

UWDMA Guideline for Fabrication of uPVC Windows and Doors



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UWDMA Guideline for Fabrication of uPVC Windows and Doorsets

FOREWORD

This UWDMA standard was established for the Indian uPVC window industry with an aim to promote best practice for the fabrication of uPVC windows and door sets, benefiting from over 60 years of world-wide uPVC fenestration experience. This document is not intended to conflict with existing or future Indian Standards (IS's), but rather to supplement them with regards to the specific requirements of uPVC windows and door sets. Wherever possible, IS and ISO standards are being referenced whilst British European standards (BS EN) and British Standards (BS) are cited to cover the product specific uPVC attributes.

We would also like to thank Federation of Safety Glass for their excellent document on Usage of Glass in Buildings which we UWDMA whole heartedly support.

This document may be used as a reference for design, selection or fabrication of various type so of uPVC windows and doors in consultation with local rules and regulations on safety and health hazards.

Errors & Omissions are excepted. Due care and diligence has been taken while writing, editing and printing the guideline. Neither the authors nor UWDMA hold any responsibility for any mistakes that may have inadvertently crept in.

About UWDMA

uPVC windows and doors manufacturers association or UWDMA is a NGO and NPO registered under societies act of 1996, Registration no. S/63770/2008 Dated October 31 2008 at flat No. 105, Kriti Mahal Building, 19, Rajendra Place, New Delhi -110008.

Since it's inception, UWDMA has been in the forefront promoting uPVC profiles, windows and doors in every forum - Exhibitions, Government, Bureau of Indian Standards as well as Institutions across the country.

We believe in elevating / dissipating right knowledge to the industry in the selection of profiles, hardware, fabrication methods and testing of uPVC windows and doors. Several activities have been done in this regard by our Technical and Marketing teams and more things are in the pipeline for the benefit of the Industry.

Please visit our website www.uwdmaindia.org for the latest updates.

FROM THE PRESIDENTS DESK

Congratulations to the Technical Team of UWDMA team in bringing out an Indian version, short and crisp booklet on different types of uPVC windows, doors, design criteria and various design principles considered while fabricating them. Special thanks to Robert Hoellrigl from Encrafts for bringing out the first draft in a short time and YP Singh, Fenesta for designing and bringing out the Guideline to this format.

I am sure it will be a good reference manual not only to our Industry fraternity but also to Architects, Developers, Designers, Consultants and general public on the right methodology of fabrication of uPVC windows and doors. It's simple illustrations and details explains complex concepts of pressure equalisation, weld strength testing, window testing simple and easy to understand.

This will be followed by Installation Guidelines and Reinforcements to be used in uPVC windows and doors shortly.

I also like to take this opportunity to invite all of you to become members of UWDMA and contribute to its growth.

You can write your views / comments / suggestions on president@uwdmaindia.org to help us improve Guideline and include additional topics to be covered

1.0 SCOPE

This guideline specifies the requirements for the design, fabrication, performance of glazed windows and glazed door sets made from uPVC extruded hollow profiles incorporating fusion welded corner joints.

It shall apply to windows and door sets fabricated into factory finished frames, to be installed vertically (within 15°) into the external face of buildings, as single or multi-light units, or coupled frame assemblies.

It is applicable to assemblies in which white frame members do not exceed 4.5 meters and dark coloured frame members do not exceed 3.0 meters. It is recommended and good practice to incorporate expansion joints thereafter. Practical experience has shown that uPVC outer frames up to 8 meters (In-line sliders, multi-pane Patio doors, fold & slide Patio doors, multi-fixed lights etc.) can be successfully manufactured and installed when special attention is paid to thermal expansion.

The standard does not apply to curtain walls that span across horizontal structural members or floors but is applicable to the actual frames within a curtain walling system.

Compliance with this Guideline does not of itself confer immunity from the need to comply with any other relevant legal or statutory requirements.

2.0 NORMATIVE REFERENCES

The referenced standards in this document are indispensable and are listed in Annex A - Reference standards

3.0 TERMINOLOGY

For the purpose of clarity and precise communication the following definitions are being suggested.

Casement sash

Framed opening light that is either hinged or pivoted

Casement window

Frame that can comprises either opening-out or opening-in sashes on hinges

Coupled assembly

Two or more separate windows or door sets mechanically connected to fill an opening

Design wind pressure

Wind pressure that can be expected on a surface of a building having taken into account the life expectancy, the height, the location and the shape of the building

Door Sash

Hinged or linear moving element with a door set

Door Set

Complete unit, as installed, comprising of door outer frame, door sash (es), occasionally side, top or bottom panels, glazing/infill material and operating hardware

Fasteners

Hardware device that mechanically joins or affixes two or more objects together

Fixings

Hardware device that secures a completed window or door set into the structure of a building

Glazing Bead

Ancillary profile which retains the glazing, in fill material or panel

Glazing Gasket

Thermoplastic or synthetic flexible member used between the glazing and the frame and between the glazing and the glazing bead

Georgian Bar

Also known as Astragal bar, fitted externally and internally, to subdivide the glass pane in order to replicate a traditional/historic frame appearance

UWDMA Guideline for Fabrication of uPVC Windows and Doorsets

Glazing Tape

Double side foam adhesive strip to enhance the security of externally beaded frames

Hardware

Device attached to the structural frame members to facility opening and closing of sashes

Hurricane Bar

Also known as Static bar, externally or internally plant-on fitted onto transoms, mullions and sashes to increase their rigidity for wind loading purpose and to resist human impact

Insulating Glass Unit

Two or more panes of glass manufactured to size and shape, spaced apart and then hermetically sealed on all four sides in a factory environment

Multi-light Window

Window incorporating opening and/or fixed lights within one perimeter frame

Low Threshold

Member at the door base, forming a mechanical connection between the jambs of the door set

Reinforcement

Additional structural (mostly metallic) section inserted and secured to uPVC profiles to increase the individual frame member rigidity

Sliding Sash

Framed opening light that slides either vertically or horizontally

Sliding Window, Sliding Door

Framed window or door set in which the sash (es) can either slide vertically, utilizing weight or balancers, or horizontally, utilising rollers on tracks

Systems Supplier

A company that provides fenestration components, technical and marketing know-how and training to its fabricating and installing associates.

Outer Frame

Non movable or fixed portion of the window or door set which is attached to the wall and to which a sash can be inserted

Transom or Mullion

Frame members that define the horizontal division (transom) and the vertical division (mullion) within outer frame and/or sash

Weather-Stripping

Piles, especially designed and manufactured for sliding windows and door sets to reduce air infiltration and water penetration.

Weather-Seal

Thermoplastic or synthetic flexible member to reduce air infiltration and water penetration

Weather Tightness

Performance in respect of air permeability, water tightness and wind resistance

4.0 DESIGNATIONS AND HANDING

All windows and door sets shall be viewed from inside unless otherwise agreed.

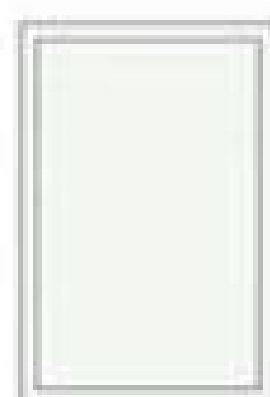
The handing of multi-light windows shall be clearly described when viewed from inside. Experience has shown that more relevant survey information will eliminate costly mistakes!

4.1 Frame designations to distinguish between the various types

Note: It will help when marketing, surveying, manufacturing and client can agree to use the same designation in order to avoid ambiguity, misunderstandings and costly errors.

F	FIXED	SH	SIDE HUNG
BH	BOTTOM HUNG	T&T	TILT&TURN
HS	HORIZONTAL SLIDING	1THS	1-TRACK H. SLIDER
2.5THS	2.5-TRACK H. SLIDER	3THS	3-TRACK H. SLIDER
FW	FRENCH WINDOW	DS	DOUBLE SASH WINDOW
VP	VERTICAL PIVOT	HP	HORIZONTAL PIVOT
TS	TOP SWING WINDOW	SW	SIDE SWING WINDOW
RD	RESIDENTIAL DOOR	BD	BALCONY DOOR
F&S	FOLD&SLIDE	L&S	LIFT&SLIDE
AL	ADJUSTABLE LOUVRES	FL	FIXED LOUVRES
LH	LEFT HAND	RH	RIGHT HAND
TH	TOP HUNG	PW	PARALLEL WINDOW
VS	VERTICAL SLIDING	CW	CURTAIN WALL
2THS	2-TRACK H. SLIDER	FD	FRENCH DOOR
4HS	4-TRACK H. SLIDER	T&S	TILT&SLIDE
AW	AWNING WINDOW	MS	MOSQUITO SCREEN

4.2 Handing - drawing convention in accordance with EN 12519



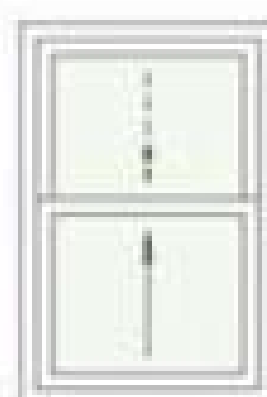
Fixed light



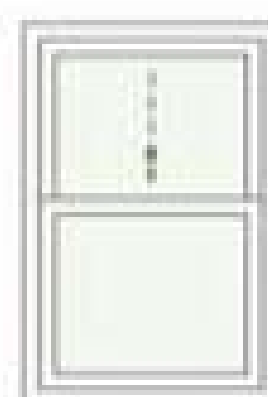
"OPEN-OUT"
single top
hung casement



"OPEN-IN"
single bottom
hung casement



Vertical slider
double sashes



Vertical slider
single top sash



"OPEN-IN"
single side
hung casement
right hand



"OPEN-IN"
single side
hung casement
left hand



"OPEN-OUT"
single side
hung casement
right hand



"OPEN-OUT"
single side
hung casement
left hand



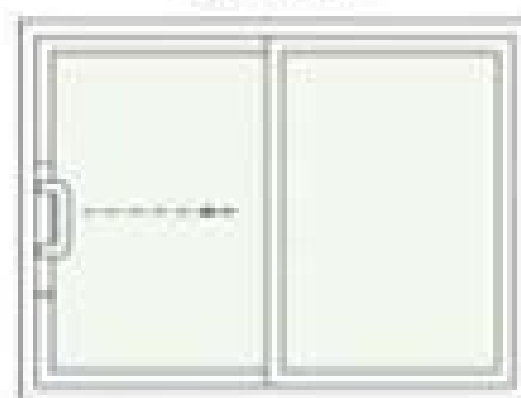
"OPEN-IN"
tilt & turn
right hand



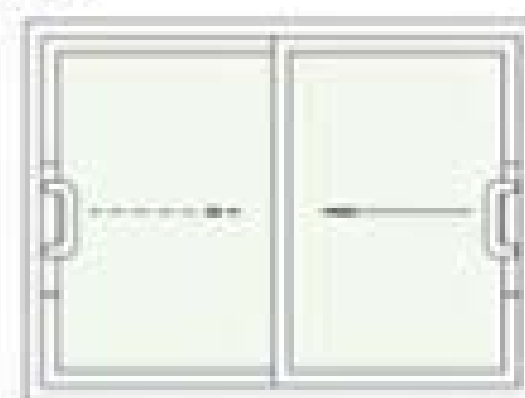
"OPEN-IN"
tilt & turn
left hand



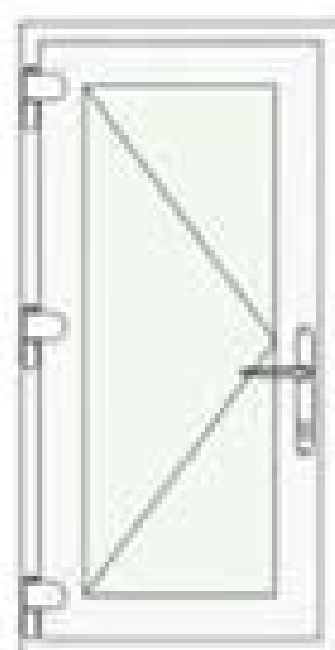
Single horizontal slider
(Patio door)
single sash right



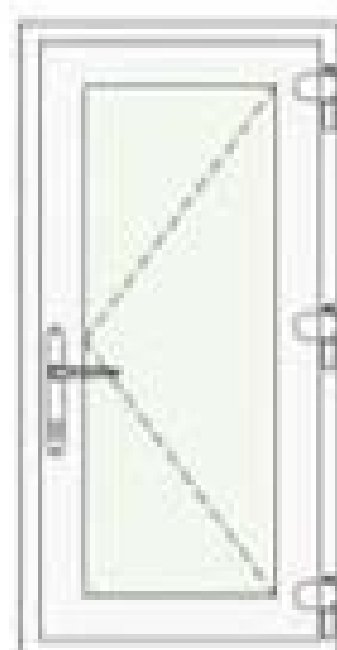
Single horizontal slider
(Patio door)
single sash left



Double horizontal slider
(Patio door)
right sash in front of left sash



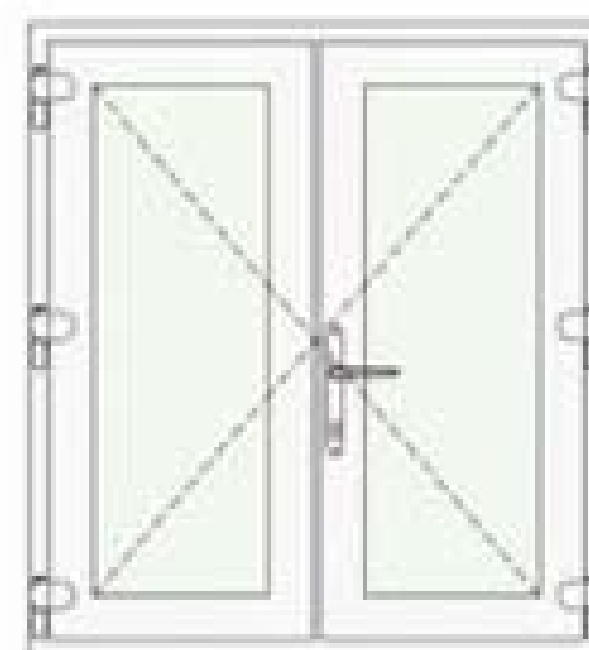
"OPEN-IN" single
side hung door
hinged on the left



"OPEN-OUT" single
side hung door
hinged on the right



"OPEN-IN"
Double leaf door
(French door)
active door leaf left



"OPEN-OUT"
Double leaf door
(French door)
active door leaf right

5.0 MATERIALS

5.1 uPVC extruded hollow profiles

White uPVC extruded hollow profiles used in windows and door sets shall conform to EN 12608.

Note: The current EN standard can cover Indian requirements for the time being. Nevertheless, there are two exceptions/ amendments allowing for India's different climatic conditions.

a) In order to reflect India's long term average of global horizontal radiation of 2000 kWh/m² annual sum, it is prudent to expose uPVC profiles to at least 7300 hours of artificial weathering testing in accordance with EN 513 severe climate.

b) Laboratory test temperature shall be raised from 23±5°C to 27±5°C.

Surface covered uPVC extruded hollow profiles used in windows and door sets shall conform to BS 7722

5.2 Glass

Glazing type and thickness shall be selected to withstand the design wind pressure calculated in accordance with IS 875-3. The type and quality of glass shall conform to: -

CED 13 (7883) WC	Draft Indian Standard Code of Practice for Use of Glass in Buildings Part 1: General Methodology for Selection
CED 13 (7884)WC	Draft Indian Standard Code of Practice for Use of Glass in Buildings Part 2: Energy and Light
CED 13 (7885) WC	Draft Indian Standard Code of Practice for Use of Glass in Buildings Part 3: Fire and Loading
CED 13 (7886) WC	Draft Indian Standard Code of Practice for Use of Glass in Buildings Part 4: Safety Related to Human Impact

5.3 Reinforcement

The use of reinforcement in uPVC windows and door sets shall conform to the recommendation of the systems supplier. The reinforcement should be non-hygroscopic and should have no adverse effect to the performance of the window or door set. When metal reinforcement is used it shall be manufactured from one of the following metals:

- a) Mild steel reinforcements for internal usage (inside the profiles) shall be hot dip zinc galvanized in accordance with IS 1079 or IS 513 with a min. coating mass of 120 g/m²
- b) Mild steel sections which are subsequently given a corrosion resistant coating in order to conform to the requirements in a). This type of reinforcement shall only be used in profiles or systems designed and sealed so that no exterior moisture can come into contact with the reinforcement.
- c) Mild steel reinforcements for external usage (frame couplings) shall be hot dip zinc galvanized in accordance with IS 277 with a minimum coating mass of 275 g/m².

Note: The cut ends shall be de-greased and dipped into corrosion resistant paint.

- d) Austenitic stainless steel or extruded Aluminum alloy can be used internally and externally and in any profile system

Note: The thickness of the reinforcements shall be as such that the windows and door sets meet the design wind pressure in accordance with IS 875-3. Design of the reinforcement should be as per the systems supplier's recommendations. In order to ensure adequate fastener retention, the minimum mild steel thickness should be at least 1.2mm!

5.4 Glazing Gasket, Weather-seal, Weather-stripping

Material for gaskets, weather-seals and weather-stripping shall be made of the following materials which shall comply with IS 3400 part 2; 4; 10; 20 and 23:

- Ethylene propylene diene monomer (EPDM) or
- Plasticized PVC (PVC-P) or
- Flexible PVC (F-PVC) or
- Polypropylene pile; or
- Cellular (foamed) elastomeric polymer; or
- Silicone (Si); or
- Thermoplastic elastomer (TPE).

5.4.1 Recommended material properties

Characteristic	Requirement	Method of test standard reference
IRHD (International rubber hardness degrees) Shore hardness A	As specified by gasket manufacturer or systems supplier	IS 3400 part 2 & 23
Compression set	max. 50%	IS 3400 part 10
Ozone resistance	No visible cracks	IS 3400 part 20
Accelerated ageing and heat resistance a) Hardness (mean change) b) Tensile strength (mean change) c) Elongation at break (mean change)	168 hours at 70°C max. 5% max. 25% max. 25%	IS 3400 part 4

5.5 Hardware

Materials for all hardware, except for fixings, shall have at least the equivalent corrosion resistance of EN 1670:1998, grade 4 (240 hours) when subjected to neutral salt spray testing in accordance with EN ISO 9227. Tests shall be carried out on complete hardware items as supplied.

There is no direct correlation between a given number of hours salt spray testing and real-time natural environment exposure. Higher levels of corrosion protection i.e. EN 1670 grade 5 (480 hours) or austenitic stainless steel hardware can be specified in order to meet the severity of coastal or non-coastal, heavily polluted industrial environments.

It is good practice to use critical hardware components like hinges, rollers and locking devices which have been life cycle tested in accordance with EN 1191 (Windows and doors - Resistance to repeated opening and closing - Test method) and have achieved at least 10,000 (ten thousand) operating cycles (i.e. opening and closing) without deterioration, failure or excessive wear.

5.6 Fasteners and Fixings

All straps, clips, brackets, metal fixing lugs, screws, nuts, bolts, rivets, metal washers, shims and other fixings shall be manufactured from one of the following: stainless steel conforming to EN ISO 3506-1:1998 or EN ISO 3506-2:1998; or steel which has been finished by zinc plating in accordance with EN 12329:2000, or hot dip zinc galvanized in accordance with EN ISO 1461 with a minimum coating mass of 460 g/m². For coastal installations, it is advisable to use fasteners and fixings that can meet EN 1670 grade 5 (480 hours) neutral salt spray testing!

6.0 APPEARANCE AND FINISH

The colour and/or appearance of profiles used in an assembled uPVC window or door set shall be uniform and consistent when viewed by normal or corrected vision at a range of 1 min45° north skylight, viewing perpendicular to the surface in accordance with ENISO105-A01:1996, Clause 14.

Note: Instrumental methods of colour measurement may be used. For each measurement on white profiles, the change in colour ΔE should be not greater than 1. The perception of colour on installed windows and door sets is affected by orientation, ambient light, length of time after installation and local environment.

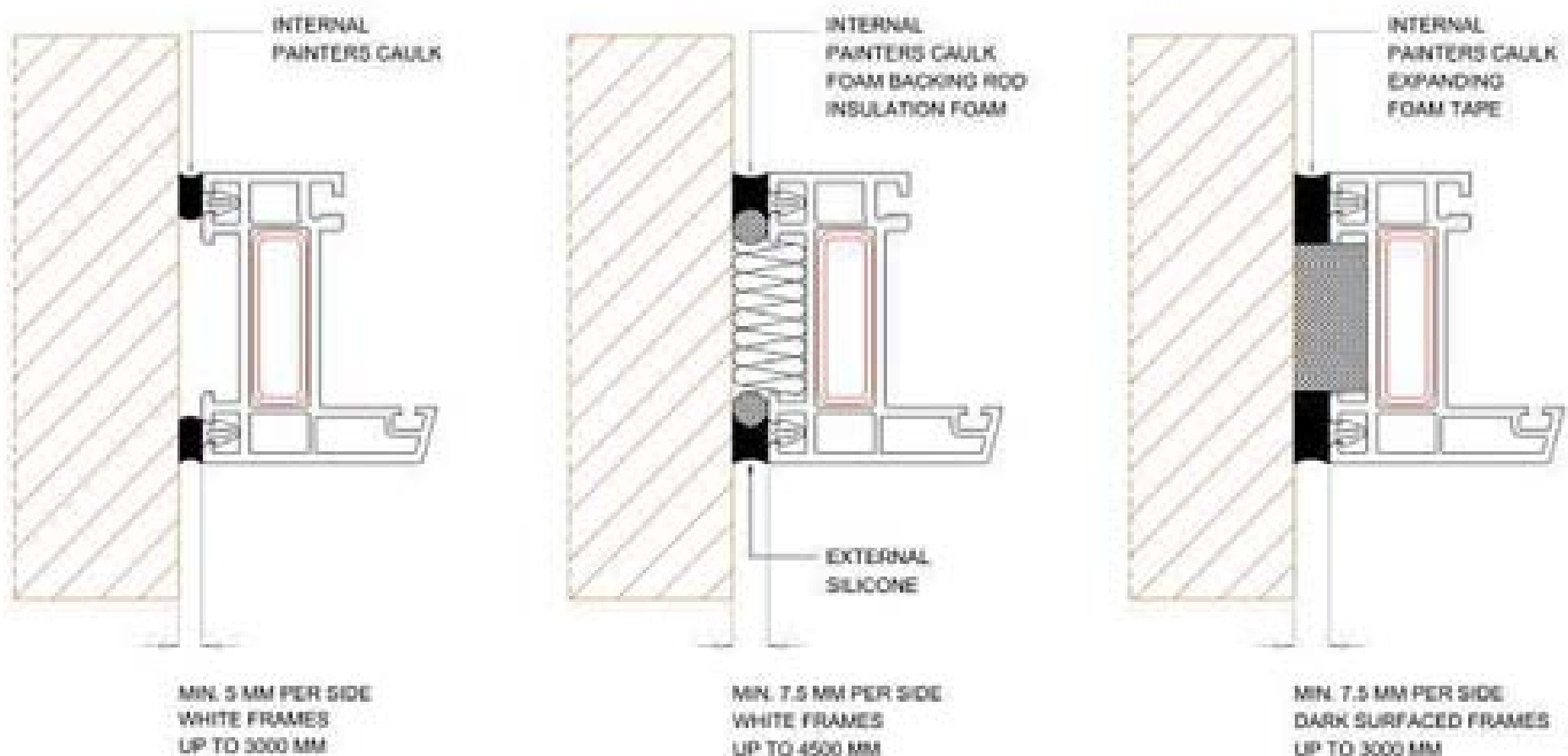
The finished uPVC windows and door sets shall be clean, free from burrs, dust and manufacturing debris.

7.0 FABRICATION

7.1 Manufacturing Sizes

The purpose of the perimeter sealant is to prevent water & air leakage due to differential thermal expansion between the aperture and the uPVC frame for the frame's guaranteed life. The optimum joint width required for effective sealant operation is a function of the frame movement that is expected in service.

Note: The joint width between uPVC frame and opening aperture shall not be less than 5 mm.



7.2 Manufacturing Tolerances

The overall height and width of an assembled uPVC window or door set shall be in accordance with BS 7412 and shall not differ from the work size by more than ± 3 mm when measured at 27 ± 5 °C, with a maximum difference of 3 mm at any point.

For assemblies with outer frames having three or more joints per frame member, the deviation shall be not more than 4 mm when similarly measured. Frame assemblies shall be such that they can be installed in a square opening with a maximum difference in the diagonals of 4 mm.

7.3 Reinforcing

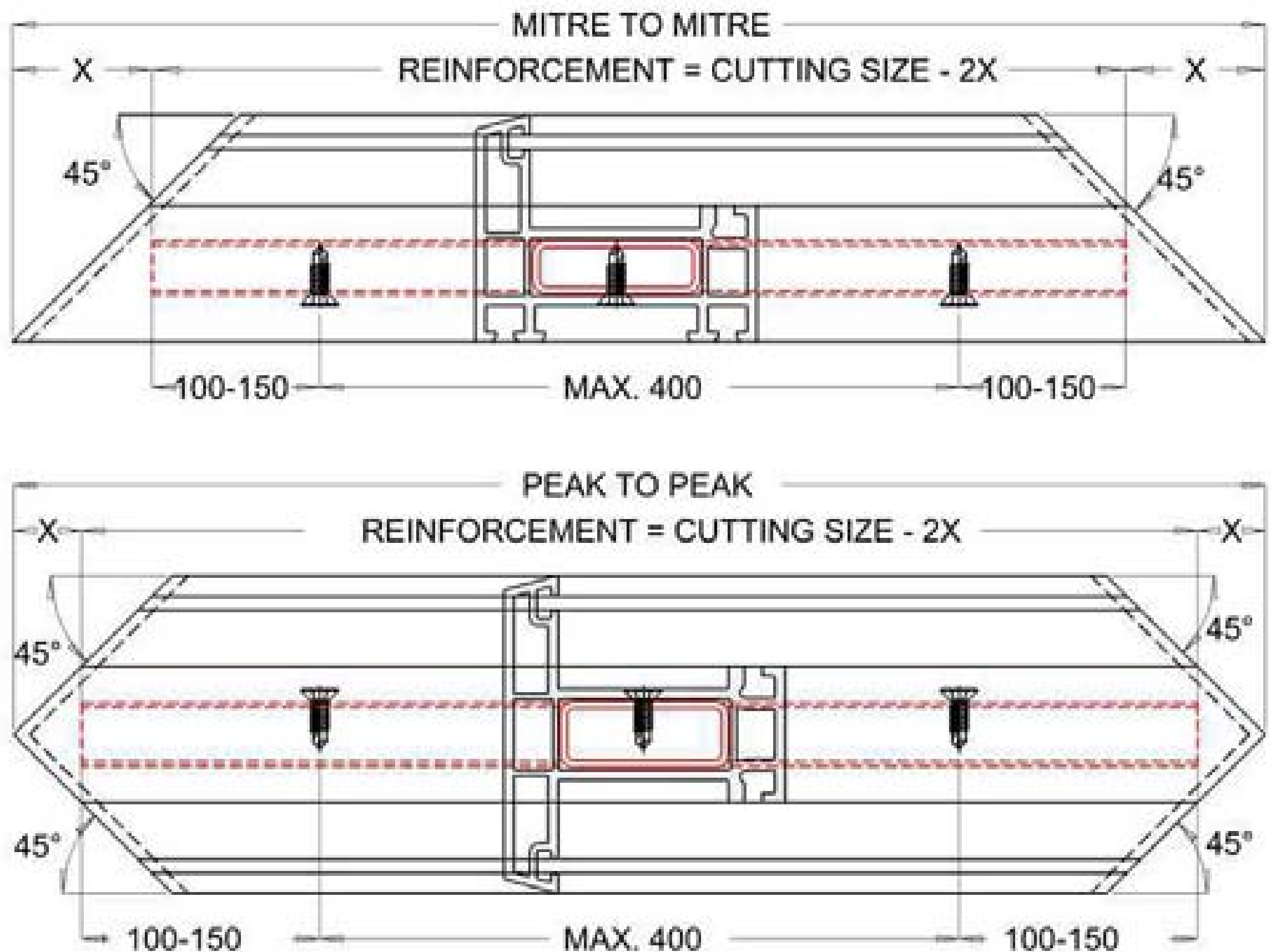
Purpose of reinforcement in uPVC profiles is to: -

- a) Resist human impact (accidental loading, i. e., safety barrier)
- b) Prevent excessive deflection due to wind load and glass weight
- c) Assist in maintaining frame straightness, transportation and installation
- d) Provide local support for hardware fastening and mechanically jointed mullions
- e) Enhance the frame security
- f) Control the deformation of the profile due to temperature changes/differentials

The reinforcements are specially designed to fill substantially the dedicated space provided within the uPVC profile, after allowance for extrusion tolerances.

Reinforcements are designed to achieve the maximum frame member rigidity. Therefore, the reinforcements shall be secured to the uPVC profile at prescribed distances and intervals; for example: maximum distance of 100mm from either end of the reinforcement and at subsequent maximum intervals of 400mm thereafter.

7.3.1 Effective Reinforcement Length



Note: Dimension X defined by systems supplier!

The type, size and reinforcement thickness used in transom mullions, sashes, coupled outer frames etc. may require a quick assessment by the fabricator prior to establishing the quotation and the material bill of quantities. Refer to Annex B – Reinforcement assessment

7.4 Drainage

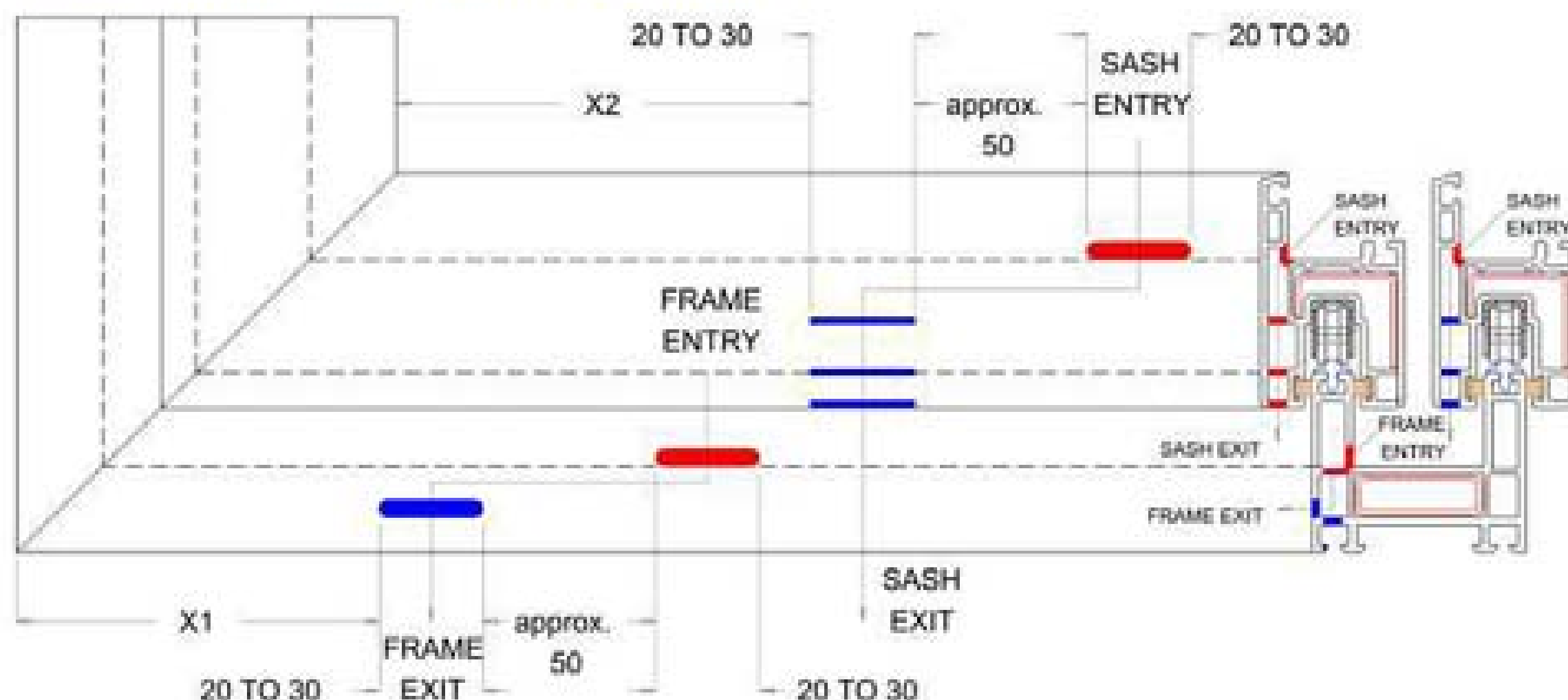
The reason for the frame drainage system is to avoid water ingress to the room inside and to prevent damage to the edge sealant of the double glazed sealed units. The number of drain slots (minimum size 5 x 20 mm) and their position within the frame depends on the frame style and the frame size as outlined in the systems supplier's guidelines. The function of the drainage system is based on equaling the atmospheric pressure at the entry and the exit of the provided drain slots to achieve rapid removal of water through the hollow profile chambers (open container principle). This is achieved by drilling min. 5-mm holes in the outer frame, sash or transoms, preferably in an unobtrusive position at the head of frame members.

The drain slot entry and exit position shall be staggered by approximately 50 mm to avoid any possible water blow back. The ability to withstand extreme weather conditions is very much dependent upon drainage system and workmanship.

Profile chamber ventilation is an essential requirement in the manufacture of surface coated or laminated, dark coloured uPVC frames.

The trapped air inside the hermetically sealed profile chambers will expand when heated-up; this can lead to permanent profile distortion in extreme conditions. It is therefore advisable to drill diameter 5-mm ventilation holes through vertical or horizontal frame members to allow the hot air to escape. This method shall apply to all mainframe chambers which are not part of the frame drainage system, including uPVC sub-sills and hollow uPVC frame extensions.

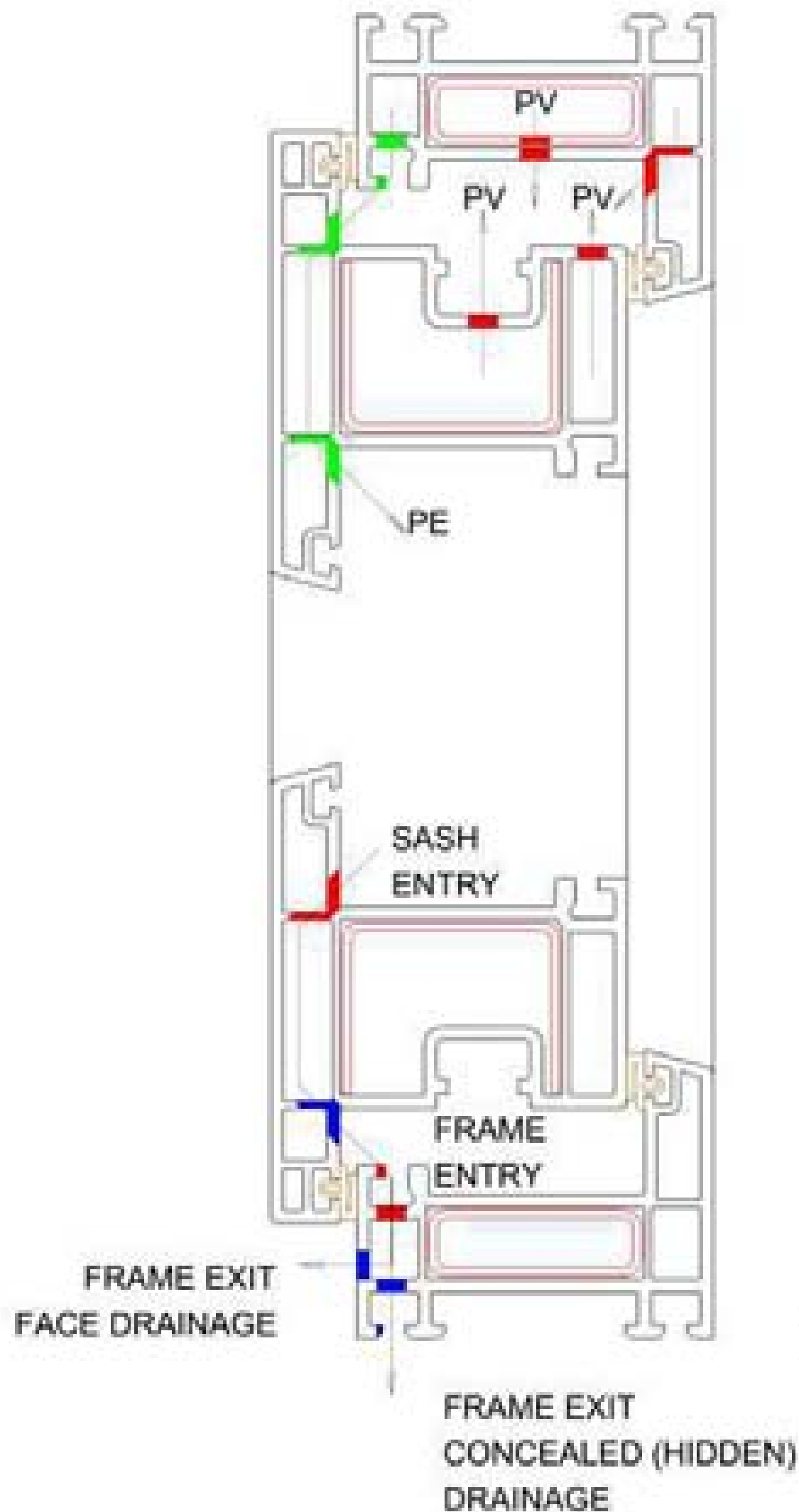
7.4.1 Recommended drain slot positions



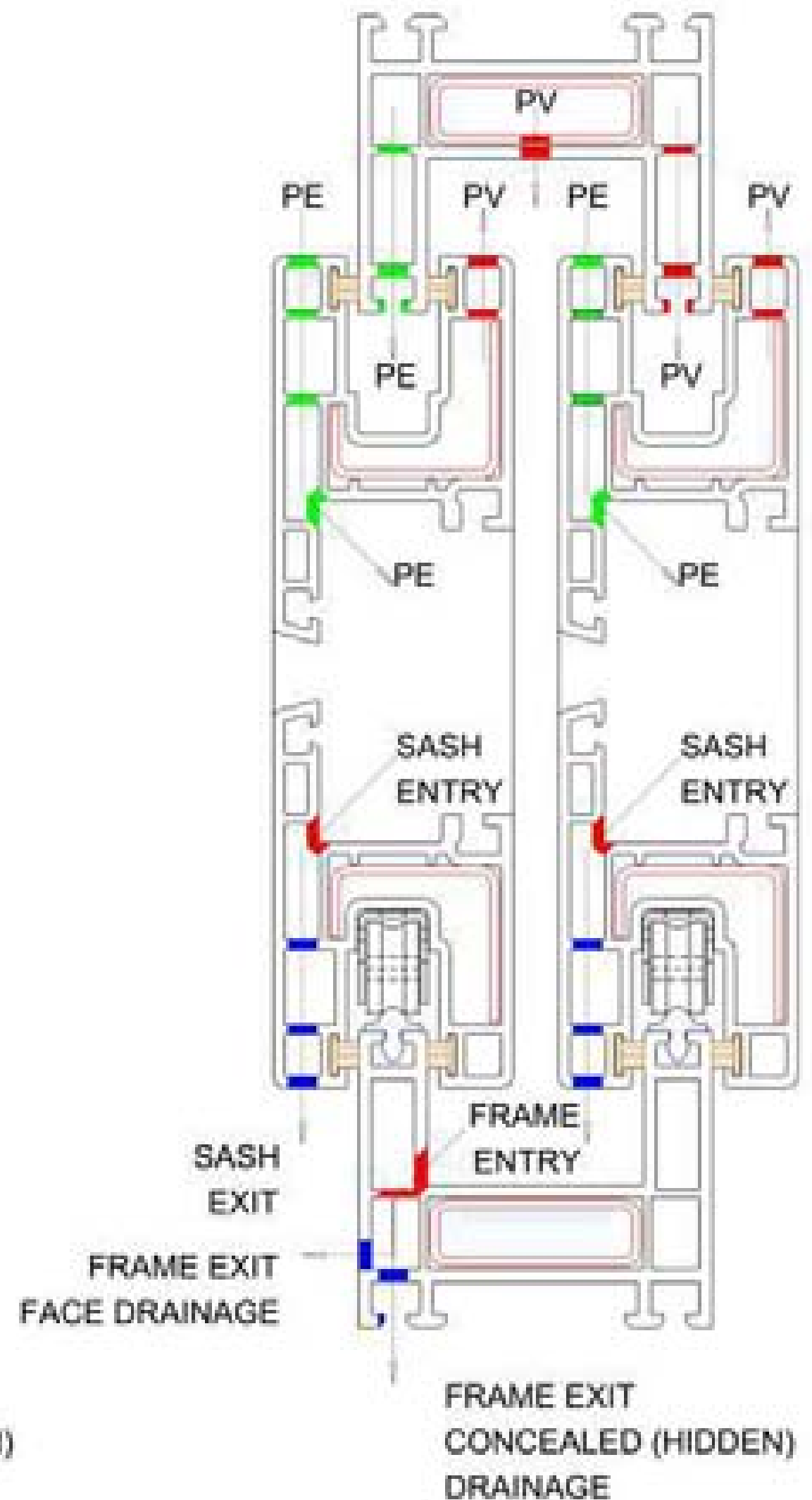
Note: Dimension X1 and x2 defined by the systems supplier!

7.4.2 Drainage, Pressure Equalisation and Ventilation

OPEN-OUT CASEMENT
DRAINAGE PATH
PRESSURE EQUALISATION (PE)
PROFILE VENTILATION (PV)



SLIDING WINDOW/DOOR
DRAINAGE PATH
PRESSURE EQUALISATION (PE)
PROFILE VENTILATION (PV)



7.5 Welding and Jointing

Joints in uPVC frames can be made by either fusion welding or by mechanical means (i.e. by profile end milling, sealing, locating and screw fixing).

Note: Although uPVC lends itself perfectly to fusion welding; corners can be also successfully mechanically jointed.

The determination of corner and T-joint weld strength shall be established in accordance with EN 514 by either utilizing the tensile bending test method (EN 514 Annex A.1) or the compression bending test method (EN 514 Annex A.2). In order to ensure consistent weld quality on daily basis, a very effective test method can be cost effectively implemented to obtain instant reassurance. Refer to Annex C – Weld test procedure

When mechanical joints are tested for Thermal stress (BS 7412 Annex E.3), torsion (BS 7412 Annex E.4) and bending due to wind load (BS 7412 Annex E.5), water shall not penetrate through the joint into the reinforcing chambers or into any undrained chambers or to the inside of the building.

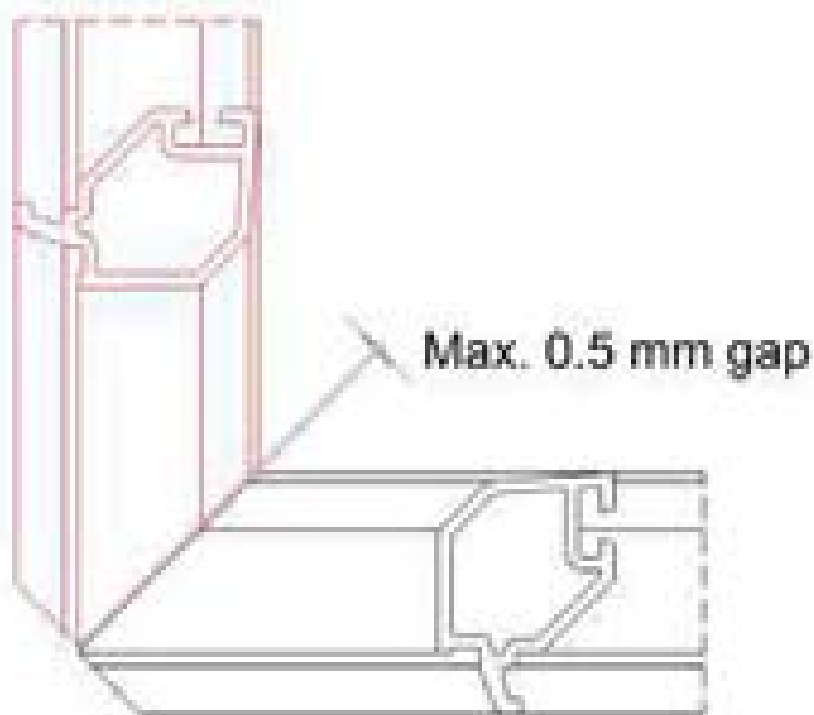
When tested in accordance with BS 7412 Annex E.5, under the static load the maximum misalignment measured at the extreme ends of the profile under load shall not exceed 2 mm from the neutral position (average of the two measurements).

When mechanical joints are tested in accordance with BS 7412 Annex E.6, water tightness shall be retained and any movement or torsion effect on the mullion/transom shall not affect the performance of the window or door set.

7.6 Glazing Beads

Glazing beads shall be placed internally, wherever possible, in order to ensure safe declaring and to provide enhanced frame security. External beading, mostly found in multi-light casements comprising open-out sash (es) and fixed light (s) can be made secure by adhering the glass onto the frame rebate by using double side foam tapes.

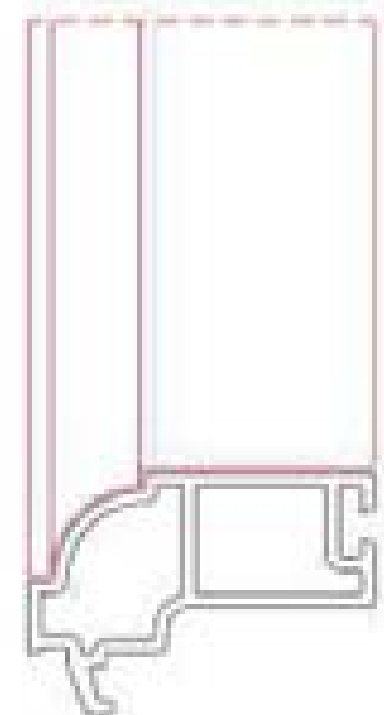
Glazing beads shall be 45 degree mitrecut, wherever possible, but other methods such as overlapping the glazing beads (for large sloping beads) or end milling of glazing beads (for large sculptured beads) are recognized manufacturing methods, helping to overcome fitting issues due to the inherent rigidity of the glazing bead. It is good practice to limit the gap between adjacent glazing beads to maximum 0.5 mm.



METHOD
45° MITRE CUT BEAD



METHOD
OVERLAPPING BEAD
STRAIGHT CUTS
HEAD & BASE
SLOPING CUTS
BOTH JAMBS



METHOD
END MILLED BEAD
STRAIGHT CUTS
HEAD AND BASE
END MILLED
BOTH JAMBS

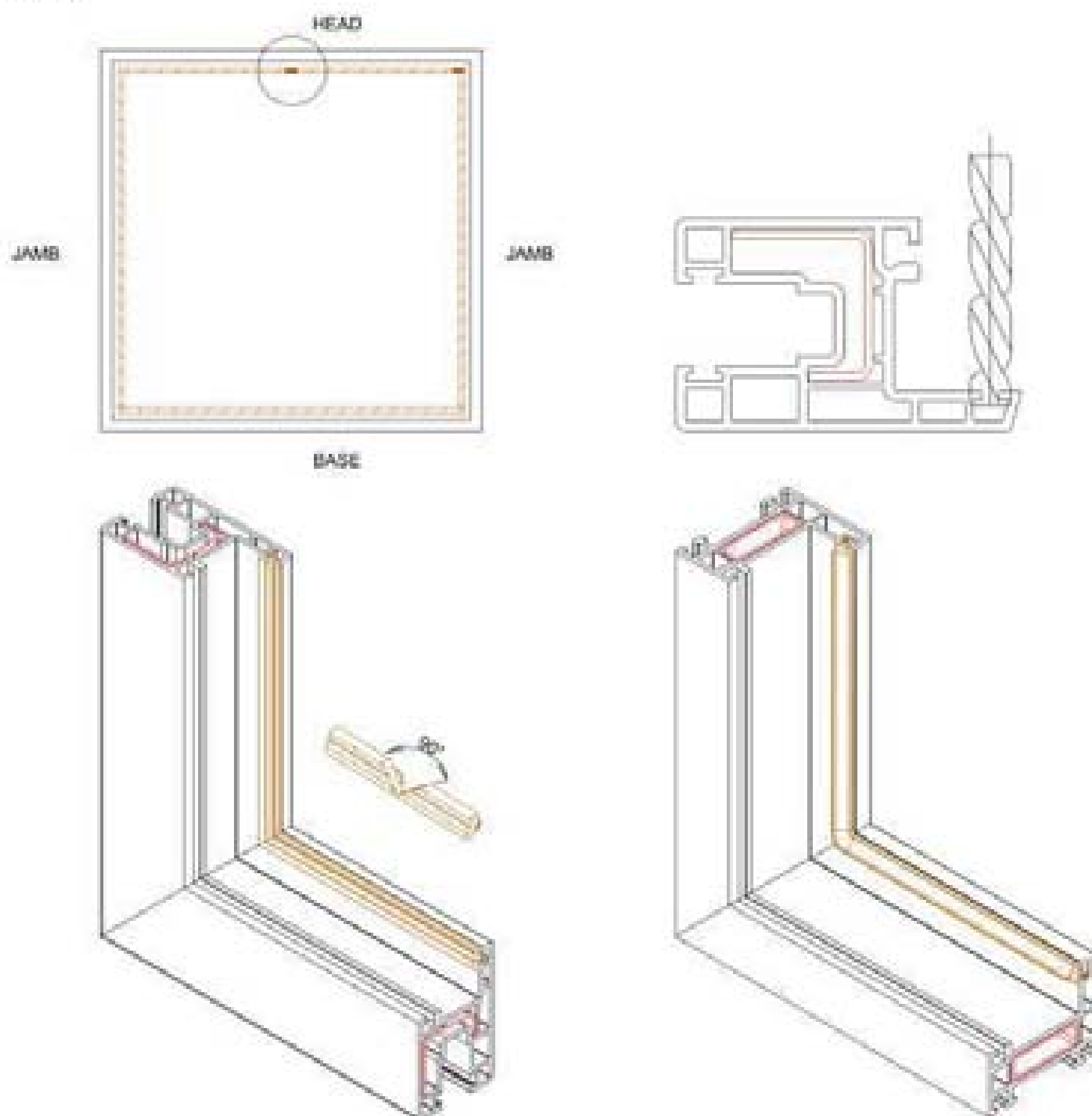
7.7 Glazing Gaskets

The soft glazing gasket forms a tight seal, when compressed between glass and glazing bead or glass and frame member but it is prone to shrinkage. The external glazing gasket, inserted into frame members, shall be mitrecut and glued in the corners (Fig.3) and butt jointed and glued at the head of the frame member (Fig.1).

Removing the excessive weld sprue in the corners and/or welded T-joints (Fig.2) will help with the all-round (one piece) gasket insertion and will also ensure the correct seating. The same sequence can be applied to internal (Fig.4) and/or external weather-seals.

Glazing gaskets shall be cut longer by approx. 10 mm (excess length depending on gasket hardness) when hand inserted in glazing beads to compensate for the potential gasket shrink-back.

Note: Glazing gaskets must be able to be replaced without removing the outer frame from the fabric of the building

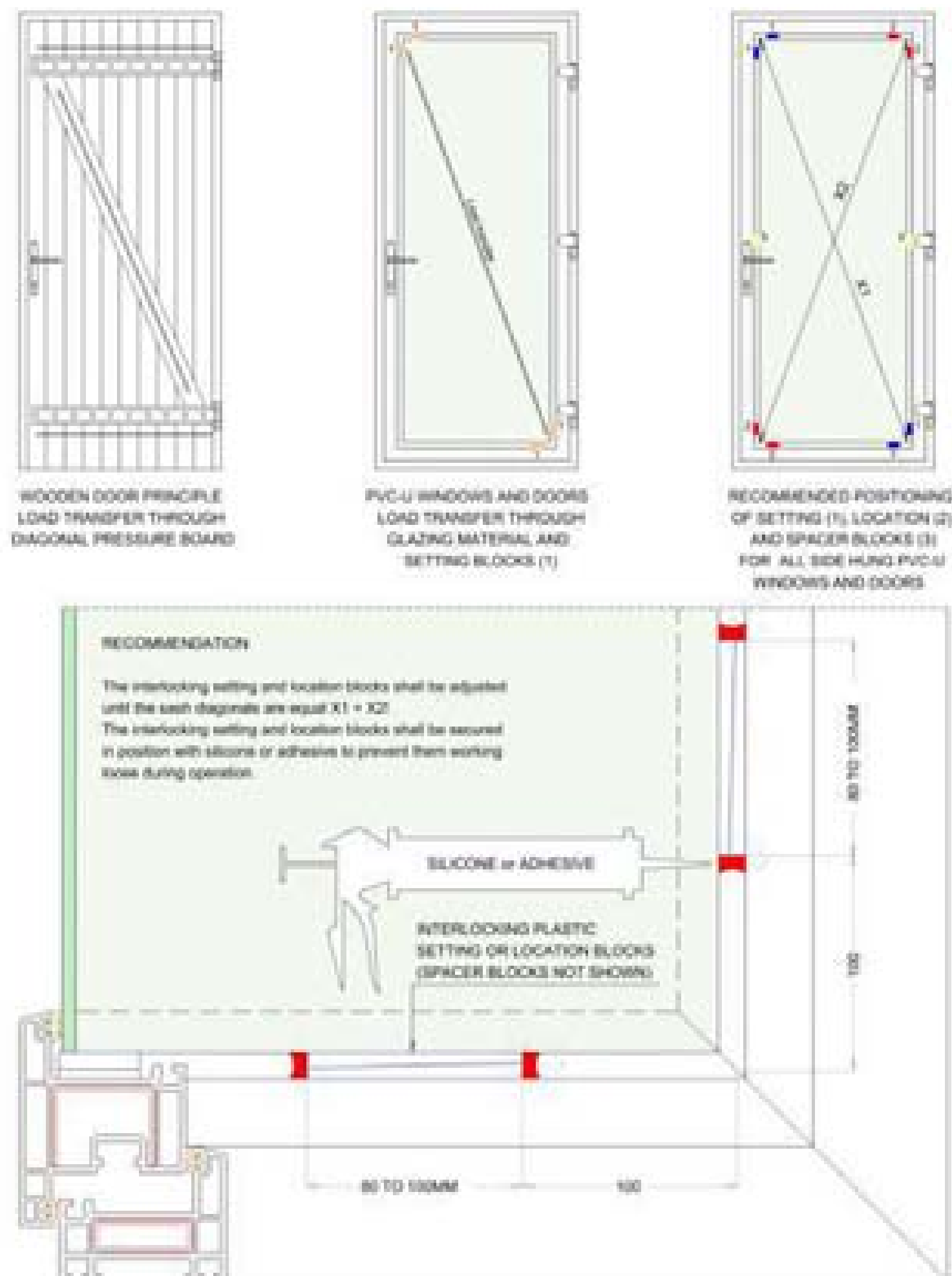


7.8 Glazing

Glazing plays an important part in the functioning of uPVC windows and door sets. All glazing, i.e. single, double or triple, shall be supported by dedicated, water resistant glazing blocks, aimed to spread the glass weight onto frame members. These setting and location blocks shall be placed without obstructing the drainage slots. It is advisable to use glazing blocks which are at least 2 mm wider than the actual glazing material.

Note: ALL glazing materials must be able to be replaced without removing the outer frame from the fabric of the building.

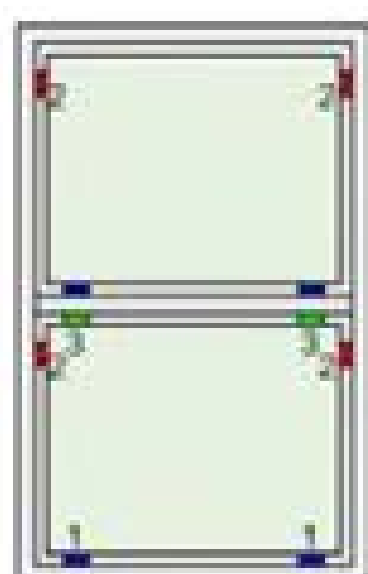
7.8.1 Principle of uPVC frame glazing



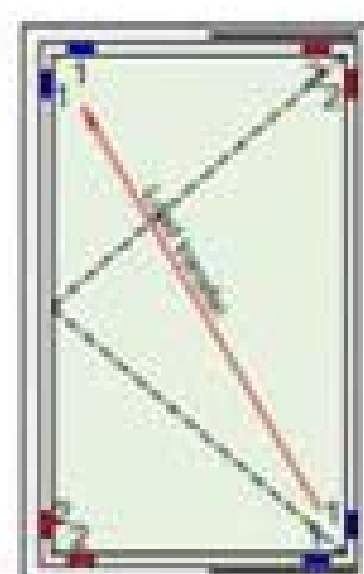
7.8.2 Recommended positions of setting and location blocks



FIXED



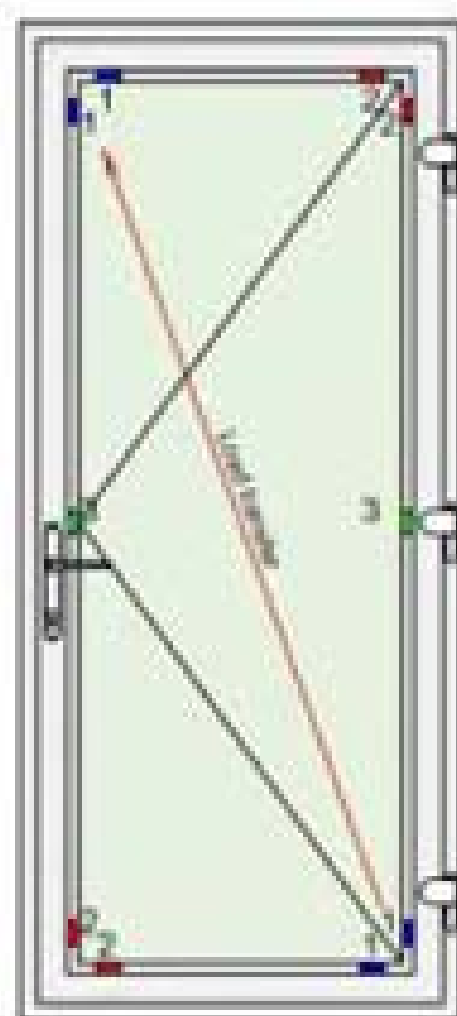
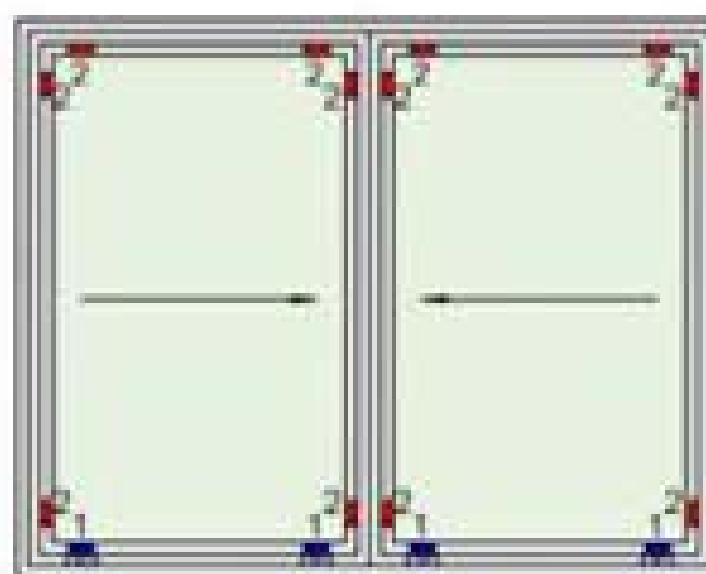
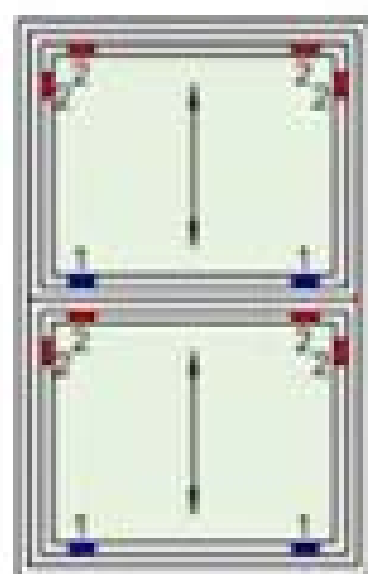
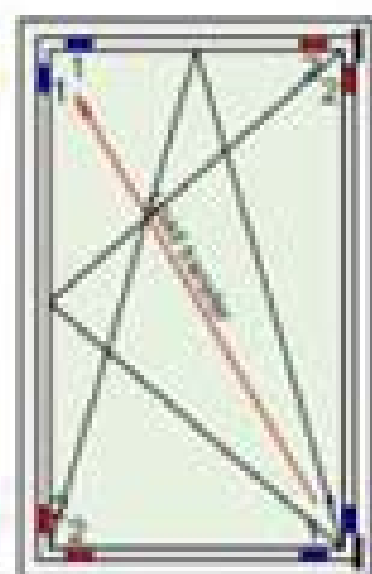
FIXED OVER FIXED



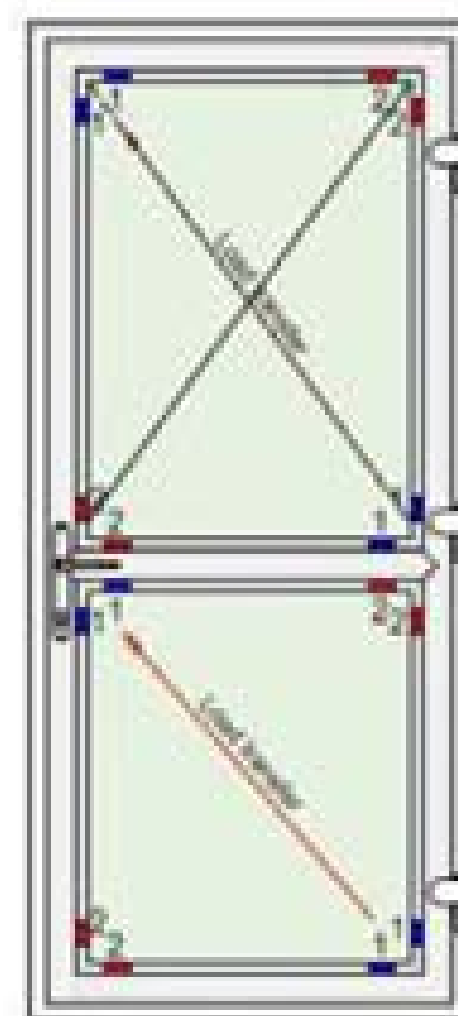
SIDE HUNG



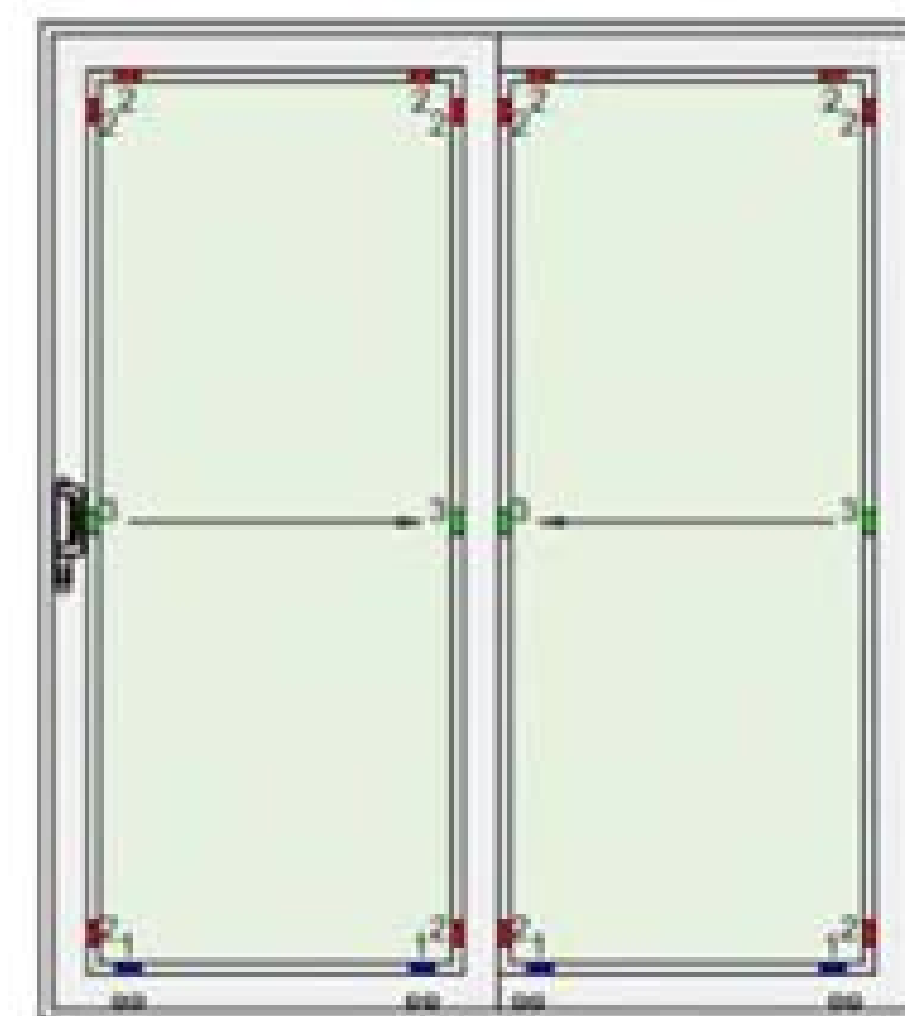
TOP HUNG



BALCONY DOOR



RESIDENTIAL DOOR



SLIDING/PATIO DOOR

1) SETTING BLOCK
FOR LOAD BEARING

2) LOCATION BLOCK
FOR KEEPING DISTANCE

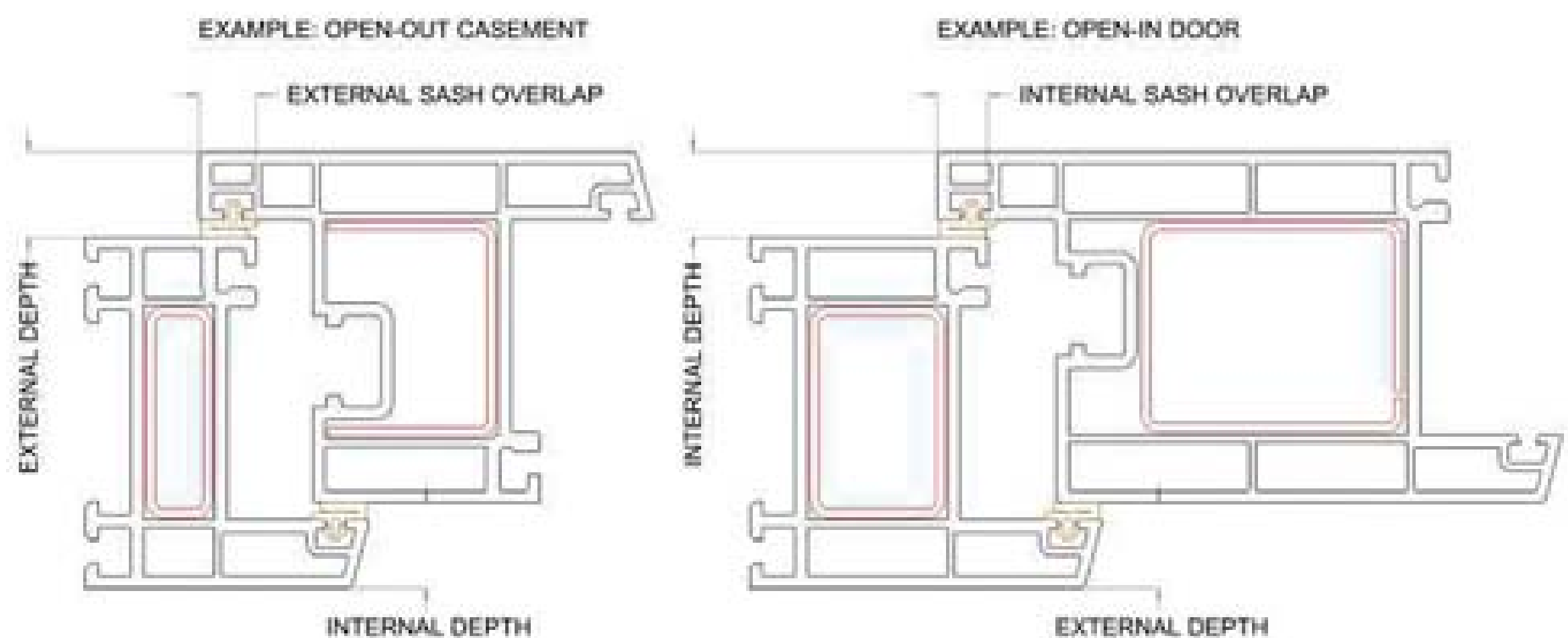
3) SPACER BLOCK
FOR OPERATION/SECURITY

7.9 Hardware

Every uPVC window and door system design is slightly different, therefore requiring systems specific hardware or profile related components like strikers and keeps. Consideration must be given to the system specific hardware requirements like roller width and roller height, friction stay stack height, espagnolette back set, mushroom height etc. Deviation from the systems supplier's hardware specification will affect the function and the performance of the frame.

The hardware supplier's guidelines and recommendations must be adhered to in terms of maximum weight carrying capacity, maximum frame sizes, suggested locking points, routine maintenance and lubrication etc.

Note: The 'correct set' overlap will ensure the functioning of the frame; it is therefore advisable to position the sash always from the lock side (critical dimension) thereby allowing the hinge side to take-up any tolerances (floating dimension).



For hinged casements, friction hinges and friction pivots shall feature built-in adjustable friction devices. Casement sashes exceeding 1200 mm in height shall utilise a pull-in wedge or pull-in claw in the center or feature alternatively 3 off butt hinges to improve weather tightness.

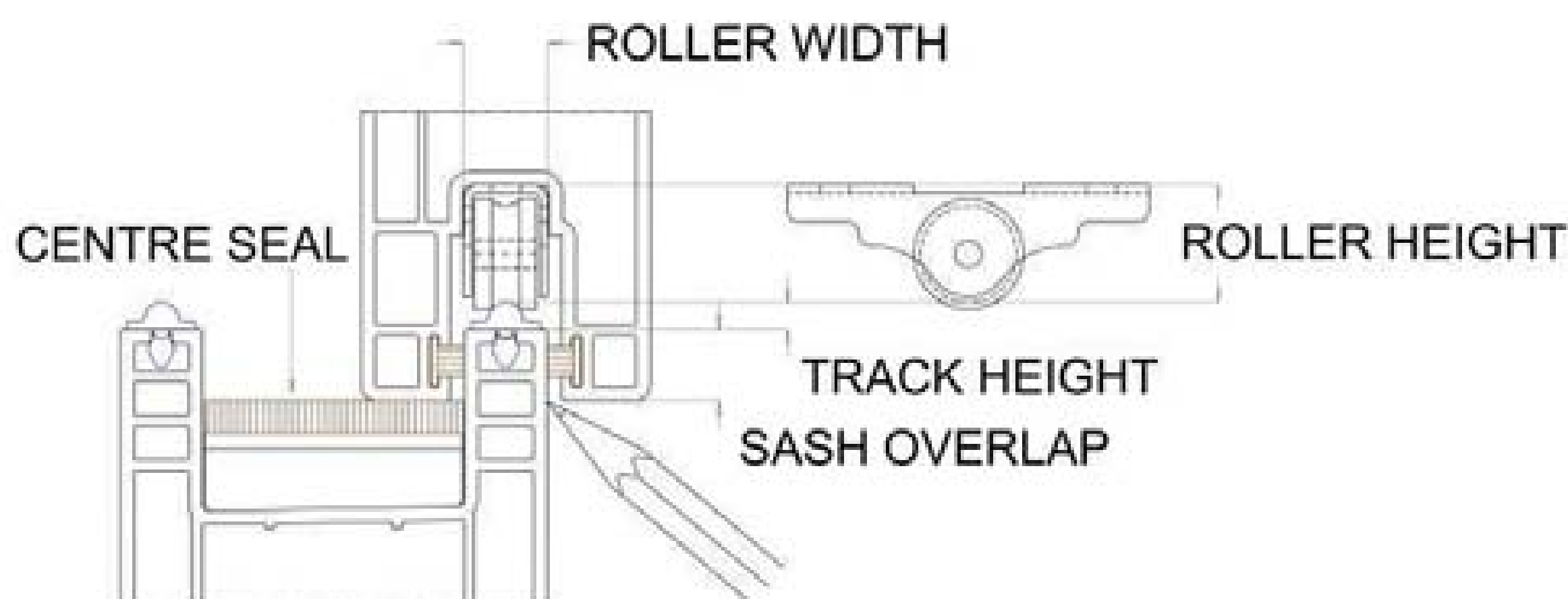
Note: For enhanced security, it may be necessary to fit pull-in claws next to friction hinges!

For hinged door sets; hinges shall have, wherever possible, 3-way adjustability. The use of more than three hinges is debatable in connection with uPVC door sets but uPVC door sets will definitely require a center locking device (or the third hinge between top and bottom) to prevent excessive deflection at the hinge jamb and to maintain air tightness. It is advisable to use locking devices with retractable hooks or bolts to improve security, to ease operations and to allow for thermal expansion and contraction due to temperature differentials.

UWDMA Guideline for Fabrication of uPVC Windows and Doorsets

For horizontal sliding windows, the sashes shall be supported on rolling or gliding devices that facilitate the movement between the sashes and outer frame. Experience has shown that the combination of nylon rollers running on Aluminum or austenitic stainless steel tracks provide currently the best and most durable long term option.

The correct relationship between track and roller height will automatically result in achieving the required sash overlap and will ensure that the centre seal will function as designed.



For vertical sliding windows the sashes shall utilise counter weight mechanisms or mechanisms utilising coil or spiral springs to carry the sash weight and hold the sash safely in any opening position.

Consideration shall be given to the ergonomics and the operational forces as recommended in EN 13115 and EN 12217. Handles play an important role in the daily operation of windows and door sets, requiring a balanced approach between aesthetics, function and ergonomics.

Note: Hardware must be able to be replaced without removing the outer frame from the fabric of the building.

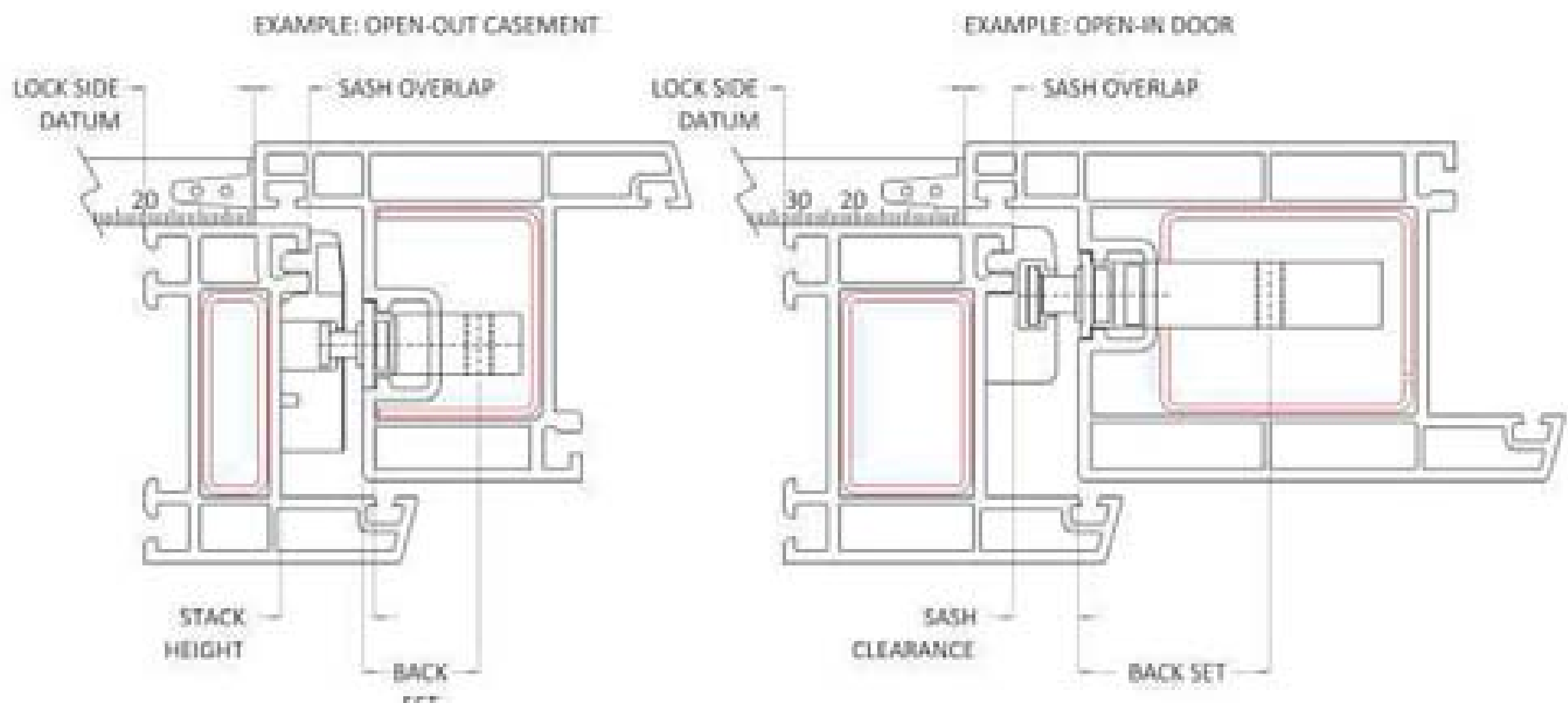
7.10 Weather-seals, Weather-stripping

Weather-seals shall be inserted in a continuous loop, butt jointed and glued at the head of the outer frame or sash to eliminate any sealing gaps and to overcome the gasket shrinkage. It is therefore advisable to remove the weld sprue Locally. Refer to 7.7.

Weather-stripping, mostly used in sliders, shall make contact with the frame members at all times in order to achieve the expected frame performance (air permeability, sound, dust, insects etc.). Special attention is required to maintain the continuous sealing effect, especially around corners, when weather-stripping has been inserted prior welding.

Recommended Weather-Seal and Hardware check

For compression weather-seals, it is good practice to check the internal or external rebate depth and the sash overlap all-round (closed sash). Both are conclusive indicators that the frame has been manufactured correctly and the specified components have been fitted. It is advisable to introduce this check as part of the in-process and/or final inspection procedure to ensure that every frame can meet the expected performance criteria.



Note: Weather-seals and weather-stripping must be able to be replaced without removing the outer frame from the fabric of the building.

8.0 PERFORMANCE REQUIREMENTS

It is expected that uPVC frames can repeat their established weathering performance year in year out, assuming that the originally tested components are still being used and the manufacturing methods have not changed. Changing components and/or manufacturing methods, for whatever reason, shall lead subsequently to re-testing in order to re-claim frame performance.

Note: The performance classes should be chosen on merits and actual requirements to avoid costly frame over-specification. For example: It is justified for rooms with AC's (air condition units) to specify air permeability class 4 (600 Pa) to combat energy losses through the frames. But it is also acceptable that a sliding door set, fitted in a sheltered balcony position on the 26th floor, requires only water tightness class 2B (50 Pa). In addition, the classification for wind resistance shall reflect the locality of the installation which may result, for example, in different frame and glass specifications depending on the height of the building.

8.1 Air Permeability classes

When tested in accordance with EN 1026; test method for air permeability
EN12207 Classification for air permeability

Class	Reference air permeability at 100 Pa overall area	Reference air permeability at 100 Pa joint length	Maximum test pressure Pa
0	not tested	not tested	not tested
1	50	12.5	150
2	27	6.75	300
3	9	2.25	600
4	3	0.75	600

8.2 Water Tightness Classes

When tested in accordance with EN 1027; test method for water tightness
EN12208 Classification for water tightness

Max. test pressure Pa	0	50	100	150	200	250	300	450	600
Test method A	1A	2A	3A	4A	4A	6A	7A	8A	9A
Test method B	1B	2B	3B	3B	5B	6B	7B	na	na
Specification min	15	20	25	30	35	40	45	50	55

Test method A - fully exposed, test method B - partially shielded

8.3 Wind Resistance classes

When tested in accordance with EN 12211; test method for resistance to wind load. Wind load Class 6 and 7 shall be added to reflect some of the Indian high-rise installations of uPVC fenestration.

EN12210 Classification wind resistance - class 6, 7 and 8 added for India

Wind load class	Test pressure P1	Test pressure P2	Test pressure P3
0	not tested	not tested	not tested
1	400	200	600
2	800	400	1200
3	1200	600	1800
4	1600	800	2400
5	2000	1000	3000
6	2400	1200	3600
7	2800	1400	4200
8	above 2800	tba	tba

Notes:

Test pressure P1 applied to measure the deflection of part of the test frame

Test pressure P2 pulsating pressure applied for 50 cycles to assess performance under repeated wind load

Test pressure P3 applied to assess the safety of the test frame under extreme conditions

tba to be agreed with architect and/or client

All test pressures are applied positively and negatively.

The test pressure relationships are $P2 = P1 \times 0.5$ and $P3 = P1 \times 1.5$

After applying test pressure P1 and P2 the uPVC frame is expected to remain undamaged.

After applying test P3 the uPVC frame can exhibit some damage but must remain safe.

8.3.1 Relative Frontal Deflection

It is the responsibility of the frame manufacturer to ensure that the frame has sufficient rigidity to stay within the permissible relative frontal deflection limits. Failing to provide the required frame rigidity will result in loss of frame performance, unnecessary strain onto frame joints and invalidation of product guarantees of glass and hardware.

EN12210 Classification relative frontal deflection - Class 6, 7 and 8 added for India

Wind load class	A <1/150	B <1/200	C <1/300
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3
4	A4	B4	C4
5	A5	B5	C5
6	A6	B6	C6
7	A7	B7	C7
8	A8	B8	C8

Notes:

A max. deflection <1/150 or max. 15 mm for single glazing

B max. deflection <1/200 or max.15 mm for double glazing and for unsupported span length up to 3.0 meters

C max. deflection <1/300 or max. 8 mm for special and/or triple glazing and for unsupported span length over 3.0 meters

Deflection 1/300 is also known as L/300 whereas L is representing the unsupported span length

8.4 Identification of frame weathering performance

Example: Weathering performance: 4 – B2 – A5

4 - air permeability 600 Pa

B2 - water tightness 50 Pa

A5 - wind load class 2000 Pa; deflection 1/150 (max. 15 mm)

8.5 Operation and Strength

Consideration shall be given to the required operating strength of windows and door sets. uPVC fenestration can be designed with ergonomics and ease of operation in mind.

Window operating forces Class 1 - EN 13115: 2001	Maximum Force	Maximum Torque
Movement of casement or sliding sash	100 N	na
Hardware lever operated	100 N	10 Nm
Hardware finger operated	50 N	5 Nm
Door operating forces Class 1 - EN 12217: 2003	Maximum Force	Maximum Torque
Movement of casement or sliding sash	75 N	na
Hardware lever operated	100 N	10 Nm
Hardware finger operated	20 N	5 Nm

8.6 Basic performance characteristics for uPVC windows and door sets

The outlined UWDMA recommendations/good practices combined with a traceable quality system will ensure that every fabricated uPVC window and door set **CAN MEET THE MINIMUM REQUIREMENT** as listed below.

Performance characteristics	Minimum requirement	Reference standard
Resistance to wind load	Class A2 (800 Pa - L/150)	EN 12210
Resistance to accidental load	1.0 kN/m (deflection max.15 mm)	EN 1991 Part 1-1
Water tightness	Class 3A (150 Pa)	EN 12208
Air permeability	Class 2 (300 Pa)	EN 12207
Heat transfer coefficient (U-value)	Indicative values -annex D	ISO 10077-1
Sound insulation (dB rating)	Indicative values - annex E	EN 12758, ISO 10140-3
Resistance to impact (glass doors)	Class 1 (200 mm drop height)	EN 13049
Hardware durability	Class 2 (10.000 cycles)	EN 12400
Operating forces	Maximum 100 N or 10 Nm	EN 13115, EN12217
Sash stability for sliders	safety >1.0 - annex F	Good practice

9.0 DURABILITY

9.1 General

The durability of uPVC windows and door sets is affected by the following factors:

- The specification of the uPVC frame material i.e. the suitability and robustness of the actual uPVC formulation to allow for the climatic variations
- The ambient atmosphere, i.e. rural, coastal, industrial etc.
- The conditions of use/abuse i.e. frequency of operation
- The specification of the components used in the manufacture
- The correctness and quality of the frame installation
- The frequent maintenance and replacement of components

Because of these variables, actual performance can vary under actual service conditions and any figures given for service life can only be general estimates. Any indications given bear no relationship to warranties given by the manufacturer.

Note: A window or door set is considered to have failed in service when it is no longer possible to repair or replace components in situation i.e. glass, gaskets, hardware and sealants or the physical frame integrity has been lost.

9.2 uPVC Profiles

PVC-U profiles when manufactured in accordance with EN 12608 on lyre quire an occasional wipe down for appearance purposes. A gradual loss of gloss might occur over time which has no effect on the function all performance of the window or door set. As uPVC profiles have been success fully used, world-wide, for windows and door sets for over 60 years, it is therefore prudent to assume that uPVC windows and door sets manufactured in accordance with the UWDMA guideline for fabrication and the systems supplier's guidelines are expected to last 'in excess of 40 years.'

9.3 Single and Double Glazing

Single glazing or double glazing manufactured in accordance with EN1279 can last 'from 15 years (double glazing) to 25 years (single glazing)' if they are correctly glazed into the frame. Glazing units shall be replaced without removing the outer frame from the fabric of the building.

9.4 Glazing Gaskets and Weather-seals

Glazing gaskets and weather-seals manufactured in accordance with IS 3400 and when correctly applied, will ensure the weather tightness of the window or door set. Over time, the performance of glazing gaskets and weather-seals generally declines. It is a fair assumption that glazing gasket and weather-seals require replacing 'after 15 years.' They can be replaced without removing the outer frame from the fabric of the building.

9.5 Hardware and Corrosion Resistance

Hardware components, when tested and certified to at least 10,000 (ten thousand) operating cycles, are providing a good indication of the expected service life in urban conditions. Allowing 2 opening and closing cycles per day will equate to 'over 10 years of service life.' The inevitable and known hardware replacement issue needs to be considered in the initial assessment when selecting or specifying hardware components. The hardware supplier's guidelines/recommendation must be adhered to in terms of maximum weight carrying capacity; maximum frame sizes, suggested locking points, routine maintenance and lubrication etc.

Materials for all hardware, except for fixings, shall have at least the equivalent corrosion resistance of EN 1670:1998, grade 4 (240 hours) when subjected to neutral salt spray testing in accordance with EN ISO 9227. Tests shall be carried out on complete hardware items as supplied.

There is no direct correlation between a given number of hours salt spray testing and real-time natural environment exposure. Higher levels of corrosion protection i.e. EN 1670 grade 5 (480 hours) or austenitic stainless steel hardware can be specified in order to meet the severity of coastal or non-coastal, heavily polluted industrial environments.

9.6 Installation

Poor installation will affect the durability of windows and door sets which is the common cause of inadequate performance. The **ONLY** official Standard for frame installations, BS 8213-4, provides guidance for the survey and installation of windows and door sets in domestic dwellings. Although the standard was originally aimed for the replacement market, BS 8213-4 can be also used for commercial applications.

Note: The frame installation principles/methods are identical for all market segments, except the building details may vary. Special attention must be paid to the selection of the employed fixings and sealants because of their expected long service life.

9.7 Recycling

uPVC profiles from windows and door sets conforming to EN 12608 can be recycled at the end of their life cycle. The myth of uPVC frame recycling is actually down cycling is misleading, especially for a country like India which imports all the required additives from abroad. Selling the 'high-value' uPVC recycle into lower grade applications will be false economy and will defy uPVC's sustainability policy.

All glass from windows and door sets can be recycled.

Gaskets and weather-seals made from natural and synthetic vulcanized rubbers can be recycled into granules and fine powders for different applications in the rubber and/or other industries. The thermo plastic materials (TPE's) can be recycled, re-processed into new gaskets or into other applications such as sports and leisure equipment.

All metallic and injection moulded components of windows and door sets are recyclable.

Annex A

A.1: Reference standards

IS 277	Galvanised steel sheets (plain and corrugated) - specification
IS 513	Cold reduced low carbon steel sheet and strip
IS 875 (part 3)	Code of Practice for Design Loads; For Building and Structures - Part 3 Wind Loads
IS 1079	Hot rolled carbon steel sheet and strip – specification
IS 3400	[parts 2, 4, 10, 20, 23], Methods of test for vulcanised rubber
BS 6262	(all parts), Glazing for buildings
BS 6375	(all parts), Performance of windows and doors
BS 7412	Specification for windows and door sets made from unplasticized polyvinylchloride (PVC-U) extruded hollow profiles
BS 7722	Surface covered PVC-U profiles for windows and doors -Specification
BS 7950	Specification for enhanced security performance of windows for domestic applications
BS 8213-4	Windows, doors and roof lights. Code of practice for the survey and installation of windows and external door sets
EN 485-2	Aluminium and Aluminium alloys - Sheet, strip and plate- Part 2:Mechanical properties
EN 514	Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors -Determination of the strength of welded corners and T-joints
EN 1026	Windows and doors- Air permeability - Test method
EN 1027	Windows and doors- Water tightness- Test method
EN 1191	Windows and doors - Resistance to repeated opening and closing -Test method
EN 1279	(all parts), Glass in building- Insulating glass units
EN 1670	Building hardware- Corrosion resistance Requirements and test methods
EN 1991	Euro code 1: Action on structures - Part 1-1: General actions – Densities, self-weight, imposed loads for buildings
EN 12207	Classification air permeability
EN 12208	Classification water tightness
EN 12210	Classification wind resistance
EN 12211	Windows and doors -Resistance to wind load- Test method
EN 12217	Doors. Operating forces. Requirements and classification
EN 12329	Corrosion protection of metals. Electrode posited coatings of zinc with supplementary treatment on iron or steel
EN 12400	Windows and pedestrian doors. Mechanical durability. Requirements and classification
EN 12519	Windows and doors, Terminology
EN 12608	Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors. Classification, requirements and test methods
EN 12758	Glass in building. Glazing and airborne sound insulation. Product descriptions and determination of properties
EN 13049	Windows. Soft and heavy body impact. Test method, safety requirements and classification
EN 13115	Windows. Classification of mechanical properties. Racking, torsion and operating forces
EN 14351	Windows and pedestrian door sets -Product standard, performance characteristics - Part 1: Windows and external pedestrian door sets without resistance to fire and smoke leakage characteristics but including external fire performance for roof windows
EN ISO 105-A01	Textiles- Tests for colour fastness
EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods
EN ISO 4042	Fasteners -Electroplated coatings
EN ISO 3506	(all parts), Mechanical properties of corrosion-resistant stainless steel fasteners. Bolts, screws and studs
EN ISO 9227	Corrosion tests in artificial atmospheres. Salt spray tests
ISO 10140-3	Acoustics – Laboratory measurement of sound insulation – Part3: Measurement of impact sound insulation
ISO 10077-1	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 1: General

Annex B

B.1: Reinforcement assessment

uPVC fenestration is based on facts and the selection of the appropriate reinforcement type, reinforcement size and gauge thickness can be predetermined by calculations or by using default tables from this annex.

It is recommended to carry-out a quick check with every frame quotation to avoid over or under specification of the reinforcement and to ensure that unsupported frame members like transoms and mullions or profile combinations such as frame coupling joints or slider meeting rails are safe in situation i.e. to resist accidentals load(i.e. human impact) and to cope with local wind speeds.

B.2: Resistance to Accidental Load

It is absolutely essential that certain uPVC frame members are designed and specified to provide sufficient fall protection in order to cope with accidental loads.

It is prudent to specify 1.0 kN/m as per EN 1991 Part 1-1, table 6.12 as accidental load q_k for the EI_x rigidity assessment.

The EI_x rigidity value calculation for transoms mullions, slider meeting rails and/or frame coupling joints will determine the required reinforcement type and size.

Note: EI_x - rigidity value is determined by the product of its Modulus of Elasticity (E) and its Moment of inertia (I) about an axis perpendicular to the deflecting force (x).

The required EI_x rigidity value for accidental loads is established with the formula:

$$EI_{x, \text{required}} = \frac{5 \cdot q_k \cdot L^4}{384 \cdot f}$$

q_k	accidental load = 1.0 kN/m
L	span of mullion/meeting rail/coupling etc. in mm
f	maximum permissible deflection = 15 mm

Example: Patio door with meeting rail length $L = 2400$ mm

$$EI_{x, \text{required}} = \frac{5 \cdot 1 \cdot 3.32 \cdot 10^{11}}{384 \cdot 15} = 28.8 \cdot 10^3 \text{ N.mm}^2$$

The available EI_x values will be provided by the systems supplier and shall be compared against the EI_x requirement using the formula below: $EI_{x, \text{available}} = 52.5 \text{ N.mm}^2$

$$\text{Safety factor} = EI_{x, \text{available}} / EI_{x, \text{required}} > 1.0 = 52.5 / 28.8 = 1.8$$

Note: The EI_x requirement for accidental load and wind load may be sometimes identical but when the results differ, the 'HIGHER' $EI_{x, \text{required}}$ (accidental or wind load) should always be used in preference!

B.3: Default design wind pressures

Default design wind pressures are based on India's average wind speed of 44 meters/second taken from IS 875-3; equivalent to wind speeds, for example, Hyderabad, Kohima, Mumbai, Nagpur, Port Blair, Surat and Vadodara

Design wind pressure category 1 50 years' design life: All general buildings and structures Height of building Category 1: Exposed, open terrain no obstructions Topography factor 1.0: Slope of the ground near the site <3° Net pressure coefficient (Cpe - Cpi) = 1.25 (av. for unknown building shape) Design wind pressure in Pa	10 mtr	30 mtr	50 mtr	100 mtr
Design wind pressure category 2 50 years' design life: All general buildings and structures Height of building Category 2: Open terrain with well scattered obstructions Topography factor 1.0: Slope of the ground near the site <3° Net pressure coefficient (Cpe - Cpi) = 1.25 (av. for unknown building shape) Design wind pressure in Pa	10 mtr	30 mtr	50 mtr	100 mtr
Design wind pressure category 3 50 years' design life: All general buildings and structures Height of building Category 3: Terrain with numerous closely spaced obstructions Topography factor 1.0: Slope of the ground near the site <3° Net pressure coefficient (Cpe - Cpi) = 1.25 (av. for unknown building shape) Design wind pressure in Pa	10 mtr	30 mtr	50 mtr	100 mtr
Design wind pressure category 4 50 years' design life: All general buildings and structures Height of building Category 4: Terrain with numerous large high closely spaced obstructions Topography factor 1.0: Slope of the ground near the site <3° Net pressure coefficient (Cpe - Cpi) = 1.25 (av. for unknown building shape) Design wind pressure in Pa	10 mtr	30 mtr	50 mtr	100 mtr

B.4: Wind load areas – example open-out casement

Fig.1 – casement window – side hung next to fixed light

Fig.2 – wind load area a and b (red) acting on unsupported mullion

Fig.3 – wind load area (blue) transferred into outer frame and aperture

Fig.4 – window load area (green) acting on sash (primarily as negative pressure)

The area either side of a transom or mullion or coupling joint will be exposed to wind load, transferring half of the load onto the unsupported frame member (fig.2). The remaining wind load (fig.3) will be taken-up by the reinforced outer frame which shall be secured to the aperture at 600 to 700 mm fixing centres.

The sash, normally being pushed shut, will be exposed to negative wind pressure i.e. the sash is trying to pull away from the outer frame rebate/seal (fig.4). Larger sashes (in height or in width) will require more locking points all-round including hinge side, to reduce the unsupported distance between locking or hinge points.

Fig.1

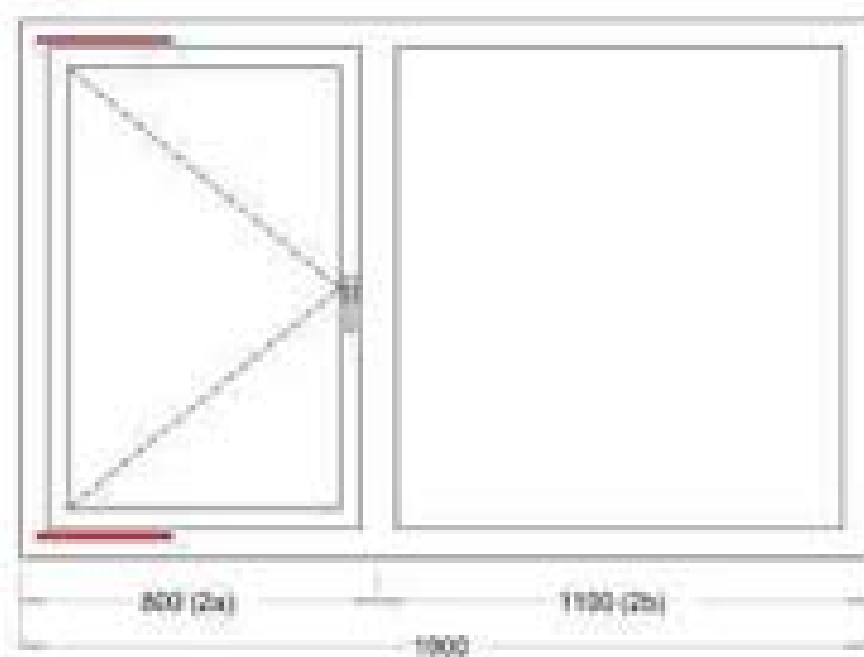


Fig.2

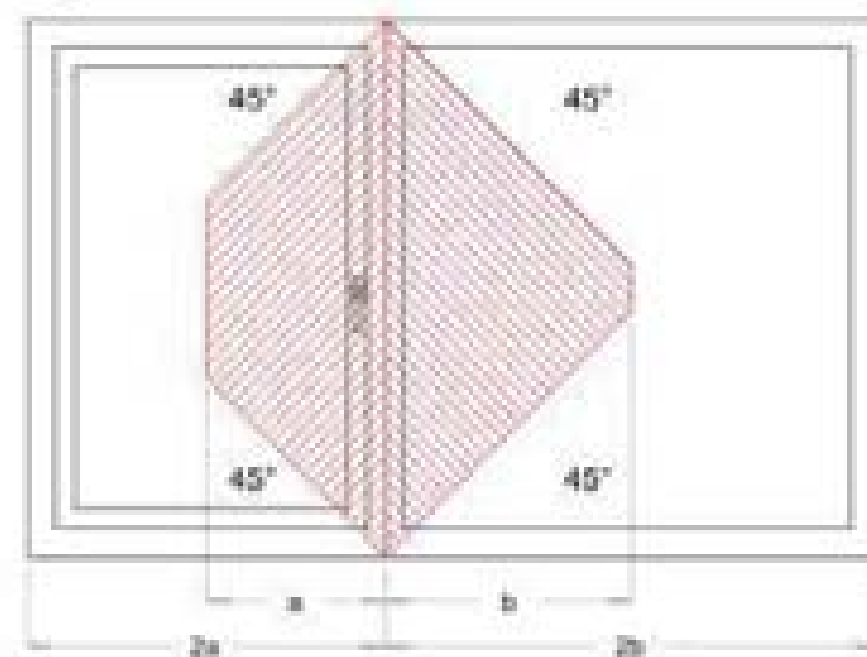


Fig.3

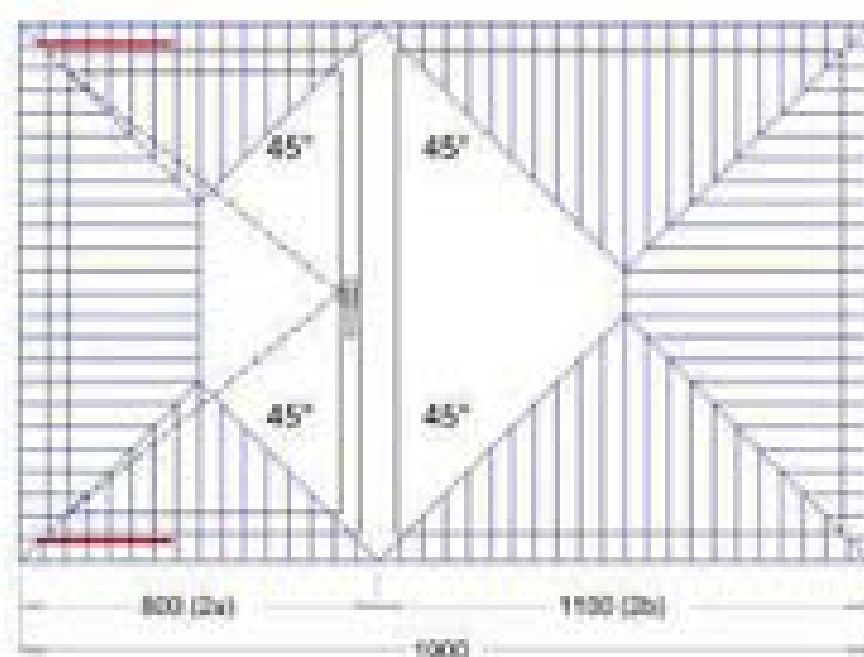
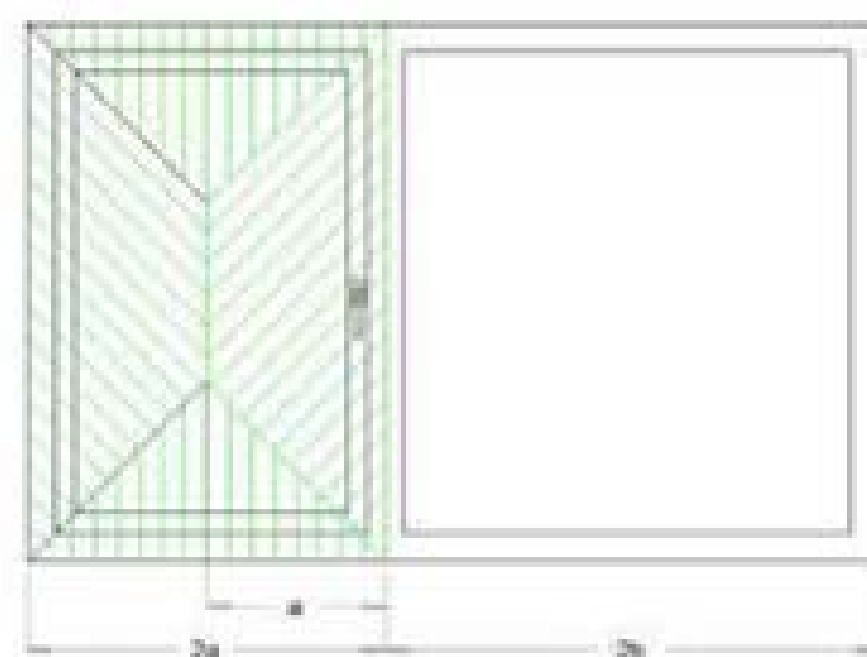


Fig.4



B.5: EI_x rigidity established by calculation

Example: Annex B4- open-out casement

The required rigidity EI_x is based on a trapezoidal load pattern assuming that the mullion acts as an unsupported beam. Formula for trapezoidal load: -

$$EI_x = \frac{W.a.l^3}{1.92 \times 10^3 f} \left(25 - 40 \left(\frac{a}{l} \right)^2 + 16 \left(\frac{a}{l} \right)^4 \right) \text{ where}$$

- W = design wind pressure in Pascal, Pa
- f = maximum deflection in millimetres, mm
- l = load span in millimetres, mm
- a = load width a in millimetres, mm
- b = load width b in millimetres, mm
- EI_x = required rigidity of the mullion, 10^9 N.mm^2

Note: EI_x (10^9 Nmm^2) rigidity is determined by the product of its Modulus of Elasticity and its Moment of inertia (I) about an axis perpendicular to the deflecting force (,).

Worked example:

- W = 2031 Pa (B3: design wind pressure, category 2, 50 metres)
- a = 400 mm $a/l = 0.3333$
- b = 550 mm $b/l = 0.4583$
- l = 1200 mm
- f = $l/175 = 6.85 \text{ mm}$

For the left hand side of the mullion (load width a):

$$EI_{\text{required}} = \frac{2031 \times 400 \times 1200^3}{1.92 \times 10^3 \times 6.85} (25 - 40 - 40 \times 0.3333^2 + 16 \times 0.3333^4) = 2.655 \times 10^9 \text{ N.mm}^2$$

For the right hand side of the mullion (load width b):

$$EI_{\text{required}} = \frac{2031 \times 550 \times 1200^3}{1.92 \times 10^3 \times 6.85} (25 - 40 - 40 \times 0.3333^2 + 16 \times 0.3333^4) = 3.044 \times 10^9 \text{ N.mm}^2$$

$$EI_{\text{required}} = -EI_{x,a} + EI_{x,b} (2.655 + 3.044) \times 10^9 \text{ N.mm}^2 = 5.70 \times 10^9 \text{ N.mm}^2$$

The selected mullion reinforcement rigidity $EI_{\text{available}}$ shall be > $5.7 \times 10^9 \text{ Nmm}^2$

Example: $EI_{\text{available}}$ for 2.0 mm mullion steel reinforcement = $7.9 \times 10^9 \text{ Nmm}^2$

Safety factor ($EI_{\text{available}}/EI_{\text{required}} > 1.0$) = $7.9 / 5.7 = 1.4$

NOTE: $EI_{\text{available}}$ rigidity values from systems supplier!

B.6: EI_r rigidity default table

EI_r rigidity values are based on 1000 Pa design wind pressure and $A < 1/150$ relative frontal deflection.
Yellow shaded area is based on 15 mm maximum deflection

Note: EI_r (10^3 Nmm^3) rigidity is determined by the product of its Modulus of Elasticity and its Moment of Inertia (I) about an axis perpendicular to the deflecting force (F).

		Load width a or b (mm)															
		300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
Load span L (mm)	900	0.4	0.4														
	1000	0.5	0.6	0.63													
	1100	0.7	0.8	0.91													
	1200	0.9	1.1	1.25	1.3												
	1300	1.2	1.5	1.67	1.8												
	1400	1.5	1.9	2.16	2.3	2.4											
	1500	1.9	2.3	2.74	3.0	3.1											
	1600	2.3	2.9	3.40	3.8	4.0	4.1										
	1700	2.7	3.5	4.2	4.7	5.0	5.2										
	1800	3.3	4.2	5.0	5.7	6.2	6.5	6.6									
	1900	3.9	5.0	6.0	6.8	7.5	7.9	8.1									
	2000	4.5	5.9	7.1	8.1	8.9	9.5	9.9	10.0								
	2100	5.3	6.8	8.2	9.5	10.5	11.3	11.8	12.1								
	2200	6.1	7.9	9.6	11.0	12.3	13.3	14.0	14.5	14.6							
	2300	7.1	9.3	11.2	13.0	14.6	15.9	16.8	17.5	17.8							
	2400	8.4	11.0	13.4	15.6	17.5	19.1	20.4	21.4	21.9	22.1						
	2500	9.9	13.0	15.9	18.5	20.9	22.9	24.5	25.8	26.6	27.1						
	2600	11.6	15.3	18.7	21.8	24.6	27.1	29.2	30.8	32.0	32.8	33.0					
	2700	13.6	17.8	21.8	25.5	28.9	31.9	34.5	36.6	38.2	39.2	39.8					
	2800	15.7	20.7	25.3	29.7	33.7	37.3	40.4	43.0	45.1	46.6	47.5	47.8				
	2900	18.1	23.8	29.3	34.4	39.1	43.3	47.1	50.3	52.9	54.9	56.2	56.9				
	3000	20.8	27.3	33.6	39.5	45.0	50.0	54.5	58.4	61.6	64.2	66.0	67.1	67.5			
	3100	23.7	31.2	38.4	45.3	51.6	57.5	62.7	67.4	71.3	74.5	77.0	78.6	79.4			
	3200	26.9	35.5	43.8	51.6	58.9	65.7	71.9	77.4	82.1	86.0	89.1	91.4	92.8	93.2		
	3300	30.5	40.2	49.6	58.5	67.0	74.8	82.0	88.4	94.0	98.8	102.7	105.6	107.6	108.6		
	3400	34.4	45.4	56.0	66.2	75.8	84.8	93.0	100.5	107.1	112.8	117.6	121.3	124.0	125.7	126.2	
	3500	38.6	51.0	63.0	74.5	85.4	95.7	105.2	113.8	121.5	128.3	134.0	138.7	142.2	144.6	145.7	
	3600	43.3	57.2	70.7	83.6	96.0	107.6	118.4	128.4	137.3	145.2	152.1	157.7	162.2	165.4	167.3	168.0

UWDMA Guideline for Fabrication of uPVC Windows and Doorsets

B.7: Deflection data

Reference standard	BS 6262 (IS draft)	EN 12210	BS 6262 (IS draft)	EN 12210	EN 12210
Dc deflection criteria	<1/125	<1/150	<1/175	<1/200	<1/300
Df deflection factor	0.83	1.00	1.17	1.33	2.0

B.8: EI_x rigidity Established by default table

Example: Annex B4 - open-out casement

Casement size: 1900 mm x 1200 mm (Load span L)	Load width a 400 mm	Load width b 550 mm (*)
$EI_{x, B4}$ figure taken from table B6	1.1	1.3
WP_{design} Design wind pressure, B3, category 2, 50 meters	2031	2031
EI_x adjusted for design wind pressure $EI_{x, wp} = (EI_{x, B4} \times (WP_{design}/WP_{1000}))$	2.2	2.6
Actual permissible deflection = L/Dc	6.86	6.86
Dc deflection criteria chosen from table B7	175	175
Df deflection factor taken from table B7	1.17	1.17
Permissible deflection > 15.0 mm	no adjustment	no adjustment
When permissible deflection < 15.0 mm $EI_{x, wp}$ adjusted for deflection; $EI_{x, df} = (EI_{x, wp} \times Df)$	2.6	3.1
$EI_{x, required}$ for load width a and load width b $10^9 \cdot Nmm^2$	2.6	3.1
$EI_{x, required}$ for combined load width (a + b) $10^9 \cdot Nmm^2$		5.7
$EI_{x, available}$ (i.e. mullion with 2.0 mm steel) $10^9 \cdot Nmm^2$		7.9
Safety factor ($EI_{x, available}/EI_{x, required} > 1.0$)		1.4

Note: (*) 600 mm figure was chosen from table B6!

The selected mullion reinforcement rigidity $EI_{x, available}$ shall be $> 5.7 \times 10^9 Nmm^2$
 Example: $EI_{x, available}$ for 2.0 mm mullion steel reinforcement $= 7.9 \times 10^9 Nmm^2$
 Safety factor ($EI_{x, available}/EI_{x, required} > 1.0$) $= 7.9 / 5.7 = 1.4$

Note: $EI_{x, available}$ rigidity values from systems supplier!

C.3: Calculation of required notch distance 'L'

	Moment of inertia I_y N/mm ⁴	Critical distance e mm	Moment of resistance $W = I_y/e$ N/mm ³	Failure load = weight F_t N	Minimum failure stress F_y N/mm ²	Required notch distance 'L' mm
Profile 1	76,118	76,118	2,445	245	20	200
Profile 2	155,836	155,836	4,193	245	20	342
Profile 3	274,482	274,482	6,383	245	20	521

Required notch distance 'L' based on ' $L = (\delta_t \cdot W) / F_t$ '

F_t Set failure load - 25 kg weight = 245 N

δ_t Set minimum failure stress – 20 MPa = 20 N/mm²

W Moment of resistance in the loading direction = I_y/e

I_y Moment of inertia about the neutral axis zz' (*)

e Distance between critical point (internal rebate) and neutral axis zz' (*)

(*) Figures obtained from systems supplier

Annex D

D.1: Heat transfer coefficient (U_w -value) for uPVC frames

Indicative U_w -values calculated in accordance with ISO 10077-1; can be used to provide data for energy rating, energy cost reduction and Carbon/ CO_2 savings.

Note: Table is based on 30% frame area (frame sight line (SL) approx. 110 mm) which is representative for uPVC windows. uPVC frames with specific sight lines (SL) i.e. different frame to glass percentages can be calculated individually – refer to D2.

Type of glazing	Glass U_g -value W/m^2K	Frame U_f -value W/m^2K frame area 30%						
		1.0	1.4	1.8	2.2	2.6	3.0	3.4
Single glazing	5.8	4.4	4.5	4.6	4.7	4.8	5.0	5.1
	5.7	4.3	4.4	4.5	4.7	4.8	4.9	5.0
	5.6	4.2	4.3	4.5	4.6	4.7	4.8	4.9
	5.5	4.2	4.3	4.4	4.5	4.6	4.8	4.9
	5.4	4.1	4.2	4.3	4.4	4.6	4.7	4.8
	5.3	4.0	4.1	4.3	4.4	4.5	4.6	4.7
	5.2	3.9	4.1	4.2	4.3	4.4	4.5	4.7
	5.1	3.9	4.0	4.1	4.2	4.4	4.5	4.6
Double glazing	3.4	2.8	2.9	3.0	3.1	3.3	3.4	3.5
	3.2	2.6	2.8	2.9	3.0	3.1	3.2	3.4
	3.0	2.5	2.6	2.7	2.9	3.0	3.1	3.2
	2.8	2.4	2.5	2.6	2.7	2.8	3.0	3.1
	2.6	2.2	2.3	2.5	2.6	2.7	2.8	2.9
	2.3	2.0	2.1	2.3	2.4	2.5	2.6	2.7
	2.2	1.9	2.1	2.2	2.3	2.4	2.5	2.7
	2.0	1.8	1.9	2.0	2.2	2.3	2.4	2.5
	1.8	1.7	1.8	1.9	2.0	2.1	2.3	2.4
	1.6	1.5	1.6	1.8	1.9	2.0	2.1	2.2
	1.4	1.4	1.5	1.6	1.7	1.9	2.0	2.1
	1.2	1.2	1.4	1.5	1.6	1.7	1.8	2.0
	1.1	1.2	1.3	1.4	1.5	1.7	1.8	1.9

D.2: U_w -value calculation

Most systems supplier will be able to provide their specific frame U_f -value figures. As a guide, uPVC profile systems ranging from 58 to 70 mm in depth; utilizing 2 to 3 chamber profile constructions; adopting minimum 2.0 mm main wall thickness; specifying fully steel reinforcement can achieve U_f -values from 1.8 to 2.2 W/m^2K .

Example: Data for U_w -value calculation in accordance with ISO 10077-1

uPVC profile system U_f -value = 1.9 W/m^2K indicative U_f -value for slim Casement
Casement sight line S_L = 0.092 m for sash and outer frame

Double glazing U_g -value = 2.7 W/m^2K for 26 mm (5/16/5) clear/toughened unit-annex E
Linear transmittance ψ = 0.04 W/mK for Aluminium spacer bar for uncoated glass, air filled

$$U_w = \frac{A_g U_g + A_f U_f + L_g \psi_g}{A_g + A_f}$$

U_w thermal transmittance of window (W/m^2K)

A_g area of the glazing (m²)

U_g thermal transmittance of the glazing (W/m^2K)

A_f area of frame (m²)

U_f thermal transmittance of frame (W/m^2K)

L_g perimeter of the glazing (m)

ψ_g linear thermal transmittance, (thermal effect of glazing, spacer and frame) (W/mK)

Window area =	1.23 m width * 1.48 m height	=	1.82 m ²	(100%)
Glass A_g =	$(1.23 - (2 * S_L)) * (1.48 - (2 * S_L))$	=	1.36 m ²	(74.7%)
Frame A_f =	$((1.23 - (2 * S_L)) * S_L * 2) + (1.48 * S_L * 2)$	=	0.46 m ²	(25.3%)
Linear L_g =	$((1.23 - (2 * S_L)) * 2) + (1.48 - (2 * S_L)) * 2$	=	4.68 m	

Window U_w - value

$$U_w = (A_g * U_g) + (A_f * U_f) + (\psi * L_g) / A_g + A_f =$$

$$U_w = (1.36 * 2.7) + (0.46 * 1.9) + (0.04 * 4.68) / 1.36 + 0.46 = 2.6 W/m^2K$$

The ISO 10077-1 principle calculation method can be applied to frames of varying sizes, multi-light configurations and doors alike. In order to compare/benchmark the data the EN 14351-1 standardized frame sizes shall be used, wherever possible. Advanced fabrication computer systems can offer additional modules that can calculate for each frame and glass specification; frame type, style and size, the corresponding U_w -value.

Annex E

E.1: Sound insulation R_w (weighted sound reduction)

Indicative sound insulation data is based ISO 10140-3 and EN 12758; it will enable to assist architects and fabricators alike in specifying/recommending/selecting the most suitable glazing option for a given living environment.

Note: Sound insulation R_w figures; courtesy of NGS Pilkington UK and AGC Glass Europe.

Glass options	Overall thickness (mm)	Double glazing break down	Glass weight (kg/m)	U_g -value Light transmission Solar factor	Sound insulation R_w (dB)	C (dB)	CTR (dB)
Clear/toughened	4.0		10.0	5.8/90/87	29	-2	-3
Clear/toughened	5.0		12.5	5.7/89/84	30	-2	-3
Clear/toughened	6.0		15.0	5.7/88/82	31	-2	-3
Clear/toughened	8.0		20.0	5.6/87/80	32	-2	-3
Clear/toughened	10.0		25.0	5.6/87/77	33	-2	-3
Clear/toughened	12.0		30.0	5.5/85/74	34	0	-2
Clear/toughened	22.0	4/14/4	20.0	2.8/82/78	31	-2	-5
Clear/toughened	22.0	6/12/4	25.0	2.8/80/73	34	-2	-5
Clear/toughened	22.0	6/10/6	30.0	2.9/79/71	31	-1	-4
Clear/toughened	22.0	8/10/4	30.0	2.9/80/71	37	-2	-5
Clear/toughened	24.0	4/16/4	20.0	2.7/82/78	31	-2	-5
Clear/toughened	26.0	5/16/5	25.0	2.7/80/73	32	-2	-5
Clear/toughened	26.0	6/16/4	25.0	2.7/80/73	34	-2	-5
Clear/toughened	28.0	6/16/6	30.0	2.7/79/71	31	-1	-4
Clear/toughened	28.0	8/16/4	30.0	2.7/80/71	37	-2	-5
Clear/toughened	30.0	8/16/6	35.0	2.7/78/69	35	-2	-6
Clear/toughened	32.0	10/16/6	40.0	2.7/77/67	40	-2	-5
Laminated	6.4		16.0	5.6/89/80	32	-1	-3
Laminated	8.8		22.0	5.5/88/77	35	-1	-3
Laminated	12.8		32.0	5.4/86/73	36	-1	-3
Laminated - clear/toughened	22.4	6.4/10/10	31.0	2.8/79/70	33	-2	-5
Laminated - clear/toughened	22.4	6.4/12/4	26.0	2.8/80/70	34	-1	4
Laminated - clear/toughened	26.4	6.4/16/4	26.0	2.7/80/70	35	-1	-5
Laminated - clear/toughened	28.8	8.8/16/4	32.0	2.7/79/67	36	-2	-6
Laminated - clear/toughened	30.8	8.8/16/6	37.0	2.7/79/67	39	-3	-7
Laminated - Laminated	28.8	6.4/16/6.4	31.0	2.7/79/69	36	-1	-5
Laminated - Laminated	31.2	8.8/16/6.4	37.0	2.7/79/66	39	-1	-5
Laminated - Laminated	33.6	8.8/16/8.8	43.0	2.6/78/66	39	-1	-5

E.2: Assessment of actual sound insulation R_w

The maximum benefit of soundproofing can be achieved when frame manufacture and frame installation were executed with great care in order to prevent any sound transmission through outer frame and opening sash (es) and outer frame and surrounding aperture.

For example: Very small air-gaps can have a profound detrimental effect on the overall window installation. Air-gaps of only 1% of the total window area can reduce the overall potential sound insulation by as much as 10 dB which means that the transmitted noises are heard twice as loud as they would be if the gaps are fully sealed (info: courtesy NSG Pilkington).

Example: Assumed external sound level $L_{eq} = 78$ dB (A)

A-weighted decibels, dB (A), are an expression of the relative loudness of sounds in air as perceived by the human ear.

Sound insulation $R_w = 35$ dB (C, Ctr; -1, -5) for double glazing 26.4 mm (6.4/16/4)

Correction value C = -1

For living activities (talking, radio, TV); railway traffic (at medium and high speeds); highway road traffic (speed in excess of 80 km/h); jet aircraft (at a short distance); factories (emitting medium and high frequency noise)

Correction value $C_{tr} = -5$

For Urban road traffic; railway traffic (at low speeds); jet aircraft (at a longer distance); Disco music; factories (emitting mainly low and medium frequency noise)

Sound reduction R_w , correction value C = -1 in reference to living activities etc.

$$R_w = 78 - 35 - (-1) = 44 \text{ dB}$$

Sound reduction R_w , correction value Ctr = -5 in reference to Urban road traffic etc.

$$R_w = 78 - 35 - (-5) = 48 \text{ dB}$$

E.3: Framing Materials

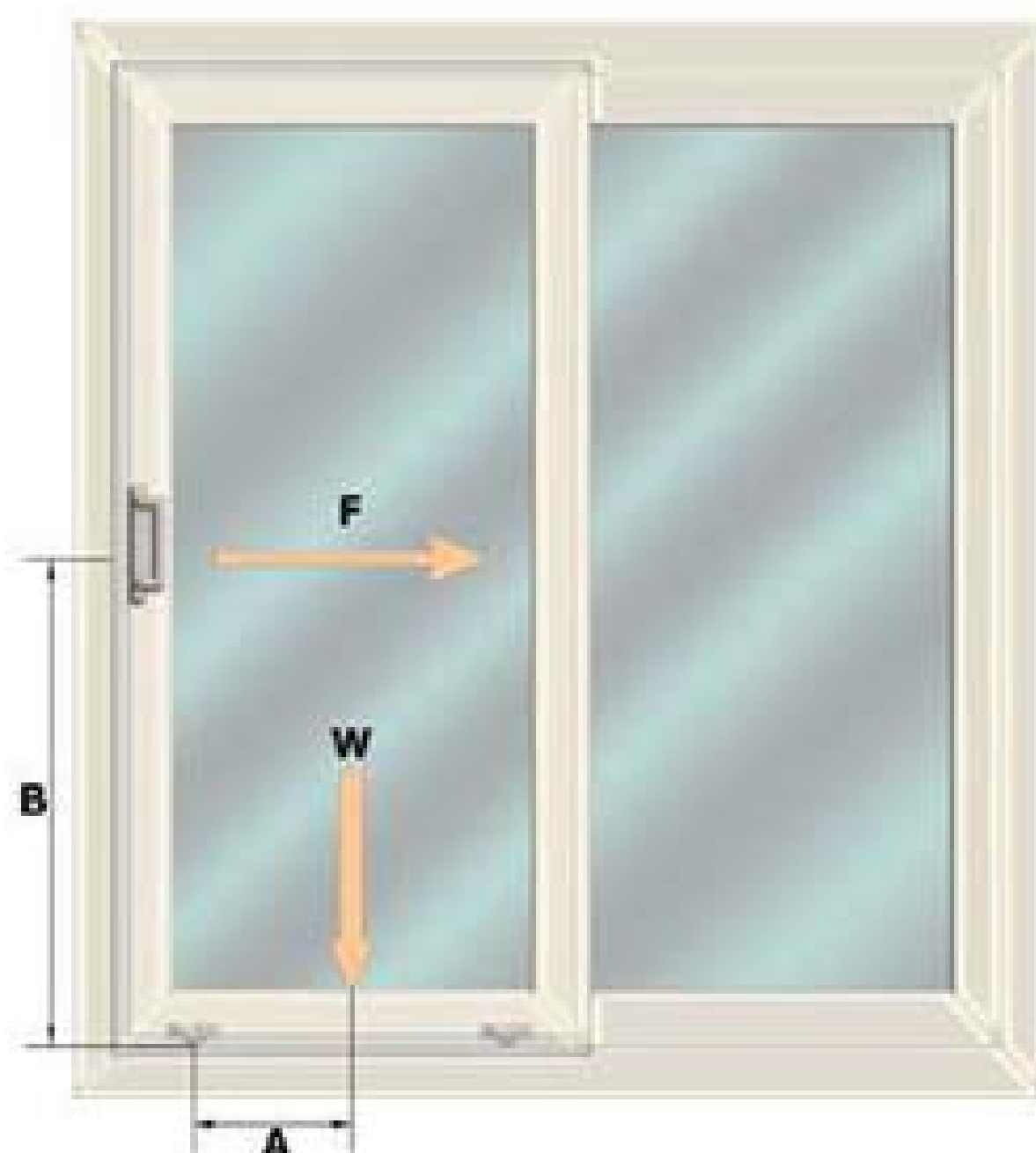
When comparing/testing windows with different frame materials, it is factual that windows with metal frames have a stronger pronounced resonance than the wooden or uPVC windows. Reason being are the inherent material damping properties of wood and uPVC but the differences between the frame materials are negligible and will NOT affect the overall window sound reduction.

Note: The sound insulation values of the glazing can be adopted as being representative of the whole frame when utilizing dual compression weather-seals. The sound reduction R_w figure of the glazing, as stated by the glass manufacturers, will be 'INCLUSIVE' of the frame material.

Annex F

F.1: Sash stability for sliders

It is good practice to apply, wherever possible, the 'rule of thumb' of sash height divided by sash width to be smaller than 2.5 in order to ensure better load distribution and ease of sash operation. The 'rule of thumb', being a very good indicator, does not allow for glass weights and variable handle heights. The sash stability of a predetermined frame design i.e. fixed frame height and frame width, can be improved by varying those parameters.



Note: Although the 'rule of thumb' ratio is 'marginally' unfavorable the stability checks with centre handle height (1200 mm) and variable handle height (1000 mm) are confirming the sash stability i.e. the sash will **NOT** topple or tilt in operation.

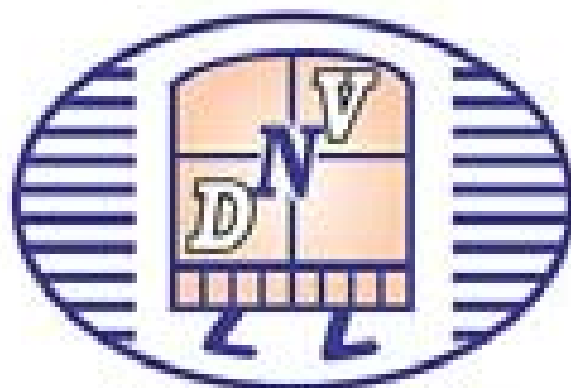
Example: Patio door – 1800 mm wide x 2400 mm tall

Outer frame height (mm)	2400
Sash width (mm)	900
Total glass thickness (mm)	6.0
A roller position (mm)	370
B centre handle position(mm)	1200
F operating force (N)	100
W sash weight (N)	399
Sash stability - fixed handle height ($S > 1.0$) = $(A * W) / (B * F)$	1.2
Alternative: B variable handle height from base (mm)	1000
Sash stability - variable handle height ($S > 1.0$) = $(A * W) / (B * F)$	1.5
Rule of thumb - sash height to sash width ($h/w < 2.5$)	2.57

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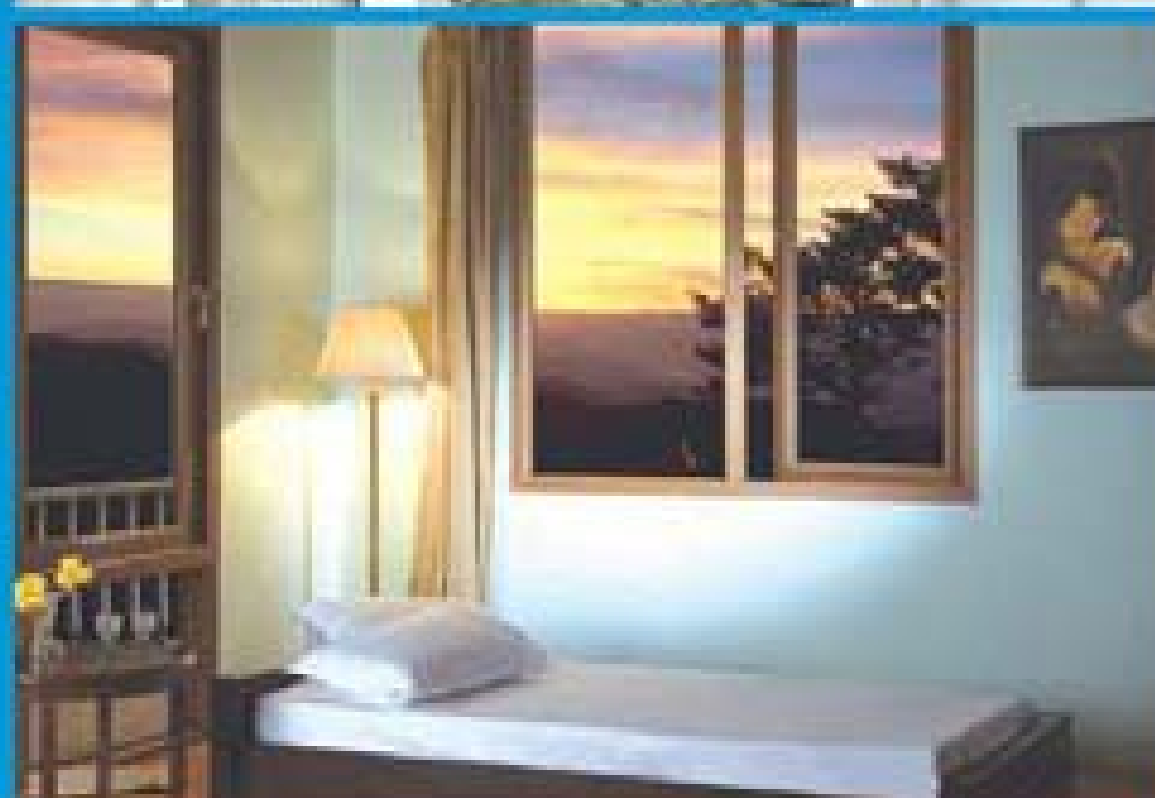
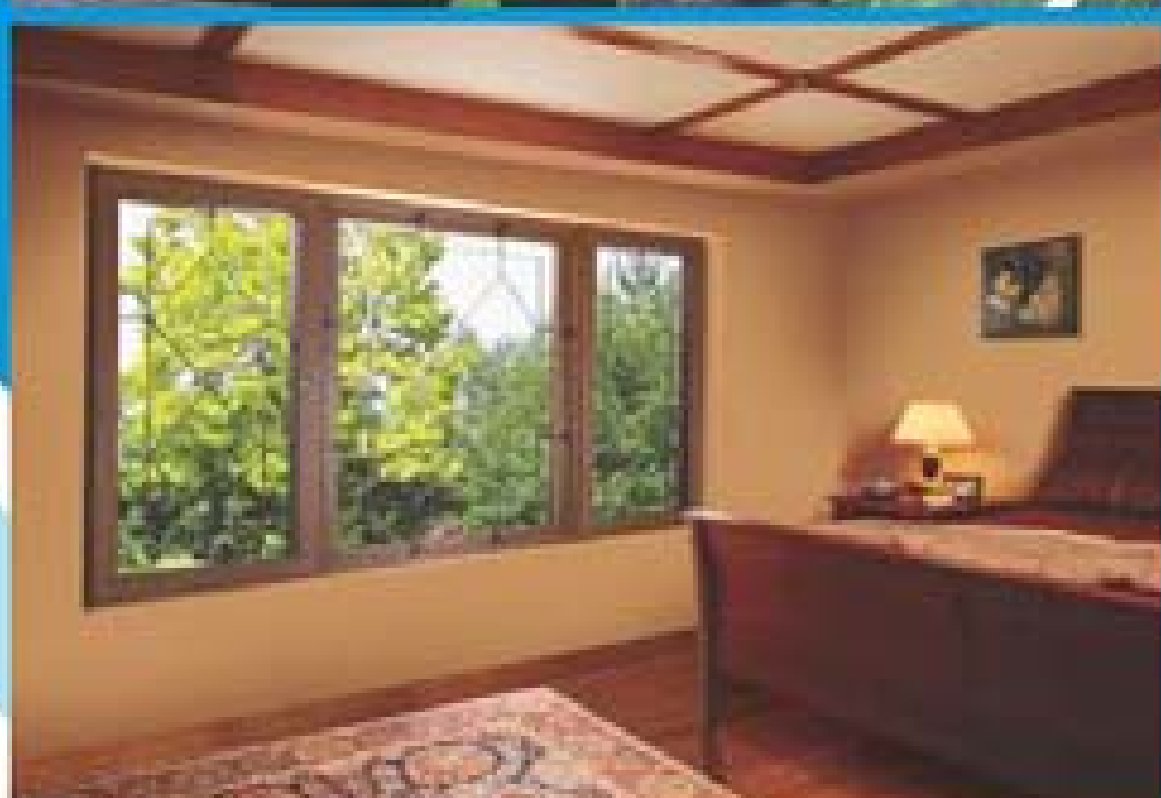
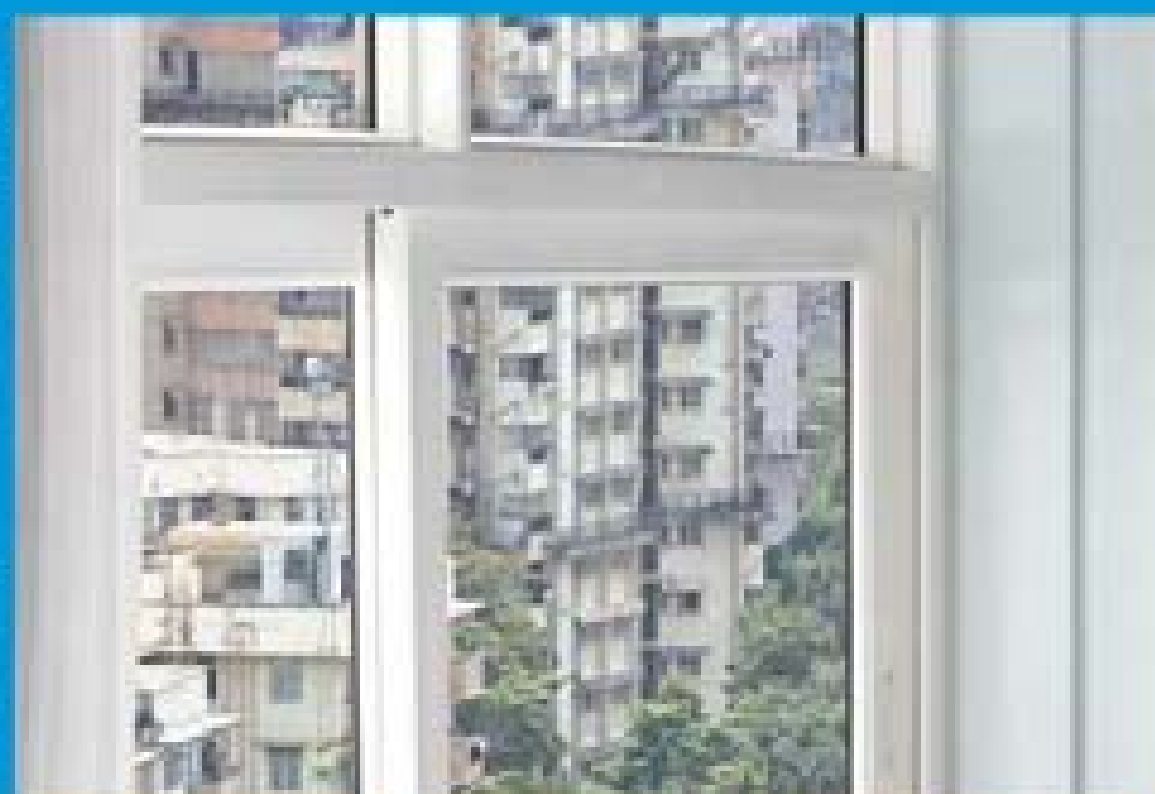


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Institutional Area, Gurgaon - 122002

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