Engineering Geology

Bridge Engineering & Infrastructure MANAGEMENT
Rockfall Mitigation: Analysis, Design & Implementation on NJ Highways
New Jersey + Rock
NEW JERSEY GEOLOGY 101
Contributing Factors to Highway Rockfall Hazards

• Geology & Geometry
  • Rock type & characteristics
  • Rock cut slope geometry
  • Discontinuities (joints, fractures)
  • Roadway geometry

• Groundwater
  • Hydrostatic pressure
  • Icejacking

• Erosional
  • Climatic
  • Chemical
  • Root jacking

• Construction Techniques
FALLING ROCK
Rockfall Hazard Management System
Rockfall Hazard Management System (RHMS)

- 440+ State & Interstate highway rock cut slopes
- Identify & monitor rockfall hazards to traveling public
- Rockfall mitigation project prioritization & development
Rockfall Hazard Rating System (RHRS)

- Developed late 1980’s by FHWA & implemented 1993
- Proactive vs Reactive
- Characterize, evaluate & numerically rank hazards
- ~ 60% of State DOT’s
RHRS

- Geology parameters
  - Rock type & structure
  - Erosional features
  - Discontinuities
  - Rock friction
  - Water
  - Slope height
  - Block size
  - Catch area
  - Rockfall history

- Roadway parameters
  - Roadway width
  - Sight distance
  - Traffic data
  - Speed limit

- Exponential scoring
ROCKFALL HAZARD MANAGEMENT SYSTEM 2018 UPDATE 3

Rockfall Hazard Management System - Complete Inventory

* one ranking established for several adjacent cuts
** based upon RHRS Detailed Rating Score; 'A' & 'B' cuts only
*** For programming use; only considers 'A' cuts not in CD/PE/PD

<table>
<thead>
<tr>
<th>RHRS Rating</th>
<th>Non-Programmed Ranking</th>
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<tbody>
<tr>
<td>Route</td>
<td>MP</td>
</tr>
<tr>
<td>46 WB</td>
<td>1.4 R</td>
</tr>
<tr>
<td>80 WB</td>
<td>1.3 R</td>
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<tr>
<td>80 WB</td>
<td>0.5 R</td>
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<tr>
<td>80 WB</td>
<td>1.15 R</td>
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<tr>
<td>78 EB</td>
<td>10.3 R</td>
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<td>29 NB</td>
<td>27.78 R</td>
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<tr>
<td>287 SB/RAMP D</td>
<td>53.0 R</td>
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<tr>
<td>287 SB</td>
<td>55.6 R</td>
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<tr>
<td>78 WB</td>
<td>10.3 R</td>
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<td>287 SB</td>
<td>67.4 R</td>
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<tr>
<td>23 NB</td>
<td>18.8 R</td>
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<td>15 NB</td>
<td>19.0 R</td>
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<tr>
<td>15 SB</td>
<td>5.2 R</td>
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<td>80 EB</td>
<td>41.0 R</td>
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<tr>
<td>29 NB</td>
<td>17.8 R</td>
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Notes/Comments
- Mitigation Construction Completed 2015
- In Preliminary Design 2012
- Outside NJDOT Jurisdiction
- In Preliminary Design 2012
- Group 2014-1: PE/FD Assignment #1 (UPC # 153380)
- Group 2014-1: PE/FD Assignment #2 (UPC # 158020)
- Group 2014-1: PE/FD Assignment #1 (UPC # 153380)
- In Preliminary Design for remediation 2012
- Catch full of debris-9/2008, mesh and fence intact
- In Concept Development Group 2016-1
- In Concept Development Group 2015-1
- In Concept Development Group 2015-1
- In Concept Development Group 2015-1
Rockfall Mitigation Program
Rockfall Mitigation Program

• Concept Development
  — Geological field mapping
  — Kinematic analysis
  — Rockfall modelling
  — Selection of mitigation measures

• Preliminary/Final Design
  — Mitigation design
  — Construction considerations

• Construction
Area B: Field Investigation
Area A: Kinematics
Rockfall Modelling
Rockfall Mitigation Approaches

- Removal
- Stabilization
- Protection
• Removal/Excavation

• Scaling
• Removal/Excavation

• Scaling

• Blasting
Route I-80 Roxbury Twp
• Stabilization
  • Shotcrete
  • Buttresses
  • Rock bolts/dowels
  • Pinned mesh
  • Drainage
• **Protection**

• **Catchment**

• **Barriers/Fences**

• **Rock mesh drapes**
Recently Completed Projects

Rt. 46 MP 1.4-2.4 Knowlton
Rt. 5 Edgewater/Fort Lee
Rt. 80 MP 21.9 Allamuchy
Rt. 80 MP 15
Frelinghuysen/Allamuchy
Rt. 80 Rockfall Mitigation
Roxbury
Rt. 10 MP 22.2 W. Orange
Rt. 46 & 80 Warren/Morris Co.
Rt. 78 MP 44.75 Berkeley Heights
Route 46 MP 1.4-2.4WB Knowlton Twp
Current Projects

Rt. 80 Hardwick/Knowlton
Rt. 78 Bethlehem
Rt. 29 Kingwood
Rt. 29 Lambertville
Rt. 22 Phillipsburg
Rt. 80 Denville
Rt. 206 Andover
Rt. 280 W. Orange
Rt. 23&94 Hardyston
Rt. 15 Jefferson
Rt. 23 West Milford
Route I-80
Delaware Water Gap
Route I-80
Delaware Water Gap
Rt. I-78 Bethlehem
Route 29 Kingwood Twp
In Conclusion...
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