Civil & Structural Engineering Design Services Pty. Ltd.

Client: **Extreme Marquees Pty. Ltd.**
Project: Design check – 12m & 11m Dome Structure for **100km/hr** Wind Speed.
Reference: Extreme Marquees Pty Ltd Technical Data

Report by: KZ
Checked by: EAB
Date: 08/04/2019

JOB NO: E-11-267049

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1 Introduction

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The following structural drawings and calculations are for the transportable 12m Dome Structure supplied by Extreme Marquees Pty Ltd.

The frame consists principally of Q235 steel components with hot dipped galvanized connections and base plate.

The report examines the effect of 3s gust wind of 100 km/hr on 12m Dome Structure as the worst-case scenario. The relevant Australian Standards AS1170.0:2002 General principles, AS1170.1:2002 Permanent, imposed and other actions and AS1170.2:2011 Wind actions are used. The design check is in accordance with AS/NZS 4100:1998 Steel Structures.

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2 Design Restrictions and Limitations

2.1 The erected structure is for temporary use only.

2.2 It should be noted that if high gust wind speeds are anticipated or forecast in the locality of the tent, the temporary erected structure should be dismantled.

2.3 For forecast winds in excess of **(refer to summary)** – all fabric shall be removed from the frames, and the structure should be completely dismantled.

(Please note that the locality squall or gust wind speed is affected by factors such as terrain exposure and site elevations.)

2.4 The structure may only be erected in regions with wind classifications no greater than the limits specified on the attached wind analysis.

2.5 The wind classifications are based upon Terrain Category 2. Considerations have also been made to the regional wind terrain category, topographical location and site shielding from adjacent structures. Please note that in many instances topographical factors such as a location on the crest of a hill or on top of an escarpment may yield a higher wind speed classification than that derived for a higher wind terrain category in a level topographical region. For this reason, particular regard shall be paid to the topographical location of the structure. For localities which do not conform to the standard prescribed descriptions for wind classes as defined above, a qualified Structural Engineer may be employed to determine an appropriate wind class for that the particular site.

2.6 The structures in no circumstances shall ever be erected in tropical or severe tropical cyclonic condition as defined on the Map of Australia in AS 1170.2-2011, Figure 3.1.

2.7 The tent structure has not been designed to withstand snow and ice loadings such as when erected in alpine regions.

2.8 For the projects, where the site conditions approach the design limits, extra consideration should be given to pullout tests of the stakes and professional assessment of the appropriate wind classification for the site.

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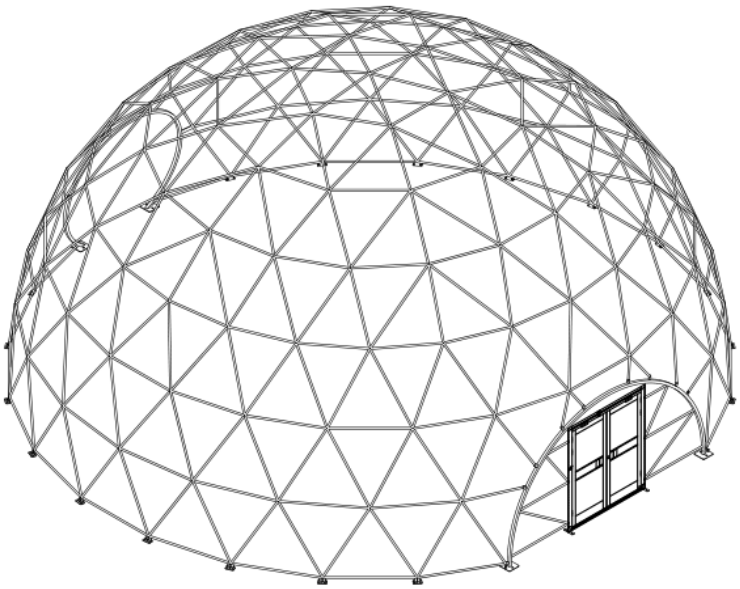
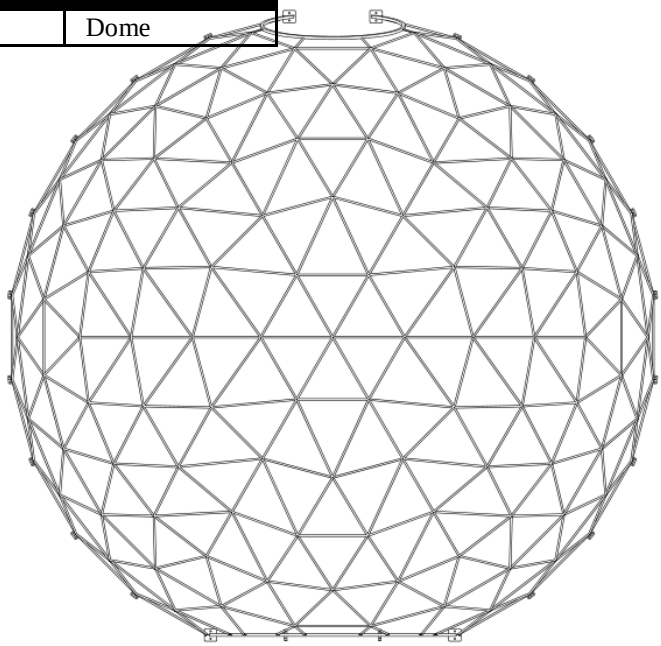
3 Specifications

3.1 General

Tent category	
Material	Steel Q235

Size	Model
12m	Dome





EXTREME MARQUEES

Dome Tents

4m / 5m / 6m / 7m / 8m / 9m / 10m / 11m / 12m

Visually striking marquee

PRODUCT PHOTOS

ITEM	SPECIFICATION								
Size	4m	5m	6m	7m	8m	9m	10m	11m	12m
Ceiling Height	2.4m	3m	3m	3.5m	4m	4m	4.5m	4.9m	6m
Floor Space	12.5 sq.m	17.8 sq.m	28 sq.m	38 sq.m	50 sq.m	63 sq.m	78 sq.m	95 sq.m	113 sq.m
Stand up Capacity	15	24	34	46	60	76	94	114	136
Sit down Capacity	10	16	23	31	40	51	63	76	90
Door Size	1.2mx1.8m			1.5 2.1m			2.4mx2.4m		
Frame Material	Steel								

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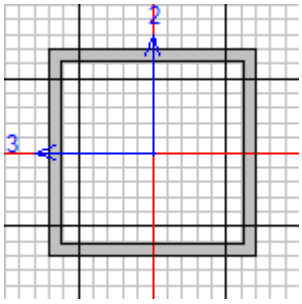
3.2 Steel Properties

TABLE: Material Properties 03a - Steel Data								
Material	**Fy**	**Fu**	**EffFy**	**EffFu**	**SHard**	**SMax**	**SRup**	**FinalSlope**
Text	KN/m2	KN/m2	KN/m2	KN/m2	Unitless	Unitless	Unitless	Unitless
Q235	235000	390000	260000	430000	0.015	0.11	0.17	-0.1

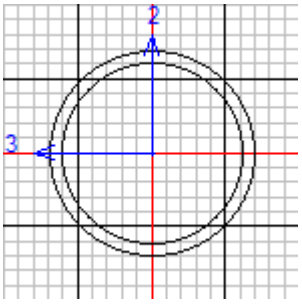
3.3 Section Properties

TABLE: Frame Section Properties 01 - General, Part 1 of 2										
SectionName	**Material**	**Shape**	**AS2**	**AS3**	**S33**	**S22**	**Z33**	**Z22**	**R33**	**R22**
Text	Text	Text	mm2	mm2	mm3	mm3	mm3	mm3	mm	mm
25X2 CHS	Q235	Pipe	72.62	72.62	770.26	770.26	1060.67	1060.67	8.162	8.162
30x2 SHS (Door Frame)	Q235	Box/Tube	120	120	1961.24	1961.24	2356	2356	11.46	11.46

TABLE: Frame Section Properties 01 - General, Part 2 of 2										
SectionName	**Material**	**Shape**	**t3**	**t2**	**tf**	**tw**	**Area**	**TorsConst**	**I33**	**I22**
Text	Text	Text	mm	mm	mm	mm	mm2	mm4	mm4	mm4
25X2 CHS	Q235	Pipe	25			2	144.51	19256.39	9628.2	9628.2
30x2 SHS (Door Frame)	Q235	Box/Tube	30	30	2	2	224	43904	29418.67	29418.67



30x2 SHS (Door Frame)



25x2 CHS (Main Frame)

4 Design Loads

4.1 Ultimate

		Distributed load (kPa)	Design load factor (-)	Factored imposed load (kPa)
Live	Q	-	1.5	-
Self weight	G	self weight	1.35, 1.2, 0.9	1.2 self weight, 0.9 self weight
3s 100km/hr gust	W	0.383 C_{fig}	1.0	0.383 C_{fig}

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4.2 Load Combinations

4.2.1 Serviceability

Gravity = $1.0 \times G$

Wind = $1.0 \times G + 1.0 \times W$

4.2.2 Ultimate

Downward = $1.35 \times G$
= $1.2 \times G + W_u$
= $1.2 \times G + W_u + W_{IS}$

Upward = $0.9 \times G + W_u$
$0.9 \times G + W_u + W_{IP}$

5 Wind Analysis

Wind towards surface (+ve), away from surface (-ve)

5.1 Parameters

Terrain category = 2
Site wind speed ($V_{sit,\beta}$) = $V_R M_d (M_{z,cat} M_s M_t)$
V_R = 27.78m/s (100 km/hr) *(regional 3 s gust wind speed)*
M_d = 1
M_s = 1
M_t = 1
$M_{z,cat}$ = 0.91 *(Table 4.1(B) AS1170.2)*

$V_{sit,\beta}$ = 25.28 m/s

Height of structure (h) = 3 m *(mid of peak and eave)*
Total height of structure = 6 m
Width of structure (w) = 12 m
Length of structure (l) = 12 m

Pressure (P) = $0.5\rho_{air} (V_{sit,\beta})^2 C_{fig} C_{dyn}$
= $0.383 C_{fig}$ kPa

5.2 Pressure Coefficients (C_{fig})

Name	Symbol	Value	Unit	*Notes*	*Ref.*
		Input			
Importance level		2			*Table 3.1 - Table 3.2 (AS1170.0)*
Annual probability of exceedance		Temporary			*Table 3.3*

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Regional gust wind speed		100	Km/hr		*Table 3.1 (AS1170.2)*
Regional gust wind speed	V_R	**27.78**	m/s		
Wind Direction Multipliers	M_d	1			*Table 3.2 (AS1170.2)*
Terrain Category Multiplier	$M_{Z,Cat}$	0.91			*Table 4.1 (AS1170.2)*
Shield Multiplier	M_S	1			*4.3 (AS1170.2)*
Topographic Multiplier	M_t	1			*4.4 (AS1170.2)*
Site Wind Speed	$V_{Site,\beta}$	**25.28**	m/s	$V_{Site,\beta}=V_R*M_d*M_{z,cat}*M_S,M_t$	
Width	B	12	m		
Length	D	12	m		
Height	Z	3	m		
	h/d	0.25			
	h/b	0.25			

Wind Pressure

ρair	ρ	1.2	Kg/m^3		
dynamic response factor	C_{dyn}	1			
Wind Pressure	$\rho*C_{fig}$	**0.383**	Kg/m^2	$\rho=0.5\rho_{air}*(V_{des,\beta})^2*C_{fig}*C_{dyn}$	*2.4 (AS1170.2)*

WIND DIRECTION 1 (Perpendicular to Length)

Internal Pressure

Opening Assumption: With Dominant Opening (Cpi MIN & MAX)

Internal Pressure Coefficient (Without Dominant) **MIN**		-0.1			*Table 5.1 A (AS1170.2)*
Internal Pressure Coefficient (Without Dominant) **MAX**		0.2			
Internal Pressure Coefficient (With Dominant) **MIN**		**-0.3**			*Table 5.1 B (AS1170.2)*
Internal Pressure Coefficient (With Dominant) **MAX**		**0.2**			
N		0.7			
Combination Factor	$K_{C,i}$	1			
Internal Pressure Coefficient **MIN**	$C_{p,i}$	-0.30			
Internal Pressure Coefficient **MAX**	$C_{p,i}$	0.20			

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External Pressure					
1. Windward Wall					
External Pressure Coefficient	$C_{P,e}$	0.7			*Table 5.2 A*
Area Reduction Factor	K_a	1			*Table 5.4*
combination factor applied to internal pressures	$K_{C,e}$	0.8			
local pressure factor	K_l	1			
porous cladding reduction factor	K_p	1			
aerodynamic shape factor	$C_{fig,e}$	0.56			
Wind Wall Pressure	P	**0.21**	**kPa**		
2. Leeward Wall					
External Pressure Coefficient	$C_{P,e}$	-0.5			*Table 5.2 B*
Area Reduction Factor	K_a	1			*Table 5.4*
combination factor applied to internal pressures	$K_{C,e}$	0.8			
local pressure factor	K_l	1			
porous cladding reduction factor	K_p	1			
aerodynamic shape factor	$C_{fig,e}$	-0.4			
Lee Wall Pressure	P	**-0.15**	**kPa**		
4. Roof					
r (rise)	r	6	m		
h/r	h/r	0.50			
Breadth Effect		1.00		*(b/d)^0.25>1*	
Rise-to-span ratio	r/d	0.50			
4.1 Roof Windward Quarter					
U	U	3	m		
Area Reduction Factor	K_a	1			
combination factor applied to internal pressures	$K_{C,e}$	0.8			
local pressure factor	K_l	1			
porous cladding reduction factor	K_p	1			
External Pressure Coefficient **MIN**	$C_{P,e}$	0			*Table C3*
External Pressure Coefficient **MAX**	$C_{P,e}$	0.3			
Factored External Pressure Coefficient **MIN**	$C_{P,e}$	0.00			

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Factored External Pressure Coefficient **MAX**	$C_{P,e}$	0.30			
aerodynamic shape factor **MIN**	$C_{fig,e}$	0.00			
aerodynamic shape factor **MAX**	$C_{fig,e}$	0.24			
Pressure **MIN**	P	**0.00**	**kPa**		
Pressure **MAX**	P	**0.09**	**kPa**		
4.2 Roof Centre Half					
T	T	6	m		
Area Reduction Factor	K_a	1			
combination factor applied to internal pressures	$K_{C,e}$	0.8			
local pressure factor	K_l	1			
porous cladding reduction factor	K_p	1			
External Pressure Coefficient **MIN**	$C_{P,e}$	-0.65			*Table C3*
External Pressure Coefficient **MAX**	$C_{P,e}$	-0.65			
Factored External Pressure Coefficient **MIN**	$C_{P,e}$	-0.65			
Factored External Pressure Coefficient **MAX**	$C_{P,e}$	-0.65			
aerodynamic shape factor **MIN**	$C_{fig,e}$	-0.52			
aerodynamic shape factor **MAX**	$C_{fig,e}$	-0.52			
Pressure **MIN**	P	**-0.20**	**kPa**		
Pressure **MAX**	P	**-0.20**	**kPa**		
4.1 Roof Windward Quarter					
D	D	3	m		
Area Reduction Factor	K_a	1			
combination factor applied to internal pressures	$K_{C,e}$	0.8			
local pressure factor	K_l	1			
porous cladding reduction factor	K_p	1			
External Pressure Coefficient **MIN**	$C_{P,e}$	-0.2			*Table C3*
External Pressure Coefficient **MAX**	$C_{P,e}$	0			
Factored External Pressure Coefficient **MIN**	$C_{P,e}$	-0.20			
Factored External Pressure Coefficient **MAX**	$C_{P,e}$	0.00			
aerodynamic shape factor **MIN**	$C_{fig,e}$	-0.16			
aerodynamic shape factor **MAX**	$C_{fig,e}$	0.00			
Pressure **MIN**	P	**-0.06**	**kPa**		
Pressure **MAX**	P	**0.00**	**kPa**		

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TABLE C3

EXTERNAL PRESSURE COEFFICIENTS ($C_{p,e}$)—CURVED ROOFS

Rise-to-span ratio (r/d)	Windward quarter (U)	Centre half (T)	Leeward quarter (D)
0.09	$-(0.2 + 0.4\ h/r)$ or 0.0	$-(0.55 + 0.2\ h/r)$	$-(0.4 + 0.2\ h/r)$ or 0.0
0.2	$(0.3 - 0.4\ h/r)$ or 0.0		$-(0.25 + 0.2\ h/r)$ or 0.0
0.5	$(0.5 - 0.4\ h/r)$ or 0.0		$-(0.1 + 0.2\ h/r)$ or 0.0

NOTES:

1 h is the average roof height and r is the rise of the arch (see Figure C3).

2 For intermediate values of rise-to-span ratio, linear interpolation shall be used.

3 For $h/r > 2$, Table C3 shall be applied with $h/r = 2$.

4 For $r/d < 0.09$, Table 5.3(A) shall be applied.

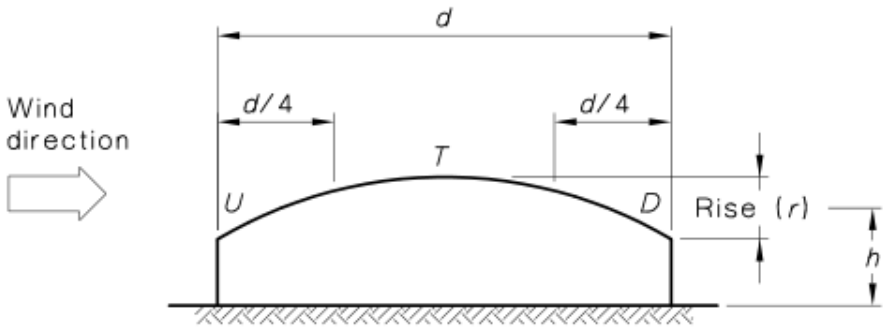

FIGURE C3 EXTERNAL PRESSURE COEFFICIENTS ($C_{p,e}$)—CURVED ROOFS

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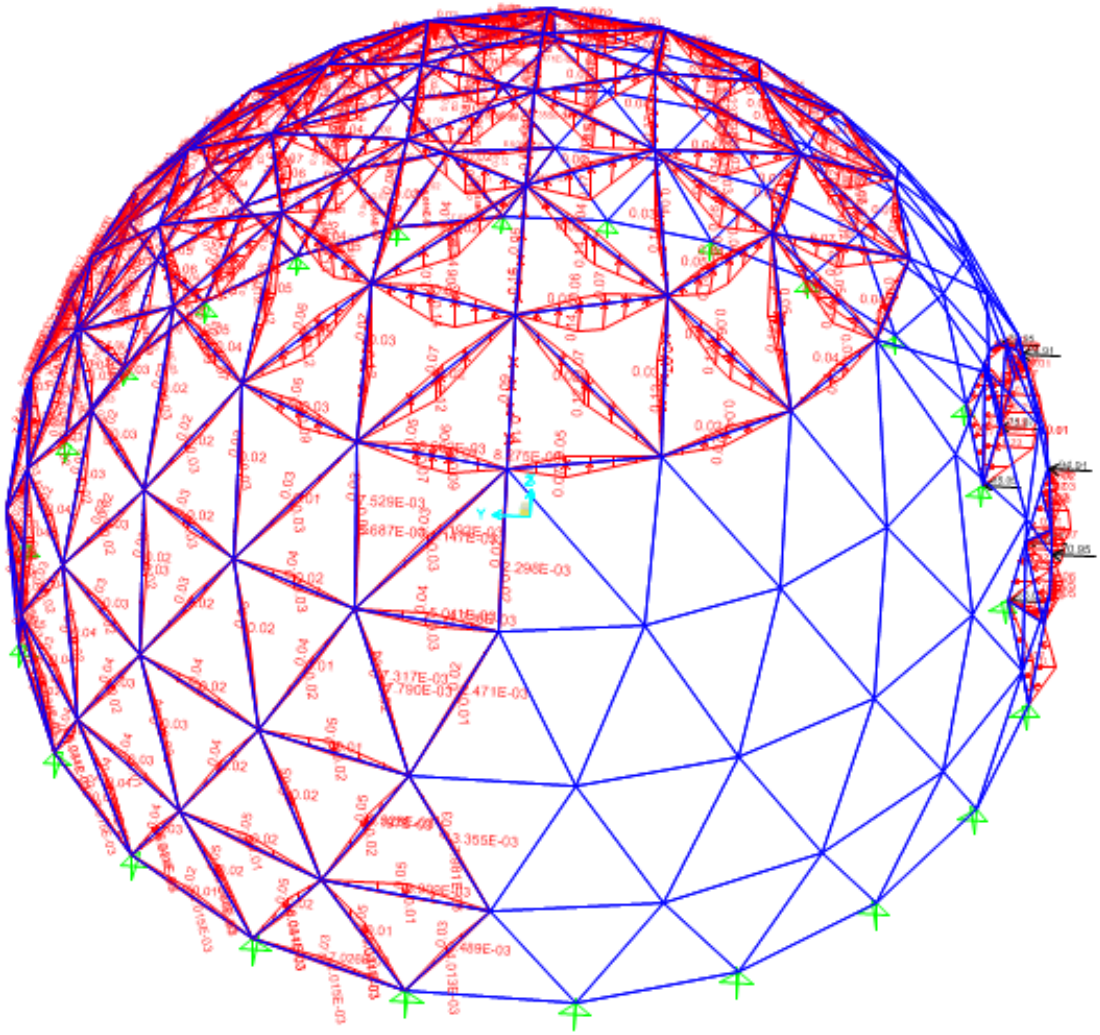
5.3 Wind Load Diagrams

5.3.1 Wind 1(case 1,min)



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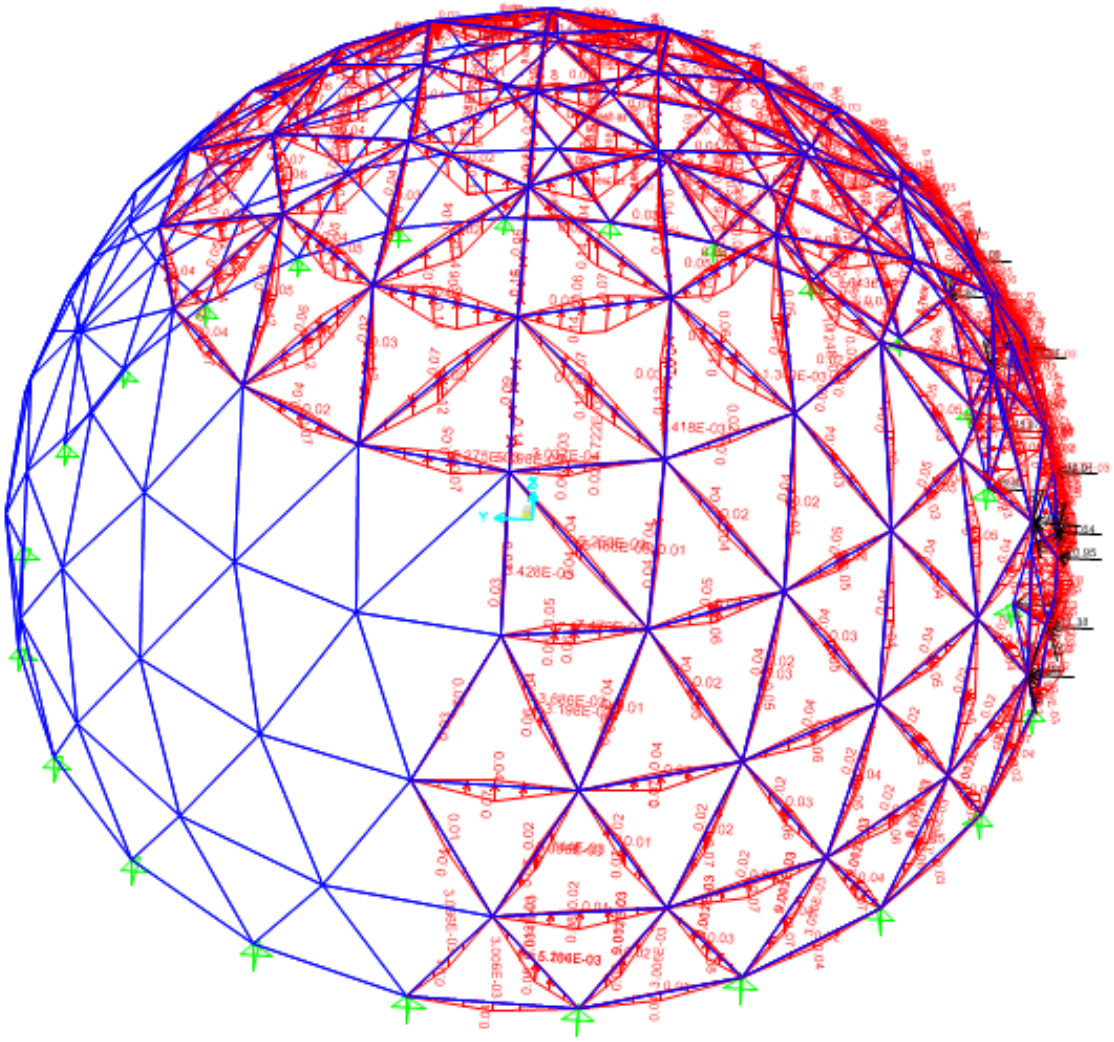
5.3.2 Wind 1(case 2,max)



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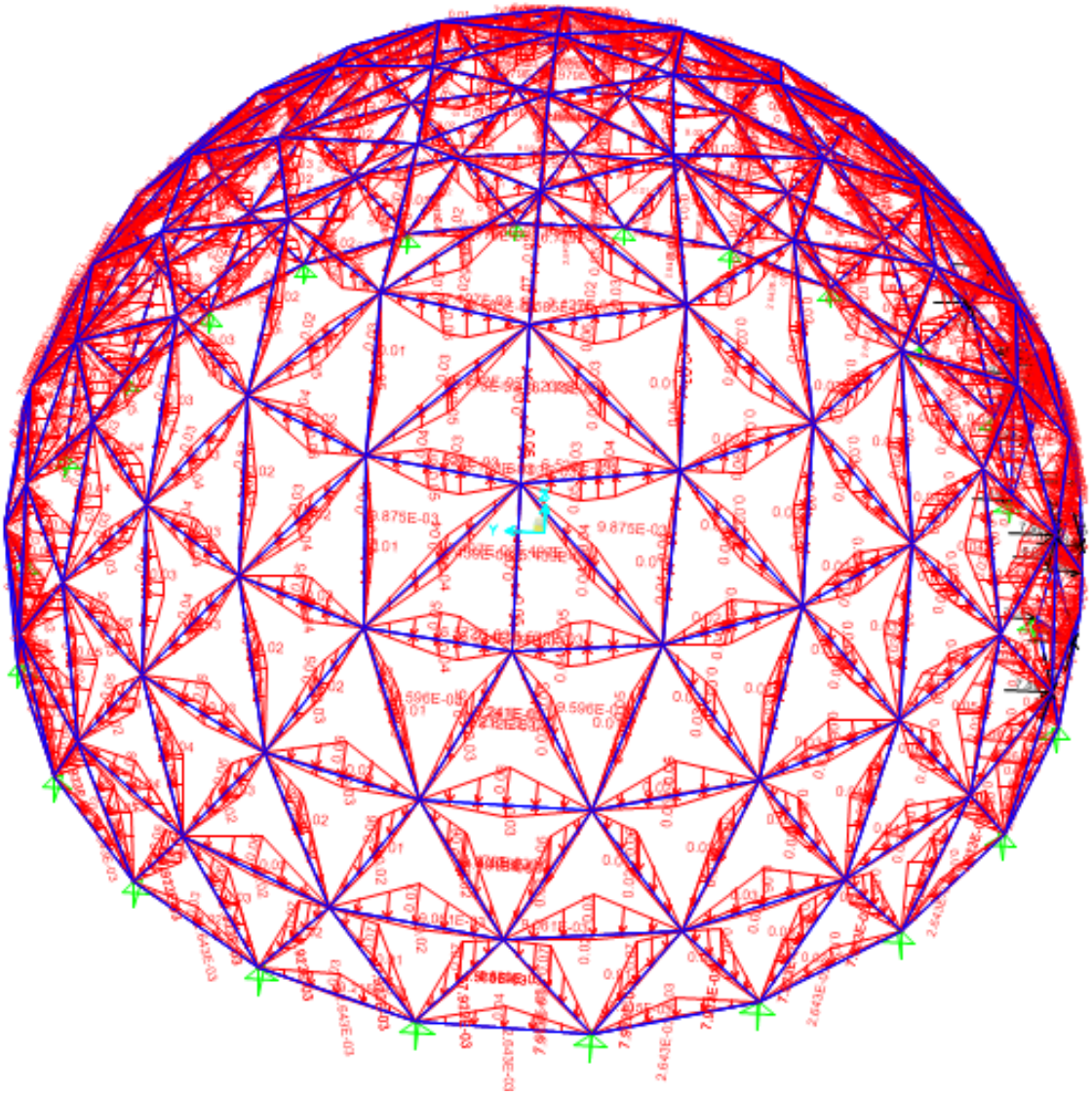
5.3.3 Wind Internal Pressure



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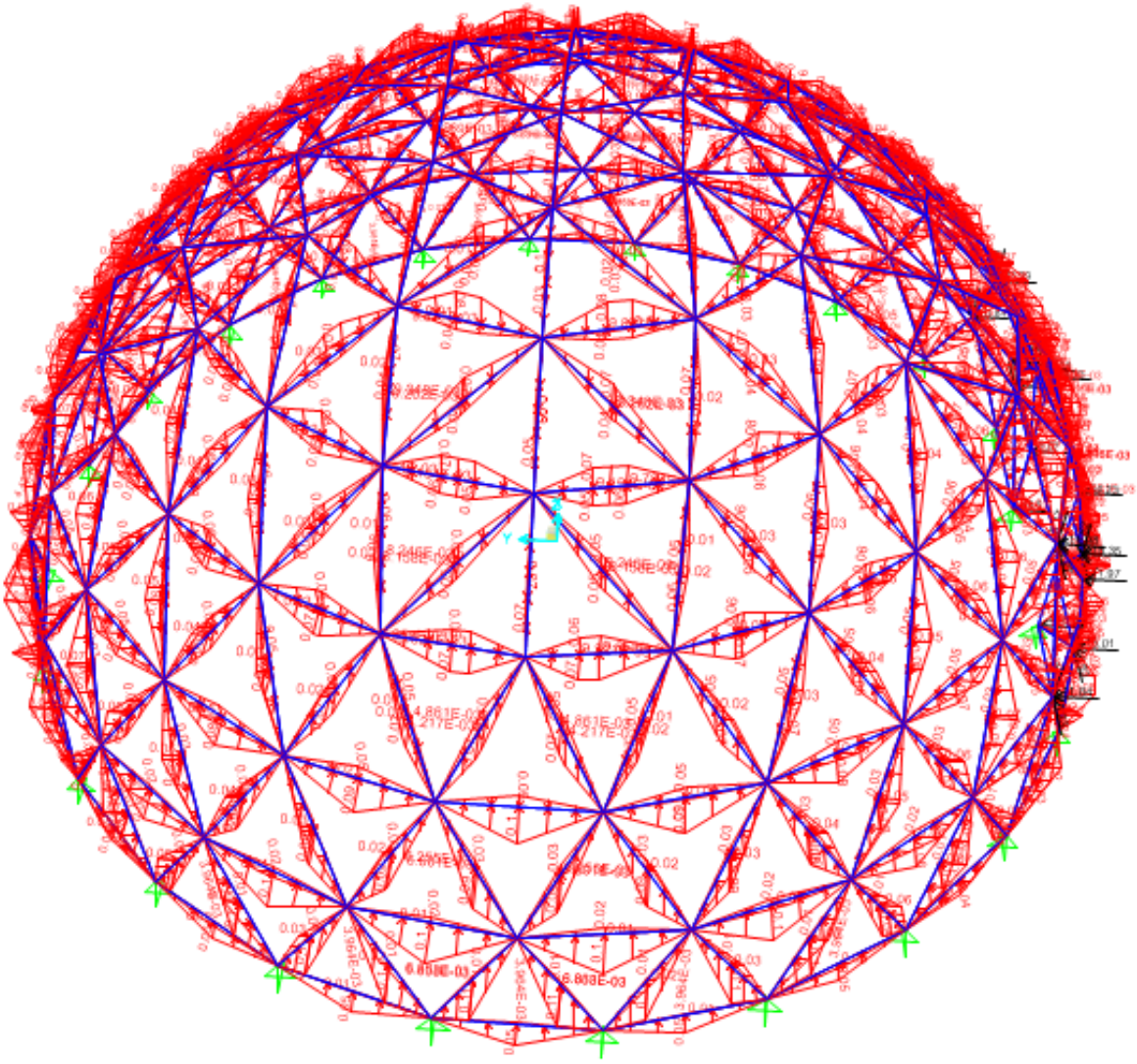
5.3.4 Wind Internal Suction



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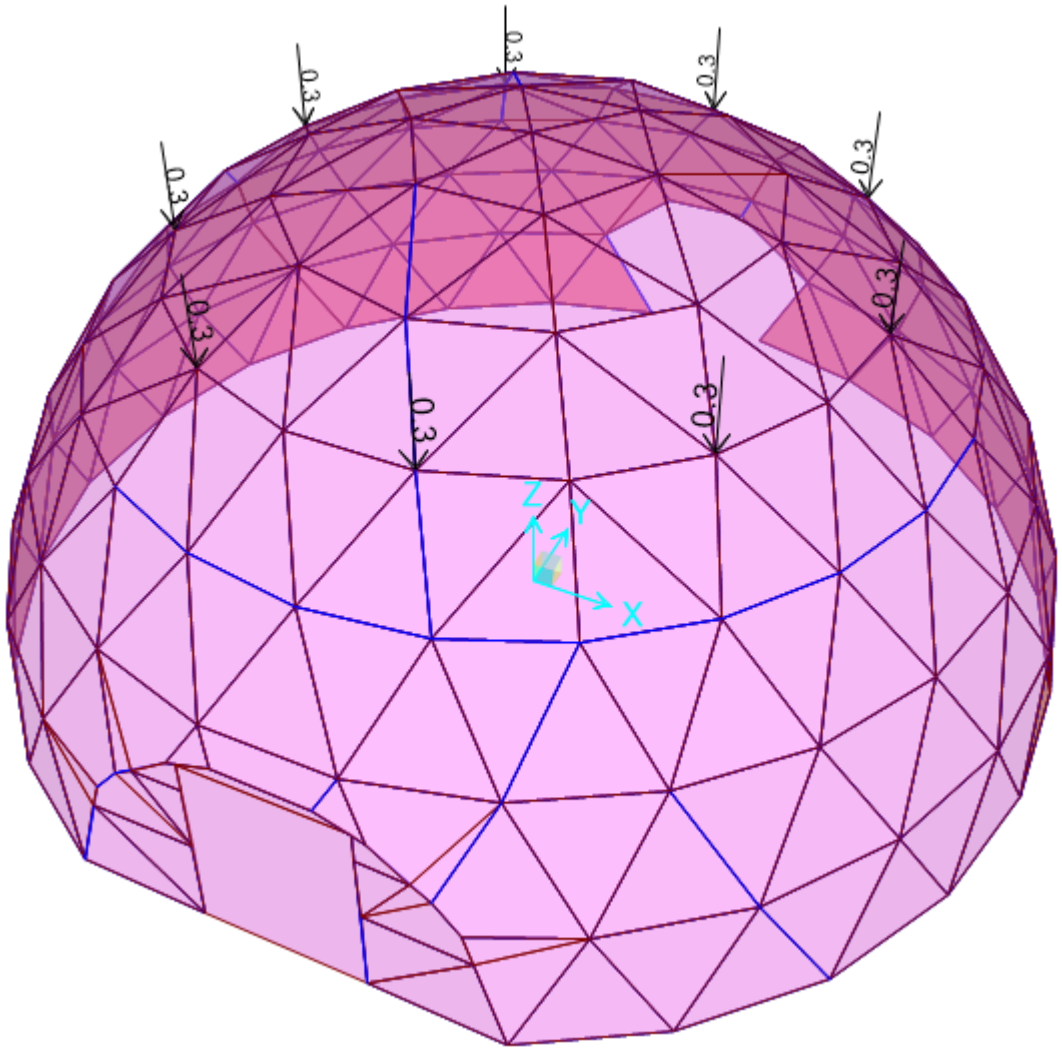
5.3.5 Super Imposed Dead Load:



10 off 0.3kN (30kg) = 300kg in total

After 3D model analysis, each member is checked based on adverse load combination.
In this regard the maximum bending moment, shear and axial force due to adverse load combinations for each member are presented as below:

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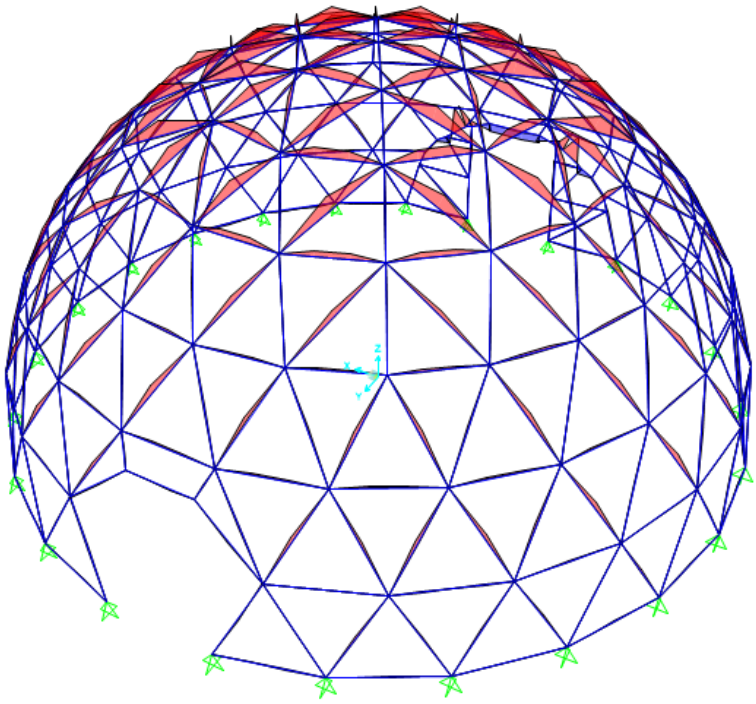
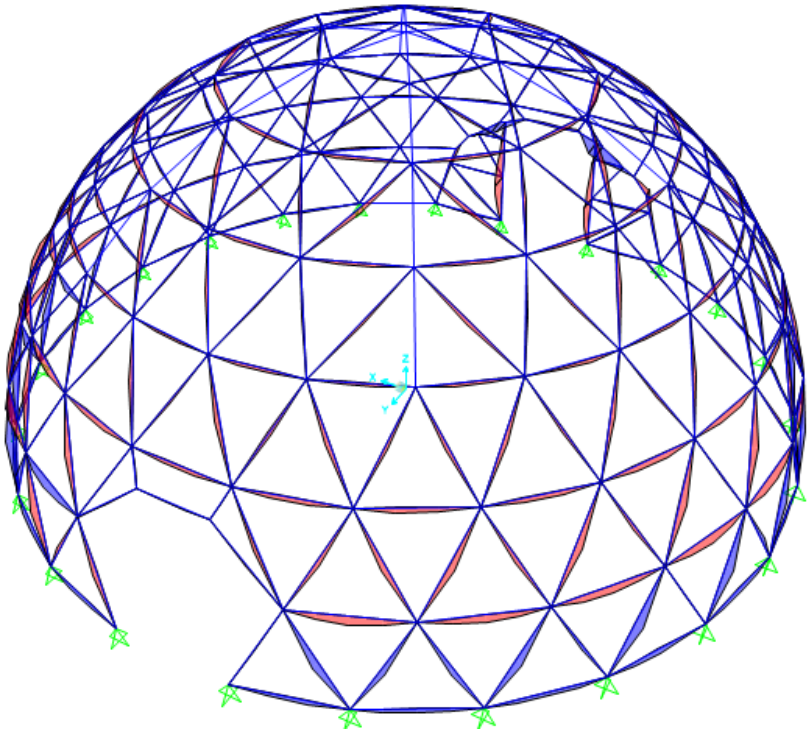
5.3.6 Max Bending Moment due to critical load combination in major axis



5.3.7 Max Bending Moment in minor axis due to critical load combination



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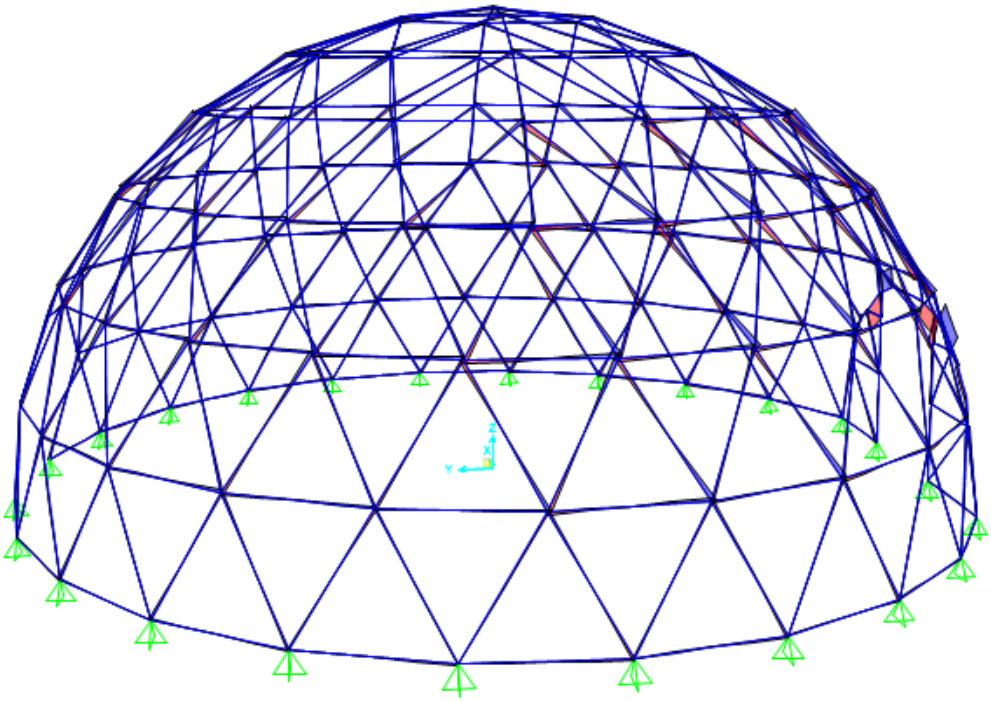
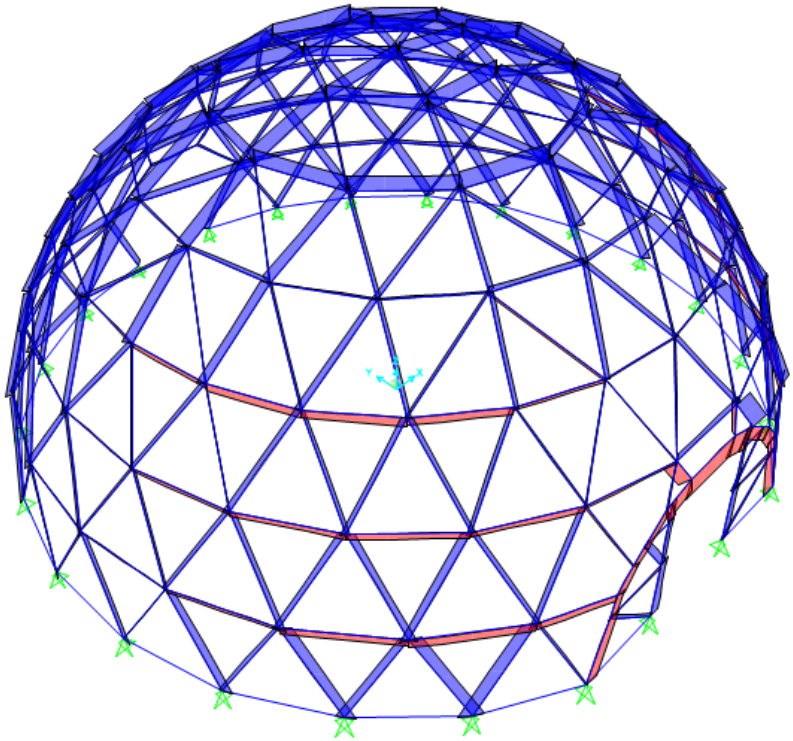
5.3.8 Max Shear in due to critical load combination



5.3.9 Max Axial force in upright support and roof beam due to critical load combination



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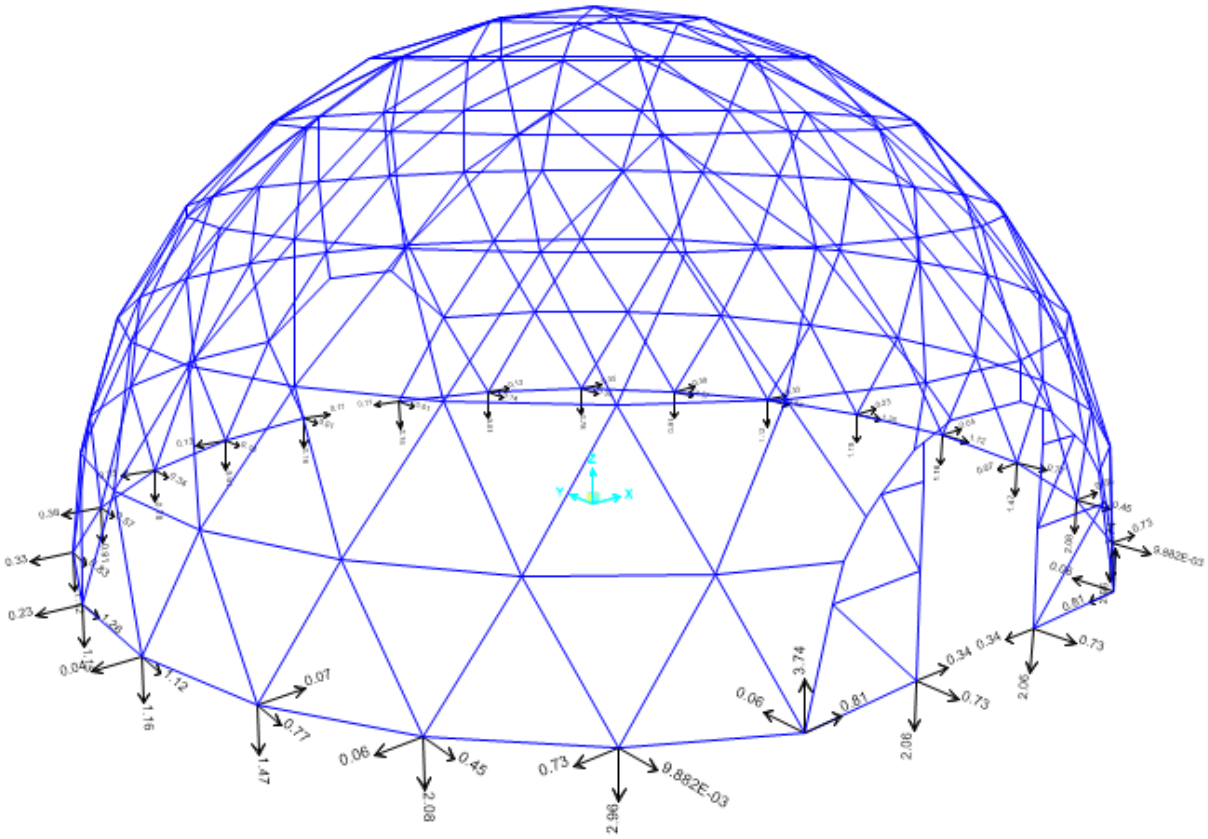
5.3.10 Max reactions



Max Reaction (Bearing) N^* = 3.4 kN
Max Reaction (Uplift) N^* = 1.5 kN

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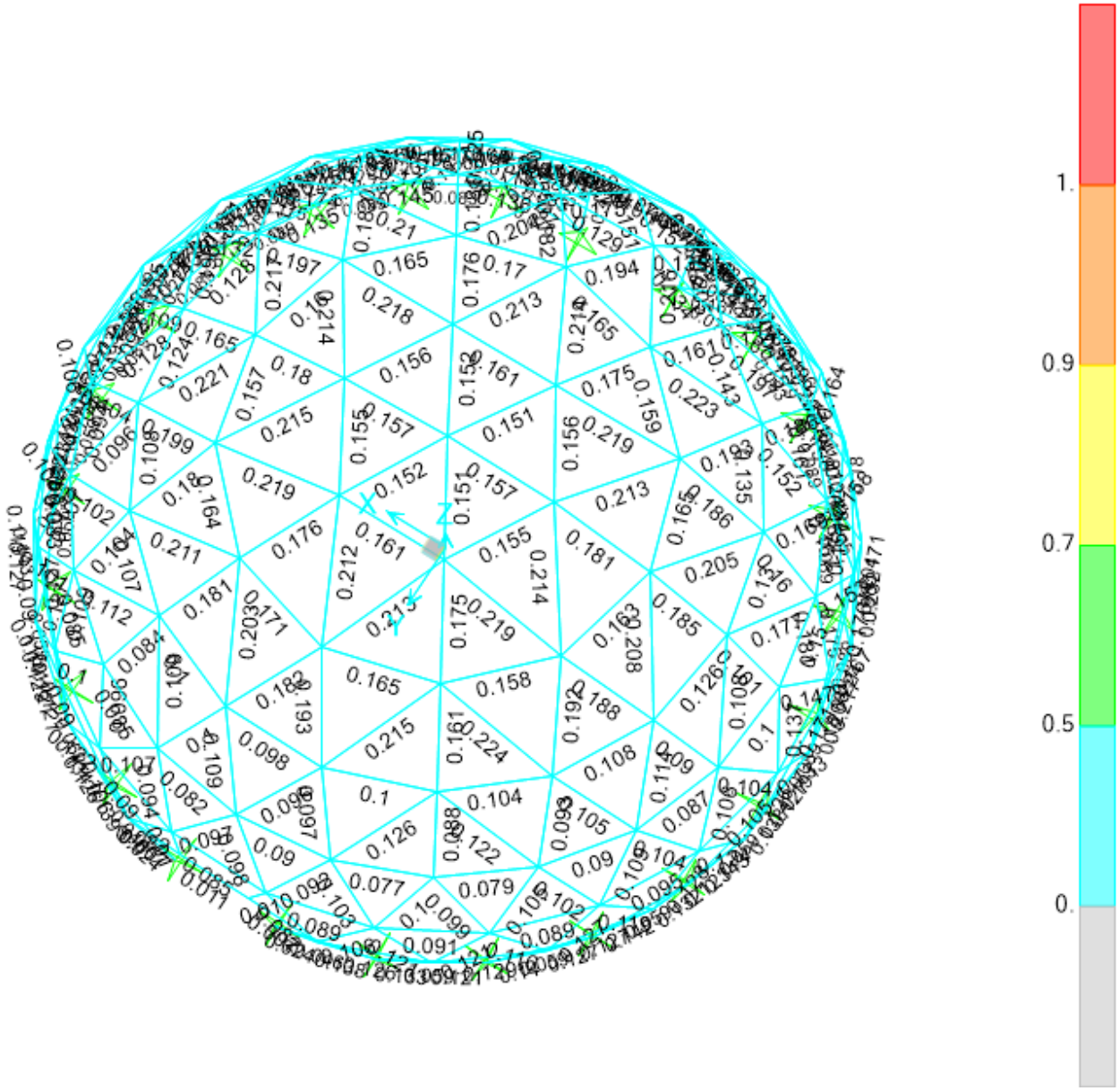
6 Checking Members Based on AS4100:1998



All steel members pass with the factor of safety 2 or greater

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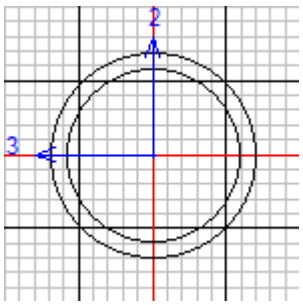

AS 4100-1998 STEEL SECTION CHECK (Summary for Combo and Station)
Units : KN, m, C

Frame : 319	X Mid: 3.059	Combo: COMB2	Design Type: Brace
Length: 1.726	Y Mid: 0.640	Shape: 25x2 CHS	Frame Type: Braced Frame
Loc : 0.863	Z Mid: 5.048	Class: Compact	Princpl Rot: 0.000 degrees

PhiB=0.900	PhiC=0.900	PhiTY=0.900	PhiTF=0.900	PhiS=0.900

A=1.445E-04	I33=9.628E-09	r33=0.008	Z33=7.703E-07	Av3=7.262E-05
J=1.926E-08	I22=9.628E-09	r22=0.008	Z22=7.703E-07	Av2=7.262E-05
E=210000000.0	fy=235000.000	Ry=1.106	S33=1.061E-06	
RLLF=1.000	Fu=390000.000	SteelType=HR	S22=1.061E-06	

STRESS CHECK FORCES & MOMENTS (Combo COMB2)

Location	N*	M33*	M22*	V2*	V3*	T*
0.863	0.552	-0.042	-0.017	-5.293E-04	-1.598E-04	0.000

PMM DEMAND/CAPACITY RATIO (8.3.4a)

D/C Ratio:	0.221 = 0.018 + 0.188 + 0.076	< 0.950	OK
	= N*/(phi*Ns) + M33*/(phi*Ms33) + M22*/(phi*Ms22)		

BASIC FACTORS

Buckling Mode	K Factor	L Factor	KL/r
Major Flexure	1.000	1.000	211.484
Minor Flexure	1.000	1.000	211.484
Major Braced	1.000	1.000	211.484
Minor Braced	1.000	1.000	211.484
LTB	1.400	1.000	296.077

AXIAL FORCE & BIAXIAL MOMENT DESIGN (8.3.4a)

Factor	L	Braced ke	Sway ke	Delta_b	Delta_s	Cm	Betam
Major Bending	1.000	1.000	1.000	1.000	1.000	1.000	-1.00
Minor Bending	1.000	1.000	1.000	1.000	1.000	1.000	-1.00

	Lltb	Kt	Kl	Kr	Alpha_m	Alpha_s
LTB Factors	1.000	1.000	1.400	1.000	1.388	0.976

	Steel Type	Kf	Kt	Alpha_a	Alpha_b	Alpha_c
Axial Factors	HR	1.000	1.000	9.821	-1.000	0.184

	Element	Lambda_e	Lambda_ep	Lambda_ey	Lambda_ew	Compactness
Bending	Any	11.750	50.000	120.000	1.000E+14	Compact
Axial	Any	11.750		82.000		Compact

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	ZeMajor	ZeMinor	de	Aeff
Effective Pro	1.061E-06	1.061E-06	0.025	1.445E-04

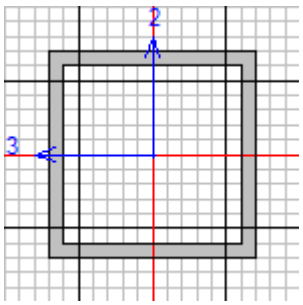
	M*	Ms	Mr	Mi	Nc
Major Moment	-0.042	0.249	0.245	0.249	6.253
Minor Moment	-0.017	0.249	0.245	0.249	6.253

	Mo,cr	Mb	Mo	Mc	Mt
Major Moment	2.305	0.249	0.254	0.249	0.245

	N*	Ns	Nc	Nt	Noz
Axial	0.552	33.961	6.253	33.961	11672.225

SHEAR CHECK

	V* Force	Vv Capacity	Stress Ratio	Status Check
Major Shear	5.293E-04	11.003	4.810E-05	OK
Minor Shear	1.598E-04	11.003	1.452E-05	OK



AS 4100-1998 STEEL SECTION CHECK (Summary for Combo and Station)
Units : KN, m, C

Frame : 374 X Mid: 0.900 Combo: COMB9 Design Type: Column
Length: 2.146 Y Mid: -5.510 Shape: 30x2 SHS Frame Type: Braced Frame
Loc : 1.000 Z Mid: 1.073 Class: Compact Princpl Rot: 0.000 degrees

PhiB=0.900 PhiC=0.900 PhiTY=0.900 PhiTF=0.900 PhiS=0.900

A=2.240E-04 I33=2.942E-08 r33=0.011 Z33=1.961E-06 Av3=1.200E-04
J=4.390E-08 I22=2.942E-08 r22=0.011 Z22=1.961E-06 Av2=1.200E-04
E=210000000.0 fy=235000.000 Ry=1.106 S33=2.356E-06
RLLF=1.000 Fu=390000.000 SteelType=HR S22=2.356E-06

STRESS CHECK FORCES & MOMENTS (Combo COMB9)

Location	N*	M33*	M22*	V2*	V3*	T*
1.000	0.139	-2.064E-05	-0.209	2.064E-05	0.066	4.930E-04

PMM DEMAND/CAPACITY RATIO (5.1b)
D/C Ratio: 0.419 = 0.419 < 0.950 OK
= M22*/(phi*Ms22)

BASIC FACTORS

Buckling Mode	K Factor	L Factor	KL/r
Major Flexure	1.000	0.466	87.259

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Minor Flexure	1.000	1.000	187.285
Major Braced	1.000	0.466	87.259
Minor Braced	1.000	1.000	187.285
LTB	1.400	1.000	262.199

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.1b)

Factor	L	Braced ke	Sway ke	Delta_b	Delta_s	Cm	Betam
Major Bending	0.466	1.000	1.000	1.000	1.000	1.000	-1.00
Minor Bending	1.000	1.000	1.000	1.000	1.000	1.000	-1.00

	Lltb	Kt	Kl	Kr	Alpha_m	Alpha_s
LTB Factors	1.000	1.000	1.400	1.000	1.689	0.974

	Steel Type	Kf	Kt	Alpha_a	Alpha_b	Alpha_c
Axial Factors	HR	1.000	1.000	10.947	-1.000	0.235

Slenderness	Lambda_e	Lambda_ep	Lambda_ey	Lambda_ew	Lambda_e/ey	Compactness
Major/Flange	12.604	30.000	45.000	180.000	0.280	Compact
/Web	12.604	82.000	115.000	180.000	0.110	Compact
Minor/Flange	12.604	82.000	115.000	180.000	0.110	Compact
/Web	12.604	30.000	45.000	180.000	0.280	Compact
Axial/Flange	12.604		45.000		0.280	Compact
/Web	12.604		45.000		0.280	Compact

	ZeMajor	ZeMinor	b-be	d-de	Aeff
Effective Pro	2.356E-06	2.356E-06	0.000	0.000	2.240E-04

	M*	Ms	Mr	Mi	Nc
Major Moment	-2.064E-05	0.554	0.554	0.554	40.797
Minor Moment	-0.209	0.554	0.554	0.554	12.346

	Mo,cr	Mb	Mo	Mc	Mt
Major Moment	4.894	0.554	0.555	0.554	0.554

	N*	Ns	Nc	Nt	Noz
Axial	0.139	52.640	12.346	52.640	13500.351

SHEAR CHECK

	V* Force	Vv Capacity	Stress Ratio	Status Check
Major Shear	2.064E-05	15.228	1.355E-06	OK
Minor Shear	0.066	15.228	0.004	OK

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7 Summary

7.1 Conclusions

a. The 12m Dome Structure as specified has been analyzed with a conclusion that it has the capacity to withstand wind speeds up to and including **100km/hr.**
b. For forecast winds in excess of **100km/hr** – all fabric shall be removed from the frames, and the structure should be completely dismantled.
c. For uplift due to 100km/hr, the supports are required to provide resistance equal to 2 kN (200kg) force downward per anchor.
d. The bearing pressure of soil should be clarified and checked by an engineer prior to any construction for considering foundation and base plate.

Yours faithfully,

E.A. Bennett M.I.E. Aust. NPER 198230

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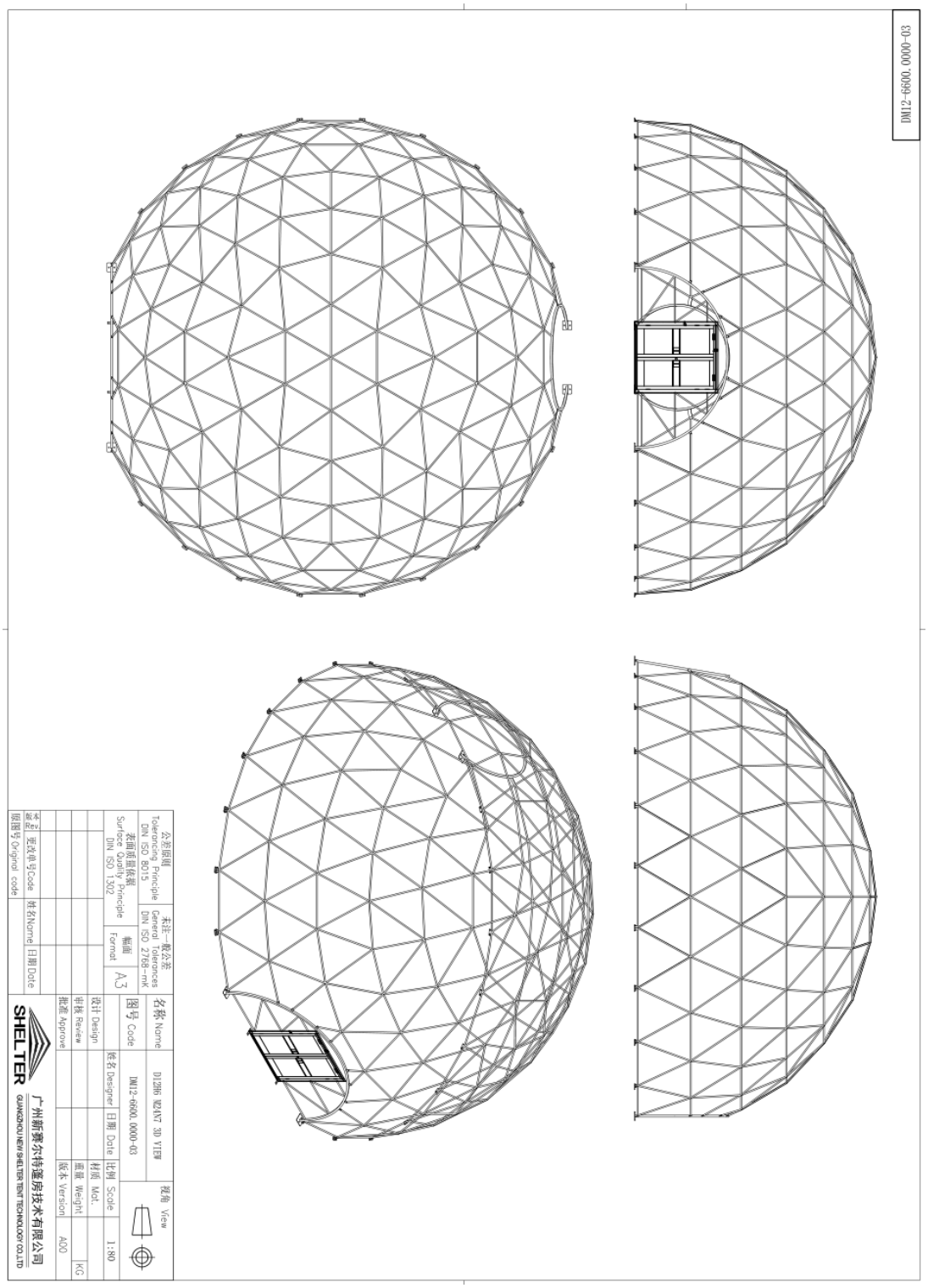
8 Appendix 'A' – Drawings



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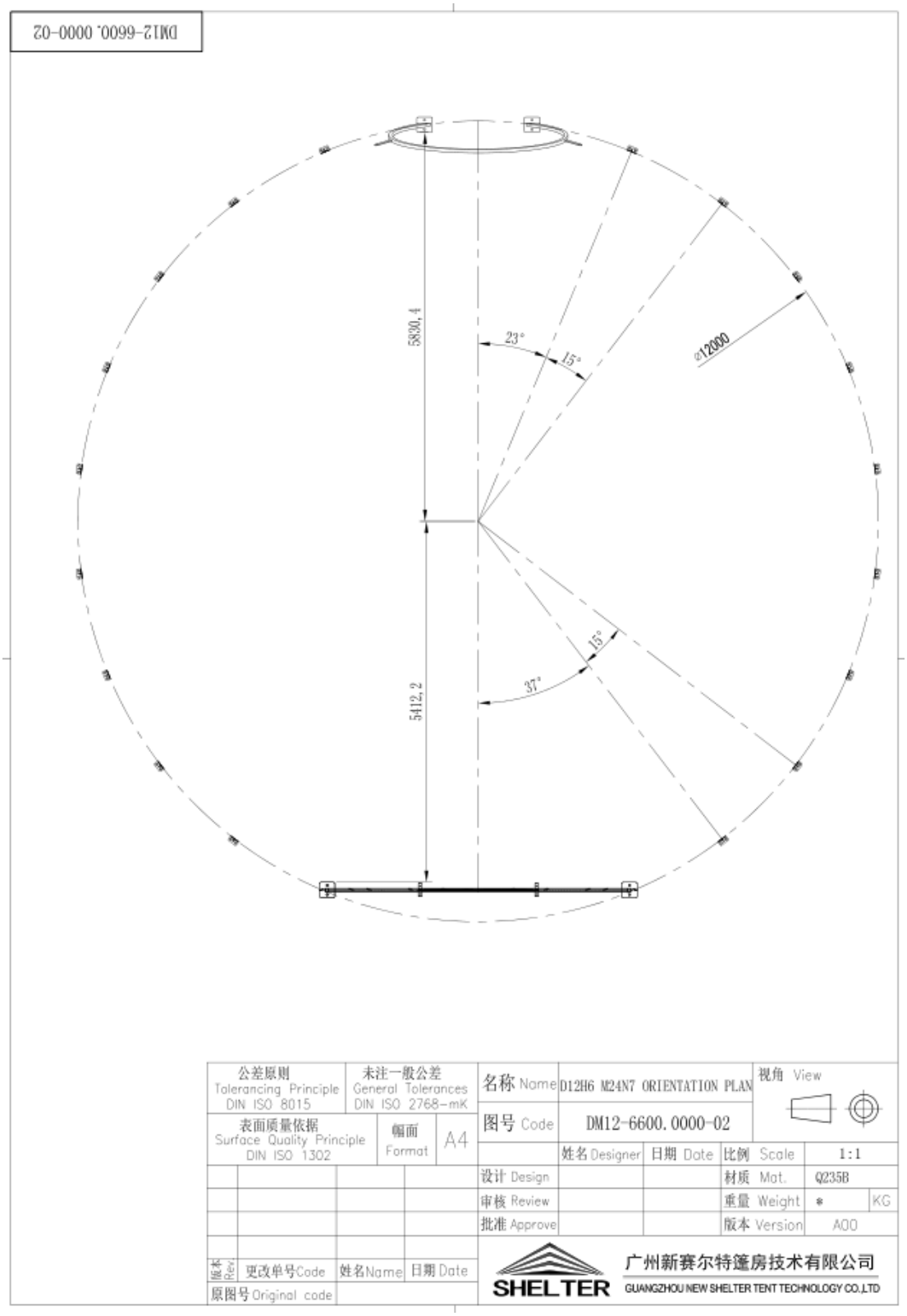

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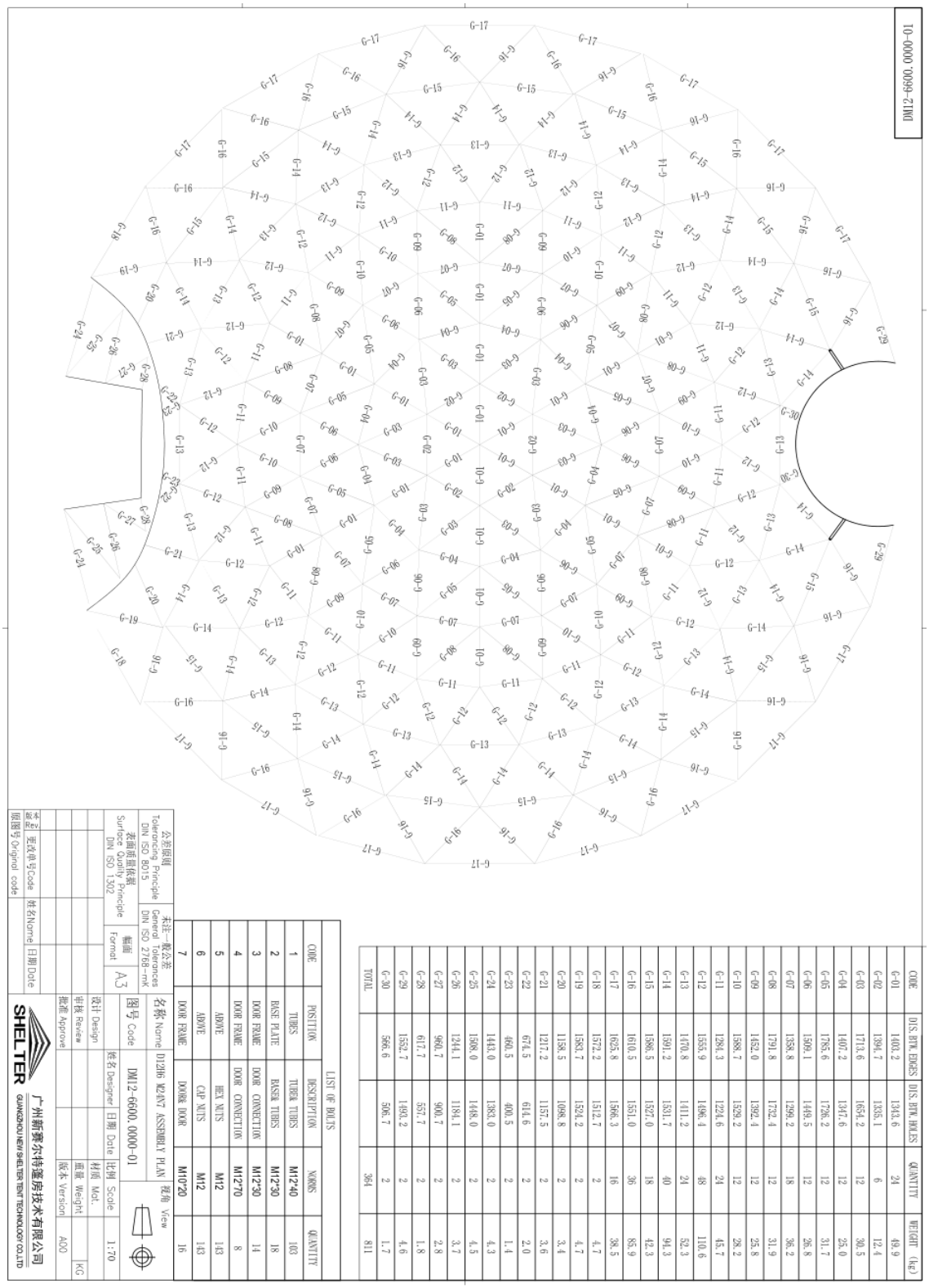

CODE	DIS. BTW. EDGES	DIS. BTW. BOLTS	QUANTITY	WEIGHT (kg)
G-01	1403.2	1343.6	24	49.9
G-02	1394.7	1335.1	6	12.4
G-03	1713.6	1654.2	12	36.5
G-04	1407.2	1347.6	12	25.0
G-05	1765.6	1726.2	12	31.7
G-06	1509.1	1449.5	12	26.8
G-07	1358.8	1299.2	18	36.2
G-08	1791.8	1732.4	12	31.9
G-09	1452.0	1392.4	12	25.8
G-10	1588.7	1529.2	12	28.2
G-11	1284.3	1224.6	24	45.7
G-12	1355.9	1496.4	48	110.6
G-13	1470.8	1411.2	24	52.3
G-14	1591.2	1531.7	40	94.3
G-15	1586.5	1527.0	18	42.3
G-16	1610.5	1551.0	36	85.9
G-17	1625.8	1566.3	16	38.5
G-18	1572.2	1512.7	2	4.7
G-19	1583.7	1524.2	2	4.7
G-20	1158.5	1098.8	2	3.4
G-21	1217.2	1157.5	2	3.6
G-22	674.5	614.6	2	2.0
G-23	460.5	400.5	2	1.4
G-24	1443.0	1383.0	2	4.3
G-25	1508.0	1448.0	2	4.5
G-26	1244.1	1184.1	2	3.7
G-27	960.7	900.7	2	2.8
G-28	617.7	557.7	2	1.8
G-29	1552.7	1493.2	2	4.6
G-30	566.6	506.7	2	1.7
TOTAL			364	811

CODE	POSITION	LIST OF BOLTS DESCRIPTION	MARKS	QUANTITY
1	TUBES	TUBES TUBES	M12*40	103
2	BASE PLATE	BASE TUBES	M12*30	18
3	DOOR FRAME	DOOR CONNECTION	M12*30	14
4	DOOR FRAME	DOOR CONNECTION	M12*70	8
5	ABOVE	HEX NUTS	M12	143
6	ABOVE	CAP NUTS	M12	143
7	DOOR FRAME	DOOR6 DOOR	M10*20	16

公差原则 Tolerancing Principle DIN ISO 8015		名称 Name	D12R6 M24X7 ASSEMBLY PLAN	视角 View	
表面质量原则 Surface Quality Principle DIN ISO 1302		图号 Code	DM12-6600.0000-01		
未注一般公差 General Tolerances DIN ISO 2768-mK	幅面 Format A3	设计 Design	姓名 Designer	日期 Date	比例 Scale 1:70
		审核 Review			重量 Weight KG
		批准 Approve			版本 Version A00
本张更改	更改单号 Code	姓名 Name	日期 Date	SHELTER 广州新豪尔特篷房技术有限公司 GUANGZHOU NEW SHELTER TENT TECHNOLOGY CO.,LTD	
原图号 Original code					

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