Effect of Statistical Uncertainties on Extreme Wind Speeds

Á. Rózsás[1)] and **M. Sýkora**[2)]

[1)]Department of Structural Engineering, Budapest University of Technology and Economics, Budapest 1111, Hungary, rozsas.arpad@epito.bme.hu

[2)]Department of Structural Reliability, Klokner Institute, Czech Technical University in Prague, Prague 16608, Czech Republic, miroslav.sykora@cvut.cz

Keywords: *Bayesian Statistics; Design Value; Extreme Load; Generalized Extreme Value Distribution; Model Selection; Parameter Estimation; Statistical Uncertainty; Wind Speed.*

Abstract

Statistical uncertainties, arising from the uncertainty of parameter estimation and model selection, are often neglected in probabilistic assessment of engineering structures. However, few previous studies indicate that this might cause severe underestimation of extreme loads and lead to insufficient structural reliability. This contribution aims to qualitatively and quantitatively investigate the effect of this simplification on extreme values of wind speed that are commonly associated with design values.

The probabilistic modelling of basic wind speeds is thoroughly investigated. Moderately high temporal resolution data – daily 10 min maxima from three distinct one hour long measurement sessions – are obtained from the Carpatclim database, covering a 50-year observation period. Data of representative locations from the Carpathian region are taken into account in the exploratory analysis.

Block maxima and peak over threshold approaches are applied to extract maxima and to fit associated distributions. Frequentist and Bayesian statistics are used to assess the effect of statistical uncertainties. The parameter estimation uncertainty is quantified by uncertainty intervals. Statistical model uncertainty is taken into account by Bayesian model averaging. Gumbel, lognormal, Weibull and generalized extreme value distributions are used to describe annual maxima of wind speed.

The conducted analyses imply that neglecting statistical uncertainties might yield to considerable underestimation of extreme values. The peak over threshold approach typically utilizes more data than block maxima; thus the effect of associated statistical uncertainties is lower. Bayesian approach offers a natural framework to incorporate statistical uncertainties into structural reliability analysis. Moreover, it has the advantage to take into account prior knowledge, which is often available in engineering practice. While using prior information, uttermost caution should be taken as incorrect prior models may yield to erroneous estimates of extreme values.

The effect of statistical uncertainties on extreme values mainly depends on the available information for probabilistic models. This is particularly important for projecting environmental loads with few observations in a long-term perspective. The

applied methods can be utilized for other extreme environmental actions such as flooding and snow loads.