Ventilative Cooling Design In Practice: Where next?

Paul D O'Sullivan*, Adam O'Donovan, Maha Sohail

Department of Process, Energy & Transport Engineering
Munster Technological University
Rossa Avenue, Bishopstown, Cork, Ireland
**Corresponding author: paul.osullivan@mtu.ie*

SUMMARY

Embedding robust yet accessible frameworks to evaluate ventilative cooling potential during the early/concept design stages for building practitioners can help in reducing the performance gap as well as avoiding vulnerability "lock-in" from design decisions that are based on poor or inadequate information. The challenge is to develop performance based evaluation methods that recognise the tacit approach to design in practice. Often design is iterative, non-linear and multi-agent. For this reason there is a need to harvest knowledge on design practices from industry experts as well as develop support approaches that recognise the potential lack of expert knowledge at the concept stages of design (i.e. limited ventilative cooling design expertise of planning consultants, architects and quantity surveyors). Simple and complex strategies also require different evaluation approaches as well as the need to address the wide varying performance of natural ventilation in reducing the design vs in-use performance gap.

KEYWORDS

Design, ventilative cooling, passive, practitioners, resilience.

1 CHALLENGES FOR EARLY STAGE VC DESIGN

The quality of future living circumstances for many will be contingent on how low energy indoor spaces respond to challenges from accelerated ambient warming. The most vulnerable spaces are likely to be those that adopt ventilative cooling, given the dependence on the cooling potential available in the outdoor ambient air as well as the relying on the natural driving forces present in the urban wind and indoor-outdoor buoyant exchange [Tavakoli et al, 2022]. There can be a significant design risk for building practitioners when evaluating natural/passive ventilative cooling strategies at the early and detailed design stages, particularly given the non-deterministic characteristics of the strategy. By way of example, the intermittency and short circuiting in solutions such as single sided ventilation can be problematic in guaranteeing adequate cooling supply when it is most needed.

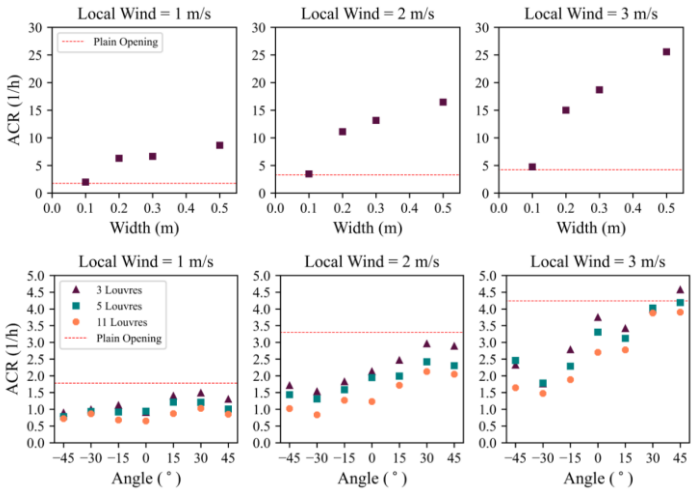

Figure 1: Wind driven SS ventilation rate performance for plain openings, louvres & guide vanes [Najafi Ziarani et al, 2023]

An example of the challenge for designers when attempting to account for VC performance at the design stages is evident from recent laboratory measurements of different window designs that highlighted a difference of over 400% [Albuquerque et al, 2021] in wind driven ventilation rates depending on window type, while a separate study reported that guide vanes were shown to outperform louvres and plain openings by a factor of over 5 [Najafi-Ziarani et al, 2023]. So there is a wide range of potential performance outcomes that design choices can influence. The issues are only examples of many that have propagating effects through design and into operation, i.e. the combined performance of thermal inertia, opening designs, hybrid and supplementary strategies, complex flows etc. Therefore, the "cooling performance gap" between design and operation is dependent on robust design approaches that better account for the cooling potential of combinations of climate-building-system as early as possible in the design process. The greater the investment in information gathering, analysis and decision making during pre-design and conceptual design phases, the fewer financial, environmental and wellbeing costs later in the project. As part of the new ventilative cooling technical specification under CEN TC156 work is progressing to define an early stage design process for practitioners that offers a performance based approach to evaluating VC potential during the concept stage. Figure 2 provides a conceptual overview of this. This will be further developed as part of the ongoing efforts of the technical specification writing group. There are many challenges around how to approach simple vs complex indoor spaces/strategies, whether a prescriptive method exists for evaluating cooling potential, how to accommodate early stage conceptual ventilation rate assessments and so forth.

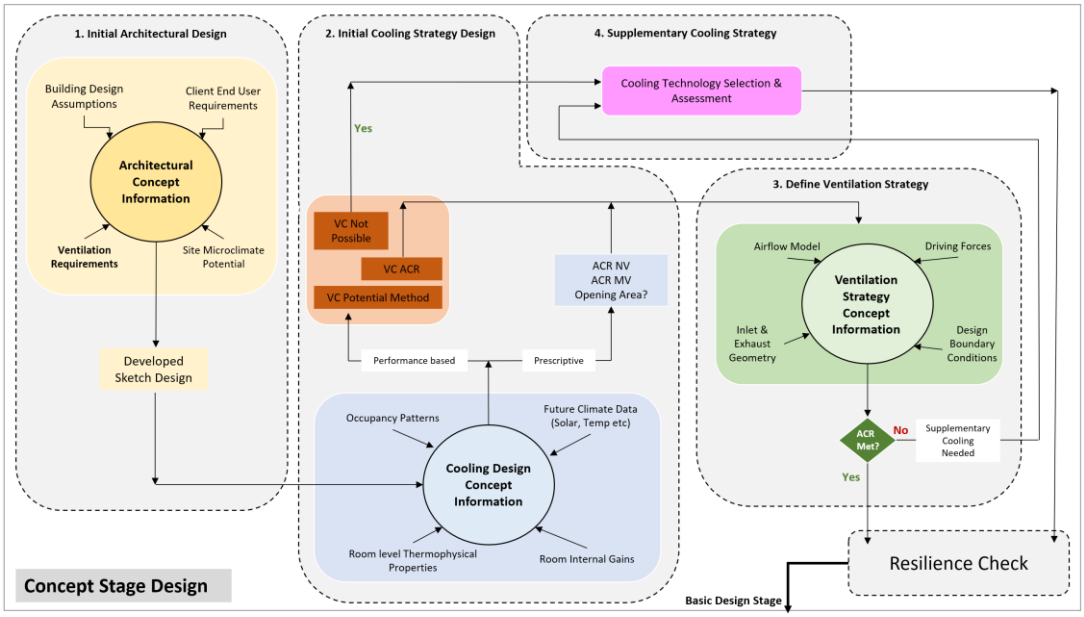

Figure 2: Evaluating Ventilative Cooling at the Concept Design Stage

2 DESIGN IN PRACTICE

Given that "design in practice" may differ from theoretical frameworks work has been completed in an attempt to map how ventilative cooling is dealt with in real design environments and whether this differs significantly from the current best practice guidance available in standards and professional body guidelines. A survey of over 30 building design practitioners has been completed which included 57 questions exploring how ventilative cooling is perceived, how the design effort is distributed throughout the design process, whether existing tools and methods are fit for purpose and what improvement are necessary to evolve VC design towards more reliable frameworks that lead to better operational outcomes for buildings [Sohail et al, 2023]. Approximately 18% of the respondents considered cooling as a design criteria but regarded it as not important. About 8% of the respondents said that it is not a design criteria in their building design practices. Around 32% of the respondents do not use any design tools to make any ventilative cooling decision and around 34% sometimes use a design tool while 34% of the respondents use the tool while making a ventilative cooling decision. It is evident that clear, reliable early stage design methods to assist designers at the concept stage to evaluate ventilative cooling potential of different strategies is important and useful to addressing the performance gap in low energy buildings. As well as the survey 10 detailed interviews with design experts have been completed and this, along with the survey work and the ongoing efforts of the writing group, should facilitate the development of a design map/ontology of how VC design is actually undertaken in practice, and how this compares to existing theoretical guidance and tools. The aim is to tailor existing frameworks and guidance to better align with the tacit knowledge of design experts and provide a

more seamless approach to evaluating ventilative cooling at the early stages through to detailed design, reducing vulnerability "lock-in" that becomes difficult to address post construction.

3 OUTLOOK

In order to reduce the performance gap for ventilative cooling it is important to first map how solutions are being selected, designed and developed in real practice based environments. Once this has been scoped and defined, it is easier to identify where there might be deficiencies in design supports, whether they be guidance documentation, evaluation tools or training and so forth. Developing support at the early stages in design, where most impact can be achieved, is key to attempting to reduce the future underperformance of ventilative cooling solutions. The new technical specification being developed under CEN TC156 aims to address this challenge by offering designers an easy to use robust, performance based approach that can evaluate VC potential early in the design to allow key decisions be made around building morphology, site microclimate exploitation, additional passive interventions, supplementary cooling requirements and so on. Good design practice will be as important as technological innovations in addressing the resilience of future indoor thermal environments.

4 ACKNOWLEDGEMENTS

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