Earth Retaining Structures and Asset Management

U.S. Department of Transportation
Federal Highway Administration

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A Critical Component Tool in Maintaining Public Safety

Earth Retaining Structures (ERS) are often an overlooked critical component of America's surface transportation network. Each year, more than 160 million sq ft of permanent ERS are constructed in the United States. Current applications of ERS in highway projects accelerate construction, reduce costs, and enable the use of complex geometric designs. The use of ERS elements also enables vehicles to travel at increased speeds, reduces congestion, and lessens the environmental impact of highway and bridge construction. Ultimately, ERS serve as a vital tool in the successful movement of both people and goods across the country.

A Significant and Growing Asset Investment

The current number of ERS used for transportation applications represents a significant asset investment. With the initial cost of building ERS often reaching or exceeding $100 per square foot of surface area, the total construction cost of the Nation's ERS network is enormous. This network has expanded greatly during the past two decades due to increases in urban development, transportation capacity demands, and construction in complex and difficult terrain. The demand for ERS on America's highways and bridges is only expected to increase in the future. Today, the construction of a single complex urban interchange routinely requires tens of thousands of square feet of ERS's. The increased demand for ERS in transportation applications has been accompanied by the development of new materials and systems for design and construction.

Permanent ERS, which may vary in height from 4 ft to more than 100 ft, are built to withstand significant technical demands and to resist very large forces. They frequently must be constructed in challenging site conditions, including mountainous terrain, soft ground, and sites that are below water. Some modern ERS systems require that engineered materials such as plastics, concrete, and steel be buried in harsh underground environments of soil and rock that may adversely influence the long-term engineering properties of the materials. ERS often have assumed design lives of 100 years, but knowledge of actual design life for these structures is minimal and failures that have occurred to date have happened without warning. Repairing these failed structures is very expensive, complex, and difficult to implement. Repairs of even single, moderately sized ERS installations often cost millions of dollars.

Loss of life due to failed ERS has been rare but safety remains a primary concern, as most ERS installations either directly support bridge components or roadways, or support ground and other transportation features that are immediately adjacent to a bridge or highway. While the transportation community's knowledge of deterioration mechanics and methods to assess in-service performance has been limited to date, asset management (AM) offers important tools and techniques to help in evaluating ERS assets.

An Essential Part of an Asset Management Program

When developing long- and short-term programming and budgeting plans, it is critical that transportation agencies start with clearly identified inventories and condition assessments. AM plans must be data driven and must include performance measures that relate to policy objectives. Engineering and economic analysis and risk assessment are especially important when trade-off decisions are made on how to best address the transportation agency's many needs, as well as in support of which projects will be funded based upon quality information and analysis.

As States and other transportation infrastructure owners determine and prioritize their highway needs, they can use transportation asset management (TAM) techniques and data tools to collect and analyze data, measure system performance, identify strategies, set goals, develop effective performance measures, and support integrated decisions in programming projects. ERS should be included in a TAM program, along with pavements, bridges, ancillary structures, etc., to help ensure optimal usage of limited available funding.

- How many earth retaining structures (ERS) does your agency own?
- How old are the structures?
- What is their condition and what is their remaining service life?
- What is the likelihood that one will collapse or experience excessive serviceability problems?

- What risk or impact would such a collapse present to the traveling public or adjacent property?

These are just some of the questions that can be answered if your agency uses TAM techniques and data tools to inventory and evaluate its ERS networks and to start incorporating ERS in its asset management plan. An ERS management system can provide valuable information on the inventory, condition, maintenance needs, and performance of this important infrastructure asset.

Introducing an Asset Management System

As transportation agencies begin to recognize the importance of this asset investment, a few agencies have developed ERS inventories that will allow them to begin systematic evaluations of their ERS network, develop improved design and construction details and inspection practices, develop strategies for maintenance and rehabilitation, and develop appropriate monitoring protocols to assess long-term behavior. The following are a few examples:

- The Oregon Department of Transportation (ODOT) is embarking on a retaining wall management program to inventory and assess the asset across the State. ODOT estimates it has over 10,000 retaining walls statewide, with an estimated replacement cost of more than $300 million. The agency is taking these measures because it has identified retaining walls as critical assets that could have significant consequences and risk if they fail.
- The City of Cincinnati has been using a retaining wall inventory and inspection system since 1990. The system allows the City to maintain a prioritized list of repairs and replacements based on regular inspections; in addition, the system helps the City respond rapidly to public concerns about its walls. The system currently tracks 6,796 retaining walls within the right-of-way, equivalent to approximately 159 miles in length, which includes privately owned walls that affect the right-of-way. Of the retaining walls within the right-of-way, the City is responsible for maintaining 1,827 of the walls, equivalent to approximately 60 miles in length. The city

engineer's office finds this program to be a very useful tool for managing ERS assets.

- The National Park Service (NPS) has recently begun implementing an ERS asset management program. The NPS structures range in age from newly constructed to over 80 years old, with many showing signs of deterioration. These critical structures support park roads, as well as scenic vistas and overlooks. FHWA's Federal Lands Highway Division office is developing an inventory and condition assessment of all ERS associated with roadways and structures throughout the NPS park road system, including collecting data on location, number, size, condition, consequences of failure, and estimated cost of replacement or repair. This effort is designed to define and quantify the needs associated with these assets and to assist in developing a facility condition index for roadway assets. To date, 26 parks have been inventoried, with data collected on nearly 3,200 ERS estimated to be worth $400 million if they were to be replaced in kind. Approximately 30 percent of the walls inventoried require some action such as immediate maintenance, repair, or replacement. The costs of the required work orders are estimated to be $10 million. Early identification of these maintenance and replacement needs will enable more efficient management of the assets and lower life-cycle costs.

Benefits of Including ERS in Your Asset Management Plan

- Make more informed, cost-effective program decisions and optimize the use of existing highway funds and resources.
- Maximize transportation system performance.
- Simplify tracking of roadway asset locations.
- Minimize life-cycle costs and maximize return on investment.
- Measure and analyze performance of like assets.
- Improve asset preservation through the use of focused preventive maintenance efforts.

Protecting the Future of Your Highway Infrastructure

To learn more about how your agency can begin to implement AM techniques and data tools to protect your critical investment in ERS, maintain public safety, and maximize maintenance funding, see the following resources. Make the most of your ERS investment and ensure the future of your vital highway infrastructure by finding out what TAM can do for you today.

Resources

Contact

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Online

www.dot.state.co.us/publications/PDFFiles/retainingwallmgt.pdf

www.cincinnati-oh.gov/transeng/pages/-7054-/

www.oregon.gov/ODOT/TD/asset_mgmt/docs/Committees/ExecSteeringCommittee/31July2007/03D-Retaining_Walls_Asset_Assessment.doc

www.fhwa.dot.gov/infrastructure/asstmgmt

http://assetmanagement.transportation.org

Publications

National Park Service Retaining Wall Inventory and Assessment Phase 1 Report, Federal Highway Administration, Federal Lands Highway Division, April 2005.

Feasibility of a Management System for Retaining Walls and Sound Barriers (Report No. CDOT-DTD-R-2003-8), Colorado Department of Transportation, Research Branch, May 2003.

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