Alaska’s Geotechnical Asset Management Program

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AKDOT&PF Transportation Network

- Low public road lane mileage (31,618)...
- Low number of bridges (1,196)...
- Vast areas with limited or no connected road system...
- Air travel reliance—255 airports managed by the agency.
- Extensive marine transportation network: 25 harbors, 33 terminals, 11 ferry vessels
AKDOT&PF GAM PROGRAM

Targeted Asset Classes:

• Rock Slopes
• Unstable Soil Slopes and Embankments
• Earth Retaining Walls
• Material Sites

Use of Online GIS Resources
AKDOT&PF Slope, Wall, & Material Site Management

The Alaska Department of Transportation and Public Facilities (AKDOT&PF) is completing development and implementing a Geotechnical Asset Management (GAM) Program which will help track rock slopes, unstable soil slopes/embankments, retaining walls, and material sites managed by the Department.

This map shows the location of all geotechnical assets in the program database, distinguished by color. The inventory currently contains 1,265 retaining walls, 1,003 rock slopes, 633 unstable soil slopes and embankments, and 2,919 material sites. This extensive inventory will help AKDOT&PF evaluate the overall health of its transportation system, instead of focusing only on under-performing sites.

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 portal. 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 (CS). In this example, inventoried assets receive a TAM 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. This Geotechnical Asset Management (GAM) program is designed to be TAM compatible. Rock slope sites around Long Lake are shown as TAM/RAP/Poly classifications in the map at right.

Tracking Adverse Events
AKDOT&P’s Rated Assets

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Determining the Condition of GAM Assets

TAM programs require that each asset be assigned a Condition State (Good/Risk/Poor). In AKDOT&P’s Condition State-based on asset performance criteria, the 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. This Geotechnical Asset Management (GAM) program is designed to be TAM compatible. Rock slope sites around Lake are shown as Good-Risk/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 GeForm is designed to allow AKDOT&P to easily add events requiring maintenance attention to the map at right. This map currently shows individual locations specific events mined from the WSN program as well as recent unstable slope events.

Better tracking of all geotechnical events will allow maintenance frequency, event size, and other site rating information to be improved. It will also improve assessments of risk and economic costs within the GAM program. Over time, it will 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 to 2010, as obtained from the WSN.
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Determining the Condition of GAM Assets

TAM programs require that each asset be assigned a Condition State (GOOD/Fair/Poor). In addition to these, a Condition State based on asset performance metrics is assigned. This Condition State can then be used to address how well the department is meeting its goals for asset performance on a regional or statewide level. This Geotechnical Asset Management (GAM) program is designed to be TAM compatible. Rock slope classes around Cook Inlet are shown as Good/Fair/Poor classifications in the map on right.

Tracking Adverse Events

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**Geotechnical Asset Management Program**

**AKDOT&PF’s Rated Assets**

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Integrating USMP Unstable Soil Slope and Embankment Assets into GAM

Repeated patching required to address frost heave on the Elliott Highway, MP 48.3. This embankment is in a Poor Condition State due to permafrost-related instability.

The Condition State map of unstable soil slopes and embankments shown at right helped highlight that most of AKDOT&PF’s poorly performing soil slopes/embankments are located in the Northern Region, where permafrost impacts are a dominant concern.

The developed Condition States can be directly mapped to TAM’s Good/Fair/Poor criteria. The...
Applying GAM - Incorporating Thawing Permafrost Risks

Throughout Alaska, mean average ground temperatures are projected to increase throughout the next century. Work conducted under Dr. Marchenko at the University of Alaska at Fairbanks modeled projected warming of Alaskan soils, and created the Alaska Permafrost Risk Application. When coupled with AKDOT's existing unstable soil slope inventory, this model can help the department predict areas where thawing permafrost will result in increased maintenance requirements and prepare long-term budgets accordingly.
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Applying GAM - Combining Activity and Asset Improvement Costs
## Resilience in geotechnical asset management

<table>
<thead>
<tr>
<th>Material condition</th>
<th>Contributing properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raveling of rock or wall face</td>
<td>Ice and freeze/thaw</td>
</tr>
<tr>
<td>Disintegration of rock face or wall</td>
<td>Design criteria</td>
</tr>
<tr>
<td>Differential erosion</td>
<td>Geological character</td>
</tr>
<tr>
<td>Debris accumulation</td>
<td>Climate</td>
</tr>
<tr>
<td>Deformation of wall or soil slope</td>
<td>Drainage and hydrology</td>
</tr>
<tr>
<td>Water infiltration and accumulation</td>
<td>Presence of mitigation features</td>
</tr>
<tr>
<td>Loss of vegetation</td>
<td>Geometry and size of slope face or wall</td>
</tr>
<tr>
<td>Permafrost degradation</td>
<td>Permafrost quality</td>
</tr>
<tr>
<td></td>
<td>Wall foundation</td>
</tr>
</tbody>
</table>

*Established practice in half the US states, e.g. Rockfall Hazard Rating Systems*
Timely mitigation highly cost-effective

- Finding the best opportunities requires quality asset inventory and condition data
- $1 spent improving slope and wall conditions not only pays for itself ...

... It returns an additional $1.06 to the Department and road users!
A massive problem

<table>
<thead>
<tr>
<th>Rock slopes $3.9 billion</th>
<th>Soil slopes $14.4 billion</th>
<th>Retaining walls $0.7 billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good 27%</td>
<td>Good 22%</td>
<td>Good 73%</td>
</tr>
<tr>
<td>Fair 65%</td>
<td>Fair 47%</td>
<td>Fair 23%</td>
</tr>
<tr>
<td>Poor 8%</td>
<td>Poor 31%</td>
<td>Poor 4%</td>
</tr>
</tbody>
</table>

- $19 billion in geotechnical assets – 3 times the value of the bridge inventory
Fitting GAM into TAM

Pavement Management System
Bridge Management System
Maintenance Management System
Geotechnical Inventory

Transportation Investment Candidate File
Tradeoff Analysis
Priority setting Resource allocation Budgeting Programming

Maximize systemwide benefits
Equity and distributional goals
Policy and political goals
Resilience

• In the same way condition affects long-term cost, resilience affects safety, mobility, and sustainability

• Long-term social cost integrates these concerns

• Cross-asset

• Multi-objective
Life cycle activity profile: rock slopes

![Graph showing life cycle activity profile of rock slopes]

- **Condition index**
- **Age of slope (years)**
- **Pure deterioration**
- **Reconstruct only**
- **Preservation**
Funding vs. condition tradeoff

Initial 2015 funding ($M) vs. condition index after 10 years.

- Condition index
- Current index
- Desired
- Pct Good
- Pct Poor

Percent Good or Poor
Conclusions

• Nation’s first comprehensive GAM system
• NHS & AHS assessments underway
Thank you!

Paul D. Thompson