The Donald M. Burmister Lecture

Department of Civil Engineering and Engineering Mechanics
Columbia University

Limit State Design Framework for Reinforced Slopes andWalls

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Zoom link: http://www.columbia.edu/cu/civileng/ling/burmister

ABSTRACT Conventional design of geosynthetic-reinforced soil structures is divided into two categories, walls and slopes, based on the batter of its facing system. Internal stability, characterized as sufficient reinforcement anchoring and strength, is performed using earth pressure-based design criteria for reinforced walls while reinforced slopes are founded on limit equilibrium (LE) slope stability analyses. LE analyses are also used to assess the global or compound stability of both types of structures, accounting for the geometry of the reinforced, retained and foundation soils. The application of LE-based methods typically results in determination of a slip surface corresponding to the lowest attained Safety Factor (SF), known as the Factor of Safety (Fs); however, it yields little information about reinforcement loading or connection load. In this study, use of the analyzed spatial distribution of SF known as a Safety Map, is modified to attain a prescribed constant Fs at any location in the reinforced soil mass. This modified framework, implemented through an iterative, top-down procedure of LE slope stability analyses originating from the crest of a reinforced structure and exiting at progressively lower elevations on the facing, enables the determination of a Tension Map that illustrates the required distribution of reinforcement tension to attain a prescribed limit state of equilibrium. This tension map is directly constrained by a pullout capacity envelope at both the rear and front of each reinforcement layer, providing a unified, LE based approach towards assessing an optimal selection of mutually dependent strength and layout of the reinforcement. To illustrate the utility of the Limit State framework, a series of instructive examples are presented. The results demonstrate the effects of facing elements, closely-spaced reinforcements, secondary reinforcement layers, and is compared to conventional design approaches. The developed methodology has been published by FHWA (Report FHWA-HIF-17-004, October 2016, “Limit Equilibrium Design Framework for MSE Structures with Extensible Reinforcement”) and has been recognized in AASHTO 2020 as an alternative design method for geosynthetic-reinforced walls.

About the Speaker Dov Leshchinsky is an Emeritus Professor of Civil Engineering, University of Delaware, and a co-founder of ADAMA Engineering, a small, highly-specialized geotechnical company. At the University of Delaware, he had conducted research on slope stability, soil reinforcing, geosynthetics and dredged materials. The National Science Foundation, US Army Corps of Engineers, Federal Highway Administration and private industries have sponsored various research projects he had conducted. Much of his work has focused on comprehensive design methods for geosynthetic reinforced steep slopes and walls as well as geotextile tubes. Through ADAMA Engineering he has co-developed design-oriented computer programs: FoSSA, ReSSA, MSEW, ReSlope, GeoCoPS. These design tools have been used worldwide. Dov Leshchinsky has been involved with advanced geotechnical consulting for the past 35 years. Governmental agencies, geotechnical outfits, geosynthetic manufacturers, and law firms have retained him as an expert. He was involved in complex, large projects dealing with construction over soft soil as well as reinforced walls and slopes. As a consultant he coauthored the design manuals “Guidelines for Geofoam Applications in Embankment Projects,” and “Defining the Boundary Conditions for Composite Behavior of Geosynthetic Reinforced Soil (GRS) Structures,” both sponsored by NCHRP, as well as FHWA-HIF-17-004 “Limit Equilibrium Design Framework for MSE Structures with Extensible Reinforcement”. He co-developed an NHI short course on Slopes and Embankments. He has been co-teaching short courses on MSE Walls Reinforced Soil Slopes, Slopes and Embankments, and Geosynthetic Reinforcement in the US (mainly State DOT’s) and globally. Dov Leshchinsky has published numerous peer-reviewed papers, several of which have received an award (e.g., TRB, G&G, Transportation Infrastructure Geotechnology J.). He had served on various editorial boards (e.g., ASCE Journal of Geotechnical Engineering; Geotextiles and Geomembranes; Soils and Foundations). He had also served on various committees such as HITEC and ASCE Slopes and Embankments. He was invited to deliver keynote presentations in several international conferences. Dov Leshchinsky received the ASCE Martin S. Kapp Award in 2010 which states: “For his innovative contribution to the unified method of design and analysis of earth retaining structures and slopes as well as implementation of such technology through computer software and continuing education”. An international symposium in honor of his research achievement was organized in 2013 in Bologna, Italy.

The late Prof. Donald M. Burmister (1895-1981) is one of the pioneers in the field of Soil Mechanics and Geotechnical Engineering. He established the Soils Laboratory at Columbia University in 1933. He was a faculty member for 34 years before retiring in 1963. During his tenure at Columbia University, he investigated earthworks and foundations for over 400 projects. Most notably among these were the Brookhaven National Laboratory, the Throgs Neck, Tappan Zee and Verrazano Narrows Bridges, the First New York World Fairs at Flushing Meadows, and the reconstruction of the White House in 1950. He has developed several soil testing methods and his soil classification system is still widely used. He also contributed to the first use of digital computer in conjunction with his theory of the layered pavement system.