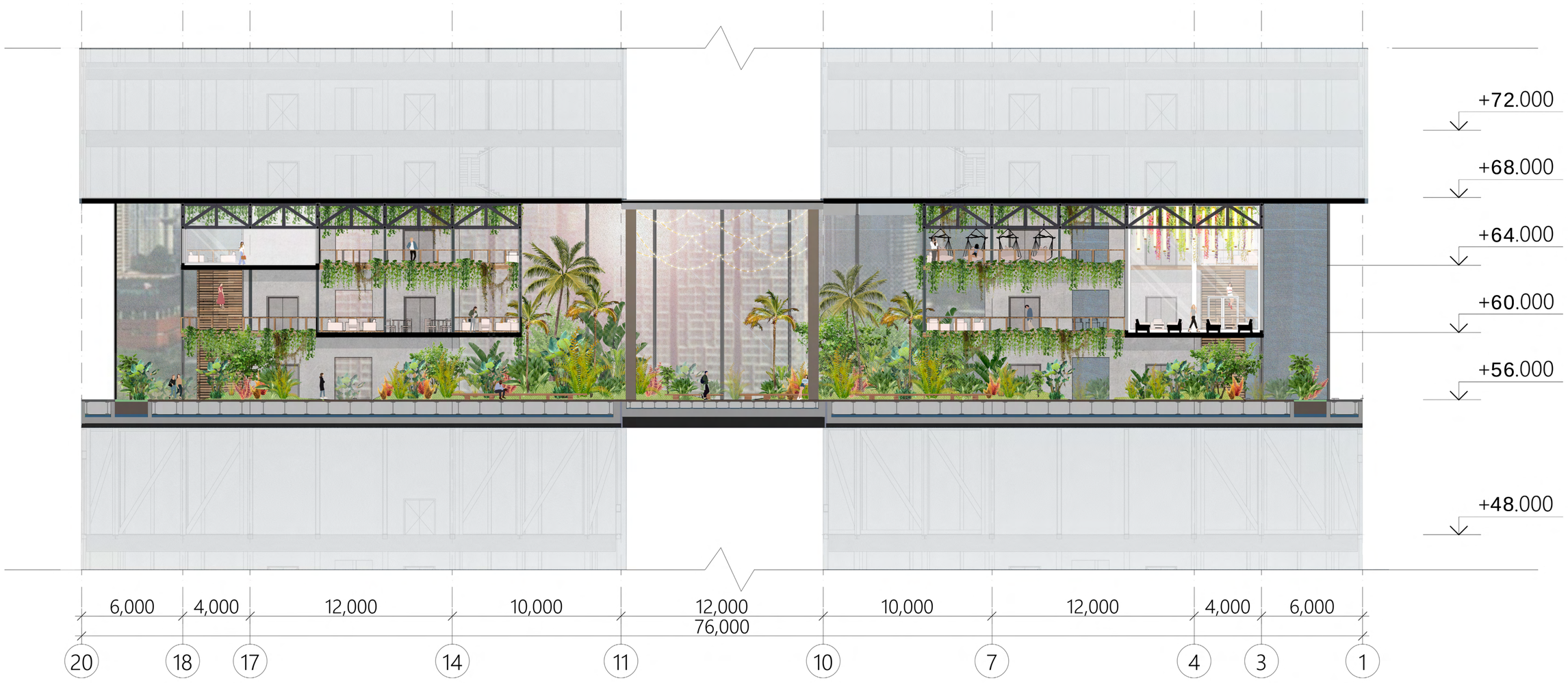
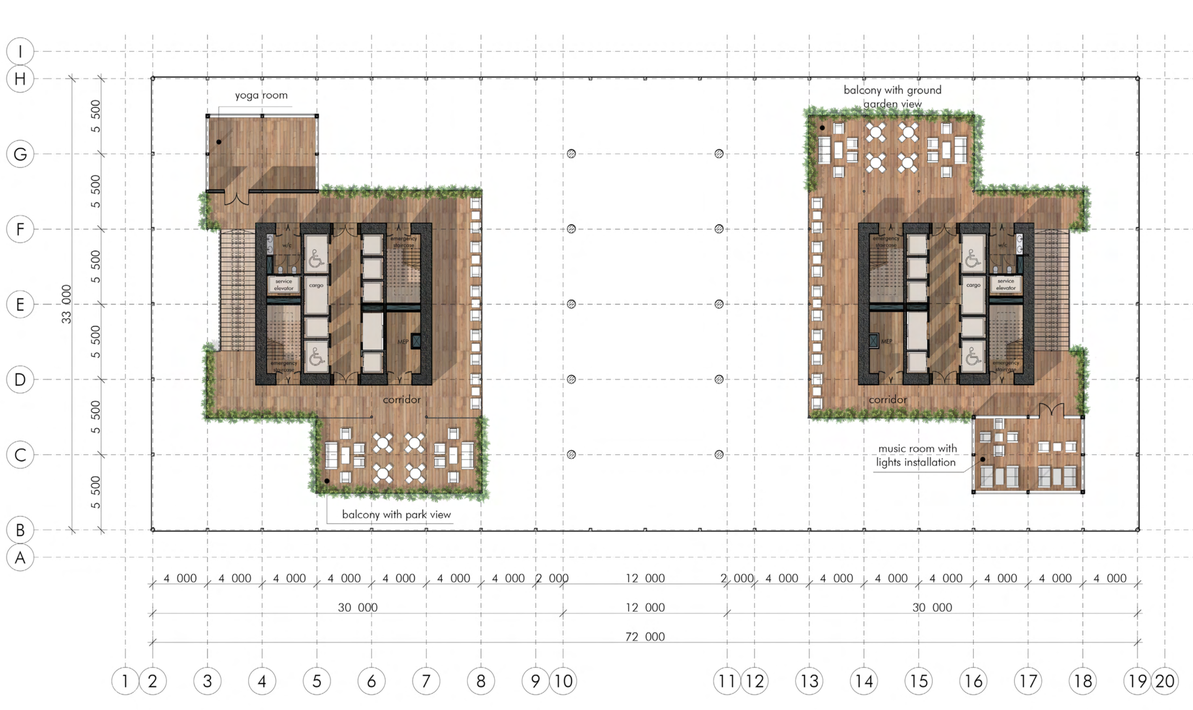
GARDEN FLOOR PLAN

garden floor plans



garden section
scale 1:100

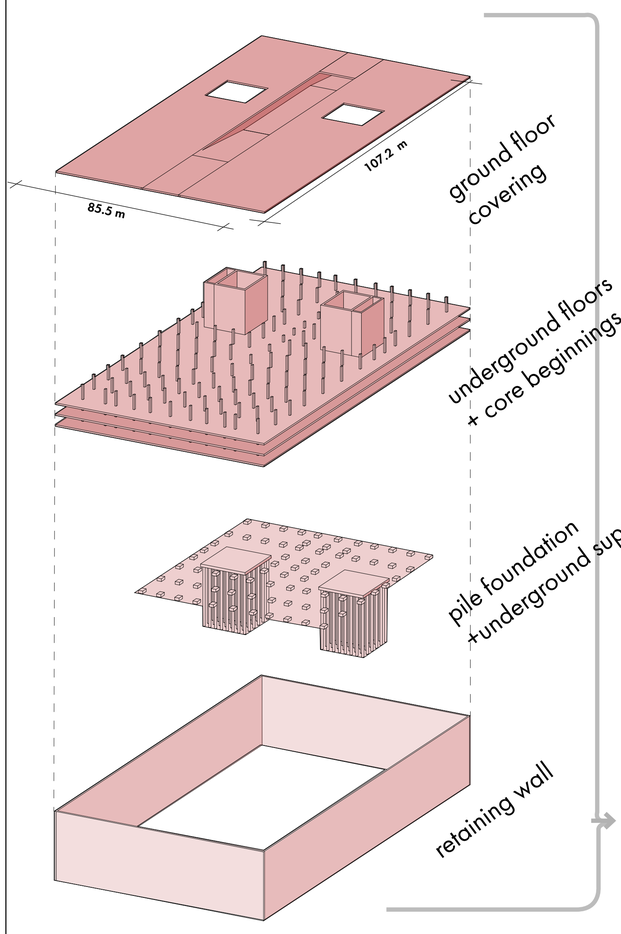
garden “ground” floor
scale 1:100



garden upper floors
scale 1:200

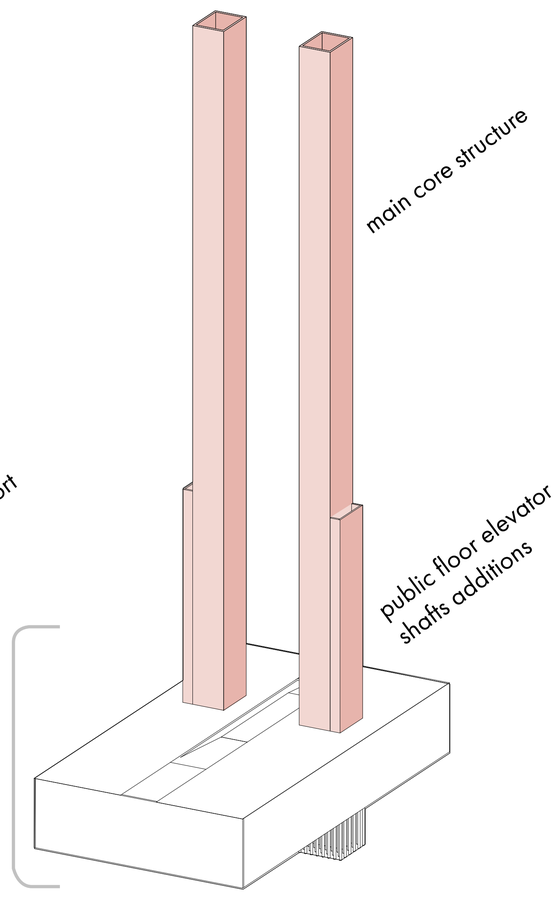
GROUP - 8 **VERTICAL HABITAT IN CBD, SINGAPORE**	**GARDEN FLOOR PLANS**	**PANEL NUMBER** **11**	**TEAM MEMBERS** **DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA**	POLITECNICO MILANO 1863 **FINAL THESIS** **28-04-2022**

STRUCTURAL SHAPING



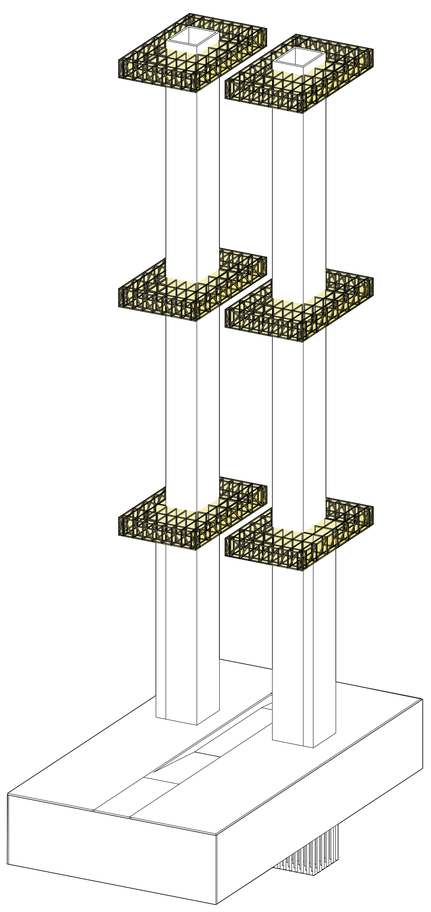
1. foundation + underground

Outline of the underground is excavated and secured by a retaining wall; then the pile foundations that are holding the cores are installed among with the raft supports for underground floors. Cores as the main structural elements are beginning construction as soon as their foundations are done.



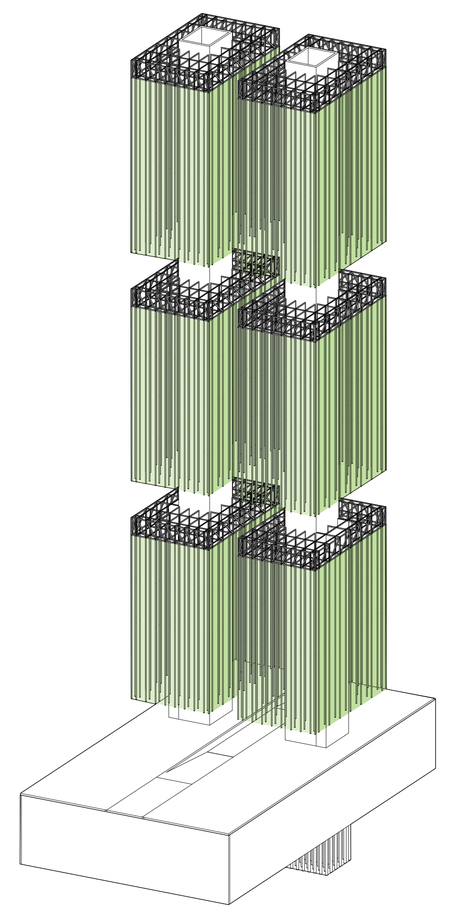
2. cores

Cores of the building are roughly symmetrical to each other.
The first third of the building has wider cores to account for extra elevator shafts in the areas open to public.



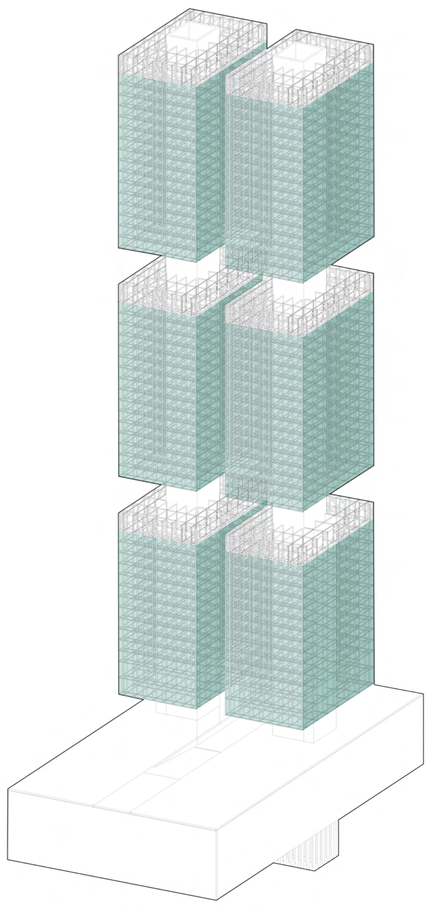
3. trusses

Six two-way steel "hat" trusses are attached to the cores, evenly distributed along the height and mirroring each other. Each truss follows the grid of the typical floors and is 32 by 37 meters in total dimensions.



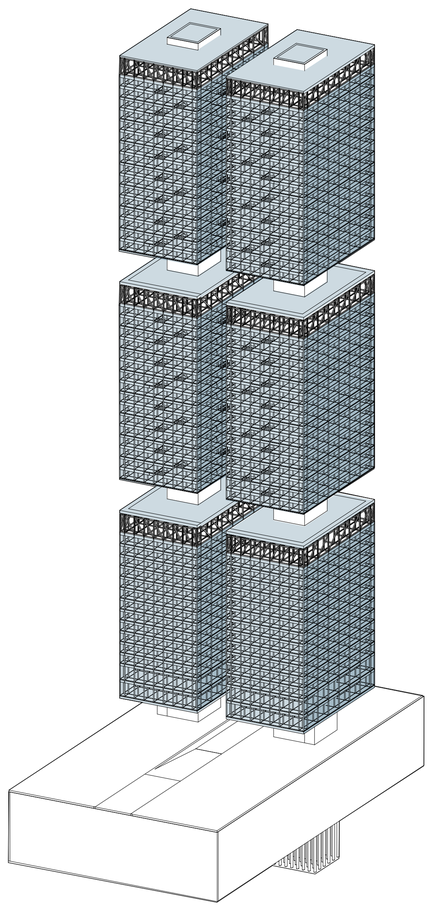
4. suspended columns

The floors are suspended on a system of balanced steel tubes, working in tension (in contrast to a standard scheme with columns working in compression and putting their load on the structures below). Suspended columns all are attached to the trusses in an upside-down manner.



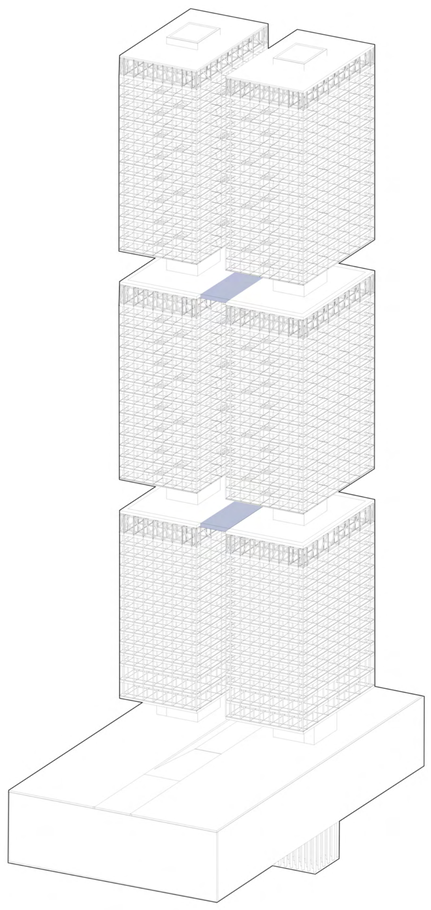
5. beams

A rectangular grid of beams is attached to the suspended columns, identical and symmetrical in all floors and dimensions - as to avoid the uneven elongation of vertical elements.



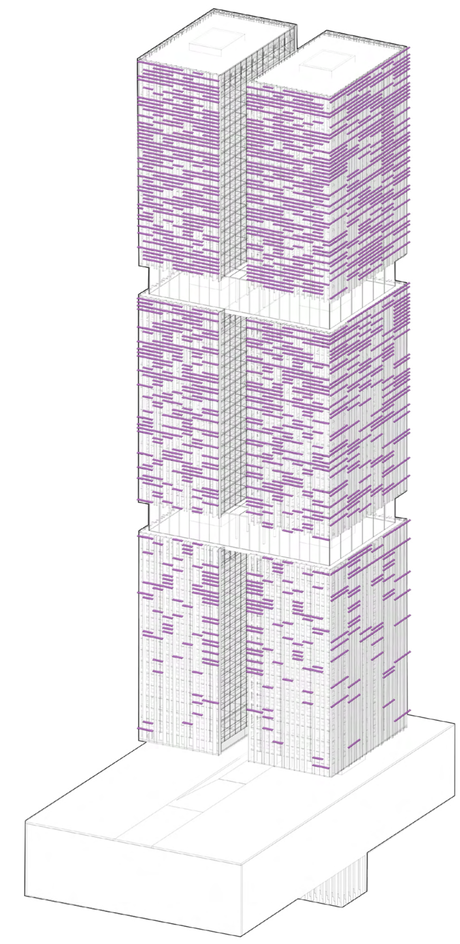
6. floor slabs

Lightweight floor slabs on metal deck are afterwards constructed in a one-way direction; a system is chosen that allows them to incorporate the floor beams in the slab height and increase usable space in the building.



7. bridges

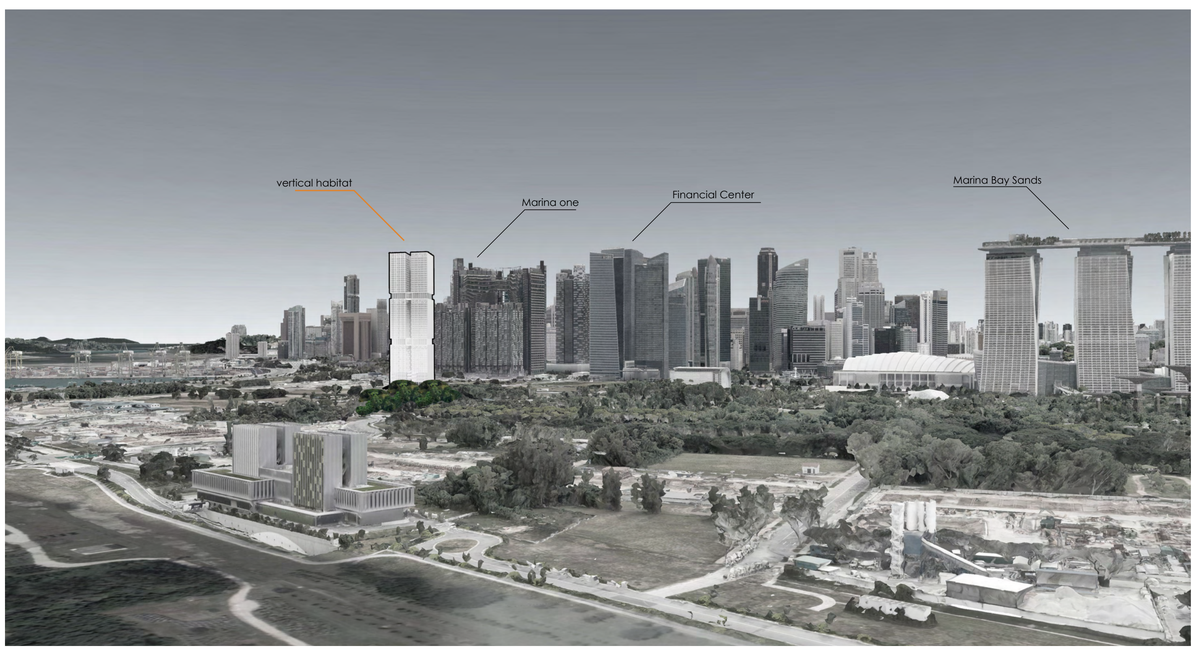
The towers are functionally connected through two "bridges" – at two levels, we have "garden floors". Structurally the gardens are independent, only transferring vertical loads to the towers' trusses; horizontally, we design a connection through flexible rubber joints, so two towers do not transmit any lateral loads among themselves.



8. skin

The two contrasting types of finishing facades are supposed to control the amount of incoming sunlight, allowing it in in garden floors and partially blocking and diffusing it in residential floors. The shaded facade is organised though a system of fin-like extrusions perpendicular to the facade. The transparent facade has to be supported on its own perimeter of supports, being really high.

structural shaping
scale 1:1000

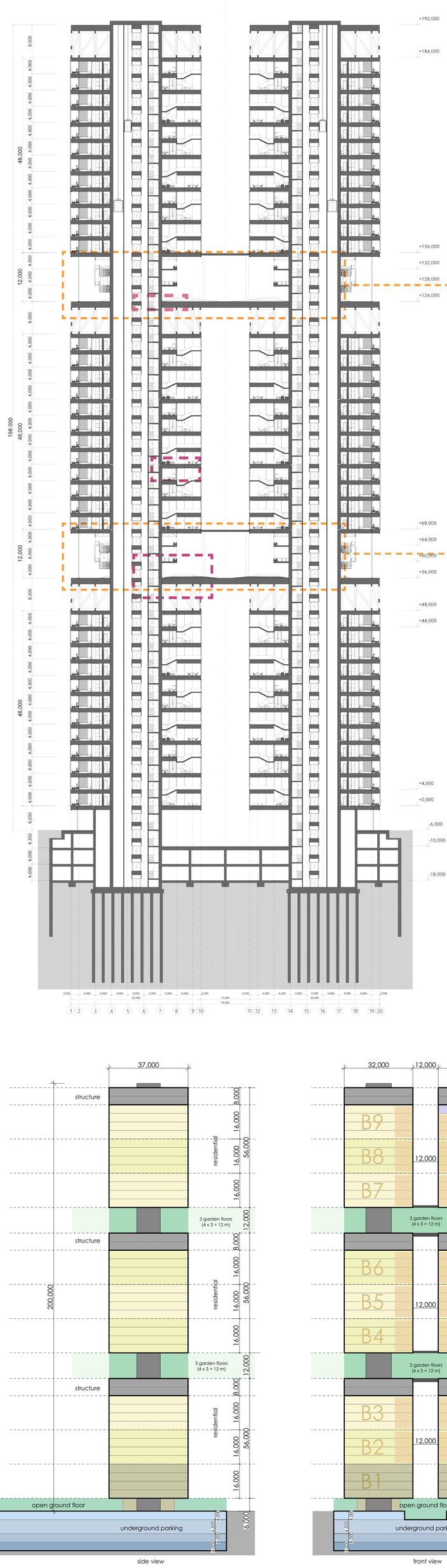


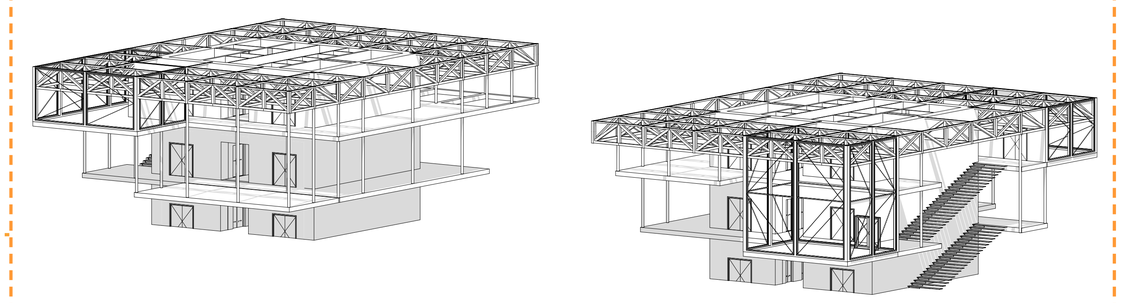
context shape

GROUP - 8 VERTICAL HABITAT IN CBD, SINGAPORE	**STRUCTURAL SHAPING**	PANEL NUMBER 12	TEAM MEMBERS DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA	POLITECNICO MILANO 1863 FINAL THESIS 28-04-2022

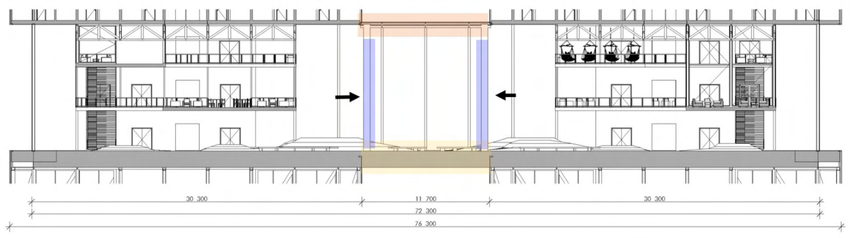
STRUCTURE

Sections & 3d behaviour of the building

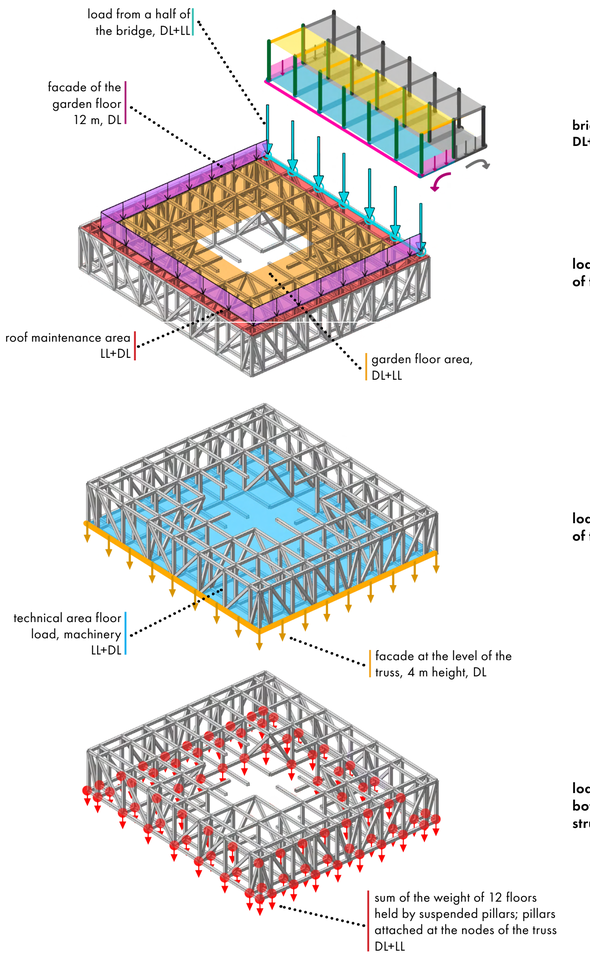




garden floor structures



independent bridge



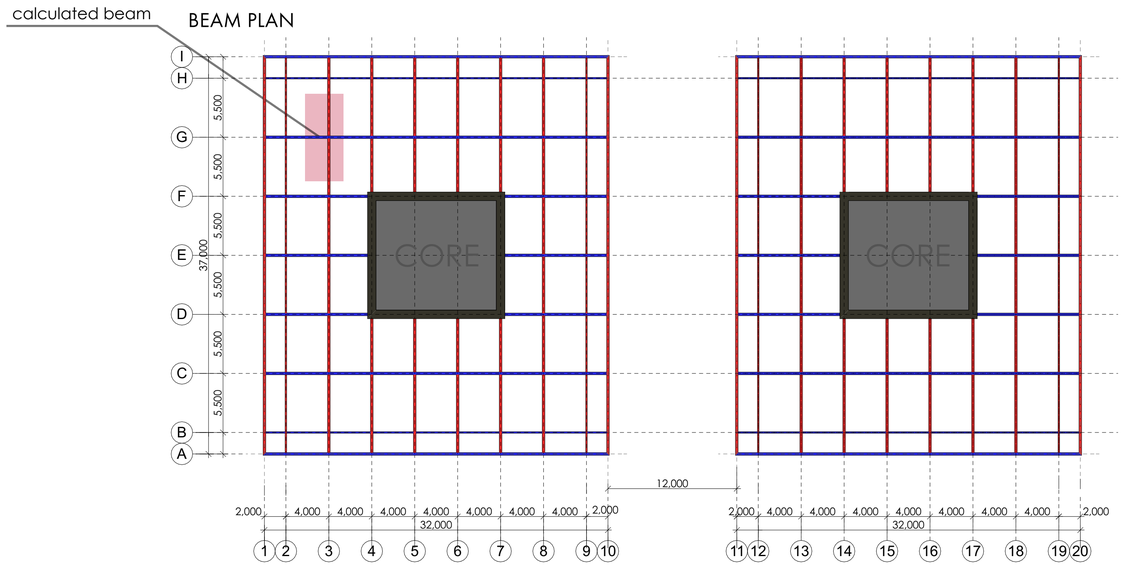
bridge (half) DL+LL

loads to the top of the structure

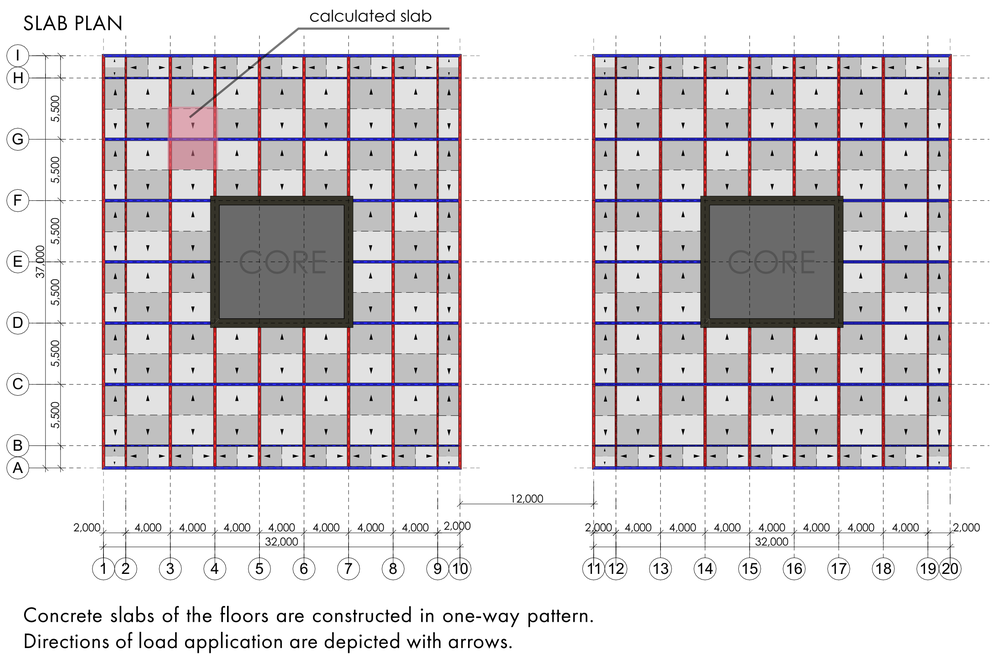
loads in the middle of the structure

loads at the bottom of the structure

Fig.56. Load distribution applied on various parts of the selected truss



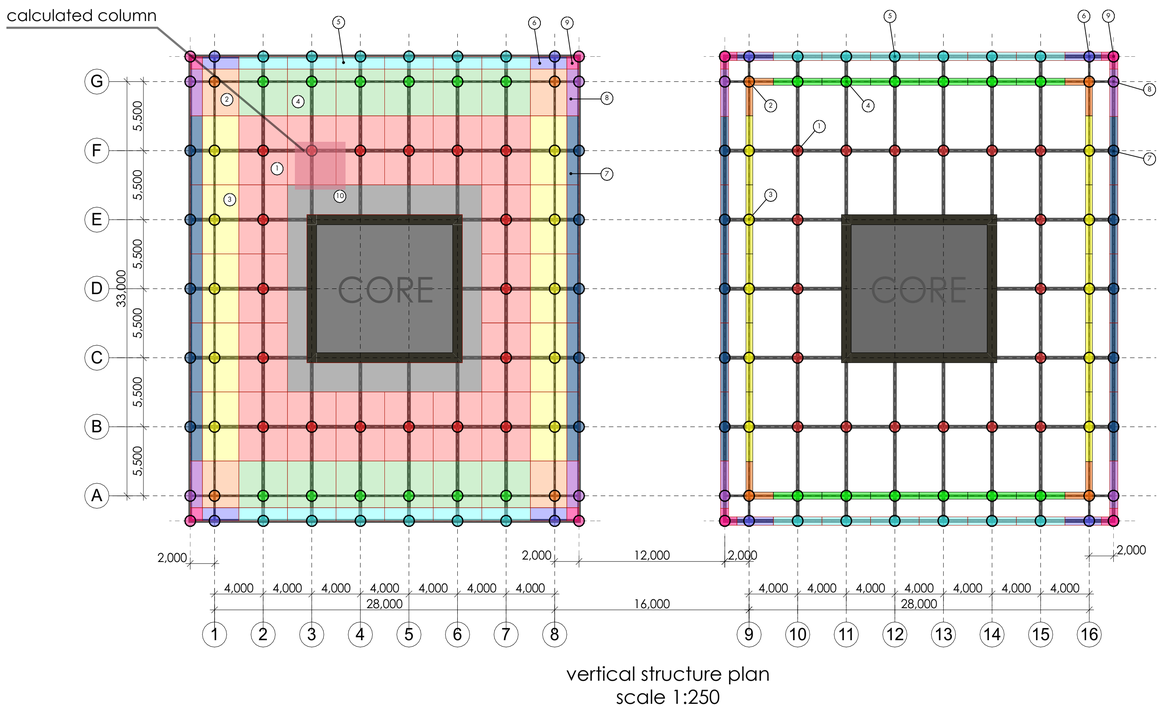
Floor beam plan layout follows the grid of the building.
The system is made to be symmetrical to the core.



Concrete slabs of the floors are constructed in one-way pattern.
Directions of load application are depicted with arrows.

slab direction
scale 1:250

beam plan
scale 1:250

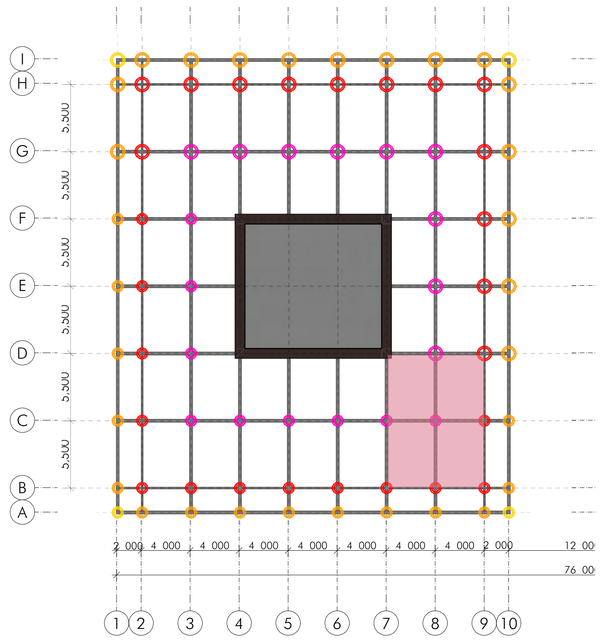


vertical structure plan
scale 1:250

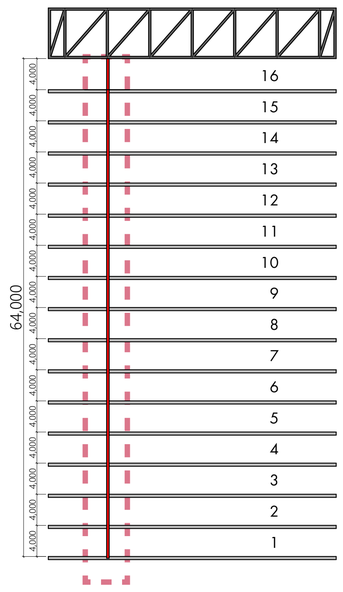
GROUP - 8 VERTICAL HABITAT IN CBD, SINGAPORE	**STRUCTURE**	PANEL NUMBER 13	TEAM MEMBERS DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA	POLITECNICO MILANO 1863 FINAL THESIS 28-04-2022

DETAILS & CALCULATION

slab layers & technological details



column tributary area

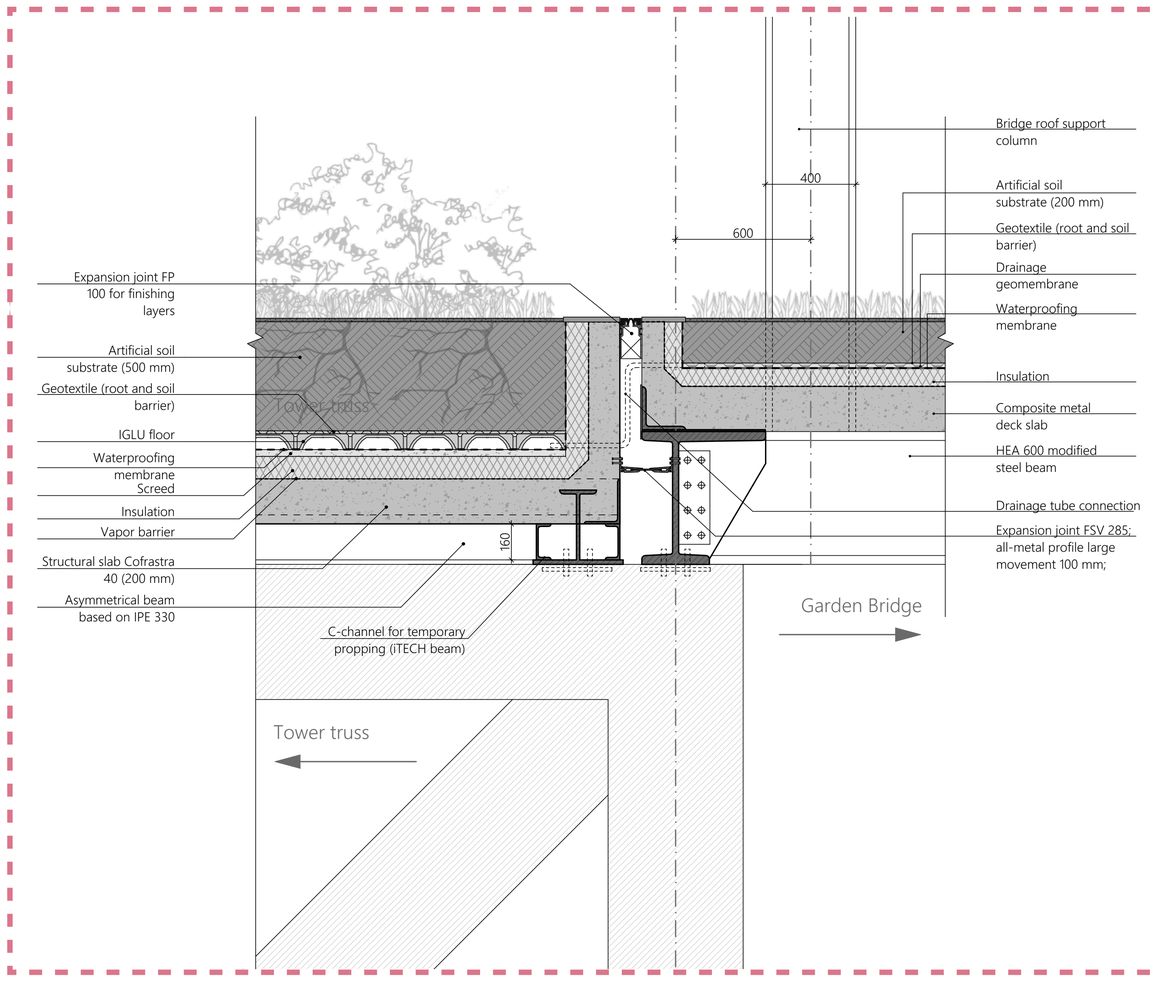


load diagram

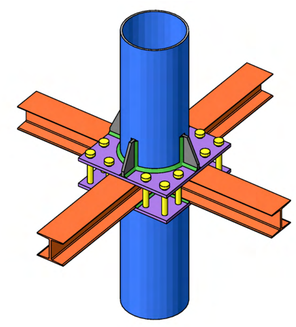
Calculations for the Tension elements							
Distance between two floors	ℓ	4	m	Selected pipe			
	ℓ	4000	mm	weight	m	47	kg/m
Number of floors	m_f	16		moment of interia	I	7572	cm^4
Dead Load	w_f	4.42	KN/m^2	Section modulus	W_{pl}	606	cm^3
Live load	q_f	2	KN/m^2	Diameter	D	323.9	mm
Total load	$q_{total} = w_f + q_f$	6.42	KN/m^2	Area	A_c	59.9	cm^2
	q_{total}	0.00642	N/mm^2	Thickness of the tube	T	6	mm
Tributary area				Radius	r	161.95	mm
Length between the beams	B1	5.5	m	Area	A_c	5990	mm^2
		5500	mm	stress $\delta = F/A$	Force = load of slab x area x no. of floors		
Width between the beams	W1	4	m	$\varepsilon = \delta/E$	$F = q_{total} \times B_1 \times A_1 \times m_f$		
		4000	mm	$\Delta\ell = F\ell/EA$	F	2259840	N
Young's Modulus E 210000 N/mm				$\Delta\ell$		7.186072025	mm
$\Delta\ell = F\ell/EA$						0.718607202	cm

Profili tubolari tondi a caldo *(segue)*

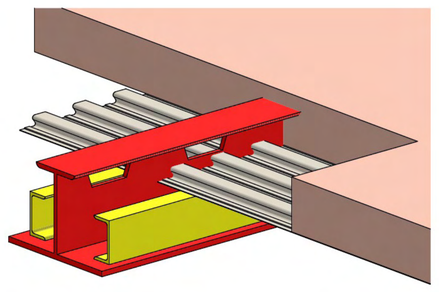
D mm	T mm	M kg/m	A cm^2	I cm^4	i cm	W_{el} cm^3	W_{pl} cm^3	I_T cm^4	C_T cm^3	A_S m^2/m	L m	A_{SV} m^{-1}
244,5	**6,3**	37	47,1	3346	8,42	274	358	6692	547	0,768	27	163
273	**20**	125	159	12798	8,97	938	1283	25597	1875	0,858	8,01	–
273	**25**	153	195	15127	8,81	1108	1543	30254	2216	0,858	6,54	–
323,9	**5**	39,3	50,1	6369	11,3	393	509	12739	787	1,02	25,4	203
323,9	**6**	47	59,9	7572	11,2	468	606	15145	935	1,02	21,3	–
323,9	**6,3**	49,3	62,9	7929	11,2	490	636	15858	979	1,02	20,3	162



garden floor section: connecting the bridge to towers
scale 1:10



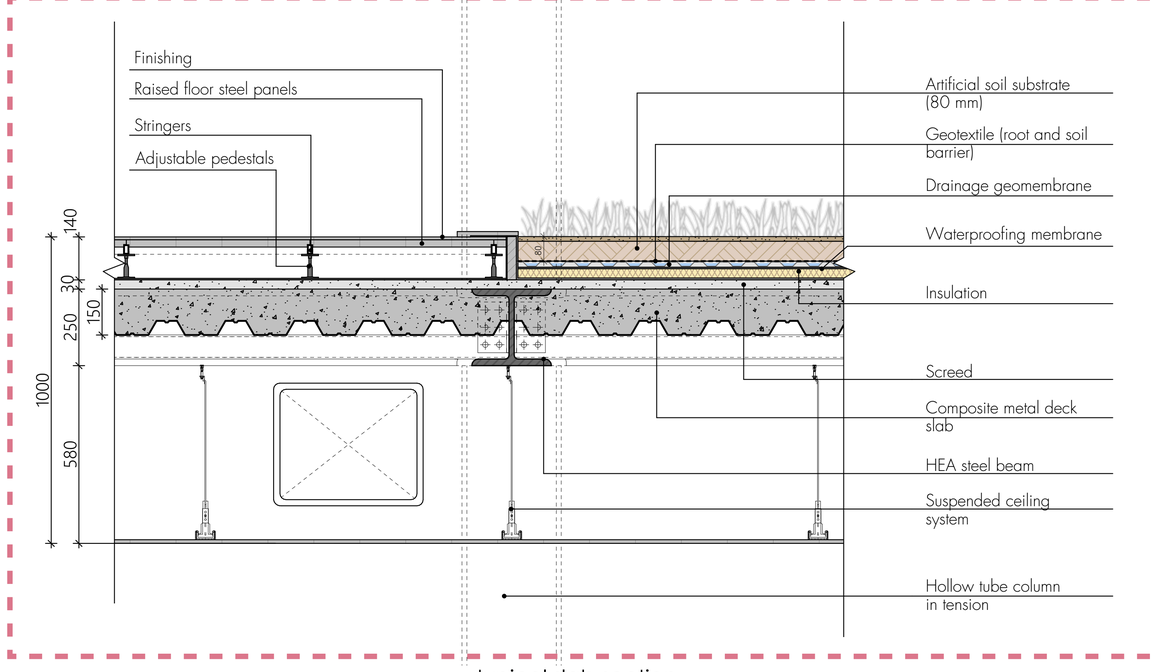
suspended column and floor beam connection



iTECH beam system 3D
(slab going through the hollowed beam and acting continiously)

Calculations for the Beam in Typical Floor										
		Values	*Units*	*Area of Loading*			*Live Load Calculations*		
Weight of the Floor	w_f	**4.42**	KN/m^2	Length	4	m	Live Load	2	KN/m^2
Live Load (class A = 2,0 or B = 3,0)	q_f	**2**	KN/m^2	Width L_T	5.5	m	Snow Load	0	KN/m^2
Formula for Reaction forces at point A				Tributary length			Wind load	0	KN/m^2
W_d ($w_f + q_f$)*L^T		***35.31***	KN/m						
q_d (1.3 x wf + 1.5 x qf) * L_T		48.103	**KN/m**						
R_A = 1/2 x q_d x L (span)		96.206	*KN*						
REACTION FORCE R_A		**96206**	***N***	**Area A1**	**22**	m^2	q_f	**2**	KN/m^2
Calculations for Bending Moment M									
Reaction force	q_d	48.103		Wpl = M/fyd			We choose **HEA 260** Section (Wpl = 919.8 cm3)		
Width of the loading area	L	4		f_{yd} for steel	338	N/mm^2			
Moment	L^2	16							
$M = 1/8 \times q_d \times L^2$	M	96.206	*KNm*	W_{pl}	284633.14	mm^3			
	M	**96206000**	*Nmm*	**W_{pl}**	284.63314	cm^3			
Calculations for Deflection δ									
HEA 260							**δ**	**19.17130473**	**mm**
wpl	w_{pl}	**919.8**	cm^3						
Area moment of Inertia	*I*	10450	cm^4						
		104500000	mm^4						
Youngs Modulus	*E*	210	*Gpa*				Check	δ<L/250	
		210000	***N/mm***	**$\delta = 5 / 384 \times q_d L^4 / EJ <= L/250$**			**L/250**	**22**	**mm**
Reaction force	W_d	35.31	*KN/m*						
		35.31	***N/mm***				δ < L / 250	**FULLFILLED**	
Length of Beam	L	5.5	*m*						
		5500	**mm**						

Designation	Weight kg/m	SIZES						Properties related to the neutral axis					
								x - x			y - y		
		section	h	b	a	e	r	Jx	Wx	Ix	Iy	Wy	Iy
		cm^2	mm	mm	mm	mm	mm	cm^4	cm^3	cm	cm^4	cm^3	cm
260	68,2	86,8	250	260	7,5	12,5	24,0	10450	836	11,0	3670	282	6,50



typical slab section
scale 1:10

Typical Floor Slab Detail							
	Material	Height (mm)	Height (m)	Width (m)	Length (m)	Unit Weight r (KN/m3)	Total Weight of the Material KN/m^2
1	**Partition Walls (approx.)**	3000	3	1	1	-	1.2
2	**Flooring (Raised Floor Decking; MicroTac Filled Steel Panel MFS1000)**	150	0.15	1	1	-	0.41
3	**Insulation (ASC StoneWool SL80)**	100	0.1	1	1	0.8	0.08
4	**Waterproofing membrane**	2	0.002	1	1	0.01	0.00002
5	**Vapor Barrier**	0.2	0.0002	1	1	0.15	0.00003
6	**Composite floor deck ComFlor46, Lightweight concrete (TataDeck)**	150	0.15	1	1	0	2.43
7	**Mechanical Plans**	-	-	-	-	-	0.2
8	**Ceiling**	60	0.06	1	1	-	0.1
9						**TOTAL WEIGHT**	**4.42005**

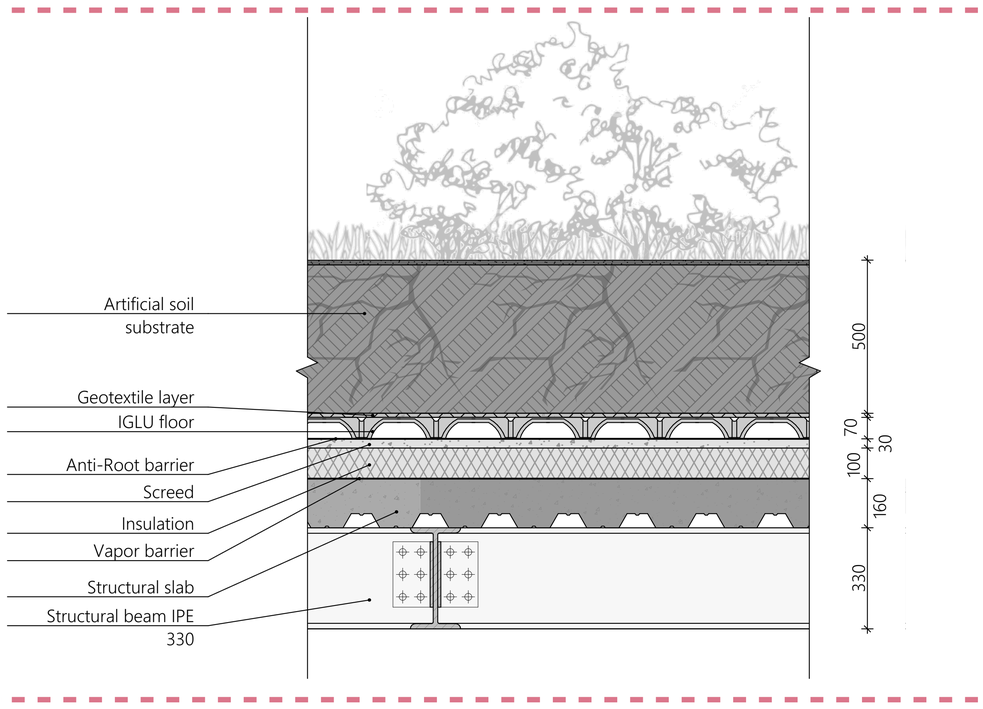
Typical Floor Slab Detail (green areas)							
	Material	Height (mm)	Height (m)	Width (m)	Length (m)	Unit Weight r (KN/m3)	Total Weight of the Material KN/m^2
1	**Boughton Extra Lightweight Green Roof Substrate**	80	0.08	1	1	11.8	0.944
2	**Composite geotextile (root&soil barrier) (WallTag)**	10	0.01	1	1	0.01	0.0001
3	**Geomembrane (TagDrain Drainage Mat, WallTag)**	30	0.03	1	1	-	0.01
4	**Waterproofing membrane**	2	0.002	1	1	0.01	0.00002
5	**Insulation (ASC StoneWool SL80)**	30	0.03	1	1	0.8	0.024
6	**Composite floor deck ComFlor46, Lightweight concrete (TataDeck)**	150	0.15	1	1	0	2.43
7	**Mechanical Plans**	-	-	-	-	-	0.2
8	**Ceiling**	-	-	-	-	-	0.1
						TOTAL WEIGHT	**3.70812**

dead loads for typical floors

Typical Partition Wall (inside apartment)							
	Material	Thickness (mm)	Thickness (m)	Width (m)	Length (m)	Unit Weight r (KN/m2)	Total Weight of the Material KN/m
1	**Insulation (ASC StoneWool SL80)**	100	0.1	1	1	0.8	0.08
2	**Steel cold-formed punched U-Channel S355MC 65/42, 1 m = 4 kg**	65/42	-	-	4.5	-	0.18
3	**Steel cold-formed punched U-Channel S355MC 50/38, 1 m = 3.5 kg**	50/38	-	-	3	-	0.105
4	**Acoustic insulation - Knauf Sound Supreme Board (SSB65)**	20 * 2	0.04	1	1	0.26	0.78
5	**Vapor Barrier**	0.2	0.0002	1	1	0.003	0.009
6	**USG Boral Firestop Plasterboard 16 mm**	16 * 2	0.032	1	1	0.272	0.816
						TOTAL WEIGHT	**1.97**

Typical Partition Wall (between apartments)							
	Material	Thickness (mm)	Thickness (m)	Width (m)	Length (m)	Unit Weight r (KN/m2)	Total Weight of the Material KN/m
1	**Insulation (ASC StoneWool SL80)**	180	0.18	1	1	0.8	0.144
2	**Steel cold-formed punched U-Channel S355MC 220/80, 1 m = 17.77 kg**	220/80	-	-	3	-	0.5333
3	**Steel cold-formed punched U-Channel S355MC 200/75, 1 m = 14.145 kg**	200/75	-	-	3	-	0.4525
4	**Acoustic insulation - Knauf Sound Supreme Board (SSB65)**	20 * 2	0.04	1	1	0.26	0.78
5	**Vapor Barrier**	0.2	0.0002	1	1	0.003	0.009
6	**USG Boral Firestop Plasterboard 16 mm**	16 * 2	0.032	1	1	0.272	0.816
7							
8							
						TOTAL WEIGHT	**2.7348**

dead load of partition walls for typical floors



garden floor slab section
scale 1:10

GROUP - 8 VERTICAL HABITAT IN CBD, SINGAPORE	**DETAILS & CALCULATIONS**	PANEL NUMBER 14	TEAM MEMBERS DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA	POLITECNICO MILANO 1863	FINAL THESIS 28-04-2022

MATERIALS

composition & producers

Singapore Green Building Product (SGBP) Scheme - certification scheme designed to evaluate and benchmark products in the industry for their notable qualities. Regarded as one of the key standard and benchmarks for green building products in the building and construction industry, the SGBP Scheme is recognised under the Green Mark Scheme, SingaporeвЂ™s national green building rating tool administered by the Building and Construction Authority (BCA).

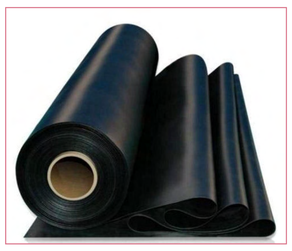
The producers chosen in the project were chosen according to the current evaluations by SGBP, with preference given to the Excellent and Leader groups.

ComFlor® 46 Metal Deck Slab (TataDeck)

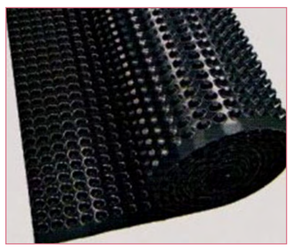
ASC Stonewool Slab SL80

KNAUF Sound Supreme Board Acoustic Insulation SSB65

USG Boral Firestop Plasterboard 16 mm



Waterproofing membrane

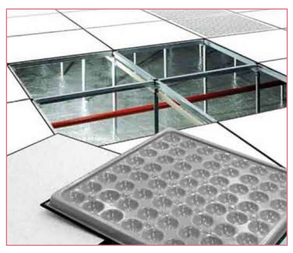


Geomembrane (TagDrain Drainage Mat, WallTag)

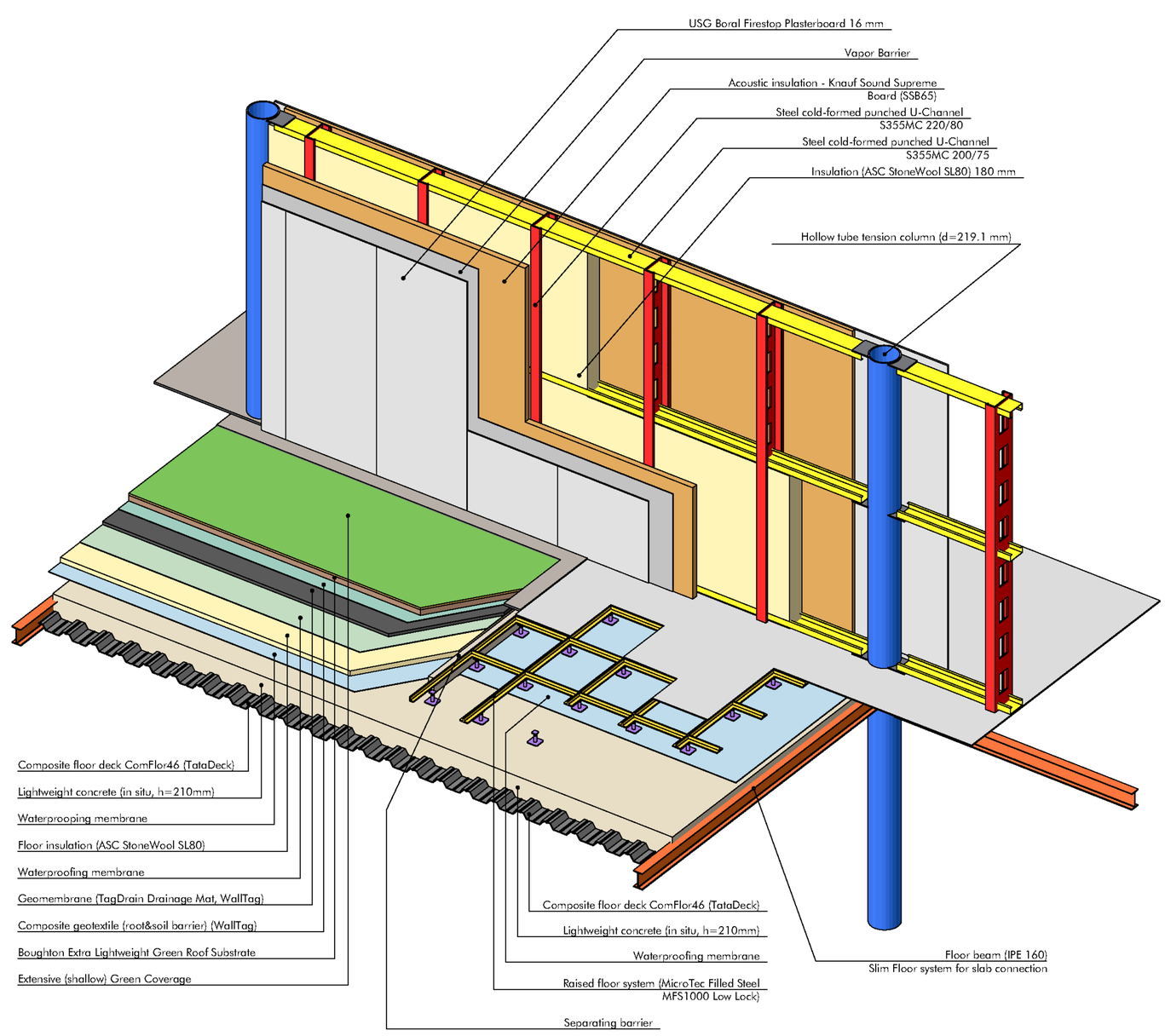
Boughton Extra Lightweight Green Roof Substrate

Lightweight concrete

Composite Geotextile WallTag



Microtac Assess Floor System (raised floor)



typical stratigraphies of floors and walls

Species of flora chosen for cultivation: interior

General qualities preferred in species:

- suitable for indoor growing (able to tolerate air conditioning):
  - lower temperatures
  - lower humidity
- able to grow on artificial soil substrate
- roots propagating horisontally, not vertically
- non-toxic in case of accidental ingestion
- native to Singapore
- not an allergy trigger

categories of plants in the indoor areas:

vines - vertical

Qualities:

- either hangs from root point or crawls up a surface
- thick foliage as to cover green wall structure

Example species:

- *Dischidia oiantha*

- *Tradescantia pallida (Rose) D.R.Hunt*

- *Phlegmariurus phlegmaria*

«green carpet» - low

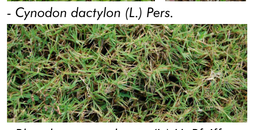
Qualities:

- able to grow on shallow soil (8-10 cm)
- soft to the touch
- resilient to stepping on

Example species:

- *Axonopus compressus*

- *Cynodon dactylon (L.) Pers.*



- *Rhynchospora colorata (L.) H. Pfeiffer*

shrubs - medium

Qualities:

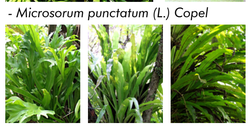
- reaches from knee height to chest height
- lack of defensive elements (spikes)
- sufficiently ornamental

Example species:

- *Schismatoglottis calyptrata*

- *Licuala spinosa*

- *Microsorum punctatum (L.) Copel*



trees - big height

Qualities:

- grows less than 10 meters
- not a thick trunk
- if possible, no trunk at all, while still appearing as a tree
- shallow root network

Example species:

- *Ficus microcarpa*

- *Terminalia buceras*

- *Ficus nitida*

- *Kentia palm*

Species of flora chosen for cultivation: exterior

General qualities preferred in species:

- suitable for local weather conditions:
  - high temperatures
  - strong sun
  - high humidity
- able to grow on artificial soil substrate
- roots propagating horisontally, not vertically
- non-toxic in case of accidental ingestion
- native to Singapore
- not an allergy trigger

categories of plants in the outdoor areas:

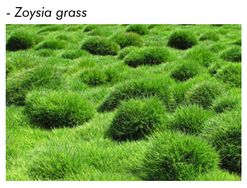
«green carpet» - low

Qualities:

- able to grow on shallow soil (8-10 cm)
- soft to the touch
- resilient to stepping on

Example species:

- *Zoysia grass*



- *Festuca arundinacea*

shrubs - medium

Qualities:

- reaches from knee height to chest height
- lack of defensive elements (spikes)
- sufficiently ornamental

Example species:

- *Cyrtostachys renda*

- *Colocasia*

trees & canopies

Qualities:

- canopy-forming
- not a thick trunk
- if possible, no trunk at all, while still appearing as a tree
- shallow root network

Example species:

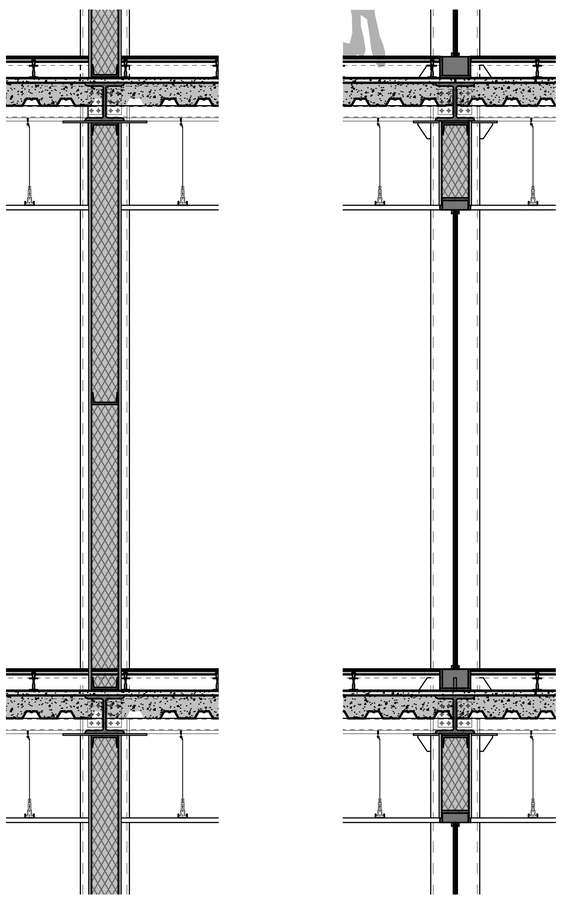
- *Bougainvillea arborea Glaz.*

- *Bougainvillea glabra*

- *Millettia pinnata (L.) Panigrahi*

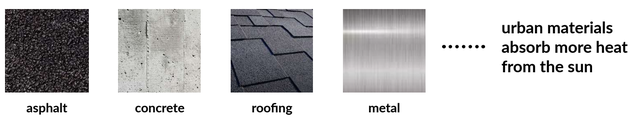
- *Syzygium zeylanicum (L.) DC*

- *Bougainvillea × buttiana 'Poultonii'*

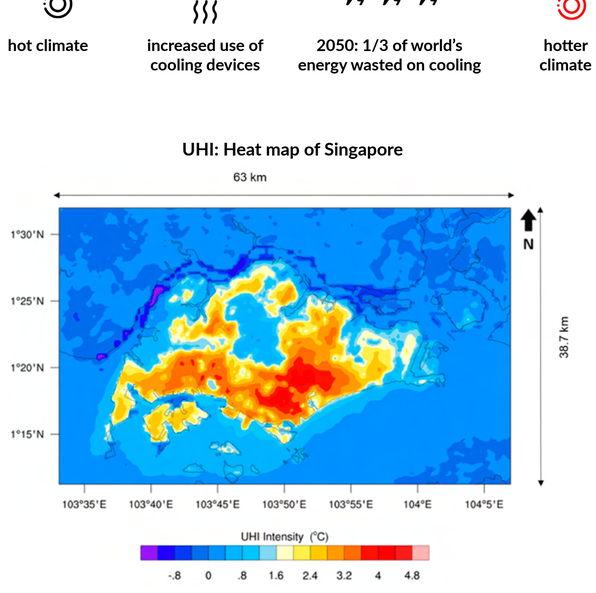


internal wall
scale 1:20

PROBLEM - URBAN HEAT ISLAND EFFECT



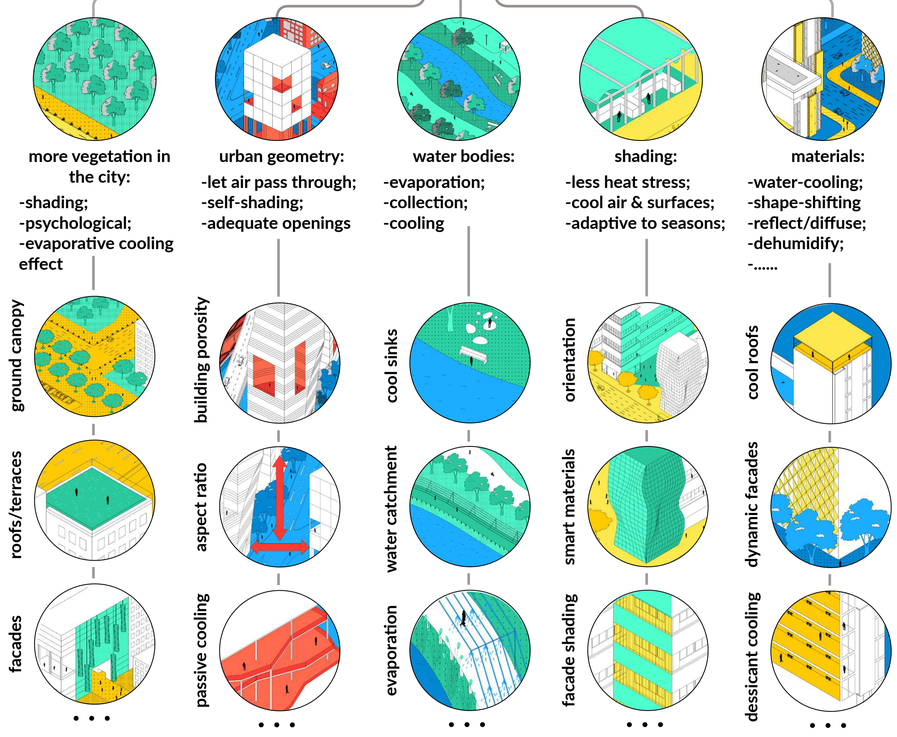
UHI: Heat map of Singapore



SOLUTIONS

"COOLING SINGAPORE" PROGRAM

STRATEGIES:



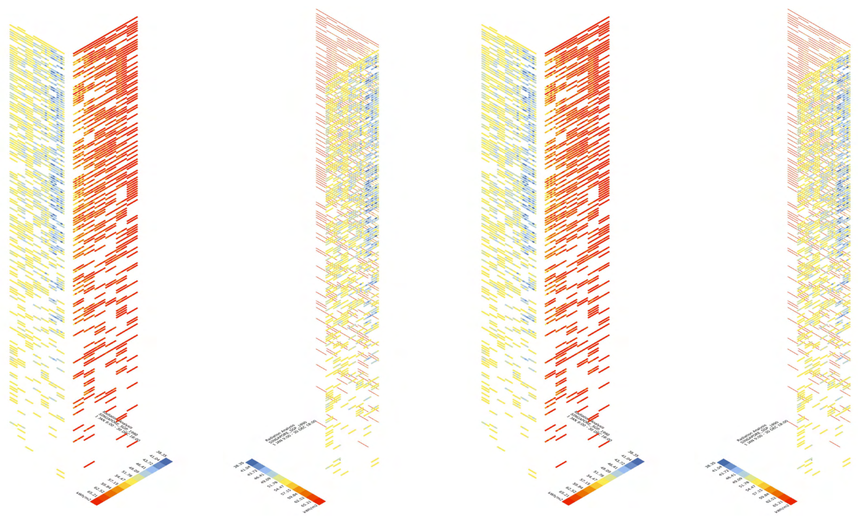
UHI effect solutions

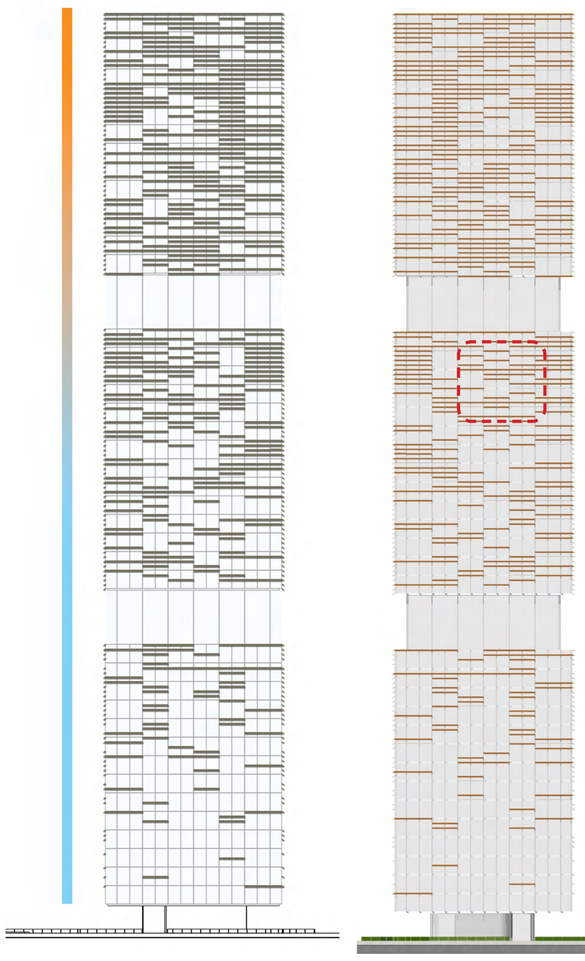
GROUP - 8 VERTICAL HABITAT IN CBD, SINGAPORE	**MATERIALS**	PANEL NUMBER 16	TEAM MEMBERS DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA	POLITECNICO MILANO 1863 FINAL THESIS 28-04-2022

PARKING & METRO CONNECTION

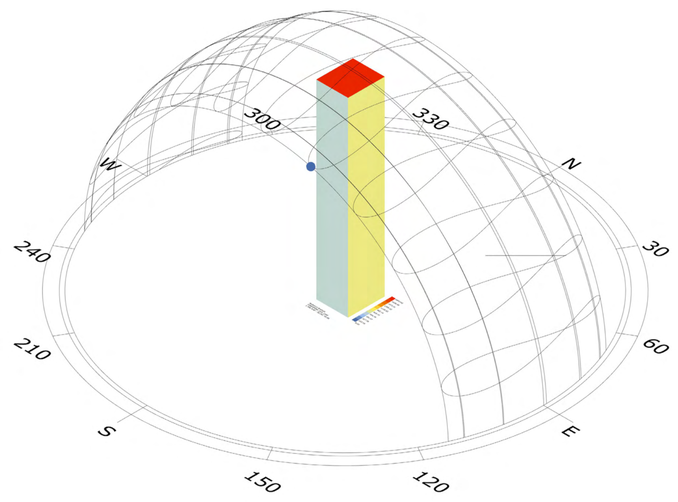
Basement plans & sections

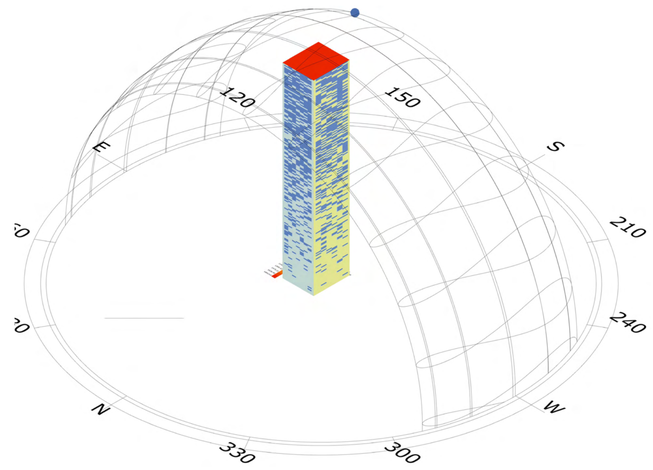
RADIATION ANALYSIS

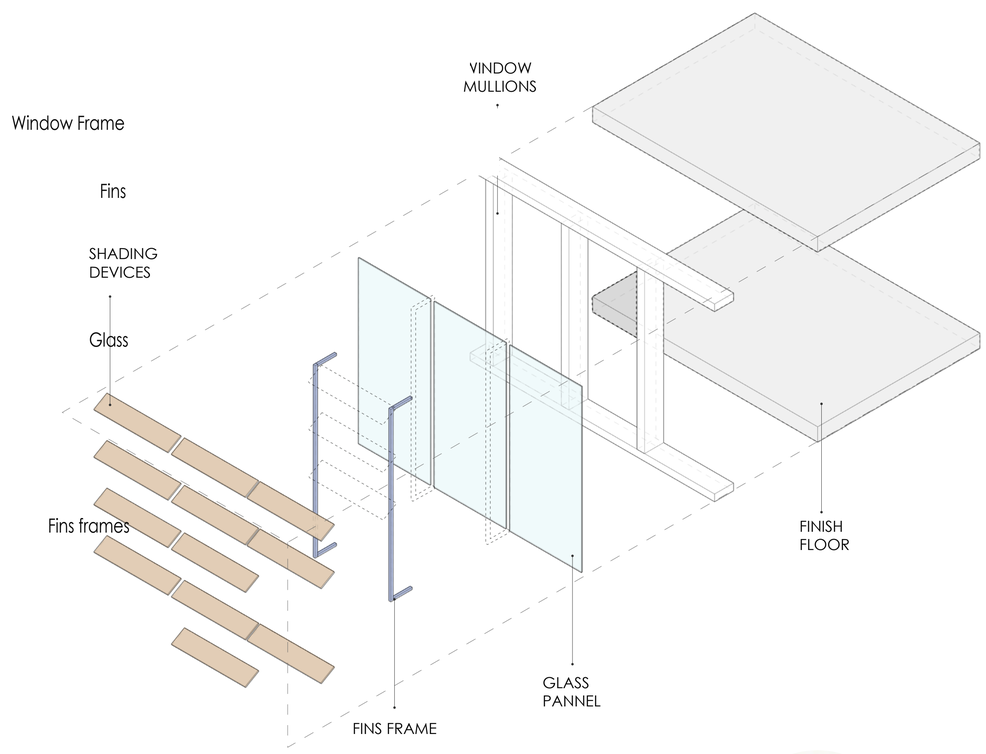


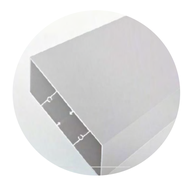


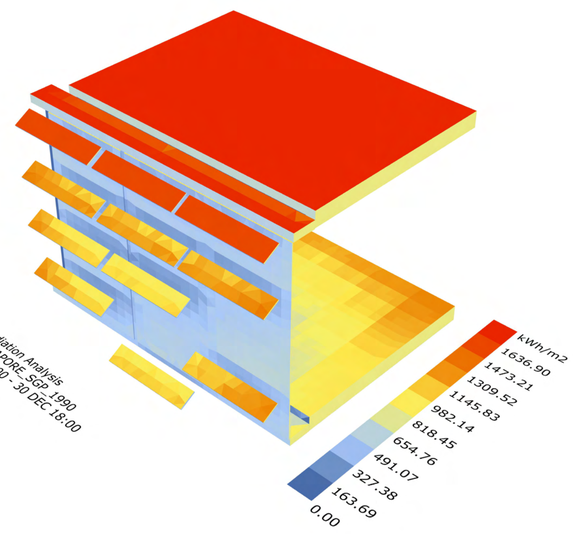
SUNPATH ANALYSIS

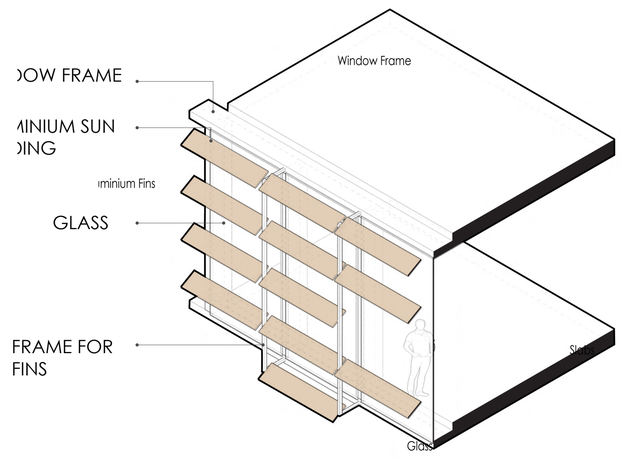






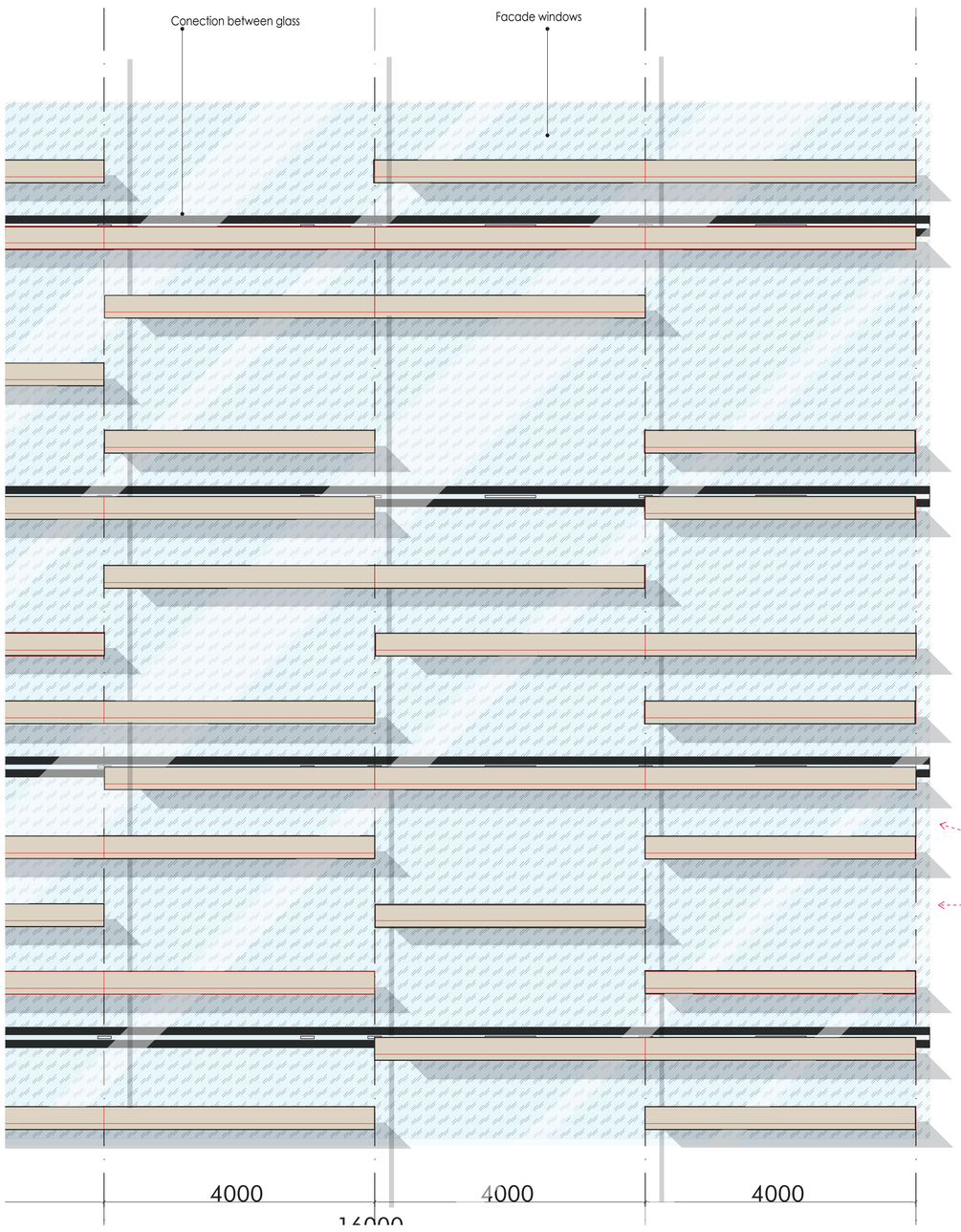


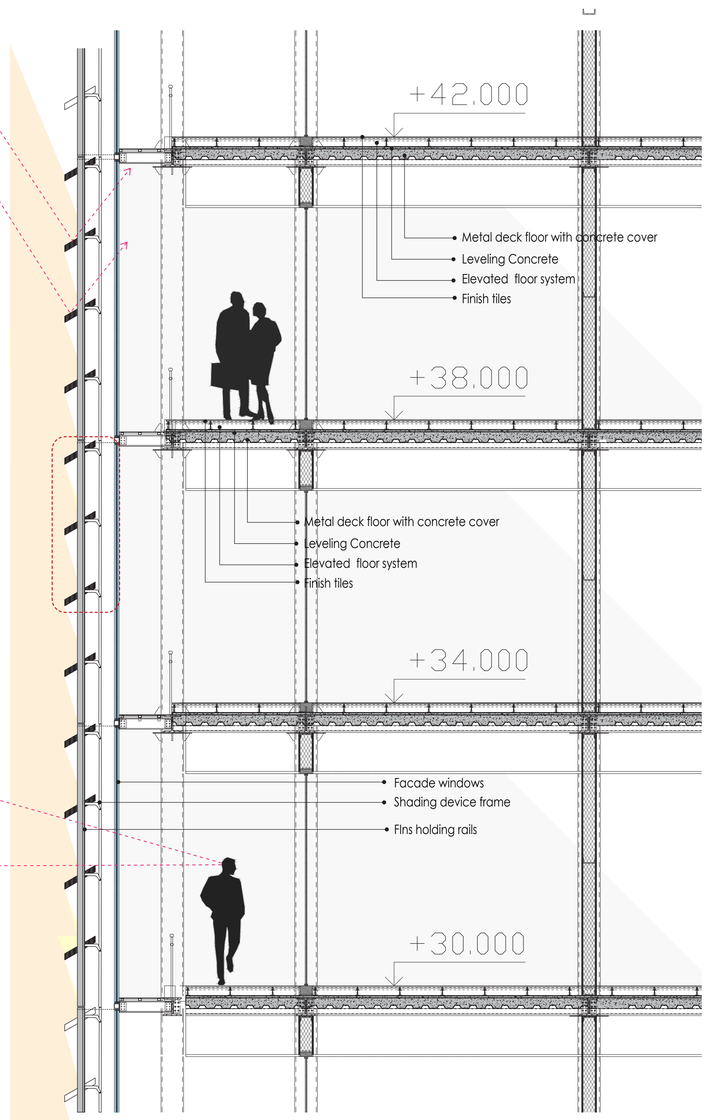




FACADE DETAILS

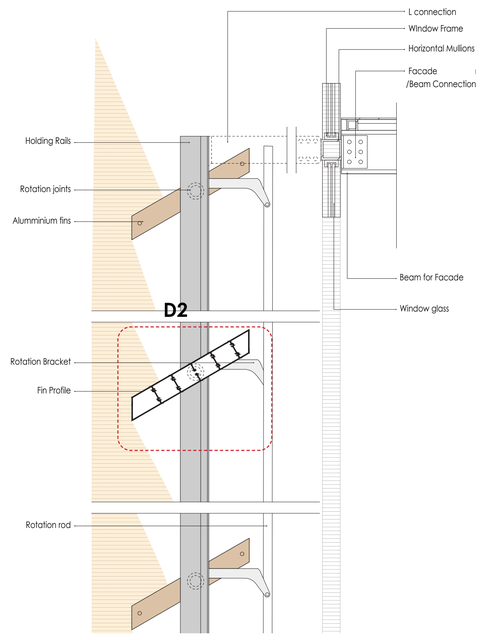
SCALE 1:50





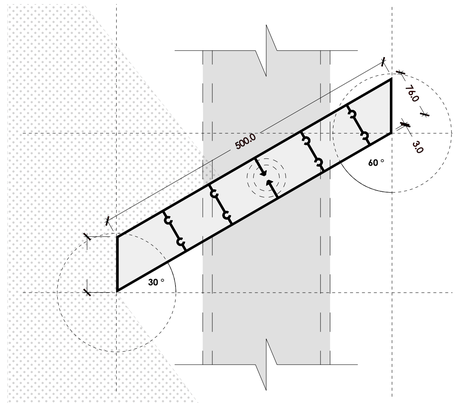
D1

SCALE 1:8



D2

SCALE 1:5



GROUP - 8 VERTICAL HABITAT IN CBD, SINGAPORE	FACADE DETAILS	PANEL NUMBER 16	TEAM MEMBERS DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA	POLITECNICO MILANO 1863 FINAL THESIS 28-04-2022

MEP

plumbing, hvac & electical distribution in the building

3RD BASEMENT PLAN WITH ALL THE MECHANICAL PLNATS

LEVEL -14 m

1ST BASEMENT PLAN WITH ALL THE MECHANICAL PLNATS

LEVEL -6 m

EXHAUST AREAS | ELECTRICAL DB | HOT WATER SUPPLY | RETURN AIR DUCTS

AHUS | CHILLERS | COLD WATER SUPPLY | FRESH AIR INTAKE

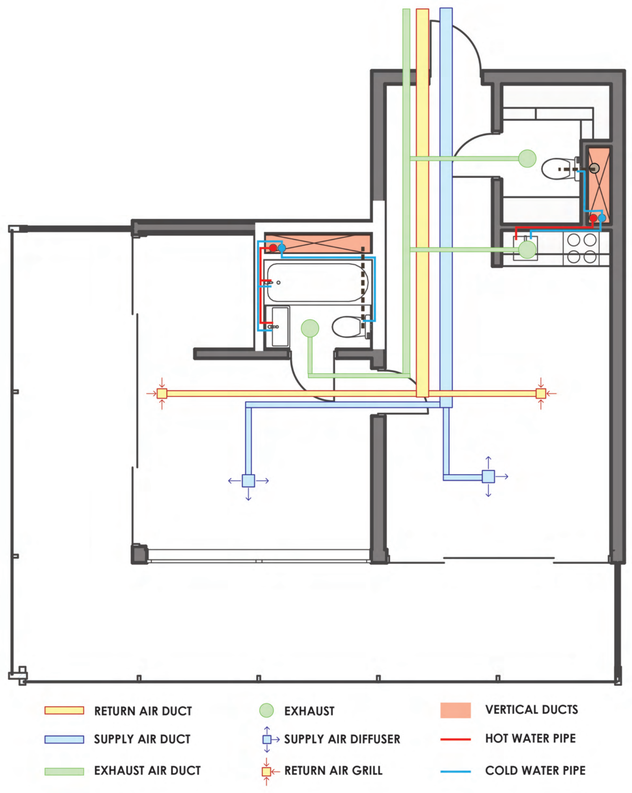
VERTICAL DUCTS | EXHAUST AIR | SUPPLY AIR DUCTS | SUPPLY DIFFUSER

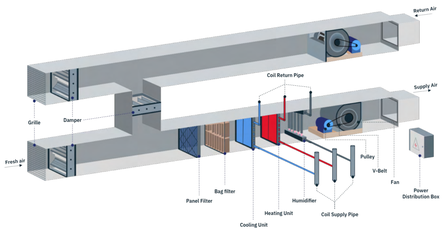
RETURN AIR DUCT | AHUS | VERTICAL DUCTS

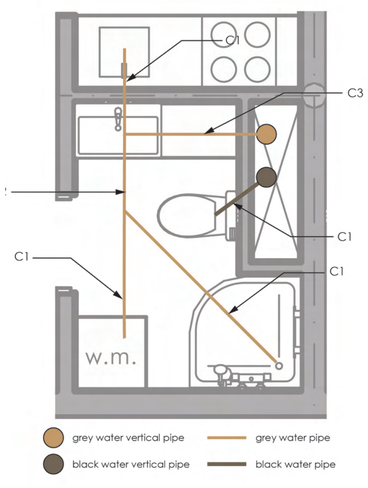
SUPPLY AIR DUCT | SEWAGE WATER TANK | HOT WATER FROM BOILER

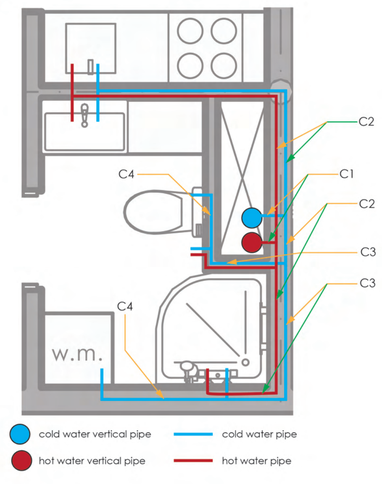
EXHAUST AIR DUCT | ELECTRICAL ROOM | COLD WATER FROM CHILLER

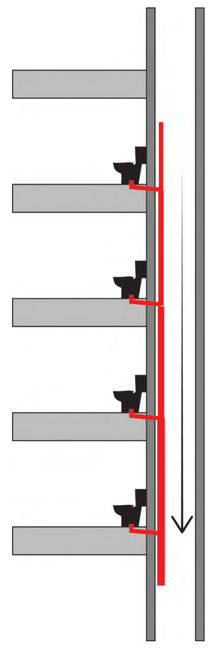
COLD WATER SUPPLY | HOT WATER SUPPLY | SEWAGE PIPES









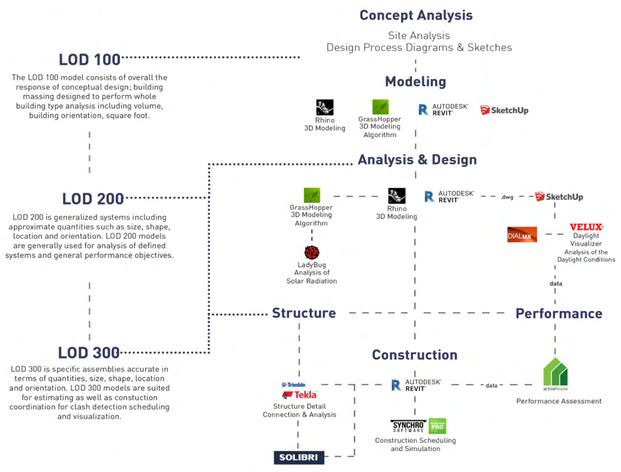


GROUP - 8 VERTICAL HABITAT IN CBD, SINGAPORE	**MEP**	PANEL NUMBER 17	TEAM MEMBERS DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA	POLITECNICO MILANO 1863 FINAL THESIS 28-04-2022

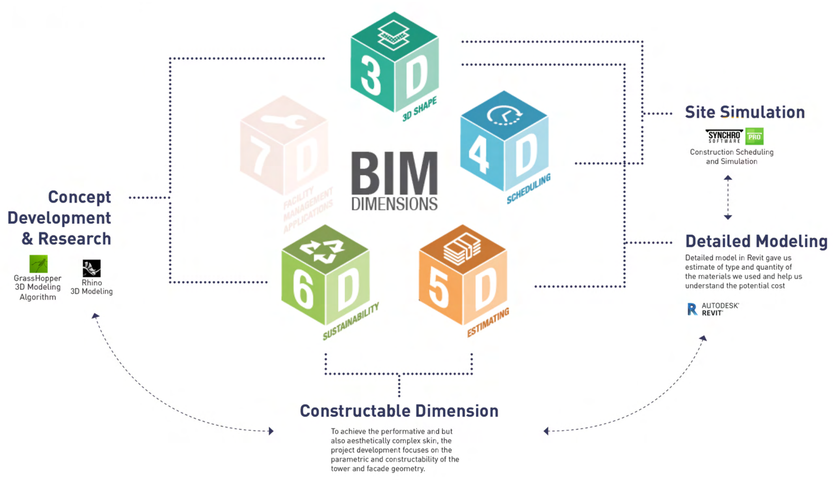
BIM

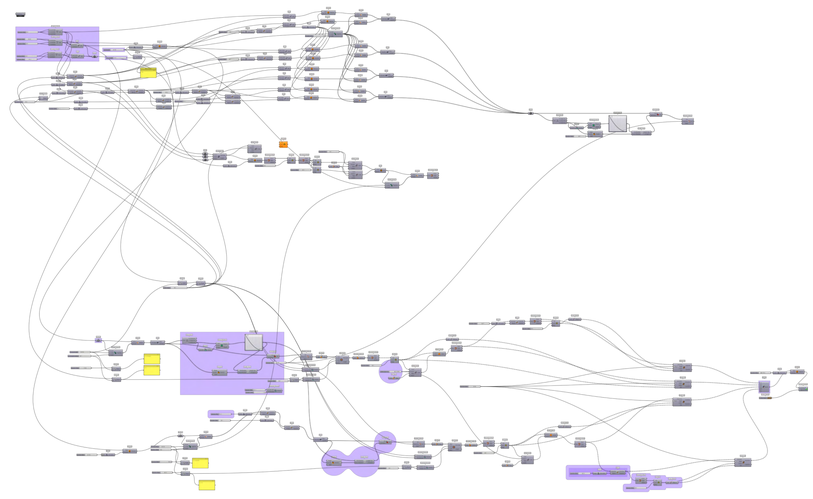
Radiation analysis, VIZ

BIM & LOD Workflow



BIM 6D Concept





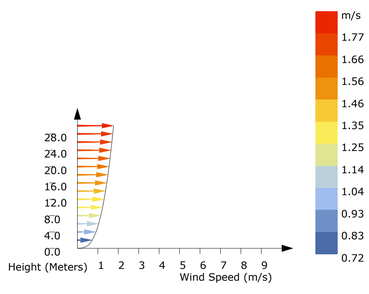
Solar Analysis

Wind-Rose
SINGAPORE_SGP
1 JAN 9:00 - 30 DEC 18:00
Hourly Data: Wind Speed (m/s)
Calm for 7.87% of the time = 686 hours.
Each closed polyline shows frequency of 0.7%. = 61 hours.

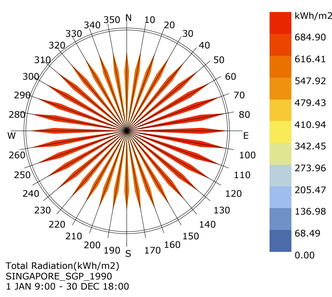
Total Radiation(kWh/m2)
SINGAPORE_SGP_1990
15 APR 9:00 - 30 JUN 15:00

Diffuse Radiation(kWh/m2)
SINGAPORE_SGP_1990
15 APR 9:00 - 30 JUN 15:00

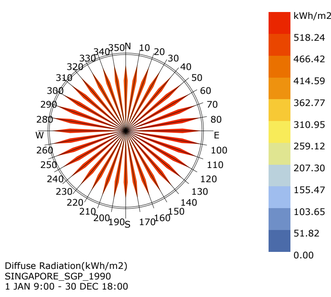
Direct Radiation(kWh/m2)
SINGAPORE_SGP_1990
15 APR 9:00 - 30 JUN 15:00



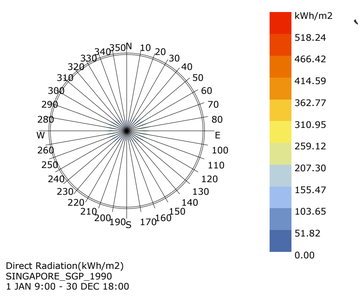
Wind Profile - Average Velocity In Time Period
SINGAPORE_SGP - City Terrain
15 APR 9:00 - 30 JUN 15:00



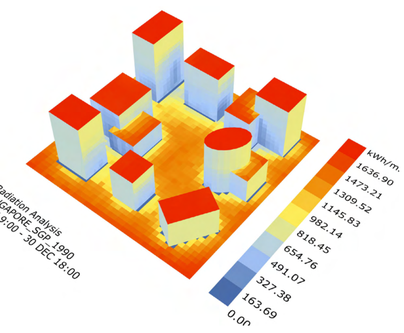
Total Radiation(kWh/m2)
SINGAPORE_SGP_1990
1 JAN 9:00 - 30 DEC 18:00

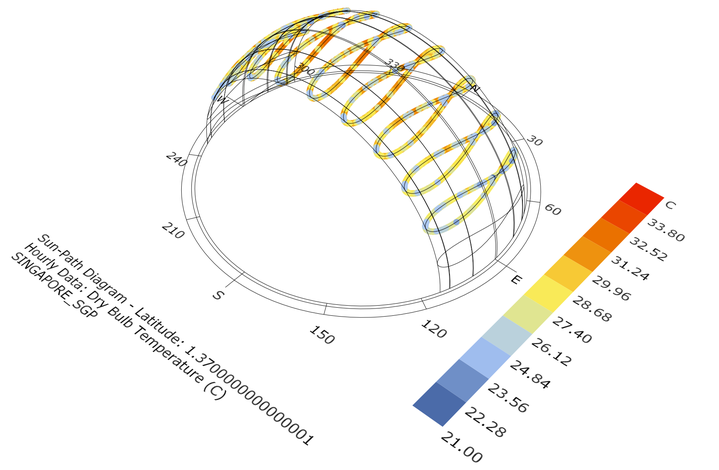


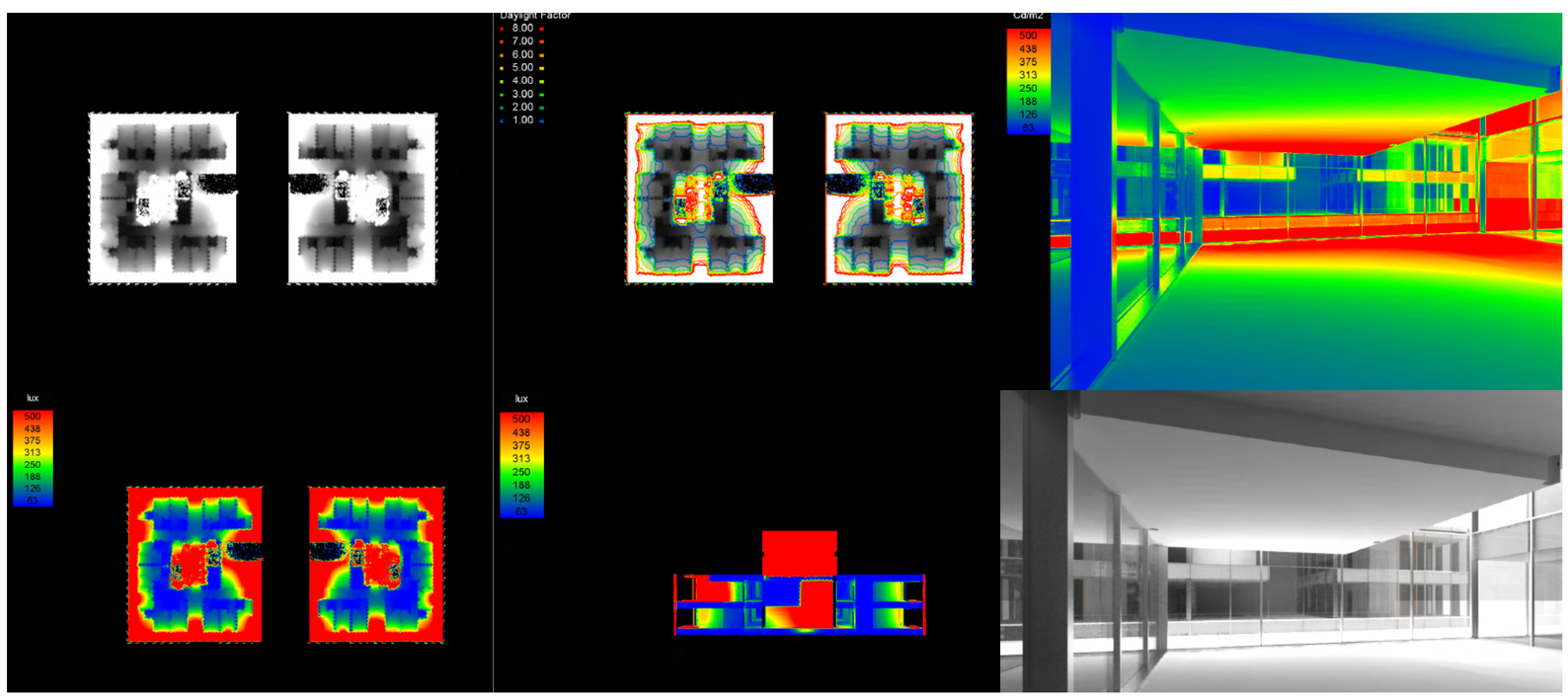
Diffuse Radiation(kWh/m2)
SINGAPORE_SGP_1990
1 JAN 9:00 - 30 DEC 18:00

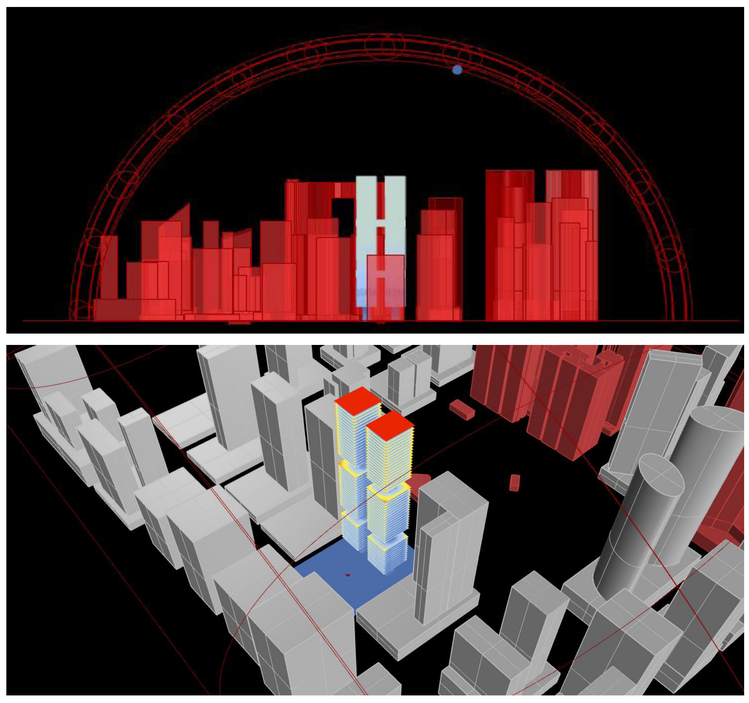


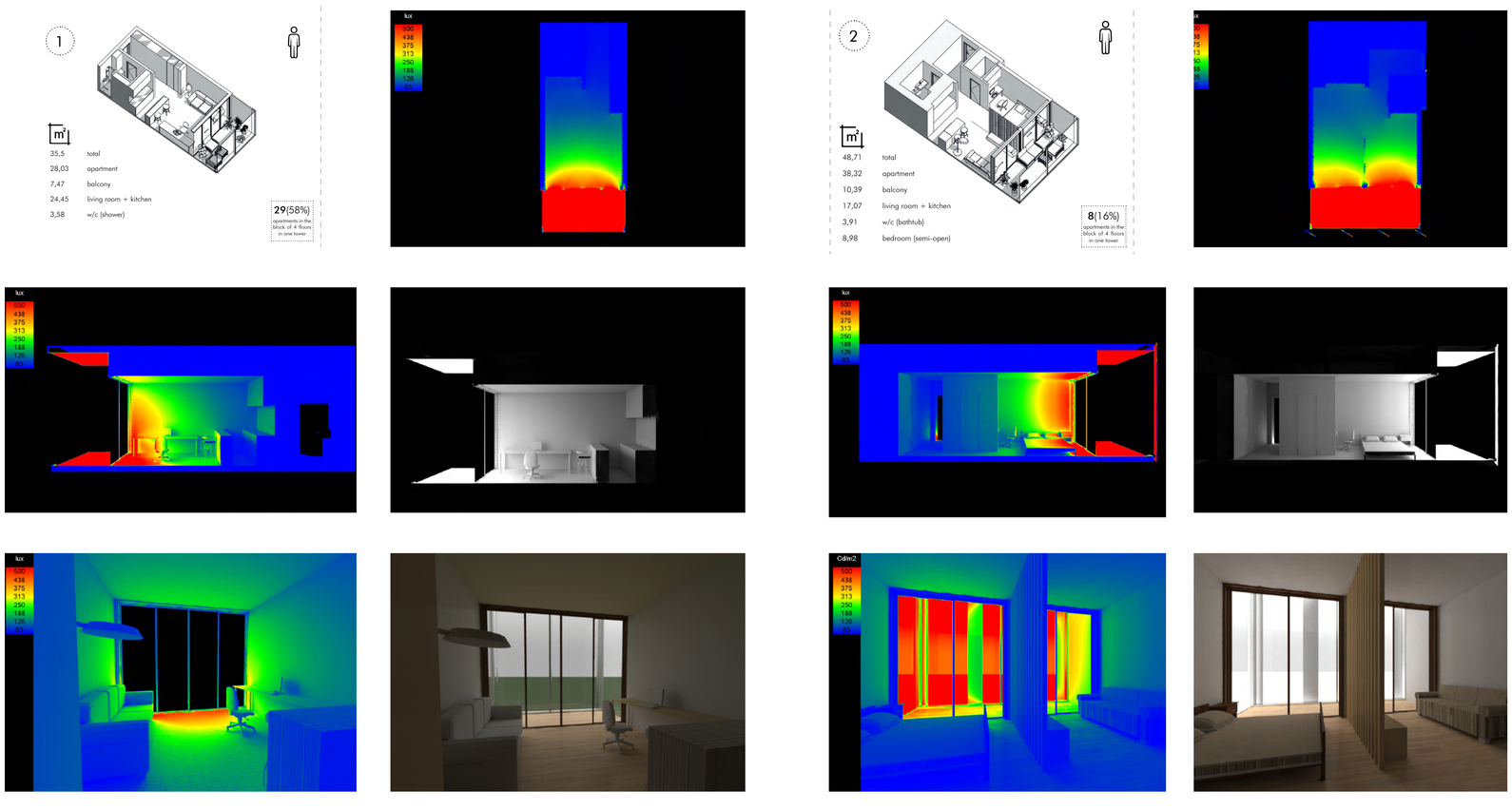
Direct Radiation(kWh/m2)
SINGAPORE_SGP_1990
1 JAN 9:00 - 30 DEC 18:00









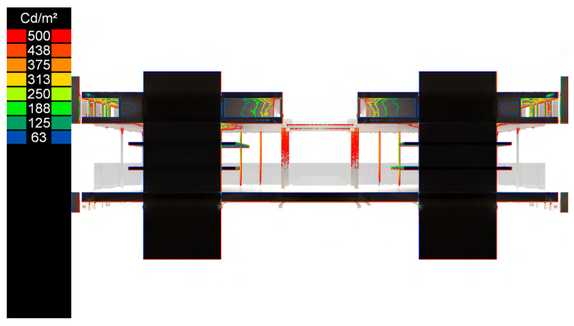


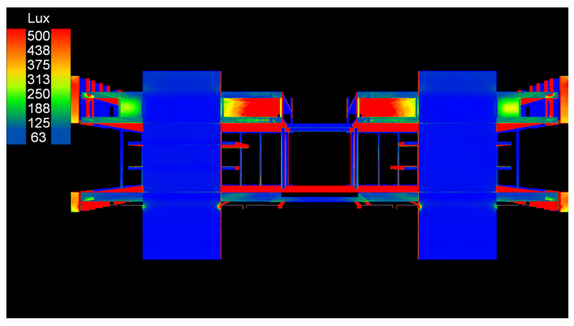
GROUP - 8 VERTICAL HABITAT IN CBD, SINGAPORE	**BIM**	PANEL NUMBER 18	TEAM MEMBERS DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA	POLITECNICO MILANO 1863 FINAL THESIS 28-04-2022

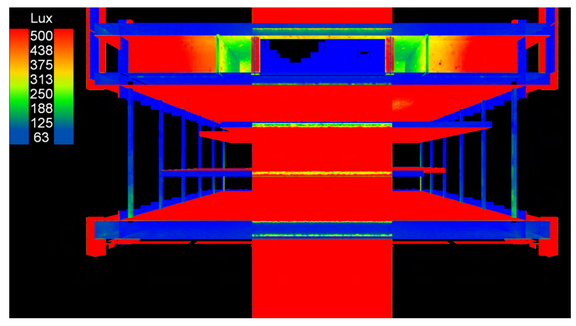
BIM

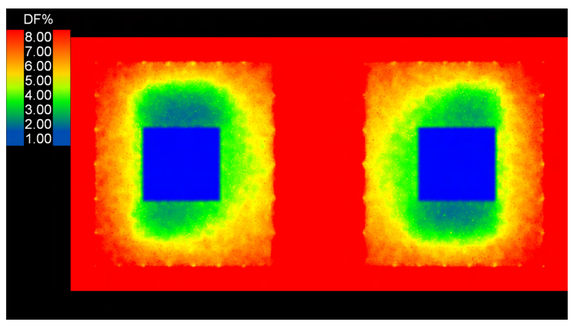
Radiation analysis, VIZ, Active House

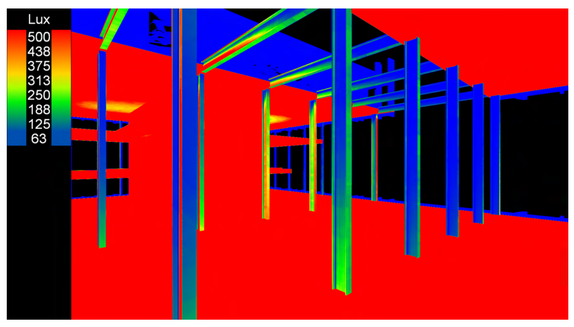
Garden floor Section

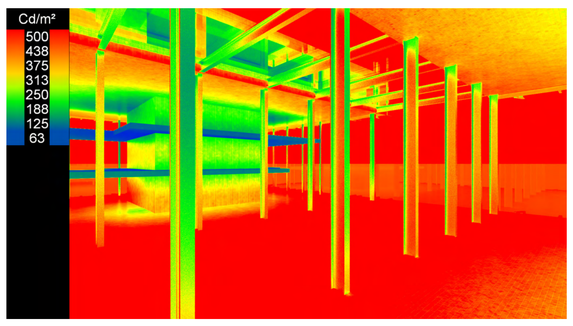






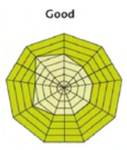


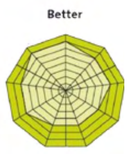


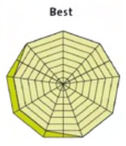


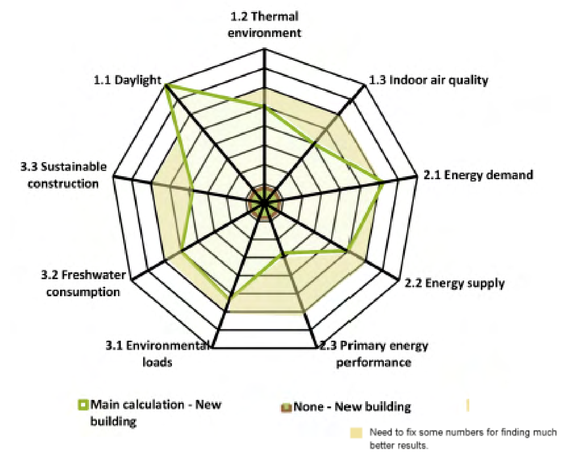
Main calculation - New building		
Comfort	**Value**	**Category**
1.1 Daylight:	6.5 %	1.0
1.2 Thermal environment:	Good level	2.5
1.3 Indoor air quality:	≤ 1000 ppm	3.0
Classification		
Energy	**Value**	**Category**
2.1 Energy demand:	58.0 kWh/m²	1.9
2.2 Energy supply:	35.8 kWh/m²	2.5
2.3 Primary energy:	24.3 kWh/m²	3.6
Classification		
Environment	**Value**	**Category**
3.1 Environmental loads:	Good level	2.3
3.2 Freshwater:	25 % savings	2.5
3.3 Sustainable construction:	Good level	3.1
Classification		

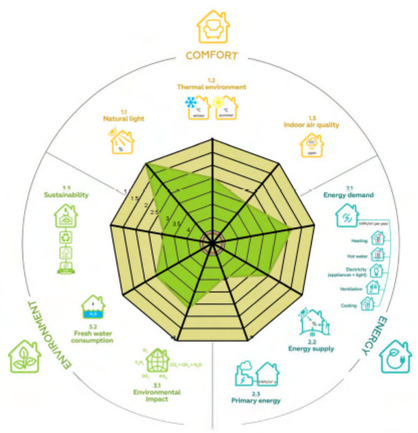
None - New building		
Comfort	**Value**	**Category**
1.1 Daylight:	0.0 %	-
1.2 Thermal environment:	Out of AH category	-
1.3 Indoor air quality:	> 1200 ppm	-
Classification		
Energy	**Value**	**Category**
2.1 Energy demand:	-	-
2.2 Energy supply:	0.0 kWh/m²	-
2.3 Primary energy:	0.0 kWh/m²	-
Classification		
Environment	**Value**	**Category**
3.1 Environmental loads:	Lowest level	-
3.2 Freshwater:	0 % savings	-
3.3 Sustainable construction:	Lowest level	-
Classification		









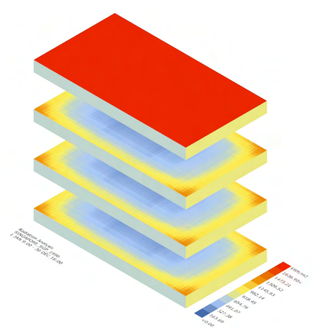


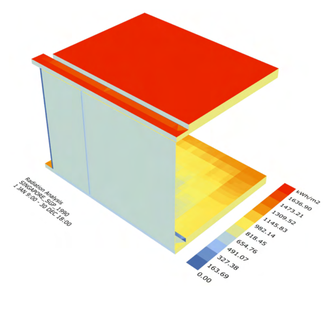
COMFORT

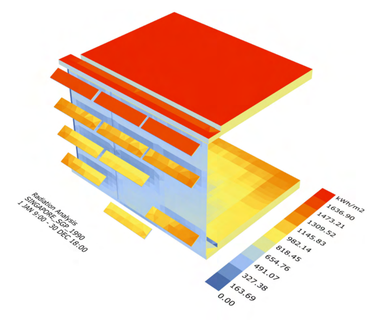
Parts in yellow show that this parameter of the building needs improvement. The daylight in the garden floor is good, reaching above 6.5%, as can be seen in the radar. The tested area of the building has decent thermal balance thanks to the applied ventilation strategies and shading systems. The air quality is reaching less than 1000 ppm, which can be considered a good result; that is attained by applying mechanical ventilation based on the needs of users; also, the choice of materials had been done as t osupport good air quality.

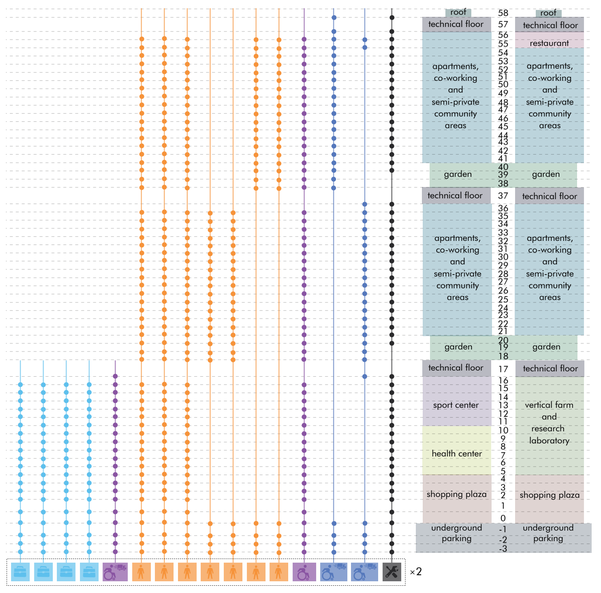
ENERGY

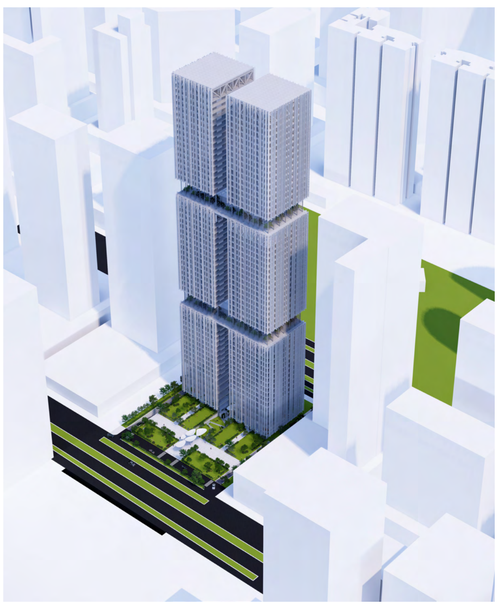
Energy-efficient technologies allowed the building to reach good levels of energy demand. Renewable energy is able to cover 35% of the needs of the building. The light supply of the internal gardens is mostly covered by the use of natural light - the shading system is designed to maximise light in spaces that need it and diffuse it where it is a problem.

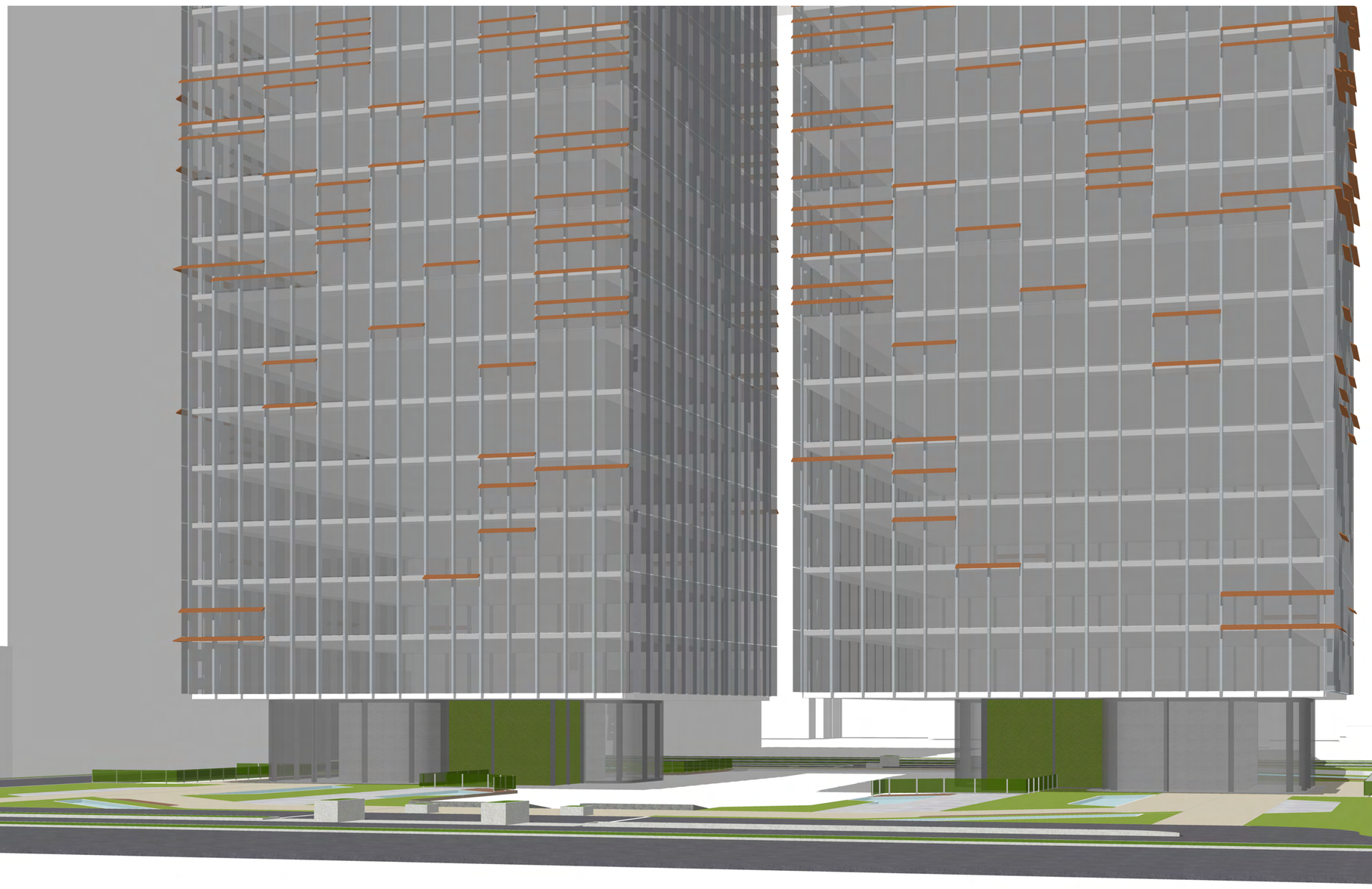








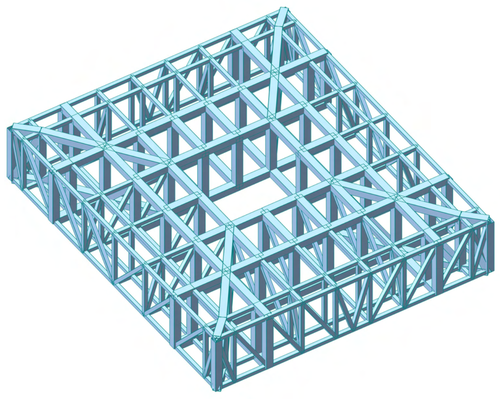


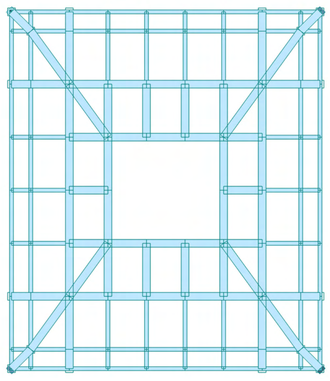


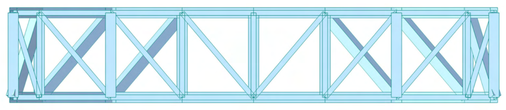
GROUP - 8 VERTICAL HABITAT IN CBD, SINGAPORE	BIM	PANEL NUMBER 19	TEAM MEMBERS DIANA TRUSHINA, HAMZA YASEEN, KRISTINA PERKOVA	POLITECNICO MILANO 1863	FINAL THESIS 28-04-2022

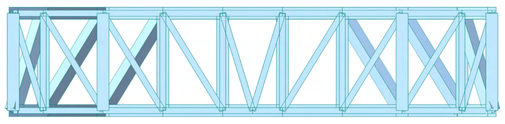
STRUCTURE

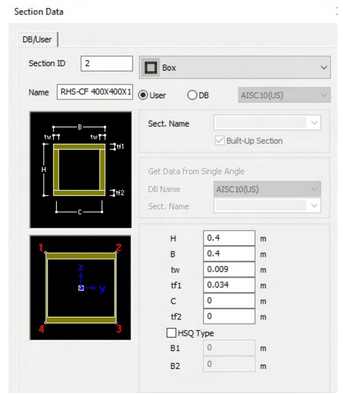
Midas analysis

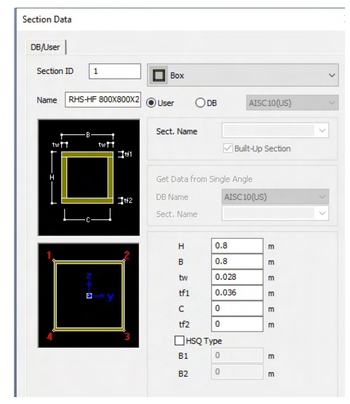




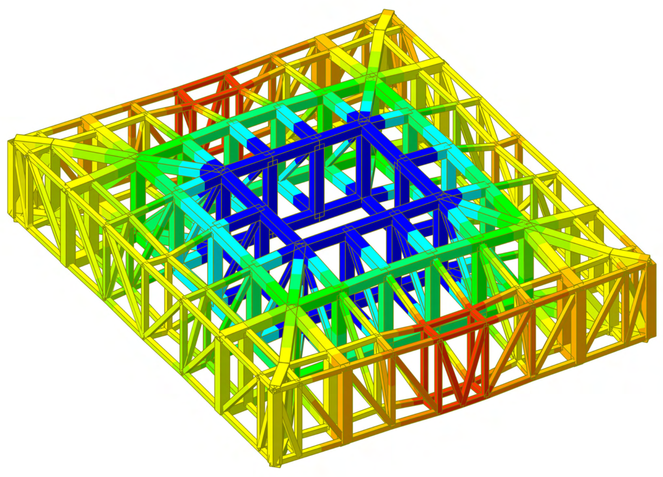








ALL DISPLACEMENT



midas Gen
POST-PROCESSOR
DISPLACEMENT
Z-DIRECTION
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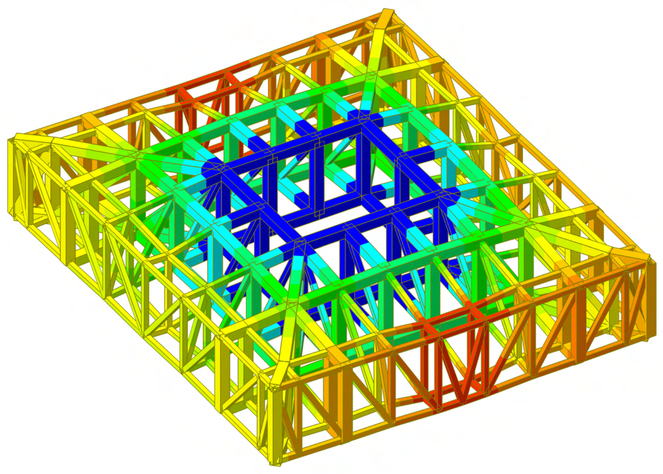
-9.46745e-03
-1.42012e-02
-1.89349e-02
-2.36686e-02
-2.84024e-02
-3.31361e-02
-3.78698e-02
-4.26035e-02
-4.73373e-02
-5.20710e-02
SCALEFACTOR= 3.6570E+01
CB: ALL
MAX : 78
MIN : 101
FILE: MIDAS FILE 6
UNIT: m
DATE: 03/31/2022
VIEW-DIRECTION
X:-0.422
Y:-0.702
Z: 0.574

DL DISPLACEMENT



midas Gen
POST-PROCESSOR
DISPLACEMENT
Z-DIRECTION
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-5.24904e-03
-7.87357e-03
-1.04981e-02
-1.31226e-02
-1.57471e-02
-1.83717e-02
-2.09962e-02
-2.36207e-02
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SCALEFACTOR= 6.5959E+01
CB: DL
MAX : 78
MIN : 101
FILE: MIDAS FILE 6
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DATE: 03/31/2022
VIEW-DIRECTION
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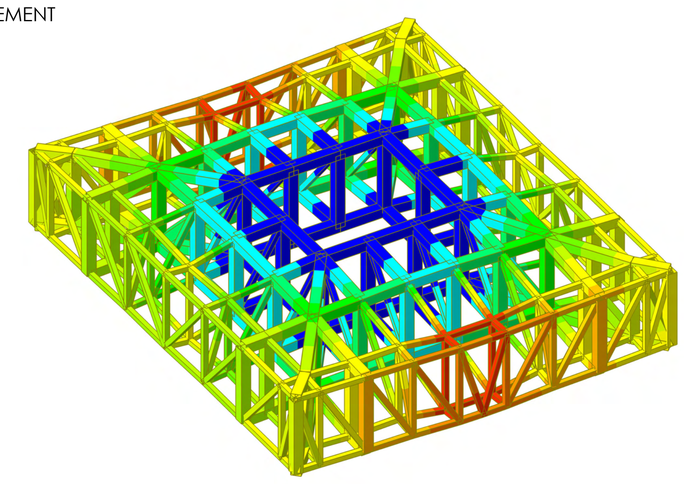
Y:-0.702
Z: 0.574

LL DISPLACEMENT



midas Gen
POST-PROCESSOR
DISPLACEMENT
Z-DIRECTION
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-4.21841e-03
-6.32761e-03
-8.43682e-03
-1.05460e-02
-1.26552e-02
-1.47644e-02
-1.68736e-02
-1.89828e-02
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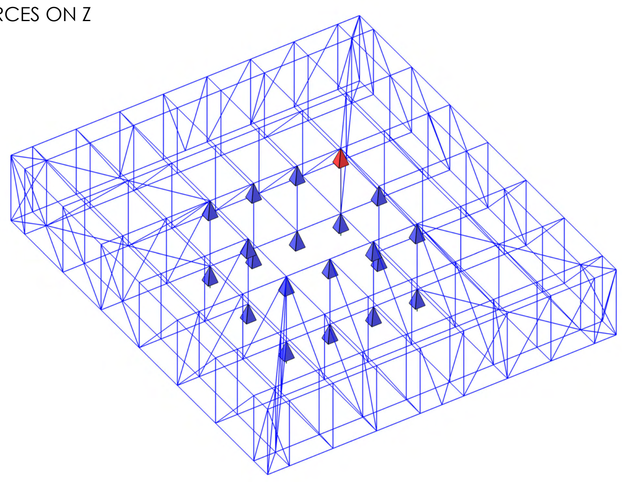
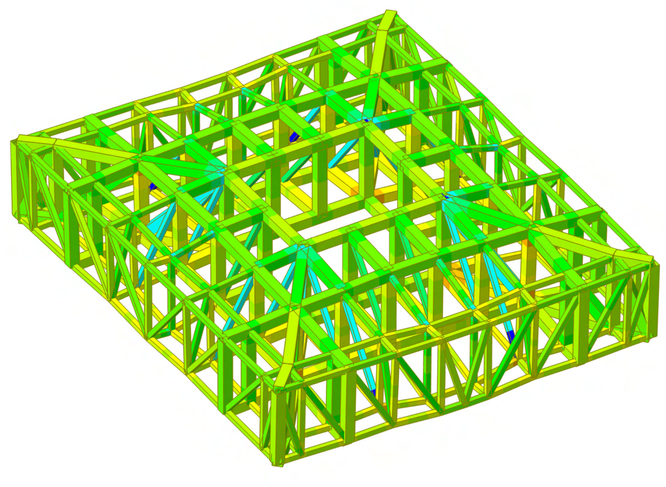
SCALEFACTOR= 8.2074E+01
CB: LL
MAX : 78
MIN : 101
FILE: MIDAS FILE 6
UNIT: m
DATE: 03/31/2022
VIEW-DIRECTION
X:-0.422
Y:-0.702
Z: 0.574

REACTION FORCES ON Z



midas Gen
POST-PROCESSOR
REACTION FORCE
FORCE-Z
MIN. REACTION
NODE= 80
FZ: 1.1585E+03
MAX. REACTION
NODE= 171
FZ: 3.0336E+04
CB: ALL
MAX : 171
MIN : 80
FILE: MIDAS FILE 6
UNIT: kN
DATE: 03/31/2022
VIEW-DIRECTION
X:-0.417
Y:-0.655
Z: 0.629

STRESS



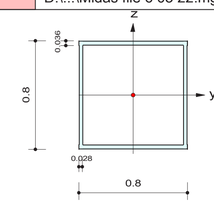
midas Gen
POST-PROCESSOR
BEAM STRESS
COMBINED
3.01372e+05
2.40807e+05
1.80623e+05
1.20411e+05
6.02408e+04
0.00000e+00
-4.67621e+04
-1.13454e+05
-1.80147e+05
-2.46839e+05
-3.13531e+05
-3.80224e+05
SCALEFACTOR= 4.1795E+01
CB: ALL
MAX : 367
MIN : 144
FILE: MIDAS FILE 6
UNIT: kN/m^2
DATE: 03/31/2022
VIEW-DIRECTION
X:-0.422
Y:-0.702
Z: 0.574

midas Gen — **Steel Checking Result**

MIDAS	Company		Project Title	
	Author	perkova.kristina@mail.ru	File Name	D:\...\Midas file 6 03 22.mgb

1. Design Information

Design Code Eurocode3:05 & SGP
Unit System kN, m
Member No 153
Material S355 (No:1)
(Fy = 355000, Es = 210000000)
Section Name RHS-HF 800X800X28/36 (No:1)
(Built-up Section).
Member Length : 4.00000



2. Member Forces

Axial Force Fxx = -9536.2 (LCB: 6, POS:I)
Bending Moments My = -4752.2, Mz = -859.70
End Moments Myi = -4752.2, Myj = 2171.92 (for Lb)
Myi = -4752.2, Myj = 2171.92 (for Ly)
Mzi = -859.70, Mzj = 859.700 (for Lz)
Shear Forces Fyy = -429.85 (LCB: 6, POS:1/2)
Fzz = -2046.8 (LCB: 6, POS:I)

Depth	0.80000	Web Thick	0.02800
Flg Width	0.80000	Top F Thick	0.03600
Web Center	0.77200	Bot.F Thick	0.03600
Area	0.09837	Asz	0.04480
Qyb	0.26271	Qzb	0.18928
Iyy	0.01021	Izz	0.00915
Ybar	0.40000	Zbar	0.40000
Wely	0.02553	Welz	0.02287
ry	0.32220	rz	0.30497

3. Design Parameters

Unbraced Lengths Ly = 4.00000, Lz = 4.00000, Lb = 4.00000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Result

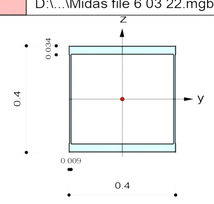
Slenderness Ratio
KL/r = 23.2 < 200.0 (Memb:519, LCB: 8)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 9536.2/34920.6 = 0.273 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 4752.2/10445.2 = 0.455 < 1.000 ..... O.K
M_Edz/M_Rdz = 859.70/9676.04 = 0.089 < 1.000 ..... O.K
Combined Resistance
R.MNRd = MAX[M_Edy/Mny_Rd, M_Edz/Mnz_Rd]
R.BiM = (M_Edy/Mny_Rd)^Alpha + (M_Edz/Mnz_Rd)^Beta
R.byN = N_Ed/(A*fy/Gamma_M0), R.byM = M_Edy/My_Rd + M_Edz/Mz_Rd
Rc.LT1 = N_Ed/(Xiy*A*fy/Gamma_M1)
Rb.LT1 = (kyy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (kyz*M_Edz)/(Wplz*fy/Gamma_M1)
Rc.LT2 = N_Ed/(Xiz*A*fy/Gamma_M1)
Rb.LT2 = (Kzy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (Kzz*M_Edz)/(Wplz*fy/Gamma_M1)
Rmax = MAX[R.MNRd, R.BiM, (R.byN+R.byM), MAX(Rc.LT1+Rb.LT1, Rc.LT2+Rb.LT2)] = 0.817 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.036 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.223 < 1.000 ..... O.K

midas Gen — **Steel Checking Result**

MIDAS	Company		Project Title	
	Author	perkova.kristina@mail.ru	File Name	D:\...\Midas file 6 03 22.mgb

1. Design Information

Design Code Eurocode3:05 & SGP
Unit System kN, m
Member No 144
Material S355 (No:1)
(Fy = 355000, Es = 210000000)
Section Name RHS-CF 400X400X12.5 UNI7 (No:2)
(Built-up Section).
Member Length : 4.00000



2. Member Forces

Axial Force Fxx = -234.02 (LCB: 6, POS:I)
Bending Moments My = -1863.3, Mz = 0.00000
End Moments Myi = -1863.3, Myj = 1185.64 (for Lb)
Myi = -1863.3, Myj = 1185.64 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 3, POS:1/2)
Fzz = -1218.3 (LCB: 6, POS:I)

Depth	0.40000	Web Thick	0.00900
Flg Width	0.40000	Top F Thick	0.03400
Web Center	0.39100	Bot.F Thick	0.03400
Area	0.03318	Asz	0.00720
Qyb	0.15204	Qzb	0.02859
Iyy	0.00097	Izz	0.00059
Ybar	0.20000	Zbar	0.20000
Wely	0.00484	Welz	0.00296
ry	0.17085	rz	0.13348

3. Design Parameters

Unbraced Lengths Ly = 4.00000, Lz = 4.00000, Lb = 4.00000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Result

Slenderness Ratio
KL/r = 63.8 < 200.0 (Memb:58, LCB: 14)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 234.0/11777.5 = 0.020 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 1863.31/1943.13 = 0.959 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.00/1380.35 = 0.000 < 1.000 ..... O.K
Combined Resistance
R.MNRd = MAX[M_Edy/Mny_Rd, M_Edz/Mnz_Rd]
R.byN = N_Ed/(A*fy/Gamma_M0), R.byM = M_Edy/My_Rd + M_Edz/Mz_Rd
Rc.LT1 = N_Ed/(Xiy*A*fy/Gamma_M1)
Rb.LT1 = (kyy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (kyz*M_Edz)/(Wplz*fy/Gamma_M1)
Rc.LT2 = N_Ed/(Xiz*A*fy/Gamma_M1)
Rb.LT2 = (Kzy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (Kzz*M_Edz)/(Wplz*fy/Gamma_M1)
Rmax = MAX[R.MNRd, R.BiM, (R.byN+R.byM), MAX(Rc.LT1+Rb.LT1, Rc.LT2+Rb.LT2)] = 0.978 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.826 < 1.000 ..... O.K

CHECKING RESULT