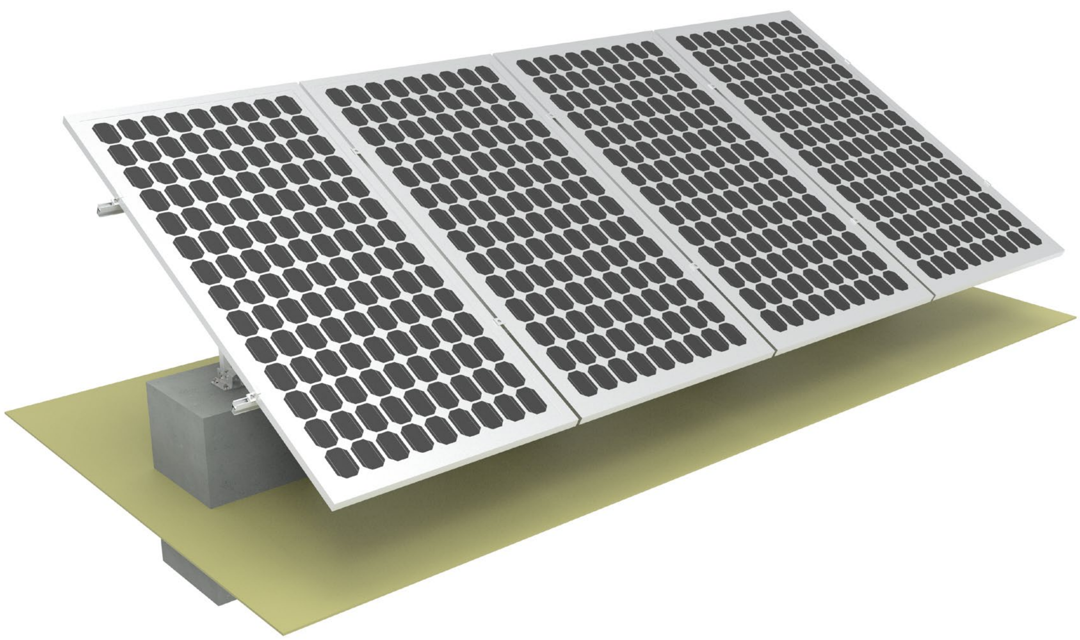
EG4® BRIGHTMOUNT ADJUSTABLE 90MPH/1100

CALCULATION REPORT



MODEL #: GM-4-BD-00

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1. MATERIAL PARAMETERS

1.1 CHEMICAL COMPOSITION & MECHANICAL PROPERTIES OF AL-6005

Elasticity modulus E=69000
Tensile/compressive/bending strength fy=240 Mpa

CHEMICAL COMPOSITION	ELEMENT (%)								
	Mg	Si	Fe	Cu	Mn	Cr	Zn	Ti	A1
	0.4-0.6	0.6-0.9	≤0.35	≤0.10	≤0.10	≤0.10	≤0.10	≤0.10	Rem

MECHANICAL PROPERTIES	TENSILE TEST		
	Tensile Strength (N/mm^2)	Non-proportional Elongation Strength (N/mm^2)	Elongation after Break (%)
	≥260	≥240	≥8

1.2 CHEMICAL COMPOSITION & MECHANICAL PROPERTIES OF Q235B

CHEMICAL COMPOSITION	ELEMENT (%)				
	C	Si	Mn	S	P
	0.16	0.2	0.44	0.025	0.025

MECHANICAL PROPERTIES	TENSILE TEST		
	Tensile Strength (N/mm^2)	Non-proportional Elongation Strength (N/mm^2)	Elongation after Break (%)
	465	235	29.5

1.3 CHEMICAL COMPOSITION & MECHANICAL PROPERTIES OF SUS304

CHEMICAL COMPOSITION	ELEMENT (%)								
	C	Si	Mn	p	s	ni	cr	ti	Other
	<=0.08	<=1.0	<=2.0	<=0.5	<=0.045	8-10.5	18-20	<=0.25	

MECHANICAL PROPERTIES	TENSILE TEST		
	Test Thickness	Tensile Strength (N/mm^2)	Yield Strength
	< = 6mm	< = 700	> = 206

2. DESIGN BASIS & JUDGEMENT STANDARDS

2.1 STANDARD CODE

ASCE 7-22

Minimum Design Loads for Building and Other Structures

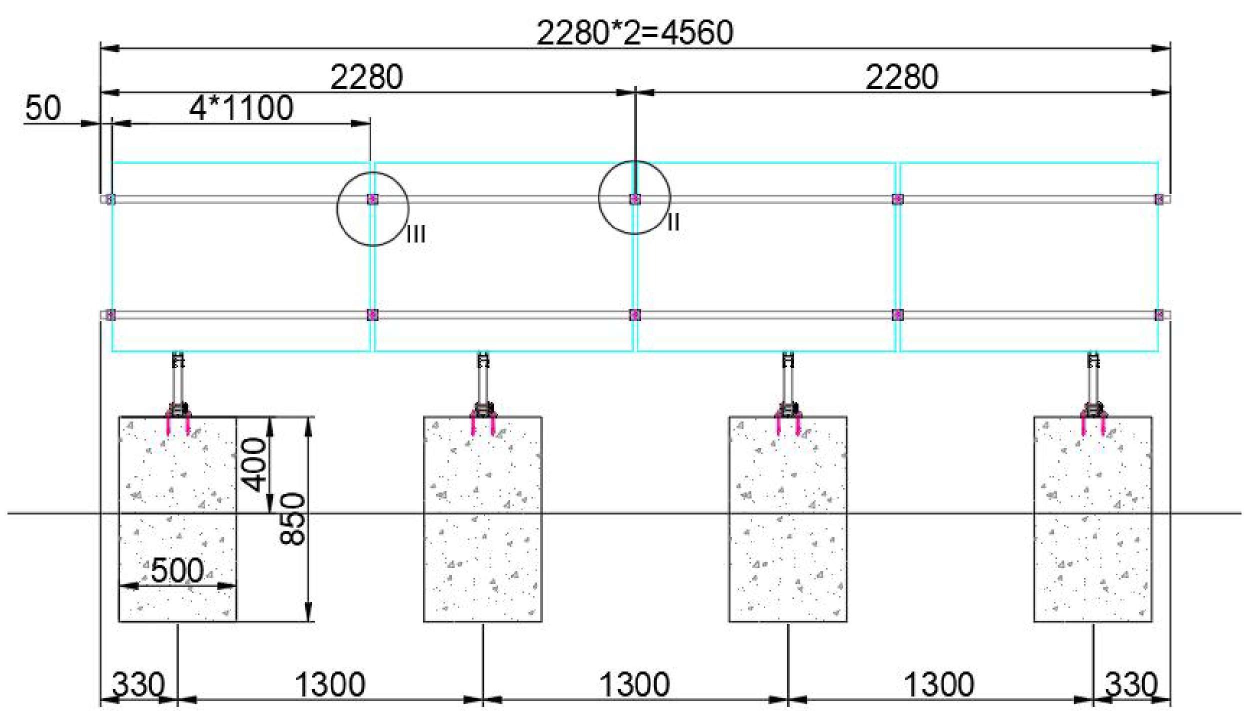
2.2 DESIGN CONDITIONS & TECHNICAL PARAMETERS

Solar Panel	90.5 × 43.3 × 1.37 in. (2300 × 1100 × 35 mm)
Layout	1 × 4 × 1 / 1 × 8 × 1
Tilt Angle	40°
Span	51.2 in. (1300 mm)
Exposure category	C
Wind Speed	90 mph (40.4 m/s) (3s gust)
Snow Load	0.6 KN/m^2

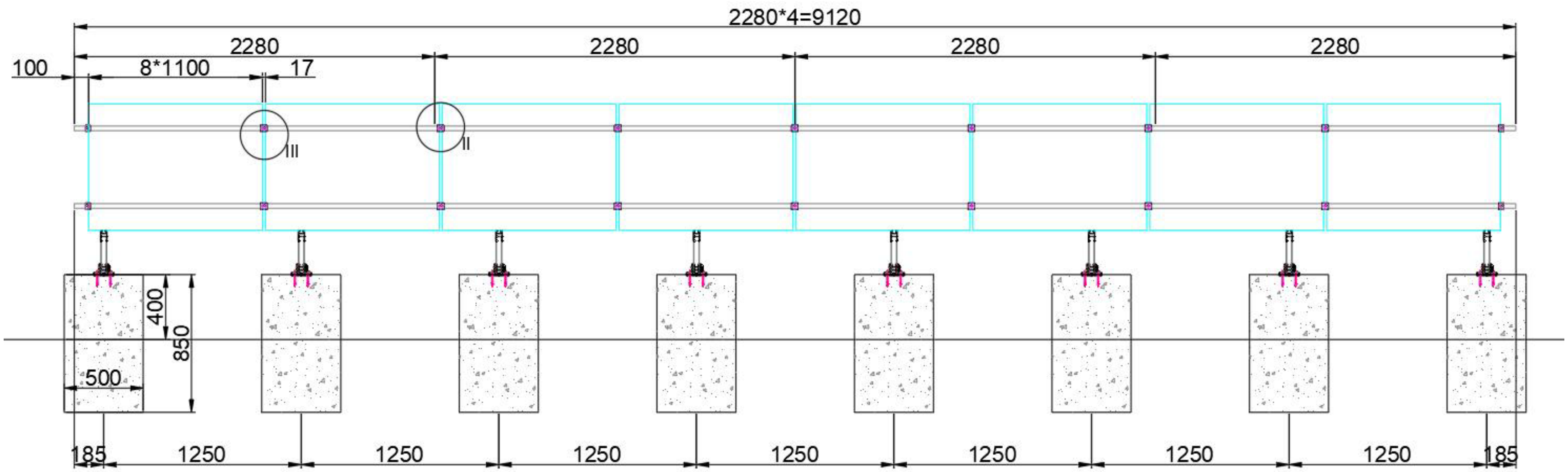
3. BRACKET & CROSS SECTION

3.1 SKETCH OF BRACKET

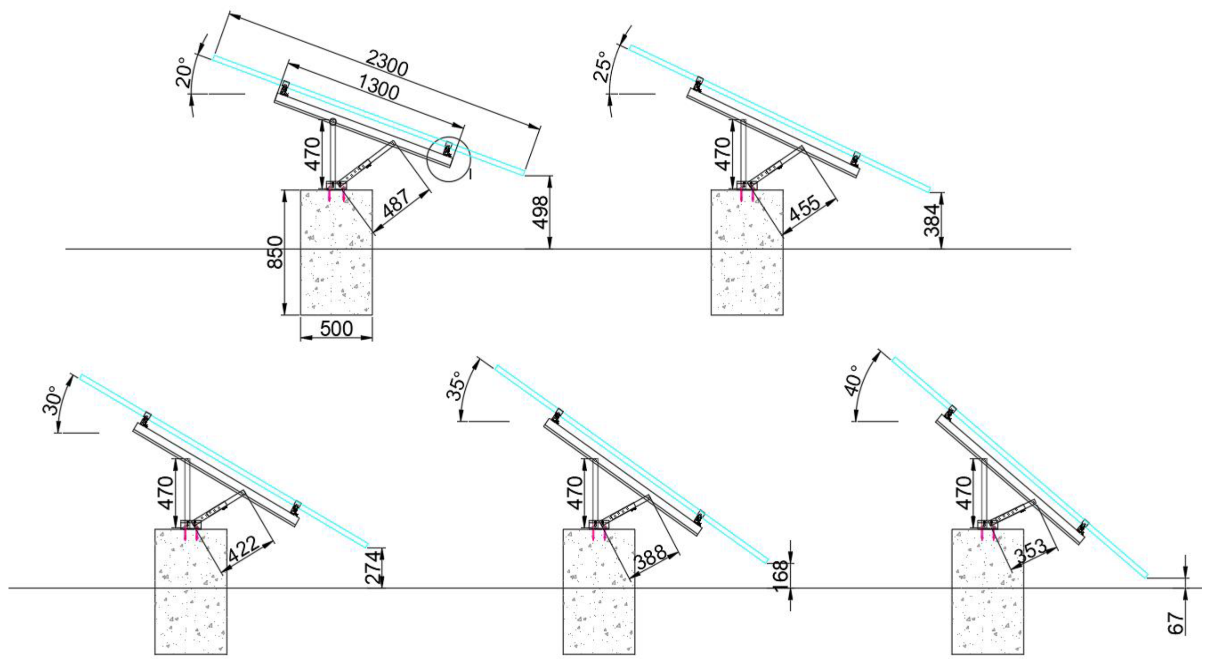
Front View – 1 × 4 × 1



Front View – 1 × 8 × 1



Side View



3.2 CROSS SECTIONS OF MEMBERS

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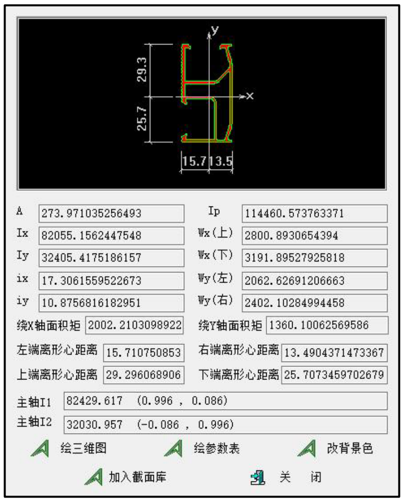
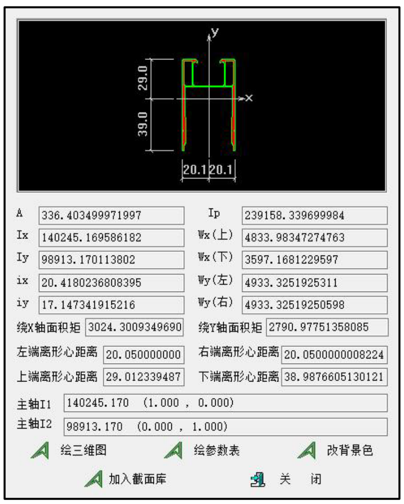
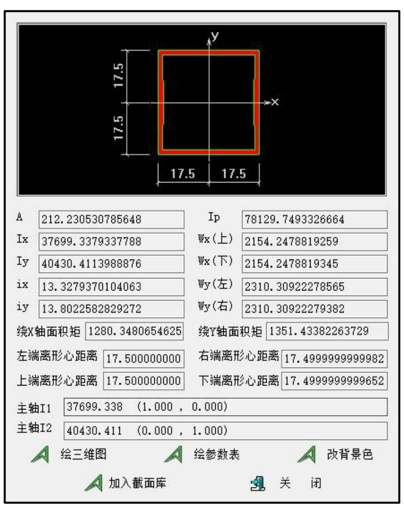
<tr><th>MEMBER</th><th>CROSS-SECTIONS</th><th colspan="2">PROPERTIES</th></tr>
<tr><td rowspan="7">Rail</td><td rowspan="7">
</td><td>A</td><td>274</td></tr>
<tr><td>Ix</td><td>82055</td></tr>
<tr><td>Iy</td><td>32405</td></tr>
<tr><td>ix</td><td>17.3062</td></tr>
<tr><td>iy</td><td>10.8757</td></tr>
<tr><td>Wx</td><td>2800</td></tr>
<tr><td>Wy</td><td>2062</td></tr>
<tr><td rowspan="7">Beam</td><td rowspan="7">
</td><td>A</td><td>336</td></tr>
<tr><td>Ix</td><td>140245</td></tr>
<tr><td>Iy</td><td>98913</td></tr>
<tr><td>ix</td><td>20.4180</td></tr>
<tr><td>iy</td><td>17.1473</td></tr>
<tr><td>Wx</td><td>3597</td></tr>
<tr><td>Wy</td><td>4933</td></tr>
<tr><td rowspan="7">Column</td><td rowspan="7">
</td><td>A</td><td>212</td></tr>
<tr><td>Ix</td><td>37699</td></tr>
<tr><td>Iy</td><td>40430</td></tr>
<tr><td>ix</td><td>13.3279</td></tr>
<tr><td>iy</td><td>13.8023</td></tr>
<tr><td>Wx</td><td>2154</td></tr>
<tr><td>Wy</td><td>2310</td></tr>
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4. LOAD CALCULATION

4.1 DEAD LOAD

Solar Panel

Weight 30 kg (one panel)

Dead-weight of panel G1= 30 × 9.8 × 4
= 1176 N

Rail AR55 AL6005-T5

Dead-weight of Rail G2 66.60 N

Dead load = G1+G2= 1243 N

4.2 SNOW LOAD

Snow pressure shall be calculated in the following formula:

The flat roof snow load, p_f, shall be calculated in lb/ft^2 (kN/m^2) using the following formula:

Formula: $p_F=0.7C_EC_TP_G$		
Flat surface snow load	$p_f = 0.7 \times C_e \times C_t \times P_g$	Based on ASCE/SEI 7-22 7.3 Table 7.3-1
	$= 0.7 \times 0.9 \times 1.2 \times 500$	
	= 454 KN/m^2	

Where:

Exposure Factor C_E = 0.9	Based on ASCE/SEI 7-22 7.3 Table 7.3-1
Thermal Factor C_t = 1.2	Based on ASCE/SEI 7-22 7.3 Table 7.3-2
Ground snow loads P_g = 600 N/m^2	Based on ASCE/SEI 7-22 7.2 Table 7.2-1

Snow loads acting on a sloping surface shall be assumed to act on the horizontal projection of that surface. The sloped roof (balanced) snow load, p_s, shall be obtained by multiplying the flat roof snow load, p_f, by the roof slope factor, C_s:

Formula: $p_s=C_SP_F$		
Sloped Snow Load	$p_s = C_s \times P_f$	Based on ASCE/SEI 7-22 7.4 Table 7.4-1
	$= 0.54 \times 378$	
	= 245 N/m^2	

Where:

Slope Factor C_s = 0.54
Module area A = 2.3 × 1.100 × 4
= 10.12 m^2
$F_s = p_s \times A$
= 2478.83 N

Based on ASCE/SEI 7-22 7.4 Table 7.4-1

4.3 WIND LOAD

Wind pressure at height Z point shall be calculated in the following formula:

26.10.2 Velocity Pressure – Velocity pressure, qz, evaluated at height z above ground shall be calculated by the following equation:

Velocity Pressure	$q_z = 0.00256K_zK_{zt}K_eV^2$ (lb/ft^2); V, mi/h
	$q_z = 0.613K_zK_{zt}K_eV^2$ (N/m^2); V, m/s
	$q_z = 0.613*0.85*1*1\ (40.4)^2 = 850.44\ N/m^2$

Where:	Variation coefficient of wind pressure and height $K_z = 0.85$	Based on ASCE/SEI 7-22 Table 26.10-1
	Landform coefficient $K_{zt} = 1$	Based on ASCE/SEI 7-22 26.9 Table 26.9-1
	Ground Elevation Factor $K_e = 1$	Based on ASCE/SEI 7-22 26.6 Table 26.6-1
	Basic wind velocity V = 40.4 m/s	

27.3.2 Open Buildings with Monoslope, Pitched, or Troughed Free Roofs – The net design pressure for the MWFRS of open buildings with monoslope, pitched, or troughed free roofs in lbs/ft^2 (N/m^2), shall be determined by equation:

Formula: $p=q_zK_dGC_N$		
Design Wind Pressure	$p = q_z \times K_d \times G \times C_N$	Based on ASCE/SEI 7-22 7.4 Table 7.4-1
	$q_z \times K_d \times G \times C_{N1} = 1640.56\ N/m^2$	windard
	$q_z \times K_d \times G \times C_{N2} = 1456.22\ N/m^2$	leeward

Where:	Wind pressure at Af form center Z point $q_z = 850.44\ N/m^2$	Based on ASCE/SEI 7-22 Table 26.10-1
	Gust-effect Facto G = 0.85	Based on ASCE/SEI 7-22 26.11.1
	Wind load shape coefficient $C_N1 = 2.67$	Based on ASCE/SEI 7-22 Table 27.3-4
	Wind load shape coefficient $C_N2 = 2.37$	Based on ASCE/SEI 7-22 Table 27.3-4
	Directionality Factor $K_d = 0.85$	Based on ASCE/SEI 7-22 26.6 Table 26.6-1
	Fw-windward = 16602.43 N	
	Fw-leedard = 14736.99 N	

4.4 LOAD INSPECTION ITEM (ALLOWABLE STRESS DESIGN METHOD)

Loads listed in this section shall be considered to act in the following combinations, which will produce the most disadvantage in the building, foundation, or structural member being considered. Effects of one or more loads not acting shall be considered.

1. D
2. D+L
3. D+ (L or S or R)
4. D+0.75L+0.75 (L or S or R)
5. D+ (0.6W or O.7E)
6. D+0.75L+0.75 (0.6W) +0.75 (L or S or R)
7. D+0.75L+0.75 (0.7E) +0.75S
8. 0.6D+0.6W
9. 0.6D+0.7E

SYMBOLS	DESCRIPTION
D	Dead load
L	Live load
S	Snow load
W	Wind load
R	Rain load
E	Earthquake load

Load Combination

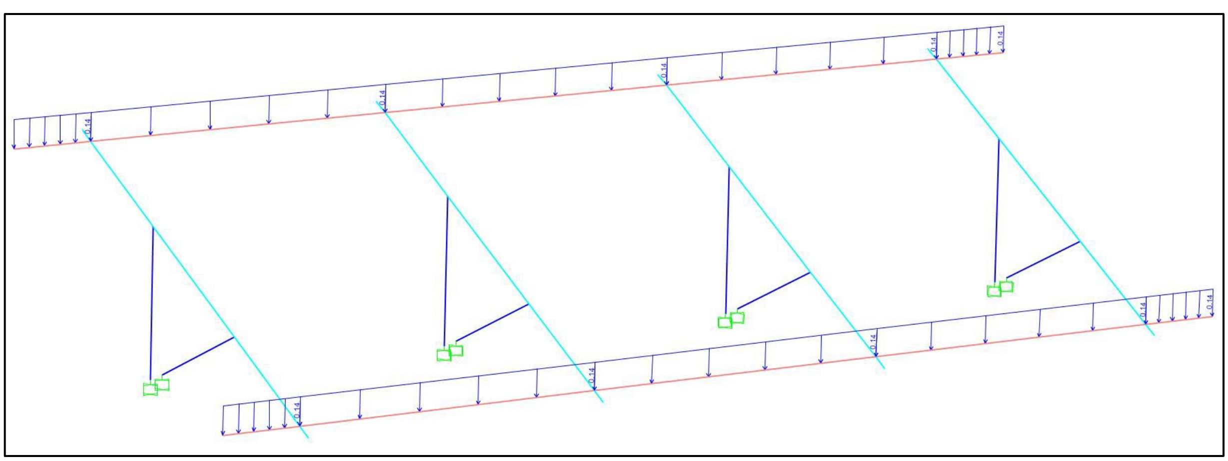
COM1	D+S	
COM2	D+0.6*W-windard	Wind compression load
COM3	D+0.75 (0.6W-windard) +0.75S	Wind compression load
COM4	0.6*D+0.6W-leeward	Wind uplift load

4.5 STRENGTH CALCULATION BASIS

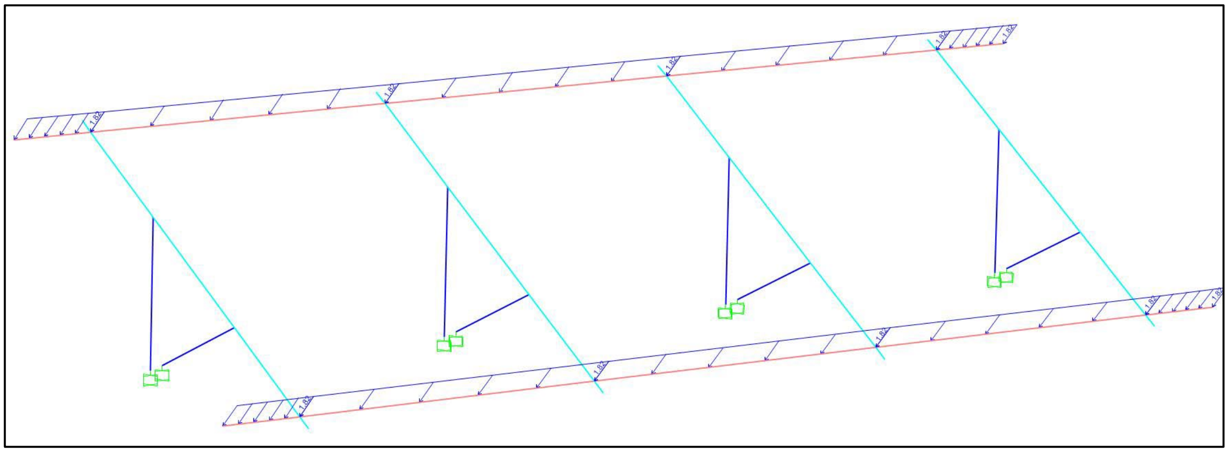
D=	1242.60	N	
F_S=	2478.83	N	
Fw-windard=	16602.43	N	
Fw-leeward=	14736.99	N	
q-D=	0.136	N/mm	Dead load liner density
q-S=	0.272	N/mm	Dead load liner density
q-windard=	1.820	N/mm	Wind positive load linear density
q-leeward=	1.616	N/mm	Wind negative load linear density

5. SAP2000 MODEL

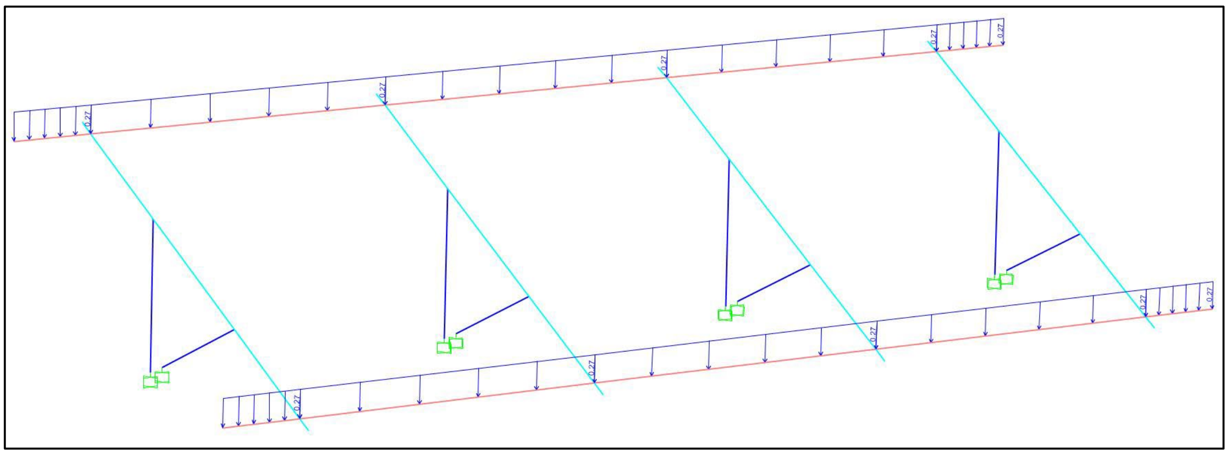
Load pattern: Dead load q-D=0.136 N/mm



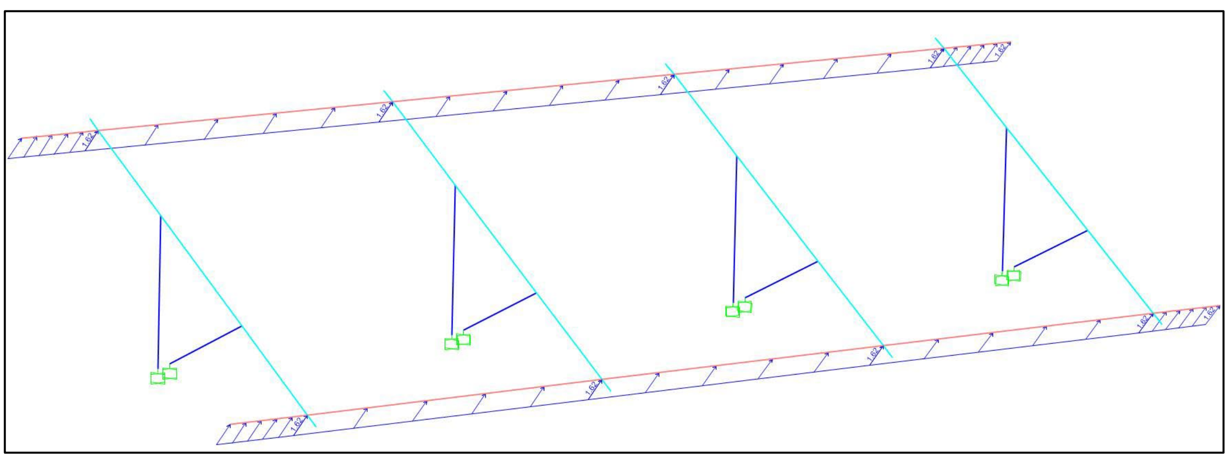
Load pattern: Snow load q-S=0.272 N/m



Load pattern: Windload-windard q-windard=-1.820 N/mm



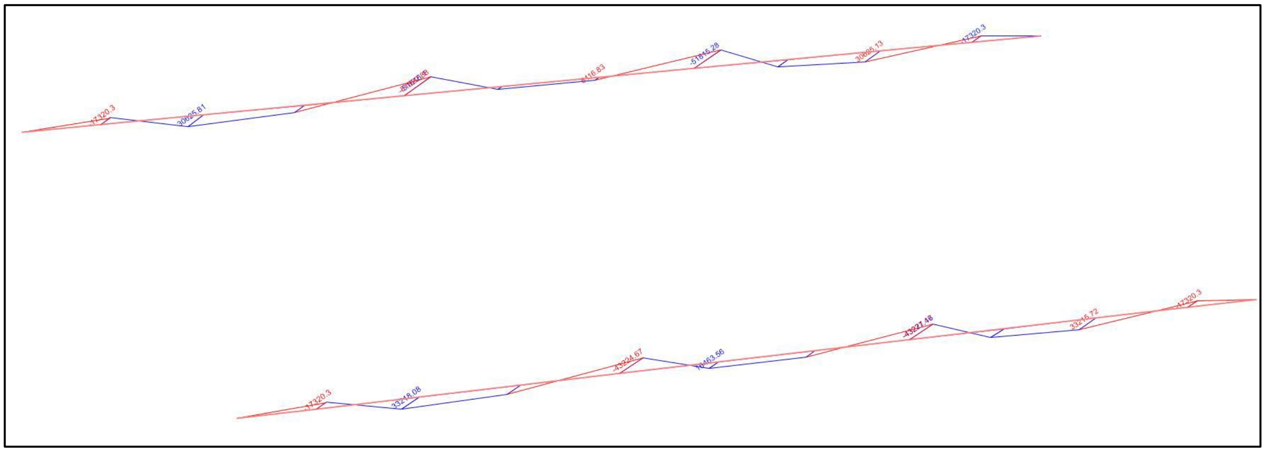
Load pattern: Windload-leeward q-leeward=1.616 N/mm

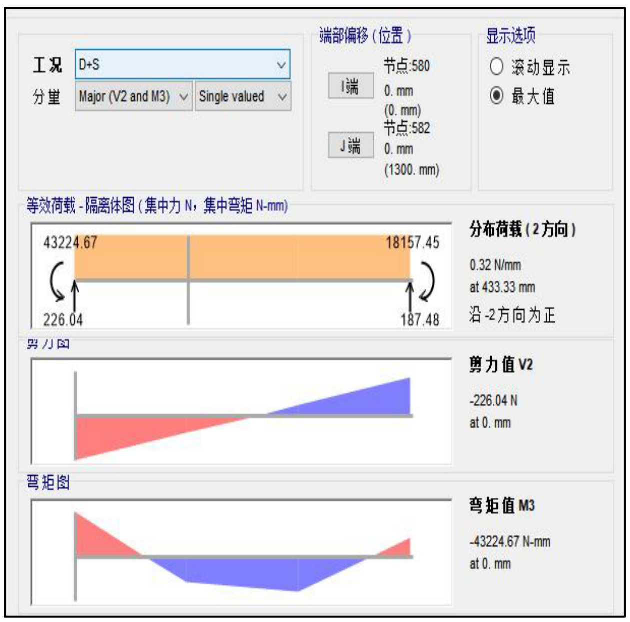


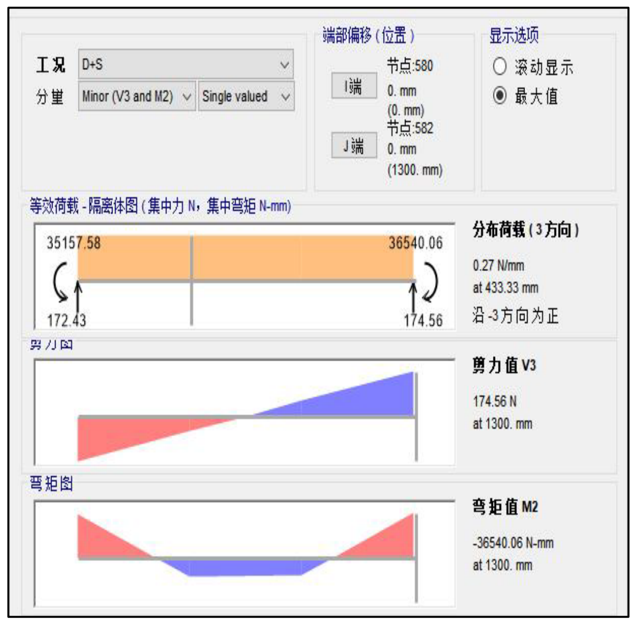
6. STRENGTH CALCULATION

6.1 AR55 RAIL

COM1 D+S bending moment

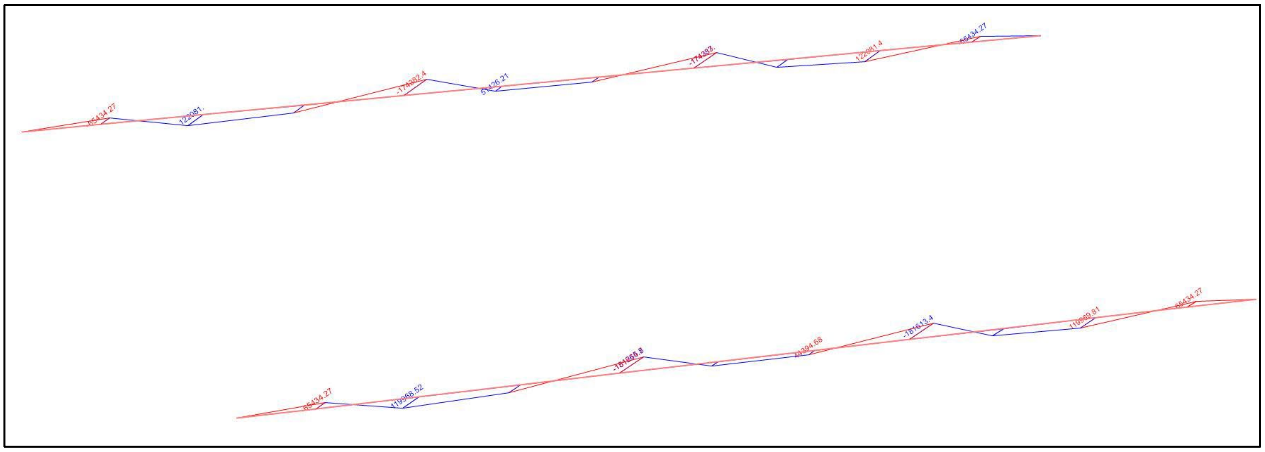


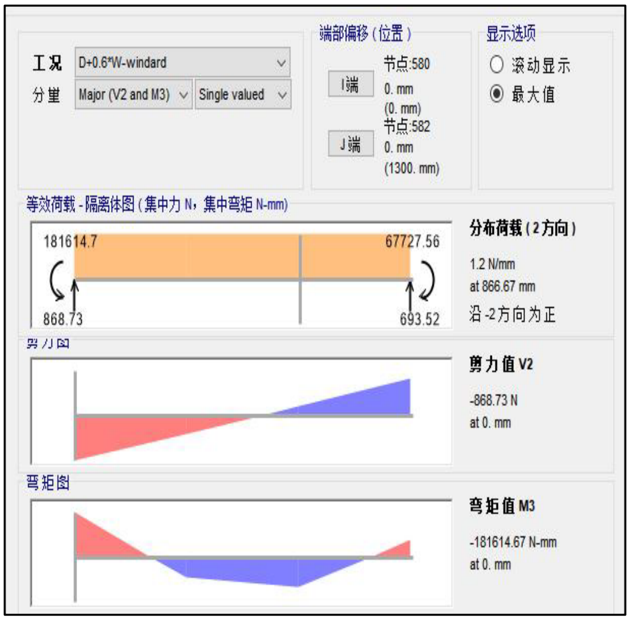


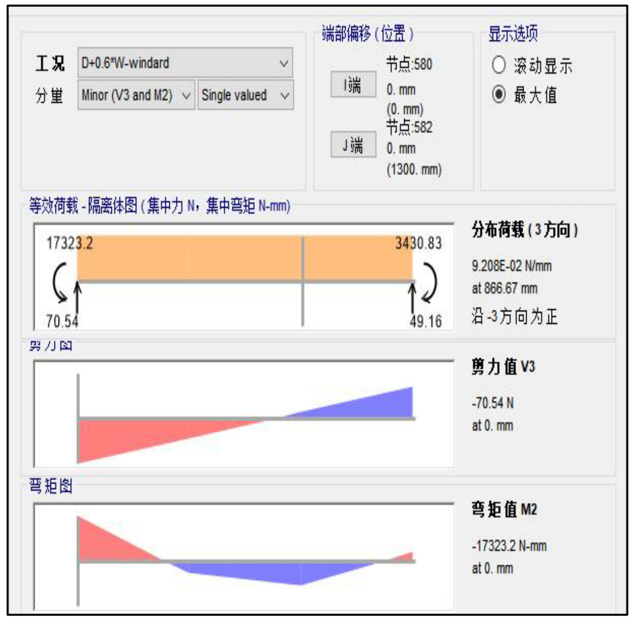


M3=	43224	N.mm
M2=	36540	N.mm
M3/Wx+M2/Wy=	33.16	Mpa<240 Mpa OK

COM2 D+0.6*W-windard bending moment

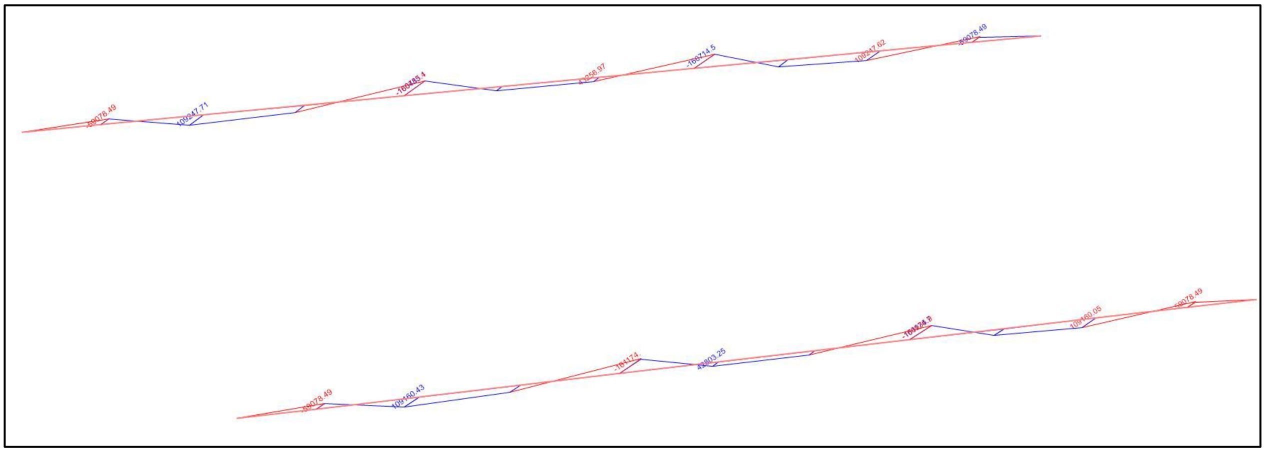


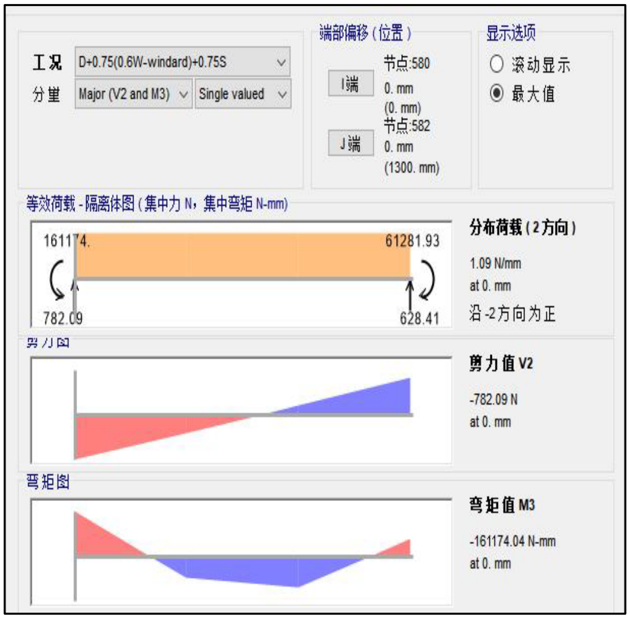


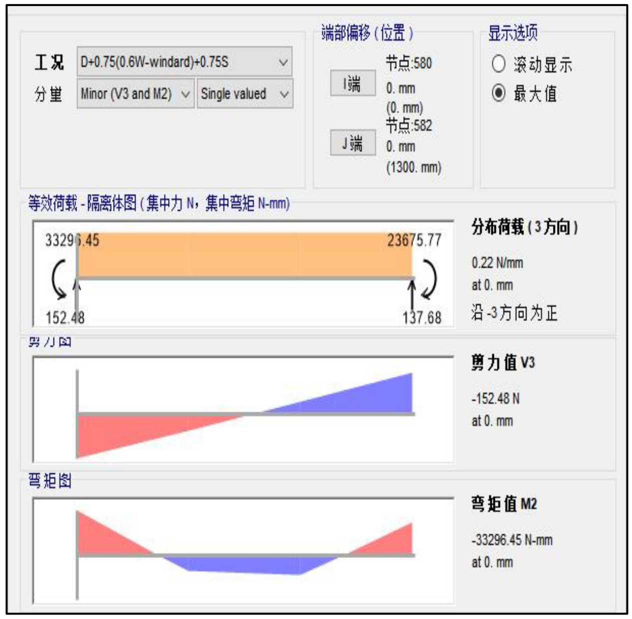


M3=	181614	N.mm
M2=	17323	N.mm
M3/Wx+M2/Wy=	73.26	Mpa<240 Mpa OK

COM3 D+0.75 (0.6W-windard) +0.75S bending moment

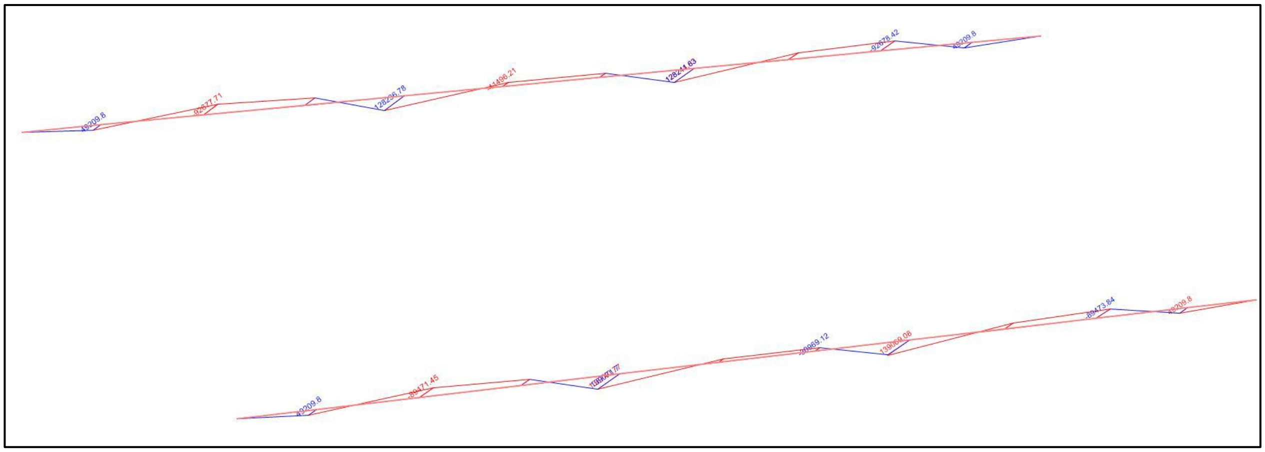


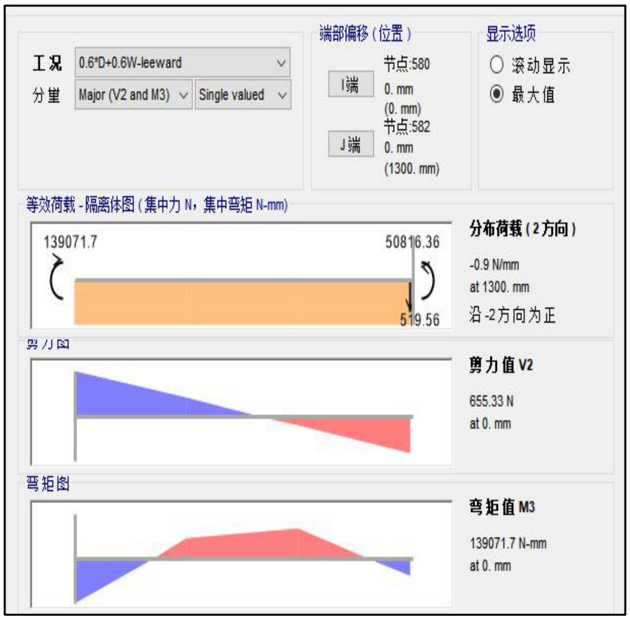


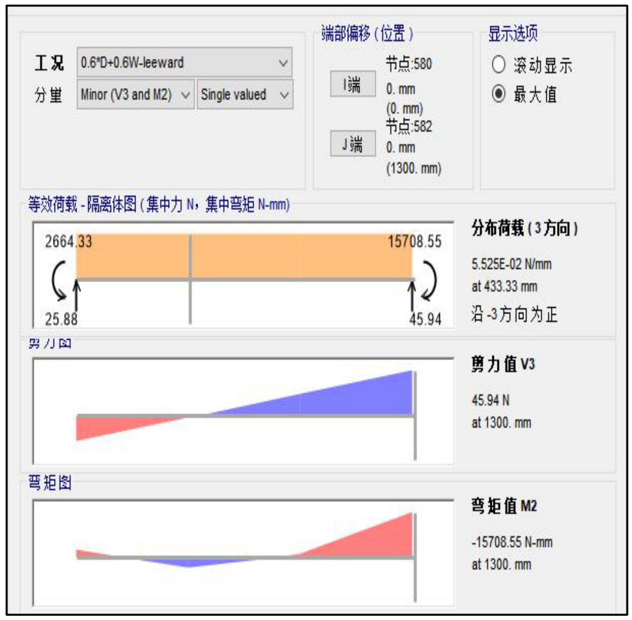


M3=	161174	N.mm
M2=	33296	N.mm
M3/Wx+M2/Wy=	73.71	Mpa<240 Mpa OK

COM4 0.6D+0.6*W-Leeward bending moment



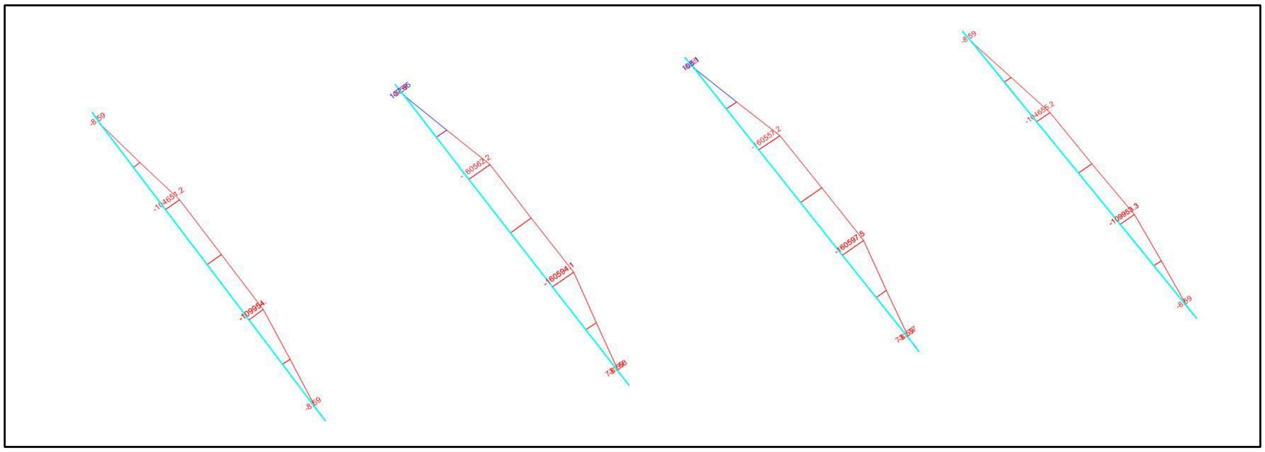


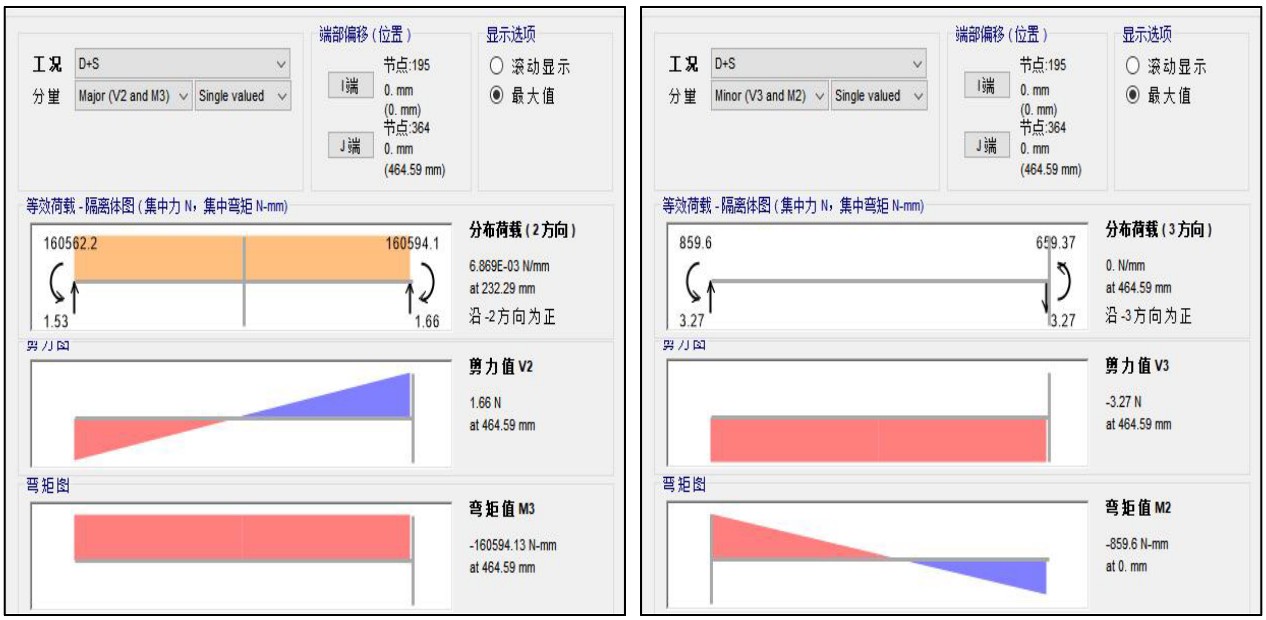


M3=	139071	N.mm
M2=	15708	N.mm
M3/Wx+M2/Wy=	57.29	Mpa<240 Mpa OK

6.2 BEAM

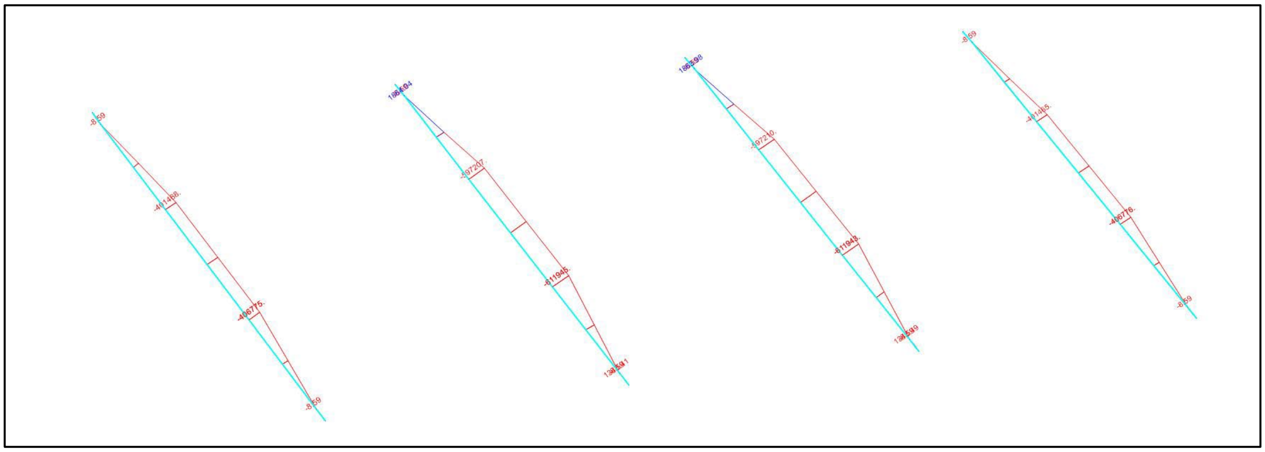
COM1 D+S bending moment

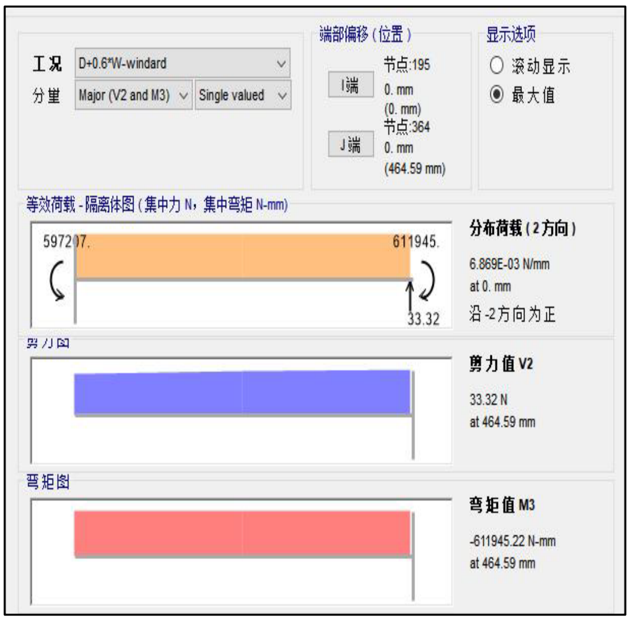




M3=	160594	N.mm
M2=	859	N.mm
M3/Wx+M2/Wy=	44.82	Mpa<240 Mpa OK

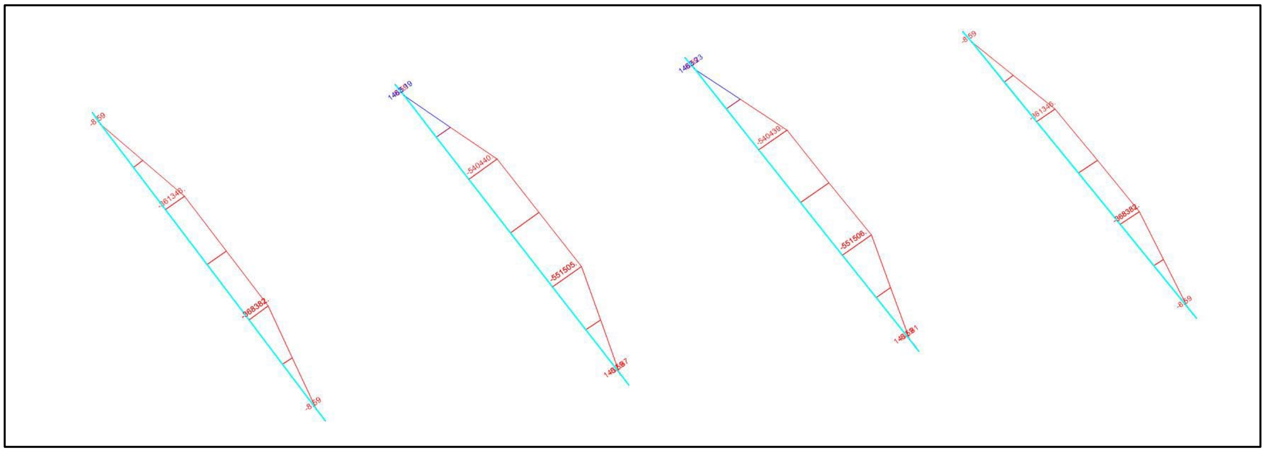
COM2 D+0.6*W-windard bending moment

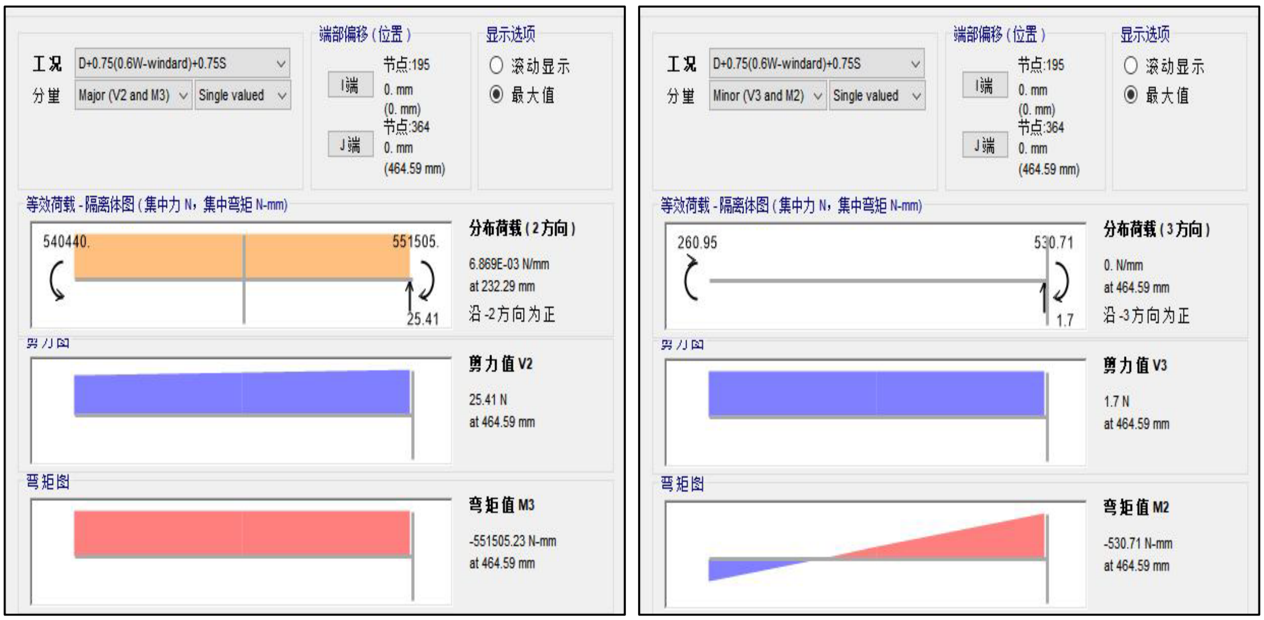




M3=	611945	N.mm
M2=	1215	N.mm
M3/Wx+M2/Wy=	170.36	Mpa<240 Mpa OK

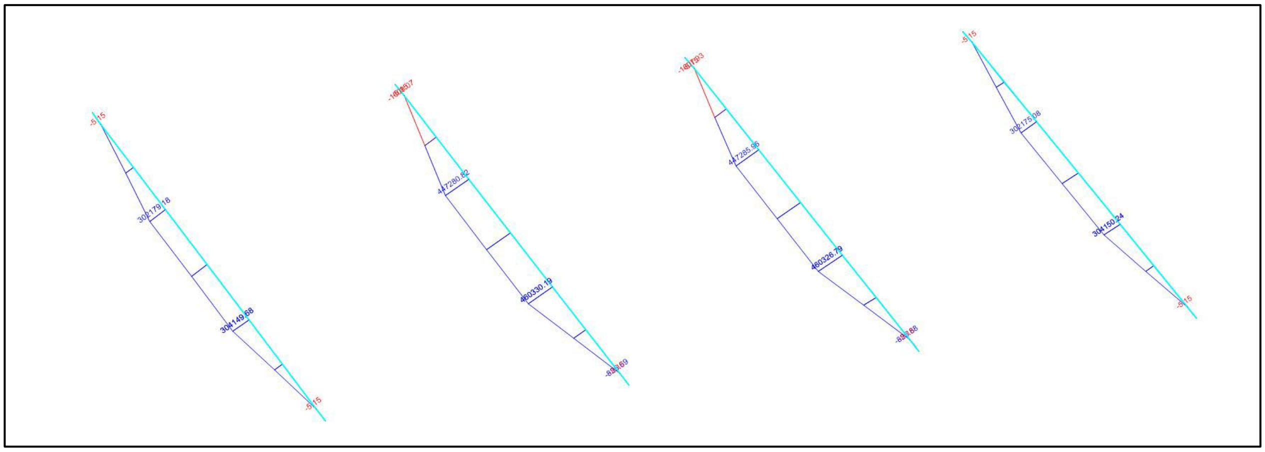
COM3 D+0.75 (0.6W-windard) +0.75S bending moment

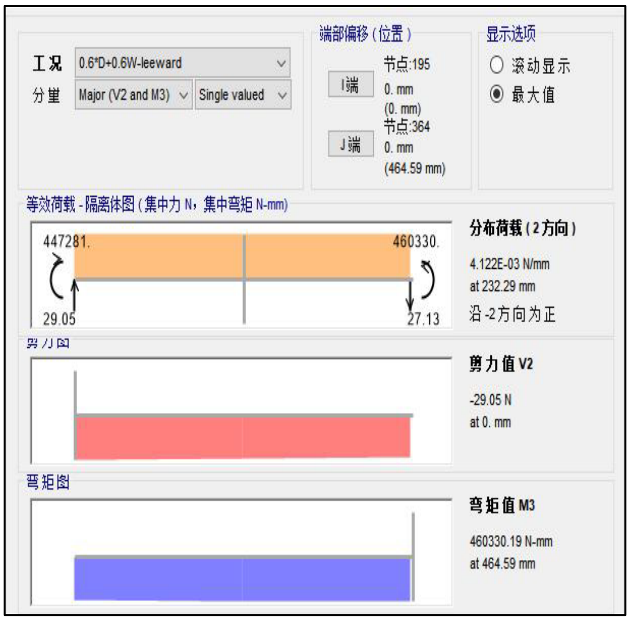


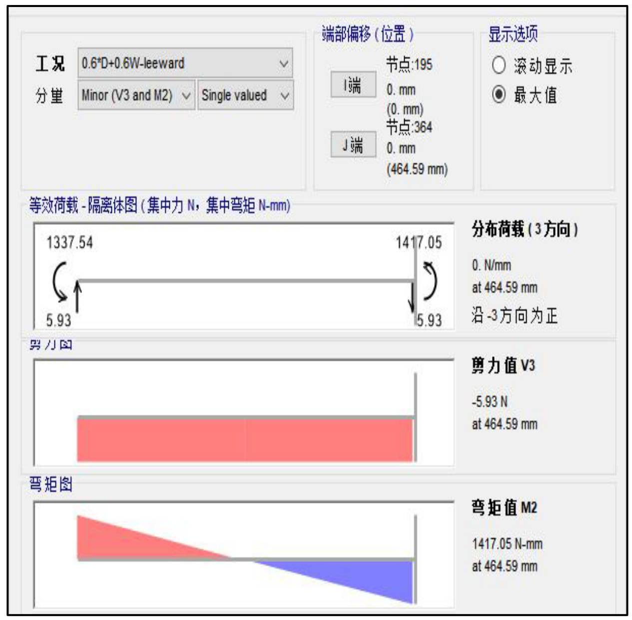


M3=	551505	N.mm
M2=	530	N.mm
M3/Wx+M2/Wy=	153.42	Mpa<240 Mpa OK

COM4 0.6D+0.6*W-Leeward bending moment





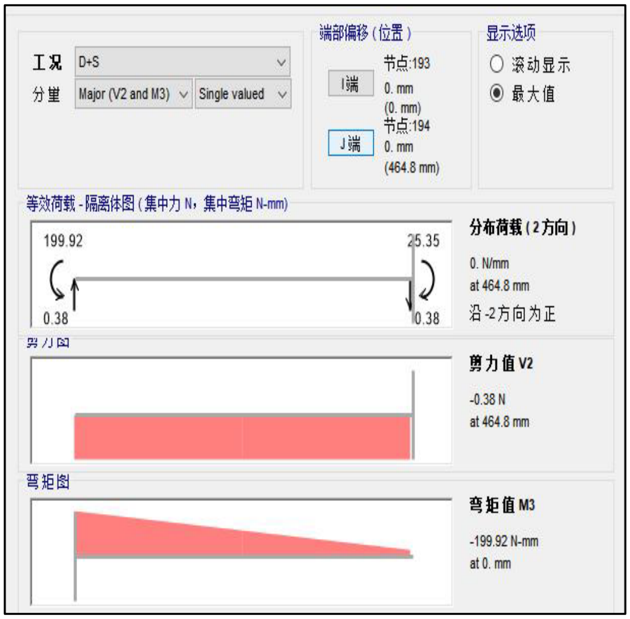


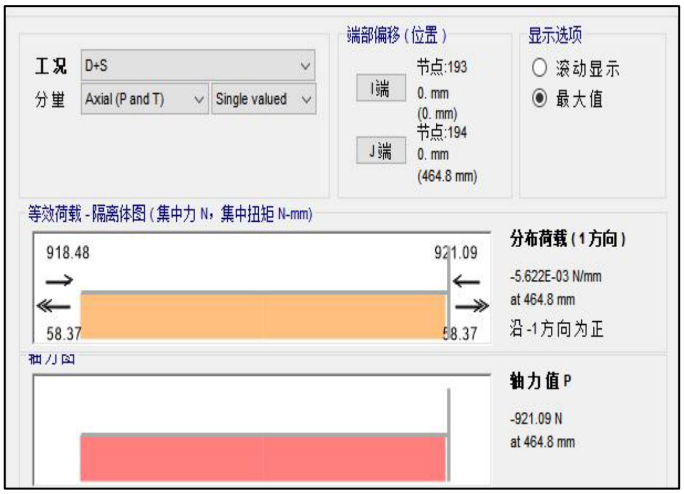
M3=	460330	N.mm
M2=	1417	N.mm
M3/Wx+M2/Wy=	128.26	Mpa<240 Mpa OK

6.3 COLUMN 1

Length: 470 mm

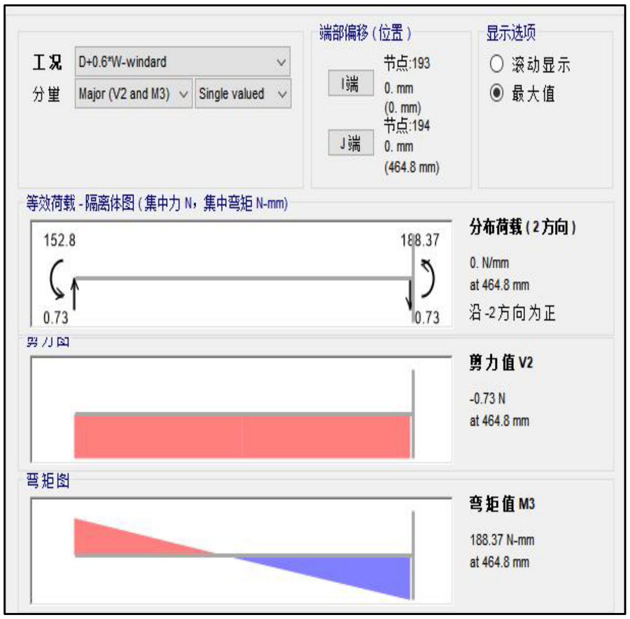
COM1 D+S bending moment

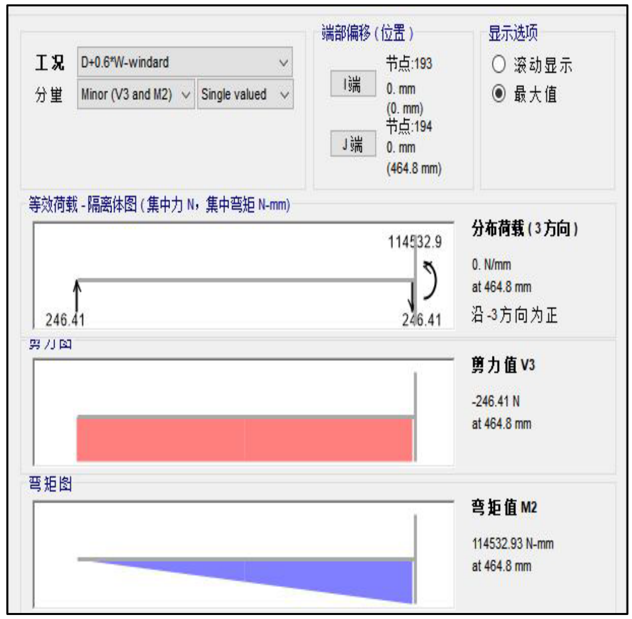


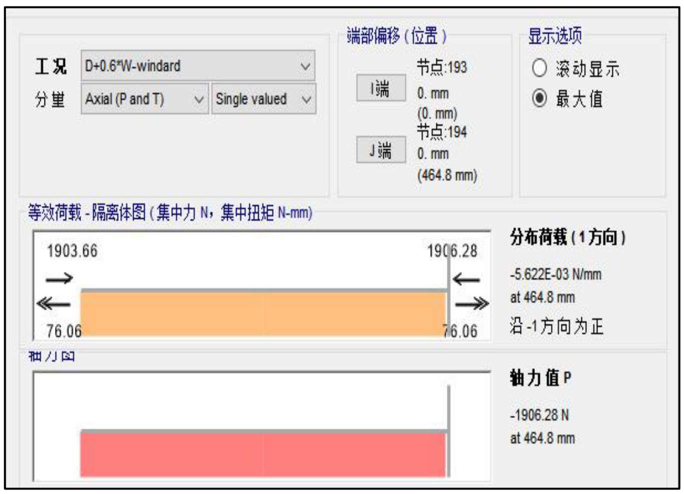


M3=	200	N.mm
M2=	187657	N.mm
Axial=	921	N
M3/Wx+M2/Wy+Axial/area=	85.67	Mpa<240 Mpa OK
Slenderness Ratio=	35.26	<180 OK

COM2 D+0.6*W-windard bending moment

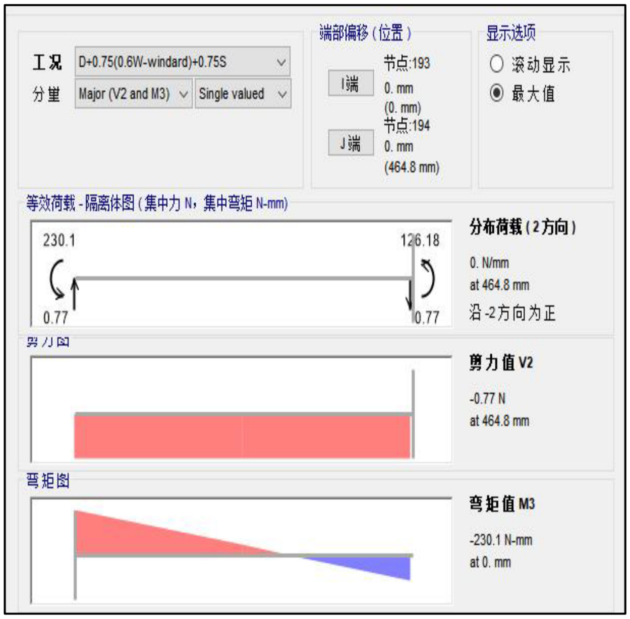


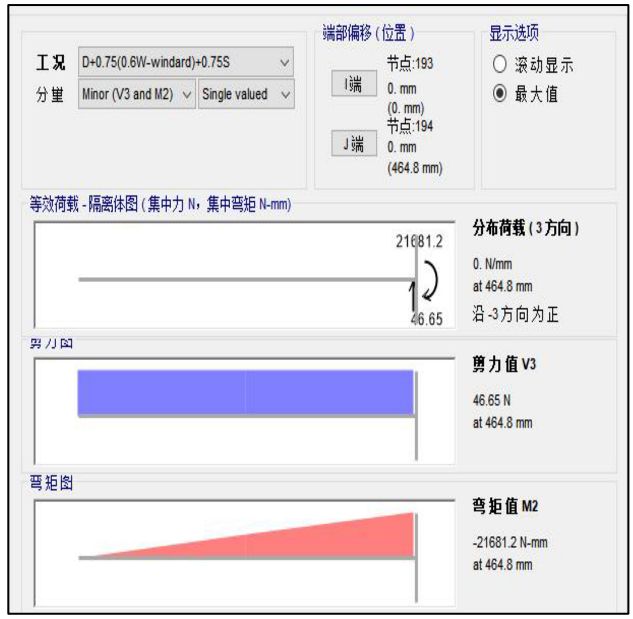


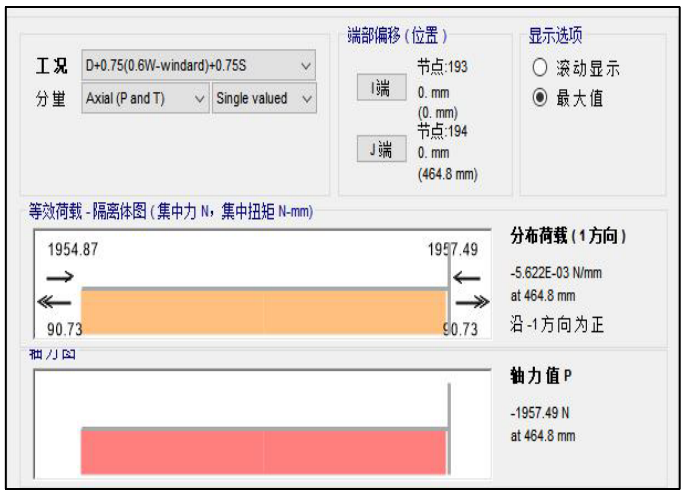


M3=	188	N.mm
M2=	114532	N.mm
Axial=	1906	N
M3/Wx+M2/Wy+Axial/area=	58.66	Mpa<240 Mpa OK

COM3 D+0.75 (0.6W-windard) +0.75S bending moment

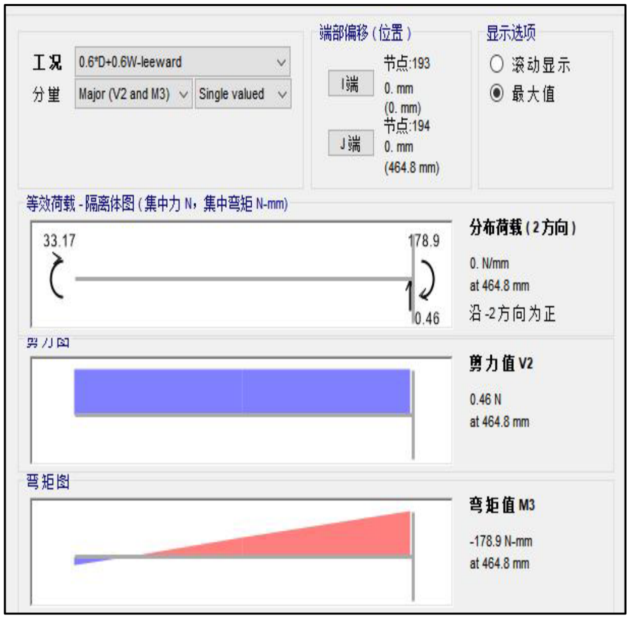


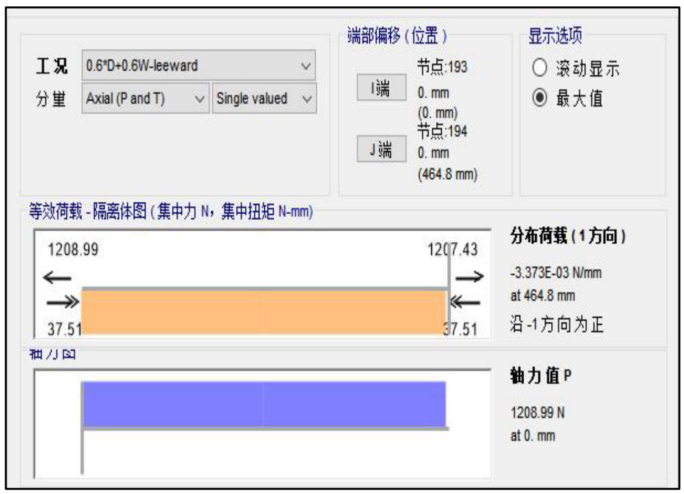




M3=	230	N.mm
M2=	21681	N.mm
Axial=	1957	N
M3/Wx+M2/Wy+Axial/area=	18.72	Mpa<240 Mpa OK

COM4 0.6D+0.6*W-Leeward bending moment



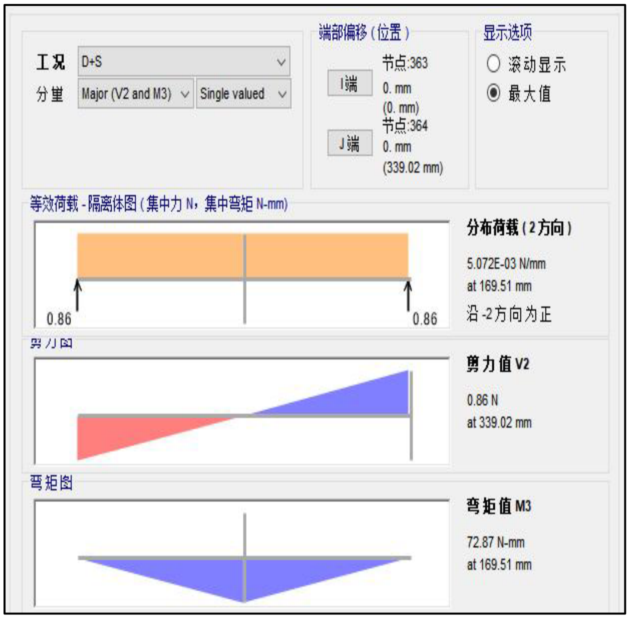


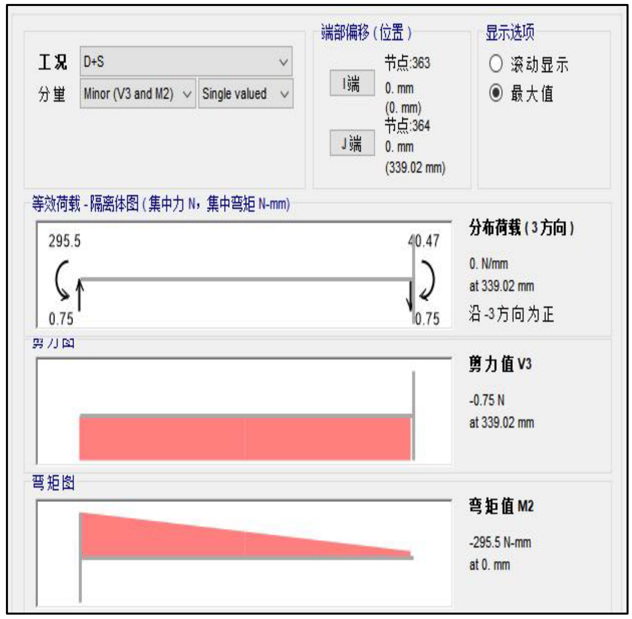
M3=	179	N.mm
M2=	200379	N.mm
Axial=	1208	N
M3/Wx+M2/Wy+Axial/area=	92.53	Mpa<240 Mpa OK

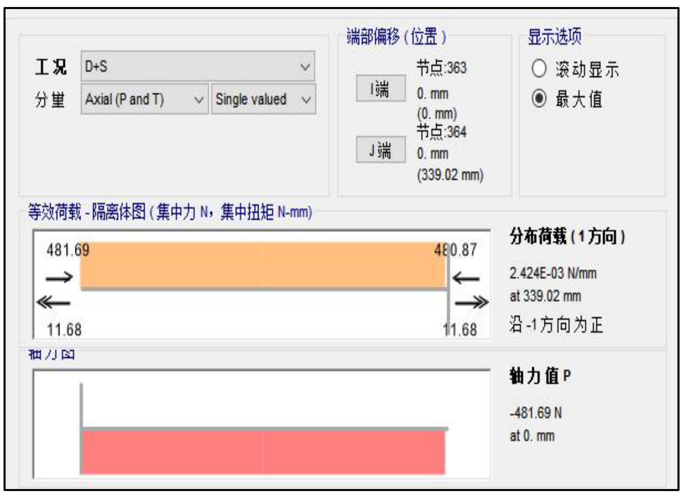
6.4 COLUMN 2

Length: 353 mm

COM1 D+S bending moment

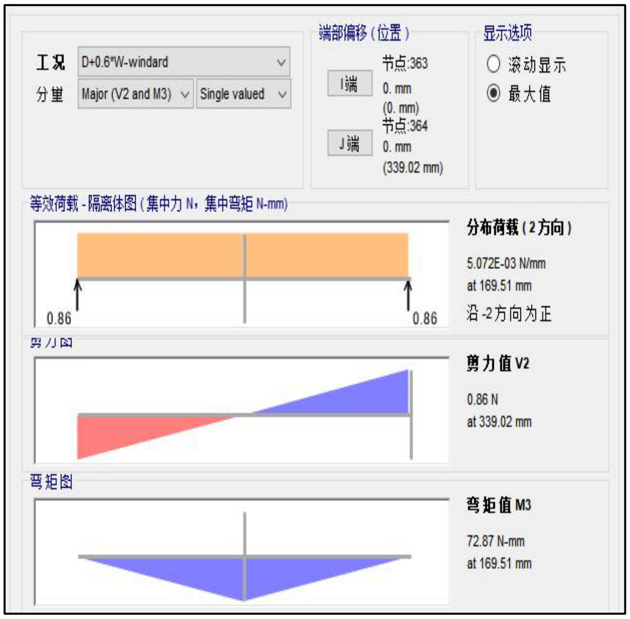


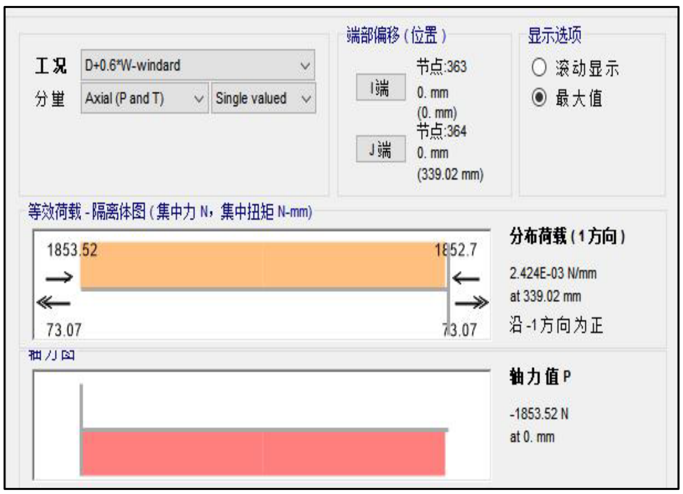




M3=	72	N.mm
M2=	295	N.mm
Axial=	481	N
M3/Wx+M2/Wy+Axial/area=	2.43	Mpa<240 Mpa OK
Slenderness Ratio=	26.49	<180 OK

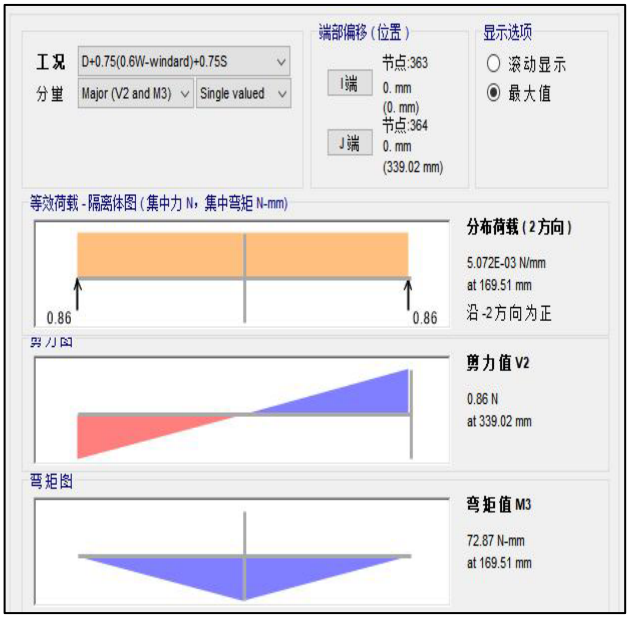
COM2 D+0.6*W-windard bending moment

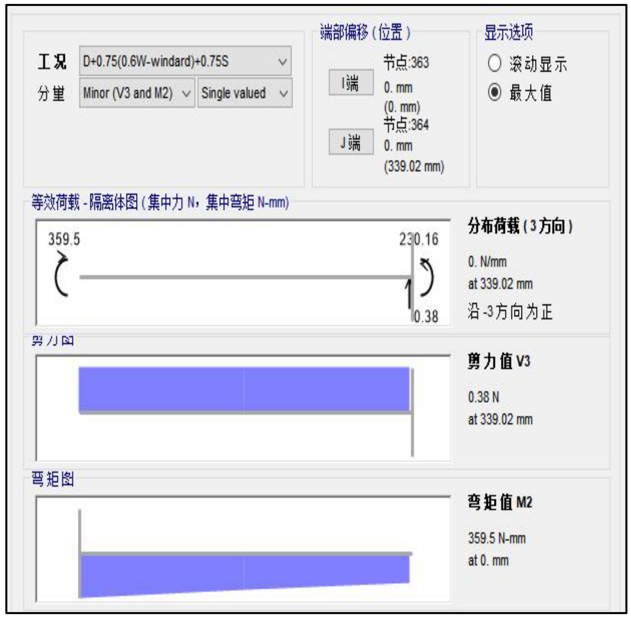


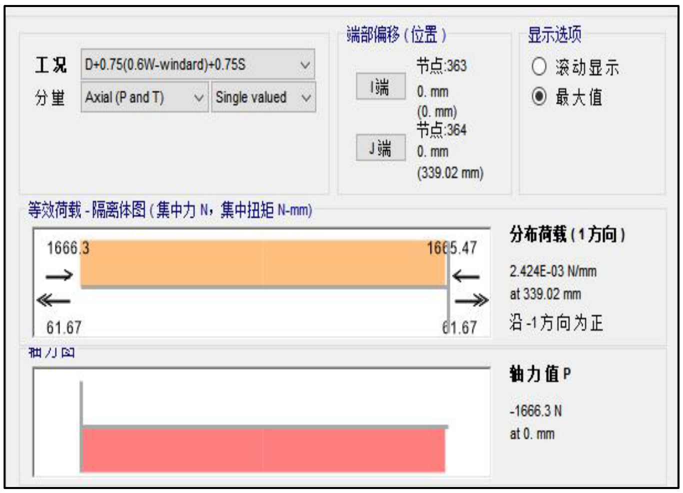


M3=	72	N.mm
M2=	706	N.mm
Axial=	1853	N
M3/Wx+M2/Wy+Axial/area=	9.08	Mpa<240 Mpa OK

COM3 D+0.75 (0.6W-windard) 0.75S bending moment

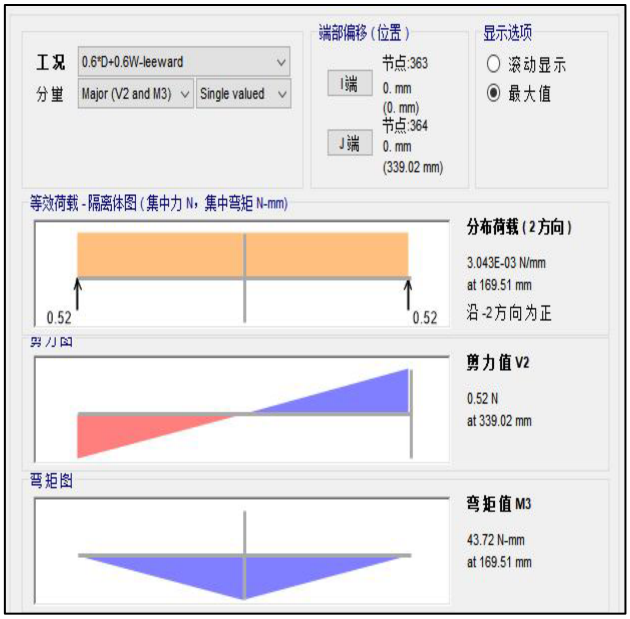


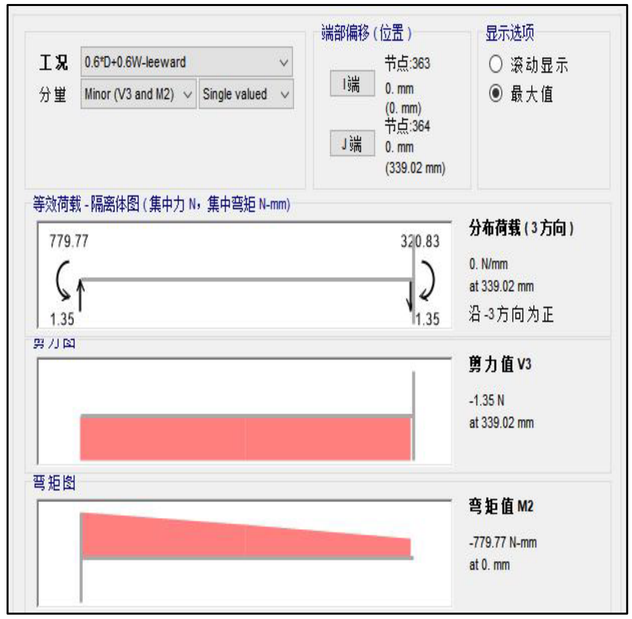


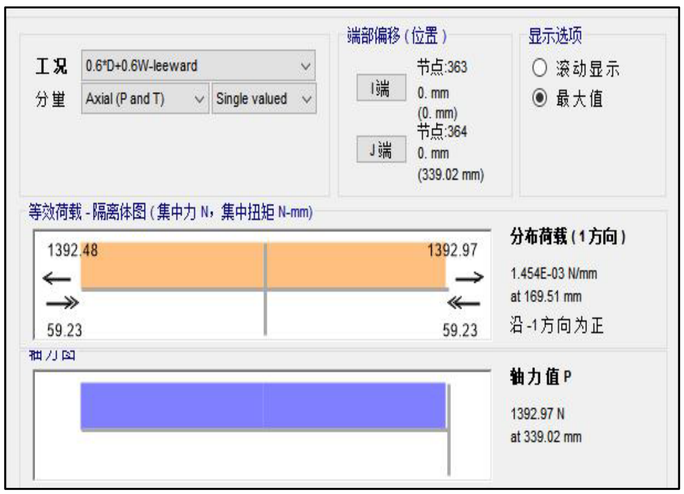


M3=	72	N.mm
M2=	359	N.mm
Axial=	1666	N
M3/Wx+M2/Wy+Arial/area=	8.05	Mpa<240 Mpa OK

COM4 0.6D+0.6*W-Leeward bending moment







M3=	43	N.mm
M2=	779	N.mm
Axial=	1392	N
M3/Wx+M2/Wy+Axial/area=	6.92	Mpa<240 Mpa OK

6.5 SUMMARY

ITEMS	RAIL	BEAM	COLUMN 1		COLUMN 2	
	Stress (Mpa)	Stress (Mpa)	Stress (Mpa)	Slenderness Ratio	Stress (Mpa)	Slenderness Ratio
D+S	33.16	44.82	85.67	35.26	2.43	26.49
D+0.6*W-windard	73.26	170.36	58.66		9.08	
D+0.75 (0.6W-windard) +0.75s	73.71	153.42	18.72		8.05	
0.6*D+0.6W-leeward	57.29	128.26	92.53		6.92	
Allowable Value	240	240	240	180	240	180
Conclusion	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**

7. WIND RESISTANCE CALCULATION OF CONCRETE FOUNDATION

Reaction Force F

Fmax=	1807.32 N < 4998 N	**OK**
Faverage=	1487.82 N < 4998 N	**OK**

Concrete foundation meets the usage requirements

The weight of concrete foundation=	0.5 × 0.5 × 0.85 × 2400 × 9.8 N = 4998 N

TABLE: JOINT REACTIONS					
Joint	Output Case	F1	F2	F3	
		N	N	N	N
4	0.6*D+0.6W-leeward	7.29	-811.73	-387.31	-1168.38
5	0.6*D+0.6W-leeward	2.13	-342.51	-781.07	
10	0.6*D+0.6W-leeward	1.35	-1256.63	-599.91	-1807.31
11	0.6*D+0.6W-leeward	-0.94	-431.09	-1207.4	
16	0.6*D+0.6W-leeward	-0.92	-1256.6	-599.89	-1807.32
17	0.6*D+0.6W-leeward	0.46	-431.11	-1207.4	
22	0.6*D+0.6W-leeward	-6.92	-811.74	-387.32	-1168.28
23	0.6*D+0.6W-leeward	-2.46	-342.61	-780.96	

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