



## PROJECT DOSSIER

# AL MIRANI FORT



## PROJECT OVERVIEW

<b>Project</b>	<b>Al Mirani Fort Restoration</b>
Location	Muscat, Oman
Client	The Sultanate of Oman
Contractor	Al Manar International L.L.C.
Consultants	Constell Consultants Pvt. Ltd.
Duration	2010

Al Mirani fort along with Al Jalali fort, flank Sultans Al Alam Palace. In olden days, these more than 600 year old forts served as bastions in defense of Muscat harbour and the old city. Al Mirani fort was restored to its original majesty as part of a concerted renovation programme.

The fort stands on the contours of a 30 - 40 m high rock mass which was showing signs of

decay and distress. With passage of time, the rock mass had undergone weathering and had formed several cracks, fissures and cavities at places. Surrounding saline weather conditions and rain water discharge points at various locations on the surface of the hill had caused adverse weathering and erosion with time. The Sultanate commissioned Atkins International and later Constell Consultants India to prepare a report on protection of the fort and suggest long term performance monitoring. The purpose was to identify weakrock conditions in the foundation that require rock stabilizing work. Al Manar of Oman were entrusted the work of rock stabilizing of the rock foundation using various methods including pressure grouting and rock bolting etc.



## Monitoring solution

Monitoring system was planned by the Consultant to ensure success of proposed rock stabilization works. Encardio-rite was given the complete package of monitoring instrumentation before and after pressure grouting, rock bolting etc. Around 200 sensors were installed for the project.

Even though the slope stabilizing work was being carried on all sides of the fort, the instrumentation was only on the east side towards the palace (zone 1) and south side facing the mosque (zone 2).

While implementing the instrumentation system, it had to be carefully ensured that it should have no detrimental impact on this precious historical structure belonging to King of Sultanate of Oman.

The monitoring system was planned to provide necessary base data to serve as ground movement benchmark. The system was designed to provide an early indication of rock slope movements or potential damage.

### Turnkey services

- Supply of geotechnical instruments
- Installation of geotechnical instruments
- Manual and automatic monitoring
- Programming and commissioning of data acquisition systems
- Setting up online web based data management system (WDMS) and maintenance during the contract period

## INSTRUMENT USED

- **In-place inclinometer (IPI):** 64 sensors in 6 boreholes in zone 1 and 85 sensors in 8 boreholes in zone 2 to accurately measure and record sub-surface rock mass movement, covering a depth from 20 to 30 m
- **Tilt:** Surface tilt of walls was monitored at 20 locations and that of turret at 2 locations
- **Borehole extensometer:** To monitor movement in 12 horizontal boreholes in zone 1 and in 16 horizontal boreholes in zone 2
- **Piezometers:** Vibrating wire type piezometers used to constantly monitor piezometric pressure in the rock for its effective stabilization
- **Temperature:** To monitor temperature variations around the fort.
- **Automatic data acquisitions systems:** For collecting data from almost 200 sensors automatically and transferring the data to Web Data Management System.

Experienced and proficient I&M team of Encardio-rite provided installation and commissioning services. Monitoring reports included interpretations of variations observed in instrument data, mentioning the factors likely to affect their behavior, were provided to the contractor on a regular basis.

