

APRIL 2017



# Glass in Facades

*The Essential Selections*

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Safety Design in Buildings

Riyadh Conference



Sunday, April 30, 2017, Moevenpick Hotel Riyadh



# Course Description

Glass selection is an extremely important phase of the design process. It is actually a combination and often a balance of performance characteristics. In this presentation we will address four of the most important aspects of glass selection – fire safety, breakage, barrier and solar performance. The intention is to provide the listener with some of the key requirements and also resources pursuant to assisting them in this regard.



## Presenter

Andy has over 30 years of experience in the field of Building and Construction, ranging from structural testing within the nuclear industry to fire testing.

Having established the Dubai Facade Technology Centre and Laboratory in 1997, and operated it for 10 years, he has particular knowledge of heavy structures testing and weathertightness testing of facades, curtain walling and building envelope systems; and business in the Middle East.

Andy is a Fellow of the Chartered Institute of Building, Fellow of the Society of Façade Engineers (CIBSE) and member of the Glass and Glazing Federation; holding committee positions in the local chapters of these organisations.

As a façade consultant he continues to provide input into the GCC codes and is a regular speaker at industry technical seminars across the region.



# Learning Objectives

1. Considerations for glass selection
2. *Glass selection considerations for fire safety*
3. *Glass selection considerations for breakage*
4. *Glass selection considerations for balustrades*
5. *Glass selection considerations for solar control*

The purpose of this presentation is to convey technical knowledge to the conference participants.

The presentation also contains slides with text that summarise the content of the presentation and the main learning objectives.

These may be used to update CPD records for relevant organisations including the Chartered Institute of Building (CIOB).



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Middle East 2017

# GLASS SELECTION

## → AGENDA

- *Glass selection factors*
- Fire
- Breakage
- Barriers / balustrades
- Solar control

# GLASS SELECTION

## → Glass Selection Factors

- Colour
- Fall protection
- Privacy
- Solar control
- Building function
- Fire safety
- Weather
- Weight
- Breakage
- Many more...

# GLASS SELECTION

## → Glass Selection Factors

- Colour
- **Fall protection**
- Privacy
- **Solar control**
- Building function
- **Fire safety**
- Weather
- Weight
- **Breakage**
- Many more...



# KEY GLASS SELECTION FACTOR 1 - FIRE

## → Fire Safety



- Key Glass Selection Factors
- Fire
- Breakage
- Balustrades
- Solar control

# REACTION TO FIRE vs FIRE RESISTANCE

Source: Exova Warringtonfire



## Reaction to Fire

- Usually materials
- Fire development
- 
- Various measurement formats
- Ignitability
- Surface spread of flame
- Smoke development
- Toxicity
- Combustibility

# REACTION TO FIRE

Source: Khaleej Times



## Biggest Issue Currently (Opinion)

- Existing building stock
  - Needs quantification
  - Needs prioritisation
  - Needs a risk assessment for each building
  - Needs enforcement



# REACTION TO FIRE vs FIRE RESISTANCE

Source: Exova Warringtonfire



## Fire Resistance

- Usually systems
- Preventing a fully-developed fire from getting from one compartment into an adjacent one
- Compartmentation – internal fire spread
- Walls, doors, windows, floors, ceilings, penetration seals
- Measured in time (temperature, integrity, structural)

# FIRE RESISTANCE CLASSIFICATIONS

## Classifications

- **E** Integrity only
- **EW** Integrity with radiation limitation
- **EI** Integrity with insulation



Sources:

Exova Warringtonfire  
Effectis

# MAIN FIRE RATED GLASS TYPES (1)

## Main Types (1)

- **Wired**  
E30, safety glass, double glazed, can be sprayed, multi-directional, clear or opaque
- **Tempered borosilicate**  
E120, safety glass, double glazed, multi-directional, no wires
- **Ceramic**  
E240, can be safety glass, double glazed, can be sprayed, no wires
- **Light-weight laminated**  
E60 or EW60, safety glass, double glazed, multi-directional, no wires
- **Modified tempered soda lime silicate**  
E60 or EW30/60, safety glass, double glazed, no wires



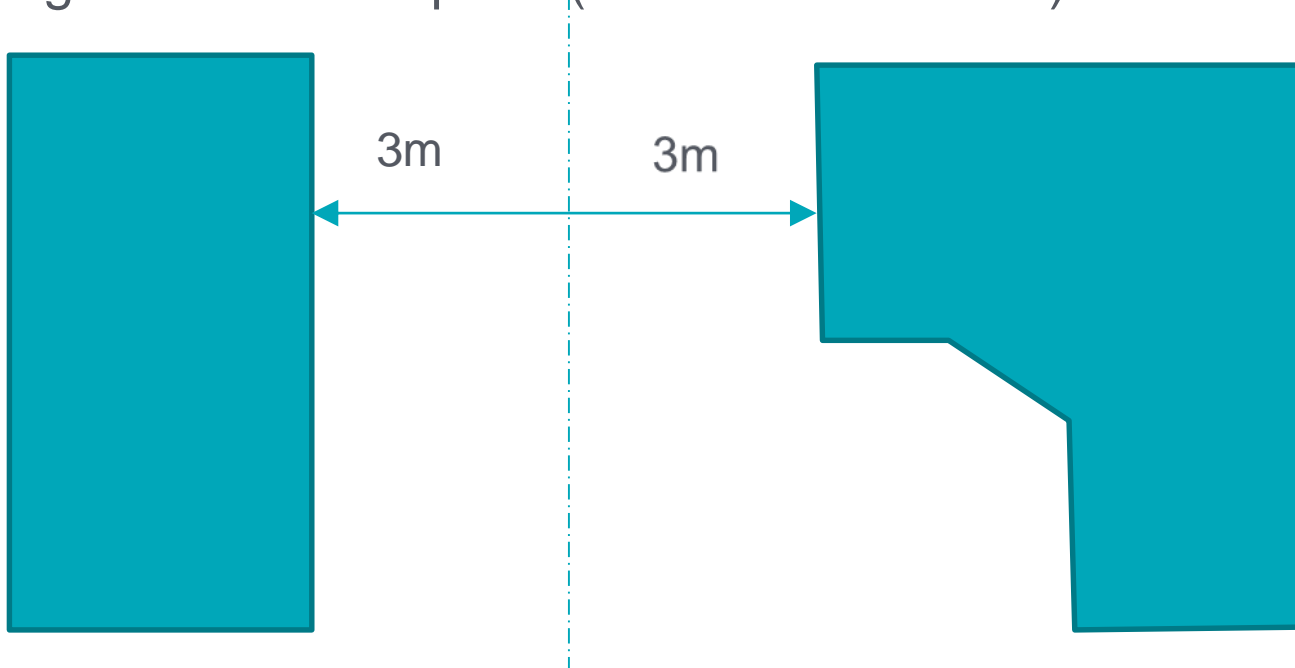
# MAIN FIRE RATED GLASS TYPES (2)

## Main Types (2)

- **Resin & PVB laminated**  
E60 or EW30/60, safety glass, double glazed, multi-directional, no wires
- **Intumescent & gel laminated**  
EI 120, safety glass, double glazed, can be sprayed, multi-directional
- **Points to consider**  
Expense, lead times, thicknesses, weight, sprayable? (collapse), insulation, multi-directional, colour

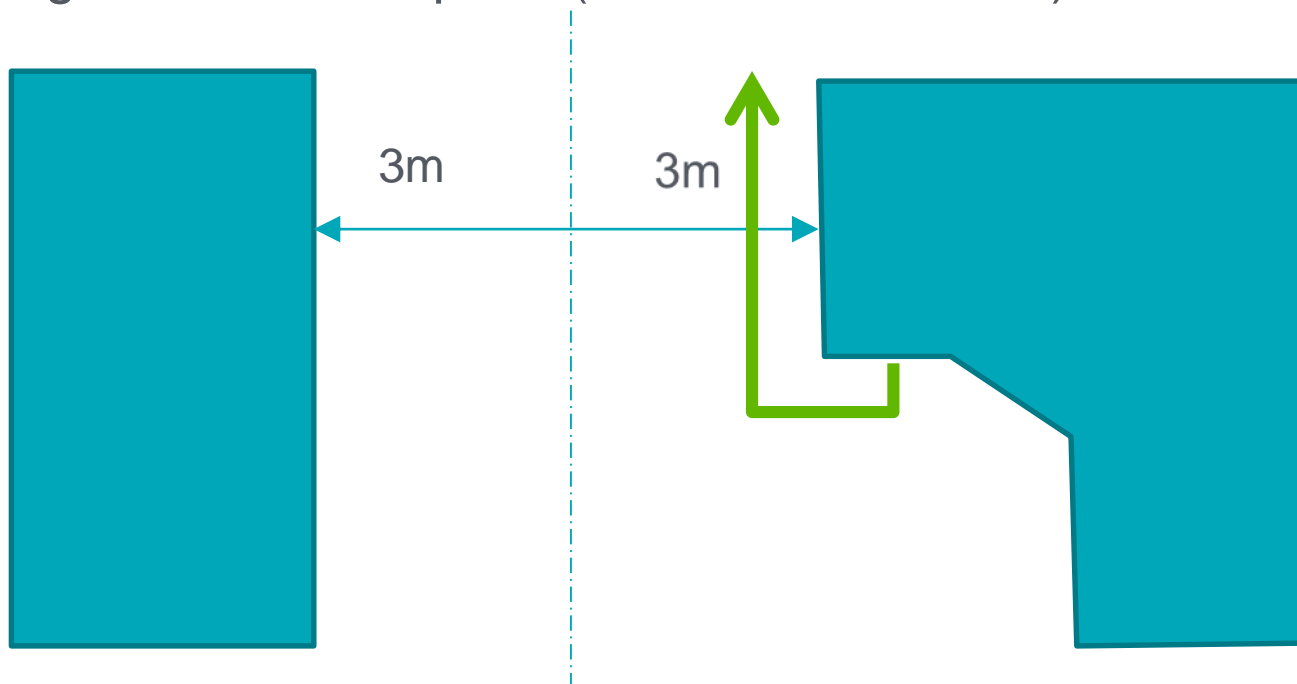
## THE REQUIREMENT FOR FIRE RESISTANCE - FAÇADE GLASS

- Preventing flame spread out of, or into, a building
- Protecting an essential space (internal or external)



## THE REQUIREMENT FOR FIRE RESISTANCE - FACADES

- Preventing flame spread out of, or into, a building
- Protecting an essential space (internal or external)



- Certain sections may need to be fire resistant, on a project-specific basis
- More frequently an internal requirement (internal partitions)

# KEY GLASS SELECTION FACTOR 2 - BREAKAGE

## → Breakage

- Key Glass Selection Factors
- Fire
- Breakage
- Security
- Solar control

# GLASS BREAKAGE FACTORS



## Considerations

- Proximity to pedestrians
- Overhead, inclined, vertical
- Thermal environment
- Building location
- Building use
- Hazard protection
- Weight
- Colour
- Quality
- History of breakage
- Existing problem
- Sensitivity

# GLASS BREAKAGE



## Heat Treatment

- Annealed
- Heat strengthened (HS)
- Fully tempered, toughened (FT)



# GLASS BREAKAGE



- Annealed ([Float](#)):
  - + Not expensive
  - + Can be cut
  - + V. low distortion
  - + No NiS effect
  - Long shards
  - Low impact res.
  - Thermal cracks
  - Not a safety glass (for most thicknesses)

# GLASS BREAKAGE



- Heat Strengthened (HS):
  - + Relatively inexpensive
  - + Low distortion
  - + Rare NiS effect
  - + No thermal cracks
  - Long shards
  - Improved impact resistance
  - Not a safety glass (for most thicknesses)

# GLASS BREAKAGE



- Fully Tempered / Toughened (FT):
  - + Relatively inexpensive
  - + Good impact resistance
  - + No thermal cracks
  - + A safety glass
  - + No long shards
  - NiS prone
  - Distortions likely
  - Readily collapses following fracture

# GLASS BREAKAGE

## Laminated Glass (positives):



- + Takes on the properties of the plies
- + Integrity after impact (depending on configuration)
- + A safety glass
- + Allows blending of properties
- + Potential for structural creations

# GLASS BREAKAGE

## Laminated Glass (negatives)



- Expensive
- Interlayer type to be considered
  - PVB / EVA
  - SentryGlas
- Extreme caution when FT used overhead / inclined
- Delamination (PVB is hygroscopic)

# INTERLAYERS



Source: GGF





# GLASS BREAKAGE

## → Critical Locations



# KEY GLASS SELECTION FACTOR 3 - BALUSTRADES

## → **Barriers / balustrades**

- Key Glass Selection Factors
- Fire
- Breakage
- **Balustrades / barriers**
- Solar control

# BALUSTRADES - CONSIDERATIONS



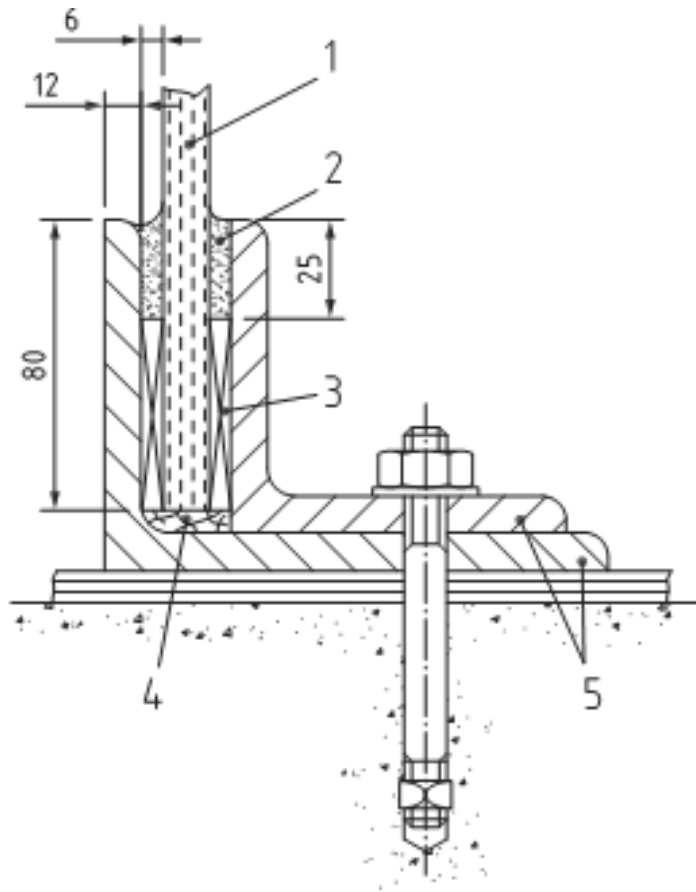
- Protecting what?
  - may be a fall?
  - may be an enclosure?
  - may just be people flow?
- Load – high variety
- Height (minimum 1.1m)
  - some higher (full height?)
- Openings (max 100mm)
  - where – floor level?
  - available generally?
  - maintenance only?
- Climbability
  - rails, steps?
- Clamping

# BALUSTRADES – SUGGESTIONS



- Cap the edges –
  - with coated aluminium, not bare metal
- Use HS laminated
- Connect the panels
  - possibly a handrail
- Support the final edge of the last panel
- Focus on the clamping design at the base

# BALUSTRADES – CLAMPING



c) Alternative clamping system

## Key

- 1 Glass
- 2 High modulus sealant
- 3 Hardwood, extruded silicone S/H 85° or epoxy polysulphide compound
- 4 Setting block
- 5 Continuous 12 mm thick angles

Source: BS 6180

- Design with a UDL in mind
- Grout is one option
  - can then use a weather sealant (low modulus)
  - may not be possible unless balustrade horizontal
- Use a high modulus sealant otherwise
- Consider testing

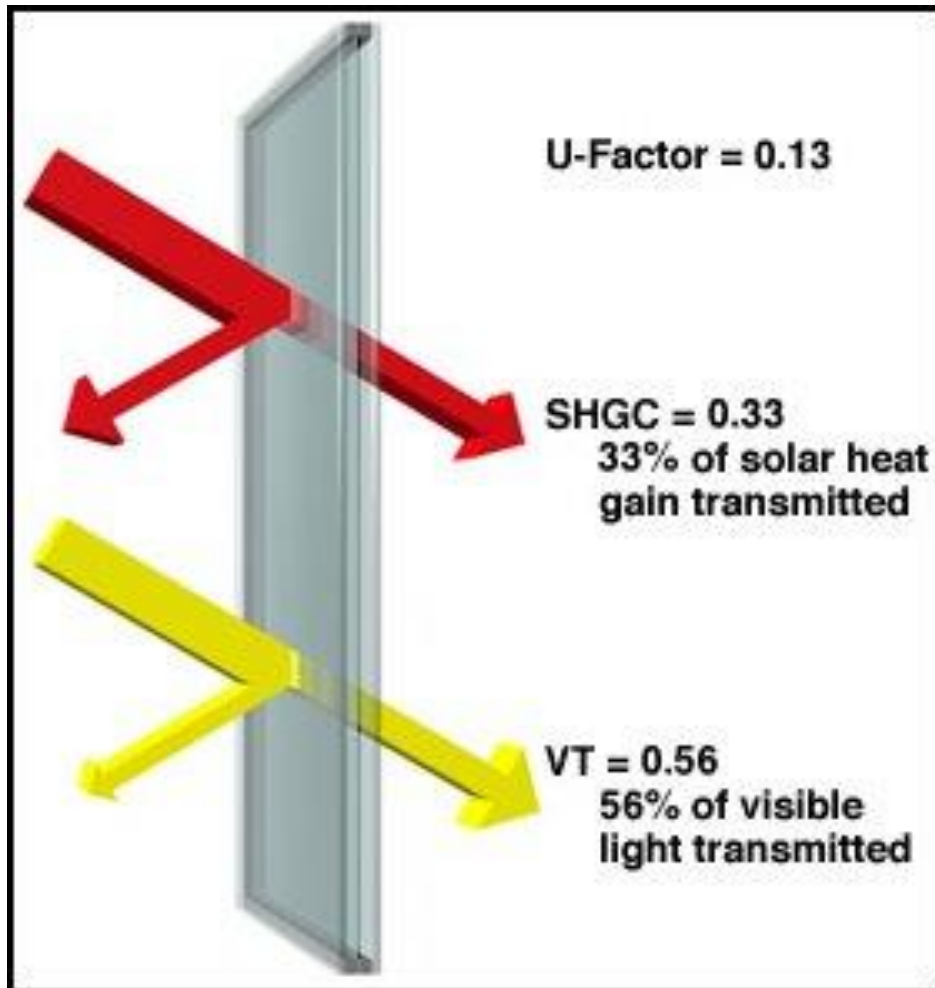
# KEY GLASS SELECTION FACTOR 4 - SOLAR

## → **Solar Control**

- Key Glass Selection Factors
- Fire
- Breakage
- Security
- **Solar control**



# U-VALUE, VLT, SHGC

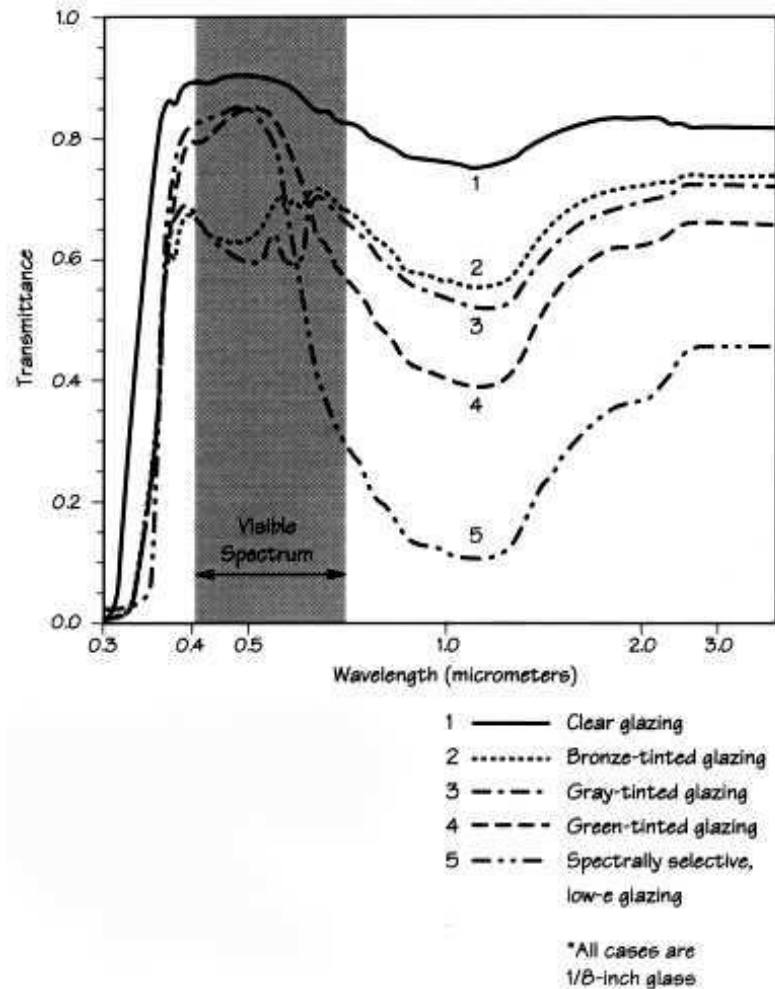


*Credit: Efficient Windows Collaborative*

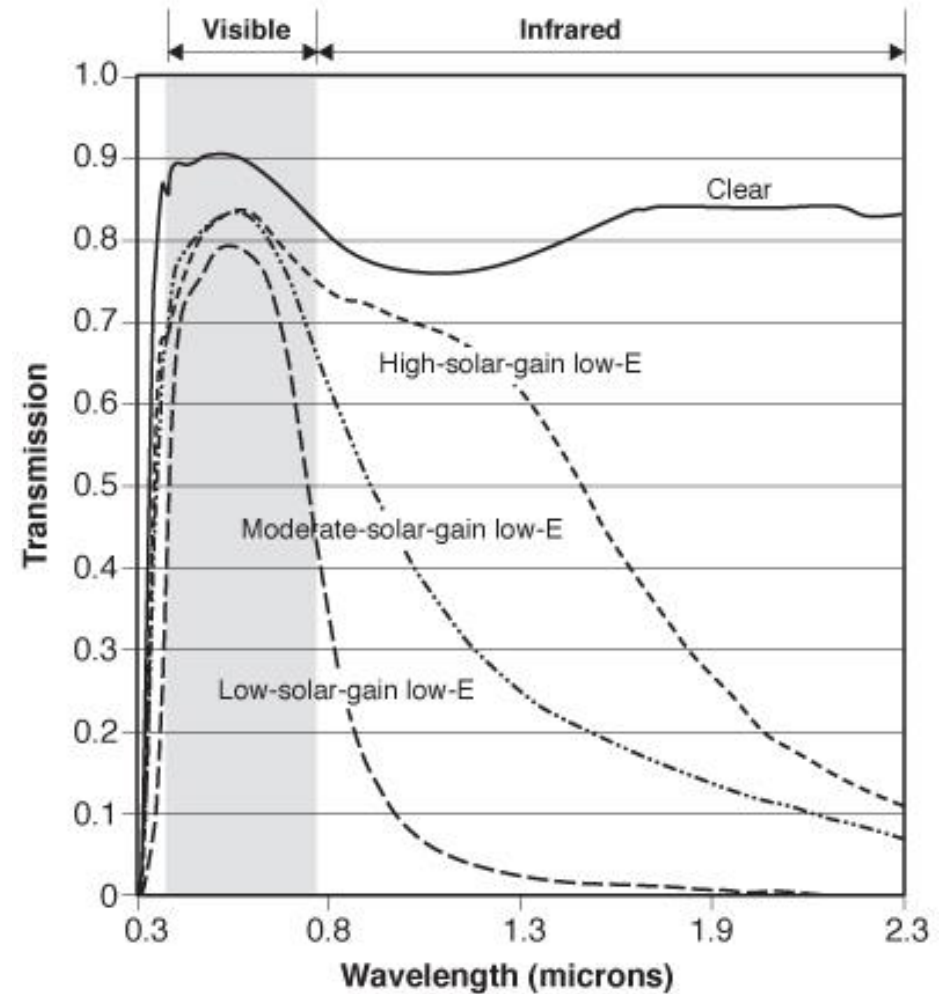
- U-value (transmittance (OHTC))
  - $\lambda$  (lamda) = thermal conductivity or efficiency (W/mK)
  - Resistance ( $m^2K/W$ )
  - $1/R = U\text{-value (W/m}^2K)$
- Visible light transmission
  - the proportion of light from the visible spectrum passing through the glass
  - may or may not be combined with the effect of fritting
- Solar heat gain coefficient = g value
  - total solar energy transmittance
  - $SHGC = SC \times 0.87$  (approx)

# SPECTRAL SELECTION GENERALLY

## → General glass types



## Low E types



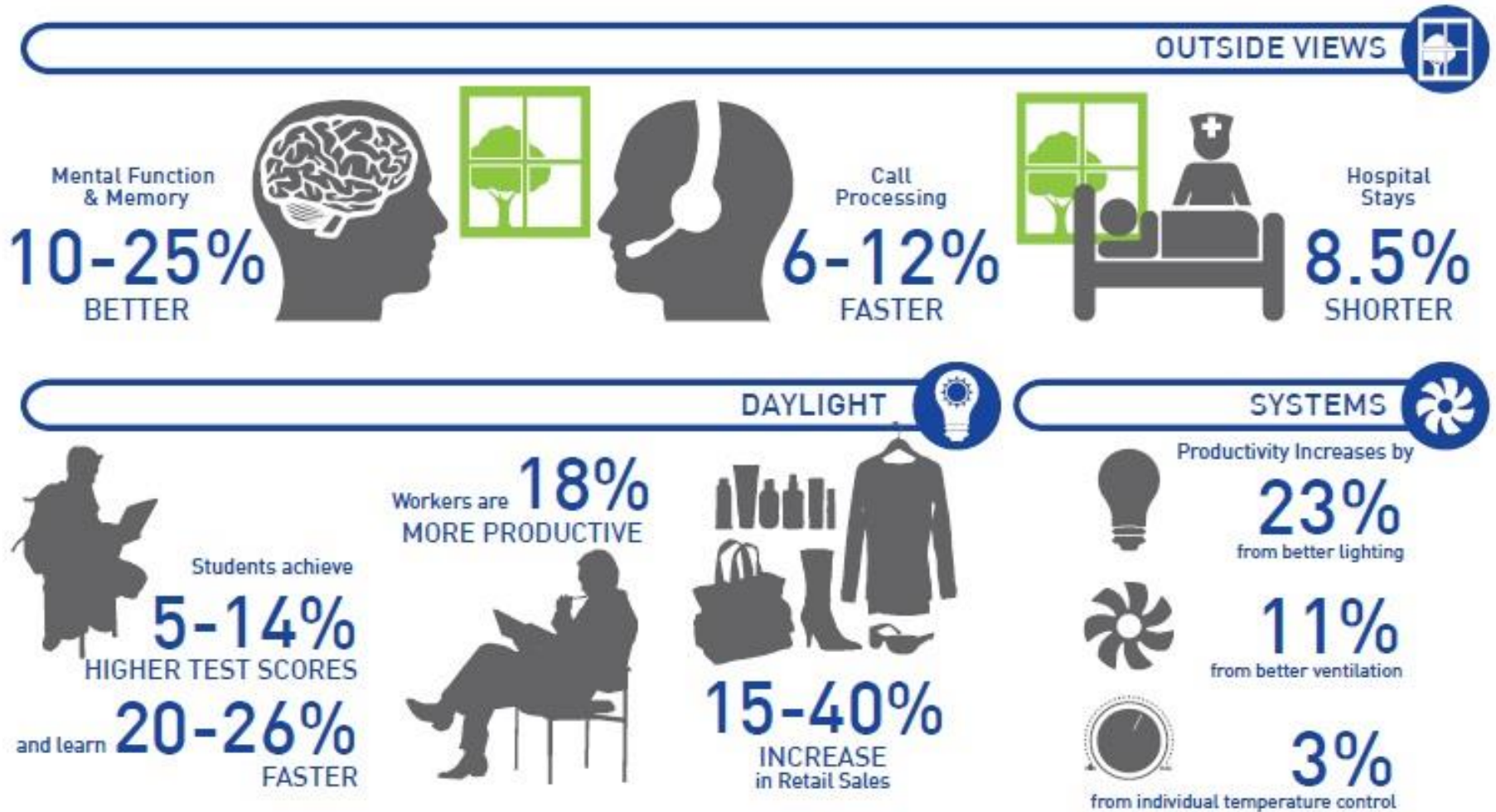
# SOLAR CONTROL (+) FACTORS



## Considerations

- Low comfort = stress  
= health issues
  - too much light – glare
  - closed curtains – no view
  - reduced productivity in schools and offices
  - patient recovery in hospitals
  - unhappy people
- The (+)...
  - Acoustics – sleep and relaxation
  - Fresh air
  - Performance – environmental pollution
  - Many other factors – many people related

# COMFORT AND HEALTH



**Figure 11**  
 Net present value analysis of the operational cost and productivity and health benefits of LEED certified buildings

Source: WGBC

# Thank you

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