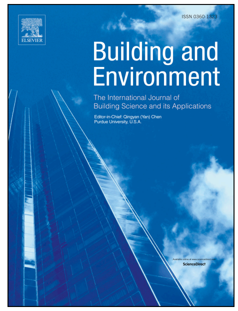

Development of an adaptive discharge coefficient to improve the accuracy of cross-ventilation airflow calculation in building energy simulation tools

Mohammadreza Shirzadi, Parham A. Mirzaei, Mohammad Naghashzadegan

PII: S0360-1323(17)30476-6

DOI: 10.1016/j.buildenv.2017.10.019

Reference: BAE 5132

To appear in: *Building and Environment*

Received Date: 9 July 2017

Revised Date: 13 October 2017

Accepted Date: 15 October 2017

Please cite this article as: Shirzadi M, Mirzaei PA, Naghashzadegan M, Development of an adaptive discharge coefficient to improve the accuracy of cross-ventilation airflow calculation in building energy simulation tools, *Building and Environment* (2017), doi: 10.1016/j.buildenv.2017.10.019.

Development of an Adaptive Discharge Coefficient to Improve the Accuracy of Cross-ventilation Airflow Calculation in Building Energy Simulation Tools

Mohammadreza Shirzadi[a], Parham A. Mirzaei[b], Mohammad Naghashzadegan[a,1]

[a] Mechanical Engineering Department, University of Guilan, Rasht, Iran
[b] Architecture and Built Environment Department, University of Nottingham, Nottingham, UK

Abstract

Airflow network (AFN) model embedded in building energy simulation tools such as EnergyPlus is extensively used for prediction of cross-ventilation in buildings. The noticeable uncertainty in the measurement of the surface pressure, discharge coefficient, and simplifications applied to the orifice-based equation result in considerable discrepancies in the prediction of the cross-ventilation airflow rate. Computational Fluid Dynamics (CFD) provides more accurate results comparing to the orifice-based equations although with an excessive computational cost.

The aim of this study is to improve the accuracy of the orifice-based model by development of an adaptive correlation for the discharge coefficient using CFD. Hence, a validated CFD model for the cross-ventilation of an unsheltered building is firstly developed using an experimental study. In the next step, by exploiting Latin hypercube sampling approaches, a large CFD dataset of 750 scenarios for different building geometries (i.e. square cube, cuboid and long corridor) is generated; the dataset is then coupled to the AFN cross-ventilation model to obtain an adaptive correlation for the discharge coefficient as a function of the openings' geometries and location using response surface and radial basis function models.

Results show that the newly developed adaptive correlation successfully increases the accuracy of AFN model for the cross-ventilation modeling of unsheltered buildings as the relative errors for the airflow rate prediction of different building geometries are decreased up to 28% in comparison with the cases with constant discharge coefficient. Results also demonstrate the importance of considering the value of the local-surface wind pressure in the AFN model.

Keywords: Cross-ventilation, CFD, Sampling, Discharge coefficient, Building Energy Simulation, Correlation

Nomenclature

ρ	Density	U_H	Inflow mean streamwise velocity at building

[1] Corresponding author: Khalij Fars highway, Rasht, Iran
Tel.: 013-33690274; Postal Code: 4199613776
Email: naghash@guilan.ac.ir