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Sol-Vent: Development of strategies for the efficient use of solar and passive ventilation in urban buildings

M Kolokotroni[♦], M Santamouris*, E Daskalaki*, J Palmer#, F Allard‡, S Alvarez[+] and A. Blanco[+]

[♦] Department of Mechanical Engineering, Brunel University, Uxbridge, UB8 3PH, UK
* University of Athens, Section Applied Physics, 157 84 Panepistimioupolis, Athens, GREECE
# BRE, Bucknalls Lane, Garston, Watford WD2 7JR, UK
‡ Universite de la Rochelle, LEPTAB, Avenue de Maurillac, F-17042 La Rochelle Cedex 1, FRANCE
[+] AICIA University of Seville, Camino de Los, Descubrimientos S/N, E-41092 Seville, SPAIN

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Abstract

This paper outlines work in progress to develop dissemination material to assist the appropriate application of solar and passive ventilation in urban buildings. The dissemination material (a multi-media package in the form of a website and a CD-ROM) will include information of the effect of the urban environment on urban buildings, will outline the principles of solar and passive ventilation and how these could be adapted for application in urban buildings, will describe design solutions in the form of case-study building and design components and will review how current regulations encourage/restrict the application of solar and passive ventilation in urban buildings.

The purpose of this paper is to generate feedback from ventilation experts and researchers on the information proposed for the multi-media package. The project will be completed in January 2001.

Introduction

Naturally ventilated and passively cooled office buildings consume approximately 50% of the energy used for heating and cooling by good practice or typical air-conditioned offices [1]. There is thus a significant potential to reduce energy consumption in the office building stock by encouraging the uptake of natural ventilation while minimising the use of air conditioning.

Most buildings are concentrated in urban areas. Various barriers, including those of external noise and air pollution have prohibited the use of solar assisted and natural ventilation in urban buildings. However, recently there has been a considerable amount of scientific and technological effort in Europe and internationally on advancing the use of solar assisted and natural ventilation, either for improving indoor air quality or for cooling purposes. The EC funded NatVent [2] and POLIS [3,4] European projects have shown that solar assisted and natural ventilation is possible for urban buildings.

For example, two buildings could be cited; the Canning Crescent Day Care Centre in North London [2] which is naturally ventilation using thermal stacks and the New Parliamentary Building in Central London [5] which use a combination of fixed omni-directional wind/thermal stacks and a solar ventilated façade to augment a low energy mechanical strategy. In addition, products have emerged in the market making it possible to use solar assisted and natural ventilation in dense urban areas. Such products are noise attenuation

and/or air pollution filtering natural ventilators produced by Dutch, Belgian and British manufacturers.

Also, important studies carried out in Europe, the USA and Japan have investigated the effects of external surface albedo, vegetation, urban layout (and wind patterns within the urban environment) and anthropogenic heat [6] in the urban environment which affect ventilation strategies.

However, the uptake of the technology is still relatively low because of lack of information in the appropriate form to convince a significant number of building professionals of the advantage and practicality of solar assisted and natural ventilation for urban buildings. The project aims to combine existing scientific and technological knowledge and make this available in the form of a website and CD-ROM.

Structure of multi-media package (Website/CD-ROM)

The target group of the multi-media package is the informed 'architect'; ie an architect familiar and/or with practical experience of passive ventilation systems. It will be also useful to engineers specialised in HVAC in their discussions with clients as an additional 'persuasion' tool for the viability of their proposed solutions for passive ventilation systems in urban buildings. In addition the multi-media package will contain technical reports that will be useful to ventilation researchers as reference material.

The Urban Context

This section will contain the current state of knowledge on urban environmental behaviour derived from European-wide and regional studies. The impact of environmental factors on building energy and environment will be explained. Statistics, design data, sources of data and methods for adapting available data to suit site conditions will be presented in order to quantify major design challenges for natural ventilation options for a site. The following areas will be covered:

- *The urban climate;* the main characteristics of the urban climate will be presented including a description of the measurable parameters related to buildings.
- *Urban energy;* the mechanisms of energy fluxes in the urban environment will be described. Subsections will include information on four parameters affecting the thermal and ventilation performance of urban buildings*; Urban Heat Island, Urban Wind Field, Urban Solar Radiation and Atmospheric Pollution.*
- *Available Tools*; references will be included to tools that could help with assessing ventilation strategies for urban buildings.

A full report containing more detailed information and references will be also included.

Principles and Adaptation

This section is intended to give the designer a "feel" for the impact of the urban environment on the indoor environment. Therefore, it will be the first page that many visitors to the website will visit. This page will contain appropriate links to all other pages. This page will essentially describe the common "basic" natural ventilation strategies which are successful for non-urban sites. These will be assessed for a range of urban circumstances in order to demonstrate the comparative degradation in performance due to the urban environment. This will illustrate the limits of application of a strategy and prompt enhancement options.
The structure of the page is a follows:

- *Climate:* a brief description of the urban climate with links to the 'urban context' page; urban heat island and local airflow patterns will be discussed.
- *Urban Typology:* the most common urban layouts will be described including various categories of urban canyons
- *Air pollution/noise:* the influence of local and remote air and noise pollution will be discussed
- *Building form:* The effect of building form on the effectiveness of ventilation strategies will be discussed
- *Ventilation strategies:* The airflow driving forces will be reviewed together with a discussion on ventilation openings, cooling strategies, controls, required components and integration with HVAC systems. This section will be probably be of use to designers unfamiliar with passive ventilation.
- *Tools:* Available tools for airflow calculations will be reviewed and appropriate references (and links) will be provided.

Design Solutions

This section will present the range of available technologies and strategies for enhancing natural ventilation and solutions to urban environmental barriers. Design and performance data from real case studies of urban naturally-ventilated buildings will be also presented to illustrate the practical feasibility of natural ventilation and flag areas which require special care.

It is anticipated that three buildings from cold climates and three buildings from hot climates will be presented. For each of the case-study specify details will be presented on:

- Urban location; to include details in the urban typology, microclimate and atmospheric and noise pollution
- Building Description
- Design Solutions in line with low energy design principles
- Ventilation strategy; the strategy will be described together with the design (tools), implementation and controls.
- Building thermal performance
- Design lessons

In addition, design components which are suited to urban passive ventilation will be described. These include systems such as PDEC [7, 8] and top-down ventilation [9], as well

as examples of photovoltaics and ventilation component integration such as the Airlit-PV window [10], double-façade systems and other suitable passive ventilation components for urban buildings.

Current Regulations

Existing regulations related to solar and passive ventilation in urban buildings is being reviewed. This section will present general listing of the current regulation, technical data and arguments for using solar and passive ventilation, current requirements on ventilation and air quality. In addition existing and on-going building energy and environmental rating procedures will be reviewed and related standards such as fire and acoustic regulations will be identified.

Conclusions

This paper presented an overview of material to be included in a dissemination website/CD-ROM dedicated to solar ventilation for urban buildings. The purpose of this paper is to generate feedback on the material proposed and invite comments and suggestions. An internet workshop will be launched in December 2000. The website/CD-ROM will be completed in January 2001 and available soon after on-line or as a stand alone CD-ROM.

Acknowledgments

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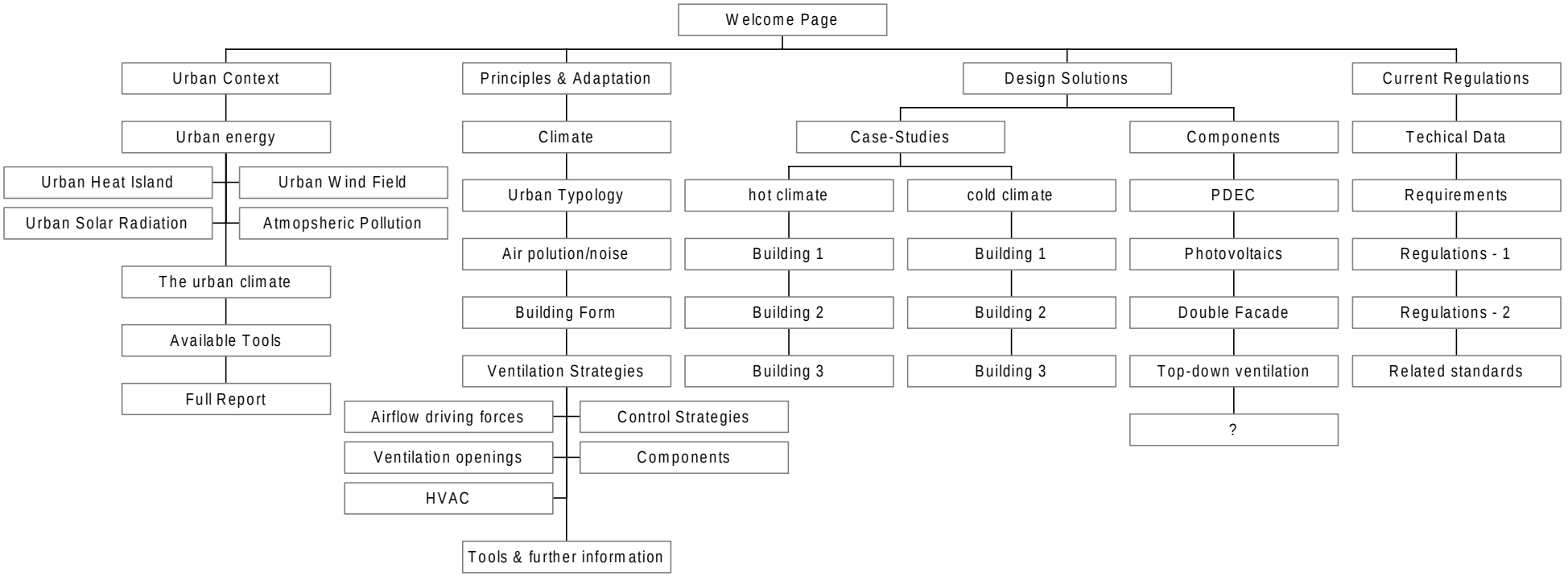

Figure 1: The structure of the multi-media package of the Sol-Vent project