Tensile Structure for Playground
Astigarraga (San Sebastián), Guipuzcoa, Spain

Master-Thesis

A thesis submitted in partial fulfillment
of the requirements for the degree of

Master Membrane Structures

submitted to

Anhalt University of Applied Sciences
Faculty of Architecture,
Facility Management and Geo Information

by

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24th November 1988, Bangkok, Thailand

Matrikel Number: 4059492

Submission date: 01.08.2017

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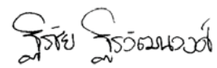
Second Tutor: M. Eng. Gustavo Ramirez Lares

Statement

I hereby declare that the work presented in this Master thesis, entitled "Tensile Structure for Playground, Astigarraga (San Sebastián), Guipuzcoa, Spain" is entirely my own and that I did not use any sources or auxiliary means other than those referenced.

Frankfurt am Main, 10.08.2017



Thirachai Dheravatnvong

Contents

Project Introduction

Project Introduction - Urumeâ Berri

This project is a part of the new residential area development next to the Banks of Urumea river in Astigarraga, Guipuzcoa, Spain. Urumeâ Berri is the developer who build this area for people to enjoy nature and quality of life that near to San Sebastián, the main city of Guipuzcoa province in Basque, like them slogan "Un hogar cerca de ti" or "A home near you." in English.

An area very well connected with new accesses such as the Urumea Autovía, the 2nd Belt of San Sebastián and a Station of Cercanías.

• Urumea motorway: Direct access with the center of San Sebastián through the tunnel of Zorroaga in 5 minutes. This road connects the N-1 in Andoain with San Sebastián passing through Urnieta and Hernani in record time.

• New Vial Martutene-Hospitals: Newly opened road that connects with the hospital city in just 3 minutes, and connects Urumea Berri with the neighborhoods of Antiguo and Ondarreta in 7 minutes.

• 2nd Belt of San Sebastián: Alternative to the variant that punctures in the roundabout that is in the Autobahn of the Urumea at the height of Urumea Berri. The departures to France or towards Bilbao through the A-8 are very fast.

• Neighborhood Station: A nerve center of communication that will generate people, wealth and revaluation of the environment. You will have a stop in front of Urumea Berri. Frequently by metro will connect with the North Station of the center of San Sebastian.

About the Project

Briefs

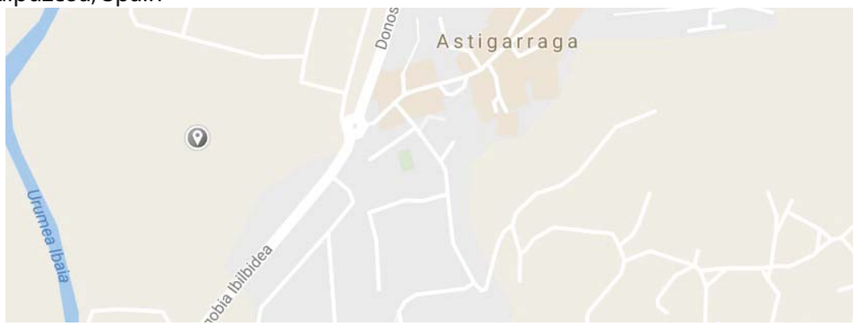
- Membrane Cover for Children Playground
- Maximun height of the membrane not blocking neigbourhood building window view.
- Low point of the membrane is higher than 2,00 meter to prevent damage from children.
- No structure in playground area.
- No cable use for prevent to harm children.
- Cover the playground area to protect from sun and rain.
- All water drain to the lawn beside the playground.

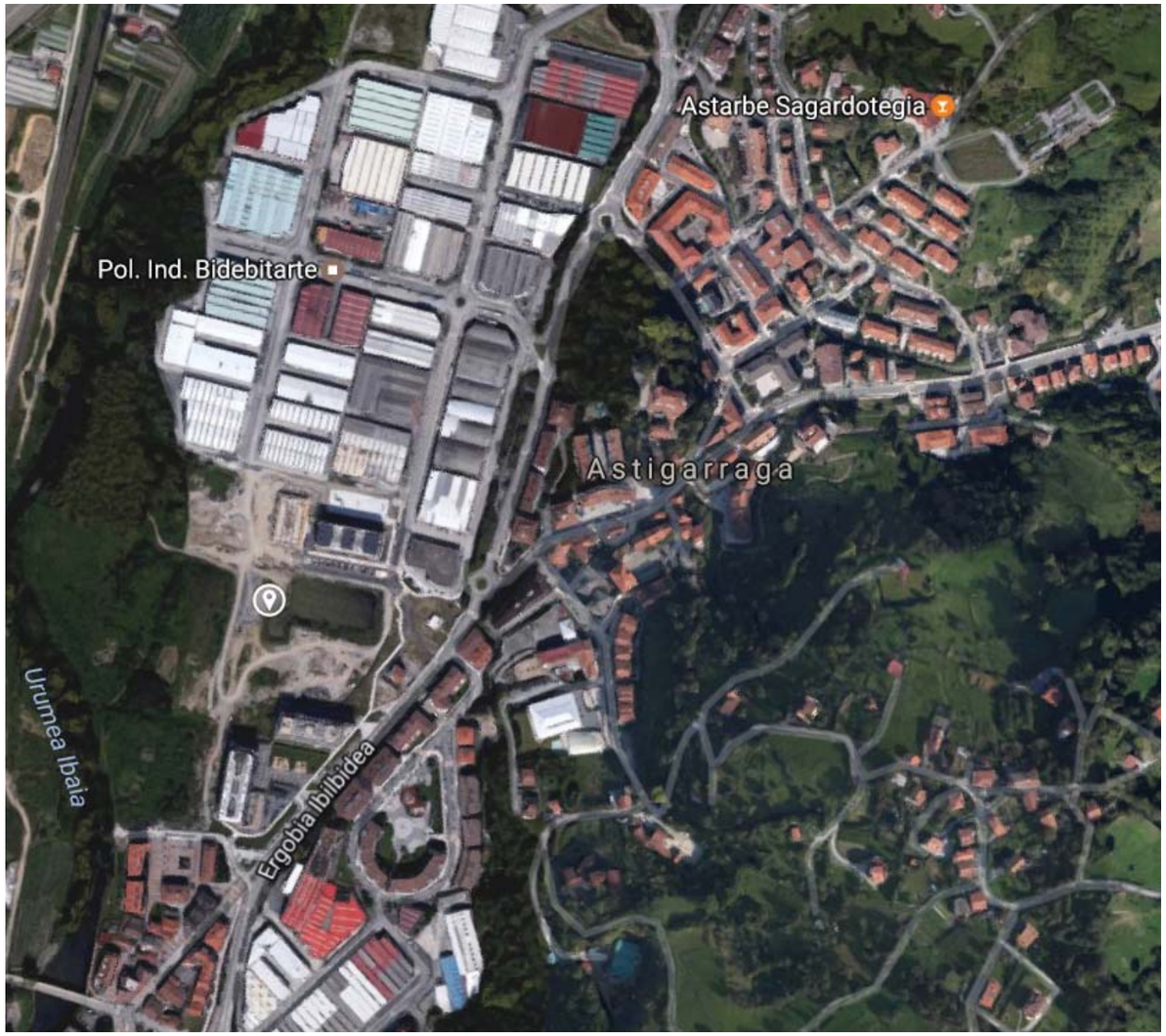
Project Management:	Carpatec, Madrid, Spain
Client:	Urumeâ Berri, Astigarraga, Spain
Site Area:	500 sq.m.
Surface Area:	380 sq.m.
Membrane:	Mehler VALMEX FR 1000 MEHATOP F, Type III (PVC) - PVDF Coated
Location:	Astigarraga (San Sebastián), Guipuzcoa, Spain
Year:	2017

Project images

Geological Location

Astigarraga (San Sebastián), Guipuzcoa, Spain

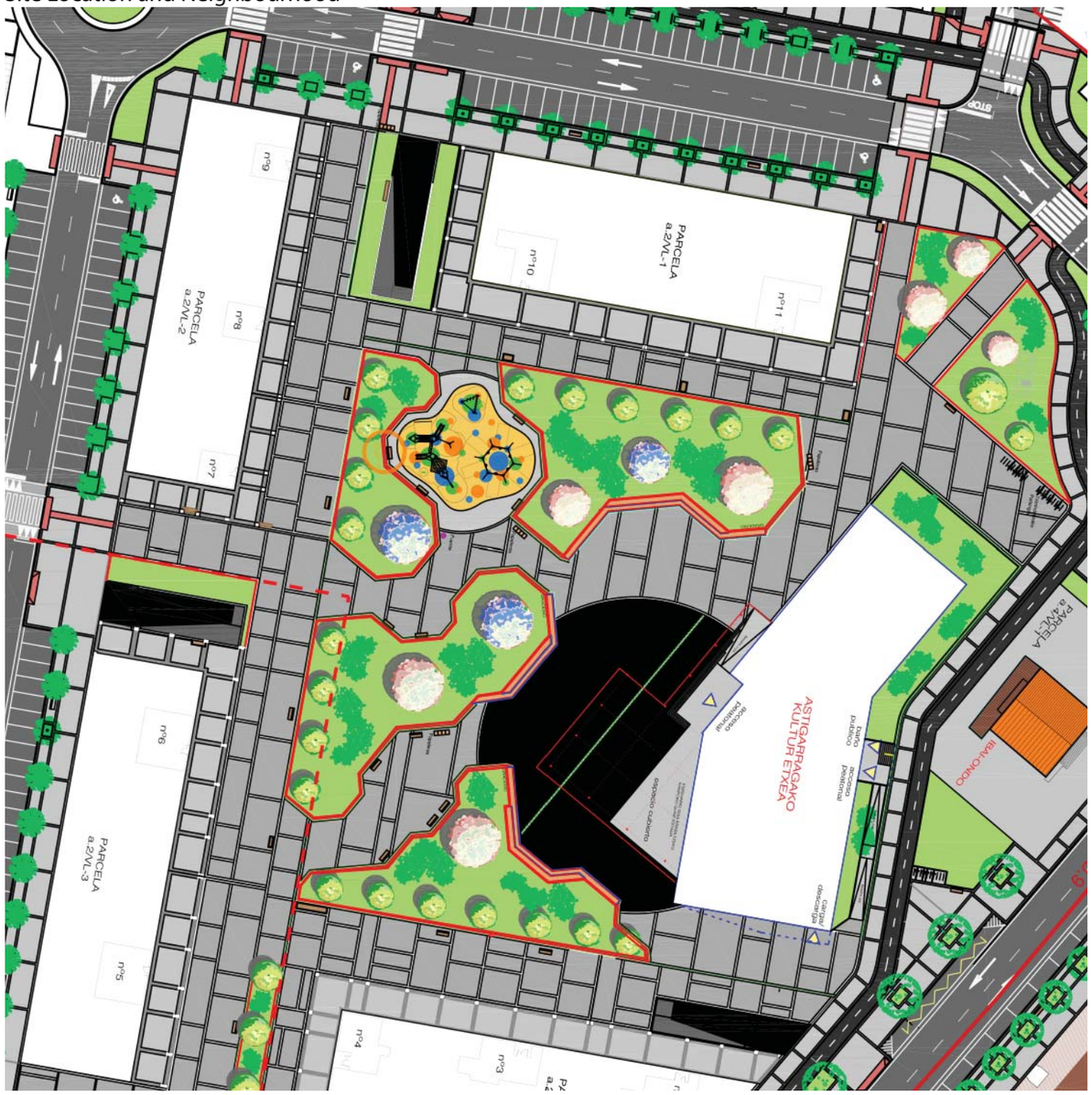




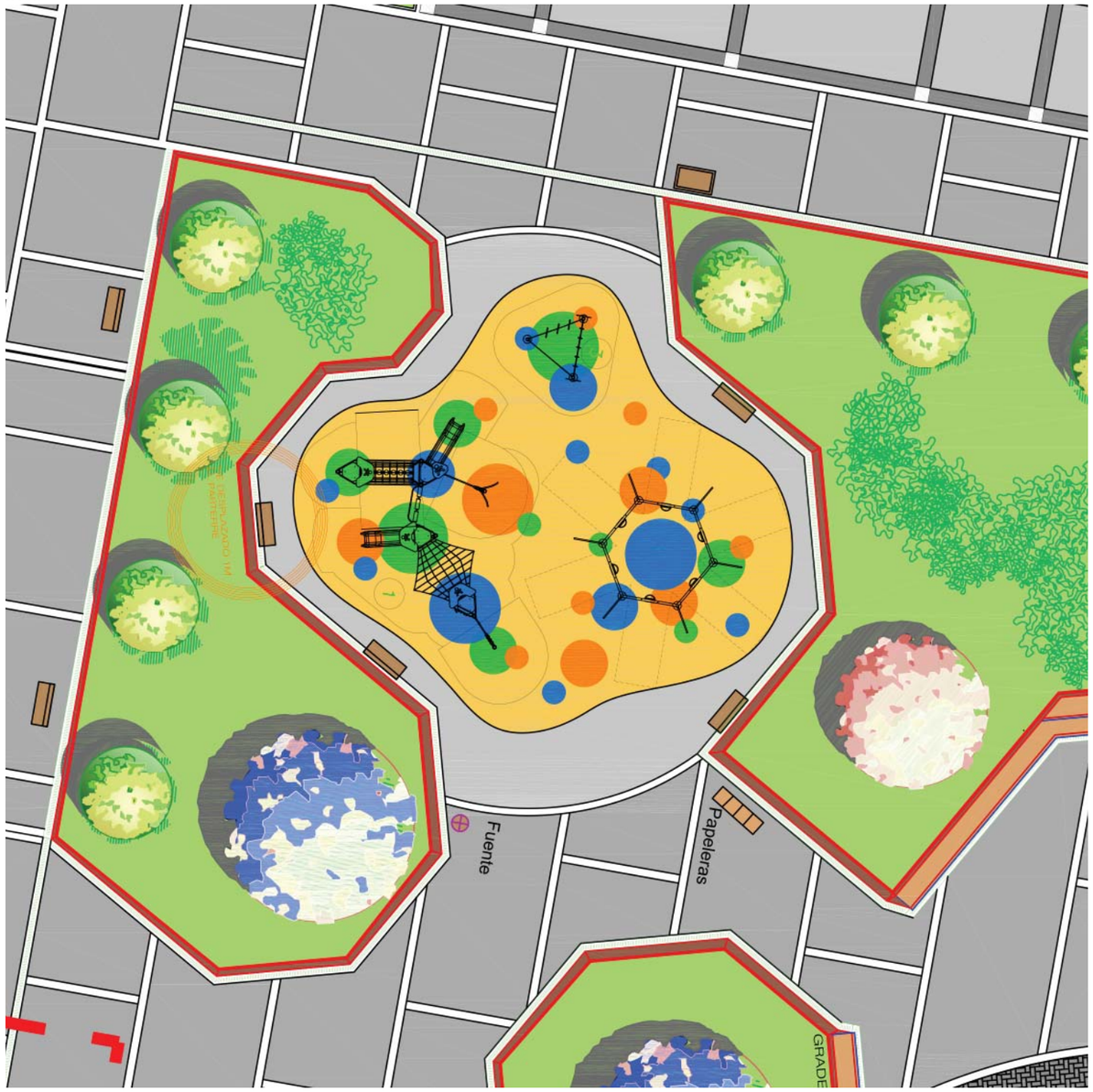
Project Area

Geological Location

Site Location and Neighbourhood



Site



Geological Location

Climate Conditions

Site perspective

Geological Location

Climate Conditions

Wind Zone	:	C
Wind Velocity	:	29 m/s

Snow Zone	:	1 (Height = 25 m)
Snow Load (0 m)	:	0.3 kN/m^2
Snow Load (200 m)	:	0.5 kN/m^2
Snow Load (400 m)	:	0.6 kN/m^2
Snow Load (500 m)	:	0.7 kN/m^2
Snow Load (600 m)	:	0.9 kN/m^2
Snow Load (700 m)	:	1.0 kN/m^2
Snow Load (800 m)	:	1.2 kN/m^2
Snow Load (900 m)	:	1.4 kN/m^2
Snow Load (1000 m)	:	1.7 kN/m^2
Snow Load (1200 m)	:	2.3 kN/m^2
Snow Load (1400 m)	:	3.2 kN/m^2
Snow Load (1600 m)	:	4.3 kN/m^2

Wind map

Snow map

Design Development

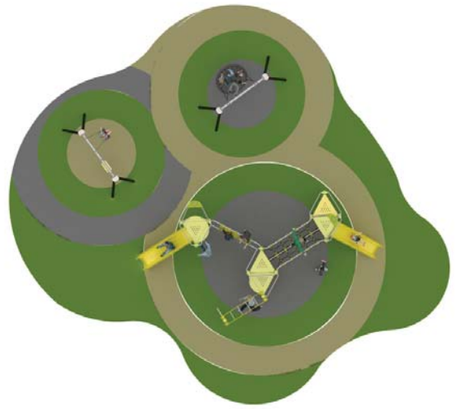
Design Development

Research and Design

From the first brief, membrane need to cover all of playground area and drain rain water to beside yards and no structure obstruct in the area.

Beside yards are higher than playground 70 cm. From this reason, low point of membrane should not lower than 2.00 m from the ground to prevent from kid's hand that could make damage to surface.

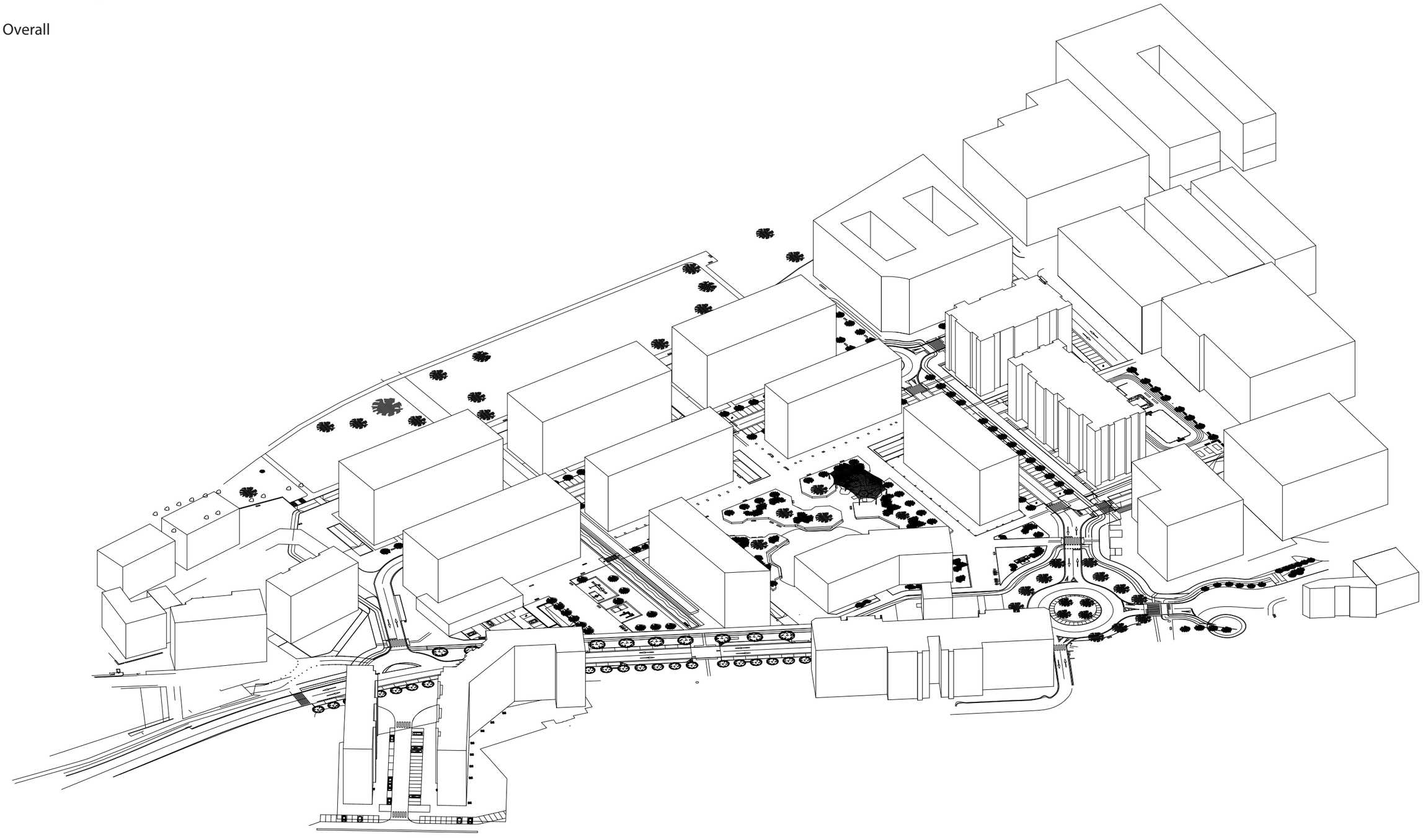
Playground Equipments



Design Development

Research and Design

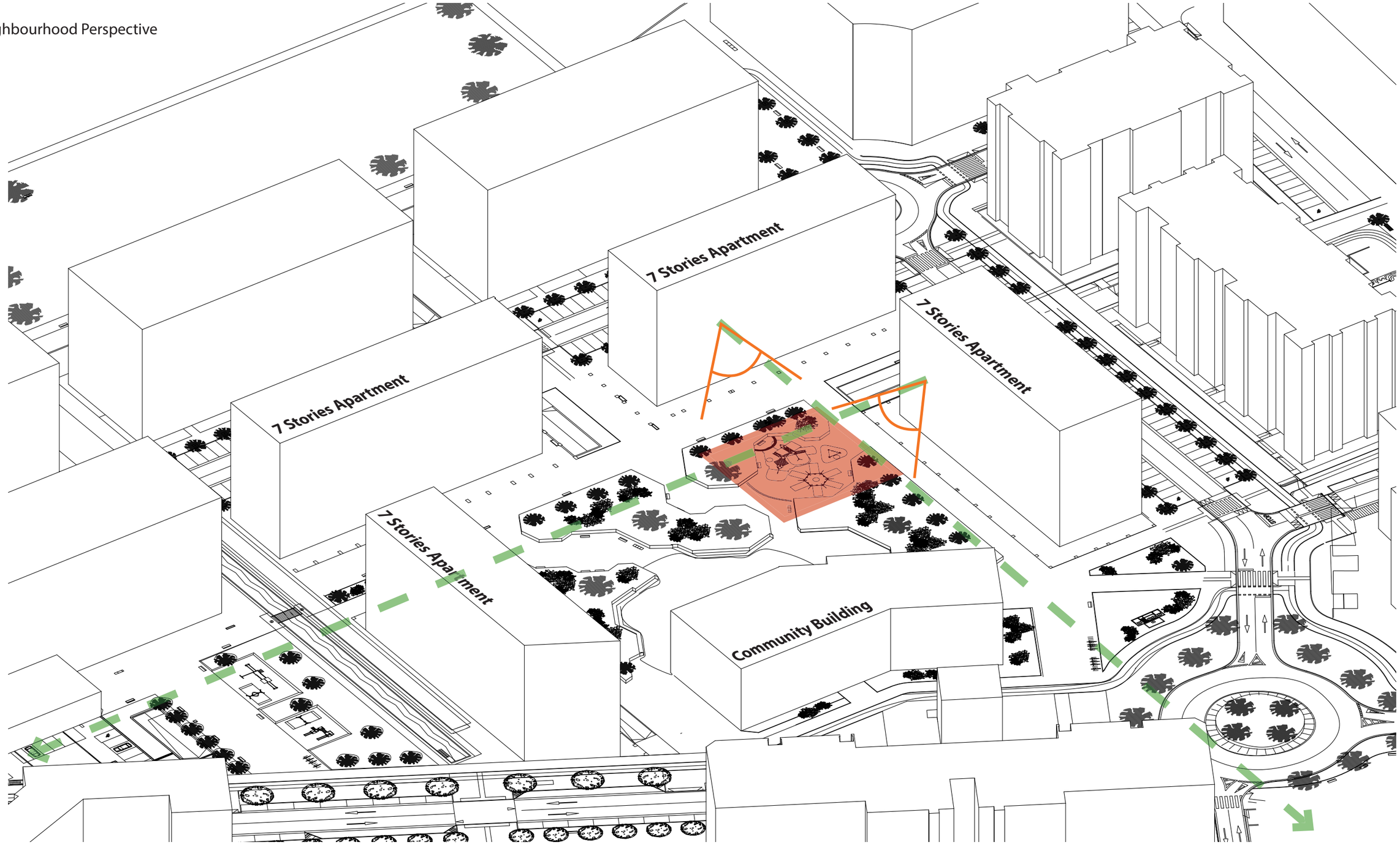
Site Overall



Design Development

Research and Design

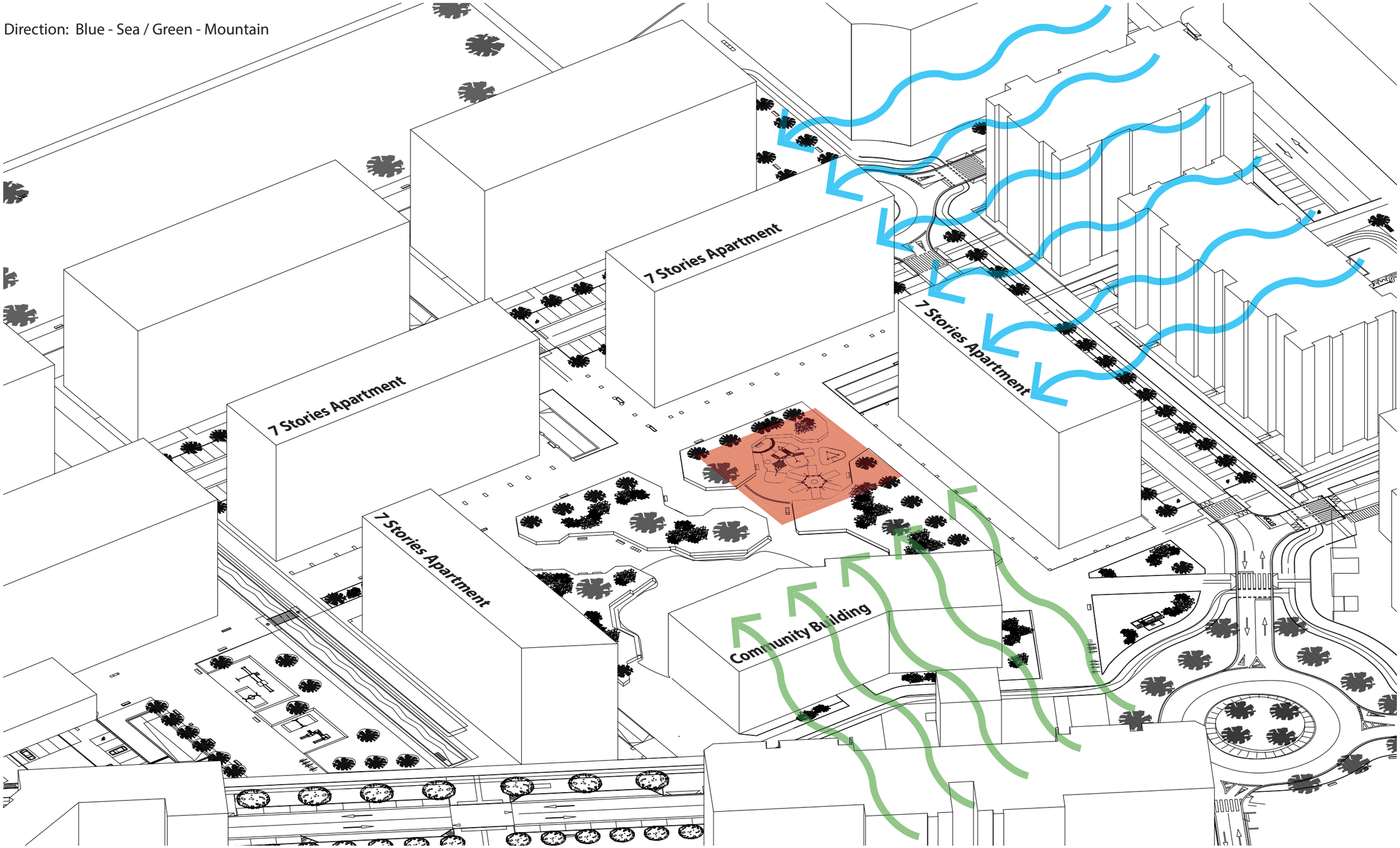
Neighbourhood Perspective



Design Development

Research and Design

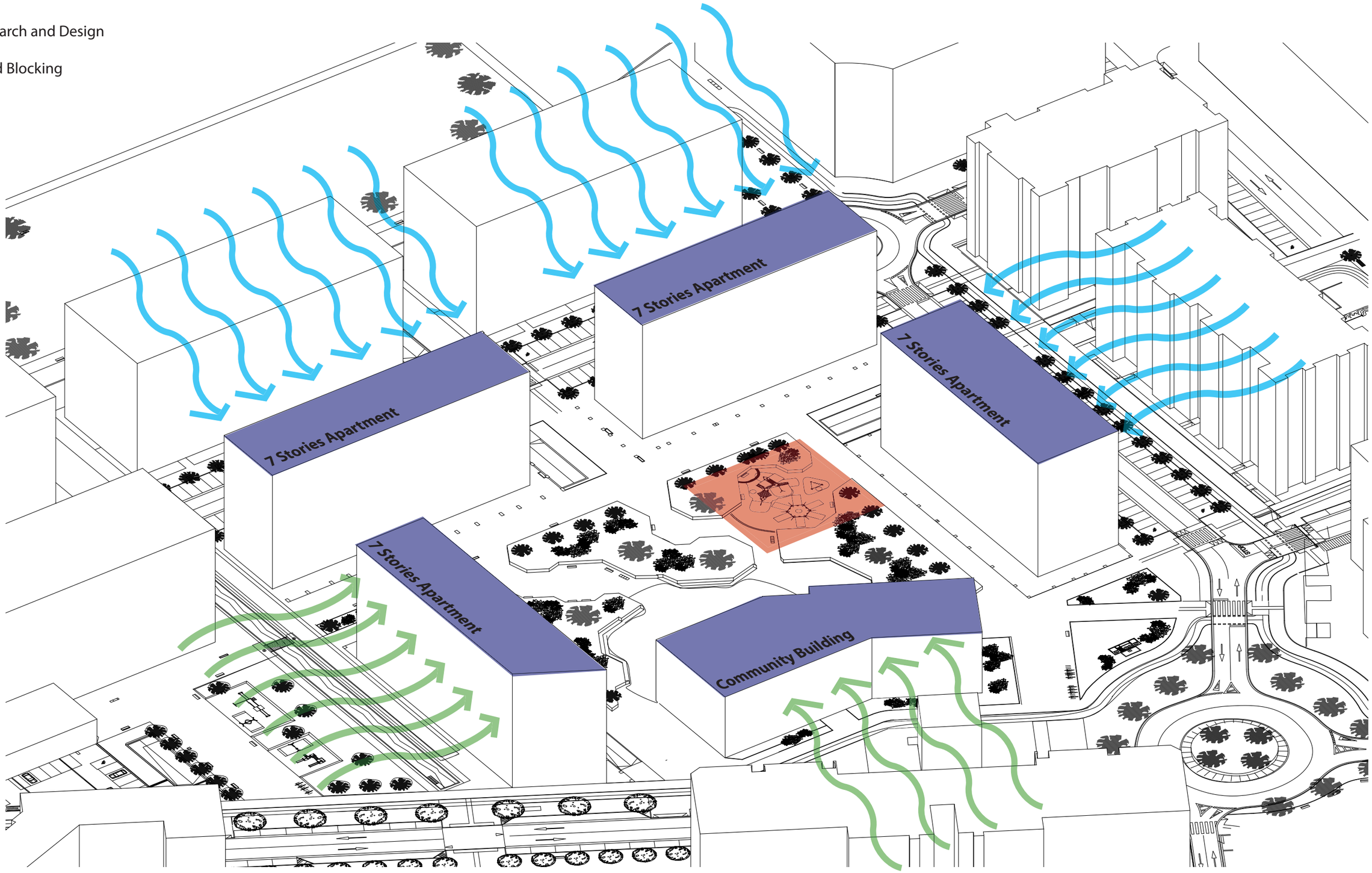
Wind Direction: Blue - Sea / Green - Mountain



Design Development

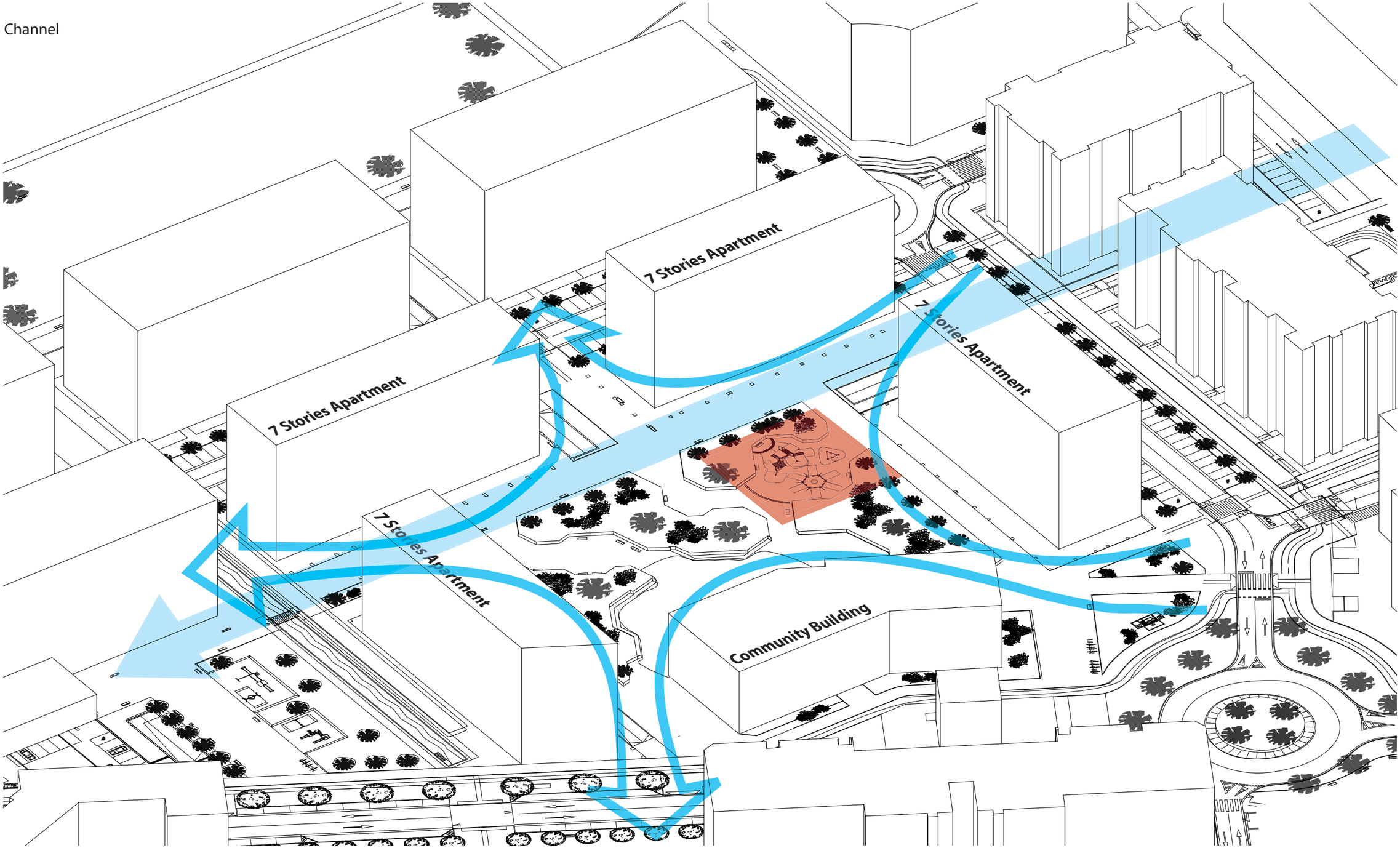
Research and Design

Wind Blocking



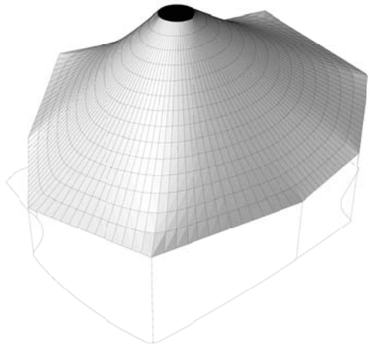
Research and Design

Wind Channel

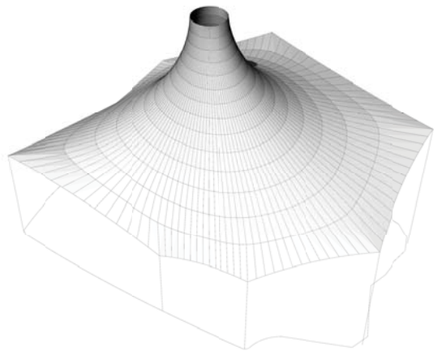


Design Development

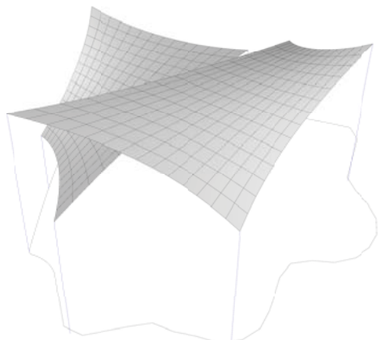
Sketch



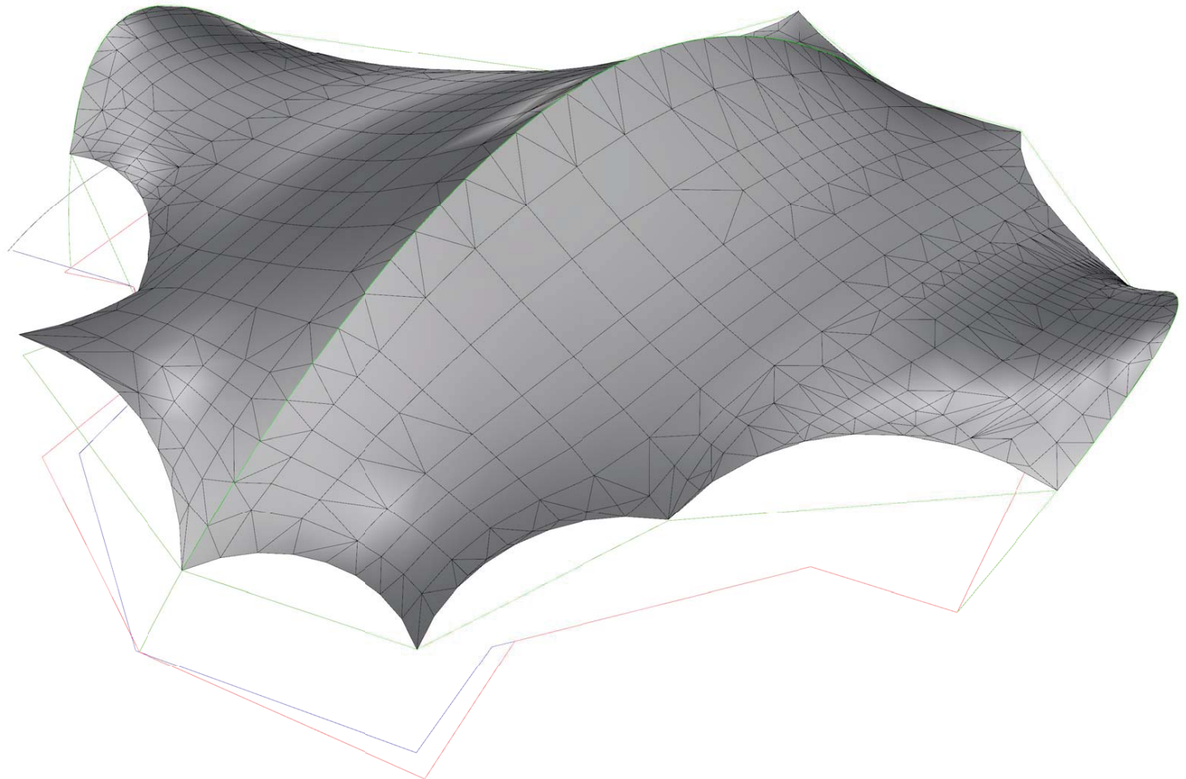
Conical 1



Conical 2



Double Layer



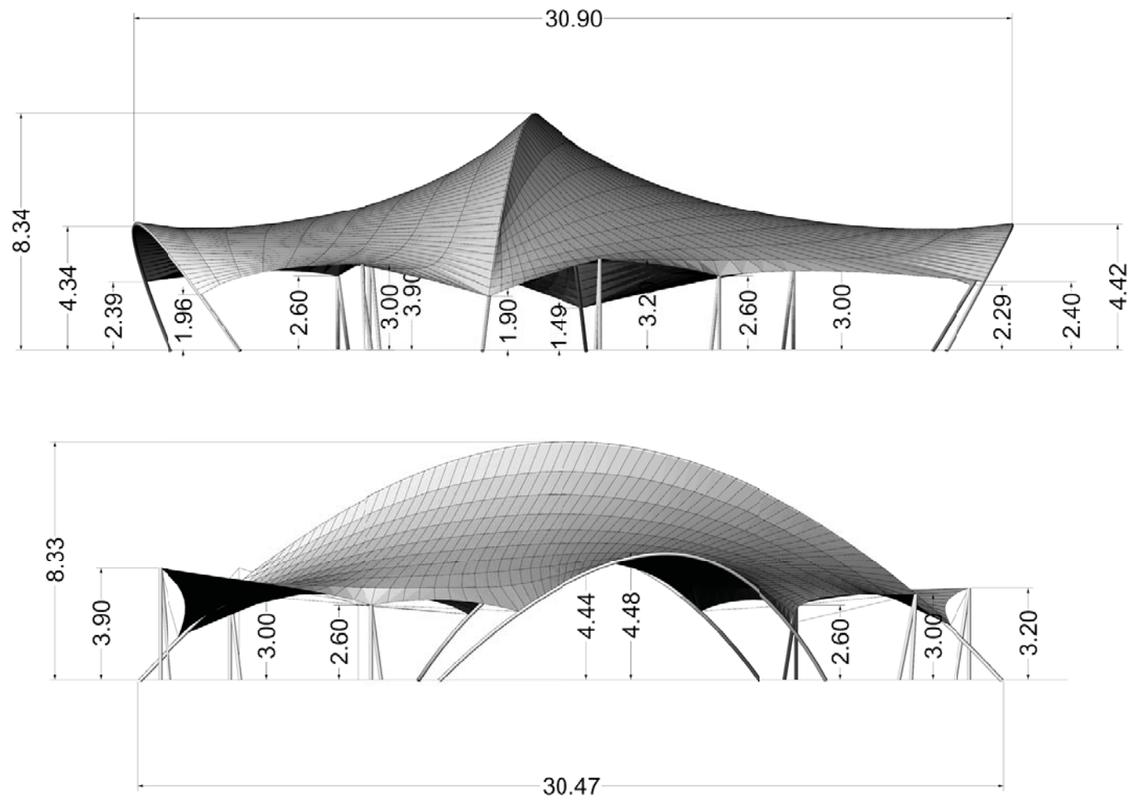
Triple Arch*

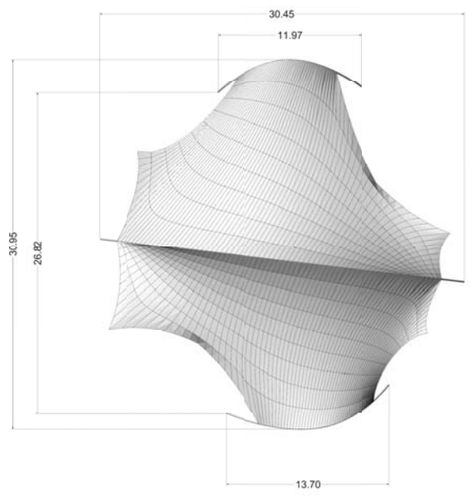
Design Development

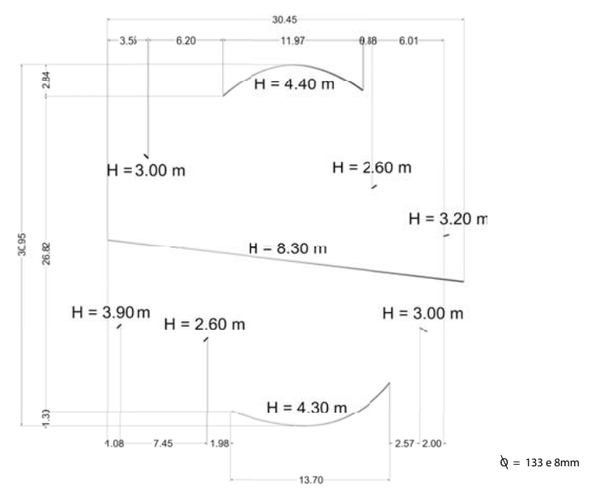
Sketch

Design Development

Design Development 1

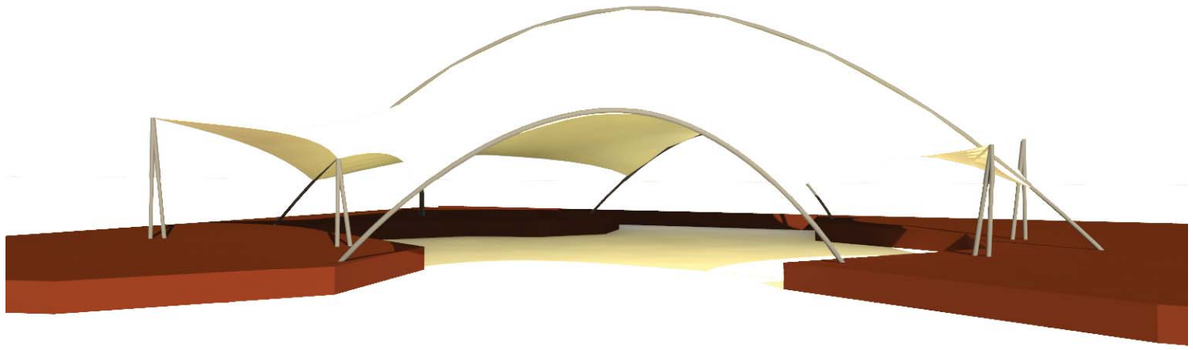


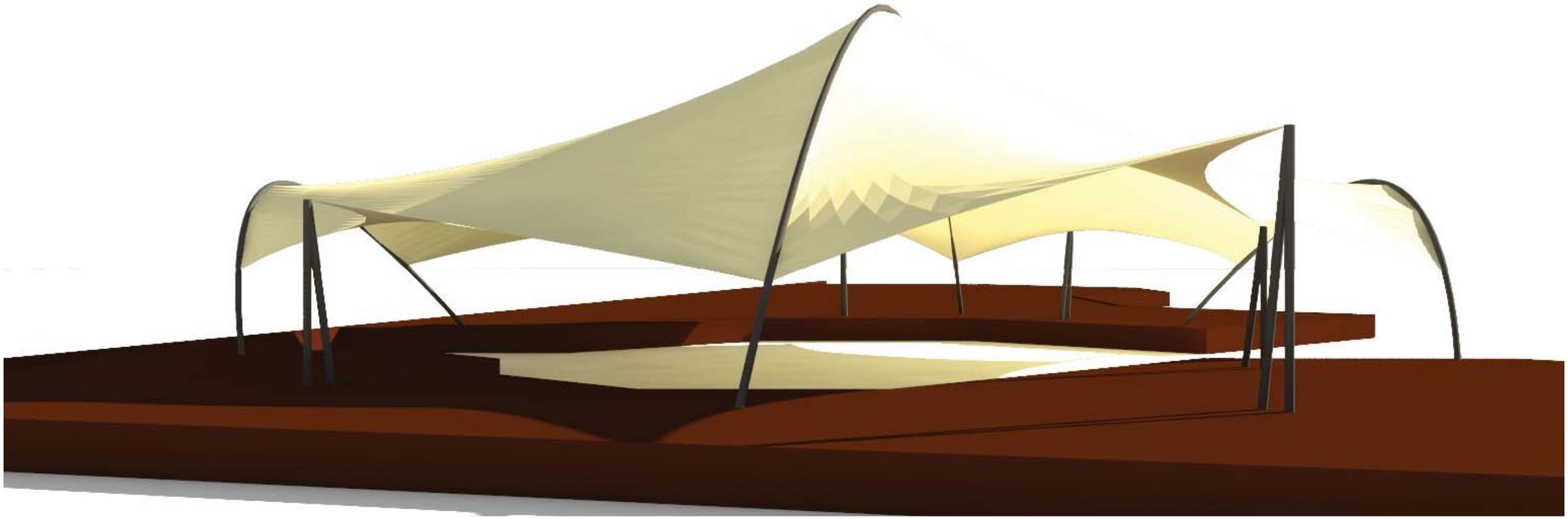




Design Development

Design Development 1



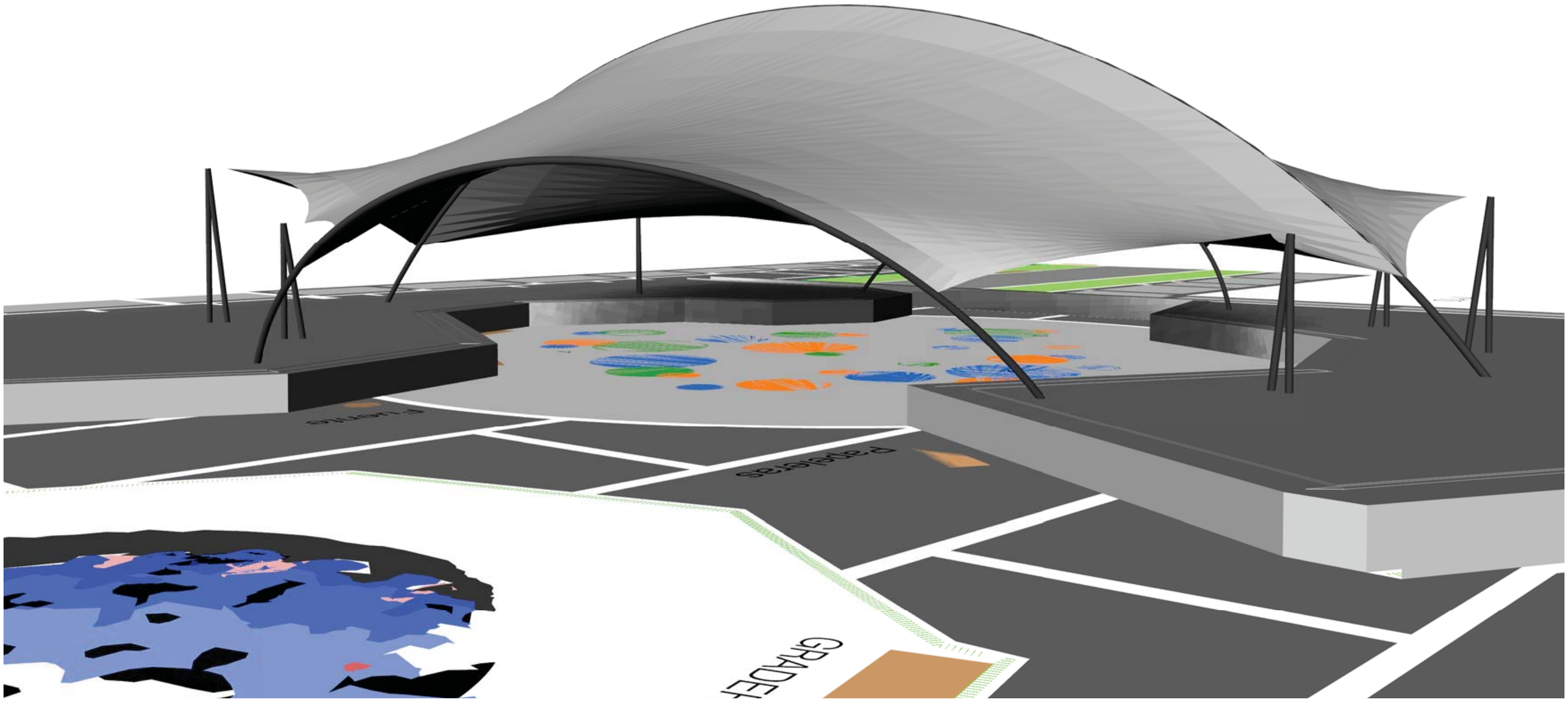


Conclution: Structures need to rearrange which make it more easier for workers to fabrication. Relax edge cables to increase border size and cover all the area.

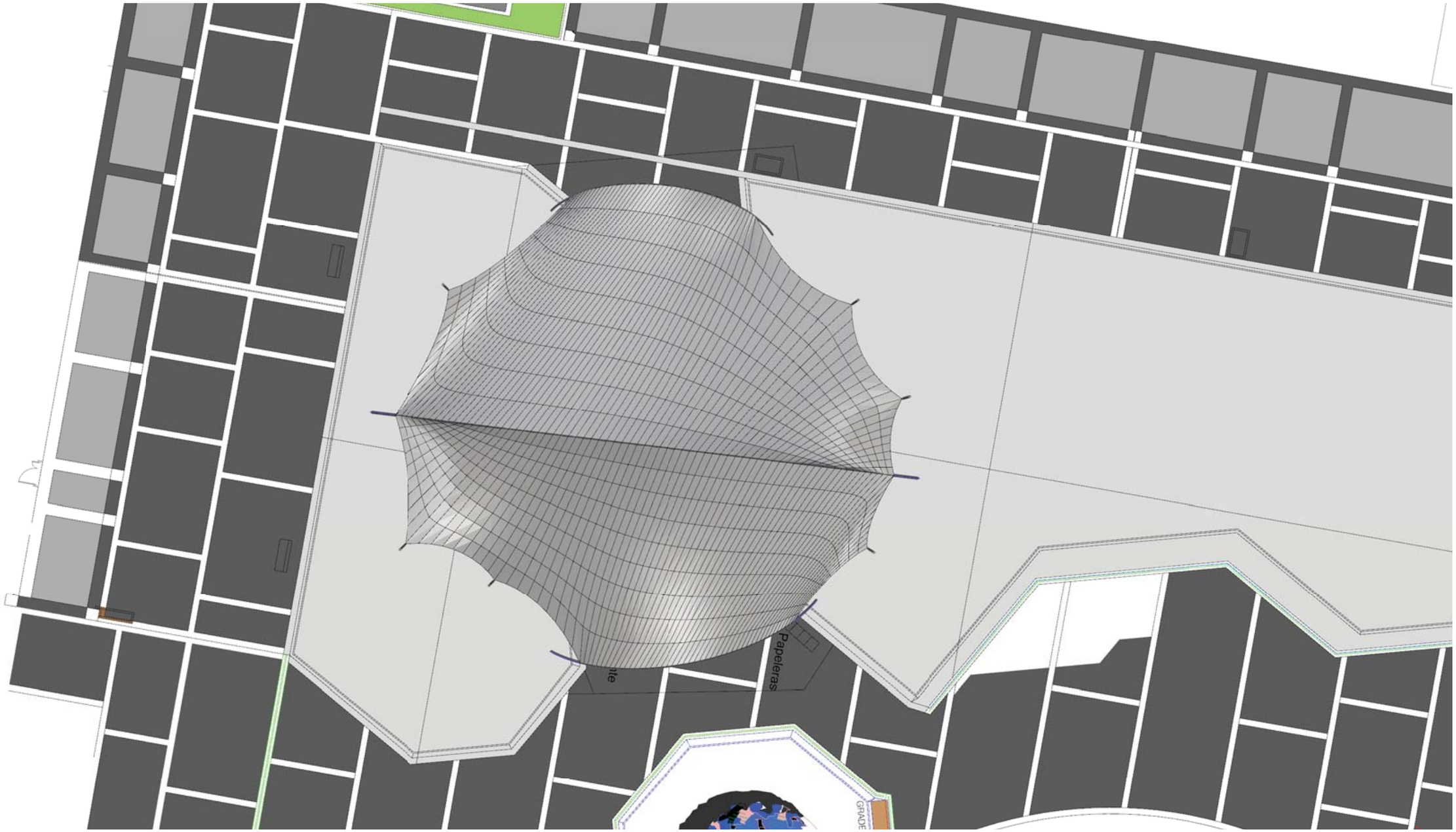
Design Development

Design Development 2

From the first design development, arches is an ellipse shape which hard to measure and fabricate. These second development solve the problem by change to normal arch from circular shape.

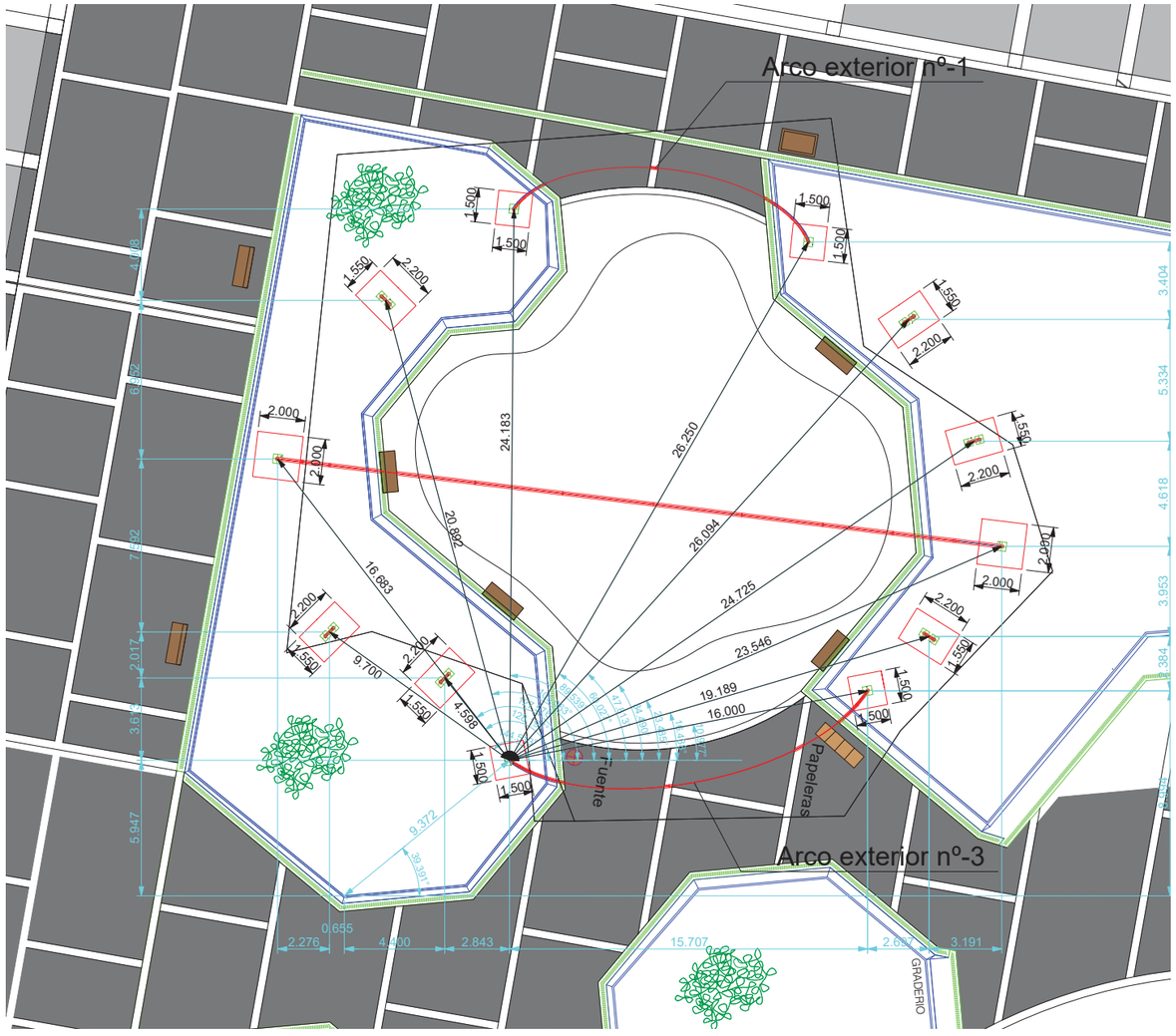


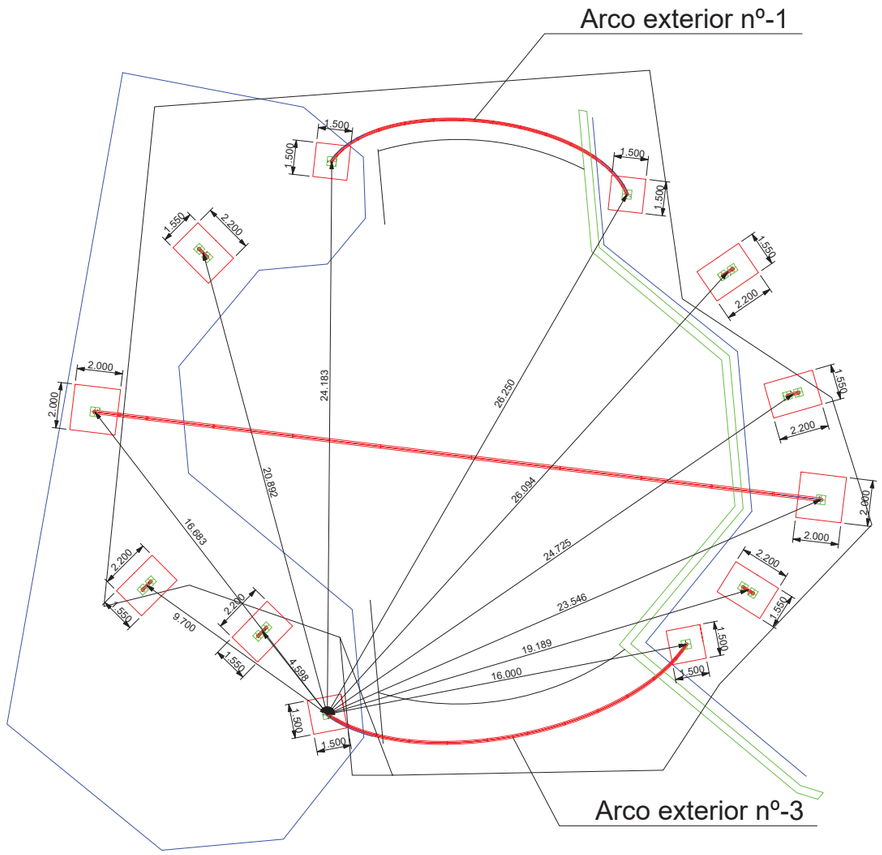
Design Development 2



Top view

Design Development 2



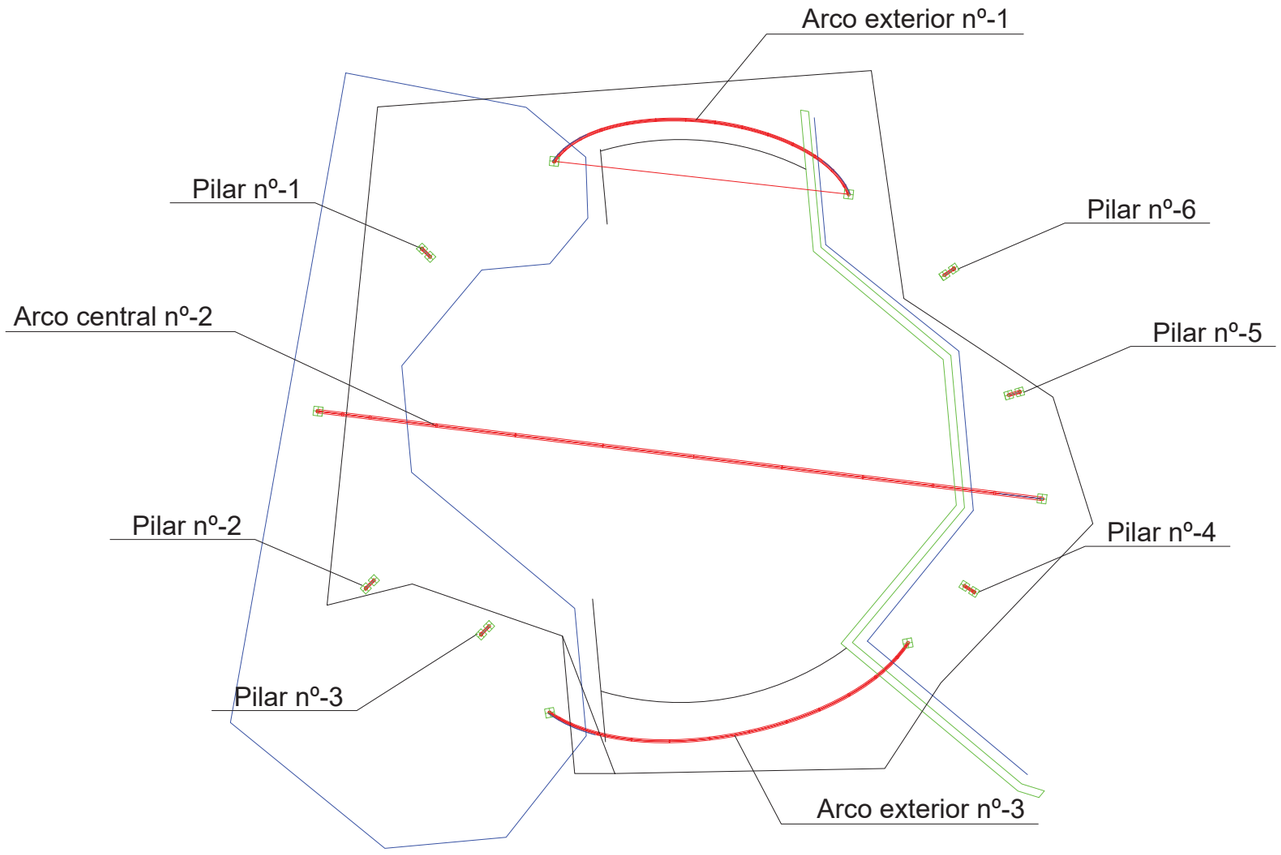


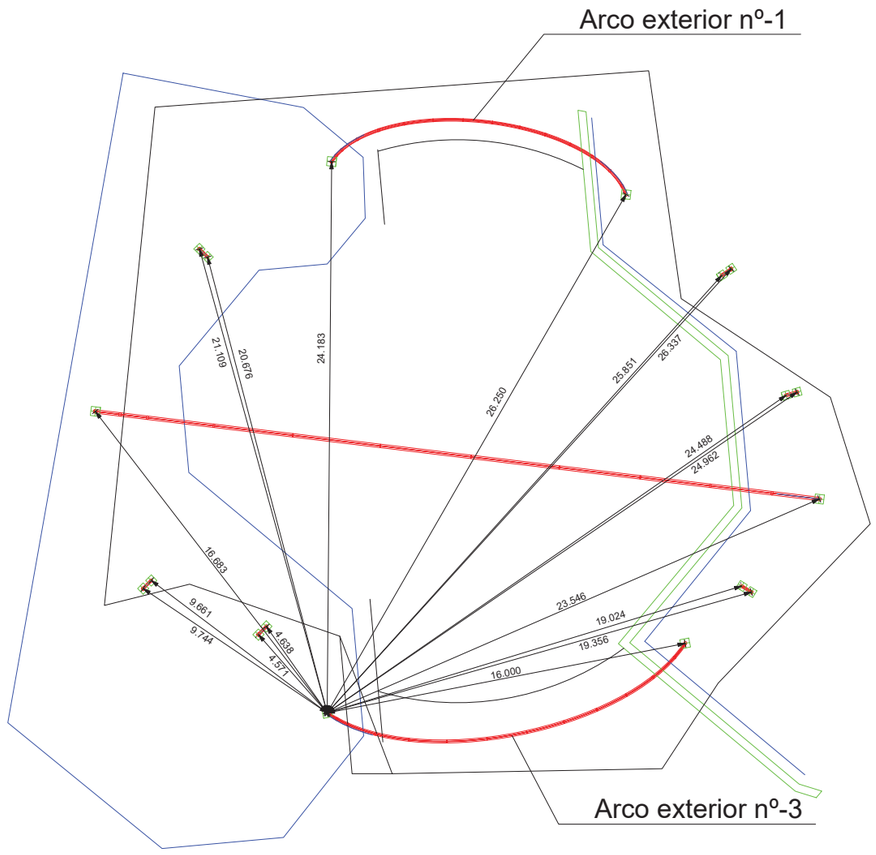
Foundation plan

Foundation plan

Design Development

Design Development 2



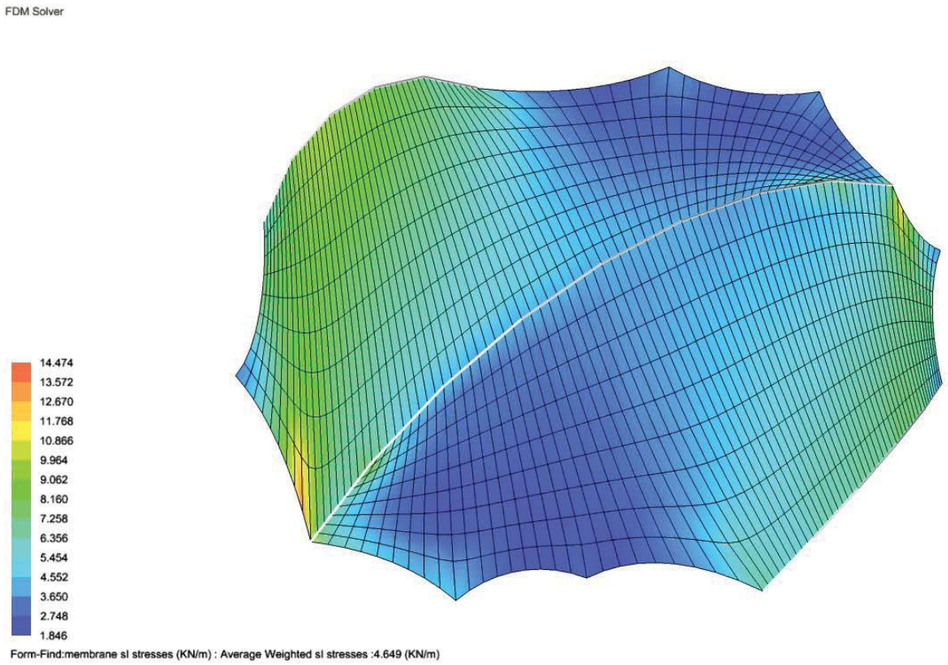


Structure code

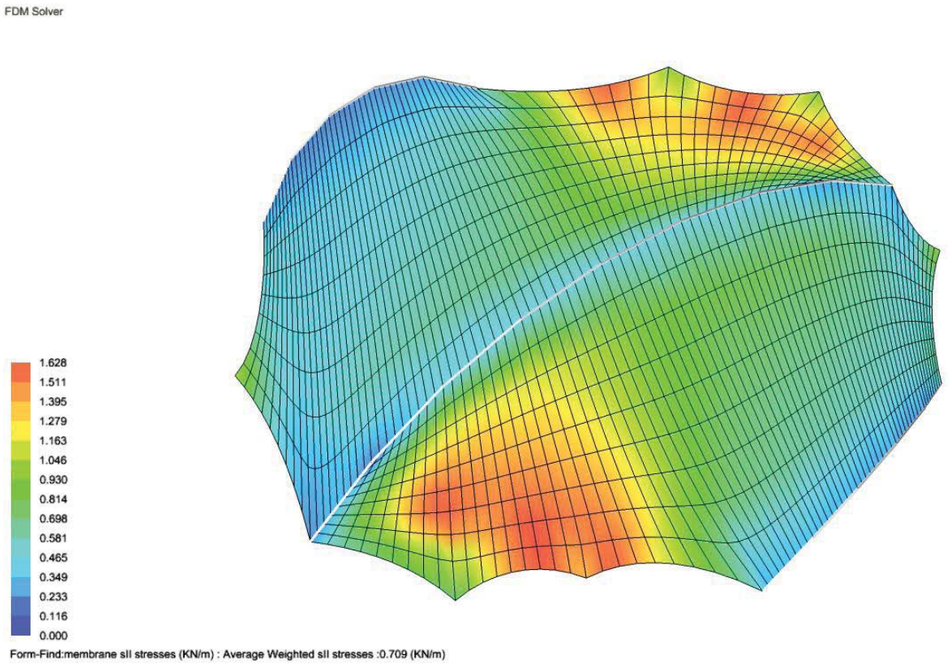
Structure plan

Thirachai Dheravatnvong
4059492

Design Development 2



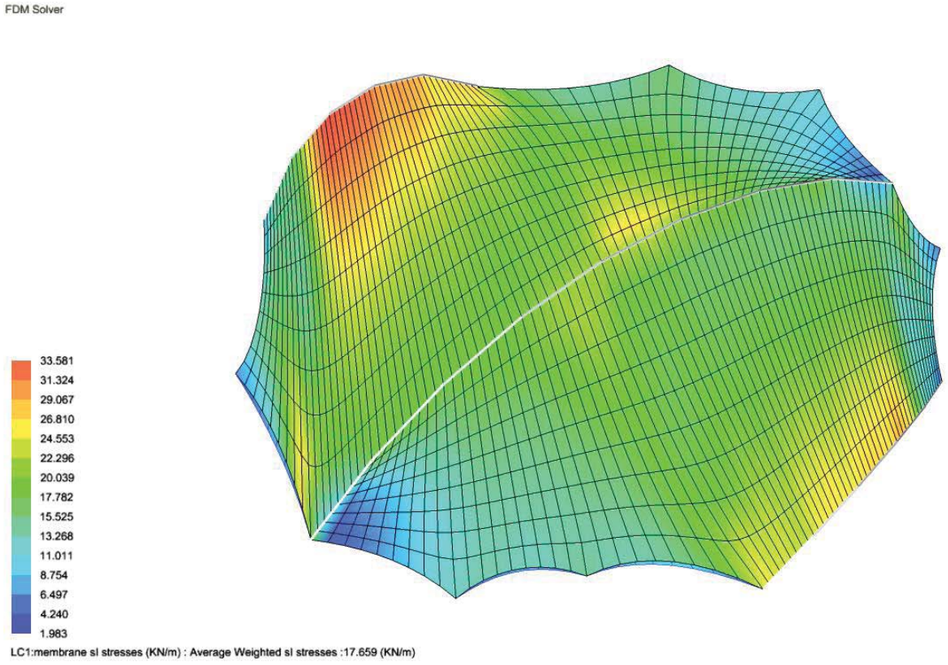
Form Finding - Stress I

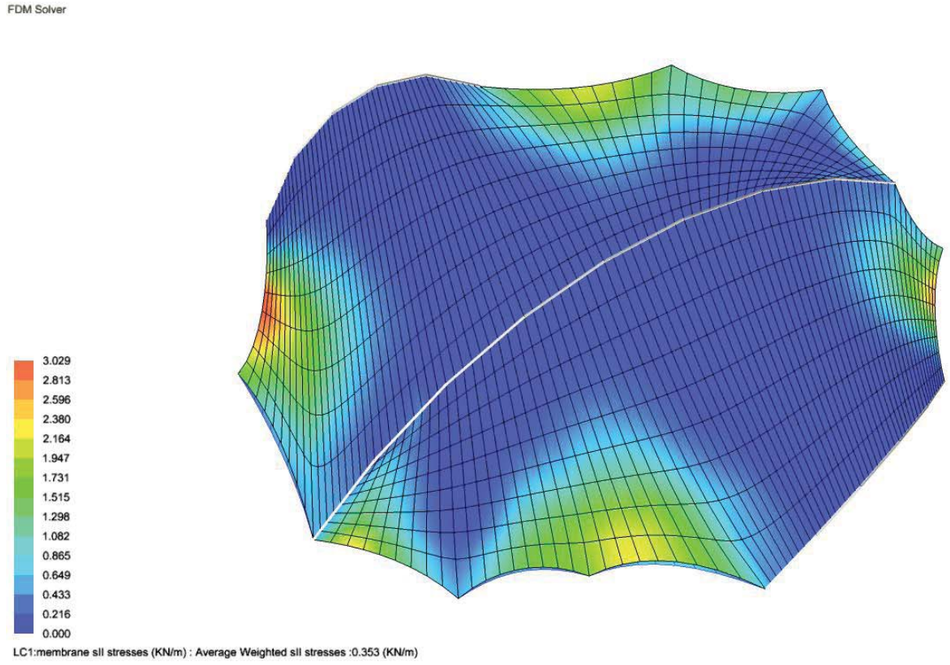


Form Finding - Stress II

Membrane stress and deformed

Design Development 2



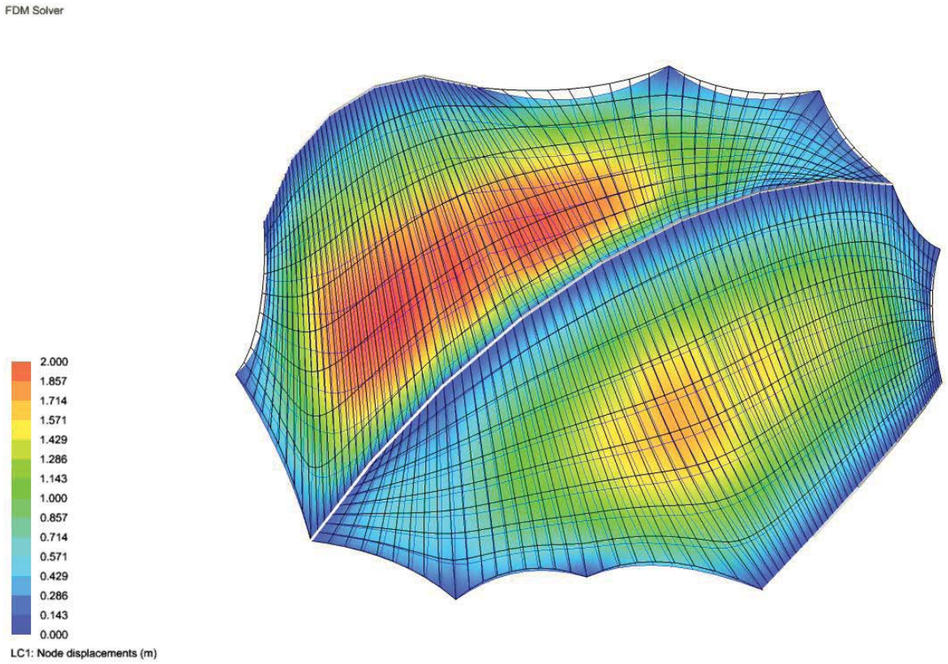


Load Case 1 - Stress I

Load Case 1 - Stress II

Membrane stress and deformed

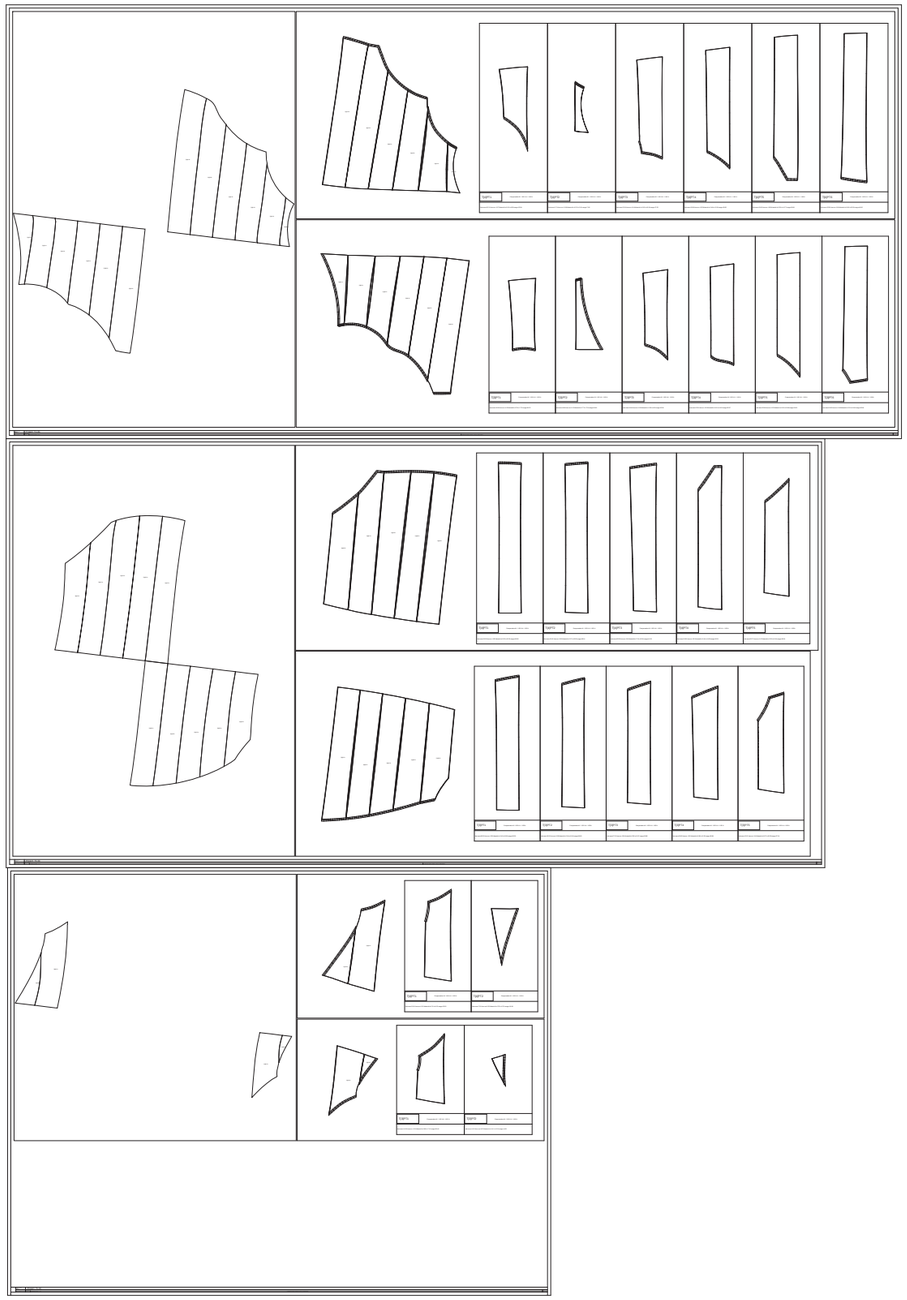
Design Development 2

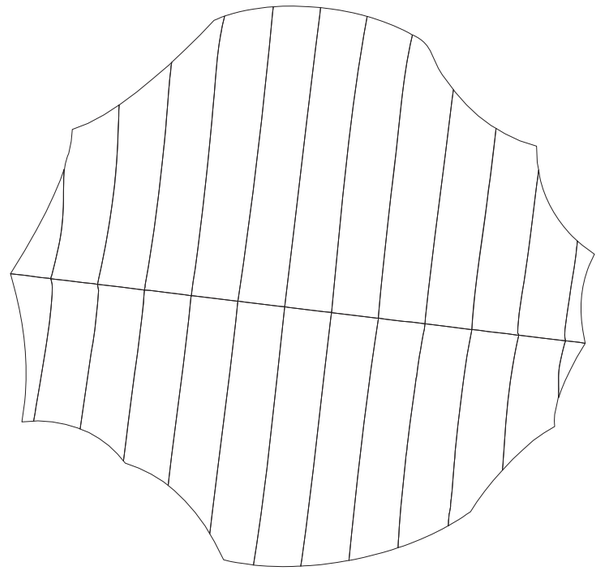


Load Case 1 - Deformed

Membrane stress and deformed

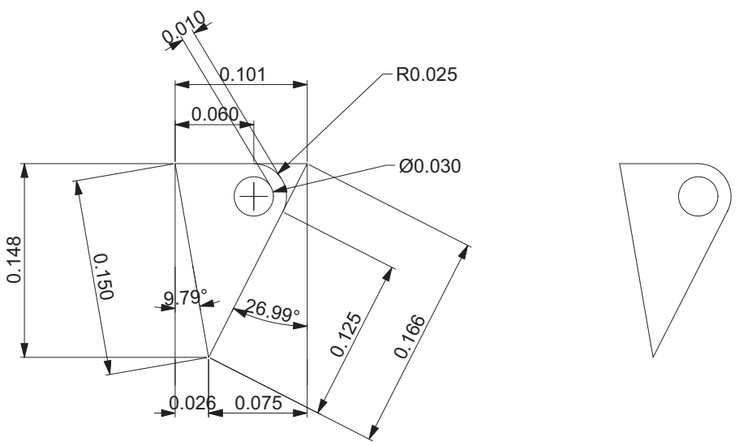
Design Development 2





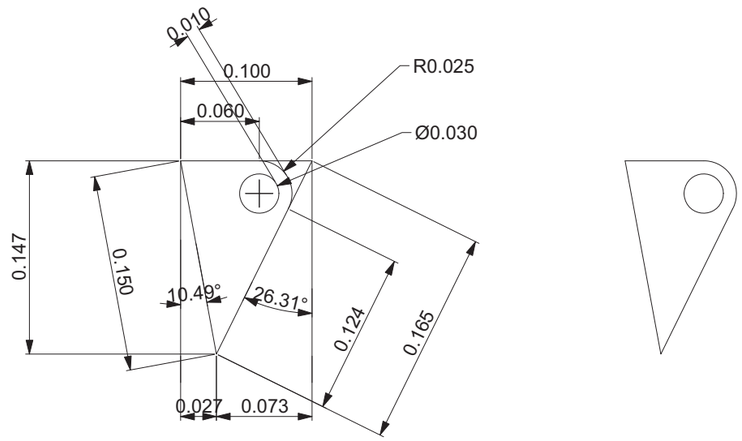
Membrane cutting pattern

Structural Details and Calculation



4 Unidads

e = 8 mm

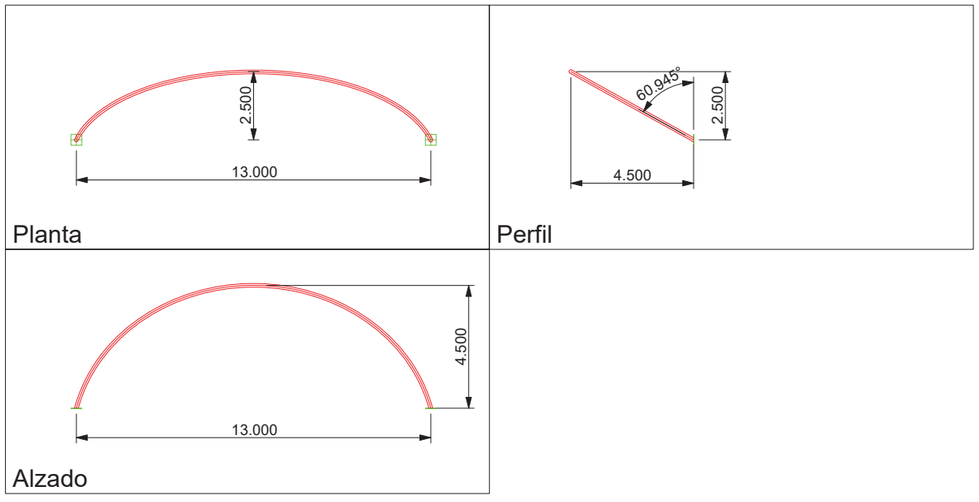


2 Unidads

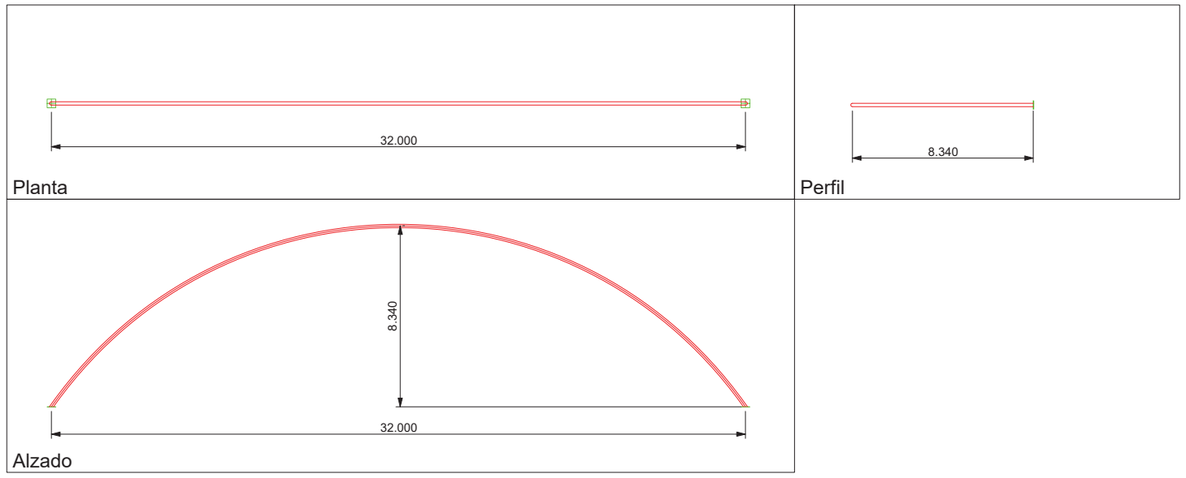
e = 8 mm

Design Development 2

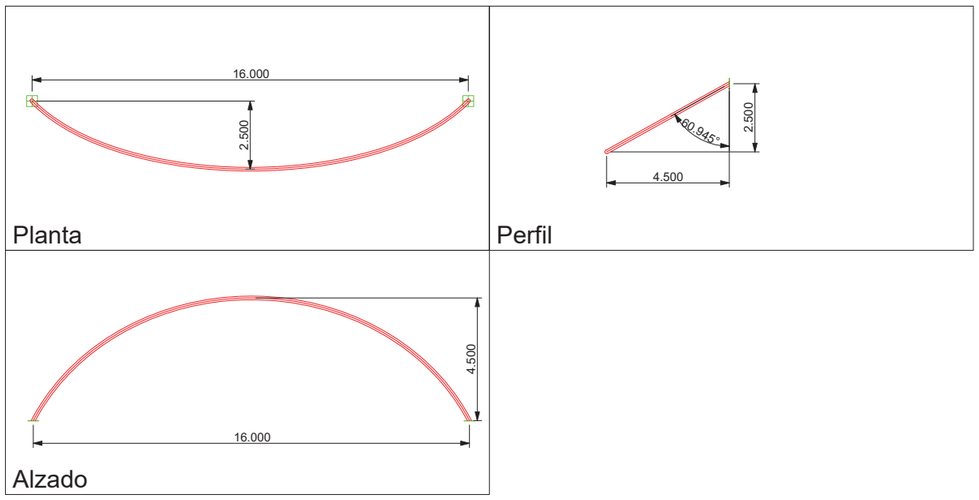
Arco exterior nº-1
CHS 133 e=5mm
Radio del arco 6.68m



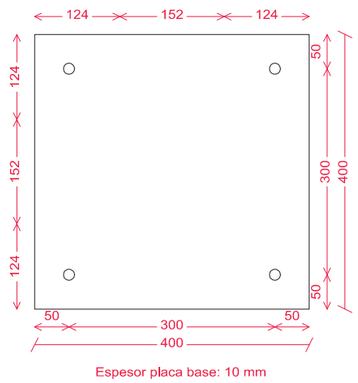
Arco central nº-2
CHS 152 e=8mm
Radio del arco 19.52m



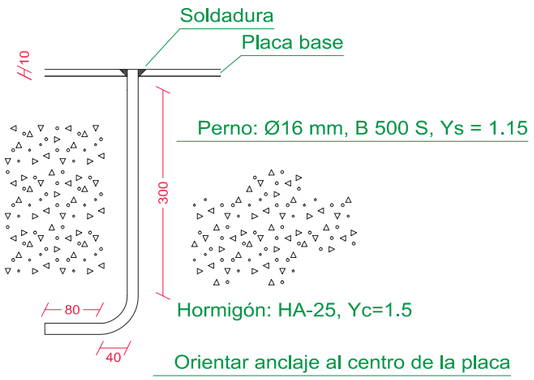
Arco exterior nº-3
CHS 133 e=5mm
Radio del arco 8.79m



6 Unidades

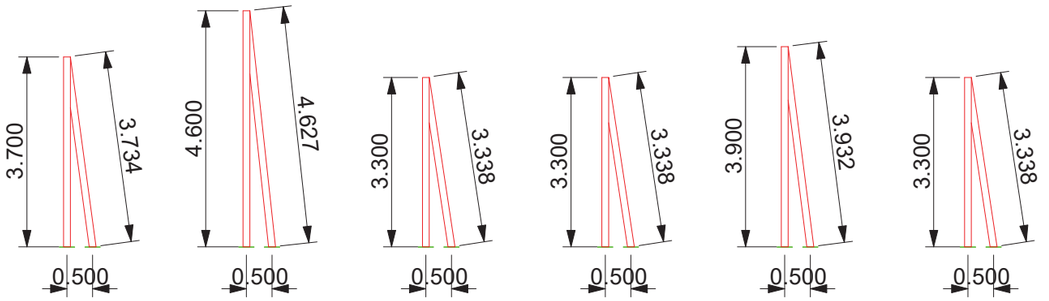


Detalle Anclaje Perno



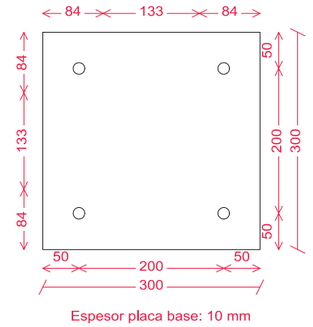
Design Development 2

Pilares
CHS 133 e=5mm



Pilar nº-1 Pilar nº-2 Pilar nº-3 Pilar nº-4 Pilar nº-5 Pilar nº-6

12 Unidades



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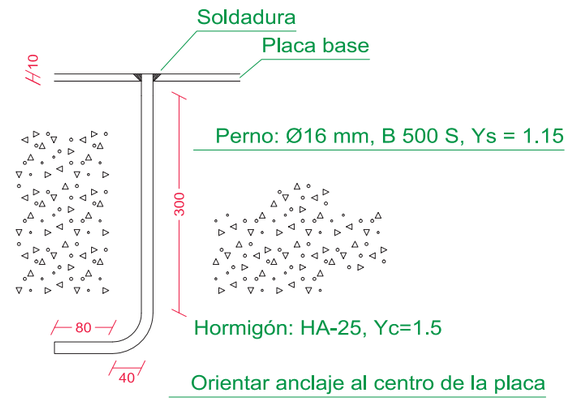

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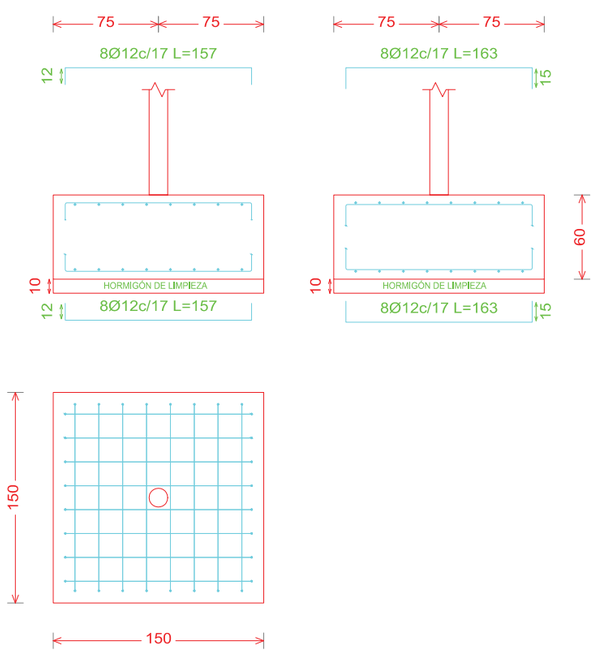
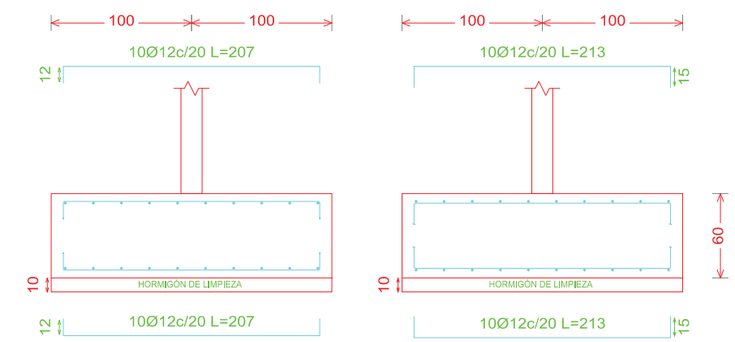
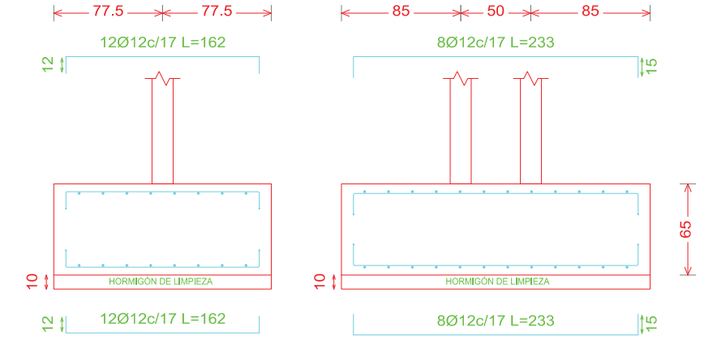
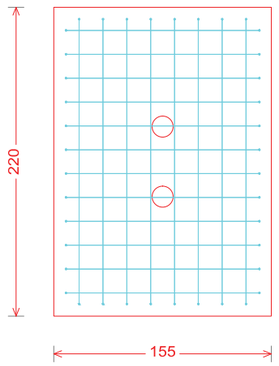








Side-Arch foundation

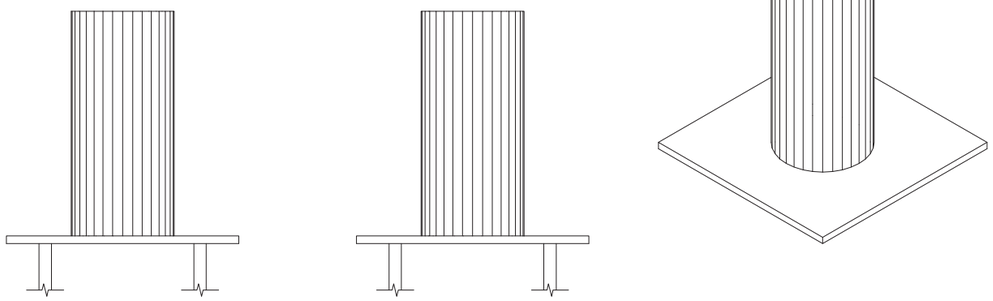
Middle-Arch foundation

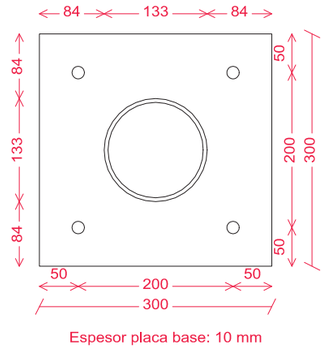
Pillar foundation

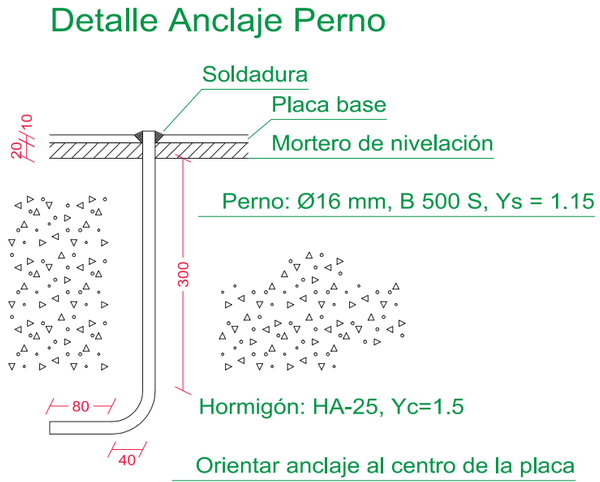
Foundation details

Design Development 2

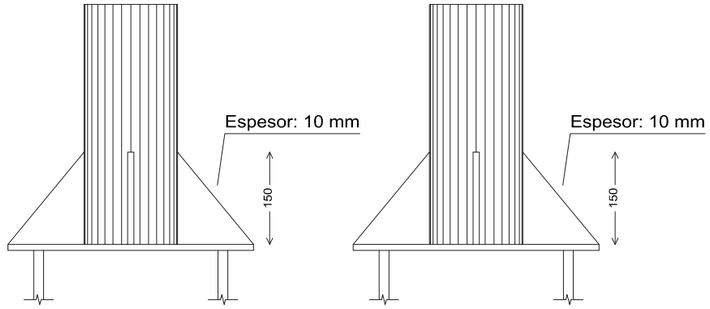
Dimensiones Placa = 300x300x10 mm (S275)
Pernos = 4Ø16 mm, B 500 S, Ys = 1.15
Escala 1 : 10

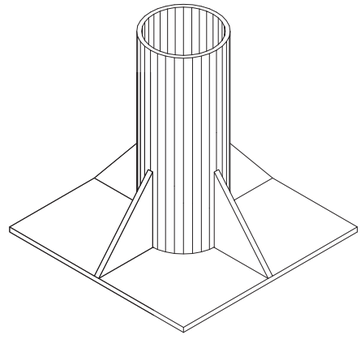


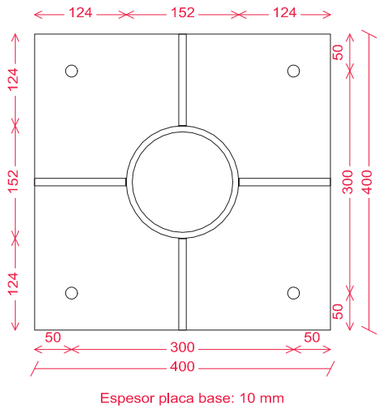


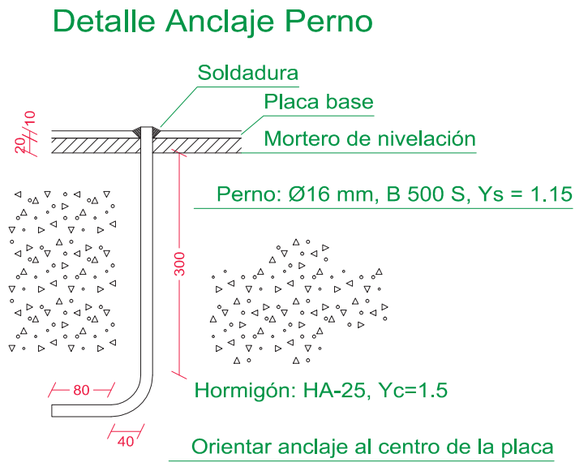


Dimensiones Placa = 400x400x10 mm (S275)
Pernos = 4Ø16 mm, B 500 S, Ys = 1.15
Escala 1 : 10









Pillar base

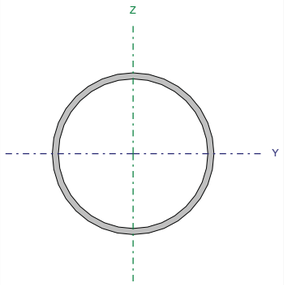
Arch base

Base plate details

Design Development 2

Barra N1/N3

Perfil: CHS 133.0x5.0
Material: Acero (S275)



Nudos		Longitud (m)	Características mecánicas			
Inicial	Final		Área (cm²)	I_y [1] (cm4)	I_z [1] (cm4)	I_t [2] (cm4)
N1	N3	4.600	20.11	412.40	412.40	824.81

Notas:
[1] *Inercia respecto al eje indicado*
[2] *Momento de inercia a torsión uniforme*

	Pandeo		Pandeo lateral	
	Plano XY	Plano XZ	Ala sup.	Ala inf.
β	1.00	0.70	0.00	0.00
L_K	4.600	3.220	0.000	0.000
C_m	1.000	1.000	1.000	1.000
C_1	-		1.000	

Notación:
β: Coeficiente de pandeo
L_K: Longitud de pandeo (m)
C_m: Coeficiente de momentos
C_1: Factor de modificación para el momento crítico

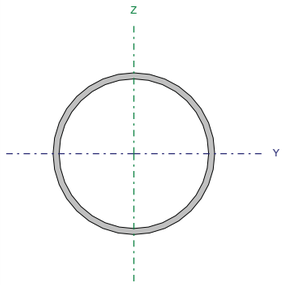
Barra	COMPROBACIONES (CTE DB SE-A)														Estado
	$\bar{\lambda}$	N_t	N_c	M_y	M_z	V_z	V_y	M_tV_z	M_zV_y	NM_yM_z	$NM_yM_zV_yV_z$	M_t	M_tV_z	M_tV_y	
N1/N3	$\bar{\lambda} \leq 3.0$ Cumple	x: 3.983 m η = 9.2	N_{Ed} = 0.00 N.P.[1]	x: 0 m η = 4.8	M_{Ed} = 0.00 N.P.[2]	η = 0.1	V_{Ed} = 0.00 N.P.[3]	η < 0.1	N.P.[4]	x: 0 m η = 13.9	η < 0.1	M_{Ed} = 0.00 N.P.[5]	N.P.[6]	N.P.[6]	**CUMPLE η = 13.9**

Notación:
$\bar{\lambda}$: Limitación de esbeltez
N_t: Resistencia a tracción
N_c: Resistencia a compresión
M_y: Resistencia a flexión eje Y
M_z: Resistencia a flexión eje Z
V_z: Resistencia a corte Z
V_y: Resistencia a corte Y
M_yV_z: Resistencia a momento flector Y y fuerza cortante Z combinados
M_zV_y: Resistencia a momento flector Z y fuerza cortante Y combinados
NM_yM_z: Resistencia a flexión y axil combinados
$NM_yM_zV_yV_z$: Resistencia a flexión, axil y cortante combinados
M_t: Resistencia a torsión
M_tV_z: Resistencia a cortante Z y momento torsor combinados
M_tV_y: Resistencia a cortante Y y momento torsor combinados
x: Distancia al origen de la barra
η: Coeficiente de aprovechamiento (%)
N.P.: No procede

Comprobaciones que no proceden (N.P.):
[1] *La comprobación no procede, ya que no hay axil de compresión.*
[2] *La comprobación no procede, ya que no hay momento flector.*
[3] *La comprobación no procede, ya que no hay esfuerzo cortante.*
[4] *No hay interacción entre momento flector y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.*
[5] *La comprobación no procede, ya que no hay momento torsor.*
[6] *No hay interacción entre momento torsor y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.*

Barra N1/N3

Perfil: CHS 133.0x5.0
Material: Acero (S275)



Nudos		Longitud (m)	Características mecánicas			
Inicial	Final		Área (cm²)	I_y [1] (cm4)	I_z [1] (cm4)	I_t [2] (cm4)
N1	N3	3.300	20.11	412.40	412.40	824.81

Notas:
[1] *Inercia respecto al eje indicado*
[2] *Momento de inercia a torsión uniforme*

	Pandeo		Pandeo lateral	
	Plano XY	Plano XZ	Ala sup.	Ala inf.
β	0.70	0.70	0.00	0.00
L_K	2.310	2.310	0.000	0.000
C_m	1.000	1.000	1.000	1.000
C_1	-		1.000	

Notación:
β: Coeficiente de pandeo
L_K: Longitud de pandeo (m)
C_m: Coeficiente de momentos
C_1: Factor de modificación para el momento crítico

Barra	COMPROBACIONES (CTE DB SE-A)														Estado
	$\bar{\lambda}$	N_t	N_c	M_y	M_z	V_z	V_y	M_tV_z	M_zV_y	NM_yM_z	$NM_yM_zV_yV_z$	M_t	M_tV_z	M_tV_y	
N1/N3	$\bar{\lambda} \leq 3.0$ Cumple	x: 2.855 m η = 11.5	N_{Ed} = 0.00 N.P.[1]	x: 0 m η = 6.1	M_{Ed} = 0.00 N.P.[2]	η = 0.2	V_{Ed} = 0.00 N.P.[3]	η < 0.1	N.P.[4]	x: 0 m η = 17.5	η < 0.1	M_{Ed} = 0.00 N.P.[5]	N.P.[6]	N.P.[6]	**CUMPLE η = 17.5**

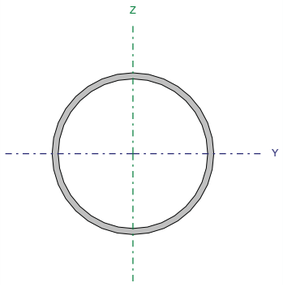
Notación:
$\bar{\lambda}$: Limitación de esbeltez
N_t: Resistencia a tracción
N_c: Resistencia a compresión
M_y: Resistencia a flexión eje Y
M_z: Resistencia a flexión eje Z
V_z: Resistencia a corte Z
V_y: Resistencia a corte Y
M_yV_z: Resistencia a momento flector Y y fuerza cortante Z combinados
M_zV_y: Resistencia a momento flector Z y fuerza cortante Y combinados
NM_yM_z: Resistencia a flexión y axil combinados
$NM_yM_zV_yV_z$: Resistencia a flexión, axil y cortante combinados
M_t: Resistencia a torsión
M_tV_z: Resistencia a cortante Z y momento torsor combinados
M_tV_y: Resistencia a cortante Y y momento torsor combinados
x: Distancia al origen de la barra
η: Coeficiente de aprovechamiento (%)
N.P.: No procede

Comprobaciones que no proceden (N.P.):
[1] *La comprobación no procede, ya que no hay axil de compresión.*
[2] *La comprobación no procede, ya que no hay momento flector.*
[3] *La comprobación no procede, ya que no hay esfuerzo cortante.*
[4] *No hay interacción entre momento flector y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.*
[5] *La comprobación no procede, ya que no hay momento torsor.*
[6] *No hay interacción entre momento torsor y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.*

Design Development 2

Barra N2/N3

Perfil: CHS 133.0x5.0
Material: Acero (S275)



Nudos		Longitud (m)	Características mecánicas			
Inicial	Final		Área (cm²)	I_y [1] (cm4)	I_z [1] (cm4)	I_t [2] (cm4)
N2	N3	3.338	20.11	412.40	412.40	824.81

Notas:
[1] *Inercia respecto al eje indicado*
[2] *Momento de inercia a torsión uniforme*

	Pandeo		Pandeo lateral	
	Plano XY	Plano XZ	Ala sup.	Ala inf.
β	0.70	0.70	0.00	0.00
L_K	2.336	2.336	0.000	0.000
C_m	1.000	1.000	1.000	1.000
C_1	-		1.000	

Notación:
β: Coeficiente de pandeo
L_K: Longitud de pandeo (m)
C_m: Coeficiente de momentos
C_1: Factor de modificación para el momento crítico

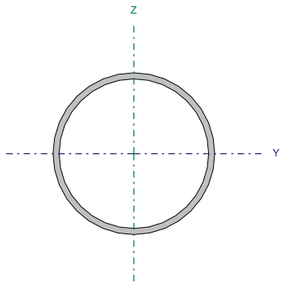
Barra	COMPROBACIONES (CTE DB SE-A)														Estado
	$\bar{\lambda}$	N_t	N_c	M_y	M_z	V_z	V_y	M_yV_z	M_zV_y	NM_yM_z	$NM_yM_zV_yV_z$	M_t	M_tV_z	M_tV_y	
N2/N3	$\bar{\lambda}$ < 2.0 Cumple	$N_{t,d}$ = 0.00 N.P.[1]	x: 0 m η = 14.9	x: 0 m η = 5.8	$M_{t,d}$ = 0.00 N.P.[2]	x: 2.894 m η = 0.2	$V_{t,d}$ = 0.00 N.P.[3]	η < 0.1	N.P.[4]	x: 0 m η = 21.1	η < 0.1	$M_{t,d}$ = 0.00 N.P.[5]	N.P.[6]	N.P.[6]	**CUMPLE η = 21.1**

Notación:
$\bar{\lambda}$: Limitación de esbeltez
N_t: Resistencia a tracción
N_c: Resistencia a compresión
M_y: Resistencia a flexión eje Y
M_z: Resistencia a flexión eje Z
V_z: Resistencia a corte Z
V_y: Resistencia a corte Y
M_yV_z: Resistencia a momento flector Y y fuerza cortante Z combinados
M_zV_y: Resistencia a momento flector Z y fuerza cortante Y combinados
NM_yM_z: Resistencia a flexión y axil combinados
$NM_yM_zV_yV_z$: Resistencia a flexión, axil y cortante combinados
M_t: Resistencia a torsión
M_tV_z: Resistencia a cortante Z y momento torsor combinados
M_tV_y: Resistencia a cortante Y y momento torsor combinados
x: Distancia al origen de la barra
η: Coeficiente de aprovechamiento (%)
N.P.: No procede

Comprobaciones que no proceden (N.P.):
[1] *La comprobación no procede, ya que no hay axil de tracción.*
[2] *La comprobación no procede, ya que no hay momento flector.*
[3] *La comprobación no procede, ya que no hay esfuerzo cortante.*
[4] *No hay interacción entre momento flector y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.*
[5] *La comprobación no procede, ya que no hay momento torsor.*
[6] *No hay interacción entre momento torsor y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.*

Barra N2/N3

Perfil: CHS 133.0x5.0
Material: Acero (S275)



Nudos		Longitud (m)	Características mecánicas			
Inicial	Final		Área (cm²)	I_y [1] (cm4)	I_z [1] (cm4)	I_t [2] (cm4)
N2	N3	4.627	20.11	412.40	412.40	824.81

Notas:
[1] *Inercia respecto al eje indicado*
[2] *Momento de inercia a torsión uniforme*

	Pandeo		Pandeo lateral	
	Plano XY	Plano XZ	Ala sup.	Ala inf.
β	1.00	0.70	0.00	0.00
L_K	4.627	3.239	0.000	0.000
C_m	1.000	1.000	1.000	1.000
C_1	-		1.000	

Notación:
β: Coeficiente de pandeo
L_K: Longitud de pandeo (m)
C_m: Coeficiente de momentos
C_1: Factor de modificación para el momento crítico

Barra	COMPROBACIONES (CTE DB SE-A)														Estado
	$\bar{\lambda}$	N_t	N_c	M_y	M_z	V_z	V_y	M_yV_z	M_zV_y	NM_yM_z	$NM_yM_zV_yV_z$	M_t	M_tV_z	M_tV_y	
N2/N3	$\bar{\lambda}$ < 2.0 Cumple	$N_{t,d}$ = 0.00 N.P.[1]	x: 0 m η = 21.3	x: 0 m η = 4.6	$M_{t,d}$ = 0.00 N.P.[2]	x: 4.011 m η = 0.1	$V_{t,d}$ = 0.00 N.P.[3]	η < 0.1	N.P.[4]	x: 0 m η = 24.3	η < 0.1	$M_{t,d}$ = 0.00 N.P.[5]	N.P.[6]	N.P.[6]	**CUMPLE η = 24.3**

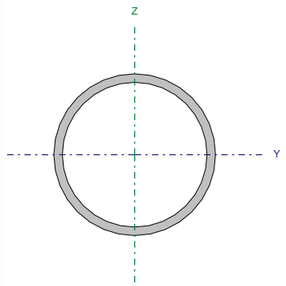
Notación:
$\bar{\lambda}$: Limitación de esbeltez
N_t: Resistencia a tracción
N_c: Resistencia a compresión
M_y: Resistencia a flexión eje Y
M_z: Resistencia a flexión eje Z
V_z: Resistencia a corte Z
V_y: Resistencia a corte Y
M_yV_z: Resistencia a momento flector Y y fuerza cortante Z combinados
M_zV_y: Resistencia a momento flector Z y fuerza cortante Y combinados
NM_yM_z: Resistencia a flexión y axil combinados
$NM_yM_zV_yV_z$: Resistencia a flexión, axil y cortante combinados
M_t: Resistencia a torsión
M_tV_z: Resistencia a cortante Z y momento torsor combinados
M_tV_y: Resistencia a cortante Y y momento torsor combinados
x: Distancia al origen de la barra
η: Coeficiente de aprovechamiento (%)
N.P.: No procede

Comprobaciones que no proceden (N.P.):
[1] *La comprobación no procede, ya que no hay axil de tracción.*
[2] *La comprobación no procede, ya que no hay momento flector.*
[3] *La comprobación no procede, ya que no hay esfuerzo cortante.*
[4] *No hay interacción entre momento flector y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.*
[5] *La comprobación no procede, ya que no hay momento torsor.*
[6] *No hay interacción entre momento torsor y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.*

Design Development 2

Barra N2/N32

Perfil: CHS 152.0x8.0
Material: Acero (S275)



Nudos		Longitud (m)	Características mecánicas			
Inicial	Final		Área (cm²)	I_y [1] (cm4)	I_z [1] (cm4)	I_t [2] (cm4)
N2	N32	1.440	36.19	940.97	940.97	1881.94

Notas:
[1] Inercia respecto al eje indicado
[2] Momento de inercia a torsión uniforme

	Pandeo		Pandeo lateral	
	Plano XY	Plano XZ	Ala sup.	Ala inf.
β	1.00	0.50	0.00	0.00
L_K	1.440	0.720	0.000	0.000
C_m	1.000	1.000	1.000	1.000
C_1	-		1.000	

Notación:
β: Coeficiente de pandeo
L_K: Longitud de pandeo (m)
C_m: Coeficiente de momentos
C_1: Factor de modificación para el momento crítico

Barra	COMPROBACIONES (CTE DB SE-A)														Estado
	$\bar{\lambda}$	N_t	N_c	M_y	M_z	V_z	V_y	M_tV_z	M_tV_y	NM_yM_z	$NM_yM_zV_tV_z$	M_t	M_tV_z	M_tV_y	
N2/N32	$\bar{\lambda}$ < 2.0 Cumple	N_{Ed} = 0.00 N.P.[1]	x: 0 m η = 22.8	x: 0 m η = 69.7	M_{Ed} = 0.00 N.P.[2]	x: 1.44 m η = 4.5	V_{Ed} = 0.00 N.P.[3]	η < 0.1	N.P.[4]	x: 0 m η = 91.0	η < 0.1	M_{Ed} = 0.00 N.P.[5]	N.P.[6]	N.P.[6]	**CUMPLE η = 91.0**

Notación:
$\bar{\lambda}$: Limitación de esbeltez
N_t: Resistencia a tracción
N_c: Resistencia a compresión
M_y: Resistencia a flexión eje Y
M_z: Resistencia a flexión eje Z
V_z: Resistencia a corte Z
V_y: Resistencia a corte Y
M_yV_z: Resistencia a momento flector Y y fuerza cortante Z combinados
M_zV_y: Resistencia a momento flector Z y fuerza cortante Y combinados
NM_yM_z: Resistencia a flexión y axil combinados
$NM_yM_zV_tV_z$: Resistencia a flexión, axil y cortante combinados
M_t: Resistencia a torsión
M_tV_z: Resistencia a cortante Z y momento torsor combinados
M_tV_y: Resistencia a cortante Y y momento torsor combinados
x: Distancia al origen de la barra
η: Coeficiente de aprovechamiento (%)
N.P.: No procede

Comprobaciones que no proceden (N.P.):
[1] La comprobación no procede, ya que no hay axil de tracción.
[2] La comprobación no procede, ya que no hay momento flector.
[3] La comprobación no procede, ya que no hay esfuerzo cortante.
[4] No hay interacción entre momento flector y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.
[5] La comprobación no procede, ya que no hay momento torsor.
[6] No hay interacción entre momento torsor y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.

Design Development 2

Comprobaciones de resistencia		
Referencia: -Placa base: Ancho X: 300 mm Ancho Y: 300 mm Espesor: 10 mm -Pernos: 4Ø16 mm L=30 cm Patilla a 90 grados -Disposición: Posición X: Centrada Posición Y: Centrada		
Comprobación	Valores	Estado
Separación mínima entre pernos: *3 diámetros*	Mínimo: 48 mm Calculado: 200 mm	Cumple
Separación mínima pernos-borde: *1.5 diámetros*	Mínimo: 24 mm Calculado: 50 mm	Cumple
Longitud mínima del perno: *Se calcula la longitud de anclaje necesaria por adherencia.*	Mínimo: 16 cm Calculado: 30 cm	Cumple
Anclaje perno en hormigón: - Tracción: - Cortante: - Tracción + Cortante:	 Máximo: 5.437 t Calculado: 1.756 t Máximo: 3.806 t Calculado: 0.007 t Máximo: 5.437 t Calculado: 1.766 t	 Cumple Cumple Cumple
Tracción en vástago de pernos:	Máximo: 6.557 t Calculado: 1.482 t	Cumple
Tensión de Von Mises en vástago de pernos:	Máximo: 3883.31 kp/cm² Calculado: 737.225 kp/cm²	Cumple
Aplastamiento perno en placa: *Límite del cortante en un perno actuando contra la placa*	Máximo: 8.543 t Calculado: 0.006 t	Cumple
Tensión de Von Mises en secciones globales: - Derecha: - Izquierda: - Arriba: - Abajo:	Máximo: 2669.77 kp/cm² Calculado: 1643.03 kp/cm² Calculado: 1643.03 kp/cm² Calculado: 1995.04 kp/cm² Calculado: 1555.68 kp/cm²	 Cumple Cumple Cumple Cumple
Flecha global equivalente: *Limitación de la deformabilidad de los vuelos* - Derecha: - Izquierda: - Arriba: - Abajo:	Mínimo: 250 Calculado: 564.264 Calculado: 564.264 Calculado: 371.504 Calculado: 413.025	 Cumple Cumple Cumple Cumple
Tensión de Von Mises local: *Tensión por tracción de pernos sobre placas en voladizo*	Máximo: 2669.77 kp/cm² Calculado: 0 kp/cm²	Cumple
Se cumplen todas las comprobaciones		
Información adicional:		
- Relación rotura pésima sección de hormigón: 0.0416		

Comprobaciones de resistencia		
Referencia: -Placa base: Ancho X: 300 mm Ancho Y: 300 mm Espesor: 10 mm -Pernos: 4Ø16 mm L=30 cm Patilla a 90 grados -Disposición: Posición X: Centrada Posición Y: Centrada		
Comprobación	Valores	Estado
Separación mínima entre pernos: *3 diámetros*	Mínimo: 48 mm Calculado: 200 mm	Cumple
Separación mínima pernos-borde: *1.5 diámetros*	Mínimo: 24 mm Calculado: 50 mm	Cumple
Longitud mínima del perno: *Se calcula la longitud de anclaje necesaria por adherencia.*	Mínimo: 16 cm Calculado: 30 cm	Cumple
Anclaje perno en hormigón: - Tracción: - Cortante: - Tracción + Cortante:	 Máximo: 5.437 t Calculado: 2.208 t Máximo: 3.806 t Calculado: 0.012 t Máximo: 5.437 t Calculado: 2.225 t	 Cumple Cumple Cumple
Tracción en vástago de pernos:	Máximo: 6.557 t Calculado: 1.863 t	Cumple
Tensión de Von Mises en vástago de pernos:	Máximo: 3883.31 kp/cm² Calculado: 926.863 kp/cm²	Cumple
Aplastamiento perno en placa: *Límite del cortante en un perno actuando contra la placa*	Máximo: 8.543 t Calculado: 0.01 t	Cumple
Tensión de Von Mises en secciones globales: - Derecha: - Izquierda: - Arriba: - Abajo:	Máximo: 2669.77 kp/cm² Calculado: 2062.29 kp/cm² Calculado: 2062.29 kp/cm² Calculado: 2508.37 kp/cm² Calculado: 1937.63 kp/cm²	 Cumple Cumple Cumple Cumple
Flecha global equivalente: *Limitación de la deformabilidad de los vuelos* - Derecha: - Izquierda: - Arriba: - Abajo:	Mínimo: 250 Calculado: 450.452 Calculado: 450.452 Calculado: 295.502 Calculado: 331.565	 Cumple Cumple Cumple Cumple
Tensión de Von Mises local: *Tensión por tracción de pernos sobre placas en voladizo*	Máximo: 2669.77 kp/cm² Calculado: 0 kp/cm²	Cumple
Se cumplen todas las comprobaciones		
Información adicional:		
- Relación rotura pésima sección de hormigón: 0.0523		

Design Development 2

Comprobaciones de resistencia		
Referencia: -Placa base: Ancho X: 400 mm Ancho Y: 400 mm Espesor: 10 mm -Pernos: 4Ø16 mm L=30 cm Patilla a 90 grados -Disposición: Posición X: Centrada Posición Y: Centrada -Rigidizadores: Paralelos X: 1(150x0x10.0) Paralelos Y: 1(150x0x10.0)		
Comprobación	Valores	Estado
Separación mínima entre pernos: *3 diámetros*	Mínimo: 48 mm Calculado: 301 mm	Cumple
Separación mínima pernos-borde: *1.5 diámetros*	Mínimo: 24 mm Calculado: 50 mm	Cumple
Esbeltez de rigidizadores:	Máximo: 50	
- Paralelos a X:	Calculado: 33.7	Cumple
- Paralelos a Y:	Calculado: 33.7	Cumple
Longitud mínima del perno: *Se calcula la longitud de anclaje necesaria por adherencia.*	Mínimo: 17 cm Calculado: 30 cm	Cumple
Anclaje perno en hormigón:		
- Tracción:	Máximo: 5.437 t Calculado: 1.016 t	Cumple
- Cortante:	Máximo: 3.806 t Calculado: 0.339 t	Cumple
- Tracción + Cortante:	Máximo: 5.437 t Calculado: 1.5 t	Cumple
Tracción en vástago de pernos:	Máximo: 8.196 t Calculado: 0.847 t	Cumple
Tensión de Von Mises en vástago de pernos:	Máximo: 4854.13 kp/cm² Calculado: 502.622 kp/cm²	Cumple
Aplastamiento perno en placa: *Límite del cortante en un perno actuando contra la placa*	Máximo: 8.543 t Calculado: 0.286 t	Cumple
Tensión de Von Mises en secciones globales:	Máximo: 2669.77 kp/cm²	
- Derecha:	Calculado: 530.356 kp/cm²	Cumple
- Izquierda:	Calculado: 530.356 kp/cm²	Cumple
- Arriba:	Calculado: 185.631 kp/cm²	Cumple
- Abajo:	Calculado: 1807.7 kp/cm²	Cumple
Flecha global equivalente: *Limitación de la deformabilidad de los vuelos*	Mínimo: 250	
- Derecha:	Calculado: 22278	Cumple
- Izquierda:	Calculado: 22278	Cumple
- Arriba:	Calculado: 48003.1	Cumple
- Abajo:	Calculado: 5780	Cumple
Tensión de Von Mises local: *Tensión por tracción de pernos sobre placas en voladizo*	Máximo: 2669.77 kp/cm² Calculado: 0 kp/cm²	Cumple
Se cumplen todas las comprobaciones		
Información adicional:		
- Relación rotura pésima sección de hormigón: 0.11		

Comprobaciones de resistencia		
Referencia: -Placa base: Ancho X: 400 mm Ancho Y: 400 mm Espesor: 10 mm -Pernos: 4Ø16 mm L=30 cm Patilla a 90 grados -Disposición: Posición X: Centrada Posición Y: Centrada -Rigidizadores: Paralelos X: 1(150x0x10.0) Paralelos Y: 1(150x0x10.0)		
Comprobación	Valores	Estado
Separación mínima entre pernos: *3 diámetros*	Mínimo: 48 mm Calculado: 340 mm	Cumple
Separación mínima pernos-borde: *1.5 diámetros*	Mínimo: 24 mm Calculado: 30 mm	Cumple
Esbeltez de rigidizadores:	Máximo: 50	
- Paralelos a X:	Calculado: 33.7	Cumple
- Paralelos a Y:	Calculado: 33.7	Cumple
Longitud mínima del perno: *Se calcula la longitud de anclaje necesaria por adherencia.*	Mínimo: 17 cm Calculado: 30 cm	Cumple
Anclaje perno en hormigón:		
- Tracción:	Máximo: 5.437 t Calculado: 1.049 t	Cumple
- Cortante:	Máximo: 3.806 t Calculado: 0.339 t	Cumple
- Tracción + Cortante:	Máximo: 5.437 t Calculado: 1.532 t	Cumple
Tracción en vástago de pernos:	Máximo: 8.196 t Calculado: 0.875 t	Cumple
Tensión de Von Mises en vástago de pernos:	Máximo: 4854.13 kp/cm² Calculado: 514.355 kp/cm²	Cumple
Aplastamiento perno en placa: *Límite del cortante en un perno actuando contra la placa*	Máximo: 8.543 t Calculado: 0.286 t	Cumple
Tensión de Von Mises en secciones globales:	Máximo: 2669.77 kp/cm²	
- Derecha:	Calculado: 506.302 kp/cm²	Cumple
- Izquierda:	Calculado: 506.302 kp/cm²	Cumple
- Arriba:	Calculado: 237.125 kp/cm²	Cumple
- Abajo:	Calculado: 1771.31 kp/cm²	Cumple
Flecha global equivalente: *Limitación de la deformabilidad de los vuelos*	Mínimo: 250	
- Derecha:	Calculado: 24486.9	Cumple
- Izquierda:	Calculado: 24486.9	Cumple
- Arriba:	Calculado: 32273.6	Cumple
- Abajo:	Calculado: 5916.42	Cumple
Tensión de Von Mises local: *Tensión por tracción de pernos sobre placas en voladizo*	Máximo: 2669.77 kp/cm² Calculado: 0 kp/cm²	Cumple
Se cumplen todas las comprobaciones		
Información adicional:		
- Relación rotura pésima sección de hormigón: 0.107		

Design Development 2

Referencia: 1 Dimensiones: 200 x 200 x 60 Armados: Xi:Ø12c/20 Yi:Ø12c/20 Xs:Ø12c/20 Ys:Ø12c/20		
Comprobación	Valores	Estado
Tensiones sobre el terreno: *Criterio de CYPE Ingenieros*		
- Tensión media en situaciones persistentes:	Máximo: 2 kp/cm² Calculado: 0.421 kp/cm²	Cumple
- Tensión máxima en situaciones persistentes sin viento:	Máximo: 2.5 kp/cm² Calculado: 0.842 kp/cm²	Cumple
- Tensión máxima en situaciones persistentes con viento:	Máximo: 2.5 kp/cm² Calculado: 0.842 kp/cm²	Cumple
Vuelco de la zapata:		
- En dirección X: *Si el % de reserva de seguridad es mayor que cero, quiere decir que los coeficientes de seguridad al vuelco son mayores que los valores estrictos exigidos para todas las combinaciones de equilibrio.*	Reserva seguridad: 184.5 %	Cumple
- En dirección Y [(1)] [(1)] *Sin momento de vuelco*		No procede
Flexión en la zapata:		
- En dirección X:	Momento: 13.36 t·m	Cumple
- En dirección Y:	Momento: 3.73 t·m	Cumple
Cortante en la zapata:		
- En dirección X:	Cortante: 7.54 t	Cumple
- En dirección Y:	Cortante: 3.22 t	Cumple
Compresión oblicua en la zapata: - Situaciones persistentes: *Criterio de CYPE Ingenieros*	Máximo: 509.68 t/m² Calculado: 59.2 t/m²	Cumple
Canto mínimo: *Artículo 58.8.1 de la norma EHE-08*	Mínimo: 25 cm Calculado: 60 cm	Cumple
Espacio para anclar arranques en cimentación: - 1:	Mínimo: 30 cm Calculado: 53 cm	Cumple
Cuantía geométrica mínima: *Artículo 42.3.5 de la norma EHE-08*	Mínimo: 0.0009	
- Armado inferior dirección X:	Calculado: 0.0009	Cumple
- Armado superior dirección X:	Calculado: 0.0009	Cumple
- Armado inferior dirección Y:	Calculado: 0.0009	Cumple
- Armado superior dirección Y:	Calculado: 0.0009	Cumple
Cuantía mínima necesaria por flexión: *Artículo 42.3.2 de la norma EHE-08*	Calculado: 0.001	
- Armado inferior dirección X:	Mínimo: 0.0008	Cumple
- Armado inferior dirección Y:	Mínimo: 0.0003	Cumple
- Armado superior dirección X:	Mínimo: 0.0001	Cumple
Diámetro mínimo de las barras: *Recomendación del Artículo 58.8.2 (norma EHE-08)*	Mínimo: 12 mm	
- Parrilla inferior:	Calculado: 12 mm	Cumple
- Parrilla superior:	Calculado: 12 mm	Cumple
Separación máxima entre barras: *Artículo 58.8.2 de la norma EHE-08*	Máximo: 30 cm	
- Armado inferior dirección X:	Calculado: 20 cm	Cumple
- Armado inferior dirección Y:	Calculado: 20 cm	Cumple
- Armado superior dirección X:	Calculado: 20 cm	Cumple
- Armado superior dirección Y:	Calculado: 20 cm	Cumple
Separación mínima entre barras: *Criterio de CYPE Ingenieros, basado en: J. Calavera. "Cálculo de Estructuras de Cimentación". Capítulo 3.16*	Mínimo: 10 cm	
- Armado inferior dirección X:	Calculado: 20 cm	Cumple
- Armado inferior dirección Y:	Calculado: 20 cm	Cumple
- Armado superior dirección X:	Calculado: 20 cm	Cumple

Design Development 2

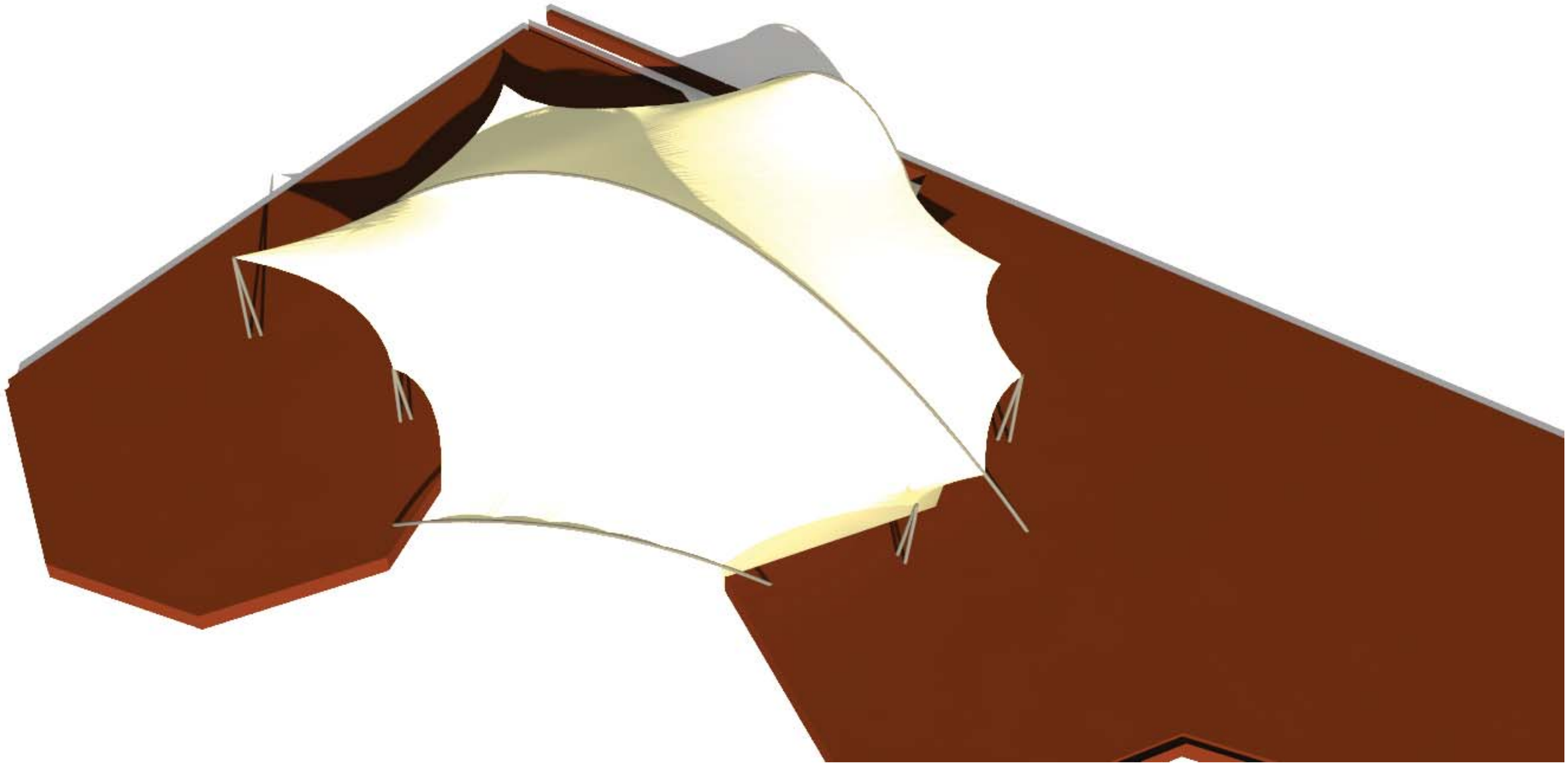
Referencia: (1-2) Dimensiones: 155 x 220 x 65 Armados: Xi:Ø12c/17 Yi:Ø12c/17 Xs:Ø12c/17 Ys:Ø12c/17		
Comprobación	Valores	Estado
Tensiones sobre el terreno: *Criterio de CYPE Ingenieros*		
- Tensión media en situaciones persistentes:	Máximo: 2 kp/cm² Calculado: 0.168 kp/cm²	Cumple
- Tensión máxima en situaciones persistentes:	Máximo: 2.5 kp/cm² Calculado: 0.336 kp/cm²	Cumple
Vuelco de la zapata:		
- En dirección X [1]		No procede
- En dirección Y: *Si el % de reserva de seguridad es mayor que cero, quiere decir que los coeficientes de seguridad al vuelco son mayores que los valores estrictos exigidos para todas las combinaciones de equilibrio.*	Reserva seguridad: 194.0 %	Cumple
[1] *Sin momento de vuelco*		
Flexión en la zapata:		
- En dirección X:	Momento: 0.00 t·m	Cumple
- En dirección Y:	Momento: -1.23 t·m	Cumple
Cortante en la zapata:		
- En dirección X:	Cortante: 0.02 t	Cumple
- En dirección Y:	Cortante: 0.75 t	Cumple
Compresión oblicua en la zapata:		
- Situaciones persistentes: *Criterio de CYPE Ingenieros*	Máximo: 509.68 t/m² Calculado: 19.56 t/m²	Cumple
Canto mínimo: *Artículo 58.8.1 de la norma EHE-08*	Mínimo: 25 cm Calculado: 65 cm	Cumple
Espacio para anclar arranques en cimentación:	Mínimo: 24 cm	
- 1:	Calculado: 58 cm	Cumple
- 2:	Calculado: 58 cm	Cumple
Cuantía geométrica mínima: *Artículo 42.3.5 de la norma EHE-08*	Mínimo: 0.001	
- Armado inferior dirección X:	Calculado: 0.001	Cumple
- Armado superior dirección X:	Calculado: 0.001	Cumple
- Armado inferior dirección Y:	Calculado: 0.001	Cumple
- Armado superior dirección Y:	Calculado: 0.001	Cumple
Cuantía mínima necesaria por flexión: *Artículo 42.3.2 de la norma EHE-08*	Calculado: 0.0011	
- Armado inferior dirección Y:	Mínimo: 0.0001	Cumple
- Armado superior dirección Y:	Mínimo: 0.0002	Cumple
Diámetro mínimo de las barras: *Recomendación del Artículo 58.8.2 (norma EHE-08)*	Mínimo: 12 mm	
- Parrilla inferior:	Calculado: 12 mm	Cumple
- Parrilla superior:	Calculado: 12 mm	Cumple
Separación máxima entre barras: *Artículo 58.8.2 de la norma EHE-08*	Máximo: 30 cm	
- Armado inferior dirección X:	Calculado: 17 cm	Cumple
- Armado inferior dirección Y:	Calculado: 17 cm	Cumple
- Armado superior dirección X:	Calculado: 17 cm	Cumple
- Armado superior dirección Y:	Calculado: 17 cm	Cumple
Separación mínima entre barras: *Criterio de CYPE Ingenieros, basado en: J. Calavera. "Cálculo de Estructuras de Cimentación". Capítulo 3.16*	Mínimo: 10 cm	
- Armado inferior dirección X:	Calculado: 17 cm	Cumple
- Armado inferior dirección Y:	Calculado: 17 cm	Cumple
- Armado superior dirección X:	Calculado: 17 cm	Cumple
- Armado superior dirección Y:	Calculado: 17 cm	Cumple

Design Development 2

Referencia: (1-2) Dimensiones: 155 x 220 x 65 Armados: Xi:Ø12c/17 Yi:Ø12c/17 Xs:Ø12c/17 Ys:Ø12c/17		
Comprobación	Valores	Estado
Tensiones sobre el terreno: *Criterio de CYPE Ingenieros*		
- Tensión media en situaciones persistentes:	Máximo: 2 kp/cm² Calculado: 0.212 kp/cm²	Cumple
- Tensión máxima en situaciones persistentes:	Máximo: 2.5 kp/cm² Calculado: 0.424 kp/cm²	Cumple
Vuelco de la zapata:		
- En dirección X [1]		No procede
- En dirección Y: *Si el % de reserva de seguridad es mayor que cero, quiere decir que los coeficientes de seguridad al vuelco son mayores que los valores estrictos exigidos para todas las combinaciones de equilibrio.*	Reserva seguridad: 108.4 %	Cumple
[1] *Sin momento de vuelco*		
Flexión en la zapata:		
- En dirección X:	Momento: 0.00 t·m	Cumple
- En dirección Y:	Momento: 1.55 t·m	Cumple
Cortante en la zapata:		
- En dirección X:	Cortante: 0.02 t	Cumple
- En dirección Y:	Cortante: 1.11 t	Cumple
Compresión oblicua en la zapata:		
- Situaciones persistentes: *Criterio de CYPE Ingenieros*	Máximo: 509.68 t/m² Calculado: 24.14 t/m²	Cumple
Canto mínimo: *Artículo 58.8.1 de la norma EHE-08*	Mínimo: 25 cm Calculado: 65 cm	Cumple
Espacio para anclar arranques en cimentación:	Mínimo: 30 cm	
- 1:	Calculado: 58 cm	Cumple
- 2:	Calculado: 58 cm	Cumple
Cuantía geométrica mínima: *Artículo 42.3.5 de la norma EHE-08*	Mínimo: 0.0009	
- Armado inferior dirección X:	Calculado: 0.001	Cumple
- Armado superior dirección X:	Calculado: 0.001	Cumple
- Armado inferior dirección Y:	Calculado: 0.001	Cumple
- Armado superior dirección Y:	Calculado: 0.001	Cumple
Cuantía mínima necesaria por flexión: *Artículo 42.3.2 de la norma EHE-08*	Calculado: 0.0011	
- Armado inferior dirección Y:	Mínimo: 0.0002	Cumple
- Armado superior dirección Y:	Mínimo: 0.0001	Cumple
Diámetro mínimo de las barras: *Recomendación del Artículo 58.8.2 (norma EHE-08)*	Mínimo: 12 mm	
- Parrilla inferior:	Calculado: 12 mm	Cumple
- Parrilla superior:	Calculado: 12 mm	Cumple
Separación máxima entre barras: *Artículo 58.8.2 de la norma EHE-08*	Máximo: 30 cm	
- Armado inferior dirección X:	Calculado: 17 cm	Cumple
- Armado inferior dirección Y:	Calculado: 17 cm	Cumple
- Armado superior dirección X:	Calculado: 17 cm	Cumple
- Armado superior dirección Y:	Calculado: 17 cm	Cumple
Separación mínima entre barras: *Criterio de CYPE Ingenieros, basado en: J. Calavera. "Cálculo de Estructuras de Cimentación". Capítulo 3.16*	Mínimo: 10 cm	
- Armado inferior dirección X:	Calculado: 17 cm	Cumple
- Armado inferior dirección Y:	Calculado: 17 cm	Cumple
- Armado superior dirección X:	Calculado: 17 cm	Cumple
- Armado superior dirección Y:	Calculado: 17 cm	Cumple

Design Development 2

Conclution: After client discuss with the government's architect, the membrane size need to reduce and change some design because they not allow to build these large scale of membrane on this area.



Final Design

Final Design

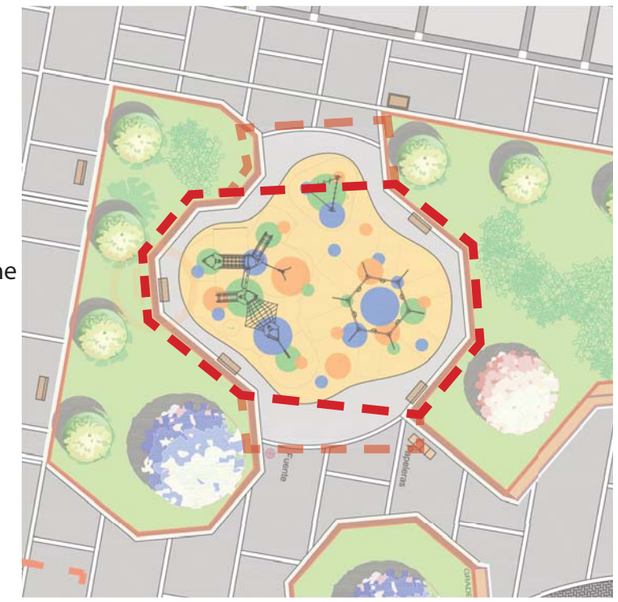
Change and Additional Briefs

- Cover area is reduce from the whole area to middle part of the playground.

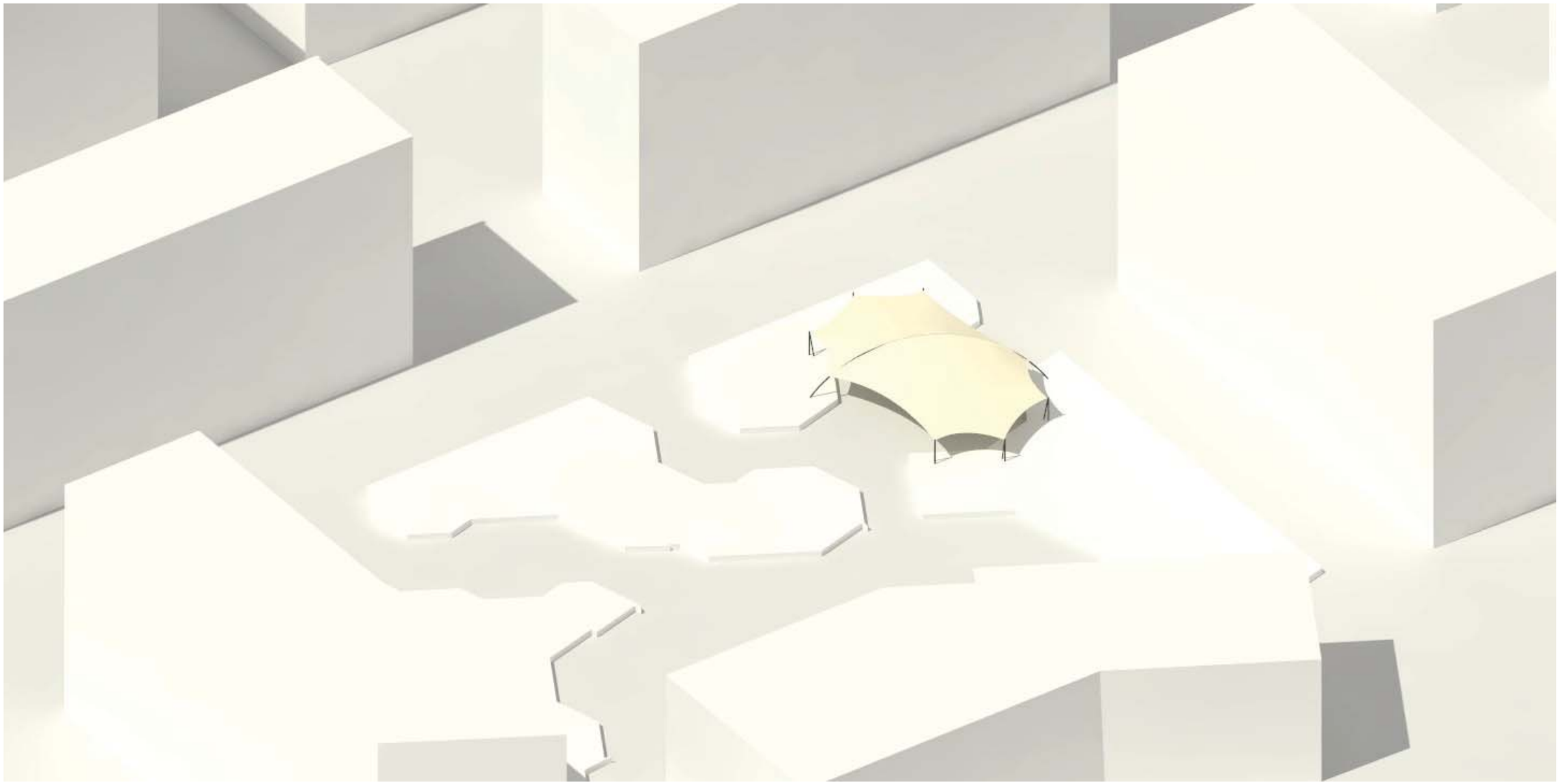
- The highest part decrease to 6,50 m

- Keep only the middle arch.

- Make a middle axis design to mirror membrane in two side. (lower cost of building.)

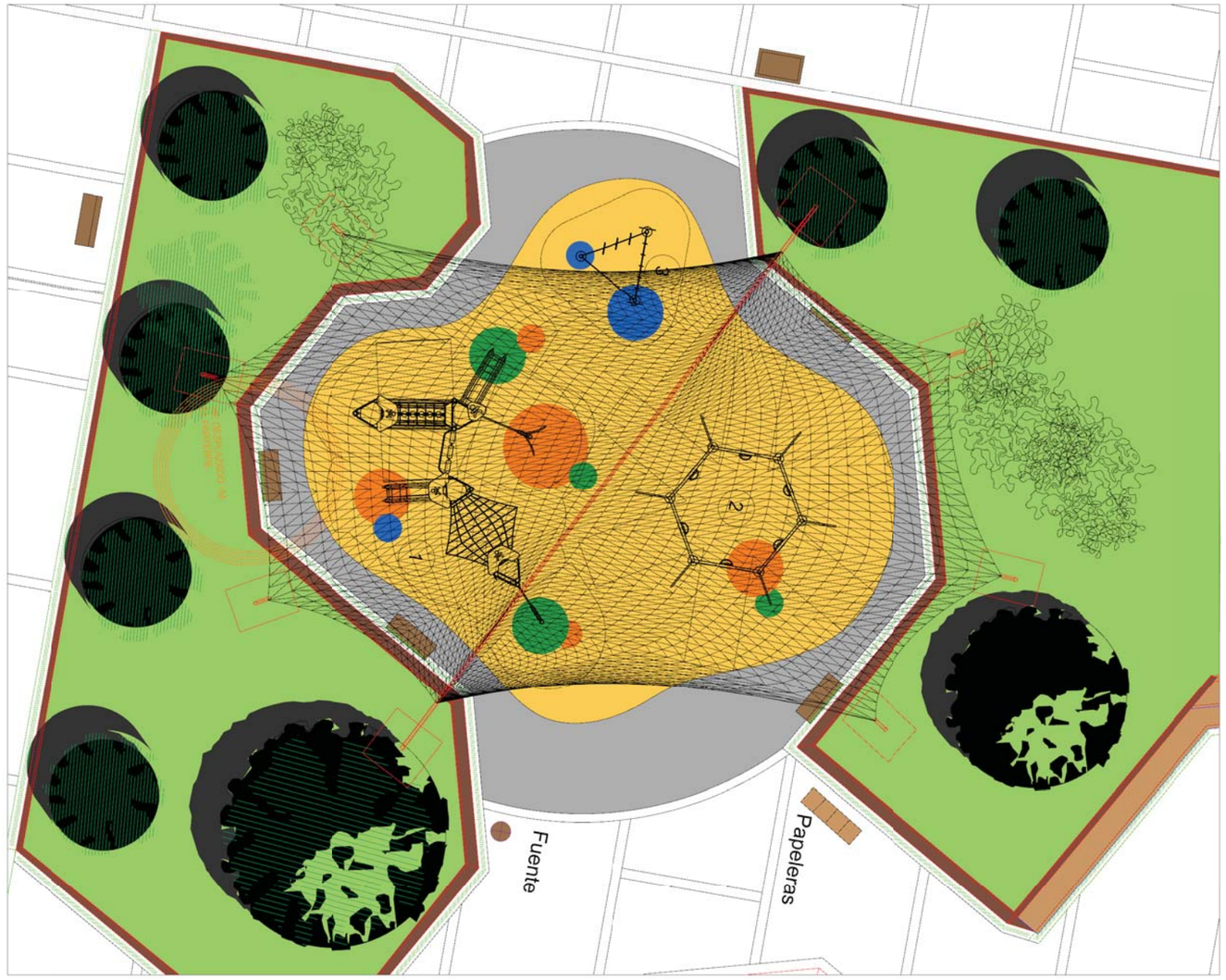


Final Design

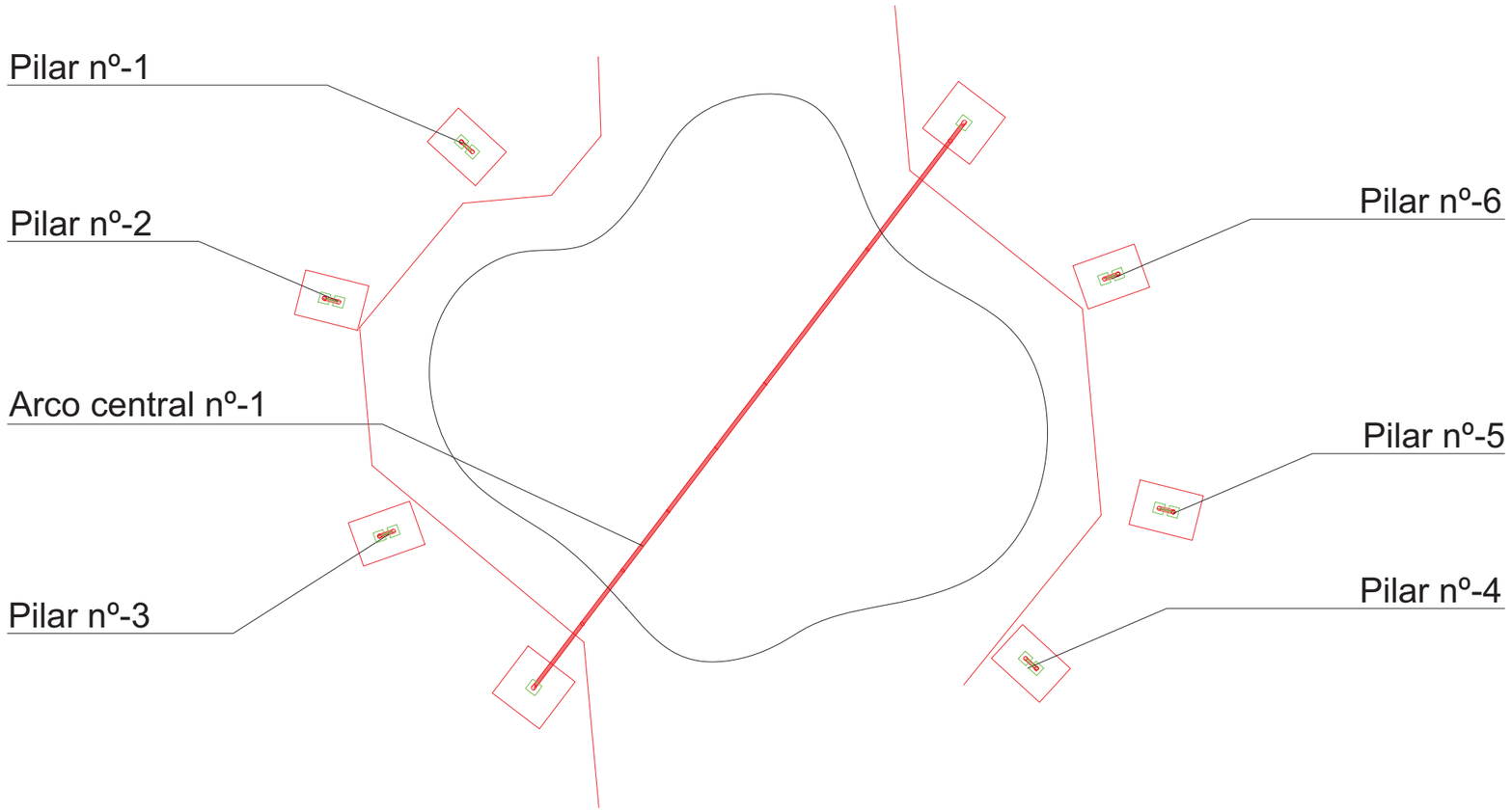


Final Design

Arcitectural Drawing and Details

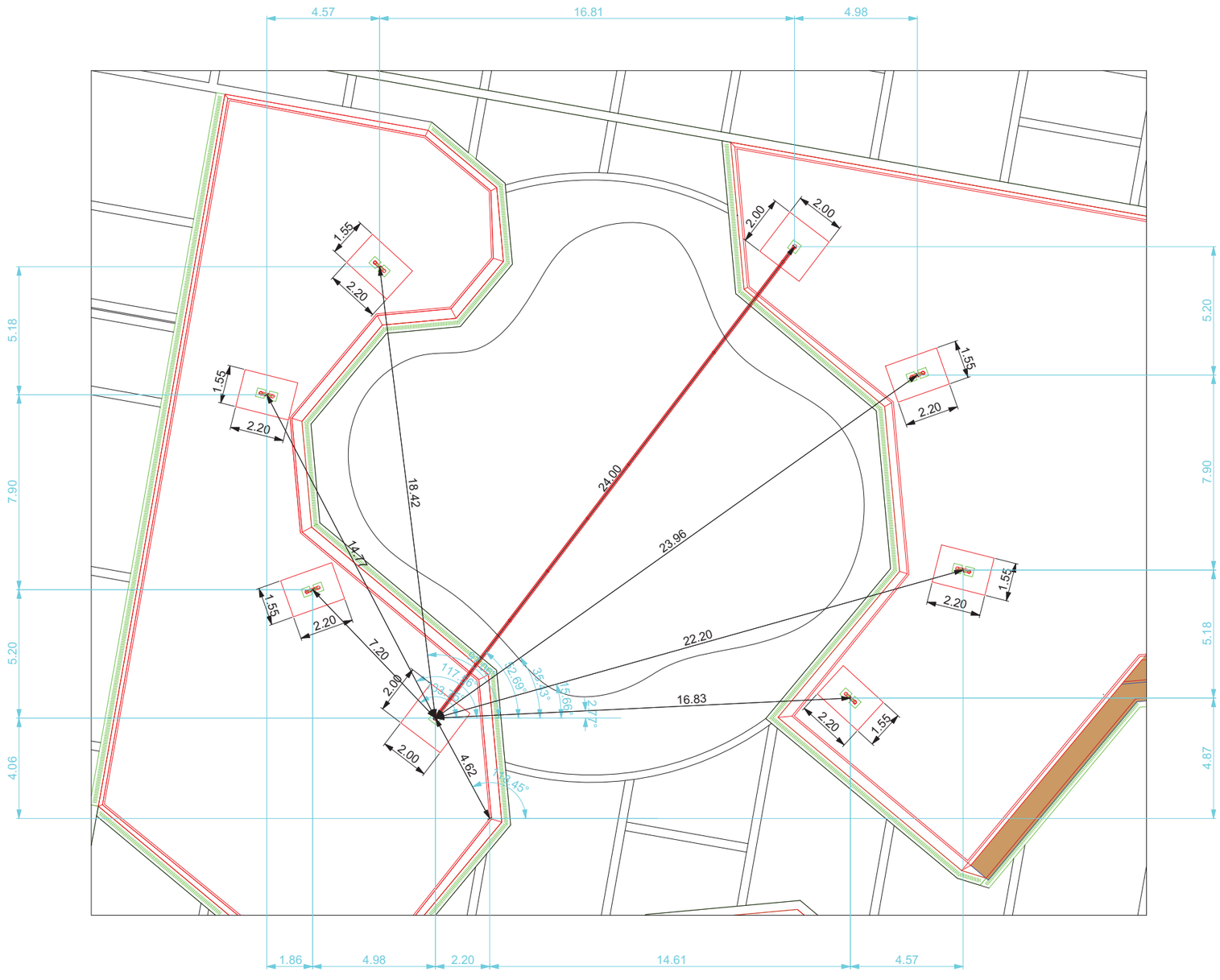


Cover area


Pilar nº-1
Pilar nº-2
Arco central nº-1
Pilar nº-3
Pilar nº-6
Pilar nº-5
Pilar nº-4

Final Design

Arcitectural Drawing and Details

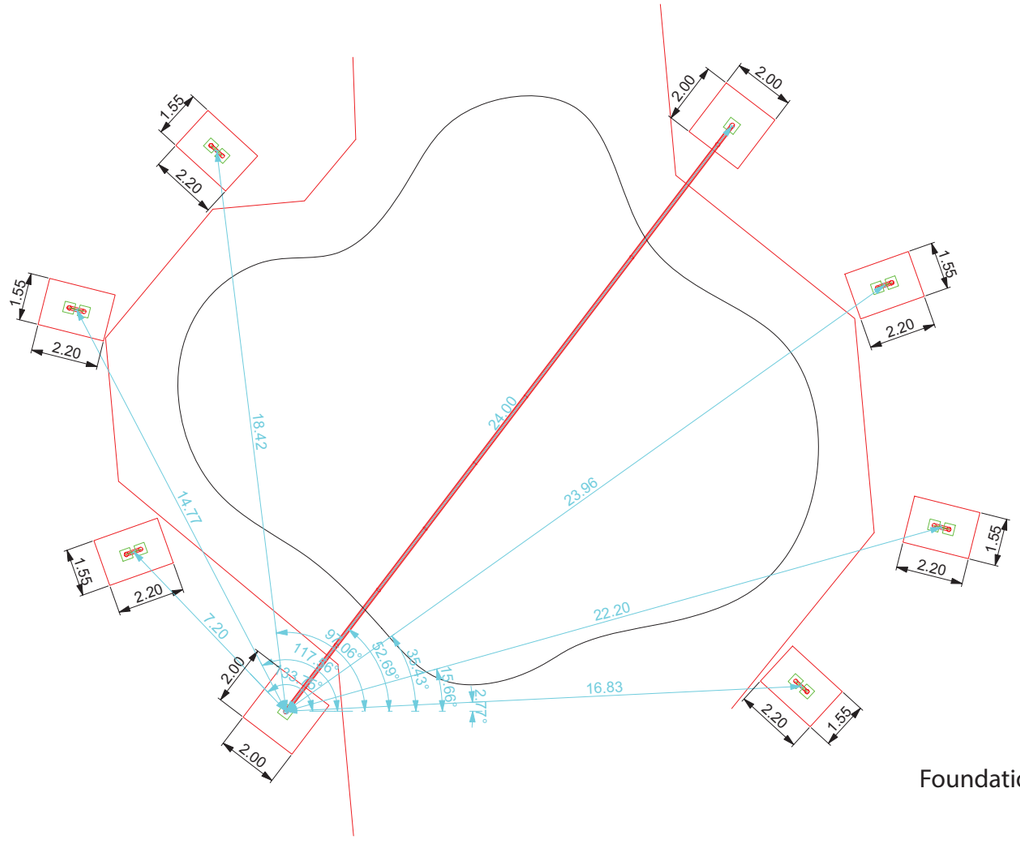


Foundation plan

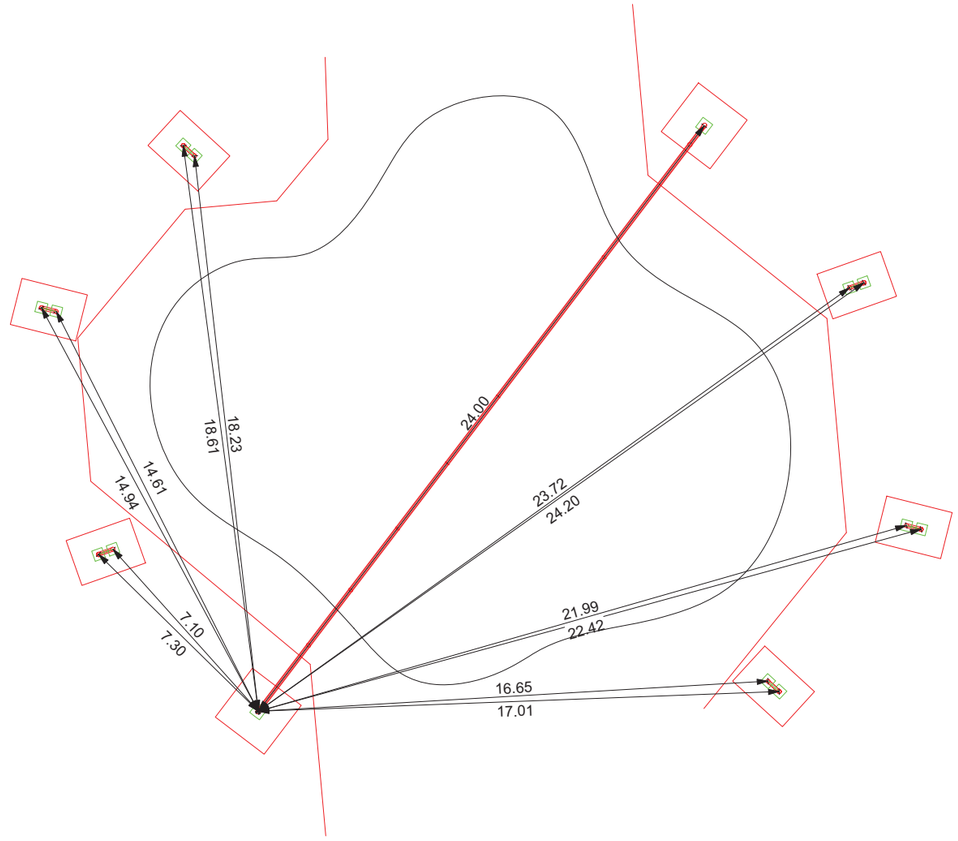
Thirachai Dheravatnvong
4059492

Final Design

Arcitectural Drawing and Details



Foundation plan

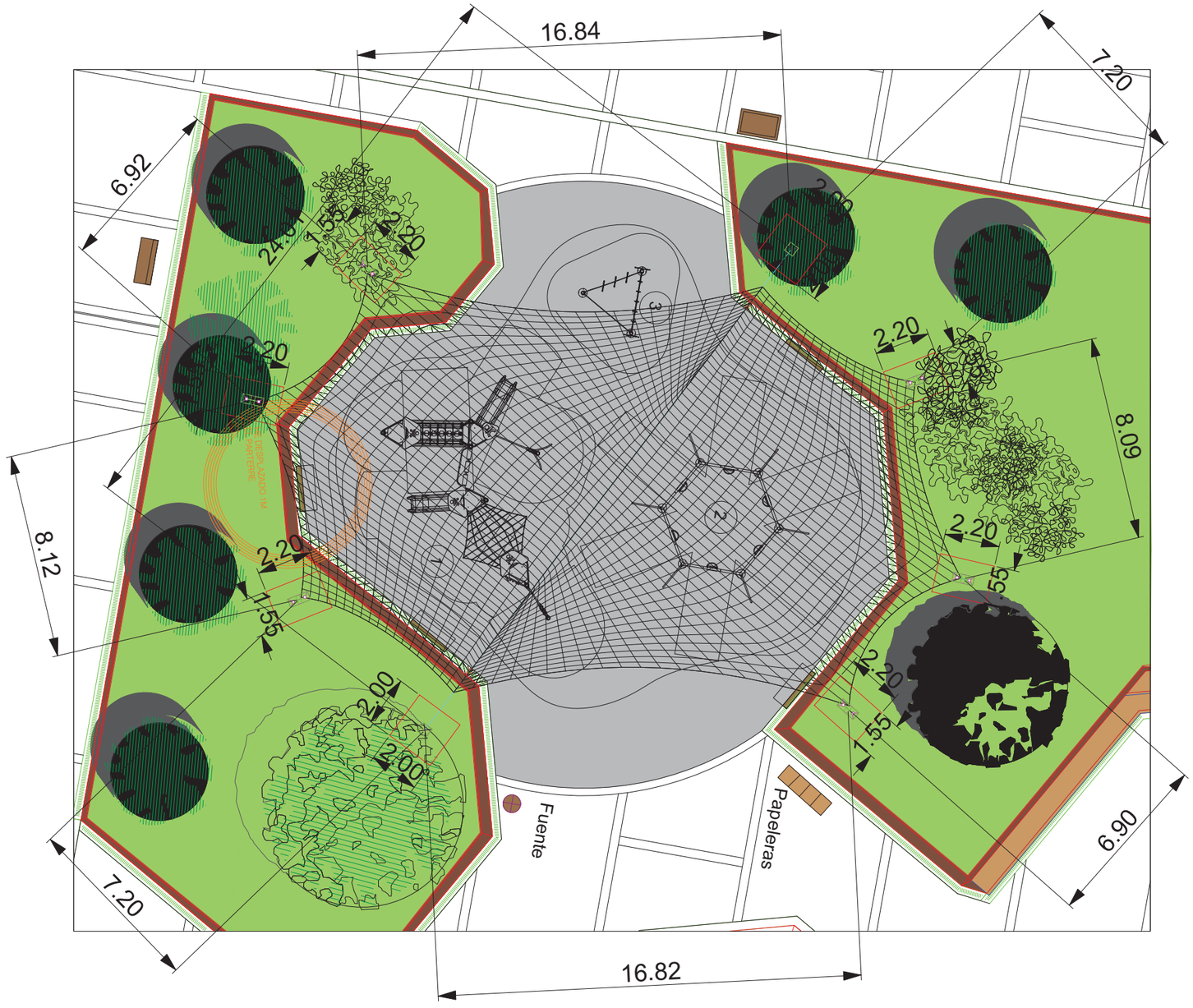


Structure plan

Final Design

Perspective

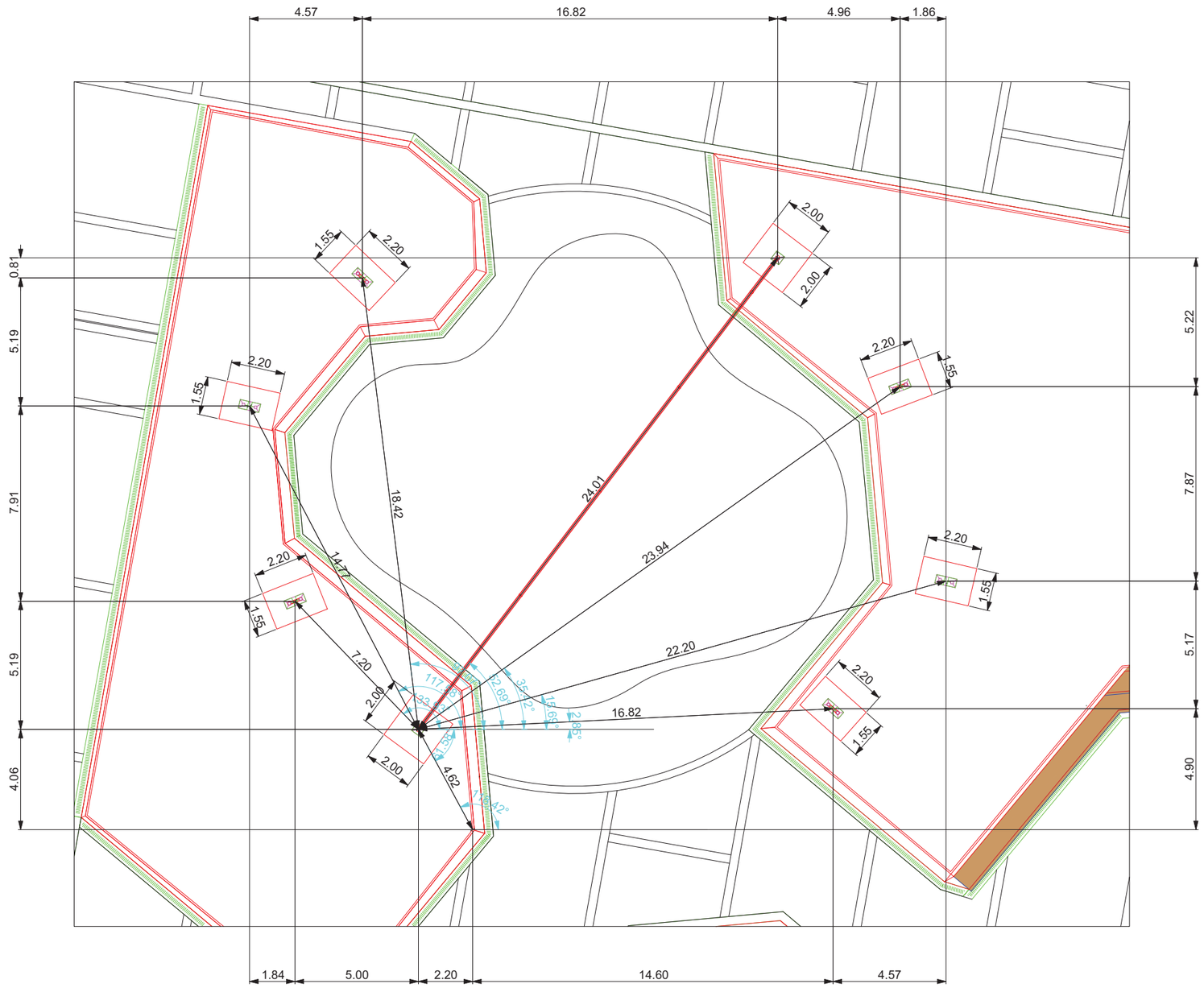
Construction Correspondence (Arcitectural Drawing and Details)



Cover area

Construction Correspondence (Arcitectural Drawing and Details)

Construction Correspondence (Arcitectural Drawing and Details)



Foundation plan

Construction Correspondence (Arcitectural Drawing and Details)

Foundation plan

Construction Correspondence (Arcitectural Drawing and Details)

Foundation plan

Construction Correspondence (Arcitectural Drawing and Details)

Pillar plan

Final Design

Membrane Details and Analysis

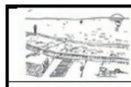
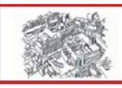
- Wind velocity pressure

Zone C = 29 m/s

- Cp - Values for membrame structures

Zone A = - 0.15
Zone B = - 0.6
Zone C = - 1.0
Zone D = + 0.4 / - 0.2

- Terrain Categories

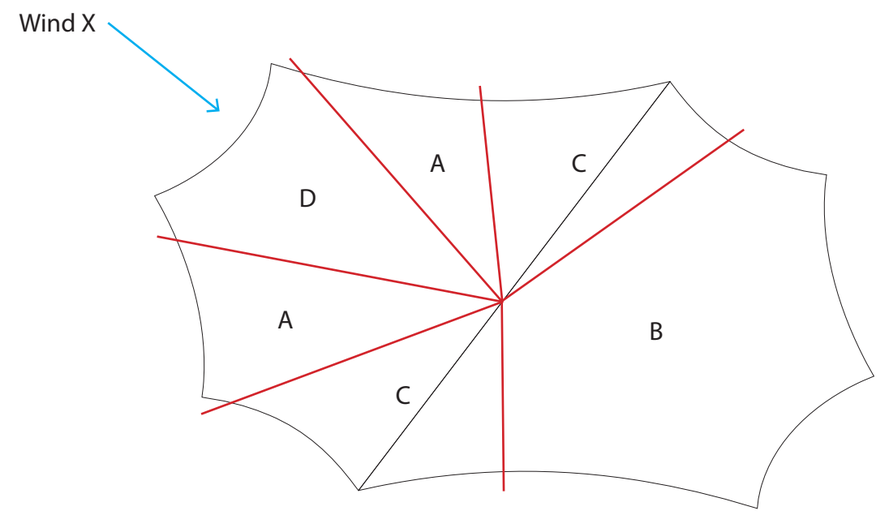
	**Category I** Rough open sea, […], even, flat country
	**Category II** Farmland with boundary hedges, […], occasional small farm structures
	**Category III** Suburban or industrial areas and permanent forests
	**Category IV** Urban areas, in which at least 15% of the surface is covered with buildings and their average height exceeds 15m

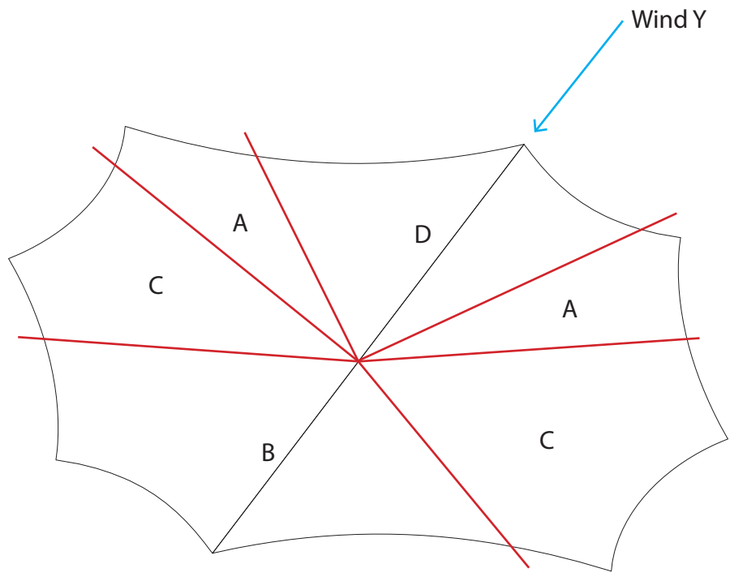
Terrain categories, DIN EN 1991-1-4, EC1-4)

- Load Cases

Combination	Self Weight	Wind X	Wind Y	Snow
LC 1	1			
LC 2	1	1		
LC 3	1		1	
LC 4	1			1
LC 5	1	1		1
LC 6	1		1	1
LC 7	1.35			
LC 8	1.35	1.5		
LC 9	1.35		1.5	
LC 10	1.35			1.5
LC 11	1.35	1.5		1.5
LC 12	1.35		1.5	1.5

- Membrane zones definition



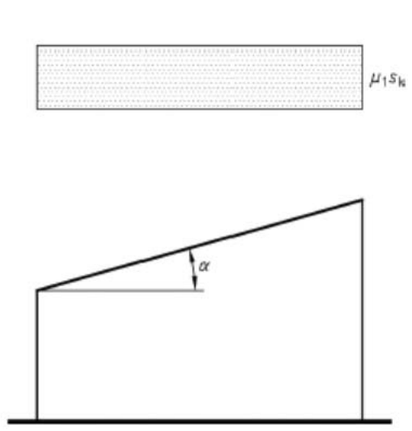


Membrane Details and Analysis

- Characteristic values for snow loads on the ground

- Ch

- Snow loads on roof : One-sided pitched roofs



Inclination α	$0° \le \alpha \le 30°$	$30° < \alpha \le 60°$	$\alpha > 60°$
Form factor μ_1	0,8	$0{,}8\,(60° - \alpha)/30°$	0

Form factor μ_1 (DIN EN 1991-1-3, EC1-3)

Load figure for even or one-sided pitched roofs
(DIN EN 1991-1-3, figure 5.2)

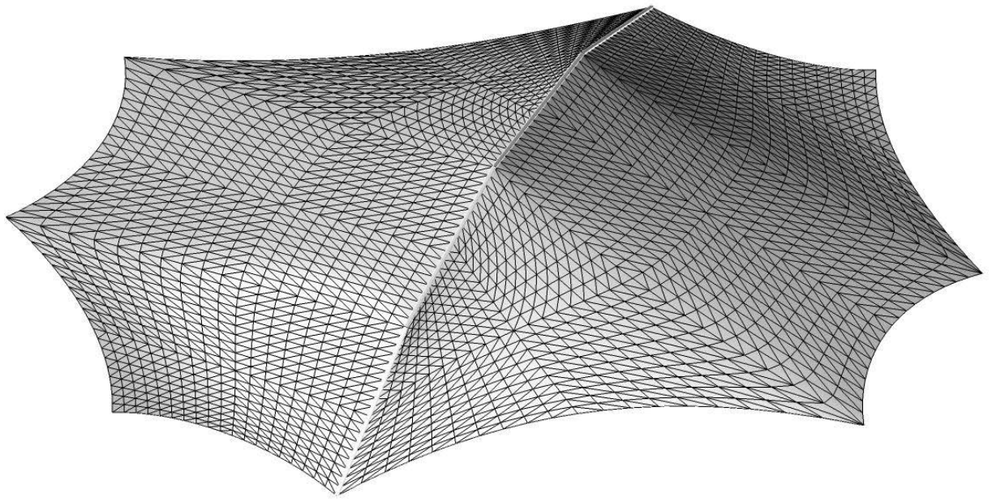
- Characteristic snow load on roof

si = μ1 * ce * ct * sk
si = 0,8 * 1,2 * 1,0 * 0,7 kN/m2 = 0,672 kN/m2

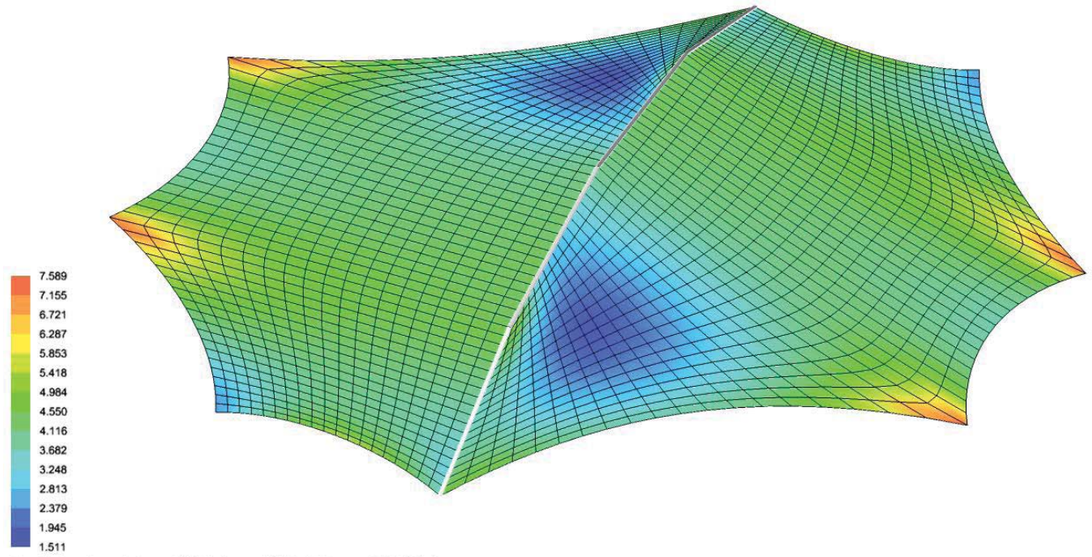
si = characteristic snow load for the roof area
μ1 = form factor of the roof area
ce = exposure coeffi cient
ct = thermal coeffi cient
sk = characteristic snow load on the ground

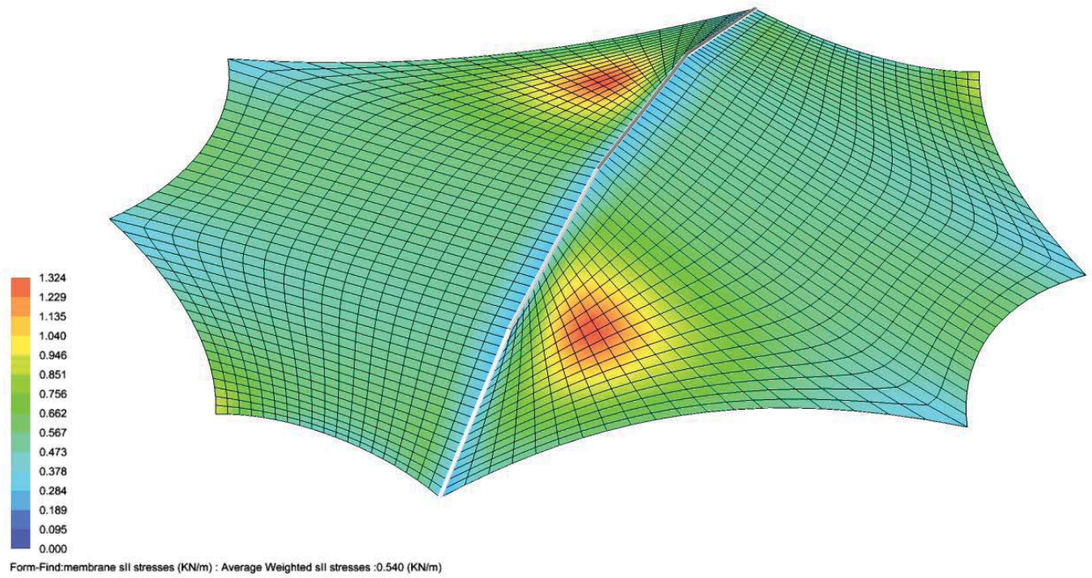
Membrane Details and Analysis

FDM Solver



FDM Solver

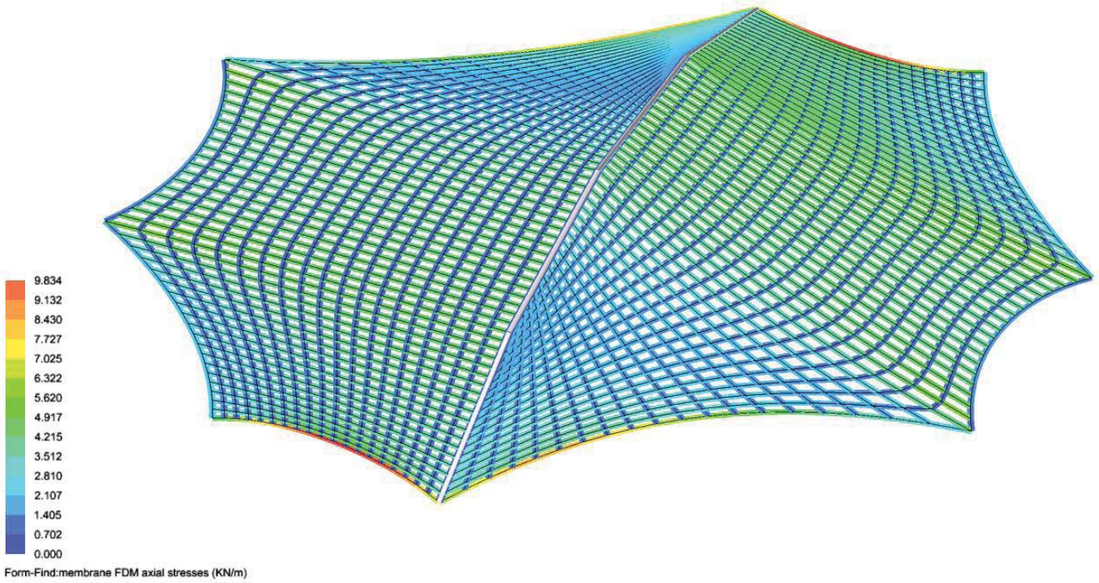




Form - finding

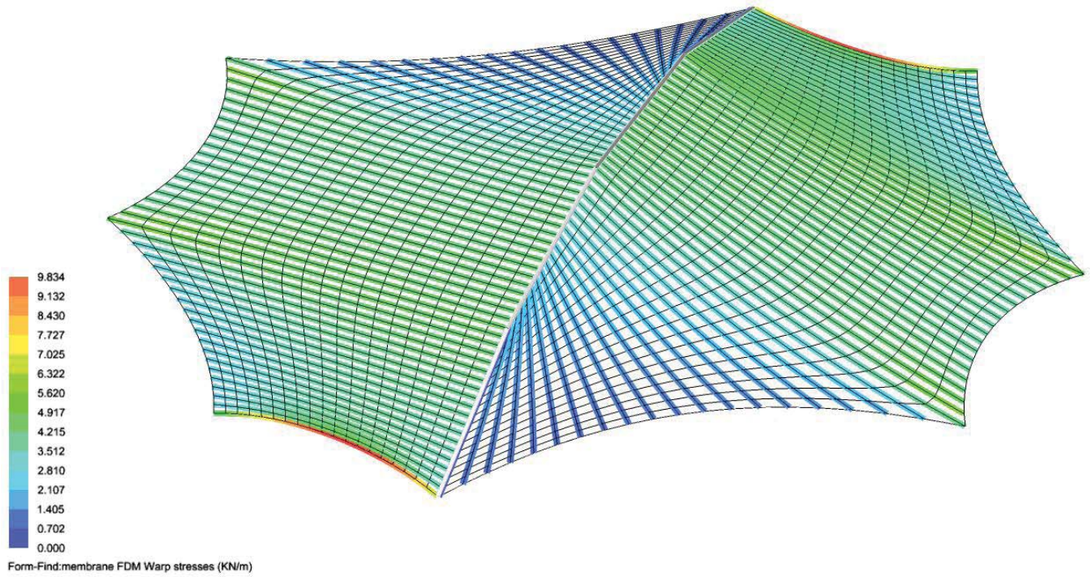
Membrane Details and Analysis

FDM Solver

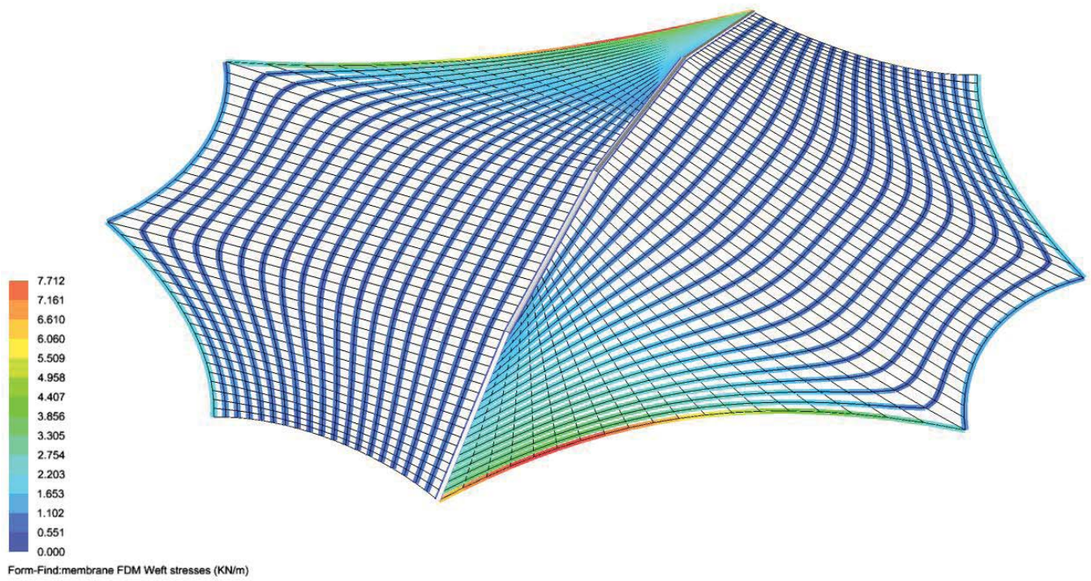


Form-Find:membrane FDM axial stresses (KN/m)

FDM Solver



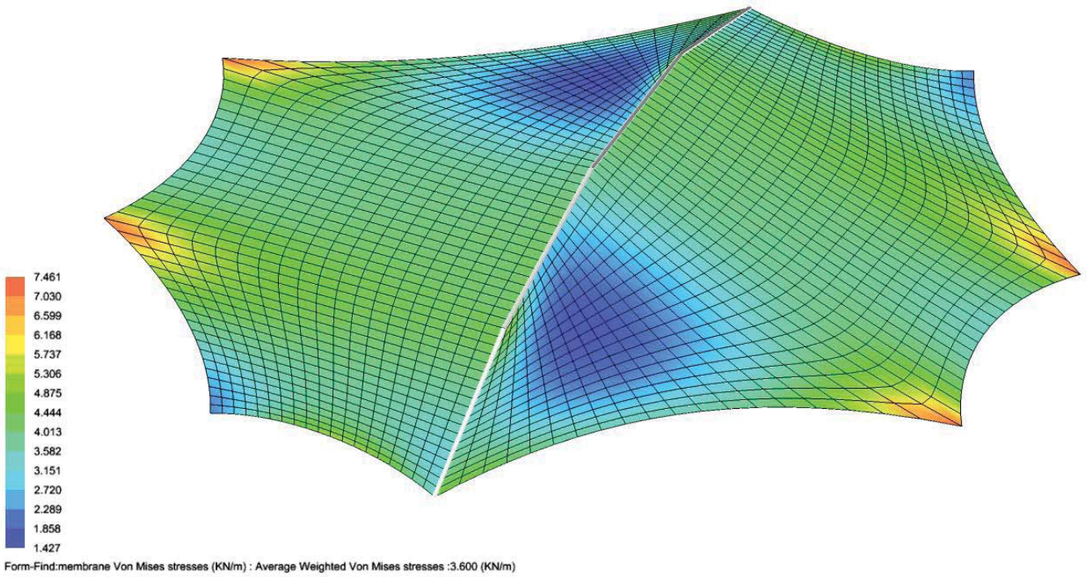
Form-Find:membrane FDM Warp stresses (KN/m)



Form-Find:membrane FDM Weft stresses (KN/m)

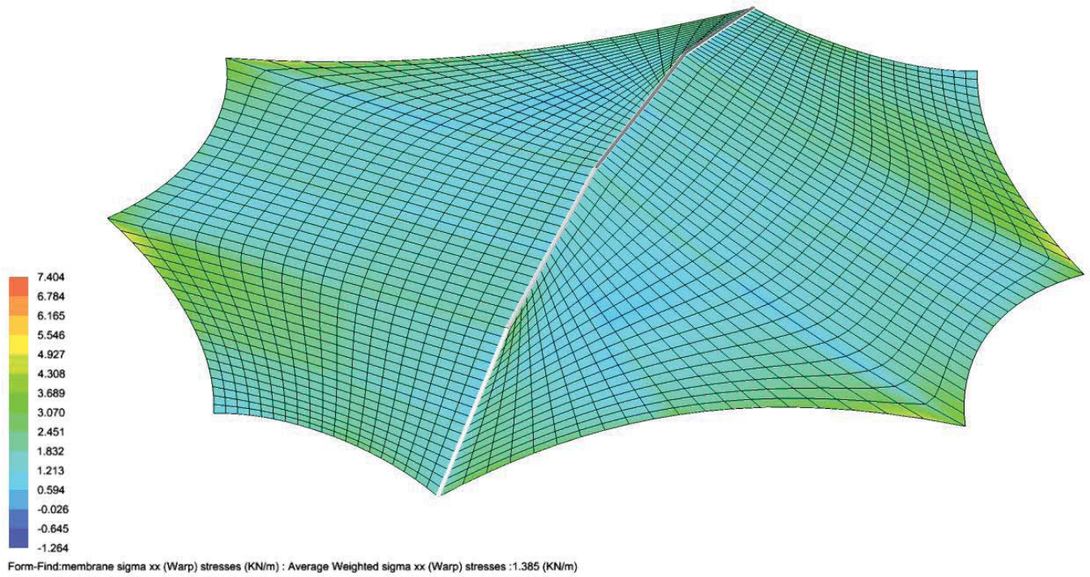
Membrane Details and Analysis

FDM Solver

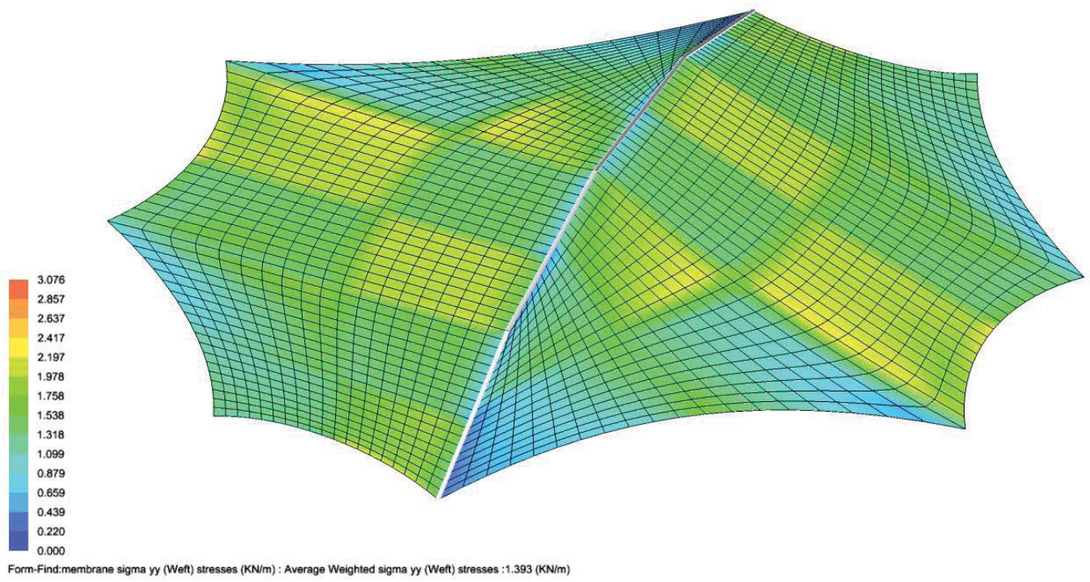


Form-Find:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :3.600 (KN/m)

FDM Solver



Form-Find:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :1.385 (KN/m)

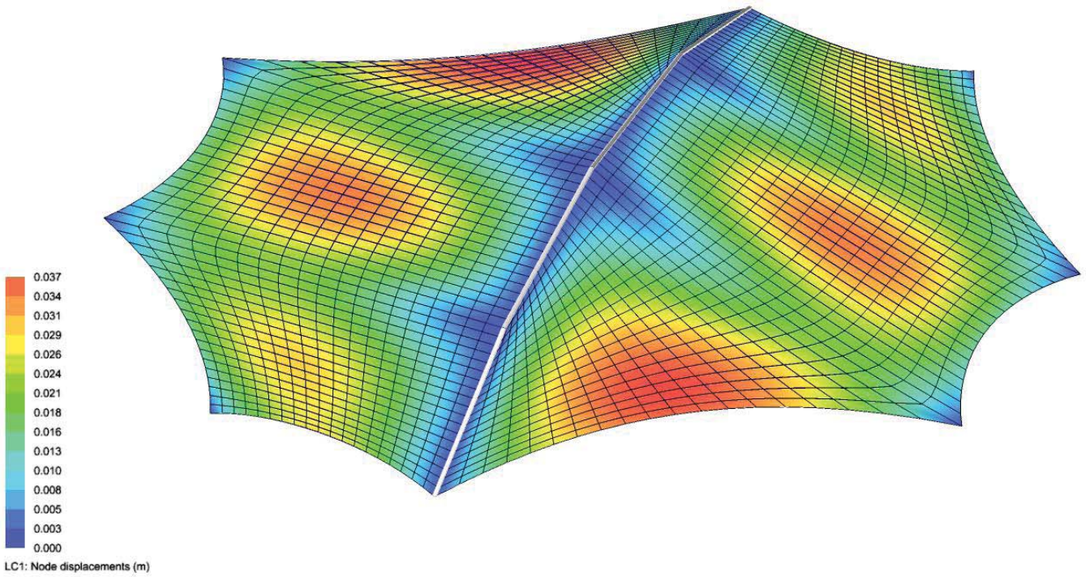


Form-Find:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :1.393 (KN/m)

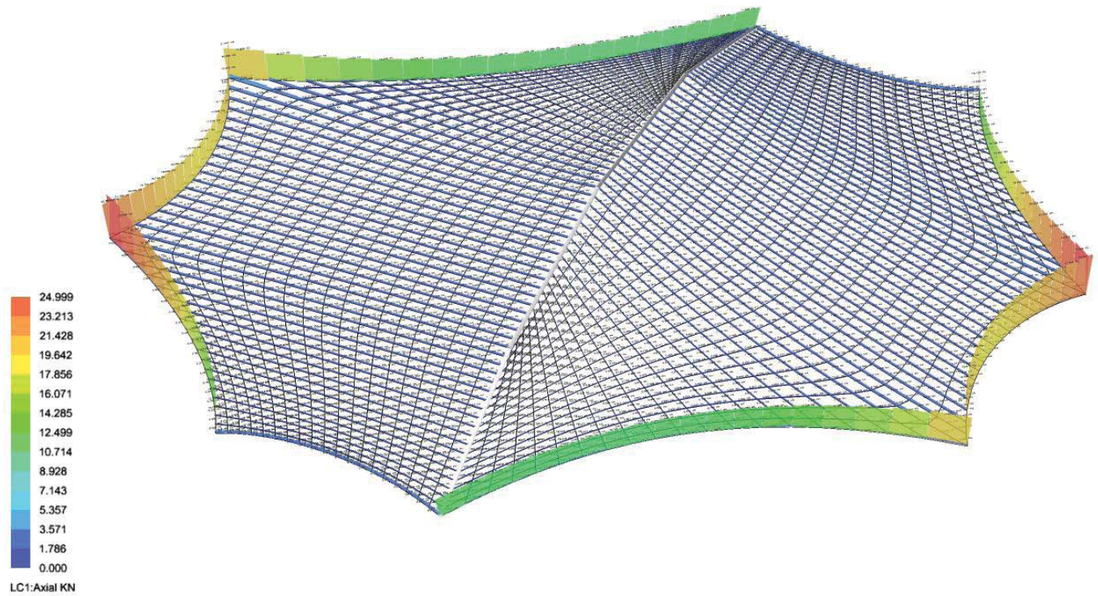
Form - finding

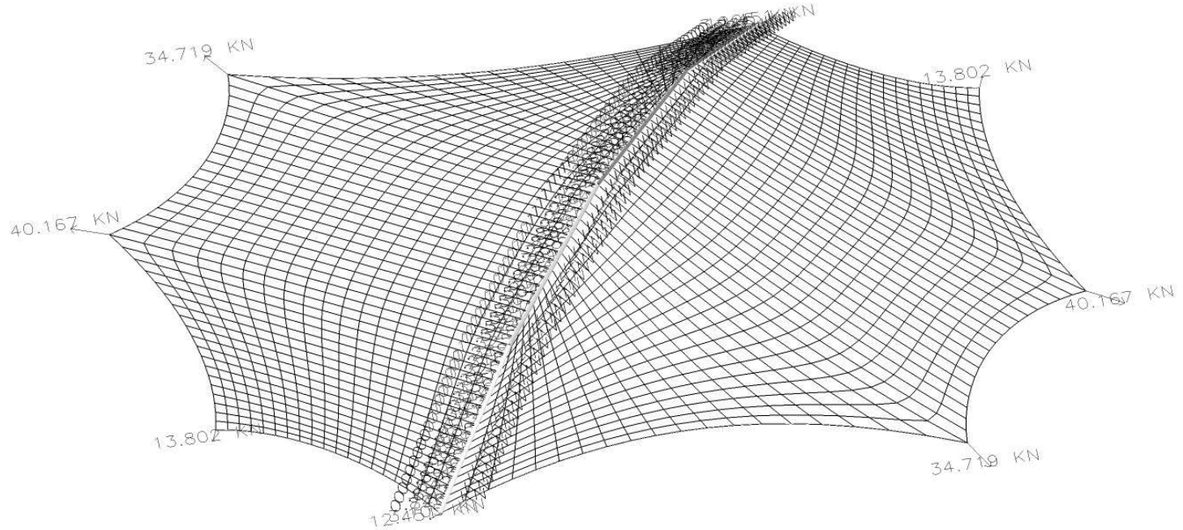
Membrane Details and Analysis

FDM Solver



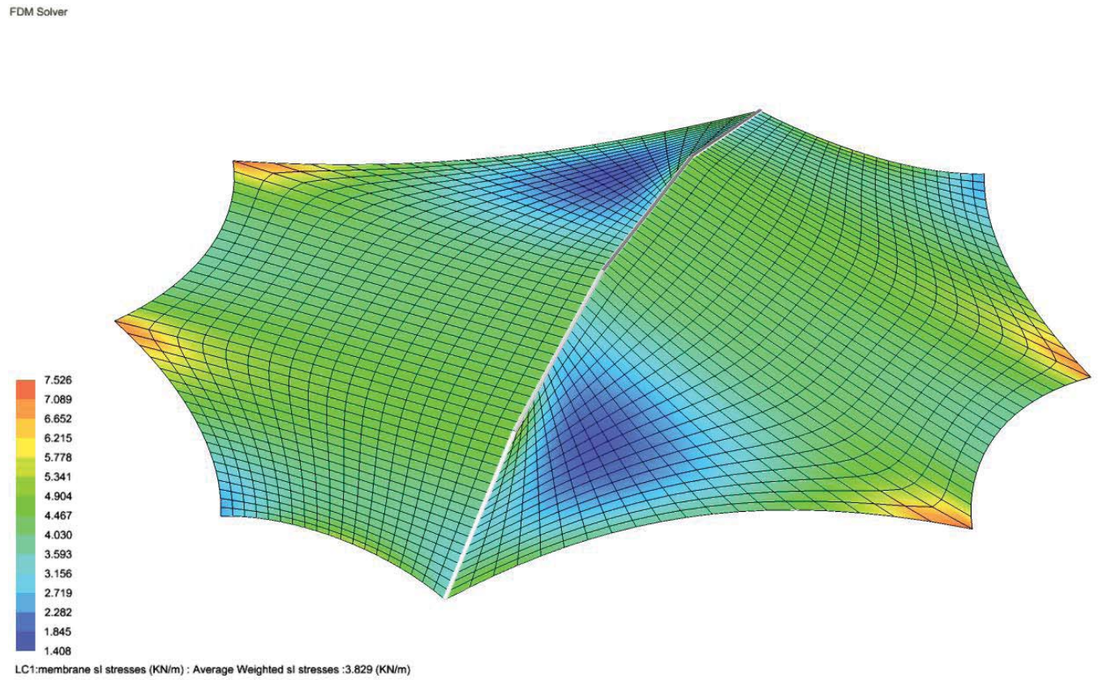
FDM Solver

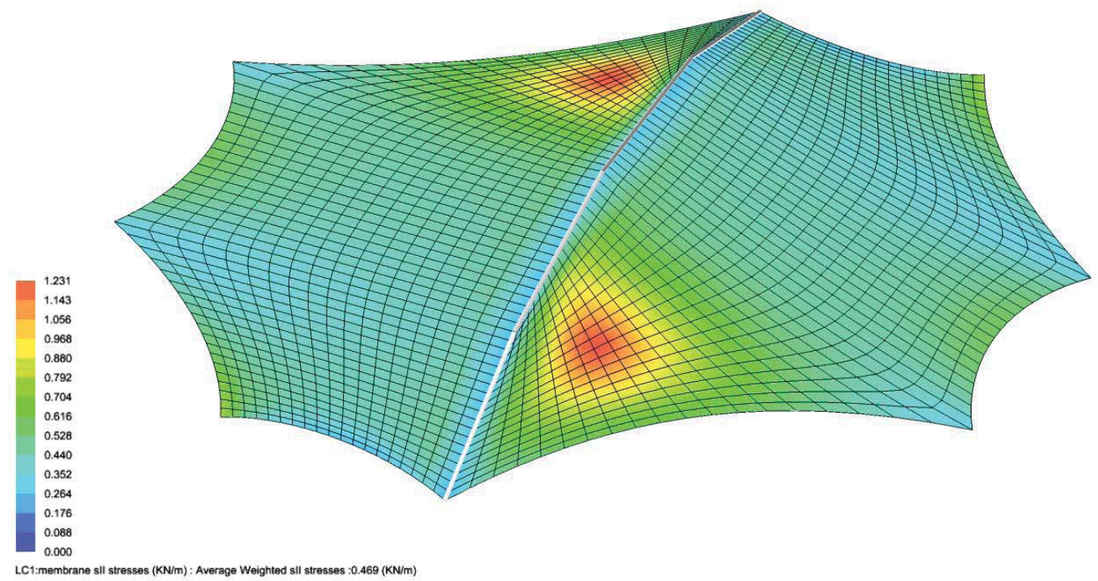




LC1 - Self weight 1.0

Membrane Details and Analysis

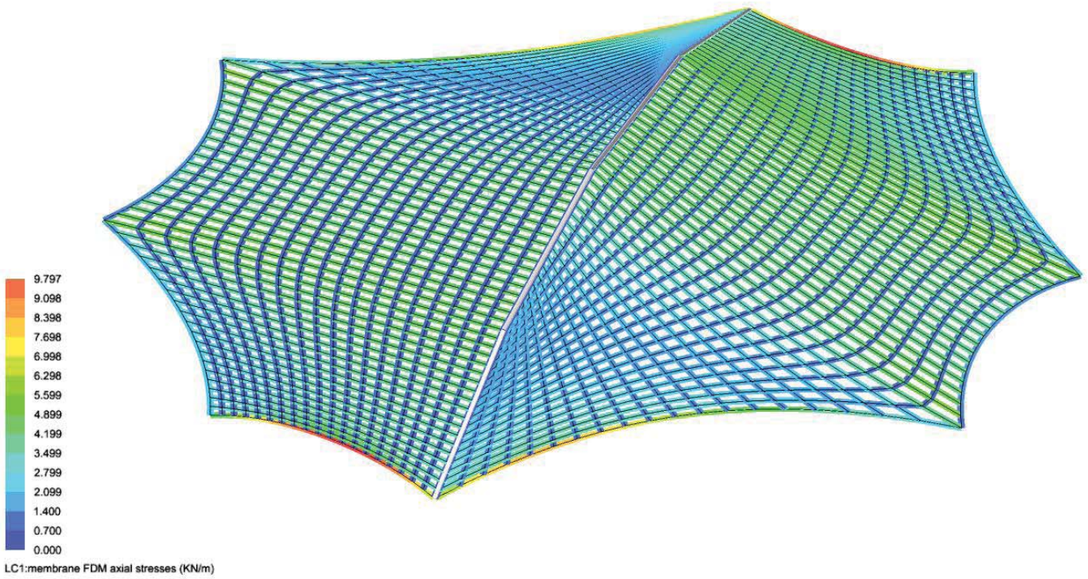




LC1 - Self weight 1.0

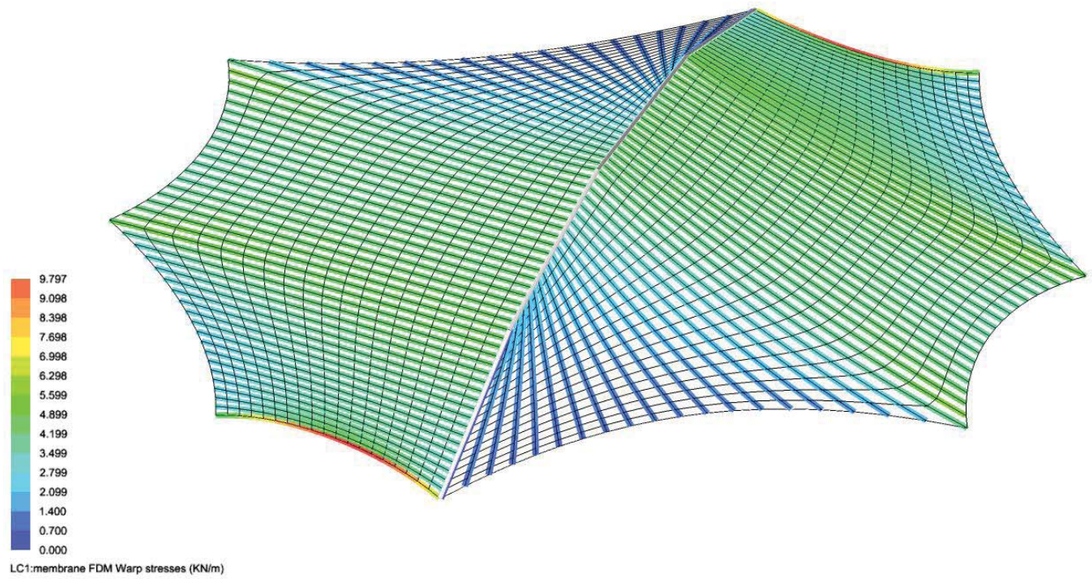
Membrane Details and Analysis

FDM Solver

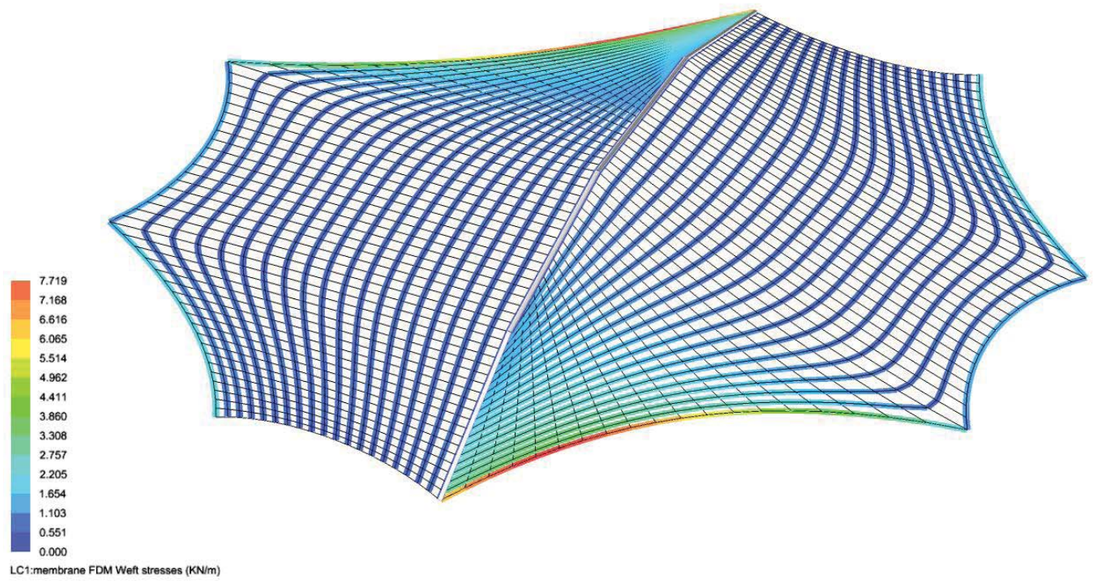


LC1:membrane FDM axial stresses (KN/m)

FDM Solver



LC1:membrane FDM Warp stresses (KN/m)

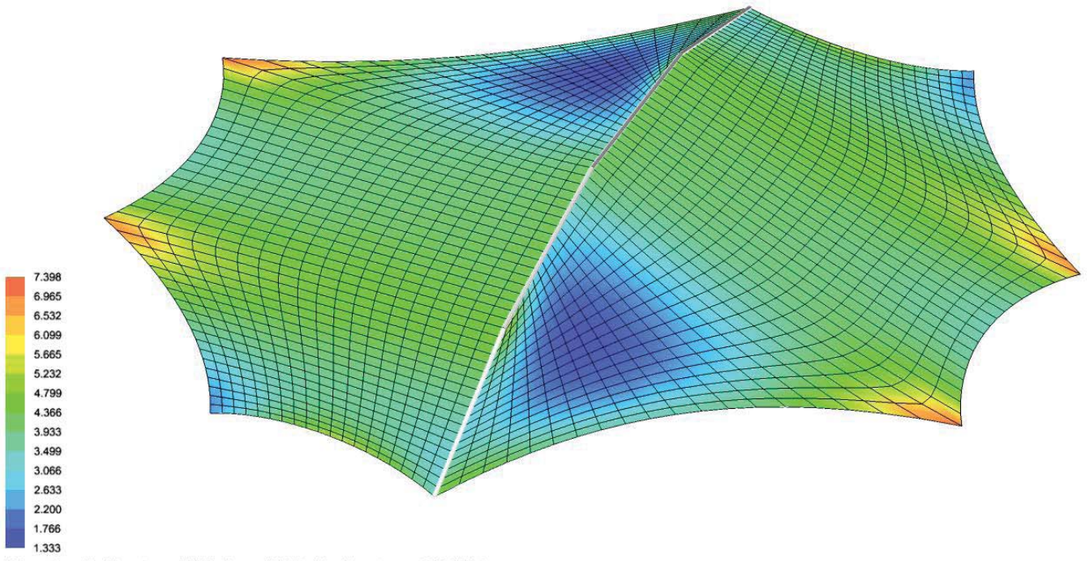


LC1:membrane FDM Weft stresses (KN/m)

LC1 - Self weight 1.0

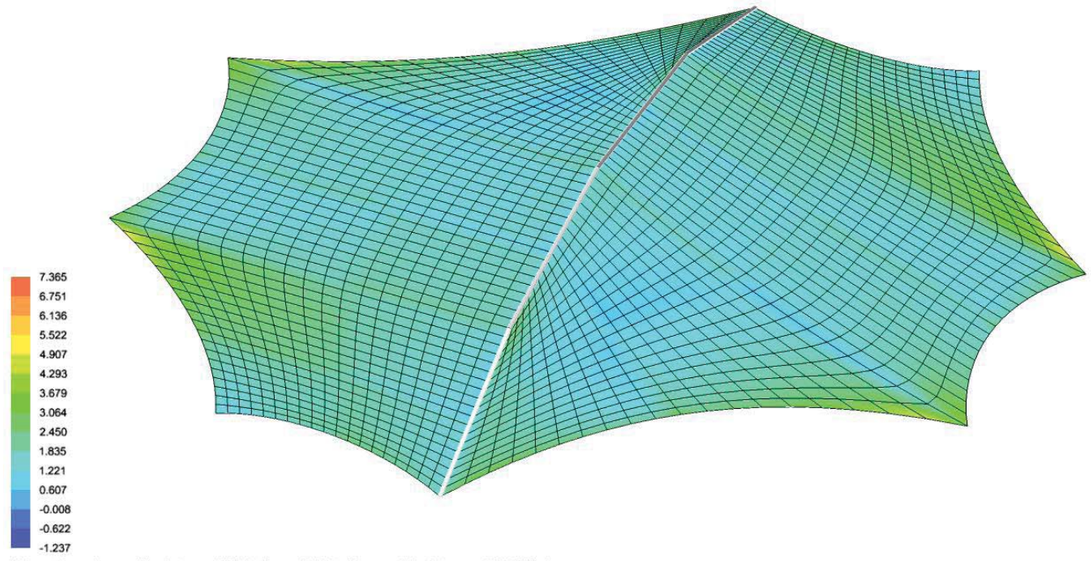
Membrane Details and Analysis

FDM Solver

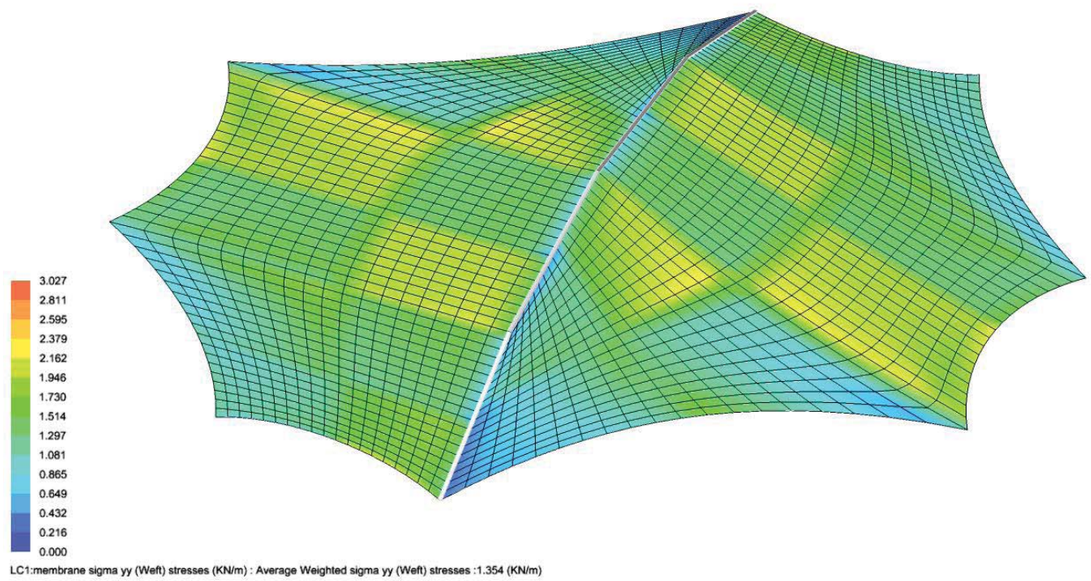


LC1:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :3.633 (KN/m)

FDM Solver



LC1:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :1.362 (KN/m)

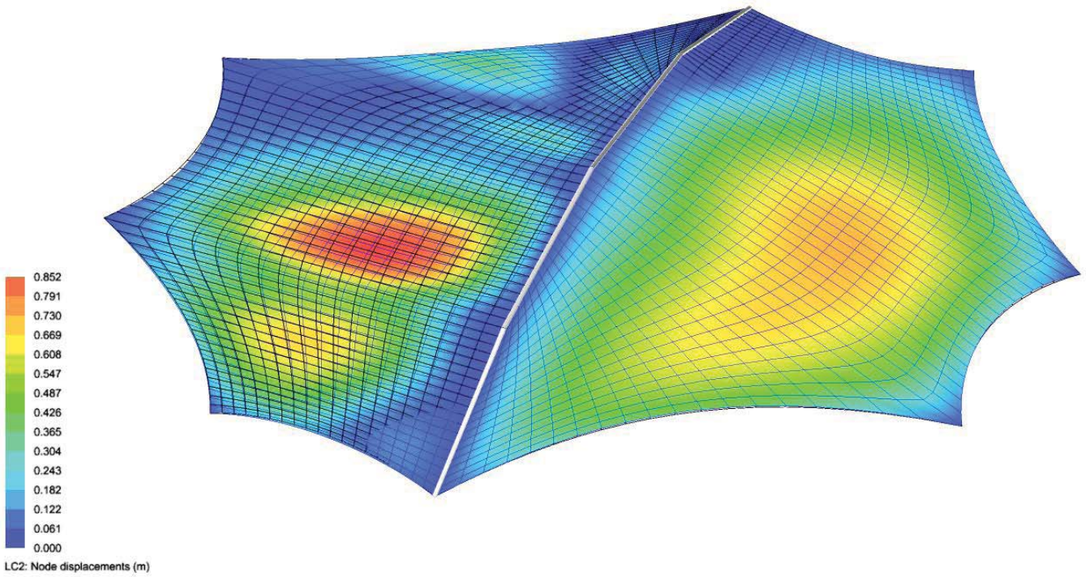


LC1:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :1.354 (KN/m)

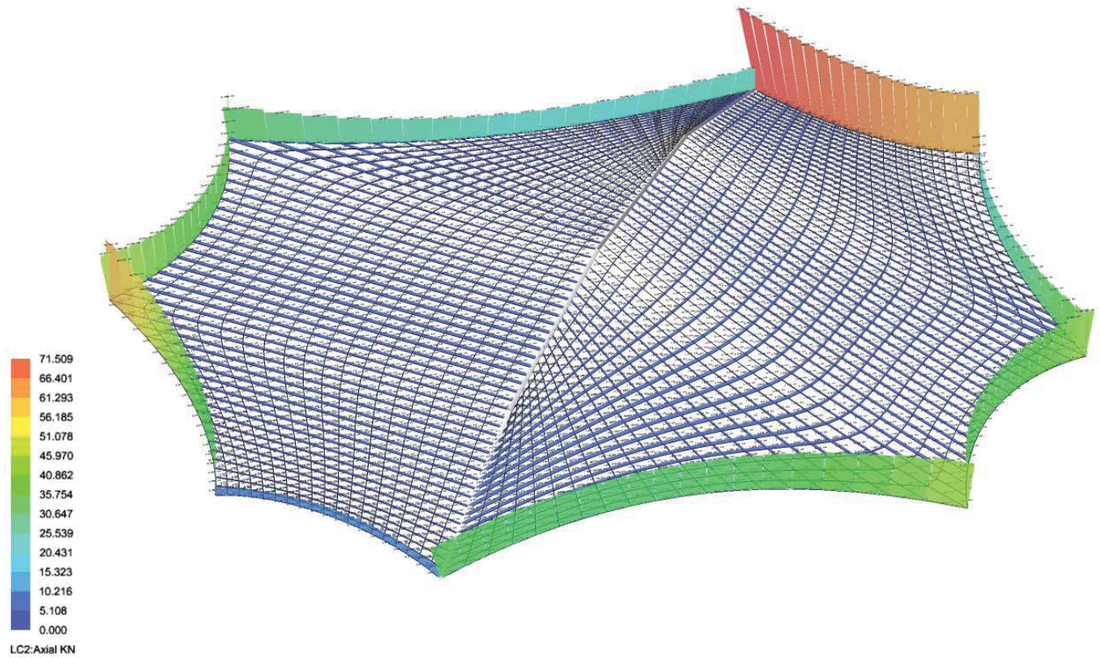
LC1 - Self weight 1.0

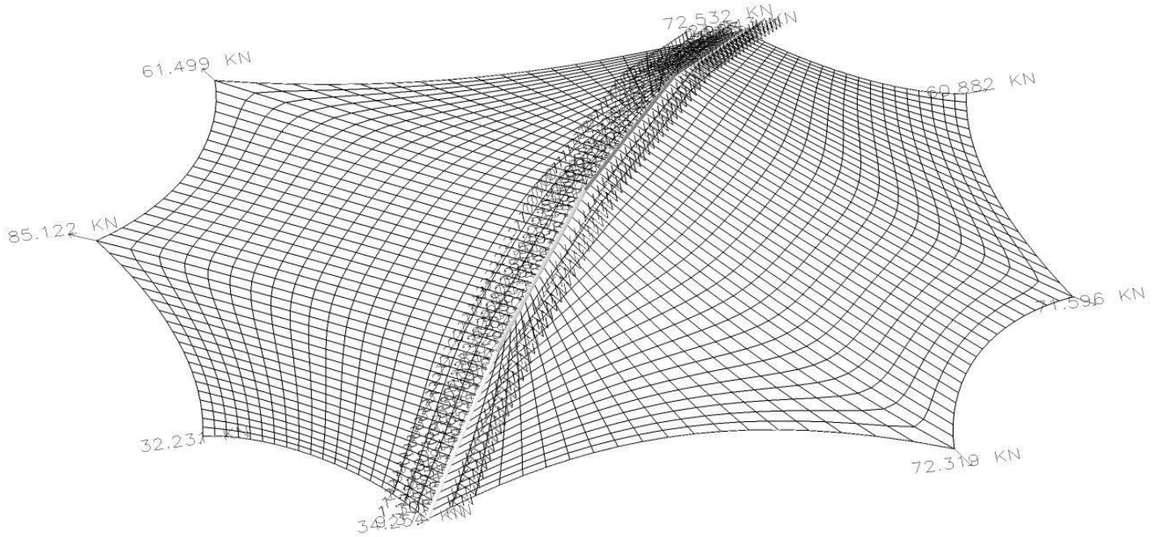
Membrane Details and Analysis

FDM Solver



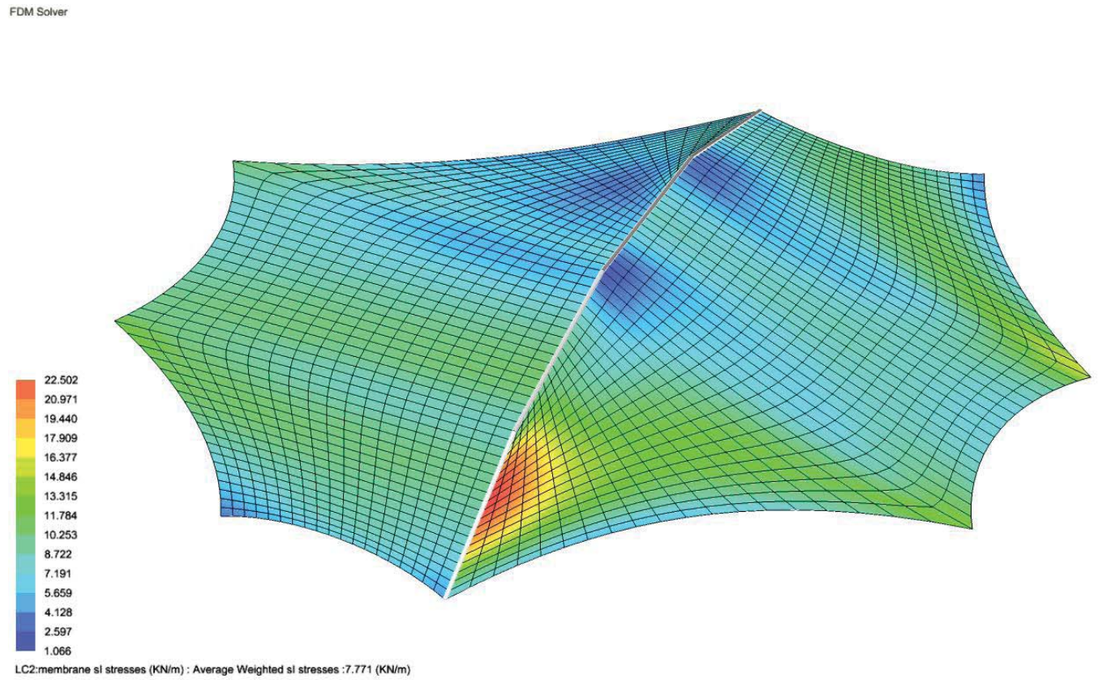
FDM Solver

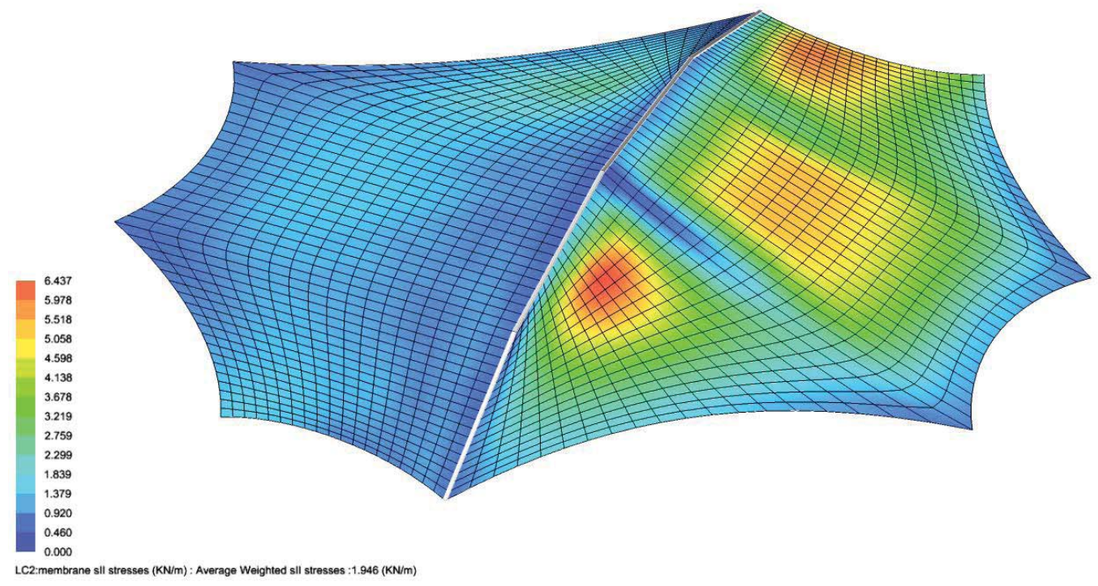




LC2 - Self weight 1.0 + Wind X 1.0

Membrane Details and Analysis

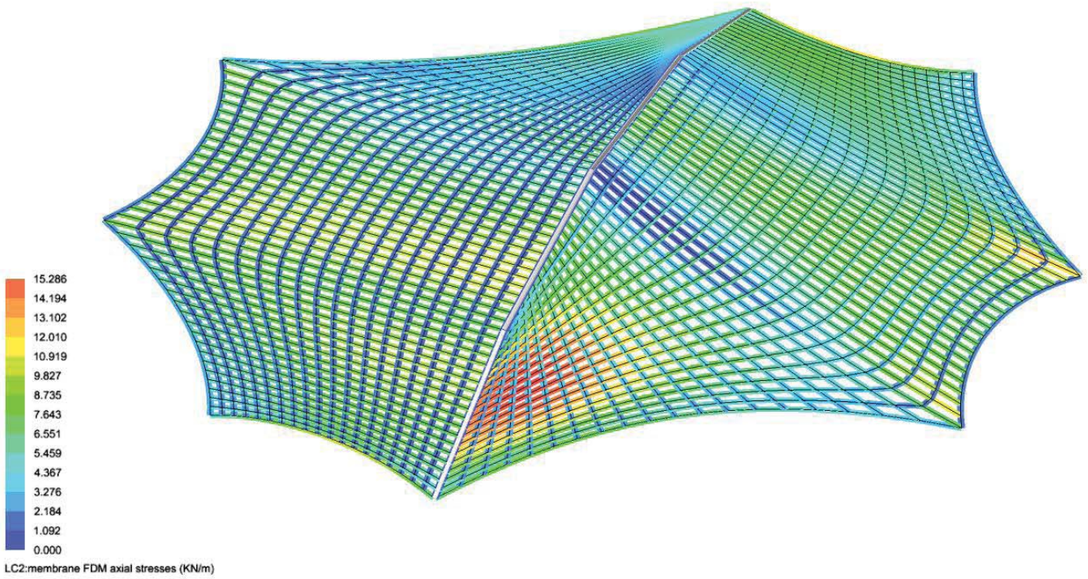




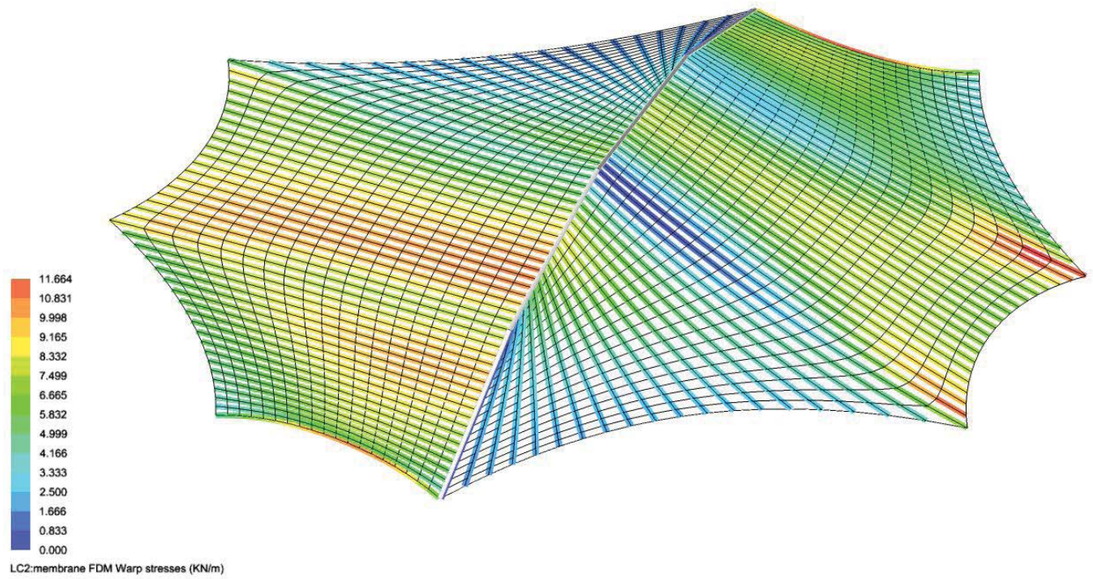
LC2 - Self weight 1.0 + Wind X 1.0

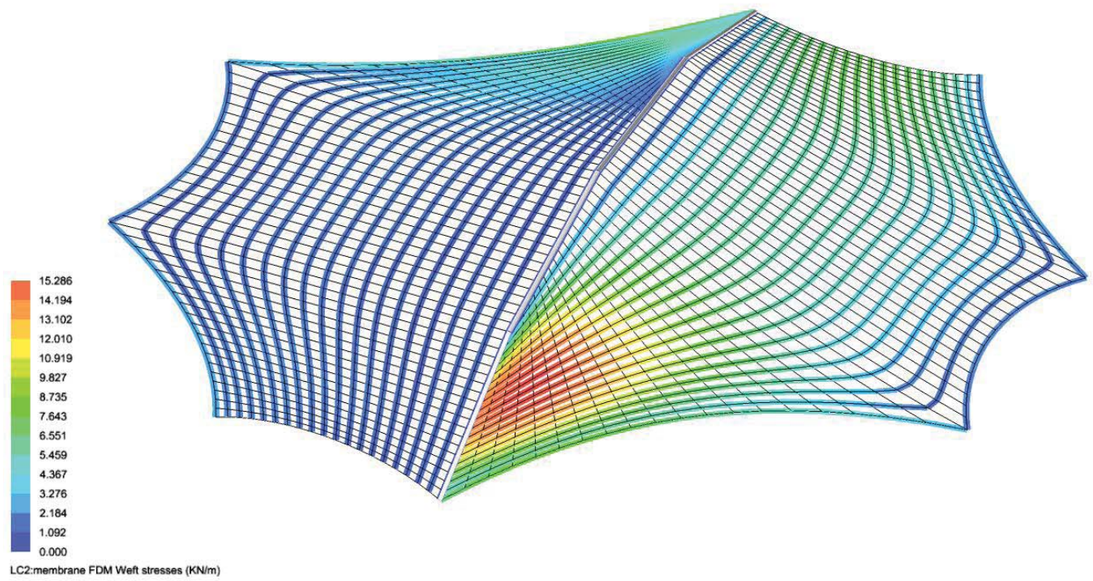
Membrane Details and Analysis

FDM Solver



FDM Solver

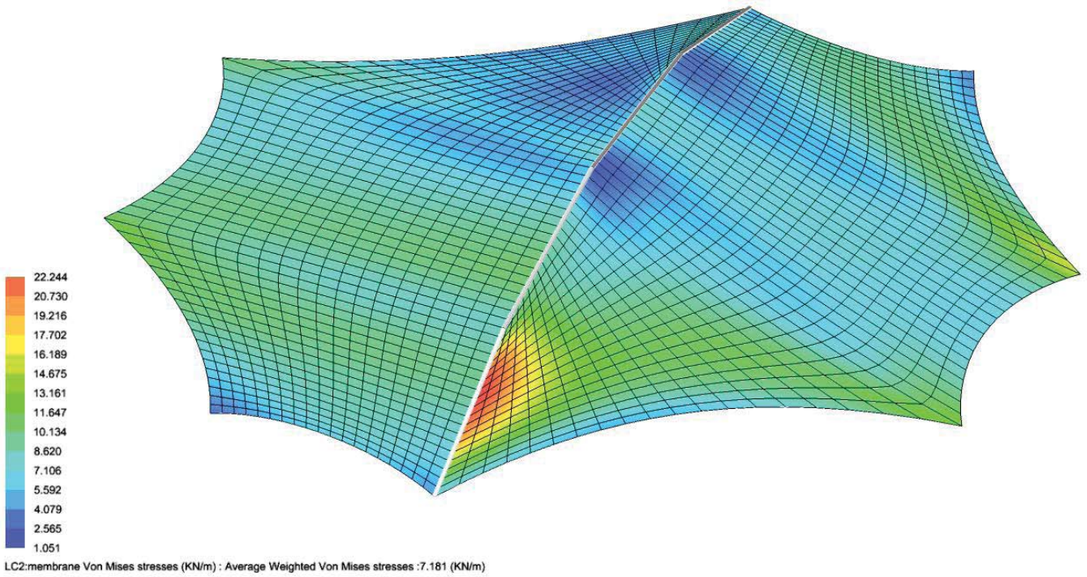




LC2 - Self weight 1.0 + Wind X 1.0

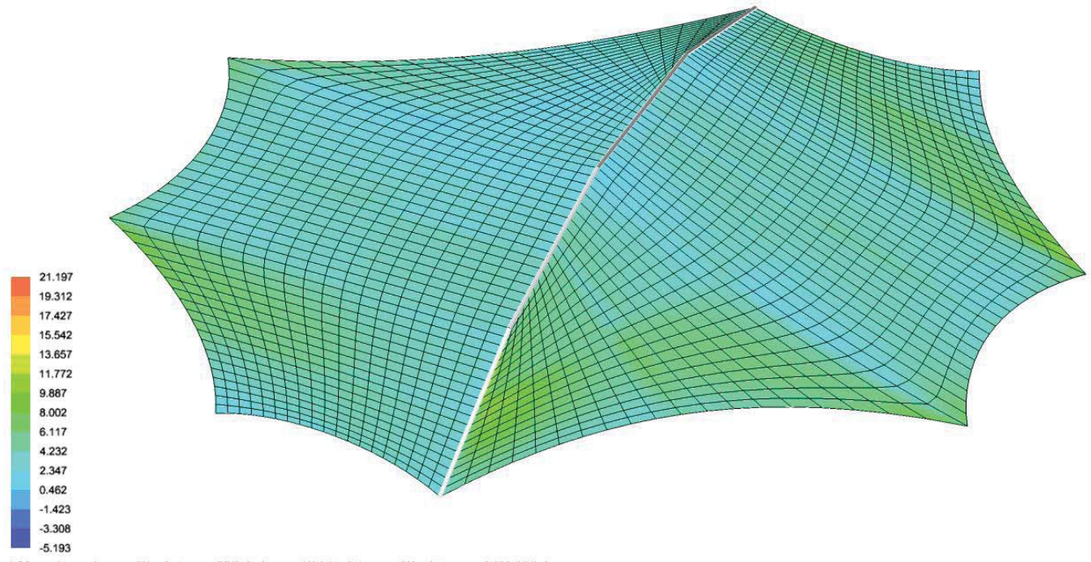
Membrane Details and Analysis

FDM Solver

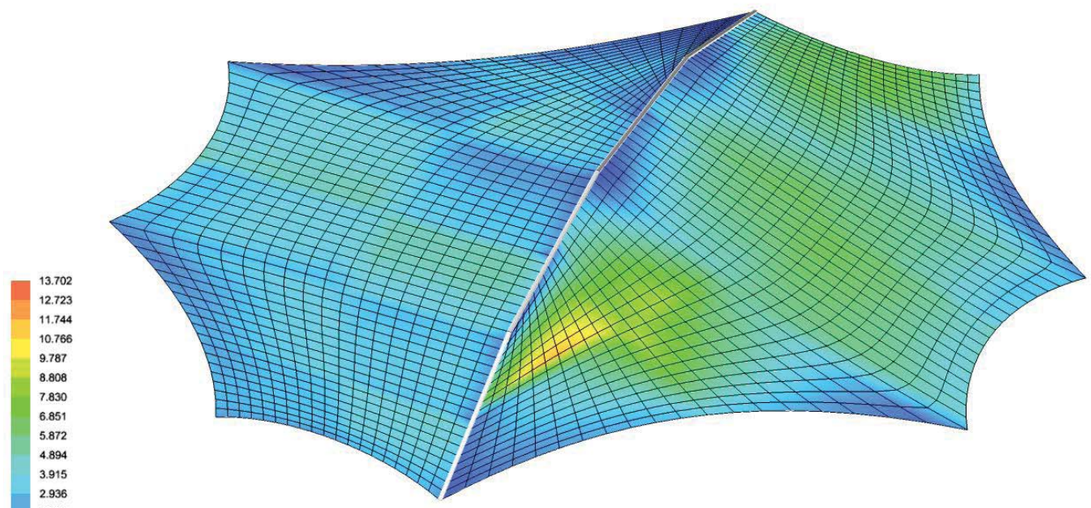


LC2:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :7.181 (KN/m)

FDM Solver



LC2:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :3.033 (KN/m)

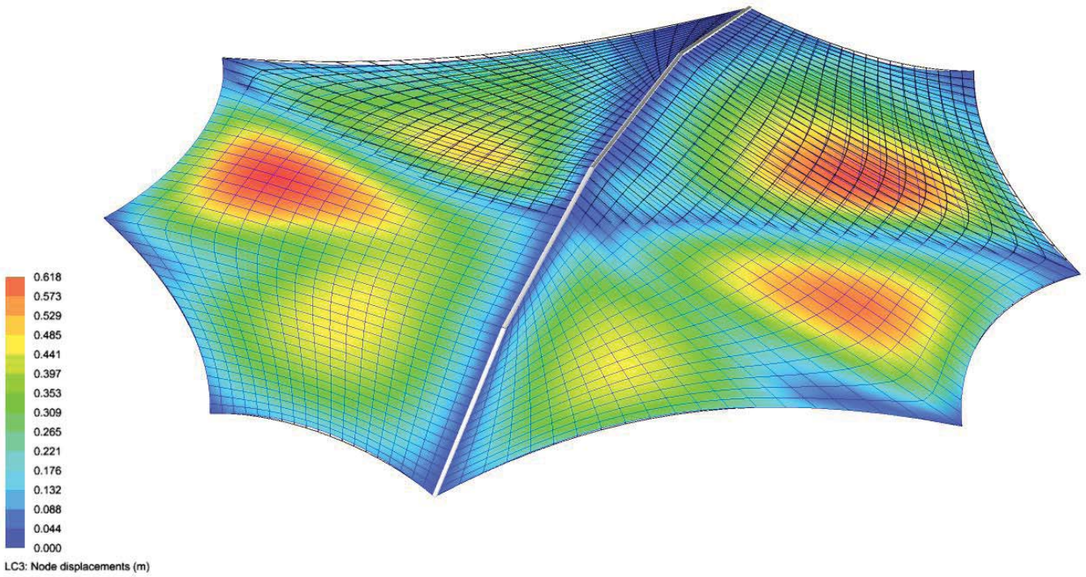


LC2:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :3.507 (KN/m)

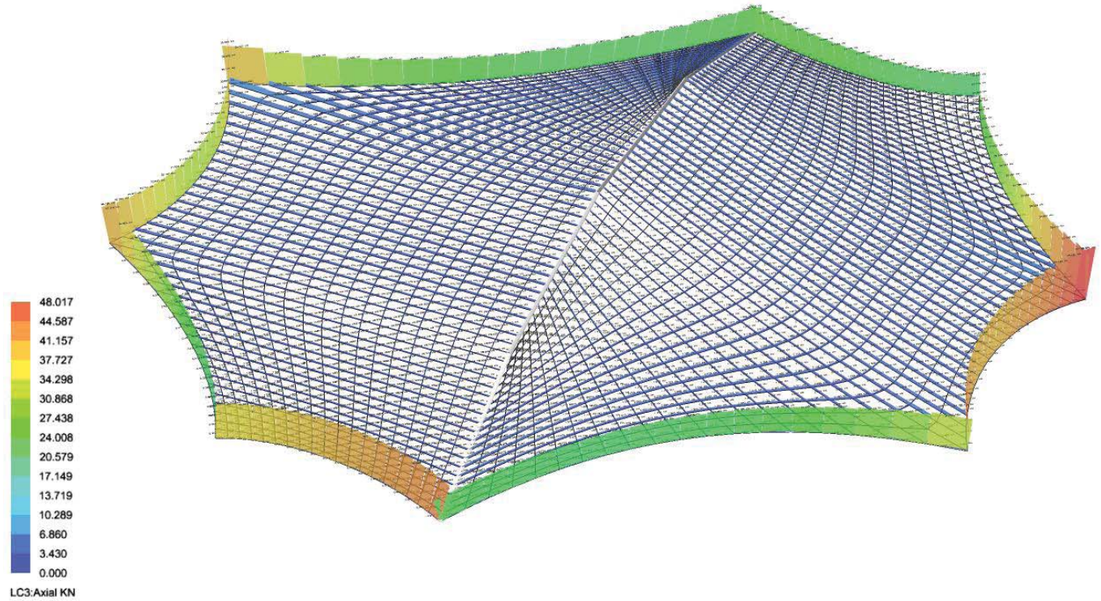
LC2 - Self weight 1.0 + Wind X 1.0

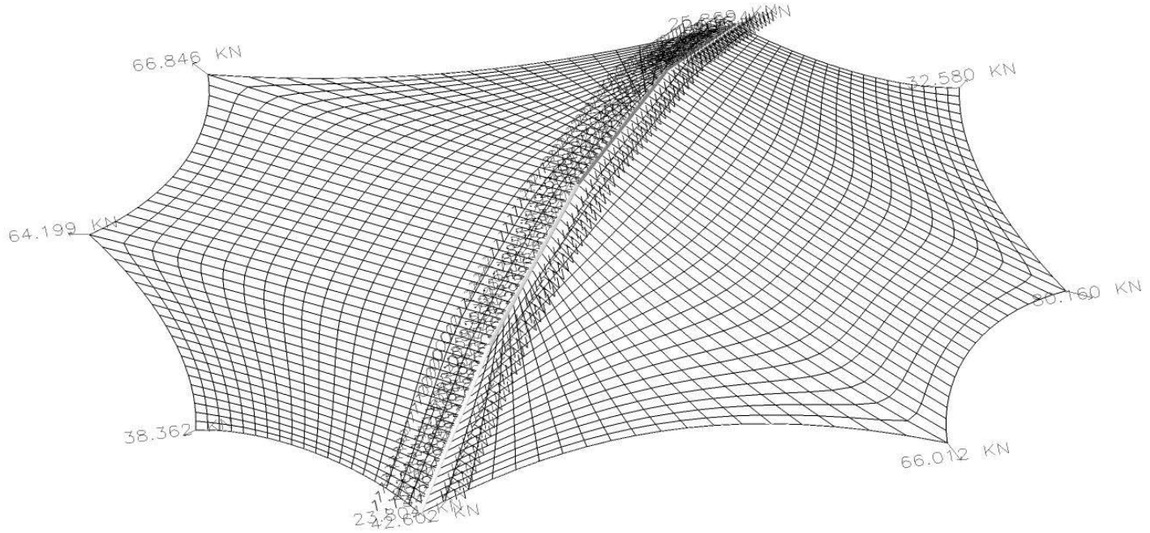
Membrane Details and Analysis

FDM Solver



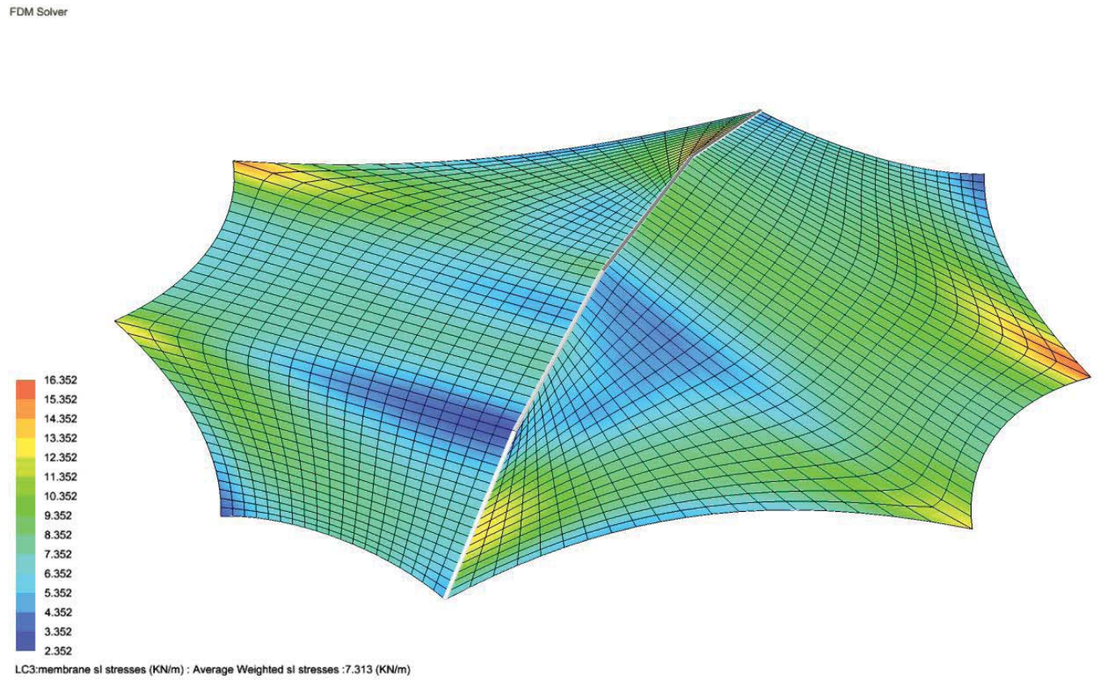
FDM Solver

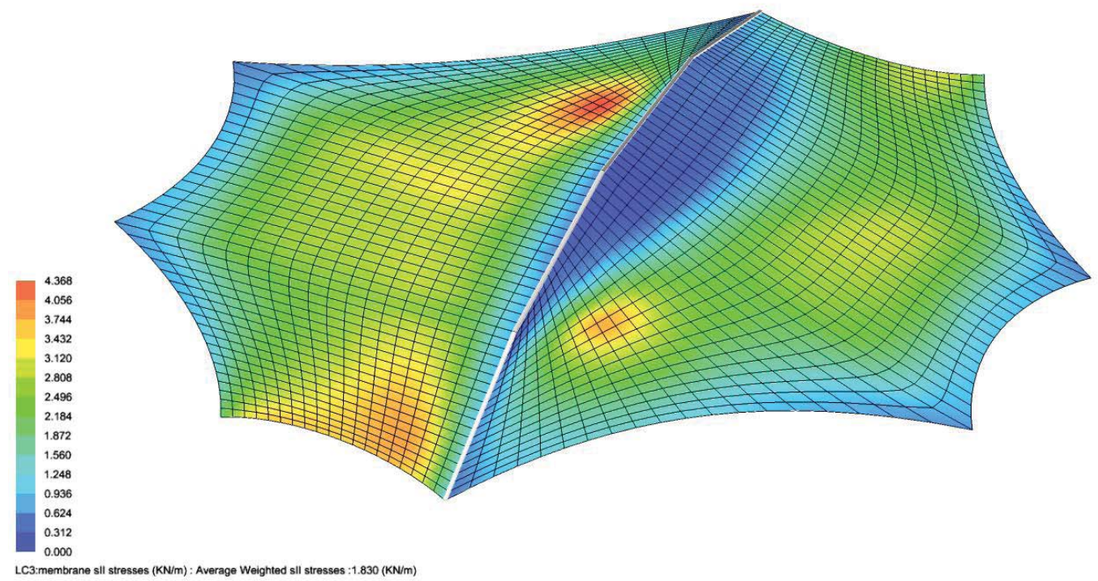




LC3 - Self weight 1.0 + Wind Y 1.0

Membrane Details and Analysis

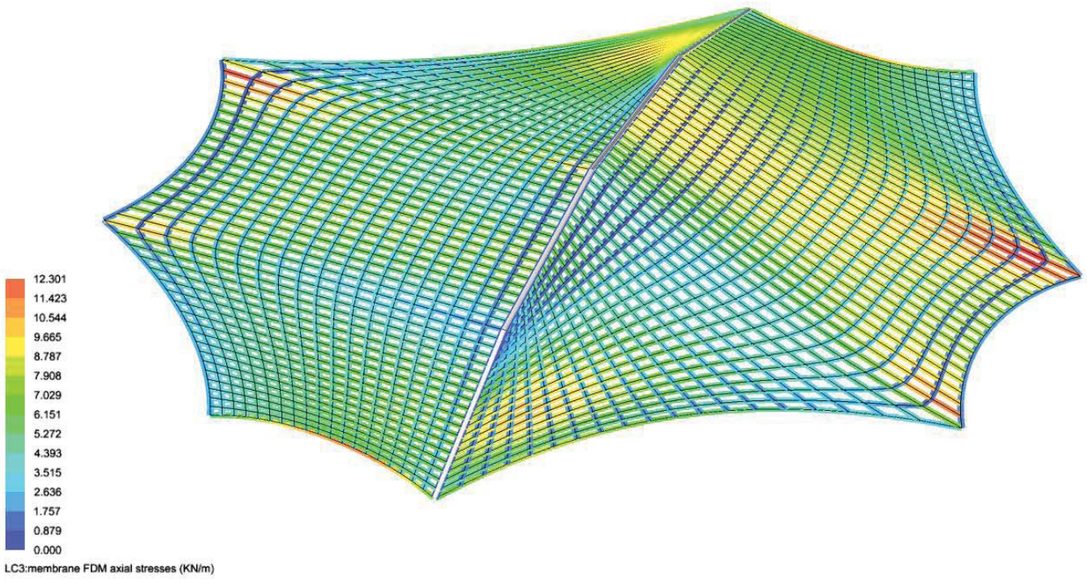




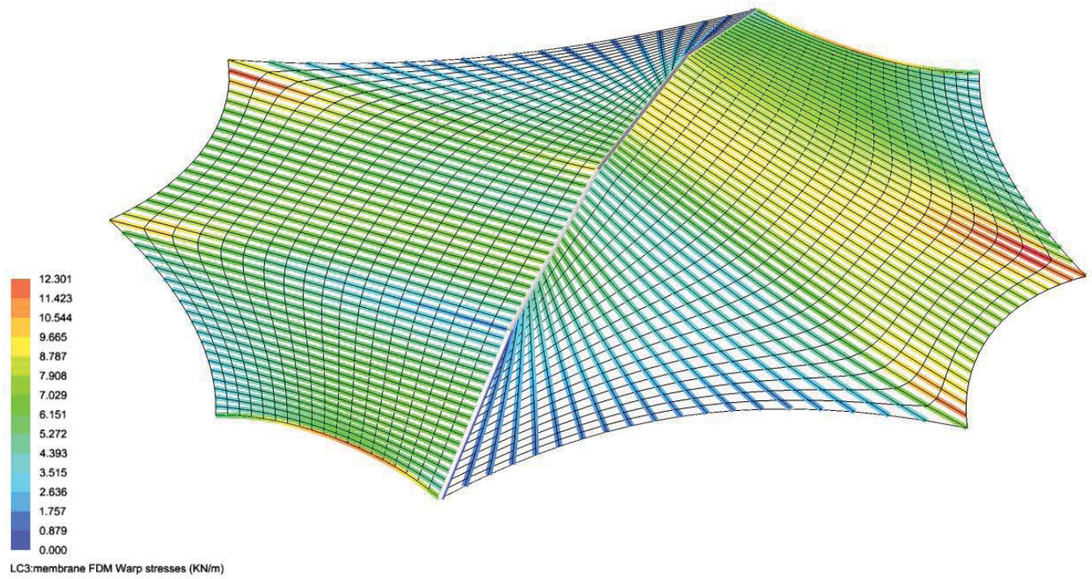
LC3 - Self weight 1.0 + Wind Y 1.0

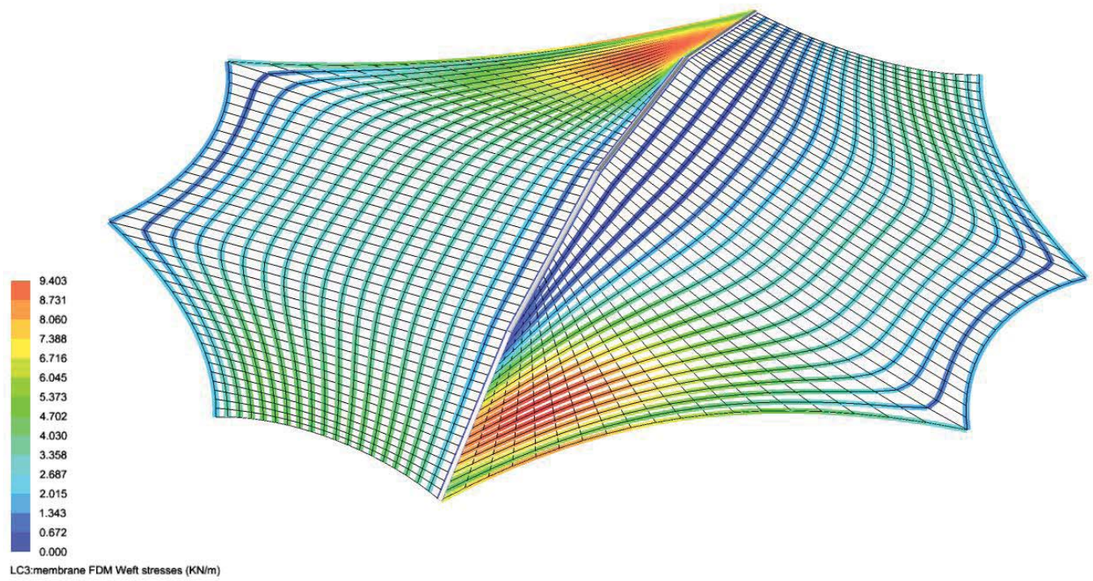
Membrane Details and Analysis

FDM Solver



FDM Solver

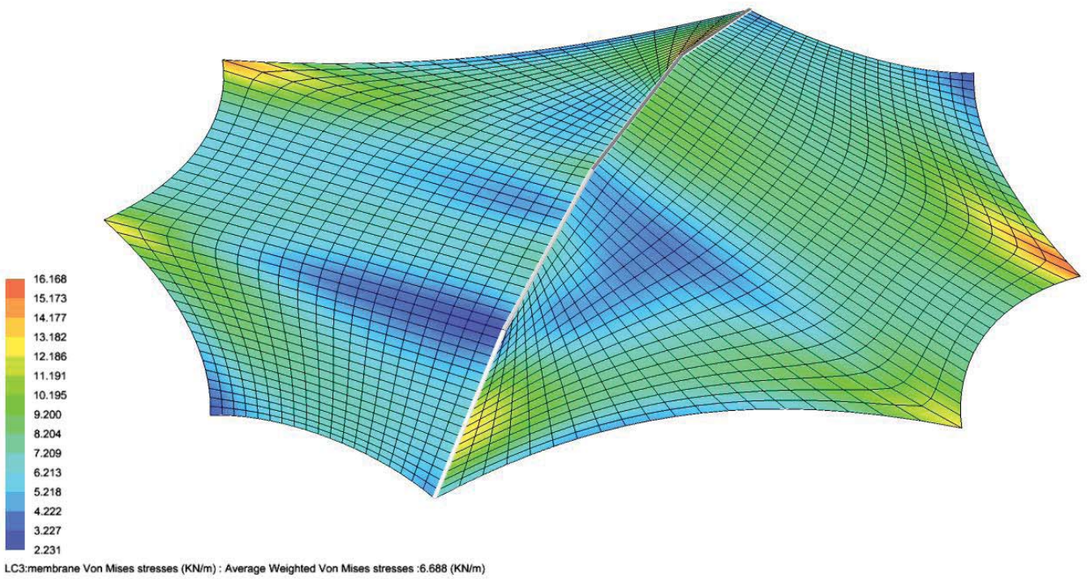




LC3 - Self weight 1.0 + Wind Y 1.0

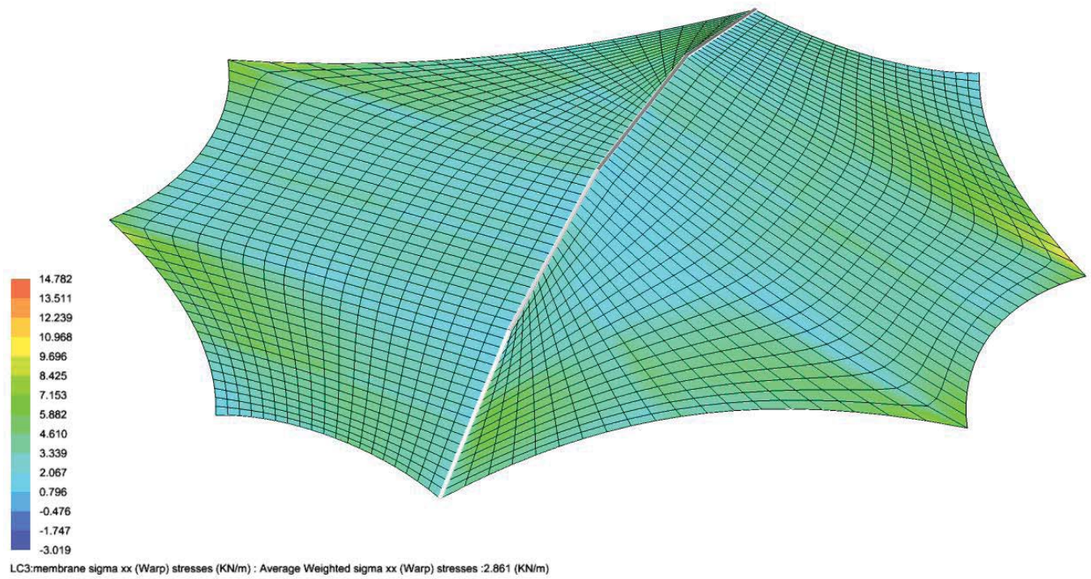
Membrane Details and Analysis

FDM Solver

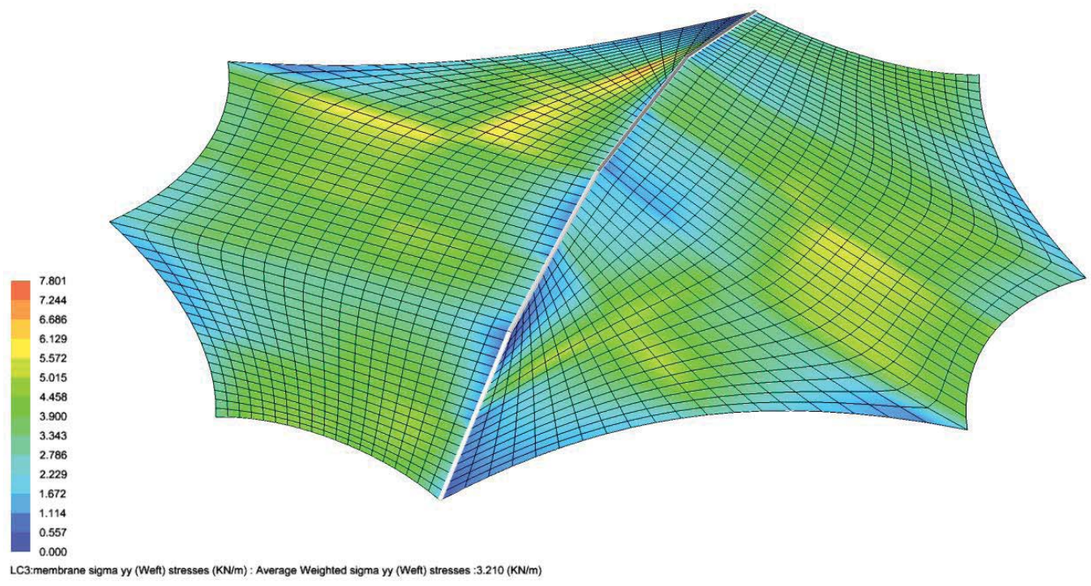


LC3:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :6.688 (KN/m)

FDM Solver



LC3:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :2.861 (KN/m)

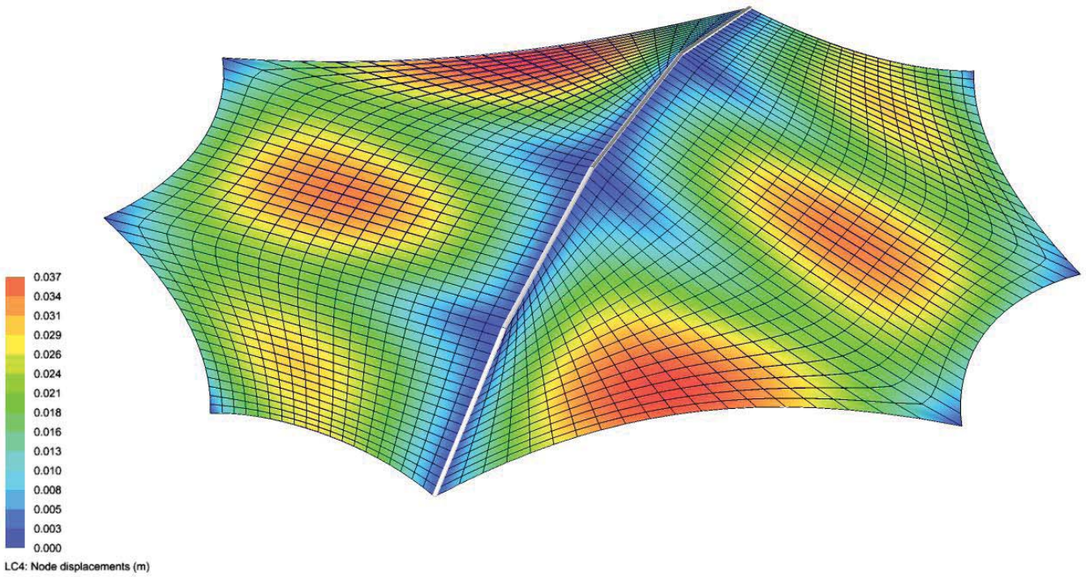


LC3:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :3.210 (KN/m)

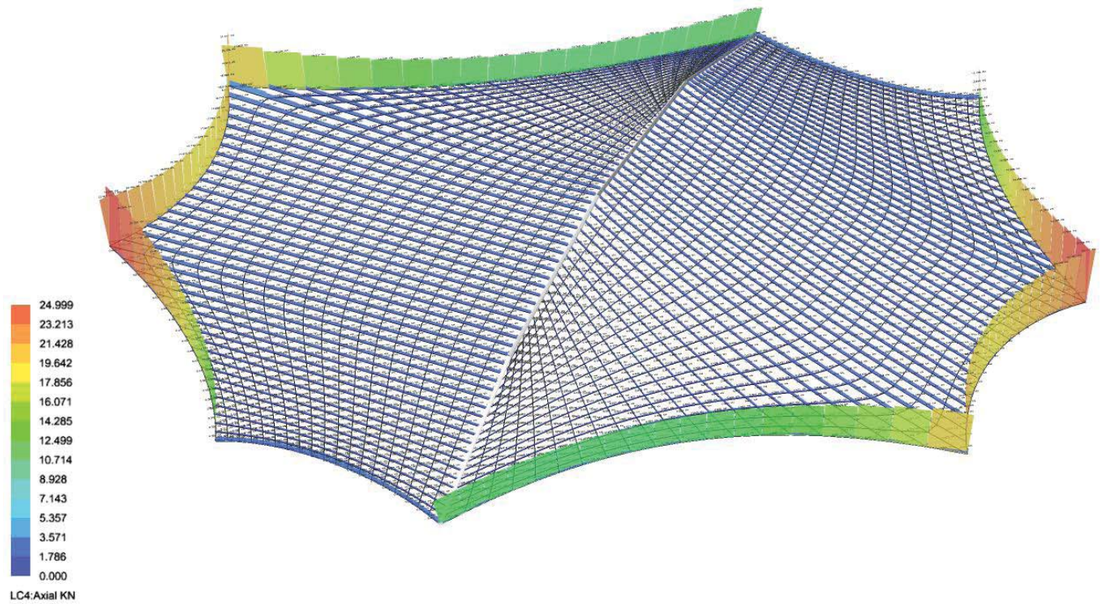
LC3 - Self weight 1.0 + Wind Y 1.0

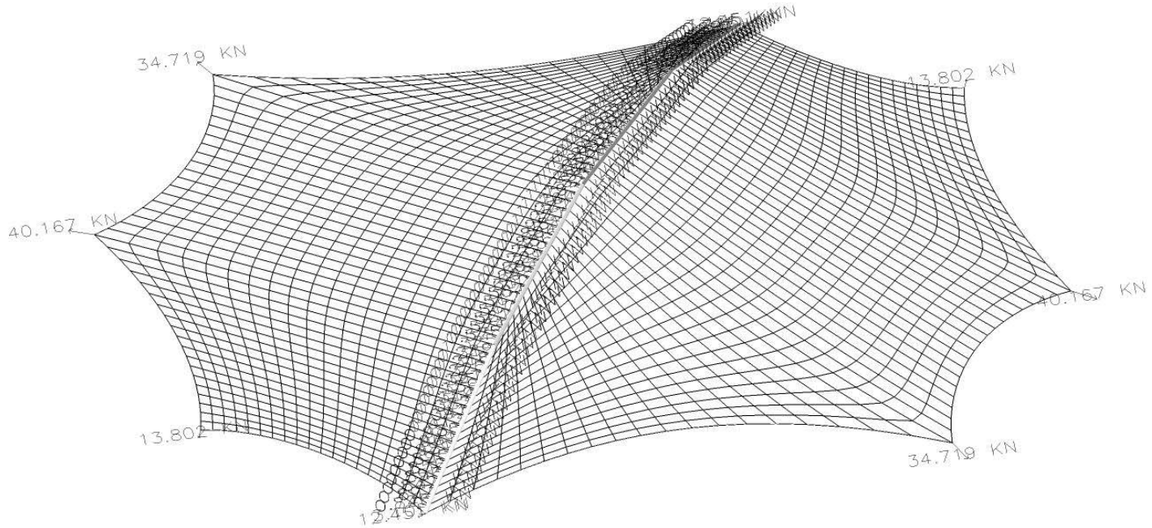
Membrane Details and Analysis

FDM Solver



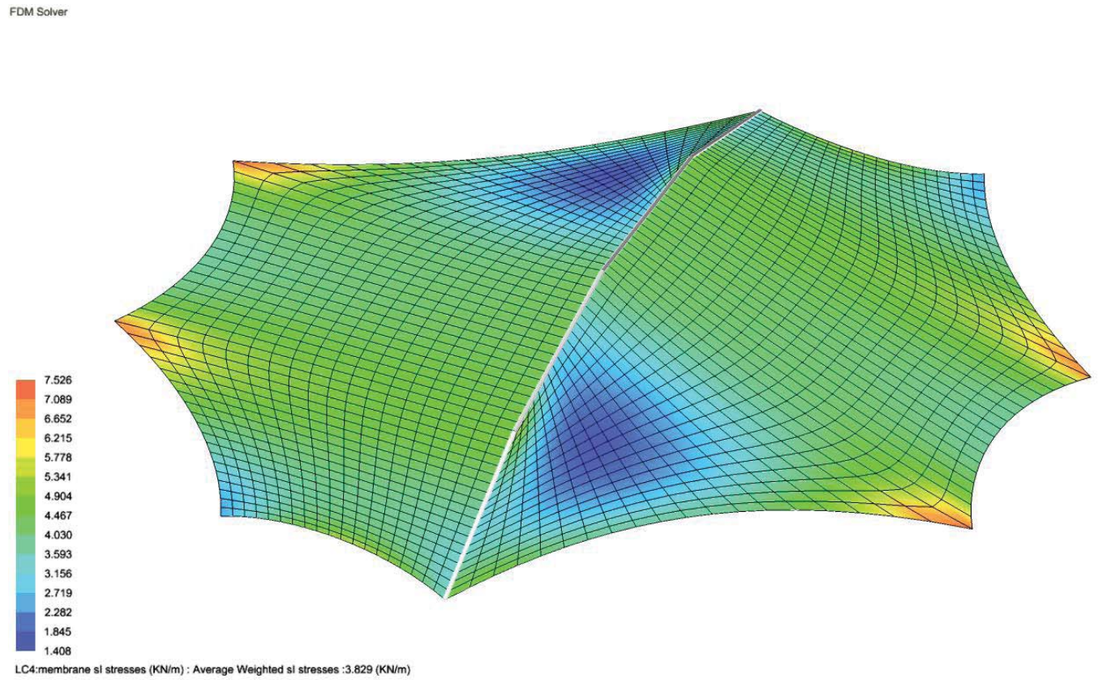
FDM Solver

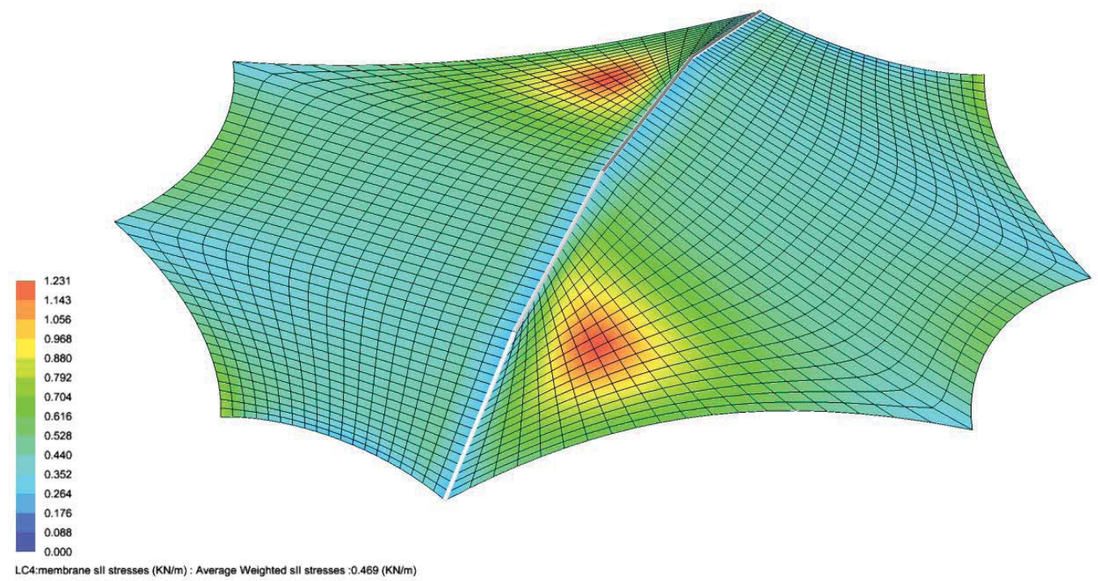




LC4 - Self weight 1.0 + Snow 1.0

Membrane Details and Analysis

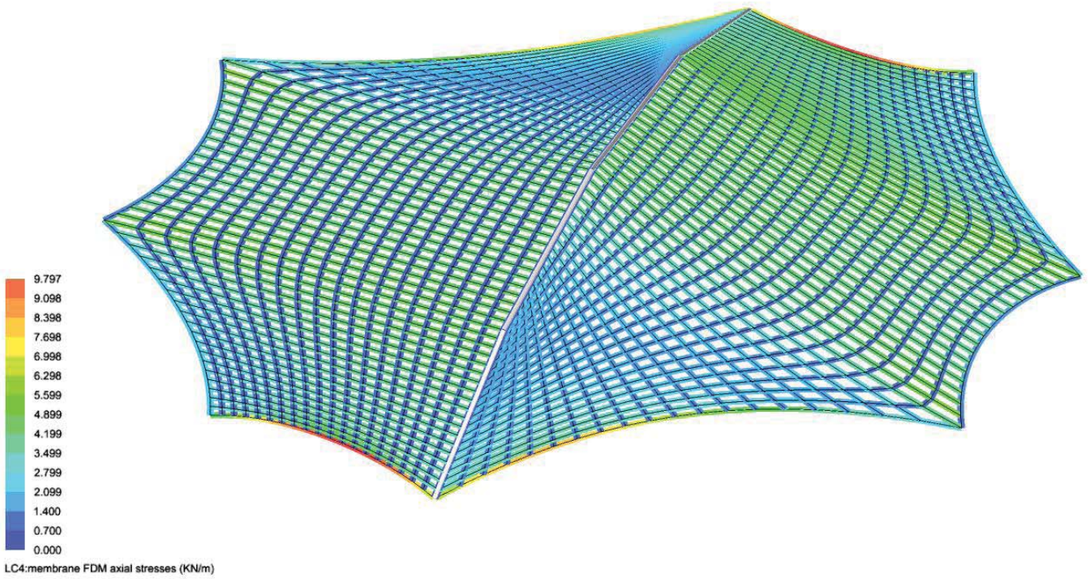




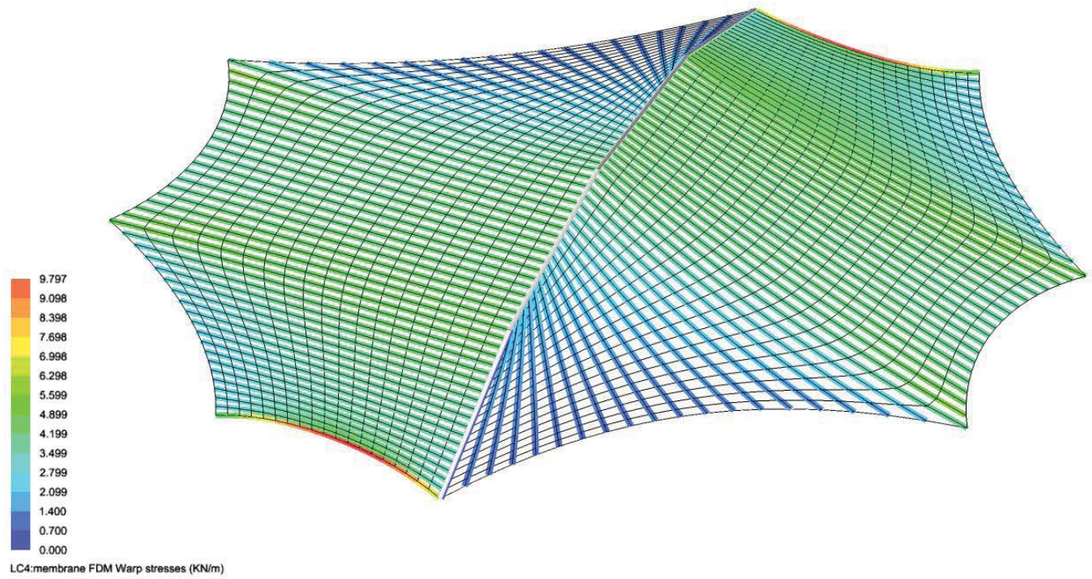
LC4 - Self weight 1.0 + Snow 1.0

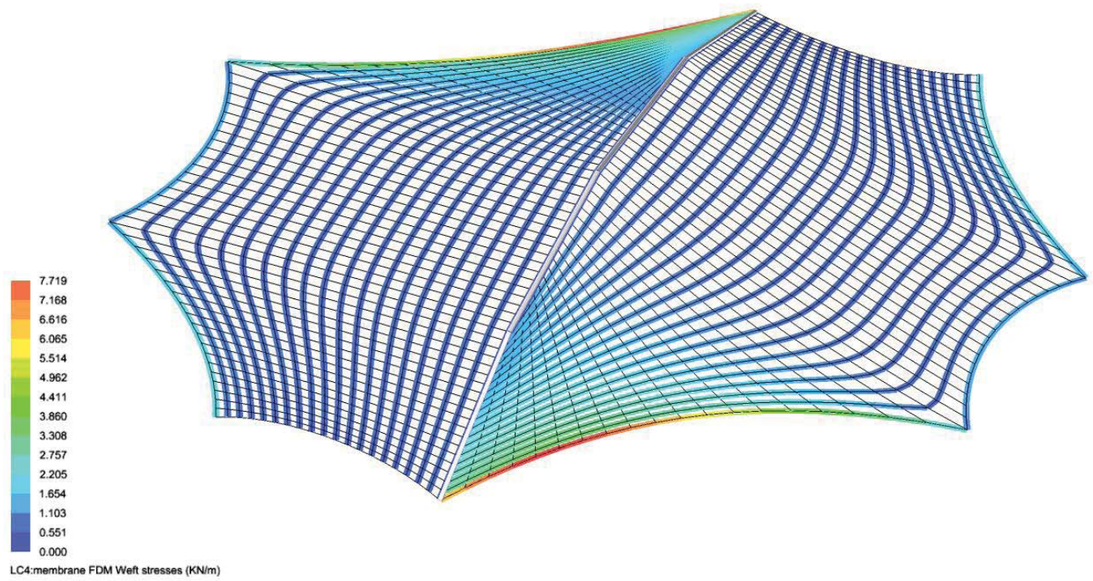
Membrane Details and Analysis

FDM Solver



FDM Solver

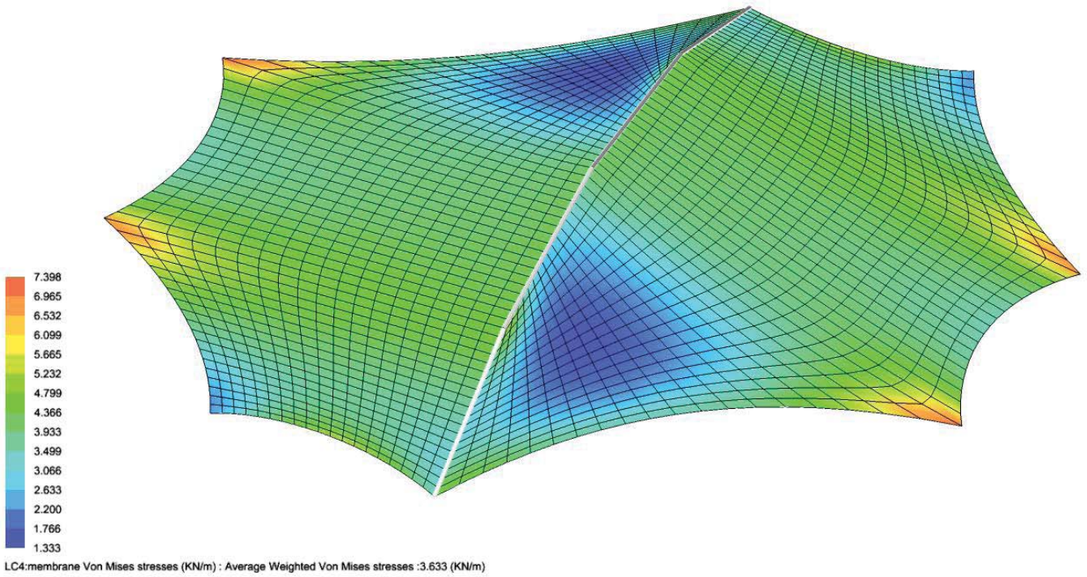




LC4 - Self weight 1.0 + Snow 1.0

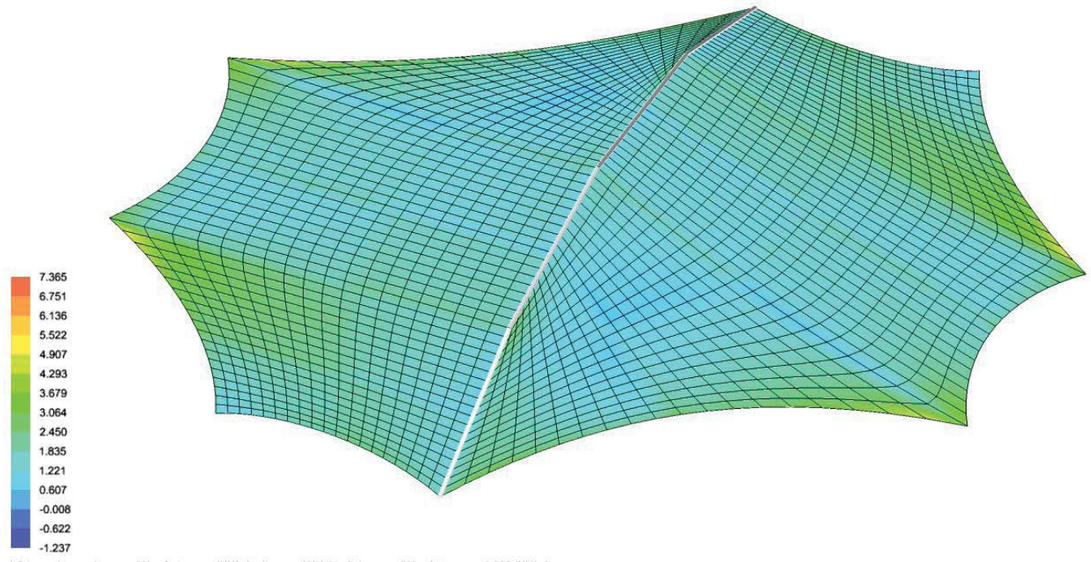
Membrane Details and Analysis

FDM Solver

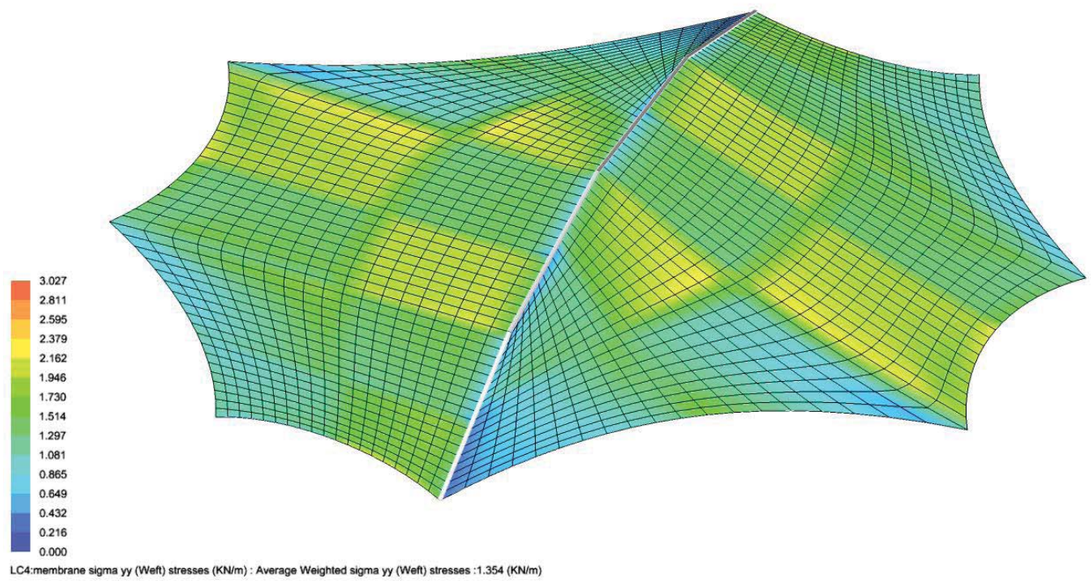


LC4:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :3.633 (KN/m)

FDM Solver



LC4:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :1.362 (KN/m)

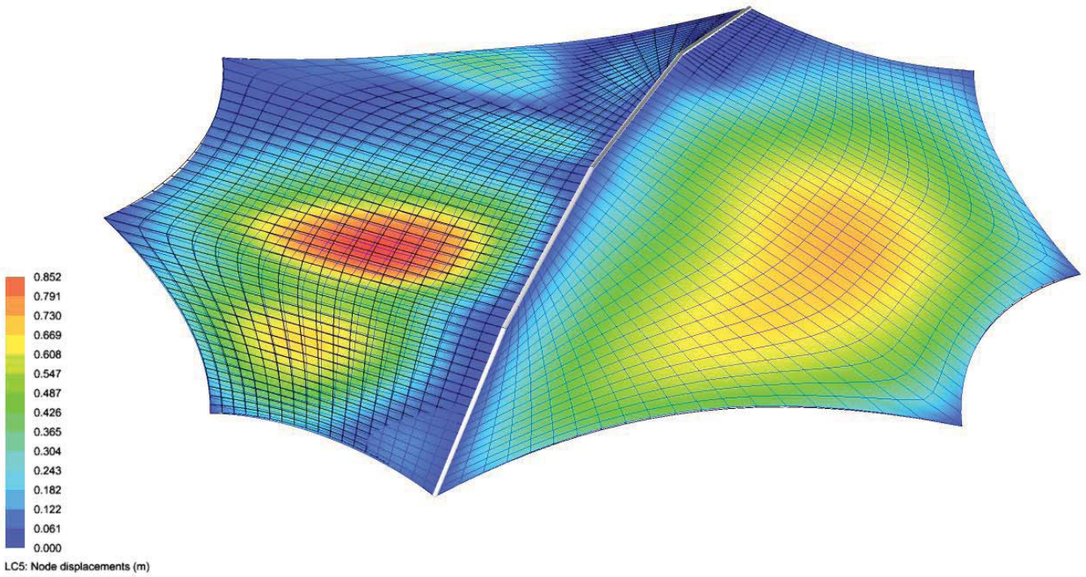


LC4:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :1.354 (KN/m)

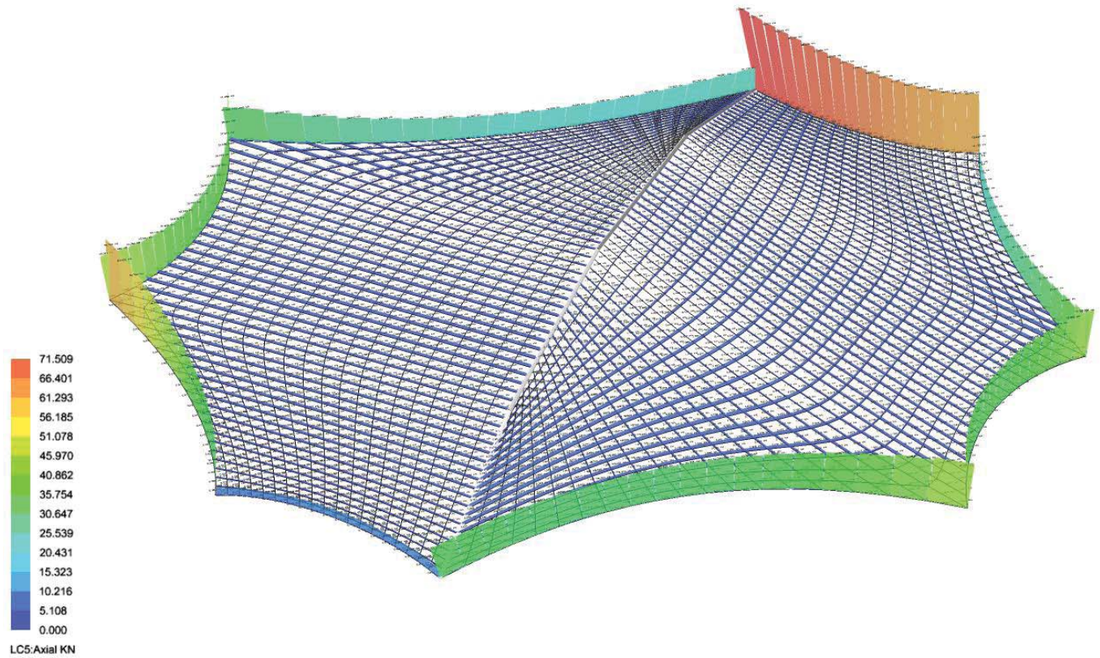
LC4 - Self weight 1.0 + Snow 1.0

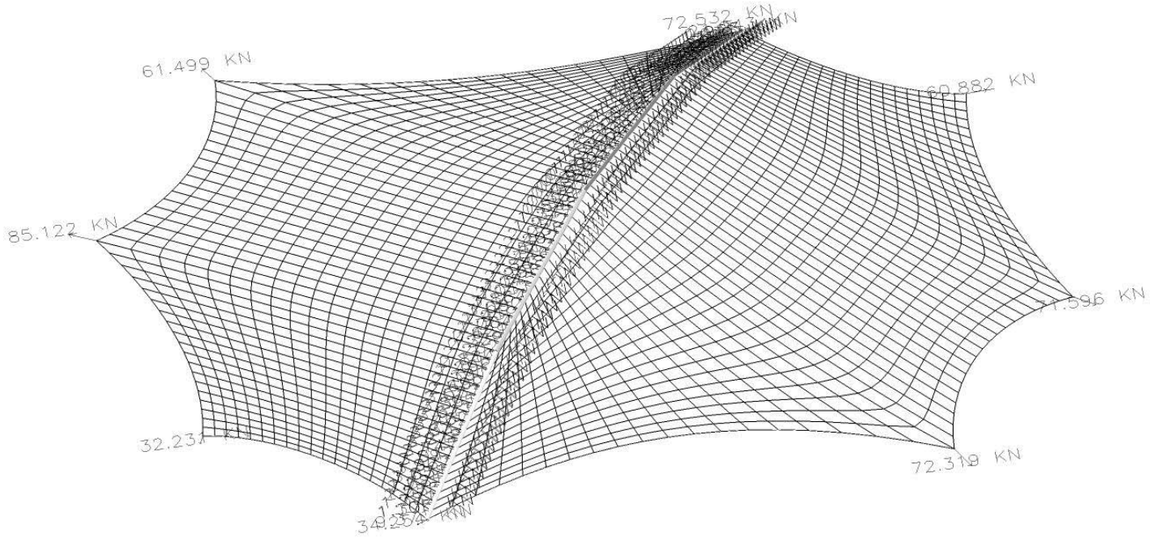
Membrane Details and Analysis

FDM Solver



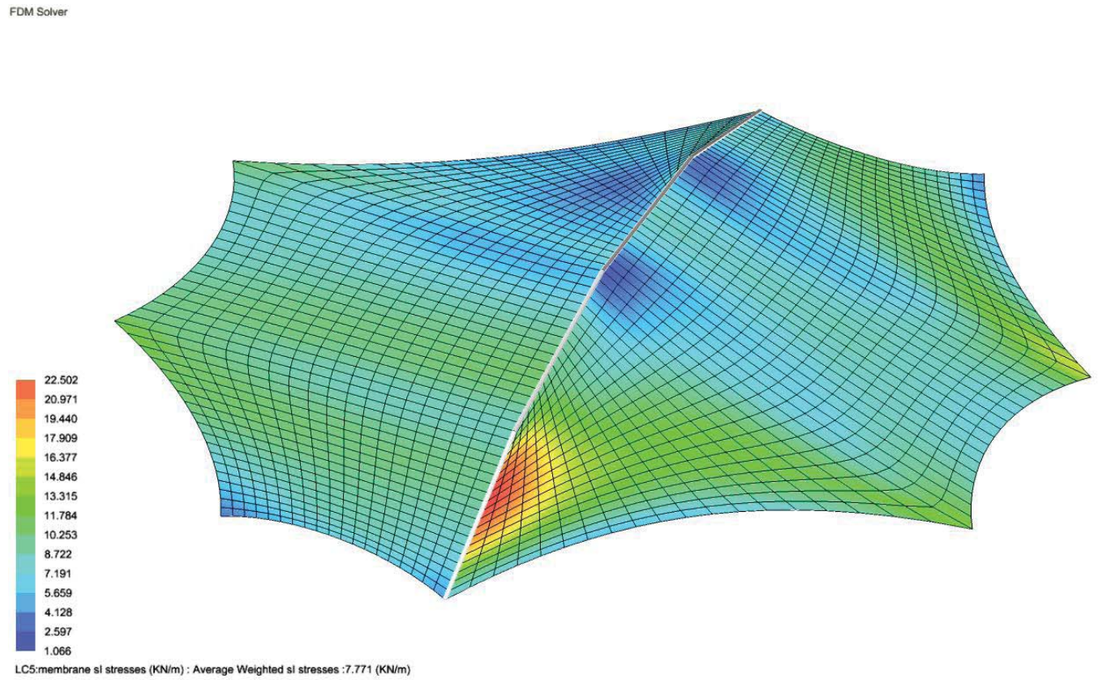
FDM Solver

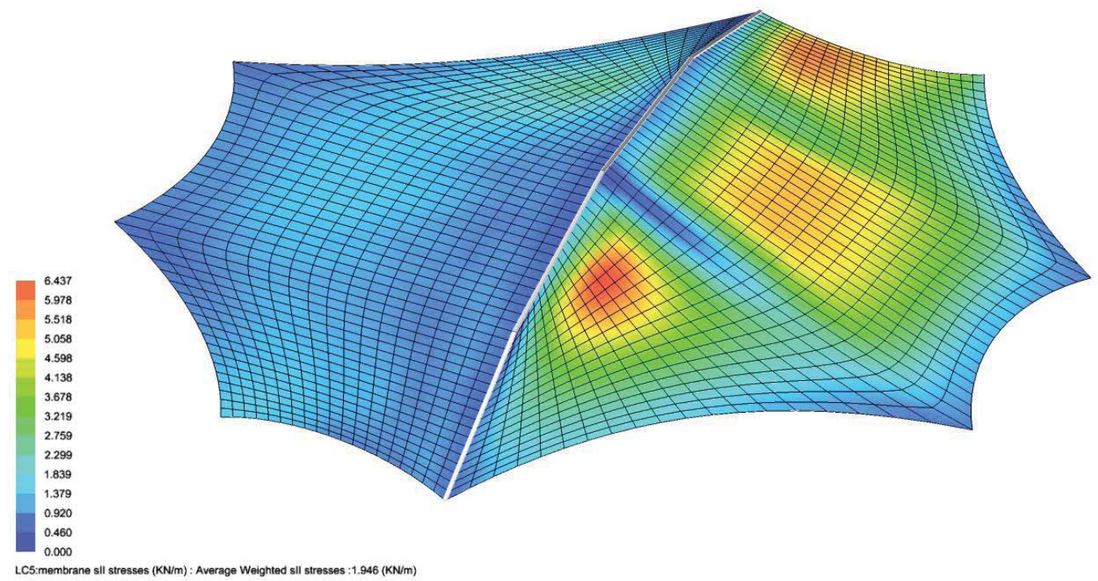




LC5 - Self weight 1.0 + Wind X 1.0 + Snow 1.0

Membrane Details and Analysis

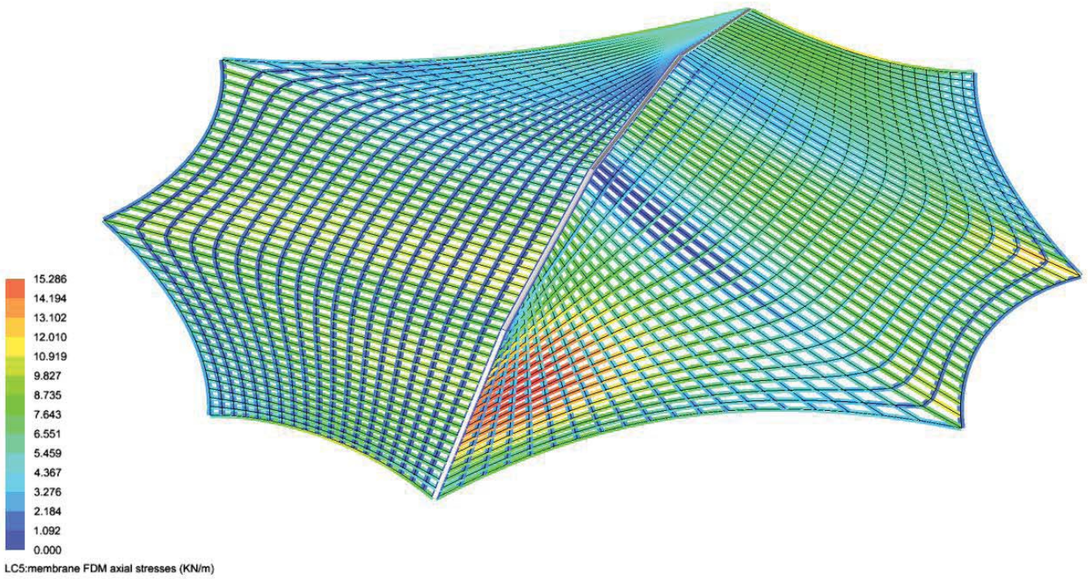




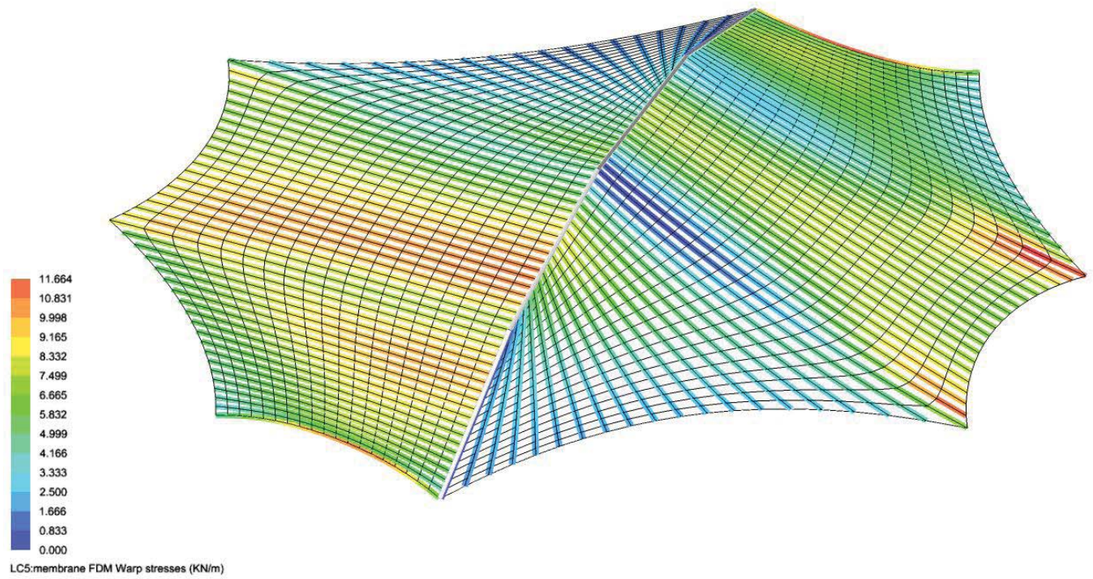
LC5 - Self weight 1.0 + Wind X 1.0 + Snow 1.0

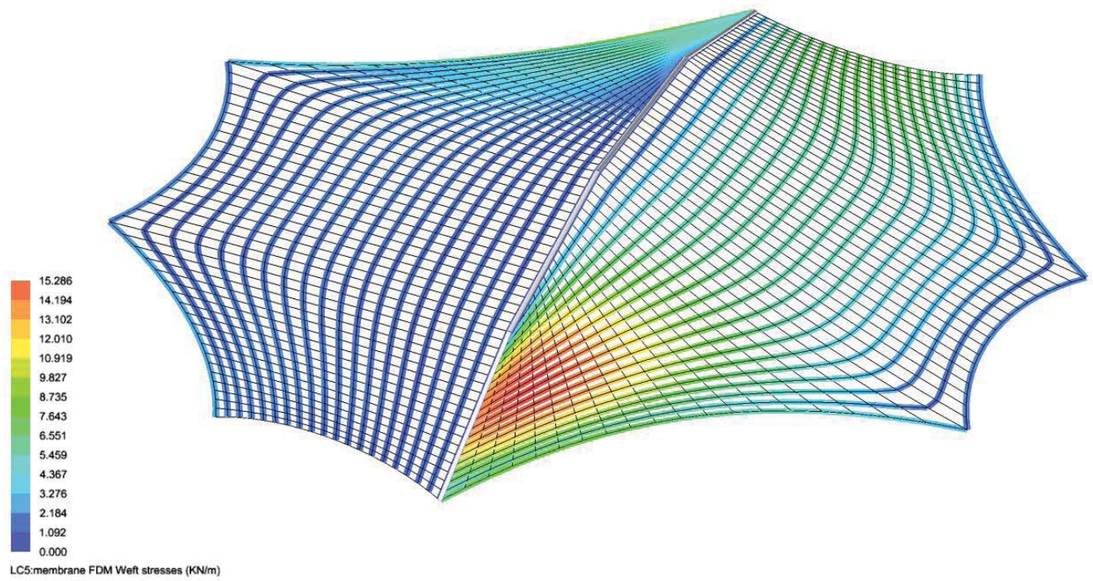
Membrane Details and Analysis

FDM Solver



FDM Solver

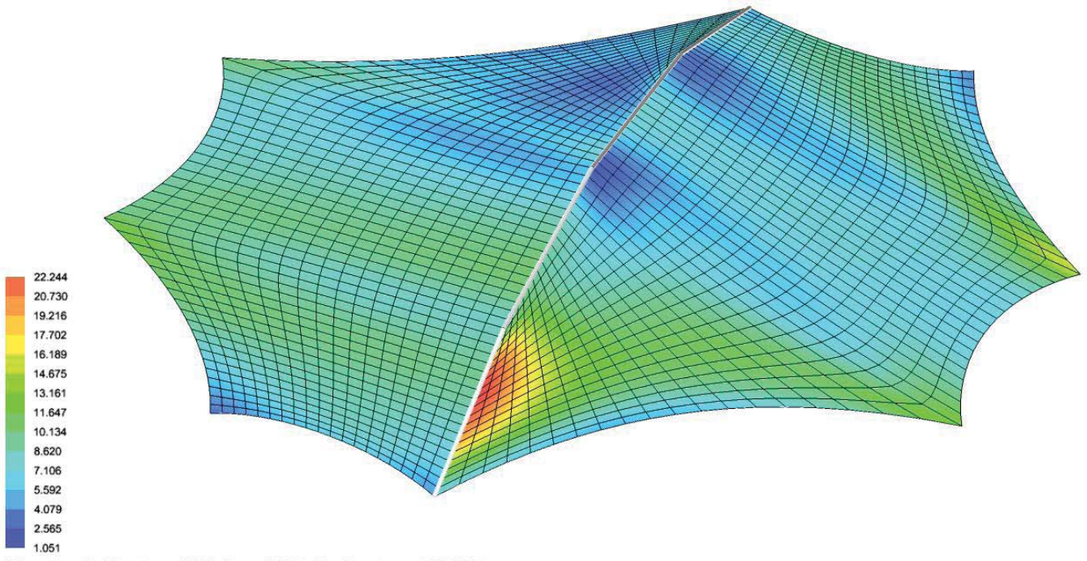




LC5 - Self weight 1.0 + Wind X 1.0 + Snow 1.0

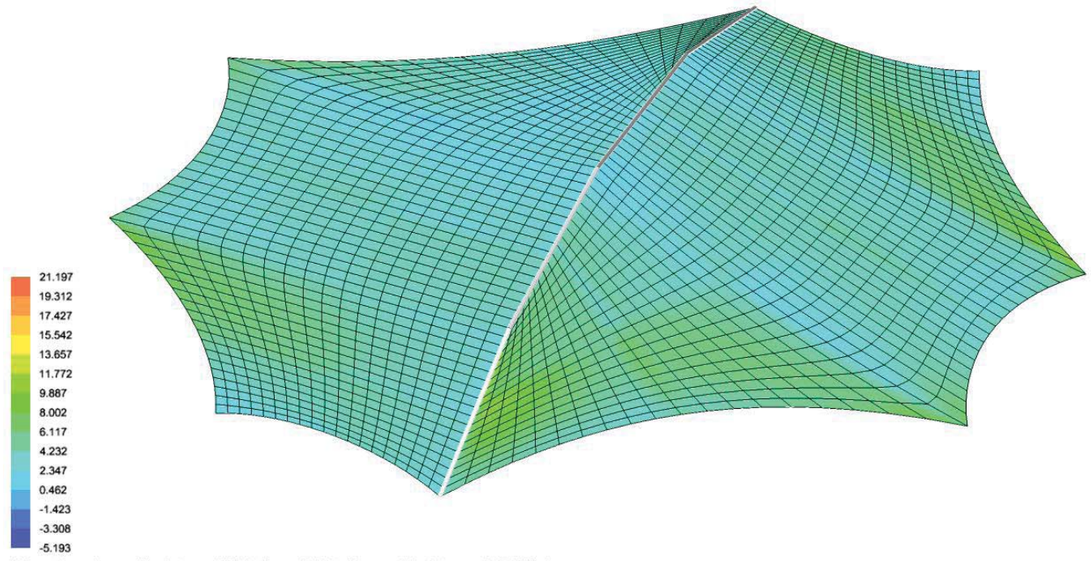
Membrane Details and Analysis

FDM Solver

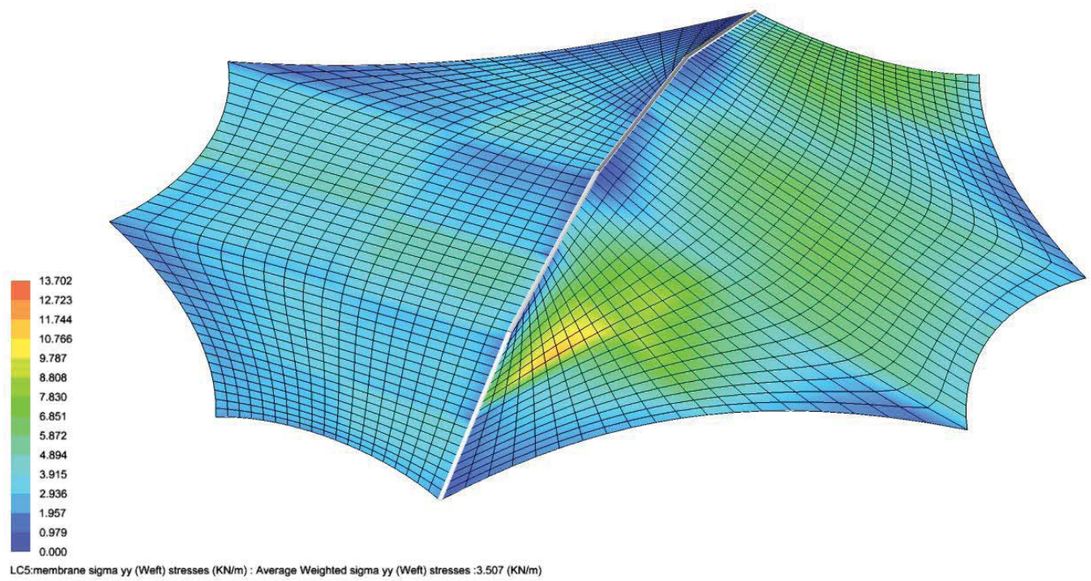


LC5:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :7.181 (KN/m)

FDM Solver



LC5:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :3.033 (KN/m)

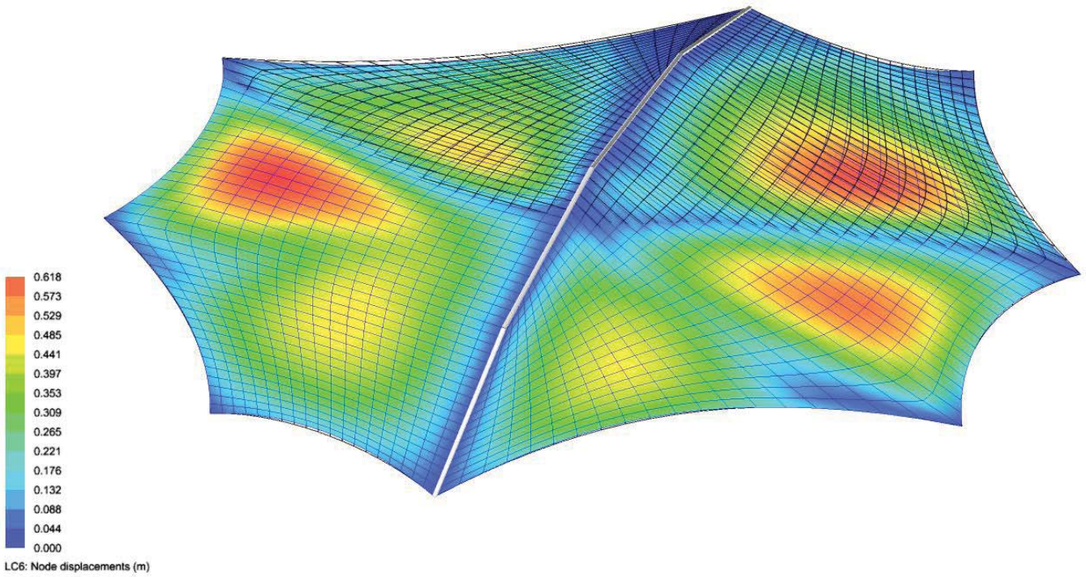


LC5:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :3.507 (KN/m)

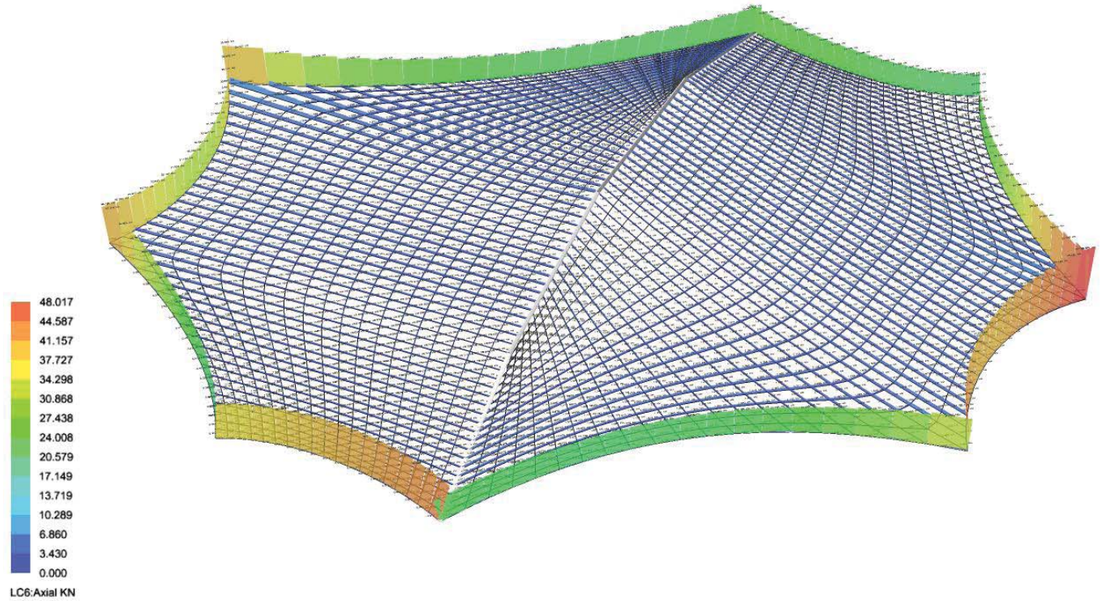
LC5 - Self weight 1.0 + Wind X 1.0 + Snow 1.0

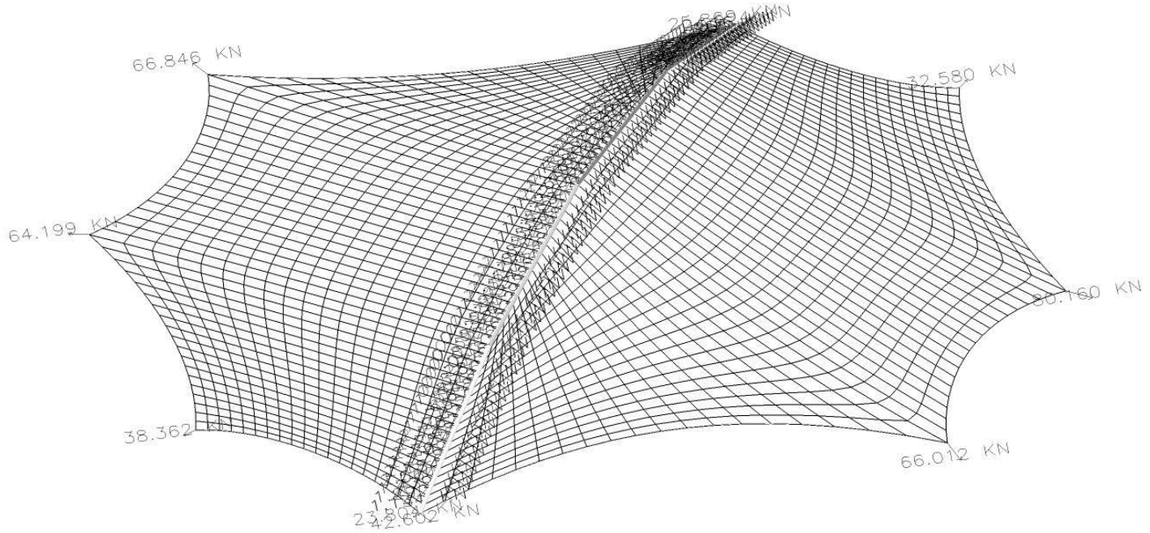
Membrane Details and Analysis

FDM Solver



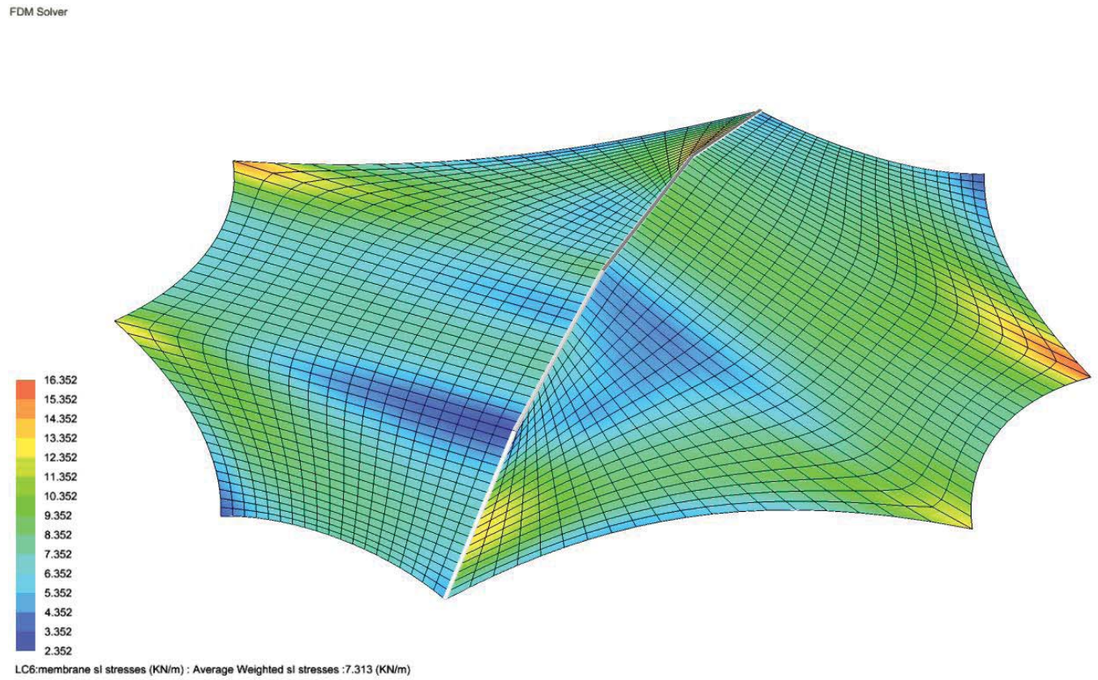
FDM Solver

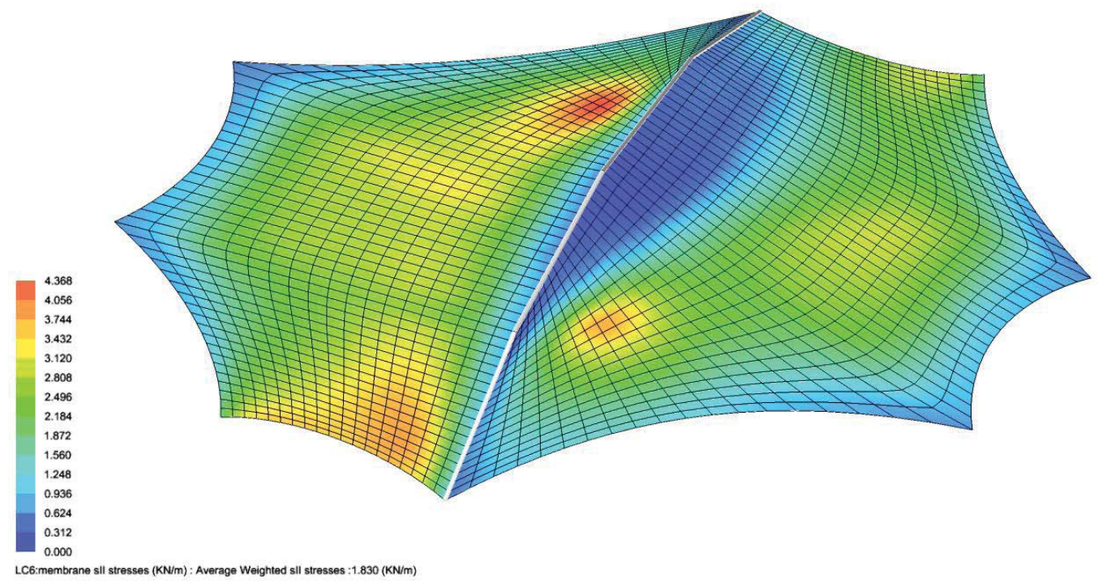




LC6 - Self weight 1.0 + Wind Y 1.0 + Snow 1.0

Membrane Details and Analysis

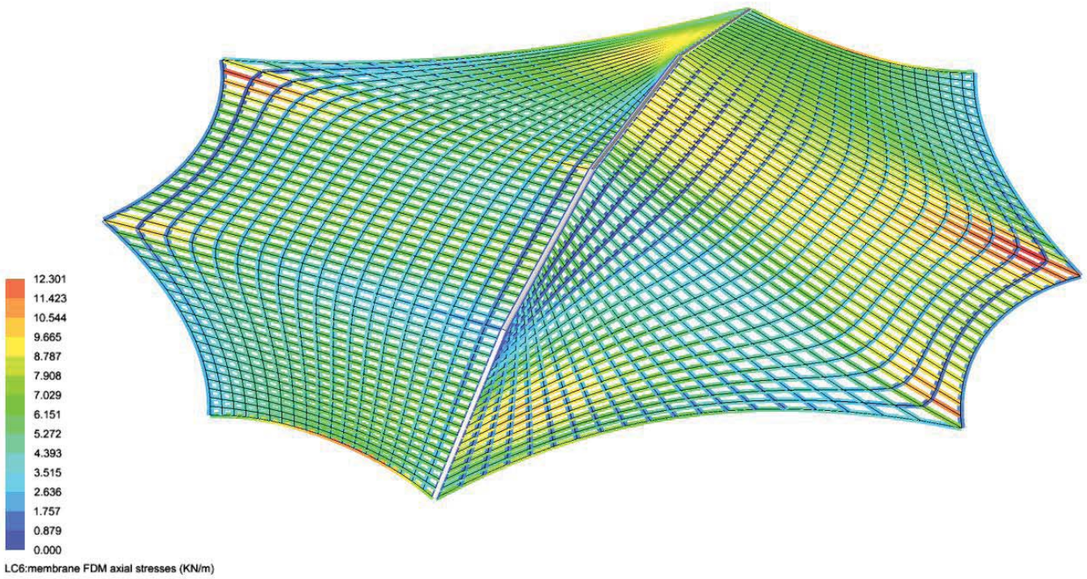




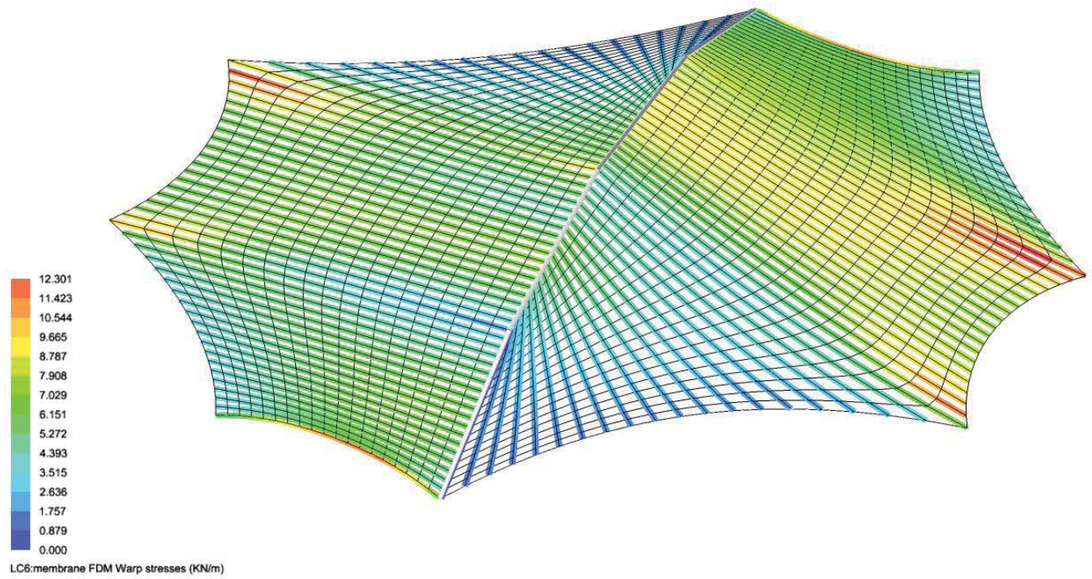
LC6 - Self weight 1.0 + Wind Y 1.0 + Snow 1.0

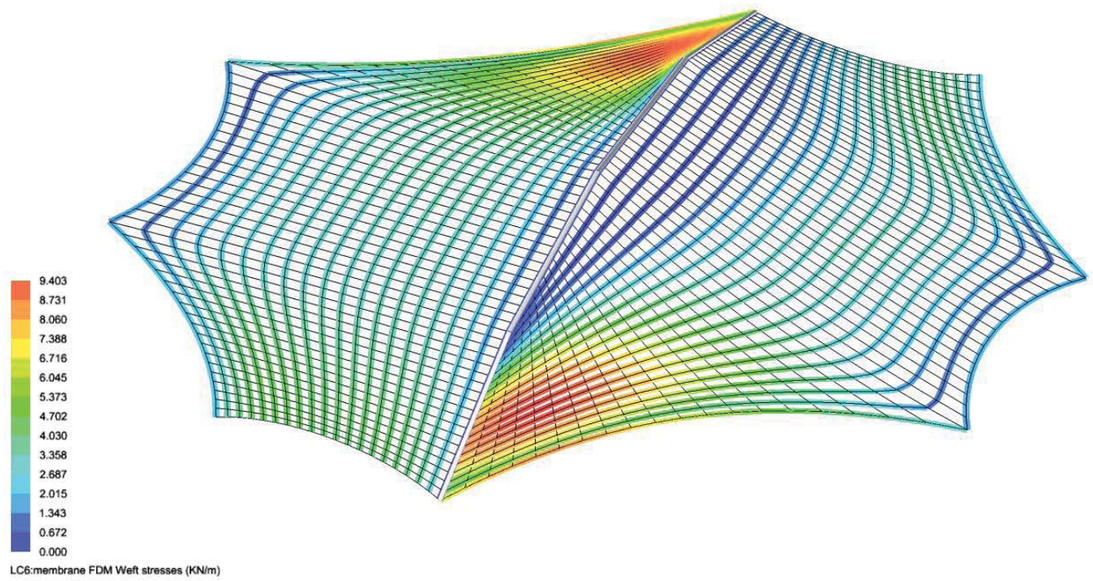
Membrane Details and Analysis

FDM Solver



FDM Solver

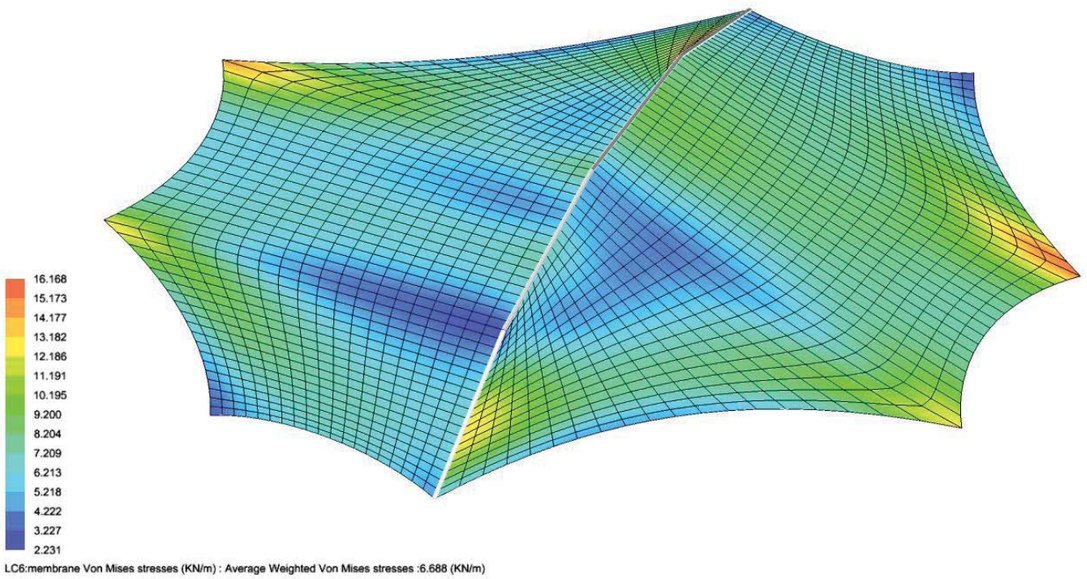




LC6 - Self weight 1.0 + Wind Y 1.0 + Snow 1.0

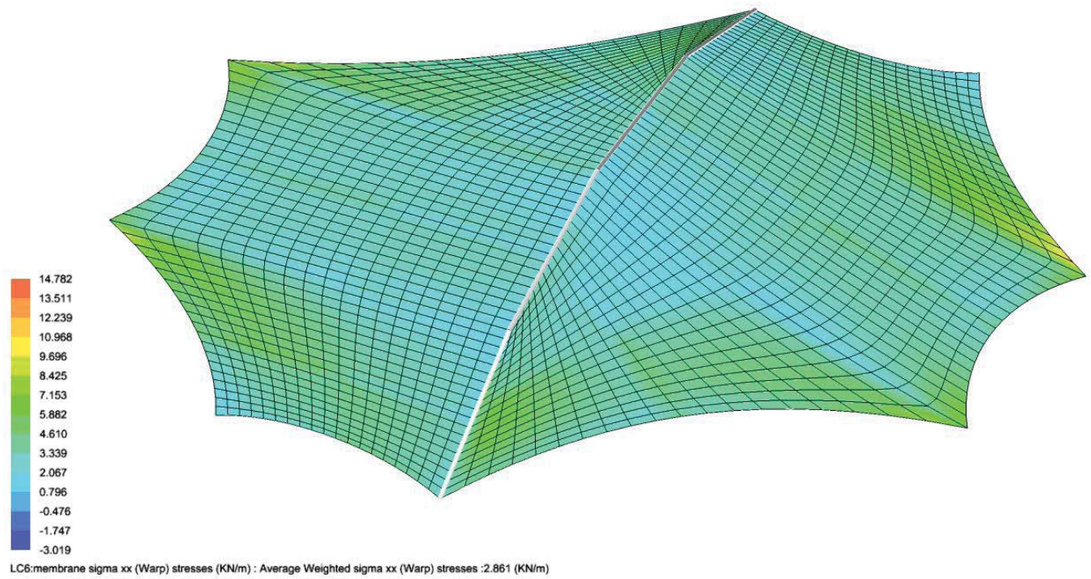
Membrane Details and Analysis

FDM Solver

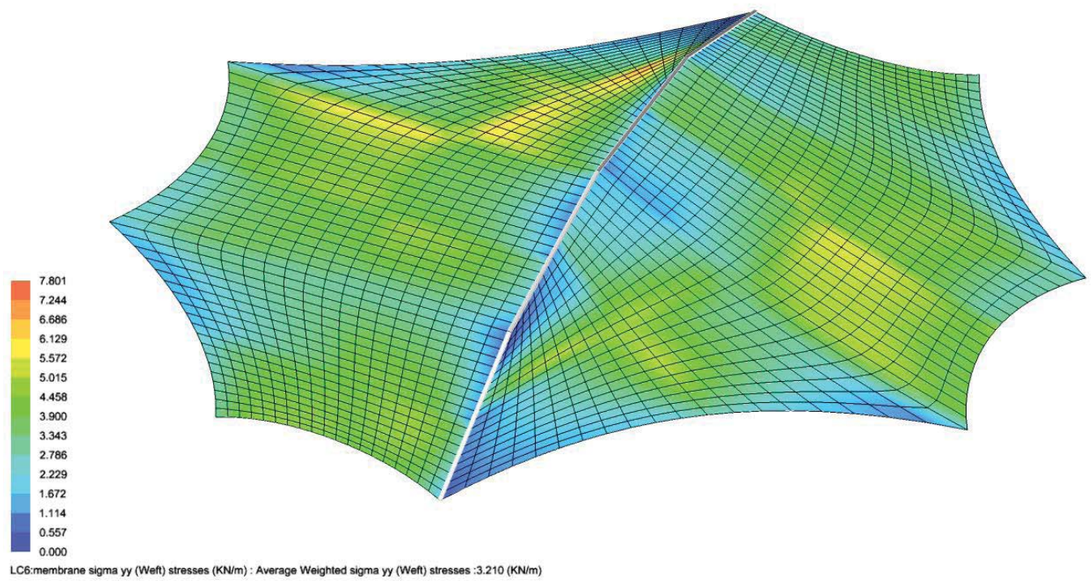


LC6:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :6.688 (KN/m)

FDM Solver



LC6:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :2.861 (KN/m)

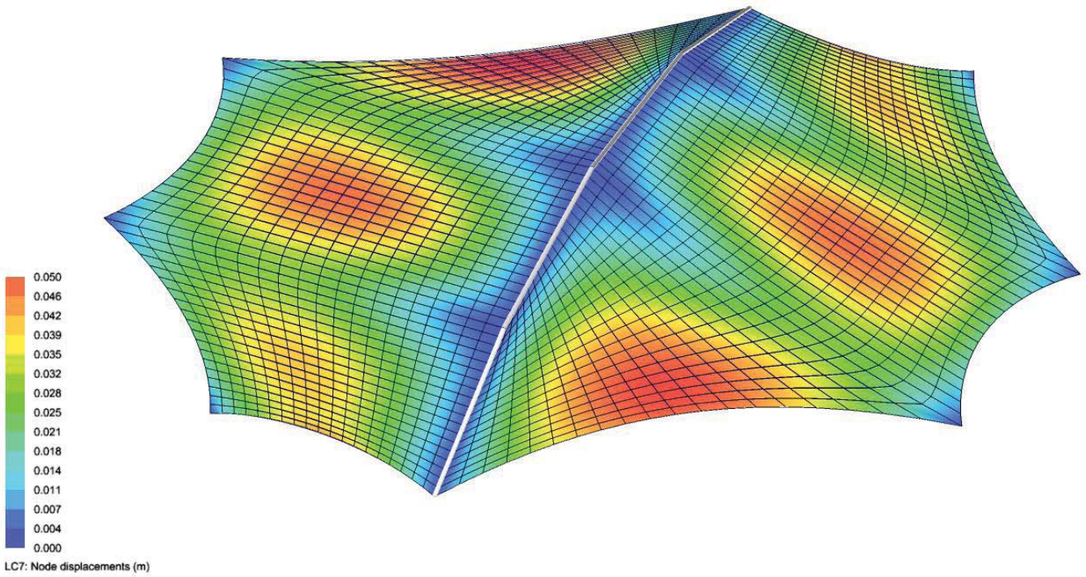


LC6:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :3.210 (KN/m)

LC6 - Self weight 1.0 + Wind Y 1.0 + Snow 1.0

Membrane Details and Analysis

FDM Solver



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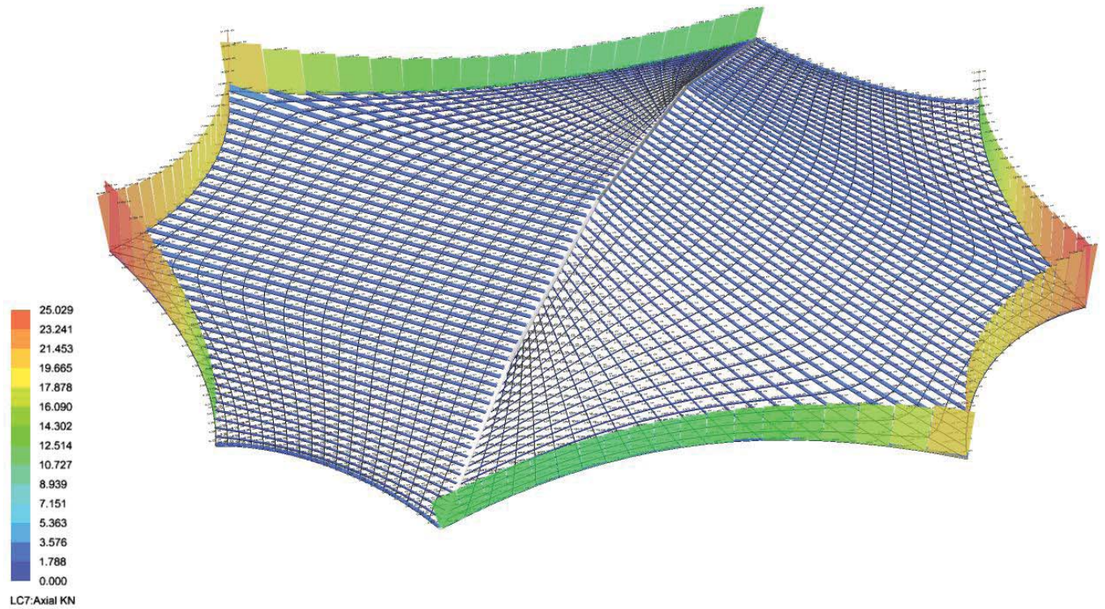
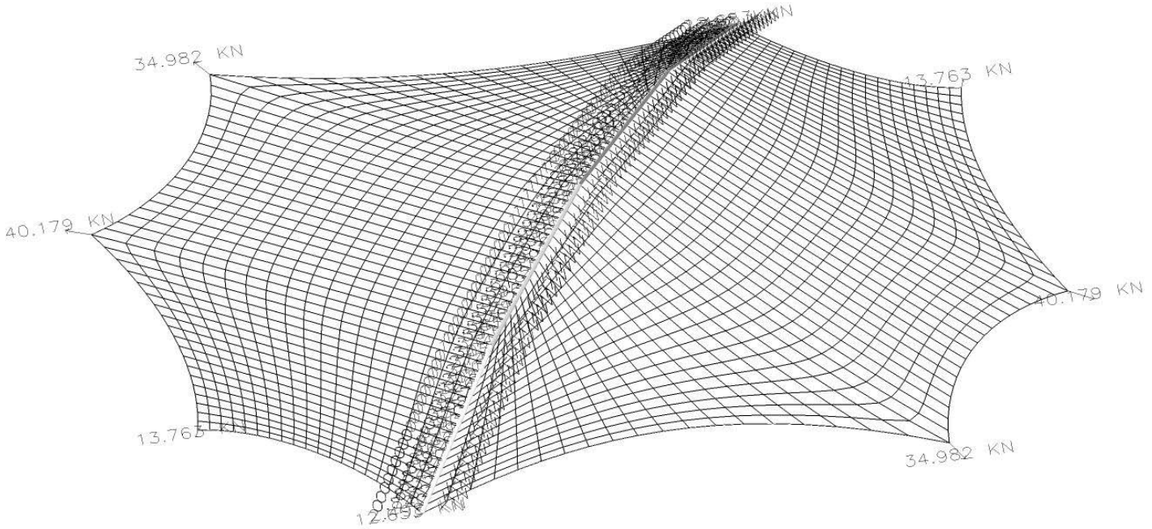
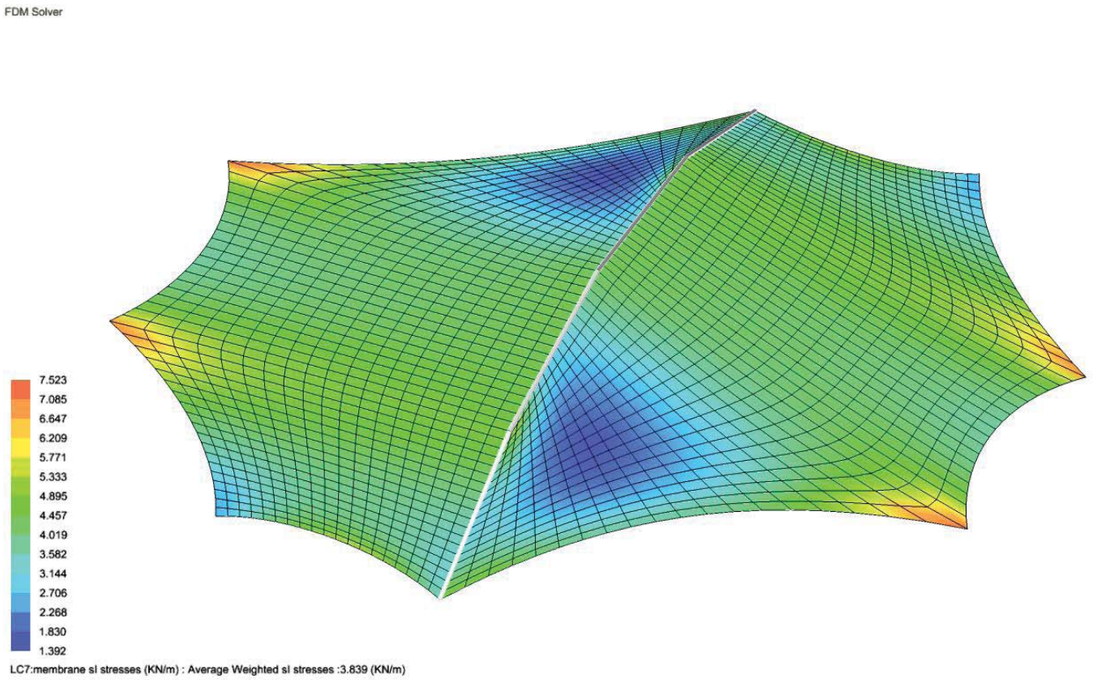
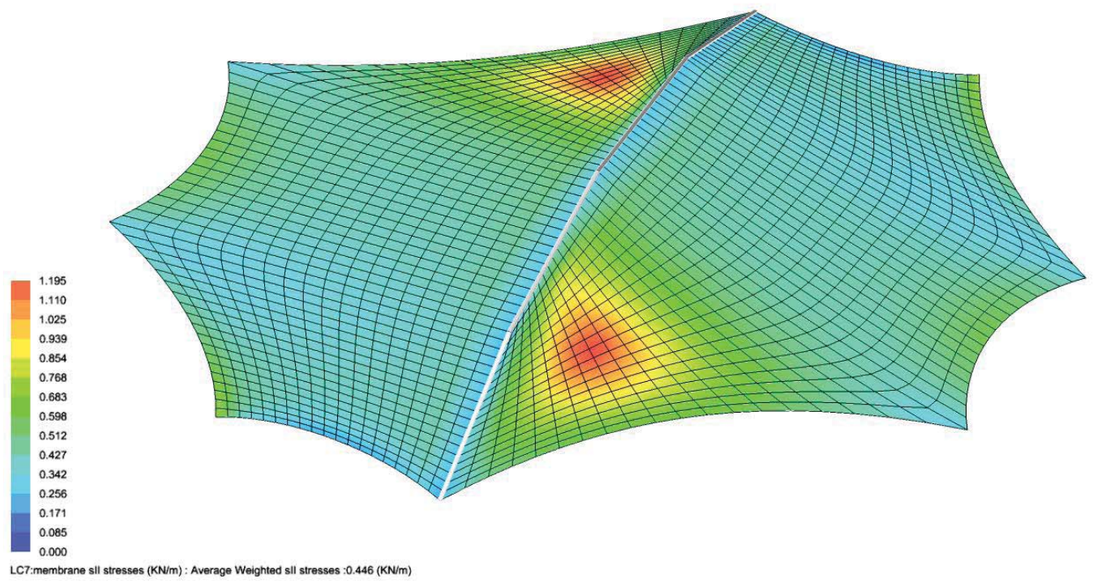




LC7 - Self weight 1.35

Membrane Details and Analysis

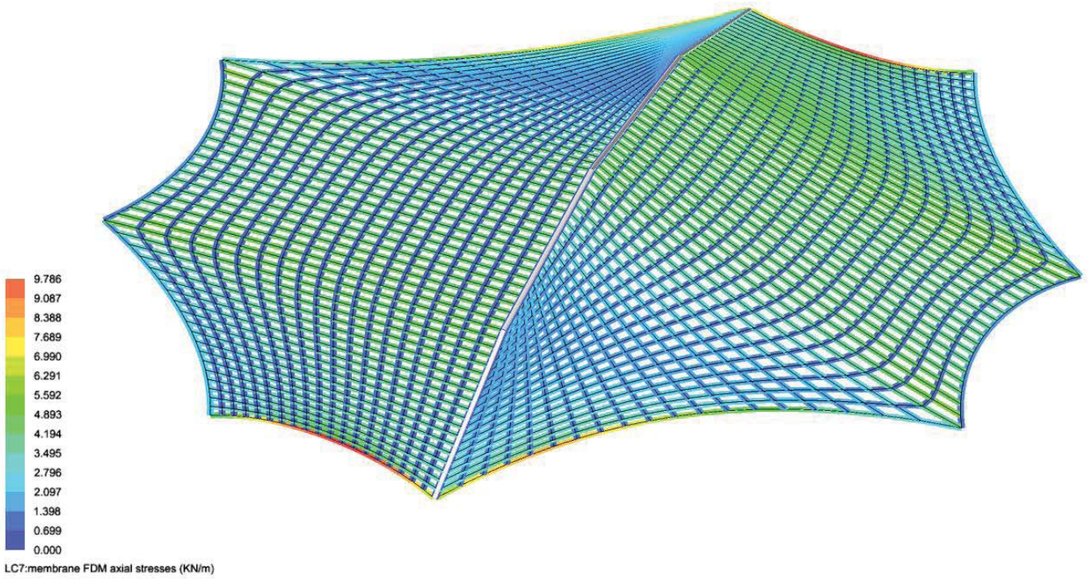




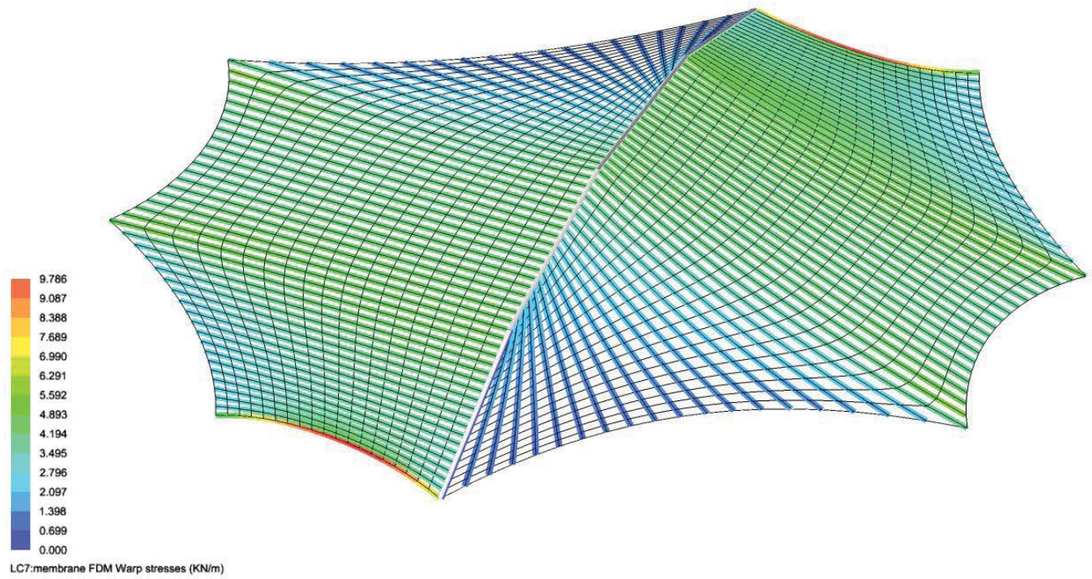
LC7 - Self weight 1.35

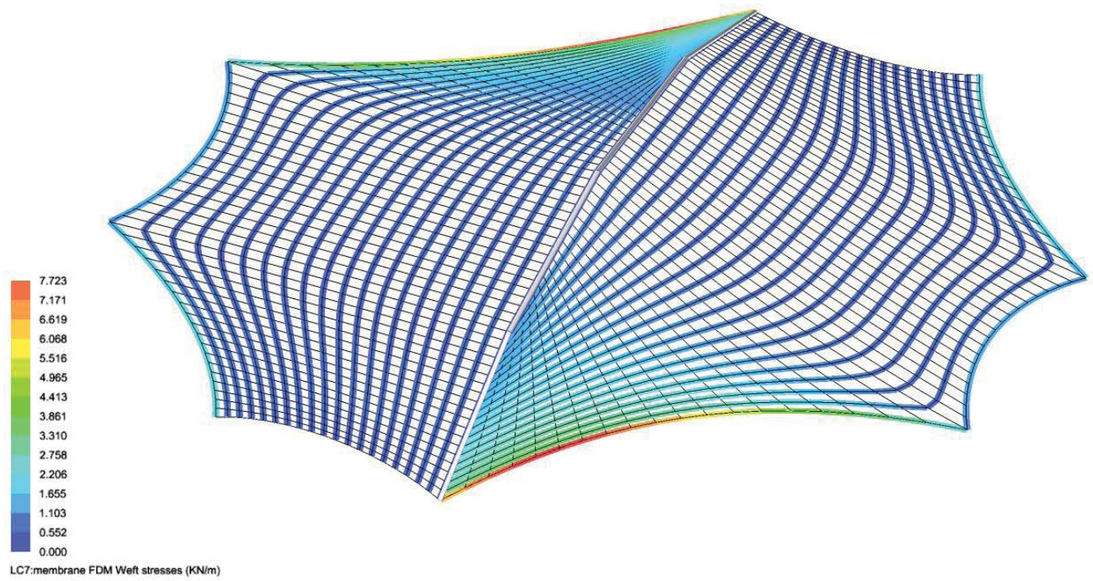
Membrane Details and Analysis

FDM Solver



FDM Solver

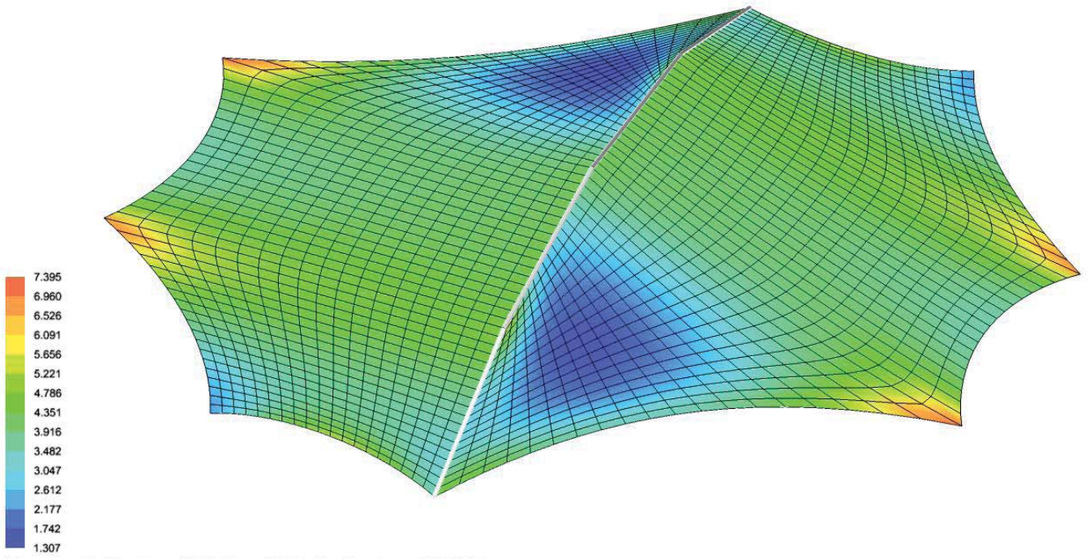




LC7 - Self weight 1.35

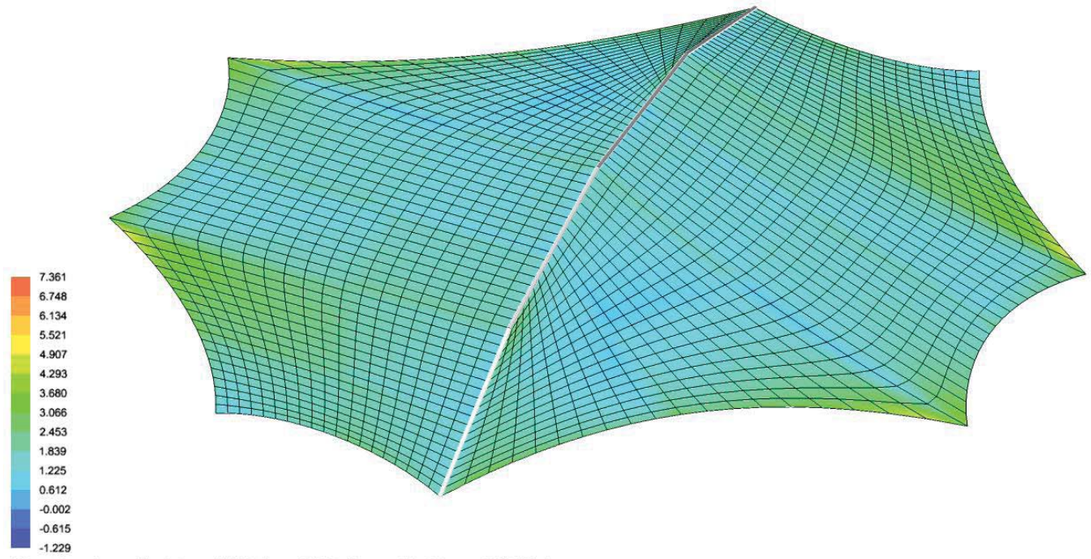
Membrane Details and Analysis

FDM Solver

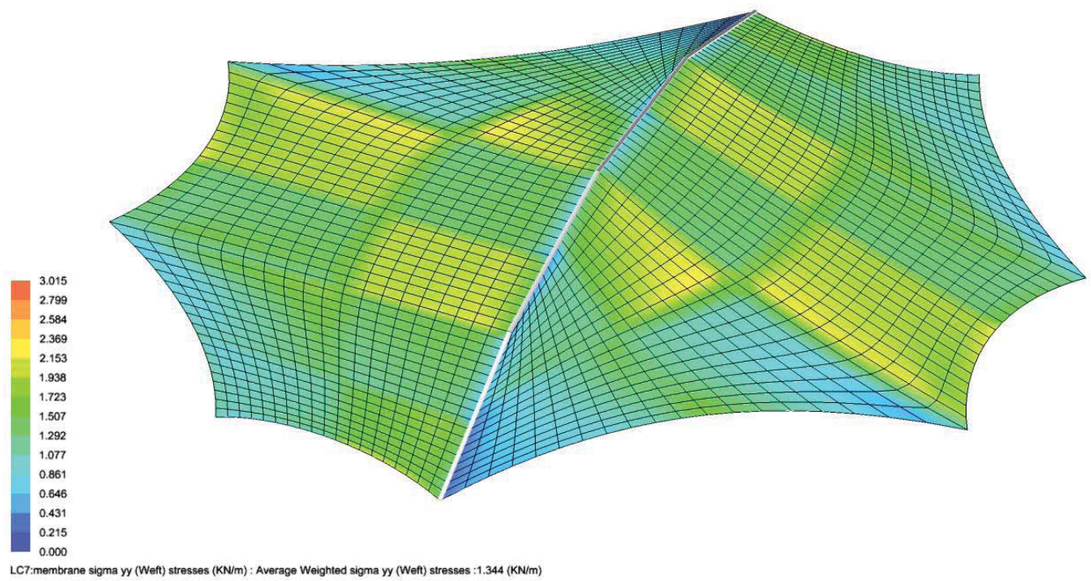


LC7:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :3.652 (KN/m)

FDM Solver



LC7:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :1.358 (KN/m)

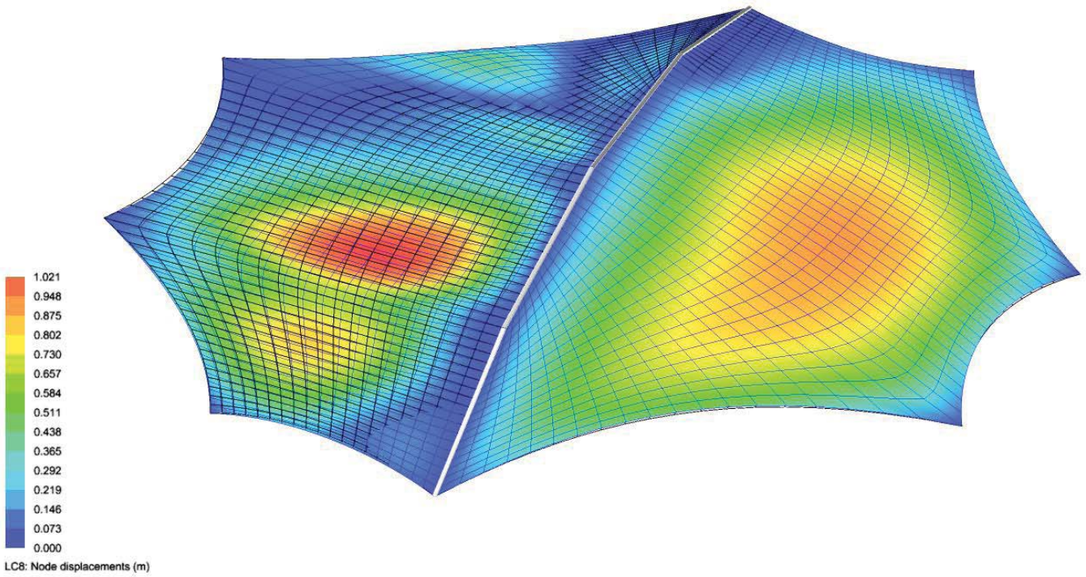


LC7:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :1.344 (KN/m)

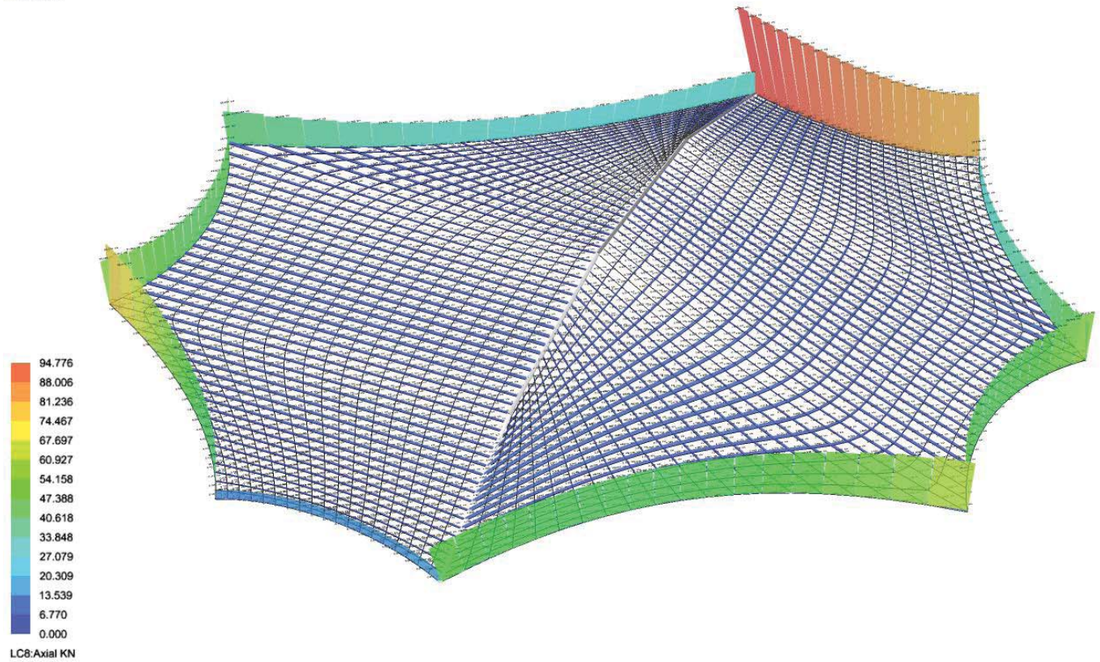
LC7 - Self weight 1.35

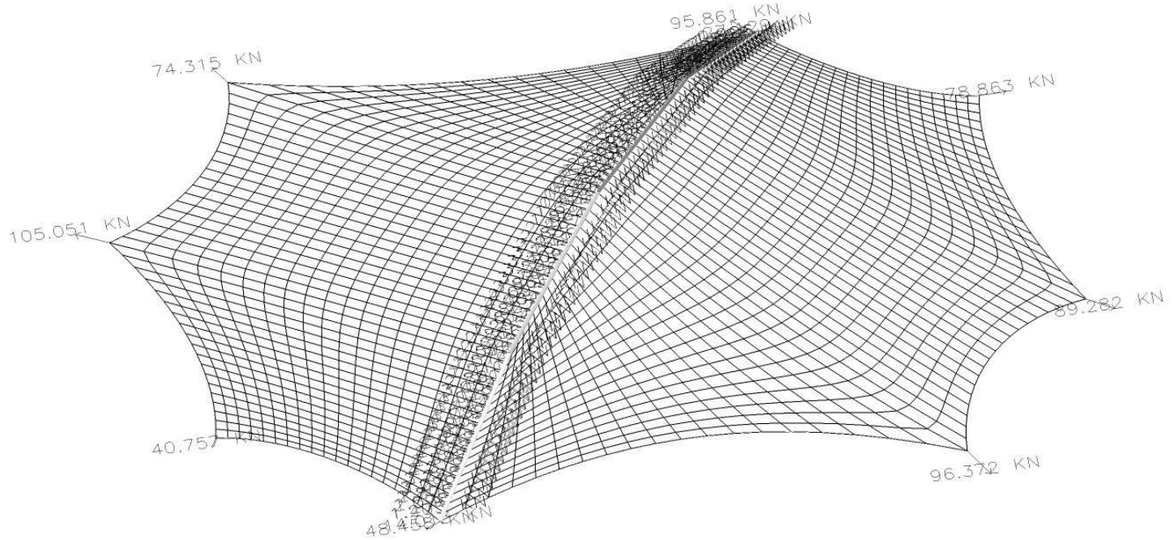
Membrane Details and Analysis

FDM Solver



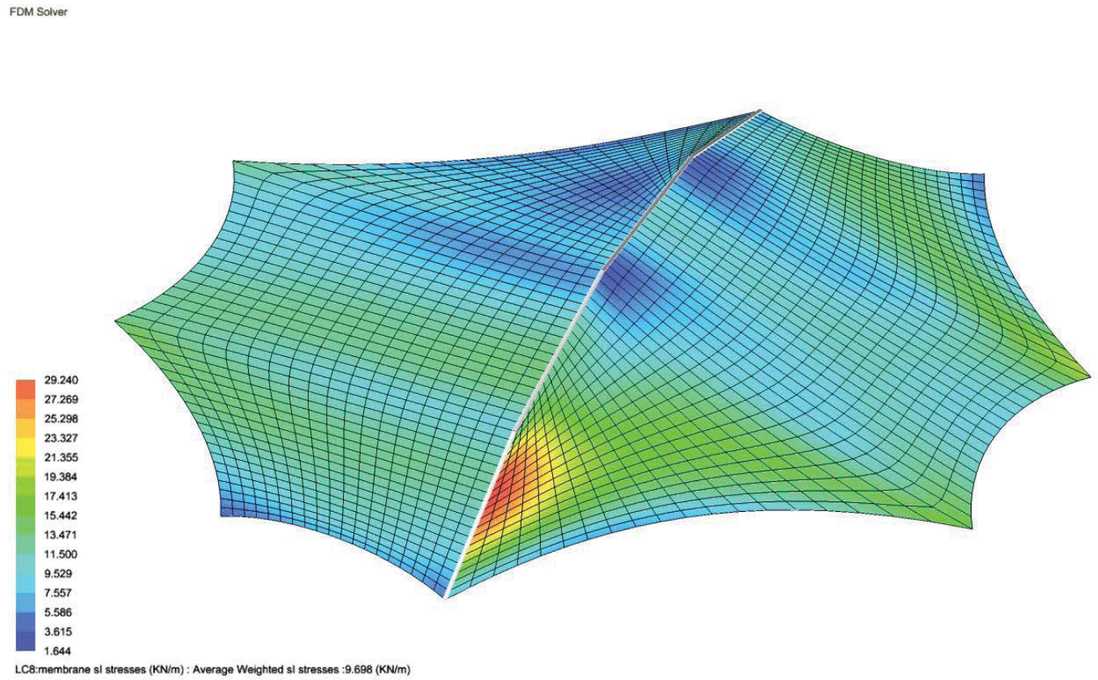
FDM Solver

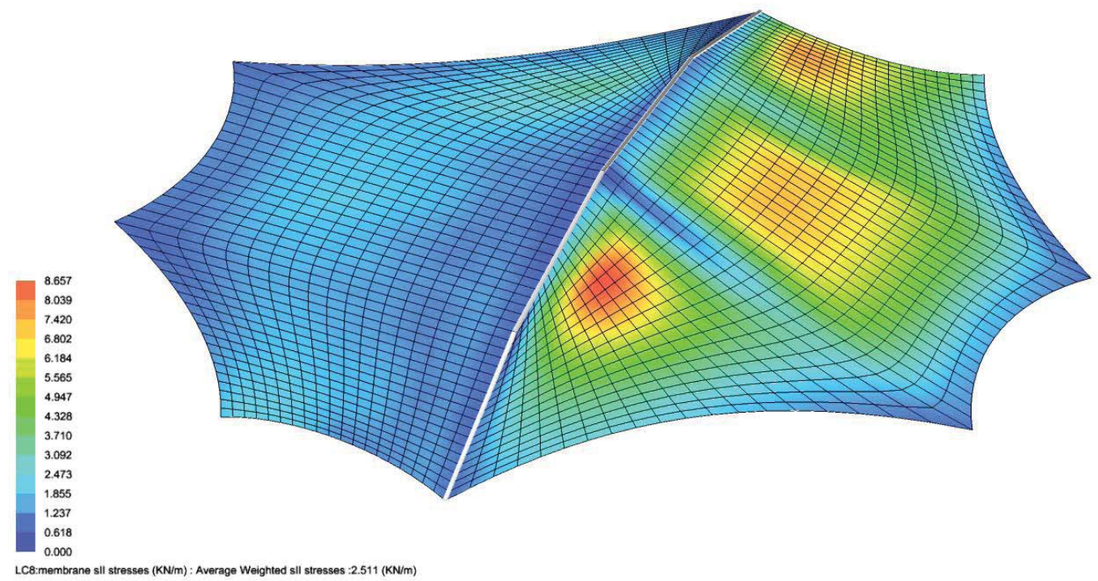




LC8 - Self weight 1.35 + Wind X 1.5

Membrane Details and Analysis

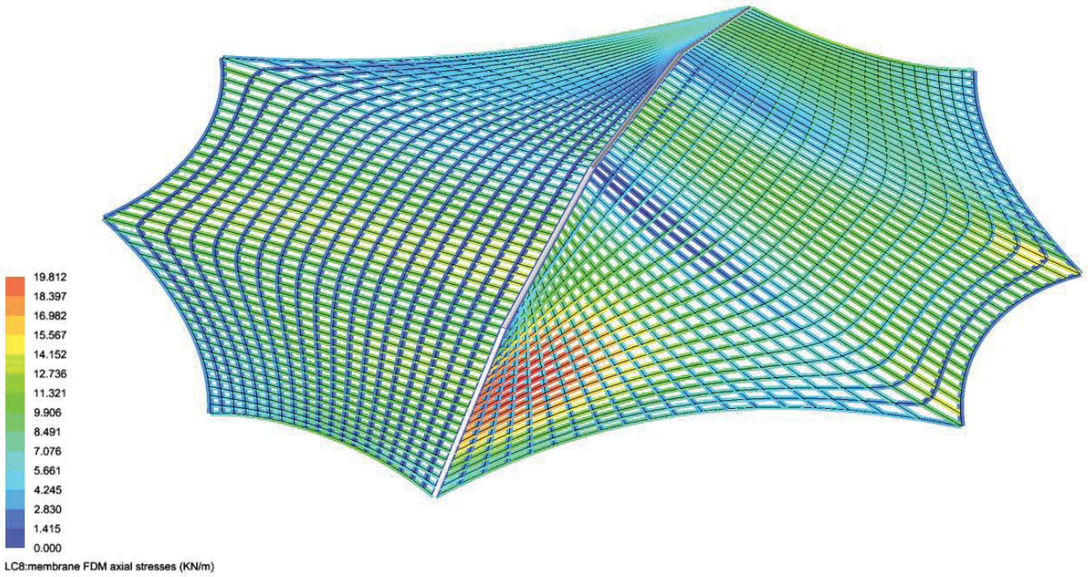




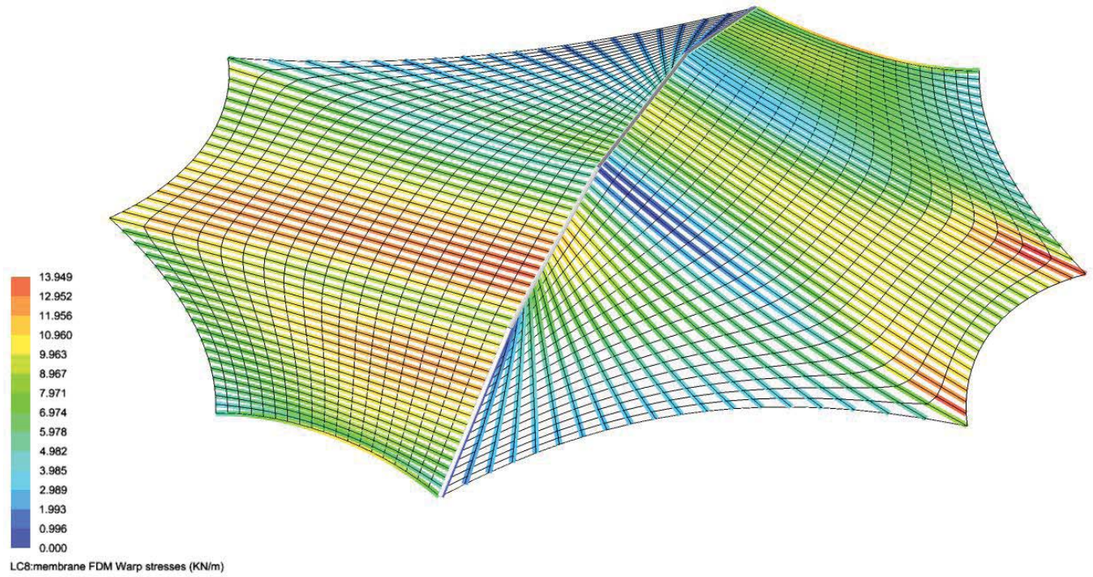
LC8 - Self weight 1.35 + Wind X 1.5

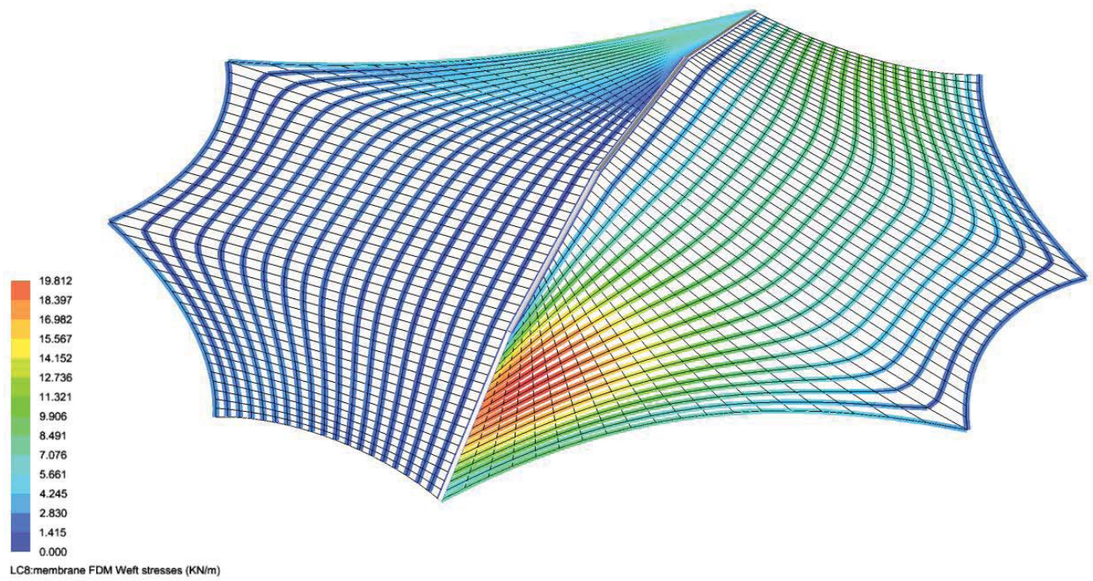
Membrane Details and Analysis

FDM Solver



FDM Solver

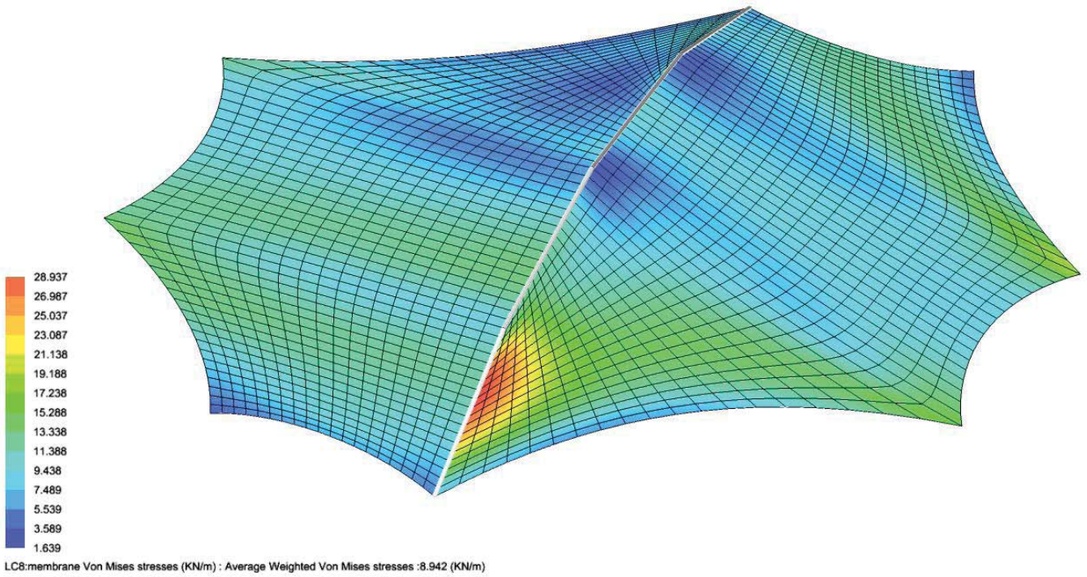




LC8 - Self weight 1.35 + Wind X 1.5

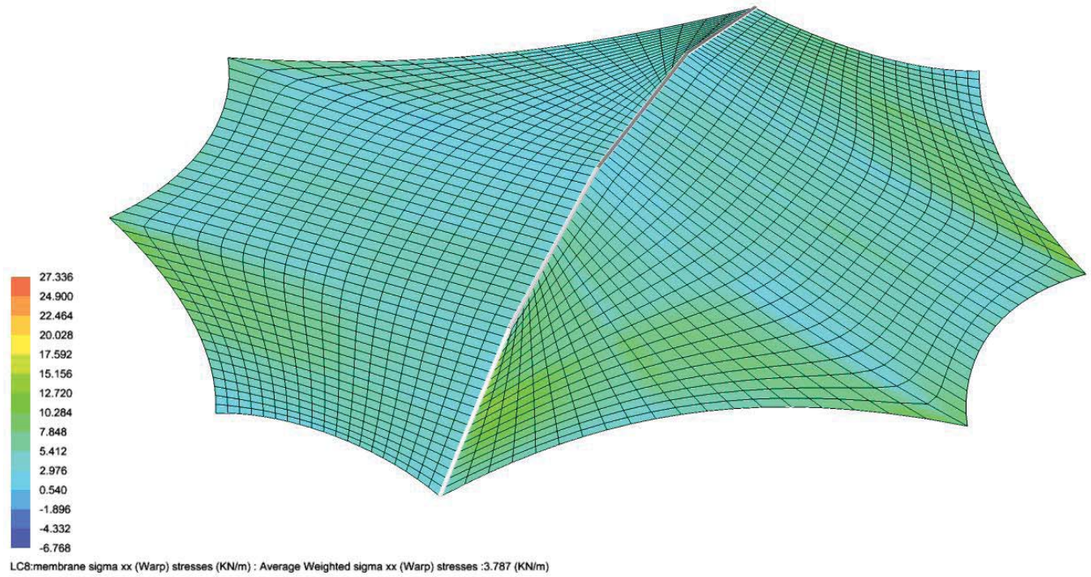
Membrane Details and Analysis

FDM Solver

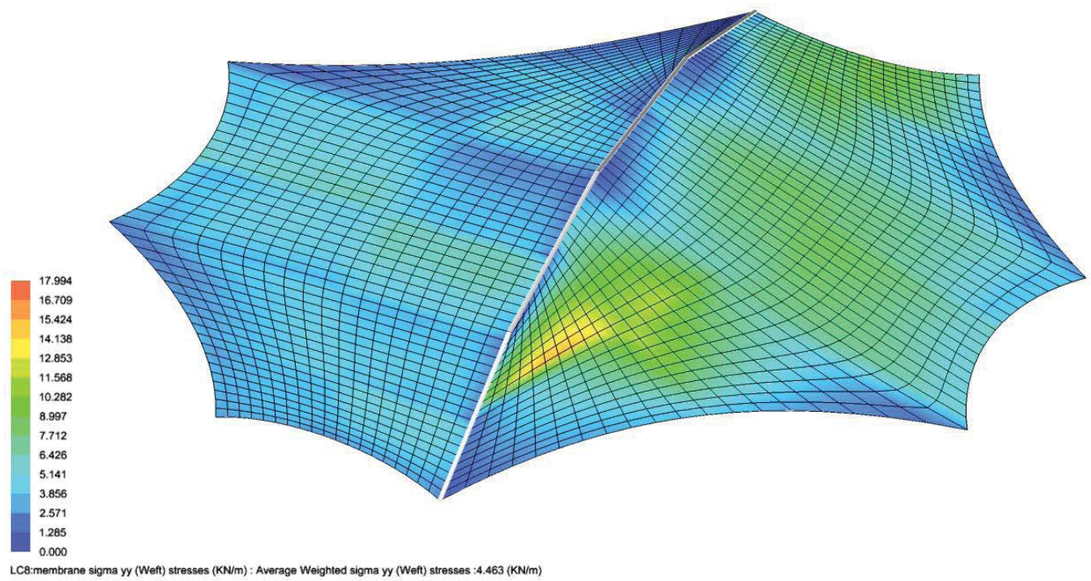


LC8:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :8.942 (KN/m)

FDM Solver



LC8:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :3.787 (KN/m)

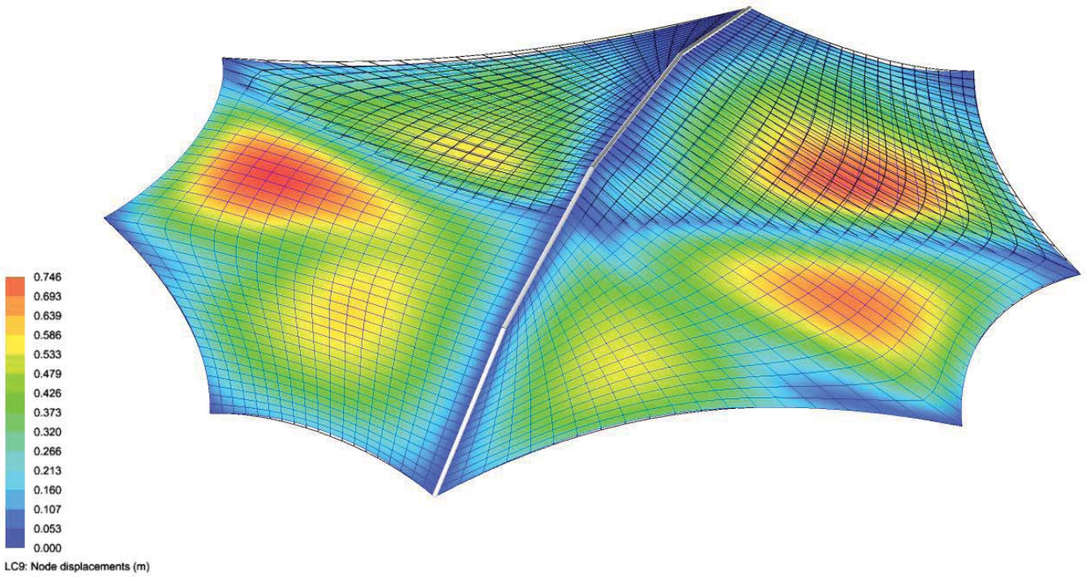


LC8:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :4.463 (KN/m)

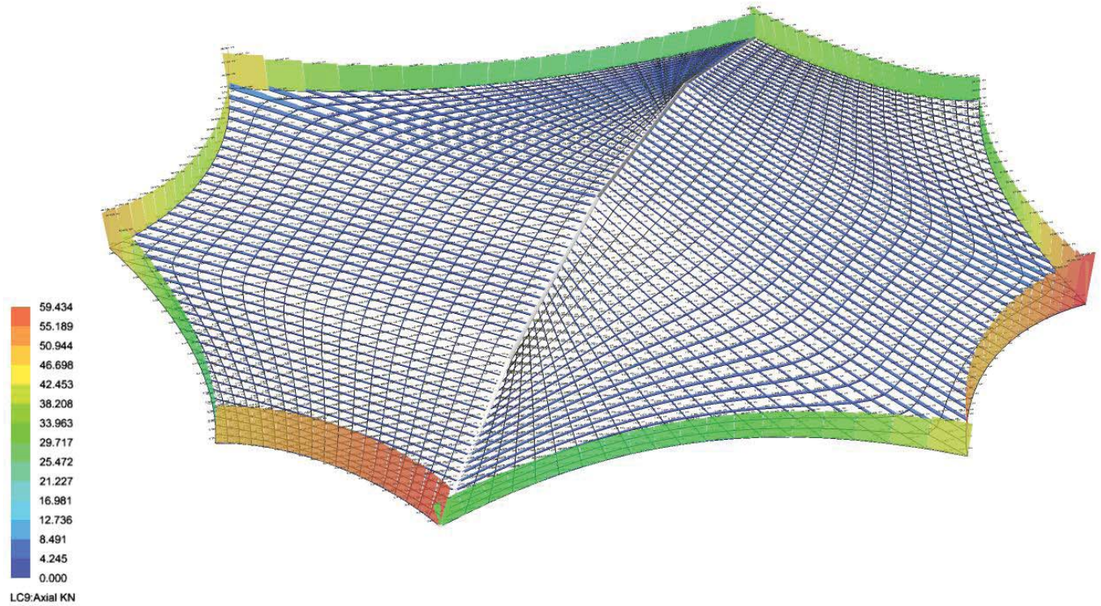
LC8 - Self weight 1.35 + Wind X 1.5

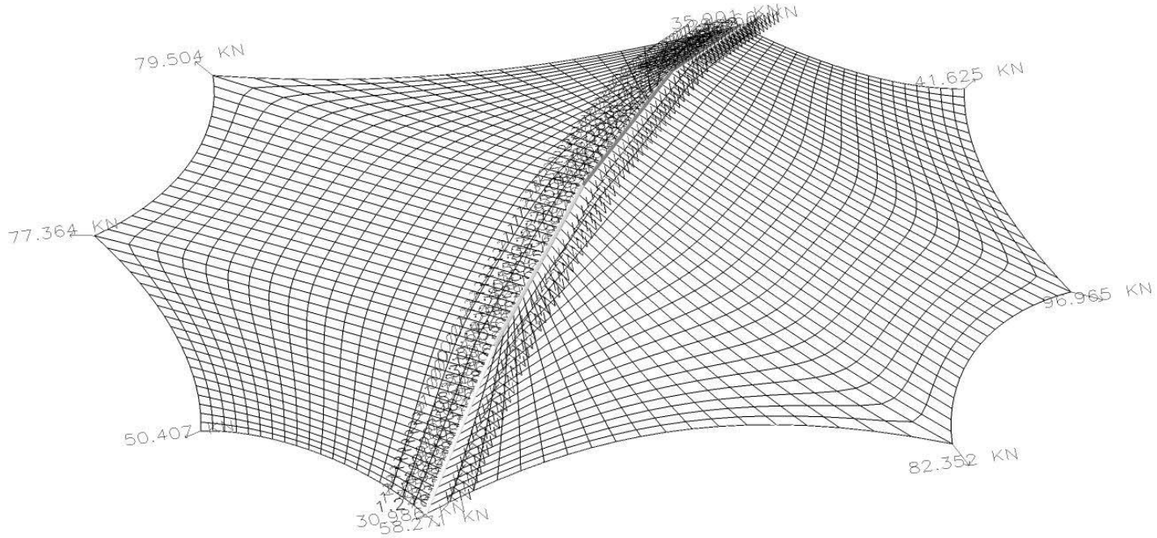
Membrane Details and Analysis

FDM Solver



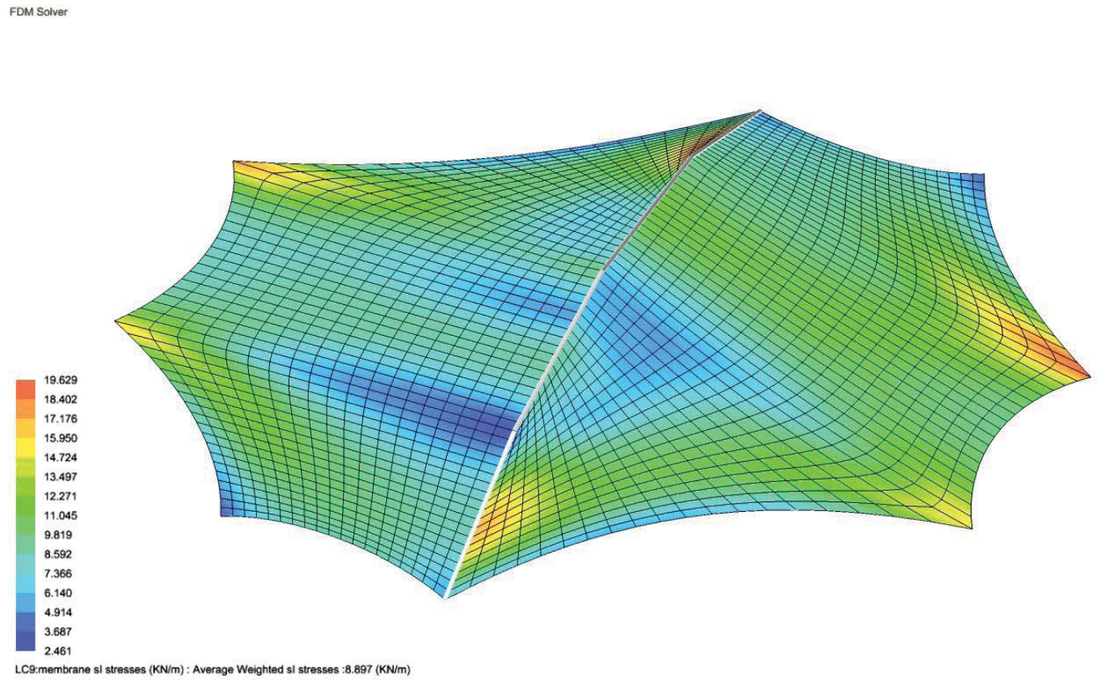
FDM Solver

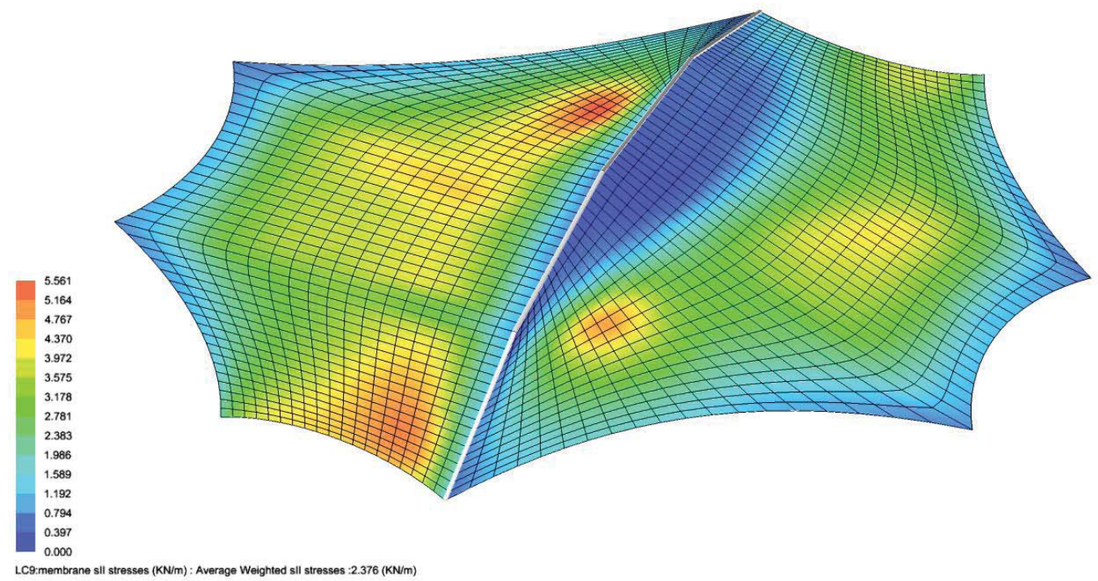




LC9 - Self weight 1.35 + Wind Y 1.5

Membrane Details and Analysis

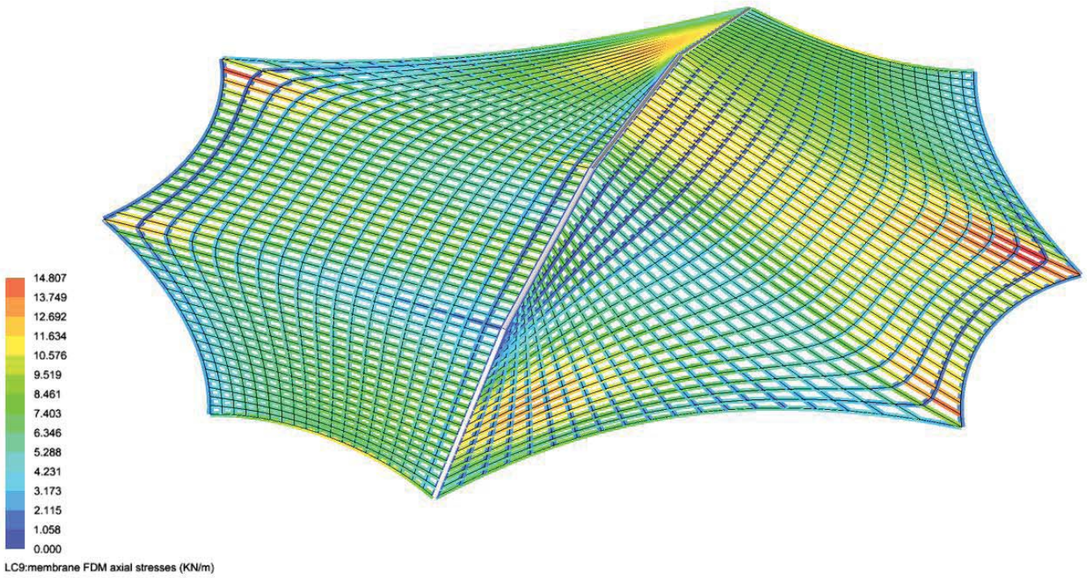




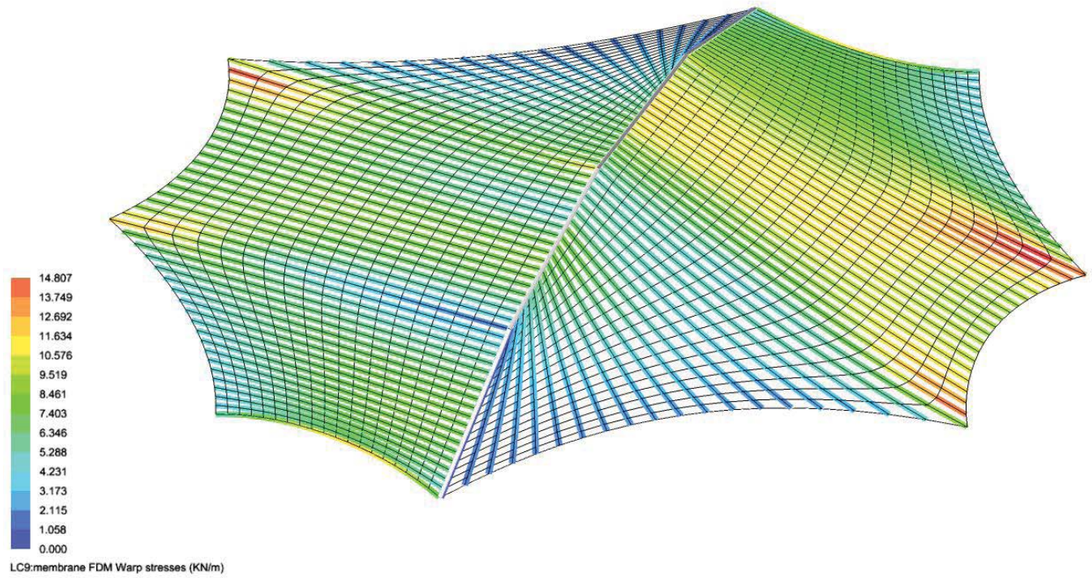
LC9 - Self weight 1.35 + Wind Y 1.5

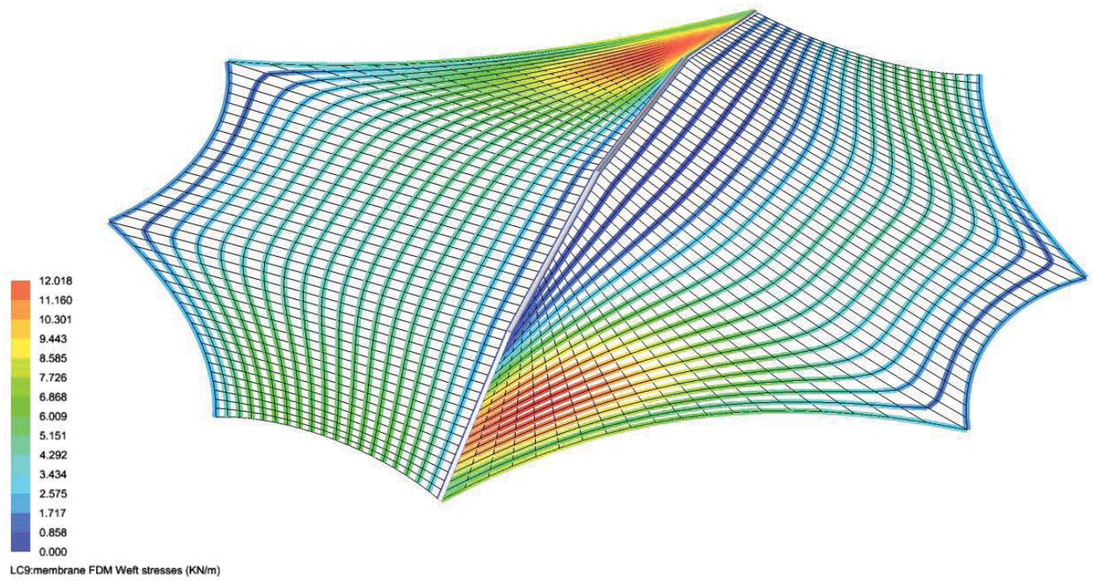
Membrane Details and Analysis

FDM Solver



FDM Solver

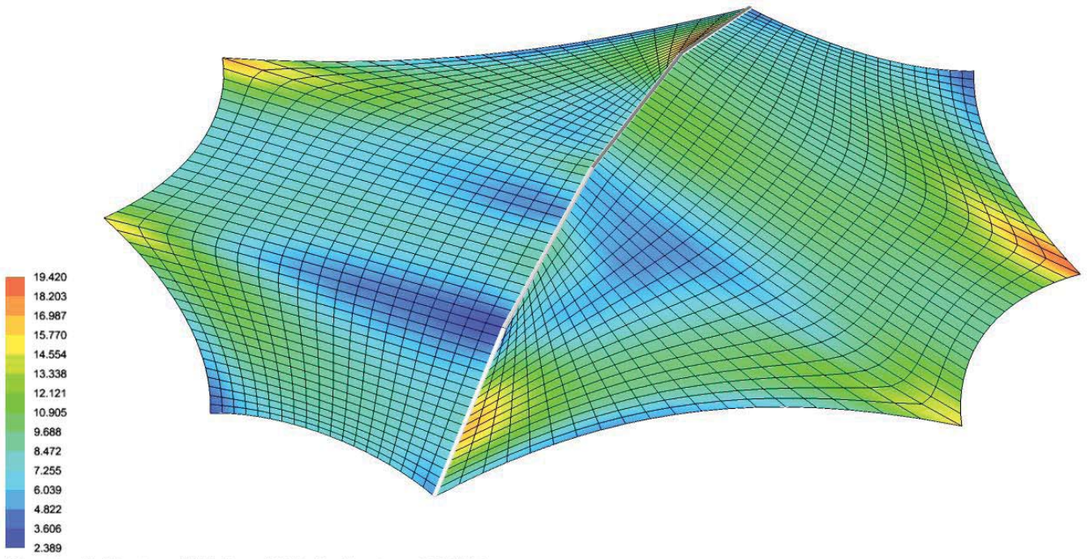




LC9 - Self weight 1.35 + Wind Y 1.5

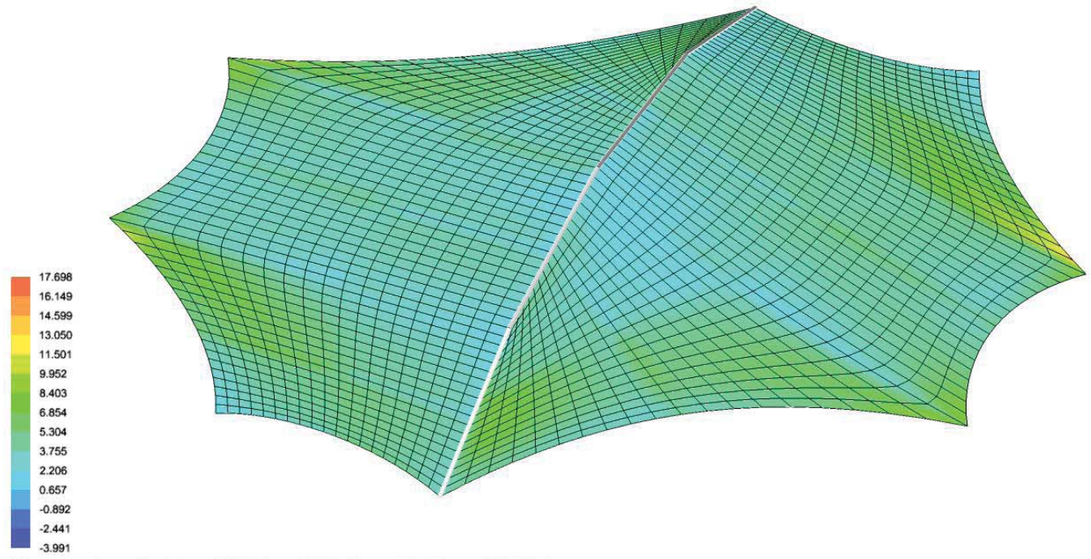
Membrane Details and Analysis

FDM Solver

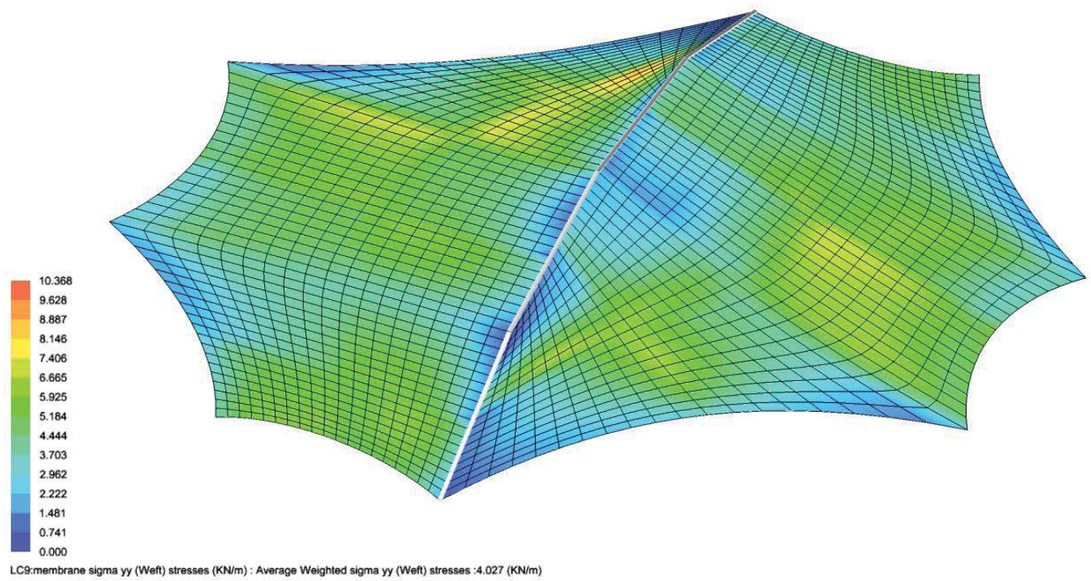


LC9:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :8.124 (KN/m)

FDM Solver



LC9:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :3.510 (KN/m)

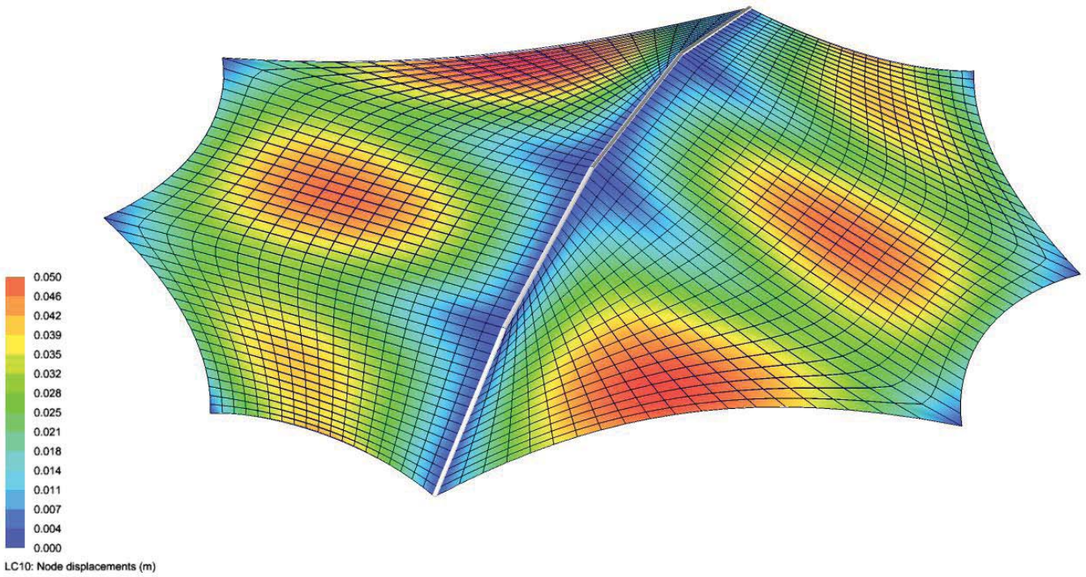


LC9:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :4.027 (KN/m)

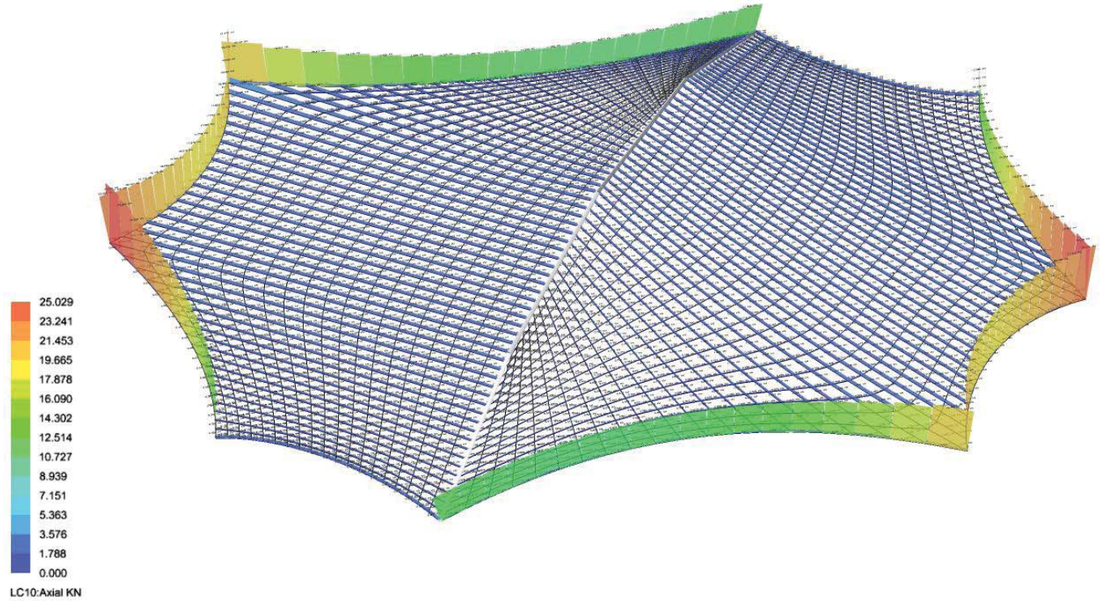
LC9 - Self weight 1.35 + Wind Y 1.5

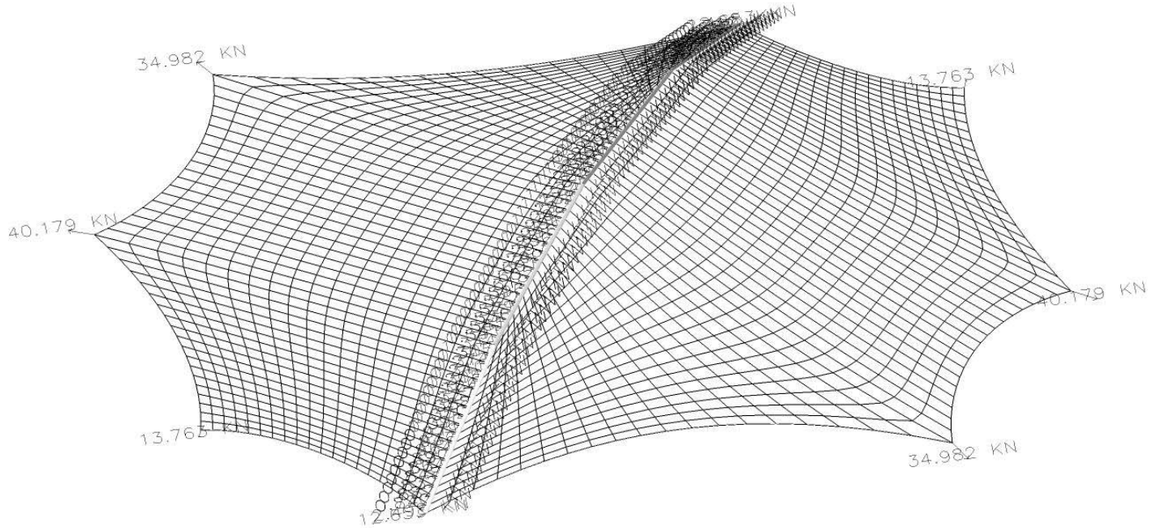
Membrane Details and Analysis

FDM Solver



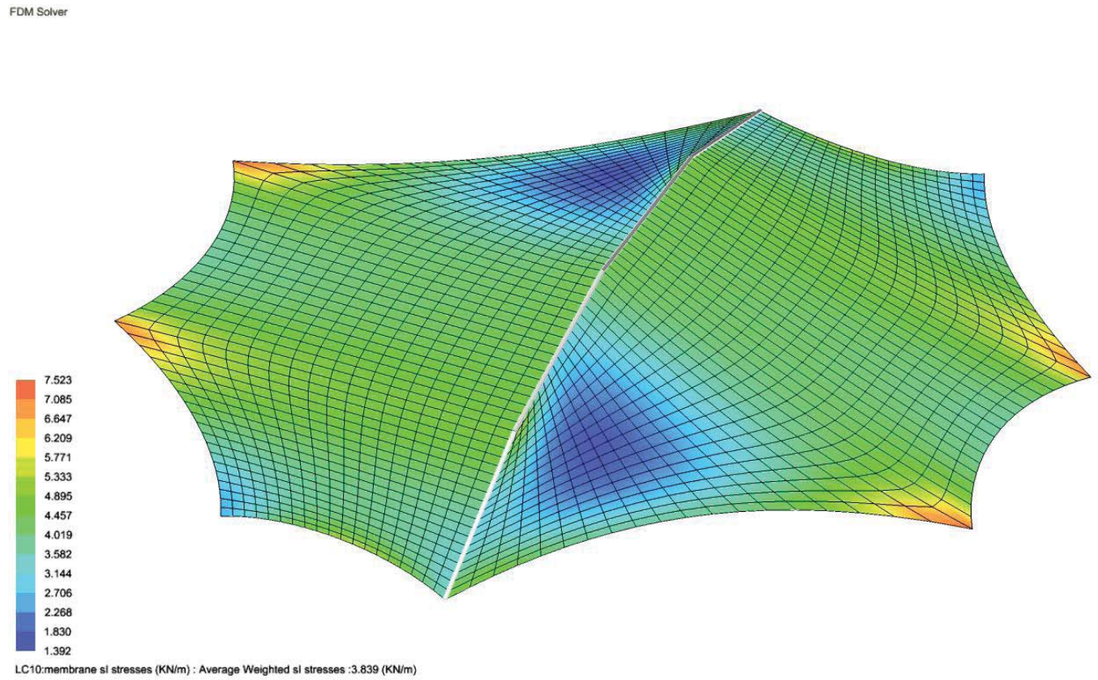
FDM Solver

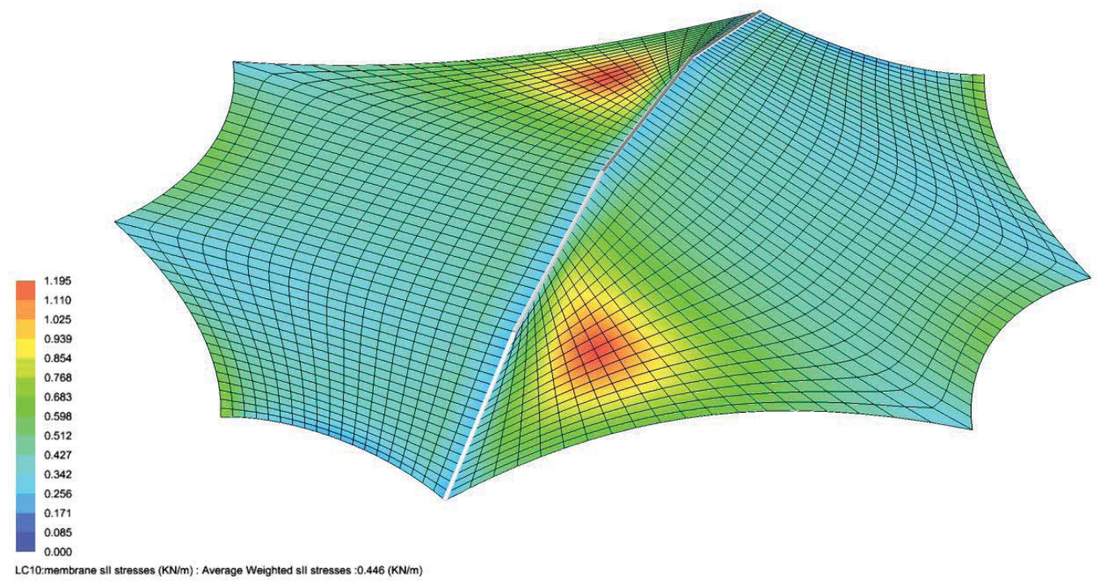




LC10 - Self weight 1.35 + Snow 1.5

Membrane Details and Analysis

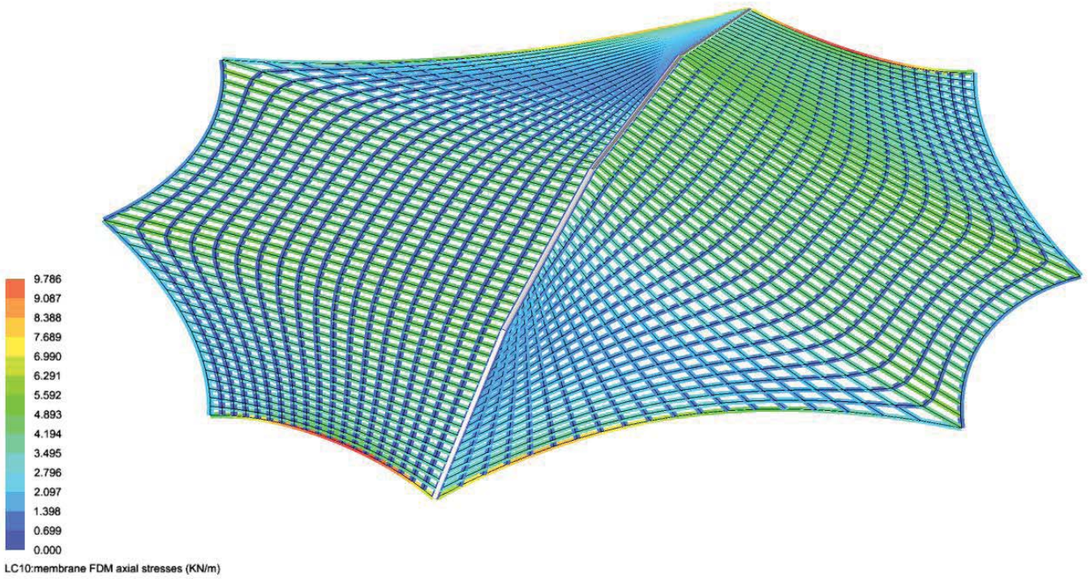




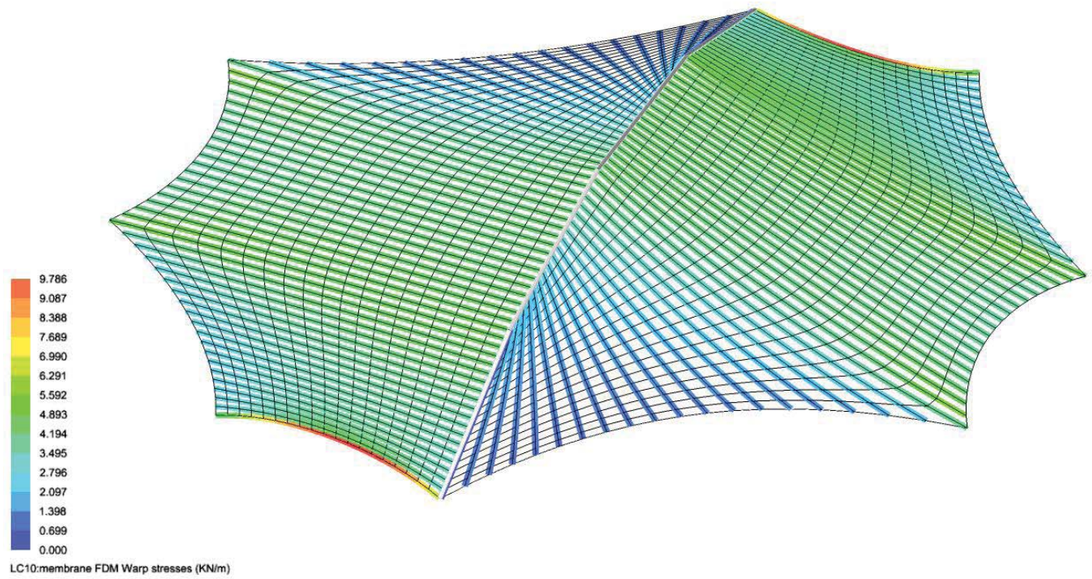
LC10 - Self weight 1.35 + Snow 1.5

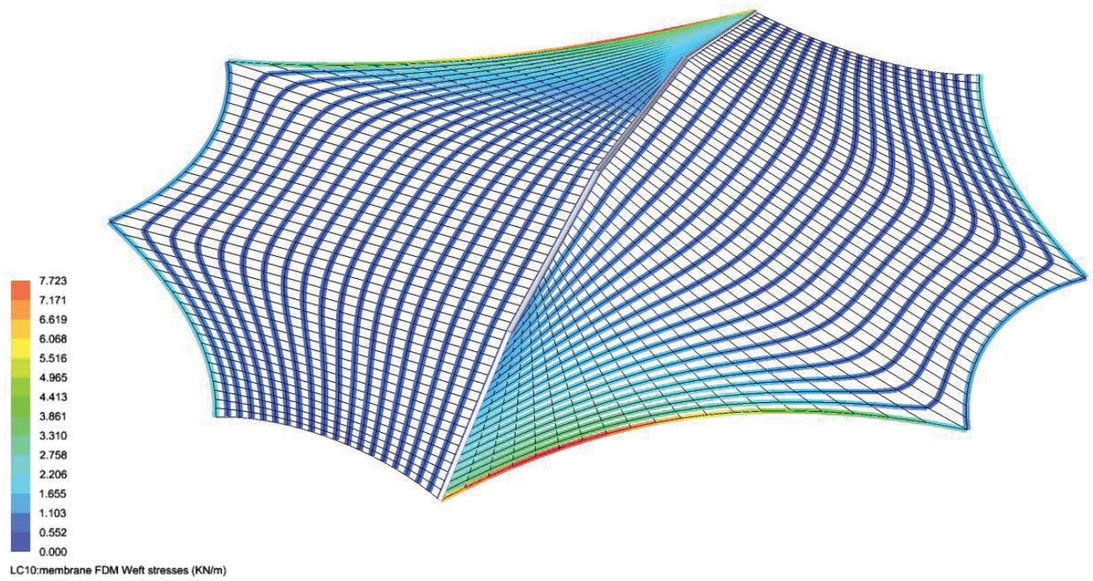
Membrane Details and Analysis

FDM Solver



FDM Solver

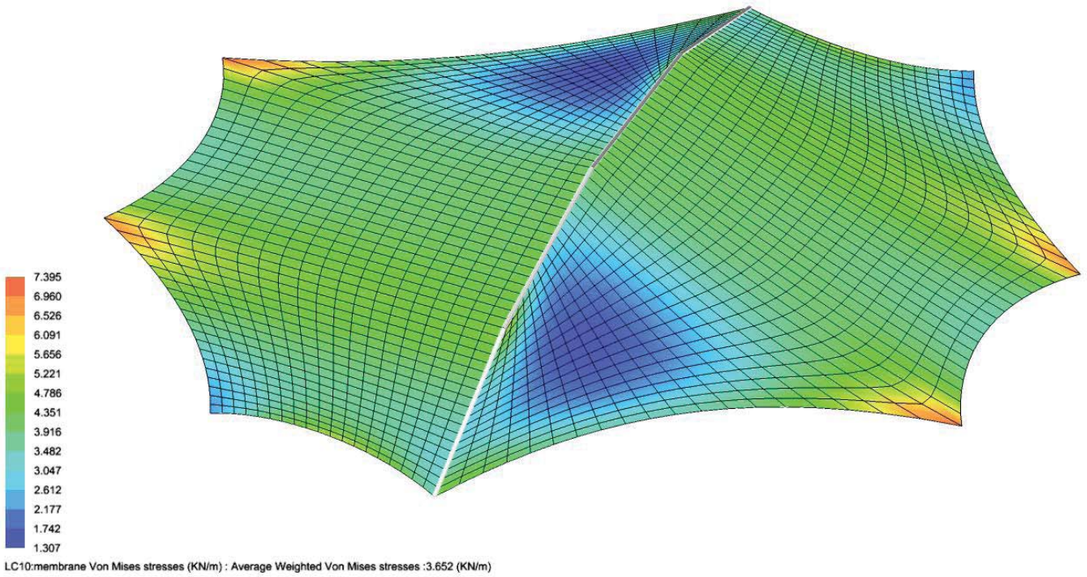




LC10 - Self weight 1.35 + Snow 1.5

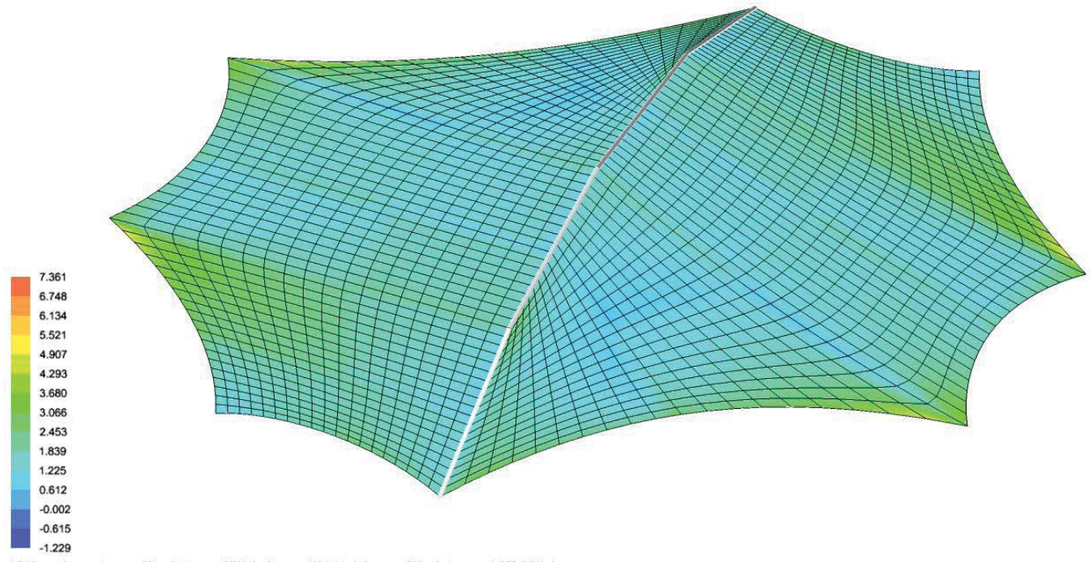
Membrane Details and Analysis

FDM Solver

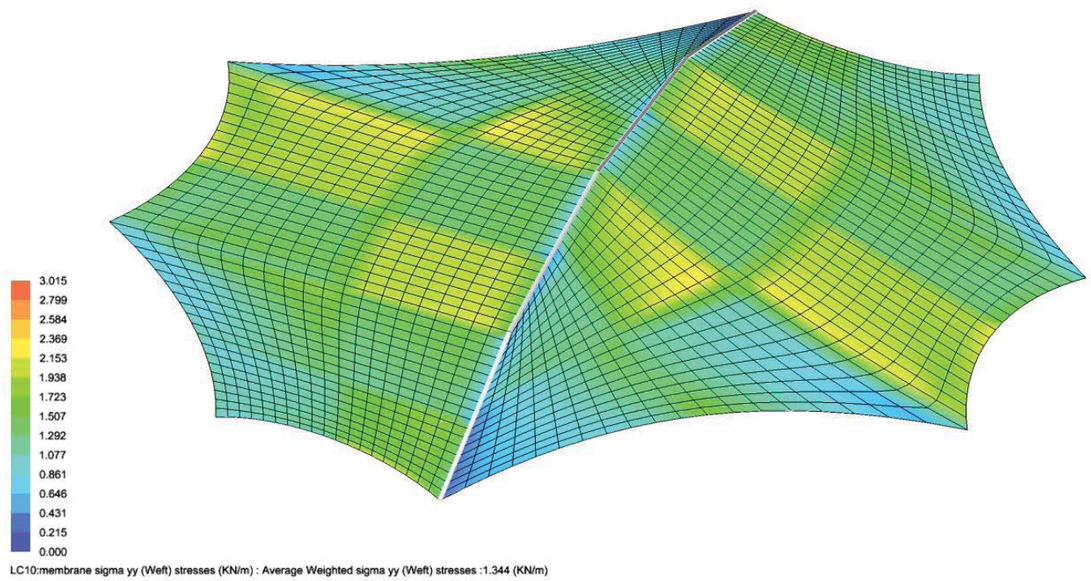


LC10:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :3.652 (KN/m)

FDM Solver



LC10:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :1.358 (KN/m)

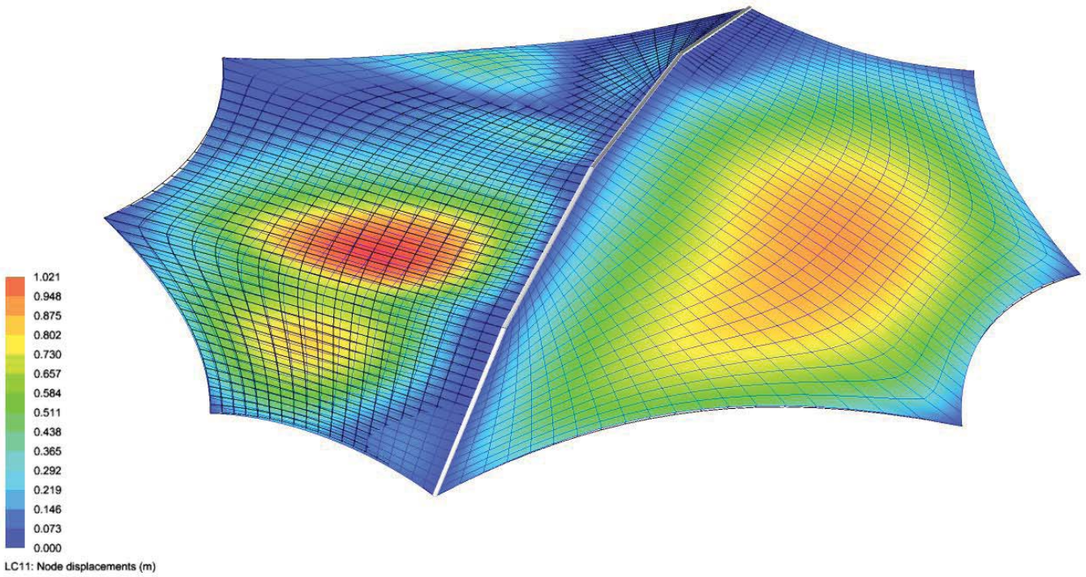


LC10:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :1.344 (KN/m)

LC10 - Self weight 1.35 + Snow 1.5

Membrane Details and Analysis

FDM Solver



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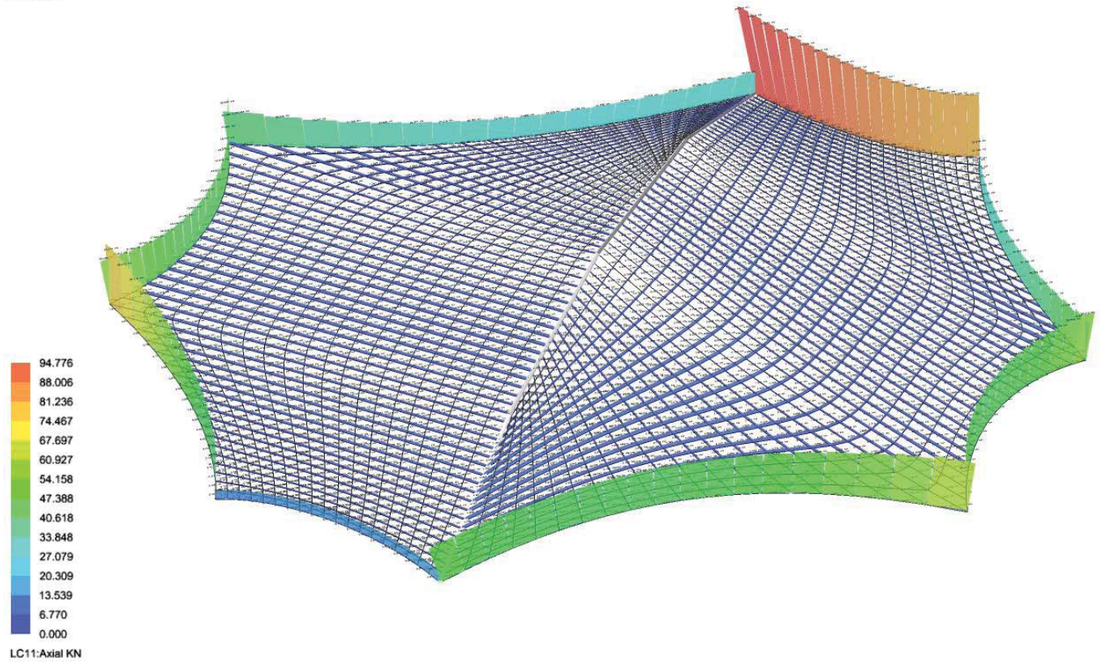
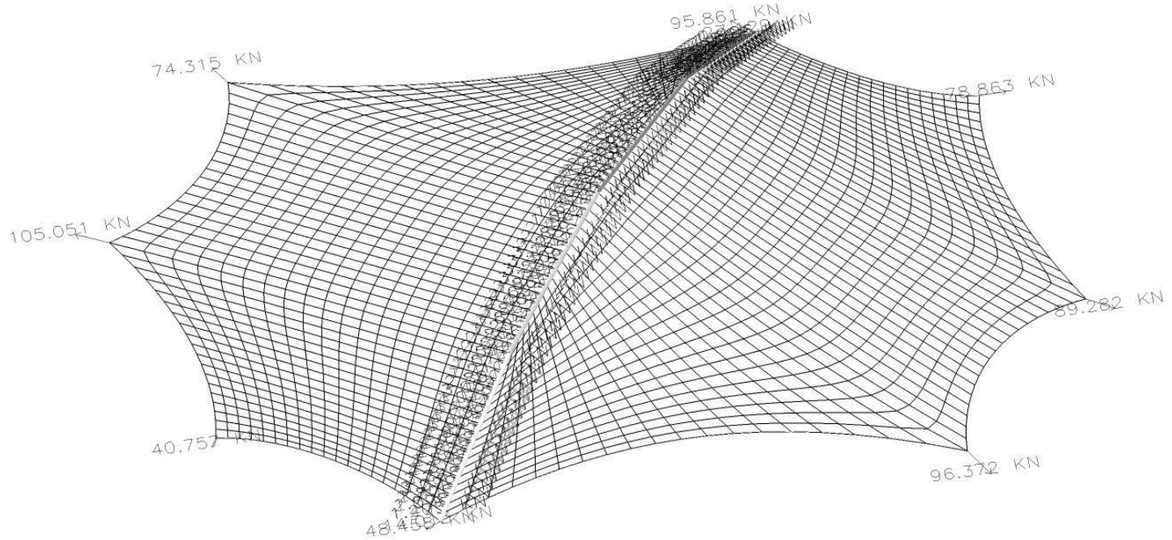
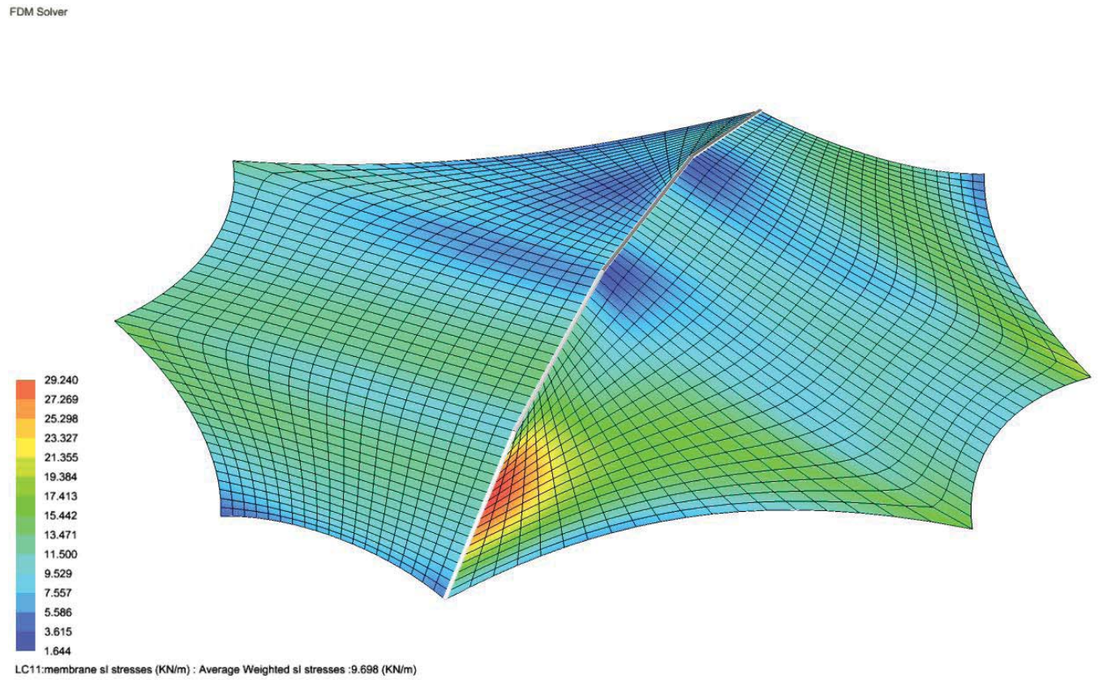
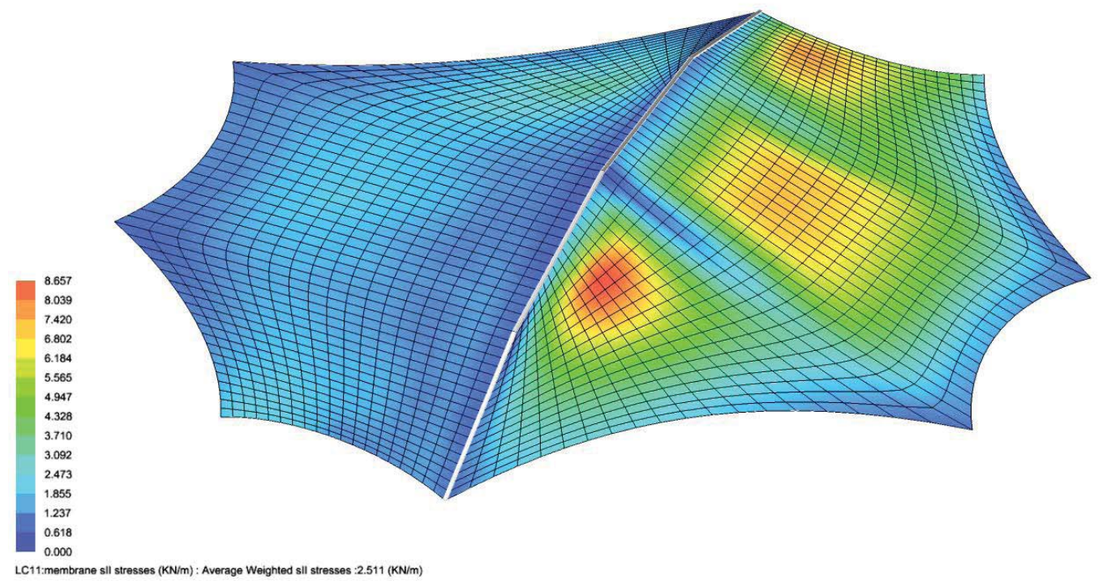




LC11 - Self weight 1.35 + Wind X 1.5 + Snow 1.5

Membrane Details and Analysis

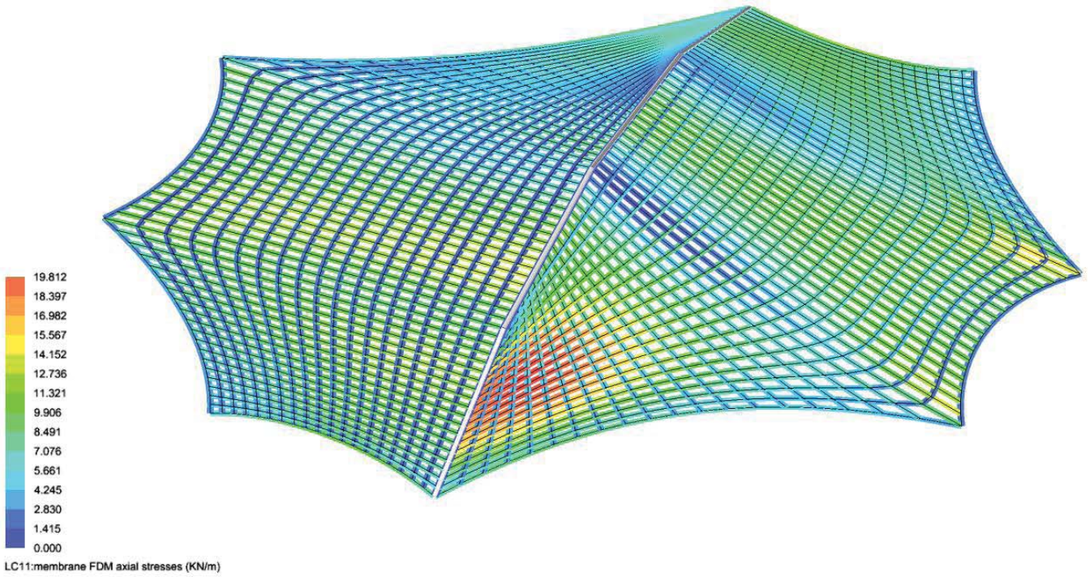




LC11 - Self weight 1.35 + Wind X 1.5 + Snow 1.5

Membrane Details and Analysis

FDM Solver



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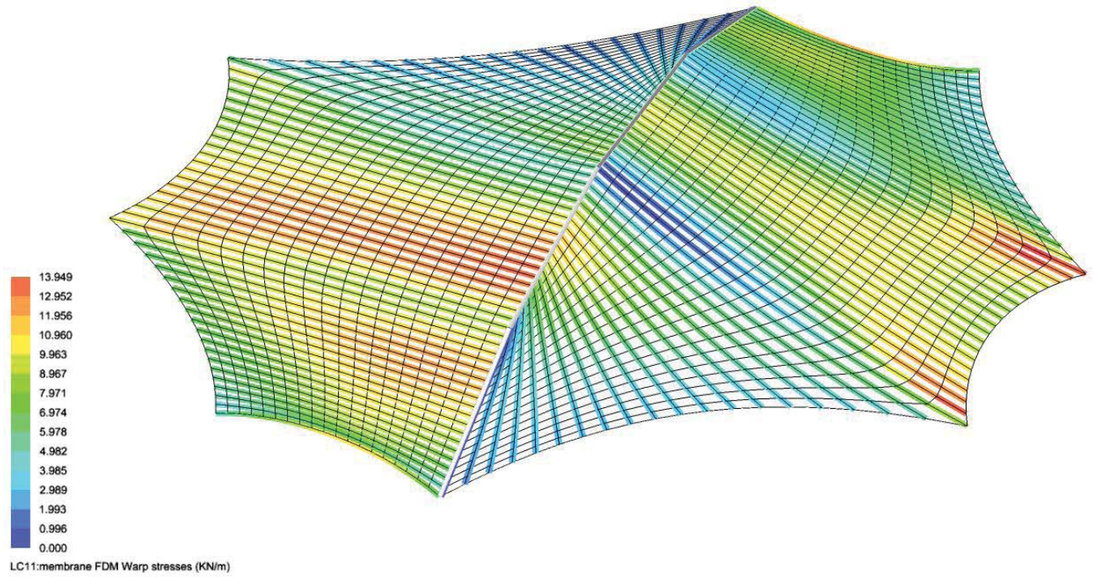
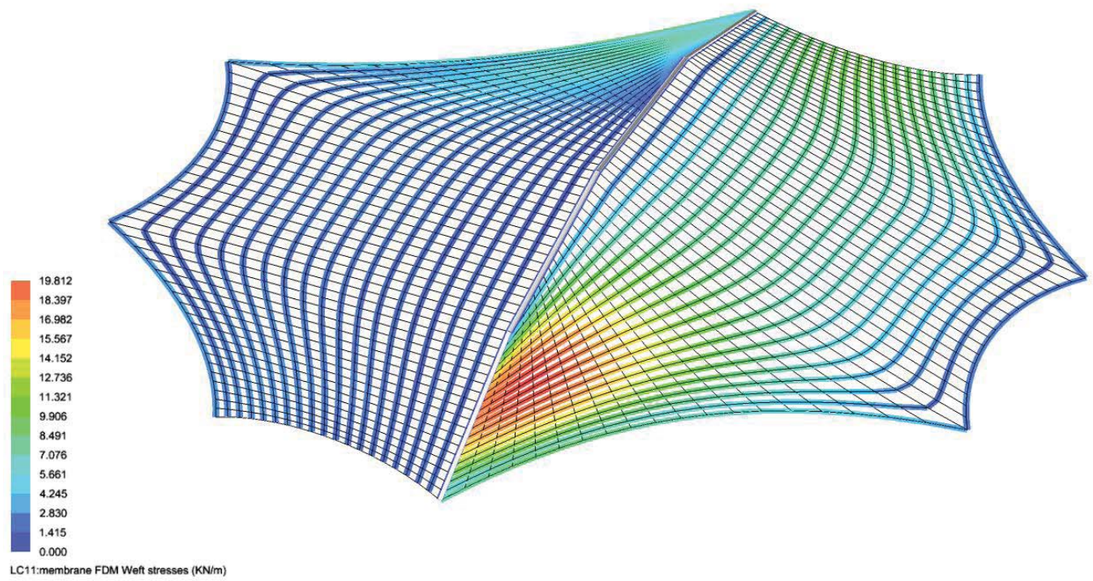
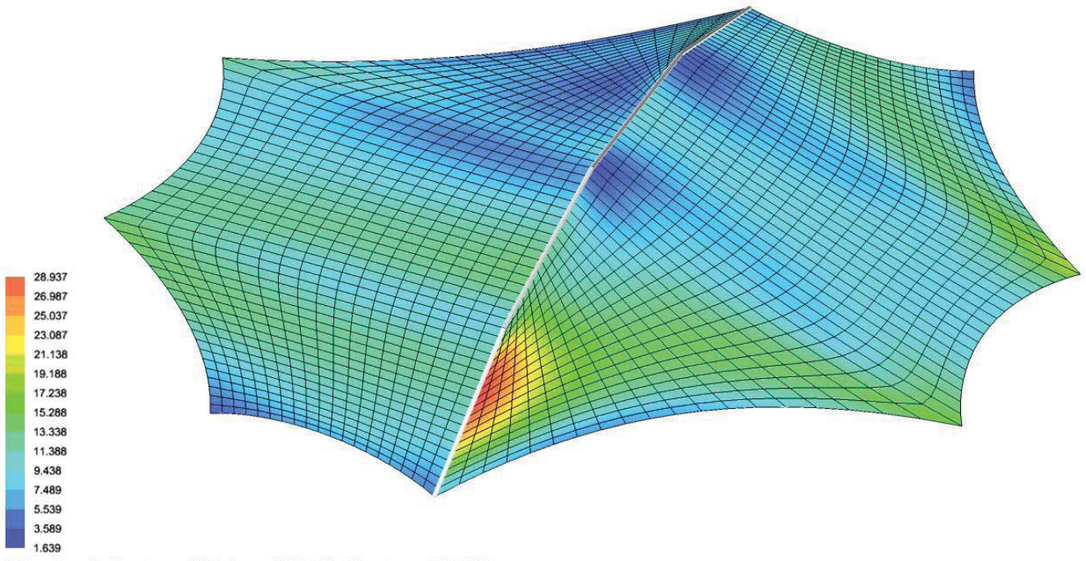




LC11 - Self weight 1.35 + Wind X 1.5 + Snow 1.5

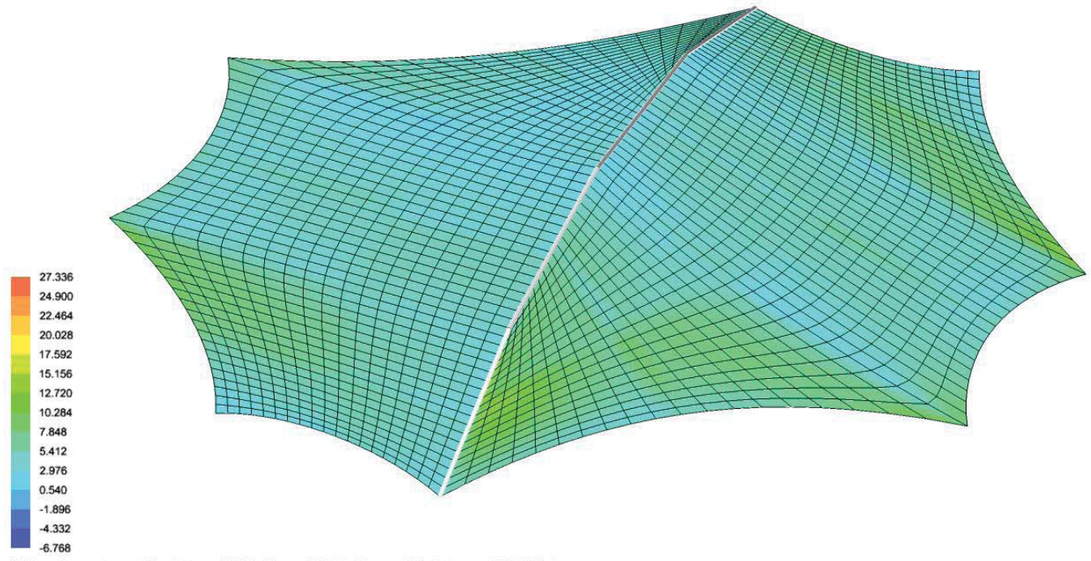
Membrane Details and Analysis

FDM Solver

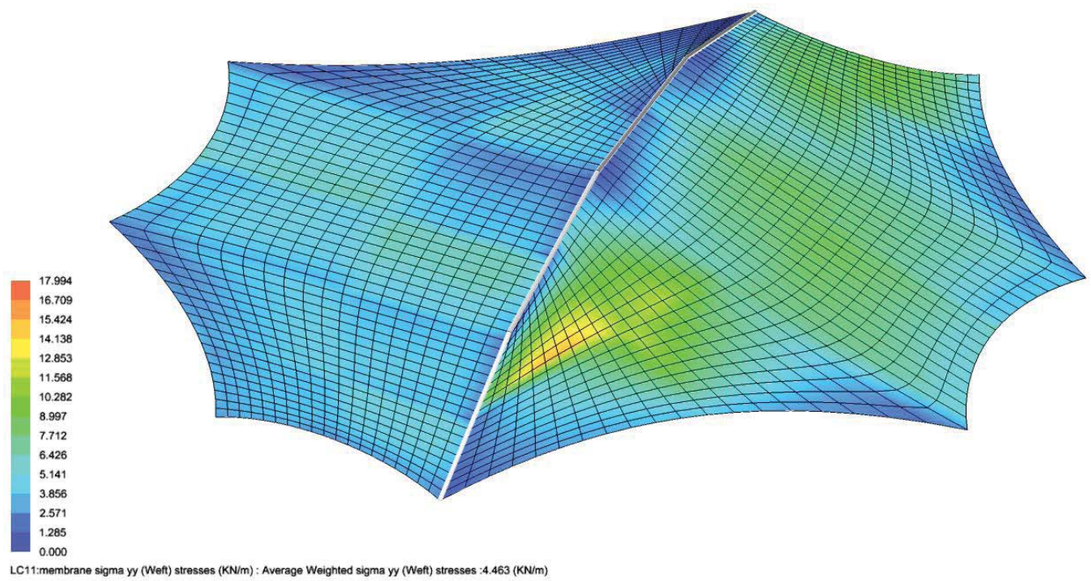


LC11:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :8.942 (KN/m)

FDM Solver



LC11:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :3.787 (KN/m)

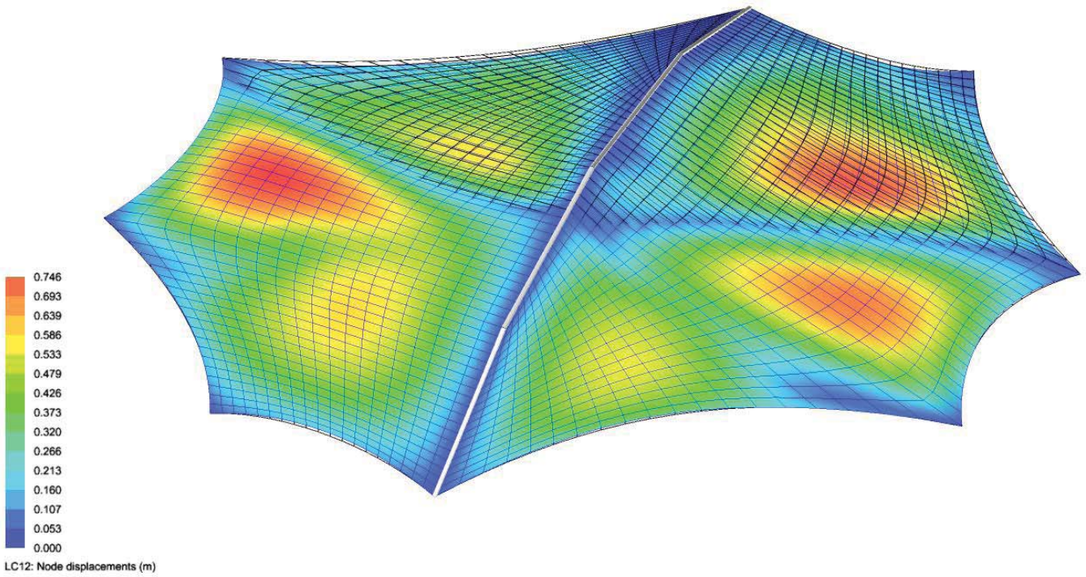


LC11:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :4.463 (KN/m)

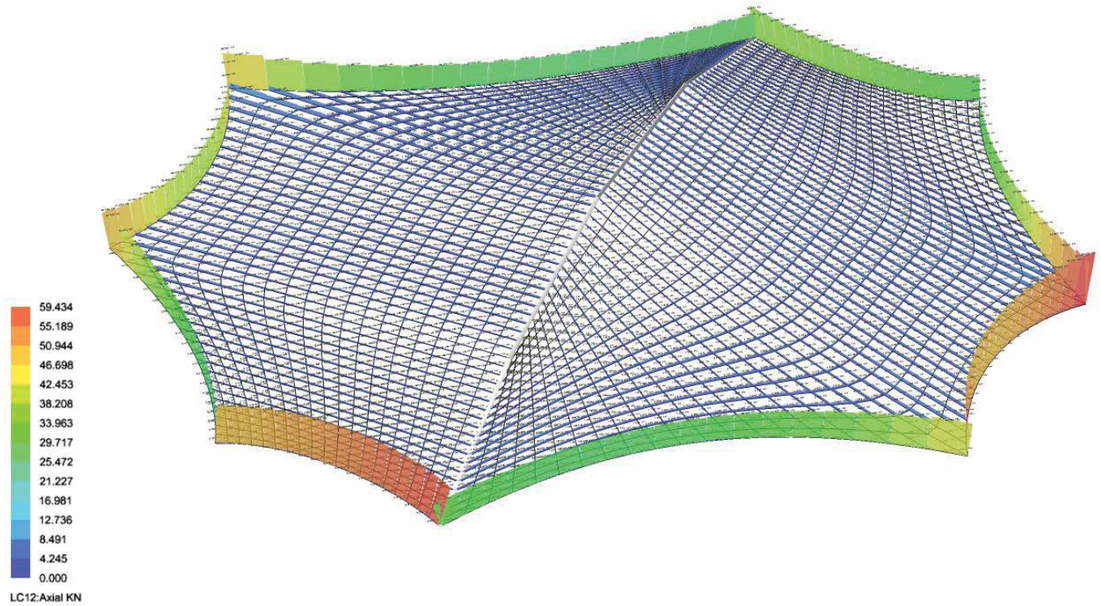
LC11 - Self weight 1.35 + Wind X 1.5 + Snow 1.5

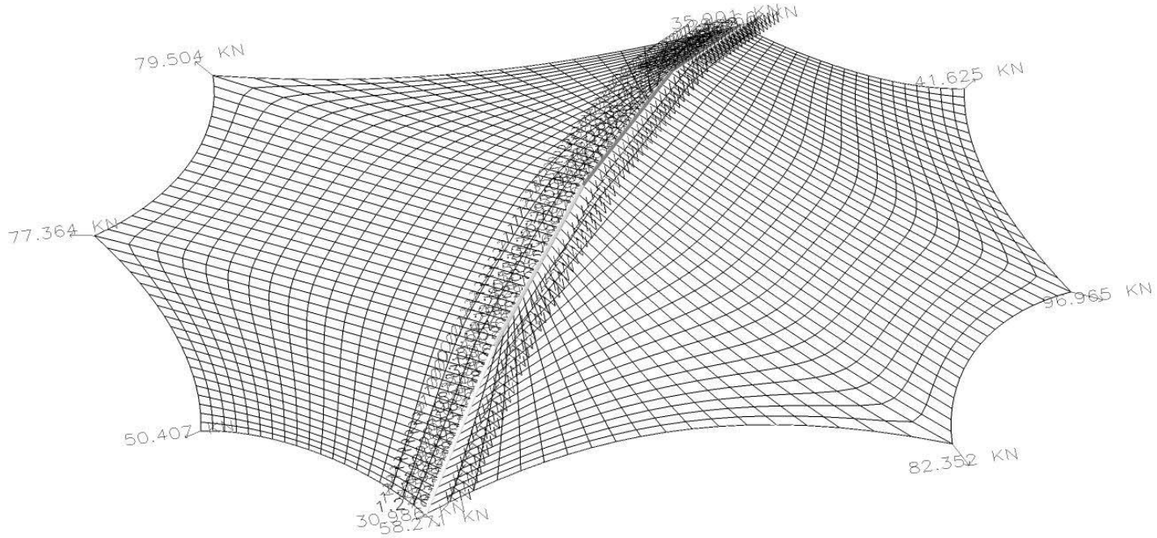
Membrane Details and Analysis

FDM Solver



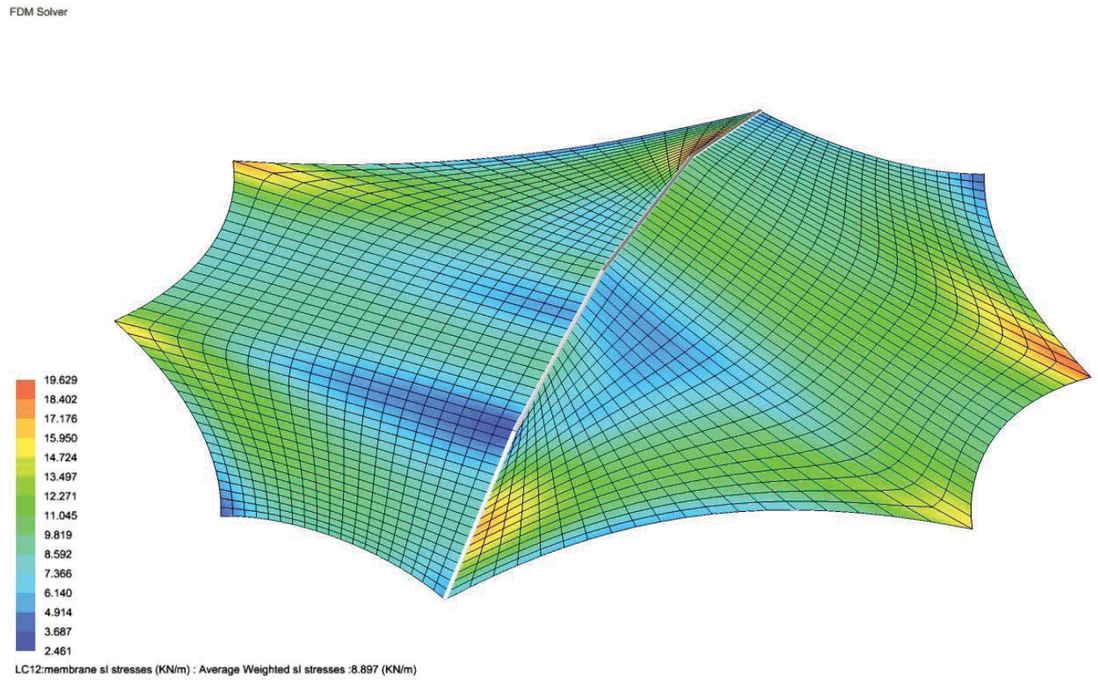
FDM Solver

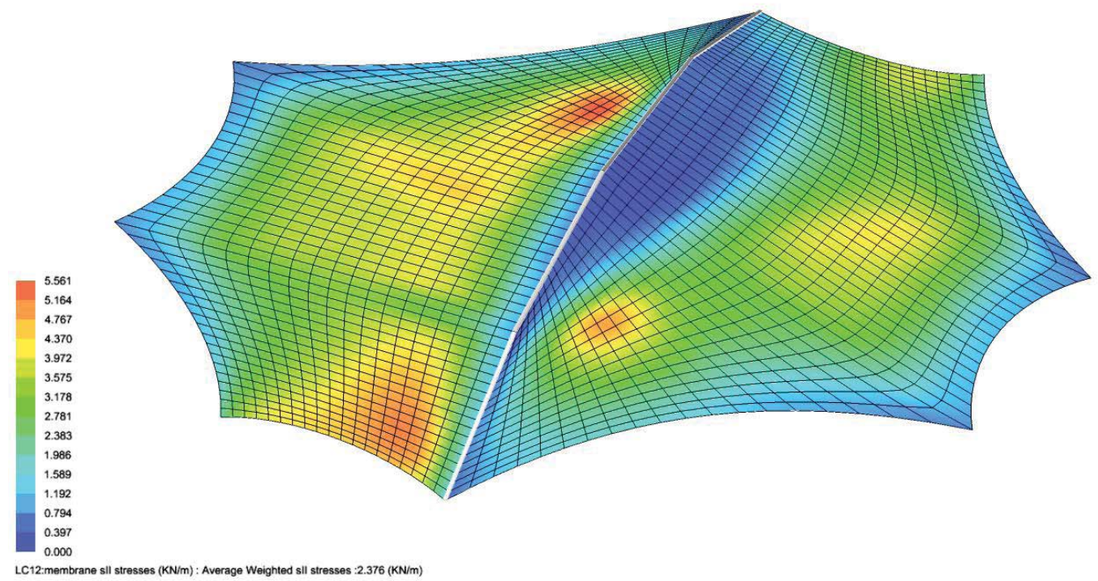




LC12 - Self weight 1.35 + Wind Y 1.5 + Snow 1.5

Membrane Details and Analysis

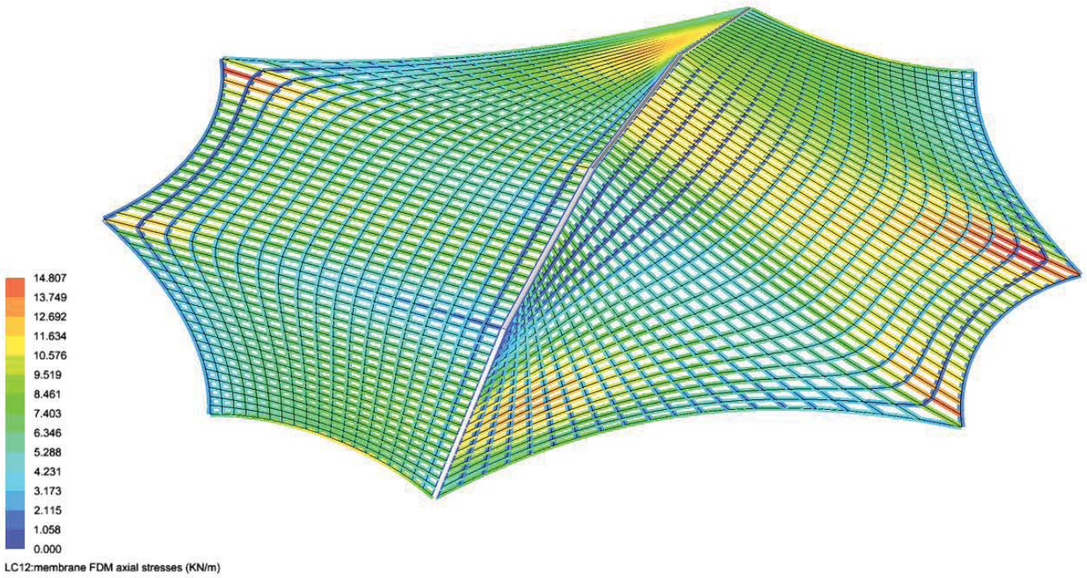




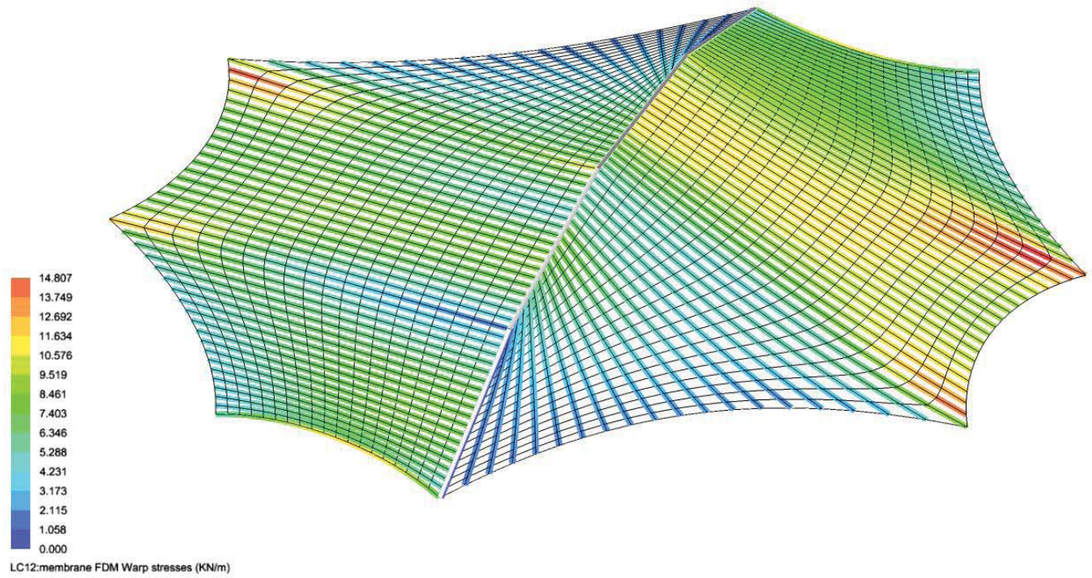
LC12 - Self weight 1.35 + Wind Y 1.5 + Snow 1.5

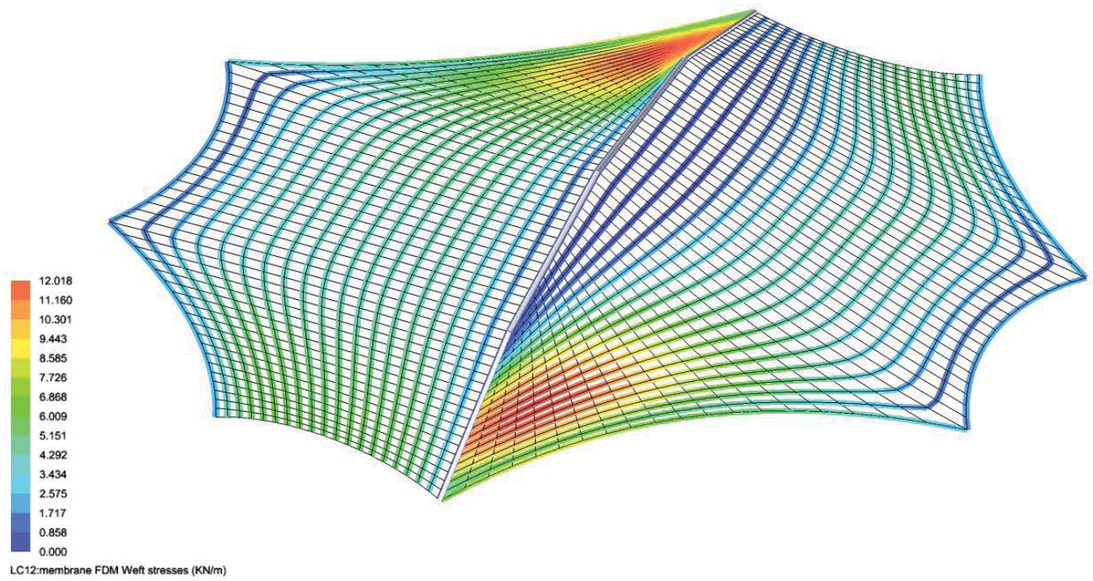
Membrane Details and Analysis

FDM Solver



FDM Solver

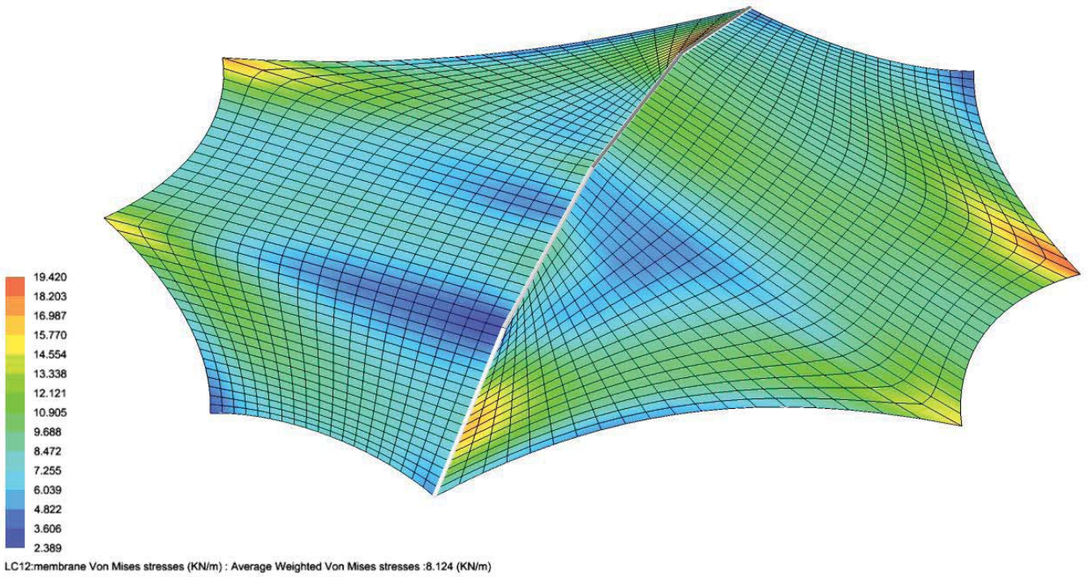




LC12 - Self weight 1.35 + Wind Y 1.5 + Snow 1.5

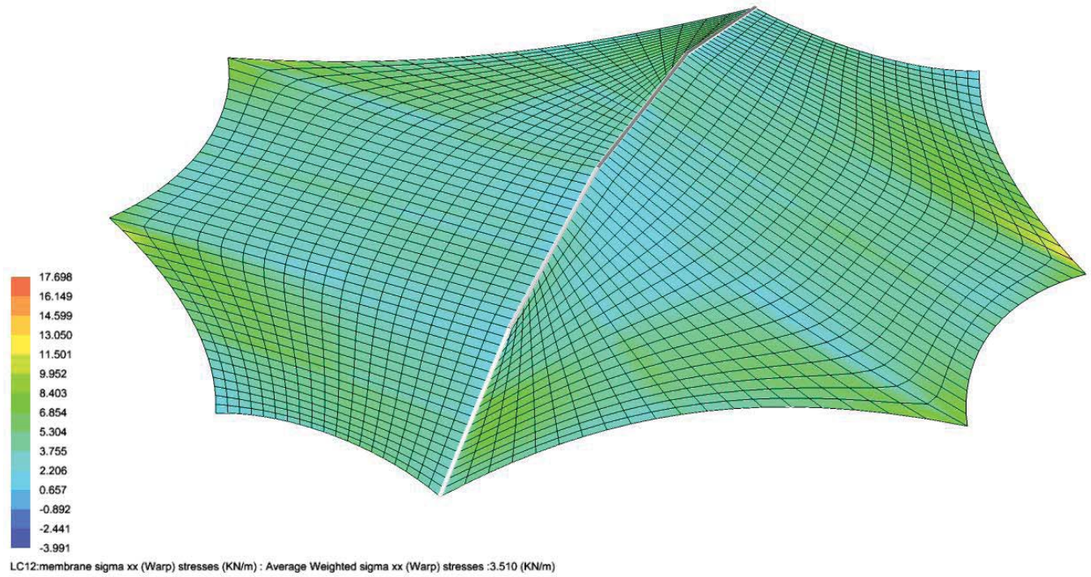
Membrane Details and Analysis

FDM Solver

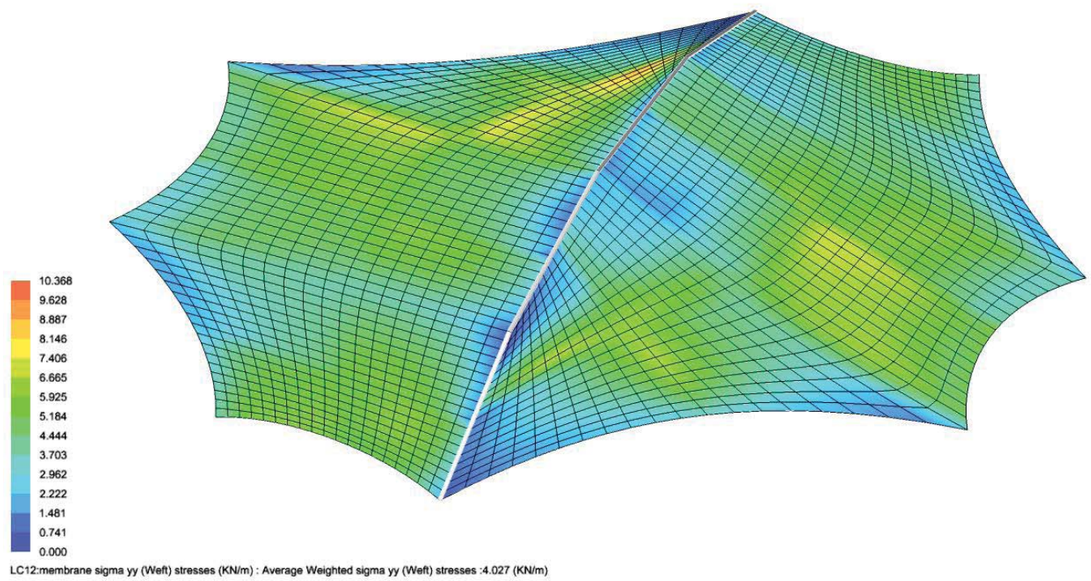


LC12:membrane Von Mises stresses (KN/m) : Average Weighted Von Mises stresses :8.124 (KN/m)

FDM Solver



LC12:membrane sigma xx (Warp) stresses (KN/m) : Average Weighted sigma xx (Warp) stresses :3.510 (KN/m)



LC12:membrane sigma yy (Weft) stresses (KN/m) : Average Weighted sigma yy (Weft) stresses :4.027 (KN/m)

LC12 - Self weight 1.35 + Wind Y 1.5 + Snow 1.5

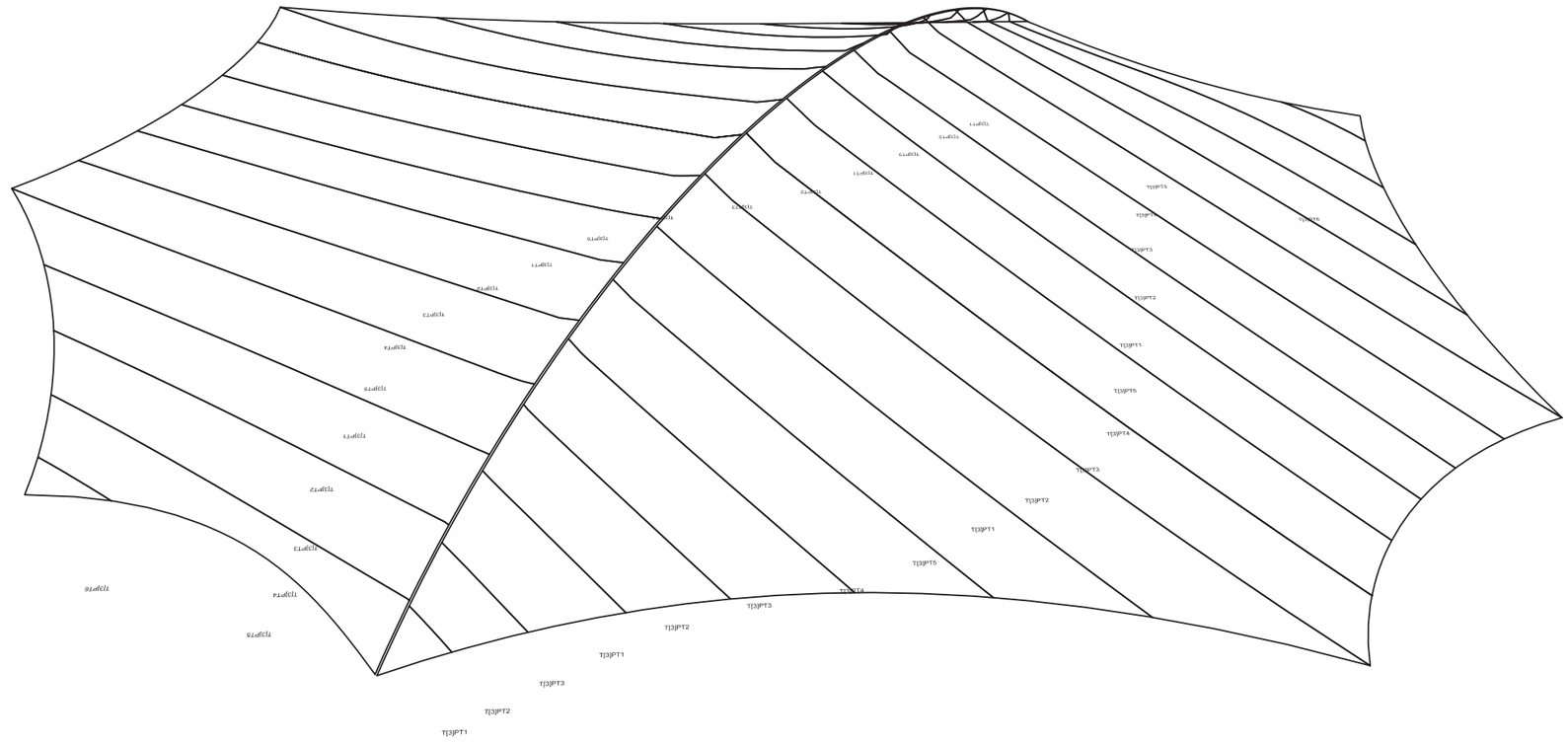
Final Design

Membrane Details and Analysis

- 4 Parts (Half) : 19 pieces

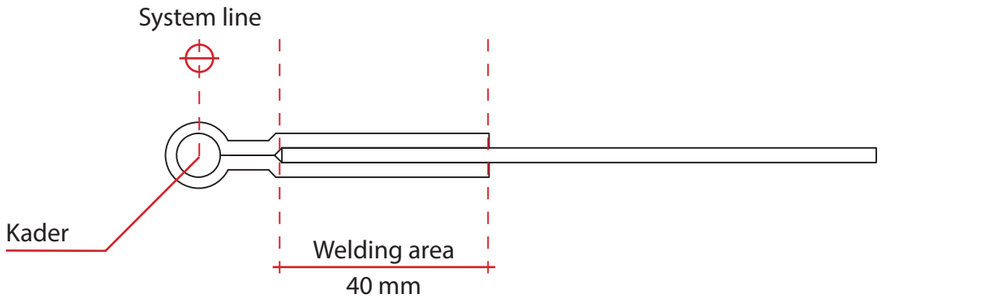
- 8 Parts (Full) : 38 pieces

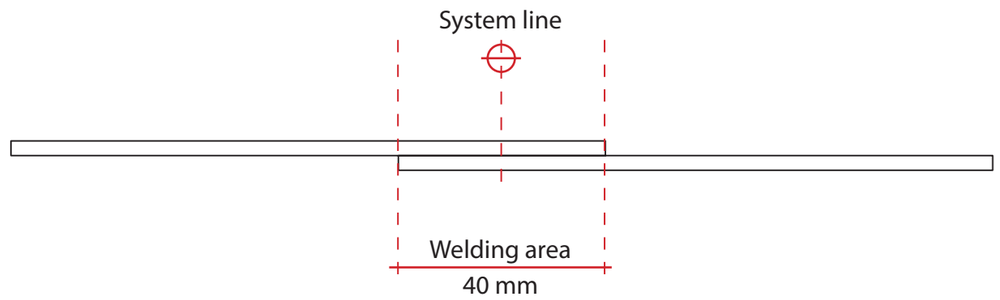
- Compernsation : 1.3 % (warp, weft)

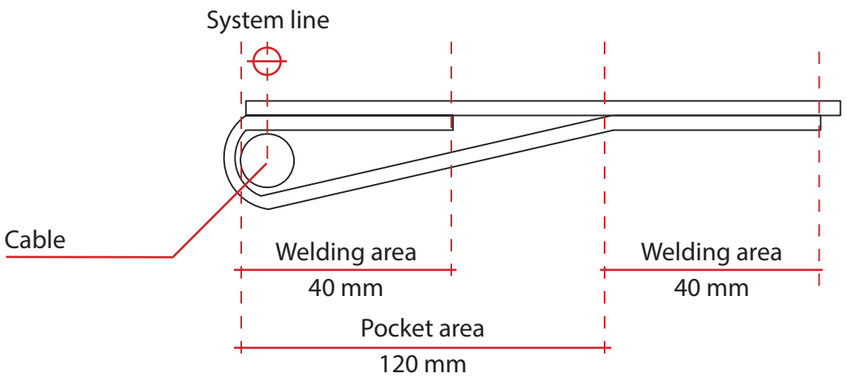


Membrane Details and Analysis

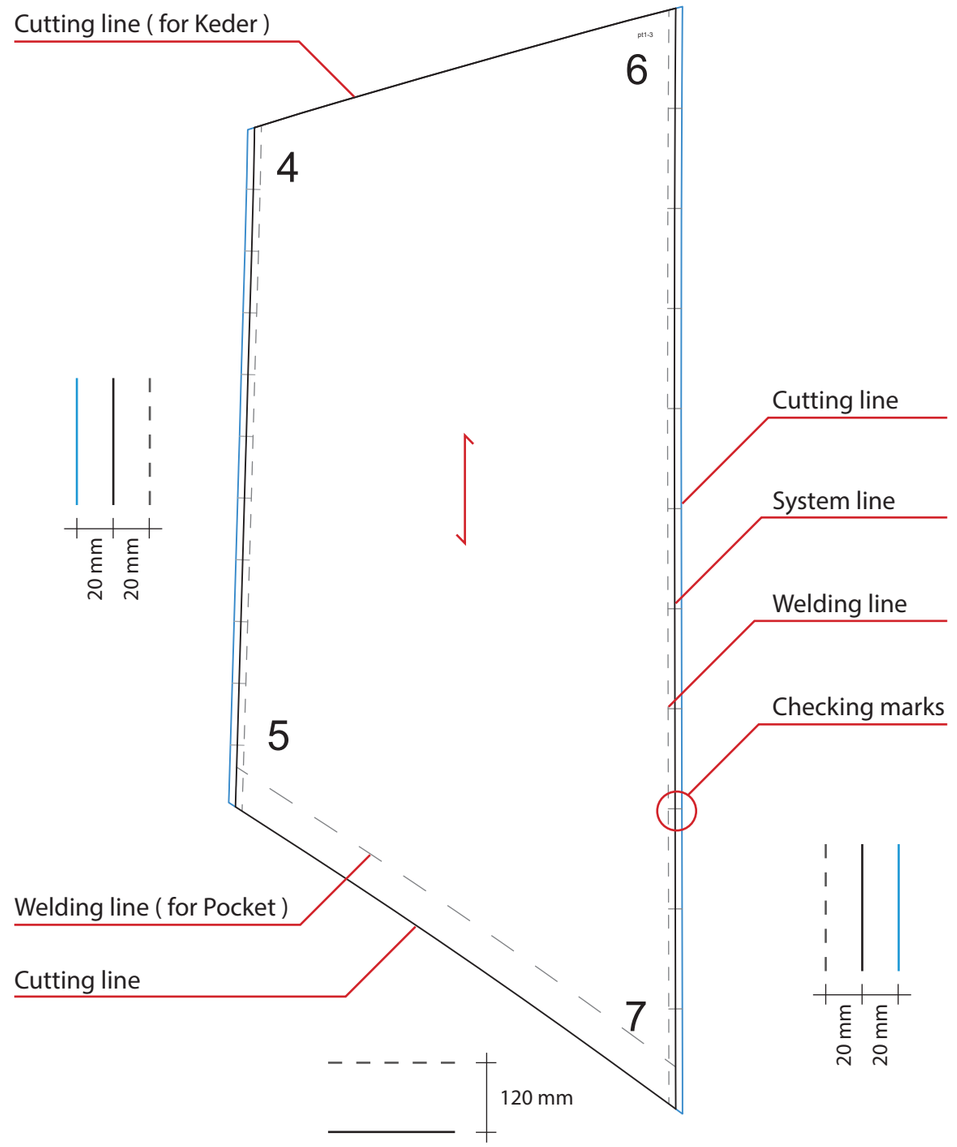
- Details







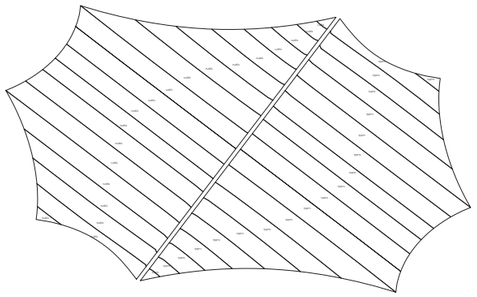
- Part 1 / Pattern 3 (Example)



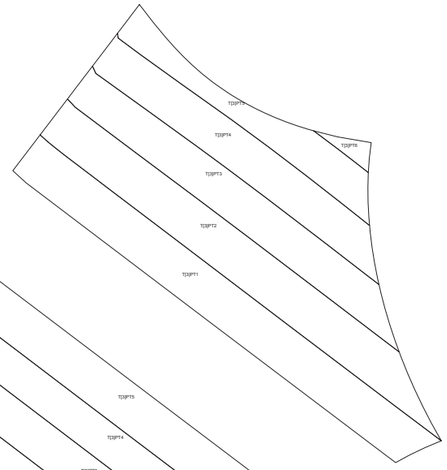
Thirachai Dheravatnvong
4059492

Membrane Details and Analysis

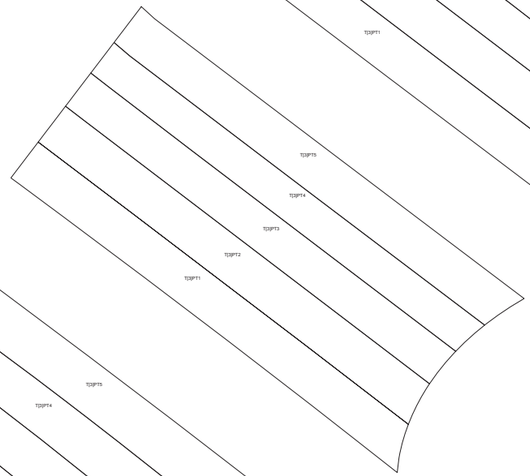
- Pattern Parts



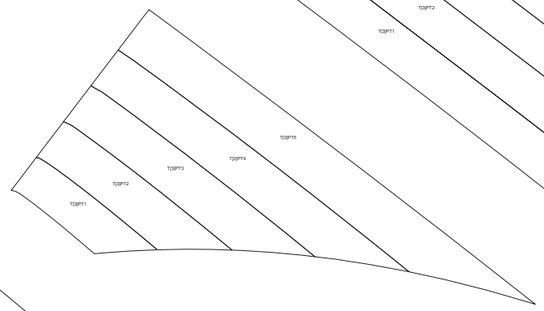
Part 4



Part 3

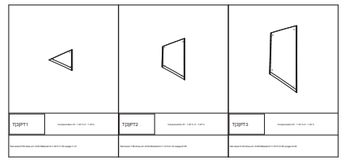


Part 2



Part 1

Part 1



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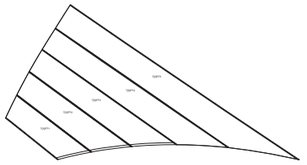
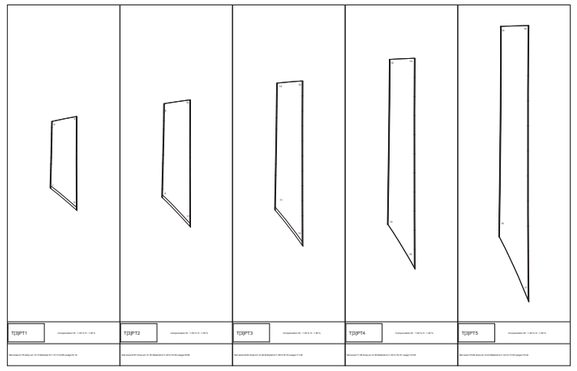
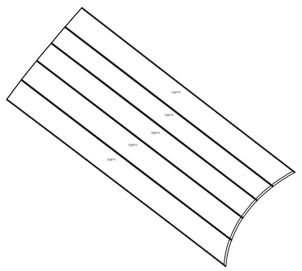
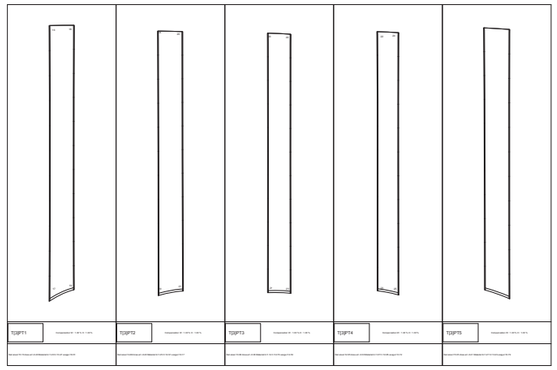


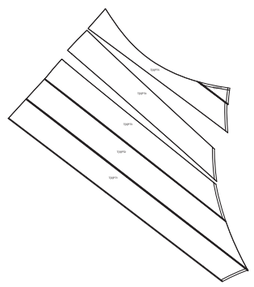


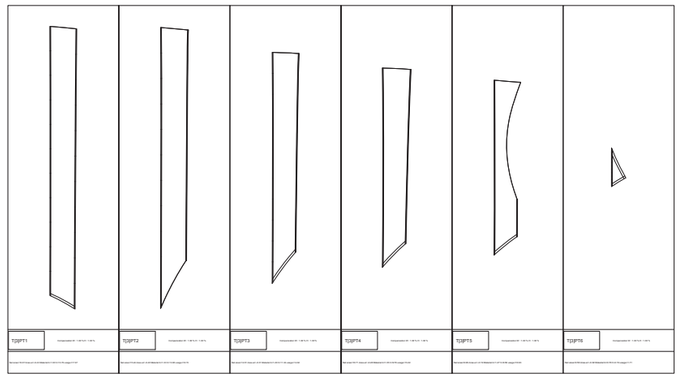
Part 3





Part 4





Patterning

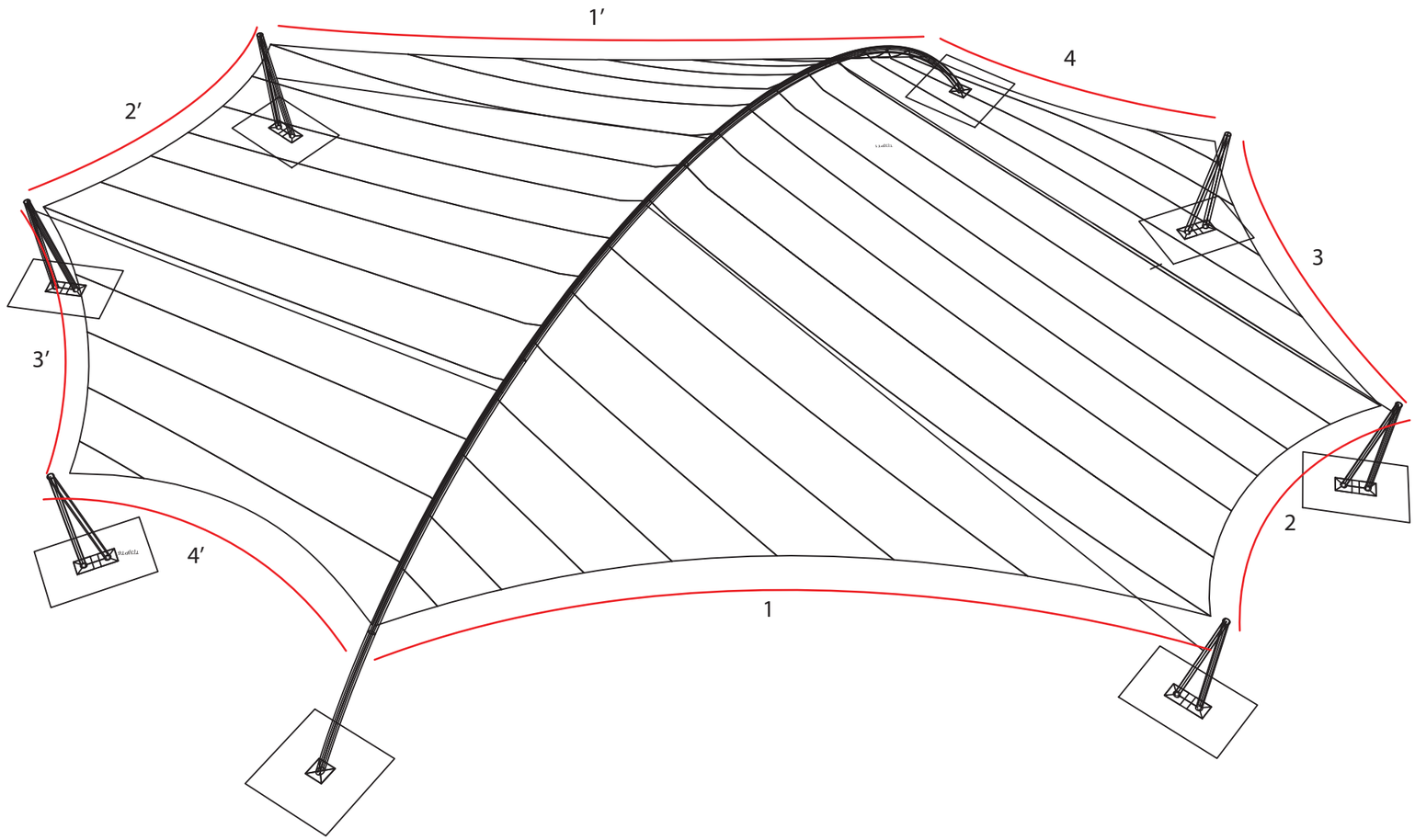
Final Design

Structural Details and Calculation

- Cable : Ø 16 mm

- Cable Length (x 2)
  1 : 15.27 m
  2 : 6.72 m
  3 : 7.68 m
  4 : 6.86 m

  Total : 73.06 m



Cable position

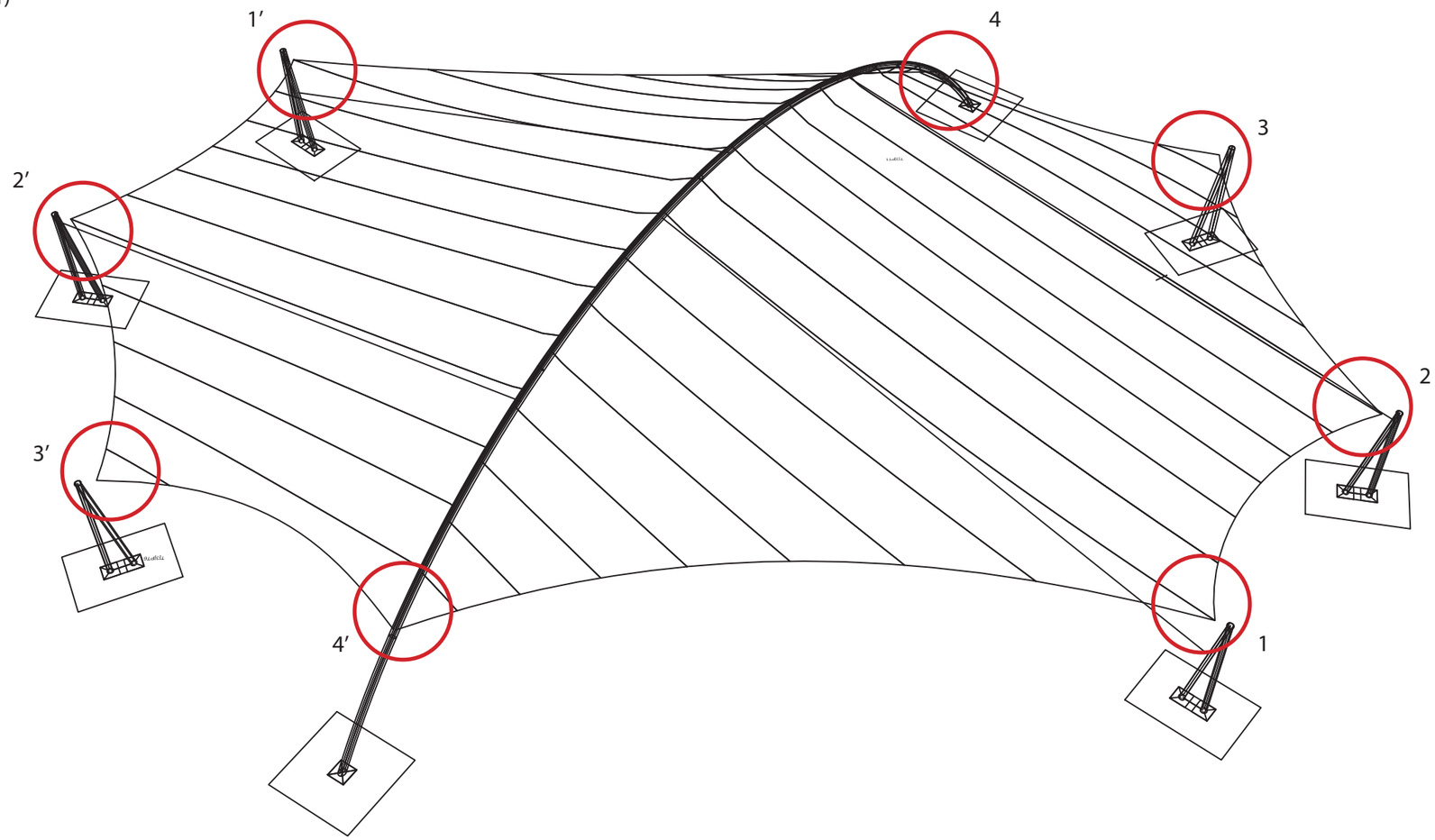
Final Design

Structural Details and Calculation

- Corner Plate : S355 Steel / e = 8 mm, 4 mm

- Thread : Ø 16 mm

- Tensor : Ø 16 mm (2 per corner)

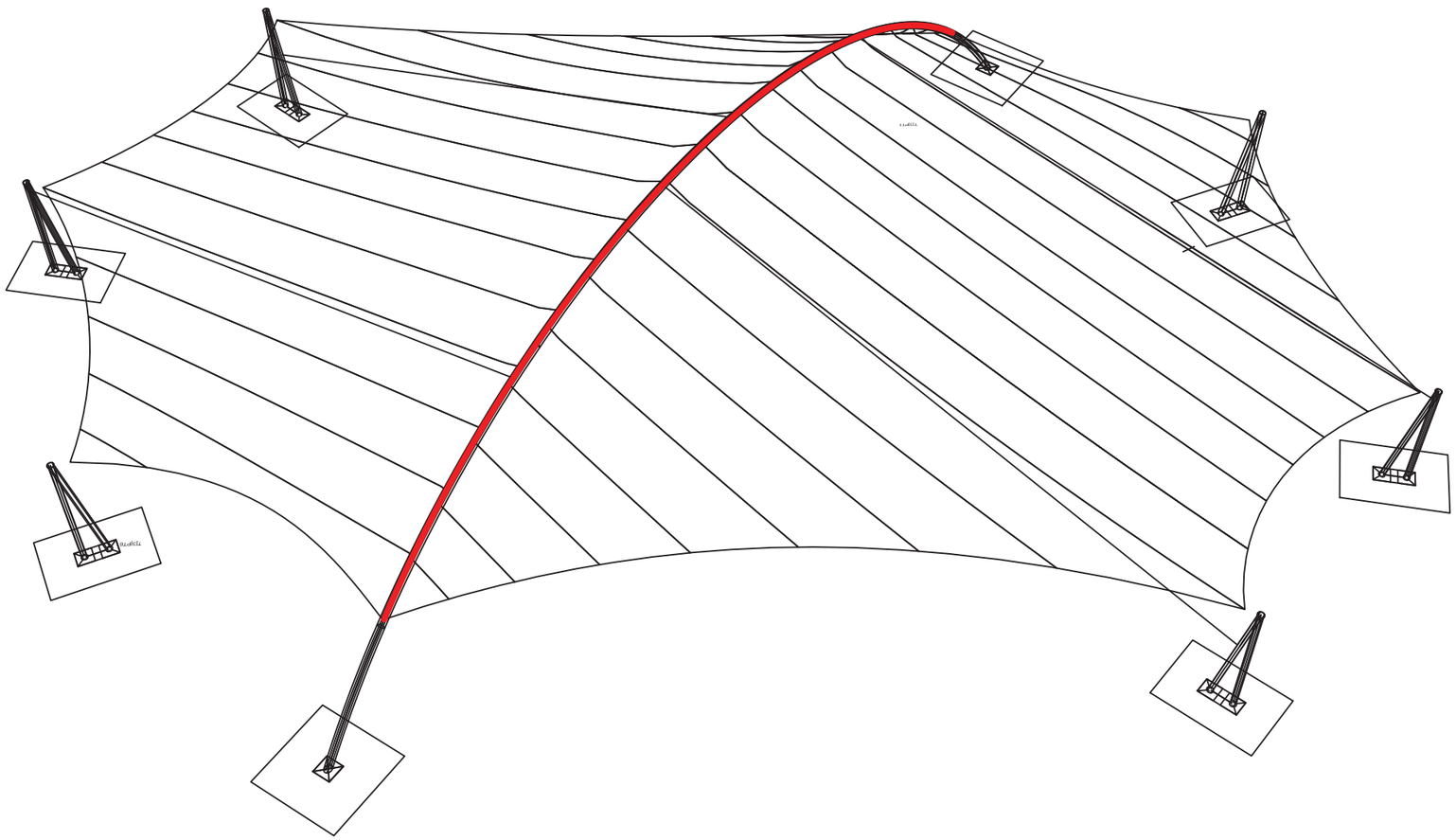


Corner plate position

Final Design

Structural Details and Calculation

- Keder : 21.30 m

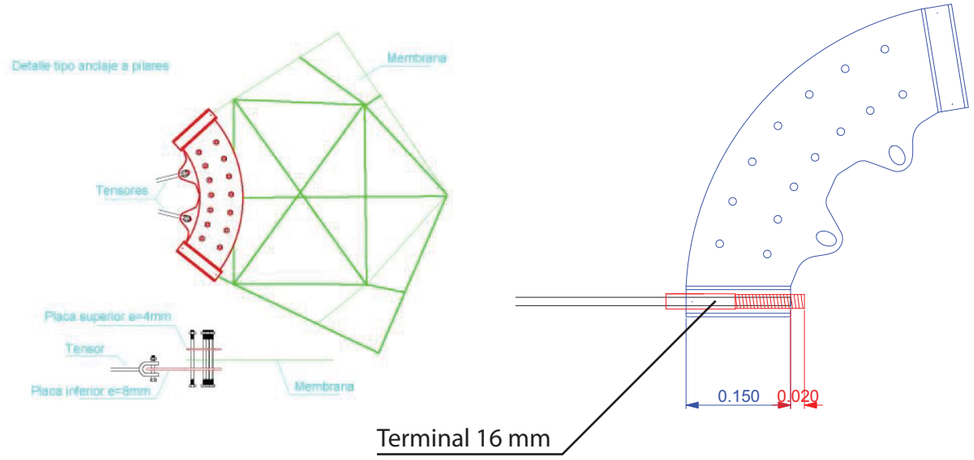


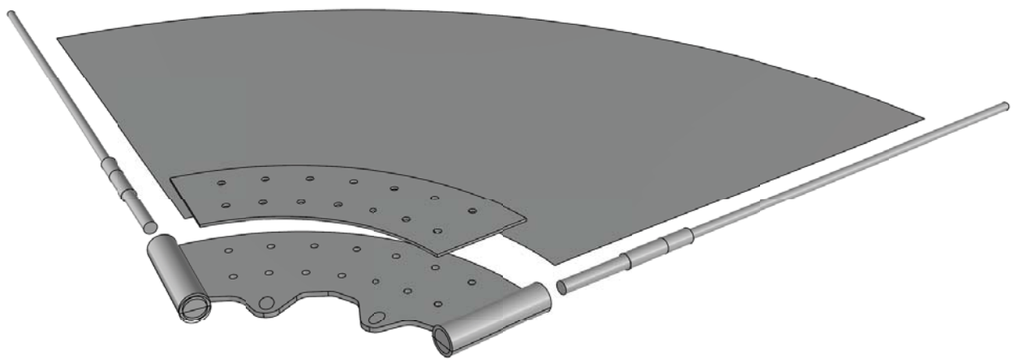
Keder position

Final Design

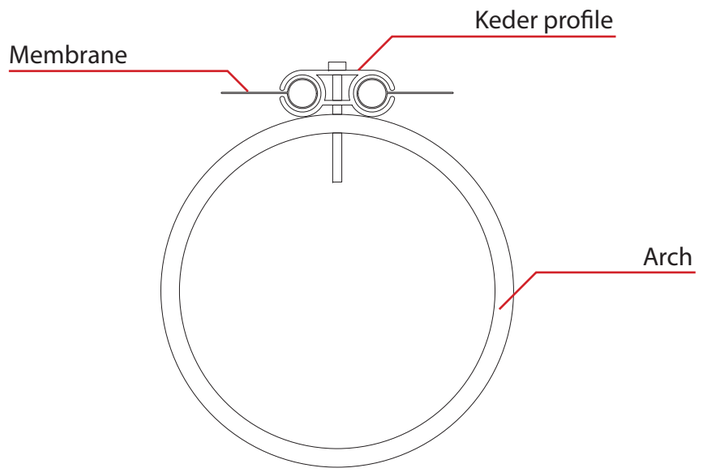
Structural Details and Calculation

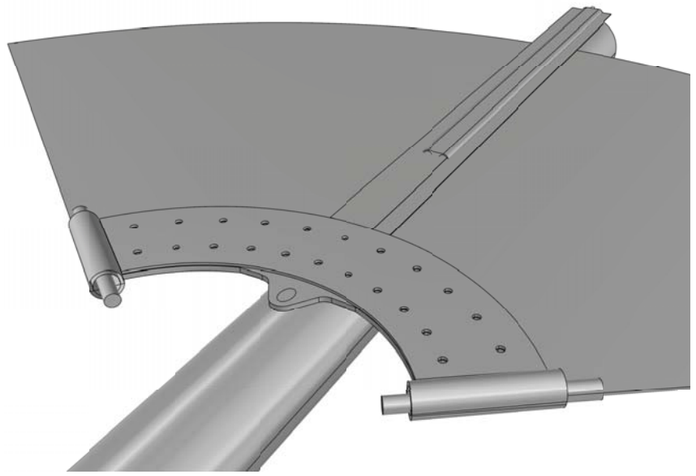
- Corner plate details





- Keder on arch details



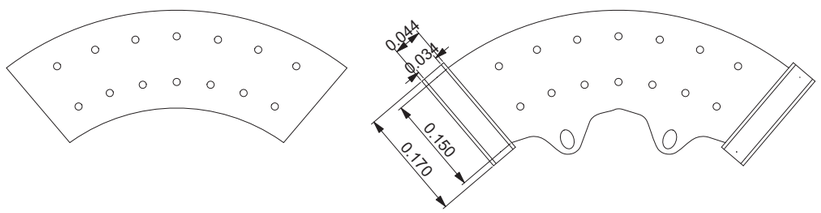


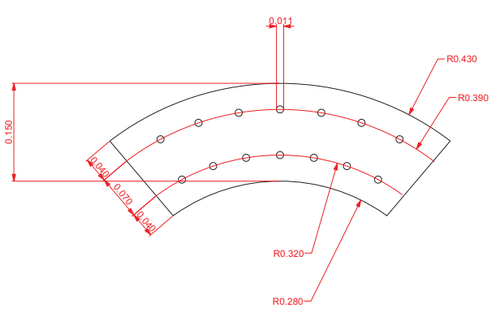
Corner plate

Final Design

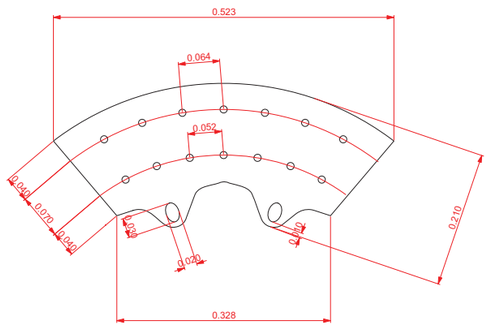
Structural Details and Calculation

- Corner 1





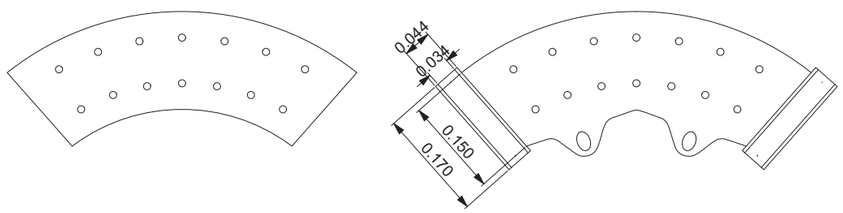
thickness: 4 mm

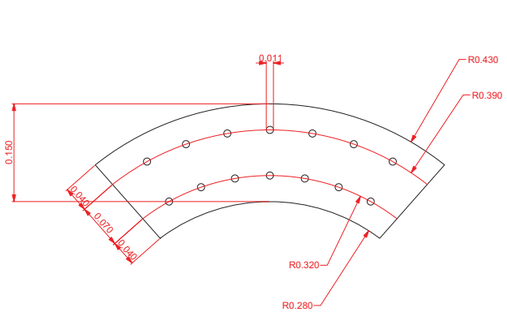


thickness: 8 mm

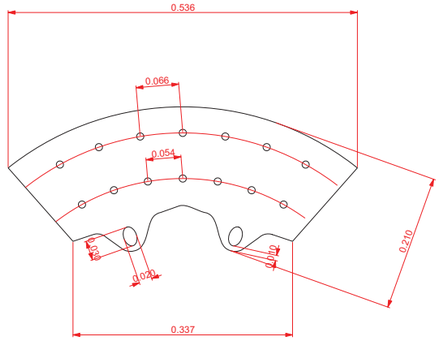
Corner plate 1

- Corner 2





thickness: 4 mm

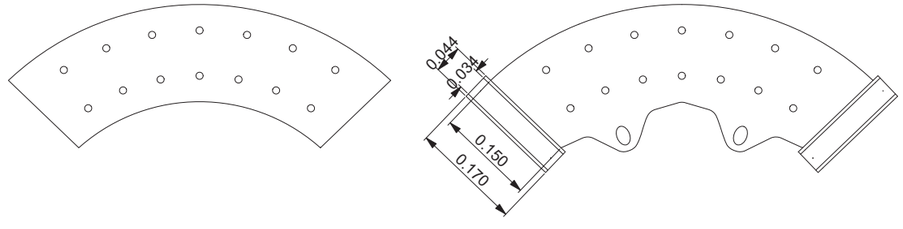


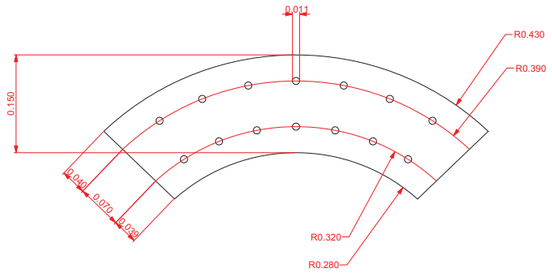
thickness: 8 mm

Corner plate 2

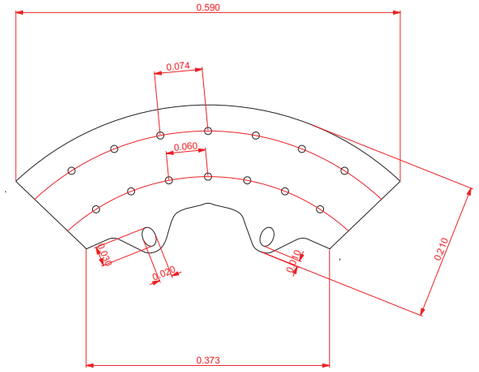
Structural Details and Calculation

- Corner 3





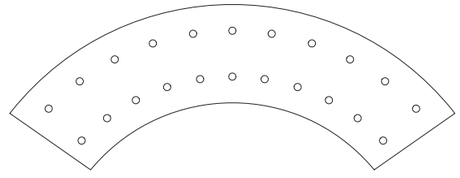
thickness: 4 mm

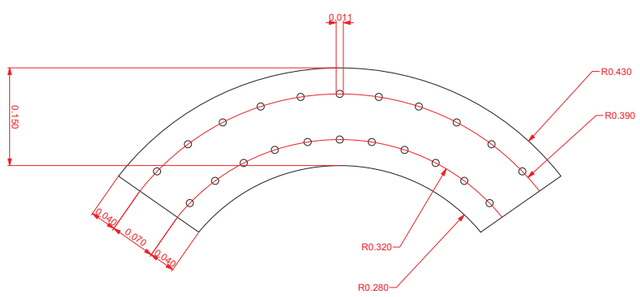


thickness: 8 mm

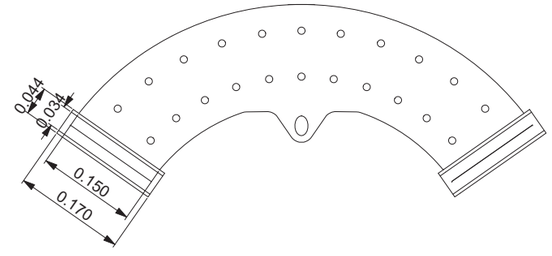
Corner plate 3

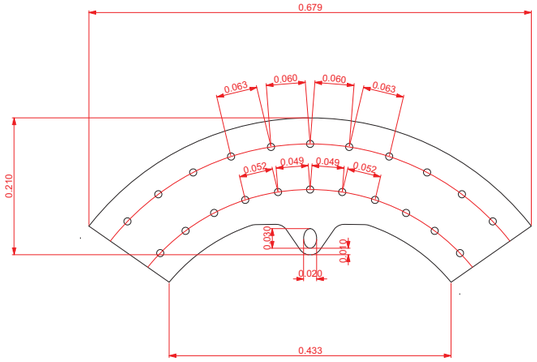
- Corner 4





thickness: 4 mm





thickness: 8 mm

Corner plate 4 (Arch)

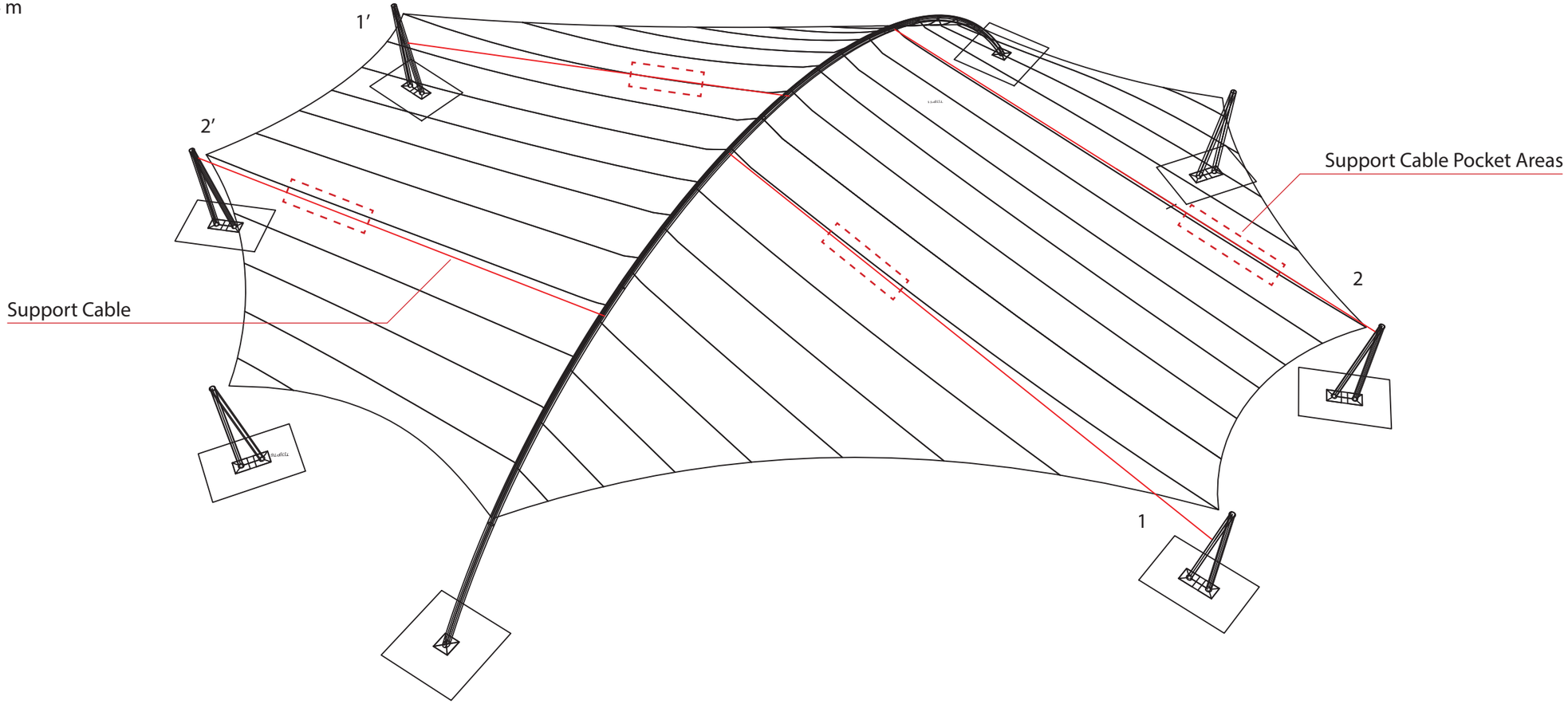
Final Design

Structural Details and Calculation

- Extra Support Cables : Ø 16 mm

- Cable Length (x 2)
  1 : 13.08 m
  2 : 13.19 m

  Total : 52.54 m

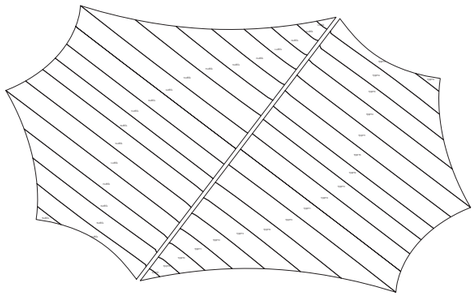


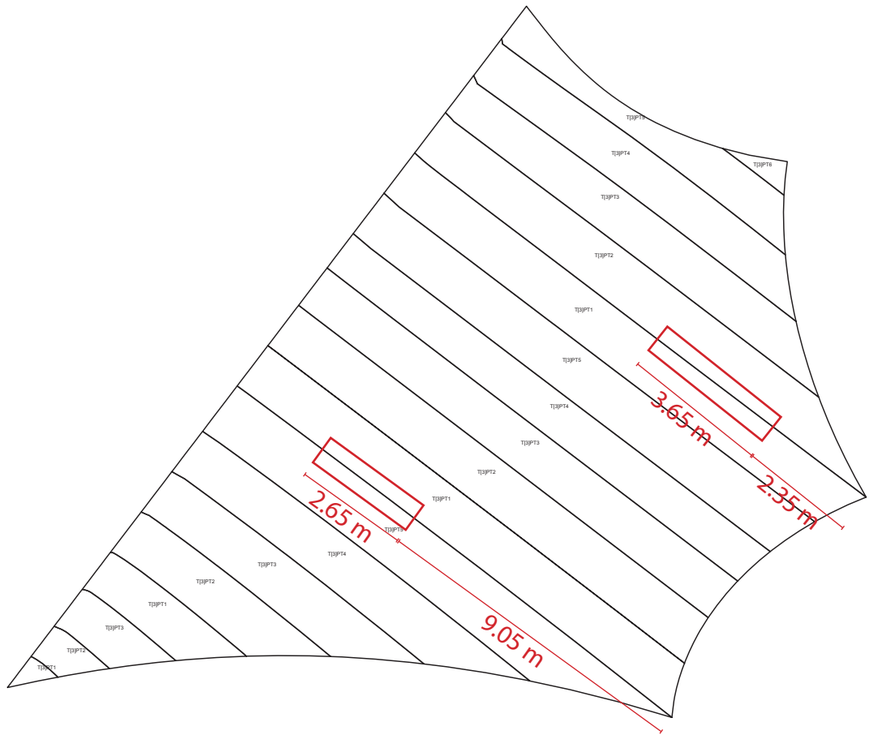
Extre support cable position

Final Design

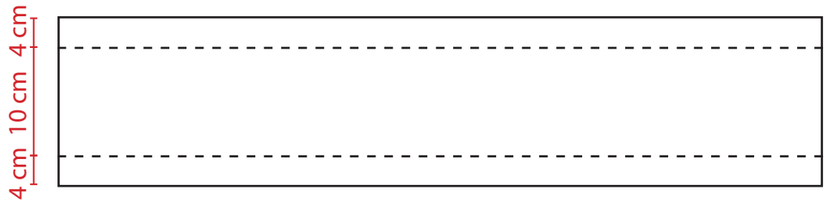
Structural Details and Calculation

- Extra Support Cable Pockets

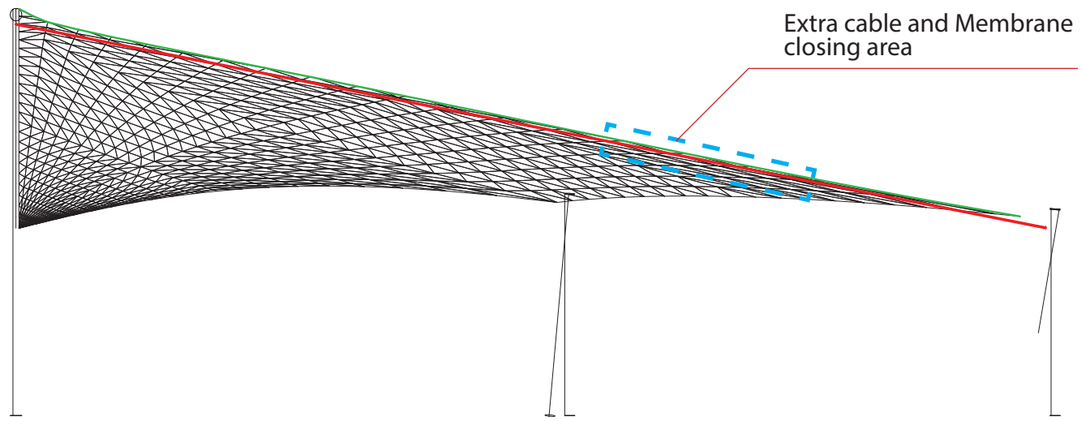




Extra cable detail



Extra cable pocket detail



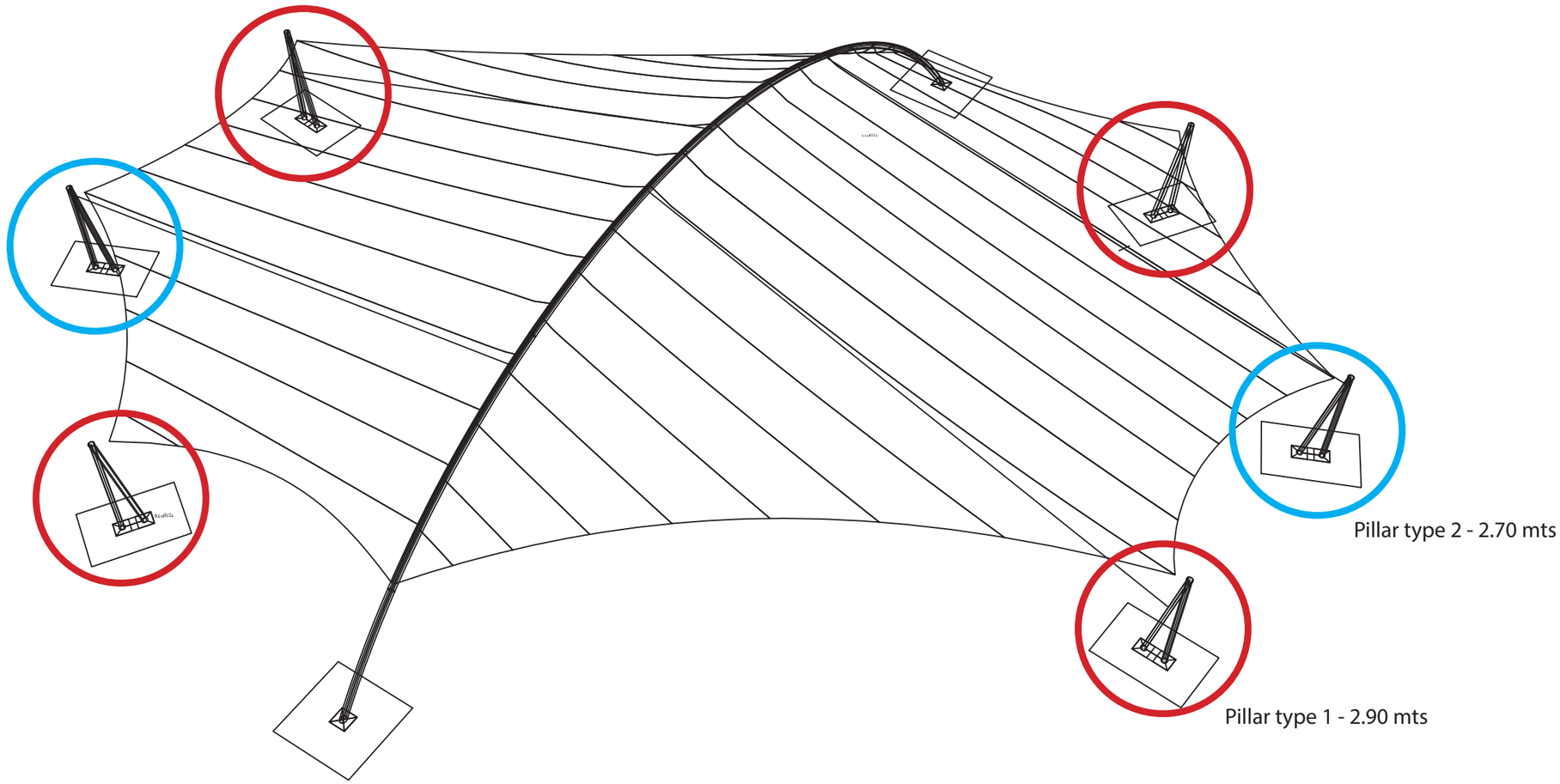
Extre support cable position

Final Design

Structural Details and Calculation

- Pillar : Tubular S275 Steel / 133 mm / e = 5 mm

- Arch : Tubular S275 Steel / 152 mm / e = 8 mm

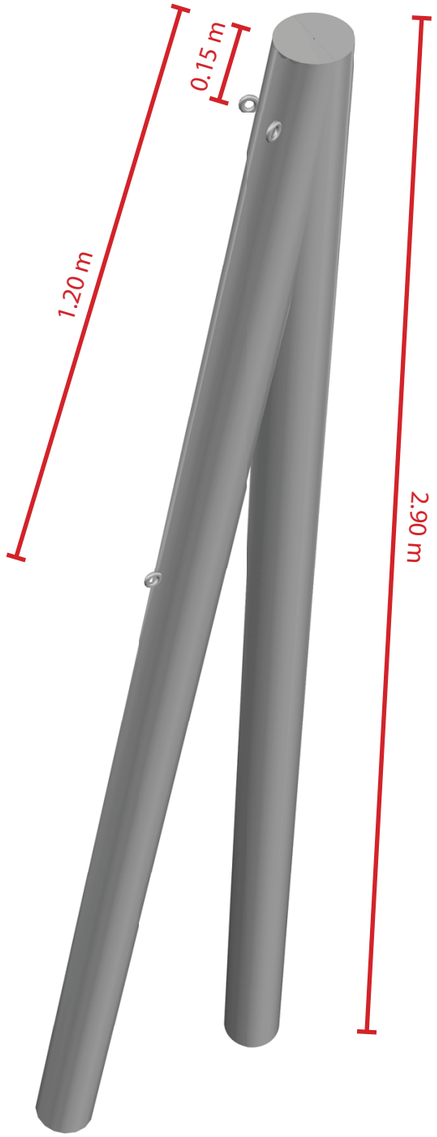


Pillar position

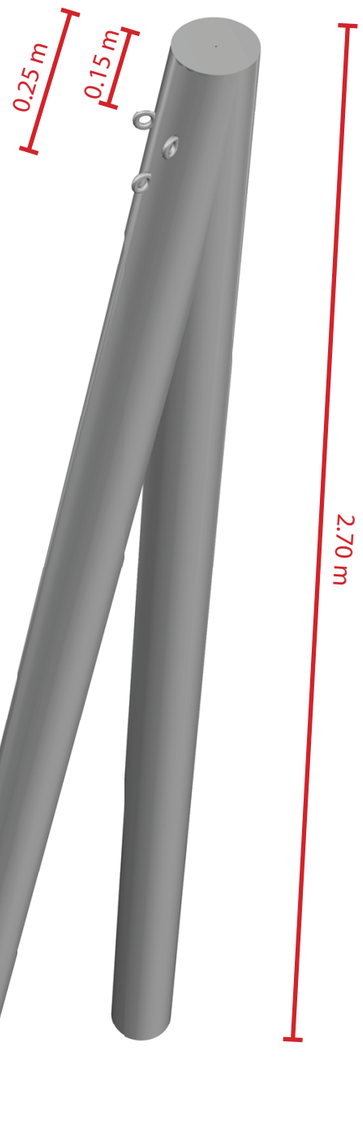
Final Design

Structural Details and Calculation

- Pillar Type 1

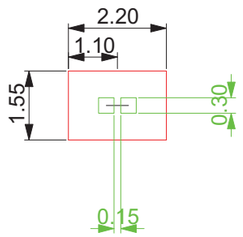


- Pillar Type 2

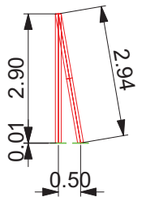


Structural Details and Calculation

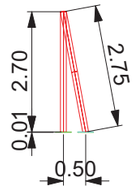
Pilares
CHS 133 e=5 mm



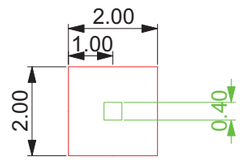
4 Unidads

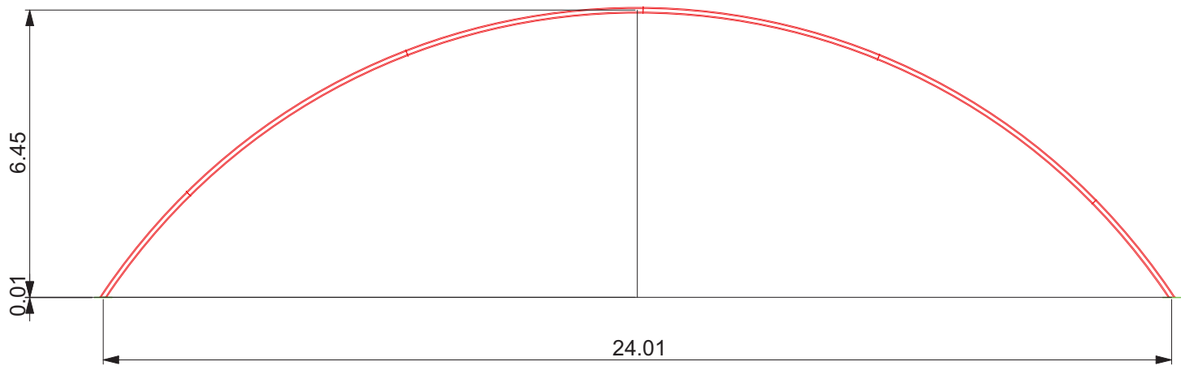


2 Unidads



Arco central nº-1
CHS 152 e=8 mm
Radio del arco 14.40 m
Longitud del arco 28.39 m





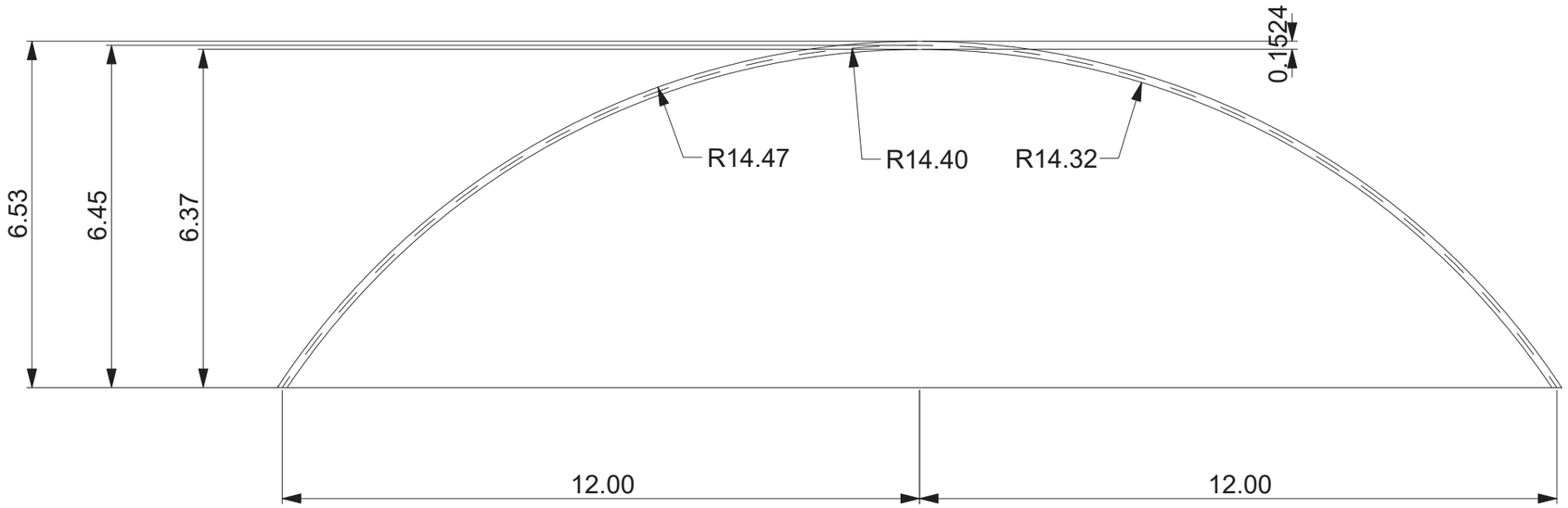
Conclusión

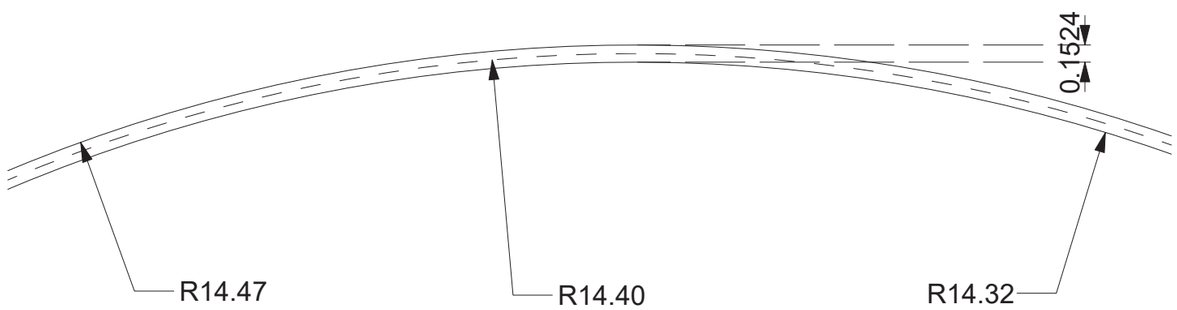
CHS 133 e=5 mm
Longitud = 35 m

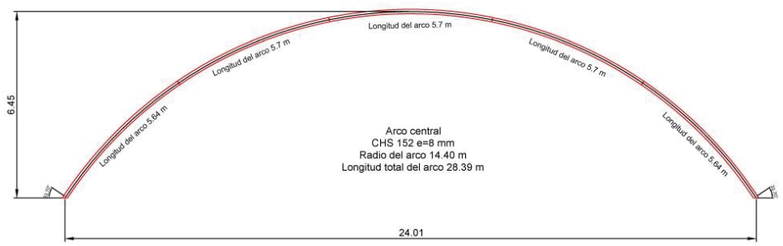
CHS 152 3=8 mm (Arco)
Longitud = 29 m

Structucture quantity

123







Arch Curvature

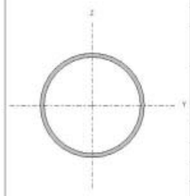
Final Design

Structural Details and Calculation

- Pillar check (vertical bar / inclined bar)

Barra N13/N14

Perfil: CHS 133.0x5.0
Material: Acero (S275)



Nudos		Longitud (m)	Características mecánicas			
Inicial	Final		Área (cm²)	I_y [1] (cm4)	I_z [1] (cm4)	I_t [2] (cm4)
N13	N14	2.900	20.11	412.40	412.40	824.81

Notas:
[1] Inercia respecto al eje indicado
[2] Momento de inercia a torsión uniforme

	Pandeo		Pandeo lateral	
	Plano XY	Plano XZ	Ala sup.	Ala inf.
β	0.70	2.00	0.00	0.00
L_k	2.030	5.800	0.000	0.000
C_m	1.000	1.000	1.000	1.000
C_1	-		1.000	

Notación:
β: Coeficiente de pandeo
L_k: Longitud de pandeo (m)
C_m: Coeficiente de momentos
C_1: Factor de modificación para el momento crítico

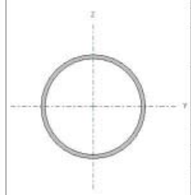
Barra	COMPROBACIONES (CTE DB SE-A)														Estado
	$\bar{\lambda}$	N_t	N_c	M_y	M_z	V_z	V_y	M_yV_z	M_zV_y	NM_yM_z	$NM_yM_zV_zV_y$	M_t	M_tV_z	M_tV_y	
N13/N14	$\bar{\lambda} \leq 2.0$ Cumple	x: 2.9 m η = 8.0	N_{Ed} = 0.00 N.P.[3]	x: 0 m η = 4.5	x: 0 m η = 1.6	η = 0.2	η = 0.1	x: 0 m η < 0.1	x: 0 m η < 0.1	x: 0 m η = 14.1	x: 0 m η < 0.1	M_{Ed} = 0.00 N.P.[3]	N.P.[3]	N.P.[3]	**CUMPLE η = 14.1**

Notación:
$\bar{\lambda}$: Limitación de esbeltez
N_t: Resistencia a tracción
N_c: Resistencia a compresión
M_y: Resistencia a flexión eje Y
M_z: Resistencia a flexión eje Z
V_z: Resistencia a corte Z
V_y: Resistencia a corte Y
M_yV_z: Resistencia a momento flector Y y fuerza cortante Z combinados
M_zV_y: Resistencia a momento flector Z y fuerza cortante Y combinados
NM_yM_z: Resistencia a flexión y axil combinados
$NM_yM_zV_zV_y$: Resistencia a flexión, axil y cortantes combinados
M_t: Resistencia a torsión
M_tV_z: Resistencia a cortante Z y momento torsor combinados
M_tV_y: Resistencia a cortante Y y momento torsor combinados
x: Distancia al origen de la barra
η: Coeficiente de aprovechamiento (%)
N.P.: No procede

Comprobaciones que no proceden (N.P.):
[3] La comprobación no procede, ya que no hay axil de compresión.
[4] La comprobación no procede, ya que no hay momento flector.
[5] No hay interacción entre momento flector y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.

Barra N12/N14

Perfil: CHS 133.0x5.0
Material: Acero (S275)



Nudos		Longitud (m)	Características mecánicas			
Inicial	Final		Área (cm²)	I_y [1] (cm4)	I_z [1] (cm4)	I_t [2] (cm4)
N12	N14	2.943	20.11	412.40	412.40	824.81

Notas:
[1] Inercia respecto al eje indicado
[2] Momento de inercia a torsión uniforme

	Pandeo		Pandeo lateral	
	Plano XY	Plano XZ	Ala sup.	Ala inf.
β	0.70	2.00	0.00	0.00
L_k	2.060	5.886	0.000	0.000
C_m	1.000	1.000	1.000	1.000
C_1	-		1.000	

Notación:
β: Coeficiente de pandeo
L_k: Longitud de pandeo (m)
C_m: Coeficiente de momentos
C_1: Factor de modificación para el momento crítico

Barra	COMPROBACIONES (CTE DB SE-A)														Estado
	$\bar{\lambda}$	N_t	N_c	M_y	M_z	V_z	V_y	M_yV_z	M_zV_y	NM_yM_z	$NM_yM_zV_zV_y$	M_t	M_tV_z	M_tV_y	
N12/N14	$\bar{\lambda} < 2.0$ Cumple	N_{Ed} = 0.00 N.P.[3]	x: 0 m η = 25.0	x: 0 m η = 4.5	M_{Ed} = 0.00 N.P.[3]	x: 2.943 m η = 0.2	V_{Ed} = 0.00 N.P.[3]	η < 0.1	N.P.[4]	x: 0 m η = 30.4	η < 0.1	M_{Ed} = 0.00 N.P.[3]	N.P.[3]	N.P.[3]	**CUMPLE η = 30.4**

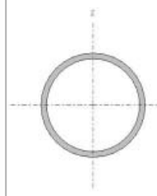
Notación:
$\bar{\lambda}$: Limitación de esbeltez
N_t: Resistencia a tracción
N_c: Resistencia a compresión
M_y: Resistencia a flexión eje Y
M_z: Resistencia a flexión eje Z
V_z: Resistencia a corte Z
V_y: Resistencia a corte Y
M_yV_z: Resistencia a momento flector Y y fuerza cortante Z combinados
M_zV_y: Resistencia a momento flector Z y fuerza cortante Y combinados
NM_yM_z: Resistencia a flexión y axil combinados
$NM_yM_zV_zV_y$: Resistencia a flexión, axil y cortante combinados
M_t: Resistencia a torsión
M_tV_z: Resistencia a cortante Z y momento torsor combinados
M_tV_y: Resistencia a cortante Y y momento torsor combinados
x: Distancia al origen de la barra
η: Coeficiente de aprovechamiento (%)
N.P.: No procede

Comprobaciones que no proceden (N.P.):
[3] La comprobación no procede, ya que no hay axil de tracción.
[4] La comprobación no procede, ya que no hay momento flector.
[5] La comprobación no procede, ya que no hay esfuerzo cortante.
[6] No hay interacción entre momento flector y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.
[7] La comprobación no procede, ya que no hay momento torsor.
[8] No hay interacción entre momento torsor y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.

- Arch check

Barra N1/N4

Perfil: CHS 152.0x8.0
Material: Acero (S275)



Nudos		Longitud (m)	Características mecánicas			
Inicial	Final		Área (cm²)	I_y [1] (cm4)	I_z [1] (cm4)	I_t [2] (cm4)
N1	N4	2.816	36.19	940.97	940.97	1881.94

Notas:
[1] Inercia respecto al eje indicado
[2] Momento de inercia a torsión uniforme

	Pandeo		Pandeo lateral	
	Plano XY	Plano XZ	Ala sup.	Ala inf.
β	4.26	0.00	0.00	0.00
L_k	12.005	0.000	0.000	0.000
C_m	1.000	1.000	1.000	1.000
C_1	-		1.000	

Notación:
β: Coeficiente de pandeo
L_k: Longitud de pandeo (m)
C_m: Coeficiente de momentos
C_1: Factor de modificación para el momento crítico

Barra	COMPROBACIONES (CTE DB SE-A)														Estado
	N_t	N_c	M_y	M_z	V_z	V_y	M_yV_z	M_zV_y	NM_yM_z	$NM_yM_zV_zV_y$	M_t	M_tV_z	M_tV_y		
N1/N4	N_{Ed} = 0.00 N.P.[3]	x: 0 m η = 61.9	x: 0 m η = 62.8	M_{Ed} = 0.00 N.P.[3]	x: 2.816 m η = 4.1	V_{Ed} = 0.00 N.P.[3]	η < 0.1	N.P.[4]	x: 0 m η = 99.6	η < 0.1	M_{Ed} = 0.00 N.P.[3]	N.P.[3]	N.P.[3]	**CUMPLE**

Notación:
N_t: Resistencia a tracción
N_c: Resistencia a compresión
M_y: Resistencia a flexión eje Y
M_z: Resistencia a flexión eje Z
V_z: Resistencia a corte Z
V_y: Resistencia a corte Y
M_yV_z: Resistencia a momento flector Y y fuerza cortante Z combinados
M_zV_y: Resistencia a momento flector Z y fuerza cortante Y combinados
NM_yM_z: Resistencia a flexión y axil combinados
$NM_yM_zV_zV_y$: Resistencia a flexión, axil y cortante combinados
M_t: Resistencia a torsión
M_tV_z: Resistencia a cortante Z y momento torsor combinados
M_tV_y: Resistencia a cortante Y y momento torsor combinados
x: Distancia al origen de la barra
η: Coeficiente de aprovechamiento (%)
N.P.: No procede

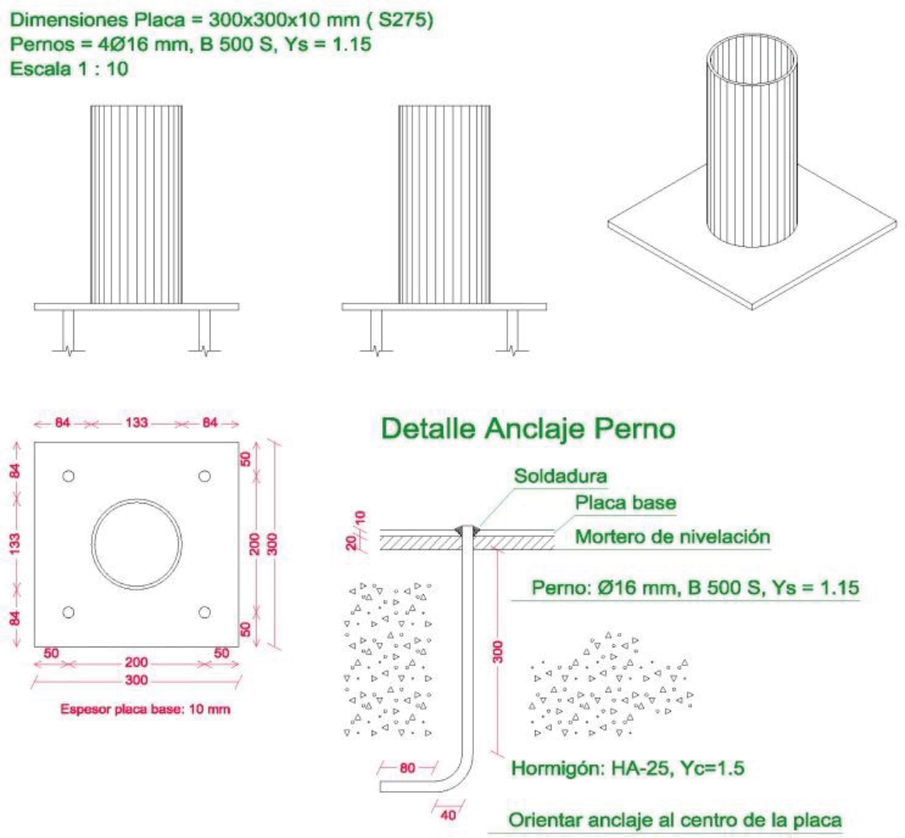
Comprobaciones que no proceden (N.P.):
[3] La comprobación no procede, ya que no hay axil de tracción.
[4] La comprobación no procede, ya que no hay momento flector.
[5] La comprobación no procede, ya que no hay esfuerzo cortante.
[6] No hay interacción entre momento flector y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.
[7] La comprobación no procede, ya que no hay momento torsor.
[8] No hay interacción entre momento torsor y esfuerzo cortante para ninguna combinación. Por lo tanto, la comprobación no procede.

Errores:
[9] Se ha producido un error, ya que la esbeltez de la barra es mayor que la esbeltez límite.

Final Design

Structural Details and Calculation

- Description of anchor plates for pillars



N12, N13

Fecha:22/05/17

Comprobaciones

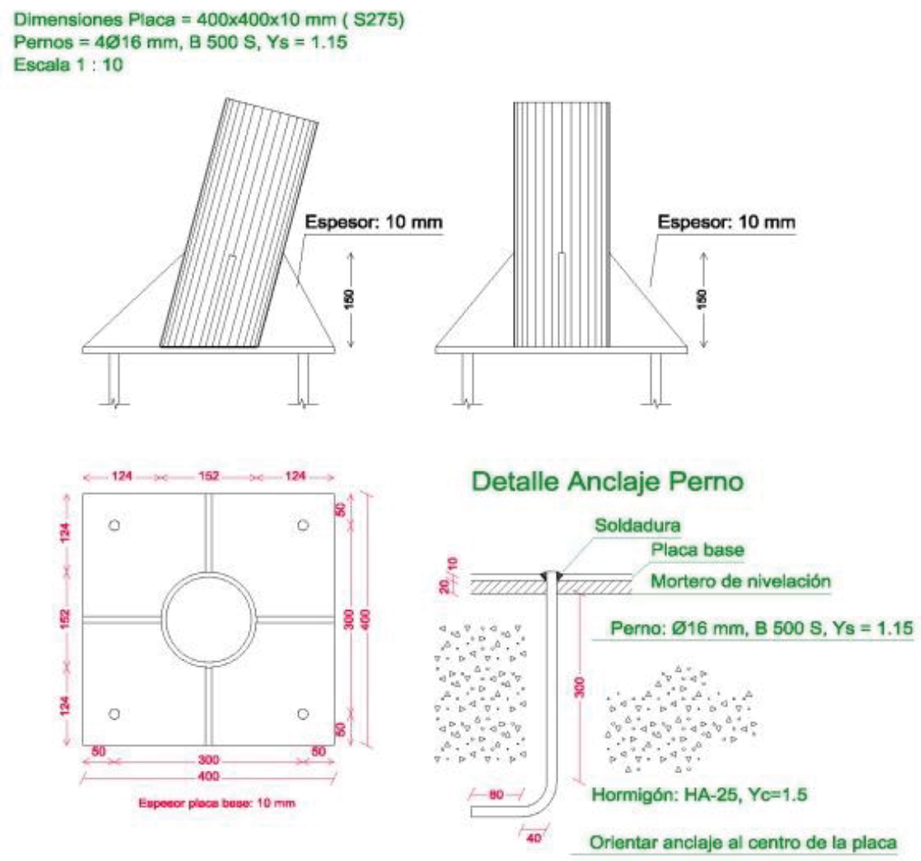
1) Placa de anclaje

Referencia: -Placa base: Ancho X: 300 mm Ancho Y: 300 mm Espesor: 10 mm -Pernos: 4Ø16 mm L=30 cm Patilla a 90 grados -Disposición: Posición X: Centrada Posición Y: Centrada		
Comprobación	Valores	Estado
Separación mínima entre pernos: *3 diámetros*	Mínimo: 48 mm Calculado: 200 mm	Cumple
Separación mínima pernos-borde: *1.5 diámetros*	Mínimo: 24 mm Calculado: 50 mm	Cumple
Longitud mínima del perno: *Se calcula la longitud de anclaje necesaria por adherencia.*	Mínimo: 17 cm Calculado: 30 cm	Cumple
Anclaje perno en hormigón:		
- Tracción:	Máximo: 5.437 t Calculado: 1.657 t	Cumple
- Cortante:	Máximo: 3.806 t Calculado: 0.011 t	Cumple
- Tracción + Cortante:	Máximo: 5.437 t Calculado: 1.673 t	Cumple
Tracción en vástago de pernos:	Máximo: 8.196 t Calculado: 1.398 t	Cumple
Tensión de Von Mises en vástago de pernos:	Máximo: 4854.13 kp/cm² Calculado: 695.722 kp/cm²	Cumple
Aplastamiento perno en placa: *Límite del cortante en un perno actuando contra la placa*	Máximo: 8.543 t Calculado: 0.009 t	Cumple
Tensión de Von Mises en secciones globales:	Máximo: 2669.77 kp/cm²	
- Derecha:	Calculado: 1314.79 kp/cm²	Cumple
- Izquierda:	Calculado: 1552.53 kp/cm²	Cumple
- Arriba:	Calculado: 1346.88 kp/cm²	Cumple
- Abajo:	Calculado: 1765.57 kp/cm²	Cumple
Flecha global equivalente: *Limitación de la deformabilidad de los vuelos*	Mínimo: 250	
- Derecha:	Calculado: 730.24	Cumple
- Izquierda:	Calculado: 596.521	Cumple
- Arriba:	Calculado: 475.506	Cumple
- Abajo:	Calculado: 452.265	Cumple
Tensión de Von Mises local: *Tensión por tracción de pernos sobre placas en voladizo*	Máximo: 2669.77 kp/cm² Calculado: 0 kp/cm²	Cumple
Se cumplen todas las comprobaciones		
Información adicional:		
- Relación rotura pésima sección de hormigón: 0.0393		

Final Design

Structural Details and Calculation

- Description of anchor plates for arch



N1, N2

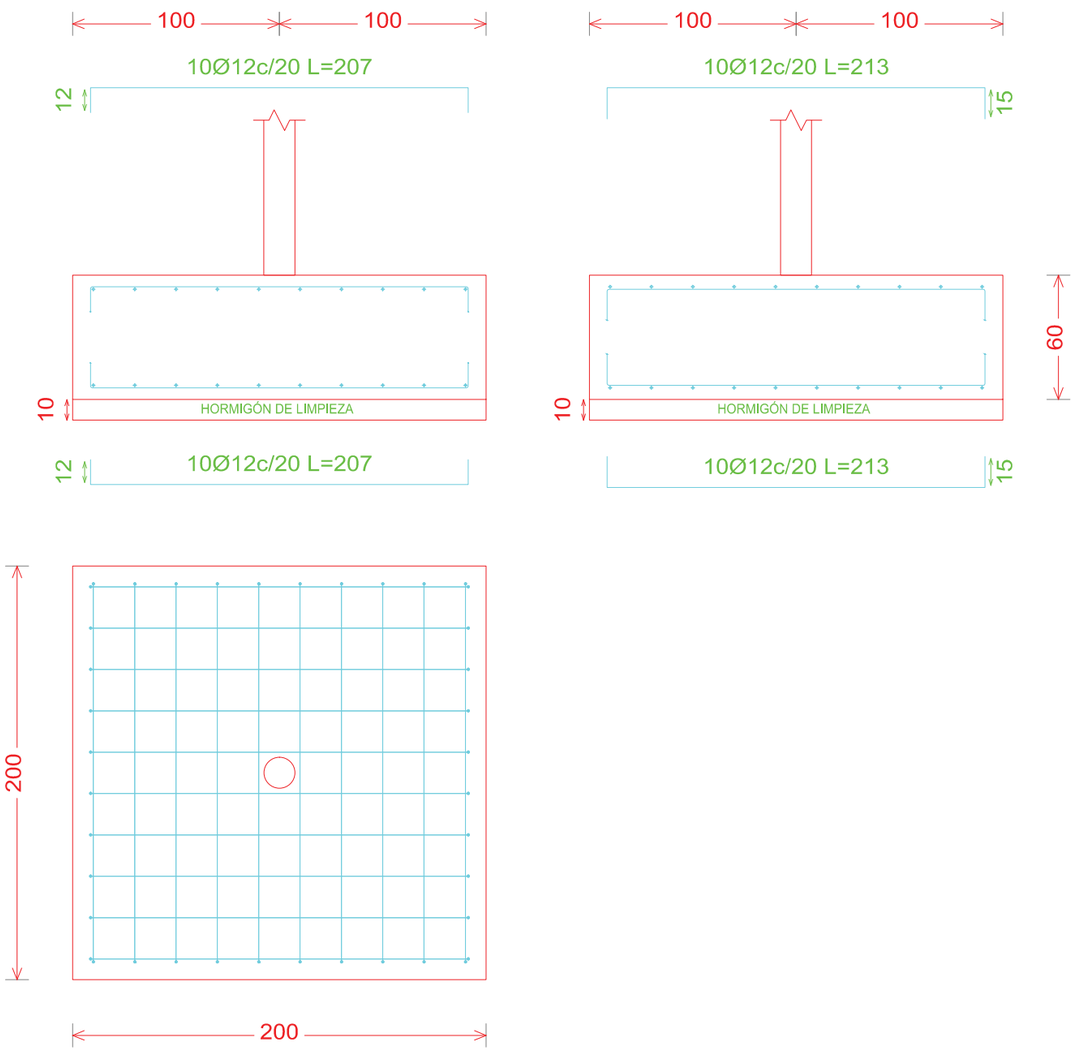
Fecha:22/05/17

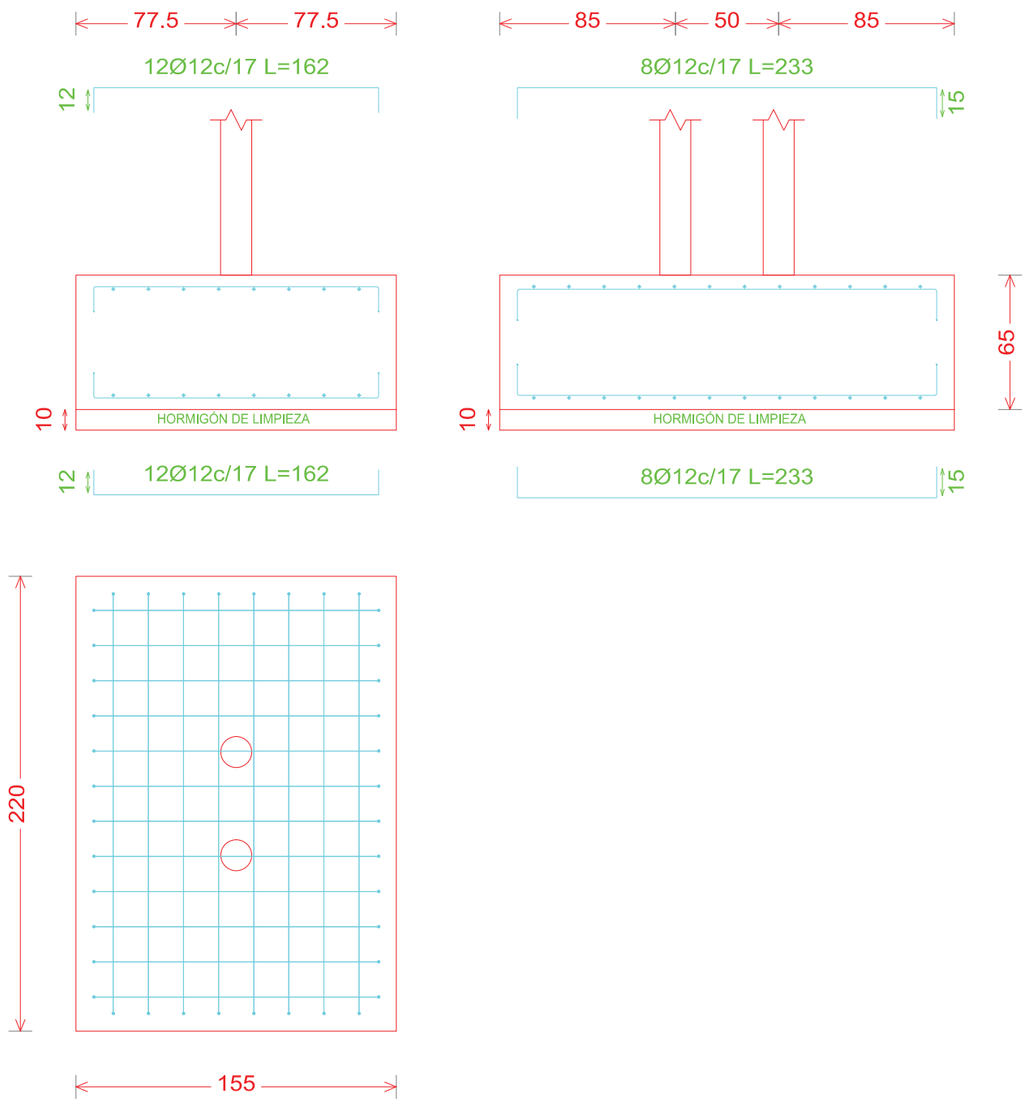
Comprobaciones

1) Placa de anclaje

Referencia: -Placa base: Ancho X: 400 mm Ancho Y: 400 mm Espesor: 10 mm -Pernos: 4Ø16 mm L=30 cm Patilla a 90 grados -Disposición: Posición X: Centrada Posición Y: Centrada -Rigidizadores: Paralelos X: - Paralelos Y: 1(110x0x10.0)		
Comprobación	Valores	Estado
Separación mínima entre pernos: *3 diámetros*	Mínimo: 48 mm Calculado: 299 mm	Cumple
Separación mínima pernos-borde: *1.5 diámetros*	Mínimo: 24 mm Calculado: 51 mm	Cumple
Esbeltez de rigidizadores: - Paralelos a Y:	Máximo: 50 Calculado: 28.7	Cumple
Longitud mínima del perno: *Se calcula la longitud de anclaje necesaria por adherencia.*	Mínimo: 17 cm Calculado: 30 cm	Cumple
Anclaje perno en hormigón: - Tracción: - Cortante: - Tracción + Cortante:	 Máximo: 5.437 t Calculado: 3.241 t Máximo: 3.806 t Calculado: 0.358 t Máximo: 5.437 t Calculado: 3.753 t	 Cumple Cumple Cumple
Tracción en vástago de pernos:	Máximo: 8.196 t Calculado: 2.729 t	Cumple
Tensión de Von Mises en vástago de pernos:	Máximo: 4854.13 kp/cm² Calculado: 1388.26 kp/cm²	Cumple
Aplastamiento perno en placa: *Límite del cortante en un perno actuando contra la placa*	Máximo: 8.543 t Calculado: 0.302 t	Cumple
Tensión de Von Mises en secciones globales:	Máximo: 2669.77 kp/cm²	
- Derecha:	Calculado: 781.542 kp/cm²	Cumple
- Izquierda:	Calculado: 781.542 kp/cm²	Cumple
- Arriba:	Calculado: 984.862 kp/cm²	Cumple
- Abajo:	Calculado: 2478.25 kp/cm²	Cumple
Flecha global equivalente: *Limitación de la deformabilidad de los vuelos*	Mínimo: 250	
- Derecha:	Calculado: 10995.4	Cumple
- Izquierda:	Calculado: 10995.4	Cumple
- Arriba:	Calculado: 7519.41	Cumple
- Abajo:	Calculado: 2773.45	Cumple
Tensión de Von Mises local: *Tensión por tracción de pernos sobre placas en voladizo*	Máximo: 2669.77 kp/cm² Calculado: 0 kp/cm²	Cumple
Se cumplen todas las comprobaciones		
Información adicional:		
- Relación rotura pésima sección de hormigón: 0.112		

Structural Details and Calculation





Foundation details

Final Design

Perspective

Building Cost

Building Cost

Cost sheet

PVC	€ 5.538,46		
KEDER	€ 87,36		
PATTERNING PRINTING	€ 2.097,00		
CORNER PLATES	€ 208,80		
CABLES	€ 4.738,37		
TRANSPORTATION OF MATERIAL	€ 940,00		
	SUBTOTAL MEMBRANE	€	13.609,99
STEEEL	€ 2.021,48		
GALVANIZED TREATMENT	€ 670,80		
PLATES FOR FOUNDATIONS	€ 162,26		
ALUMINIUM KEDER	€ 156,80		
TRANSPORTATION OF MATERIALS	€ 408,00		
	SUBTOTAL STRUCTURE	€	3.419,34
HARDWARE cable accesories, welding materials, etc		€	1.125,60
	TOTAL MATERIALS	**€**	**18.154,93**

MANUFACTURING COST		**€**	**4.040,00**
MEMBRANE COST (2 person, 8 days)	€ 1.280,00		
STRUCTURE COST (2 person , 6 days)	€ 960,00		
designing and engineering	€ 1.800,00		
INSTALLATION COST		**€**	**9.771,47**
transportation			
accomodation, meals and workers, 8 days	€ 6.912,00		
Crane	€ 2.859,47		
TOTAL COST		€	31.966,40

Project Flowchart

Project Flowchart

Day by day flowchart

	Task Name	Duration	February		March																										April
			Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun
		(days)	27	28	1	2	3	4/5	6	7	8	9	10	11/12	13	14	15	16	17	18/19	20	21	22	23	24	25/26	27	28	29	30	31	1/2
1	Preliminary Work																														
	Client Discussion	4																													
	Preliminary Design	13																													
	Client Decided	1																													
2	Design Process																														
	Pre - dimensioning																														
	Form finding																														
	Structural analysis																														
	Structural detailing																														
	Foundation design																														
	Patterning																														
3	Final Design																														
	Final computational model																														
	Final structural analysis																														
	Final drawing																														
4	Fabrication																														
	Procurement																														
	Foundation																														
	Steel fabrication																														
	Membrane fabrication																														
5	Installation																														
	Transportation																														
	Scaffolding																														
	Structural erection																														
	Membrane erection																														
	Tensioning																														
	Paint touch - up																														
	Fabric cleaning																														
	Site cleaning																														
	Total	18																												(14 Workdays)	

	Task Name	Duration	April																								May					
			Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun
		(days)	3	4	5	6	7	8/9	10	11	12	13	14	15/16	17	18	19	20	21	22/23	24	25	26	27	28	29/30	1	2	3	4	5	6/7
1	Preliminary Work																														
	Client Discussion	1																													
	Preliminary Design	3																													
	Client Decided	2																													
2	Design Process																														
	Pre - dimensioning	3																													
	Form finding	5																													
	Structural analysis	5																													
	Structural detailing	5																													
	Foundation design	4																													
	Patterning	2																													
3	Final Design																														
	Final computational model																														
	Final structural analysis																														
	Final drawing																														
4	Fabrication																														
	Procurement																														
	Foundation	8																													
	Steel fabrication																														
	Membrane fabrication																														
5	Installation																														
	Transportation																														
	Scaffolding																														
	Structural erection																														
	Membrane erection																														
	Tensioning																														
	Paint touch - up																														
	Fabric cleaning																														
	Site cleaning																														
	Total	38																												(21 Workdays)	

Project Flowchart

Day by day flowchart

	Task Name	Duration	May																					June									
			Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun
		(days)	8	9	10	11	12	13/14	15	16	17	18	19	20/21	22	23	24	25	26	27/28	29	30	31	1	2	3/4	5	6	7	8	9	10/11
1	Preliminary Work																															
	Client Discussion																															
	Preliminary Design																															
	Client Decided																															
2	Design Process																															
	Pre - dimensioning																															
	Form finding																															
	Structural analysis																															
	Structural detailing																															
	Foundation design																															
	Patterning	4																														
3	Final Design																															
	Final computational model																															
	Final structural analysis																															
	Final drawing																															
4	Fabrication																															
	Procurement	4																														
	Foundation																															
	Steel fabrication	15																														
	Membrane fabrication	9																														
5	Installation																															
	Transportation	2																														
	Scaffolding	1																														
	Structural erection	3																														
	Membrane erection	3																														
	Tensioning	2																														
	Paint touch - up																															
	Fabric cleaning																															
	Site cleaning																															
	Total	43																											(25 Workdays)				

	Task Name	Duration	June																		July												
			Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun	Mon	Tue	Wed	Thu	Fri	Sat/Sun
		(days)	12	13	14	15	16	17/18	19	20	21	22	23	24/25	26	27	28	29	30	1/2	3	4	5	6	7	8/9	10	11	12	13	14	15/16
1	Preliminary Work																															
	Client Discussion																															
	Preliminary Design																															
	Client Decided																															
2	Design Process																															
	Pre - dimensioning																															
	Form finding																															
	Structural analysis																															
	Structural detailing																															
	Foundation design																															
	Patterning																															
3	Final Design																															
	Final computational model																															
	Final structural analysis																															
	Final drawing																															
4	Fabrication																															
	Procurement																															
	Foundation																															
	Steel fabrication																															
	Membrane fabrication																															
5	Installation				(Playground Installation)																													
	Transportation																															
	Scaffolding																															
	Structural erection																															
	Membrane erection																															
	Tensioning	2																														
	Paint touch - up	2																														
	Fabric cleaning	2																														
	Site cleaning	2																														
	Total	8										(3 Workdays)																					

	Grand Total	107	(63 Workdays)

Project Flowchart

Responsibilities

		PM	D	S	C	SS
Entry	Client discussion	1				
	Site inspection	1				1
	Preliminary design	1	1			
	Client decided and contract	1				

		PM	D	S	C	SS
Design	Form finding	1	1			
	Structural analysis		1			
	Structural detailing		2			
	Patterning		1			
	Shop drawing		2			

		PM	D	S	C	SS
Fabricarion	Foundations				2	1
	Membrane Fabrication		2		2	
	Steel Fabrication		1		2	
	Cable Fabrication		1		1	
	Packing		1		4	

		PM	D	S	C	SS
Installation	Transportation and unpacking				3	1
	Scaffolding				3	1
	Steel erection	1	1		3	1
	Membrane erection	1	1		3	1
	Tensioning	1	1		3	1
	Repairing defects an fabric cleaning	1			2	1
	Site cleaning	1				1

Legend

PM	Project manager
D	Designer (Architect, Engineer)
S	Supplier (Fabric, Steel, Cable)
C	Construction contractor
SS	Site supervision

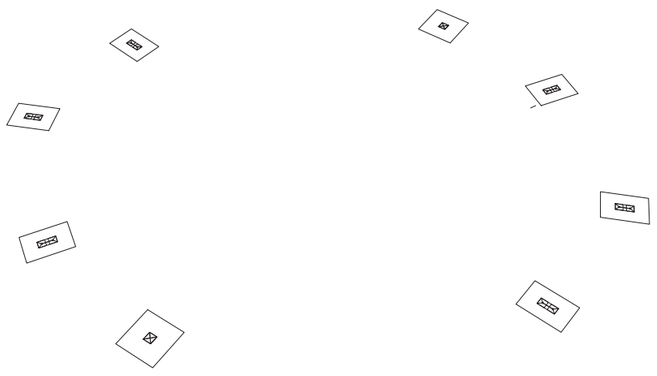
Number	Workers

Erection Process

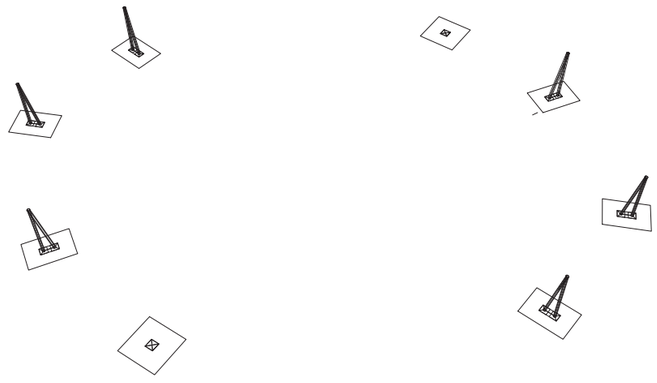
Erection Process

Erection Phases - Structure Parts

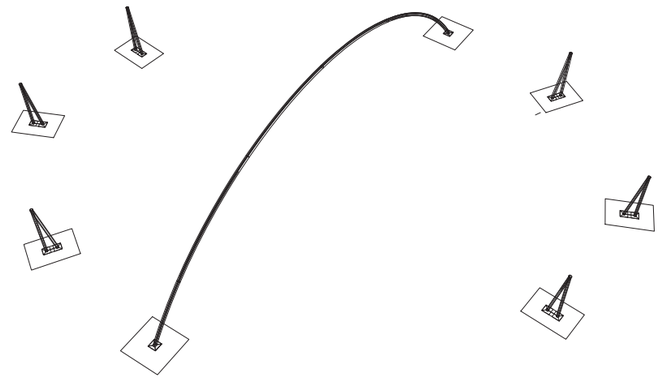
1 - Foundations / Base Plates



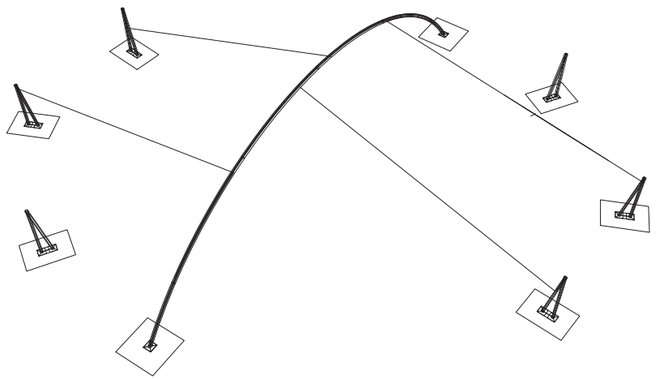
2 - Pillars



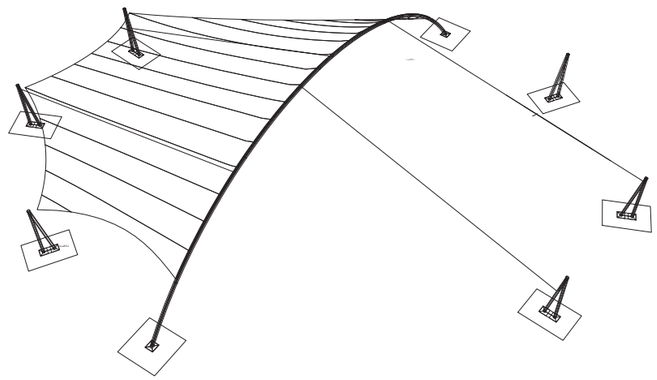
3 - Arch



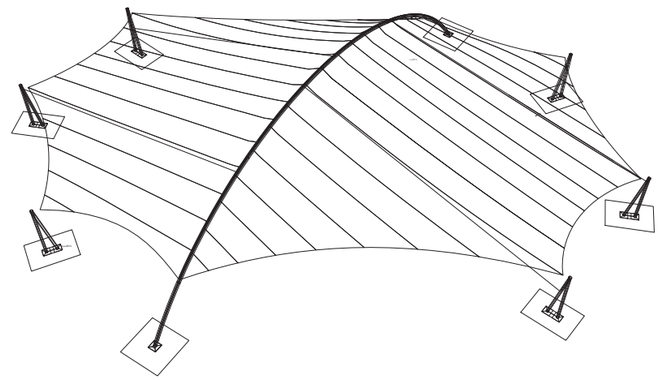
4 - Support cables



5 - Membrane (1st side)



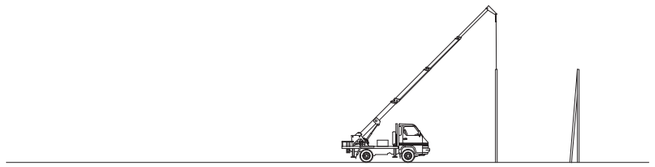
6 - Membrane (both sides)



Erection Process

Erection Phases - Construction

1 - Pillar erection



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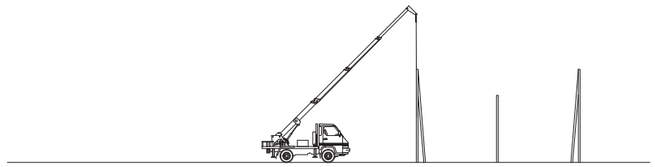
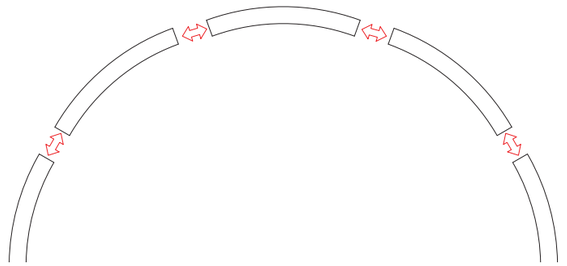
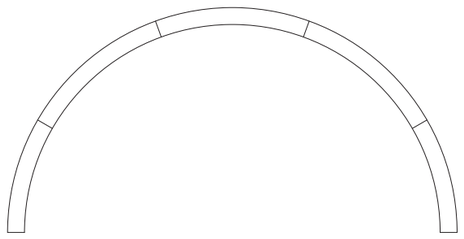


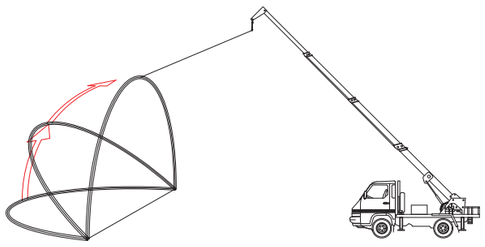
3 - Arch assemble



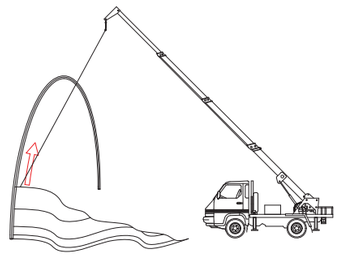
4



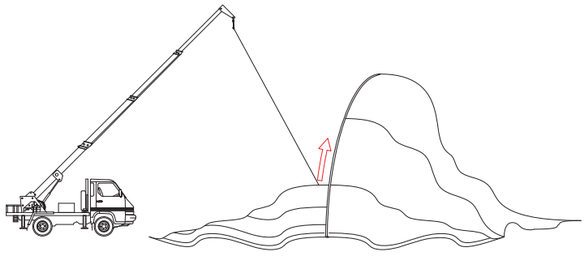
5 - Arch erection



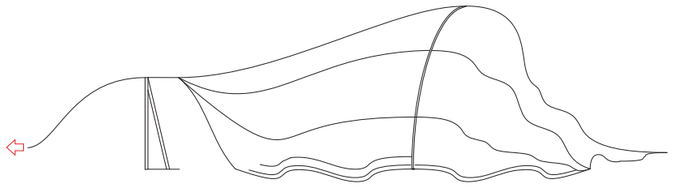
6 - First membrane installation



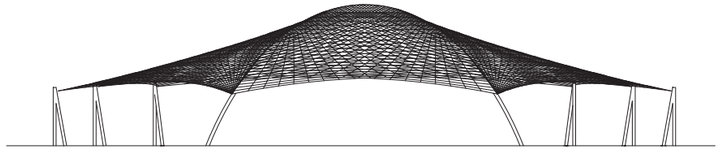
7 - Second membrane installation



8 - Membrane tensioning



9 - Finished



Tools and Machinery

Crane car

Folk lift

Car lift

Driller

Driller

Hand circular saw

Welding

Belt

Wire extension

Hot air blower pvc fabric welding machine

Erection Process

Site Preparation

Foundation

Erection Process

Site Preparation

Base plate (pre)

Structure Fabrication

Corner plate

Cleat

Erection Process

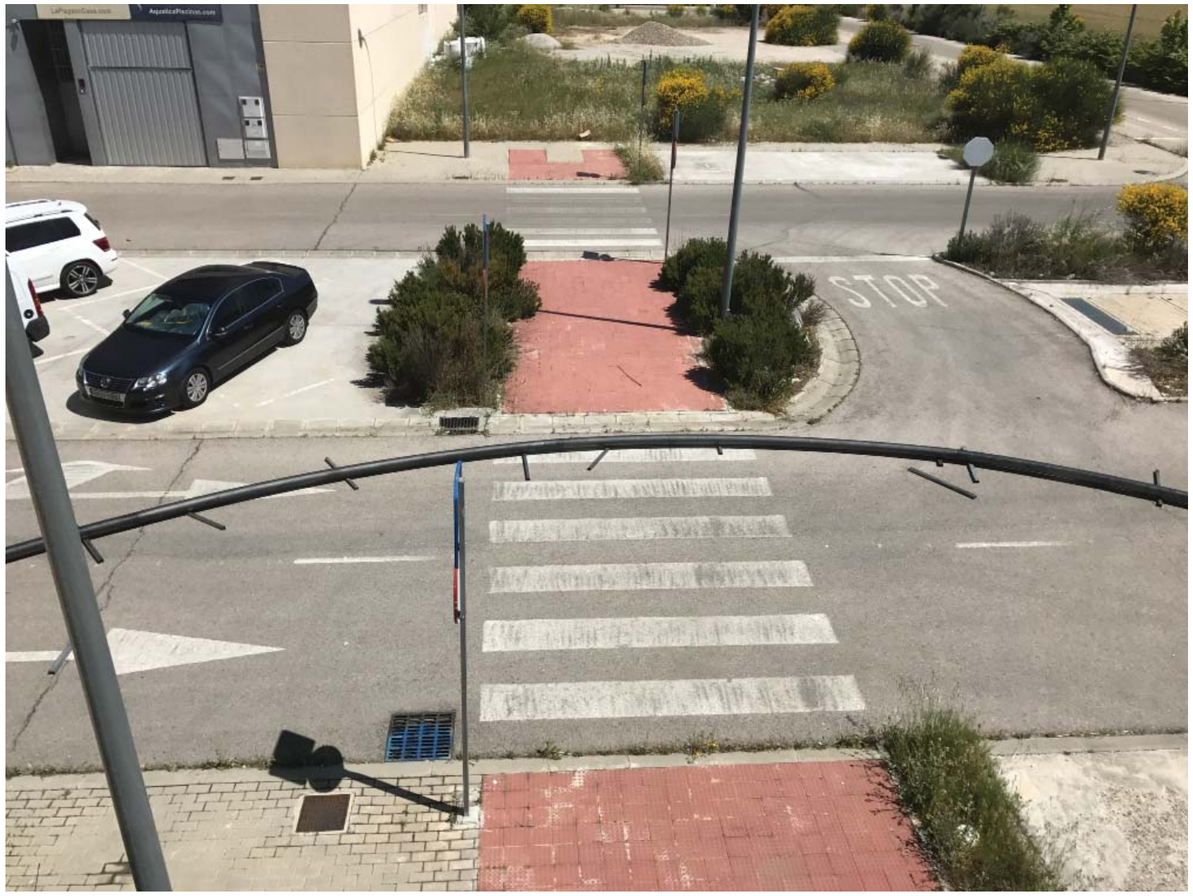
Structure Fabrication

Column

Arch - joint

Erection Process

Structure Fabrication



Arch pre - assemble testing

Erection Process

Membrane Fabrication

Pattern cutting

Erection Process

Membrane Fabrication

Membrane welding and pocket fabrication

Erection Process

Membrane Fabrication

Packing and transportation

Erection Process

Installation

Site

Material preparation

Erection Process

Installation

Base plate replace

Pillars installation

Erection Process

Installation

Arch assemble

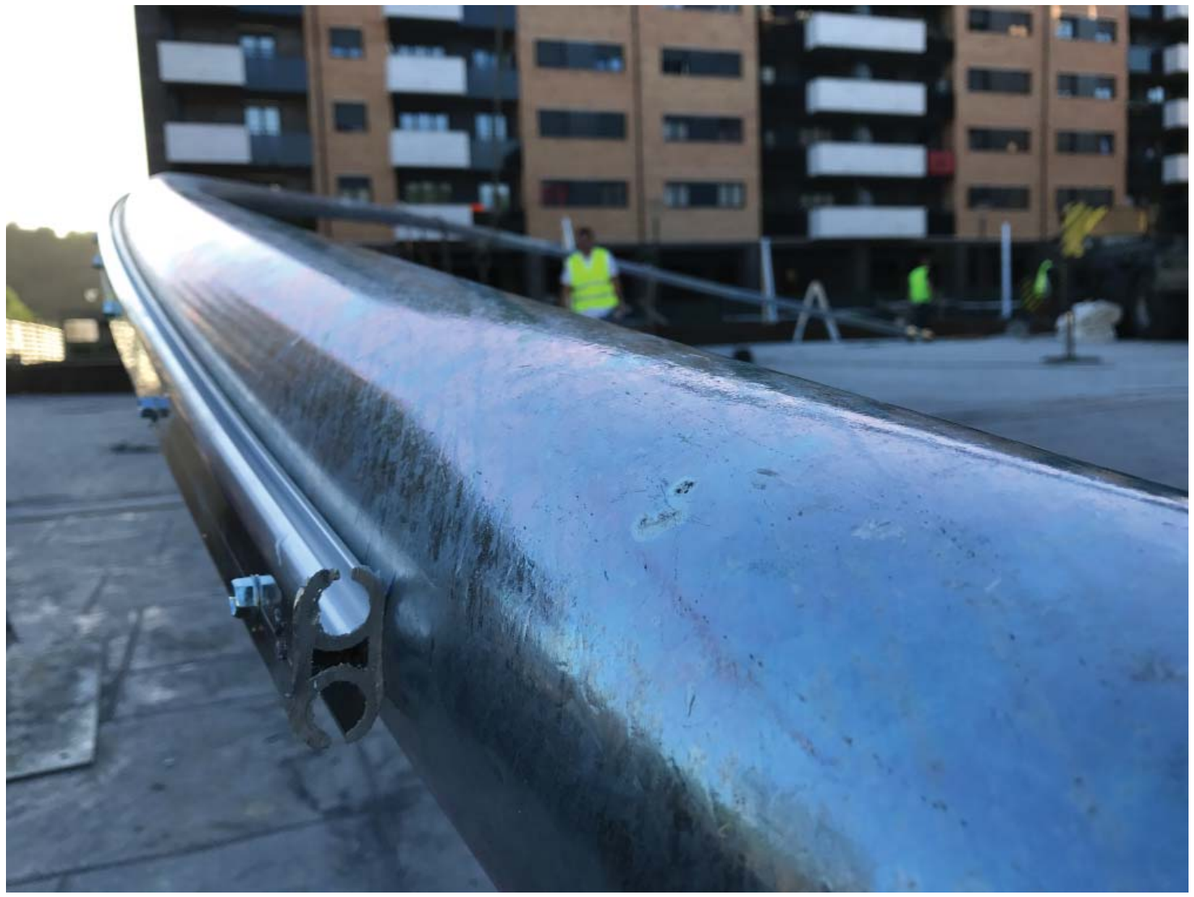
Installation

Vertical check

Welding

Erection Process

Installation



Ring and Keder attachment

Erection Process

Installation

Installation

Arch reinforce cables

Installation

Clean the area for unfold membrane

Membrane unfold

Installation

Attach corner plates to membrane

Installation

Put cable into membrane pocket

Membrane installation

Installation

Membrane installation

Erection Process

Installation

Membrane installation

Erection Process

Installation

Membrane installation

Installation

Membrane installation

Installation

Membrane installation

Installation

Membrane installation

Erection Process

Installation

Membrane installation

Erection Process

Installation

Membrane installation

Erection Process

Installation

Membrane installation

Erection Process

Installation

Water testing

Membrane installation

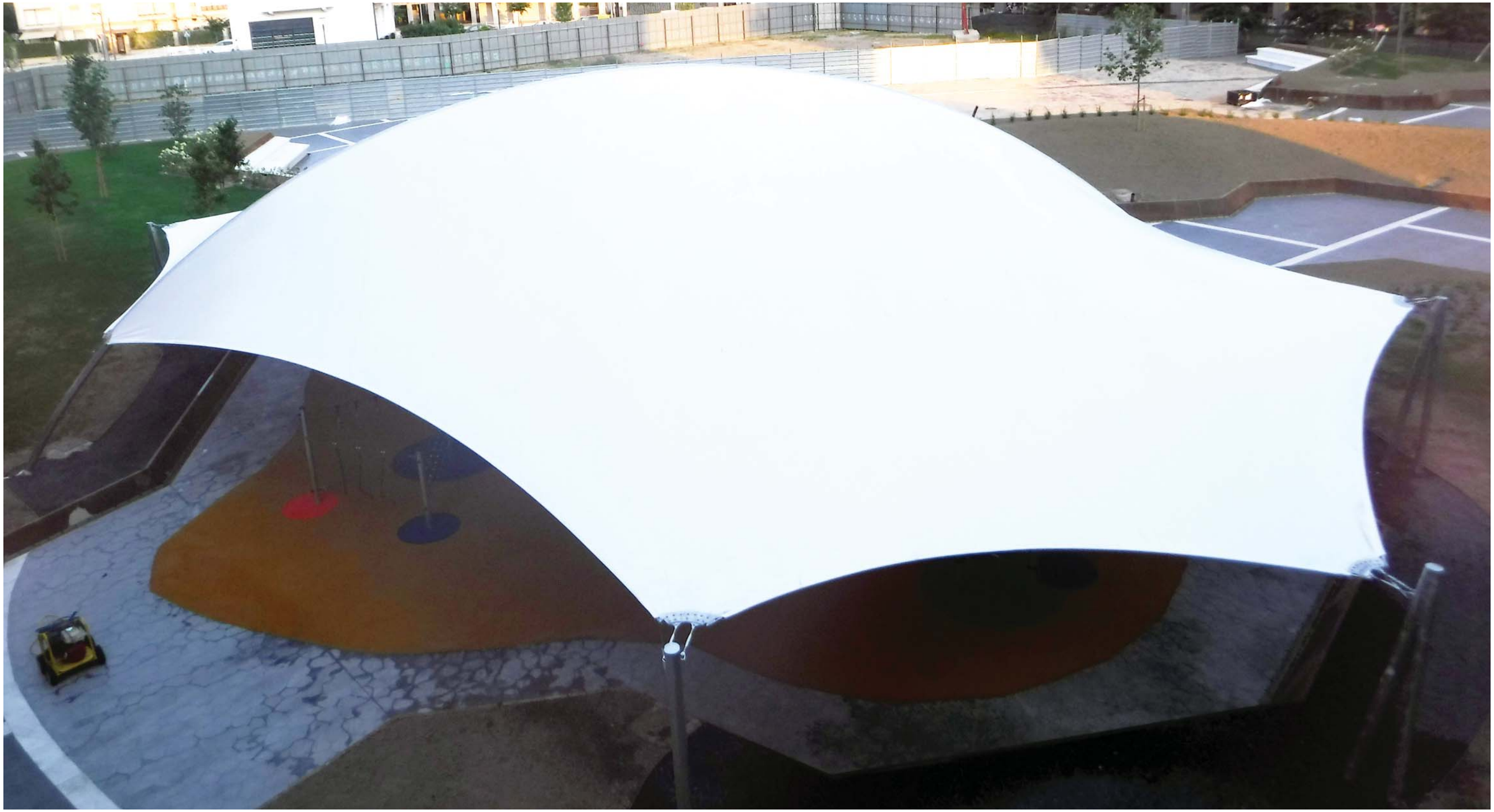
Erection Process

Installation

Playground Installation

Erection Process

Installation



Finished

Local Published

Local news online website

Reference Information

Reference Information

Membrane: Mehler VALMEX FR 1000 MEHATOP F, Type III (PVC) - PVDF Coated

MEHGIES
MEHLER • TEXNOLOGIES

Hoja Caracteristicas Tecnicas no.: **1012.9**

Producto **VALMEX®** FR 1000 MEHATOP F1 - type III

Articulo no.: 7269 5246

clase de recubrimiento y acabado				
Clase de recubrimiento	**PVC**			
Acabado	**Barniz PVDF multi-compuesto en ambas caras, cara exterior capa "primer" de dioxido de titanio (TiO2), tratamiento microbiocida, protegido contra los rayos UV, baja capilaridad (low-wick)**			
Comportamiento a la llama	**BS 7837, California T 19, DIN 4102: B1, CAN ULC S109, EN 13501-1: B-s2-d0, D.M. 26.06.84 (UNI 9177): CL. 2**			
ir a comportamiento a la llama	**Comprobar siempre la actualidad del certificado FR (ignifugo)**			
Peso total		**1050**	g/m²	EN ISO 2286-2
Resistencia rotura cadena/trama		**6000 / 5500**	N/50 mm	EN ISO 1421/V1
Resist. al desgarro urdimbre/trama		**900 / 800**	N	DIN 53363
Adherencia		**25**	N/cm	PA 09.03 (intern)
Resistencia al frio.		**-40**	°C	EN 1876-1
Resistencia al calor		**+70**	°C	PA 07.04 (intern)
Solidez a la luz		**>6**	Note, Value	EN ISO 105 B02
Resistencia al pandeo	sin roturas	**100000 x**		DIN 53359 A
tejido base				
Material		**PES Low Wick**		DIN EN ISO 2076
Hilo		**1670**	dtex	DIN EN ISO 2060
tejido		**P 2/2**		
Observaciones	**apto para soldar s/metódos habituales sin tratamiento previo, todos los datos tecnicos asi como TiO2 se refieren al color "blanco**			

Los datos tecnicos son valores aproximados, obtenidos a base de valores medios. Por razones técnicas puede haber ligeras variaciones durante la fabricación . Estas indicaciones corresponden a los conocimientos técnicos actuales y dan información sobre nuestros productos, sin vinculación jurídica. Estos datos son válidos para productos de nueva fabricación.

Progress through performance
A **Low&Bonar** solution

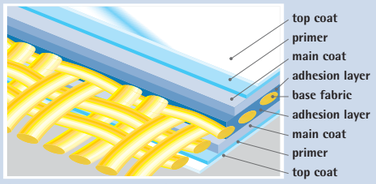
QM-071/3-08/00
EA/007-06/98

VL/LB:
Fecha 24.05.2017

Membrane: Mehler VALMEX FR 1000 MEHATOP F, Type III (PVC) - PVDF Coated

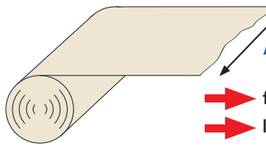
VALMEX® MEHATOP F

Mehler Texnologies' membrane **VALMEX® MEHATOP F** is a multi-layer composite material with special densely woven low-wick yarns in the base fabric. The surface lacquering, that includes PVDF lacquer (MEHATOP F) developed by Mehler Texnologies, finishes the material with a double top coat that has a protective and refining effect.

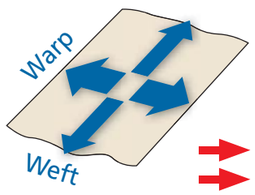


Schematic sectional drawing of
VALMEX® MEHATOP F

The advantages of VALMEX® MEHATOP F:



- fewer seams
- lower manufacturing costs



VARIO-STRETCH:
less stretch in warp direction than in weft direction

- lighter equipment
- shorter assembly times
- lower erecting costs

very flexible	easier handling
high strength	higher safety
lacquered both sides	more durable
high gloss	attractive appearance
no need to grind	directly weldable

Fabrics are certified by:

15 YEARS WARRANTY
CONDITIONS APPLY

Made in Germany

ALL COMPONENTS REACH COMPLIANT

MEHLER eco-care

Mehler Texnologies - around the world

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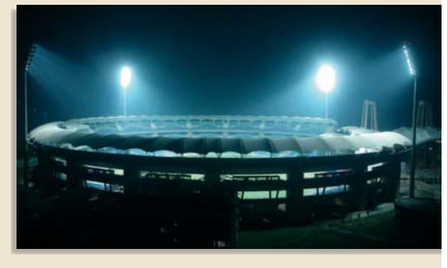
V3 14/08/2011



MEHLER TEXNOLOGIES

Membrane: Mehler VALMEX FR 1000 MEHATOP F, Type III (PVC) - PVDF Coated

VALMEX® MEHATOP F both sides PVDF lacquer

700 g/m²

VALMEX® FR 700 MEHATOP F, Type I

900 g/m²

VALMEX® FR 900 MEHATOP F, Type II

1050 g/m²

VALMEX® FR 1000 MEHATOP F, Type III

1350 g/m²

VALMEX® FR 1400 MEHATOP F, Type IV

1550 g/m²

VALMEX® FR 1600 MEHATOP F, Type V

VALMEX® MEHATOP F varieties

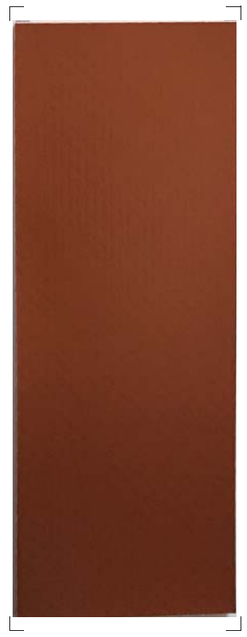
VALMEX® FR MEHATOP F, highly translucent

VALMEX® FR MEHATOP F, opak

VALMEX® MEHATOP M top side metallic lacquer

952 metallic gold

911 metallic silver



951 metallic bronce

All technical data stated are based on laboratory tests at average results and are provided as a source of information and do not constitute a warranty. Applications suggested here do not release customer to test material for its intended application. Colours are subject to slight variations. Always check the validity of fire certificate.

VALMEX® is recyclable.

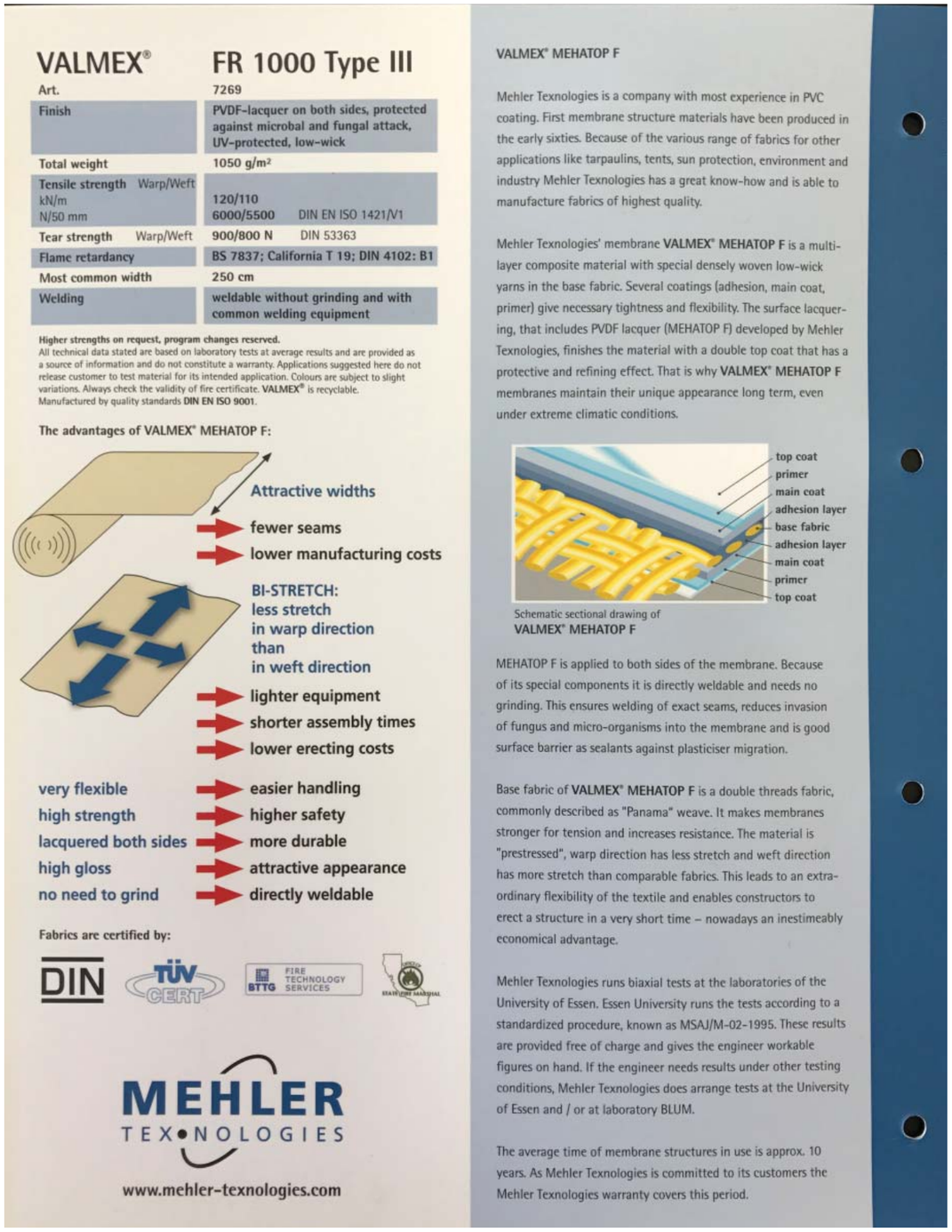
All products of our technical textiles are in accordance with the European **REACH** directive - **R**egistration, **E**valuation and **A**uthorisation of **Ch**emicals.

Manufactured in Germany under the internationally recognized standard of quality **DIN EN ISO 9001:2008**.

VALMEX® Art.	FR 700 Type I 7205	FR 900 Type II 7211	FR 1000 Type III 7269	FR 1400 Type IV 7270	FR 1600 Type V 7274
Finish	PVDF-lacquer on both sides, protected against microbial and fungal attack, UV-protected, low-wick				
Total weight	700 g/m²	900 g/m²	1050 g/m²	1350 g/m²	1550 g/m²
Tensile strength Warp/Weft kN/m N/50 mm DIN EN ISO 1421/V1	60/60 3000/3000	86/84 4300/4200	120/110 6000/5500	160/140 8000/7000	200/180 10000/9000
Tear strength Warp/Weft DIN 53363	300/300 N	500/500 N	900/800 N	1200/1200 N	2000/2000 N
Flame retardancy	BS 7837 California T 19 DM26.0684(UNI 9177)CL2 DIN 4102: B1 NFP 92507: M2 SIS 650082	BS 7837 California T 19 DIN 4102: B1	BS 7837 California T 19 DIN 4102: B1	BS 7837 California T 19 DIN 4102: B1	BS 7837 DIN 4102: B1
Most common width	250 cm	250 cm	250 cm	250 cm	250 cm
Welding	weldable without grinding and with common welding equipment				

Higher strengths on request, program changes reserved.

Membrane: Mehler VALMEX FR 1000 MEHATOP F, Type III (PVC) - PVDF Coated



VALMEX® FR 1000 Type III

Art.	7269
Finish	PVDF-lacquer on both sides, protected against microbal and fungal attack, UV-protected, low-wick
Total weight	1050 g/m²
Tensile strength Warp/Weft kN/m N/50 mm	120/110 6000/5500 DIN EN ISO 1421/V1
Tear strength Warp/Weft	900/800 N DIN 53363
Flame retardancy	BS 7837; California T 19; DIN 4102: B1
Most common width	250 cm
Welding	weldable without grinding and with common welding equipment

Higher strengths on request, program changes reserved.
All technical data stated are based on laboratory tests at average results and are provided as a source of information and do not constitute a warranty. Applications suggested here do not release customer to test material for its intended application. Colours are subject to slight variations. Always check the validity of fire certificate. **VALMEX®** is recyclable.
Manufactured by quality standards **DIN EN ISO 9001**.

The advantages of VALMEX® MEHATOP F:

Attractive widths
- fewer seams
- lower manufacturing costs

BI-STRETCH:
less stretch in warp direction than in weft direction
- lighter equipment
- shorter assembly times
- lower erecting costs

very flexible	easier handling
high strength	higher safety
lacquered both sides	more durable
high gloss	attractive appearance
no need to grind	directly weldable

Fabrics are certified by:

DIN · TÜV CERT · BTTG FIRE TECHNOLOGY SERVICES

MEHLER TEXNOLOGIES

www.mehler-texnologies.com

VALMEX® MEHATOP F

Mehler Texnologies is a company with most experience in PVC coating. First membrane structure materials have been produced in the early sixties. Because of the various range of fabrics for other applications like tarpaulins, tents, sun protection, environment and industry Mehler Texnologies has a great know-how and is able to manufacture fabrics of highest quality.

Mehler Texnologies' membrane **VALMEX® MEHATOP F** is a multi-layer composite material with special densely woven low-wick yarns in the base fabric. Several coatings (adhesion, main coat, primer) give necessary tightness and flexibility. The surface lacquering, that includes PVDF lacquer (MEHATOP F) developed by Mehler Texnologies, finishes the material with a double top coat that has a protective and refining effect. That is why **VALMEX® MEHATOP F** membranes maintain their unique appearance long term, even under extreme climatic conditions.

Schematic sectional drawing of
VALMEX® MEHATOP F

MEHATOP F is applied to both sides of the membrane. Because of its special components it is directly weldable and needs no grinding. This ensures welding of exact seams, reduces invasion of fungus and micro-organisms into the membrane and is good surface barrier as sealants against plasticiser migration.

Base fabric of **VALMEX® MEHATOP F** is a double threads fabric, commonly described as "Panama" weave. It makes membranes stronger for tension and increases resistance. The material is "prestressed", warp direction has less stretch and weft direction has more stretch than comparable fabrics. This leads to an extraordinary flexibility of the textile and enables constructors to erect a structure in a very short time – nowadays an inestimeably economical advantage.

Mehler Texnologies runs biaxial tests at the laboratories of the University of Essen. Essen University runs the tests according to a standardized procedure, known as MSAJ/M-02-1995. These results are provided free of charge and gives the engineer workable figures on hand. If the engineer needs results under other testing conditions, Mehler Texnologies does arrange tests at the University of Essen and / or at laboratory BLUM.

The average time of membrane structures in use is approx. 10 years. As Mehler Texnologies is committed to its customers the Mehler Texnologies warranty covers this period.

Tensor

Tenso Unitex Spain

C/Cargol, 8-12 P.I. El Coll de Montcada – 08110 Montcada i Reixac (Barcelona)
Tel. 93 575 02 62 Fax 93 564 59 00 www.tenso.es / www.unitex.org

UNITEX SPAIN, S.L.U. Inscrito en el Registro Mercantil de Barcelona, Tomo 42618, Folio 12, Hoja B-411870, Inscripción 1ª, al 31 de mayo de 2011. CIF ES-B65580334

Ref.	A	B	D	E	L cerrado	Rosca	l	d	F
116105	6	8	5	80	121	M-5	41	3	2,5
116106	7,5	9	6	95	144	M-6	52	4	3,5
116108	10	11	8,5	105	161	M-8	60	5	3,5
116110	12	13	9,5	125	195	M-10	70	6	4,5
116112	13	20	12	150	244	M-12	85	7	5
116114	14	21	13	165	272	M-14	90	7	5
116116	16	26	16	190	326	M-16	105	8	5,5
116120	20	30	19	210	334	M-20	115	9	5,5
116122	24	36	22	255	425	M-22	135	10	7,5
116124	25	59	25	280	500	M-24	155	10,5	5,5