by N P Skinner

Weathertight Windows and Doors


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There has been considerable effort recently to establish performance specifications for a number of building components. An early outcome has been the acceptance of weathertightness requirements for windows. These are now being demanded in a rapidly increasing proportion of tender invitations all over the UK.

There are several reasons for this demand. There are more tall buildings, which have greater exposure to wind and rain. Heating standards and acceptable comfort standards have risen; the same cold draught now feels relatively much colder. Lower ventilation rates have been found to be acceptable. Heating plant capacity and cost can be reduced if unnecessary cold air leakage is minimised; the full benefits of improved building insulation can thus be achieved. The national use of standard test methods has shown the levels of performance given by existing windows and what can be achieved with improved designs.

It seems likely that air leakage is of major concern. Although window manufacturers rarely receive complaints about this a recent research survey of domestic buildings in Scotland showed that those occupants concerned about weathertightness cited air leakage much more frequently than rain penetration. The latter, when it occurs, may of course be of greater importance because of damage to the building fabric and decoration; it is also more readily quantified than relatively ephemeral draughts.

Several public authority proposals have been made for determining the desirable minimum standard of weathertightness in a particular building. These are all based on site location relative to wind speed contours, local exposure conditions, building height and height of terrain; the main variations are in the minimum leakage standards specified. Agreement on uniform practices depends partly on the following aspects of the situation–which are still fluid and developing: experience of performance specified windows in a variety of service conditions, determination of the unavoidable variability between nominally identical production line windows, and establishment of the essential cost penalties for high performance.

Other window performance factors are now bring specified. The most prominent currently is strength against extreme wind gusts, accompanied by limitations on deflection. The desirable standard is assessed by an approach similar to that for air and water leakage. In this case there is fairly uniform agreement on the practices to be adopted. When necessary, such tests can be conveniently carried out in conjunction with those for air and water penetration. It is questionable whether they are necessary for windows whose construction is traditional in relation to the building exposure.

Weathertightness testing

This is carried out by mounting the specimen component so as to form one side of a closed box with the weather face to the inside. The effect of wind is simulated by air pressure; wind exerts pressure on building facades proportional to the square of its speed. The conventional units used are millimetres of Water Gauge (mm WG)– the head of water equivalent to the pressure.

Air penetration is determined by applying pressures raised incrementally and measuring consequent flow through the component. Normally, only the gaps between opening parts and the frame are of practical consequence. The units used are cubic metres per hour (m^3/h). Results are usually expressed per unit length of opening joint ($m^3/h/m$) or per unit area of opening part ($m^3/h/m^2$). The first is better for comparing different families of components, the second for opening parts of similar area but differing proportions.

Water is applied in coarse droplets with a defined trajectory and flow rate to the head of the component. It flows continuously while air pressure is raised incrementally. Resistance to water leakage is stated as the air pressure at which it occurs. Two leakage pressures may be determined: 'initial', when penetration occurs whatever the quantity, and 'gross', when the amount is sufficient to cause damage. The latter is clearly more important. The water test, necessarily of an arbitrary nature, is much less representative of results in service than that for air. It seems that low performance windows, of types which have long given satisfactory service in sheltered exposures, are underrated. But the test does classify windows in a scale of merit.

Weather resistant design

The basic principles for good weather resistance in an opening window or an external door are to provide a sizeable channel at the joint, positioned between the weather and the inside faces; keep the air within this channel stagnant at outside pressure: arrange to drain off to the outside any rain which penetrates into the channel. These principles impose considerable constraints on design, over the existing ones of economic manufacture with few basic components, low maintenance, security and convenience and ease of operation.

Windows and doors are not usually very thick and they have to accommodate hinges and catches. A seal is generally necessary if low air leakage is required. Because of the space limitations, solutions are rarely perfect or simple to achieve. They are even more difficult when a range of different designs is to be made from the same few basic components, as in volume production of standard windows.

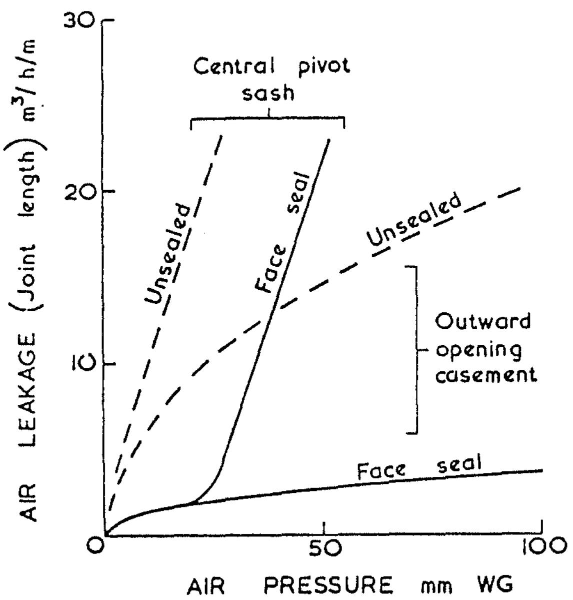

Figure 1 *Typical air leakage performance of existing windows*

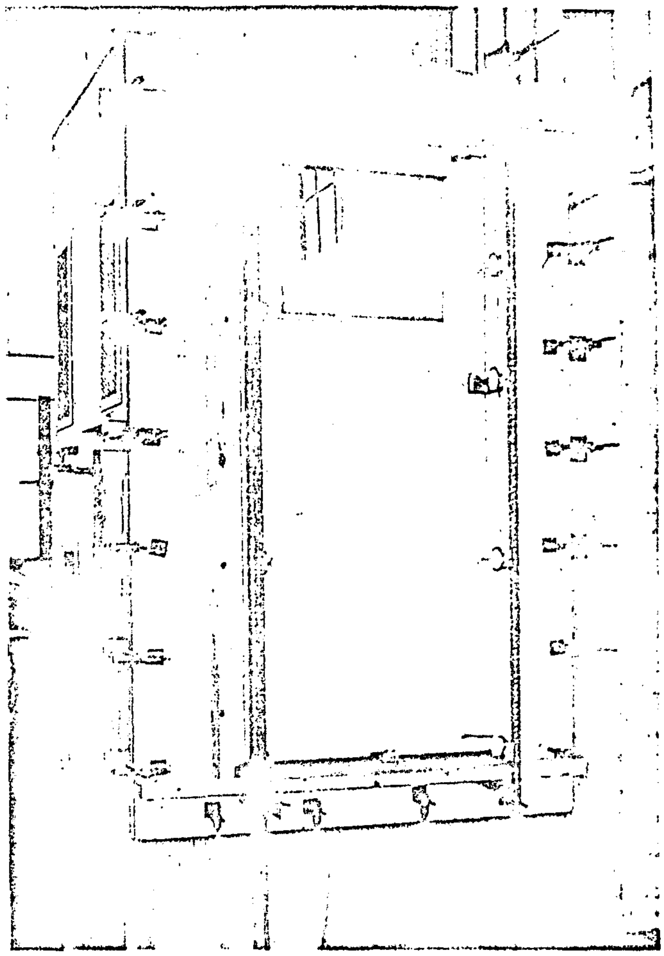

Figure 2 *Standard door in weather rig. The dial gauges measure deflection*

Research and development

Windows Timberlab's research into the tightness of windows is substantially sponsored by the British Woodwork Manufacturers' Association (BWMA). Many aspects of the performance of existing windows have been examined. Some of the general findings on air leakage are illustrated in Figure 1. Unsealed outward opening casement sashes usually leak at a rate roughly proportional to the square root of pressure; the leakage gaps generally close up somewhat as pressure increases, due to deflection of the sash. A simple face seal fitted to the frame rebate can reduce leakage substantially.

Unsealed pivot windows leak at a rate approximately proportional to pressure, although at low pressures they are no worse than casements. The increased leakage at higher levels is due to inward deflection of one half of the sash. This can cause normal face seals to be ineffective at higher pressures, when contact with the sash is broken. The effect can be overcome by using multiple catch points, usually operated by a single handle. A performance such as indicated on the graph should not, however, be regarded as bad for sheltered exposures, as the breakaway point corresponds to an air speed of about 65 kilometres per hour.

High resistance to water penetration depends greatly on small detail of construction, even though the pressures involved are small. Typically, they are around *one twentieth* of a pound per square inch (around 25 mm WG). Many new designs, although low in air leakage have proved no better than traditional constructions in their resistance to water leakage. Indeed, a common adage has been that rain resistance falls as airtightness is increased. Timberlab work has shown this to be largely an illusion; with the correct approach the whole performance of a window can be lifted into a class apart. More recently Timberlab expertise has been used in projects sponsored by individual manufacturers, for the development of high weather performance in particular designs. This has been very successful and projects have moreover been completed quickly by making design modifications on the spot, often without removal from the weather rig.

Doors

Similar work on doors is less advanced, but is proceeding. Again a substantial part of the Timberlab research is sponsored by BWMA. Doors present a somewhat different functional problem. They are usually much larger than window sashes and have to operate more easily. The average door gets very much more use, and must continue to work with greater reliability. Clearances from the frame therefore are generally larger and most external doors open inwards.

Examination of the weathertightness of existing doors has shown that: The joint length air leakages ($m^3/h/m$) are much higher than for unsealed windows. Simple face seals are relatively ineffective because appreciable deflection can take place at low air pressures (Figure 2 shows a typical experiment on a weather rig). Water penetration takes place at very low pressures although, as with windows, the performance in service is probably much underrated by the test method. Nevertheless a noticeable proportion of external doors in service do leak water from time to time. The gradual erosion of the porch in domestic architecture over the past few decades has contributed to this.

Experimental constructions with greater weather resistance have been explored at Timberlab. Although performance has been much improved, this has only been achieved by treating the door/frame combination as a relatively complex inward opening window with functionally unacceptable threshold design. Attention is now being focussed on practical constructions having intermediate performance.