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QUANTIFYING NOISE EXPOSURE AND NATURAL VENTILATION PERFORMANCE IN URBAN AREAS

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1 INTRODUCTION

Natural ventilation strategies are difficult to implement for buildings in urban areas for a number of reasons, such as lower wind speeds, higher temperatures due to the urban heat island effect, pollution and noise. This paper deals with how noise and ventilation performance can be quantified. The easiest way to achieve the least restriction of a ventilation path is to open large areas of the façade[1,2]. This leads to the conflict between attempts to reduce noise ingress and the maximizing of natural ventilation rates.

Quantifying these sometimes competing factors with information and tools that are appropriate to building design professionals should help improve design decisions. The information and tools presented in this paper involve a number of different scales. These have the aim of integrating and comparing different environmental factors affecting natural ventilation. These scales are both spatial and temporal. Different calculation methodologies have to be used for different scales as different physical processes and relationships are important, and also the requirements for accuracy differ. The linking of these different scales is necessary and is the main contribution presented in this paper. An example of the smallest scale considered involves the finite element model of the ventilation aperture and the largest scale deals with the mapping of noise around an urban area.
The same consideration of scales is important for the natural ventilation calculations, with different approaches being used to represent the driving forces of the weather, the air flow around a building or urban area and airflow through an opening or across a number of building zones/rooms.

This paper gives an overview of a method to quantify the relationships between noise exposure and natural ventilation performance in urban areas. The energy consequences of trading off reduced natural ventilation cooling against acceptable noise levels in buildings are also considered. The aim of the research was to determine where noise reduction technologies would have the most significant impact in terms of enhancing natural ventilation potential in urban areas. More details of this approach and more example results can be found in the thesis of one of the authors[3].

2 CALCULATION METHOD

The methods and example results presented here help weigh up the benefits and challenges for specific cases of natural ventilation and urban noise ingress. There are a number of steps in the integration of the different calculation procedures. Firstly, the sound reduction of five ventilation opening sizes was calculated; these opening were set as fully open, fully closed and three points in-between. This equated to aperture widths ranging from 40mm to 200mm, representing the 0% to 5% opening of the ventilation building model's window area. Secondly, the noise exposures for various building forms in two urban locations were determined via noise mapping techniques. Thirdly, after the sound levels at the building façades had been determined, the concept of a "Tolerated noise level" was applied in the following way - the degree of opening for each window (within a ventilation model) was chosen such that the internal noise levels were as close as possible to the "Tolerated noise level". Five "Tolerated noise level"s were used that split the range between a fully open and fully closed façade. Finally, a separate thermal building model was used that used openings that corresponded to each "Tolerated noise level". The thermal building model performance results could then be plotted against "Tolerated noise level". This quantified the relationship between acoustic considerations and natural ventilation potential for the specific