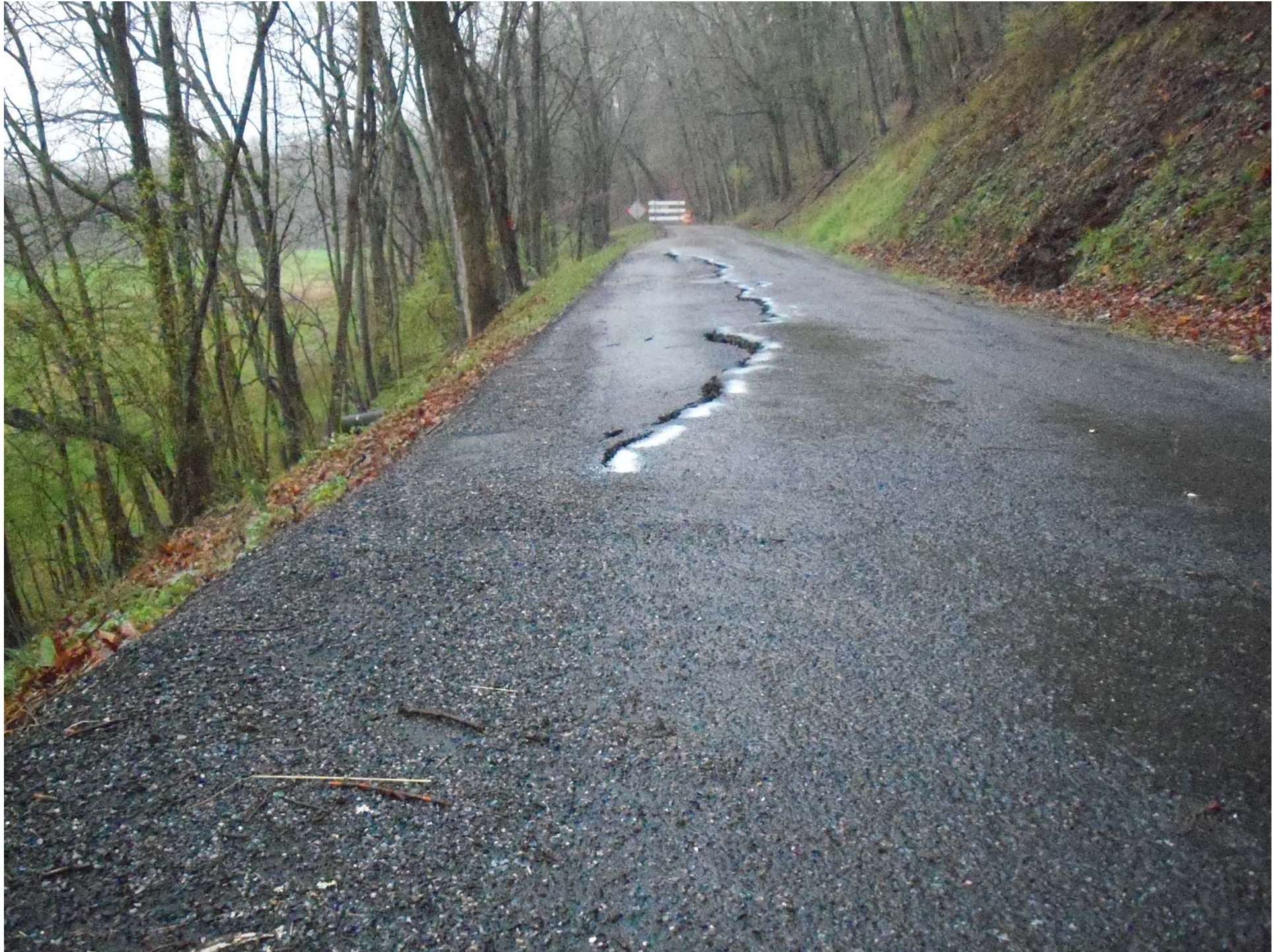


Case Histories – Innovative Roadway Landslide Repair Technologies



Colby Barrett

Nate Beard



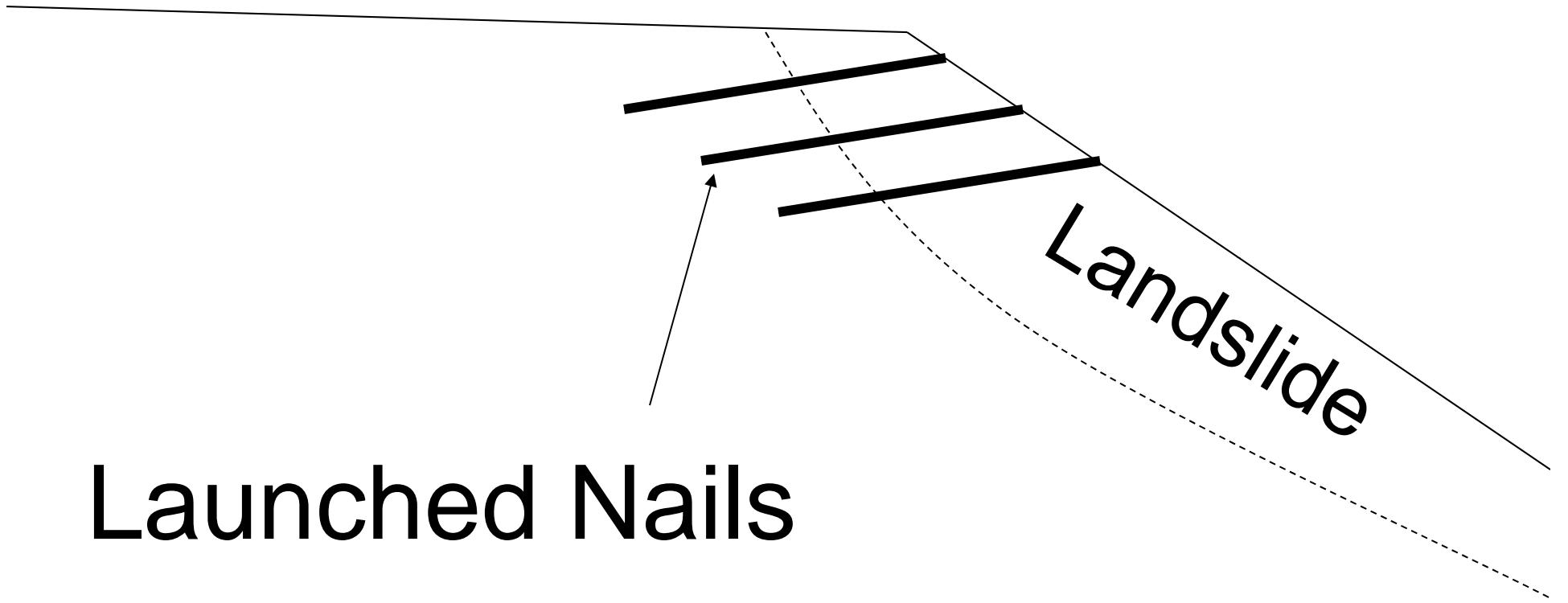
Technology Overview





GalvaDized™ Launched Nails
Before Installation





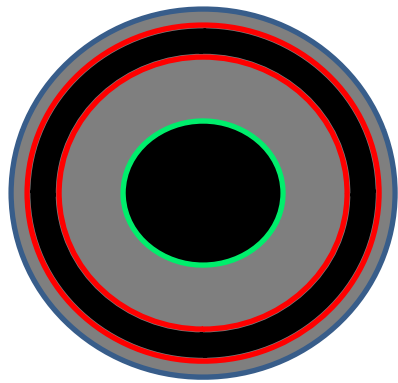
Launched Nails

Landslide

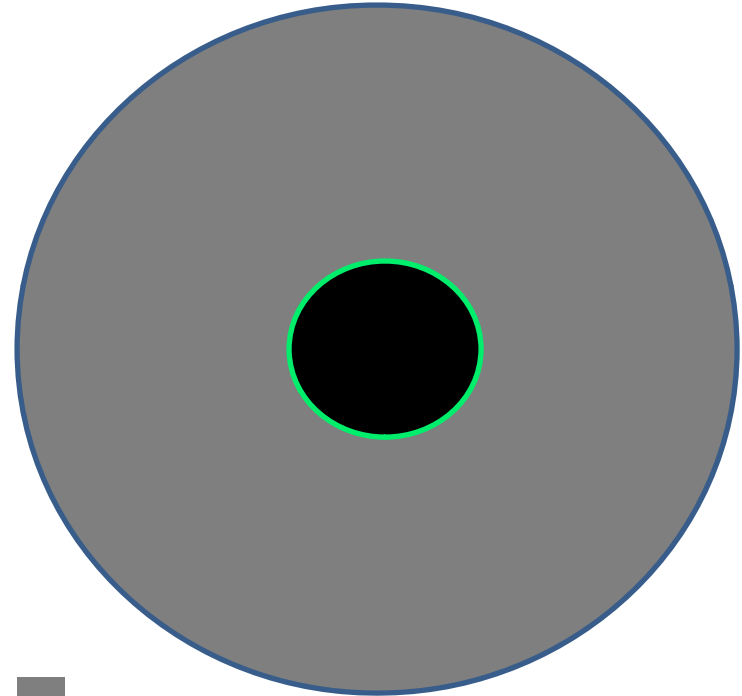




SuperNail®



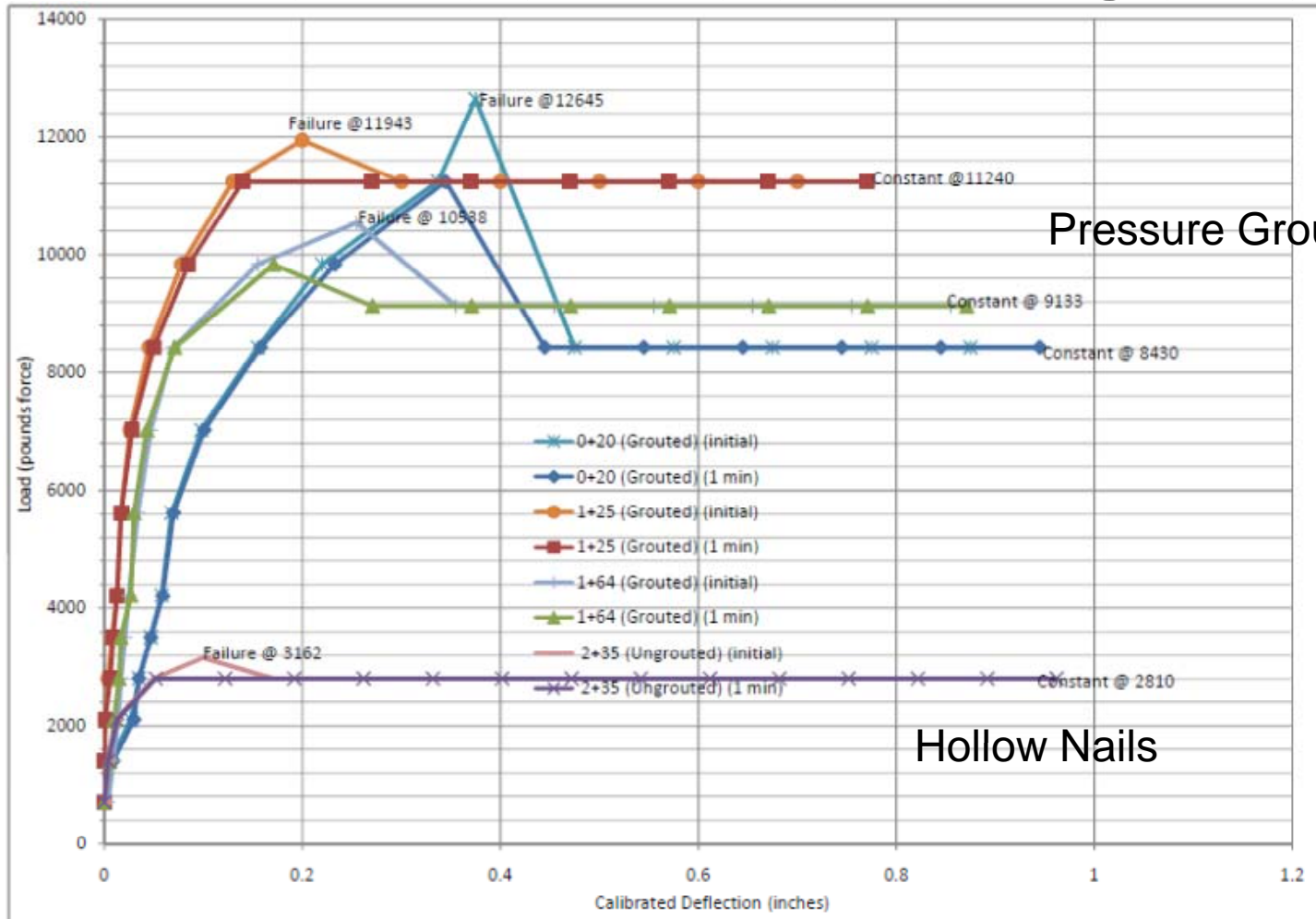
Traditional Soil Nail



Grout
Galvanization
Steel
Epoxy



Pullout Test Results - Sand



1. Average bond = 3.1 psi (ungouted); 11.5 psi (grouted)



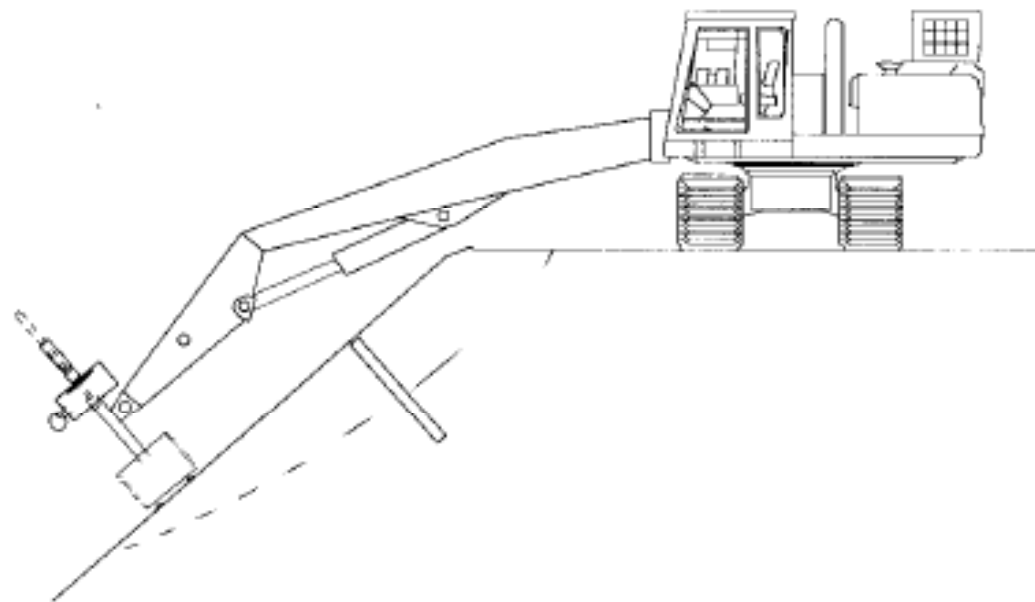
United States
Department of
Agriculture
Forest Service
Engineering Staff
EM 7170-12B



United States
Department of
Transportation
**Federal Highway
Administration**
FHWA-FPL-93-004
July 1994

Project Report for Launched Soil Nails— 1992 Demonstration Project

Volume 2



Local [Play] [Pause] [Next]

Maximize on Play Stats Gizmos

Water Nails Tubes Facings CastInPlace 1 Shotcrete 1 Flexible 1 Beam
SN Wall 2 SN Wall 3 Flex 1 Frame Wall 1 Seismics Bishop Report

L_H, m L_V, m
2.9 0.5
2.0 0.5
3.6 2.2
1.4 1.5
2.0 1.5
1.6 1.0
1.9 0.5
1.6 0.4
0.0 4.2

0 1 2 3 4 5 F_s

Existing Slope

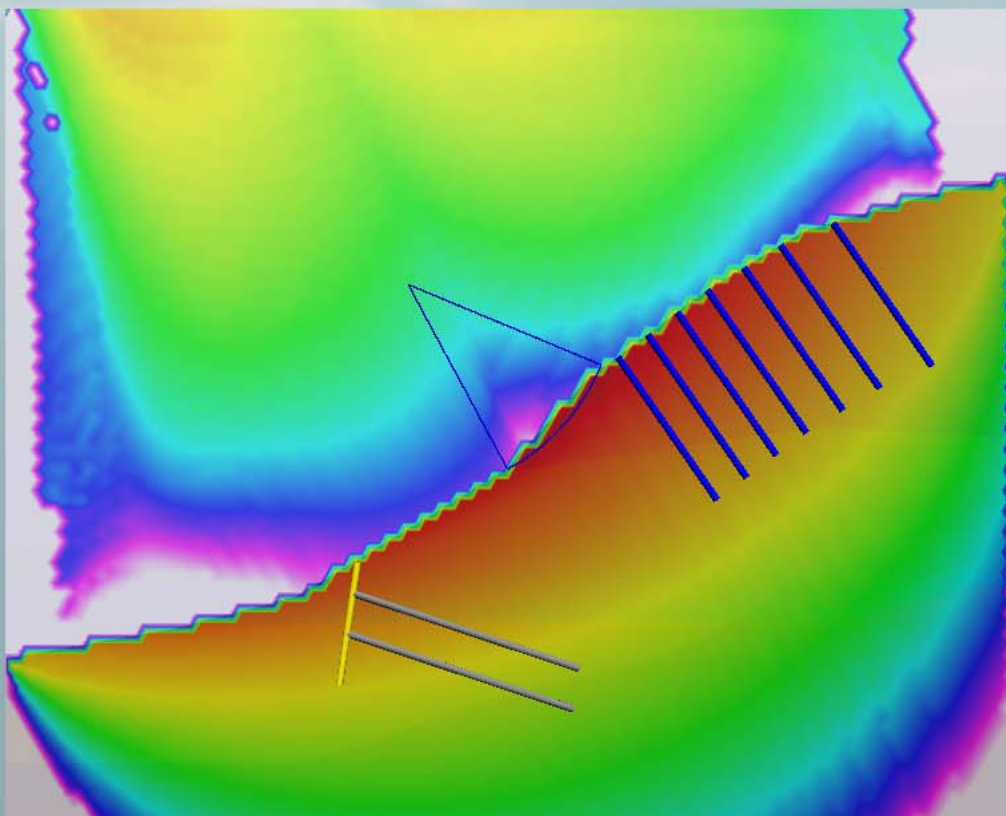
Hierarchy
Create + All
Blob Light Projector
Enums
LSnap
Module_BookReader
Module_Chat
Module_DEM
Module_LSnap
Bishop
Data
Facing
Facing CastInPlace
Facing Coefficients
Facing Flexible
Facing Nail Coefficients
Facing Shotcrete
Facings
Flex
Nails
Plane
Plane Base
Plot
Report
Rockery
Seismics
Slope
SnWall
Soils
Surcharge
Tubes
Walls
Water
Module_Materials
Module_Project
Module_Rockery
Bishop
Input
Plane
Plot
Project
Report
Module_Server
Module_SlopeSection

Inspector
Package_Base
Tag Untagged
Transform
Position
X 0 Y 0
Rotation
X 0 Y 0
Scale
X 1 Y 1
Package_Base (S)
Script
Package
Info
Warning
Error
Project
Terrain
Module Gui Skin

Console
Clear Collapse Clear on play Error pause

Project
Create + All
Module_LSnap
Module_LSnap
Module_LSnap_Data
Module_LSnap_Data_Bars
Module_LSnap_Data_Coeffici
Module_LSnap_Data_Coeffici
Module_LSnap_Data_NailGeor
Module_LSnap_Data_Safety
Module_LSnap_Data_Seismic
Module_LSnap_Data_SlopeGe
Module_LSnap_Data_Soil

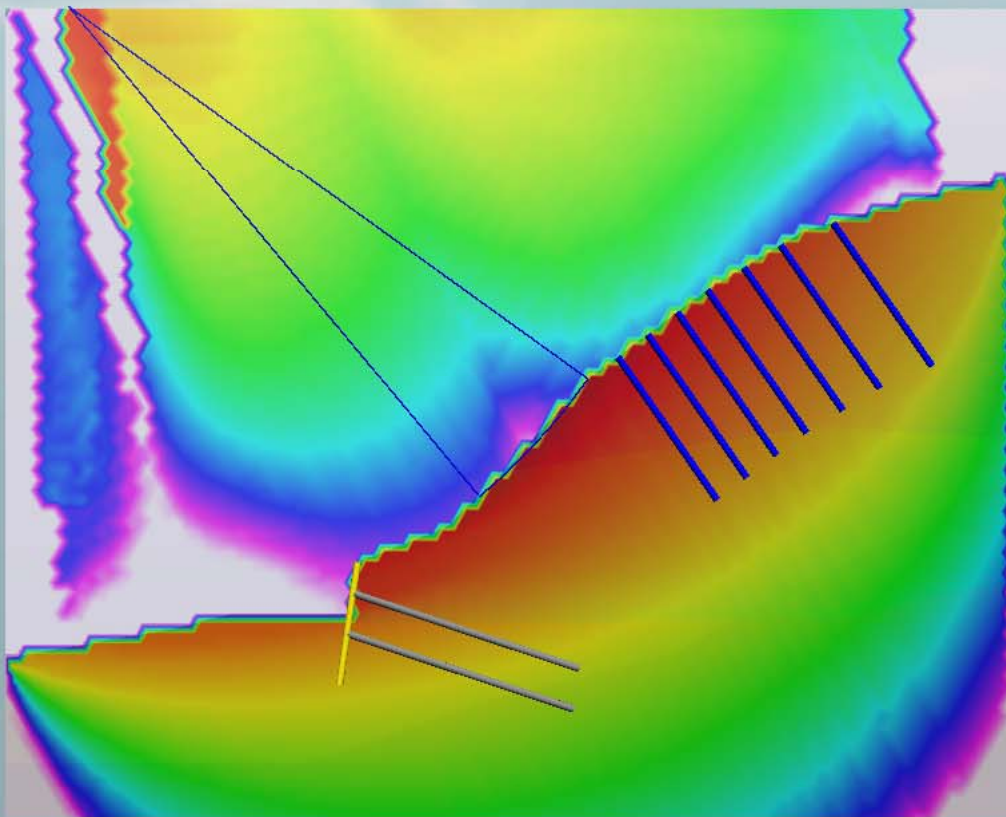
Fail_{Min} 2.06 m
Seismic
Scale 0.051
Center 1.061 m
Radius 3.5 m
FoS 0.64
Calc



LSnap Wall Modified Bishop global stability -- (internal failures through rockery excluded)

Hierarchy
Create + Q All
Blob Light Projector
Enums
LSnap
Module_BookReader
Module_Chat
Module_DEM
Module_LSnap
Bishop
Data
Facing
Facing CastInPlace
Facing Coefficients
Facing Flexible
Facing Nail Coefficients
Facing Shotcrete
Facings
Flex
Nails
Plane
Plane Base
Plot
Report
Rockery
Seismics
Slope
SNWall
Soils
Surcharge
Tubes
Walls
Water
Module_Materials
Module_Project
Module_Rockery
Bishop
Input
Plane
Plot
Project
Report
Module_Server
Module_SlopeSection
Project
Create + Q All
Module_LSnap
Module_LSnap
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data

Fail_{Min} 2.06 m
Seismic
Scale 0.051
Center -4.7, 10.8 m
Radius 10.7 m
FoS 0.59
Calc



LSnap Wall Modified Bishop global stability -- (internal failures through rockery excluded)

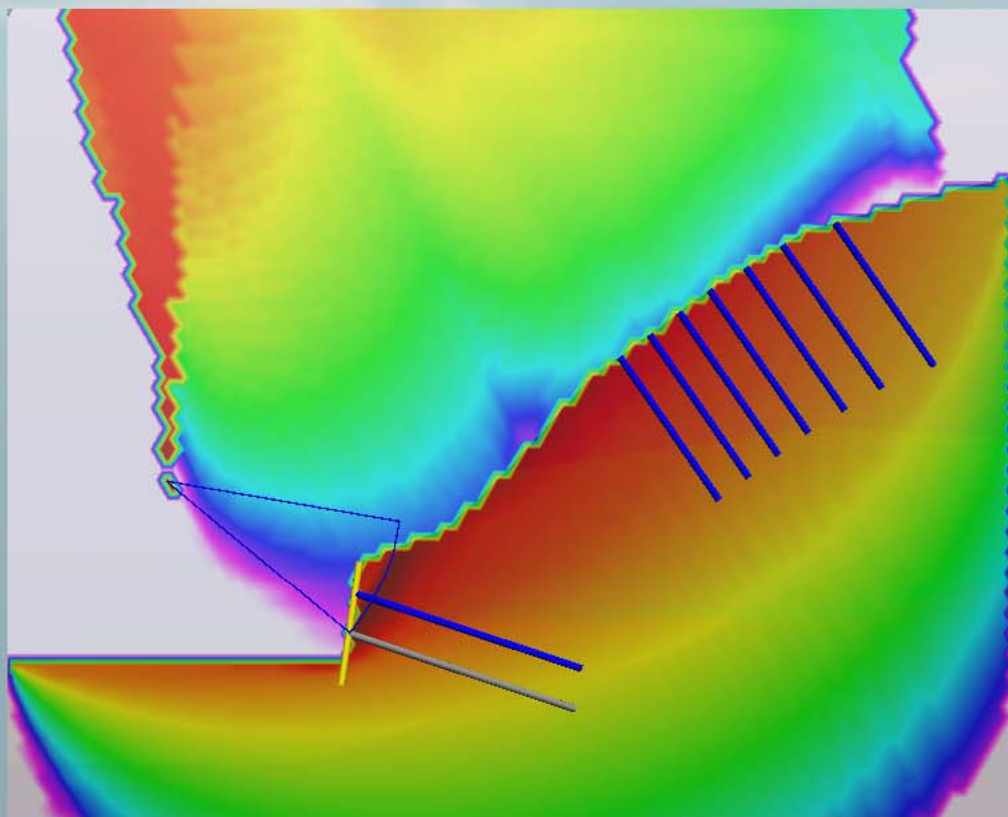
Hierarchy

- Create + All
- Blob Light Projector
- Enums
- LSnap
 - Module_BookReader
 - Module_Chat
 - Module_DEM
 - Module_LSnap
 - Bishop
 - Data
 - Facing
 - Facing CastInPlace
 - Facing Coefficients
 - Facing Flexible
 - Facing Nail Coefficients
 - Facing Shotcrete
 - Facings
 - Flex
 - Nails
 - Plane
 - Plane Base
 - Plot
 - Report
 - Rockery
 - Seismics
 - Slope
 - SnWall
 - Soils
 - Surcharge
 - Tubes
 - Walls
 - Water
 - Module_Materials
 - Module_Project
 - Module_Rockery
 - Bishop
 - Input
 - Plane
 - Plot
 - Project
 - Report
 - Module_Server
 - Module_SlopeSection

Project

- Create + All
- Module_LSnap
- Module_LSnap
- Module_LSnap_Data
- Module_LSnap_Data
- Module_LSnap_Data
- Module_LSnap_Data
- Module_LSnap_Data
- Module_LSnap_Data
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- Module_LSnap_Data
- Module_LSnap_Data

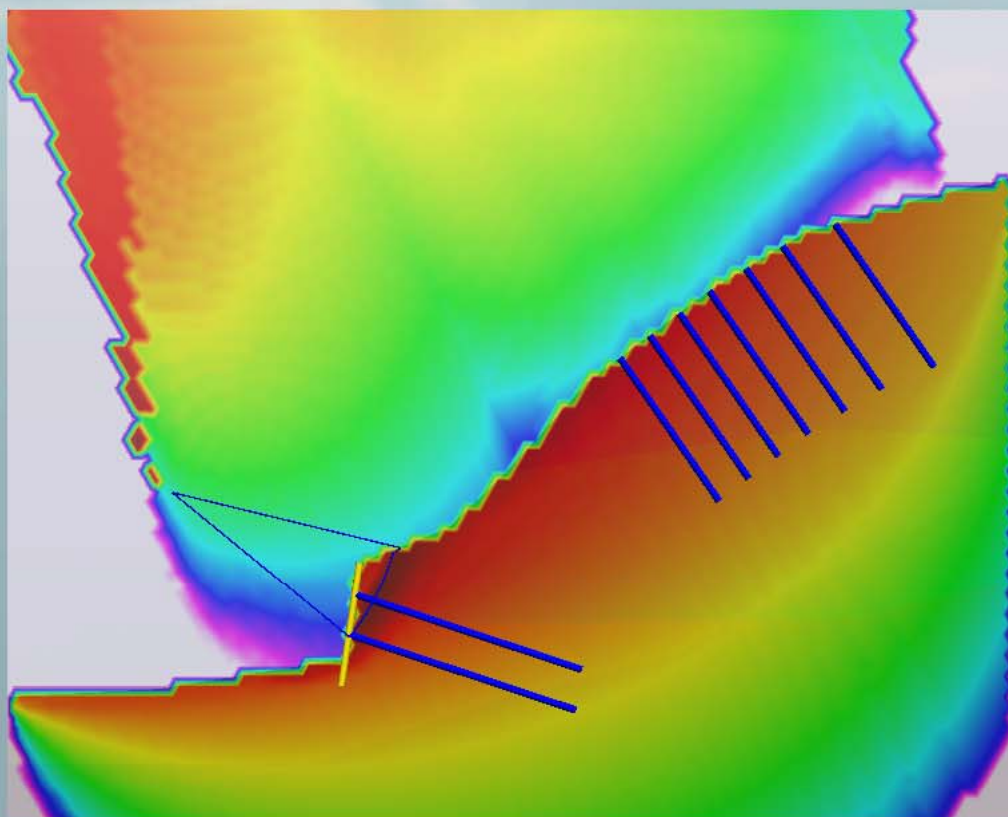
Fail_{Min} 2.06 m
Seismic
Scale 0.051
Center -3.128 m
Radius 4.0 m
FoS 0.39
Calc



LSnap Wall Modified Bishop global stability -- (internal failures through rockery excluded)

Hierarchy
Create All
Blob Light Projector
Enums
LSnap
Module_BookReader
Module_Chat
Module_DEM
Module_LSnap
Bishop
Data
Facing
Facing CastInPlace
Facing Coefficients
Facing Flexible
Facing Nail Coefficients
Facing Shotcrete
Facings
Flex
Nails
Plane
Plane Base
Plot
Report
Rockery
Seismics
Slope
SnWall
Soils
Surcharge
Tubes
Walls
Water
Module_Materials
Module_Project
Module_Rockery
Bishop
Input
Plane
Plot
Project
Report
Module_Server
Module_SlopeSection
Project
Create All
Module_LSnap
Module_LSnap
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data

Fail_{Min} 2.06 m
Seismic
Scale 0.051
Center -30.26 m
Radius 3.8 m
FoS 0.39
Calc



LSnap Wall Modified Bishop global stability -- (internal failures through rockery excluded)

Hierarchy
Create + Q All
Blob Light Projector
Enums
LSnap
Module_BookReader
Module_Chat
Module_DEM
Module_LSnap
Bishop
Data
Facing
Facing CastInPlace
Facing Coefficients
Facing Flexible
Facing Nail Coefficients
Facing Shotcrete
Facings
Flex
Nails
Plane
Plane Base
Plot
Report
Rockery
Seismics
Slope
SNWall
Soils
Surcharge
Tubes
Walls
Water
Module_Materials
Module_Project
Module_Rockery
Bishop
Input
Plane
Plot
Project
Report
Module_Server
Module_SlopeSection
Project
Create + Q All
Module_LSnap
Module_LSnap
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data
Module_LSnap_Data

- Slope
- Soils
- Water
- Drilled Nails
- Launched Nails
- Facings
- Shotcrete 1
- Flexible 1
- Walls
- SN Wall 1
- Flex 1
- SN Wall 2
- Surcharge
- Seismics
- Plot
- Bishop**
- Report

Construction # 17

MinDepth 3.0 ft

Resolution 0.7

Layers

Seismics

Shear 30

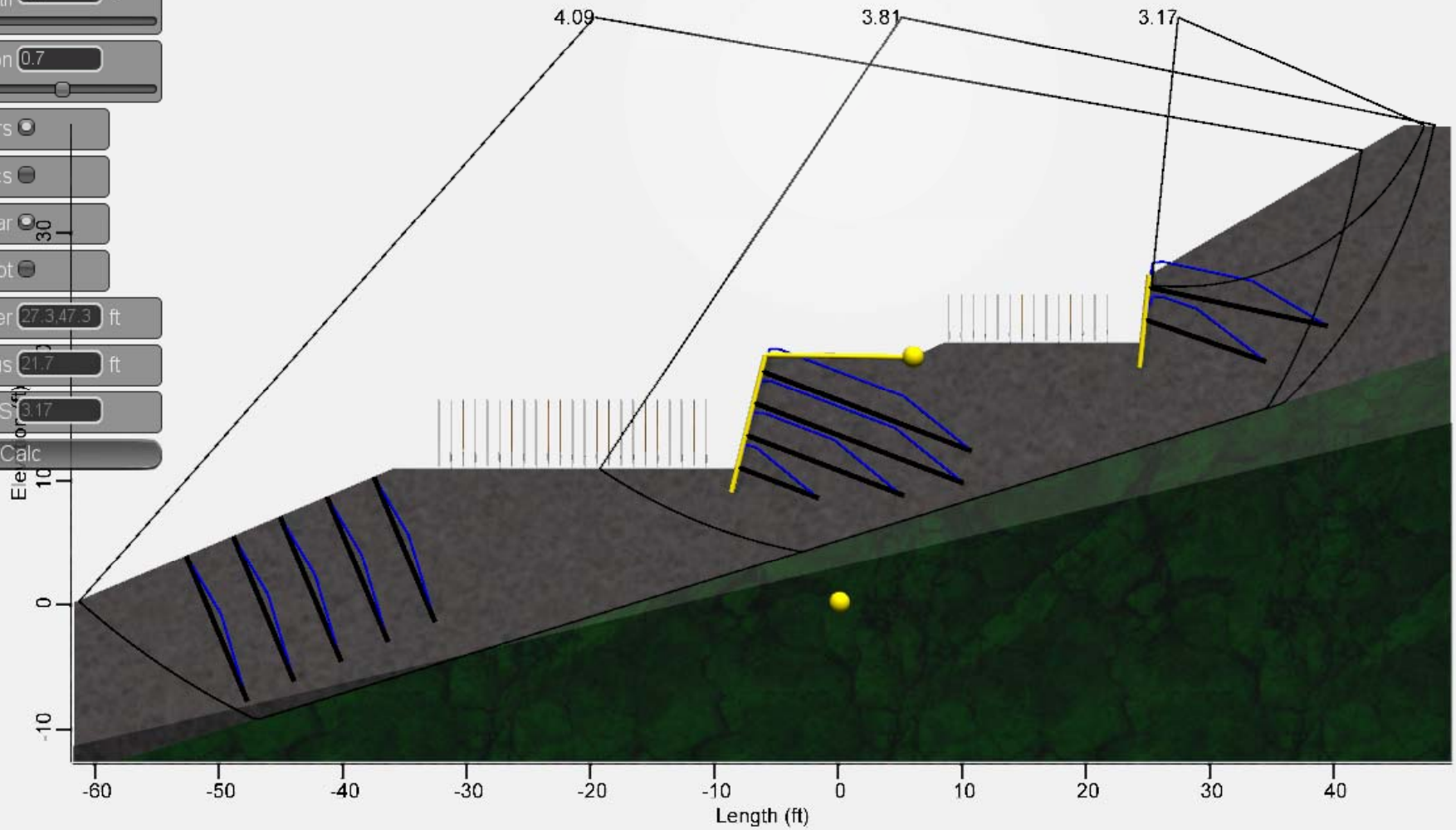
Show Plot

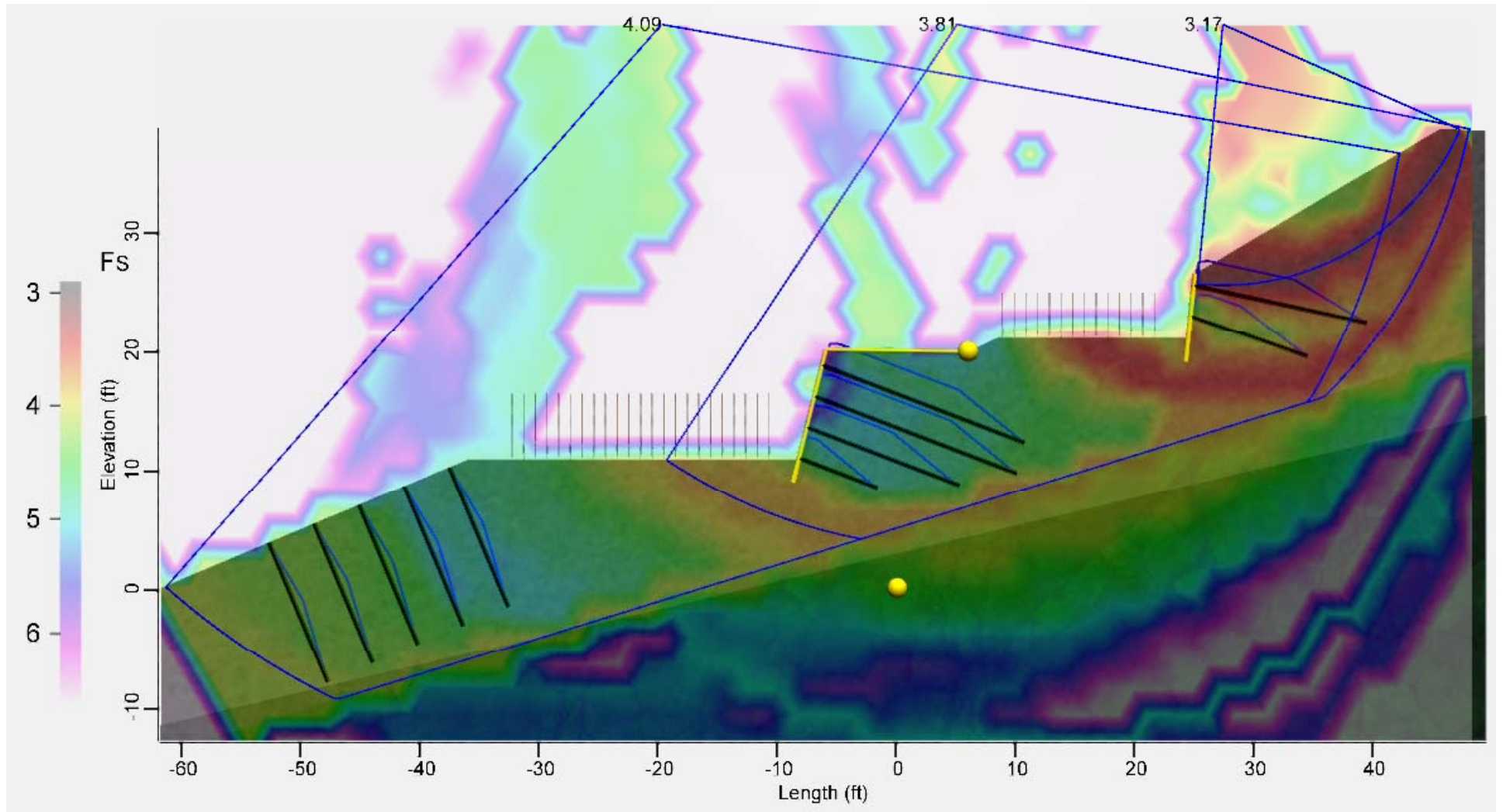
Center 27.3473 ft

Radius 21.7 ft

FoS 3.17

Calc





Projects LSnap

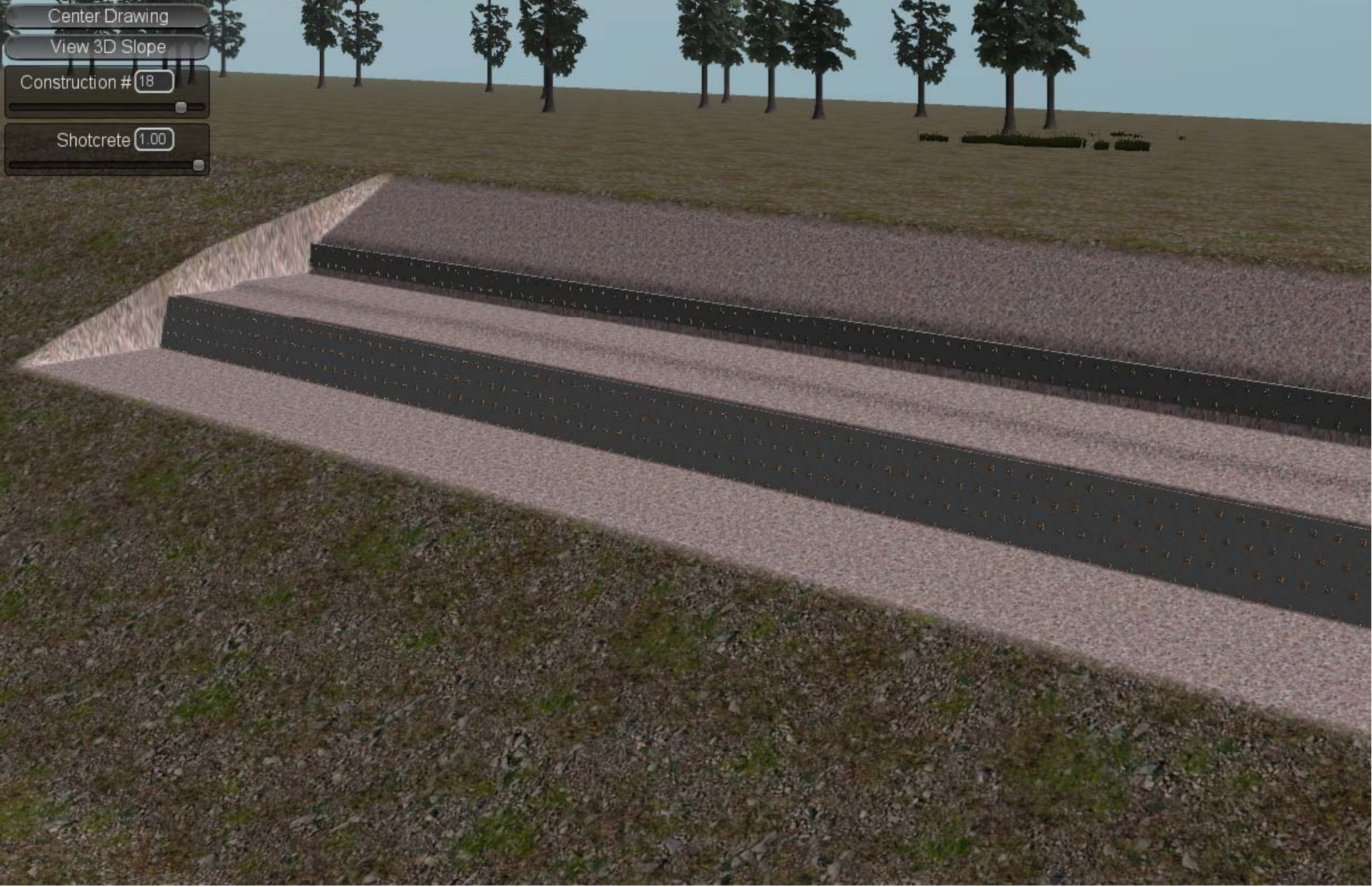
- Slope
- Soils
- Water
- Drilled Nails
- Launched Nails
- Facings
- Shotcrete 1
- Flexible 1
- Walls
- SN Wall 1
- Flex 1
- SN Wall 2
- Surcharge
- Seismics
- Plot
- Bishop
- Report

Center Drawing

View 3D Slope

Construction # 18

Shotcrete 1.00



Projects LSnap

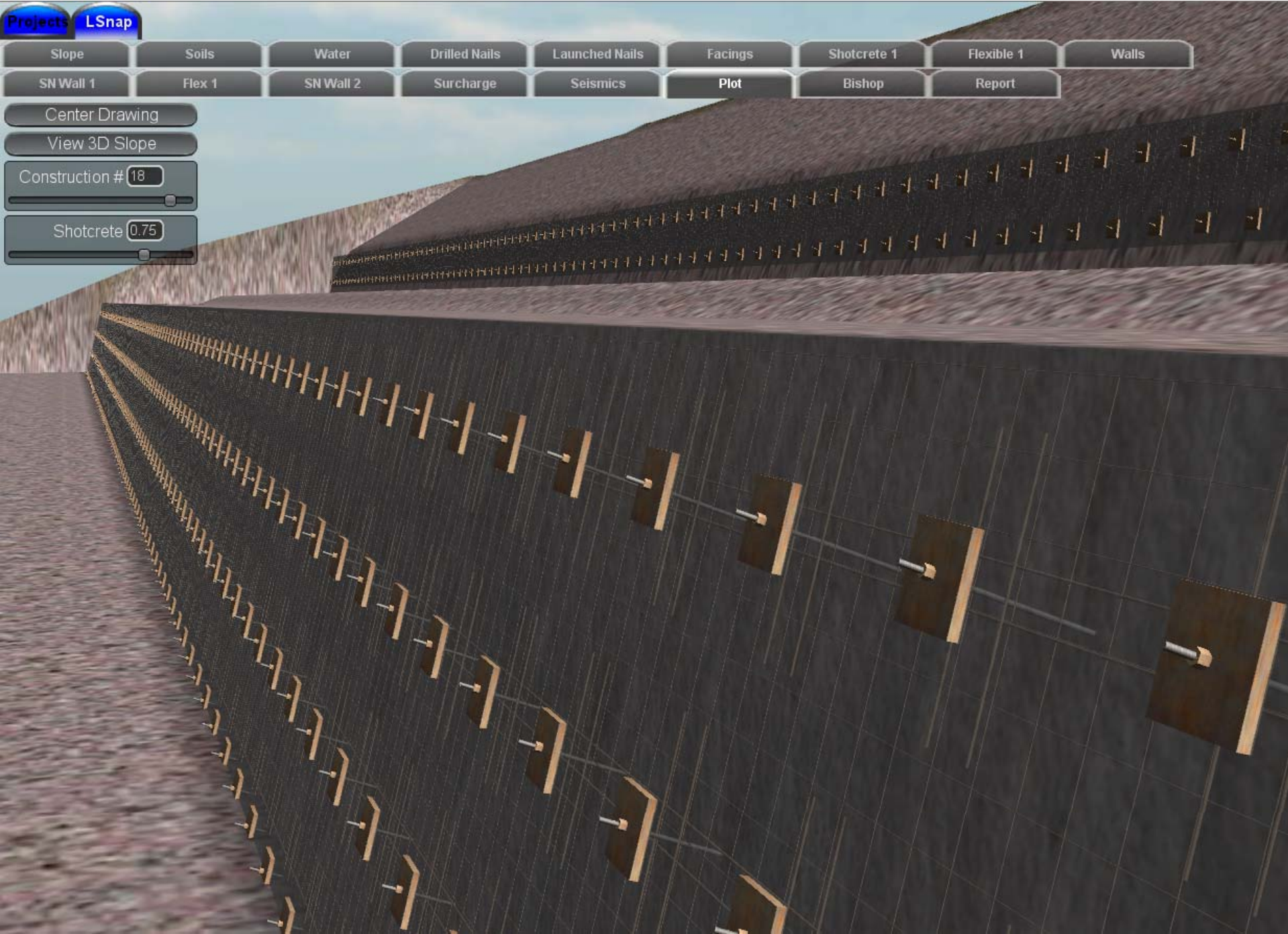
- Slope
- Soils
- Water
- Drilled Nails
- Launched Nails
- Facings
- Shotcrete 1
- Flexible 1
- Walls
- SN Wall 1
- Flex 1
- SN Wall 2
- Surcharge
- Seismics
- Plot
- Bishop
- Report

Center Drawing

View 3D Slope

Construction # 18

Shotcrete 0.75















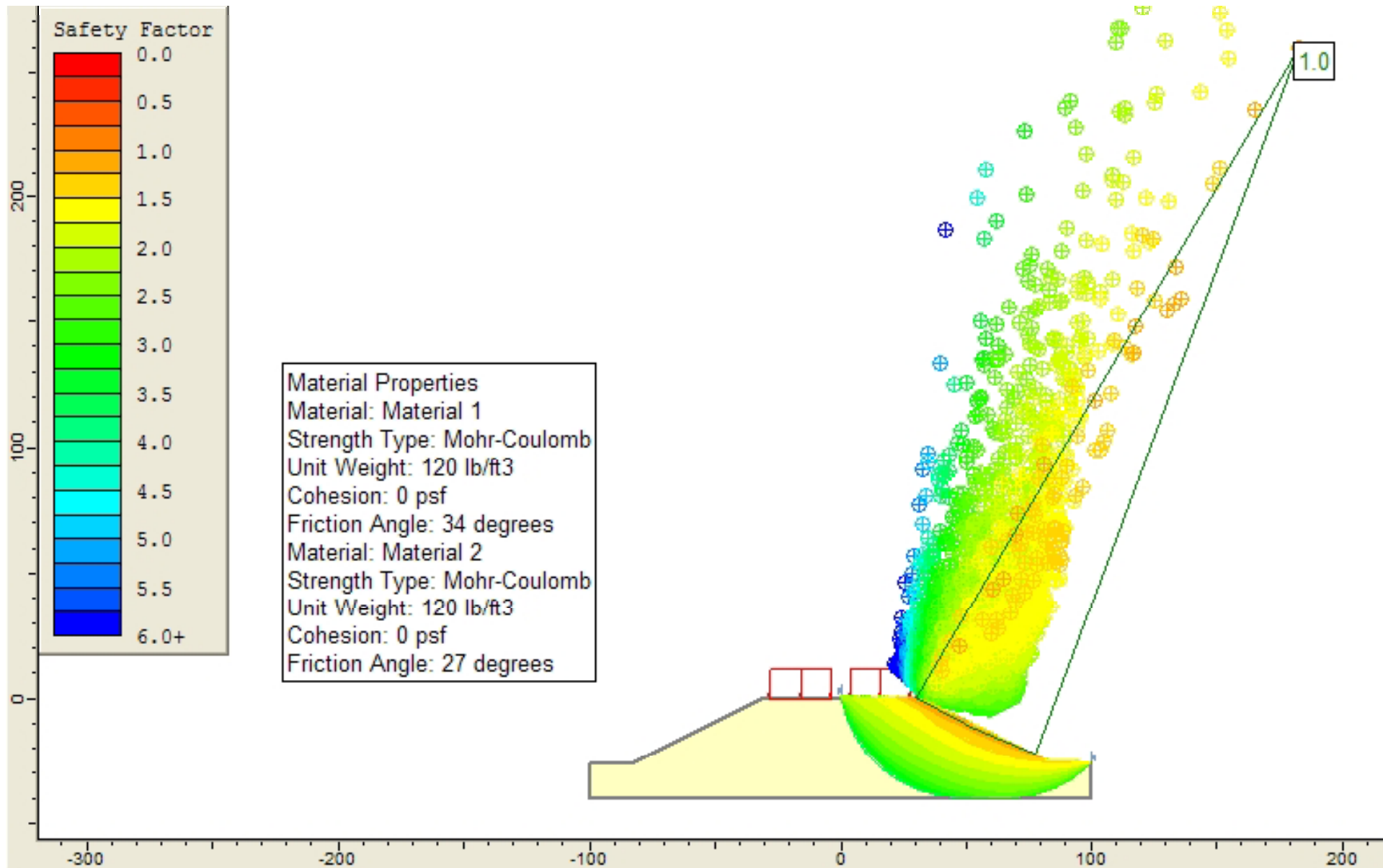


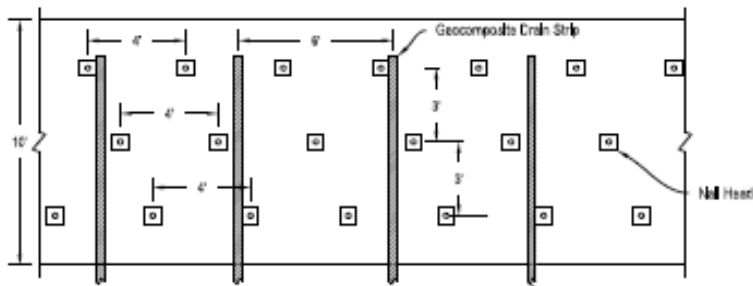








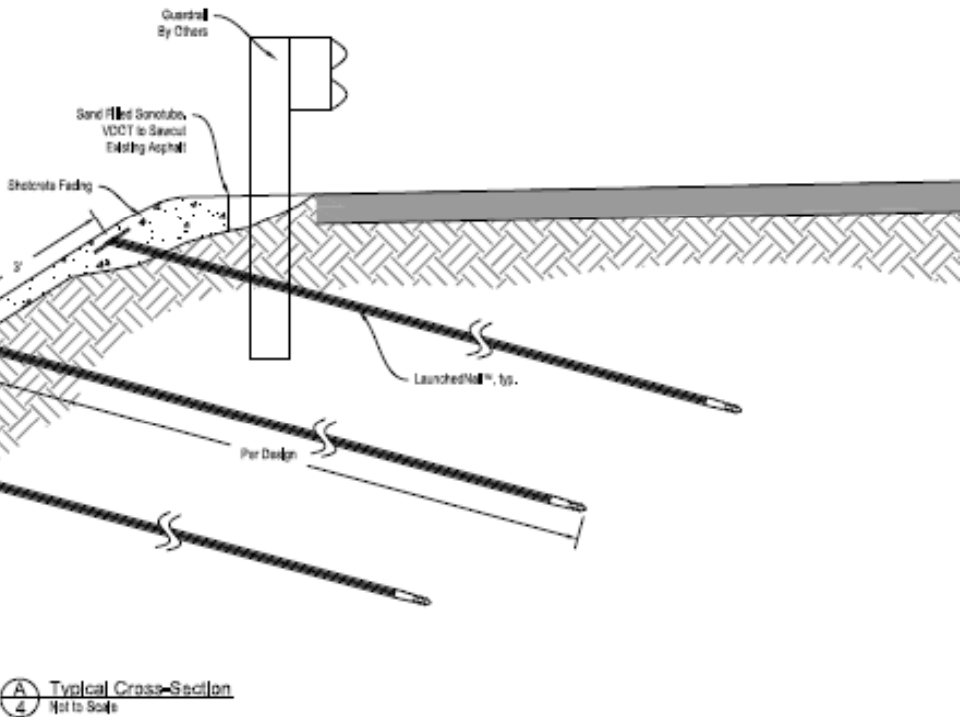




Extend Geocomposite Drain Strip Below Shotcrete Wall, typ.

Shotcrete Shoulder Build Up 40 LF

Minor Excavation To Be Accomplished Prior To Launched Nail Installation.



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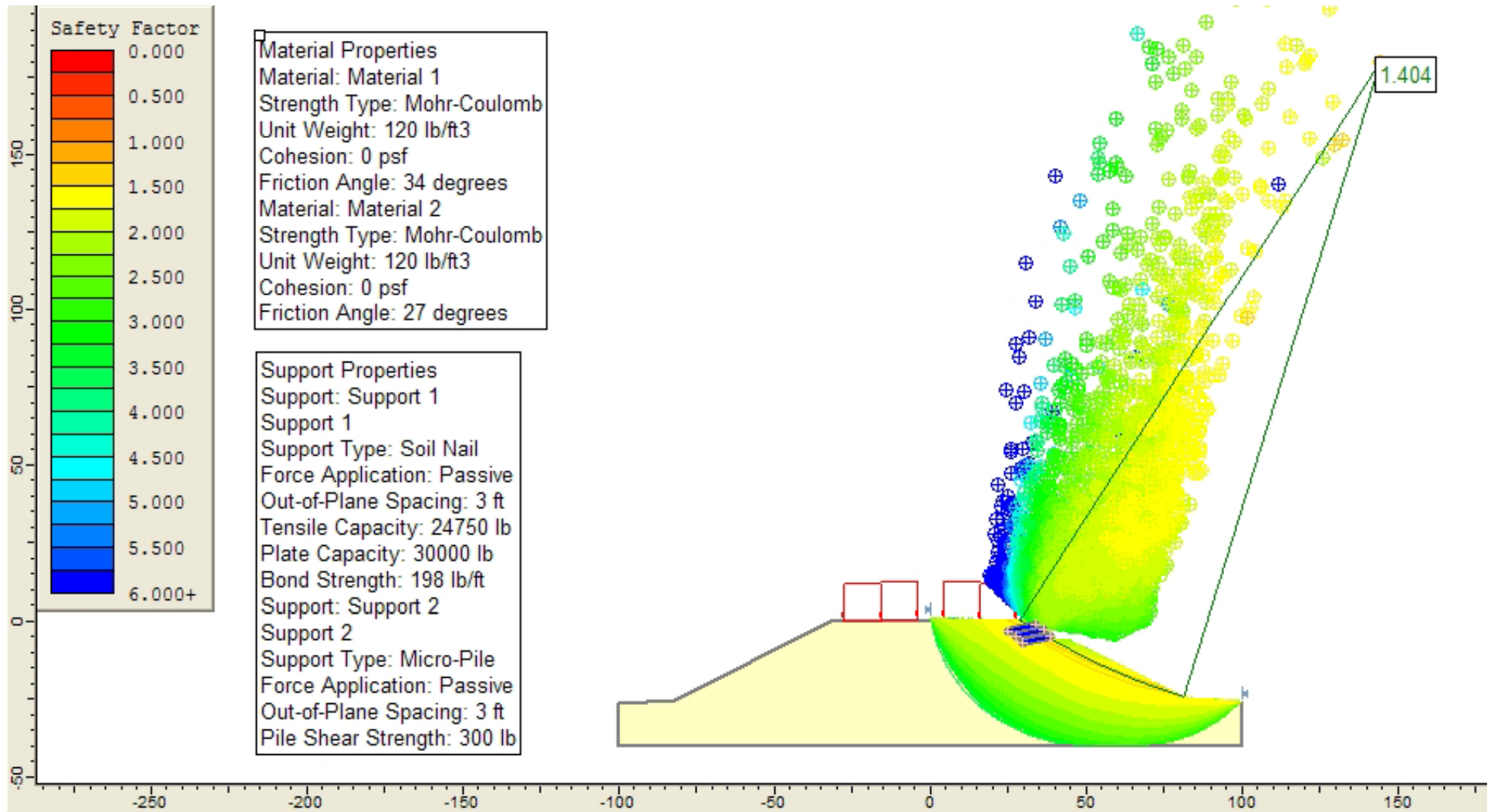
Sheet Revision	
Date	By

Typical Cross-Section (Shoulder Build Up)	
Project: Route 58 at 29 Business	Drawn By: NRB
Date: January 12, 2010	Checked By:

Project No./Code
Sheet No. 4



Soil Nail Launcher, Inc.
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Grand Junction, CO 81502
(979) 214-6170
colby@snli.com
www.soilnailauncher.com











2008









2012



















Parking Lot 6, TOSV

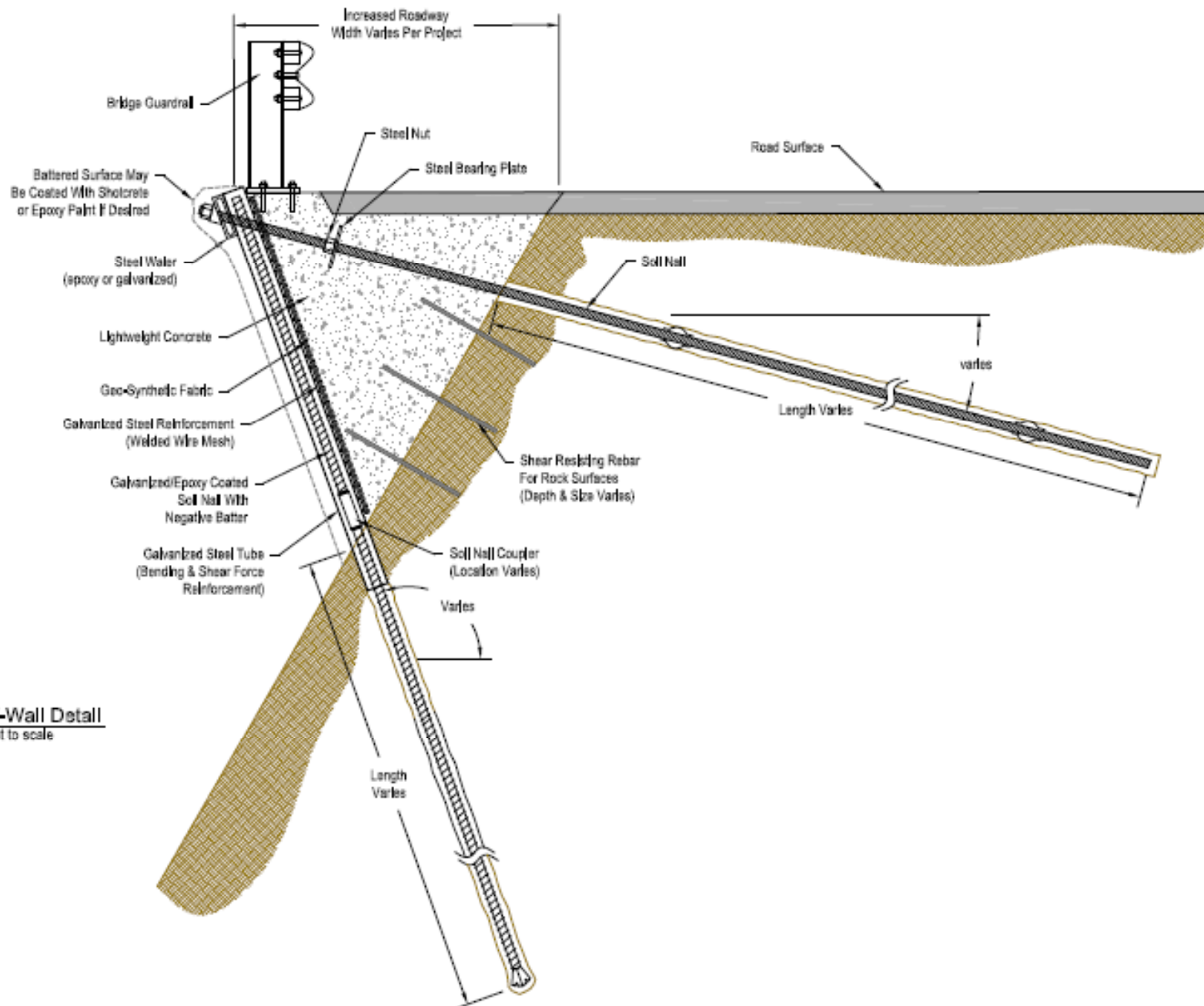






Case Study – Route 621, VA





A V-Wall Detail
 1 not to scale

















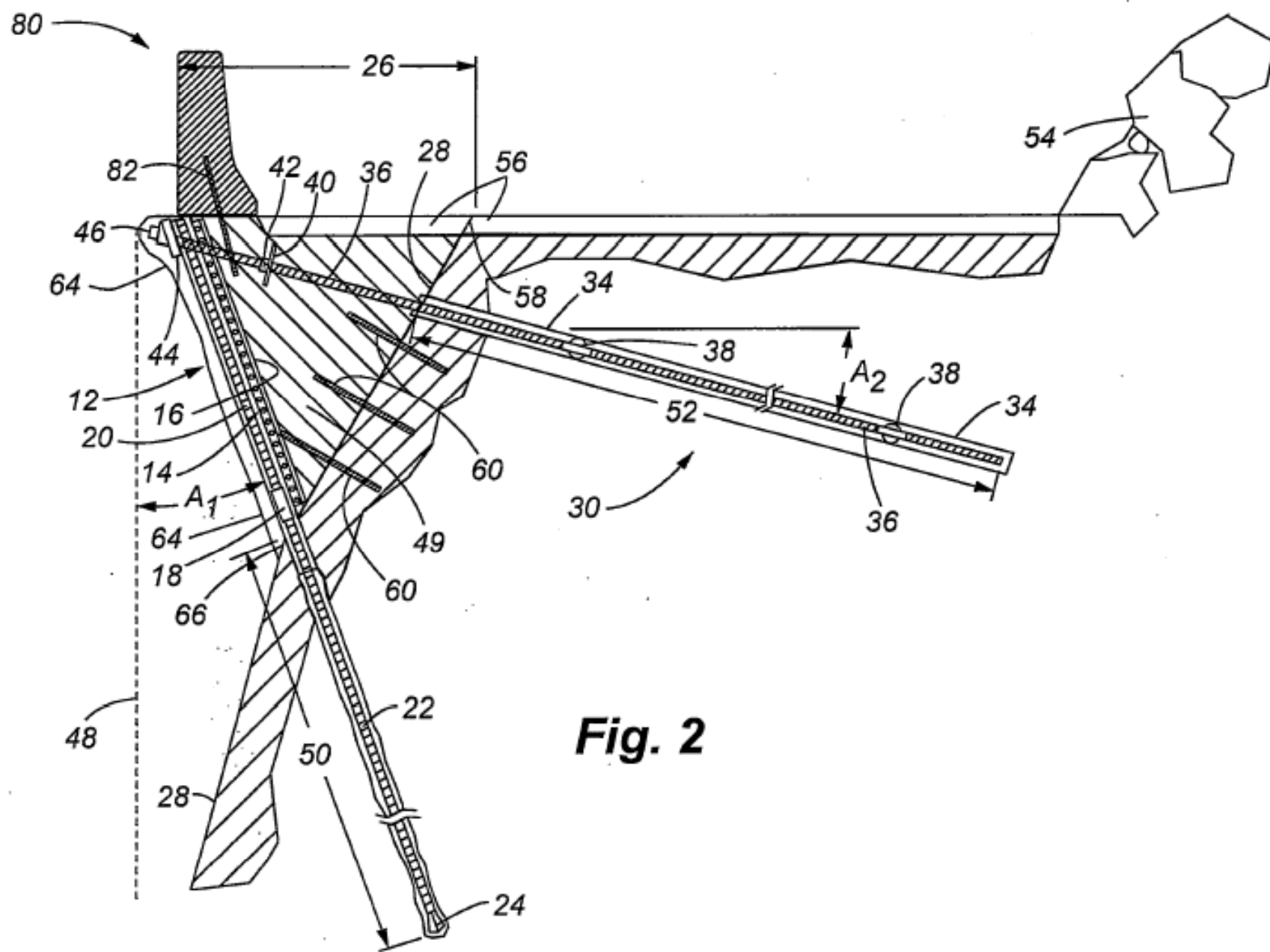
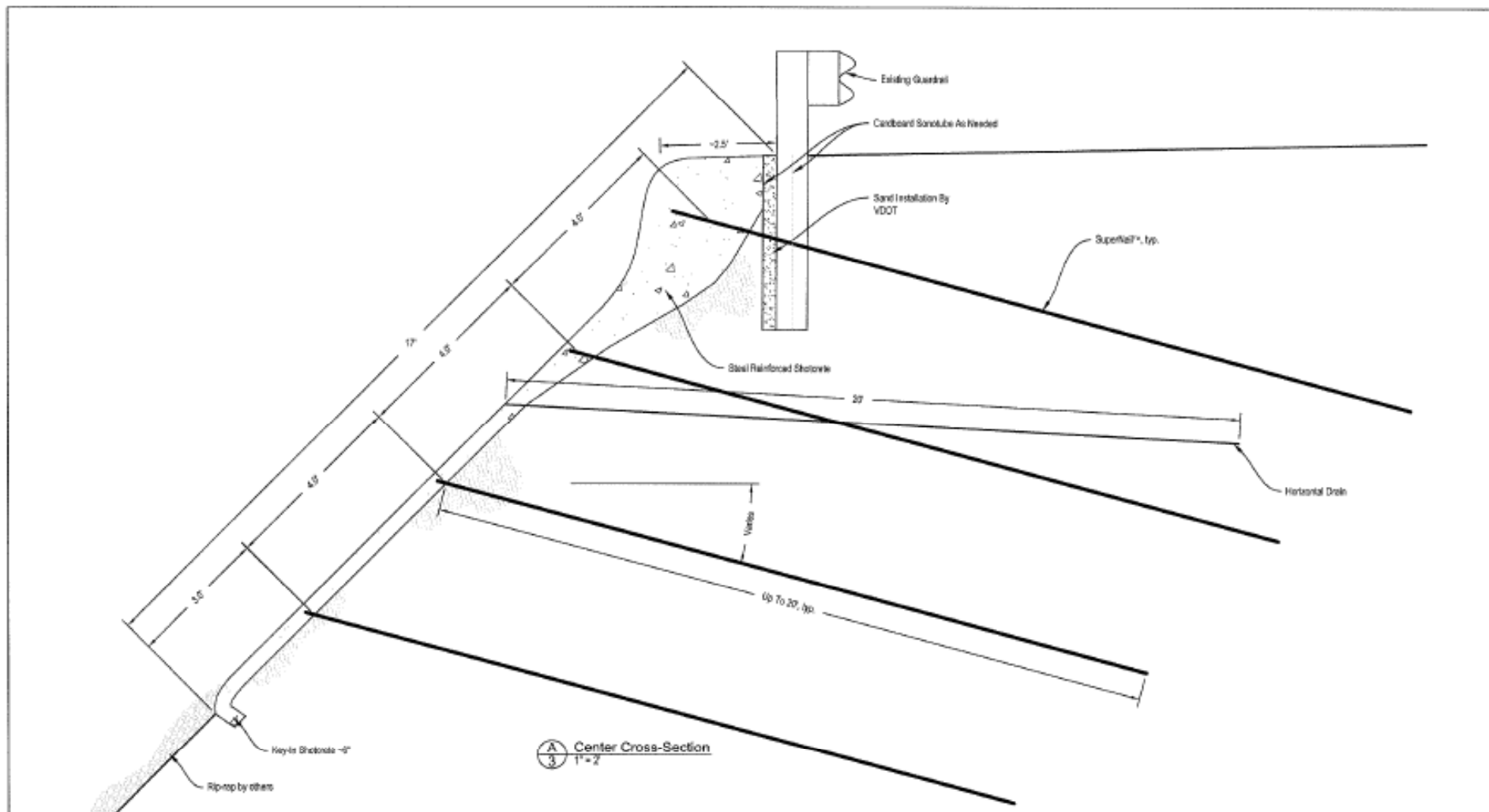


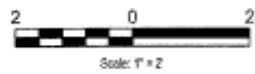
Fig. 2







Center Cross-Section
1" = 2'



Sheet Revision		
Date	Description	By
3/20/09	as-built dimensions	NRB

Typical Cross-Section	
Project: Route 39, Rockbridge County	Drawn By: NRB
Date: April 21, 2009	Checked By:

Project No./Code: 2009-331
Sheet No.: 3



Soil Nail Launcher, Inc.
988 Malachite Drive
Fruita, CO 81521
(970) 210-6170
colby@snl.com
www.soilnaillauncher.com









Carroll County, VA - SR-765 Emergency Rock Slide Repair (VDOT)





- Drilled into the boulders and injected an Expansive Demolition Agent



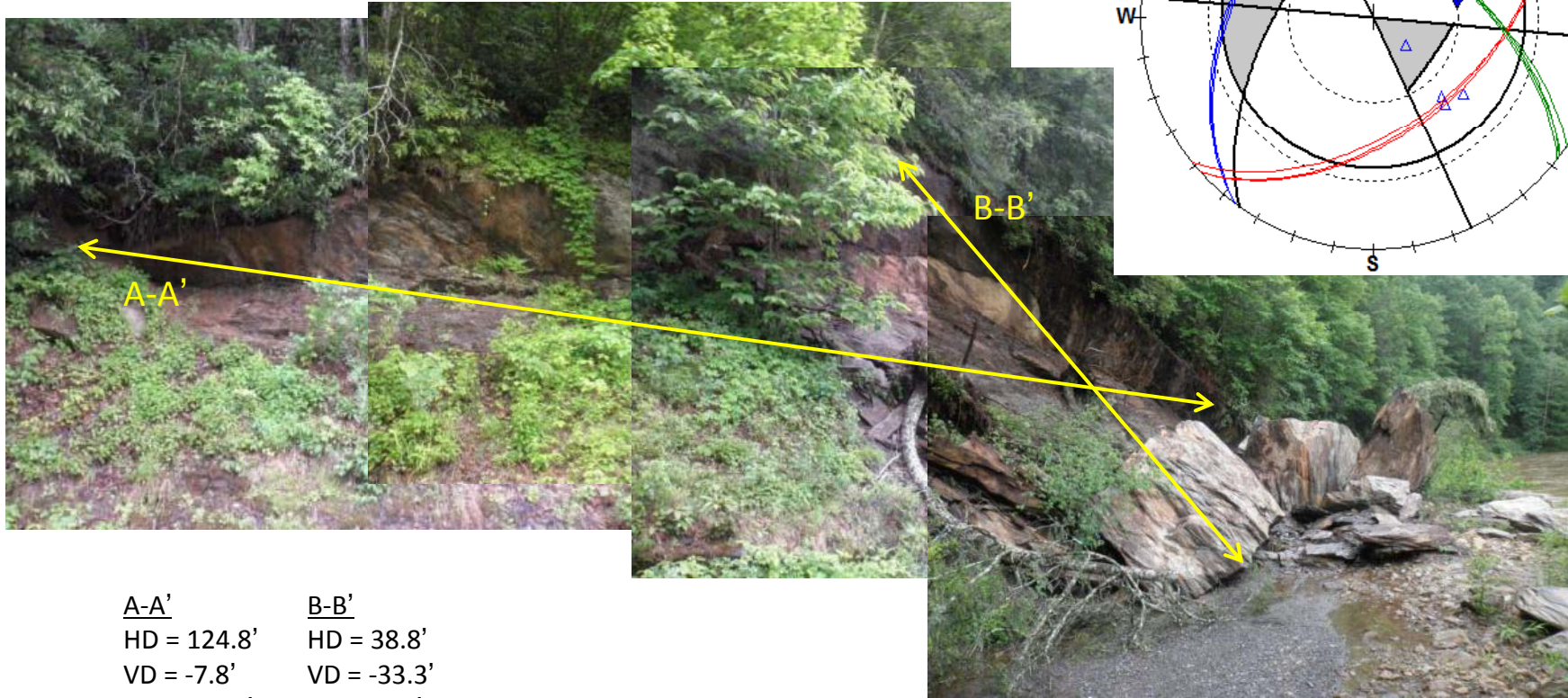
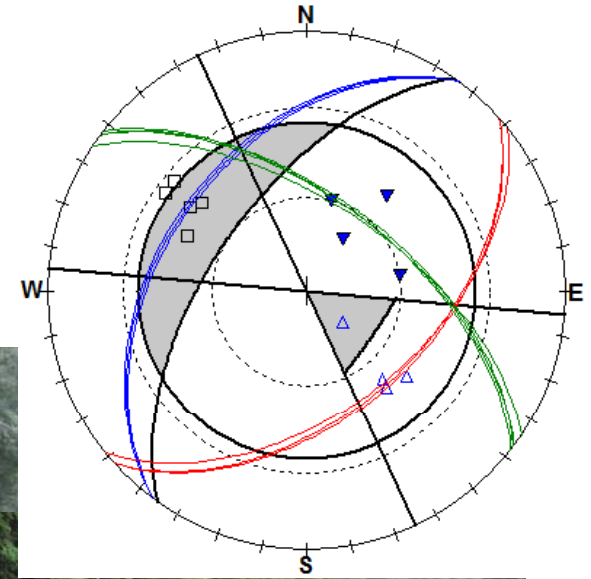
- Left overnight the expansive agent breaks the block into manageable pieces
- VDOT was able to haul off the broken boulders

3 Repair Options

1. Retaining Wall Buttress
2. Post-Tensioned Rock Bolts
3. Ignore / Clear Rock from Roadway



Joint Set I – Blue
 Joint Set II – Red
 Joint Set III - Green



<u>A-A'</u>	<u>B-B'</u>
HD = 124.8'	HD = 38.8'
VD = -7.8'	VD = -33.3'
SD = 125.1'	SD = 51.1'
INC = -3.6°	INC = -40.7°
AZ = 228.7°	AZ = 279.0°

Site Survey:

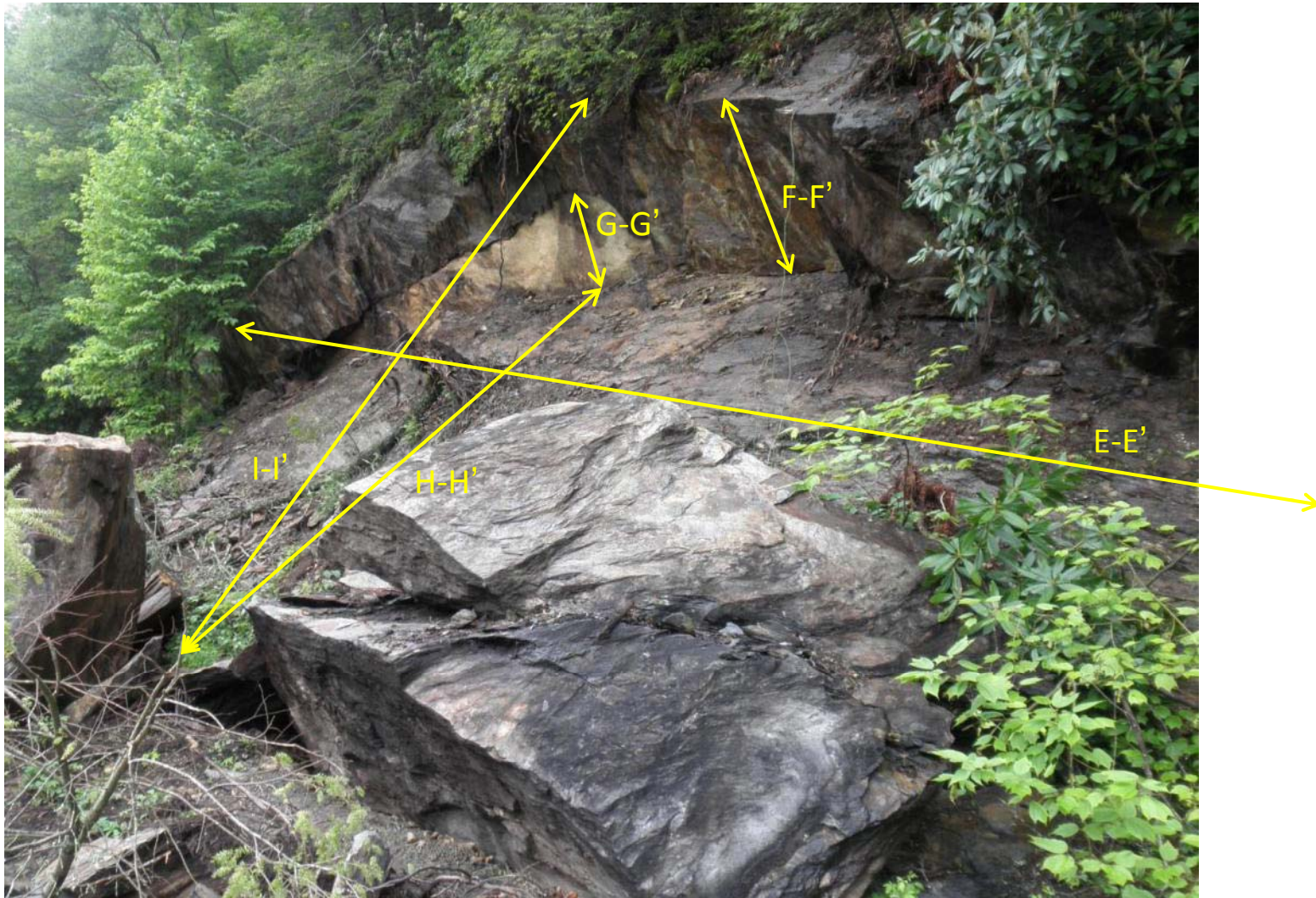
- Skip Watts –Radford University
- Brendan Fisher – Fisher & Strickler Rock Engineering



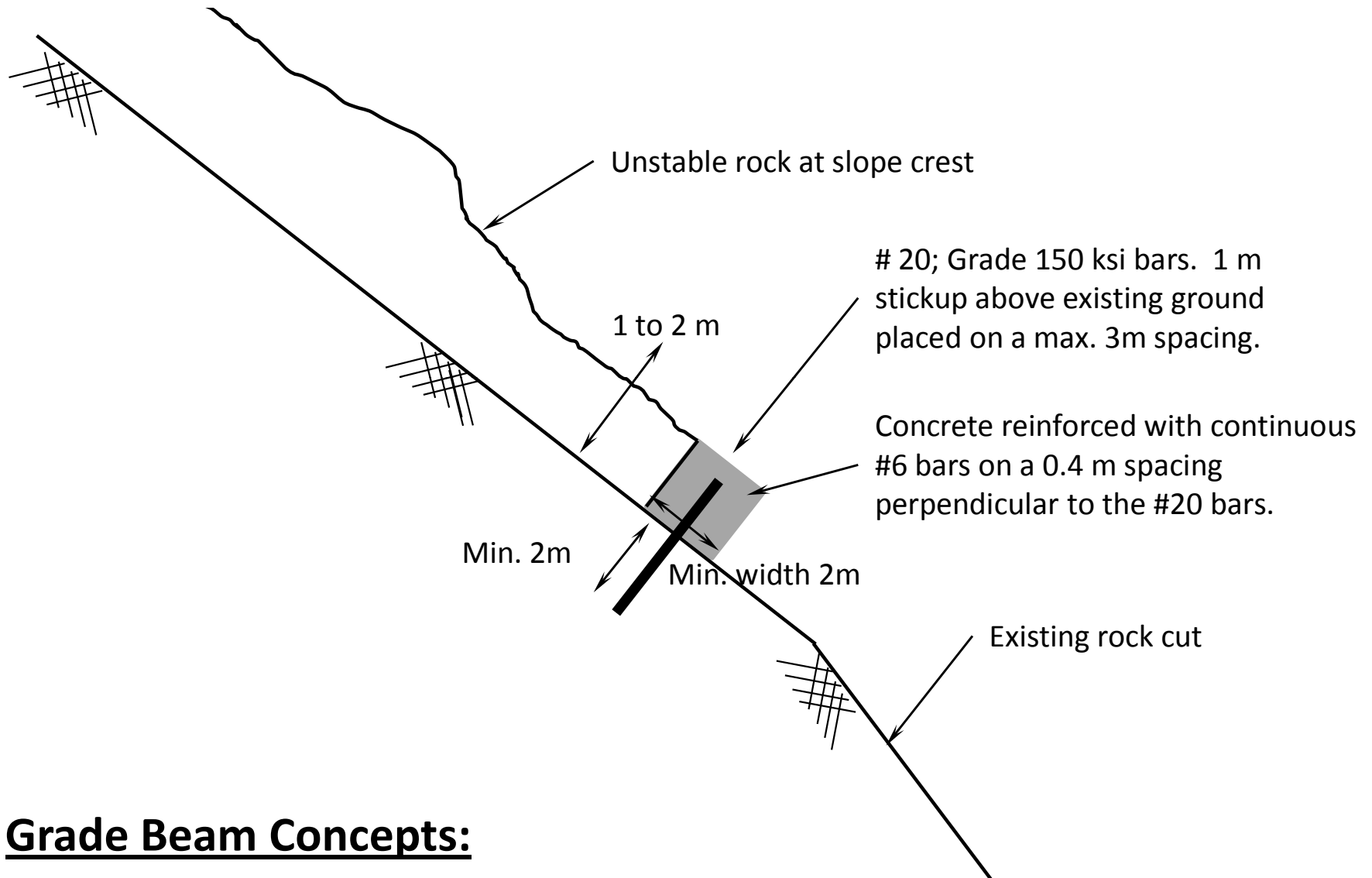
<u>C-C'</u>	<u>D-D'</u>
HD = 6.8'	HD = 3.4'
VD = -16.2'	VD = -10.4'
SD = 17.5'	SD = 10.9'
INC = -67.8°	INC = -71.6°
AZ = 220.8°	AZ = 207.9°

Site Survey:

- Joint between unstable and stable material - 40 deg
- Upslope Distance – 50 feet



<u>E-E'</u>	<u>F-F'</u>	<u>G-G'</u>	<u>H-H'</u>	<u>I-I'</u>
HD = 99'	HD = 7.8'	HD = 1.4'	HD = 22.4'	HD = 31'
VD = -15'	VD = -4.6'	VD = -5.7'	VD = -19.6'	VD = -30'
SD = 100'	SD = 9.1'	SD = 5.9'	SD = 29.8'	SD = 43'
INC = -8.5°	INC = -29.9°	INC = -76.2°	INC = -41.2°	INC = -44.4°
AZ = 227.4°	AZ = 97.6°	AZ = 128.7°	AZ = 319.5°	AZ = 264.3°



Grade Beam Concepts:

- Fisher and Strickler Engineering
- Used by WSDOT

Grade Beam Design Allowed Our Crews to Work Safely Under Stabilized Material

Grade Beam Example: Washington State



Figure D-13

Grade beam design by Wyllie & Norrish for a WSDOT project



Grade Beam Example:
Washington State

Figure D-15

Grade beam design by Wyllie & Norrish for a WSDOT project





Construction:

- 150 L.F. of Repair
- 8' anchors w/ 5' drilled into stable material
- 4-ft Tall on Ends – 7-ft Tall in the Center



Shotcrete:

- Placed in 12-inch lifts
- Reinforced with Rebar and WWM

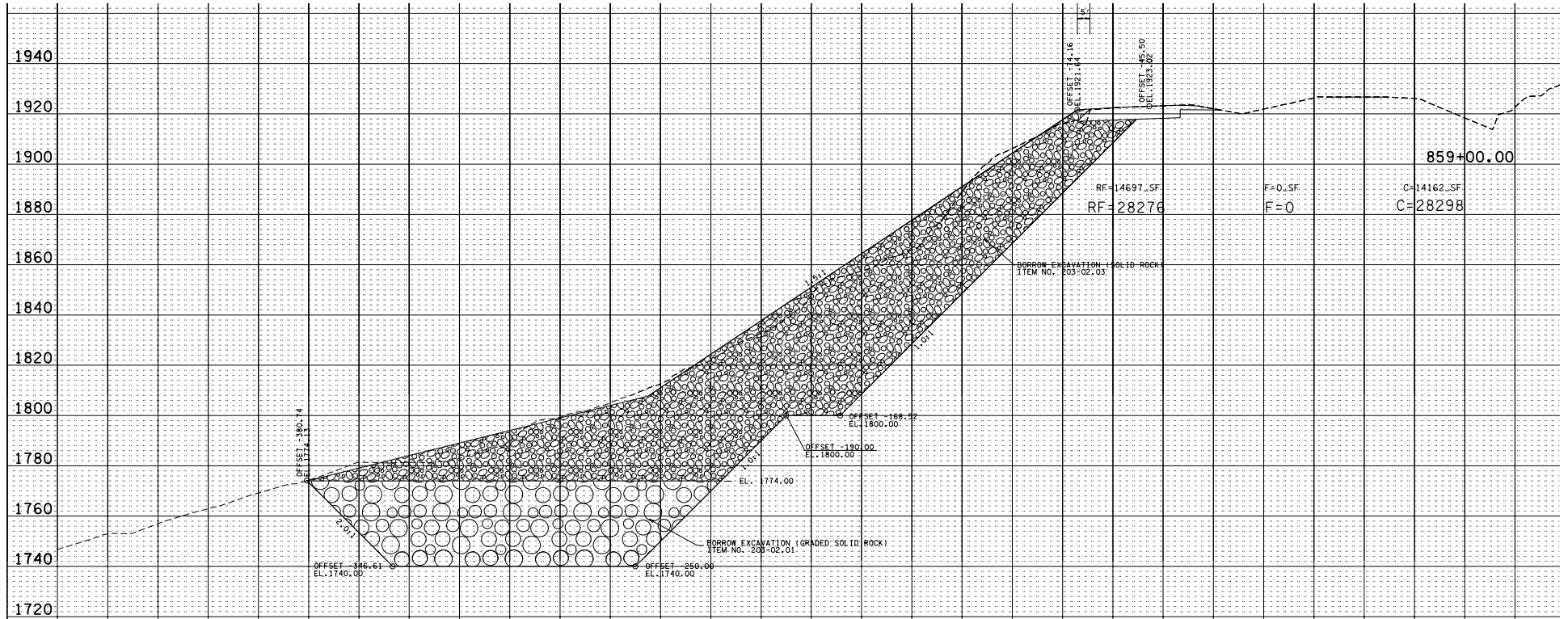




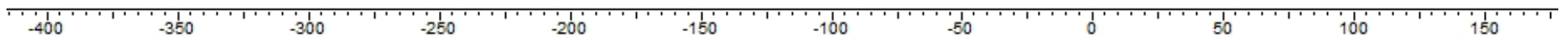
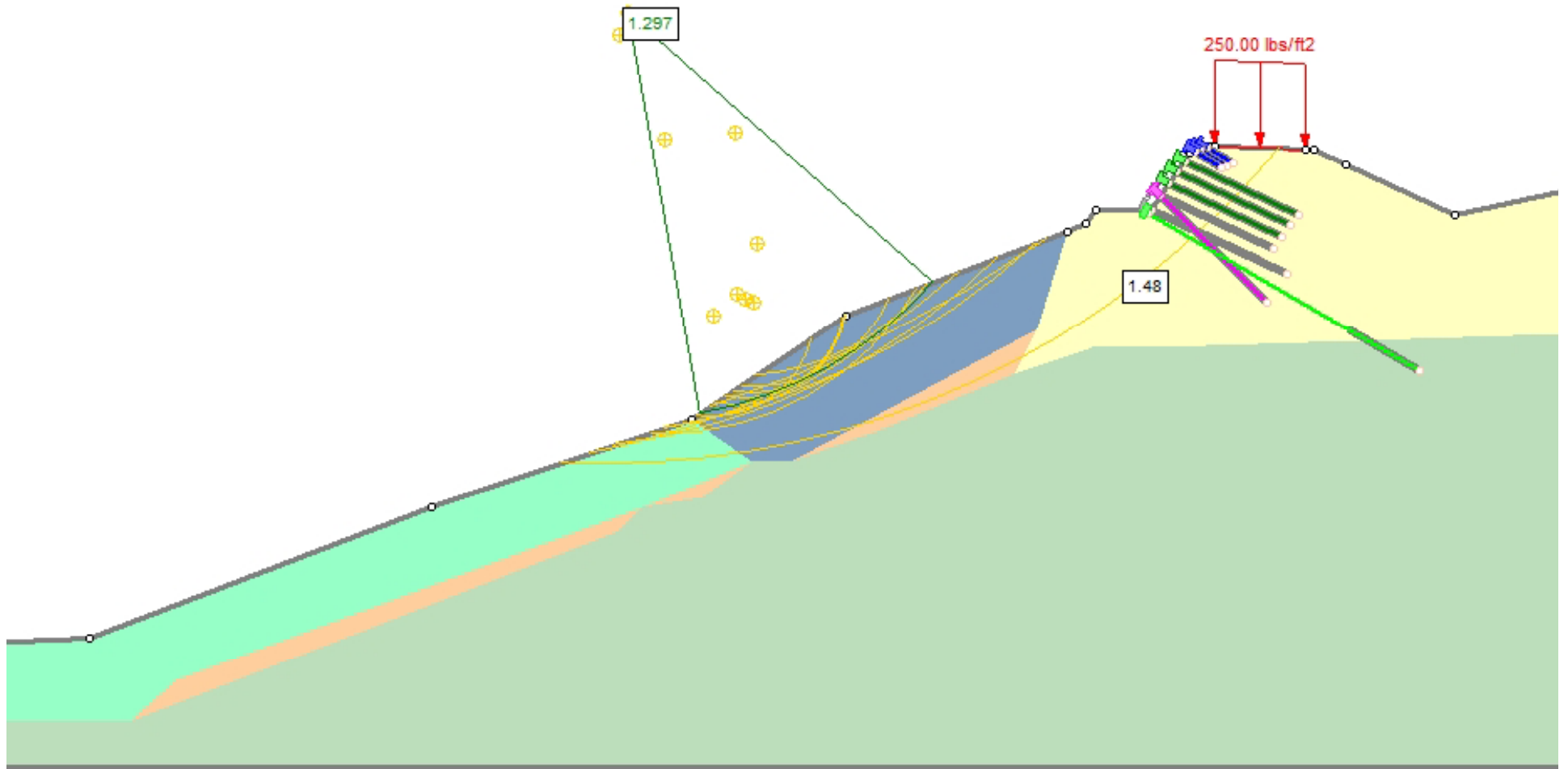


Case Study – I-75, TN







































Questions?

www.soilnaillauncher.com