Geotechnical Asset Management at AKDOT&PF

Barry A. Benko
Chief Engineering Geologist
The Broad Overview...

- GAM Basic Concepts
- AKDOT&PF GAM Program Background
- GAM Program Research & Development Accomplishments
- GAM Implementation Needs
The Main Questions to Answer...

• Geotechnical assets — what’s the problem?
• Why do GAM?
• The necessary parts and pieces for implementing GAM in Alaska — what do we have...what is needed?
What are Geotechnical Assets?

• “Geotechnical” means the asset consists of earth, pertains to earth, or its performance is achieved through interaction with a structure or non-earth modification.

• Performance is largely attributed to soil or rock performance
What are Geotechnical Assets?
Targeted Asset Classes for AKDOT&PF

- Rock Slopes
  - Seward Highway
- Retaining Walls
  - Rabbit Creek, Seward NB Ramp
- Unstable Soil Slopes & Embankments
  - MP 50 Glenn Highway
- Material Sites
  - MS 498-010 T. Hope
The problem

- Slopes, embankments, and retaining walls can deteriorate and fail for entirely natural reasons. This failure can disrupt traffic, compromise safety, and create extra costs.
Growing maintenance costs

- The Department spends enormously in maintenance dollars keeping roads passable.
A massive problem

- $19.7 billion in geotechnical assets – 3 times the estimated value of the bridge inventory
Asset Management, the framework

• Transportation Asset Management (TAM)
  “Strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their lifecycle” – AASHTO
What is “Geotechnical Asset Management”

- Goals and policies
  - Asset inventory
  - Condition assessment and performance modeling
  - Alternatives evaluation and program optimization
- Forecasting models
- Budget, resource allocation
- Performance monitoring and feedback
- Program implementation
- Short and long-range plans, programs, and targets
Geotechnical Asset Management...Why do it?

- Federal Rules require TAM for Bridges and Pavements; *encouraged* for other ancillary assets – such as GEOTECHNICAL ASSETS
- FHWA and AASHTO have strongly supported efforts to develop GAM
GAM...Why do it, cont.

• Geotechnical Assets are linked to all other transportation assets and must be operated, managed and maintained so that they support the function of the transportation corridors.
GAM...Why do it, cont.?

• National Performance Measures (NHS):
  • Safety
  • Infrastructure Condition
  • Congestion Reduction
  • System Reliability
  • Freight Movement and Economic Vitality
  • Environmental Sustainability
  • Reduced Project Delivery Delays

Performance and MAP-21
Decision-Making

- Geotechnical Asset Management
- Transportation Asset Management
- Performance Management
AKDOT&PF Geotechnical Asset Management Program

Statewide Materials - Geotechnical Services

Geology
The Geology Group at Statewide Materials provides engineering geology and drilling/evaluation services in the collection, analysis, interpretation, and documentation of high quality engineering and geological data. Technical advice and reports are required for the design, construction and maintenance of Alaska's transportation facilities in support of the Department's goals of safety, mobility, and economic development.
Contact: Tim Weiss Foundation Engineering Geologist
(907) 265-6233, timweiss@akdotp.state.ak.us

Structural Foundations/Soils Engineering
The Structural Foundation and Soils Engineering Group provide a full range of Professional Engineering Services required to support the design, construction and maintenance requirements for soils and foundations for the State of Alaska's highway transportation system.
Contact: Dave Harebut, P.E., State Foundation Engineer
(907) 265-6233, dave.harebut@akdotp.state.ak.us

Geotechnical Asset Management
The Department's Geotechnical Asset Management (GAM) Program Office and Operations and Management is under development in parallel with the Transportation Asset Management Program. GAM incorporates performance and risk management principles in managing assets such as material stores, soil and soil slopes, embankments and retaining walls. These assets have a vital role in providing new materials to build our roads and airports, as well as physically supporting our transportation assets and structures. The Statewide Materials Geotechnical Services group is actively conducting research to guide development of GAM principles and practices.
Geotechnical Asset Management Page
Contact: Barry Danske, C.P.G., GAM Program Manager
(907) 265-6241, baryx@danskepoland.com

Materials Info
- Materials Home
- Quality Assurance
- Pavement Engineering
- Geotechnical Services
- Price Indices
- Alaska Concrete Alliance
- Resources
- Staff
Contact D&H Whittemore
AKDOT&PF Geotechnical Asset Management Program

RESEARCH & DEVELOPMENT

• Darren Beckstrand, Aine Mines, Lawrence Pierson – Landslide Technology
• Paul D. Thompson – Consultant
• Robert Kimmerling – PanGEO
• Mark Vessely, Beth Widmann – Shannon & Wilson

PROGRAM FOUNDER

• David A. Stanley (ret.)
AKDOT&PF Conceives a GAM Research Project

• Geotechnical assets are an underappreciated contributor to highway function

• Often provide unplanned, unbudgeted, unpredictable projects

• Alaska had no framework for inventorying, assessing condition & risk, measuring performance, modeling when to intervene, or budgeting for timely improvements for minimizing lifecycle costs

• Transportation Asset Management offered the needed framework
GAM R&D Accomplishments

- Completed baseline asset Inventories
- Condition index and condition state classification systems
- Inspections to establish baseline conditions of assets in NHS
- GAM life cycle cost analytical framework
  - Cost models
  - Treatment models
  - Deterioration models
  - Risk models
- Database incorporated into GIS platform
- Tools for tracking performance over time
- GAMP
Asset Inventories

Targeted Asset Classes:

- Rock Slopes: 1,003
- Unstable Soil Slopes and Embankments: 633
- Earth Retaining Walls: 1,400
- Material Sites: 2,934
### Condition States

<table>
<thead>
<tr>
<th>Condition state</th>
<th>Rock slopes</th>
<th>Soil slopes</th>
<th>Retaining walls</th>
<th>Material sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Good</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>2 - Fair</td>
<td>72.1</td>
<td>59.6</td>
<td>79.8</td>
<td>82.2</td>
</tr>
<tr>
<td>3 - Fair</td>
<td>47.4</td>
<td>43.5</td>
<td>49.7</td>
<td>55.4</td>
</tr>
<tr>
<td>4 - Poor</td>
<td>31.0</td>
<td>21.6</td>
<td>28.1</td>
<td>30.4</td>
</tr>
<tr>
<td>5 - Poor</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
A massive problem

<table>
<thead>
<tr>
<th>Rock slopes</th>
<th>Soil slopes</th>
<th>Retaining walls</th>
<th>Material sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3.3 billion</td>
<td>$16.0 billion</td>
<td>$0.4 billion</td>
<td>$11 million</td>
</tr>
</tbody>
</table>

- **Rock slopes**
  - Good: 26%
  - Fair: 66%
  - Poor: 7%

- **Soil slopes**
  - Good: 16%
  - Fair: 37%
  - Poor: 47%

- **Retaining walls**
  - Good: 62%
  - Fair: 32%
  - Poor: 4%
## Condition Example

<table>
<thead>
<tr>
<th>Cond. State</th>
<th>Rock Slopes</th>
<th>Soil Slopes</th>
<th>Retaining Walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Good</td>
<td>Slope produces little to no rockfall. No history of rock reaching the road. Little to no maintenance needs to be performed due to rockfall activity.</td>
<td>Soil slope or embankment is stable and generally will not be inventoried or assessed. Some slopes may have been successfully mitigated with a long stability history.</td>
<td>Wall alignment is good vertically and horizontally. No structural cracks in wall surfaces. No visual distortion or lost/missing bearing elements. No history of movement/deformation.</td>
</tr>
</tbody>
</table>
Life Cycle Cost Analytical Framework

- **Funding**
- **Mitigation & preservation policy**
- **Deterioration model**
- **Inspection**
- **Site risk assessment**
- **Traffic volume**
- **Detour route**

**Treatment model**
- Routine maintenance
- Mitigation & preservation
- Reconstruction

**Effects**

**Current and forecast conditions**

**Likelihood of transportation service disruption**

**Consequences of disruption**
- Mobility cost
- Safety cost
- Recovery cost

**Life cycle cost**

- **Condition outcomes and targets**
- **Return on investment**

**Risk cost**
## Treatment Cost Modelling

### Results for Cost Estimates Per Condition State

<table>
<thead>
<tr>
<th>Number of Condition States Improved by Mitigation Activities</th>
<th>Rock Slopes – Average Mitigation Costs per sq. ft. of Rock Slope Face</th>
<th>Soil Slopes – Average Mitigation Cost per ln ft. of Unstable Soil Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotechnical Component Cost</td>
<td>Incorporating Overhead Costs</td>
<td>Geotechnical Component Cost</td>
</tr>
<tr>
<td>1</td>
<td>$3.56</td>
<td>$7.30</td>
</tr>
<tr>
<td>2</td>
<td>$7.12</td>
<td>$14.60</td>
</tr>
<tr>
<td>3</td>
<td>$10.68</td>
<td>$21.90</td>
</tr>
<tr>
<td>4</td>
<td>$14.24</td>
<td>$29.20</td>
</tr>
</tbody>
</table>
## Deterioration modeling

### Deterioration model - Soil slopes

<table>
<thead>
<tr>
<th>Current conditions</th>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>State 5</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sq. ft by state</td>
<td>55,987</td>
<td>19,342</td>
<td>186,467</td>
<td>93,161</td>
<td>46,229</td>
<td>354,957</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transition time - median years to the next state</th>
<th>Consensus model</th>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darren Beckstrand</td>
<td></td>
<td>19.3</td>
<td>15.5</td>
<td>10.3</td>
<td>6.3</td>
<td>69</td>
</tr>
<tr>
<td>Barry Benko</td>
<td></td>
<td>15.0</td>
<td>12.0</td>
<td>9.0</td>
<td>5.0</td>
<td>55</td>
</tr>
<tr>
<td>Bob Kimmerling</td>
<td></td>
<td>20.0</td>
<td>17.0</td>
<td>9.0</td>
<td>7.0</td>
<td>71</td>
</tr>
<tr>
<td>Aine Mines</td>
<td></td>
<td>15.0</td>
<td>15.0</td>
<td>12.0</td>
<td>7.0</td>
<td>66</td>
</tr>
<tr>
<td>Paul Thompson</td>
<td></td>
<td>25.0</td>
<td>20.0</td>
<td>15.0</td>
<td>10.0</td>
<td>94</td>
</tr>
<tr>
<td>Mark Vessely</td>
<td></td>
<td>21.0</td>
<td>14.0</td>
<td>7.0</td>
<td>4.0</td>
<td>61</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment frequency and cost</th>
<th>Unit cost per state improved</th>
<th>$/sq.ft</th>
<th>OH%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain same state</td>
<td></td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Improve by 1 state</td>
<td></td>
<td>0.50%</td>
<td>1328</td>
</tr>
<tr>
<td>Improve by 2 states</td>
<td></td>
<td>1.00%</td>
<td>2656</td>
</tr>
<tr>
<td>Improve by 4 states</td>
<td></td>
<td>1.50%</td>
<td>3984</td>
</tr>
<tr>
<td>Total acted upon</td>
<td></td>
<td>2.50%</td>
<td>5312</td>
</tr>
</tbody>
</table>

### Comparison of deterioration models - Barry Benko

![Graph showing comparison of deterioration models](image)

Preservation model starts with current condition; others with new condition.
Deterioration plus Treatment: Soil Slopes

Condition index vs Age of slope (years)

- Pure deterioration
- Reconstruct only
- Preservation
Funding vs. Condition Tradeoff: rock slopes
A path towards the Happy Medium....

$1 spent improving slope and wall conditions not only pays for itself ...

... It returns an additional 17 cents to the Department and road users!
AKDOT&PF's Geotechnical Asset Management Program

This overview map shows the location of all assets in AKDOT&PF's Geotechnical Asset Management Program.

Please click on the appropriate tab for detailed information in the asset-specific maps.

- Retaining Wall Locations - Assessed Walls
- Retaining Wall Locations - As-Built Inventory
- Rock Slope Locations
- Rated Soil Slope and Embankment Locations
- Material Site Locations
- AKDOT_Route_Data

Route Classification
National Highway System (NHS)
- NHS NOT INTERMODAL
- NHS IM AIRPORT TERMINAL
- NHS IM PORT TERMINAL
- NHS IM FERRY TERMINAL

Road Centerlines

Content may not reflect National Geodatabase current inputs policy. Sources: National Geodatabase, Esri, Vermont DOT, Calgary and ADBI.
Geotechnical Asset Management Plan

Technical Report

Prepared by:
Paul D. Thompson
17035 NE 28th Place
Bellevue, WA 98008

May 31, 2016

Prepared for:
Alaska Department of Transportation & Public Facilities
Statewide Research Office
3132 Channel Drive
Juneau, AK 99801-7898

Report STP000S(802)(A)

Alaska Department of Transportation and Public Facilities
Geotechnical Asset Management Plan
Executive Summary

31 May, 2016

Agreement 035-3-1-042, Task H

Paul D. Thompson
Applications of GAM

• Tools that will help planners be more efficient.
• Identify crucial geotechnical asset presence and condition, EARLY in the project planning process.
• Ready access to asset inventory data and condition assessments.
• Programmatic cost estimates for mitigation.
“We can’t do that, we’ve only got 1 Million per mile budgeted.”

- This may sound familiar to some others in the DOT’s.
- Planning & budgeting ignoring:
  - Poor-condition retaining walls,
  - Rockfall issues,
  - Thaw-unstable embankments
  - Construction material availability
  - Etc.
- Only focused capacity and safety deficiencies in corridor studies

Result:......missed opportunities to do what's truly needed and under-designed projects in order to stay in budget.
We incorporated the GAM database into our project efforts... First, we performed a desktop review of the database to become familiar... GAM database provided useful information that we used to target rock slopes... we were able to plan the field schedule to make efficient use of field time, resulting in cost savings to the project. (Golder Assoc)
AKDOT&PF’s Rated Assets

The primary interface for AKDOT&PF’s GAM program is shown at right. This online GIS platform was used to compile the individual maps for all 4 geotechnical asset classes evaluated under the Department’s current GAM program.

All evaluation data are available for mapping both with online and desktop GIS software platforms through AKDOT&PF’s GIS server. Custom maps using data mined from the rating categories can be formulated and evaluated by geotechnical or planning personnel.

Determining the Condition of GAM Assets

TAM programs require that each asset be assigned a Condition State (Good/FAIR/Poor). In AKDOT&PF’s GAM system, this is done using a TAMS-compatible Condition State based on select performance criteria. This Condition State can then be used to assess how well the department is meeting its goals for asset performance on a regional or statewide level. The Geotechnical Asset Management (GAM) program is designed to be TAMS compatible. Rock slope sites around Long Lake are shown as Good/Fair/Poor classifications in the map at right.

Tracking Adverse Events

In addition to database maintenance, powerful tools were implemented to track individual events. The Geotechnical Event Tracker Geiform is designed to allow AKDOT&PF to easily add events requiring maintenance attention to the map at right. This map currently shows individual location-specific events mined from the TAMS program as well as recent unstable slope events.

Better tracking of all geotechnical events will allow maintenance frequency, event size, and other site monitoring information to be improved. It will also improve assessments of risk and economic costs within the GAM program. Over time, it may also show areas where activity has increased, indicating asset deterioration. As an example, the video below shows rockfall events along the Turnagain Arm from 2009-2015, as obtained from the TAMS.
Applying GAM - Seward Highway Improvements

A planned roadway improvement project is currently underway on the Seward Highway along Kenai Lake. As part of the project, adjacent Fair Condition rock slopes are also being improved. The rock slopes are being re-cut and modern catchment ditches are being constructed, resulting in Good Condition rock slopes.
Geotechnical Event Tracker

1. Enter Information

- EVENT DATE
- TYPE OF EVENT
- EVENT SIZE
- ACCIDENTS
- CLOSURE DURATION
- RESOURCES APPLIED TO EVENT RESPONSE
- COST IN DOLLARS

2. Select Location

Specify the location for this entry by clicking/tapping the map or by using one of the following options.

3. Complete Form

Add this information to the map.
Needed steps

- Complete baseline asset condition inspection; maintain and update
- Better tracking and budgeting of mitigation and response work

*Both would facilitate more proactive management of problems*
Needed steps

After completion of the inventory and implementation of better cost tracking:

• Development of 10-year fiscally-constrained condition targets
• Management toward achievement of the targets
• Development of better preservation and mitigation strategies to get to the targets more quickly or economically

Better management of asset performance using Transportation Asset Management methods
any meaningful strategy for minimizing life cycle cost and managing risk for pavements and bridges is significantly incomplete unless geotechnical asset management is included in the discussion...
Thank you!

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Statewide Materials Section
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barry.benko@alaska.gov

AKDOT&PF GAM webpage:
http://www.dot.state.ak.us/stwddes/desmaterials/mat_geotech_services/mat_gam2.shtml