A Review on Worlds Largest Tent {Khan Shatyr}

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Abstract: We all know that the tent is the ancient form of human structure, which is easy to assemble, fast to dismantle and capable of providing shelter in any terrains. It is a form that has light, functional and can be found in one form or another throughout the human history. We came into a major change in this tradition and started to build a massive tent. The khan Shatyr entertainment centre represents a major civic, cultural and social venue for the people of the capital city Astana, Kazakhstan. It is a structure made of three major components which holds the tent together. Tripod stand, radial cables and ETFE cushions are the three components that hold the structure. We are going to know about a structure which is the advanced form of ancient form of tent in both its dimensions and usage. It is the tallest tensile structure in the world. In this paper we present about climatic conditions around the structure, components of the structure, construction of the structure. Structural details and floor plans of the structure are also presented.

KEYWORDS: Tallest tensile structure, tripod, Radial cables, Ethylene tetra fluoroethylene cushions.

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INTRODUCTION

The tent may be the oldest form of human structure which is easy to assemble, fast to dismantle and capable of being erected in any terrain. It's a form that's light, functional and low maintenance, and can be found in one form or another throughout much of human history. But in this present world it is possible that this oldest type of structure may hold the key to architecture's future.

Kazakhstan planned to use the tents as one of the world largest building, which is constructed at the center of the capital Astana. It was designed by the British designers/builders Foster & Partners. It is named as, the Khan Shatyr Entertainment Centre in the capital Astana, which is 150m (490ft) high.

SECTIONAL VIEW OF KHAN SHATYR

(Royal Marquee)

It is named as the khan shatyr also known as Royal Marquee. The center has a huge indoor fun/relaxation park, designed to be protected from the area's harsh climate. Standing on a 200m concrete base, Khan Shatyr is the city's highest structure and the world's tallest tent. Inside, visitors will find shops, restaurants and movies - even a (not made by nature/fake) beach and a running track.

Astana experiences extreme changes in temperature, from 30C in the summer to -30C in the winter. The giant tent, which took four years to build, is designed to survive harsh weather and maintain a comfortable temperature inside. It is made from three layers of ETFE; a special see-through plastic that allows daylight to wash the interiors while sheltering them from weather extremes.

The Khan Shatyr first appearance comes more than twelve years after President Nazarbayev moved the Kazakh capital from Almaty to the cold and far apart from north-central city of Astana. It is called as Aqmola in 1997.

CLIMATE CONDITION

During summer a temperature of 30^0c can be observed. In winter max temperature of -30^o c is seen. During these temperature changes it is hard for workers to progress the work, but the construction work is successfully completed within 4years. Even though there is the existence of the harsh climate, construction on the Khan Shatyr happened all year round tried under the direction of Sembol firm using some specialist contractors to enable the opening for President Nazarbayev's birthday in 2010.

INITIAL CONCEPT

Initially the engineers are challenged with creating a giant, free-spanning enclosure with the minimum of support. the engineers felt that a single compression masted cable net in a conical form was the natural choice due to its simpleness and creating a large volume of space underneath. With a single compression mast to lift the net and create a large volume underneath. The roof skin is in tension and can use cables rather than beams to carry all loads. It also creates a very strong "famous" form on the skyline and provides country with fame for such an important building in the capital city.

STRUCTURE DETAILS

Area : 1, 23,000m2
Length : 200m
Width : 195m
Height : 150m
Concrete base : 200m x 195m
Base of cable net : 143m x115m
No of radial cables : 192
No of circumferential cables : 16
ETFE cladding : 19,000m²

STRUCTURAL COMPONENTS

There are three main components in the design of this structure. They are

i. Tripod structure.
ii. Cable structure.
iii. ETFE cushions.

TRIPOD STRUCTURE

A tripod is a three-legged frame or stand, used as a platform for supporting the weight and maintaining the stability of some other object. The three-legged triangular stance design provides good stability against gravitational loads as well as horizontal shear forces, and better leverage for resisting tipping over due to lateral forces can be achieved by spreading the legs away from the vertical centre.

- In this structure each tripod leg is formed from a trichord truss with a 1000mm diameter hallow main section.
- The back leg of a tripod resists 140MN (meganewton) weight and both frond legs resist 50MN.
- These legs meet at a point which supports a 12 pins end struts reaching to the cable net top ring.
- This point is located with the center line corresponding with the resulting axial force from the cable net under prestress loads.
- The tripod provides the single point of support to the center of the cable net and is an important element for the architecture of the building.
- The tripod structure which is used provides a robust constructible base while the articulated top ring that it supports provides some movement to relieve the forces in the cable net.
- The movable part of the mast is then a much smaller element that was easier to temporarily brace during construction.

CABLE STRUCTURE

Cable structure, Form of long-span structure that is subject to tension and uses suspension cables for support. Highly efficient, cable structure includes the suspension bridge, the cable-stayed roof, and the bicycle-wheel roof. The cable-stayed roof is supported from above by steel cables radiating downward from masts that rise above roof level. The bicycle-wheel roof involves two layers of tension cables radiating from an inner tension ring and an outer compression ring, which in turn is supported by columns.

- This structure contains a total of 192 pairs of 38mm diameter radial cables. These cables length differs from 125m at front and 70m at the back.
- A relatively high prestress of 80% pf peak cable force is used in this structure to control the deflection to around 800mm over the longest cable span.
- Traditionally the central support of a conic tent is a single mast, pinned at both the top and the bottom and stabilized by the tent that it supports.
- This only ever places axial force in the mast which moves with the tent under asymmetric loads and reduces the peak tensions within.

ETFE CUSHIONS.

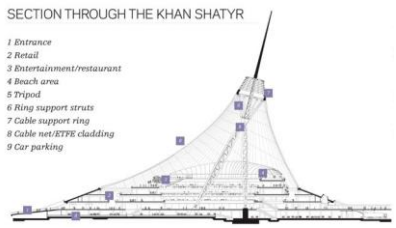
ETFE represents **Ethylene Tetra Flouro Ethylene**. It is a polymer fabric which is extruded into thin films and supported in an aluminum perimeter extrusion, which is supported on the building frame.

- The skin of ETFE cushions is very lightweight and insulates while still providing natural daylight.
- The cushions are flexible to accept the large deflections of the cable net, however their frames are much more rigid, and so they decided a staggered arrangement of cushions.
- This allows the hoop frame of one panel to squeeze in on the midpoint of the adjacent panel and benefit from the inherent flexibility of the cushion.

CONSTRUCTION

Primary task is to lay a concrete floor on base of size 200m x 195m. Now construction of this structure involves 3 major installations. They are

i. Tripod erection.
ii. Cable installation.
iii. ETFE cousin's installation.

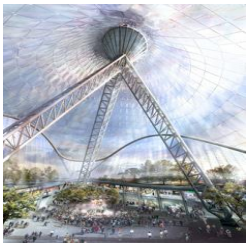


SECTIONAL VIEW THROUGH KHAN SHATYR

TRIPOD ERECTION

Strand jacks are attached to the top of a temporary tower in front of the tripod, pulled on by using lifting cables attached to a frame on the tripod hub. As the front legs pivoted up, the top of the back leg lifted on a temporary pin connection under the hub whilst its base slid in on a bogey running on a rail track. Temporary bracing to the cable ring remained in place until the

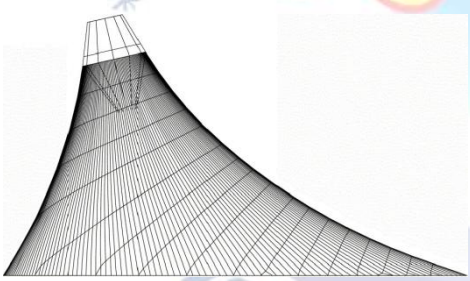
cables had been installed and correctly prestressed. Although the tripod provided the most dramatic sequence in the construction of the Khan Shatyr, the installation of the cable net was also challenging. The radial cables were lifted individually into a slack condition with cable clamps attached ready to accept the hoop cables which were placed over the top of the radials.



ERECTION OF TRIPOD

CABLE INNSTALLATION

The radial cables were lifted individually into a slack condition with cable clamps attached ready to accept the hoop cables which were placed over the top of the radials. Once all the cables were in place tension was pulled into them using a jacking detail at the base of the radial cables to bring the net into shape and allow the installation of the cushions to proceed.



CABLE INSTALLATION

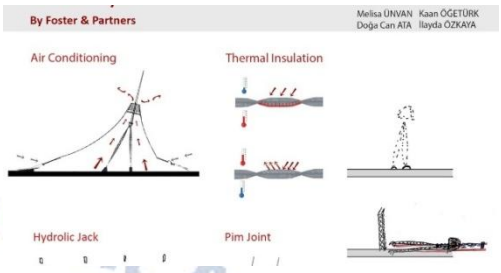
ETFE COUSIONS INSTALLATION

The ETFE cushions were slid into their extrusions from the base and pulled through to the top. The length of the cushions was maximized to reduce their number and make the installation as fast as possible, but during the winter months the cold temperatures made the ETFE much harder to work and to accept tension.

ETFE COUSIONS INSTALLATION

VENTILATION

In summer, fritting on the outermost foil layer provides Shatyr shading. Inside, low-level jets direct cool air across the space, while vents at the apex induce stack-effect ventilation.



VENTILATION IN DIFFERENT SECTIONS

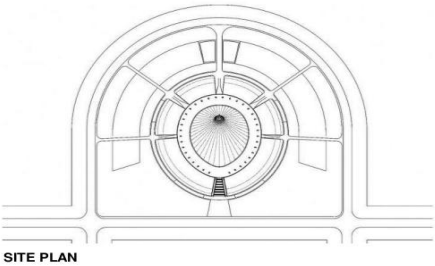
Air can be directed out of the top of the tent if it gets really hot inside, and there are generous tolerances for internal temperature. For example, the landscaped areas are maintained at 15°c in the winter and allowed to rise to 30°c in the summer. The ultimate aim of the building is to provide Astana with a range of civic, cultural and social amenities all year round, whatever the weather.

INSIDE ENVIRONMENT OF KHAN SHATYR

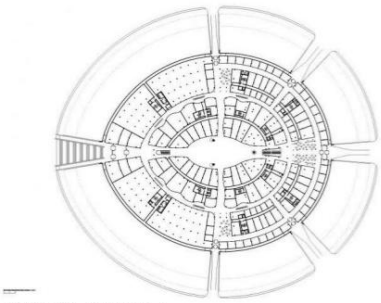
Inside this huge tent there are different types of entertainment centers. They are

1. Artificial beach.
2. Internal parks.
3. Shops and cafes.

PLANS OF FLOORS IN KHAN SHATYR

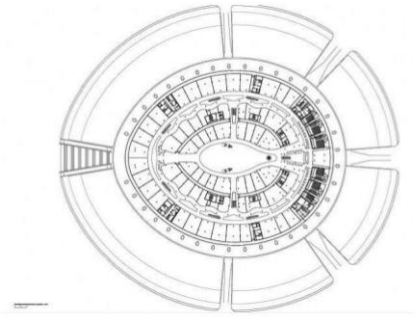


SITE PLAN



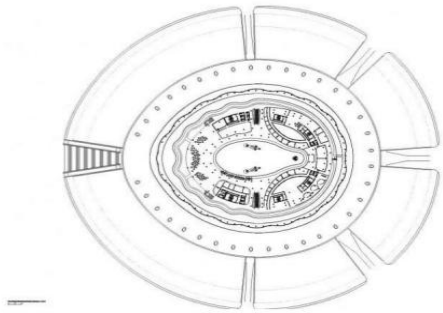
FLOOR PLAN LEVEL 1

FIRST FLOOR PLAN



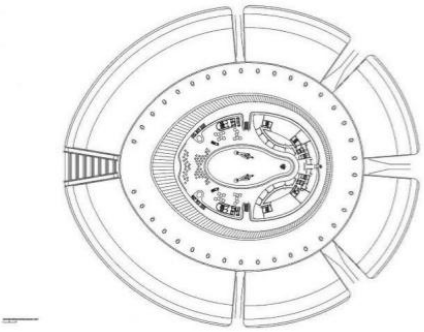
FLOOR PLAN LEVEL 2

SECOND LEVEL FLOOR PLAN



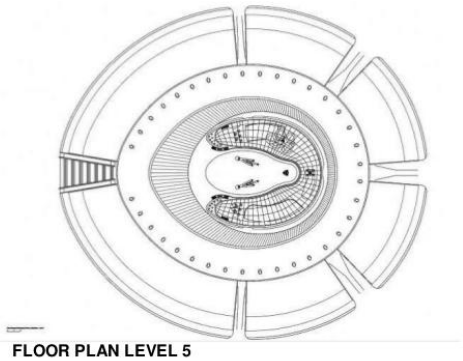
FLOOR PLAN LEVEL 3

THIRD LEVEL FLOOR PLAN



FLOOR PLAN LEVEL4

FOURTH LEVEL FLOOR PLAN



FLOOR PLAN LEVEL 5

FIFTH LEVEL FLOOR PLAN

CONCLUSION

The design and construction of the **Khan Shatyr Entertainment Centre** was only achieved by harnessing the expertise of international team of designers and working closely together. It has successfully overcome significant challenges to provide a unique, large, open space for the people of Astana touse all year round in comfort despite the climatic extremes that the city experiences.

The grand opening of the khan Shatyr has happened in the year 2010 by Kazakhstan president on his 70th birth day. It is an ancient structure built with new materials much higher than the regular tents. This structure height is 150m and has a horizontal spread of 35 acres. It took 4 years for completion of this building. It is a 5-floor building which contains different entertainment places. This structure is built to with stand the different climatic condition.

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