

## Expo Engineering

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Founded in 1995, the engineering office Expo Engineering has emerged to an international specialist for engineering services in the event industry.

The core competences are:

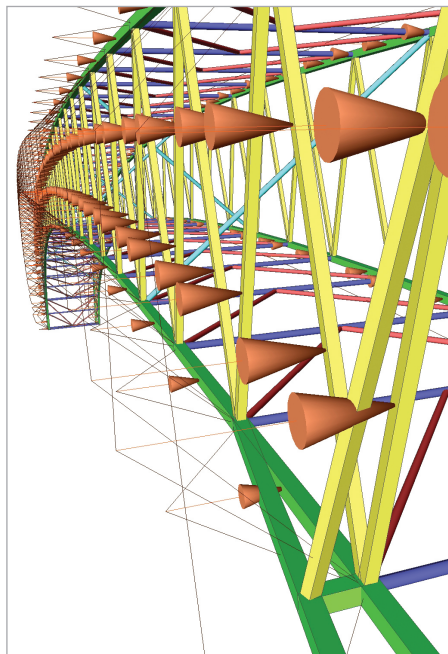
- Design and development
- Construction
- Static analysis

With at the time 9 engineers from the fields of mechanical engineering, structural engineering and event engineering, Expo Engineering is highly skilled in its genre.

This bundling of competences enables the realisation of complex requests with a new approach and an extended view for technical solutions.

The variety of services reaches from the static analysis of open-air-stages and grandstands up to complete development of fun rides.

Also temporary structures as tents or exhibition stands are subjects of Expo Engineering's work.



Software: Scia Engineer

## Moving Arches - Muscat, Oman

'Moving Arches' at 'The Royal Equestrian and Camel Festival 2011'

### Background

Every 5 years the Sultan of Oman organizes the Royal Equestrian and Camel Show. In this show 1.000 horses, 500 camels and about 1.500 musicians perform in a 2 hours show on January 1st. Via P.S.I. Performance Sales International GmbH, Paul Schockemöhle, Hank van Campen and Bert Okker have been involved in the organization of the show.

In a first concept drawing the designer team planned the 250 m wide stage assembly in the stadium with two movable, hovering arches flanking the central portal. The function of the arches is to narrow the visual field of the audience and focus the view on solo artists or smaller groups. The operating company PRG GmbH mandated Expo Engineering with the complete technical planning of the arch-structures and the drive mechanism of the arches.

The arches are equipped with show lighting, water fountains, pyrotechnics and decorations. The design of the arches had to be fragile and modern. The movement of the arches should work smooth and with a tangential speed of 50 m/min.

### Starting the project

The results of the feasibility study showed that there was no possibility for a hovering arch at one end. It was the demand of the client to use standard scaffolding for building the towers of the arches. The big overturning moment of the 40 m long arch was not to handle with scaffolding parts and led to a ground supported wheel solution. For this approach Expo Engineering made a first draft. The new static system allowed a 60 m long arch. Expo Engineering chose an attractive elliptical shape with a light framework solution. The cross section is tapered with a thin tip for the drive mechanics.

The calculation of the framework was done with Scia Engineer. It was essential to determine the steel profiles and the reactions to develop the drive mechanics and the bearings on top of the scaffold tower. Later, some flanges have been designed with Frilo.

### Used modules in Scia Engineer:

- The Import module was used to read a DXF directly from the centre line of the 3D CAD.
- Both ground supports (wheels of the drive mechanics) have been set to "only compression" with a non-linear calculation.
- Wind loads have been generated directly by Scia Engineer Surface-Load-Generator.
- The steel profiles have been checked with the DIN 18800 module in Scia Engineer.
- The resonance frequency had to be checked, because the ground might be not even and bumpy. For this reason the Dynamic module was used.

### Detailed Design

On the top of the arch, the width was enhanced to 6 m to decrease the stress in the members caused by torsion as a reaction of wind and one lift-off support (wheel).

The whole steel structure was manufactured in Aurich, Germany and shipped to Muscat, Oman. This fact required a demountable construction with flanges in mainchords and braces for the transportation by truck. Also the rotating centre and the drive mechanism were designed demountable with bolted connections.

The bracing on top and bottom of the arch was carried out with half-round plate connections to realize a simple geometry of the tubes. The plates are notched and the tubes are placed in the slots to be connected with a fillet weld. So no different angles had to be cut.

For the calculation of shafts, gear boxes and shaft to collar connections programs for mechanical engineering have been used. Some parts have been calculated according to the Palmgren-Miner rules for fatigue analysis.

## Project information

Owner Sultan Quaboos Bin Said - Sultan of Oman  
Architect Expo Engineering, Dipl.-Ing. Michael Lück  
General Contractor PRG GmbH  
Engineering Office Expo Engineering, Dipl.-Ing. Michael Lück  
Construction Start From March 2010 to December 2010  
Location Muscat, Oman



## Short project description

*A spectacular event needs (e)motion. Every 5 years the Sultan of Oman organizes the Royal Equestrian and Camel Show. For the show 2011 two 60 m long elliptical shaped steel arches with an electric drive mechanism have been built. The arches, equipped with show lighting and pyrotechnics are movable to focus the audience's view on solo artists in the centre of the stadium. The tapered cross section of the framework and the graceful design are impressive. The draft design, the implementation planning, the statics and the planning of the drive mechanism have been made by Expo Engineering.*

