

An Intro to Tensile Structures:

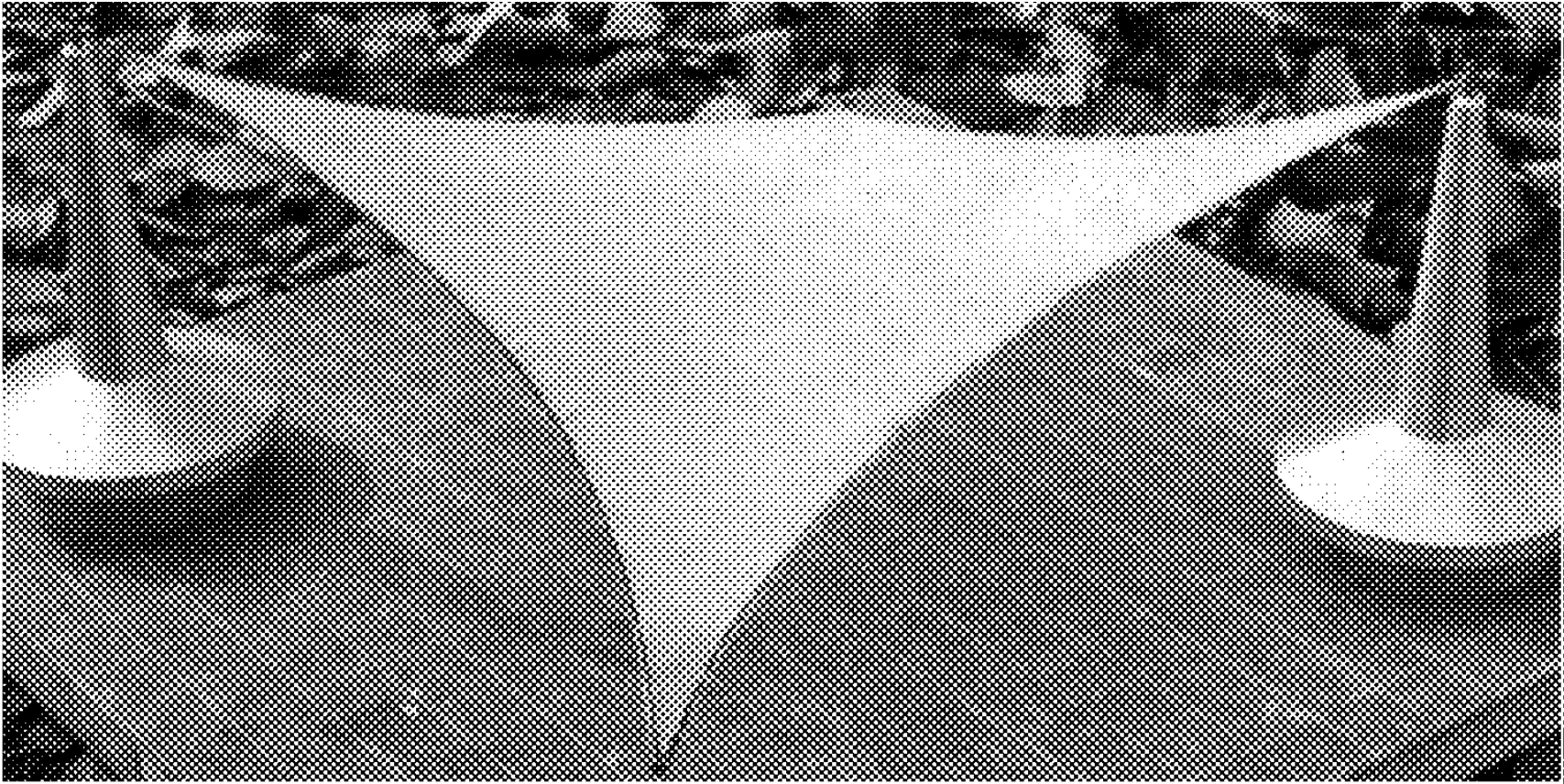
References:

Wolfgang Schueller, *The Design of Building Structures*

Horst Berger, *Light Structures – Structures of Light*

Hans – Joachim Schock, *Soft Shells*

Maritz Vandenberg, *Soft Canopies*

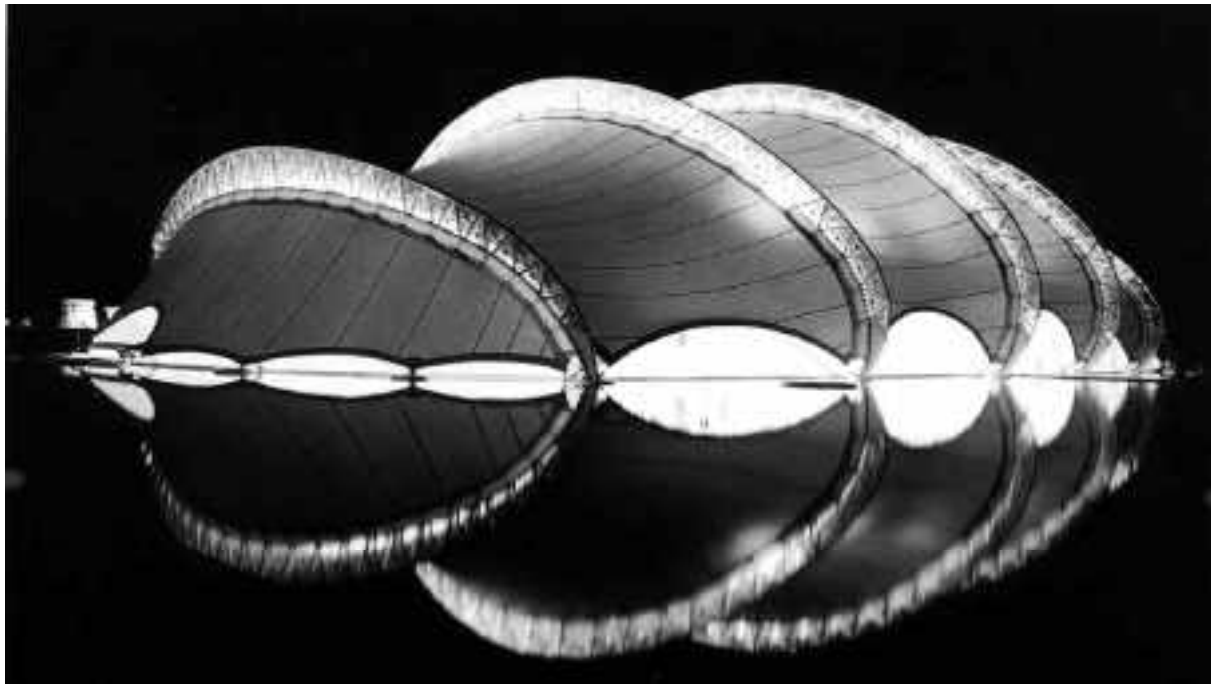


Definition:

- Tension roofs or canopies are those in which every part of the structure is loaded only in tension, with no requirement to resist compression or bending forces. Vandenberg; page 6

Classes of Tensile Structures

- Membranes
 - *The structural membrane acts also as the weathershield*



Classes of Tensile Structures

- Cable Nets
 - *A separate grid of structural cables supports a non-structural weathershield*



Classes of Tensile Structures

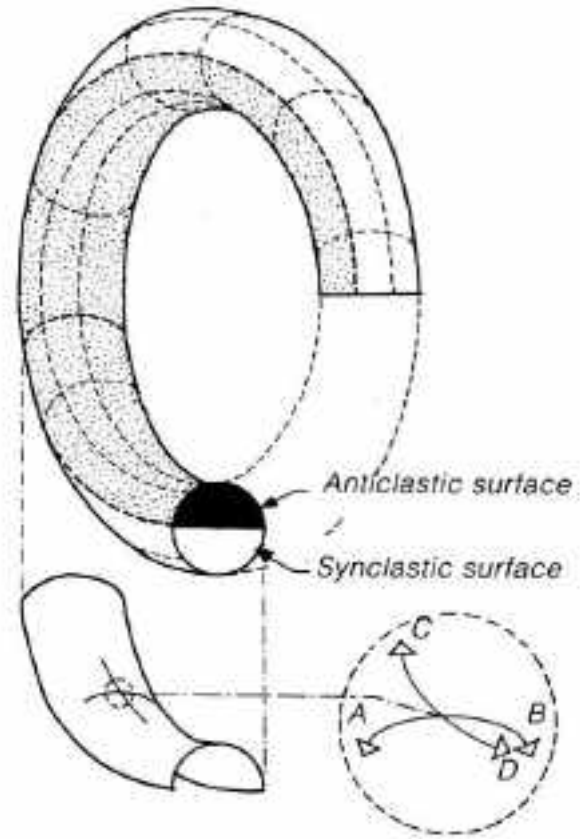
- *Pneumatics*

- *The tension force is created by an interior positive pressure and the membrane acts as the weathershield*



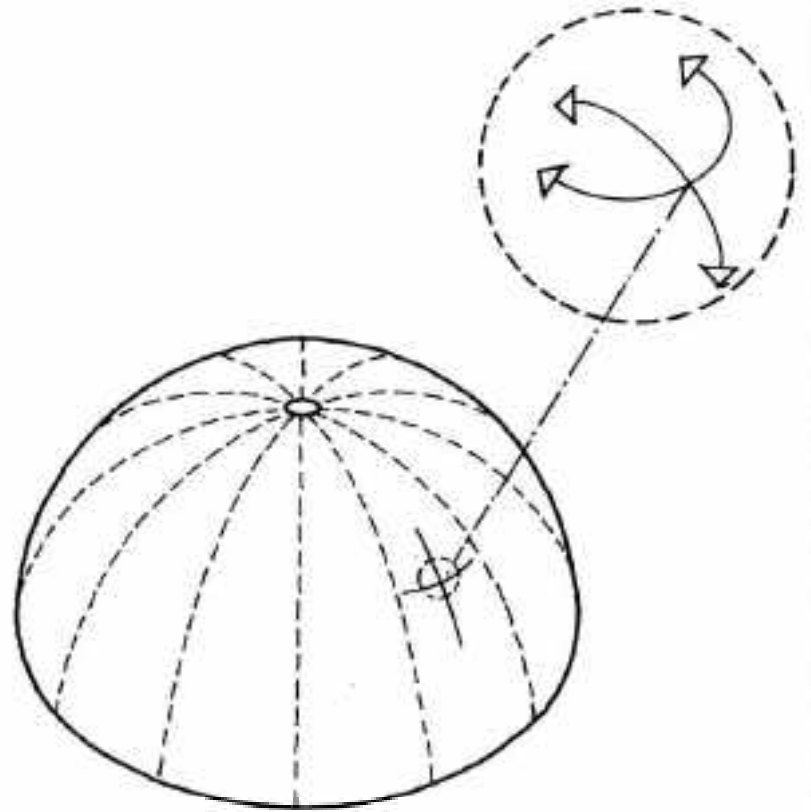
Shapes

- Anticlastic Surfaces
 - *The centers of curvature of the membrane are on opposite sides of the membrane e.g. hyperbolic paraboloid, torus*



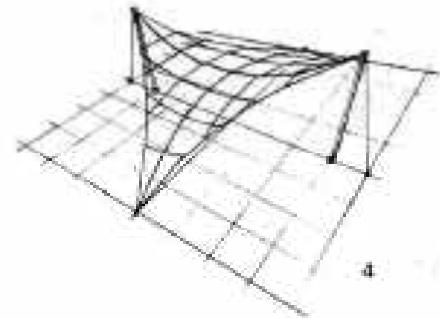
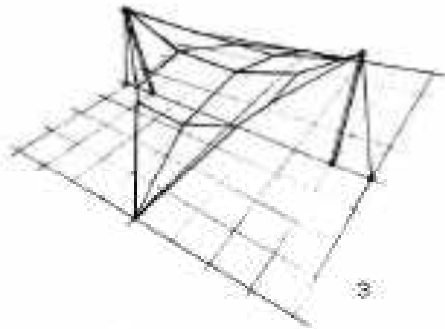
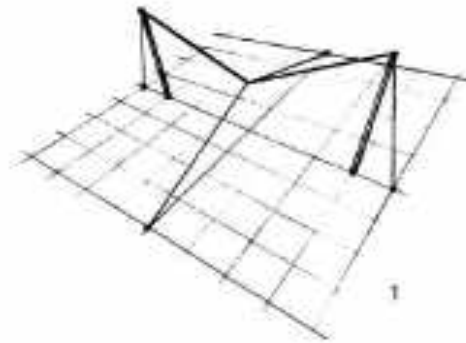
Shapes

- Synclastic Surfaces
 - *The centers of curvature of the membrane are on the same side of the membrane. E.g sphere or balloon*



A Simple Paraboloid

- Defined by a Minimum of Four Points w/ at Least One out of Plane



Equilibrium Forces

- Anticlastic Surfaces
 - *The surface is stabilised because the tension forces from prestressing or load are in equilibrium.*
- Synclastic Surfaces
 - *The surface is stabilised because the tension forces from internal pressure are in equilibrium with the tension forces in the membrane.*

A Simple Example



A Simple Example



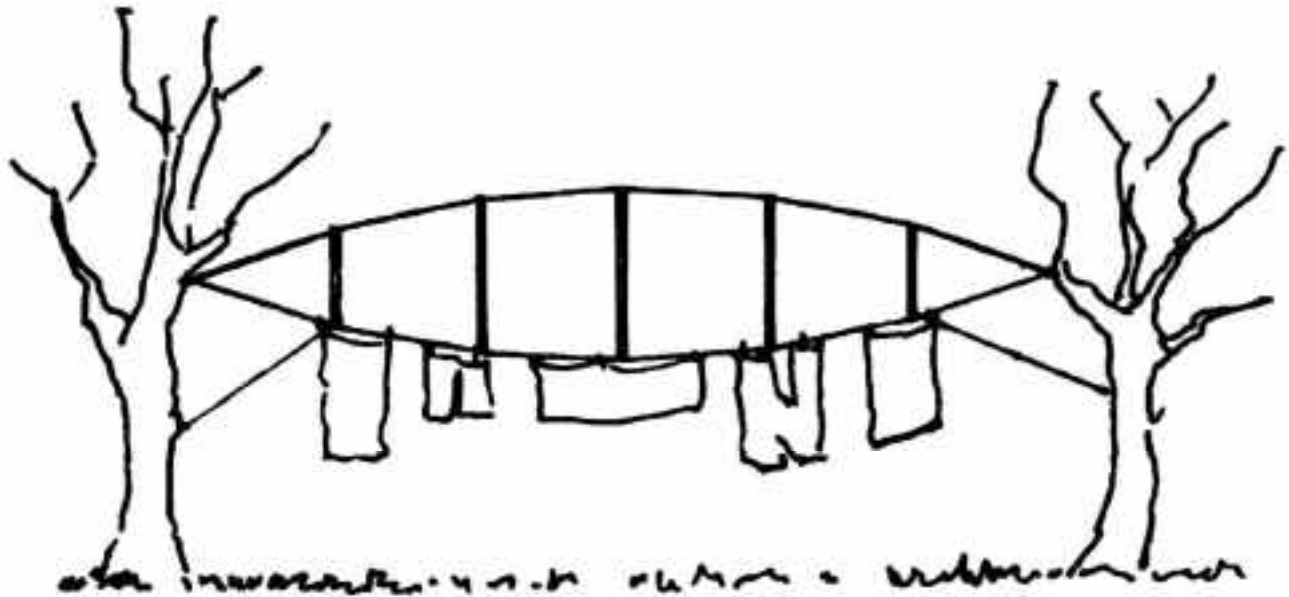
A Simple Example



A Simple Example



A Simple Example



A Simple Example



Deformations

- By definition, the membrane can only resist forces in tension, so forces perpendicular to the membrane cause large deformations and large membrane forces.
- Tensile roofs are susceptible to vibration.
 - *Reverse curvature and/ or prestressing can bring these forces to zero.*

Materials

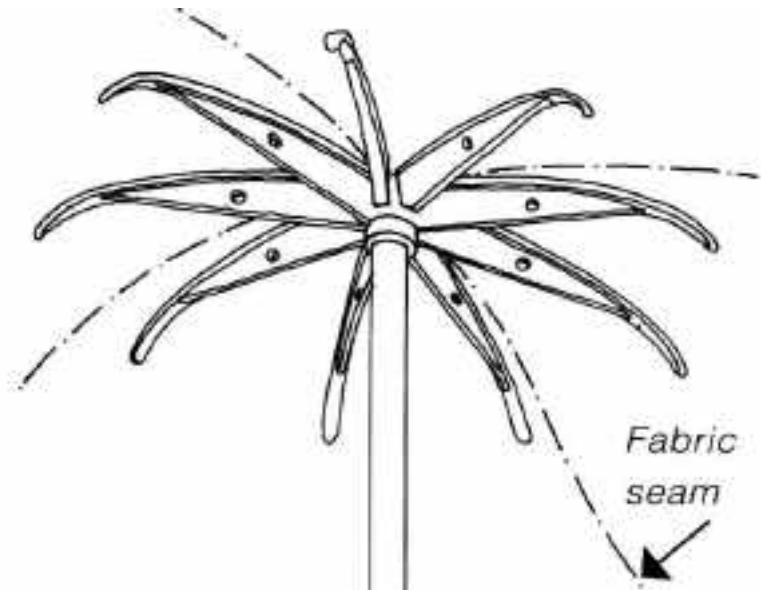
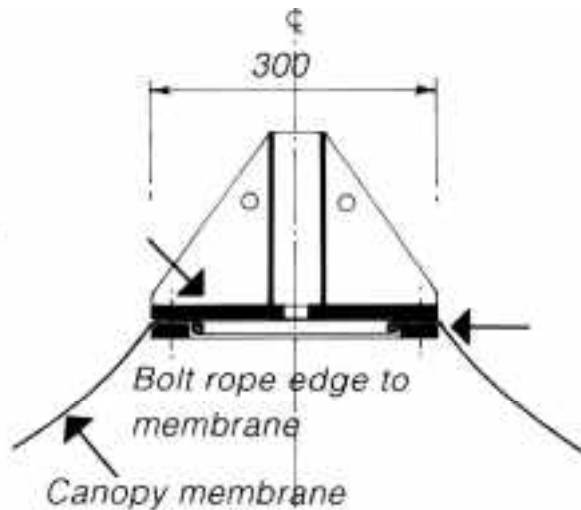
- Uncoated fabrics
 - *Simple woven fibers*
 - *Canvas, nylon*
- Coated fabrics
 - *High strength woven fibers w/ coatings to prevent UV- & environmental degradation and improve weather resistance.*
 - *PVC-coated polyester: relatively short service life*
 - *PTFE-coated glass fiber: high strength, long service life*
- Foils
 - *PVC- and ETFE- foil*

Edge Conditions

- **Rope Edge**
 - *A cable running in a sleeve and connected to a rigid structure at both ends*
- **Hard Edge**
 - *A continuous connection to a rigid structure through clamping plates w/ or w/o prestressing devices.*

Point Supports

- Masts capable of resisting compression and buckling forces.
- The magnitude of forces at the point support require distribution via rings or umbrellas



Line Shaped Supports

- Arches – internal or External
- Valley and Ridge Cables