Case Studies on Rockfall Mitigation & Rock Slope Stabilization in CA, TN, & VA

August 2, 2012
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USACE
Cut Slope created in 70’s
90’ tall, 850’ long section with continuous failures
• CR 29 in Eastman Lake Park
• Closely to moderately fractured with joint spacing between 3 to 10 feet.
• Heavy rains caused portions of the slope to fail in 1996-1997
• Winter of 2010-2011 large blocks (30’x20’) had fallen on the road.
• Rock dowels vs. spin-lock
• 10’/14’ to 20’/24’
• 42kips to 59.3 kips
Double twist wire mesh cable system
Access!
Army Corp predicted 316 bolts (4,108 LF) for the lower slope and 108 bolts (1,260 LF) for the mid slope.
USACE reports no further dilation or failure of the rock slope since completion in 2011.
Grundy County, TN
Emergency Repair

Sandstone underlain by a very soft, decomposed shale containing clay seams and coal layers.
Blount County, TN - SR-73 Emergency Slide Repair (TDOT)
Narrow Roadway: All work completed from the inboard lane of SR-73
**Working Bench:**
- Drilled from below with bench up to 10-ft.
- Max Reach: 35-ft
- Increased Drill Rate
Crane Basket:
Used to drill all anchors at heights > 35-ft
Safety:
• Rock Fence in place to protect traffic lane
**Hybrid Barrier:**
- Catch additional debris that may fall from flatter slope above

**Tecco® Mesh:**
- 5’H x 5’V Pattern
- 5-25’ Embedment Lengths
Height Increase:

- Increased 20’ in some areas after scaling
- Called Frank Amend - Geobrugg Rush Shipped 10,000 SF of Tecco® Mesh to keep the project on schedule
Shotcrete:
• Area with highly weathered rock
• Erosion concerns
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

Site Survey:
• Skip Watts – Radford University
• Brendan Fisher – Fisher & Strickler Rock Engineering
C-C’  D-D’
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
Grade Beam Example:
Washington State

Grade Beam Design:
- Skip Watts – Radford University
- Used in Washington State

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

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
Rockfall Barriers

- Base = 0.5 * Height
- Stop anything that won’t roll over the wall

Wolf Creek Pass, Colorado
• 5+ Million Foot-pound Impact
• 12’ Diameter
• Fell from 75-100’ upslope
Damage to Blocks, Structure Intact. Note that back portion of block remains adhered to backfill, preventing material loss.
Tremendous Impact Energy with No Front Facing Deformation
10+ Million Foot Pound Impact
Structure impacted by this rock falling over 100 ft
Minimal Damage to Upper Rows
Back in Service After Minor Repairs

Note: Color Difference – original block manufacturer went out of business