Amphitheatre Single Support Arched Tensile Structure

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

IMS BAUHAUS Archineer® Institutes e.V.

by

Irving Allande
Born March 03, 1978

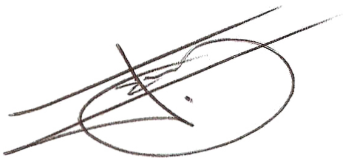
Student ID number 4065612

Submission date: March 26th, 2021

First Tutor: Prof. Dr. Robert Off
Second Tutor: M.Eng. Samuel Alejandro Carrillo Garcia

Statement

I hereby certify that the present thesis is of my own creation, not using external means nor copying from any other project.



Irving Allande

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1. Proposal of the project

Indian Riverside Bandshell Amphitheater Tensile Membrane Structure

The project consist on an existing historic venue amphitheater concrete platform exposed to the harsh element in need a cover for outdoor music festivals, weddings, and social distancing gatherings, situated at The Tuckahoe Terrace Amphitheater which is located within the Indian Riverside Park, at 1707 NE Indian River Drive in Jensen Beach, Martin County, Florida.

My focus is merely Architectural based on current site conditions.
Our client inducated that they would prefer not to have to many vertical element (supports) that impedes or obstructs the beautiful view of the coatal line for this venue.
This presents a challenging opportunity as we face very critical conditions along the Florida USA coastal line, such as, water table, high wind speed exposure of 150mph (240km/h) and limited anchoring points space. Whit this in mind our design will need to meet all the required local codes to meet the need for this tensile structure to integrate to this historical site.

On The initial explorations for shallow soil types and groundwater levels we found in the immediate vicinity, to be underlain by loose to moderately dense fine sands and groundwater table was encountered at a depth of about 10 feet below the existing ground surface, which are considered satisfactory to support the proposed tensile structure construction on a shallow foundation.

The tensile structure will then need to be cantilevered and supported on shallow foundation proportioned for an allowable bearing stress of 2,000 pounds per square foot [psf], which are proposed to be installed within the existing planters located on either side of the stage.

This determination will allow for minimal anchoring points and no disruption to the existing stage platform, allowing our client for a more affordable solution given the circumstances.

As of this moment we have proposed a design with the following characteristics:

- **Location:** Florida, USA.
- **Foundation:** 2 spread footings, based on the Geotech report and limited space.
- **Type of Design:** Cantilever design structure
- **Type of structure:** Arched structure with
- **Dimensions:** approximate (33ft x 40ft x 19ft height) = (10m x 13m x 6m height)
- **Membrane type:** Single layered membrane PVDF/PVC Soltis proof 502 by serge Ferrari.
- **Hardware:** Stainless steel hardware due to corrosion in coastal area.

- **Structure Finish**: the final finish was with white enamel paint, the treatment was to place the base of the primary paint, then place white enamel for the final finish.

Although much effort & hard work has been invested on this acoustic band shell & outdoor stage due to its site constraints over the seawall banks, this historic venue is ready for outdoor music festivals, weddings, and social distancing gatherings.

Is entirely my own and that I did not use any sources or auxiliary means other than those referenced here.

HISTORY

1928:
Elizabeth W. Bates passes away, leaving Coca- Cola fortune to daughter, Anne Bate (later Anne Leach) and Emily and Elizabeth Watsh Coca-Cola becomes official beverage for the international Olympics.

1938:
Anne and Willafor Ransam Leach build Tuckahoe. (A Coca- Cola Room is designed in the basement as a testament).

1941-1945:
Coca-Cola mode available to American servicemen in Europe during WWI, expanding Coca-Cola interest abroad. Bottling plants are built non-stop and the Coca-Cola industry is underway.

1950-1977:
Philanthropy continues by Ann Leach to Bascom Parmer Eye Institute at University of Miami, Palm Beach charities and Emary University in Atlanta.

Mt. Elizabeth and the surrounding property were purchased by explorer William Henry Racey in the 1850. In 1891, his son Charles Racey, built a three-story wood-frame house on the mound for this family and started a pineapple and citrus plantation on the property. The Racey family sold the property. The Racey family sold the property to a New York judge after the home burned to the ground in 1921.

The Leach family and Tuckahoe:

In 1936 Atlanta businessman Willaford Leach and his wife Anne Bates Leach, a Coca- Cola heiress, purchased Mt. Elizabeth and the surrounding property and built the Mediterranean Revival home that exists today. Named “Tuckahoe”. The estate was completed in 1939 with the latest in architectural design for that time.

Sitting on approximately 54 acres of riverfront woodland and rolling lawns, Tuckahoe was the hub of social life in Martin Country and the setting for countries parties attended by the local social set and WWII soldiers from camp Murphy. Mrs Leach Who helped organize The Garden club of Stuart, donated funds for the Anne Bates Leach Eye Hospital, affiliated with Bascom Palmer Eye Institute in Miami.

St. Joseph Novitiate and college:
In the early 1950, the leaches decided to move to palm Beach and sold the property to the Catholic Church. The estate became a novitiate of the Sister of St. Joseph and the mansion was used as a dormitory. In 1996 the admission of lay student began, and the school would become Florida only two year liberal and college. Economic difficulties resulted in the closing of the school in 1972.

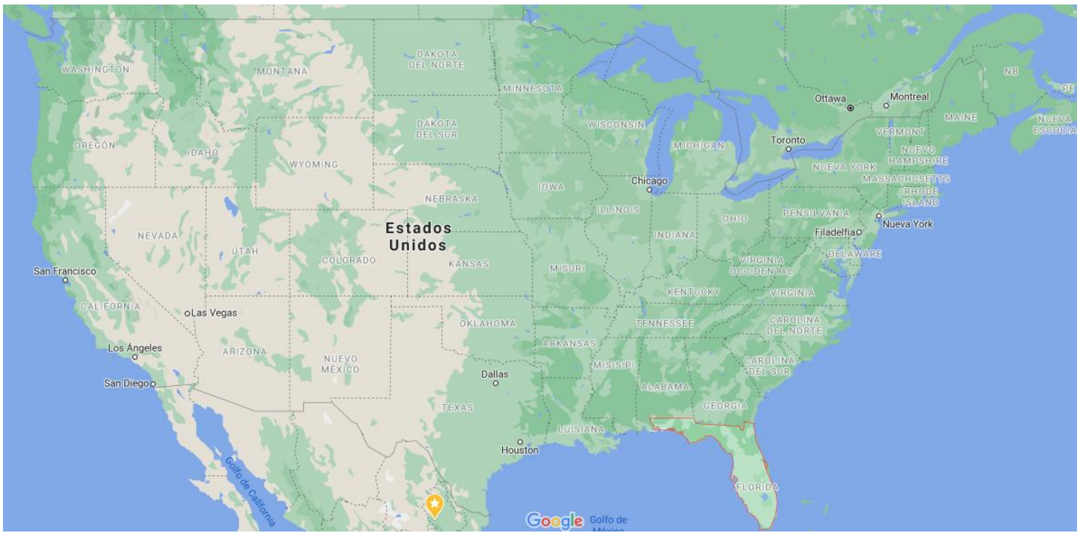
Florida Institute of Technology (FIT):
FIT purchased the property in 1972 and it became the site of a four-year college offering advance degrees in marine related subjects. The mansion became the administration building and student center. FIT was an important part of the community for 14 years until operating expenses forced the closing of the school en 1986.

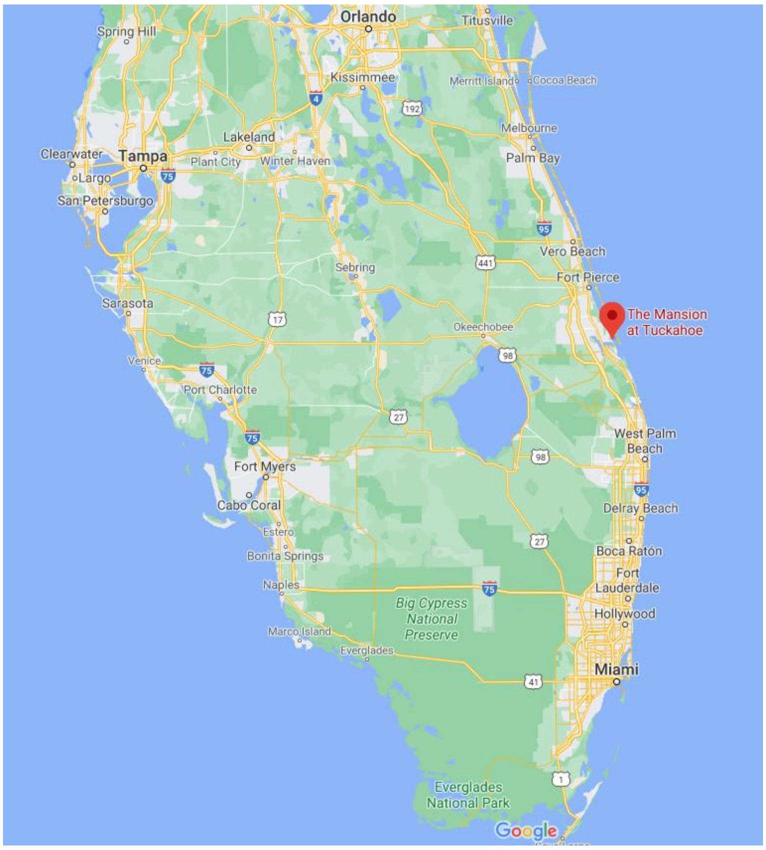
Indian Riverside Park:
Following the FIT closure, Tuckahoe and the surrounding property stood vacant until local community leaders led a successful referendum drive to encourage Martin County to purchase the property. In 1997, the property became the site of this park. Restoration of the Mansion was completed in 2009.

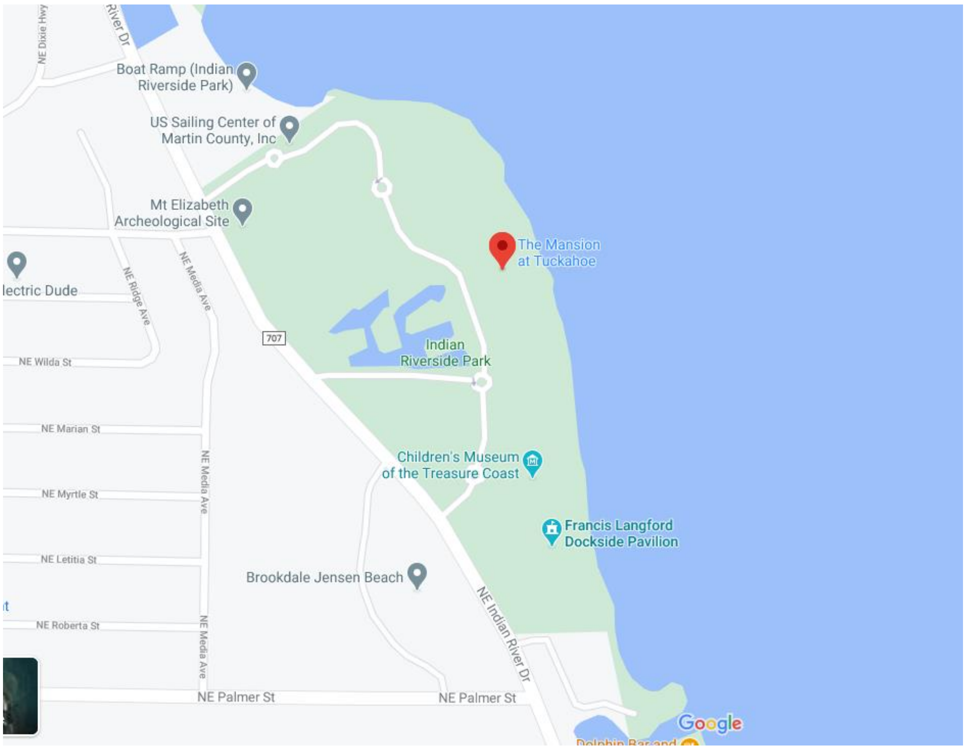
Nacional Historic Registry:
The Mansion at Tuckahoe was place on the National Register of Historic Places in November 2005 with the help of the Friends of Mount Elizabeth.

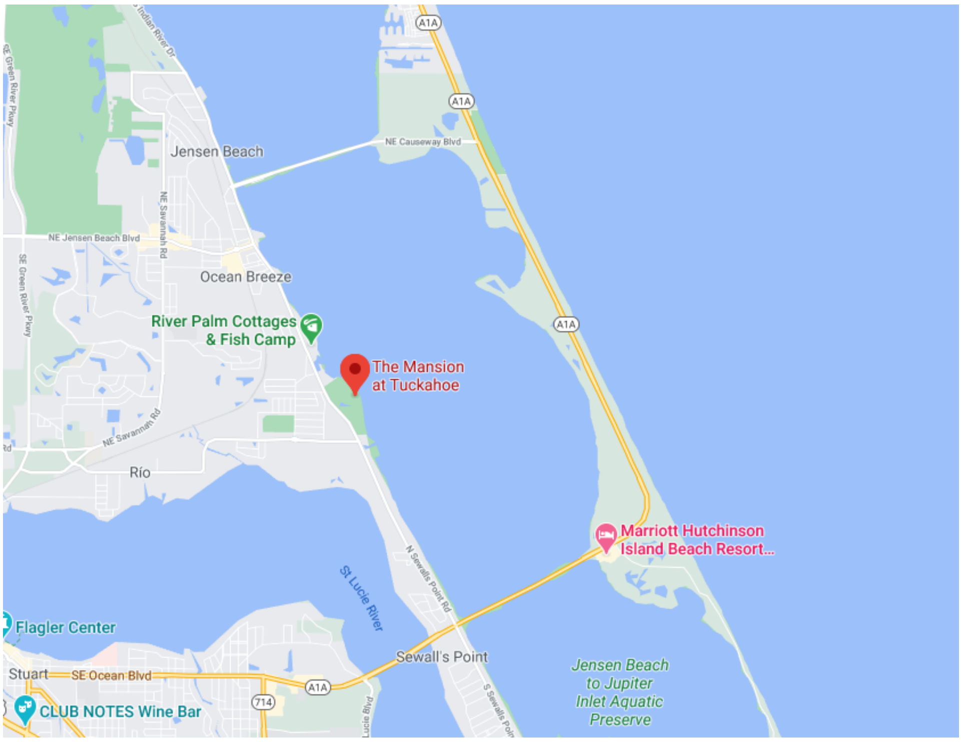
PHOTOS OF THE SITE BEFORE THE PROJECT USING A TENT.

Location:
Florida, United States.
The Mansion at Tuckahoe
1707 NE Indian River Dr, Jensen Beach, FL 34957



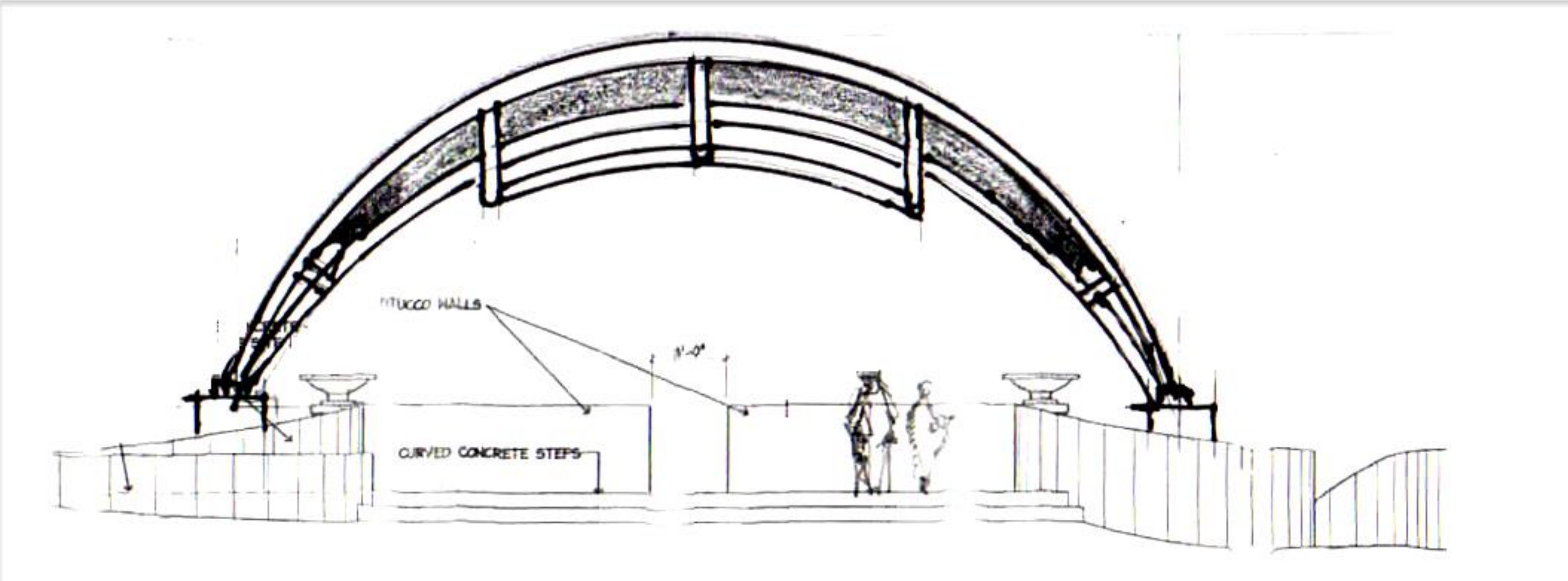



Boat Ramp (Indian Riverside Park)
US Sailing Center of Martin County, Inc
Mt Elizabeth Archeological Site
The Mansion at Tuckahoe
Indian Riverside Park
Children's Museum of the Treasure Coast
Francis Langford Dockside Pavilion
Brookdale Jensen Beach
NE Indian River Dr
NE Palmer St
NE Media Ave
NE Wilda St
NE Marian St
NE Myrtle St
NE Letitia St
NE Roberta St
Google

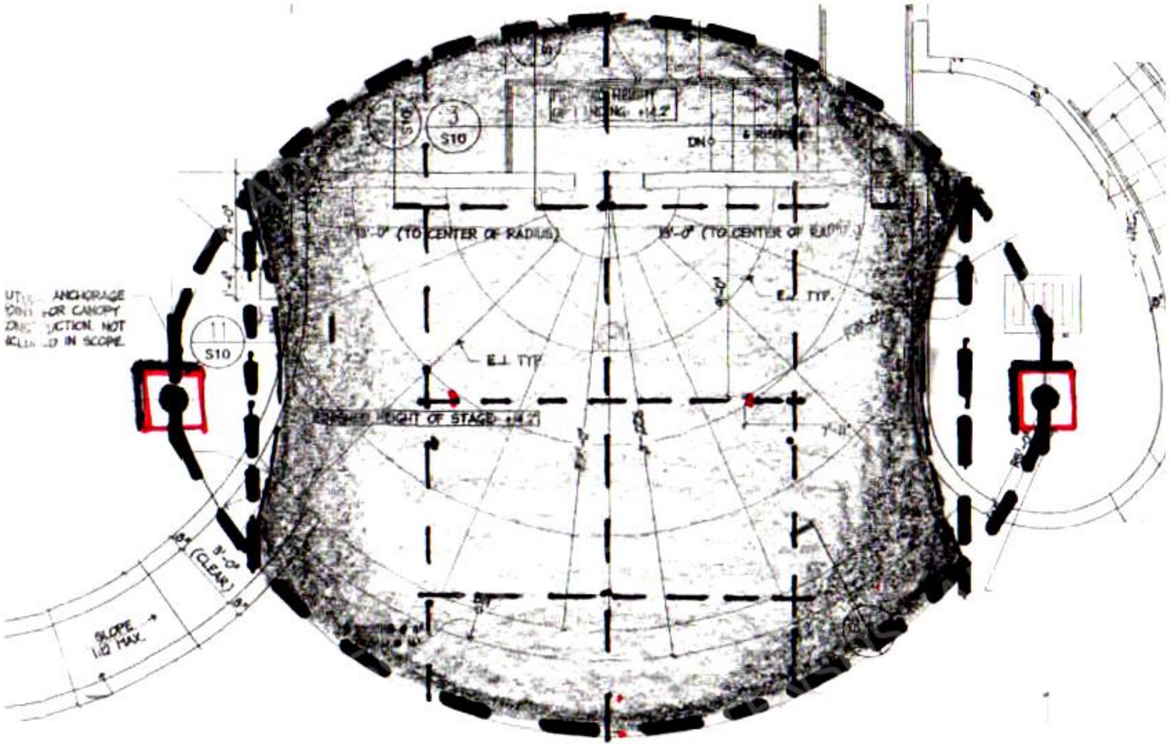

Jensen Beach
NE Causeway Blvd
Ocean Breeze
River Palm Cottages & Fish Camp
The Mansion at Tuckahoe
Río
Marriott Hutchinson Island Beach Resort...
St Lucie River
Flagler Center
Sewall's Point
Stuart
SE Ocean Blvd
CLUB NOTES Wine Bar
Jensen Beach to Jupiter Inlet Aquatic Preserve

CONCEPT

Sketch (frontal view)



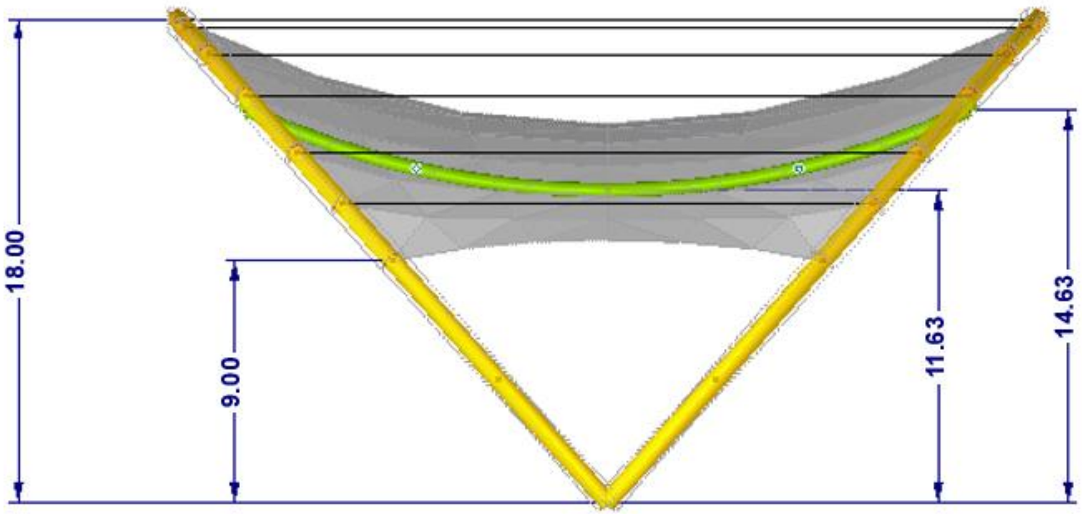
Sketch (plan view)



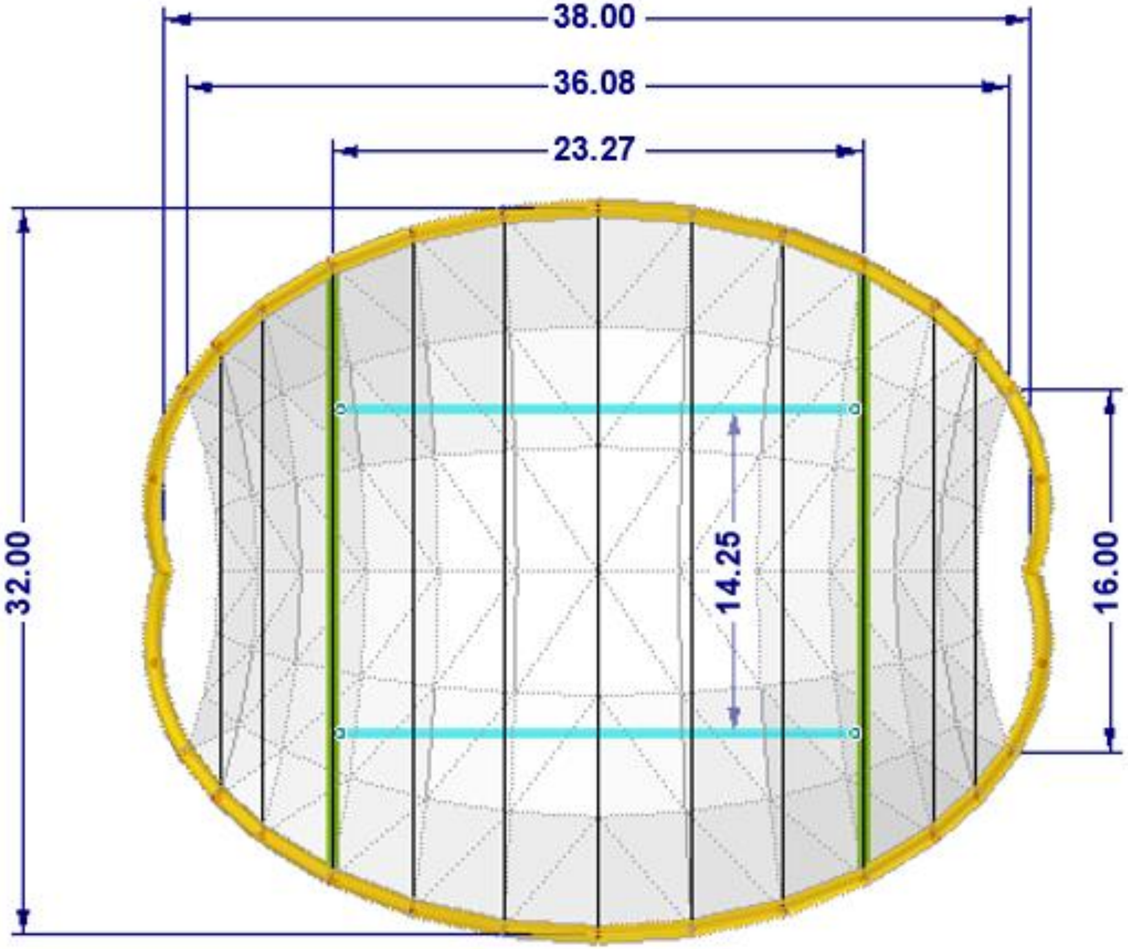
Sketch Concept - Custom Design

Custom Shade Structure
Consceptual Model
Image for Presentation Purposes Only

Side view



Plan view


38.00
36.08
23.27
32.00
14.25
16.00

The reason for proposing this shape is site restrictions, functionality, and maintenance. The choice made by the client for the arch shape and cantilevered was mainly influenced by its simplicity, lower cost, and minor maintenance.

In this market, there are many competing materials such as polycarbonate, acrylic, steel, concrete and glass. For this reason, were proposed, taking into consideration that the client should have options with different materials and shapes, so the decision could be made freely.

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
- Acoustic properties
- Visual appeal
- Lower price
- Shorter fabrication time
- Installation period
- Minimum maintenance
- Free form

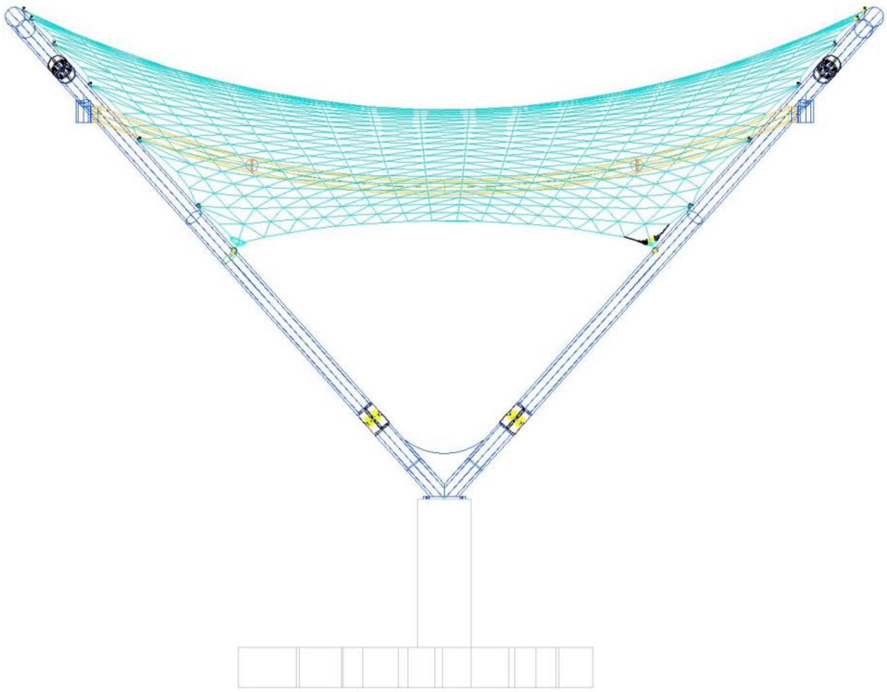
2. The form finding.

In the fabric architecture industry, there are two concepts of shape types, synclastic and anticlastic. In this project, the steel structure is an arch shape, but the membrane in the top of the curvature has an anticlastic shape.

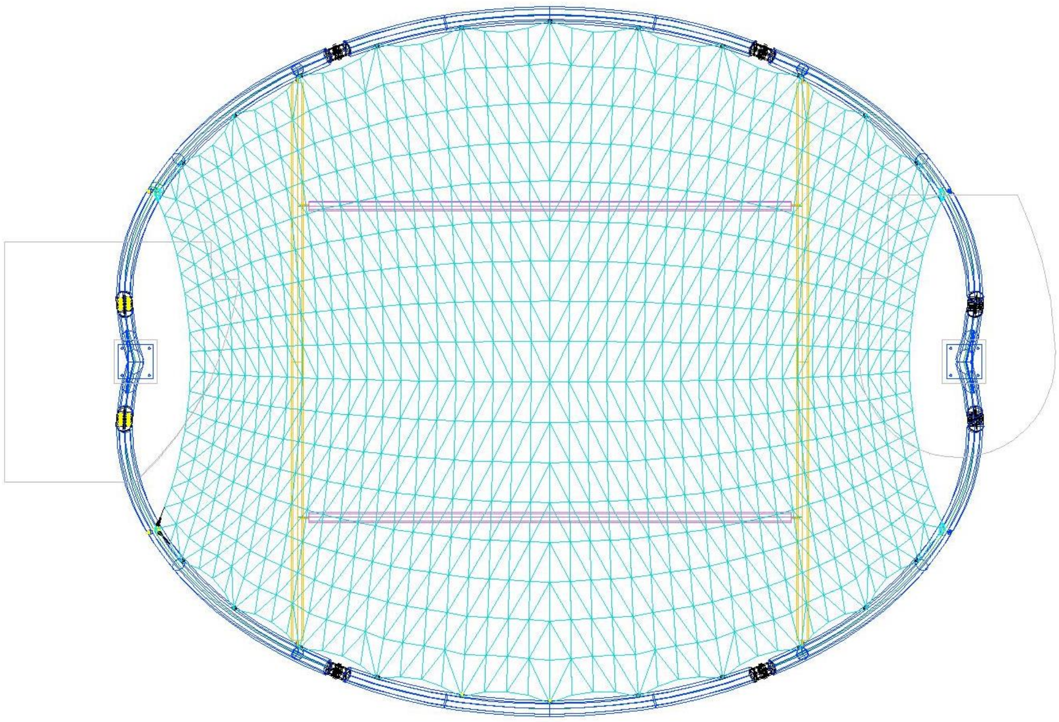
The form finding was obtained with RFEM from Dlubal. After the client selected this option, shapes and calculations were attained, and details were drawn.

For a more successful sale of the project, different 3D renders were exhibited, serving as an accurate reference for appearance once the project was finalized. The renders exposed to the client are shown below:

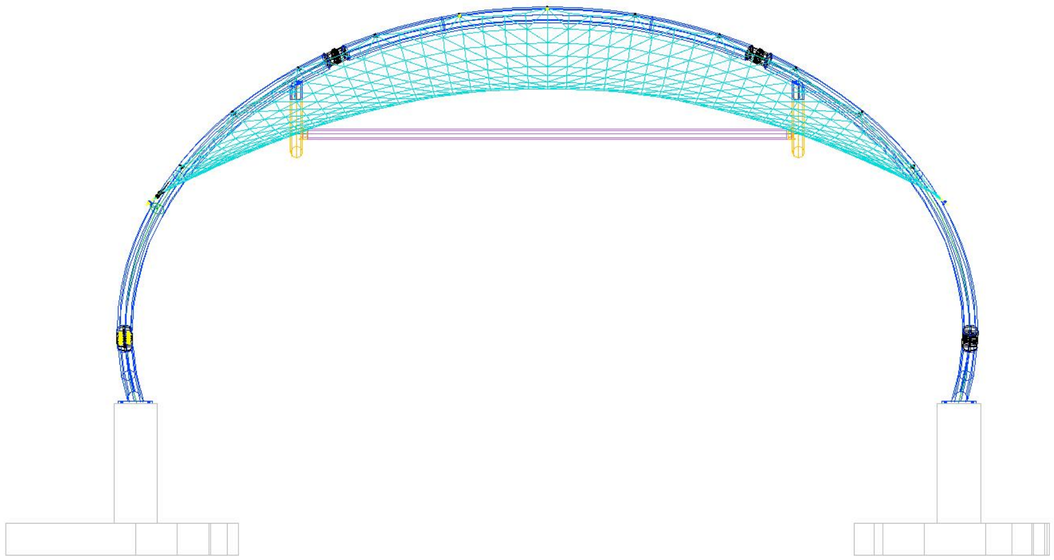
Side view



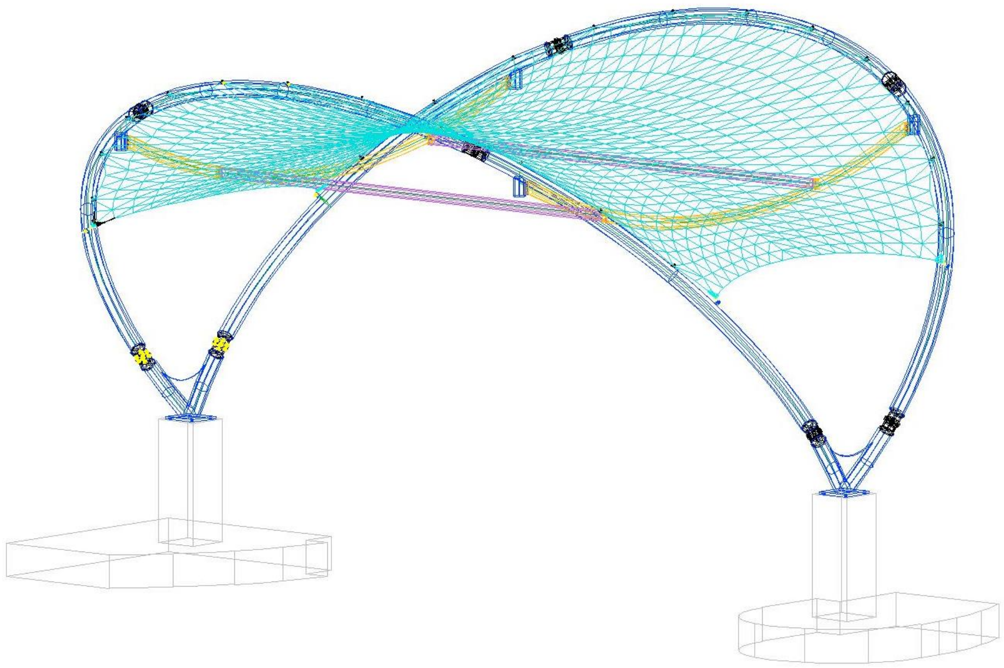
Top view



Front view



Perspective View



3. Structure analysis for obtain reactions force

Report of structural Analysis

Rocky Summit Engineering Consulting, LLC
PO Box 816151
Dallas, TX, 75381

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Sheet: 1

Project: Model: Indian Riverside Park V2 Date: 11/29/2019

STRUCTURAL ANALYSIS

PROJECT	PAVILLION INDIAN RIVERSIDE PARK JENSEN BEACH, FL BANDSHELL FABRIC SHADE STRUCTURE
CLIENT	TENSOSHADE
CREATED BY	ROCKY SUMMIT ENGINEERING CONSULTING, LLC PO BOX 816151 DALLAS, TX, 75381

THOMAS R. SADLER
LICENSE
No 4844
STATE OF FLORIDA
PROFESSIONAL ENGINEER

Digitally signed by Thomas Sadler
Date: 2019.12.05 13:51:31 -06'00'

DESIGN PARAMETERS

BUILDING CODE: FLORIDA BUILDING CODE 2017, ASCE 7-10, ANSI/AISC 360-10

DEAD LOAD: Calculated automatically Gravity -z Load Case DL

LIVE LOAD: 5 psf (Awnings and Canopies Other Construction Table 1607.1) (Roof)

SNOW LOAD: 0 psf

WIND LOAD: 150 MPH (3-SEC GUST) Ultimate EXPOSURE C, Building Category II

Wind pressures calculated based on chapter 26 of ASCE 7-10

Using Formulas from 29.3.2

qz = 0.00256 Kz Kzt Kd V^2 = 0.00256 (0.85) (1.0) (0.85) (150)^2 = 41 psf

p = qz G Cw

Using Figure 27.4-5 For Pitched Free Roofs 15 deg Case A and Case B:

Direction 0 deg in X
Case A CNW = (41) (0.85) (1.1) = 38 psf
Case A CNL = (41) (0.85) (-0.4) = -14 psf
Case B CNW = (41) (0.85) (0.1) = 4 psf
Case B CNL = (41) (0.85) (-1.1) = -38 psf

Using Figure 27.4-6 For Throughed Free Roofs 15 deg Case A and Case B:

Direction 0 in Y
Case A CNW = (41) (0.85) (-1.1) = -38 psf
Case A CNL = (41) (0.85) (0.4) = 14 psf
Case B CNW = (41) (0.85) (0.1) = 4 psf
Case B CNL = (41) (0.85) (1.1) = 38 psf

LOAD COMBINATIONS (ASD for Steel Design):

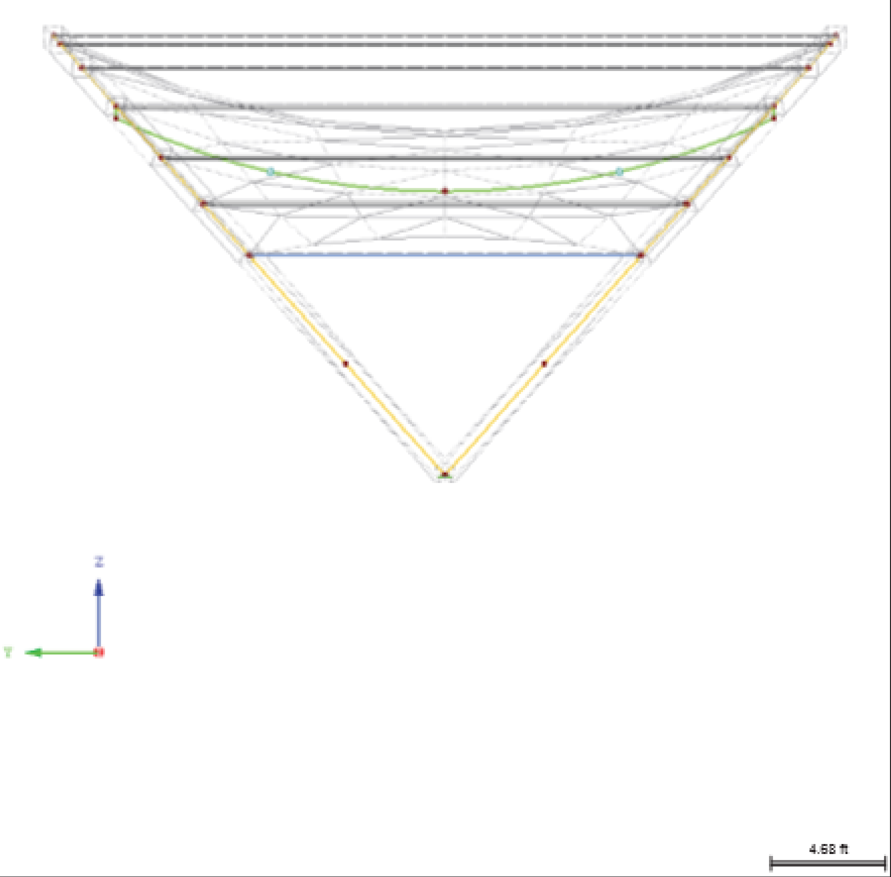
DL + LL/SL
DL + 0.6WL (all cases)
DL + .75 LL + 0.45 WL (all cases)

LOAD COMBINATIONS (LRFD for Footing and Anchor Design):

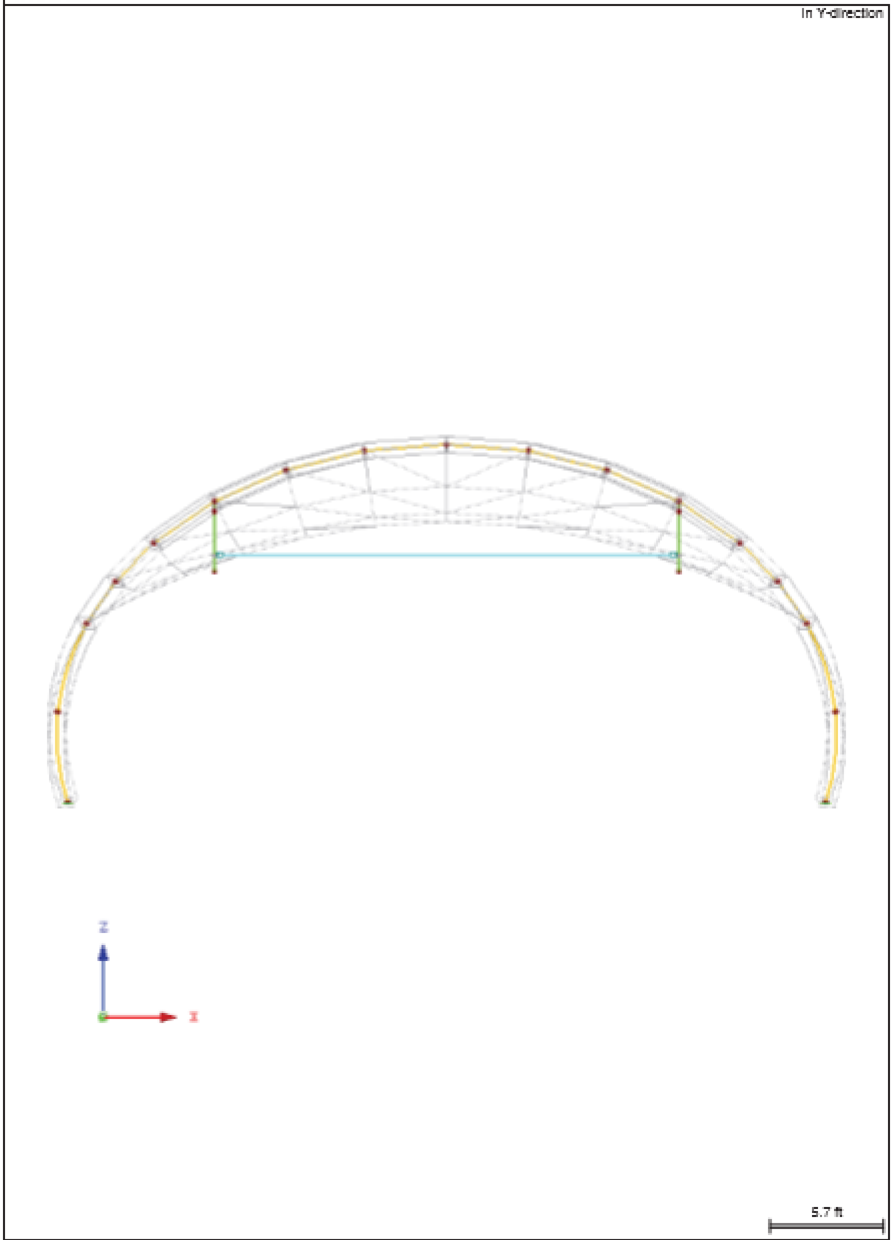
1.2DL + 0.5 LL/SL + 1.0 WL (all cases)
1.2DL + 1.6 LL/SL + 0.5 WL (all cases)

MODEL

In X-direction

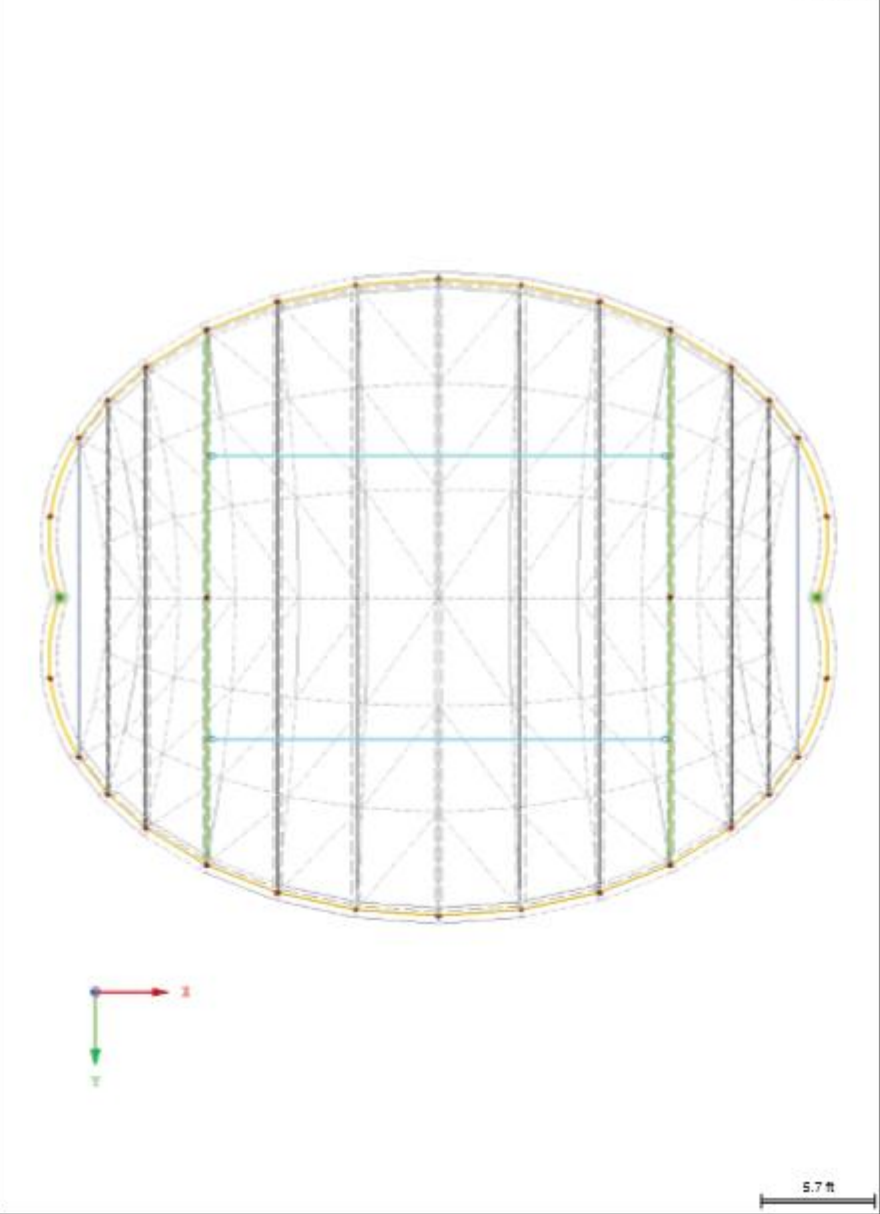


■ MODEL



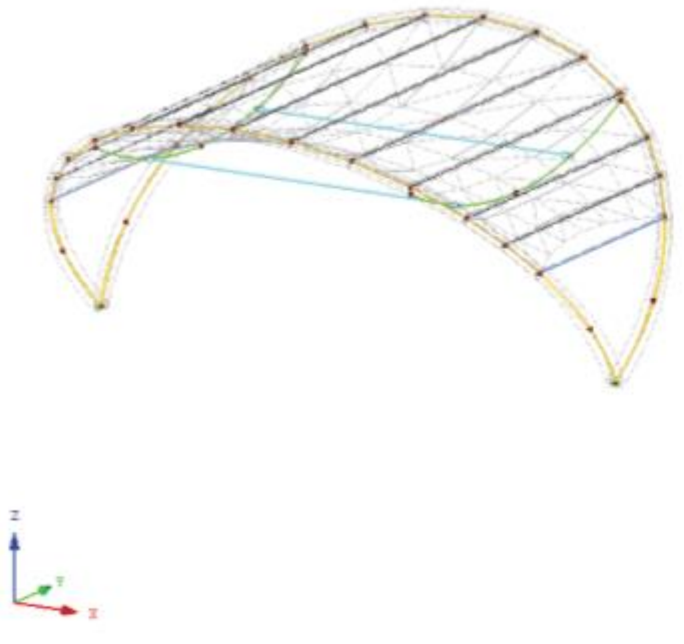
MODEL

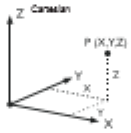
In Z-direction



MODEL

Isometric





1.1 NODES

Node No.	Node Type	Reference Node	Coordinate System	Node Coordinates X [ft]	Y [ft]	Z [ft]	Comment
1	Standard	-	Cartesian	0.00	0.00	0.00	
2	Standard	-	Cartesian	38.00	0.00	0.00	
3	Standard	-	Cartesian	-0.47	-4.05	4.58	
4	Standard	-	Cartesian	38.47	-4.05	4.58	
5	Standard	-	Cartesian	-0.47	4.05	4.58	
6	Standard	-	Cartesian	38.47	4.05	4.58	
7	Standard	-	Cartesian	0.96	-8.00	9.00	
8	Standard	-	Cartesian	37.04	-8.00	9.00	
9	Standard	-	Cartesian	0.96	8.00	9.00	
10	Standard	-	Cartesian	37.04	8.00	9.00	
11	Standard	-	Cartesian	2.42	-9.88	11.12	
12	Standard	-	Cartesian	35.58	-9.88	11.12	
13	Standard	-	Cartesian	2.42	9.88	11.12	
14	Standard	-	Cartesian	35.58	9.88	11.12	
15	Standard	-	Cartesian	7.38	0.00	11.83	
16	Standard	-	Cartesian	30.64	0.00	11.83	
17	On Line	13	Cartesian	7.38	-7.13	12.44	
18	On Line	14	Cartesian	30.64	-7.13	12.44	
19	On Line	13	Cartesian	7.38	7.13	12.44	
20	On Line	14	Cartesian	30.64	7.13	12.44	
21	Standard	-	Cartesian	4.31	-11.58	13.03	
22	Standard	-	Cartesian	33.69	-11.58	13.03	
23	Standard	-	Cartesian	4.31	11.58	13.03	
24	Standard	-	Cartesian	33.69	11.58	13.03	
25	Standard	-	Cartesian	7.38	-13.45	14.83	
26	Standard	-	Cartesian	30.64	-13.45	14.83	
27	Standard	-	Cartesian	7.38	13.45	14.83	
28	Standard	-	Cartesian	30.64	13.45	14.83	
29	Standard	-	Cartesian	7.38	-13.45	15.13	
30	Standard	-	Cartesian	30.64	-13.45	15.13	
31	Standard	-	Cartesian	7.38	13.45	15.13	
32	Standard	-	Cartesian	30.64	13.45	15.13	
33	Standard	-	Cartesian	10.94	-14.84	16.70	
34	Standard	-	Cartesian	27.06	-14.84	16.70	
35	Standard	-	Cartesian	10.94	14.84	16.70	
36	Standard	-	Cartesian	27.06	14.84	16.70	
37	Standard	-	Cartesian	14.88	-15.71	17.87	
38	Standard	-	Cartesian	23.12	-15.71	17.87	
39	Standard	-	Cartesian	14.88	15.71	17.87	
40	Standard	-	Cartesian	23.12	15.71	17.87	
41	Standard	-	Cartesian	19.00	-16.00	18.00	
42	Standard	-	Cartesian	19.00	16.00	18.00	

1.2 LINES

Line No.	Line Type	Nodes No.	Line Length L [ft]		Comment
1	Arc	1,3,7	12.28		
2	Arc	8,4,2	12.28		
3	Arc	9,5,1	12.28		
4	Arc	2,6,10	12.28		
5	Polyline	7,9	16.00	Y	
6	Polyline	10,8	16.00	Y	
7	Polyline	11,7	3.18		
8	Polyline	8,12	3.18		
9	Polyline	9,13	3.18		
10	Polyline	14,10	3.18		
11	Polyline	11,13	19.76	Y	
12	Polyline	14,12	19.76	Y	
13	Arc	25,15,27	27.78	YZ	
14	Arc	26,16,28	27.78	YZ	
15	Polyline	21,11	3.18		
16	Polyline	12,22	3.18		
17	Polyline	13,23	3.18		
18	Polyline	24,14	3.18		
19	Polyline	17,18	23.27	X	
20	Polyline	19,20	23.27	X	
21	Polyline	21,23	23.16	Y	
22	Polyline	22,24	23.16	Y	
23	Polyline	29,21	4.15		
24	Polyline	22,30	4.15		
25	Polyline	23,31	4.15		
26	Polyline	32,24	4.15		
27	Polyline	29,25	0.30	Z	
28	Polyline	30,26	0.30	Z	
29	Polyline	31,27	0.30	Z	
30	Polyline	32,28	0.30	Z	
31	Polyline	29,31	26.89	Y	
32	Polyline	32,30	26.89	Y	
33	Polyline	33,29	4.15		
34	Polyline	30,34	4.15		
35	Polyline	31,35	4.15		
36	Polyline	36,32	4.15		
37	Polyline	33,35	29.69	Y	
38	Polyline	36,34	29.69	Y	

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MODEL

Project: | Model: Indian Riverside Park V2 | Date: 11/29/2019

1.2 LINES

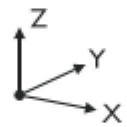
Line No.	Line Type	Nodes No.	Line Length L [ft]		Comment
39	Polyline	37,33	4.15		
40	Polyline	34,38	4.15		
41	Polyline	35,39	4.15		
42	Polyline	40,36	4.15		
43	Polyline	37,39	31.42	Y	
44	Polyline	40,38	31.42	Y	
45	Polyline	41,37	4.15		
46	Polyline	38,41	4.15		
47	Polyline	39,42	4.15		
48	Polyline	42,40	4.15		
49	Polyline	42,41	32.00	Y	

1.3 MATERIALS

Matl. No.	Modulus E [psi]	Modulus G [psi]	Poisson's Ratio ν [-]	Spec. Weight γ [lbf/in³]	Coeff. of Th. Exp. α [1/°C]	Partial Factor γ_M [-]	Material Model
1	Cable PE (Pfeifer) | Z-14.7-411						
	16854900.0	7251690.0	0.300	0.2947	1.80E-05	1.10	Isotropic Linear Elastic
2	HDPE Mesh						
				0.0090	0.00E+00	1.00	Orthotropic Elastic 2D...
	Additional material parameters are defined in the Material Model dialog box						
3	Steel A500, Grade B (Shapes) | ANSI/AISC 360-05:2005-03						
	28998600.0	11153300.0	0.300	0.2892	1.20E-05	1.00	Isotropic Linear Elastic
4	Steel A500, Grade B (Rounds) | ANSI/AISC 360-16:2016						
	28998600.0	11153300.0	0.300	0.2892	1.20E-05	1.00	Isotropic Linear Elastic
5	PVC-P | No code						
	76870.0	26506.9	0.450	0.0472	1.95E-04	1.00	Isotropic Linear Elastic
6	Steel A36 | ANSI/AISC 360-16:2016						
	29000000.0	11200000.0	0.295	0.2892	1.20E-05	1.00	Isotropic Linear Elastic
7	Concrete C30/37 | DIN 1045-1:2008-08						
	4104570.0	1710240.0	0.200	0.0921	1.00E-05	1.00	Isotropic Linear Elastic
	Beton C30/37						
8	Steel S 235 | DIN EN 1993-1-1:2010-12						
	30457900.0	11714600.0	0.300	0.2892	1.20E-05	1.00	Isotropic Linear Elastic
	Baustahl S 235						

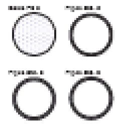
1.4 SURFACES

Surface No.	Surface Type Geometry	Surface Type Stiffness	Boundary Lines No.	Matl. No.	Thickness Type	Thickness d [in]	Area A [ft²]	Weight W [lb]
1	Quadrangle	Membrane - Isotropic	7,5,9,11	5	Constant	0.1	39.25	20.9
2	Quadrangle	Membrane - Isotropic	10,6,8,12	5	Constant	0.1	39.25	20.9
3	Quadrangle	Membrane - Isotropic	11,17,21,15	5	Constant	0.1	51.61	27.5
4	Quadrangle	Membrane - Isotropic	22,18,12,16	5	Constant	0.1	51.61	27.5
5	Quadrangle	Membrane - Isotropic	23,21,25,31	5	Constant	0.1	85.09	45.3
6	Quadrangle	Membrane - Isotropic	26,22,24,32	5	Constant	0.1	85.09	45.3
7	Quadrangle	Membrane - Isotropic	33,31,35,37	5	Constant	0.1	103.24	55.0
8	Quadrangle	Membrane - Isotropic	36,32,34,38	5	Constant	0.1	103.24	55.0
9	Quadrangle	Membrane - Isotropic	39,37,41,43	5	Constant	0.1	117.01	62.3
10	Quadrangle	Membrane - Isotropic	42,38,40,44	5	Constant	0.1	117.01	62.3
11	Quadrangle	Membrane - Isotropic	45,43,47,49	5	Constant	0.1	124.49	66.3
12	Quadrangle	Membrane - Isotropic	48,44,46,49	5	Constant	0.1	124.49	66.3



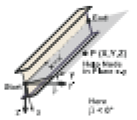
1.7 NODAL SUPPORTS

Support No.	Nodes No.	Axis System	Column in Z	Support Conditions u_X	u_Y	u_Z	φ_X	φ_Y	φ_Z
1	1,2	Global X,Y,Z	☐	☒	☒	☒	☒	☒	☒



1.13 CROSS-SECTIONS

Section No.	Matl. No.	J [in⁴] / A [in²]	I_y [in⁴] / A_y [in²]	I_z [in⁴] / A_z [in²]	Principal Axes α [°]	Rotation α' [°]	Overall Dimensions [in] Width b	Height h
1	Cable PE 5 | Pfeifer							
	1	0.0	0.0	0.0	0.00	0.00	0.22	0.22
		0.1	0.0	0.0				
2	Pipes Std. 8 | AISC 15							
	4	136.0	68.1	68.1	0.00	0.00	8.63	8.63
		7.8	3.9	3.9				
3	Pipes Std. 5 | AISC 15							
	4	28.6	14.3	14.3	0.00	0.00	5.56	5.56
		4.0	2.0	2.0				
4	Pipes Std. 6 | AISC 15							
	4	52.9	26.5	26.5	0.00	0.00	6.63	6.63
		5.2	2.6	2.6				



1.17 MEMBERS

Mbr. No.	Line No.	Member	Rotation Type	β [°]	Cross-Section Start	End	Hinge No. Start	End	Ecc. No.	Div. No.	Length L [ft]	
1	1	Beam	Angle	0.00	2	2	-	-	-	-	12.28	
2	2	Beam	Angle	0.00	2	2	-	-	-	-	12.28	
3	3	Beam	Angle	0.00	2	2	-	-	-	-	12.28	
4	4	Beam	Angle	0.00	2	2	-	-	-	-	12.28	
5	5	Cable	Angle	0.00	1	1	-	-		-	16.00	Y
6	6	Cable	Angle	0.00	1	1	-	-		-	16.00	Y
7	7	Beam	Angle	0.00	2	2	-	-	-	-	3.16	
8	8	Beam	Angle	0.00	2	2	-	-	-	-	3.16	
9	9	Beam	Angle	0.00	2	2	-	-	-	-	3.16	
10	10	Beam	Angle	0.00	2	2	-	-	-	-	3.16	
11	13	Beam	Angle	0.00	4	4	-	-	-	-	27.78	YZ
12	14	Beam	Angle	0.00	4	4	-	-	-	-	27.78	YZ
13	15	Beam	Angle	0.00	2	2	-	-	-	-	3.16	
14	16	Beam	Angle	0.00	2	2	-	-	-	-	3.16	
15	17	Beam	Angle	0.00	2	2	-	-	-	-	3.16	
16	18	Beam	Angle	0.00	2	2	-	-	-	-	3.16	
17	19	Beam	Angle	0.00	3	3	2	2	-	-	23.27	X
18	20	Beam	Angle	0.00	3	3	2	2	-	-	23.27	X
19	23	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
20	24	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
21	25	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
22	26	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
23	27	Beam	Angle	0.00	4	4	-	-	-	-	0.50	Z
24	28	Beam	Angle	0.00	4	4	-	-	-	-	0.50	Z
25	29	Beam	Angle	0.00	4	4	-	-	-	-	0.50	Z
26	30	Beam	Angle	0.00	4	4	-	-	-	-	0.50	Z
27	33	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
28	34	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
29	35	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
30	36	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
31	39	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
32	40	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
33	41	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
34	42	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
35	45	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
36	46	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
37	47	Beam	Angle	0.00	2	2	-	-	-	-	4.15	
38	48	Beam	Angle	0.00	2	2	-	-	-	-	4.15	

1.21 SETS OF MEMBERS

Set No.	Set of Members Description	Type	Member No.	Length [ft]	Comment
1	Continuous Members 1	Contin. member	2,8,14,20,28,32,38,35,31,27,19,13,7,1	70.45	
2	Continuous Members 2	Contin. member	4,10,16,22,30,34,38,37,33,29,21,15,9,3	70.45	

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PO Box 816151
Dallas, TX, 75381

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LOADS

Project: Model: Indian Riverside Park V2 Date: 11/29/2019

2.1 LOAD CASES

Load Case	Load Case Description	No Standard Action Category	Self-Weight - Factor in Direction Active	X	Y	Z
LC1	DL	Permanent	☒	0.000	0.000	-1.000
LC2	LL/SL	Snow / Ice	☐			
LC3	WLXA	Wind	☐			
LC4	WLXB	Wind	☐			
LC5	WLYA	Wind	☐			
LC6	WLYB	Wind	☐			
Form-Finding			☐			

2.5 LOAD COMBINATIONS

Load Combin.	DS	Load Combination Description	No.	Factor	Load Case	
CO1		DL + LL	1	1.00	LC1	DL
			2	1.00	LC2	LL/SL
CO2		DL + 0.6+WLXA	1	1.00	LC1	DL
			2	0.60	LC3	WLXA
CO3		DL + 0.6+WLXB	1	1.00	LC1	DL
			2	0.60	LC4	WLXB
CO4		DL + 0.6WLYA	1	1.00	LC1	DL
			2	0.60	LC5	WLYA
CO5		DL + 0.6WLYB	1	1.00	LC1	DL
			2	0.60	LC6	WLYB
CO6		DL + .75 LL + .45 +WLXA	1	1.00	LC1	DL
			2	0.75	LC2	LL/SL
			3	0.45	LC3	WLXA
CO7		DL + .75 LL + .45 +WLXB	1	1.00	LC1	DL
			2	0.75	LC2	LL/SL
			3	0.45	LC4	WLXB
CO8		DL + .75 LL + .45 WLYA	1	1.00	LC1	DL
			2	0.75	LC2	LL/SL
			3	0.45	LC5	WLYA
CO9		DL + .75 LL + .45 WLYB	1	1.00	LC1	DL
			2	0.75	LC2	LL/SL
			3	0.45	LC6	WLYB
CO10		1.2DL + 0.5LL + 1.0WLXA	1	1.20	LC1	DL
			2	0.50	LC2	LL/SL
			3	1.00	LC3	WLXA
CO11		1.2DL + 0.5LL + 1.0WLXB	1	1.20	LC1	DL
			2	0.50	LC2	LL/SL
			3	1.00	LC4	WLXB
CO12		1.2DL + 0.5LL + 1.0WLYA	1	1.20	LC1	DL
			2	0.50	LC2	LL/SL
			3	1.00	LC5	WLYA
CO13		1.2DL + 0.5LL + 1.0WLYB	1	1.20	LC1	DL
			2	0.50	LC2	LL/SL
			3	1.00	LC6	WLYB
CO14		1.2D + 1.6LL + 0.5WLXA	1	1.20	LC1	DL
			2	0.50	LC2	LL/SL
			3	0.50	LC3	WLXA
CO15		1.2D + 1.6LL + 0.5WLXB	1	1.20	LC1	DL
			2	0.50	LC2	LL/SL
			3	0.50	LC4	WLXB
CO16		1.2D + 1.6LL + 0.5WLYA	1	1.20	LC1	DL
			2	0.50	LC2	LL/SL
			3	0.50	LC5	WLYA
CO17		1.2D + 1.6LL + 0.5WLYB	1	1.20	LC1	DL
			2	0.50	LC2	LL/SL
			3	0.50	LC6	WLYB

2.7 RESULT COMBINATIONS

Result Combin	Description	Loading
RC1	ASD Combinations	CO1 or to CO9
RC2	LRFD Combinations	CO10 or to CO17

LC2
LL/SL

3.2 MEMBER LOADS

LC2: LL/SL

No.	Reference to	On Members No.	Load Type	Load Distribution	Load Direction	Reference Length	Load Parameters Symbol	Value	Unit
1	Members	17,15	Force	Uniform	ZL	True Length	p	-50.0	lbf/ft

3.2/1 MEMBER LOADS - LOAD ECCENTRICITY

LC2: LL/SL

No.	Reference to	On Members No.	Absolute Offset Mbr. Start		Absolute Offset Mbr. End		Relative Offset Mbr. Start		Relative Offset Mbr. End	
			e_y [in]	e_z [in]	e_y [in]	e_z [in]	y-Axis	z-Axis	y-Axis	z-Axis
1	Members	17,18	0.00	0.00	0.00	0.00	Middle	Middle	Middle	Middle

3.4 SURFACE LOADS

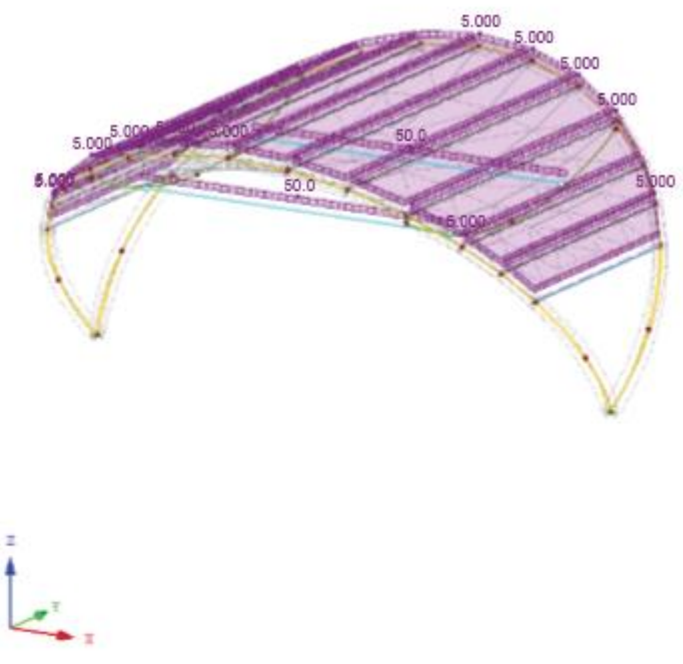
LC2: LL/SL

No.	On Surfaces No.	Load Type	Load Distribution	Load Direction	Symbol	Load Parameters Value	Unit
1	1-12	Force	Uniform	ZL	p	-5.000	psf

LC2: LL/SL

LC 2: LL/SL
Loads [lbf/ft], [psf]

Isometric



LC3
WLXA

3.4 SURFACE LOADS

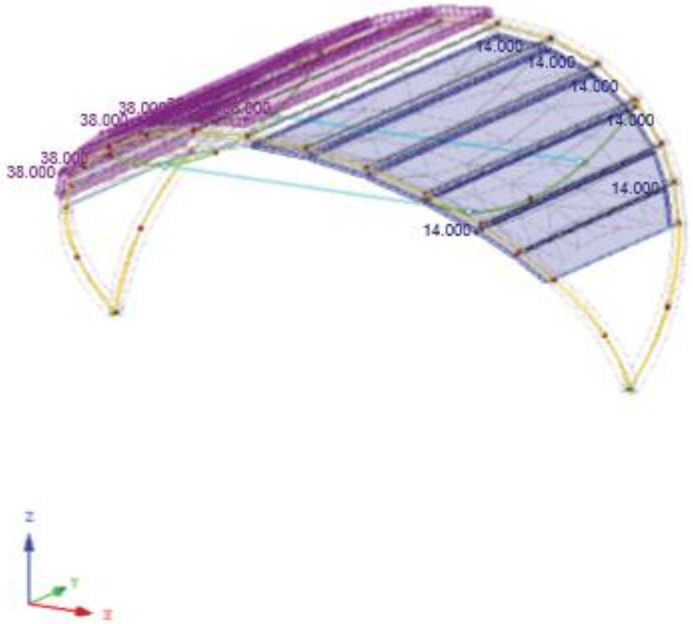
LC3: WLXA

No.	On Surfaces No.	Load Type	Load Distribution	Load Direction	Symbol	Load Parameters Value	Unit
1	1,3,5,7,9,11	Force	Uniform	z	p	-35.000	psf
2	2,4,6,8,10,12	Force	Uniform	z	p	14.000	psf

LC3: WLXA

LC 3: WLXA
Loads [psf]

Isometric



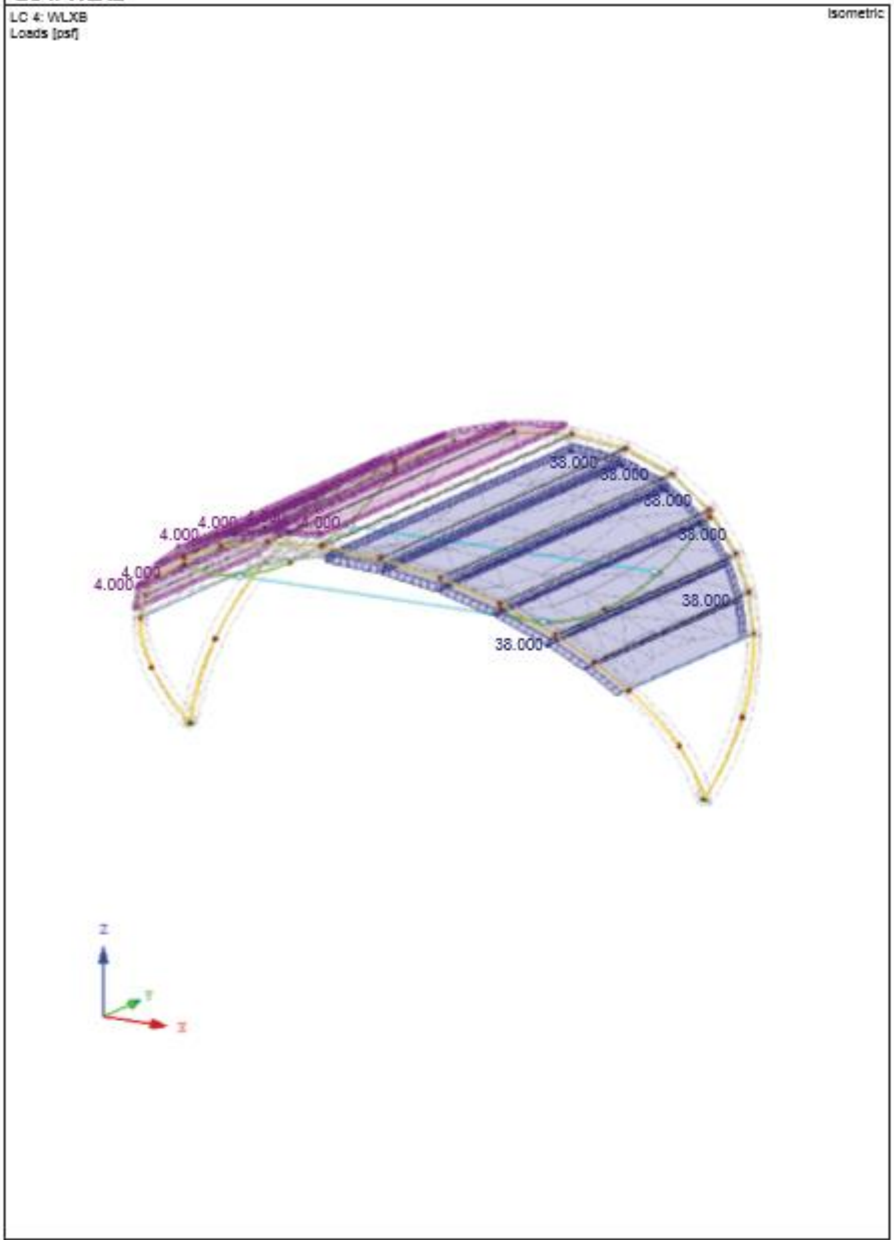
LC4
WLXB

3.4 SURFACE LOADS

LC4: WLXB

No.	On Surfaces No.	Load Type	Load Distribution	Load Direction	Symbol	Load Parameters Value	Unit
1	1,3,5,7,9,11	Force	Uniform	z	p	-4.000	psf
2	2,4,6,8,10,12	Force	Uniform	z	p	38.000	psf

LC4: WLXB


LC 4: WLXB
Loads [psf]
Isometric
4.000
4.000
4.000
4.000
38.000
38.000
38.000
38.000
38.000
38.000
Z
Y
X

LC5
WLYA

3.4 SURFACE LOADS

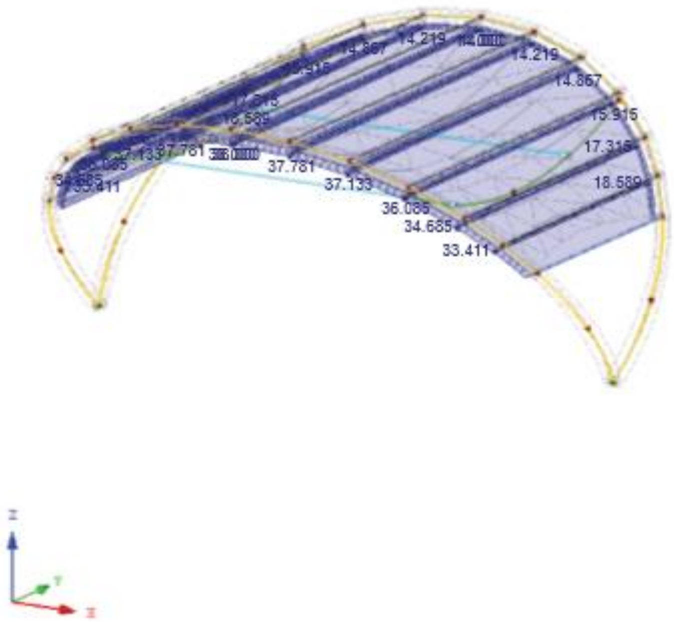
LC5: WLYA

No.	On Surfaces No.	Load Type	Load Distribution	Load Direction	Load Parameters Symbol	Value	Unit	On Node No.
2	1-12	Force	Linear in Y	z	p_1	38.000	psf	41
					p_2	14.000	psf	42

LC5: WLYA

LC 5: WLYA
Loads [psf]

Isometric



LC6
WLYB

3.4 SURFACE LOADS

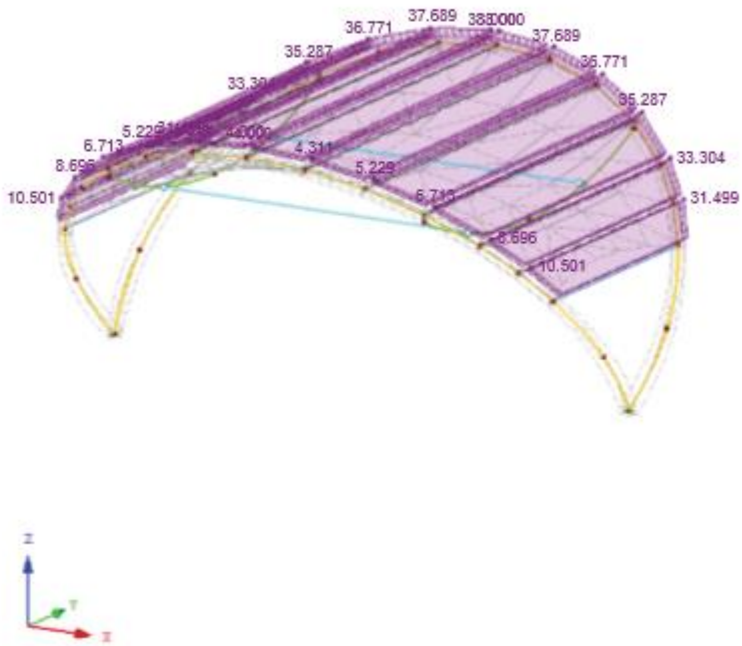
LC6: WLYB

No.	On Surfaces No.	Load Type	Load Distribution	Load Direction	Load Parameters Symbol	Value	Unit	On Node No.
2	1-12	Force	Linear in Y	z	p_1	-4.000	psf	41
					p_2	-38.000	psf	42

LC6: WLYB

LC 6: WLYB
Loads [psf]

Isometric



■ 4.1 NODES - SUPPORT FORCES

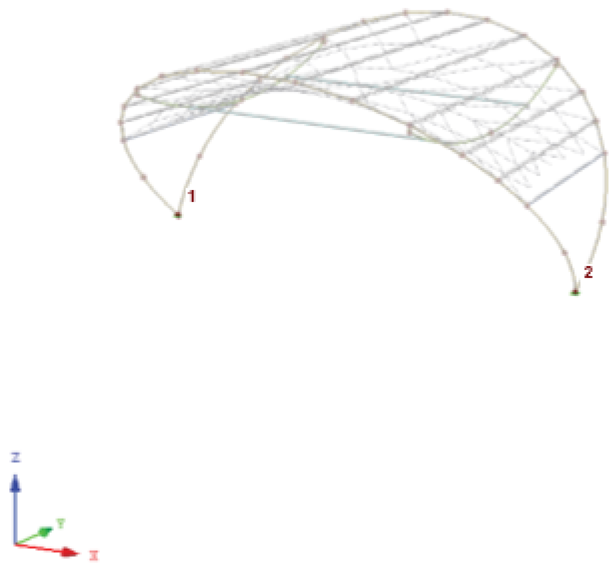
Node No.	LC/CO	Support Forces [lbf] P_X	P_Y	P_Z	Support Moments [lbft] M_X	M_Y	M_Z	
1	Form-Finding	184.8	0.0	0.0	0.0	1392.1	0.0	
	CO1	-3238.9	0.0	-6815.7	0.0	-14985.8	0.0	DL + LL
	CO2	-311.8	0.0	-9444.9	0.0	12745.0	0.0	DL + 0.6+WLXA
	CO3	5039.5	0.0	-425.7	0.0	38801.0	0.0	DL + 0.6+WLXB
	CO4	4932.0	424.7	4425.7	-20748.4	27793.7	5584.3	DL + 0.6WLYA
	CO5	-4098.9	709.4	-9085.7	-32088.5	-18419.3	8570.3	DL + 0.6WLYB
	CO6	-2388.4	0.0	-10871.0	0.0	-1005.2	0.0	DL + .75 LL + .45 +WLXA
	CO7	1817.8	0.0	-3951.1	0.0	17428.3	0.0	DL + .75 LL + .45 +WLXB
	CO8	1418.4	343.8	-257.2	-16169.5	9415.1	4457.4	DL + .75 LL + .45 WLYA
	CO9	-4913.0	545.2	-10388.8	-24434.2	-22355.5	6389.7	DL + .75 LL + .45 WLYB
	CO10	-1351.1	0.0	-16191.0	0.0	18277.3	0.0	1.2DL + 0.5LL + 1.0WLXA
	CO11	7320.2	0.0	-1123.4	0.0	54147.5	0.0	1.2DL + 0.5LL + 1.0WLXB
	CO12	7031.5	891.2	6891.4	-34008.4	39581.0	8846.8	1.2DL + 0.5LL + 1.0WLYA
	CO13	-7373.5	1203.3	-15550.3	-54946.1	-33487.5	14083.9	1.2DL + 0.5LL + 1.0WLYB
	CO14	-1951.5	0.0	-10873.8	0.0	2401.5	0.0	1.2D + 1.6LL + 0.5WLXA
	CO15	2507.8	0.0	-3387.7	0.0	22883.2	0.0	1.2D + 1.6LL + 0.5WLXB
	CO16	2346.4	372.5	695.3	-17768.7	14398.8	4557.3	1.2D + 1.6LL + 0.5WLYA
	CO17	-4895.1	600.9	-10556.7	-27080.8	-22272.5	7133.8	1.2D + 1.6LL + 0.5WLYB
2	Form-Finding	-184.8	0.0	0.0	0.0	-1392.1	0.0	
	CO1	3238.9	0.0	-6815.7	0.0	14985.8	0.0	DL + LL
	CO2	4151.4	0.0	-3579.4	0.0	29489.1	0.0	DL + 0.6+WLXA
	CO3	-1728.4	0.0	4057.4	0.0	-4417.4	0.0	DL + 0.6+WLXB
	CO4	-4932.0	424.7	4425.7	-20748.4	-27793.7	-5584.3	DL + 0.6WLYA
	CO5	4098.9	709.4	-9085.7	-32088.5	18419.3	-8570.3	DL + 0.6WLYB
	CO6	5231.8	0.0	-6251.7	0.0	32826.2	0.0	DL + .75 LL + .45 +WLXA
	CO7	751.7	0.0	-481.8	0.0	7358.2	0.0	DL + .75 LL + .45 +WLXB
	CO8	-1418.4	343.8	-257.2	-16169.5	-9415.1	-4457.4	DL + .75 LL + .45 WLYA
	CO9	4913.0	545.2	-10388.8	-24434.2	22355.5	-6389.7	DL + .75 LL + .45 WLYB
	CO10	7554.0	0.0	-6443.2	0.0	52198.8	0.0	1.2DL + 0.5LL + 1.0WLXA
	CO11	-1788.8	0.0	6195.8	0.0	-1881.8	0.0	1.2DL + 0.5LL + 1.0WLXB
	CO12	-7031.5	891.2	6891.4	-34008.4	-39581.0	-8846.8	1.2DL + 0.5LL + 1.0WLYA
	CO13	7373.5	1203.3	-15550.3	-54946.1	33487.5	-14083.9	1.2DL + 0.5LL + 1.0WLYB
	CO14	5124.1	0.0	-5971.0	0.0	32950.8	0.0	1.2D + 1.6LL + 0.5WLXA
	CO15	187.5	0.0	425.5	0.0	4630.8	0.0	1.2D + 1.6LL + 0.5WLXB
	CO16	-2346.4	372.5	695.3	-17768.7	-14398.8	-4557.3	1.2D + 1.6LL + 0.5WLYA
	CO17	4895.1	600.9	-10556.7	-27080.8	22272.5	-7133.8	1.2D + 1.6LL + 0.5WLYB

Rocky Summit Engineering Consulting, LLC PO Box 816151 Dallas, TX, 75381	Page: 22/25 Sheet: 1 RESULTS
Project: Model: Indian Riverside Park V2	Date: 11/29/2019

MODEL

Node Numbering
Set of Members Numbering

Perspective



RF-STEEL AISC
CA1
Design of steel members according to AISC (LRFD or ASD)

1.1 GENERAL DATA

Members to design:	1-4,7-35	
Sets of members to design:	1,2	
Standard:	ASD 2010	
Ultimate Limit State Design		
Load combinations to design:	CO1	DL + LL
	CO2	DL + 0.6+WLXA
	CO3	DL + 0.6+WLXB
	CO4	DL + 0.6WLYA
	CO5	DL + 0.6WLYB
	CO6	DL + .75 LL + .45 +WLXA
	CO7	DL + .75 LL + .45 +WLXB
	CO8	DL + .75 LL + .45 WLYA
	CO9	DL + .75 LL + .45 WLYB
Serviceability Limit State Design		
Load combinations to design:	CO1	DL + LL
	CO2	DL + 0.6+WLXA
	CO3	DL + 0.6+WLXB
	CO4	DL + 0.6WLYA
	CO5	DL + 0.6WLYB
	CO6	DL + .75 LL + .45 +WLXA
	CO7	DL + .75 LL + .45 +WLXB
	CO8	DL + .75 LL + .45 WLYA
	CO9	DL + .75 LL + .45 WLYB

1.2 MATERIALS

Matl. No.	Material Description	E-Modulus E [psi]	Shear Modulus G [psi]	Poisson's Ratio v [-]	Yield Stress f_y [psi]	Max. Thickness t [in]
4	Steel A500, Grade B (Rounds) | ANSI/AISC 360-16:2016	2.9000E+07	1.1200E+07	0.300	42000.00	

1.3 CROSS-SECTIONS

Sect. No.	Matl. No.	Cross-Section Description	Cross-Section Type	Max Design Ratio	Comment
2	4	Pipes Std. 8 | AISC 15	Pipe	0.78	
3	4	Pipes Std. 5 | AISC 15	Pipe	0.65	
4	4	Pipes Std. 6 | AISC 15	Pipe	0.84	

2.2 DESIGN BY CROSS-SECTION

Sect. No.	Member No.	Location x [ft]	LC/CO/RC	Design		Equation No.	Description
2	Pipes Std. 8 | AISC 15						
	7	3.18	CO4	0.01	≤ 1	101)	Chapter D - Tensile strength acc. to D2
	9	0.00	CO9	0.04	≤ 1	102)	Chapter E - Compressive strength acc. to E3
	1	0.00	CO4	0.78	≤ 1	106)	Chapter F - Yielding - Bending about y-axis and/or z-axis acc. to F8 or F11
	1	0.00	CO1	0.00	≤ 1	131)	Chapter F - Local buckling of round HSS does not Apply - acc. to F8
	3	12.27	CO9	0.08	≤ 1	162)	Chapter G - Nominal shear strength in y-axis and/or z-axis - acc. to G6
	9	0.00	CO9	0.08	≤ 1	301)	Chapter E - Flexural buckling about y-axis acc. to E3
	9	0.00	CO9	0.08	≤ 1	311)	Chapter E - Flexural buckling about z-axis acc. to E3
	9	0.00	CO9	0.04	≤ 1	321)	Chapter E - Torsional or flexural-torsional buckling acc. to E4
	1	0.00	CO4	0.78	≤ 1	331)	Chapter H - Biaxial bending without axial forces - acc. to H1.1
	2	12.27	CO2	0.58	≤ 1	332)	Chapter H - Single axis /or biaxial/ flexure with axial compression force - acc. to H1.1
	7	3.18	CO4	0.41	≤ 1	333)	Chapter H - Single axis /or biaxial/ flexure with tensile force - acc. to H1.2
	3	12.27	CO5	0.17	≤ 1	336)	Chapter H - Torsional strength of round and rectangular HSS - acc. to H3.1
	1	0.00	CO4	0.78	≤ 1	343)	Chapter H - HSS subject to combined torsion, shear, flexure and axial force, if Tr ≈ 0.2 Tc - acc. to H3.2
	1	0.00	CO4	0.78	≤ 1	350)	Set of Members - Stability analysis of doubly and singly symmetric members acc. to Chapters E, F and H
	1	0.00	CO1	0.00	≤ 1	400)	Chapter L - Design for Serviceability - Negligible deflections
	31	0.00	CO5	0.43	≤ 1	401)	Chapter L - Design for Serviceability - Deflection in z-direction (Beam)
	35	0.00	CO5	0.55	≤ 1	402)	Chapter L - Design for Serviceability - Deflection in y-direction (Beam)
3	Pipes Std. 5 | AISC 15						
	18	0.00	CO9	0.02	≤ 1	101)	Chapter D - Tensile strength acc. to D2

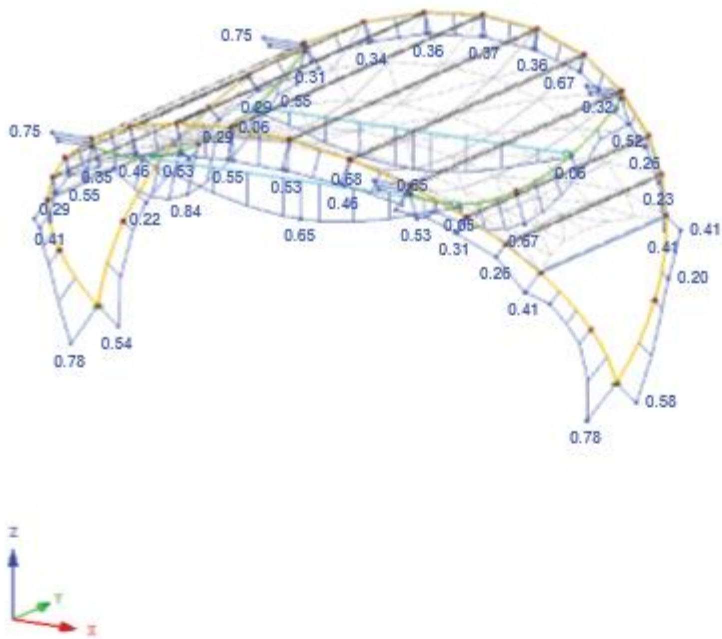
2.2 DESIGN BY CROSS-SECTION

Sect. No.	Member No.	Location x [ft]	LC/CO/ RC	Design		Equation No.	Description
	17	11.84	CO1	0.30	≤ 1	106)	Chapter F - Yielding - Bending about y-axis and/or z-axis acc. to F8 or F11
	17	0.00	CO1	0.00	≤ 1	131)	Chapter F - Local buckling of round HSS does not Apply - acc. to F8
	17	0.00	CO1	0.02	≤ 1	162)	Chapter G - Nominal shear strength in y-axis and/or z-axis - acc. to G6
	17	10.34	CO4	0.02	≤ 1	301)	Chapter E - Flexural buckling about y-axis acc. to E3
	17	10.34	CO4	0.02	≤ 1	311)	Chapter E - Flexural buckling about z-axis acc. to E3
	17	10.34	CO4	0.02	≤ 1	321)	Chapter E - Torsional or flexural-torsional buckling acc. to E4
	17	11.84	CO1	0.30	≤ 1	331)	Chapter H - Biaxial bending without axial forces - acc. to H1.1
	17	11.84	CO4	0.08	≤ 1	332)	Chapter H - Single axis /or biaxial/ flexure with axial compression force - acc. to H1.1
	18	11.84	CO9	0.25	≤ 1	333)	Chapter H - Single axis /or biaxial/ flexure with tensile force - acc. to H1.2
	17	15.52	CO2	0.05	≤ 1	336)	Chapter H - Torsional strength of round and rectangular HSS - acc. to H3.1
	17	11.84	CO7	0.25	≤ 1	343)	Chapter H - HSS subject to combined torsion, shear, flexure and axial force, if Tr ≤ 0.2 Tc - acc. to H3.2
	17	0.00	CO1	0.00	≤ 1	400)	Chapter L - Design for Serviceability - Negligible deflections
	17	11.84	CO1	0.85	≤ 1	401)	Chapter L - Design for Serviceability - Deflection in z-direction (Beam)
	18	11.84	CO9	0.13	≤ 1	402)	Chapter L - Design for Serviceability - Deflection in y-direction (Beam)
4	Pipes Std. 6 | AISC 15						
	11	13.88	CO2	0.05	≤ 1	102)	Chapter E - Compressive strength acc. to E3
	23	0.00	CO2	0.81	≤ 1	106)	Chapter F - Yielding - Bending about y-axis and/or z-axis acc. to F8 or F11
	11	0.00	CO1	0.00	≤ 1	131)	Chapter F - Local buckling of round HSS does not Apply - acc. to F8
	23	0.00	CO2	0.16	≤ 1	162)	Chapter G - Nominal shear strength in y-axis and/or z-axis - acc. to G6
	23	0.00	CO2	0.81	≤ 1	331)	Chapter H - Biaxial bending without axial forces - acc. to H1.1
	11	0.00	CO3	0.58	≤ 1	332)	Chapter H - Single axis /or biaxial/ flexure with axial compression force - acc. to H1.1
	23	0.00	CO4	0.44	≤ 1	336)	Chapter H - Torsional strength of round and rectangular HSS - acc. to H3.1
	23	0.00	CO2	0.81	≤ 1	343)	Chapter H - HSS subject to combined torsion, shear, flexure and axial force, if Tr ≤ 0.2 Tc - acc. to H3.2
	23	0.00	CO3	0.75	≤ 1	344)	Chapter H - HSS subject to combined torsion, shear, flexure and axial force, if Tr ≤ 0.2 Tc - acc. to H3.2
	11	0.00	CO1	0.00	≤ 1	400)	Chapter L - Design for Serviceability - Negligible deflections
	11	13.88	CO2	0.84	≤ 1	401)	Chapter L - Design for Serviceability - Deflection in z-direction (Beam)
	12	13.88	CO6	0.13	≤ 1	402)	Chapter L - Design for Serviceability - Deflection in y-direction (Beam)

DESIGN RATIO

RF-STEEL AISC CA1
Ultimate Limit State
Serviceability Limit State

Isometric



Members Max Design Ratio: 0.84

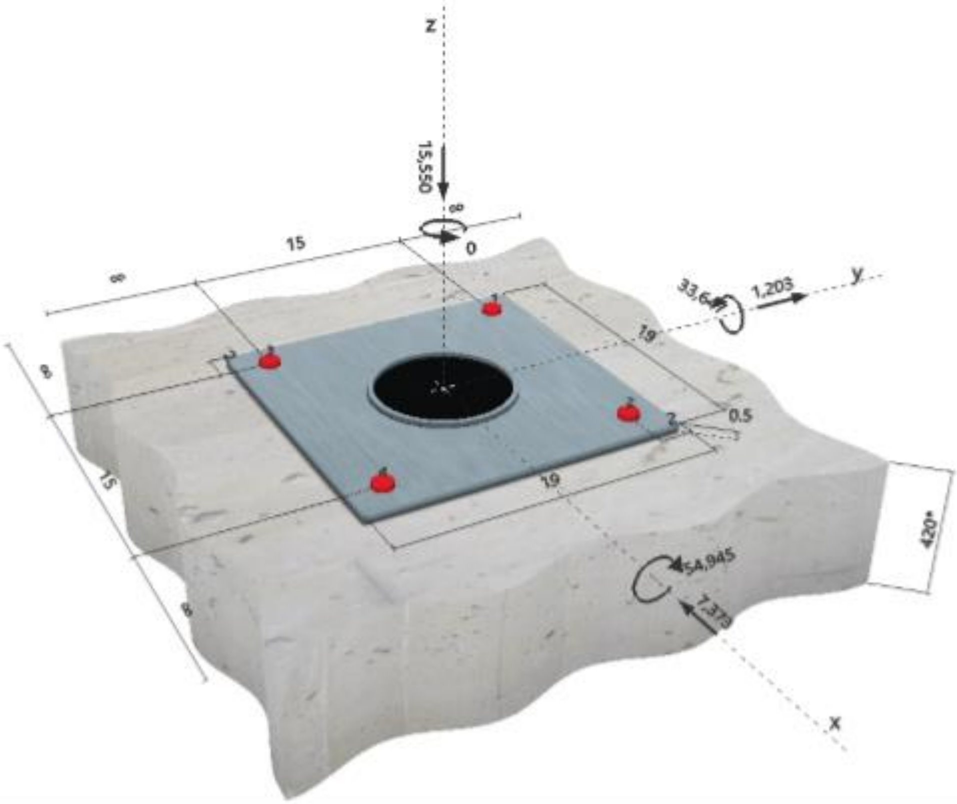
Company:		Page:	1
Specifier:		Project:	Indian Riverside Park
Address:		Sub-Project I Pos. No.:	Anchoring
Phone I Fax:	|	Date:	11/29/2019
E-Mail:			

Specifier's comments:

1 Input data

Anchor type and diameter:	**Heavy Hex Head ASTM F 1554 GR. 36 1 1/4**
Effective embedment depth:	h_{ef} = 12.000 in.
Material:	ASTM F 1554
Proof:	Design method ACI 318-14 / CIP
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate:	l_x x l_y x t = 19.000 in. x 19.000 in. x 0.500 in.; (Recommended plate thickness: not calculated
Profile:	Round HSS, Steel pipe (AISC); (L x W x T) = 8.630 in. x 8.630 in. x 0.322 in.
Base material:	uncracked concrete, 3000, f_c' = 3000 psi; h = 420.000 in.
Reinforcement:	tension: condition A, shear: condition A; anchor reinforcement: tension, shear edge reinforcement: > No. 4 bar with stirrups

Geometry [in.] & Loading [lb, ft.lb]



Company:		Page:	2
Specifier:		Project:	Indian Riverside Park
Address:		Sub-Project I Pos. No.:	Anchoring
Phone I Fax:	|	Date:	11/29/2019
E-Mail:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Steel Strength	24693	42151	59 / -	OK
Shear	Steel Strength	1868	21919	- / 9	OK

Loading	β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
Combined tension and shear loads	0.586	0.085	5/3	43	OK

3 Warnings

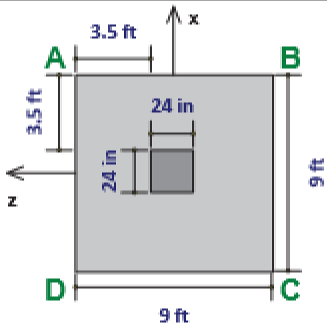
- Please consider all details and hints/warnings given in the detailed report!

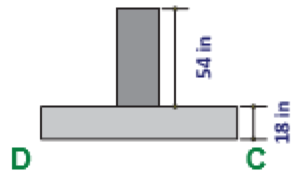
Fastening meets the design criteria!

4 Remarks; Your Cooperation Duties

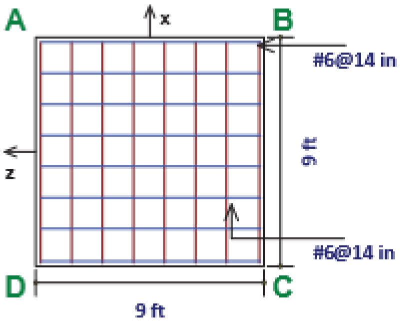
- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

Sketch



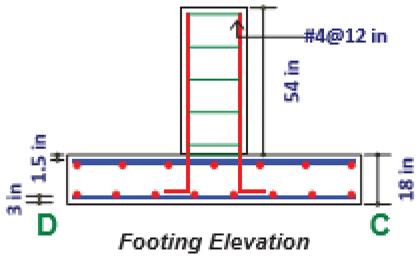


Details



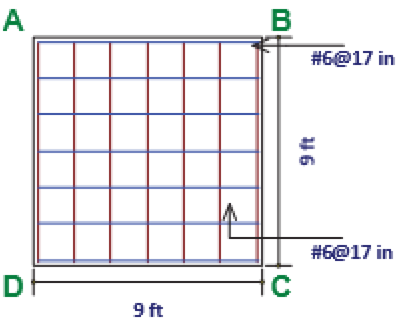
x Dir. Steel: 3.53 in^2 (min)(8 #6)
z Dir. Steel: 3.53 in^2 (min)(8 #6)

Bottom Rebar Plan



Footing Elevation

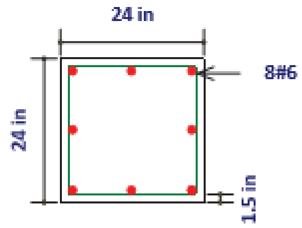
Footing 1 - N1



x Dir. Steel: 3.09 in^2 (min)(7 #6)

z Dir. Steel: 3.09 in^2 (min)(7 #6)

Top Rebar Plan



Pedestal Rebar Plan

Geometry, Materials and Criteria

Length	:9 ft	eX	:0 in	Gross Allow. Bearing	:2 ksf (gross)	Steel fy	:60 ksi
Width	:9 ft	eZ	:0 in	Concrete Weight	:.1 k/ft^3	Minimum Steel	:.0018
Thickness	:18 in	pX	:24 in	Concrete f'c	:3 ksi	Maximum Steel	:.0075
Height	:54 in	pZ	:24 in	Design Code	:ACI 318-14		
Rot. Angle	:0 deg						

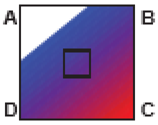
Footing Top Bar Cover	:1.5 in	Overturning / Sliding SF	:1.5	Phi for Flexure	:0.9
Footing Bottom Bar Cover	:3 in	Coefficient of Friction	:0.3	Phi for Shear	:0.75
Pedestal Longitudinal Bar Cover	:1.5 in	Passive Resistance of Soil	:0 lb	Phi for Bearing	:0.65

Loads

	P (lb)	Vx (lb)	Vz (lb)	Mx (lb-ft)	Mz (lb-ft)	Overburden (ksf)
DL						.2
LL	15550	-7373	-1203	54945	-33647	

Soil Bearing

Description	Categories and Factors	Gross Allow.(ksf)	Max Bearing (ksf)	Max/Allowable Ratio
Service	1DL+1LL+1HL	2	1.9 (C)	1



1DL+1LL+1HL
QA: 0 ksf
QB: .5 ksf
QC: 1.9 ksf
QD: .7 ksf
NAZ: 175.5 in
NAX: 142.5 in

Footing Flexure Design (Bottom Bars)

As-min x-dir (Top Flexure): **3.5 in^2**
As-min z-dir (Top Flexure): **3.5 in^2**
As-min x-dir (Bot Flexure): **3.5 in^2**
As-min z-dir (Bot Flexure): **3.5 in^2**
As-min x-dir (T & S): **3.5 in^2**
As-min z-dir (T & S): **3.5 in^2**

Description	Categories and Factors	Mu-xx UC Max	Mu-xx (lb-ft)	z-Dir As Required (in^2)	z-Dir As Provided (in^2)	Mu-zz UC Max	Mu-zz (lb-ft)	x-Dir As Required (in^2)	x-Dir As Provided (in^2)
Strength	1.2DL+1.6LL+1.6HL	.24803	54693.36	.859	3.534	.29204	64398.03	1.012	3.534

Footing Flexure Design (Top Bars)

Description	Categories and Factors	Mu-xx (lb-ft)	z Dir As (in^2)	Mu-zz (lb-ft)	x Dir As (in^2)
SW+OB	1SW+1OB-(Strength, Strength)	7489.5	.1	14357.1	.2

Moment Capacity of Plain Concrete Section Along xx and zz= **63097.6lb-ft,63097.6lb-ft** Per Chapter 22 of ACI 318.

Footing Shear Check

Two Way (Punching) Vc: **4.777e+5 lb** One Way (x Dir. Cut) Vc **1.686e+5 lb** One Way (z Dir. Cut) Vc: **1.686e+5 lb**

Description	Categories and Factors	Punching Vu(lb)	Punching Vu/⌀Vc	x Dir. Cut Vu(lb)	x Dir. Cut Vu/⌀Vc	z Dir. Cut Vu(lb)	z Dir. Cut Vu/⌀Vc
Strength	1.2DL+1.6LL+1.6HL	25167.7	.1	20681.9	.2	24377.4	.2

Pedestal Design

Shear Check Results (Envelope):

	Vc (lb)	Vs (lb)	Vu (lb)	Vu/phi*Vn	phi	Gov LC
Shear Along x Direction:	56853.6	42460.6	11796.8	.2	.8	NC
Shear Along z Direction:	56853.6	42460.6	1924.8		.8	NC

Pedestal Ties : **#4 @ 12 in**

Bending Check Results (Envelope): PCA Load Contour Method (for biaxial)

Unity Check	: .7	Phi	: .9	Parme Beta	: .7
Pu	: 28012 lb	Mux	: 96573.6 lb-ft	Muz	: -1.069e+5 lb-ft
Pn	: 31124.4 lb	Mnx	: 1.073e+5 lb-ft	Mnz	: 1.188e+5 lb-ft
Governing LC	: 2	Mnox	: 2.094e+5 lb-ft	Mnoz	: 2.094e+5 lb-ft
Pedestal Bars	: 8 #6	% Steel	: .6136		

Concrete Bearing Check (Vertical Loads Only)

Bearing Bc : 2.938e+6 lb

Description	Categories and Factors	Bearing Bu (lb)	Bearing Bu/øBc
Strength	1.2DL+1.6LL+1.6HL	28012	

Overturning Check (Service)

Description	Categories and Factors	Mo-xx (lb-ft)	Ms-xx (lb-ft)	Mo-zz (lb-ft)	Ms-zz (lb-ft)	OSF-xx	OSF-zz
Service	1DL+1LL+1HL	62163	2.303e+5	77885	2.303e+5	3.7	3

Mo-xx: Governing Overturning Moment about AD or BC
Ms-xx: Governing Stablizing Moment about AD or BC
OSF-xx: Ratio of Ms-xx to Mo-xx

Sliding Check (Service)

Description	Categories and Factors	Va-xx (lb)	Vr-xx (lb)	Va-zz (lb)	Vr-zz (lb)	SR-xx	SR-zz
Service	1DL+1LL+1HL	7373	15353.2	1203	15353.2	2.1	12.8

Va-xx: Applied Lateral Force to Cause Sliding Along xx Axis
Vr-xx: Resisting Lateral Force Against Sliding Along xx Axis
SR-xx: Ratio of Vr-xx to Va-xx

Geotechnical report

REPORT OF SUBSURFACE SOIL EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION
TUCKAHOE TERRACE AMPHITHEATER
PROPOSED SHADE STRUCTURE
MARTIN COUNTY, FLORIDA

AACE FILE NO. 19-124

ANDERSEN ANDRE CONSULTING ENGINEERS, INC.

834 SW Swan Avenue
Port St. Lucie, Florida 34983
Ph: 772-807-9191 Fx: 772-807-9192
www.aaceinc.com

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REPORT OF SUBSURFACE SOIL EXPLORATION AND
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MARTIN COUNTY, FLORIDA

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PAGE #

ANDERSEN ANDRE CONSULTING ENGINEERS, INC.
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ANDERSEN ANDRE CONSULTING ENGINEERS, INC.
Geotechnical Engineering
Construction Materials Testing
Environmental Consulting

AACE File No. 19-124
February 13, 2019

Martin County Board of County Commissioners
Department of Parks and Recreation
2401 SE Monterey Road
Stuart, FL 34996

Attention: Mr. Todd Foust
Special Facilities Administrator

REPORT OF SUBSURFACE SOIL EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION TUCKAHOE TERRACE AMPHITHEATER - PROPOSED SHADE STRUCTURE MARTIN COUNTY, FLORIDA

1.0 INTRODUCTION

In accordance with your request and authorization, Andersen Andre Consulting Engineers, Inc. (AACE) has completed a subsurface exploration and geotechnical engineering analyses for the above referenced project. The purpose of performing this exploration was to determine shallow soil types and groundwater levels as they relate to the proposed shade structure construction, and restrictions which these soil and groundwater conditions may place on the foundation system. Our work included a Standard Penetration Test (SPT) boring, limited laboratory testing, and engineering analysis. This report documents our explorations and tests, presents our findings, and summarizes our conclusions and recommendations.

2.0 EXECUTIVE SUMMARY

The following summary is intended to provide a brief overview of our findings and recommendations, however, the entire report should be read in its entirety by the project design team members.

- The explored area in the immediate vicinity of the proposed shade structure location was found to be underlain by loose to moderately dense fine sands which are considered satisfactory to support the proposed shade structure construction on the proposed shallow foundation. An allowable foundation bearing pressure of 2,000 pounds per square foot (psf) may be utilized in the foundation design, with a permissible one-third increase in edge pressure for transient loads (i.e. wind loads).

- Site preparation procedures will include clearing, stripping and grubbing of all surface vegetation and organic topsoil, removal of any underground utilities/drainage (if any), followed by compaction efforts in the areas of the proposed shade structure foundations.

- The groundwater table was encountered at a depth of about 10 feet below the existing ground surface. In general, fluctuations in groundwater levels should be anticipated throughout the year primarily due to seasonal variations in rainfall, tidal fluctuations, and other factors that may vary from the time our boring was performed.

3.0 Site and Project Information

3.1 Site Location and Description

The Tuckahoe Terrace Amphitheater is located within the Indian Riverside Park, which in turn is located at 1707 NE Indian River Drive in Jensen Beach, Martin County, Florida (within Section 16, Township 38 South, Range 41 East). The location of the site is graphically depicted on the Site Vicinity Map included on our Sheet No. 1, and on a reproduction of the 2003 USGS Quadrangle Map of "St. Lucie Inlet, Florida" also included on Sheet No. 1. The USGS Quadrangle Map depicts the overall amphitheater site as having surface elevations ranging from about 10 feet to 25 feet relative to the National Geodetic Vertical Datum (NGVD) of 1929, with an estimated ground surface elevation of about 10 feet to 15 feet NGVD near the stage area.

3.2 Review of USDA Soil Survey

According to the USDA NRCS Web Soil Survey, the predominant surficial soil type within the site is the *Paola and St. Lucie sands, 8 to 20 percent slopes (Map Unit ID 77)*. This composite soil type is noted to consist of sandy marine deposits originating from knolls and ridges on historic marine terraces, with sands present to depths in excess of 80 inches and a depth-to-water of more than 80 inches.

The approximate location of the site is shown superimposed on a copy of the USDA Web Soil Survey aerial photograph, presented on Sheet No. 1, and the summary report obtained from the USDA Web Soil Survey is included in Appendix I.

3.3 Project Understanding

Based on our review of the forwarded project-related information, we understand that an approximately 20-ft x 30-ft "Tensoshade™" shade structure is proposed to be installed across the Tuckahoe Terrace Amphitheater stage. The shade structure will be cantilevered and supported on shallow foundations which are proposed to be installed within planters located on either side of the stage. We have not been provided with any structural loads for this structure. However, we expect that the maximum compression column loads will be on the order of 30-50 kips, and that it will be designed (by others) to withstand uplift forces and overturning moments stemming from wind loading.

4.0 Field Exploration Program

To explore subsurface conditions at the site, one (1) Standard Penetration Test (SPT) boring (ASTM D1586) was performed at the approximate location shown on Sheet No. 2. The boring was performed on February 7, 2019 and was completed at a depth of about 20 feet below the existing grades. The boring location shown on Sheet No. 2 was determined in the field by our field crew using the provided site information, obtained aerial photographs, existing site features, and tape/wheel measurements. The boring location should be considered accurate only to the degree implied by the method of measurement used. We anticipate that the actual boring location is within 10 feet of that shown on Sheet No. 2.

A summary of our field procedures is included in Appendix II and the soil boring profile is presented on the attached Sheet No. 2. Samples obtained during performance of the boring were visually classified in the field, and representative portions of the samples were transported to our laboratory in sealed sample jars for further classification. The soil samples recovered from our explorations will be kept in our laboratory for 60 days, then discarded unless you specifically request otherwise.

5.0 OBSERVED SUBSURFACE CONDITIONS

5.1 General Soil Conditions

Detailed subsurface conditions are illustrated on the soil boring profile presented on the attached Sheet No. 2. The stratification of the boring profile represents our interpretation of the field boring log and the results of laboratory examinations of the recovered samples. The stratification lines represent the approximate boundary between soil types. The actual transitions may be more gradual than implied.

In general, at the location and depths explored, our boring encountered loose to moderately dense fine sands from the existing ground surface and reaching the termination depth of about 20 feet below grade.

The above soil profile is outlined in general terms only. Please refer to the attached Sheet No. 2 for soil profile details.

5.2 Measured Groundwater Level

The groundwater table was encountered at a depth of about 10 feet below the existing ground surface, as shown on the boring profile presented on Sheet No. 2. In general, fluctuations in groundwater levels should be anticipated throughout the year primarily due to seasonal variations in rainfall, tidal fluctuations, and other factors that may vary from the time our boring was completed.

6.0 LIMITED LABORATORY TESTING PROGRAM

Our drillers observed the soil recovered from the SPT sampler, placed the recovered soil samples in moisture proof containers, and maintained a log for the boring. The recovered soil samples, along with the field boring log, were transported to our Port St. Lucie soils laboratory where they were visually examined by AACE's project engineer to determine their engineering classification. The visual classification of the samples was performed in accordance with the Unified Soil Classification System, USCS.

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7.0 Geotechnical Engineering Evaluation

Based on the findings of our site exploration, our evaluation of subsurface conditions, and judgment based on our experience with similar projects, we conclude that the soils underlying this site are generally satisfactory to support the proposed shade structure on shallow concrete foundations.

As preparation for the foundation and shade structure construction, the following recommendations are presented:

- Clear, grub, and strip the proposed foundation areas, including an area lying 3 feet outside the foundation perimeter, of all surface vegetation, trash, debris and topsoil. Stumps, underground utilities (if any), etc. should be removed entirely.

- After completion of the clearing preparations discussed above, the excavation for the foundations can proceed. We recommend using excavation equipment with buckets without teeth (i.e. with a smooth edge) to avoid unnecessary disturbance of the foundation soils. Following the foundation excavation, the bottom of the excavation should be compacted so as to densify soils loosened during or after the excavation process, or washed or sloughed into the excavation prior to the placement of forms. It is strongly recommended to utilize foundation forms within the encountered sandy conditions. A heavy vibratory, walk-behind plate compactor can be used for this final densification immediately prior to the placement of reinforcing steel, with the soils being compacted to a dry density of at least 98 percent of the modified Proctor (ASTM D1557) maximum dry density to depths of at least 2 feet below the foundation bearing surface.

- Following removal of foundation forms, backfill around the foundation should be placed in lifts six inches or less in thickness, with each lift individually compacted with a plate tamper. The backfill should be compacted to a dry density of at least 98 percent of the modified Proctor (ASTM D1557) maximum dry density. Proper compaction of backfill around the foundation is imperative.

After the foundation soils have been prepared as recommended above, the site should be suitable for supporting the proposed shade structure construction on a conventional shallow foundation proportioned for an allowable bearing stress of 2,000 pounds per square foot [psf], or less. A one-third increase in edge pressure due to transient loads is permissible. To provide an adequate factor of safety against a shearing failure in the subsoils, the foundations should bear at least 24 inches below adjacent outside final grades.

Based upon the boring information and the provided loading conditions, we estimate that the recommended allowable bearing stress will provide a minimum factor of safety in excess of two against bearing capacity failure. With the site prepared and the foundation designed and constructed as recommended, we anticipate total settlements of one inch or less, and differential settlements of less than one-half of an inch between the two proposed foundations. Because of the granular nature of the subsurface soils, the majority of the settlements should occur during construction; post-construction settlement should be minimal.

Following are conservative estimates of pertinent engineering properties of the shallow subsoils.

Table No. 1 - Soil Parameters

Depth [feet]	Soil Description	Dry Unit Weight [pcf]	Submerged Unit Weight [pcf]	Friction Angle [degrees]	Cohesion [psf]
0-10	Loose to medium dense fine sand	112	62	33	0

The concrete-soil interaction friction angle ϕ_f is estimated to be 26° for the upper loose to moderately dense fine sands. To obtain the coefficient of friction between the concrete foundation and the subgrade soil, use the following equation:

$$\mu = \tan(\phi_f)$$

where μ is the coefficient of friction.

The Rankine coefficients of lateral pressures can be obtained from the following equations:

Active pressure: $K_a = \tan^2(45 - \phi/2)$
Passive pressure: $K_p = \tan^2(45 + \phi/2)$
where ϕ is the friction angle of the soil (see Table 1 above).

We recommend that representatives of AACE inspect foundation excavation in order to verify that footing bearing conditions are consistent with expectations. Foundation concrete should not be cast over a foundation surface containing topsoil or organic soils, trash of any kind, surface made muddy by rainfall runoff, or groundwater rise, or loose soil caused by excavation or other construction work. Reinforcing steel should also be clean at the time of concrete casting. If such conditions develop during construction, the reinforcing steel must be lifted out and the foundation surface reconditioned and approved by AACE. We recommend establishing a suitable quality control program to verify that all site preparation and foundation construction is conducted in accordance with the appropriate plans and specifications. Materials testing and inspection services should be provided by Andersen Andre Consulting Engineers, Inc.

As noted, we understand that the foundation system and shade structure will be designed (by others) to withstand uplift forces and overturning moments stemming from wind loading. We remain available to assist in this regard, if needed.

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8.0 CLOSURE

The geotechnical evaluation submitted herein is based on the data obtained from the soil boring presented on Sheet No. 2 and our previously described understanding of the proposed shade structure construction. Limitations and conditions to this report are presented in Appendix III.

This report has been prepared in accordance with generally accepted soil and foundation engineering practices for the exclusive use of Martin County BOCC for the subject project. No other warranty, expressed or implied, is made.

We are pleased to be of assistance to you on this phase of your project. When we may be of further service to you or should you have any questions, please contact us.

Sincerely,
ANDERSEN ANDRE CONSULTING ENGINEERS, INC.
Certificate of Authorization No. 26794

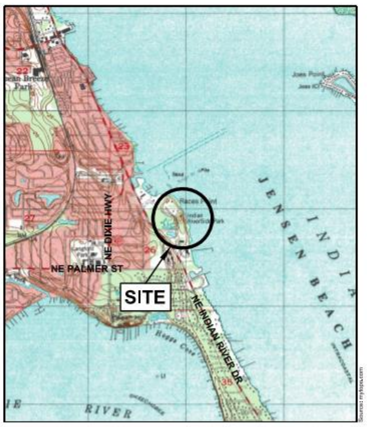
Peter G. Andersen, P.E.
Principal Engineer
Fla. Reg. No. 57956

David P. Andre, P.E.
Principal Engineer
Fla. Reg. No. 53969
2/13/19

PGA/DPA:pa

2018 AERIAL PHOTOGRAPH

USGS TOPOGRAPHIC MAP
(2003 USGS Quadrangle Map of "St. Lucie Inlet, Florida")



USDA NRCS WEB SOIL SURVEY MAP

Section 16
Township 38 South
Range 41 East

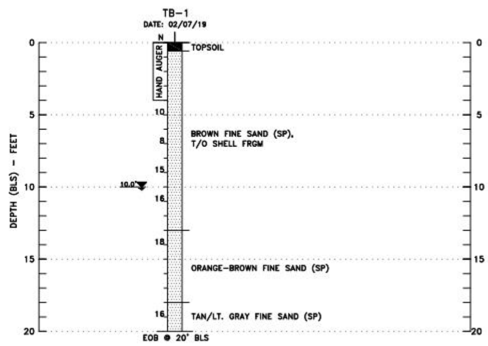
USDA SOIL TYPE ON SUBJECT SITE
(Source: USDA Web Soil Survey)

77: Paola and St. Lucie sands, 8 to 20 percent slopes

NORTH
NOT TO SCALE

ANDERSEN ANDRE CONSULTING ENGINEERS, INC. 834 SW Swan Avenue, Port St. Lucie, FL 34983 772-807-9191 www.AACEInc.com Certificate of Authorization No. 26794	SITE VICINITY MAPS	SUBSURFACE SOIL EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION TUCKAHOE TERRACE AMPHITHEATER PROPOSED SHADE STRUCTURE MARTIN COUNTY, FLORIDA	Drawn by: PGA Checked by: DPA AACE File No: 19-124	Date: February 2019 Date: February 2019 Sheet No. 1

BORING LOCATION PLAN



SOIL GRAPHICAL LEGEND:

- TOPSOIL
- FINE SAND (SP)

DRILLING NOTES:

TB-#	STANDARD PENETRATION TEST BORING (ASTM D1586)
N	SPT RESISTANCE IN BLOWS PER FOOT
X.X'	GROUNDWATER TABLE AT TIME DRILLED (FT BELOW EXIST. GRADE)
EOB	END OF BORING
BLS	BELOW LAND SURFACE
SP:	UNIFIED SOIL CLASSIFICATION SYSTEM [USCS] USCS GROUPS DETERMINED BY VISUAL CLASSIFICATION

NOTES AND LEGEND

TB-# Standard Penetration Test Boring

Shown boring location is approximate and was located using the provided site plan, obtained aerial photographs, existing site features, and tape/wheel measurements. The shown field work locations should be considered accurate only to the degree implied by the method of measurement used.

NORTH
NOT TO SCALE

ANDERSEN ANDRE CONSULTING ENGINEERS, INC. 834 SW Swan Avenue, Port St. Lucie, FL 34983 772-807-9191 www.AACEInc.com Certificate of Authorization No. 26794	BORING LOCATION PLAN AND SOIL BORING PROFILE	SUBSURFACE SOIL EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION TUCKAHOE TERRACE AMPHITHEATER PROPOSED SHADE STRUCTURE MARTIN COUNTY, FLORIDA	Drawn by: PGA Checked by: DPA AACE File No: 19-124	Date: February 2019 Date: February 2019 Sheet No. 2

Appendix II

General Notes

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Martin County, Florida

Tuckahoe Terrace Amphitheater

February 13, 2019

Custom Soil Resource Report
Soil Map (Tuckahoe Terrace Amphitheater)

Map Scale: 1:415 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 5, 10, 20, 30

Feet: 0, 20, 40, 80, 120

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

9

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Martin County, Florida
Survey Area Data: Version 17, Sep 17, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 14, 2015—May 8, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (Tuckahoe Terrace Amphitheater)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
77	Paola and St. Lucie sands, 8 to 20 percent slopes	0.7	97.3%
99	Water	0.0	2.7%
Totals for Area of Interest		**0.7**	**100.0%**

Map Unit Descriptions (Tuckahoe Terrace Amphitheater)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Martin County, Florida

77—Paola and St. Lucie sands, 8 to 20 percent slopes

Map Unit Setting

National map unit symbol: 1jq9t
Mean annual precipitation: 56 to 64 inches
Mean annual air temperature: 72 to 79 degrees F
Frost-free period: 350 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Paola and similar soils: 50 percent
St. lucie and similar soils: 45 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Paola

Setting

Landform: Ridges on marine terraces, knolls on marine terraces
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

A - 0 to 4 inches: sand
E - 4 to 32 inches: sand
C - 32 to 80 inches: sand

Properties and qualities

Slope: 8 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 39.96 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 4.0
Available water storage in profile: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Forage suitability group: Sandy soils on ridges and dunes of xeric uplands (G156BC113FL)
Other vegetative classification: Sand Pine Scrub (R156BY001FL)
Hydric soil rating: No

Description of St. Lucie

Setting

Landform: Knolls on marine terraces, ridges on marine terraces
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Eolian or sandy marine deposits

Typical profile

A - 0 to 3 inches: sand
C - 3 to 80 inches: sand

Properties and qualities

Slope: 8 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 39.96 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 4.0
Available water storage in profile: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Forage suitability group: Sandy soils on ridges and dunes of xeric uplands (G156BC113FL)
Other vegetative classification: Sand Pine Scrub (R156BY001FL)
Hydric soil rating: No

Minor Components

Archbold

Percent of map unit: 3 percent
Landform: Flats on marine terraces, rises on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: Sand Pine Scrub (R156BY001FL)
Hydric soil rating: No

Pomello

Percent of map unit: 2 percent
Landform: Ridges on marine terraces, knolls on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: South Florida Flatwoods (R156BY003FL)
Hydric soil rating: No

99—Water

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Appendix I

USDA Web Soil Survey Summary Report

ANDERSEN ANDRE CONSULTING ENGINEERS, INC.

SOIL BORING, SAMPLING AND TESTING METHODS

GENERAL

Andersen Andre Consulting Engineers, Inc. (AACE) borings describe subsurface conditions only at the locations drilled and at the time drilled. They provide no information about subsurface conditions below the bottom of the boreholes. At locations not explored, surface conditions that differ from those observed in the borings may exist and should be anticipated.

The information reported on our boring logs is based on our drillers' logs and on visual examination in our laboratory of disturbed soil samples recovered from the borings. The distinction shown on the logs between soil types is approximate only. The actual transition from one soil to another may be gradual and indistinct.

The groundwater depth shown on our boring logs is the water level the driller observed in the borehole when it was drilled. These water levels may have been influenced by the drilling procedures, especially in borings made by rotary drilling with bentonitic drilling mud. An accurate determination of groundwater level requires long-term observation of suitable monitoring wells. Fluctuations in groundwater levels throughout the year should be anticipated.

The absence of a groundwater level on certain logs indicates that no groundwater data is available. It does not mean that groundwater will not be encountered at that boring location at some other point in time.

STANDARD PENETRATION TEST

The Standard Penetration Test (SPT) is a widely accepted method of in situ testing of foundation soils (ASTM D-1586). A 2-foot (0.6m) long, 2-inch (50mm) O.D. split-barrell sampler attached to the end of a string of drilling rods is driven 24 inches (0.60m) into the ground by successive blows of a 140-pound (63.5 Kg) hammer freely dropping 30 inches (0.76m). The number of blows needed for each 6 inches (0.15m) increments penetration is recorded. The sum of the blows required for penetration of the middle two 6-inch (0.15m) increments of penetration constitutes the test result of N-value. After the test, the sampler is extracted from the ground and opened to allow visual description of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load. The following tables relate N-values to a qualitative description of soil density and, for cohesive soils, an approximate unconfined compressive strength (Qu):

Cohesionless Soils:	N-Value	Description
	0 to 4	Very loose
	4 to 10	Loose
	10 to 30	Medium dense
	30 to 50	Dense
	Above 50	Very dense

Cohesive Soils:	N-Value	Description	Qu
	0 to 2	Very soft	Below 0.25 tsf (25 kPa)
	2 to 4	Soft	0.25 to 0.50 tsf (25 to 50 kPa)
	4 to 8	Medium stiff	0.50 to 1.0 tsf (50 to 100 kPa)
	8 to 15	Stiff	1.0 to 2.0 tsf (100 to 200 kPa)
	15 to 30	Very stiff	2.0 to 4.0 tsf (200 to 400 kPa)
	Above 30	Hard	Above 4.0 tsf (400 kPa)

The tests are usually performed at 5 foot (1.5m) intervals. However, more frequent or continuous testing is done by AACE through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid. After completion of a test borings, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed by backfilling, either with accumulated cuttings or lean cement.

Representative split-spoon samples from each sampling interval and from different strata are brought to our laboratory in air-tight jars for classification and testing, if necessary. Afterwards, the samples are discarded unless prior arrangement have been made.

POWER AUGER BORINGS

Auger borings (ASTM D-1452) are used when a relatively large, continuous sampling of soil strata close to the ground surface is desired. A 4-inch (100 mm) diameter, continuous flight, helical auger with a cutting head at its end is screwed into the ground in 5-foot (1.5m) sections. It is powered by the rotary drill rig. The sample is recovered by withdrawing the auger our of the ground without rotating it. The soil sample so obtained, is classified in the field and representative samples placed in bags or jars and returned to the AACE soils laboratory for classification and testing, if necessary.

HAND AUGER BORINGS

Hand auger borings are used, if soil conditions are favorable, when the soil strata are to be determined within a shallow (approximately 5-foot [1.5m]) depth or when access is not available to power drilling equipment. A 3-inch (75mm) diameter hand bucket auger with a cutting head is simultaneously turned and pressed into the ground. The bucket auger is retrieved at approximately 6-inch (0.15m) interval and its contents emptied for inspection. On occasion post-hole diggers are used, especially in the upper 3 feet (1m) or so. Penetrometer probings can be used in the upper 5 feet (1.5m) to determine the relative density of the soils. The soil sample obtained is described and representative samples put in bags or jars and transported to the AACE soils laboratory for classification and testing, if necessary.

UNDISTURBED SAMPLING

Undisturbed sampling (ASTM D-1587) implies the recovery of soil samples in a state as close to their natural condition as possible. Complete preservation of in situ conditions cannot be realized; however, with careful handling and proper sampling techniques, disturbance during sampling can be minimized for most geotechnical engineering purposes. Testing of undisturbed samples gives a more accurate estimate of in situ behavior than is possible with disturbed samples.

Normally, we obtain undisturbed samples by pushing a 2.875-inch (73 mm) I.D., thin wall seamless steel tube 24 inches (0.6 m) into the soil with a single stoke of a hydraulic ram. The sampler, which is a Shelby tube, is 30 (0.8 m) inches long. After the sampler is retrieved, the ends are sealed in the field and it is transported to our laboratory for visual description and testing, as needed.

ROCK CORING

In case rock strata is encountered and rock strength/continuity/composition information is needed for foundation or mining purposes, the rock can be cored (ASTM D-2113) and 2-inch to 4-inch diameter rock core samples be obtained for further laboratory analyses. The rock coring is performed through flush-joint steel casing temporarily installed through the overburden soils above the rock formation and also installed into the rock. The double- or triple-tube core barrels are advanced into the rock typically in 5-foot intervals and then retrieved to the surface. The barrel is then opened so that the core sample can be extruded. Preliminary field measurements of the recovered rock cores include percent recovery and Rock Quality Designation (RQD) values. The rock cores are placed in secure core boxes and then transported to our laboratory for further inspection and testing, as needed.

SFWMD EXFILTRATION TESTS

In order to estimate the hydraulic conductivity of the upper soils, constant head or falling head exfiltration tests can be performed. These tests are performed in accordance with methods described in the South Florida Water Management District (SFWMD) Permit Information Manual, Volume IV. In brief, a 6 to 9 inch diameter hole is augered to depths of about 5 to 7 feet; the bottom one foot is filled with 57-stone; and a 6-foot long slotted PVC pipe is lowered into the hole. The distance from the groundwater table and to the ground surface is recordedand the hole is then saturated for 10 minutes with the water level maintained at the ground surface.

If a constant head test is performed, the rate of pumping will be recorded at fixed intervals of 1 minute for a total of 10 minutes, following the saturation period.

LABORATORY TEST METHODS

Soil samples returned to the AACE soils laboratory are visually observed by a geotechnical engineer or a trained technician to obtain more accurate description of the soil strata. Laboratory testing is performed on selected samples as deemed necessary to aid in soil classification and to help define engineering properties of the soils. The test results are presented on the soil boring logs at the depths at which the respective sample was recovered, except that grain size distributions or selected other test results may be presented on separate tables, figures or plates as discussed in this report.

THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHEAST FLORIDA
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

The soil descriptions shown on the logs are based upon visual-manual procedures in accordance with local practice. Soil classification is performed in general accordance with the United Soil Classification System and is also based on visual-manual procedures.

BOULDERS (>12" [300 MM]) and COBBLES (3" [75 MM] TO 12" [300 MM]):

GRAVEL: Coarse Gravel: 3/4" (19 mm) to 3" (75 mm)
Fine Gravel: No. 4 (4.75 mm) Sieve to 3/4" (19 mm)

Descriptive adjectives:

0 - 5%	– no mention of gravel in description
5 - 15%	– trace
15 - 29%	– some
30 - 49%	– gravelly (shell, limerock, cemented sands)

SANDS:

COARSE SAND: No. 10 (2 mm) Sieve to No. 4 (4.75 mm) Sieve
MEDIUM SAND: No. 40 (425 µm) Sieve to No. 10 (2 mm) Sieve
FINE SAND: No. 200 (75 µm) Sieve to No. 40 (425 µm) Sieve

Descriptive adjectives:

0 - 5%	– no mention of sand in description
5 - 15%	– trace
15 - 29%	– some
30 - 49%	– sandy

SILT/CLAY: < #200 (75µM) Sieve

SILTY OR SILT: PI < 4
SILTY CLAYEY OR SILTY CLAY: 4 ≤ PI ≤ 7
CLAYEY OR CLAY: PI > 7

Descriptive adjectives:

< - 5%	– clean (no mention of silt or clay in description)
5 - 15%	– slightly
16 - 35%	– clayey, silty, or silty clayey
36 - 49%	– very

ORGANIC SOILS:

Organic Content	Descriptive Adjectives	Classification
0 - 2.5%	Usually no mention of organics in description	See Above
2.6 - 5%	slightly organic	add "with organic fines" to group name
5 - 30%	organic	SM with organic fines
		Organic Silt (OL)
		Organic Clay (OL)
		Organic Silt (OH)

THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHEAST FLORIDA

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

Organic Clay (OH)

HIGHLY ORGANIC SOILS AND MATTER:

Organic Content	Descriptive Adjectives	Classification
30 - 75%	sandy peat	Peat (PT)
	silty peat	Peat (PT)
> 75%	amorphous peat	Peat (PT)
	fibrous peat	Peat (PT)

STRATIFICATION AND STRUCTURE:

Descriptive Term		Thickness
with interbedded		
seam	--	less than ½ inch (13 mm) thick
layer	--	½ to 12-inches (300 mm) thick
stratum	--	more than 12-inches (300 mm) thick
pocket	--	small, erratic deposit, usually less than 1-foot
lens	--	lenticular deposits
occasional	--	one or less per foot of thickness
frequent	--	more than one per foot of thickness
calcareous	--	containing calcium carbonate (reaction to diluted HCL)
hardpan	--	spodic horizon usually medium dense
marl	--	mixture of carbonate clays, silts, shells and sands

ROCK CLASSIFICATION (FLORIDA) CHART:

Symbol	Typical Description
LS	Hard Bedded Limestone or Caprock
WLS	Fractured or Weathered Limestone
LR	Limerock (gravel, sand, silt and clay mixture)
SLS	Stratified Limestone and Soils

THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHEAST FLORIDA

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

LEGEND FOR BORING LOGS

N:	Number of blows to drive a 2-inch OD split spoon sampler 12 inches using a 140-pound hammer dropped 30 inches
R:	Refusal (less than six inches advance of the split spoon after 50 hammer blows)
MC:	Moisture content (percent of dry weight)
OC:	Organic content (percent of dry weight)
PL:	Moisture content at the plastic limit
LL:	Moisture content at the liquid limit
PI:	Plasticity index (LL-PL)
qu:	Unconfined compressive strength (tons per square foot, unless otherwise noted)
-200:	Percent passing a No. 200 sieve (200 wash)
+40:	Percent retained above a No. 40 sieve
US:	Undisturbed sample obtained with a thin-wall Shelby tube
k:	Permeability (feet per minute, unless otherwise noted)
DD:	Dry density (pounds per cubic foot)
TW:	Total unit weight (pounds per cubic foot)

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you —* should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE THE GEOPROFESSIONAL BUSINESS ASSOCIATION

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

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Appendix III

Project Limitations and Conditions

Project Limitations and Conditions

Andersen Andre Consulting Engineers, Inc. has prepared this report for our client for his exclusive use, in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made herein. Further, the report, in all cases, is subject to the following limitations and conditions:

VARIABLE/UNANTICIPATED SUBSURFACE CONDITIONS

The engineering analysis, evaluation and subsequent recommendations presented herein are based on the data obtained from our field explorations, at the specific locations explored on the dates indicated in the report. This report does not reflect any subsurface variations (e.g. soil types, groundwater levels, etc.) which may occur adjacent or between borings.

The nature and extent of any such variations may not become evident until construction/excavation commences. In the event such variations are encountered, Andersen Andre Consulting Engineers, Inc. may find it necessary to (1) perform additional subsurface explorations, (2) conduct in-the-field observations of encountered variations, and/or re-evaluate the conclusions and recommendations presented herein.

We at Andersen Andre Consulting Engineers, Inc. recommend that the project specifications necessitate the contractor immediately notifying Andersen Andre Consulting Engineers, Inc., the owner and the design engineer (if applicable) if subsurface conditions are encountered that are different from those presented in this report.

No claim by the contractor for any conditions differing from those expected in the plans and specifications, or presented in this report, should be allowed unless the contractor notifies the owner and Andersen Andre Consulting Engineers, Inc. of such differing site conditions. Additionally, we recommend that all foundation work and site improvements be observed by an Andersen Andre Consulting Engineers, Inc. representative.

SOIL STRATA CHANGES

Soil strata changes are indicated by a horizontal line on the soil boring profiles (boring logs) presented within this report. However, the actual strata's changes may be more gradual and indistinct. Where changes occur between soil samples, the locations of the changes must be estimated using the available information and may not be at the exact depth indicated.

SINKHOLE POTENTIAL

Unless specifically requested in writing, a subsurface exploration performed by Andersen Andre Consulting Engineers, Inc. is not intended to be an evaluation for sinkhole potential.

MISINTERPRETATION OF SUBSURFACE SOIL EXPLORATION REPORT

Andersen Andre Consulting Engineers, Inc. is responsible for the conclusions and recommendations presented herein, based upon the subsurface data obtained during this project. If others render conclusions or opinions, or make recommendations based upon the data presented in this report, those conclusions, opinions and/or recommendations are not the responsibility of Andersen Andre Consulting Engineers, Inc.

CHANGED STRUCTURE OR LOCATION

This report was prepared to assist the owner, architect and/or civil engineer in the design of the subject project. If any changes in the construction, design and/or location of the structures as discussed in this report are planned, or if any structures are included or added that are not discussed in this report, the conclusions and recommendations contained in this report may not be valid. All such changes in the project plans should be made known to Andersen Andre Consulting Engineers, Inc. for our subsequent re-evaluation.

USE OF REPORT BY BIDDERS

Bidders who are reviewing this report prior to submission of a bid are cautioned that this report was prepared to assist the owners and project designers. Bidders should coordinate their own subsurface explorations (e.g.; soil borings, test pits, etc.) for the purpose of determining any conditions that may affect construction operations. Andersen Andre Consulting Engineers, Inc. cannot be held responsible for any interpretations made using this report or the attached boring logs with regard to their adequacy in reflecting subsurface conditions which may affect construction operations.

IN-THE-FIELD OBSERVATIONS

Andersen Andre Consulting Engineers, Inc. attempts to identify subsurface conditions, including soil stratigraphy, water levels, zones of lost circulation, "hard" or "soft" drilling, subsurface obstructions, etc. However, lack of mention in the report does not preclude the presence of such conditions.

LOCATION OF BURIED OBJECTS

Users of this report are cautioned that there was no requirement for Andersen Andre Consulting Engineers, Inc. to attempt to locate any man-made, underground objects during the course of this exploration, and that no attempts to locate any such objects were performed. Andersen Andre Consulting Engineers, Inc. cannot be responsible for any buried man-made objects which are subsequently encountered during construction.

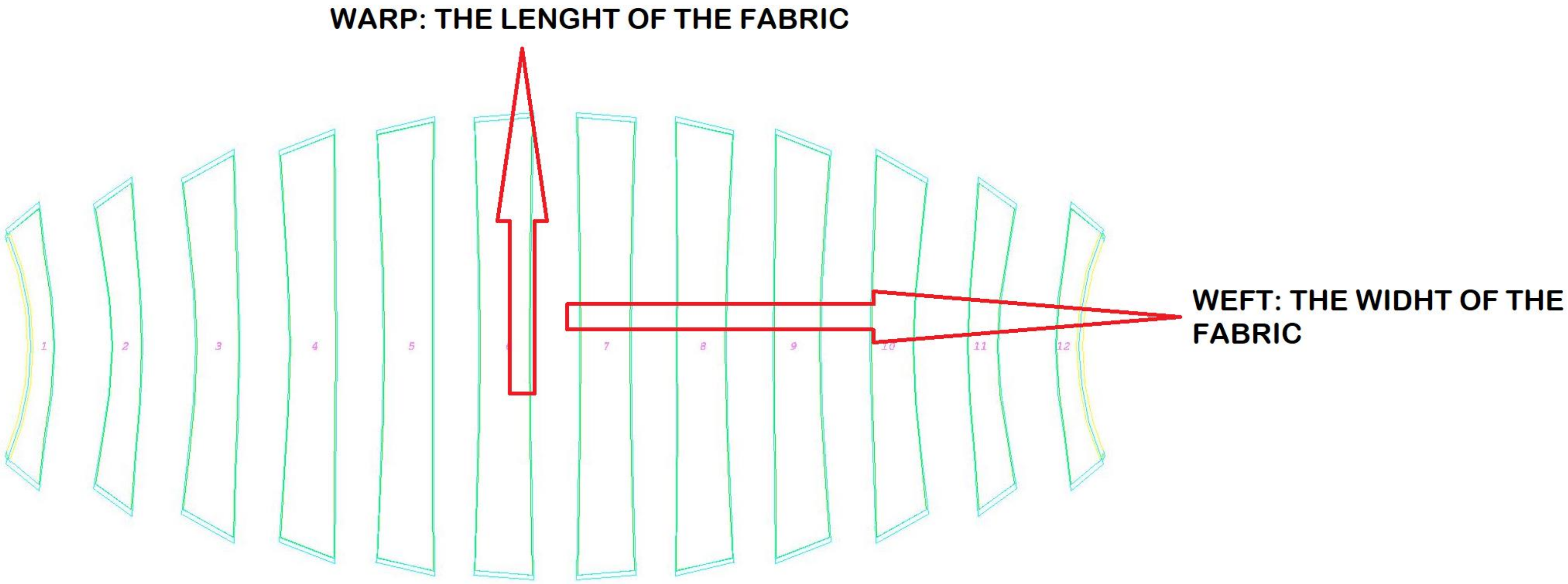
PASSAGE OF TIME

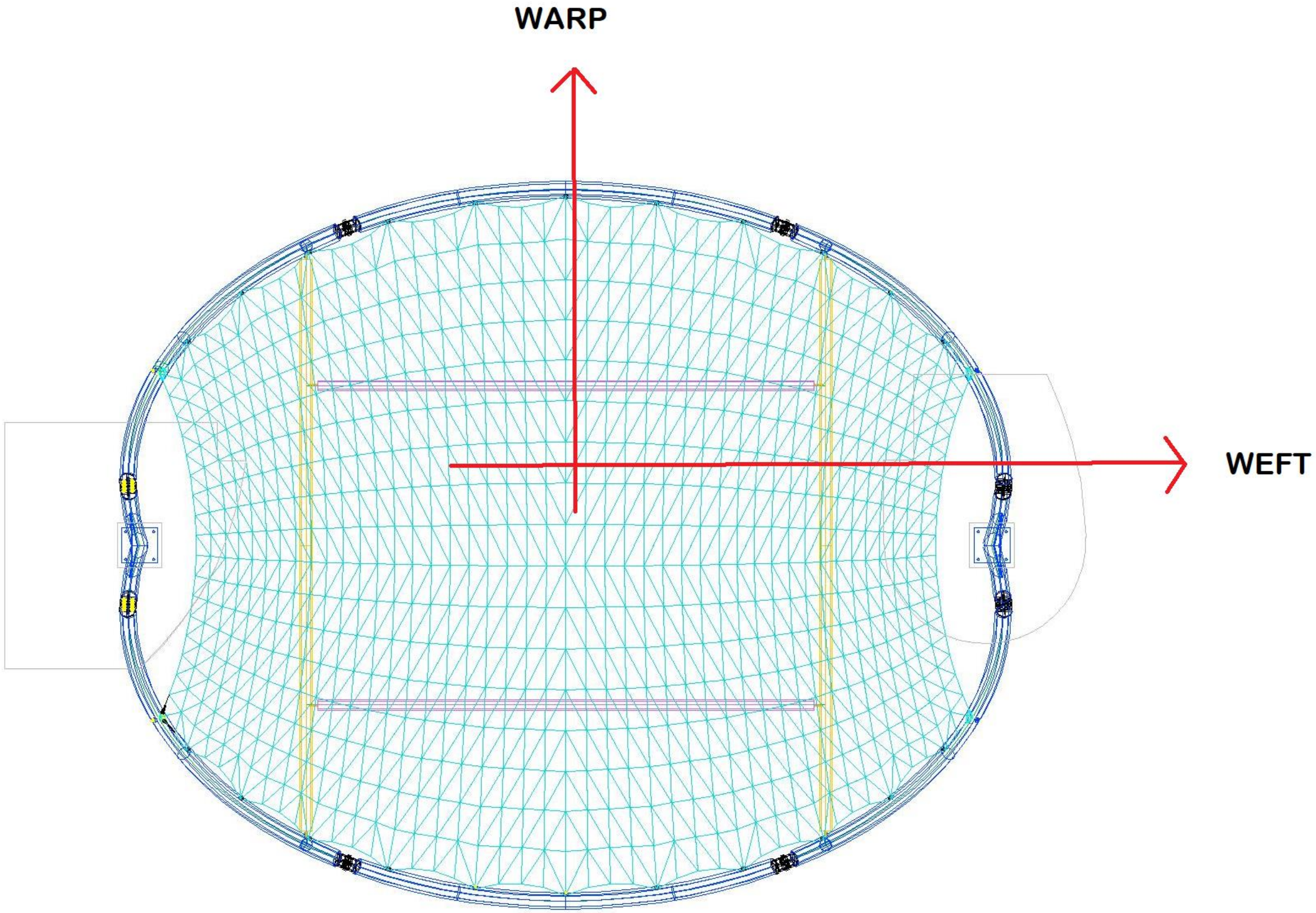
This report reflects subsurface conditions that were encountered at the time/date indicated in the report. Significant changes can occur at the site during the passage of time. The user of the report recognizes the inherent risk in using the information presented herein after a reasonable amount of time has passed. We recommend the user of the report contact Andersen Andre Consulting Engineers, Inc. with any questions or concerns regarding this issue.

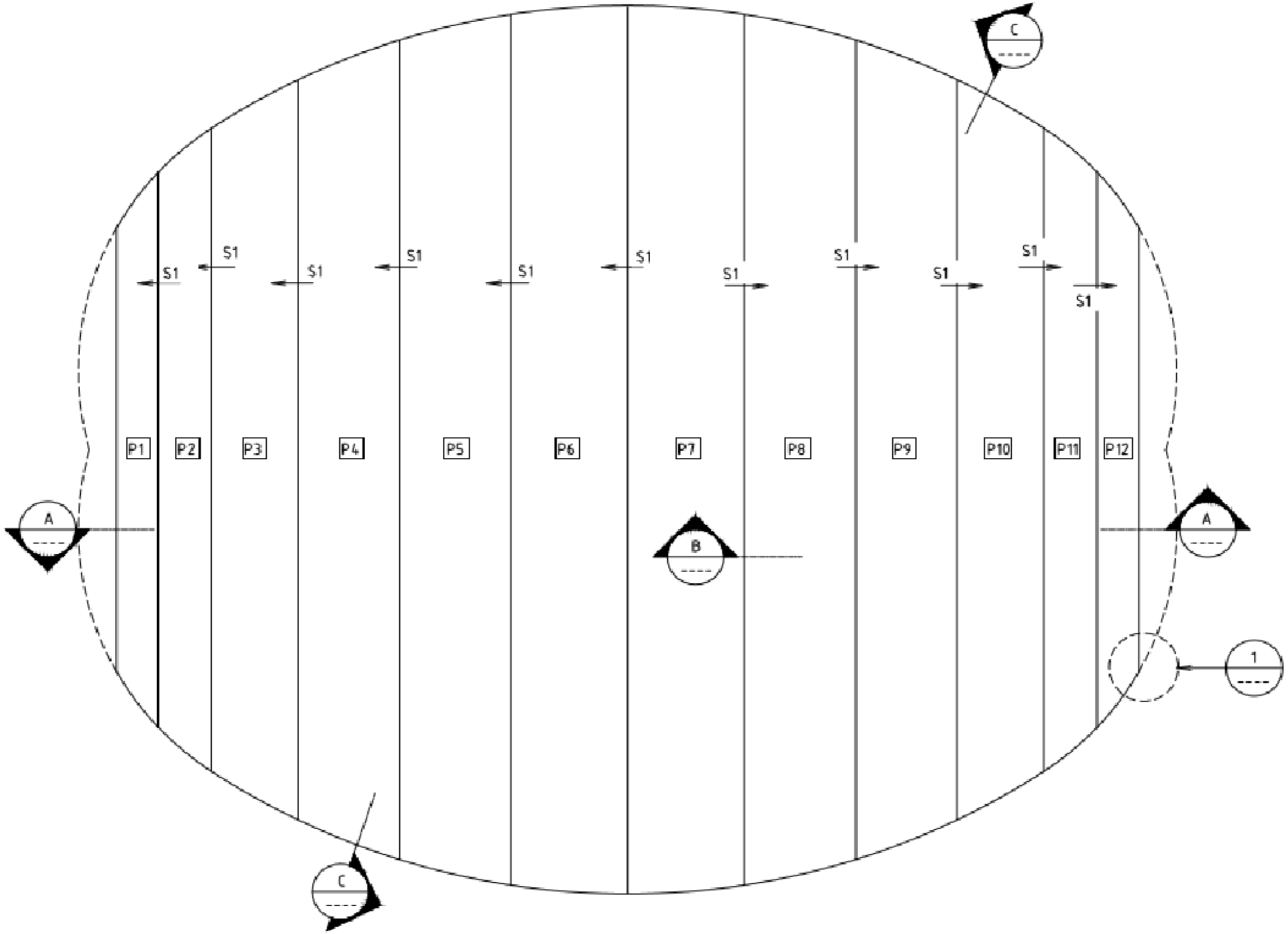
This document may be reproduced upon request in an alternative format by contacting the County ADA Coordinator (772) 320-3131, the County Administration Office (772) 288-5400, Florida Relay 711, or by completing our accessibility feedback form at www.martin.fl.us/accessibility-feedback<http://www.martin.fl.us/accessibility-feedback>

4. The patterning

We have an anticlastic shape, so our patterns are in this picture:




WARP
WEFT


C
S1
S1
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S1
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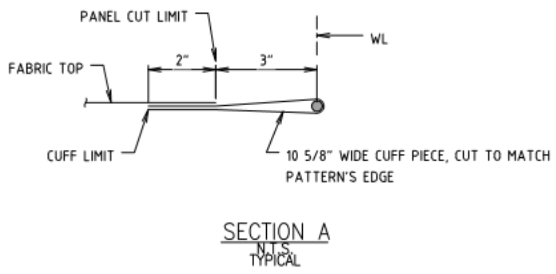
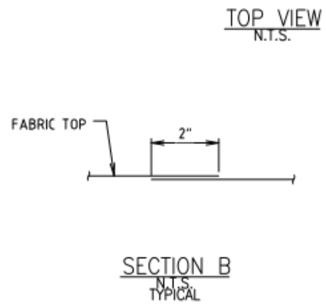
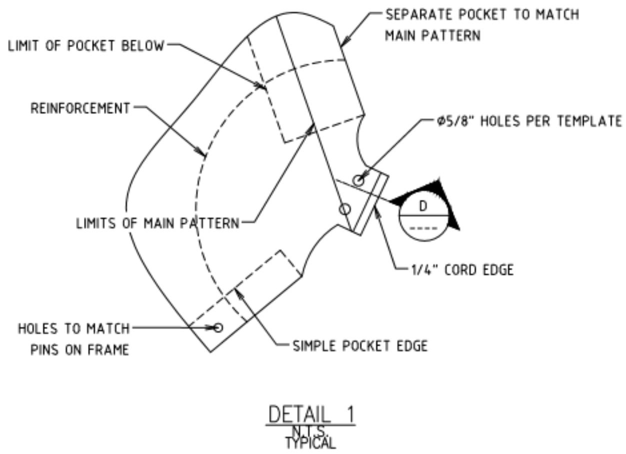
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
A
B
A
1
C

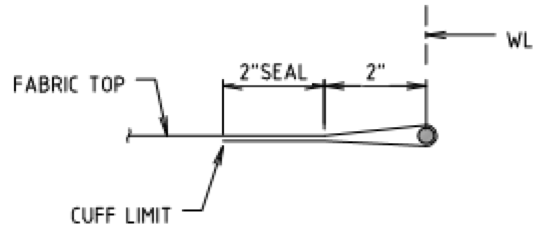
TOP VIEW
N.T.S.

DETAILS OF THE FABRIC

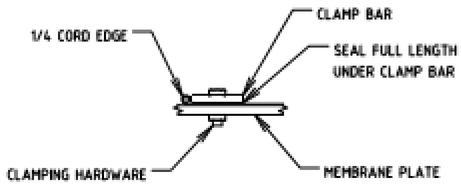






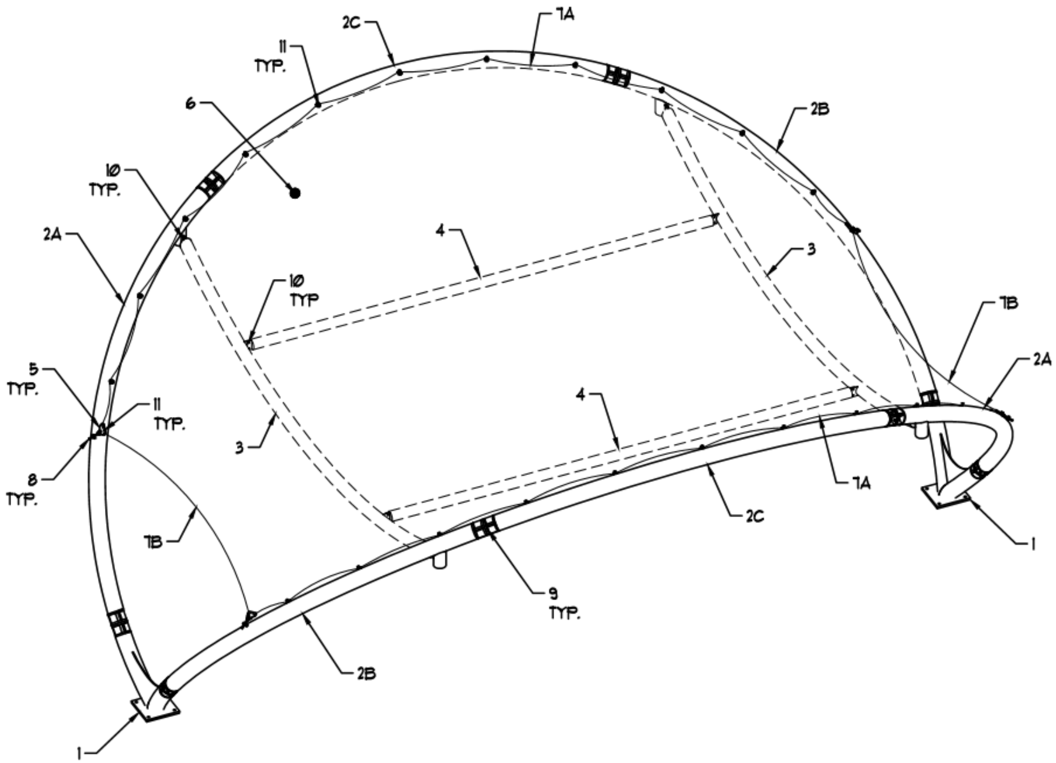


SECTION C
N.T.S.
TYPICAL



SECTION D
N.T.S.
TYPICAL

5. The detailing of corners, cables, and all connections Pieces.



1 ISOMETRIC VIEW
SCALE: N.T.S.

LIST OF MATERIALS			
ITEM	DESCRIPTION	QTY	MATERIAL/SHAPE
1	COLUMN ARCH BASE	2	8" SCH 40
2A	LEFT ARCH	2	8" SCH 40
2B	RIGHT ARCH	2	8" SCH 40
2C	CENTER ARCH	2	8" SCH 40
3	SIDE ARCH BEAM	2	6" SCH 40
4	CENTER PURLIN	2	5" SCH 40
5	MEMBRANE PLATE	4	7" X 4"X1/2" PLATE
6	FABRIC PANEL	1	PVC COATED POLYESTER
7A	LONG CABLE	2	1/4" 6X19 GALVANIZED
7B	SIDE CATENARY CABLE	2	1/4" 6X19 GALVANIZED
8	JAW END	4	5/8"X6" GALVANIZED
9	1-8NC X 4" HEX BOLT SET	32	A325 GALVANIZED
10	3/4-10NC x 2 1/2" HEX BOLT SET	20	A325 GALVANIZED
11	1/2-13NC X 2" HEX BOLT SET	30	A 325 GALVANIZED

- ALL HEX BOLT SETS INCLUDE, HEX NUT, SPLIT LOCK WASHER AND 2 FLAT WASHERS
- ALL JAW ENDS INCLUDE FLAT WASHER, HEX NUT AND JAM NUT

TENSOSHADE ADVISORY ⚠

FABRIC SHADE TOP NEEDS TO BE REMOVE IN WINTER SEASON AND OR INCLEMENT WEATHER IS PRESENT WITH PRECIPITATION THE FORM OF SNOW OR ICE.

MAXIMUM PSF ALLOWED OF SNOW .... 5 (PSF)

FABRIC SHADE TOP NEEDS TO BE REMOVED IN WINDS EXCEEDING 115 MPH ARE ANTICIPATED IN THE FORECAST (THIS WIND SPEED IS TRUE OR ASD VALUE, IT IS EQUIVALENT TO LRFD OR ULTIMATE VALUE IN DESIGN CRITERIA ABOVE)

SEE NOTES COVERING DESIGN CRITERIA

GENERAL NOTES:

CODES AND SPECIFICATIONS
1. FLORIDA BUILDING CODE, 2017.
2. ASCE 7-10, MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES.
4. AISC 360-10 CODE OF STANDARD PRACTICE FOR STEEL BUILDINGS AND BRIDGES
5. ANSI/AWS D1.1 STRUCTURAL WELDING CODE - STEEL

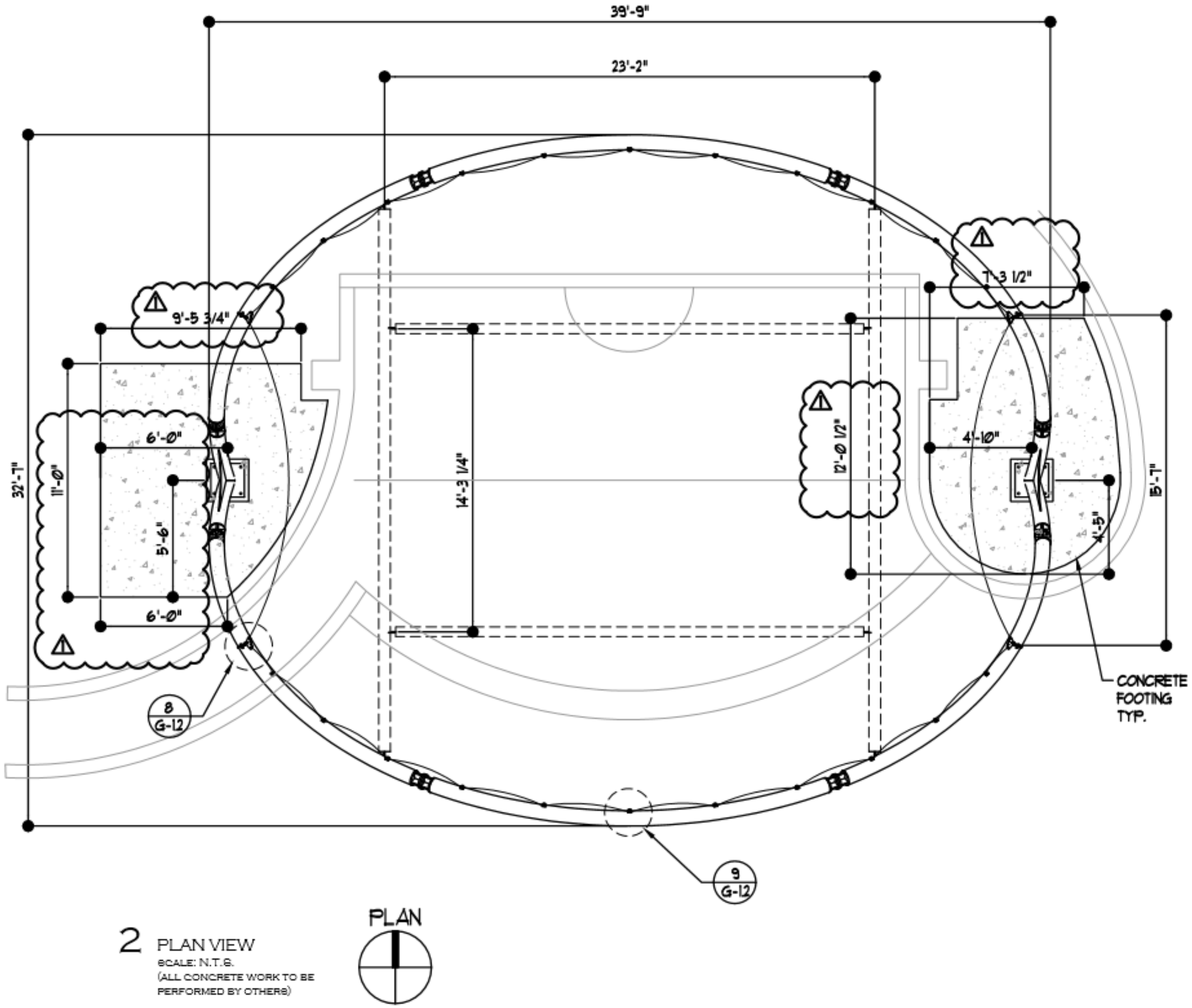
STRUCTURAL STEEL
1. MATERIAL:
- STRUCTURAL ROUND TUBING, ASTM A-500, GRADE B (FY 42 KSI).
- STRUCTURAL SHAPED TUBING, ASTM A-500, GRADE B (FY 46 KSI).
- PLATES A 572
2. PRIME POWDER COAT PAINTING IS REQUIRED FOR ALL STEEL SEE ARCH FOR FINISH.

STEEL FRAMING NOTES
1. FIELD VERIFY EXISTING DIMENSIONS AND ELEVATIONS WHICH AFFECT FABRICATION PRIOR TO SUBMITTAL OF SHOP DRAWINGS AND FABRICATION.

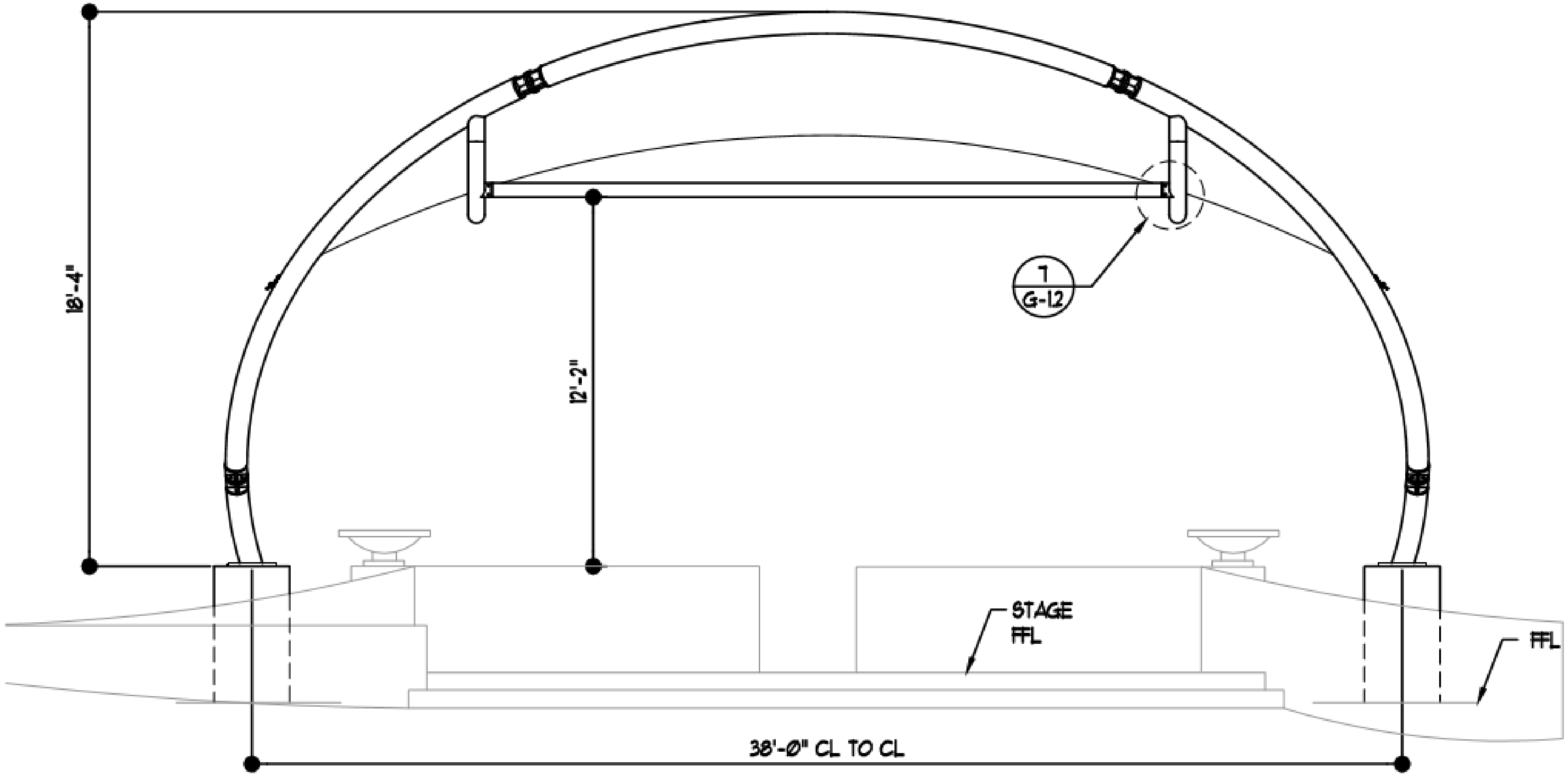
FABRIC NOTES:
- FABRIC TO BE SOLTIS PROOF 502 AS MANUFACTURED BY FERRARI TEXTILES, SEE MANUFACTURER'S WEB PAGE FOR TECHNICAL DATA.

DESIGN LOADS
1. ROOF LOAD:
ROOF LIVE LOAD, MINIMUM: 5 PSF
2. SNOW LOAD:
GROUND SNOW LOAD: PG = 0 PSF
~~3. WIND LOAD:~~
BASIC WIND SPEED ULTIMATE (3-SECOND GUST): 150 MPH ⚠
WIND EXPOSURE: D
4. BUILDING RISK CATEGORY II
5. OTHER LOADS:
CONCENTRATED 1000 LB MID SPAN, OR 50 LB/FT ON EACH CENTER PURLIN.

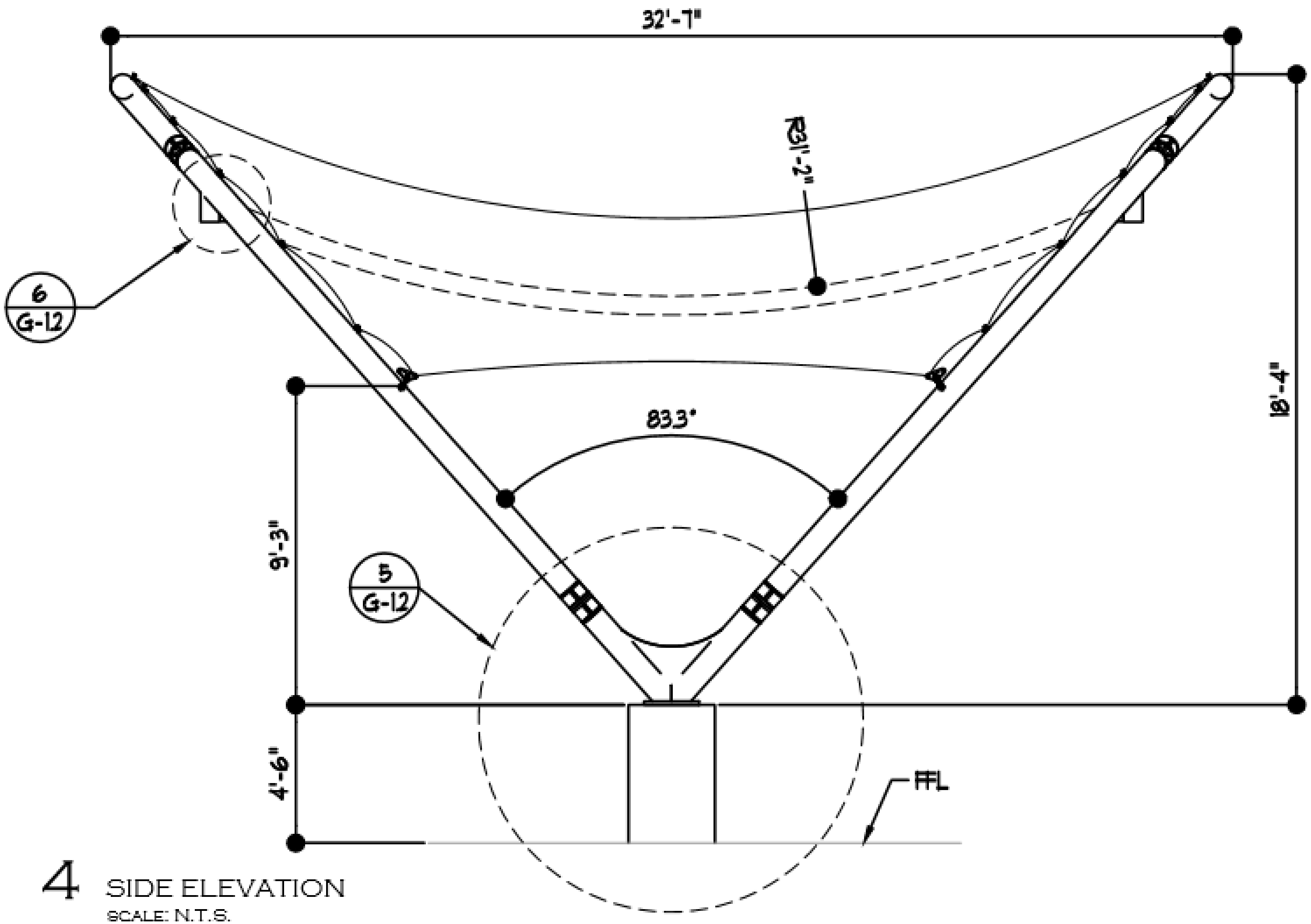
FOUNDATIONS:
1. FOUNDATIONS ARE DESIGNED BASED ON GEOTECHNICAL INVESTIGATION AND REPORT PREPARED BY ANDERSEN ANDRE CONSULTING ENGINEERING DATED FEBRUARY 13TH, 2019.
2. CONCRETE SHALL HAVE A SPECIFIED MINIMUM COMPRESSIVE STRENGTH OF 2,500 PSI AT 28 DAYS.
2. CONCRETE REINFORCING STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A615, GRADE 60
3. ALLOWABLE SOIL BEARING PRESSURE (NET) IS 2.0 KSF PER GEOTECH REPORT MENTIONED ABOVE.
3. ALL ANCHOR RODS EMBEDDED IN CONCRETE (IF APPLICABLE) SHALL BE F1554 G 36 GALVANIZED
4. ALL CONCRETE WORK TO BE PERFORMED BY OTHERS.



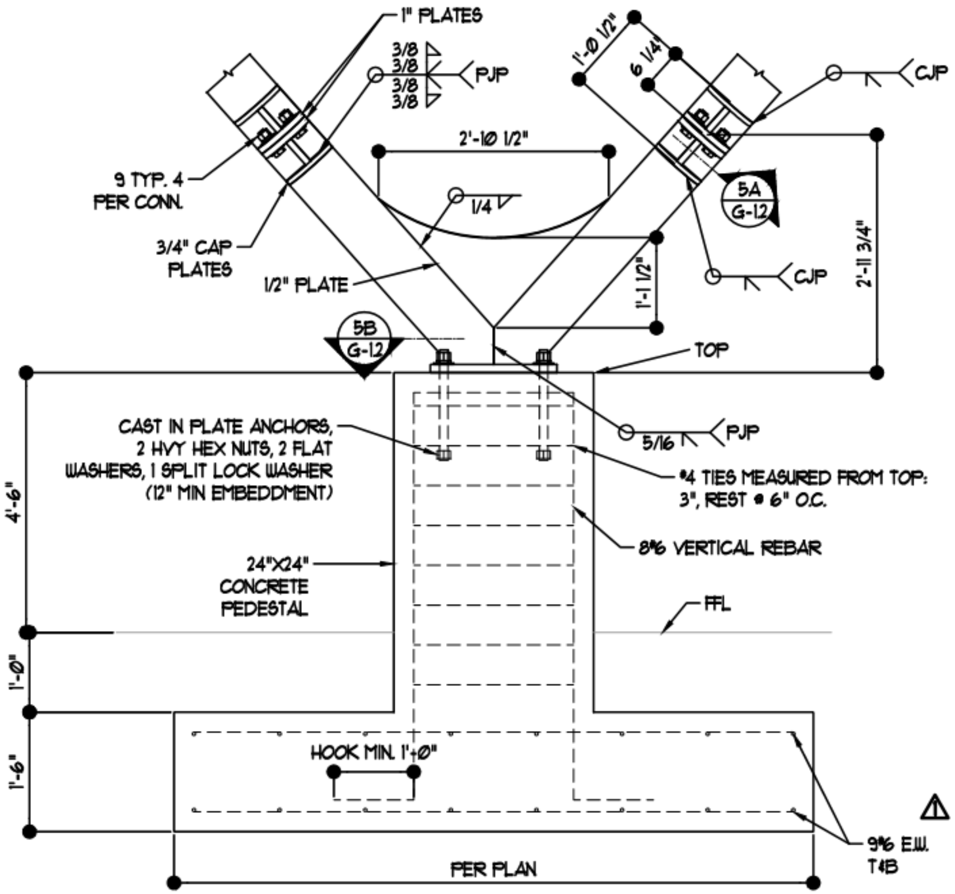
2 PLAN VIEW
SCALE: N.T.S.
(ALL CONCRETE WORK TO BE PERFORMED BY OTHERS)



3 FRONT ELEVATION
SCALE: N.T.S.



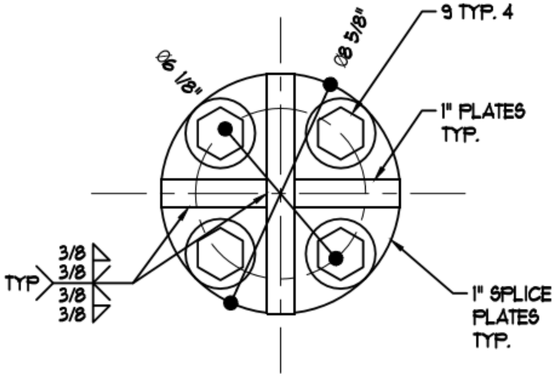
4 SIDE ELEVATION
SCALE: N.T.S.



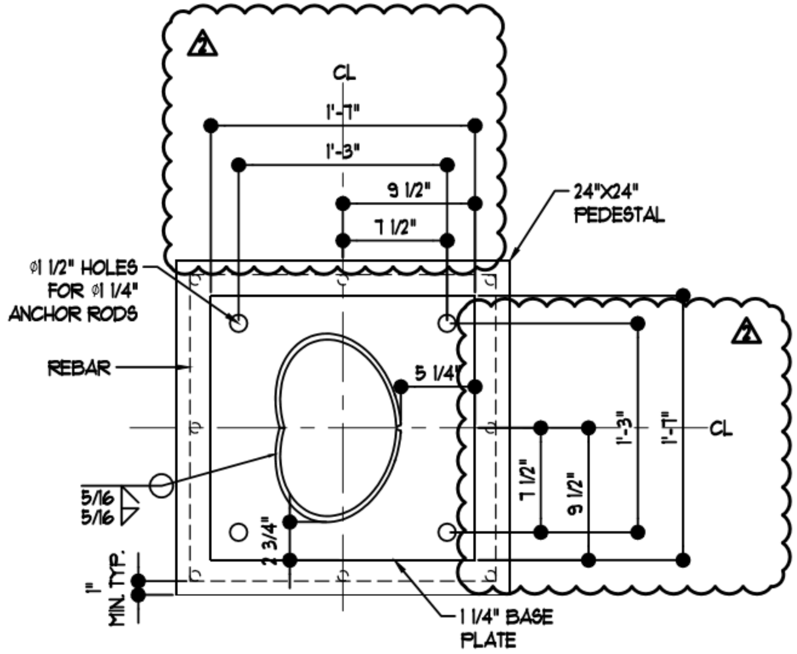
5 COLUMN ARCH BASE / FOOTING CONNECTION

SCALE: N.T.S.

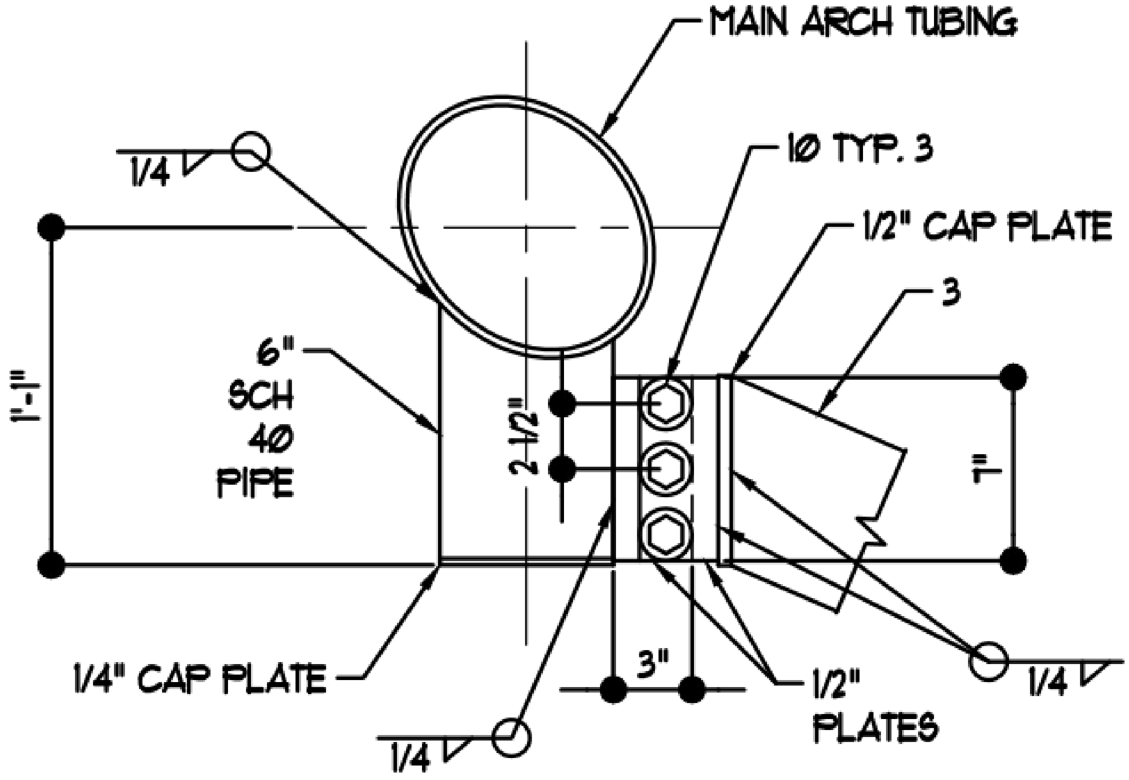
(ALL CONCRETE WORK TO BE PERFORMED BY OTHERS)



5A MAIN ARCH SPLICE SECTION
SCALE: N.T.S.
TYPICAL

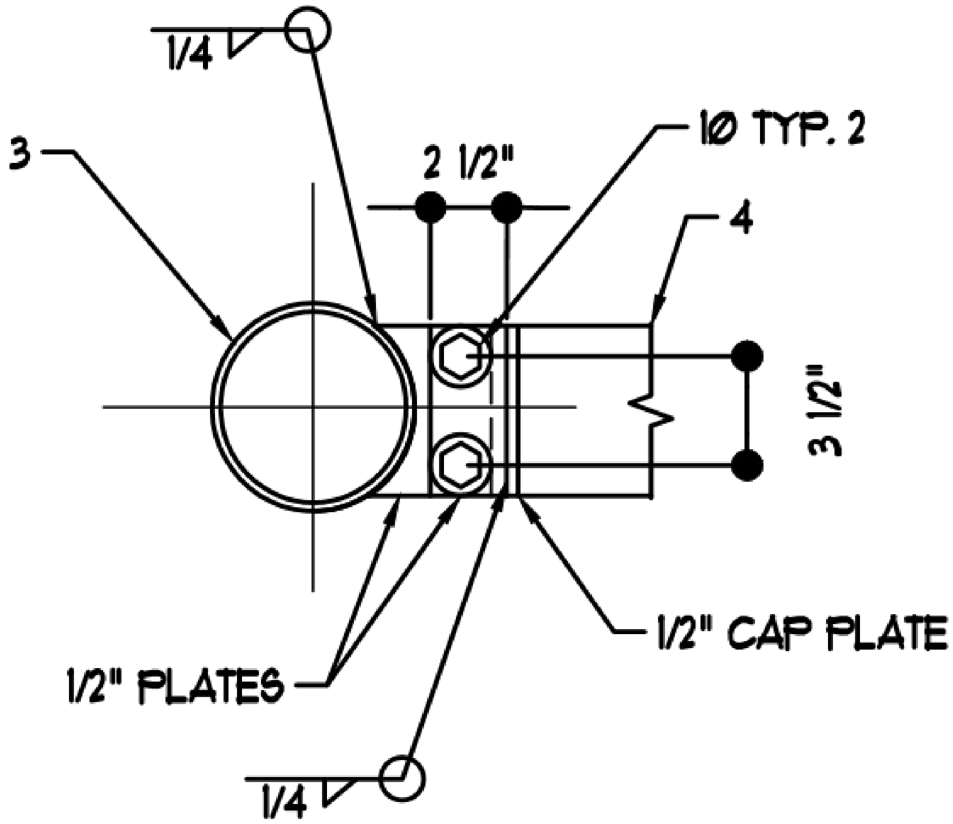


5B BASE PLATE AND MOUNTING DETAIL
SCALE: N.T.S.
(ALL CONCRETE WORK TO BE PERFORMED BY OTHERS)

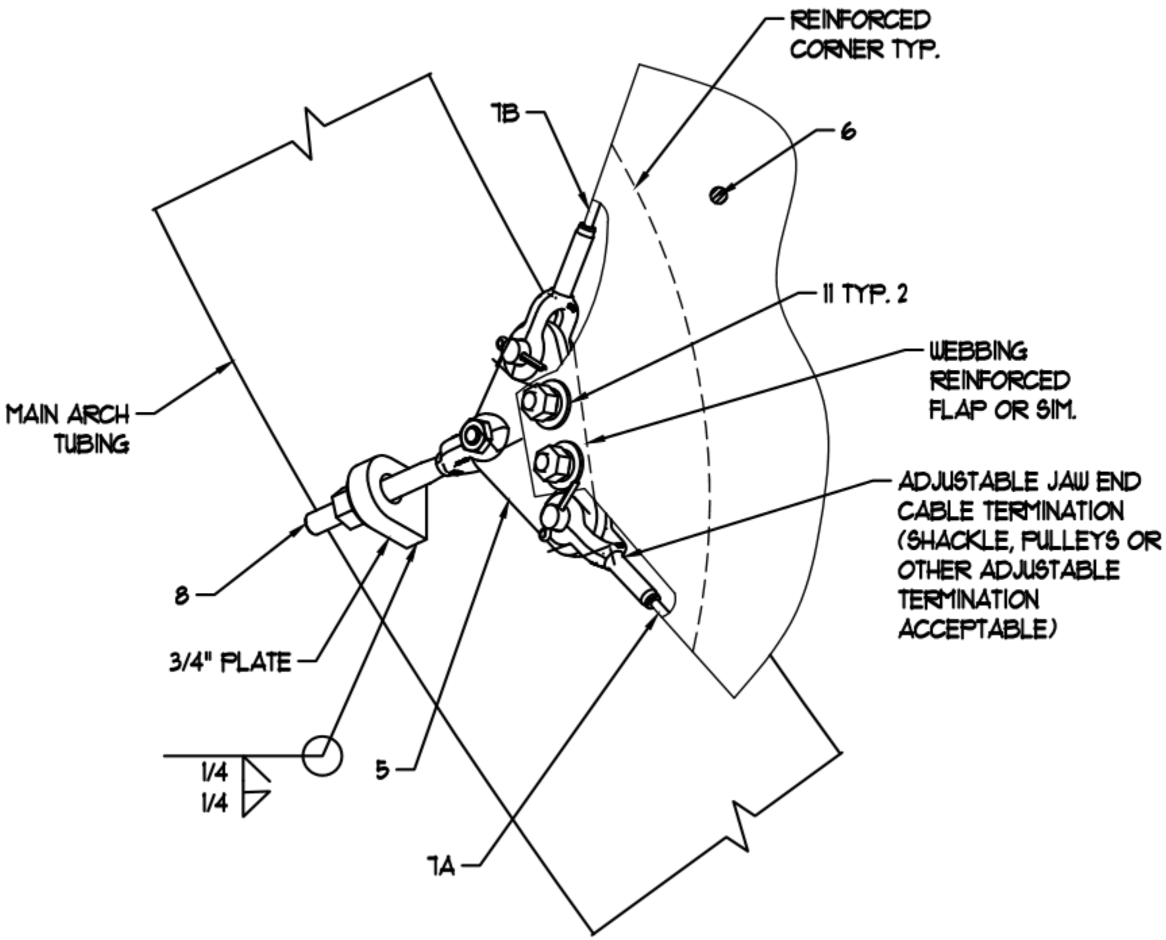


6 SIDE ARCH BEAM CONNECTION

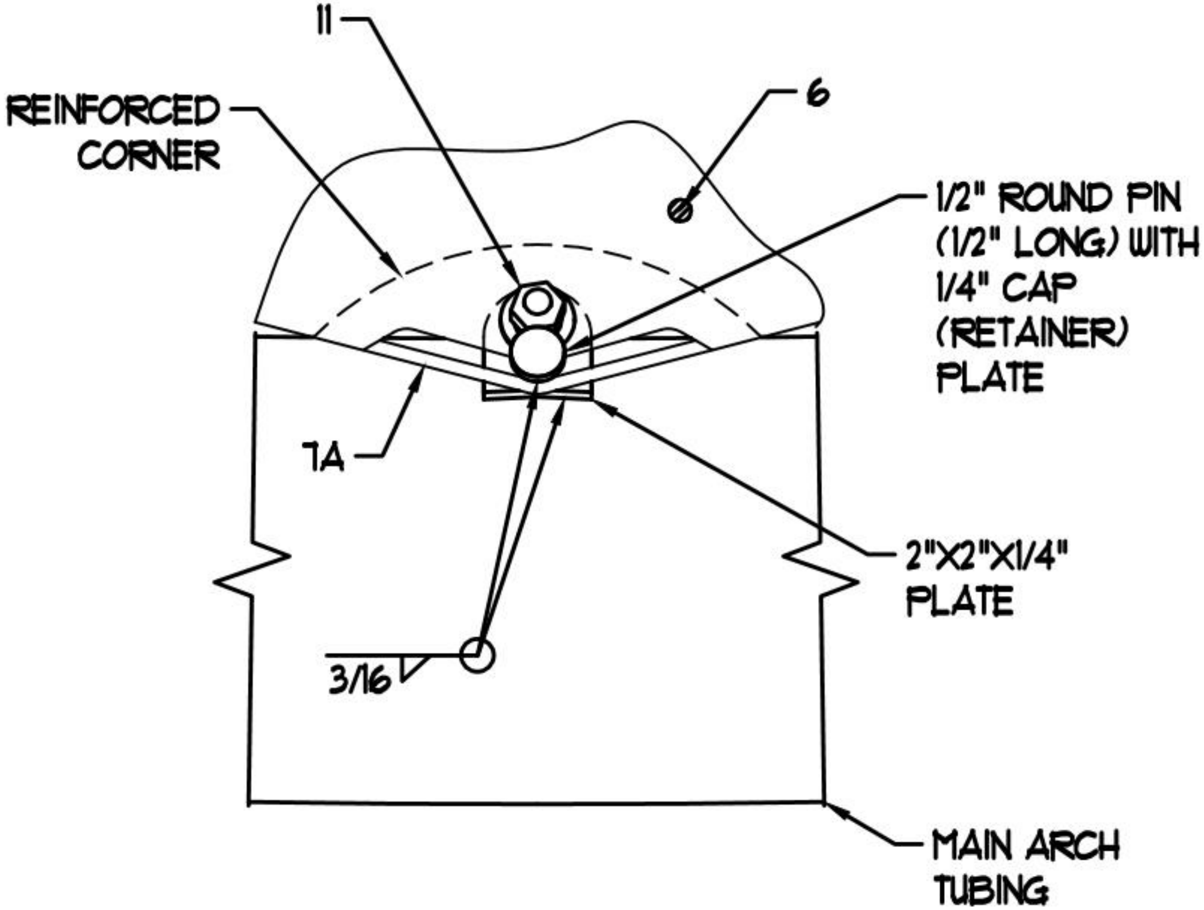
SCALE: N.T.S.



7 BEAM-PURLIN CONNECTION
SCALE: N.T.S.



8 FABRIC CORNER CONNECTION DETAIL
SCALE: N.T.S.



9 INTERMEDIATE FABRIC CORNER CONNECTION DETAIL
SCALE: N.T.S.

6. 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, vehicles, crane, machinery, and everything required for the execution of the project.
- Check the area to know if it is possible to install a buffer secured area to safe keep tools and use as lunch/rest area for workers.
- Consider the distance of the project area from the living area of workers involved. In this case, the project is located on a different state at min from the central office, so accommodation for the workers was not required, allowing saving capital from the budget.
- Guarantee material availability:
  - Concrete
  - Sand and gravel
  - Bars
  - Screws
  - Steel plates
  - Steel pipes
  - Paint for touch ups.
  - 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)
- Assure tool availability:
  - Security equipment:
    - Gloves
    - Glasses
    - Helmets
    - Harnesses
    - Safety shoes
    - Welding machines for steel and fabric
    - Tensioning machine
    - Face masks
- For structure and fabric assembly:
  - 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
    - Skid steer
- Cleaning:
  - Verify the fabric is in good condition and appearance. Washing and cleaning must be done when necessary.
  - Inspect the steel structure. Paint touch ups 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”.

6.1. FOUNDATION

- The entire work site needs to be **cautioned taped**, according to local codes for precaution. Only authorized personnel can access the work area.

- After meticulously survey the property and mark the column locations utilizing **tape measures and a transit** to shoot elevations and obtain the proper elevation grades.

- As per engineering recommendations, the site is being suitable for supporting the proposed tensile structure construction on a conventional shallow foundation proportioned for an allowable bearing stress of 2,000 pounds per square foot [psf], or less.

- Foundation concrete is not over a foundation surface containing topsoil or organic soils, trash of any kind, surface made muddy by rainfall runoff, or groundwater rise, or loose soil caused by excavation or other construction work. Reinforcing steel is clean at the time of concrete casting.
  Once both spread footings are in place, a **cement truck is called on site for an onsite concrete pour**, making sure the concrete has the resistance required per engineering.


MAKE IT HAPPEN


SCHWING
SP 500

6.2. MANUFACTURE OF STEEL STRUCTURE

- In the next images, I show you the manufactured and verifiation for the correct curvature and inclination of the arched columns as per engineering plans. We assembly the entire structure prior to prepare it to receive final finish.

6.3. ERECTION

- All steel members are brought on site and placed according to pre-established installation procedure. Primary Structure Columns are hoist and erection begin.

- With the use of a **Skid-steer Compact Loader** we hoist the columns in place.

- Once main supports are secured, we proceed to install horizontal steel, such as beams, and secondary structures rafters, bracing, etc. with the use of a **Skid-steer Compact Loader.**

- For the erection of the steel structure, a 12 ton crane was used. The pipe, with the most weight was 4“ with 100 kg per pieze aproximately. In total, all the structure had a weight close to 1000 kg, and the steel plates for foundation and those for connection with cables and membranes was about 700 kg.
  Most of the work was done on-site due to the fact that the arches were ready to be assembed with the columns. This made the process simpler and allowed savings in the budget.

- Since the complete structure was fabricated on shop. All pieces must be bolted secure on site with our **power drill tool.**

- We inspect that all connections are secured, all steel members are leveled and cleaned to receive the next step, membrane.


United Rentals


United Rentals
TL12R2
TAKEUCHI
1-800-UR-RENTS


EQUIPMENT RENTAL


EQUIPMENT RENTAL

Membrane Installation:

- Membrane was cut according to the form finding and pattering software process on shop and welded with the **hot air gun and robot** process.

- Membrane gets transported on site with caution and maintaining it as cleaned as possible. Folded according to installation procedure.

- Once on site, we hoist the membrane with the **Articulated Boom Lift** to the spot where it has been pre-established to unfold and commence installation.

- We start pulling membrane across the beams, ensuring secure temporary connections with the **Articulated Boom Lift and Skid-steer Compact Loader** to unfold the entire membrane. We synchronize pulling forces with our **heavy-duty ropes.**

- Once all membrane corners are in place, we Visually confirm that all connections are secured and proceed to detach all **heavy-duty ropes and pulleys.**

Tensioning:

- Cables are inserted throughout the perimeter pockets.

- Pre-Tensioning commence utilizing winch and proprietary tensioning devices included on the rafters at the fabrication stage to ensure even forces are applies uniformly.

- We inspect the cables and end fittings, cap them to ensure no cable is either loose or thorn and potentially damage the membrane.

- Inspect the tension by hitting the membrane expecting a drum like sound.


772-210-7962 5533A
Rent-Return-Repeat
Haulotte

Cleaning:

- A complete clean out throughout the structure and site is performed to ensure we deliver our product and project in mint conditions.

- If there is a need to repair or replace anything that does not meet requirements nor a good project, we will do so.

Delivery:

- A meeting with the client is scheduled to deliver the project. If all looks good. Project is completed.


TENSOSHADE™


TENSOSHADE™

COST OF THE PROJECT

Estimated Costs for Acoustic band shell & outdoorstage									Overall Costs [$]	amount or percentage of damage [$]	amount or percentage of damage [%]	damage [$]	probability of damage [%]	amount of risk [$]
Designing Works	Preliminary Design+Concept						costs all inclusive		$ 500.00	0.00	0.00%	0.00	0.00%	0.00
	Statics						costs all inclusive		$ -	0.00	0.00%	0.00	0.00%	0.00
	Detailed Design						costs all inclusive		$ 3,500.00	0.00	0.00%	0.00	0.00%	0.00
	Other Costs (Printing, Stamps)						costs all inclusive		$ 1,000.00	0.00	0.00%	0.00	0.00%	0.00
							Subtotal Designing Works		**$ 5,000.00**			**0.00**		**0.00**
Construction-Material	**Construction Component**		**approx. total lenght/surface/pieces**		**weight [lbs/ft]**	**total weight [lbs/ft]**	**standard price (approx.)**		**Overall Costs [$]**					
	Steel components													
	Columns	Ø 8" Sch 40	15	ft	28.58	428.7	26.50	$/Ft	$ 397.50	0.00	0.00%	$ -	0.00%	$ -
	Arched Beams	Ø 8" Sch 40	100	m	28.58	2858	26.50	$/Ft	$ 2,650.00	0.00	15.00%	$ 397.50	15.00%	$ 59.63
	Trusses	Ø 6" Sch 40	75	m	18.99	1424.25	23.00	$/Ft	$ 1,725.00	0.00	15.00%	$ 258.75	15.00%	$ 38.81
	Gussets and small parts 8% of steel weight	estimated	8	%		1313	23.00	$/Ft	$ 184.00	0.00	0.00%	$ -	0.00%	$ -
	Cables and accessory											$ -		
	edge cable	Ø 1/4" x 6x19	4	Pieces				$ Piece	$ 450.00	0.00	0.00%	$ -	0.00%	$ -
	Bolts and Nuts	1-8NCx4"HEX	32	Pieces	0		40.00	$ Piece	$ 1,280.00					
	Bolts and Nuts	3/4-10NCx4"HEX	20	Pieces	0		40.00	$ Piece	$ 800.00	0.00	0.00%	$ -	0.00%	$ -
	Bolts and Nuts	1/2-13NCx2"HEX	20	Pieces	0		40.00	$ Piece	$ 800.00	0.00	0.00%	$ -	0.00%	$ -
	Membrane and accessory											$ -		
	Delta rings / Clamps	Grade A	2	pieces			15.00	$ Piece	$ 30.00	0.00	15.00%	$ 4.50	15.00%	$ 0.68
	Pins	galvanized	26	pieces			25.00	$ Piece	$ 650.00	0.00	0.00%	$ -	0.00%	$ -
	Membrane material: SergeFerrari Soltis Proof 502	1 layer	1250	sqft			3.50	$/Ft	$ 4,375.00	0.00	25.00%	$ 1,093.75	25.00%	$ 273.44
							Subtotal Construction		**$ 13,341.50**			**$ 1,093.75**		**$ 372.55**
Fabrication Steelwork	Fabrication						costs all inclusive		$ 6,500.00	0.00	0.00%	$ -	0.00%	$ -
	PowderoCoat						costs all inclusive		$ 4,500.00	0.00	0.00%	$ -	0.00%	$ -
	Transport						costs all inclusive		$ 6,500.00	0.00	15.00%	$ 975.00	15.00%	$ 146.25
	Working Hours						costs all inclusive		$ 12,500.00	0.00	0.00%	$ -	0.00%	$ -
	Other Costs						costs all inclusive		$ -	0.00	0.00%	$ -	0.00%	$ -
							Subtotal Fabrication Steelwork		**$ 30,000.00**			**$ 975.00**		**$ 146.25**
Fabrication Membrane	Membrane copl. excl. assembly						costs all inclusive		$ -	0.00	0.00%	$ -	0.00%	$ -
	Membrane fabrication						costs all inclusive		$ 2,500.00	0.00	15.00%	$ 375.00	15.00%	$ 56.25
							Subtotal Fabrication Membrane		**$ 2,500.00**			**$ 1,350.00**		**$ 56.25**
Transport/Supply to Site	for Steelwork						costs all inclusive		$ 1,500.00	0.00	15.00%	$ 225.00	15.00%	$ 33.75
	for Membrane						costs all inclusive		$ 500.00	0.00	15.00%	$ 75.00	15.00%	$ 11.25
							Subtotal Transport		**$ 2,000.00**			**$ 2,025.00**		**$ 45.00**
Construction management							costs all inclusive		**$ 5,500.00**					$ -
							Subtotal Construction Management		**$ 5,500.00**			$ 2,325.00		$ -

Installation on Site	Scaffold/Crane etc.	costs all inclusive	$ 4,500.00	0.00	15.00%	$ 675.00	15.00%	$ 101.25
	Erection Steelwork	costs all inclusive	$ 3,900.00	0.00	15.00%	$ 585.00	15.00%	$ 87.75
	Erection Membrane	costs all inclusive	$ 2,250.00	0.00	15.00%	$ 337.50	15.00%	$ 50.63
	Other Positions	costs all inclusive	$ -	0.00	0.00%	$ -	0.00%	$ -
		Subtotal Installation on Site	**$ 10,650.00**			**$ 1,597.50**		**$ 239.63**
On Site Tasks	Surveying	costs all inclusive	**$ 450.00**			$ -		$ -
	Foundation	costs all inclusive	**$ 10,000.00**			$ -		$ -
		Subtotal On Site Tasks	**$ 10,450.00**			**$ 1,597.50**		$ -
Approval membrane	Fees government structural verification	costs all inclusive	$ 500.00	0.00	0.00%	$ -	0.00%	$ -
	Testing membrane	costs all inclusive	$ 500.00	0.00	0.00%	$ -	0.00%	$ -
		Subtotal Approval Membrane	**$ 1,000.00**			**$ 1,597.50**		$ -
		Total	**$ 80,441.50**			**$ 12,561.25**	**6.84%**	**$859.68**

	0.00	0.00%	0.00	0.00%	0.00
	0.00	0.00%	0.00	0.00%	0.00
	0.00	0.00%	0.00	0.00%	0.00
	0.00	0.00%	0.00	0.00%	0.00
	0.00	0.00%	0.00	0.00%	0.00
	0.00	0.00%	0.00	0.00%	0.00
	0.00	0.00%	0.00	0.00%	0.00
	0.00	0.00%	0.00	0.00%	0.00
					0.00

capital	interst rate	Duration	summ
$ -	0.00%	0.00	0.00
$ -	0.00%	0.00	0.00
$ -	0.00%	0.00	0.00
$ -	0.00%	0.00	0.00
$ -	0.00%	0.00	0.00
		Total	**0.00**

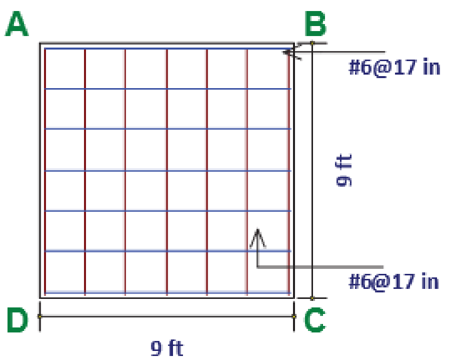
Project Financing		**$ 80,441.50**
Project Development	10.00%	**$ 8,044.15**
Risk	1.07%	**$ 859.68**
Overhead & Profit	40.00%	**$ 32,176.60**
Total	**$**	**121,521.93**

$121,521.93 AMERICAN DOLLARS

7. Conclusions

Based on all the calculation of the foundation, steel structure, membrane, tensioners, and cables, we can say the next data:

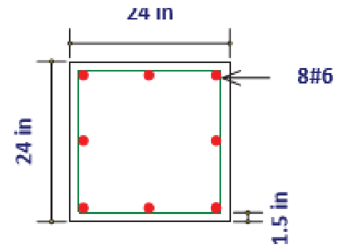
Technical Data:



x Dir. Steel: 3.09 in^2 (min)(7 #6)

z Dir. Steel: 3.09 in^2 (min)(7 #6)

Top Rebar Plan



Pedestal Rebar Plan

Geometry, Materials and Criteria

Length	: 9 ft	eX	: 0 in	Gross Allow. Bearing	: 2 ksf (gross)	Steel fy	: 60 ksi
Width	: 9 ft	eZ	: 0 in	Concrete Weight	: .1 k/ft^3	Minimum Steel	: .0018
Thickness	: 18 in	pX	: 24 in	Concrete f'c	: 3 ksi	Maximum Steel	: .0075
Height	: 54 in	pZ	: 24 in	Design Code	: ACI 318-14		
Rot. Angle	: 0 deg						

Footing Top Bar Cover	: 1.5 in	Overturning / Sliding SF	: 1.5	Phi for Flexure	: 0.9
Footing Bottom Bar Cover	: 3 in	Coefficient of Friction	: 0.3	Phi for Shear	: 0.75
Pedestal Longitudinal Bar Cover	: 1.5 in	Passive Resistance of Soil	: 0 lb	Phi for Bearing	: 0.65

The foundation is with Design Code Florida building code 2017 ASCE 7-10, calculate with concrete column, steel bar and the base in the floor.

8. Key Participants and Consultants:

Irving Allande:

As Tensoshade Director, I was involved in almost every aspect of this project.

- Initial negotiations and sales.
- Site visits with client and owner to establish alternatives.
- Design conceptualization and Architectural design.
- Budgeting.
- Construction Administration and execution.
- Logistics.
- On site erection and assembly supervision.
- Project Delivery.

Martin County parks and recreation:

- Site access.
- Site amenities.

TensoShade, LLC:

- Subcontractor.
- Budgeting.
- Material purchasing.
- Structural fabrication.
- Structure powder coating finishing.
- Membrane cut and welding.
- Logistics and transportation.
- Machinery operation.
- Structure erection, assembly, and installation.
- Project documentation and video.
- Project administration and billing.

Rocky Summit Engineering Consultants:

- Structural engineering design.
- Structural calculation and reaction reports.
- Form finding.
- Membrane patterning.

Andersen Andre Consulting Engineers Consultants:

- Geotechnical Report.

Lindell Construction:

- Contract Commissioner and General Contractor.
- Onsite footing layout and construction.
- Local accommodations.
- Onsite construction supervision.

I sincerely would like to thank everyone that collaborated on this fun project. Thank you.

9. References

Property Owner
Martin County Board of County Commissioners
Department of Parks and Recreation

Architect and Designer
Irving Allande

Tensile structure contractor
Tensoshade, LLC

Structural Engineer Consultant
Rocky Summit Engineering Consultants, Inc.

Geotechnical Consultant
Andersen Andre Consulting Engineers Inc.

Local General Contractor
LINDELL Construction

End of Document