Reducing Cost and Errors: Blower Door Testing Using a Simplified Method
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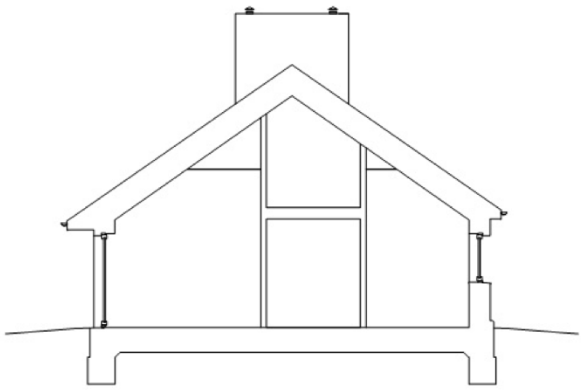
The Passivhaus n_{50} airtightness limit of $0.6h^{-1}$ is a key certification target. However the internationalisation of the Passivhaus Standard is highlighting uncertainty about the accurate determination of this key metric due to local variations in choice of reference volume.

With an n_{50} of 0.6 increasingly seen as a backstop experienced designers and builders realise achieving Passivhaus Standards of airtightness is cost effective . However for first projects, some borderline cases, and small buildings re-calculation of the Vn_{50} by the certifier has resulted in the n_{50} result changing from a near pass to a fail (figure 1).



Measured:
n_{50} without false ceiling; 0.56
n_{50} with dropped ceiling; 0.63
q_{50ext}: 0.28 in both cases

Figure 1. Example from Racecourse Estate, UK where the late addition of dropped ceilings changed the n_{50} result from pass to fail.

Vn_{50}

In the UK air tightness specialists determine the permeability at 50 Pascals (q_{50}) using ATTMA standards based on BS EN 13829. Experience shows testers are erroneously calculating a Vn_{50} with the dimensions used to calculate the q_{50}. Of particular concern is the significant additional time spent verifying the Passivhaus specific test volume.

PHPP

An unnecessary opportunity for confusion exists because PHPP relies upon two reference volumes. One for ventilation, the other for airtightness.

Whilst air leakage has a significant impact on energy demand, the Vn_{50} is arbitrary in terms of calculating the energy balance as the PHPP multiplies n_{50} and Vn_{50} together to determine the fan air flow, thus cancelling Vn_{50}.

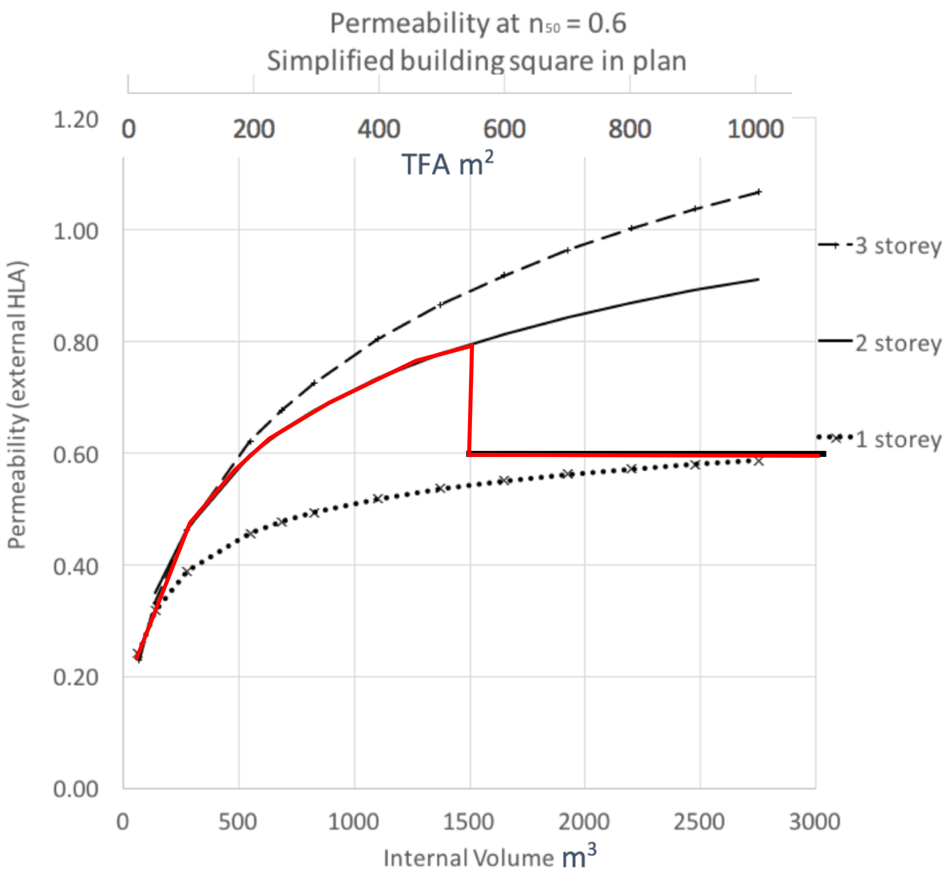
$$n_{v,Rest} \cdot \frac{\dot{V}_{50}}{\cancel{V_{n50}}} \cdot e \cdot \frac{\cancel{V_{n50}}}{V_v}$$

where $\dot{V}_{50}$ is the blower door flow rate

Cost of workmanship

Permeability (q_{50}) is arguably the clearest indicator of the standard of workmanship required. The Passivhaus Standard recognises the need for a stringent airtightness requirement in order to control moisture and prevent damage to the building envelope. Feist [2005] recommends an air permeability of 2 m/h where the fabric is diffusion open and 0.5 m/h where it is diffusion closed.

Graph 1 shows the calculated permeability required to meet an n_{50} of 0.6 $m.h^{-1}$. The model building is square in plan and of 1, 2 or 3 storeys high. Very small buildings require a much tighter envelope (q_{50}) to achieve the same n_{50} target. The appropriateness of this is questioned.



Graph 1. shows how the required permeability (q_{50}) to meet the 0.6 $h^{-1} n_{50}$ target varies with building size (25m^2 to 1000m^2 TFA). The horizontal line illustrates the emerging requirement for a q_{50} of 0.6 for buildings with an internal volume greater than 1500m^3.

Recommendations

The authors recommend replacing the current n_{50} limit of $0.6h^{-1}$ with a q_{50} permeability limit of 0.6m/h based on external dimensions. These dimensions are already measured and checked to determine heat loss area and will not change with the late addition of dropped ceilings or boxed in ducts. Furthermore, by using the external envelope area, the opportunity for error or game playing is significantly reduced.

Whilst n_{50} is arguably redundant, it could be determined simply using the Vn_{50} volume used by local testing methodologies. As long as the same Vn_{50} value is entered in the PHPP, the infiltration heat loss will be calculated correctly.

[Feist, 2005] Hochwarmegedammte Dachkonstruktionen, Arbeitskreis kostengunstige Passivhauser Phase III, Protokollband Nr 29, Passivhaus Inst., Darmstadt, Juni 2005

[ATTMA, 2016] ATTMA Technical Standard L1. Measuring the Air Permeability of Building Envelopes (Dwellings). September 2016., Air Tightness Testing & Measurement Assoc, 2016.