



“DEVELOPMENT OF TENSILE STRUCTURE PARKING COVER PROJECT”

Master-Thesis

Master Membrane Structures

submitted to

Anhalt University of Applied Sciences

Faculty of Architecture

by

SAMUEL ALEJANDRO CARRILLO GARCIA

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Matrikel number

4061565

Submission date:

First Tutor: ROBERT OFF

Second Tutor: GUSTAVO RAMIREZ LARES



THE CLIENT

Minera Fresnillo S.A. de C.V. is an important Company in the world of mining, their location being Madero Community in Zacatecas, Zacatecas, Mexico. The company has a philosophy strongly related to environmental awareness, which translates in the development of various projects involving the use of sustainable, ecological materials. This vision led the company to choose the use of tensile structures.

- ▶ The client was not aware of the characteristics of membranes, which provided an opportunity to discuss their advantages in depth, finally proposing PVC fabrics because of their resistance to drastic weather changes and the protection they provide from sunlight. This last characteristic was of great interest to the client given that the parking area is also used as a gathering space for events and meetings.



LOCATION OF PROJECT



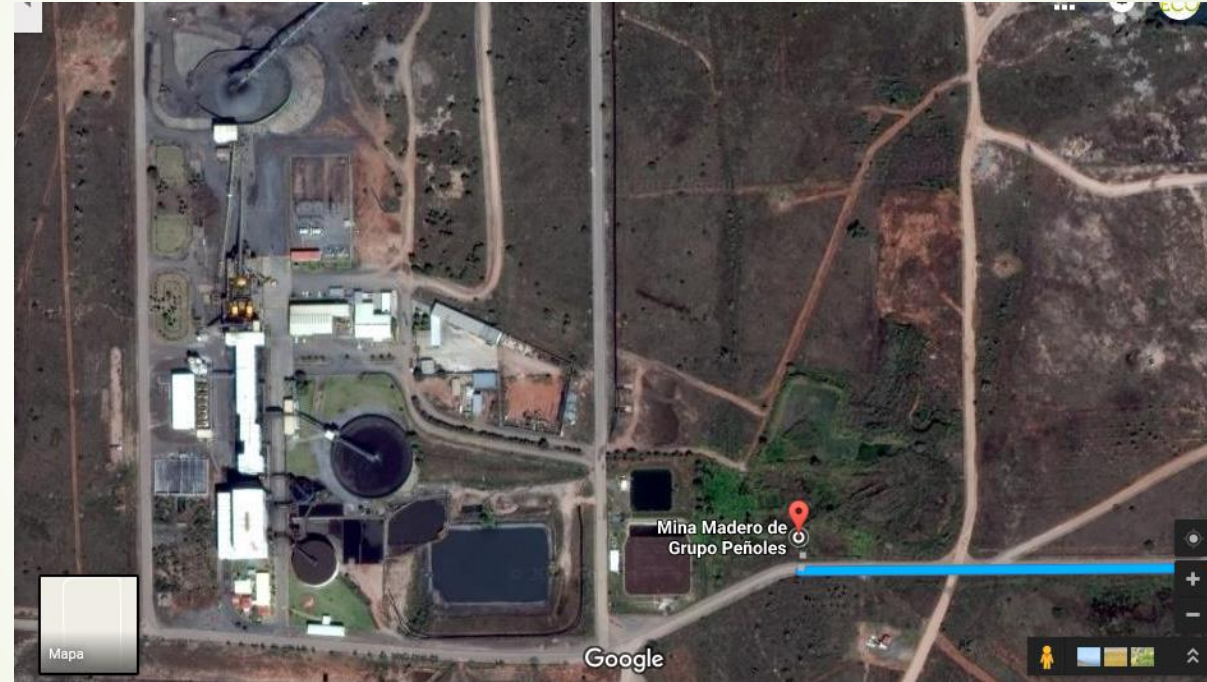


LOCATION OF PROJECT



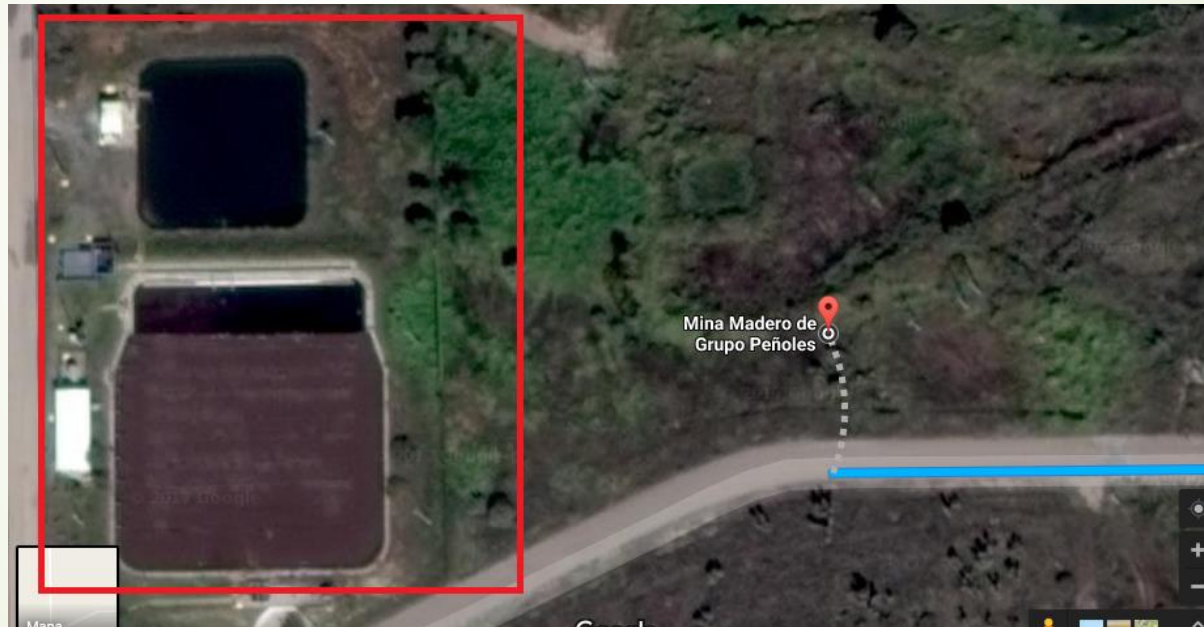


LOCATION OF PROJECT



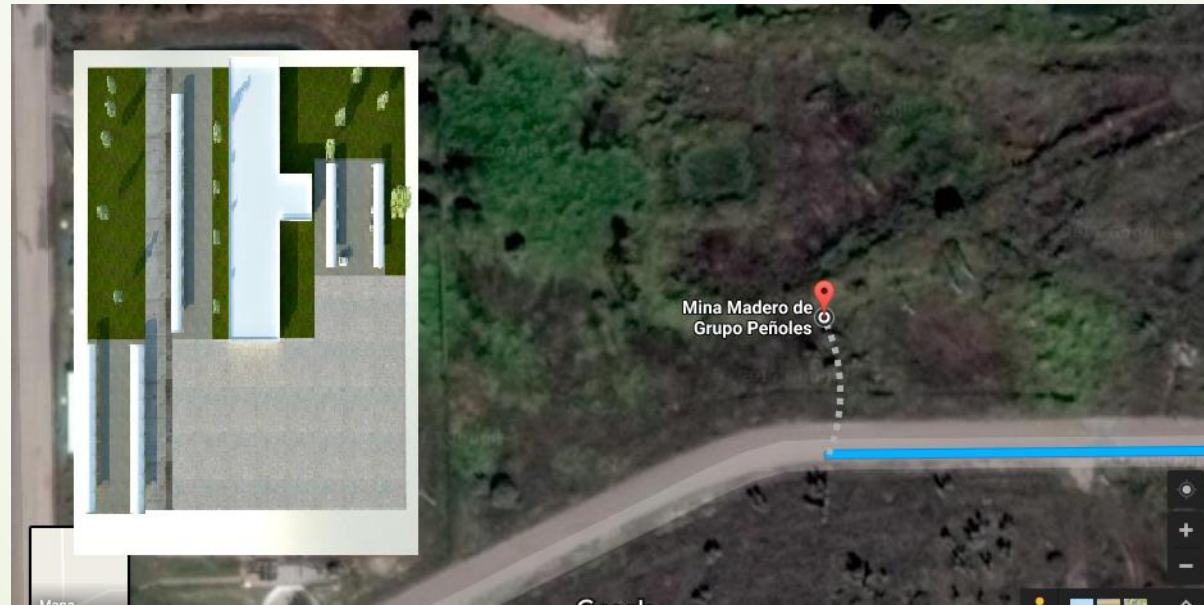


LOCATION OF PROJECT





LOCATION OF PROJECT





PROJECT PROPOSAL

- ▶ Two different options with different shapes were proposed for the parking area. This space has 46 places for cars, divided in three sections:
 - ▶ Management 1 has 12 places assigned
 - ▶ Management 2 has 14 places assigned
 - ▶ Workers have 20 places assigned
- ▶ Each parking space is 3 x 6 m, approximately, making the project area a total of 828 sqm. In the present thesis, the first stage, "MANAGEMENT 2" parking project, will be developed, providing the results of this stage at the end of it.



CONTENT OF MASTER THESIS

- ▶ The content of this master thesis will include:
- ▶ Proposal of two shapes
- ▶ The form finding of the ARCH SHAPE.
- ▶ The calculate of the membrane in the option that the client choosen for known the reactions for the steel structure and the foundation.
- ▶ The patterning only the shape that the client choosen
- ▶ The detailing of the corners, cables, and all connections pieces with the shape that the client choosen.
- ▶ Cost analysis.
- ▶ The project management and how sold the project to the client.
- ▶ Conclusions.



PROPOSAL OF TWO SHAPES

- ▶ The reason for proposing two shapes is comparing cost, functionality and maintenance. The choice made by the client for the arch shape was mainly influenced by its simplicity, lower cost and minor maintenance.
- ▶ The functionality of this option is heightened due to the absence of obstructing columns in the middle of the area, element required for the hyper shape, thus highly inclining the client towards the selection of the arch shape.



PROPOSAL OF TWO SHAPES

- ▶ Entirely conscious of the fact that the client must know the advantages and disadvantages of the given materials, thorough information was provided. In this case, the client chose the fabric for his project based on numerous reasons, them being:
- ▶ THERMIC PROPERTIES
- ▶ ACUSTIC PROPERTIES
- ▶ VISUAL APPEAL AND LOWER PRICE
- ▶ SHORTER INSTALLATING PERIOD
- ▶ MINIMIUM MAINTENANCE
- ▶ FREE FORM



PROPOSAL OF TWO SHAPES

- ▶ For a more successful sale of the project, different renders were exhibited, serving as an accurate reference for appearance once the project was finalized. The renders exposed to the client are shown below:



PROPOSAL OF TWO SHAPES: ARCH





PROPOSAL OF TWO SHAPES: ARCH





PROPOSAL OF TWO SHAPES: ARCH





PROPOSAL OF TWO SHAPES: ARCH



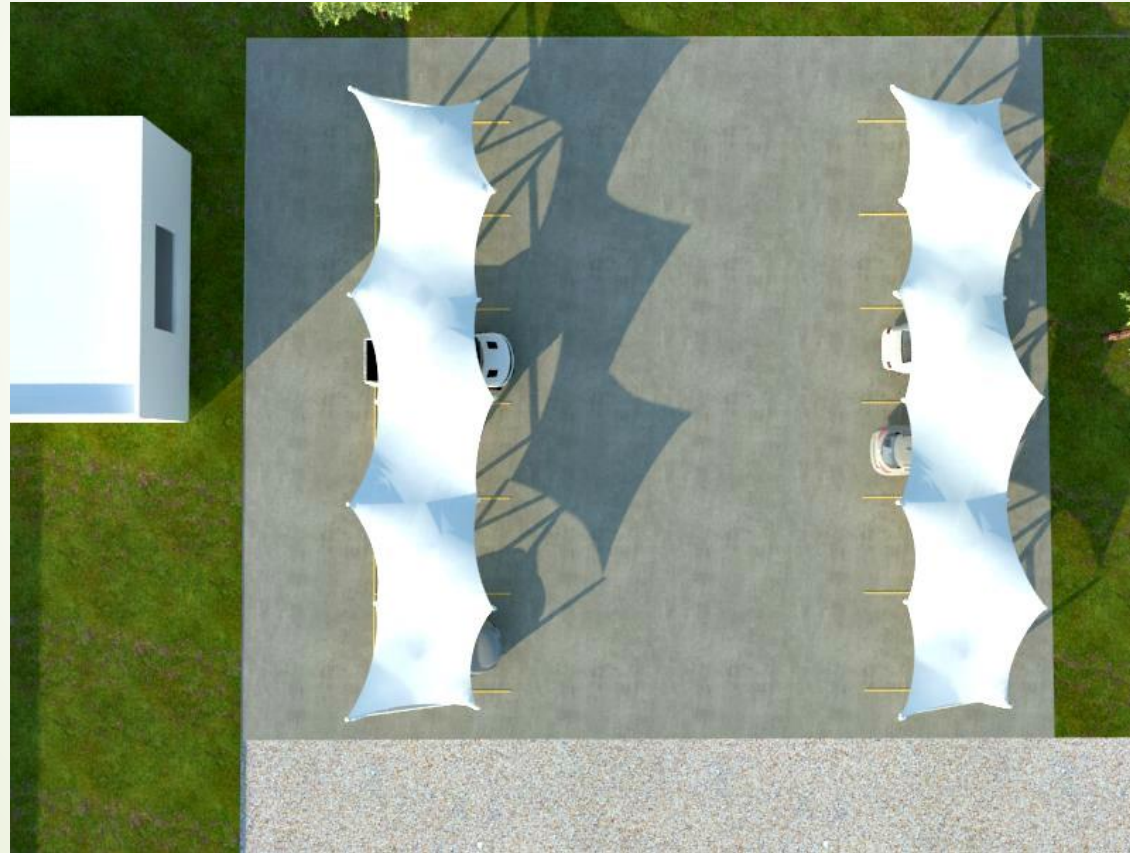


PROPOSAL OF TWO SHAPES: HYPAR



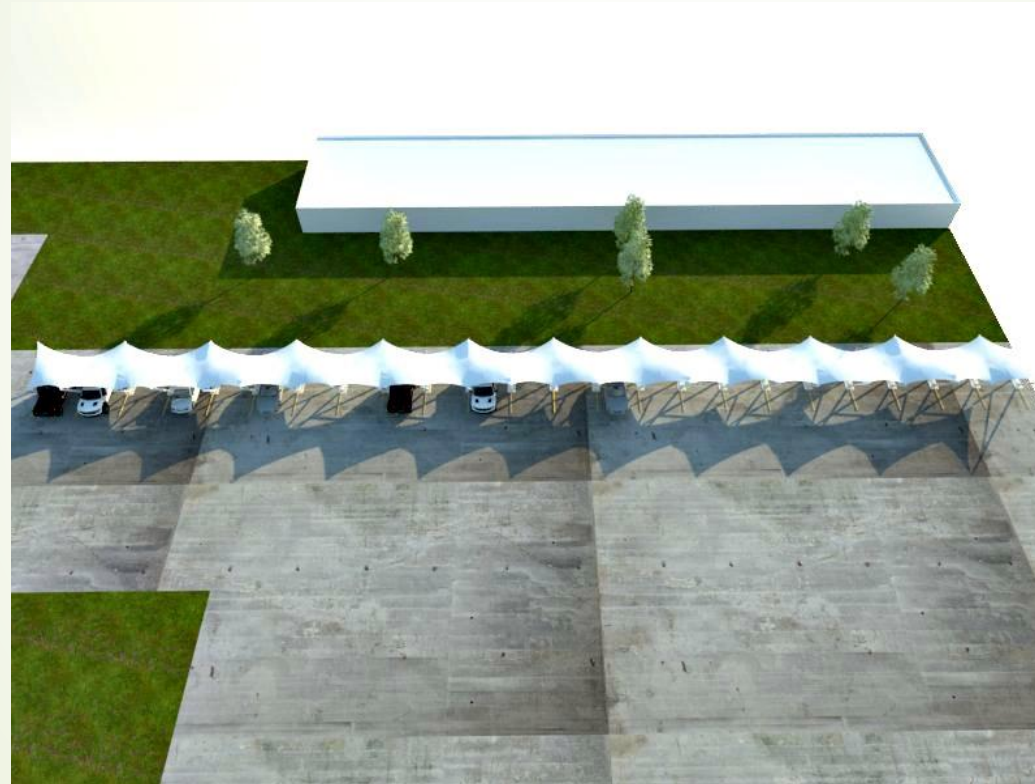


PROPOSAL OF TWO SHAPES: HYPAR





PROPOSAL OF TWO SHAPES: HYPAR



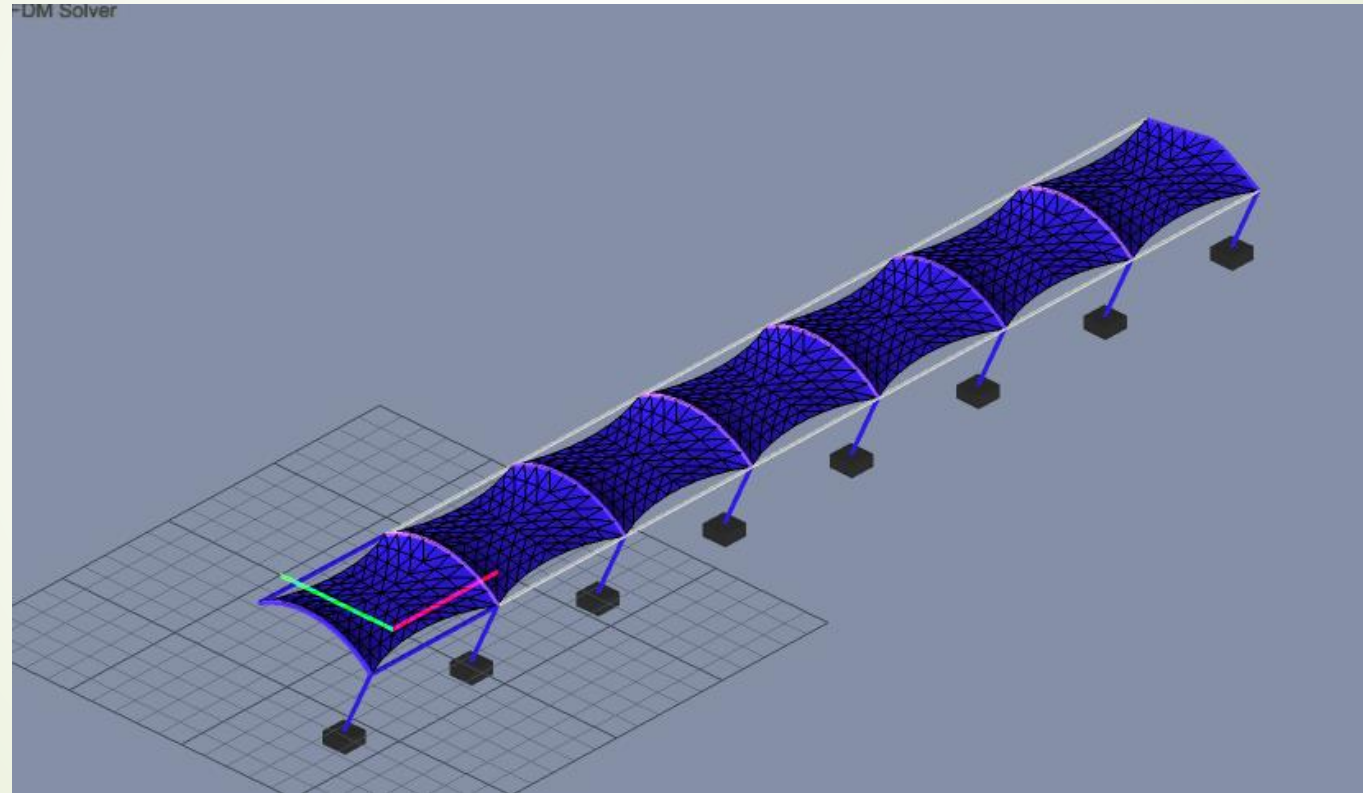


PROPOSAL OF TWO SHAPES: HYPAR



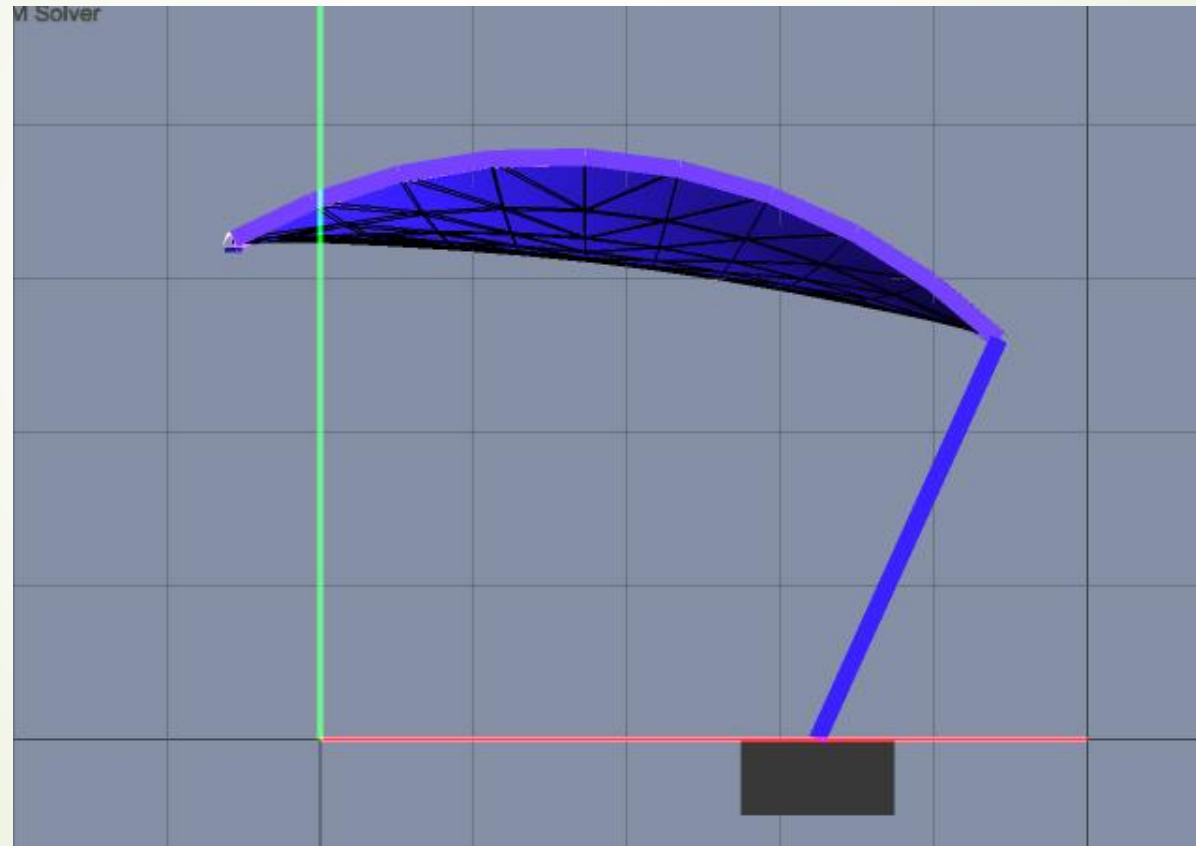


FORMFINDING



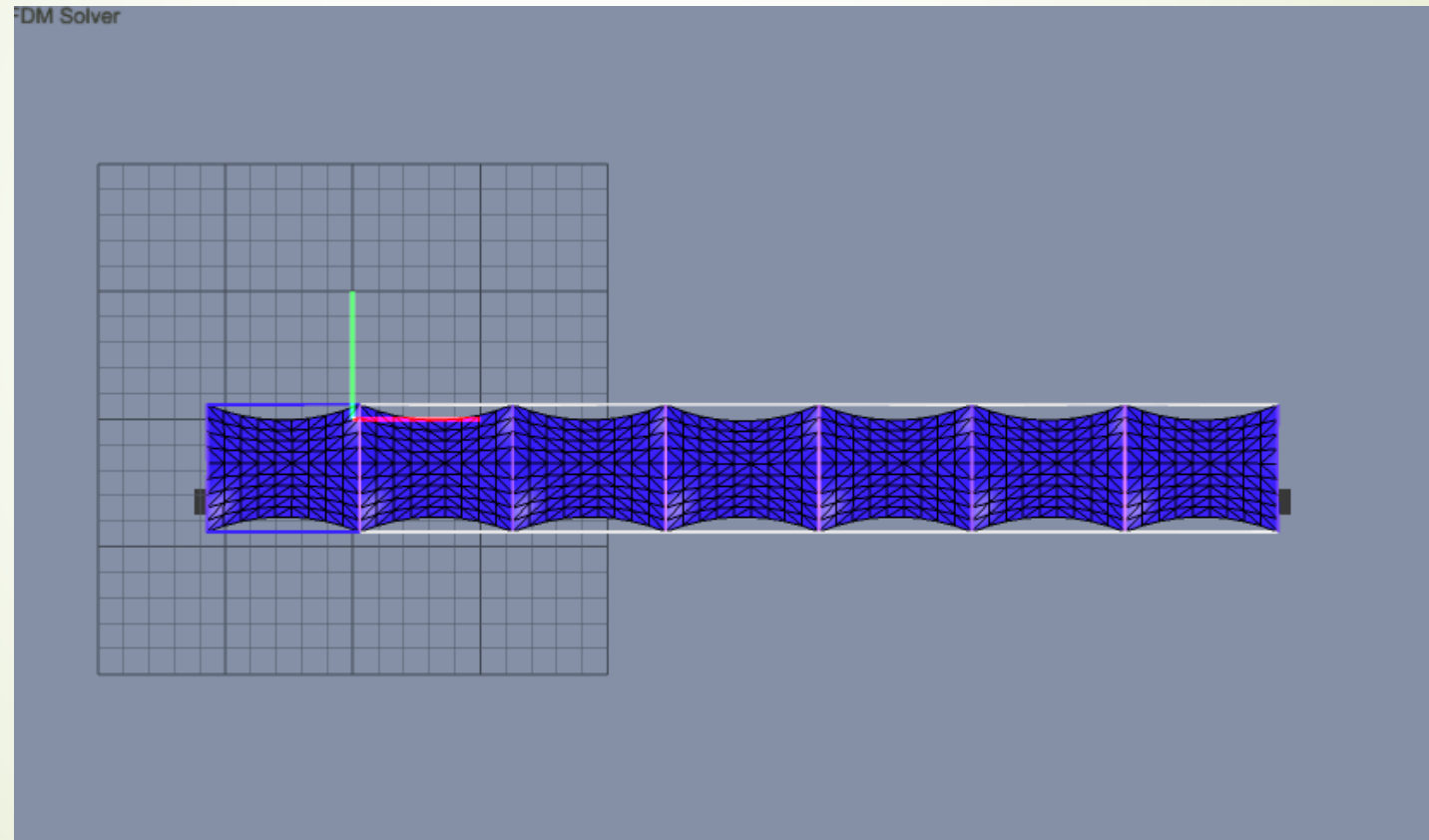


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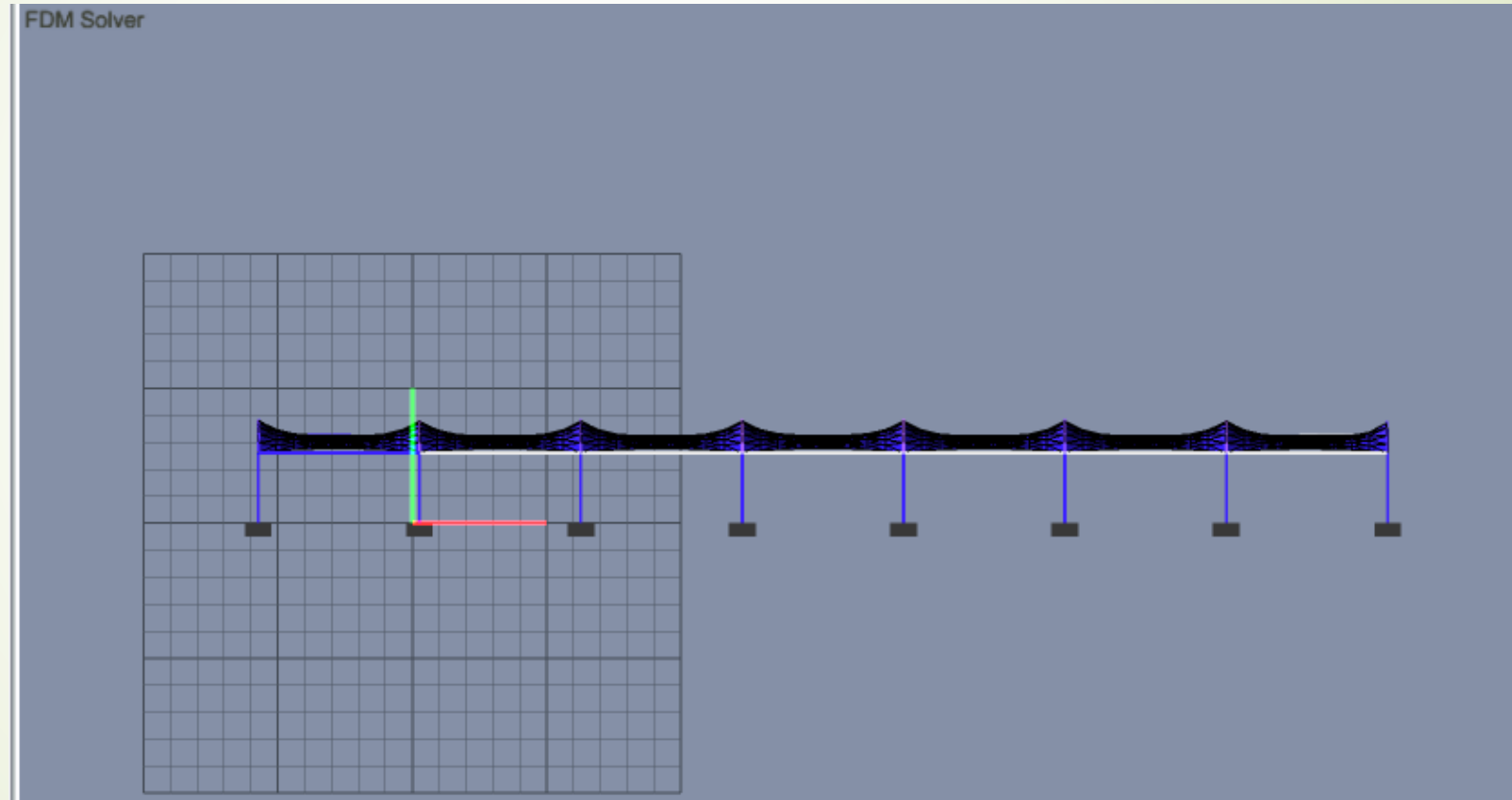


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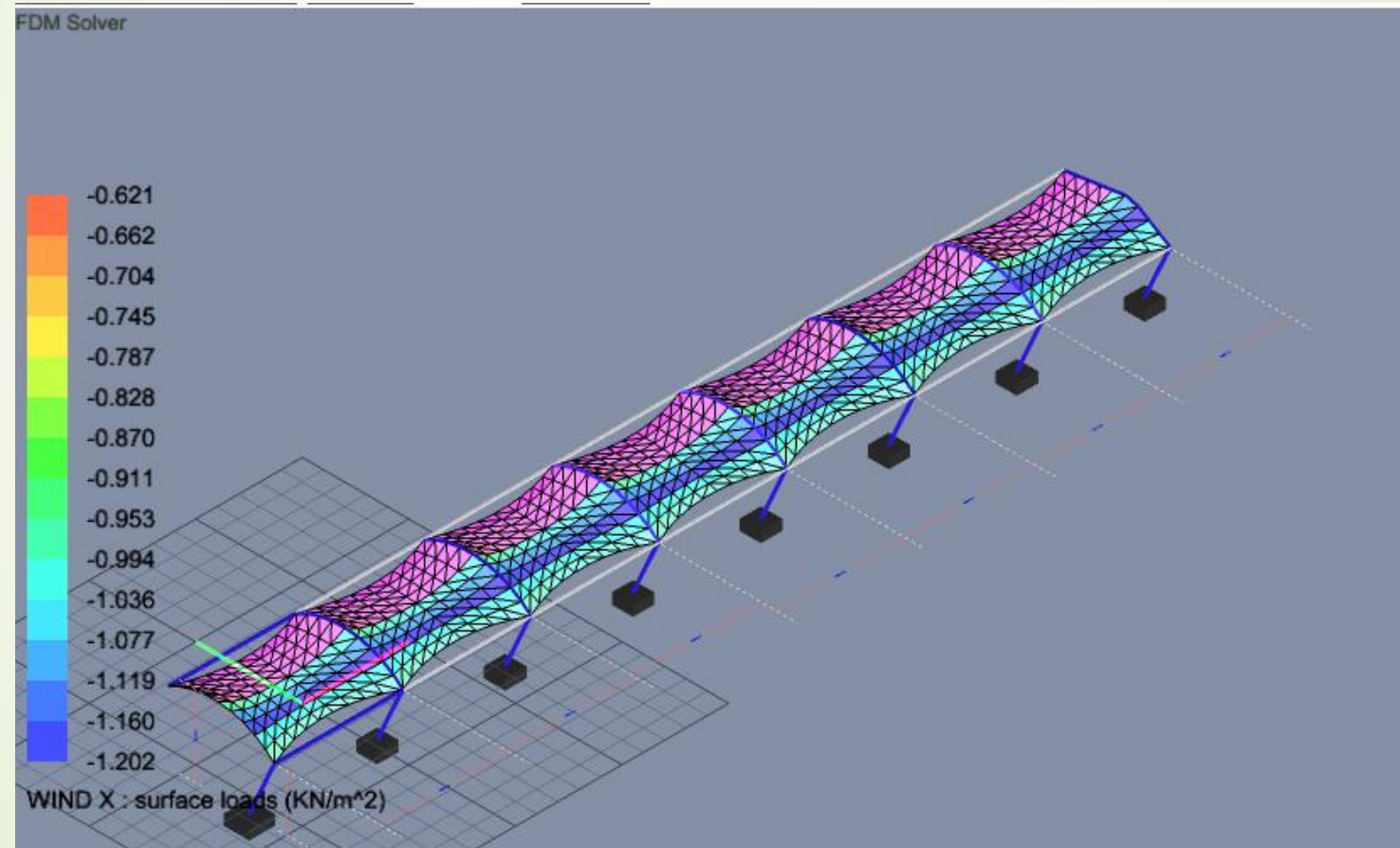


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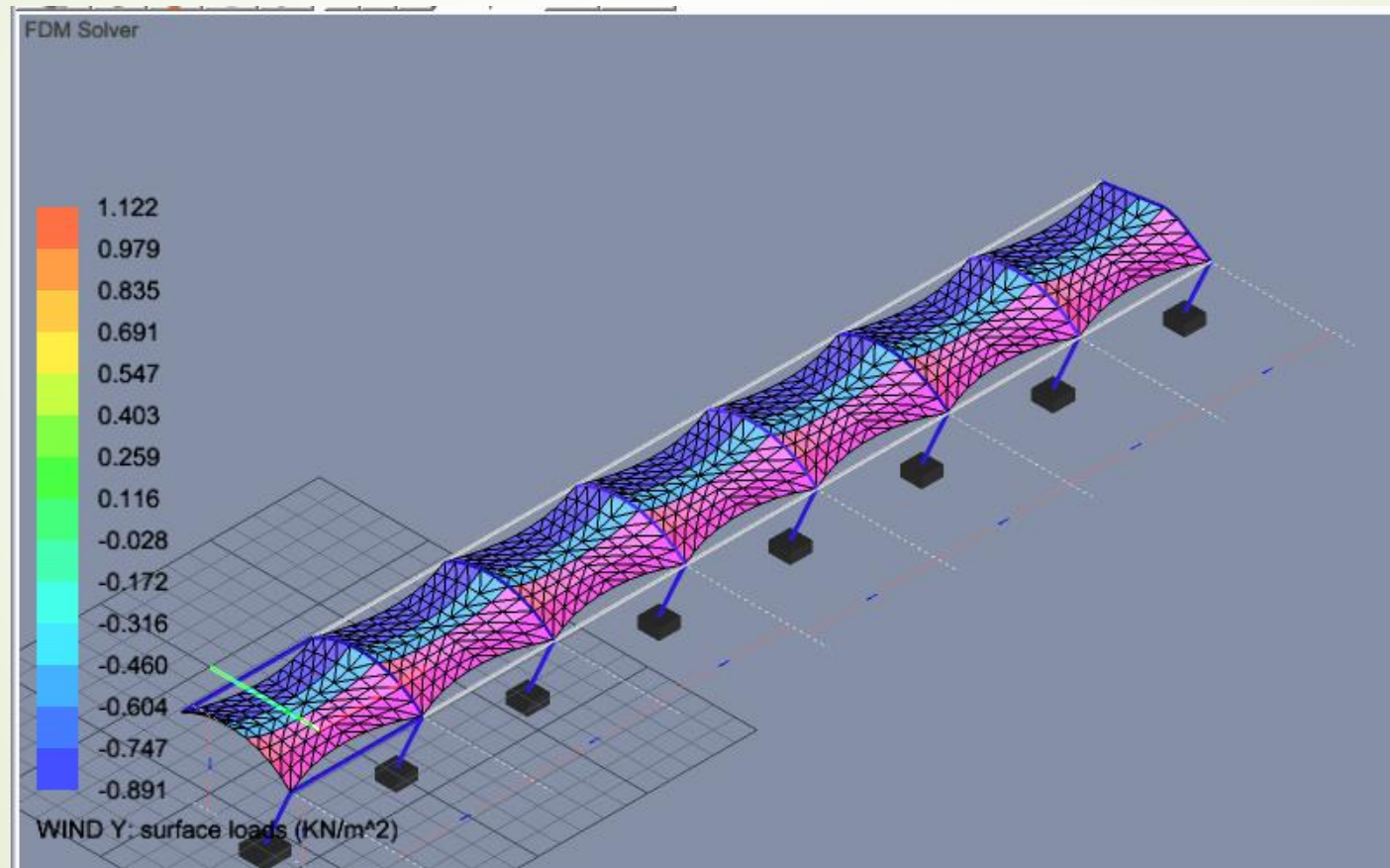


SURFACE LOADS WIND X



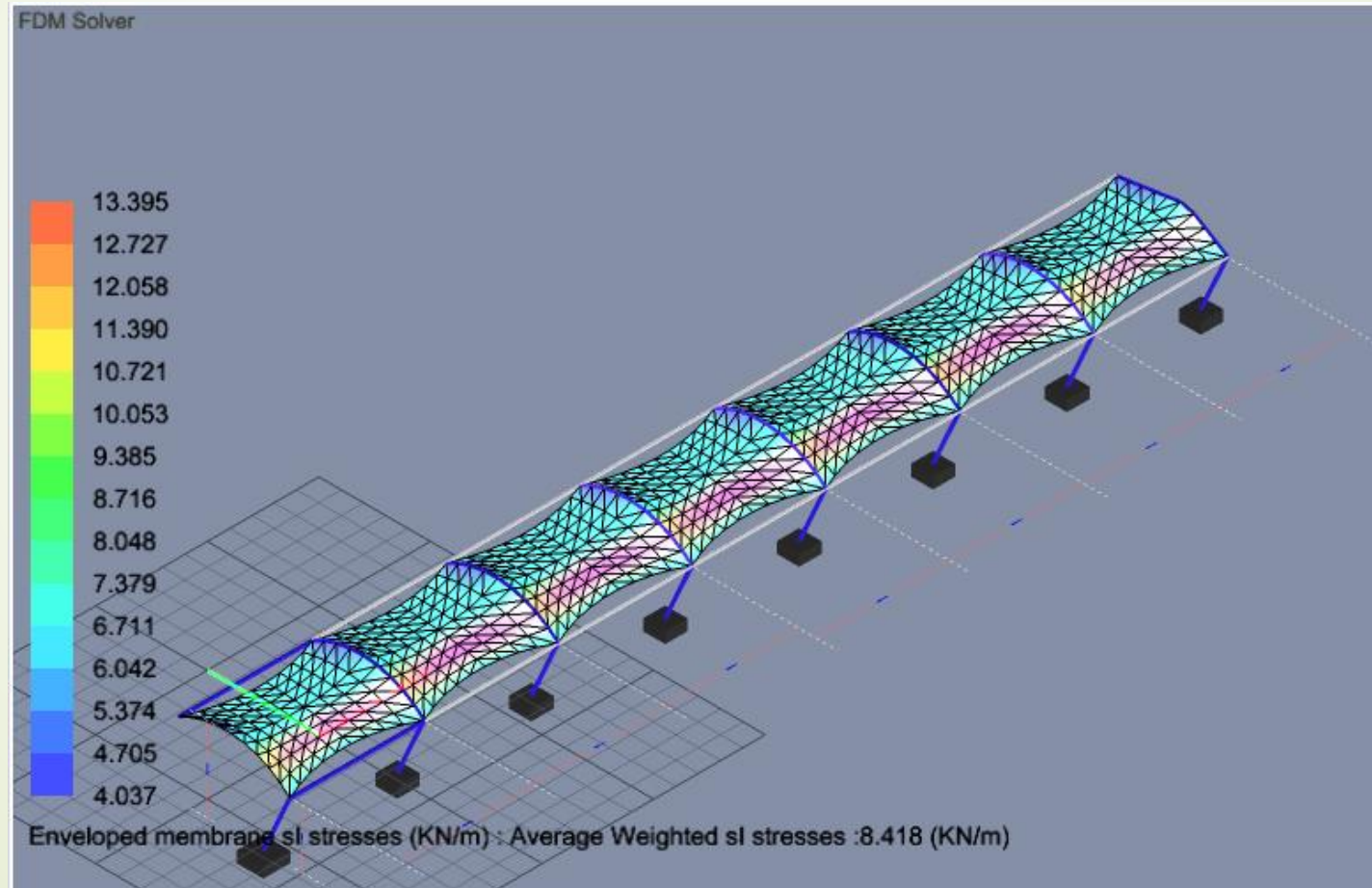


SURFACE LOADS WIND Y





Enveloped membrane stresses: 8.418 kn/m





CABLES AND TENSORS

- ▶ In the edge cables, the maximum force is 54.54 KN, due to this result, the following materials were proposed:
 - ▶ High resistance cable 6 x 36ws; 9.5 mm or 3/8" with 0.377 kg/m linear density.
 - ▶ 3/4" tensor with 2.36 ton of force. This because in the corner areas the maximum forces are 14KN, which, per the information chart provided below, are well endured by the tensor.



CABLES:

CABLE DE CONSTRUCCION PARA USO GENERAL: 6 x 36WS



6 x 36WS

Construcción
 del cordón:
 1+7+7/7+14

Diám. nom. mm	Peso		180 kg/mm ²				200 kg/mm ²			
	AT	AA	AT		AA		AT		AA	
	kg/100m	kg/100m	kN	kgf	kN	kgf	kN	kgf	kN	kgf
9,5	34,3	37,7	52,6	5370	56,3	5700	64,6	6600	69,8	7100
11	45,9	50,6	70,6	7200	75,5	7700	77,9	7900	86,5	8800
13	64,3	70,7	98,3	10000	106	10800	109	11100	118	12000
14	74,5	82	114	11600	124	12600	127	12900	137	13900
16	97,3	107	149	15200	161	16400	166	16900	179	18200
18	123	135	189	19200	204	20800	209	21300	226	23000
19	137	150	211	21500	227	23100	233	23800	252	25700
20	152	167	234	23800	252	25600	259	26400	279	28400
22	184	202	282	28700	304	31000	313	31900	338	34500
24	219	241	336	34200	363	36900	372	37900	402	41000
26	257	283	395	40100	425	43300	437	44600	472	48100
28	298	328	458	46600	493	50300	507	51700	547	55800
30	342	376	526	53600	566	57700	544	55500	587	59900
32	389	428	598	60800	644	65700	662	67500	715	72900
35	466	512	715	72900	771	78600	792	80800	852	86900
36	493	542	757	77000	816	83100	838	85500	907	92500
38	549	604	843	86000	887	90500	934	95300	1010	103000



TENSORS:

Tensores Green Pin® Horquilla - Horquilla con pasador de retención

Generalmente según ASTM F1145-92

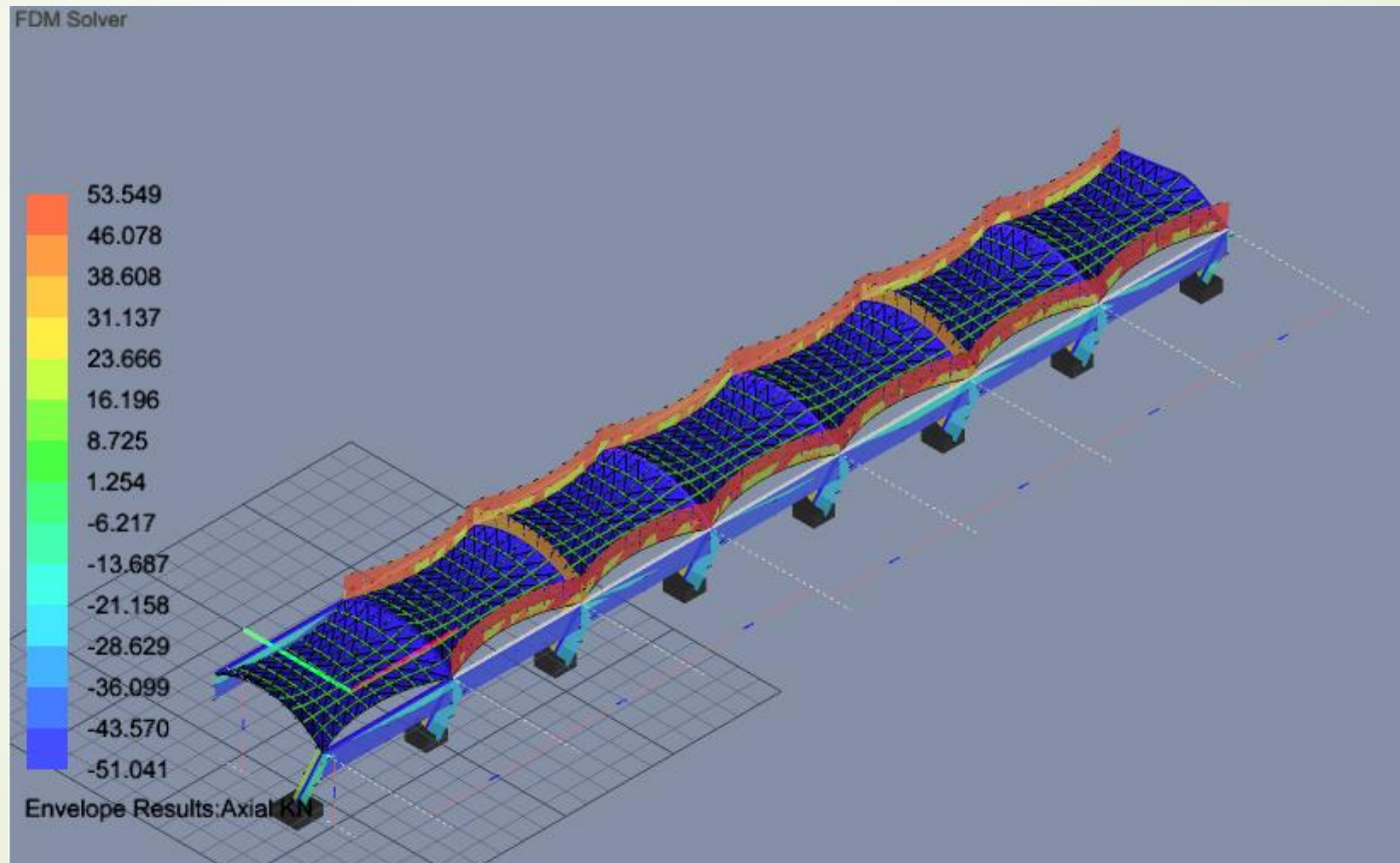


- Material : acero de alta resistencia forjado SAE 1035 o 1045
- Factor de Seguridad : CMR = 5 x CMT
- Norma : Generalmente según ASTM F1145-92
Anillos U.S. Fed. Spec. FF-T-791b
- Acabado : galvanizado en caliente
- Certificación : **21 22 31**

carga máxima de trabajo	diámetro rosca	capacidad de abertura	longitud posición cerrada	longitud posición abierta	longitud posición cerrada	abertura horquilla	longitud interior	diámetro pasador	espesor ojo horquilla	diámetro ojo horquilla	peso unidad
tons.	pulgada	pulgada	pulgada	pulgada	pulgada	pulgada	pulgada	pulgada	pulgada	pulgada	lbs
2.36	3/4	6	14 1/2	19 3/16	17 1/2	1 1/2	1 1/2	5/8	5/8	1 1/2	5.71
2.36	3/4	9	17 1/2	25 3/16	20 1/4	1 1/2	1 1/2	5/8	5/8	1 1/2	6.90
2.36	3/4	12	20 1/2	31 5/16	23 1/4	1 1/2	1 1/2	5/8	5/8	1 1/2	7.54
2.36	3/4	18	26 1/2	43 1/2	29 1/2	1 1/2	1 1/2	5/8	5/8	1 1/2	9.94
3.27	7/8	12	22 3/2	32 1/2	25 1/2	1 3/2	1 1/2	3/4	3/4	1 3/2	10.87
3.27	7/8	18	28 1/2	44 3/16	31 3/2	1 3/2	1 1/2	3/4	3/4	1 3/2	14.13
4.54	1	6	17 1/2	21 3/16	20 3/16	1 1/4	1 3/2	7/8	3/2	2 1/2	11.42
4.54	1	12	23 3/16	33 3/16	26 1/2	1 1/4	1 3/2	7/8	3/2	2 1/2	14.18
4.54	1	18	29 1/2	46	32 1/2	1 1/4	1 3/2	7/8	3/2	2 1/2	18.52
4.5	1	24	35 3/16	57 1/2	38 3/16	1 1/4	1 3/2	7/8	3/2	2 1/2	19.62
6.9	1 1/4	12	25 1/4	35 1/2	29 1/2	1 3/4	2 3/2	1 1/2	1 1/2	2 1/2	24.7
6.9	1 1/4	18	31 1/2	48 1/2	35 3/16	1 3/4	2 3/2	1 1/2	1 1/2	2 1/2	30.0
6.9	1 1/4	24	37 1/2	60 3/2	42 3/2	1 3/4	2 3/2	1 1/2	1 1/2	2 1/2	33.1
9.71	1 1/2	12	26 3/16	37 3/2	31 3/4	2 1/2	2 3/2	1 3/4	1 1/2	3 1/2	37.5
9.71	1 1/2	18	32 1/2	48 1/2	37 1/2	2 1/2	2 3/2	1 3/4	1 1/2	3 1/2	42.5
9.71	1 1/2	24	38 3/2	61 1/16	43 3/4	2 1/2	2 3/2	1 3/4	1 1/2	3 1/2	45.6
12.7	1 3/4	18	36 3/2	51 3/16	43	2 1/2	3 3/4	1 3/4	1 1/2	3 3/16	55.1
12.7	1 3/4	24	42 1/2	63 3/16	48 3/16	2 1/2	3 3/4	1 3/4	1 1/2	3 3/16	63.3
16.8	2	24	45 1/16	65 3/2	52 1/16	2 1/2	3 1/2	2	1 3/2	4 3/16	100.1
27.2	2 1/2	24	49 3/16	72 3/2	58 3/2	2 1/2	4 1/2	2 1/4	1 3/2	5 1/2	194.0
34	2 3/4	24	53 3/2	74 3/2	63 1/2	3 3/16	4 1/2	2 3/4	1 3/2	6 3/16	216.1

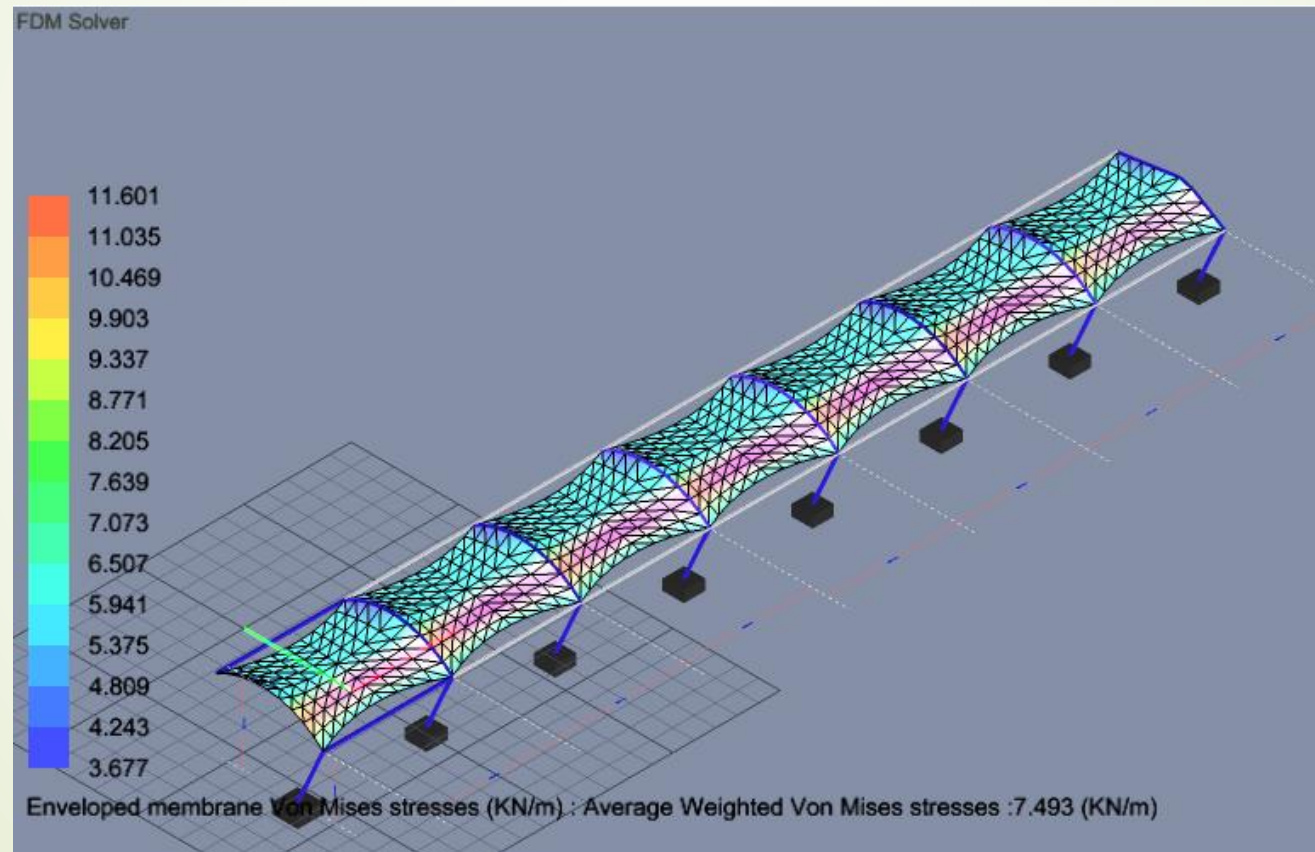


AXIAL FORCES





VON MISES STRESSES: 7.493KN/M



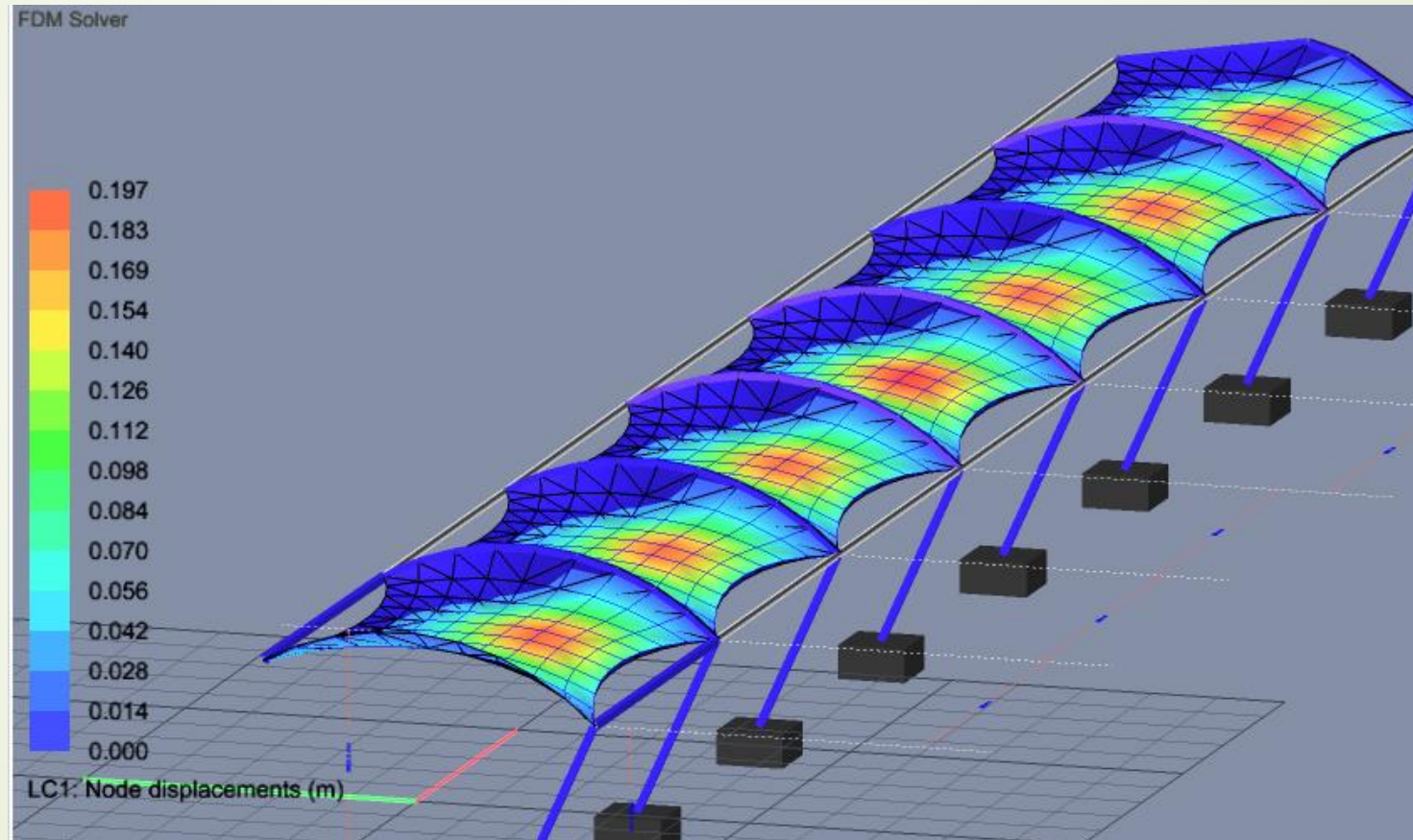


DISPLACEMENTS

- The input data for IXCUBE was:
- Wind speed: 118.8 km/h
- Load wind factor: 1.4

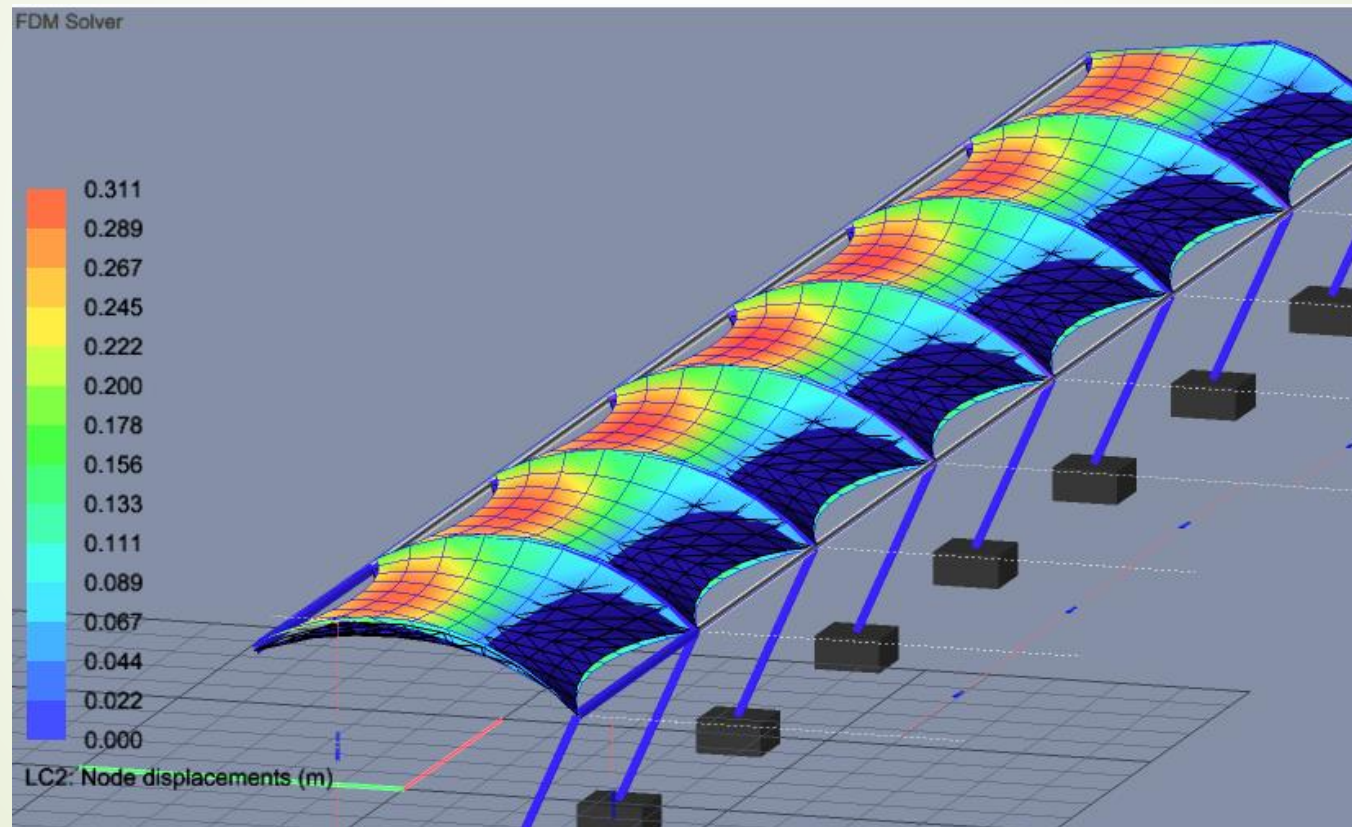


LC1: BACK SIDE PRESSURE UNDER MEMBRANE



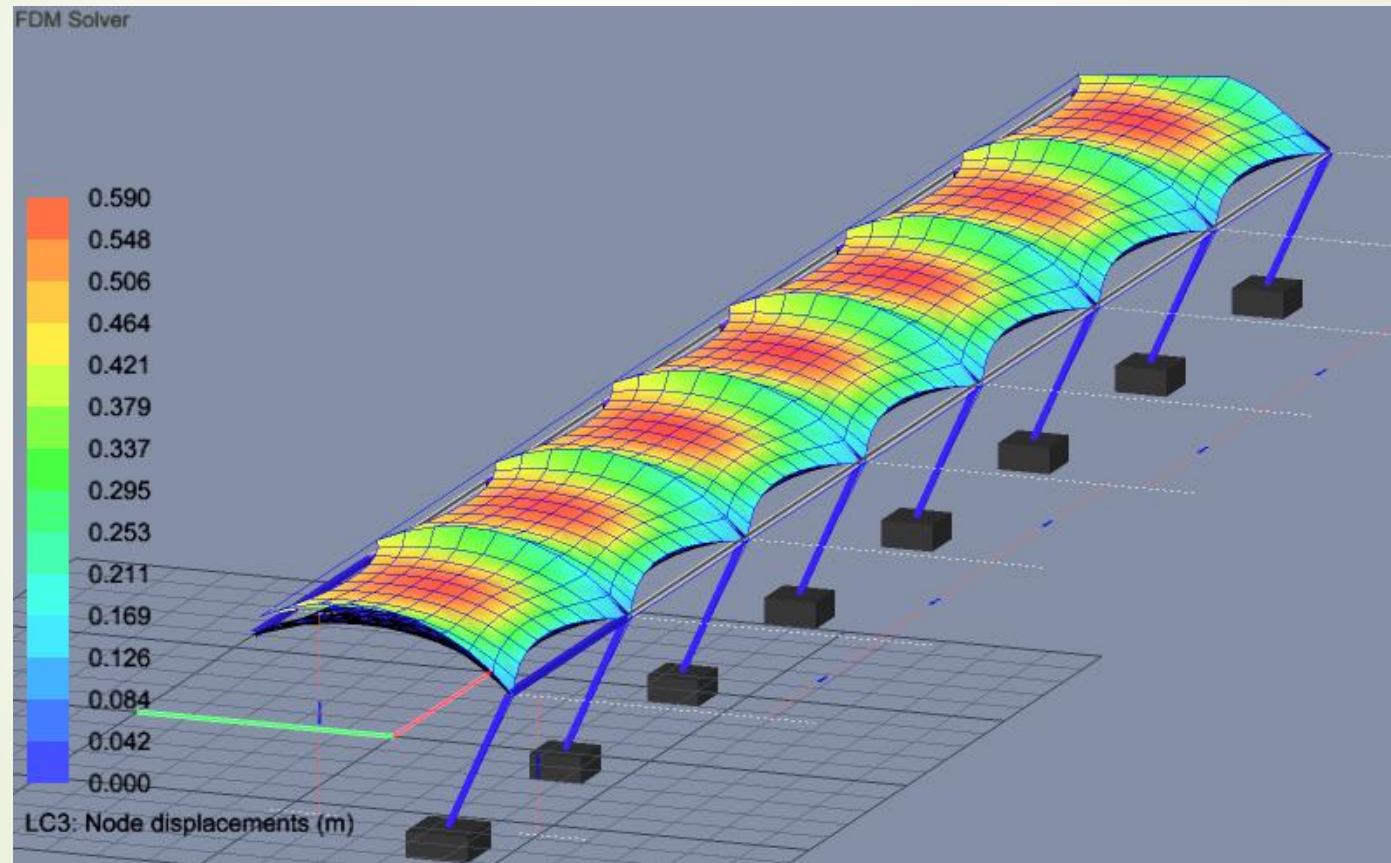


LC2: FRONT MEMBRANE UNDER PRESSURE



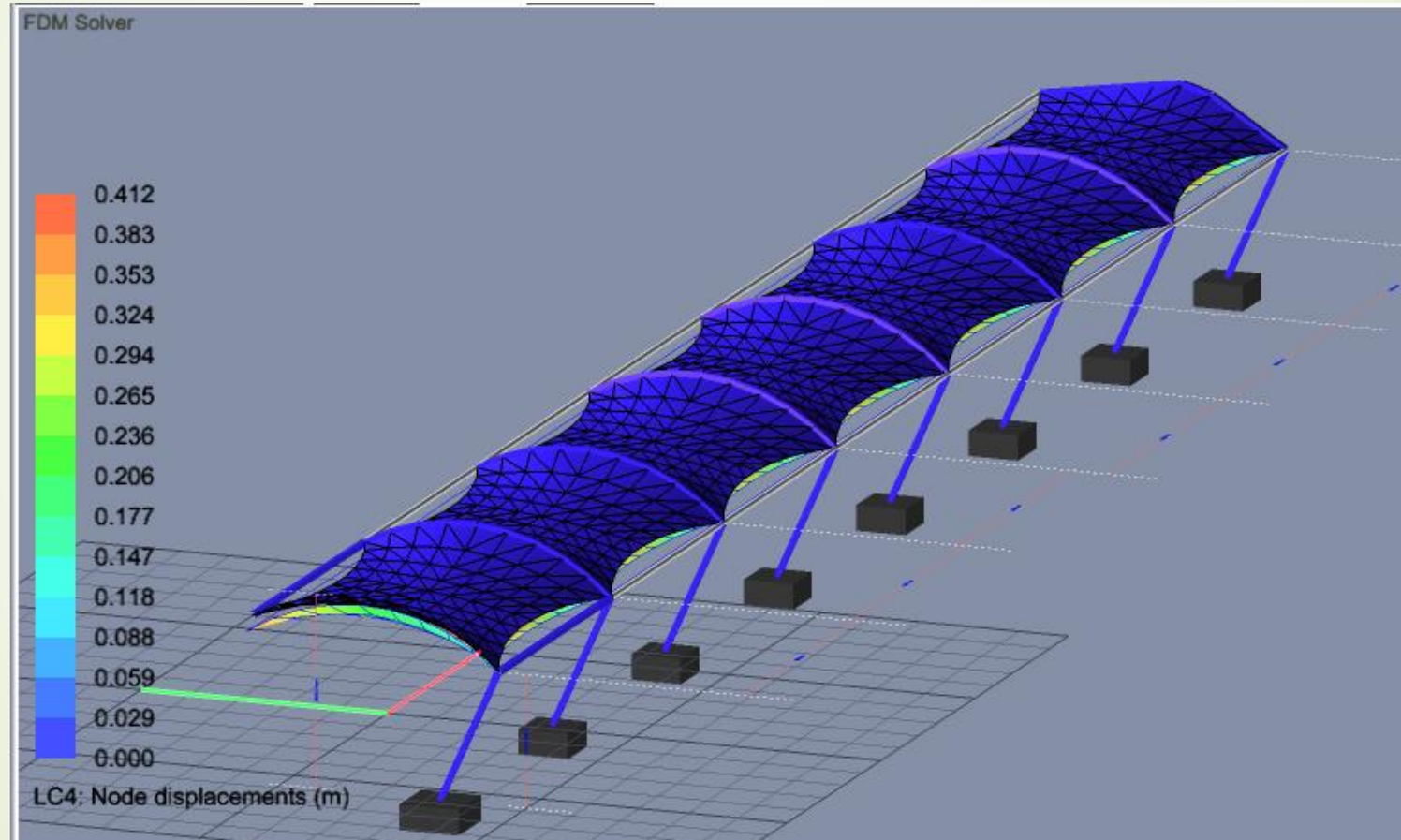


LC3: MEMBRANE UNDER PRESSURE



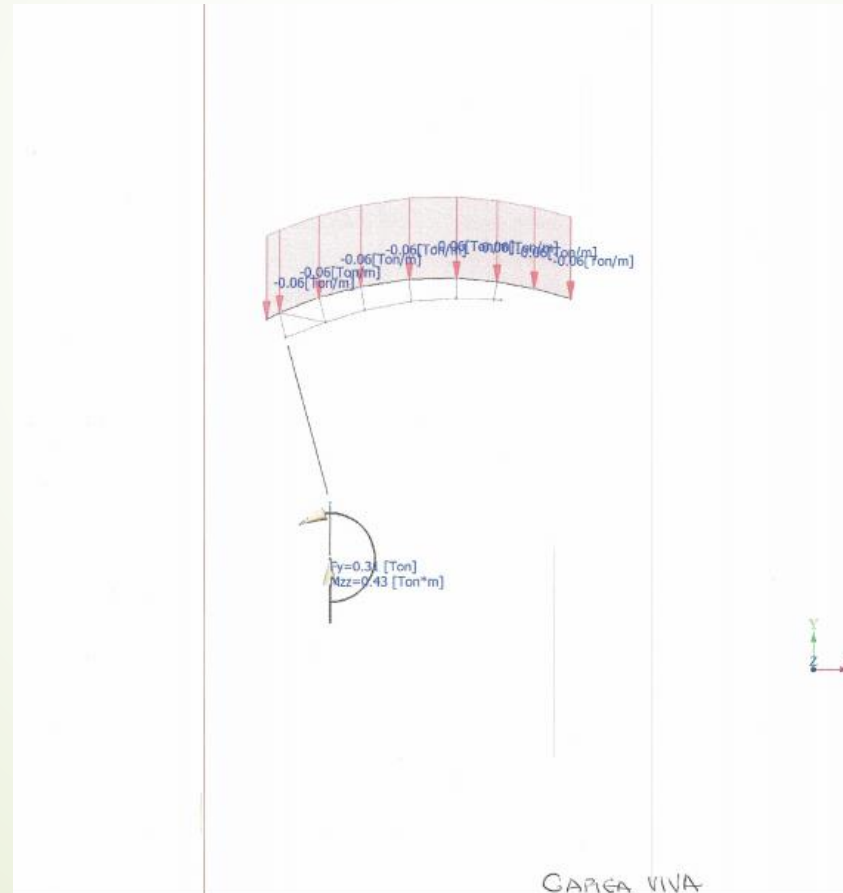


LC4: MEMBRANE UP PRESSURE



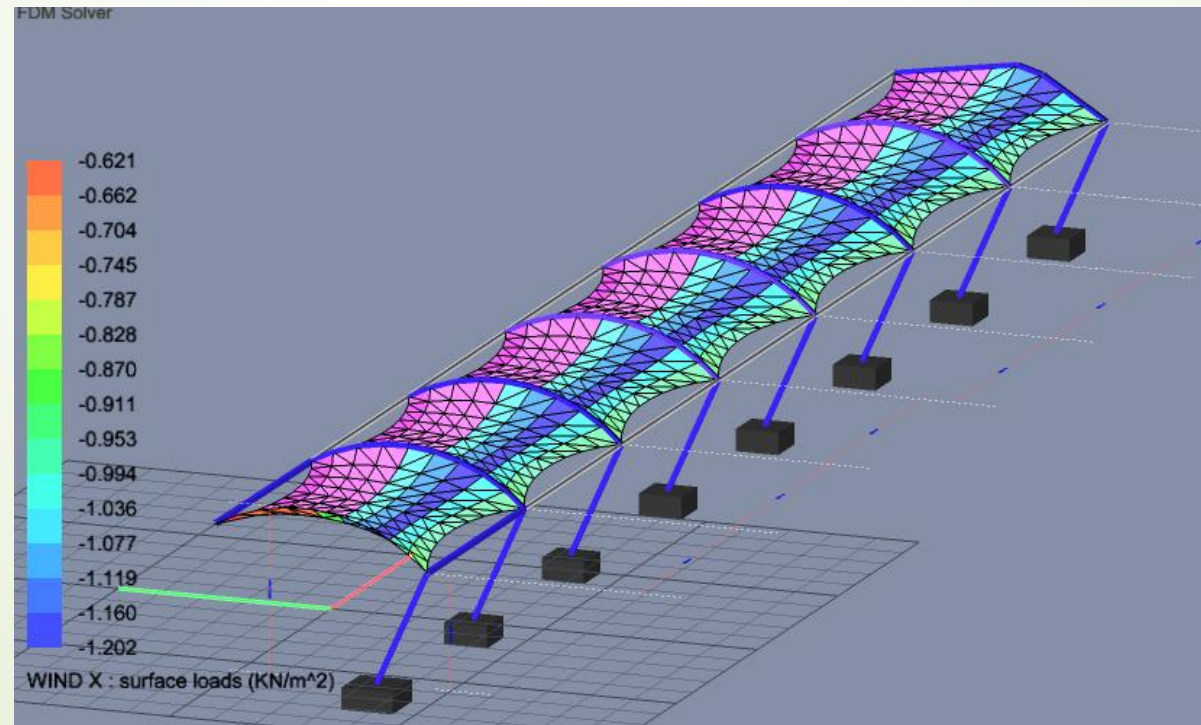


LOAD CASES IN THE STEEL STRUCTURE: LOAD 1: .60 KN/M LIKE .621 KN/M² MEMBRANE SURFACE LOADS MEMBRANE



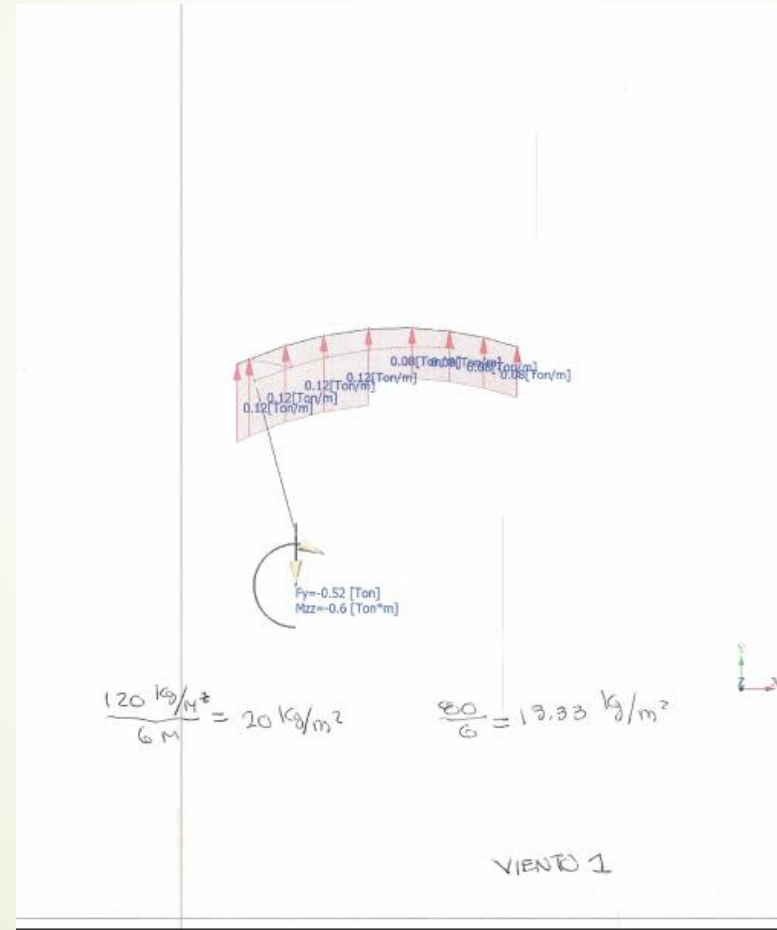


LOAD CASES IN THE STEEL STRUCTURE: LOAD 1: .60 KN/M LIKE .621 KN/M² MEMBRANE SURFACE LOADS MEMBRANE



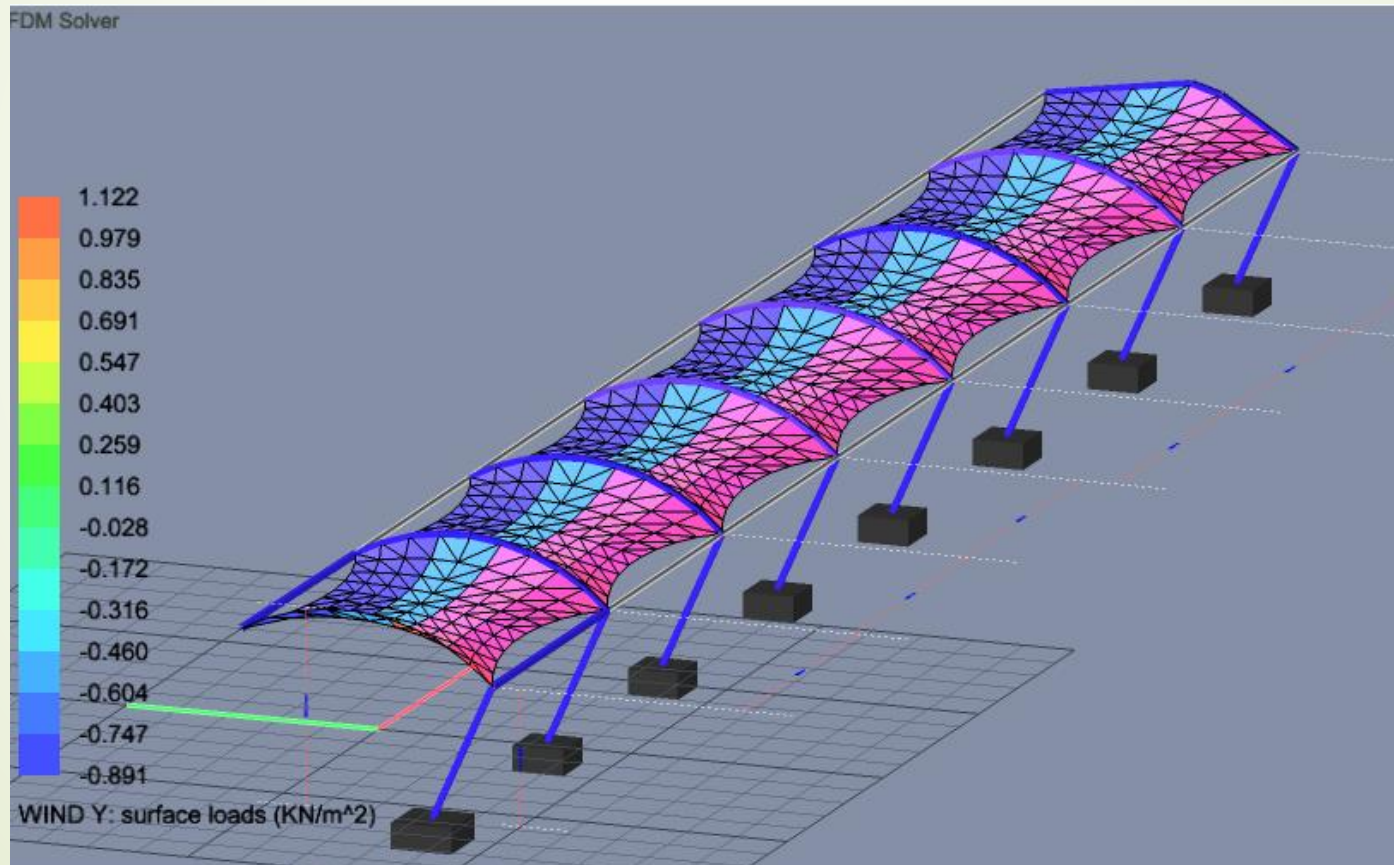


LOAD 2: 1.17 KN/M LIKE 1.12 KN/M² MEMBRANE SURFACE LOADS MEMBRANE





LOAD 2: 1.17 KN/M LIKE 1.12 KN/M² MEMBRANE SURFACE LOADS MEMBRANE



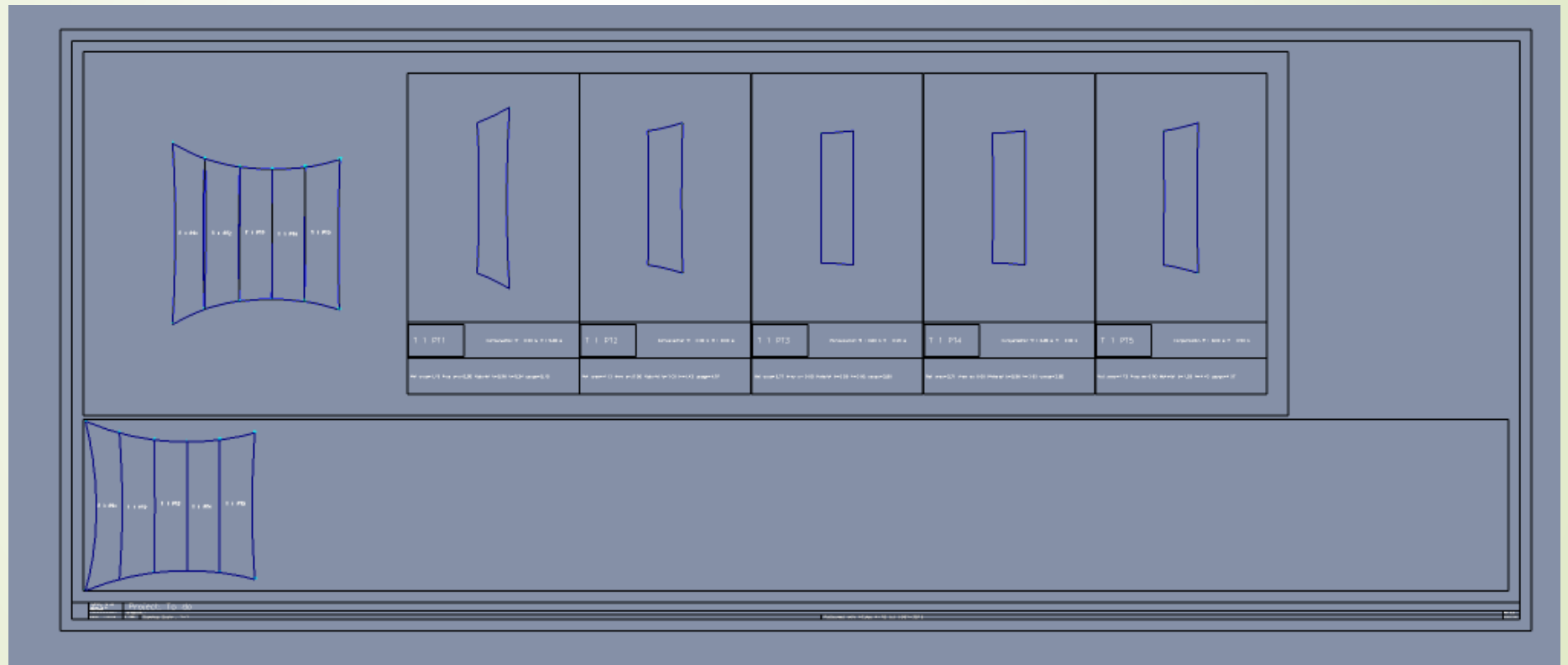


PIECES OF STEEL STRUCTURE

PIEZE	THICKNESS	POSITION
Column	4"x.237"	Support
Beam	2"x.105"	Beam frontal view
Beam	4"x.237"	Beam rear view
Bar	2"x.105"	Support of the arch

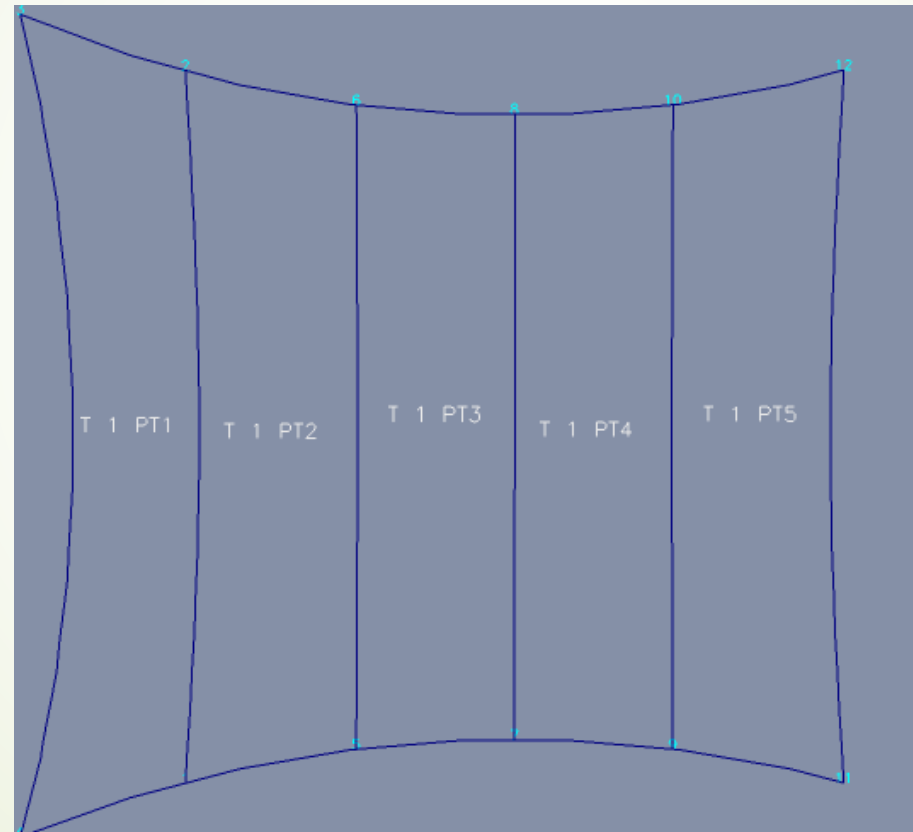


PATTERNING





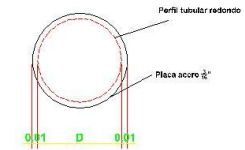
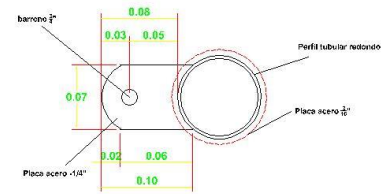
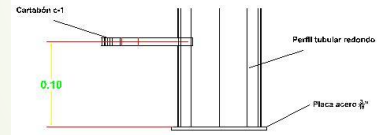
PATTERNING





DETAILING

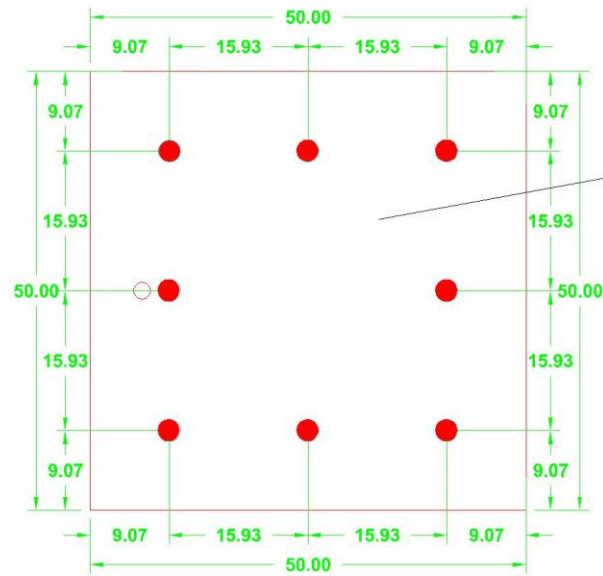
DETAILING C-1





DETAILING

DETAILING OF PLATE PL-1



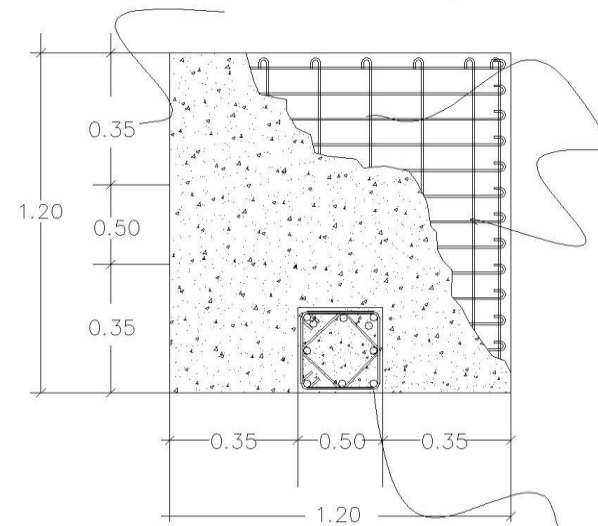
PLACA DE ACERO A-23 CON
ESPESOR DE $\frac{1}{4}$ " CON SECCION
DE 0.50M X0.50M



DETAILING

FOUNDATION

Concreto $f'c=250\text{kg/cm}^2$



Reticula inferior: Vrs
 $\text{Ø } 3/8'' @ 0.10 \text{ m en}$
ambos sentidos
Reticula superior: Vrs
 $\text{Ø } 3/8'' @ 0.25 \text{ m en}$
ambos sentidos

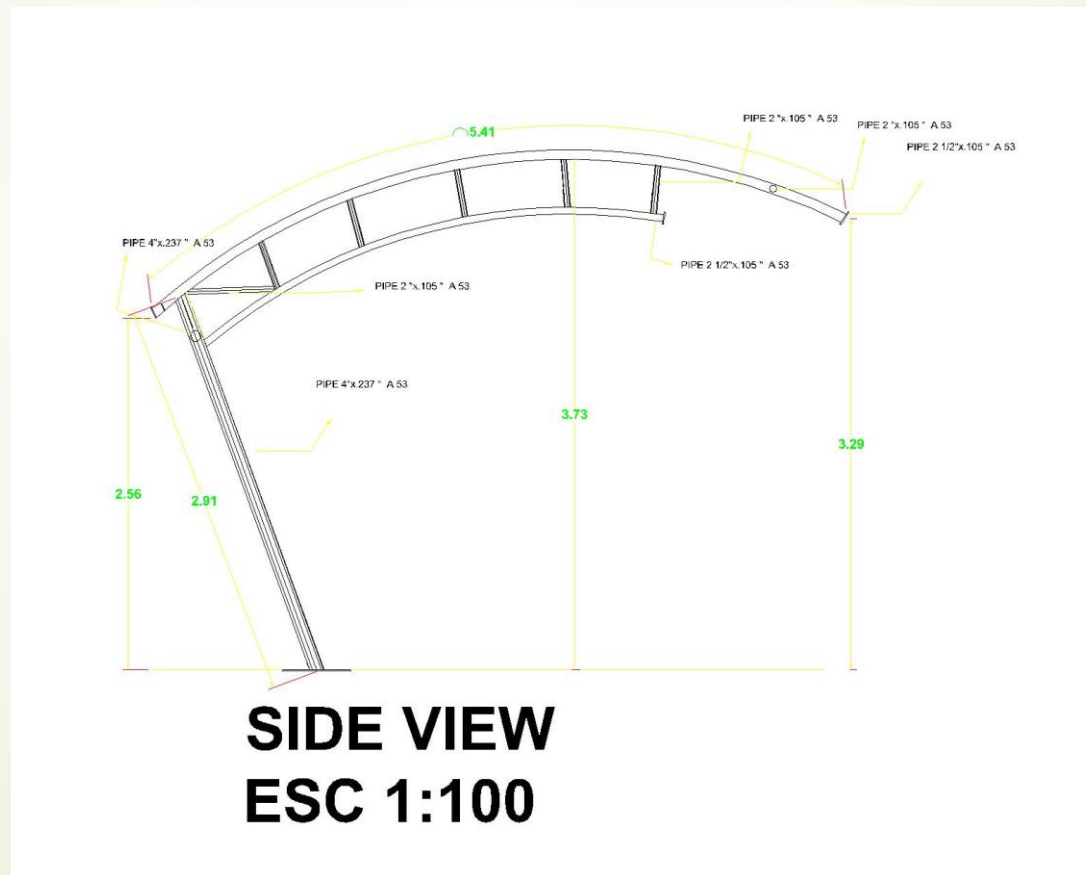
DADO (D-1)
Seccion 0.50 mts x 0.50mts

10 varillas del no. 4
7 Estribos del no.3 ($\frac{3}{8}''$) @
0.20 m
Concreto $f'c=250\text{kg/cm}^2$
 $h= 0.90\text{m}$

TOP VIEW

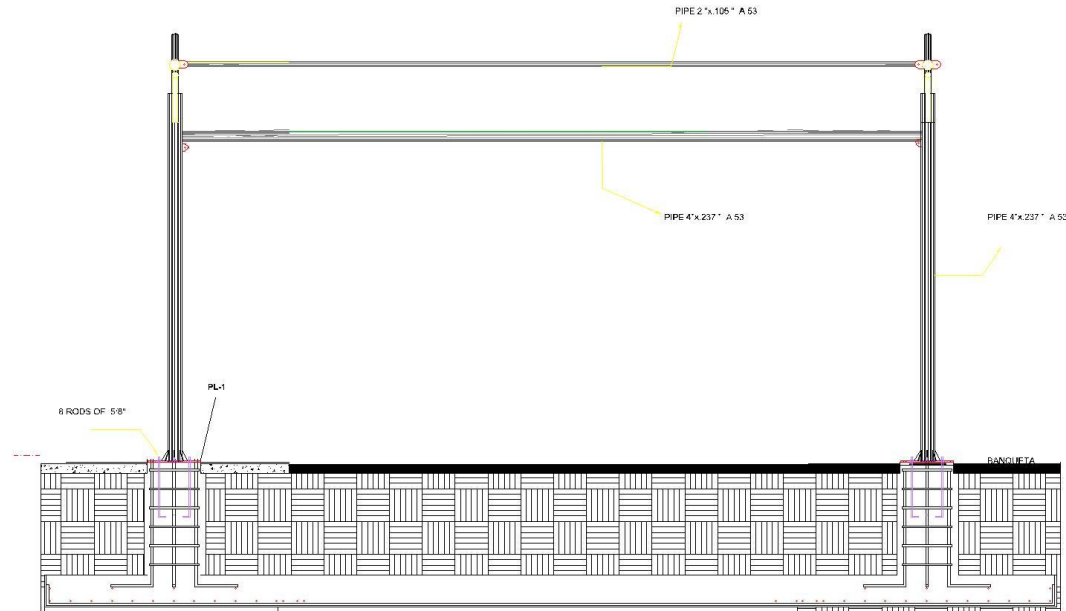


DETAILING





DETAILING



FRONT VIEW 1:100

DETAILING



ESPECIFICACIONES

El edificio se construye en un terreno de 20 m de anchura y 120 m de longitud. El tipo de terreno es de tipo III. La construcción del edificio se hará en un terreno de tipo III. La construcción del edificio se hará en un terreno de tipo III.

El terreno es de tipo III. La construcción del edificio se hará en un terreno de tipo III. La construcción del edificio se hará en un terreno de tipo III.

El terreno es de tipo III. La construcción del edificio se hará en un terreno de tipo III. La construcción del edificio se hará en un terreno de tipo III.

ELEMENTO	REQUERIMIENTO LINEAL
LOSAS	12 mm
ZAPATAS	12 mm
BARRAS	12 mm
CUBIERTAS	12 mm
CONCRETO	200 MPa

SIMBOLOGIA

Z ZAPATA

	<p style="font-size: small;">PROYECTO: CONTRUCCION DE CUBIERTAS PARA ESTACIONAMIENTO DE VEHICULOS EN LA AVENIDA SEVILLA 11-5A, FRACCIONAMIENTO "AT-CNA", ZAPATELAS, ZAPATELAS, C.P. 06036</p> <p style="font-size: small;">AUTOR: GRUPO ECO VELARIAS</p> <p style="font-size: small;">DESCRIPCION: CONTRUCCION DE CUBIERTAS PARA ESTACIONAMIENTO DE VEHICULOS EN LA AVENIDA SEVILLA 11-5A, FRACCIONAMIENTO "AT-CNA", ZAPATELAS, ZAPATELAS, C.P. 06036</p>	<p style="font-size: small;">TITULO: VARIOS</p> <p style="font-size: small;">ESCALA: 1:100</p> <p style="font-size: small;">FECHA: 2017-10-17</p>	<p style="font-size: small;">DICIEMBRE 2018</p> <h2 style="margin: 0;">PLN-1</h2>
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ANALYSIS COST

ANALYSIS COST							
MEMBRANE							
DESCRIPTION	UNIT	AMOUNT	FACTOR	AMOUNT		PRICE /M2	TOTAL
convered area	m2	226					
surface factor			1.2	271.2	m2		
waste+doublings+edges			2	542.4	m2	9.56 €	5,185.34 €
pvc tpye I sales price				230	m2	9.56 €	2,198.80 €
pvc tpye I confection price				230	m2	9.56 €	2,198.80 €
SUBTOTAL MEMBRANE							9,582.94 €
MEMBRANE FITTINGS							
						PRICE	
aluminum rail profile	m	43.28				4.52 €	195.63 €
hilti nails	u	216				5.20 €	1,123.20 €
SUBTOTAL MEMBRANE FITTINGS							1,318.83 €



ANALYSIS COST

TOTAL OF						
SUPPLY AND MAKING OF IMPORTED MEMBRANE SERGE FERRARI PRECONTRAIN 502 S2, IN TRASLUCID WHITE COLOR, WITH 5 YEAR WARRANTY WITH PROVIDER AGAINST WEARS WEARED BY UV RAYS, AND DURABILITY OF UP TO 10 YEARS, IGNIFUGA, RESISTANCE TO DISCONTENT AND TENSION, INCLUDES: MAQUILAR LONARIUM ACCORDING TO PROJECT, INSTALLATION, CUT, DURABILITY OF UP TO 4 YEARS, TOOL AND ALL NECESSARY FOR ITS CORRECT OPERATION						10,901.77 €
CABLES						
DESCRIPTION	UNIT	AMOUNT	FACTOR	AMOUNT	PRICE /M2	TOTAL
edge cable membrane 9.5 mm	MI	86.56			1.78 €	154.08 €
SUBTOTAL CABLE MATERIAL						154.08 €
CABLE FITTINGS					PRICE	
cable terminal	u	14			1.73 €	24.22 €
nuts for cable	u	14			0.50 €	7.00 €
special pieze for connection cable	u	14			1.00 €	14.00 €
SUBTOTAL CABLE FITTINGS						45.22 €
TOTAL CABLES						199.30 €
TOTAL MEMBRANE+CABLES						11,101.07 €



ANALYSIS COST

FOUNDATION							
DESCRIPTION	UNIT	AMOUNT	FACTOR	AMOUNT		PRICE /M2	TOTAL
PLANT BASED ON SIMPLE CONCRETE FOUNDATION OF F'C = 100 KG / CM ² OF 5 CM S OF THICKNESS, INCLUDES: LEVELS, MATERIALS PLACED AT THE PLACE OF EXECUTION OF WORK, WASTE, PLACEMENT, VIBRATION, PULP, CURED, HAND TOOL, TOOL, EQUIPMENT AND CLEANING.	M2	11.52				7.17	82.5984
SUPPLY, ENABLED AND REINFORCED STEEL REINFORCEMENT OF FY = 4200 KG / CM ² , IN FOUNDATION AND FLOORS, USING ROD CALCULATION OF DIAMETER, INCLUDES: HOOKS, TRAPS, WASTE, WORK HAND, TOOL AND ALL NECESSARY FOR THEIR EXECUTION.	KG	5.26				87.93	462.16 €
CONCRETE FOR FOUNDATION OF F'C = 250 KG / CM ² , WITH T.M.A. DE 3/4 " , WORKMADE WITH REVOLVING MACHINE INCLUDES: MATERIALS, WASTE, PLACEMENT, VIBRATION, CURING, WORK HAND, TOOL AND ALL NECESSARY FOR IMPLEMENTATION.	m3	292.80				1.52	445.06 €
COMMON CIMBRA IN DATA (CONTACT AREA) BASED ON PINE WOOD OF 3rd. CLASS, INCLUDES: ENABLED, CIMBRADO, DESCIMBRADO, TREATMENT OF WOOD, MATERIALS PLACED ON THE WORK, WASTE, HAND TOOL, TOOL AND	m2	14.44				9.6	138.62 €
TOTAL FOUNDATION							1,128.44 €



ANALYSIS COST

ERECTION						
WORKERS	NUMBER OF WORKERS	DAYS	AMOUNT	PRICE/DAY(MEXICO)	TOTAL	
site installation	2	1	2.00 €	5.00 €	10.00 €	
foundation	4	7	28.00 €	5.00 €	140.00 €	
steel+ membrana assembly	6	12	72.00 €	5.00 €	360.00 €	
checking	2	1	2.00 €	5.00 €	10.00 €	
site clean up	2	2	4.00 €	5.00 €	20.00 €	
		23				
SUBTOTAL WORKERS					540.00 €	
EQUIPMENTS	PIECES	DAYS	AMOUNT/DAY	TOTAL	TOTAL	
crane	1	4	60.00 €	240.00 €	240.00 €	
generator of electric current(2200 WATTS)	1	15	20.00 €	300.00 €	300.00 €	
safety equipment	12	15	8.00 €	1,440.00 €	1,440.00 €	
scaffolding(HEIGHT 8M)	4	22	5.00 €	440.00 €	440.00 €	
SUBTOTAL EQUIPMENTS					2,420.00 €	
TOTAL ERECTION					2,960.00 €	



ANALYSIS COST

PLANNING AND COST ENGINEERING						
DESCRIPTION	UNIT	AMOUNT	FACTOR	AMOUNT	PRICE /M2	TOTAL
preliminary					385.21	385.21 €
executive project	U	1			900.00 €	900.00 €
topographic survey	U	1			339.00 €	339.00 €
aproval fees government	U	1			150.00 €	150.00 €
structural anaylsis	U	1			668.96	668.96 €
TOTAL PLANNING AND COST ENGINEEGING						2,443.17 €
FINISHES						
DESCRIPTION	UNIT	AMOUNT			PRICE /M2	TOTAL
paint enamel of brand and quality recognized by the secretary in metallic structure, uniform finished work includes cleaning and preparation of the surface materials waste work, tool and all the necessary for their execution	m2	35.2			3.53 €	124.26 €
TOTAL OF FINISHES						124.26 €



ANALYSIS COST

					SUBTOTAL	22,164.86 €
					TAX(16%)	3,546.38 €
					TOTAL	25,711.23 €
STATISCAL VALUES	M2	226	COST/M2	TOTAL OF PROJECT		%
FOUNDATION			4.99 €	1,128.44 €		5%
STEEL(3642.25KG)			19.50 €	4,407.93 €		20%
FINISHES			0.55 €	124.26 €		1%
MEMBRANE			48.24 €	10,901.77 €		49%
CABLES			0.88 €	199.30 €		1%
ERECTION			13.10 €	2,960.00 €		13%
PLANNING AND COST ENGINEERING			10.81 €	2,443.17 €		11%
					SUBTOTAL	22,164.86 €
					TAX	3,546.38 €
					TOTAL	25,711.23 €
					PROFIT(15%)	3,856.69 €
					RISK MANAGEMENT (5%)	1,285.56 €
					TOTAL	30,853.48 €



PROJECT MANAGEMENT

- This is the most important element in a real project, because the cost depends on the time and money of the execution, so, no matter the size of the project, the following steps are recommended for appropriate management:
- Paperwork with government of security of workers, cars, crane, machinery, and everything required for the execution of the project.
- Check the area to know if it's possible to install a buffer to safe keep tools and use as lunch area for workers.
- Consider the distance of the project area from the living area of workers involved. In this case, the project is min from the central office, so accommodation for the workers was not required, allowing saving capital from the budget.



PROJECT MANAGEMENT

- Guarantee material availability:
 - Concrete
 - Sand and gravel
 - Bars
 - Screws
 - Steel plates
 - Steel pipes
 - Paint
 - Fabric (It is essential to consider the time it will take to be imported, this way, the client will have an accurate date for completion of the project)



PROJECT MANAGEMENT

- ▶ Assure tool availability:
 - ▶ Security equipment:
 - ▶ Gloves
 - ▶ Glasses
 - ▶ Helmets
 - ▶ Harnesses
 - ▶ Safety shoes
 - ▶ Welding machines for steel and fabric
 - ▶ Tensioning machine
 - ▶ For the assembling of structure and fabric:
 - ▶ Check the capacity of the crane, in this case a crane with maximum of 8 ton was required.
 - ▶ Check safety rules of the client. For this project, the client requested specific safety measures regarding:
 - ▶ Workers
 - ▶ Cranes
 - ▶ Trucks




PROJECT MANAGEMENT

- Cleaning:
 - Verify the fabric is in good condition and appearance. Washing and cleaning must be done when necessary.
 - Inspect the steel structure. Repainting and cleaning might be necessary.
- Obtaining feedback from the client. Once the project is concluded, the client must be consulted regarding agreement and compliance with it. If there are any points to be discussed, each should be thoroughly explained and every element justified. It is imperative the client is well informed and aware of both the warranty and maintenance process log to be kept for delivered project.





Example of the sheet “delivered jobs” .



JOSE SAMUEL CARRILLO RUIZ
CARRISAJEORRY
AV. SEVELLA #115-A, FRACC. TAHOMA
ZACATECAS, ZAC.
TEL: 02 3 64 34

DELIVERED PROJECT AND WARRANTY


DATE: ZACATECAS, MEXICO APRIL 2017.

MADERO MINE:
In this sheet we delivered the Project with ubication Carretera Francisco I. Madero No. Km 11.5, COL. Noria de Gringoe, Morelos Zacatecas, México.

- SUPPLY AND MAKING OF IMPORTED MEMBRANE SERGE FERRARI PRECONTRAIINT 502 S2, IN TRASLUCID WHITE COLOR, WITH 5 YEAR WARRANTY WITH PROVIDER AGAINST WEARS WEARED BY UV RAYS, AND DURABILITY OF UP TO 10 YEARS, IGNIFUGA, RESISTANCE TO DISCONTENT AND TENSION, INCLUDES: MAQUILAR LONARIUM ACCORDING TO PROJECT, INSTALLATION, CUT, DURABILITY OF UP TO 4 YEARS, TOOL AND ALL NECESSARY FOR ITS CORRECT OPERATION

EXPLANATORY NOTES:

- WARRANTY OF FABRIC: 5 YEARS
- WARRANTY OF MANUFACTURE OF FABRIC: 1 YEAR
- WARRANTY OF STEEL STRUCTURE: 1 YEAR AND USEFUL LIFE: 10 YEARS.



ATENTAMENTE

SAMUEL ALEJANDRO CARRILLO GARCIA
CEO
GRUPO ECO

SIGNATURE AND NAME OF COSTUMER



FOUNDATION





TOPOGRAPHIC REVISION





ERECTION





CLEANING





CLEANING





CLEANING





CLEANING





COMPLETE PROJECT





COMPLETE PROJECT





COMPLETE PROJECT





COMPLETE PROJECT





COMPLETE PROJECT





COMPLETE PROJECT





COMPLETE PROJECT





Project sale to the client

- ▶ In the world of the textile architecture, the sale of this type of covers is not simple, especially because most of the projects clients are familiar with involve common materials such as concrete, glass, polycarbonate and acrylic, using PVC, PTFE or ETFE fabrics, this materials names 5t materials, because is the 5t option after of the comun materials, However, textile architecture with fabrics presents numerous advantages, most of them unknown to clients, which include:
- ▶ LIGHTWEIGHT STRUCTURES
- ▶ FREE FORMS
- ▶ MINIMUM MAINTENANCE
- ▶ MINIMUM STRUCTURAL ELEMENTS
- ▶ APPEALING FORMS
- ▶ THERMIC AND ACOUSTIC PROPERTIES
- ▶ TRANSLUCENT
- ▶ RECYCLED MATERIALS
- ▶ ECOLOGICAL MATERIALS



Project sale to the client

- ▶ Many of these reasons were quite important for the client to make a decision, the most relevant being recycled and ecological materials. The second most important advantage was the material being translucent because of the uses given to the area and the minimum maintenance compared to other materials.
- ▶
- ▶ Approximately 15 meetings and 10 phone calls took place. The client had chosen our company and the CANTILIVERED proposal to review costs, advantages and disadvantages of each.



Project sale to the client

- ▶ When the first meeting took place, the client had a COMMERCIAL 95 architectural mesh in mind. It is a good product, used for providing shade and protection from the sun, however, it is not a membrane structure. Compared to FERRARI 502 S2, COMMERCIAL 95 is more affordable, but it does not provide as many long-term advantages, therefore, many meetings were dedicated to convincing the client to use FERRARI 502 S2.



CONCLUSIONS: Technical Data

- ▶ The foundation is with Design Code ACI 318 -05, calculate with concrete column, steel bar and the base in the floor.
 - ▶ The base is 1.20m x 1.20m x .35 m of hight, with steel bar indoor, in longitudinal direction exactly 12 bar of 3/8", spacing between bars 10.00 cm and transverse 10 bar of 3/8" each 25.00 cm.
 - ▶ The column of concrete that will be connect with the steel structure will be 50.00 cm x 50.00 cm. this column will have In longitudinal direction 8 bar of 1/2" each 20.00 cm and will have in transverse direction 4 bar of 3/8" each 20.00 cm.
 - ▶ The steel is $F_y = 4200 \text{ kg/cm}^2$
 - ▶ The concrete resist is $F_c = 200 \text{ kg/cm}^2$
- ▶ The steel structure was design with AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM), and the normative for our steel structure was A53 where the resistance to rupture is 50 Ksi, that means 344,737.864 kn/m².
 - ▶ In general terms we used two kinds of PIPES for our model:
 - ▶ PIPE 2" that's means 60.33 mm external diameter, and thickness of 3.91 mm with weight of 5.432 kg/m.
 - ▶ PIPE 4" that's means 114.30 mm external diameter, and thickness of 6.02 mm with weight of 16.057 kg/ m.
- ▶ The cables that we used on based of the calculates was Cable high resistance 6x36ws of 9.5 mm or 3/8" with height .377 kg/m because In the edge cables, the maximum force in KN is 54 kn.



Warranty

- The warranty of all the project was:
- In general project in anything defect have a 1 year.
- The fabric have 5 years with the brand SERGE FERRARI.
- The structure have 10 years in anything problem of defects.



FABRIC

- The membrane that we used on base of the calculates was:
 - SERGE FERRARI PRECONTRAIINT 502:
 - Weight: 590 g/m²
 - Width of roll: 2.67 cm
 - Resistance: 52 KN/m
 - System of Quality: ISO 9001
 - Quality years: 5 years
 - Color: white



Prices

- ▶ In the cost of analysis we see that have a competitive price is around 90.50 EUR/M², the most comparative with a rigid material is a polycarbonate that the cost is around 71.42 EUR/M², but a fabric have a different advantages in comparison with a polycarbonate:
- ▶ Minimum maintenance.
- ▶ The membrane SERGE FERRARI looks better than a polycarbonate.
- ▶ Don't have an insulation effect.
- ▶ Is a thermic material.
- ▶ Is a lightweight material than the polycarbonate.
- ▶ Freeform



GENERAL TECHNICAL DATA

SIZE(M2)	SHAPE	BRAND	WEIGHT OF STEEL	COST	TIME OF EXECUTION OF PROJECT
230 M2	ARCH	FERRARI PRECONSTRAINT 502	.902 TON	30,858.48EUR	125 DAY