Reliability analysis of a mechanically stabilized earth wall using the surface response methodology optimized by a genetic algorithm

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Abstract. A probabilistic study of a reinforced earth wall in a frictional soil using the surface response methodology (RSM) is presented. A deterministic model based on numerical simulations is used (Abdelouhab et al. 2011, 2012b) and the serviceability limit state (SLS) is considered in the analysis. The model computes the maximum horizontal displacement of the wall. The response surface methodology is utilized for the assessment of the Hasofer-Lind reliability index and is optimized by the use of a genetic algorithm. The soil friction angle and the unit weight are considered as random variables while studying the SLS. The assumption of non-normal distribution for the random variables has an important effect on the reliability index for the practical range of values of the wall horizontal displacement.

Keywords: reinforced earth walls; reliability analysis; surface Response methodology; limit states; approximate performance function; genetic algorithm.

1. Introduction

Traditionally, analysis of the behavior of reinforced earth walls is based on deterministic approaches, where the uncertainties of the geomechanical parameters are addressed through a global safety factor. To account more rigorously for uncertainties, the reliability theory is used. This permits to take into account the hazards of each uncertain parameter via its probability distribution. These approaches have the advantage of giving the system response (the maximum displacement, the safety factor, etc.), not only by a single value representing its mean, but by its mean and variance, or by its reliability index or its probability of failure. Thus, the reliability approaches allow considering the propagation of uncertainties of the input parameters to the response of the system using a mechanical model of the system studied. The design based on reliability was applied to geotechnical engineering by Kulhawy and Phoon (2002), Low (2005, 2014), DV Griffiths et al. (2001, 2002), Mollon (2009), Hamrouni and al (2017).

The mechanically stabilized earth (MSE) wall is a composite material formed by the combination of soil and metallic or synthetic strips able to sustain significant tensile loads. The reinforcing strips give to the soil mass an anisotropic cohesion in the direction perpendicular to the