



Balconies Influence on Buildings Natural Ventilation: Pressure coefficients determination through experimental trials in wind tunnel

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Abstract

Facade elements may impact the performance of natural ventilation in buildings. This research investigated the influence of balconies on the natural ventilation performance of a high-rise building located in Sao Paulo's city center, by analyzing its envelope wind pressure coefficients. Wind tunnel experiments were performed in the atmospheric boundary layer wind tunnel from the Instituto de Pesquisas Tecnológicas (IPT), Sao Paulo, by using reduced scale models with and without balconies of different lengths and depths, in order to obtain envelope wind pressure coefficients for different wind directions. Results were used to generate isoline graphics, by applying Origin software. Results show that balconies are obstruction elements to natural ventilation, once its presence caused a reduction of the wind pressure difference between inlet and outlet openings. However, there were no significative changes on the natural ventilation performance by using two different depths of balconies.

Key words:

Natural ventilation; wind pressure coefficient; balcony.

Introduction

The atmospheric boundary layer (ABL) wind tunnel is commonly used to perform natural ventilation analyses of reduced scale building models¹, such as wind pressure coefficients (C_p). The building envelope C_p s describe the wind pressure by a dimensionless quantification of the relative wind pressure in reference to the undisturbed dynamic pressure². It is proved that balconies influence the envelope wind pressure distribution, however, detailed information about how façade's geometries alterations modify the C_p s are still necessary³. This research aimed to investigate the influence of balconies on the natural ventilation performance of a high-rise building located in Sao Paulo's city center, by analyzing its envelope wind pressure coefficients.

Results and Discussion

The tested building was 34,1 m height, 22 m length and 11 m depth. Image 1 shows the floor plan. A total of 12 scenarios of different balcony sizes were tested, being three of them analyzed in this paper: no balconies, 0,5 m depth balconies and 2,0 m depth balconies. Being the balcony length 5 m and the banister height 1,1 m. A 1:50-scale model was built and tested for wind directions varying in 15° ranges (Image 2). A total of 128 pressure intakes were placed at the four facades.

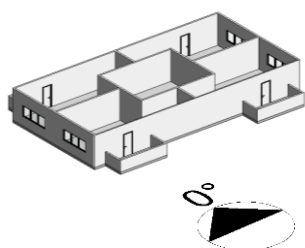


Image 1. Building floor plan



Image 2. Small-scale model plan

Image 3 shows the wind pressure coefficients for the building with no balconies, 0° wind direction. The C_p s of windward facades were predominantly positive, while in leeward facades the C_p s were negative. Also, the absence of balconies resulted in higher C_p values for windward

facades. A small difference between 0,5 and 2 m depth balconies was observed: 0,5 m depth balconies showed constant C_p values of approximately 0.6 at windward façades, while 2 m depth balconies showed a wider variation, reaching 0.8 at the central area and -0.4 near the edges.

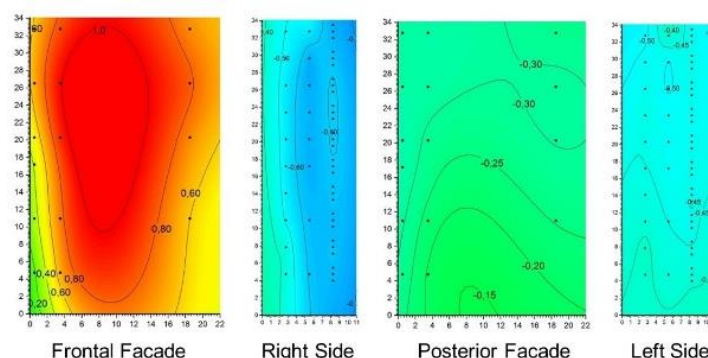


Image 3. Wind pressure coefficients for scenario 1.

Conclusions

Balconies were identified as obstruction elements to natural ventilation, mainly in higher and lower floors of the building. However, there were no significant changes on natural ventilation performance by using two different depths.

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¹ MATSUMOTO, E. et al. Túnel de vento do LaCAF/FEC/UNICAMP: Instrumento para ensaios de modelos físicos reduzidos e ventilação natural. Anais... In: Congresso Latinoamericano de Ingenieria del Viento. Universidad Nacional de La Plata, La Plata, 2012.

³ CASTAÑO, H. F. M. Impacto de dispositivos de sombreamento externos e muro na ventilação natural e no desempenho térmico de uma habitação de interesse social. Dissertação (mestrado), Universidade de São Paulo, 2017.

⁴ CHAND, I. et al. Effect of Balconies on Ventilation Inducing Aeromotive Force on Low-rise Buildings. Building and Environment, v. 33, n. 6, p. 385-39, 1998.