Optimizing Building Design With Glass

Asahi India Glass Ltd
Shailesh Ranjan

Glass – A quick background

Glass is an amorphous (non-crystalline) solid material

The word ‘Glass’ is derived from the Latin term ‘Glesum’ which means transparent substance

Glass is typically brittle and optically transparent

The commonly used glass types are Flat glass and Container glass

Flat glass is a type of glass, initially produced in plane form, commonly used for windows, glass doors, transparent walls and windshields and of two types:
• Sheet Glass
• Float Glass

Container glass is a type of glass used for the production of glass containers.
Glass – A paradigm shift

Concrete Building  Clear or Tinted Glass  High Performance Glass  Smart Buildings with High Performance Glasses

Shattering Myths

Shailesh Ranjan
When people think of glass, they tend to think of simple applications, like windows and cookware; but scientists have manipulated glass at the molecular level to take on countless capabilities.

1. Glass for Windows

2. Glass doesn’t bend

3. Glass is Fragile
4. All Glasses are Same

A single element added to glass can significantly change its properties.

- Clear
- Tinted
- Reflective
- Hard Coat
- Soft Coat
- Lacquered
- Frosted
- Mirror

High Performance

USE GLASS, DON’T ABUSE IT

5. Glass – (Not) A Green Building Material

- Improves Day lighting
- Energy Efficiency

ENERGY EFFICIENT
5. Glass – (Not) A Green Building Material

- Recyclable & Reusable
- Acoustic comfort
- Human Comfort

Opportunities with Glass

- Gives shape to your imagination by giving enormous application possibilities
- Can be bent to shapes and is strong enough to suffice strength requirement.
- Different types of glasses gives freedom for different application
- Fulfills requirement prescribed for materials to be a Green Building material.
- Helps in energy Efficiency.
Glazing selection Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesthetic</td>
<td>Enhances look of the building</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>It is a combination of lighting &amp; cooling energy saving</td>
</tr>
<tr>
<td>Improved Day-lighting</td>
<td>Reduces artificial lighting requirement by using glazing</td>
</tr>
<tr>
<td>Glare Reduction</td>
<td>It can defeat the purpose of using glass</td>
</tr>
<tr>
<td>Acoustic</td>
<td>It can reduce sound transmission significantly</td>
</tr>
<tr>
<td>Strength</td>
<td>Gives strength that even can be used as flooring</td>
</tr>
</tbody>
</table>

Energy Efficiency

- Use high performance glass
- Use glass in appropriate orientation
- Smartly design building with shades, inclination etc. to reduce direct heat ingress
- Use IGU, if building design requires
- Use rated frames

Climate Response  +  Orientation & Design  +  Façade Design  +  Material used
Right Selection of Glass

<table>
<thead>
<tr>
<th>DGU Glass (DGU 6-12air-6 Clear)</th>
<th>Solar Factor (%age)</th>
<th>U-Value (W/M².K)</th>
<th>RHG (W/M²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>71%</td>
<td>2.8</td>
<td>535</td>
</tr>
<tr>
<td>Tinted</td>
<td>45%</td>
<td>2.8</td>
<td>347</td>
</tr>
<tr>
<td>Solar Control Glass</td>
<td>35%</td>
<td>2.8</td>
<td>275</td>
</tr>
<tr>
<td>Solar Control Low E Glass</td>
<td>20%</td>
<td>1.7</td>
<td>158</td>
</tr>
</tbody>
</table>

Design factors impacting Glass Selection

**Climate Analysis :**
Climatic condition of the location is important to select type of glazing as different weather impacts differently.

**Optimum Orientation of Building:**
Before selecting any glazing material, study of building orientation is must, if rightly oriented, we may get energy efficiency without using high performance glass. (according to Indian context, South West orientation is responsible for maximum heat gain)

**Shadow Analysis:**
Shadow of the building as well as surrounding also impacts heat ingress (direct & defused), hence changes the glazing requirement.

**Daylight Analysis :**
Study of available lux level, window size and other passive design should be consider before defining the required VLT of a glass.
Energy Savings with Glass - Real Life Case Studies

How glass is integrated - Double skin facade

A school in Mumbai

<table>
<thead>
<tr>
<th>Type</th>
<th>Total Electricity Consumption (Mwh)</th>
<th>Electricity Cost Annual (in lakhs)</th>
<th>Savings Annual (in thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case - 12mm AIS Clear</td>
<td>871</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>12mm Ref</td>
<td>884</td>
<td>53</td>
<td>-78.88</td>
</tr>
<tr>
<td>12 mm Low SF Ref</td>
<td>876</td>
<td>52</td>
<td>-27.80</td>
</tr>
<tr>
<td>Low SF Ref</td>
<td>876</td>
<td>52</td>
<td>-27.80</td>
</tr>
<tr>
<td>SC + LE</td>
<td>876</td>
<td>52</td>
<td>-27.80</td>
</tr>
<tr>
<td>Ventilated cavity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12mm Low SF Ref DGU</td>
<td>718</td>
<td>43</td>
<td>921.07</td>
</tr>
<tr>
<td>Low SF Ref DGU</td>
<td>718</td>
<td>43</td>
<td>921.07</td>
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<tr>
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<td>718</td>
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</tr>
</tbody>
</table>

The non-solar heat gets trapped between the perforated aluminium façade and inside skin when using a low-E glass.

Non-solar heat gain is the reason for increase in heat gains.
Daylight Analysis:
For a corporate building in Mumbai, daylight analysis was done for Clear Glass (VLT = 78%) and the high performance glass (VLT = 21%). Both the glasses performed identically in terms of achieving the optimal lux levels. Clear Glass, in fact, caused glare in certain portions of the building.

• Daylight analysis is important as it prevents overdesigning of the building and at the same time optimizes VLT requirement.
• In the case mentioned, we can use high performance glass which will reduce cooling load without compromising on lighting load.

Climate Analysis
Office Building in Bangalore
Climatic condition of the location is important to select type of glazing as different weather conditions have different impact on glass.

<table>
<thead>
<tr>
<th>Calculations</th>
<th>Total (KWh)</th>
<th>Cost of Electricity (KWh/yr)</th>
<th>Savings (KWh/yr)</th>
<th>Savings (Rs.)</th>
<th>Cost of Glass (KWh)</th>
<th>Costing Load in TR</th>
<th>Units</th>
<th>Cost</th>
<th>Saving</th>
<th>Extra Paid for Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case clear Glass (78%)</td>
<td>7202840</td>
<td>42197163</td>
<td>2750000</td>
<td>1052</td>
<td>862</td>
<td>300TR*3</td>
<td></td>
<td></td>
<td></td>
<td>21375000</td>
</tr>
<tr>
<td>Enhance Pine SGU (78%)</td>
<td>7034840</td>
<td>40597354</td>
<td>-56989</td>
<td>-2082</td>
<td>-12491</td>
<td>550000</td>
<td>2895</td>
<td>820</td>
<td>300TR*3</td>
<td>21375000</td>
</tr>
<tr>
<td>Enhance Reef SGU (78%)</td>
<td>7099559</td>
<td>40597354</td>
<td>-10687</td>
<td>-32747</td>
<td>-1724085</td>
<td>550000</td>
<td>2876</td>
<td>812</td>
<td>300TR*3</td>
<td>21375000</td>
</tr>
<tr>
<td>Proposed Glass</td>
<td>7640898</td>
<td>45845389</td>
<td>-768038</td>
<td>-283747</td>
<td>-1081059</td>
<td>608000</td>
<td>2885</td>
<td>814</td>
<td>300TR*3</td>
<td>21375000</td>
</tr>
<tr>
<td>Proposed Glass with Lighting</td>
<td>7720286</td>
<td>45845389</td>
<td>-66699</td>
<td>-120654</td>
<td>-1536427</td>
<td>625000</td>
<td>2876</td>
<td>812</td>
<td>300TR*3</td>
<td>21375000</td>
</tr>
</tbody>
</table>

Glass with SF of 37 & U-Val – 5.7 was as efficient as a glass with SF of 25 & U-Val – 3.7. The building design & the local weather conditions meant that you can relax the glass values and still be energy efficient.
Glazing Selection process

To summarize:

- Effective Aperture Approach- Keep EA between 0.2 and 0.3. Larger windows will permit more light hence low-VLT glazing will do.
- Bigger windows require better glazing.
- Choose products with least SHGC and U value and optimum VLT.
- Vary glazing selection by façade
- Determine an optimum set of values for U-value, solar heat gain coefficient, and visible transmittance through more rigorous computer modeling with whole building simulation programs

Do's in Indian context

- Add overhead shading
- Add internal shading
- Have more windows on North and South facades
- Use glazing with Optimum VLT; low SHGC and U value
- Use dark tinted glass at visible height and clear at higher levels
- Use EA between 0.2 to 0.3
- Add light shelves to interiors
- Use high windows (ventilators in naturally ventilated buildings)
Don’t in Indian context

- Do not use glass with very low U value and moderate SHGC.
- Do not assume dark tinted glass brings solar control
- Do not use un-insulated frames
- Do not use Tempered glass as safety glass
- Do not use IGU as sound insulation glass

![U value graph]

**U value**

<table>
<thead>
<tr>
<th>Material</th>
<th>U Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>0.5</td>
</tr>
<tr>
<td>Al</td>
<td>0.7</td>
</tr>
<tr>
<td>awb</td>
<td>0.8</td>
</tr>
<tr>
<td>Wood</td>
<td>1.0</td>
</tr>
<tr>
<td>Ins</td>
<td>1.2</td>
</tr>
<tr>
<td>Sin</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Learning

- Remember that same fenestration product behaves differently w.r.t. the specific design.
- It should not be assumed that products with Low U-value and SHGC are best and universal solution.
- Direct radiation falling on the windows should be minimized.
- For shaded windows, products with lower U values perform better.
- For un-shaded windows receiving high amount of solar radiation, products with low SHGC would perform better.
- Hence glazing should be selected after thoroughly considering the design.
Glass Selection – AIS helps in the selection of the right product depending on your requirements

Glass Products – AIS, with its wide range of products, offers solutions to fulfil all requirements, exteriors as well as interiors, performing well on parameters

Glass Processing – AIS provides all kind of processing of glass as per your requirements

Glass Integration – AIS fulfils all your needs related to glass as it is present in every part of the value chain, be it glass manufacturing, processing, consultation, interior installation, window solutions and much more

AIS – An overview

Asahi India Glass Limited (AIS) is the largest integrated glass company in India offering end-to-end solutions across the entire glass value chain

AIS offers the ideal combination of customised glass solutions, expertise and knowledge of design, installation and retail

AIS has grown from being a ‘single product, single customer’ company to a world-class integrated company with 13 plants/sub assembly units and global customers

Today, AIS is broadly structured into four verticals:
• Auto
• Architectural
• Consumer Glass
• Solar Glass
About AIS – the journey so far

<table>
<thead>
<tr>
<th>AIS in 1987</th>
<th>AIS today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive glass manufacturing</td>
<td>Largest integrated glass company in India, and probably among the very few glass players in the world, with significant presence in the complete glass value chain</td>
</tr>
<tr>
<td>Single Product – Tempered Safety Glass</td>
<td>Offering end-to-end glass solutions, with complete range of automotive and architectural glass products and services</td>
</tr>
<tr>
<td>Single Customer – Maruti Suzuki</td>
<td>Wide spread customer-base across all business verticals. Market leader in automotive glass with ~ 69 % share, and a significant market share in architectural and consumers glass business</td>
</tr>
<tr>
<td>Single Plant – Bawal (Haryana)</td>
<td>13 manufacturing units at 4 locations, supported by a network of warehouses, zonal and local offices and facilities with pan-India spread out</td>
</tr>
<tr>
<td>Local operations – National Capital Region</td>
<td>Pan-India presence with strategically located manufacturing units, warehouses, sales and marketing offices</td>
</tr>
</tbody>
</table>

From being a manufacturer of automotive tempered glass supplying to one customer, AIS has grown and transformed to be a complete solutions provider in the glass value chain

Value Proposition - Integrated Glass Operations

**SAND TO CAR GLASS**
- Automotive Glass
- Automotive Glass Distribution (AIM)
- Allied Products Distribution (Adhesives)
- Auto Glass Fitment Services (WE)

**SAND TO WINDOWS**
- Value Added Products, Reflective & Mirrors
- Processing Laminated, Tempered, Insulated Glass, Products
- Fabrication uPVC windows
- Installation

**Architectural Glass**
- 2 Float Lines, 1200 TPD
- Soft Coat
- Hard Coat
- Mirror Line
- Architectural Processing Lines – 1.4 mn.sqm.

**Automotive Glass**
- Laminated windshield 5.4 mn. pcs
- Tempered glass 7.7 mn. sqm.
- 4 Laminated Plants
- 3 Tempered Plants

**Consumer Glass (Auto & Arch)**
- AIM, one of the 2 pan-India distributors in ARG market
- AIS Adhesives – Sealants
- Windshield Experts – 54 R&R stores in 31 cities
- Glasxperts – Retail store for design, supply and installation

Pan-India presence with strategically located manufacturing units, warehouses, sales and marketing offices
Welcome to a world which enables you to do more

Thank you for your time