RELIABILITY ANALYSIS OF RETAINING WALL USING SEISMIC CONE TEST DATA

I. Bagińska[1], M. Wyjadłowski[1]

[1] *Wroclaw University of Science and Technology, Wrocław, Poland*

e-mail: marek.wyjadlowski@pwr.edu.pl

The aim of this paper is to examine the influence of geotechnical uncertainties on the reliability retaining wall. The results from seismic piezocone tests (SCPTu) are shown to be applicable for providing all the necessary input parameters to drive the computations and calculate displacements of retaining wall. Reliability sensitivity analysis was conducted using MCS (Monte Carlo simulations).

The physical uncertainties of action, the inherent variability of soil and model error were assessed by experimental in situ standard penetration test (SCPTu). The approach involves a combination of finite element analysis, random field theory and Monte Carlo simulations. Small-strain stiffness is mostly found to be manifold of stiffness obtained in classical laboratory testing. Therefore, not accounting for it in geotechnical analyses may result in overestimating retaining wall deflections.

The overall reliability of numerical displacements analysis is considerably increased. In this calculation HS-small input parameter soil stiffness G_o [1], [2] (in program PLAXIS [3] parameter: G_{oref}) is derived from SCPTu testing. The stiffness of the surrounding soil is represented by a shear modulus G. The initial fundamental small-strain shear modulus of the ground is obtained from the shear wave velocity measurements:

$$Go = \rho \cdot Vs^2 \qquad (1)$$

where

ρ- total mass density of the soil.

This small-strain stiffness is within the true elastic region of soil corresponding to nondestructive loading. To approximately account for nonlinearity of the stress-strain-strength behaviour of soils, a modified hyperbola is adopted [4]:

$$G = Go \cdot [1 - (P/P_{ult})g] \qquad (2)$$

Where:

P - applied force,

P_{ult} - axial capacity of the pile segment, and the exponent "g" is a fitting parameter.

Thus when P = 0, initially $G = G_o$ and at all higher load levels the shear modulus reduces accordingly. In the analysis of the retaining wall displacement the soil parameter has been expected as a random variable: G shearing module and parameters entered for model HS-small : G_{oref} (shear stiffness at very small levels).

The value is described in a one-dimensional random field with a average value μ_x, standard deviation σ_x , and Markov's correlation structure. In the random finite element method (RFEM) in first place a random field that represents the parameters of the analysed ground foundation has been generated. Next the field is discretised to a net of finite-elements and for this a method of random variables. is used. The next step is the calculation method where the Finite element method is used in order to calculate the response of structure[5]. Multiple repeating for the consecutive field realization leads to reaching set results. Because of the difficulties in showing the systems answer in a functional way Monte Carlo simulation method was used. The number of simulations n must be chosen in order to provide stability of the solution during simulations. For the considered task a stable answer was reached after about 100000 simulations. The task shows usefulness of the used modelling tools with the help non-linear ground model and ground parameters based on SPTU [6] sounding.

References

[1] T. Benz. Small-strain stiffness of soils and its numerical consequences. Ph.D. Thesis. Institut für Geotechnik, Universität Stuttgart, 2006.

[2] T. Schanz, T., P.A.Vermeer, P.G. Bonnier. The hardening soil model: Formulation and verification. *Beyond 2000 in computational geotechnics*. Balkema, Rotterdam, 281-290, 1999.

[3] R. Brinkgreve et al. *Plaxis Material Model Manual*. Plaxis bv, Delft, Netherland, 2011.

[4] M. Fahey. Shear modulus of cohesionless soil: variation with stress and strain level. *Canadian Geotechnical Journal* Vol. 29, No. 1, 157-161, 1992.

[5] M. Lloret-Cabot, G.A. Fenton, M.A. Hicks. On the estimation of scale of fluctuation in geostatistics. *Georisk: Assessment and Management of Risk for Engineered Systems and Geohazards*. 8(2), 129–140, 2014.

[6] P.K. Robertson. Soil classification using the cone penetration test. *Canadian Geotechnical Journal*. 27(1), 151– 158, 1990