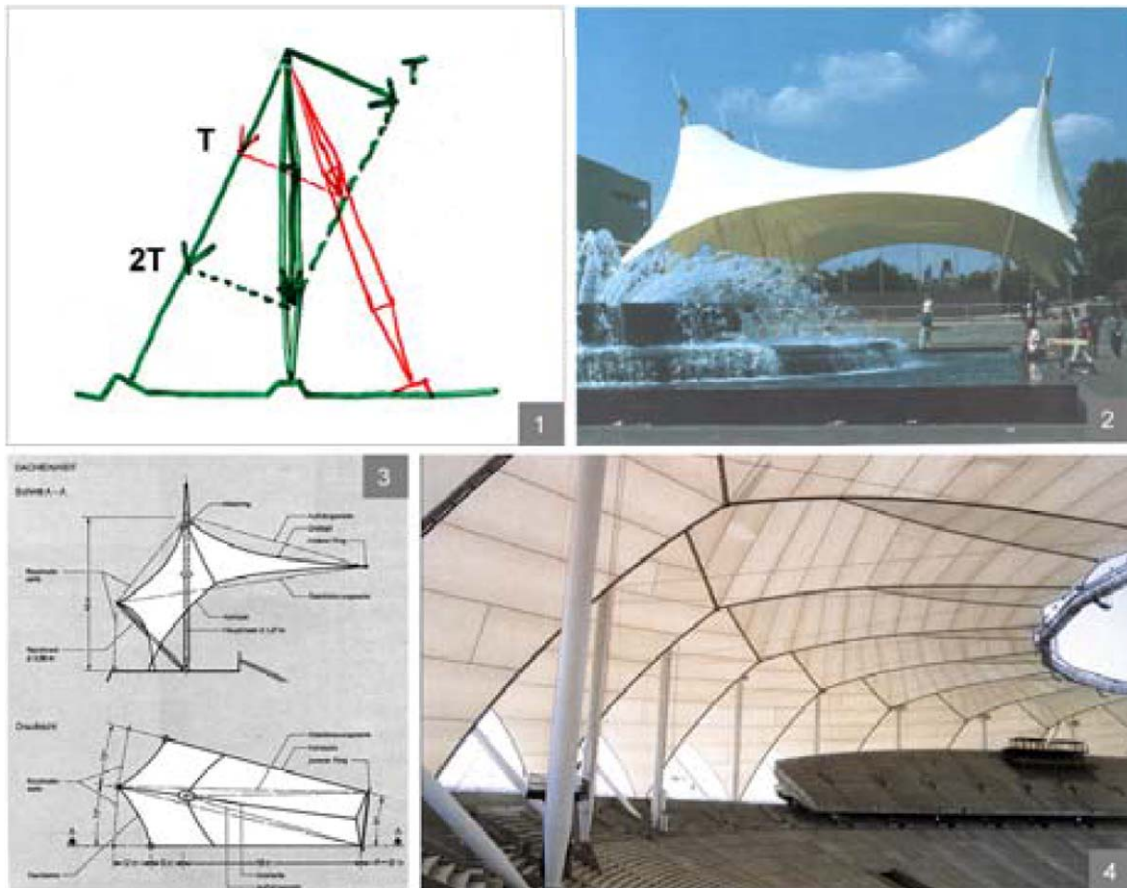


THE ANGLE EFFECT



1 Masts are most efficiently constructed so that they align with the resultant of the accumulated forces at the peak of the fabric. Balancing the mast with the membrane expresses equilibrium and *reduces loading*. External cabling to the top of the mast serves primarily to stabilize it in the event of strong wind load or a tear in the fabric.

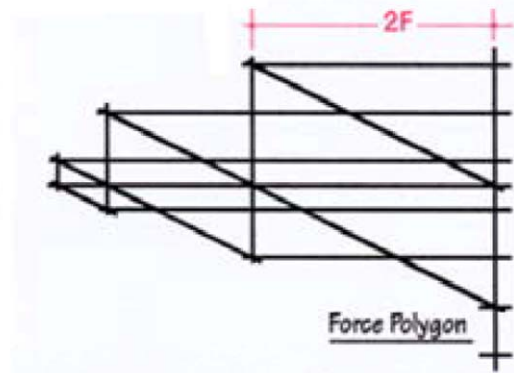
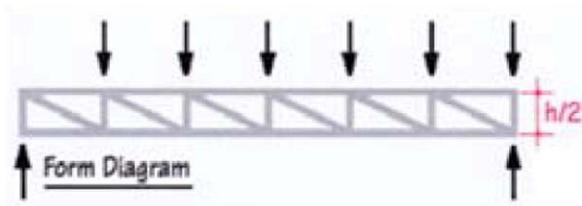
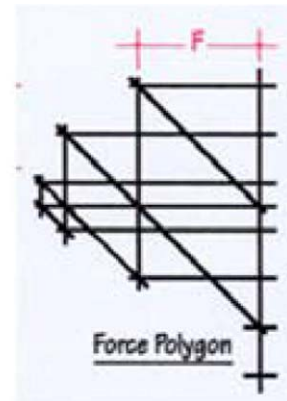
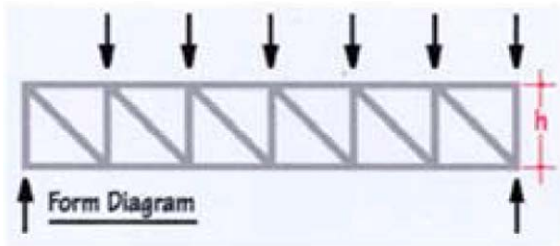
2 H2L2 Architects with Geiger-Berger Associates and Owens-Corning Fiberglas Corp. 1976: Independence Mall Pavilion, Philadelphia. The masts are balanced with the fabric because they bisect the angle of the cone. Note also their extension with cables carrying tensions from the fabric to the mast as halyards raising mainsails.

3 At Riyadh the resultant of the fabric membrane shape pulls markedly inward at its peak while the masts 58 m high are vertical and do not bisect the angle of the stays in order to satisfy non-structural considerations. The external guy cables must perform the additional function of resisting the horizontal resultant force at the top of the mast. (C.G.Huntington, 2003).

4 From outside, the roof surface, measuring over 30,000 sqm, appears to be a pure membrane structure, but, in fact, it has a clear self-sufficient primary structure made of masts and cables as well as a separately-attached secondary structure made of PTFE-coated fiberglass membrane with edge cables. (<https://www.sbp.de/en/project/king-fahd-international-stadium/>).

Changing the depth of the truss.

What happens if the depth of a truss is reduced by half, while the span and loads stay the same?



The Force Polygons tell the story: Angles are more acute. The path of the load from the points of application to the support is more constrained and deviates more. As a result: Member forces in the top and bottom chords of the truss exactly double. Force in the diagonals increase, but by a lesser amount. Forces in the vertical members remain unchanged. Member forces in the top and bottom chords are inversely proportional to the depth of the truss. Mechanical work $\Sigma P \cdot \ell$ increases from $126 \cdot P$ to $160 \cdot P$ (+27%)