

Using Geotechnical Numerical Tools to Support Typical Muck Excavation

Ceren Aydin, Joe Nietfeld, Raul Velasquez,
Contributor X

2025 Midwest Geotechnical Conference

September 23-25, 2025

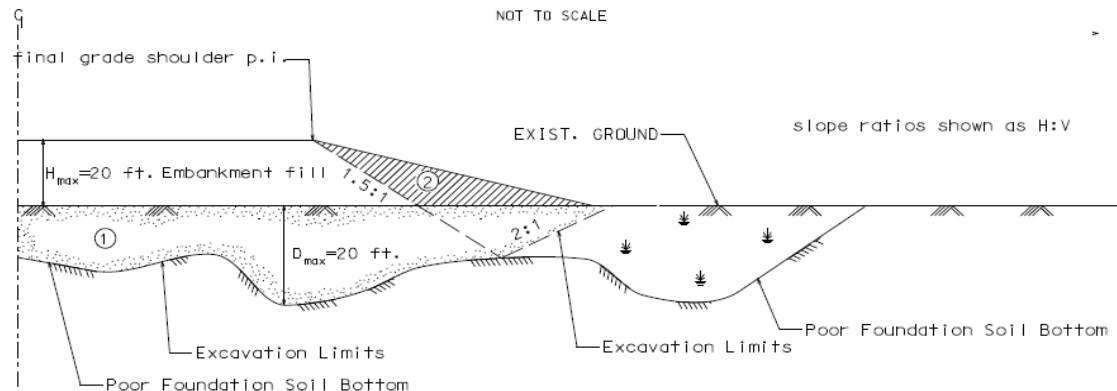
Sheraton City Centre Hotel, Indianapolis, Indiana

How Did It Start?

Review and revise subcut/embankment/muck excavation detail



POOR FOUNDATION SOIL
TYPICAL SUBCUT SECTION
Figure 4-2.02A
revised October 2020



notes:

This typical section may be used if all of the following apply:

- embankment fill is 20 ft. or less
- poor foundation soils depths (as measured by d_{max}) are 20 ft. or less
- poor foundation soil bottom slopes away from centerline at a 6:1 slope or flatter

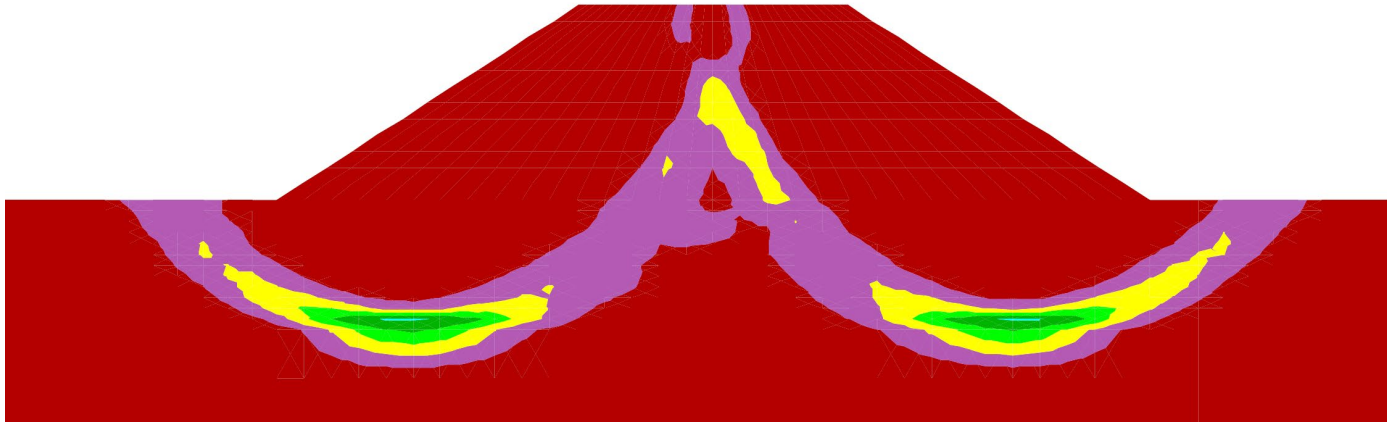
For higher embankments, deeper poor foundation soils and steeper sloping bottoms, consult the Geotechnical Engineering Section (Office of Materials).

- Excavate Poor Foundation Soils and backfill with suitable material (to be determined by Soils Engineer). Poor Foundation Soils consist of slightly organic soils ($\leq 5\%$ organic content by weight), marl, or other soils as directed by the Soils Engineer
- Disposal area and slope dressing. Place suitable or unsuitable backfill material as directed by the Soils Engineer. Place a maximum of 5 ft. of excavated poor foundation soil, do not place suitable grading material on top of organic soils.

Poor Foundation Soil –Typical Subcut Section

- Sensitivity Analysis:
 - **Stability (FOS)** for different slope dressing slopes & $D_{\max}$
 - Deformation (i.e., serviceability)
- Scenarios:
 - Road Core / Embankment (no slope dressing)
 - Embankment with slope dressing
 - Excavation of poor soil (construction sequence)
- “Typical” soil parameters used in analysis

Road Core / Embankment Assessment



In terms of stability (FOS), detail/cross section/design of road core is in good shape (based on typical soil parameters assumed for the analyses)

Embankment with Slope Dressing Assessment

Given uncertainties of soil properties and geometry, the following is assumed for analyses:

- Failure => very low FOS (~ 1.1)
- Stable under undrained conditions => $FOS > 1.3$
- ***Slope dressing slope (H:V) => 2.5:1, 3:1, 4:1, 5:1 and 6:1***
- Slope dressing material is a mix of suitable and unsuitable materials
- Poor foundation soil, bottom slopes away from the centerline at a 6:1 slope
- $D_{\max} = 25$ ft (poor foundation soil bottom) deep cleanout
- $D_{\max} = 10$ ft (poor foundation soil bottom) shallow cleanout

Embankment with Slope Dressing Assessment

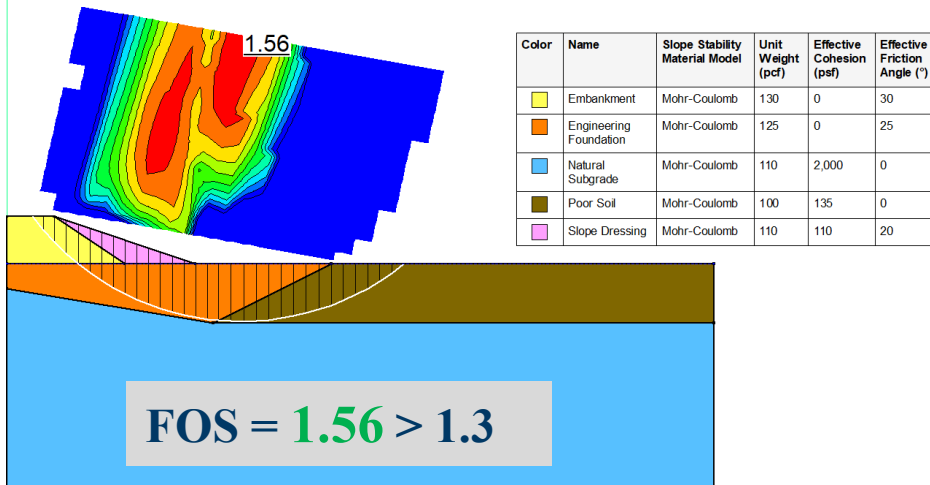
$D_{\max} = 25$ ft Deep cleanout

$D_{\max} = 25 \text{ ft}$



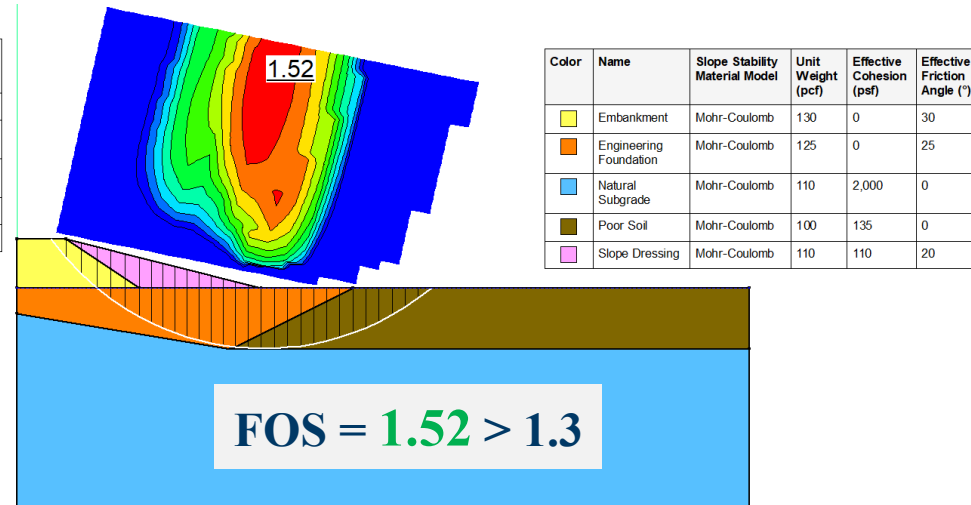
Embankment with Slope Dressing Assessment

Slope Dressing 3:1

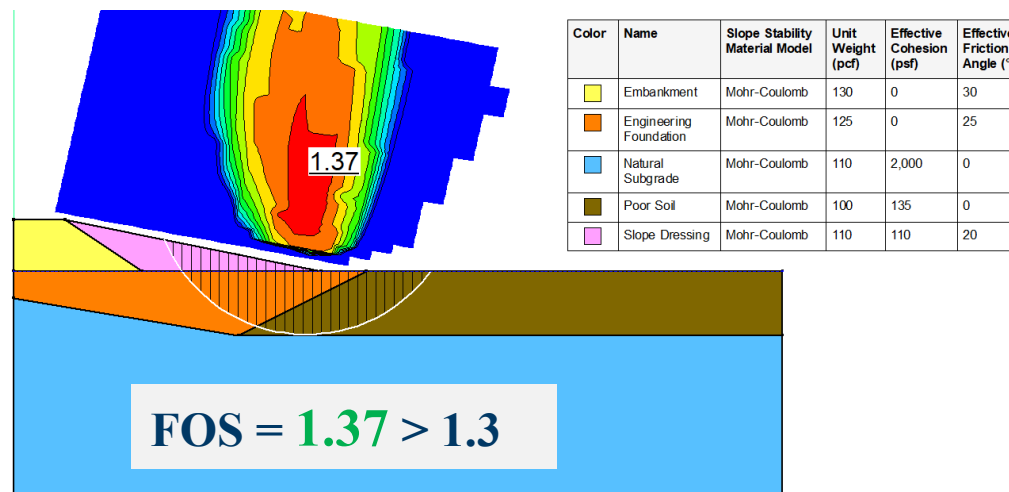


Slope Dressing 4:1

$D_{max} = 25$ ft



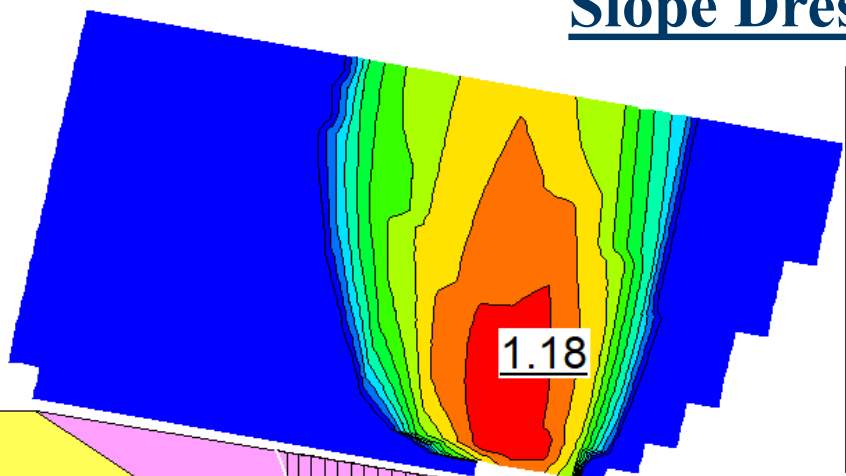
Slope Dressing 5:1



Embankment with Slope Dressing Assessment

Slope Dressing 6:1

$D_{\max} = 25 \text{ ft}$



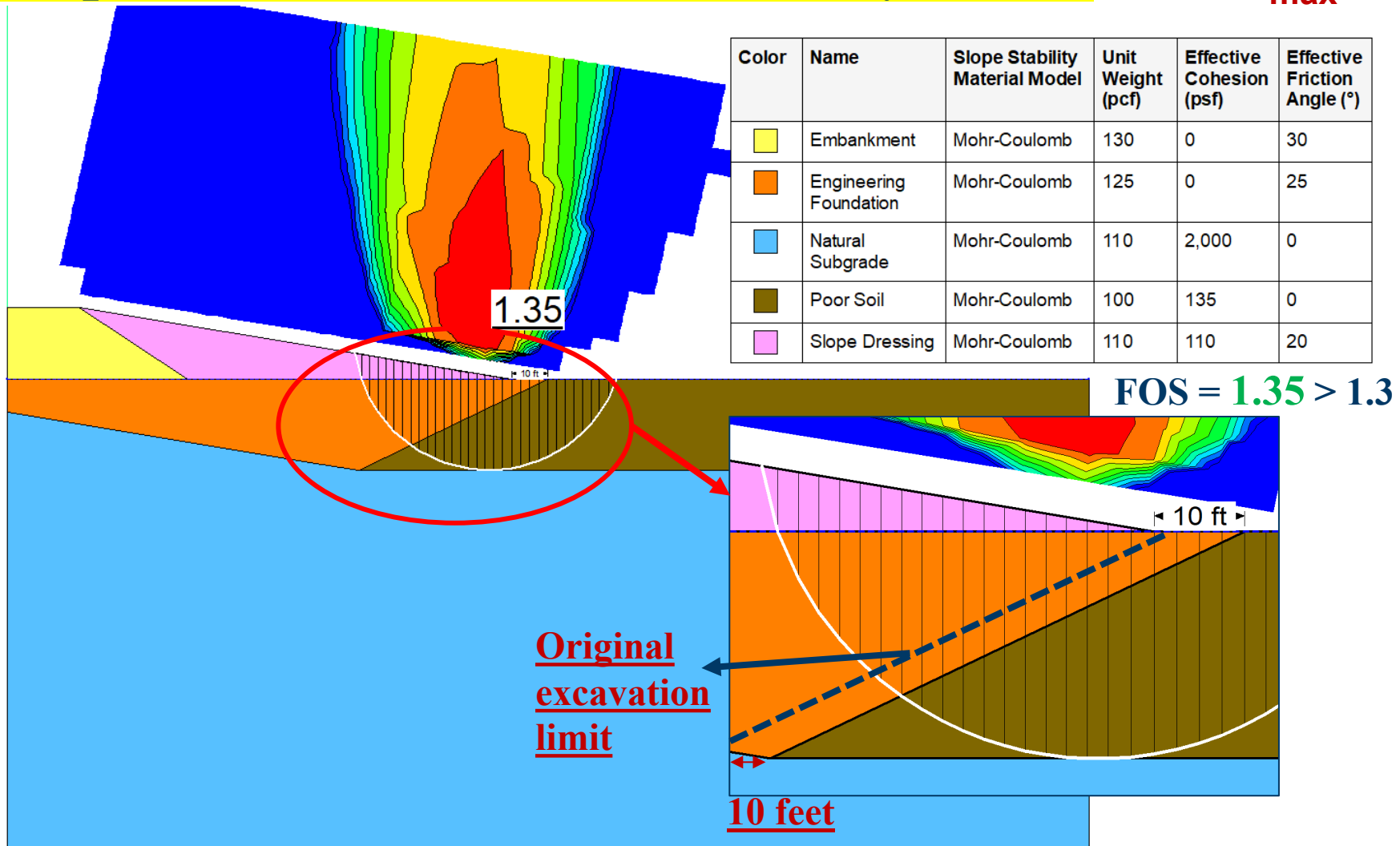
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
Yellow	Embankment	Mohr-Coulomb	130	0	30
Orange	Engineering Foundation	Mohr-Coulomb	125	0	25
Light Blue	Natural Subgrade	Mohr-Coulomb	110	2,000	0
Brown	Poor Soil	Mohr-Coulomb	100	135	0
Pink	Slope Dressing	Mohr-Coulomb	110	110	20

$FOS = 1.18 < 1.3$

Embankment with Slope Dressing Assessment

Proposed: Offset excavation limits by 10 feet

$D_{\max} = 25 \text{ ft}$



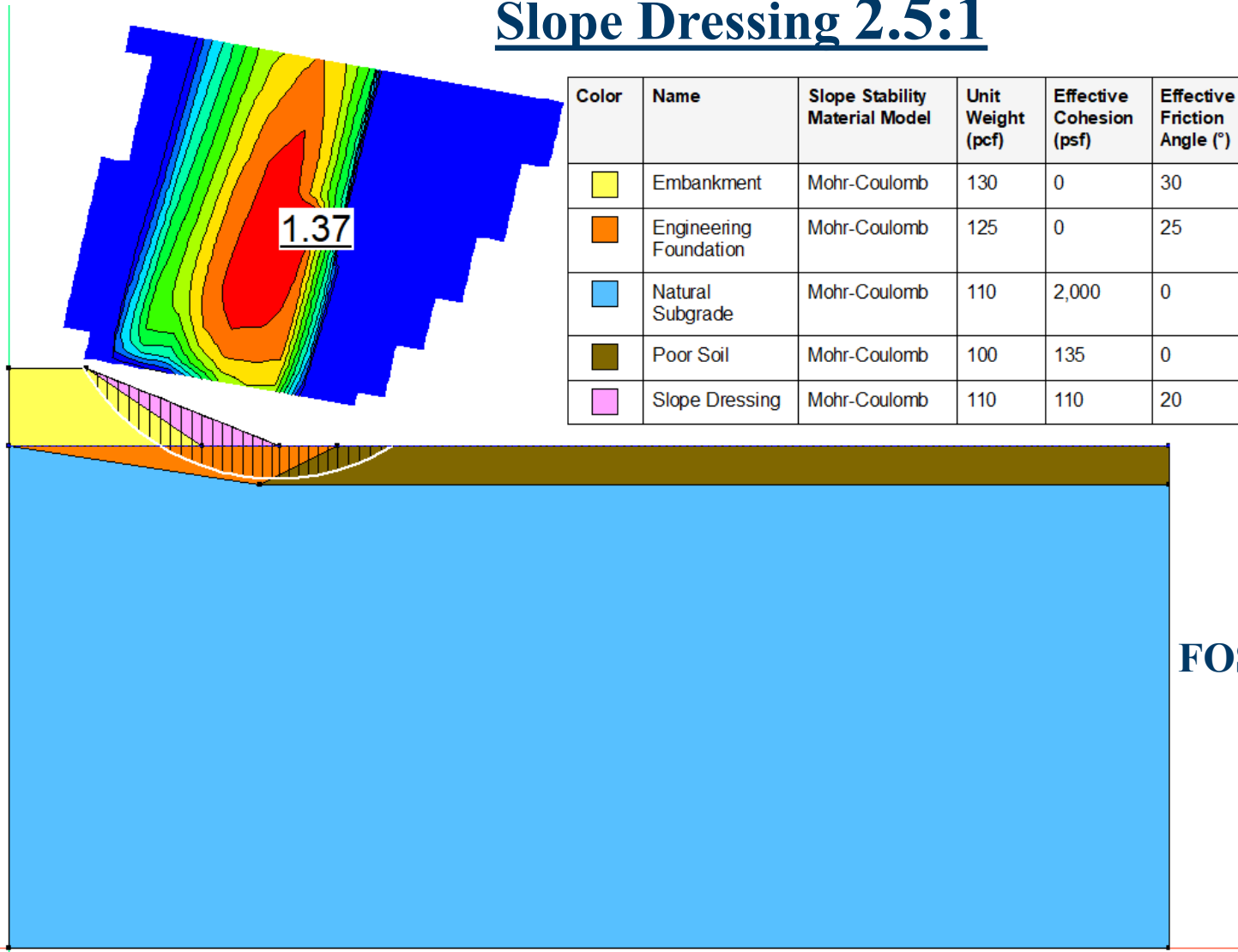
Embankment with Slope Dressing Assessment

$D_{\max} = 10$ ft Shallow cleanout

Embankment with Slope Dressing Assessment

Slope Dressing 2.5:1

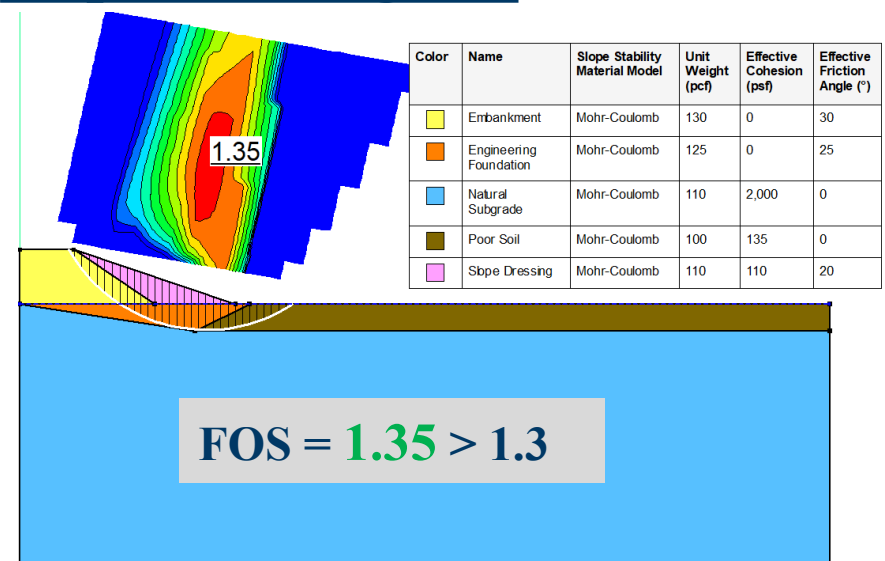
$D_{\max} = 10 \text{ ft}$



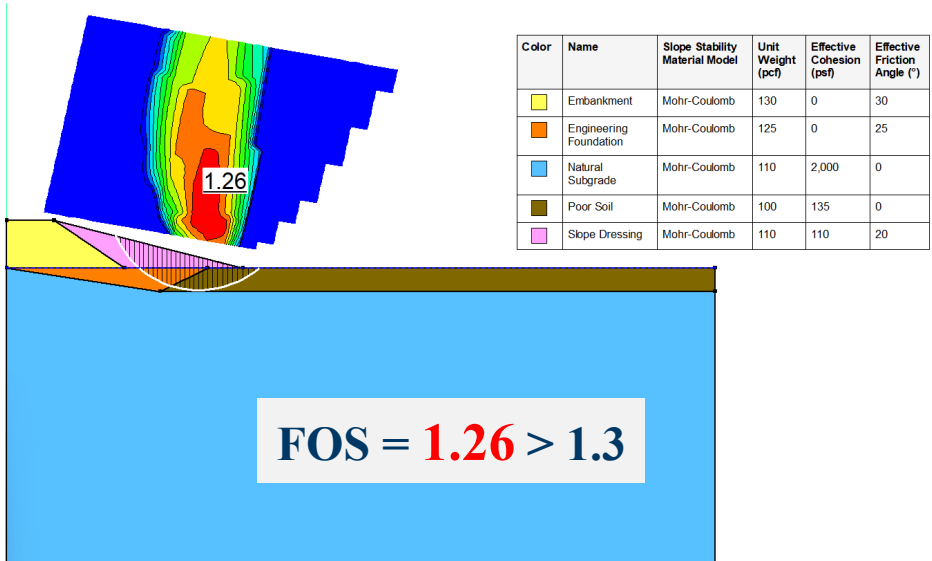
FOS = 1.37 > 1.3

Embankment with Slope Dressing Assessment

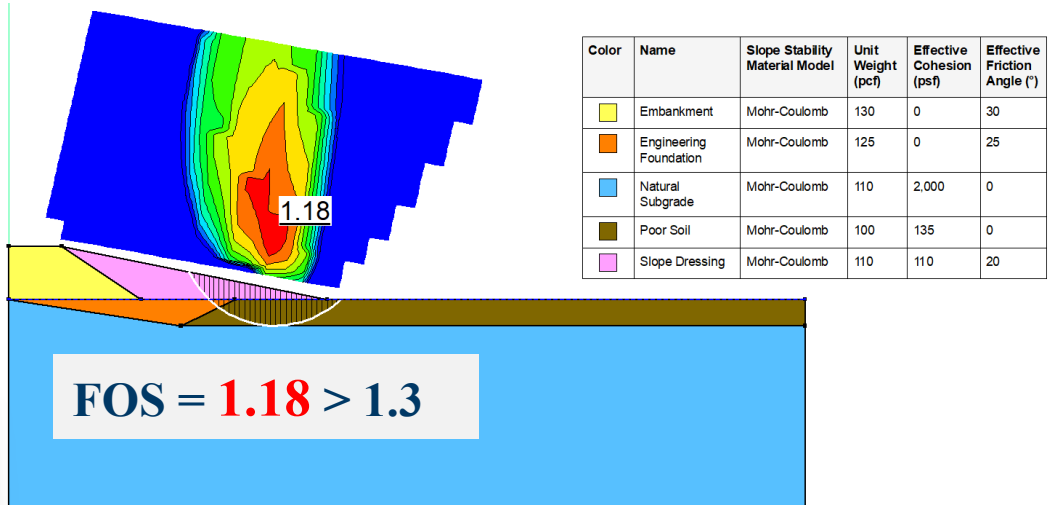
Slope Dressing 3:1



Slope Dressing 4:1 $D_{max} = 10\text{ ft}$



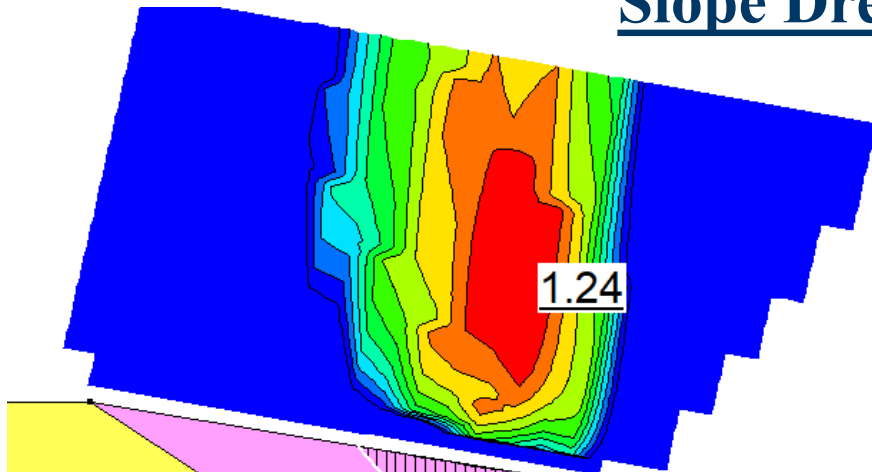
Slope Dressing 5:1



Embankment with Slope Dressing Assessment

Slope Dressing 6:1

$D_{\max} = 10 \text{ ft}$



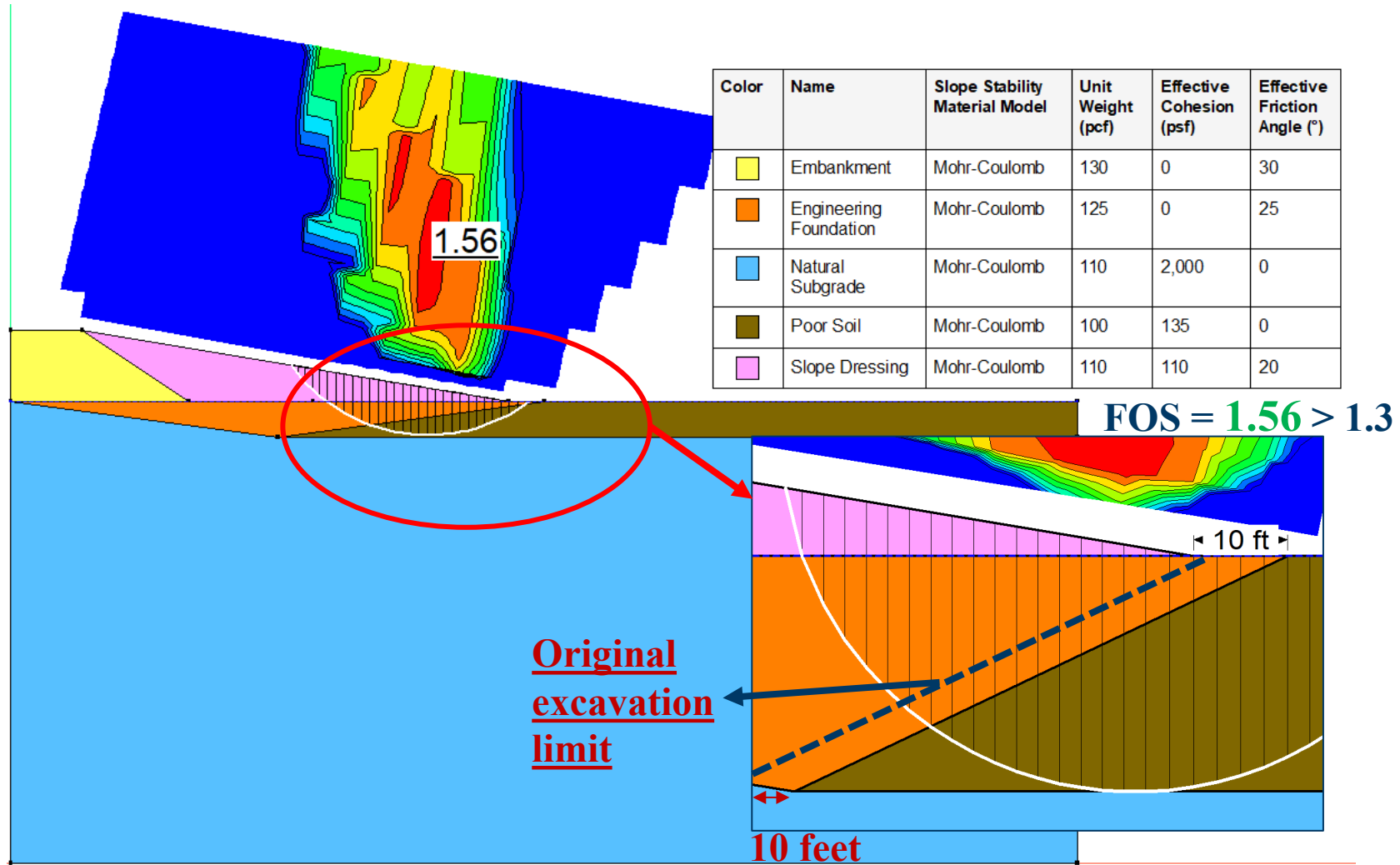
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
Yellow	Embankment	Mohr-Coulomb	130	0	30
Orange	Engineering Foundation	Mohr-Coulomb	125	0	25
Blue	Natural Subgrade	Mohr-Coulomb	110	2,000	0
Brown	Poor Soil	Mohr-Coulomb	100	135	0
Pink	Slope Dressing	Mohr-Coulomb	110	110	20

$FOS = 1.24 < 1.3$

Embankment with Slope Dressing Assessment

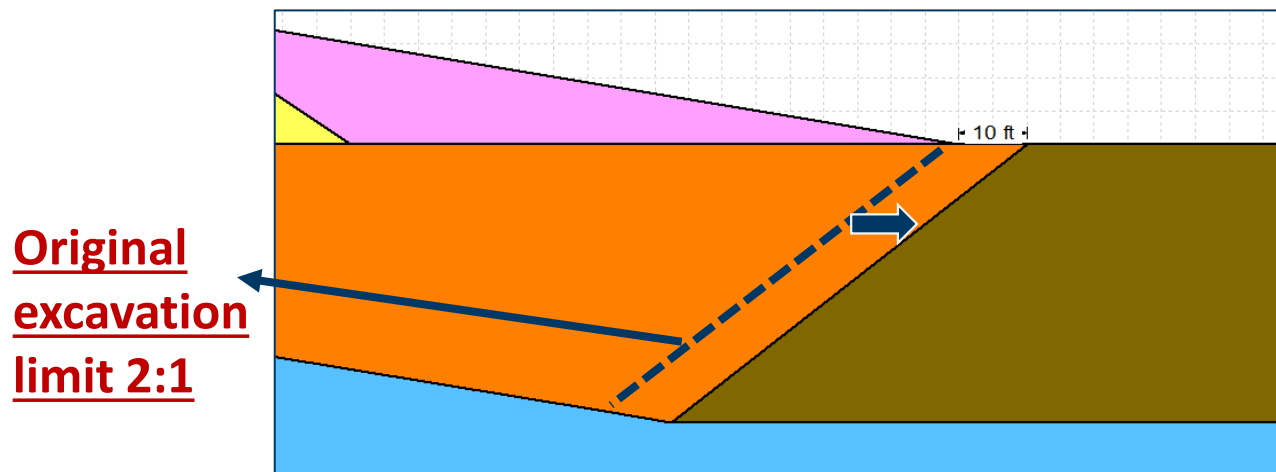
Proposed: Offset excavation limits by 10 feet

$D_{\max} = 10 \text{ ft}$



Recommendations

- To improve the undrained stability of embankment for both shallow (10 ft) and deep (25 ft) cleanout :
 - Offset current excavation limit by **10ft**

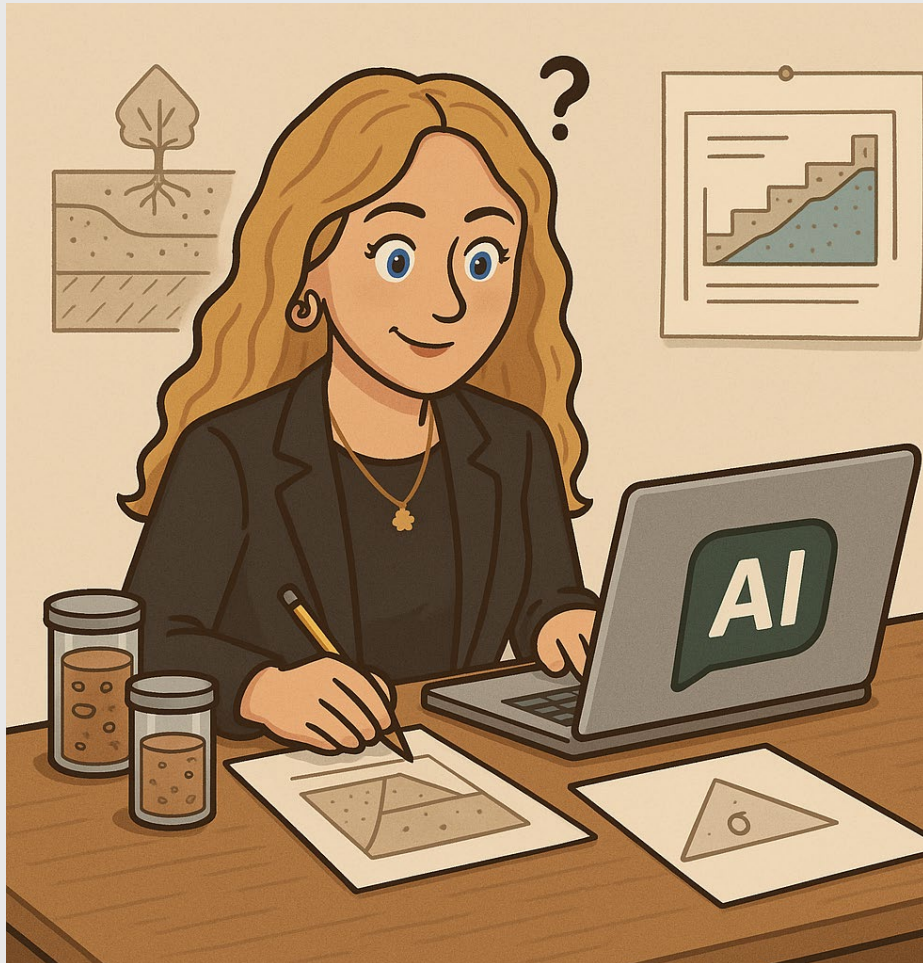


Closing Notes - *Technical*

- Templates developed for Case-Specific Analysis.
- Improved workflow to address more complicated muck excavation
- Districts can reach out to the Geotech or Research Section for running analyses or training.
- Serviceability

Geomaterials are probabilistic in nature. These results apply only to the assumed geometry and material properties. For more complex analysis or training, please contact the Research or Geotech Section.

Contributor X: *Artificial Intelligence*

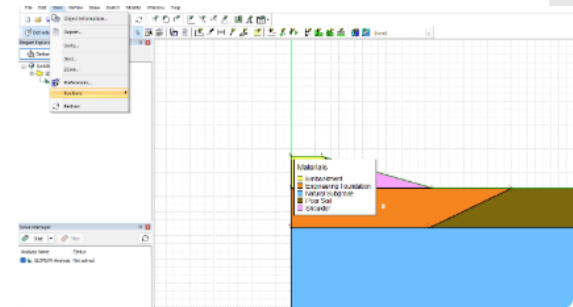


- Young (?) engineer and researcher
- Passionate about Geotechnical Engineering
- Tasked with running analyses
- New software

Image generated by ChatGPT 5

Contributor X: *Artificial Intelligence*

ChatGPT 4o ▾



this is view

Thanks for sharing the screenshot! Since there is no direct option in the "View" menu for legend settings, try the following methods:

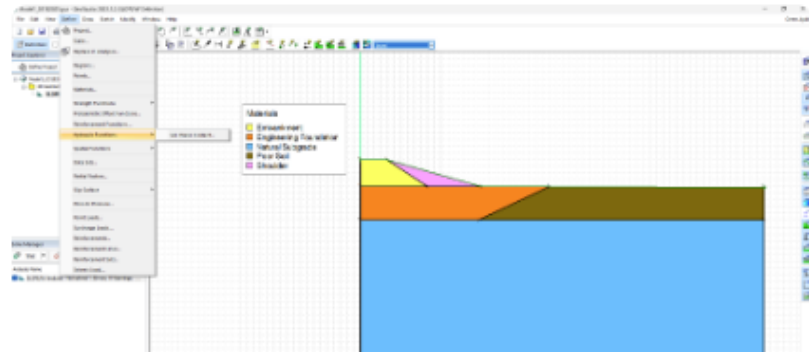
3. Try Dragging While in Modify Mode

- Go to the **"Modify"** tab at the top.
- Make sure you are in **selection mode**, not drawing mode.
- Try **clicking and dragging** the legend.

- Go to the **"Modify"** tab at the top.
- Make sure you are in **selection mode**, not drawing mode.
- Try **clicking and dragging** the legend.

Contributor X: *Artificial Intelligence*

Model1_03182025.gis - GeoStudio 2023.1.2 (SLOPE/W D



+ |Ask anything

ChatGPT can make mistakes. Check important info.

Since the **Water Table** option is missing from both **Draw** and **Define** menus, try these solutions:

1. Check the Analysis Type

- **Water tables** are only available in analyses that support pore-water pressures.
- Click on **SLOPE/W Analysis** in the **Project Explorer** (left panel).
- Check if the **pore-water pressure method** is set.
 - If it is set to "**None**", change it to "**Phreatic Surface**" or "**Ru Coefficient**".

THANK YOU!

2025 Midwest Geotechnical Conference

September 23-25, 2025

Sheraton City Centre Hotel, Indianapolis, Indiana



Recommendations

- Revise text and schematics in the Pavement Design Manual, as it is confusing
 - Section 320 Pages 7-14
- Be more specific about allowable materials and slopes (e.g., 6:1) for slope dressing.
- Language for the slope dressing material is very confusing (e.g., Place a max of 5 ft of excavated poor foundation soil).
- Revised $D_{\max}$ from 20 to 25 ft.