PAM NORTHERN CHAPTER CPD

UBBL BY-LAW 38A

BUILDING **ENVELOPE**

11 February 2017

Ar Chan Seong Aun
Immediate Past President PAM
Chairman GBI Accreditation Panel
M. Arch. B. Arch (NZ), P. Arch, APAM

UBBL by-Law 38A Amendment 2012
Energy efficiency in buildings

(1) New or renovated non-residential buildings with air-conditioned space exceeding 4,000 square metres shall be –

a)designed to meet the requirements of MS 1525 with regards to the Overall Thermal Transfer Value (OTTV) and the Roof Thermal Transfer Value (RTTV); and

b) provided with an Energy Management System.

MS1525:2007

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

   a) Applies to non-residential, air-conditioned buildings, $\geq$ 4,000 sq m. (pending revision)

   b) Architects and Engineers must submit OTTV & RTTV calculations.

   c) Requirement for Energy Management Control system is under Clause 9.

R

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”.

MS1525:2007

THERMAL RESISTANCE

Relationships between thermal conductivity, thermal resistance and U-value

k = Thermal conductivity

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

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

ROOF THERMAL RESISTANCE

Roof thermal resistance RESIDENTIAL

SSTH
75%

DSTH
50%

5S Flat
40%

MALAYSIA GREEN BUILDING CONFEDERATION

ENVELOPE THERMAL RESISTANCE

Envelope thermal resistance NON-RES

FACTORIES	LOW RISE	HIGH RISE
25%	60%	80%

THERMAL RESISTANCE

Solar Heat Gain in typical Malaysian homes

	Single Storey Terrace	**Double Storey Terrace**	**Five Storey Flats**	**Eight Storey Apartments**
Gross Floor Area	880	1,408	60,500	81,680
Roof over Envelope Area	68%	45%	30%	18%
Wall over Envelope Area	32%	55%	70%	82%
North-South Facing				
Roof Solar Heat Gain in kWh/day	30	24	363	306
Total Solar Heat Gain in kWh/day	35	33	726	908
Roof over Total Solar Heat Gain	**86%**	**73%**	**50%**	**34%**
East-West Facing				
Roof Solar Heat Gain in kWh/day	30	24	363	306
Total Solar Heat Gain in kWh/day	40	43	842	1,141
Roof over Total Solar Heat Gain	**75%**	**55%**	**40%**	**27%**

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

MS1525:2007 CLAUSE 5.6

RTTV applies to roof with skylights

CONCEPT OF **OTTV**

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**

Assumptions

The concept of OTTV is based on the assumption that the envelope of the building is completely enclosed.

In the OTTV formulation, the following items are not considered:

- **internal shading devices eg curtains**
- **solar reflection or shading from adjacent buildings**

CONCEPT OF **OTTV**

MS1525:2007 Clause 5.2.2 says

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%**

CONCEPT OF **OTTV**

Heat Conduction through Walls

$15\alpha(1\text{-}WWR)Uw$ + $6(WWR)Uf$ + $194xCFxWWRxSC$

Heat Conduction through Walls	+	**Heat Conduction through Windows**	+	**Solar Heat Gain through Windows**	< $50W/m^2$

0.2% to 5%

CONCEPT OF **OTTV**

Heat Conduction through Walls

15 α (1-WWR) Uw

where α = Solar Absorption = Colour of walls

CONCEPT OF **OTTV**

Heat Conduction through Walls

15 α (1-WWR) Uw

where α = Solar Absorption = Colour of walls

and WWR =

CONCEPT OF **OTTV**

Heat Conduction through Walls

$15\ \alpha\ (1\text{-}WWR)\ Uw$

where α = Solar Absorption = Colour of walls

and WWR = Window-to-Wall Ratio

and Uw =

CONCEPT OF **OTTV**

Heat Conduction through Walls

15 α (1-WWR) Uw

where α = Solar Absorption = Colour of walls

and WWR = Window-to-Wall Ratio

and Uw = U-value of the wall

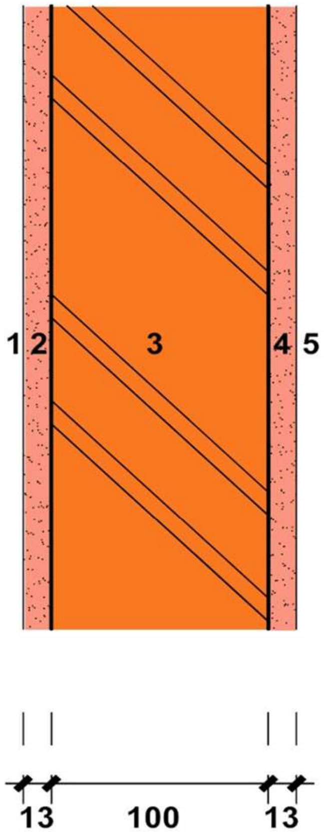
15 x α x Wall area ratio x U-value of Wall

Heat Conduction through Walls

Absorptivity, α for Wall and Roof Surfaces

Black glass	**0.99**
Red brick, dark brown paint	**0.88**
Asphalt pavement	**0.82**
Bare uncoloured concrete	**0.65**
Green paint	**0.47**
White semi-gloss paint	**0.25**
Silver paint	**0.25**
Polished aluminium sheet	**0.12**

Plastered Brickwall



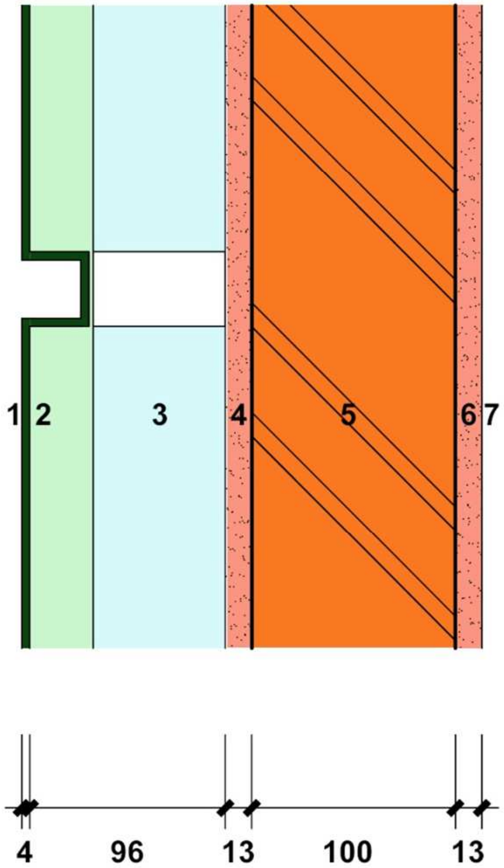
		THERMAL CONDUCTIVITY (W/mk)	R THERMAL RESISTANCE (m^2k/W)
1	External surface	-	0.040
2	External wall plaster, 13mm thk	0.57	0.023
3	Brickwall, 100mm thk	0.77	0.132
4	Internal wall plaster, 13mm thk	0.57	0.023
5	Internal surface	-	0.130
		Total R	0.348

$$\text{U-Value} = \frac{1}{R}$$

$$= \frac{1}{0.348}$$

$$= 2.870\ W/m^2k$$

Aluminium Composite Cladding without insulation



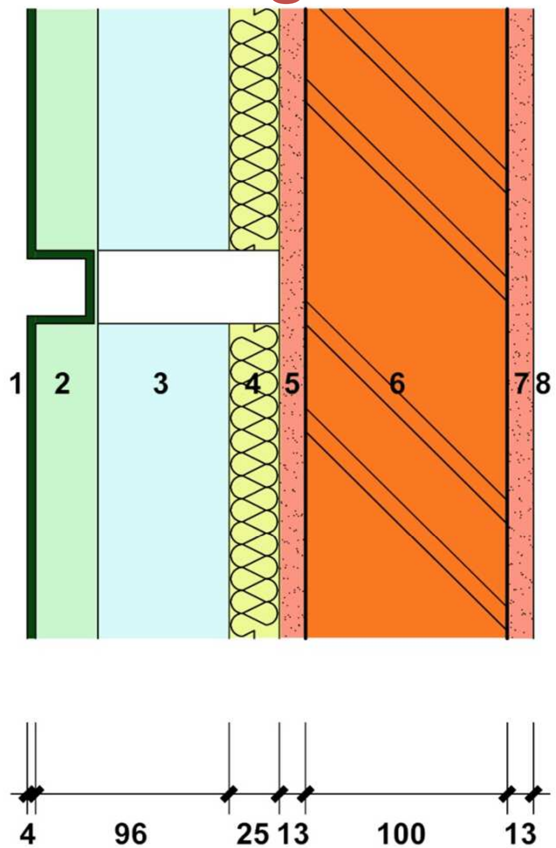
		THERMAL CONDUCTIVITY (W/mk)	R THERMAL RESISTANCE ($m^2 k/W$)
1	External surface	-	0.040
2	ACP Cladding, 4mm thk	0.40	0.010
3	Cavity	-	0.090
4	External wall plaster, 13mm thk	0.57	0.023
5	Brickwall, 100mm thk	0.77	0.132
6	Internal wall plaster, 13mm thk	0.57	0.023
7	Internal surface	-	0.13
		Total R	0.448

$$\text{U-Value} = \frac{1}{R}$$

$$= \frac{1}{0.448}$$

$$= 2.230\ W/m^2k$$

Aluminium Composite Cladding with insulation



		THERMAL CONDUCTIVITY (W/mk)	R THERMAL RESISTANCE (m^2k/W)
1	External surface	-	0.040
2	ACP Cladding, 4mm thk	0.40	0.010
3	Cavity	-	0.090
4	Exp.Polystyrene board,25mm thk	0.04	0.625
5	External wall plaster,13mm thk	0.57	0.023
6	Brickwall, 100mm thk	0.77	0.132
7	Internal wall plaster, 13mm thk	0.57	0.023
8	Internal surface	-	0.13
		Total R	1.073

$$\text{U-Value} = \frac{1}{R} = \frac{1}{1.073} = 0.932\ W/m^2k$$

CONCEPT OF **OTTV**

Heat Conduction through Windows

Heat Conduction through Walls	+	**Heat Conduction through Windows**	+	Solar Heat Gain through Windows	$< 50W/m^2$
$15\alpha(1\text{-}WWR)Uw$	+	$6(WWR)Uf$	+	$194xCFxWWRxSC$	

10% to 20%

CONCEPT OF **OTTV**

Heat Conduction through Windows

6 (WWR) Uf

6 x Window to Wall ratio x U-value of Window

Glazing type	U-values
Single glazed clear	5.7 to 6.2
Laminated clear / PVB / clear	4.5 to 5.5
Double glazed clear / air / clear	2.6 to 2.9

CONCEPT OF **OTTV**

Solar Heat Gain through Windows

Heat Conduction through Walls	+	Heat Conduction through Windows	+	Solar Heat Gain through Windows	$< 50W/m^2$
$15\alpha(1-WWR)Uw$	+	$6(WWR)Uf$	+	$194 \times CF \times WWR \times SC$	
				70% to 85%	

CONCEPT OF **OTTV**

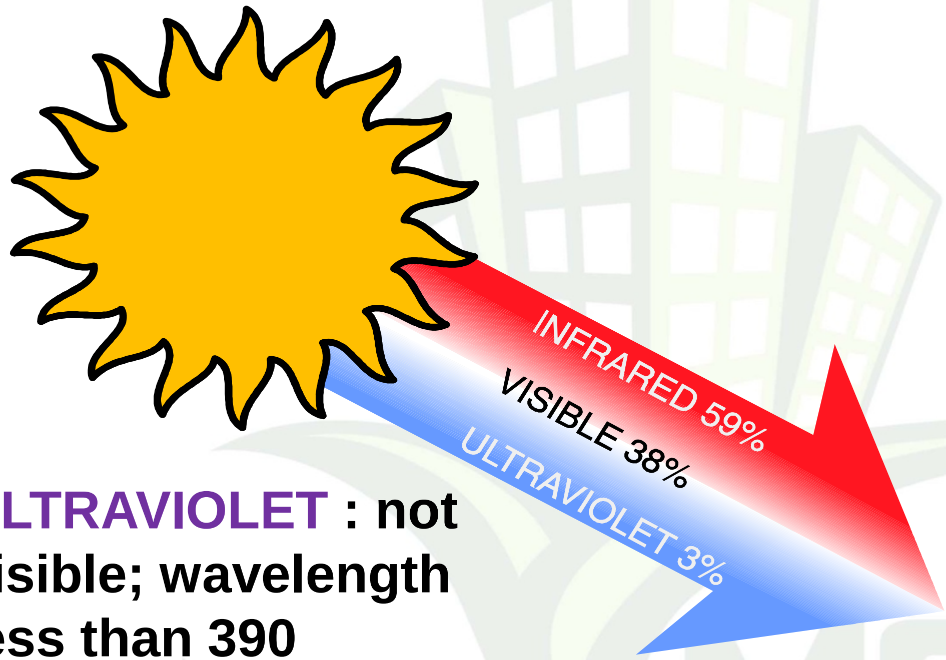
Solar Heat Gain through Windows

194 x CF x WWR x SC

where CF = Correction Factor (Table 4)
WWR = Window to Wall ratio
SC = Shading Coefficient (Tables 5,6 & 7)

Table 4 specifies the CF for the various orientation of the fenestration. It is based on weather data for KL. Data shows East solar radiation is higher than West.

SOLAR RADIATION AND GLAZING



INFRARED : not visible; wavelength greater than 750 nanometers

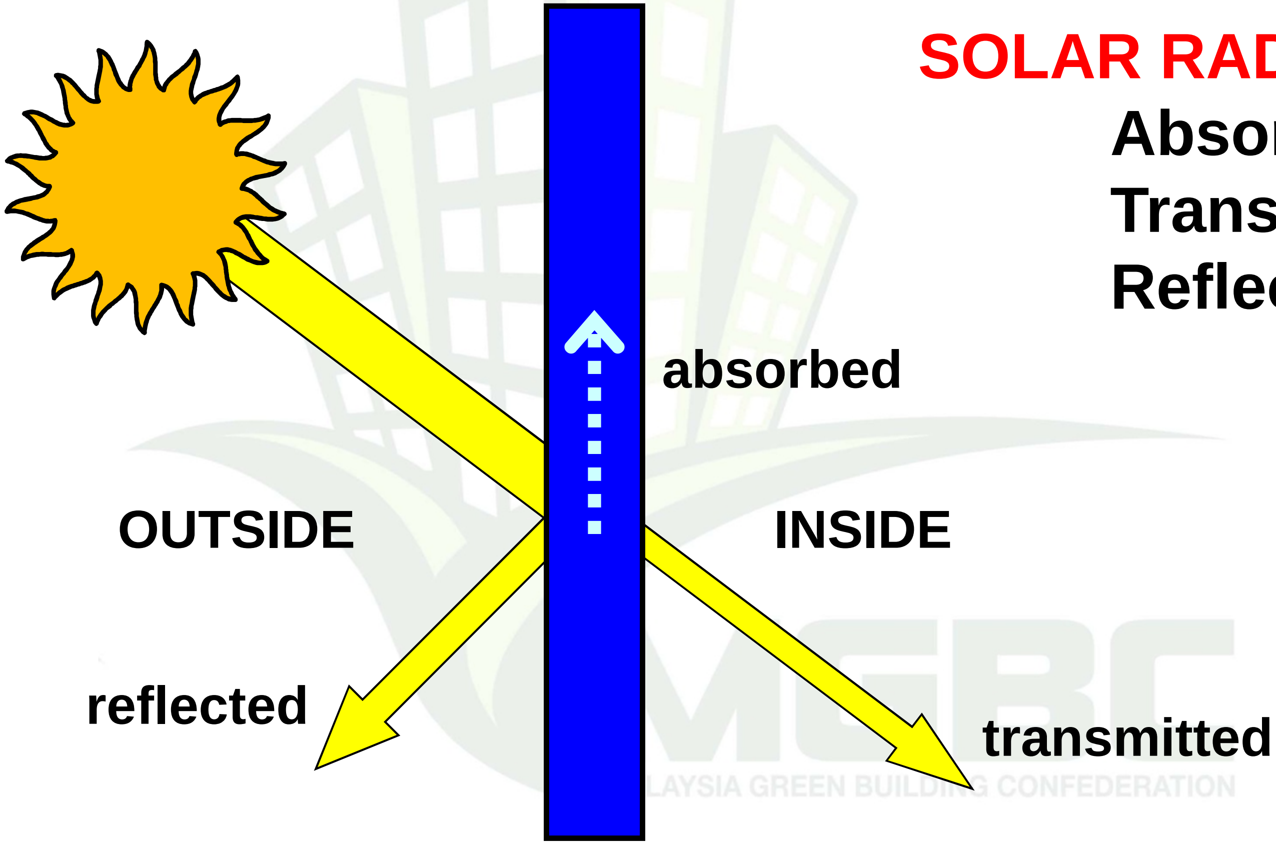
Long Wave Energy

ULTRAVIOLET : not visible; wavelength less than 390 nanometers

Short Wave Energy

VISIBLE : visible to the human eye; wavelength between 390 and 750 nanometers.

SOLAR RADIATION AND GLAZING



SOLAR RADIATION :

- Absorbed
- Transmitted
- Reflected

SOLAR RADIATION AND GLAZING

1. Glass Shading Coefficient (SC)

is the amount of solar energy that passes through the glass, relative to a 3mm clear glass tested under similar conditions. A low value means less heat passes through the glass.

Eg, a glazing with a SC of 0.45 would allow only 45% as much solar energy to pass through as would a 3mm clear glass.

SOLAR RADIATION AND GLAZING

Description of Glass	Visible Light (%)			Solar Energy (%)			American U-value (W/m²k)	Shading Coefficient
	Transmittance	Reflectance		Transmittance	Reflectance	Absorption	Summer Daylight	
		Outdoor	Indoor					
Double glazed glass consisting of : 8mm ASG Blue Float with 30% ceramic coverage on surface #2 + 12mm Airspace + 8mm ASG Clear Low E#3	24.18	9.89	21.01	13.74	7.50	78.76	2.59	0.32
Double glazed glass consisting of : 8mm ASG Green Float with 30% ceramic coverage on surface #2 + 12mm Airspace + 8mm ASG Clear Low E#3	30.19	13.40	21.66	12.12	7.24	80.64	2.62	0.28
Double glazed glass consisting of : 8mm ASG Green Float with 100% ceramic coverage on surface #2 + 12mm Airspace + 8mm ASG Clear Float	0.22	23.00	74.45	0.10	10.32	89.58	3.30	0.15
Double glazed glass consisting of : 8mm ASG Solar Control Green #2 + 12mm Airspace + 8mm ASG Green Float	19.41	16.37	19.05	7.04	8.07	84.89	3.33	0.26
Double glazed glass consisting of : 8mm ASG Green Float with 30% coverage ceramic printing on surface #2 + 12mm Airspace + 8mm ASG Clear Low E Float #3	33.35	12.65	22.09	11.85	7.31	80.84	1.92	0.21

Glass Reference	Visible Light Transmittance (%)	Visible Light Reflectance (%)	Solar Direct Transmittance (%)	Solar Direct Reflectance (%)	Solar Direct Absorption (%)	U factor (W/m².°C)	Shading Coefficient
8mm ASG Solar Control Green #2 + 1.52 mm Clear PVB + 8mm ASG Green Low-E #4	18.94	12.96	6.84	7.16	86.00	3.84	0.25

SOLAR RADIATION AND GLAZING

Light & Heat Control Characteristics of Glass

Glass Type	Thick-ness (mm)	Visible Light		Solar Energy			Relative Heat Gain (W/m²)	Shading Coefficient	U-value (W/m²k)
		Trn (%)	Ref (%)	Trn (%)	Ref (%)	Abs (%)			
Monolithic Clear									
3mm	3	91	8	88	8	4	681	1.01	5.82
6mm	6	89	8	80	7	13	651	0.96	5.79
10mm	10	87	8	73	7	20	612	0.90	5.70
12mm	12	86	8	70	7	23	595	0.87	5.66
Monolithic Tinted									
6mm Bronze	6	48	6	50	6	44	498	0.71	6.14
6mm Dark Grey	6	13	4	31	5	64	404	0.56	6.31
Laminated - 2 Ply (Clear Glass with Clear PVB)									
3/0.38/3	6.38	89	8	78	8	14	637	0.94	5.73
5/0.38/5	10.38	86	8	72	7	22	599	0.88	5.66
6/0.38/6	12.38	86	8	67	7	16	580	0.85	5.62
Laminated - 2 Ply (Clear Glass with Tinted PVB)									
3/0.38/3 A.Blue	6.38	76	7	68	7	25	589	0.86	5.86
3/0.38/3 Bronze	6.38	52	6	50	6	44	498	0.71	6.07
3/0.38/3 T.White	6.38	66	13	58	9	32	532	0.77	5.95
Clear Insulating Glass Unit (IGU)									
6+A12+6	24	80	14	64	11	24	549	0.83	3.11

Ajiya

SOLAR RADIATION AND GLAZING

SC - major contributor to reduce OTTV .

SC can be in the form of horizontal and/or vertical shading devices that help to reduce solar heat gain through the windows.

$$SC = SC1 \times SC2$$

SC1 is shading coeff of glazing

SC2 is shading coeff of external shading device

SOLAR RADIATION AND GLAZING

2. Insulated Glazing Units (IGU)

are multiple glass panes assembled into units to insulate against heat and sound. Most IGUs are double glazed (DGUs), but some IGUs have three sheets or more. IGUs are becoming more common due to higher energy costs.

SOLAR RADIATION AND GLAZING

3. Visible Light Transmittance (VLT)

is the fraction of visible light at a specified wavelength that passes through the glass. Usually quoted between 0 and 1, a high value means more light passes through the glass.

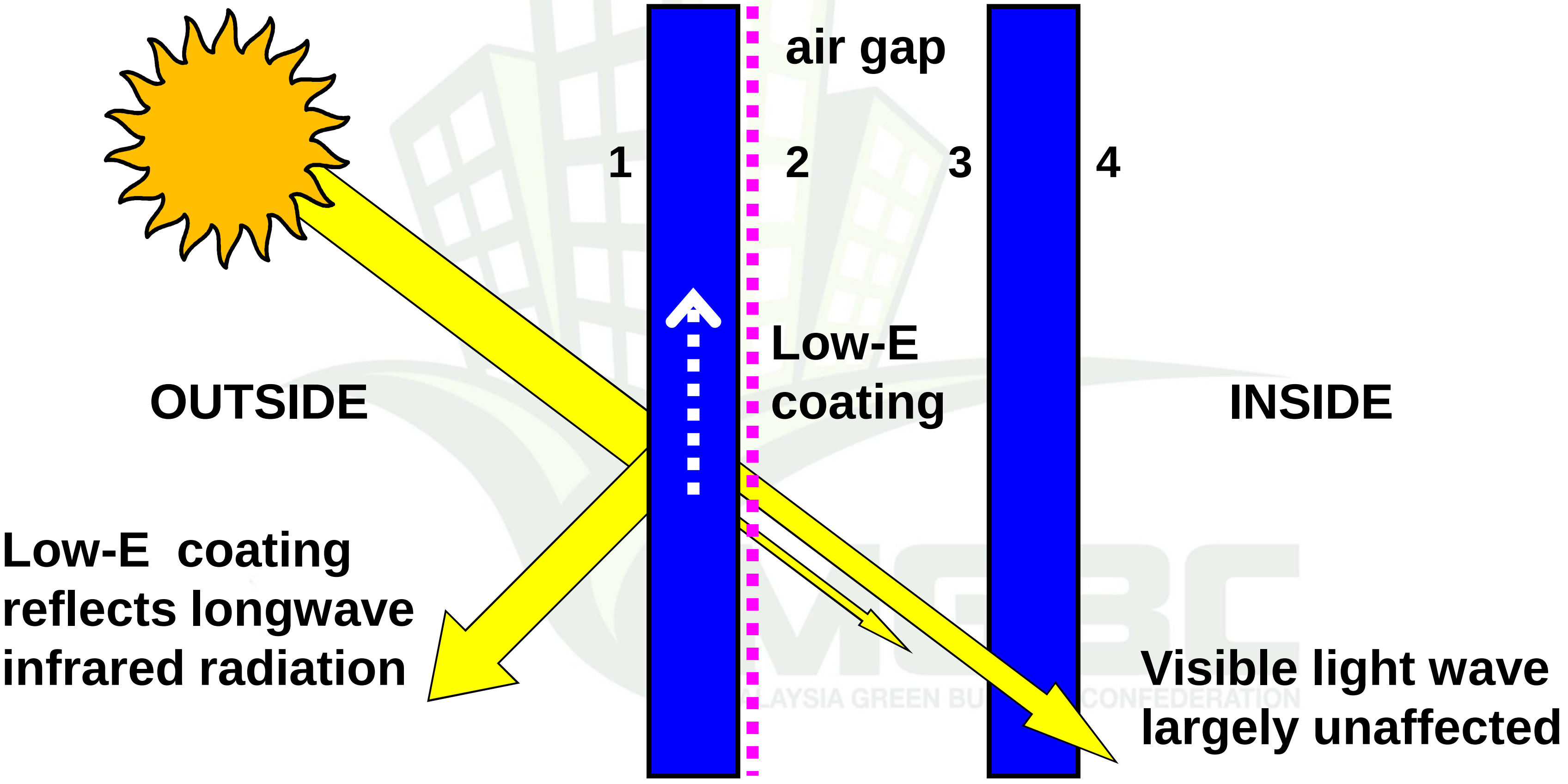
Eg, a glazing with a VLT of 0.70 would allow 70% of visible light to pass through.

SOLAR RADIATION AND GLAZING

Heat insulation of the IGUs can be further improved through the use of:

1. **Tinted glass**
2. **Coated glass**
3. **Low-Emissivity glass (Low-E)**
   - reflects away long-wave infrared radiation
   - hard coat or soft coat

SOLAR RADIATION AND GLAZING



SOLAR RADIATION AND GLAZING

Glazing type	U-values
Single glazed clear	5.7 to 6.2
Single glazed clear with Low-E	4.0 to 4.4
Laminated clear / PVB / clear	4.5 to 5.5
Laminated clear w Low-E / PVB / clear	4.2 to 5.3
Double glazed clear / air / clear	2.6 to 2.9
Double glazed clear w Low-E / air /clear	1.2 to 1.8

SUNSHADING DEVICES

SUNSHADING DEVICES

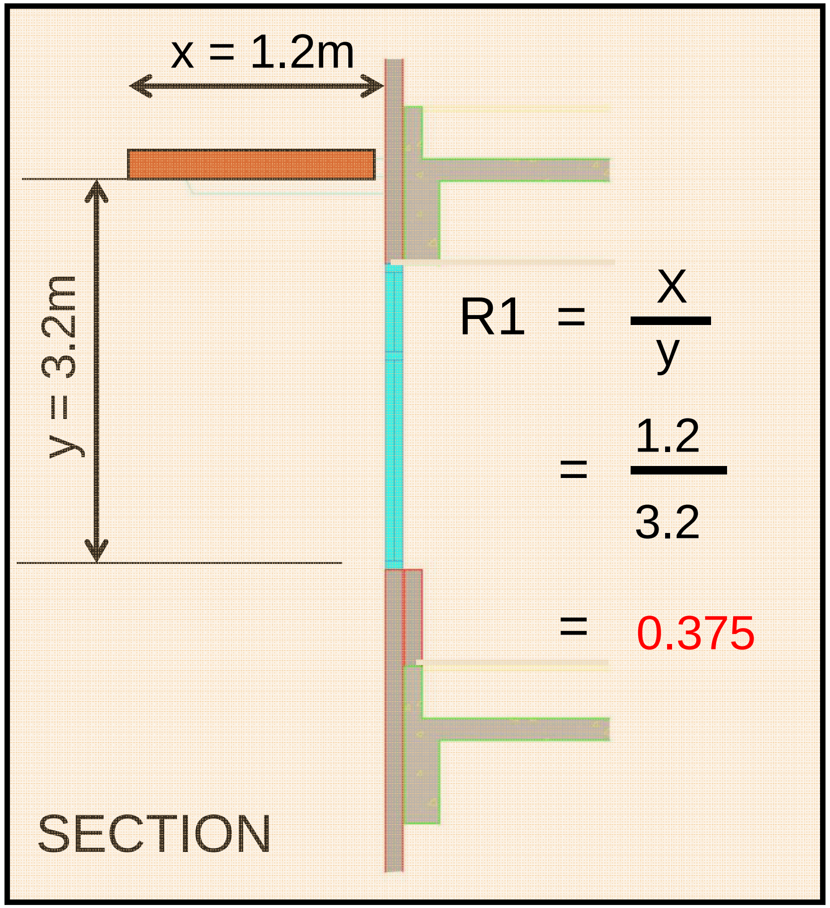
SUNSHADING DEVICES

- External Shading Devices are more effective than Internal Blinds.
- External Shading Devices block out Direct Sunlight.

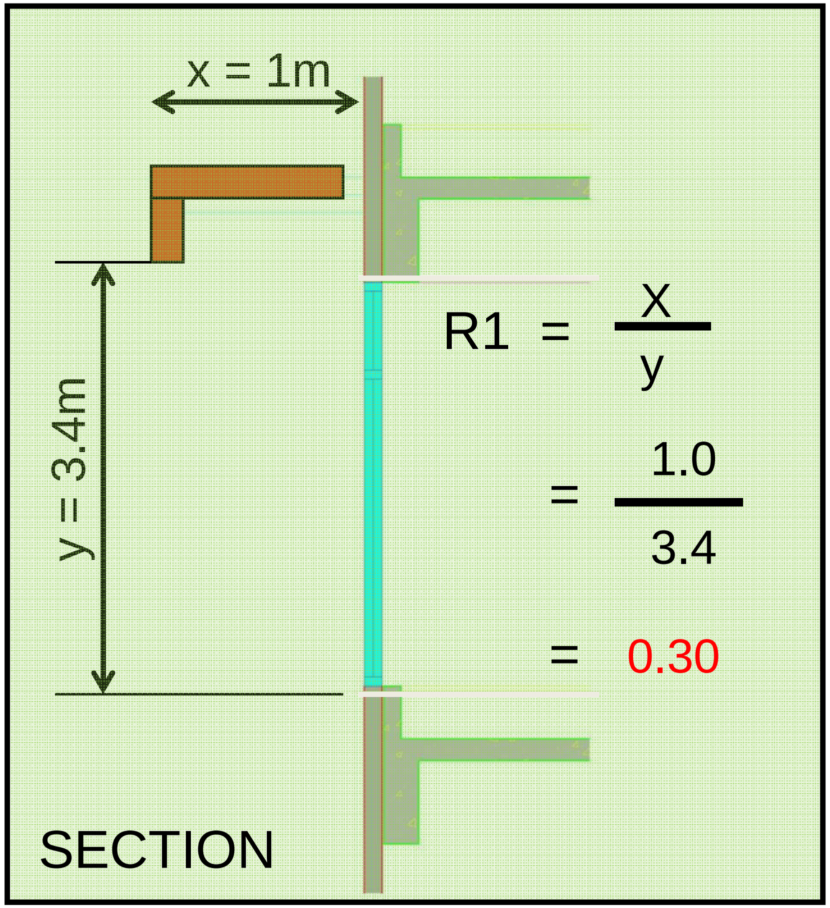
SHADING COEFFICIENT – R1

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 :

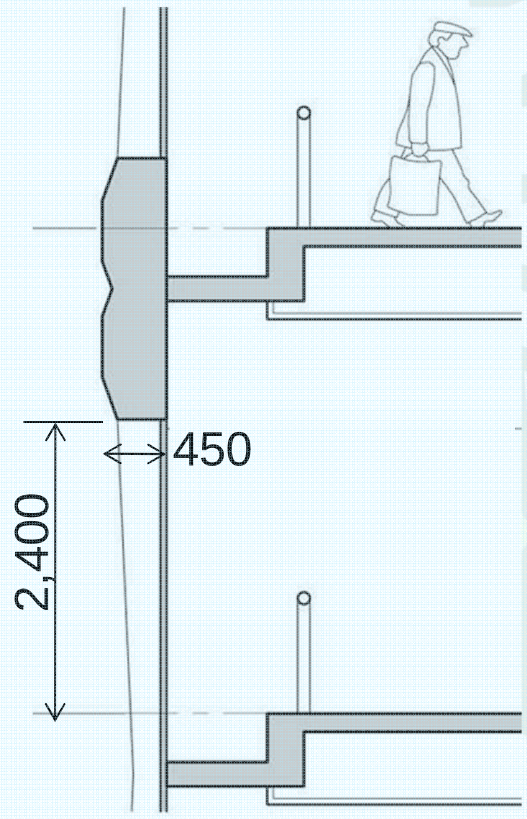
R1 is the ratio: Width of horizontal projection / Height of fenestration

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

Horizontal Shading Devices



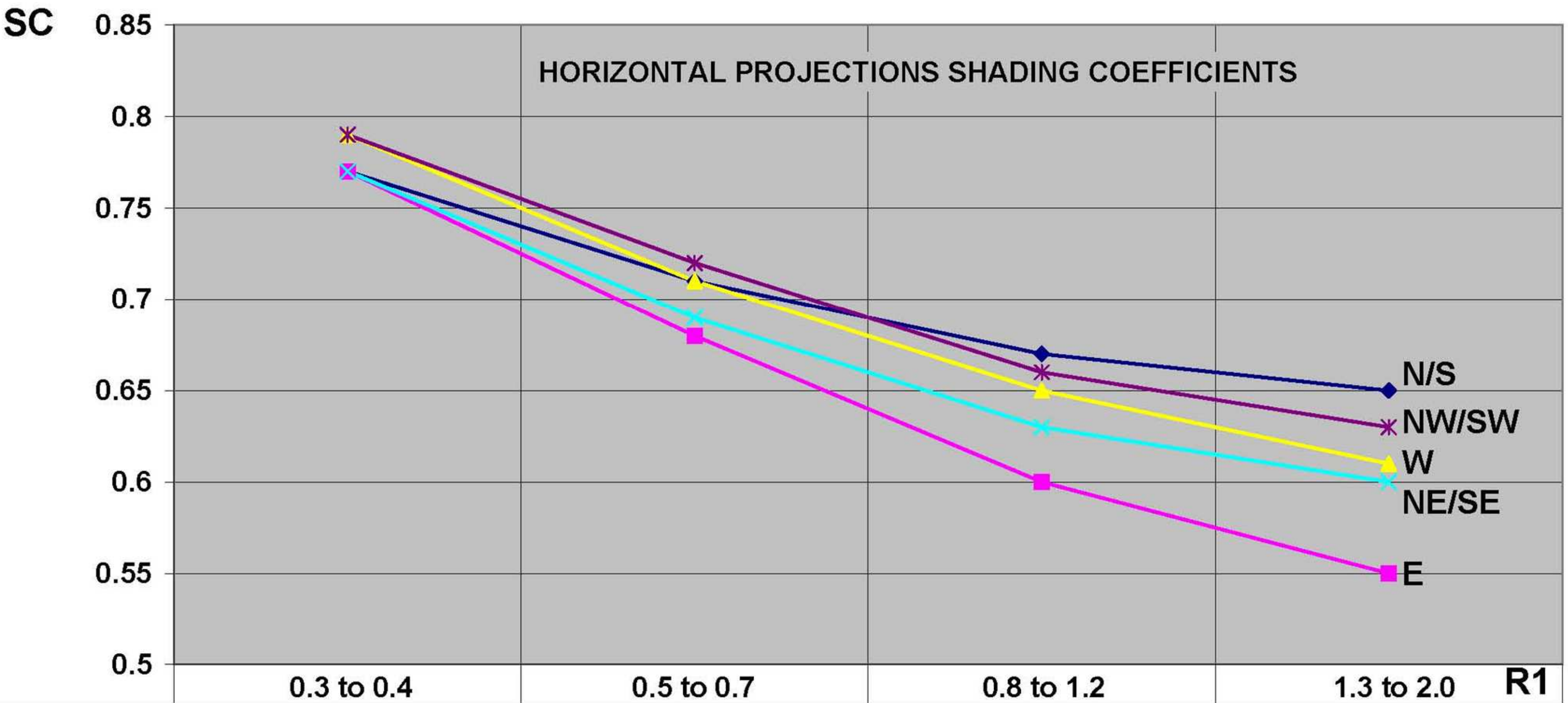
$$R1 = \frac{450}{2{,}400}$$

$$= 0.1875$$

$SC2 = 1$

If R1 ≤ 0.30, SC2 = 1.

The horizontal shading device did not contribute to the shading of the window at all.

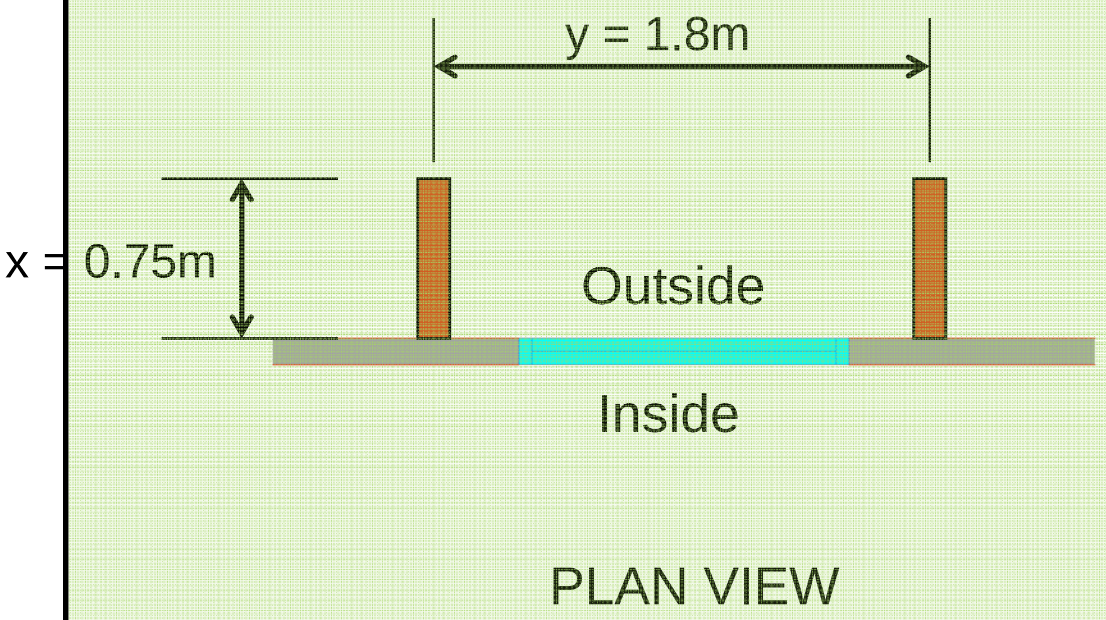


	0.3 to 0.4	0.5 to 0.7	0.8 to 1.2	1.3 to 2.0
North/South	0.77	0.71	0.67	0.65
East	0.77	0.68	0.60	0.55
West	0.79	0.71	0.65	0.61
NE/SE	0.77	0.69	0.63	0.60
NW/SW	0.79	0.72	0.66	0.63

SHADING COEFFICIENT - R2

Vertical Shading Devices

Eg 1



$$R2 = \frac{X}{y} = \frac{0.75}{1.8} = 0.42$$

MS1525:2007 Table 6

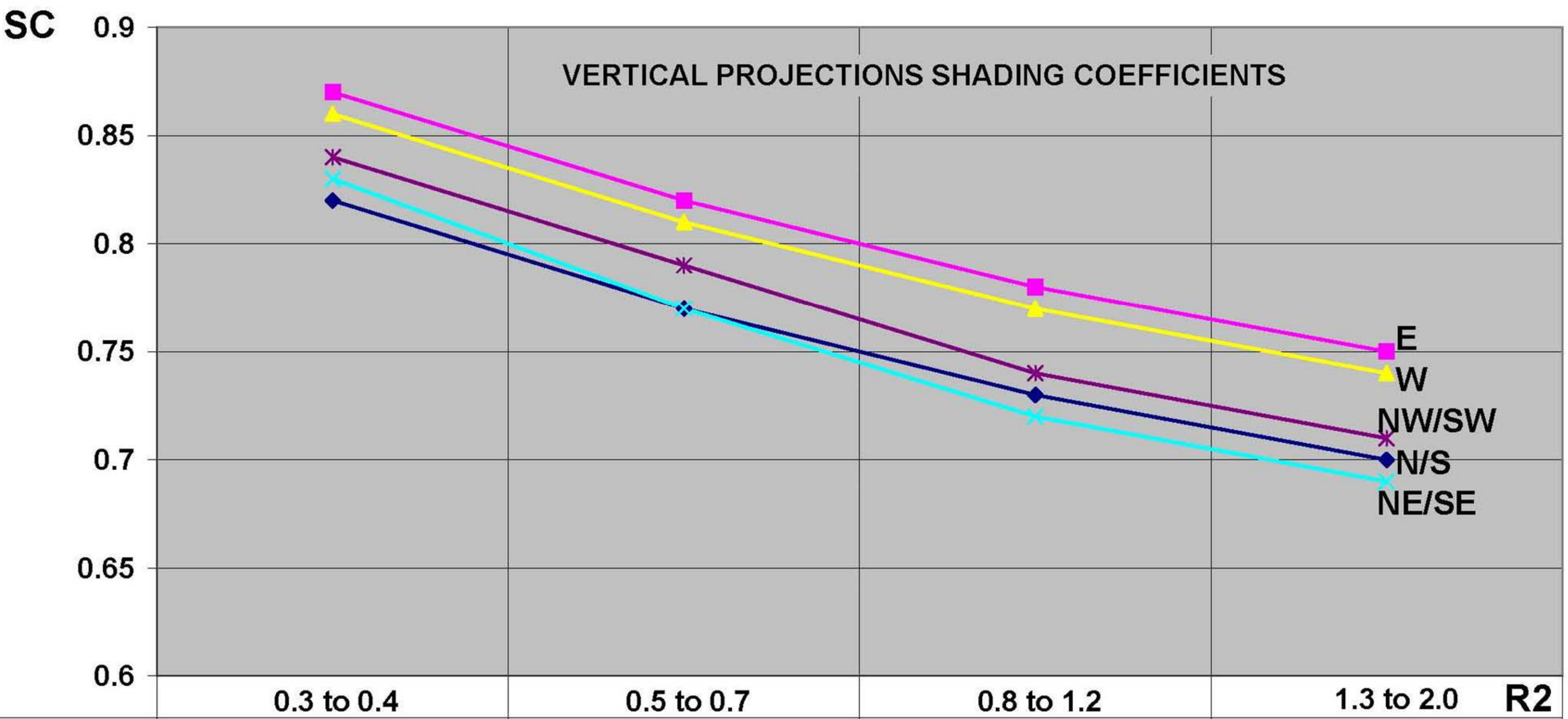
SHADING COEFFICIENT OF VERTICAL PROJECTIONS

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.



	0.3 to 0.4	0.5 to 0.7	0.8 to 1.2	1.3 to 2.0
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

Eggcrate Shading Devices
MS1525:2007 Table 7

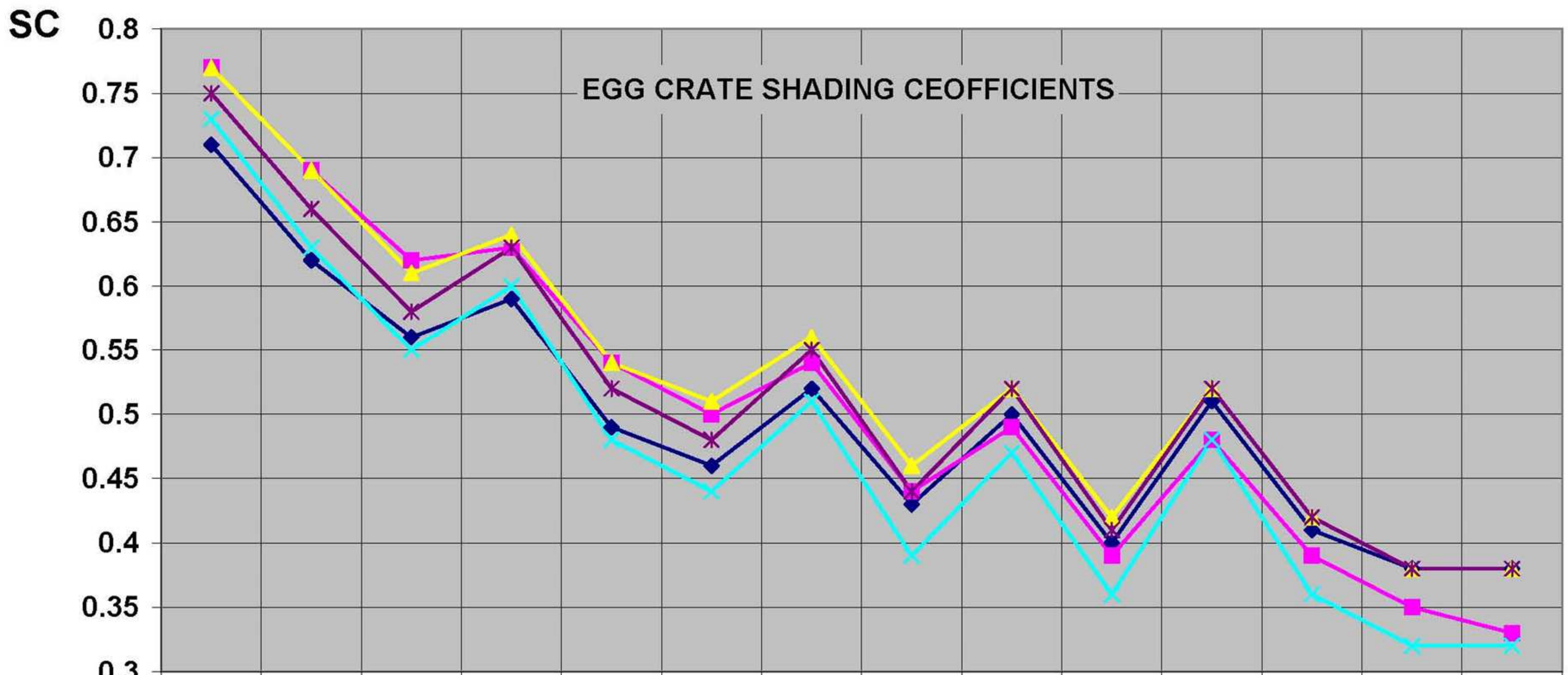
SHADING COEFFICIENT OF EGG-CRATE LOUVRES

RATIO		ORIENTATION				
R1	R2	North / South	East	West	North-East / South-East	North-West/ South-West
0.20	0.20	0.71	0.77	0.77	0.73	0.75
	0.40 - 0.60	0.62	0.69	0.69	0.63	0.66
	0.60 - 1.80	0.56	0.62	0.61	0.55	0.58
0.40	0.20 - 0.40	0.59	0.63	0.64	0.60	0.63
	0.60 - 1.20	0.49	0.54	0.54	0.48	0.52
	1.40 - 1.80	0.46	0.50	0.51	0.44	0.48
0.60	0.20 - 0.60	0.52	0.54	0.56	0.51	0.55
	0.80 - 1.80	0.43	0.44	0.46	0.39	0.44
0.80	0.20 - 0.60	0.50	0.49	0.52	0.47	0.52
	0.80 - 1.80	0.40	0.39	0.42	0.36	0.41
1.00	0.20 - 0.40	0.51	0.48	0.52	0.48	0.52
	0.60 - 1.20	0.41	0.39	0.42	0.36	0.42
	1.40 - 1.80	0.38	0.35	0.38	0.32	0.38
1.20 - 1.80	0.20 - 1.80	0.38	0.33	0.38	0.32	0.38

Notes :

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

R2 is the ratio: Width of vertical projection / Length of fenestration



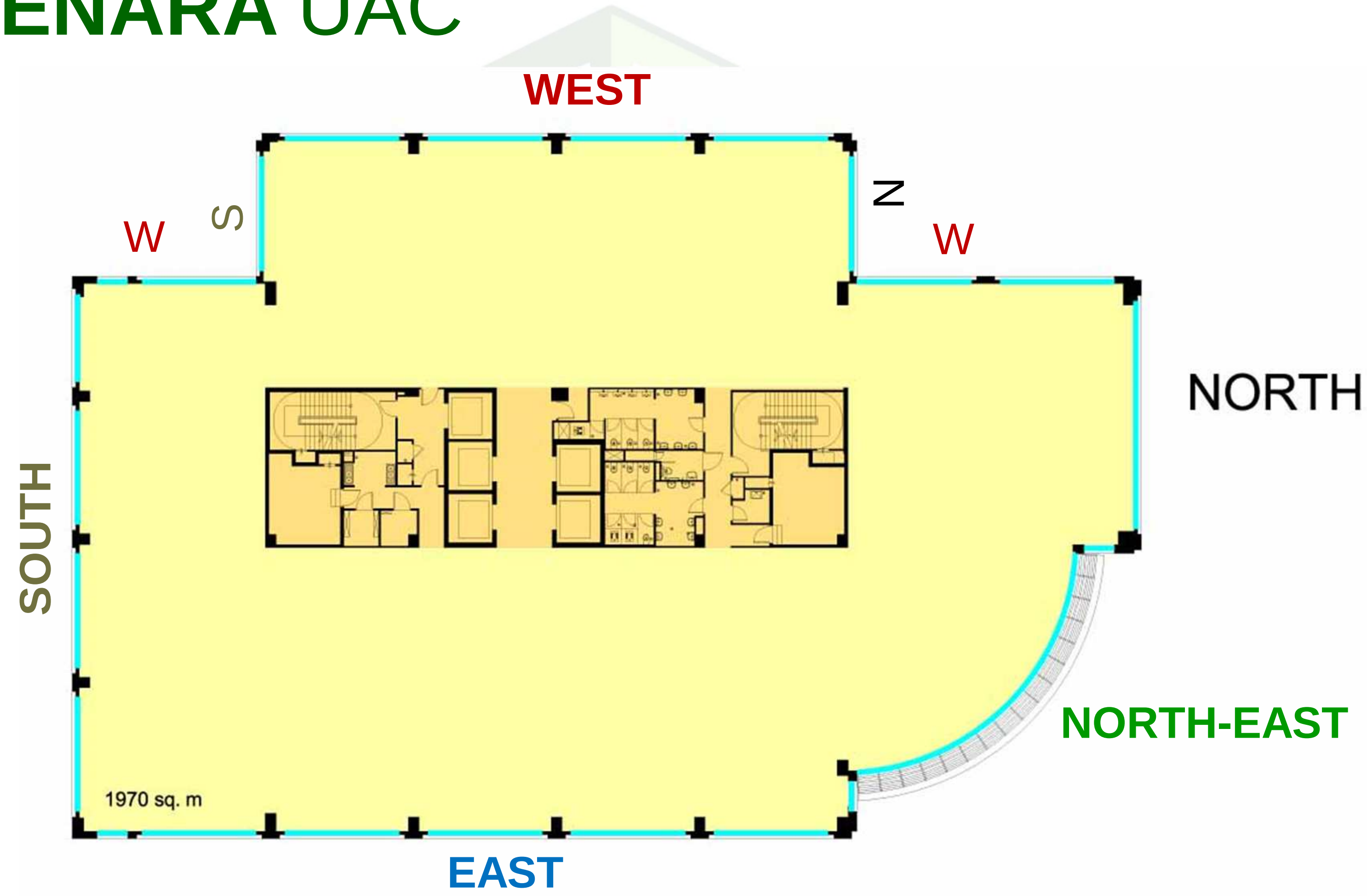
	R2=0.2 R1=0.2	R2=0.4-0.6 R1=0.2	R2=0.6-1.8 R1=0.2	R2=0.2-0.4 R1=0.4	R2=0.6-1.2 R1=0.4	R2=1.4-1.8 R1=0.4	R2=0.2-0.6 R1=0.6	R2=0.8-1.8 R1=0.6	R2=0.2-0.6 R1=0.8	R2=0.8-1.8 R1=0.8	R2=0.2-0.4 R1=1	R2=0.6-1.2 R1=1	R2=1.4-1.8 R1=1	R2=0.2-1.8 R1=1.2-
North/South	0.71	0.62	0.56	0.59	0.49	0.46	0.52	0.43	0.50	0.40	0.51	0.41	0.38	0.38
East	0.77	0.69	0.62	0.63	0.54	0.50	0.54	0.44	0.49	0.39	0.48	0.39	0.35	0.33
West	0.77	0.69	0.61	0.64	0.54	0.51	0.56	0.46	0.52	0.42	0.52	0.42	0.38	0.38
NE/SE	0.73	0.63	0.55	0.60	0.48	0.44	0.51	0.39	0.47	0.36	0.48	0.36	0.32	0.32
NW/SW	0.75	0.66	0.58	0.63	0.52	0.48	0.55	0.44	0.52	0.41	0.52	0.42	0.38	0.38

R1 & R2

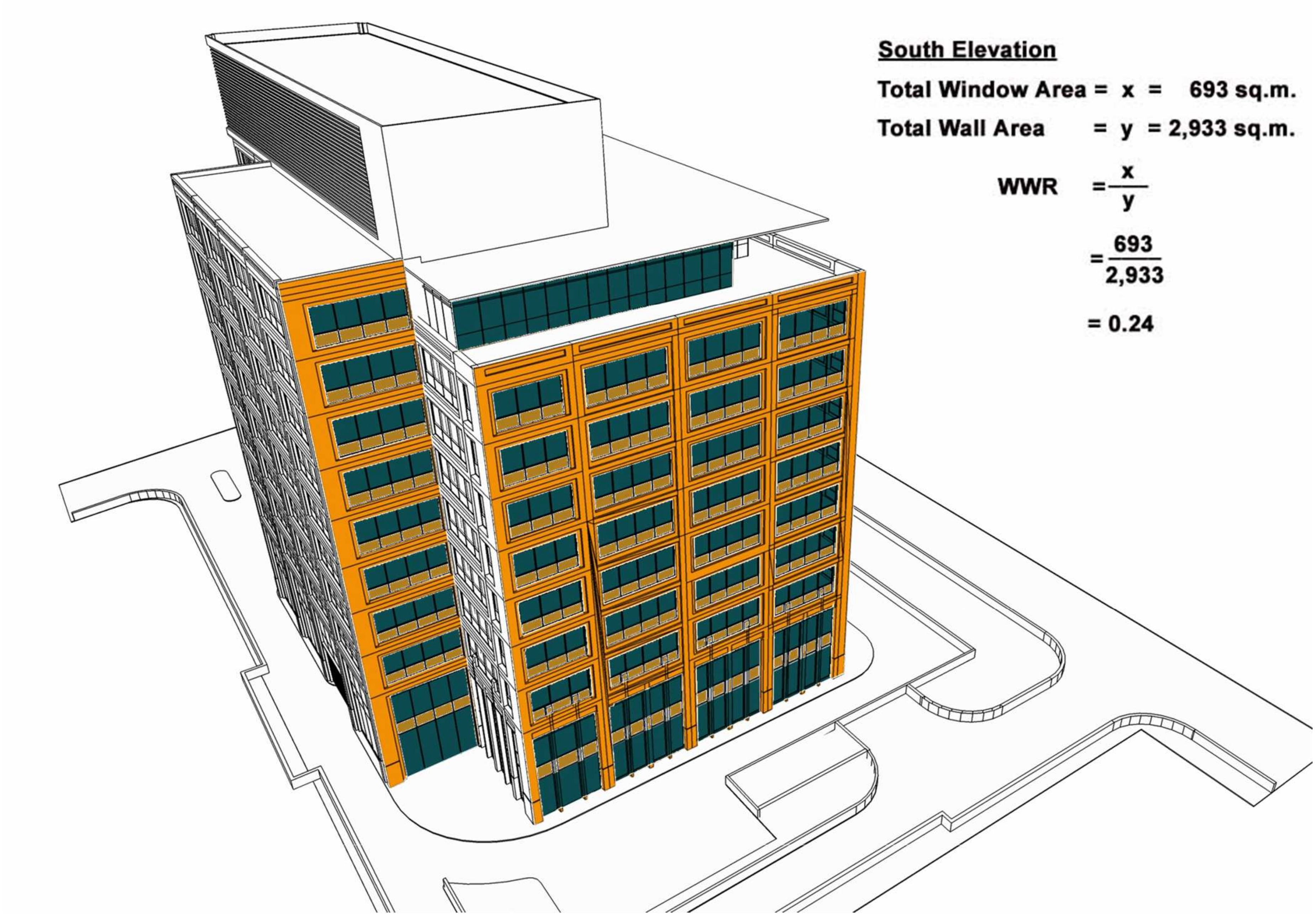
SAMPLE BUILDING

MENARA UAC

MENARA UAC



MENARA UAC


South Elevation
Total Window Area = x = 693 sq.m.
Total Wall Area = y = 2,933 sq.m.
WWR = x/y
= 693/2,933
= 0.24

MENARA UAC

HEAT CONDUCTION THROUGH WALLS

OTTV Calculation for Menara UAC, Mutiara Damansara

	ELEVATION	Façade Area (A) m^2	Constant	Solar Absorption Factor (α)	Window to Wall Ratio (WWR)	(1 - WWR)	U-Value W/m^2k (Uv)	Orientation Correction Factor (CF)	Shading Coeff SC = $SC_1 \times SC_2$	Termal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	North Wall (Alumn. Cladding)	1187.7	15	0.1	0.39	0.61	0.92	N/A	N/A	0.84	999.8
	South Wall (Alumn. Cladding)	2933.8	15	0.1	0.24	0.76	0.92	-	-	1.05	3,077.0
	East Wall (Alumn. Cladding)	2010.5	15	0.1	0.43	0.57	0.92	-	-	0.79	1,581.5
	West Wall (Alumn. Cladding)	2430.7	15	0.1	0.35	0.65	0.92	-	-	0.90	2,180.3
	North-East Wall (Alumn. Cladding)	683.2	15	0.1	0.46	0.54	0.92	-	-	0.75	509.1
	TOTAL WALL OTTV		15 x α x (1 - WWR) U							4.32	8,347.7
	OVERALL BUILDING OTTV	9245.9								**51.17**	473,126.3

MENARA UAC

HEAT CONDUCTION THROUGH WINDOWS

OTTV Calculation for Menara UAC, Mutiara Damansara

	ELEVATION	Façade Area (A) m^2	Constant	Solar Absorption Factor (α)	Window to Wall Ratio (WWR)	(1 - WWR)	U-Value W/m^2k (Uv)	Orientation Correction Factor (CF)	Shading Coeff SC = $SC_1 \times SC_2$	Termal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WINDOWS	North Window (Single, Grey)	1187.7	6	N/A	0.39	N/A	6.31	N/A	N/A	14.77	17,536.9
	South Window (Single, Grey)	2933.8	6	-	0.24	-	6.31	-	-	9.09	26,657.7
	East Window (Single, Grey)	2010.5	6	-	0.43	-	6.31	-	-	16.28	32,730.5
	West Window (Single, Grey)	2430.7	6	-	0.35	-	6.31	-	-	13.25	32,209.2
	North-East Window (Single, Grey)	683.2	6	-	0.46	-	6.31	-	-	17.42	11,898.3
	TOTAL WINDOW OTTV		6 x WWR x U							70.80	121,032.6
	OVERALL BUILDING OTTV	9245.9								**51.17**	473,126.3

MENARA UAC

SOLAR HEAT GAIN THROUGH WINDOWS

OTTV Calculation for Menara UAC, Mutiara Damansara

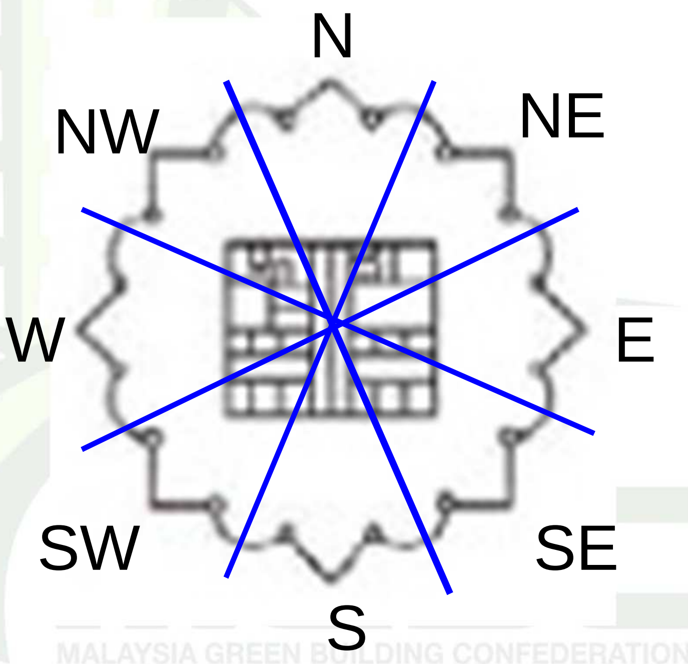
	ELEVATION	Façade Area (A) m^2	Constant	Solar Absorption Factor (α)	Window to Wall Ratio (WWR)	(1 - WWR)	U-Value W/m^2k (Uv)	Orientation Correction Factor (CF)	Shading Coeff (SC = $SC_1 \times SC_2$)	Termal Transfer Value (OTTV)	A x OTTV
SOLAR HEAT GAIN THROUGH WINDOWS	North Window Shading	1187.7	194	N/A	0.39	N/A	N/A	0.9	0.56	38.13	45,290.1
	South Window Shading	2933.8	194	-	0.24	-	-	0.92	0.56	23.99	70,375.1
	East Window Shading	2010.5	194	-	0.43	-	-	1.23	0.56	57.46	115,522.7
	West Window Shading	2430.7	194	-	0.35	-	-	0.94	0.56	35.74	86,879.4
	North-East Window Shading	683.2	194	-	0.46	-	-	1.09	0.56 x 0.69	37.59	25,678.6
	TOTAL SOLAR HEAT GAIN		194 x CF x WWR x SC							192.91	343,746.0
OVERALL BUILDING OTTV		9245.9								**51.17**	473,126.3

MENARA UAC

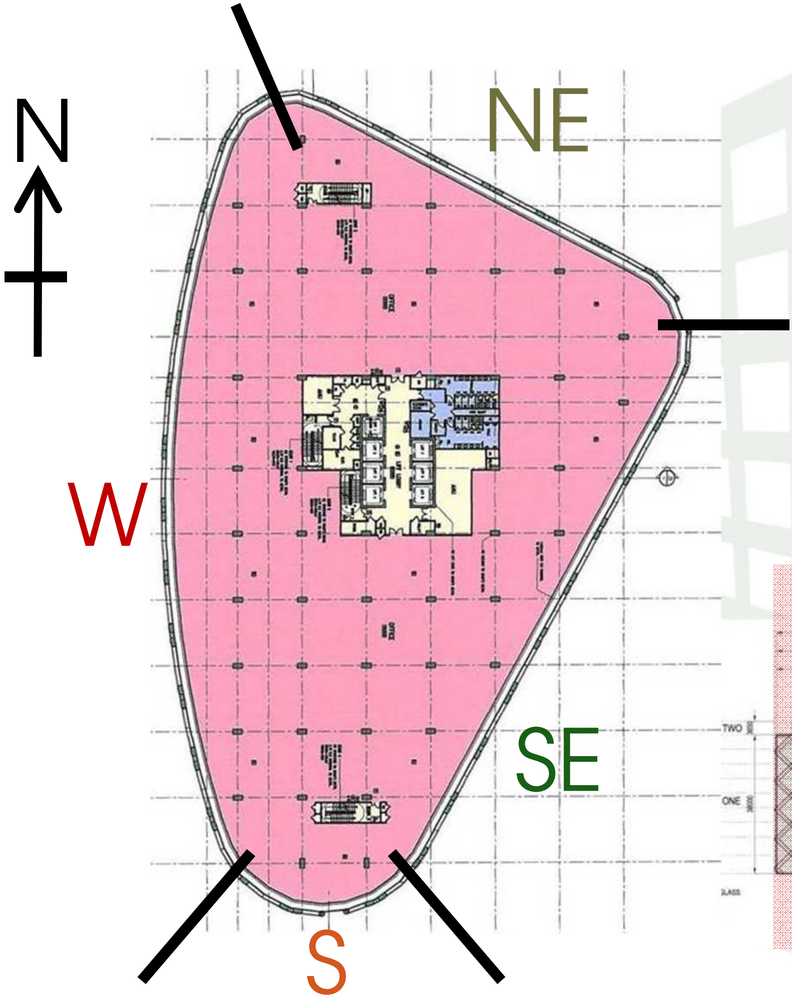
OTTV Calculation for Menara UAC, Mutiara Damansara

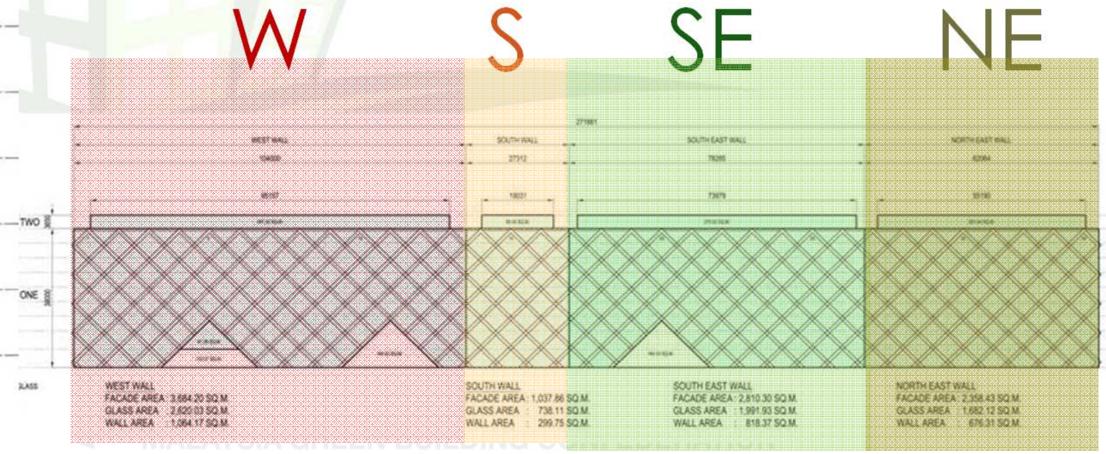
	ELEVATION	Façade Area (A) m^2	Constant	Solar Absorption Factor (α)	Window to Wall Ratio (WWR)	(1 - WWR)	U-Value W/m^2k (Uv)	Orientation Correction Factor (CF)	Shading Coeff (SC = SC_1 x SC_2)	Termal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	North Wall (Alumn. Cladding)	1187.7	15	0.1	0.39	0.61	0.92	N/A	N/A	0.84	999.8
	South Wall (Alumn. Cladding)	2933.8	15	0.1	0.24	0.76	0.92	-	-	1.05	3,077.0
	East Wall (Alumn. Cladding)	2010.5	15	0.1	0.43	0.57	0.92	-	-	0.79	1,581.5
	West Wall (Alumn. Cladding)	2430.7	15	0.1	0.35	0.65	0.92	-	-	0.90	2,180.3
	North-East Wall (Alumn. Cladding)	683.2	15	0.1	0.46	0.54	0.92	-	-	0.75	509.1
	TOTAL WALL OTTV		15 x α x (1 - WWR) U								8,347.7
HEAT CONDUCTION THROUGH WINDOWS	North Window (Single, Grey)	1187.7	6	N/A	0.39	N/A	6.31	N/A	N/A	14.77	17,536.9
	South Window (Single, Grey)	2933.8	6	-	0.24	-	6.31	-	-	9.09	26,657.7
	East Window (Single, Grey)	2010.5	6	-	0.43	-	6.31	-	-	16.28	32,730.5
	West Window (Single, Grey)	2430.7	6	-	0.35	-	6.31	-	-	13.25	32,209.2
	North-East Window (Single, Grey)	683.2	6	-	0.46	-	6.31	-	-	17.42	11,898.3
	TOTAL WINDOW OTTV		6 x WWR x U								121,032.6
SOLAR HEAT GAIN THROUGH WINDOWS	North Window Shading	1187.7	194	N/A	0.39	N/A	N/A	0.90	0.56	38.13	45,290.1
	South Window Shading	2933.8	194	-	0.24	-	-	0.92	0.56	23.99	70,375.1
	East Window Shading	2010.5	194	-	0.43	-	-	1.23	0.56	57.46	115,522.7
	West Window Shading	2430.7	194	-	0.35	-	-	0.94	0.56	35.74	86,879.4
	North-East Window Shading	683.2	194	-	0.46	-	-	1.09	0.56 x 0.69	37.59	25,678.6
	TOTAL SOLAR HEAT GAIN		194 x CF x WWR x SC								343,746.0
	OVERALL BUILDING OTTV	9245.9								**51.17**	473,126.3

For circular or symmetrical floor plates, divide into 8 zones



green
building
index





DEVELOPED WALL
ELEVATIONS

WAYS TO IMPROVE OTTV

1. Identify which component contributes the most to OTTV.
2. Review Solar Correction Factor (CF) in Table 4.
3. Review glass selection and its Shading Coefficient (SC).
4. Review sunshades and its Shading Coefficient (SC) in Tables 5, 6 and 7.
5. Review WWR.

SUMMARY

Clause 5.2

OTTV applies to building envelope, where

OTTV $\leq$ 50 W/m^2

Clause 5.5

Roof U-value refers to the thermal transmittance of the roof, where

Roof U-value $\leq$ 0.4 - 0.6 W/m^{2}K

Clause 5.6

RTTV applies to roof with skylights, where

RTTV $\leq$ 25 W/m^2

THANK YOU

Ar Chan Seong Aun
Immeiate Past President PAM 2015-2017
Chairman GBI Accrediation Panel
M. Arch. B. Arch (NZ), P. Arch, APAM