Prime Consulting Engineers Pty. Ltd.

Design Report:

8m Dome Structure (enclosed)

For

EXTREME MARQUEES

Ref: R-22-211-2

Date: 12/05/2022

Amendment: A

Prepared by: KZ

Checked by: SD

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1 Introduction and Scope:

The report and certification are the sole property of Prime Consulting Engineers Pty. Ltd.

Prime Consulting Engineers have been engaged by Extreme Marquees Pty. Ltd. to carry out a structural analysis of 8m dome structure for wind loads region A (non-cyclonic) and snow loads for sub-alpine regions. It should be noted that the outcome of our analysis is limited to the selected items as outlined in this report.

This report shall be read in conjunction with the documents listed in the references (Section 1.2)

1.1 Project Description

The report examines the effect of 3s gust wind of **(refer to summary)** and snow loads of sub-alpine region positioned for the worst effect on the 8m dome structure. The result of this report is also applicable to the smaller dome structure with identical member sizes. The relevant Australian Standards AS1170.0:2002 General principles, AS1170.1:2002 Permanent, imposed and other actions, AS1170.2:2021 Wind actions and AS1170.3 Snow actions are used. The design check is in accordance with AS4100:1998 steel structures.

1.2 References

- The documents referred to in this report are as follows:
  - Report of results produced through SAP2000 V24 software & excel spreadsheets.
  - Detail drawing provided by manufacturer. Refer to appendix 'A'.
- The basic standards used in this report are as follows:
  - AS 1170.0:2002 – Structural Design Actions (Part 0: General principles)
  - AS 1170.1:2002 – Structural Design Actions (Part 1: Permanent, imposed, and other actions)
  - AS 1170.2:2021 – Structural Design Actions (Part 2: Wind Actions)
  - AS 1170.3:2003 – Snow and ice actions.
  - AS4100:1998 – Steel Structures.
- Section Properties of Steel (Q235) Section provided by the client.
- The program(s) used for this analysis are as follows:
  - SAP2000 V24
  - Microsoft Excel

1.3 Notation

AS/NZS	Australian Standard/New Zealand Standard
FEM/FEA	Finite Element Method/Finite Element Analysis

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SLS	Serviceability Limit State
ULS	Ultimate Limit State

2 Design Overview

2.1 Geometry Data

EXTREME MARQUEES

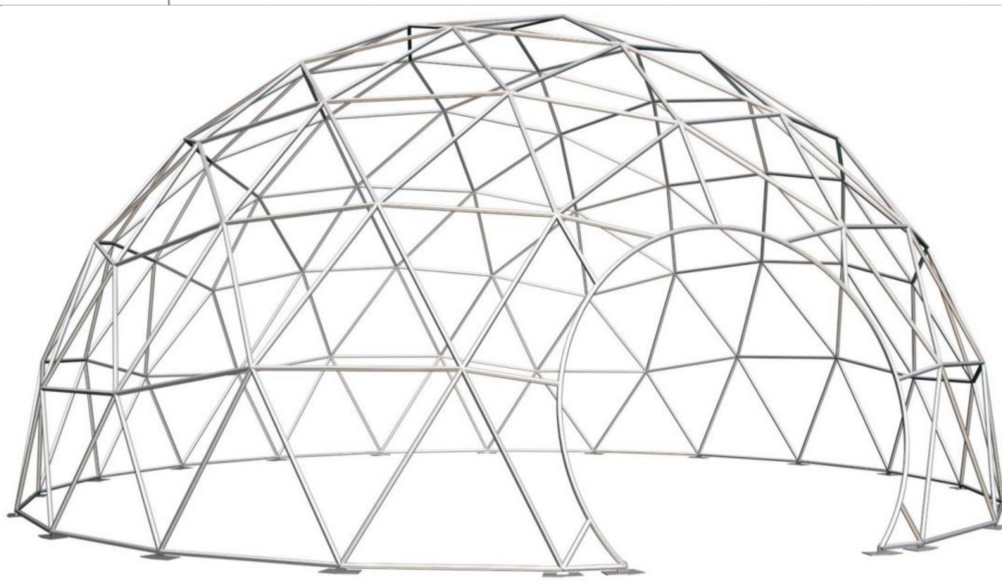
WE CAN CUSTOM PRINT ANY COLOUR

DOME RANGE

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

EVENT TENT

ITEM	SPECIFICATION								
Size	4m	5m	6m	7m	8m	9m	10m	11m	12m
Ceiling Height	2.4m	2.5m	3m	3.5m	4m	4.5m	5m	5.5m	6m
Door Size	1200mm W x 1800mm H			1500mm W × 2100mm H			1500mm W x 2400mm H		
Dome Style	Lapela								
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
Frame Material	Steel								



Isometric view of structures

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2.2 Assumptions & Limitations

- The erected structure is for temporary use only.
- For forecast winds in excess of **(refer to summary)** the dome structure should be completely dismantled.
- The structure may only be used in regions with wind and snow classifications no greater than the limits specified in cl. 5 & 6 of this report.
- Parameters used for wind & snow calculations:
  - TC 2
  - Wind Region A
  - Sub-alpine region (Orange, NSW)
- Topographical factors such as erecting the structure on the crest of a hill or on the top of an escarpment may result in a higher wind speed classification. Thus, special considerations should be taken to the topographical location of the installation site.
- Shall the site conditions, wind or snow parameters exceed prescribed design actions (refer to cl.7), Prime Consulting Engineers Pty. Ltd. should be informed to determine appropriate wind/snow classifications and amend computations accordingly.
- It is assumed that the structure is fully enclosed with equally permeable side walls to calculate Wind Internal Forces.

2.3 Exclusions

- Design of fabric
- Wind actions due to tropical or severe tropical cyclonic areas.
- Snow actions due to snow loads other than Orange, NSW.
- Super imposed loads such as live load.

2.4 Design Parameters and Inputs

2.4.1 Load Cases

1.	G	Permanent actions (Dead load)
3.	W_u	Ultimate wind action (ULS)
4.	W_s	Serviceability wind action (SLS)
5.	S	Snow action (SLS)

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2.4.2 Load Combinations

Strength (ULS):

1. 1.35G — Permanent action only
3. $0.9G+W_u$ — Permanent and wind actions
4. $1.2G+W_u$ — Permanent and wind actions
5. 1.2G+S — Permanent and snow actions

Serviceability (SLS):

2. $G+W_s$ — Wind service actions

3 Specifications

3.1 Material Properties

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

3.2 Member Sizes & Section Properties

TABLE: Frame Section Properties 01 - General												
SectionName	**t3**	**t2**	**tf**	**tw**	**Area**	**TorsConst**	**I33**	**I22**	**Z33**	**Z22**	**R33**	**R22**
Text	mm	mm	mm	mm	mm2	mm4	mm4	mm4	mm3	mm3	mm	mm
32x2 CHS	32			2	188.5	42600	21300	21300	1331.3	1331.3	10.63	10.63
40x40x2	40	40	2	2	304	109744	73365.33	73365.33	4336	4336	15.535	15.535

4 Design Loads

Self weight	**G**	**self weight**
3s 100km/hr gust	W_u	0.751 C_{fig} (kPa)
Sub-alpine snow load	W_s	0.33 - 0.64 (kPa)

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5 Wind Analysis

5.1 Ultimate

PRIME CONSULTING ENGINEERS PTY. LTD

Project: *8m Dome Structure*

Jon no. *22-211-2* *Designer:* *KZ*

Date: *4/05/2022* *Amendment:* *A-12/05/2022*

Name	*Symbol*	*Value*	*Unit*	*Notes*	*Ref.*
			General		
Importance level		3			*Table 3.1 - Table 3.2 (AS1170.0)*
Annual probability of exceedance		Temporary			*Table 3.3*
Regional gust wind speed		**139.97**	Km/hr		
Regional gust wind speed	V_R	38.88	m/s		
Wind Direction Multipliers	M_d	1			*Table 3.2 (AS1170.2)*
Terrain Category	TC	2			
Terrain Category Multiplier	$M_{Z,Cat}$	0.91			
Shield Multiplier	M_S	1			*4.3 (AS1170.2)*
Topographic Multiplier	M_t	1			*4.4 (AS1170.2)*
Site Wind Speed	$V_{Site,\beta}$	**35.38**	m/s	$V_{Site,\beta}=V_R*M_d*M_{z,cat}*M_S,M_t$	
Pitch	α	0	Deg		
Pitch	α	0.000	rad		
Width	B	8	m		
Width Span	S_w	-	m		
Length	D	8	m		
Height	Z	2	m		
Bay Span		-	m		
	h/d	0.25			
	h/b	0.25			
			Wind Pressure		
ρair	ρ	1.2	Kg/m^3		

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dynamic response factor	C_{dyn}	1			
Wind Pressure	ρ*C_{fig}	**0.751**	Kg/m^2	ρ=0.5ρ_{air}*($V_{des,\beta}$)^2*C_{fig}*C_{dyn}	*2.4 (AS1170.2)*
WIND DIRECTION 1 (Perpendicular to Length)					
Internal Pressure					
Opening Assumption					
	Without Dominant Opening				
Internal Pressure Coefficient (Without Dominant) **MIN**		-0.3			
Internal Pressure Coefficient (Without Dominant) **MAX**		0.2			
Internal Pressure Coefficient (With Dominant) **MIN**		0			
Internal Pressure Coefficient (With Dominant) **MAX**		0.3			
N		0.7		*Cpi= N*Cpe*	
Combination Factor	$K_{C,i}$	1			
Internal Pressure Coefficient **MIN**	$C_{p,i}$	-0.30			
Internal Pressure Coefficient **MAX**	$C_{p,i}$	0.20			
External Pressure					
1. Windward Wall					
External Pressure Coefficient	$C_{P,e}$	0.7			
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	**0.42**	**kPa**		
2. Leeward Wall					
External Pressure Coefficient	$C_{P,e}$	-0.5			
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			

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Leeward Wall Pressure	P	**-0.30**	**kPa**		
3. Side Wall					
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			
External Pressure Coefficient	$C_{P,e}$	-0.65		*0 to 1h*	
External Pressure Coefficient	$C_{P,e}$	-0.5		*1h to 2h*	
External Pressure Coefficient	$C_{P,e}$	-0.3		*2h to 3h*	
External Pressure Coefficient	$C_{P,e}$	-0.2		*>3h*	
aerodynamic shape factor	$C_{fig,e}$	-0.52		*0 to 1h*	
aerodynamic shape factor	$C_{fig,e}$	-0.4		*1h to 2h*	
aerodynamic shape factor	$C_{fig,e}$	-0.24		*2h to 3h*	
aerodynamic shape factor	$C_{fig,e}$	-0.16		*>3h*	
Side Wall Pressure	P	**-0.39**	**kPa**	*0 to 1h*	
Side Wall Pressure	P	**-0.30**	**kPa**	*1h to 2h*	
Side Wall Pressure	P	**-0.18**	**kPa**	*2h to 3h*	
Side Wall Pressure	P	**-0.12**	**kPa**	*>3h*	
4. Roof					
r (rise)	r	4	**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	2	**m**		Table C3
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	$C_{P,e}$	0.3			
Factored External Pressure Coefficient	$C_{P,e}$	0.30			
aerodynamic shape factor	$C_{fig,e}$	0.24			
Pressure	P	**0.18**	**kPa**		
4.2 Roof Centre Half					

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T	T	4	**m**	Table C3
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	$C_{P,e}$	-0.65		
Factored External Pressure Coefficient	$C_{P,e}$	-0.65		
aerodynamic shape factor	$C_{fig,e}$	-0.52		
Pressure	P	**-0.39**	**kPa**	
4.2 Roof Centre Half				
D	D	2	**m**	Table C3
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	$C_{P,e}$	-0.2		
Factored External Pressure Coefficient	$C_{P,e}$	-0.20		
aerodynamic shape factor	$C_{fig,e}$	-0.16		
Pressure	P	**-0.12**	**kPa**	

5.1.1 Summary Forces

WIND EXTERNAL PRESSURE (kPa)				
			Wind Direction	
Windward			0.42	
Leeward			-0.30	
Sidewall	0m - 2m		-0.39	
	2m - 4m		-0.30	
	4m - 6m		-0.18	
	> 6m		-0.12	
Roof				
	Windward Quarter (U)	2m	0.18	
	Centre Half (T)	4m	-0.39	
	Leeward Quarter (D)	2m	-0.12	
Wind Internal Pressure (kPa)				
			-0.23	0.15

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6 Snow Load

6.1 Sub-Alpine

S = Sg x Ce x μi

Annual probability of exceedance: 1/20
Snow region: Orange, NSW
Sg = 0.9kPa

C_e = 1

Average slope:
Segment 1: 9º → μ= = 0.71
Segment 2: 36º → μ= = 0.37
Segment 3: 72º → μ= = 0

Snow loads:
Segment 1: 0.64 kPa
Segment 2: 0.33 kPa
Segment 3: 0.0 kPa

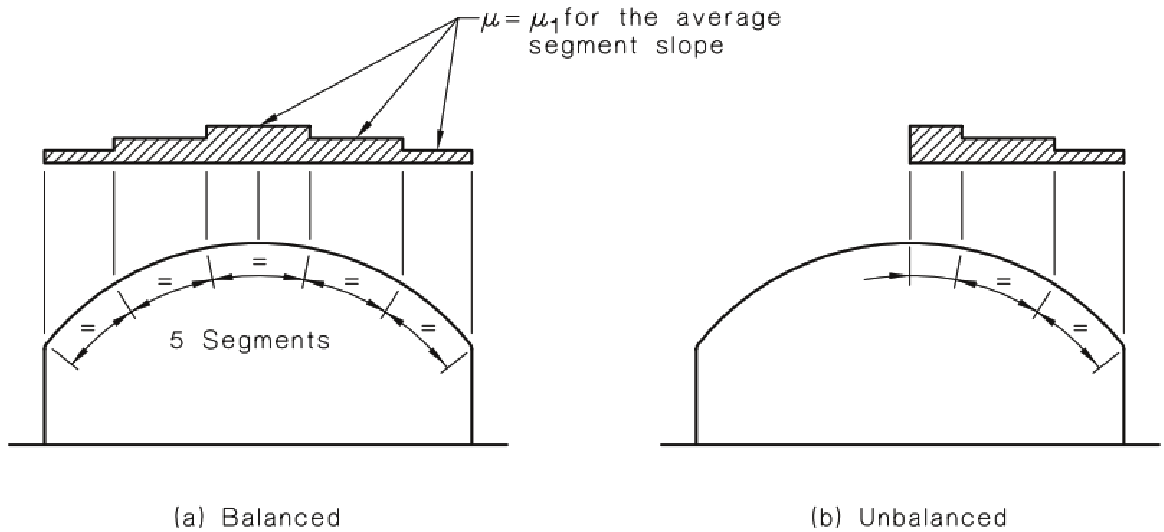

FIGURE 7.4 TYPES OF SNOW LOAD ON CURVED ROOFS (SUB-ALPINE)

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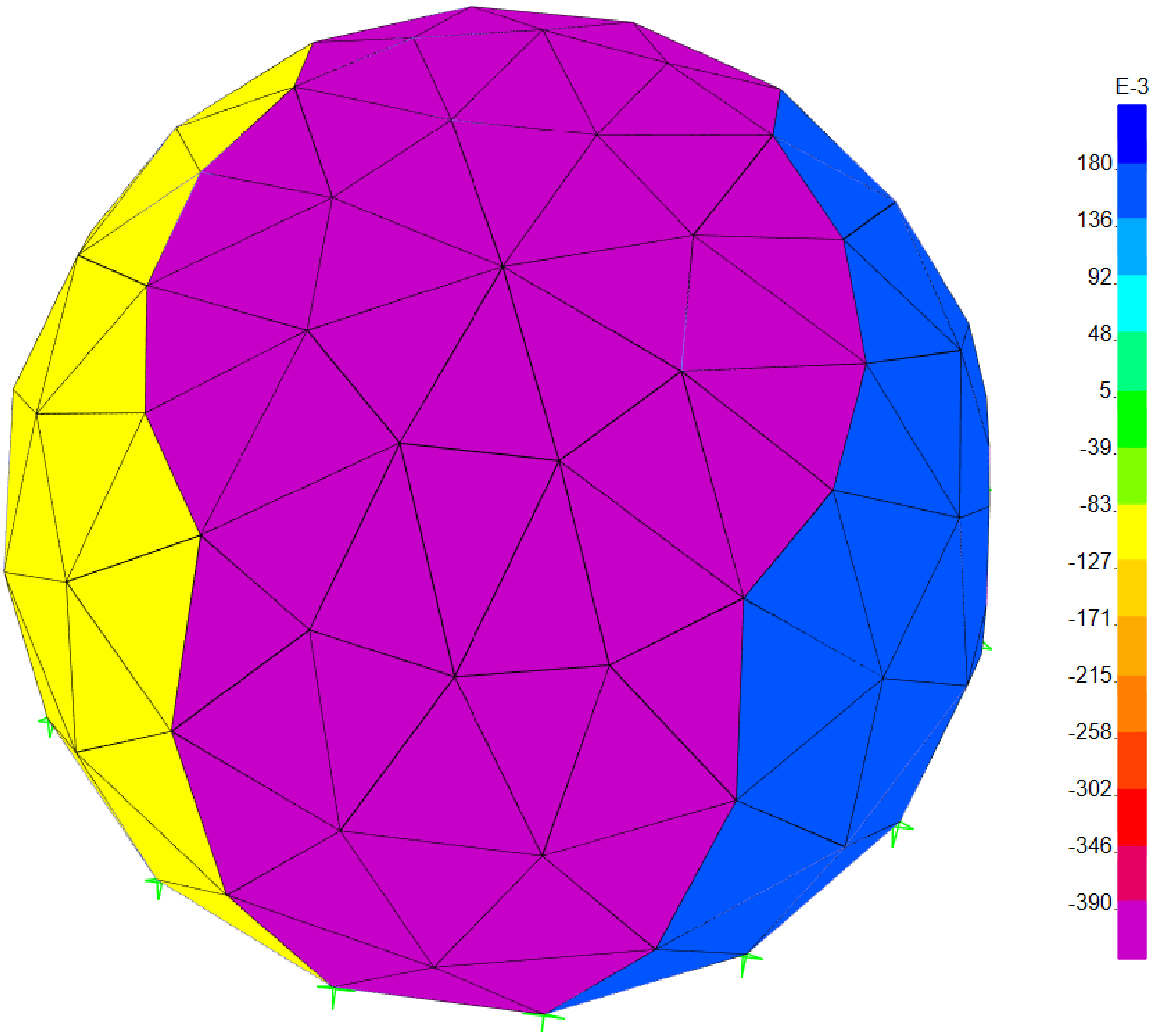
7 Load Diagrams

7.1 Wind Load

7.1.1 Wind Load Ultimate (W_U)



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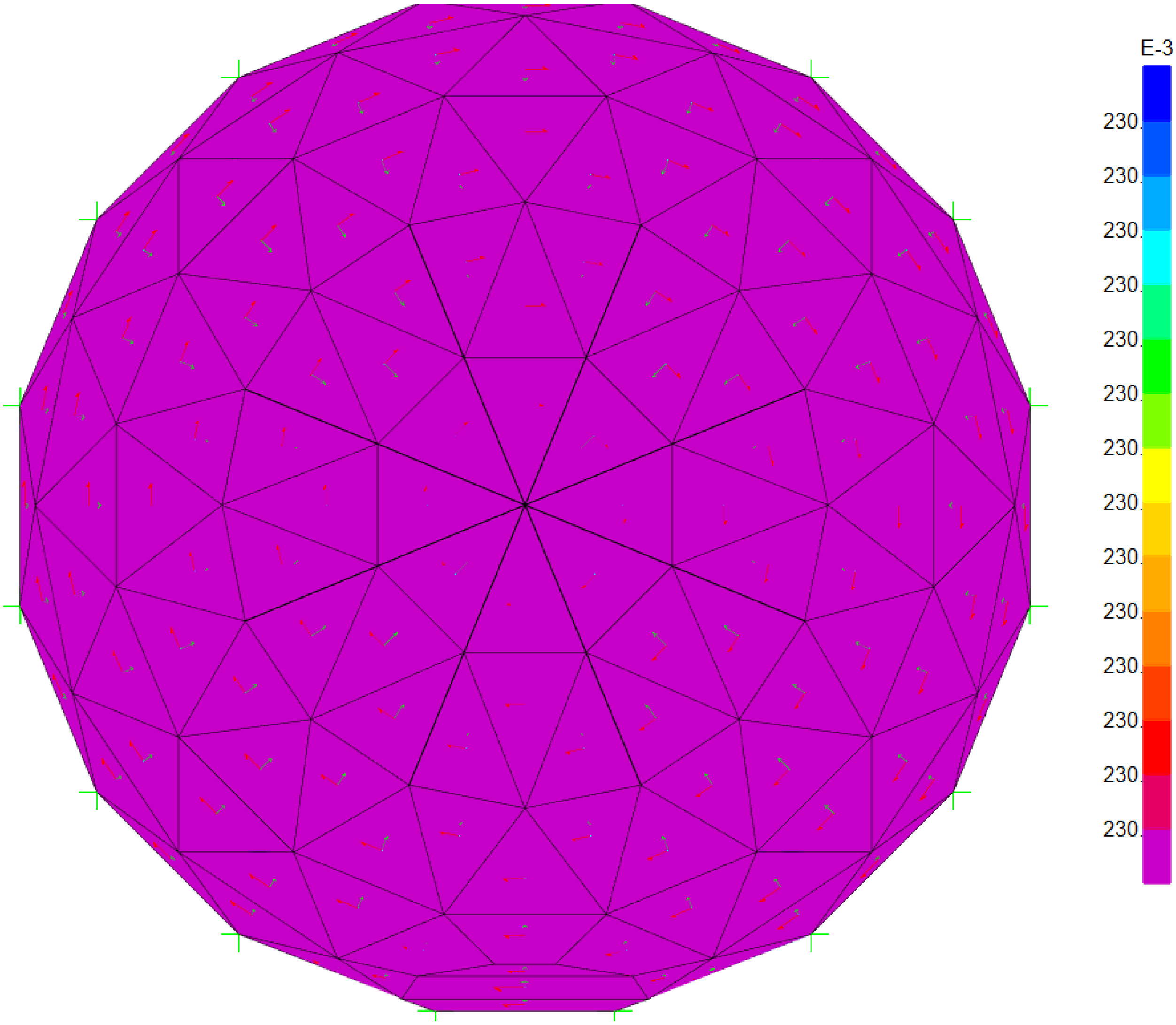
7.1.2 Wind Load Internal Pressure ($W_{I,pressure}$)



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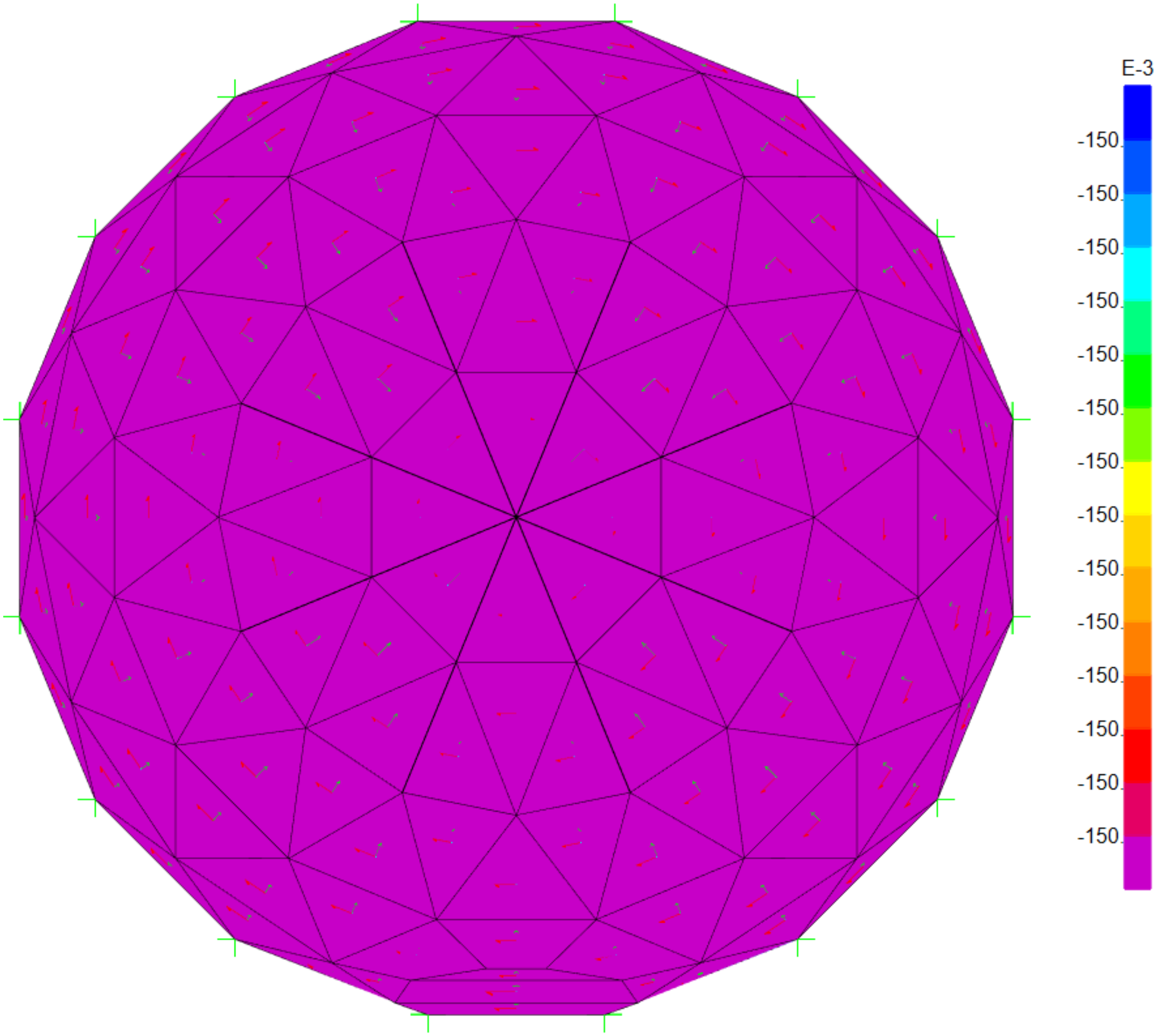
7.1.3 Wind Load Internal Suction ($W_{I,suction}$)



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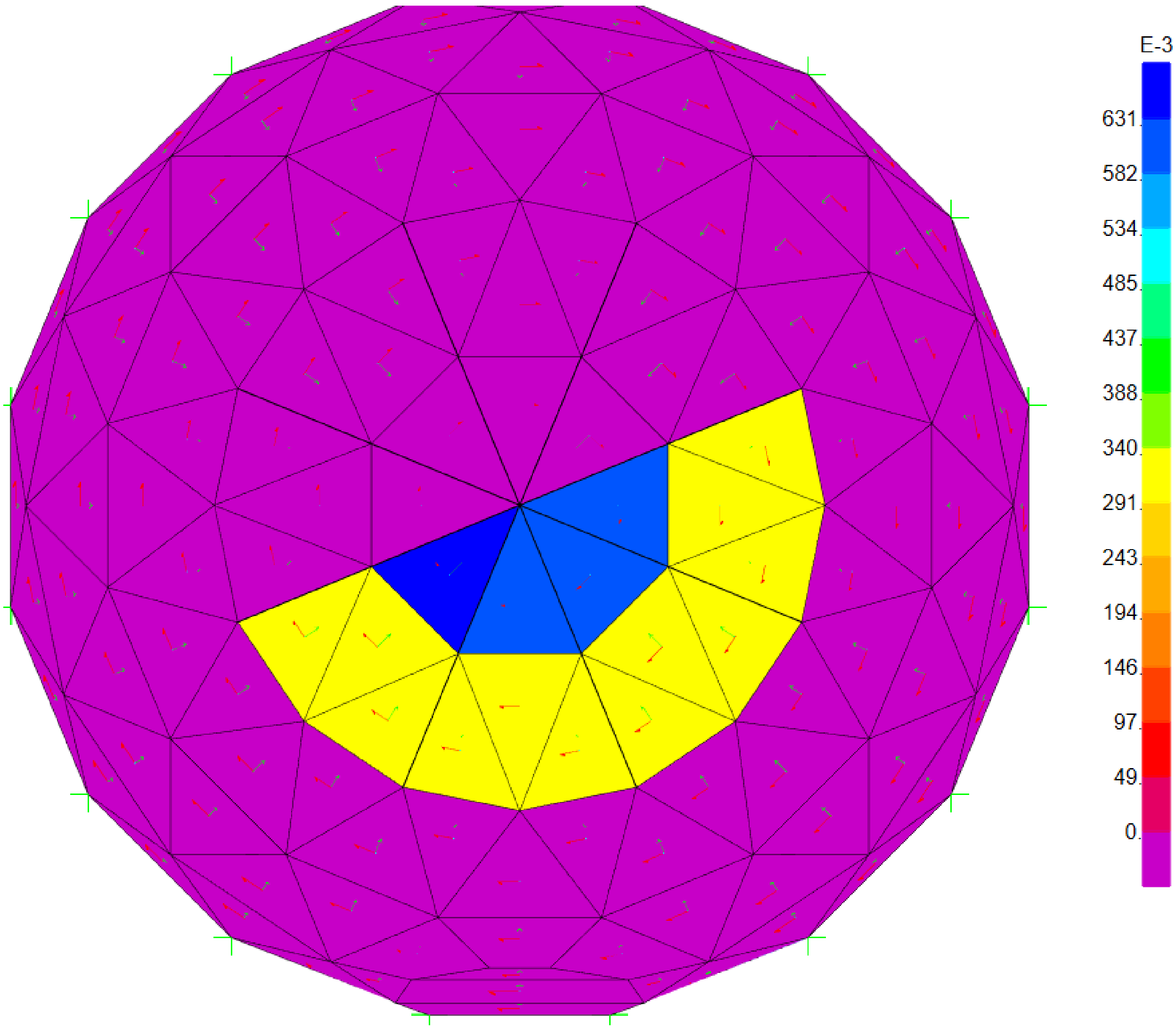
7.2 Snow Load

7.2.1 Snow Load (Case1)



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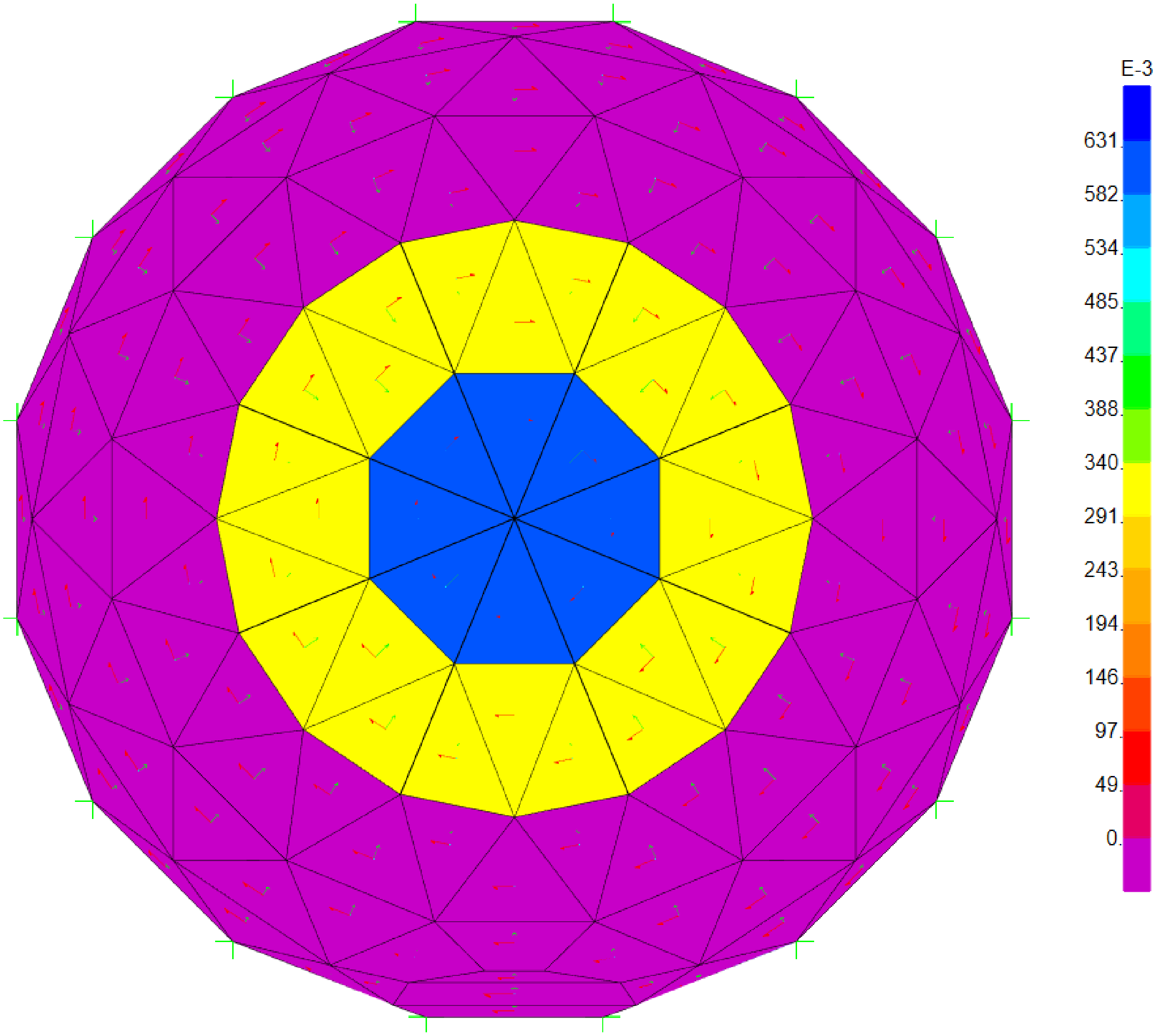
7.2.2 Snow Load (Case2)



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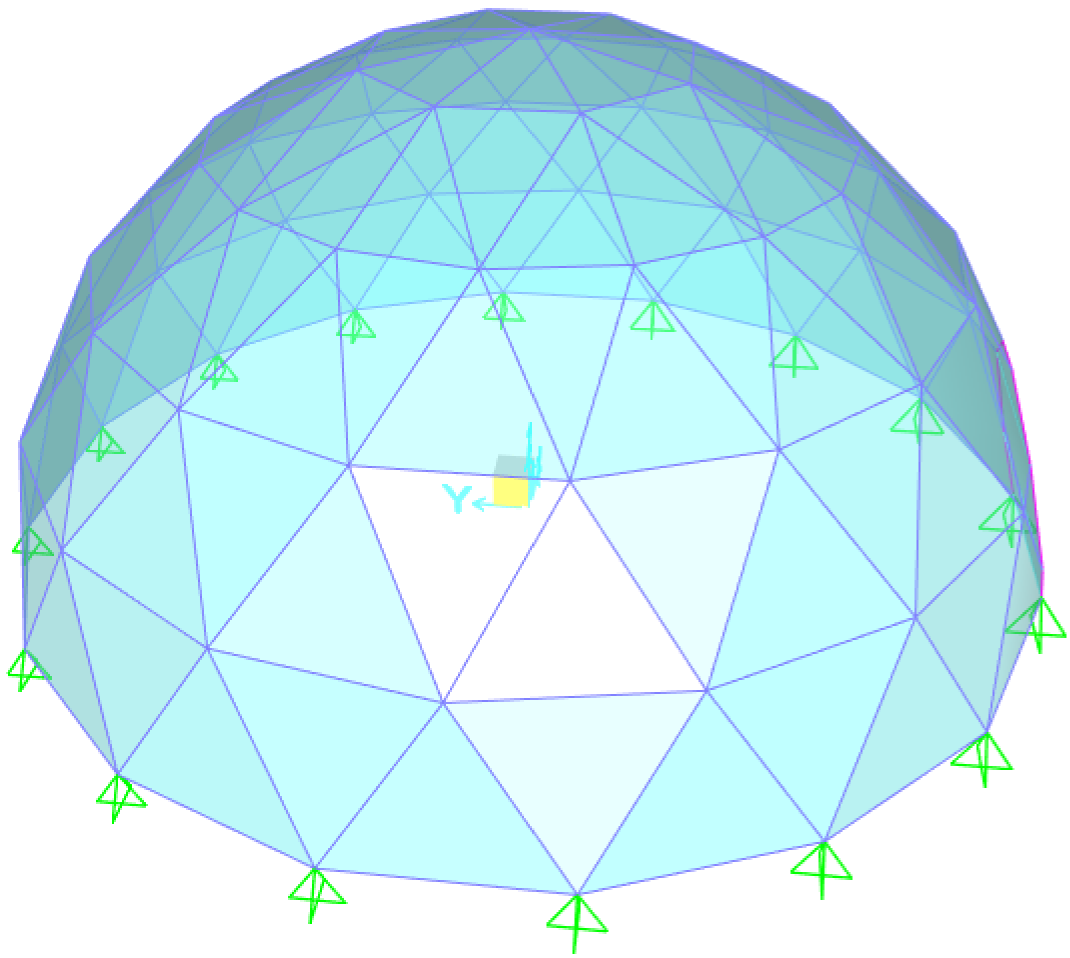
8 Analysis

8.1 3D model



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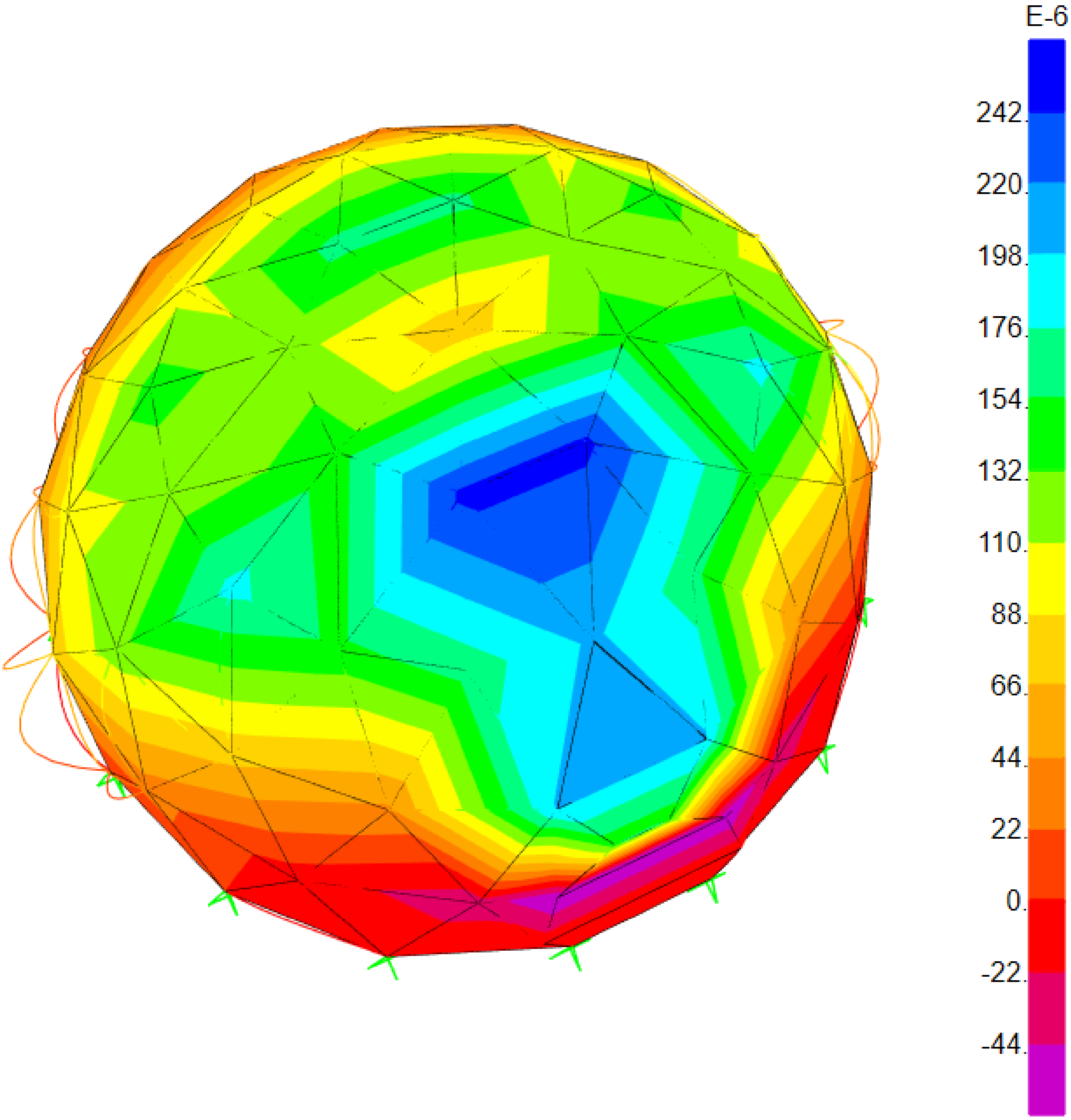
8.2 Results

8.2.1 Maximum vertical deflection (serviceability)



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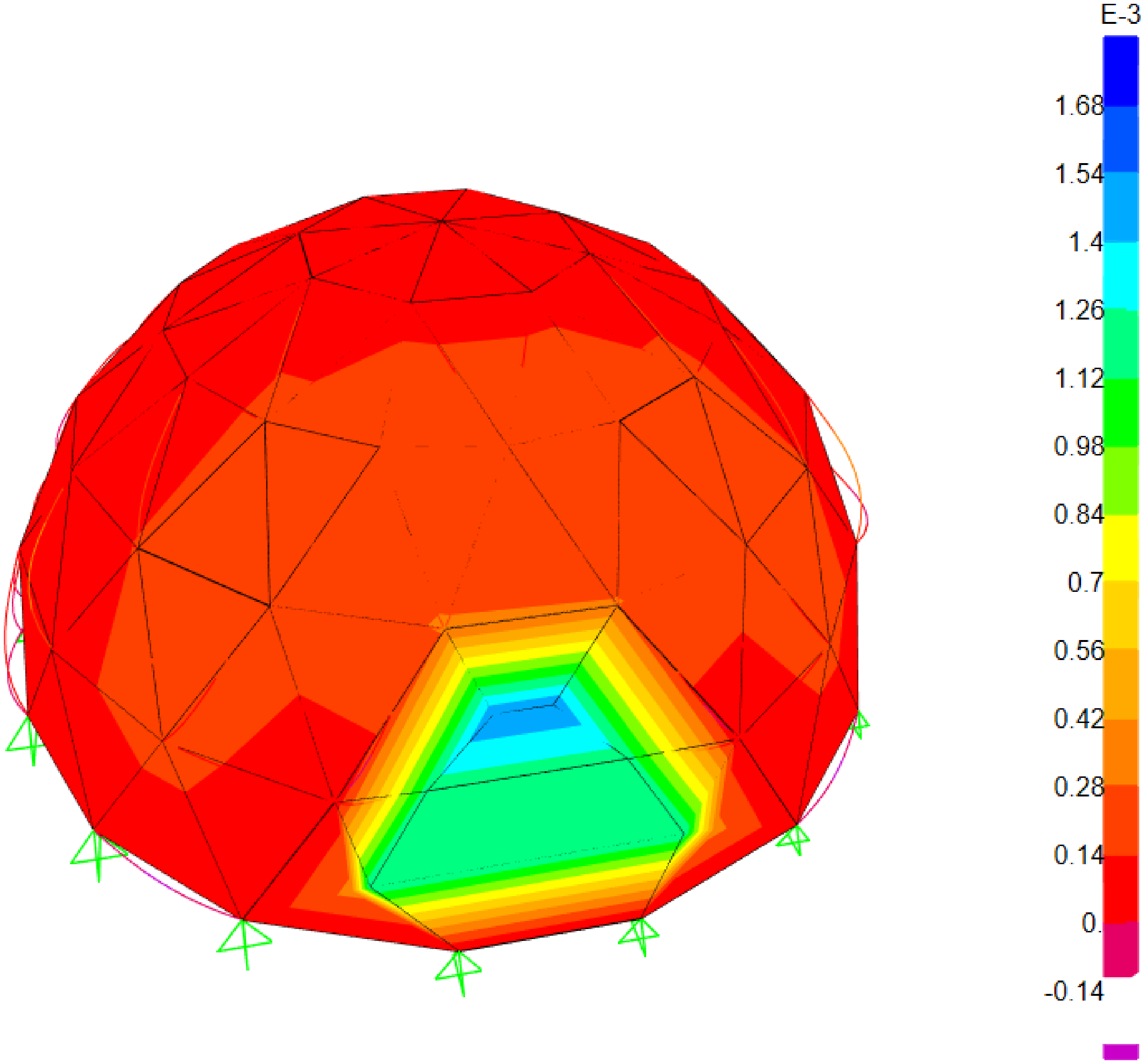
8.2.2 Maximum horizontal deflection (serviceability)



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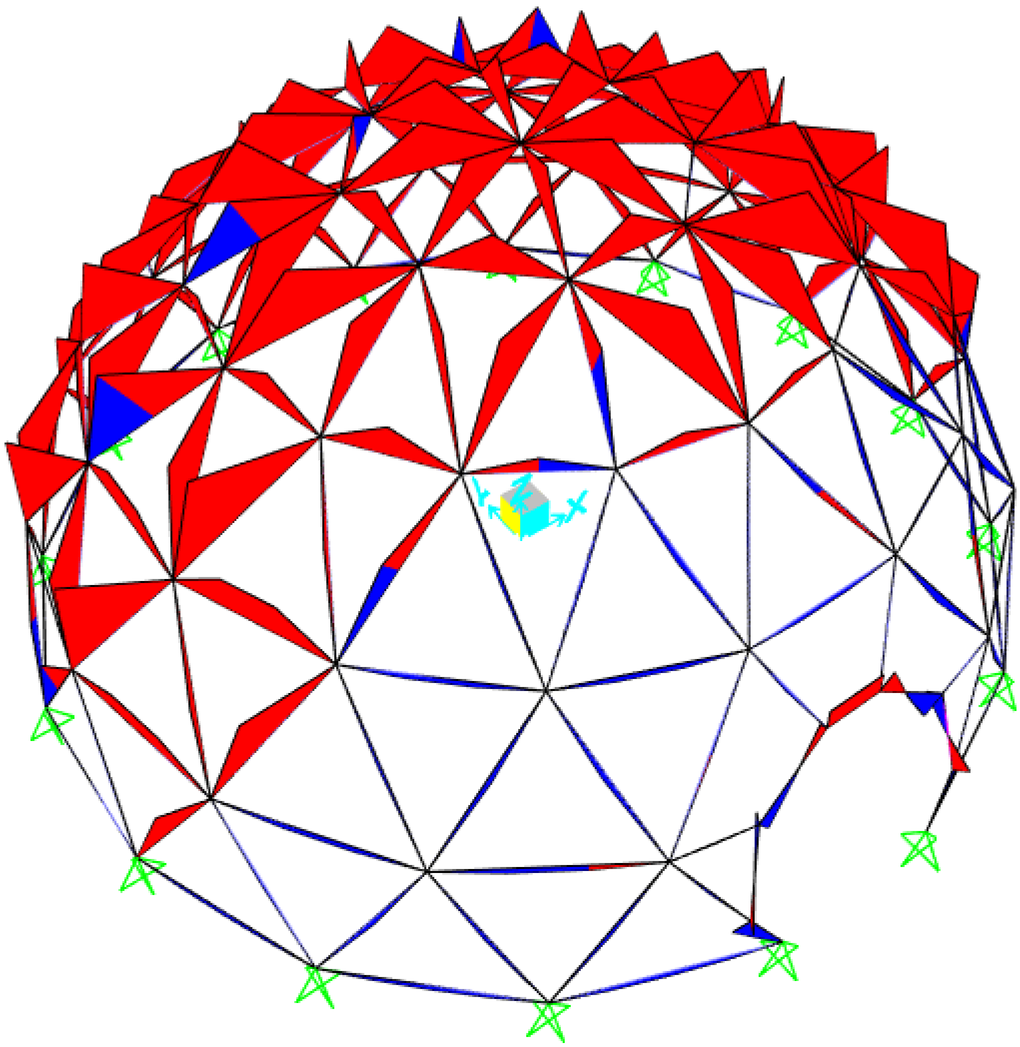
8.2.3 Maximum Bending Moment in Major Axis



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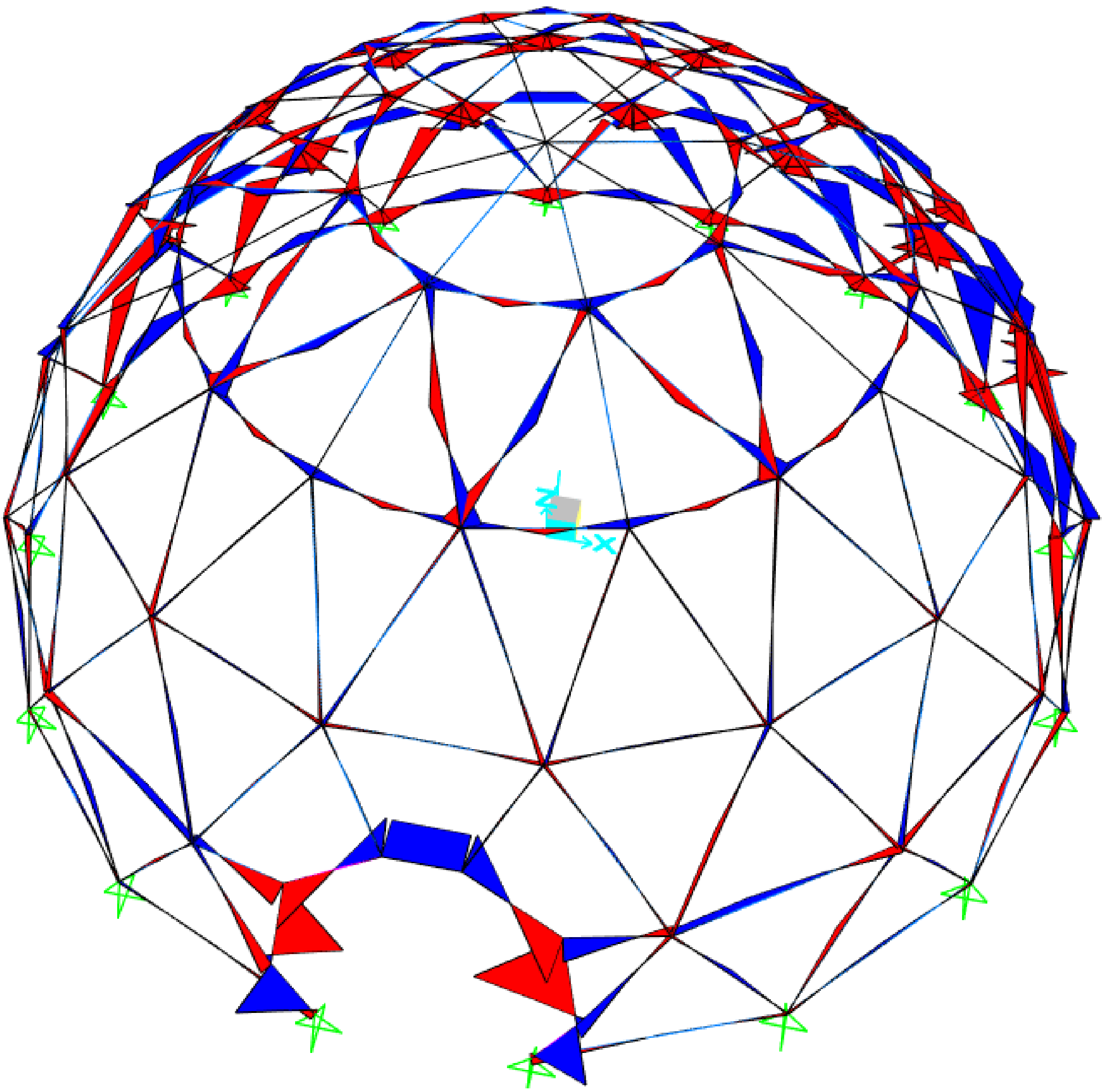
8.2.4 Maximum Bending Moment in Minor Axis



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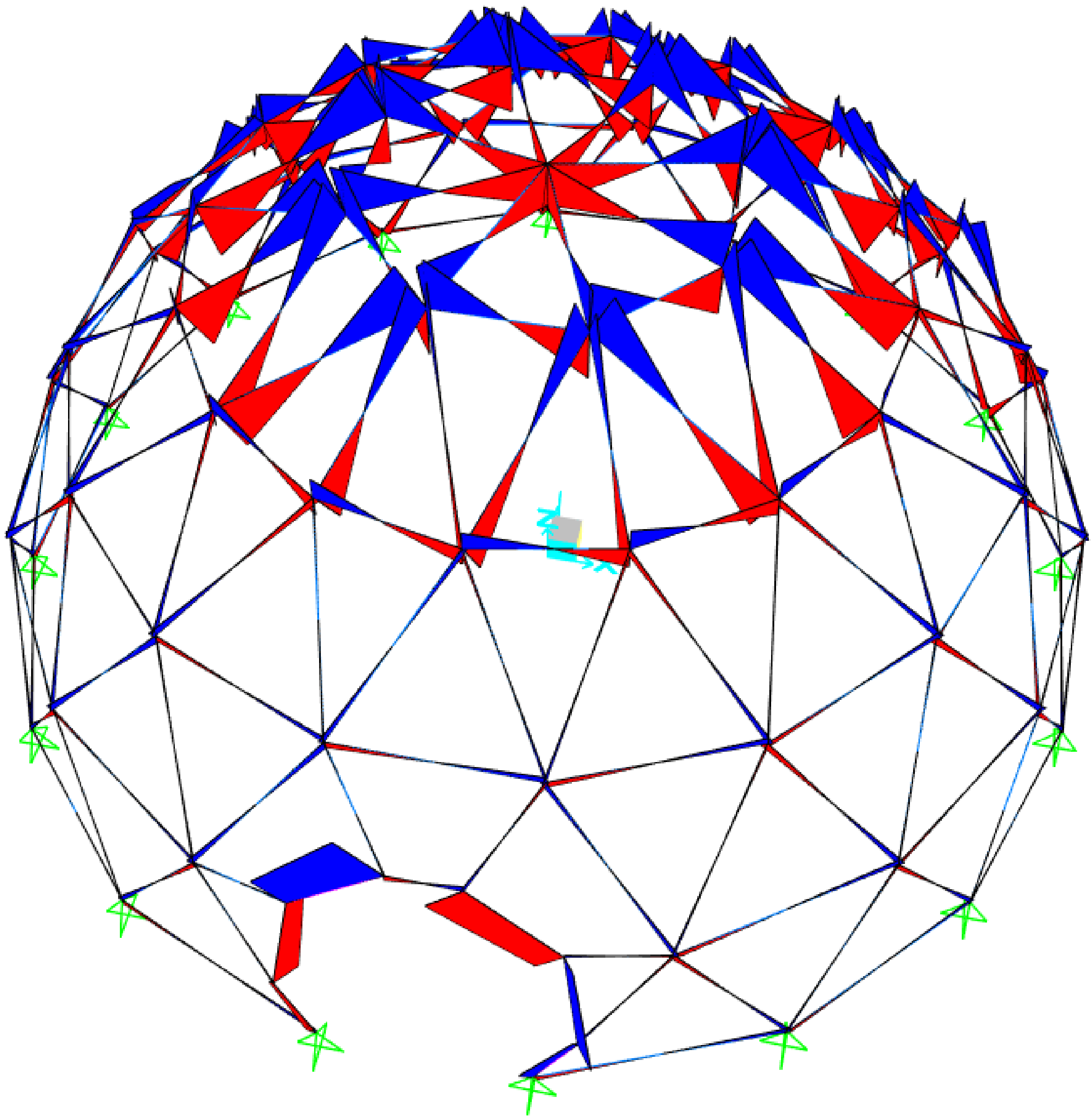
8.2.5 Maximum Shear



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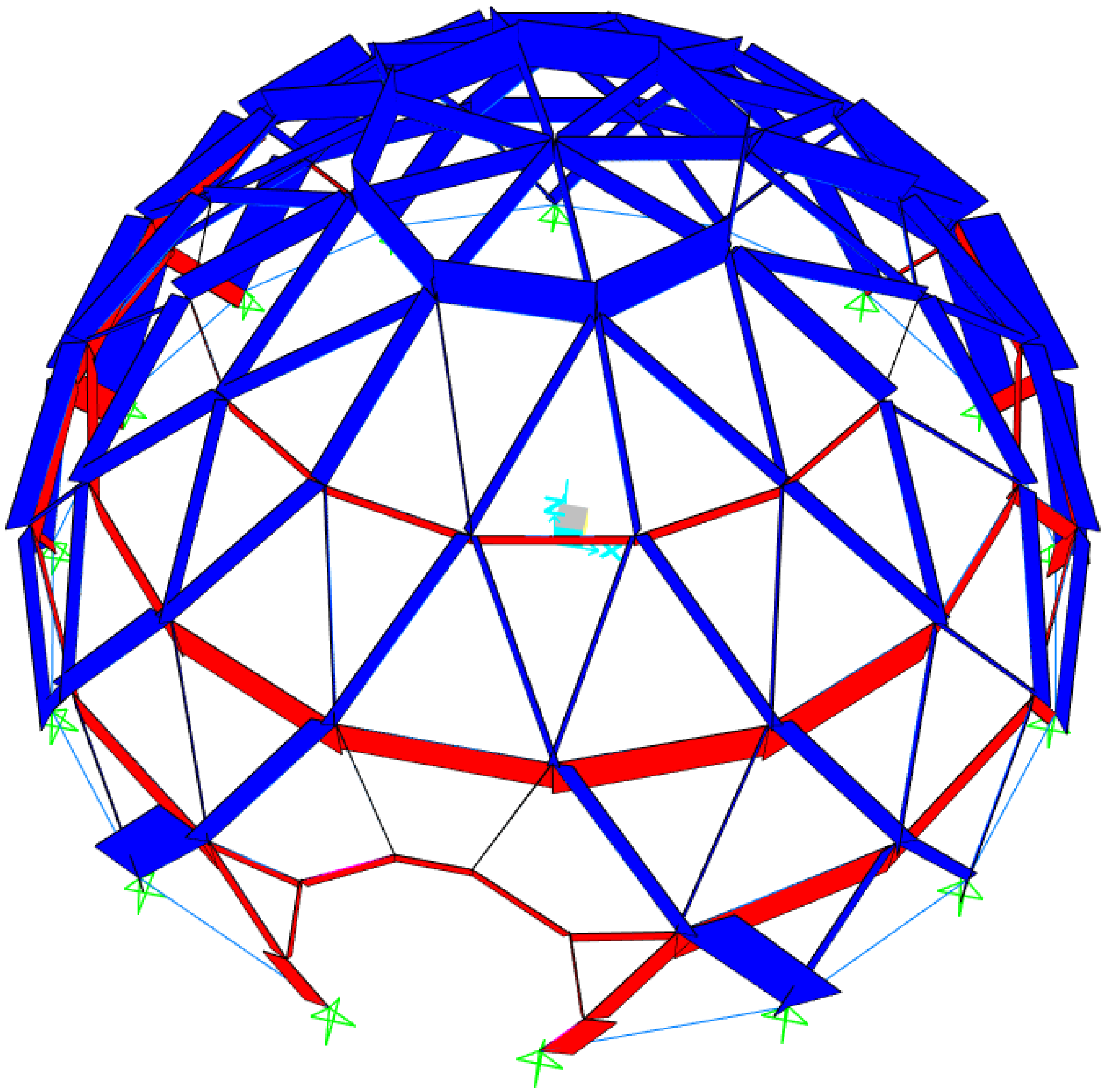
8.2.6 Maximum Axial Force



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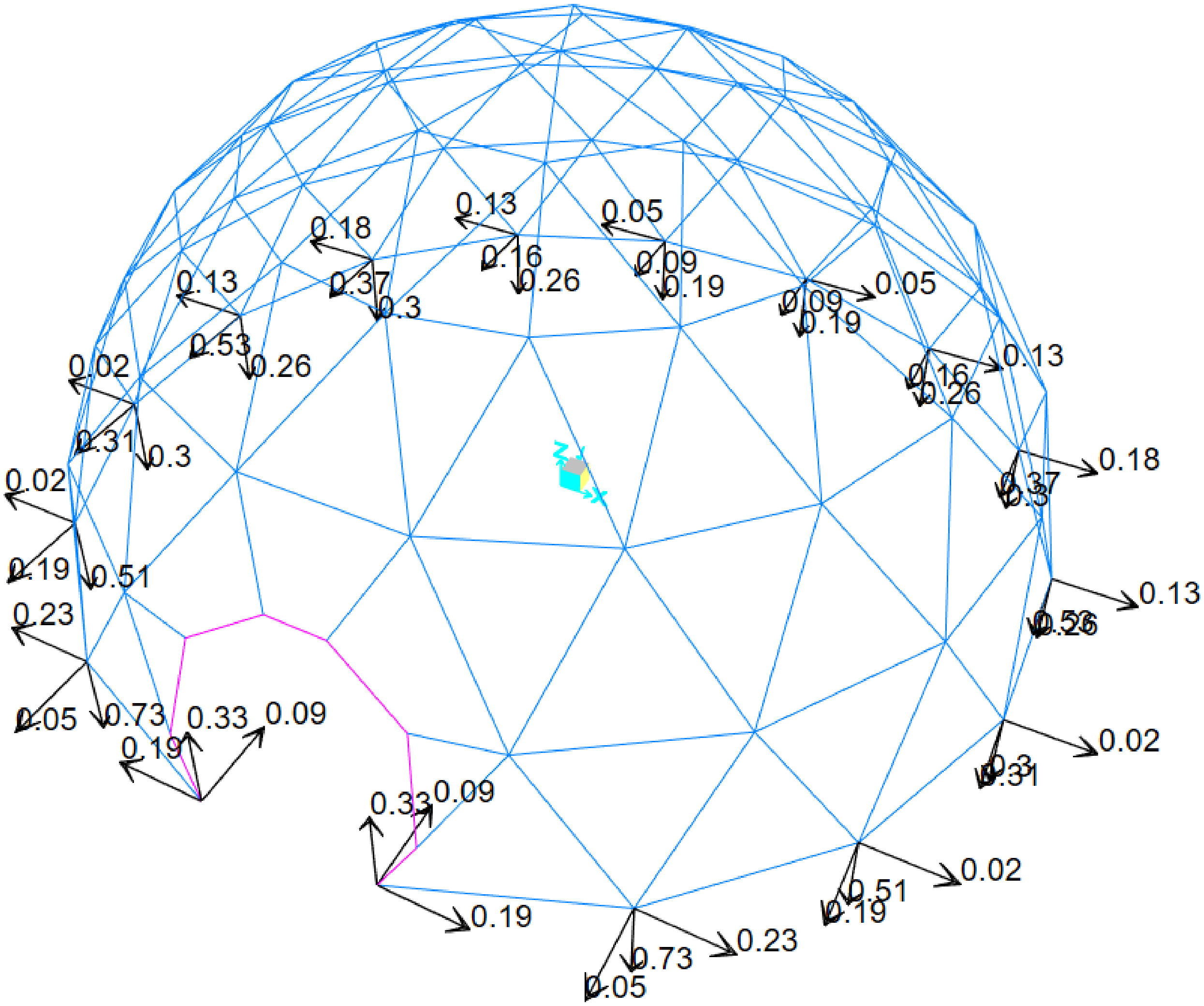
8.2.7 Maximum Reactions



Max. F_x = 0.8 kN
Max. F_y = 0.8 kN
Max. $F_{Z, Bearing}$ = 1.72 kN
Max. $F_{Z, uplift}$ = 1.58 kN

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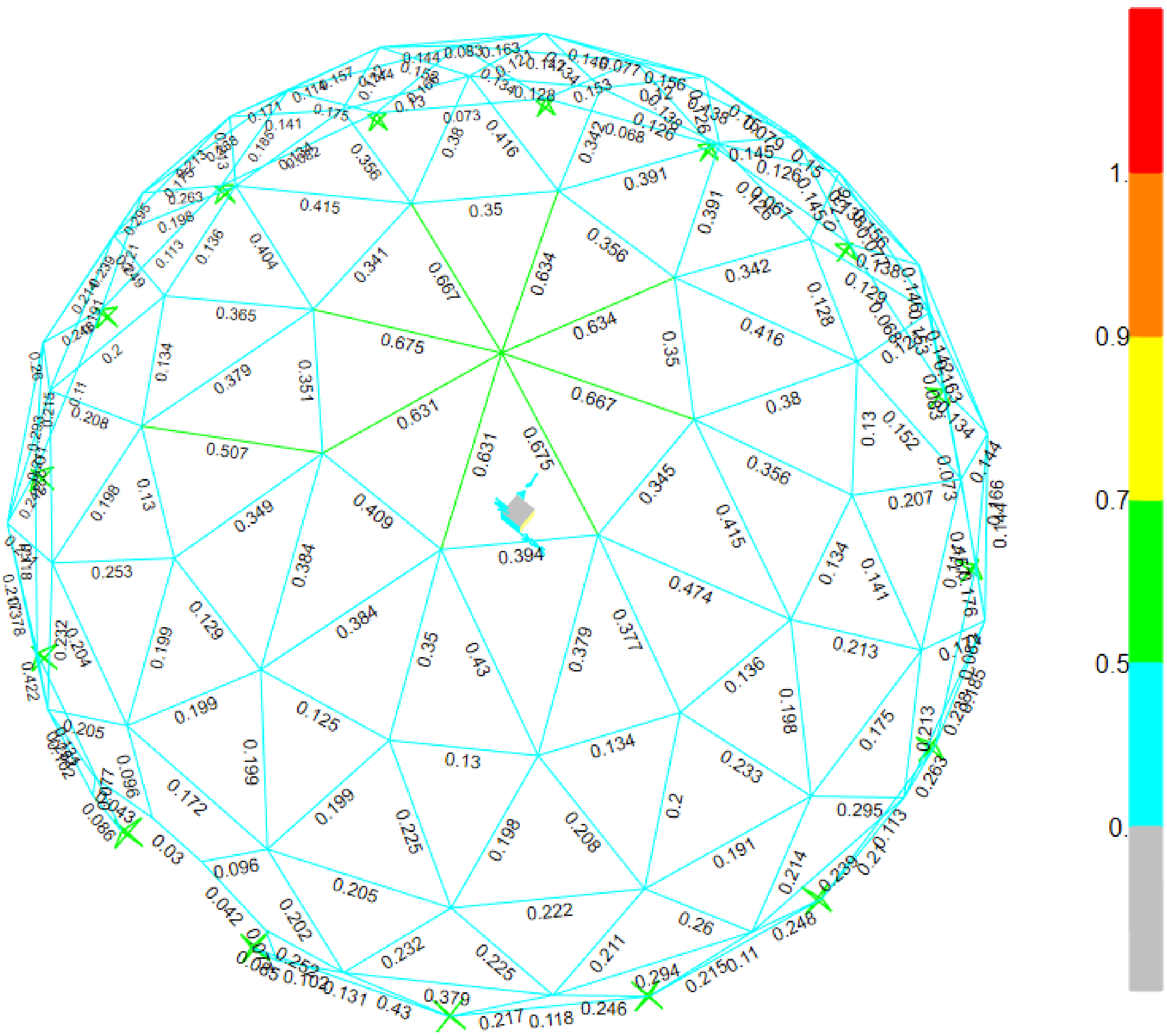
9 Steel Member Design

All members pass for the defined design wind actions. Refer to Appendix 'B' for section capacities and factor of safeties.



All members Pass

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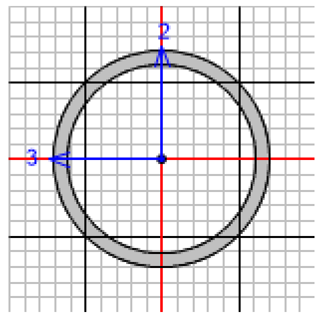
9.1 30x2 CHS

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

Frame :   209         X Mid:   0.571      Combo:   COMB5          Design Type:   Brace
Length:   1.251       Y Mid:   -0.236     Shape:   32x2 CHS       Frame Type:    Braced Frame
Loc   :   0.626       Z Mid:   3.902      Class:   Compact        Princpl Rot: 0. degrees

PhiB=0.9            PhiC=0.9            PhiTY=0.9           PhiTF=0.9           PhiS=0.9

A=1.885E-04         I33=2.130E-08       r33=0.011           Z33=1.331E-06       Av3=9.453E-05
J=4.260E-08         I22=2.130E-08       r22=0.011           Z22=1.331E-06       Av2=9.453E-05
E=206000000.        Fy=235000.          Ry=1.106            S33=1.803E-06       Iw=0.
RLLF=1.             Fu=370000.          SteelType=HR        S22=1.803E-06


STRESS CHECK FORCES & MOMENTS (Combo COMB5)
    Location              N*         M33*         M22*          V2*          V3*           T*
    0.626             -0.858        0.051    3.303E-06        0.009    5.065E-05    2.853E-06

PMM DEMAND/CAPACITY RATIO   (8.3.4a)
    D/C Ratio:     0.16 = 0.022 + 0.138 + 0.                        <   0.95           OK
                        = N*/(phi*Ns) + M33*/(phi*Ms33) + M22*/(phi*Ms22)

BASIC FACTORS
    Buckling Mode   K Factor    L Factor        KL/r
    Major Flexure         1.          1.     117.726
    Minor Flexure         1.          1.     117.726
    Major Braced          1.          1.     117.726
    Minor Braced          1.          1.     117.726
    LTB                  1.4          1.     164.816

AXIAL FORCE & BIAXIAL MOMENT DESIGN   (8.3.4a)
    Factor                    L   Braced ke      Sway ke      Delta_b      Delta_s     Cm Betam
    Major Bending            1.          1.           1.        1.032           1.     1.    -1.
    Minor Bending            1.          1.           1.           1.           1.  0.276  0.811

                           Lltb          Kt           Kl           Kr    Alpha_m      Alpha_s
    LTB Factors              1.          1.          1.4           1.      1.388        1.003

                     Steel Type          Kf           Kt      Alpha_a    Alpha_b      Alpha_c
    Axial Factors            HR          1.           1.       15.853        -1.        0.552

                        Element    Lambda_e    Lambda_ep   Lambda_ey   Lambda_ew Compactness
```


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Bending	Any	15.04	50.	120.	1.000E+14	Compact
Axial	Any	15.04		82.		Compact

	ZeMajor	ZeMinor	de	Aeff
Effective Pro	1.803E-06	1.803E-06	0.032	1.885E-04

	M*	Ms	Mr	Mi	Nc
Major Moment	0.053	0.424	0.415	0.407	24.471
Minor Moment	3.303E-06	0.424	0.415	0.407	24.471

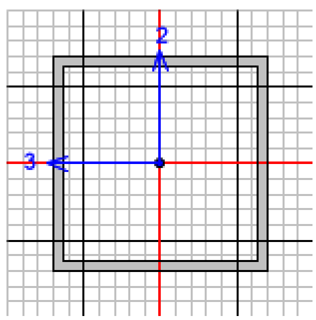
	Mo,cr	Mb	Mo	Mc	Mt
Major Moment	6.901	0.424	0.407	0.407	0.407

	N*	Ns	Nc	Nt	Noz
Axial	-0.858	44.296	24.471	44.296	14934.648

SHEAR CHECK

	V* Force	Vv Capacity	Stress Ratio	Status Check
Major Shear	0.009	14.352	0.001	OK
Minor Shear	5.065E-05	14.352	3.529E-06	OK

9.2 30x2 SHS



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

Frame : 288	X Mid: -0.829	Combo: COMB8	Design Type: Brace
Length: 0.513	Y Mid: -3.876	Shape: 40x40x2	Frame Type: Braced Frame
Loc : 0.513	Z Mid: 0.215	Class: Compact	Princpl Rot: 0. degrees

PhiB=0.9	PhiC=0.9	PhiTY=0.9	PhiTF=0.9	PhiS=0.9

A=3.040E-04	I33=7.337E-08	r33=0.016	Z33=3.668E-06	Av3=1.600E-04
J=1.097E-07	I22=7.337E-08	r22=0.016	Z22=3.668E-06	Av2=1.600E-04
E=206000000.	Fy=235000.	Ry=1.106	S33=4.336E-06	Iw=0.
RLLF=1.	Fu=370000.	SteelType=HR	S22=4.336E-06	

STRESS CHECK FORCES & MOMENTS (Combo COMB8)

Location	N*	M33*	M22*	V2*	V3*	T*
0.513	-0.973	0.078	-0.007	-0.145	-0.014	0.004

PMM DEMAND/CAPACITY RATIO (8.4.4.1)

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D/C Ratio: 0.086 = 0.086 < 0.95 OK
= M33*/(phi*Mo33)

BASIC FACTORS

Buckling Mode	K Factor	L Factor	KL/r
Major Flexure	1.	1.	33.044
Minor Flexure	1.	1.	33.044
Major Braced	1.	1.	33.044
Minor Braced	1.	1.	33.044
LTB	1.4	1.	46.261

AXIAL FORCE & BIAXIAL MOMENT DESIGN (8.4.4.1)

Factor	L	Braced ke	Sway ke	Delta_b	Delta_s	Cm	Betam
Major Bending	1.	1.	1.	1.001	1.	0.999	-0.997
Minor Bending	1.	1.	1.	1.002	1.	1.	-1.

	Lltb	Kt	Kl	Kr	Alpha_m	Alpha_s
LTB Factors	1.	1.	1.4	1.	1.796	1.027

	Steel Type	Kf	Kt	Alpha_a	Alpha_b	Alpha_c
Axial Factors	HR	1.	1.	15.052	-1.	0.988

Slenderness	Lambda_e	Lambda_ep	Lambda_ey	Lambda_ew	Lambda_e/ey	Compactness
Major/Flange	17.452	30.	45.	180.	0.388	Compact
/Web	17.452	82.	115.	180.	0.152	Compact
Minor/Flange	17.452	82.	115.	180.	0.152	Compact
/Web	17.452	30.	45.	180.	0.388	Compact
Axial/Flange	17.452		45.		0.388	Compact
/Web	17.452		45.		0.388	Compact

	ZeMajor	ZeMinor	b-be	d-de	Aeff
Effective Pro	4.336E-06	4.336E-06	0.	0.	3.040E-04

	M*	Ms	Mr	Mi	Nc
Major Moment	0.078	1.019	1.019	1.003	70.609
Minor Moment	-0.007	1.019	1.019	1.003	70.609

	Mo,cr	Mb	Mo	Mc	Mt
Major Moment	50.112	1.019	1.003	1.003	1.003

	N*	Ns	Nc	Nt	Noz
Axial	-0.973	71.44	70.609	71.44	18014.713

SHEAR CHECK

	V* Force	Vv Capacity	Stress Ratio	Status Check
Major Shear	0.145	20.304	0.007	OK
Minor Shear	0.014	20.304	0.001	OK

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10 Pegging Design

PCE PRIME CONSULTING ENGINEERS PTY. LTD

Project:	**8m Dome**
Jon no.	**22-211-2**
Date:	**4/05/2022**

Name	Value	Unit	Notes
minimum embedment depth for lateral bearing:			
Max. Horizontal Force	0.8	*kN*	
Max. Vertical Force	1.58	*kN*	
Number of Pegs	2		
Horizontal Load per peg	0.4	*kN*	
Vertical Load per peg	0.8	*kN*	
Sticking out of Ground	0	*m*	
S (bearing capacity)	150	*kPa*	To be confirmed by the Geotechnical engineer
φ	0.02	*m*	
H	133	*mm*	
M	**0.00**	*kNm*	
γ	19	*kN/m³*	To be confirmed by the Geotechnical engineer
min required Embedment:	**133**	*mm*	
F.S	**9.00**		
	OK		
Bending:			
Profile	φ20mm Peg		
Fy	350	*mPa*	
Ze	785.4	*mm3*	
phi	0.9		
phi Ms	**0.25**	*kNm*	
	OK		
Pull out Checking:			
Clay:			
Cu	25	*kPa*	To be confirmed by the Geotechnical engineer

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α (reduction factor)	1	
Provided Embedment	1200	*mm*
L/d	60	
Rs	0.96	
Perimeter	63	*mm*
Total Surface Area	0.075	*m^2*
min required Embedment:	0.53	*m*
F.S	2.28	
	OK	
Coefficient of Friction	0.6	
Equivalent Ballast	**0.16**	*tonne*

Reference: Foundations of Structures - Dunham, Mc Graw-Hill

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11 Summary and Recommendations

- The 8m Dome Structure as specified is capable of withstanding 3s gust wind speed up to **140km/hr** in region A, TC2.
- The dome structure is required to be dismantled for forecast winds in excess of **140km/hr**.
- The dome structure is designed to withstand snow loads of sub-alpine region (Orange, NSW) with maximum ground snow (Sg) 0.9kPa.
- For uplift due to 140km/hr, 1.8 kN (180kg) holding down weight/per support is required. (16 anchor points/support in total). Alternatively, pegging system described in Cl. 10 can be used.
- Design of fabric is by others.

Yours faithfully,

Prime Consulting Engineers Pty. Ltd.

Kevin Zia, BEng, Meng, MIEAust, CPENG NER

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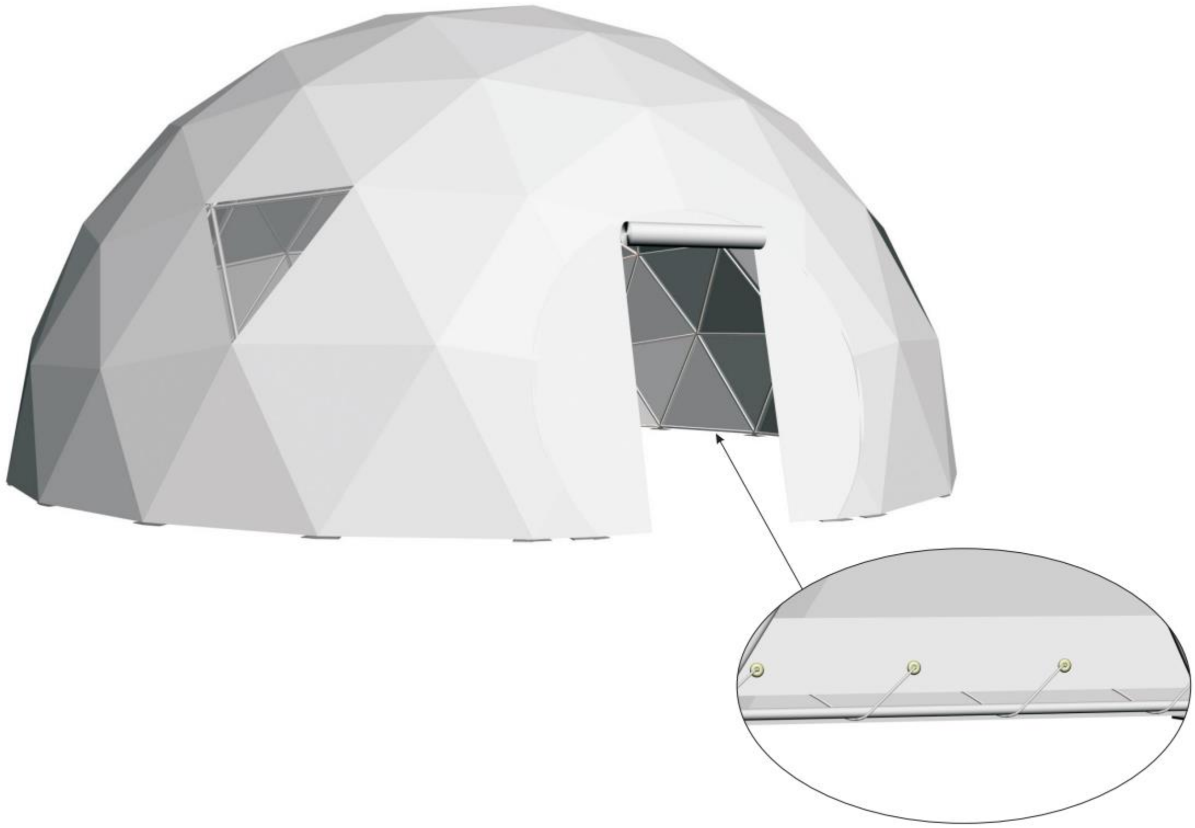
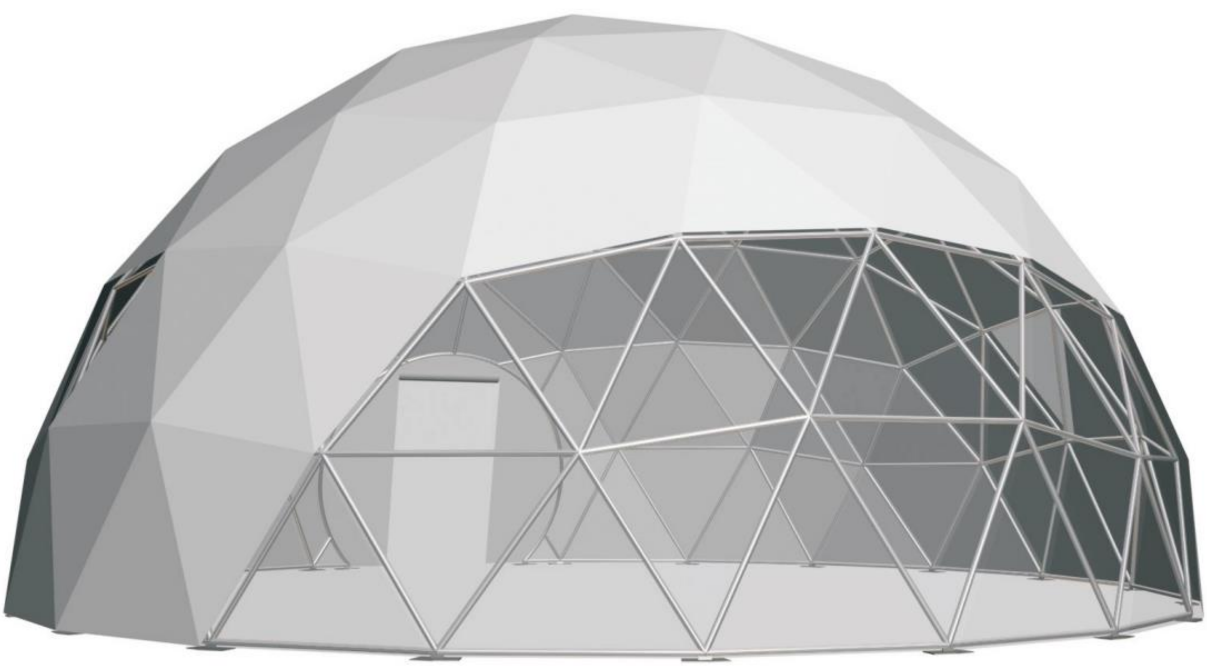
12 Appendix A – Detail Drawings





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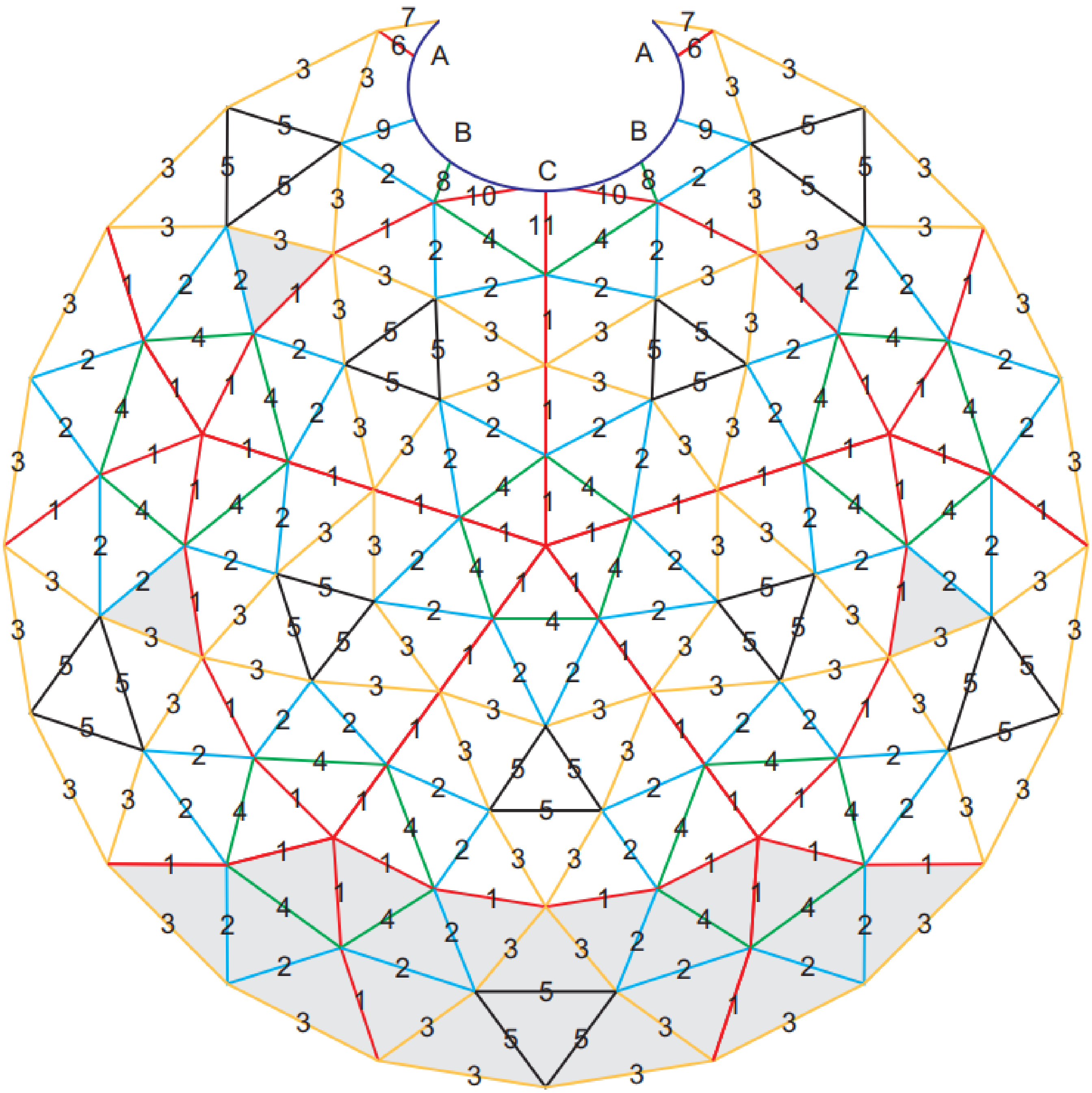

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