Robust Assessment of Shear Parameters in Geotechnics

W. Fellin[1)] and **M. Oberguggenberger**[2)]

[1)]Geotechnical and Tunnel Engineering, University of Innsbruck, 6020 Innsbruck, Austria
wolfgang.fellin@uibk.ac.at

[2)]Engineering Mathematics, University of Innsbruck, 6020 Innsbruck, Austria
michael.oberguggenberger@uibk.ac.at

Keywords: *Shear parameters; Non-normal regression; Robust Bayesian methods; Bootstrap confidence intervals; Computational statistics.*

Abstract

One of the principal tasks in geotechnical engineering is the determination of characteristic values of the shear strength τ_f, the cohesion c and the angle of internal friction φ. Eurocode EC 7 requires that laboratory and in situ experiments have to be supplemented by experience in comparable situations and – in case statistical procedures are used – 95%-confidence limits are observed for the the characteristic values.

Usually, the results of shear tests are processed by performing a linear regression in the Mohr-Coulomb limit state law $\tau_f = c + \sigma \tan\varphi$, with the normal stress σ, to obtain estimates for characteristic values of c and φ. A discussion of confidence intervals based on a standard linear regression model can be found in **?**.

There are two obstacles for the standard linear regression model: (1) The coefficients c and $\tan\varphi$ must be nonnegative; (2) the respective random variables typically are not normally distributed. We deal with the first problem by replacing the quadratic optimization problem in the regression analysis by a quadratic optimization with constraints (this leads to subcases of regression with or without intercepts). What concerns the second problem, the literature on regression analysis offers only approximate methods for cases that are not too far away from normal distributions.

In this paper, we propose two approaches to address non-normality and to obtain confidence limits. In the case of small sample sizes (≥ 3) we find a Bayesian approach appropriate, that replaces the confidence intervals by high probability density regions of the posterior distribution. Here we face the problem of assigning the prior distribution. We deal with this in a robust way by using priors with interval parameters. In the case of availability of a sufficiently large sample size (≥ 15), we propose a different computational approach that provides bootstrap confidence intervals by repeated resampling of the data.

In both situations, current methods from computational statistics have to be employed, resulting in credible confidence limits for the characteristic values.

References

Fellin, W., Berghamer, S. and D. Renk. Konfidenzgrenzen für die Scherfestigkeit als Grundlage zur Festlegung charakteristischer Scherparameter. *Geotechnik*, 32(1):30–36, 2009.