

# SLOPE STABILIZATION USING CELLULAR CONFINEMENT

## US50 Salisbury Bypass



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**Schnabel**  
ENGINEERING

# Outline

- Project Background
- Subsurface Conditions and Evaluation
- Design Options Considered
- Construction
- Performance
- Lessons Learned
- Questions



# Project Background

Location:

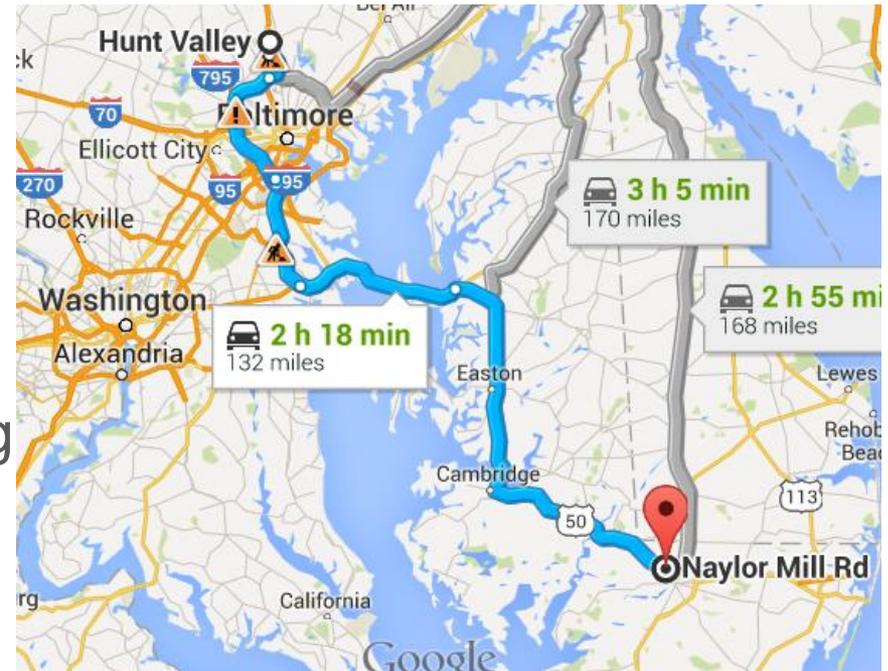
- Salisbury, Maryland

Owner:

- MDSHA
  - District 1

Designer:

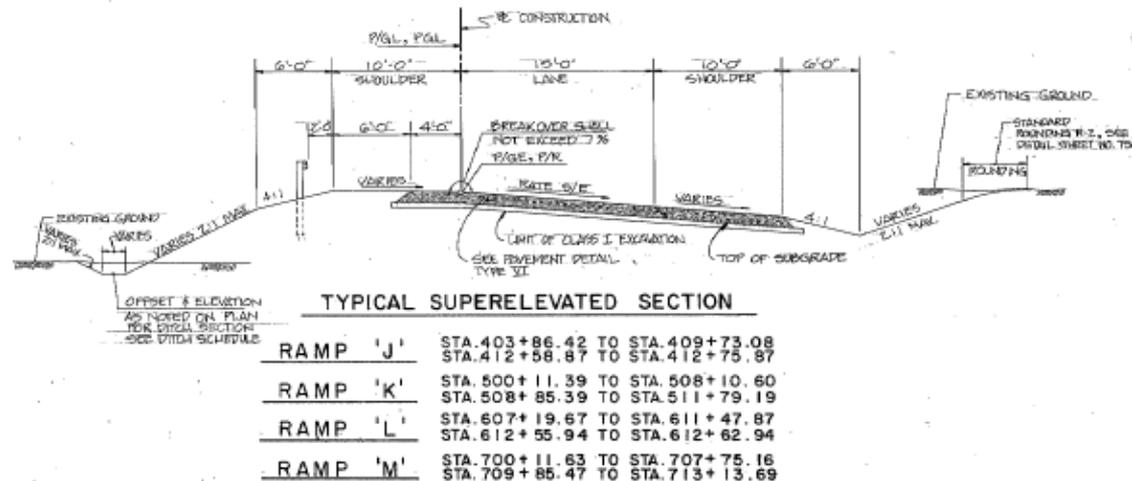
- Schnabel Engineering
- Sabra-Wang and Associates





# Project Background (cont'd)

- Ramp Embankment Slopes:
  - Constructed in 2000
  - 2H:1V
  - 30 to 35 feet tall at tallest point



- Failures occurred during and after construction



# Site Reconnaissance and Subsurface Study

- The ramps are open sections – no curb or gutters



- Failed areas are 2 to 3 feet deep
- Failures not necessarily where you would expect it to occur.



# What is Causing Instability?

- Hand Augers
  - Up to 10" to 18" of topsoil at failed areas
    - Topsoil very soft and saturated

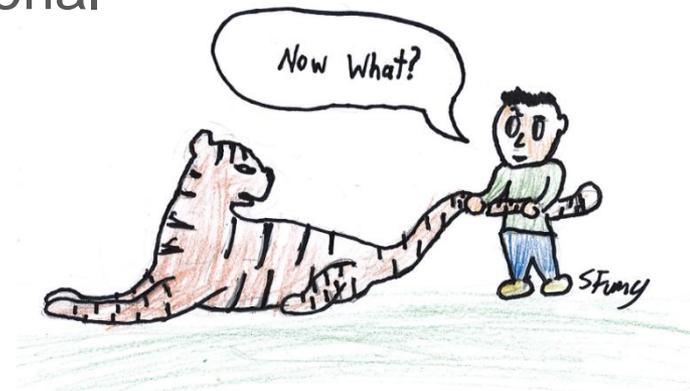


- Medium dense to dense Clayey Sand (SC) embankment fill



# What is Causing Instability?

- Surface water flowing down the slope face is the triggering mechanism for the slope erosion
- Saturates the thick, soft topsoil layer and causes it to slouch down the slope
- Surface runoff then erodes the exposed granular embankment material



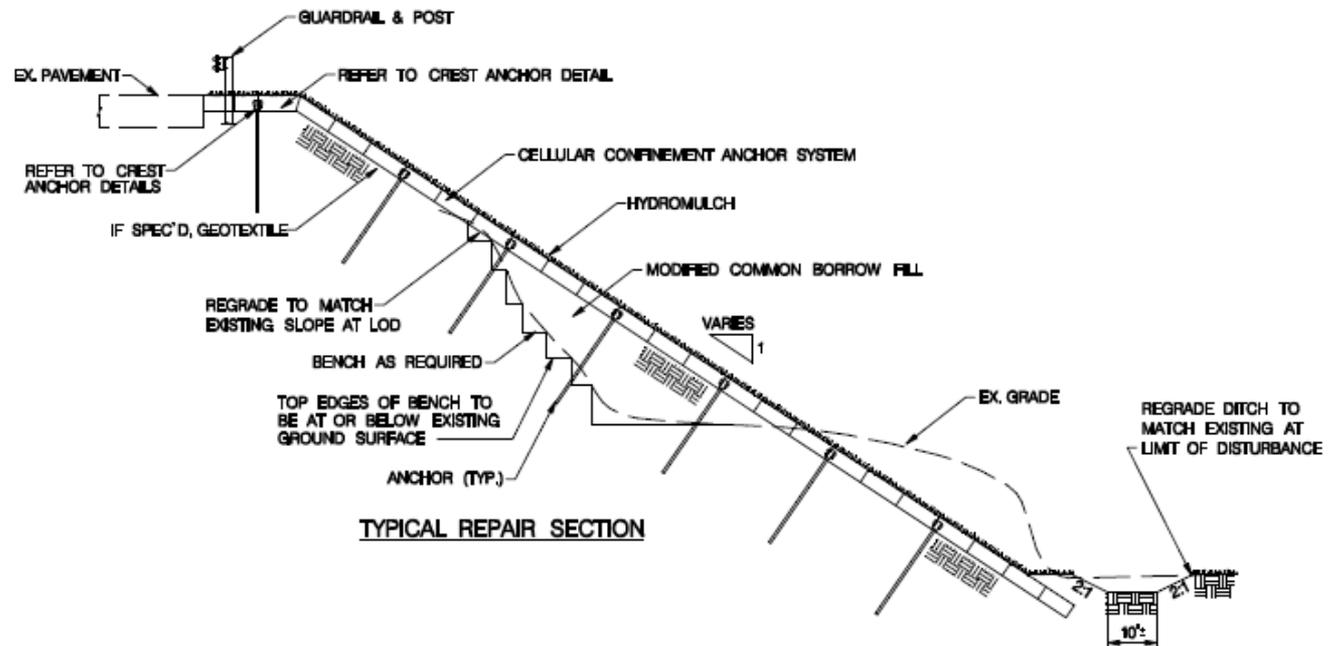
# Design Options Considered

- Several options considered, but the two that made the most sense were:
  - Install riprap for slope repair and protection
    - Owner is comfortable with this method.
  - Re-grade and install cellular confinement slope protection
    - Owner does not have experience with this, but is open to using it
    - Cost competitive
    - Creates a “natural” looking slope



# Design

- Cellular Confinement selected for Slope Stabilization
  - Simple to design
    - Supplier can help with design



- Stakes at 3 cells spacing
- 4" thick cellular confinement



# Bidding



- Develop “perfect” set of Plans and Specs
- Develop Engineers Estimate:
  - \$401,758

Four bids submitted:

- \$391,495
- \$399,931
- \$406,294
- \$416,473



Bids within 4% of our estimate!

- Celebrate!



# Bidding

- Engineers Estimate for cellular confinement:
  - \$141,361 (\$7 per SF)
- Bid price for cellular confinement:
  - \$71,692 (\$3.55 per SF)
  - \$84,819 (\$4.20 per SF)
  - \$66,644 (\$3.30 per SF)
  - \$61,191 (\$3.03 per SF)
- We were off by as much as a factor of 3 on some bid items!





# Construction

- How are slopes repaired?
  - Bench Slopes
    - Remove loose soils
  - Place and compact new fills



# Construction

- Install Cellular Confinement



# Construction

- Install Stakes



# Construction

- Place topsoil



# Construction

- Seed and place erosion control matting



- Completed in 19 work days!
- Final Cost: \$357,279
  - Contract came in about \$34k under original bid price!



# Performance

Two Years Later

- Slope is vegetated and looking good!



# Performance

Two Years Later

- Weeds on the slope – but still looking good!



# Performance

Two Years Later

- However...
  - Topsoil thickness is still up to 18 inches in some areas!
  - Some localized areas are very soft and some of the topsoil started to slouch down the slope
  - Potential for more topsoil to slouch down slope again



- But the risk of failures within the embankment fill is reduced.



# Lessons Learned

- Construct slope properly the first time!
  - Overbuild slope to get compaction near edges. Then cut back.
  - Keep topsoil thickness to 6 inches or less
- For Repairs: Insist that contractor bench the slope and place and compact the fill properly
- When done correctly, very little maintenance is required
- Costs about the same as rip-rap and is better looking than rip-rap slopes
- The designer should be involved during construction
- Keep topsoil thickness to 6 inches or less!



# Questions?

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# Thank You

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Have a safe trip!

