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Dr Laurent Perret
Associate Professor
LHEEA lab, UMR CNRS 6598
Centrale Nantes
laurent.perret@ec-nantes.fr

Report on the doctoral thesis "*Flow dynamics and pollutant transport in street canyons of different roof heights and geometries: a wind tunnel and LES modeling*" **submitted by Ms. Zuzana Kluková**

In her Postgraduate Research thesis entitled "Flow dynamics and pollutant transport in street canyons of different roof heights and geometries: a wind tunnel and LES modeling", Ms. Zuzana Kluková addresses the issue of understanding and modeling the flow and dispersion processes within a complex urban area in neutral atmospheric stability regime. The emphasis is put on the role of the building geometry, the test of advanced methods for analyzing the coherent structure dynamics, and the validation of numerical models. As there is a clear lack on these topics in the literature, this is a welcome contribution to the body of knowledge on flows over urban terrain. This work is based on detailed wind tunnel experiments conducted on street canyon configurations but also on LES simulations, with main objective of investigating the influence of building geometry on the flow and dispersion, understanding the underlying processes and complementing this experimental work with data from numerical simulations.

Chapter 1 presents the theoretical background of this work as well as the statistical tools used to process and validate both the experimental data and the results from LES. This is complemented by a presentation of the investigated configurations in Chapter 2. Chapter 3 briefly presents the results from the previous wind tunnel experiments conducted by the author's research group, which constitute the basis of this thesis and show the need for additional experiments and further analysis.

This need is addressed in the second half of the manuscript, first in Chapter 4, where new high-speed Particle Image Velocimetry (PIV) measurements are justified and presented. They offer dense spatial information about the flow dynamics, at high temporal rate, allowing first to test advanced analysis methods such as Proper Orthogonal Decomposition and Dynamic Mode Decomposition (or Oscillation Pattern Decomposition, its equivalent) and studying the influence of their key parameters (mainly the number of snapshots and the number of retained POD modes).

While the conclusions of this section about the ability of these methods are interesting, the criterion fixing the number of used snapshots to the number of degrees of freedom (d.o.f) retained by the authors seems a bit to restrictive as nothing prevents in the POD or SVD algorithms the use of non-square matrices. On the contrary, using more snapshots than d.o.f. can improve the statistical convergence and therefore the significance of analysis.
In the next section of this fourth chapter, basic statistical information (mean flow and turbulent kinetic energy) on the flow obtained from the PIV are presented to highlight the impact of the building geometry on the flow characteristics. A quadrant analysis of the vertical momentum flux is also presented to show the partitioning of the flow events into sweeps, ejections and first and third quadrant events.
The last section of this chapter is devoted to the application of the POD and OPD methods to all canyon flow configurations in order to elucidate the influence of the building geometry on the dynamics of the flow. While the authors presents a detailed analysis of the topology of the first spatial modes, their temporal behaviour is only addressed via some time series plots. Having high-rate PIV data, the authors could have studied their spectral content but also their cross-temporal correlation to gain better insight of the coherent structure dynamics as a function of the canyon geometry.

In Chapter 5, Ms. Kluková presents the LES simulations that were run previously and from which she extracted velocity and dispersion data to compare and extend her previous PIV analysis. Comparison between PIV and LES results are first shown. While the comparison of the mean flow shows good agreement between the two, it would have been interesting to analyze other higher-order statistics and also apply the POD and OPD methods to these numerical data in order to fully assess the performance of the LES model to reproduce the street canyon flow characteristics. Reinforcing the confidence in the model would have strengthen the presentation of the results from the LES simulations on the concentration dispersion within the street canyon arrays that are presented in the last section of this fifth chapter.

The last Chapter is devoted to a summary of each section, accompanied with a brief outlook. Offering a broader perspective from the present findings on future work would have constituted a great addition to this section.

Throughout the presentation of her work in the submitted thesis manuscript, Ms. Kluková has demonstrated her ability to develop skills in analyzing turbulent flows and performing advanced data analysis to investigate mechanisms underlying the flow physics. She has also proved able to employ the most recent methods such as POD or OPD to obtain both quality data sets and detailed analysis.
Ms. Kluková has generated new scientific results based on existing but also new experimental and numerical datasets, contributing to the understanding of the flow physics in heterogeneous urban environments. She further confirmed the ability of LES models to reproduce the key transport phenomena and therefore to address the crucial problem of urban air quality.

Dr. Laurent Perret
Centrale Nantes