INDOT INITIATIVES FOR GEOTECHNICAL ASSET MANAGEMENT

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Overview

• Background
• Geotechnical Asset Management Plan
• Geotechnical Assets
• Challenges
• Strategy & Planning
• Collect Asset Inventory
• Future Modifications
• Q & A ?
Background

• INDOT asset management programs

• Active programs
  * Bridges
  * Drainage Structures
  * Traffic signs
  * Pavements

• Proposed Programs
  * Geotechnical
Geotechnical Asset Management Plan

Phase I

• Know your Assets
• Quantify Your Assets
• Data & Condition Assessment
• Condition based Ranking & Monitoring program
Geotechnical Asset Management Plan

Phase II

• Effective tool for planning
• Monitoring asset performance
• Risk Assessment
• Life cycle cost analysis
• Update inventory and condition assessments
• Program as a project
• Cost estimates for mitigation/ replacement
Geotechnical Assets?

- Foundations
- Retaining Structures
- Slopes
- Embankments
- Landslides
- Tunnels
- Levees
- Geotechnical experimental features
Geotechnical Assets- Foundation

Drilled Shaft

Piles inside MSE wall

S.R. 46 IN COLUMBUS, INDIANA OVER THE WHITE RIVER
45° ANGLE DRILLED SHAFT SOCKETED IN BEDROCK
Geotechnical Assets- Precast Panel MSE Walls
Geotechnical Assets
Slope & Landslide
Geotechnical Assets

Levee

Tunnel
Geotechnical Experimental Features

- Coal Combustion By-products
- Foundry Sand
- Shredded Tires
- Crushed Glass
- EPS
- Light Weight Cellular Concrete
- Embankment over landfill
Geotechnical Experimental Features

Foundry Sand Construction

Landfill Embankment, Dynamic Compaction
I-164 over U.S. 41 Vanderburgh County
Geotechnical Experimental Features - EPS
Geotechnical Experimental Features

Tire Shreds/EPS as Backfill

Marion County Coal Ash Project
Geotechnical Experimental Features

- Shredded Tires
- Light Weight Cellular Concrete
- Evansville, Vanderburgh County

Slide Correction on I-74
7/10th mile East of SR-1 and I-74

SR19 at CR46
Intersection Improvement
Geotechnical Experimental Features

Crushed Glass

Tire Chips

Waste Foundry Sand

Coal Ash
Geotechnical Experimental Features

Andela Hopper used to crush glass

Shredded Tires for US31 in Marshall County

Bruceville, Indiana Crushed Glass Project

Hauling and compacting the mixture
Challenges

• Classify assets
• Geotechnical Structures- Above ground
  * Retaining Walls
  * Landslides
  * Embankments
  * Slopes
• Geotechnical Structures- Below ground
  * Spread footing
  * Piles
  * Shafts
  * Subgrade
• Defects are not visible for underground structures
• Difficult to inspect & assess conditions
• Natural & Human activities may affect
• Quantify assets
Strategy and Planning

• Limited in-house resources
• Prioritization of assets
• Development of Criteria & guidelines
• Selection of consultants
• Collection of data
• Implementation
INDOT Priorities

- Retaining Structures
- Landslides
- Projects with Experimental Features
- Other Assets
Collect Asset Inventory

• Hired consultants
• Collector App, ESRI (GIS based)
• Consultants inspect assets as per INDOT inspection manuals
• Collect inventory- Office
  * Plans
  * Reports
• Collect inventory- Field
  * Permissions / Coordination
  * Inspection & Condition rating
Collect Asset Inventory

If issues discovered during inventory collection, immediate steps are needed-

• INDOT reviews & takes action depending on conditions
• Direct district offices for immediate inspections
• Perform risk assessments
• Mitigation/ Replacement
• Assets are contained
Retaining Wall Asset Program
Retaining Wall Asset Program

- Streamline In-house resources
- Drafted INDOT Inspection Manual for Retaining walls
- Hired consultants with experience in GAM
- Using ArcGIS, ESRI application to input data
- Condition ratings of walls recorded
- Monitoring Program → Interface to Phase II
Retaining Wall Asset Program

- Structures that are visible above ground (> 5 ft.)
- Priority
  * State owned structures
  * LPA owned structures
  * Others
- Finding retaining walls through Google Maps
- Searching one route at a time
- Cross-checking our inventory for info
Retaining Wall Asset Program

- One consultant per two districts
  
  * La Porte & Fort Wayne - RII (Northern IN)
  * Crawfordsville & Greenfield - WSP (Central IN)
  * Vincennes & Seymour - CTL (Southern IN)

- Ensure not to overlap with the Bridge Inventory data
Retaining Wall Asset Program

Inventory challenges

• Many dated structures without any records
• Design Data available only for last 10 -15 years
• Many structures and their locations are unknown
• Asset life of such structures is unknown
• Physically searching undocumented structures
Retaining Wall Collector App

Legend-
- Masonry
- RC Cantilever
- RC Counterfort
- Pre-stressed Concrete
- Cantilever Sheet Pile
- Anchored Bulkhead
- Diaphram
- Bored Pile
- Soldier Pile
- Reinforced Earth
- MSE
- Timber
- Bin
- Wire
## Retaining Wall Collector App

### Fields for data input in app

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor name</td>
<td>CTL / RII / WSP</td>
</tr>
<tr>
<td>Arrival date &amp; time</td>
<td>4/25/2018, 11:17 AM</td>
</tr>
<tr>
<td>Departure date &amp; time</td>
<td>4/25/2018, 11:17 AM</td>
</tr>
<tr>
<td>Observer name</td>
<td>xyz</td>
</tr>
<tr>
<td>Weather Condition</td>
<td>Sunny 62°F</td>
</tr>
<tr>
<td>Wall Type</td>
<td>MSE</td>
</tr>
<tr>
<td>Associated Feature</td>
<td>Bridge abutment</td>
</tr>
<tr>
<td>Incenteroid facing direction</td>
<td>West</td>
</tr>
<tr>
<td>Wall Facing Type</td>
<td>Precast concrete panel</td>
</tr>
<tr>
<td>Panel height</td>
<td>5 ft.</td>
</tr>
<tr>
<td>Panel width</td>
<td>10 ft.</td>
</tr>
<tr>
<td>Wall design method</td>
<td>LRFD</td>
</tr>
<tr>
<td>Latitude</td>
<td>41.06792471</td>
</tr>
<tr>
<td>Longitude</td>
<td>-85.01113566</td>
</tr>
<tr>
<td>Altitude</td>
<td>235.2605231</td>
</tr>
<tr>
<td>Wall height</td>
<td>22ft</td>
</tr>
<tr>
<td>NBI</td>
<td>000000</td>
</tr>
<tr>
<td>Des</td>
<td>1234567</td>
</tr>
<tr>
<td>Public Safety Rating</td>
<td>Green</td>
</tr>
</tbody>
</table>
Retaining Wall Collector App
Retaining Walls Rating Codes

Wall Rating Codes

- Code 9- Excellent (Recently installed or recently repaired)
- Code 7- Good (No repairs needed, next inspection to be examined)
- Code 5- Fair (Significant defects, frequent inspections)
- Code 3- Poor (Structural issues, repair by qualified contractor)
- Code 1- Critical (Failing or failed, major mitigation or replacement)
Retaining Walls Rating Codes

Public Safety Rating Codes

• Green flag- No danger of failure
• Orange flag- Repairs needed
• Yellow flag- Public safety issue, closure of lane/ traffic
• Red flag- Roads relying on wall for support are closed
<table>
<thead>
<tr>
<th>Retaining Walls Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Abrasion/ wear (concrete)</td>
</tr>
<tr>
<td>• Freeze-thaw damage</td>
</tr>
<tr>
<td>• Masonry displacement</td>
</tr>
<tr>
<td>• Mortar breakdown</td>
</tr>
<tr>
<td>• Patched area masonry</td>
</tr>
<tr>
<td>• Rust stains</td>
</tr>
<tr>
<td>• Split/ spall masonry</td>
</tr>
<tr>
<td>• Settlement</td>
</tr>
<tr>
<td>• Backfill Leakage</td>
</tr>
<tr>
<td>• Damage</td>
</tr>
<tr>
<td>• Delamination/ Spall</td>
</tr>
<tr>
<td>• Erosion</td>
</tr>
<tr>
<td>• Exposed rebar/ fabric</td>
</tr>
<tr>
<td>• Efflorescence</td>
</tr>
<tr>
<td>• Graffiti</td>
</tr>
<tr>
<td>• Vegetation</td>
</tr>
<tr>
<td>• Bulging</td>
</tr>
<tr>
<td>• Corrosion</td>
</tr>
<tr>
<td>• Cracking</td>
</tr>
<tr>
<td>• Connection</td>
</tr>
<tr>
<td>• Distortion</td>
</tr>
<tr>
<td>• Horizontal rotation</td>
</tr>
<tr>
<td>• Separation</td>
</tr>
<tr>
<td>• Vertical rotation</td>
</tr>
</tbody>
</table>
Retaining Wall App Dashboard

Collector app showing percentage of walls collected by consultants up to date

Poor or failing walls up to date
Causes-
- Fabric tear-off
- Incorrect installation of panels
- Vandalism
- Construction mistakes
- Incorrect fabrication of panels
- Damaged fabric during construction

Possible Solutions-
- Backer rod system and sealant
- Bituminous joint filler
MSE wall showing backfill loss

Before Repair

After Repair
Landslide Asset Program
Landslide Asset Program

- Streamline In-house resources
- Customized INDOT Template for Landslide Inventory Program
- Using ArcGIS, ESRI application to input data
- Condition ratings of landslides developed
- Transition to Phase II as a programming tool
Landslide Asset Program

Criteria for Landslide Inventory

• Landslide length
• Affected slope height
• Pavement affected length
• Pavement affected width
• Pavement lateral displacement
• Pavement vertical displacement
• Potential For Additional Slope Failure
Landslide Asset Program

• Pilot program to collect landslides Inventory
• Route Assessment for potential landslides
• Hired consultants with landslide experience
• Currently, slope assessment along the routes are in progress
## Landslide Asset Program

Five routes selected for assessment

<table>
<thead>
<tr>
<th>Route</th>
<th>From</th>
<th>To</th>
<th>Miles</th>
</tr>
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<tbody>
<tr>
<td>SR 262</td>
<td>US 50</td>
<td>SR 56</td>
<td>15.3</td>
</tr>
<tr>
<td>SR 1</td>
<td>US 50</td>
<td>I 74</td>
<td>15.3</td>
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<td>SR 156</td>
<td>SR 250</td>
<td>SR 262</td>
<td>11</td>
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<tr>
<td>US 52</td>
<td>SR 101</td>
<td>SR 46</td>
<td>13.7</td>
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<tr>
<td>SR 62</td>
<td>SR 145</td>
<td>SR 66</td>
<td>14.5</td>
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</tbody>
</table>
## Landslide Asset Program

### In-app data entry template

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Earth Exploration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>Verified - Consultant</td>
</tr>
<tr>
<td>Slope Type</td>
<td>Fill</td>
</tr>
<tr>
<td>Total Slope Height (ft)</td>
<td>10</td>
</tr>
<tr>
<td>Slope Steepness</td>
<td>2 : 1</td>
</tr>
<tr>
<td>Preliminary Cause</td>
<td>Groundwater and embankment fill on natural slope of likely high PI</td>
</tr>
<tr>
<td>Possible Solutions</td>
<td>Nails</td>
</tr>
<tr>
<td>Possible Solutions Cost</td>
<td>$1,300 to $1,500/ft plus pavement and incidentals</td>
</tr>
<tr>
<td>Existing Remedial Activities</td>
<td>None</td>
</tr>
<tr>
<td>DES</td>
<td>ROUTE_POST_AND_OFFSET 12.2, Right</td>
</tr>
</tbody>
</table>
Landslides

Legend-
- Active emergency repair required
- Active, Consider for acceleration
- Active, monitor
- Historical
- Historical/New Activity
- In construction
- Slide Must Go
- Suspended
- Other
Problems & Corrections

Slope Failure on US 52

Cause of Slope Failure - Sliding

Sliding - downslope movement of a coherent block of earth material
Problems & Corrections

Slope Failure Treated On US 52

Type of Repair - Soil Nail Wall
Cost of Repair = $225,000
Cost of Replacement = $1,447,300
Road closed for maintenance = 21 days
Asset new life = 35 years
Problems & Corrections

Landslide On SR 237

Causes:
- Slope measured steeper than 2:1
- Inadequate benching
- Unknown mines behind slope
- Rain water swept in mines
- Destabilized slope causing damage
Problems & Corrections

After Correction On SR 237

Type of Repair- Soil Nail Wall + Drilled Pier Wall
Cost of Repair= $781,250
Cost of Replacement= $ 1,529,500
Road closed for maintenance= 141 days
Asset new life= 40 - 35 years
Future modifications

New Technologies

• Use of Drones to assess inaccessible terrain
• LiDAR to assess inside conditions
• GPR to assess inside conditions
Future Modifications

- Using GPR to track the reinforcement behind the panels
- Forensic investigation validating the construction as per design
Future Modifications

• Crew performing coring for forensic investigation