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The leaky horror show

by Douglas Lawson

Air infiltration through building envelopes can lead to a whole host of problems, including poor indoor air quality and high energy usage. Douglas Lawson argues the case for tighter fabrication.

While the undesirable aspects of uncontrolled air infiltration have been well known for several years, many new buildings continue to have excessively leaky envelopes. These cross the spectrum of construction specifications from masonry cavity walls with drylining, right through to profiled metal sheeting and curtain walling.

Such uncontrolled air leakage can cause problems such as staff discomfort, water penetration, high energy usage and poor indoor air quality. Remedial sealing of the building envelope to an acceptable level of tightness will invariably result in the particular performance deficiency being overcome, but such post-occupancy problems are a distressing experience for the building owner and result in a continuing diversion of both manpower and funds for the designer/builder.

While there is a growing recognition of the need to achieve an acceptably tight standard of envelope construction, there continues to be a small body of opinion expressing concern that perhaps buildings might be constructed too tightly, and that this could somehow contribute to such problems as poor air quality, condensation and sick building syndrome.

However, there is much to commend the philosophy that a building cannot be oversealed; it can only be under-ventilated. In reality, the lack of an envelope tightness standard means that the tightness or leakiness of a given envelope is unknown. Even if the building just happens to achieve an acceptable overall tightness level, the location of the accidental leakage areas will be unpredictable, and may be in entirely the wrong places. This can cause staff discomfort due to air movement across perimeter work stations.

Figures 1 to 5 highlight just a few of the variety of such "accidental" leakage areas. The location and severity of such leakage is entirely random, and differs from building to building. Leakage has been found to occur at pretty well all levels between floor and ceiling slabs, and even through some hot roof assemblies.

Give this situation, it is easy to understand the unpredictability of the performance of some buildings, and how occupiers can feel totally unable to exert any level of personal control over their comfort and ventilation requirements.

Historically, we have relied on accidental cracks, gaps, holes and porosity in the envelope to provide ventilation. Sometimes this was satisfactorily achieved, but frequently it wasn't.

Occasionally, the "ventilation system" (a euphemism for accidental openings) performed acceptably for part of the time, but if winds grew to a little more than average levels, or came from the wrong direction, then excessive air movement resulted around areas of the building, and the required office setpoints could not be maintained.

Surely it cannot be desirable to leave ventilation to the vagaries of accidental openings which – by their very nature – may or may not exist, will vary in their leakage areas, location and from building to building and which provide no means of permitting the occupier to change the size of these openings in line with ventilation needs.

Controlled ventilation

How, then, can this problem be overcome? The answer is simply by building a tight envelope and providing custom-designed ventilation. It should be recognised that even when tight envelopes are constructed, this does not mean that the building shell is airtight, as there will still be fairly significant residual leakage in such constructions.

However, the tightness which may be achieved with modern design and construction methods can ensure that such residual leakage is minimised and fairly predictable, avoids large cracks and gaps and is thus able to overcome the traditional problems of too high exchange rates and air movement discomfort.

Having achieved an envelope of acceptable tightness, the provision of the "ventilation system" must be addressed.

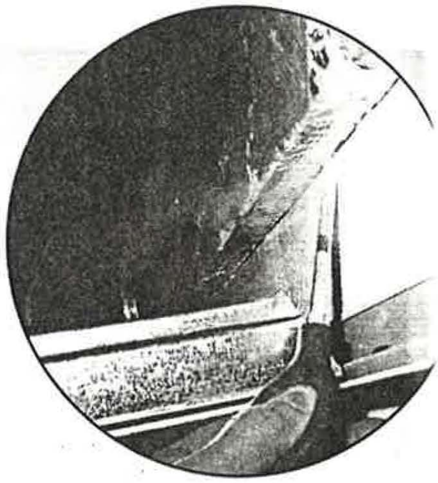

Figure 1: A masonry wall with part-filled cavity and drylining. Significant infiltration is occurring above the drop ceiling at the junction of the top of the plasterboard and the underside of the concrete ring beam.

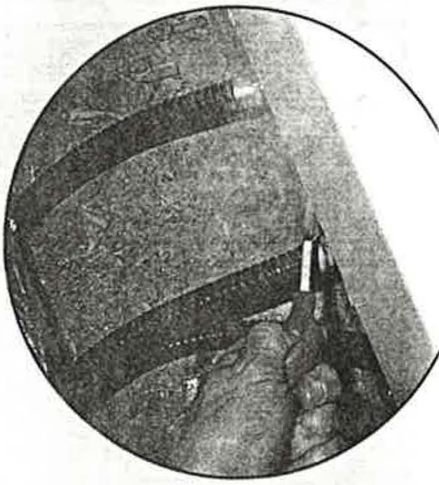

Figure 5: A masonry wall with part-filled cavity and drylining. Below the floor tiles, the drywall is not continuous down to the floor slab and infiltration is occurring.

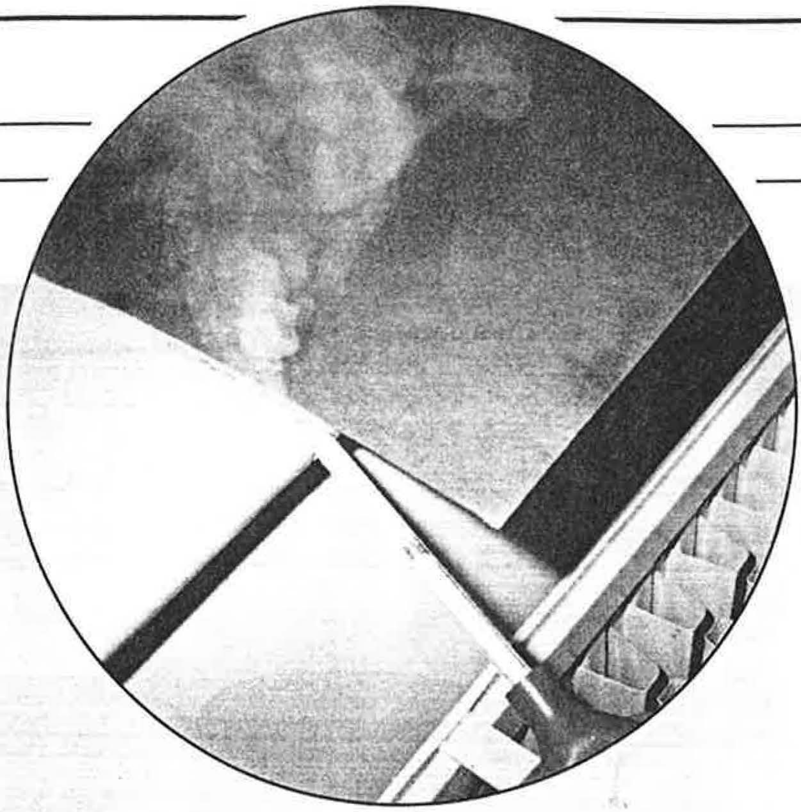

Figure 2: The smoke shows the tremendous air infiltration at a junction in the window sill. Pressurisation of the cavity behind the sill/drywall air barrier components is occurring via air leakage through the masonry walls.

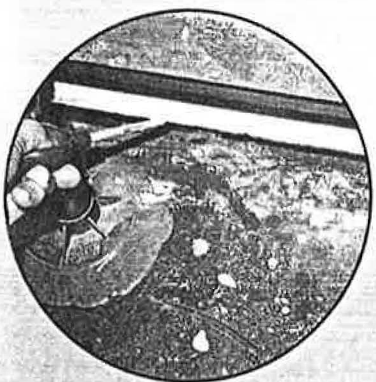

Figure 3: Below the floor tiles, the drywall is not continuous down to the floor slab. Infiltration is occurring from behind the drywall due to air leakage through the external masonry walls.

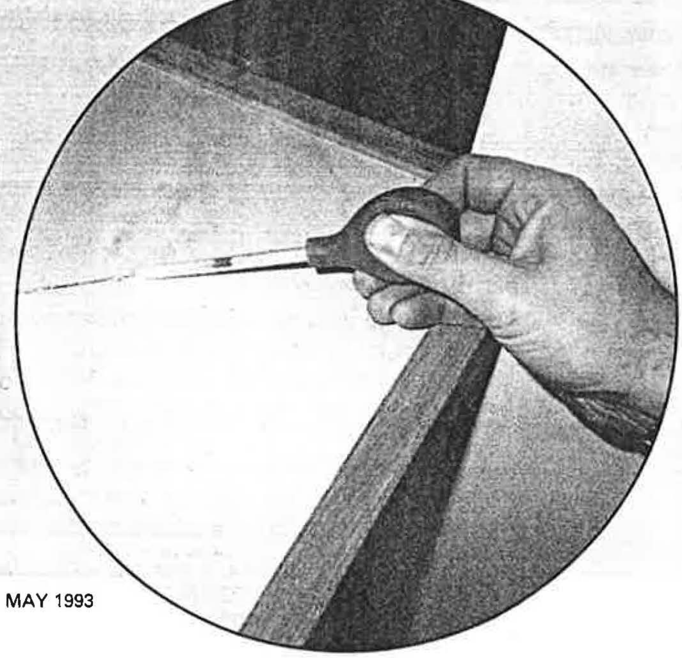

Figure 4: A masonry wall with part-filled cavity and drylining. Smoke illustrates significant amounts of air infiltration at the junction in the window sill.

For a naturally-ventilated building this will necessitate the provision of some form of custom-designed wall and/or window ventilator systems, preferably with facilities to permit a level of control that can be exercised by the building occupiers.

For summer conditions the windows can be opened to provide more extensive ventilation if required. For mechanically-ventilated buildings, the mechanical systems are designed to put the conditioned air just where it is needed throughout the building.

Envelope leakiness can therefore be seen to have a serious impact on comfort, ventilation and energy efficiency. In addition, however, there is also the important matter of moisture deposition within the building walls.

Vapour barriers

Vapour barriers are frequently included in envelope designs in order to limit diffusion into the wall. The inclusion of such a vapour diffuser recognises moisture deposition as a potential problem, but the fact that air leakage transmits significantly greater quantities of water vapour into the envelope than diffusion is regularly overlooked.

The ever growing trend towards increasing insulation levels in walls means that we are aggravating this moisture deposition problem by drawing the dew point deeper into the wall. Envelope air tightness is therefore the key mechanism for the effective control of moisture exfiltration into the wall structure.

Based upon the problems created by unpredictable envelope tightness, the philosophy advocating that we "build tight, ventilate right" seems compelling. Indeed, the proposed amendments to *Part L* of the *Building Regulations* address the need for envelope tightness and include measures to limit infiltration.

This could have a significant impact, not only on how we design and construct our buildings, but also with regard to their ongoing structural integrity and how comfortable and energy efficient we plan to be in the future.

Douglas Lawson is managing director of Building Sciences. The company provides envelope consultancy services at the design stage and for buildings with performance problems.

Further reading
Lawson D, "Problems with air leakage", *Building Services*, July 1990.
Perera E and Parkins L, "Build tight - ventilate right", *Building Services*, June 1992.