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Report

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WP1.3- air tightness

ROBUST

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STRATEGIES FOR IMPROVING AIR-TIGHTNESS IN OVER-CLADDING AND OVER-ROOFING

Introduction

Energy is lost through the building envelope by three main routes:

1. Building fabric losses, through the plane of the building element
2. Linear thermal bridging, through building details and areas of reduced thermal resistance
3. Air infiltration. Cold air entering the building through joints and interfaces, subsequently requiring heating to the building's ambient temperature

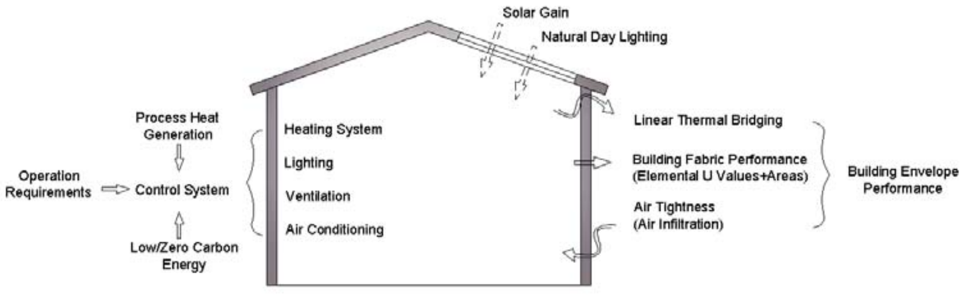

Figure 1. Factors affecting building CO_2 emission rate

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Evaluation of actual air infiltration rates for large buildings shows:

$$\text{Air changes per hour}_{\text{In use}} = \frac{\text{Air-tightness @50Pa} \times \text{Envelope area*}}{\text{Cladding area} \times 60}$$

*Envelope area is the cladding and floor slab area combined

The energy (Watts) required to heat the cold air entering the building is;

$$\frac{\text{Air changes/hour} \times \text{volume} \times \text{specific heat capacity of air} \times \text{density of air} \times \text{temp difference}}{3600}$$

For a typical industrial building, having the dimensions in Figure 2, the breakdown of losses is as shown in Figure 3.

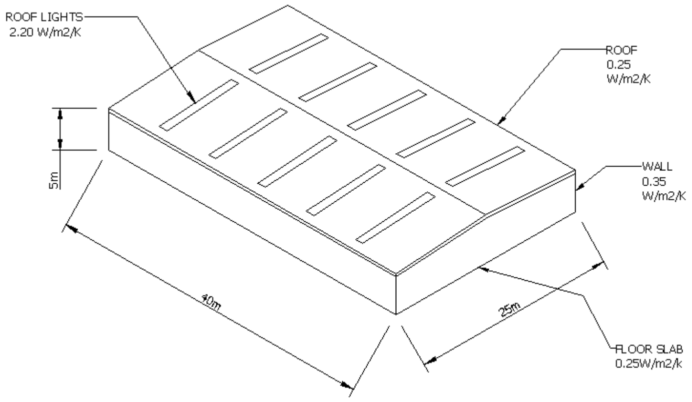

Figure 2. An example of an industrial building

Fabric U values As per Part L 2006 minimum requirements
Air-tightness $10m^3/h/m^2$
Total thermal bridging heat loss -@ 10% sum of fabric values

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Figure 3. Building envelope energy losses

Figure 3 shows that building air-tightness offers the greatest opportunity for energy savings. However, to maintain a good working environment within the building, sufficient ventilation is necessary, dependant upon activity levels.

Best practice dictates that the building envelope should be constructed as air- tight as possible and the ventilation controlled to the optimum level.
Air-tightness of a building is measured in m^3 of air per hour per m^2 of building envelope at an applied pressure of 50Pa. (The area of building envelope includes the walls, roof and floor slab.) This measure is termed air permeability. In practice, the floor slab can be considered air-tight.

Air-tightness is tested using a number of large mobile fan units pressurising the building to 50 Pa. The volume of air leakage is divided by the total envelope area (including floor slab) to obtain a figure for air permeability.

Air tightness and renovation

As thermal insulation levels increase, so the influence of air leakage on the overall energy use becomes more important, particularly in the residential sector. In existing buildings, air-tightness is often poor, mainly due to the porosity of the materials and imperfect joints between the components. Even in buildings constructed to recent standards, the air leakage rate can be higher than 10 $m^3/m^2/hr$ (at 50 Pa) and unwanted leakage of the warm internal air can represent 20% of the overall energy use.

For buildings constructed to higher modern thermal insulation standards, this level of air leakage can increase proportionately to 30-40% of the overall energy use, and therefore it is important to reduce air leakage whilst maintaining good levels of air quality and controlling condensation. In new light steel framing construction, it is possible to achieve air-tightness levels of to 3 to 5 $m^3/m^2/hr$, provided that measures are taken to eliminate air leakage at service points and between the plasterboards.

In over-cladding of existing buildings, the build-up of external layers does not necessarily have a major impact on the air-tightness of the renovated facade, especially if the major contributor to leakage is through the joints in the existing façade. Furthermore, if the over-cladding is in the form of a 'rain-screen', then ventilation behind the new cladding is required to achieve pressure equalisation. Also some ventilation through the existing façade is required to avoid condensation (in the absence of a vapour barrier on the inside of the building).

Therefore, it follows that reduction of air leakage in over-cladding systems is technically difficult to achieve unless a strategy exists for improving the quality of the joints in the existing building. For low-rise buildings, control of leakage at the wall-roof junction is also important.

Strategies

The strategies to achieve effective air-tightness are therefore:

- Add a membrane on the inside of the building with an additional plasterboard layer to form the finished surface. A 30 mm cavity may be introduced between the plasterboard and existing wall in order to allow for services to be passed through it. This would require some intervention within the building but may be a sensible option when windows are also replaced.
- Or, add a membrane externally to the existing façade with insulation outside the membrane. In practice, the membrane will also act as a vapour barrier and therefore there is a risk of local condensation on its surface, unless the membrane is kept warm (above the dew point temperature) to avoid condensation.
- Or use closed-cell insulation board externally to the existing wall with taped joints (which reduces air flow and has the effect of a membrane).
- Alternatively, local barriers may be introduced across all joints in the existing façade and junctions between components. This will not act as an effective air-barrier if there are many gaps and sources of air leakage, but it may be more sensible to identify the main points of leakage before embarking on the use of a continuous membrane.
- In addition, all joints around the windows and other penetrations should be sealed.
- The junction between walls and the roof is also a potential area of air-leakage which should be corrected locally

These strategies depend on the type of over-cladding system that is used, i.e.:

- Rain-screen façade allowing for ventilation.
- Face-sealed façade (minimal air movement).
- Trickle ventilation system (ie with modest air movement).

Possible locations of the air-leakage barrier insulation and vapour barriers are indicated in the attached figures.