Solar Decathlon India™

THE ARCHONS

DIVISION - EDUCATIONAL BUILDING

Appendix

(Final Design Report)

April 2021

School of Planning and Architecture, New Delhi

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Area Program

The school curriculum is to include the Pre Primary years programme (PPYP) , Primary years programme (PYP) , Middle years programme (MYP) and Diploma programme (DP) of the International Baccalaureate Organisation (IB). Each class is to accommodate 24 students in flexible arrangements.

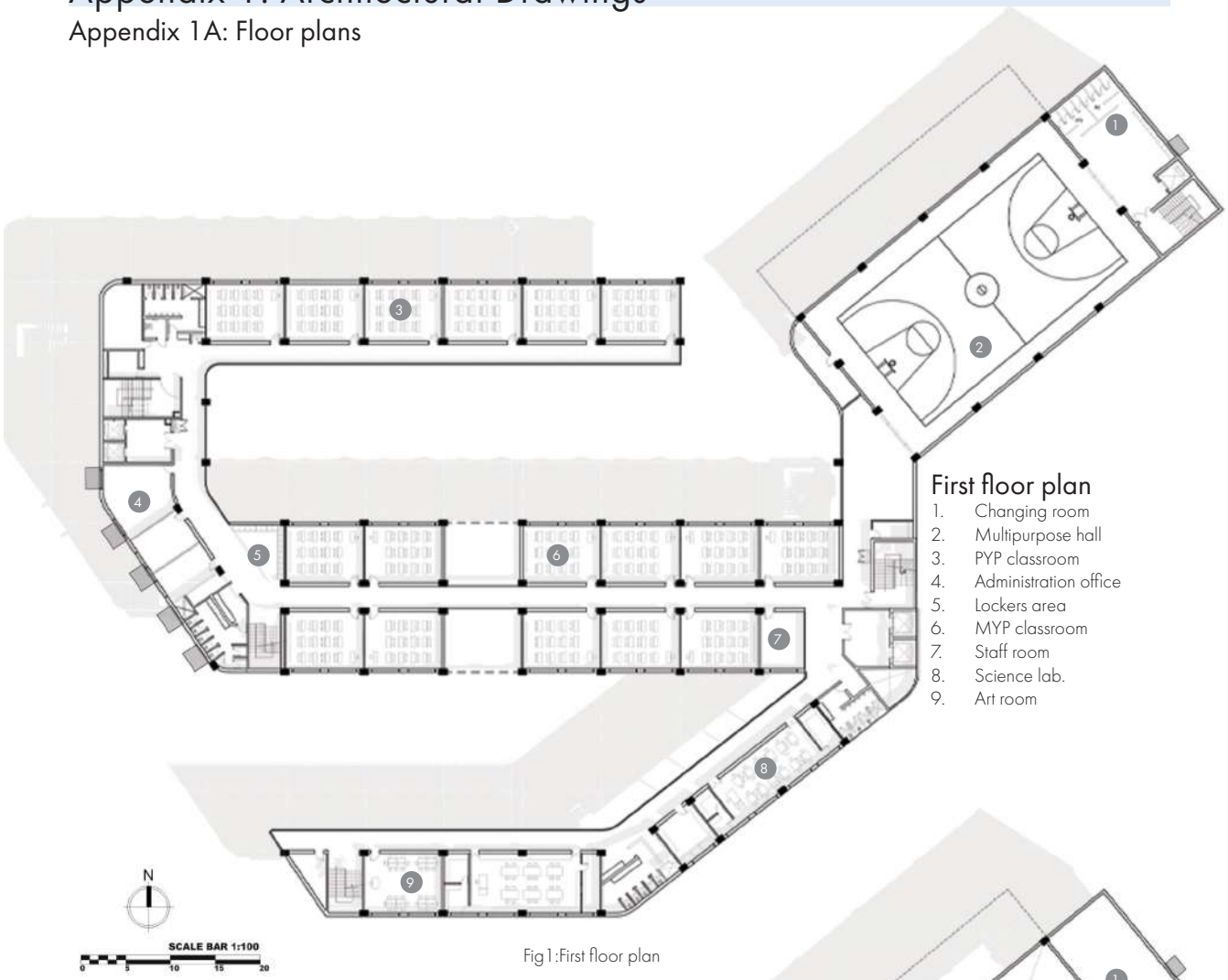
Other areas		
Open play ground	926	sqm
Green area	6536	sqm
Parking area	1165	sqm
Roof area	3050	sqm
PV panel Cover	1650	sqm

Area calculation summary			
Plot area		15256	sqm
Permissible ground coverage	40%	6102.4	sqm
Permissible FAR basic	1	15256	sqm
Permissible ancillary FAR	15%	2288.4	sqm
Proposed areas			
Proposed FAR		15185.8	sqm
Basement Area		4938	sqm
Proposed height		21.6	m

Area Program						
Sl. no	**Type**	**No.**	**Area(sqm)**	**Total area (sqm)**	**Conditioned area**	**Break-up**
1	PPYP Classroom	5	56	280	Yes	2 years, 5 classrooms
2	PYP Classroom	30	56	1680	Yes	5 years, 6section each
3	MYP Classroom	30	56	1680	Yes	5 years, 6section each
4	DP Classroom	24	56	1344	Yes	2 years,12 section each
	Activity rooms					
5	Dance room	1	120	120	Yes	
6	Music room	1	100	100	Yes	
7	A/v Room,Playroom,Robotics	3	56	168	Yes	
8	Art room	2	60	120	Yes	
9	Makers space	1	60	60	-	
10	Student exchange	2	56	112	Yes	
	Laboratory rooms					
11	Chemistry lab	2	120	240	Yes	
12	Physics lab	2	100	200	Yes	
13	Computer lab	2	110	220	Yes	
14	Biology lab	1	120	120	Yes	
15	Science lab	1	100	100	Yes	
	Administration					
16	Admin	2	110	220	Yes	office , accounts , storage
17	Staff room	6	34	204	Yes	
18	Library	2	110	220	Yes	Junior and senior
19	Print room	2	25	50	-	
20	storeroom	1	25	25	-	
21	Canteen Dining hall	1	345	345	Yes	
22	Kitchen	1	155	155	-	
23	Multipurpose hall	1	850	850	Yes	Basketball, seating
	Utility					
24	Rest room	1	910	910	-	1st,2nd ,3rd,4th,5th floors
25	Corridor/Lobby	1	4666	4666	-	
	Total			**14188.8**		
27	Services	6.6%	943	**943**		
28	Wind tower	6	9	**54**		
	Total area			**15185.8**		
	Total conditioned areas			**8478**		

Appendix 1: Architectural Drawings

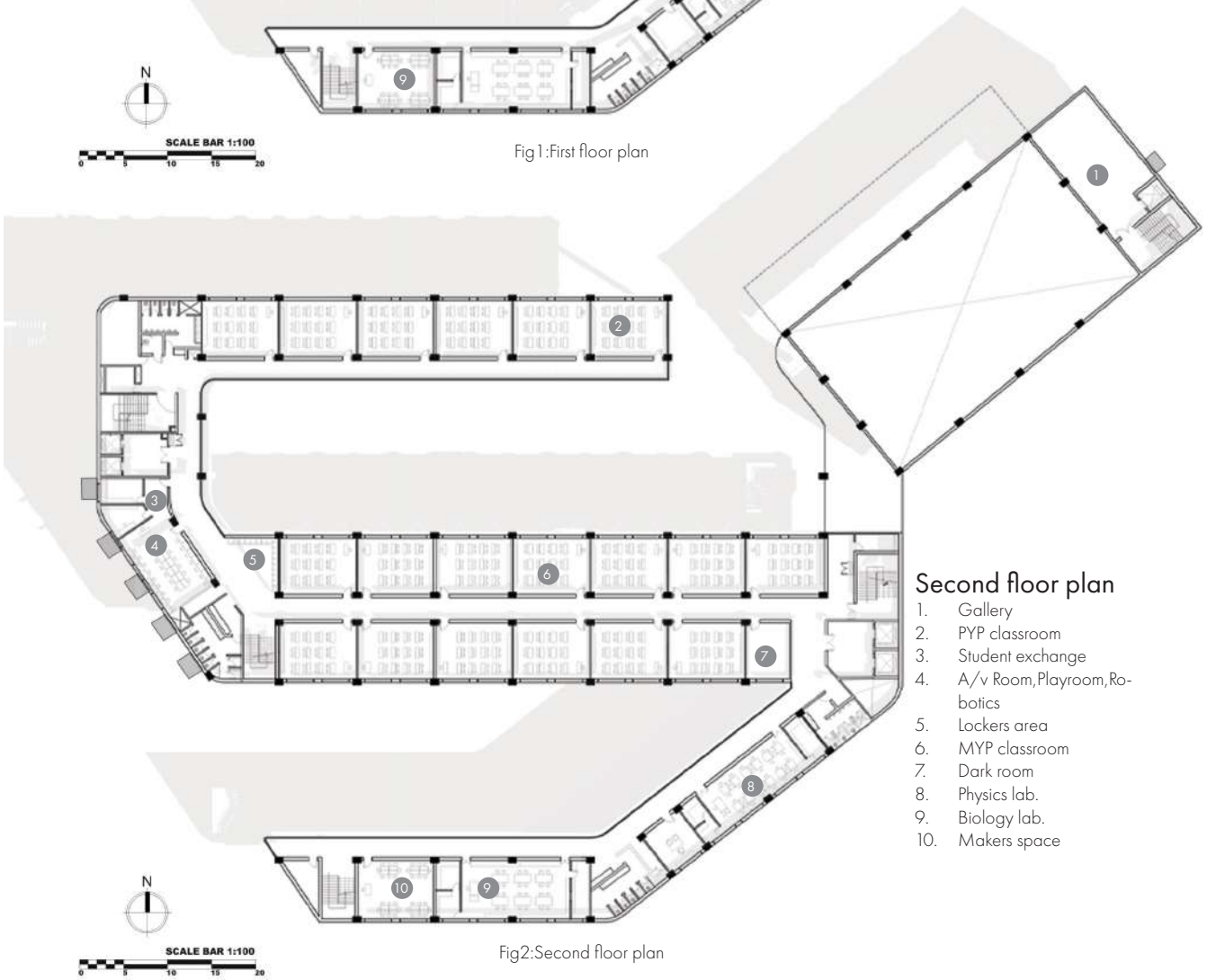
Appendix 1A: Floor plans



First floor plan

1. Changing room
2. Multipurpose hall
3. PYP classroom
4. Administration office
5. Lockers area
6. MYP classroom
7. Staff room
8. Science lab.
9. Art room

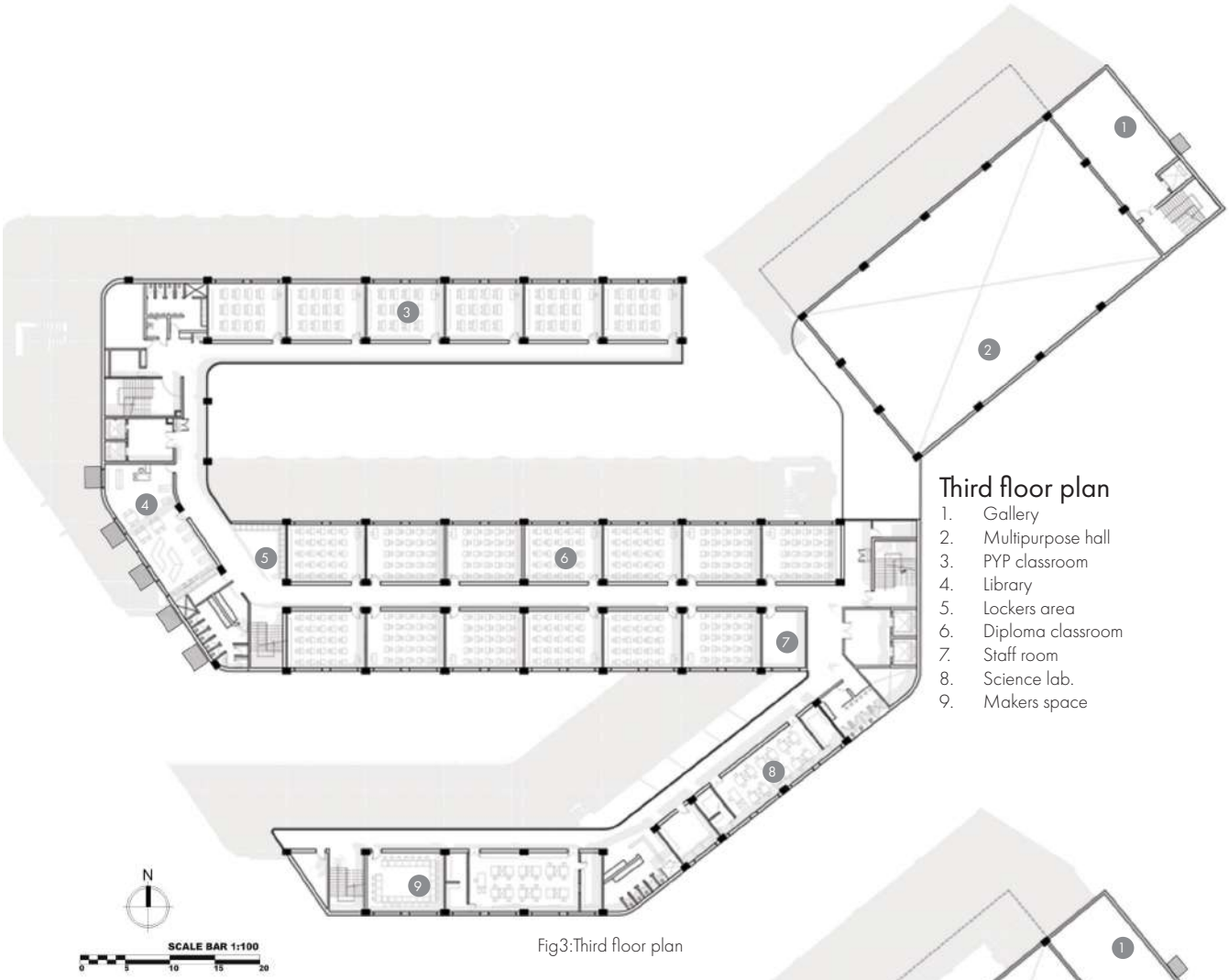
Fig1:First floor plan



Second floor plan

1. Gallery
2. PYP classroom
3. Student exchange
4. A/v Room,Playroom,Robotics
5. Lockers area
6. MYP classroom
7. Dark room
8. Physics lab.
9. Biology lab.
10. Makers space

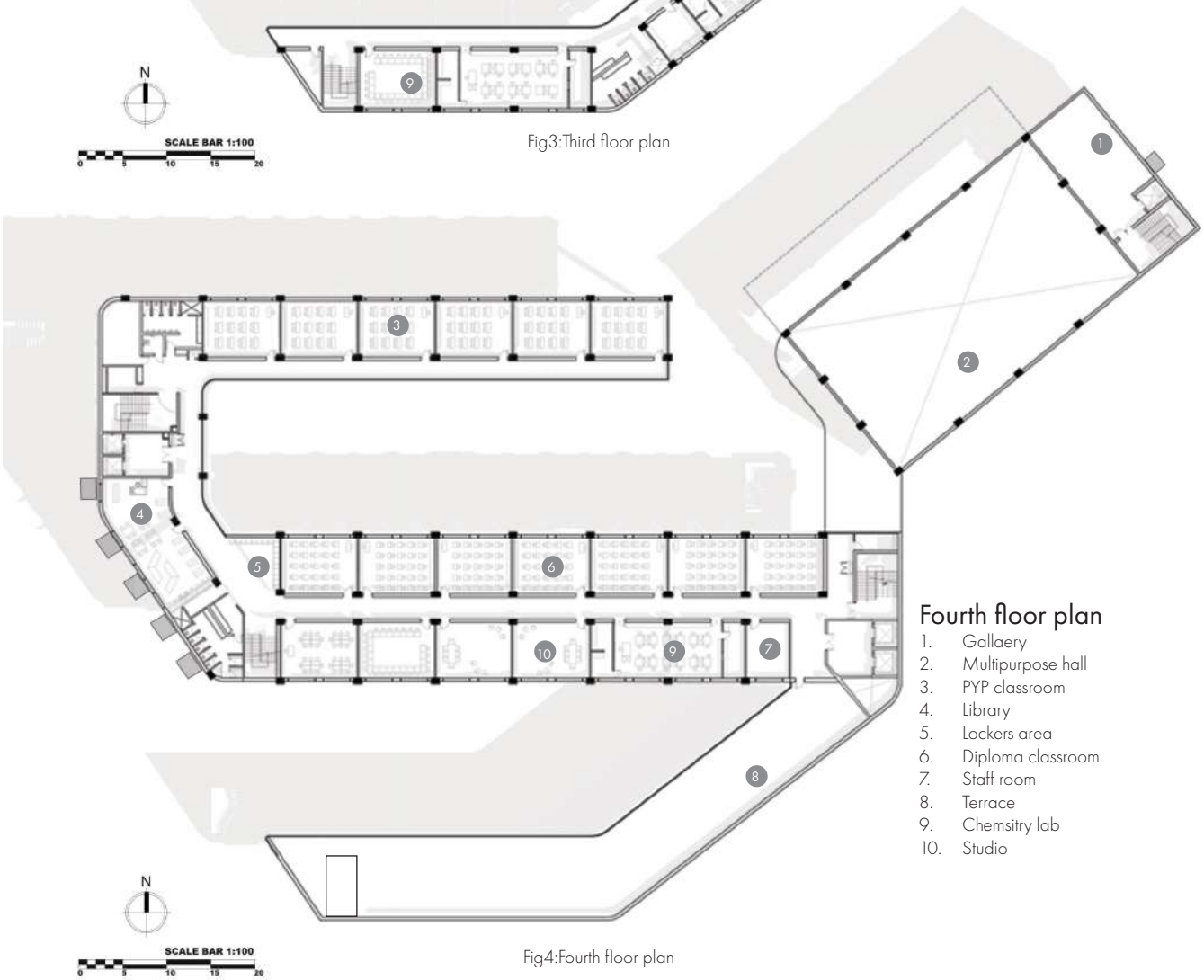
Fig2:Second floor plan



Third floor plan

1. Gallery
2. Multipurpose hall
3. PYP classroom
4. Library
5. Lockers area
6. Diploma classroom
7. Staff room
8. Science lab.
9. Makers space

Fig3:Third floor plan



Fourth floor plan

1. Gallaery
2. Multipurpose hall
3. PYP classroom
4. Library
5. Lockers area
6. Diploma classroom
7. Staff room
8. Terrace
9. Chemsitry lab
10. Studio

Fig4:Fourth floor plan

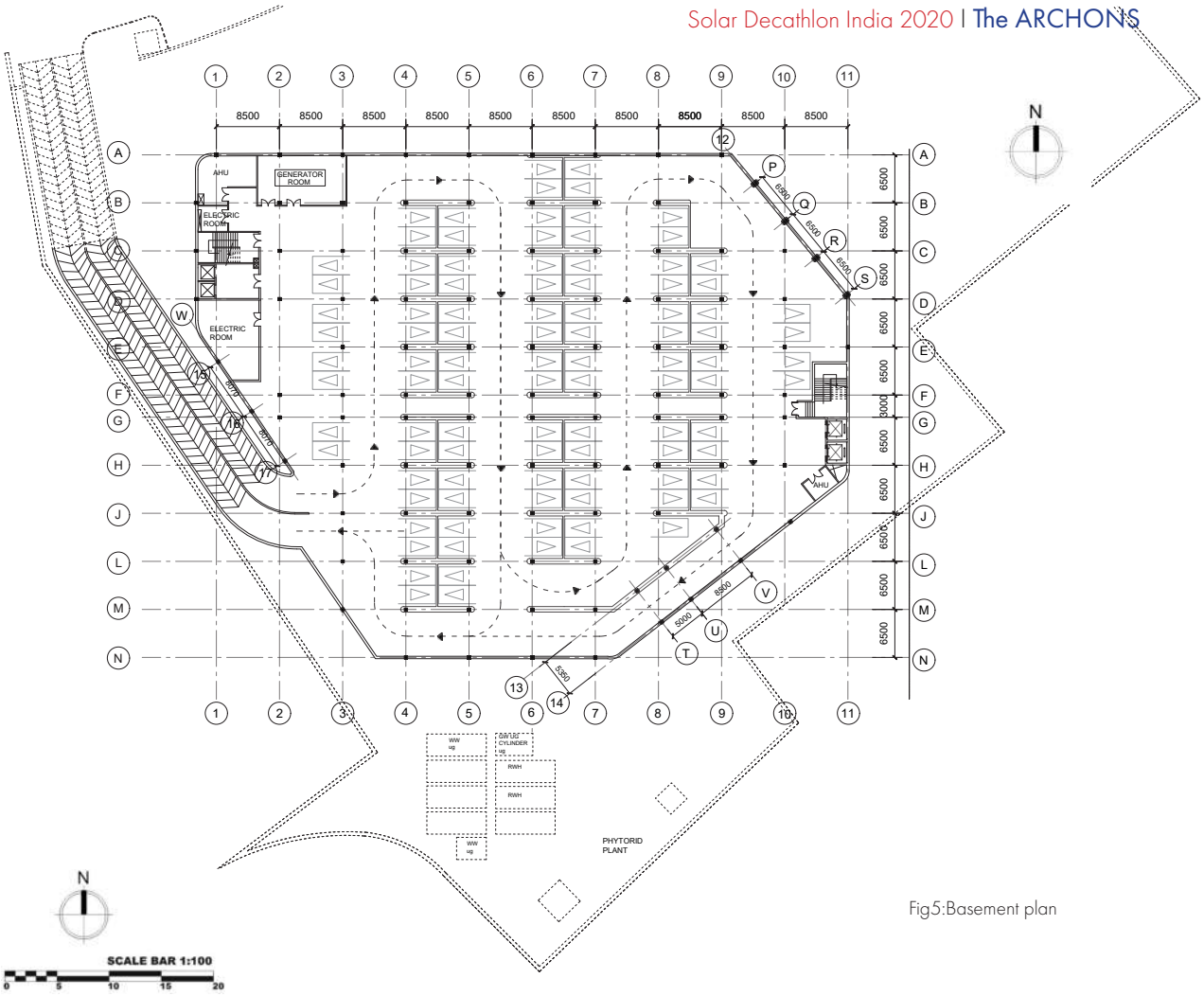


Fig5:Basement plan

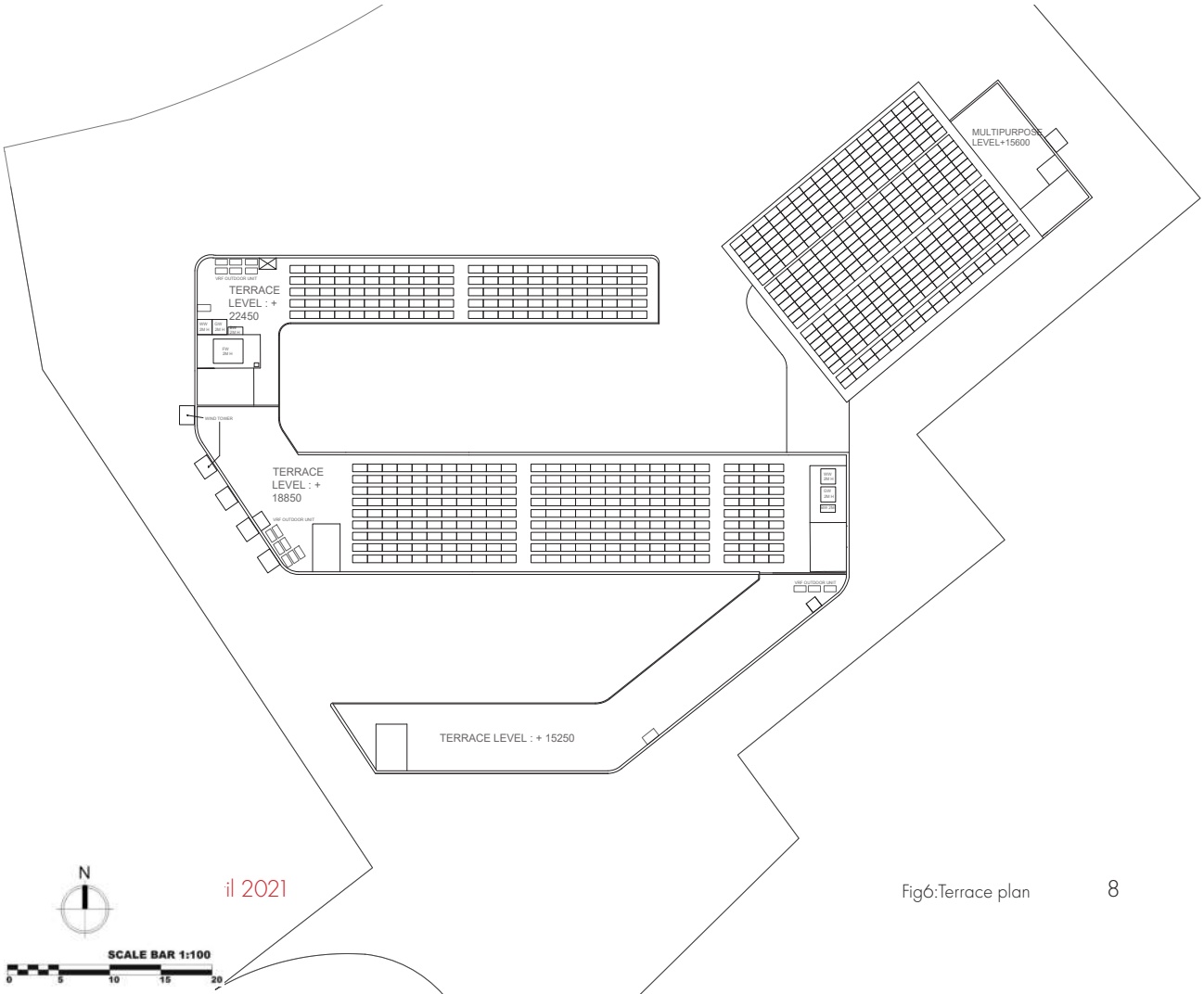


Fig6:Terrace plan

Appendix 1B: Facade details

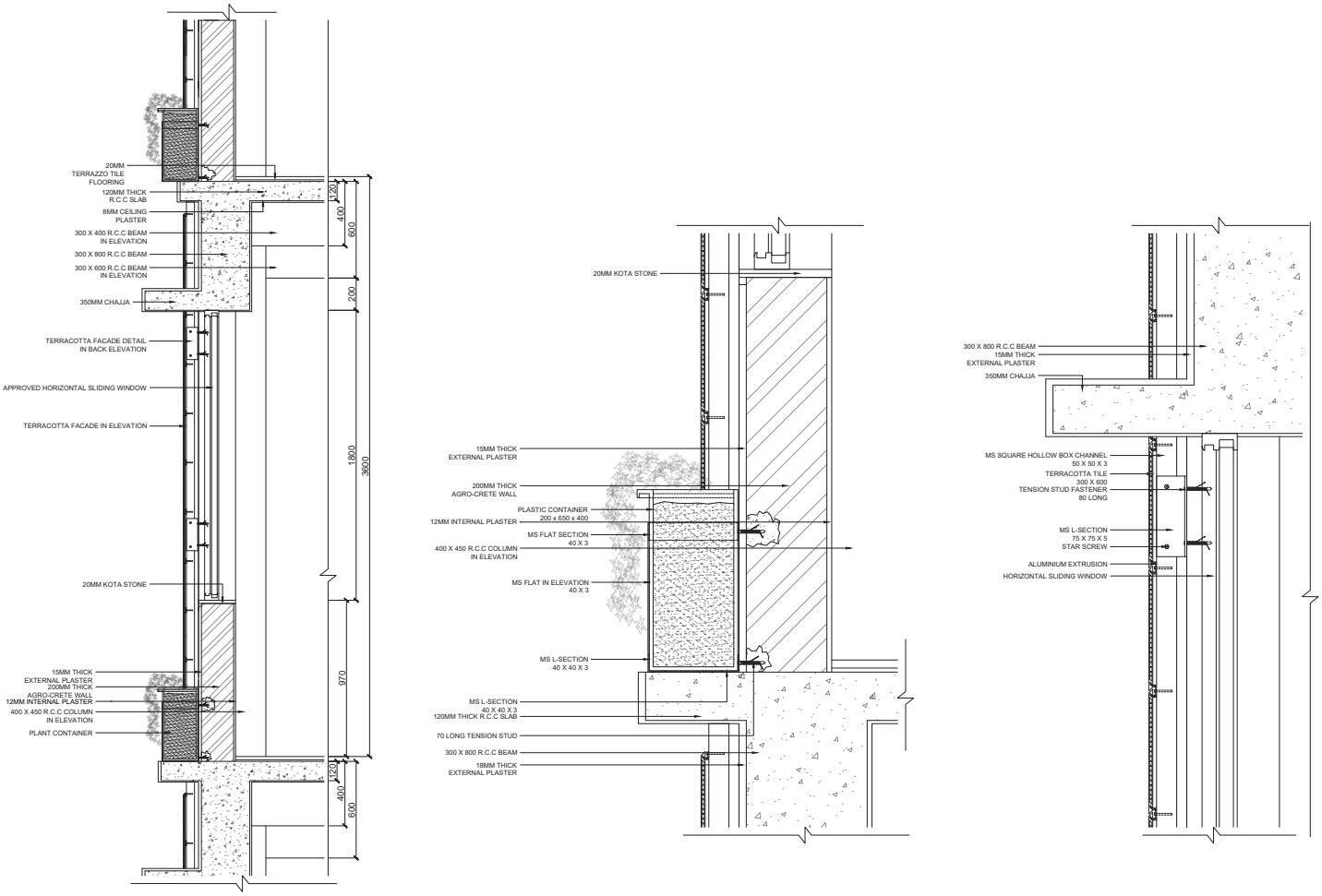


Fig 8: External wall (North) section

Fig 9: North Elevation

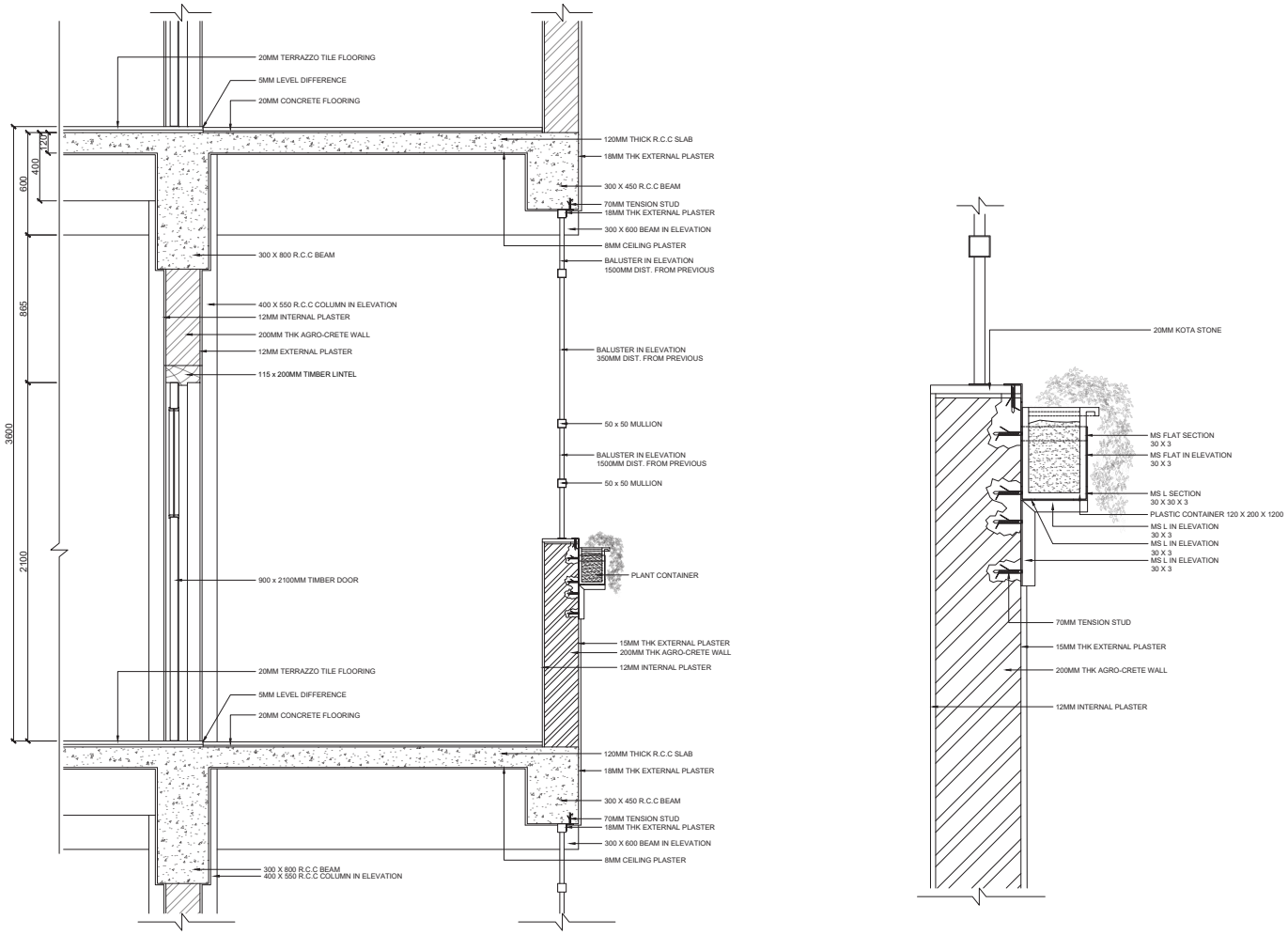


Fig 10: Corridor section

Fig 11: South elevation

Appendix 1C: 3D Visualizations

Courtyard 1

Courtyard 2

Futsal court

Kindergarten

Entrance

Reception lobby

Rooftop PV Installation

PYP Classroom

Appendix 2: Construction Drawings

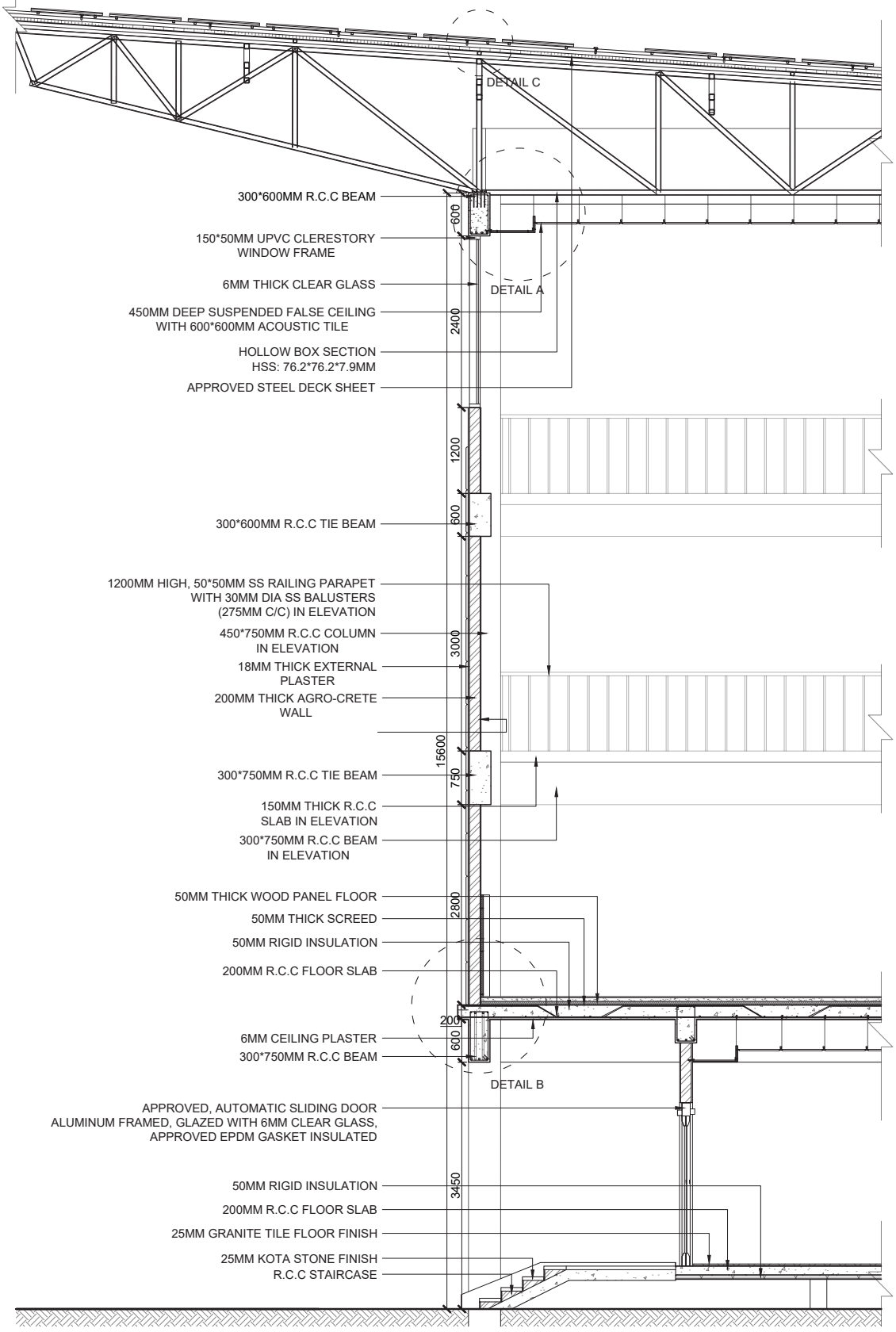


Fig 12: Multipurpose hall external wall section

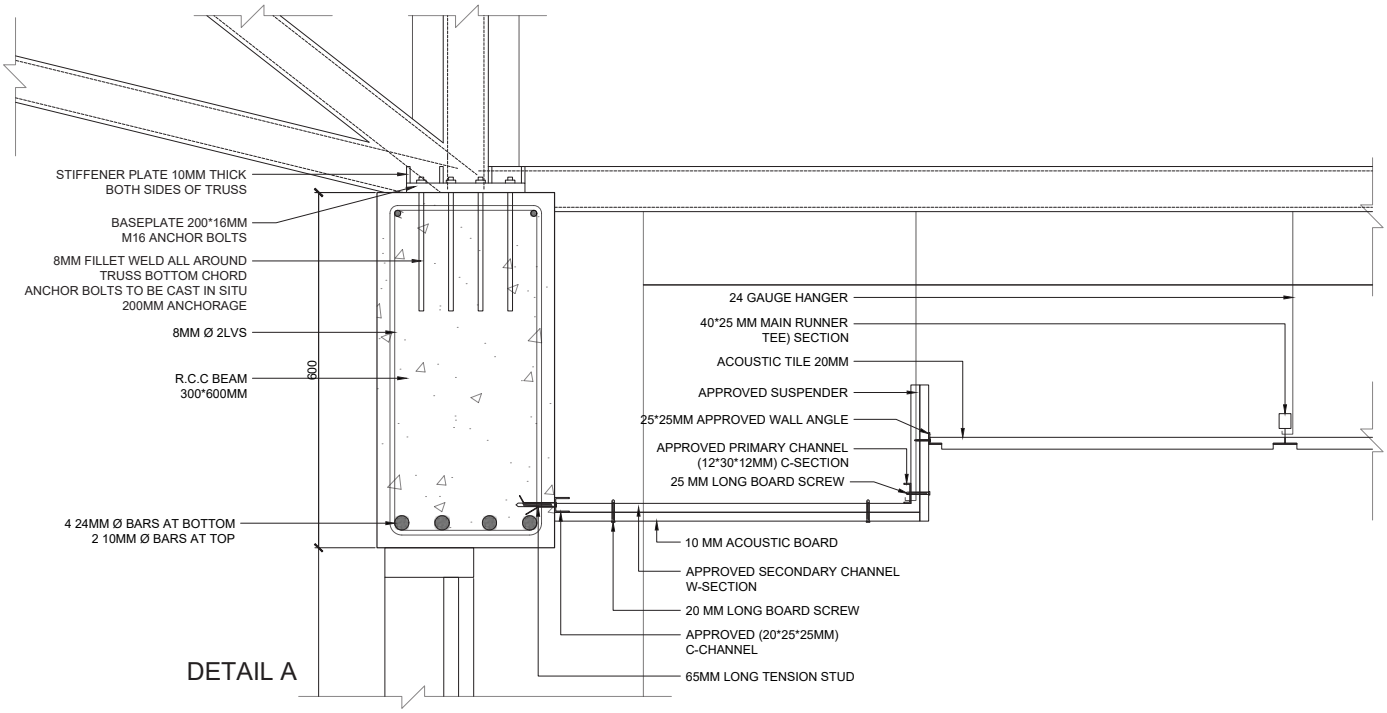


Fig 13: Truss joint detail

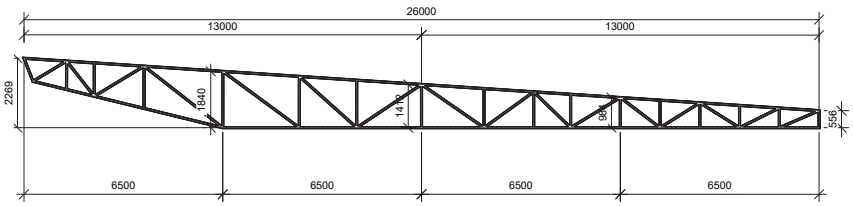


Fig 14: Truss section

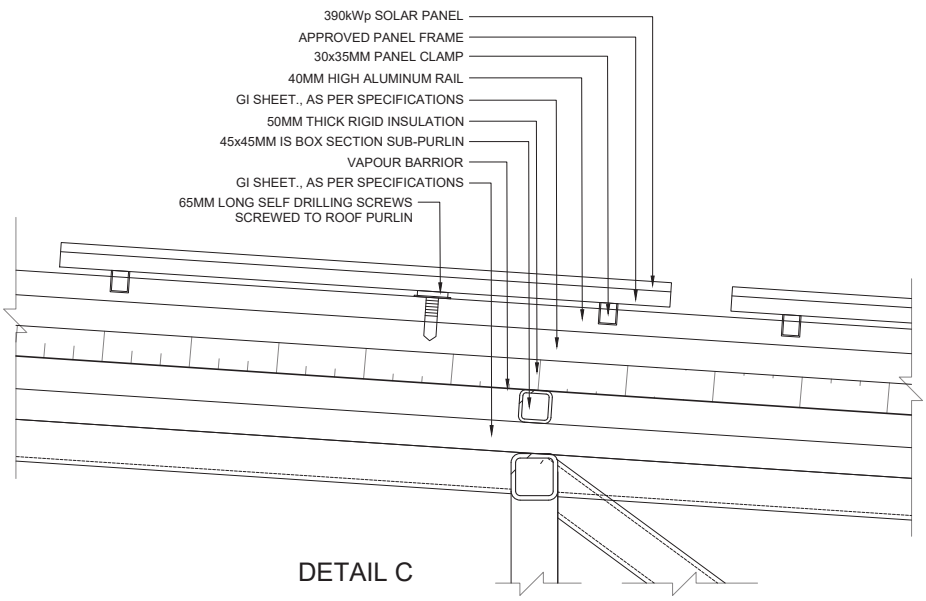


Fig 15: Truss roofing

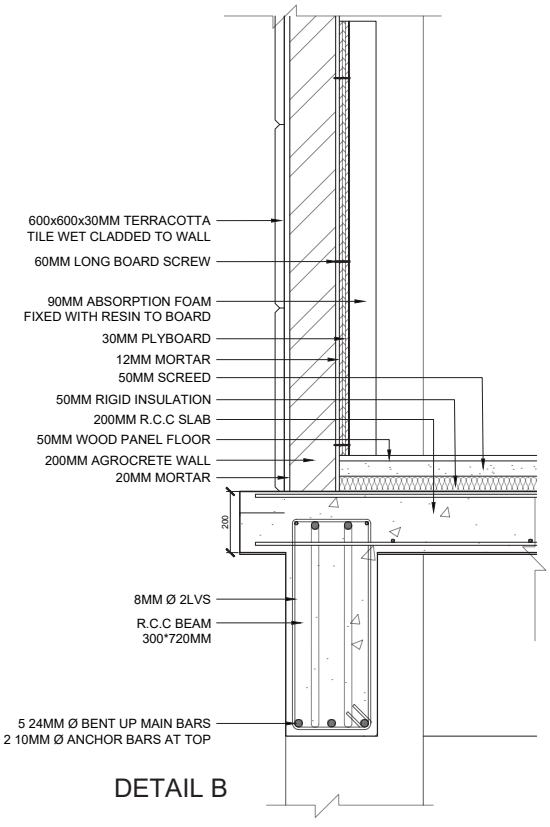


Fig 16: External wall

Cooling Tower

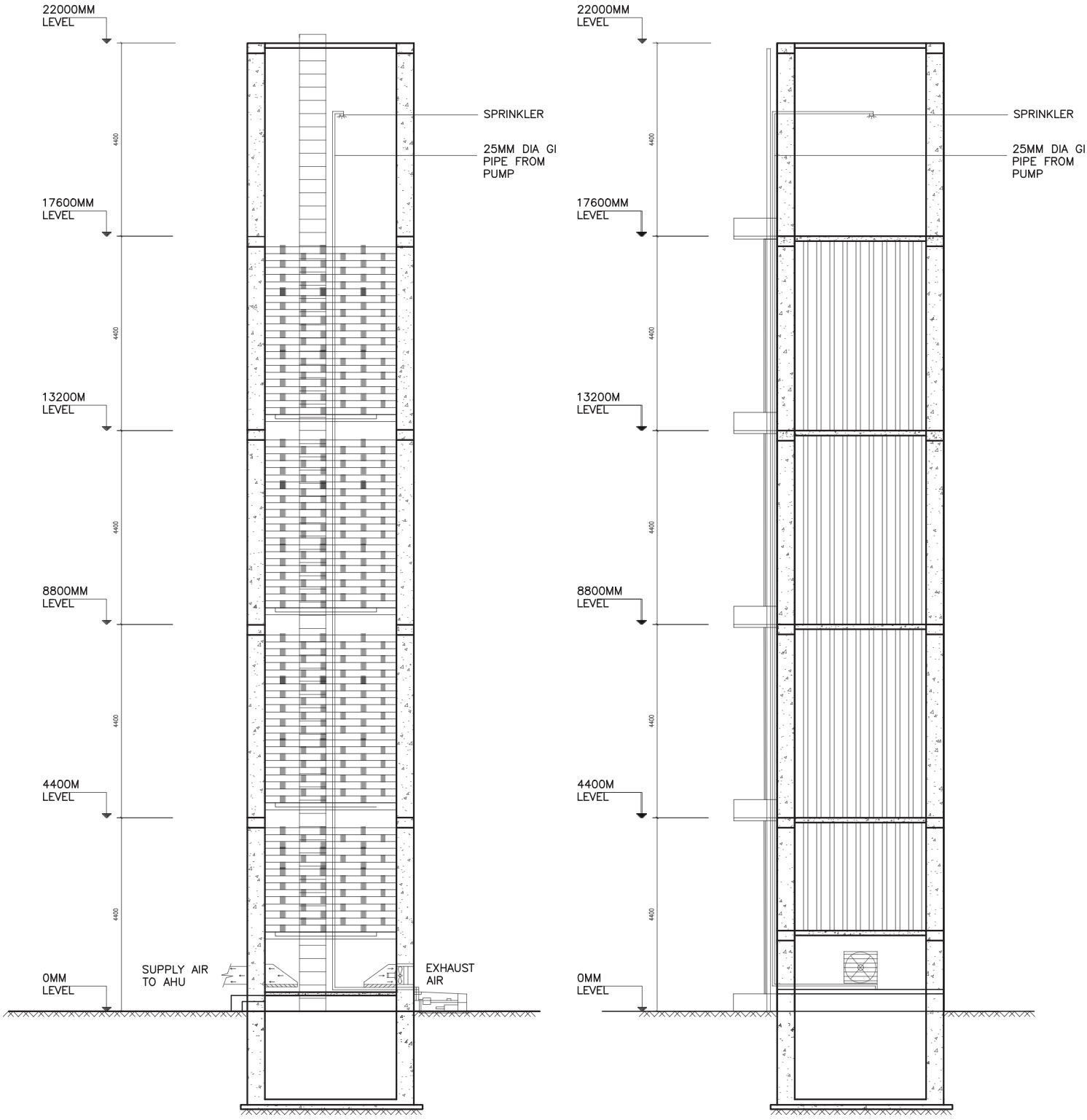


Fig 17: Cooling tower details

Appendix 3: Structure Design

Appendix 3A: Calculations

SLAB DESIGN

(Slab S1)	CLASSROOM	Chosen		
	Case 1	Case 2	Case 3	Case 4
Slab Thickness (m)	0.14	0.12	0.16	0.18
Concrete Unit Weight (kN/m3)	25	25	25	25
Self Weight of Slab (kN/m2)	3.50	3	4	4.5
Floor Finish (kN/m2)	1	1	1	1
Live Load (kN/m2)	4	4	4	4
Any Other Load (kN/m2)	0	0	0	0
wo (kN/m2)	8.50	8	9	9.5
Long Span, Ly (m)	6.5	6.5	6.5	6.5
Long Span, Lx (m)	2.83	2.83	2.83	2.83
Span Ratio, β	2.29	2.29	2.29	2.29
Triangular Area Load (kN/m)	One Way	One Way	One Way	One Way
Trapezoidal Area load (kN/m)	One Way	One Way	One Way	One Way
If it is One way Slab then,				
Load on Longer Span (kN/m)	12.04	11.33	12.75	13.46
Depth of Slab	0.14	0.12	0.16	0.18
Depth of Slab (mm)	141.67	123.19	157.41	177.08
D	0.17	0.15	0.18	0.20
Eff. Span	2.83	2.83	2.83	2.83
M (kN)	8.53	8.03	9.03	9.53
Mu (kN)	12.79	12.04	13.55	14.30
Eff. Depth Reqd. (mm)	60.90	59.08	62.66	64.38
Eff. Depth Reqd. (m)	0.061	0.059	0.063	0.064
Verification	OK	OK	OK	OK
Mu/bd2	0.64	0.79	0.55	0.46
Pt (%)	0.19%	0.17%	0.20%	0.20%
Area (mm2)	263.5	210.6521739	306.9444444	355.9375
re-bar dia size (mm)	10	10	10	10
Area per bar (mm2)	78.5	78.5	78.5	78.5
Ast (Min), Distribution steel	170	147.826087	188.8888889	212.5
Verification	OK	OK	OK	OK
Main bars spacing				
Spacing calculated (mm)	297.91	372.65	255.75	220.54
As per Code	300	300	300	300
3d	420	360	480	540
Spacing (mm)	300.00	300.00	260.00	230.00
Distribution bars spacing				
Calculated (mm)	461.76	531.03	415.59	369.41
As per Code (mm)	450	450	450	450
5d	700	600	800	900
Spacing (mm)	450.00	450.00	420.00	370.00
Check for Shear				
Vu	12.04	11.33	12.75	13.46
Nominal Shear Stress (Tv)	0.09	0.09	0.08	0.08
100*As/bd	0.12%	0.12%	0.12%	0.12%
Design Shear Stress (Tc)	0.29	0.29	0.29	0.29
Verification	OK	OK	OK	OK
Check for Deflection				
Ast provided	261.67	261.67	301.92	341.30
fs	239.03	298.99	236.76	230.80
% tension reinforecement	0.18	0.21	0.19	0.19
Modification Factor	1.7	1.7	1.7	1.7
Now, L/d = 20K, K=1.7				
d (mm)	83.33	83.33	83.33	83.33
Verification	OK	OK	OK	OK

(Slab S2)	CORRIDOR	Chosen		
	Case 1	Case 2	Case 3	Case 4
Slab Thickness (m)	0.14	0.12	0.16	0.18
Concrete Unit Weight (kN/m3)	25	25	25	25
Self Weight of Slab (kN/m2)	3.50	3	4	4.5
Floor Finish (kN/m2)	1	1	1	1
Live Load (kN/m2)	4	4	4	4
Any Other Load (kN/m2)	0	0	0	0
wo (kN/m2)	8.50	8	9	9.5
Long Span, Ly (m)	8.5	8.5	8.5	8.5
Long Span, Lx (m)	2.50	2.50	2.50	2.50
Span Ratio, β	3.40	3.40	3.40	3.40
Triangular Area Load (kN/m)	One Way	One Way	One Way	One Way
Trapezoidal Area load (kN/m)	One Way	One Way	One Way	One Way
If it is One way Slab then,				
Load on Longer Span (kN/m)	10.63	10.00	11.25	11.88
Depth of Slab	0.14	0.12	0.16	0.18
Depth of Slab (mm)	138.89	119.05	156.25	178.57
D	0.16	0.15	0.18	0.20
Eff. Span	2.50	2.50	2.50	2.50
M (kN)	6.64	6.25	7.03	7.42
Mu (kN)	9.96	9.38	10.55	11.13
Eff. Depth Reqd. (mm)	53.73	52.13	55.29	56.81
Eff. Depth Reqd. (m)	0.054	0.052	0.055	0.057
Verification	OK	OK	OK	OK
Mu/bd2	0.52	0.66	0.43	0.35
Pt (%)	0.19%	0.17%	0.20%	0.20%
Area (mm2)	258.3333333	203.5714286	304.6875	358.9285714
re-bar dia size (mm)	10	10	10	10
Area per bar (mm2)	78.5	78.5	78.5	78.5
Ast (Min), Distribution steel	166.6666667	142.8571429	187.5	214.2857143
Verification	OK	OK	OK	OK
Main bars spacing				
Spacing calculated (mm)	303.87	385.61	257.64	218.71
As per Code	300	300	300	300
3d	420	360	480	540
Spacing (mm)	300.00	300.00	260.00	220.00
Distribution bars spacing				
Calculated (mm)	471.00	549.50	418.67	366.33
As per Code (mm)	450	450	450	450
5d	700	600	800	900
Spacing (mm)	450.00	450.00	420.00	370.00
Check for Shear				
Vu	10.63	10.00	11.25	11.88
Nominal Shear Stress (Tv)	0.08	0.08	0.07	0.07
% tension Reinforcement	0.12%	0.12%	0.12%	0.12%
Design Shear Stress (Tc)	0.29	0.29	0.29	0.29
Verification	OK	OK	OK	OK
Check for Deflection				
Ast provided	261.67	261.67	301.92	356.82
fs	243.81	309.39	238.52	239.28
% tension reinforecement	0.19	0.22	0.19	0.20
Modification Factor	1.7	1.7	1.7	1.7
Now, L/d = 20K, K=1.7				
d (mm)	73.53	73.53	73.53	73.53
Verification	OK	OK	OK	OK

Table 1 : Slab design

BEAM DESIGN

Beam	BY1	6.5*2.7	Intermediate	
			Chosen	
SIZE	option 1	option 2	option 3	option 4
Width (mm)	300.00	300.00	**300.00**	300.00
Depth (mm)	500.00	350.00	**400.00**	450.00
Length (m)	6.50	6.50	**6.50**	6.50
UDL LOADs				
Self wt. (kN)	24.38	17.06	19.50	21.94
Wall wt. (kN)	0.00	0.00	0.00	0.00
Slab Wt. (kN)	64.22	64.22	**64.22**	64.22
Total ('A' kN)	88.60	81.28	**83.72**	86.16
Point Loads				
A				
B				
C				
Total ('B' kN)	0.00	0.00	0.00	0.00
Vs (A+B) kN	88.60	81.28	83.72	86.16
w (kN/m)	13.63	12.51	12.88	13.26
M (kN-m)	71.99	66.04	68.02	70.00
Mu (kN-m)	107.98	99.07	102.04	105.01
Mu/bd2	1.44	2.70	2.13	1.73
Pt (%)	**0.43%**	**0.88%**	**0.67%**	**0.53%**
Area (mm2)	649.50	919.80	798.00	708.75
re-bar dia size (mm)	20.00	20.00	20.00	20.00
Area per bar (mm2)	314.00	314.00	314.00	314.00
bars	3.00	3.00	**3.00**	3.00
fraction	2.07	2.93	2.54	2.26
Verification	OK	OK	OK	OK
Min depth.	323.00	309.38	**313.98**	318.52
Actual Ast	942	942	942	942
Min Ast.	307.23	215.06	245.78	276.51
Max. Ast.	6000	4200	4800	5400
Factored SF (Vu)	44.30	40.64	41.86	43.08
Nominal Shear Stress (Tv)	0.30	0.39	0.35	0.32
% tension Reinforcement	0.63	0.90	0.79	0.70
Design Shear Stress (Tc)	0.53	0.69	**0.65**	0.55
Verification	OK	OK	OK	OK
STIRRUPS				
Diameter	5.00	5.00	5.00	5.00
Ties should be more than 5mm				
re-bar dia size (mm)	8	8	8	8
No. of Legs	2	2	2	2
cross-sectional area of stirrup (Asv)	100.48	100.48	100.48	100.48
breadth of the beam (b)	300.00	300.00	300.00	300.00
characteristic strength (fy)	415	415	415	415
stirrup spacing (Sv) (mm)	302.3	302.3	302.3	302.3
stirrup spacing (Sv) (mm)	300	300	**300**	300
Development length of bar	922.22	922.22	922.22	922.22
LAP SPLICES				
spacing not more than	150	150	150	150
Lap length	922.22	922.22	922.22	922.22
CLOSE SPACING OF LINKS				
d/4	125	87.5	100	112.5
or 8x of smallest long. bar	80	80	80	80
or	100	100	100	100
Spacing of links	80	80	**80**	80

Beam	BX2	8.5*2.5	Main	
			Chosen	
SIZE	option 1	option 2	option 3	option 4
Width (mm)	300.00	300.00	**300.00**	300.00
Depth (mm)	700.00	750.00	**800.00**	850.00
Length (m)	8.50	8.50	**8.50**	8.50
UDL LOADs				
Self wt. (kN)	44.63	47.81	51.00	54.19
Wall wt. (kN)	79.56	79.56	79.56	79.56
Slab Wt. (kN)	12.50	12.50	**12.50**	12.50
Total ('A' kN)	136.69	139.87	**143.06**	146.25
Point Loads				
A	41.86	41.86	**41.86**	41.86
B	41.86	41.86	**41.86**	41.86
C				
Total ('B' kN)	83.72	83.72	83.72	83.72
Vs (A+B) kN	220.41	223.59	226.78	229.97
w (kN/m)	16.08	16.46	16.83	17.21
M (kN-m)	303.37	306.76	310.14	313.53
Mu (kN-m)	455.05	460.13	465.21	470.29
Mu/bd2	3.10	2.73	2.42	2.17
Pt (%)	**1.04%**	**0.89%**	**0.76%**	**0.68%**
Area (mm2)	2181.90	1998.00	1828.80	1726.35
re-bar dia size (mm)	24.00	24.00	24.00	24.00
Area per bar (mm2)	452.16	452.16	452.16	452.16
bars	5.00	5.00	**5.00**	4.00
fraction	4.83	4.42	4.04	3.82
Verification	OK	OK	OK	OK
Min depth.	663.07	666.76	**670.43**	674.09
Actual Ast	2260.8	2260.8	2260.8	1808.64
Min Ast.	430.12	460.84	491.57	522.29
Max. Ast.	8400	9000	9600	10200
Factored SF (Vu)	68.34	69.94	71.53	73.12
Nominal Shear Stress (Tv)	0.33	0.31	0.30	0.29
% tension Reinforcement	1.08	1.00	0.94	0.71
Design Shear Stress (Tc)	0.71	0.64	**0.638**	0.609
Verification	OK	OK	OK	OK
STIRRUPS				
Diameter	6.00	6.00	6.00	6.00
Ties should be more than 5mm				
re-bar dia size (mm)	8	8	8	8
No. of Legs	2	2	2	2
cross-sectional area of stirrup (Asv)	100.48	100.48	100.48	100.48
breadth of the beam (b)	300.00	300.00	300.00	300.00
characteristic strength (fy)	415	415	415	415
stirrup spacing (Sv) (mm)	302.3	302.3	302.3	302.3
stirrup spacing (Sv) (mm)	300	300	**300**	300
Development length of bar	1106.67	1106.67	1106.67	1106.67
LAP SPLICES				
spacing not more than	150	150	150	150
Lap length	1106.67	1106.67	1106.67	1106.67
CLOSE SPACING OF LINKS				
d/4	175	187.5	200	212.5
or 8x of smallest long. bar	80	80	80	80
or	100	100	100	100
Spacing of links	80	80	**80**	80

Beam	BX3	8.5*2.7	External	
			Chosen	
SIZE	option 1	option 2	option 3	option 4
Width (mm)	300.00	300.00	**300.00**	300.00
Depth (mm)	700.00	750.00	**800.00**	850.00
Length (m)	8.50	8.50	**8.50**	8.50
UDL LOADs				
Self wt. (kN)	44.63	47.81	51.00	54.19
Wall wt. (kN)	79.56	79.56	79.56	79.56
Slab Wt. (kN)	0.00	0.00	**0.00**	0.00
Total ('A' kN)	124.19	127.37	**130.56**	133.75
Point Loads				
A	41.86	41.86	**41.86**	41.86
B	41.86	41.86	**41.86**	41.86
C				
Total ('B' kN)	83.72	83.72	83.72	83.72
Vs (A+B) kN	207.91	211.09	214.28	217.47
w (kN/m)	14.61	14.99	15.36	15.74
M (kN-m)	290.09	293.48	296.86	300.25
Mu (kN-m)	435.13	440.21	445.29	450.37
Mu/bd2	2.96	2.61	2.32	2.08
Pt (%)	**0.98%**	**0.84%**	**0.73%**	**0.65%**
Area (mm2)	2053.80	1883.25	1752.00	1644.75
re-bar dia size (mm)	24.00	24.00	24.00	24.00
Area per bar (mm2)	452.16	452.16	452.16	452.16
bars	5.00	5.00	**4.00**	4.00
fraction	4.54	4.17	3.87	3.64
Verification	OK	OK	OK	OK
Min depth.	648.40	652.17	**655.92**	659.65
Actual Ast	2260.8	2260.8	1808.64	1808.64
Min Ast.	430.12	460.84	491.57	522.29
Max. Ast.	8400	9000	9600	10200
Factored SF (Vu)	62.09	63.69	65.28	66.87
Nominal Shear Stress (Tv)	0.30	0.28	0.27	0.26
% tension Reinforcement	1.08	1.00	0.75	0.71
Design Shear Stress (Tc)	0.71	0.64	**0.638**	0.609
Verification	OK	OK	OK	OK
STIRRUPS				
Diameter	6.00	6.00	6.00	6.00
Ties should be more than 5mm				
re-bar dia size (mm)	8	8	8	8
No. of Legs	2	2	2	2
cross-sectional area of stirrup (Asv)	100.48	100.48	100.48	100.48
breadth of the beam (b)	300.00	300.00	300.00	300.00
characteristic strength (fy)	415	415	415	415
stirrup spacing (Sv) (mm)	302.3	302.3	302.3	302.3
stirrup spacing (Sv) (mm)	300	300	**300**	300
Development length of bar	1106.67	1106.67	1106.67	1106.67
LAP SPLICES				
spacing not more than	150	150	150	150
Lap length	1106.67	1106.67	1106.67	1106.67
CLOSE SPACING OF LINKS				
d/4	175	187.5	200	212.5
or 8x of smallest long. bar	80	80	80	80
or	100	100	100	100
Spacing of links	80	80	**80**	80

Beam	BY2	6.5*2.7	Main	
			Chosen	
SIZE	option 1	option 2	option 3	option 4
Width (mm)	300.00	300.00	**300.00**	300.00
Depth (mm)	500.00	550.00	**600.00**	650.00
Length (m)	6.50	6.50	**6.50**	6.50
UDL LOADs				
Self wt. (kN)	24.38	26.81	29.25	31.69
Wall wt. (kN)	79.56	79.56	79.56	79.56
Slab Wt. (kN)	64.22	64.22	**64.22**	64.22
Total ('A' kN)	168.16	170.59	**173.03**	175.47
Point Loads				
A			0.00	
B			0.00	
C				
Total ('B' kN)	0.00	0.00	0.00	0.00
Vs (A+B) kN	168.16	170.59	173.03	175.47
w (kN/m)	25.87	26.25	26.62	27.00
M (kN-m)	136.63	138.61	140.59	142.57
Mu (kN-m)	204.94	207.91	210.88	213.85
Mu/bd2	2.73	2.29	1.95	1.69
Pt (%)	0.89%	0.72%	**0.60%**	0.51%
Area (mm2)	1332.00	1191.30	1081.80	998.40
re-bar dia size (mm)	20.00	20.00	20.00	20.00
Area per bar (mm2)	314.00	314.00	314.00	314.00
bars	5.00	4.00	**4.00**	4.00
fraction	4.24	3.79	3.45	3.18
Verification	OK	OK	OK	OK
Min depth.	444.98	448.20	**451.39**	454.56
Actual Ast	1570	1256	1256	1256
Min Ast.	307.23	337.95	368.67	399.40
Max. Ast.	6000	6600	7200	7800
Factored SF (Vu)	84.08	85.30	86.52	87.73
Nominal Shear Stress (Tv)	0.56	0.52	0.48	0.45
% tension Reinforcement	1.05	0.76	0.70	0.64
Design Shear Stress (Tc)	0.65	0.63	**0.55**	0.55
Verification	OK	OK	OK	OK
STIRRUPS				
Diameter	5.00	5.00	5.00	5.00
Ties should be more than 5mm				
re-bar dia size (mm)	8	8	8	8
No. of Legs	2	2	2	2
cross-sectional area of stirrup (Asv)	100.48	100.48	100.48	100.48
breadth of the beam (b)	300.00	300.00	300.00	300.00
characteristic strength (fy)	415	415	415	415
stirrup spacing (Sv) (mm)	302.3	302.3	302.3	302.3
stirrup spacing (Sv) (mm)	300	300	**300**	300
Development length of bar	922.22	922.22	922.22	922.22
LAP SPLICES				
spacing not more than	150	150	150	150
Lap length	922.22	922.22	922.22	922.22
CLOSE SPACING OF LINKS				
d/4	125	137.5	150	162.5
or 8x of smallest long. bar	80	80	80	80
or	100	100	100	100
Spacing of links	80	80	**80**	80

Beam	BX1	8.5*2.5	Cantilever	
			Chosen	
SIZE	option 1	option 2	option 3	option 4
Width (mm)	300.00	300.00	**300.00**	300.00
Depth (mm)	450.00	500.00	**550.00**	400.00
Length (m)	8.50	8.50	**8.50**	8.50
UDL LOADs				
Self wt. (kN)	28.69	31.88	35.06	25.50
Wall wt. (kN)	26.52	26.52	26.52	26.52
Slab Wt. (kN)	12.50	12.50	**12.50**	12.50
Total ('A' kN)	67.71	70.90	**74.08**	64.52
Point Loads				
A	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00
C				
Total ('B' kN)	0.00	0.00	0.00	0.00
Vs (A+B) kN	67.71	70.90	74.08	64.52
w (kN/m)	7.97	8.34	8.72	7.59
M (kN-m)	71.94	75.33	78.71	68.55
Mu (kN-m)	107.91	112.99	118.07	102.83
Mu/bd2	1.78	1.51	1.30	2.14
Pt (%)	0.55%	0.45%	**0.39%**	0.66%
Area (mm2)	737.10	676.50	635.25	786.00
re-bar dia size (mm)	20.00	20.00	20.00	20.00
Area per bar (mm2)	314.00	314.00	314.00	314.00
bars	3.00	3.00	**3.00**	3.00
fraction	2.35	2.15	2.02	2.50
Verification	OK	OK	OK	OK
Min depth.	322.89	330.41	**337.75**	315.20
Actual Ast	942	942	942	942
Min Ast.	276.51	307.23	337.95	245.78
Max. Ast.	5400	6000	6600	4800
Factored SF (Vu)	33.85	35.45	37.04	32.26
Nominal Shear Stress (Tv)	0.25	0.24	0.22	0.27
% tension Reinforcement	0.70	0.63	0.57	0.79
Design Shear Stress (Tc)	0.55	0.55	**0.59**	0.50
Verification	OK	OK	OK	OK
STIRRUPS				
Diameter	5.00	5.00	5.00	5.00
Ties should be more than 5mm				
re-bar dia size (mm)	8	8	8	8
No. of Legs	2	2	2	2
cross-sectional area of stirrup (Asv)	100.48	100.48	100.48	100.48
breadth of the beam (b)	300.00	300.00	300.00	300.00
characteristic strength (fy)	415	415	415	415
stirrup spacing (Sv) (mm)	302.3	302.3	302.3	302.3
stirrup spacing (Sv) (mm)	300	300	**300**	300
Development length of bar	922.22	922.22	922.22	922.22
LAP SPLICES				
spacing not more than	150	150	150	150
Lap length	922.22	922.22	922.22	922.22
CLOSE SPACING OF LINKS				
d/4	112.5	125	137.5	100
or 8x of smallest long. bar	80	80	80	80
or	100	100	100	100
Spacing of links	80	80	**80**	80

Beam	BY3	8.5*2.5	Cantilever	
		Chosen		
SIZE	option 1	option 2	option 3	option 4
Width (mm)	300.00	**300.00**	300.00	300.00
Depth (mm)	550.00	**600.00**	650.00	700.00
Length (m)	2.50	**2.50**	2.50	2.50
UDL LOADs				
Self wt. (kN)	10.31	11.25	12.19	13.13
Wall wt. (kN)	0.00	0.00	0.00	0.00
Slab Wt. (kN)	0.00	**0.00**	0.00	0.00
Total ('A' kN)	10.31	**11.25**	12.19	13.13
Point Loads				
A	32.26	**32.26**	32.26	32.26
B	32.26	**32.26**	32.26	32.26
C				
Total ('B' kN)	64.52	64.52	64.52	64.52
Vs (A+B) kN	74.83	75.77	76.71	77.65
w (kN/m)	4.13	4.50	4.88	5.25
M (kN-m)	174.19	175.36	176.53	177.71
Mu (kN-m)	261.29	263.04	264.80	266.56
Mu/bd2	2.88	2.44	2.09	1.81
Pt (%)	**0.95%**	**0.78%**	**0.65%**	**0.55%**
Area (mm2)	1564.20	1398.60	1265.55	1161.30
re-bar dia size (mm)	20.00	20.00	20.00	20.00
Area per bar (mm2)	314.00	314.00	314.00	314.00
bars	5.00	**5.00**	5.00	4.00
fraction	4.98	4.45	4.03	3.70
Verification	OK	OK	OK	OK
Min depth.	502.44	**504.13**	505.81	507.49
Actual Ast	1570	1570	1570	1256
Min Ast.	337.95	368.67	399.40	430.12
Max. Ast.	6600	7200	7800	8400
Factored SF (Vu)	5.16	5.63	6.09	6.56
Nominal Shear Stress (Tv)	0.03	0.03	0.03	0.03
% tension Reinforcement	0.95	0.87	0.81	0.60
Design Shear Stress (Tc)	0.65	**0.53**	0.51	0.55
Verification	OK	OK	OK	OK
STIRRUPS				
Diameter	5.00	5.00	5.00	5.00
Ties should be more than 5mm				
re-bar dia size (mm)	8	8	8	8
No. of Legs	2	2	2	2
cross-sectional area of stirrup (Asv)	100.48	100.48	100.48	100.48
breadth of the beam (b)	300.00	300.00	300.00	300.00
characteristic strength (fy)	415	415	415	415
stirrup spacing (Sv) (mm)	302.3	302.3	302.3	302.3
stirrup spacing (Sv) (mm)	300	**300**	300	300
Development length of bar	922.22	922.22	922.22	922.22
LAP SPLICES				
spacing not more than	150	150	150	150
Lap length	922.22	922.22	922.22	922.22
CLOSE SPACING OF LINKS				
d/4	137.5	150	162.5	175
or 8x of smallest long. bar	80	80	80	80
or	100	100	100	100
Spacing of links	80	**80**	80	80

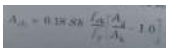
Table 2 : Beam design

COLUMN DESIGN

Formula	Pu=0.4*fck*Ac + 0.67Fy*As

C1	Main Block, G+5 w/ Basement
Load 1	107.14
Load 2	107.14
Load 3	86.52
Load 4	
TOTAL Load (kN)	**300.80**
No. of floors	7.00
Pu (kN)	**2105.59**
Width (mm)	400.00
Pu/Ag (kN/mm2)	12.68
Ag (mm2)	166049.31
Calculated Depth (mm)	415.12
Depth (mm)	420.00
Design Depth (mm)	**450.00**
COMPRESSION CHECK	
P (kN)	**1403.73**
Area (mm2)	180000
Allowable stress	7.80
Applied stress	415
Result	**SAFE**
BUCKLING CHECK	
L (mm)	3600
Leff (mm)	2520
E (N/mm2)	25000
I (mm4)	1366875000000
Per (kN)	53055086.10
Result	**SAFE**
Slenderness Ratio	**6.30**
Eccentricity	22.20
Emin	20.00
Emax	22.50
Status	**SAFE**
SUMMARY	**C1**
Width (mm)	**400.00**
Depth (mm)	**450.00**
BAR & SPACING	
Asc (mm2)	1660.49
Rebar Dia Size (mm)	**20.00**
Area of Bar (mm2)	314
No. of Bars (fraction)	5.29
No. of Bars	**6.00**
Asc provided	1884.00
Verification	**OK**
Transverse Reinforcement	
16d (dia of bar) (mm)	320.00
least lateral dimension (mm)	300.00
Pitch (mm)	300.00
Spacing	**300.00**
STIRRUPS	
Diameter	5.00
Ties should be more than 5mm	
Tie bars (mm)	8.00
CONFINEMENT REINFORCEMENT	
Larger Lateral dimension (mm)	450
1/6 of clear span (mm)	600
Or	450
Lo. length	**600**
Spacing for special confinement bars	
Size of ties	8.00
	
Area of tie bar (8mm)	50.24
Area of column	180000
Dkx	520
Dky	220
h	260.00
Ak	114400.00
Spacing	**36.73**
Max. Permissible spacing	
spacing	36.73
1/4 of min. lateral dimension	100.00
or	100.00
but not less than	75.00
Final spacing	**75.00**
Transverse Reinforcement	
h/4	900.00
should be ≥ h/4	1000.00
As per 7.4.2	200.00
Lap splices	
Shall not exceed	100.00
Confined joint of beam- column	
Shall not exceed	150.00

C2	Main Block, G+5 w/ Basement
Load 1	113.39
Load 2	113.39
Load 3	75.77
Load 4	86.52
TOTAL Load (kN)	**389.07**
No. of floors	7.00
Pu (kN)	**2723.48**
Width (mm)	400.00
Pu/Ag (kN/mm2)	12.68
Ag (mm2)	214776.89
Calculated Depth (mm)	536.94
Depth (mm)	540.00
Design Depth (mm)	**550.00**
COMPRESSION CHECK	
P (kN)	**1815.65**
Area (mm2)	220000
Allowable stress	8.25
Applied stress	415
Result	**SAFE**
BUCKLING CHECK	
L (mm)	3600
Leff (mm)	2520
E (N/mm2)	25000
I (mm4)	3050208333333
Per (kN)	118393463.73
Result	**SAFE**
Slenderness Ratio	**6.30**
Eccentricity	25.53
Emin	20.00
Emax	27.50
Status	**SAFE**
SUMMARY	**C2**
Width (mm)	**400.00**
Depth (mm)	**550.00**
BAR & SPACING	
Asc (mm2)	2147.77
Rebar Dia Size (mm)	**20.00**
Area of Bar (mm2)	314
No. of Bars (fraction)	6.84
No. of Bars	**7.00**
Asc provided	2198.00
Verification	**OK**
Transverse Reinforcement	
16d (dia of bar) (mm)	320.00
least lateral dimension (mm)	300.00
Pitch (mm)	300.00
Spacing	**300.00**
STIRRUPS	
Diameter	5.00
Ties should be more than 5mm	
Tie bars (mm)	8.00
CONFINEMENT REINFORCEMENT	
Larger Lateral dimension (mm)	550
1/6 of clear span (mm)	600
Or	450
Lo. length	**600**
Spacing for special confinement bars	
Size of ties	8.00
	
Area of tie bar (8mm)	50.24
Area of column	220000
Dkx	520
Dky	220
h	260.00
Ak	114400.00
Spacing	**22.82**
Max. Permissible spacing	
spacing	22.82
1/4 of min. lateral dimension	100.00
or	100.00
but not less than	75.00
Final spacing	**75.00**
Transverse Reinforcement	
h/4	900.00
should be ≥ h/4	1000.00
As per 7.4.2	200.00
Lap splices	
Shall not exceed	100.00
Confined joint of beam- column	
Shall not exceed	150.00

C1	Main Block, G+4 w/ Basement
Load 1	107.14
Load 2	107.14
Load 3	86.52
Load 4	
TOTAL Load (kN)	**300.80**
No. of floors	6.00
Pu (kN)	**1804.79**
Width (mm)	400.00
Pu/Ag (kN/mm2)	12.68
Ag (mm2)	142327.98
Calculated Depth (mm)	355.82
Depth (mm)	360.00
Design Depth (mm)	**450.00**
COMPRESSION CHECK	
P (kN)	**1203.19**
Area (mm2)	180000
Allowable stress	6.68
Applied stress	415
Result	**SAFE**
BUCKLING CHECK	
L (mm)	3600
Leff (mm)	2520
E (N/mm2)	25000
I (mm4)	1366875000000
Per (kN)	53055086.10
Result	**SAFE**
Slenderness Ratio	**6.30**
Eccentricity	22.20
Emin	20.00
Emax	22.50
Status	**SAFE**
SUMMARY	**C1**
Width (mm)	**400.00**
Depth (mm)	**450.00**
BAR & SPACING	
Asc (mm2)	1423.28
Rebar Dia Size (mm)	**20.00**
Area of Bar (mm2)	314
No. of Bars (fraction)	4.53
No. of Bars	**5.00**
Asc provided	1570.00
Verification	**OK**
Transverse Reinforcement	
16d (dia of bar) (mm)	320.00
least lateral dimension (mm)	300.00
Pitch (mm)	300.00
Spacing	**300.00**
STIRRUPS	
Diameter	5.00
Ties should be more than 5mm	
Tie bars (mm)	8.00
CONFINEMENT REINFORCEMENT	
Larger Lateral dimension (mm)	450
1/6 of clear span (mm)	600
Or	450
Lo. length	**600**
Spacing for special confinement bars	
Size of ties	8.00
	
Area of tie bar (8mm)	50.24
Area of column	180000
Dkx	520
Dky	220
h	260.00
Ak	114400.00
Spacing	**36.73**
Max. Permissible spacing	
spacing	36.73
1/4 of min. lateral dimension	100.00
or	100.00
but not less than	75.00
Final spacing	**75.00**
Transverse Reinforcement	
h/4	900.00
should be ≥ h/4	1000.00
As per 7.4.2	200.00
Lap splices	
Shall not exceed	100.00
Confined joint of beam- column	
Shall not exceed	150.00

C3	Main Block, G+3 w/ Basement
Load 1	113.39
Load 2	113.39
Load 3	86.52
Load 4	
TOTAL Load (kN)	**313.30**
No. of floors	6.00
Pu (kN)	**1879.79**
Width (mm)	400.00
Pu/Ag (kN/mm2)	12.68
Ag (mm2)	148242.58
Calculated Depth (mm)	370.61
Depth (mm)	380.00
Design Depth (mm)	**450.00**
COMPRESSION CHECK	
P (kN)	**1253.19**
Area (mm2)	180000
Allowable stress	6.96
Applied stress	415
Result	**SAFE**
BUCKLING CHECK	
L (mm)	3600
Leff (mm)	2520
E (N/mm2)	25000
I (mm4)	1366875000000
Per (kN)	53055086.10
Result	**SAFE**
Slenderness Ratio	**6.30**
Eccentricity	22.20
Emin	20.00
Emax	22.50
Status	**SAFE**
SUMMARY	**C3**
Width (mm)	**400.00**
Depth (mm)	**450.00**
BAR & SPACING	
Asc (mm2)	1482.43
Rebar Dia Size (mm)	**20.00**
Area of Bar (mm2)	314
No. of Bars (fraction)	4.72
No. of Bars	**5.00**
Asc provided	1570.00
Verification	**OK**
Transverse Reinforcement	
16d (dia of bar) (mm)	320.00
least lateral dimension (mm)	300.00
Pitch (mm)	300.00
Spacing	**300.00**
STIRRUPS	
Diameter	5.00
Ties should be more than 5mm	
Tie bars (mm)	8.00
CONFINEMENT REINFORCEMENT	
Larger Lateral dimension (mm)	450
1/6 of clear span (mm)	600
Or	450
Lo. length	600
Spacing for special confinement bars	
Size of ties	8.00
	
Area of tie bar (8mm)	50.24
Area of column	180000
Dkx	520
Dky	220
h	260.00
Ak	114400.00
Spacing	**36.73**
Max. Permissible spacing	
spacing	36.73
1/4 of min. lateral dimension	100.00
or	100.00
but not less than	75.00
Final spacing	**75.00**
Transverse Reinforcement	
h/4	900.00
should be ≥ h/4	1000.00
As per 7.4.2	200.00
Lap splices	
Shall not exceed	100.00
Confined joint of beam- column	
Shall not exceed	150.00

Table 3 : Column design

FOOTING DESIGN

G+5	
Load on column C1 (kN)	**2105.59**
Width (m)	**0.4**
Depth (m)	**0.45**
c/c distance b/w columns	8.5
M25 (N/mm2)	25
fy (N/mm2)	415
Safe bearing capacity, q (kN/m2)	150
Af	P/SBC
Af (m2)	14.04
Side of footing (m)	3.75
Side of footing (m)	**4**
Net soil Pressure	Pc/Af provided
Af provided	16
Net soil Pressure	**131.60**
Check for BM	
Clear overhang of footing from face of column	1.55
Max. Cantelilver BM	wl2/2
Mmax	158.08
Factored BM, Mu	**237.13**
Assume D (mm)	**800**
Effective Depth, d (mm)	**740**
Effective Depth, d (m)	0.74
Mu/bd2 (kNm)	433.03
Mu/bd2 (Nmm)	0.433
Pt %	**0.127**
Ast (mm2)	Pt*bd/100
Ast (mm2)	**939.8**
Bar diameter (mm)	**16**
Area of bar	200.96
Spacing (mm)	(ast/Ast)*1000
Spacing (mm)	213.83
Final Spacing (mm)	**200**
Checking for shear force	
V	663141.89
Vu	**994712.83**
Shear Stress	0.34
Permissible shear stress	0.37
Verification	**SAFE**
Pt % against shear stress (N/mm2)	0.34
Pt %	**0.41**
Ast (mm2)	3034
Bar diameter (mm)	**22**
Ast (mm2)	379.94
Spacing	**125.23**
Punching Shear	
Side of punching area b' (m)	1.74
Punching Shear (kN)	1707.16
Vup	**2560.74**
Punching Shear stress (kN/m2)	497.19
Punching Shear stress (N/mm2)	0.497
Allowable Punching Shear (N/mm2)	1.25
Verification	**SAFE**
Development length (m)	**0.8**
Allowabe Development length (m)	1.5
Verification	**SAFE**
Strap beam	
Mu (kNm)	237.13
Mu (Nmm)	237125436.1
Mu/bd2	0.138fck
d	sqrt(Mu/0.138fckb)
0.138fckb	1552.5
d	390.82
final d	**400.00**
D	**460.00**
Ast (mm2)	Pt*bd/100
Ast (mm2)	**223.35**
Bar diameter (mm)	**10**
Area of bar	78.5
No. of Bars	2.85
No. of Bars	**3.00**
STIRRUPS	
re-bar dia size (mm)	**8**
No. of Legs	2
cross-sectional area of stirrup (Asv)	100.48
breadth of the beam (b)	450
stirrup spacing (Sv) (mm)	201.5
stirrup spacing (Sv) (mm)	**200**
LAP SPLICES	
spacing not more than	150
Lap length (m)	0.8
CLOSE SPACING OF LINKS	
d/4	100
or 8x of smallest long. bar	80
or	100
Spacing of links	**80**
CONFINEMENT REINFORCEMENT FOR FOOTING	
Larger Lateral dimension (mm)	450
1/6 of clear span (mm)	600
Or	450
Lo. length	**600**
Spacing for special confinement bars	
Size of ties	8.00
Area of tie bar (8mm)	50.24
Area of column	180000
Dkx	410
Dky	360
h	205.00
Ak	147600.00
Spacing	**58.63**
Max. Permissible spacing	
spacing	58.63
1/4 of min. lateral dimension	100.00
or	100.00
but not less than	75.00
Final spacing	**75.00**

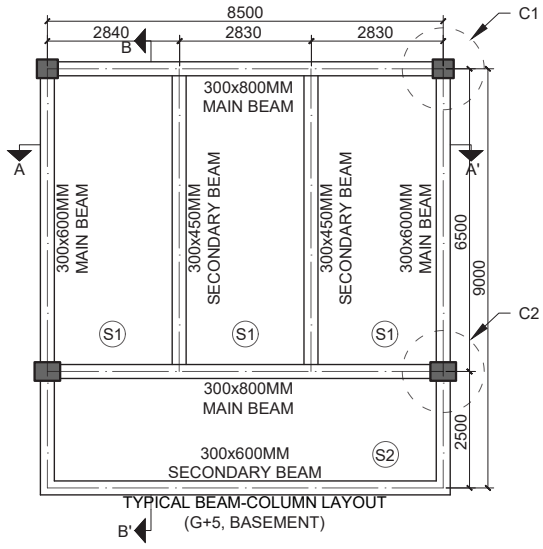
G+5	
Load on column C2 (kN)	**2723.48**
Width (m)	**0.4**
Depth (m)	**0.55**
c/c distance b/w columns	8.5
M25 (N/mm2)	25
fy (N/mm2)	415
Safe bearing capacity, q (kN/m2)	150
Af	P/SBC
Af (m2)	18.16
Side of footing (m)	4.26
Side of footing (m)	**4**
Net soil Pressure	Pc/Af provided
Af provided	16
Net soil Pressure	**170.22**
Check for BM	
Clear overhang of footing from face of column	1.55
Max. Cantelilver BM	wl2/2
Mmax	204.47
Factored BM, Mu	**306.71**
Assume D (mm)	**900**
Effective Depth, d (mm)	**840**
Effective Depth, d (m)	0.84
Mu/bd2 (kNm)	434.68
Mu/bd2 (Nmm)	0.435
Pt %	**0.129**
Ast (mm2)	Pt*bd/100
Ast (mm2)	**1083.6**
Bar diameter (mm)	**16**
Area of bar	200.96
Spacing (mm)	(ast/Ast)*1000
Spacing (mm)	185.46
Final Spacing (mm)	**180**
Checking for shear force	
V	789621.48
Vu	**1184432.22**
Shear Stress	0.35
Permissible shear stress	0.37
Verification	**SAFE**
Pt % against shear stress (N/mm2)	0.35
Pt %	**0.41**
Ast (mm2)	3444
Bar diameter (mm)	**22**
Ast (mm2)	379.94
Spacing	**110.32**
Punching Shear	
Side of punching area b' (m)	1.84
Punching Shear (kN)	2147.19
Vup	**3220.79**
Punching Shear stress (kN/m2)	520.96
Punching Shear stress (N/mm2)	0.521
Allowable Punching Shear (N/mm2)	1.25
Verification	**SAFE**
Development length (m)	**0.8**
Allowabe Development length (m)	1.5
Verification	**SAFE**
Strap beam	
Mu (kNm)	306.71
Mu (Nmm)	306710470.1
Mu/bd2	0.138fck
d	sqrt(Mu/0.138fckb)
0.138fckb	1552.5
d	444.48
final d	**450.00**
D	**510.00**
Ast (mm2)	Pt*bd/100
Ast (mm2)	**258.02**
Bar diameter (mm)	**10**
Area of bar	78.5
No. of Bars	3.29
No. of Bars	**4.00**
STIRRUPS	
re-bar dia size (mm)	**8**
No. of Legs	2
cross-sectional area of stirrup (Asv)	100.48
breadth of the beam (b)	450
stirrup spacing (Sv) (mm)	201.5
stirrup spacing (Sv) (mm)	**200**
LAP SPLICES	
spacing not more than	150
Lap length (m)	0.8
CLOSE SPACING OF LINKS	
d/4	112.5
or 8x of smallest long. bar	80
or	100
Spacing of links	**80**
CONFINEMENT REINFORCEMENT FOR FOOTING	
Larger Lateral dimension (mm)	450
1/6 of clear span (mm)	600
Or	450
Lo. length	**600**
Spacing for special confinement bars	
Size of ties	8.00
Area of tie bar (8mm)	50.24
Area of column	180000
Dkx	410
Dky	360
h	205.00
Ak	147600.00
Spacing	**58.63**
Max. Permissible spacing	
spacing	58.63
1/4 of min. lateral dimension	100.00
or	100.00
but not less than	75.00
Final spacing	**75.00**

G+4	
Load on column C1 (kN)	**1804.79**
Width (m)	**0.4**
Depth (m)	**0.45**
c/c distance b/w columns	8.5
M25 (N/mm2)	25
fy (N/mm2)	415
Safe bearing capacity, q (kN/m2)	150
Af	P/SBC
Af (m2)	12.03
Side of footing (m)	3.47
Side of footing (m)	**4**
Net soil Pressure	Pc/Af provided
Af provided	16
Net soil Pressure	**112.80**
Check for BM	
Clear overhang of footing from face of column	1.55
Max. Cantelilver BM	wl2/2
Mmax	135.50
Factored BM, Mu	**203.25**
Assume D (mm)	**700**
Effective Depth, d (mm)	**640**
Effective Depth, d (m)	0.64
Mu/bd2 (kNm)	496.22
Mu/bd2 (Nmm)	0.496
Pt %	**0.127**
Ast (mm2)	Pt*bd/100
Ast (mm2)	**812.8**
Bar diameter (mm)	**16**
Area of bar	200.96
Spacing (mm)	(ast/Ast)*1000
Spacing (mm)	247.24
Final Spacing (mm)	**220**
Checking for shear force	
V	613527.08
Vu	**920290.62**
Shear Stress	0.36
Permissible shear stress	0.37
Verification	**SAFE**
Pt % against shear stress (N/mm2)	0.36
Pt %	**0.41**
Ast (mm2)	2624
Bar diameter (mm)	**22**
Ast (mm2)	379.94
Spacing	**144.79**
Punching Shear	
Side of punching area b' (m)	1.64
Punching Shear (kN)	1501.40
Vup	**2252.11**
Punching Shear stress (kN/m2)	536.42
Punching Shear stress (N/mm2)	0.536
Allowable Punching Shear (N/mm2)	1.25
Verification	**SAFE**
Development length (m)	**0.8**
Allowabe Development length (m)	1.5
Verification	**SAFE**
Strap beam	
Mu (kNm)	203.25
Mu (Nmm)	203250373.8
Mu/bd2	0.138fck
d	sqrt(Mu/0.138fckb)
0.138fckb	1552.5
d	361.83
final d	**370.00**
D	**430.00**
Ast (mm2)	Pt*bd/100
Ast (mm2)	**206.78**
Bar diameter (mm)	**10**
Area of bar	78.5
No. of Bars	2.63
No. of Bars	**3.00**
STIRRUPS	
re-bar dia size (mm)	**8**
No. of Legs	2
cross-sectional area of stirrup (Asv)	100.48
breadth of the beam (b)	450
stirrup spacing (Sv) (mm)	201.5
stirrup spacing (Sv) (mm)	**200**
LAP SPLICES	
spacing not more than	150
Lap length (m)	0.8
CLOSE SPACING OF LINKS	
d/4	92.5
or 8x of smallest long. bar	80
or	100
Spacing of links	**80**
CONFINEMENT REINFORCEMENT FOR FOOTING	
Larger Lateral dimension (mm)	450
1/6 of clear span (mm)	600
Or	450
Lo. length	**600**
Spacing for special confinement bars	
Size of ties	8.00
Area of tie bar (8mm)	50.24
Area of column	180000
Dkx	410
Dky	360
h	205.00
Ak	147600.00
Spacing	**58.63**
Max. Permissible spacing	
spacing	58.63
1/4 of min. lateral dimension	100.00
or	100.00
but not less than	75.00
Final spacing	**75.00**

G+3	
Load on column C1 (kN)	**1879.79**
Width (m)	**0.4**
Depth (m)	**0.45**
c/c distance b/w columns	8.5
M25 (N/mm2)	25
fy (N/mm2)	415
Safe bearing capacity, q (kN/m2)	150
Af	P/SBC
Af (m2)	12.53
Side of footing (m)	3.54
Side of footing (m)	**4**
Net soil Pressure	Pc/Af provided
Af provided	16
Net soil Pressure	**117.49**
Check for BM	
Clear overhang of footing from face of column	1.55
Max. Cantelilver BM	wl2/2
Mmax	141.13
Factored BM, Mu	**211.70**
Assume D (mm)	**750**
Effective Depth, d (mm)	**690**
Effective Depth, d (m)	0.69
Mu/bd2 (kNm)	444.65
Mu/bd2 (Nmm)	0.445
Pt %	**0.127**
Ast (mm2)	Pt*bd/100
Ast (mm2)	**876.3**
Bar diameter (mm)	**16**
Area of bar	200.96
Spacing (mm)	(ast/Ast)*1000
Spacing (mm)	229.33
Final Spacing (mm)	**220**
Checking for shear force	
V	615525.49
Vu	**923288.23**
Shear Stress	0.33
Permissible shear stress	0.37
Verification	**SAFE**
Pt % against shear stress (N/mm2)	0.33
Pt %	**0.41**
Ast (mm2)	2829
Bar diameter (mm)	**22**
Ast (mm2)	379.94
Spacing	**134.30**
Punching Shear	
Side of punching area b' (m)	1.69
Punching Shear (kN)	1544.24
Vup	**2316.35**
Punching Shear stress (kN/m2)	496.60
Punching Shear stress (N/mm2)	0.497
Allowable Punching Shear (N/mm2)	1.25
Verification	**SAFE**
Development length (m)	**0.8**
Allowabe Development length (m)	1.5
Verification	**SAFE**
Strap beam	
Mu (kNm)	211.70
Mu (Nmm)	211696662.8
Mu/bd2	0.138fck
d	sqrt(Mu/0.138fckb)
0.138fckb	1552.5
d	369.27
final d	**370.00**
D	**430.00**
Ast (mm2)	Pt*bd/100
Ast (mm2)	**211.04**
Bar diameter (mm)	**10**
Area of bar	78.5
No. of Bars	2.69
No. of Bars	**3.00**
STIRRUPS	
re-bar dia size (mm)	**8**
No. of Legs	2
cross-sectional area of stirrup (Asv)	100.48
breadth of the beam (b)	450
stirrup spacing (Sv) (mm)	201.5
stirrup spacing (Sv) (mm)	**200**
LAP SPLICES	
spacing not more than	150
Lap length (m)	0.8
CLOSE SPACING OF LINKS	
d/4	92.5
or 8x of smallest long. bar	80
or	100
Spacing of links	**80**
CONFINEMENT REINFORCEMENT FOR FOOTING	
Larger Lateral dimension (mm)	450
1/6 of clear span (mm)	600
Or	450
Lo. length	**600**
Spacing for special confinement bars	
Size of ties	8.00
Area of tie bar (8mm)	50.24
Area of column	180000
Dkx	410
Dky	360
h	205.00
Ak	147600.00
Spacing	**58.63**
Max. Permissible spacing	
spacing	58.63
1/4 of min. lateral dimension	100.00
or	100.00
but not less than	75.00
Final spacing	**75.00**

Table 4 : Footing design

Appendix 3B: Drawings



TYPICAL BEAM-COLUMN LAYOUT
(G+5, BASEMENT)

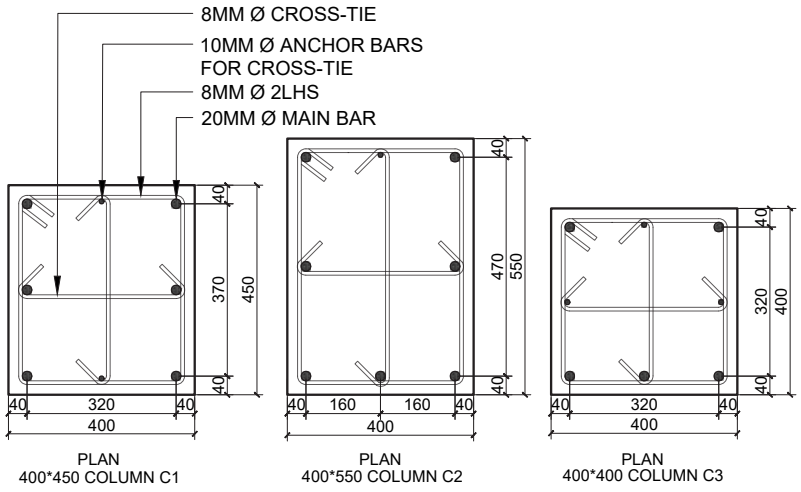
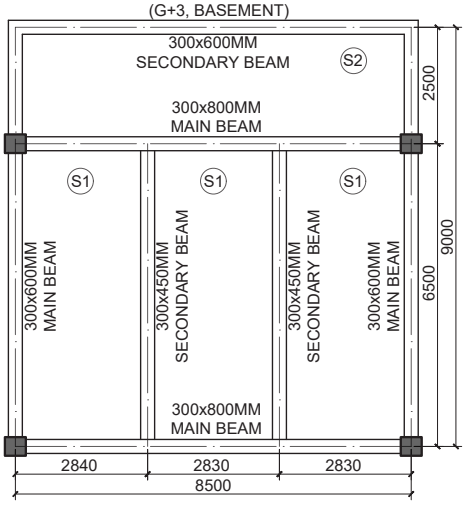
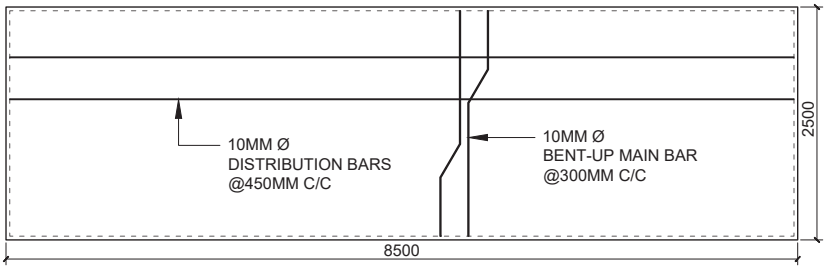


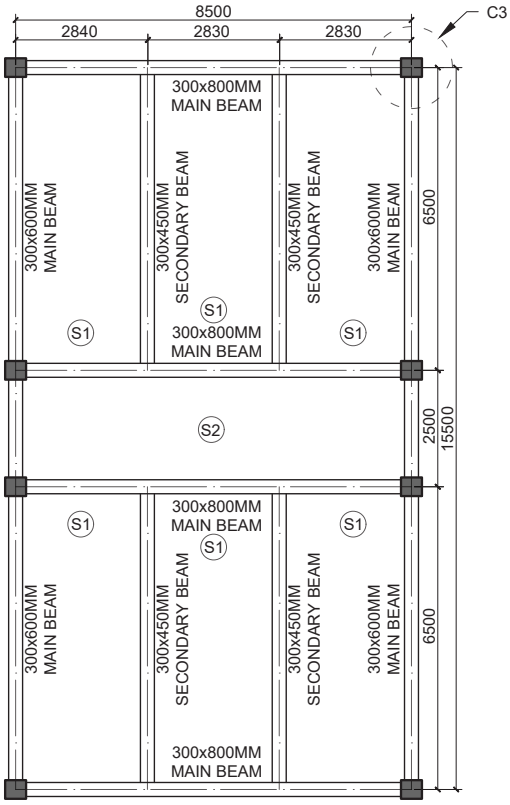
Fig 19: Column reinforcement detail

TYPICAL BEAM-COLUMN LAYOUT
(G+3, BASEMENT)



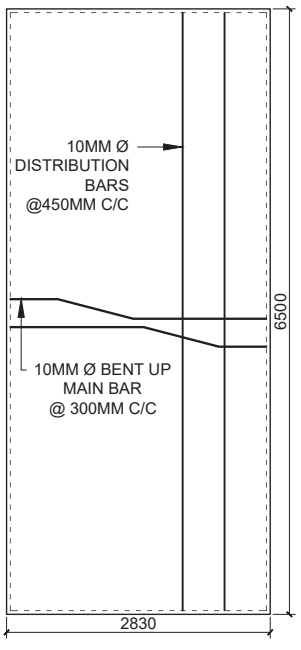


TYPICAL SLAB (S2) REINFORCEMENT
(CORRIDORS)



TYPICAL BEAM-COLUMN LAYOUT
(G+4, BASEMENT)

Fig 18: Typical frame layouts



TYPICAL SLAB (S1) REINFORCEMENT
(CLASSROOM SPACES)

Fig 20: Slab reinforcement detail

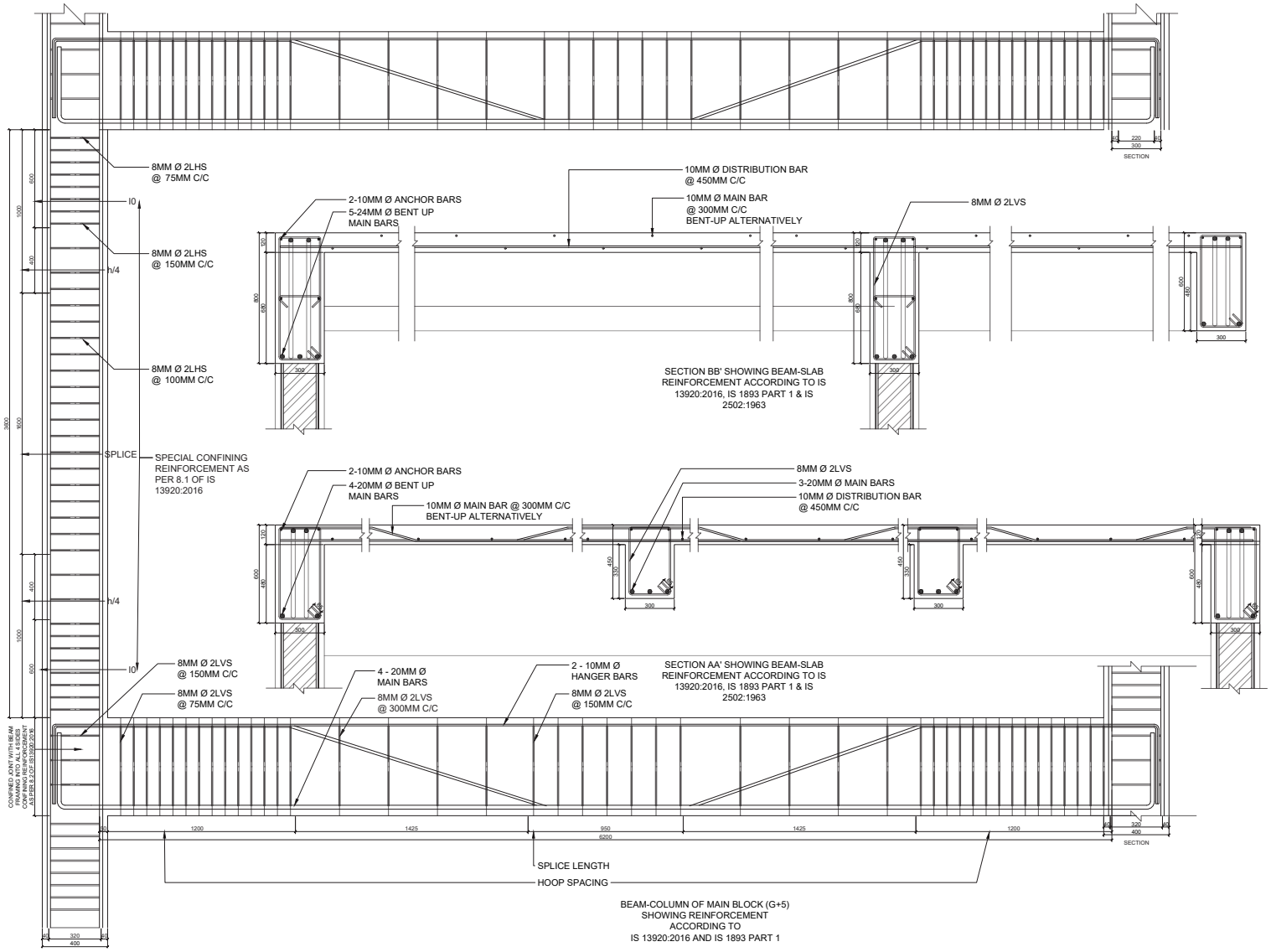


Fig 21: Beam-column Reinforcement detail

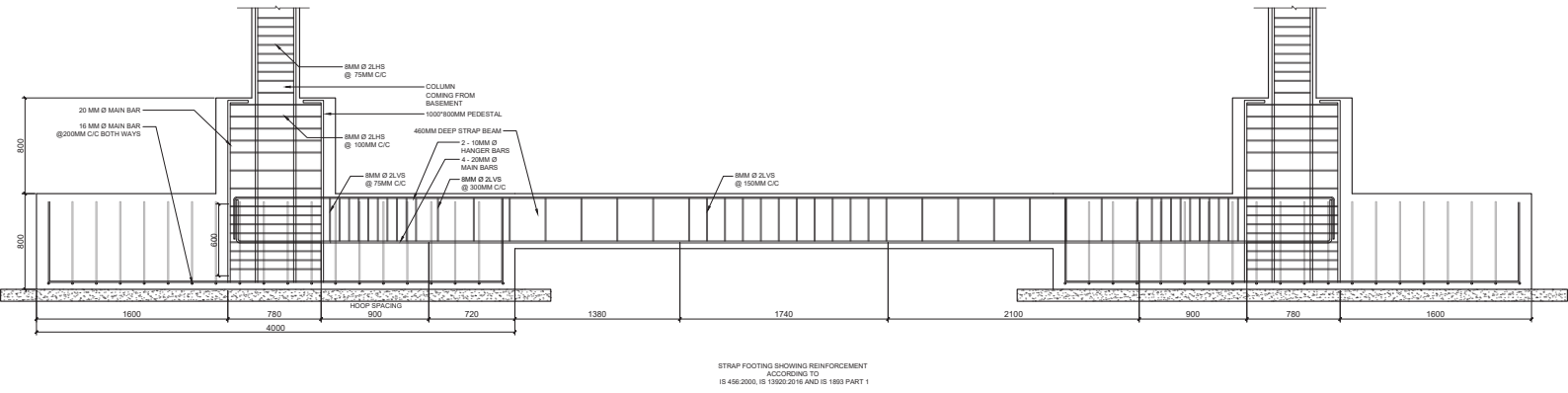


Fig 22: Footing detail

Appendix 4: MEP Layouts & Single Line Diagrams

Appendix 4A: HVAC

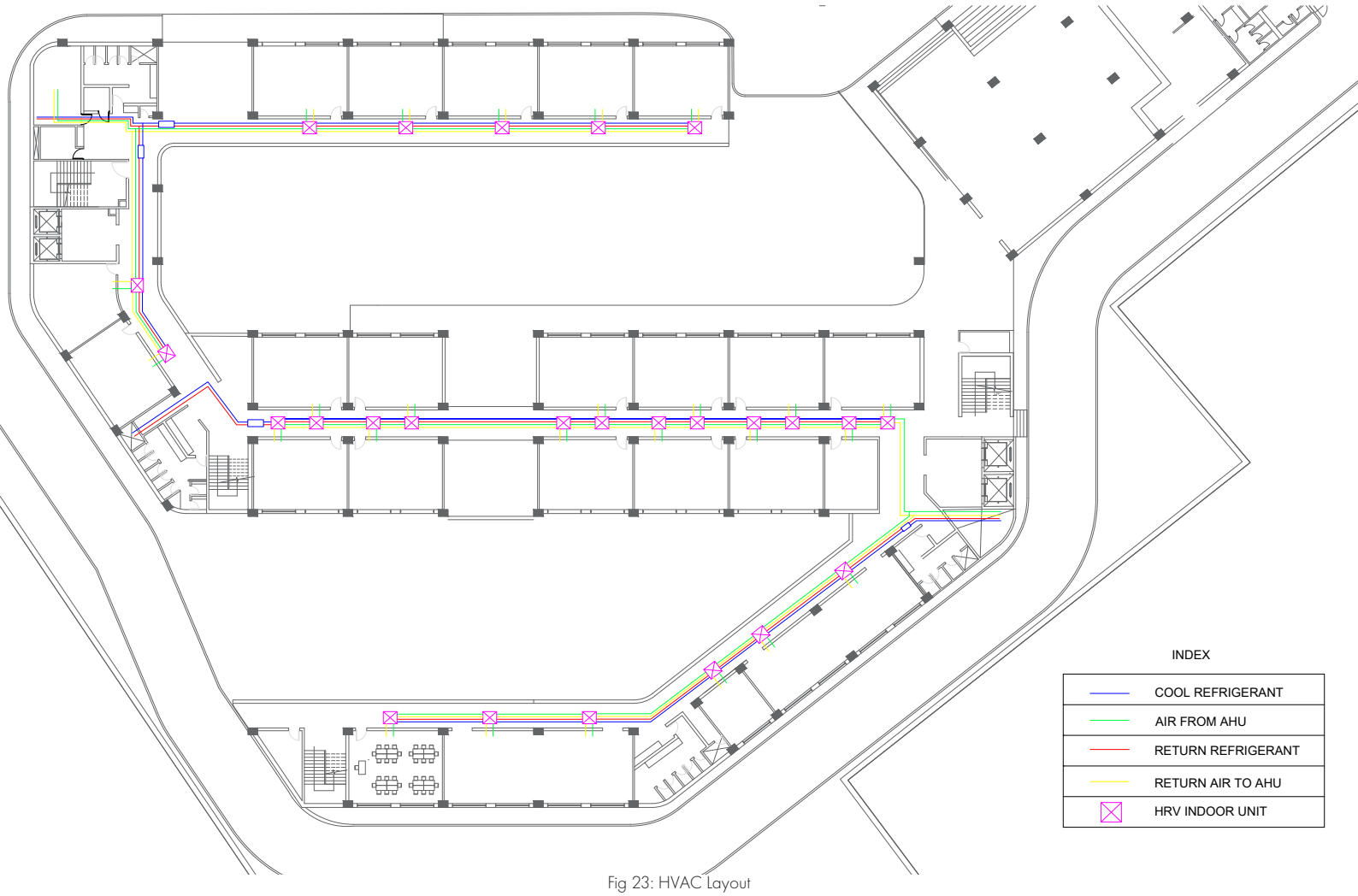


Fig 23: HVAC Layout

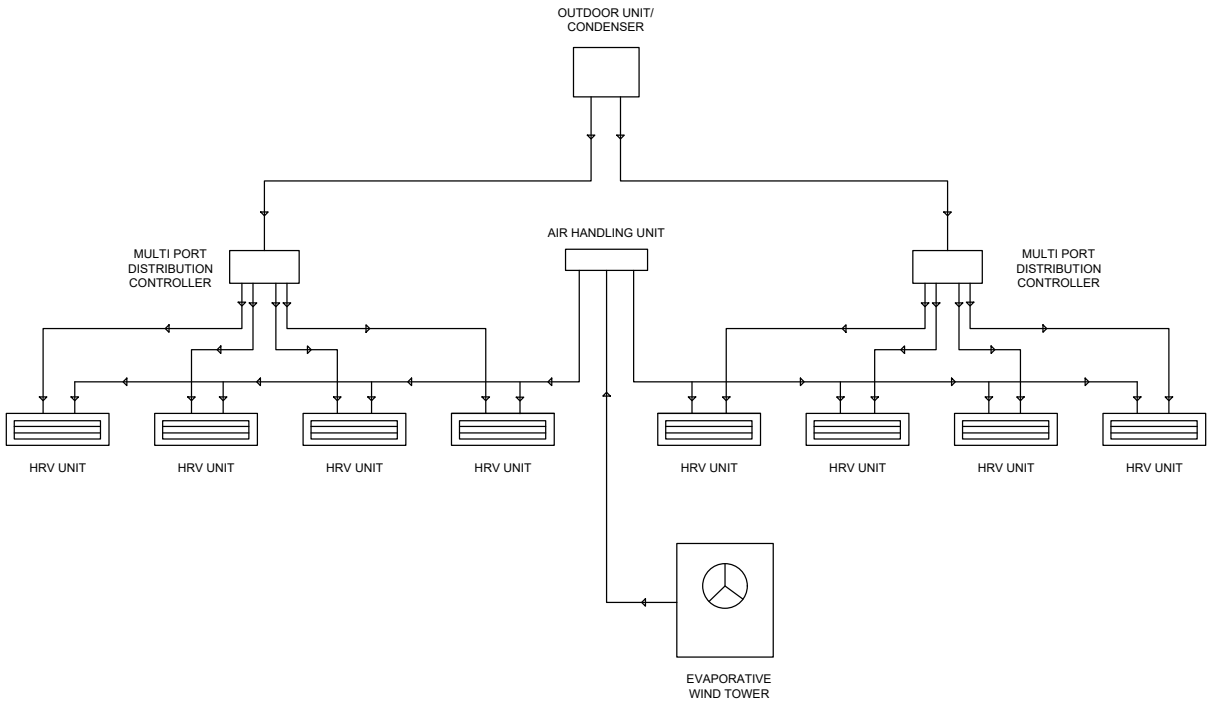


Fig 24: HVAC SLD

Appendix 4B: Electrical

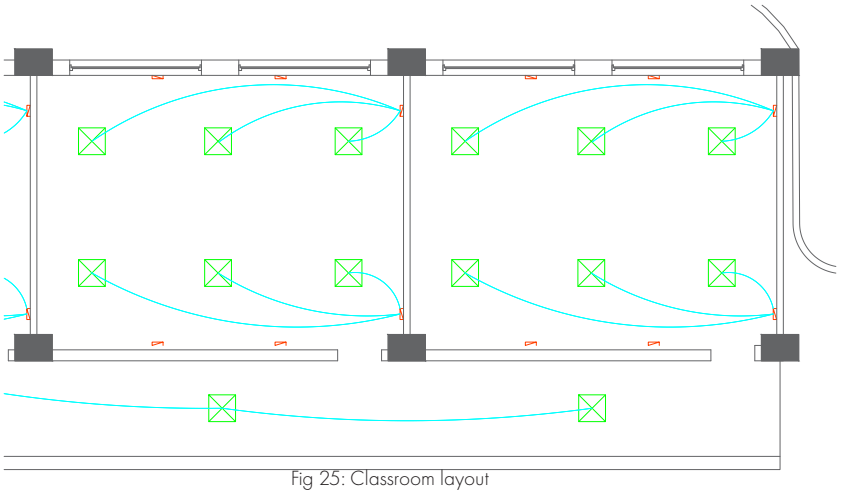


Fig 25: Classroom layout

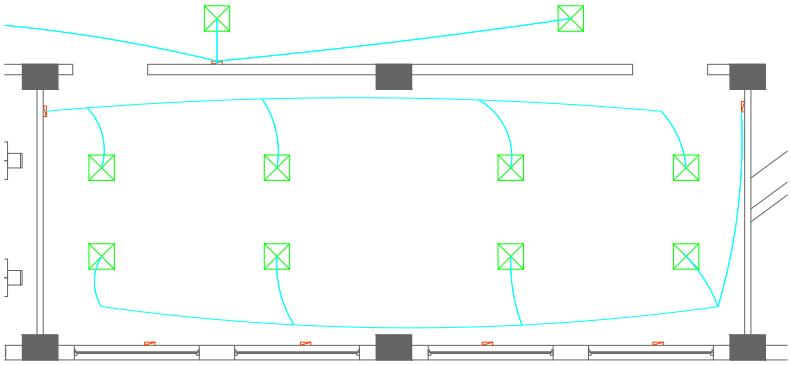


Fig 26: Laboratory layout

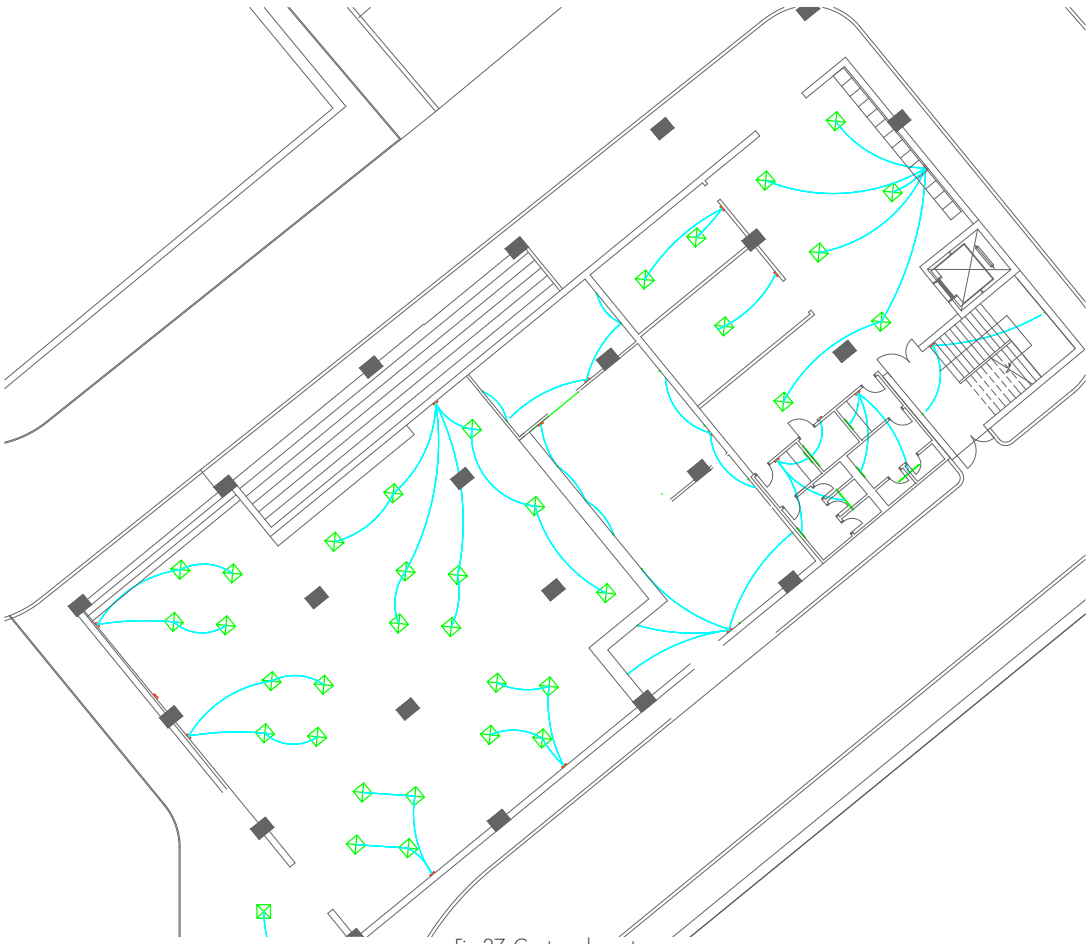


Fig 27: Canteen layout

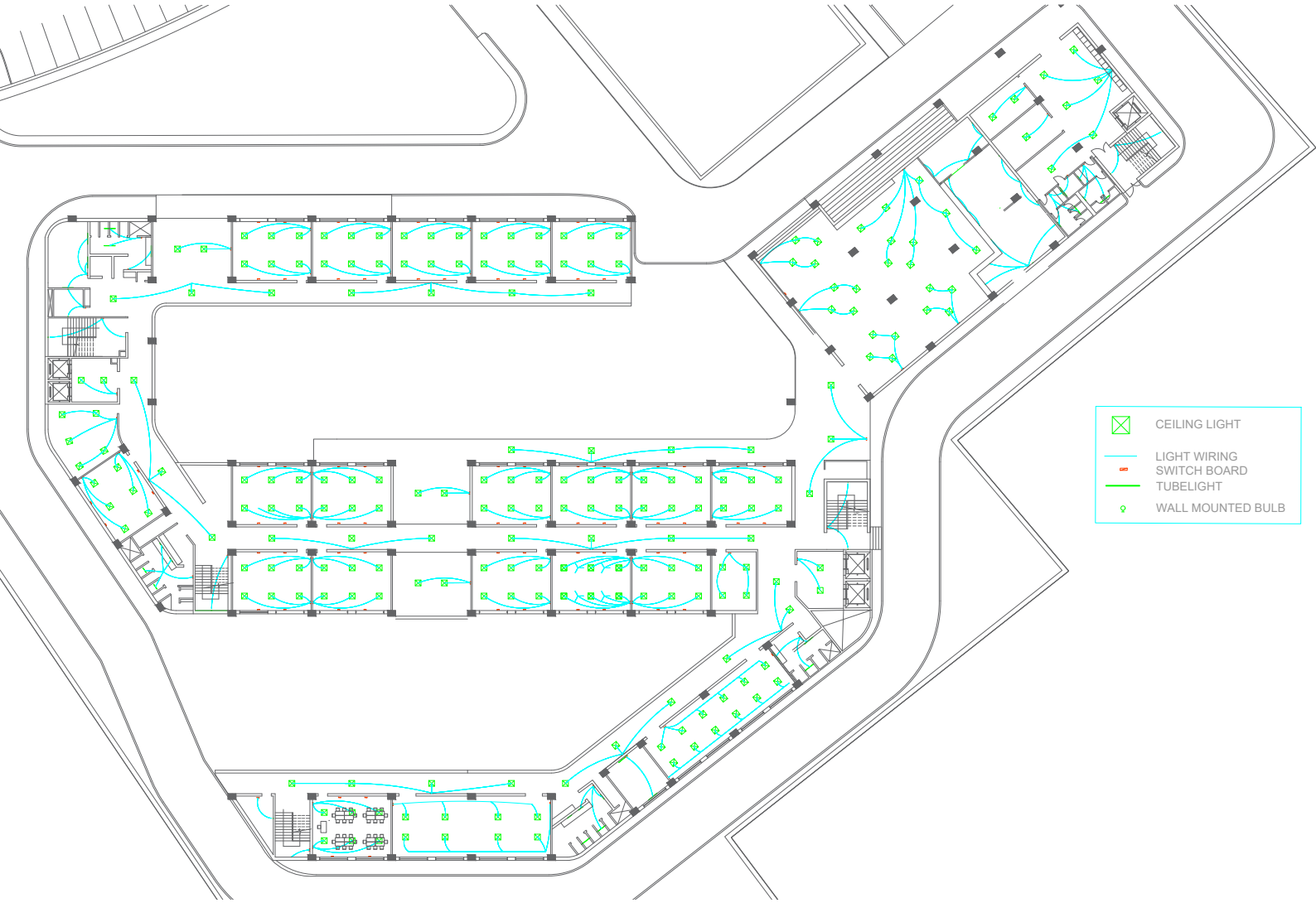


Fig 28: Typical floor layout

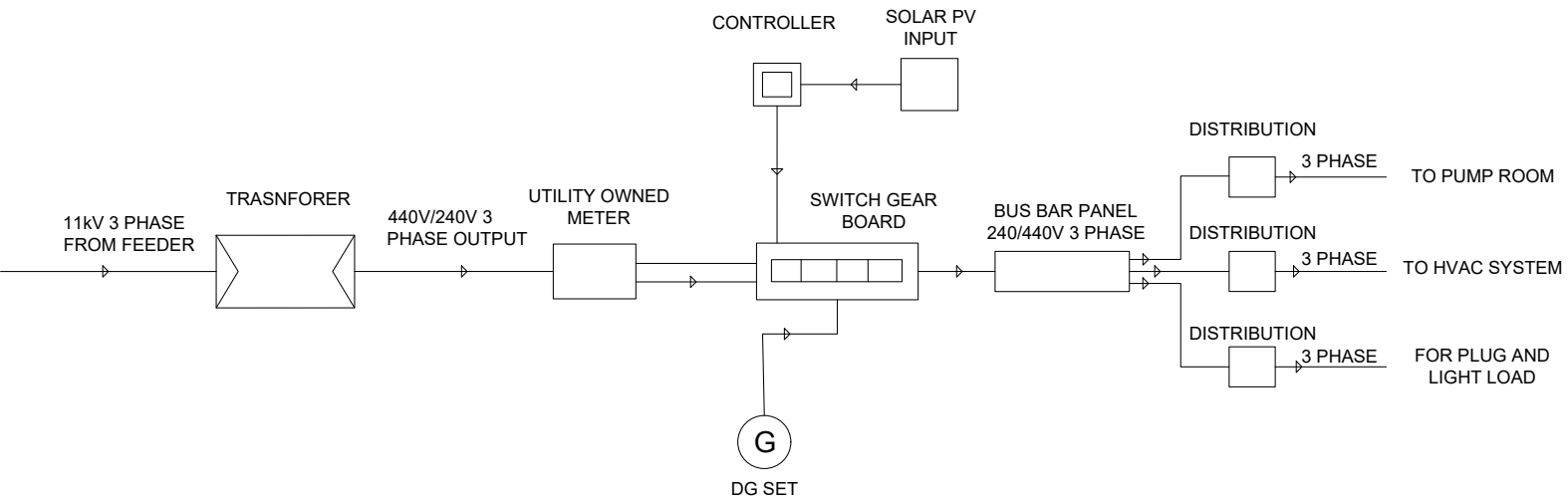


Fig 29: Electrical SLD at site level

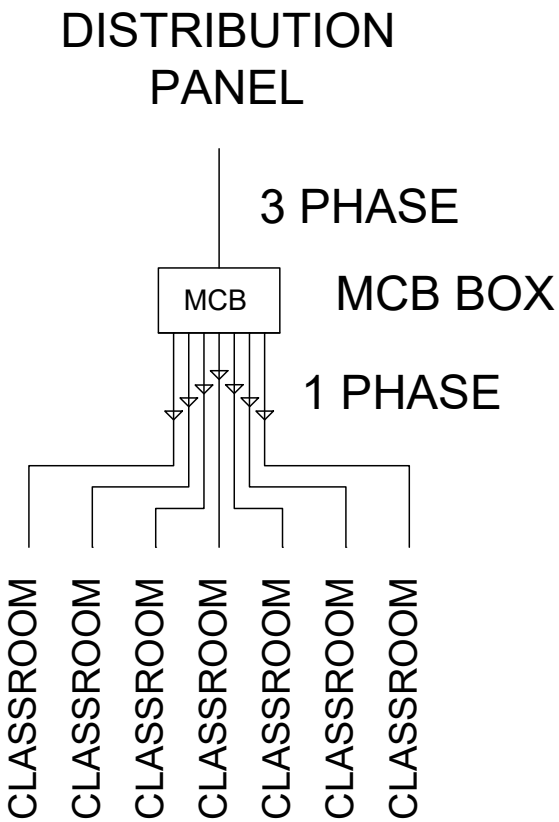


Fig 30: Electrical SLD

Appendix 4C: Solar

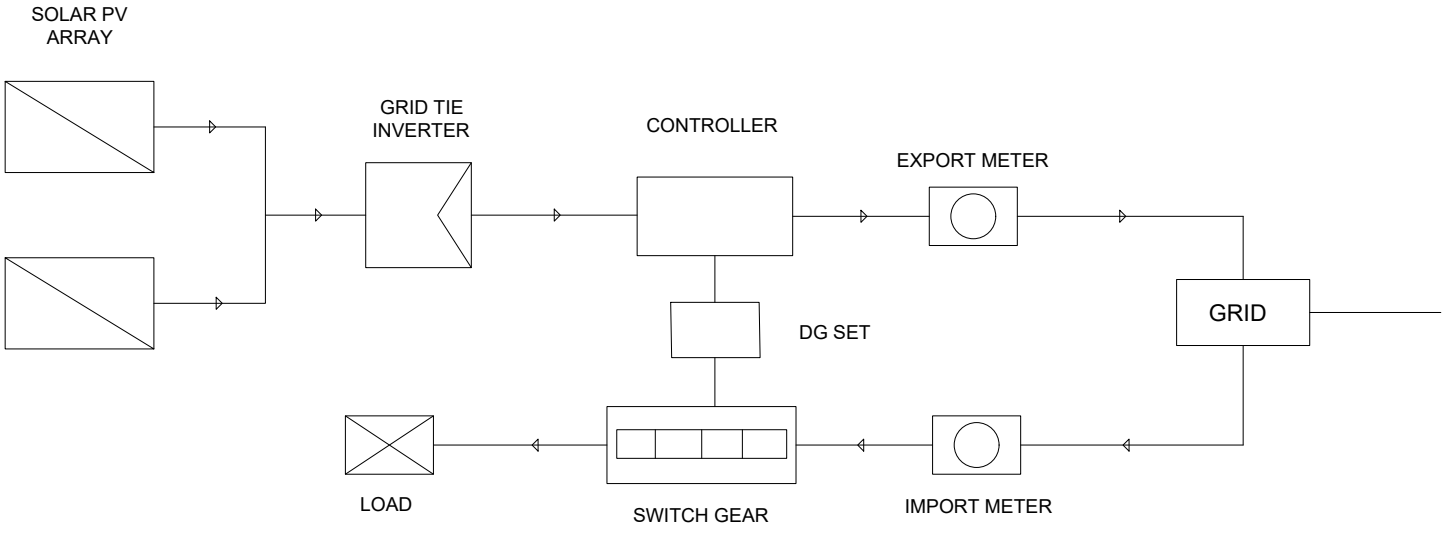


Fig 31: Solar SLD

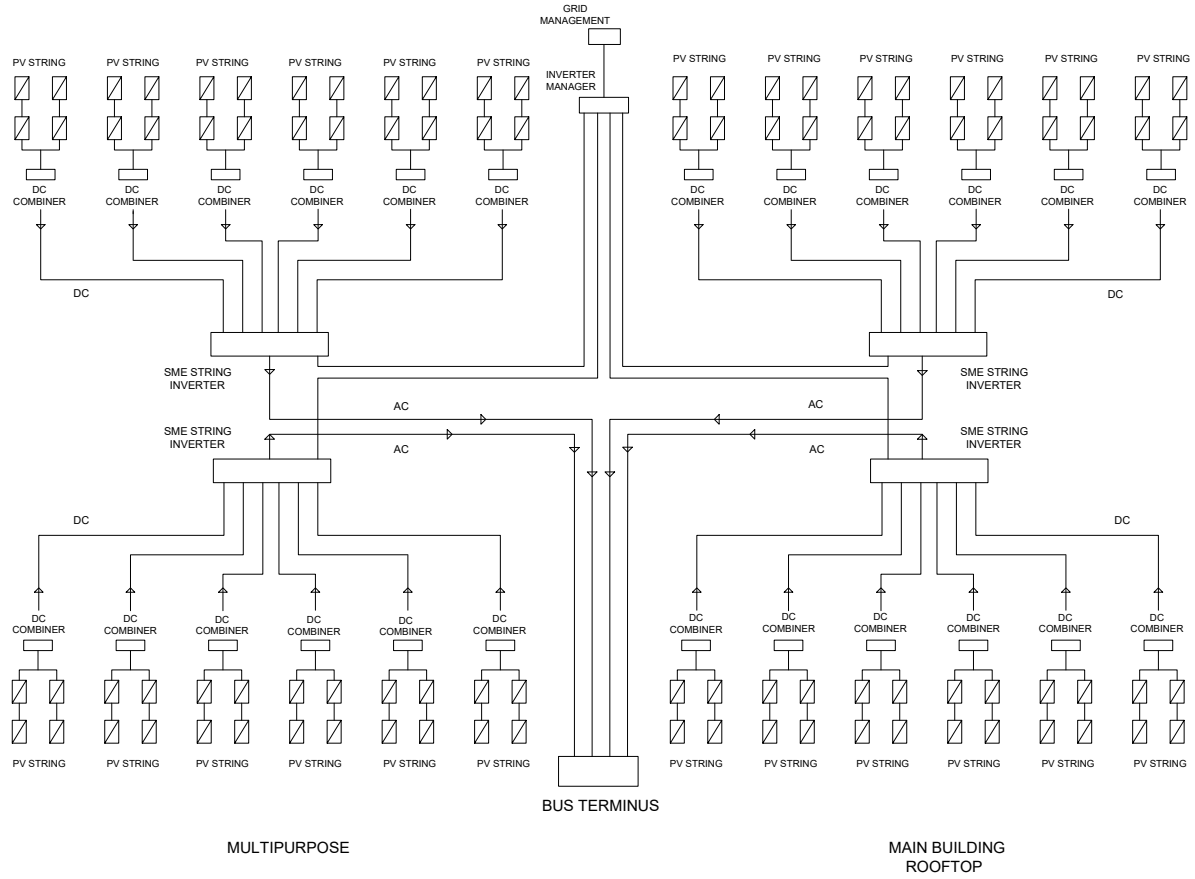


Fig 32: Solar array SLD

Appendix 4D: Fire

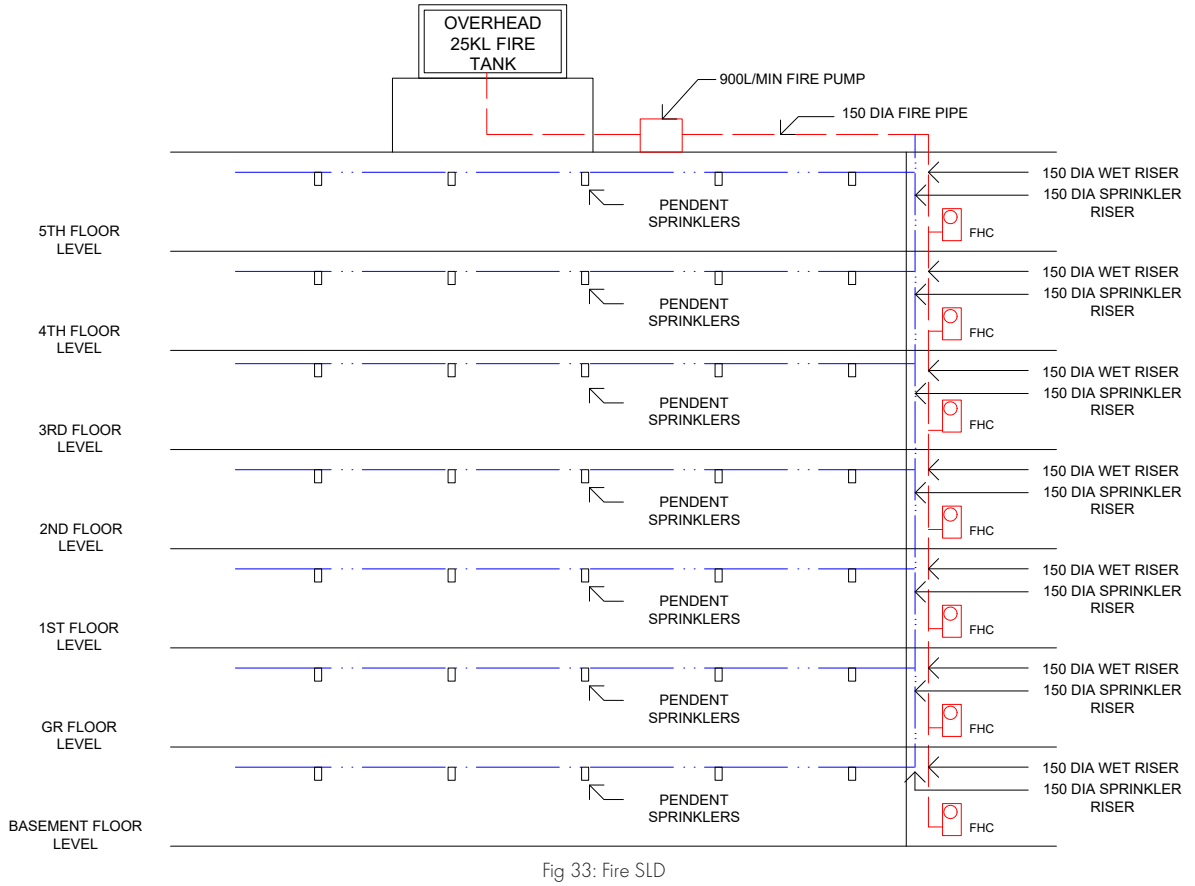


Fig 33: Fire SLD

Appendix 4E: Plumbing

	100mmØ GREY WATER OUTLET PIPE PVC
	100MMØ BLACK WATER OUTLET PIPE PVC
	80MM Ø GREY WATER INLET PIPE PVC
	80MM Ø BLACK WATER INLET PIPE PVC
	80MM WHITE WATER INLET PIPE CPVC

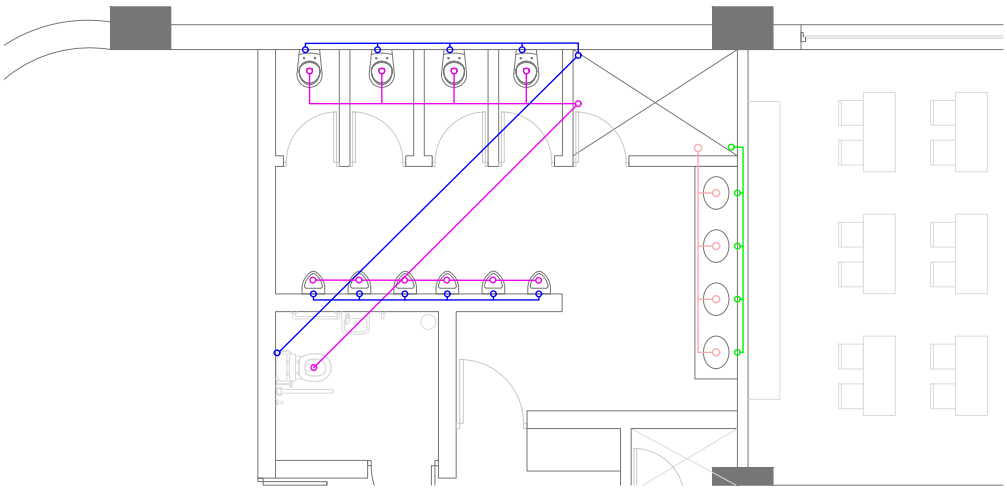


Fig 34: Typical toilet layout

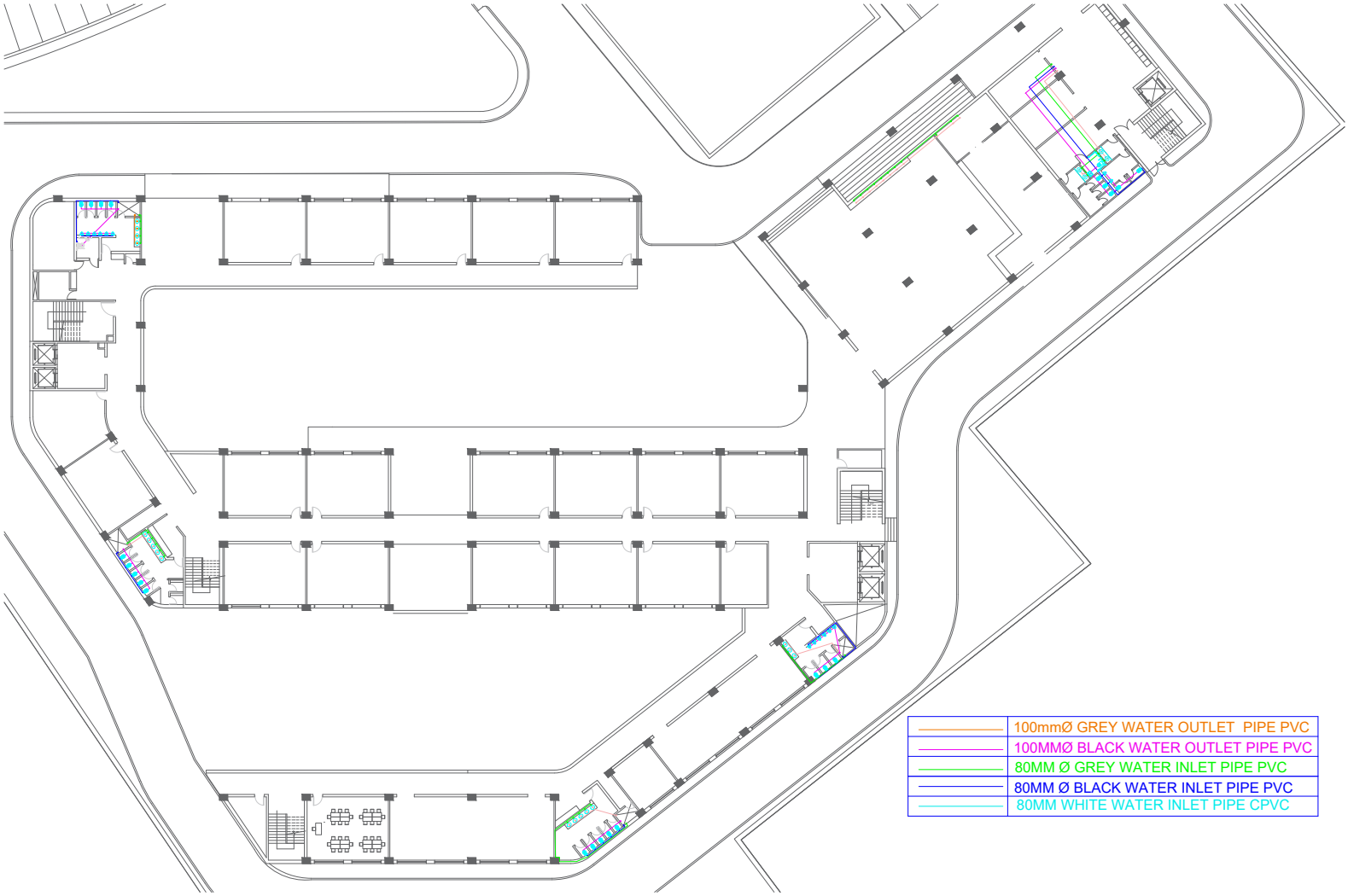


Fig 35: Plumbing layout

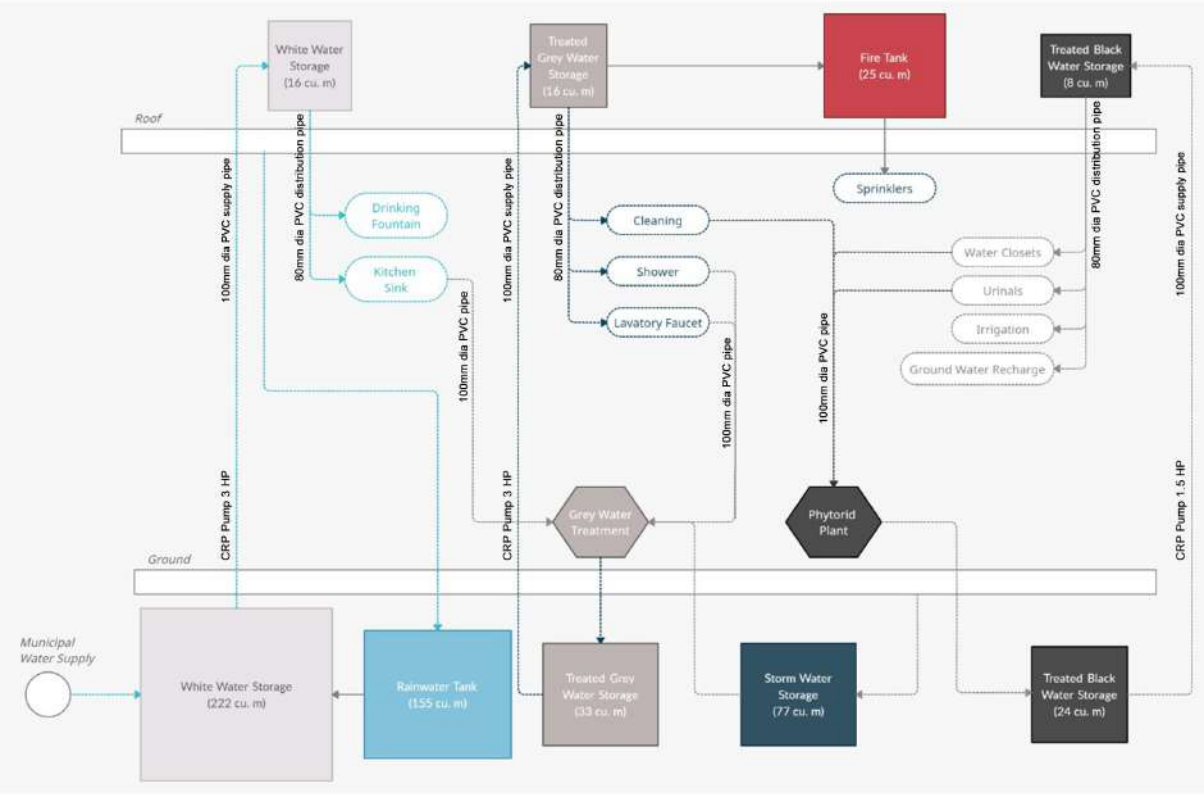


Fig 36: Plumbing SLD

Appendix 5: Water Calculations

Month	Days in month	No. of working days	Generated black water	Filtered black water	Generated Grey water	Filtered grey water	Harvested rainwater	Occupant demand	Irrigation demand (l)	Total water demand (l)	Municipal water demand (l)
Jul	31	23	840181	838506	1128067	1015260	937767.6	2107444	263348.65	2370793	0
Aug	31	23	840181	838687	1128067	1015260	933031.4	2107444	234,988.02	2342432	0
Sep	30	22	803651	802124	1079021	971119	629914.6	2015816	243,091.06	2258907	0
Oct	31	23	840181	838506	1128067	1015260	80515.4	2107444	263,348.65	2370793	436510
Nov	30	22	803651	802247	1079021	971119	0	2015816	229,246.94	2245063	471698
Dec	31	18	657533	656605	882835	794552	14208.6	1649304	186,369.81	1835674	370308
Jan	31	18	657533	657040	490464	441418	71043	1649304	178,266.78	1827571	658070
Feb	28	20	730592	729427	980928	882835	73411.1	1832560	197,086.73	2029647	343973
Mar	31	20	730592	729534	735696	662126	37889.6	1832560	264,196.86	2096757	667207
Apr	30	23	840181	839220	539510	485559	14208.6	2107444	305,824.24	2413268	1074280
May	31	13	474885	473647	637603	573843	33153.4	1191164	344,379.00	1535543	454900
Jun	30	0	0	0	0	0	269963.4	0	313,665.88	313666	0
Total water consumption (l)=				**23640113**	**Water used from alternate sources (l)=**			**20129002**	**Water recharged into the ground (l) =**		**3511111**

Table 5: Net zero calculation

Table 6: Landscape water demand

Outdoor water demand reduction

LPD = Litre per day

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement (l/day)
	January	1	Lawns(bermuda grass)	0.0044	0.45	2242	0.85	5222.541176
		2	Newly planted Native Trees	0.0044	0.15	162.5	0.9	119.1666667
		3	Newly planted Native Trees	0.0044	0.15	132.5	0.9	97.16666667
		4	Newly planted Native Trees	0.0044	0.15	150	0.9	110
		5	Newly planted Native Trees	0.0044	0.15	275	0.9	201.6666667
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophytes	0	0	150	0.9	0
						3262		
					Total daily water requirement (l)			5750.54
					Total monthly water requirement (l)			178266.78

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement (l/day)
	January	1	Lawns	0.0044	1	6524	0.75	38274.13
					Total monthly water requirement (l)			1186498.13

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement (l/day)
	February	1	Lawns(bermuda grass)	0.0052	0.45	2242	0.85	6172.094118
		2	Newly planted Native Trees	0.0052	0.15	162.5	0.9	140.8333333
		3	Newly planted Native Trees	0.0052	0.15	132.5	0.9	114.8333333
		4	Newly planted Native Trees	0.0052	0.15	150	0.9	130
		5	Newly planted Native Trees	0.0052	0.15	275	0.9	238.3333333
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophytes	0	0	150	0.9	0
								6796.09
					Total monthly water requirement (l)			197086.73

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement (l/day)
	February	1	Lawns	0.0052	1	3112	0.75	21576.53
					Total monthly water requirement (l)			625719.47

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement (l/day)
	March	1	Lawns(On ground /podium)	0.0063	0.45	2242	0.85	7477.729412
		2	Newly Planted Native shrubs	0.0063	0.15	162.5	0.9	170.625
		3	Newly Planted Exotic shrubs	0.0063	0.15	132.5	0.9	139.125
		4	Newly planted Native Trees	0.0063	0.15	150	0.9	157.5
		5	Newly Planted Exotic Trees	0.0063	0.15	275	0.9	288.75
		6	Newly Planted xerophytes	0	0	150	0.9	288.75
		7	Newly Planted xerophyte	0	0	150	0.9	0.00
					Total daily water requirement (l)			8522.48
					Total monthly water requirement (l)			264196.86

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement (l/day)
	March	1	Lawns	0.0063	1	3112	0.75	26140.80
					Total monthly water requirement (l)			810364.80

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement (l/day)
	April	1	Lawns(On ground /podium)	0.0078	0.45	2242	0.85	9258.141176
		2	Newly Planted Native shrubs	0.0078	0.15	162.5	0.9	211.25
		3	Newly Planted Exotic shrubs	0.0078	0.15	132.5	0.9	172.25
		4	Newly planted Native Trees	0.00780	0.15	150	0.9	195
		5	Newly Planted Exotic Trees	0.0078	0.15	275	0.9	357.5
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophyte	0	0	150	0.9	0
					Total daily water requirement (l)			10194.14
					Total monthly water requirement (l)			305824.24

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement (l/day)
	April	1	Lawns	0.0078	1	3112	0.75	32364.80
					Total monthly water requirement (l)			970944.00

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement (l/day)
	May	1	Lawns(On ground /podium)	0.0085	0.45	2242	0.85	10089
		2	Newly Planted Native shrubs	0.0085	0.15	162.5	0.9	230.2083333
		3	Newly Planted Exotic shrubs	0.0085	0.15	132.5	0.9	187.7083333
		4	Newly planted Native Trees	0.0085	0.15	150	0.9	212.5
		5	Newly Planted Exotic Trees	0.0085	0.15	275	0.9	389.5833333
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophyte	0	0	150	0.9	0
					Total daily water requirement (l)			11109.00
					Total monthly water requirement (l)			344379.00

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement (l/day)
	May	1	Lawns	0.0085	1	3112	0.75	35269.33
					Total monthly water requirement (l)			1093349.33

Table 6: Landscape water demand

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement
	July	1	Lawns(On ground /podium)	0.0065	0.45	2242	0.85	7715.117647
		2	Newly Planted Native shrubs	0.0065	0.15	162.5	0.9	176.0416667
		3	Newly Planted Exotic shrubs	0.0065	0.15	132.5	0.9	143.5416667
		4	Newly planted Native Trees	0.0065	0.15	150	0.9	162.5
		5	Newly Planted Exotic Trees	0.0065	0.15	275	0.9	297.9166667
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophyte	0	0	150	0.9	0
					Total daily water requirement (l)			8495.12
					Total monthly water requirement (l)			263348.65

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement
	July	1	Lawns	0.0065	1	3112	0.75	26970.67
					Total monthly water requirement (l)			836090.67

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement
	August	1	Lawns(On ground /podium)	0.0058	0.45	2242	0.85	6884.258824
		2	Newly Planted Native shrubs	0.0058	0.15	162.5	0.9	157.0833333
		3	Newly Planted Exotic shrubs	0.0058	0.15	132.5	0.9	128.0833333
		4	Newly planted Native Trees	0.0058	0.15	150	0.9	145
		5	Newly Planted Exotic Trees	0.0058	0.15	275	0.9	265.8333333
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophyte	0	0	150	0.9	0
					Total daily water requirement (l)			7580.26
					Total monthly water requirement (l)			234988.02

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement
	August	1	Lawns	0.0058	1	3112	0.75	24066.13
					Total monthly water requirement (l)			746050.13

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement
	September	1	Lawns(On ground /podium)	0.0062	0.45	2242	0.85	7359.035294
		2	Newly Planted Native shrubs	0.0062	0.15	162.5	0.9	167.9166667
		3	Newly Planted Exotic shrubs	0.0062	0.15	132.5	0.9	136.9166667
		4	Newly planted Native Trees	0.0062	0.15	150	0.9	155
		5	Newly Planted Exotic Trees	0.0062	0.15	275	0.9	284.1666667
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophyte	0	0	150	0.9	0
					Total daily water requirement (l)			8103.04
					Total monthly water requirement (l)			243091.06

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement
	September	1	Lawns	0.0062	1	3112	0.75	25725.87
					Total monthly water requirement (l)			797501.87

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement
	October	1	Lawns(On ground /podium)	0.0065	0.45	2242	0.85	7715.117647
		2	Newly Planted Native shrubs	0.0065	0.15	162.5	0.9	176.0416667
		3	Newly Planted Exotic shrubs	0.0065	0.15	132.5	0.9	143.5416667
		4	Newly planted Native Trees	0.0065	0.15	150	0.9	162.5
		5	Newly Planted Exotic Trees	0.0065	0.15	275	0.9	297.9166667
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophyte	0	0	150	0.9	0
					Total daily water requirement (l)			8495.12
					Total monthly water requirement (l)			263348.65

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement
	October	1	Lawns	0.0065	1	3112	0.75	26970.67
					Total monthly water requirement (l)			836090.67

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement
	November	1	Lawns(On ground /podium)	0.0057	0.45	2242	0.85	6765.564706
		2	Newly Planted Native shrubs	0.0057	0.15	162.5	0.9	154.375
		3	Newly Planted Exotic shrubs	0.0057	0.15	132.5	0.9	125.875
		4	Newly planted Native Trees	0.0057	0.15	150	0.9	142.5
		5	Newly Planted Exotic Trees	0.0057	0.15	275	0.9	261.25
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophyte	0	0	150	0.9	0
					Total daily water requirement (l)			7641.56
					Total monthly water requirement (l)			229246.94

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement
	November	1	Lawns	0.0057	1	3112	0.75	23651.20
					Total monthly water requirement (l)			733187.20

Design case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system Efficiency	Water requirement
	December	1	Lawns(On ground /podium)	0.0046	0.45	2242	0.85	5459.929412
		2	Newly Planted Native shrubs	0.0046	0.15	162.5	0.9	124.5833333
		3	Newly Planted Exotic shrubs	0.0046	0.15	132.5	0.9	101.5833333
		4	Newly planted Native Trees	0.0046	0.15	150	0.9	115
		5	Newly Planted Exotic Trees	0.0046	0.15	275	0.9	210.8333333
		6	Newly Planted xerophytes	0	0	150	0.9	0
		7	Newly Planted xerophyte	0	0	150	0.9	0
					Total daily water requirement (l)			6011.93
					Total monthly water requirement (l)			186369.81

Base case	Month	S. No.	Plant Species	Evapotranspiration rate (m/day)	Plant factor	Canopy area (sq. m)	Irrigation system efficiency	Water requirement
	December	1	Lawns	0.0046	1	3112	0.75	19086.93
					Total monthly water requirement (l)			591694.93

Table 6: Landscape water demand

Design case monthly landscape water requirement		
S.No.	Month	Total water requirement (l)
1	January	178266.78
2	February	197086.73
3	March	264196.86
4	April	305824.24
5	May	344379
6	June	313665.88
7	July	263348.65
8	August	234988.02
9	September	243091.06
10	October	263348.65
11	November	229246.94
12	December	186369.81
Total Annual Water requirement (l)		3023812.61

Base case monthly landscape water requirement		
S.No.	Month	Total water requirement (l)
1	January	1186498.13
2	February	625719.47
3	March	810364.8
4	April	970944
5	May	1093349.33
6	June	1029034.67
7	July	836090.67
8	August	746050.13
9	September	797501.87
10	October	836090.67
11	November	733187.2
12	December	591694.93
Total Annual Water requirement (l)		10256525.87

Water use reduction (%) =	70.52

Average Daily Water requirement (l) =	8262.9

Table 7: Landscape water requirements

Building water demand

No. of uses* (In case of Water closets and urinals) = number of usage per person/ per day

No. of uses* (In case of faucets) = duration of use * number of usage per person / per day

Building occupancy (x)	2400	Female	1200	Working days	200
		Male	1200		

Design case					
Sr. No.	Fixtures	No. of fixtures	Flow rates (lpf/lpm)	No. of uses *	Water Consumption (l)
1	Water Closets (solids)	124	3.54	0.35	2973.6
2	Kitchen Faucets	4	3.97	5	47640
3	Water Closets (liquid)(female)	70	1.16	3	4176
4	Urinals (male)	76	1.6	3	5760
5	Lavatory faucets	124	3.97	5	47640
6	Shower head	8	5.86	0.1	1406.4
				Daily water consumption (l)	109596
				Annual water consumption (l)	21919200

Base case					
Sr. No.	Fixtures	No. of fixtures	Flow rates (lpf/lpm)	No. of uses *	Water Consumption (l)
1	Water Closets (solids)	124	9	0.35	7560
2	Kitchen Faucets	4	10	5	120000
3	Water Closets (liquid)(female)	70	9	3	32400
4	Conventional urinals (male)	76	4	3	14400
5	Lavatory faucets	124	10	5	120000
6	Shower head	8	10	0.1	2400
				Daily water consumption (l)	296760
				Annual water consumption (l)	59352000

Water use reduction (%) =	63.06914679

[Annual water demand (Base case) - Annual water demand (design case) / Annual water demand (Base case)] *100

Table 8: Indoor water consumption

Appendix 6: Energy Simulation Parameters

Input Parameters	Units	Proposed Design Values
General		
Building Area	m^2	15131
Conditioned Area	m^2	8478
Electricity Rate	INR/kWh	upto 1000 kWh: 9, above 1000 kWh: 9.3
Natural Gas Rate	INR/GJ	-
Building Occupancy Hours	-	7:00 AM - 3:00 PM
Average Occupant Density	m^2 / person	8
Internal Loads		
Interior Average Lighting Power Density	W/m^2	3.9
List of Lighting Controls	-	occupancy, daylight - stepped (3 steps)
Average Equipment Power Density	W/m^2	4.8
Minimum OA Ventilation (Building Average)	$l/sec.m^2$	1.9
Envelope		
Roof Assembly U value	$W/m^2.K$	0.263
Roof Assembly SRI		0.8
Average Wall Assembly U value	$W/m^2.K$	0.312
Window to Wall Area Ratio (WWR)	%	35
Windows U value	$W/m^2.K$	1.4, 1.3
Windows SHGC		0.47, 0.28
Windows VLT	%	59, 52
Infiltration Rate	ac/h	5
Describe Exterior Shading Devices		sunshades dervied from shading masks
HVAC System		
HVAC System Type and Description	-	Wind Tower with VRF air cooled system
Describe Mixed mode strategy in operation/controls of AC and windows	-	Mechanical Ventilation with variable setpoints. AC switch to steady state with constant ach when the setpoint is met
Heating Source	-	-
Heating Capacity	kW	-
Heating COP		-
Cooling Source	-	Electricity
Cooling Capacity	kW	945
Cooling COP		4.47
Operation Hours		7:00 AM - 3:00 PM
Heating Set Point	°C	-
Cooling Set Point	°C	*variable
Relative Humidity Setpoint		*variable
Service Hot Water		
SHW Type and Description	-	-

Table 9: List of energy simulation input parameters

Jan - Feb	March	April	May - Sept	October	November	December
25° C	26° C	28° C	30° C	29° C	27° C	25° C

Table 10: Temperature set points

Output Parameters	Units	Proposed Design Values	
Proposed EUI (Total)	kWh/m²/ yr	21.06	
EUI Breakdown by End Use			
Heating	kWh/m²/ yr	-	
Cooling	kWh/m²/ yr	5.93	
Fans	kWh/m²/ yr	5.59	
Pumps	kWh/m²/ yr	0.24	
Heat Rejection	kWh/m²/ yr	-	
Service Hot Water	kWh/m²/ yr	-	
Lighting	kWh/m²/ yr	3.34	
Equipment	kWh/m²/ yr	5.96	
Total Envelope Heat Gain (Peak)	W/m²	10.62	
Cooling Capacity per Conditioned Area	SF/ Tr	338.0	
Building Electric (Peak)	W/m²	7.50	
Annual Operating Energy Cost	INR/m²	-30.6168065	
Annual Unmet Hours	-	26	
Cooling Capacity	Tr	270	
Annual Hours of Comfort without Air Conditioning		77.8% (1335 of 1700)	
Monthly Energy Performance		**Generation**	**Consumption**
Jan	kWh	26555.50	24618.01
Feb	kWh	26805.35	22959.51
Mar	kWh	46704.04	31983.72
Apr	kWh	59829.40	17630.26
May	kWh	56527.58	23234.78
Jun	kWh	55034.02	0.00
Jul	kWh	47792.93	35505.97
Aug	kWh	40033.50	39353.48
Sep	kWh	38192.98	38190.43
Oct	kWh	35106.73	31632.15
Nov	kWh	32012.14	31019.29
Dec	kWh	27057.31	21418.94

Table 11: List of energy simulation output parameters

Appendix 7: Comfort Parameters

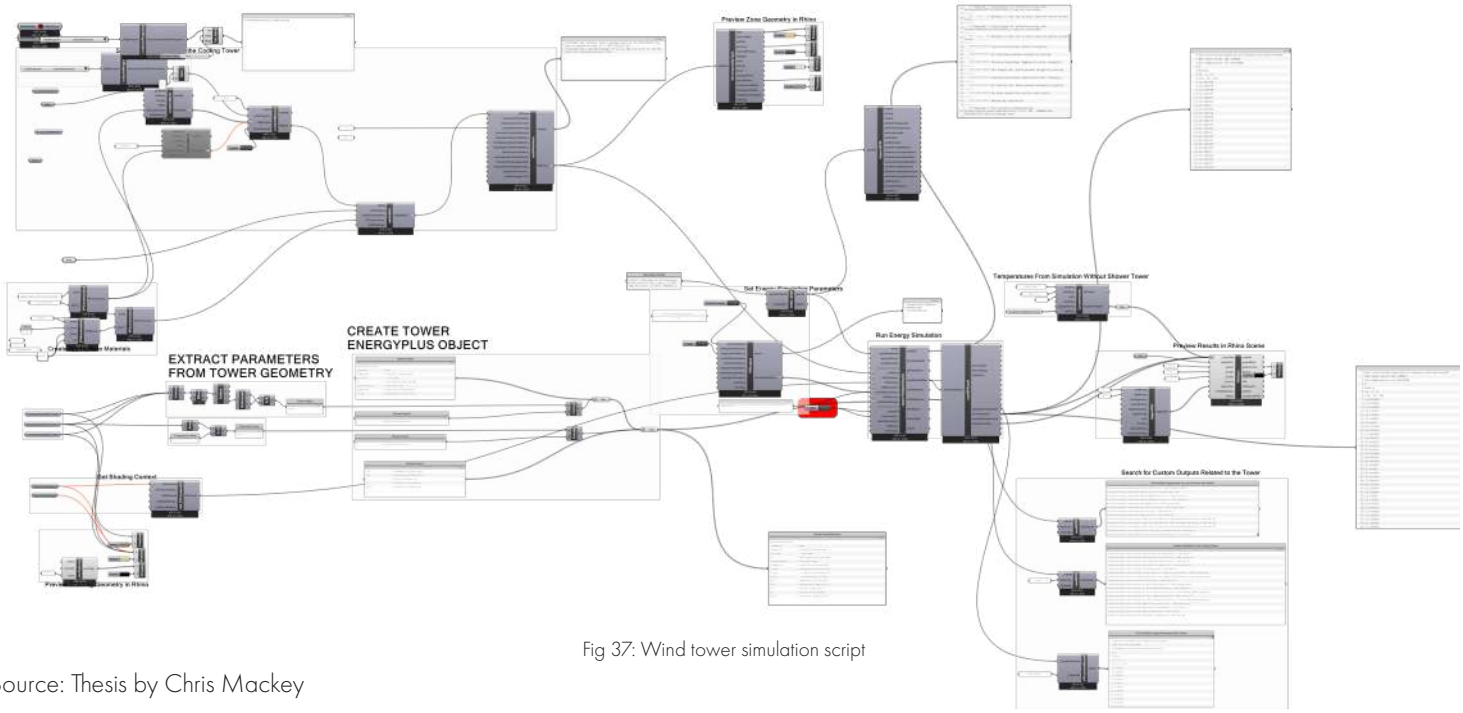
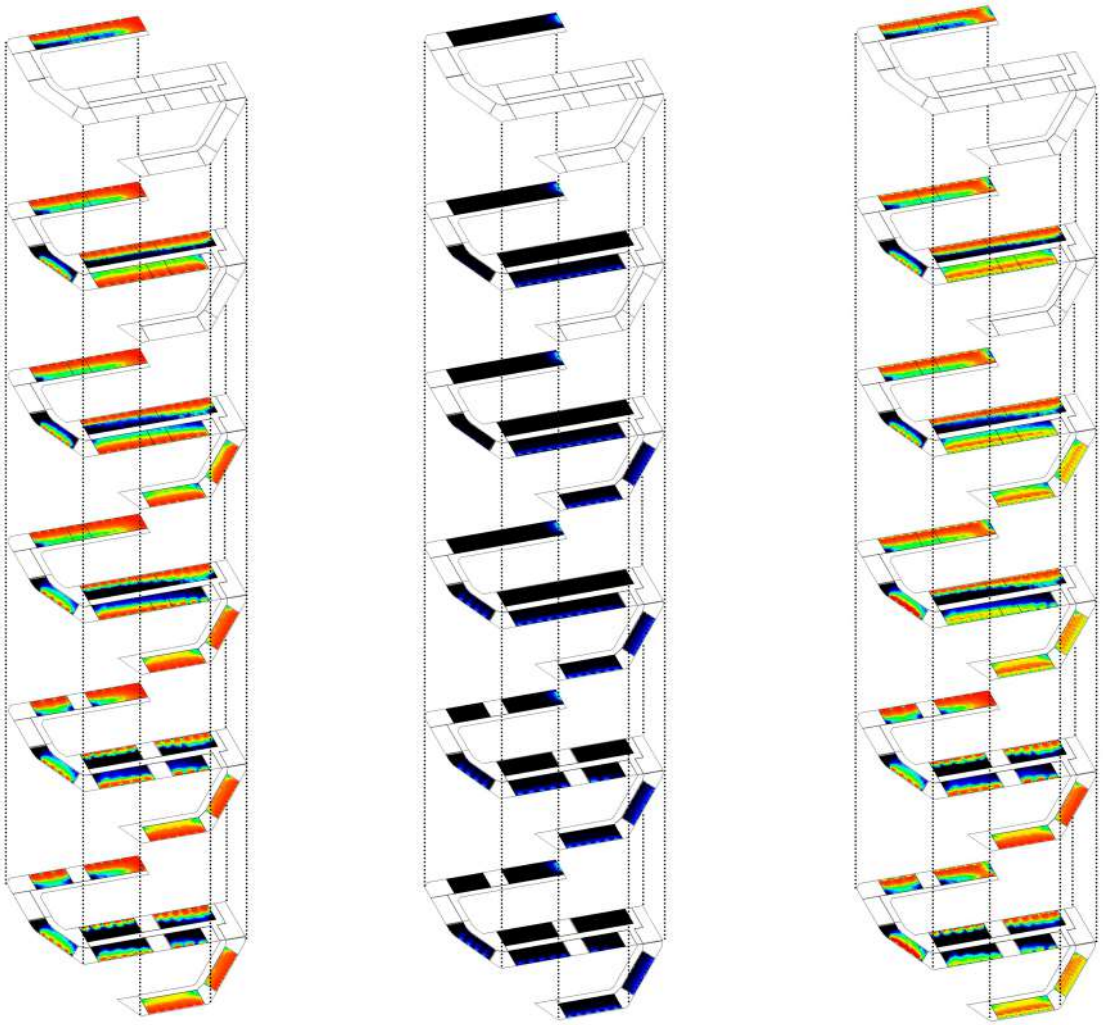


Fig 37: Wind tower simulation script

Source: Thesis by Chris Mackey



Spacial daylight autonomy | Annual sun exposure | Useful daylight index

Fig 38: Daylight maps

Appendix 8: Building Outline Specifications

Electrical Equipment							
Name	Equipment	Watt	Model No.	Specification	Price	Uses	Required No.
Epson Projector	Projector	282w	EB-X05 XGA V11H839040	1. Light Output of 3,300 lumens 2.Create the big screen experience 3.Projector Screen Type: Wall and Ceiling Projector Screens	Rs.37860	A/v Room Classroom Art room Computer Lab Bio Lab Science Lab Lecture Room	97
ELCOR PRO Series Projector screen	Projector Screen		-	Keeps your Eyes Strain Free while Viewing, Comes With Anti UV Coating to Protect Eyes, Good Fabric, Supports 1080P FULL HD	Rs.1000	Same as projector	97
Spiral CFL Light Bulb	Light bulb	14w	-	Features - CFLs With Less Mercury Energy Star Certification -Yes Type of light - Compact fluorescent Lifespan -10,000 hours Brightness - 800 lumens Color - 5000 K (Daylight)	Rs.232.00	All room, Toilet	49
Philips LED bulb	Led bulb	23w	-	Energy Star Certification -Yes Lifespan -12,000 hours Brightness -1600 lumens Color -2700 K (Soft white)	Rs.250	Toilet,Staircase	-
Syska T5 LED Tubelight	Led tubelight	20w	HOMSYSKA-T5-20-PROM92280062B2FE27	Lifespan - 50,000 Hours Color - White	Rs.595	Toilet	-
LED FANTASY LED PANEL LIGHT	Led panel Light	40w	-	Lifespan - 50,000HRS Brightness - 4500 Color - 5000K Day White light lux - 72lux	Rs.3500	All classroom	681
HP 21-b0101 Computer	Computer		21-b0101	Windows 10 Home Single Language 64 Operating System Intel UHD Graphics 600 4 GB RAM, 1 TB Internal Storage 52.57 cm (20.7 inch) Full HD Anti Glare Display Warranty: 3 Years manufacturer warranty	Rs.25000	All classroom, Computer lab Admin Office	30
Kyocera Taskalfa print machine	Print Machine	30 to 50 watts on standby 300 to 500 watts when printing.	3212i	Engine speed : Up to 32/17 pages per minute A4/A3 Time to first print Approx. 4.9 seconds or less	Rs.117000	Admin Office,	2
Hikvision CCTV Dome camera	CCTV camera	12w	-	2MP Ultra Low Light Dome Camera 2MP Turbo HD 1080p resolution20 mtr range	Rs.1890		117
neox panel LED light	LED light	27w	-	Lifespan-81,000HRS Brightness-3064 Color -5000k Day White light Colour Watt-27W Lux-48lux		Cafe, Corridor, Lift Lobby	190
Hikvision CCTv Bullet camera	CCTv camera	12w	DS-2CE1AD0T-PIR	Full HD Metal 2MP Ultra Low Light Bullet Camera - Indoor/Outdoor 2.8 mm, 3.6 mm fixed focal lens PIR detection, visual alarm Up to 20 m IR distance IP67	Rs.2350	-	44

Table 12: List of equipments

DG Set									
Prime rating at rated rpm (as per ISO 8528)		Genset Model	Frequency	Power factor	Voltage (with three phase supply)	Fuel Consumption			Fuel Tank capacity
						at 100% load	at 75% load	at 50% load	
kVA	kW	cummins diesel generator sets	Hz	lagging	V	Ltrs/hr			Ltrs
500	400	KTAA19-G10	50	0.8	415, 3 phase	109	84.28	56.18	700

Table 13: DG set specifications

HVAC						
Name	Equipment	Watt	Model No.	Specification	Dimension (in)	Uses
Daikin	VRF Outdoor unit	4.47 kW	RXQ20ARY6	208/230V, 3-Phase, 60Hz 16 tonnage	1,657 X 1,240 X 765	outdoor unit works as condenser and cools the refrigerant
Daikin	Multiport Distribution Controller (MDC)	-	40VMD016ML-3	208/230V, 1-Phase, 60Hz number of ports - 16 capacity - 4.5 tonnage	53-7/8 x 18 x 33-1/8	distribution controller distributes the refrigerant flow to different indoor units
Daikin	Heat Reclaim Ventilation Unit	80W	VKM80GAM	1~, 50Hz, 220-240V, Cooling: 7.46kW,	1,764 X 1,2114 X 387	Indoor unit acts as evaporator and it exchanges heat from the air to the refrigerant

Table 14: HVAC specifications

LOCKERS		
Name	Material	Price
Blue Mild Steel School Lockers	Mild Steel	₹ 13,500/ Piece
Shakuntal Modern School Storage Locker,	Mild Steel	₹ 3,000/ Piece
Powder Coating Mild Steel School Locker	Mild Steel	₹ 15,000/ Piece

Table 15: Lockers

Inverter										
Brand	Model Name	Voltage input	Power Consumption	Effciency	Rated Power	Weight	Module Dimensions	Water Protection	AC Range	Max Output Current
SMA String Inverter	Sunny Tripower 60	1000 Volts	<20 W	98.8	61240 W	910 g	160 / 125 / 49 mm	IP21	360V - 530 V	87 A

Solar panels											
Brand	Model Name	Authorised Dealer India	Peak Power Watts-PMAX (Wp) *	Module Effciency η m (%)	Solar Cells	Cell Orientation	Module Dimensions	Weight	Glass	Frame	Required No.
TRINA Solar	Framed 144 Half-Cell Multi-Busbar Module	Loop Solar	390	19.2	Monocrystalline	144 cells	2176 ×1098× 35 mm	22.8kg	3.2 mm	35 mm Anodized Aluminium Alloy	721

Table 16: Solar PV system specification

CEILING & FLOOR TILES						
Brand	Name	Price	Size and color	Material	Application	Feature
ARMSTRONG	Armstrong White Mineral Fiber Ceiling	₹ 55/ Square Feet	Thickness-12mm	mineral fiber	Classroom ceiling Admin Office Ceiling , Activity room, Library, Reception	Light reflectance-87% Sound Absorption-0.95 NRC Lifespan-30yr gaurantee
Techo acoustic	Techno Acoustic Wall Panels	Rs.60/sq ft.	2440 mm X 1220 mm	PET (polyethylene terephthalate),	Auditorium Conference lecture hall Cafeteria	High Performance – Noise Reduction Coefficient (NRC) 0.85-0.9 Light weight, Flexible & Easily Customisable Made from 100 % Recycled material Does not aid to the spread of fire High Resistance to Humidity, Moisture & Chemicals
Freeform	Terrazzo Flooring	₹ 100-150/ Square Feet	20mm thickness colour - light Brown Mix Terr. Copper	Terrazzo	Classroom flooring	hard, heavy, durable and long lasting.
ARMSTRONG	Armstrong Vct Vinyl Composite Tile	₹ 100-150/ Square Feet	305 mm x 305 mm x 3.2 mm 305 mm x 305 mm x 2.4 mm 305 mm x 305 mm x 2.0 mm	Vinyl	Nursery Classroom flooring	Dent resistant, Scratch and stain resistant, 100% waterproof. 30-year warranties
Orientbell	Orientbell Onyx Multi Porcelain Tile	Rs.64 sq/ft	600X600 mm	Porcelain	Staircase	Dent resistant, Scratch and stain resistant, 100% waterproof.
Orientbell	ODP Camrilo-Sugar Non Digital Ceramic Floor Tiles	₹ 70/ sq ft	600x600 mm	Ceramic	Toilet and dado kitchen	environmentally friendly from mining to installation, Water Resistance. Durable, Easy Maintenance, No Allergy Concerns Harder Surface,Ceramic is a Cold Material.
pulse	Pulse PP Carpet tile	₹70.20/sqft	20 pieces (53.8 sqft) / case	Polypropylene	Library, Admin office	sustainable, durable, Versatile, Improve indoor air quality, superior acoustics.
	Glossy Decorative Colored Concrete Flooring	₹ 35/ Square Feet	10 to 20 mm Thickness	Concrete	Corridor , Lab, Reception	Acid Resistant, Double Loading
Aeroflex	Wooden Flooring	Approx. Price: Rs 300 / Square Fee	Mapple,Finish- Matte	Wooden	Multipurpose hall	easy maintenance and improve the player performances

DESK/BENCH				
Name	Material	Price	Brand	Seatiing capacity
Ergomaxx Wooden Dual Desk Bench	Wood	₹ 4,560/ Number	Ergomaxx	2
Mild Steel Rectangular Duel Desk Bench	Mild Steel	₹ 4,500/ Piece	SAI SINDHU	-
Wood Classroom Bench,	Wood	₹ 7,500/ Piece	Fsc	3
Brown Double Wooden Desk Cum Bench For School	Wood	₹ 2,250/ Piece	-	2

WALL PAINT					
Paint Brand	Paint name	Price	Washability	Color	Toxicity
Berger	BERGER Bison Acrylic Emulsion	₹ 134/per litre ₹ 2114/20litre	Medium	Matt	50gm/ltr
Berger	Berger WeatherCoat Exterior Primer	Rs.122/litre	Medium	white	less than 50gm/ltr
Berger	Berger Paints Bison Wall Putty	Rs.1037/40kg	Medium	white	less than 50gm/ltr
Berger	Berger WeatherCoat Anti Dust	Rs.5900/4ltr	Medium	Rich soft sheen	less than 50gm/ltr

Table 17: Interior finishes

Figure	Product Name	Product Specification	Price	Quantity
	Rainy Rainwater Harvesting Filter FL-200	Filter Element: SS-304 Screen Mesh Size: 250 Microns Inlet: 110 MM Clean Water Outlet: 75 Mm Drain Outlet: 90 MM	10382	6
	Crompton centrifugal monoset pump MBQ32(1PH)-15	Power HP- 3 power kw - 2.2 phase- 1 stage-1	17750	2
	Crompton centrifugal monoset pump MBN1.52-VX	Power HP- 1.5 power kw- 1.1 phase- 1 stage-1 discharge range lpm- 500	10025	1
	PP Aquatech UV Water Treatment System	Power: 110 Watts Pure Water: 5.4t/h 24GPM Fountain: 4.32t/h 19.2GPM Capacity: 0.5 - 150 CUM/HR	9500	2
	110 mm Astral PVC Pipes	Size/ Diameter: 110 mm Length of Pipe: 6 m	1080	-
	80mm Supreme PVC Pipes	Length of one pipe: 6m Class: Class 3 Type: Hard Tube (round) UV Resistant: Yes Material: PVC	80	-
	SINTEX FRP UNDERGROUND WATER TANK	Capacity - 50,000L	6,25,000	7
	SINTEX FRP UNDERGROUND WATER TANK	Capacity - 35,000L	4,25,000	1
	SINTEX FRP UNDERGROUND WATER TANK	Capacity - 25,000L	3,12,500	1
	Hunter MP200090MP2000 Popup Sprinkler	Adjustable Radius 4 M 6 4 M Adjustable Arc 90 210 Female Threaded Black Capacity: 2.5 - 10.7 M Material: Plastic	591	60
	KSNM Plastic Drip Irrigation System	-	7.5	570

List of plumbing fixtures used												
MODEL		Water Consumption				Green Points Rating System				Price (excl. GST)	Price (incl. 18% GST)	Total
						IGBC		LEED				
		Baseline	Rated	Savings		Homes	Factory Bldg.	CS	NC&MR			
Water Efficient Faucets												
HINDWARE ELEMENT Pillar Cock Body F360001		8.30 Lpm	3.97 Lpm	4.33 Lpm	52%	4	4	4	4	1120	1322	143360
Dual Flush Water Closets												
		high/low (Lpf)	high/low (Lpf)	high/low (Lpf)								
HINDWARE Wall Hung 20082 EWC Mario with R&T G3004 Concealed Cistern		6.0 / 3.0	3.54 / 1.16	2.46 / 1.84	41% / 61%	4	4	3	3	5500	6490	1067000
Urinals												
HINDWARE Edge Urinal Sensor Based		3.8	1.6 - 2.6	2.2 - 1.2	58% - 31.5%	-				6552	7990	497952
Shower Heads												
High Sierra's All Metal High Efficiency Low Flow Showerhead		10	5.68	4.32	43.20%	-				3000	3540	24000

Table 18: Plumbing fixtures

Appendix 9: Schedules

Table 9-13 Schedules for Educational - School Buildings (A)

Educational - School						
Time Period	Occupancy Schedule		Lighting Schedule		Equipment Schedule	
	Student Zone	Back Office	Student Zone	Back Office	Student Zone	Back Office
	5 Days/ week	5 Days/ week	5 Days/ week	5 Days/ week	5 Days/ week	5 Days/ week
00:00-01:00	0.00	0.00	0.00	0.00	0.00	0.00
01:00-02:00	0.00	0.00	0.00	0.00	0.00	0.00
02:00-03:00	0.00	0.00	0.00	0.00	0.00	0.00
03:00-04:00	0.00	0.00	0.00	0.00	0.00	0.00
04:00-05:00	0.00	0.00	0.00	0.00	0.00	0.00
05:00-06:00	0.00	0.00	0.00	0.00	0.00	0.00
06:00-07:00	0.00	0.00	0.00	0.20	0.00	0.00
07:00-08:00	0.70	0.00	0.90	0.70	0.35	0.35
08:00-09:00	0.90	0.90	0.90	0.90	0.95	0.95
09:00-10:00	0.90	0.90	0.90	0.90	0.95	0.95
10:00-11:00	0.90	0.90	0.90	0.90	0.95	0.95
11:00-12:00	0.20	0.90	0.20	0.90	0.20	0.95
12:00-13:00	0.90	0.90	0.90	0.90	0.95	0.95
13:00-14:00	0.90	0.20	0.90	0.30	0.95	0.40
14:00-15:00	0.00	0.90	0.00	0.90	0.00	0.95
15:00-16:00	0.00	0.90	0.00	0.90	0.00	0.95
16:00-17:00	0.00	0.90	0.00	0.90	0.00	0.95
17:00-18:00	0.00	0.50	0.00	0.30	0.00	0.25
18:00-19:00	0.00	0.00	0.00	0.10	0.00	0.00
19:00-20:00	0.00	0.00	0.00	0.00	0.00	0.00
20:00-21:00	0.00	0.00	0.00	0.00	0.00	0.00
21:00-22:00	0.00	0.00	0.00	0.00	0.00	0.00
22:00-23:00	0.00	0.00	0.00	0.00	0.00	0.00
23:00-24:00	0.00	0.00	0.00	0.00	0.00	0.00

Table 19: Whole building schedules

Schedules for Educational - School Buildings (B)

Educational - School						
Time Period	Elevator Schedule	HVAC Fan Schedule (On/Off)		External Lighting Schedule	Basement Ventilation	Basement Lighting
		Student Area	Back Office			
	7 Days/ week	5 Days/ week	5 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	0.00	0	0	0.80	0.00	0.05
01:00-02:00	0.00	0	0	0.80	0.00	0.05
02:00-03:00	0.00	0	0	0.80	0.00	0.05
03:00-04:00	0.00	0	0	0.80	0.00	0.05
04:00-05:00	0.00	0	0	0.80	0.00	0.05
05:00-06:00	0.00	0	0	0.80	0.00	0.05
06:00-07:00	0.05	0	0	0.00	0.00	0.05
07:00-08:00	0.80	1	1	0.00	0.00	0.05
08:00-09:00	0.80	1	1	0.00	1.00	1.00
09:00-10:00	0.25	1	1	0.00	1.00	1.00
10:00-11:00	0.25	1	1	0.00	1.00	1.00
11:00-12:00	0.25	1	1	0.00	1.00	1.00
12:00-13:00	0.25	1	1	0.00	1.00	1.00
13:00-14:00	0.90	1	1	0.00	1.00	1.00
14:00-15:00	0.60	0	1	0.00	1.00	1.00
15:00-16:00	0.20	0	1	0.00	1.00	1.00
16:00-17:00	0.30	0	1	0.00	1.00	1.00
17:00-18:00	0.40	0	0	0.00	1.00	0.50
18:00-19:00	0.00	0	0	0.80	0.00	0.05
19:00-20:00	0.00	0	0	0.80	0.00	0.05
20:00-21:00	0.00	0	0	0.80	0.00	0.05
21:00-22:00	0.00	0	0	0.80	0.00	0.05
22:00-23:00	0.00	0	0	0.80	0.00	0.05
23:00-24:00	0.00	0	0	0.80	0.00	0.05

Table 20: Equipment schedules

Reference: ECBC 2017,pg. no. 125 & 126

Appendix 10: LEED Checklist

LEED v4 for BD+C: Schools
Project Checklist

Project Name: ORD International School
Date:

Y	?	N			
1			Credit	Integrative Process	1

9	2	4	**Location and Transportation**		15
			Credit	LEED for Neighborhood Development Location	15
1			Credit	Sensitive Land Protection	1
		2	Credit	High Priority Site	2
4	0	1	Credit	Surrounding Density and Diverse Uses	5
2	2		Credit	Access to Quality Transit	4
1			Credit	Bicycle Facilities	1
		1	Credit	Reduced Parking Footprint	1
1			Credit	Green Vehicles	1

8	4	0	**Sustainable Sites**		12
Y			Prereq	Construction Activity Pollution Prevention	Required
Y			Prereq	Environmental Site Assessment	Required
1			Credit	Site Assessment	1
	2		Credit	Site Development - Protect or Restore Habitat	2
1			Credit	Open Space	1
3			Credit	Rainwater Management	3
2			Credit	Heat Island Reduction	2
	1		Credit	Light Pollution Reduction	1
1			Credit	Site Master Plan	1
	1		Credit	Joint Use of Facilities	1

7	0	5	**Water Efficiency**		12
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
1		1	Credit	Outdoor Water Use Reduction	2
5		2	Credit	Indoor Water Use Reduction	7
		2	Credit	Cooling Tower Water Use	2
1			Credit	Water Metering	1

29	2	0	**Energy and Atmosphere**		31
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
6			Credit	Enhanced Commissioning	6
16			Credit	Optimize Energy Performance	16
1			Credit	Advanced Energy Metering	1
2			Credit	Demand Response	2
3			Credit	Renewable Energy Production	3
	1		Credit	Enhanced Refrigerant Management	1
1	1		Credit	Green Power and Carbon Offsets	2

5	6	2	**Materials and Resources**		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
	3	2	Credit	Building Life-Cycle Impact Reduction	5
2			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
2			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
1	1		Credit	Building Product Disclosure and Optimization - Material Ingredients	2
	2		Credit	Construction and Demolition Waste Management	2

14	0	2	**Indoor Environmental Quality**		16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
Y			Prereq	Minimum Acoustic Performance	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
2		1	Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
2			Credit	Indoor Air Quality Assessment	2
1			Credit	Thermal Comfort	1
2			Credit	Interior Lighting	2
2		1	Credit	Daylight	3
1			Credit	Quality Views	1
1			Credit	Acoustic Performance	1

4	2	0	**Innovation**		6
3	2		Credit	Innovation	5
1			Credit	LEED Accredited Professional	1

4	0	0	**Regional Priority**		4
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1

81	16	13	**TOTALS**	Possible Points:	**110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

Appendix 11: Costing

Appendix 11A: Cost estimation

Constructioin Cost Summary

Constuction Cost Summary - Hard Cost

Team: The Archons
Lead Institute Name: School of Planning and Architecture, New Delhi
Division: EDUCATIONAL

	Sq.M.		
Site Area	15256	**City:**	Noida
Built-up Area (BUA)	15131	**State:**	Uttar Pradesh
Ground Coverage (Plinth Area)	3668		

No.	Item Description	Unit	Baseline Estimate (Project Partner / SOR basis)				Proposed Design Estimate				Notes Required ?	Justification / Notes
			Quantity	Rate (Rs)	Amount (Rs. Millions)	Cost per sqm. (Rs)	Quantity	Rate	Amount	Cost per sqm		
A. CIVIL WORKS												
1	**EXCAVATION**											
1.1	Excavation In Soil	Cu.m	30000.00	181.85	5.46	360.55	30000.00	181.85	5.46	360.55	NO	
1.2	Backfilling+ Compaction	Cu.m	4500.00	68.00	0.31	20.22	4500.00	68.00	0.31	20.22	NO	
1.3	Antitermite treatment	Sq.m	5743.50	150.00	0.86	56.94	5743.50	150.00	0.86	56.94	NO	
2	**RCC WORK**											
2.1	PCC Plinth M10	Cu.m	622.40	6126.50	3.81	252.01	622.40	6126.50	3.81	252.01	NO	
2.2	PCC For Footing M10	Cu.m	285.00	8025.00	2.29	151.15	285.00	8025.00	2.29	151.15	NO	
2.3	Foundation, Raft, shear walls	Cu.m	3129.00	8137.00	25.46	1682.68	3129.00	8137.00	25.46	1682.68	NO	
2.4	RCC(M35 grade) Plinth Level (Beam and Columns)	Cu.m	673.00	8136.75	5.48	361.91	673.00	8136.75	5.48	361.91	NO	
2.5	RCC (M35 grade) Above Plinth Level (Beam and Columns	Cu.m	1383.00	9540.30	13.19	872.00	1383.00	9540.30	13.19	872.00	NO	
2.6	RCC Slab (M35)	Cu.m	3937.00	9540.00	37.56	2482.25	3937.00	9540.00	37.56	2482.25	NO	
2.7	Reinforcement ,TMT Fe 415 in Foundation	kg	204000.00	76.65	15.64	1033.41	204000.00	76.65	15.64	1033.41	NO	
2.8	Reinforcement, TMT Fe 415 in Column and Beam	kg	274320.00	78.10	21.42	1415.93	274320.00	78.10	21.42	1415.93	NO	
2.9	Reinforcement ,TMT Fe 415 in Slabs	kg	438240.00	77.50	33.96	2244.64	438240.00	77.50	33.96	2244.64	NO	
2.10	RCC (M35 grade) Wind Tower	Cu.m	0.00	0.00	0.00	0.00	633.00	9540.00	6.04	399.10	YES	Evaporative Wind Tower is proposed.
3	**SHUTTERING WORK**											
3.1	Shuttering Area	Sq.m	26403.00	660.00	17.43	1151.67	26403.00	660.00	17.43	1151.67	NO	
4	**FAÇADE WORK**											
4.1	230 mm Thick Brick Wall Class 12.5	cum	1726.00	7501.50	12.95	855.70	1501.00	6000.00	9.01	595.20	YES	Agrocrete Block is used which costs 21% less.
4.2	External Plaster 15mm 1:4	Sqm	13981.00	307.90	4.30	284.50	9481.00	307.90	2.92	192.93	YES	Terracotta cladded facade system helping in performance and aesthetics is proposed at main elevations
4.3	Painting of External Walls	Sqm	13981.00	250.00	3.50	231.00	9481.00	250.00	2.37	156.65	YES	
4.4	*Terracotta Ventilated Rainscreen Façade Systems*	Sqm	0.00	0.00	0.00	0.00	1138.00	6500.00	7.40	488.86	YES	
4.5	*Terracotta Wet Cladding*	Sqm	0.00	0.00	0.00	0.00	4500.00	500.00	2.25	148.70	YES	
	TOTAL (A)				**203.61**	**13456.57**			**212.85**	**14066.82**		
B. INTERNAL WORKS												
5	**INTERNAL WALLS , FINISHES**											
5.1	115 mm Thick Brick Wall of class 7.5	cum	269.19	956.60	0.26	17.02	145.00	853.50	0.12	8.18	YES	Proposed gypsum partition walls which costs less
5.2	Internal Plaster - Walls 1:3	Sqm	13981.00	340.85	4.77	314.94	13981.00	340.85	4.77	314.94	NO	
5.3	Painting of Internal Wall +Ceiling	Sqm	13981.00	236.81	3.31	218.81	13981.00	236.81	3.31	218.81	NO	
6	**WATERPROOFING**											
6.1	Toilet	Sqm	800.00	705.70	0.56	37.31	800.00	705.70	0.56	37.31	NO	
6.2	Water Proofing on horizontal Surface below NGL	Sqm	6260.50	1353.70	8.47	560.10	6260.50	1353.70	8.47	560.10	NO	
6.3	Retaining Wall using Kota Stone	Sqm	1784.40	1738.00	3.10	204.96	1784.40	1738.00	3.10	204.96	NO	
6.4	Top terrace	Sqm	3406.12	1398.50	4.76	314.81	3406.12	1398.50	4.76	314.81	NO	
7	**TILING WORK**											
7.1	Flooring - Polished Kota	Sqm	8612.20	1531.00	13.19	871.41	0.00	0.00	0.00	0.00	YES	kota stone used in classes and tiles used in lobbies
7.2	Flooring - Lobbies vitrified tiles	Sqm	4666.00	1500.00	7.00	462.56	0.00	0.00	0.00	0.00	YES	
7.3	Flooring - Vinyl and Terrazzo	Sqm	0.00	0.00	0.00	0.00	8612.20	1250.00	10.77	711.47	YES	Vinyl and terrazo tiles used in classes and polished cement flooring used in lobby
7.4	Flooring - Lobbies polished concrete	Sqm	0.00	0.00	0.00	0.00	4666.00	807.00	3.77	248.86	YES	
7.5	Ceramic 12 x 12 Toilets	Sqm	711.70	1300.00	0.93	61.15	711.70	1300.00	0.93	61.15	NO	
7.6	Staircase - Tread	Sqm	192.00	1345.00	0.26	17.07	192.00	1345.00	0.26	17.07	NO	
7.7	Staircase - Riser	Sqm	104.00	1345.00	0.14	9.24	104.00	1345.00	0.14	9.24	NO	
7.8	Staircase - landing	Sqm	215.00	1345.00	0.29	19.11	215.00	1345.00	0.29	19.11	NO	
7.9	Dado - Lift	Sqm	311.00	1400.00	0.44	28.78	311.00	1400.00	0.44	28.78	NO	
7.10	Dado - Toilet	Sqm	1538.00	1400.00	2.15	142.30	1538.00	1400.00	2.15	142.30	NO	
8	**DOORS**											
8.1	D1(entrance door for toilet)- 0.9 *2.1	Sqm	25.00	1200.00	0.03	1.98	25.00	1200.00	0.03	1.98	NO	
8.2	D2 (Classroom doors)	Sqm	200.00	1800.00	0.36	23.79	200.00	1800.00	0.36	23.79	NO	
8.3	FD1(door for fire staircase and lifts)- 1*2.1	Sqm	18.00	2000.00	0.04	2.38	18.00	2000.00	0.04	2.38	NO	
8.4	FD2 (fire exit door in the main core)-2*2.1	Sqm	2.00	2000.00	0.00	0.26	2.00	2000.00	0.00	0.26	NO	
9	**FABRICATION**											
9.1	Railing for Staircase	Rm	155.00	700.00	0.11	7.17	155.00	700.00	0.11	7.17	NO	
9.2	Railing for foyer and foyer cutouts	Rm	584.00	400.00	0.23	15.44	584.00	400.00	0.23	15.44	NO	
	TOTAL (B)				**50.40**	**3330.61**			**44.61**	**2948.13**		

C. MEP SERVICES												
10	**HVAC**											
10.1	Water Based Chiller 1900kW	Tr	550.00	25000.00	13.75	908.73	0.00	0.00	0.00	0.00	YES	VRF Sytem is proposed. LCC is attached
10.2	Heat Reclaim Ventilation	Tr	0.00	0.00	0.00	0.00	272.00	20000.00	5.44	359.53	YES	
10.3	VRF Outdoor Unit - 16 Tr	Each	0.00	0.00	0.00	0.00	17.00	380000.00	6.46	426.94	YES	
10.4	Air Handling Unit	Each	0.00	0.00	0.00	0.00	6.00	120000.00	0.72	47.58	YES	Installed for evaporative wind tower
10.5	Air Suction Fans	Each	0.00	0.00	0.00	0.00	6.00	30000.00	0.18	11.90	YES	
10.6	Ducting	sqm	8478.00	50.00	0.42	28.02	8478.00	50.00	0.42	28.02	NO	
11	**ELECTRICAL & ALLIED SERVICES**											
11.1	Substation (Including Transformers)	Each	1.00	1500000.00	1.50	99.13	1.00	1500000.00	1.50	99.13	NO	
11.2	Internal Electric Installations	BUA Sqm	15131.00	3000.00	45.39	3000.00	15131.00	3000.00	45.39	3000.00	NO	
11.3	Earthing & Lightning Protection	BUA Sqm	15131.00	55.00	0.83	55.00	15131.00	55.00	0.83	55.00	NO	
11.4	D.G. Sets 750 KVA	Each	1.00	3500000.00	3.50	231.31	0.00	0.00	0.00	0.00	YES	Total Electric Load is reduced, due to less energy consumption
11.5	D.G. Sets 500 KVA	Each	0.00	0.00	0.00	0.00	1.00	2500000.00	2.50	165.22	YES	
11.6	Solar PV Panels	Per Piece	0.00	0.00	0.00	0.00	721.00	11300.00	8.15	538.45	YES	PV is installed in proposed case
12	**PLUMBING & SANITATION**											
12.01	Faucets	Each	128.00	400.00	0.05	3.38	128.00	1120.00	0.14	9.47	YES	
12.02	Water Closet	Each	194.00	2720.00	0.53	34.87	194.00	6590.00	1.28	84.49	YES	Low Flow fixtures are used in proposed case
12.03	Urinals	Each	76.00	999.00	0.08	5.02	76.00	7990.00	0.61	40.13	YES	
12.04	Shower Head	Each	8.00	530.00	0.00	0.28	8.00	2300.00	0.02	1.22	YES	
12.05	Wash Basin	Each	128.00	1200.00	0.15	10.15	128.00	1200.00	0.15	10.15	NO	
12.06	Internal Drainage 2%	Nos.	22.00	1080.00	0.02	1.57	22.00	1080.00	0.02	1.57	NO	
12.07	External Drainage	BUA Sqm	15.00	1080.00	0.02	1.07	15.00	1080.00	0.02	1.07	NO	
12.08	STP - Phytorid Plant	Each	0.00		0.00	0.00	1.00	3000000.00	3.00	198.27	YES	Phytorid and sand filtration plants has been proposed in design
12.09	Grey Water Treatment - Sand Filtration	Each	0.00	0.00	0.00	0.00	1.00	1800000.00	1.80	118.96	YES	
12.10	Centrifugal pump 3HP	Each	2.00	17750.00	0.04	2.35	2.00	17750.00	0.04	2.35	NO	
12.11	Centrifugal pump 1.5HP	Each	1.00	10025.00	0.01	0.66	1.00	10025.00	0.01	0.66	NO	
12.12	Rainwater filter	Each	0.00	0.00	0.00	0.00	4.00	10382.00	0.04	2.74	YES	RAINY Rainwater Harvesting Filters
12.13	UV water treatment system	Each	0.00	0.00	0.00	0.00	1.00	9500.00	0.01	0.63	YES	final treatment stage for grey water reuse
12.14	110mm PVC pipes	per 6m	214.00	1080.00	0.23	15.27	214.00	1080.00	0.23	15.27	NO	
12.15	80mm PVC pipes	per 6m	286.00	80.00	0.02	1.51	286.00	80.00	0.02	1.51	NO	
12.16	Underground tank 50000L	Each	7.00	625000.00	4.38	289.14	7.00	625000.00	4.38	289.14	NO	
12.17	Underground tank 35000L	Each	1.00	425000.00	0.43	28.09	1.00	425000.00	0.43	28.09	NO	
12.18	Underground tank 25000L	Each	1.00	312500.00	0.31	20.65	1.00	312500.00	0.31	20.65	NO	
12.19	Sprinklers	Each	0.00	0.00	0.00	0.00	60.00	591.00	0.04	2.34	YES	efficient irrigation methods like sprinklers and drip irrigation systems used in order to avoid unnecesary usage of water for irrigation.
12.20	Drip Irrigation System	meter	0.00	0.00	0.00	0.00	570.00	7.50	0.00	0.28	YES	
12.21	Irrigation system	BUA Sqm	3262.00	3.70	0.01	0.80	0.00	0.00	0.00	0.00	YES	
13	**FIRE FIGHTING**											
13.1	Plant Room	No.	1.00	300000.00	0.30	19.83	1.00	300000.00	0.30	19.83	NO	
13.2	Down comer and sprinkler system	BUA Sqm	15131.00	600.00	9.08	600.00	15131.00	600.00	9.08	600.00	NO	
14	**IBMS AND SECURITY SYSTEM**											
14.1	Fire Alarm System	BUA Sqm	15131.00	600.00	9.08	600.00	15131.00	600.00	9.08	600.00	NO	
14.2	Public Address System 0.5%	Nos.	1.00	150399.00	0.15	9.94	1.00	150399.00	0.15	9.94	NO	
14.3	Building Management System	BUA Sqm	0.00	0.00	0.00	0.00	15131.00	1937.00	29.31	1937.00	YES	Smart Building Operations
14.4	Waterleak detection system	BUA Sqm	15131.00	10.00	0.15	10.00	15131.00	10.00	0.15	10.00	NO	
15	**INSTALLATION OF LIFT**											
15.1	Passenger Elevator G+4	Nos	3.00	1800000.00	5.40	356.88	3.00	1800000.00	5.40	356.88	NO	
15.2	Passenger Elevator G+5	Nos	2.00	2000000.00	4.00	264.36	2.00	2000000.00	4.00	264.36	NO	
	TOTAL (C)				**99.83**	**6598.02**			**141.61**	**9358.79**		
D. EQUIPMENT & FURNISHING												
16	Office Interiors: Furnishing, Inernal Paiting, False Ceiling, internal electrification, Ducting & Lighitng Etc	Carpet Area (Sq.m)	424.00	15000.00	6.36	420.33	424.00	15000.00	6.36	420.33	NO	
16.1	School Office, classroom , canteen, and all other wooden furniture (or required)	Sqm	3000.00	2450.00	7.35	485.76	3000.00	2450.00	7.35	485.76	NO	
	TOTAL (D)				**13.71**	**906.09**			**13.71**	**906.09**		
E. LANDSCAPE & SITE DEVELOPMENT												
17	**SITE DEVELOPMENT**											
17.1	Internal road with WBM and Bituminous top	Sq.m	2939.50	175.00	0.51	34.00	2939.50	175.00	0.51	34.00	NO	
17.2	Cement Concrete pavment with vacuum dewatered con	Sq.m	5190.00	85.00	0.44	29.16	5190.00	90.00	0.47	30.87		
18	**LANDSCAPING**											
18.1	Horticulture Operations including plantations	Sq.m	6536.00	250.00	1.63	107.99	6536.00	250.00	1.63	107.99	NO	
	TOTAL (E)				**2.59**	**171.14**			**2.62**	**172.86**		

Table 21: Construction cost summary

Project Summary					
S.No.	Particulars	Baseline Estimate (Project Partner / SOR basis)		Proposed Design Estimate	
		Amount (Rs Millions)	%	Amount (Rs Millions)	%
1	Land		0.0%		0.0%
2	Civil Works	203.61	52.0%	212.85	54.3%
3	Internal Works	50.40	12.9%	44.61	11.4%
4	MEP Services	99.83	25.5%	141.61	36.1%
5	Equipment & Furnishing	13.71	3.5%	13.71	3.5%
6	Landscape & Site Development	2.59	0.7%	2.62	0.7%
7	Contingency	18.66	5.0%	20.92	5.0%
	TOTAL HARD COST	**388.80**	**99.5%**	**436.31**	**111.0%**
8	Pre Operative Expenses	3.00	0.8%	3.00	0.8%
9	Consultants	0.05	0.0%	0.05	0.0%
10	Interest During Construction	-	0.0%	-	0.0%
	TOTAL SOFT COST	**3.05**	**0.8%**	**3.05**	**0.8%**
	TOTAL PROJECT COST	**391.85**	**100.0%**	**439.36**	**112.1%**

Table 22:Project cost summary

Appendix 11B: Life Cycle Cost

Life cycle cost and Payback period for HVAC system

Description	Unit	Base Case (314 Tr)	(Proposed Case (272 Tr)
System Name		PTHP	VRF
Cooling Capacity	KWatts	1100	956
Cooling capacity	Tr	314	272
COP		2.5	4.47
Cost/ton	INR	₹25,000.00	₹45,551.00
Total Cost of installation	INR	₹7,850,000.00	₹12,389,872.00
Cost of wind tower	INR	₹0.00	₹6,038,820.00
Total cost	INR	**₹7,850,000.00**	**₹18,428,692.00**
Incremental cost	INR		**₹10,578,692.00**
Cost of Electricity	INR/Kwhr	₹9.30	₹9.30
Working Hrs/day	Hr	8	8
total annual energy consumed	kWh	306533	175641
cost of electricity per year		₹2,850,760.99	₹1,633,458.84
Cost of maintenance annually		₹5,000.00	₹2,500.00
operational cost (maintenance + electrical)	INR/yr	₹1,570,000.00	₹544,000.00
Total cost for 1 year	**INR**	**₹4,420,760.99**	**₹2,177,458.84**
Total life cycle cost for 10 years	**INR**	**₹52,057,609.92**	**₹40,203,280.42**
Savings in system against B. A. U per year	INR	**₹2,243,302.15**	
Total payback period	INR	**4.72**	

Table 23: HVAC System

25 years Life Cycle cost and Payback for Solar panel						
Description	**Unit**	**Per unit**	**Number**	**Total**	**Total life time cost**	**Remarks**
Total plant size	Wp	390	721	281,190		
Installation cost	INR	29	281,190	₹8,154,510	₹8,154,510	bought once in 25 years
Inverter cost	INR	267,000	5	₹1,335,000	₹3,337,500	bought 2.5 times in 25 years
Maintenance cost annual	INR	1,000	281	₹281,000	₹7,025,000	for 25 years
Total life cycle cost	INR				**₹18,517,010**	
Daily energy produced	kWh	5	281	1,349		
Annual energy produces	kWh			492,312		from design builder
Cost of energy		**9**	**492,312**	**₹4,553,886**	**₹4,553,886**	
Total payback period	years				**4.07**	payback of 4 years

Table 24: PV Panel System

25 years Life Cycle Costing of Bulbs				
Case taken		**60 Watt Incandecent**	**18 Watt CFL**	**12 Watt LED**
Description	**Unit**	**Incandecent**	**Compact Fluo**	**LED**
Wattage	Watt	60	18	12
Brightness	Lumens	850	1200	1000
Average Lifespan	Hours	1500	8000	25000
Total operating hours in a year	Hours	1600.0	1600.0	1600.0
Total hours of lighting in a year	Hours	560.0	560.0	560.0
Total Wattage for lighting hours	kWh	33.6	10.08	6.72
Bulbs needed for 560 hours	No.	0.373	0.070	0.022
Bulbs needed for 25 years	No.	9.33	1.75	0.56
Total Wattage 25 Years	kW	840.0	252.0	168.0
Average Cost of Bulb	INR	10	200	250
Total cost of bulbs	**INR**	**15.00**	**350.00**	**140.00**
Cost of electricity	INR/Kwhr	₹9.30	₹9.30	₹9.30
Cost of electricity for 25 years	**INR/Kwhr**	**₹7,812.00**	**₹2,343.60**	**₹1,562.40**
Life Cycle Cost of Bulb		**₹7,952.00**	**₹2,956.10**	**₹1,640.80**

Table 25: Lighting

Appendix 11C: Business model proposal

CALCULATIONS				
EXPENDITURE				
Franchise Fees (IB)		₹ 2,000,000.00	**₹ 2,000,000.00**	
SALARIES	**No.**	**Salary per person**	**Total**	
Teaching staff	150	₹ 800,000.00	₹ 120,000,000.00	
Admin Staff	25	₹ 600,000.00	₹ 15,000,000.00	
Security	12	₹ 300,000.00	₹ 3,600,000.00	
Housekeeping	20	₹ 180,000.00	₹ 3,600,000.00	
		TOTAL - ADMINISTRATION (A)	**₹ 142,200,000.00**	52.78%
ELECTRICITY	**Electricity Bill**	**cost saved from solar**	**Total**	
			₹ 0.00	
WATER	**months**	**fix charge**	**Total**	
	12	29233	**₹ 350,796.00**	
CATERING	**No. of students**	**Cost per plate/yr**	**Total**	
	2200	16000	**₹ 35,200,000.00**	
EQUIPMENT			**Total**	
HVAC	Maintenence + Repair		₹ 816,000.00	
Solar	Maintenence + Repair		₹ 281,000.00	
BMS	Maintenence + Repair		₹ 1,000,000.00	Assumed
Lighting & Equipment	Maintenence + Repair		₹ 500,000.00	Assumed
		TOTAL - DIRECT MAINTENANCE (B)	**₹ 38,147,796.00**	14.16%
		Total Expenditure (A+B)	**₹ 180,347,796.00**	1673.61%
Expenses	**% of income**	**Income Amount**	**Total**	
MARKETING	1.00%	₹ 269,400,000.00	₹ 2,694,000.00	1.00%
INSURANCE	1.00%	₹ 269,400,000.00	₹ 2,694,000.00	1.00%
GENERAL EXPENSES	2.00%	₹ 269,400,000.00	₹ 5,388,000.00	2.00%
		TOTAL - EXTRA (C)	**₹ 10,776,000.00**	
		Total Expenditure (A+B+C)	**₹ 191,123,796.00**	
School Profit		10.00%	**₹ 19,112,379.60**	
Client Profit (lease amount)		10% of building cost	**₹ 50,000,000.00**	
		TOTAL EXPENDITURE (including profits)	**₹ 260,236,175.60**	
INCOME				
Expenditure	**No.**	**Terms/yr**	**Min student fees / yr**	
Student Fees (min)	2200	4	**₹ 29,572.29**	
PROPOSED				
INCOME				
Income via	**No.**	**Fees / student / yr**	**Total**	
Student Fees	2200	120000	**₹ 264,000,000.00**	
Income via	**No. of days**	**Rent / day**	**Total**	
Multipurpose Hall	90	60000	**₹ 5,400,000.00**	
		TOTAL INCOME	**₹ 269,400,000.00**	140.96%
		Total Expenditure	**₹ 191,123,796.00**	100.00%
		PROFIT	**₹ 78,276,204.00**	29.06%
	Client Profit	60.00%	**₹ 46,965,722.40**	17.43%
	School Profit	40.00%	**₹ 31,310,481.60**	16.38%

Table 26: Business model presumptions

Appendix 12: Project Timeline

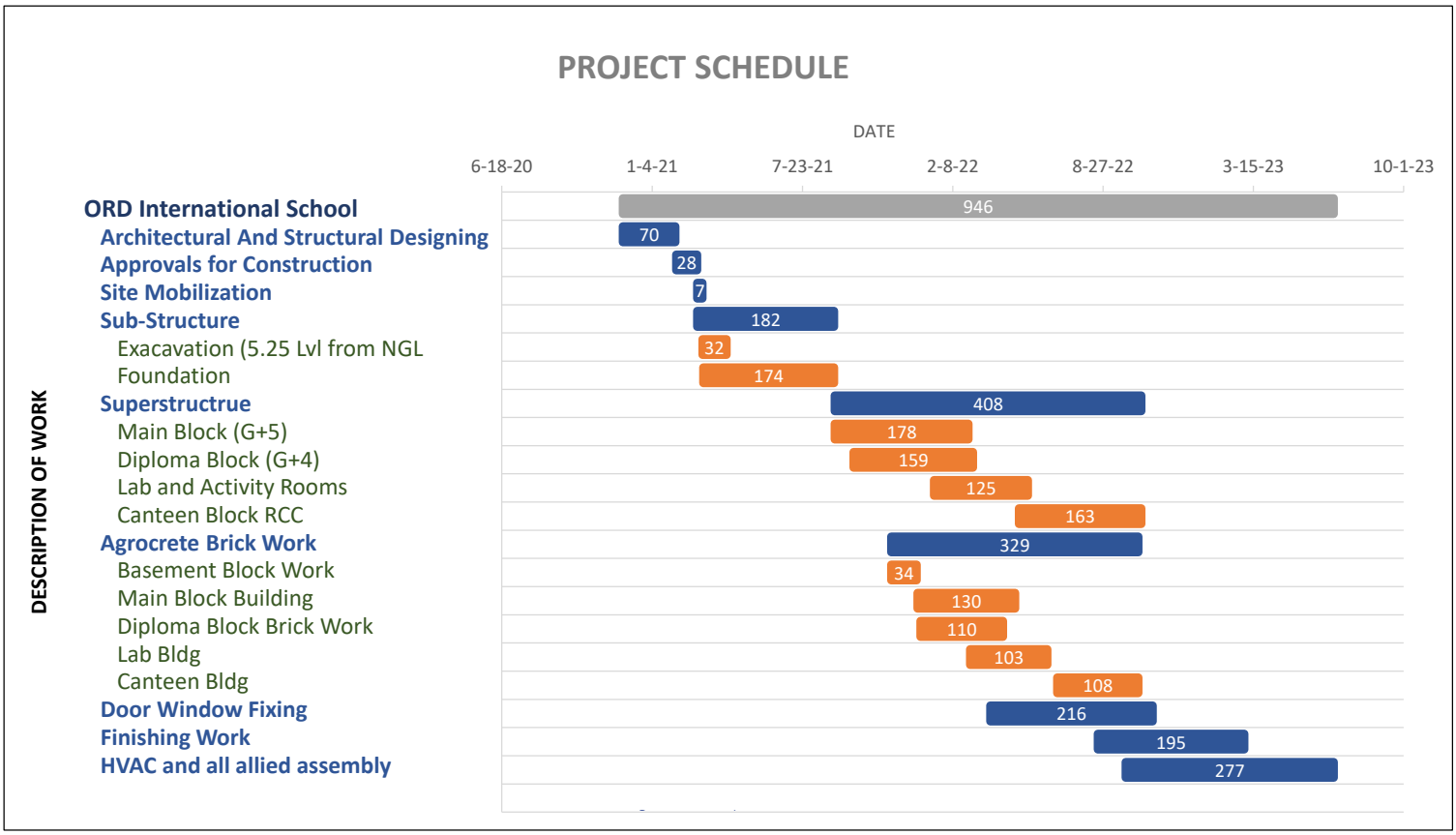


Fig 39: Project timeline

Appendix 13: Letter of Confirmation

Appendix 13A : Project partner

ORD TOWERS
(A SCHOOL PROJECT)

07 October 2020

To,

The Director,
Solar Decathlon India

Dear Sir,

This is to inform you that our organization, ORD TOWERS, has provided information about our Educational Building project to the participating team led by School of Planning and Architecture, New Delhi, so that their Team The Archons may use this information for their Solar Decathlon India 2020-21 competition entry.

As a Project Partner to this team for the Solar Decathlon India 2020-21 competition, we are interested in seeing the Net-Zero-Energy, Net-Zero-Water, resilient and affordable solution this student team proposes and the innovation that results from this. We intend to have a representative from our organization attend the Design Challenge Finals event in April, if this team is selected for the finals.

We would like our organization's logo to be displayed on the Solar Decathlon India website, recognizing us as one of the Project Partners for the 2020-21 competition.

With warm regards,

Deepanshu Gupta
Chief Enabling Officer
ORD Towers
deepanshu@ordgroup.in
+91 9971792468
ordgroup.in

ORD

Appendix 13B : Industry partners

ALPRO INDUSTRIES

ALUMINIUM / uPVC DOORS WINDOWS FACADES

February 6, 2021

To,

The Director,
Solar Decathlon India

Dear Sir,

This is to inform you that our organisation, Alpro Industries, is collaborating with the participating team led by School of Planning & Architecture on a Educational Building project for their Solar Decathlon India 2020-21 competition entry.

The nature of our collaboration will be to help & guide students and help them find market ready solutions for low energy facades and fenestration materials.

We would like have a representative from our organisation attend the Design Challenge Finals event in April/May, if this team is selected for the Finals.

We would like our organisation's logo to be displayed on the Solar Decathlon India website, recognising us as one of the Industry Partners for the 2020-21 competition.

With warm regards,

Nikhil Jain
Director
Alpro Industries
9810834689
nikhil@alproindustries.com

C-81, 1st Floor, Hosiery Complex, Phase-II, Noida -201305 (UP)Tel. +91-120-4138000
Email : alproindustries.com | www.alproindustries.com

Address

GreenJams BuildTech Pvt. Ltd.,

Next to Rahimpur Railway Crossing,
Rahimpur Village, Paniyala Road,
Roorkee - 247667

February 12, 2021

To,

The Director,
Solar Decathlon India

Dear Sir,

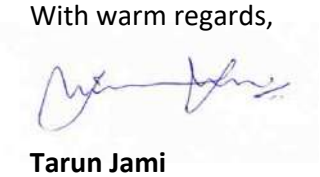
This is to inform you that our organization, GreenJams BuildTech Pvt Ltd, is collaborating with the participating team led by School of Planning and Architecture, New Delhi on an Educational Building project for their Solar Decathlon India 2020-21 competition entry.

The nature of our collaboration will be to guide students on how to use carbon-negative building material in their design and provide them details on sizes and properties of Agrocrete® and Hempcrete.

We would like to have a representative from our organization attend the Design Challenge Finals event in April/May, if this team is selected for the Finals.

We would like our organization's logo to be displayed on the Solar Decathlon India website, recognizing us as one of the Industry Partners for the 2020-21 competition.

With warm regards,



Tarun Jami
Founder, GreenJams™
tarun@greenjams.org
9591170791

CYAN ENERGY

Date: 19-02-2021

To,
The Director,
Solar Decathlon India

Subject: Regarding Solar Decathlon India 2020-21

Dear Sir,

This is to inform you that my firm CYAN ENERGY LLP, is collaborating with the participating team led by School of Planning and Architecture, New Delhi on an educational building design project for their entry to the Solar Decathlon India 2020-21.

The nature of our collaboration will be to guide the participating team and advise them in finding best market ready solutions for solar energy generation.

I would like to have a representative from my firm to attend the concluding round of the competition if this team is selected to the finals.

With best wishes.

Atul Dhir
Director - Cyan Energy LLP
Personal Email: atuldhir@outlook.com
Personal Mobile: +91 9996 084 266

Registered Office: CYAN Energy LLP, #42, Street No-2, Narender Nagar, Sonipat, Haryana -131001

Avrio Energy Pvt. Ltd.

February 16, 2021

To,

The Director,
Solar Decathlon India

Dear Sir,

This is to inform you that our organization, Avrio Energy, is collaborating with the participating team led by School of Planning and Architecture, New Delhi on an Educational Building project for their Solar Decathlon India 2020-21 competition entry.

The nature of our collaboration will be to design a Budling Management system with focus on energy efficiency for a educational building setup.

We would like to have a representative from our organization attend the Design Challenge Finals event in April/May, if this team is selected for the Finals.

We would want our organization's logo to be displayed on the Solar Decathlon India website, recognizing us as one of the Industry Partners for the 2020-21 competition.

With warm regards,

Name: Puneet Batra
Designation: Director
Name of the organization: Avrio Energy Pvt. Ltd.
Email: puneet@avrioenergy.in
Phone: 9920935066