A new application model of building ventilation with light shafts: a proposal based on case study assessment

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Key words:
outdoor air quality; light shaft; natural ventilation; CFD; air change efficiency

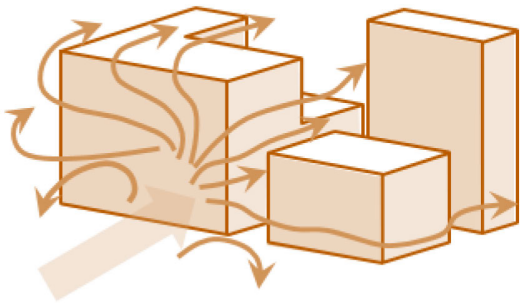
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OBJECTIVES

- To develop a methodology to directly evaluate the air change quality in confined outdoor spaces.
- It is necessary to determine the real-evaluation domain and how could the outdoor air flow be analysed.
- To use both: the air change efficiency and the age of the air concepts in order to evaluate the flow patterns within atmospheric open domains.
- To determine how lightshafts as confined outdoor spaces provide quality air to promote healthy indoor ventilation.

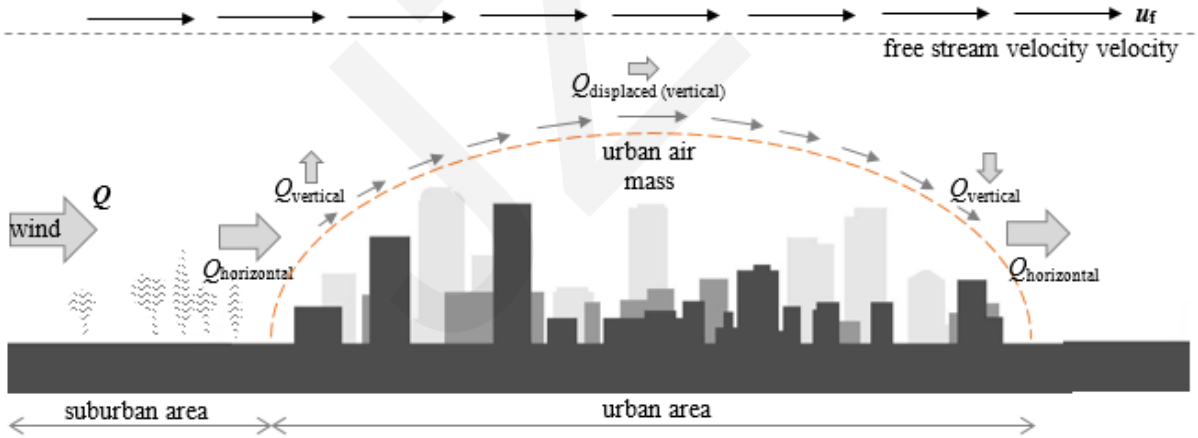


outdoor air change



It has been proved that the air change distribution in confined outdoor spaces depends on numerous factors related to the site, the architectural shape and the mesh of the urban environment.

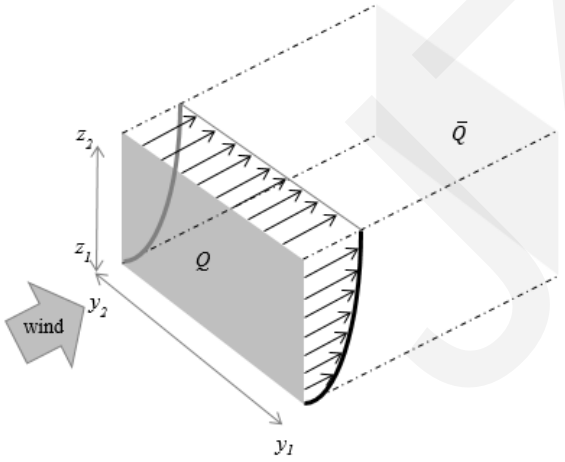
Indoor spaces are naturally ventilated by taking air from outdoors (Ok et al, 2008). Exhaust air which has been used inside the building can circumstantially be discharged in outdoor spaces (Seppanen, 2008). Due to a lack of sufficient air exchanged in outdoor spaces, the indoor ventilation process is carried out with partially polluted air as a result of progressive contamination by environmental agents and others. Although outdoor air is exposed to a flow of "fresh" air which eases the air change, it may happen that the air distribution was not performed properly throughout the volume leaving areas and without a complete mixing.



air change efficiency

The mean age of the air is the concept by which the average time which a set of air particles takes to traverse the paths followed in a domain is analysed. The mean residence time of the set of air particles in the domain determines the mean exchange time.

The air change efficiency index evaluates the ability of the architectural design to facilitate the natural air change, a factor that implies an important energy impact. The higher the efficiency, the more the quality of the exchange increases, but it does not cause an increase of the air quality, which can be partly assessed by the age of the air. An adequate air change in a given domain is guaranteed when the efficiency approaches the perfect mix value, estimated at 50%.



The equivalent air flow for a control domain (Q) within a larger computational domain, whose boundary condition for the inlet is defined by a logarithmic wind velocity profile, can be obtained by its perpendicular projection (surface y-z).

results and conclusions

Efficiency patterns can be established by means of approximating the trend curves of the results set to geometric functions, taking into account the tolerances. The results obtained are numerically related in a single power-law equation dependent on the H/L rate, the wind velocity (U) and the building width (cr).

