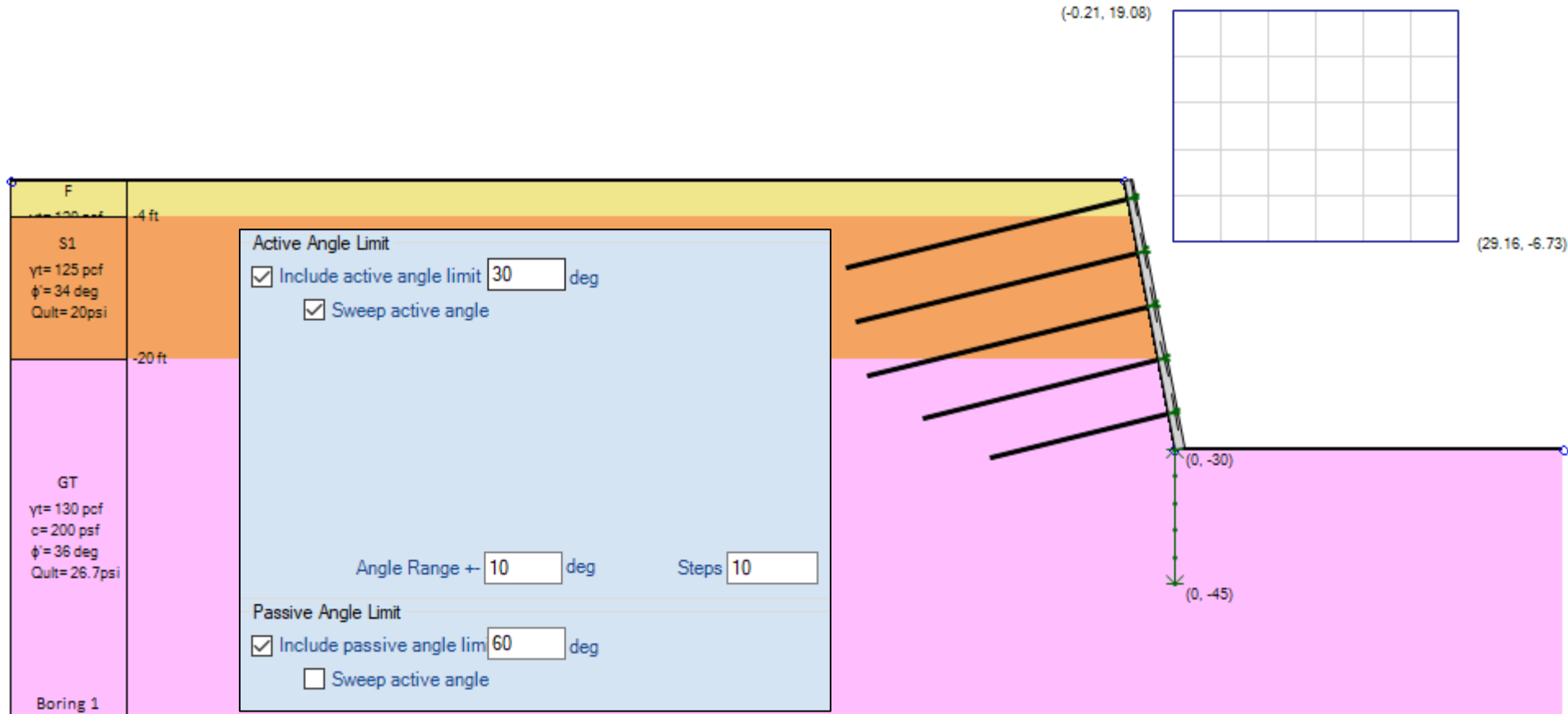
E2. Circular Surface Search Method - Slope Stability FS



Presented Results:

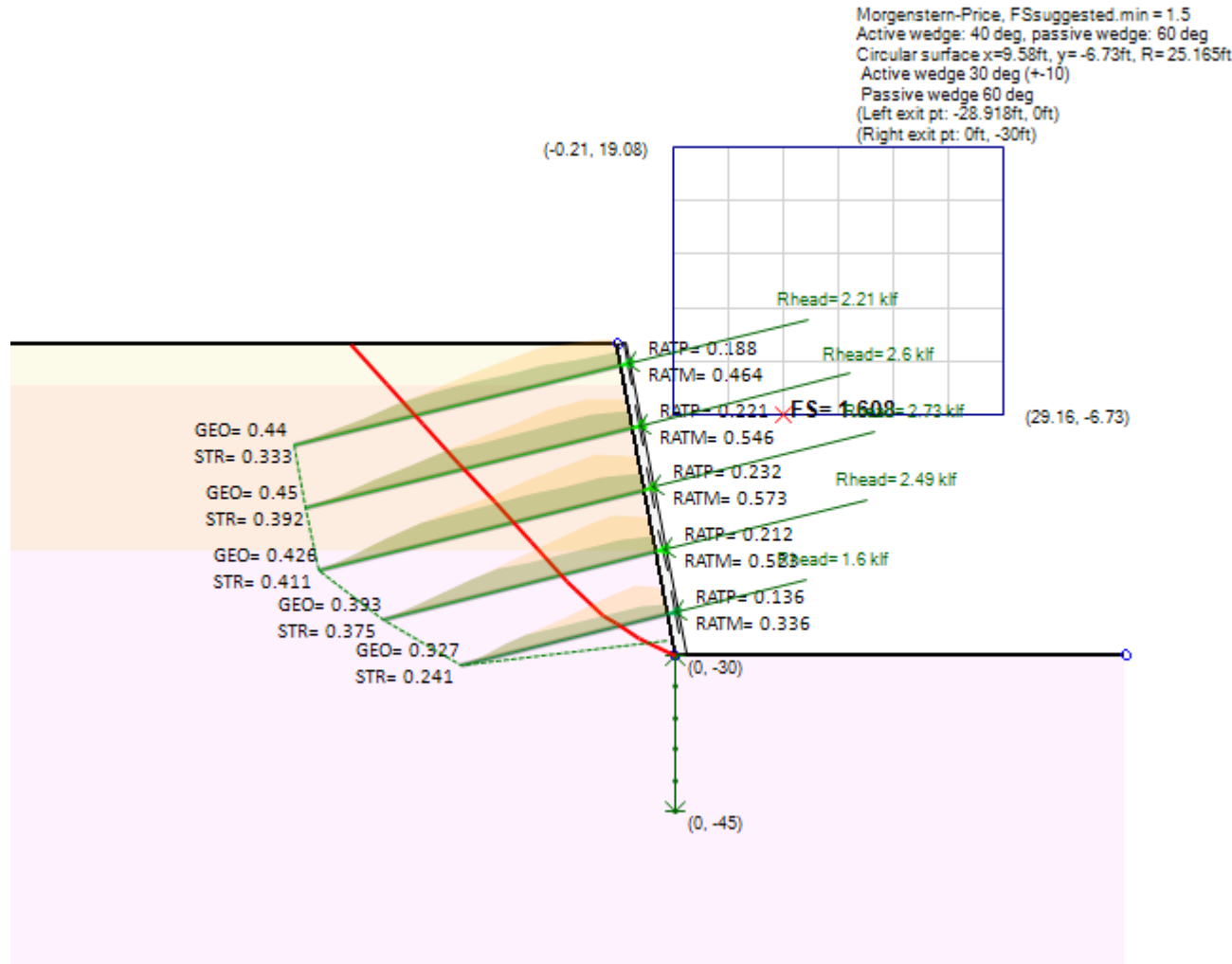
- Critical Slope Surface
- Slope Stability FS (GLE Method)
- Soil Nail Head Reactions
- Plate Punching & Moment Check Ratios
- Soil Nail Structural & Geotechnical Check Ratios

F1. Circular Surface with Wedges Search Method - Input



Circular Surface Search Method with Active/Passive Wedges:
 SnailPlus checks circular slope surfaces and uses Wedges on the Active and/or Passive side

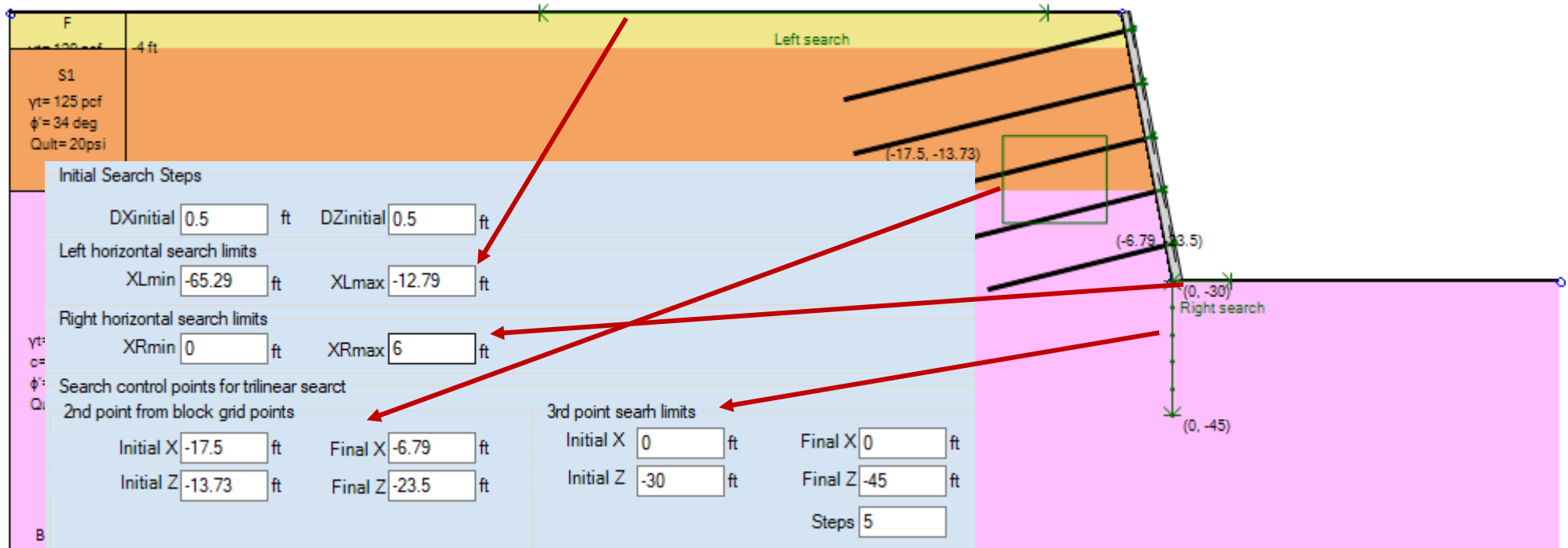
F2. Circular Surface with Wedges Search Method - Slope Stability FS



Presented Results:

- Critical Slope Surface
- Slope Stability FS (GLE Method)
- Soil Nail Head Reactions
- Plate Punching & Moment Check Ratios
- Soil Nail Structural & Geotechnical Check Ratios

G1. Tri-Linear Search Method - Input

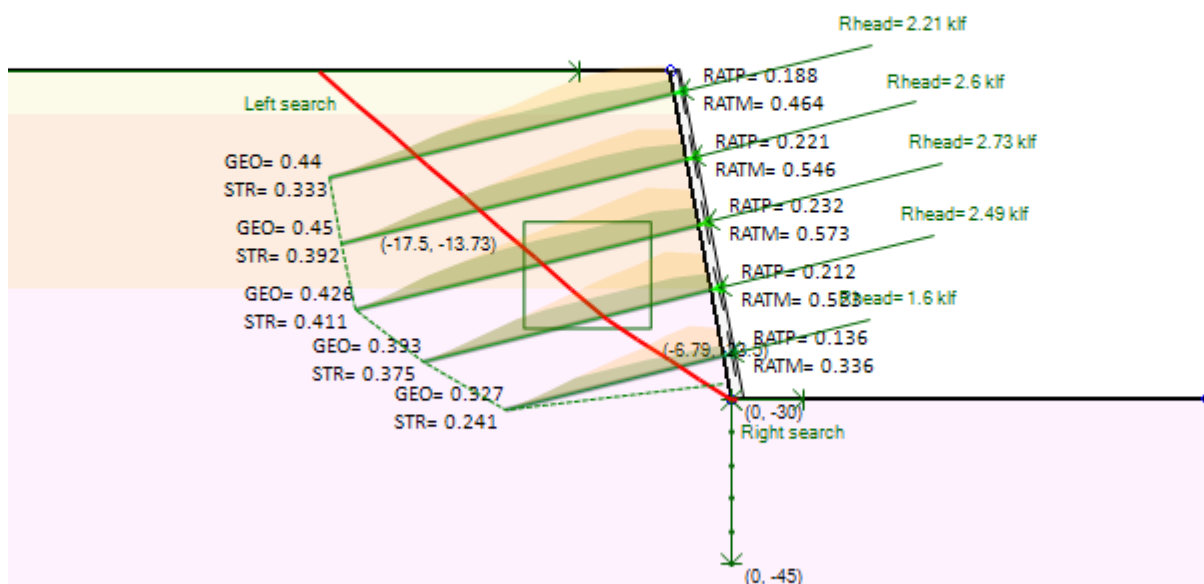


Tri-Linear Search Approach:
 SnailPlus checks surfaces that pass from 4 points with predefined search limits

G2. Tri-Linear Search Method - Slope Stability FS

Morgenstern-Price, FSsuggested.min = 1.5
 Active wedge: 30 deg, passive wedge: 60 deg
 Circular surface x=-0.21ft, y=19.08ft, R=0ft
 Active wedge 30 deg (+10)
 Passive wedge 60 deg
 (Left exit pt: -34.79ft, 0ft)
 (Right exit pt: 0.5ft, -30ft)

FS= 1.645



Presented Results:

- Critical Slope Surface
- Slope Stability FS (GLE Method)
- Soil Nail Head Reactions
- Plate Punching & Moment Check Ratios
- Soil Nail Structural & Geotechnical Check Ratios

H. Table Results - All Methods Top Soil Nail & Head Plate Results for Each Method

4. Results for all stages

	Tension	Max. tension stab. analysis	Force at head Po	Max. mob. force Pmax.m	Tension stress check	Shear stress check	Critical stress check	Tension capacity STR	Design Tension cap GEO	Crit. shear GEO	Shear C2	Shear C3	Shear C4	Shear C4 LE	Modulus ks	Lateral pressure Po	Ult. lateral pressure Pu	Length lo	bxCalc	SxxCalc	Thickness loss	% STR loss	Moment on plate M	Plate Mres	Punching perimeter	Punching depth Dp	Punching area Ap	Ultimate punching cap PLv	Required factored load PLdes	Geotech plate cap PLnen	Punching ratio chek RAT.Pv	Critical
Units	k	k	k	k	-	-	-	k	k	k	k	k	k	k	ksf	ksf	ksf	ft	in4	in3	in	%	k-ft	k-ft	in	in	ft2	k	k	k		Mode
0: Stage 0	19.31	33.46	13.25	17.31	0.333	0	0.44	84.24	39.36	0	Not in...	Not in...	Not in...	Not in...	N/A	N/A	N/A	N/A	0.19	0.28	N/A	N/A	2.5365...	5.46875	67.863	8.966	2	99.98	12.52	N/A	0.188	GEO
1: Stage 1	15.83	37.69	13.25	17.31	0.333	0	0.44	84.24	39.36	0	Not in...	Not in...	Not in...	Not in...	N/A	N/A	N/A	N/A	0.19	0.28	N/A	N/A	2.5365...	5.46875	67.863	8.966	2	99.98	12.52	N/A	0.188	GEO
2: Stage 2	16.81	34.04	13.25	17.31	0.333	0	0.44	84.24	39.36	0	Not in...	Not in...	Not in...	Not in...	N/A	N/A	N/A	N/A	0.19	0.28	N/A	N/A	2.5365...	5.46875	67.863	8.966	2	99.98	12.52	N/A	0.188	GEO
3: Stage 3	11.6	34.36	13.25	17.31	0.333	0	0.44	84.24	39.36	0	Not in...	Not in...	Not in...	Not in...	N/A	N/A	N/A	N/A	0.19	0.28	N/A	N/A	2.5365...	5.46875	67.863	8.966	2	99.98	12.52	N/A	0.188	GEO

Shotcrete Facing Results for Each Method

	Lh (ft)	Lv (ft)	Mxx.Nail(Bi (k-ft/ft)	Mxx.Span((k-ft/ft)	Myy.Nail(Bi (k-ft/ft)	Myy.Span((k-ft/ft)	Mcap.Nail (k-ft/ft)	Mcap.Spar (k-ft/ft)	Mcap.Nail (k-ft/ft)	Mcap.Spar (k-ft/ft)	Vxx (k-ft/ft)	Vyy (k-ft/ft)	Vcap (k-ft/ft)
0	6	6	-1.691	1.256	-1.691	1.256	23.717	22.611	23.509	20.012	1.208	1.208	11.831
1	6	6	-1.691	1.256	-1.691	1.256	23.717	22.611	23.509	20.012	1.208	1.208	11.831
2	6	6	-1.691	1.256	-1.691	1.256	23.717	22.611	23.509	20.012	1.208	1.208	11.831
3	6	6	-1.691	1.256	-1.691	1.256	23.717	22.611	23.509	20.012	1.208	1.208	11.831

Stage 0: Automatic Search Method

Stage 1: Circular Search Method

Stage 2: Circular Search with Wedges Method

Stage 3: Tri-linear Search Method

Thank You!

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