Drive system innovation – winch development for moveable membrane structure

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Abstract

Tensile structures are often the spearhead of architectural design. The lightness of the material, free form shapes and the mix of materials and finally the sheer size, which can be realized is spectacular. The special properties of membrane structures often challenge standard solutions in engineering of all trades. When combining innovative architectural design with moveable membrane structures the use of off the shelf components is not suitable. In some cases, even the adoption and changes to standard components are not sufficient and new active elements need to be developed.

The performance criteria of the shade drive system at the Guggenheim Abu Dhabi project is a perfect example and forced the development of a new drive system with innovative single components.

In contrary to any other membrane project the focus is on a loose membrane which gently moves in the wind. In case of higher wind forces the membrane needs to be tensioned. Next to the focus on a loose membrane the winch cables need to be guided through a trumpet and moved back and forth very exactly. The winch will be installed horizontally and vertically. As the ice on the cake the winch cable should not influence the free hanging shape of the membrane and wear and tear is of big concerns as the loose winch cables could get in contact with the membrane. Finally, the movement length is between 2 and 10m most of the time, but sometimes 40m for maintenance or in case of sandstorms. Not to forget temperatures up to 50 degrees Celsius and coastal atmosphere.

The local fixed cable outlet and the ejection of a loose horizontally orientated cable rules out a traditional drum winch. Different alternatives with friction winches and other connection components like chains, belts and fiber cables are considered in search for the jack of all trade's solution.

Finally, a friction winch with the use of high strength fiber cables as pulling medium and a spring-loaded rope storage drum seems to be the best solution, which checks most of the boxes. The very different properties of a fiber cable make common design solutions not suitable and testing mandatory. The necessary questioning of each machine part, each design detail, materials and composition of all together result in an innovative drives system, developed to the special needs of the Guggenheim Abu Dhabi Shades.

Therefore, the special demand of some architectural moveable membrane structures amplifies the demand for innovative drive system components and shows the potential for further use cases and benefits at other sophisticated projects.

Keywords: Lightweight structures, retractable roofs, moveable structure, drive system, fiber cable