



## PROJECT DOSSIER

# CABO FORT RAJ BHAVAN



## PROJECT OVERVIEW

<b>Project</b>	<b>Cabo Raj Bhavan (Governor's House) Slope stability of Cabo Hill</b>
Location	Goa, India
Client	Water Resources Department
Contractor	ITD Cementation
Consultants	Geological Survey of India
Duration	2007- 2017

Cabo Fort that houses the present Raj Bhavan in Goa was built around 1540 AD to guard the entrance to both the Mandovi and Zuari rivers. Cabo fort is the finest of the Raj Bhavans in India.

The fort is located on Cabo Hill at a height of 40 m above the sea. It is a two-storied monumental structure constructed with 0.7 m thick walls comprising of laterite blocks in mud mortar.

The hill slope was reported to have been undergoing a gradual distress due to natural processes

over several decades with cracks appearing on the asphalted pavement in front of Chapel and on the floor of the verandah. The parapet wall constructed around the edge of the steep slope adjacent to Raj Bhavan had also developed cracks at many places indicative of horizontal and lateral movement.

The upper part of the slope was stabilized by using pre-stressed cable to tie up the fractured, hard lateritic media. The middle part of the slope was stabilized by installing shear interceptors using micro piles. Vertical sand piles were also provided to release the possible ground water pressure. The toe part of the slope was stabilized with retaining walls.

To monitor the distressed unstable slopes of Cabo Hill, GSI recommended field monitoring through instrumentation. The instrumentation scheme included monitoring of slope movement, settlement, water pressure and ground cracks.



## Monitoring solution

Encardio-rite was given the complete package of monitoring instrumentation. While implementing the instrumentation system, it had to be carefully ensured that it should have no detrimental impact on this precious historical structure.

The information provided by Encardio-rite instruments was very useful in devising strengthening measures for the slope foundation and the Fort structure. Encardio-rite's monitoring instrumentation is still providing data online to the relevant authorities.

### 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):** These were installed at slopeto accurately measure and record sub-surface lateral movements.
- **Borehole extensometer:** These were installed to monitor settlement. Manual as well as automatic monitoring was done.
- **Piezometers:** Vibrating wire type piezometers were used to constantly monitor ground water pressure in the slope for its effective stabilization
- **Crack meter and joint meters:** To monitor changes in the cracks around the buildings. Bothe manual and automatic readings were taken depending on the criticality of the location and crack.
- **Automatic data acquisitions systems:** For collecting data from the installed sensors automatically, data acquisition system was commissioned with sim cards to transfer the data to central server with Web Data Management System.

Experienced and proficient I&M team of Encardio-rite provided installation and commissioning services. Combined report for both manual as well as online data was provided on monthly basis. Monitoring reports included interpretations of variations observed in instrument data, mentioning the factors likely to affect their behavior.

