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# **Optimum Usage of Glass In Building**

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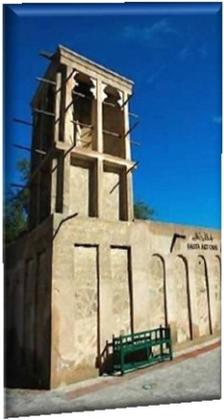
# Glass – Indispensible?



Ans: Nearly.....

- Glass is an indispensable part of all buildings purely because of its unmatched qualities.
- Freedom from conventional building shapes, with unmatched aesthetics.
- Does not deteriorate, corrode, stain or fade.
- Transparent to visible light.
- Helps to maintain clean environment because of zero degeneration.
- It can be recycled indefinitely- structure does not deteriorate through the process.
- Glass is a pure and sustainable material.
- Helps to maintain hygienic environment with easy maintenance

# Glass – A paradigm shift



Concrete Building



Clear or Tinted Glass



High Performance Glass



Smart Buildings with  
High Performance  
Glasses

- Glass touches various components of a building like :-
  - External Façade
  - Internal partition
  - Shop fronts
  - Furniture
  - Glass floors
  - Staircase
  - Decorative application in interiors
  - Fire resistance
  - And many more...





# Issues in Glass Usage

## Safety

- Glass is treated as a fragile material.
- Can be fatal, if not used properly

## Applications

- Glass can be a good alternative for concrete wall.
- Can be more energy consuming, if not used intelligently

Challenges with glass is only due to **ignorance** of the product & not because of the product per se. Glass can be as safe & efficient, if not more, as any other conventional building material.

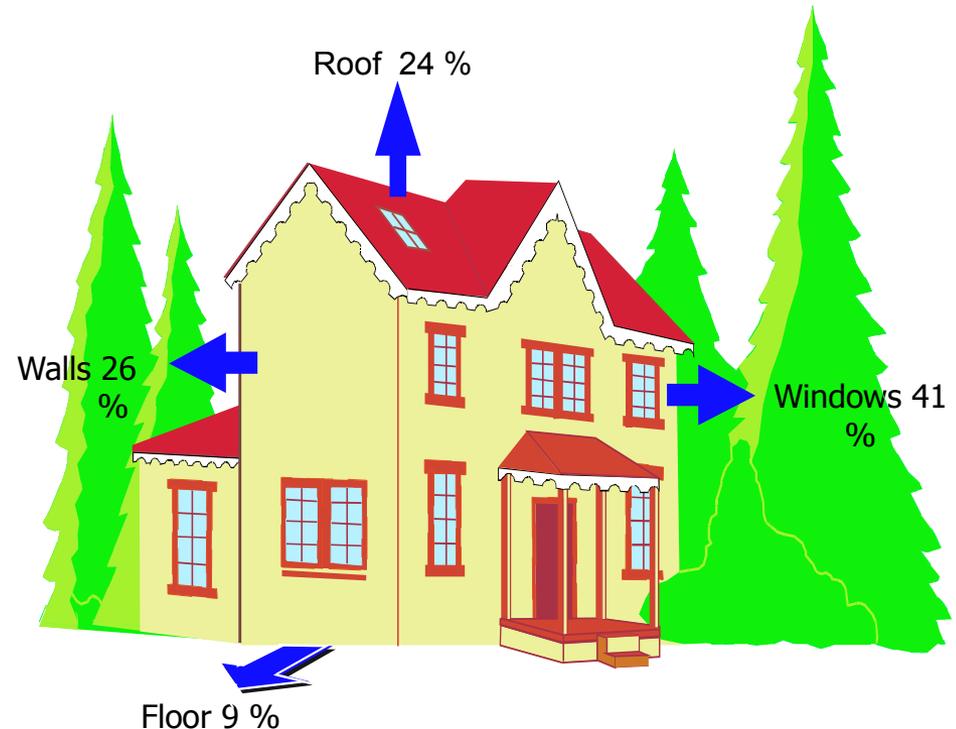
**USE GLASS, DON'T ABUSE IT**

# Glass & Energy (in)efficiency



## Why Glass is important in energy conservation

- For a standard building, Windows contribute approx. 41% of the total heat transfer.
- This is for a WWR of 15% and naturally more the WWR, more will be the heat gain
- Right selection of glazing will positively impact the energy requirement of the building.



As windows contribute to a significant portion of the heat transfer in a building, choice of glazing plays a vital in the total heat gain to the building.

# Glass – A Green Building Material



**Improves Day lighting**  
; Because of the  
unique property glass  
carries, it reduces  
artificial lighting  
demand

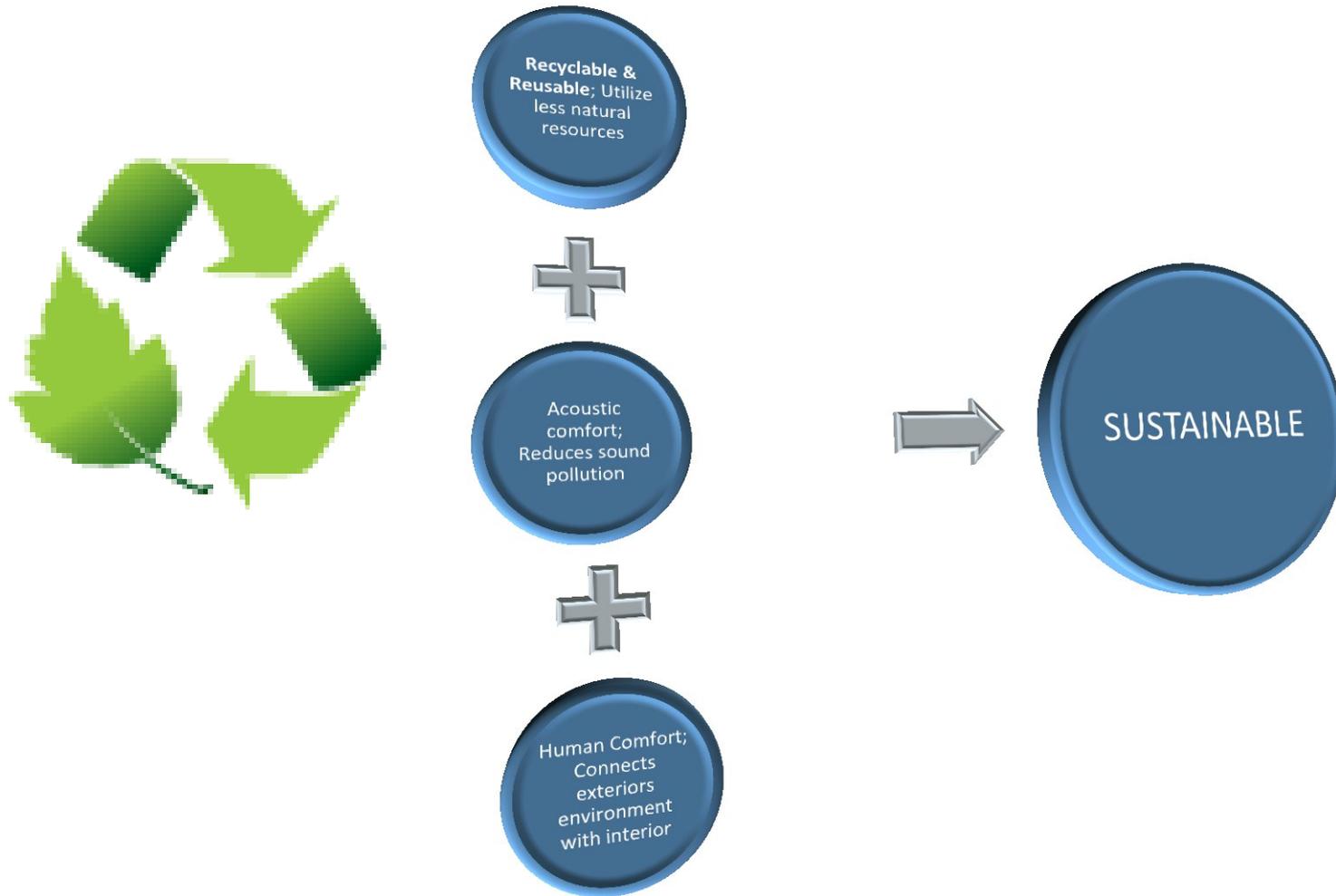


**Energy Efficiency ;**  
With the use of high  
performance glass, it  
reduces air  
conditioning load and  
also reduces overall AC  
load demand



**ENERGY  
EFFICIENT**

# Glass – A Green Building Material



# Using Glass – Indian Context

# Glance At Terminology

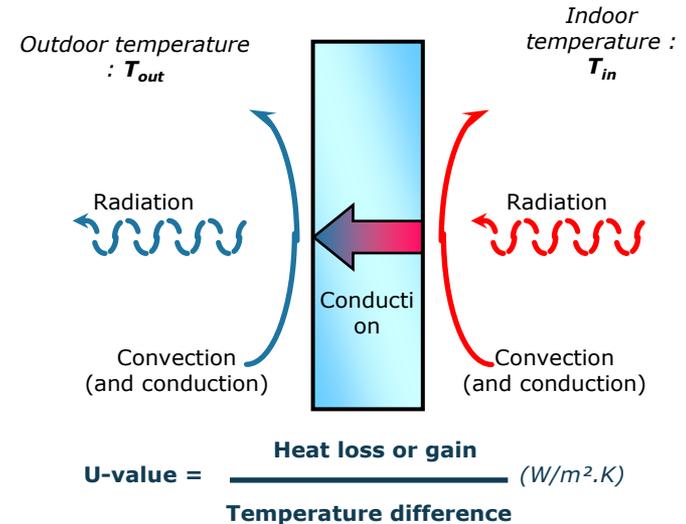
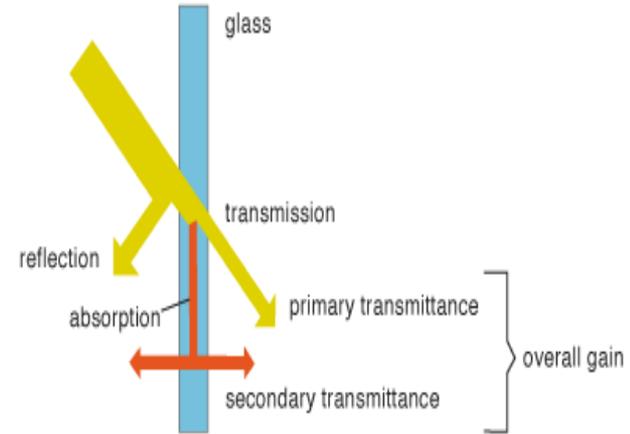


**SHGC (Solar Heat Gain Coefficient)/SF (Solar Factor)** :-The fraction of external solar radiation that is admitted through a window or skylight, both directly transmitted, and absorbed and subsequently released inward.

**U Value (W/m<sup>2</sup>-K)** :- A value that describes the ability of a material to transmit heat. The lower the number, the lower is the heat transferred through the material.

**RHG (Relative Heat Gain)** :- An attribute which describes the total performance of the glazing with regard to heat transfer due to temperature differential (U-Value), as well as solar gain (shading coefficient).

*Usually 80% is contributed by Solar gain and 20% through temperature differential*



# Glance At Terminology



**Visible transmittance (VLT)** – It is the percentage of visible light, incident on the glazing, that will pass through.

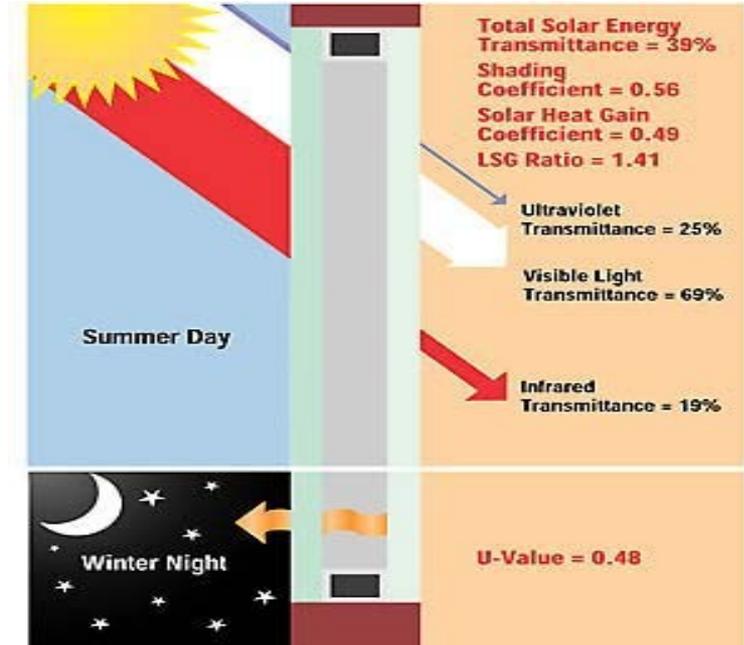
**Ultraviolet transmittance** – It indicates the percentage of ultraviolet radiation, striking the glazing, that will pass through.

**WWR**- Window to wall ratio

**Effective Aperture (EA)** = WWR X VLT

**M factor** = multiplication factor

**Sound transmission**- It is represented by Outdoor to Indoor Transmission Class (OITC). Higher is this rating, better will be the glazing unit at sound insulation.



Window Glass	Normal STC Range	Typical Value
Single pane glass	26-28	27
Dual pane glass	26-33	28
<b>Soundproof Window</b> over a single pane window	43-49	48
<b>Soundproof Window</b> over a dual pane window	45-54	48

# Glazing products available



## On-line processing

- Clear Float Glass
- Tinted Glass
- Pyrolytic Reflective Glass

## Off-line processing

- Tempered Glass
- Heat Strengthened Glass
- Laminated Glass
- Low-e coated glass
- Sputter coat Reflective glass
- Photovoltaic Glass
- Lacquered Glass
- Mirror
- Frosted Glass

# Glazing selection Parameters

- Aesthetic
- Energy Efficiency
- Improved Day-lighting
- Strength
- Security
- Sound Insulation

# Glazing selection Parameters

Parameters	Importance
Aesthetic	Enhances look of the building
Energy Efficiency	It is a combination of lighting & cooling energy saving
Improved Day-lighting	Reduces artificial lighting requirement by using glazing
Glare Reduction	It can defeat the purpose of using glass



Glass	Colour	Visual light transmission	Internal Reflection	External Reflection	Solar Factor	Shading coefficient	U value
		VLT	IR	ER	SF	SC	
A	Shade	%	%	%	%	0.y	W/m2

# 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



DGU Glass (DGU 6-12air-6 Clear)	Solar Factor (%age)	U-Value (W/M <sup>2</sup> .K)	RHG (W/M <sup>2</sup> )
Clear	71%	2.8	535
Tinted	45%	2.8	347
Solar Control Glass	35%	2.8	275
Solar Control Low E Glass	20%	1.7	158

**Assumption :**  
Solar Intensity : 630  
Temp Difference : 7.8

# Strength, Safety & Sound Insulation



## Strength

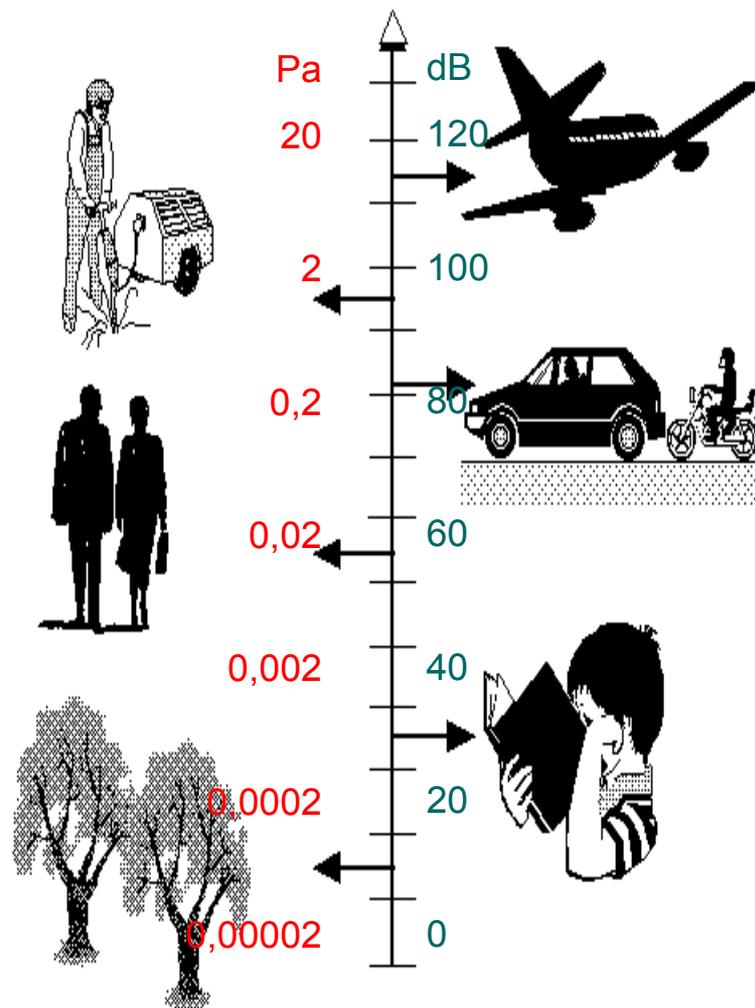
- Use tempered, heat strengthened or laminated glass

## Safety

- Use Laminated Glass
- Select the types of lamination according to safety requirement & safety norms

## Sound Insulation

- Use laminated glass with special acoustic interlayer



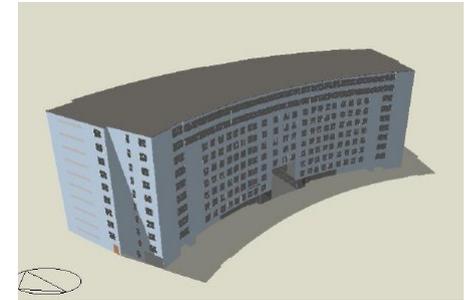
# **Design Factors affecting Glazing Selection**

# Glazing Selection process



## Climate Analysis :-

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



An Office building in Bangalore, where 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 & still be energy efficient.

Calculations	Total (KWh)	Cost of Electricity	Savings (KWh)/Yr	Savings (Rs.)/Yr.	Cost of Glass	Cooling design (KW H)	Cooling Load in TR	Units	Cost	Savings	Extra Paid for Glass
base case Clear Glass SGU	7032860	42197163			2750000	3052	862	300tr*3	21375000		
Enhance Pine SGU	7244067	43464400	-211206	-1267237	5500000	2060	836	300tr*3	21375000	0	2750000
Enhance Reef SGU	7034942	42209653	-2082	-12491	5500000	2905	820	300tr*3	21375000	0	2750000
Proposed Glass	7099559	42597354	-66699	-400191	5750000	2800	790	300tr*2 +200*1	19000000	2375000	3000000
Proposed Glass as per Green Consultant with Lighting controls	7320208	43921247	-287347	-1724085	5750000	2876	812	300tr*2 +250*1	20187500	1187500	3000000
Proposed Glass as per Green Consultant without Lighting controls	7640898	45845389	-608038	-3648227	4250000	2885	814	300tr*2 +250*1	20187500	1187500	1500000

# Glazing Selection process

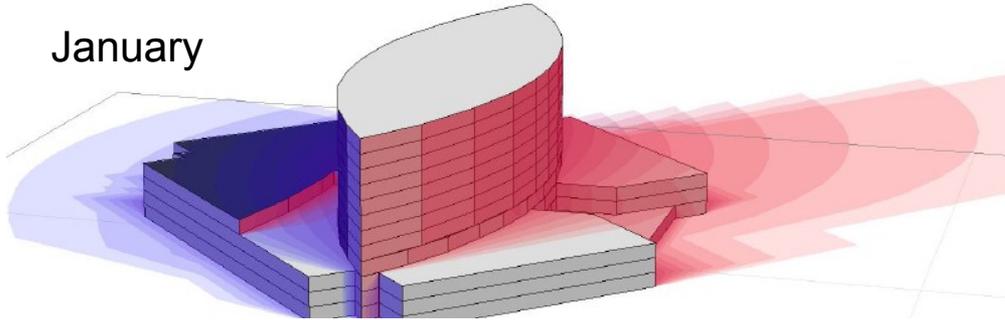


## Optimum Orientation of Building: -

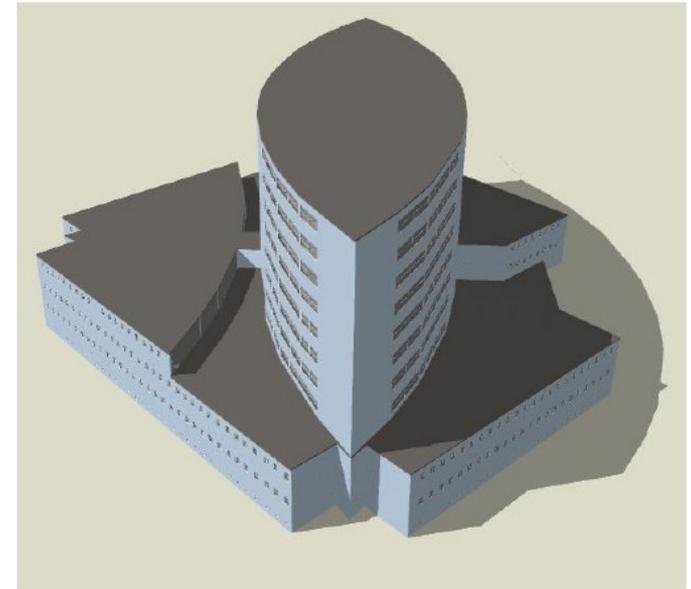
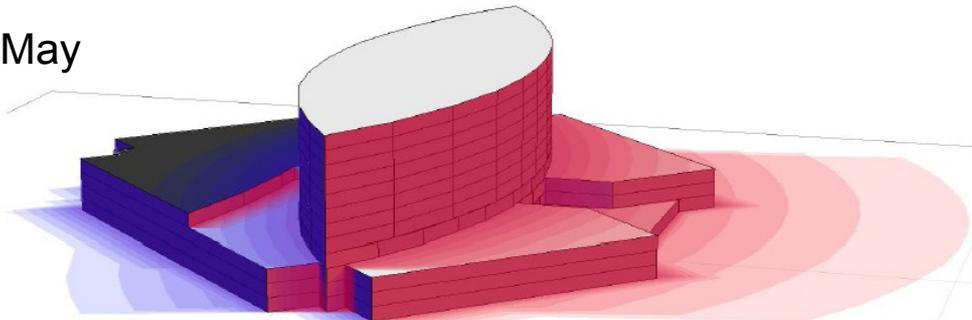
A commercial complex at Navi Mumbai with glazing on East & South Façade showed that Clear Glass performed as good as the so called “high – performance glasses” and the choice came down to aesthetics

## Shadow Analysis :-

January



May



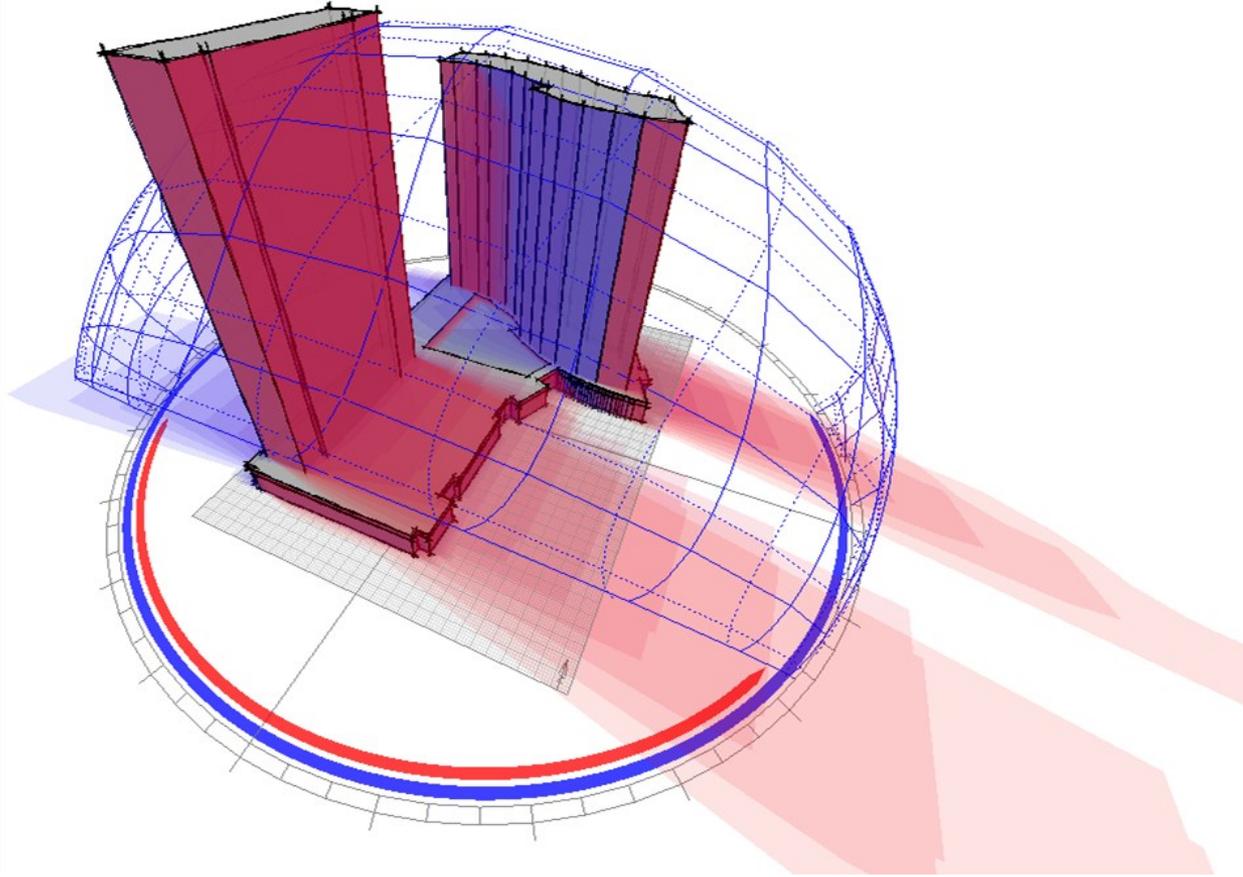
Right orientation reduces the demand for high performance parameters.

# Glazing Selection process



## Shadow Analysis: -

Blue indicates Summer sun path and Red indicates Winter sun path.



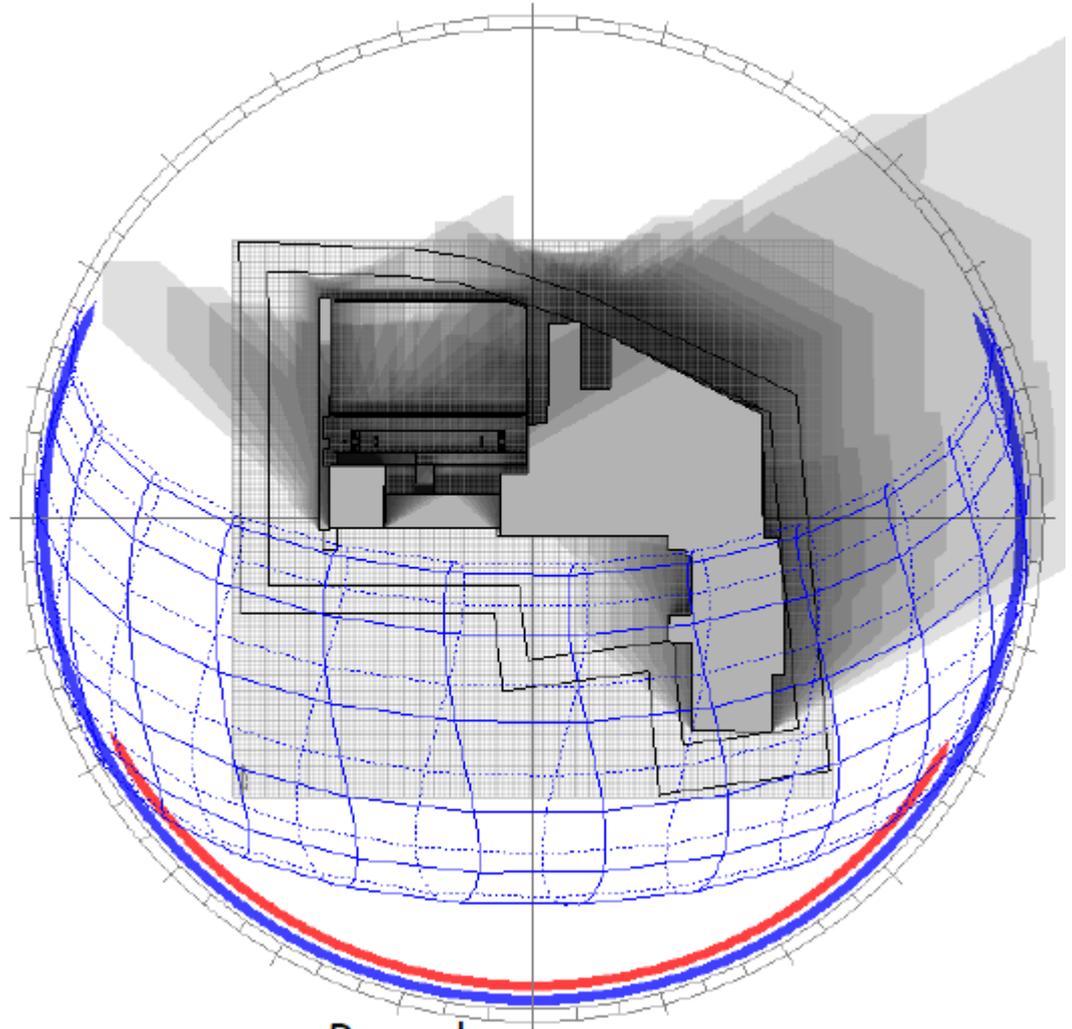
**Shadow Analysis suggests the optimum requirement of Glazing performance parameter to be used.**

# Glazing Selection process



## Passive Design: -

- A hotel building in Gurgaon had avoided their demand of high performance glasses just by adding shading devices.
- Correct shading reduces overall solar radiation intake in the building and also optimizes Light inside the building.

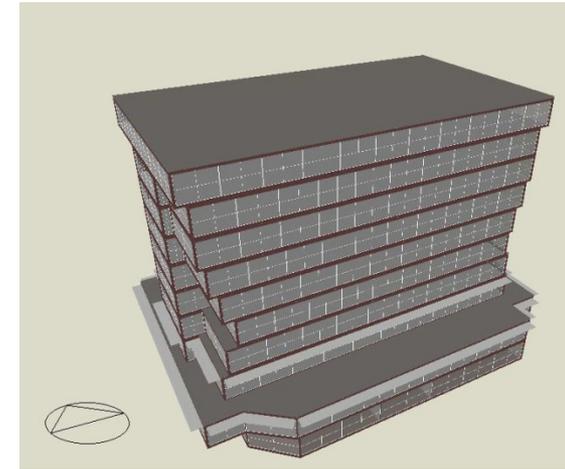


# Glazing Selection process



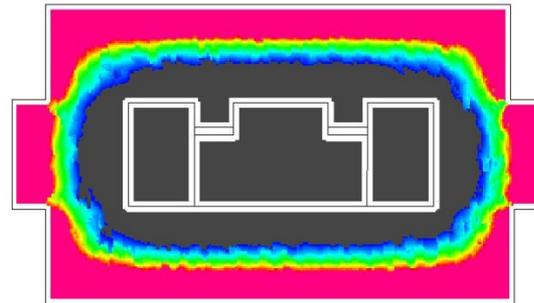
## Daylight Analysis :-

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 identical in terms of achieving the optimal lux levels. Clear Glass, in fact, caused glare in certain portions of the building.

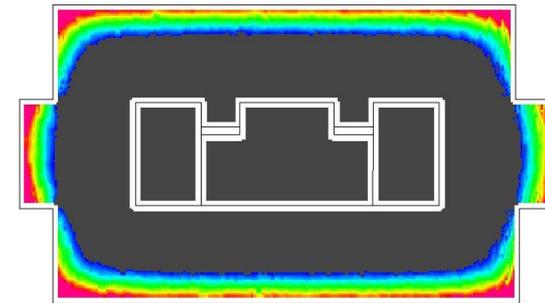


Red Colour region shows area which will have Glare and grey indicates sub-optimal lighting  
In 2<sup>nd</sup> case, we can see reduction in Glare area without reducing optimum lux level.

VLT 78%



VLT 21%



- 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.

# Glazing Selection process



## Glazing Products: -

Before selecting the glass, we need to look at the key performance parameters and select the best suited one depending on the building property

Glazing combination options	VLT	SHGC	U - Value
Option 1	78	0.70	2.8
Option 2	41	0.24	1.75
Option 3	34	0.22	1.7
Option 4	31	0.24	1.7
Option 5	37	0.24	1.7

# Glazing Selection process



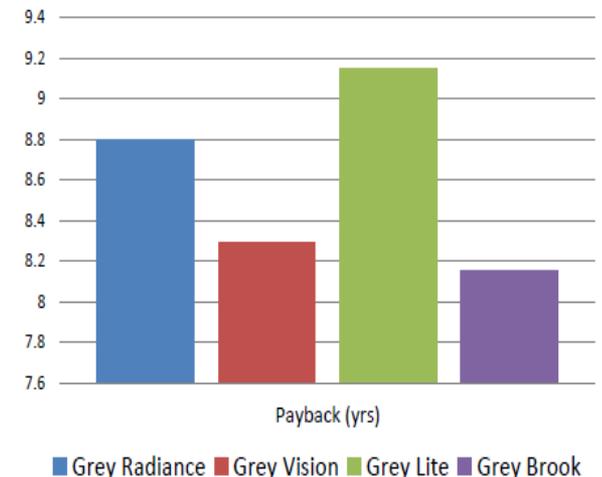
## Overall Energy consumption & Payback period: -

Once the aesthetic of the glazing is chosen, a comprehensive analysis of the products available, when integrated with the building systems, should be done to arrive at the optimal glazing parameters without overdesigning or under-designing the glazing systems

This will justify the glazing selection both by performance & cost

Type	Total Electricity consumption (KWH)	Electricity cost Annual (Rs)	Savings Annual (Rs)	Glazing Cost (Rs)	Extra payment for HP glass (Rs)	Payback years	Payback Months
Base case Clear DGU	2403120	14418720		6600000			
Grey Radiance	1027763	6166578	8252142	12650000	6050000	0.73	8.80
Grey Vision	944143	5664855.6	8753864.4	12650000	6050000	0.69	8.29
Grey Lite	1080116	6480696	7938024	12650000	6050000	0.76	9.15
Grey Brook	919781	5518686	8900034	12650000	6050000	0.68	8.16

Assumptions	
Cost of electricity assumed to be Rs. 6/ unit	
Required quantity = 5500 sqm	
Cost of following glass:	Rs./-
DGU	1200
Grey Radiance	2300
Grey Vision	2300
Grey Lite	2300
Grey Brook	2300
Enhance Mist (Spandrel Area) N/S	2000
Reflective Low e glass (Spandrel Area) E/W	1600
Additional spandrel area glass cost	Rs./-
Rs. 2000 x 1645 sq.mt	3290000
Rs. 1600 x 300 sq.mt	480000
	<b>3770000</b>

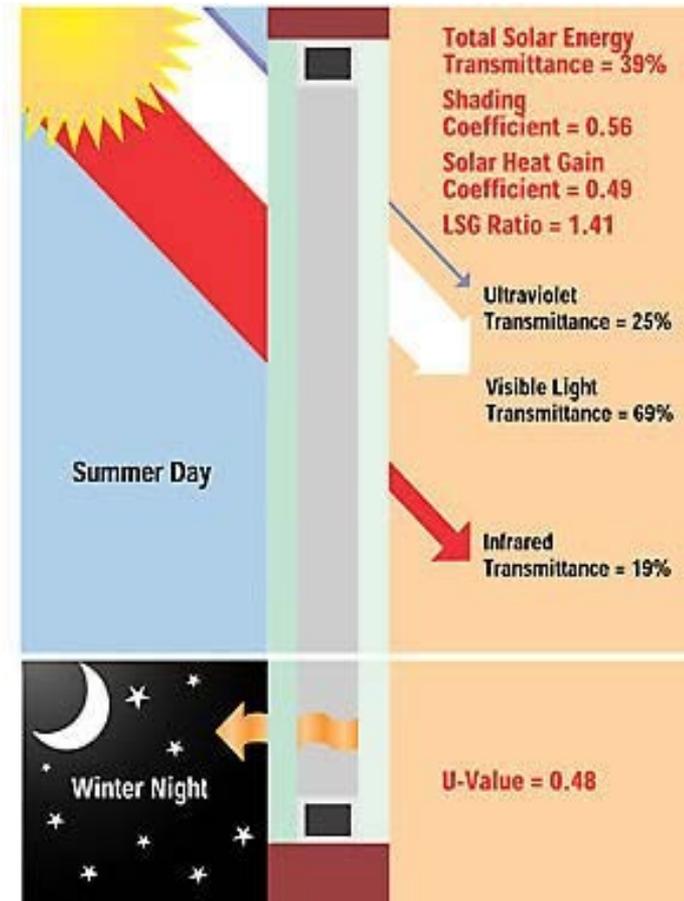


# Glazing Selection process



## 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

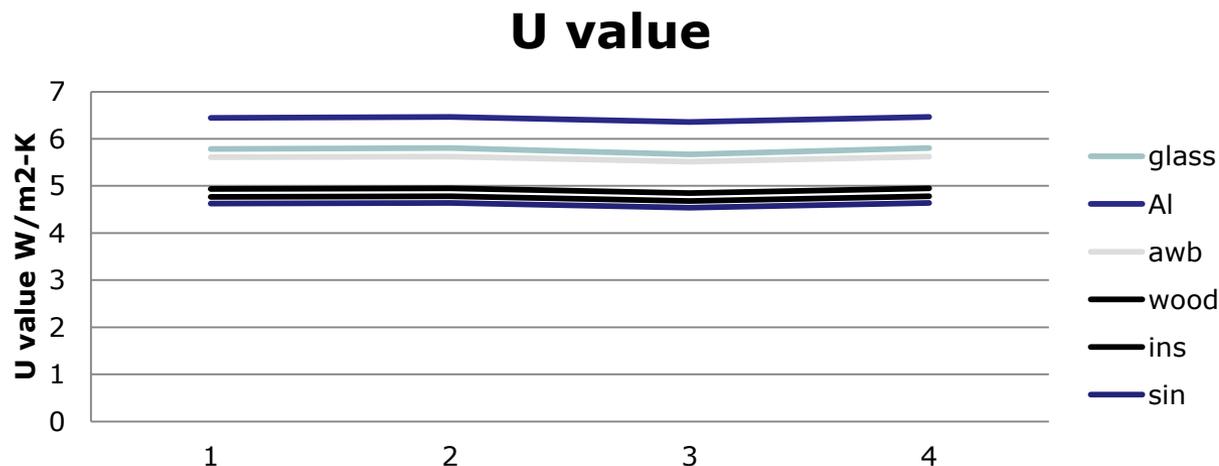


- Add overhead shading
- Add internal shading
- Have more windows on North and South facades
- Use glazing with Optimum VLT ; low SHGC and U value
- Use dark tinted glass at visible height and clear at higher levels
- Use EA between 0.2 to 0.3
- Add light shelves to interiors
- Use high windows (ventilators 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



- 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.





Thank you