2018 Midwest Geotechnical Workshop

Geotechnical Asset Management Implementation for Transportation Agencies - Outcomes from Project 24-46

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### Finding Success in Your Agency

- Implementation should be flexible to allow adaptation to various:
  - Performance objectives
  - Agency cultures
  - Department processes
  - Systems
<table>
<thead>
<tr>
<th>Paths to Implementation of Geotechnical Asset Management in Your Agency</th>
<th>Successful Implementation of Geotechnical Asset Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff and Team</td>
<td></td>
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<tr>
<td>Treatment Planning</td>
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<td>GAM in Design</td>
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<td>Training</td>
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<tr>
<td>GAM Plan</td>
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</tbody>
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Enabling GAM Success

- Optional and flexible steps that can enable GAM success
Implementation of Geotechnical Asset and Performance Management

Steps Towards GAM Success

- Staff and Team
- Treatment Planning
- GAM in Design
- Training
- GAM Plan
Organization Structure

• Advanced programs have individuals who have full time capacity for GAM
  – Aspirational goal that limit distractions from typical design or construction duties

• Implementation Manual recommends designation of a geotechnical asset manager who interacts with TAM and performance program managers
GAM Team Options

• Who could it be?
  – Geotechnical/Geology staff
  – TAM staff
  – Maintenance staff
  – Bridge Inspection staff
  – Others?
Steps Towards GAM Success
The Need to Prioritize Planning

• GAM will indicate needs far exceed reasonable investment strategies

• Additional prioritization steps guide the process to treatments that provide the greatest value to the organization
  – Objectives will vary by agency and by time within an agency so flexibility is necessary for sustained success
Treatment Planning

- Several approaches to prioritize treatments and enable GAM acceptance and investment support
Risk Prioritization

- Risk Prioritization is a beneficial process for identifying and guiding treatment decisions that align with executive and stakeholder interest areas.
Risk Prioritization

Example:
Important corridors and/or areas of higher risk from geotechnical assets
Risk Prioritization

Example:
Agency tolerance for risk – is management okay with level of risk values of D or F?
Risk Prioritization

Example:
Source of risk from on ROW assets and/or beyond ROW features
Implementation of Geotechnical Asset and Performance Management

Risk Prioritization

Example:
Examining the distribution between safety, mobility/economic, or condition performance areas
Risk Prioritization

Example:
Interaction with other assets such as culverts, bridges, walls/embankments, etc.
Example:
External performance areas such as environmental compliance, legal exposures, etc.
Life-Cycle Investment Prioritization

- Comparison of treatment alternatives at the asset/segment level to identify the optimum decision from economic perspective

  - Identify specific recommendations in the maintain, rehab, or reconstruction options, e.g.:
    - What are wall maintenance activities?
    - What is the best action for a slope rehabilitation?
## Life-Cycle Prioritization

<table>
<thead>
<tr>
<th>Geotechnical Asset</th>
<th>Treatment Category</th>
<th>Asset Specific Alternatives</th>
<th>Investment and Risk Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slope</strong></td>
<td>Maintenance</td>
<td>Periodic scaling and debris removal</td>
<td>Each alternative will present a different threat to traveler safety and level of effort for maintenance staff.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequent ditch cleaning</td>
<td></td>
</tr>
<tr>
<td><strong>Slope</strong></td>
<td>Rehabilitation</td>
<td>Draped Mesh</td>
<td>While lower initial cost, barrier or draped mesh alternatives may have a high threat to safety when compared to anchored mesh.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anchored Mesh</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barriers</td>
<td></td>
</tr>
<tr>
<td><strong>Slope</strong></td>
<td>Reconstruction</td>
<td>Flatten slope inclination</td>
<td>One alternative may impact environmental resources or require property acquisition while the other adds a more complex asset to the network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Retaining wall</td>
<td></td>
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# Life-Cycle Prioritization

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<tr>
<td>Wall</td>
<td>Maintenance</td>
<td>Cleaning and inspection of drainage elements</td>
<td>Cleaning and rinsing actions require annual investment and resources but can slow deterioration rates. I&amp;M may have lower cost and provides early warning of problems but will not slow deterioration.</td>
</tr>
<tr>
<td></td>
<td>Rehabilitation</td>
<td>Add structural reinforcement</td>
<td>Each alternative should consider service life of rehabilitation method relative to required remaining service life of wall asset</td>
</tr>
<tr>
<td></td>
<td>Reconstruction</td>
<td>Rebuild wall to current design standard</td>
<td>Select wall type based on required service life and lowest life-cycle cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- **Wall Maintenance**: Cleaning and inspection of drainage elements
- **Wall Rehabilitation**: Add structural reinforcement
- **Wall Reconstruction**: Rebuild wall to current design standard
- **Asset Specific Alternatives**: Cleaning and rinsing actions require annual investment and resources but can slow deterioration rates. I&M may have lower cost and provides early warning of problems but will not slow deterioration.

- **Investment and Risk Considerations**: Each alternative should consider service life of rehabilitation method relative to required remaining service life of wall asset.
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<tr>
<td>Embankment</td>
<td>Rehabilitation</td>
<td>Install reinforcements</td>
<td>Each alternative will have a different design reliability that results in different impacts to future maintenance needs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Partial reconstruction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install groundwater drainage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Add buttress fill</td>
<td></td>
</tr>
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<tr>
<td>Subgrade</td>
<td>Maintenance</td>
<td>Increased pavement treatment frequency</td>
<td>Evaluate tradeoff between higher initial cost and potential for reduced pavement maintenance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install and maintain drainage improvements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rehabilitation</td>
<td>Install ground improvement</td>
<td>Several improvement technologies exist and can be evaluated using resources such as GeoTechTools.com</td>
</tr>
<tr>
<td></td>
<td>Reconstruction</td>
<td>Reconstruct roadway and placed improved subgrade materials</td>
<td>Each alternative will have different initial costs, potential ROW impacts, O&amp;M costs, and expected life-cycle duration that should be considered in a option selection process.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relocate roadway away from poor subgrade</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorporate structural solution to bridge poor subgrade</td>
<td></td>
</tr>
</tbody>
</table>
Life-Cycle Planning

Question:
• Could we consider monitoring as a possible action under the maintenance treatment category?
  – Predict/forecast failure
  – Manage consequences
Whole Life/Life-Cycle Cost

- O&M treatments escalate whole-life cost
Treatment Planning - Life-Cycle Investment Prioritization

• Life-Cycle Cost Analysis: Evaluation of cost over the life of the asset
  – Net Present Value (NPV) Analysis: An evaluation of direct costs among different options for a similar analysis period (e.g. 50 years for all options)
  – Cost Benefit Analysis: An evaluation of the direct costs compared to the financial and indirect (e.g. user) benefits over analysis period
### Project Level NPV

<table>
<thead>
<tr>
<th>Cost Type</th>
<th>Cost Description</th>
<th>Embankment Reconstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Cost</td>
<td>Design needs are similar between options</td>
<td>$10,000</td>
</tr>
<tr>
<td>ROW Cost</td>
<td>Option 1 requires purchase of ROW</td>
<td>$20,000</td>
</tr>
<tr>
<td>Construction Cost</td>
<td>More embankment material required for Option 1</td>
<td>$100,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$80,000</td>
</tr>
<tr>
<td>Total Initial Cost</td>
<td>Year 0 cost</td>
<td>$130,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$90,000</td>
</tr>
<tr>
<td>Annual Maintenance</td>
<td>Option 2 O&amp;M cost is three times greater due to need for erosion repairs on steeper slopes and roadway barrier maintenance</td>
<td>$1,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$3,000</td>
</tr>
<tr>
<td>50-year Present Worth Value of Annual Maintenance</td>
<td>Cost in current dollars for 50 years of annual maintenance using a 4% discount rate</td>
<td>$21,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$66,500</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>Sum of initial and annual maintenance costs in current dollars</td>
<td>$151,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$156,500</td>
</tr>
</tbody>
</table>

- Implementation Manual includes Microsoft Excel worksheet with a NPV analysis framework
<table>
<thead>
<tr>
<th>Why GAM</th>
<th>Starting GAM</th>
<th>Connecting to TAM</th>
<th>Steps to Success</th>
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Example

Project Level NPV
Data Driven Treatment Decisions

• GAM is a voluntary process that must compete on business case

• Guide staff to be able to answer the question:

  “If given $X amount of dollars, what can be done for the greatest return of investment?”

Starting small with gradual improvements may improve potential for success?
Steps Towards GAM Success
The Asset Life-Cycle

- Planning
- Design
- Construction
- Operation & Maintenance
- Rehabilitation and/or Reconstruction
Incorporating GAM in Design

• For new assets and rehabilitation decisions designers can consider questions such as:
  – What is the desired life of the asset?
  – What is the estimated O&M cost for option?
  – What are the agency O&M capabilities and resources?
  – What design changes can influence life-cycle cost?
Incorporating GAM in Design

- Up to 80% of life-cycle cost may be locked in by preconstruction decisions
Steps Towards GAM Success
Training for GAM

• Asset management is a cross-functional process that can benefit from training in less familiar topics such as:
  – Transportation asset management
    • E.g. FHWA-NHI-136113 or 136106
  – Geotechnical assets
  – Risk and risk management
    • E.g. NHI, ASCE, etc.
  – Life-cycle cost analysis
Steps Towards GAM Success
Developing a GAM Plan

• GAM Plan can be a process improvement step and a “living” document

• GAM Plan is tool for communicating the strategy for geotechnical assets to cross-disciplinary stakeholders

• Drawing from the Network Rail experience, 7 versions of the GAM plan have been issued with the first version several years after starting implementation
Developing a GAM Plan

- Implementation Manual provides framework and annotated outline that can be used to author a simple GAM plan at the start of implementation
  - Includes recommended objectives and measures for
    - Tracking safety performance
    - Risk to safety, mobility, and economic vitality
    - Asset condition
Strategy Discussion on Overcoming Barriers and Questions

Future questions and feedback:
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