DESIGN OF PRE-ENGINEERED BUILDING

GROUP 2

CE332 COURSE PROJECT

PROBLEM STATEMENT

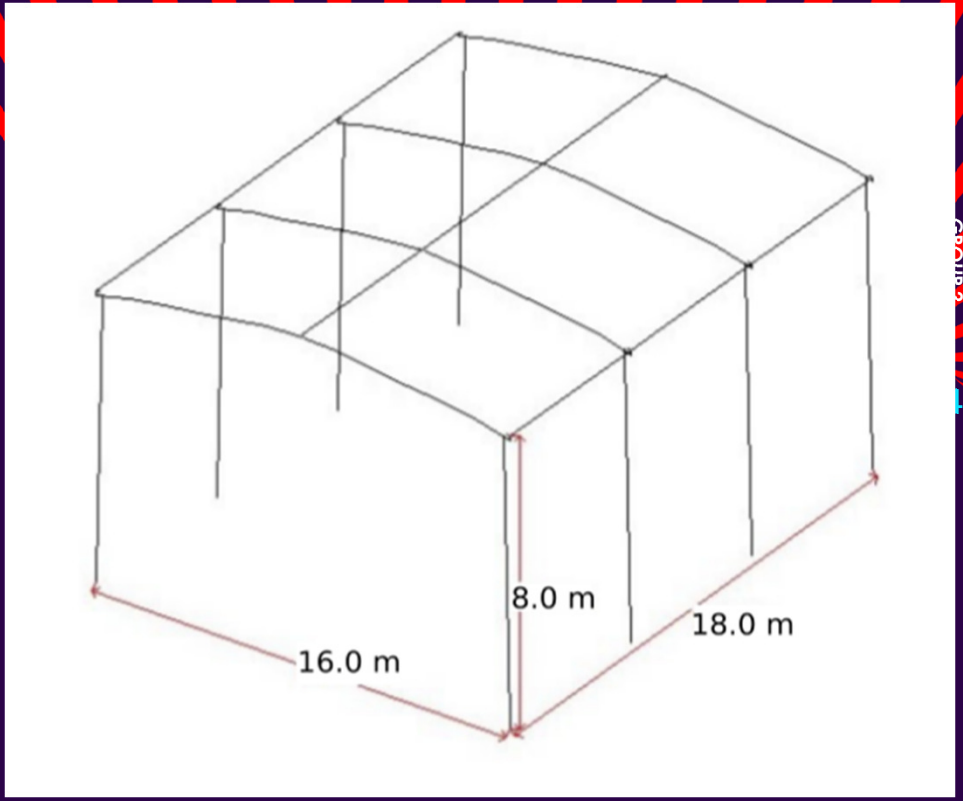
The team has just won a contract from a client to design and detail a pre-engineered building of plan dimensions 18m x 16m. The building needs to be designed for an industrial area in non cyclonic region of Mumbai. It is to be done in accordance with appropriate IS Codes.

Additional Information

- Prepare a General Arrangement (GA) of the structure. The team needs to decide and arrange the frame of varying depth column sand beams as per requirement due to bending moment developed.
- The basic components of the structure are beams, columns, purlins, and bracings.
- Design as per the requirements of section 5, of this document.
- Satisfy the required Deliverables, as per section 6 of this document.
- Any data or method of analysis/design not mentioned or described in this document, means that the team shall follow appropriate Indian Standard (IS) Code

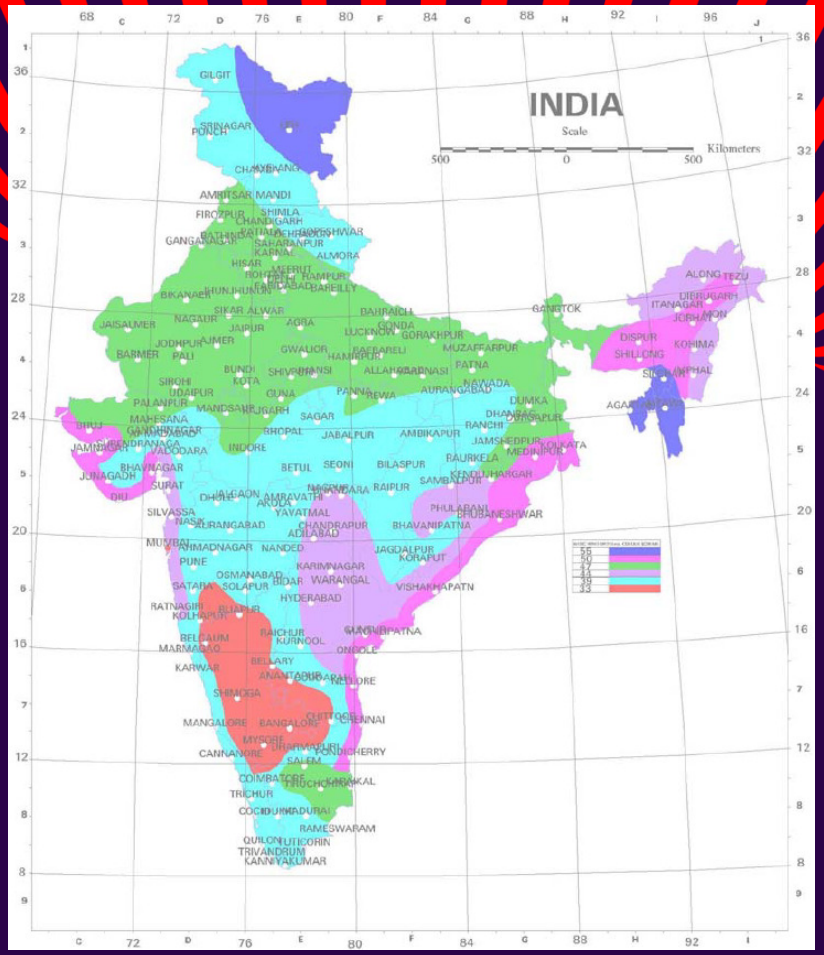
General Arrangement

- The plan dimension of the PEB: 16m (width) X 18m (length)
- Eaves height of the structure: 8m
- Slope of roof: 1 in 7.5
- Support at base: Hinged
- Longitudinal Bracing between frames along one span
- Side sheeting along the length (18 m span) and roof should be considered c during loading



Site Conditions

- Site is at location in industrial areas.
- The topography of the site is such that the upwind slope is less than 3 deg.
- Site is at non cyclonic region in Mumbai.



Load Details

Dead Load

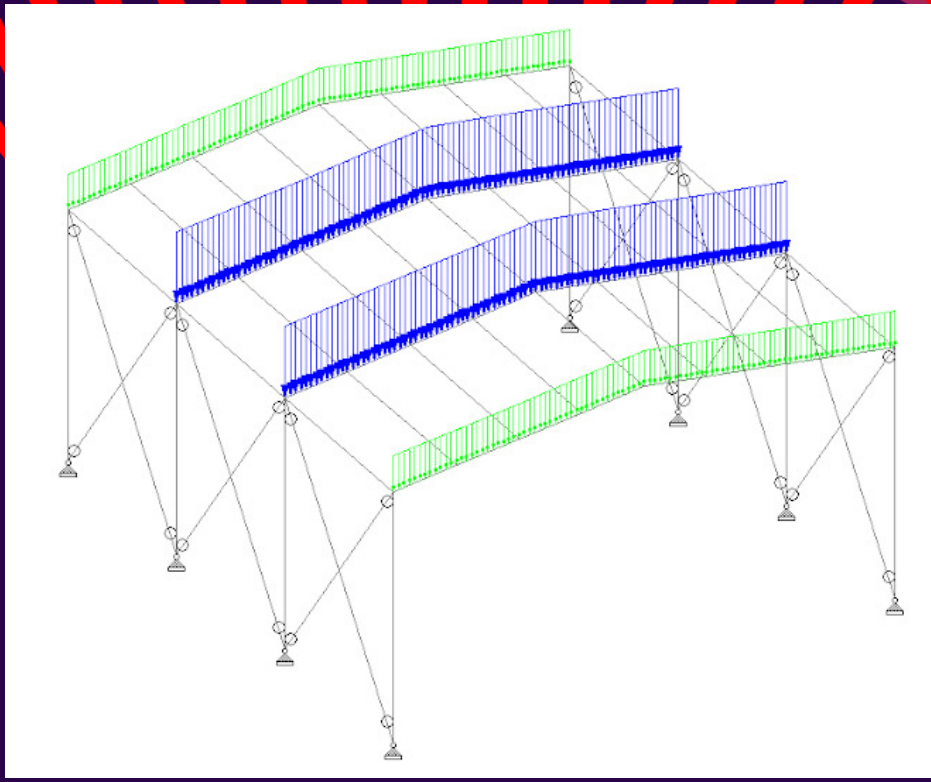
- Self-weight of the structure (Refer IS 875 (Part-1) for density of different materials.)
- Weight of roof and side sheeting (consider sheeting weight: 4 kg/m2)

Live Load

- Roof live load as per Table 2 IS 875 (Part-2).

Wind Load

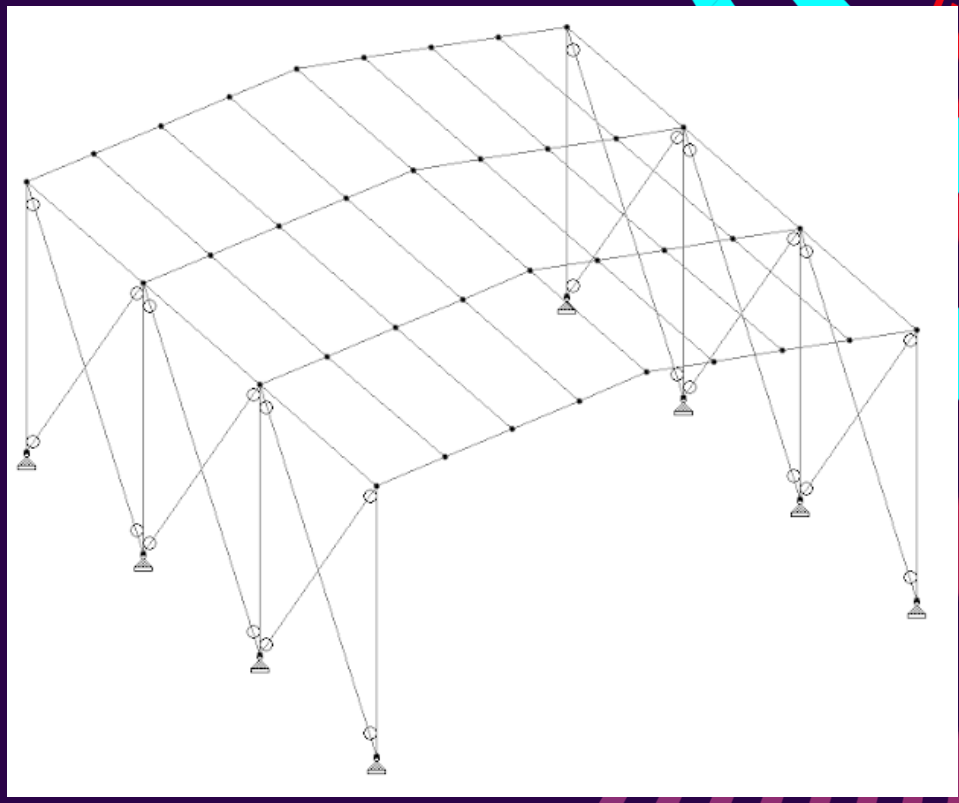
- Side and roof wind load as per IS 875 (Part-3).



Dead Load

Dead Load

- Weight of roof and side sheeting = 2314.19 kg (4kg/m^2)
  - Density = 4 kg/m^2
  - Area = (2*18*8) + {2*18*((7.5^2) + 1)^(1/2))*8/7.5) = 578.54 m^2
  - Total weight = 4* Area = 4* 578.54 = 2314.19 kg
- Structural Weight = 14,512.75 kg



Live Load

- Roof live load = 216 kN (0.75 kN/m^2 as per IS 875 (Part 2))
  - Roof live load = density * area
  - Plan Area = 18 *16 = 288 m^2
  - Density to be taken as 0.75 KN/m^2 as per IS 875.2000 (Part 2).
  - Live Load = 0.75 * Area = 0.75 * 288 = 216 KN

TABLE 2 IMPOSED LOADS ON VARIOUS TYPES OF ROOFS

(Clause **4.1**)

Sl No.	Type of Roof	Uniformly Distributed Imposed Load Measured on Plan Area	Minimum Imposed Load Measured on Plan
(1)	(2)	(3)	(4)
i)	Flat, sloping or curved roof with slopes up to and including 10 degrees		
	a) Access provided	1·5 kN/m^2	3.75 kN uniformly distributed over any span of one metre width of the roof slab and 9 kN uniformly distributed over the span of any beam or truss or wall
	b) Access not provided except for maintenance	0·75 kN/m^2	1·9 kN uniformly distributed over any span of one metre width of the roof slab and 4·5 kN uniformly distributed over the span of any beam or truss or wall

Wind Load Parameters and Calculations

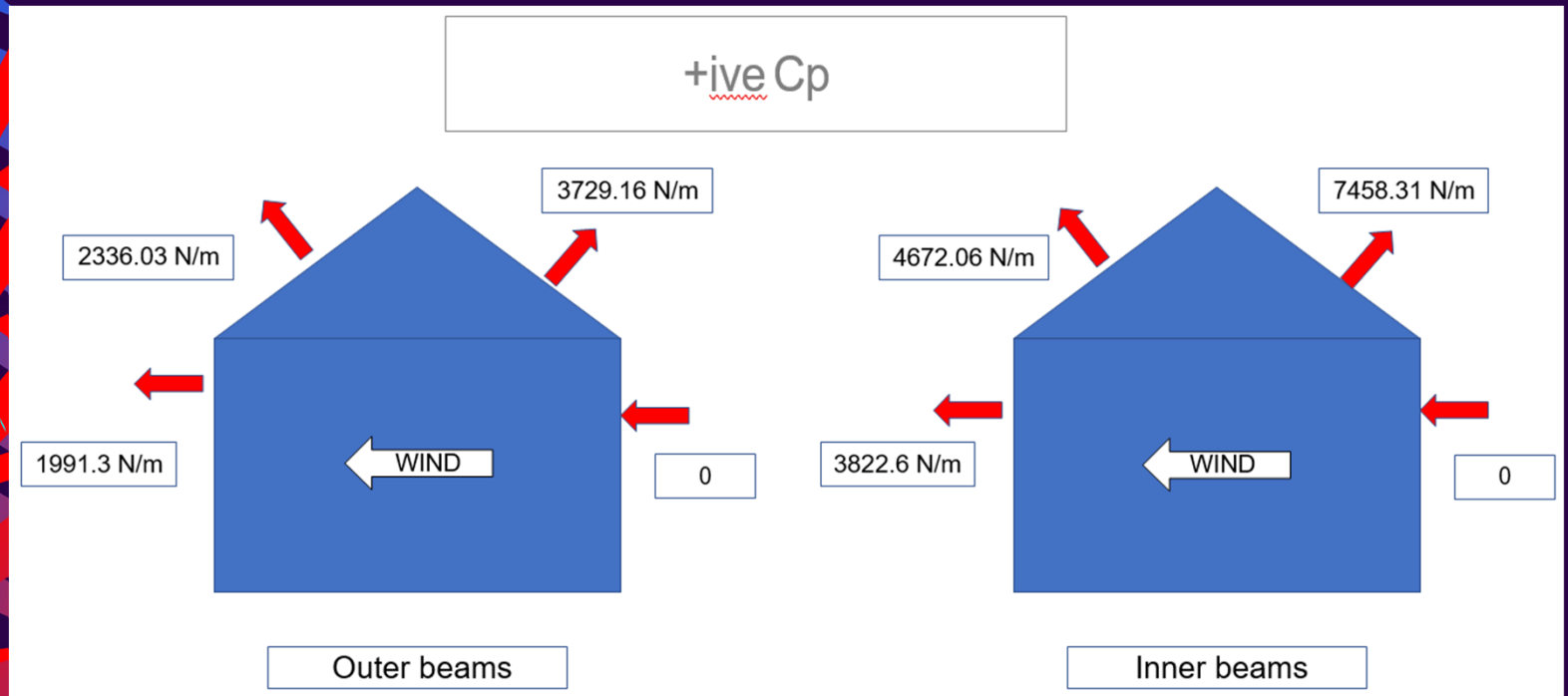
	A	B	C
1	K1	1	
2	K2	0.91	
3	K3	1	
4	K4	1.15	
5			
6	Vb	44	
7	Vz	46.046	m/s
8			
9	pz	1272.14047	
10	kd	0.9	
11	ka	0.8	
12	kc	1	
13	PD	915.9411381	N/M^2
14			
15	CPE FOR WALL		
16	WINDWARD	0.7	
17	Leeward	-0.2	
18			
19	CPE OF ROOF		
20	WINDWARD	-1.056	
21	LEEWARD	-0.4	

	A	B	C	D	E	F
21	LEEWARD	-0.4				
22						
23	LOAD CALCULATION FOR WALL				cpi	0.7
24	windword					-0.7
25	FOE CPI=-0.7	1282.317593	N/M^2			
26	CPI=0.7	0				
27						
28	LEEWARD					
29	CPI=-0.7	457.9705691				
30	CPI=0.7	-824.3470243				
31						
32						
33	FORCE CALCULATION OF ROOF					
34	WINDWORD					
35	CPI=-0.7	-326.0750452				
36	CPI=0.7	-1608.392639				
37						
38						
39	LEEWARD					
40	CPI=-0.7	274.7823414				
41	CPI=0.7	-1007.535252				

Sheet1

WIND LOAD

- Code followed: IS 875 (Part 3)
- Category of Site: Category 4 Class A
- Windward Force (F/A)
  - For Positive C_{pi}
    - Roof = -1243.05 N/m^2
    - Walls = 0 N/m^2
  - For Negative C_{pi}
    - Roof = -252.01 N/m^2
    - Walls = 991.04 N/m^2
- Leeward Force (F/A)
  - For Positive C_{pi}
    - Roof = -778.68 N/m^2
    - Walls = -637.10 N/m^2
  - For Negative C_{pi}
    - Roof = 212.37 N/m^2
    - Walls = 353.94 N/m^2

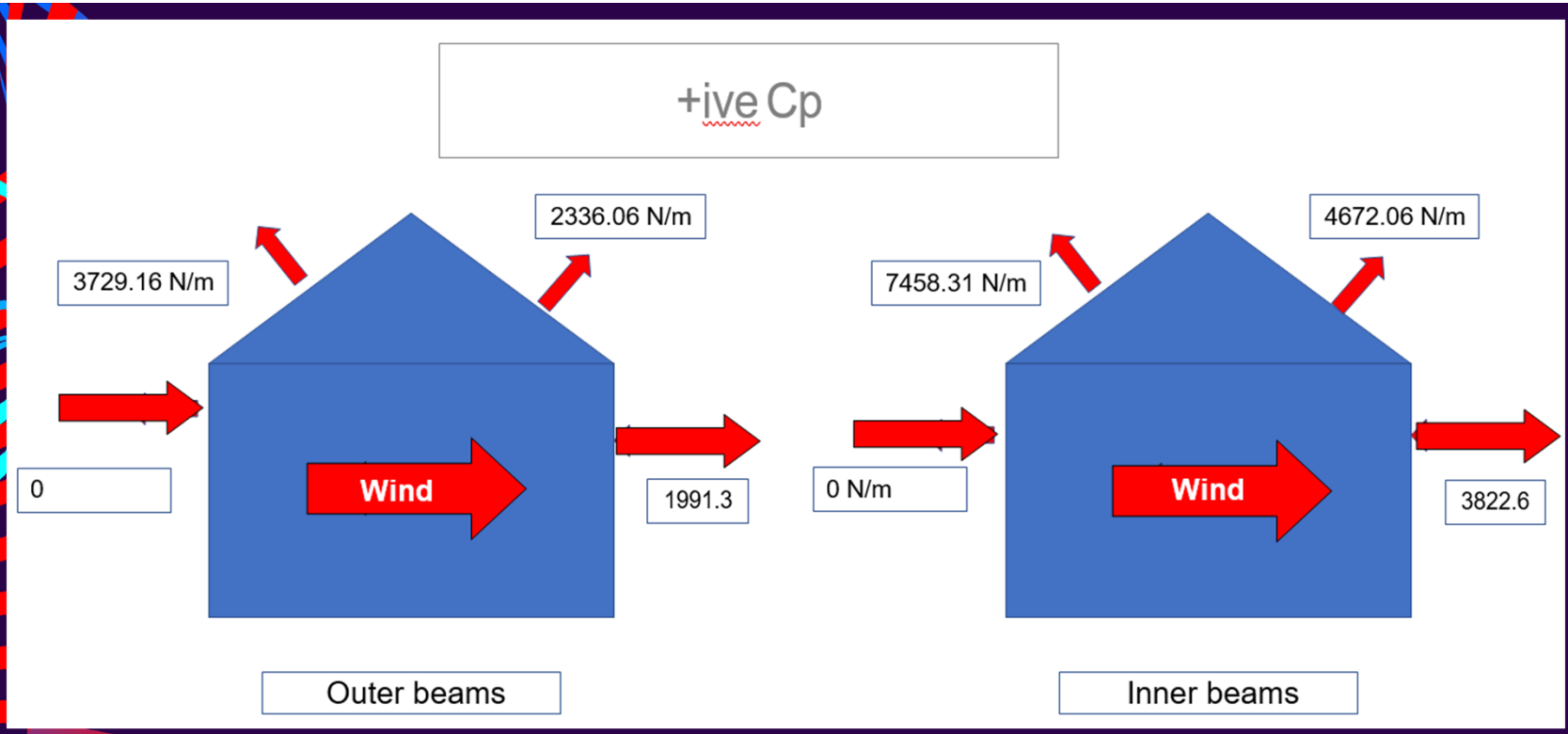


Case 1

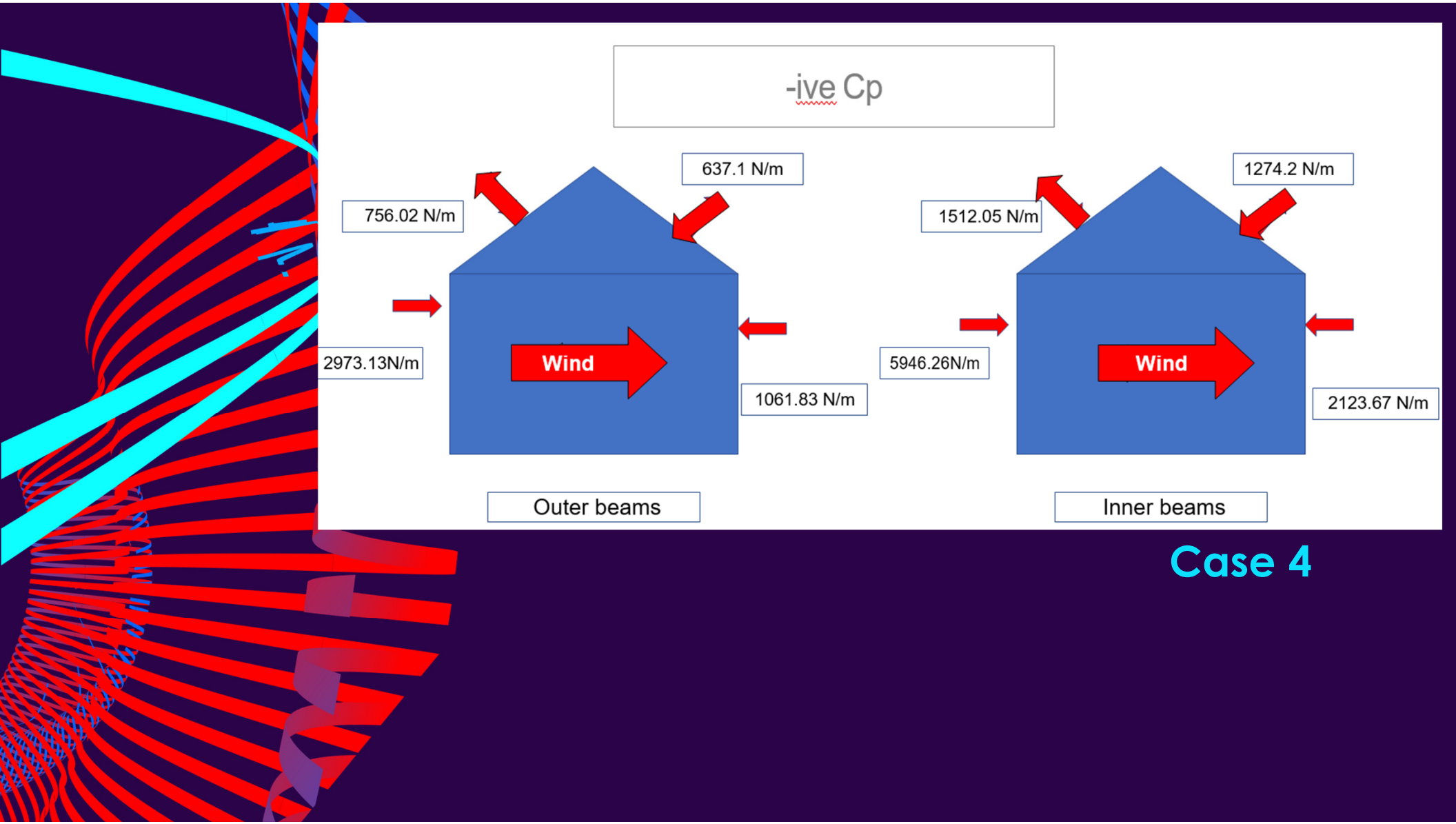
Note: not considering the wind perpendicular to the plane/structure (given in question), and hence only considering the leftward and rightward winds' cases.


-ive Cp
637.1 N/m
756.02 N/m
1061.83N/m
WIND
2973.13 N/m
Outer beams
1274.2 N/m
1512.05 N/m
2123.67N/m
WIND
5946.26 N/m
Inner beams

Case 2


+ive Cp
2336.06 N/m
3729.16 N/m
0
Wind
1991.3
Outer beams
4672.06 N/m
7458.31 N/m
0 N/m
Wind
3822.6
Inner beams

Case 3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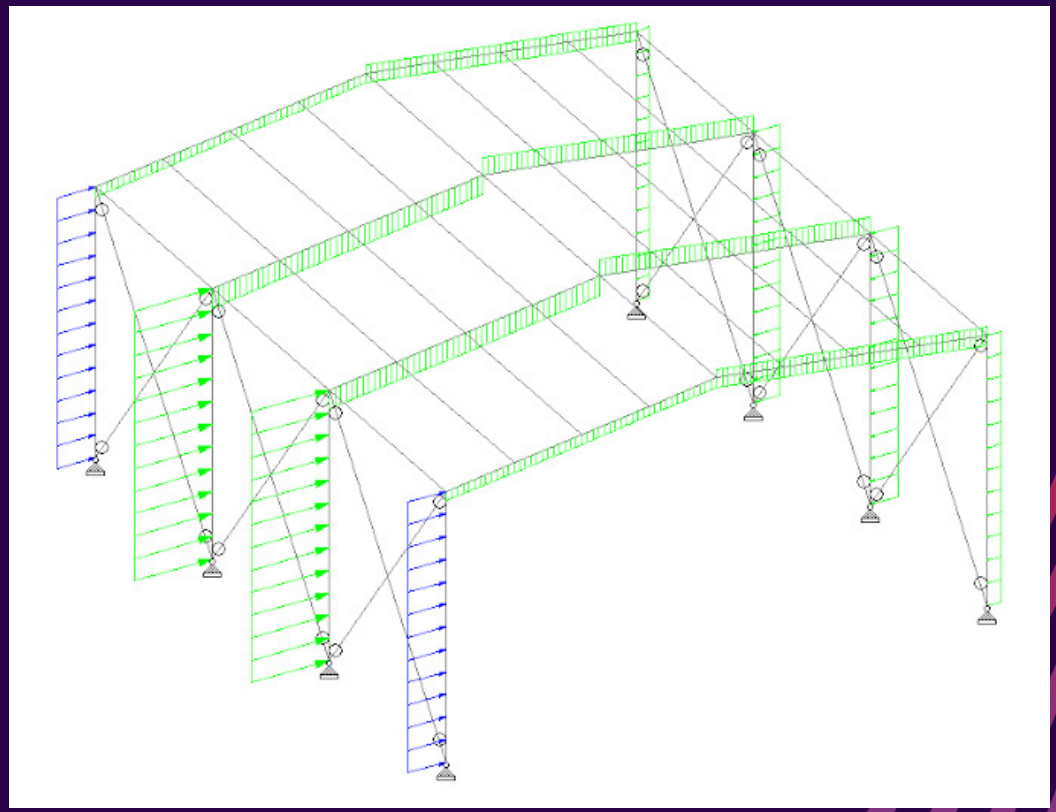
756.02 N/m
2973.13N/m
Wind
1061.83 N/m
Outer beams
1274.2 N/m
1512.05 N/m
5946.26N/m
Wind
2123.67 N/m
Inner beams

Case 4

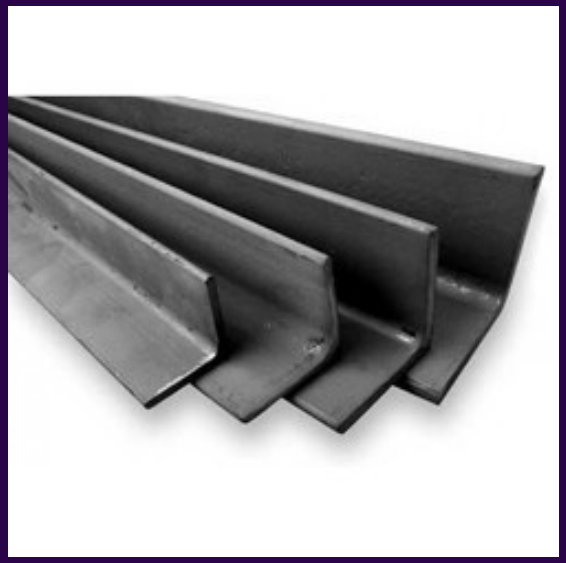
Load Combinations

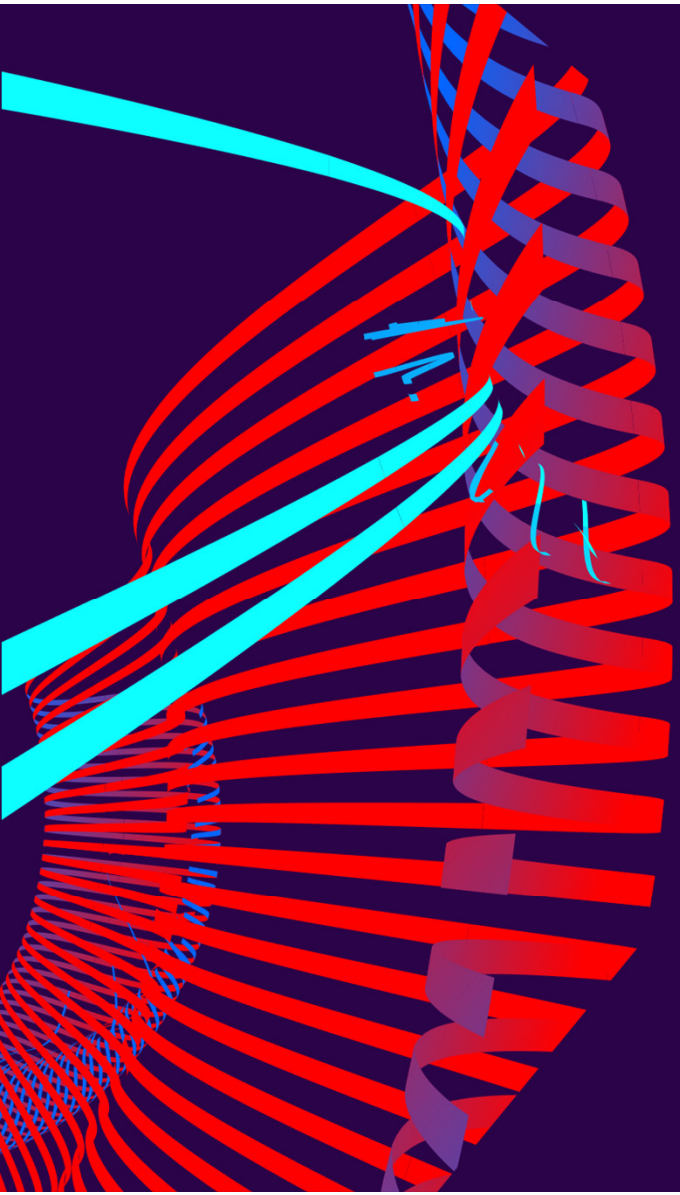
- 1.2 DL + 1.2 LL
- 1.2 DL + 1.2 LL + 1.2 WL
- 1 DL + 1 LL



SECTION PROPERTIES

- Rafters - WB 300 to WB 450 (linearly varying)
- Columns - WB 300 to WB 450 (linearly varying)
- Ridge Board – LB 300
- Purlin – LB 300
- Bracings – ISA 50x50x5



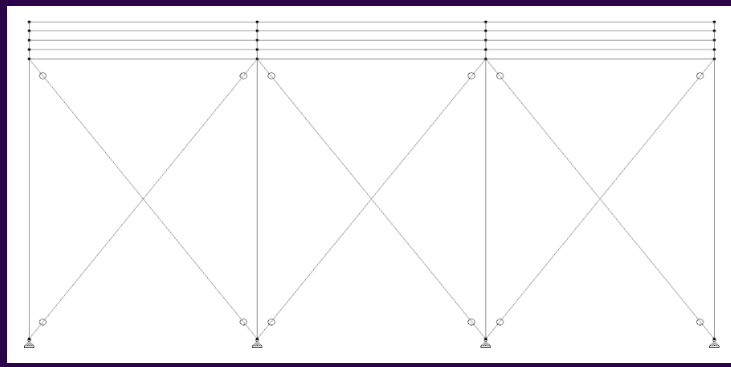


STAAD Analysis

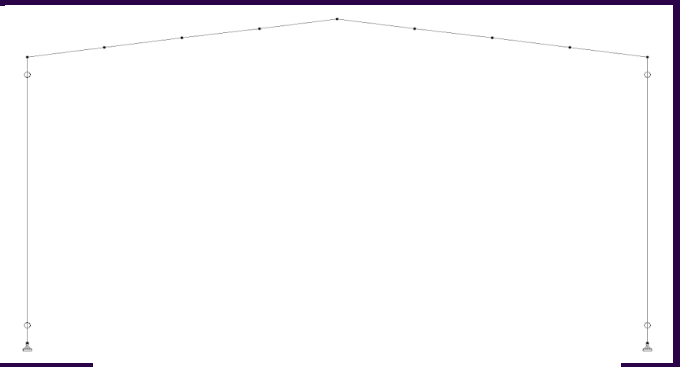
GROUP 2

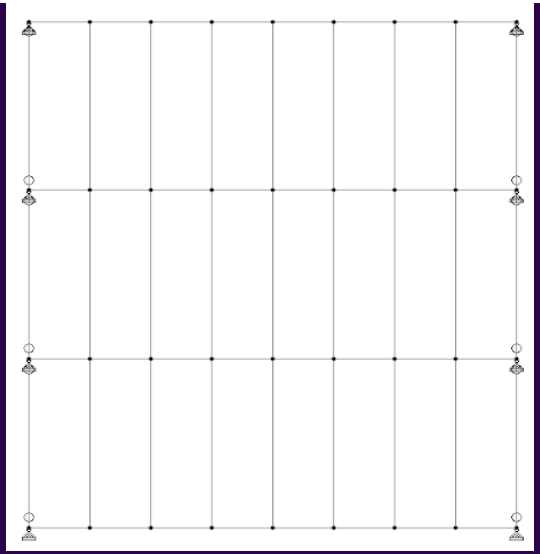
Overview of Model

Side View



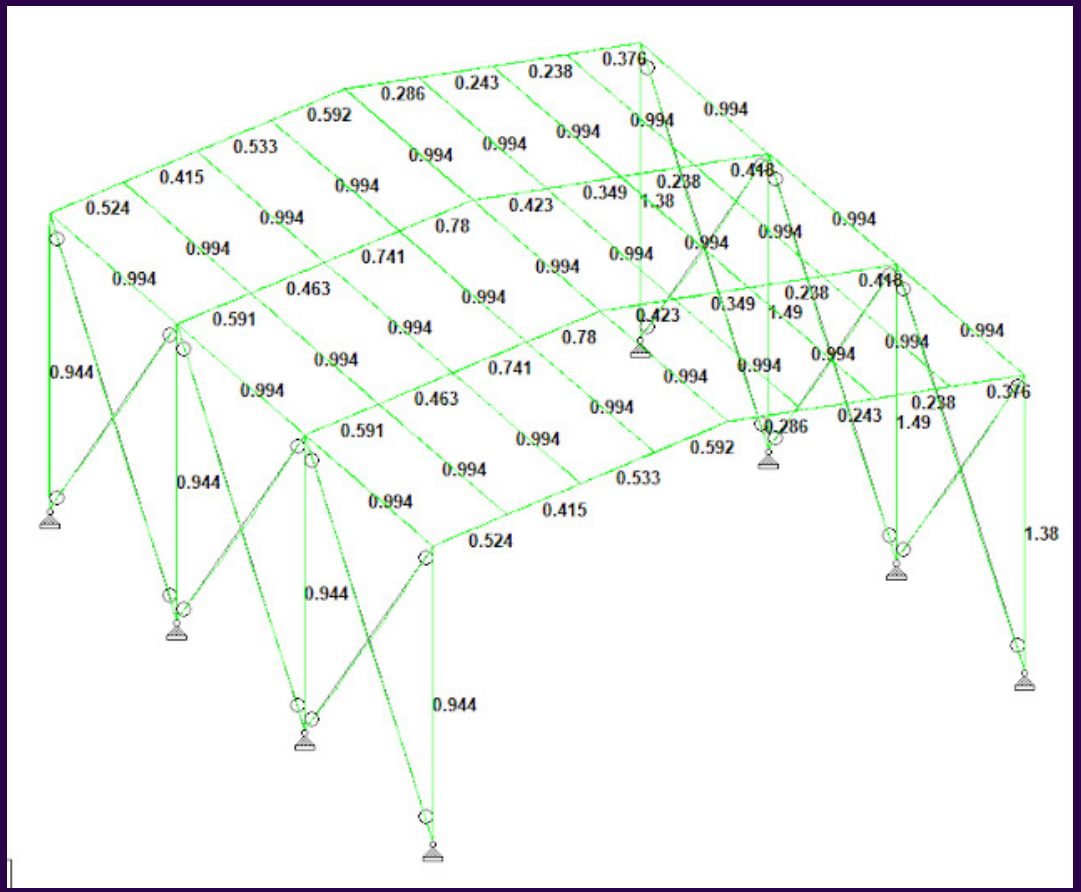
Front View



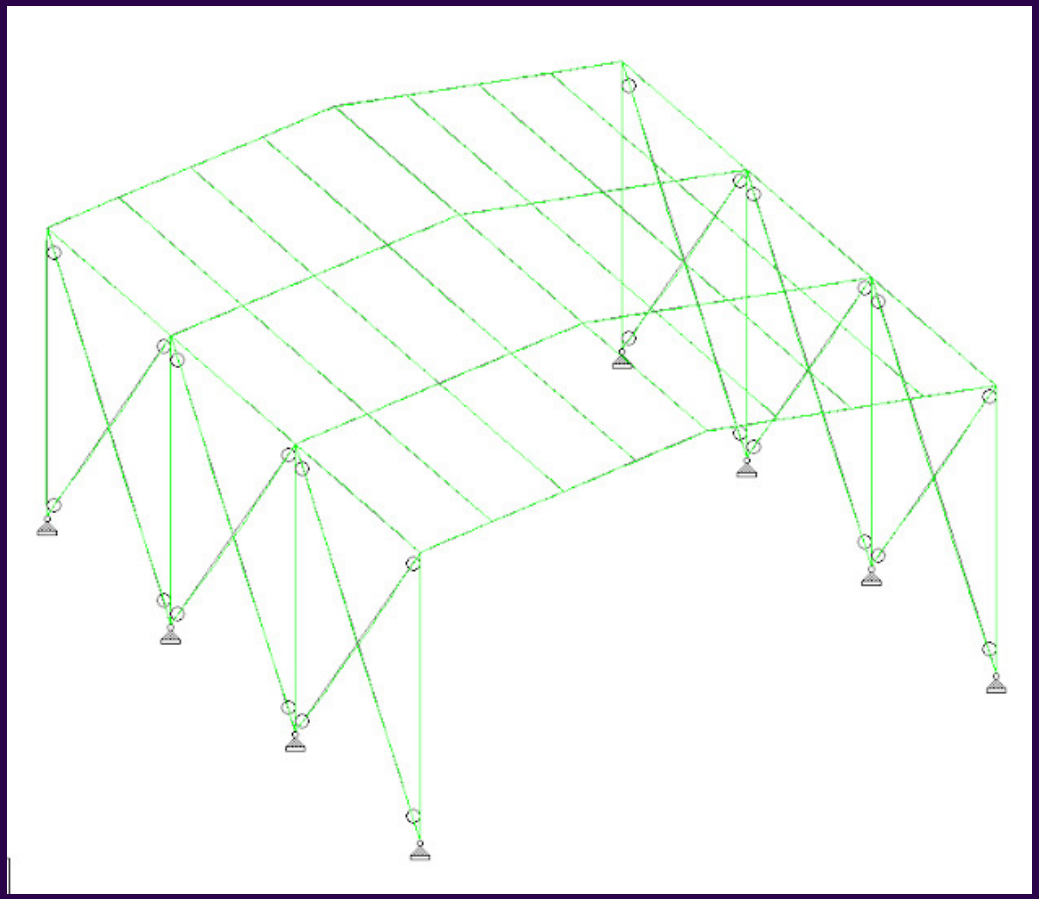


Top View

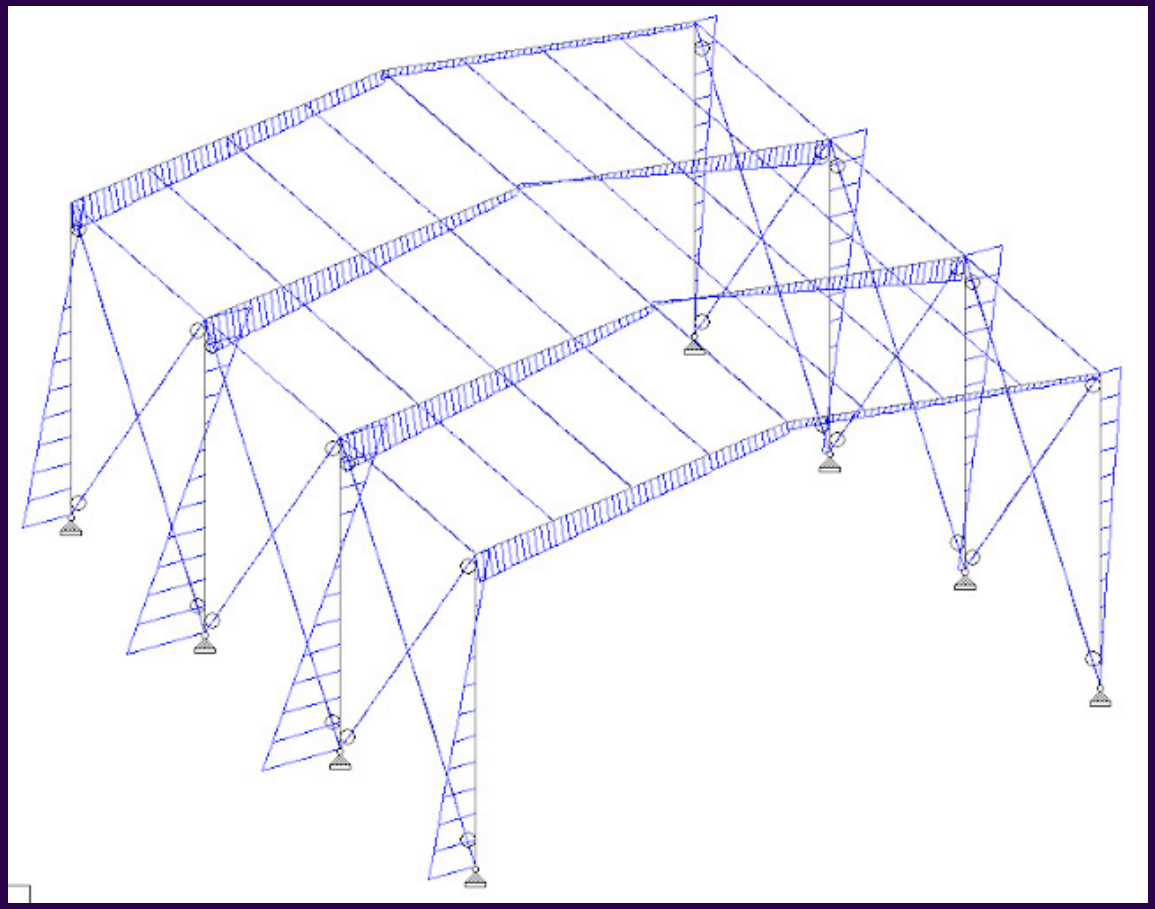
Utilization Ratio



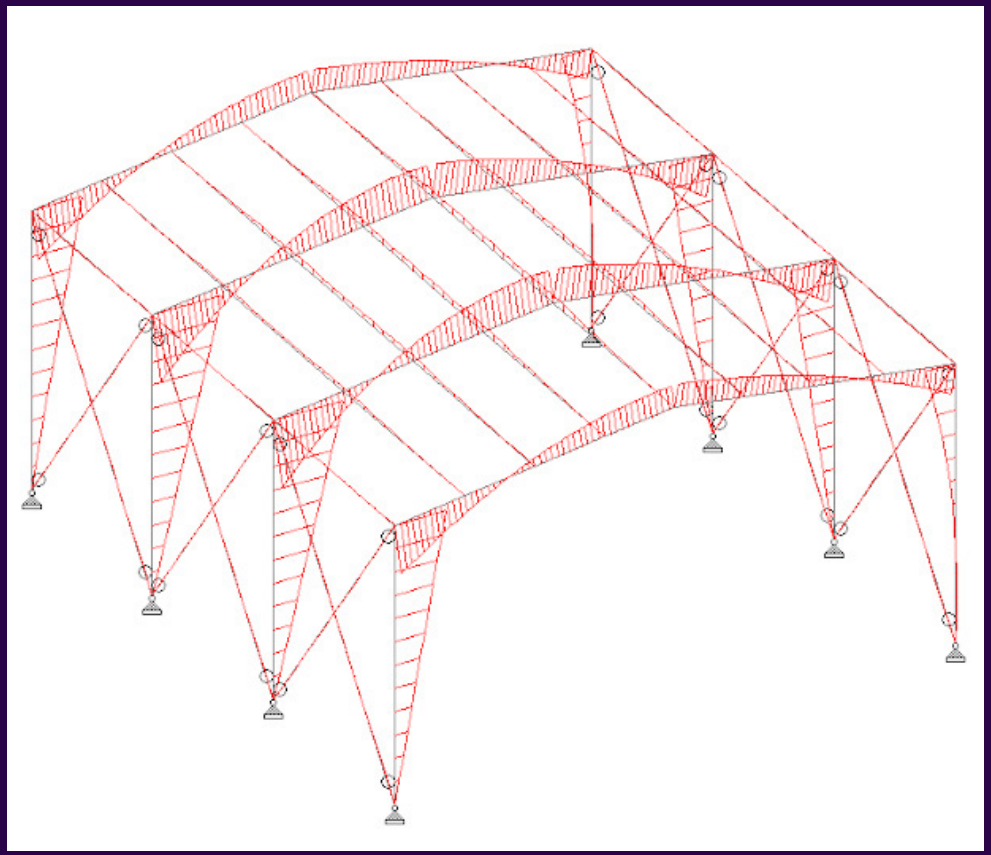
Displacements



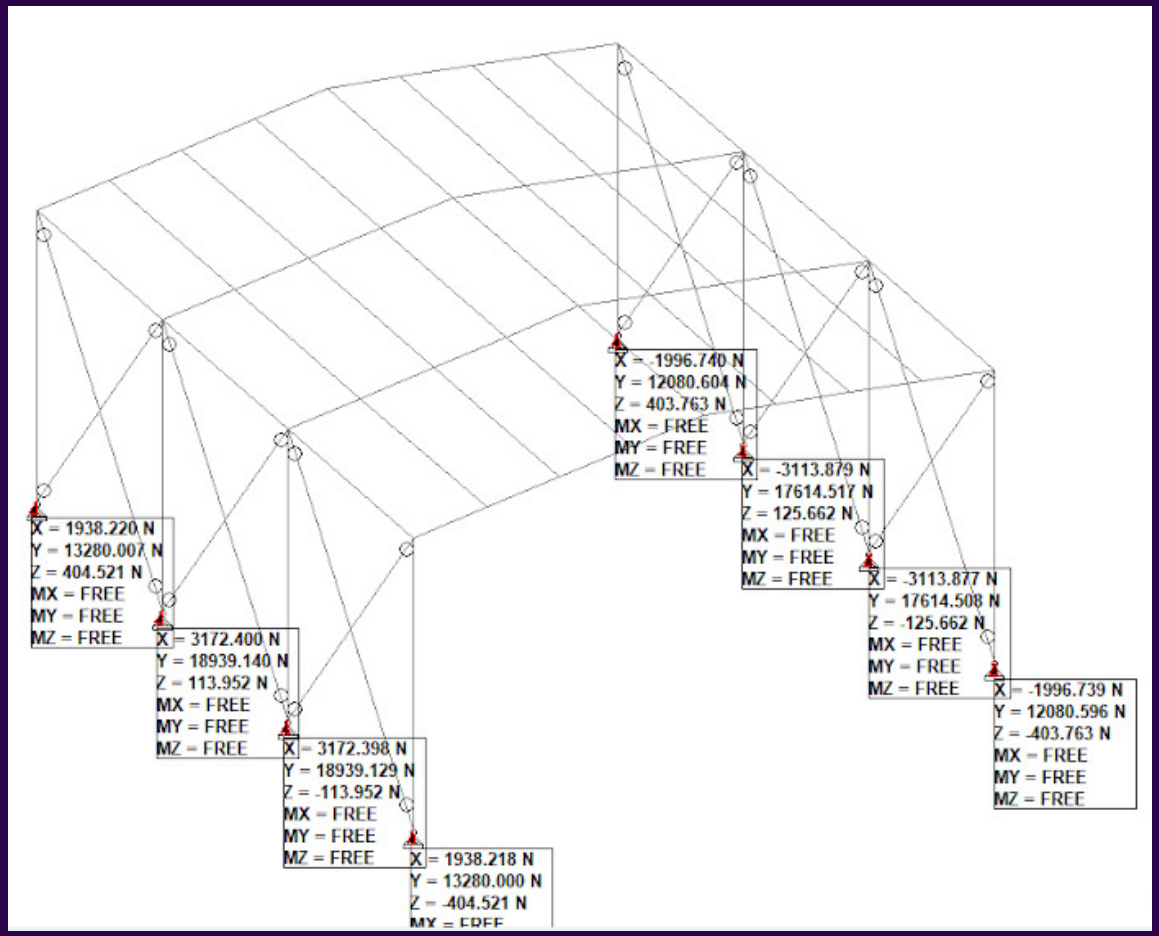
Shear Force (F_y)

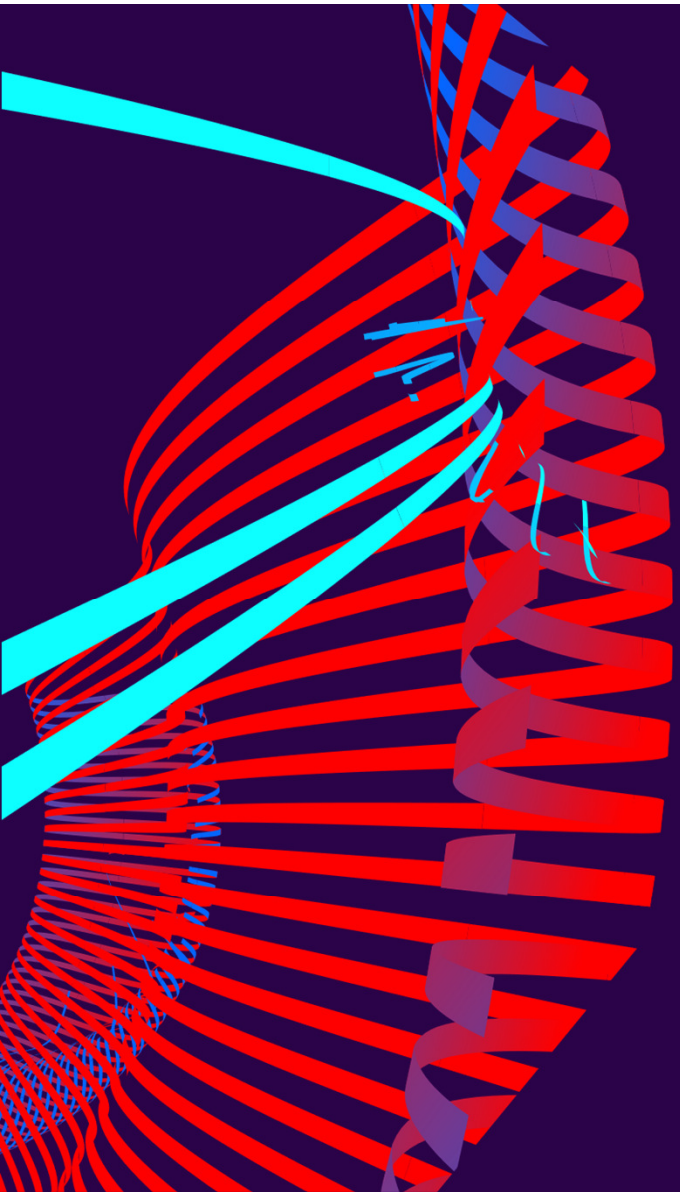


Bending Moment along Z (M_z)



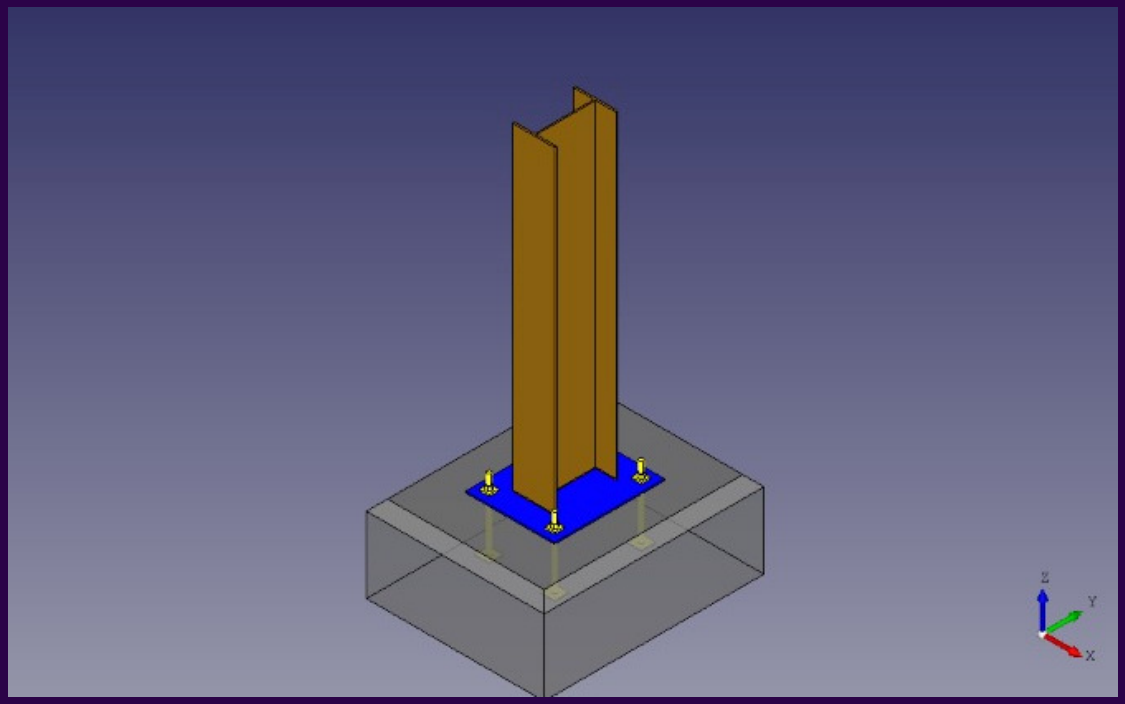
Support Reactions





CONNECTION DESIGN

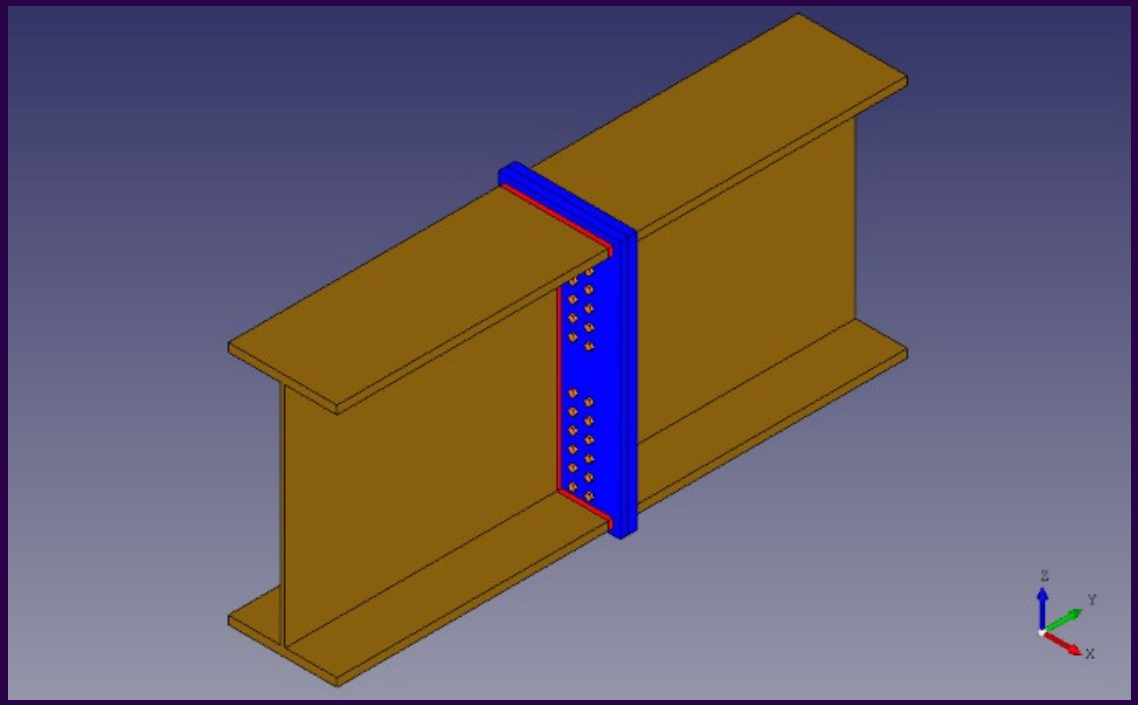
Baseplate Connection



Output Dock

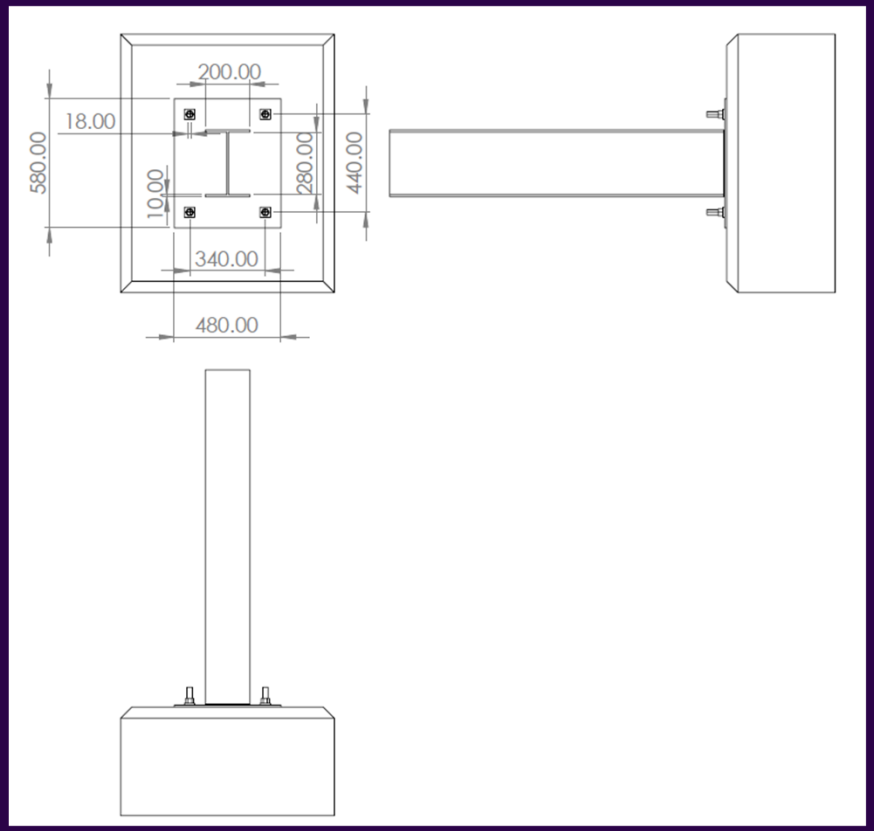
Anchor Bolt - Outside Column Flange	
Diameter (mm)	20
Property Class	12.9
No. of Anchors	4
Shear Capacity (kN)	138.06
Bearing Capacity (kN)	87.25
Bolt Capacity (kN)	87.25
Tension Demand (kN)	0
Tension Capacity (kN)	215.21
Combined Capacity (kN)	N/A
Anchor Length (mm)	344.5
Anchor Bolt - Inside Column Flange	
Diameter (mm)	N/A
Property Class	N/A
No. of Anchors	0
Tension Demand (kN)	0
Tension Capacity (kN)	N/A
Anchor Length (mm)	N/A
Base Plate Connection	
Thickness (mm)	10
Length (mm)	520.0
Width (mm)	420.0
Bearing Stress (MPa)	1.91
Typical Sketch	Typical Sketch

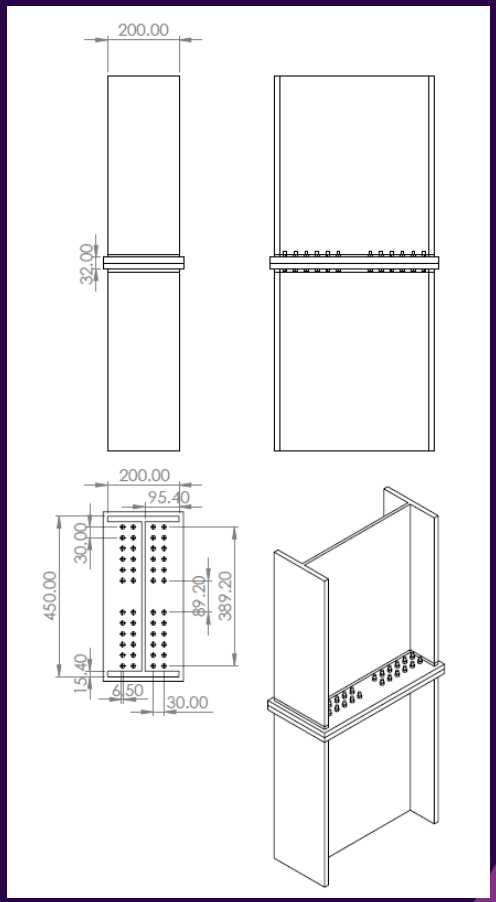
Beam-to-Beam End Plate Connection



Critical Bolt Design	
Diameter (mm)	8
Property Class	10.9
Shear Demand (kN)	0.83
Shear Capacity (kN)	17.58
Bearing Capacity (kN)	65.08
β_{lg}	1.0
Bolt Capacity	17.58
Tension Due to Moment (kN)	27.12
Prying Force (kN)	0.0
Tension Demand (kN)	27.12
Tension Capacity (kN)	27.41
Combined Capacity, I.R	0.981
Detailing	
No. of Bolts	48
No. of Columns	4
No. of Rows	12
Pitch Distance (mm)	30
Gauge Distance (mm)	30
Cross-centre Gauge (mm)	56
End Distance (mm)	15
Edge Distance (mm)	15
Typical Detailing	Details
End Plate	
Thickness (mm)	16

Drawings for both connections





TEAM MEMBERS

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THANK YOU