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HDMR methods to assess reliability in slope stability analyses

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Stability analyses of complex rock-soil deposits shall be tackled considering the complex structure of discontinuities within rock mass and embedded soil layers. These materials are characterized by a high variability in physical and mechanical properties. Thus, to calculate the slope safety factor in stability analyses two issues must be taken into account: 1) the uncertainties related to structural setting of the rock-slope mass and 2) the variability in mechanical properties of soils and rocks. High Dimensional Model Representation (HDMR) (Chowdhury et al. 2009; Chowdhury and Rao 2010) can be used to carry out the reliability index within complex rock-soil slopes when numerous random variables with high coefficient of variations are considered. HDMR implements the inverse reliability analysis, meaning that the unknown design parameters are sought provided that prescribed reliability index values are attained. Such approach uses implicit response functions according to the Response Surface Method (RSM). The simple RSM can be efficiently applied when less than four random variables are considered; as the number of variables increases, the efficiency in reliability index estimation decreases due to the great amount of calculations. Therefore, HDMR method is used to improve the computational accuracy. In this study, the sliding mechanism in Polish Flysch Carpathian Mountains have been studied by means of HDMR. The Southern part of Poland where Carpathian Mountains are placed is characterized by a rather complicated sedimentary pattern of flysh rocky-soil deposits that can be simplified into three main categories: (1) normal flysch, consisting of adjacent sandstone and shale beds of approximately equal thickness, (2) shale flysch, where shale beds are thicker than adjacent sandstone beds, and (3) sandstone flysch, where the opposite holds. Landslides occur in all flysch deposit types thus some configurations of possible unstable settings (within fractured rocky-soil masses) resulting in sliding mechanisms have been investigated in this study. The reliability indices values drawn from the HDRM method have been compared with conventional approaches as neural networks: the efficiency of HDRM is shown in the case studied.

References

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