Meteorološki izazovi današnjice 3
EKSTREMNE VREMENSKE PRILIKE I UTJECAJ NA DRUŠTVO
21.-22.11.2013.

Estimating urban wind characteristics via neural networks

Josip Križan; Goran Gašparac; Hrvoje Kozmar; Oleg Antonić; Branko Grisogono

While experiments in boundary layer wind tunnels remain to be a major research tool in wind engineering and environmental aerodynamics, designing the modelling hardware required for a proper atmospheric boundary layer (ABL) simulation can be costly and time consuming. Hence, possibilities are sought to speed-up this process, make it more efficient. The aim of this study was to develop two artificial neural networks (ANN) for estimation of optimal design of the Counihan hardware, i.e. castellated barrier wall, vortex generators and surface roughness, in order to simulate the ABL flow developing above urban terrain. Model in this approach allow estimation of parameters that describe wind flow and atmospheric turbulence, i.e. mean wind velocity, turbulent Reynolds stress, turbulence intensity, turbulence length scales, and power spectral density of longitudinal velocity fluctuations. Experimental results obtained using twenty-three different hardware setups are used when creating ANNs. In those tests, basic barrier height, barrier castellation height, surface roughness spacing density and height are the parameters that were varied to create satisfactory ABL simulations. The first ANN was used for estimation of integral turbulence parameters - mean wind velocity, turbulent Reynolds stress, turbulence intensity and length scales, while the second one was used for estimation of the power spectral density of velocity fluctuations. Modelling results are validated with an extensive set of ABL wind-tunnel simulations and they in general show very good agreement with the experiments, particularly in the lower ABL within the height range of the most engineering structures. Moreover, ANNs indicate a strong sensitivity to sudden changes in profiles of wind-tunnel results. In overall, the proposed approach proves to be a valuable and practical tool in wind-tunnel studies of environmental aerodynamics and wind engineering, as it offers a possibility for a quick and economic designing of the necessary experimental hardware.