An-Najah National University

Faculty of Engineering

Building Engineering Department

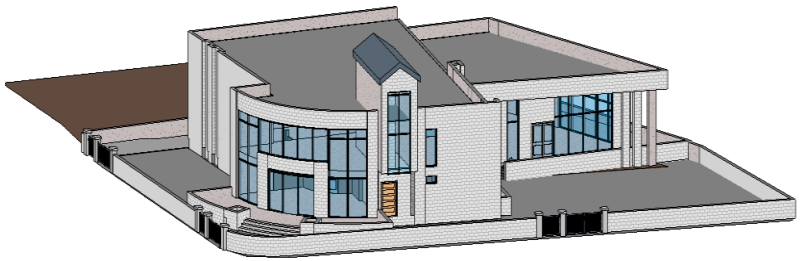
Graduation Project 2

A Comprehensive Redesign of Rogue Fitness Club in Jenin City

Group Members; Bayan Sharqawi
Dina Aqel

Supervisor: Haitham Sawalha

2020/2021



Contents

Introduction

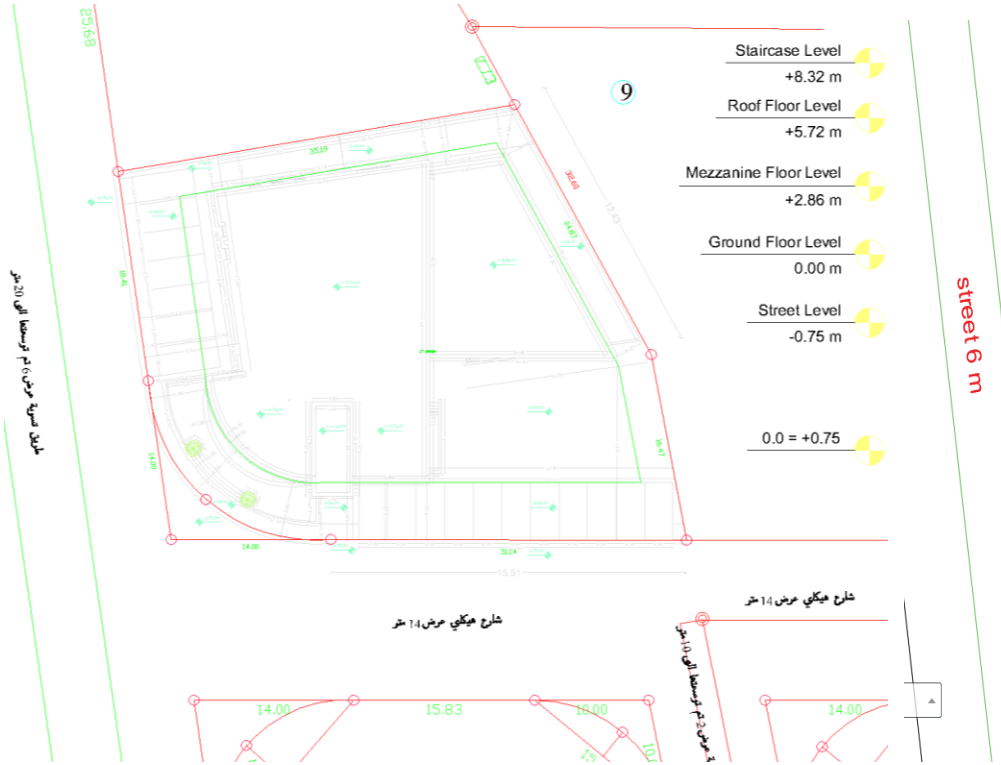
Project objectives are:

- Evaluation and analysis of the existing Rogue gymnasium.
- New integrated design is introduced taking all strengths into consideration and demolishing all weaknesses.

- Rogue fitness club is a time parted gymnasium located in the city of Jenin.
- The gym is located in a neighborhood called Hai-Albasatin which is about 2km away from the city center/
- It is surrounded by residential buildings with low vertical rise.

Architectural Aspects

Site plan



Before

After

Ground Floor

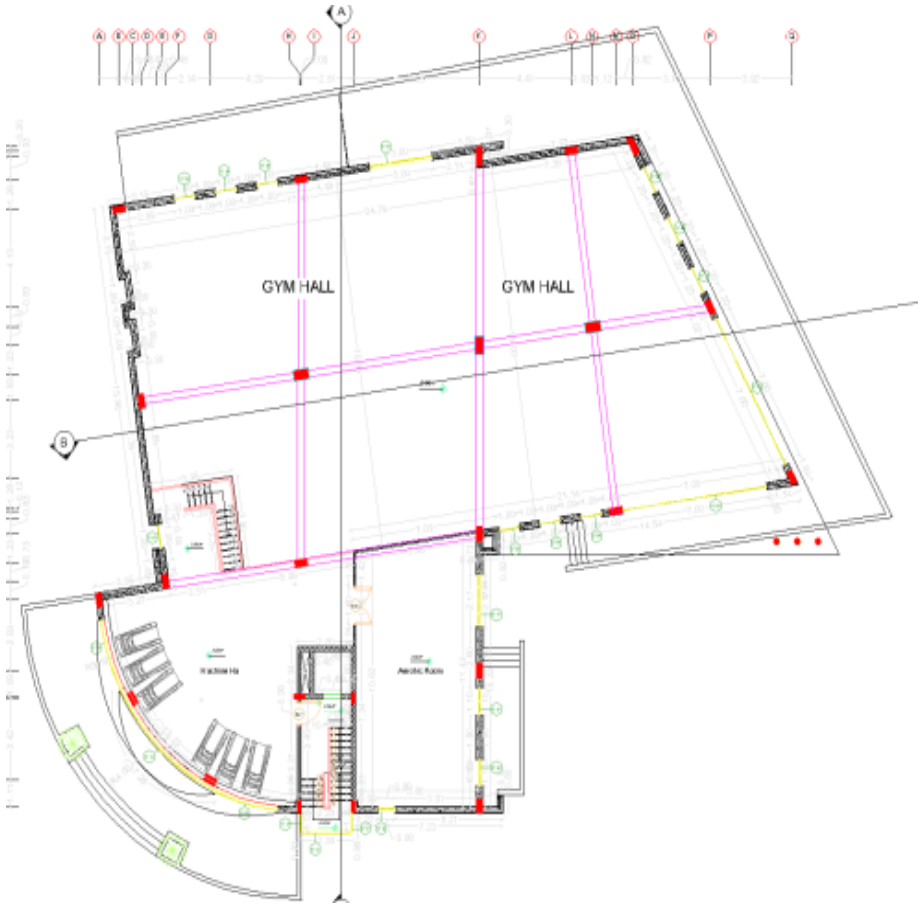
Modifications made:

- Some spaces has to be enlarged such as changing area, showers and WC's.
- Other functions are introduced such as a first aid room, waiting area and a children zone at women's section.

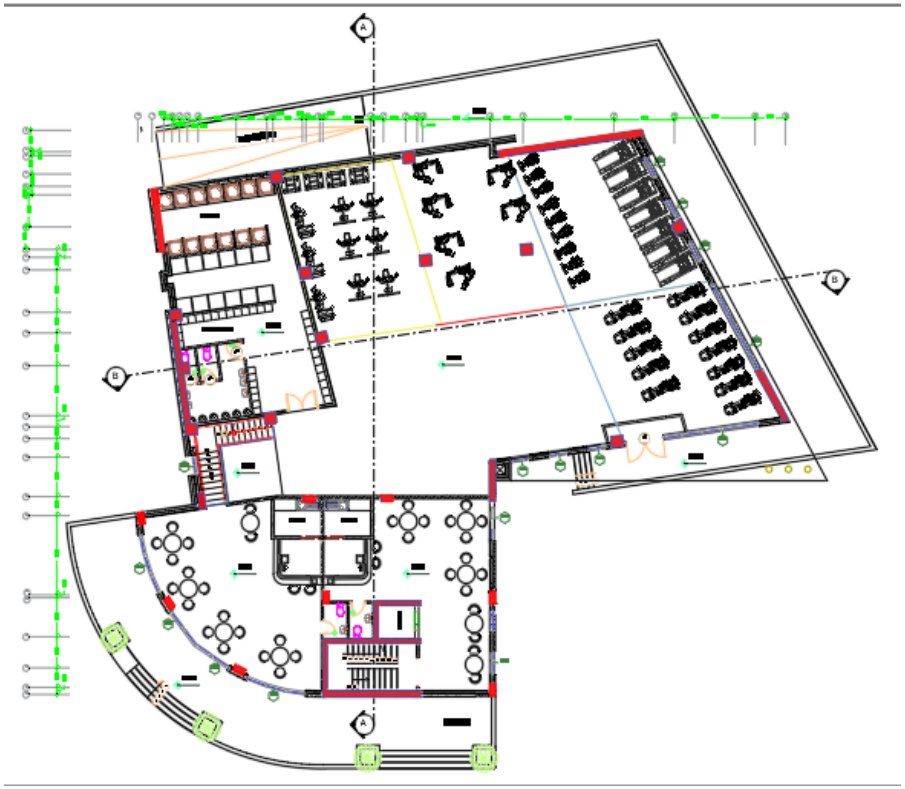
Before

After

Mezzanine Floor



Before

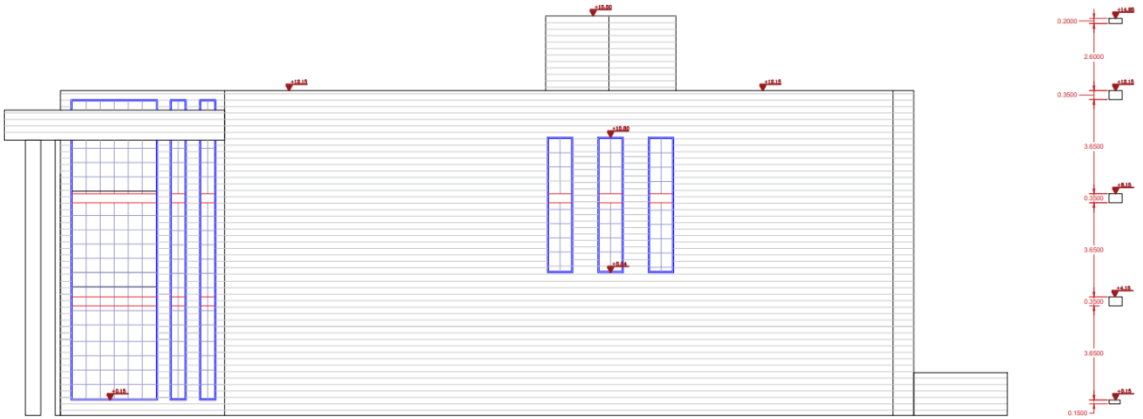


After

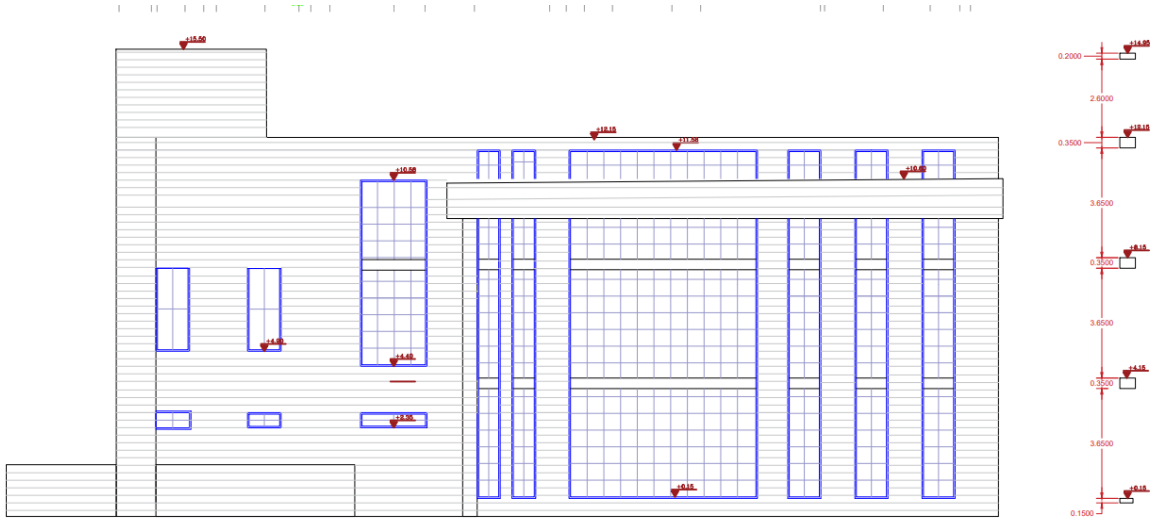
Second Floor

New story was introduced as being a women part.

Elevations

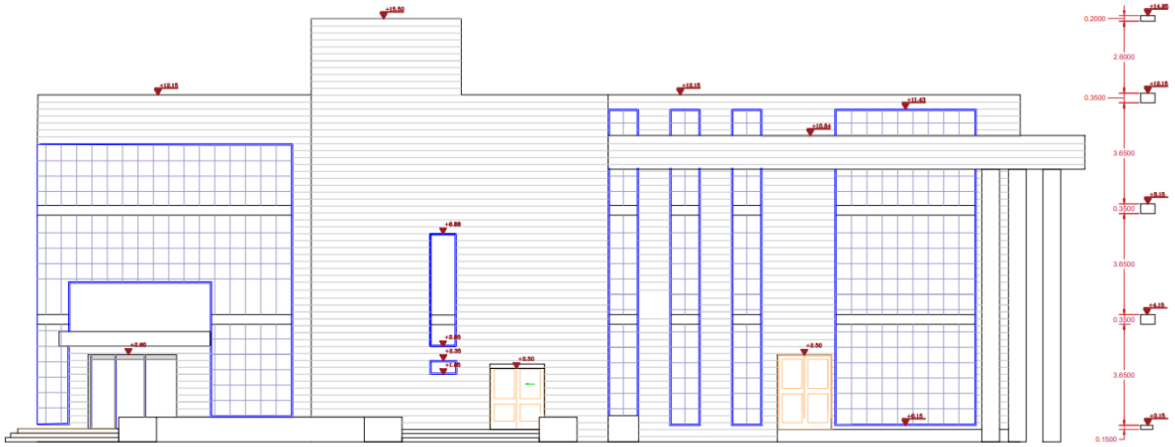


North elevation

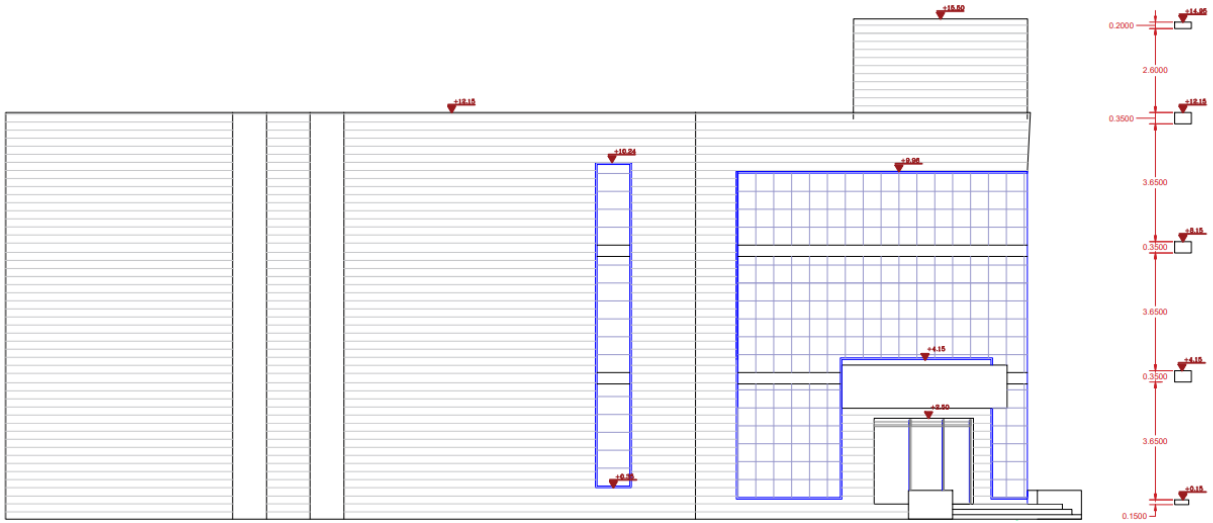


East elevation

Elevations

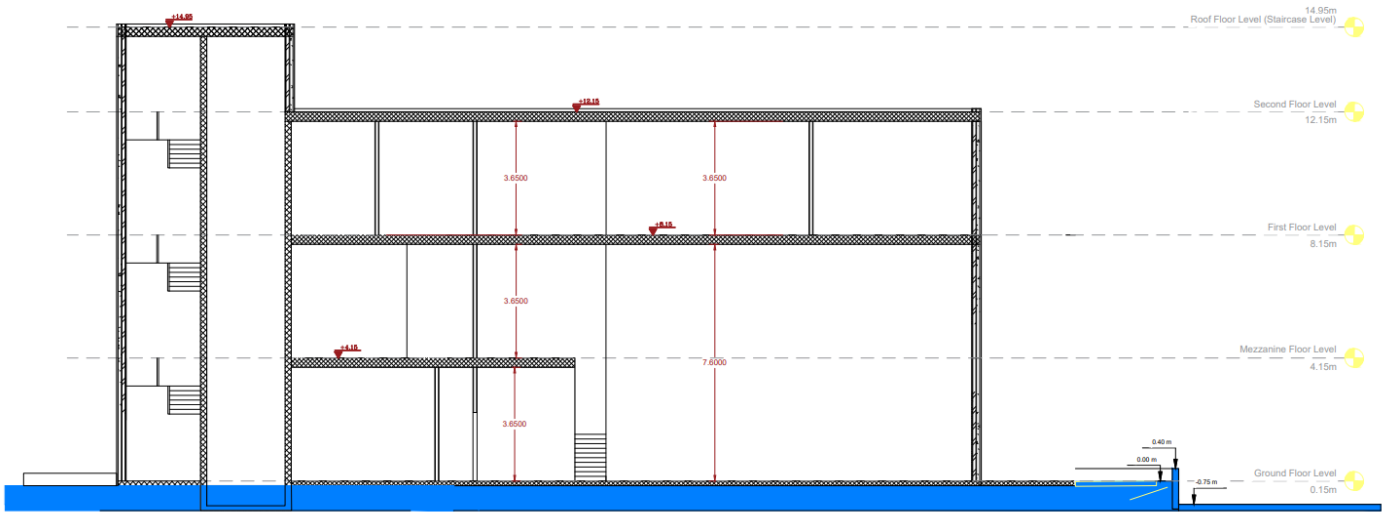


South elevation

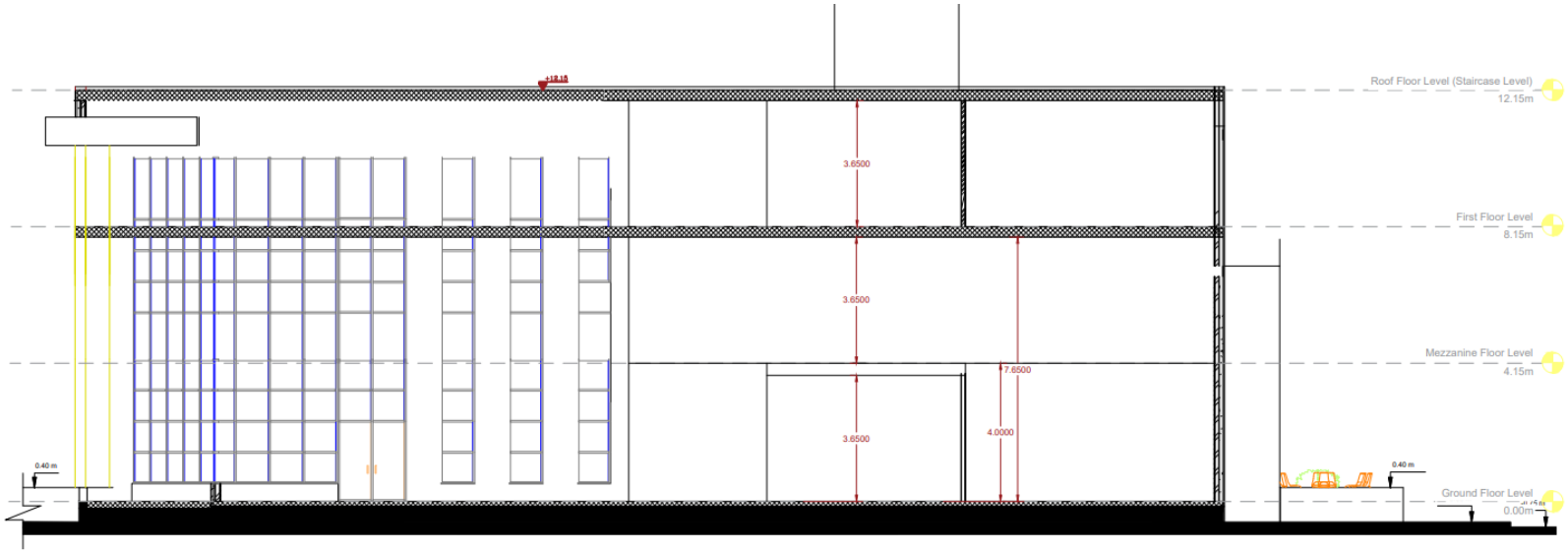


West elevation

Sections

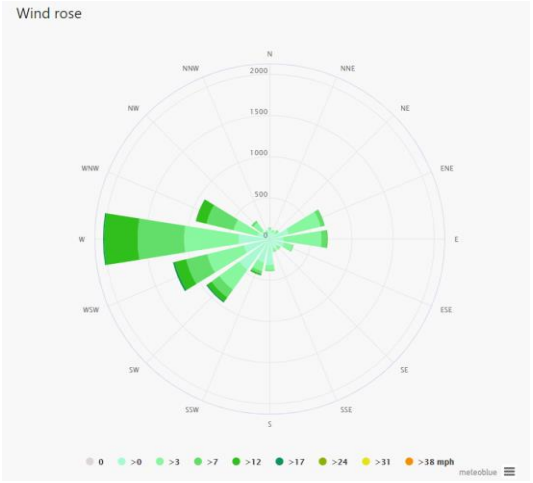


Section A-A



Section B-B

Environmental Aspects



This category includes:

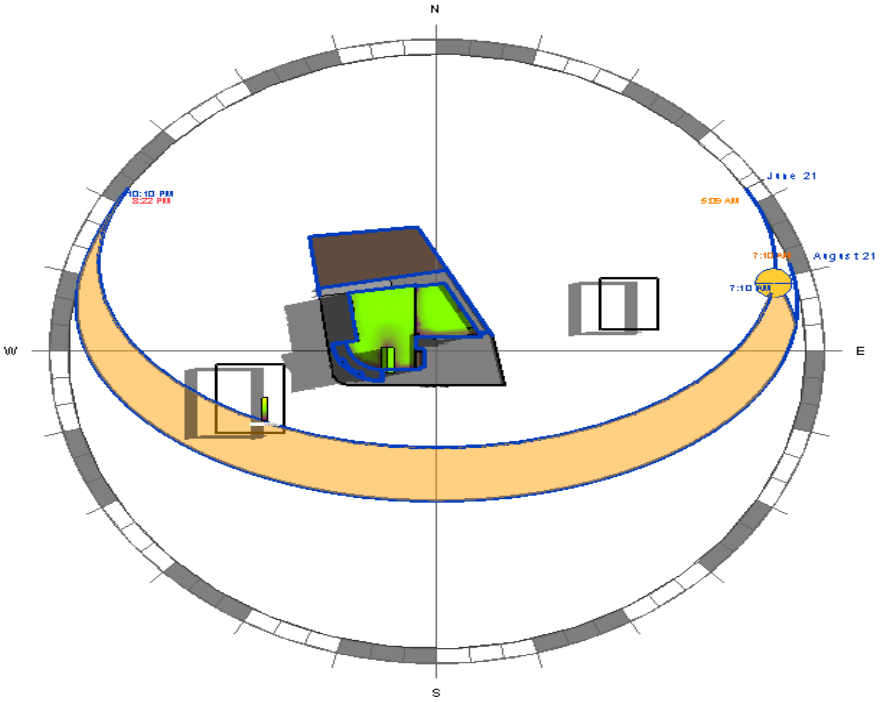
- Solar radiation on building surfaces
- Overshadowing analysis.
- Daylight factor inside the building spaces & artificial lighting
- Acoustical Analysis and design
- Cooling and Heating loads calculations
- HVAC system
- Drainage system
- Water supply
- Fire fighting system
- Elevator

Solar radiation (summer study as a sample)

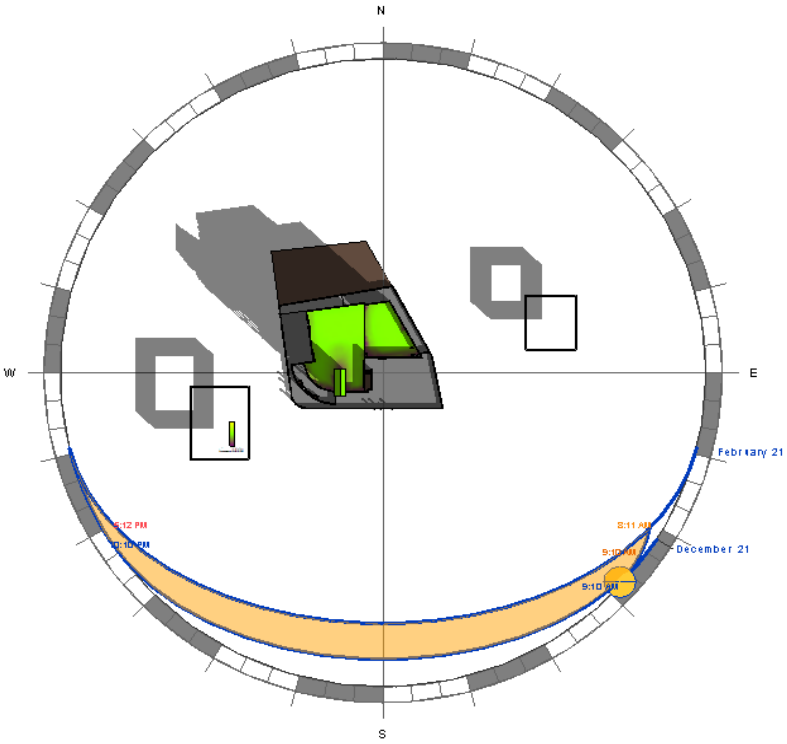
Before

After

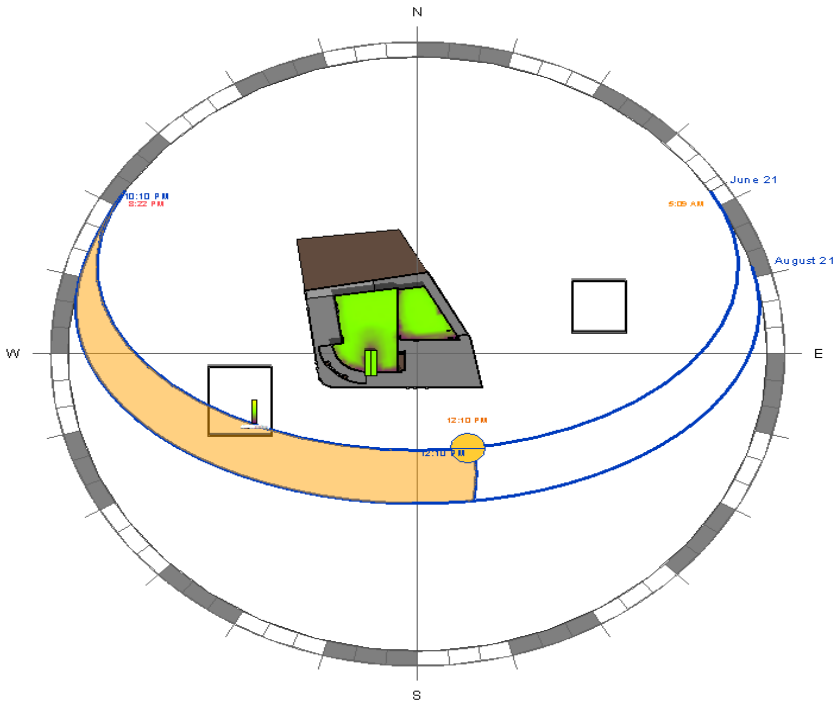
Overshadowing analysis



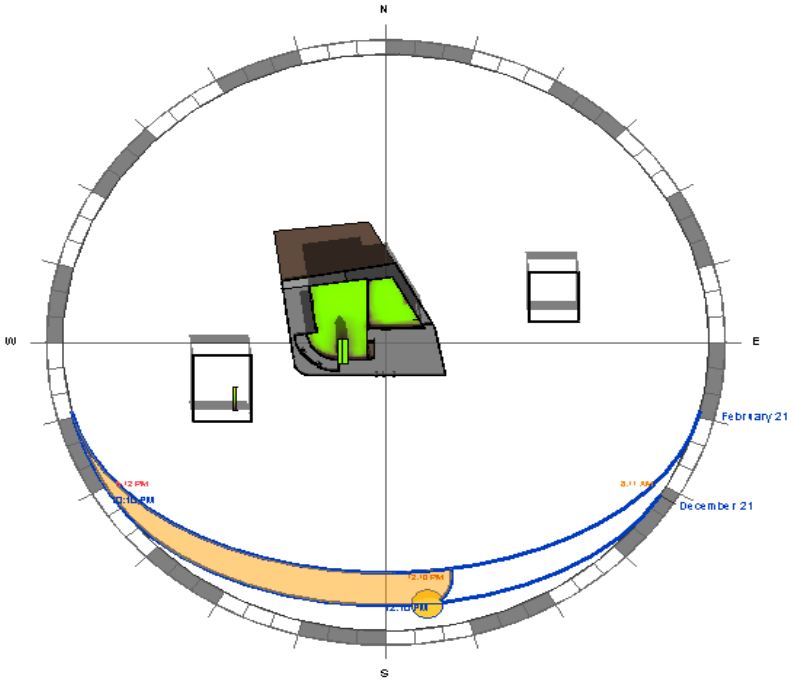
Shadow in Summer (Jun-Aug)Early morning



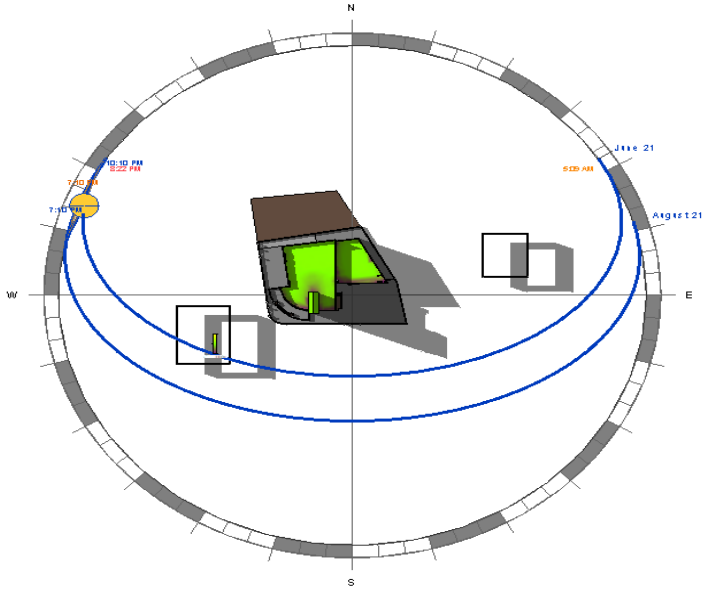
Shadow in winter (Dec-Feb)Early morning



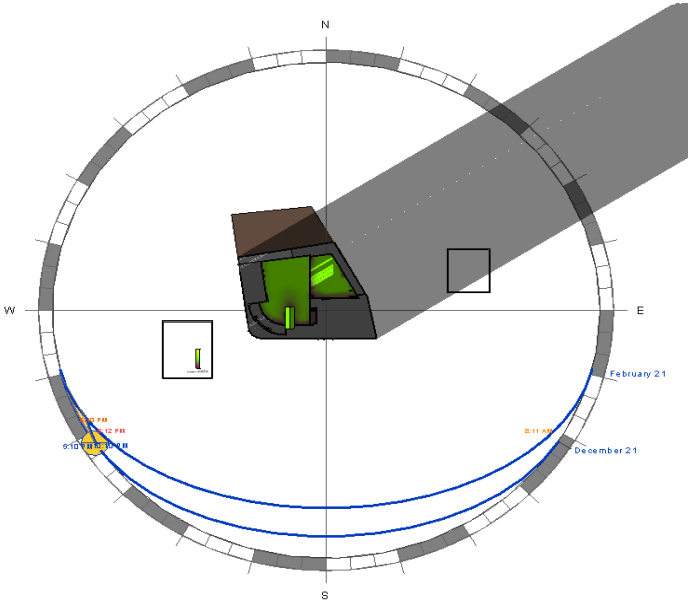
Shadow in Summer (Jun-Aug)noon time



Shadow in winter (Dec-Feb)noon time



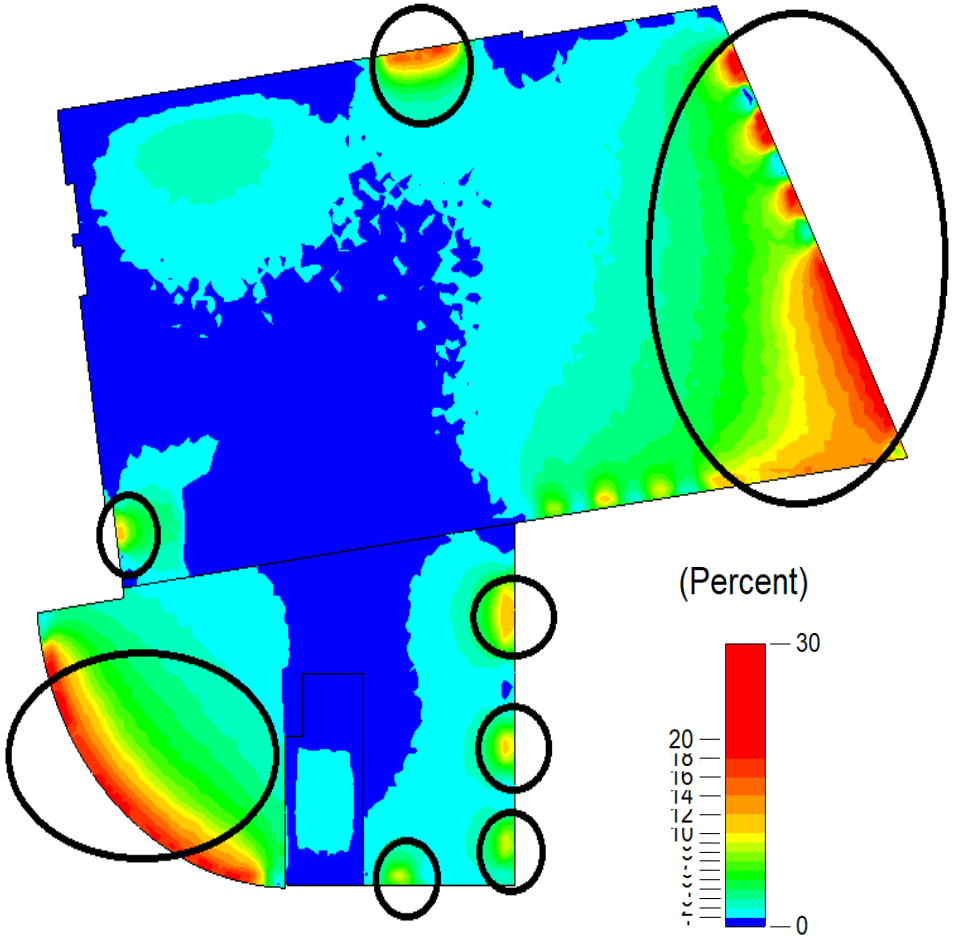
Shadow in Summer (Jun-Aug) evening



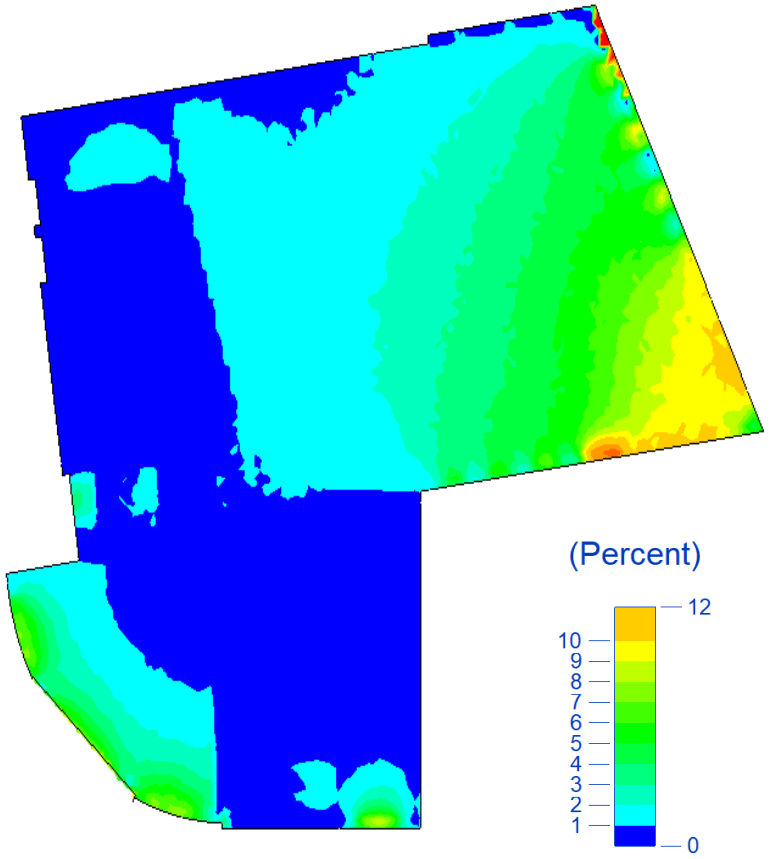
Shadow in winter (Dec-Feb) evening

Natural Lighting

Before



After

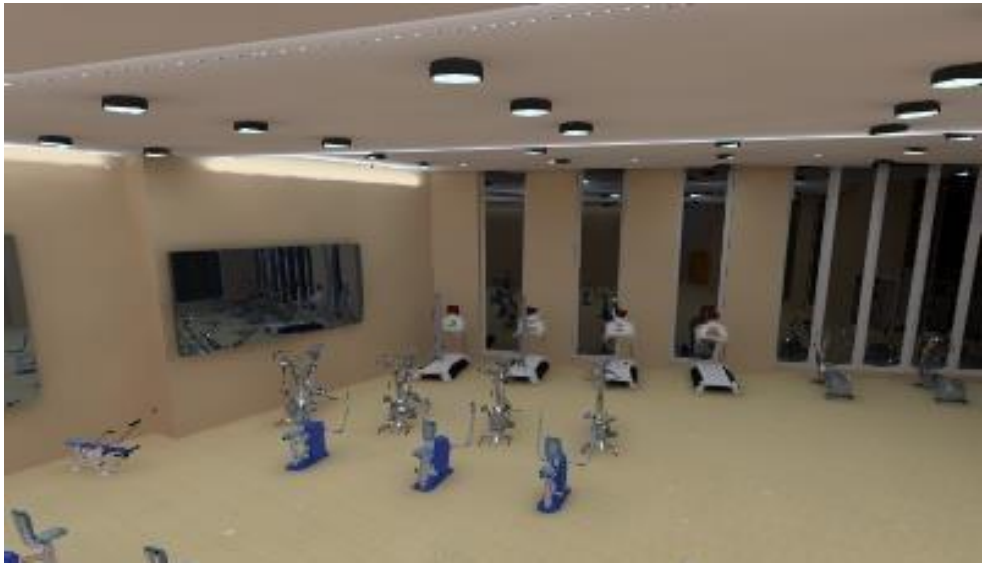


Daylight factor at ground floor

Artificial lighting

Characteristic	Value
Illuminance	200-300 lux
Efficacy	130-180 lm/watt
Uniformity ratio	0.8
Color temperature	~5000 k
CRI	70-85

Office render by Dialux.



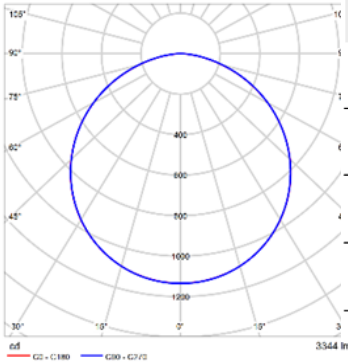
Gym Hall render by Dialux.

Gym Hall design

Luminaries used

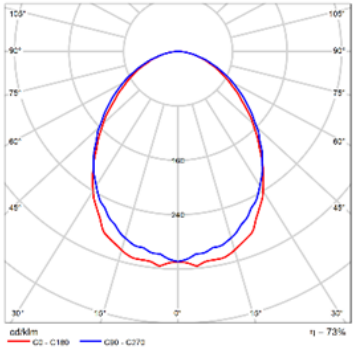
PROLED Flex Strip 1200 Single Extra Bright Mono - WW

P	36.5 W
$\Phi_{Luminaire}$	3344 lm
Luminous efficacy	91.7 lm/W
CCT	3000 K
CRI	90



BRIGHTSPECIALLIGHTING FIRMUS BLACK

P	40.0 W
Φ_{Lamp}	3165 lm
$\Phi_{Luminaire}$	2296 lm
η	72.53 %
Luminous efficacy	57.4 lm/W
CCT	3000 K
CRI	83



Polar LDC

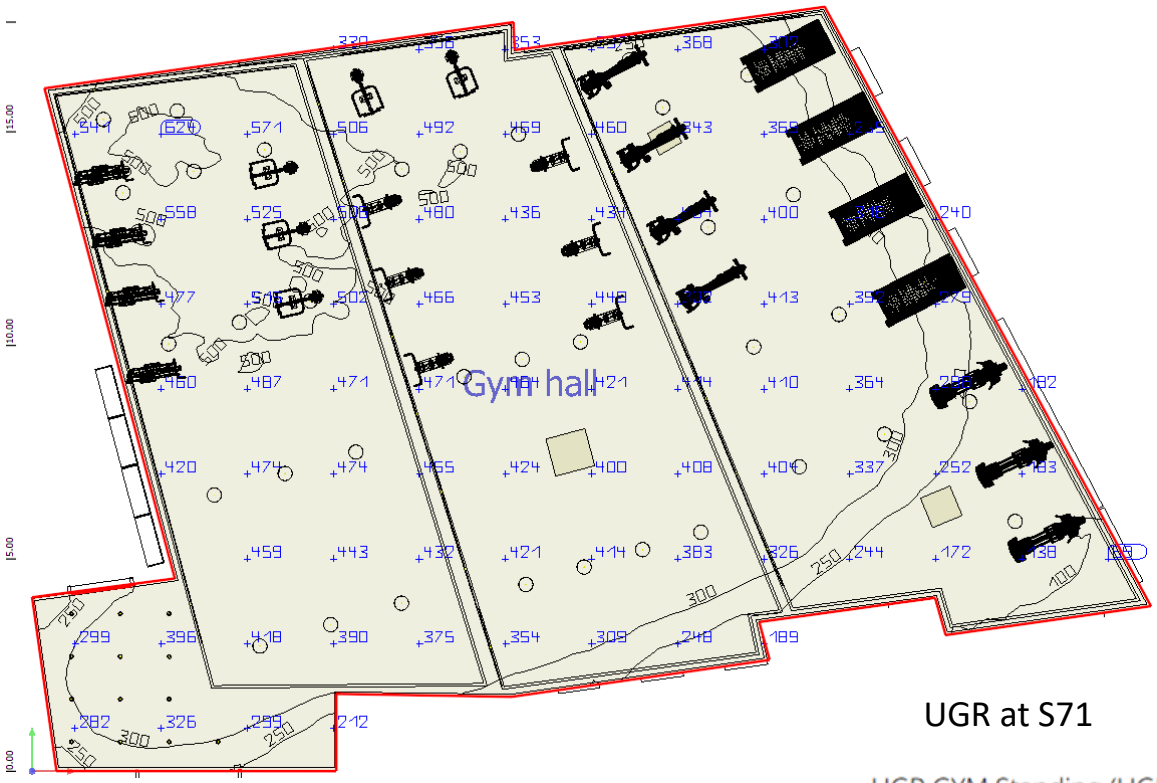
Luminaire list

Φ_{total}	P_{total}	Luminous efficacy
190690 lm	2606.8 W	73.2 lm/W

pcs.	Manufacturer	Article No.	Article name	P	Φ	Luminous efficacy	Index
35	BRIGHTSPECIALLIGHTING	LED-LAMP	FIRMUS BLACK	40.0 W	2296 lm	57.4 lm/W	
30	PROLED	L67806S	Flex Strip 1200 Single Extra Bright Mono - WW	36.5 W	3344 lm	91.7 lm/W	
13	PROLED	L71A308W	Downlight Sirius 80U - Type A - NW	8.6 W	770 lm	89.5 lm/W	

Work planes

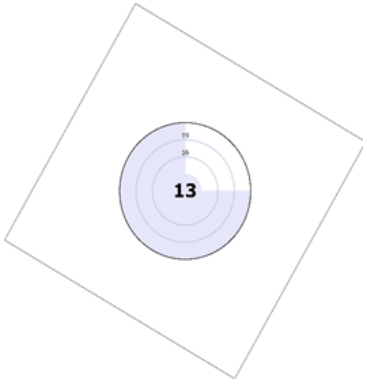
Illuminance value chart



UGR at S70

UGR Gym Hall (UGR)

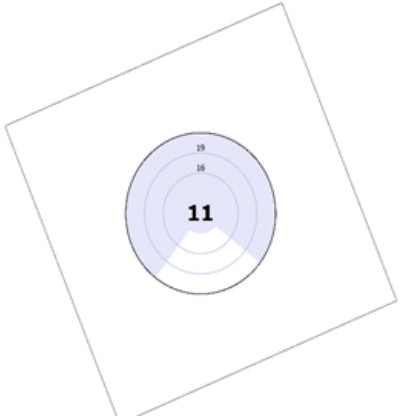
Strongest glare at	120°
max	12.9
Target	≤22.0
Viewing sector	30° - 120°
Step width	15°
Height	1.700 m
Index	S70



UGR at S71

UGR GYM Standing (UGR)

Strongest glare at	30°
max	10.7
Target	≤22.0
Viewing sector	30° - 120°
Step width	15°
Height	1.700 m
Index	S71

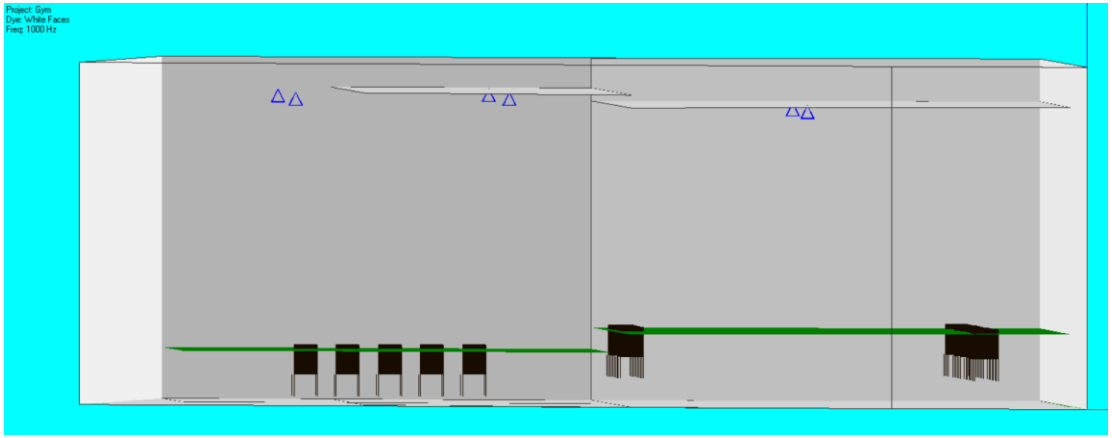


space	Required illuminance (lux)	Perpendicular illuminance (lux)	Required Uniformity	Uniformity	Comment
Gym Hall	200-300	389	0.60	0.58	Ok
Office	500	554	0.60	0.65	OK
Waiting area	200	329	0.40	0.50	OK
Reception	300	319	0.60	0.42	OK
First aid	500	507	0.60	0.64	OK
WC	200	207	0.40	0.54	OK
Showers	200	237	0.40	0.57	OK
Lockers	100	114	0.40	0.42	OK
Changing area	200	206	0.40	0.50	OK
Entrance	200	226	0.40	0.45	OK
Cafeteria	200	205	0.40	0.48	OK

- Lighting system in gym hall could be dimmed up to 50% at day time due to natural lighting.

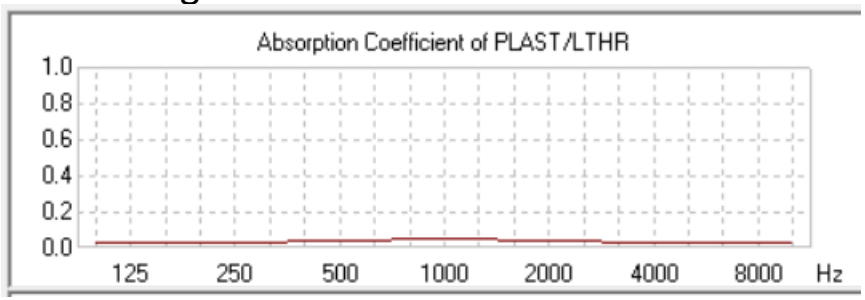
Acoustical Analysis

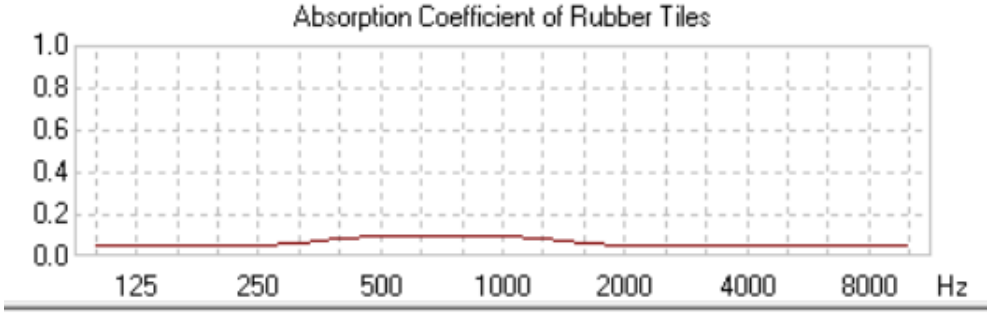
Parameter	Value
RT60	1-1.5 sec
SPL	80-100 dB
NC	45-50
STC	>50
STI	0.6

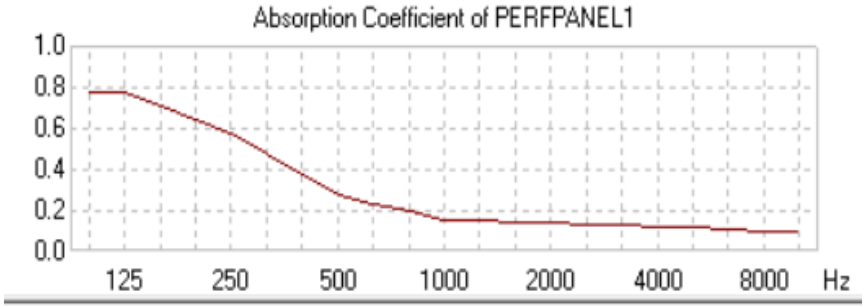


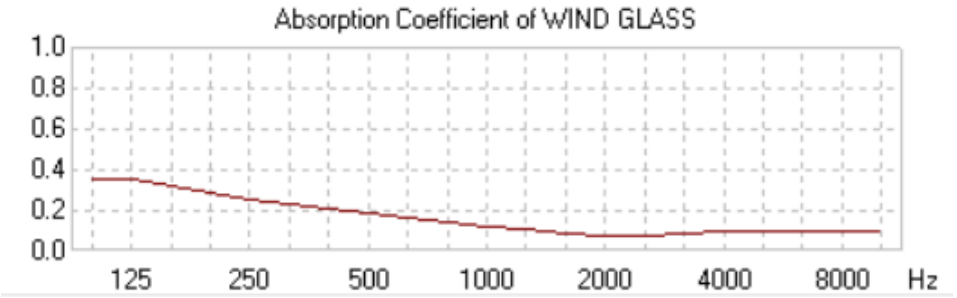
Gym hall design

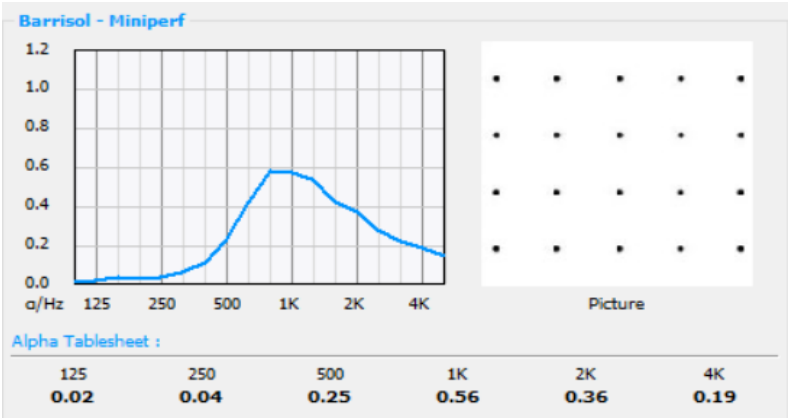
Ceiling materials

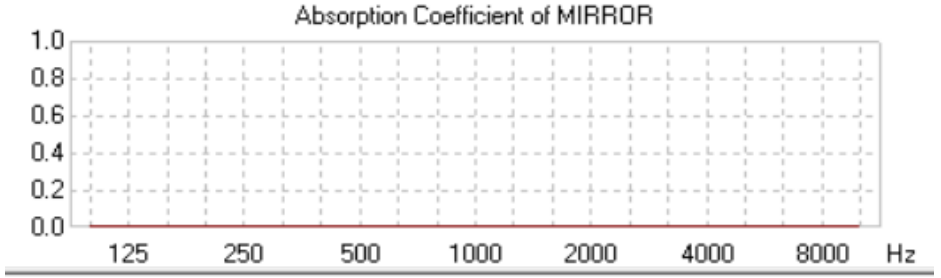




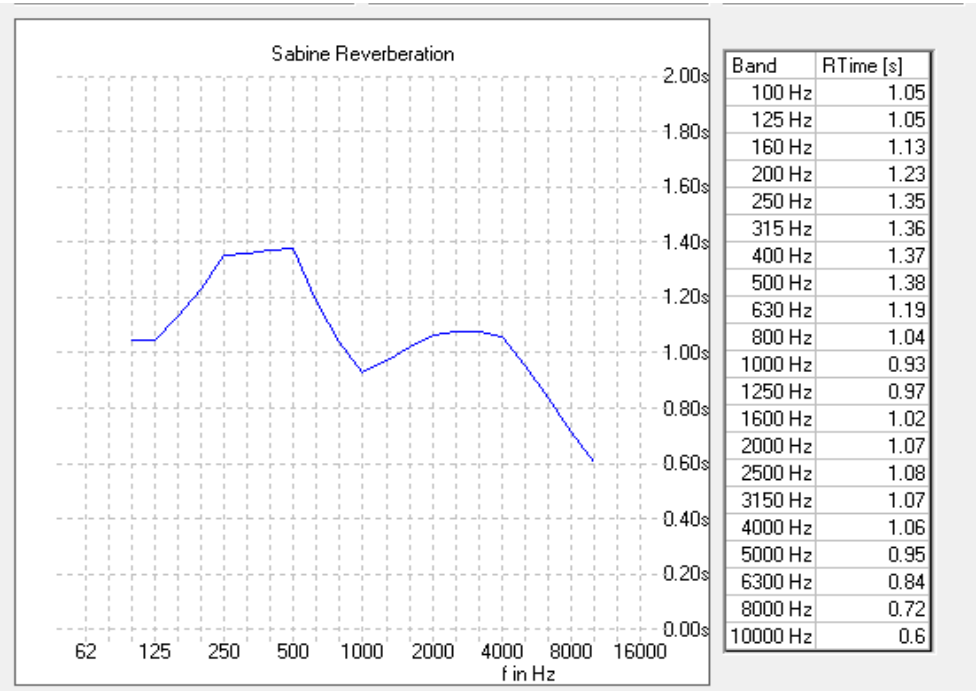






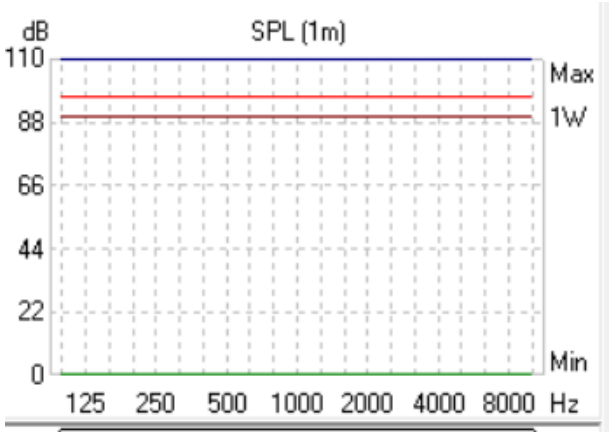


RT_{60}

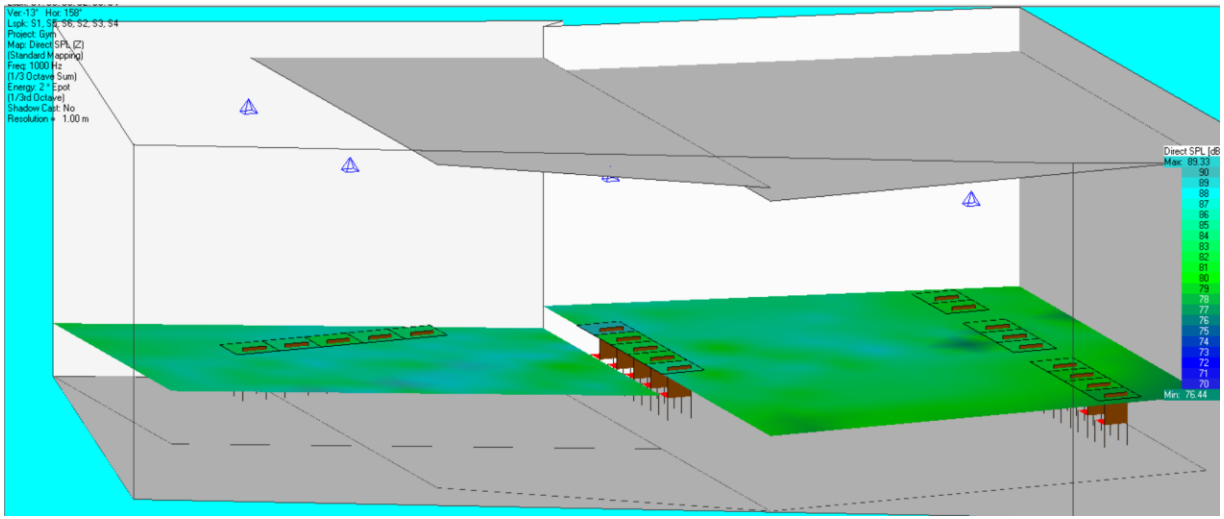


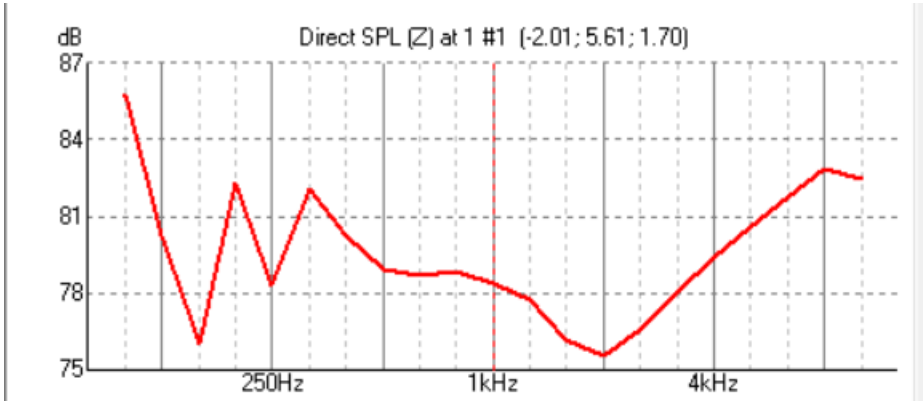
Band	RTime [s]
100 Hz	1.05
125 Hz	1.05
160 Hz	1.13
200 Hz	1.23
250 Hz	1.35
315 Hz	1.36
400 Hz	1.37
500 Hz	1.38
630 Hz	1.19
800 Hz	1.04
1000 Hz	0.93
1250 Hz	0.97
1600 Hz	1.02
2000 Hz	1.07
2500 Hz	1.08
3150 Hz	1.07
4000 Hz	1.06
5000 Hz	0.95
6300 Hz	0.84
8000 Hz	0.72
10000 Hz	0.6

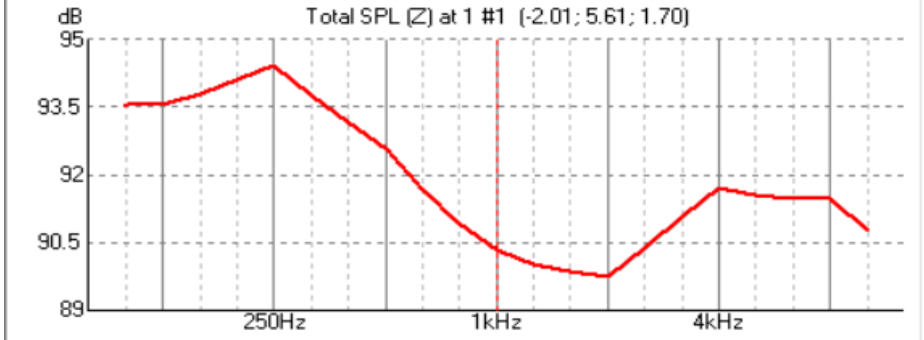
Speakers used are of canon type (V100).



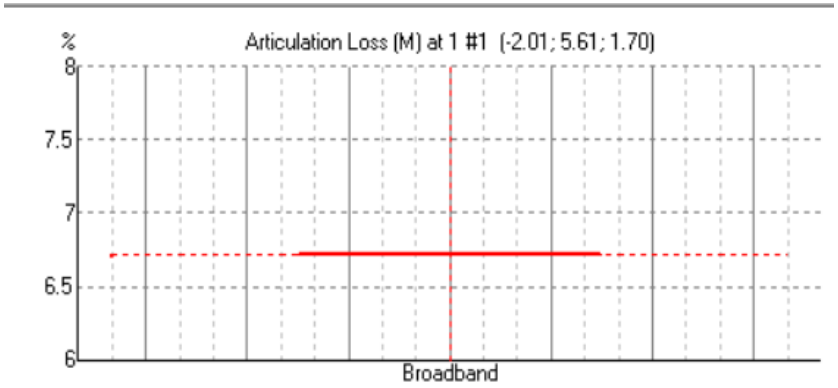
❖ Direct SPL


Direct SPL [dB
Max: 89.33
Min: 76.44

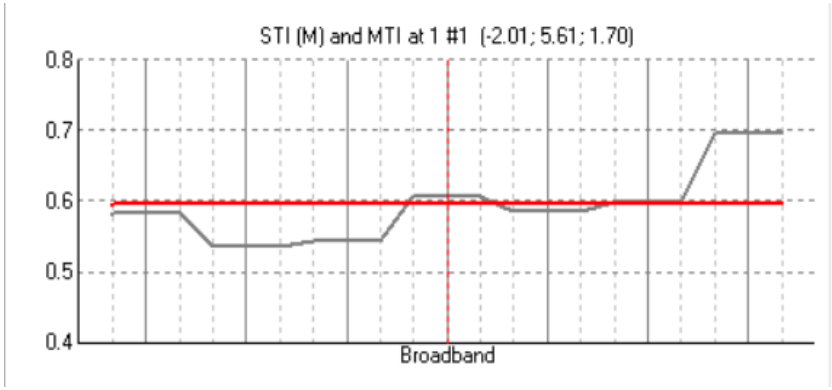

dB
Direct SPL (Z) at 1 #1 (-2.01; 5.61; 1.70)
87
84
81
78
75
250Hz
1kHz
4kHz


dB
Total SPL (Z) at 1 #1 (-2.01; 5.61; 1.70)
95
93.5
92
90.5
89
250Hz
1kHz
4kHz

❖ Articulation loss



❖ STI

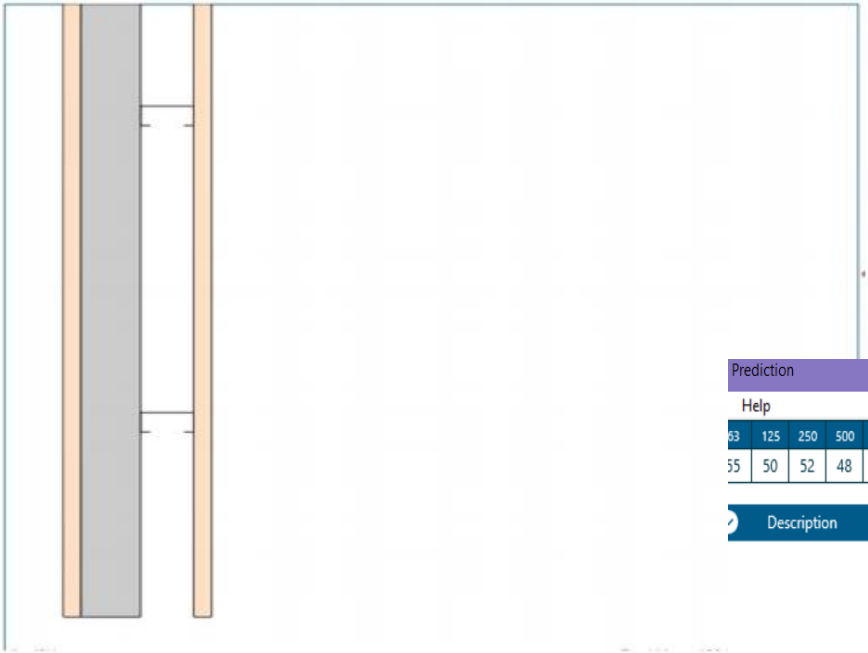


63	125	250	500	1k	2k	4k
27	41	47	50	55	57	68

STC 55 OITC 48

Description

Wall: 1 x 30 mm mm Plasterboard + 1 x 100 mm CMU Hollow (95 lb/ft^3) + Steel Stud (1.0-1.6mm) + 0.4 mm Fibreglass (10kg/m3) + 1 x 30 mm mm Plasterboard



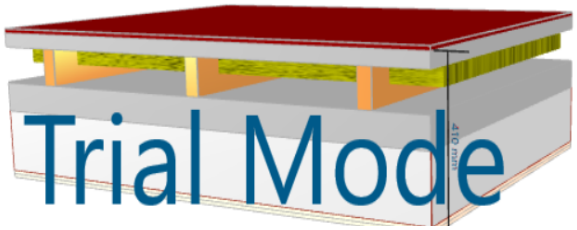
Prediction

Help

63	125	250	500	1k	2k	4k
55	50	52	48	45	21	15

IIC 69

Description



Single

Floor covers | Par

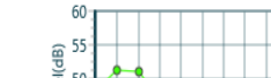
Layer 1 | Layer 2

concre

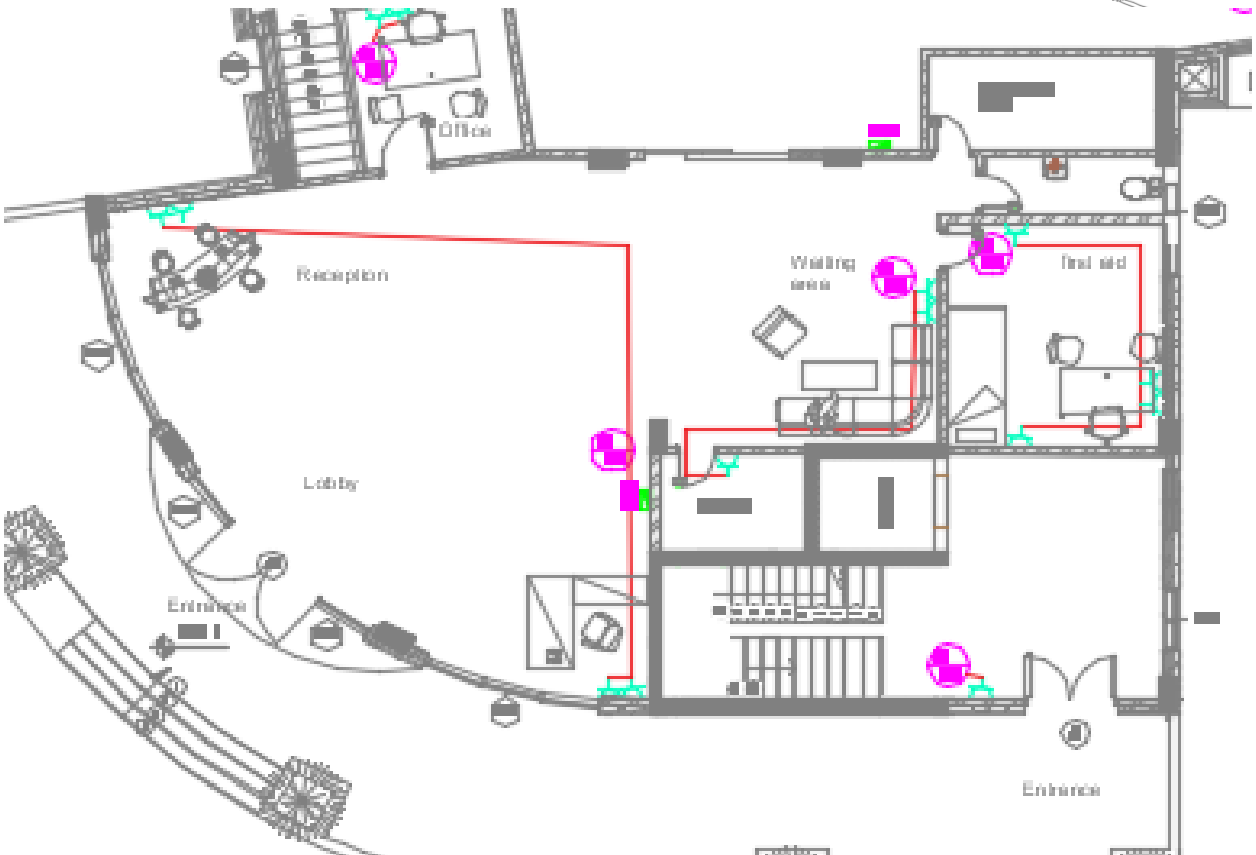
Products

- Composite Floor-Dek 2
- Composite Floor-Dek 3
- Lightweight concrete
- Brick
- CMU Hollow (95 lb/ft^3)
- CMU Hollow (115 lb/ft^3)
- CMU Hollow (135 lb/ft^3)
- CMU Grout Filled (95 lb/ft^3)
- CMU Grout Filled (135 lb/ft^3)
- Hollow Concrete planks
- Aerated Concrete
- Gypcrete

Chart



Electrical system

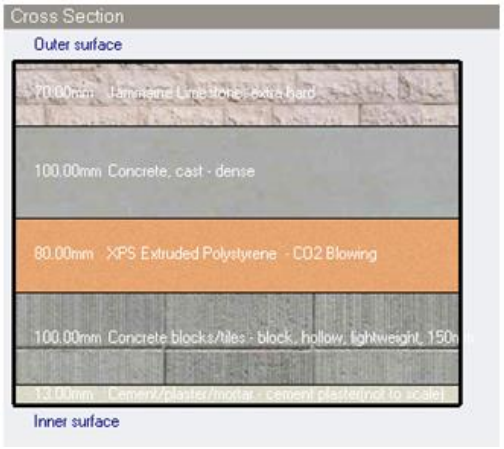


Socket Calculations for Ground floor

Name distribution bored		Volt	#of socket	length	Roh	Power	Power(watt)*0.3	R(wire)	I(load)	Vdrop	%Vdrop	Ic.b	I cable	cross sectional area cable	circuit breaker
	Unit	volt		meter	Ω	watt	watt	Ω	amp	volt	-	amp	amp	mm^2	amp
D.B1	P1	220	8	15.5	17.5*10^-9	2000	600	0.11	2.73	0.30	0.13	3.14	3.61	2.5	16
	P2	220	4	1.5	17.5*10^-9	1000	300	0.01	1.36	0.01	0.01	1.57	1.80	2.5	16
	P3	220	6	7.5	17.5*10^-9	1500	450	0.05	2.05	0.11	0.05	2.35	2.71	2.5	16
	P4	220	8	7	17.5*10^-9	2000	600	0.05	2.73	0.13	0.06	3.14	3.61	2.5	16
	P5	220	2	5	17.5*10^-9	500	150	0.04	0.68	0.02	0.01	0.78	0.90	2.5	16
	SUM					7000									
D.B2	P1	220	10	14	17.5*10^-9	2500	750	0.10	3.41	0.33	0.15	3.92	4.51	2.5	16
	SUM					7250									
D.B3	P1	220	28	31.5	17.5*10^-9	7000	2100	0.22	9.55	2.10	0.96	10.98	12.62	2.5	16
	P2	220	16	21	17.5*10^-9	4000	1200	0.15	5.45	0.80	0.36	6.27	7.21	2.5	16
	SUM					11000									

Cooling and Heating loads calculations

- External wall



Thickness (m)	0.3630
Km - Internal heat capacity (KJ/m2-K)	83.5296
Upper resistance limit (m2-K/W)	2.839
Lower resistance limit (m2-K/W)	2.839
U-Value surface to surface (W/m2-K)	0.375
R-Value (m2-K/W)	2.839
U-Value (W/m2-K)	**0.352**

- Roof

Thickness (m)	0.4720
Km - Internal heat capacity (KJ/m2-K)	228.0192
Upper resistance limit (m2-K/W)	3.076
Lower resistance limit (m2-K/W)	2.974
U-Value surface to surface (W/m2-K)	0.347
R-Value (m2-K/W)	3.025
U-Value (W/m2-K)	**0.331**

- Window

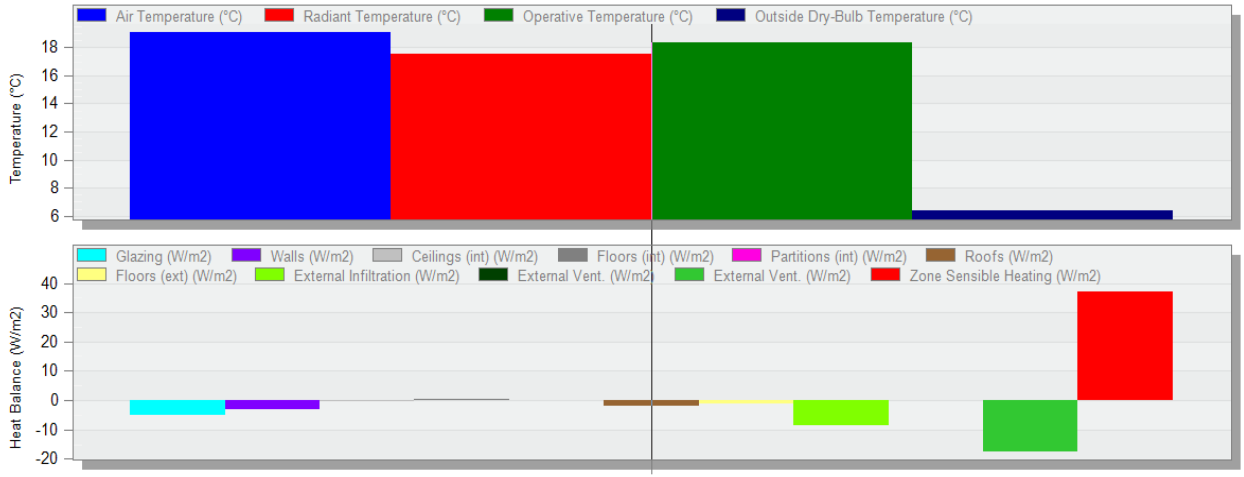
Calculated Values	
Total solar transmission (SHGC)	0.474
Direct solar transmission	0.354
Light transmission	0.381
U-value (ISO 10292/ EN 673) (W/m2-K)	2.509
U-Value (W/m2-K)	**2.379**

19.07

EnergyPlus Output

Temperature and Heat Loss

Student



Air Temperature (°C)	19.07
Radiant Temperature (°C)	17.58
Operative Temperature (°C)	18.33
Outside Dry-Bulb Temperature (°C)	6.40
Glazing (W/m2)	-4.93
Walls (W/m2)	-3.23
Ceilings (int) (W/m2)	-0.39
Floors (int) (W/m2)	0.39
Partitions (int) (W/m2)	0.00
Roofs (W/m2)	-1.79
Floors (ext) (W/m2)	-1.04
External Infiltration (W/m2)	-8.72
External Vent. (W/m2)	-0.15
External Vent. (W/m2)	-17.32
Zone Sensible Heating (W/m2)	37.17

Zone	Comfort Temperature (°C)	Steady-State Heat Loss (kW)	Design Capacity (kW)	Design Capacity (W/m2)
− Building 1 Total Design Heating Capacity = 79.250 (kW)				
− GF Total Design Heating Capacity = 25.780 (kW)				
Gym Hall	17.27	13.01	**16.26**	45.8026
entrance	18.26	0.38	**0.48**	167.0309
mechanical room	15.88	0.00	**0.00**	0.0000
wc	19.43	0.12	**0.15**	47.9796
waiting area	19.58	0.50	**0.62**	25.2247
reception	18.87	1.98	**2.47**	38.1530
office	19.89	0.32	**0.40**	59.5015
first aid	20.89	0.73	**0.91**	66.8966
elevator	19.65	0.08	**0.10**	29.3143
entrance	19.16	0.53	**0.66**	41.8061
stairs	19.32	0.34	**0.42**	37.2275
Storage	19.63	0.10	**0.12**	29.1094
showers	21.01	0.75	**0.94**	47.9237
changig area	21.22	0.59	**0.74**	38.2668
lockers	21.02	0.93	**1.16**	47.2475
WC	19.58	0.20	**0.25**	32.3168
WC	19.61	0.04	**0.05**	38.2648
WC	19.79	0.04	**0.05**	27.9017

HVAC system

System component specification

Kvadra

Size: 150 - 450 mm
Air flow: 100 - 1075 m³/h | 28 - 299 l/s | 59 - 634 cfm

- Louver faced ceiling diffuser used for supply and return air, with removable core
- Manufactured from aluminium and galvanized steel, powder painted in white RAL 9010
- Fixing directly to the square duct or to the round duct with KRC
- All sizes are stock articles
- Accessories: KRC transfer inlet, PER plenum box or opposed blade damper

KVK Slim EC

Box fan with circular duct connection equipped with EC motor.

Insulated hatch for easy maintenance.

Used for supply and extract of air in different applications such as commercial and residential buildings.

Air volumes from 42-1670 l/s (150-6000 m³/h)

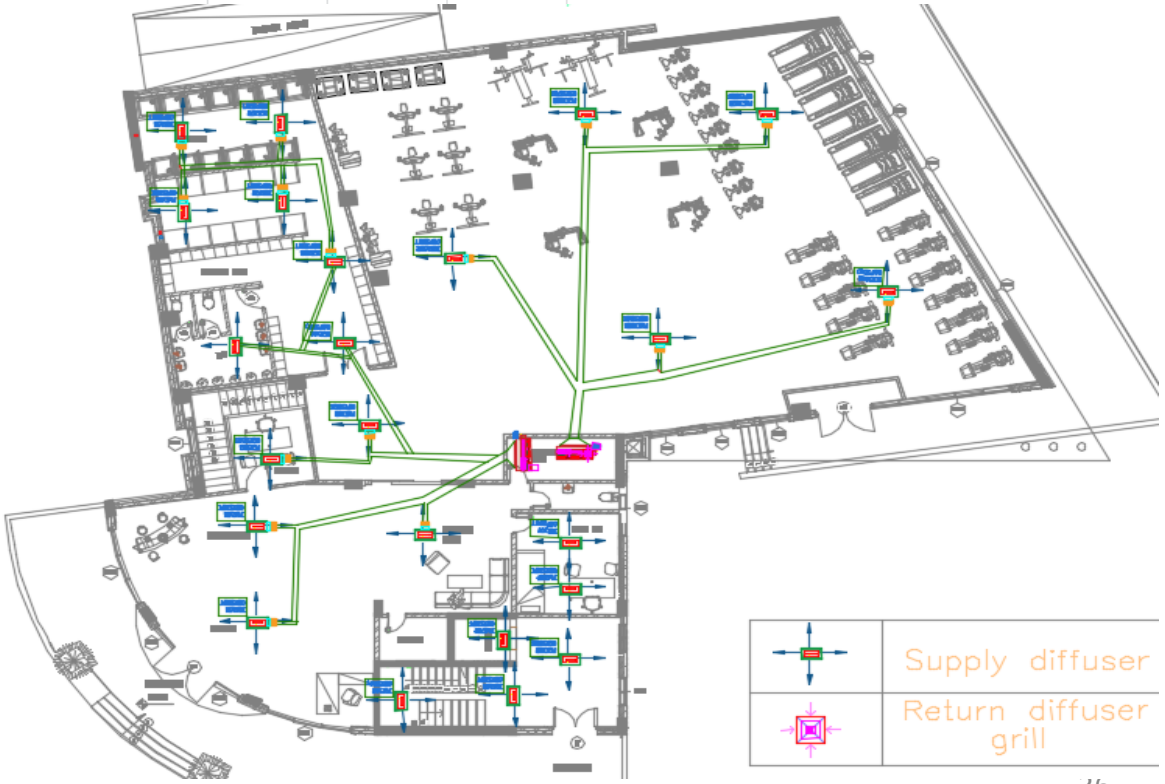
GHP

Description
Gas-engine Heat Pump VRF System

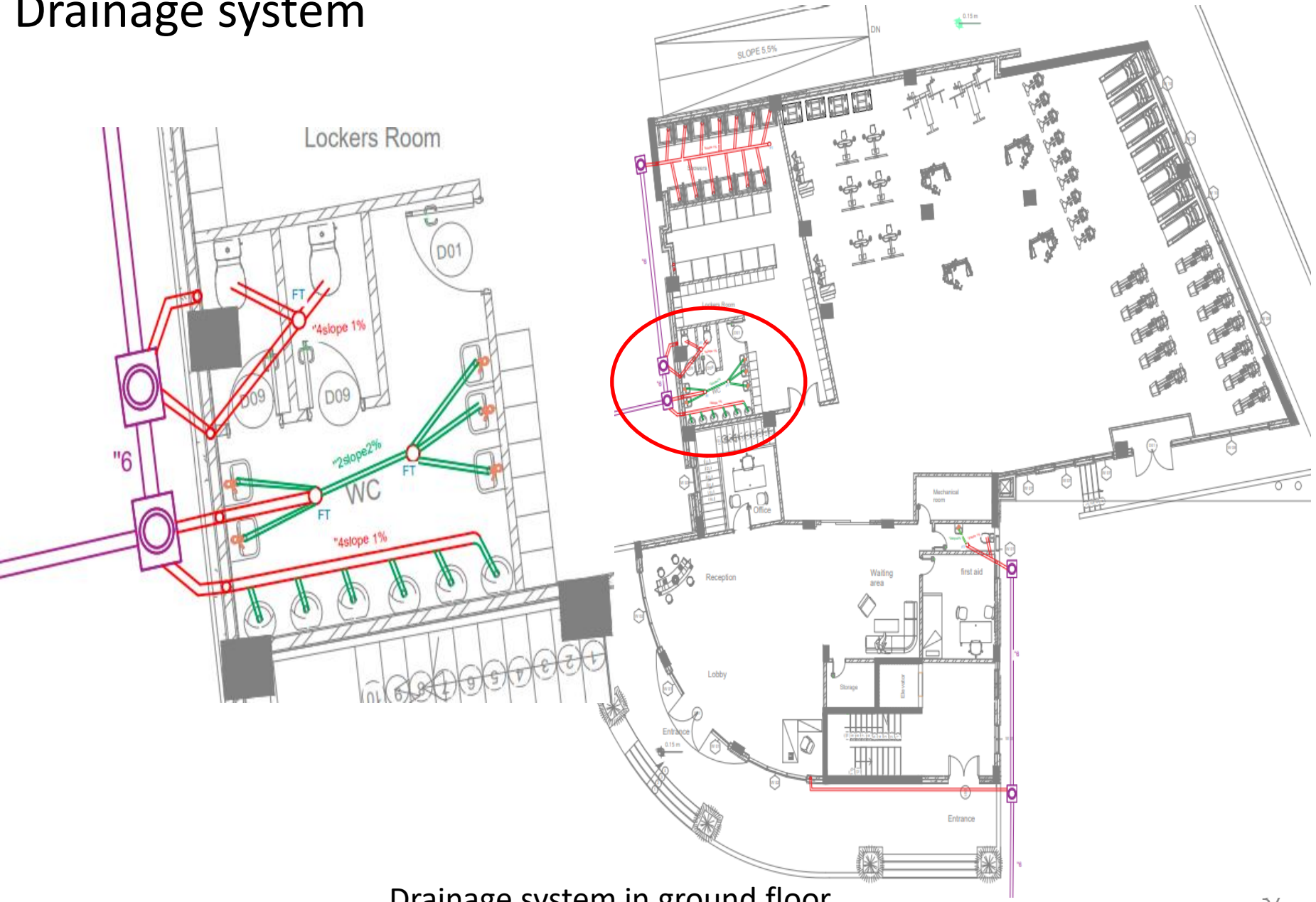
TICA GHP variable refrigerant flow (VRF) are JV cooperating with YANMAR Japan. The Yanmar GHP variable refrigerant flow (VRF) air-conditioning system provides a very flexible way to provide highly efficient gas powered heating and cooling for buildings. Each system comprises of a gas engine powered outdoor unit which exchanges heat energy with the outdoor air, and multiple indoor units whicj exchange heat energy with the air in the building.

Cooling capacity: 45kW~85kW
Heating capacity: 50kW~95kW

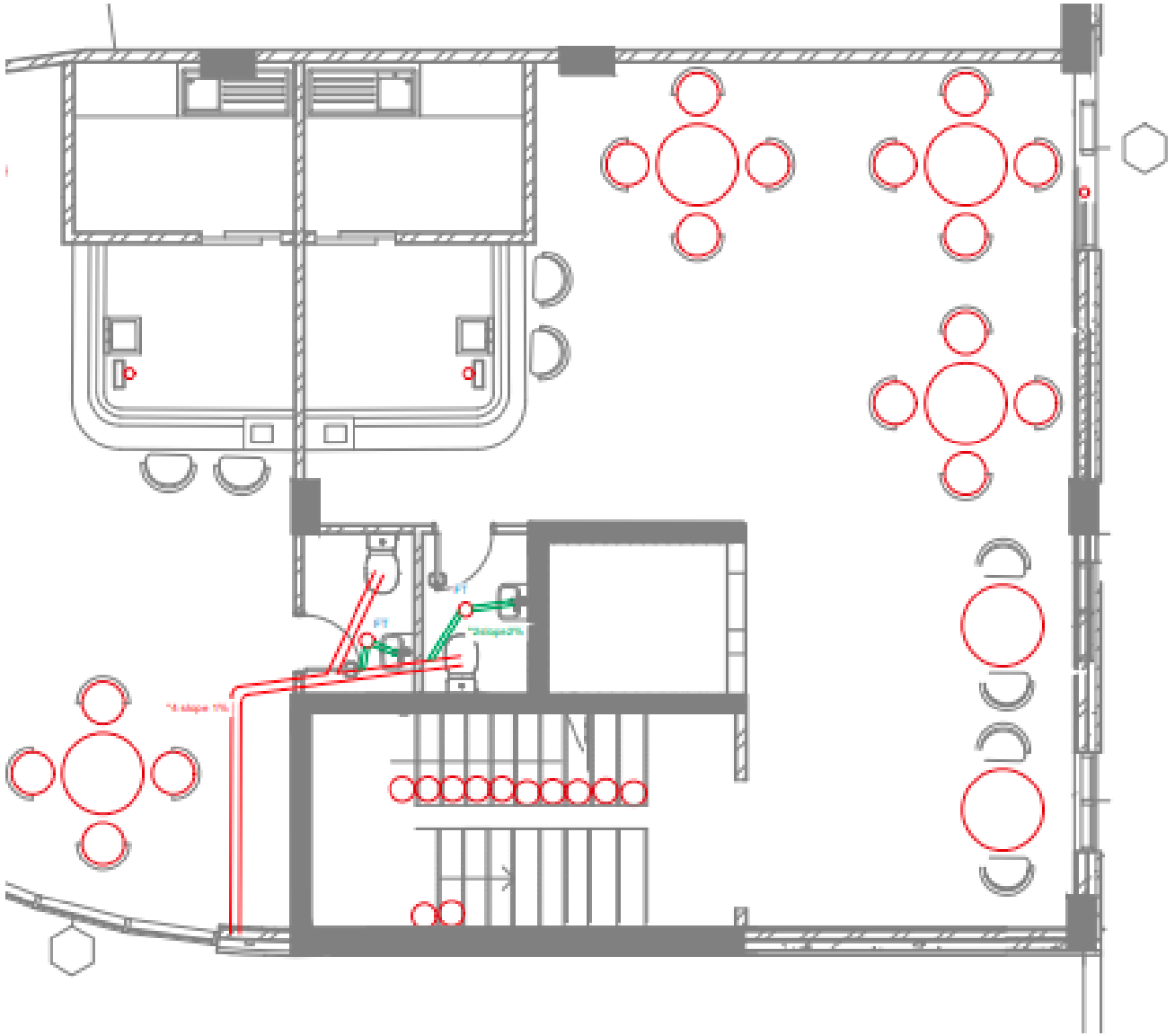
Ground Floor							
Space	Area (m2)	Volume (m3)	Peak cooling load (w)	Peak cooling load per floor area (w/m2)	Air flow (L/s)	Flow rate / diffuser	# of diffusers
Gym Hall	354.98	2839.84	20297.51	65.76	1180.00	250.00	5
Entrance	2.85	11.40	845.49	341.62	60.00	30.00	2
WC	3.21	12.84	304.01	108.79	20.00	30.00	1
Office	6.76	27.04	435.75	77.20	30.00	30.00	1
First aid room	13.62	54.48	1102.42	93.05	80.00	30.00	3
Elevator	3.51	14.04	302.48	99.14	20.00	30.00	1
Stairs	11.36	45.44	837.79	84.84	60.00	30.00	2
Storage	4.13	16.52	0.00	0.00	0.00	0.00	0
Showers	19.66	78.64	704.08	41.18	44.00	30.00	2
Changing area	19.24	76.96	616.53	36.85	40.00	30.00	2
Lockers	24.50	98.00	856.27	40.20	40.00	30.00	2
WC 1	7.88	31.52	353.09	51.56	22.00	30.00	1
WC 2	1.26	5.04	113.37	103.14	7.00	30.00	1
WC 3	1.71	6.84	94.26	63.43	6.00	30.00	1
Total			26863.05				



Drainage system



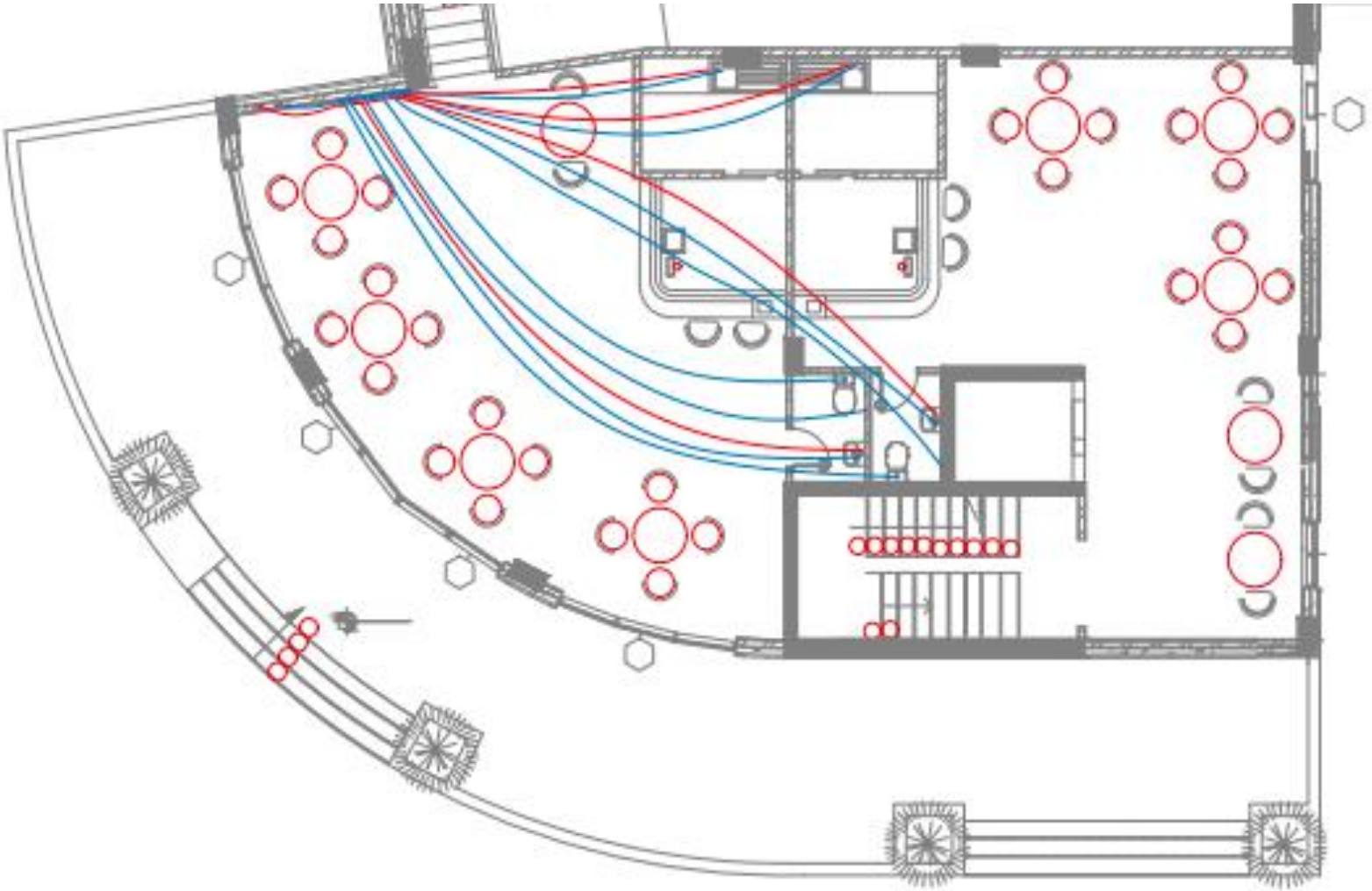
Drainage system in ground floor



Drainage system in mezzanine floor

Water supply

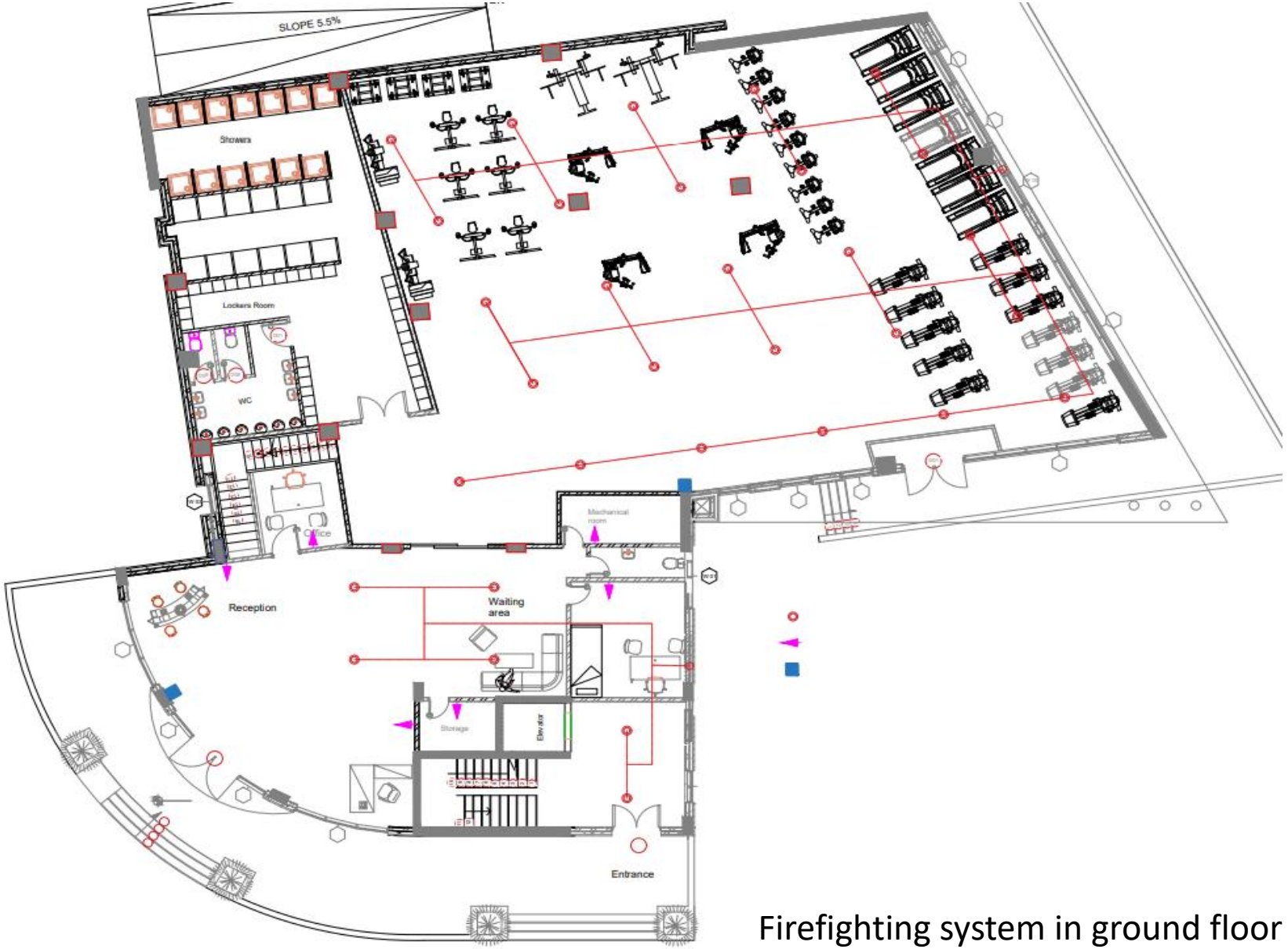
Water supply system in ground floor



Water supply system in mezzanine floor

	diameter	Losses
vertical	2.5	1.88
horizontal	2	0.6
branch	1	0.84
meter	2	5
Total losses		8.32 < 9.25 ok

Fire fighting system



Firefighting system in ground floor

Functional area	Type of extinguisher
Gym hall	Water sprinkler
Corridor	Water sprinkler
Office	Dry powder extinguisher
First aid	Dry powder extinguisher
Mechanical room	Dry powder extinguisher
Storage	Dry powder extinguisher
Reception	Dry powder extinguisher
Waiting area	Water sprinkler
Cafeteria	Water sprinkler
Kitchen	Dry powder extinguisher

Detecting system

Smoke detector

Heat detector

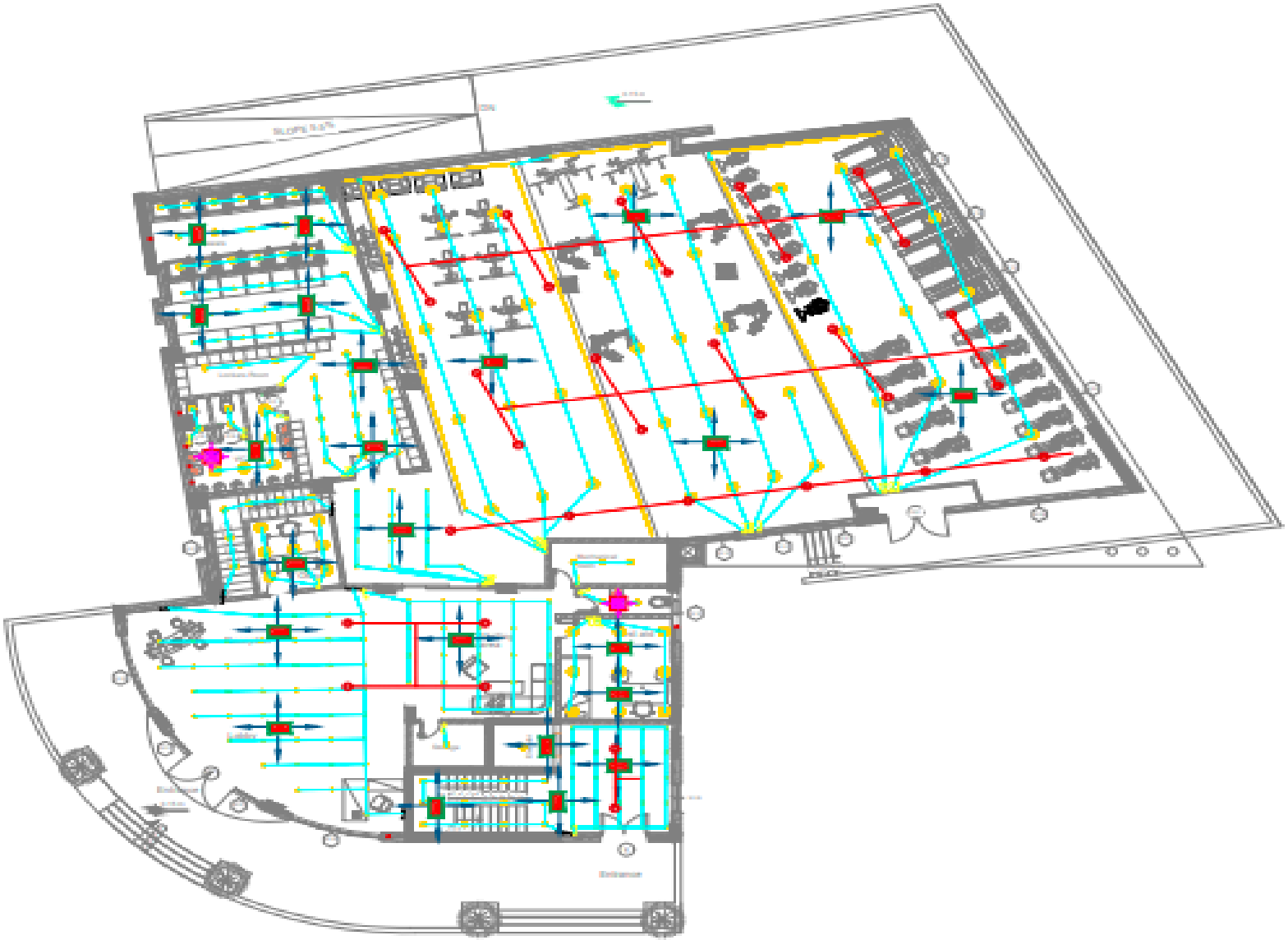
Flame detector

Manual detector

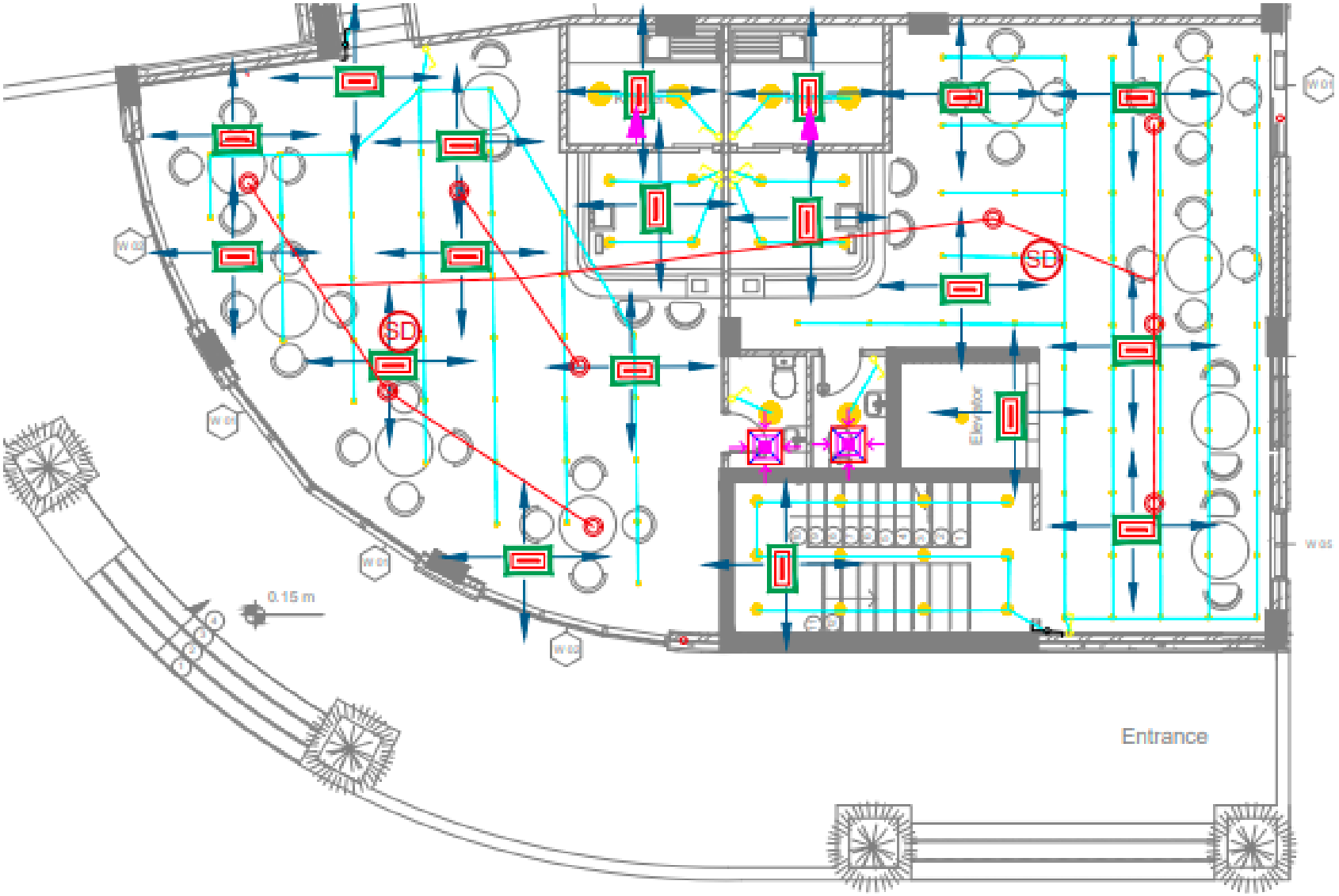
Elevator

Parameters	Elevator 2500/350
P (normal passenger load per trip)	13
Round trip time (RT)	90
hc = $\frac{300P}{RT}$	43.3
N = $\frac{HC}{hc}$	3.1
Ń	4
I = $\frac{RT}{Ń}$	22.5 OK
PHC = $\frac{Ń \times hc}{population}$	1.25 OK

Systems integrated

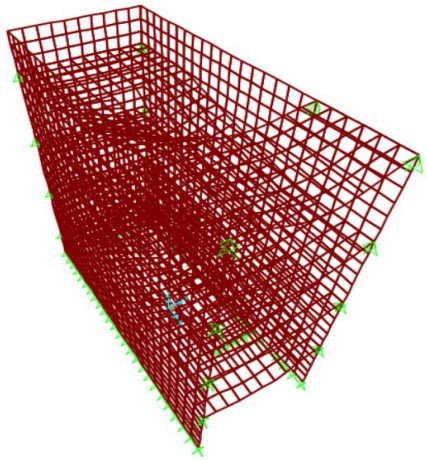


Integrated design in ground floor

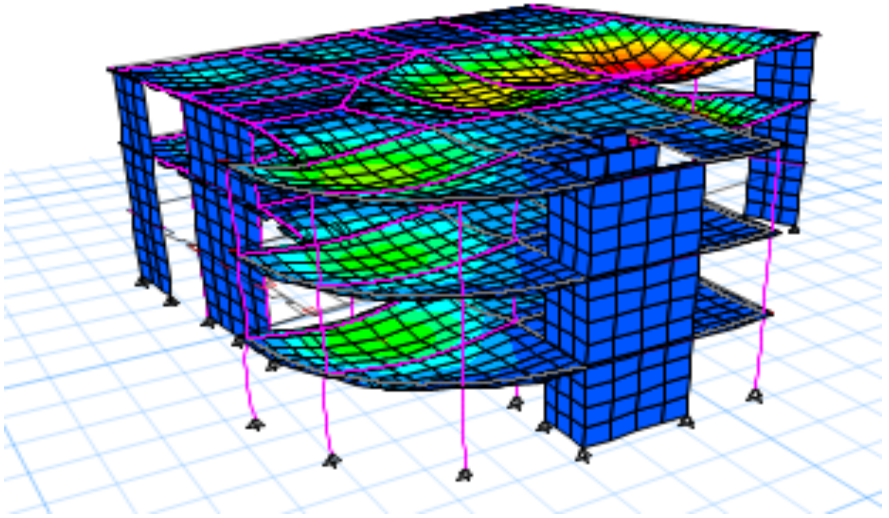


Integrated design in mezzanine floor

Integrated design in first floor

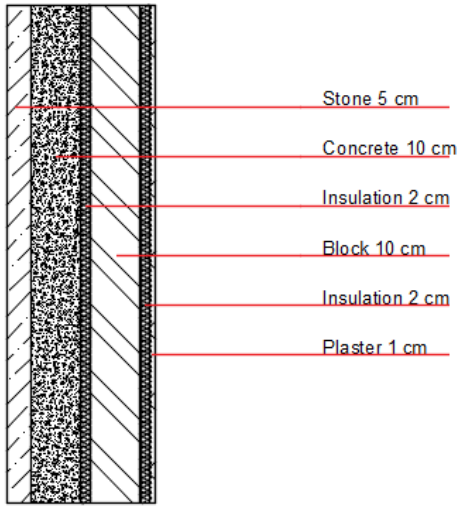


Structural aspects

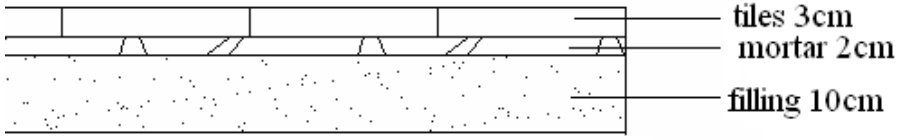


Limitation of design

- Code: ACI 318-
- Material specifications:
  Concrete compressive strength (fc’ = 24MPa)
  Yielding strength of steel (fy = 420Mpa)
- Loads:
  Live Load = 5KN/m²
  SID = 4KN/m²
  Wall = 20 KN/m
- Load combinations:
  1.4D
  1.2D+1.2SID+ 1.6L
  1.34D+1.34SID+1L+1EQx
  1.34D+1.34SID+1L+1EQy
  0.76D+0.76SID+1L+1EQx
  0.76D+0.76SID+1L+1EQy
  Envelope
  Service load



Section in wall.



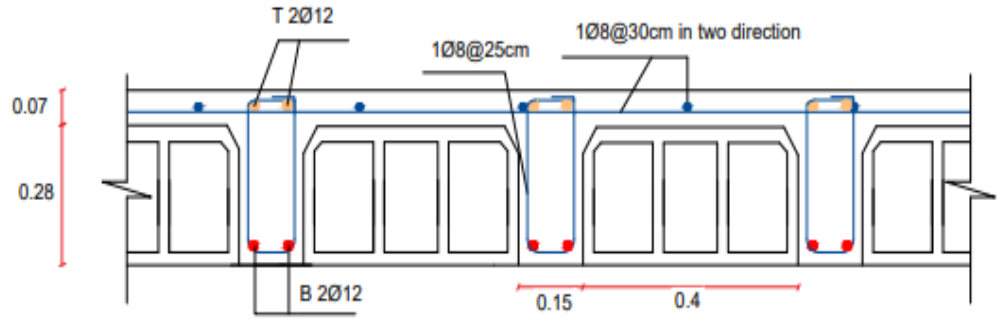
Section in floor.

Slab

Tow way ribbed slab, thickness = 0.35 m

Beams

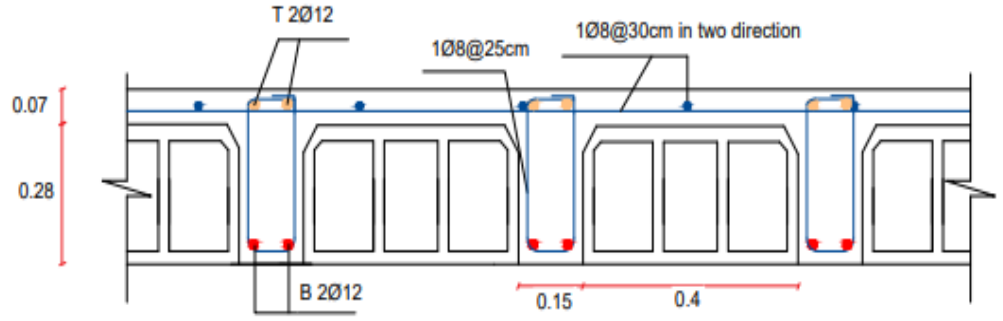
- Drop beam 0.6 × 1 m
- Hidden beam 0.6× 0.35 m



Section in ribbed slab in x direction

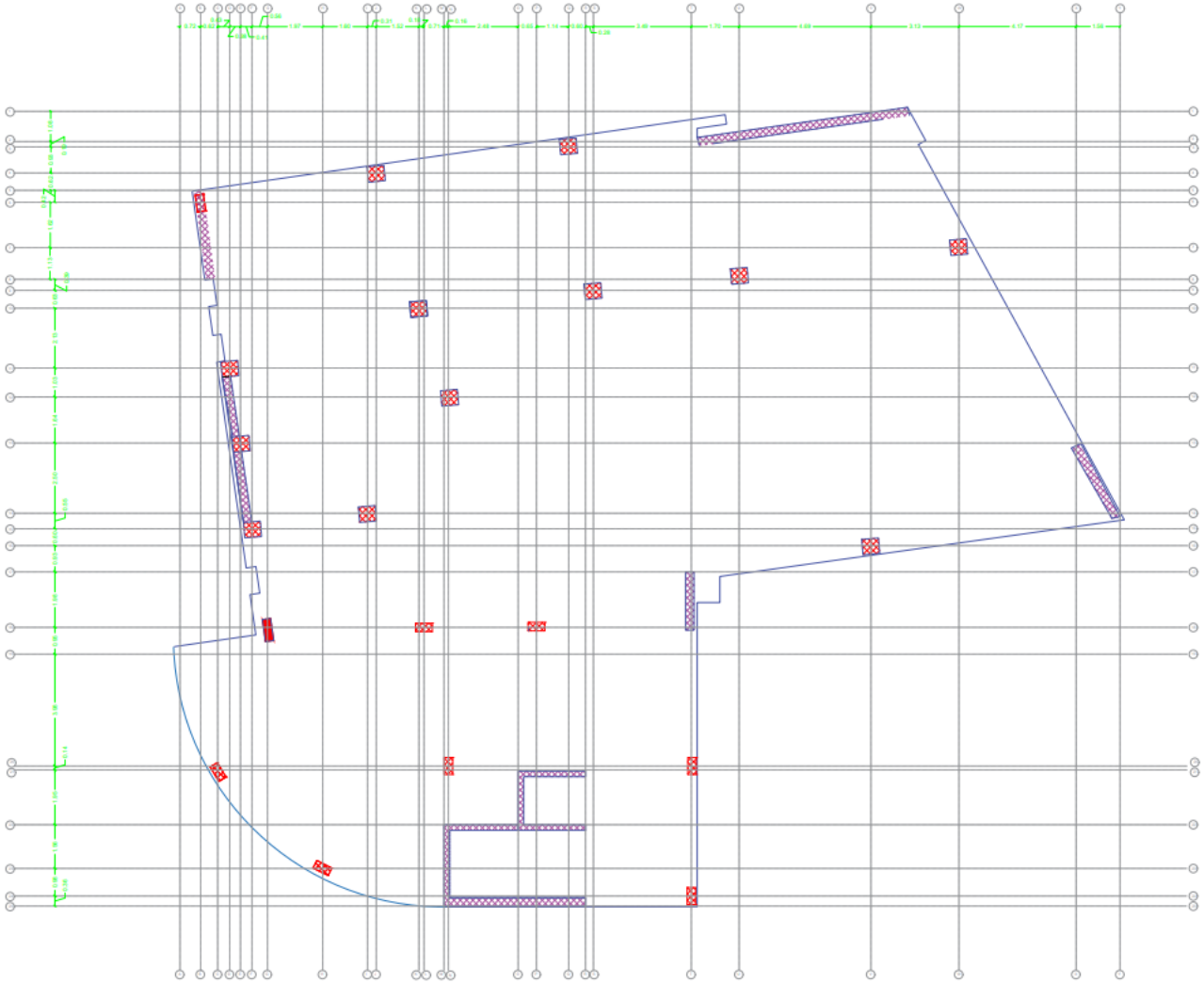
Columns

- Long columns 0.6 × 0.55 m
- Short columns 0.6 × 0.3 m



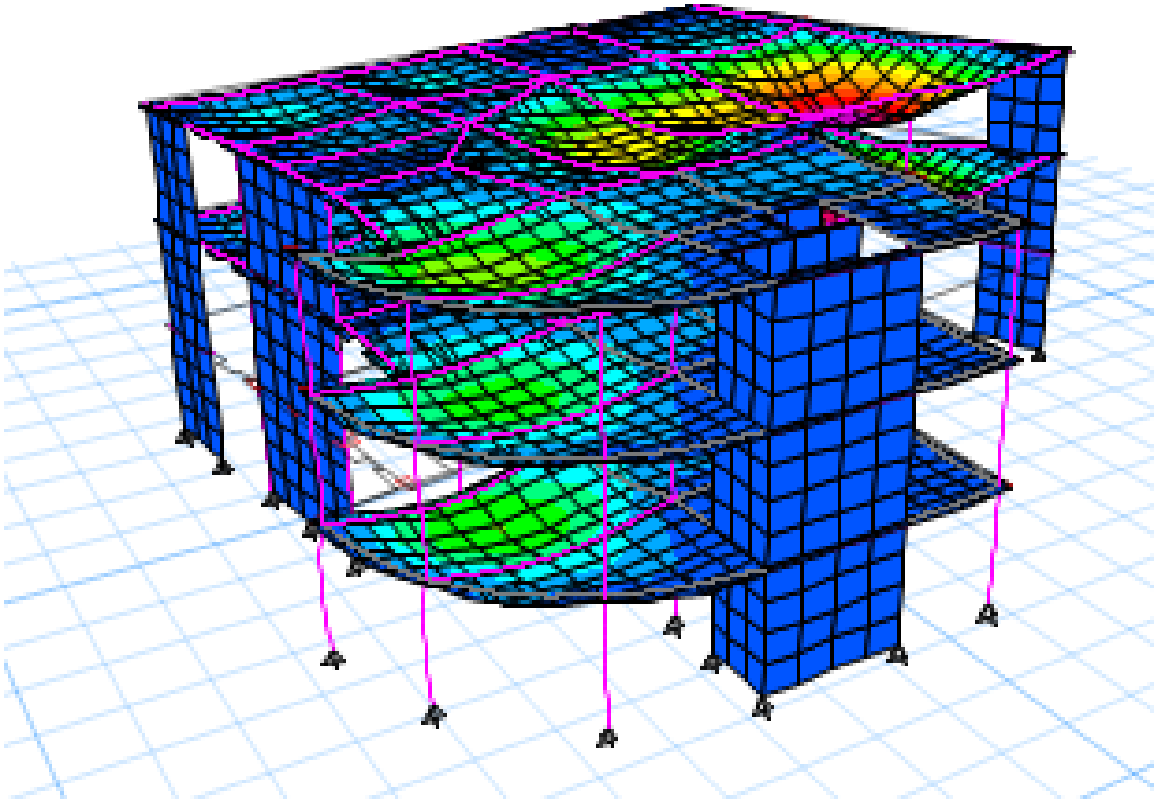
Section in ribbed slab in Y direction

Columns layout



Model checks

- Compatibility



- Equilibrium

Etabs values for equilibrium check

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Dead	0	-3.006E-06	17381.6185	388071.4707	-375722.4592	-0.0001
Live	0	-2.005E-06	6879.2077	153674.6553	-152389.899	-0.0001
sid	0	-2.028E-06	9768.4097	211313.0032	-214343.8152	-0.0001

Hand calculated values for equilibrium check.

Load	By hand	By sap	Error%
Dead load	17553	17381.6185	0.98%
Live load	6735.55	6879.2077	2.08%
SID load	9750.64	9768.4097	0.18%

Stress-strain check for columns.

Column	Trib. area	Pu slab	Pu beam	Column weight	Pu total	From ETAB	Erorr%
Corner	7	441	86	45	572	685.8	16
edge	35	1470	510	99	2079	2018.8	2.98
interior	50	2100	862.5	99	3061	2795.8	9.4

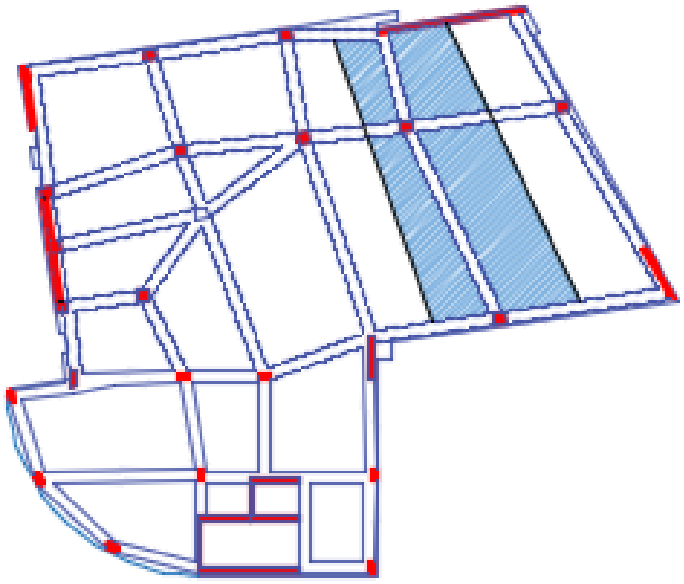
Stress-strain check for beam.

By hand	By Etab	Error %	check
Wu Ln²\8 =320.6	266	20.9%	OK

Stress-strain check for slab in y-direction

Stress-strain check for slab column strip.

Location of moment	By hand	By Etabs	Error %	Check
Exterior (-)	380.7	1014	7.55%	ok
Positive	1356.3	987		
Interior (-)	1665.6	1437		

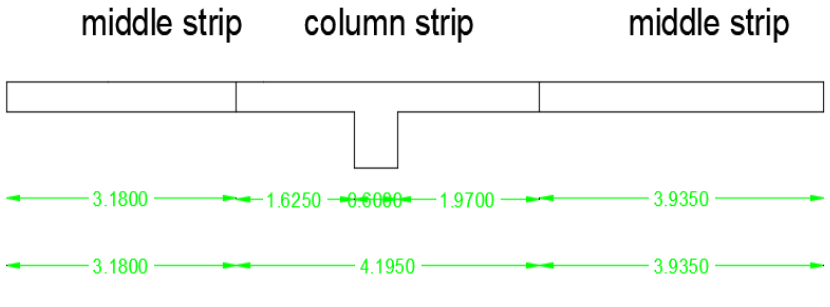


Stress-strain check for slab middle strip.

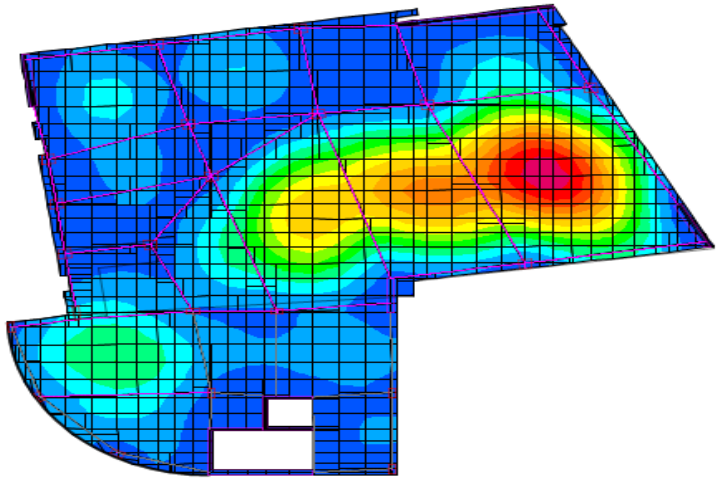
Location of moment	By hand	By Etabs	Error %	Check
Exterior (-)	126.9	430	20.3%	ok
Positive	452	460		
Interior (-)	555.15	640		

Stress-strain check for beam

Location of moment	By hand	By Etabs	Error %	Check
Exterior (-)	323.6	686	44.8%	ok
Positive	1152.8	481		
Interior (-)	1415.8	583		



Deflection Check



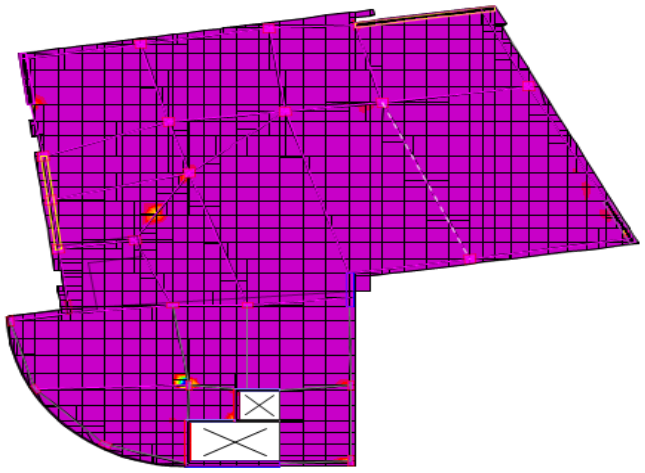
Deflection check for critical beam

By hand	By Etab	check
Ln\240 = 0.045	0.024	OK

Deflection check for slab.

By hand	ByEtab	Check
Ln\240 = 0.045	0.0338	OK

Shear check



Shear check for critical beam.

By hand	By Etab	Check
ØVc =345.4	268	OK

Shear check for slab.

By hand	By Etab	Check
ØVc =177.6	130	OK

Seismic Checks

- Seismic zone:2B
- Soil profile: SD
- Ca=0.28
- Cv=0.40
- R=5.5
- Manual V = 3935.3 KN

❖ *Base reaction check*

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Dead	0	-2.697E-06	17381.6214	388071.4955	-375722.5106	-0.0001
Live	0	-1.795E-06	6879.2077	153674.6553	-152389.8989	-0.0001
sid	0	-1.821E-06	9768.4097	211313.0031	-214343.8151	-0.0001
EQX Max	14012.1008	3083.3881	4.806E-05	30534.0776	140524.2628	303283.4461
EQY Max	18339.0661	3935.3079	0.0001	38936.5235	183918.1361	396021.4423

❖ *Mass participation check*

Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY
Modal	1	0.374	0.0132	0.6537	0	0.0132	0.6537
Modal	2	0.298	0.8377	0.0283	0	0.8509	0.682
Modal	3	0.196	0.0159	0.1881	0	0.8668	0.8701
Modal	4	0.136	0	0.0113	0	0.8668	0.8815
Modal	5	0.123	0.0437	0.0052	0	0.9105	0.8867
Modal	6	0.111	0.0016	0.0006	0	0.9121	0.8873
Modal	7	0.105	0.0026	0.0052	0	0.9147	0.8924
Modal	8	0.102	0.0005	0.0004	0	0.9152	0.8928
Modal	9	0.096	0.0002	0.0416	0	0.9155	0.9345
Modal	10	0.092	0.0053	0.0053	0	0.9207	0.9398
Modal	11	0.09	0.0007	0.0002	0	0.9214	0.94
Modal	12	0.077	2.954E-05	0.0003	0	0.9215	0.9402

Sum X = 92%

Sum Y = 94%

Both are more than 90%

❖ *Drift check*

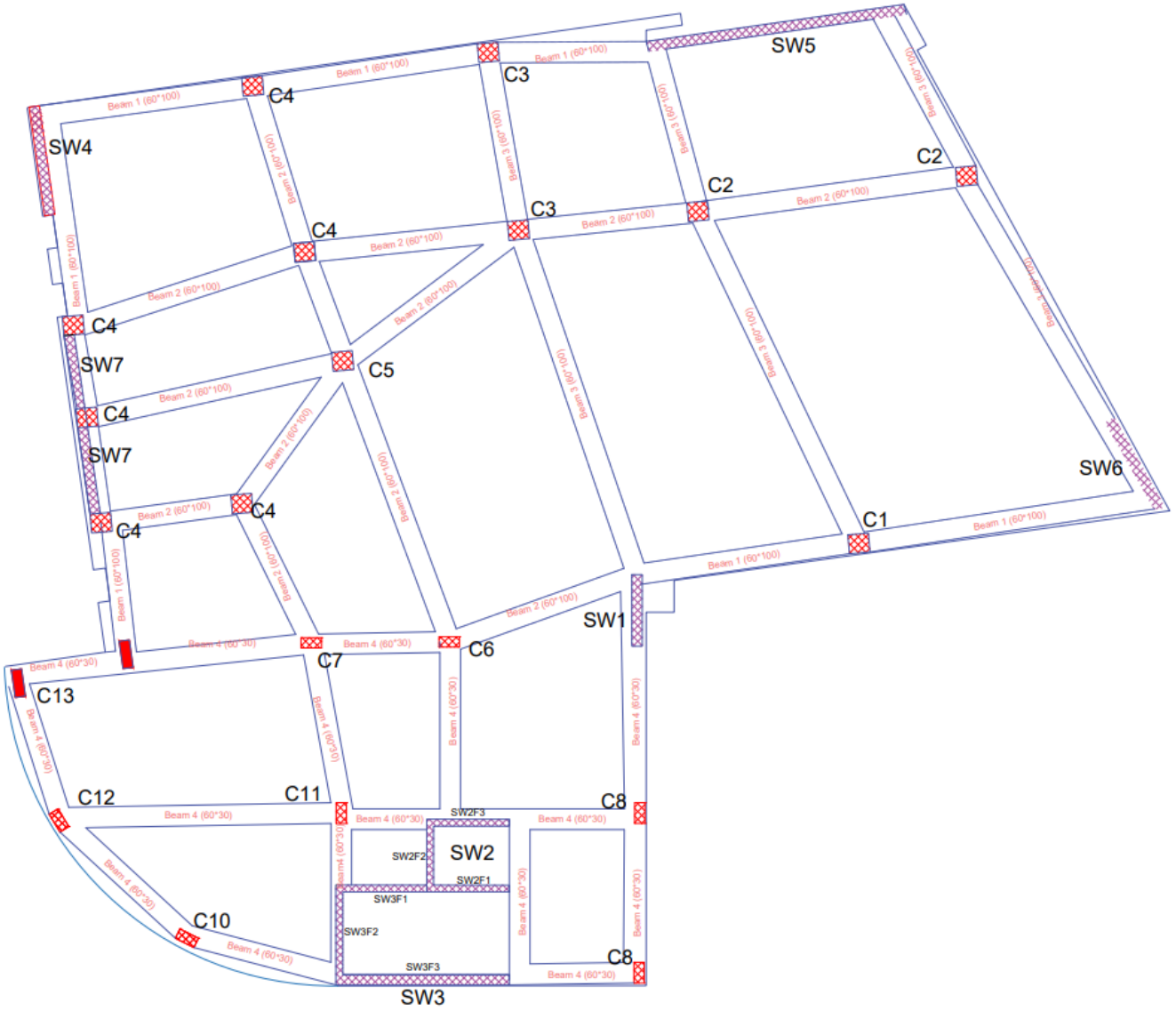
Story	height	X-DIS	Y-DIS	X-DRIFT	Y-DRIFT	X-DELTA	Y-DELTA	Delta limit
0	0	0	0					
1	4000	0.089	0.04	0.089	0.04	0.34	0.15	80
2	4000	0.043	0.311	-0.046	0.271	-0.18	1.04	80
3	4000	0.063	0.717	0.02	0.406	0.08	1.56	80

❖ *Period check*

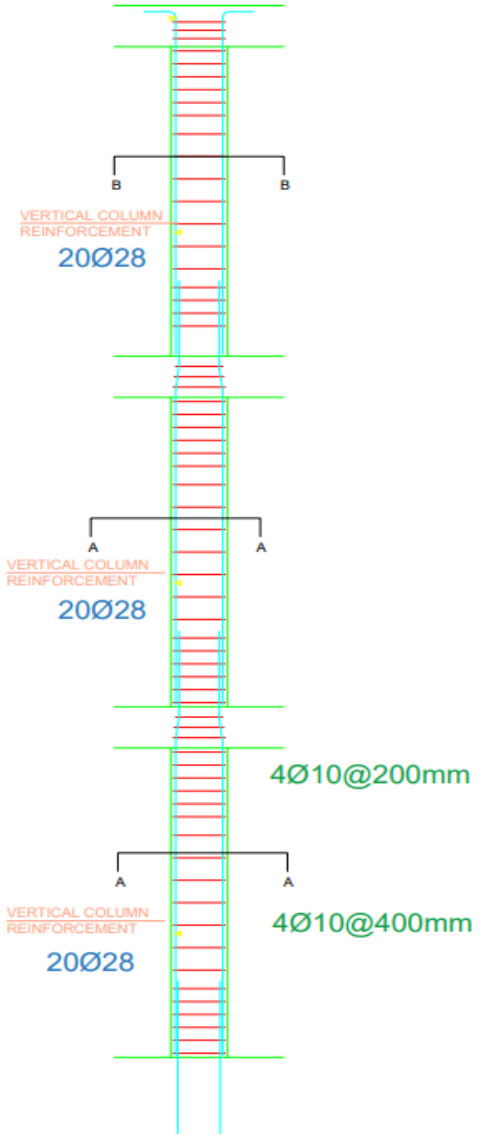
T = $0.0488 \times h^{\frac{3}{4}}$ = 0.408 sec

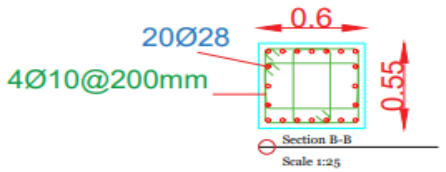
Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY	Sum UZ
Modal	1	0.374	0.0132	0.6537	0	0.0132	0.6537	0

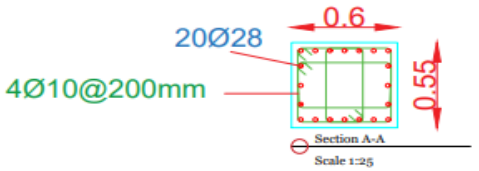
Column-beam layout



Column C1 detailing

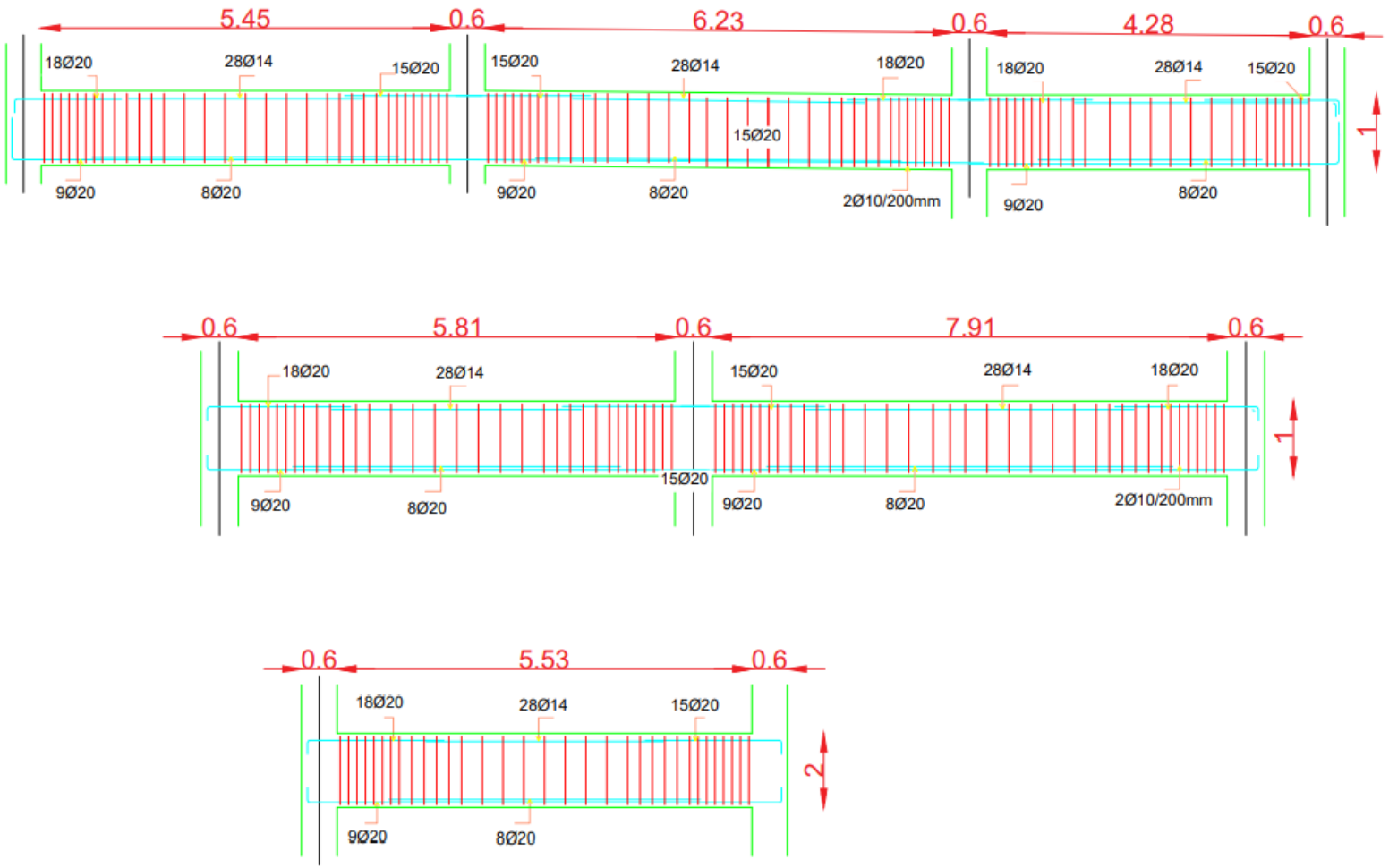






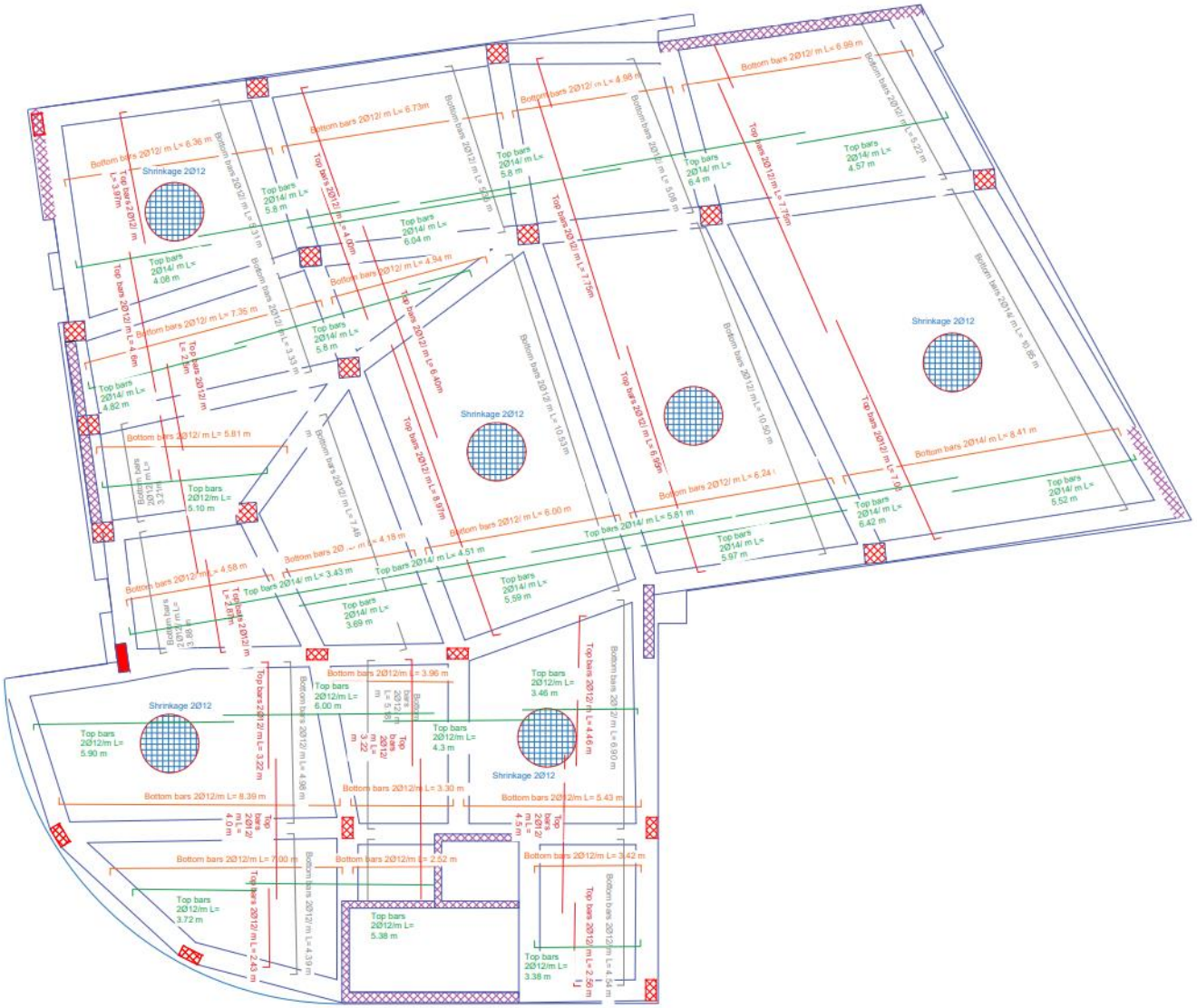
CC1

Beams design

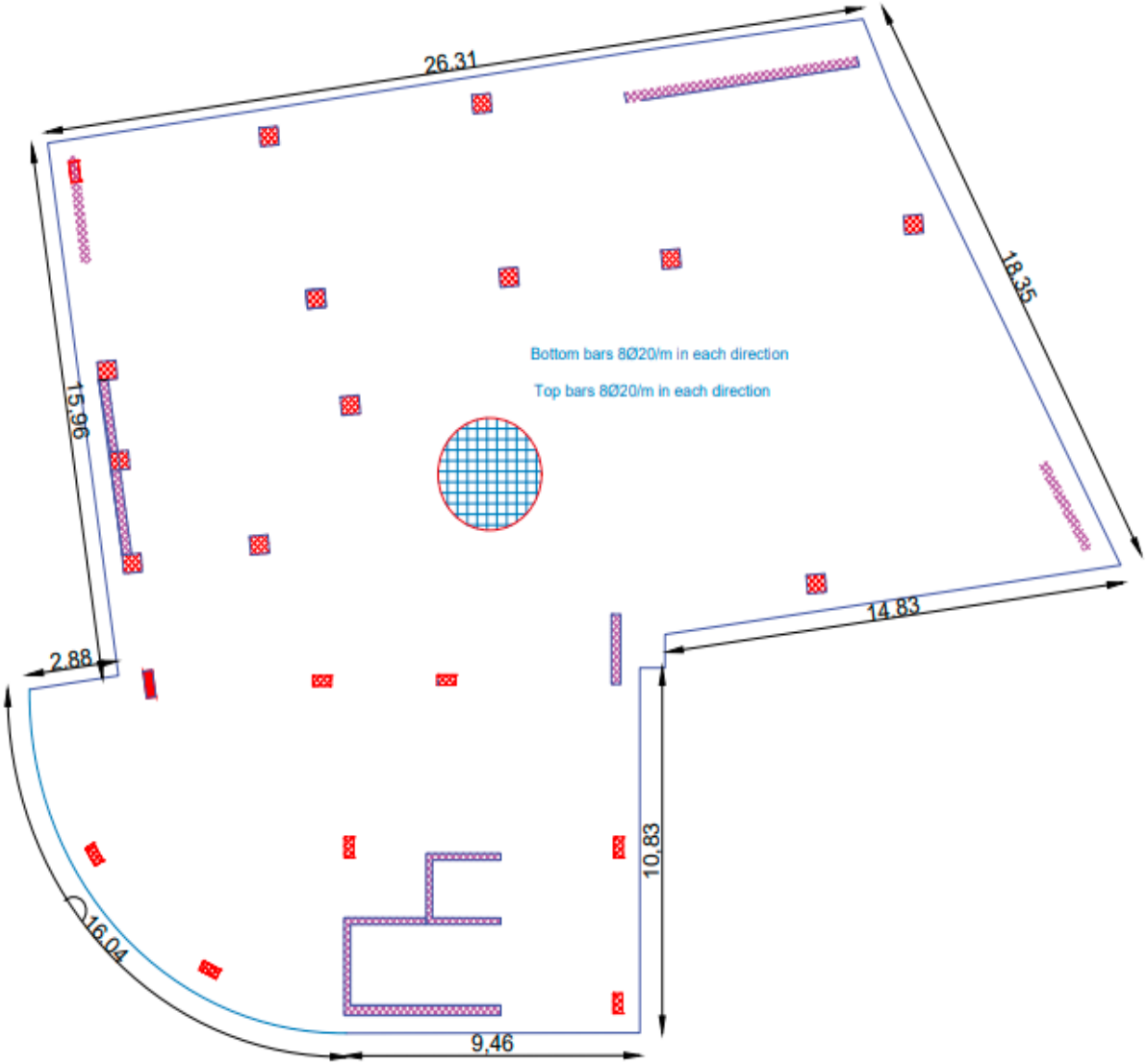


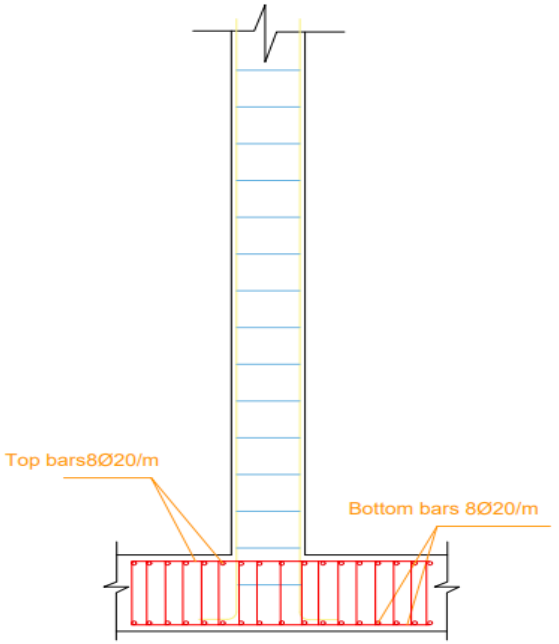
B1

Slab detailing



Footing Design





Scale:1:50

Quantity Surveying and Cost Estimate

- Total cost of the project is 1772062 NIS.

Earth work = 277894 NIS

Structural work = 569711 NIS

Finishing work = 472974 NIS

Mechanical work = 283960 NIS

Electrical work = 168043 NIS

Thanks for listening
Hope you Enjoy it