# Deterioration rates and unit costs for geotechnical assets

## Description

“The term ‘asset management’ means a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.’’ (23 USC 101(a)(2))

Federal rules in 23 CFR 515.9 encourage transportation agencies to incorporate in their Transportation Asset Management (TAM) Plans all infrastructure assets within the highway right of way. This may include geotechnical assets such as retaining walls, unstable slopes, embankments, and other asset classes whose functionality may affect the whole life cost and/or performance of the network. AASHTO guidance on asset management notes that best practice is the use of deterioration and cost models as central tools in forecasting future preservation needs and estimating life cycle cost.

Agencies implementing geotechnical asset management will need to develop consistent quantitative tools to forecast deterioration and costs for best practice asset management and to provide accurate investment plans in the TAM Plan. The deterioration of unstable slopes, embankments, and retaining walls increases the likelihood each year that transportation service in a road corridor will be disrupted by rockfall, slope movement, frost heaves, washouts, and other damage. These problems then require an agency response – either proactive risk mitigation or preservation, or reactive emergency repair – to maintain continuity of service.

## Objective

The objective of this research is to develop measurable, consistent, broad-based deterioration and cost models for the three most significant types of geotechnical assets; retaining walls, embankments, and unstable slopes. The models will be developed mainly using existing condition assessments already gathered by transportation and other agencies, and may be supplemented by field surveys conducted by the researchers, particularly to follow up on earlier surveys or to fill in asset classes not covered by available data. Agency data on quantities and costs of past risk mitigation, preservation, and reconstruction projects will also be used. Within the limitations of available data, the models will provide guidance on customization of the models to fit agency variations, regional differences in climate, hydrology, geological character, and other significant variables. Statistical analysis of historical data would be relied on to the greatest extent possible with supplementation from professional engineering judgement from practicing engineers. Limitations and assumptions would be documented that lead to a consistent and broad-based approach to cost analysis. The models must be suitable for use with TAM performance measures (such as condition states) commonly used by transportation agencies.

## Benefits

Currently geotechnical asset management procedures rely exclusively on expert judgment because of the relative newness of the field and lack of sufficient historical data in many agencies. Expert judgment in matters regarding long lifespans can be of limited or questionable reliability. Using these models, agencies will have a consistent basis for the initial forecasting models they will use in their TAM planning processes, to more credibly tie the forecasts to historical field assessments. Systematic and objective methods will ensure that geotechnical risks are managed consistently and fully considered in planning and programming.

## Related Research

NCHRP 24-46 is developing implementation guidance for geotechnical asset management, but is not expected to perform the research necessary to develop the quantitative models described here. Many agencies have developed Rockfall Hazard Rating Systems that build on a visual assessment of slope characteristics to characterize the vulnerability of rock slopes. In recent geotechnical asset management practice this information has been used to develop judgment-based deterioration models, most commonly Markov models. Similar methods have been used, less commonly, for soil slopes and for retaining walls. A number of agencies incorporate retaining walls within their bridge management systems and use deterioration and cost models developed for those systems.

## Tasks

It is envisioned that the research will involve at least the following tasks:

1. Review and synthesize the relevant literature including the sources listed above and any other ongoing or completed work in the area.
2. Identify and recruit research partners, transportation agencies that are willing to contribute their historical data on condition assessments and activity costs. Obtain and characterize these contributed data sets in terms of coverage of national needs within the United States.
3. Document a data collection plan to supplement the data sources as needed to maximize the quality and coverage of the analysis. The plan will describe the data to be collected, including field procedures and coding of condition assessments and geological characteristics.
4. Prepare an Interim Report describing the findings and recommendations of the preceding tasks. Solicit comments from the project Panel. Meet face-to-face with the Panel for one day to discuss the comments and proposed recommendations.
5. Based on Panel discussions, refine and carry out the data collection plan. Analyze individual agency databases and collected data to develop deterioration and cost models using valid statistical analysis methods. The resulting models will be delivered as Excel spreadsheet files or other media as appropriate.
6. Prepare a draft Final Report describing the work that was done over the project. The report will fully describe the models and provide examples of their use in forecasting of needs. Submit the draft Final Report to the Panel for review and comment.
7. Finalize and submit the Final Report.

## Implementation

This research is envisioned to feed directly into TAM Plans and management systems for geotechnical assets. Continued FHWA and AASHTO support for asset management and performance management will help to ensure successful and widespread implementation. Depending on the quality of data and models obtained, the Panel may elect to conduct a follow up study to gather additional data for incorporation into the model. In the longer term agencies should be able to repeat the methodology with data collected over longer timeframes to improve and further customize the models.

Sponsoring Committee: AFP00(1) - Joint Section Subcommittee on Geotechnical Asset Management (AFP00 and AFS00)

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Index Terms: Geotechnical assets, asset management, deterioration modeling, cost estimation, unit price analysis