

## Structural Membranes in Motion

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### Abstract

Membrane structures are connected with professional excellence – of architects and engineers. Most of them are signature projects for the clients as well as for consultants and construction companies. It is this signature nature of such projects that makes consultants and specialist contractors push the limits of construction beyond what has been done before. It is the architect's target to become nearly invisible and the engineer's dream to become lighter and yet even stronger.

Before but even faster after millenium the art of lightweight structures has taken amazing steps with each project, mostly done with structural membranes. Envisaging a most flexible and multi-purposable destination, clients have added one more demand to the script of stadia envelopes and roofs: Be retractable! Lightweight, wide-spanning, retractable: this is structural membrane in motion!

The intriguing design of Al Janoub stadium in Qatar includes such a retractable roof. It is a unique combination of structural cables and structural membrane in motion. Consisting of two halves that are closing in onto a central girder this retractable roof has a surface area of 12,000 sqm, 129,000 sqft respectively. The combination of a cable structure with membrane and its widening geometry of the roof created challenges for the drive system never faced before.

50 grid lines are arranged in "V" shape by valley and ridge cables. At the circumference of this roof the trolleys of the drive system have to travel on rails not being straight but slightly arched. Different lengths, different levels, different slopes, changing distances between the grid lines: how more complicated can a retractable roof get? This one needed an advanced driving system with maximum control flexibility, to move the membrane smoothly and tension it correctly.

The presentation will give an inside view on the path of elaborate engineering and design-tuning that has been travelled to bring the project to a success.

**Keywords:** Lightweight architecture, retractable roofs, envelopes, control system, control topology, drive systems, safety, communication

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