Technical Note No. 8  
SELECTION OF WINDOWS - a checklist for specifiers

Introduction

The specification of windows is an area where many issues need to be considered in order to arrive at the best solution. This note simply lists the items that the Specifier might need to consider, possible alternatives and the role of relevant British Standards.

Window specification may be divided into six key areas:

1 Aesthetic needs  
2 Performance requirements  
3 Environmental concerns  
4 Health and safety issues  
5 Installation requirements  
6 Maintenance requirements

Each of these may be further sub-divided into several areas, sometimes depending upon the frame material, as follows.

Aesthetic needs

Frame material

There are four key materials, namely aluminium, PVC-U, steel and timber. However, these materials may be used in combination (composite frames), and there are also a number of new materials, such as fibreglass and pultruded resins.

Aluminium is available in the form of various alloys, such as 6063 in various tempers complying with BS 1474. Although originally a single aluminium extrusion, these frames usually now incorporate a plastic thermal break to reduce heat loss. A wide range of finishes is available, including natural and coloured anodising and an extensive range of coloured polyester powder coatings. Aluminium alloy windows should be specified according to BS 4873.

PVC-U frames are made from extrusions of plastic, possibly including some recycled material, which are heat fusion welded at the corners to form the frame. PVC-U extrusions usually incorporate an aluminium or galvanised steel hollow section within the central chamber to increase stiffness and provide a stronger base for fixing hardware. PVC-U frames were traditionally only available in a natural white finish, but are now available with a range of coloured finishes, typically applied as a foil covering, which may also have a simulated wood-grain finish. Body-coloured PVC-U is also available. PVC-U windows should be specified according to BS 7412.

Steel frames are either fabricated from hot-rolled strip (non-thermally-broken) or made from cold-formed sheet (often thermally-broken with a plastic or foam insert) - the hot-rolled type is predominant in the UK, and the cold-formed type is dominant in the rest of Europe. Steel windows are hot-dip galvanised to help prevent corrosion and a range of surface coatings are available in many colours.

Timber is available in a range of softwoods and hardwoods. The timber may be pressure treated, or may simply be coated with preservative. A range of finishes are available, in many colours, including a natural look. Timber windows should be specified according to BS 644: Part 1.

Frames of composite construction are increasing in availability, usually combining timber or PVC-U to the inside with aluminium to the outside. These frames may also include more than two materials (for example a timber inner section separated from an aluminium outer section with a PVC-U separator). Although not covered directly by British Standards these frames are often assessed indirectly using the existing British Standards for the various frame materials.
materials. Timber or aluminium frames can also be covered with a bronze or stainless steel skin for decoration and protection.

New materials are continually being introduced, and most can be produced with coloured coatings. However, these materials would not be covered by existing British Standards.

Jointing techniques must be adequate whichever frame material is used, including joints between frame members (e.g. at corners), and between hardware and glazing beads and the frame.

**Colour**

Whilst any colour is theoretically possible, some are particularly difficult to formulate and are available subject to certain technical considerations (e.g. weathering characteristics) of the paint manufacturer. The range of standard colours vary according to the type of finish and the manufacturer. Some colours are more colourfast than others - reputable paint manufacturers can advise as to the most durable colours.

**Proportion (frame area)**

If all other parameters are constant then the proportion of frame face width to total window area depends upon the stiffness of the frame material. Hot-rolled steel frames usually have the least ratio of frame to glazing, and PVC-U or timber frames the largest. However, the style of the window is important, as is the fit of the window into the opening - a window which is recessed behind the outer leaf of the wall will appear to have less frame.

**Style**

Typical styles include fixed lights, casements (side-hung, top-hung, bottom-hung), pivoted lights (horizontal axis, vertical, centre-axis, vertical off-centre axis), sliders (vertical and horizontal), tilt-turn (tilt-before-turn or turn-before-tilt) and louvre windows. Most of these styles are available in all frame materials, although hot-rolled steel frames are usually limited to simple fixed, casement and pivoted lights. Tilt-turn windows are usually single light but other styles (e.g. top swing) may combine opening and fixed lights.

The overall shape of the window is usually rectangular. Triangular, circular, semicircular or arched windows are available to achieve a particular aesthetic effect, to match those being replaced or to co-ordinate with adjacent buildings. Opening lights may be outward or inward opening.

**Size**

The size of window may limit the styles available - the number, thickness and area of panes dictate the size of frame required and strength of hardware for opening lights. Ease of operation, installation and glazing/reglazing also need to be considered. For example, designers should think about how large glass units can be handled and glazed safely and without damage.

**Glazing type**

Glazing selection is often based on energy criteria, but there may be a need to limit solar gain, provide privacy (reflective coatings, tinted or patterned glass), colour, acoustic isolation, improved safety, security or fire resistance.

Ordinary soda-lime glass is available in clear (usually with a green tint, which is only visible edge-on, although low-iron clear-white glass is produced by a number of manufacturers), body-tinted (a range of colours) and coated (usually visually or thermally reflective) forms. Obscure glazing may also be used (etched or patterned).

Note that glazings with light-reflective coatings or body-tints should be heat-strengthened or toughened. Toughened or heat-strengthened glass may suffer from breakage caused by nickel sulphide inclusions, although this problem can be moderated by heat soaking the glass.

Plastics glazing materials are also available, although these materials have a poor resistance to water vapour transmission and cannot be used in sealed units.

Further information on glass is given in TN 13 Glass types.
Hardware

Materials (e.g. brass or stainless steel) for the window handles, hinges and locks can also be chosen to compliment the appearance of the window but must be suitable for the frame material, weight, service environment and frequency of operation.

Performance requirements

Air-tightness

This depends upon the style of the window - more opening lights mean greater air permeability. Air-tightness also depends upon the glazing method - fully-bedded systems may be more air-tight, but can lead to problems with water penetrating between the seal and the glass unit and causing the unit edge seal to deteriorate and are seldom used. The setting of the hardware is significant - properly adjusted hardware will pull the opening light onto the weather-seal. Centre-frame gaskets may improve air-tightness, whilst reducing convective heat transfer within the window frame. The sealing of joins in gaskets (e.g. at corners) and the use of proper glazing procedures is important. Air-tightness may be classified according to BS 6375: Part 1. Further information on air-tightness is given in Technical note no. 1 Representing air leakage through windows and glazed cladding systems.

Water-tightness

The same issues apply to water-tightness as to air-tightness. However, rather than obtaining water-tightness by a continuous outer seal on the face of the window, special techniques such as pressure-equalisation can be used, or frames may be drained and ventilated, TN 6 The princlp of pressure equalisation. Water-tightness may be classified according to BS 6375: Part 1. Most commercial windows are now drained and ventilated.

Wind resistance

The effect of wind-load depends upon the size of the window - larger areas require more or stronger frame fixings. For windows which combine fixed and opening lights, mullion and transom sections may require stiffening - perimeter frames are usually stiffened sufficiently. Wind-resistance (elastic deformation) may be classified according to BS 6375: Part 1.

Note that wind pressure may affect the ease of operation and structural requirements of the hardware - hardware has been known to fail suddenly as a result of shock loads generated by gusts of wind acting on large open lights.

Further information on calculating wind loading is given in TN 2 introduction to wind loading on cladding and TN 3 Wind loading on wall cladding and windows of low-rise buildings.

Heat loss

Heat loss depends upon the glazing type, frame type and proportion of frame to glazing. It is always possible to reduce heat loss with better frame or better glazing thermal performance. Heat loss can be measured in accordance with BS 874: Part 3, or computer prediction methods are available.

Multiple glazings are also possible, with a range of glazing options and gas fills. Thermally-insulating edge spacers are available (warm edge technology).

Good thermal performance is achieved if the design of all of the elements of the window - frame, glass and cill - are balanced.

Condensation risk

The occurrence of condensation can only be predicted given a realistic assessment of the frame and glazing temperatures, and accurate knowledge of the psychrometric conditions. Temperature data can be obtained by measurement to BS 874: Part 3 or by computer prediction. Guidance on evaluating psychrometric conditions is given in BS 5250. Note that building occupancy and use are key features in the occurrence of condensation.

Ventilation

Different styles of window offer different degrees of control of ventilation. Background
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(trickle) ventilation is now a requirement of the Building Regulations Approved Document F.

Security

It is always possible to break through a window given sufficient time and suitable tools. Security standards are aimed at assessing resistance to unauthorised entry assuming limited tools and limited time, but with wide knowledge of how windows are secured. Breaking of the glazing with a sharp implement is unlikely on the grounds that the noise will attract attention and so limit the time available to the intruder. A soft-body impact to dislodge glazing or frame is more likely. Tests may be performed to BS 7950 Specification for enhanced security performance of casement and tilt/turn windows for domestic applications (limited to certain styles of domestic window) or to Windows with enhanced resistance to intrusion (CWCT, 1994) (any window style, domestic or commercial).

It is important to recognise that a security rating can only be applied to the particular combination of frame and hardware. Changing the hardware or its method of fixing will invalidate any existing security rating and require a re-test.

Various processes are available for improving the security of glass (wired, heat-strengthened, toughened or laminated glass). Adhesive films may be applied, although this is usually a retrofit option.

Kite marks

British Standard Kite marks are usually required as a set - a window must be Kite marked for air-tightness, water-tightness, resistance to wind load and security. However, some individual components may be Kite marked, such as glass units.

Interface design

There should be adequate clearance between the glass and glazing frame to allow thermal expansion and movement to occur without glass-to-frame contact and to permit proper drainage of the glazing rebate. The glazing rebate must provide adequate edge cover to support the glass under wind loading (see BS 6262). The window perimeter is normally sealed with a butt sealant joint. The sealant joint design width must take account of the practical (installation) and physical (movement capabilities) requirements of the sealant and deviations and dimensional changes in the window frame and opening.

Environmental concerns

Recycling

Some materials can simply be melted down and reprocessed for reuse in windows (aluminium, PVC-U, steel). Other materials may not be recyclable into windows, but can be recycled into other products (timber). Note that a material such as PVC-U, which includes several additives intended to ease processing and prolong life, cannot be directly re-used but needs to be either blended with virgin material (as much as 85 per cent new material may be required) or clad with a skin of virgin material.

Durability

Durability depends upon frame material (blend/alloy/species), surface coatings (coating type and thickness, surface preparation, colour), environment (inland, coastal, industrial, marine) and maintenance (both quality and frequency). Achieving the best durability is often a balance between conflicting interests, for example, if the window is mounted flush with the outer face of the wall then the perimeter sealant is exposed and thus less durable; if the window is recessed then the seal is sheltered but the window frame finish is not washed by rainfall and dirt may accumulate, trapping moisture and accelerating corrosion. Durability of the window or the perimeter seal can also be affected by poor fabrication or poor installation.

Issues such as regular cleaning and maintenance are important, but are difficult to guarantee. Guidance on the durability of materials and finishes is given in BS 7543, and information on compatibility of materials in PD 6484.
Health and safety issues

Hardware (restrictors)
It is possible to fit restrictors to windows to limit the opening. However, restrictors may need to be capable of rapid release to allow egress in an emergency or to allow cleaning, but they should re-engage automatically upon closing. This is generally a more expensive option than fixed restrictors. Restrictors are usually required where there is a risk of occupants, particularly children, falling from an open window. The Standard for Curtain Walling (CWCT, 1996) states that opening lights shall be provided with catches to limit the opening of any light to 100mm to limit the risk of falling out.

Fire safety (egress, access)
Provision may be required to allow access and egress in the event of fire as key-lockable hardware may hinder or prevent escape. Special hardware for quick operation in the event of a fire should be clearly distinguishable from other hardware, and should also be visible from outside the building if intended to be used by fire-fighters.

Operating forces
The force required to operate hardware is important, particularly for the elderly and wheelchair users. Ease of reach is also important and must be balanced by the need for security against opening by children. Guidance on operating forces is given in BS 6375: Part 2.

Repair and renovation
In a domestic situation is the window suitable for home repair? Can spare parts be obtained? Is hardware labelled with the manufacturer’s name and part number? Is the glazing clearly labelled as to type? All of these questions must be considered.

Access
Is the window safely accessible? Inward opening and internally glazed windows offer many advantages in terms of access, cleaning, inspection and repair. Practice for the safe use and cleaning of windows is given in BS 8213: Part 1.

Adjustment of hardware
What adjustment does the hardware require initially? Is periodic adjustment required? Hardware is often ignored, and yet must usually undergo some adjustment if the window is to operated within the specified limits of air-tightness, water-tightness, operating force and security.

Installation requirements

Size and weight (H&S)
How heavy is the window? Are the windows supplied ready glazed or as a kit of parts? Is mechanical lifting gear required? Again, these questions must be considered. Whilst size and weight is often not a problem for new build (due to the plentiful supply of labour, plant and equipment), it does become a concern when replacing glazing or windows.

Substrate
What substrate is the window to be fixed into (e.g. clay brick, concrete, stone or metal)? Is the substrate sound? Is the fixing position clear? The substrate may actually be a lightweight cavity closer which is insufficient to support the weight of a large window. Cavity closers should be considered with the window - many window manufacturers also have their own cavity closer system.

Fixing method
What type of fixing is required? How many fixings are required? The selection of fixings may depend upon the substrate material, wind loading and security requirements. Selecting a security window and then fixing it in place with an expanded foam is not sensible practice - the window can often be sawn out of the opening. At present, complete fixing of any window by foam is not permitted - foam is generally only used with domestic windows and then is not a substitute for fixings but can reduce the number required. Security window fixing screws are often fixed with rotating collars to prevent sawing-through.
Preparation of window and substrate

Does the window or the substrate need preparation? Can the perimeter sealant be applied directly to the substrate and frame? The frame or substrate material(s) may not adhere or be chemically compatible with all sealant types. Some sealants are known to cause staining of porous materials (e.g., concrete and natural stone), and some may be attacked by certain surface coatings. DPCs should be returned, or if short, a new piece fitted.

Design for installation

Is the window designed to allow easy installation and sealing? Is there provision to locate a sealant backer rod prior to sealant application? Some window frames have a thin nib of material against which a perimeter seal is to be made; others have a deep shelf with a groove that can be used to locate a backer rod. Some frames are secured by fixing through the frame, others use a system of clips/brackets that locate into a proprietary cavity closer. Some window manufacturers also supply proprietary clips which are used to locate dry linings against the frame - these features help to ensure a good finished installation. Windows must be installed vertical, regardless of substrate, in order to function properly.

Ease of installation depends on the practicality of fitting the window within the opening, which requires:

1. Account being made of dimensional tolerances in the window frame and particularly the opening when designing the perimeter seal;
2. Maintenance of reasonable/specified tolerances when constructing openings (see BS 5606, BS 8000: Part 3 and BRE Digest 199).

Incompatibility of tolerances at the window-cladding interface is too often ignored, increasing construction costs and/or compromising the finished appearance (due to wide joints, or a cut substrate) and durability of the seal (due to incorrect joint configuration).

Trained installers

Is the installer properly (and independently) trained? Even the best window design will fail to perform if poorly installed. Over-tightening of fixings can distort the frame and poor adjustment of hardware can prevent opening or reduce weathertightness. The use of properly trained installers, e.g., those registered and certificated with the Centre for Window and Cladding Technology (CWCT, 1996), will significantly reduce the risk of problems. Installers must also have an up-to-date installation manual for the window system.

Design for removal

Can the window be easily removed when it needs to be replaced? For example, are special tools required? Some types of fixing allow for easier removal. Fixings should be accessible - some types of window are now supplied ready glazed, and can be fixed without removing the glazing - this also allows easier removal.

Cleaning and Maintenance requirements

Maintenance (re-coat, reseal, re-glaze)

Windows typically need washing, re-coating and repairing if damaged. Glazing needs to be replaced upon failure - glass units have a limited life-span, depending on the edge seal and the glazing technique (fully-bedded glazing systems are prone to allowing water to penetrate to the edge seal due to their reliance on site workmanship). Resealing of the window perimeter may be required, and re-coating of timber windows with paint or preservative is a frequent requirement. Maintenance of hardware (e.g., lubrication and adjustment) is also needed, and drainage channels which are exposed when the window is opened should be washed out periodically.

The use of chemicals for cleaning should be carefully considered and a manufacturer’s maintenance guide provided to prevent damage by chemical attack or abrasion. Guidance on safe access, materials and methods for cleaning is given in BS 8213: Part 1.
Summary

Much of this technical note is concerned with the specification of framing systems and materials used for windows, and of different glazing infill panels. The technical note deals with all aspects of window selection and covers each different framing material by reference to relevant British Standards. Reference is made to all other British Standards that relate to window performance and safety.

References

BRE, 1977, Getting good fit, Building Research Establishment Digest 199.


BS 4873, 1986, Aluminium alloy windows, British Standards Institution.


BS 6510, 1984, Steel windows, sills, window boards and doors, British Standards Institution.


BS 7543, 1992, Guide to the design of buildings and building elements, products and components, British Standards Institution.


BS 8213: Part 1 Code of practice for safety in use and during cleaning of windows and doors (including guidance on cleaning methods and methods - draft, British Standards Institution.


CWCT, 1994, Windows with enhanced resistance to intrusion, Centre for Window and Cladding Technology, University of Bath.

CWCT, 1996, Registration and Certification Scheme for Window & Curtain Walling Installers, Scheme Description, Centre for Window and Cladding Technology, University of Bath.

DD171, 1987, Guide to specifying performance requirements for hinged or pivoted doors - including test methods, British Standards Institution.


PD 6484, 1979, Commentary on corrosion of bimetallic contacts and its alleviation, British Standards Institution.