

King Abdullah Petroleum Studies and Research Centre Design and Engineering of Tensile Fabric Canopies

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As a tensile fabric structures engineer, Katerina's responsibilities are to develop form finding for scheme design in close collaboration with the architect and client, as well as to perform membrane stress analysis, structural analysis and design of supporting structure.

Keywords: *Tensile fabric structures, membrane stress analysis, structural analysis, canopy cells*

1. Introduction

Tony Hogg Design (THD) was responsible for carrying out the detail design and engineering to achieve Zaha Hadid Architect's vision for covering the central courtyard of the research centre (KAPSARC) with fifty unique fabric canopies. The Architect's inspiration of producing an organic form to tie in with the desert landscape in Riyadh, Saudi Arabia, has generated many interesting challenges in the engineering and design of the canopy cells.

2. Content

There are fifty different canopy cells covering an area of 9,550m² between the main buildings. THD was involved in the initial meetings to establish the form and shape of this hybrid conic and inverted conic canopy cell. Each cell has a unique geometry to respect the organic nature of the project and therefore a separate analysis was required for each one. THD was provided with wind tunnel test data to evaluate the applied loads on the structure. Each canopy is composed of an upper and lower PTFE glass fibre membrane in order to conceal the supporting steel structure in between.



Fig.1: KAPSARC model by Zaha Hadid Architect's



Fig.2: Some of the canopy cells during construction

Membrane analysis was performed by Tensys consultants in conjunction with THD. Problems such as high stresses due to tight curvature of the supporting steel resulted in changing the geometry quite a few times. Structural analysis and finite element analysis of components was performed using Bentley software. This project has challenged our engineering knowledge by solving complex problems such as cranking steel beams to avoid clashes with fabric, extensive 3D modelling for the production of fabric fittings to fit the non-planar geometry of the canopy cells, and the development and testing of a unique fabric in order to comply with the client's specifications.

3. Conclusions

This project has been an exciting journey of challenge and learning, resulting in a great outcome through the collaboration between the architects and the engineers. Tensile fabric structures can be part of innovative and sustainable buildings of the future, due to their adaptable nature and fascinating aesthetical appeal.