



شركة الخيام والمظلات الممدودة  
TENTS & AWNING CO. LTD  
( TFS )



The world of TFS

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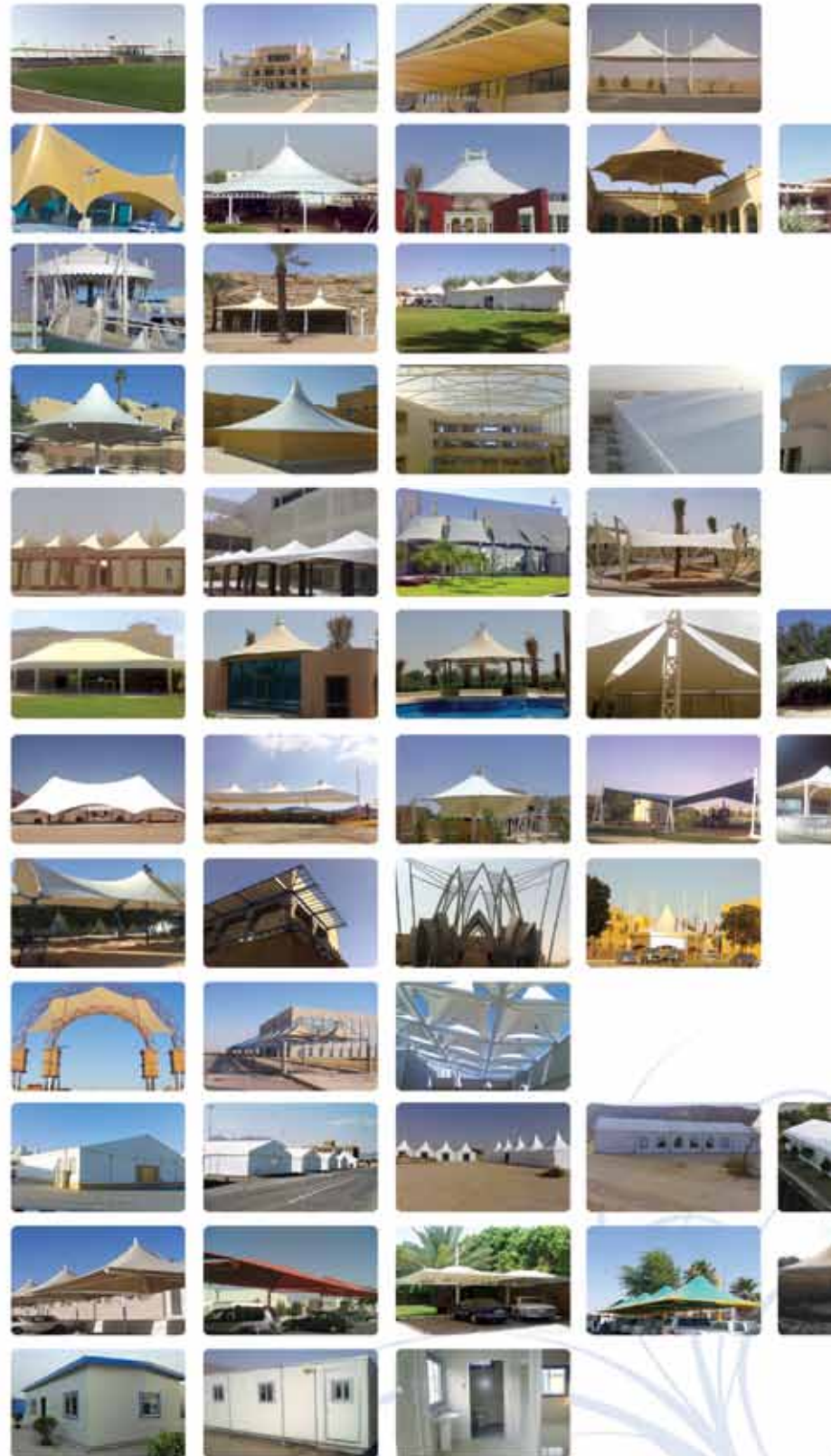
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## Introduction

Tents & Awnings Co. Ltd. (TACO) is one of the leading companies and largest also in the Middle East region specializing in the field of tension structures and shading large areas certified in ISO 9001.

As one of the leading companies in the field of textile architecture, TACO in close co-operation with renowned architects and consultants engineers – makes it possible to realize the most complicated of projects together with a single partner. A highly experienced and qualified staff team, the most modern manufacturing and processing technologies combined with efficient project and quality management assure the innovative development of high quality materials and products based on many years of TACO experience, Hundred of project all over Gulf Area document that TACO is more than capable of meeting any demands required, vigilance and openness in advisory discussions, creativity and flexibility in planning, economical and cost conscious thinking have always been the basis for this success.



## Sports Buildings

Textile roofing offers durable and long – lasting protection for both small and large free spaces, Over wide spans the membrane can be used without the need for additional supports. The weather resistant material withstands even strong winds and heavy rainfall and provide for shaded zones in hot regions. Yet the open air character is always maintained. The high degree of translucence of the material provide an airy light character even with existing buildings. Because the membrane of TACO can be even subsequently mounted on a wide variety of existing structures.



King Adullah Playground Taif. Second Phase Awning



King Adullah Playground Taif. Phase One Awning



Al-Reem Car Race – Main Building – Tension Fabric structure



Race beginning point bridge



Entrance gate awning



King Fahd Security College Awning



Village Phantom Awning





King Khalid equestrian collage stadium Awning



Al-Imam University playground – VIP platform Awning

## Commercial Building

Architecture can attract attention, architecture can create identities, and architecture can be primarily purposeful. Textile Building by TACO combine different specifications in useful, individual spaces that make the company culture visible to the outside. The multifaceted possibilities of textile architecture leave nearly unlimited room for attention arresting presentation and sales activities in the company specification environment. Noise and Heat Insulation, particularly through translucent membranes and interior space design, provide additional comfort to the distinguished points of attraction.



Tabuk Center. Al Hokair Co. Tabuk







Al NAKhil Plaza. Al Hokair CO.  
Boriada





Al Fath Commercial Center Courtyard Awning



Rehab Plan Awning



Vegetables market awnings – Beljurshi

Al RAjhi Commercial Center.  
Boriada



Sultana Plaza Market  
Al-Madina



## Tent's Tension Structures

Fabric structures offer a host of benefits to the design, construction and operation of virtually any building. Given the amazing range of fabrics available today, the design possibilities are endless, limited only by imagination. Fabric structures, from simple canopies to shade structures and elaborate fabric elements, provide many benefits: protection from the sun and weather elements; expanded usable and decorative outdoor space; branding, promotion and identification; energy efficiency and much more.



Farm Tents at Riyadh



Tents and Awning at Private Park. Wadi Laban



Private Resort Awning



Private Palace Tent





Half moon Beach rest tent



Conferences Awning for Aramco Co.





Welcome Tent for villas complex



Royal traditional Tent

## Educational Building

Create maximum shading for Students and visitors; provide maximum views to the sky; create a visual discourse between the canopy and the schools' architecture; and be c"heap. "The first three functional and aesthetic requirements were achieved easily enough through the design of conical and carved awnings for educational buildings.



Elementary school courtyard awning



Beige color



Children garden awning – Medical services



White color





Student Courtyard.Ministry of Foreign Affairs Housing



Girl's walkway and courtyard Awning. Girls Education school





Girls University Courtyards Awning. Al Qassim University



Al Safra Girls Facilities. Boriada



Interior Awning Of King Saoud University, Elisha-Riyadh



Education management  
headquarter Quieah



## Walkways

The main benefit of a Walkway is to provide protection from the wind and rain as people move from one building to another. Similarly, for goods or materials in transit, a walkway keeps them dry. In the summer, a Walkway can provide up to 97% protection from the harmful UV rays emitted by the sun.



Preparing Year Building Walkway awning  
Al Qassim University-Boriada



Governorate of Deera Building's Awnings





Al Jawal Building Tent-STC



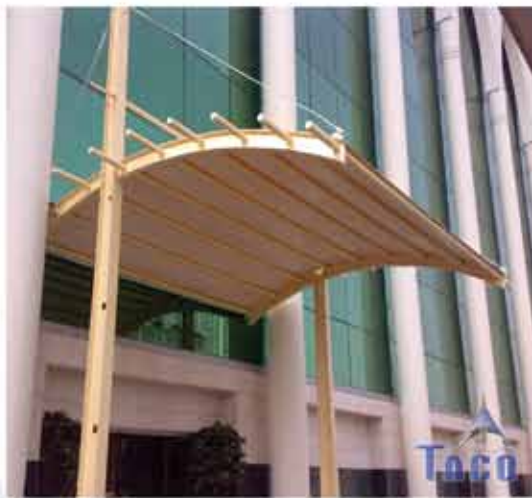
Qassim University Square College Of Engineering



Entrance Tent At Private Palace



Engineering Department Entrance – Al Qassim University



Courtyards and Entrance Awning- Ministry Of Education

## Home Decoration

We intuitively understand that sunlight adds a comforting, refreshing quality to any room. However, achieving the greatest beauty and efficiency in each room means being able to control the light that surrounds you. With TACO Shading Solutions, you can quickly and easily control sunlight.



Private palace  
Swimming pool awning







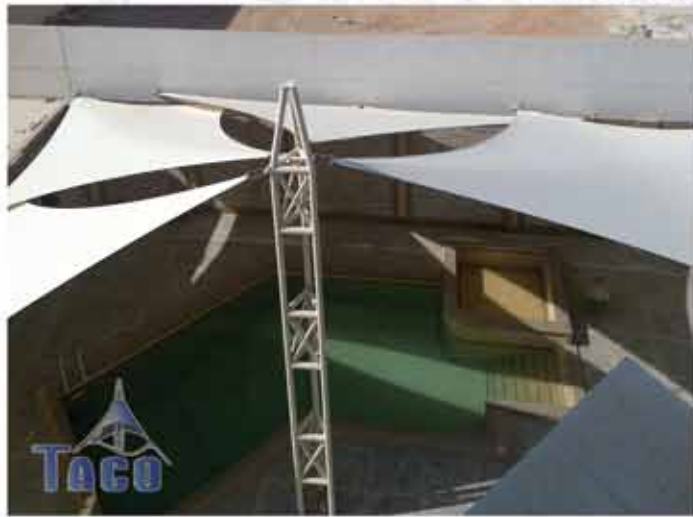
Conical Shape Awning At Private Palace



Sail Shape Awning at Private Palace



Sail Shape Awning at Private Palace



Tension Structure Awning Special Swimming Pool



Conical - Curved Shape Awning





Nayyara Medical Center Awning



## Landscape

When you speak of outdoor shade structures, you are most certainly implying cost effective instant shade that is also highly aesthetic in looks. The present day sun shade structures have come of age in terms of quality of fabrics & structures used and designs and ease of erection and are hardly comparable with the shades of a few years old.



PanPan Garden resort – Entrance Awning - Gate No : 2



PanPan Garden resort – Entrance Awning - Main Gate





Al Meghwah Resort. Haaeil City



Garden celebration awning – Municipality of Al-Kharj



Salwa Garden Village Awnings



Playground Awning



Embassy of Kazakhstan. Welcome Tent





Double cone. Dorret Riyadh – Panpan



Conical Shape Awning

## Architectural Solutions

With Taco's several designs and architectural solutions, you will have the ability to cover your entrances, your courtyards, and swimming pools in addition to many applications like traffic, public buildings, and chiller areas.

TACO Used to be specialized in covering mosques courtyards with different kinds of fabrics and wooden plastic foam.



Developing King Abdulaziz historical museum building project



Steel Structure Awning



Steel bridge



Car parking shades





Tension Steel Structure  
Awning – Private palace



Steel Awning



Steel bridge



Internal courtyard



Boudel Welcome Tent



Swimming Pool Awning – Qassim cement factory



Riyadh Entrance check point ▶  
Al-Damman Road



◀ Riyadh Entrance check point  
Al-kharj Road



◀ Riyadh Entrance check point  
Al-Qassim Road

Riyadh Entrance check point ▶  
Makkah Road





Trucks Entrance Awning For Pepsi Factory



Prince Fahd Bin Abdulla Al Saoud Mosque Courtyard Awning



PVC Tensioned Awning – prayers courtyards



Al Bawardi Mosque-Riyadh- Awning and Hall



Tension Fabric Structure – waiting area  
Al-Bedaa and Haki Accommodating Camp



Chiller Area Awning- SABIC HQ Riyadh



Chiller Area Awning- Faysalia Commercial Center

## Space Structures

### Why Space Frame?

Space Frames have a built-in reserve strength enabling the structure to take local overloading. Even when badly damaged they do not collapse rapidly. This property is of great importance in the case of fire, earthquake, explosion or terrorist attack. Due to the inherent stiffness of space frames, their deflection is considerably less.

Posse's great rigidity and stiffness hence resist large concentrated and unsymmetrical loading. Ideal for long column-free like Sports facilities, exhibition centers, passenger terminals, malls, assembly areas, and production facilities etc.

Long cantilevers are made possible, increasing roof area even with smaller ground area for columns.

Redefine industry standards of aesthetic requirements.

True new medium for architectural expression meeting the challenges for lightweight, and aesthetic forms required of these facilities.

There is virtually no limit to the shapes and spans that are possible.

The light and strong space structures are efficient and, most importantly, beautiful. Space structures provide an architecturally pleasing appearance. In multi layer structures, lights, air-conditioning ducts and other facilities can be kept inside the roof elements thus giving a clean appearance.

Computer automated software now achieves very rapid design and detailing.



Alyahya centre Tabuk – Entrance



Side walkway





Car Parking-Al Qaseem Cement factory

Dallah Hospital – waiting area awning



Ministry of Health entrance awning



Side walkways

## Light Weight Structures

TACO Tents products are stable and safe, have gorgeous appearance, and are easy to set up and dismantle. They are widely used for outdoor exhibition, fair, business promotion, product show, celebration, party, government publicizing and consultation activities, reception, sports, racing activities, outdoor wedding and festival (art festival, beer festival, food festival). The well-equipped facilities such as decoration ceiling and curtain, steel sidewall, movable glass door, furniture, air-conditioner, floor, blanket and lighting and hi-fi system make our products more powerful in practice. The party tents are made from high reinforced and light-weight aluminum alloy as its frame and the fabric is double PVC coated polyester textile. It is waterproof, flame retardant and UV resistant and the maximum allowed wind speed is 100km/h. The security and variability of our products have reached the standard of similar products in Europe. .



Rental Tent  
Halls & Exhibitions





202 Tents size 10 X 20 M  
Hard alloyed aluminum  
frame





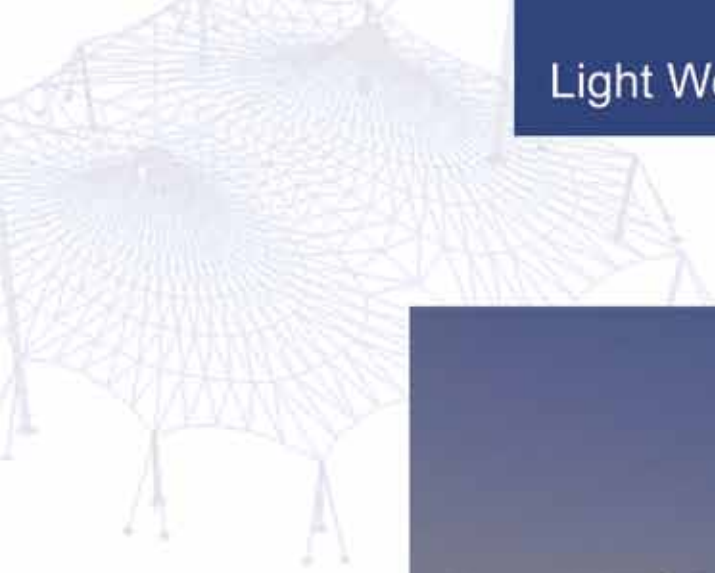
Bedaa & Haki Accommodating Camp



Conical tents for rent



5 X 5 Conical tent



Rental tent 5 X 5 conical shape



Festival tent's furniture



Tent's internal closing



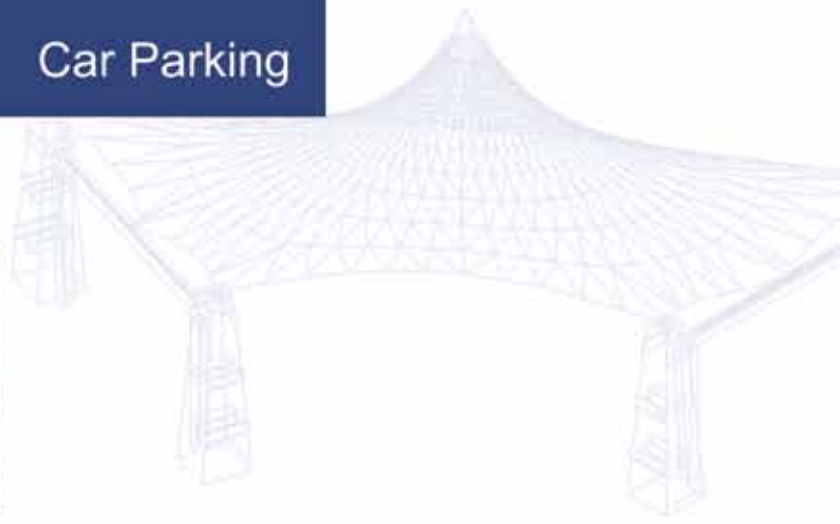
10 X 20 Accommodating Tent



Hard alloyed aluminum sections  
for Tents



1 - Conical Car Parking



2 - Car parking umbrella



3 - Gardens Awning. Umbrella type



4 - Car parking shade



5 - Conical entrance awning



6 - Continues conical awnings



7 - Conical car parking shade



8 - Café conical cover



9 - Tensioned awning for villa courtyard



10 - Tensioned conical awning





11 - Conical awning tensioned by beams



12 - Tensioned conical awning with push up cables



13 - Gardens one centre column awning



14 - One center column awning



15 - Conical space frame awning



16 - Stainless steel conical awnings



17 - Space frame awning



18 - Cantilever conical car parking shades



19 - Conical car parking shades



20 - Cantilever conical awning



21 - HDPE conical awning for café



22 - HDPE Awning



23 - HDPE Awning for sitting area



24 - Car parking shades



25 - Conical car parking shades



26 - Walk way awning Sail shape



27 - Walk way tensioned sail



28 - Architectural umbrella



29 - Tension structure awning



30 - Entrance tension structure awnings



31 - Emotional tensioned sail



32 - Swimming pool tension structure awning



33 - -- Exhibition conical awning



34 - HDPE car Parking



35 - Tensioned awning for villa courtyard



36 - Bus stop shades



37 - Pyramid awning



38 - Curved car parking awnings



39 - Swimming pool HDPE conical awnings



40 - Conical HDPE awning



41 - Pyramid car parking shade



42 - Pyramid roofing awning



43 - Pyramid awning



44 - Multi levels pyramid awning



45 - HDPE tensioned fabric awning



46 - Island Umbrella



47 - HDPE car Parking Shade



48 - Pyramid awnings



49 - Cantilever curved awning



50 - Curved awning



51 - Curved shape awning



52 - Entrance awning



53 - walkway conical awning



54 - Mosque courtyard awning



55 - Restaurant conical awning



56 - Pyramid walkway awning



57 - Natural Farm HDPE Awning



58 - Garden Awning



59 - Conical Shape Awning for Home Courtyard



60 - Car Parking Shade. Conical Shape



61 - Cantilever car parking. Curved Shape



62 - Car parking shade. Curved Shape



63 - Pyramid car parking shade



64 - Gardens awning. Tensioned HDPE Fabric



65 - Gardens awning tensioned HDPE fabric



66 - Car parking shade. HDPE fabric



67 - Café tensioned conical awning



68 - Pyramid car parking shade

## L. MOVABLE HOUSE

Tightly airproof, heat insulated and preservation, waterproof, resistant to fire and moisture proof. Easy assembly and disassembly, flexible layout, green and environmental friendly.

Beautiful in design and structure; color-coated steel sheet used in and out of the house; good appearance and effectiveness; the trade-off between design and color.

Over 10 years life span by normal use; space saving for containershipping; repeatable and recycled.

The standard container for various purposes is suitable for international container transport. It is of appropriate external dimensions and has connections for lifting and fixing or compounding.

The container is designed as a light construction consisting of floor and roof frames and corner profiles.



The construction enables compounding of individual containers in longitudinal and transverse directions without limits. It also enables compounding of containers in 2 floors and 3 floor in height.

The wainscots of the containers are made of sandwich panels and offer pleasant climate in the interior due to their building and physical properties.

Material and labor extremely cost-efficient and environmental friendly.

## • APPLICATION

1. Refugee camps, construction and mining companies (construction sites in town and remote locations)
2. Emergency and disaster sites (hurricanes/floods/earthquake)
3. Humanitarian disasters (housing camps)
4. Areas with desperate needs for instant and cost-effective shelters
5. Medical units
6. Military units
7. Temporary accommodation
8. Office/Administration space



## • SPECIFICATION DETAILS

**Roof :** Roof panel: 0.476mm thick, color steel sheet insulation: 50mm thick glass wool ceiling: 0.476mm thick color steel sheet covered with pvc film.

**Wall Panel :** Exterior cladding: color steel sheet, 0.476mm interior cladding: color steel sheet, 0.476mm covered with pvc film insulation: 50mm eps slabs.

**Flooring :** Sub floor: 0.476mm thick galvanized steel sheet insulation: 50mm glass wool floor: 16mm cca board to be covered with synthetic fiber carpet.

**Doors :** 820w x 2100h sandwich door panel.

**Windows :** 800w x 1000h u-pvc sliding windows.





## • FITTINGS

1. Electricity wire
2. Electric distribution box: 1 set
3. Lights
4. Switches
5. Sockets
6. Plastic wire duct.



## • LOAD REQUIREMENTS

1. Wind load acc. to DIN 4112
2. Min. length 1000m
3. Max. length unlimited in truss-distance



China's earthquake stricken accommodating camp  
Al-Sinidi Co. - China

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## INTRODUCTION

### FABRIC STRUCTURES ARE RIGHT FOR ANY BUILDING

Fabric structures offer a host of benefits to the design, construction and operation of virtually any building. Given the amazing range of fabrics available today, the design possibilities are endless, limited only by imagination. Fabric structures, from simple canopies to shade structures and elaborate fabric elements, provide many benefits: protection from the sun and weather elements; expanded usable and decorative outdoor space; branding, promotion and identification; energy efficiency and much more.

Bold, vibrant fabric colors and patterns, combined with sophisticated printing technologies and advanced construction techniques provide designers and architects with the necessary basis for creating structures that will dramatically enhance any buildings' visual appeal as well as its functionality.

With the importance in today's marketplace of branding, fabric structures allow for vivid, colorful messages, identification and promotional markers while offering practical functionality for outdoor areas. Also, the increasing focus on taking advantage of and enhancing both indoor and outdoor environments, affects building owners, occupants and visitors alike.

Fabric structures also provide the benefits of flexibility, energy and cost efficiency, and the compatibility to be coordinated with any architectural style.



## TENSIONED FABRIC STRUCTURES (TFS) SPECIFICATIONS

### A. BRIEF DESCRIPTION

- The Tensioned Fabric Structure Manufacturer (hereafter referred to as TFS Manufacturer )"shall be responsible for the design, engineering, fabrication, supply and installation of the work specified herein. The intent of this specification is to have single source responsibility for the above functions.
- Performance Requirements: The TFS Manufacturer shall be responsible for the configuration, fabrication and erection of the tensioned membrane structure. All materials provided shall be new and unused.
- Erection of the complete system shall be the responsibility of the same firm designing and manufacturing the building.
- The fabric structure shall be a cable and/or frame supported tensioned membrane structure. The fabric shall have low elongation characteristics under tension and shall assume an anticlastic configuration. Structures that have designs incorporating fabric in a flat or mono-axially curved configuration at any location in the roof will not be acceptable.
- Provide a structure as shown in the drawings and described in this specification. Foundations and anchoring for the structure shall be the responsibility of General Contractor or the TFS Manufacturer.



## i. Engineering

-Prepared with knowledge and experiences which able to work on recently international programs.



### Functions:

1. Based on the structural calculations as defined in this section, prepare structural design drawings defining the complete structure, precise interface geometry determination, reaction loads imposed on foundations, anchoring loads, connection details, interfaces and seam layouts.
2. Structural calculations for the fabric structure shall include:
  - a. Large deflection numerical shape generation that will insure a stable, uniformly stressed, three dimensionally curved shape that is in static equilibrium with the internal prestress forces and is suitable to resist all applied loads.
  - b. Large deflection finite element method structural analysis of the membrane system under all applicable wind, seismic and snow loads.
  - c. Finite element method structural analysis of the support frame system.
  - d. Member sizing calculations of all primary structural members.
  - e. Connection design including bolt, weld and ancillary member sizing.
  - f. Biaxial Fabric test specification, interpretation and fabric compensation determination.
  - g. Accurate generation of the two dimensional compensated fabric templates required to generate the three dimensional equilibrium shapes.

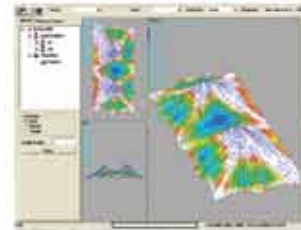


## ii. DESIGN

- The structural design shall comply with applicable codes and regulations.
- Design Engineering documentation of complete tensioned membrane structure will meet all applicable codes.
- The structure shall be designed in accordance with the IBC Building Code with the design wind speed to be 90 MPH minimum.
- Below are some of our design softwares':

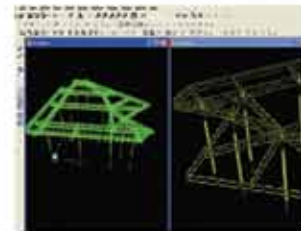
### Forten 32 Software

-Used in tension structure for awnings in addition for cutting it accurately and bring the most beautiful look of the fabric structure.



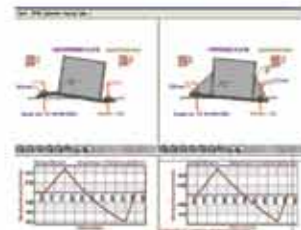
### SAP Software steel modeling

- Concentrated in steel modeling, sections, and thicknesses which used for every project to ensure that the awning is stable.



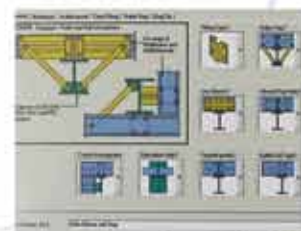
### PROKON Software

-Used for designing steel connections.



### STRUCAD Software

- Concentrated in steel structures designing and Drawing, used section quantity calculation and its type accurately in addition to load forces studies.



### Foundation

-Special software for concrete foundations.



## B. FABRIC MATERIALS

- Most fabric structures are composed of actual fabric rather than meshes or films. Typically, the fabric is coated and laminated with synthetic materials for increase strength, durability and environment resistance. Among the most widely used materials are as follows

### i. APPROVED ARCHITECTURAL FABRIC MEMBRANE MATERIALS

a. **PVC (Polyvinyl Chloride)** – is by far the most commonly used coating for architectural purposes, generally being coated or laminated onto polyester. It is inexpensive and can be easily flexible and flame retardant when coated on polyester by adding adding chemical compounds.

#### PROPERTIES:

1. Raw Material: Polyester
2. Construction: PVC/PVDF Coated Polyester
3. Tensile Strength: to meet requirements of engineer
4. Light Transmission: 8% - 14%, depending on required strength
5. Color: White
6. Expected service life: 7 – 10 years
7. Flame retardant: NFPA 701
8. Composure: Solid and water repellent
9. Seams: RF Sealed with sufficient strength to develop 90 percent of full strength of fabric
10. Recyclable material construction

b. **PTFE (Polytetrafluoroethylene) coated Fiberglass** – is made from PTFE (Teflon) coated glass fibers. PTFE is used worldwide as a preferred material for large scale permanent structures.

#### PROPERTIES:

1. Base Fabric: Woven "EC6" glass.
2. Coating: PTFE.
3. Tensile Strength: as required by engineer
4. Combustibility: Non-combustible substrate when tested in accordance with ASTM E 136.
5. Intermittent Flaming: Class A, when tested in accordance with ASTM E 108.
6. Flame Spread: Class A, when tested in accordance with ASTM E 84.
7. Flame Retardancy: Passing NFPA 701.
8. Solar Transmission: 19 percent, minimum.
9. Seams: Welded, with sufficient strength to develop 90 percent of full strength of fabric
10. Expected Service Life: 20 to 25 years.
11. Color After Exposure to Sunlight: White.
12. Composure: Solid and water repellent
13. Neoprene gaskets will be used to protect PTFE against contact with metal Components

- c. **HDPE (High Density Polyethylene)** – UV stabilized to retain strength and flexibility.

#### PROPERTIES:

1. Mesh fabric made from UV stabilized HDPE
2. Fire Retardancy: NFPA 701
3. Sewn with PTFE thread in a zig-zag stitch to prevent failure under tension
4. Color: As approved by architect/owner from available selection

- d. **ETFE (Expanded Polytetrafluoroethylene)** – a transparent membrane with fabric like qualities and the advantages of PTFE, such as a self cleaning capability.

#### PROPERTIES:

1. Tear strength: as required by engineer
2. Light Transmission: 30% - 40% with respect to associated required strength
3. Color: White
4. Flame retardant: NFPA 701
5. Flame spread: Class A (ASTM E84)
6. Composure: Solid and water repellent
7. Seams: RF Sealed with sufficient strength to develop 90 percent of full strength of fabric
8. 25 year expected life - 15 year full warranty
9. Recyclable material construction

- e. **Silicone glass fabric** – has a much greater tensile strength than polyester and fabrics are made from diameter to avoid damage from flexing.

#### PROPERTIES:

1. Silicone coated fiberglass fabrics combine the superior strength and dimensional stability of woven fiberglass with a high temperature silicone coating.
2. These fabrics exhibit excellent thermal and mechanical properties. Additionally, the silicone coating provides better friction than PTFE coated fabrics with very good release properties - especially when in contact with adhesives and other tacky substances.
3. continuous use temperatures up to 450°F, these fabrics can be used in a broad range of applications including: heat curtains, release sheets and general elting.

### ii. STRUCTURAL STEEL FRAMING

- a. Structural frame shall be fabricated from structural steel using standard shapes. The steel shall be minimum ASTM A36 for standard profiles and A500 Grade B for structural tubes.
- b. The fabrication of the steel shall be in accordance with guidelines set forth in the AISC steel design manual and the AWS code of structural welding. All weld shall be in accordance with manufacturers design and performed prior to shipping. No welding shall be performed in the field unless authorized in writing by the Owner or Owner's representative.



- c. The structural members shall be fabricated in as large segments as possible to minimize field joints.
- d. All segments of the assembly will be welded or stamped with the appropriate part number in a manner that will still be visible after powder coating is applied.
- e. Grind all corners and sharp edges.
- f. The steel shall be polyester powder painted to a minimum of 3 mils.
- g. Steel will require abrasive blasting and primer before application of the polyester powder paint finish.

### iii. ALUMINUM MEMBRANE PLATES AND CLAMPS.

- a. Aluminum shall conform to alloy 6061-T6
- b. All components will be welded or stamped with the appropriate part number in a manner that will still be visible after powder coating is applied.
- c. The aluminum shall be polyester powder painted to a minimum of 3 mils.

### iv. CABLES AND END FITTINGS

#### a. Galvanized Cables and Fittings:

1. All structural wire rope shall be made from Wire Rope conforming to AISI Steel Cable Manual requirements with a Class A galvanized coating or approved substitute. The cable should be IWRC improved plow steel. All cable terminations and connectors shall be hot-dipped galvanized for corrosion protection. Cables should be designed with a minimum safety factor of 2 on breaking strength.
2. Cables which are designated to be prestretched shall be prestretched per ASTM A603 for wire rope. Cables of the same type shall have the same modulus of elasticity.
3. All cables and end fittings shall be delivered clean and dry.
4. All swaged and splattered fittings shall be designed and attached to develop the full breaking strength of the cable. Thimble end fittings shall develop a minimum of 110% of the cable breaking strength.
5. Swaged end fittings, pins, nuts and washers shall be electro-galvanized.
6. Splattered end fittings shall be hot dipped galvanized.
7. Attach a tag indicating the cable length and mark number to each cable assembly.
8. The design load is the load in the cable under prestressed load condition per the recommendation of the engineer on record.
9. Cables shall be tensioned to double the design load before length is cut
10. Cables shall be tensioned to the design load when measuring the cut length that is indicated on the shop drawings

#### b. Stainless Steel Cables and Fittings:

1. Cables shall be 1x19 Stainless Steel Open Strands, Grade 316
2. Cables and fittings will be fabricated per the standard operating procedures of the following approved manufacturers:
  - Frontier Technologies
  - Ronstan International

3. Attach a tag indicating the cable length and mark number to each cable assembly.
4. The design load is the load in the cable under prestressed load condition per the recommendation of the engineer on record
5. Cables shall be tensioned to double the design load before length is cut
6. Cables shall be tensioned to the design load when measuring the cut length that is indicated on the shop drawings

## V. BOLTS AND RELATED FASTENERS

- a. Fasteners and hardware accessories shall be of types and sizes best suited for the purpose as recommended by the engineer on record.
- b. Fasteners used on main structural members shall be hot-dipped galvanized high strength bolts including nuts and washers, and conforming with ASTM A325 or A490 as applicable. All other fasteners shall be adequately sized and treated for corrosion protection.
- c. Concrete anchor bolts shall conform to A307 and be Hot-dipped Galvanized.

## C. COST OF FABRIC

Fabric Type	Typical use	Cost comparison
PTFE – Coated fiberglass	Large scale permanent structures class A ASTM E - 108	75\$ - 100 per m <sup>2</sup>
Silicone – coated fiberglass	Large scale permanent structures class A ASTM E-108	75\$ - 100 per m <sup>2</sup>
Vinyl – coated polyester	Temporary and permanent structures	50\$ - 75 per m <sup>2</sup>
Woven PTFE	(More pliable than standard PTFE) Retractable roofs, structures	85\$ - 125 per m <sup>2</sup>
ETFE	High Transparency (97%) Atria, Indoor parks, biospheres skylight applications	100\$ - 125 per m <sup>2</sup>
HDPE ( high density polyethylene)	Shade structures / systems	25\$ - 50 per m <sup>2</sup>
Laminates	Tents, Awnings, and Canopies	35\$ - 50 per m <sup>2</sup>

## D. MATERIAL SPECIFICATIONS

Fabric Type	Transmission	Reflection	Absorption
Acrylic Solution - dyed	<2%	98+%	-
Expended PTFE	19 – 38%	62 – 81 %	<1.0 – 1.0 %
Fiberglass PTFE - Coated	7 – 29%	65 – 75 %	0 – 8 %
HDPE	4.7 – 5.2%	20 – 75 %	9 – 10 %
HDPE, LDPE - Coated	72 – 12 %	74.3 – 80.3 %	12.5 – 13.7 %
Modacrylic Solution - dyed	<2%	95+%	-
Polyester	8 – 65%	-	-
Polyester acrylic coated	Depends on color	-	-
Polyester PVC coated	5 – 15% (also opaque)	77 78 %	16 – 17 %
Polyester PVDF coated	5 – 9%	76 – 78 %	16 – 17 % 51% rate
Silicone	15 – 36%	52 – 75 %	12 %

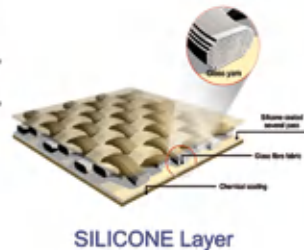
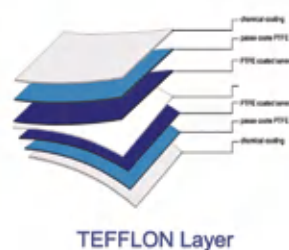
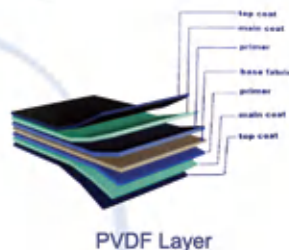
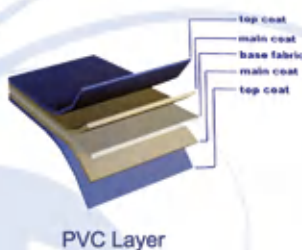
### E. MATERIALS COMPARISON

Properties	PVC-PVDF	Silicon-Glass	PTFE	ETFE
Fire Retardency	Self Extinguishing	Inherently flame retardant	Inherently flame retardant	Self Extinguishing
Life Span	Good/Excellent 10/20 yrs	Excellent 20 yrs	Excellent 20 yrs	Excellent 25 yrs
Costing	Low	Medium	High	Highest
UV protection	100%	UV-A Pass through	UV-A Pass through	UV can be filtered as per requirement
Flexibility	High	Medium	Low	Low
Translucency	0-20%	10-40%	8-20% max	Approx.90% can be regulated by printing
Color Range	Extensive	Extensive depends of order quantity	Limited	Extensive depends of order quantity
Joining techniques	HF weldable	Bonding with silicon adhesive	Thermal splicing with FEP tapes	Thermal Splicing
Warranty	5-15 years	5-12 years	5-12 years	10 years
Ecological	Full Recyclable	Partial Recyclable	Not Recyclable	Full Recyclable

### F. SCHEDULE OF VALUE

- Breakdown of the major cost (design, engineering, project management, steel fabric and hardware fabrication, installation and equipment, shipping).

Schedule of values	
Design (5 – 15%)	Design development to construction document percentage versus depending on design/build versus plans and specification
Engineering (5-15%)	Awnings to dome stadium all project require a structural analysis it depends on how many load cases (DD, LL, etc.)
Project Management (5-15%)	Varies depending on the scope of work some projects are membrane only while most are single source complete structures
Steel and Fabrication (10-60%)	Large variable mast supported structures versus frame supported structures
Membrane and Fabrication (10-60%)	Cost varies depending on the complexity of design
Installation (10-30%)	Cost can vary depending on labor rates and location
Equipment (5-10%)	Cost can vary depending on access and site location
Shipping (1-5%)	Membrane is fabricated around the world shipping cost may include sea freight air freight dedicated trucks etc. Costs vary depending on as prices and final destination



## G. IDEAS FOR TENSILE STRUCTURES :

Item	Description	Remarks
The Design comply with Taco 2010		
The wind load as per ASCE 7 – 92 160km/h		
The membrane design as per European design guide		
<b>A</b>	<b>Structure Steel Finish</b>	
1	Surface Preparation	Industrial blast cleaning according to SSPC – SP 15/NAC No. 6 to the surface to be paint
2	Galvanizing	Hot deep galvanizing finish – zinc coating ASTM 123
3	Damage to the zinc coating	Cleaned & painted with gray zinc paint as per ASTM A780
<b>B</b>	<b>Polyurethane Finish System</b>	
4	Primer	Epoxy Primer 200u
5	Finish	Polyurethane top coat 80u
6	Surface preparation	Galvanized steel SSPC SPI "solvent Cleaning"
<b>C</b>	<b>Tensioned Fabric Structure</b>	
7	Fabric Coating	Polyvinyl Chloride (PVC)
8	Fabric- Protective top coat	Fluotop T2 (High Concentration PVDF)
9	Weave	High tenacity polyester weave
10	Prestress	Prestress fabric in two direction during the manufacturing process for better coating less elongation and stability
11	recyclable	PVC fabric should be 100% recyclable
12	Coating thickness	270 to 350u
13	Fabric flame Retardency	M2/NF P 92-507 B1/DIN 4102-1 BS 7837 VKF 5.2/SN 198898 TEST2/NFPA 701CSFM T19 ASTM E84 Class C/ASTM E108
14	Tensile Strength (warp/Weft)	Min. 580/580daN/5cm Depends on the design calculation
15	Tear strength (warp/weft)	B0/65 daN Min. Depends on design calculation
16	Fabricated Joint	Tensile strength of the joint should be 90% of the original tensile strength of the welded material.
17	Adhesion	12 daN/5 cm
18	Biaxial test	At least two representative sample of the outer fabric shall be biaxial test loaded
19	Warranty	10 Years
<b>D</b>	<b>Accessories</b>	
20	steel wire rope cables standard 1 X 19	ASTM A 492
21	Swaged end fitting, pins, nuts & washers	Stainless steel 316L
<b>E</b>	<b>Steel Structure</b>	
22	Support structure shapes & plats	ASTM A36/A 36M
23	Structural Pipes	ASTM A53/A53M, Grade B
<b>F</b>	<b>Structure Bolts</b>	
24	High strength bolts	ASTM A326M
25	Threaded nuts	ASTM A36/A 36M
26	Anchor bolts	ASTM F 588 M, Property class 4.6
<b>G</b>	<b>Fasteners for Fabric Clamping</b>	
27	Bolts & studs	ASTM F593
28	Nuts	ASTM F594
29	Washers	Plain, Narrow and conform to AISI Type 304 (18-8)

## H. EXECUTION

### i. ERECTION

- a. TFS Manufacturer will prepare a full and comprehensive assembly procedure guide prior to installation.
- b. Comply with the TFS Manufacturer recommendations, the approved shop drawing and the applicable Code requirements.
- c. Weather Conditions: Proceed with installation of the fabric and associated work only when existing and forecasted weather conditions will permit work to be performed in accordance with manufacturers recommendations. The Tensioned Fabric Structure shall not be installed when wind conditions are deemed in excess of manufacturers' determination of safe wind speed erection conditions. It shall be the manufacturers' sole discretion to determine acceptable and safe wind condition for i installation.
- d. Framing and structural members: Anchor bolts shall be accurately set. Uniform bearing under base plates shall be provided using non shrink grouting compound where applicable. Members shall be accurately set to assure proper fitting and covering. As erection progresses, the work shall be securely fastened to resist the dead load and wind and erection stresses. Erected structural frame work shall be adequately guyed and secured to resist all possible loads due to wind and the installation process.
- e. Fabric: Prior to start of installation; check all surfaces of framing members and other rigid construction elements to be in contact with fabric to ensure that all edges are smooth and well rounded. Remove any potential causes for snagging or tearing of the fabric. Properly install all connections and provide all materials and equipment required for the erection and stressing of the fabric. Unroll the fabric in such a manner as to avoid snagging or dragging the fabric over sharp objects during installation. Adequate fabric prestress shall be confirmed by the fabric structure manufacturer and the appearance of the fabric membrane roof shall be smooth and wrinkle free. Creasing or folding the fabric around sharp corners shall be avoided at all times.
- f. Fabric tensioning system: Cables shall be free of all kinks and bends. Care shall be taken not to damage cables during installation. Bolt holes shall be 1/16" larger than the bolt, unless otherwise indicated.
- g. After installation, restore marred or abraded surfaces to original condition using same paint or coating as factory-applied finishes, when the results are acceptable to the Architect, otherwise replace damaged equipment.

### I. WARRANTY

- Warrant frame materials and workmanship against defects for a period of 1 year from date of substantial completion of the work.
- Warrant fabric materials and workmanship against defects for a period of 5 to 15 years (depending on selected and approved fabric), on a prorated basis, from the date of substantial completion of the work and/or offer the same warranty offered by the fabric mill that manufactured or supplied the fabric.

## FOR GENERAL CONCRETE CONSTRUCTION

### i. Portland Cement:

- 1) Portland cement shall conform to ASTM Standard Specifications C 150 Type I or Type 1A latest edition.
- 2) High-Early strength Portland shall conform to ASTM Standard Specifications C 150 Type III or Type IIIA.
- 3) All cement poured under extreme heat conditions shall use ASTM Standard Specifications C-150 Type II.
- 4) White Portland Cement shall conform to U.S. Governmental Federal Specifications SSC-181 latest editions.

### ii. Sand (or Fine Aggregate):

Sand for concrete work shall be capable of developing 80% of the tensile strength of Ottawa sand. It shall be well graded from coarse to fine aggregate and not contain more than 1% clay or 1% coal or lignite when tested according ASTM methods. It shall not show darker than light amber when tested by the color metric test method.

All fine aggregate shall conform to the following requirements:

<u>Sieve Size</u>	<u>% Passing</u>
3/8 inch	100%
No. 4	95-100%
No. 16	45-80%
No. 50	5-30%
No. 100	0-10%

### iii. Coarse Aggregate:

Coarse Aggregate shall be composed of hard, strong crystalline rock free from shale or other soft materials and free from any adherent coating or vegetable matter.

All crushed stone or gravel for concrete work shall be well graded and shall pass the following sieve analysis:

<u>Sieve Size</u>	<u>% Passing</u>
2 inch	100%
1-1/2"	90-100%
1 inch	20-55%
3/4 inch	0-15%
3/8 inch	0-5%
No. 4	0%

### v. Base:

Unless the plans show differently, the base under all concrete work shall be a minimum of 6 inches deep and shall be constructed of selected gravel or crushed stone of such size that 100% will pass a 2 inch sieve and 98% will be retained on a No. 200 sieve. All gravel shall be uniformly graded between these limits and rolled with a 3 to 5 ton roller until no yielding or creeping occurs under the roller.

#### iv. Reinforcing Steel:

##### 1. General:

All reinforcing steel shall be manufactured from new billet steel, intermediate grade, deformed bars, in accord with Standard Specifications ASTM A 15 latest edition.

##### 2. Description:

Steel reinforcement shall consist of furnishing and placing bar steel or steel fabric reinforcements as shown on the plans and required by the contract.

##### 3. Materials:

Materials used in this work shall meet the requirements for the class of material named, and as provided in the specifications.

#### vi. Joint Sealing Materials:

For slabs or pavements exposed to the weather, asphalt filler shall be used conforming to the latest revision of AASHTO Specification M-18 Type A an approved master filler.

## K. LOADS

Under loads (sand, wind, pressure, uplift, snow, dead, live..etc.) Tensile structures behave quite different to conventional steel or concrete structures. They undergo large displacements to carry loads with tension stress to the ground.

The linear theory of structures where strain (and displacements) is small compared to the overall size of the structure, where loads are applied in the undeformed state are not applicable to membrane structures. This is the reason why geometrical nonlinear analysis is necessary.

Static means that loads are applied at time to fixed, while geometrical nonlinear means that the equilibrated state is the final deformed one and not the initial shape as in linear theory.

After form finding we have a starting geometry in equilibrium with prestress, so geometry and prestress represents our structure, the overall stiffness and the capacity of carrying loads depends on these two components.

A good tensile structure design depends on geometry and prestress and the Architect/Engineer should never forget this.

## DESIGN CRITERIA

SAND LOAD .....	10 kg/m <sup>2</sup>
WIND LOAD EXPOSURE .....	Zone C
BASIC WIND SPEED .....	160 km/h
HOT TEMPERATURE .....	+ 70 C°
COLD TEMPERATURE .....	- 30 C°
LIVE LOAD .....	75 kg







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