October 2013

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THE WIND ENGINEER

NEWSLETTER OF AMERICAN ASSOCIATION FOR WIND ENGINEERING

In this issue:

Detached-eddy simulation of pollutant dispersion around an urban two-building configuration

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A numerical simulation is developed using the unsteady-state Detached-eddy simulation (DES) turbulence model on a structured highly refined grid to predict the wind-flow field and dispersion field of a pollutant emitted from a rooftop stack around a two-building configuration shown in figure 1. The results obtained are compared with those a of steady-state re-normalization group (RNG) *k*-ε turbulence model, previously reported by the authors (Lateb et al., 2013), as well as wind tunnel experiments (Stathopoulos et al., 2004). The pollutant concentrations are examined on the roof where the stack is located as well as on the leeward wall of an upstream tower to the emitting building in order to evaluate how the pollutant is dispersed by the DES mode compared to RNG model. DES results are discussed against those from RNG *k*-ε approach and wind tunnel. The study emphasizes limits in reproducing correctly the wind-flow field, when using the RNG *k*-ε model, due to (i) significant overestimation of the recirculation zone length in the tower wake and (ii) insignificant reproduction of the horseshoe phenomenon in the upstream part of the tower. In addition, DES model reproduces well the vortex shedding in the

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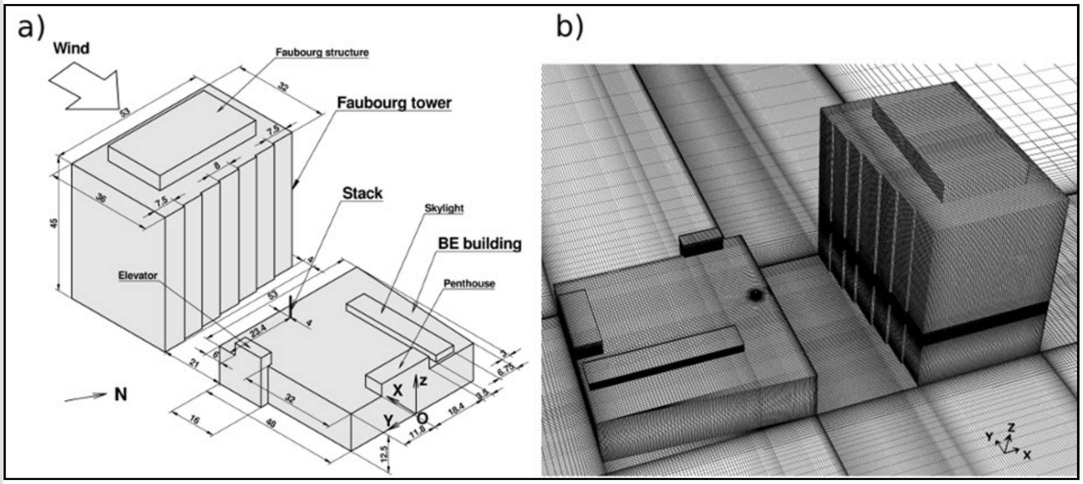

Figure 1: The two-building configuration showing (a) the buildings full-scale dimensions in metres and (b) the highly refined meshing.

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immediate tower wake region while no such phenomenon is observed with RNG model. Therefore, the steady-state methodology of RNG does not favour the vortex shedding; hence the lateral diffusion is highly underestimated specially in the wake region. Consequently, since the dispersion field is closely related to flow-field behaviour (Tominaga and Stathopoulos, 2009), the steady-state RNG methodology cannot predict the turbulent pollutant transport process accurately.

In terms of CPU time, the DES model required approximately 30 times more computing time than the RNG model. Given the similar average errors of concentration obtained by the DES and RNG approaches, the steady-state RNG model remains an approach that can be used and trusted for obtaining an insight into the dispersion process at specific measurement points where dispersion is mainly dominated by the advection transport phenomenon (Lateb et al., 2013). Finally, the DES model has demonstrated that the unsteady-state approach is clearly better suited to understand the flow-field development and the dispersion process.

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Prediction of peak wind loads on a low-rise building

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Several techniques exist to statistically define the peak surface pressure coefficients (C_{p_peak}) on low rise buildings using wind tunnel data (e.g. Cook and Mayne, 1979; Sadek and Simiu, 2002; Tieleman et al., 2006; Kwon and Kareem, 2011; Huang et al., 2013). The precision and accuracy of these methods are associated with the time duration of the wind tunnel test. This requires a trade-off between the uncertainty of the estimated peak wind loads and the desire to minimize data record lengths to limit the time and cost of wind tunnel experiments. However, the relative uncertainty of the available methods has not been systematically evaluated, and thus the most reliable technique has not been established.

This paper presented an overview of traditional peak estimation methods and developed two new procedures for estimating peak distribution of non-Gaussian process. One is a modification to the Hermite polynomial probability model (HPM) and is applied within a translation framework. The other is a mixed PDF translation model (PAR), which is developed using the empirical distribution in the bulk and Pareto distributions in tails. A 30-hr long time record from wind tunnel test were used to provide a benchmark of quantifying the accuracy and precision of the existing ('SAD', 'TIE', 'HUA', 'KWO', and 'G01') and proposed methods.

The 30-hr wind tunnel pressure coefficient data at each tap was divided into 120 fifteen minute (full scale) segments, each estimated by employing 7 methods. Figure 1 presents the results from the 7 methods (one plot for each method) using all 474 roof taps on a low-rise building at a specific wind direction and terrain. The abscissa represents the empirical peak pressure coefficient, $C_{p\_peak\_emp}$, and the ordinate is the estimated pressure coefficients, $C_{p\_peak\_est}$. The mean (black dot) and 2.5th & 97.5 percentiles (gray stars) from the 120 estimates $C_{p\_peak\_est}$ for each tap are plotted, representing the accuracy and precision, respectively. The black solid line indicates equality of estimated peaks ($C_{p\_peak\_est}$) and empirical peaks ($C_{p\_peak\_emp}$). The ±15% range relative to $C_{p\_peak\_emp}$ is presented as well (dashed lines). Note that the mean square error (MSE) is a significant metric for evaluation of precision and accuracy. PAR and G01 have a larger variability (spread of the gray stars) relative to HPM, illustrated by the lower MSE score for HPM. KWO shows more scatter and has a higher MSE than HPM due to a large number of taps with strongly non-Gaussian data. SAD, HUA and TIE visually have more scatter than the other methods, quantified by higher MSEs.

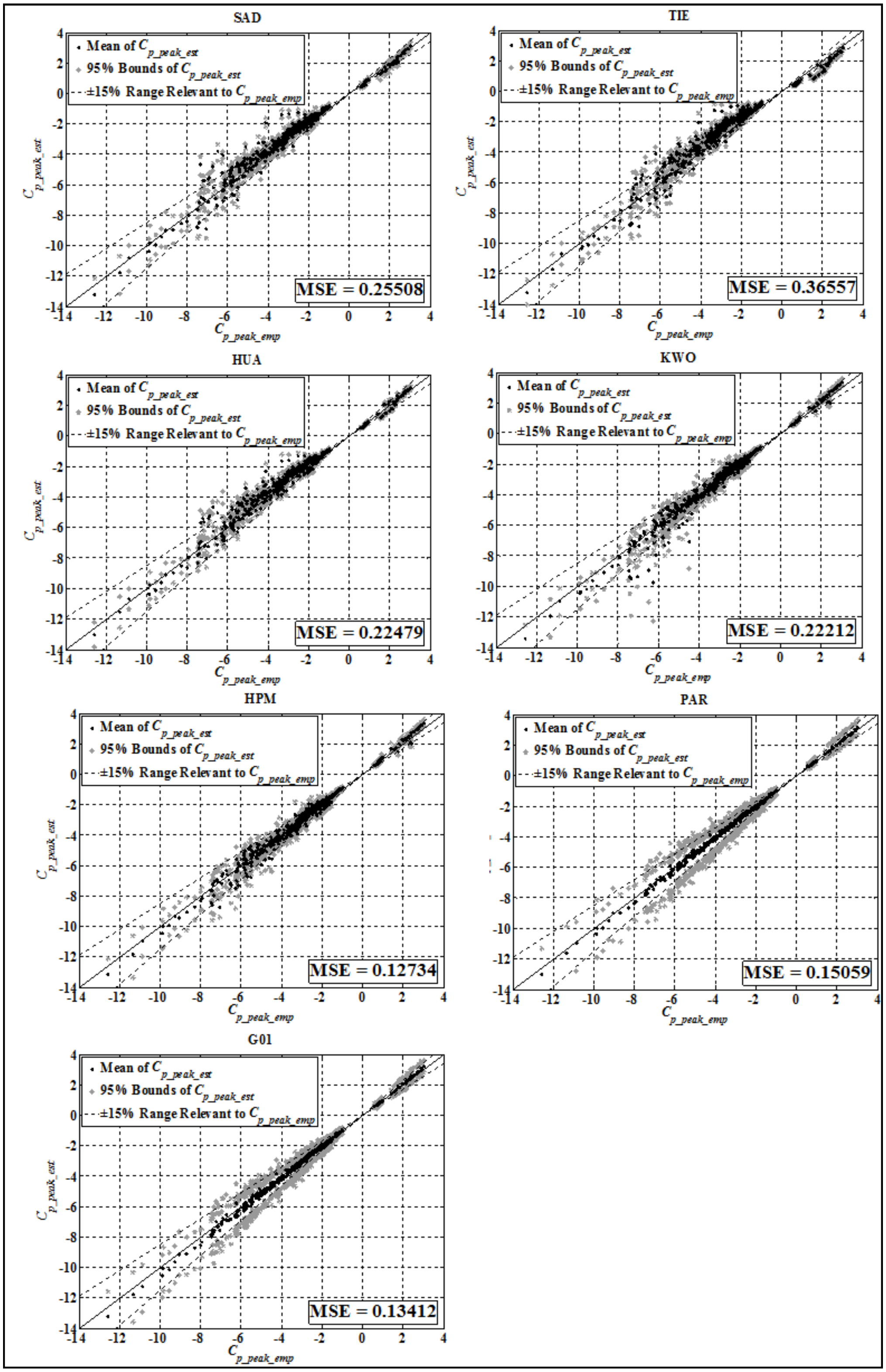

Figure 1. Comparative study of five existing and two proposed methods

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