DOUBLE SKIN FAÇADES

Double Skin Façades:

by Andrew Morrison and David Walshe

Design and Technology for the Irish Climate

This is the first in a series of technical articles promoting a better understanding of sustainable and low-energy design solutions, with particular focus on their appropriateness to the Irish climate.

Double skin façades have long been a feature of architectural competitions and feasibility studies, however, until recently, few designs in Ireland were realised. This was due to a number of factors, including unfavourable cost reporting / payback periods; an un-readiness to reduce plant size and associated costs due to lack of performance certainty; or client scepticism. Within the last 12 months, a number of buildings, particular in Dublin, are proudly displaying their new 'double skin', and there are as many on the drawing boards. What has driven this change? Have market forces demanded a higher performance façade, or is this a consequence of the new Part L Regulations, or a greater desire to develop low energy solutions?

The development of the double skin façade has been promoted as the answer to providing a fully glazed curtain wall and as an effective way of controlling heat, light, air and noise through the building envelope as well as reducing energy consumption. These claims depend, however, on the particular climate, site, and orientation that the double skin is placed. So what are the main attributes of double skin façades in relation to the Irish climate, and what configurations are most suitable?

Reduction of Solar Heat Gain

The primary attribute of a double façade is its ability to reduce solar heat gain. Allowing for occupancy and equipment, the solar gain to a building is by far the largest heat element, which must be reduced in order that it may be naturally ventilated or utilise low energy techniques to provide a comfortable working environment.

The simplest way to reduce solar heat gain to a building is to reduce the surface area of the glazing, shade the glazing or use body tints / fritting to improve the solar performance of the glazing. An office building in Ireland will typically be successfully naturally ventilated if the solar heat gain to the floor is limited to the region of 15 – 25 W/m^2. In the case of a west façade with low-E double glazing, this would equate to a maximum percentage glazing of 25-40%. For many building types such as open plan office spaces, this may prove too restrictive.

Where large surface areas of glazing are preferred, solar heat gain can be reduced by providing shading or solar coating to the glazing. External shading is potentially the most effective means of reducing solar gain, as all heat is removed prior to reaching the building. However, by their nature, these shading systems will often compromise views and have more complex maintenance issues. This is particularly true of south façades, where a horizontal brise soleil is effective in removing solar heat gain in summer-time when the sun is at a relatively high altitude (50-60°).

However, horizontal external shading alone is not effective to east/west façades in Ireland, due to low sun angles in summer. The solar altitude at 10:00/ 16:00 in August would only provide 500mm shading for a 1-m deep brise soleil for east/west façades respectively. West façades are particularly problematic, as they have to be shaded during the hottest time of the day, the afternoon.

One option to achieve reduction in solar gain is to improve the solar properties of the glazing itself, such as tinted or reflective glazing. While solar coatings have improved in recent years, there will be a relative decrease in light transmission and daylighting quality and physiologically can create a sense of separation from the exterior with a reliance on artificial lighting to create a comfortable environment. Body tints will not necessarily deal with glare and therefore internal blinds are often used, which further reduce daylighting.

Double skin façades are therefore particularly suited in Ireland to west (and east) façades, where horizontal shading such as brise soleil cannot be effectively implemented. The benefit of the double skin façade is that a vertical shield, such as Venetian blinds, effective for all solar angles, is provided. Furthermore, the blinds can be raised during cloudy conditions, which is particularly important in terms of maximising daylight for Ireland's variable climate. As the blind is contained within the double façade cavity, it is not exposed to the elements, and vastly easier to maintain and clean than external shading elements.

Ventilation

Ireland is particularly suited to naturally ventilated buildings, as external air temperatures rarely exceed design internal temperatures [see Figure 2]. The advantage of the two layers of glazing allows controllable natural ventilation without the gusts and breezes associated with openable windows. This is particularly true for buildings at an exposed site or for taller urban buildings where wind pressures increase at higher storeys. The extended air path into the building also controls issues such as noise infiltration, dust and insect infiltration. If the façade is to be used to naturally ventilate the internal space, it will typically consist of external louvres and dampers,

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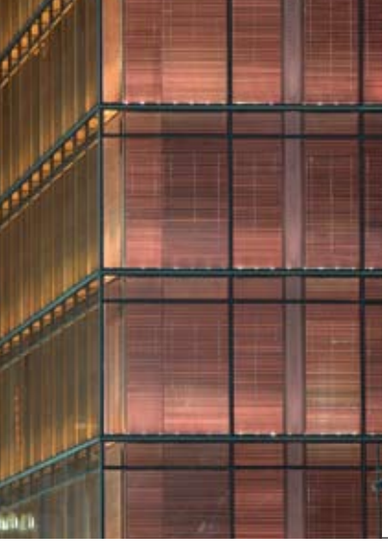

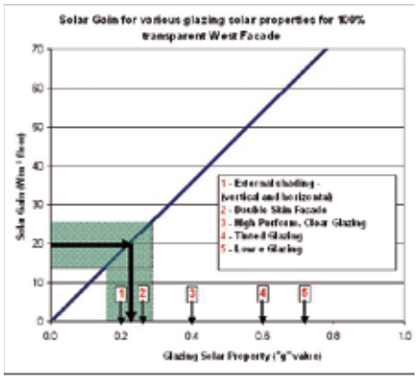

Figure 1 – Naturally Ventilated buildings typically require that solar gain does not exceed 15-25 W/m² of floor area. This equates to a maximum "g" value in the region of 0.18 – 0.28. This can be achieved by effective external shading, or by a double skin façade.

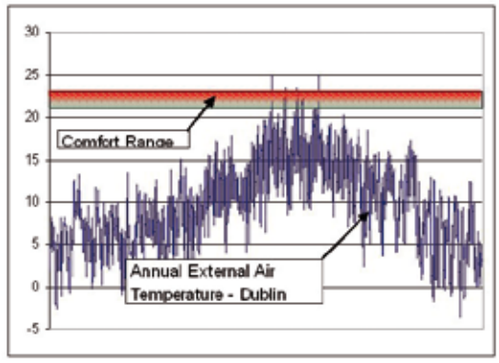

Figure 2 – External Air Temperatures for Dublin, with Design Internal Air Temperature band shown. Note external air temperature rarely exceed internal design comfort range.

which inherently provide a resistance to air flow, reducing draughts. The double skin façade may also be used solely to remove solar heat gain on the shading elements, with mechanical ventilation systems to the internal space. The flue can be used as a means or supplying or extracting air though the façade to a mechanical ventilation system. *[Figure 2]*

Thermal Performance

The addition of the double skin creates a 'buffer' zone, which improves the U-value performance when viewed against standard double glazed units. A double skin façade has a theoretical U-Value of 1.8 W/m²K. However, the internal blind trapping passive solar heat in winter has a positive effect in reducing heat loss, leading to an equivalent U-Value of 1.6 W/m²K. It may be noted that a double skin façade provides a marginal improvement over its equivalent single skin type however, an argon filled low-E double glazed proprietary system would perform as well as a standard double skin configuration of clear double / clear single glazed skins. However, the reduction in heat loss is not as significant in modern commercial office spaces (well sealed with high internal head load) for Ireland's relatively mild climate.

Acoustic Performance

Another significant benefit associated with a double skin façade is the improved sound insulation performance over and above that associated with standard double glazing or proprietary acoustic double glazing.

The acoustic benefits are particularly notable in respect of naturally-ventilated buildings in busy urban locations. With a traditional single skin design, open windows can reduce sound insulation performance dramatically, leading to excessive levels of noise intrusion from sources such as road traffic and aircraft. The application of a second external skin enhances the sound insulation performance significantly, allowing natural ventilation without compromising the internal acoustic environment. In order to optimise the performance that is afforded by the double skin arrangement, steps should be taken to attenuate noise as it travels along the tortuous path between the external environment and the room being ventilated.

The sound insulation performance of a double skin façade is a function of several factors, including glass weight and configuration, size of opening sections and depth of cavity between the skins. In general, better performance can be used through the use of heavier glass and a deeper cavity. The figure below compares the performance of a double skin façade with that of traditional thermal double glazing and also an acoustic double glazing unit with enhanced performance, achieved through the use of heavy glass of different thicknesses. The double skin façade offers appreciably better performance than either of the other systems.

One drawback in relation to double skin façades is cross talk between openable vents into the flue. This can be problematic with full height flues, if there is multiple tenancy or cellular offices which require privacy.

Part L Compliance

The revised Part L – Conservation of Energy (2006) of the Building Regulations impacts on façades in terms of both thermal performance and solar overheating. The use of a double skin façade will improve thermal performance (althought not significantly), however it can greatly reduce solar overheating, which would enable compliance for buildings with large areas of glazing, without relying on external shading.

Costs

The required capital cost of double skin façades vary greatly between buildings, as their overall value is dependant not only on the façade skin itself, but also for the variety of components used. These could include walkways, integrated shading, motorised blinds, motorised louvres and/ or dampers, as well as the associated costs for wiring and controls. Indicative costs for double skin façades vary greatly from €1400 to €2700 dependent on configuration used, as compared to typical unitised single skin façades which would typically cost in the region of €850 to €1100. However, double skin façade costs can be offset against reduced capital outlay for mechanical plant, particularly in Ireland where it can be feasible to omit a/c plant through the use of double skin façade technology.

DOUBLE SKIN FAÇADES - CONFIGURATIONS

The double skin façade label covers a wide range of different enclosure types, and some are more suitable than others, depending on the building type, orientation, and location. The concept of a twin skin façade is an outer layer of glazing (double or single glazed) and an inner layer of glazing (sometimes partially glazed).

Ventilation and solar control devices are then located between the two glazing layers. The air flow through the glazing cavity is driven by either natural buoyancy and wind pressures (aided sometimes by the use of fans) or a hybrid system, where mechanical supply or exhaust airflows are directed through the glazing cavity. Ventilated cavities may extend the height of the building, several stories, or be limited to a single storey.

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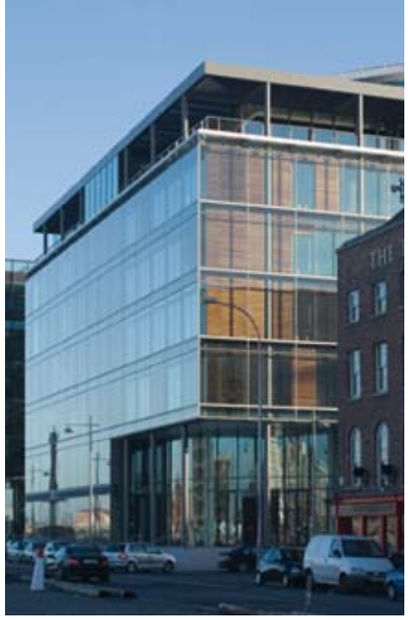

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1. Full Height Ventilated Flue vs. Single Storey Ventilated Façade

The advantages of the single-storey ventilated façade are that it is generally a simpler solution in terms of construction, fire separation, and noise transfer between floors. A single storey façade is more suitable for naturally ventilated buildings as fresh, cool air is available for occupants at each floor level. In contrast, a full height ventilated flue would have solar heat build up over a number of floors, which may mean that temperatures at the top of the flue are too excessive to be used for natural ventilation to the occupied space.

It is essential that full height flues utilised in naturally ventilated buildings are used solely for exhaust air, cross ventilating from opening windows on other façades. In this configuration, the flue is acting in a similar manner to an atrium and the exhaust louvres normally required to extend to above the roof level in order to ensure that hot air does not re-circulate to the highest floor level. The principle of this is similar to ensuring a smoke layer in an atrium. The full height flue does, however, have the aesthetic advantage of not requiring louvres at each floor level.

Optimum double skin façade flue widths are 200 to 400mm for single-storey flues, which require all sections of the internal skin to be openable for maintenance. Full height ventilated flues are of the order of 800 to 1200mm, and an access platform for maintenance can be provided, with less opening required to the inner skin, and less disruption to the internal space, during maintenance.

2. External Skin - Double Glazed or Single Glazed

Using a single glazed external skin can create a very transparent external appearance, particularly when using low iron glazing. Blinds and solar shading devices (preferably controllable) can then be placed within the cavity and the solar gain on the blinds can be removed by ventilating the cavity. Openable windows into the flue as a means of providing natural ventilation must be carefully considered, as there is a risk of warm air from the occupied areas causing condensation on the cold external glazed skin. By placing the double glazed units on the external face, condensation can be avoided.

Double glazed units are best suited to be positioned to the external skin for naturally ventilated solutions, whereas hybrid / mechanical schemes can be achieved with a single glazed external skin.

3. Double Skin Façades with Air Conditioning/ Mechanical Ventilation vs Naturally Ventilated Systems

The double skin façade can also be used in conjunction with an air conditioned or mechanically ventilated building. In this instance, the primary purpose of the double façade is to reduce solar heat gains and subsequently air conditioning cooling loads. The external flue can be used either as a stand-alone system for removing solar heat gains by natural convection (with the building sealed from the façade) or used as a return air path for the mechanical ventilation network, which has the advantage of the heat trapped in the double skin flue being available for heat reclaim at central plant.

While the above mechanically ventilated/ hybrid configurations are most popular world-wide, it is also often possible in most building applications in Ireland to utilise a double skin façade with an entirely naturally ventilated building, due to the moderate climate.

The benefits of a full naturally ventilated system are energy consumption, increased fuel costs, and the cost saving of mechanical plant, as well as carbon emissions, and low energy credentials. There are also comfort issues as many people prefer naturally ventilated spaces, provided the ventilation is controllable and overheating is not a problem.

Another option is to provide a mixed mode system. This has two meanings; either that the building is partially naturally ventilated/partially air conditioned, or that the building operates with natural ventilation in spring/autumn, and with air conditioning in summer.

However, regardless of preferred system, it must be noted that in order to achieve successful operation, occupant users need to play a role in operating and maintaining the systems, and their effectiveness, will often depend on a combination of user control and a sophisticated Building Control System.

Note:
Graphs courtesy of IN2 Engineering Design Partnership.
Acoustic data courtesy of AWN Consulting Engineering.
Cost data courtesy of KSN.

1-6 *Recent examples of double skin façades in office buildings in Dublin*

1,2,4,5 *Riverside One, Scott Tallon Walker Architects*

3,6 *Riverside Two, KMD Architecture*

Photos by Dennis Gilbert