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Impact of a Pilot Draught Sealing Program on Public Housing Air Permeability

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Abstract

Air tightness (or permeability) is a property of a building envelope that describes how air moves though it when subjected to a pressure difference (wind, stack effect, etc.), this impacts on building performance including energy usage, thermal comfort and air quality. The NSW Land and Housing Corporation (LAHC) implemented a pilot program of simple leak (or draught) sealing measures to improve air permeability and building performance on some of its domestic building stock. The effectiveness of this program was evaluated via blower door testing to international standards including measuring overall envelope permeability, and qualitative and quantitative investigation of the leakage paths through the structure. Testing was undertaken before and after the leak sealing interventions to determine the relative impact, the extent of the works implemented was documented, and potential for further improvements investigated.

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Keywords: Air Permeability; Air Leakage; Residential; Australia; Energy Efficiecny; Blower Door; Draught Proofing; Draught Sealing;

1. Introduction

Air tightness (or permeability) is a property of a building envelope that describes how air moves though it when subjected to a pressure difference (wind, stack effect, etc.). Ventilation is deliberate and controlled air flow through

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a building for human comfort and wellbeing whereas infiltration is uncontrolled inadvertent 'leakage' that can negatively impact on building performance. Measurements of building permeability focus on this leakage.

Nomenclature

ACH50	Air permeability expressed as air changes per hour at 50 Pascal's of pressure
BCA	Building Code of Australia
LAHC	New South Wales Land and Housing Corporation

The most well-established air tightness measurement technique is the fan pressurisation or 'blower door' method. This method requires creating a pressure difference across a building envelope, measuring the pressure, and the resulting air flow. This method uses: a fan temporarily installed in the building envelope to create pressure (often a temporary panel installed in a doorway), a manometer measuring pressure difference (usually a digital manometer integrating control of the fan), and flow measurement equipment (typically the fan itself is calibrated). Measurements of flow are taken at a number of pressures and the results are used to find a numerical relationship. This relationship is often expressed as air changes per hour, defined as the measured flow rate at 50 Pascals pressure divided by the building volume; equivalently this is the number of times the building volume is turned over at a test pressure of 50 pascals (ACH50 or ACH @ 50Pa).

Within the residential international context, several studies have demonstrated that building performance in terms of energy consumption [1,2] and air quality [1,3,4, 5] are significantly affected by infiltration rate. A Finnish study [4] revealed via energy modelling simulations that 15% to 30% of the heating use in a typical Finnish detached house was due to infiltration. Chan, Joh and Sherman [3] underlined that 'drafty' homes use more energy to condition and are more uncomfortable to live in. In contrast very air-tight dwellings have improved comfort and energy efficiency but may require mechanical ventilation to keep acceptable indoor air quality.

Linkages between air permeability and building performance have been made in the Australian context, Sustainability Victoria [2] conducted an on-ground energy efficiency assessment, including audits and fan pressurisation tests on 15 existing homes in Melbourne. Thereafter, the house characteristics and experimental air tightness values were used in a building thermal performance simulation tool to model the impact of sealing upgrades on the energy consumption. Simulation results showed that draught sealing improved performance with payback periods under ten years for most of the 15 dwellings [2].

While linkage between air permeability and residential building performance has been long established internationally (more recently so in Australia), there have only been a small number of air permeability test results of Australian residential buildings published. A study by Ambrose [6] of 129 homes across Australian capital cities constructed after 2012 found an average permeability of 15.4 ACH@50Pa. Biggs [7] measured 32 homes in NSW and Victoria built from 1956 to 1986 and found an average permeability of 26.3 ACH50. In a study of 15 homes built between 1900 and 1980 in Victoria, Moreland [2] found an average permeability of 29.1 ACH50. The average envelope permeability found in all of these studies is considered high by international standards [10,11] and accordingly offers the opportunity to improve residential building efficiency in Australia.

Within the literature reviewed some attempts were made to relate leakage paths with permeability. Ambrose [6] attempted to correlate visual inspection of weather sealing with blower door test results on new homes. Biggs [7] used an experimental test room to attempt to measure leakage from certain building components and Moreland [2] simulated the impact of an estimated change in air permeability on building performance. None of these studies however sought to identify typical leakage paths in Australian residential buildings and measure their relative impact, nor did any assess the effect of common draught proofing measures. As this information is needed to assess the opportunity and relative value of draught sealing measures, this represents a gap in the published literature.