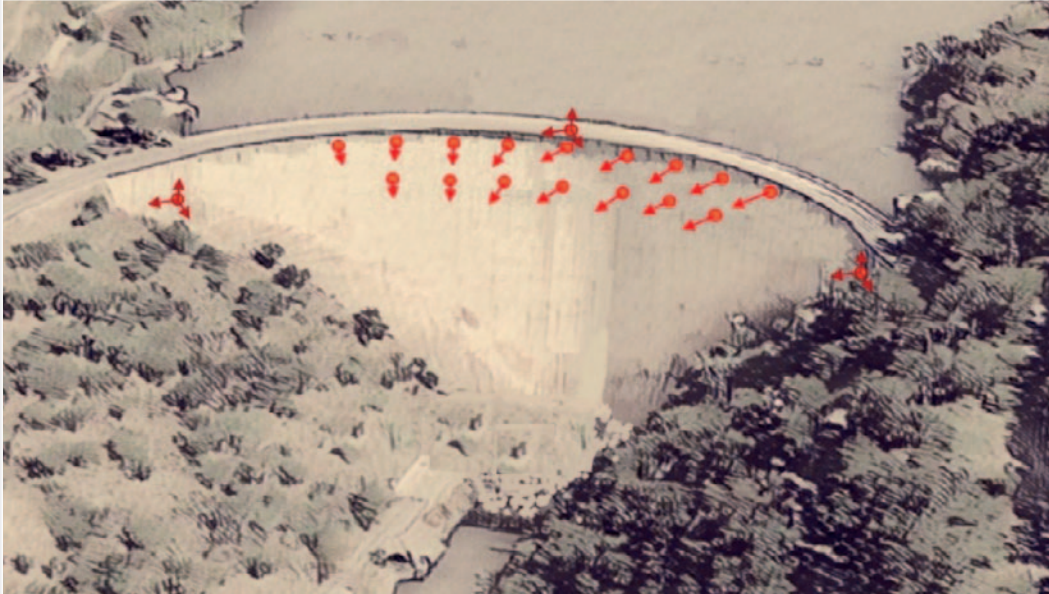


Turning Data into Actionable Information to Increase Understanding of Dam Performance and Safety



CASE STUDY



Continuous vibration monitoring systems are installed in large concrete dams to enable the permanent structural condition assessment over time and to monitor the dynamic response during seismic events.

These Seismic and Structural Health Monitoring (SSHM) systems should retrieve useful information from monitoring data, namely for analyzing vibrations measured under ambient/operational excitation and during seismic events, and compare the measured dynamic response with the response computed using finite element models.

KMIDam is a technology platform designed to manage your portfolio of dams with real-time information before, during and post-event. Leveraging a combination of smart sensing, modelling, digital twins, and real-time processing tools, KMIDam provides immediate feedback during events, and tracks changes to your structures that may lead to problems over time.

By investing in KMIDam platform solutions, including high-quality equipment, dam owners can obtain clear evidence on the performance and safety conditions of dams.

This case study outlines results for a dam outfitted with the SSHM4Dams solution, which is part of the KMIDam platform.

This solution was implemented on a 130 m-high double curvature arch dam with a crest length of 300m.

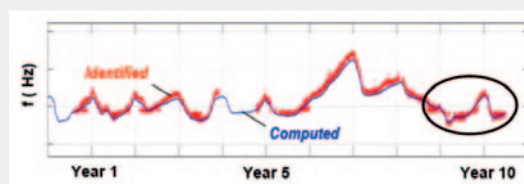
In operation for almost 70 years, horizontal cracks appeared in the upper part of the downstream face during the first filling of the reservoir, and concrete swelling was detected in the late 1990s.

The dam was instrumented over a decade ago with a continuous vibrations monitoring system, developed to continuously evaluate dam performance in normal operating conditions and to control the response during seismic events. The monitoring system comprises 16 uniaxial (EpiSensor ES-U2) and 3 triaxial (EpiSensor ES-T) force balance accelerometers from Kinometrics.

Key Solution Processes

Structural Health Monitoring

- Analysis of the evolution of natural frequencies over time
- Comparison with predicted frequency values from finite element models

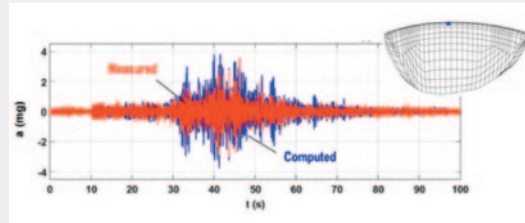


Dam performance is according to what was expected.

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Seismic Behavior Monitoring

- Comparison between the response measured during seismic events and the response computed using finite element models

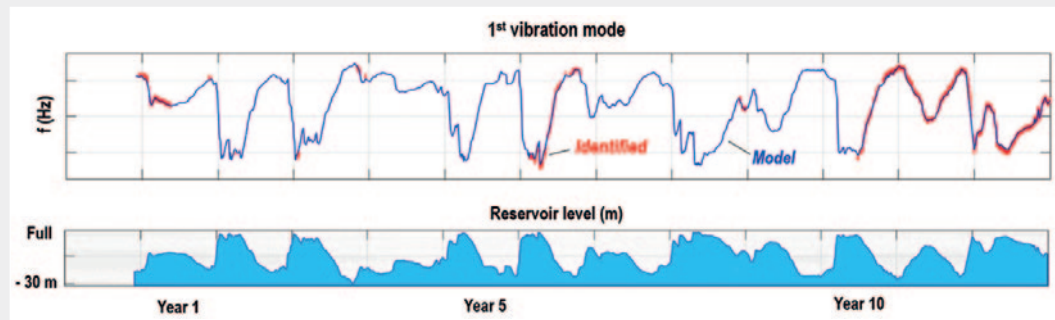


Measured response matches the response predicted using a reference model.

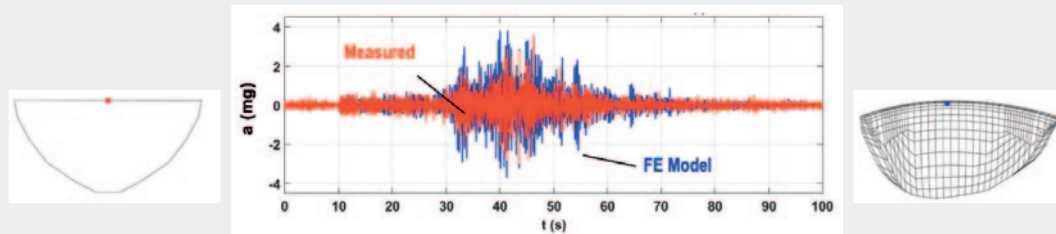
Results

Valuable data has been retrieved for modal parameter analysis and seismic response analysis:

1. Understand the evolution of existing deterioration phenomena in the dam: the variation of the main natural frequencies for over a decade did not reveal the influence of time effects, thus indicating that the global stiffness of the structure has not been decreasing.



2. The seismic responses measured during low-intensity seismic events have been analyzed and successfully compared with the responses predicted using models with linear-elastic behavior.



3. Calibration of finite element models used in behavior prediction studies, e.g., for seismic safety assessment under strong earthquakes.

Conclusion

The implementation of a complete dam monitoring solution based upon the KMIDam platform gathers the data and delivers the information required by the dam operators to understand how the structure has changed over time. Questions regarding dam safety raised by specific observed conditions were answered effectively through the information provided by the solution. Through automatic data management, detection of vibrations during seismic events, modal parameters identification, comparison between experimental results and finite element modelling results, and automatic emails and reports, the solution provides additional on-going benefits for dam owners, facility managers, operators, and engineers.

- Permanent surveillance of the system operation and of dam performance
- Support informed decision-making for regular maintenance needs or emergency situations
- Increase confidence in dam safety
- Respond to information needs of investors and insurance companies

CASE STUDY