



QUAKELOGIC

AI-POWERED EARTHQUAKE RISK MANAGEMENT SOLUTIONS

STRUCTURAL HEALTH MONITORING
FOR
WALNUT CANYON DAM | **ANAHEIM, CALIFORNIA**



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OUR TECHNOLOGY

QUAKELOGIC's intelligent technology platform integrating structural health monitoring (SHM) and earthquake early warning (EEW) systems is the most sophisticated disaster and risk management solution available today.

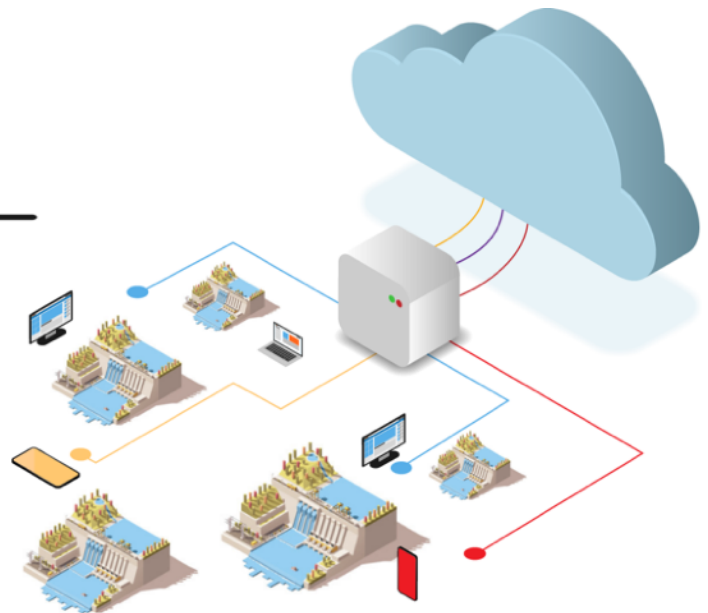
Our platform protects infrastructure, buildings and businesses from the impacts of structural compromise while safeguarding human life, the environment and investor interests.

The SHM system provides critical real-time information on structural performance, and sends rapid response notifications to decision-makers to prioritize response options based on detailed assessments.

Information from the monitoring system is processed by our intelligent SHM technology platform to provide an instantaneous and centralized cloud-based monitoring for all instrumented structures.

SMART AND SAFE DAMS

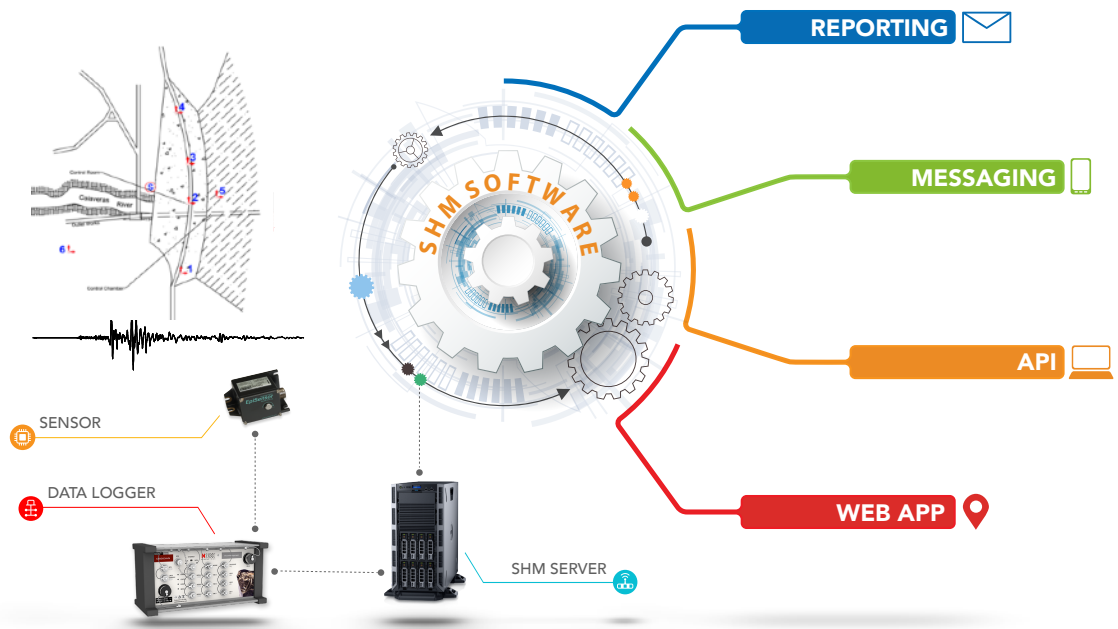
We create smart and safer dams by combining cloud-computing and artificial intelligence (AI) with advanced sensor technologies and centralized monitoring.



QUAKESENSE (SHM)

QUAKESENSE is our proprietary SHM system. Sensors and data logging devices positioned on each structure are connected to state-of-the-art SHM monitoring software running on the on-site server. This software continuously monitors the integrity of the structure and sends real-time event data to the cloud-based mobile-friendly web application in the form of a management dashboard.

Notifications supported by comprehensive reports are sent within seconds of an event, allowing decision-makers to coordinate emergency responses, prioritize



inspections and plan appropriate recovery actions based on accurate, detailed information.

QUAKESENSE is the only SHM product on the market that uses a cloud-based, AI-powered technology platform to trigger automated intelligent actions, notifications and structural assessments based on real-time sensor data.

DASHBOARD

Real-time information about the health of each monitored structure is displayed in the form of a well-designed management dashboard. The mobile-friendly dashboard is intuitive to use and provides drill-down functionality from the initial single-screen overview through increasingly detailed levels of data and information as needed.

The dashboard works seamlessly with QUAKESENSE's computational platform to organize, store and display current SHM data and reports. Password security is provided to avoid unauthorized access to information.



The dashboard includes advanced features such as sensor display, a map of most recent earthquakes around the globe, fault maps, etc. It also provides an asset management layout showing all relevant structural, geotechnical, seismic hazard and other information relevant to the monitored structure.



SYSTEM FEATURES

Real-Time Monitoring

- Cloud or on-site 24/7 monitoring for event triggers
- Web application with an accessible dashboard display
- Real-time continuous waveform analysis
- API (Application Programming Interface)

Rapid Notification and Response

- Real-time motion capture and imaging
- AI-based threshold for response triggers
- Automated safety alerts and spillway gate opening
- Text and WhatsApp notifications to decision-makers

Comprehensive Analysis and Reporting

- Ambient data collection
- Comprehensive condition analysis
- Detailed structural assessment analysis
- Multi-level reporting

Broad Platform Compatibility with:

- Accelerometers
- LVDTs
- GPS
- Potentiometers
- Strain and crack gauges
- Tilt meters
- Thermocouples
- Weather stations
- Piezometers
- Other analog and digital sensors



TECHNICAL FEATURES

- Artificial intelligence and machine learning
- Real-time displacement computation
- GNSS/GPS station data integration and analysis
- Torsion and rocking analysis
- Wave propagation analysis
- Modal analysis
- Normalized crest displacement, NCS
- Newmark displacement spectra
- Base-shear capacity vs. demand
- Base-shear, overturning moment and hysteretic response
- Acceleration and displacement response spectra
- Spectrograms
- Frequency response analysis
- Coherence, cross-spectrum phase and cross-correlation
- Fourier amplitude spectra
- Power spectral density
- P-phase picking
- Polarization
- Intensity measures:
 - PGA and PGV
 - Arias intensity
 - CAV
 - RMS acceleration
 - Duration interval
 - Cumulative Arias intensity
- Custom fragility function integration
- USGS-PRISM processing (COSMOS)

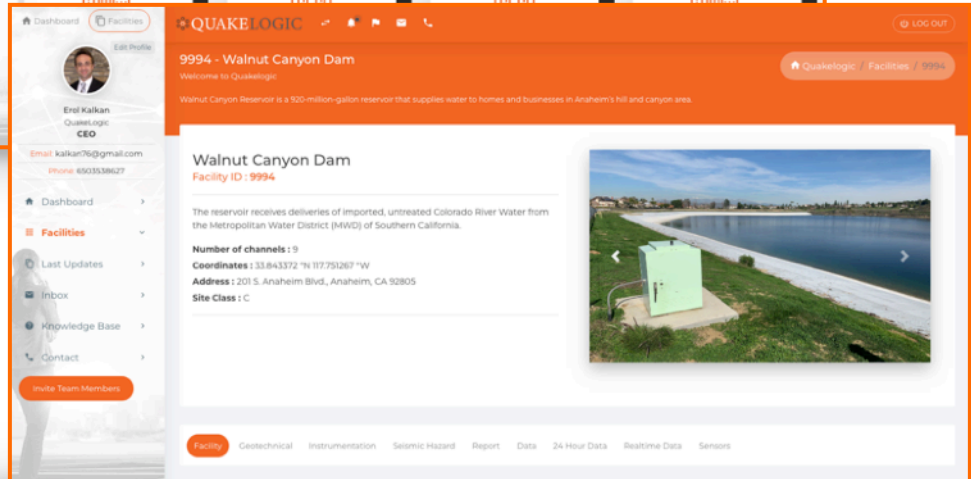
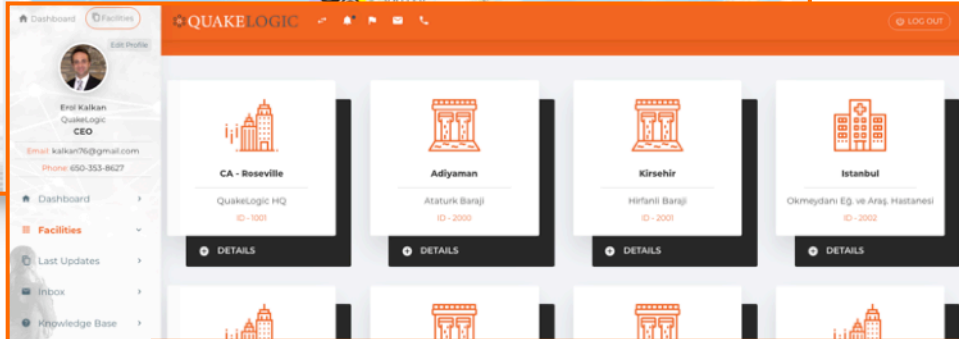
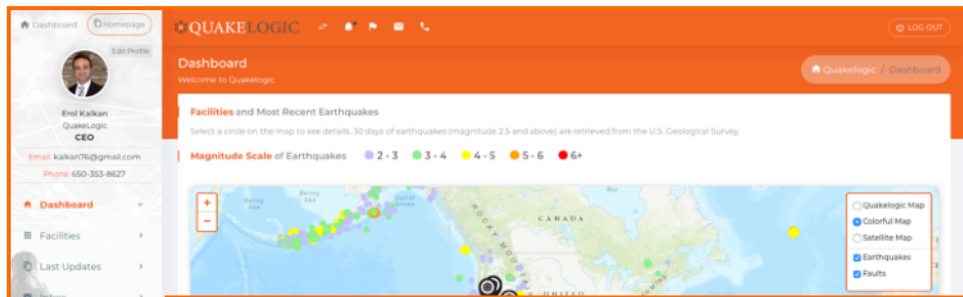
WALNUT CANYON DAM SHM SYSTEM

Walnut Canyon Dam deliveries of imported, untreated Colorado River Water from the Metropolitan Water District of Southern California. It's reservoir is capable of storing 920 million gallons of imported water.



The dam has two weather stations, a series of piezometers, tilt meters and three recorders with triaxial accelerometers. The accelerometers are located at the crest, left abutment and downstream. These sensor systems work seamlessly with the QUAKELOGIC's SHM platform.

This platform, continuously monitoring earthquakes within 200 km radius, sends immediate notifications to the dam's owner about structural performance after earthquakes.



QUAKELOGIC's mobile-friendly dashboard is a data management framework to support aggregation, storage and reporting of SHM data obtained and analyzed from the users' facilities.



| Host | Service | Status | Last Check | Duration | Attempt | Status Information |
|---------------|-----------------|----------|---------------------|----------------|---------|---|
| QuakeLogic_17 | CPU Performance | OK | 04-02-2020 06:20:31 | 0s 7h 49m 35s | 1/3 | OK - CPU M = 29.22% |
| | CPU Temperature | OK | 04-02-2020 06:23:11 | 0s 7h 41m 35s | 1/3 | SENSORS OK |
| | Current Load | CRITICAL | 04-02-2020 06:17:58 | 0s 22m 50v 30s | 9/3 | CRITICAL - load average per CPU 0.70 0.62 0.58 |
| | Current Users | OK | 04-02-2020 06:14:41 | 0s 7h 50m 45s | 1/3 | USERS OK - 0 users currently logged in |
| | Disk Space | OK | 04-02-2020 06:10:02 | 0s 7h 49m 22s | 1/3 | DISK OK - Free space = 4153 MB (51.1%) inode=7252 / total=8198 / 338 infs / 100.00% inode=2000 / total=17423 / 100 / 34 / 0.00% / 1000-3904 Free (280 MB) (21.81% / used=680%) / using=4153 MB (51.16% / used=72%) |
| | SSH Process | OK | 04-02-2020 06:23:48 | 0s 7h 49m 35s | 1/3 | SSH OK: Earthworm process found running 0 |
| | PHP Process | OK | 04-02-2020 06:16:59 | 0s 7h 47m 35s | 1/3 | PHP OK: Earthworm process found running 0 |
| | Memory Usage | OK | 04-02-2020 06:17:36 | 0s 7h 45m 51s | 1/3 | OK - 1421 / 3576 MB (39%) Free (Memory Usage 2622 MB, Shared 12.5 MB, Buffer 22 MB, Cache 320 MB) |
| | NTP Time | OK | 04-02-2020 06:21:00 | 0s 1h 5m 18s | 1/3 | NTP OK: Offset: 0.002970 / 3028 secs |
| | Ping | OK | 04-02-2020 06:18:00 | 0s 1h 5m 25s | 1/3 | PING OK: Packet loss = 0% RTT = 116.82 ms |
| | SSH | OK | 04-02-2020 06:23:03 | 0s 7h 45m 51s | 1/3 | SSH OK - OpenSSH 7.6.2 (protocol 2.0) |
| | Swap Usage | OK | 04-02-2020 06:14:27 | 0s 7h 50m 35s | 1/3 | SWAP OK: 0% / 1024 MB / 0 / 0 (0% / 1024 MB) |
| | Total Processes | OK | 04-02-2020 06:21:19 | 0s 1h 43m 44s | 1/3 | PROCS OK: 274 processes |
| | Uptime | OK | 04-02-2020 06:14:44 | 0s 7h 50m 42s | 1/3 | Uptime OK: 45 days / 14 hours / 14 min / 46s |

QUAKELOGIC's watchdog system, QUAKEDOG, continuously monitors the entire SHM system platform, including applications, system services, operating systems, network infrastructure and protocols, system metrics and security.

” Proper monitoring, surveillance and maintenance can provide early detection and intervention –Emergency Response

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