

Forces in a Folded Form – - Tension Membrane Roof for Al Wakrah Stadium in Qatar

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Abstract

There are a few fundamental requirements for any Tension Membrane Structure to perform safely in an environment, for which it has been designed. Two of them are listed in the Motto of 2019 IASS Symposium, i.e., **Form** – a 3D anticlastic shape of the structure and **Force** – safe distribution of all applied loads to the supports of the structure. These 2 conditions, along with other design requirements, are the basis of any workable tension membrane system. In case of a kinetic architecture, there is an additional requirement for the structure to function as designed – a reliable mechanization system, which can change the form of a building. This is specifically critical for any foldable tension membrane systems, where the membrane needs to be transformed from a stored state with no or little load carrying capabilities, to a pre-stressed 3 dimensional form, which has to perform safely under all applied loads, as per design brief. Permanent foldable membrane roofs have been built since late 1960's, and some of them are functioning well to date, as originally intended. The lightweight structures designers, including Frei Otto and Roger Tallibert in late 1960's, and the specialty construction companies have learn since than, how to transform loose membrane into a 3D form and how to introduce the pre-tension forces for a workable permanent fabric roof. For the vast majority of a large-scale foldable fabric roofs these requirements were achieved by the means of a radial layout of the supporting cable net structure. Membrane is traveling on radial cables from a stored position somewhere in the center, to the clamping position on the perimeter. During this process, membrane is pre-tensioned to a required value due to the trapezoidal geometry of individual sections and due to the custom engineered mechanical system. The shape of membrane roof for Al Wakrah Stadium is far from a bicycle wheel with a central hub. It has been designed and built in a shape of folded plate where cables form ridges and valleys connected at one central steel truss crossing the roof opening. How was it possible to put the membrane into a required pre-stress is the subject of this paper and presentation.

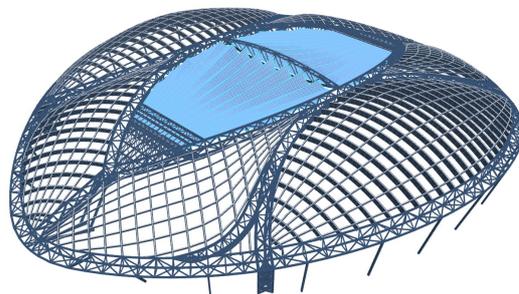


Fig. 1., Al Wakrah Stadium Roof

References

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