CNLC

Double-Sided High Mast Structure Calculation

Double-Sided High Mast Structure Calculation

Chapter 1 Load Calculation

1.2 Wind Load Calculation

GB 50009-2012 Code for Design of Building Structures – Loads

Wind pressure return period: windperiod := "50年"

Level 9 wind speed: $v_w := 20.8\frac{m}{s}$

Basic wind pressure: $w_o := \left[\frac{\left(\frac{v_w}{\frac{m}{s}}\right)^2 kPa}{1600}\right] = 0.27 \cdot kPa$

Design height of building: $z := 10 \cdot m$

Ground roughness category: roughness := "C"

Wind pressure height variation factor: $\mu_z = 0.65$

Gust factor: $\beta_{gz} = 2.05$

Local amplification factor: $\mu_{sl} := 1.0$

Standard wind load value: $WS := \beta_{gz} \cdot \mu_{sl} \cdot \mu_z \cdot w_o = 0.36 \cdot kPa$

Table 8.2.1 Wind Pressure Height Variation Factor μz

Height above ground(m)	Land surface roughness category			
	A	B	C	D
5	1.09	1.00	0.65	0.51
10	1.28	1.00	0.65	0.51
15	1.42	1.13	0.65	0.51
20	1.52	1.23	0.74	0.51
30	1.67	1.39	0.88	0.51
40	1.79	1.52	1.00	0.60
50	1.89	1.62	1.10	0.69
60	1.97	1.71	1.20	0.77
70	2.05	1.79	1.28	0.84
80	2.12	1.87	1.36	0.91
90	2.18	1.93	1.43	0.98
100	2.23	2.00	1.50	1.04

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Table 8.2.1 (Continued)

Height above ground (m)	Land surface roughness category			
	A	B	C	D
150	2.46	2.25	1.79	1.33
200	2.64	2.46	2.03	1.58
250	2.78	2.63	2.24	1.81
300	2.91	2.77	2.43	2.02
350	2.91	2.91	2.60	2.22
400	2.91	2.91	2.76	2.40
450	2.91	2.91	2.91	2.58
500	2.91	2.91	2.91	2.74
⩾550	2.91	2.91	2.91	2.91

Table 8.6.1Gust Factor βμ

Height above ground (m)	Land surface roughness category			
	A	B	C	D
5	1.65	1.70	2.05	2.40
10	1.60	1.70	2.05	2.40
15	1.57	1.65	2.05	2.40
20	1.55	1.63	1.99	2.40
30	1.53	1.59	1.90	2.40
40	1.51	1.57	1.85	2.29
50	1.49	1.55	1.81	2.20
60	1.48	1.54	1.78	2.14
70	1.48	1.52	1.75	2.09
80	1.47	1.51	1.73	2.04
90	1.46	1.50	1.71	2.01

Table 8.6.1 (continued)

Height above ground (m)	Land surface roughness category			
	A	B	C	D
100	1.46	1.50	1.69	1.98
150	1.43	1.47	1.63	1.87
200	1.42	1.45	1.59	1.79
250	1.41	1.43	1.57	1.74
300	1.40	1.42	1.54	1.70
350	1.40	1.41	1.53	1.67
400	1.40	1.41	1.51	1.64
450	1.40	1.41	1.50	1.62
500	1.40	1.41	1.50	1.60
550	1.40	1.41	1.50	1.59

1.3 Self-weight Load Calculation

Average load on panels and component $q_{dk} := 0.5kPa$

1.4 Seismic Load Calculation

<GB50011-2010 Code for Seismic Design of Buildings>

Seismic intensity (degree): seismic_intensity := 7

Basic seismic acceleration (g): $acceleration := 0.10 \cdot g$

Maximum value of horizontal seismic influence coefficient: $\alpha_{max} := 0.08$

Dynamic amplification factor: $\beta_e := 5$

Characteristic value of horizontal seismic action: $q_{ek} := \beta_e \alpha_{max} \cdot q_{dk} = 0.2 \cdot kPa$

1.5 Load Combination

Load Combination 1 (Strength Check): 1.3D+1.5W+0.7E

Load perpendicular to the curtain wall surface: $q_y := 1.5q_{wk} + 0.65q_{ek} = 3.97 \cdot kPa$

Load parallel to the curtain wall surface: $q_z := 1.3q_{dk} = 0.65 \cdot kPa$

Load Combination 2 (Deflection Check): 1.0D+1.0W

Load perpendicular to the curtain wall surface: $q'_y := 1.0q_{wk} = 2.56 \cdot kPa$

Load parallel to the curtain wall surface: $q'_z := 1.0q_{dk} = 0.5 \cdot kPa$

Chapter 2 Keel Verification

1. Calculation Description

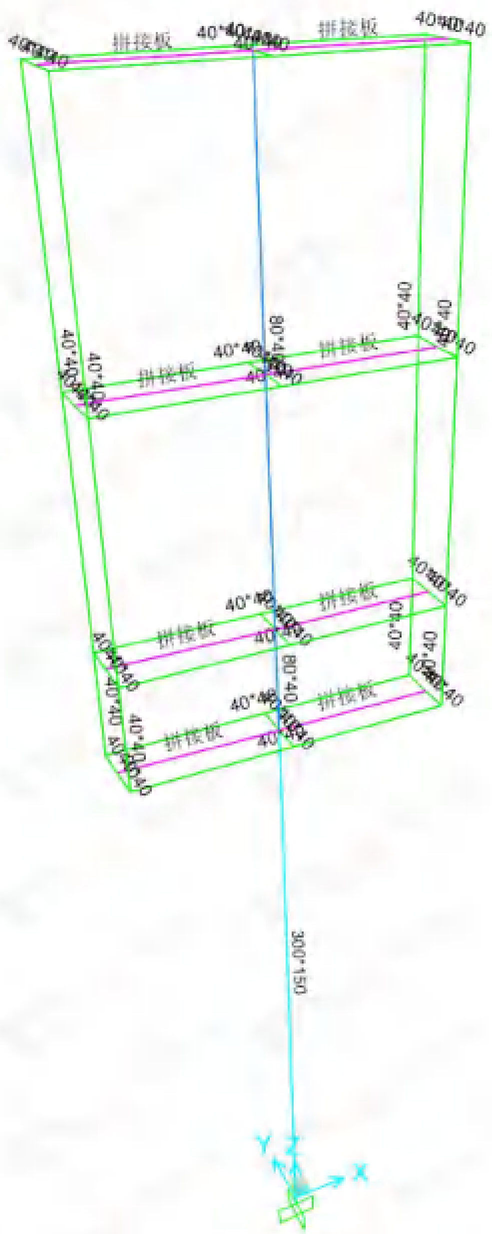
The self-weight of the steel structure keel is automatically appliedby the SAP2000 software.

The structural model is as follows: designated keel

The blue keel adopts an 80×40 Rectangular Hollow Section (RHS) for its cross-section, the purple components are splicing plates, the cyan

components are 300×150 support columns, the green components are

40×40 Square Hollow Section (SHS), and the material grade is specified as Q235B.



Node Label

TABLE: Objects And Elements - Joints			
JointElem	GlobalX	GlobalY	GlobalZ
Text	m	m	m
1	0.00	0.00	0.00
2	0.00	0.00	2.68
4	-0.63	0.00	2.68
5	0.63	0.00	2.68
6	-0.63	0.13	2.68
7	0.63	0.13	2.68
8	-0.63	-0.13	2.68
9	0.63	-0.13	2.68
10	-0.63	0.00	4.93
11	0.63	0.00	4.93
12	-0.63	0.13	4.93
13	0.63	0.13	4.93
14	-0.63	-0.13	4.93
15	0.63	-0.13	4.93
16	-0.63	0.00	3.11
17	-0.63	-0.13	3.11
18	0.63	-0.13	3.11
19	-0.63	0.13	3.11
20	0.63	0.13	3.11
21	0.00	0.00	4.93
22	0.63	0.00	3.11
23	0.00	0.00	3.11
24	-0.63	0.00	4.02
25	-0.63	-0.13	4.02
26	0.63	-0.13	4.02
27	-0.63	0.13	4.02
28	0.63	0.13	4.02
29	0.63	0.00	4.02
30	0.00	0.00	4.02
34	0.00	-0.13	2.68
35	0.00	0.13	2.68
36	0.00	-0.13	3.11
37	0.00	0.13	3.11
38	0.00	-0.13	4.93
39	0.00	0.13	4.93
40	0.00	-0.13	4.02
41	0.00	0.13	4.02

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Member Label

TABLE: Frame Section Assignments			
Frame	SectionType	AnalSect	DesignSect
Text	Text	Text	Text
1	Box/Tube	300*150	300*150
15	Box/Tube	40*40	40*40
16	Box/Tube	40*40	40*40
17	Box/Tube	40*40	40*40
18	Box/Tube	40*40	40*40
19	Channel	splicing plate	splicing plate
20	Channel	splicing plate	splicing plate
21	Box/Tube	40*40	40*40
22	Box/Tube	40*40	40*40
23	Box/Tube	40*40	40*40
24	Box/Tube	40*40	40*40
25	Box/Tube	40*40	40*40
26	Box/Tube	40*40	40*40
27	Box/Tube	40*40	40*40
28	Box/Tube	40*40	40*40
29	Box/Tube	40*40	40*40
30	Box/Tube	40*40	40*40
31	Box/Tube	40*40	40*40
32	Box/Tube	40*40	40*40
33	Box/Tube	40*40	40*40
34	Box/Tube	40*40	40*40
35	Box/Tube	40*40	40*40
36	Box/Tube	40*40	40*40
37	Box/Tube	40*40	40*40
38	Box/Tube	40*40	40*40
39	Box/Tube	40*40	40*40
40	Box/Tube	40*40	40*40
41	Box/Tube	80*40	80*40
42	Box/Tube	80*40	80*40
43	Channel	splicing plate	splicing plate
44	Channel	splicing plate	splicing plate
45	Box/Tube	40*40	40*40
46	Box/Tube	40*40	40*40
47	Box/Tube	40*40	40*40
48	Box/Tube	40*40	40*40
49	Box/Tube	40*40	40*40
50	Box/Tube	40*40	40*40
51	Channel	splicing plate	splicing plate
52	Channel	splicing plate	splicing plate

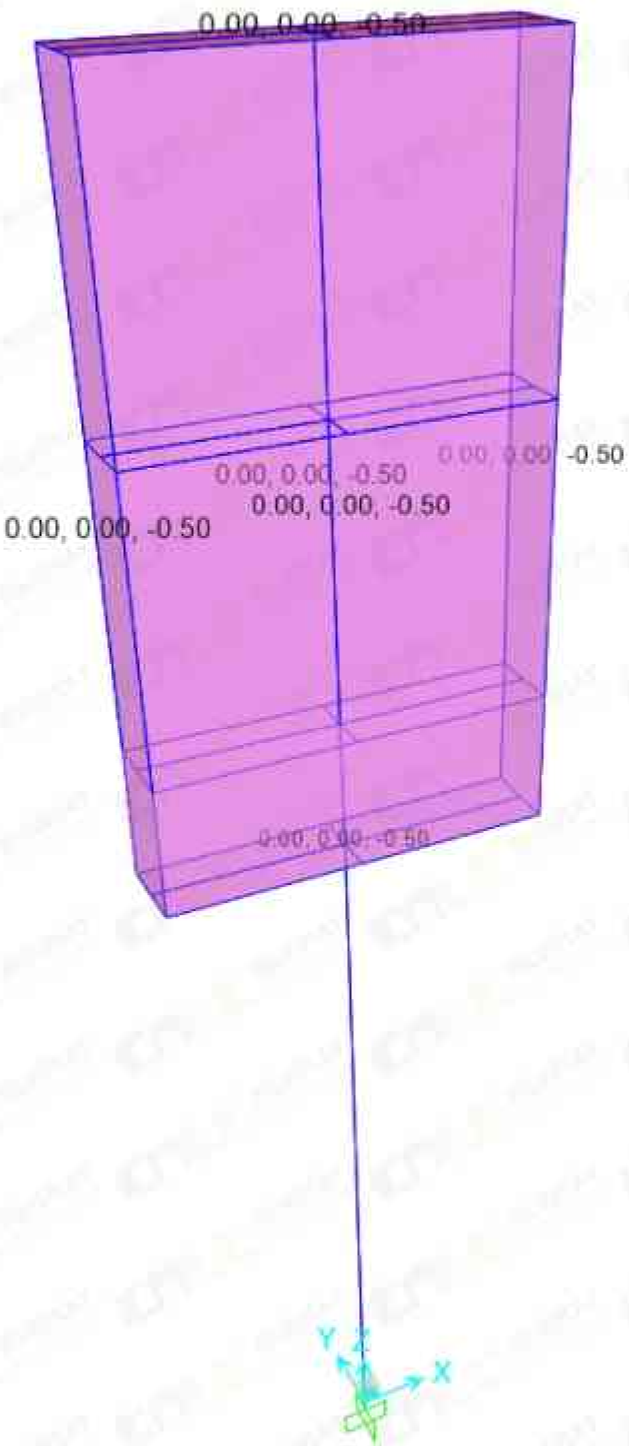
53	Box/Tube	40*40	40*40
54	Box/Tube	40*40	40*40
59	Channel	splicing plate	splicing plate
60	Channel	splicing plate	splicing plate
63	Box/Tube	40*40	40*40
64	Box/Tube	40*40	40*40
65	Box/Tube	40*40	40*40
66	Box/Tube	40*40	40*40
67	Box/Tube	40*40	40*40
68	Box/Tube	40*40	40*40
69	Box/Tube	40*40	40*40
70	Box/Tube	40*40	40*40

2. Load Definition

Dead Load D G=0.5kPa
Wind Load W q=0.36kPa

Seismic Load: Seismic fortification intensity is 7 degrees, w ith a design basic seismic acceleration of 0.10g
Self-weight of steel tubular members is automatically appli ed

Load Application:
Dead Load


0.00, 0.00, -0.50
0.00, 0.00, -0.50
0.00, 0.00, -0.50
0.00, 0.00, -0.50
0.00, 0.00, -0.50
0.00, 0.00, -0.50
Y
Z
X

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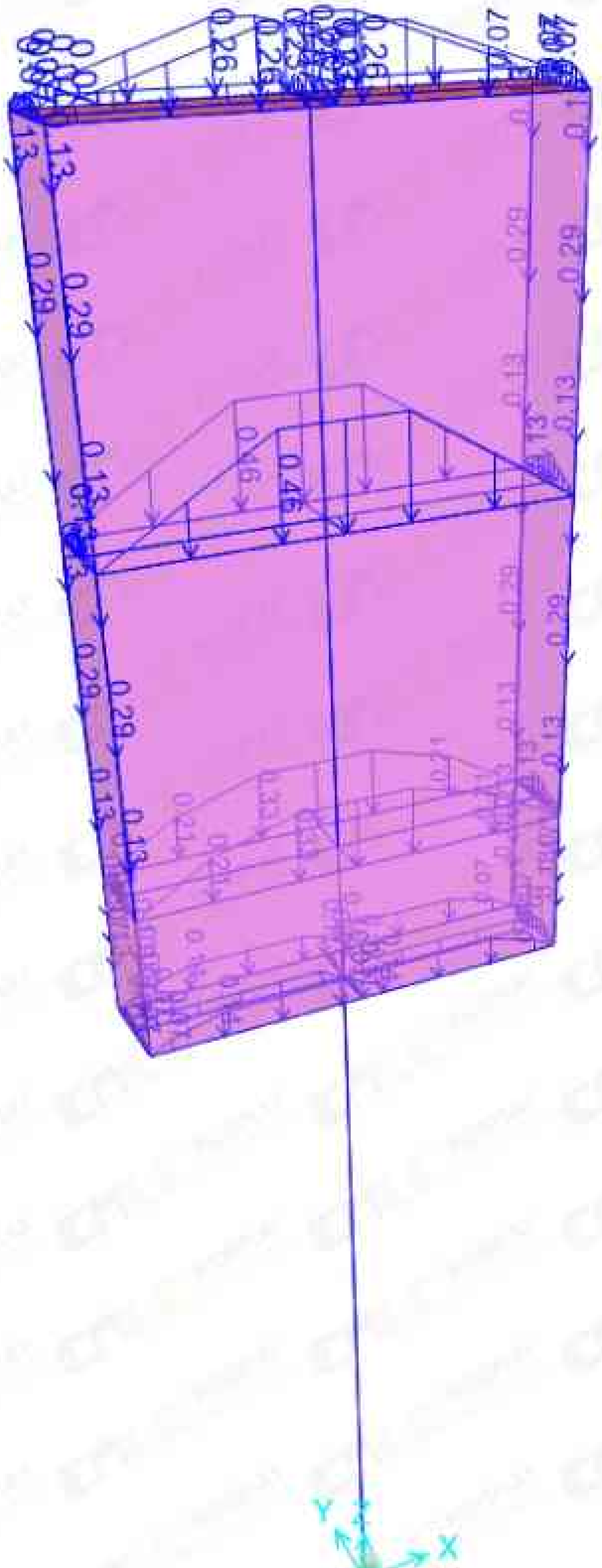

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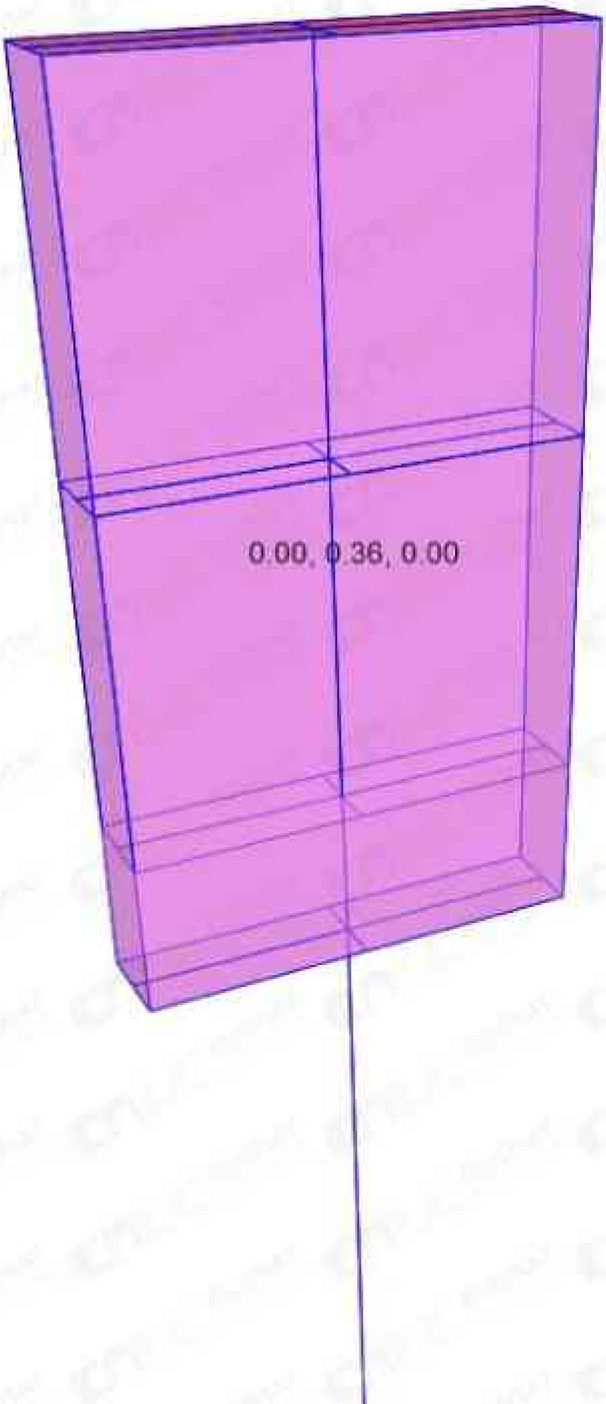
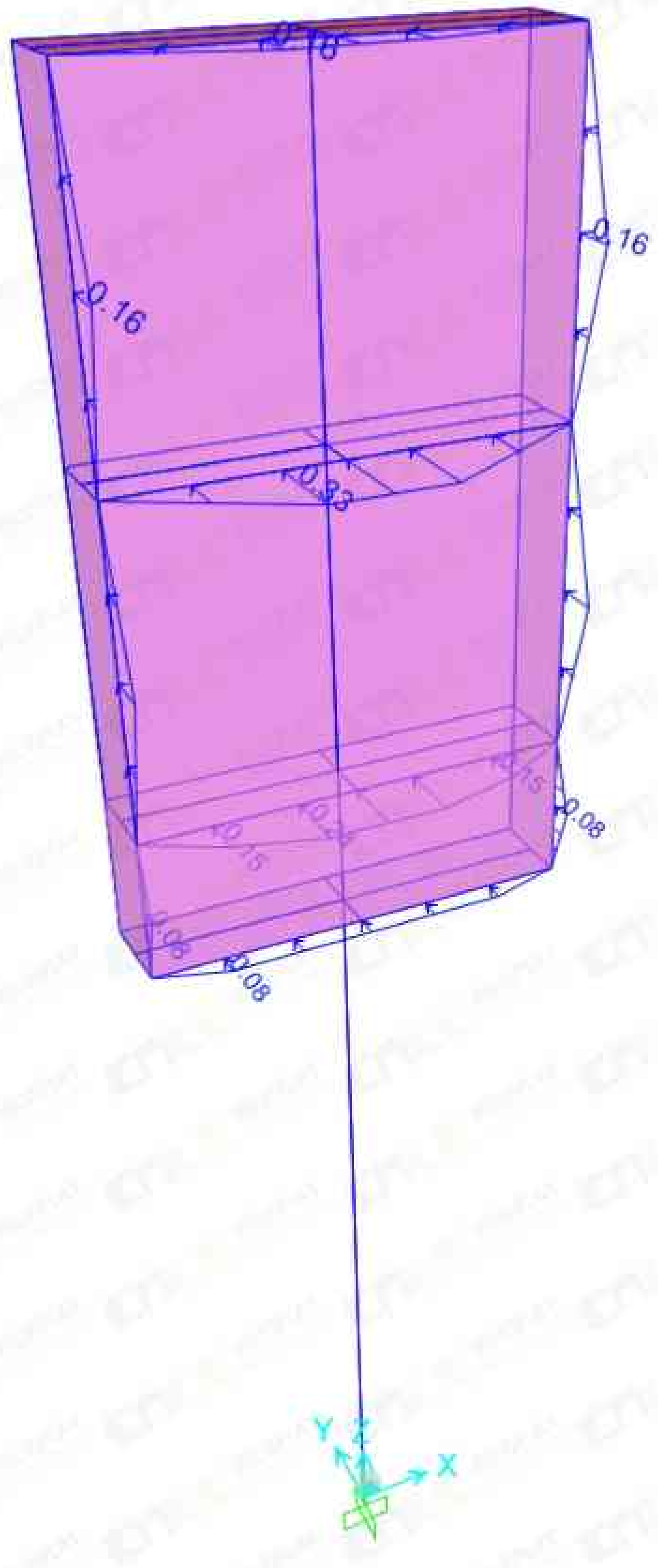
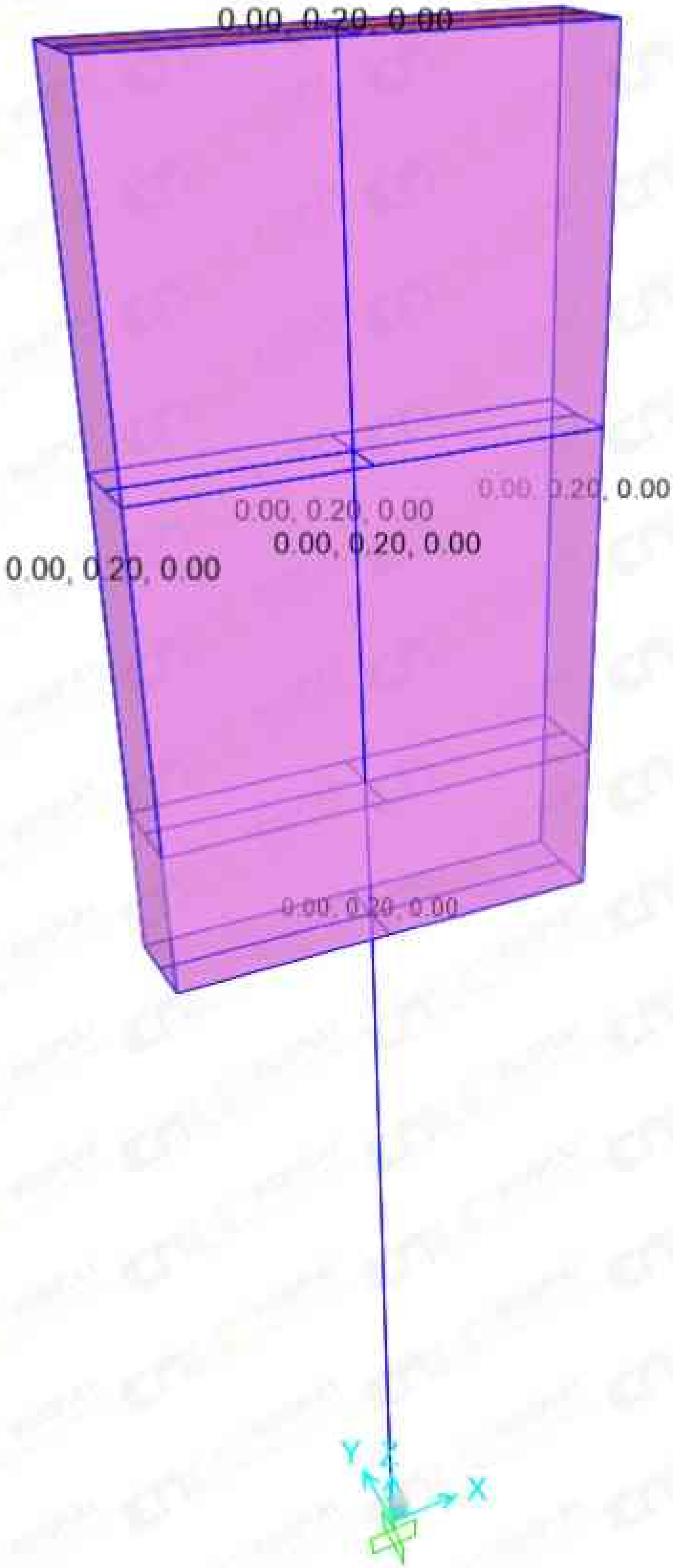
Wind Load





Seismic Load


0.00, 0.20, 0.00
0.00, 0.20, 0.00
0.00, 0.20, 0.00
0.00, 0.20, 0.00
0.00, 0.20, 0.00
0.00, 0.20, 0.00
Y
Z
X

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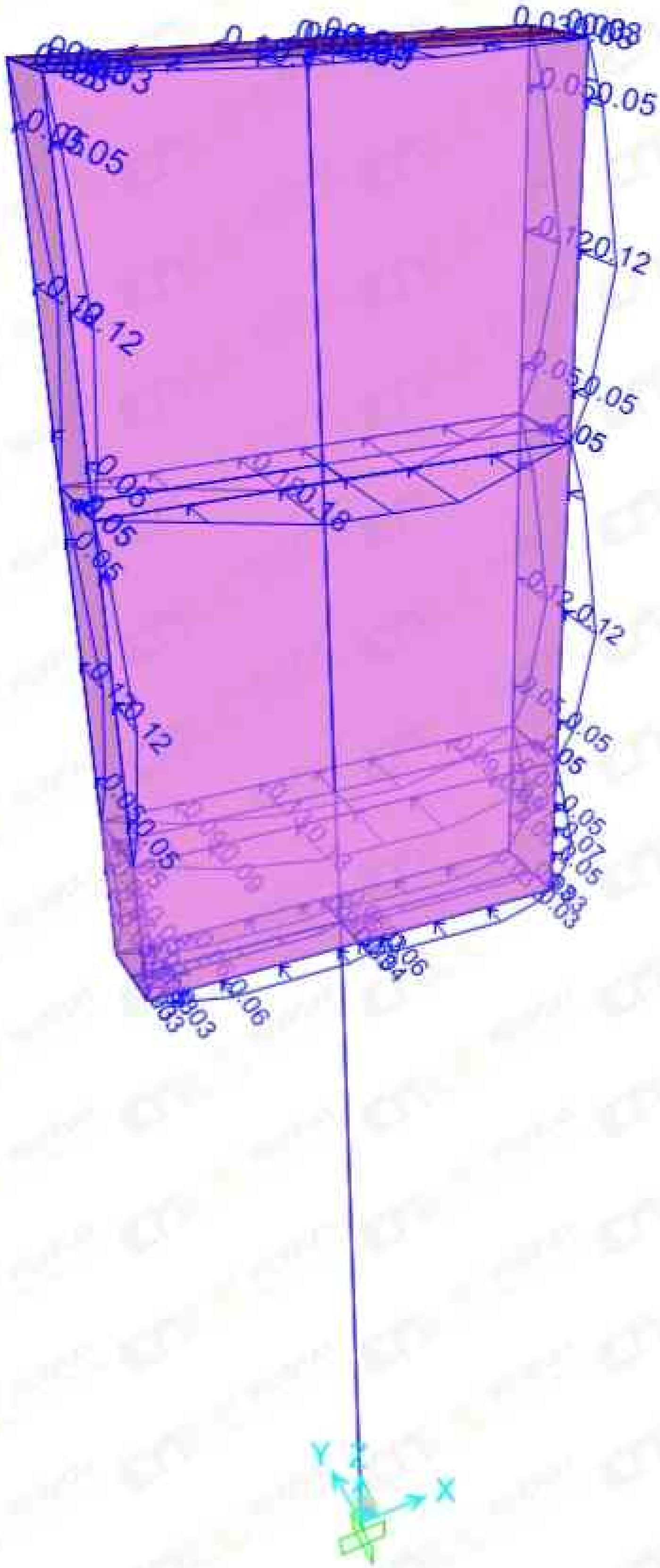
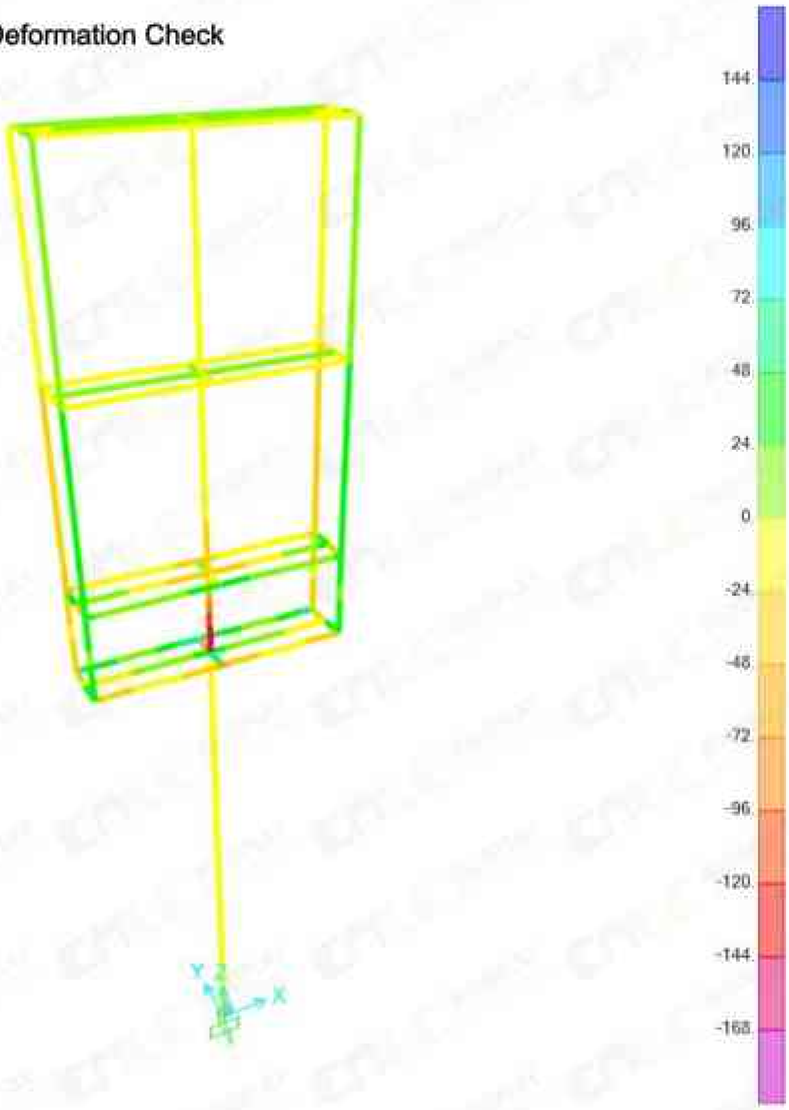
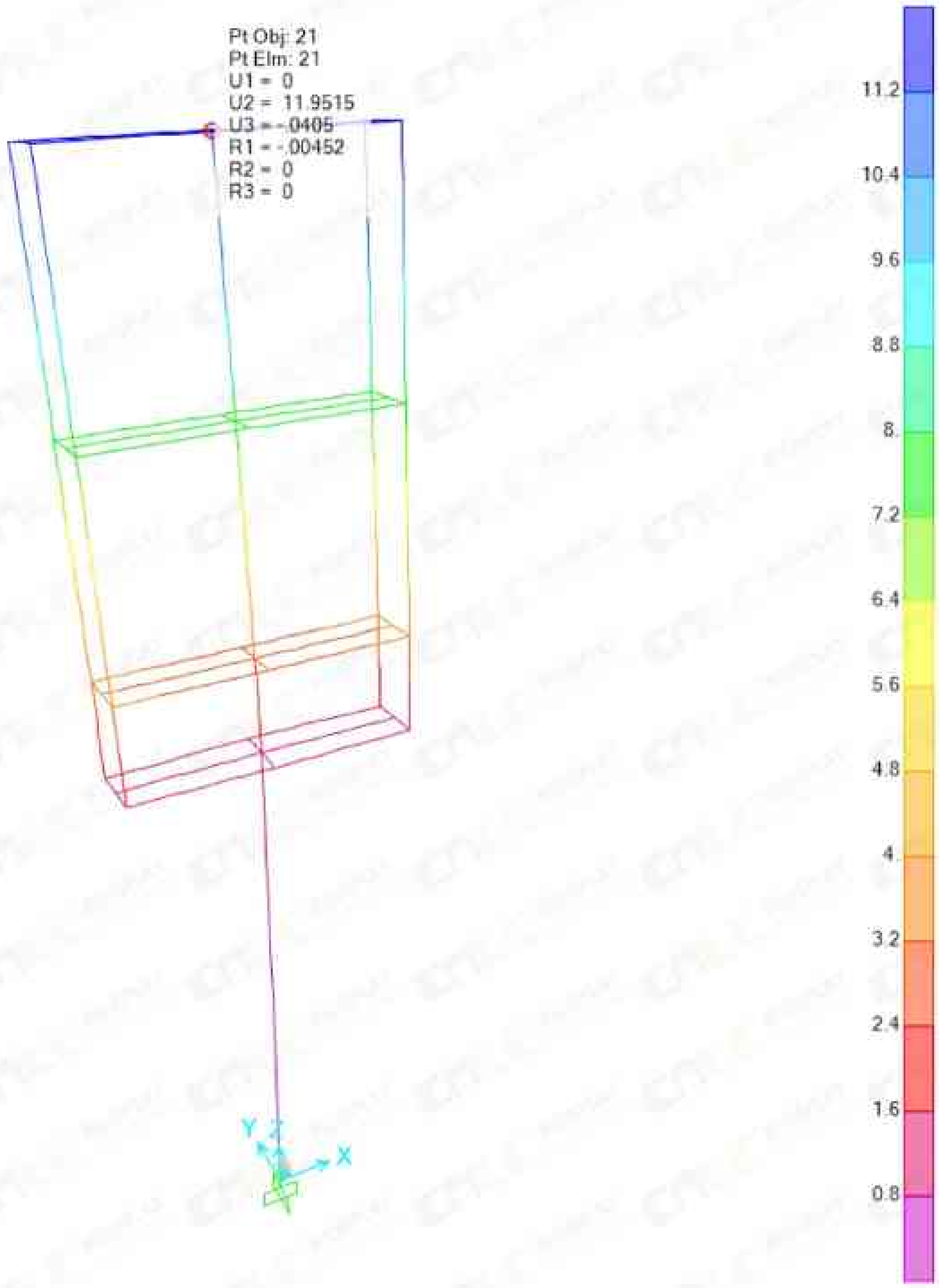


3. Load Combination

4. Strength and Deformation Check

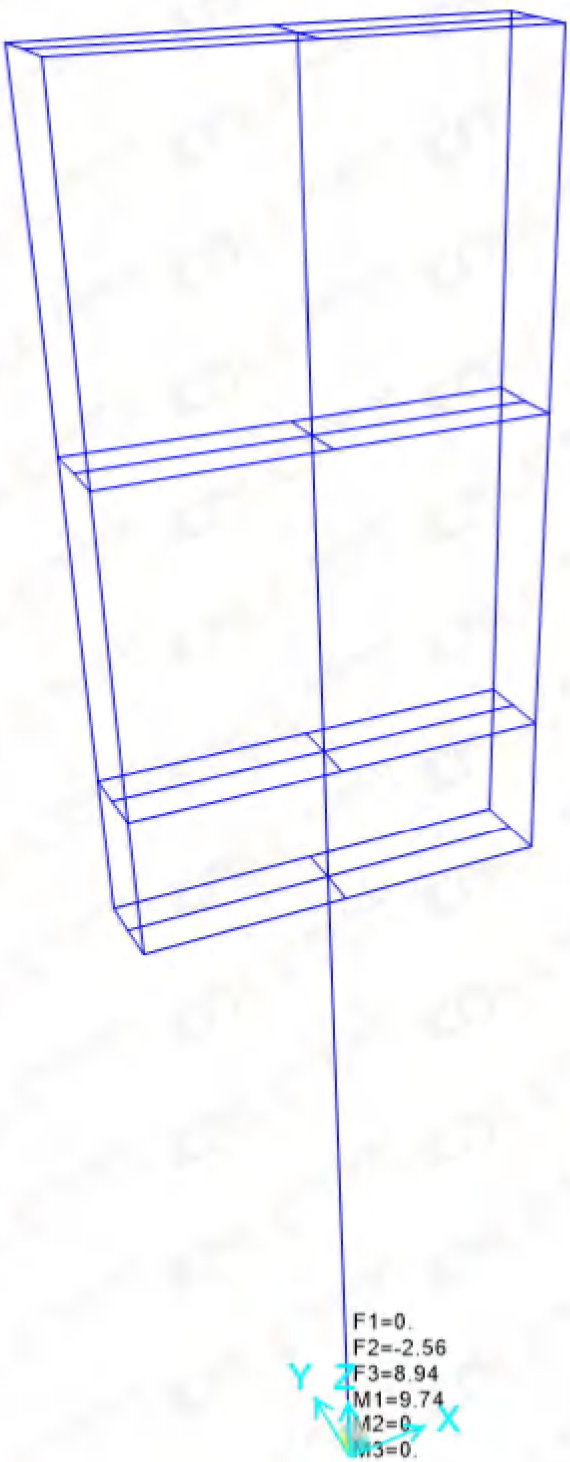


Maximum member stress under strength load case:168MPa<215MPa



Maximum member deflection under deflection load case:12mm<2680+2250/125=39.4mm

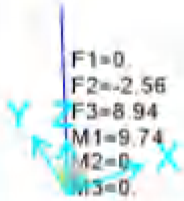
5. Conclusion



In summary: Under Grade 9 wind speed, the member stress and deflection of the double-sided high-mast LED structure meet the calculation requirements. The design is approve d and the scheme is feasible.

Chapter 3 Embedded Calculation

1 Reaction Check



The maximum reaction force is selected for the connection calculation of the steel frame root:

Axial force:	$N := 8.94kN$
Shear force:	$V := 2.56kN$
Bending moment:	$M := 9.74kN \cdot m$

2 Embedment Check

Anchor bars are arranged in 2 rows and 3 columns, adopting 16mm diameter HRB400 grade steel bars, with an anchor bar spacing of 270mm and an anchor plate thickness of 14mm.

2.1 Checking Calculation of Anchor Bar Area

In accordance with Appendix C of Technical Code for Glass Curtain Wall Engineering JGJ102-2003, under the combined action of shear force, normal tension and bending moment, the area of anchor bars shall be calculated according to the following formula and shall be greater than the maximum value.

Concrete Grade	Concrete Grade = "C30"
Design value of axial compressive strength of concrete	$f_c = 14.3 \cdot MPa$
Design value of axial tensile strength of concrete	$f_t = 1.43 \cdot MPa$
Design value of tensile strength of anchor bar	$f_y := 300MPa$
Diameter of anchor bar	$d = 16 \cdot mm$
Thickness of anchor plate	$t = 14 \cdot mm$
Influence coefficient of reinforcement layer number	$a_r = 0.9$

Center distance of the outermost anchor bars $L_z = 270 \cdot mm$

Shear bearing capacity coefficient of stirrups $a_v := \min\left[\left(4 - \frac{0.08 \cdot d}{mm}\right) \cdot \sqrt{\frac{f_c}{f_y}}, 0.7\right] = 0.594$

Reduction coefficient for bending deformation of anchor plate $a_b := 0.6 + 0.25 \cdot \frac{t}{d} = 0.819$

Calculation of anchor bar cross-sectional area:

$$A_{s1} := \frac{V}{a_r \cdot a_v \cdot f_y} + \frac{N}{0.8 \cdot a_b \cdot f_y} + \frac{M}{1.3 \cdot a_r \cdot a_b \cdot f_y \cdot L_z} = 186.989 \cdot mm^2$$

$$A_{s2} := \frac{N}{0.8 \cdot a_b \cdot f_y} + \frac{M}{0.4 \cdot a_r \cdot a_b \cdot f_y \cdot L_z} = 453.459 \cdot mm^2$$

Minimum required cross-sectional area of anchor bars for the embedded part $A_{m1} := \max(A_{s1}, A_{s2}) = 453.459 \cdot mm^2$

Number of anchor bars: $n = 6$

Actual total cross-sectional area of anchor bars for the embedded part: $A_1 := n \cdot \frac{\pi \cdot d^2}{4} = 1206.372 \cdot mm^2$

Check: $\frac{A_{m1}}{A_1} = 0.376$

Anchor bar area meets the requirements!

2.2 Check of Anchorage Length

Shape coefficient of anchor bar $\alpha = 0.14$

Calculation of anchorage length $l_{a0} := \alpha \cdot \frac{f_y}{f_t} \cdot d = 0.47 m$

Correction coefficient of anchorage length $\zeta_a := 0.6$

Corrected anchorage length $l_a := 1.1 \zeta_a \cdot l_{a0} = 310.154 \cdot mm$

Actual anchorage length $l_{ef} = 0.32 \cdot m$

Check $\text{ratio}\left(\frac{l_a}{l_{ef}}\right) = $ "0.969 <1 PASS!"

Check passed!