Futuristic Sustainable Glazing

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National Head
Design & Commercial
Saint-Gobain Glass

Super Selective Triple silver
Dynamic Facades Electrochrome
24*365 TGU
FSE Partitions
Criterion 13: Optimize Building Design

• Mandatory requirement (failing to fulfil which the project does not qualify)
  • Solar passive measures
    • Orientation of the building
    • Provision of shade to minimize solar exposure
    • Effective selection of high solar & thermal insulations for the building envelope – glazing, walls & roof
  • Daylighting
    • Through use of transparent building material, such as glass

• Why?
  • To reduce pressure on conventional energy for space conditioning and lighting systems in buildings

Overview Criterion - 13

<table>
<thead>
<tr>
<th>S. N o.</th>
<th>Objective</th>
<th>Commitments</th>
<th>Appraisal</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Climate responsive building design</td>
<td>13.1.1 In order to optimize the building design appropriate climate responsive design strategies should be adopted.</td>
<td>By adopting appropriate climate responsive building design, the WWR and/or SSR is limited and all the fenestrations meet the SHGC requirement of ECBC 2007</td>
<td>Mandatory with 2 points</td>
</tr>
<tr>
<td>1</td>
<td>Climate responsive building design</td>
<td>13.1.2 The WWR (window to wall ratio) is limited to a maximum of 60% of gross wall area and the SRR (skylight to roof ratio) is limited to a maximum of 5% of gross roof area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Climate responsive building design</td>
<td>13.1.3 Demonstrate that the effective SHGC (Solar Heat Gain Coefficient)* of the fenestration (accounting for glazing, overhangs and/or vertical fins) is compliant with the maximum SHGC requirement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Adequate daylighting</td>
<td>13.1.4 Ensure that the total daylighted area* of the proposed building is &gt; 25% of the total living area and achieve the recommended DF at the centre of the daylighted area in a design sky condition</td>
<td>Minimum of 25% of the living area should be daylighted and adequate level of daylight is provided as prescribed by IS code</td>
<td>Mandatory with 2 points</td>
</tr>
<tr>
<td>3</td>
<td>Efficient artificial lighting system</td>
<td>13.1.5 Perform artificial lighting simulation to demonstrate that the lighting levels in indoor spaces are maintained as recommended in NBC 2005</td>
<td>Over-design of lighting system is avoided as per clause</td>
<td>Mandatory with 2 points</td>
</tr>
</tbody>
</table>
# Methodology

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Design Optimization</th>
<th>Analysis Steps</th>
<th>Study Parameters</th>
<th>Design Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Site &amp; Surrounding</td>
<td>Climate Analysis</td>
<td>Macro-climatic factors (Geographical location, Temperature, Humidity, Solar radiation, Rainfall, Wind, Sky-condition etc.)</td>
<td>Appropriate Design Strategies (Active+Passive)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Micro-climatic Factors (topography &amp; landform, geologic &amp; seismic data, soil quality, vegetation, local wind movement etc.)</td>
<td>Building Spacing (Foot-print)</td>
</tr>
<tr>
<td>2</td>
<td>Building Block</td>
<td>Solar Exposure Analysis</td>
<td>Critical Building Facade</td>
<td>Orientation, Internal space arrangement, Buffer spaces</td>
</tr>
<tr>
<td>3</td>
<td>Fenestration</td>
<td>Sun-path analysis</td>
<td>Critical Solar Angle</td>
<td>Appropriate shading design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solar Heat Gain</td>
<td>Window Size &amp; Glazing Properties</td>
<td>WWR &amp; Glass SHGC</td>
</tr>
<tr>
<td>4</td>
<td>Internal Space</td>
<td>Daylight Analysis</td>
<td>Daylighted Area, Daylight Factor</td>
<td>Glass VLT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Artificial lighting analysis</td>
<td>Lighting Level &amp; LPD</td>
<td>Efficient lighting scheme</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Daylight Integration</td>
<td>Daylighted Area, Daylight level &amp; Artificial lighting layout</td>
<td>Lighting Controls</td>
</tr>
</tbody>
</table>

## WWR Window to Wall Ratio

### Case 1
![Diagram of Case 1]

\[
WWR = \frac{2.4\times(30+15)\times2\times4}{16\times(30+15)\times2}
\]

### Case 2
![Diagram of Case 2]

\[
WWR = \frac{2.4\times(30+15)\times2\times4}{16\times(30+15)\times2}
\]
Can a building get a GRIHA rating without the use of glass?

Probably NOT

Why?!
Glazing Information for a GRIHA Rating Contd.,

- **Daylighting**
  - Minimum 25% of total living area should be daylit (2 mandatory points)
  - For 50% of the area illuminated by daylight, 1 rating point is earned
  - For 75% of the area illuminated by daylight, an additional point is earned
  - This area should have corresponding daylight factor of:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Location</th>
<th>Daylight Factor Percent (2 DF: 0.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dwellings</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Kitchen</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Living room</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Study room</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Circulation</td>
<td>0.315</td>
</tr>
<tr>
<td>2</td>
<td>Schools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom/desk top, black board</td>
<td>1.0–3.0</td>
</tr>
<tr>
<td></td>
<td>Laboratory</td>
<td>2.5–3.0</td>
</tr>
<tr>
<td>3</td>
<td>Office</td>
<td></td>
</tr>
<tr>
<td></td>
<td>General</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Drawing, typing</td>
<td>3.75</td>
</tr>
<tr>
<td></td>
<td>Enquiry</td>
<td>0.625–1.9</td>
</tr>
<tr>
<td>4</td>
<td>Hospital</td>
<td></td>
</tr>
<tr>
<td></td>
<td>General wards</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Pathological laboratory</td>
<td>2.5–3.75</td>
</tr>
<tr>
<td>5</td>
<td>Libraries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Book room</td>
<td>0.5–1.9</td>
</tr>
<tr>
<td></td>
<td>Reading room</td>
<td>1.9–3.75</td>
</tr>
<tr>
<td></td>
<td>Counter area</td>
<td>2.5–3.75</td>
</tr>
<tr>
<td></td>
<td>Catalogue room</td>
<td>0.9–2.2</td>
</tr>
</tbody>
</table>

Note: 100 lux is equal to a 0.25 component of value 1.25% based on a 600 lux design exterior illuminance.

Source: Table 3.3, 2490–1895

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**Solar Heat Gain Coefficient**

- Should meet the ECBC requirements

<table>
<thead>
<tr>
<th>Climate</th>
<th>WWR ≤ 40%</th>
<th>40% &lt; WWR ≤ 60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum U-factor</td>
<td>Maximum SHGC</td>
<td>Maximum SHGC</td>
</tr>
<tr>
<td>Composite</td>
<td>3.30</td>
<td>0.25</td>
</tr>
<tr>
<td>Hot and Dry</td>
<td>3.30</td>
<td>0.25</td>
</tr>
<tr>
<td>Warm and Humid</td>
<td>3.30</td>
<td>0.25</td>
</tr>
<tr>
<td>Moderate</td>
<td>6.00</td>
<td>0.40</td>
</tr>
<tr>
<td>Cold</td>
<td>3.30</td>
<td>0.51</td>
</tr>
</tbody>
</table>

**Documentation details required to be furnished**

- Type of spaces per conditioned / non-conditioned
- Window type
- Window dimension in mm
- SHGC of the proposed glazing (SHGC as per manufacturers' sheet)
- Sheeting dimensions in mm
- Depth of horizontal flange
- Depth of vertical flange
- Projection factor (PF)
- Multiplication factor (iod)
- Adjusted SHGC of the fenestration (glass SHGC * MF)
- ECBC recommended SHGC (Table 13.4)
- Remark

Note: Space name should be same as given in the architectural drawing and AC/non-AC spaces should be segregated and the SHGC calculator should be used to calculate the adjusted SHGC as recommended by the ECBC 2007.
Criterion 14 of GRIHA mandates optimization of energy performance of a building within specified comfort limits.

The total energy consumption of the building is measured in terms of kwhr/sqm/annum.

Use of appropriate glazing combinations with and/or shading devices reduce requirements of artificial lighting & cooling.

Making glass more cost effective:

- **Daylight Integration**
- **Optimum WWR**
  - 20 – 40%
- **Thermal Performance**

Only ECBC Envelope Gives a Pay Back Period of 7 – 8 years.

ECBC Envelope + Daylight Integration
Reduces payback period to 4 years.
**Super Selective**
Triple silver

[DAYLIGHT• SOLAR CONTROL• LOW-E]

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**Past**

**Online coating technology**
- Dominant aesthetic driven selection
- Low on selectivity (Less than 1)
- Less on energy parameters

**Present**

**Offline coating technology**
- Energy + aesthetic driven selection
- High selectivity (1-2)
- Meets benchmark requirements of building codes

**Future**

**Offline superselective coating technology**
- Super selectivity – 2+
- Outstrips requirements of building codes
Super Selective Triple silver

- Selectivity is a ratio of Light to Solar Heat Ratio.
- Occupant comfort even during harshest environment
  - Light
    - Optimal transmission
    - No visual glare
  - Solar Heat
    - Extremely low

<table>
<thead>
<tr>
<th>Brand</th>
<th>Light Transmission</th>
<th>SF/SHGC/g</th>
<th>Spectral Selectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Coated – Solar</td>
<td>30%</td>
<td>46%</td>
<td>0.65</td>
</tr>
<tr>
<td>Offline Coated – Solar</td>
<td>46%</td>
<td>46%</td>
<td>1.00</td>
</tr>
<tr>
<td>Offline Coated – Solar + Thermal (Single Silver)</td>
<td>47%</td>
<td>36%</td>
<td>1.30</td>
</tr>
<tr>
<td>Offline Coated – Solar + Thermal (Double Silver)</td>
<td>50%</td>
<td>27%</td>
<td>1.85</td>
</tr>
<tr>
<td>Offline Coated – Solar + Thermal (Triple Silver)</td>
<td>50%</td>
<td>22%</td>
<td>2.27</td>
</tr>
</tbody>
</table>
Dynamic Facades
Electrochrome

- Transition performance from clear view to high solar control at will.
- Transition control by solar sensor or manual override.
- Weather responsive filtering of light transmission & solar heat gain,
  Eliminates glare
  Provides solar insulation
- Outstanding system durability,
  Exterior façade
  Skylights
Dynamic Facades
Electrochrome

- Light transmission: 55% to 5%
- Solar Factor: 0.40 to 0.06
- U Value: 1.1 W/SqmK

Flexibility
- Building integration
- Zone integration
- Panel integration
Glass Façade
Chabot College, Hayward, CA

Skylights
100 West Putnam, Greenwich, CT.
Each window type was modeled in a standard eight-story office building using computer simulations based on the ASHRAE 90.1-2007. Analysis was conducted for different climates: Hot & dry, Mixed hot/cold climate.

<table>
<thead>
<tr>
<th>Energy Analysis</th>
<th>Electrochrome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Annual Energy Savings</td>
<td>Normal Single Pane</td>
</tr>
<tr>
<td>Electrochrome in DGU</td>
<td>45%</td>
</tr>
<tr>
<td>Electrochrome in TGU</td>
<td>53%</td>
</tr>
</tbody>
</table>
Key Benefits

*Estimates provided by Lawrence Berkeley National Lab

Power consumption

<table>
<thead>
<tr>
<th>Power Per Unit Area</th>
<th>Watts /m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average During Tinting</td>
<td>2.5</td>
</tr>
<tr>
<td>Typical Daily Average</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Electricity consumed

- Power up to 200 sq.m. of EC glass for the equivalent of powering a 60 watt light bulb
24 x 365 TGU

[• THERMAL INSULATION • 4 SEASON • OCCUPANT COMFORT]

Glazing system that provides
- Solar control during SUMMERS
- Thermal control during WINTERS
Round the clock “solar-thermal” performance.
FSE
Floor Space Efficiency
Partitions

[LEAN • LIGHT • SAFE]

**Super-built-up area**
21,165 sqft
Exterior wall (230mm) – 505 sqft

**Internal cubicle office partition**
Cubicle partition thickness – 100mm
Cubicle partition area – 210 sqft

**Glass Partition replaced (12mm)** – 25 sqft
**Saving in carpet area** – 185 sqft
**Typical Rental cost (INR 40/Sqft)**
INR 88,800 / annum
**Typical Property cost (INR 10,000/Sqft)**
INR 18.5 lacs

Typical Office Floor Dimension – 75.8 m X 25.95m
Impact of Energy Efficiency measures on costs

- **Glazing**
  - 12.5 lacs
  - 15.5 lacs per annum

- **Air Tunnel**
  - Efficient Lighting & HVAC

- **Roof Insulation**
  - 79 lacs
  - 60 lacs per annum

- **HVAC**
  - Efficient Lighting Controls
Criterion 17: Use of Low-Energy Material in Interiors

- Requirement:
  - To use low-energy/recycled materials/finishes/products in the interiors, which minimize the use of wood as a natural resource
  - To use low-energy materials and products, such as composite wood products/renewable materials/reused wood/low embodied energy products/products which utilize industrial waste/recycled products like glass, crushed stone and other waste, such as terrazzo, or which are resource efficient finishes such as finished concrete flooring, ceiling tiles, and ceramic tiles

Other Benefits of Glazing: Acoustics

- Glazing grants excellent acoustic insulation through
  - Use of thicker glass
  - Use of lamination
  - Use of asymmetrical DGU or lamination
  - Combination of above
Acoustic Requirements for GRIHA Rating

- Ensuring that the indoor noise levels conform to the levels described in the NBC 2005 (BIS 2005a)

Table 29.2 Acceptable indoor noise levels for various buildings

<table>
<thead>
<tr>
<th>Location</th>
<th>Noise level (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditoria and concert hall</td>
<td>20-25</td>
</tr>
<tr>
<td>Radio and television studios</td>
<td>20-25</td>
</tr>
<tr>
<td>Music rooms</td>
<td>25-30</td>
</tr>
<tr>
<td>Hospitals and cinema theatres</td>
<td>35-40</td>
</tr>
<tr>
<td>Apartments, hotels, and homes</td>
<td>35-40</td>
</tr>
<tr>
<td>Conference rooms, small offices and libraries</td>
<td>35-40</td>
</tr>
<tr>
<td>Court rooms and class rooms</td>
<td>40-45</td>
</tr>
<tr>
<td>Large public offices, banks, and stores</td>
<td>45-50</td>
</tr>
<tr>
<td>Restaurants</td>
<td>50-55</td>
</tr>
</tbody>
</table>

Sustainability rests on Infinite Possibilities
Please do send any new ideas for Sustainable Materials to Saint-Gobain Research India at designstudio@saint-gobain.com

Thank you.