Proceedings of the 10th World Congress on Civil, Structural, and Environmental Engineering (CSEE 2025)
Barcelona, Spain - April, 2025
DOI: 10.11159/icgre25.003

Limit-State Design Framework for Geosynthetic Reinforced Structures

Dov Leshchinsky
Emeritus Professor, U. of Delaware,
Co-Founder, ADAMA Engineering

Application of limit-state analysis, such as limit equilibrium (LE), yields the critical slip surface and its associated minimum safety factor. However, at a limit state, it produces little information about the distribution of local load of an individual reinforcement, including its load at connection to the facing. In this presentation, the Safety Map, generated by LE analysis, is modified so as to attain a prescribed constant Fs at any location within the reinforced soil mass. A modified design framework then is presented enabling one to generate the Tension Map showing the distribution of reinforcement tension, along each layer, at a limit state. This tension map is constrained by a pullout capacity envelope at both the rear and front of each reinforcement layer, providing a robust and consistent LE-based approach towards assessing an optimal selection of reinforcement. It yields the maximum load in each layer, Tmax, its location, the connection load To, possible horizontal face displacement at a limit state, as well as bearing load, eccentricity, and aspects associated with external stability. The approach can consider complex slope geometries and layouts of reinforcement. To illustrate the utility of the Framework, a series of instructive examples are presented including internal stability, consideration of facing, horizontal movement, and bearing capacity. The developed methodology was published in 2016 as FHWA-HIF-17-004, "Limit Equilibrium Design Framework for MSE Structures with Extensible Reinforcement" and was recognized in AASHTO 2020 as an alternative design method for geosynthetic-reinforced walls.

References

[1] Han, J., and Leshchinsky, D., "General Analytical Framework for Design of Flexible Reinforced Earth Structures," ASCE, Journal of Geoenvironmental and Geotechnical Engineering, 132(11), 2006, 1427-1435.
[2] Leshchinsky, D., Kang, B.J., Han, J., Ling, H.I., "Framework for Limit State Design of Geosynthetic-Reinforced Walls and Slopes," Transportation Infrastructure Geotechnology, Springer, 1(2), May 2014, 129-164.
[3] Leshchinsky, D., Leshchinsky, B., and Leshchinsky, O., "Limit State Design Framework for Geosynthetic Reinforced Soil Structures," Geotextiles and Geomembranes, Elsevier, 2017, 45(6), 642-652.
[4] Zhang, F., Ge, B., Leshchinsky, D., Shu, S., and Gao, Y. (2023). "Effects of Multitiered Configuration on Internal Stability of GRS Walls," J. Geotech. and Geoenvironmental Eng., ASCE, October 2023.
[5] Ahmad Rajabian, Farshid Vahedifard, and Dov Leshchinsky (2024). "A Framework for Analyzing the Stability of Geosynthetic Reinforced Soil Walls under Unsaturated Conditions," J. Geotech. and Geoenvironmental Eng., ASCE, April 2024.
[6] Leshchinsky, D., Leshchinsky, O., Zelenko, B., and Horne, J., Limit Equilibrium Design Framework for MSE Structures with Extensible Reinforcement, FHWA-HIF-17-004, October 2016.