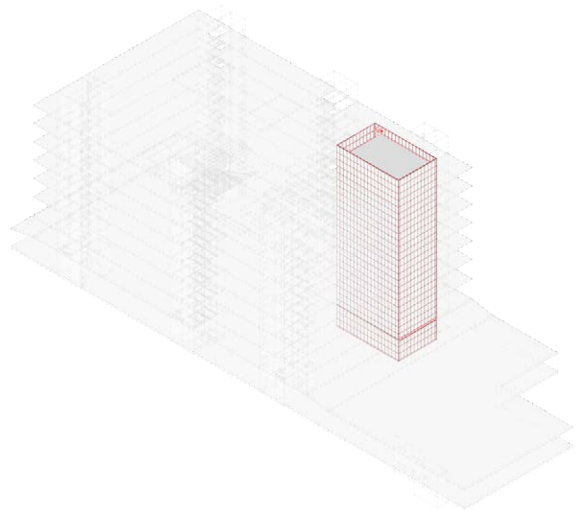
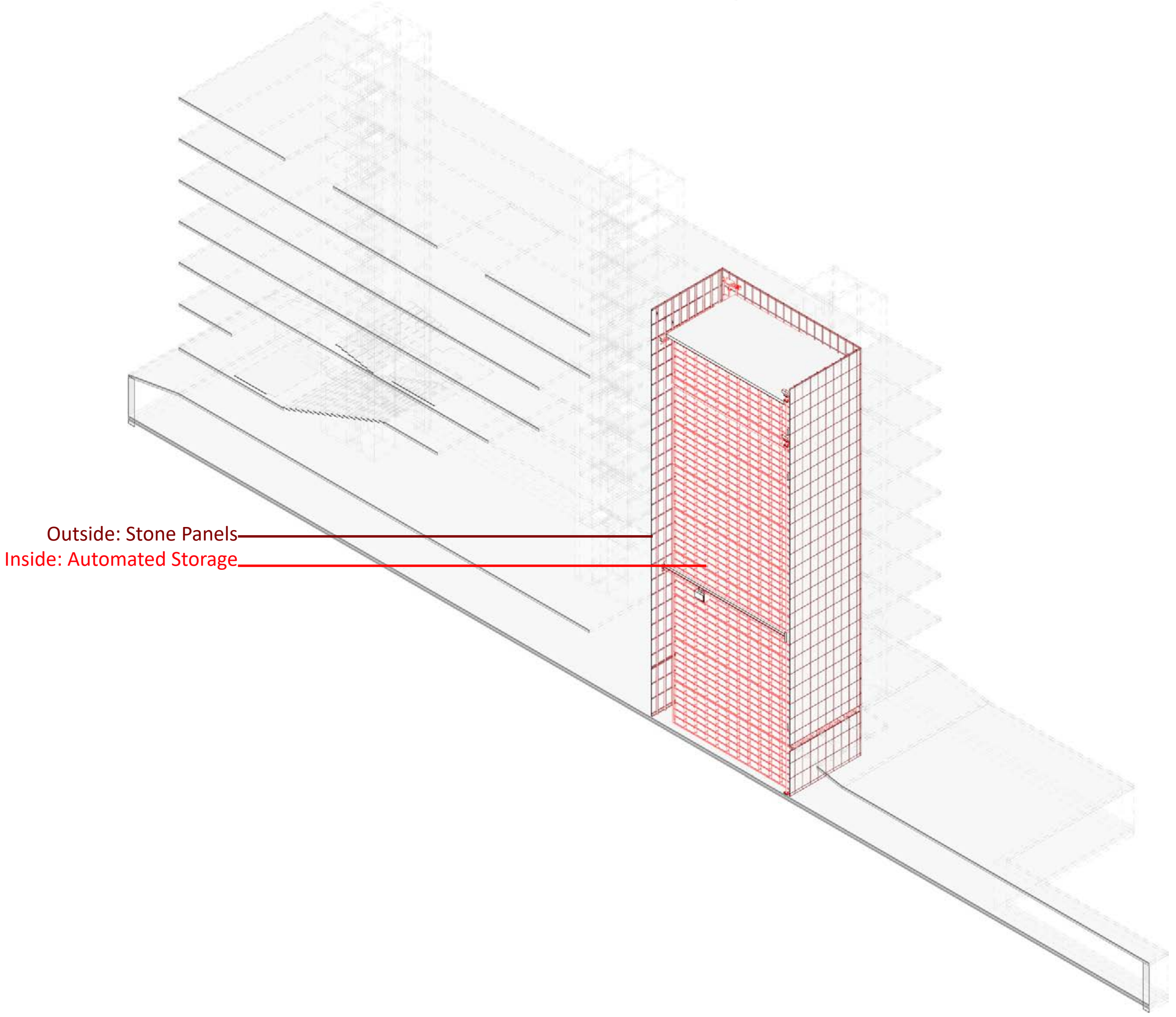
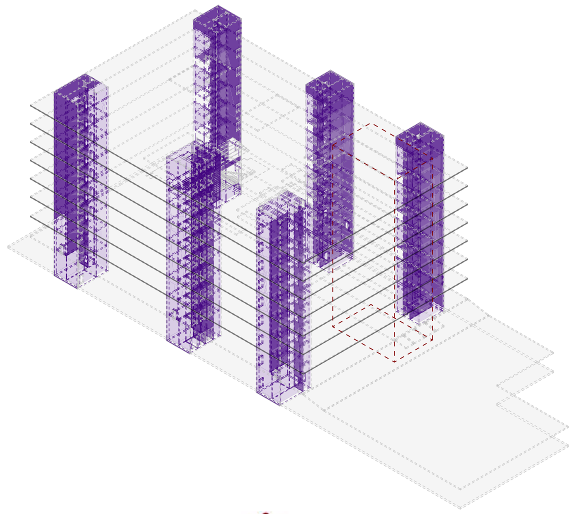
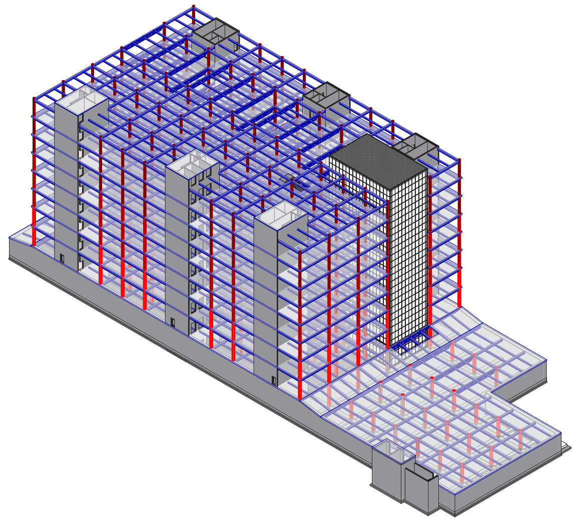
SELF-BEARING TOWER OF BOOKS
Autonomous Structure

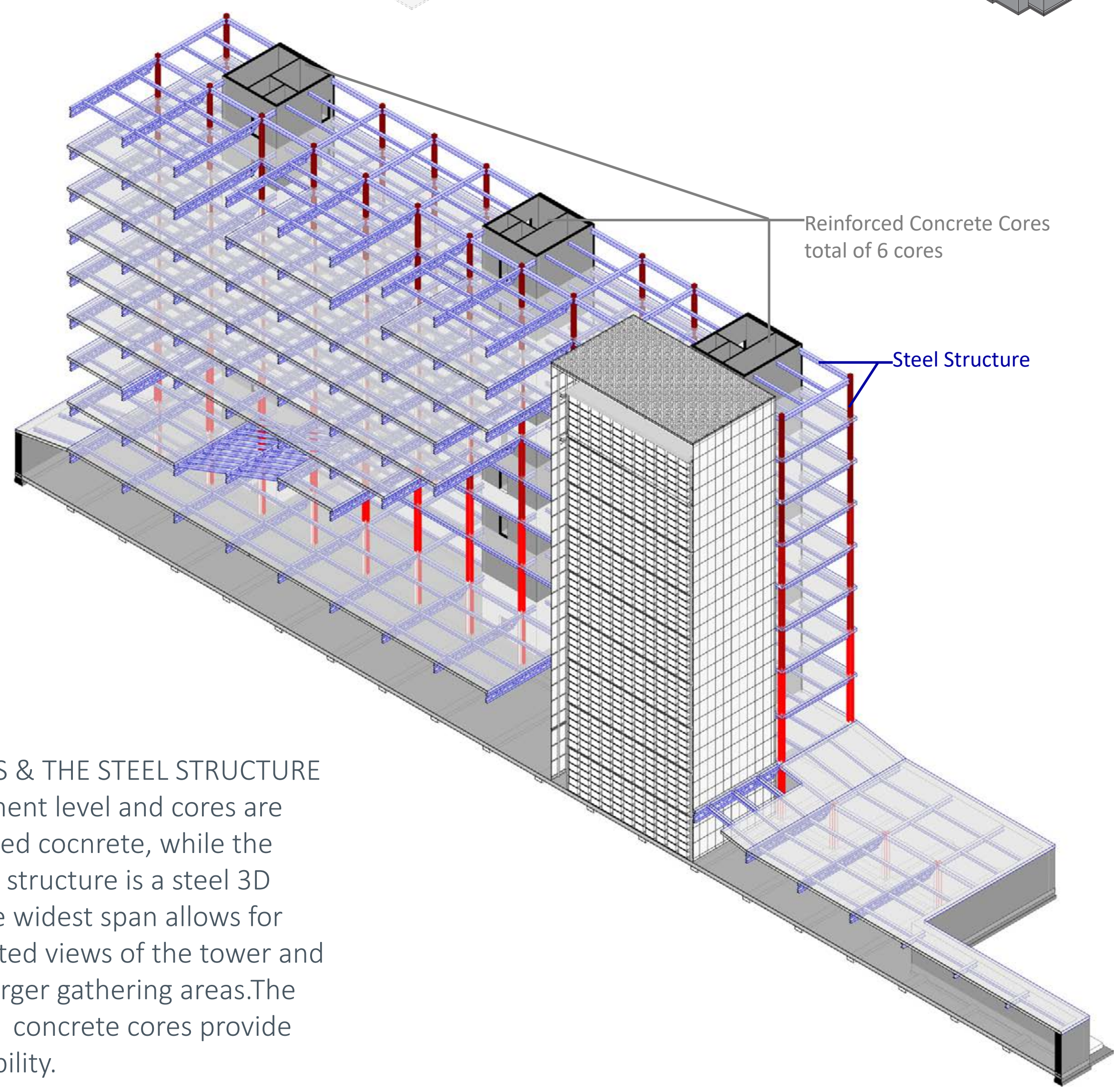




REINFORCED CONCRETE BASEMENT AND CORES & STEEL 3D FRAME
wide span opening views to the Tower of Books







R.C. CORES & THE STEEL STRUCTURE
The basement level and cores are of reinforced cocnrete, while the rest of the structure is a steel 3D frame. The widest span allows for unobstructed views of the tower and creating larger gathering areas.The reinforced concrete cores provide lateral stability.

Figure 60: Structural Elements I

TRUSSES ABOVE & TENSION CABLES
facade suspended from trusses for the perception of 'lightness'

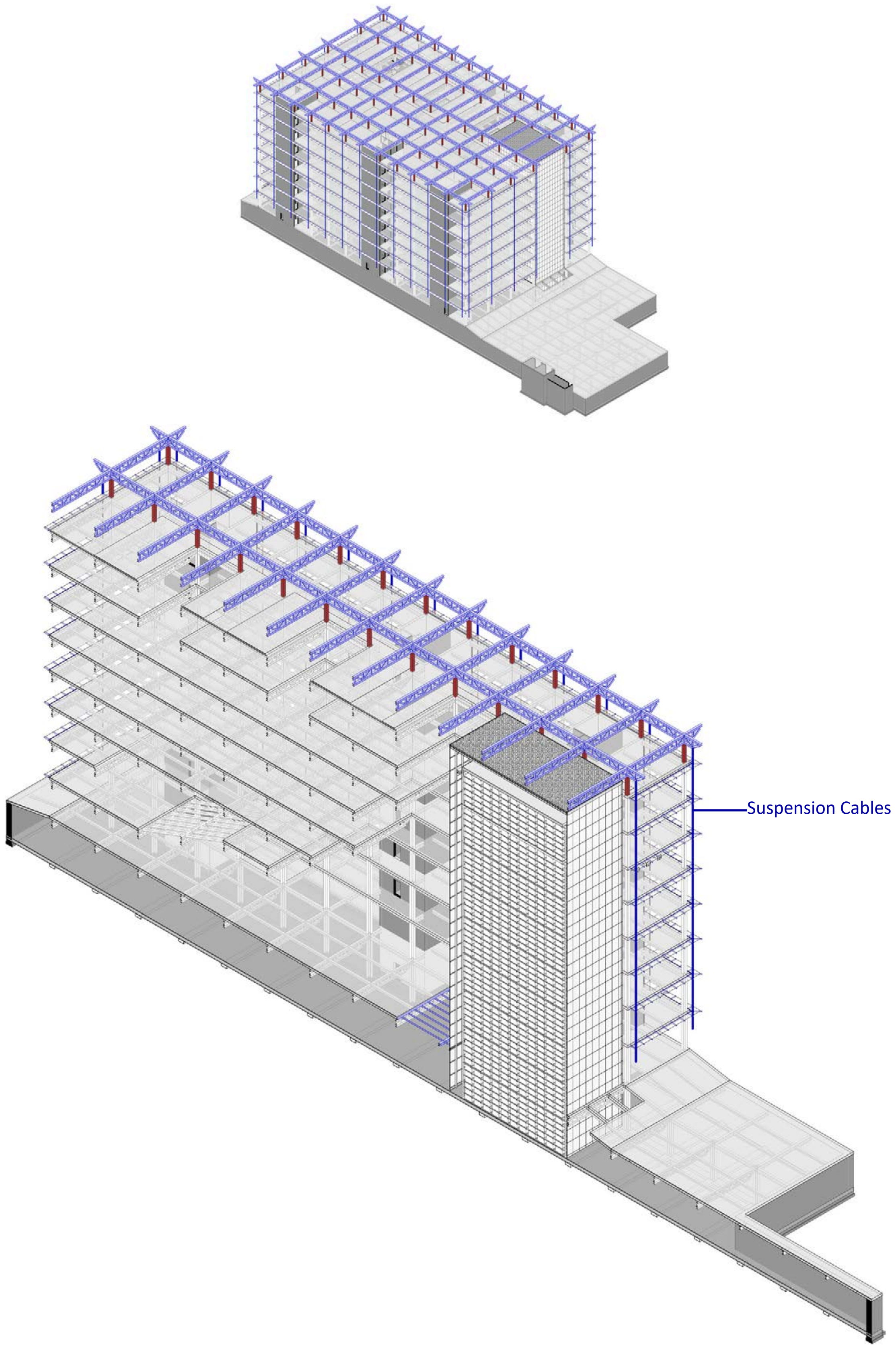


Figure 61: Structural Elements II

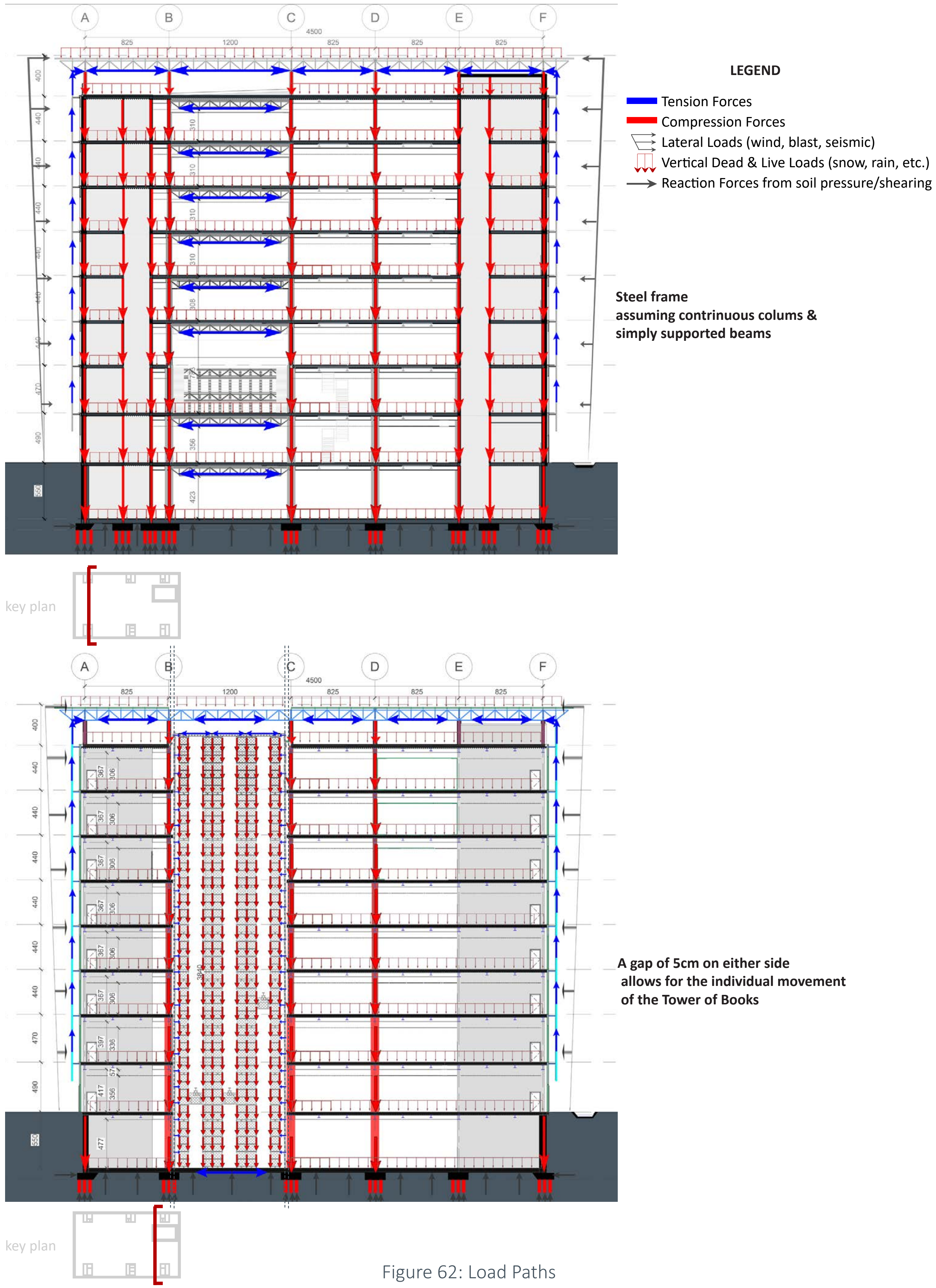
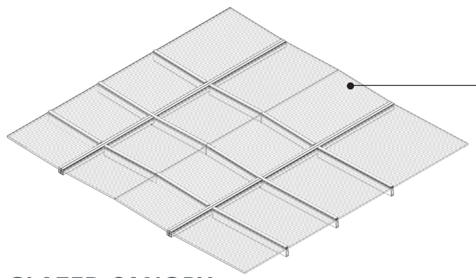


Figure 62: Load Paths

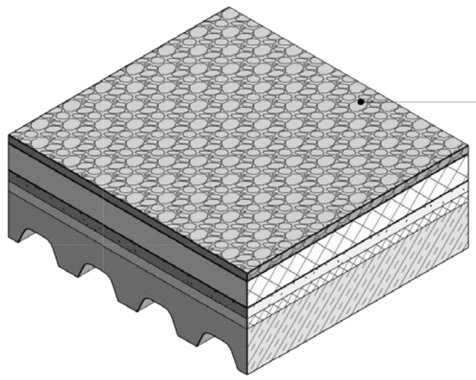
SLABS: Loads on typical slabs



3. Building integrated photovoltaics
2. Glazing
1. Aluminium profile

/overall thickness ~ 40 mm/

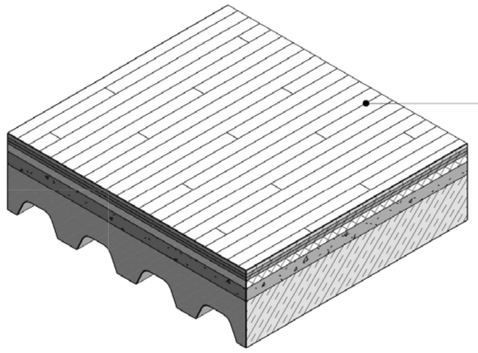
3 GLAZED CANOPY
Covered with Building Integrated Photovoltaics (BIPV)



8. Gravel, tks. 30mm
7. Filter sheet
6. Waterproofing membrane, tks. 4 mm
5. Isolating layer, tks.100 mm
4. Vapour barrier, tks. 4 mm
3. Screed sloping layer in concrete, tks. 40 mm
2. Acoustic insulation slabs, tks. 40 mm
1. Composite roof, tks. 180 mm in total:
   Steel deck, tks. 80 mm;
   Reinforced concrete layer

/overall thickness ~ 400 mm/

2 ROOF SLAB



8. Wood flooring - 15 mm
7. Wood flooring glue layer
6. Plywood layer - 12.5 mm
5. Plywood layer - 12.5 mm
4. Plywood glue layer
3. Acoustic board, 30 mm
2. Cement screed, tks. 50mm
1. Structural floor, tks. 180 mm in total:
   Steel deck 80 mm,
   Reinforced concrete

/overall tks - 300mm/

1 TYPICAL FLOOR SLAB

Note:
Chosen composite floor decking solution Cofraplus 80 by ArcelorMittal can be seen on the next page.

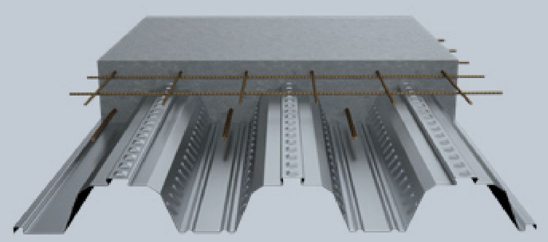
LOADS ON ROOF CANOPY		
	G1, self weight	0,294 kN/m^2
	Q1, maintenance	0,400 kN/m^2
	Q2 , snow load	0,842 kN/m^2
LOADS ON ROOF SLAB		
	G1, roof	4,931 kN/m^2
	Q1, roof	5,000 kN/m^2
LOADS ON TYP. FLOOR SLAB		
	G1, slab	6,043 kN/m^2
	Q1, slab	5,000 kN/m^2

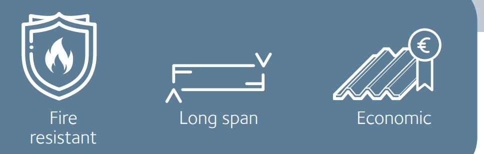
SUMMARY OF LOADS ON SLABS

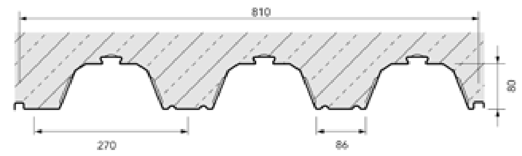
Cofraplus® 80

Composite floor decking with trapezoidal section

With its embossments and its dovetail geometry, Cofraplus® 80 is a performant composite slab solution, ideal alternative to precast slab.
Its lightness, its stackable design and its flexibility offers numerous of advantages not only from a mechanical point of view but also logistical and economical as well.
Cofraplus® 80 is compatible with all structural materials. Its specific accessories allow suspended options such as ceiling or ducts without any drillings.







Structural performance

Load/Span table

Design is made according to the Eurocodes.
The value provided in each cell of the table loads is the maximum live load capacity Q (kN/m²), with no safety factor. The self weight of the slab is already included.
The color of each cell give information about the required steel thickness.
A calculation using Cofra® 5 optimises these values according to the project requirements.

Single span — L

Thickness of the slab [cm]	Span [m]																				
	3,00	3,10	3,20	3,30	3,40	3,50	3,60	3,70	3,80	3,90	4,00	4,10	4,20	4,30	4,40	4,50	4,60	4,70	4,80	4,90	5,00
22	5.82	5.49	5,19	4,90	4,63	4,37	4,13	3,90	3,68	3,48	3,28	3,10	2,92	2,75	2,59	2,44	2,29	2,15	2,01	1,88	1,76
21	5.75	5.43	5,13	4,85	4,59	4,34	4,11	3,89	3,68	3,48	3,29	3,11	2,93	2,77	2,61	2,46	2,32	2,19	2,05	1,93	1,81
20	5.68	5,37	5,08	4,81	4,55	4,31	4,09	3,87	3,67	3,47	3,29	3,11	2,95	2,79	2,64	2,49	2,35	2,22	2,09	1,97	1,85
19	5.43	5,13	4,86	4,6	4,36	4,13	3,91	3,71	3,51	3,33	3,15	2,99	2,83	2,68	2,54	2,40	2,27	2,14	2,02	1,90	1,79
18	5.17	4,89	4,63	4,39	4,16	3,94	3,74	3,54	3,36	3,19	3,02	2,86	2,71	2,57	2,43	2,30	2,18	2,06	1,95	1,84	1,73
17	4.92	4,66	4,41	4,18	3,96	3,76	3,57	3,38	3,21	3,04	2,89	2,74	2,60	2,46	2,33	2,21	2,09	1,98	1,87	1,77	1,67
16	4.67	4,42	4,19	3,97	3,77	3,57	3,39	3,22	3,06	2,9	2,75	2,61	2,48	2,35	2,23	2,12	2,01	1,90	1,80	1,70	1,61
15	4.41	4,18	3,97	3,76	3,57	3,39	3,22	3,06	2,90	2,76	2,62	2,49	2,36	2,25	2,13	2,02	1,92	1,82	1,72	1,63	1,55
14	4.16	3,94	3,74	3,55	3,37	3,20	3,05	2,89	2,75	2,62	2,49	2,36	2,25	2,14	2,03	1,93	1,83	1,74	1,65	1,57	1,48
13	3.91	3,71	3,52	3,34	3,18	3,02	2,87	2,73	2,6	2,47	2,35	2,24	2,13	2,03	1,93	1,84	1,75	1,66	1,58	1,50	1,42
	Without propping											With propping									

Nominal concrete consumption

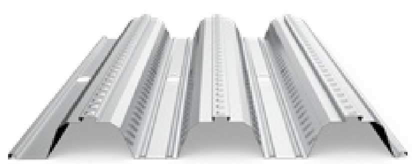
	Thickness of the slab [cm]												
	13	14	15	16	17	18	19	20	21	22	24	26	28
Concrete volume [l/m²]	85	95	105	115	125	135	145	155	165	175	195	215	235
Theoretical weight* of the composite slab [kg/m²]	213	238	263	288	313	338	363	388	413	438	488	538	588

Concrete density 25 kN/m³
Maximum recommended slab thickness d = 28 cm
*Additional weight du to pounding effect is not included

Able to reach spans:
- Up to 4,5 m without props
- Up to 6,5 m with props

Reduces by 15% the CO2 emission and 30% lighter compared to a precast solution.
Flexible, sustainable and easy to install, Cofraplus® 80 is adapted to every kind of modern construction project.

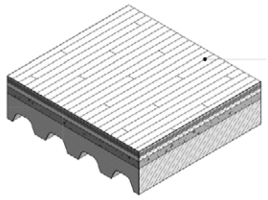
Cofraplus® 80 P:
Pre-punched version, compatible with shear connectors, welded in advance or in shop to the composite beams.



14 ArcelorMittal Construction Floors guide 06/2021

Reference: *ArcelorMittal Floors Guide Composite Floor Solutions, p.14-15*

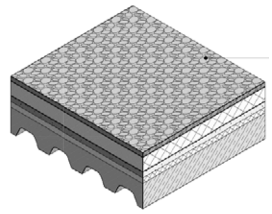
SLABS: Loads on typical slabs



1 TYPICAL FLOOR SLAB

LOADS ON TYPICAL FLOOR SLAB				
Gk (Dead Loads)				
Self Weight	Thickness (m)	γ (kN/m^3) (g=9,81 m/s^2)	qk (kN/m^2)	
Oak Floor Planks	0,015	5,884	0,088	
Plywood Sheathing	0,013	3,923	0,049	
Plywood Sheathing	0,013	3,923	0,049	
Glasswool	0,030	14,710	0,441	
Cement Screed	0,050	3,923	0,196	
Composite Floor Slab	0,180	-	3,315	
R. Concrete: C25/30 with density 25 kN/m3	0,100	-	-	
Trapezoidal metal deck: S 350 GD, galvanized	0,080	-	-	
floor slab thickness:	0,300	**Weight, floor slab**	**4,139**	
Partition Walls	Thickness (m)	γ (kN/m^3)	qk (kN/m^2)	
Type C Fire Resistant Gypsum	0,013	75,000	0,953	
Type C Fire Resistant Gypsum	0,013	75,000	0,953	
Fiberglass insulation	0,060	0,012	0,001	
25-Gauge EQ Galvanized Steel Stud	0,000	0,130	0,000	
Type C Fire Resistant Gypsum	0,013	75,000	0,953	
Type C Fire Resistant Gypsum	0,013	75,000	0,953	
		Weight, partitions	3,811	*EN 1991-1-1:2002 (E) 6.3.1.2(8) for movable partitions with a self weight ≤1,0 kN/m wall*
		Weight, partitions	**0,500**	
Suspended Ceilings*	Thickness (m)	γ (kN/m^3)	qk (kN/m^2)	
Galvanized steel framing	0,010	76,002	0,760	
Oak Battens	0,050	5,884	0,294	
		Weight,ceiling	**1,054**	*suspended from the beams, the weight of the ceiling is considered in this section to group*
Fixed Services (Lifts+MEP)	Thickness (m)	γ (kN/m^3)	qk (kN/m^2)	
	n/a	n/a	n/a	
Skin 1 (Curtain Wall)	Thickness (m)	γ (kN/m^3)	qk (kN/m^2)	
Curtain Wall (laminated double glass)	n/a	n/a	0,350	
		Weight,skin 1	**0,350**	
		G1, slab	**6,043**	**kN/m^2**

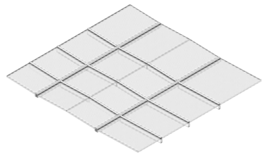
Qk (Live Loads)				
Q1 Live Load				
Floor Level	Use	Category	qk (kN/m^2)	*EN 1991 Eurocode 1 Table 6.2*
7	Library	C3	5,000	
		Q1, slab	**5,000**	**kN/m^2**



2 ROOF SLAB

LOADS ON ROOF SLAB				
Gk (Dead Loads)				
Self Weight	Thickness (m)	γ (kN/m^3) (g=9,81 m/s^2)	qk (kN/m^2)	
Gravel	0,030	0,014	0,000	
Polyethylene Foil Filter Sheet	0,002	0,001	0,000	
BITUMAT PVC Waterproofing Membrane	0,004	0,001	0,000	
Extruded Polystyrene Thermal Insulation	0,100	0,275	0,028	
Low-density polyethylene (LDPE) Vapour Barrier	0,004	0,001	0,000	
Concrete Screed	0,040	25,000	1,000	
Glasswool	0,040	14,710	0,588	
Composite Floor Slab	0,180	-	3,315	
R. Concrete: C25/30 with density 25 kN/m3	0,100	-	-	
Trapezoidal metal deck: S 350 GD, galvanized	0,080	-	-	
roof slab thickness:	0,400	**Weight, roof slab**	**4,931**	
Fixed Services (Lifts+MEP)	Thickness (m)	γ (kN/m^3)	qk (kN/m^2)	
	n/a	n/a	n/a	
		G1, roof	**4,931**	**kN/m^2**

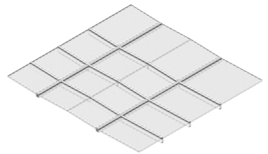
Qk (Live Loads)				
Q1 Live Load				
Floor Level	Use	Category	qk (kN/m^2)	*EN 1991 Eurocode 1 Table 6.2 & 6.9*
8	Rooftop	I	5,000	
		Q1, roof	**5,000**	**kN/m^2**



3 **GLAZED CANOPY**
Covered with BIPV

LOADS ON ROOF CANOPY				
Gk (Dead Loads)				
G1: Self Weight	Weight (kg/m)	γ (kN/m^3) (g=9,81 m/s^2)	qk (kN/m^2)	
Building Integrated Photovoltaics	-	-	-	
Glass Panels & Aluminium profiles	-	-	-	
		Weight, canopy	**0,294**	30 kg/m^2
		G1, canopy	**0,294**	**kN/m^2**

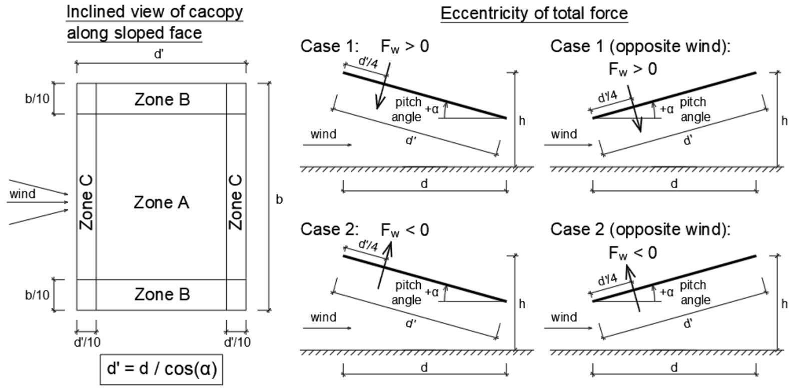
Qk (Live Loads)				
Q1: Live Load (maintenance)	Canopy	H	0,40	*EN 1991 Eurocode 1 Table 6.2 & 6.9*
		Q1, maintenance	**0,400**	**kN/m^2**
Q2: Snow Load				
s=μ*Ce*Ct*Sk				
Topography	Normal			
Ce	1,00			
Ct	1,00			
μ	0,80			
sk *(EN 991-1-3:2003 (E) Table C.1.)*	Mediterranean	*sk=(0,498*2-0,209)(1+(120/452)^2)*	0,842	*Mediterranean European climatic region*
Z *(EN 991-1-3:2003 (E) Figure C.6)*	Zone 4.5			
Z (kN/m^2) when λ=0	2,00			
A (m)	120			
where μ: snow load shape coefficient, sk: characteristic value of snow load on the ground, Ce: Exposure coefficient, Ct: Thermal coefficient, A: Site altitude above sea level, Z: Zone number				
		Q2 , snow load	**0,842**	**kN/m^2**



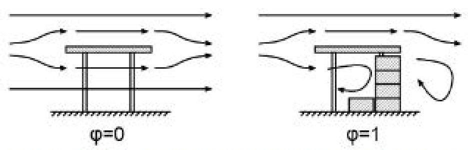
3 **GLAZED CANOPY**
Covered with BIPV

Q3: Wind Load			
			According to EN 1991-1-4:2005 +A1:2010 Section 7.3
Terrain category	IV		
Basic wind velocity vb [m/s]	27		
Horizontal dimension of rectangular plan parallel to the wind direction d [m]	75		
Horizontal dimension of rectangular plan perpendicular to the wind direction (crosswind dimension) b [m]	45		
Height of canopy from ground up to the maximum roof level h [m]	40		
Roof pitch angle α [°]	0		
Degree of blockage under the canopy roof ϕ	0,294		*The ratio of the area of feasible, actual obstructions under the canopy*
Orography factor at reference height c0(ze)	1		
Structural factor cscd	1		
Air density ρ [kg/m^3]	1,25		
	Q3 , wind load		**kN/m^2**
	Net wind pressure on zone A	*w* net,A =	(-0,853 or + 0,493)
	Net wind pressure on zone B	*w* net,B =	(-1.427 or +1.776)
	Net wind pressure on zone C	*w* net,C =	(-1.613 or +1.085)
	Total wind force	*Fw =*	(-2447.74 or +665.87)
	Eccentricity of total wind force from windward edge	e =	d'/4 = 18,750 m

How to interpret the wind load result given a specific canopy:



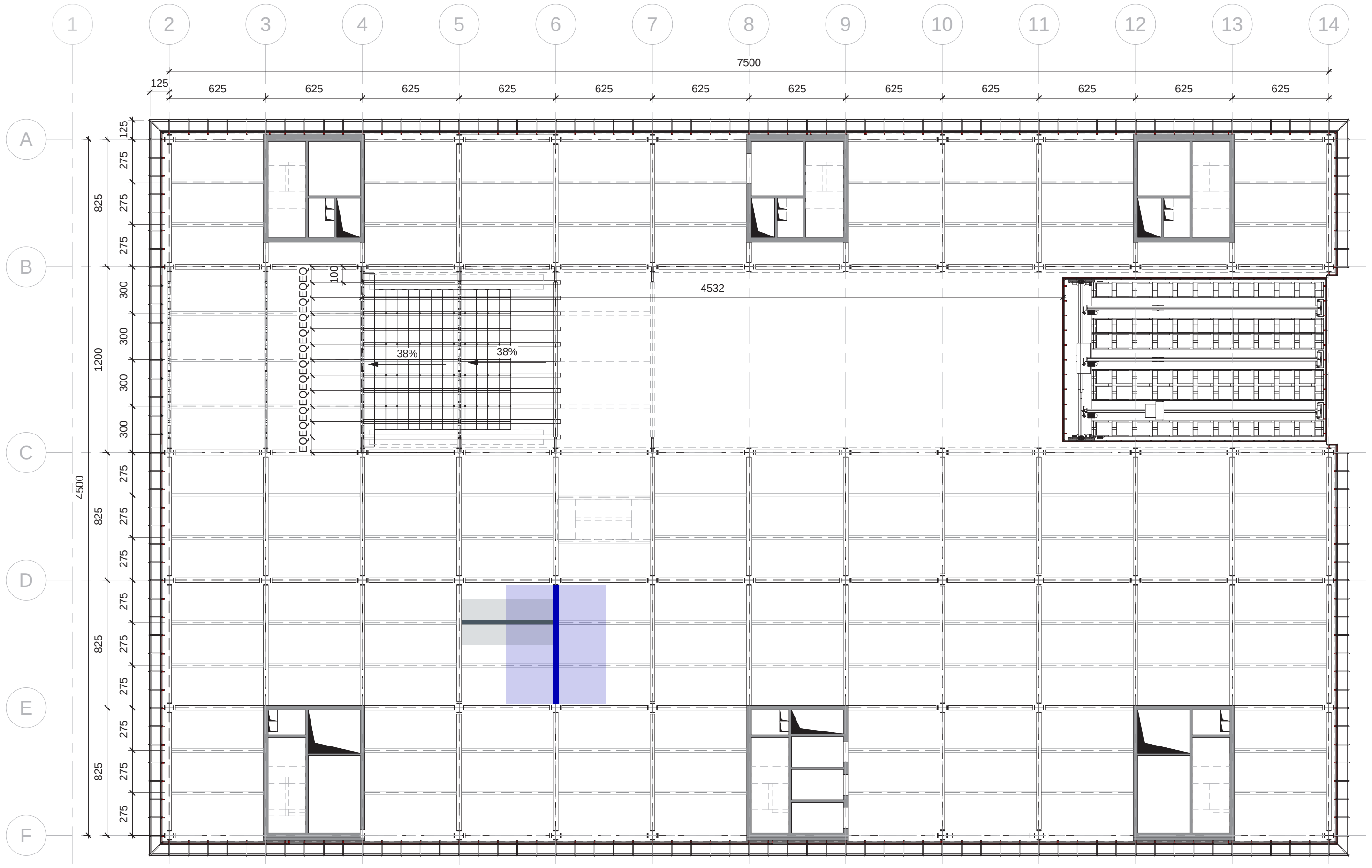
Pressure zones for monopitch canopy roofs, reproduced from EN1991-1-4 Table 7.6 and Figure 7.16



Definiton of blockage factor for canopy roofs (see also EN1991-1-4 Figure 7.15)

Wind on Canopy Reference: *https://eurocodeapplied.com/design/en1991/wind-pressure-monopitch-canopy*

LIMIT STATE ANALYSIS OF BEAMS



GROUND FLOOR STRUCTURAL PLAN
Showing tributary areas of selected beams

Primary Beam
Secondary Beam

Figure 63: Tributary Areas of Beams

Eurocode 3 - UK National Annex

Wide flange beams - HE, Section properties - Dimensions and properties

Section designation	Dimensions						Properties						
	Mass per metre	Depth of section	Width of section	Thickness		Root radius	Second moment of area		Elastic modulus		Plastic modulus		Area of section
HE 600 B	212	600.0	300.0	15.5	30.0	27.0	171,000	13,500	5,700	902	6,420	1,390	270
HE 500 B	187	500.0	300.0	14.5	28.0	27.0	107,000	12,600	4,290	842	4,820	1,290	239
HE 400 B	155	400.0	300.0	13.5	24.0	27.0	57,700	10,800	2,880	721	3,230	1,100	198
HE 240 B	83.2	240.0	240.0	10.0	17.0	21.0	11,300	3,920	938	327	1,050	498	106
HE 140 B	33.7	140.0	140.0	7.0	12.0	12.0	1,510	550	216	79	245	120	43.0
HE 400 M	256	432.0	307.0	21.0	40.0	27.0	104,000	19,300	4,820	1,260	5,570	1,930	326
HE 240M	256	432.0	307.0	21.0	40.0	27.0	104,000	19,300	4,820	1,260	5,570	1,930	326

CATALOG OF HE SECTIONS (edited to fit page)
Section Properties of Principle Structural Members

Beam Sections Catalog Reference: *https://orangebook.arcelormittal.com/design-data/uk-na/beams/he/section-properties-dimensions-and-properties/*

Beam Sections Properties Reference: *https://eurocodeapplied.com/design/en1993/ipe-hea-heb-hem-design-properties*

Secondary Beam - Typical Floor

SECONDARY BEAM - TYPICAL FLOOR				*formula*
Length (m)		6,25	6250 mm	
Tributary width (m)		3,00		
Dead load (kN/m^2)		6,04		
G1: Dead load on slab	per tributary width		18,13 kN/m	
G2: Self weight (kN/m)		1,54		
				maximum live load
Live load on slab (kN/m^2)		5,00		*among all levels*
Q1	per tributary width		15,00 kN/m	
	q,sls,typical floor		34,67 kN/m	*1,00*(G1+G2)+1,00*(Q1)*
	q,uls,typical floor		49,05 kN/m	*1,35*(G1+G2)+1,50*(Q1)*
Section Profile	**HEM240**			
Cross sectional area (m^2)		0,02		
Steel class		S235		
Unit weight γ (kN/m^3)		76,49		
Self weight (kN/m)		1,54		*[kg/m] / 102 = [kN/m]*
E (N/mm^2)		210000,00		
Iy (mm^4)		242900000,00		
W,pl,y (mm^3)		2117000,00		
Av,z (mm^2)		6007,00		
f,y (N/mm^2)		360,00		
				Steel partial material
				safety factor for
γm		1,05		*cross-section resistance*
f,yd (N/mm^2)		342,86		*f,y [N/mm^2] / γm*
SLS				
Md		169,26	kNm	*q,sls*L^2/8*
Vd		108,33	kN	*q,sls*L/2*
Deflection δmax		13,50	mm	*(5*q,sls*(L^4))/(384*E*Iy)*
Verification				
Bending moment				
Ma		725,83	kNm	*W,pl*f,yd*
	Md<Ma			**Verified**
Shear	**169,26 < 725,83**			
Va		1189,08	kN	*Av/sqrt(3)*f,yd*
	Vd<Va			**Verified**
	108,33 < 1189,08			
Deflection				
δmax/L	**δmax<δa**			**Verified**
	13,50 < 25,00			
		25,00	mm	*L/250 for decks, in general*
δ2/L	**δ2<δ2a**			**Verified**
		20,83	mm	*L/300 for decks, in general*
q,sls,only LL		15,00	kN/m	*1*(Q)*
δ2		5,84	mm	*(5*q,sls,only LL*(L^4))/(384*E*Iy)*
		5,84 < 20,83		
ULS				
Md		239,49	kNm	*q,uls*L^2/8*
Vd		153,28	kN	*q,uls*L/2*
Deflection δmax		19,10	mm	*(5*q,uls*(L^4))/(384*E*Iy)*

LIMIT STATE ANALYSIS OF BEAMS

Verification	Secondary Beam - Typical Floor (continued)			
Bending moment				
Ma	**Md<Ma**			**Verified**
	239,49 < 725,83			
Shear				
Va	**Vd<Va**			**Verified**
	153,28 < 1189,08			
Deflection				
δmax/L	**δmax<δa**			**Verified**
	19,10 < 25,00			
q,uls,only LL		22,50 kN/m		*1,50*(Q)*
δ2		8,76 mm		*(5*q,uls,only LL*(L^4))/(384*E*Iy)*
	δ2<δ2a			**Verified**

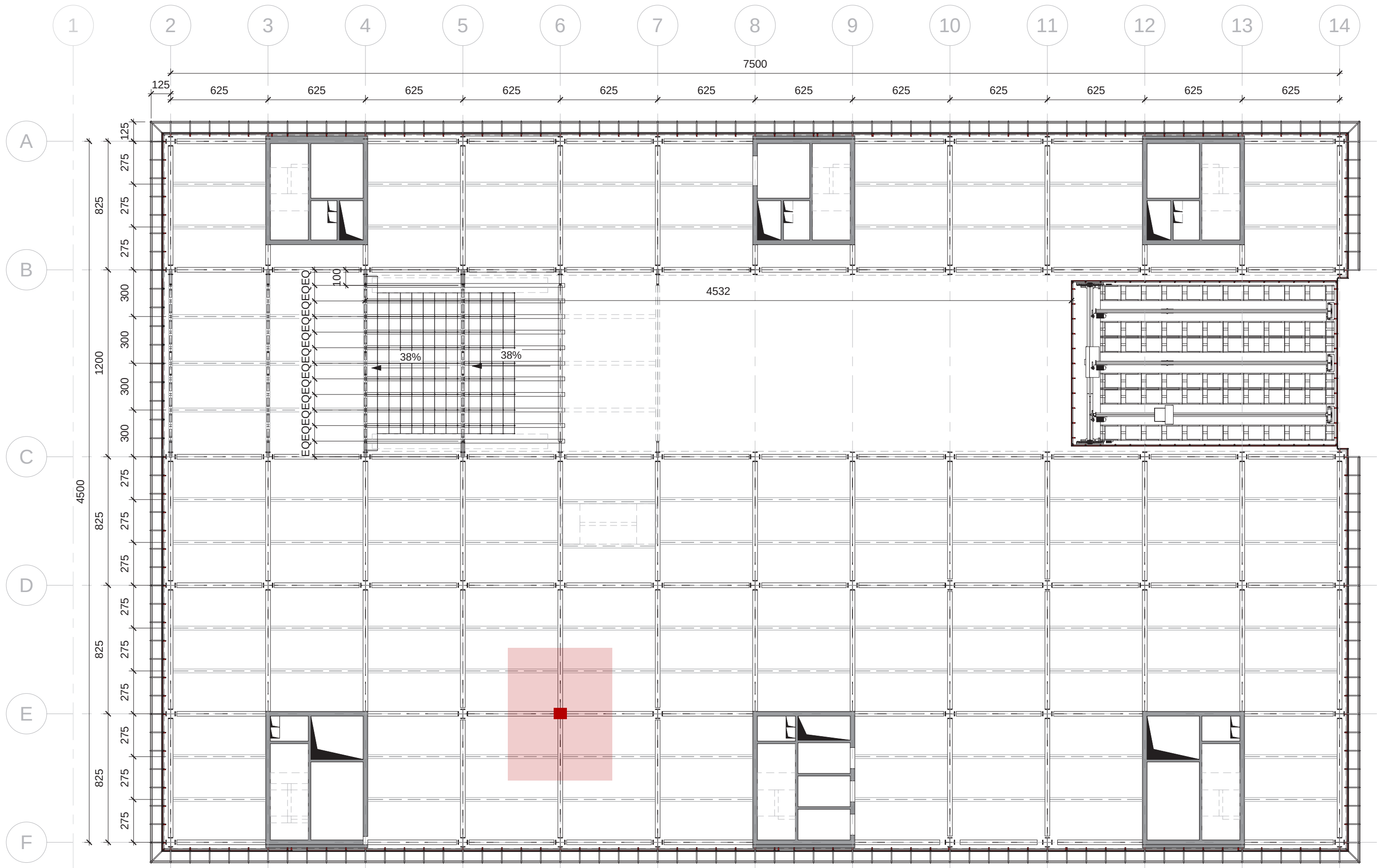
Primary Beam - Typical Floor

PRIMARY BEAM - TYPICAL FLOOR				
Length (m)		8,25	8250 mm	
Tributary width (m)		6,25	6250 mm	
Dead load (kN/m^2)		6,04		
G1: Dead Load on Slab	per tributary width		37,77 kN/m	
G2: Self weight (kN/m)		2,51		
Secondary beams weight (kN/m)		1,54		
G3: Secondary Beams Weight	per tributary area		3,07 kN/m	*secondary beam weight *number of beams*
Live load (kN/m^2)		5,00		*maximum live load among all levels*
Q1:Live Load	per tributary width		31,25 kN/m	
	q,sls,typical floor		74,60 kN/m	*1,00*(G1+G2+G3)+1,00*(Q1)*
	q,uls,typical floor		105,40 kN/m	*1,35*(G1+G2+G3)+1,50*(Q1)*
Section Profile	**HEM400**			
Cross sectional area (m^2)		0,03		
Steel class		S235		
Unit weight γ (kN/m^3)		76,49		
Self weight (kN/m)		2,51		*[kg/m] / 102 = [kN/m]*
E (N/mm^2)		210000		
Iy (mm^4)		1041000000		
W,pl,y (mm^3)		5571000		
Av,z (mm^2)		11018,00		
f,y (N/mm^2)		360		
γm		1,05		*Steel partial material safety factor for cross-section resistance*
f,yd (N/mm^2)		342,86		
SLS				
Md		634,67 kNm		*q,sls*L^2/8*
Vd		307,72 kN		*q,sls*L/2*
Deflection δmax		20,58 mm		*(5*q,sls*(L^4))/(384*E*Iy)*
Verification				
Bending moment				
Ma		1910,06 kNm		*W,pl*f,yd*
	Md<Ma			**Verified**
	634,67 < 1910,06			
Shear				
Va		2181,00 kN		*Av/sqrt(3)*f,yd*

Primary Beam - Typical Floor (continued)

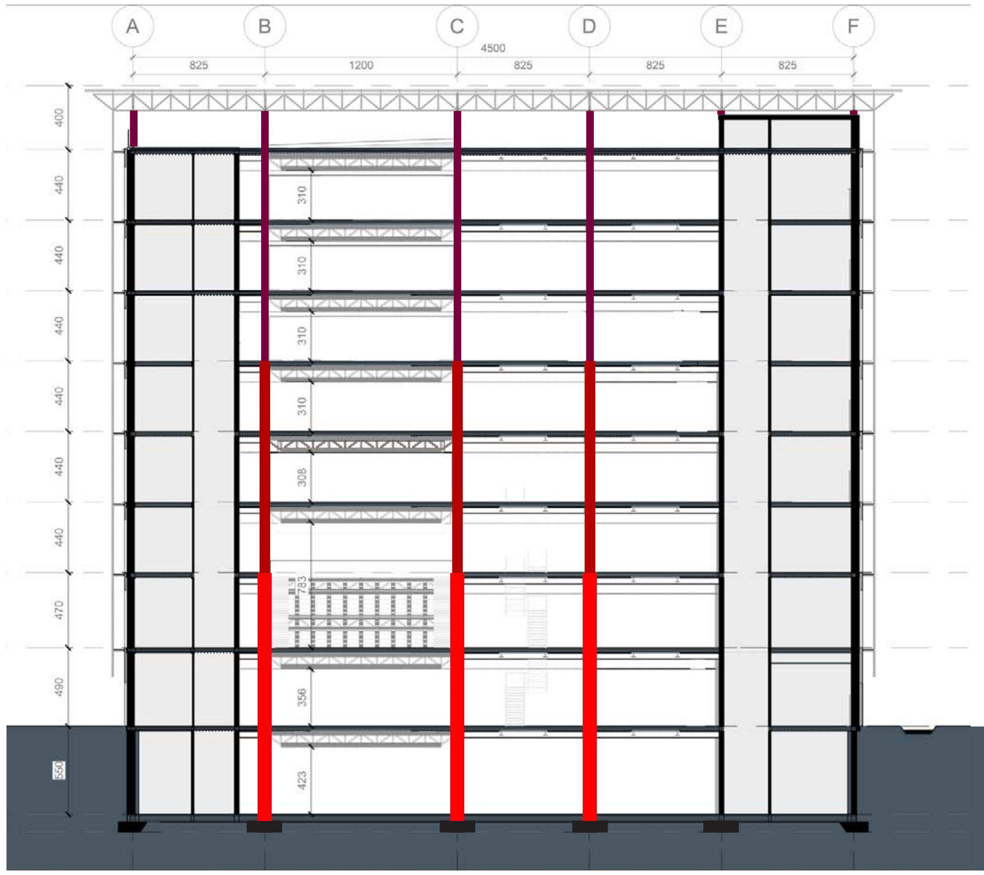
	Vd<Va		**Verified**
	307,72 < 2181,00		
Deflection			
δmax/L	**δmax<δa**		**Verified**
	20,58 < 33,00		
		33,00 mm	*L/250 for decks, in general*
δ2/L	**δ2<δ2a**		**Verified**
		27,50 mm	*L/300 for decks, in general*
q,sls,only LL		74,60 kN/m	*1,00*(Q)*
δ2		20,58 mm	*(5*q,sls,only LL*(L^4))/(384*E*Iy)*
ULS			
Md		481,10 kNm	*q,uls*L^2/8*
Vd		318,45 kN	*q,uls*L/2*
Deflection δmax		29,08 mm	*(5*q,uls*(L^4))/(384*E*Iy)*
Verification			
Bending moment			
Ma	**Md<Ma**		**Verified**
	481,10 < 1910,06		
Shear			
Va	**Vd<Va**		**Verified**
	318,45 < 2181,00		
Deflection			
δmax/L	**δmax<δa**		**Verified**
	29,08 < 33,00		
q,uls,only LL		46,88 kN/m	*1,50*(Q)*
δ2		12,93 mm	*(5*q,uls,only LL*(L^4))/(384*E*Iy)*
	δ2<δ2a		**Verified**

BUCKLING CHECK OF THE COLUMNS



GROUND FLOOR STRUCTURAL PLAN
Showing tributary area of selected columns

Figure 64: Tributary Area of Column



Zone 3
tot. height: 14,20m

Zone 2
tot. height: 13,20m

Zone 1
tot. height: 15,10m

Upper floors of the building host the main library functions, such as the departments and reading halls. To allow these spaces to be more open, the building was considered in three zones. Therefore, the buckling check for the column was performed for each zone, with the aim of using smaller cross-sections on high levels, and larger cross-sections on the base levels.

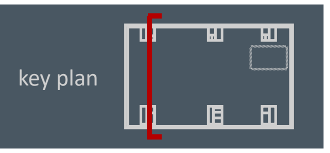


Figure 65: Vertical 'Zones' of Columns

Q1 ON DIFFERENT FLOOR SLABS

Level	Main Program	*(EN 1991 Eurocode 1 Table 6.2)*	qk (kN/m^2)	Zone	Cross-Section	Height (m)
L8	Rooftop	I	5,00	3	HEB400	1,00
L7	Library Departments	C1	3,00	3	HEB400	4,40
L6	Library Departments	C1	3,00	3	HEB400	4,40
L5*	Digital Departments	C1	3,00	3	HEB400	4,40
L4	Offices	B	3,00	2	HEB500	4,40
L3	Laboratories	B	3,00	2	HEB500	4,40
L2*	Auditorium & Multi-Media	C2	4,00	2	HEB500	4,40
L1	Auditorium & Multi-Media	C2	4,00	1	HEB600	4,70
L0	Entrance Hall	C3	5,00	1	HEB600	4,90
L-1*	Basement Storage	E1	7,50	1	HEB600	5,50

VERTICAL LOAD ON COLUMNS
ZONE 3

	qk (kN/m^2)	Slab Repetition	*Explanations*
G1,canopy dead loads (kN/m^2)	0,29	1	
			assuming perforated al.panels 1400 (kg/m^2); suspension cables, panel frames,
G2, aluminium façade (kN/m^2)	15,73		*catwalks 2 kN/m^2)*
			assuming HEB240 for top and bottom chords, HEB140 for webs;
G3,canopy structural truss per unit length (kN/m^2)	33,76		*within tributary area*
Q(1,2), canopy live load (kN/m^2)	1,24		*maintenance + snow*
q,sls, canopy (kN/m^2)	51,03		*1,00*G(1+2+3) + 1,00*Q(1,2)*
q,uls, canopy (kN/m^2)	69,07		*1,35*G(1+2+3) + 1,50*Q(1,2)*
G1, roof dead loads (kN/m^2)	4,93	1	
G3, roof structural framing per unit length (kN/m^2)	4,04		
Q1, roof live load (kN/m^2)	5,00		
q,sls, roof (kN/m^2)	13,97		*1,00*G(1+3) + 1,00*Q1*
q,uls, roof (kN/m^2)	19,62		*1,35*G(1+3) + 1,50*Q1*
G1, slab dead loads (kN/m^2)	6,04	2	
G3, slab structural framing per unit length (kN/m^2)	4,04		
Q1, slab zone 3 live load (kN/m^2)	3,00		
q,sls, slab zone 3 (kN/m^2)	26,17		*1,00*G(1+3) + 1,00*Q1*
q,uls, slab zone 3 (kN/m^2)	36,23		*1,35*G(1+3) + 1,50*Q1*
q,sls zone 3 tot (kN/m^2)	**91,17**		
q,uls zone 3 tot (kN/m^2)	**124,92**		

Column Self Load

ZONE 3	q,sls (kNm^2)		q,uls (kNm^2)
Weight	3,11		4,20
		Height, total Zone 3 (m)	14,20
		N,sls column zone 3 (N)	44142,12
		N,uls column zone 3 (N)	59591,86

Zone 3 Column - Section & Buckling Check

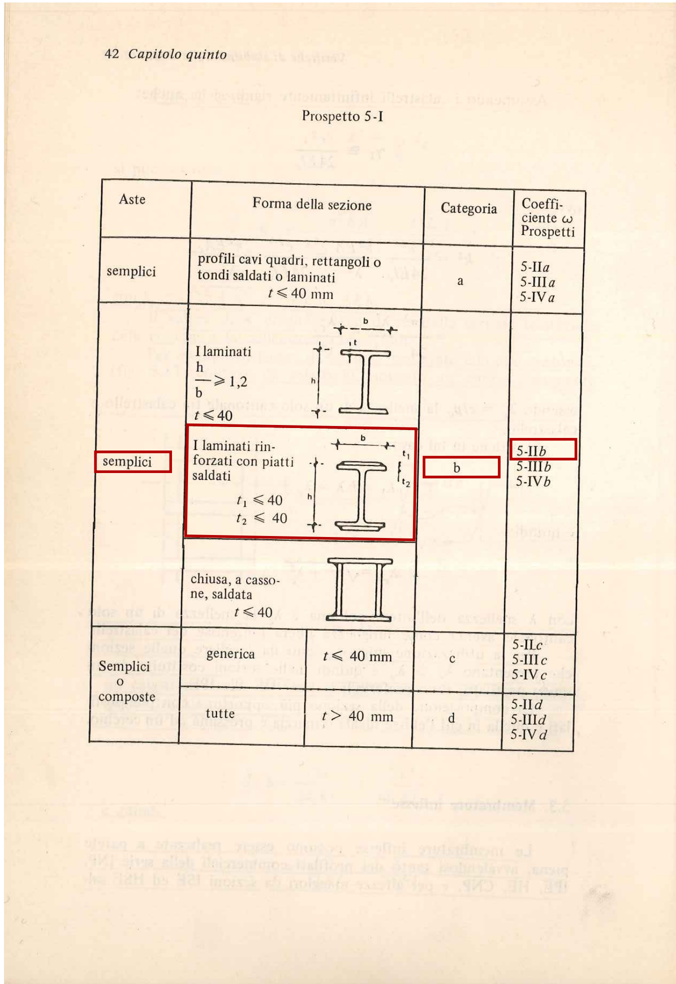
ZONE 3 COLUMN SECTION & BUCKLING CHECK

Structural Element	**King Cross HEB400**			
Level	5			
l (mm)	4400,00			
l0 (mm)	2860,00			*l0= 0,65 * l for fixed-fixed column*
A: Tributary Area (m^2)	51,56			
Cross-Sectional Data				
h (mm)	400,00			
b (mm)	300,00			
a (mm)	24,00			
s (mm)	13,50			
ρ: Fe360 (kN/m^3)	78,50			
A: Cross-sectional Area (mm^2)	39600,00	*198 cm^2*100*2*	0,040 (m^2)	
Intertia Moments				
Ix (mm^4)	685000000,00			*Ix=Iy=24300 (cm^4)*10000 + 8150 (cm^4)*10000*
Iy (mm^4)	685000000,00			*Ix=Iy=24300 (cm^4)*10000 + 8150 (cm^4)*10000*
Slenderness				
λ	21,75			*λ=l0/sqrt(Iy/A)*
λ < 150	Verified			

BUCKLING CHECK OF THE COLUMNS

Zone 3 Column - Section & Buckling Check

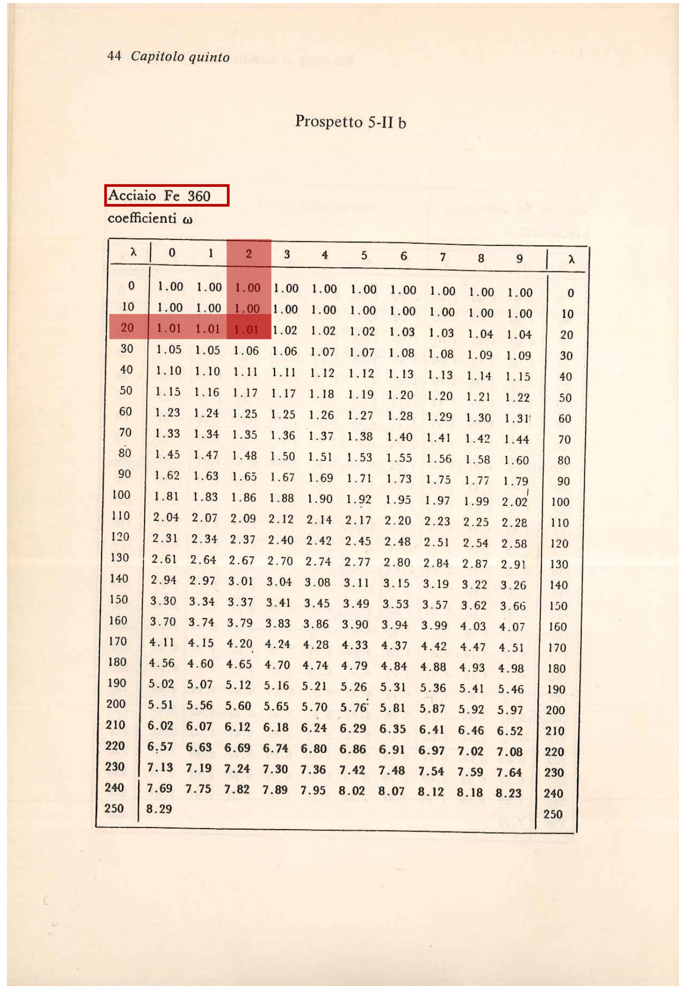
ZONE 3 COLUMN SECTION & BUCKLING CHECK			
Structural Element	King Cross HEB400		
Level	5		
l (mm)	4400,00		
l0 (mm)	2860,00		*l0= 0,65 * l for fixed-fixed column*
A: Tributary Area (m^2)	51,56		
Cross-Sectional Data			
h (mm)	400,00		
b (mm)	300,00		
a (mm)	24,00		
s (mm)	13,50		
ρ: Fe360 (kN/m^3)	78,50		
A: Cross-sectional Area (mm^2)	39600,00	*198 cm^2*100*2*	0,040 (m^2)
Intertia Moments			
Ix (mm^4)	685000000,00		*Ix=Iy=24300 (cm^4)*10000 + 8150 (cm^4)*10000*
Iy (mm^4)	685000000,00		*Ix=Iy=24300 (cm^4)*10000 + 8150 (cm^4)*10000*
Slenderness			
λ	21,75		*λ=l0/sqrt(Iy/A)*
λ < 150	Verified		
Allowable Stress			
N	4745318,99		
ω (Fe360)	1,01		*Verifiche di stabilità delle strutture, capitolo quinto, pagina 44, Prospetto (5-II b)*
σ (MPa)	121,03		
σ < 160	Verified		σ=ω*N/A S235 > Fe 360 *σ=1600daN/cm2 = 160MPa*
Limit State			
γM1	1,05		*Steel partial material safety factor in Italy*
α	0,34		*section classification: Class 1, curve b for welded section*
fy of S235 Fe360 steel (MPa)	235		
E (MPa)	210000		
N,cr (N)	173571151,78		*N,cr=E*Iy*(π^2/(l0)^2)*
λ	0,23		*λ=sqrt(A*fy/Ncr)*
ϕ	0,53		*φ=0,5(1+α(λ-0,2)+λ^2)*
χ	0,99		*χ=1/(ϕ+sqrt(ϕ^2-λ^2)*
Compression Check			
Nb,Rd (N)	8763590,789		*Nrd=χ*A*fy/γM1*
N,ed (N)	6500868,49		*N,ed=(q,uls,zone3*tributary area)*1000+N,uls,zone3*
N,ed/Nb,Rd ≤ 1,00			
0,74	Verified		*Note: Margin is left to accommodate the weight of mechanical ventilation equipment.*



42 *Capitolo quinto*

Prospetto 5-I

Aste	Forma della sezione		Categoria	Coefficiente ω Prospetti
semplici	profili cavi quadri, rettangoli o tondi saldati o laminati $t \leqslant 40$ mm		a	5-IIa 5-IIIa 5-IVa
	I laminati $\frac{h}{b} \geqslant 1{,}2$ $t \leqslant 40$			
semplici	I laminati rinforzati con piatti saldati $t_1 \leqslant 40$ $t_2 \leqslant 40$		b	5-IIb 5-IIIb 5-IVb
	chiusa, a cassone, saldata $t \leqslant 40$			
Semplici o composte	generica	$t \leqslant 40$ mm	c	5-IIc 5-IIIc 5-IVc
	tutte	$t > 40$ mm	d	5-IId 5-IIId 5-IVd



44 *Capitolo quinto*

Prospetto 5-II b

Acciaio Fe 360
coefficienti ω

λ	0	1	2	3	4	5	6	7	8	9	λ
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10
20	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.04	1.04	20
30	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	30
40	1.10	1.10	1.11	1.11	1.12	1.12	1.13	1.13	1.14	1.15	40
50	1.15	1.16	1.17	1.17	1.18	1.19	1.20	1.20	1.21	1.22	50
60	1.23	1.24	1.25	1.25	1.26	1.27	1.28	1.29	1.30	1.31	60
70	1.33	1.34	1.35	1.36	1.37	1.38	1.40	1.41	1.42	1.44	70
80	1.45	1.47	1.48	1.50	1.51	1.53	1.55	1.56	1.58	1.60	80
90	1.62	1.63	1.65	1.67	1.69	1.71	1.73	1.75	1.77	1.79	90
100	1.81	1.83	1.86	1.88	1.90	1.92	1.95	1.97	1.99	2.02	100
110	2.04	2.07	2.09	2.12	2.14	2.17	2.20	2.23	2.25	2.28	110
120	2.31	2.34	2.37	2.40	2.42	2.45	2.48	2.51	2.54	2.58	120
130	2.61	2.64	2.67	2.70	2.74	2.77	2.80	2.84	2.87	2.91	130
140	2.94	2.97	3.01	3.04	3.08	3.11	3.15	3.19	3.22	3.26	140
150	3.30	3.34	3.37	3.41	3.45	3.49	3.53	3.57	3.62	3.66	150
160	3.70	3.74	3.79	3.83	3.86	3.90	3.94	3.99	4.03	4.07	160
170	4.11	4.15	4.20	4.24	4.28	4.33	4.37	4.42	4.47	4.51	170
180	4.56	4.60	4.65	4.70	4.74	4.79	4.84	4.88	4.93	4.98	180
190	5.02	5.07	5.12	5.16	5.21	5.26	5.31	5.36	5.41	5.46	190
200	5.51	5.56	5.60	5.65	5.70	5.76	5.81	5.87	5.92	5.97	200
210	6.02	6.07	6.12	6.18	6.24	6.29	6.35	6.41	6.46	6.52	210
220	6.57	6.63	6.69	6.74	6.80	6.86	6.91	6.97	7.02	7.08	220
230	7.13	7.19	7.24	7.30	7.36	7.42	7.48	7.54	7.59	7.64	230
240	7.69	7.75	7.82	7.89	7.95	8.02	8.07	8.12	8.18	8.23	240
250	8.29										250

Zone 3: λ= 21,75; ω = 1,01
Zone 2: λ= 18,08; ω = 1,00
Zone 1: λ= 19,34; ω = 1,00

BUCKLING CHECK OF THE COLUMNS

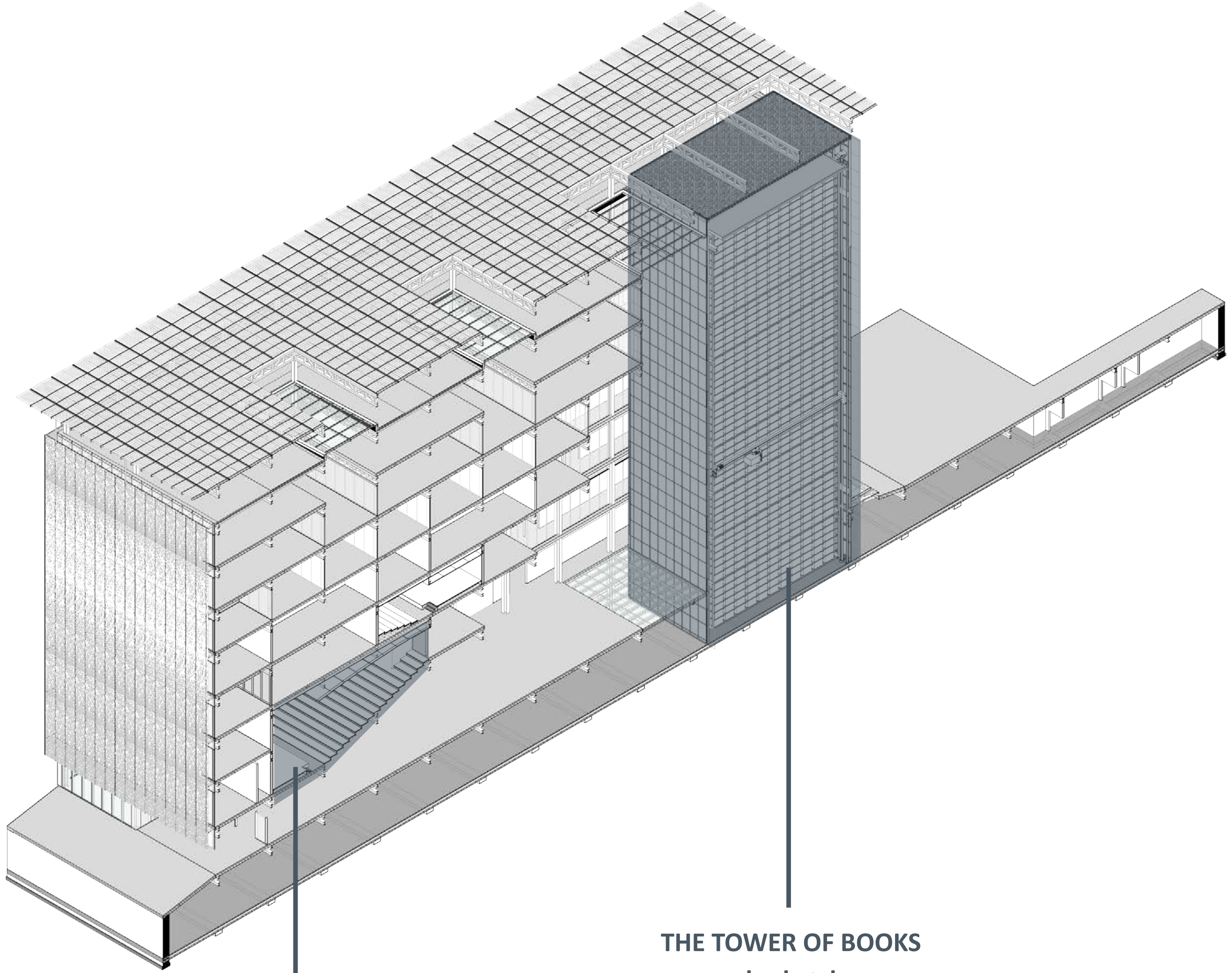
Zone 2 Column - Section & Buckling Check

ZONE 2				
	qk (kN/m^2)	Slab Repetition		*Explanations*
G1, slab dead loads (kN/m^2)	6,04	2		
G3, slab structural framing per unit length (kN/m^2)	4,04			
Q1, slab zone 2 average live load (kN/m^2)	3,33			
q,sls, slab zone 2 (kN/m^2)	**26,84**			*1,00*G(1+3) + 1,00*Q1*
q,uls, slab zone 2 (kN/m^2)	**37,23**			*1,35*G(1+3) + 1,50*Q1*
Column Self Load				
ZONE 2	q,sls (kNm^2)		q,uls (kNm^2)	
Weight	3,75		5,065605	
		Height, total Zone 2 (m)	10,00	
		N,sls column zone 2 (N)	37523	
		N,uls column zone 2 (N)	50656,05	
ZONE 2 COLUMN SECTION & BUCKLING CHECK				
Structural Element	King Cross HEB500			
Level	2			
l (mm)	4400,00			
l0 (mm)	2860,00			*l0= 0,65 * l for fixed-fixed column*
A: Tributary Area (m^2)	51,56			
Cross-Sectional Data				
h (mm)	500,00			
b (mm)	300,00			
a (mm)	28,00			
s (mm)	14,50			
p: Fe360 (kN/m^3)	78,50			
A: Cross-sectional Area (mm^2)	47800,00	*239 cm^2*100*2*	0,048 (m^2)	
Intertia Moments				
Ix (mm^4)	1196000000,00			*Ix=Iy=59200 (cm^4)*10000 + 19400 (cm^4)*10000*
Iy (mm^4)	1196000000,00			
Slenderness				
λ	18,08			*λ=l0/sqrt(Iy/A)*
λ < 150	Verified			
Allowable Stress				
N	6166725,41			*Allowable stress 'N' from zone 3 added* *Verifiche di stabilità delle strutture, capitolo quinto, pagina 44, Prospetto (5-II b)*
ω (Fe360)	1,00			
σ (MPa)	129,01			σ=ω*N/A
σ < 160	Verified			S235 > Fe 360 σ=1600daN/cm2 = 160MPa
Limit State				
γM1	1,05			*Steel partial material safety factor in Italy* *section classification: Class 1,*
α	0,34			*curve b for welded section*
fy of S235 Fe360 steel (MPa)	235			
E (MPa)	210000			
N,cr (N)	303052697,12			*N,cr=E*Iy*(π^2/(l0)^2)*
λ	0,19			*λ=sqrt(A*fy/Ncr)*
ϕ	0,52			*φ=0,5(1+α(λ-0,2)+λ^2)*
χ	1,00			*χ=1/(ϕ+sqrt(ϕ^2-λ^2))*
Compression Check				
Nb,Rd (N)	10726405,84			*Nrd=χ*A*fy/γM1*
N,ed (N)	8471329,65			*N,ed=(q,uls,zone2*tributary area)*1000+N,uls,zone2 +N,ed ,zone3*
N,ed/Nb,Rd ≤ 1,00				
0,79	Verified			

Zone 1 Column - Section & Buckling Check

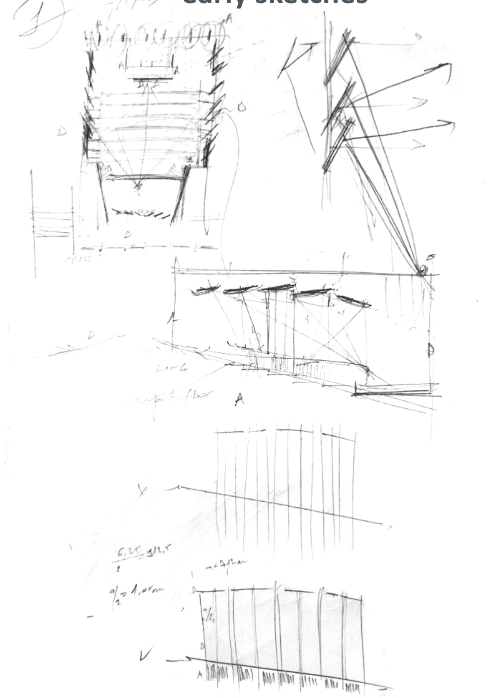
ZONE 1				
	qk (kN/m^2)	Slab Repetition		*Explanations*
G1, slab dead loads (kN/m^2)	4,14	2		
G3, slab structural framing per unit length (kN/m^2)	4,04			
Q1, slab zone 1 average live load (kN/m^2)	5,50			
q,sls, slab zone 1 (kN/m^2)	**27,36**			*1,00*G(1+3) + 1,00*Q1*
q,uls, slab zone 1 (kN/m^2)	**38,59**			*1,35*G(1+3) + 1,50*Q1*
Column Self Load				
ZONE 1	q,sls (kNm^2)		q,uls (kNm^2)	
Weight	4,24		5,72265	
		Height, total Zone 1 (m)	15,10	
		N,sls column zone 1 (N)	64008,9	
		N,uls column zone 1 (N)	86412,015	
ZONE 1 COLUMN SECTION & BUCKLING CHECK				
Structural Element	King Cross HEB600			
Level	-1			
l (mm)	5500,00			
l0 (mm)	3575,00			*l0= 0,65 * l for fixed-fixed column*
A: Tributary Area (m^2)	51,56			
Cross-Sectional Data				
h (mm)	600,00			
b (mm)	300,00			
a (mm)	30,00			
s (mm)	15,50			
p: Fe360 (kN/m^3)	78,50			
A: Cross-sectional Area (mm^2)	54000,00	*270 cm^2*100*2*	0,054 (m^2)	
Intertia Moments				
Ix (mm^4)	1845000000,00			*Ix=Iy=59200 (cm^4)*10000 + 19400 (cm^4)*10000*
Iy (mm^4)	1845000000,00			
Slenderness				
λ	19,34			*λ=l0/sqrt(Iy/A)*
λ < 150	Verified			
Allowable Stress				
N	7641682,54			*Allowable stress 'N' from zone 2 added* *Verifiche di stabilità delle strutture, capitolo quinto, pagina 44, Prospetto (5-II b)*
ω (Fe360)	1,00			
σ (MPa)	141,51			
σ < 160	Verified			σ=ω*N/A S235 > Fe 360 σ=1600daN/cm2 = 160MPa
Limit State				
γM1	1,05			*Steel partial material safety factor in Italy* *section classification: Class 1,*
α	0,34			*curve b for welded section*
fy of S235 Fe360 steel (MPa)	235			
E (MPa)	210000			
N,cr (N)	299201191,27			*N,cr=E*Iy*(π^2/(l0)^2)*
λ	0,21			*λ=sqrt(A*fy/Ncr)*
ϕ	0,52			*φ=0,5(1+α(λ-0,2)+λ^2)*
χ	1,00			*χ=1/(ϕ+sqrt(ϕ^2-λ^2))*
Compression Check				
Nb,Rd (N)	12060263,8			*Nrd=χ*A*fy/γM1*
N,ed (N)	10547599,91			*N,ed=(q,uls,zone1*tributary area)*1000+N,uls,zone1 +N,ed ,zone2*
N,ed/Nb,Rd ≤ 1,00				
0,87	Verified			

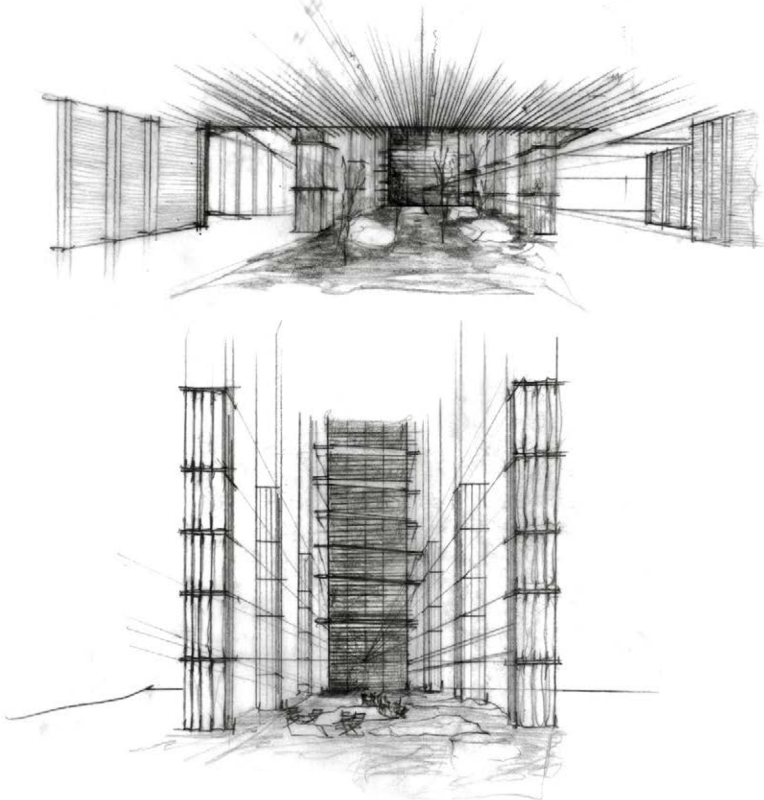
SPECIAL ZONES



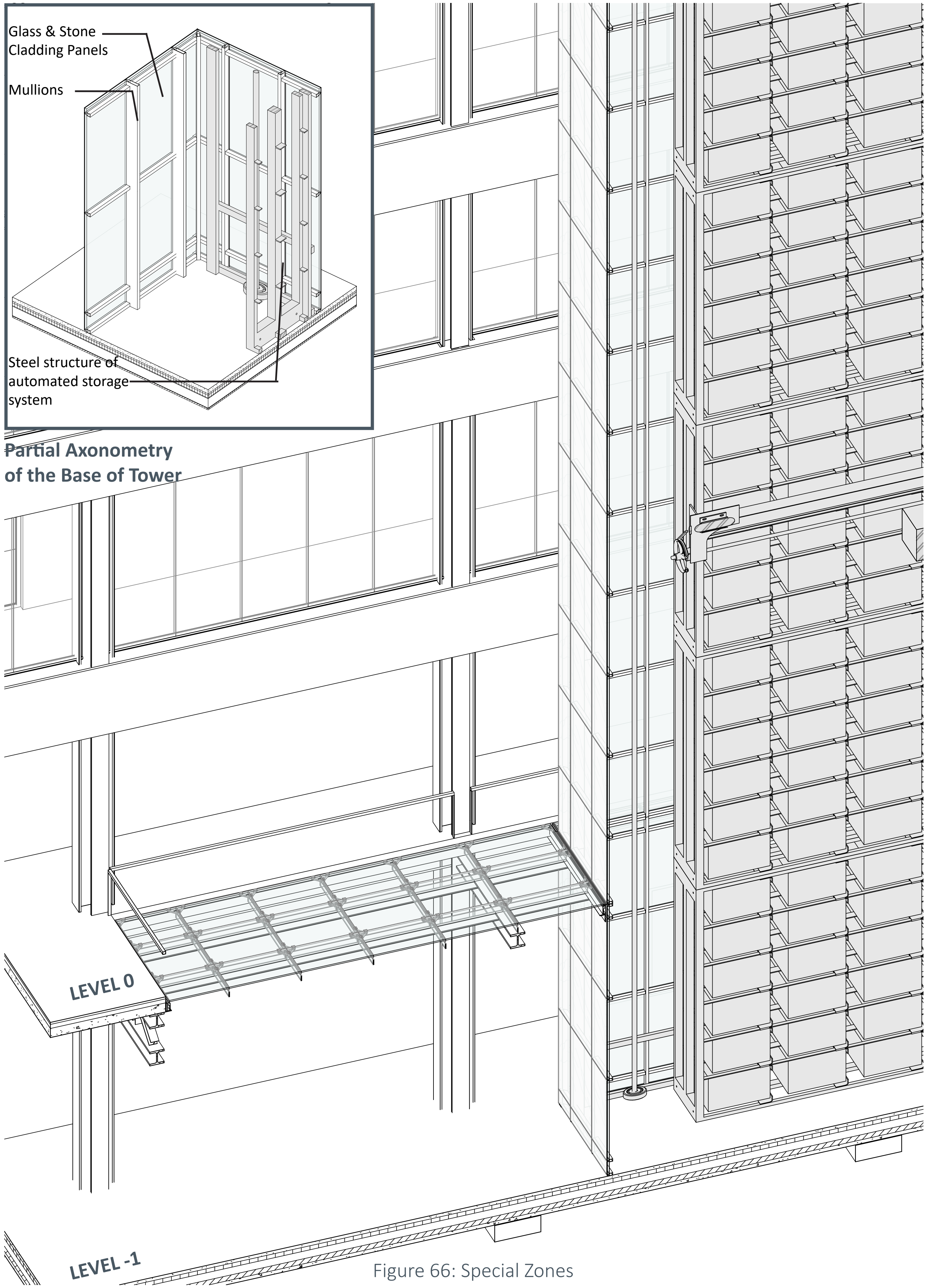
THE TOWER OF BOOKS
early sketches
showing intended relationship with columns

THE AUDITORIUM
early sketches





TOWER OF BOOKS

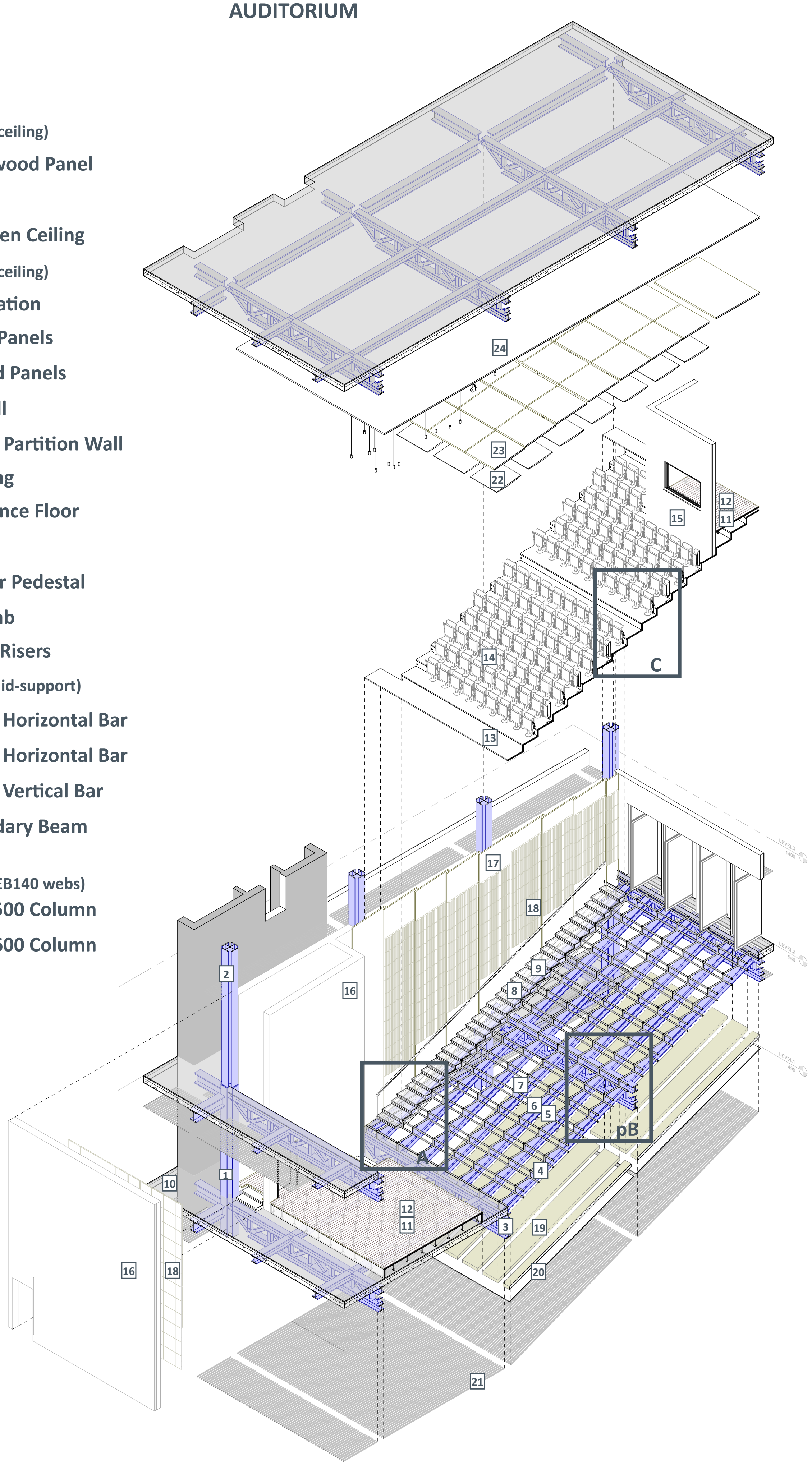


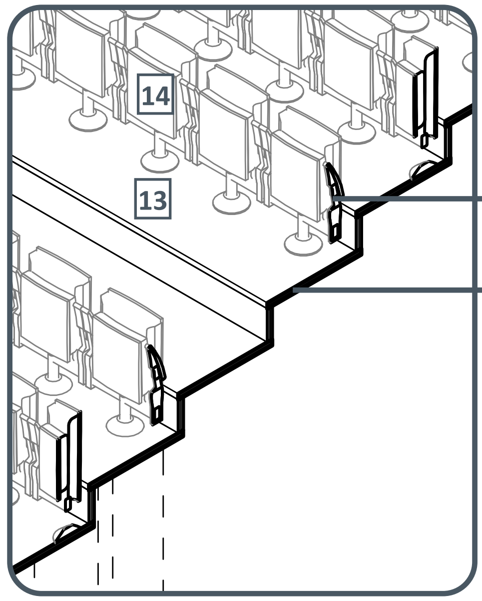
Partial Axonometry of the Base of Tower

Figure 66: Special Zones

AUDITORIUM

- 24 Gypsum Panel (ceiling)
- 23 Suspended Plywood Panel
- 22 Acoustic Panel
- 21 Suspended Batten Ceiling
- 20 Gypsum Panel (ceiling)
- 19 Fiberglass Insulation
- 18 Sound Diffuser Panels
- 17 Angled Plywood Panels
- 16 Auditorium Wall
- 15 2hr-Rated GWB Partition Wall
- 14 Audience Seating
- 13 Carpeted Audience Floor
- 12 Raised Floor
- 11 Adjustable Floor Pedestal
- 10 Typical Floor Slab
- 9 Stair Tread and Risers
- 8 Stair Stringer (mid-support)
- 7 4x4 Hollow Box Horizontal Bar
- 6 4x4 Hollow Box Horizontal Bar
- 5 4x4 Hollow Box Vertical Bar
- 4 HEM240 Secondary Beam
- 3 Truss Beam (HEB280 chords, HEB140 webs)
- 2 King Cross HEB500 Column
- 1 King Cross HEB600 Column



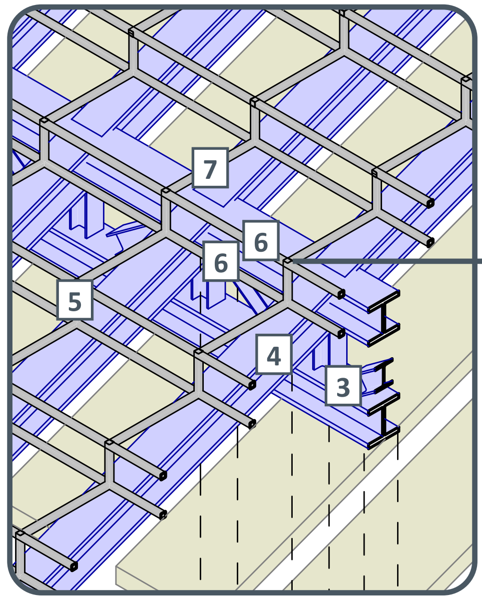


C

Minispace 5071 by Figueras Seating

Carpeted Audience Floor
(cut-outs for air diffusers grills and lighting fixtures to be added)

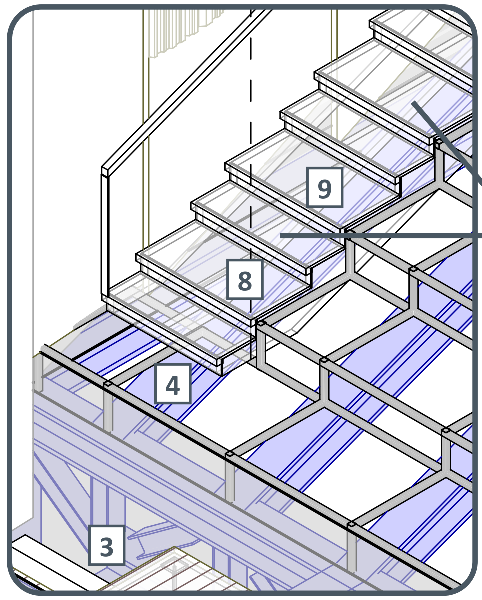
-7mm Interface Carpet Tile monolithic installation excess cut;
-CQuest™Bio backing with 3mm closed-cell polymerised foam;
-Tackifier Adhesive sprayed on backingboard;
-20mm Plywood as backingboard screwed on plywood;
-20mm Plywood screwed to the sub-structure for seating.



B

Sub-Structure for Audience Seating

-40x40mm hollow box horizontal bars welded to join rows;
-40x40mm hollow box horizontal bars welded to verticals;
-40x40mm hollow box vertical vars welded to secondary beams.
(secondary beams are 1000mm apart)



A

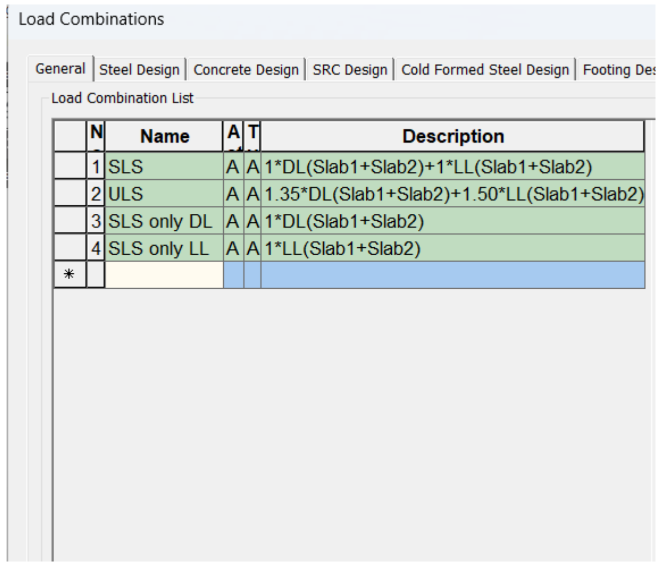
Stair
(with middle stringer)

-7mm Interface Carpet Tile installed on treads;
-Tackifier Adhesive sprayed on treads;
-20mm thick treads welded to the risers;
-20mm thick aluminium industrial treads welded to the risers;
-10mm thick aluminium risers welded to the stringer;
-50mm thick stringer (middle support)welded to secondary beam.

Figure 67: Exploded Axonometry of the Auditorium

STRUCTURAL ANALYSIS (MIDASGEN SOFTWARE)

DEFINITION OF LOAD CASES



Load Combinations

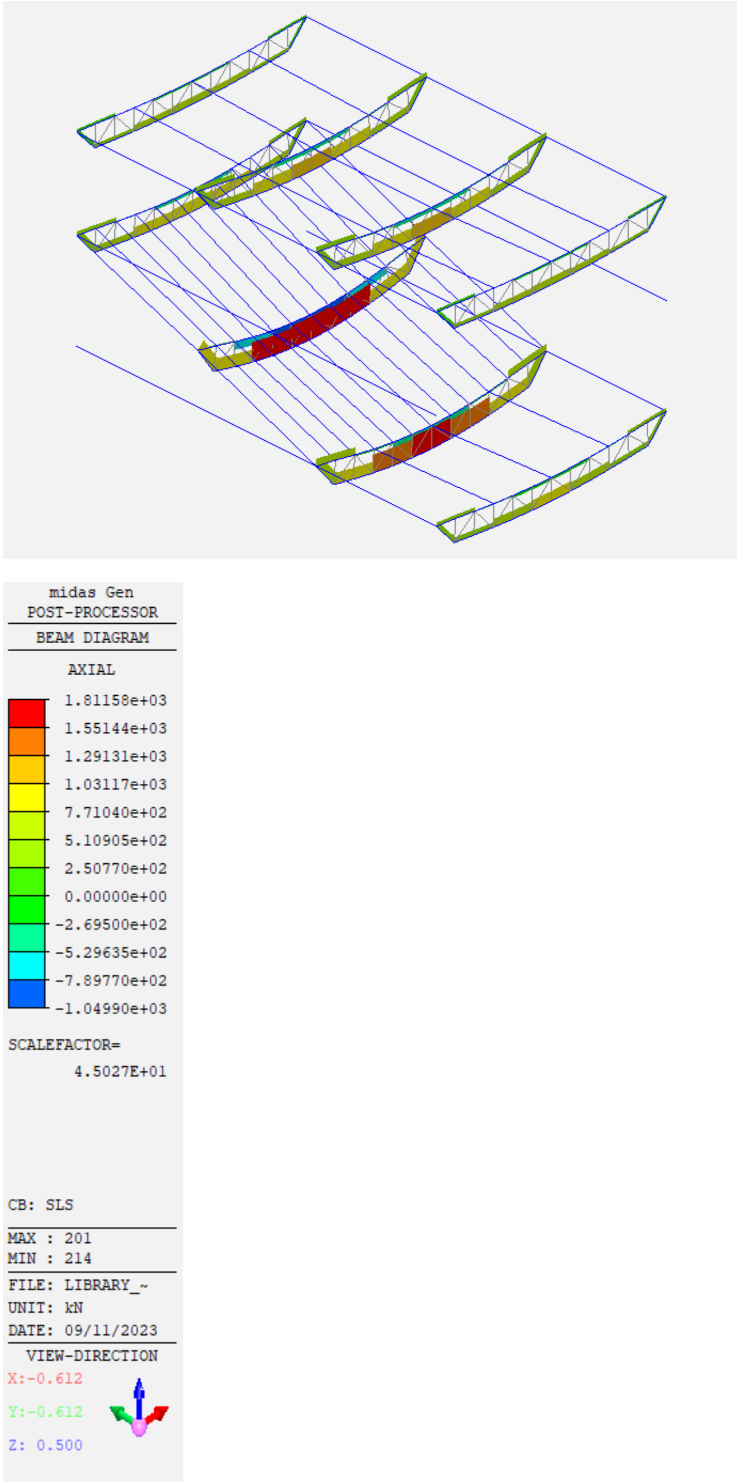
General | Steel Design | Concrete Design | SRC Design | Cold Formed Steel Design | Footing Des

Load Combination List

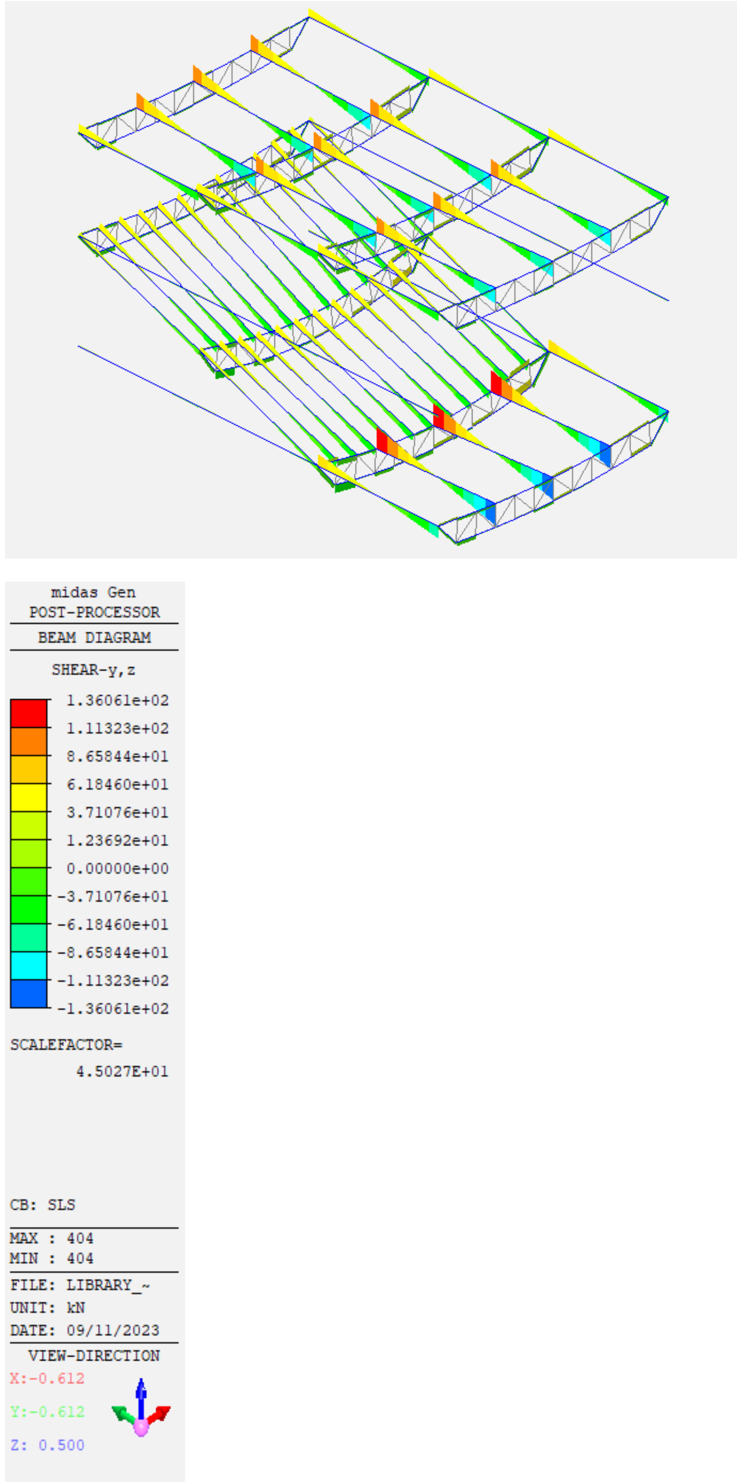
N	Name	A	T	Description
1	SLS	A	A	1*DL(Slab1+Slab2)+1*LL(Slab1+Slab2)
2	ULS	A	A	1.35*DL(Slab1+Slab2)+1.50*LL(Slab1+Slab2)
3	SLS only DL	A	A	1*DL(Slab1+Slab2)
4	SLS only LL	A	A	1*LL(Slab1+Slab2)
*				

SLS: 1.00*DL+1.00*LL
ULS: 1.35*DL+1.50*LL

BEAM AXIAL DIAGRAM (SLS)



BEAM SHEAR DIAGRAM (SLS)



BEAM MOMENT DIAGRAM (SLS)

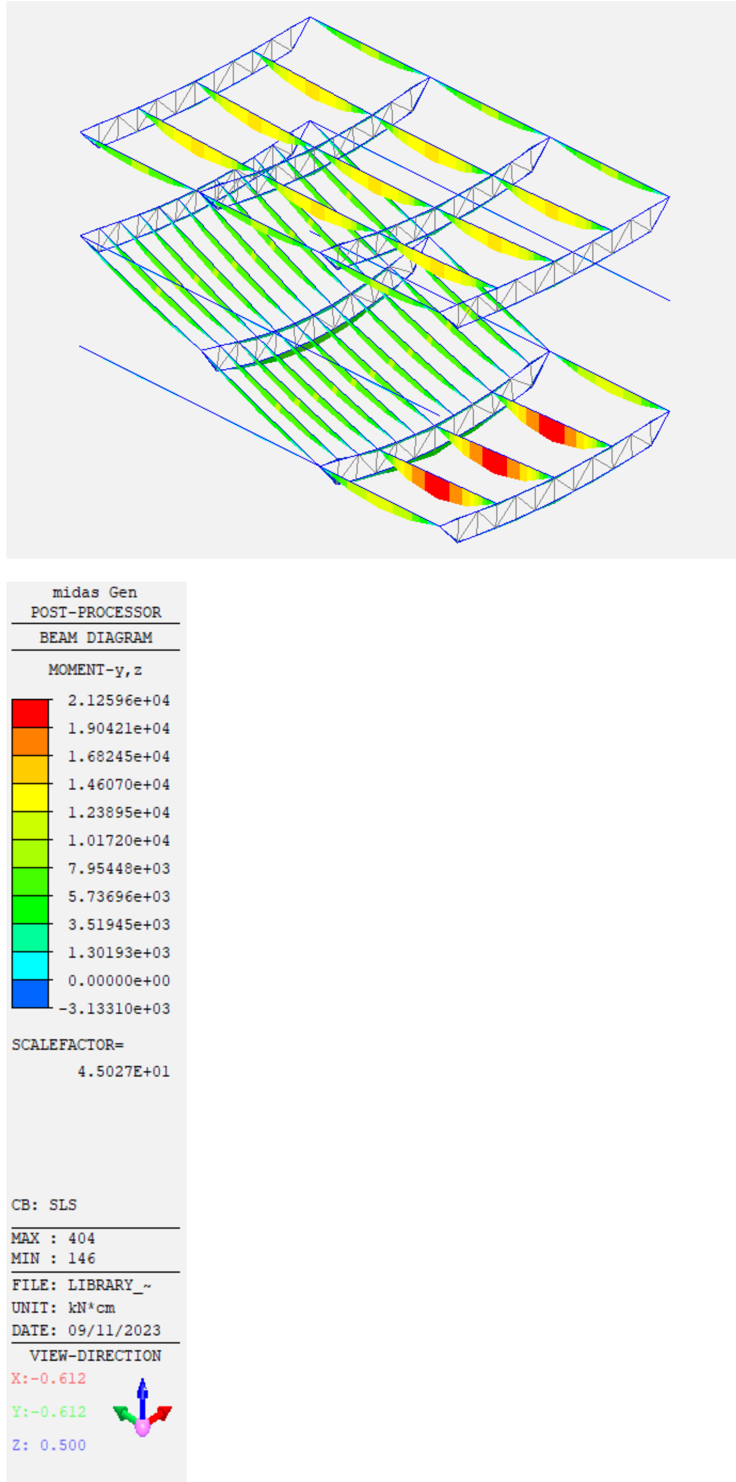


Figure 68: Midas Beam Diagrams

DEFINITION OF LOAD CASES

Load Combinations

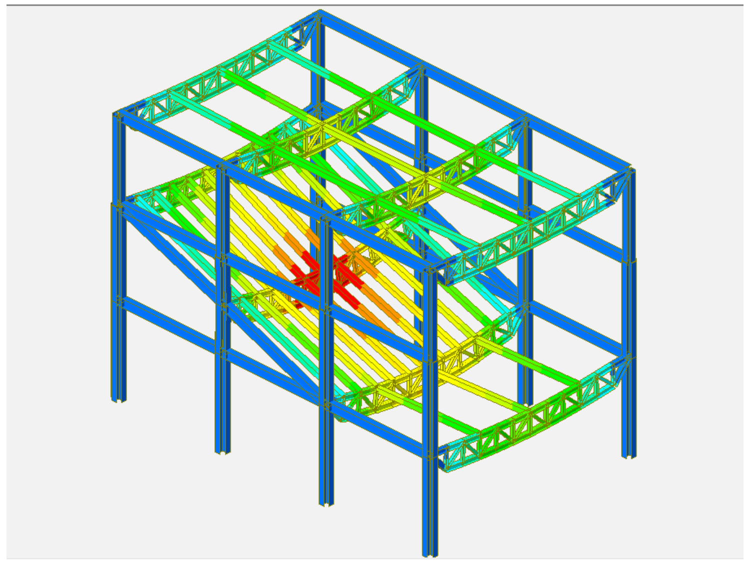
General | Steel Design | Concrete Design | SRC Design | Cold Formed Steel Design | Footing Des

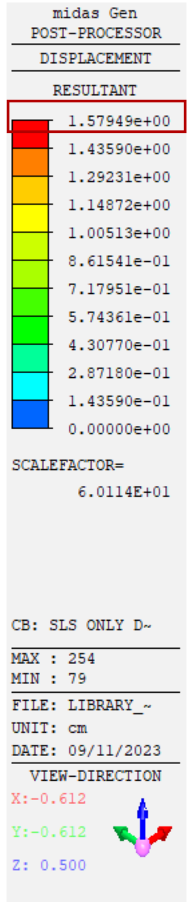
Load Combination List

N	Name	A	T	Description
1	SLS	A	A	1*DL(Slab1+Slab2)+1*LL(Slab1+Slab2)
2	ULS	A	A	1.35*DL(Slab1+Slab2)+1.50*LL(Slab1+Slab2)
3	SLS only DL	A	A	1*DL(Slab1+Slab2)
4	SLS only LL	A	A	1*LL(Slab1+Slab2)
*				

SLS: 1.00*DL+1.00*LL
ULS: 1.35*DL+1.50*LL

DISPLACEMENT - RESULTANT (SLS) under only Dead Load (DL)

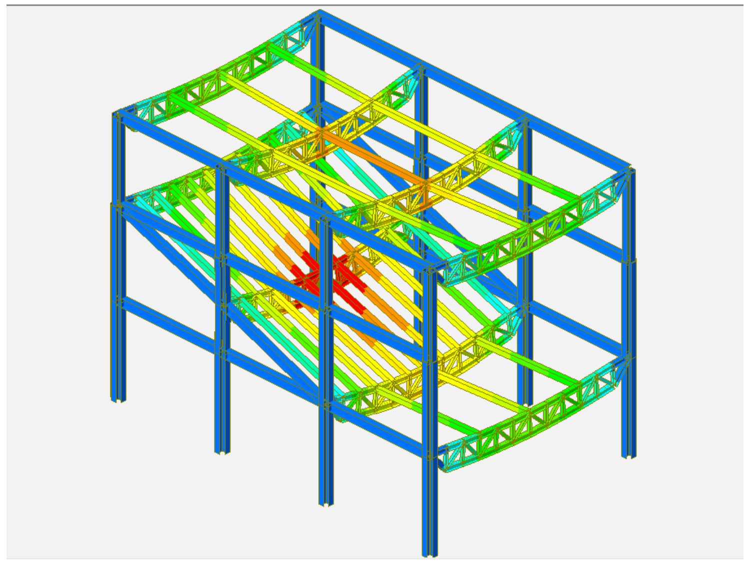


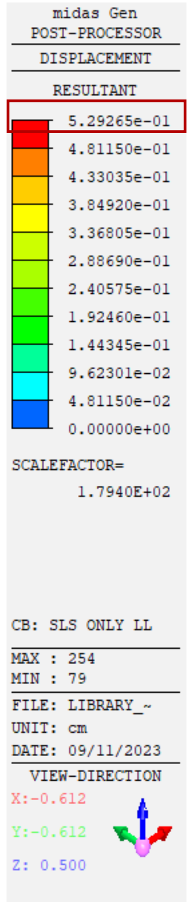


δmax

VERIFICATION
L/120
1200 cm/120=10
1.58 < 10

DISPLACEMENT - RESULTANT (SLS) under only Live Load (LL)

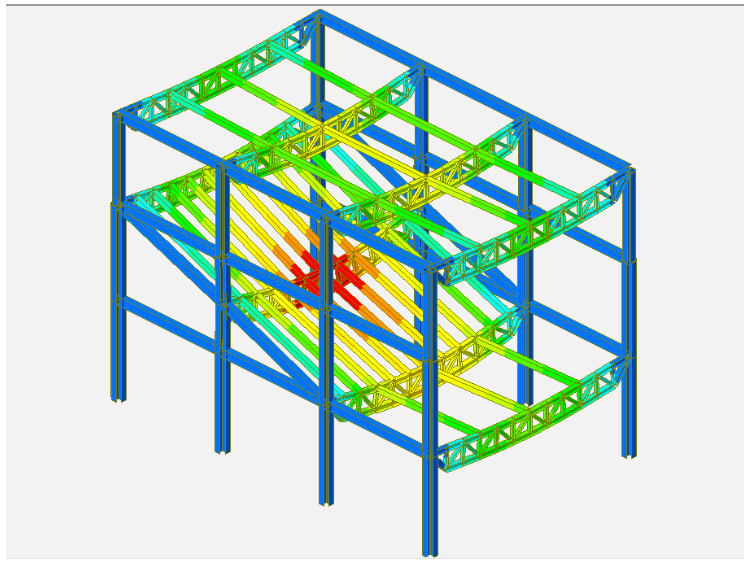


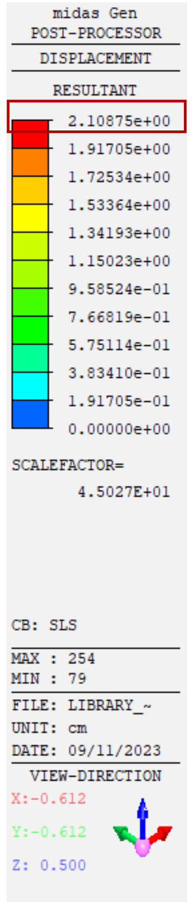


δmax

VERIFICATION
L/360
1200 cm/360=3.33
0.53 < 3.33

DISPLACEMENT - RESULTANT (SLS) under Dead Load (DL) and Live Load (LL)





δmax

VERIFICATION
L/250
1200/250=4.8
2.11 < 4.8

Figure 69: Midas Displacement Diagrams

STRUCTURAL ANALYSIS (MIDASGEN SOFTWARE)

CHECK 1

Steel Code Checking Result for Truss Chords with section HEB240

Eurocode3:05 Code Checking Result Dialog

Code : EC3:05 Unit : kN , m

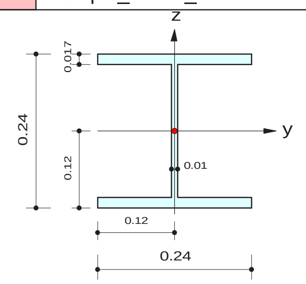
Sorted by ○ Member ● Property [Change...] [Update...]

CHK	MEMB	SECT	SEL	Section	
	COM	SHR		Material	Fy
NG	202	3	☐		HEB240
	99.990	0.039		S235	235000
OK	390	4	☐	Primary Beams, HEM400	
	0.122	0.068		S235	235000
OK	228	5	☐	Truss Webs, HEB140	
	0.884	0.000		S235	235000
OK	405	6	☐	HEM240	
	0.652	0.231		S235	235000

midas Gen **Steel Checking Result**

MIDAS	Company		Project Title	
	Author	Hp	File Name	Temple_Midas_Auditorium.mgb

1. Design Information



Design Code Eurocode3:05

Unit System kN, m

Member No 202

Material S235 (No:1)

(Fy = 235000, Es = 210000000)

Section Name (No:3)

(Rolled : HEB240).

Member Length : 1.00000

2. Member Forces

Axial Force Fxx = 2534.19 (LCB: 3, POS:1/2)

Bending Moments My = 53.2979, Mz = 0.00000

End Moments Myi = 61.6457, Myj = 44.6748 (for Lb)

Myi = 61.6457, Myj = 44.6748 (for Ly)

Mzi = 0.00000, Mzj = 0.00000 (for Lz)

Shear Forces Fyy = 0.00000 (LCB: 6, POS:1/2)

Fzz = 17.5217 (LCB: 3, POS:J)

Depth	0.24000	Web Thick	0.01000
Top F Width	0.24000	Top F Thick	0.01700
Bot.F Width	0.24000	Bot.F Thick	0.01700
Area	0.01060	Asz	0.00240
Qyb	0.05080	Qzb	0.00720
Iyy	0.00011	Izz	0.00004
Ybar	0.12000	Zbar	0.12000
Wely	0.00094	Welz	0.00033
ry	0.10300	rz	0.06080

3. Design Parameters

Unbraced Lengths Ly = 1.00000, Lz = 1.00000, Lb = 1.00000

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 = 16.4 < 200.0 (Memb:15, LCB: 3)................................... O.K

Axial Resistance

N_Ed/Nt_Rd = 2534.19/2491.00 = 1.017 > 1.000 .... N.G

Bending Resistance

M_Edy/M_Rdy = 53.298/247.690 = 0.215 < 1.000 .... O.K

M_Edz/M_Rdz = 0.000/116.266 = 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

Rmax = MAX[R.MNRd, (R.byN+R.byM)] = 99.990 > 1.000 .... N.G

Shear Resistance

V_Edy/Vy_Rd = 0.000 < 1.000 .... O.K

V_Edz/Vz_Rd = 0.039 < 1.000 .... O.K

5. Deflection Checking Results

L/ 250.0 = 0.0040 > 0.0002 (Memb:202, LCB: 4, POS: 0.5m, Dir-Z)..................... O.K

CHECK 2

Steel Code Checking Result for Certain Truss Chords with section HEB280

Eurocode3:05 Code Checking Result Dialog

Code : EC3:05 Unit : kN , m

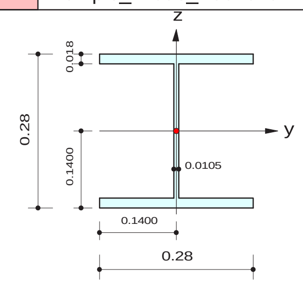
Sorted by ○ Member ● Property [Change...] [Update...]

CHK	MEMB	SECT	SEL	Section	
	COM	SHR		Material	Fy
OK	249	3	☐		HEB240
	0.843	0.068		S235	235000
OK	390	4	☐	Primary Beams, HEM400	
	0.122	0.068		S235	235000
OK	228	5	☐	Truss Webs, HEB140	
	0.883	0.000		S235	235000
OK	405	6	☐	HEM240	
	0.652	0.231		S235	235000
NG	202	7	☐	HEB280	
	1.194	0.025		S235	235000

midas Gen **Steel Checking Result**

MIDAS	Company		Project Title	
	Author	Hp	File Name	Temple_Midas_Auditorium.mgb

1. Design Information



Design Code Eurocode3:05

Unit System kN, m

Member No 202

Material S235 (No:1)

(Fy = 235000, Es = 210000000)

Section Name HEB280 (No:7)

(Rolled : HEB280).

Member Length : 1.00000

2. Member Forces

Axial Force Fxx = 2520.44 (LCB: 3, POS:I)

Bending Moments My = 88.1603, Mz = 0.00000

End Moments Myi = 88.1603, Myj = 74.7565 (for Lb)

Myi = 88.1603, Myj = 74.7565 (for Ly)

Mzi = 0.00000, Mzj = 0.00000 (for Lz)

Shear Forces Fyy = 0.00000 (LCB: 6, POS:1/2)

Fzz = 14.0845 (LCB: 3, POS:J)

Depth	0.28000	Web Thick	0.01050
Top F Width	0.28000	Top F Thick	0.01800
Bot.F Width	0.28000	Bot.F Thick	0.01800
Area	0.01310	Asz	0.00294
Qyb	0.07032	Qzb	0.00980
Iyy	0.00019	Izz	0.00007
Ybar	0.14000	Zbar	0.14000
Wely	0.00138	Welz	0.00047
ry	0.12100	rz	0.07090

3. Design Parameters

Unbraced Lengths Ly = 1.00000, Lz = 1.00000, Lb = 1.00000

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

L/r = 14.1 < 300.0 (Memb:202, LCB: 3)................................... O.K

Axial Resistance

N_Ed/Nt_Rd = 2520.44/3078.50 = 0.819 < 1.000 .... O.K

Bending Resistance

M_Edy/M_Rdy = 88.160/360.490 = 0.245 < 1.000 .... O.K

M_Edz/M_Rdz = 0.000/167.396 = 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

Rmax = MAX[R.MNRd, (R.byN+R.byM)] = 1.194 > 1.000 .... N.G

Shear Resistance

V_Edy/Vy_Rd = 0.000 < 1.000 .... O.K

V_Edz/Vz_Rd = 0.025 < 1.000 .... O.K

5. Deflection Checking Results

L/ 250.0 = 0.0040 > 0.0002 (Memb:202, LCB: 4, POS: 0.5m, Dir-Z)..................... O.K

STRUCTURAL ANALYSIS (MIDASGEN SOFTWARE)

CHECK 3

Steel Code Checking Result for Certain Truss Chords with section HEB240, HEB280,HEB300

Eurocode3:05 Code Checking Result Dialog

Code : EC3:05 Unit : kN , cm

Sorted by: Member / Property (selected) — Change... Update...

CHK	MEMB / COM	SECT / SHR	SEL	Section / Material	Fy
OK	249	3	☐	HEB240	
	0.843	0.068		S235	23.5000
OK	390	4	☐	Primary Beams, HEM400	
	0.122	0.068		S235	23.5000
OK	228	5	☐	Truss Webs, HEB140	
	0.884	0.000		S235	23.5000
OK	106	6	☐	HEB280	
	0.997	0.064		S235	23.5000
OK	202	7	☐	HEB300	
	0.949	0.029		S235	23.5000
OK	405	8	☐	HEM240	
	0.652	0.231		S235	23.5000

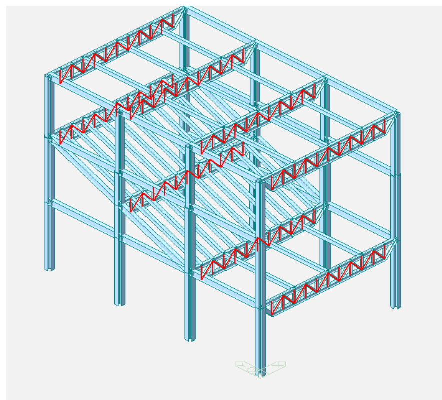
Two initial checks were performed regarding the steel code checking. First check showed that
certain members of the truss did not satisfy the requirements; therefore their cross-sections were changed to the profile of HEB280.

Following the second check, it was seen that for the two elements of the bottom chord of the truss in the middle of the inclined plane, the combined resistance was 1.194, which is greater than 1.00. The cross-sections of these two elements were changed to HEB300.

The third and final check verified that the steel code checking result ratio for all elements was smaller than 1.00, which meant the capacity (100%) of the element is not exceeded.

DETAILED GRAPHICS FOR EACH SECTION

HEB140

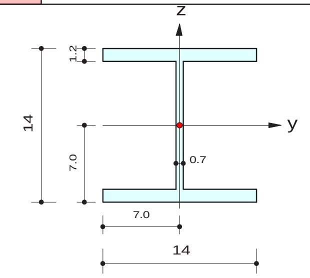


midas Gen — **Steel Checking Result**

Company		**Project Title**	
Author	Hp	**File Name**	Library_Midas_Auditorium.mgb

1. Design Information

Design Code Eurocode3:05
Unit System kN, cm
Member No 228
Material S235 (No:1)
(Fy = 23.5000, Es = 21000.0)
Section Name Truss Webs (No:5)
(Rolled : HEB140).
Member Length : 141.421



2. Member Forces

Axial Force Fxx = -791.17 (LCB: 3, POS:J)
Bending Moments My = 0.00000, Mz = 0.00000
End Moments Myi = 0.00000, Myj = 0.00000 (for Lb)
Myi = 0.00000, Myj = 0.00000 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 3, POS:J)
Fzz = 0.00000 (LCB: 3, POS:J)

Depth	14.0000	Web Thick	0.70000
Top F Width	14.0000	Top F Thick	1.20000
Bot.F Width	14.0000	Bot.F Thick	1.20000
Area	43.0000	Asz	9.80000
Qyb	170.420	Qzb	24.5000
Iyy	1510.00	Izz	550.000
Ybar	7.00000	Zbar	7.00000
Wely	216.000	Welz	78.5000
ry	5.93000	rz	3.58000

3. Design Parameters

Unbraced Lengths Ly = 141.421, Lz = 141.421, Lb = 141.421
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

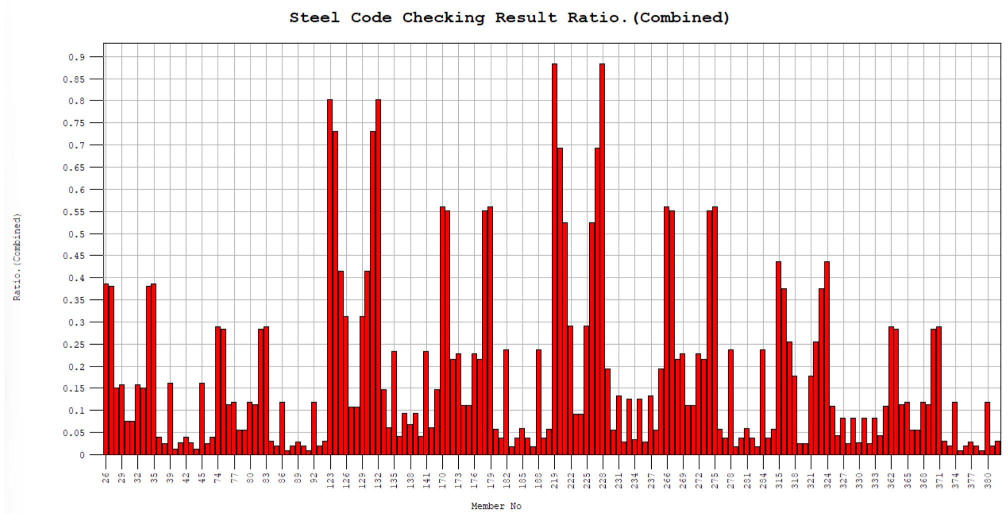
Slenderness Ratio
KL/r = 39.5 < 200.0 (Memb:228, LCB: 3)................................. O.K

Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 791.168/895.659 = 0.883 < 1.000 .... O.K

Bending Resistance
M_Edy/M_Rdy = 0.00/5781.00 = 0.000 < 1.000 .... O.K
M_Edz/M_Rdz = 0.00/2796.99 = 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.byN+R.byM), MAX(Rc.LT1+Rb.LT1, Rc.LT2+Rb.LT2)] = 0.884 < 1.000 .. O.K

Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 .... O.K
V_Edz/Vz_Rd = 0.000 < 1.000 .... O.K



DETAILED GRAPHICS FOR EACH SECTION

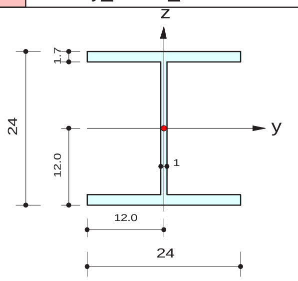
HEB240

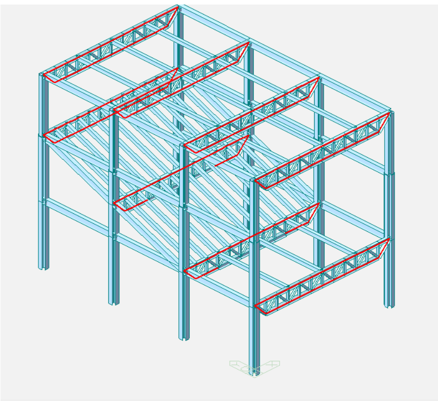
midas Gen **Steel Checking Result**

MIDAS	Company		Project Title	
	Author	Hp	File Name	Library_Midas_Auditorium.mgb

1. Design Information

Design Code Eurocode3:05
Unit System kN, cm
Member No 249
Material S235 (No:1)
(Fy = 23.5000, Es = 21000.0)
Section Name (No:3)
(Rolled : HEB240).
Member Length : 100.000





2. Member Forces

Axial Force Fxx = 1636.25 (LCB: 3, POS:I)
Bending Moments My = 4606.87, Mz = 0.00000
End Moments Myi = 4606.87, Myj = 1591.51 (for Lb)
Myi = 4606.87, Myj = 1591.51 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 6, POS:1/2)
Fzz = 30.7044 (LCB: 3, POS:J)

Depth	24.0000	Web Thick	1.00000
Top F Width	24.0000	Top F Thick	1.70000
Bot.F Width	24.0000	Bot.F Thick	1.70000
Area	106.000	Asz	24.0000
Qyb	507.965	Qzb	72.0000
Iyy	11260.0	Izz	3920.00
Ybar	12.0000	Zbar	12.0000
Wely	938.000	Welz	327.000
ry	10.3000	rz	6.08000

3. Design Parameters

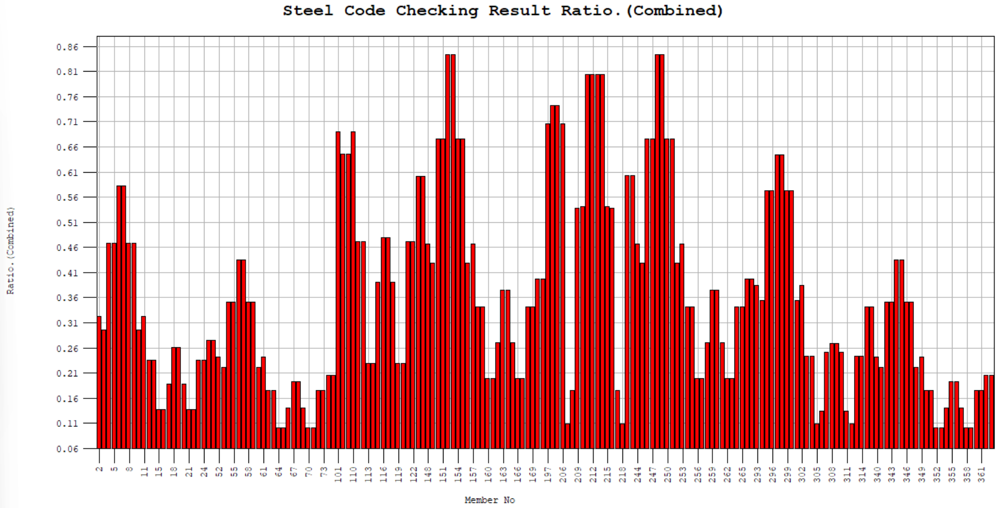
Unbraced Lengths Ly = 100.000, Lz = 100.000, Lb = 100.000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Result

Slenderness Ratio
KL/r = 16.4 < 200.0 (Memb:15, LCB: 3)................................... O.K
Axial Resistance
N_Ed/Nt_Rd = 1636.25/2491.00 = 0.657 < 1.000 .... O.K
Bending Resistance
M_Edy/M_Rdy = 4606.9/24769.0 = 0.186 < 1.000 .... O.K
M_Edz/M_Rdz = 0.0/11626.6 = 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
Rmax = MAX[R.MNRd, (R.byN+R.byM)] = 0.843 < 1.000 .... O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 .... O.K
V_Edz/Vz_Rd = 0.068 < 1.000 .... O.K

5. Deflection Checking Results

L/ 250.0 = 0.4000 > 0.0171 (Memb:214, LCB: 4, POS: 50.0cm, Dir-Z).................... O.K



DETAILED GRAPHICS FOR EACH SECTION

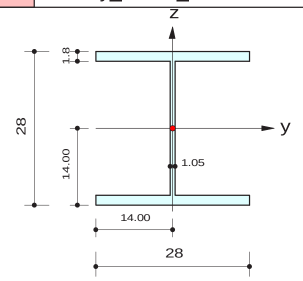
HEB280

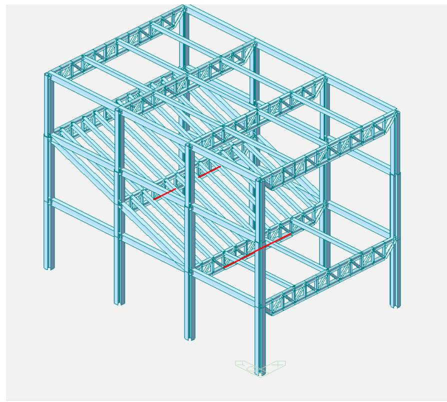
midas Gen **Steel Checking Result**

MIDAS	Company		Project Title	
	Author	Hp	File Name	Library_Midas_Auditorium.mgb

1. Design Information

Design Code Eurocode3:05
Unit System kN, cm
Member No 106
Material S235 (No:1)
(Fy = 23.5000, Es = 21000.0)
Section Name HEB280 (No:6)
(Rolled : HEB280).
Member Length : 100.000





2. Member Forces

Axial Force Fxx = 2363.41 (LCB: 3, POS:I)
Bending Moments My = 8253.30, Mz = 0.00000
End Moments Myi = 8253.30, Myj = 4770.29 (for Lb)
Myi = 8253.30, Myj = 4770.29 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 6, POS:1/2)
Fzz = 35.5108 (LCB: 3, POS:J)

Depth	28.0000	Web Thick	1.05000
Top F Width	28.0000	Top F Thick	1.80000
Bot.F Width	28.0000	Bot.F Thick	1.80000
Area	131.000	Asz	29.4000
Qyb	703.220	Qzb	98.0000
Iyy	19270.0	Izz	6590.00
Ybar	14.0000	Zbar	14.0000
Wely	1380.00	Welz	471.000
ry	12.1000	rz	7.09000

3. Design Parameters

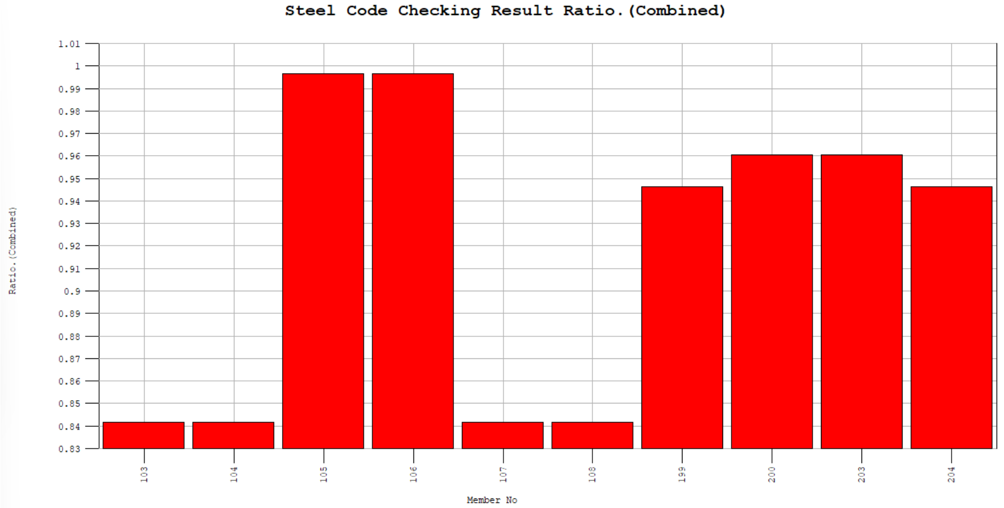
Unbraced Lengths Ly = 100.000, Lz = 100.000, Lb = 100.000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Result

Slenderness Ratio
L/r = 14.1 < 300.0 (Memb:106, LCB: 3).................................. O.K
Axial Resistance
N_Ed/Nt_Rd = 2363.41/3078.50 = 0.768 < 1.000 .... O.K
Bending Resistance
M_Edy/M_Rdy = 8253.3/36049.0 = 0.229 < 1.000 .... O.K
M_Edz/M_Rdz = 0.0/16739.6 = 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
Rmax = MAX[R.MNRd, (R.byN+R.byM)] = 0.997 < 1.000 .... O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 .... O.K
V_Edz/Vz_Rd = 0.064 < 1.000 .... O.K

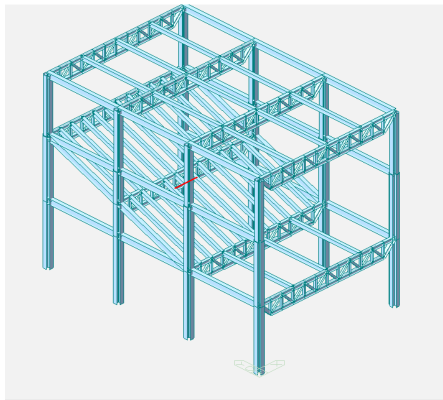
5. Deflection Checking Results

L/ 250.0 = 0.4000 > 0.0182 (Memb:203, LCB: 4, POS: 50.0cm, Dir-Z).................... O.K



DETAILED GRAPHICS FOR EACH SECTION

HEB300

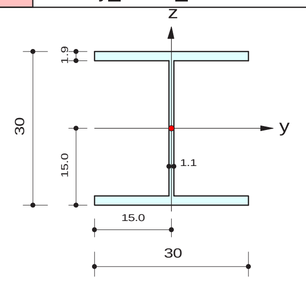


midas Gen — **Steel Checking Result**

Company		**Project Title**	
Author	Hp	**File Name**	Library_Midas_Auditorium.mgb

1. Design Information

Design Code Eurocode3:05
Unit System kN, cm
Member No 202
Material S235 (No:1)
(Fy = 23.5000, Es = 21000.0)
Section Name HEB300 (No:7)
(Rolled : HEB300).
Member Length : 100.000



2. Member Forces

Axial Force Fxx = 2513.86 (LCB: 3, POS:I)
Bending Moments My = 10155.2, Mz = 0.00000
End Moments Myi = 10155.2, Myj = 8387.97 (for Lb)
Myi = 10155.2, Myj = 8387.97 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 6, POS:1/2)
Fzz = 18.4461 (LCB: 3, POS:J)

Depth	30.0000	Web Thick	1.10000
Top F Width	30.0000	Top F Thick	1.90000
Bot.F Width	30.0000	Bot.F Thick	1.90000
Area	149.000	Asz	33.0000
Qyb	813.850	Qzb	112.500
Iyy	25170.0	Izz	8560.00
Ybar	15.0000	Zbar	15.0000
Wely	1680.00	Welz	571.000
ry	13.0000	rz	7.58000

3. Design Parameters

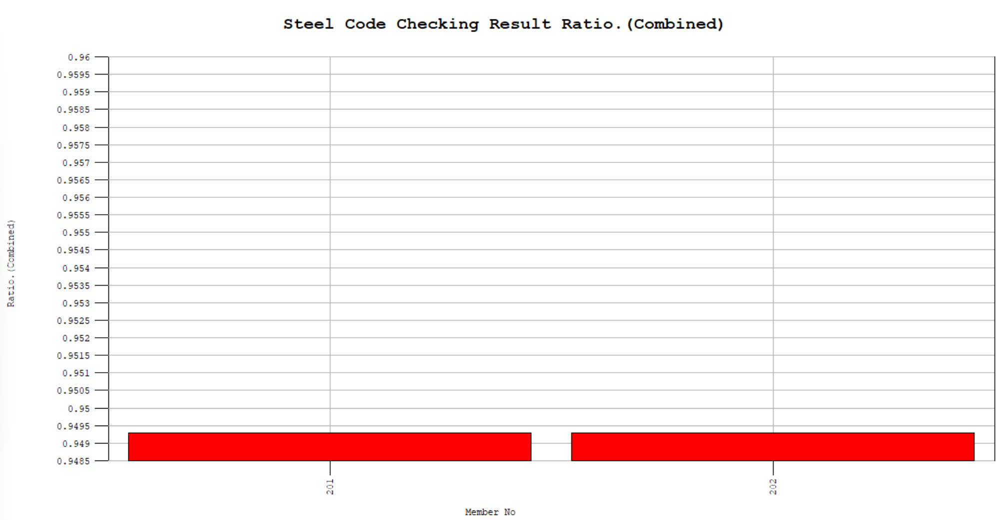
Unbraced Lengths Ly = 100.000, Lz = 100.000, Lb = 100.000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Result

Slenderness Ratio
L/r = 13.2 < 300.0 (Memb:202, LCB: 3)................................. O.K
Axial Resistance
N_Ed/Nt_Rd = 2513.86/3501.50 = 0.718 < 1.000 .... O.K
Bending Resistance
M_Edy/M_Rdy = 10155.2/43898.0 = 0.231 < 1.000 .... O.K
M_Edz/M_Rdz = 0.0/20278.7 = 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
Rmax = MAX[R.MNRd, (R.byN+R.byM)] = 0.949 < 1.000 .... O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 .... O.K
V_Edz/Vz_Rd = 0.029 < 1.000 .... O.K

5. Deflection Checking Results

L/ 250.0 = 0.4000 > 0.0159 (Memb:202, LCB: 4, POS: 50.0cm, Dir-Z).................... O.K



DETAILED GRAPHICS FOR EACH SECTION

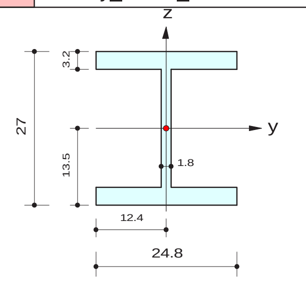
HEM240

midas Gen — **Steel Checking Result**

Company		**Project Title**	
Author	Hp	**File Name**	Library_Midas_Auditorium.mgb

1. Design Information

Design Code Eurocode3:05
Unit System kN, cm
Member No 405
Material S235 (No:1)
(Fy = 23.5000, Es = 21000.0)
Section Name HEM240 (No:8)
(Rolled : HEM240).
Member Length : 625.000



2. Member Forces

Axial Force Fxx = -0.1343 (LCB: 3, POS:1/2)
Bending Moments My = 29579.3, Mz = 0.00000
End Moments Myi = 0.00000, Myj = 0.00000 (for Lb)
Myi = 0.00000, Myj = 0.00000 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 6, POS:1/2)
Fzz = 189.308 (LCB: 3, POS:J)

Depth	27.0000	Web Thick	1.80000
Top F Width	24.8000	Top F Thick	3.20000
Bot.F Width	24.8000	Bot.F Thick	3.20000
Area	200.000	Asz	48.6000
Qyb	577.703	Qzb	76.8800
Iyy	24290.0	Izz	8150.00
Ybar	12.4000	Zbar	13.5000
Wely	1800.00	Welz	657.000
ry	11.0000	rz	6.39000

3. Design Parameters

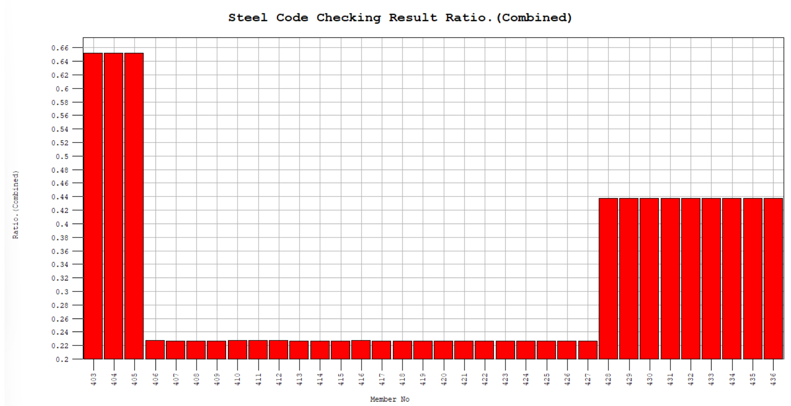
Unbraced Lengths Ly = 625.000, Lz = 625.000, Lb = 625.000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Result

Slenderness Ratio
KL/r = 104.5 < 200.0 (Memb:406, LCB: 3)................................. O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 0.13/4700.00 = 0.000 < 1.000 .... O.K
Bending Resistance
M_Edy/M_Rdy = 29579.3/45366.6 = 0.652 < 1.000 .... O.K
M_Edz/M_Rdz = 0.0/23517.6 = 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.byN+R.byM), MAX(Rc.LT1+Rb.LT1, Rc.LT2+Rb.LT2)] = 0.652 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 .... O.K
V_Edz/Vz_Rd = 0.231 < 1.000 .... O.K

5. Deflection Checking Results

L/ 250.0 = 2.5000 > 1.7500 (Memb:405, LCB: 4, POS: 312.5cm, Dir-Z).................... O.K



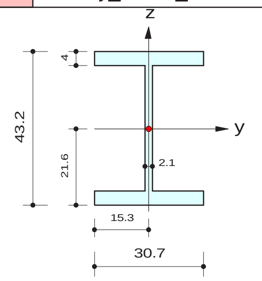
DETAILED GRAPHICS FOR EACH SECTION

midas Gen **Steel Checking Result**

MIDAS	Company		Project Title	
	Author	Hp	File Name	Library_Midas_Auditorium.mgb

1. Design Information

Design Code Eurocode3:05
Unit System kN, cm
Member No 390
Material S235 (No:1)
(Fy = 23.5000, Es = 21000.0)
Section Name Primary Beams (No:4)
(Rolled : HEM400).
Member Length : 625.000



2. Member Forces

Axial Force Fxx = -0.3941 (LCB: 3, POS:1/2)
Bending Moments My = 15936.5, Mz = 0.00000
End Moments Myi = 0.00000, Myj = 0.00000 (for Lb)
Myi = 0.00000, Myj = 0.00000 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 6, POS:1/2)
Fzz = 101.993 (LCB: 3, POS:J)

Depth	43.2000	Web Thick	2.10000
Top F Width	30.7000	Top F Thick	4.00000
Bot.F Width	30.7000	Bot.F Thick	4.00000
Area	326.000	Asz	90.7200
Qyb	1301.01	Qzb	117.811
Iyy	104100	Izz	19340.0
Ybar	15.3500	Zbar	21.6000
Wely	4820.00	Welz	1260.00
ry	17.9000	rz	7.70000

3. Design Parameters

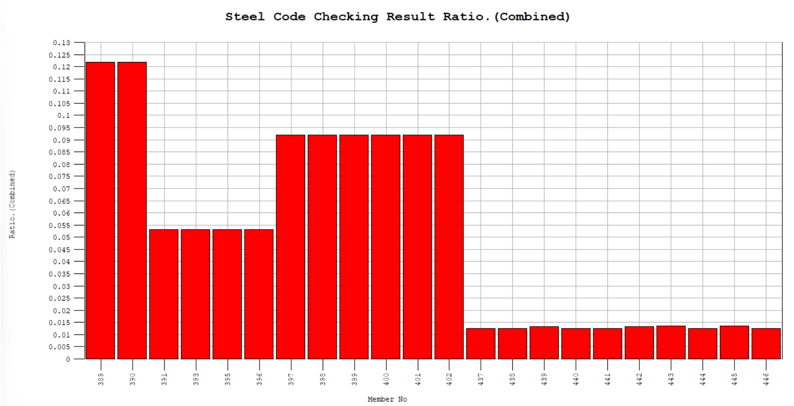
Unbraced Lengths Ly = 625.000, Lz = 625.000, Lb = 625.000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Result

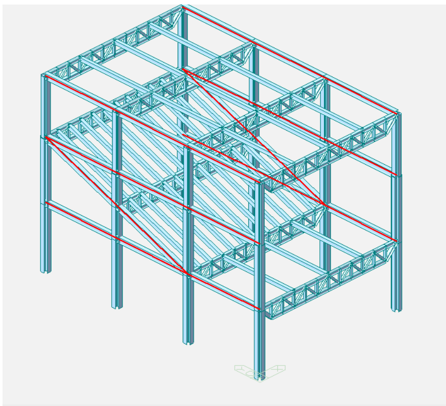
Slenderness Ratio
KL/r = 86.7 < 200.0 (Memb:391, LCB: 3)................................ O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 0.39/7661.00 = 0.000 < 1.000 .... O.K
Bending Resistance
M_Edy/M_Rdy = 15936/ 130895 = 0.122 < 1.000 .... O.K
M_Edz/M_Rdz = 0.0/45209.0 = 0.000 < 1.000 .... O.K
Combined 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.byN+R.byM), MAX(Rc.LT1+Rb.LT1, Rc.LT2+Rb.LT2)] = 0.122 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 .... O.K
V_Edz/Vz_Rd = 0.068 < 1.000 .... O.K

5. Deflection Checking Results

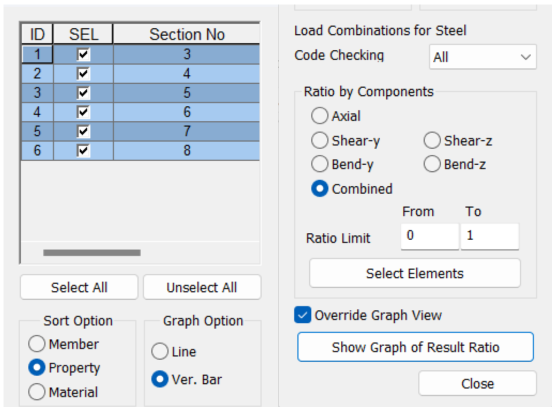
L/ 250.0 = 2.5000 > 0.2293 (Memb:390, LCB: 4, POS: 312.5cm, Dir-Z).................... O.K



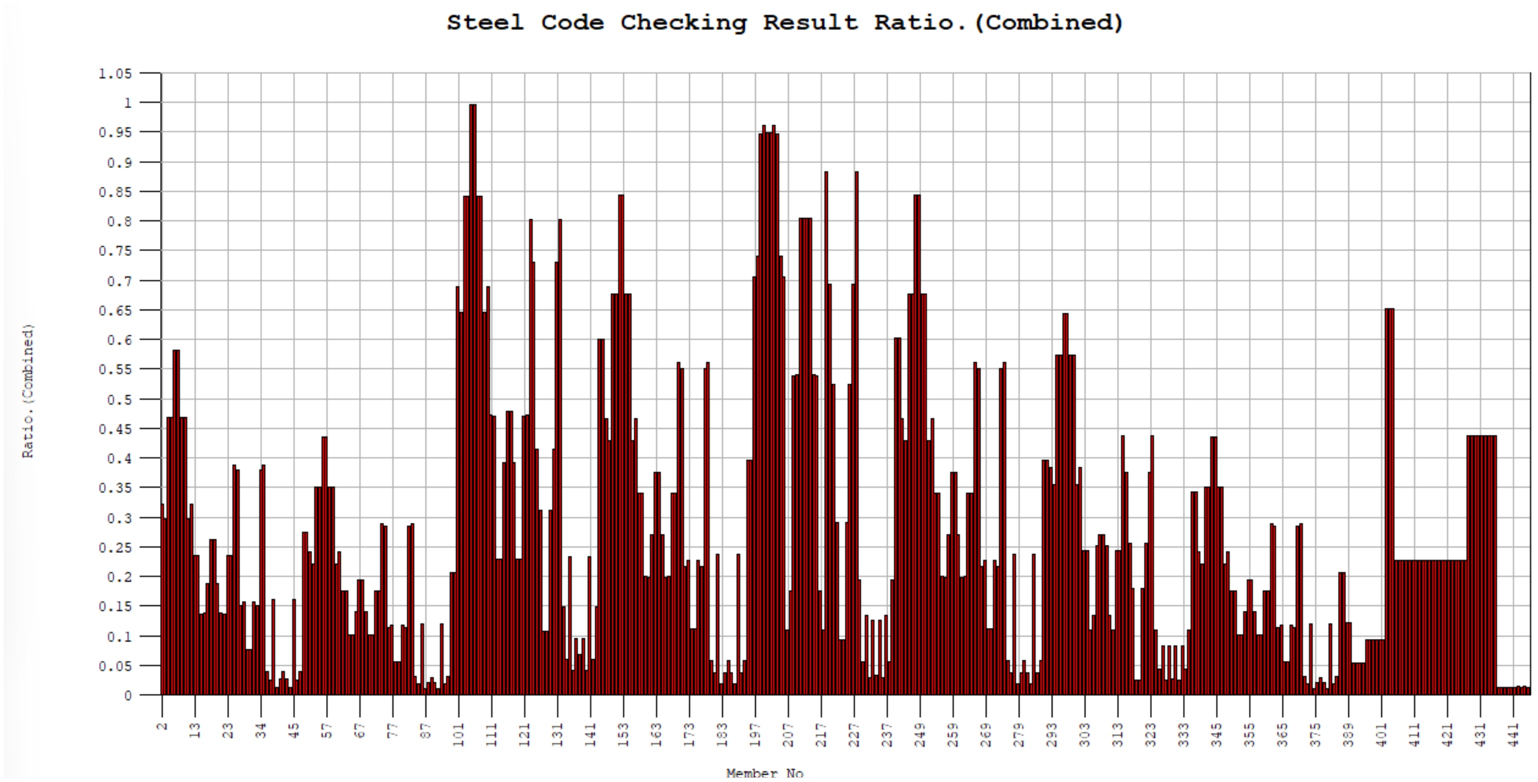
HEM400



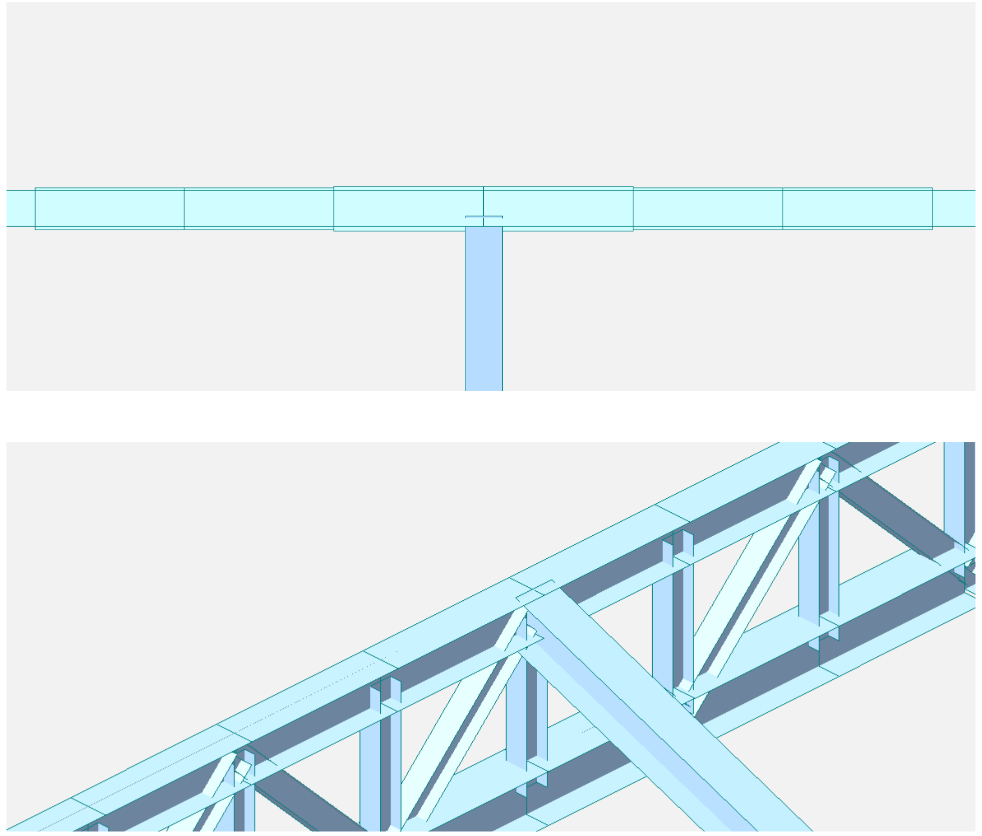
FINAL Steel Code Checking Result



ALL ELEMENTS (442 elements in total)



CONNECTION



The connection between the truss' top chord (HEB240) and the secondary beam (HEM240) should not transfer moments, to not create torsion on the truss.

Such a connection is designed with plates and bolts. A stiffener plate is welded to the web of the top chord on one side, and an end plate is welded to that covering the face of the section, with pre-drilled holes. Another end plate is welded to the face of the angled secondary beam. These two plates are bolted together. Bolts are spaced closely so the connection is still thought of as a pinned connection, which allows for displacements but not rations.

Figure 70: Steel Connection Between Beams

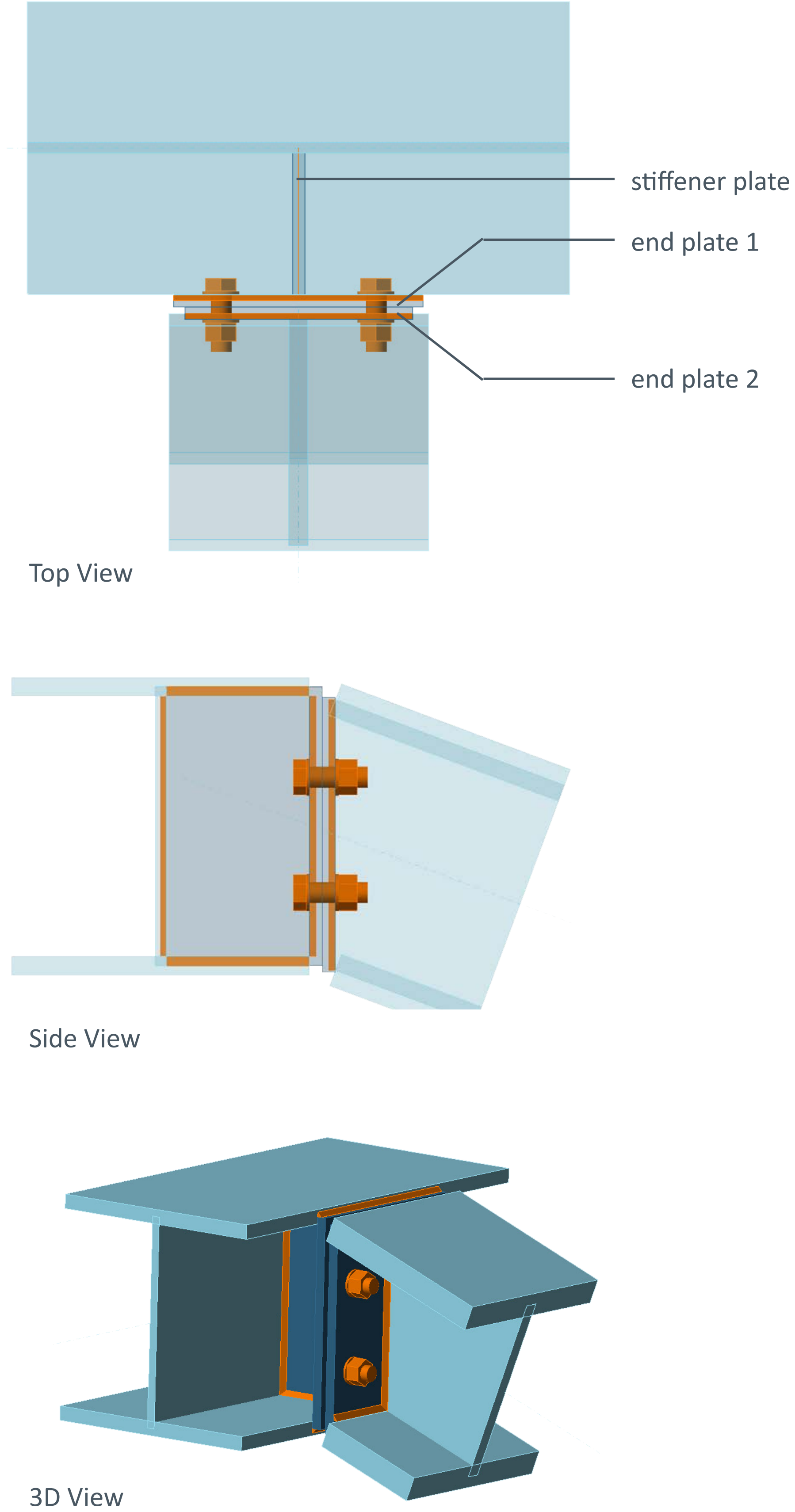


Figure 71: Steel Connection Detail

LIBRARY: Technological Design and BIM Tools

1 - BIM WORKFLOW

2 - PROJECT SITE ANALYSIS
- Radiation Analysis (*Grasshopper*)
- Wind Analysis (*Grasshopper*)
- Climate Analysis (*Grasshopper, Excel*)

3 - CONCEPTUAL DESIGN AND MODELING
- Orientation (*Grasshopper*)
- Volumetric Composition (*Grasshopper*)
- Program Distribution (*Grasshopper, Excel*)
- Bim Uses

4 - TECHNICAL AND STRUCTURAL DESIGN
- Structural Analysis (*Tekla*)
- MEP Systems (*Revit*)
- Rainwater Harvesting
- Natural Ventilation / Chimney Effect
- Light Wells (*Velux Daylight Visualizer*)
- Auditorium Acoustic Design (*Pachyderm*)
- Facade Generation (*Grasshopper, Ladybug*)

5 - PERFORMANCE EVALUATION
- Photovoltaics Performance (*Onyx Solar*)
- Thermal Performance (*U-bakus*)
- Sustainability (*ActiveHouse*)

6 - BIM MANAGEMENT
- Model Check (*Solibri*)
- Construction Site Simulation (*Synchro*)

BIM INITIATIVE MODEL USES TABLE

CODES	GENERAL MODEL USE
1010	ARCHITECTURAL MODELING
1100	DUCTED SYSTEMS MODELING
1120	FACADE SYSTEM MODELING
1190	HVAC SYSTEM MODELING
1310	PARAMETRIC MODELING
4020	ACOUSTICS ANALYSIS
4040	CLASH DETECTION
4120	LIGHTING ANALYSIS
4210	STRUCTURAL ANALYSIS
4220	SUSTAINABILITY ANALYSIS
7030	PERFORMANCE MONITORING
7040	REAL-TIME UTILIZATION

LOD 100

CONCEPTUAL DESIGN

Focusing on the urban strategies for the city of Milan and specifically the Porta Vittoria area, then comparing these goals with the natural conditions of the site formed specific strategies for improving the quality of built environment

LOD 200

SCHEMATIC DESIGN

Conceptual ideas were translated into a geometries and measures were controlled on 3D models. The character of the project was expressed in terms of program, spatial hierarchy, structural design, circulation patterns and relationship with surroundings.

LOD 300

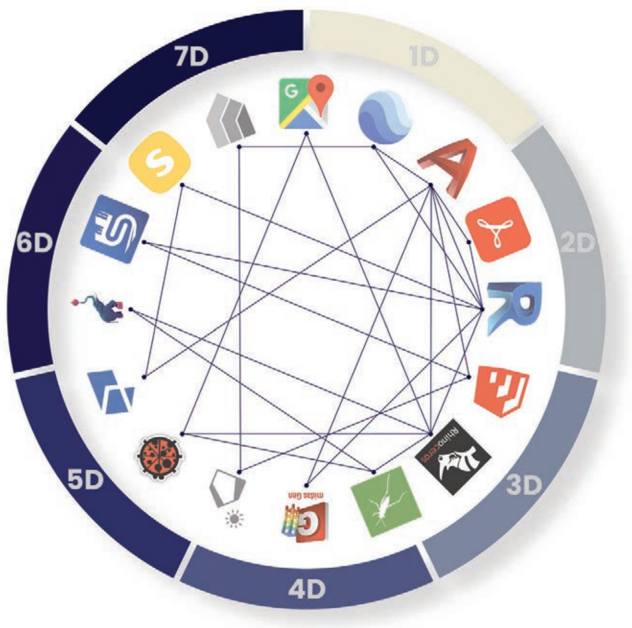
DESIGN DEVELOPEMENT

The facade was defined in a precise manner using parametric tools to obtain the best performance. Interior spaces were analysed and revised based on data obtained.

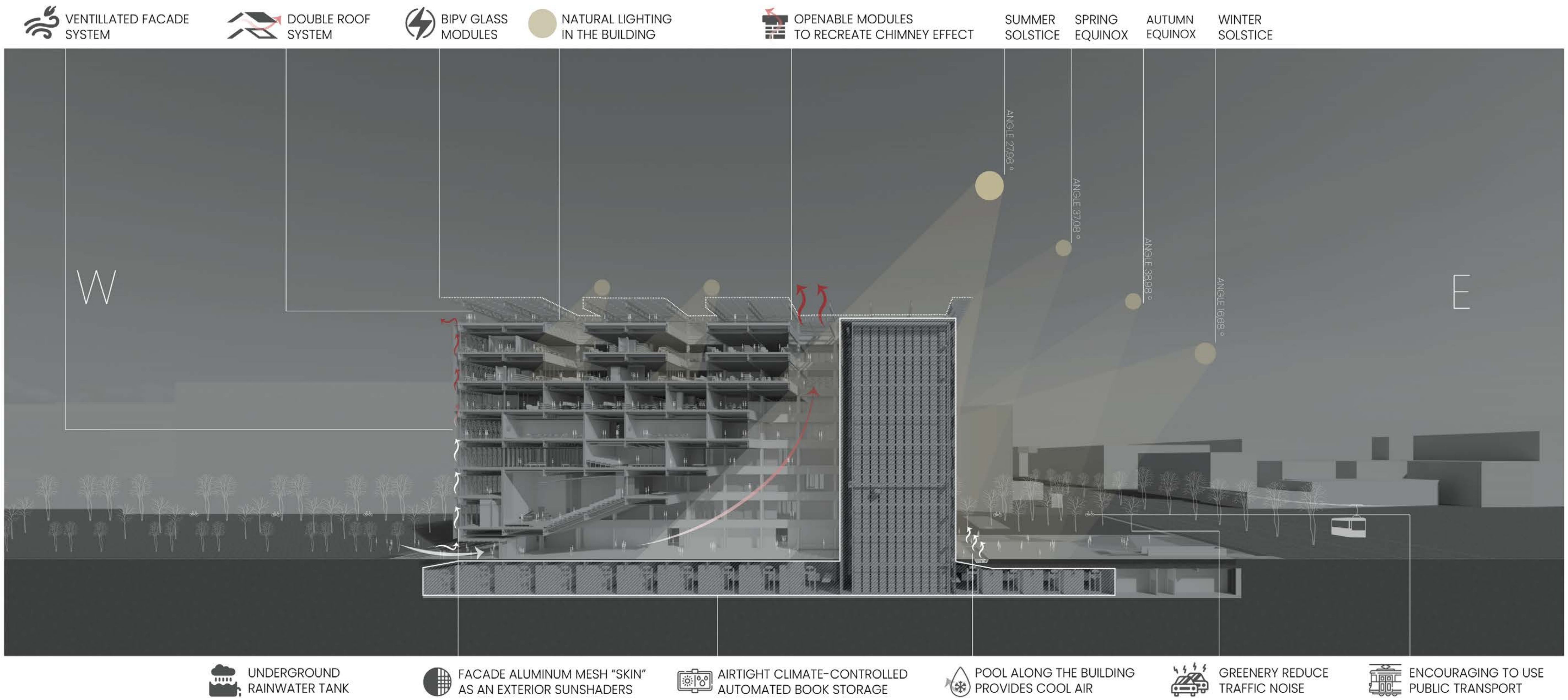
LOD 400

PERFORMANCE EVALUATION

Coordination between BIM softwares, as well as architectural and technical solutions, simulation of construction sequence and the level of sustainability were evaluated to make sure that the resulting project meets the initial goals defined on the urban scale.



INTERCONNECTION WEB BETWEEN THE SOFTWARES



SUSTAINABILITY STRATEGIES

SYSTEM CHOSEN: DAKU ITALIA EXTENSIVE PLUS

SYSTEM COMPONENTS

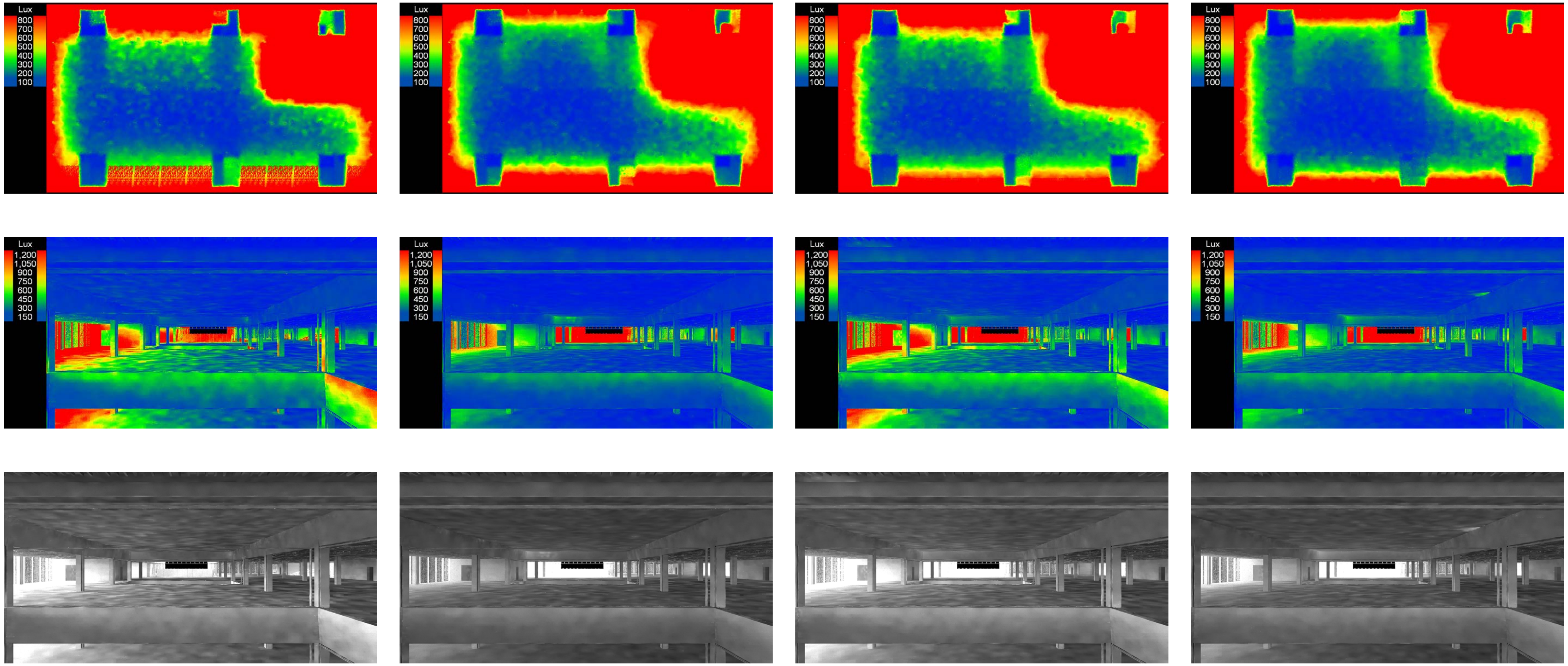
1. DAKU SEDUM (Mixture of Sedum) and perennial grasses
2. DAKU ROOF SOIL 2 (substrate, 10 cm thick)
3. DAKU STABILFILTER SFE (Filter)
4. DAKU FSD 20 (component for drainage and water storage)

ROOFTOP GREEN AREAS **Extensive garden reducing thermal dispersion during the winter and the roof surface's temperature during the summer.**

RENDERING - Panoramic Rooftop (Level 8)

Figure 72: Sustainability Strategy

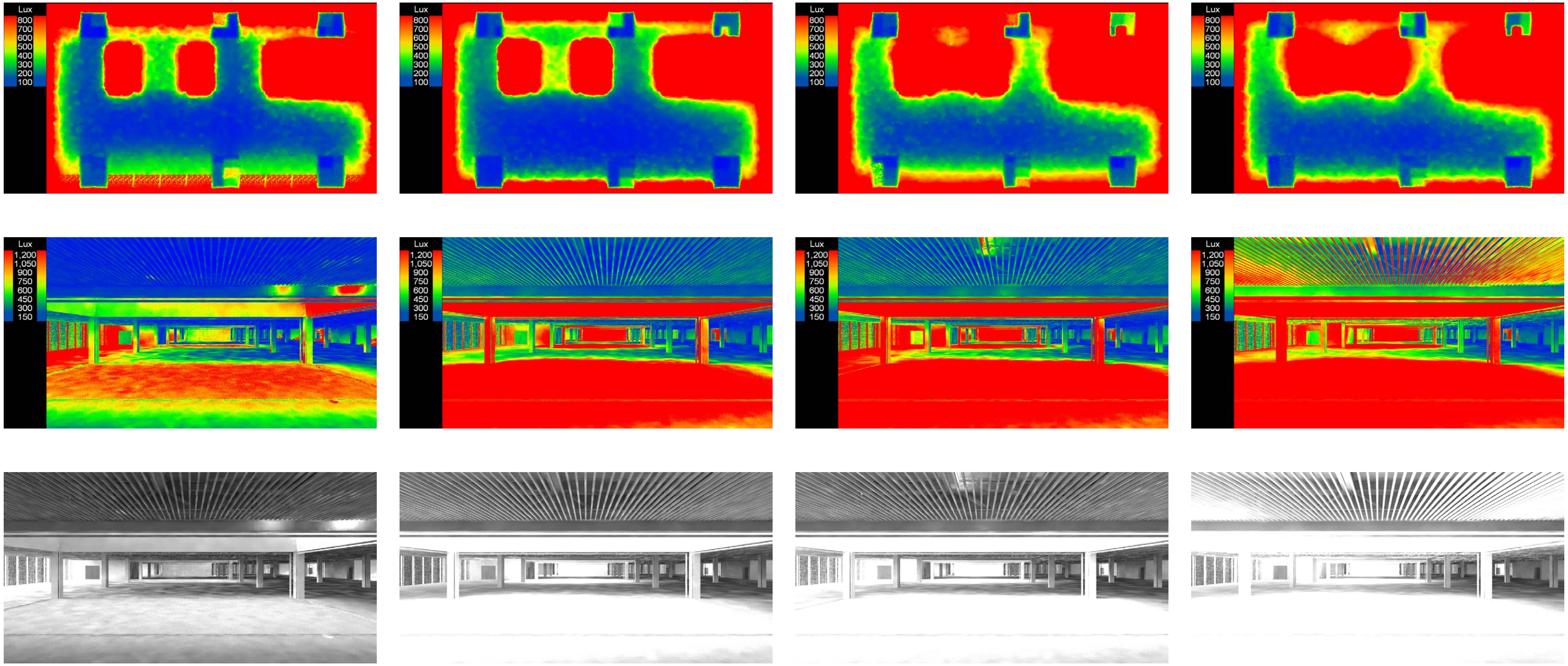
Figure 73: Rendering of Panoramic Terrace



WINTER AUTUMN SPRING SUMMER

LEVEL 7 (highest floor) READING AREA - VERSION 1

Figure 74: Daylight of Library without Skylights



WINTER

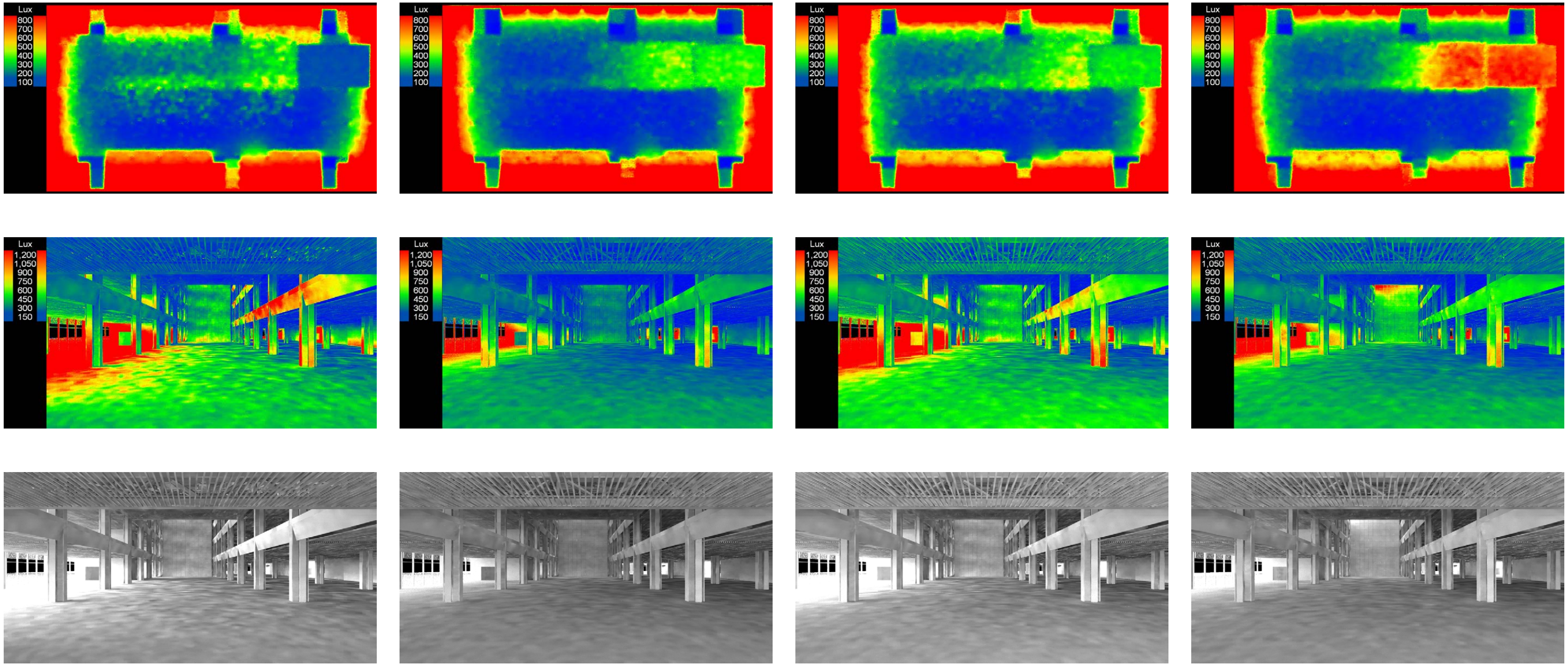
AUTUMN

SPRING

SUMMER

LEVEL 7 (highest floor) READING AREA - VERSION 2

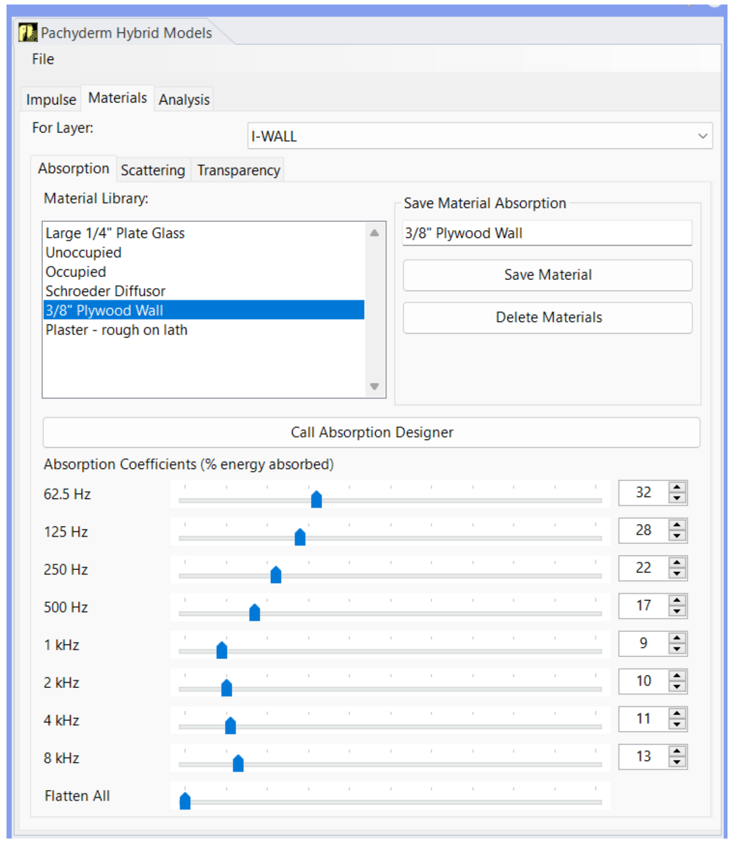
Figure 75: Daylight of Library with Skylights



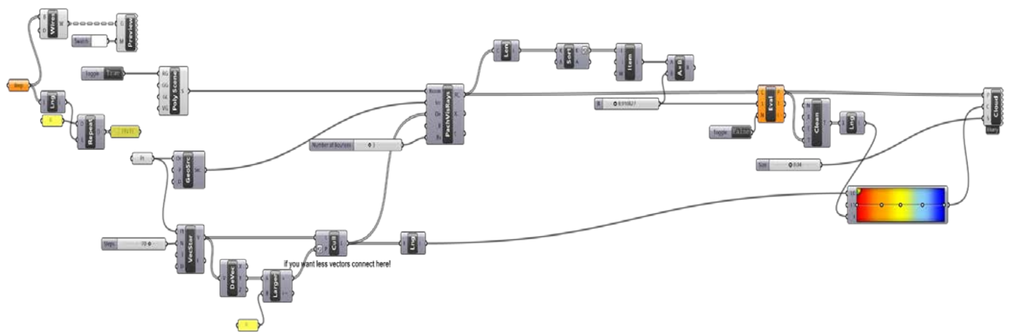
WINTER AUTUMN SPRING SUMMER

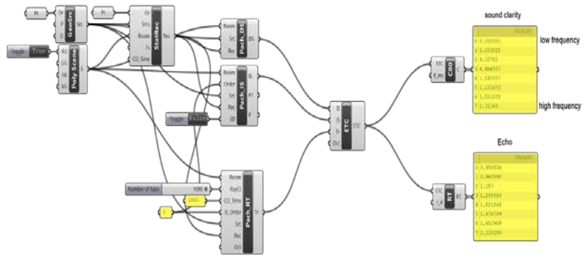
LEVEL 0 (ground floor) ENTRANCE HALL - VERSION 2

Figure 76: Daylight of Atrium



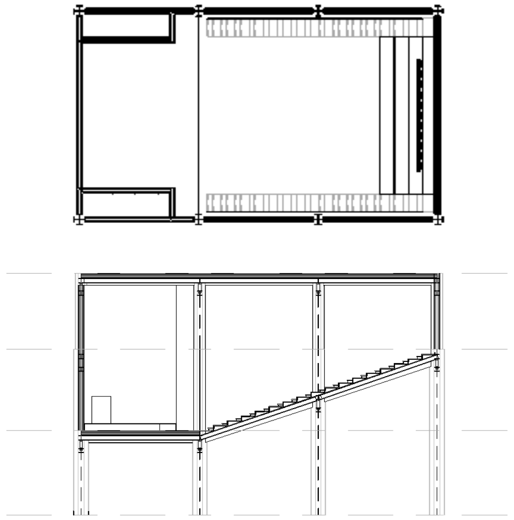
MATERIAL ACOUSTIC ASSIGNMENT



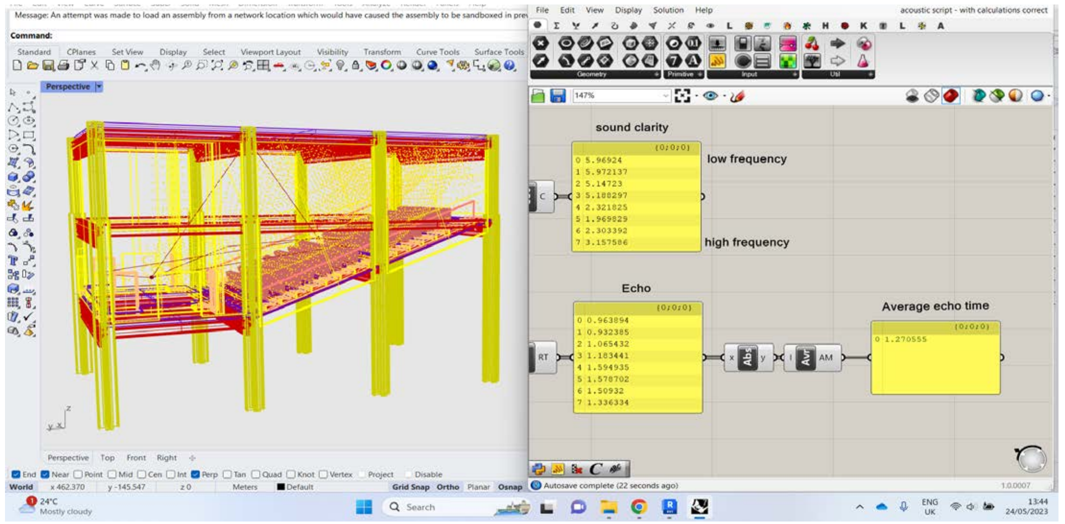


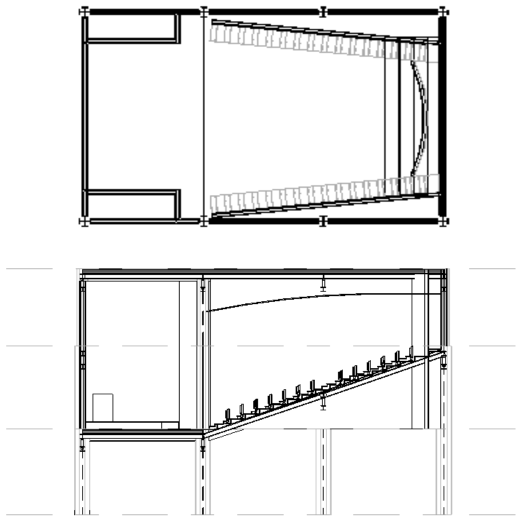
PACHYDERM SCRIPT

AUDITORIUM ACOUSTIC PERFORMANCE - COMPARISON

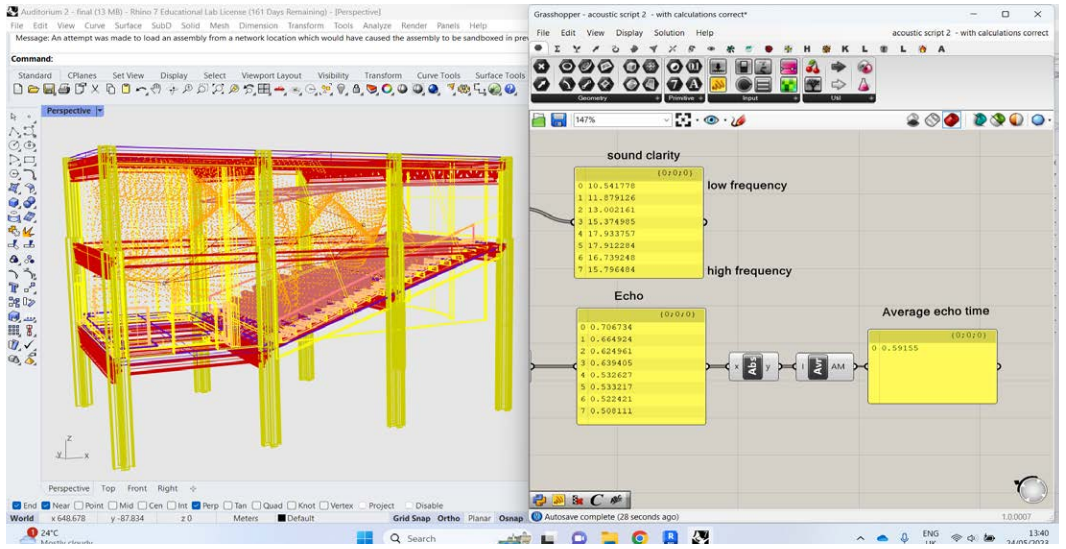


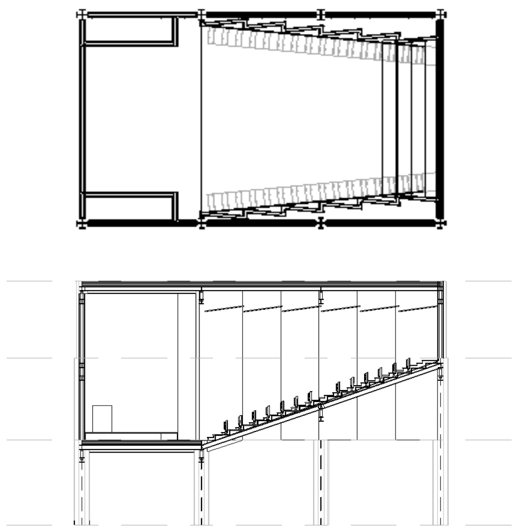
AUDITORIUM VERSION 1





AUDITORIUM VERSION 2





AUDITORIUM VERSION 3

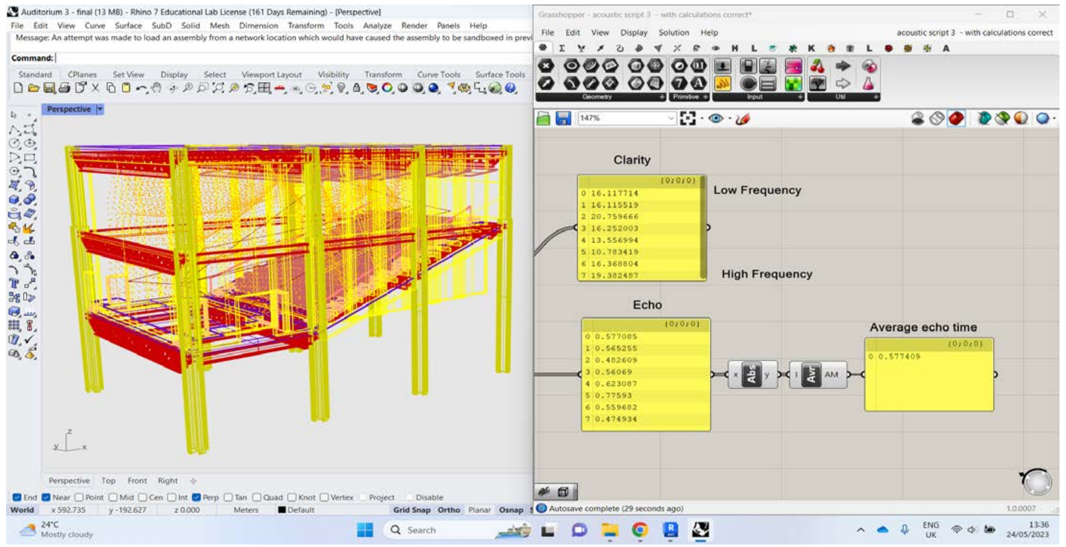


Figure 77: Pachyderm Performance Comparison

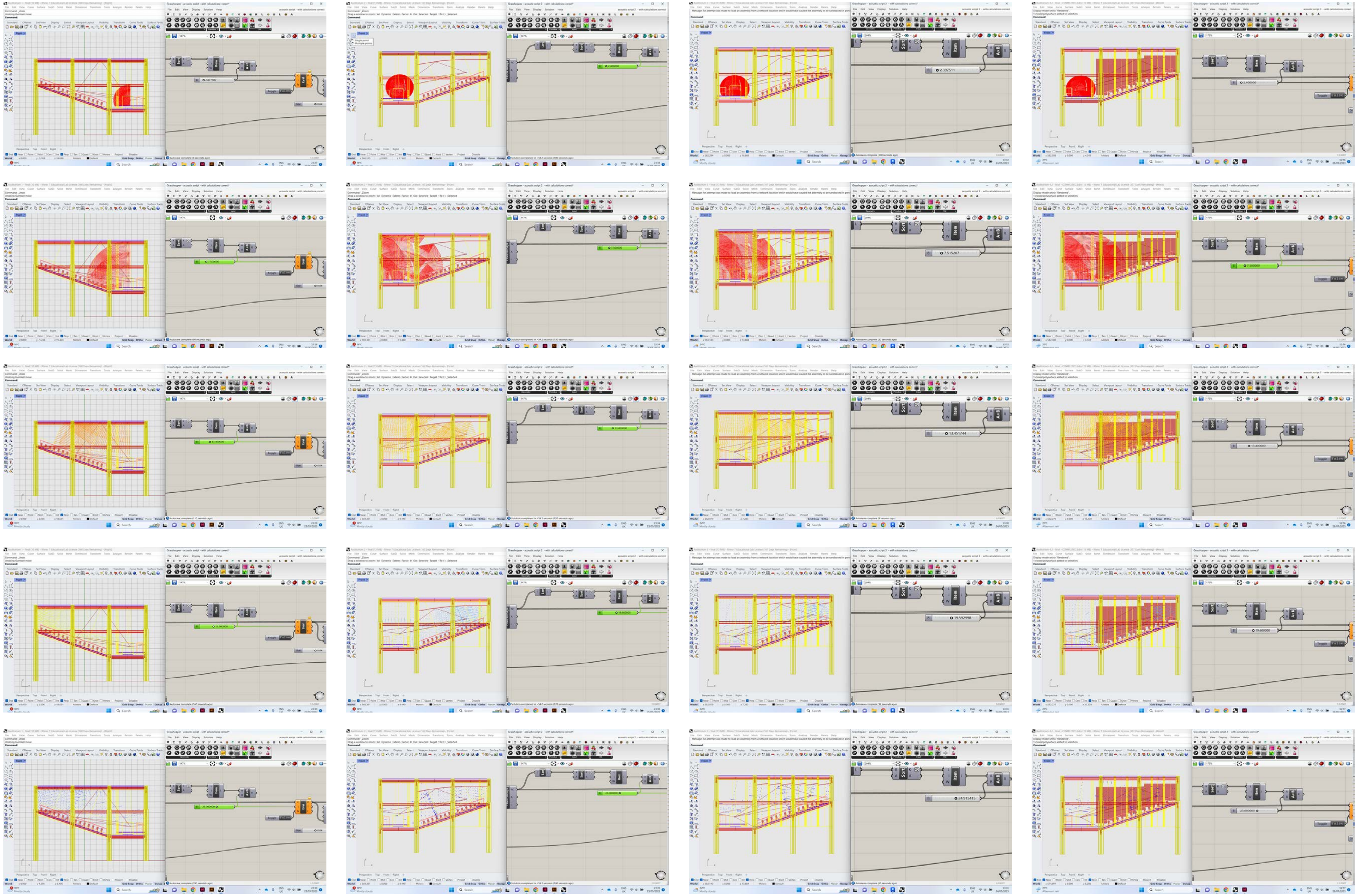
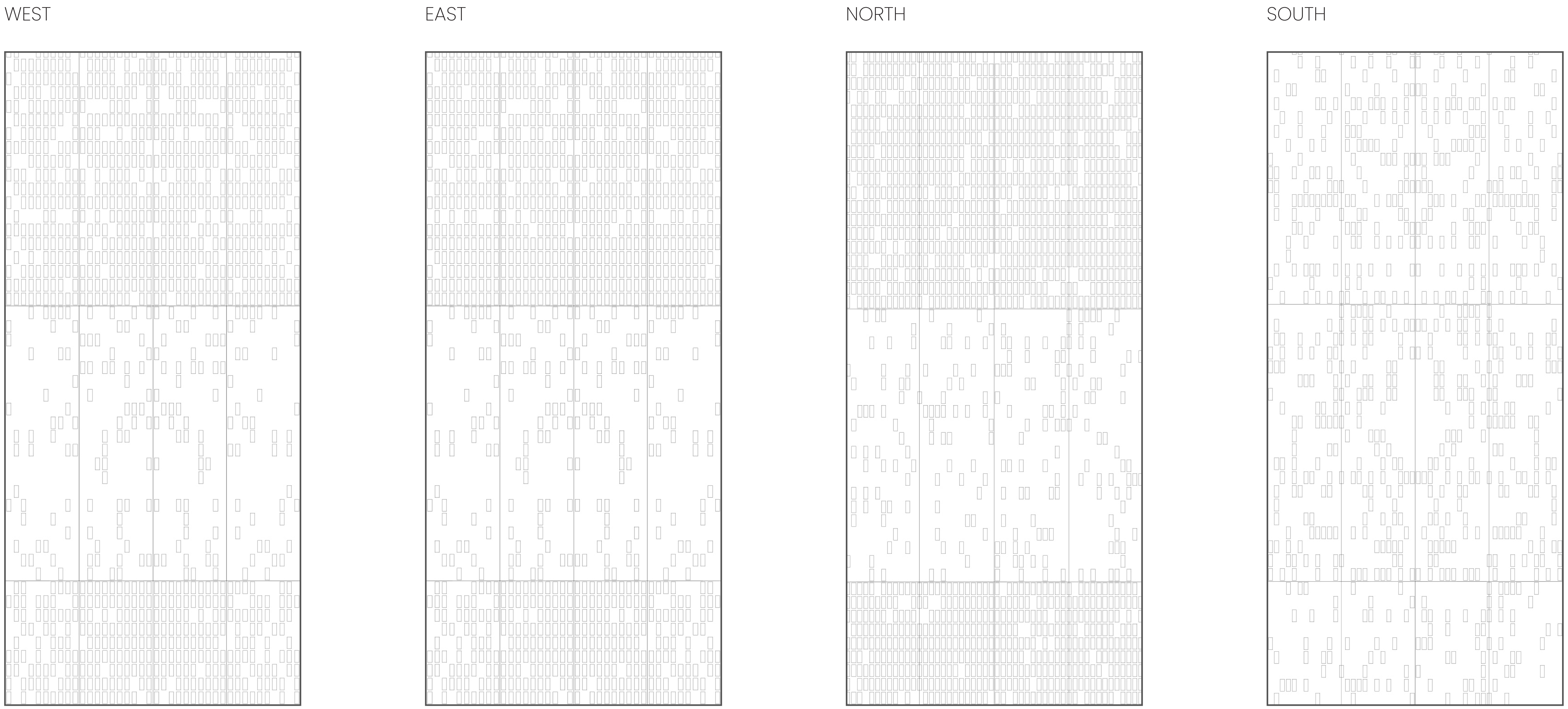


Figure 78: Pachyderm Acoustical Analysis



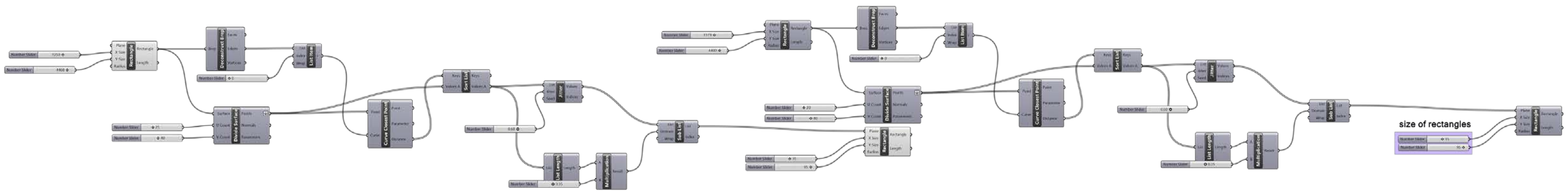
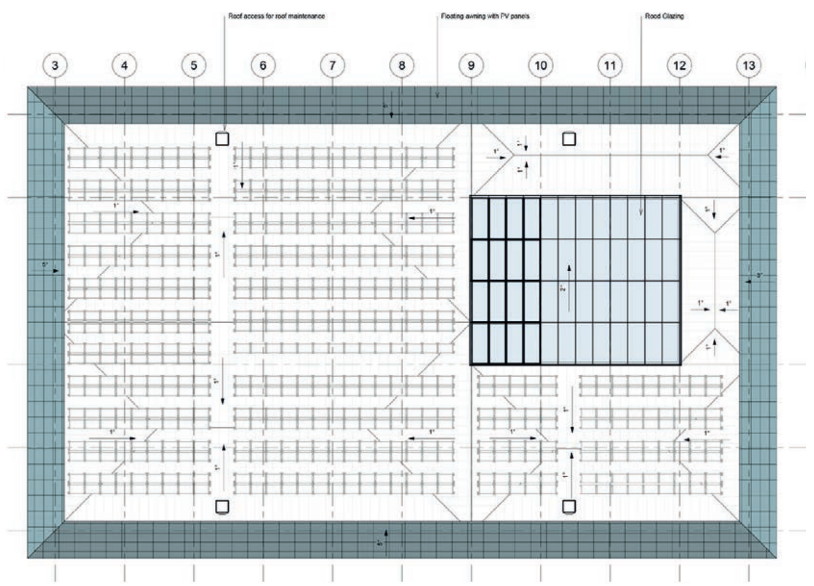


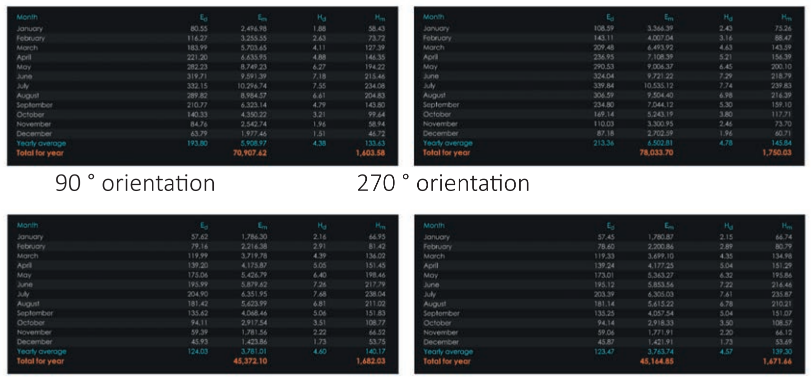
Figure 79: Parametric Façade Panels

Product used: Crystalline silicon PV glass (low solar cell density)

THICKNESS CONFIGURATION (mm)**	SHGC	Valor U m2	U value ft^2	External Light Reflection	Transparency
	%	**W/m^2K	Btu/h ft^2 F	%	%
6T+6T	40%	5,5	0.97	8,3%	38,0%

BIPV covered roof area = 1,107 m^2





90 ° orientation

270 ° orientation

0 ° orientation
slope 2°

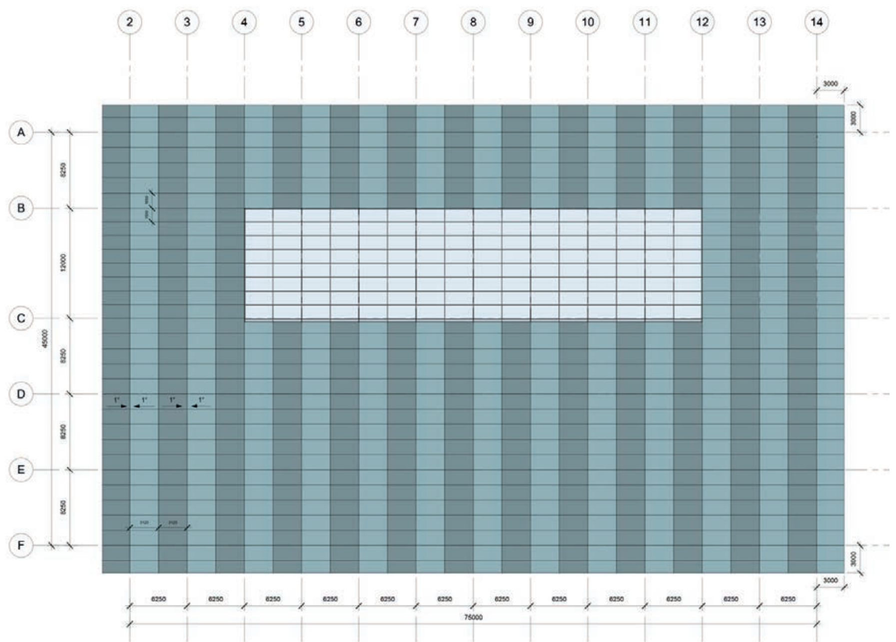
180 ° orientation

Annual electricity production from the given system /kWh/

≈239478 kWh

VERSION 1 - CONCEPT

BIPV covered roof area = 3,533 m^2



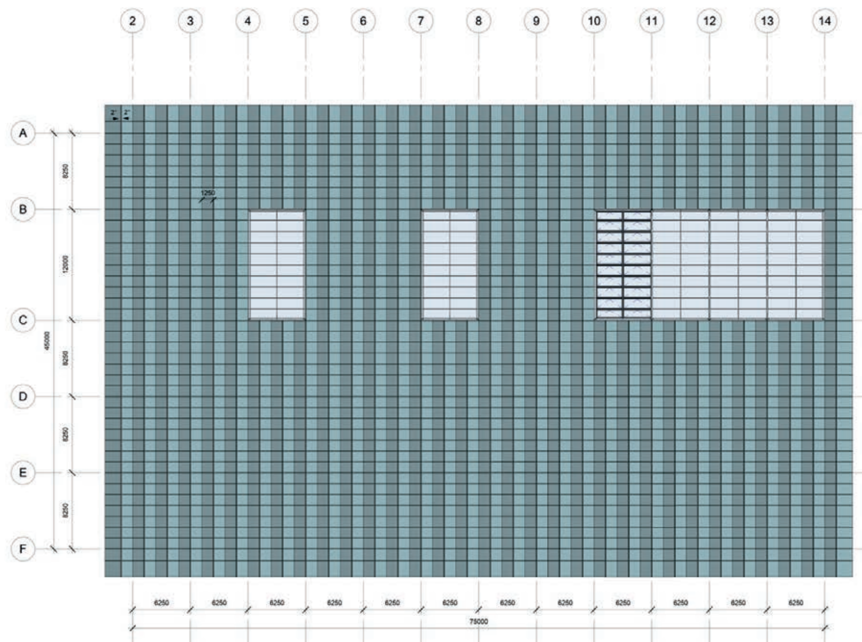
90 ° orientation
slope 2°

270 ° orientation

≈765672 kWh

VERSION 2 - FIRST STEP

BIPV covered roof area = 3,682 m^2



90 ° orientation
slope 2°

270 ° orientation

≈798189 kWh

VERSION 3 - SECOND STEP - FINALISED

Figure 80: BIPV Configurations Comparison

ubakus

Flat roof

Flat roof
created on 10.5.2023

Thermal protection

U = 0,25 W/(m²K)

GEG 2020 Bestand*: U<0,2 W/(m²K)

excellent insufficient

Moisture proofing

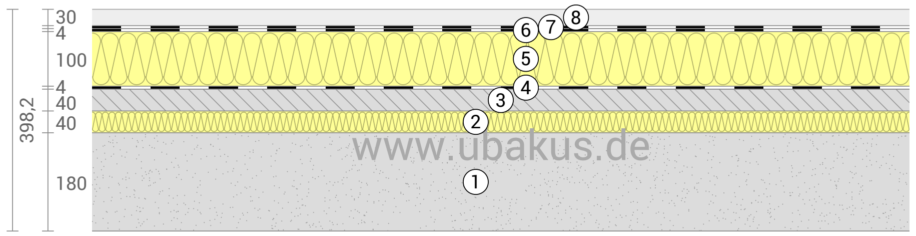
No condensate

excellent insufficient

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: 693 kJ/m²K

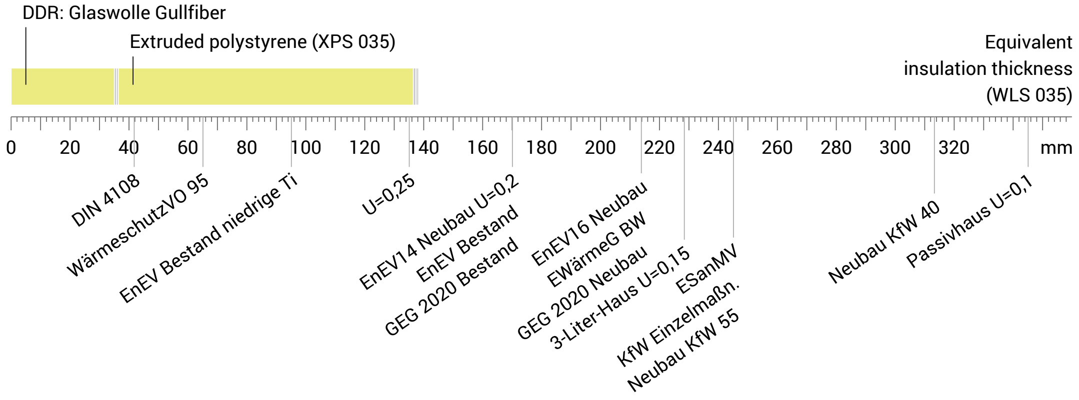
excellent insufficient



① Steel (180 mm)
② DDR: Glaswolle Gullfiber (40 mm)
③ Concrete (40 mm)
④ Vapor barrier sd=100m
⑤ Extruded polystyrene (100 mm)
⑥ BITUMAT PVC Waterproofing Membrane
⑦ Foil, PE
⑧ gravel (30 mm)

Impact of each layer and comparison to reference values

For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity 0,035 W/mK.



Inside air : 20,0°C / 50%
Outside air: -5,0°C / 80%
Surface temperature.: 18,5°C / -4,8°C

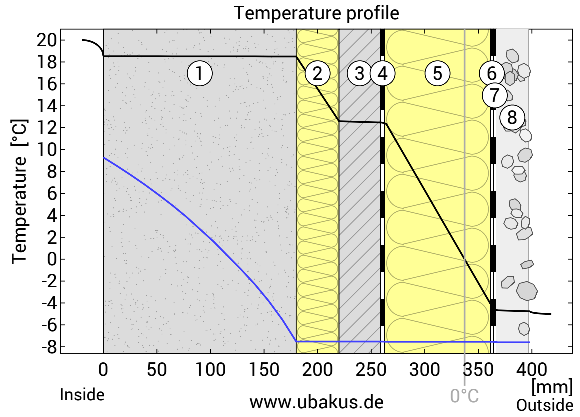
sd-value: 180452,7 m

Thickness: 39,8 cm
Weight: 1585 kg/m²
Heat capacity: 833 kJ/m²K

ubakus

Flat roof, U=0,25 W/(m²K)

Temperature profile



① Steel (180 mm)
② DDR: Glaswolle Gullfiber (40 mm)
③ Concrete (40 mm)
④ Vapor barrier sd=100m
⑤ Extruded polystyrene (100 mm)
⑥ BITUMAT PVC Waterproofing Membrane
⑦ Foil, PE
⑧ gravel (30 mm)

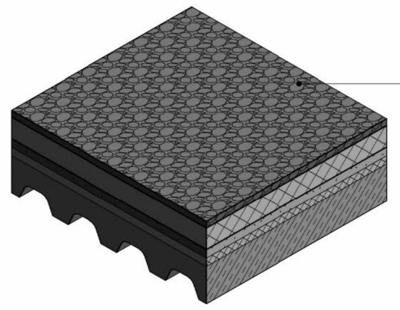
Temperature and dew-point temperature in the component. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew-point temperature, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,100	18,5	20,0	
1	18 cm	Steel	50,000	0,004	18,5	18,5	1.413,0
2	4 cm	DDR: Glaswolle Gullfiber	0,040	1,000	12,6	18,5	0,6
3	4 cm	Concrete	2,000	0,020	12,5	12,6	96,0
4	0,4 cm	Vapor barrier sd=100m	0,220	0,018	12,4	12,5	1,0
5	10 cm	Extruded polystyrene (XPS 035)	0,035	2,857	-4,5	12,4	3,5
6	0,4 cm	BITUMAT PVC Waterproofing Membrane	0,170	0,024	-4,7	-4,5	4,2
7	0,02 cm	Foil, PE	0,400	0,001	-4,7	-4,7	0,2
8	3 cm	gravel	2,000	0,015	-4,8	-4,7	66,0
		Thermal contact resistance*		0,040	-5,0	-4,8	
	39,82 cm	Whole component		4,078			1.584,5

*Thermal contact resistances according to DIN 6946 for the U-value calculation. Rsi=0,25 and Rse=0,04 according to DIN 4108-3 were used for moisture proofing and temperature profile.

Surface temperature inside (min / average / max): 18,5°C 18,5°C 18,5°C
Surface temperature outside (min / average / max): -4,8°C -4,8°C -4,8°C



8. Gravel, tks. 30mm
7. Filter sheet
6. Waterproofing membrane, tks. 4 mm
5. Isolating layer, tks.100 mm
4. Vapour barrier, tks. 4 mm
3. Screed sloping layer in concrete, tks. 40 mm
2. Acoustic insulation slabs, tks. 40 mm
1. Composite roof, tks. 180 mm in total:
   Steel deck, tks. 80 mm;
   Reinforced concrete layer

/overall thickness ~ 400 mm/

All statements without guarantee

Flat roof, U=0,25 W/(m²K)

Moisture proofing

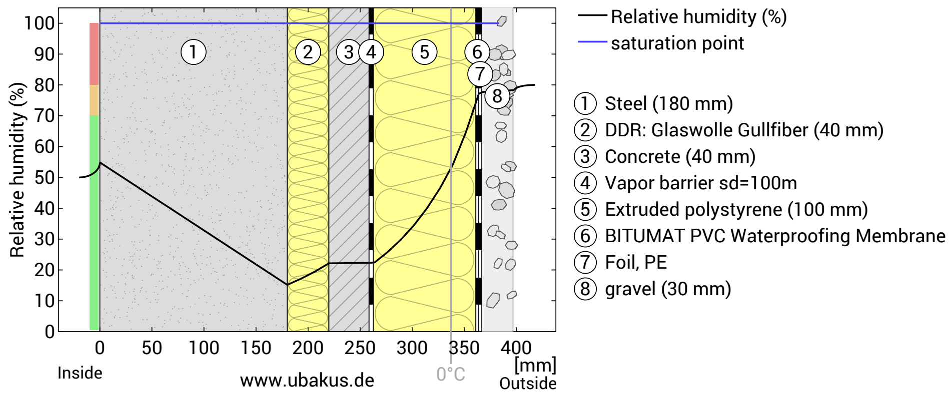
For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

This component is free of condensate under the given climate conditions.

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	18 cm	Steel	180000	-		1.413,0
2	4 cm	DDR: Glaswolle Gullfiber	0,04	-		0,6
3	4 cm	Concrete	3,20	-		96,0
4	0,4 cm	Vapor barrier sd=100m	100,00	-		1,0
5	10 cm	Extruded polystyrene (XPS 035)	8,00	-		3,5
6	0,4 cm	BITUMAT PVC Waterproofing Membrane	320,00	-		4,2
7	0,02 cm	Foil, PE	20,00	-		0,2
8	3 cm	gravel	1,50	-		66,0
	39,82 cm	Whole component	180.452,72	0		1.584,5

Humidity

The temperature of the inside surface is 18,5 °C leading to a relative humidity on the surface of 55%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



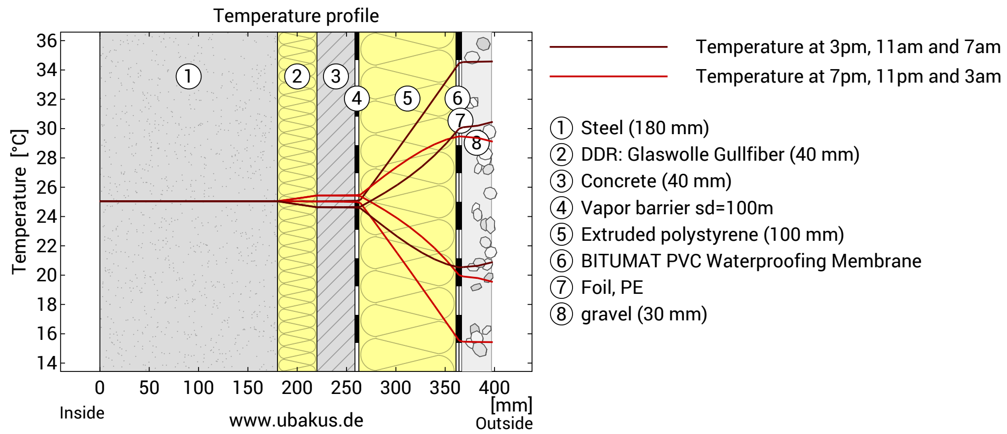
Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

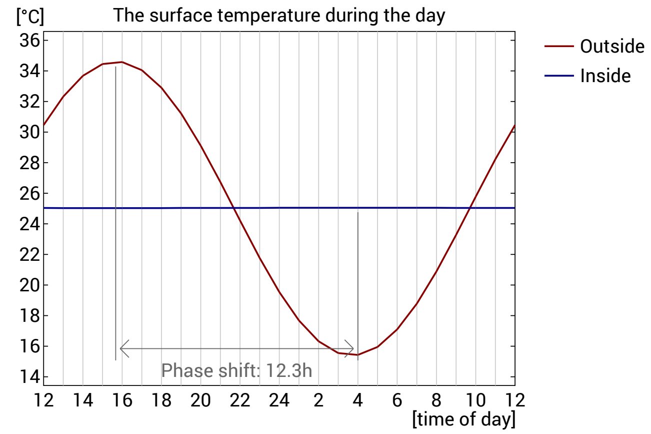
All statements without guarantee

Flat roof, U=0,25 W/(m²K)

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	non relevant	Heat storage capacity (whole component):	833 kJ/m²K
Amplitude attenuation **	>100	Thermal capacity of inner layers:	693 kJ/m²K
TAV ***	0,001		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

ubakus

Floor

Floor
created on 10.5.2023

Thermal protection

U = 0,71 W/(m²K)

Heated on both sides: No requirement*

excellent insufficient

Moisture proofing

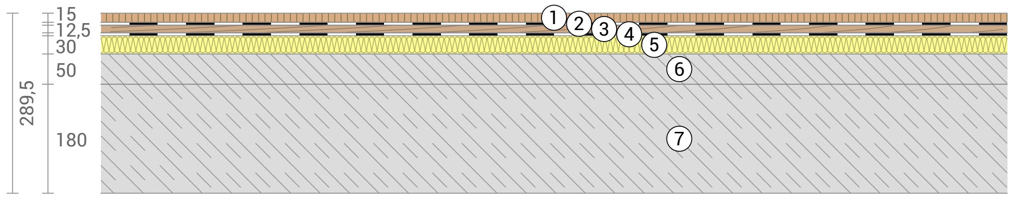
No condensate

excellent insufficient

Heat protection

Temperature amplitude damping: 4,0
phase shift: 9,3 h
Thermal capacity inside: 57 kJ/m²K

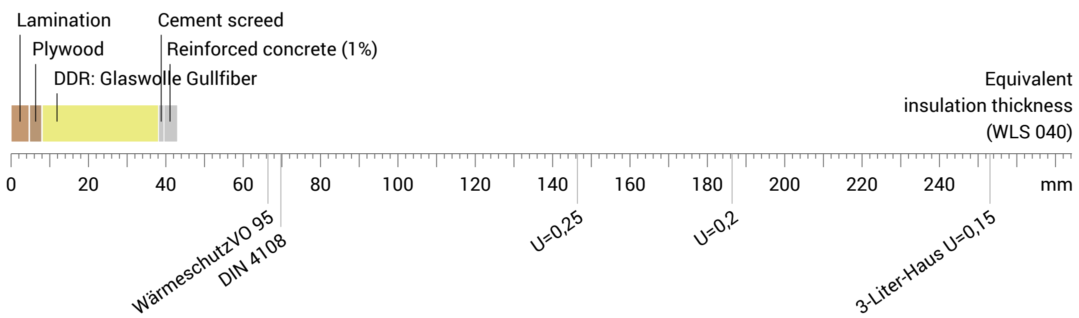
excellent insufficient



1. Lamination (15 mm)
2. Polyurethan
3. Plywood (12,5 mm)
4. Polyurethan
5. DDR: Glaswolle Gullfiber (30 mm)
6. Cement screed (50 mm)
7. Reinforced concrete (180 mm)

Impact of each layer and comparison to reference values

For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity 0,040 W/mK.

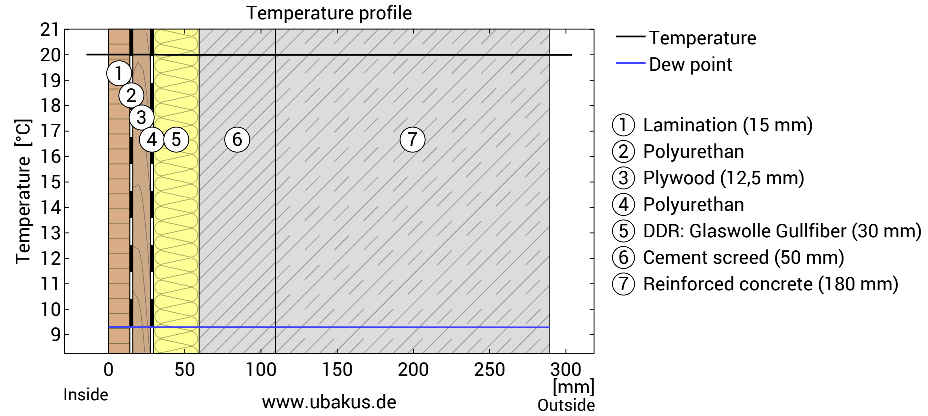


Inside air :	20,0°C / 50%		Thickness: 28,9 cm
Inside air 2:	20,0°C / 50%	sd-value: 37,3 m	Weight: 532 kg/m²
Surface temperature.:	20,0°C / 20,0°C		Heat capacity: 498 kJ/m²K

ubakus

Floor, U=0,71 W/(m²K)

Temperature profile



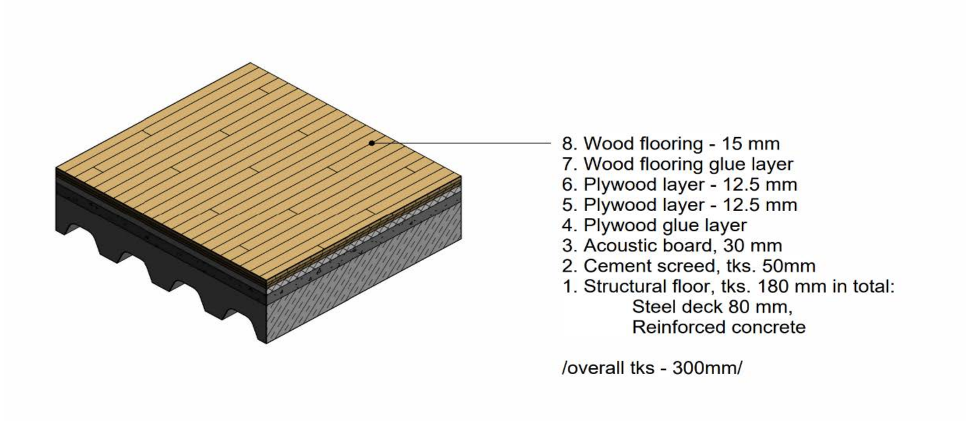
Temperature and dew-point temperature in the component. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew-point temperature, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,170	20,0	20,0	
1	1,5 cm	Lamination	0,130	0,115	20,0	20,0	7,5
2	0,1 cm	Polyurethan (PU)	0,250	0,004	20,0	20,0	1,2
3	1,25 cm	Plywood	0,160	0,078	20,0	20,0	7,5
4	0,1 cm	Polyurethan (PU)	0,250	0,004	20,0	20,0	1,2
5	3 cm	DDR: Glaswolle Gullfiber	0,040	0,750	20,0	20,0	0,5
6	5 cm	Cement screed	1,400	0,036	20,0	20,0	100,0
7	18 cm	Reinforced concrete (1%)	2,300	0,078	20,0	20,0	414,0
		Thermal contact resistance*		0,170	20,0	20,0	
	28,95 cm	Whole component		1,406			531,9

*Thermal contact resistances according to DIN 6946 for the U-value calculation. Rsi=0,25 and Rse=0,04 according to DIN 4108-3 were used for moisture proofing and temperature profile.

Surface temperature inside (min / average / max):	20,0°C	20,0°C	20,0°C
Surface temperature outside (min / average / max):	20,0°C	20,0°C	20,0°C



Floor, U=0,71 W/(m²K)

Moisture proofing

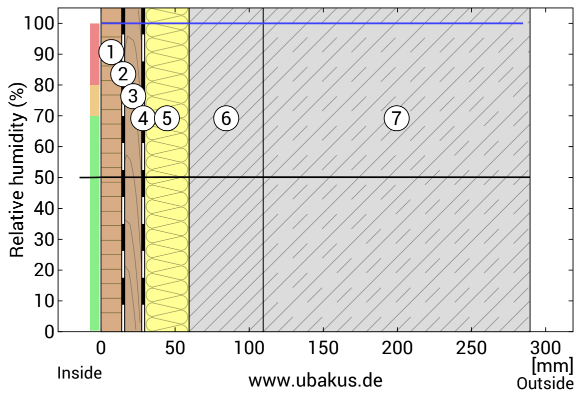
For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20.01°C und 50% Humidity; outside: 20°C und 50% Humidity (Climate according to user input).

This component is free of condensate under the given climate conditions.

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	1,5 cm	Lamination	0,45	-	-	7,5
2	0,1 cm	Polyurethan (PU)	6,00	-		1,2
3	1,25 cm	Plywood	0,63	-	-	7,5
4	0,1 cm	Polyurethan (PU)	6,00	-		1,2
5	3 cm	DDR: Glaswolle Gullfiber	0,03	-		0,5
6	5 cm	Cement screed	0,75	-		100,0
7	18 cm	Reinforced concrete (1%)	23,40	-		414,0
	28,95 cm	Whole component	37,26	0		531,9

Humidity

The temperature of the inside surface is 20,0 °C leading to a relative humidity on the surface of 50%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.

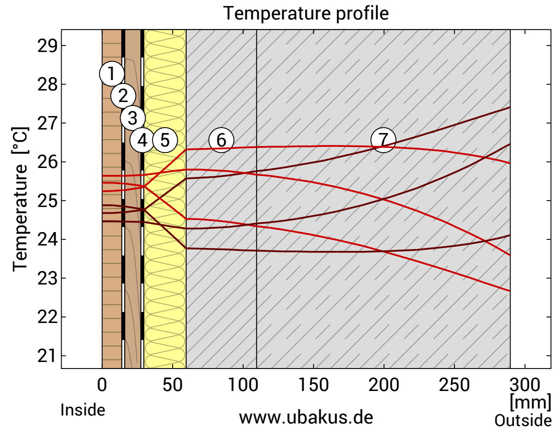


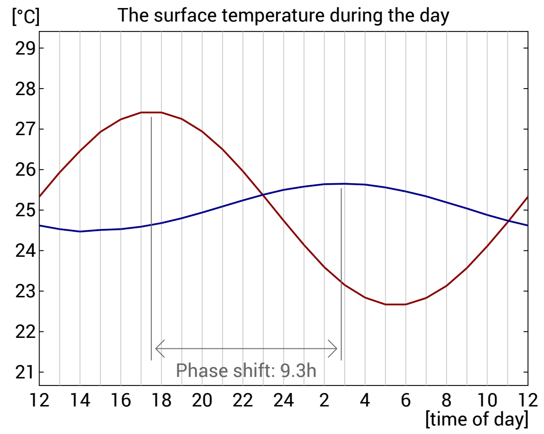
Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

Floor, U=0,71 W/(m²K)

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





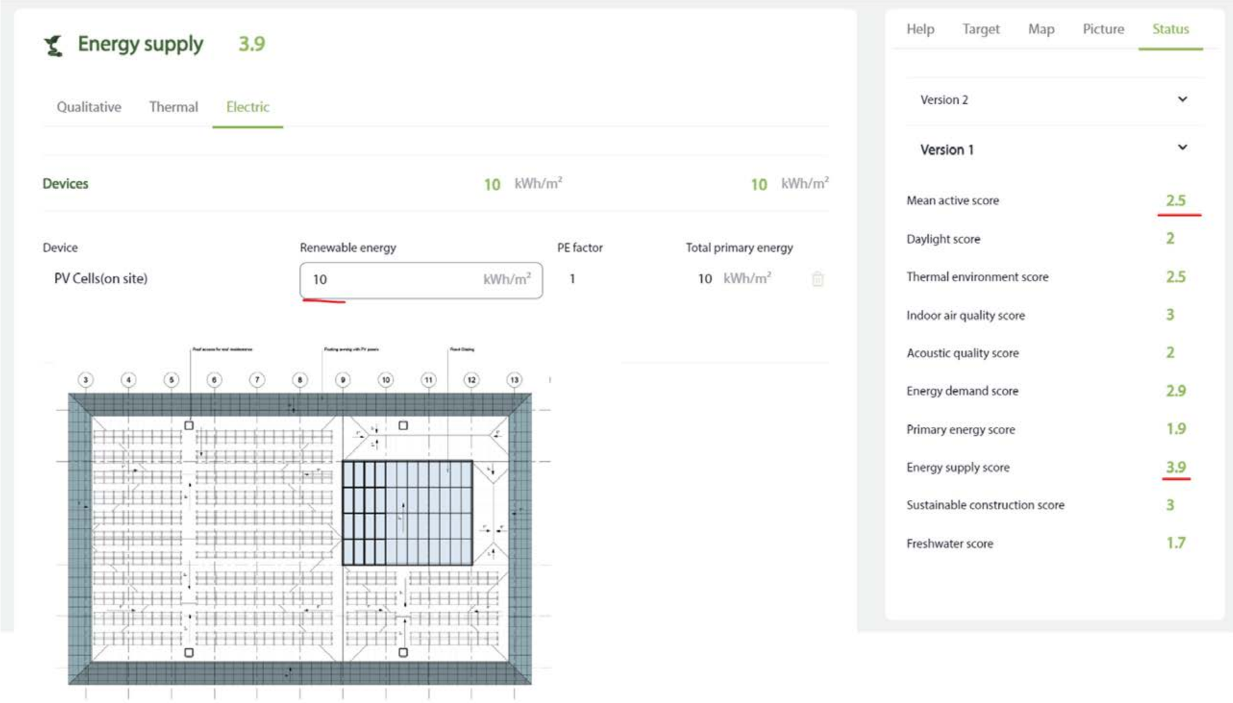
Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	9,3 h	Heat storage capacity (whole component):	498 kJ/m²K
Amplitude attenuation **	4,0	Thermal capacity of inner layers:	57 kJ/m²K
TAV ***	0,251		

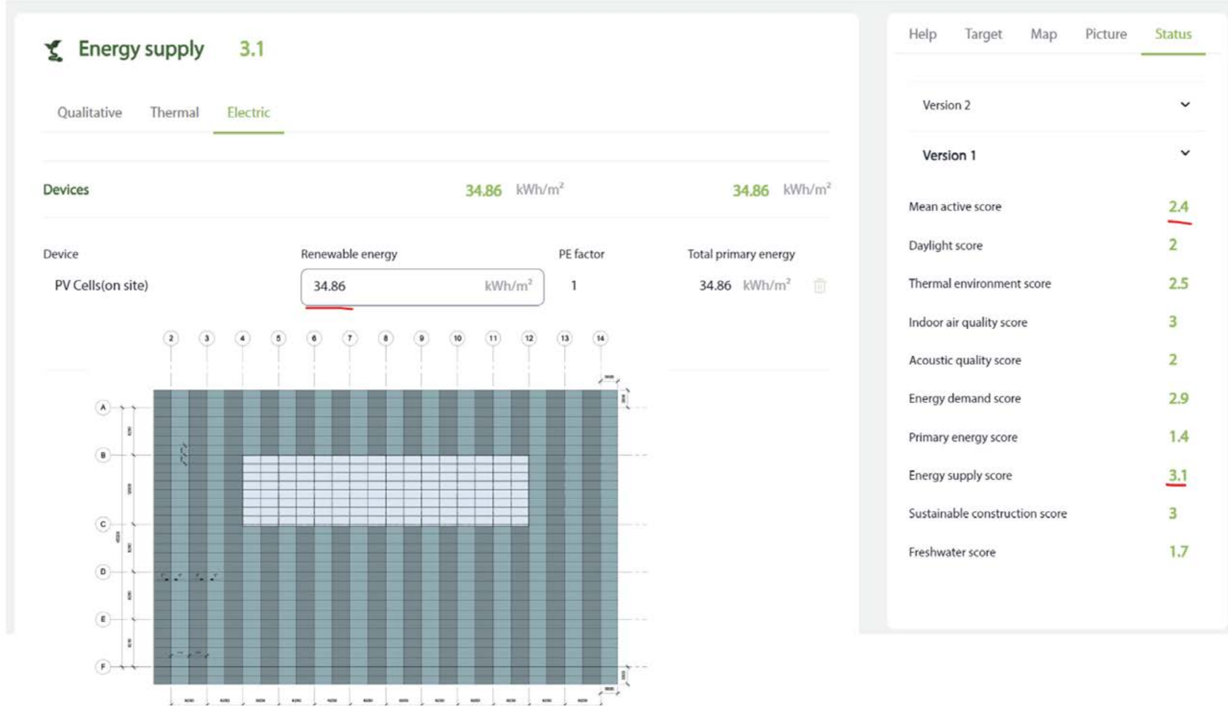
* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

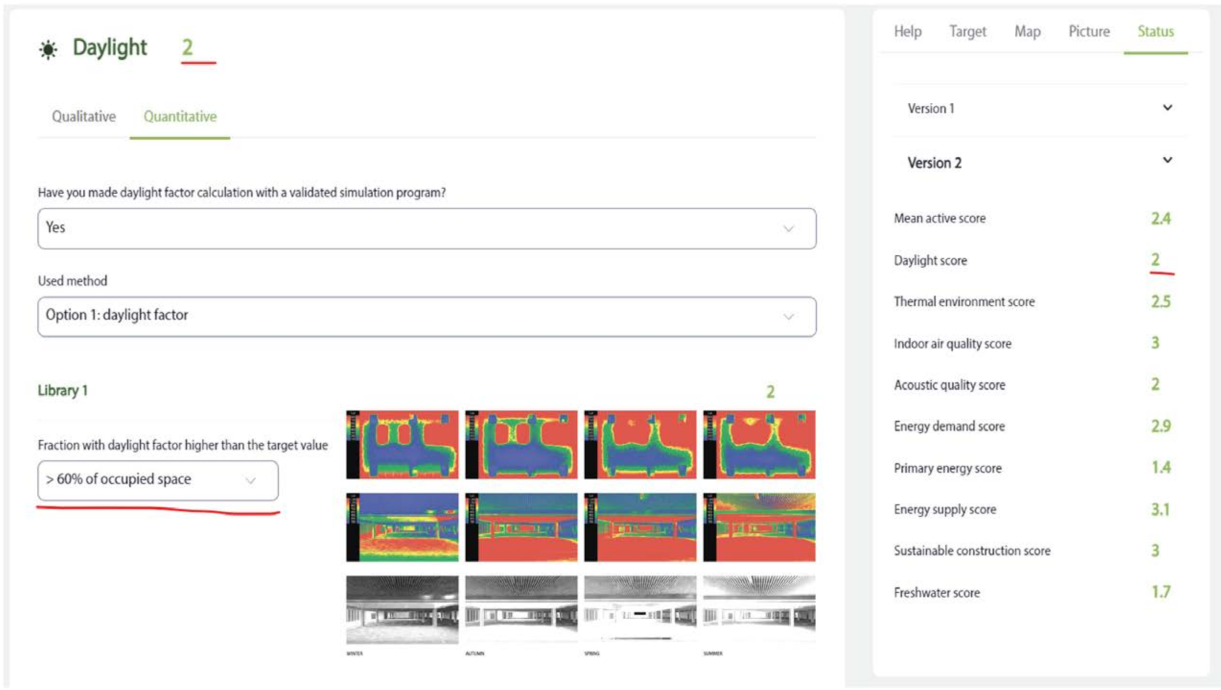
Active House Radar



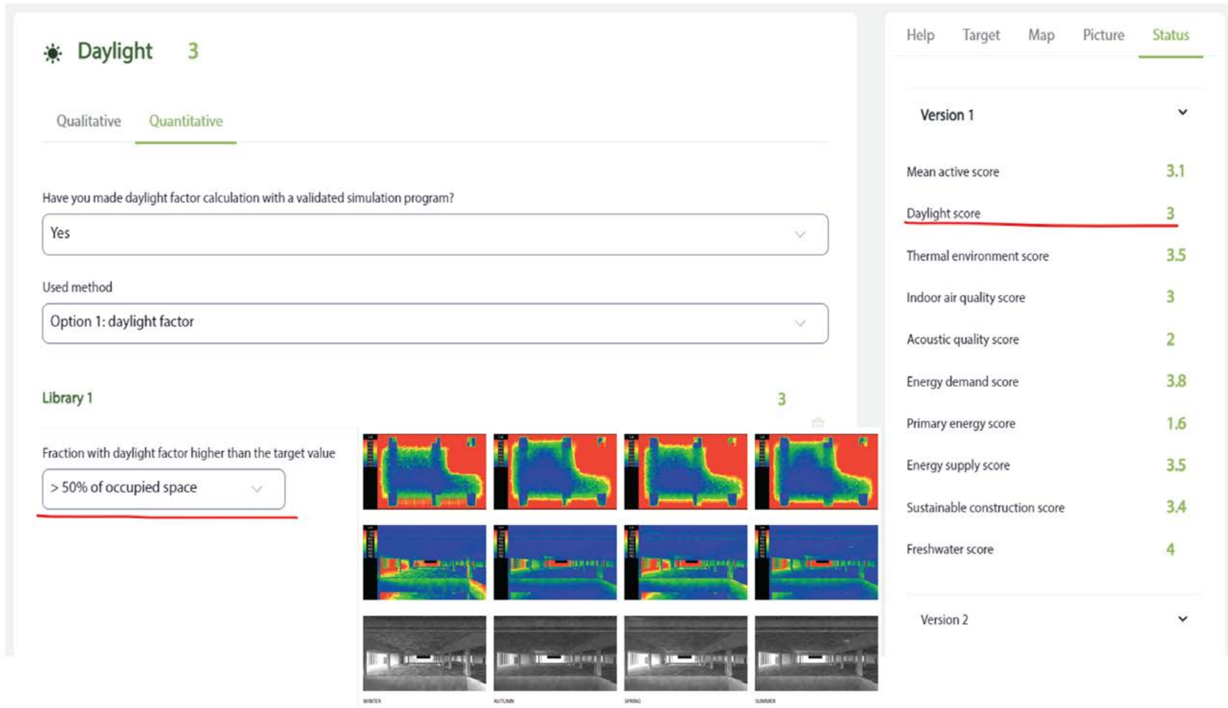
ENERGY SUPPLY VERSION 1



ENERGY SUPPLY VERSION 2

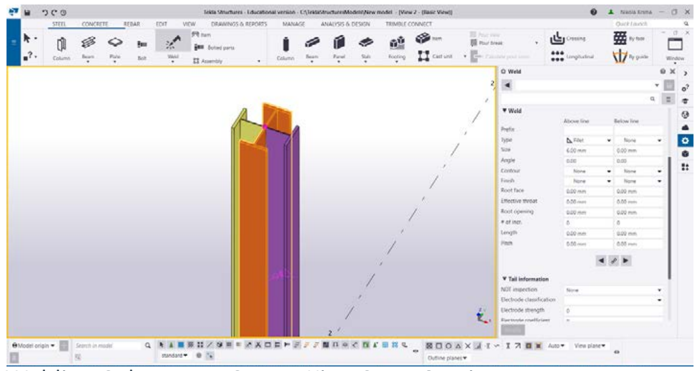


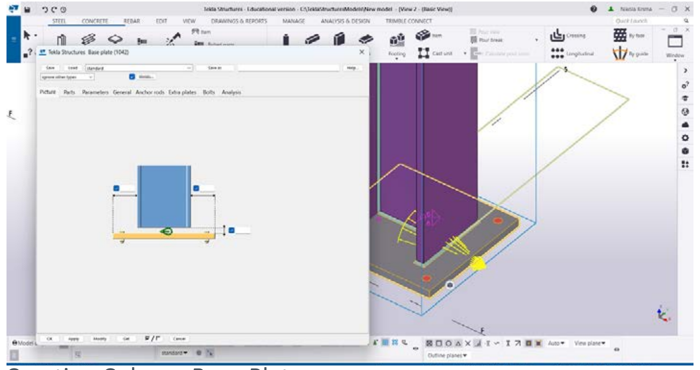
DAYLIGHT VERSION 1

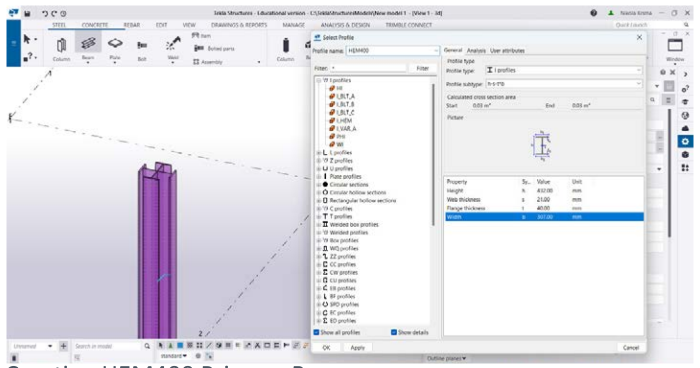


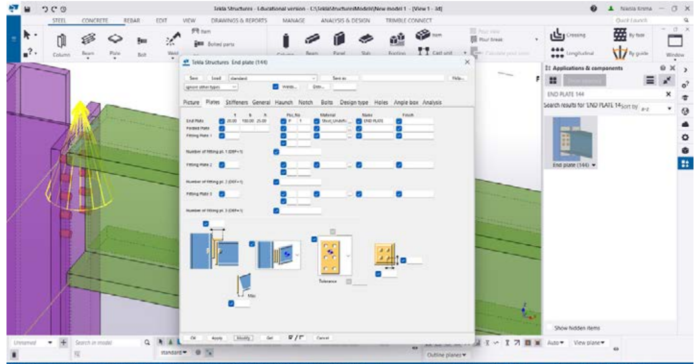
DAYLIGHT VERSION 2

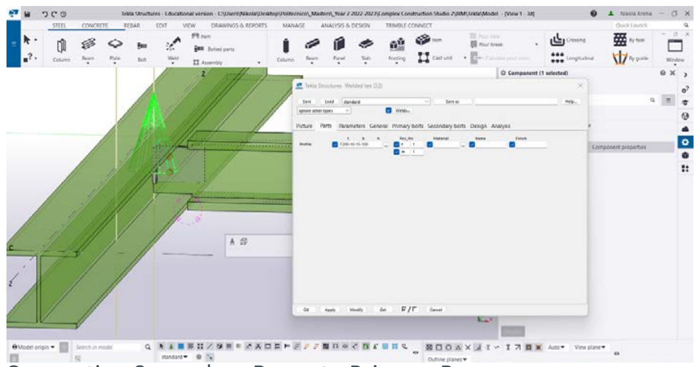
Tekla Structures & Solibri Model Check

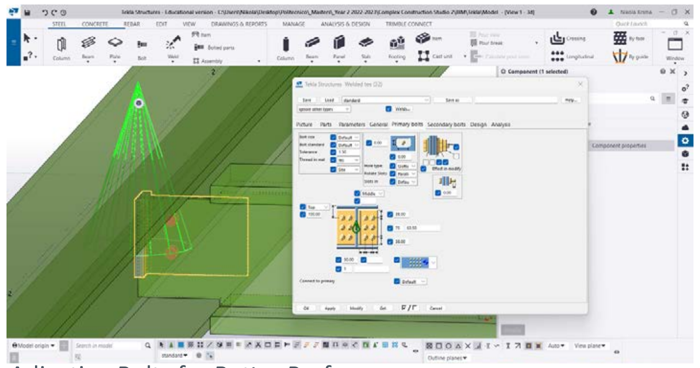

Welding Columns to Create King Cross Section

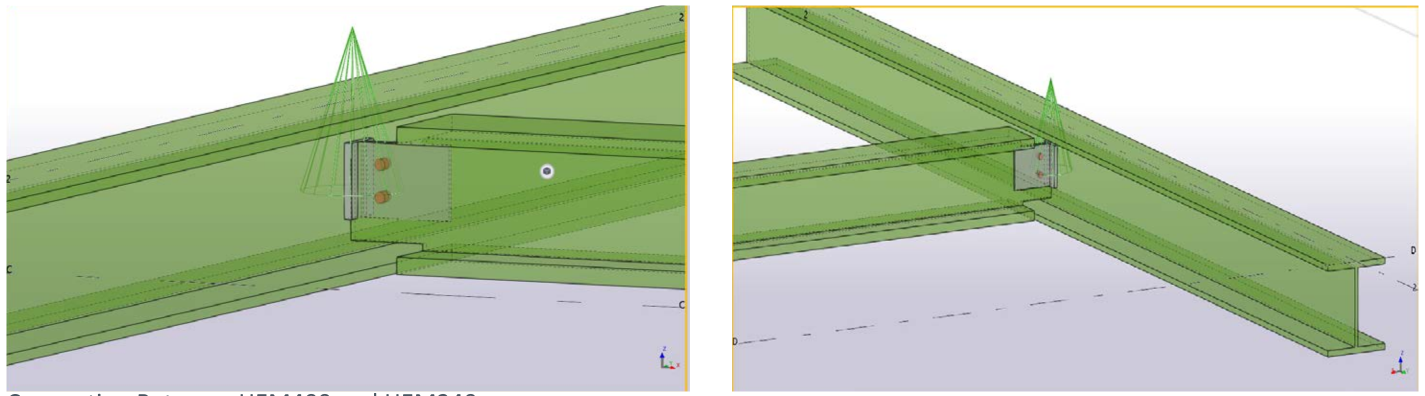

Creating Column Base Plate


Creating HEM400 Primary Beam


Connecting Primary Beam to Column using End Plate


Connecting Secondary Beam to Primary Beam


Adjusting Bolts for Better Performance

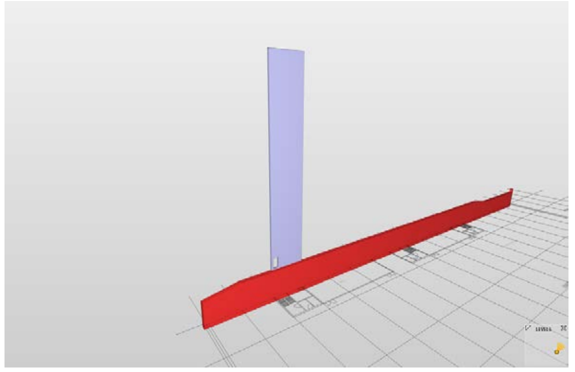

Connection Between HEM400 and HEM240

Presentation 1

Wall.-1.33 (Wall-Ret_200) and Wall.-1.89 (Wall-Fnd_750Con_Footing) are intersecting

Wall - Wall Intersections
The depth, width, height, and volume of the intersections are:
Wall.-1.33, Wall.-1.89, 21'-5 7/8", 7 7/8", 19'-8 7/16", 277.81 cu ft

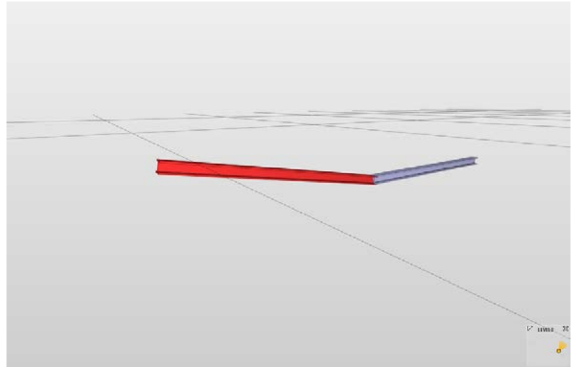
Tracking ID: 9



Beam.0.283 (HEM240) and Beam.0.38 (HEM240) are intersecting

Beam - Beam Intersections
The depth, width, height, and volume of the intersections are:
Beam.0.38, Beam.0.283, 9 3/4", 4 1/4", 10 5/8", 0.05 cu ft

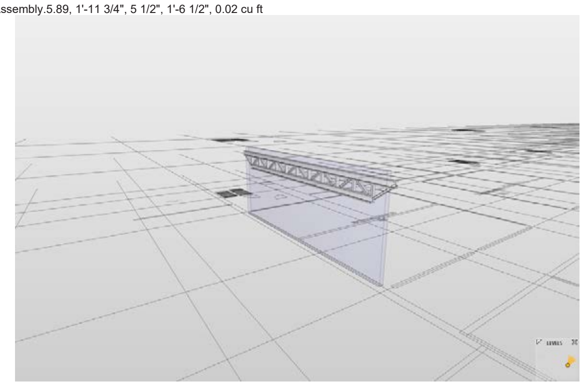
Tracking ID: 11



LEVEL-1 CONSUMABLES STORAGE[4]

Assembly.5.89 (nave truss 1200:nave truss 1200) and Wall.4.48 (Wall-Partn_30Gwb-70MStd-30Gwb) are inside each other

Wall Intersections
The depth, width, height, and volume of the intersections are:
Wall.4.48, Assembly.5.89, 5 1/2", 3 1/16", 1'-5 1/8", 0.01 cu ft
Wall.4.48, Assembly.5.89, 1'-11 3/4", 5 1/2", 1'-6 1/2", 0.02 cu ft

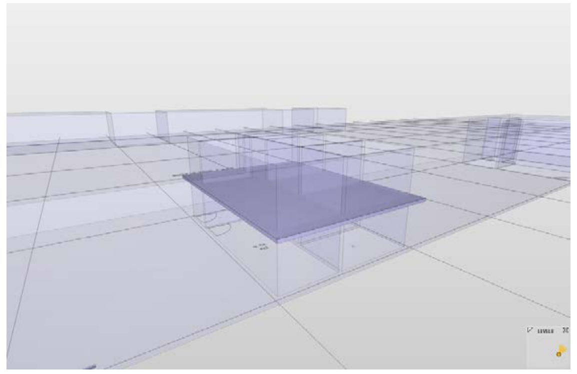


LEVEL4 INTERNAL SERVICES[266]

Roof.8.3 (Roof_Generic-125mm) and Space.8.18 : PANORAMIC TERRACE[409] (PANORAMIC TERRACE 409) are intersecting

Roof Intersections
The depth, width, height, and volume of the intersections are:
Roof.8.3, Space.8.18 : PANORAMIC TERRACE[409], 28'-3 1/8", 3'-3 1/2", 4 15/16", 55.14 cu ft

Tracking ID: 14

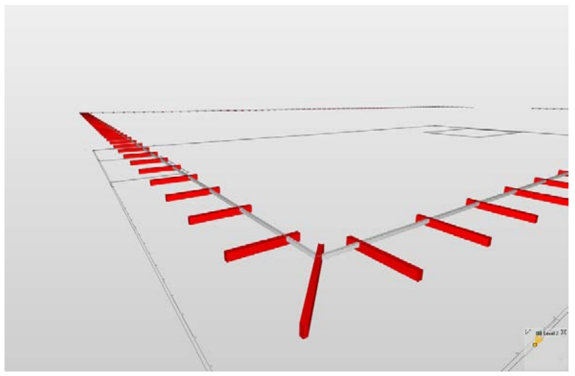


LEVEL8 V. Cir.[419], V. Cir.[422], Shaft[418], Shaft[417], V. Cir.[416], PANORAMIC TERRACE[409], V. Cir.[420], V. Cir.[421]

(B) Object.-1.1 (Structural Framing 9) and (B) Object.-1.3 (Structural Framing 1) are intersecting

BuildingElementProxy - IfcBuildingElementProxy Intersections/duplications
The depth, width, height, and volume of the intersections are:
(B) Object.-1.1, (B) Object.-1.3, 249'-10 7/8", 34'-10", 1 15/16", 0.63 cu ft

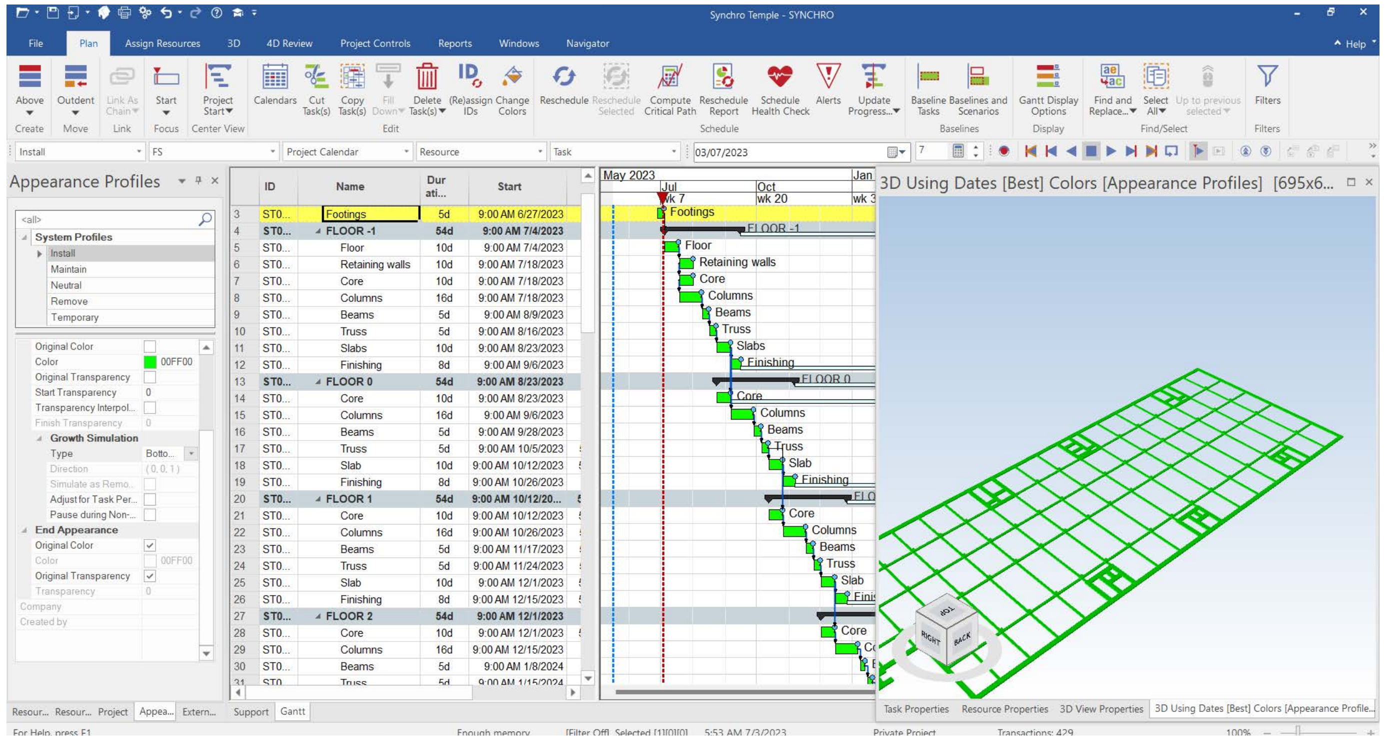
Tracking ID: 8



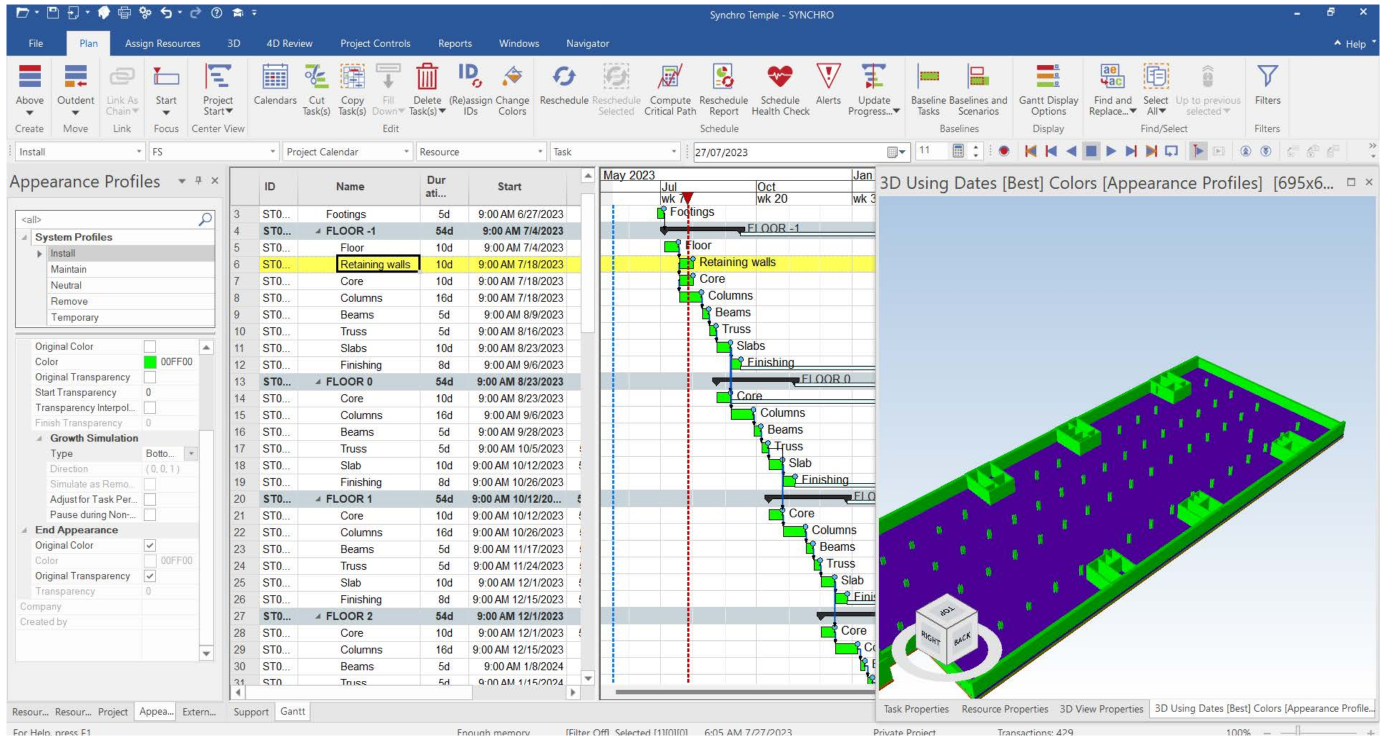
(B) Level 1

Clashes Detected by Solibri

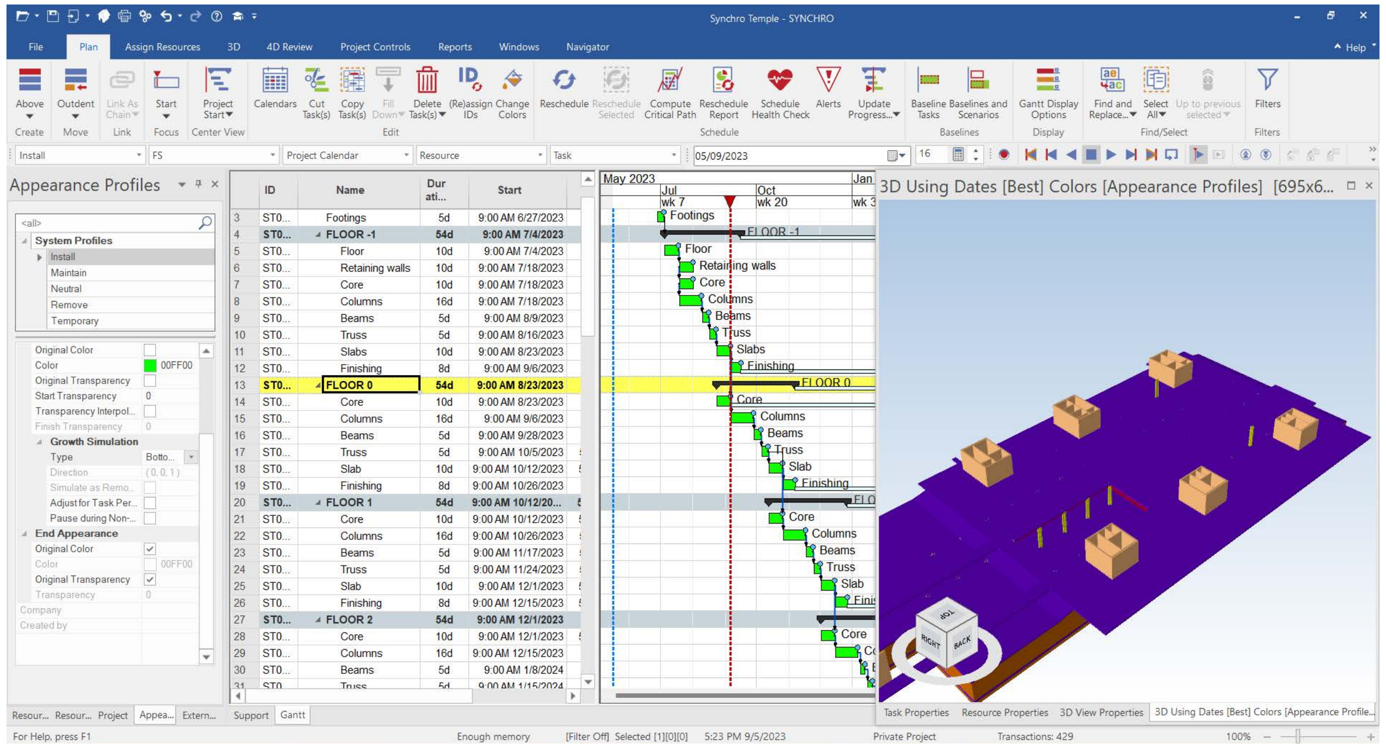
Synchro Construction Sequence Simulation
Part I



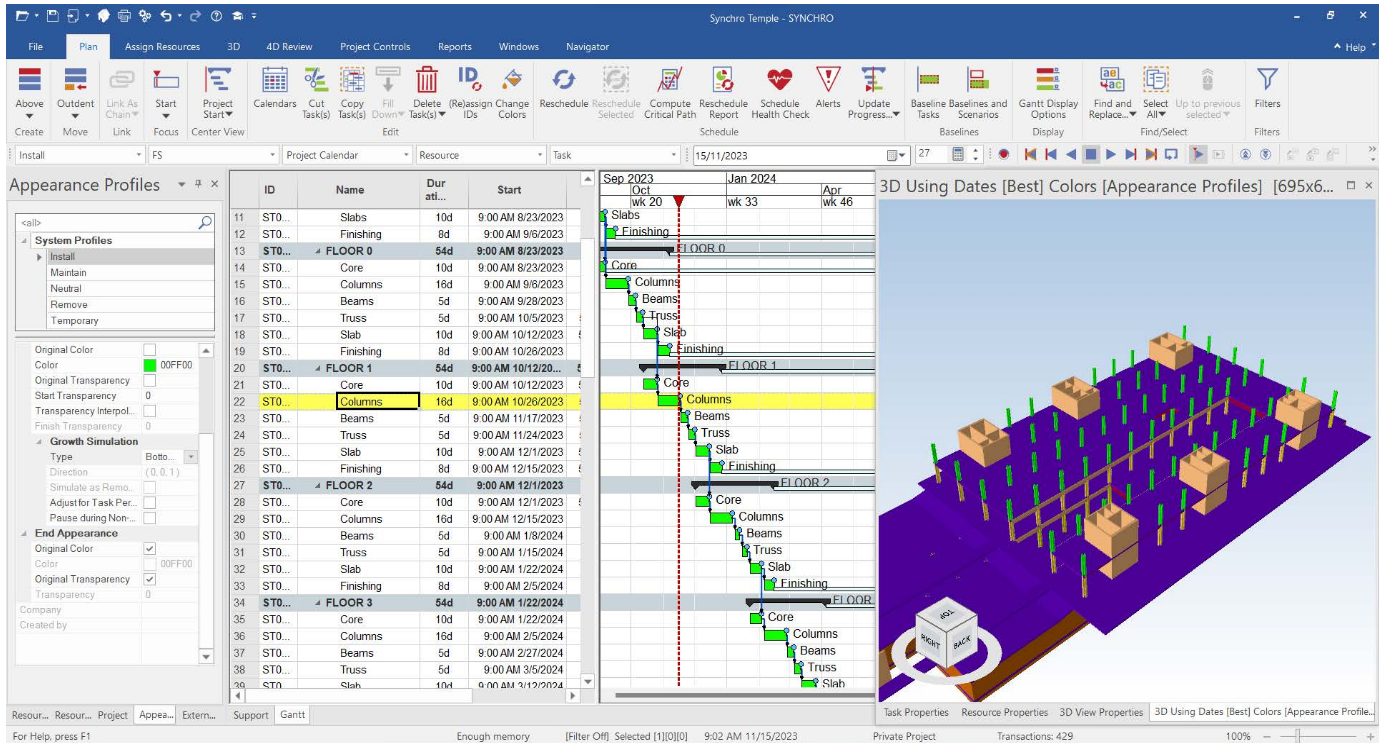
FOUNDATION 3. 7. 2023.



RETAINING WALLS 27. 7. 2023.

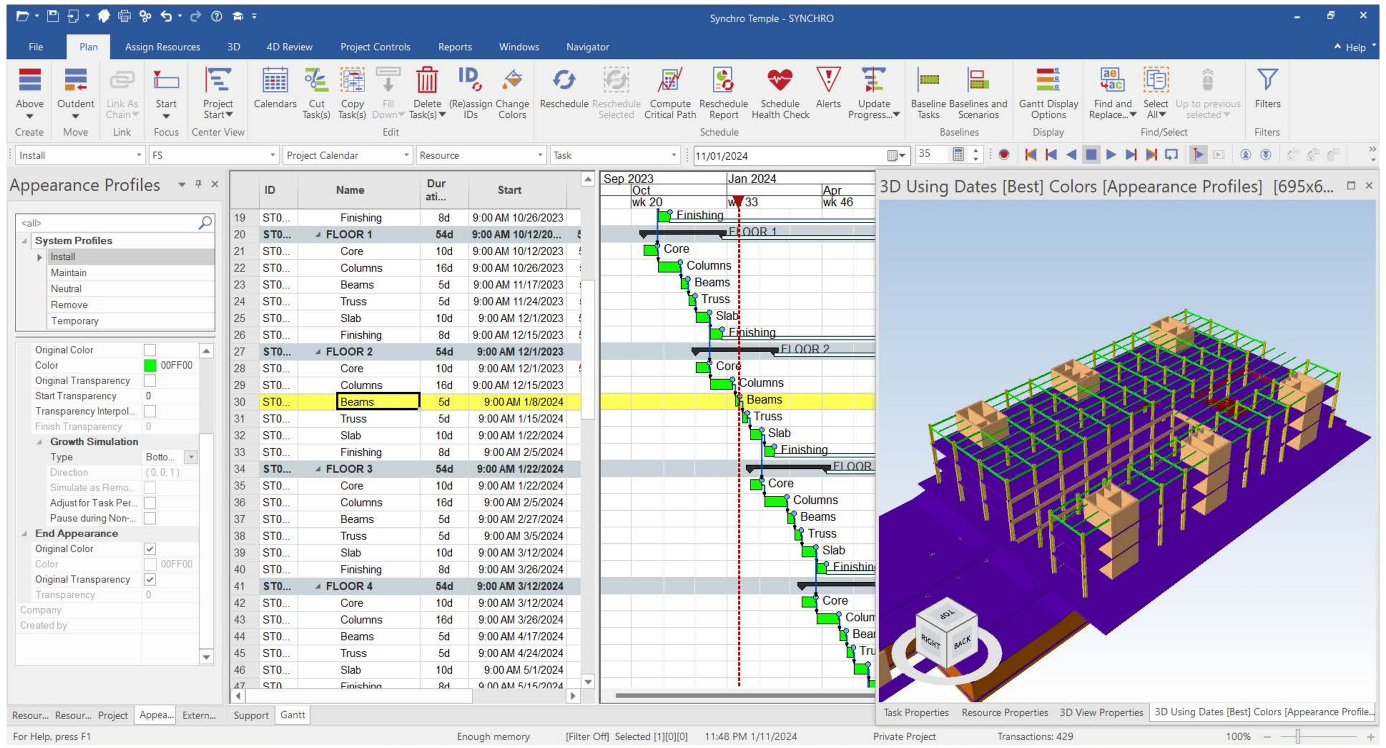


GROUND FLOOR 5. 9. 2023.

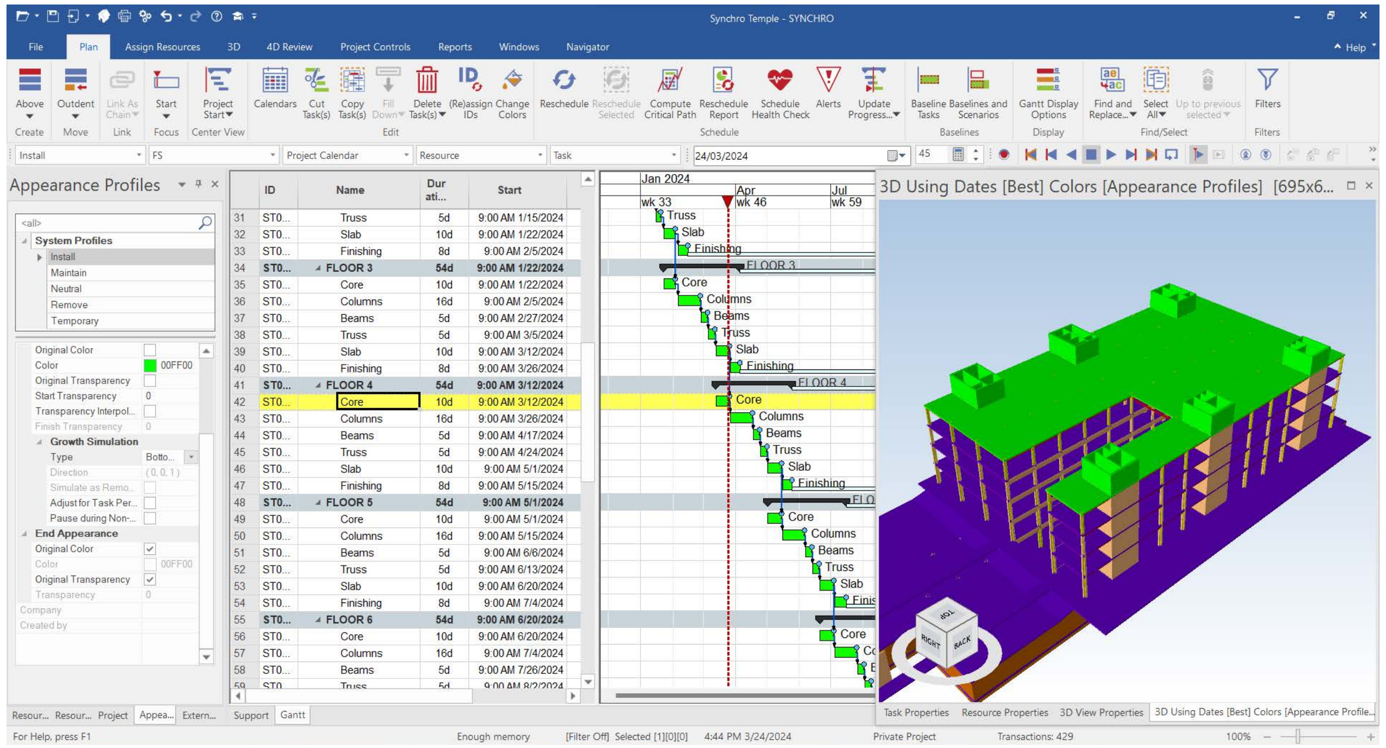


COLUMNS FIRST FLOOR 15. 11. 2023.

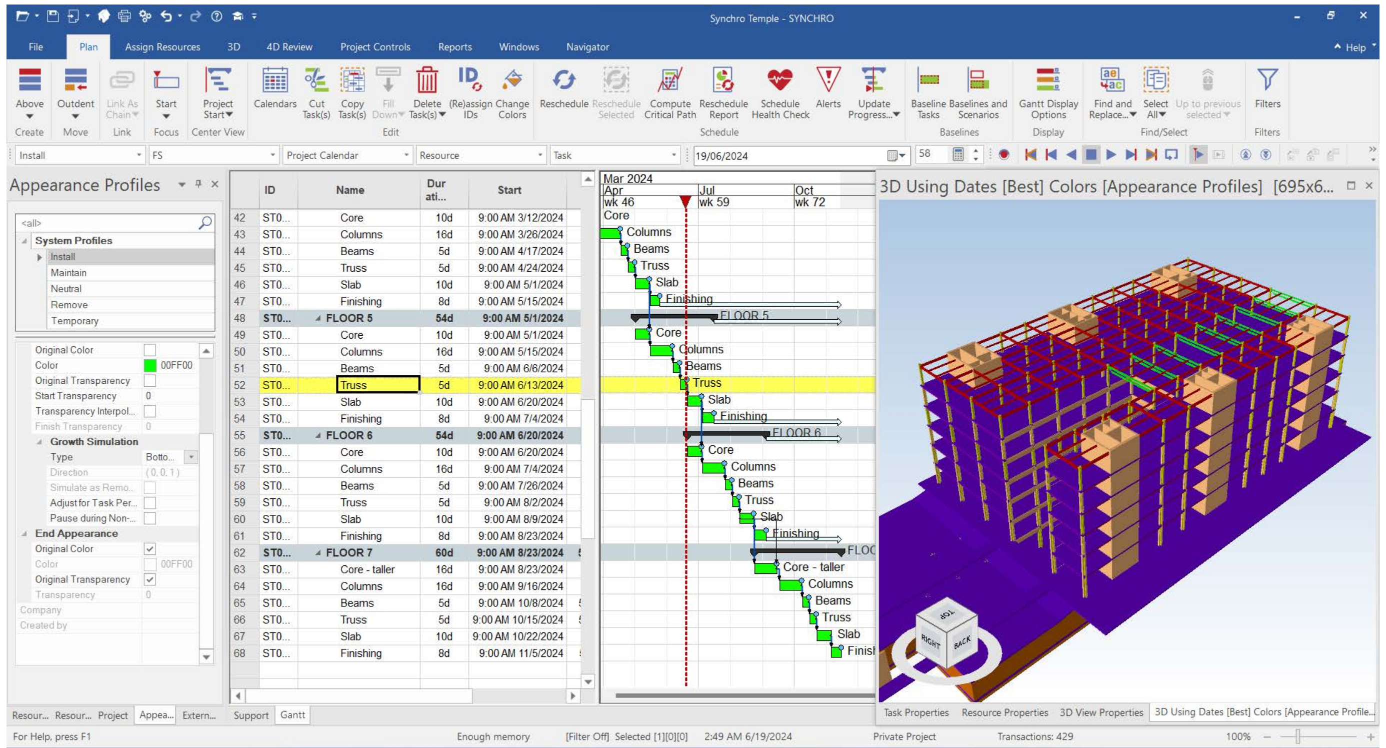
Synchro Construction Sequence Simulation
Part II



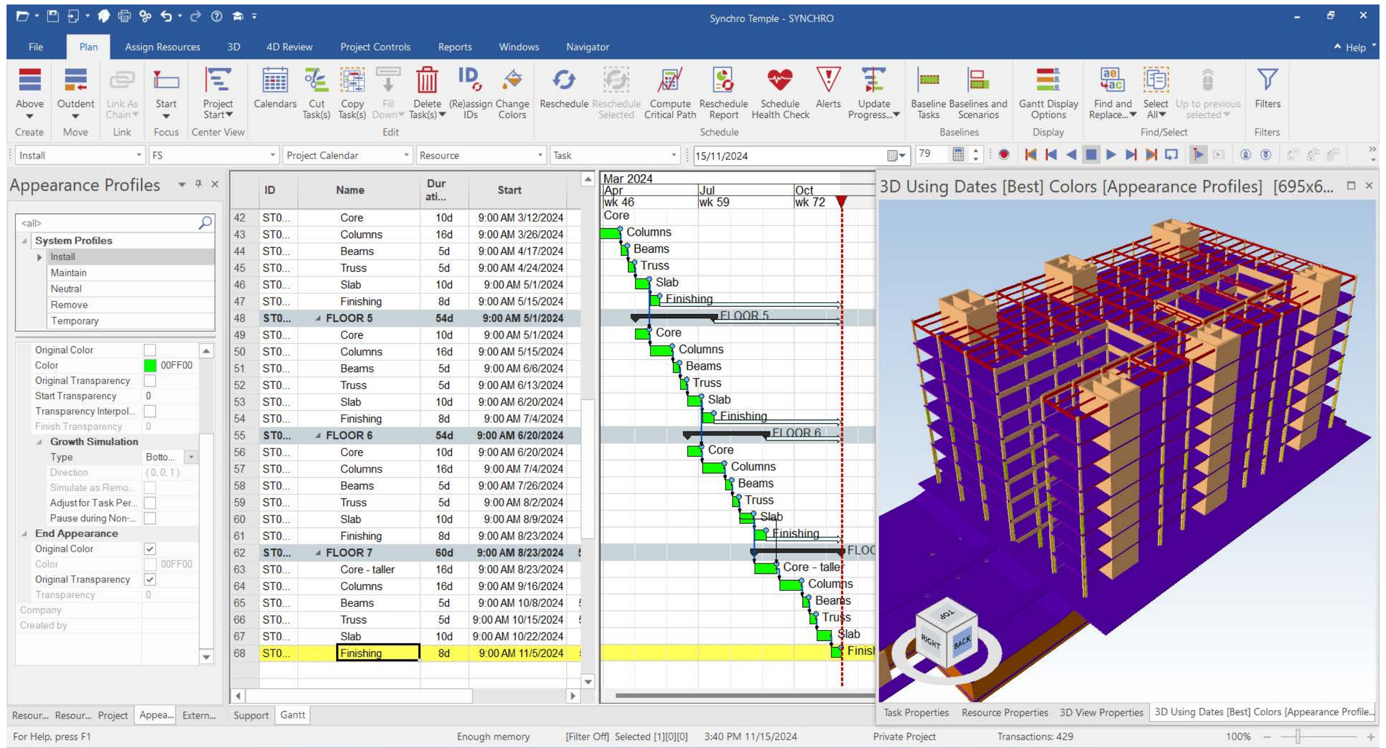
BEAMS SECOND FLOOR 11. 1. 2024.



CORE FORTH FLOOR 24. 3. 2024.

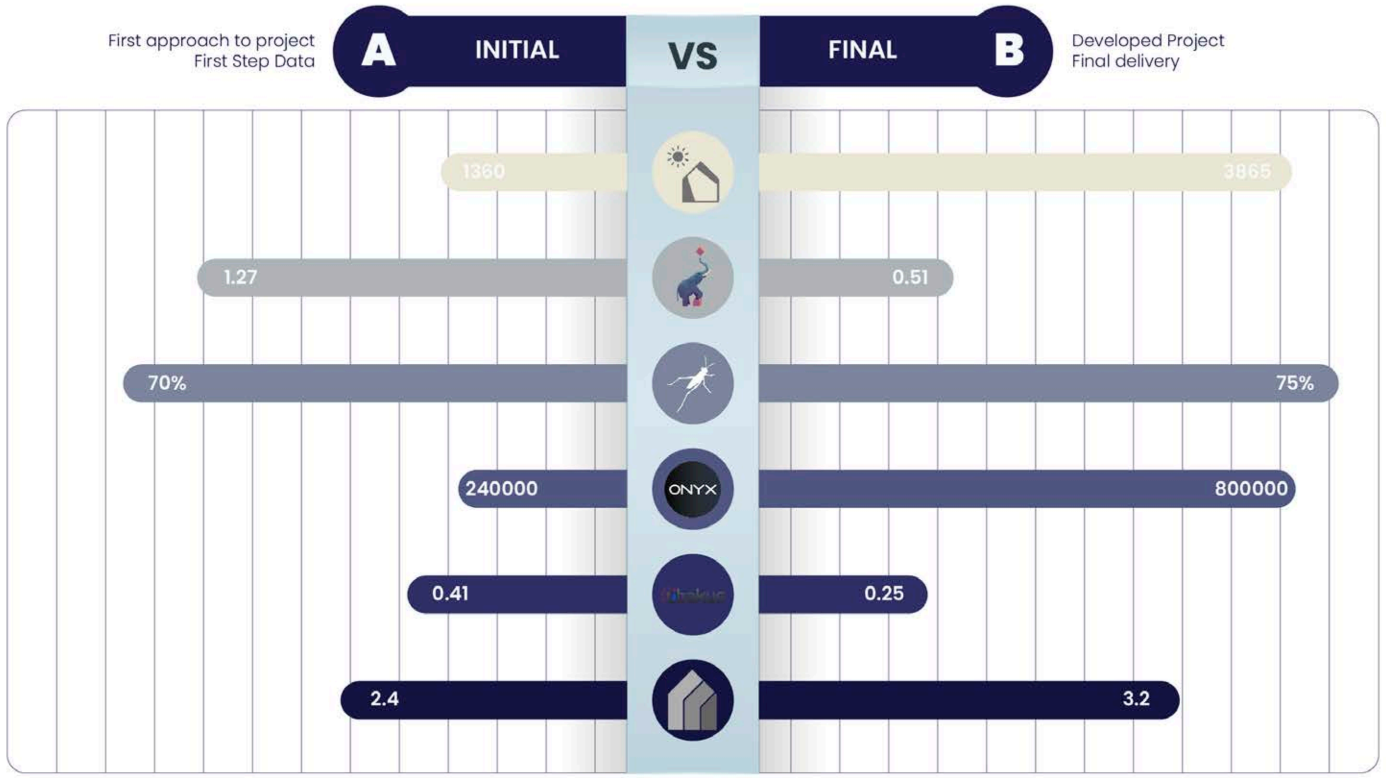


TRUSSES FIFTH FLOOR 19. 6. 2024.



END OF CONSTRUCTION OF STRUCTURE 23. 11. 2024.

Comparison of Performance Before and After BIM Uses



SCORES

mean active score	2.4
daylight score	2
thermal environment score	2.5
indoor air quality score	3
acoustic quality score	2
energy demand score	2.9
primary energy score	1.4
energy supply score	3.1
sustainable construction score	3
freshwater score	1.7

SCORES

mean active score	3.2
daylight score	3
thermal environment score	3.5
indoor air quality score	3
acoustic quality score	3
energy demand score	3.8
primary energy score	1.6
energy supply score	3.5
sustainable construction score	3.4
freshwater score	4

PERFORMANCE EVALUATION - COMPARISON

Figure 81: Performance Comparison

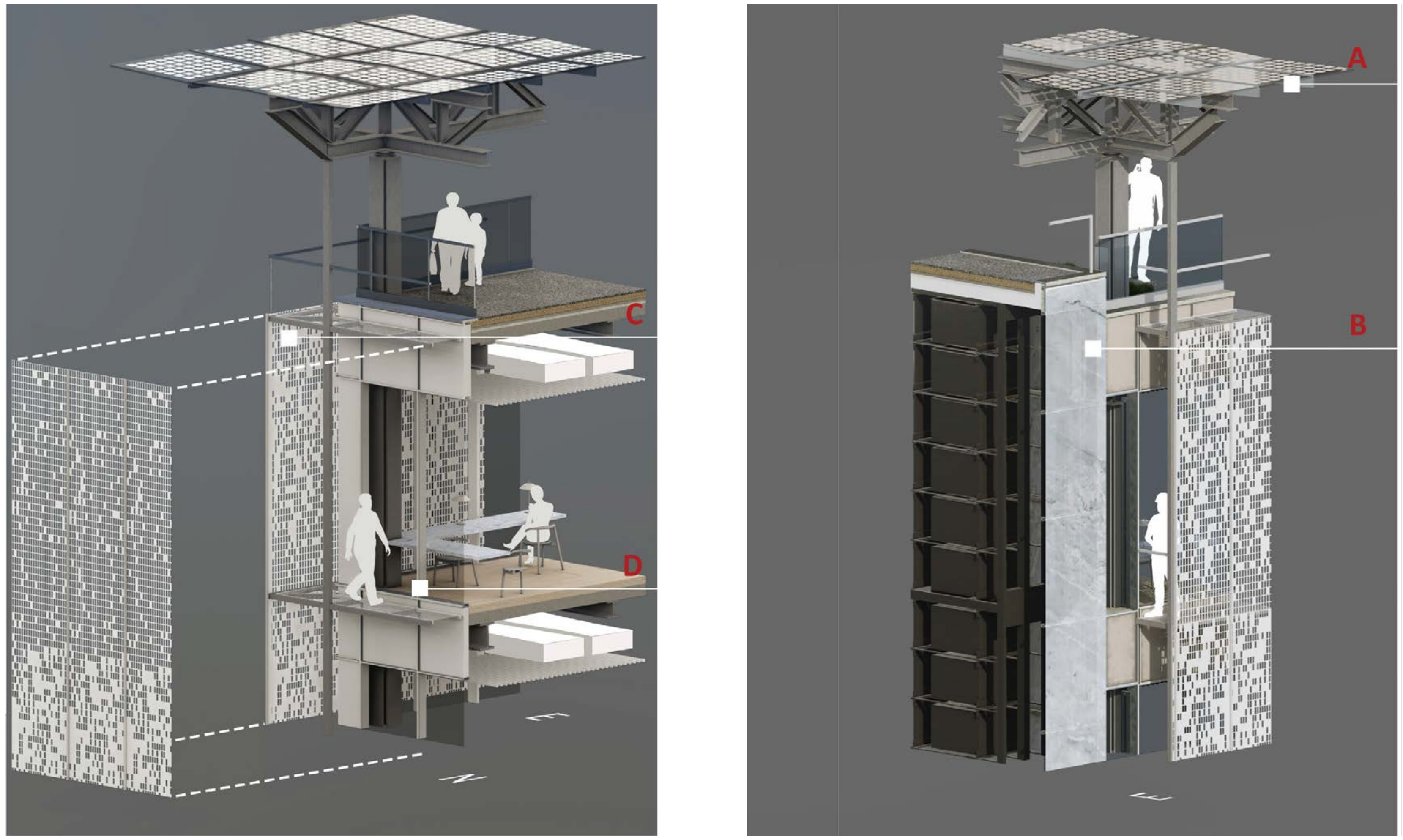


Figure 82: Partial Axonometric Views of the Building

A

CRYSTALLINE SILICON PV GLASS

PRODUCER: **ONYX SOLAR**
LOCATION: **SPAIN**
COMPLIANCE: **ISO 9001:2005 (Quality Management) and the ISO 14001:2015 (Environmental Management)**

B

BACKLIT MARBLE PANELS GLUED ON GLASS

PRODUCER: **SACERDOTE MARMI**
LOCATION: **ITALY**
THICKNESS: **43mm total assembly**

C

PERFORATED ALUMINIUM PANELS

PRODUCER: **ITALMESH**
LOCATION: **ITALY**
COMPLIANCE: **ISO 9001**
THICKNESS: **3mm aluminium panel**

D

FACADE SYSTEM FWS 50 SG.SI

PRODUCER: **SCHÜCO**
LOCATION: **GERMANY**
COMPLIANCE: **ISO 9001 and ISO 14001**
THICKNESS: **50mm face width**
COMPATIBILITY: **Schüco AWS 114 window system**

E

ESSENTIALS XXL 832 CARAMEL OAK LAMINATE FLOOR TILES

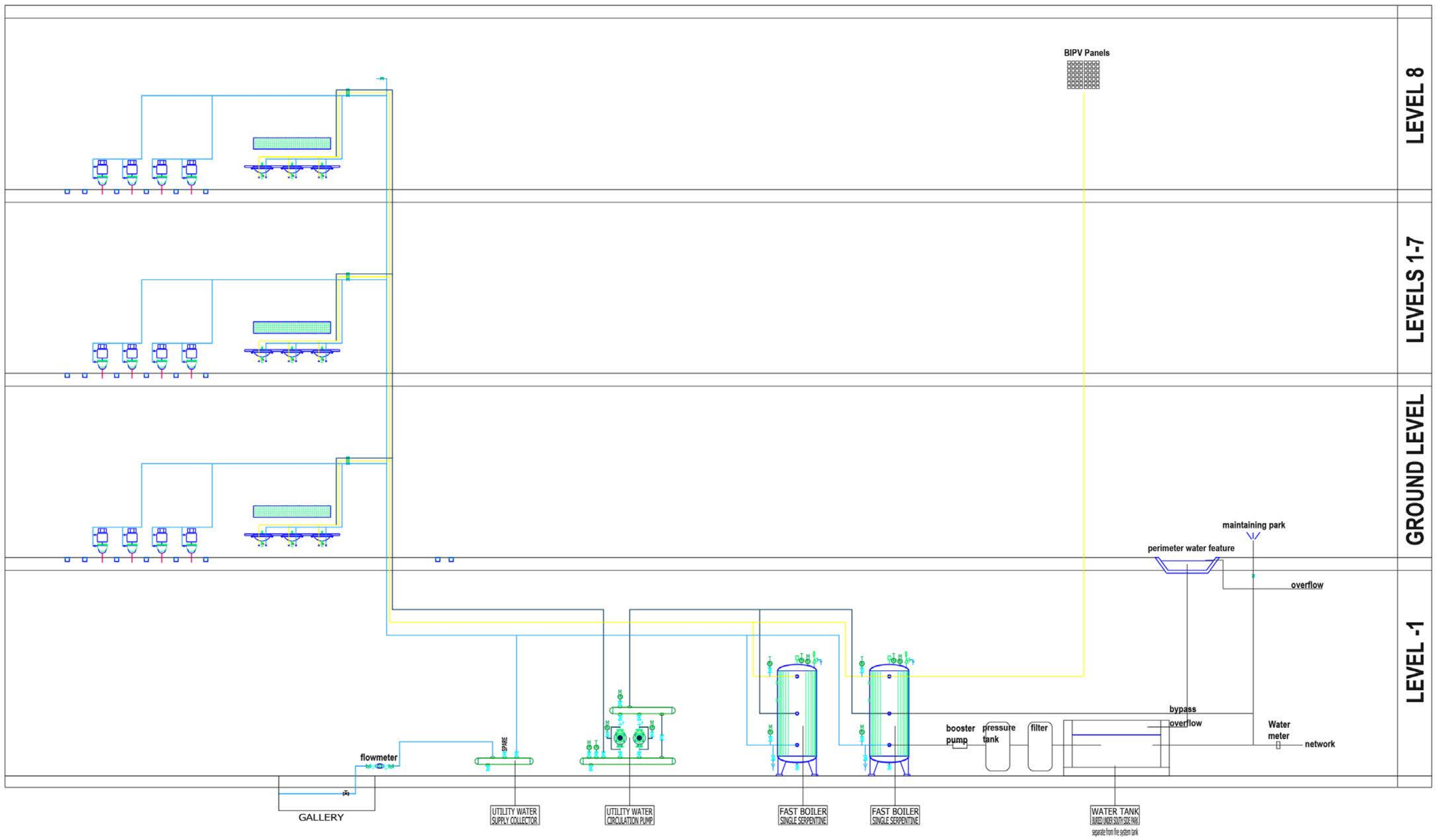
PRODUCER: **TARKETT**
LOCATION: **GERMANY**
EPD NO: **S-P-01354**
THICKNESS: **8mm**
SIZE: **240x2033mm**

F

ICÔNE BLEU NOIR PORCELAIN STONEWARE TILES

PRODUCER: **ITALGRANITI**
LOCATION: **ITALY**
COMPLIANCE:**UNI EN 14411 ISO 13006 APP. G standards**
THICKNESS: **9mm**
SIZE: **1200x1200mm**

Figure 83: Material Palette



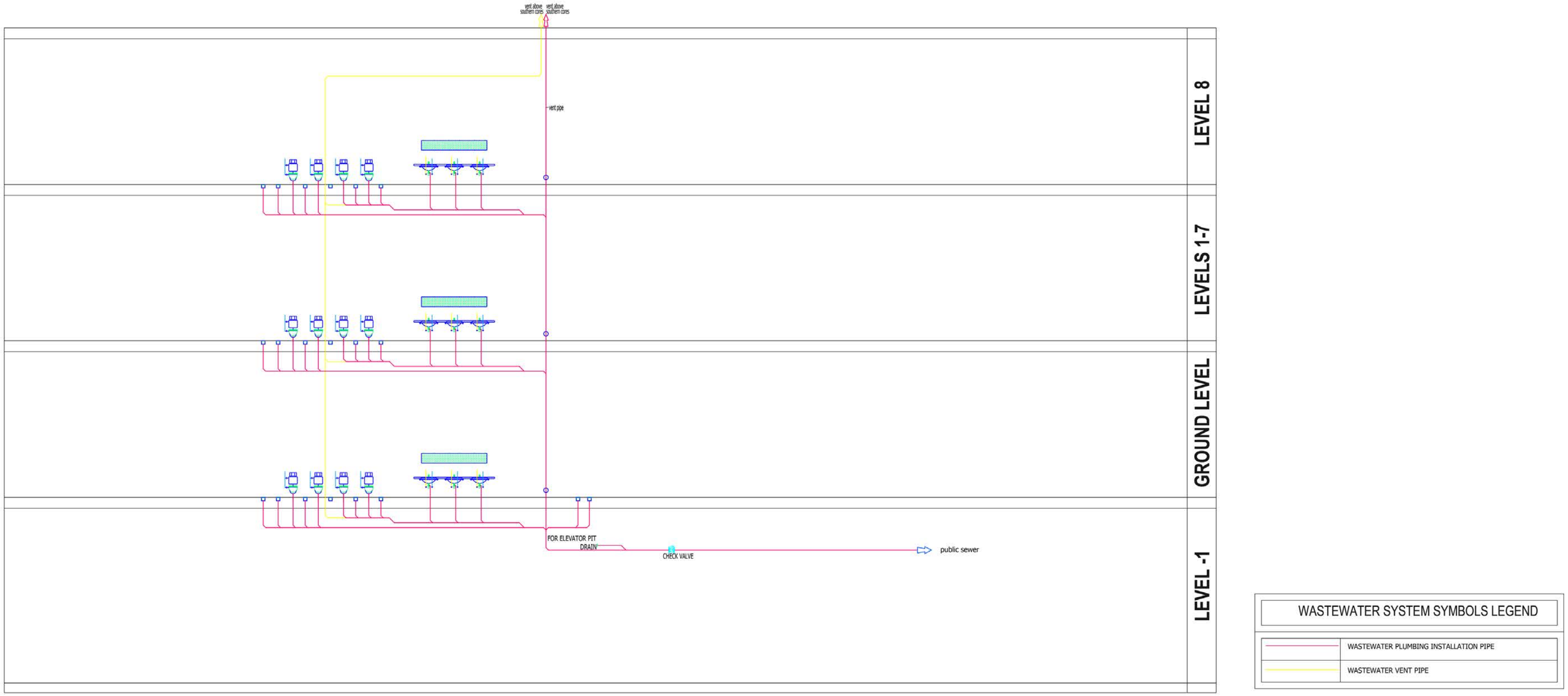
CLEAN WATER SYSTEM SYMBOLS LEGEND	
	UTILITY COLD WATER PLUMBING PIPE
	UTILITY HOT WATER PLUMBING PIPE
	UTILITY HOT WATER CIRCULATION PLUMBING PIPE
	VALVE
	DEBRIS FILTER
	CHECK VALVE
	COMPENSATOR
	SAFETY VALVE
	THERMOMETER
	MANOMETER

PLUMBING ROOM FIXTURES	
NO	FIXTURE NAME
01	UTILITY WATER CIRCULATION PUMP
02	SINGLE SERPENTINE FAST BOILER

UTILITY WATER SYSTEM

Given the volume of the building, the solar panels were chosen to be used for heating utility water, which would be directed to the sinks and faucets in bathrooms.

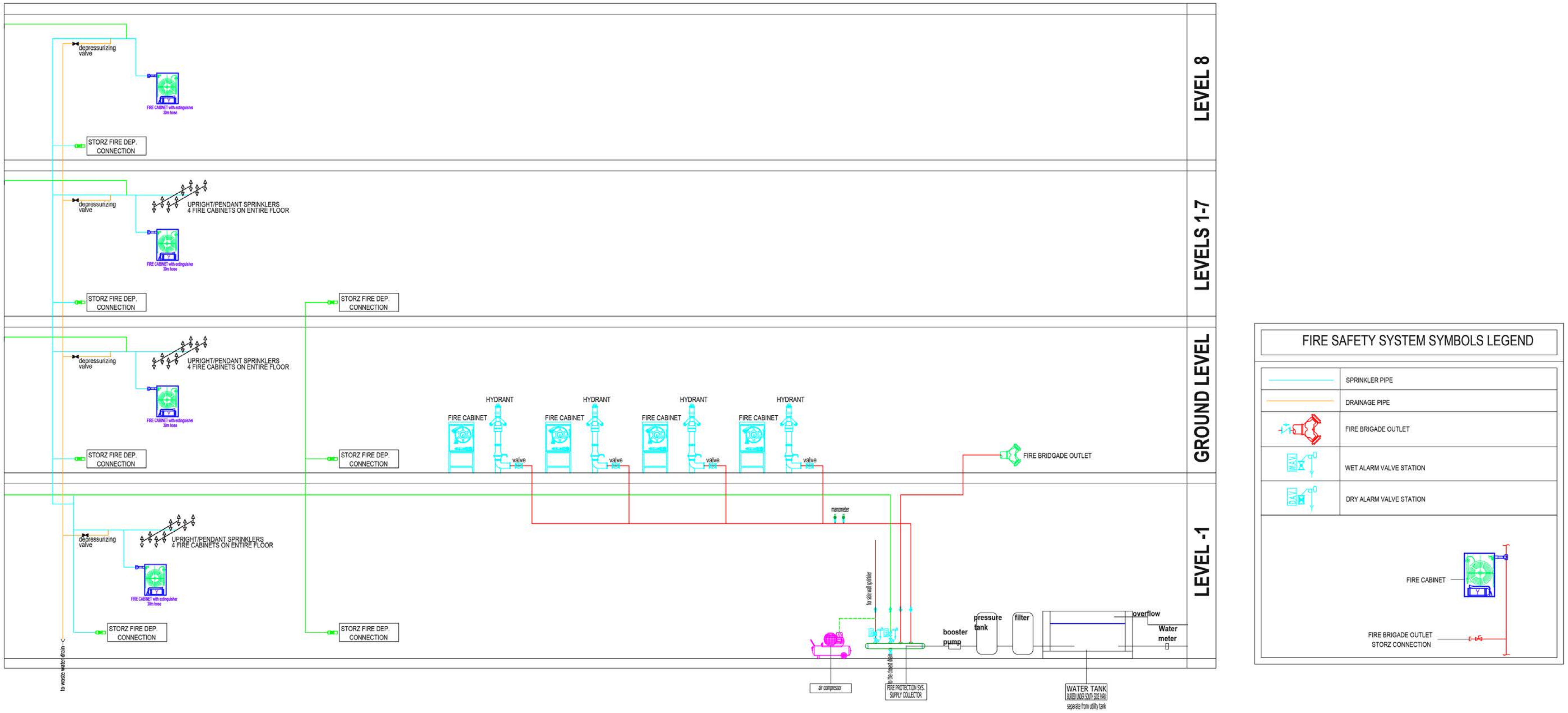
Figure 84: Utility Water System Scheme



WASTEWATER DRAINAGE SYSTEM

The wet areas are found within the cores. Basement level is dedicated to automated storage and mechanical rooms, without bathrooms.

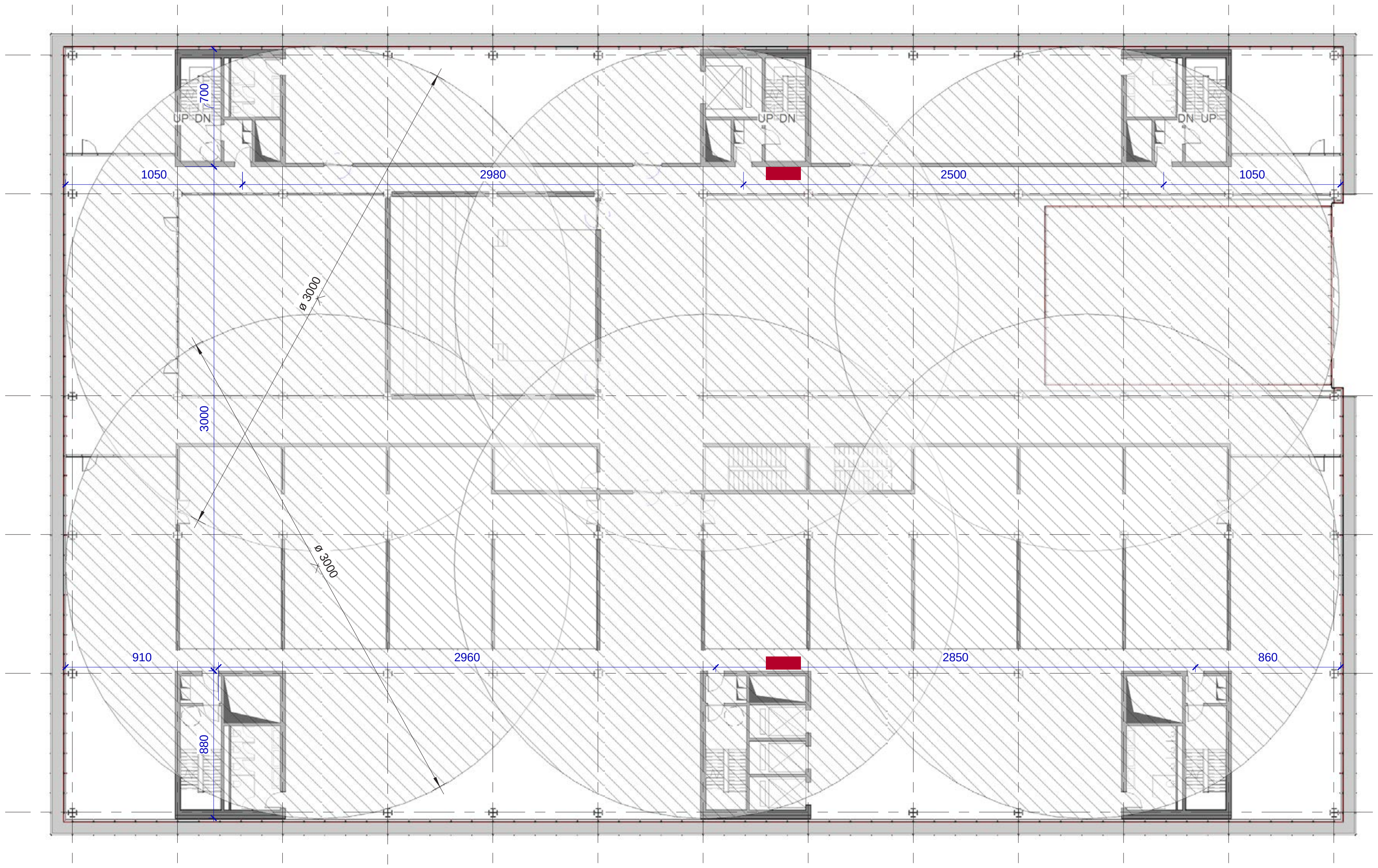
Figure 85: Wastewater Drainage Scheme

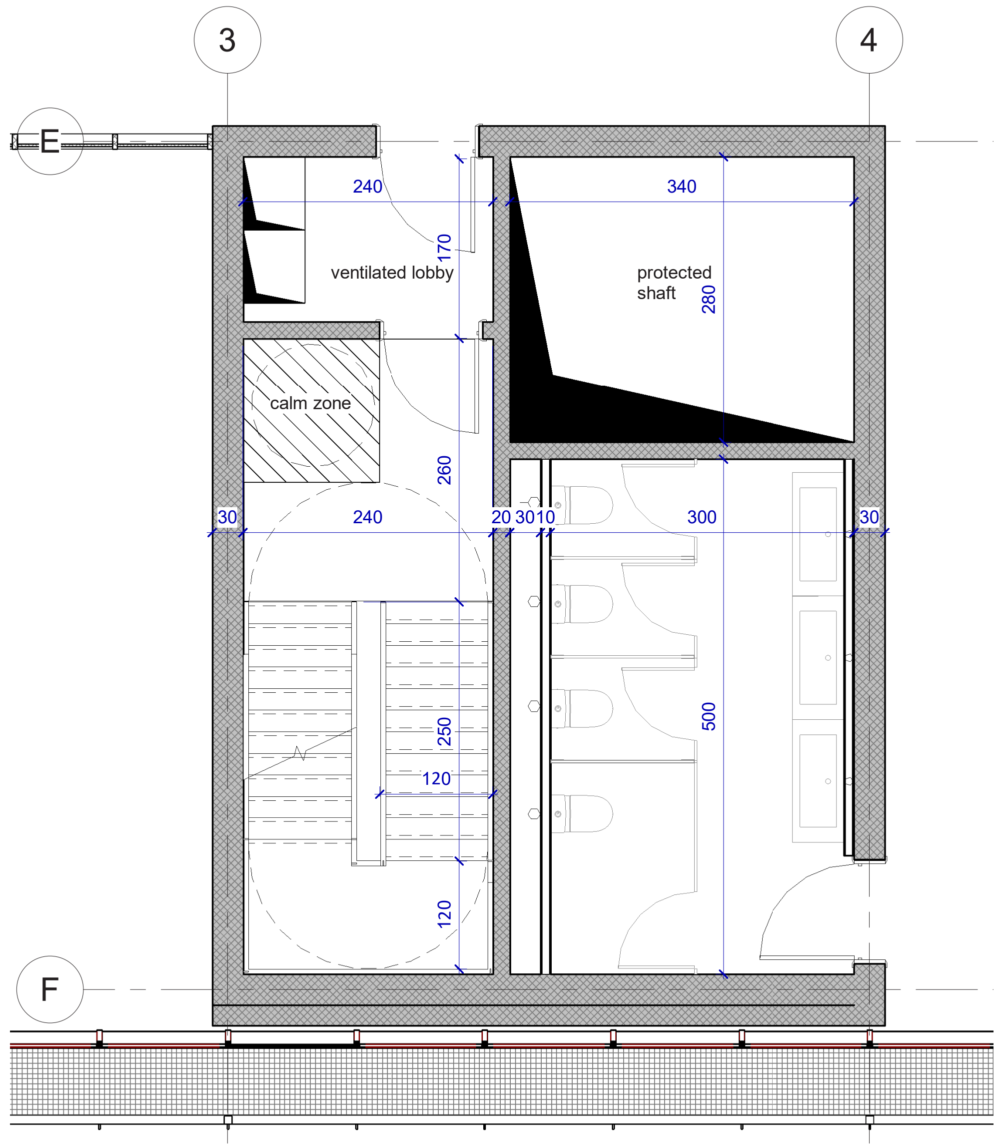


FIRE SAFETY SYSTEM

In case of an emergency, the fire bridgade arrives to the southeastern corner where there is the parking lot and outdoor outlets. On the basement level, there is a separate water tank for sprinklers, each of which covers an area of $12m^2$.

Figure 86: Fıre Safety System Scheme



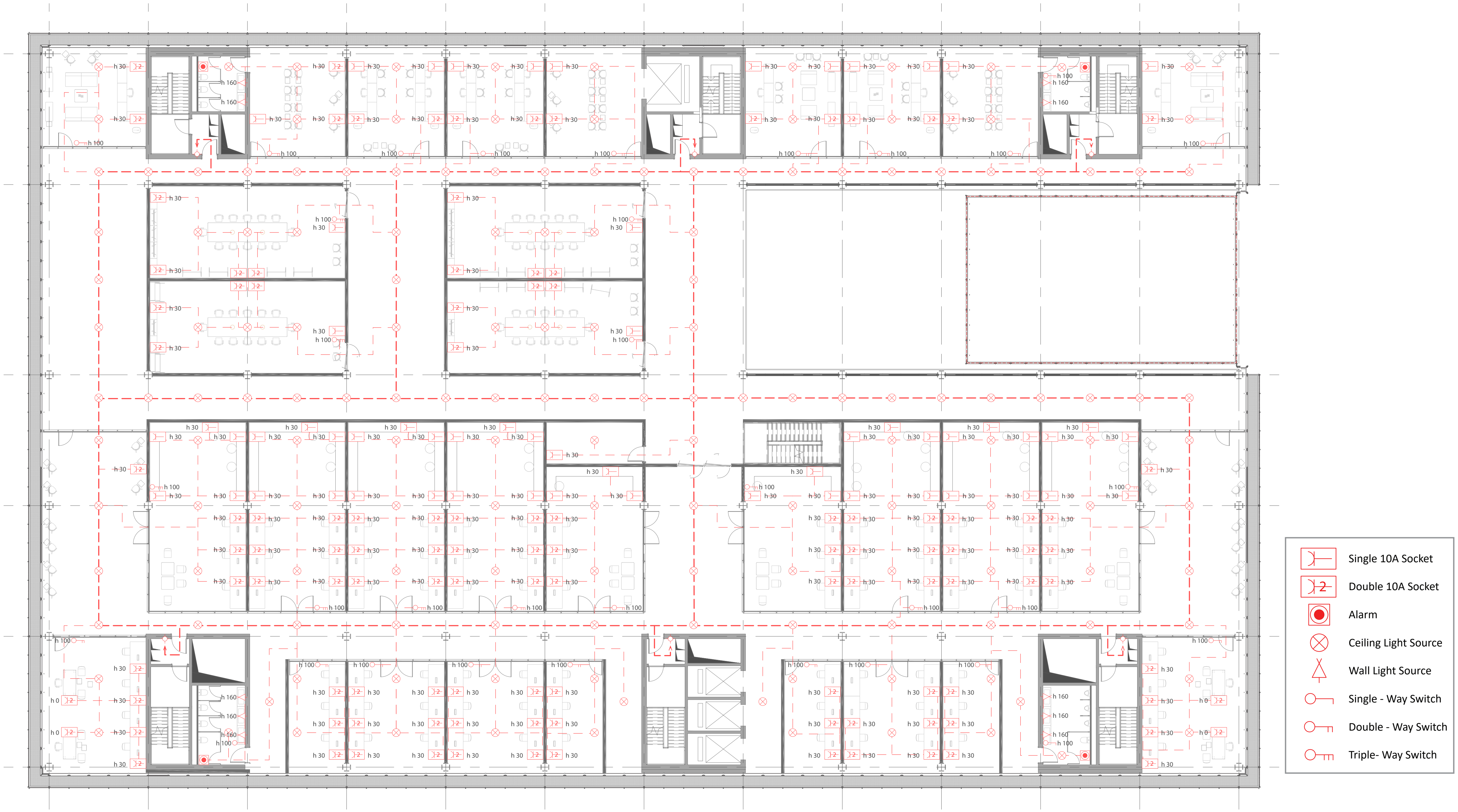


FIRE SAFETY
EVACUATION DISTANCE
shown on Level 3 Plan

The maximum distance travelled to an emergency stair is 30m; 2 fire cabinets are found at each floor with a hose of 30m.

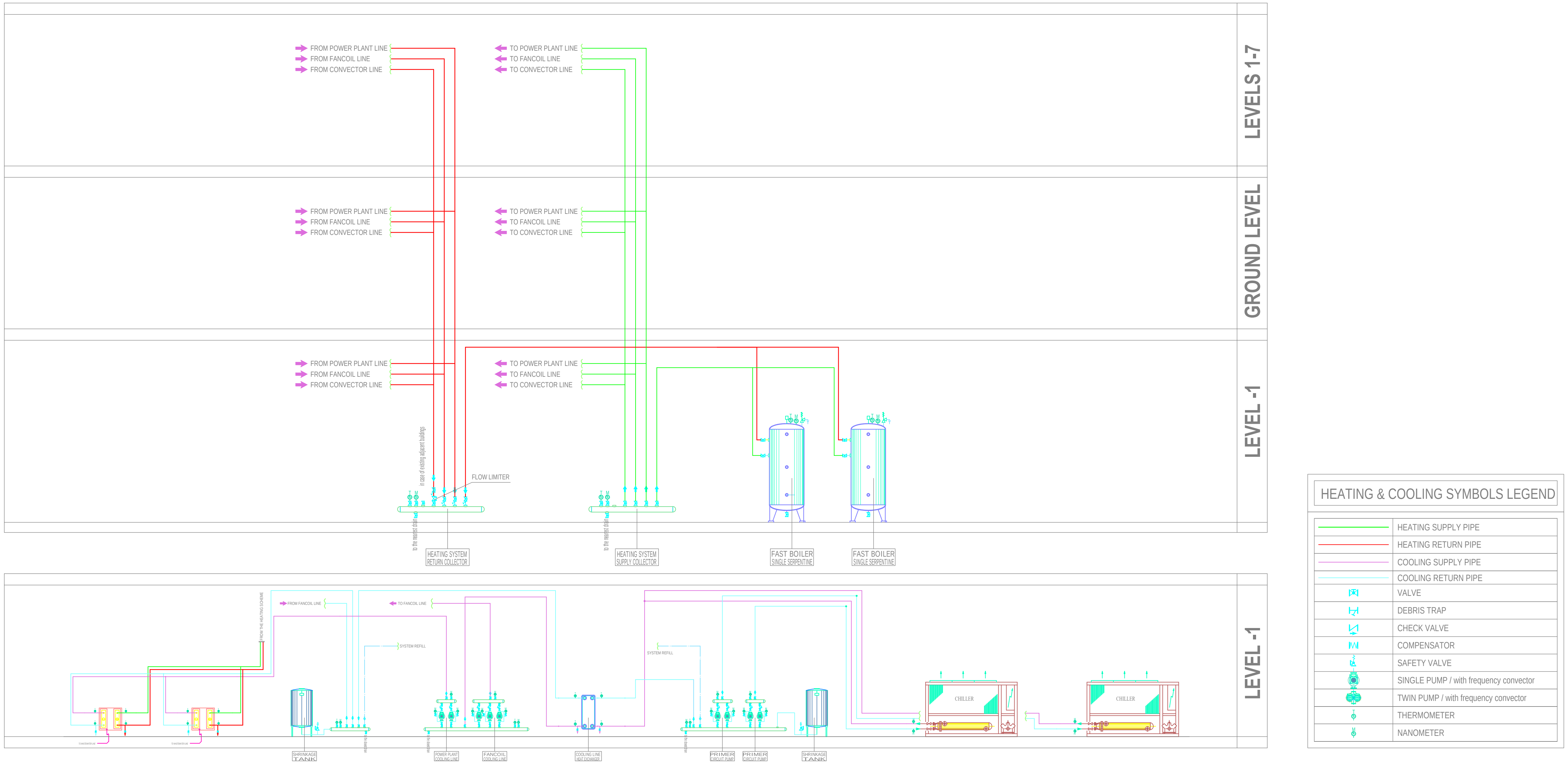
Figure 87: Evacuation Distances

Figure 88: South Core I Plan



ELECTRICAL SYSTEM
shown on Level 4 Plan

Figure 89: Electrical Plan of Level 4



HEATING & COOLING SYSTEM

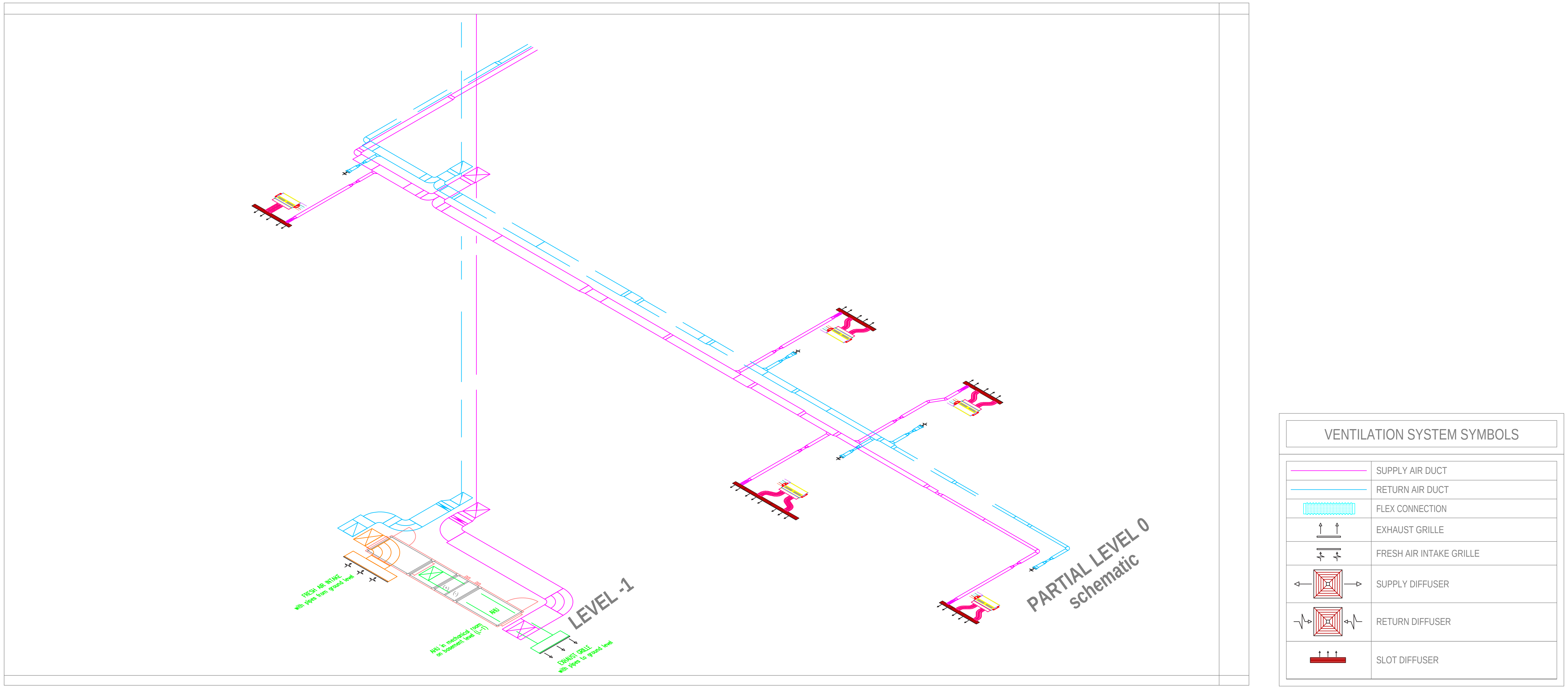
The system is a combination of fan-coils and convectors. Convectors run (discontinuously) at the base of the perimeter to prevent condensation on the glazed façadeç

Heat losses and gains can be estimated based on the location and the volume of the building, which is then used to select the appropriate boiler. In this project, fan-coils and convectors share the load from heat losses.

Figure 90: Heating & Cooling System Schemes

VENTILATION DUCTS
shown on Level 3 Plan

Figure 91: Ventilation Ducts on Level 3 Plan



VENTILATION SYSTEM

The air handling unit is located in the basement level, and the unit receives fresh air from the outside via pipes that open to an isolated island by the parking lot.

Figure 92: Ventilation System Scheme

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