PROJECT SUMMARY

Texas Department of Transportation

5-6957-01: Slope Repair and Maintenance Management System

Background

Recurring slope failures are common in Texas due to the extreme weather and soil conditions. The Texas Department of Transportation (TxDOT) spends millions of dollars annually to repair embankment slope failures along state roads and highways. The proactive maintenance of highway embankments and cut slopes can significantly reduce the cost of emergency stabilization and improve highway operations. This project aims to develop a Slope Repair Maintenance and Management System (SRMMS) to identify the most critical highway slopes in order to facilitate proactive slope maintenance. The objectives of this implementation project were to:

1. collect data and create layers of an existing Receiving Agency ArcGIS database for assessing conditions of slopes and slope repairs,
2. develop slope failure predictive models,
3. monitor slope failures, calibrate slope failure predictive models, and update the location of critical segments of corridors,
4. recommend rapid, resilient, and sustainable repair methods to prevent recurring failures, and
5. develop a repair and maintenance master plan.

What the Researchers Did

The geospatial data on soil properties, precipitation, historical slope failures, slope geometry, and landcover in the TxDOT Paris district slopes were collected and integrated into a geodatabase. The geospatial data were used as inputs to a physically based geotechnical model to assess the stability of the slopes along the highway corridors. Based on the minimum duration of rainfall required to trigger slope instabilities, color-coded slope failure susceptibility maps were prepared using the following categorizations:

- Highly critical (<3 days of rainfall)
- Critical (3–10 days)
- Moderately critical (10–45 days)
- Non-critical (>45 days)

A map-based interface (Figure 1) was developed to visualize the collected geospatial data entities and color-coded slope failure susceptibility maps. The slope failure susceptibility maps were calibrated to consider the effect of landcover on slope stability. The validation of the susceptibility maps was carried out using the 10 past slope failures that were located in the corridors for which the susceptibility maps were developed. Nine slope failures were located in highly critical regions, which require rainfall duration of fewer than 3 days to trigger slope instability, and 1 slope failure was located in the critical region, which requires less than 7 days of rainfall to trigger slope instability. The validation results showed that slope failure susceptibility maps could effectively identify the slope segments highly susceptible to failures. A multi-criteria decision support system was developed to recommend a list of methods for maintenance and repair of critical slope segments. Finally, a repair and maintenance master plan was prepared for critical slope segments along US 75 and Loop 286 corridors in the TxDOT Paris district. The order of magnitude cost estimate and maintenance schedule was prepared for the proactive maintenance of the critical slope segments.

What They Found

Through physics-based slope failure susceptibility analysis, the researchers identified critical roadside slopes along the corridors of the TxDOT Paris district.

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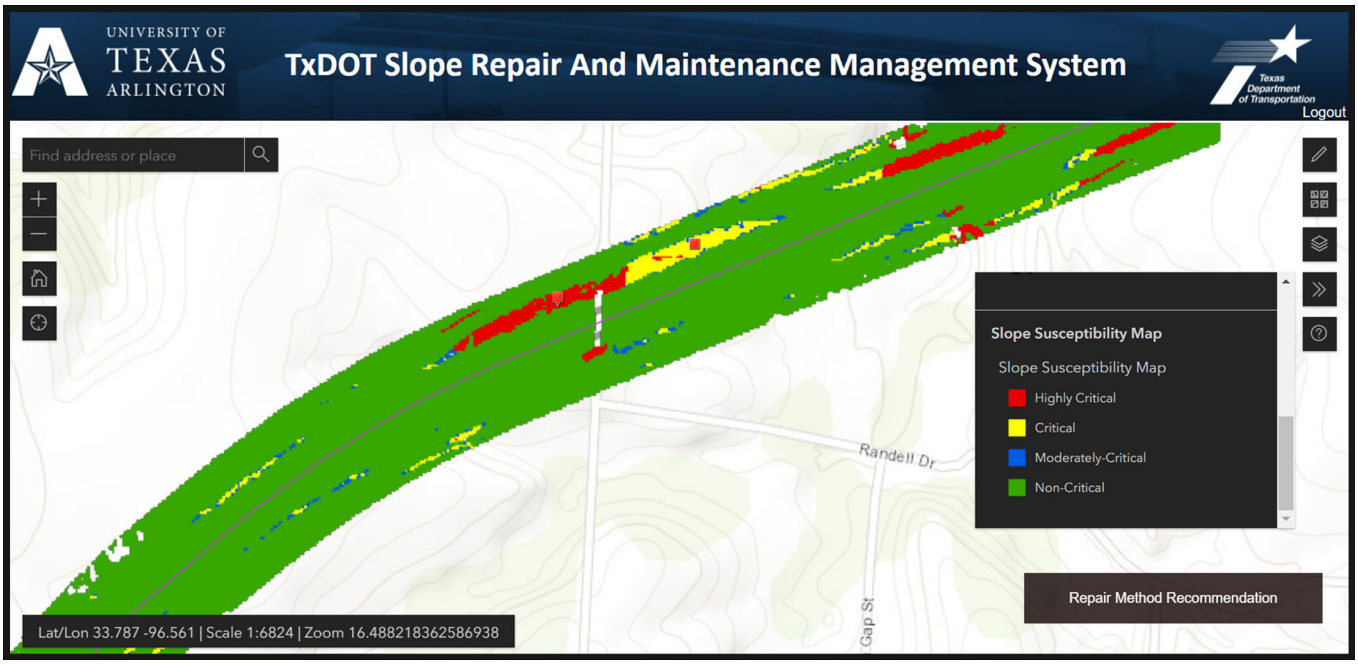

Figure 1. Map-based interface for Slope Repair and Maintenance Management System (SRMMS)

The researchers observed that most past slope failures were in regions where rainfall intensity corresponding to 3 days' duration and a 10-year return period were sufficient to trigger slope instabilities. The researchers also developed a multi-criteria decision-making tool to recommend the slope repair methods based on user-defined criteria, such as rapidity of repair, equipment availability, budget availability, skill manpower requirement, and impact on traffic.

The researchers developed a map-based interface for visualization of the slope failure susceptibility map and incorporated the repair method recommendation system into the interface. The map-based interface helps TxDOT to visualize critical slope segments and develop maintenance plans for proactive rehabilitation.

What This Means

The Slope Repair and Maintenance Management System (SRMMS) will help to minimize traffic disruptions and the cost of emergency slope restorations by aiding TxDOT personnel in identifying critical slope segments in corridors and facilitating proactive slope maintenance decision-making. The implementation of the system will minimize slope failures and enhance safety, road-user satisfaction, infrastructure service life, environmental sustainability, and transportation system reliability.

For More Information

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