RITE GEOSYSTEMS

ENCARDIO RITE METASENSING FOR MEGA STRUCTURES

Project dossier

PROJECT DOSSIER

Idukki Dam, India

(One of the highest arch dams in Asia)

PROJECT OVERVIEW

Idukki Dam is a double curvature thin parabolic concrete arch dam constructed across the Periyar River in a narrow gorge between two granite hills locally known as Kuravan and Kurathi in Kerala, India.

At 169.16 m (555 ft) Idukki Dam is one of the **highest arch dams in Asia.** It is the **first and the only arch dam in India**. Length of the dam on its top is 365.76 m (1200 ft). Width of the dam is 7.62 m (25 ft) at the top and 19.81 m (65 ft) at the bottom. Problems inherent in the site were overcome by the innovative use of load transfer, parabolic geometry and rock mechanics techniques. The dam construction completed in 1973.

Idukki dam is constructed and owned by the Kerala State Electricity Board (KSEB). The dam was constructed along with two other dams at Cheruthoni and Kulamavu. Together, the three dams have created an artificial lake. Idukki Arch Dam does not have any shutters; only Cheruthoni Dam has shutters to release water and maintain the reservoir level.

The installed capacity of the power house is 780 MW consisting of 6 units of Pelton-type turbines with a power generation capacity of 130 MW each. The regulated waters of Periyar falls through a drop of about 669.2 m while generating power in the underground power house.

Project	Idukki Hydroelectric Rehabilitation Project
Location	India
Owner	Kerala State Electricity Board (KSEB).
Duration	2019 - 2024 (contract for 5 years)

WHY MONITORING?

Idukki dam was constructed in 1973 and due to long years of service, it required rehabilitation. The rehabilitation program comes under Dam Rehabilitation and Improvement Project (DRIP) that focuses not only on the rehabilitation and improvement of dam structures, but also addresses shortcomings in instrumentation and maintenance.

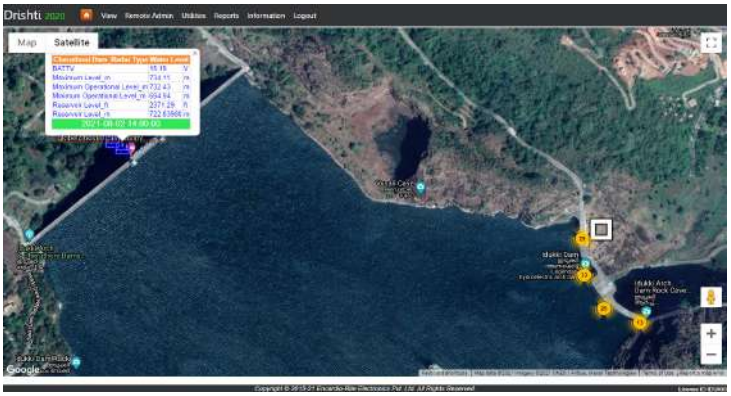
A Real Time Structural Health Monitoring & Early Warning System (RTSHMEWS) was planned for Idukki Dam to provide continuous and up-to-date information about the key parameters related to the dam's structure and performance. This information would help the dam operators to make informed decisions about the dam's operation and to ensure its safety.

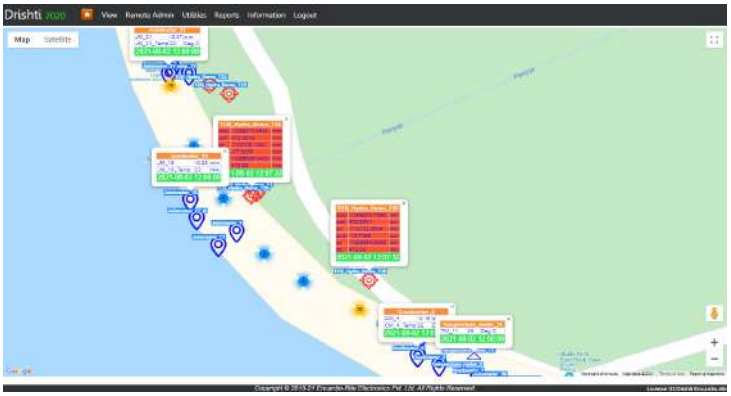
Purpose of RTSHMEWS can be summarized as follows:

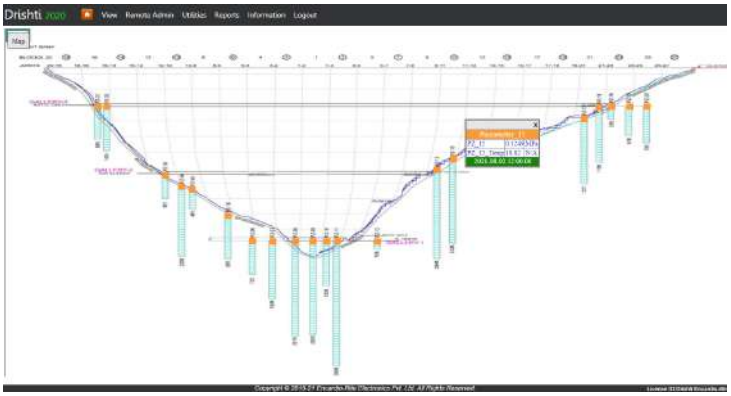
- To ensure the safety & longevity of the dam and improve its reliability
- Timely detection of any behaviour that may deteriorate the dam and potentially result in its shutdown or failure, in order to implement corrective measures without losing time
- Generating data related to the dam's performance in real world situation for future design improvements
- To know the impact of any natural event of the structural integrity of the dam
- To plan the maintenance of the dam in an effective and efficient manner.

MONITORING SOLUTION

Real Time Structural Health Monitoring & Early Warning System (RTSHMEWS) designed for Idukki Dam covered supply, installation and commissioning of new geodetic and geotechnical safety monitoring instrumentation (real time) as well as automation of existing geotechnical monitoring instrumentation (manual readings to real time).







Scope of works

Encardio-rite was entrusted with the crucial task of safety monitoring for the dam i.e. RTSHMEWS. Scope included:

- Supply and Installation of Geotechnical, Geodetic and Hydro-meteorological sensors
- Programming and commissioning of dataloggers and robotic total stations with control boxes, equipped with wireless data transmission
- Integration of existing working sensors in the dam with the new monitoring system; the historic data correlated into the new monitoring system.
- Data storage and back-up servers
- Lightening, surge protection and earthing
- Setting up of data management software, for real time monitoring with instant alarms.

Sensors used under RTSHMEWS

Uplift pressure meter	installed in dam galleries (drilled drains), to monitor the uplift pressure acting on dam
Crack meter & joint meter	installed at the cracks/joints in dam galleries, to monitor opening of existing cracks or the joints between different blocks of the dam.
Tilt meter	installed in the vaults at top of the dam and at other location to monitor the tilt of dam structure.
Concrete temperature meter	installed in the galleries in inclined holes, towards downstream side of the dam. These were required to monitor the concrete temperature.
Water temperature meter	installed towards the upstream side of the dam to monitor water temperature close to the dam's face. A chain of temperature meters at different depths was suspended in water from top, to monitor water temperature at various depth, spanning the dam height.
Flow meter	installed in dam drains in galleries along with V-notch, to monitor the rate of water seeping through dam's foundation.
Reservoir level sensor	installed at top of Cheruthoni dam (located near Idukki Dam) to monitor the water level of the reservoir. Both radar type as well as vw type sensors were used.
Weather station	consisted of air temperature and relative humidity, wind speed and direction, solar radiation, atmospheric pressure and rain gage.
Dataloggers	to collect data automatically from the sensors at required intervals; incorporated with GSM/GPRS modem for wireless data transmission to central server
Prism targets	installed at the downstream intrados (concave surface) of the arch dam. Special prism targets with 60 mm dia and hood for protection were used.
Robotic total station	two stations with individual control boxes were commissioned to monitor the prism targets.

An elaborate earthing and lightning protection system is also employed at the site, as the location is prone to thunderstorms and lightning.

Joint meter

Uplift meter

Crack meter

Tilt meter

Temperature meter (concrete)

Temperature meter (water)

Flow meter

Automatic water level monitoring (radar)

Automatic water level monitoring (vw)

Automatic weather station

Data collection and presentation

The monitoring system is capable of continuous monitoring of data from sensors installed in the dam. It is also capable of accepting manual data of non-automated geotechnical sensors, as well as manual survey data from geodetic targets.

Compact dataloggers and data acquisition system, with suitable interface unit and BusMux are collecting the data from Geotechnical and Hydro-meteorological sensors at desired intervals. The frequency is re-configurable, depending on site requirements.

Two robotic total stations collect the data from prism targets installed on curved surface of dam at desired frequencies. Each total station is equipped with our in-house developed control box. The control boxes have suitable software, that allows to control the total stations remotely.

Data acquisition system

Instrumentation control room with servers

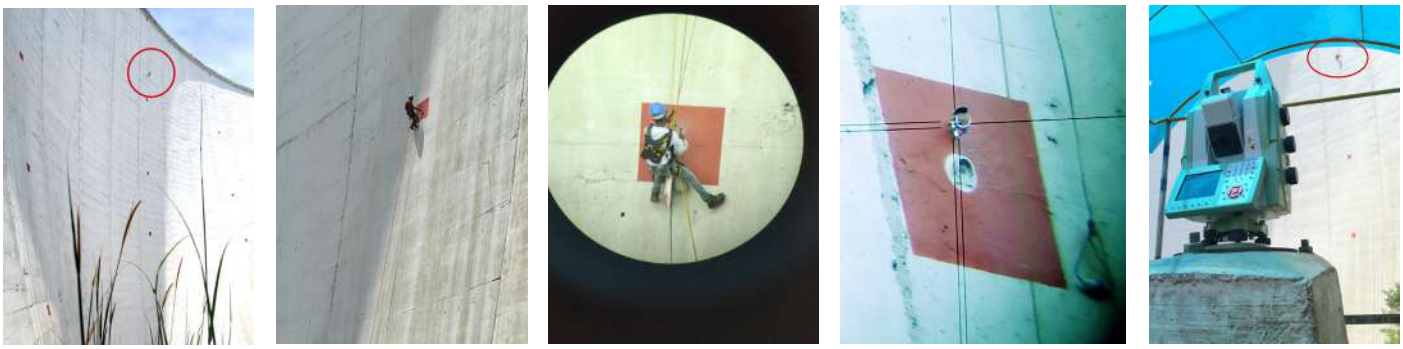
The dataloggers and robotic total station's control box transmit the data wirelessly to the central server having our database management software. The central server is installed in an instrumentation & control room located at quite a distance from the dam location.

CHALLENGES FACED

The installation of prism target on the concave side on the double arch dam was quite challenging. A lot of preparatory works and arrangements were done for the installation of prisms, as it was difficult to reach the installation location due to the double curvature-parabolic surface of the intrados of dam, and the huge height of the dam (169.16 m).

A trained person, with proper license to work at heights, did the installations, as can be seen in the installation photographs. A rope access technician, at the dam top, controlled/assisted the movement of the installation person.

During the installation, an experienced surveyor was always at the robotic total station to ensure the correct direction of prism target. The successful installation of all the prism targets was quite an achievement.



Installation of prism targets on the concave side of the double curvature arch of the dam (downstream side) and its automatic surveying by robotic total station

TRAINING

An extensive training program has been conducted successfully at site on the geotechnical, geodetic, hydro-meteorological, seismic sensors and data acquisition systems installed at site. The training program was provided by the Encardio-rite experts to the KSEB site team. An elaborate training was also provided on the Drishti database management system, data presentation, evaluation, interpretation etc. The training included both classroom and field trainings.

Classroom training

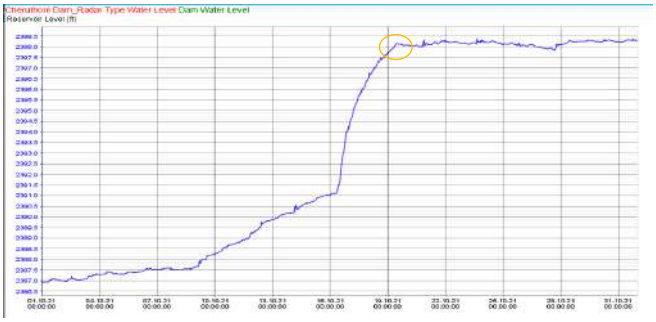
On site training

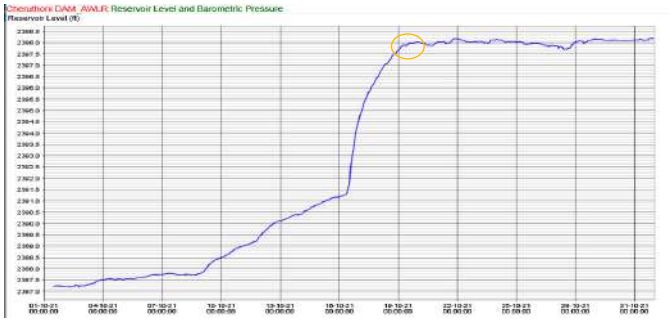
CASE STUDY

The data from our state-of-the-art monitoring system installed under Real Time Structural Health Monitoring & Early Warning System (RTSHMEWS) program at Idukki Dam, ensured the safety of hundreds of people when the water level at Idukki dam breached all trigger values.

On October 18, 2021, the water level was recorded at ~2397.37 feet in Idukki reservoir - one of the largest reservoir in India. An orange alert siren was given. The full reservoir level of Idukki dam is 2,403 feet. After the red alert sounded on October 19, 2021, three gates of the Cheruthoni dam on the Periyar river were opened by the local authorities in Kerala to ease the pressure on the Idukki dam structure in the wake of heavy rainfall in the area. Cheruthoni dam is one of the three dams that form the Idukki reservoir. As water gushed down, its level rose in Cheruthoni River - a tributary of the Periyar River. As many as 200 families residing on the banks of the Periyar were alerted and shifted to relief camps as a precautionary measure.

Gates of Cheruthoni Dam opened





Tabular and graphical data from our data management software -
from water level sensors (radar and vw) installed at Cheruthoni Dam, 2397 ~ 2398 feet during October 18-19, 2021

Encardio-Rite Electronics Pvt. Ltd. A-7, Industrial Estate, Talkatora Road, Lucknow, UP-226011, India | geotech@encardio.com | www.encardio.com