

Building and Construction Authority

ALUMINIUM WINDOW
GOOD INDUSTRY PRACTICES

Aluminium Window - Good Industry Practices

The Good Industry Practices – “Aluminium Window” is part of the Conquas Quality Assessment System (CONQUAS) 2022. Is now the eleventh edition of the CONQUAS assessment scheme after more than 30 years of implementation.

Windows are classified as a major components of a buildings.

The purpose of creating this guide book is to share the good work practices of Contractors and Practitioners who have been consistently delivering productive and high-quality work.

BCA has published 17 guide books on various trades.

Aluminium Window - Good Industry Practices

Contents:

1. Introduction on Type of Windows.
2. Design - Aluminium Window.
3. Materials & Hardware - Selection.
4. Manufacturing & Fabrication.
5. Protection of Frames.
6. Delivery, Storage and Handling on Site.
7. Type of Installation Method.
8. Common defects and Remedies.
9. Final cleaning & Handling Over.



Aluminium Window - Good Industry Practices

1.0 INTRODUCTION ON TYPE OF WINDOWS.

1.0 Introduction on type of windows.

The design of a window system is strictly based on the followings:

- A) Specifications / Tender Documents – Design, Finishes etc.
- C) Pricing - Materials to be used / Fabrication / Installation.
- D) Facilities / Access for Installation.

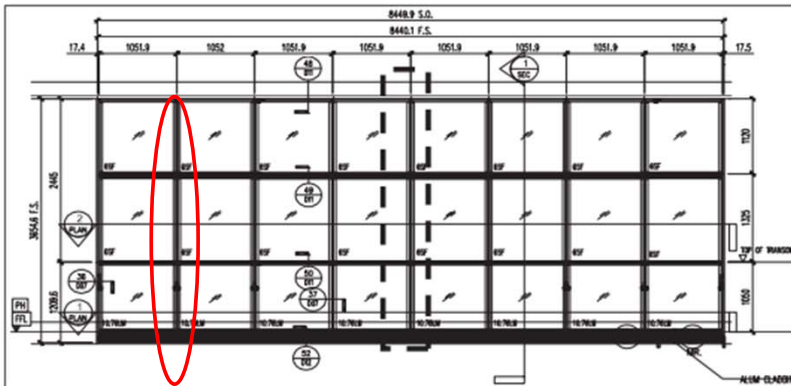
A) Specifications.

- a. Design of Alum Structures – Eurocode 9.
- b. Wind Actions – Eurocode 1 – Part 4.
- b. Window system - Sliding, Casement, Top hung.
- c. Design intent – Profiles, Wall thickness.
- d. Finishes to frame - Powder coat, fluorocarbon coating finishes.
- e. Glass – Thickness, combinations, technical data.
- f. Acoustic – STC requirement.
- g. Performance test - SS 212:2007–Aluminium Alloy Windows.

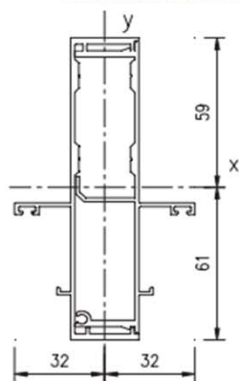
1.0 Introduction on type of windows.

1. Design Analysis & Calculations.

4.3 CHECK MULLION UNDER WIND LOAD



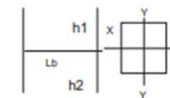
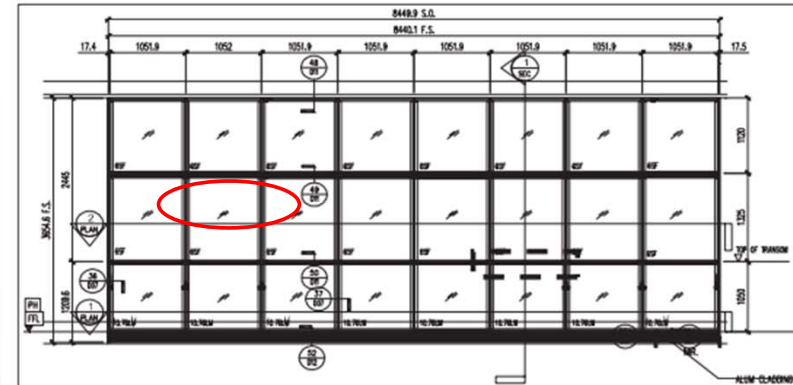
Design wind pressure	$p(+ve) = 0.78 \text{ KN/m}^2$
	$p(-ve) = 0.78 \text{ KN/m}^2$
Left spacing of mullion	$b_L = 1052.00 \text{ mm}$
Right spacing of mullion	$b_R = 1052.00 \text{ mm}$
Max.equ.mullion spacing	$b = (b_L + b_R)/2 = 1052.00 \text{ mm}$
Typical Mullion Span	$L = 3655.00 \text{ mm}$
UWL on mullion due to wind load(+ve)	$w = p \cdot b = 0.82 \text{ KN/m}$



MASS PROPERTIES (UNIT)	VALUES
Area (mm ²) :	801
Perimeter (mm) :	885
Bounding Box - X (mm):	-32 to 32
Bounding Box - Y (mm):	-61 to 59
Centroid - X (mm) :	0
Centroid - Y (mm) :	0
Moments of inertia - X (mm ⁴) :	1266336
Moments of inertia - Y (mm ⁴) :	120046
Product of inertia - XY (mm ⁴) :	972
Radii of gyration - X (mm) :	40
Radii of gyration - Y (mm) :	12
Principal moments along X-Y (mm ⁴) :	120045 along [0 1]
Principal moments along Y-X (mm ⁴) :	1266337 along [-1 0]
Elastic Modulus - Zx (mm ³):	$I / y_{-max} = 20852$
Elastic Modulus - Zy (mm ³):	$J / x_{-max} = 3712$

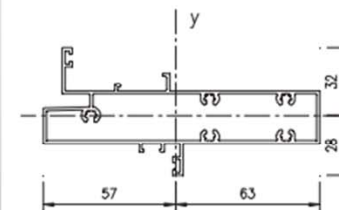
Depth of mullion section(y-y)	$D = 120.00 \text{ mm}$
Width of the section(x-x)	$B_m = 64.50 \text{ mm}$
Thickness of mullion	$t = 1.50 \text{ mm}$
Area of the section	$A_s = 801.00 \text{ mm}^2$
Section extreme point(x-x)	$y = 61.00 \text{ mm}$

4.4 CHECK TRANSOM UNDER WIND LOAD



i) WIND LOAD

Design wind pressure	$p(+ve) = 0.78 \text{ KN/m}^2$
	$p(-ve) = -0.78 \text{ KN/m}^2$
Max.Frame Width (mullion spacing)	$b = 1052.00 \text{ mm}$
Length for dead load	$b1 = 1052.00 \text{ mm}$
Frame height above	$h1 = 1330.00 \text{ mm}$
Frame height below	$h2 = 1100.00 \text{ mm}$



MASS PROPERTIES (UNIT)	VALUES
Area (mm ²) :	652
Perimeter (mm) :	847
Bounding Box - X (mm):	-57 to 63
Bounding Box - Y (mm):	-28 to 32
Centroid - X (mm) :	0
Centroid - Y (mm) :	0
Moments of inertia - X (mm ⁴) :	105777
Moments of inertia - Y (mm ⁴) :	907784
Product of inertia - XY (mm ⁴) :	-47170
Radii of gyration - X (mm) :	13
Radii of gyration - Y (mm) :	37
Principal moments along X-Y (mm ⁴) :	103012 along [1 0]
Principal moments along Y-X (mm ⁴) :	910548 along [0 1]
Elastic Modulus - Zx (mm ³):	$I / y_{-max} = 3317$
Elastic Modulus - Zy (mm ³):	$J / x_{-max} = 14487$

Depth of transom section(y-y)	$D = 120.00 \text{ mm}$
Width of the transom section(x-x)	$B = 60.00 \text{ mm}$
Area of the section	$A_s = 652.00 \text{ mm}^2$
Second moment of area 1(x-x)	$I_{x1} = 105777.00 \text{ mm}^4$

1.0 Introduction on the type of windows.

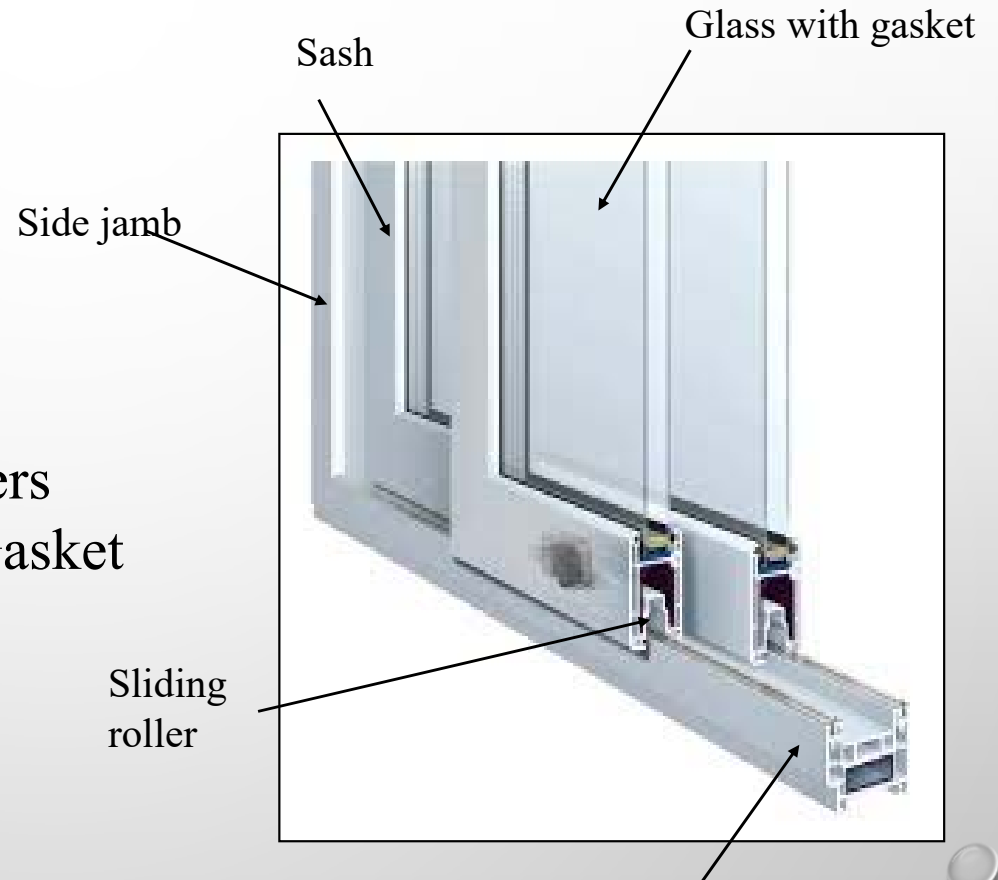
A. Sliding Window System - Comprises of various components as below:

- a. Top Head
- b. Side Jamb
- c. Bottom Track
- d. Vertical sash
- e. Interlock meeting stile
- f. Top / Bottom / Side Inners
- g. Roller / Lock / Guide / Gasket / Mohair
- a. Glass

Top head



Interlock meeting stile



Sliding bottom track.

Section thru 2 track sliding window.

1.0 Introduction on type of windows.

B. Casement window: Components of casement cum fixed window below.

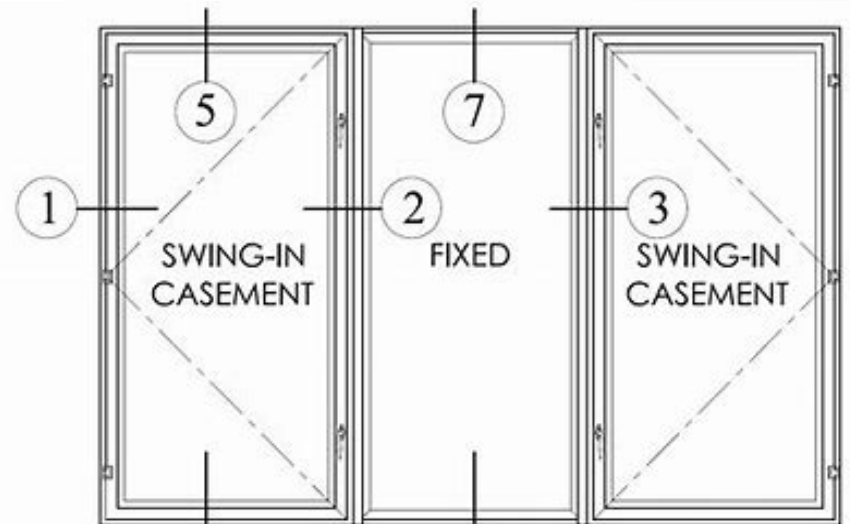


1.0 Introduction on type of windows.

B. Casement window.



For 4 panels casement window.



Casement window cum fixed.



4 panels casement cum fixed window.

1.0 Introduction on type of windows.

C. Top Hung window.



3 panels top hung window with fixed below.



Top Hung cum fixed glass window.



Top hung window.



Aluminium Window - Good Industry Practices

2.0 DESIGN ALUMINIUM WINDOW.

2.0 Design – Aluminium Window.

Design of Window System

A. Aluminium fixed glass window.

- i) Frames – subject to wind load
- ii) Glass – subject to wind load, impact load.
- iii) Design – design and constructed in accordance to SS212 – specification for aluminium alloy windows.



Fixed full height glass window.

The top fixed of the fixed glass window may adopt a minimum 6mm thick float glass panel, but subject to the wind load calculation.

Whereas, the bottom fixed, 1.0m below FFL, the minimum use of glass is 10.76mm thick laminated glass to satisfy authority requirements & specifications.

2.0 Design – Aluminium Window.

Design of Window System

- A. Aluminium casement cum fixed glass window.
- i) Frames – subject to wind load.
 - ii) Glass – subject to wind load, impact load.
 - iii) Design – design and constructed in accordance to SS212 specification for aluminium alloy windows.



4 panels top hung window

This is a common window system which is widely use for residential and public housing projects.

The advantage of this system is considered as 100% of free opening, providing ventilation and light.

2.0 Design

Design of Window System

- A. Aluminium top hung window.
- i) Design – design and constructed in accordance to SS212 specification for aluminium alloy window.



Top hung window

Smaller top hung window, of size ranging from 650mm W x 600mm H is commonly use for toilet, store room etc in residential, public housing, institutional building and commercial projects.

Larger top hung are mostly adopted in commercial buildings.

2.0 Design

- A. Aluminium casement cum fixed glass window.
- i) Frames – subject to wind load.
 - ii) Glass – subject to wind load.
 - iii) Design – design and constructed in accordance to SS212 specification for aluminium alloy windows.



2 Tracks sliding window

Sliding window is commonly used in all public housing projects and also for kitchen area or residential projects.

It is easy to function by sliding the panels but has to compromise on only 50% free opening as compare to other types of window.

Acoustic is not as good as compare to top hung and casement windows.

2.0 Design

D. Aluminium full height window.

- i) Frames – subject to wind load.
- ii) Glass – subject to wind load, impact load.
- iii) Design – design and constructed in accordance to SS212 specification for aluminium alloy windows.



Composite Full Height Window

This is name as full height window system and is commonly used in residential projects.

It comprises of 4 casement glass panels (can be top hung glass panels) with below 4 fixed glass panels. The fixed glass panels below 1m, has to use laminated glass to comply to the authority requirement and specifications.

The 4 casement glass panels can be in 6mm thick float glass, subject to satisfy the wind load calculation.

2. Design

Type of Aluminium Frame Systems.

There are basically 4 types of framing system:

a. Sub-Frame System.

Consist of a sub frame with a main frame, outer and inner. Install sub frame, allow wet works to proceed, main frame follow next via glazing.

b. Cast-in window system – HDB projects.

Outer and inner frames - install in the pre-casting yard

c. Fixing Lug system – Commonly adopted in construction sector.

Outer and inner frames - install on site.

d. Sub-frame Bracket System.

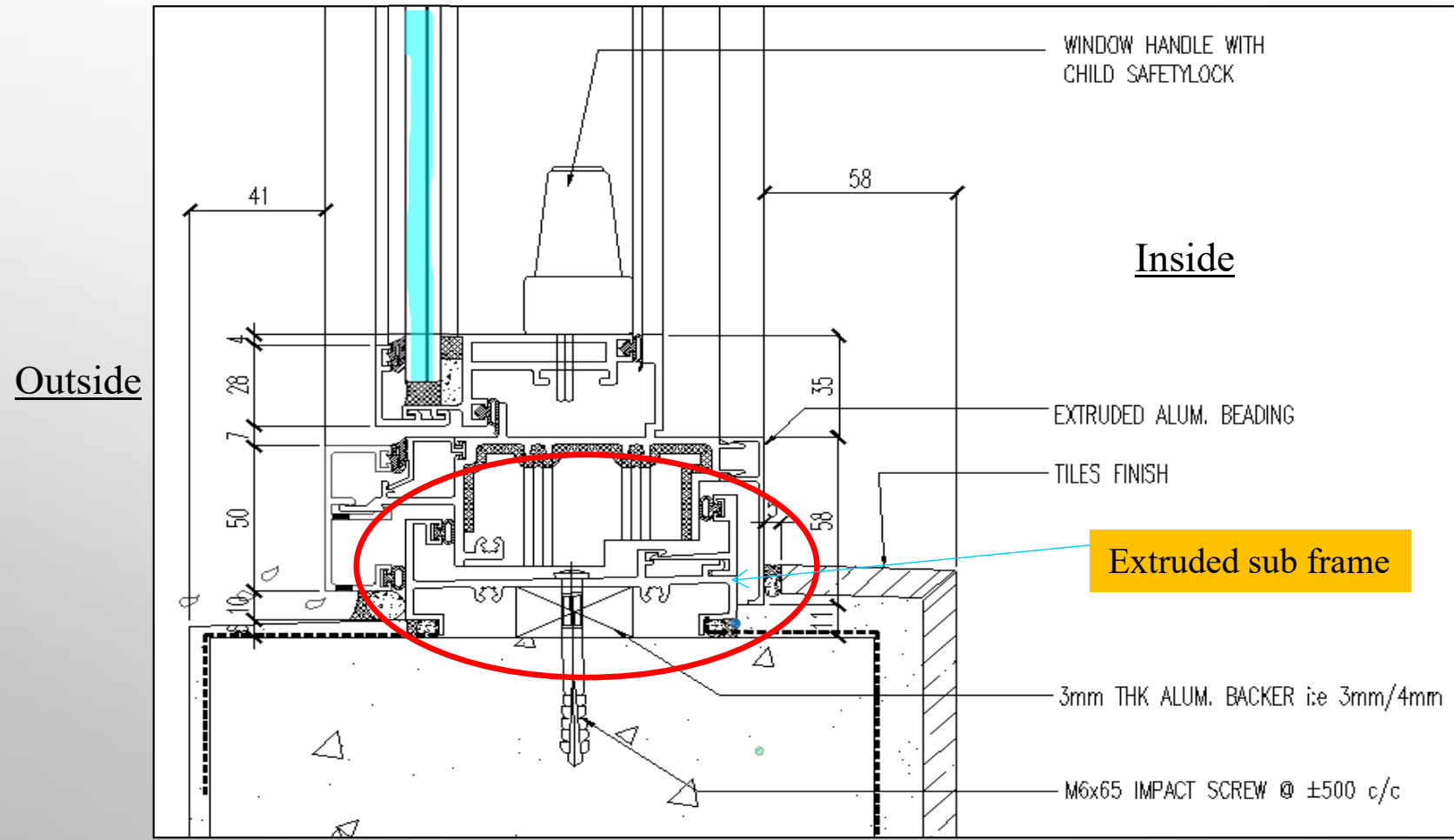
Outer and inner frame – brackets fixing.

e. Full Height Window System

Secured with fixing lugs. The purpose of this type of design to stimulate the façade as curtain wall system.

2. Design

Type of framing systems - a. Full Sub-Frame System.



Full sub frame window system – Top Hung window

2. Design

Type Of Framing System

a. Full Sub-Frame System.

This system has a sub-frame that is anchored onto the wall structure.

The main-frame is subsequently mounted onto the sub-frame once all wet works are completed.

Advantages.

- i. The proposed sub frame is to be installed first to allow other trades to proceed on.
- ii. The system comes with a gutter (bottom sub frame) to discharge water.
- iii. The sub frame will be in chromated treatment.
- iv. Reduce abortive works – damage to main frame.

Disadvantages

- i. Smaller dimensional tolerances when install main frame, +/- 3mm.
- ii. Very high costs as compared to other systems, both in materials and labor costs.

2.0 Design

Full Sub Frame System

a. Sub-frame System

Alum sub frame profile



Installed Sub Frame - Window

Alum sub inner frame profile



Install Inner Frame into sub frame

2. Design

Type of Framing Systems

a. Sub-frame System – it has to be extruded aluminium profile.

Installed sub
frame with
plastering
completed.



Installed
Sub –
Frame

Installing
Main Frame
to Sub-
Frame.

Sub Frame System

2.0 Design

Type of Framing System.

b. Cast in Window System

Window frames will be pre-fabricated in accordance to the approved shop drawing before sending to the pre-cast yard for installation.

Advantages

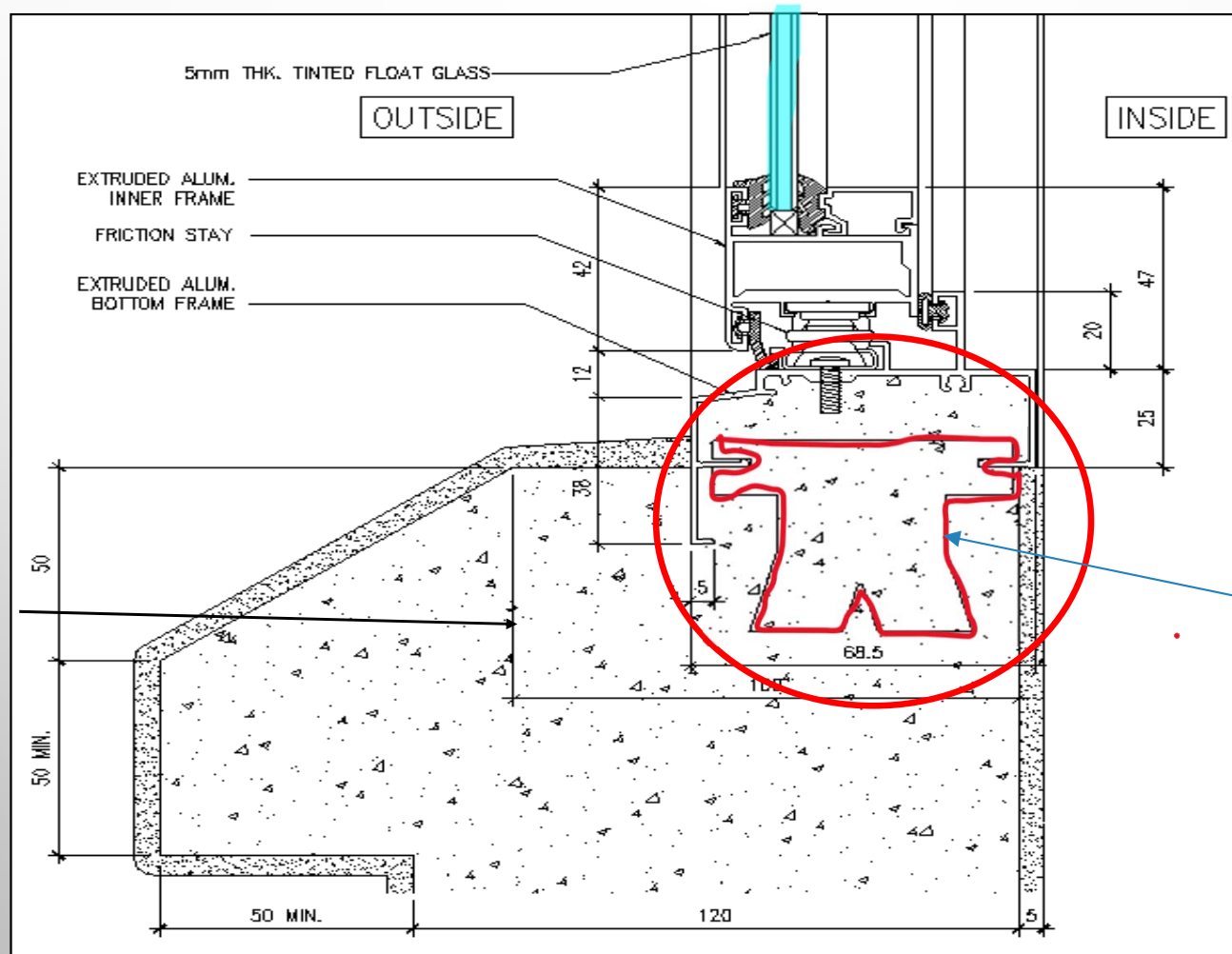
- i. Eliminate the need for site grouting / no site works during the initial period.
- ii. Quality control is efficient as installation is done at precast yard, working environment is conducive.
- iii. Mass production of windows, saving time and money.
- iv. Eliminate possible seepage.

Disadvantages

- i. Tight schedule and require strong finances.
- ii. Adequate storage space to stand by.
- iii. Must have standby workforce to install as and when required, even small quantity.
- iv. Rectification and replacement is very costly.

2. Design

Type of framing systems - b. Cast-in window system – HDB projects.



R.C.
precast
wall

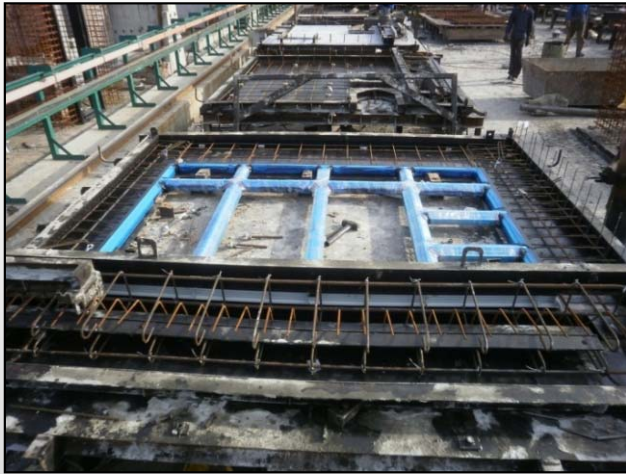
Stainless steel fish tail
Bracket @ not more
600mm c/c

Cast in window system – Casement window

2.0 Design

Type Of Framing System.

b. Cast-in Window System.



Window being placed the pre-cast mould. Inspect and ready for concrete casting.



Stainless steel fish tail bracket @ 600mm c/c as per HDB specifications



Completed precast unit

2.0 Design

Type of Framing System.

c. Fixing Lug System

This system is the commonly adopted for buildings in the construction industries. The lugs are manufacture from 0.8mm thick galvanized sheet and bend to the desire size and length.

Advantages

- i. The 0.8 / 1mm thick electro galvanized / galvanized lug is easily available.
- ii. Command a better tolerance for installation, recommended is 20mm to 30mm.
- iii. The lugs, nail and cartridge is lower costs as compared to others.
- iv. Speed is the advantage and minimum manpower.

Disadvantage

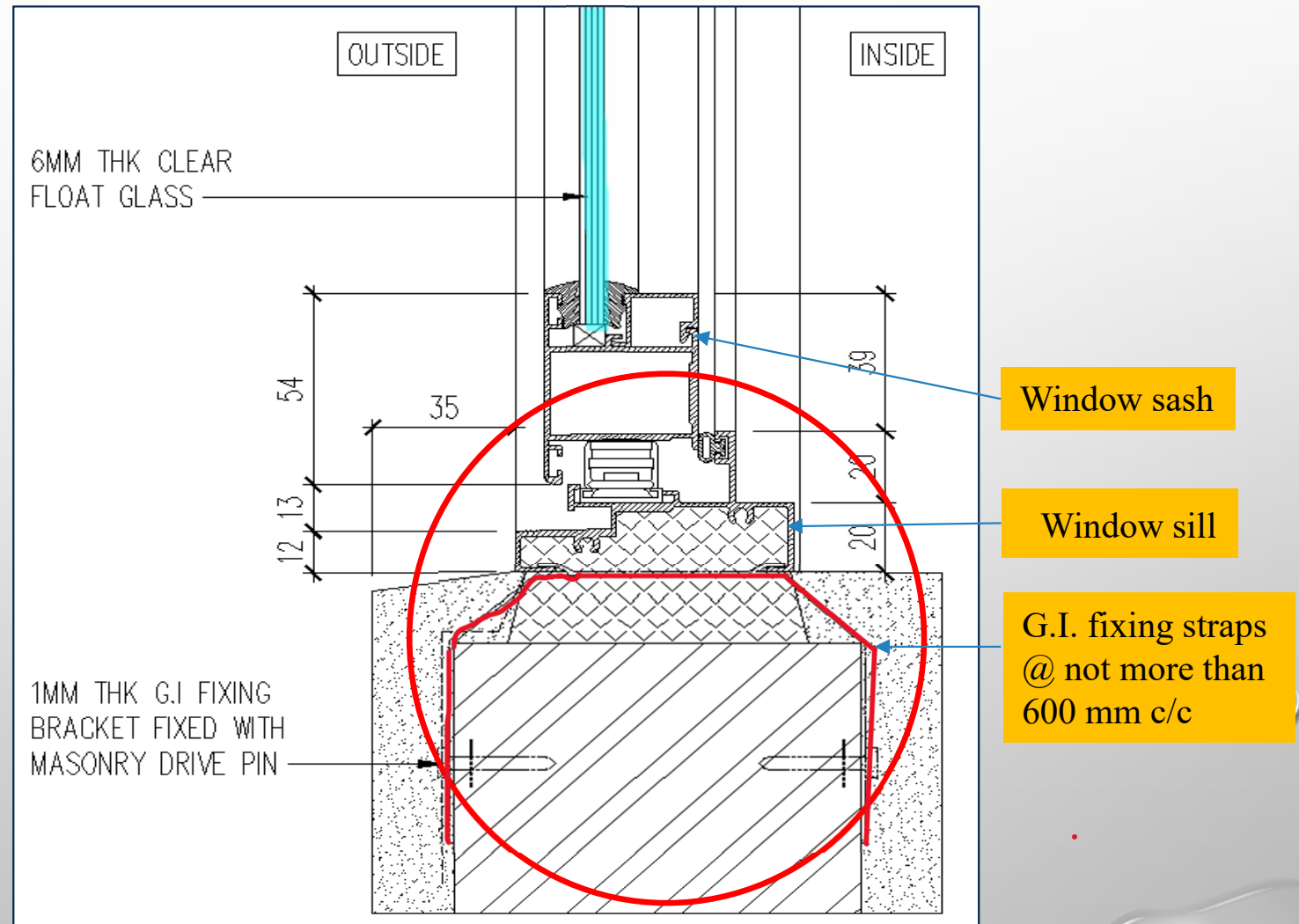
- i. Outer frames installed during the initial stage is subject to damage.



G. I. Fixing lug.

2.0 Design

Type of framing systems c. Fixing Lug system – Commonly seen in many projects.



Fixing lug system – Casement window

2.0 Design

Type Of Framing System.

c. Fixing Lug System

Fixing lugs being spaced at not more than @ 600mm on aluminium outer frame.



Fixing lug being secured to wall with pin & cartridge.



2.0 Design

d. Sub-Frame Bracket System

This is a simplify version of “full sub-frame system”. It is adopted if the wall is either skim coat, precast or bare finished.

The system has a series of primary brackets ($< 600\text{mm c/c}$) that is being pre-fixed in factory. The secondary brackets will need to be secured to the top and sides of wall at the same positions of the primary brackets. Align both brackets together and secure with M5 x 19mm L self drill screw.

Advantages

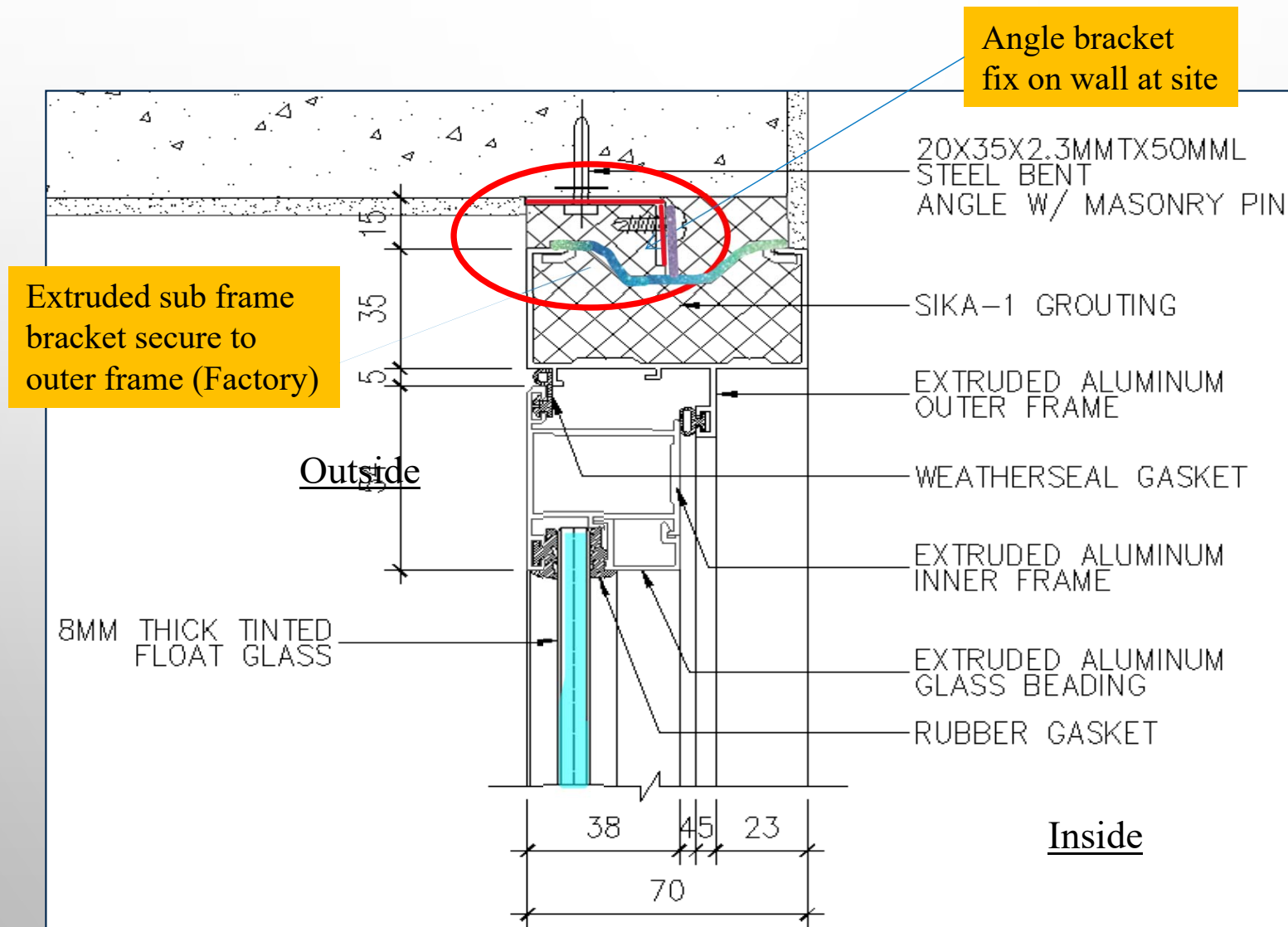
- i. Not involve any wet works, no plastering to wall.
- ii. Less damages to frames being installed.

Disadvantages

- i. Need to verify dimensions for all openings to determine fabrication sizes, time factor.
- ii. Will required longer time in fabrication due to the various sizes.
- iii. High installation costs, double work.
- iv. Potential water seepage if weather seal fails on the external.

2. Design

Type of framing systems - d. Sub-Frame Bracket System.



Sub frame bracket system – Top Hung window

2.0 Design

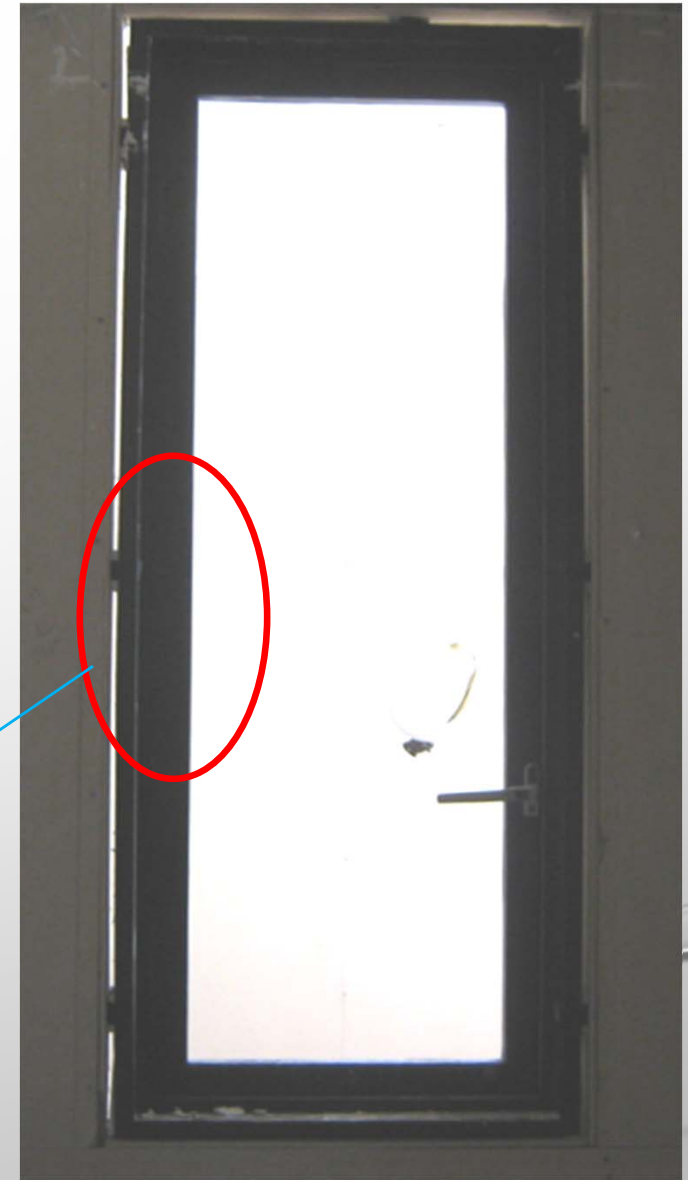
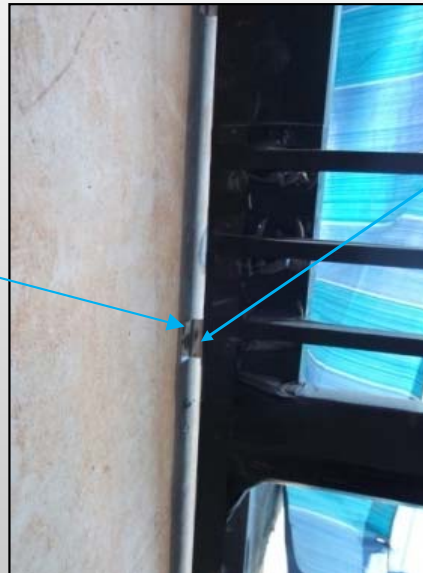
Type of Framing System

d. Sub-frame Bracket System.

The primary bracket (angle x 50mmL) is pre-fixed to the outer frames @ <600mm c/c in the factory.

The secondary bracket will be installed on site as per the position of the primary bracket.

Primary bracket can be an angle or extruded profiles.



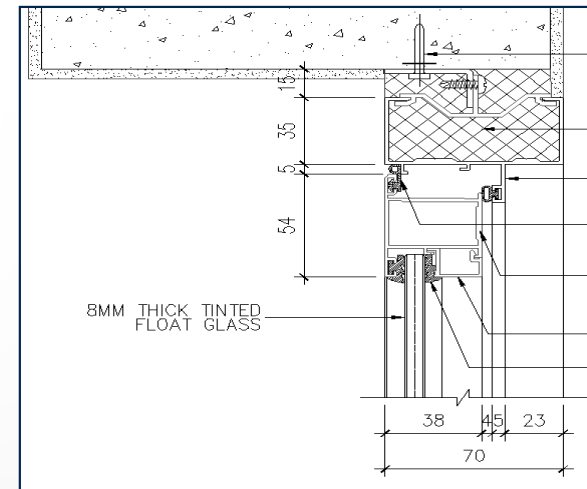
2.0 Design

Type of Framing System

d. Sub-Frame Bracket System



Extruded secondary bracket
to outer frame



Vertical section thru window

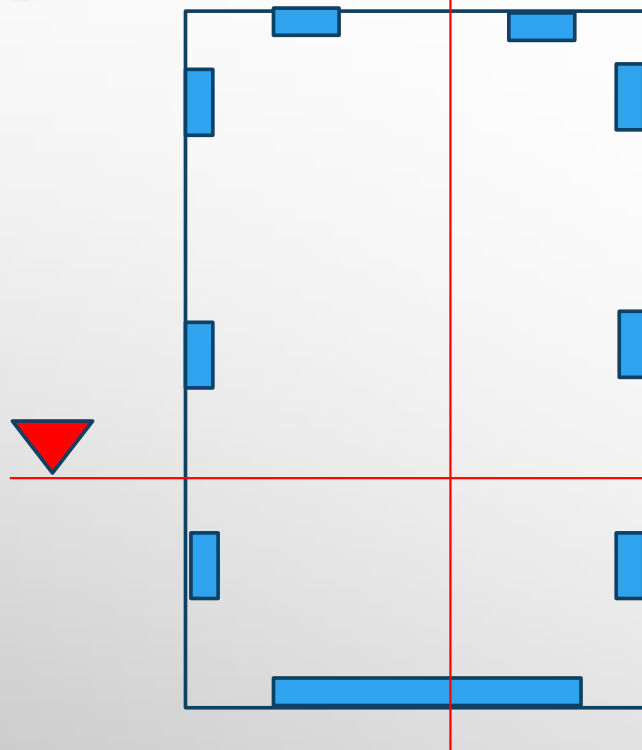


Fixing of primary bracket on wall

2.0 Design

Type of frame system

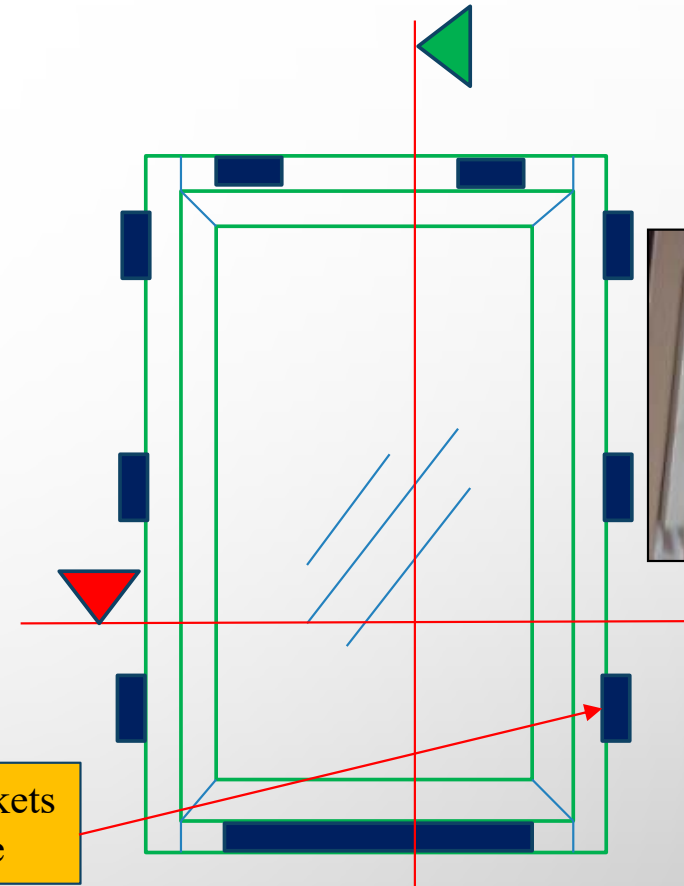
d. Sub frame bracket system.



Site opening



primary brackets
L-shape angle



Frame assembly - Factory



Secondary brackets
Extruded profile

Primary brackets
to be installed
align & level as secondary
brackets on outer framings

Secondary brackets
on outer/inner frame
pre fabricated



Aluminium Window - Good Industry Practices

3.0 MATERIALS SELECTION

1. Aluminium Extrusions.
 2. Finishes – Powder coating / Fluorocarbon coating.
 3. Type of Glass.
 4. Hardware & Accessories.
 5. Visual Mock Up Unit.
 6. Endurance / Operational Test – Hardware.
 7. Performance Mock Up Test Unit.
- 

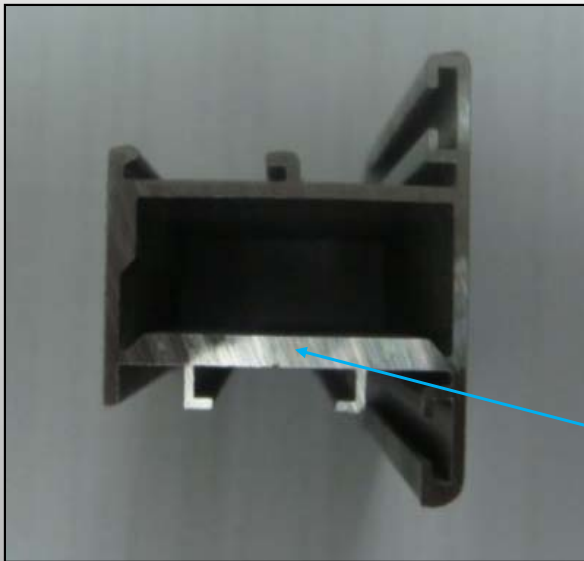
3.0 Materials Selection

Aluminium Frame (extrusions).

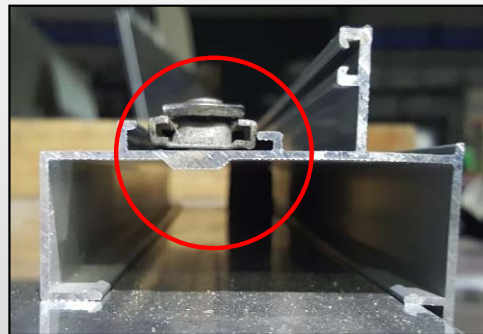
- a. Extruded aluminium member: aluminium alloys, 6063T5 or 6063T6 complying EN 1999-1-1:2007. The wall thickness and size of extrusion is subject to the design wind load and specifications. Load is based on EN 1991-1-1:2002 part 1-1.

Grade T5 and T6 are difference in tensile strength (as per SS212:2007 Section 4.1) and is suitable and widely for the building industry.

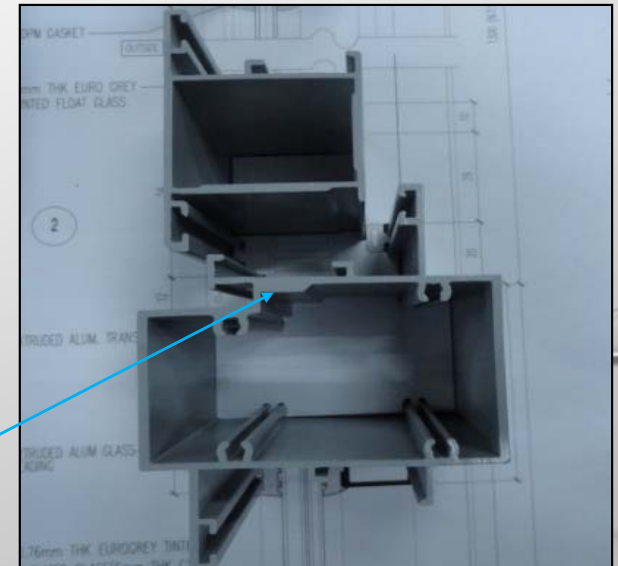
- b. The wall thickness that is receiving any fixings, shall not less than 2.75mm ~ 3.00mm thick.



Cut profile of window sash



Adequate wall thickness to receive fixings of screws.



Section thru' outer / inner.

3.0 Materials Selection

Aluminium Extrusion.

Alloy AA 6063

Commonly known as an architectural alloy, **Alloy AA 6063** provides a good balance of extrudability and mechanical properties. Its excellent extrudability allows thin-walled hollow shapes, intricate solids, and other shapes that are usually difficult to extrude with a satisfactory finish, to be produced more easily. It responds well to polishing, chemical brightening, anodising and dyeing. It also has a high degree of resistance to corrosion.

MECHANICAL PROPERTIES

BS EN ISO 6506-1:2014

TEMPER	THICKNESS (mm)	ULTRA STRENGTH Min.	0.2% STRESS		HARDNESS BRINELL (HB)	HARDNESS BRINELL (HB)
			Min. (Mpa)	Max. (Mpa)		
T4	UP TO 12.50	115	60	-	12	40
	12.50-25.00	110	55	-	12	-
T5	UP TO 12.50	150	110	-	8	60
	12.50-25.00	145	105	-	8	-
T6	UP TO 12.50	205	170	-	8	80
	12.50-5.00	205	170	-	10	-

3.0 Materials Selection

Aluminium Extrusion.

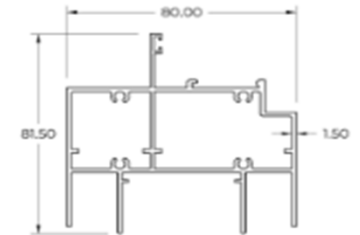
1. Determine the window system to be used.
2. Select the profiles – size, shape, wall thickness according to design requirements and specifications.
3. Compute the analysis and calculations.



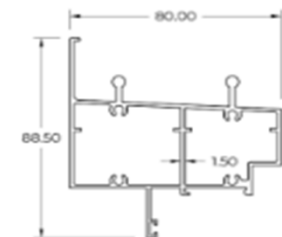
Common window profiles



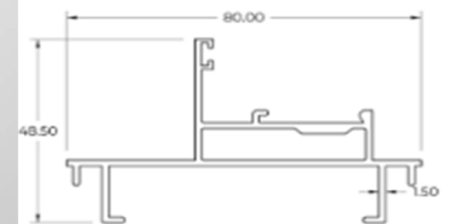
Custom made profiles



ALL 3019



ALL 3020



ALL 3021

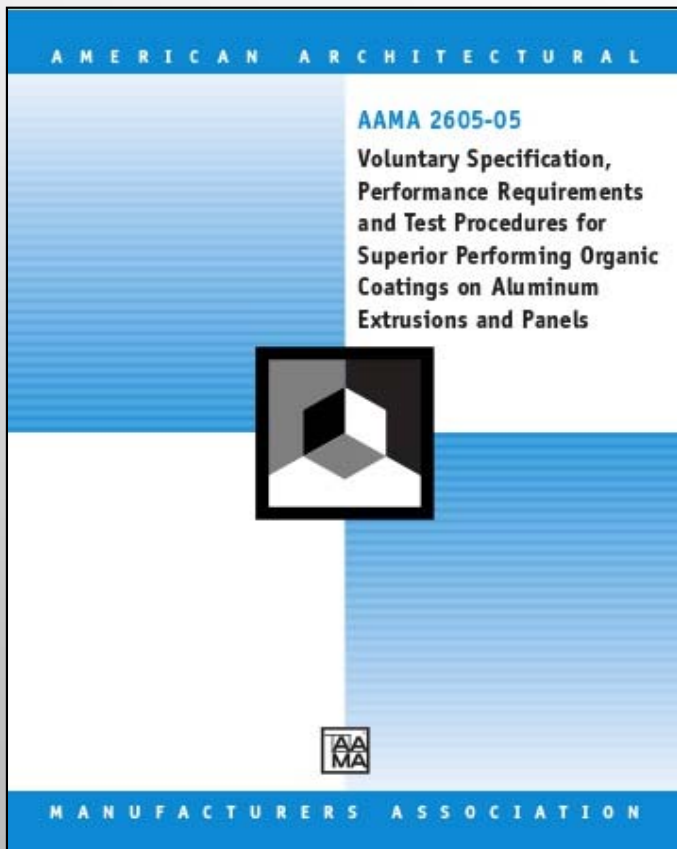
Window profiles

3.0 Materials Selection

Type of Coating / Finishes.

Anodic Coating Complying BS3987.

1. Liquid Organic Coating Complying to AAMA2605 (Fluorocarbon Coating)
2. Powder Organic Coating Complying to AAMA2604 (Powder Coating)
3. Anodizing (Natural, Black or Bronze) Not available. BS 3987 +/- 25 microns



American Architectural Manufacturers Association (AAMA)

AAMA 2603 – Basic Standard

AAMA 2604 – High performance coating.

AAMA2605 – Superior coating.

4.0 Materials Selection.

Manufacture & Fabrication process – Powder Coat.

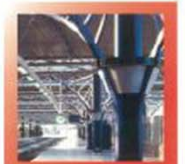


Architectural
Powder Coatings for Life

PR12/4379/C4* Pearl White Gloss	T: 85.3 D: 81.7 S: 3.3	PR12/4326/CS1* Ivory White Satin	T: 69.7 D: 66.0 S: 3.1	PR12/4371/CS1* Satin White Satin	T: 79.2 D: 76.5 S: 2.4	PR12/263/C32* RAL 6027 Light Green Satin	T: 39.6 D: 38.0 S: 3.1
PR12/43156/TX4* Horizon White Texture	T: 87.4 D: 83.9 S: 3.3	PR12/4761/CS1* Sunrise Satin	T: 64.3 D: 61.7 S: 2.6	PR12/8741/CS1* RAL 7047 Teagrey Satin	T: 52.9 D: 50.3 S: 2.4	PR12/315/CS12* RAL 5018 Turquoise Blue Satin	T: 19.7 D: 18.6 S: 3.1
PR12/4752/CS10* Shoji White Satin	T: 73.9 D: 70.6 S: 3.3	PR12/69978/CS1* Gull Satin Satin	T: 65.3 D: 62.2 S: 3.1	PR12/60149/CS2* APO Grey Satin	T: 42.8 D: 40.4 S: 2.4	PR12/343/CS12* RAL 5012 Light Blue Satin	T: 33.6 D: 30.3 S: 3.3
PR12/827/CS11* RAL 7032 Peckish Grey Satin	T: 36.2 D: 36.3 S: 2.9	PR12/63464/CS6* Gull Grey Satin	T: 44.6 D: 42.0 S: 2.4	PR12/89745/CS4* Annex Grey Satin	T: 25.8 D: 23.9 S: 1.9	PR12/346/CS17* RAL 5014 Pigeon Blue Satin	T: 20.0 D: 18.9 S: 3.1
PR12/11416/CS5* Champagne Silver Metallic Satin	T: 34.9 D: 26.2 S: 5.7	PR12/68124/CS2* RAL 7040 Window Grey Satin	T: 24.6 D: 31.5 S: 3.1	PR12/89416/CS4* Olive Powder Satin	T: 19.5 D: 17.3 S: 2.4	PR12/318/CS16* RAL 6007 Brilliant Blue Satin	T: 13.5 D: 10.5 S: 3.1
PR12/80042/CS2* RAL 7030 Stone Grey Satin	T: 25.6 D: 23.4 S: 2.2	PR12/83015/CS2* RAL 7046 Teagrey Satin	T: 24.7 D: 22.0 S: 2.1	PR12/89513/CS6* Ironstone Satin	T: 10.1 D: 7.8 S: 2.1	PR12/3106/CS4* Olive Blue Satin	T: 12.8 D: 9.4 S: 3.4
PR12/80145/CS2* Dark Grey Satin	T: 18.0 D: 14.7 S: 3.3	PR12/8367/CS21 Trunking Grey Satin	T: 16.3 D: 13.0 S: 3.3	PR12/892/CS10* RAL 7004 Graphite Grey Satin	T: 10.0 D: 6.8 S: 3.2	PR12/355/CS46* RAL 5005 Signal Blue Satin	T: 10.7 D: 8.2 S: 2.3
PR12/80355/CS7* Slate Grey Satin	T: 11.1 D: 8.2 S: 2.9	PR12/81032/CS17* Monument Satin	T: 8.9 D: 5.4 S: 2.4	PR12/890/CS6* RAL 7016 Anthracite Grey Satin	T: 8.8 D: 5.2 S: 2.3	PR12/359/CS11* RAL 5010 Cerise Blue Satin	T: 11.0 D: 7.6 S: 3.4
PR12/7056/CT11* Black Sandflex Texture	T: 4.5 D: 4.2 S: 0.5	PR12/7361/CM1* Mat Black Mat	T: 4.7 D: 3.1 S: 1.5	PR12/798/CS132* Black Satin Satin	T: 4.7 D: 1.3 S: 3.4	PR12/355/CS11* RAL 5002 Ultramarine Blue Satin	T: 9.7 D: 6.8 S: 3.1

PR12/20643/CS5* Russet Green Satin	T: 27.4 D: 24.8 S: 2.9	PR12/1210/CS11 RAL 9015 Pure White Satin	T: 80.5 D: 77.7 S: 3.8	PR12/2941/CS68 RAL 1315 Light Ivory Satin	T: 41.4 D: 39.3 S: 2.3	PR12/70437/CS13* Primrose Gloss	T: 47.3 D: 43.5 S: 3.4
PR12/20823/CS3* Acid Green Gloss	T: 29.3 D: 29.4 S: 4.4	PR12/2210/CS17* Pole beige Satin	T: 14.3 D: 11.7 S: 2.6	PR12/70167/CS13* RAL 1314 Ivory Satin	T: 51.2 D: 49.2 S: 2.0	PR12/101/CS11* RAL 1314 Zinc Yellow Satin	T: 52.5 D: 50.0 S: 2.6
PR12/3599/CS10* Mint Green Gloss	T: 15.1 D: 15.3 S: 3.5	PR12/70113/CS1* Pole beige Gloss	T: 42.2 D: 38.5 S: 3.6	PR12/15228/CS12* Dio Gold Metallic Satin	T: 24.1 D: 20.1 S: 4.3	PR12/127/CS1* RAL 1321 Traffic Yellow Satin	T: 45.9 D: 42.2 S: 3.3
PR12/2753/CS2* RAL 6033 Mint Turquoise Satin	T: 20.3 D: 17.3 S: 3.0	PR12/70167/CS4* Beige Satin	T: 53.9 D: 51.3 S: 2.6	PR12/2631/CS11* RAL 3012 Beige Red Satin	T: 33.4 D: 30.4 S: 3.0	PR12/164/C Signal Yellow Gloss	T: 52.9 D: 48.1 S: 4.8
PR12/2234/CS13 RAL 6029 Mint Green Satin	T: 4.9 D: 7.3 S: 2.6	PR12/70107/CS14* Paper Bark Satin	T: 48.1 D: 45.1 S: 3.0	PR12/2640/CS6* RAL 8001 Ochre Brown Satin	T: 17.5 D: 14.5 S: 3.0	PR12/553/CS5 RAL 2008 Willow Orange Satin	T: 32.3 D: 29.5 S: 2.8
PR12/2045/CS2* RAL 6001 Emerald Green Satin	T: 10.5 D: 7.4 S: 2.1	PR12/773/CS1 Paper Bark Satin	T: 27.9 D: 24.6 S: 3.3	PR12/2385/CS6 RAL 8003 Clay Brown Satin	T: 13.5 D: 10.4 S: 3.2	PR12/526/CS28 RAL 3009 Traffic Red Satin	T: 24.4 D: 21.8 S: 3.0
PR12/2656/CS4* RAL 6009 Olive Green Satin	T: 1.7 D: 6.7 S: 2.0	PR12/7228/CS6* RAL 7004 Beige Grey Satin	T: 15.1 D: 12.9 S: 2.5	PR12/2354/CS12 RAL 6011 Nut Brown Satin	T: 4.0 D: 5.2 S: 2.6	PR12/507/CS40 Signal Red Gloss	T: 20.4 D: 10.4 S: 4.0
PR12/2551/CS7* RAL 6023 Pine Green Satin	T: 9.0 D: 6.1 S: 2.9	PR12/20404/CS5* Jasper Satin	T: 13.8 D: 11.0 S: 2.8	PR12/20160/CS4* Sawyer Brown Satin	T: 8.7 D: 5.9 S: 2.8	PR12/5093/CS7* RAL 3005 Wine Red Satin	T: 7.1 D: 3.5 S: 3.5
PR12/212/CS11 RAL 6003 Moss Green Gloss	T: 7.0 D: 2.8 S: 4.2	PR12/295/CS16* Desert Brown Satin	T: 11.3 D: 7.6 S: 3.7	PR12/20131/CS1 RAL 8028 Terra Brown Satin	T: 1.6 D: 5.0 S: 2.6		
PR12/20964/CS12* Rain Forest Green Gloss	T: 7.6 D: 3.7 S: 3.0	PR12/20707/CS3* Lofi Satin	T: 3.8 D: 3.2 S: 3.4	PR12/20151/CS3* RAL 8017 Chocolate Brown Satin	T: 4.6 D: 3.7 S: 2.8		

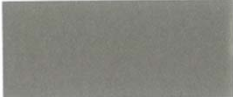
* RoHS - Compliant * Non stock



4.0 Materials Selection.

Manufacture & Fabrication process – Fluorocarbon Coating.

PREMIUM SHADES

 FS 1001 COAL BLACK T: 3.86% D: 2.02% S: 1.84%	 FS 1253 VIVID YELLOW T: 49.38% D: 47.82% S: 1.56%	 FS 1222 LEMON YELLOW T: 69.47% D: 67.75% S: 1.72%
 FS 1255 RICH BROWN T: 6.67% D: 4.72% S: 1.95%	 FS 1708 SERENE BLUE T: 27.20% D: 25.37% S: 1.83%	 FM 3113 CHAMPAGNE GOLD T: 52.66% D: 49.46% S: 3.20%
 FS 1150 COCOA BROWN T: 6.50% D: 4.50% S: 2.00%	 FS 1703 FIESTA BLUE T: 25.45% D: 23.50% S: 1.95%	 FM 3254 METALLIC ROSE PINK T: 46.37% D: 42.78% S: 3.59%
 FS 1453 MOSS GREEN T: 11.86% D: 9.85% S: 2.01%	 FM 3002 METALLIC SILVER T: 61.24% D: 57.02% S: 4.22%	 FM 3508 METALLIC BERYL GREEN T: 18.91% D: 16.72% S: 2.19%
 FS 1541 GRASS GREEN T: 24.88% D: 23.08% S: 1.80%	 FM 3032 GREY SILVER T: 26.32% D: 23.74% S: 2.58%	 FM 3761 METALLIC TWILIGHT BLUE T: 21.16% D: 19.36% S: 1.80%

CLASSIC SHADES

 FS 1555 SMART GREEN T: 12.46% D: 10.74% S: 1.72%	 ▲ FM 3181 HARVEST GOLD T: 52.10% D: 45.42% S: 6.68%	 FM 3088 GLITTER SILVER T: 67.15% D: 58.72% S: 8.43%
 FS 1717 PANTONE BLUE T: 17.04% D: 15.43% S: 1.61%	 FM 3131 PURE GOLD T: 46.60% D: 43.37% S: 3.23%	 FM 3073 STAR SILVER T: 67.36% D: 59.44% S: 7.92%
 FS 1730 ROYAL BLUE T: 9.08% D: 7.24% S: 1.84%	 FM 3263 METALLIC PEARL GREY T: 27.93% D: 25.22% S: 2.71%	 FM 3020 SPARKLE SILVER T: 47.99% D: 43.91% S: 4.08%
 FS 1772 MID BLUE T: 11.48% D: 9.64% S: 1.84%	 FM 3773 METALLIC HORIZON BLUE T: 35.28% D: 32.11% S: 3.17%	 FM 3033 BRIGHT SILVER T: 59.67% D: 54.38% S: 5.29%

▲ Must be 10 - 15 microns above the specified dry film thickness.

EXTERNAL DAYLIGHT REFLECTANCE ON COATED ALUMINIUM SUBSTRATES

T :	Total Reflectance
D :	Diffuse Reflectance
S :	Specular Reflectance
TEST METHOD :	Total, diffuse and specular reflectance measurement - using a spectrophotometer with a 150mm diameter integrating sphere- ASTM E903.

3.0 MATERIALS SELECTION

Type of Coating / Finishes.

Anodic Coating Complying BS3987.



Sample comparison between original based and production panel.



Checking colour tonality / acceptance measurement.
Portable Color Spectrophotometer.

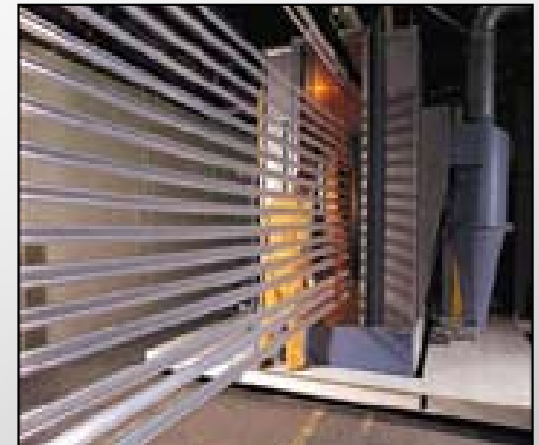
Acceptable reading is ΔE 2-3 – Small difference, visible if viewed side by side.

3.0 MATERIALS SELECTION

Type of Finishes / Coating.

1. Fluorocarbon Coating - AAMA 2605 (佛碳)
 - a. This is the high performance exterior specification.
 - b. Substrates are chemically treated before coating.
 - c. Based material is fluoropolymer resins (PVDF).
 - d. Categorize into 2, 3 & 4 coats system with minimum micron thickness 30, 40 & 50.
 - e. Able to match and produce wide range of colours.
 - f. The surface finishes is in matt.
 - g. Is resistant to moisture, weathering, ozone and UV radiation.

2. Powder coating – AAMA 2604. (粉末涂层)
 - a. This is an intermediate specification.
 - b. Substrates are chemically treated before coating.
 - c. Material is modified polyester resins.
 - d. The minimum thickness is 60 micron -/+.
 - e. Able to match and produce wide range of colours.
 - f. The surface finishes is in semi gloss finish.
 - g. This finish will provide good colour and gloss retention. It will also provide good hardness and abrasion resistance.



Extrusions – Jigged and in process of coating.

3.0 Materials Selection

Type of Coating / Finishes:

Daylight Reflectance of Materials – For Exterior of Buildings.

Selected powder coat or pvdf2 colours are to comply to “Specular Reflectance” not exceeding 10% - BCA circular dated 27 Jun 2016.



Extrusions are dipped into various tanks to rinses and chemical treated via air dry.



Cladding or extrusions being jigged and move into the furnace for coating.

3.0 Materials Selection

Type of Coating / Finishes: % Specular Reflectance Value.

 OXYPLAST	LEA HIN CO. (POWDER MANUFACTURERS) PTE LTD 293, Alexandra Road, Singapore 159940 Tel: 65-64756198 Fax: 65-64736185 E-mail: sales@leahinpowder.com	 OXYPLAST	
To: Whom It May Concern		From: Peter Wong	
Co:			
Fax:		Date: 30 April 2021	
To Whom It May Concern,			
Re: <u>% Daylight Reflectance of Oxyplast Colours</u>			
	% Total Reflectance	% Diffuse Reflectance	% Specular Reflectance
APR/80169/CS40 GREY	14.7	11.1	3.6

Note: The above data are average % reflectance values obtained from readings at 400-700nm wavelength range (visible light); detailed results available upon request. Measurements are done with reference to ASTM E903-12 test method using a spectrophotometer with 152mm diameter integrating sphere.

3.0 Materials Selection

Glass.

- A. Glass shall be based on standard AS1288-2006: Glass in buildings -Selection and installation.
- B. Glass types are as below:
 - a. Annealed glass – Clear, Tinted, Diamant clear (super clear) etc.
 - b. Heat strengthened glass.
 - c. Tempered glass / Heat soaked.
 - d. Laminated glass.
 - e. Insulated glazed unit. (Double glaze unit)
 - f. Low-E performance glass.
 - g. Ceramic frit pattern glass.
 - h. Frosted glass / Sand Blasting..
 - i. Acid wash glass.
 - j. Wire glass.

3.0 Materials Selection

Type of Glass.

1. Annealed Glass (Float Glass).

- a. Blue tinted – Light blue, Dark blue, Blue green etc.
- b. Green tinted- Light green, Dark green.
- c. Grey tinted – Dark grey.
- d. Bronze tinted.
- e. Clear glass.
- f. Diamant clear glass.



Blue tinted



Bronze tinted



Green tinted



Diamant clear

2. Selection of glass type is based on the followings:

- a. Brand name, manufacturers, suppliers.
- b. The Tint , Low-Emissivity Glass, Solar Control, the Colour etc.
- c. The thickness of glass and combination i.e. laminated, double glazed etc.
- d. The glass performance data – Shading co-efficient, U value etc
- e. Acoustic requirements.

3.0 Materials Selection

Types of Glass.

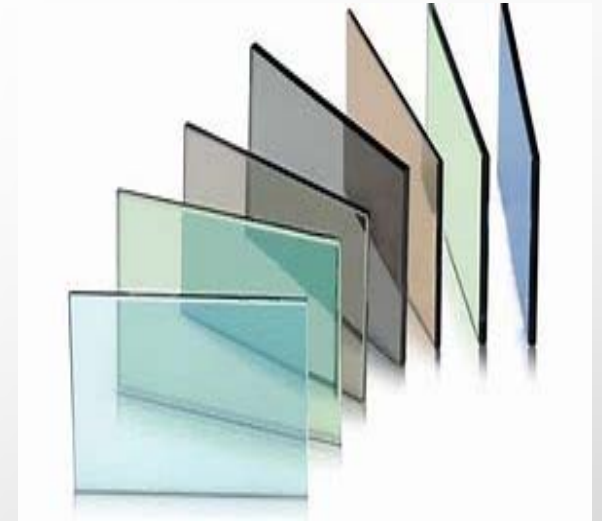


Types of Low-E glass.



Window using Low-E glass

Low-E performance glass /
Solar Control Glass.



Range of tinted glass.

3.0 Materials Selection

Glass – Performance Data.

Important values

INDOFLOT AND PANASAP

INDOFLOT & PANASAP											
Type Of Glass	Standard Thickness (mm)	Light Characteristic			Energy Characteristic				Solar Factor (%)	Shading Coefficient	U Value W/m²K
		Transmittance (%)	Reflectance Out (%)	Reflectance In (%)	Transmittance (%)	Reflectance (%)	Absorption (%)	Ultra Violet Transmissi on (%)			
Indoflot Clear (FL)	2	91	8	8	88	8	4	79	90	1,03	5,9
	3	90	8	8	86	8	6	71	87	1,00	5,8
	4	90	8	8	84	8	8	67	86	0,99	5,8
	5	89	8	8	82	7	11	64	85	0,97	5,8
	6	89	8	8	80	7	13	61	83	0,96	5,7
	8	88	8	8	77	7	16	56	81	0,93	5,7
	10	87	8	8	74	7	19	52	79	0,91	5,6
	12	86	8	8	70	7	23	49	77	0,88	5,5
	15	83	8	8	66	6	28	43	73	0,84	5,5
19	81	7	7	61	6	33	38	69	0,80	5,3	
Panasap Bronze (BRFL)	5	56	6	6	57	6	37	22	67	0,77	5,8
	6	51	6	6	52	6	42	18	63	0,73	5,7
	8	42	5	5	44	5	51	12	57	0,65	5,7
Panasap Dark Grey (DGFL)	3	39	5	5	52	6	42	55	63	0,73	5,8
	4	29	5	5	44	5	51	49	57	0,65	5,8
	5	21	5	5	37	5	58	45	52	0,59	5,8
	6	16	5	5	31	5	64	41	47	0,55	5,7
Panasap Green (GNFL)	5	72	7	7	45	6	49	22	58	0,67	5,8
	6	69	7	7	41	5	54	18	55	0,63	5,7
	8	63	6	6	33	5	62	12	49	0,57	5,7
	10*	57	6	6	28	5	67	9	45	0,52	5,6
	12	52	6	6	24	5	71	6	42	0,48	5,5
Panasap Euro Grey (GEFL)	5	51	6	6	51	6	43	24	62	0,72	5,8
	6	45	5	5	46	5	49	20	58	0,67	5,7
	8	36	5	5	37	5	58	14	52	0,59	5,7
	10*	28	5	5	29	5	66	10	46	0,53	5,6
	12	22	5	5	23	5	72	7	42	0,48	5,5
Panasap Blue Green (BNFL)	5	67	6	6	46	5	49	26	58	0,67	5,8
	6	62	6	6	41	5	54	22	55	0,63	5,7
	8	55	6	6	33	5	62	16	49	0,56	5,7
Panasap Dark Blue (DHFL)	6	58	6	6	45	5	50	29	58	0,67	5,7
	8	50	5	5	37	5	58	23	52	0,60	5,7
	10*	43	5	5	30	5	65	18	47	0,54	5,6
	12	36	5	5	25	5	70	15	43	0,50	5,5
Panasap New Dark Blue (DHNFL)	5	50	6	6	41	5	54	26	55	0,63	5,8

3.0 Materials Selection.

Type of Glass.

MONOLITHIC ACOUSTICAL DATA

The performance data below applies to monolithic glass. Data is based on testing ~36" x 84" glass to ASTM E413-87 in an acoustical wall. *OITC is estimated based on this test. Glass size and glazing system will affect STC rating. The monolithic glass is one lite of glass.

Monolithic Glass Construction	STC	OITC*	Frequency (Hz)																	
			100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
			Sound Transmission Loss (dB)																	
1/8" overall - 1/8" glass	30	25	19	17	18	21	23	22	24	27	28	30	30	32	34	35	36	33	26	30
1/4" overall - 1/4" glass	31	29	23	25	25	24	28	26	29	31	33	34	34	35	34	30	27	32	37	31
3/8" overall - 3/8" glass	34	32	26	27	27	30	32	31	34	35	36	35	33	30	30	35	38	41	46	48
1/2" overall - 1/2" glass	36	33	26	30	26	30	33	33	34	36	37	35	32	32	36	40	43	46	50	51

6mmt glass – 31 STC reading

3.0 Materials Selection.

Type of Glass.

32mm DGU consist of 10mmt glass + 12mm airspace + 10mmt glass – 37 STC reading

INSULATING ACOUSTICAL DATA



Viracon Acoustical Glass is made from combinations of various glass types along with acoustical window frames to help you effectively reduce sound transmission from airplanes, trains, vehicles and other unwanted noises. The performance data below applies to an insulating unit constructed with two plies of glass and an air or argon filled space. Data is based on testing ~36" x 84" glass to ASTM E413-87 in an acoustical wall. *OITC is estimated based on this test. Glass size and glazing system will affect STC rating.

The **STC (Sound Transmission Class)** rating is a single-number rating system for interior building partitions and viewing windows used to categorize acoustic performance. Its original intent was to quantify interior building partitions not exterior wall components. As a result it is not recommended for glass selection of exterior wall applications since the single-number rating was achieved under a specific set of laboratory conditions.

The **OITC (Outside-Inside Transmission Class)** rating is used to classify acoustic performance of glazing in exterior applications.

Insulating Glass Construction	STC	OITC*	Frequency (Hz)																	
			100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
			Sound Transmission Loss (dB)																	
1/2" overall - 1/8" glass, 1/4" airspace, 1/8" glass	28	26	26	21	23	23	26	21	19	24	27	30	33	36	40	44	46	39	34	45
5/8" overall - 1/8" glass, 3/8" airspace, 1/8" glass	31	26	26	23	23	20	23	19	23	27	29	32	35	39	44	47	48	41	36	43
1" overall - 1/4" glass, 1/2" airspace, 1/4" glass	35	30	27	24	29	22	22	25	30	33	35	38	40	42	42	37	37	43	46	49
1" overall - 1/4" glass, 1/2" argon space, 1/4" glass	35	29	32	29	28	22	20	25	30	33	37	40	43	45	44	39	40	45	49	52
1" overall - 1/4" glass, 9/16" airspace, 3/16" glass	37	30	32	26	25	20	24	29	33	34	38	41	43	46	46	42	36	43	48	53
1-1/8" overall - 5/16" glass, 1/2" airspace, 5/16" glass	37	32	26	24	25	31	24	32	32	35	37	39	39	38	36	38	42	44	46	49
1-1/4" overall - 3/8" glass, 1/2" airspace, 3/8" glass	37	32	29	23	23	29	31	34	34	35	36	36	35	35	36	40	43	47	49	48
1-1/2" overall - 1/4" glass, 1" airspace, 1/4" glass	37	30	22	19	27	23	31	30	35	35	36	39	41	42	41	36	37	46	51	56
1-1/16" overall - 1/4" glass, 1/2" airspace, 5/16" glass	38	33	30	24	29	26	29	33	34	36	39	41	41	40	38	37	39	43	46	48
1-1/4" overall - 1/4" glass, 3/4" airspace, 1/4" glass	38	31	27	23	28	21	27	29	34	35	37	41	43	45	44	39	39	46	49	52
1-1/8" overall - 1/4" glass, 1/2" airspace, 3/8" glass	39	34	28	26	32	29	29	31	35	37	38	39	41	43	41	40	41	44	47	49
1-3/16" overall - 5/16" glass, 1/2" airspace, 3/8" glass	39	34	29	26	26	31	30	37	36	37	39	39	40	37	35	39	43	46	48	49
1-3/8" overall - 1/4" glass, 3/4" airspace, 3/8" glass	40	33	30	23	31	28	33	37	39	40	41	39	38	38	39	39	40	47	51	53

3.0 Materials Selection.

Type of Glass.



32mm DGU consist of 6mmt glass + 1.52mmt PVB Interlayer + 3mmt glass – 37 STC reading

LAMINATED ACOUSTICAL DATA

The performance data below applies to laminated glass units constructed with two plies of glass and an interlayer. Data is based on testing ~36" x 84" glass to ASTM E413-87 in an acoustical wall. *OITC is estimated based on this test. Glass size and glazing system will affect STC rating.

Laminated Glass Construction	STC	OITC*	Frequency (Hz)																	
			100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
			Sound Transmission Loss [dB]																	
1/4" overall - 1/8" glass, .015" PVB, 1/8" glass	33	30	27	23	27	24	27	28	29	31	33	35	35	35	33	31	32	37	41	45
3/16" overall - S/S glass, .030" PVB, S/S glass	35	31	29	29	29	25	27	29	29	31	32	34	34	34	34	35	33	36	39	41
1/4" overall - 1/8" glass, .030" PVB, 1/8" glass	35	31	25	26	28	27	29	29	30	32	34	35	35	36	36	35	35	38	43	46
1/4" overall - 1/8" glass, .045" PVB, 1/8" glass	35	31	24	27	27	28	28	29	30	32	34	35	36	36	37	36	35	38	43	46
5/16" overall - 1/8" glass, .060" PVB, 1/8" glass	35	31	25	25	26	29	28	30	30	32	34	35	35	36	36	36	36	39	43	46
3/8" overall - 3/16" glass, 0.15" PVB, 3/16" glass	36	32	27	25	26	30	31	31	33	35	35	35	35	33	33	37	41	44	48	51
3/8" overall - 3/16" glass, .030" PVB, 3/16" glass	36	33	27	27	27	30	31	31	33	34	35	36	36	35	34	37	41	45	49	52
3/8" overall - 1/4" glass, .030" PVB, 1/8" glass	36	33	27	28	26	30	31	31	32	34	35	36	36	35	35	36	40	44	48	51
1/2" overall - 1/4" glass, .015" PVB, 1/4" glass	36	32	25	25	27	30	32	32	34	35	35	35	33	32	35	40	43	46	49	51
9/16" overall - 1/4" glass, .075" Storm, 1/4" glass	36	35	27	30	30	31	31	33	32	33	34	35	35	34	36	40	43	45	47	47
9/16" overall - 1/4" glass, .090" SGP, 1/4" glass	36	34	31	30	29	31	32	33	33	34	35	35	34	32	34	37	40	42	44	47
7/16" overall - 1/4" glass, .060" PVB, 1/8" glass	37	33	27	28	27	30	31	31	33	35	36	37	37	37	36	37	41	44	48	51
9/16" overall - 1/4" glass, .100" StormGuard, 1/4" glass	37	35	32	31	30	31	33	34	34	34	35	36	35	35	37	41	44	47	49	51
1/2" overall - 1/4" glass, .030" PVB, 1/4" glass	38	34	25	29	28	30	33	33	34	36	37	37	37	36	37	41	45	48	51	53
1/2" overall - 1/4" glass, .045" PVB, 1/4" glass	38	34	26	30	27	30	33	33	34	36	37	38	37	36	37	41	45	48	51	54
9/16" overall - 1/4" glass, .060" PVB, 1/4" glass	39	34	26	29	28	30	33	33	35	36	37	38	38	37	38	41	44	47	51	54
3/4" overall - 1/2" glass, .030" PVB, 1/4" glass	39	36	31	35	33	33	34	36	36	37	36	35	34	39	41	46	48	50	52	56
5/8" overall - 3/8" glass, .030" PVB, 1/4" glass	40	36	29	30	28	32	34	35	36	38	38	38	36	38	42	46	49	52	55	57
13/16" overall - 1/2" glass, .060" PVB, 1/4" glass	41	36	29	30	29	32	35	35	37	38	38	38	37	41	44	48	50	53	56	56

3.0 Materials Selection

Glass – Types.

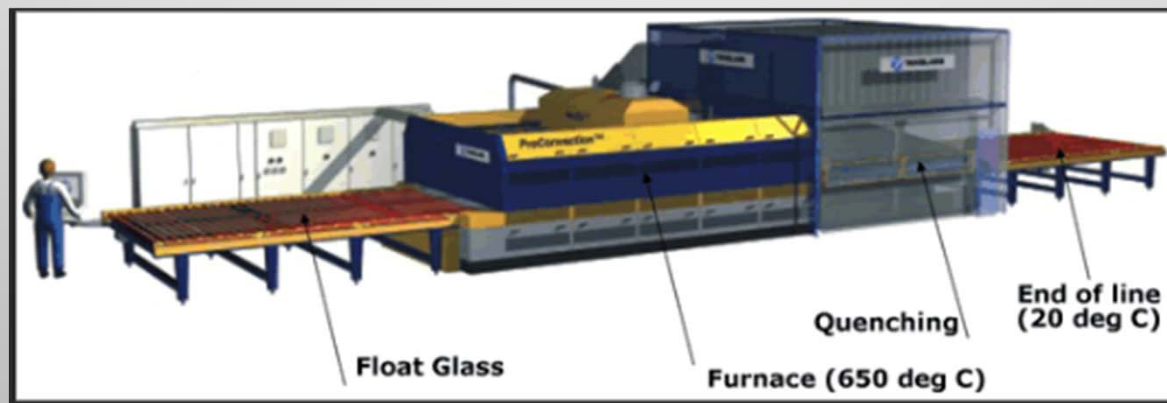
b. Heat strengthened glass.



Designation: C 1048 – 04

Standard Specification for
Heat-Treated Flat Glass—Kind HS, Kind FT Coated and
Uncoated Glass¹

1. The float glass is being heat treated in the furnace at a temperature of +/- 670 degree celsius.
2. In heat strengthened process, it undergoes a “slower cooling process” than tempered glass resulting in lower compressive strengthened.
3. Heat strengthened glass is approximately twice as strong as a regular annealed glass of the same thickness.
4. Heat strengthened glass is proposed to used for spandrel glass panels of the façade glass wall.
5. The surface appearance of the glass is less wavy as compared to tempered glass.



3.0 Materials Selection

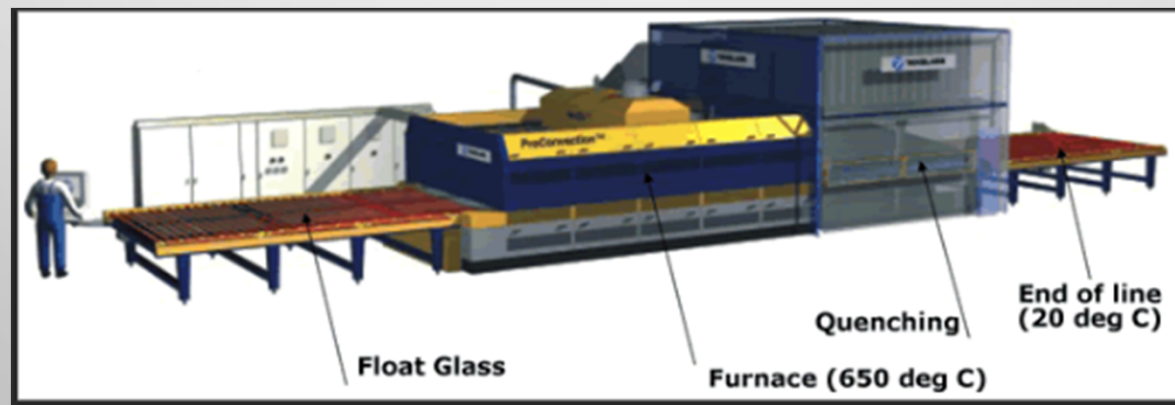
c. Tempered Glass.



Designation: C 1048 – 04

Standard Specification for
Heat-Treated Flat Glass—Kind HS, Kind FT Coated and
Uncoated Glass¹

1. The float glass is being heat treated in the furnace at a temperature of +/- 670 degree celsius.
2. In the process, the glass is “cooled rapidly” and therefore, creating a higher surface compression and edge compression in glass.
3. Tempered glass is 4 to 5 times the strength of annealed glass of the similar thickness.



3.0 Materials Selection.

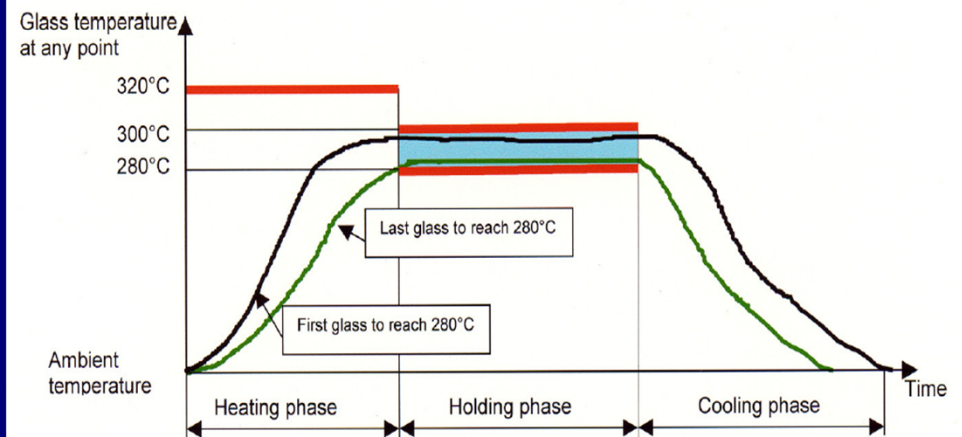
Type of Glass.

To minimize the risk of spontaneous breakage in fully tempered glass caused by nickel sulfide inclusions.

Heat Soak Test EN 14179-1



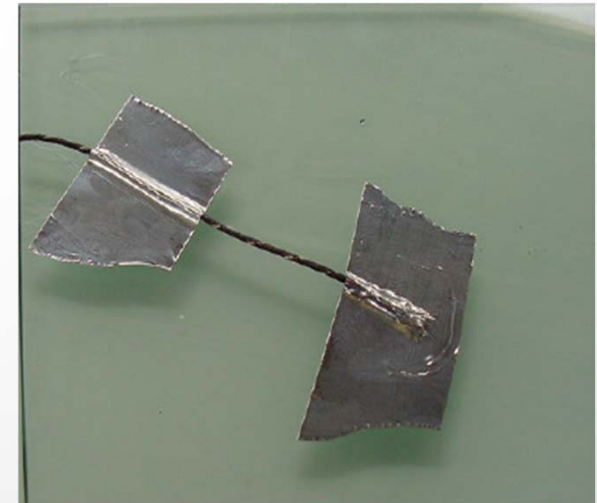
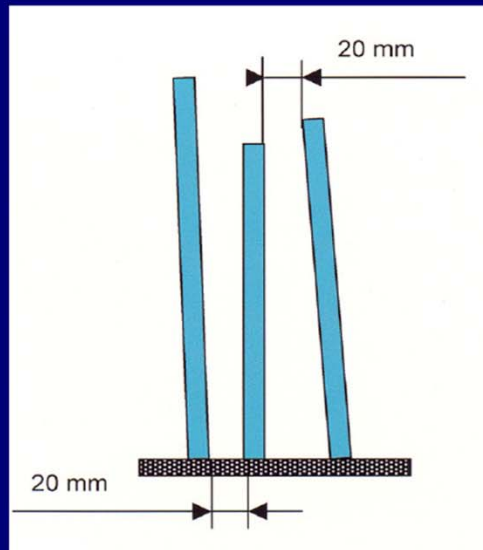
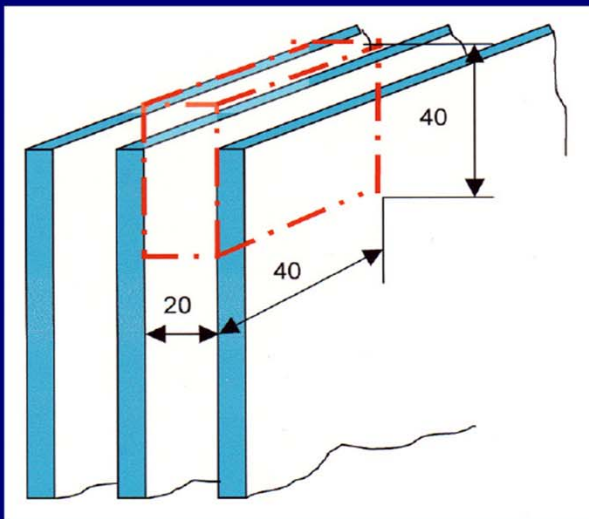
Heat soak process cycle EN 14179



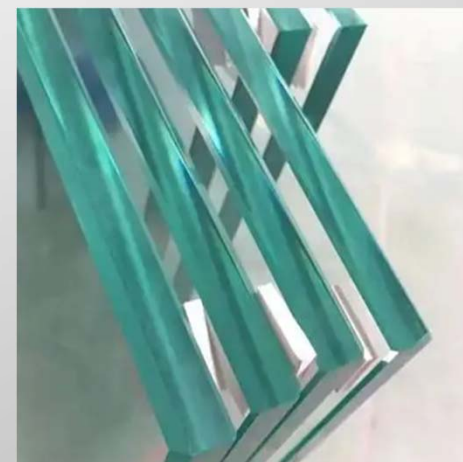
3.0 Materials Selection.

Glass – Heat Soaked.

Recommended glass support and separation



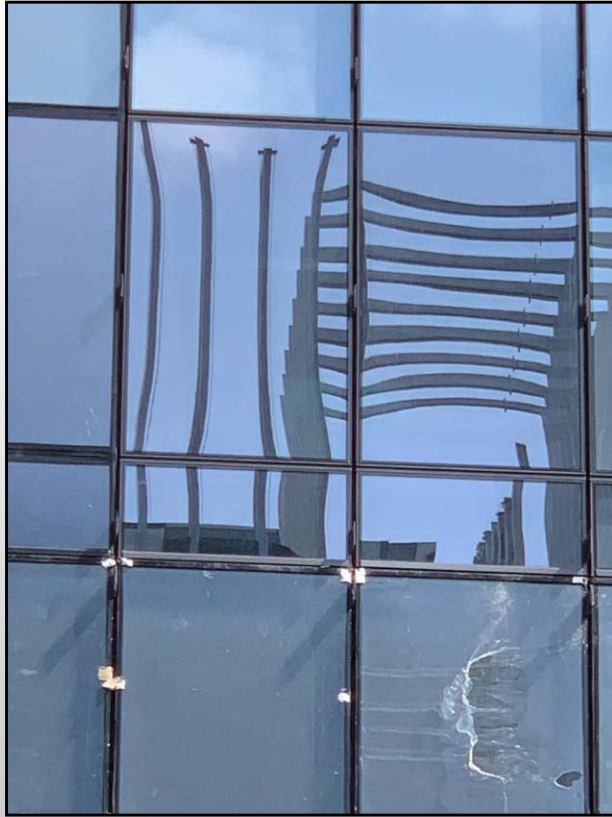
Thermocouple on glass



Spacer of glass

3.0 Materials Selection.

Glass – Appearance after installed.



Waviness / distorted on glass surface is observed from the external of the façade.



External view of the glass façade is acceptable.

3.0 Materials Selection.

Glass.

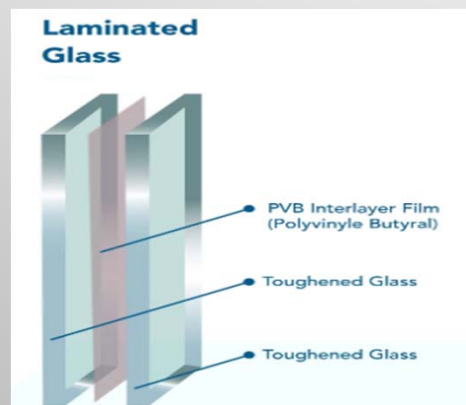


Designation: C1172 – 09

d. Laminated glass.

Standard Specification for
Laminated Architectural Flat Glass¹

1. It is the process of sandwiching 2 pieces of the glass together with PVB interlayer in between.
2. PVB interlayer comes in standard thickness of 0.38mm, 0.76mm, 1.52mm etc.
3. Sentry Glass Interlayer is an interlayer for safety glass that boast 5 times the strength and 100 times the stiffness of the conventional PVB film. It cost many times more than normal type. Thickness: 0.89 mm (35 mil), 1.52 mm (60 mil), 2.28 mm (90 mil), 2.53 mm (100 mil)
4. Laminated glass is classified as safety glass and is mandatory use for railings and barriers.
5. Laminated Glass achieve a slightly better acoustic performance versus a Double Glazed Unit.



Laminated Glass Formation

3.0 Materials Selection.

Glass.

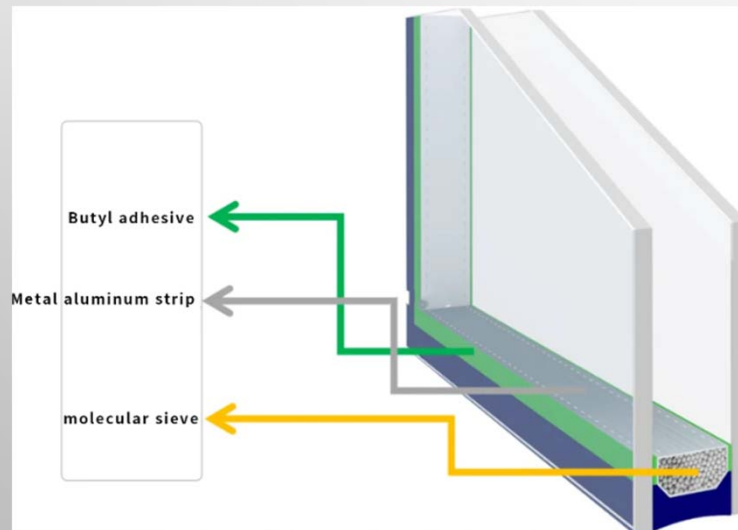


Designation: E 2190 – 08

Standard Specification for
Insulating Glass Unit Performance and Evaluation¹

e. Insulated glazed unit. (Double Glazed Unit)

1. It is process of placing 2 pieces of the glass in between a spacer (desiccant - absorb moisture and humidity within the air space to keep window from condensation and fogging,) with perimeter seal.
2. Able to achieve a better thermal insulation versus laminated glass.
3. Commonly design as vision glass panels for office buildings.



Double Glazed Formation



Double Glazed Unit

3.0 Materials Selection.

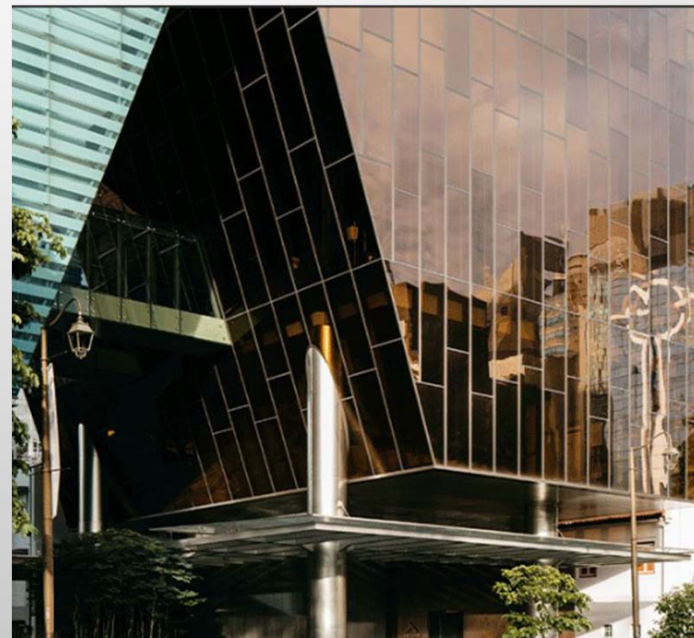
Glass.

f. Low-Emissivity glass.

1. Low-E glass is a type of energy efficient glass that has microscopically thin coating applied to it, which minimizes the infrared and ultraviolet light that passes through while allowing visible light to enter.
2. The coating reflects heat, allowing the glass window significantly more energy- efficient.
3. Good performance product will have very low SC value and thus provides greater performance against solar transmittance thorough the building .



Low-E Glass



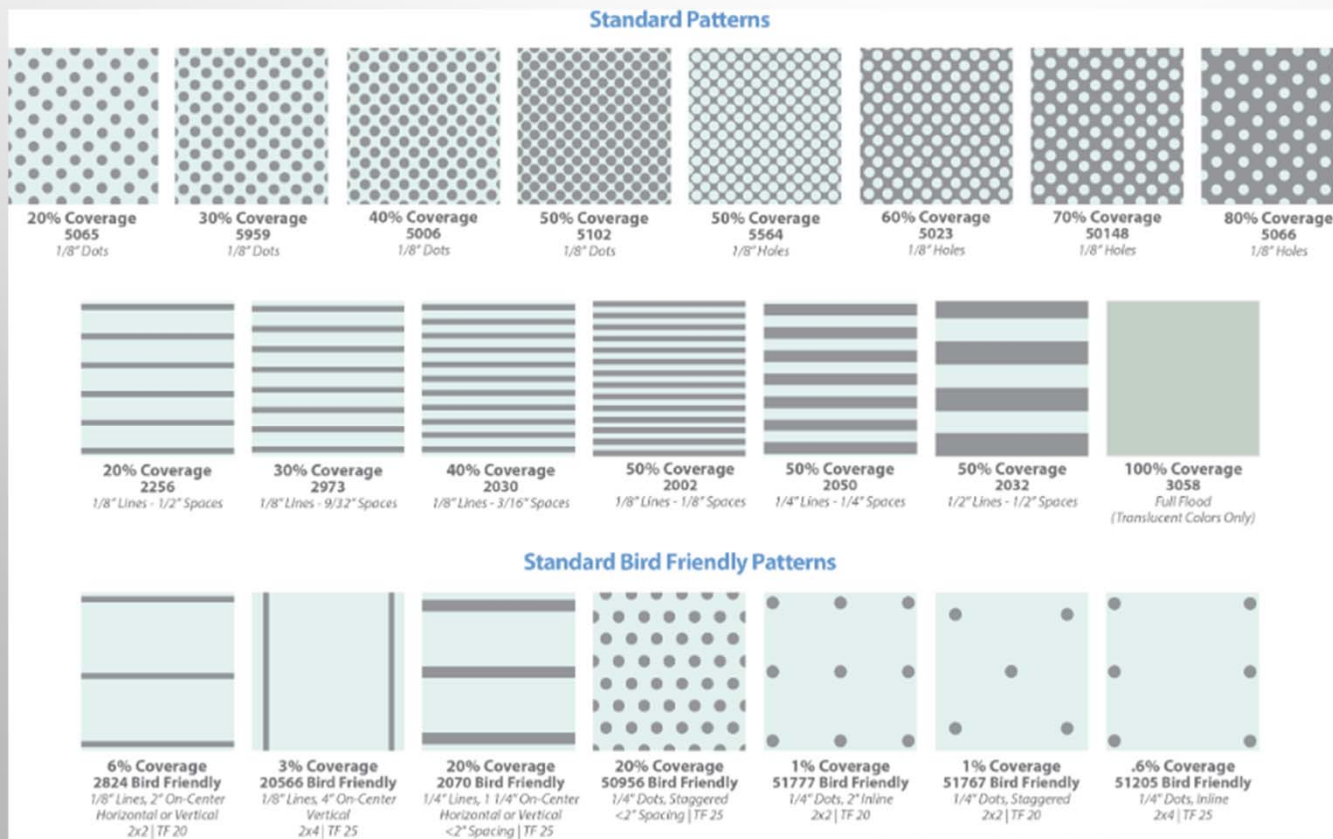
Low-E Glass Facade

3.0 Materials Selection.

Glass.

g. Ceramic frit glass.

1. The inner surface of the glass is applied with layers of paint and heated in the furnace.
2. Available in solid full frits on various colour.
3. Frit patterns such as pokka dots, squares, odd shapes are commonly use.



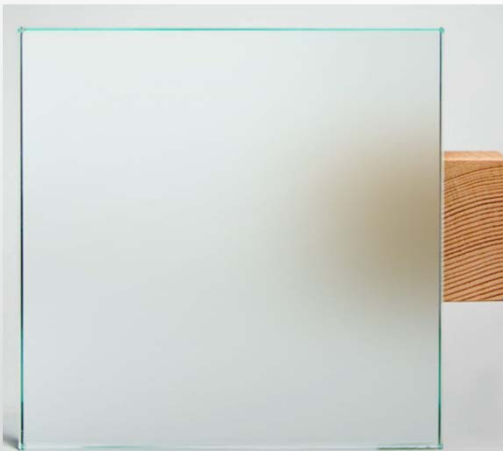
Colour Chart

3.0 Materials Selection.

Glass.

h. Frosted glass.

1. The inner glass surface is being blasted with fine sand to the desire rough surface.



Frosted Glass

The glass is opaque on one surface and is rough.
Easily stain – finger print, oil, dust, dirt
Removal of stain is difficult.

i. Acid treated glass.

1. Glass surface is treated with acid application to the desire smooth finish.

The glass is opaque on one surface
but it is much smoother than sand
blast finish.
Stains can be easily wash &
remove.



Acid Edge Treated Glass

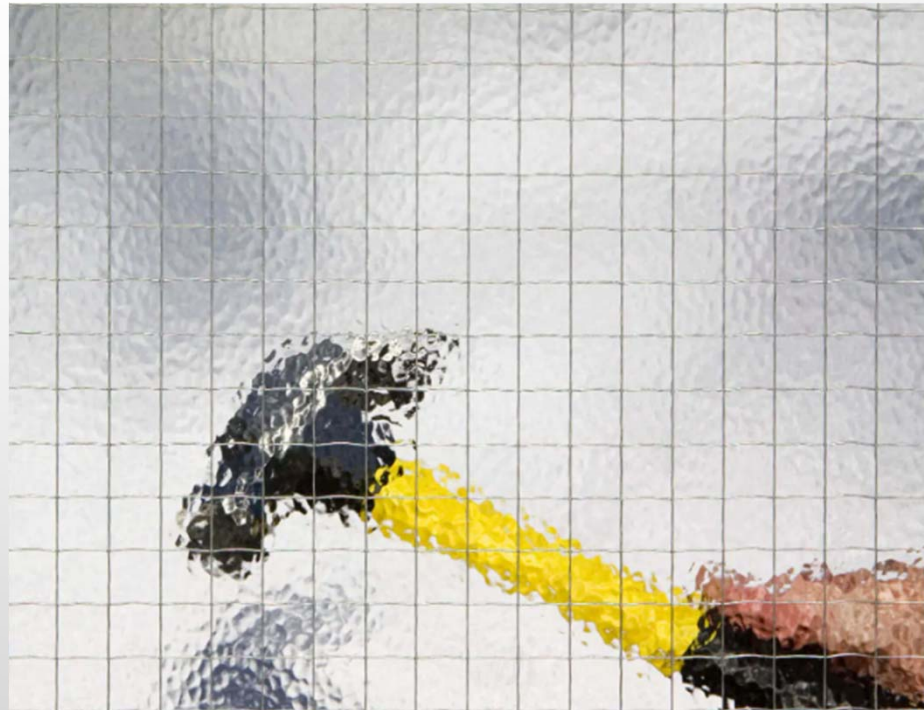
3.0 Materials Selection.

Types of Glazing

- j. Wire glass.
 - a. Use as security barrier – Safety usage such as in Mental Hospital etc.



Wire Glass



3.0 Materials Selection

Brackets, Screws, Anchors Bolts, Basic Hardware.

- a. Stainless Steel complying BS EN 10088
- b. Aluminium complying BS EN 755 (euro code)
- c. Steel materials with the acceptable finish:
 - G.I. sheet, fixing lugs for window frame installation.
 - Hot dip galvanizing (steel supports / brackets)
 - Sprayed zinc coating (for touch up works)
 - Carbon steel – zinc coated fastener.
 - Zinc chromate paint finishes.

3.0 Materials Selection.

Operating and Bearing Devices for Window.

- a. Stainless steel friction stay – Top hung, casement window.
- b. Cast alloy hinges – Casement window.
- c. Cam handles – Casement and top hung window.
- d. Locking devices – Casement and top hung window.
- e. Wind block – Casement window only.
- f. Crescent lock – Sliding window.
- g. Stopper – Sliding window – Jumping Track.
- h. Sliding roller – Sliding window.

3.0 Materials Selection.

Operating and Bearing devices.



a. Stainless steel friction stay



b. Stainless steel restrictors



c. Cast alloy cam handle



e. Casement guider



d. Locking device – dual lock

3.0 Materials Selection.

Types of Stainless-Steel Friction Stay.

Stainless steel friction stay is use to secure to the outer and window inner frame to facilitate the function of opening.

It consist of a wide range of products which you have to select to meet the specifications and functions.



Stay – open 90 degree with
Minimum edge distance



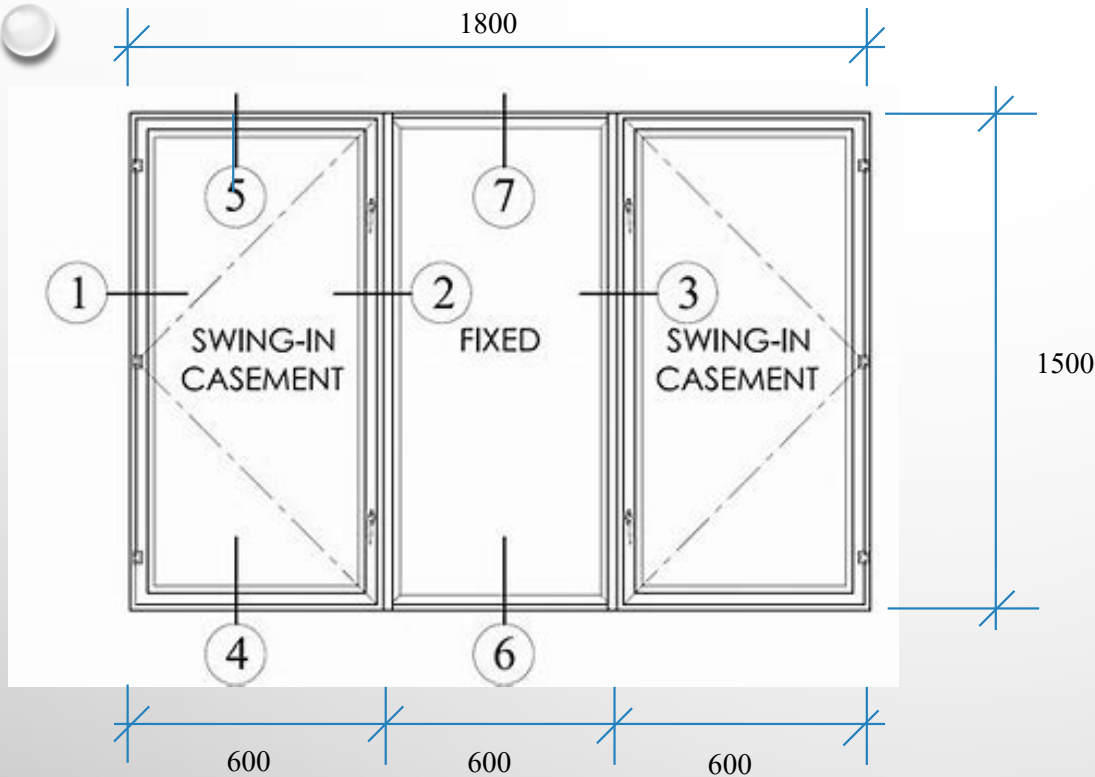
Standard stay – open at
90 degree with gap of
210mm



Stay with Press Button Control –
Open at 30degree, lock.
Press to release to full 90 degree.

3.0 Materials Selection.

Types of Stainless-Steel Friction Stay.



Specification:

1. Inner frame CA100 – 0.791kg/m
2. 8mmt tinted glass – 20kgm²
3. Hardware – Allow for 1kg

Calculation of Friction Stay:

1. Inner frame CA100
 - a. $(0.6 \times 2) + (1.5 \times 2) = 4.2\text{kg}$
2. Tinted Glass
 - a. $0.6\text{m} \times 1.5\text{m} = 0.9 \times 20\text{kg/m}^2 = 18\text{kg}$
3. Hardware
 - a. 1.0kg

Total weight of 1 single casement window with glass:

$$1.a + 2.a + 3.a = \underline{\underline{23.2 \text{ kg}}}$$

Choose a suitable type of stainless steel stay range from the catalogue.

Beside the above, also need to consider the width of each individual casement frame.

3.0 Materials Selection – Casement/top hung

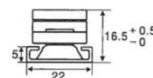
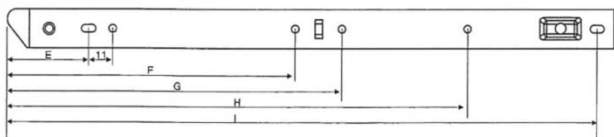
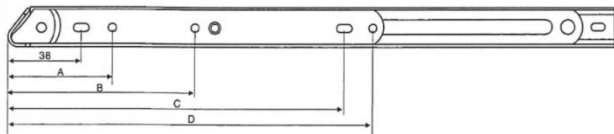
Stainless Steel Friction Stay for Casement Window.

左右角仔型鉸鏈 Left and Right Handed Friction Stay

- ◆選用優良的(304#)不銹鋼製造。
- ◆五萬次嚴格開關測試後仍能操作正常，確保恒久耐用。
- ◆可調節角度，祇需要把定位滑塊調節至所需角度即可。
- ◆左右角仔型鉸鏈分左右方向。
- ◆質量符合新加坡SS212:1998和香港房署標準。
- ◆符合中國建築工業行業JG/T127-2007標準。
- ◆產品隨着技術的改進，某些參數會有所變化。

鋁窗規格 Sash Size

型號 Description	窗最高(mm) Max.Vert.Height/mm	窗最寬(mm) Max.Vert.Width/mm	窗最重(kg) Max.Vert.Weight/Kg	開窗角度 Opening Angle ± 2°	連杆數 Arm Qty
08	850	500	20	58 ± 2°	4
10	1000	600	24	87 ± 2°	4
12	1500	700	28	87 ± 2°	4
14	1500	700	33	87 ± 2°	4
16	1600	700	36	87 ± 2°	4
18	1600	800	43	87 ± 2°	4
20	1800	800	48	87 ± 2°	5
22	1800	900	50	87 ± 2°	5
24	1800	1000	52	45 ± 2°	5



客戶安裝尺寸 The Installation Dimensions(mm)

單位: mm

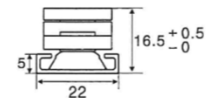
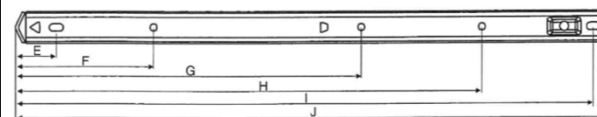
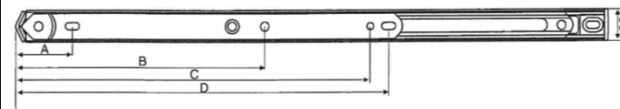
型號規格	A	B	C	D	E	F	G	H	I
10	58	—	123.5	135.5	36	190	217	—	260
12	58	—	207	219	36	215	242	—	304
14	58	—	224	236	36	238.5	265.5	304.5	348.5
16	58	—	244	256	36	266.5	293.5	358.5	402.5
18	58	—	260	272	36	288	315	411	455
20	58	157	271.5	284.5	36	309	336	442.5	504
22	58	173	299	312	36	345	372	491	553
24	58	195	324	327	36	203	230	535	597

帶按掣鉸鏈 Friction Stay With Press Button Device

- ◆選用優良的(304#)不銹鋼製造。
- ◆五萬次嚴格開關測試後仍能操作正常，確保恒久耐用。
- ◆多角度定位，開到固定角度時自動定位，按下按掣，可繼續開到下一個固定角度，再按下按掣，可開到最大角度。
- ◆質量符合新加坡SS212:1998和香港房署標準。
- ◆符合中國建築工業行業JG/T127-2007標準。
- ◆產品隨着技術的改進，某些參數會有所變化。

鋁窗規格 Sash Size

型號 Description	窗最高(mm) Max.Vert.Height/mm	窗最寬(mm) Max.Vert.Width/mm	窗最重(kg) Max.Vert.Weight/Kg	開窗角度 Opening Angle ± 2°
12	1500	600	22	30° / 60° / 90°
14	1500	700	28	30° / 60° / 90°
16	1600	700	35	30° / 60° / 90°
18	1600	800	40	30° / 60° / 90°
20	1800	1000	43	30° / 60° / 90°



客戶安裝尺寸 The Installation Dimensions(mm)

單位: mm

型號規格	A	B	C	D	E	F	G	H	I
12	75	—	198	211	31	210	237	—	299
14	93	—	215	228	31	234	261	300	343
16	114	—	235	248	31	261	288	353	397
18	132	—	251	264	31	283	310	406	450
20	57	157	271.5	284.5	31	304	331	437.5	499

3.0 Materials Selection – Casement / Top Hung.

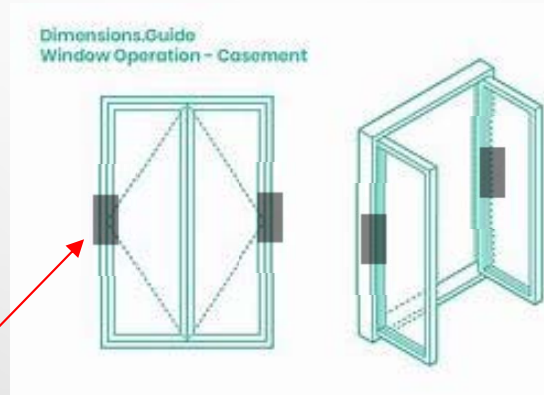
Operating and Bearing Devices for Casement Window.

The wind block is provided when the casement window exceeded the height of more than 1200mm.

This is to resist buckling when the vertical inner sash is subject to wind load.



Part view of an casement window
- installed with wind block.



Wind block – resist buckling when
subject to wind load.

3.0 Materials Selection – Casement / Top Hung.

Operating and Bearing devices.

1. Stainless steel restrictor is basically adopted when the opening glass panel is very high, such as above 1500mm. This is will enable to control the opening angle of the top hung window.
2. The safety child lock is to use for safety reason and also control the opening of the glass panel.



Stainless steel restrictor – restrict the opening angle.



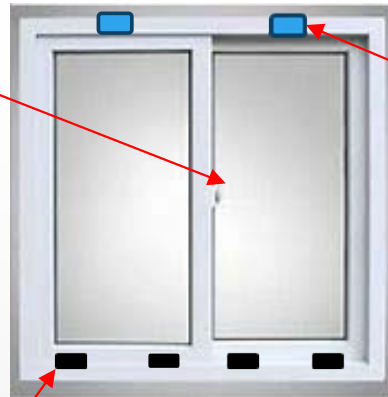
Safety child lock – with key.

3.0 Materials Selection – Sliding Window.

Operating and Bearing devices.



e. Crescent lock for sliding window



f. Nylon stopper – sliding window



g. Sliding window roller



h. Location of stoppers

3.0 Materials Selection – Aluminium Window.

Visual Mock Up Sample.



Typical full size mock up sample



Typical full size mock up sample

3.0 Materials Selection – Aluminium Window.

Operating and Bearing devices – Test report

Test Report No. 7191069252-MEC13-02-DL
dated 27 Sep 2013


PSB Singapore

TEST RESULTS:

Endurance of Fastener or Hardware (E.9 Test 8)

Sample Reference		Number of cycles						SS 212 : 2007 Requirements
		Initial	10,000	20,000	30,000	40,000	50,000	
Observation		No visual damage is observed.						No visual damage to the fastener / hardware shall be detected.
Ease of fastener operation	Torque applied on fastener to close the sash (Nm)	2.9	2.9	2.9	2.9	2.9	2.9	10 maximum
	Torque applied on fastener to open (release) the sash (Nm)	3.1	3.1	3.1	3.1	3.1	3.1	
Ease of movement of sash	Force to initiate movement (N)	68.7 (open)	55.9 (open)	45.1 (open)	45.1 (open)	37.3 (open)	37.3 (open)	80 maximum (area of sash = 0.90 m ²)
		74.6 (close)	68.7 (close)	68.7 (close)	68.7 (close)	62.8 (close)	62.8 (close)	
	Force to sustain movement (N)	63.8 (open)	39.2 (open)	34.3 (open)	31.4 (open)	29.4 (open)	29.4 (open)	
		63.8 (close)	49.1 (close)	45.1 (close)	45.1 (close)	39.2 (close)	39.2 (close)	

Results: Passed.
Remarks: (1) No visual damage is observed.
(2) The top hung window remains operable (open, close & lock) after 50,000 cycles of endurance test.


David Li
Associate Engineer


Ong Khay Beng
Engineer
Building
Mechanical Centre

Results on the endurance / operational test.

Test Report No. 7191069252-MEC13-02-DL
dated 27 Sep 2013


PSB Singapore

APPENDIX: PHOTOS TAKEN DURING TEST

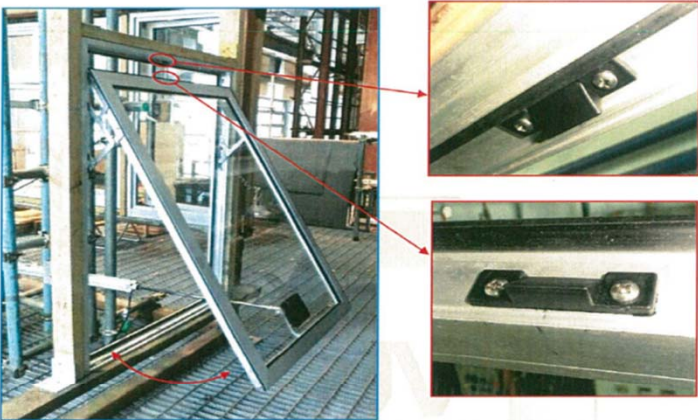


Figure 1: Endurance of fastener or hardware



Figure 2: 18 inch friction stay before endurance test


David Li

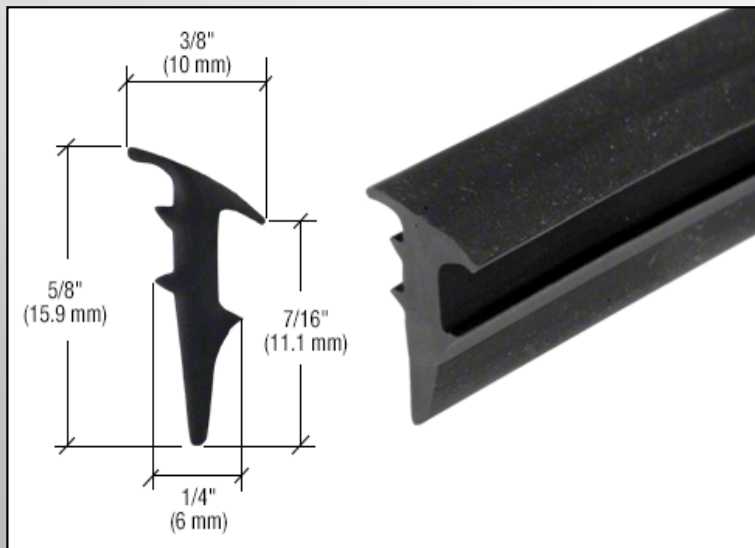
Page 3 of 7

Product is reviewed after endurance test.

3.0 Material Selection.

Gaskets.

- a. Gasket is manufactured in various sizes and shapes as per the design requirements / specifications.
- b. Recommended colour is only “black” only.
- c. Materials used as:
 - a. Neoprene
 - b. Santoprene
 - c. EPDM synthetic rubber (Ethylene Propylene Diene Monomer) or equivalent



Profile of Gasket.

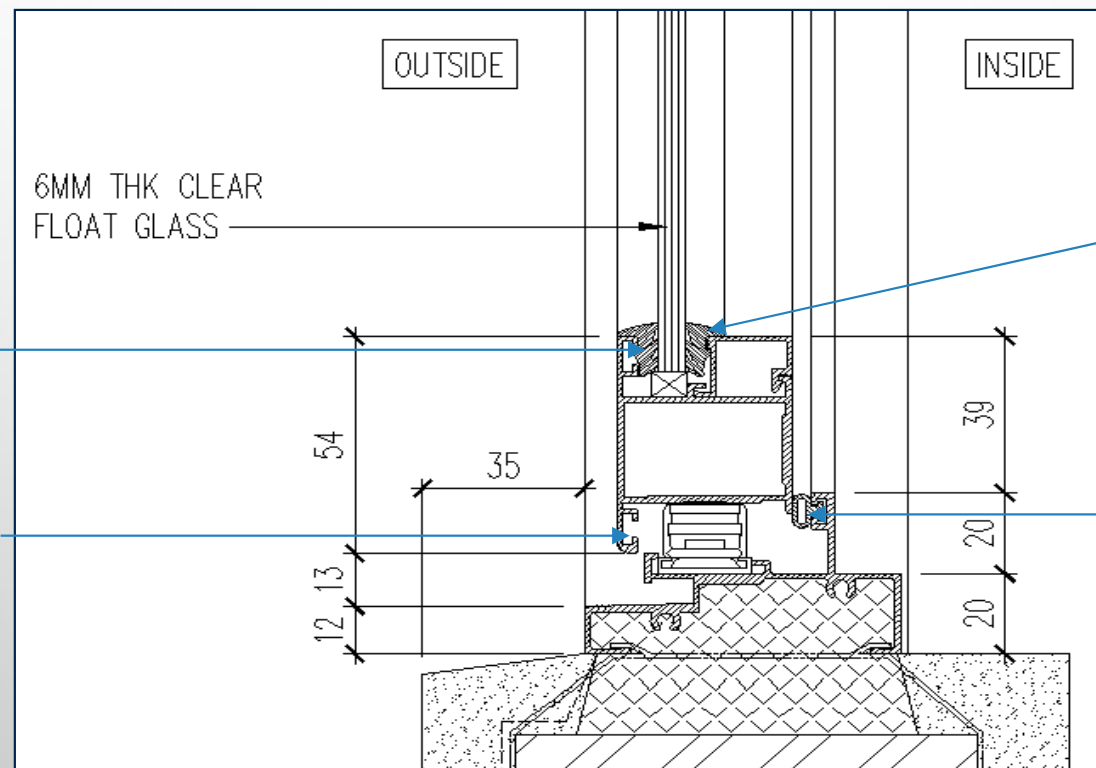


3.0 Material Selection

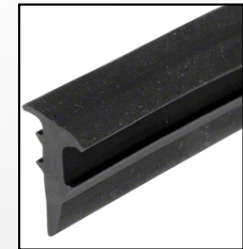
Window Gasket.

Glazing gasket
inserted in factory.

Glazing gasket
inserted in factory
but to provide break
off at weep holes
location.



Typical section details of window sill.

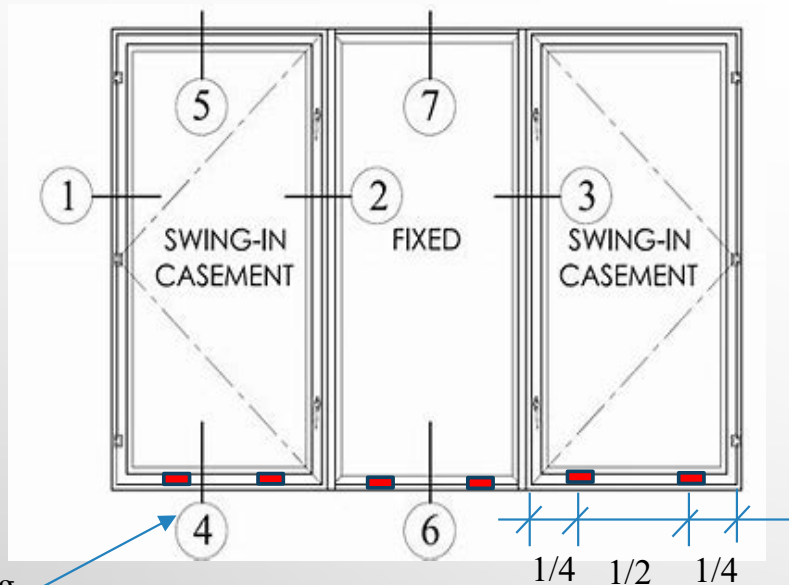


Glazing gasket
inserted on site.

Glazing gasket
inserted in factory.

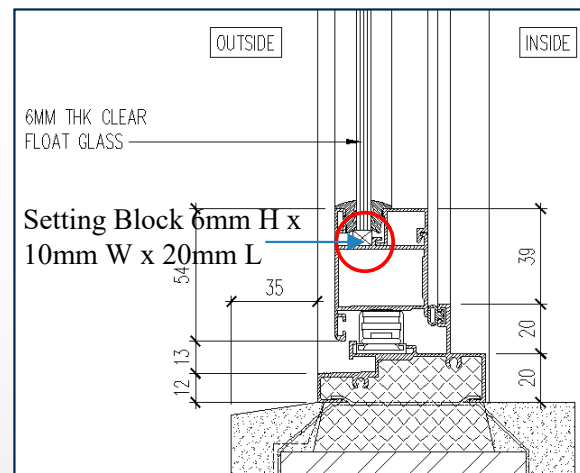
3.0 Material Selection

Window – Setting Block.

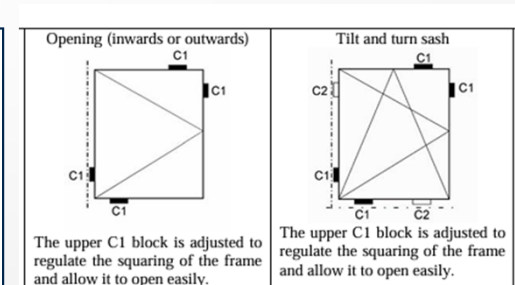


Setting
block
location

Casement cum fixed glass window.



Section thru casement window – Detail 4.



To regulate the squareness of frame.



Setting block 85+/- Shore A Durometer Block at 1/4 with length depending upon the glass area.

- Material: Ethylene Propylene Diene Monomer (EPDM) rubber.
- Hardness: Often specified in Shore A, with common ranges from 50 to 90, though values like 65+/-5 Shore A are frequently used.

3.0 Material Selection

Silicone sealant.

- a. Weather silicone sealant.
- b. Polyurethane sealant.
- c. Acrylic sealant – Internal use only and paintable.
- d. Structural silicone sealant.
- e. Non-bleed weather seal.



Type of silicone sealant.

Dow Corning® 791 Silicone Building Sealant

COLOR		CRT	SGE	2 GAL PAIL	4.5 GAL PAIL	DRUM
	Black	MTS	MTS	MTO	MTS	SS
	Bronze	MTS	MTS	MTO	MTO	NS
	Camel	MTS	MTO	MTO	MTO	MTS
	Gray	MTS	MTS	MTO	NS	MTO
	Limestone	MTS	MTS	MTO	MTO	MTO
	Precast White	SS	MTS	MTO	MTO	MTO
	White	MTS	MTS	NS	MTO	NS

Availability:

MTS/SS: Typically a stocked item

NS: No inventory available and lead time varies based on product/size

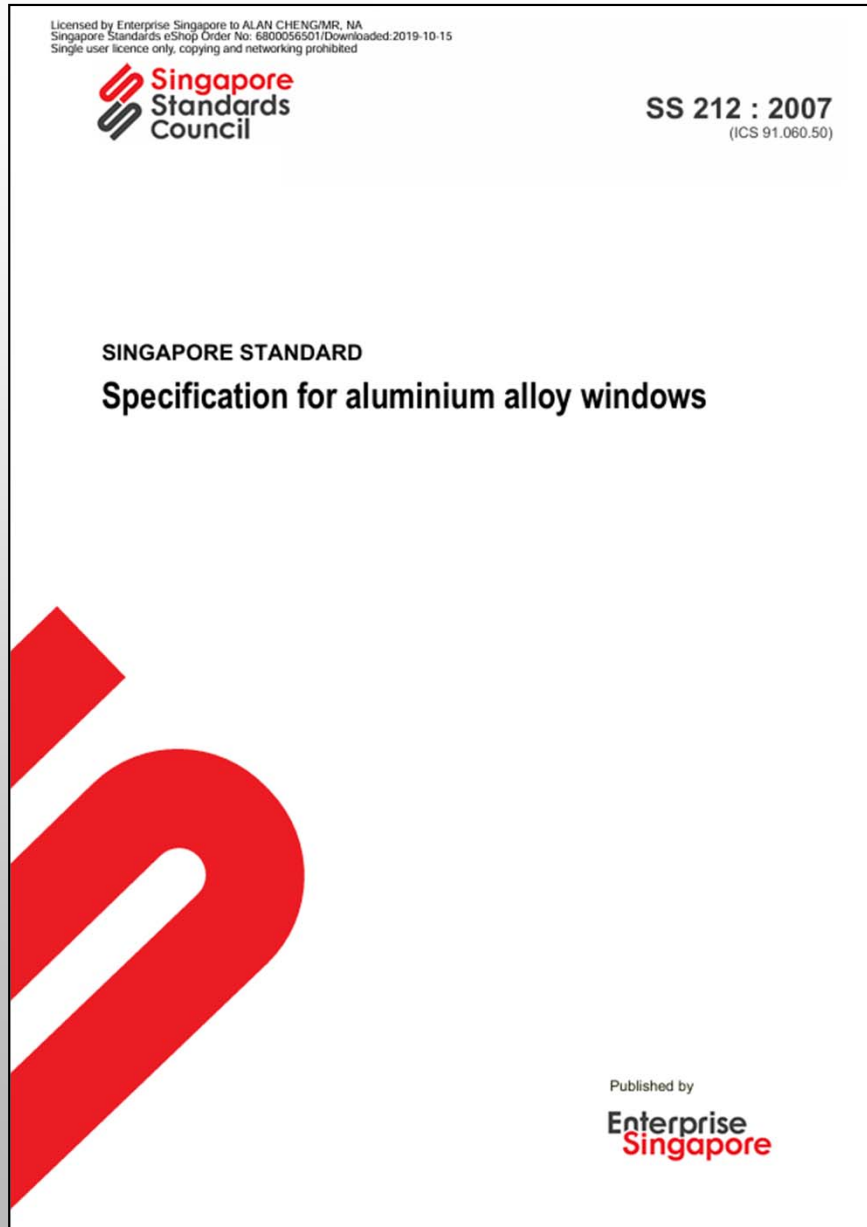
MTO sausages: 3-day lead time, 2-cases minimum, standard pricing

MTO pails: 3–4-week lead time, 18-pail minimum, standard pricing

Key: MTS = Made to Stock SS = Safety Stock MTO = Made to Order NS = Non-Stocked • = Not Available

3.0 Material Selection

Performance Test of Window.



SS 212 : 2007 **Aluminium Alloy Windows**

Performance Test on Window

Sequence of Test.

- a) Air leakage,
- b) Water tightness,
- c) Structural performance,
- d) Repeat air leakage,
- e) Repeat water tightness,
- f) Proof load test.

3.0 Material Selection

Performance Test of Window – Air Leakage.

2. Test Sample

The casement window system to be tested having an overall size of 1500mm(H) x 950mm(W) and having an overall area of 1.43m² shall be installed onto our curtain wall test chamber, where external face of the test sample will face inwards, creating a pressure chamber around the test sample (see Figure 1 for details).

3. Sample Installation

The test sample shall be mounted and sealed onto TÜV SÜD PSB curtain wall chamber at 60 Tuas South Street 1 premises in the same manner and by the same fixings that are intended to attach to the building structure. The support frame is similar stiffness to that supporting building.

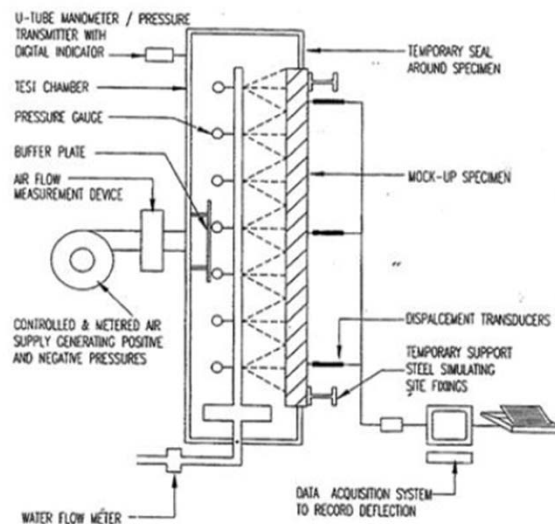
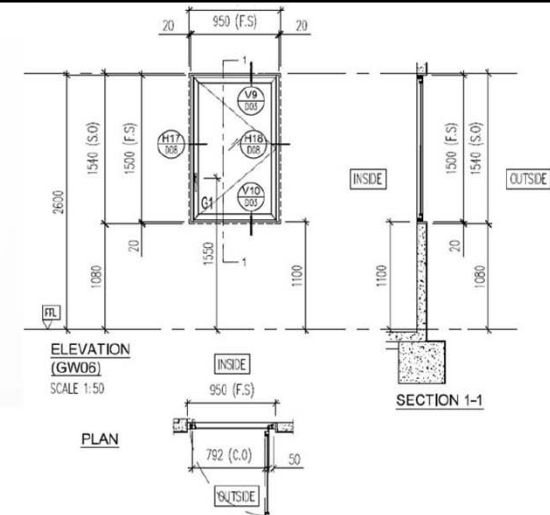


Figure 1 - General arrangement for test set up.
(Exterior of test specimen facing inwards of chamber)



4. Testing Requirements

The tests shall be conducted with reference to Singapore Standards for Aluminium Alloy Windows SS 212: 2007 Specifications. The test parameters and criteria are as follows:

Positive Design Pressure (Pa) : + 1310

Negative Design Pressure (Pa) : - 1310

4.1 Air Leakage

Test	Referencing SS 212: 2007 Test Parameters	Referencing SS 212: 2007 Test Parameters
Air leakage	a. 3 pulses of 500 Pa are applied, and each pulse are maintained for 3 seconds b. Unlock, open, close and lock vent for 5 times. c. Positive pressures are applied in steps of 50, 100, 150, 200, 250, 262 Pa d. Leakage readings are obtained for each pressure step.	Non Air-con condition Opening light: Air leakage shall not exceed: 10 m³/hr/m

The air leakage rate through the test chamber will be measured by a calibrated flow meter connected in the air pressure line with the test pressure as tabulated above. This shall be used as the initial leakage rate. The sealing film or tape shall then be removed from the test sample and the total air leakage rates determined. The air leakage through the test sample shall be the difference between the initial and total readings.

It is an accepted practice to report the total air leakage rates if the sample and test chamber of the total air leakage rate is less than the allowable rate.

3.0 Material Selection.

Performance Test of Full Height Window.

1. Window performance test in compliance SS212:2007 Specification for Aluminium Alloy Windows.
 - a. Water tightness
 - b. Structural performance,
 - c. Repeat air leakage,
 - d. Repeat water tightness,
 - e. Proof load.



Steel chamber



Window installed - Side



Window installed - Elevation



Water spray on façade.

3.0 Material Selection.

Performance Test of Full Height Window.

SUMMARY OF TEST AND TEST RESULTS

Project: Meyer Blue

Test	Project Test Parameters	Project Requirements	Results
Pre-load	Preload to 50% positive design wind pressure(505 Pa & -650 Pa) and hold for 10 seconds.	-	-
Air Permeability	a. Open and close all windows 5 times. b. Mock-up specimen is sealed with PVC sheet. c. Positive pressures in steps are applied; (80, 160 and 240 Pa). d. Repeat for negative pressures (-86, -173, -260 Pa). e. Chamber leakage readings are obtained for each pressure step, Q ₁ . f. Remove the PVC sheet. g. Repeat step (c) to (d) after removing plastic sheet for fixed air permeability. The difference between Q ₂ and the chamber leakage Q ₁ is the net air permeability through the test mock-up for fixed glass. h. Remove the PVC tape at the perimeter of the operable panel. i. Repeat step (c) to (d) after removing plastic sheet for operable air permeability. The difference between Q ₃ and the chamber leakage Q ₂ is the net air permeability through the test mock-up for operable panel.	Reference to SS654:2020 <u>Fixed vents:</u> Air leakage shall not exceed: 1.293 m ³ /hr/m ² @ 240 Pa 1.364 m ³ /hr/m ² @ -260 Pa <u>Opening vents:</u> Air leakage shall not exceed: 1.720 m ³ /hr/m @ 240 Pa 1.815 m ³ /hr/m @ -260 Pa Area of Façade = 13.54 m ² Perimeter = 11.18 m	Passed
Static Water-tightness	a. Open and close all windows 5 times. b. Wet the test specimen for 3 mins. c. Positive pressure of 338 Pa is applied for in 3 equal steps (113, 226, 338 Pa) for duration of 5 minutes at each step respectively on surface frontal area. d. Record all points of water leakage.	Reference to SS654:2020 No uncontrolled water leakage up to test pressure at a water spray of 4 l/min/m ²	Passed

Structural Performance	a. Pre-load of 505 Pa (50%) and maintain for 10 sec. b. Take residual reading after 1 - 5 minutes. c. Apply positive pressure of 1010 Pa. In 4 equal steps (253, 505, 758, 1010 Pa). d. Take maximum deflection reading after 10 sec for each step. e. When reached 100%, maintain for 10s, then reduce to 0 Pa. f. Take residual deflection after 3 - 5 minutes. g. Repeat (a) to (f) for negative pressure at -1500 Pa.	<u>Reference to SS654:2020</u> Mullion/transom deflection: shall not exceed span/175 for span up to 4.110 m: <table><tr><td>1-2-3</td><td>2985/175</td><td>17.05 mm</td></tr><tr><td>4-5-6</td><td>2985/175</td><td>17.05 mm</td></tr><tr><td>7-8-9</td><td>1350/175</td><td>7.71 mm</td></tr></table> Glass deflection: shall not exceed span/60: <table><tr><td>10-11-12</td><td>1220/60</td><td>20.33 mm</td></tr></table>	1-2-3	2985/175	17.05 mm	4-5-6	2985/175	17.05 mm	7-8-9	1350/175	7.71 mm	10-11-12	1220/60	20.33 mm	Passed
1-2-3	2985/175	17.05 mm													
4-5-6	2985/175	17.05 mm													
7-8-9	1350/175	7.71 mm													
10-11-12	1220/60	20.33 mm													
Proof Load	a. Apply 150% of positive pressure of 1515 Pa and maintain for 10 seconds. b. Between 3 to 5 minutes, take residual deflection after load is removed. c. Repeat step (a) to (b) for negative pressure at -1950 Pa.	<u>Reference to SS654:2020</u> No breakage, permanent damage to panels, fastener or anchors shall occur.	Passed												



Aluminium Window - Good Industry Practices

4.0 MANUFACTURING AND FABRICATION PROCESSES.



4.0 Manufacturing and Fabrication Processes.

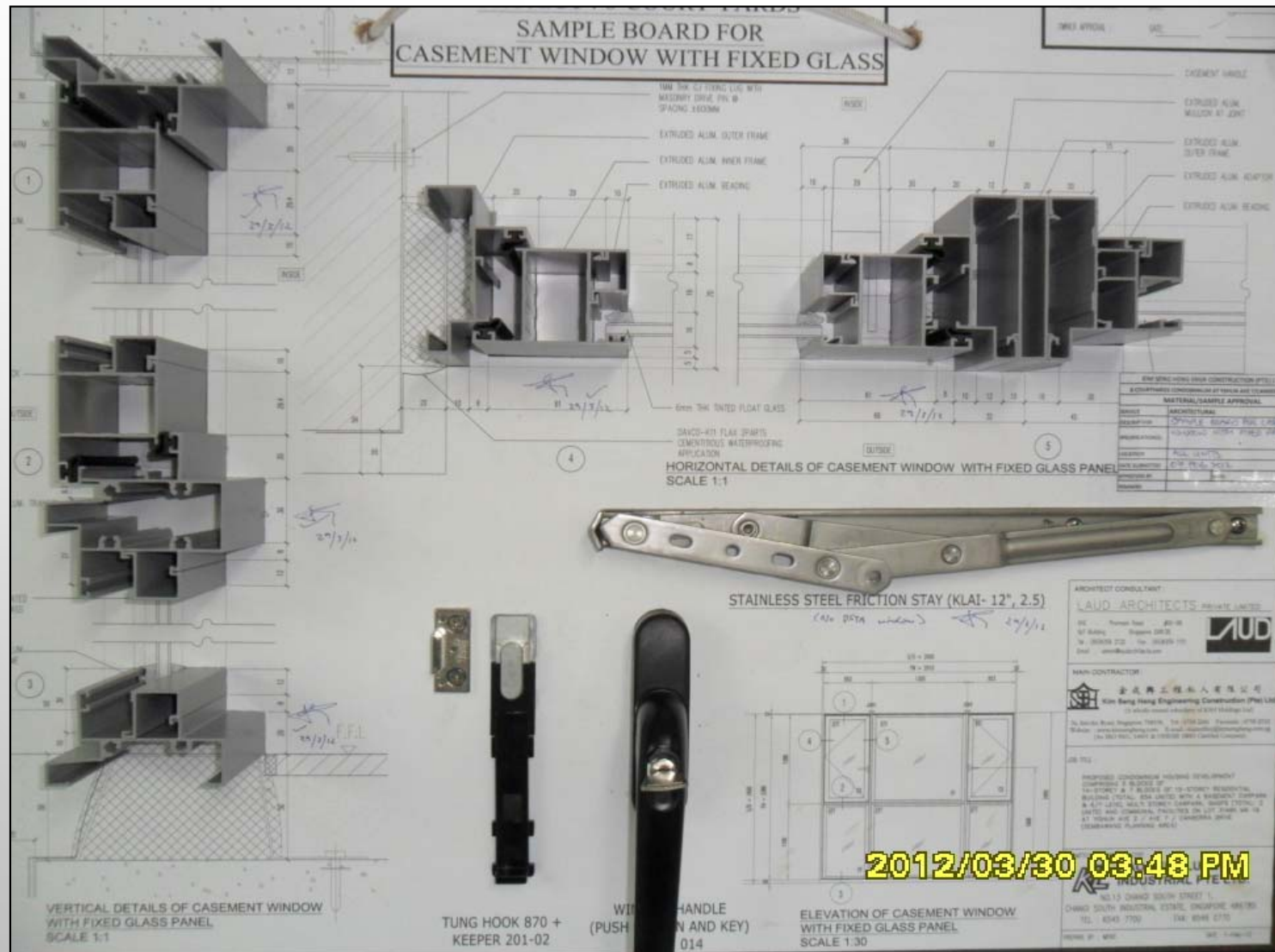
Manufacture & fabrication processes.

Manufacturing processes includes the followings:

- a. Produce workshop drawings and cutting list.
- b. Check in-coming materials, shape /profile, wall thickness, hardness & micron thickness.
- c. Cutting, notching, milling, drilling, punching.
- d. Assembly of units.
- e. Assembly of accessories and hardware.
- f. QA/QC check.
- g. Protection & delivery to site.

4.0 Manufacturing & Fabrication Processes.

Manufacture & fabrication process – Sample Board.



Typical sample board – Casement window & accessories

4.0 Manufacturing & Fabrication Processes.

Manufacture & Fabrication process – Powder Coat.

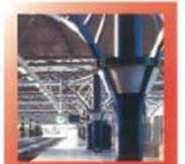


Architectural
Powder Coatings for Life

PR12/4379/C4* Pearl White Gloss	T: 85.3 D: 81.7 S: 3.3	PR12/4326/CS1* Ivory White Satin	T: 69.7 D: 66.0 S: 3.1	PR12/4371/CS1* Soft White Satin	T: 79.2 D: 76.5 S: 2.4	PR12/263/C32* RAL 6027 Light Green Satin	T: 39.6 D: 38.0 S: 3.1
PR12/43156/TX4* Horizon White Texture	T: 87.4 D: 83.9 S: 3.3	PR12/4761/CS1* Sunrise Satin	T: 64.3 D: 61.7 S: 2.6	PR12/8741/CS1* RAL 7047 Teagrey Satin	T: 52.9 D: 50.3 S: 2.4	PR12/315/CS123* RAL 5018 Turquoise Blue Satin	T: 19.7 D: 19.6 S: 3.1
PR12/4752/CS10* Shoji White Satin	T: 73.9 D: 70.6 S: 3.3	PR12/69978/CS1* Gull Satin Satin	T: 65.3 D: 62.2 S: 3.1	PR12/60149/CS2* APO Grey Satin	T: 42.8 D: 40.4 S: 2.4	PR12/343/CS121* RAL 5012 Light Blue Satin	T: 33.6 D: 20.3 S: 3.3
PR12/827/CS11* RAL 7032 Peckish Grey Satin	T: 36.2 D: 36.3 S: 2.9	PR12/63464/CS6* Gull Grey Satin	T: 44.6 D: 42.0 S: 2.4	PR12/89745/CS4* Amour Grey Satin	T: 25.8 D: 23.9 S: 1.9	PR12/346/CS17* RAL 5014 Pigeon Blue Satin	T: 20.0 D: 14.9 S: 3.1
PR12/11416/CS5* Champagne Silver Metallic Satin	T: 34.9 D: 26.2 S: 5.7	PR12/68124/CS2* RAL 7040 Window Grey Satin	T: 24.6 D: 31.5 S: 3.1	PR12/89416/CS4* Olive Powder Satin	T: 19.5 D: 17.3 S: 2.4	PR12/318/CS16* RAL 6007 Brilliant Blue Satin	T: 13.5 D: 10.5 S: 3.1
PR12/80042/CS2* RAL 7030 Stone Grey Satin	T: 25.6 D: 23.4 S: 2.2	PR12/83015/CS2* RAL 7046 Teagrey Satin	T: 24.7 D: 22.0 S: 2.1	PR12/89513/CS6* Ironstone Satin	T: 10.1 D: 7.8 S: 2.1	PR12/3106/CS4* Olive Blue Satin	T: 12.8 D: 9.4 S: 3.4
PR12/80145/CS2* Dark Grey Satin	T: 18.0 D: 14.7 S: 3.3	PR12/8367/CS21 Trunking Grey Satin	T: 16.3 D: 13.0 S: 3.3	PR12/892/CS18* RAL 7004 Graphite Grey Satin	T: 10.0 D: 6.8 S: 3.2	PR12/355/CS46* RAL 5005 Signal Blue Satin	T: 10.7 D: 8.2 S: 2.3
PR12/80355/CS7* Slate Grey Satin	T: 11.1 D: 8.2 S: 2.9	PR12/81032/CS17* Monument Satin	T: 8.9 D: 5.4 S: 2.4	PR12/890/CS6* RAL 7016 Anthracite Grey Satin	T: 8.8 D: 5.2 S: 2.3	PR12/359/CS11* RAL 5010 Cerise Blue Satin	T: 11.0 D: 7.6 S: 3.4
PR12/7056/CT11* Black Sandfax Texture	T: 4.5 D: 4.2 S: 0.5	PR12/7361/CM1* Matte Black Matte	T: 4.7 D: 3.1 S: 1.5	PR12/798/CS132* Black Satin Satin	T: 4.7 D: 1.3 S: 3.4	PR12/355/CS116* RAL 5062 Ultramarine Blue Satin	T: 9.7 D: 6.8 S: 3.1

PR12/20643/CS5* Ranger Green Satin	T: 27.4 D: 24.8 S: 2.9	PR12/1219/CS11 RAL 9015 Pure White Satin	T: 80.5 D: 77.7 S: 3.8	PR12/2941/CS68 RAL 1315 Light Ivory Satin	T: 41.4 D: 39.3 S: 2.3	PR12/70437/CS13* Primrose Gloss	T: 47.3 D: 43.5 S: 3.4
PR12/20823/CS3* Acid Green Gloss	T: 29.3 D: 29.4 S: 4.4	PR12/2210/CS17* Pole Beige Satin	T: 14.3 D: 11.7 S: 2.6	PR12/70167/CS13* RAL 1314 Ivory Satin	T: 51.2 D: 49.2 S: 2.0	PR12/121/CS11* RAL 1314 Zinc Yellow Satin	T: 52.5 D: 40.0 S: 2.6
PR12/2399/CS10* Mint Green Gloss	T: 15.1 D: 15.3 S: 3.5	PR12/70111/CS1* Pole Beige Gloss	T: 42.2 D: 38.5 S: 3.6	PR12/15228/CS2* Metallic Satin	T: 24.1 D: 20.1 S: 4.3	PR12/127/CS11* RAL 1321 Traffic Yellow Satin	T: 45.9 D: 42.2 S: 3.3
PR12/2753/CS2* RAL 6033 Mint Turquoise Satin	T: 20.3 D: 17.3 S: 3.0	PR12/70167/CS4* Beige Satin	T: 53.9 D: 51.3 S: 2.6	PR12/2631/CS11* RAL 3012 Beige Red Satin	T: 33.4 D: 30.4 S: 3.0	PR12/164/C Signal Yellow Gloss	T: 52.9 D: 48.1 S: 4.8
PR12/2234/CS13 RAL 6029 Mint Green Satin	T: 4.9 D: 7.3 S: 2.6	PR12/70107/CS14* Paper Bark Satin	T: 48.1 D: 45.1 S: 3.0	PR12/2640/CS6* RAL 8001 Ochre Brown Satin	T: 17.5 D: 14.5 S: 3.0	PR12/553/CS5 RAL 2008 Willow Orange Satin	T: 32.3 D: 29.5 S: 2.8
PR12/2045/CS2* RAL 6001 Emerald Green Satin	T: 10.5 D: 10.5 S: 2.1	PR12/70107/CS1 RAL 1019 Grey Beige Satin	T: 27.9 D: 24.6 S: 3.3	PR12/2385/CS6 RAL 8003 Clay Brown Satin	T: 19.5 D: 10.4 S: 3.2	PR12/526/CS28 RAL 3009 Traffic Red Satin	T: 24.4 D: 21.4 S: 3.0
PR12/2656/CS4* RAL 6009 Olive Green Satin	T: 1.7 D: 6.7 S: 2.0	PR12/7228/CS6* RAL 7036 Beige Grey Satin	T: 15.1 D: 12.9 S: 2.5	PR12/2354/CS12 RAL 6011 Nut Brown Satin	T: 4.0 D: 5.2 S: 2.6	PR12/507/CS40 Signal Red Gloss	T: 20.4 D: 10.4 S: 4.0
PR12/2551/CS7* RAL 6023 Pine Green Satin	T: 9.0 D: 6.1 S: 2.9	PR12/70404/CS5* Jasper Satin	T: 13.8 D: 11.0 S: 2.8	PR12/20160/CS4* Sawyer Brown Satin	T: 8.7 D: 5.9 S: 2.8	PR12/5093/CS7* RAL 3005 Wine Red Satin	T: 7.1 D: 3.5 S: 3.5
PR12/212/CS11 RAL 6003 Moss Green Gloss	T: 7.0 D: 2.8 S: 4.2	PR12/295/CS116* Desert Brown Satin	T: 11.3 D: 7.6 S: 3.7	PR12/20131/CS1 RAL 8028 Terra Brown Satin	T: 1.6 D: 5.0 S: 2.6		
PR12/20964/CS12* Rain Forest Green Gloss	T: 7.6 D: 3.7 S: 3.0	PR12/20707/CS3* Lift Satin	T: 3.8 D: 3.2 S: 3.4	PR12/20151/CS3* RAL 8017 Chocolate Brown Satin	T: 4.6 D: 3.7 S: 2.8		

* RoHS - Compliant * Non stock



4.0 Manufacturing & Fabrication Processes.

Manufacture & fabrication process – Powder Coating.



Colour sample



Colour Code