GERMANY/HONG KONG JOINT RESEARCH SCHEME
THE PROJECT REPORT

(for Project Completion)

Project Number: G_HK026/11

Title

Towards Urban Planning Strategies to Improve the Wind Environment in High Density Cities Based on Better Understanding of the Urban Morphology by Using Large Eddy Simulation Model (LES)
提高高密度城市風環境質素的規劃方法研究 --基於城市環境的大渦數值模擬 **(LES)**

Particulars

	Hong Kong team	German team
Name of Project Co-ordinator (with title)	English: Prof. Edward NG Yun Yung Chinese: 吳恩融教授	Prof. Siegfried Raasch
Name of Co-Investigator (if any)	English: Chao Yuan Chinese: 袁超	Marcus Oliver Letzel
Institution or Institutional affiliation	[ ] CityU [ ] HKU [√] CUHK [ ] HKUST [ ] HKBU [ ] LU [ ] HKIEd [ ] PolyU	[√] University of Hannover _____ [ ] Others: _____
Other project team members (if any)		

Funding Period

	1st year	2nd year (if applicable)
Start Date	1 Jan 12	1 Jan 13
Completion Date	31 Dec 12	31 Dec 13

Objective(s) as per original application

Hong Kong is one of the highest density cities in the world. With a high rate of urbanization, higher and bulkier buildings with very limited open spaces in between blocked urban natural ventilation at the pedestrian level which is important to the civilians' health and thermal comfort (Yim et al., 2009, Wong et al. 2010, Ng, 2011). Therefore, optimizing building permeability to ensure adequate nature ventilation into high density urban areas is a major design problem facing planners.

This project proposes to understand Hong Kong's mega density urban morphology and fabric by using Large Eddy Simulation (LES) model. LES is a powerful computational fluid dynamics scientific technique known to produce reliable results for turbulence studies.

The research team under the leadership of Prof. Ng will team up with meteorological scientists in Institute of Meteorology and Climatology, University of Hannover, Germany. In this project, the parametric study will be conducted to get the detailed understanding about the wind behaviors in different urban morphology and street fabric. Based on the detailed understanding, planning criteria and strategies could be established. The finding from this project will not only be of interest for the scientific community but also serve as practical tools for decision-makers in public health, urban climatology and urban planners. The contribution of this study is to apply the LES model for real life problems.

This project is the first step in sustainable collaboration with colleagues from Germany. Results from this project will be compared with those from a parallel study conducted by other researchers. A wide range of future projects not only in China and Germany but also in other countries can benefit from the results of this project.

Details of Report [Please attach relevant document(s)]

i) Outline of proposed research and results obtained

DATA

The following data of the urban areas has been collected to establish the corresponding experimental models:

a. Land use
b. Street map to 1:1000 for all urban areas
c. Building ground plan map
d. Building podium plan and podium heights
e. Building tower plan and building heights

The following data of regional and local climate from some Hong Kong meteorology stations has been collected from Hong Kong Observatory:

a. Wind speed
b. Wind direction

The data of mesoscale atmospheric circulation, especially wind speed and wind direction has been collected from The Hong Kong University of Science and Technology: Mesoscale Model5 (MM5).

MODEL

The following parametric models has been established, based on the real urban morphology:

a. Experimental models which reflect the current urban morphology and street fabric;
b. Experimental models which reflect the urban morphology in the future without controls;
c. Experimental models which reflect the urban morphology with possible planning strategies.

SIMULATION

The data collected and the models established have been input into the parallelized LES model PALM in super computer in University of Hannover, and CFD simulations by using LES models has been conducted:

a. Use DEM data to build up models and surrounding buffer region in LES model;
b. Set up the models' boundary condition;
c. Set up a constant horizontal grid length and a constant vertical grid length, according to the narrow streets in site;
d. Chose the vertical resolution to get the result of velocity measurement at 2 m above the ground;
e. Release grid points to conduct the simulation in PALM; and Collect the simulation result.

ASSESSMENT

Through these PALM simulations, the wind velocity ratio (VR) (air ventilation performance) on the ground and air flow modification potential in the high density urban context were captured to reveal the different features of air flow movement in different morphologies, the impact of the planning strategies on the wind behavior were assessed. The detailed methodology, LES simulation results and statistical analysis were documented (see published paper).

ii) Significance of research results

(A) First time LES has been applied to the study of high density city air flow at very high resolution.
(B) The complex flow regime of high density urban areas has been visualised.
(C) Important urban design techniques (e.g. using down flow vortexes of tall buildings) have been developed.

iii) Research output

Letzel, M. O., Helmke, C., Ng, E., An, X., Lai, A. & Raasch, S. (2012). LES Case Study on Pedestrian Level Ventilation in Two Neighborhoods in Hong Kong, *Meteorologische Zeitschrift,* Vol. 21, No. 6, 575–589, *doi: 10.1127/0941-2948/2012/0356*

iv) Potential for or impact on further research collaboration

(A) A Joint GRF Grant (2014-16) has been submitted.
(B) A joint research consultancy project with Macau Government (2014-15) has been initiated.
(C) A "Regional Joint workshop on LES" has been held in HK in 2013, this will be continued annually.