MALAYSIA GREEN BUILDING CONFEDERATION

High Performance Façade and Overall Thermal Transfer Value (OTTV)

by

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GBI DA & CVA

> 90% compliant

Wide understanding of Passive Design and Building Envelope

New

Amendments to UBBL

OTTV and Roof U-value compliant

GBI RNC v3 : Prerequisite with One Point

MS1525:2007

1. MS1525:2007 is a Code of Practice (CP), and will be incorporated into UBBL, hence a CP becomes part of a By-law.

2. MS1525:2007 provides the baseline minimum standard for the GBI rating tools for energy efficient design.

MS1525:2007

MS 1525 primarily deals with building energy.

The steps towards Energy Efficient buildings are:

PASSIVE MEASURES

Clause 4 :

Architectural and Passive Design Strategy

Clause 5 :

Building Envelope

+

ACTIVE MEASURES

Clause 6 : Lighting

Clause 7

Power System and Distribution System

Clause 8

Air Cond and Mech Ventilation System

Clause 9

Energy Management Control System

PASSIVE DESIGN STRATEGIES

Building Envelope

MS1525:2007 Clause 4.2

The basic approach towards good passive design is

to orientate,
to shade,
to insulate,
to ventilate and
to daylit buildings.

PASSIVE DESIGN STRATEGIES

Building Envelope

MS1525:2007 Clause 4.2

The basic approach towards good passive design is

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Building Envelope

CONCEPT OF OTTV
Walls and Roof

MS1525:2007 Clause 5.2

OTTV applies to building envelope

MS1525:2007 Clause 5.5

Roof U-value refers to the thermal transmittance of the roof construction

CONCEPT OF OTTV

BUILDING ENVELOPE

"the external portions of a building through which thermal energy is transferred" and

"this thermal transfer is the major factor affecting interior comfort level and energy usage".

CONCEPT OF OTTV

MS1525:2007 Clause 5.2

A design criterion for building envelope known as the Overall Thermal Transfer Value (OTTV) has been adopted. The OTTV aims at achieving the design of building envelope to reduce heat gain through the building envelope and hence reduce the cooling load of the air-conditioning system.

The OTTV…should not exceed 50 W / m^2

CONCEPT OF OTTV

MS1525:2007 Clause 5.2.1

The OTTV of building envelope is given by the formula:

$$OTTV = \frac{A_{o1} \ x \ OTTV_1 + A_{o2} \ x \ OTTV_2 \ ...... + A_{on} \ x \ OTTV_n}{A_{o1} + A_{o2} \ ...... + A_{on}}$$

where A_1 is the gross exterior wall area for orientation 1;

$OTTV_1$ is the OTTV value for orientation 1; and

OTTV for the whole building $\leq$ 50 W/m²

CONCEPT OF OTTV

MS1525:2007 Clause 5.2.2

The formula for the OTTV of any given wall orientation is as follows:

$$OTTVi = 15\,\alpha\,(1 - WWR)\,U_w + 6\,(WWR)\,U_f + (194 \times CF \times WWR \times SC)$$

CONCEPT OF OTTV

MS1525:2007 Clause 5.2.2

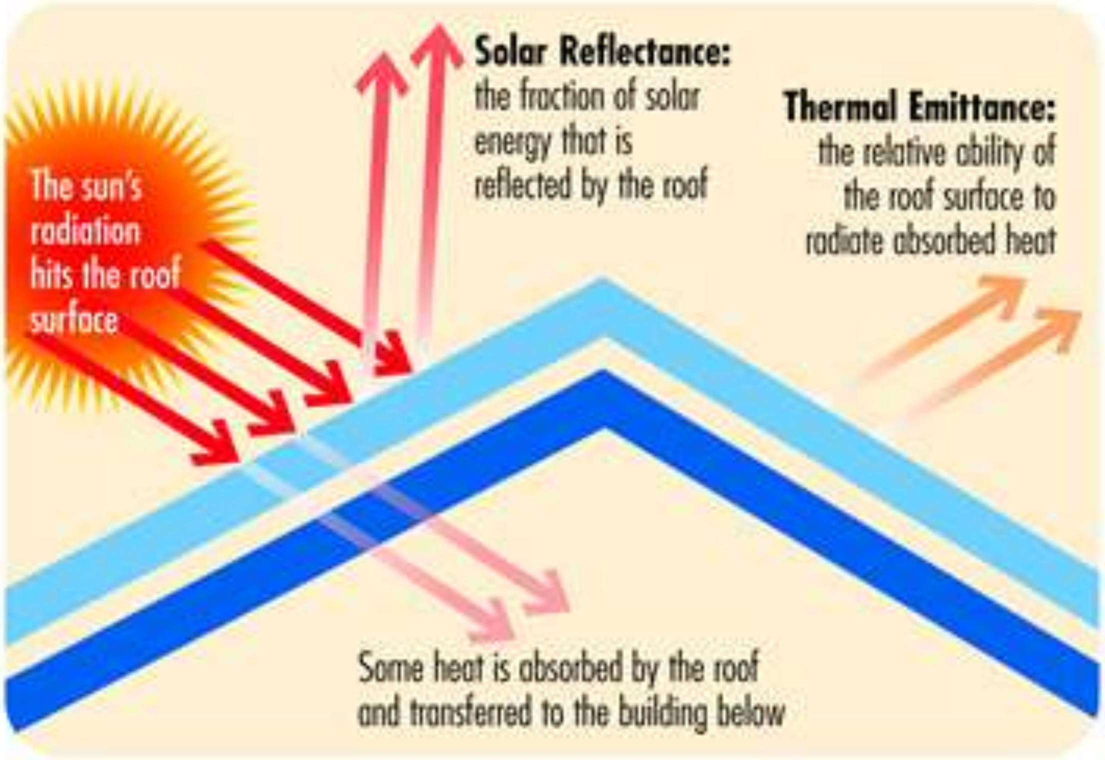
The formula for the OTTV of any given wall orientation is as follows:

$$OTTVi = 15\alpha(1 - WWR)U_w + 6(WWR)U_f + (194 \times CF \times WWR \times SC)$$

OTTV =	**Heat Conduction through Walls**	**+**	**Heat Conduction through Windows**	**+**	**Solar Heat Gain through Windows**

THERMAL RESISTANCE

Solar Radiation and Roof Thermal Resistance



THERMAL RESISTANCE

Relationships between thermal resistance, thermal conductivity and U-value

1. **In heat transfer, the Thermal Conductivity, *k* of a material is its ability to conduct heat.**
2. **Thermal conductivity approx tracks electrical conductivity, as moving electrons transfer not only electric current, but also heat energy.**
3. **Therefore, heat conductivity through layers of materials in a composite wall construction is analogous to adding up the resistance in an electric circuit connected in series.**

THERMAL RESISTANCE

Relationships between thermal resistance, thermal conductivity and U-value

4. **Thermal Resistance, R of each material is**

   R = (material thickness) ÷ (thermal conductivity, *k*)

5. **Increasing the thickness of the material will increase its thermal resistance.**

6. **In a composite wall construction, the total R is**

   $$R_{total} = R_1 + R_2 + R_3 + \ldots\ldots + R_n.$$

THERMAL RESISTANCE

Relationships between thermal resistance, thermal conductivity and U-value

7. Therefore, R_{total} is the sum of the thermal resistance of all the respective materials making up the composite wall.

8. U-value of the wall is the heat transmission value of the composite wall in W/m^2K, and is inversely proportional to the total R,

   ie, $U = 1 / R_{total}$.

9. The higher the R, the lower the U, the better.

THERMAL RESISTANCE

Relationships between thermal conductivity, thermal resistance and U-value

$$k = \text{Thermal conductivity}$$

$$R = \frac{\text{Material thickness}}{k}$$

$$U = \frac{1}{R}$$

THERMAL RESISTANCE

Examples of thermal conductivity, *k*

Mineral wool insulation	0.039
Mineral fibreboard	0.053
Plasterboard	0.160
Common clay brick	0.950
Glass 3mm thick	1.050
Concrete	2.160
Granite	3.810
Aluminium sheet	160.0

MGBC

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CONCEPT OF OTTV

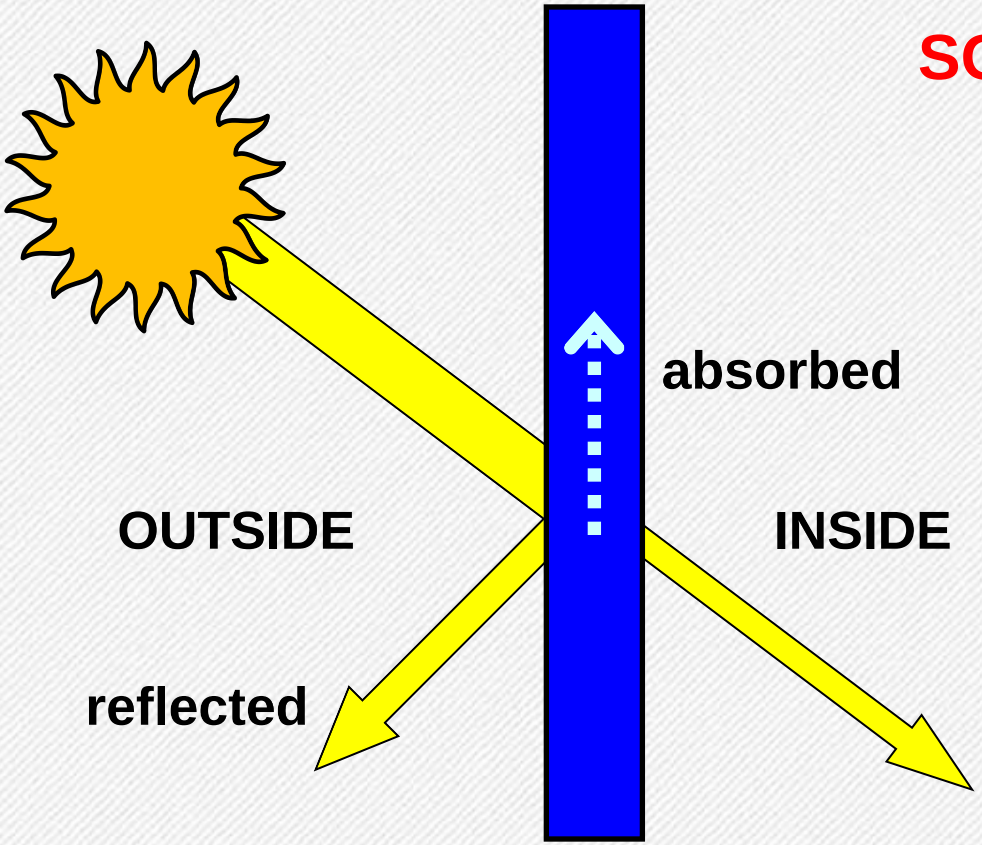
MS1525:2007 Clause 5.2.2

The formula for the OTTV of any given wall orientation is as follows:

$$OTTVi = 15\,\alpha\,(1 - WWR)\,U_w + 6\,(WWR)\,U_f + (194 \times CF \times WWR \times SC)$$

OTTV =	Heat Conduction through Walls	+	Heat Conduction through Windows	+	Solar Heat Gain through Windows
	0.2% to 5%		10% to 20%		70% to 85%

SOLAR RADIATION AND GLAZING



SOLAR RADIATION :

Absorbed
Transmitted
Reflected

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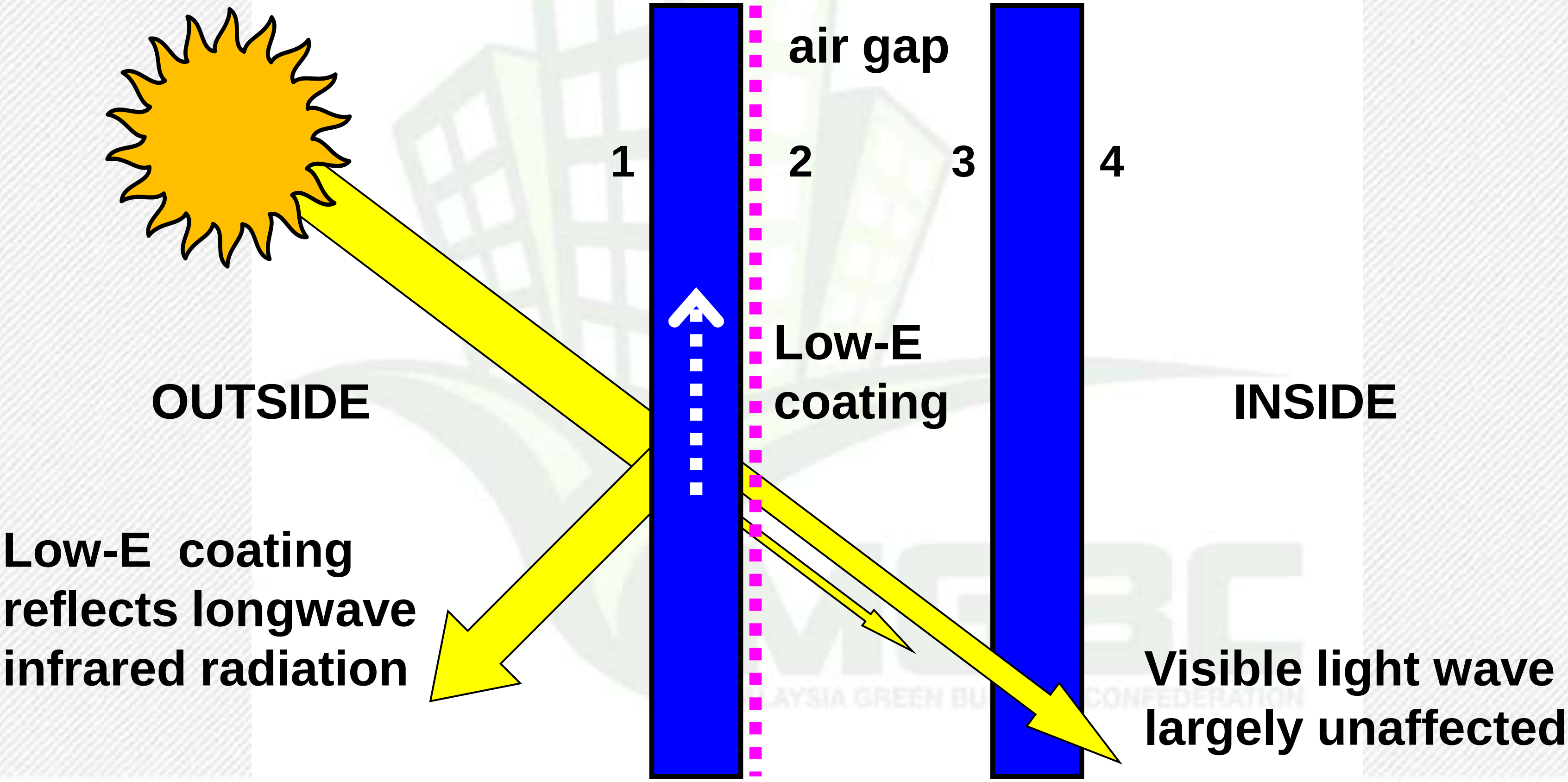
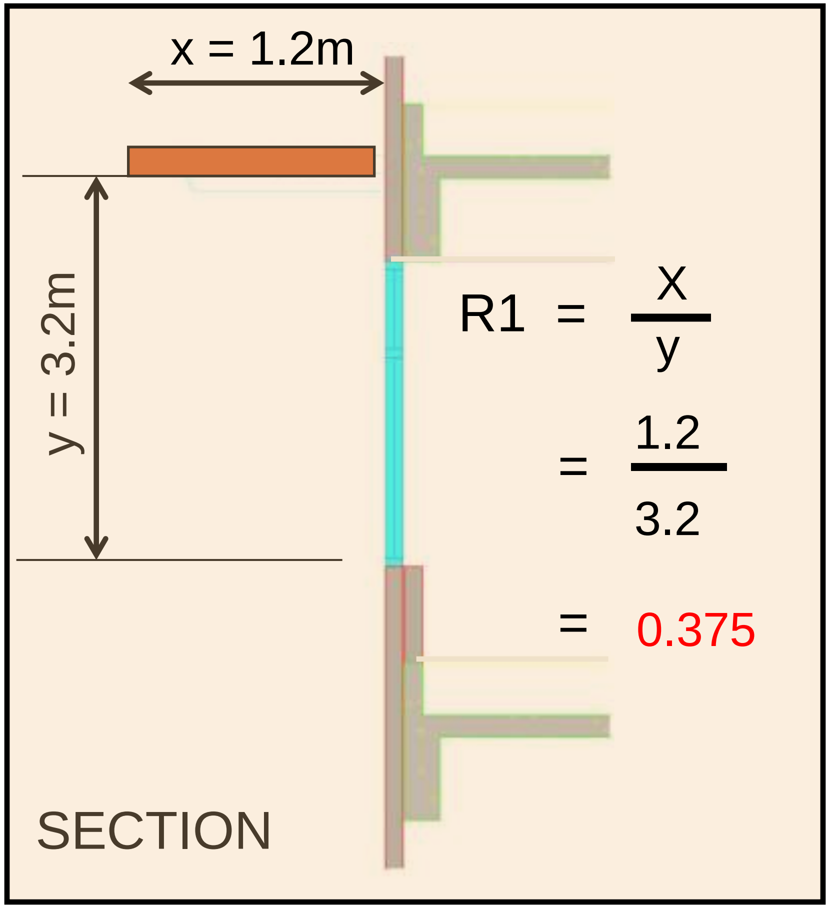
SOLAR RADIATION AND GLAZING



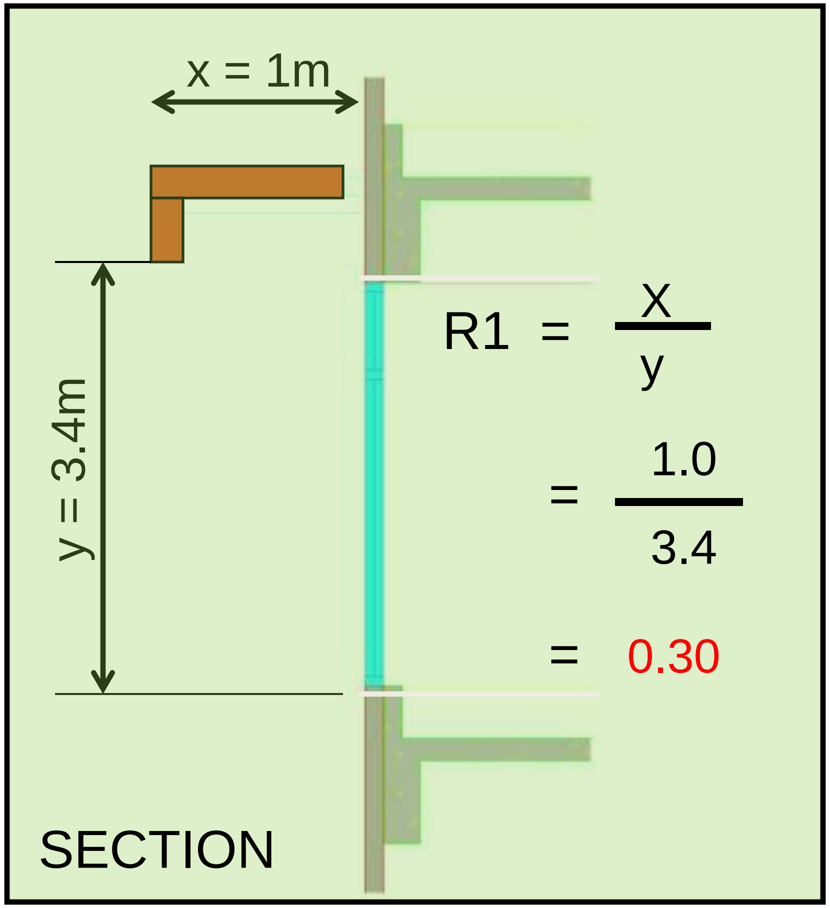
SHADING COEFFICIENT – R1

Horizontal Shading Devices

Eg 1



Eg 2



MS1525:2007 Table 5

SHADING COEFFICIENT OF HORIZONTAL PROJECTIONS

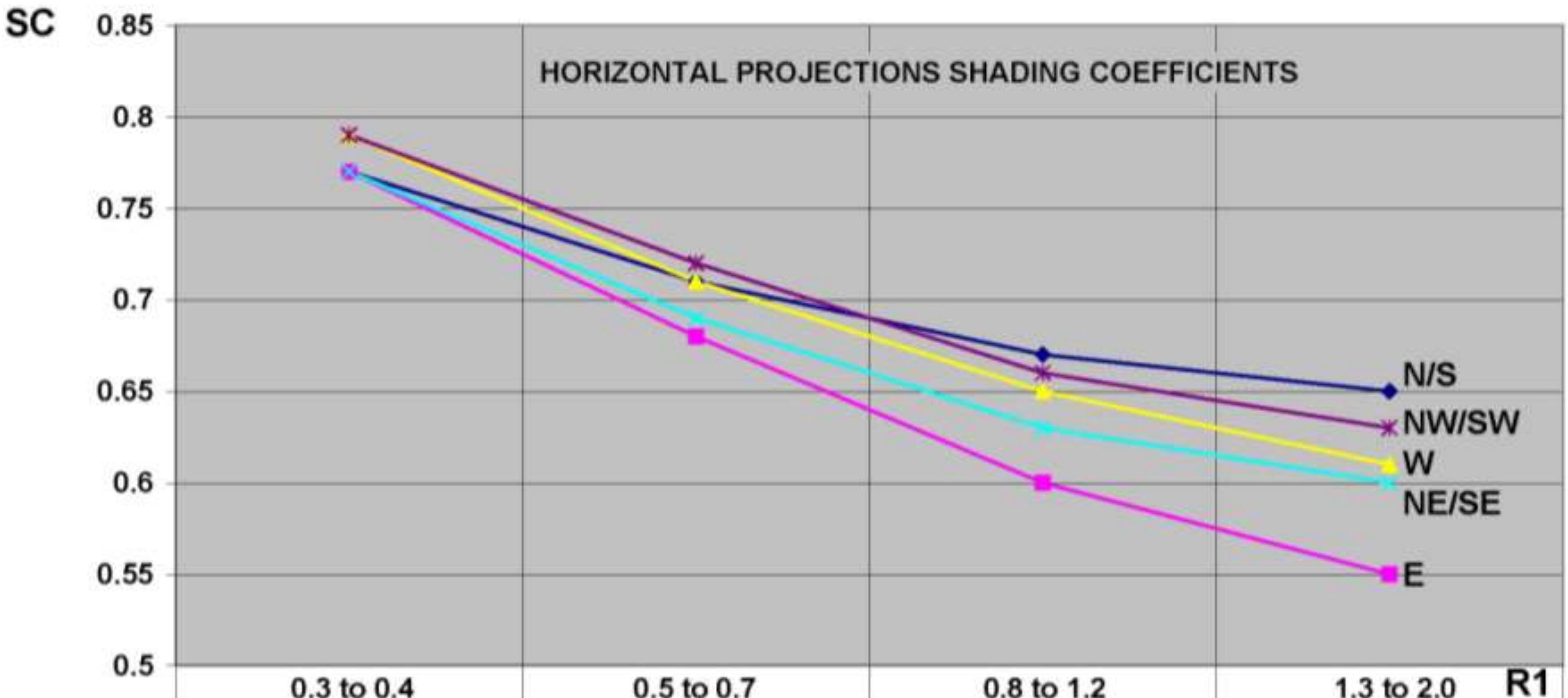
RATIO	ORIENTATION				
R1	North / South	East	West	North-East / South-East	North-West/ South-West
0.30 - 0.40	0.77	0.77	0.79	0.77	0.79
0.50 - 0.70	0.71	0.68	0.71	0.69	0.72
0.80 - 1.20	0.67	0.60	0.65	0.63	0.66
1.30 - 2.00	0.65	0.55	0.61	0.60	0.63

Note :

R1 is the ratio: Width of horizontal projection / Height of fenestration

If R1 falls between increments, adopt the next larger ratio.
If R1 is below 0.30, SC2 = 1.
If R1 is > 2.00, SC2 values shall be the same as R1 between 1.30 and 2.00

SHADING COEFFICIENT - R1

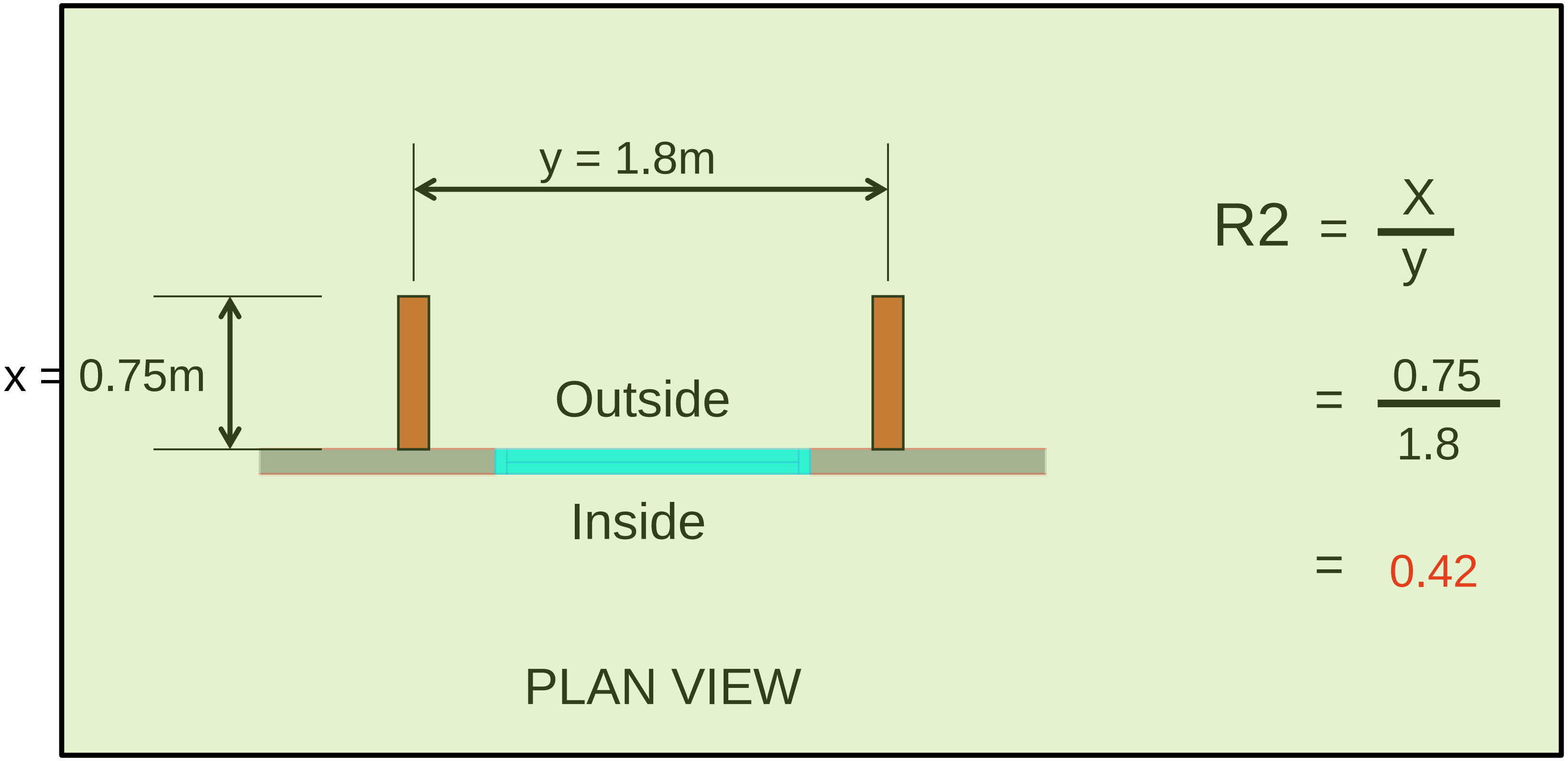


	0.3 to 0.4	0.5 to 0.7	0.8 to 1.2	1.3 to 2.0
North/South	0.77	0.71	0.67	0.65
East	0.77	0.68	0.60	0.55
West	0.79	0.71	0.65	0.61
NE/SE	0.77	0.69	0.63	0.60
NW/SW	0.79	0.72	0.66	0.63

SHADING COEFFICIENT - R2

Vertical Shading Devices

Eg 1



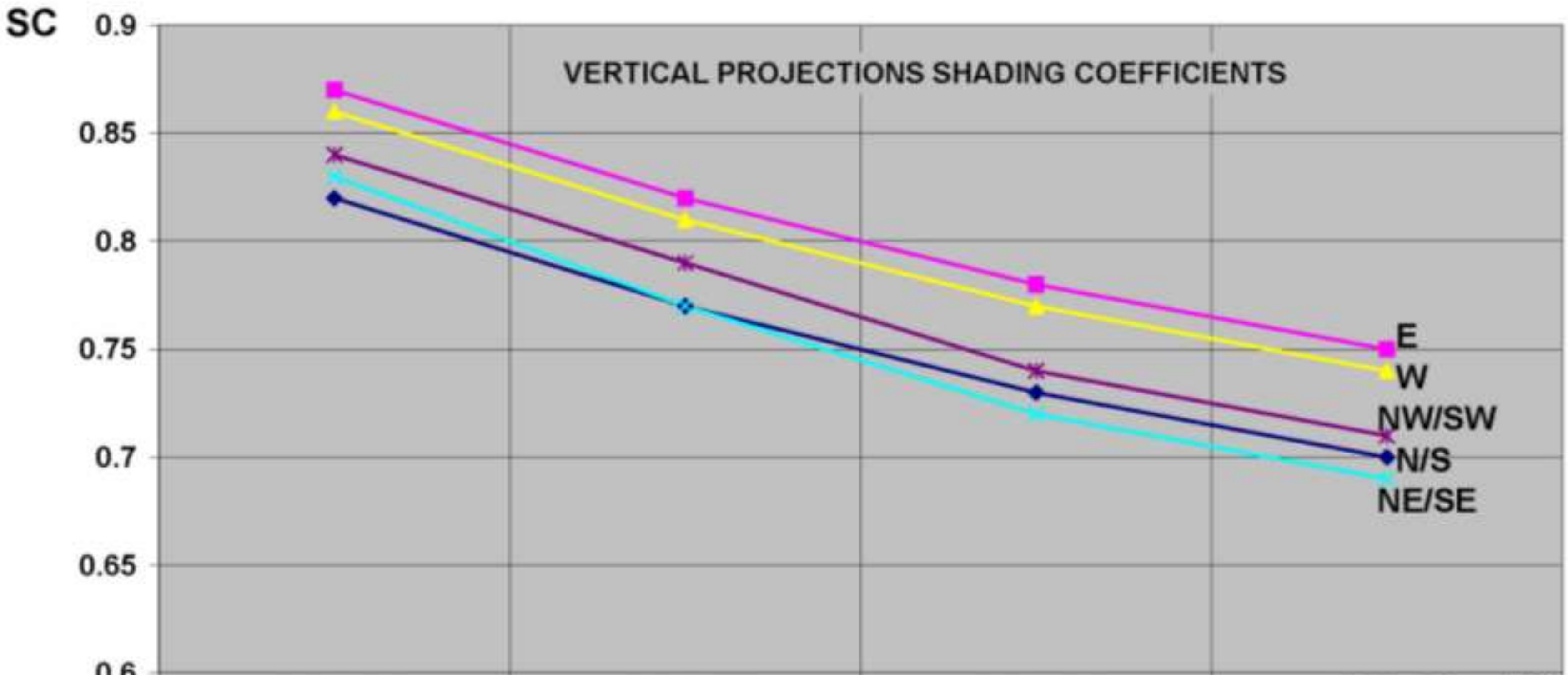
MS1525:2007 Table 6

SHADING COEFFICIENT OF VERTICAL PROJECTIONS

RATIO	ORIENTATION				
R2	North / South	East	West	North-East / South-East	North-West/ South-West
0.30 - 0.40	0.82	0.87	0.86	0.83	0.84
0.50 - 0.70	0.77	0.82	0.81	0.77	0.79
0.80 - 1.20	0.73	0.78	0.77	0.72	0.74
1.30 - 2.00	0.70	0.75	0.74	0.69	0.71
Note : R2 is the ratio: Width of vertical projection / Length of fenestration					

If R2 falls between increments, adopt the next larger ratio.
If R2 is below 0.30, SC2 = 1.
If R2 > 2.00, SC2 values shall be the same as R2 is between 1.30 and 2.00.

SHADING COEFFICIENT - R2



	0.3 to 0.4	0.5 to 0.7	0.8 to 1.2	1.3 to 2.0 R2
North/South	0.82	0.77	0.73	0.70
East	0.87	0.82	0.78	0.75
West	0.86	0.81	0.77	0.74
NE/SE	0.83	0.77	0.72	0.69
NW/SW	0.84	0.79	0.74	0.71

VARIABLES OF OTTV

$$OTTVi = 15\,\alpha\,(1 - WWR)\,U_w + 6\,(WWR)\,U_f + (194 \times CF \times WWR \times SC)$$

VARIABLES:

1. α
2. WWR
3. Uw
3. Uf
4. CF
5. SC

These variables are some of the passive design parameters an architect is required to consider in the design of a building.

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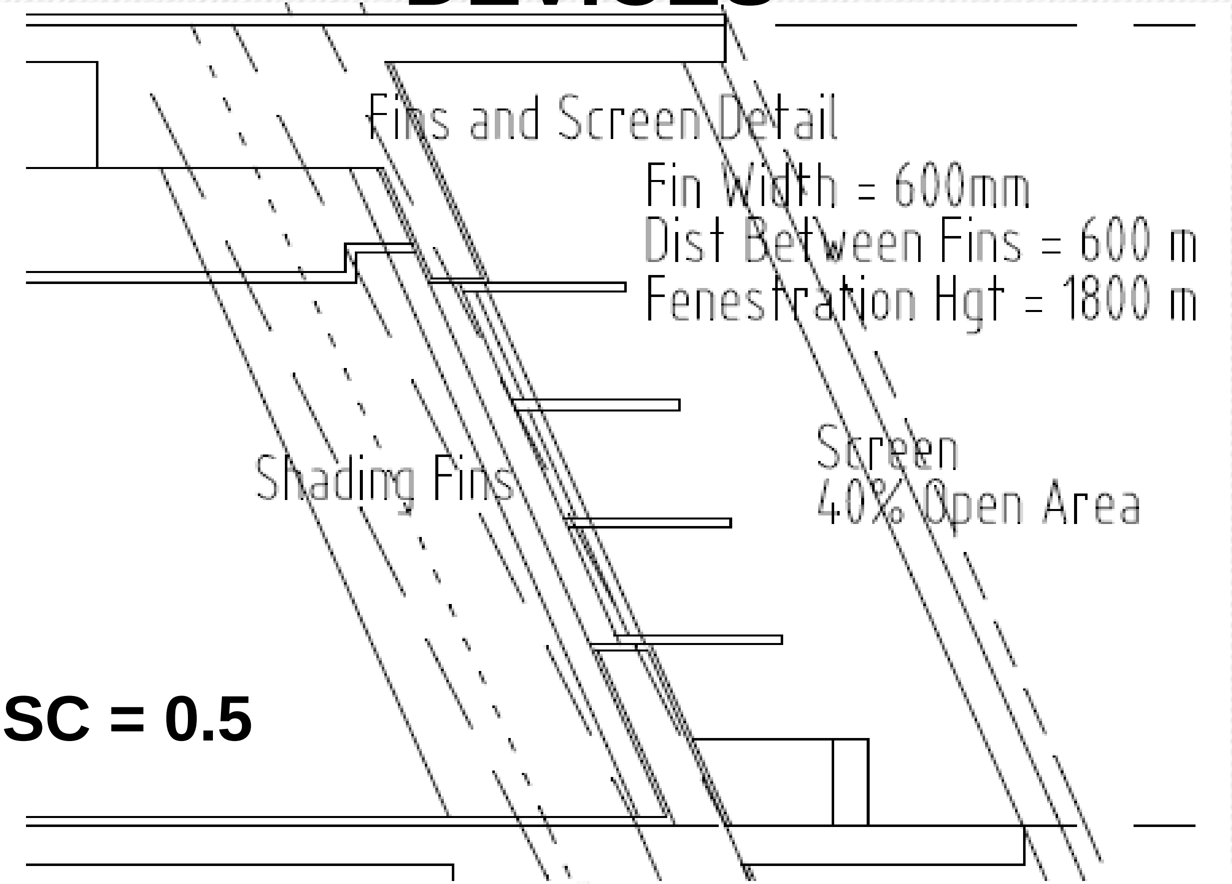
CASE 1: MULTIPLE TYPES OF SHADING DEVICES

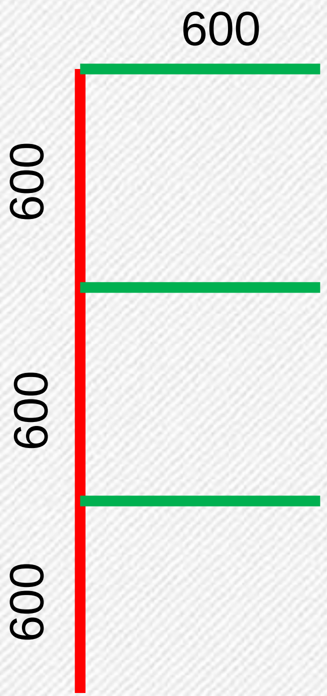


Glass SC = 0.5

MALAYSIA GREEN BUILDING CONFEDERATION

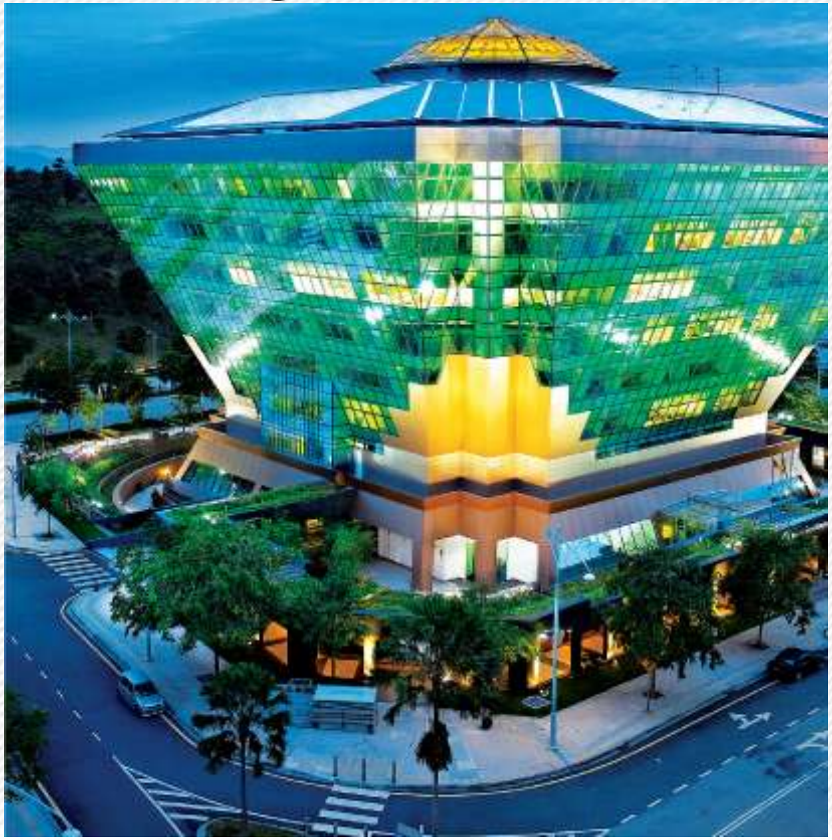
CASE 1: MULTIPLE TYPES OF SHADING DEVICES

SC2: Intermediate Fins



R = Projection / Window Height
R = 600/600 or 1800/1800 = 1
SC2 (N) = 0.67

CASE 2: ST BUILDING
Self Shading Due to Pitch Angle



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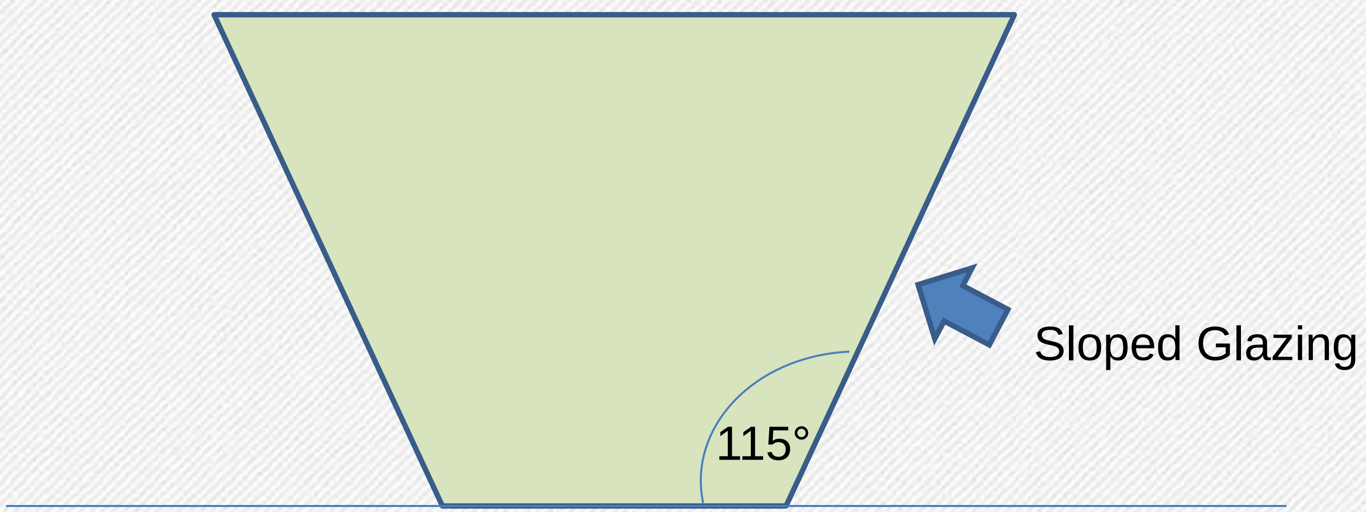
Self Shading Due to Pitch Angle



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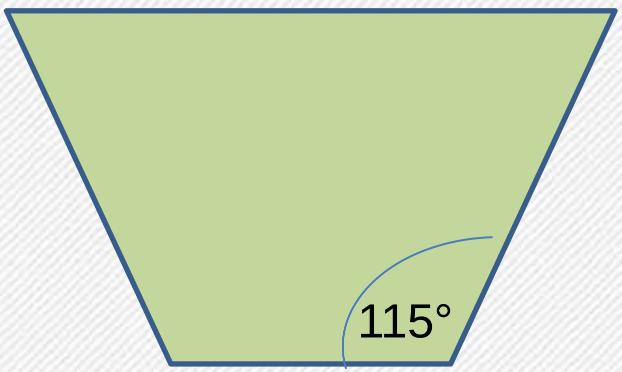
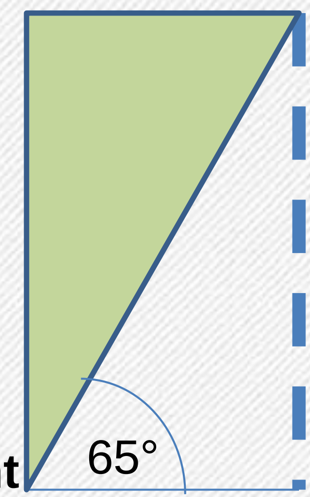
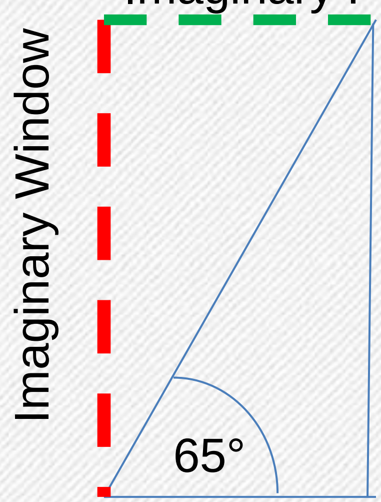
Self Shading Due to Pitch Angle





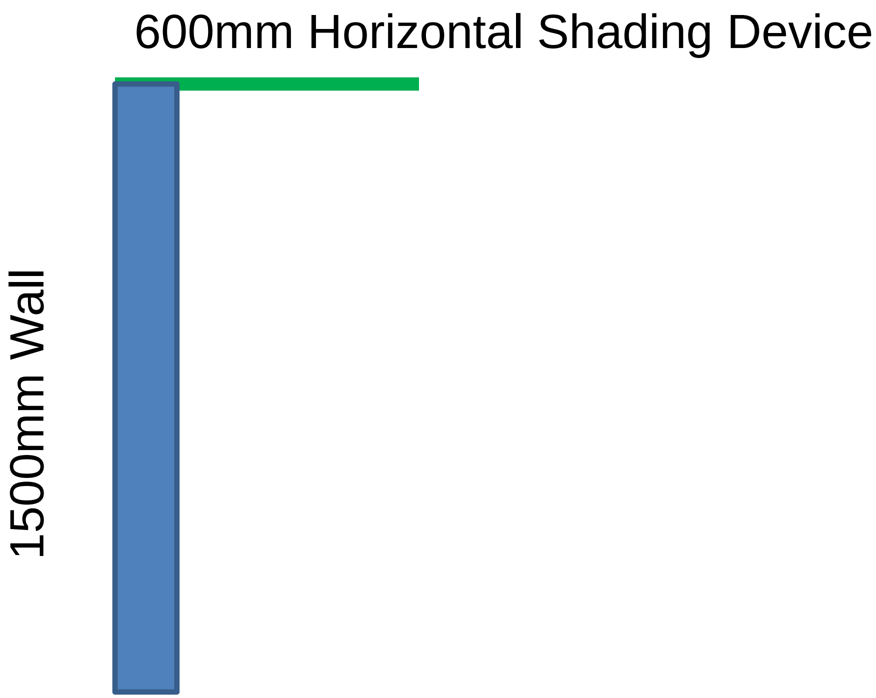


R = Projection / Window Height

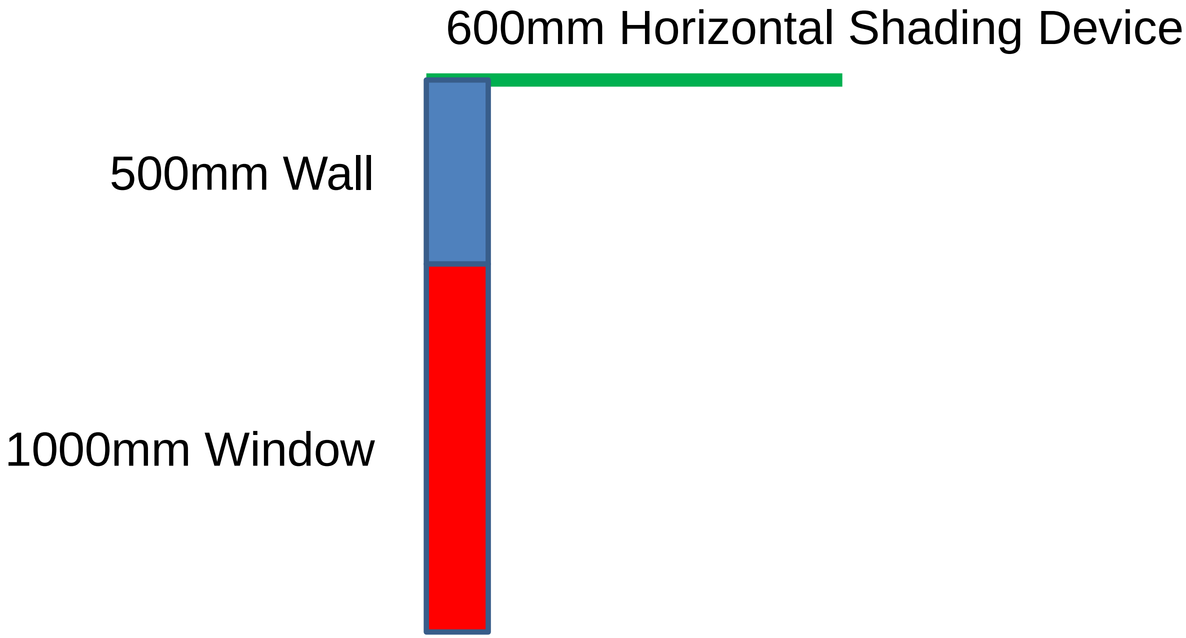
R = 1 / tan (65°) = 0.466

SC2 (N/S) = 0.71

BONUS Question: Calculate the SC

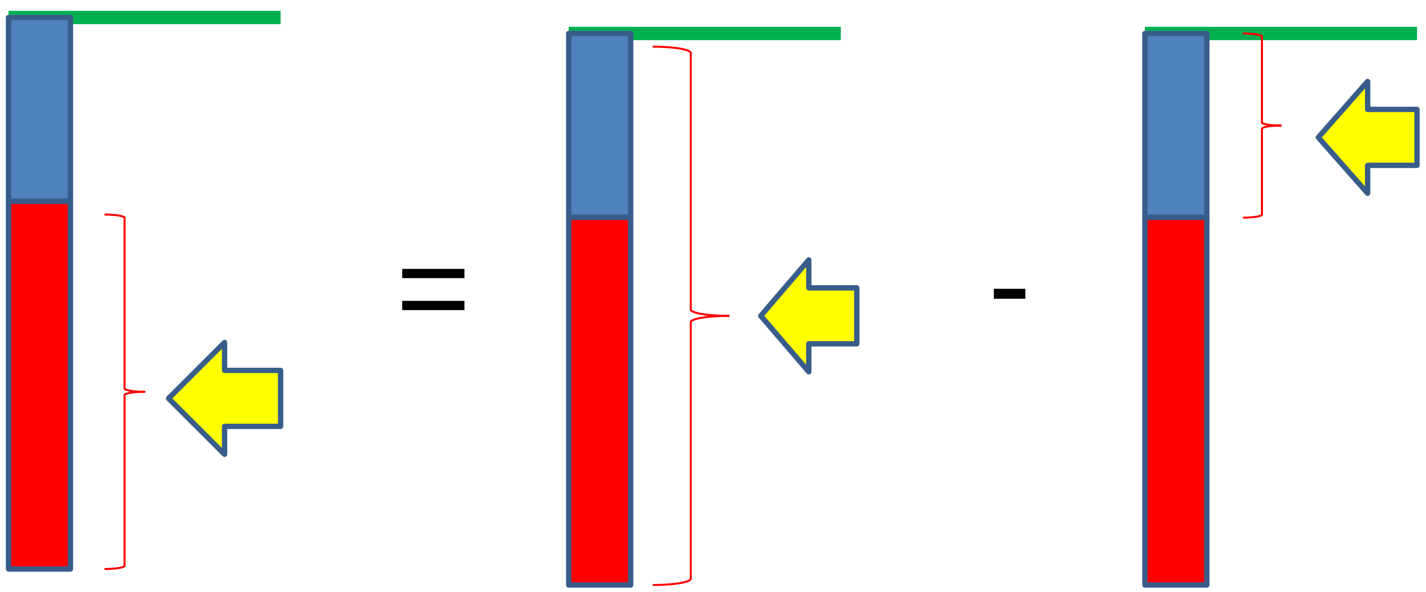


Case 3: Windows Offset from Horizontal Shading Device



Case 3: Windows Offset from Horizontal Shading Device

Heat gain on window = Heat Gain on All - Heat Gain on Wall



Solar Heat Gain Through Windows

$$194 \times CF \times WWR \times SC$$

Case 3: Windows Offset from Horizontal Shading Device

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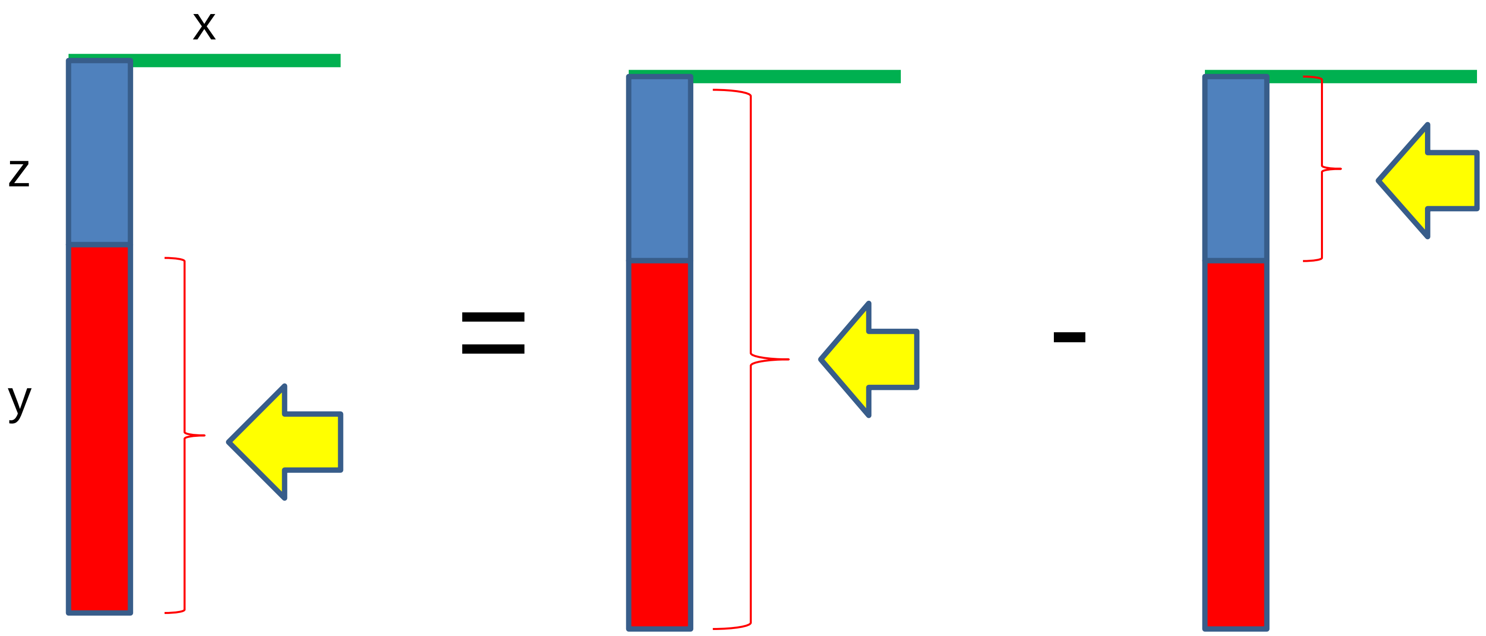


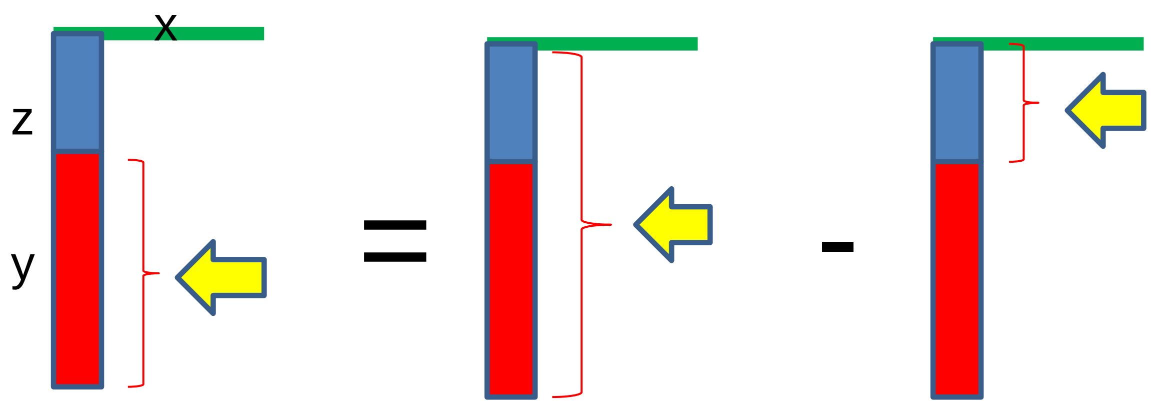
$$194 \times CF \times WWR \times SC$$

SCwindow * (y) = SCall * (z+y) – Scwall * (z)

Case 3: Windows Offset from Horizontal Shading Device

Heat gain on window = Heat Gain on All - Heat Gain on Wall

X = 600mm
Z = 500mm
Y = 1000mm



SCall = Refer Table 5 for Rall of 0.4 (0.6/1.5) = 0.77

SCwall = Refer Table 5 for Rwall of 1.2 (0.6/0.5) = 0.67

SCwindow * (1) = SCall * (1+0.5) – Scwall * (0.5)

SCwindow * (1) = 0.77 * (1+0.5) – 0.67 * (0.5)

SCwindow * (1) = 1.155 – 0.335

SCwindow = 0.82

Is there an easier way?

BEIT Software free to download from ACEM website

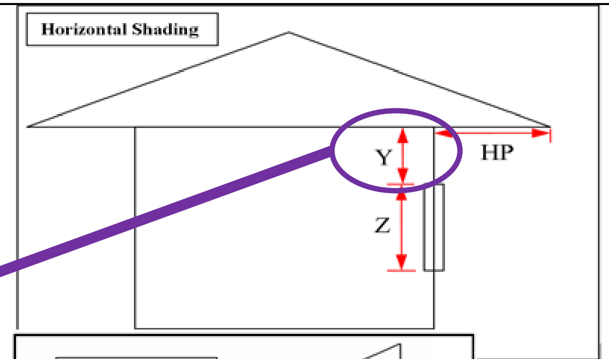
2 *OTTV* *(Heat Gain from Building Walls and Glazing)*

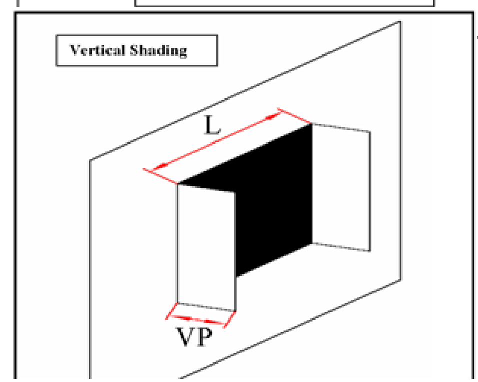
Use Simplified Data (same data for all 4 façades)? Yes

Data below is used for façades in all 4 orientations

	Baseline Building	Proposed Building	Estimated Cost (RM)
Windows to Wall Ratio	0.40	0.40	$ -
Alpha (Colour of opaque Wall)	0.30	0.30	$ -
U-value of Walls (W/m2K)	2.60	2.60	$ -
U-value of Glazing (W/m2K)	5.70	1.80	$ -
SC of glazing	0.37	0.32	$ -
Horizontal Shading			
Width of Horizontal Projection (**HP**) (m)	0.00	0.00	$ -
Height of fenestration (**Z**) (m)	2.00	1.70	$ -
Height of top of fenestration to bottom of projection (**Y**) (m)	0.00	0.00	$ -
Vertical Shading			
Width of Vertical Projection (**VP**) (m)	0.00	0.00	$ -
Length of fenestration (**L**) (m)	2.60	2.60	$ -
OTTV Calculated (W/m2) must ≤ 50	**49.46**	**36.22**	**$ -**

OTTV cals is based on same data input for all 4 façades.





THANK YOU