HIGH COURT-AMARAVATI,

ANDHRA PRADESH

ENVELOPE OPTIMISATION– FAÇADE MATRIX

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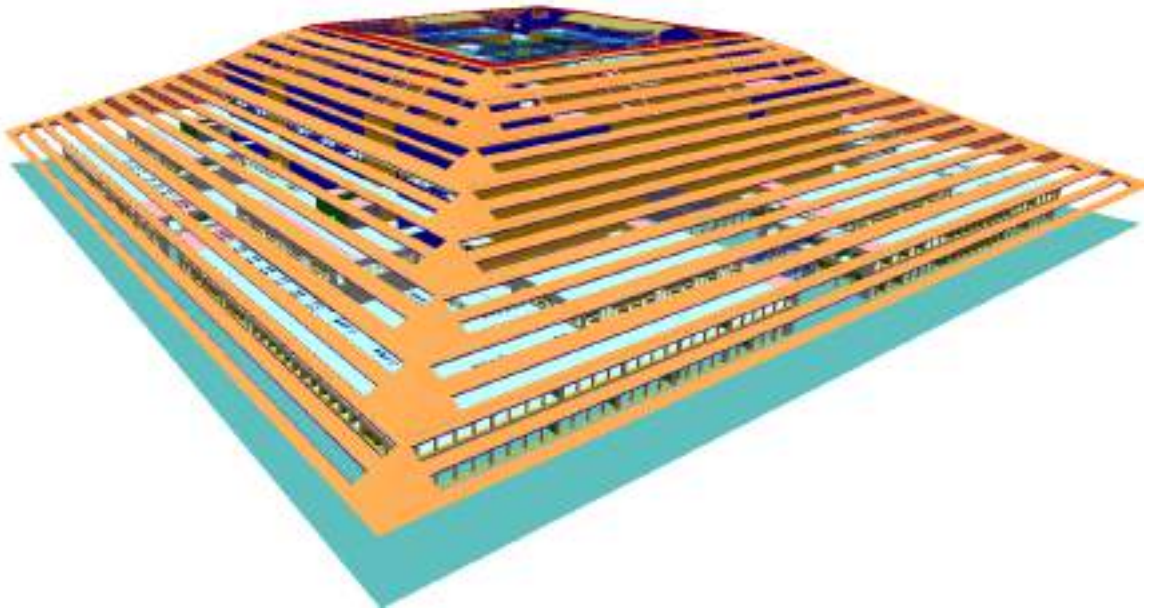
Environmental Design Consultancy



Introduction

- The thermal analysis of the Amaravati High court has been conducted in EDSL TAS which runs on Radiosity engine and generates a climate based hourly simulation data.
- The weather file used was for Vijayawada with the location co-ordinates of 16.53 °N and 80.0° E.
- The High court building has been planned such that it's facades are oriented exactly in cardinal directions.
- The building has a combination of conditioned and unconditioned spaces. The open and private office spaces , legal services areas, court halls and other regularly occupied spaces are mechanically ventilated. The circulation are semi- external , un-conditioned and heavily shaded spaces which mainly include the promenade , court hall waiting spaces etc.
- The fresh air calculations, internal conditions and schedules assumed for the simulation can be referred to in the Heat Loads calculation excel sheet.

Methodology

- The main aim of the simulation study is to understand the effects of various Glazing types on representative spaces in the High court.
- This is accomplished through the use of Cooling loads as a metric for measuring energy usage for HVAC sizing. Similarly, Radiant & Resultant temperatures are used to gauge thermal comfort in each space.
- The patterns of diurnal thermal gain and loss have been studies with respect to the positioning, orientation and typology of the space to optimize glazing in order to lower the heat gain wherever necessary.
- The specification of the Glazing types have been listed in the following slides.

Glazing Specifications

External Wall :	200mm Brick Wall with 15mm Plaster on both faces
Internal Wall:	150mm Brick Wall with 15mm Plaster on both faces
Court Walls:	150mm Brick Wall with 100mm stone Cladding
Court Partition Walls :	150mm Brick Wall with Acoustic Timber Cladding
Internal Floor/Ceiling Slab :	150mm RCC Slab with 25mm concrete screed and 50mm Stone floor finish and Plastered soffit
Roof Slab:	150mm RCC Slab with 25mm concrete screed and 50mm Stone floor finish and Plastered soffit
Internal/ External Sheer Walls :	450mm thick Fair Faced concrete wall
Stupa Roof :	200mm Light weight Precast Concrete slab
Glazing frames :	400mm*100mm Wooden frames

Glazing Options								
	Windows			Achieved U value	Reflectance (%)	VLT (%)	SHGC	Roof lights
	inside		outside					G-Rooflights
Base Case	6mm Clear Glass			5.63	7.00	78.00	0.82	Single Laminated Glazing
Double Glazing	6mm Clear Glass	12mm Air Gap	6mm Clear Glass	2.83	12.60	79.00	0.71	Double Laminated glazing w/clear glass
Planitherm Pristine White	Inner 6mm Clear Glass	12mm Air Gap	6mm with Coating face 2	1.77	19.00	47.00	0.54	Laminated Sandwich glass panel (Sgcool)
SG Cool Lite SKN 165	Inner 6mm Clear Glass	12mm Air Gap	6mm with Coating face 2	1.64	14.40	79.00	0.35	Laminated Sandwich glass panel (Sgcool)

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Glazing -Observations & Inferences

The Glazing results were run initially with other building elements including wall and roof surfaces set to baseline values to understand the effects of glazing on selected spaces in the building. This was done using four glazing types:

- Clear Single Glazing
- Clear Double Glazing
- Planitherm Pristine White
- SG Nanoplus SKN 165

This was compared to an option with SKN165 Glazing, 0.4 W/m2 K Roof and Wall U-values to understand which building element had a greater effect on the reduction in Cooling loads.

Results from selected spaces in the Level 1 and Level 5 are presented considering their different built form – Level 1 being single skinned and exposed , where as Level 5 spaces double skinned and sheltered.

Inferences

Level 1

1. Since the spaces on the peripheral facades are directly exposed to the elements , the improvement in the Glazing specifications , specifically the SHGC significantly reduces the cooling loads. This can be clearly seen in the Percentage reduction in Annual cooling load graph, where the SKN165+0.4R&W have no effects on reduction in cooling loads compared to the SKN165 option.
2. The spaces in the internal building such as the High Court Library, Original Side etc . which are sheltered show lesser sensitivity to the type of glazing as compared to the exposed peripheral spaces. On the other hand the SKN165+0.4R&W option creates almost double the impact on the cooling loads as compared to the SKN165 option.
3. However, Glazing for the internal building must be chosen keeping in mind the requirement for Higher VLT to allow more light transmittance thereby reducing the lighting load.

Level 5

1. The court halls in the spaces are sheltered by the stupa roof which is heavily shaded. Hence there is negligible direct solar radiation and this does not have any effect on the cooling loads.
2. However, since the ambient external temperature go above 35 degrees on a regular basis (i.e. almost 8% of the time), the U-value of the building element matters much more. This is evident from the Percentage reduction in Annual cooling load graph where the the SKN165+0.4R&W option has a 8-24% reduction in Cooling loads compared to just above 2% for the SKN 165 option.
3. Here too, Glazing with greater VLT must be chosen to reduce lighting load in the courtrooms.
4. In order to further reduce the U-value, Argon filling in the 12mm gap for the specified Glazing is recommended. This will reduce the 1.1 W/m2K.

Glazing Recommendations – Ground Floor Plan

Spaces with rooflights

- N W HC Museum
- N HC Book Centre
- E ARD Arbitration halls

Open office spaces

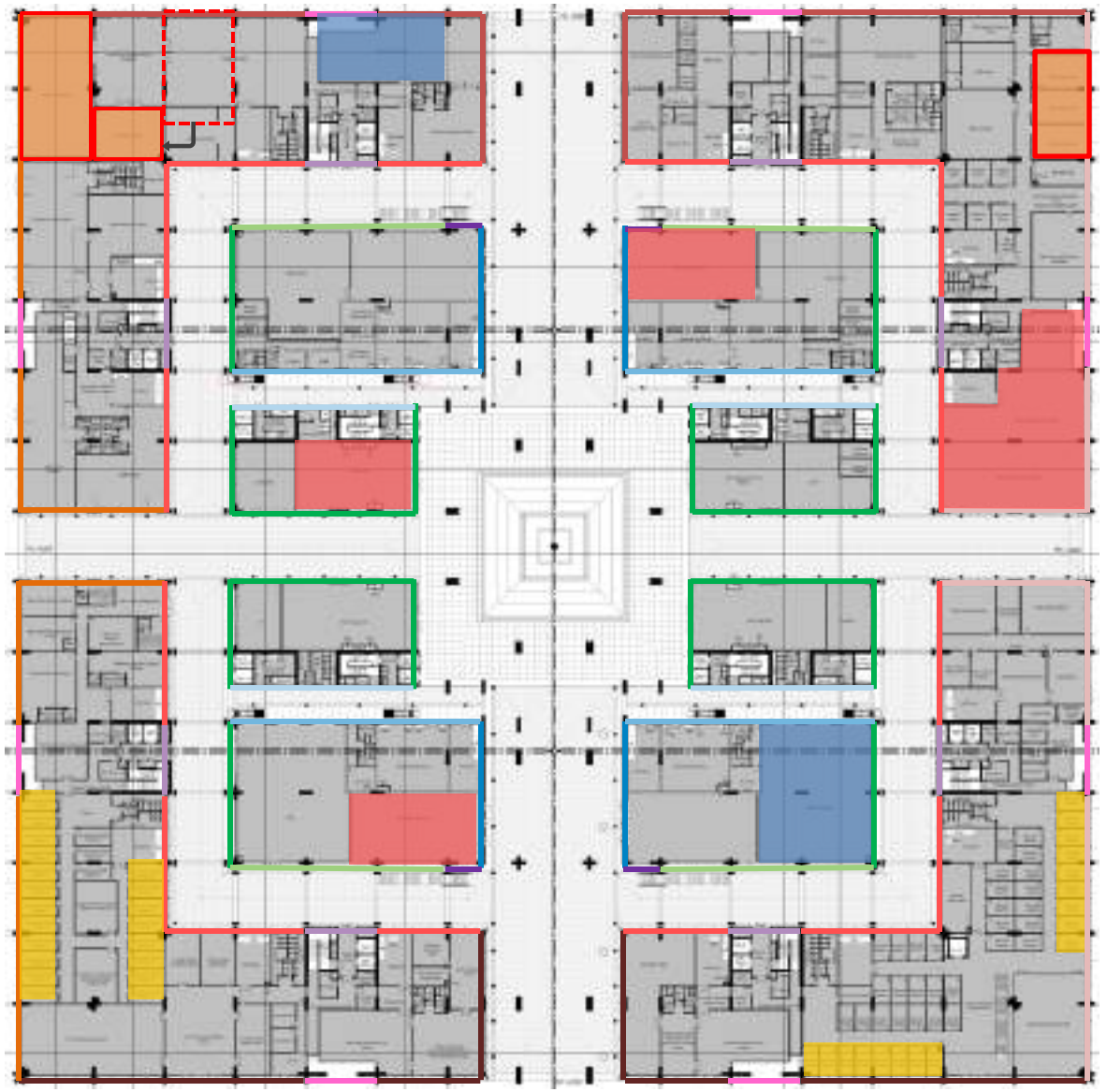
- I New Filing – Criminal
- E ARD Mediation rooms
- E State Legal Services Authority
- I Original Side
- I Writ Posting Services

Private office spaces

- E Advocate chambers 1-8 E
- S Advocate chambers 21-28
- W Government Pleaders chambers 1-12
- I Government Pleaders chambers 13-25

Public spaces

- N HC Auditorium
- I HC Library



PHERIPERAL BUILDING

- EWS-01 (A,B,C,D,E)
- EWS-02
- EWS-03 (A,B)
- CR-01

EWS-01 North
EWS-01 East
EWS-01 South
EWS-01 West

CENTRAL BUILDING

- EWS-04
- EWS-05
- EWS-06
- EWS-07
- EWS-08
- EWS-09
- EWS-10
- CR-02
- CR-03
- CR-04
- CR-05

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Glazing Recommendations – First Floor Plan

Spaces with Rooflight

- N — Conference Hall
- N — Computer Training Centre
- N — Stationery

Record

- [redacted] — English Record

Open office spaces

- [redacted] — Digitization Vendor Staff Section
- [redacted] — Lab

Open office spaces w/ Rooflights

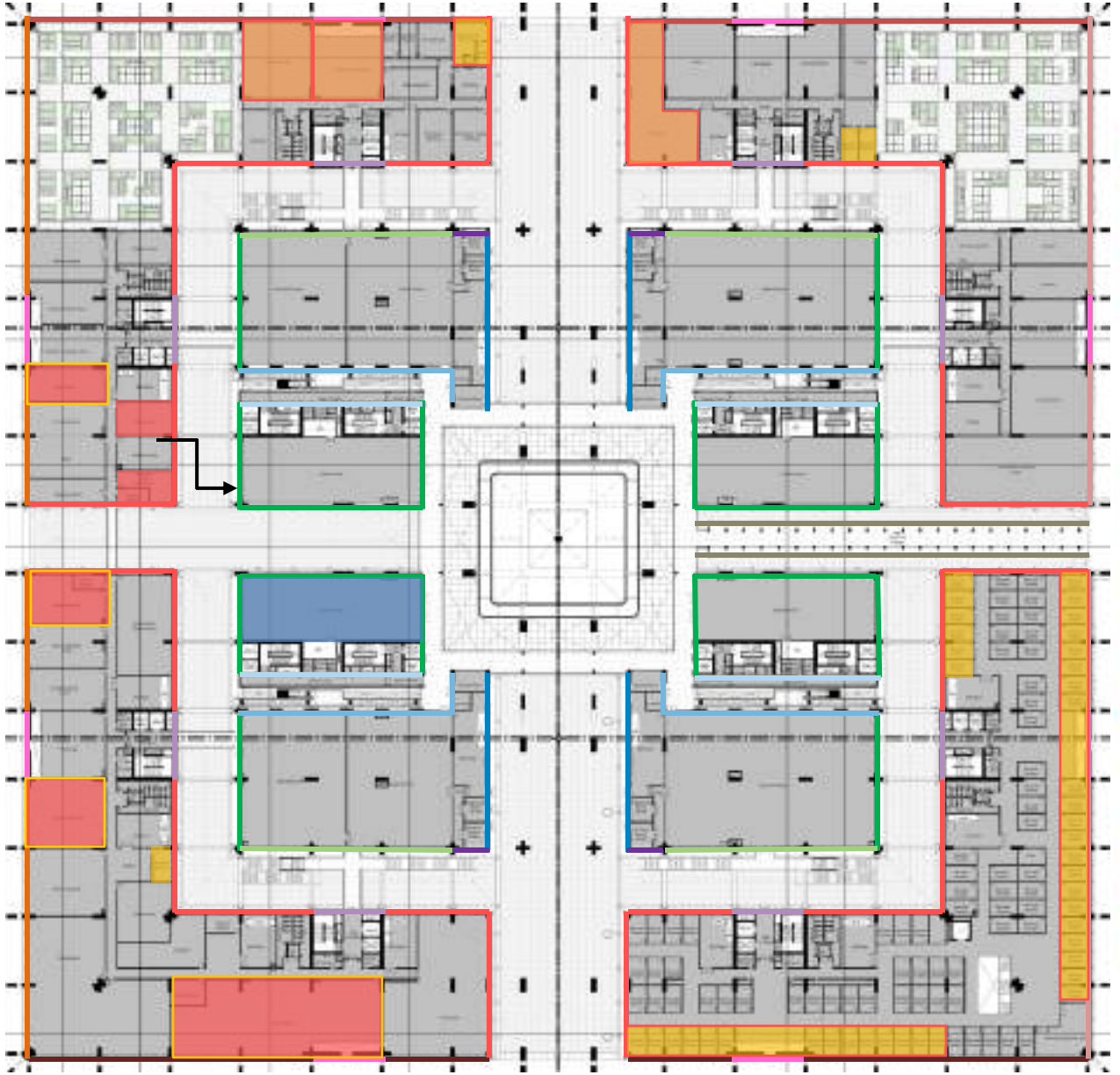
- W — Record Verification Section
- W — Special Drafting Cell
- S — Court Officers
- W — Staff Computer Lab

Private office spaces

- [redacted] — Assistant Registrars1
- [redacted] — Assistant Registrars 2
- E — Advocate chambers Row 1

Private office w/ Rooflights

- N — NIC Director's Cabin
- [redacted] — Advocate chambers Row 4
- S — Advocate chambers Row 5



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Glazing Recommendations – Second floor Plan

Open office spaces

- N — B. Special Cell
- N — E. Section
- E — Vigilance Cell
- N — OP Cell

Private office spaces

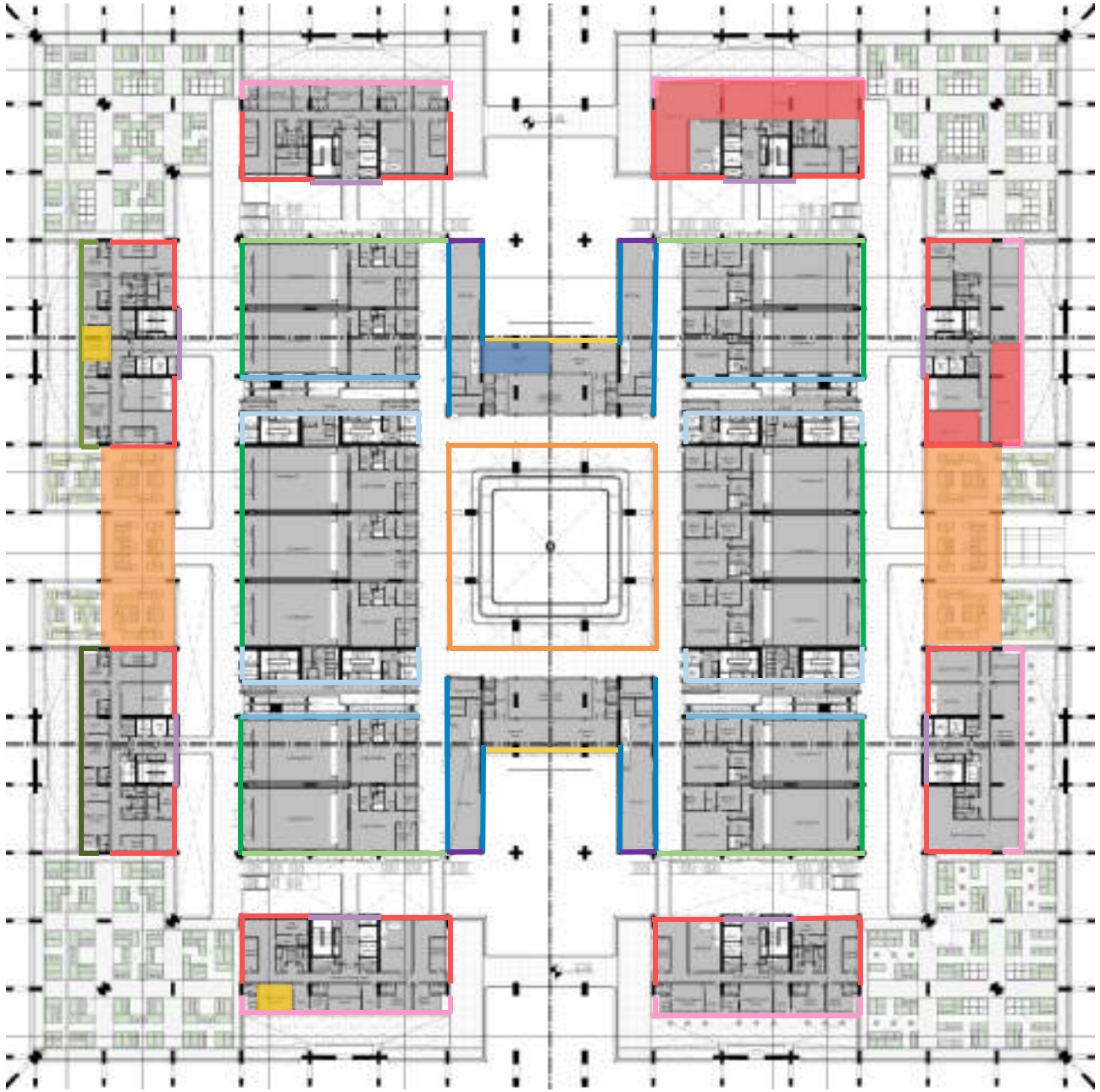
- W — Registrar Recruitment
- S — Registrar Judicial

Misc. spaces

- I — Conference Room

External Waiting

- E — External Waiting Space –E
- W — External Waiting Space -W



PHERIPERAL BUILDING

- EWS-01 (A,B,C,D,E)
- EWS-02
- EWS-03 (A,B)
- CR-01

CENTRAL BUILDING

- EWS-04
- EWS-05
- EWS-06
- EWS-07
- EWS-08
- EWS-09
- EWS-10
- CR-02
- CR-03
- CR-04
- CR-05

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Glazing Recommendations - Level 5 Plan

Court Halls

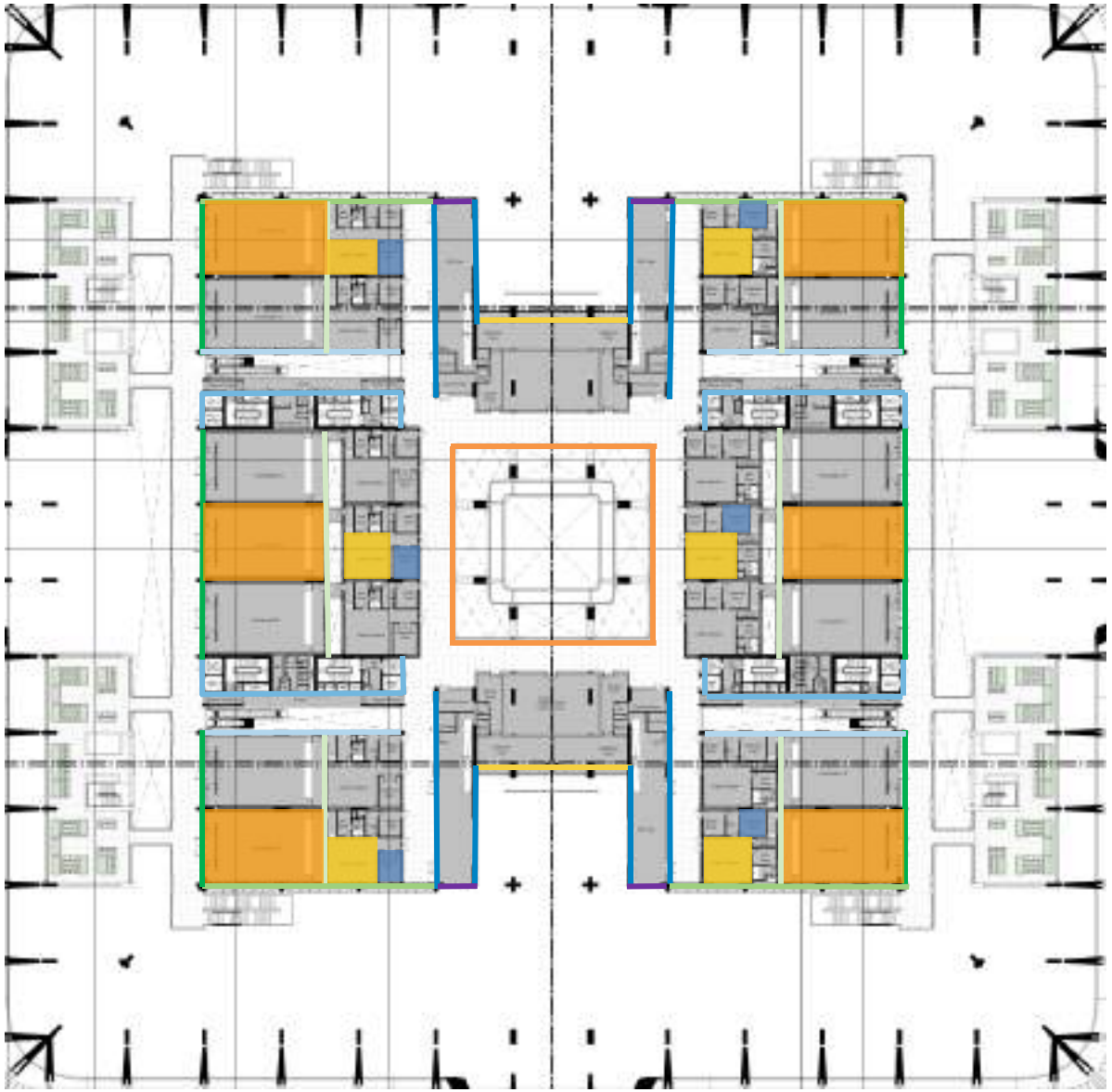
- N E — Court Hall 13
- E — Court Hall 16
- S E — Court Hall 19
- N W — Court Hall20
- W — Court Hall23
- S W — Court Hall26

Judge's Chamber

- Judge's Chamber 13
- Judge's Chamber 16
- Judge's Chamber 19
- Judge's Chamber 20
- Judge's Chamber 23
- Judge's Chamber 26

Conference Room

- Conference Room 13
- Conference Room 16
- Conference Room 19
- Conference Room 20
- Conference Room 23
- Conference Room 26



PHERIPERAL BUILDING

- EWS-01 (A,B,C,D,E)
- EWS-02
- EWS-03 (A,B)
- CR-01

CENTRAL BUILDING

- EWS-04
- EWS-05
- EWS-06
- EWS-07
- EWS-08
- EWS-09
- EWS-10
- CR-02
- CR-03
- CR-04
- CR-05

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Glazing Recommendations - Level 7 Plan

Court Halls

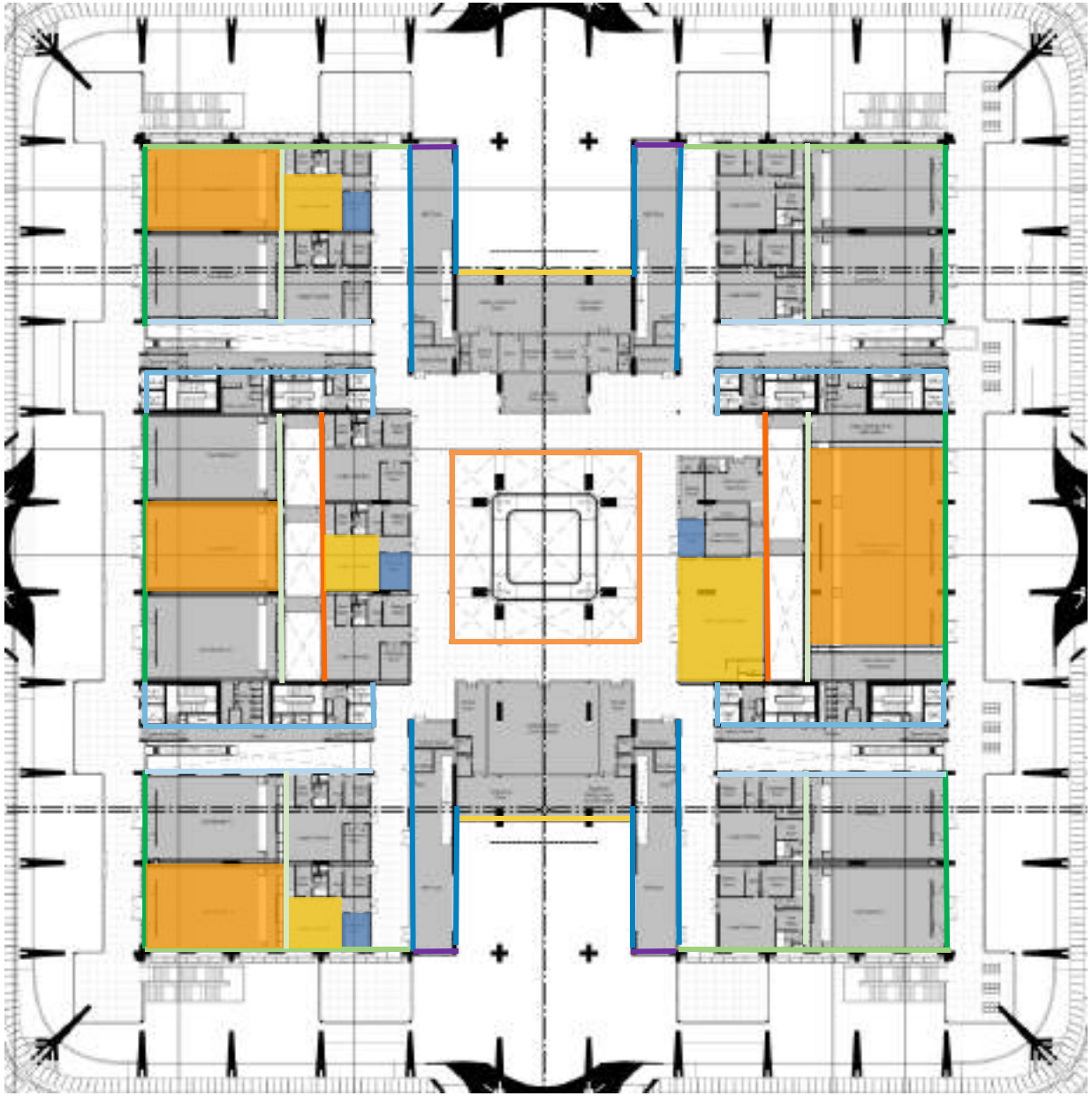
- E — Court Hall 1
- N W — Court Hall 3
- W — Court Hall 6
- S W — Court Hall9

Judge's Chamber

- Chief Justice Chamber
- Judge's Chamber 3
- Judge's Chamber 6
- Judge's Chamber 9

Conference Room

- Chief Justice Peshi
- Conference Room 3
- Conference Room 6
- Conference Room 9



PHERIPERAL BUILDING

- EWS-01 (A,B,C,D,E)
- EWS-02
- EWS-03 (A,B)
- CR-01

CENTRAL BUILDING

- EWS-04
- EWS-05
- EWS-06
- EWS-07
- EWS-08
- EWS-09
- EWS-10
- CR-02
- CR-03
- CR-04
- CR-05

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Conference Room

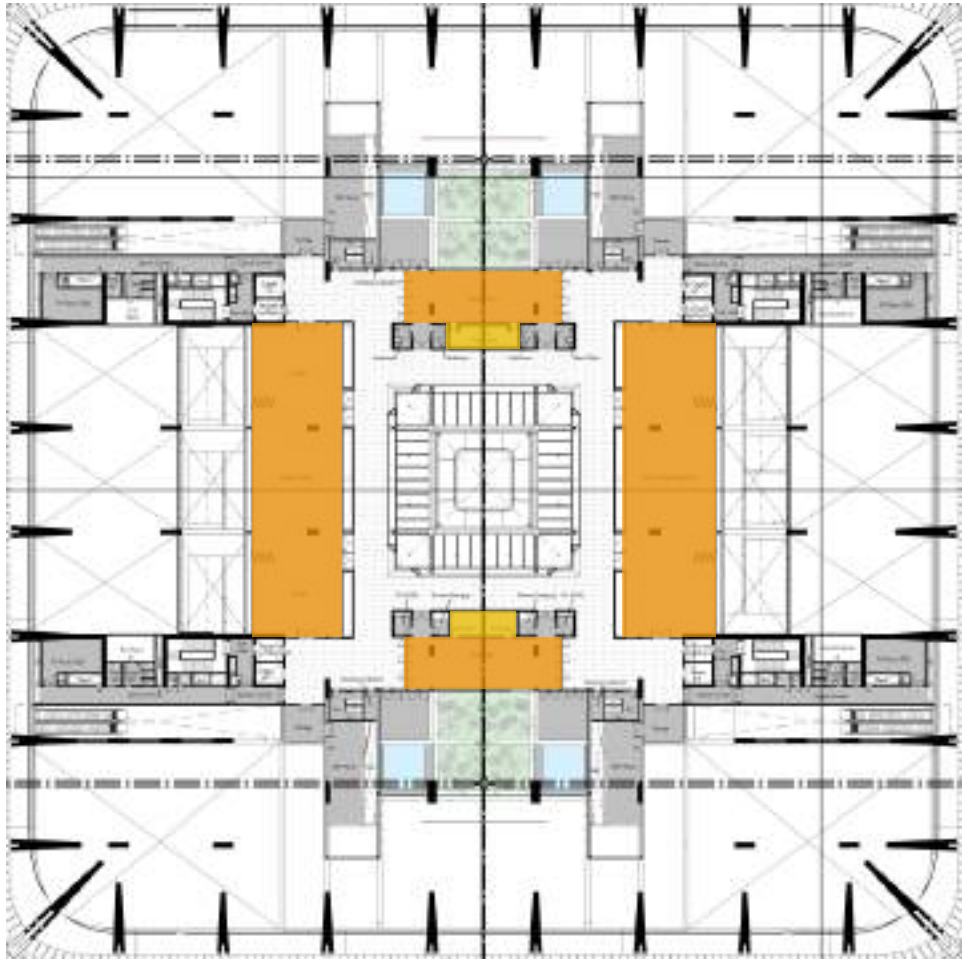
- S — Full Court Meeting room
- W — Judge's Lounge
- N — Judges' Reference Library
- E — Full Court Dining Room

Conference Room

- W — Yoga Centre
- E — Gym

Utilities

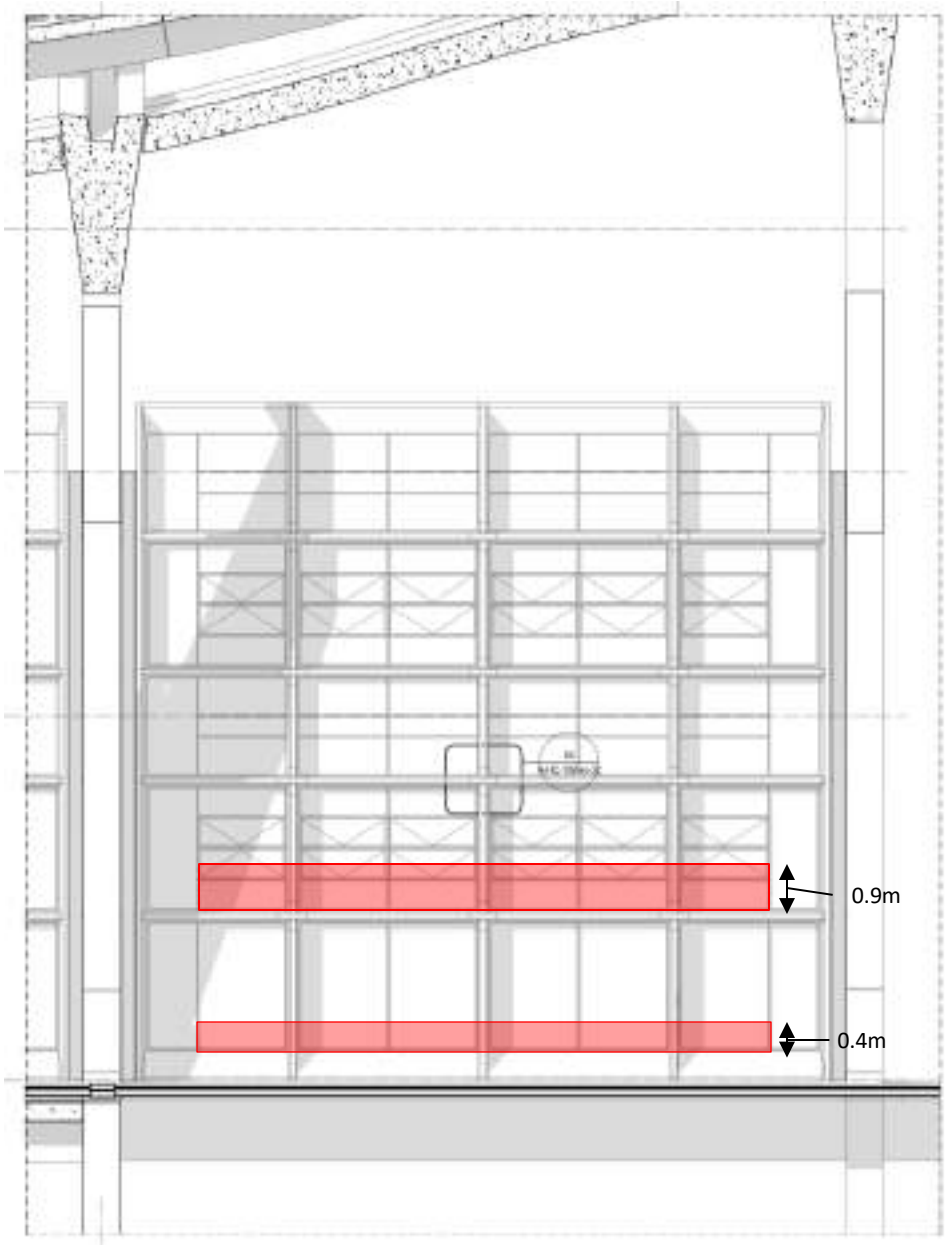
- I — Pantry
- I — WC

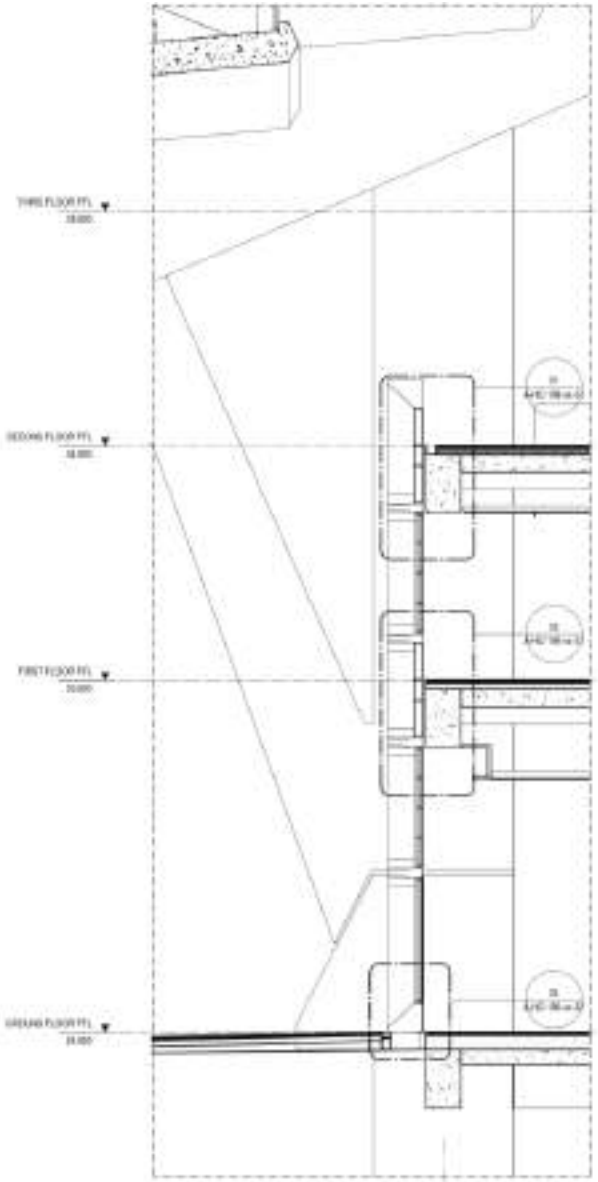


Glazing Recommendations

EWS_01 (A,B,C,D)

System	Types	
	Plan Color Code	
	Name	Stone Cladding
	Location	Peripheral Buildings, External Elevations-NORTH
	System Tags	EWS_01
	General description	Pre-cast steel-reinforced concrete system with stone veneer panels and glazed system with openable windows and access panels for smoke evacuation..
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.62
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.79
	Frame to Glazing ratio	0.13-0.2
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	1.67-3.12
	Sample Analysis Space	HC Museum-GF, Stationary lvl 1
	WWR Recommendation	WWR to be kept around 0.5
General Notes		Minimise SHGC with optimum VLT. VLT to be finalised based on daylight studies. Ideal option - SKN154 until 2.1m (first transom height) height, SKN 165 above 2.1m
Performance requirments - St Gobain Code or Similar		St Gobain SKN 154 (with 15mm Argon filling)
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	1.10
	Maximum SHGC	0.28
	Minimum VLT, %	50%
Extra / Alternative Options		Above 2.1m
Performance requirments		St Gobain SKN 165 (with 15mm Argon filling)
Alternate option	Maximum U-Value (W/m^{2}K)	1.10
	Maximum SHGC	0.34
	Minimum VLT, %	60%





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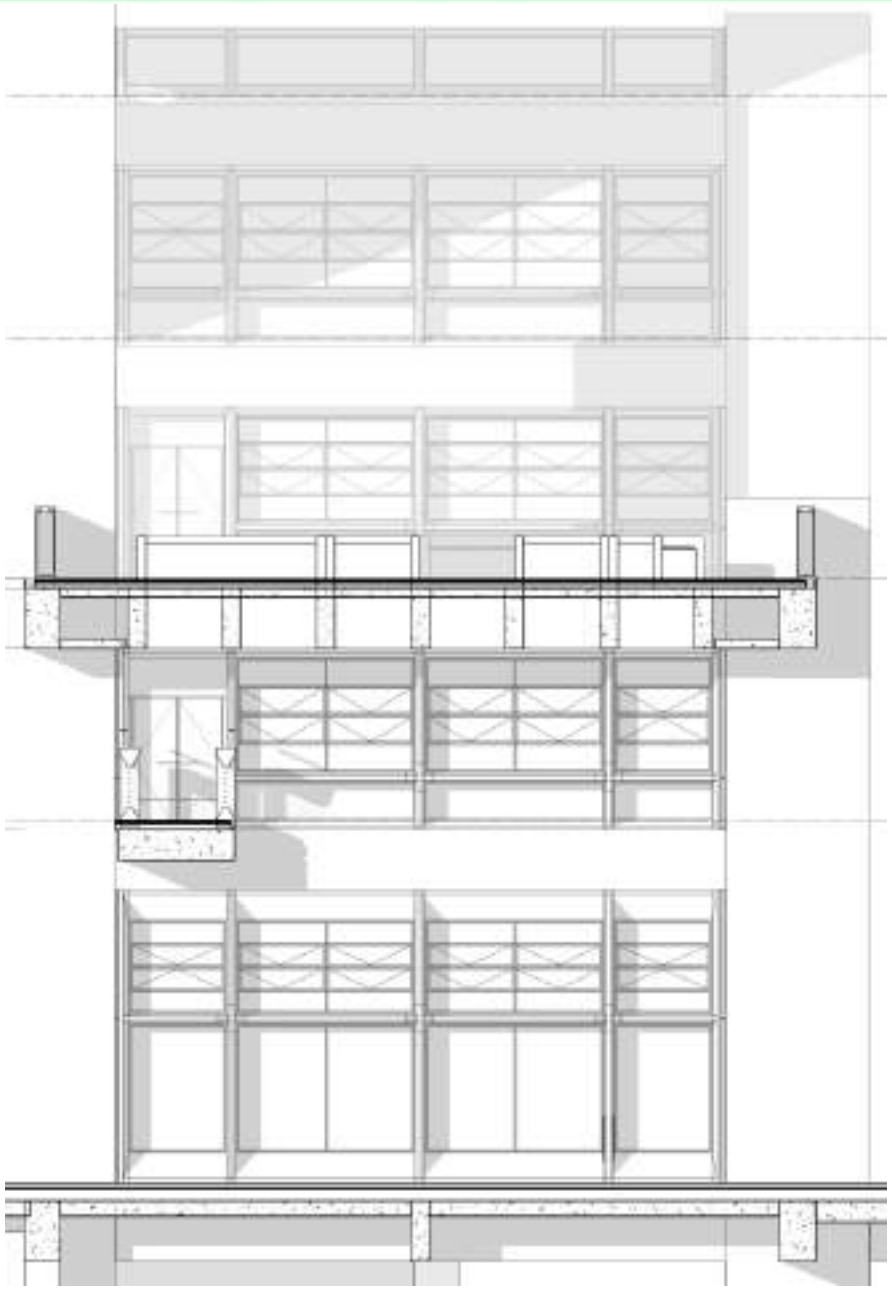
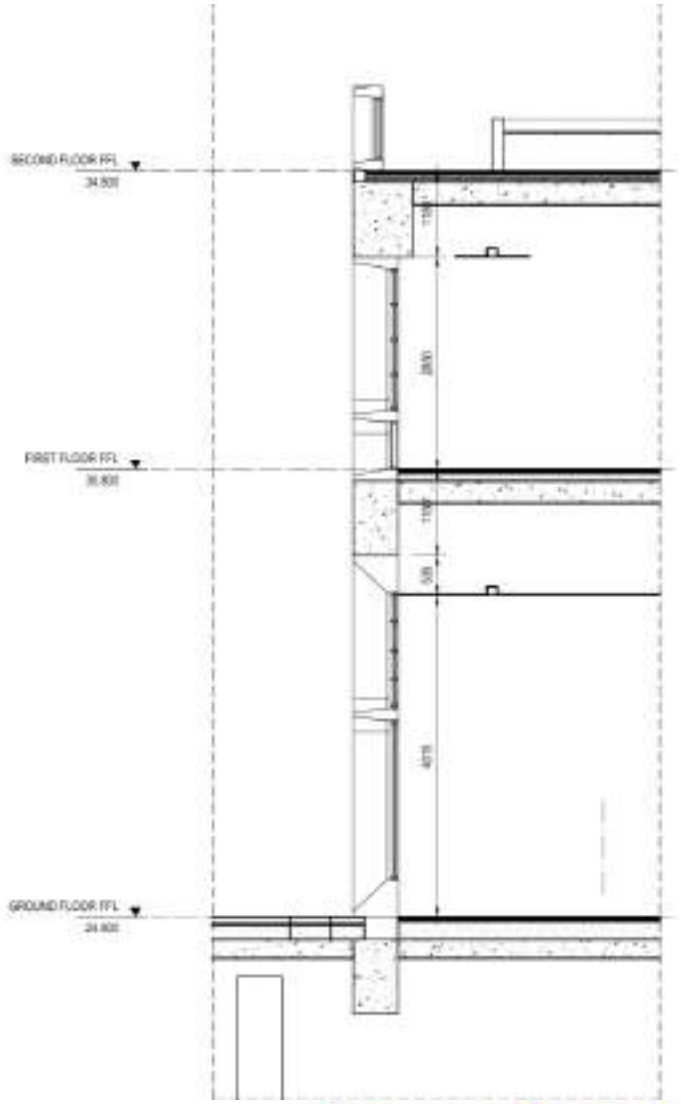
EWS – 01 (E)

System	Types	
	Plan Color Code	
	Name	Stone Cladding
	Location	Peripheral Buildings, Internal Elevations
	System Tags	EWS_01
	General description	Pre-cast steel-reinforced concrete system with stone veneer panels and glazed system with openable windows and access panels for smoke evacuation..
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.46
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.71
	Frame to Glazing ratio	0.13-0.2
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	0.83-2.3
	Sample Analysis Space	Stationary-lvl 1, record verification,Govt pleader chamber 13-25
	WWR Recommendation	WWR to be kept around 0.5
General Notes		Minimise U value with max VLT achievable. Ideal option - Planitherm clear
Performance requirments - St Gobain Code or Similar		St Gobain SKN 172 (with 15mm Argon filling)
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	1.10
	Maximum SHGC	0.40
	Minimum VLT, %	67%
Extra / Alternative Options		Alternative Option
Performance requirments		St Gobain Planitherm clear (with 15mm Argon filling)
Alternate option	Maximum U-Value (W/m^{2}K)	1.32
	Maximum SHGC	0.54
	Minimum VLT, %	75%





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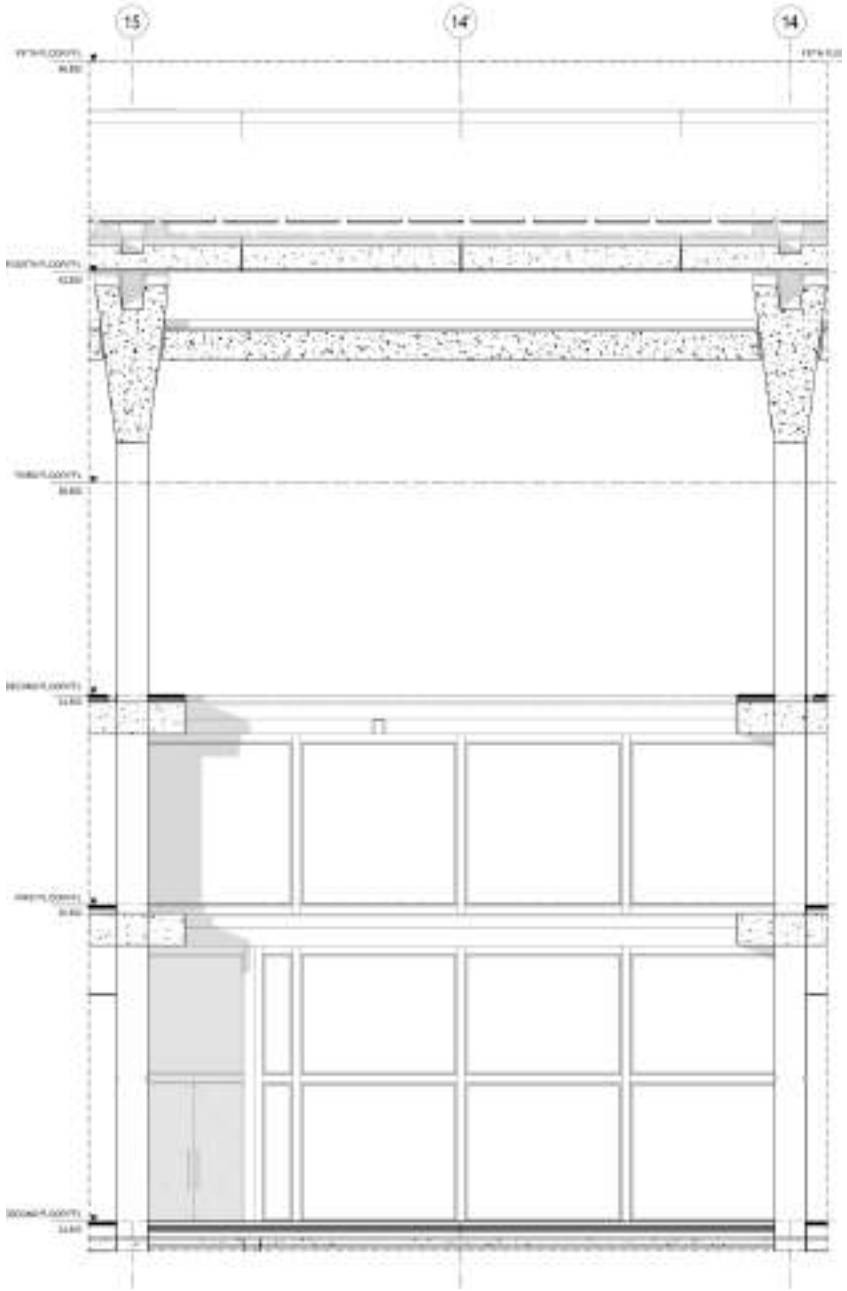
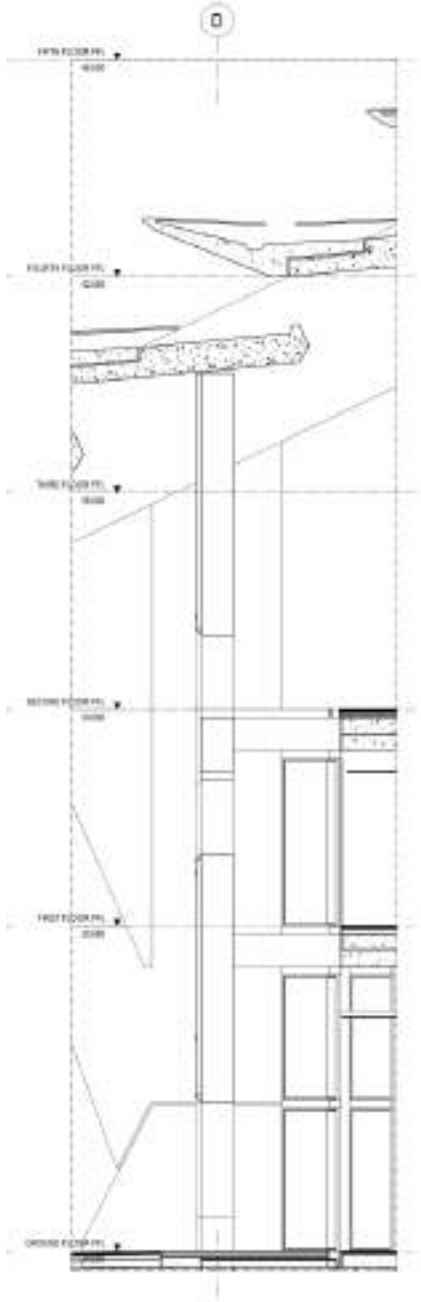
EWS – 02

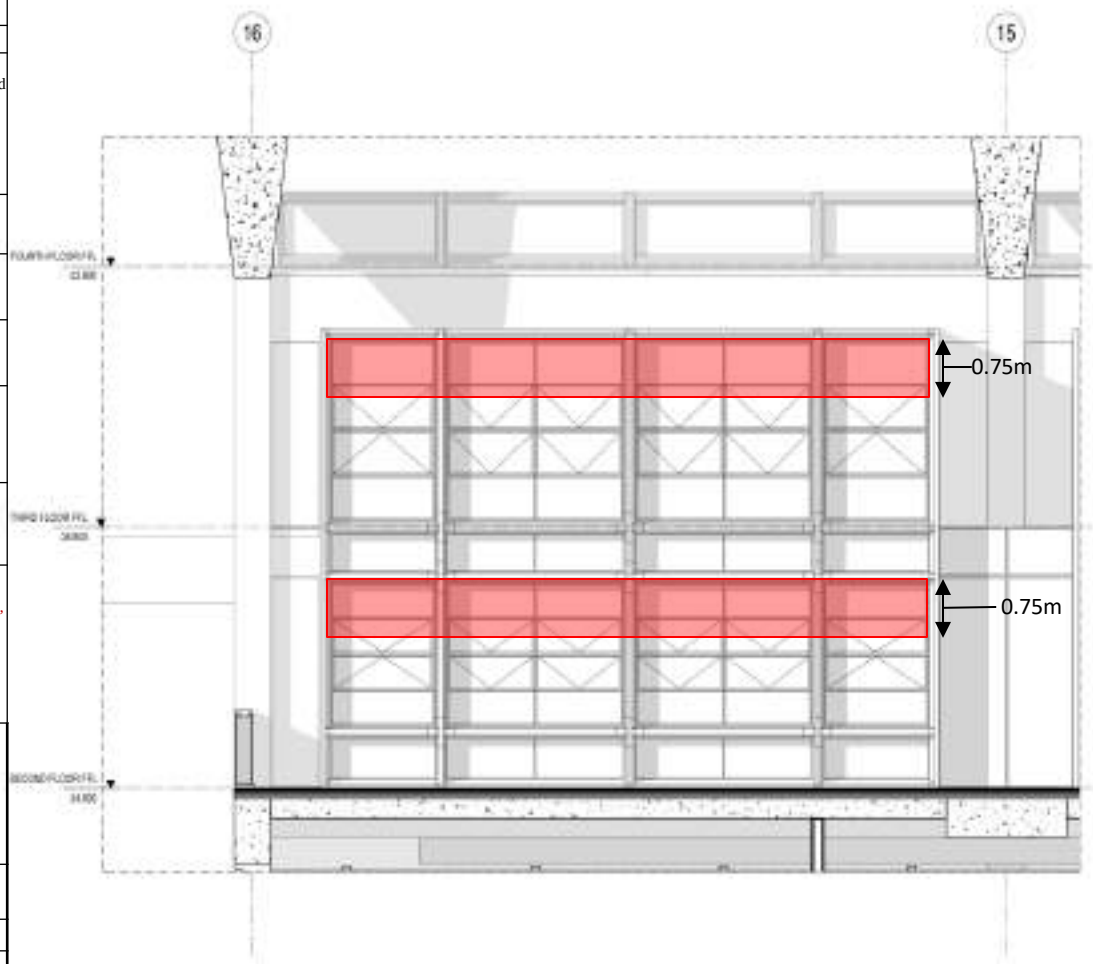
System	Types	
	Plan Color Code	
	Name	Glass Rainscreen Wall
	Location	Peripheral Buildings, external façades behind shear wall
	System Tags	EWS_02
	General description	Glazing system
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.16
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.60
	Frame to Glazing ratio	
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	
	Sample Analysis Space	
	WWR Recommendation	NO change in WWR
General Notes		Minimise U value and SHGC with max VLT achievable. Ideal option - SKN 172
Performance requirments - St Gobain Code or Similar		St Gobain SKN 172 (with 15mm Argon filling)
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	1.10
	Maximum SHGC	0.40
	Minimum VLT, %	67%
Extra / Alternative Options		Alternative Option
Performance requirments		St Gobain Planitherm clear (with 15mm Argon filling)
Alternate option	Maximum U-Value (W/m^{2}K)	1.32
	Maximum SHGC	0.54
	Minimum VLT, %	75%

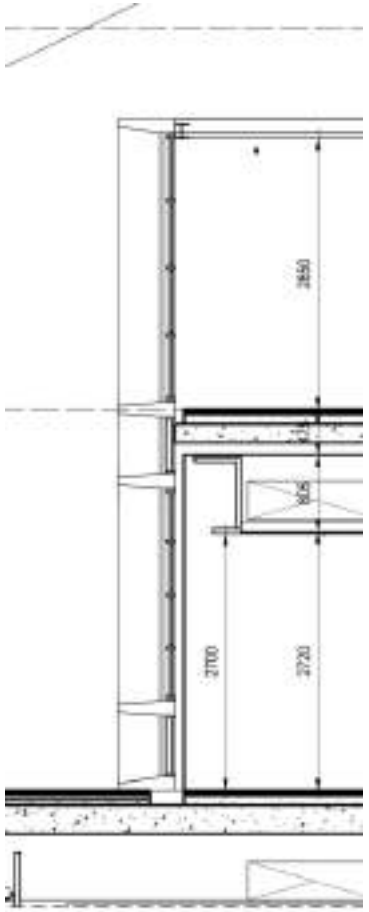




EWS – 03(A, B)

System	Types		
	Plan Color Code		
	Name	Pavilions	Pavilions
	Location	Peripheral Buildings, L01 & L02 Terraces- West	Peripheral Buildings, L01 & L02 Terraces- North, South & East
	System Tags	EWS_03	EWS_03
	General description	Pre-cast steel-reinforced concrete system with stone veneer panels and glazed system.	Pre-cast steel-reinforced concrete system with stone veneer panels and glazed system.
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.56	0.56
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.40	0.36
	Frame to Glazing ratio	0.2 - 0.3	0.2 - 0.3
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	2.00	2 - 2.25
	Sample Analysis Space	Registrar Recruitment	E-Section, OPCell, Registrar Judicial
	WWR Recommendation	To keep resultant temperatures low, WWR to be kept at 0.4. However, minimum glazing to be provided should be based on daylight requirements	To keep resultant temperatures low, WWR to be kept at 0.4. However, minimum glazing to be provided should be based on daylight requirements
General Notes		Minimise U value and SHGC with max VLT achievable. Ideal option - SKN 172	Minimise U value and SHGC with max VLT achievable. Ideal option - SKN 172
Performance requirments - St Gobain Code or Similar		St Gobain SKN 172 (with 15mm Argon filling)	St Gobain SKN 172 (with 15mm Argon filling)
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	1.10	1.10
	Maximum SHGC	0.40	0.40
	Minimum VLT, %	67%	67%
Extra / Alternative Options		Alternative Option	Alternative Option
Performance requirments		St Gobain Planitherm clear (with 15mm Argon filling)	St Gobain Planitherm clear (with 15mm Argon filling)
Alternate option	Maximum U-Value (W/m^{2}K)	1.32	1.32
	Maximum SHGC	0.54	0.54
	Minimum VLT, %	75%	75%





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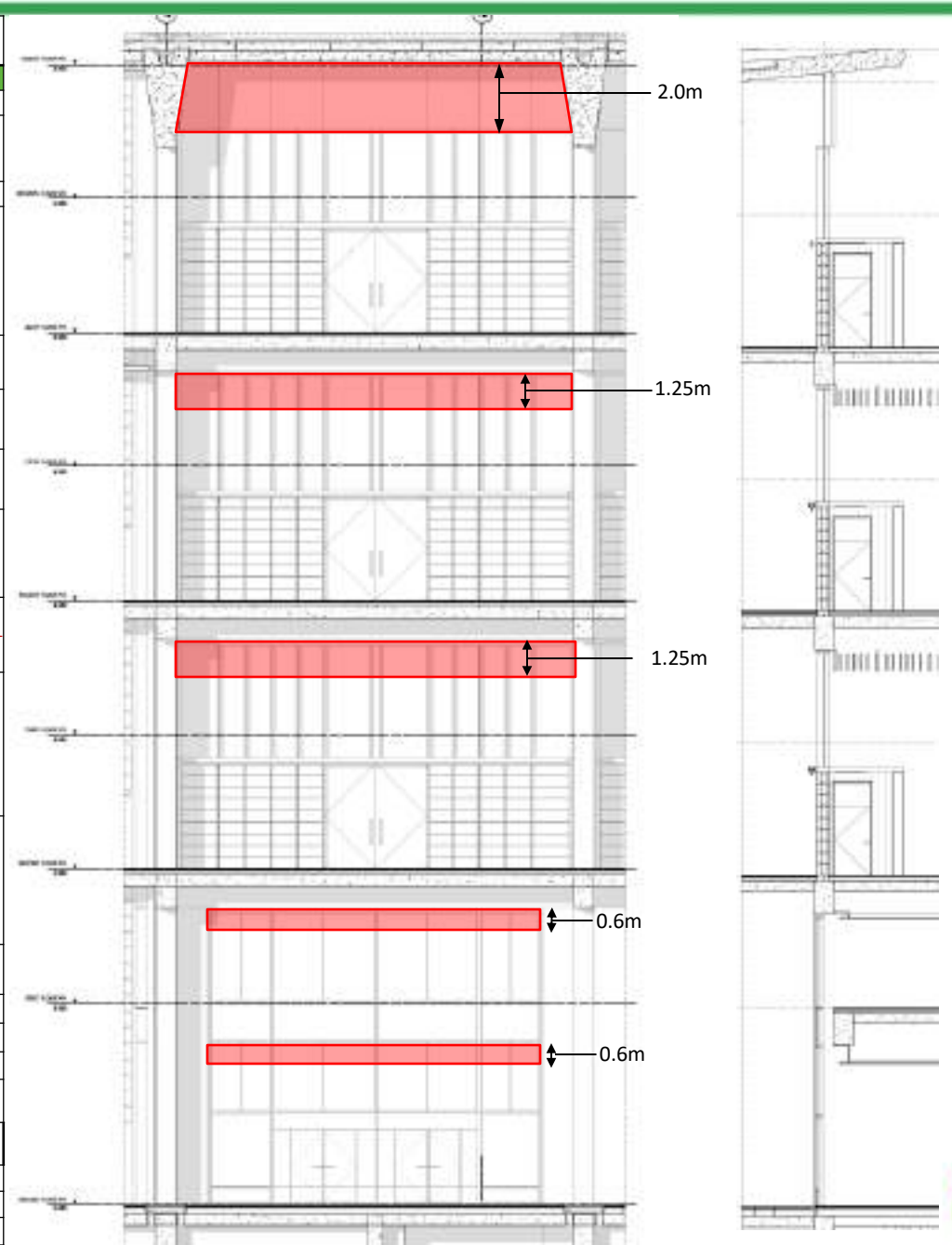
EWS – 04(02, 04, 06)

System	Types	External Wall Systems - Central Building		
	Plan Color Code			
	Name	Court Front Facades	Court Front Facades	Court Front Facades
	Location	Central Building, East/West Elevations (GF+L01)	Central Building, East/West Elevations (02,L04)	Central Building, East/West Elevations (L06)
	System Tags	EWS_04	EWS_04	EWS_04
	General description	Stone veneer and cast glass system	Stone veneer and cast glass system	Stone veneer and cast glass system
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.51	0.51	0.51
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.34	0.34	0.34
	Frame to Glazing ratio	0.10	0.10	0.10
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	2.00	2.10	3.2-3.5
	Sample Analysis Space	English record-lvl-1	court hall 20-NW	Chief Justice Court hall-east, court hall 12- West, court hall 6-NW
	WWR Recommendation	To keep resultant temperatures low, WWR to be kept at around 0.3. However, minimum glazing to be provided should be based on daylight requirements	To keep resultant temperatures low, WWR to be kept at 0.30. However, minimum glazing to be provided should be based on daylight requirements	To keep resultant temperatures low, WWR to be kept at 0.30. However, minimum glazing to be provided should be based on daylight requirements
General Notes		Minimise U value with max VLT achievable. Ideal option - SKN172	Minimise U value with max VLT achievable. Ideal option - SKN172	Minimise U value with max VLT achievable. Ideal option - SKN165
Performance requirments - St Gobain Code or Similar		St Gobain SKN 172 (with 15mm Argon filling)	St Gobain SKN 172 (with 15mm Argon filling)	St Gobain SKN 165 (with 15mm Argon filling)
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	1.10	1.10	1.10
	Maximum SHGC	0.40	0.40	0.34
	Minimum VLT, %	67%	67%	60%
Extra / Alternative Options		Alternative Option	Alternative Option	Alternative Option
Performance requirments		St Gobain Planitherm clear (with 15mm Argon filling)	St Gobain Planitherm clear (with 15mm Argon filling)	St Gobain SKN 172 (with 15mm Argon filling)
Alternate option	Maximum U-Value (W/m^{2}K)	1.32	1.32	1.10
	Maximum SHGC	0.54	0.54	0.40
	Minimum VLT, %	75%	75%	67%



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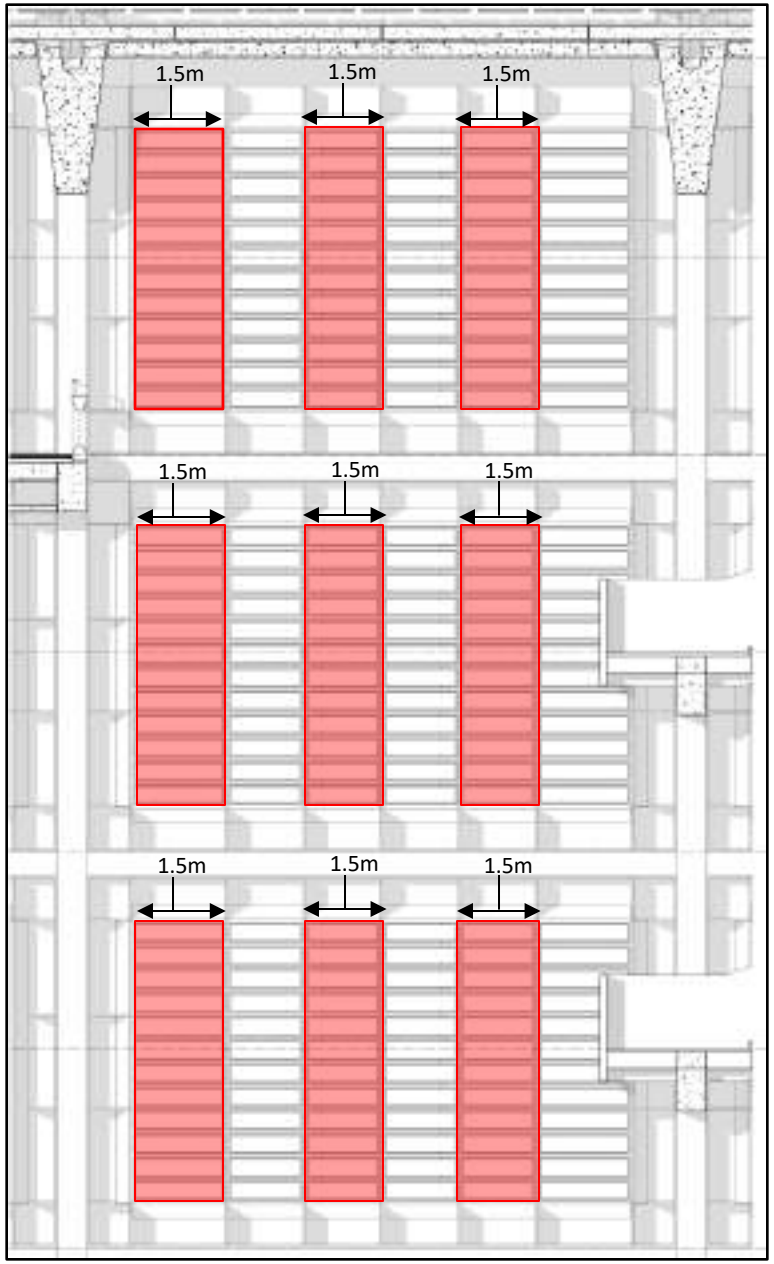
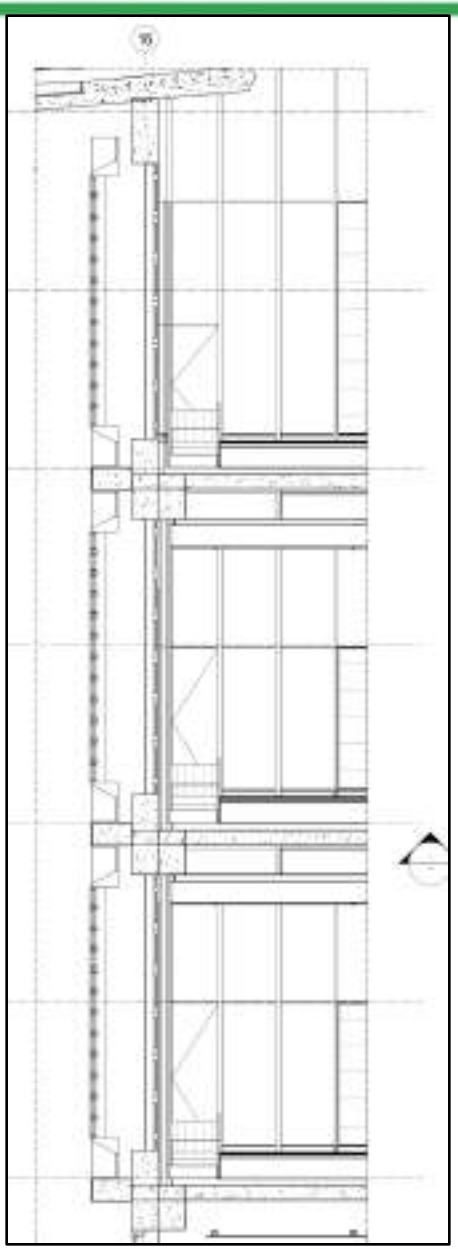
EWS – 05 (02, 04, 06)

System	Types			
	Plan Color Code			
	Name	Court Side Facades	Court Side Facades	Court Side Facades
	Location	Central Building, North/South Elevations (GF+L01)	Central Building, North/South Elevations (L02,L04)	Central Building, North/South Elevations (06)
	System Tags	EWS_05	EWS_05	EWS_05
	General description			
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.55	0.55	0.55
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.00	0.00	0.00
	Frame to Glazing ratio	0.10	0.10	0.10
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	2.00	2.10	3.2-3.5
	Sample Analysis Space	English record-lvl-1	court hall 20-NW	Chief Justice Court hall-east, court hall 12- West, court hall 6-NW
	WWR Recommendation	To keep resultant temperatures low, WWR to be kept at 0.3. However, minimum glazing to be provided should be based on daylight requirements	To keep resultant temperatures low, WWR to be kept at 0.30. However, minimum glazing to be provided should be based on daylight requirements	To keep resultant temperatures low, WWR to be kept at 0.30. However, minimum glazing to be provided should be based on daylight requirements
General Notes		Minimise U value with max VLT achievable. Ideal option - SKN172	Minimise U value with max VLT achievable. Ideal option - SKN172	Minimise U value with max VLT achievable. Ideal option - SKN165
Performance requirments - St Gobain Code or Similar		St Gobain SKN 172 (with 15mm Argon filling)	St Gobain SKN 172 (with 15mm Argon filling)	St Gobain SKN 165 (with 15mm Argon filling)
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	1.10	1.10	1.10
	Maximum SHGC	0.40	0.40	0.34
	Minimum VLT, %	67%	67%	60%
Extra / Alternative Options		Alternative Option	Alternative Option	Alternative Option
Performance requirments		St Gobain Planitherm clear (with 15mm Argon filling)	St Gobain Planitherm clear (with 15mm Argon filling)	St Gobain SKN 172 (with 15mm Argon filling)
Alternate option	Maximum U-Value (W/m^{2}K)	1.32	1.32	1.10
	Maximum SHGC	0.54	0.54	0.40
	Minimum VLT, %	75%	75%	67%





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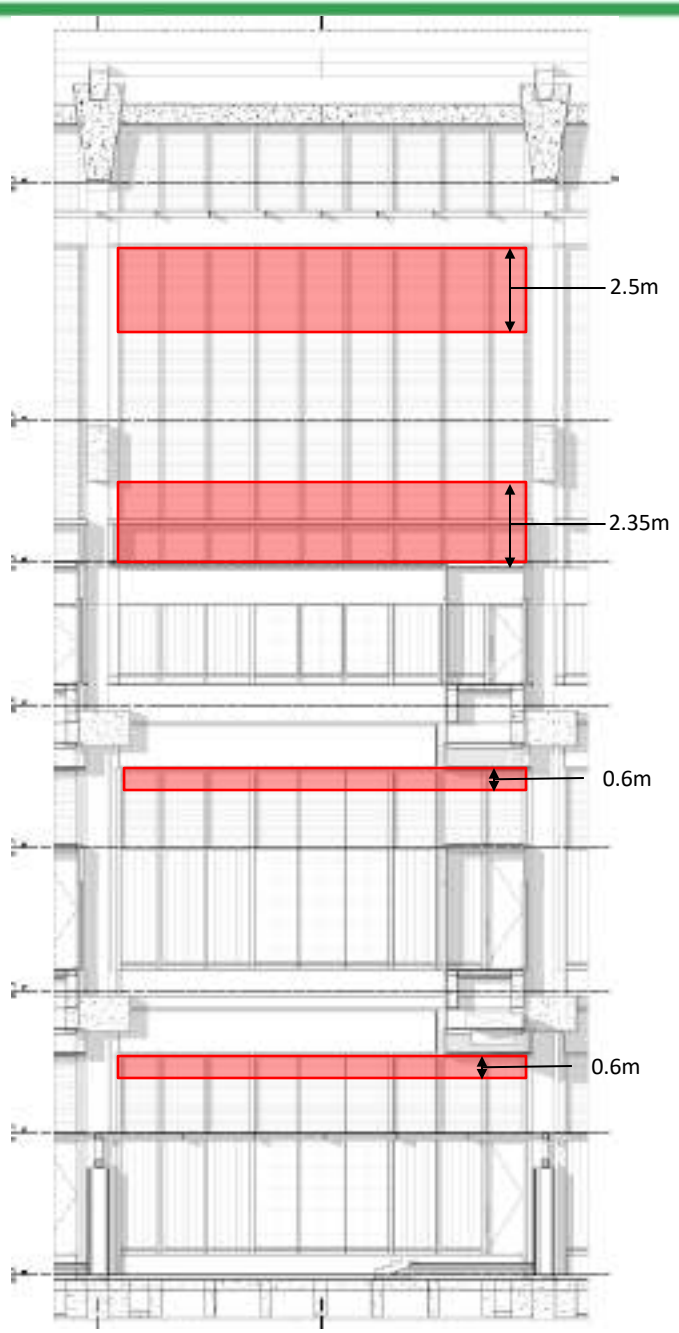
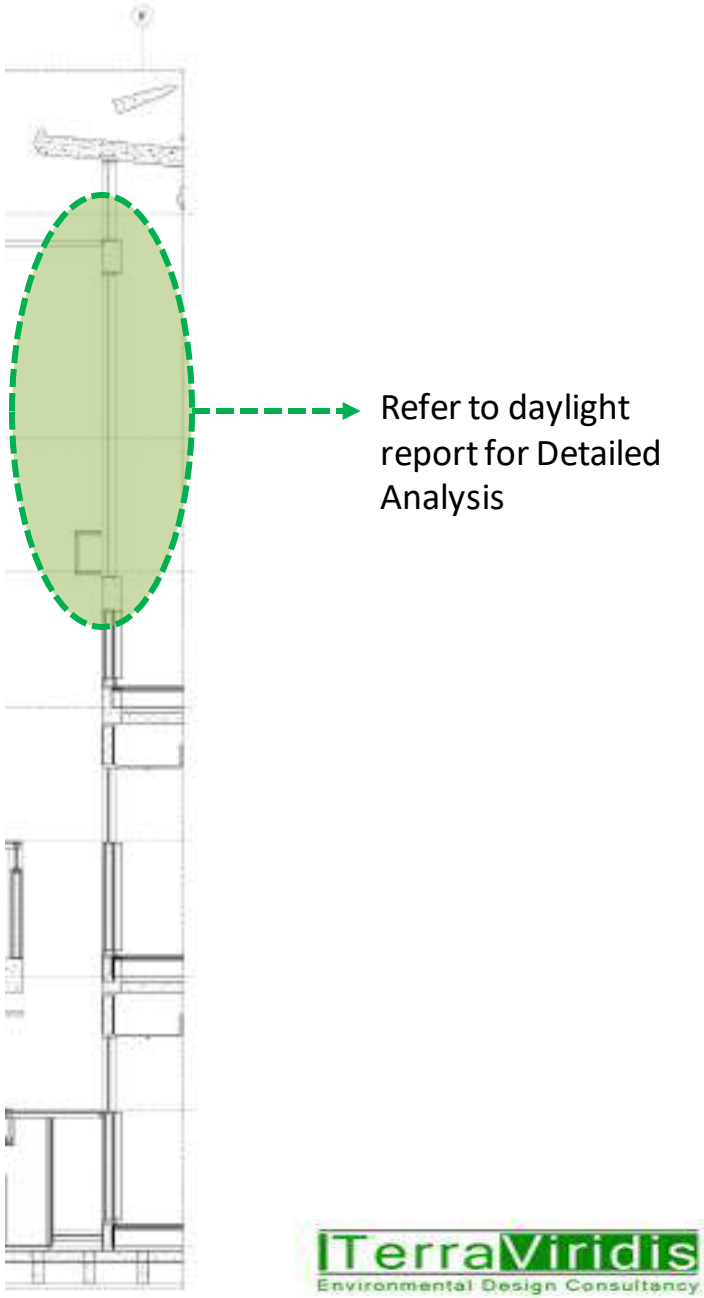
EWS-06

System	Types	
	Plan Color Code	
	Name	Court Rear Facades
	Location	Central Building, Lightwell Elevations
	System Tags	EWS_06
	General description	Stone veneer and cast glass system
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.51
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.33
	Frame to Glazing ratio	
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	
	Sample Analysis Space	
	WWR Recommendation	To keep the resultant temperatures low , Keep WWR to 0.35 . Please refer to Daylight Report for detailed analysis.
General Notes		
Performance requirments - St Gobain Code or Similar		
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	
	Maximum SHGC	
	Minimum VLT, %	
Extra / Alternative Options		
Performance requirments		
Alternate option	Maximum U-Value (W/m^{2}K)	
	Maximum SHGC	
	Minimum VLT, %	





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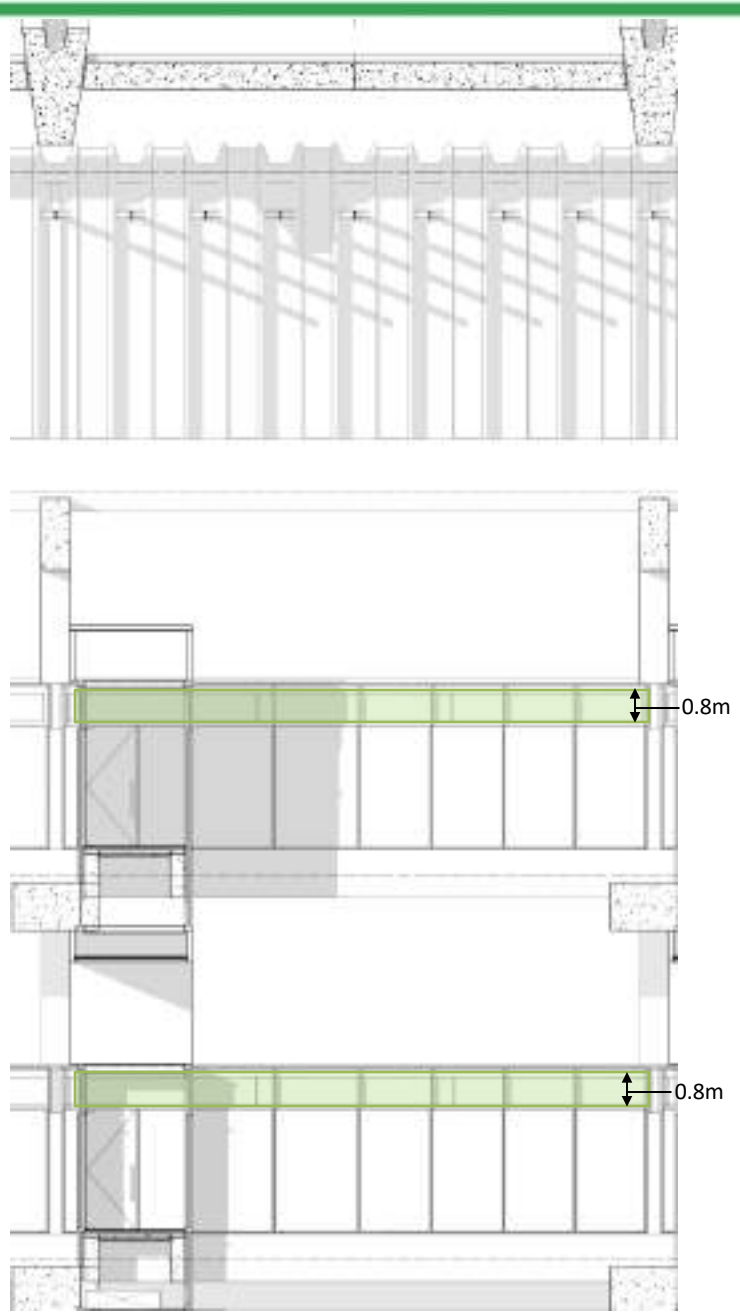
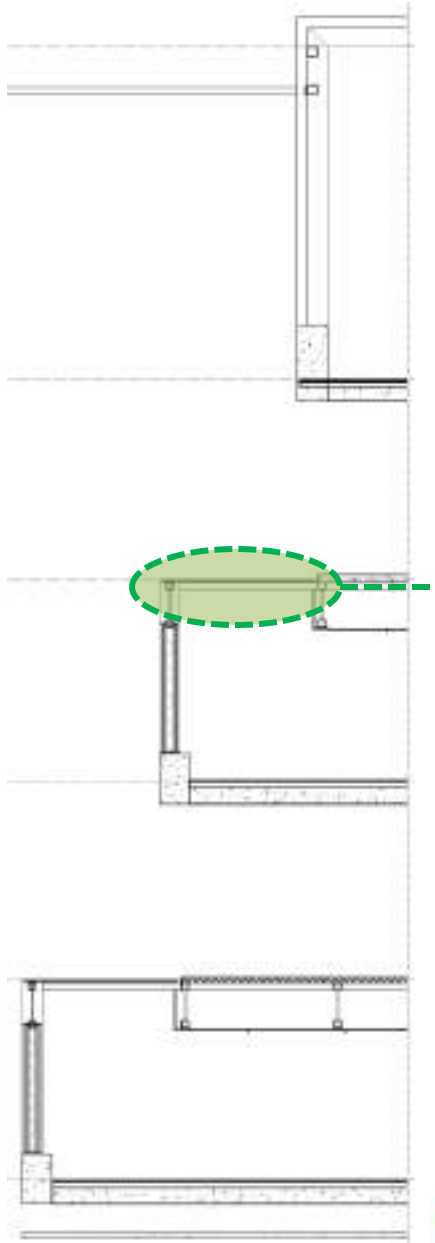
EWS-09

System	Types	
	Plan Color Code	
	Name	
	Location	Central Building, Lightwell Elevations
	System Tags	EWS_09
	General description	
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.00
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.00
	Frame to Glazing ratio	
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	
	Sample Analysis Space	
	WWR Recommendation	There are no windows planned on this façade which significantly reduces the daylight in the Adjacent space. Kindly provide openings to achieve a WWR of 0.15-0.20
General Notes		
Performance requirments - St Gobain Code or Similar		
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	
	Maximum SHGC	
	Minimum VLT, %	
Extra / Alternative Options		
Performance requirments		
Alternate option	Maximum U-Value (W/m^{2}K)	
	Maximum SHGC	
	Minimum VLT, %	





Refer to daylight report for Detailed Analysis

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CR-03

System	Types	
	Plan Color Code	
	Name	Core Wall
	Location	Central Building, Escalator shaft/Side of Corridor+Core
	System Tags	CR-03
	General description	
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.40
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	
	Frame to Glazing ratio	
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)	
	Sample Analysis Space	
	WWR Recommendation	To keep resultant temperatures in courthalls low, WWR to be kept at 0.25. However, minimum glazing to be provided should be based on daylight requirements
General Notes		Minimise U value with max VLT achievable. Ideal option - SKN172
Performance requirments - St Gobain Code or Similar		St Gobain SKN 172 (with 15mm Argon filling)
Energy (overall performance)	Maximum U-Value (W/m^{2}K)	1.10
	Maximum SHGC	0.40
	Minimum VLT, %	67%
Extra / Alternative Options		Alternative Option
Performance requirments		St Gobain Planitherm clear (with 15mm Argon filling)
Alternate option	Maximum U-Value (W/m^{2}K)	1.32
	Maximum SHGC	0.54
	Minimum VLT, %	75%

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No change in WWR

System	Types					
	Plan Color Code					
	Name	Core Wall			Judges Entrance	Core Wall
	Location	Peripheral Buildings, Internal Elevations	Central Building, North/South Entrance Elevations	Central Building, Central Space Elevations	Central Building, East Entrance	Central Building, Escalator shaft/Side of Courts
	System Tags	CR_01	EWS_07	EWS_08	EWS_10	CR-02
	General description	Concrete Panels with glazing and metal system				
Arc Drawings - WWR	Window to Wall Ratio (WWR) as per Architect	0.16	0.43	0.43	0.67	0.27
WWR - Thermal Model	Window to Wall Ratio as per simulation(WWR)	0.00		0.46		
	Frame to Glazing ratio			0.2-0.3		
	DELTA T (Drybulb temperature - Resultant Temperature) on a peak summer day. (^{0}C)					
	Sample Analysis Space					
	WWR Recommendation	NO change in WWR	NO change in WWR	NO change in WWR	NO change in WWR	NO change in WWR
General Notes			Minimise U value with max VLT achievable. Ideal option - SKN172	Minimise U value with max VLT achievable. Ideal option - SKN172	This glazing is not opening into a conditioned space and spec is not evaluated.	Minimise U value with max VLT achievable. Ideal option - SKN172
Performance requirments - St Gobain Code or Similar			St Gobain SKN 172 (with 15mm Argon filling)	St Gobain SKN 172 (with 15mm Argon filling)		St Gobain SKN 172 (with 15mm Argon filling)
Energy (overall performance)	Maximum U-Value (W/m^{2}K)		1.10	1.10		1.10
	Maximum SHGC		0.40	0.40		0.40
	Minimum VLT, %		67%	67%		67%
Extra / Alternative Options			Alternative Option	Alternative Option		Alternative Option
Performance requirments			St Gobain Planitherm clear (with 15mm Argon filling)	St Gobain Planitherm clear (with 15mm Argon filling)		St Gobain Planitherm clear (with 15mm Argon filling)
Alternate option	Maximum U-Value (W/m^{2}K)		1.32	1.32		1.32
	Maximum SHGC		0.54	0.54		0.54
	Minimum VLT, %		75%	75%		75%

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Correlation between air velocity and thermal comfort

There is s strong co-relation between the air velocity and thermal comfort till a certain critical velocity. It has been shown that the acceptable dry bulb temperature can be increased based on the air velocity at occupancy level. The increase in temperature pertains to both mean radiant temperature and air temperature. However, if the air temperature is high and the mean radiant temperature is low, the increase in velocity is not as effective as when there is a low air temperature and high mean radiant temperature.

The below graphs create a link between the acceptable temperatures for comfort based on the other ambient factors.

For example , in figure 1 , if the Dry Bulb Temperature is 27°C and Wet Bulb temperature is 24 °C, then an air velocity of 5m/s is required to get an effective temperature of 22 °C

Similarly, Figure 2 indicates the air velocity required to offset temperature rise. Hence, an air velocity of 0.6m/s is required (for a difference of 5°C in the radiant and dry bulb temperature) , to offset a temperature by 2.2 °C.

It is recommended that Energy efficient fans be installed in conditioned spaces to be able to increase the setpoint temperature while maintaining thermal comfort. It would also allow the occupants more control .

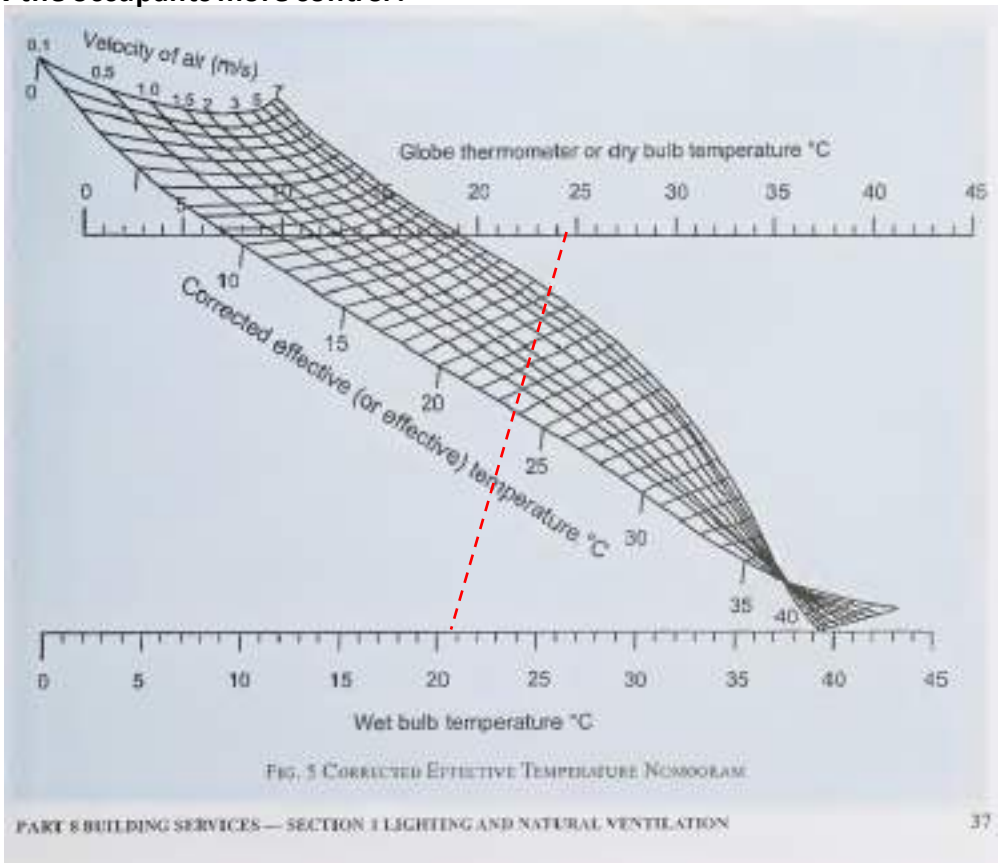

Figure 1

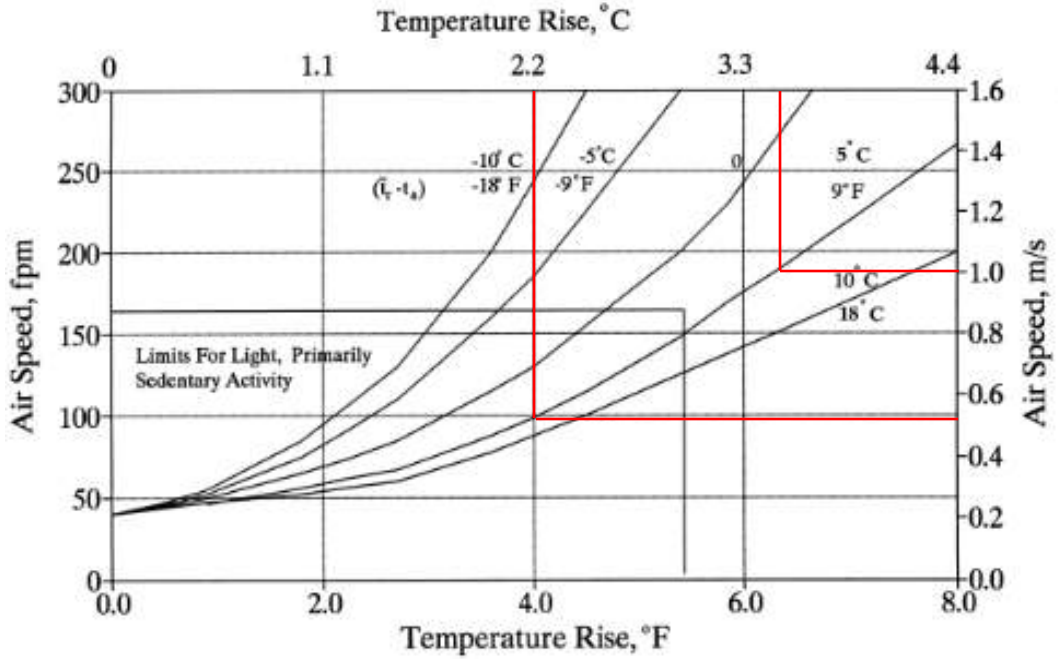

Figure 2 Air speed required to offset increased temperature.

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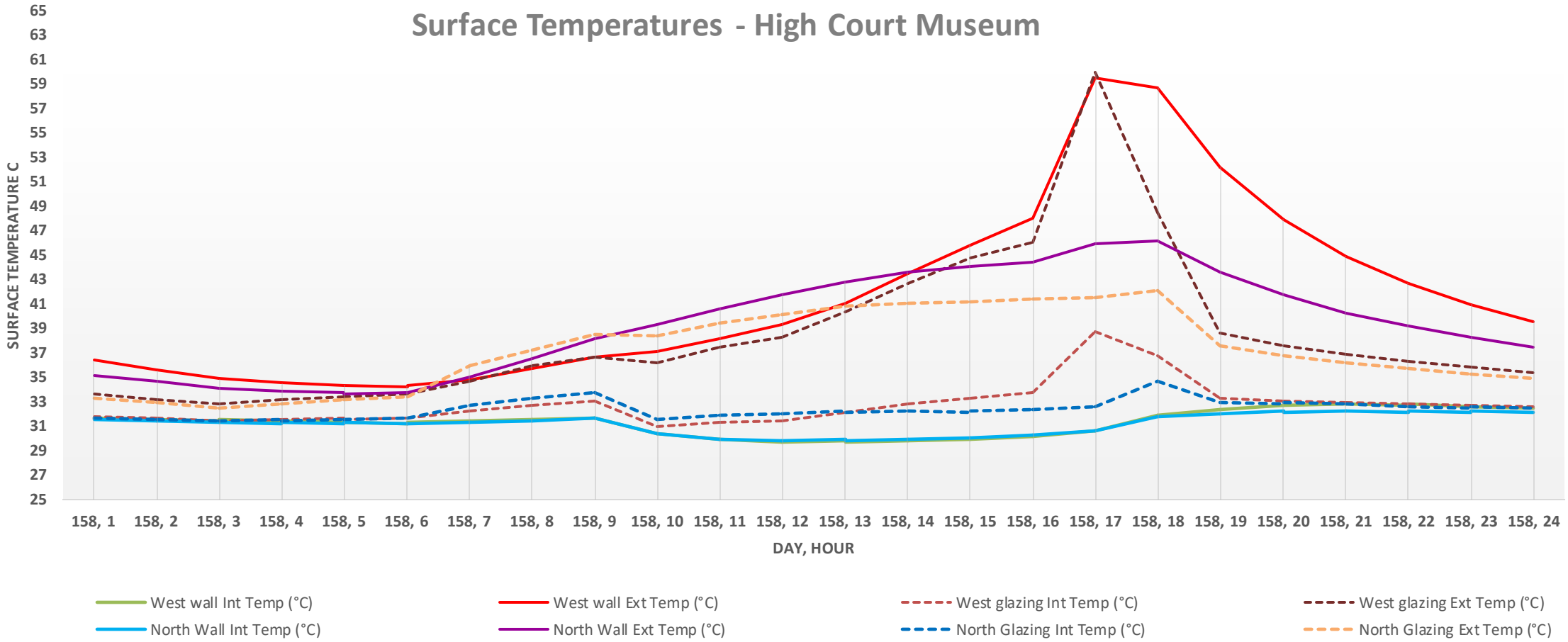
Surface temperature – Level 1

The following graphs show the surface temperatures in High court Museum on Level 1 and Court hall 13 on the Level 5. The dotted lines indicate glazing surface temperatures. Surface temperatures play an important part in determining the thermal comfort of occupants. Glazing internal temperatures shoot higher than the wall internal temperatures due to the high U-value thus affecting thermal comfort. The internal surface temperatures are controlled in these conditioned spaces to 26 C.

In both the Level 1 & Level 5, the Glazing inner surface temperatures are always higher than the inner wall temperatures thus increasing discomfort. Hence Glazing Percentage on the Level 5 needs to be reduced.



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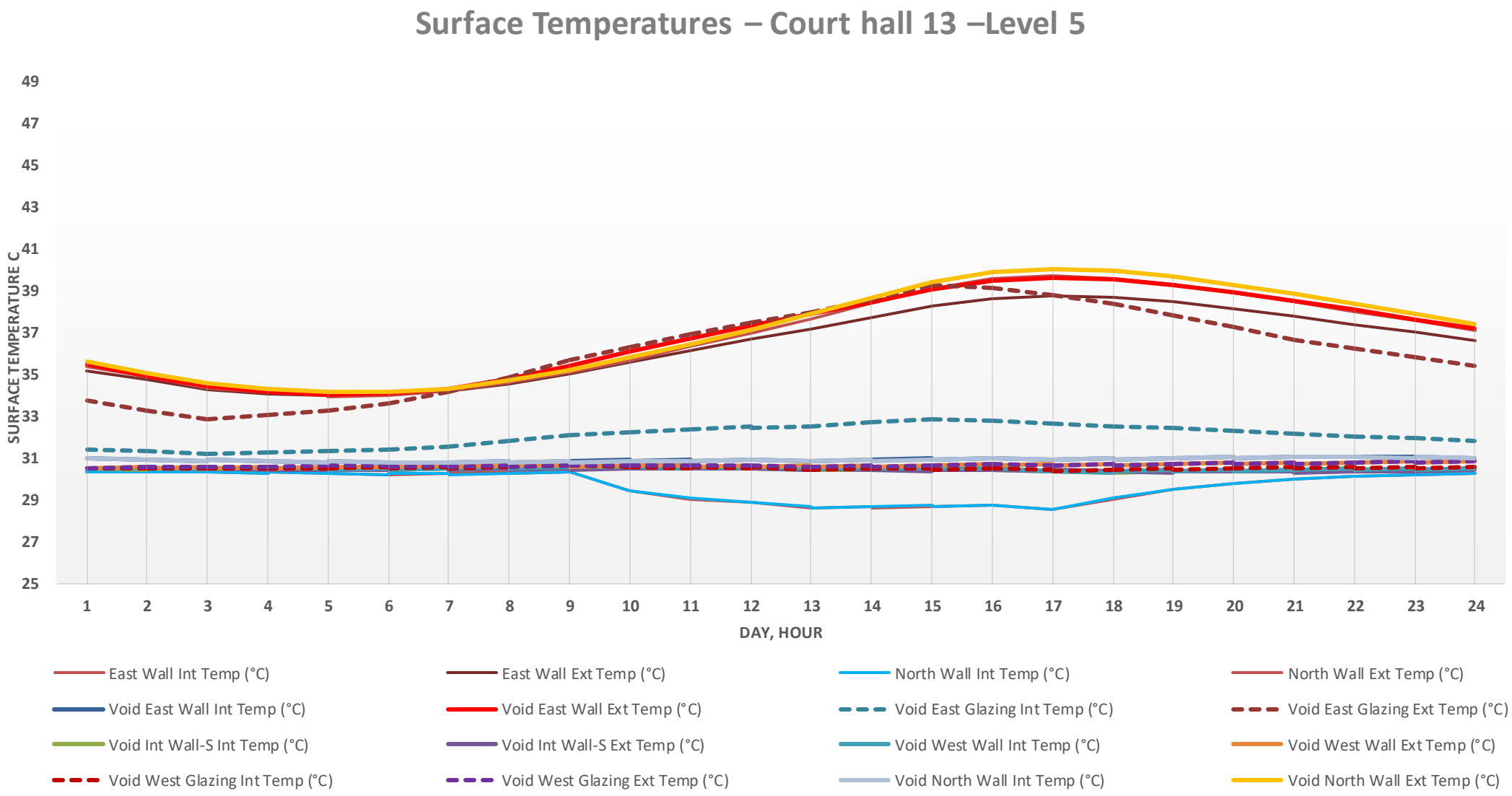
Surface temperature – Level 5



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Roof and Wall optimisation

For the first level of Roof and Wall optimisation , two sets of runs were done.

Walls

The roof and glazing elements were kept constant at 0.4W/m2K and SKN 165 (Best Case) respectively while reducing the U-value of Walls from Baseline (1.45w/m2k) to Best case (0.22W/m2K)

Roof

Similarly , the wall and glazing elements were kept constant at 0.4W/m2K and SKN 165 (Best Case) respectively while reducing the U-value of Roofs from Baseline (1.95w/m2k) to Best case (0.22W/m2K)

The constructions considered are outlines in the following slides.

Sensitivity graphs for both the wall and roof were plotted to understand the trendline in the reduction of cooling loads.

Based on results from the previous studies , second level of wall and roof U-value optimisation was carried out to get a clarity on the best case and most economic option.

Level 1 Wall optimisation - List of Constructions

Internal Wall:	150mm Brick Wall with 15mm Plaster on both faces
Internal Floor/Ceiling Slab :	150mm RCC Slab with 50mm XPS insulation and 50mm Stone floor finish and Plastered soffit
Roof Slab:	150mm RCC Slab with 50mm XPS insulation and 50mm Stone floor finish and Plastered soffit
Stupa Roof :	200mm Light weight Pre-caste Concrete slab
Glazing frames :	200mm*100mm Insulated Aluminium frame
Glazing pane :	SKN 165 with Argon filling (U-value – 1.1 w/m2k , SHGC -0.35)

The below wall assemblies were applied to all external facing walls including Courthall walls , External Walls and Sheer walls. Only Internal partitions walls were exempt from it.

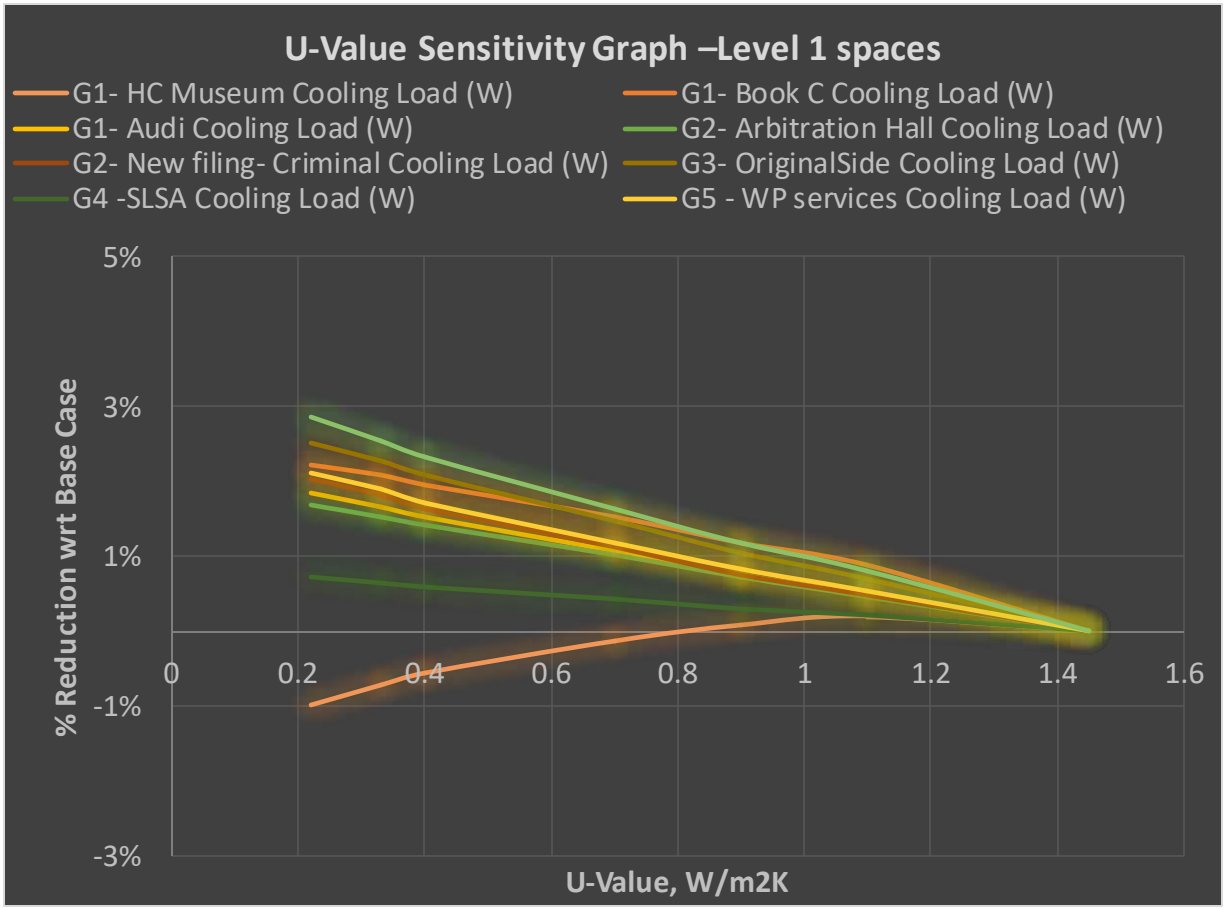
Wall Options						
	Description					Achieved U value
	Inside				Outside	
Base Line	40mm Cement Board		35mm Air (Horizontal flow)	40mm Stone Cladding		1.45
case 1	15mm Cement Board	10mm XPS insulation	15mm Cement Board	35mm Air (Horizontal flow)	40mm Stone Cladding	1.1
case 2	15mm Cement Board	16mm XPS insulation	15mm Cement Board	35mm Air (Horizontal flow)	40mm Stone Cladding	0.95
case 3	15mm Cement Board	27mm XPS insulation	15mm Cement Board	35mm Air (Horizontal flow)	40mm Stone Cladding	0.70
case 4	15mm Cement Board	60mm XPS insulation	15mm Cement Board	35mm Air (Horizontal flow)	40mm Stone Cladding	0.41
case 5	15mm Cement Board	10mm XPS insulation	15mm Cement Board	35mm Air (Horizontal flow)	40mm Stone Cladding	0.33
case 6	15mm Cement Board	10mm XPS insulation	15mm Cement Board	35mm Air (Horizontal flow)	40mm Stone Cladding	0.22

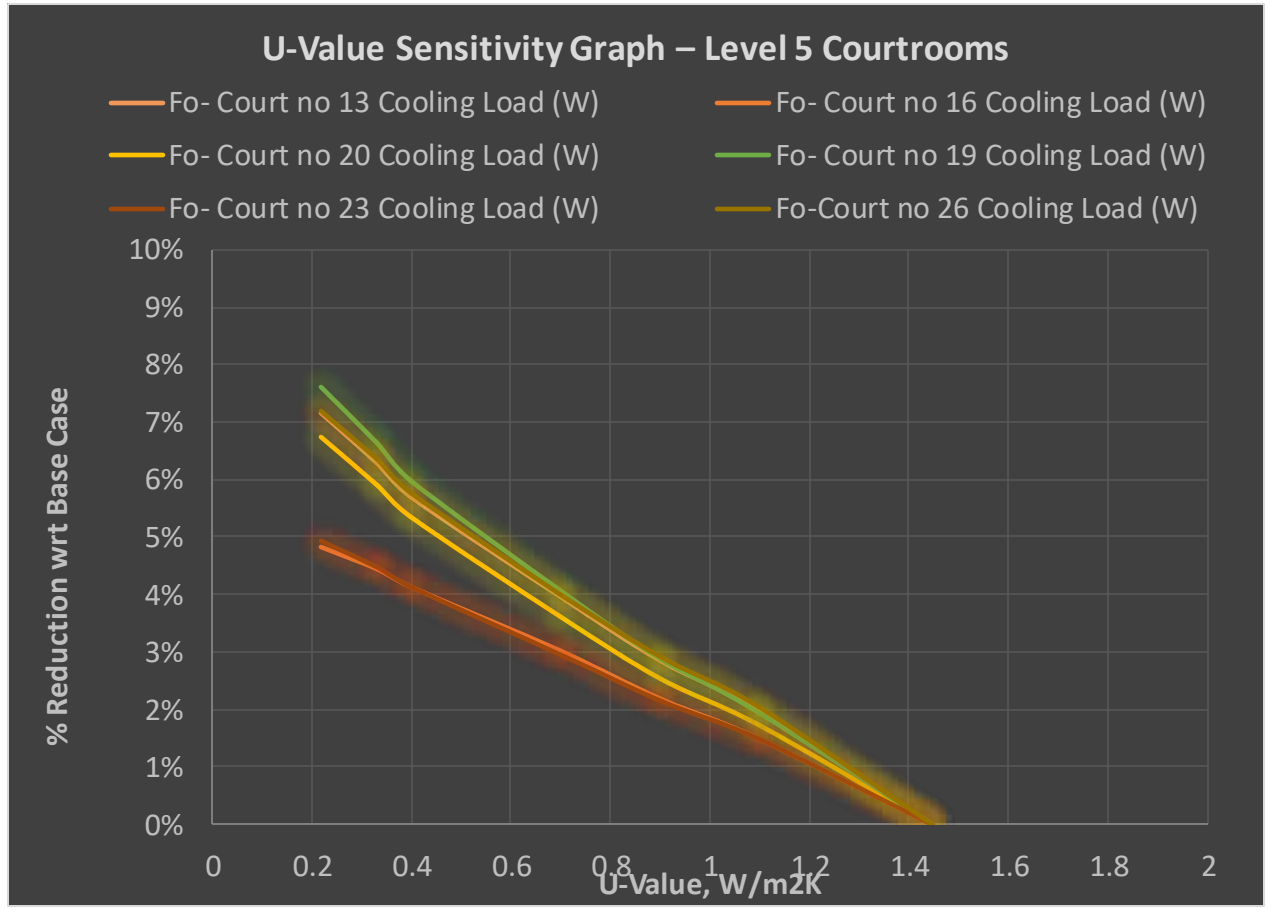
Level 1 Roof optimisation - List of Constructions

External Wall :	200mm Cement board Sandwich panel with 60mm insulation and Stone cladding (U-value –0.41 W/m2k)
Internal Wall:	200mm Cement board Sandwich panel with 60mm insulation and Stone cladding (U-value –0.41 W/m2k)
Court Walls:	200mm Cement board Sandwich panel with 60mm insulation and Stone cladding (U-value –0.41 W/m2k)
Court Partition Walls :	200mm Cement board Sandwich panel with 60mm insulation and Acoustic Timber cladding (U-value –0.41 W/m2k)
Stupa Roof :	200mm Light weight Pre-caste Concrete slab
Glazing frames :	200mm*100mm Insulated Aluminium frame
Glazing pane :	SKN 165 with Argon filling (U-value –1.1 W/m2k , SHGC -0.35)

Roof & Internal floor/Ceiling Options						
	Description					**Achieved U value**
	Top				**Bottom**	
Base Line	40mm Limestone	Flooring screed. 50mm		150mm Concrete 3% m.c. 8	12mm Lime Plaster	**2.00**
Case 1	40mm Limestone	Flooring screed. 50mm	5mm PU foam Board	150mm Concrete 3% m.c. 8	12mm Lime Plaster	**1.45**
Case 2	40mm Limestone	Flooring screed. 50mm	14mm PU foam Board	150mm Concrete 3% m.c. 8	12mm Lime Plaster	**0.95**
Case 3	40mm Limestone	Flooring screed. 50mm	24mm PU foam Board	150mm Concrete 3% m.c. 8	12mm Lime Plaster	**0.70**
Case 4	40mm Limestone	Flooring screed. 50mm	50mm PU foam Board	150mm Concrete 3% m.c. 8	12mm Lime Plaster	**0.41**
Case 5	40mm Limestone	Flooring screed. 50mm	60mm PU foam Board	150mm Concrete 3% m.c. 8	12mm Lime Plaster	**0.30**
Case 6	40mm Limestone	Flooring screed. 50mm	90mm PU foam Board	150mm Concrete 3% m.c. 8	12mm Lime Plaster	**0.22**

Wall U-value sensitivity





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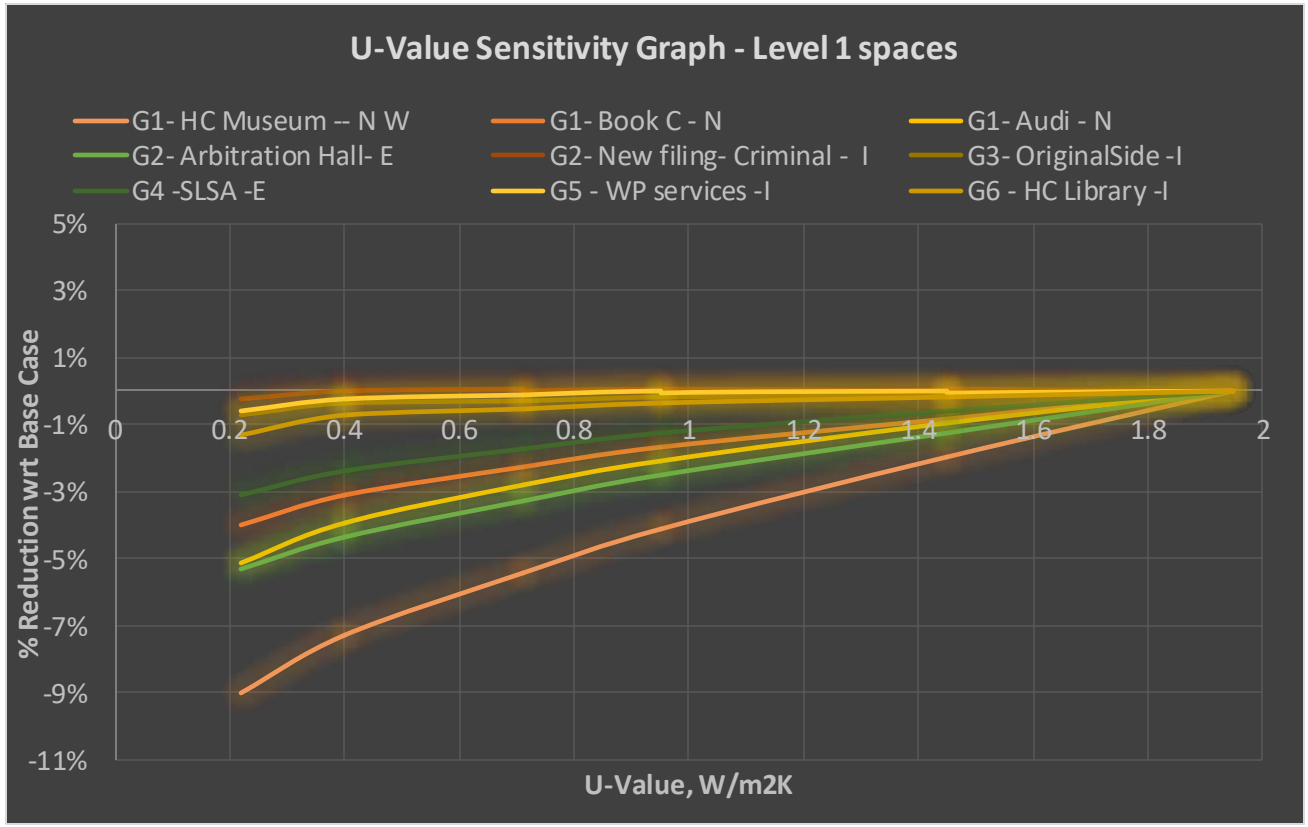
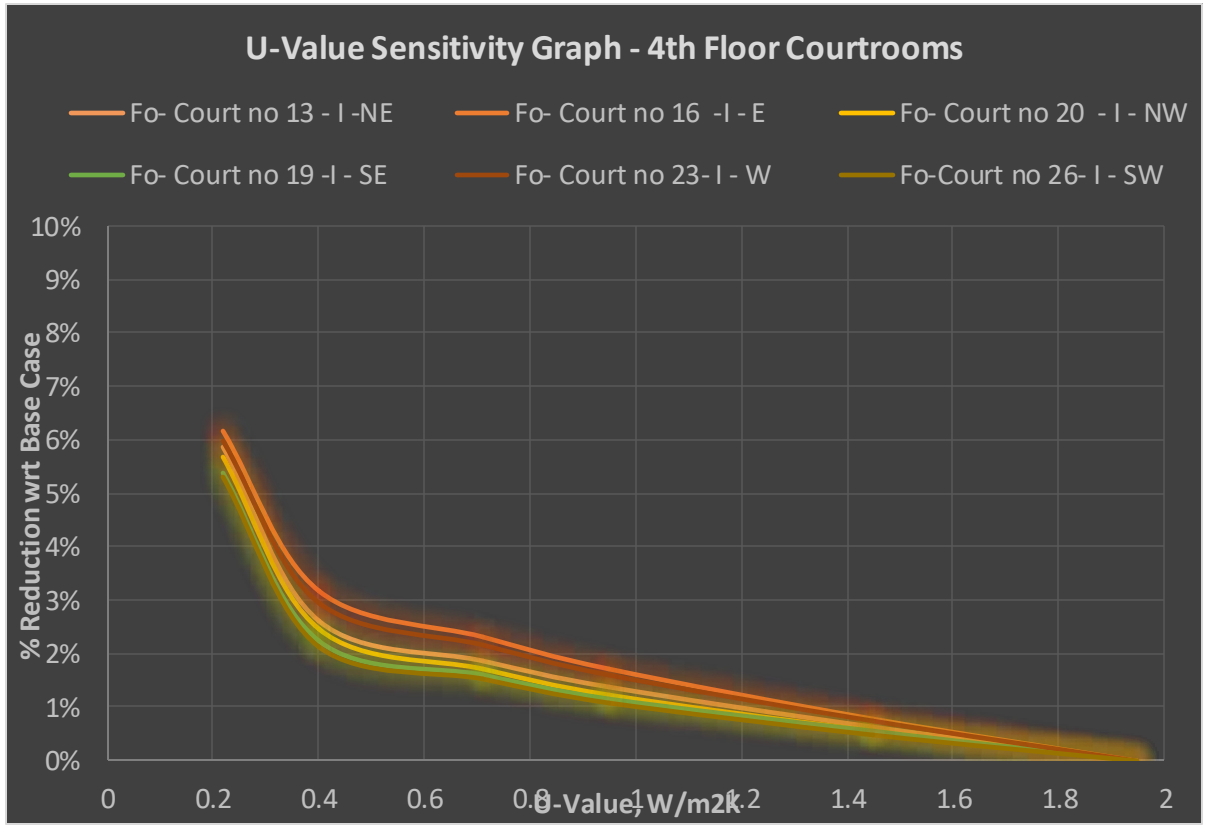
Roof U-value sensitivity





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Optimisation of Roof and Wall

5 of the following options have been simulated and compared against each other .

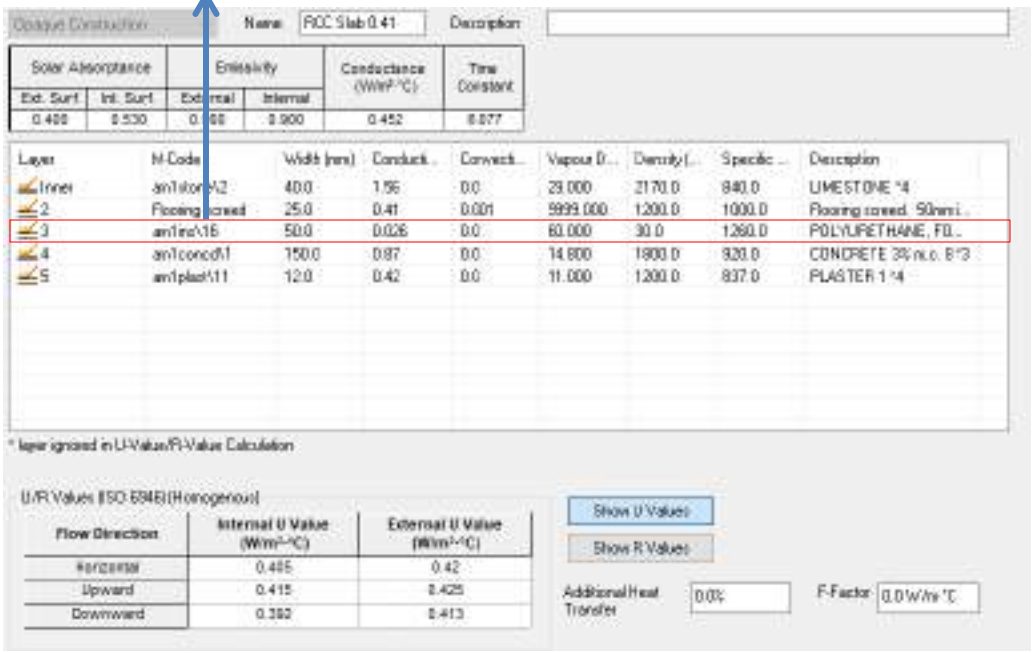
1. The roofs included in this simulation consisted of all internal Ceiling/ Floor slabs as well as exposed roof slabs and internally exposed slabs.
2. The Walls included in the simulation include Court walls, External walls and Sheer walls.
3. The Window frames were considered as Insulated Aluminium frames.
4. The Glazing is uniformly considered to be SKN 165 high glazing with Argon filling by Saint Gobain or Equivalent.

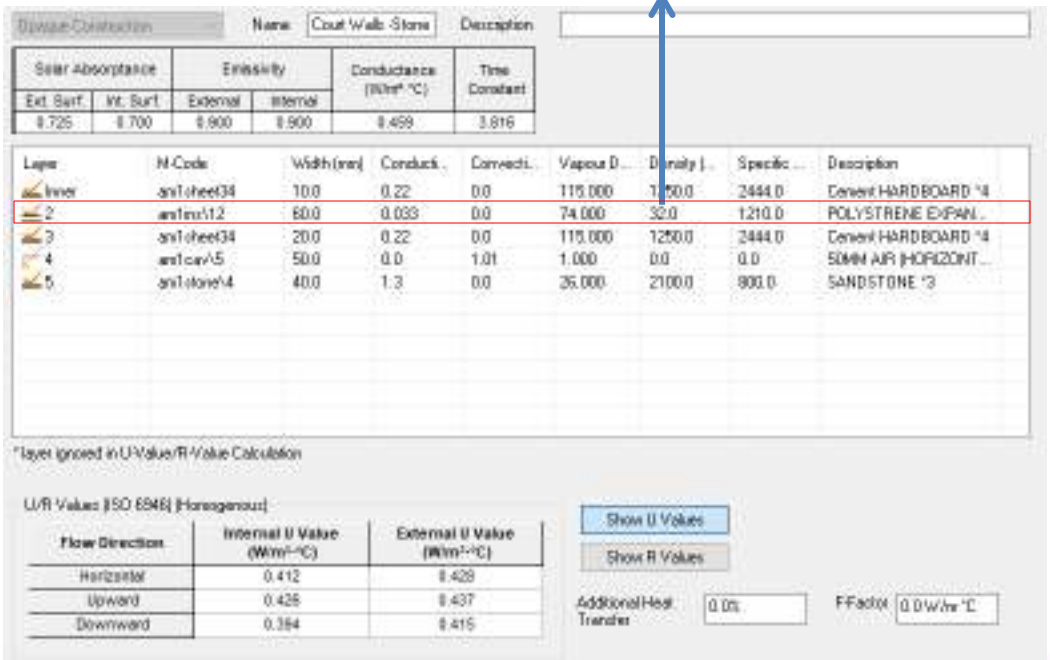
U-value (W/m2 K)	Insulation Thickness
0.41	50mm
0.3	60mm
0.22	90mm

Roof - 0.40	**Wall-0.40**
	Wall-0.33
	Wall-0.22

Wall - 0.40	**Roof - 0.40**
	Roof - 0.33
	Roof - 0.22

U-value (W/m2 K)	Insulation Thickness
0.41	60mm
0.3	80mm
0.22	130mm





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Inferences & Recommendations

Inferences

1. On the Level 1 neither the wall nor the roof makes much of a difference in the cooling loads because the most amount of exposed area is the glazed curtain wall and not of the wall or the roof. There are only a few spaces with exposed roof areas on the Level 1, increasing slightly in the Level 2 which has more of an impact from the change in roof U-values.

2. On the Level 5, the lower U-values of roof and wall , both make a great impact in terms of cooling load reduction as conduction gains are the biggest sources of heat gain in the court halls and associated spaces

3. However, the roof U –value has the biggest and most visible impact on the peak cooling loads. There is a 12% reduction in Peak cooling loads with a roof U-value of 0.33W/m2k as compared to just about 1.8% with a wall U-value of 0.33W/m2k.

Wall and Roof recommendations

1. It is proposed that the wall U-value is kept to 0.4W/m2k as reducing it does not have any significant impact on the cooling loads.

2. All the internal and external exposed roof surfaces such as those below the external waiting areas, the roof of judge's chamber and ceilings below service cavities must be insulated with 60mm under deck insulation or equivalent to a U-value of 0.3W/m2K. This is because the heat gain occurs through these surfaces rather than the building elements between adjoining conditioned spaces. These surfaces have been marked on the plans in the following slides.

3. Internal Floor/Ceiling can have 50mm under-deck insulation or equivalent of 0.41W/m2K U value.

4. The window to Wall ratio for the court walls (EWS 04 , EWS 05) needs to be reduced. This is because the U-value of the Glazing cannot be reduced below a 1.1W/M2k.

Based on the above recommendations, a simulation was run with the Best Case scenario.

Best Case – Summary of Constructions

Glazing

Ground & Level 2 (External)- View pane	**Nano Plus SKN 154** or Equivalent with Argon filling (outer: 6mm with coating Face 2 - 12mm Argon filling - inner 6mm Clear)
Ground & Level 2 (External)- Day pane	**Nano Plus SKN 165** or Equivalent with Argon filling (outer: 6mm with coating Face 2 - 12mm Argon filling - inner 6mm Clear)
Ground & Level 2 (Internal)	**Nano Plus SKN 172** or Equivalent with Argon filling (outer: 6mm with coating Face 2 - 12mm Argon filling - inner 6mm Clear)
Court Castglass Units	**Nano Plus SKN 172** or Equivalent with Argon filling
Court Rooflights	**Nano Plus SKN 165** or Equivalent with Argon
Atrium Wall (EWS09)	**Planitherm Pristine White** or Equivalent with Argon filling (outer: 6mm with coating Face 2 - 12mm Air Gap - inner 6mm Clear)
Level 8 Door & Window Glazing	**Nano Plus SKN 165** or Equivalent with Argon
Judges Roof Lights	**Envision SKN 144** or Equivalent with Argon
Glazing frames :	400mm*100mm Insulated Aluminium frame

Walls

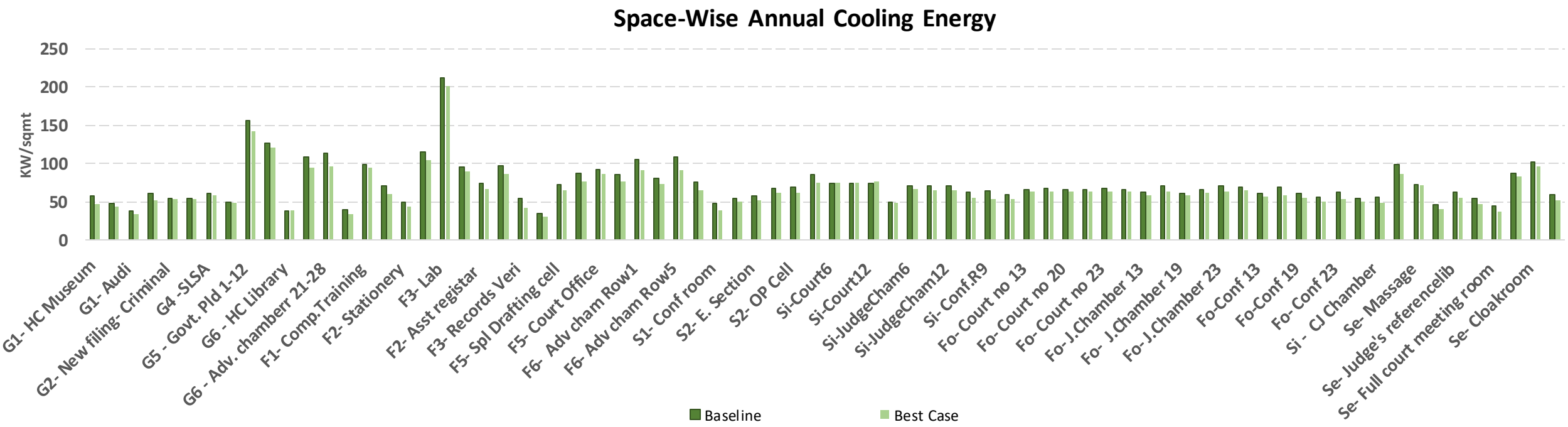
External Walls/Court Walls : (EWS01, EWS03, EWS04, EWS05)	200mm Cement board Sandwich panel with 60mm XPS insulation and Stone cladding (U-values : 0.41W/m2k)
Internal Wall:	As per Architect's Specification
Court Partition Walls :	200mm Cement board Sandwich panel with 60mm insulation with Acoustic Timber cladding (U-values : 0.41W/m2k)

Roof

Stupa Roof :	200mm Light weight Pre-caste Concrete slab
Exposed External Roof :	150mm RCC Slab with 60mm Insulation and 50mm Stone floor finish and Plastered soffit (U-values : 0.30 W/m2k)
Exposed Internal Roofs :	150mm RCC Slab with 60mm Insulation and 50mm Stone floor finish and Plastered soffit (U-values : 0.30 W/m2k)
Ceiling below Service Cavities :	150mm RCC Slab with 60mm Insulation and 50mm Stone floor finish and Plastered soffit (U-values : 0.30 W/m2k)
Internal Floor/ Ceiling :	150mm RCC Slab with 60mm Insulation and 50mm Stone floor finish and Plastered soffit (U-values : 0.30 W/m2k)

Best Case Results - Annual Cooling Energy

1. On an average there is a 7.68% reduction in the annual cooling energy in the selected conditioned spaces.
2. The Annual consumption of energy for Cooling of conditioned spaces is 17.09 KWh/Sqmt./Year . This is the energy required to offset heat gain from Equipment , Occupancy, Lighting and includes sensible as well as Latent Loads.



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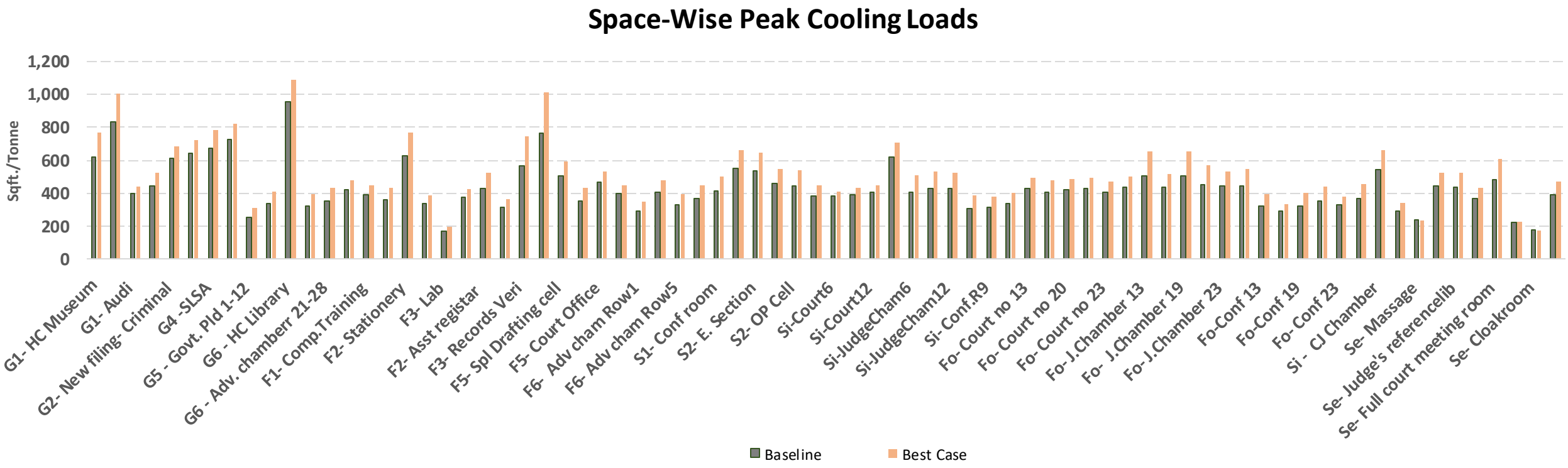
Best Case Results – Peak Cooling Load

1. On an average there is a 15% reduction in the Peak Cooling loads in the selected conditioned spaces.
2. The results show that the Day 155 has the highest peak cooling loads in the year. This is because the high court building reopens after more than a month of holidays which causes there to be a build up of heat. It is suggested that the building must be pre-cooled for a few hours on the previous day. This would significantly reduce the HVAC Sizing from 1526 tonne to 1378tonnes.
3. The Annual consumption of energy for Cooling of conditioned spaces is 17.09 KWh/Sqmt./Year . This is the energy required to offset heat gain from Equipment , Occupancy, Lighting and includes sensible as well as Latent Loads.



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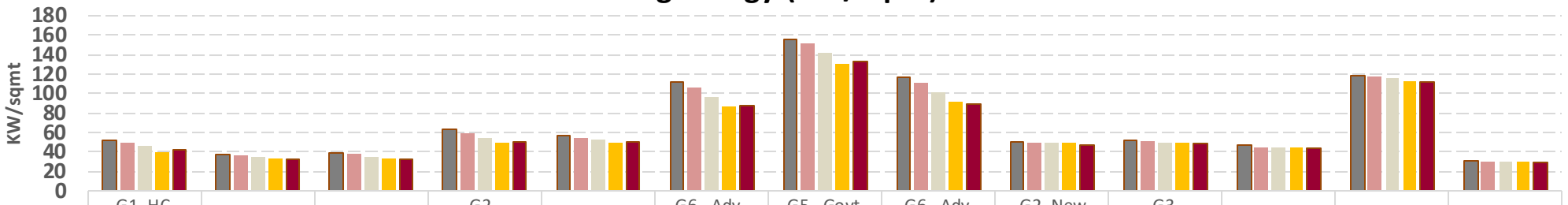
Appendix- Glazing
Roof & Wall Graphs

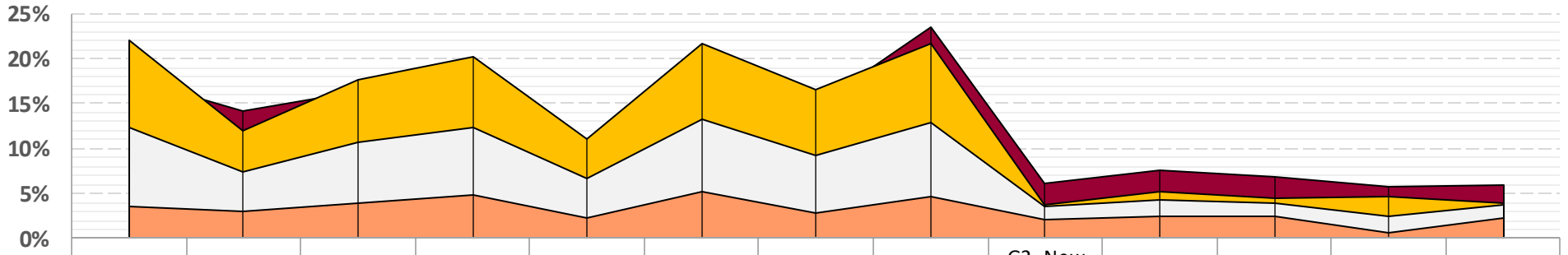
Glazing Optimisation – Level 1

Annual Cooling Energy (KW/Sqmt)



	G1- HC Museum -- NW	G1- Book C - N	G1- Audi - N	G2- Arbitration Hall- E	G4 -SLSA -E	G6 - Adv. chamberr 1-8 - E	G5 - Govt. Pld 1-12 - W	G6 - Adv. chamberr 21-28 - S	G2- New filing- Criminal - I	G3- OriginalSide -I	G5 - WP services -I	G5 -Govt. Pld 13-25 -I	G6 - HC Library -I
Single Glazing	51.78	37.76	39.43	62.42	56.26	111.53	156.27	116.08	50.50	51.98	46.32	118.74	30.59
Double Glazing	49.97	36.59	37.88	59.36	54.93	105.66	151.76	110.58	49.39	50.72	45.19	117.92	29.88
Planitherm Pristine White	45.43	34.93	35.19	54.67	52.50	96.67	141.94	101.09	48.73	49.73	44.47	115.87	29.47
SKN 165	40.33	33.23	32.49	49.77	49.99	87.31	130.39	90.87	48.58	49.23	44.26	113.23	29.38
Best Case (SKN 165 + 0.4 u)	42.52	32.37	32.95	50.08	50.61	87.83	133.32	88.69	47.43	48.03	43.19	111.86	28.75

Percentage reduction in Annual Cooling Energy WRT Baseline



	G1- HC Museum - - N W	G1- Book C - N	G1- Audi - N	G2- Arbitration Hall- E	G4 -SLSA - E	G6 - Adv. chamberr 1-8 - E	G5 - Govt. Pld 1-12 - W	G6 - Adv. chamberr 21-28 - S	G2- New filing- Criminal - I	G3- OriginalSide -I	G5 - WP services -I	G5 -Govt. Pld 13-25 -I	G6 - HC Library -I
Best Case (SKN 165 + 0.4 u)	17.88%	14.26%	16.45%	19.77%	10.03%	21.26%	14.69%	23.59%	6.09%	7.59%	6.77%	5.79%	6.01%
SKN 165	22.10%	11.99%	17.61%	20.27%	11.15%	21.71%	16.56%	21.72%	3.80%	5.28%	4.45%	4.63%	3.95%
Planitherm Pristine White	12.25%	7.49%	10.76%	12.43%	6.68%	13.33%	9.17%	12.92%	3.51%	4.33%	4.00%	2.42%	3.66%
Double Glazing	3.49%	3.08%	3.93%	4.91%	2.36%	5.27%	2.89%	4.74%	2.19%	2.42%	2.44%	0.69%	2.33%

Note : All spaces in the graphs contain letters in their nomenclature indicating the façade orientation – North(N) , South(S) , East(E), West(W) , Interior(I)

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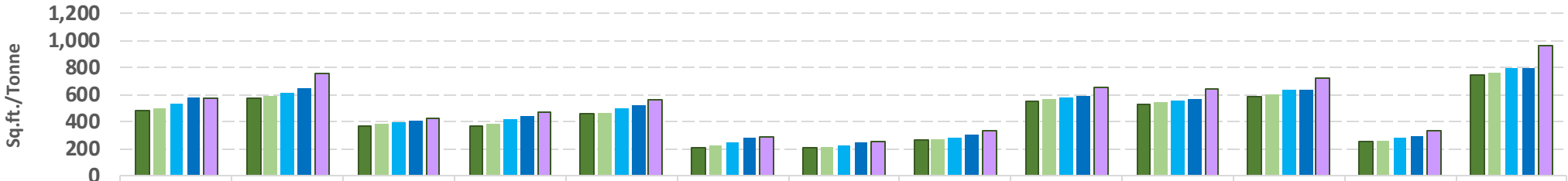
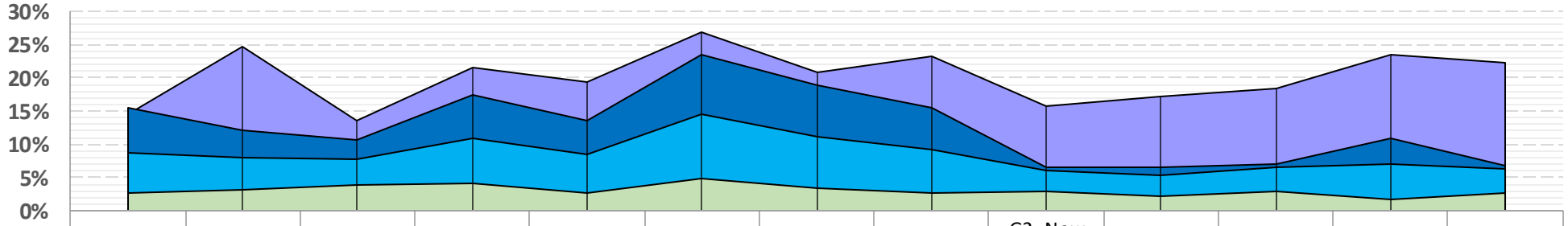
Glazing Optimisation – Level 1

Peak Cooling Load (Sqft/Tonne)



	G1- HC Museum -- NW	G1- Book C - N	G1- Audi - N	G2- Arbitration Hall- E	G4 -SLSA -E	G6 - Adv. chamberr 1-8 - E	G5 - Govt. Pld 1-12 - W	G6 - Adv. chamberr 21-28 - S	G2- New filing- Criminal - I	G3- OriginalSide - I	G5 - WP services -I	G5 -Govt. Pld 13-25 -I	G6 - HC Library -I
Single Glazing	485.79	569.15	367.01	368.72	454.98	211.73	202.22	260.17	548.44	527.39	590.12	258.12	743.07
Double Glazing	499.06	587.38	381.62	384.71	466.92	222.31	209.13	267.09	564.43	539.41	607.72	262.68	764.21
Planitherm Pristine White	531.92	619.22	397.65	414.29	497.45	248.10	227.40	286.67	584.42	557.76	630.82	277.32	793.05
SKN 165	574.82	648.02	410.56	446.44	526.14	276.95	249.58	307.49	587.32	564.33	634.66	289.35	796.89
Best Case (SKN 165 + 0.4 u)	568.25	755.89	425.04	470.74	564.62	289.21	255.73	338.58	651.52	637.51	722.41	337.46	956.95

Percentage reduction in Peak Cooling Load WRT Baseline



	G1- HC Museum - - N W	G1- Book C - N	G1- Audi - N	G2- Arbitration Hall- E	G4 -SLSA - E	G6 - Adv. chamberr 1-8 - E	G5 - Govt. Pld 1-12 - W	G6 - Adv. chamberr 21-28 - S	G2- New filing- Criminal - I	G3- OriginalSide -I	G5 - WP services -I	G5 -Govt. Pld 13-25 -I	G6 - HC Library -I
Best Case (SKN 165 + 0.4 u)	14.51%	24.71%	13.65%	21.67%	19.42%	26.79%	20.92%	23.16%	15.82%	17.27%	18.31%	23.51%	22.35%
SKN 165	15.49%	12.17%	10.61%	17.41%	13.52%	23.55%	18.98%	15.39%	6.62%	6.55%	7.02%	10.79%	6.75%
Planitherm Pristine White	8.67%	8.09%	7.70%	11.00%	8.54%	14.66%	11.07%	9.25%	6.16%	5.45%	6.45%	6.92%	6.30%
Double Glazing	2.66%	3.10%	3.83%	4.16%	2.56%	4.76%	3.30%	2.59%	2.83%	2.23%	2.90%	1.74%	2.77%

Note : All spaces in the graphs contain letters in their nomenclature indicating the façade orientation – North(N) , South(S) , East(E), West(W) , Interior(I)

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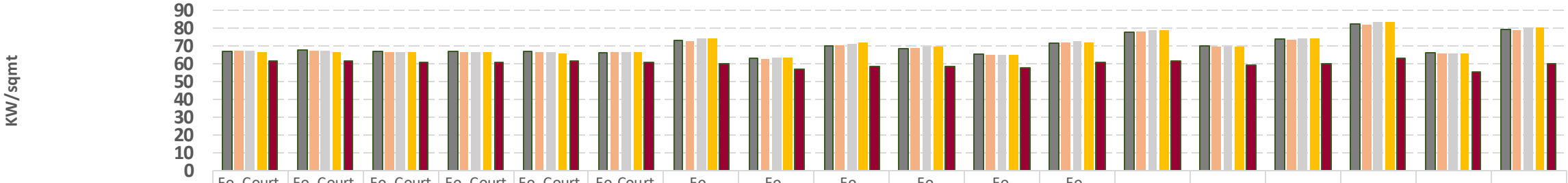
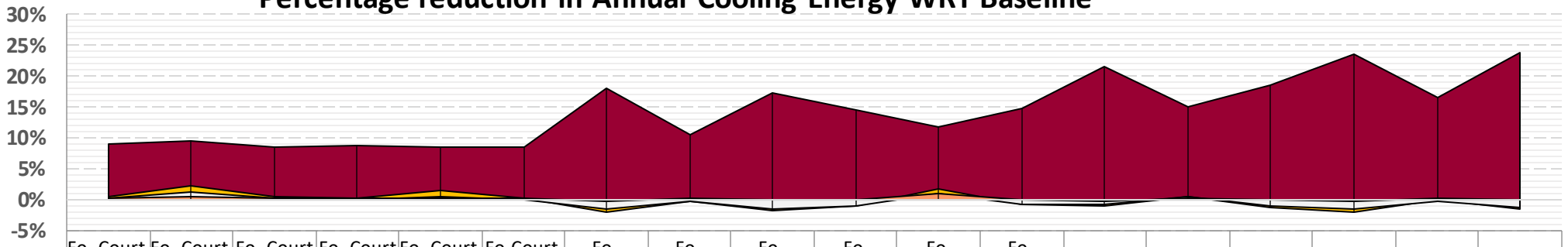
Glazing Optimisation – Level 5

Annual Cooling Energy (KW/Sqmt)



	Fo- Court no 13 - I - NE	Fo- Court no 16 -I - E	Fo- Court no 20 - I - NW	Fo- Court no 19 -I - SE	Fo- Court no 23- I - W	Fo-Court no 26- I - SW	Fo- J.Chamber 13- I	Fo- J.Chamber 16 - I	Fo- J.Chamber 19 - I	Fo- J.Chamber 20 - I	Fo- J.Chamber 23 - I	Fo- J.Chamber 26 - I	Fo-Conf 13 -I	Fo-Conf 16 - I	Fo-Conf 19 - I	Fo-Conf 20 - I	Fo- Conf 23- I	Fo- Conf 26 -I
Single Glazing	67.06	67.62	66.65	66.48	66.68	66.33	72.71	63.06	70.19	68.64	65.59	71.58	77.99	69.54	73.53	82.01	65.76	79.00
Double Glazing	66.92	67.31	66.51	66.41	66.50	66.29	72.87	62.97	70.29	68.71	64.99	71.65	78.16	69.38	73.65	82.18	65.63	79.12
Planitherm Pristine White	66.96	66.90	66.60	66.54	66.34	66.44	73.91	63.31	71.25	69.42	64.90	72.24	78.72	69.30	74.34	83.40	65.91	80.09
SKN 165	66.71	66.12	66.38	66.34	65.78	66.25	74.15	63.27	71.49	69.42	64.53	72.21	78.82	69.23	74.48	83.66	65.82	80.23
Best Case (SKN 165 + 0.4 u)	61.12	61.27	61.04	60.74	61.10	60.78	59.72	56.53	58.14	58.74	57.92	61.00	61.30	59.17	60.01	62.73	54.97	60.19

Percentage reduction in Annual Cooling Energy WRT Baseline



	Fo- Court no 13 - I - NE	Fo- Court no 16 -I - E	Fo- Court no 20 - I - NW	Fo- Court no 19 -I - SE	Fo- Court no 23- I - W	Fo-Court no 26- I - SW	Fo- J.Chamber 13- I	Fo- J.Chamber 16 - I	Fo- J.Chamber 19 - I	Fo- J.Chamber 20 - I	Fo- J.Chamber 23 - I	Fo- J.Chamber 26 - I	Fo-Conf 13 -I	Fo-Conf 16 - I	Fo-Conf 19 - I	Fo-Conf 20 - I	Fo- Conf 23- I	Fo- Conf 26 -I
Best Case (SKN 165 + 0.4 u)	8.86%	9.38%	8.41%	8.63%	8.36%	8.37%	17.86%	10.36%	17.17%	14.42%	11.70%	14.78%	21.40%	14.92%	18.38%	23.51%	16.40%	23.81%
SKN 165	0.52%	2.21%	0.40%	0.21%	1.34%	0.12%	-1.98%	-0.33%	-1.85%	-1.14%	1.62%	-0.87%	-1.06%	0.45%	-1.29%	-2.02%	-0.09%	-1.56%
Planitherm Pristine White	0.15%	1.06%	0.07%	-0.09%	0.50%	-0.16%	-1.65%	-0.39%	-1.50%	-1.14%	1.05%	-0.92%	-0.93%	0.34%	-1.11%	-1.69%	-0.23%	-1.38%
Double Glazing	0.21%	0.46%	0.20%	0.11%	0.27%	0.07%	-0.23%	0.15%	-0.14%	-0.11%	0.91%	-0.09%	-0.21%	0.24%	-0.17%	-0.21%	0.19%	-0.15%

Note : All spaces in the graphs contain letters in their nomenclature indicating the façade orientation – North(N) , South(S) , East(E), West(W) , Interior(I)

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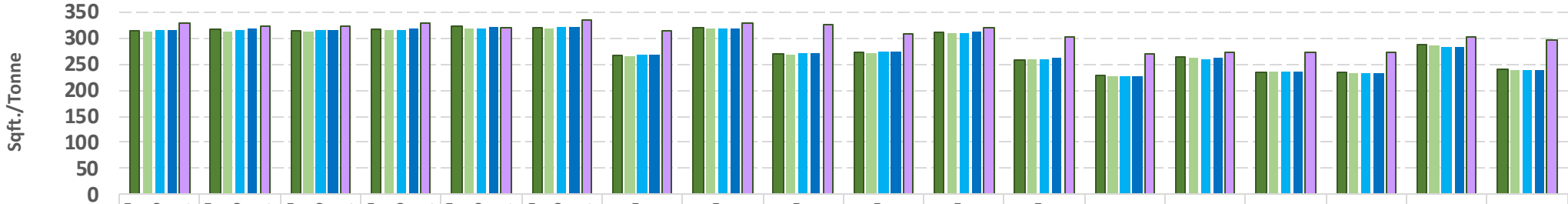
Glazing Optimisation – Level 5

Peak Cooling Load (Sqft/Tonne)



	Fo- Court no 13 - I - NE	Fo- Court no 16 -I - E	Fo- Court no 20 - I - NW	Fo- Court no 19 -I - SE	Fo- Court no 23 - I - W	Fo-Court no 26 - I - SW	Fo- J.Chamber 13- I	Fo- J.Chamber 16 - I	Fo- J.Chamber 19 - I	Fo- J.Chamber 20 - I	Fo- J.Chamber 23 - I	Fo- J.Chamber 26 - I	Fo-Conf 13 -I	Fo-Conf 16 - I	Fo-Conf 19 - I	Fo-Conf 20 - I	Fo- Conf 23- I	Fo- Conf 26 -I
Single Glazing	313.90	316.03	314.14	315.66	321.37	319.46	265.99	318.42	269.22	271.18	309.69	257.95	227.43	262.44	235.38	232.88	286.49	239.06
Double Glazing	313.05	313.69	313.25	314.83	318.77	318.58	265.67	318.78	269.10	270.82	310.59	257.74	227.17	262.66	235.26	232.61	286.89	238.87
Planitherm Pristine White	314.49	315.35	314.55	316.46	319.38	320.04	267.19	317.33	270.82	273.31	309.48	260.40	227.84	260.61	236.12	231.75	283.37	238.54
SKN 165	315.67	319.01	315.66	317.97	322.48	321.42	266.64	317.73	270.31	273.62	311.12	260.90	227.77	261.02	236.12	231.54	283.87	238.52
Best Case (SKN 165 + 0.4 u)	328.47	321.42	323.20	327.22	320.35	333.12	314.79	327.59	325.58	308.58	321.05	301.79	269.52	272.36	271.81	272.22	301.11	294.86

Percentage reduction in Peak Cooling Load WRT Baseline

	Fo- Court no 13 - I - NE	Fo- Court no 16 -I - E	Fo- Court no 20 - I - NW	Fo- Court no 19 -I - SE	Fo- Court no 23 - I - W	Fo-Court no 26 - I - SW	Fo- J.Chamber 13- I	Fo- J.Chamber 16 - I	Fo- J.Chamber 19 - I	Fo- J.Chamber 20 - I	Fo- J.Chamber 23 - I	Fo- J.Chamber 26 - I	Fo-Conf 13 -I	Fo-Conf 16 - I	Fo-Conf 19 - I	Fo-Conf 20 - I	Fo- Conf 23- I	Fo- Conf 26 -I
Best Case (SKN 165 + 0.4 u)	4.44%	1.68%	2.80%	3.53%	-0.32%	4.10%	15.50%	2.80%	17.31%	12.12%	3.54%	14.53%	15.62%	3.64%	13.40%	14.45%	4.86%	18.93%
SKN 165	0.56%	0.93%	0.48%	0.72%	0.34%	0.61%	0.24%	-0.22%	0.40%	0.89%	0.46%	1.13%	0.15%	-0.55%	0.31%	-0.58%	-0.92%	-0.23%
Planitherm Pristine White	0.19%	-0.21%	0.13%	0.25%	-0.62%	0.18%	0.45%	-0.34%	0.59%	0.78%	-0.07%	0.94%	0.18%	-0.70%	0.31%	-0.49%	-1.10%	-0.22%
Double Glazing	-0.27%	-0.74%	-0.28%	-0.26%	-0.82%	-0.28%	-0.12%	0.11%	-0.04%	-0.13%	0.29%	-0.08%	-0.11%	0.08%	-0.05%	-0.12%	0.14%	-0.08%

Note : All spaces in the graphs contain letters in their nomenclature indicating the façade orientation – North(N) , South(S) , East(E), West(W) , Interior(I)

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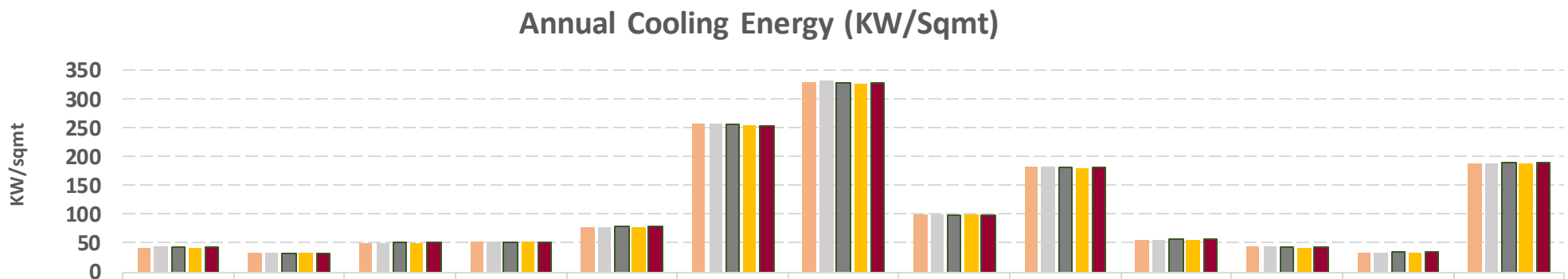
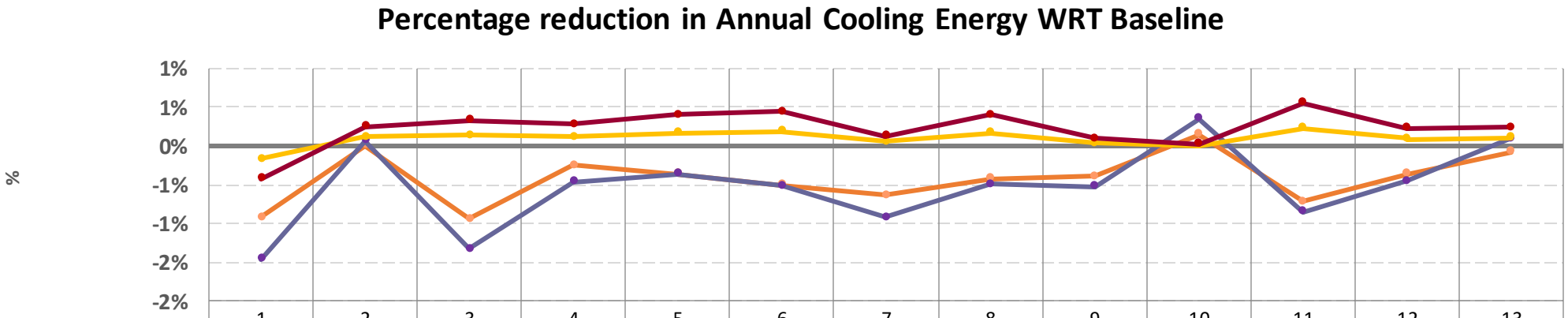
Optimisation of Roof and Wall-Level 1



	G1- HC Museum Cooling Load	G1- Book C Cooling Load	G1- Audi Cooling Load	G2- Arbitration Hall Cooling Load	G2- New filing- Criminal Cooling Load	G3- OriginalSide Cooling Load	G4 -SLSA Cooling Load	G5 - WP services Cooling Load	G5 - Govt. Pld 1-12 Cooling Load	G5 -Govt. Pld 13-25 Cooling Load	G6 - HC Library Cooling Load	G6 - Adv. chamberr 1-8 E Cooling Load	G6 - Adv. chamberr 21-28 Cooling Load
W-0.40 R- 0.33	42.88	32.35	50.78	52.26	78.37	257.56	330.75	99.26	181.95	55.61	43.40	33.90	189.85
W - 0.40 R - 0.22	43.11	32.32	50.97	52.38	78.37	257.59	331.68	99.33	182.21	55.50	43.46	33.93	189.51
W-0.40 R-0.40	42.49	32.35	50.30	52.13	78.09	256.28	328.66	98.84	181.25	55.69	43.09	33.78	189.70
W-0.33 R-0.40	42.56	32.31	50.23	52.07	77.96	255.80	328.50	98.67	181.18	55.69	42.99	33.74	189.50
W- 0.22 R-0.40	42.67	32.27	50.13	51.99	77.77	255.14	328.26	98.44	181.08	55.68	42.85	33.70	189.24



	1	2	3	4	5	6	7	8	9	10	11	12	13
W-0.40 R- 0.33	-0.92%	0.00%	-0.94%	-0.25%	-0.36%	-0.50%	-0.64%	-0.43%	-0.39%	0.14%	-0.72%	-0.36%	-0.08%
W - 0.40 R - 0.22	-1.47%	0.07%	-1.33%	-0.47%	-0.36%	-0.51%	-0.92%	-0.49%	-0.53%	0.35%	-0.85%	-0.46%	0.10%
W-0.33 R-0.40	-0.17%	0.11%	0.14%	0.12%	0.17%	0.19%	0.05%	0.17%	0.04%	0.01%	0.23%	0.10%	0.10%
W- 0.22 R-0.40	-0.43%	0.25%	0.33%	0.28%	0.40%	0.45%	0.12%	0.40%	0.09%	0.02%	0.56%	0.23%	0.24%

Baseline is taken as 0.4 W/sqmt U-value for the Roof RCC slab as well as wall.

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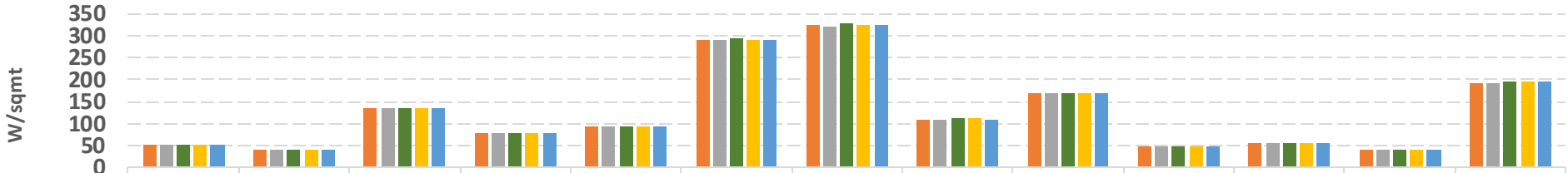
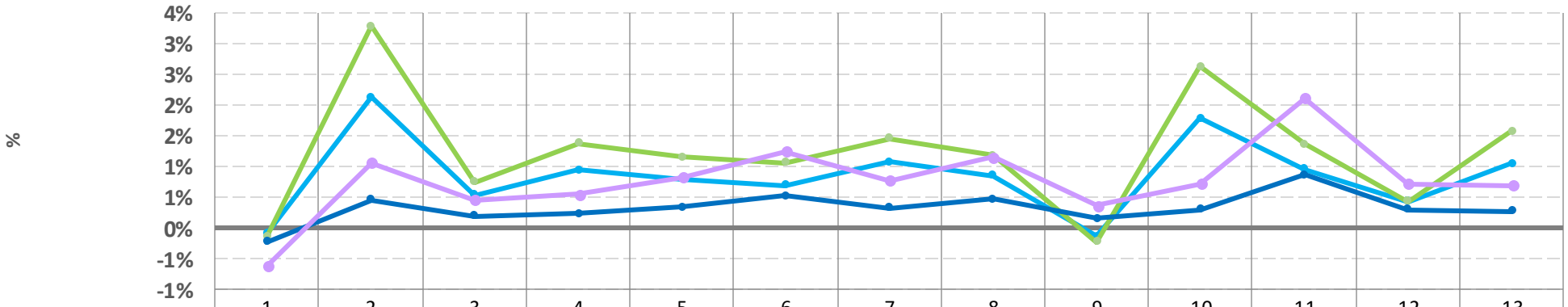
Optimisation of Roof and Wall-Level 1

Peak Cooling Load (W/Sqmt)



	G1- HC Museum Cooling Load	G1- Book C Cooling Load	G1- Audi Cooling Load	G2- Arbitration Hall Cooling Load	G2- New filing- Criminal Cooling Load	G3- OriginalSide Cooling Load	G4 -SLSA Cooling Load	G5 - WP services Cooling Load	G5 - Govt. Pld 1-12 Cooling Load	G5 -Govt. Pld 13-25 Cooling Load	G6 - HC Library Cooling Load	G6 - Adv. chamberr 1-8 E Cooling Load	G6 - Adv. chamberr 21-28 Cooling Load
W-0.40 R- 0.33	51.09	39.17	135.01	77.49	94.61	291.87	324.16	110.56	170.35	47.12	54.58	38.88	193.69
W - 0.40 R - 0.22	51.12	38.70	134.72	77.15	94.27	290.82	322.90	110.20	170.51	46.72	54.36	38.88	192.68
W-0.40 R-0.40	51.04	40.02	135.74	78.22	95.37	293.93	327.69	111.52	170.13	47.98	55.11	39.05	195.76
W-0.33 R-0.40	51.16	39.84	135.48	78.04	95.05	292.37	326.62	110.99	169.86	47.83	54.63	38.93	195.19
W- 0.22 R-0.40	51.36	39.60	135.11	77.79	94.59	290.25	325.13	110.22	169.50	47.63	53.94	38.77	194.40

Percentage reduction in Peak Cooling Load WRT Baseline



	1	2	3	4	5	6	7	8	9	10	11	12	13
W-0.40 R- 0.33	-0.10%	2.13%	0.54%	0.94%	0.80%	0.70%	1.08%	0.86%	-0.13%	1.79%	0.96%	0.43%	1.06%
W - 0.40 R - 0.22	-0.14%	3.29%	0.75%	1.37%	1.15%	1.06%	1.46%	1.18%	-0.23%	2.63%	1.36%	0.43%	1.57%
W-0.33 R-0.40	-0.22%	0.46%	0.19%	0.24%	0.34%	0.53%	0.32%	0.47%	0.16%	0.30%	0.86%	0.30%	0.29%
W- 0.22 R-0.40	-0.61%	1.06%	0.46%	0.55%	0.82%	1.25%	0.78%	1.16%	0.37%	0.72%	2.12%	0.72%	0.70%

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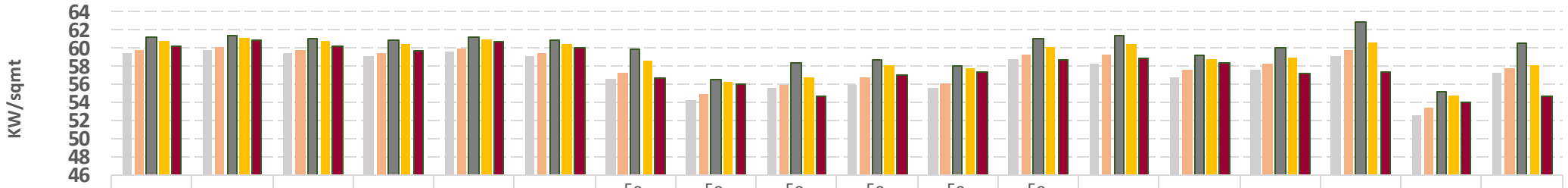
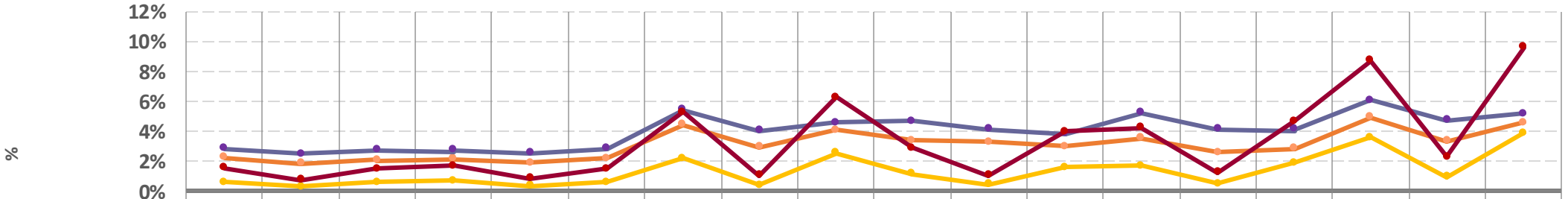
Optimisation of Roof and Wall-Level 5

Annual Cooling Energy (KW/Sqmt)



	Fo- Court no 13 Cooling Load	Fo- Court no 16 Cooling Load	Fo- Court no 20 Cooling Load	Fo- Court no 19 Cooling Load	Fo- Court no 23 Cooling Load	Fo-Court no 26 Cooling Load	Fo-J.Chamber 13 Cooling Load	Fo-J.Chamber 16 Cooling Load	Fo-J.Chamber 19 Cooling Load	Fo-J.Chamber 20 Cooling Load	Fo-J.Chamber 23 Cooling Load	Fo-J.Chamber 26 Cooling Load	Fo-Conf 13 Cooling Load	Fo-Conf 16 Cooling Load	Fo-Conf 19 Cooling Load	Fo-Conf 20 Cooling Load	Fo- Conf 23 Cooling Load	Fo- Conf 26 Cooling Load
W - 0.40 R - 0.22	59.48	59.80	59.45	59.18	59.59	59.16	56.63	54.31	55.64	56.04	55.68	58.80	58.24	56.73	57.57	59.06	52.64	57.35
W-0.40 R- 0.33	59.87	60.20	59.85	59.54	60.01	59.55	57.23	54.92	55.94	56.80	56.18	59.30	59.26	57.65	58.34	59.78	53.41	57.73
W-0.40 R-0.40	61.24	61.34	61.13	60.83	61.16	60.90	59.87	56.59	58.32	58.80	58.09	61.14	61.45	59.18	60.06	62.88	55.27	60.50
W-0.33 R-0.40	60.86	61.14	60.76	60.41	60.95	60.53	58.57	56.35	56.83	58.12	57.83	60.17	60.41	58.88	58.93	60.61	54.74	58.13
W- 0.22 R-0.40	60.29	60.88	60.22	59.79	60.66	59.99	56.70	56.01	54.65	57.09	57.47	58.69	58.86	58.45	57.25	57.39	54.01	54.69

Percentage reduction in Annual Cooling Energy WRT Baseline



	Fo-Court no 13 Cooling Load	Fo-Court no 16 Cooling Load	Fo-Court no 20 Cooling Load	Fo-Court no 19 Cooling Load	Fo-Court no 23 Cooling Load	Fo-Court no 26 Cooling Load	Fo-J.Chamber 13 Cooling Load	Fo-J.Chamber 16 Cooling Load	Fo-J.Chamber 19 Cooling Load	Fo-J.Chamber 20 Cooling Load	Fo-J.Chamber 23 Cooling Load	Fo-J.Chamber 26 Cooling Load	Fo-Conf 13 Cooling Load	Fo-Conf 16 Cooling Load	Fo-Conf 19 Cooling Load	Fo-Conf 20 Cooling Load	Fo-Conf 23 Cooling Load	Fo-Conf 26 Cooling Load
W-0.40 R- 0.33	2.23%	1.85%	2.10%	2.13%	1.88%	2.22%	4.42%	2.95%	4.08%	3.40%	3.30%	3.00%	3.56%	2.60%	2.86%	4.93%	3.36%	4.58%
W - 0.40 R - 0.22	2.87%	2.50%	2.76%	2.72%	2.57%	2.86%	5.42%	4.03%	4.60%	4.70%	4.16%	3.83%	5.22%	4.15%	4.15%	6.07%	4.75%	5.20%
W-0.33 R-0.40	0.62%	0.33%	0.61%	0.69%	0.36%	0.61%	2.18%	0.43%	2.56%	1.16%	0.44%	1.58%	1.69%	0.52%	1.89%	3.61%	0.95%	3.91%
W- 0.22 R-0.40	1.54%	0.74%	1.49%	1.72%	0.83%	1.50%	5.29%	1.04%	6.29%	2.90%	1.07%	4.00%	4.22%	1.23%	4.68%	8.73%	2.28%	9.60%

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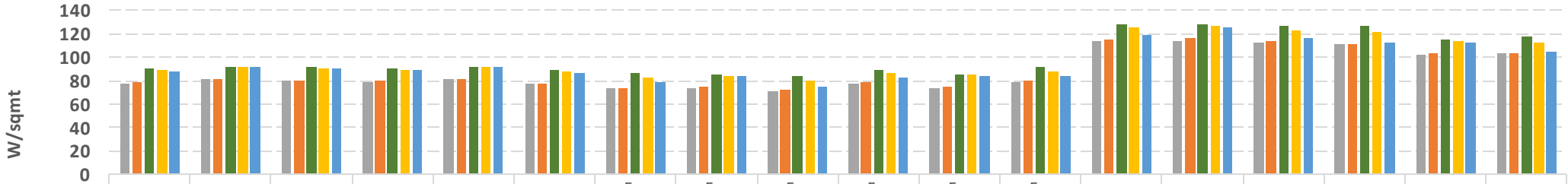
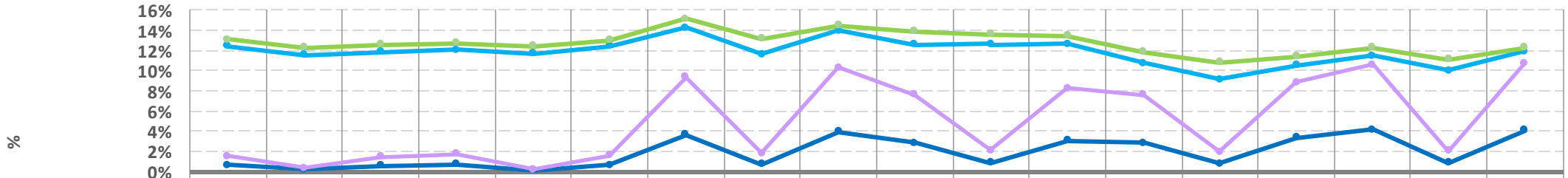
Optimisation of Roof and Wall-Level 5

Peak Cooling Load (W/Sqmt)



	Fo- Court no 13 Cooling Load	Fo- Court no 16 Cooling Load	Fo- Court no 20 Cooling Load	Fo- Court no 19 Cooling Load	Fo- Court no 23 Cooling Load	Fo-Court no 26 Cooling Load	Fo- J.Chamber 13 Cooling Load	Fo- J.Chamber 16 Cooling Load	Fo- J.Chamber 19 Cooling Load	Fo- J.Chamber 20 Cooling Load	Fo- J.Chamber 23 Cooling Load	Fo- J.Chamber 26 Cooling Load	Fo-Conf 13 Cooling Load	Fo-Conf 16 Cooling Load	Fo-Conf 19 Cooling Load	Fo-Conf 20 Cooling Load	Fo- Conf 23 Cooling Load	Fo- Conf 26 Cooling Load
W - 0.40 R - 0.22	78.11	80.92	80.06	78.86	80.88	77.06	73.30	73.78	71.59	77.26	73.90	78.89	113.30	113.78	112.64	110.86	102.49	103.12
W-0.40 R- 0.33	78.69	81.59	80.73	79.46	81.56	77.63	74.06	75.09	72.01	78.45	74.70	79.64	114.76	115.88	113.78	111.86	103.77	103.51
W-0.40 R-0.40	89.84	92.22	91.58	90.38	92.39	88.61	86.41	84.98	83.70	89.75	85.51	91.17	128.57	127.53	127.17	126.35	115.34	117.56
W-0.33 R-0.40	89.30	92.04	91.06	89.77	92.27	88.05	83.26	84.36	80.41	87.21	84.80	88.40	124.94	126.53	122.92	121.14	114.39	112.75
W- 0.22 R-0.40	88.50	91.90	90.28	88.82	92.19	87.22	78.32	83.42	75.09	82.94	83.75	83.65	118.86	125.03	115.91	112.96	113.00	104.94

Percentage reduction in Peak Cooling Load WRT Baseline



	Fo- Court no 13 Cooling Load	Fo- Court no 16 Cooling Load	Fo- Court no 20 Cooling Load	Fo- Court no 19 Cooling Load	Fo- Court no 23 Cooling Load	Fo- Court no 26 Cooling Load	Fo- J.Chamber 13 Cooling Load	Fo- J.Chamber 16 Cooling Load	Fo- J.Chamber 19 Cooling Load	Fo- J.Chamber 20 Cooling Load	Fo- J.Chamber 23 Cooling Load	Fo- J.Chamber 26 Cooling Load	Fo-Conf 13 Cooling Load	Fo-Conf 16 Cooling Load	Fo-Conf 19 Cooling Load	Fo-Conf 20 Cooling Load	Fo- Conf 23 Cooling Load	Fo- Conf 26 Cooling Load
W-0.40 R- 0.33	12.42%	11.53%	11.85%	12.08%	11.72%	12.40%	14.29%	11.64%	13.97%	12.58%	12.64%	12.65%	10.74%	9.14%	10.53%	11.47%	10.04%	11.95%
W - 0.40 R - 0.22	13.06%	12.26%	12.58%	12.75%	12.46%	13.04%	15.17%	13.18%	14.46%	13.91%	13.58%	13.47%	11.88%	10.79%	11.43%	12.26%	11.14%	12.28%
W-0.33 R-0.40	0.61%	0.20%	0.56%	0.67%	0.13%	0.63%	3.64%	0.73%	3.93%	2.83%	0.83%	3.04%	2.82%	0.79%	3.34%	4.12%	0.83%	4.09%
W- 0.22 R-0.40	1.49%	0.35%	1.42%	1.72%	0.21%	1.57%	9.36%	1.83%	10.29%	7.59%	2.06%	8.25%	7.55%	1.97%	8.85%	10.60%	2.03%	10.73%

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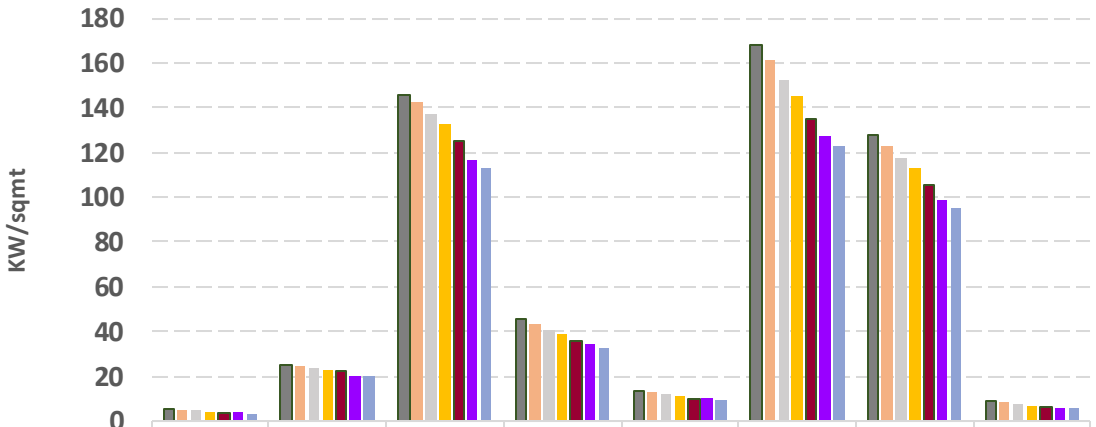
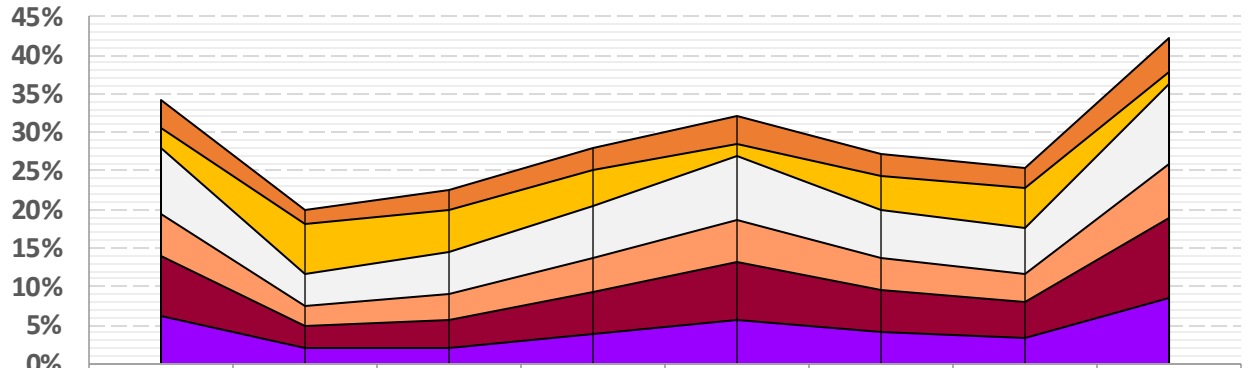
Optimisation of Roof and Wall-Level 8

Annual Cooling Energy (KW/Sqmt)



	Se-Massage	Se- Gym/ Yoga	Se- Judge's referencelib	Se- Dining room	Se- Food Prep	Se- Ante room	Se- Full court meeting room	Se-Cloakroom
Roof- 2.0	5.29	24.98	145.83	45.27	13.78	168.17	127.44	9.18
Roof- 1.45	4.97	24.50	142.83	43.48	12.99	161.24	123.14	8.40
Roof - 0.95	4.55	23.74	137.48	41.03	11.96	152.05	117.21	7.45
Roof-0.71	4.26	23.10	132.83	39.13	11.22	145.33	112.62	6.81
Roof-0.40	3.81	22.05	124.78	36.07	10.08	134.73	105.05	5.86
Roof-0.33	3.67	20.43	116.62	33.94	9.84	127.12	98.37	5.70
Roof- 0.22	3.49	20.01	112.97	32.65	9.34	122.65	95.01	5.29

Percentage reduction in Annual Cooling Energy WRT Baseline



	Se-Massage	Se- Gym/ Yoga	Se- Judge's referencelib	Se- Dining room	Se- Food Prep	Se- Ante room	Se- Full court meeting room	Se-Cloakroom
Roof- 0.22	34.09%	19.92%	22.53%	27.88%	32.19%	27.07%	25.45%	42.34%
Roof-0.33	30.61%	18.23%	20.03%	25.03%	28.53%	24.41%	22.81%	37.86%
Roof-0.40	27.86%	11.74%	14.43%	20.32%	26.85%	19.88%	17.57%	36.19%
Roof-0.71	19.43%	7.52%	8.92%	13.57%	18.57%	13.58%	11.63%	25.80%
Roof - 0.95	13.95%	4.98%	5.73%	9.38%	13.19%	9.58%	8.03%	18.81%
Roof- 1.45	6.10%	1.94%	2.06%	3.95%	5.71%	4.12%	3.37%	8.49%

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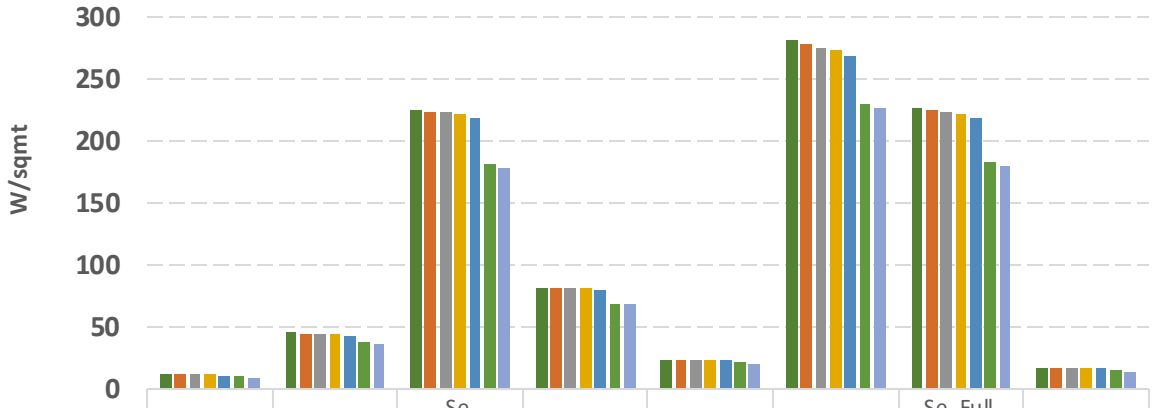
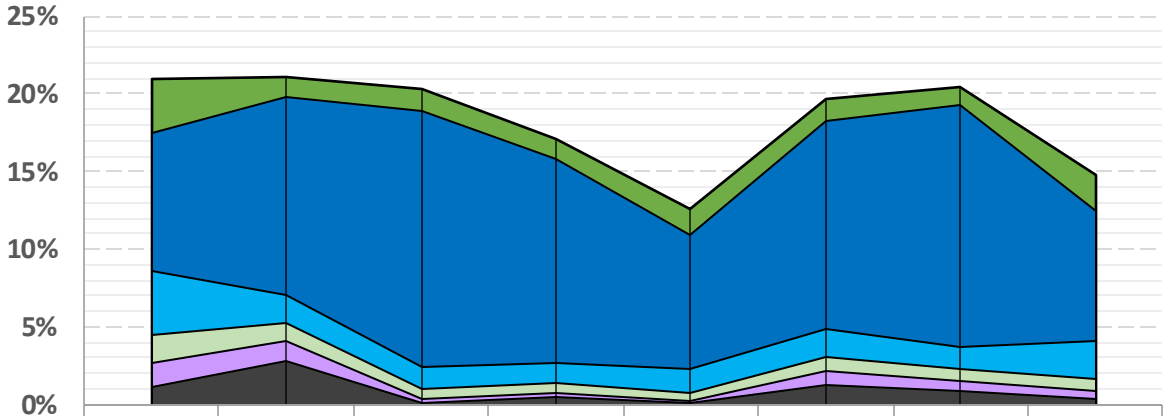
Optimisation of Roof and Wall-Level 8

Peak Cooling Load (W/Sqmt)



	Se-Massage	Se- Gym/ Yoga	Se-Judge's referencelib	Se- Dining room	Se- Food Prep	Se- Ante room	Se- Full court meeting room	Se-Cloakroom
Roof- 2.0	11.74	46.00	223.95	81.92	23.25	280.97	226.74	16.56
Roof- 1.45	11.62	44.74	223.70	81.57	23.23	277.53	224.82	16.50
Roof - 0.95	11.43	44.10	223.05	81.28	23.20	274.92	223.28	16.42
Roof-0.71	11.22	43.60	221.64	80.84	23.10	272.42	221.56	16.29
Roof-0.40	10.73	42.79	218.45	79.73	22.72	267.48	218.23	15.88
Roof-0.33	9.69	36.89	181.70	68.93	20.72	229.66	182.92	14.50
Roof- 0.22	9.27	36.28	178.42	67.92	20.33	225.74	180.26	14.11

Percentage reduction in Peak Cooling Load WRT Baseline



	Se-Massage	Se- Gym/ Yoga	Se-Judge's referencelib	Se- Dining room	Se- Food Prep	Se- Ante room	Se- Full court meeting room	Se-Cloakroom
Roof- 0.22	21.03%	21.14%	20.33%	17.09%	12.58%	19.66%	20.50%	14.79%
Roof-0.33	17.46%	19.82%	18.86%	15.86%	10.88%	18.26%	19.33%	12.41%
Roof-0.40	8.65%	6.99%	2.45%	2.68%	2.27%	4.80%	3.75%	4.11%
Roof-0.71	4.43%	5.23%	1.03%	1.32%	0.68%	3.04%	2.29%	1.65%
Roof - 0.95	2.65%	4.13%	0.40%	0.78%	0.23%	2.16%	1.53%	0.83%
Roof- 1.45	1.08%	2.73%	0.11%	0.44%	0.10%	1.23%	0.85%	0.34%