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Construction Equipment

CST:

Well-Supported Walls, Well-Traveled Highways

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By Ed O'Malley

Charged with maintaining the safety and technological superiority of the nation's road network, the Federal Highway Administration (FHWA) has seen it all. Leaking tunnels. Failed bridges. Frustrations due to construction delays, cost overruns and traffic tie-ups. Even predictions of the end of the era of the automobile. So when the agency within the U.S. Department of Transportation calls because of a potentially unsafe roadway, it's a strong indication that quick action is needed.

Such was the case with the federally owned and managed Baltimore-Washington Parkway at the Route 197 interchange. A combination of excessive rain and highly plastic fill material caused a slope to fail, destabilizing a precast retaining wall and threatening the road itself with tension cracking.

Owned by the National Park Service (NPS), the 53-year-old highway runs along a tree-lined route that presented a unique engineering challenge: stabilize the slope without disturbing the adjacent tree line (or at least minimize the impact to it).

Because the road was constructed on a raised embankment to allow for grade separation between it and the access roads, there were few options. Excavation and reinstallation of structural fill would have required closing the road for an extended period and disrupting thousands of daily commuters. In addition, the slope and limited space made use of heavy equipment difficult.

FHWA engineers conducted a geotechnical investigation to determine subsurface conditions and to develop possible repair schemes. Inclinometer results found that the slope failed 15 feet below the surface due to the cumulative softening effect of wetting and drying of the highly plastic clay fill. This caused the slope to move downward, the roadway pavement to crack and the precast barrier wall to move along the slope crest.

Engineers considered traditional strategies such as drilled shafts and H-piles for reinforcing the 30-foot- to 40-foot-high slope, but decided those approaches would be too expensive and disruptive. They zeroed in on a combination of two options: creation of a berm constructed of rock at the toe of the slope, and foundation reinforcement with rammed aggregate piers.

For this plan to work, engineers had to construct the berm first with crushed, recycled concrete (RC6), wire baskets and high-density polyethylene geogrid for tensile strength. This provided crews with a working area to flatten the slope to some extent and to install the rammed aggregate piers underneath the slope. The platform was built strong enough to support a crawler crane for removal and replacement of the 330 feet of retaining wall, and for installation of the rammed aggregate piers underneath the wall.

Rammed aggregate piers typically function by forcing the aggregate laterally into the sidewall of the excavated cavity, stiffening the surrounding soil. For this project their deployment provided the necessary shear strength to stop the slope from sliding any further.

A total of 472 rammed aggregate piers were built by drilling 30-inch-diameter holes to depths ranging between 10 feet and 21 feet. Controlled lifts of aggregate were placed within the cavities and compacted with a specially designed, high-energy beveled impact tamper. The first lift consisted of clean stone and was rammed into the soil to form a bottom bulb below the excavated shaft. The piers were completed with additional 1-foot-thick lifts of tamped aggregate.

Following replacement of the barrier wall and installation of topsoil, seed and erosion mat according to FHWA specifications, the roadway was stable once again and able to handle traffic without fear of slope failure. With its inviting landscape of native trees and shrubs for commuters and tourists to view while traveling between the capital city and its northern neighbor, the federally designated National Scenic Byway is a model for fulfilling FHWA's priorities of safety, congestion mitigation and environmental stewardship.

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