

BACKGROUND

The Muscat Expressway is a 55km long highway. It includes 7 large precast arch underpass structures which were designed using the TechSpan® arch system technology. The purpose of the structures is mitigation of storm water (wadi culverts) and provision of rout for vehicles below highway (vehicle underpass).

2 different arch sections were used; 15m span x 7.5m rise and 20m span x 10m rise. The maximum fill height over the arches was 35m above the base level, requiring specific design of the arch and raft foundation profiles to minimize bending moments in the finished structure and also to deal with the very high axial forces at the base of the arch.

CHALLENGE

A number of design challenges were encountered on the project. Due to their size, the adopted arches set a new standard for pre-cast arches under very high backfill and required careful attention to analysis, design and detailing in order to deal with the resulting high loads.

Factors requiring careful analysis and design included:

- A large amount of soil fill above the structures resulting in high vertical and lateral earth pressures acting on the arch and foundation.
- Analysis and design of double arch structures.
- Fill over the arches was restrained by terraced reinforced soil retaining walls, resulting in stepped vertical loading on the arch and in longitudinal loads on the arch and foundations.
- Few of the arches were constructed with a skew to the highway alignment, resulting in significantly asymmetrical loading to sections at the ends of the arches.

SOLUTION

The TechSpan® arch system uses project specific arch profiles designed to minimize bending moments and shear forces in the finished structure by use of funicular curve theory and complex soil behavior models. This is particularly important with large arches subject to very high fills, where non-optimized arch profiles may generate high bending moments that would make a precast arch solution impractical.

The maximum unfactored load at the base of the arches was about 7,400 kN/m at the external supports, and a combined load of about 12,500 kN/m from both arches at the central supports. Provision of a system to support these loads on soil foundations provided a considerable challenge. Alternatives considered included piled foundations, soil improvement and large spread footings. The ultimately chosen solution was the raft foundations with a variable depth to reduce hogging moments in the center of the raft allowing big savings in material consumption. The longitudinal effects were minimized by provision of movement joints at all significant steps of vertical loading, nonetheless detailed longitudinal analyses were carried out to ensure that the size of the structures and the high fills did not give rise to unexpected effects.

Muscat Expressway

Muscat, Oman

TechSpan® Arches
 Reinforced Earth® MSE walls

Client: Muscat Municipality – Oman
Consultant: Parsons International & Majan Engineering Consultants
Contractor: Galfar
Construction: 2006 - 2010



Project Specifications

System	TechSpan®
Arch Type	Funicular shape 3 pin arch
Span	5m/12m/20m
Height	7.5m/10m
Thickness	400mm/500mm
Length	46.5m/663m
System	MSE walls
Structure	Head/wing and retaining walls
Area	81,400 m ²
Max. Height	35m (terraces)
Design Life	120 years