

CASE STUDY

How AI analytics delivered actionable intelligence from lock and dam structural health data



The U.S. Army Corps of Engineers (USACE) is one of the world's premier public engineering organisations. With a team of 37,000 civilians and soldiers, it is responsible for building and maintaining America's critical infrastructure, strengthening national security, and leading major environmental protection and restoration efforts.

Challenge

The USACE needed to move beyond slow, costly, and reactive manual inspections for their critical, ageing dams. Their challenge was converting vast amounts of sensor data into early warnings of structural degradation to prevent failures.

Solution

HBK deployed Monitor360, an AI-powered analytics platform. The system learned the normal structural behaviour of a lock gate from multi-sensor data and then continuously monitored for subtle deviations, combining multiple AI methods to provide a single, easy-to-interpret anomaly score for engineers.

Result

The system successfully detected early-stage structural drift weeks ahead of any scheduled inspection. This allowed USACE to shift from reactive maintenance to a predictive, condition-based strategy, improving safety and enabling proactive repairs while reducing uncertainty and the risk of costly failures.



Summary

The U.S. Army Corps of Engineers (USACE) manages over 200 locks and dams – infrastructure critical to national logistics and supply chains. It already collects large volumes of structural data from this infrastructure through strain sensors, displacement gauges, and environmental monitors.

Their challenge isn't data – it's turning that data into timely, actionable insight.

HBK introduced an AI-driven intelligence layer that continuously analyses multi-sensor data to detect early signs of structural degradation. Instead of relying on periodic inspections, the system learns normal structural behaviour and identifies subtle deviations – such as drift, stress redistribution, and emerging fatigue – long before visible damage occurs.

This enables a shift from reactive maintenance to predictive, risk-informed decision-making, where maintenance is triggered by real structural conditions rather than schedules or failures.



AI-driven predictive maintenance for lock and dam infrastructure.

Customer Challenge

Like many owners and operators of critical infrastructure, USACE needs to ensure safe, continuous operation of assets that are ageing, difficult to access, and exposed to highly variable loading and environmental conditions.

Traditional maintenance approaches rely heavily on periodic manual inspections, which are:

- Costly and time consuming
- Associated with safety risks
- Reactive rather than predictive

Although strain sensors and other monitoring devices are increasingly deployed, large volumes of data alone do not prevent failures. Maintenance teams face a critical challenge: how to convert complex, multi sensor data into clear, reliable indicators of early structural degradation – before damage escalates into unplanned outages or costly repairs.

The Solution

HBK Monitor360, an AI-powered structural health monitoring and analytics platform, was used to support a data-driven predictive maintenance approach for an in service lock gate.

By combining advanced analytics with multi sensor data integration, HBK Monitor360 enabled engineers to move from raw monitoring data to early anomaly detection and decision-ready insight.

The system first learns what normal structural behaviour looks like under varying operational and environmental conditions. It then continuously monitors for deviations from that baseline using an ensemble of complementary AI methods.

The solution brought together:

- **Multi sensor data fusion**, analysing strain measurements collectively rather than in isolation
- **Advanced feature extraction and PCA**, reducing complex time series data into meaningful indicators
- **Ensemble machine learning anomaly detection**, combining multiple algorithms to improve robustness and reduce false positives
- **A single, normalised anomaly score**, making complex structural behaviour easier for maintenance teams to interpret

This analytics driven approach was validated using real operational data from strain sensors located in high load regions of a mitre gate, alongside environmental data such as water and air temperature.

Key Benefits

With HBK Monitor360, maintenance teams gained early visibility of abnormal structural behaviour that would have been difficult to identify using traditional inspection methods or single sensor analysis.

Applied to real lock gate sensor data, the system detected early-stage drift in May – weeks before any scheduled inspection would have flagged it. Anomaly scores escalated progressively through June, with multiple sensors independently confirming the same structural trend.

The system did not simply detect noise; it identified signatures consistent with local deformation and fatigue cracking in the gate skin plate. This is precisely the outcome predictive maintenance must deliver: detecting slow, subtle degradation well before it becomes a safety or operational risk.

Key outcomes included:

- Detection of subtle strain drift that emerged gradually over time
- Clear identification of anomalous behaviour propagating across multiple sensors, increasing confidence in the findings
- Reduced risk of false alarms by combining the outputs of several complementary anomaly detection models
- Improved understanding of how environmental factors, such as water temperature, influence structural response

By presenting results as a single anomaly score, HBK Monitor360 helped engineers focus quickly on emerging risks – rather than manually reviewing large volumes of raw sensor data.

The Result

Using HBK Monitor360, USACE demonstrated how **machine learning enabled structural health monitoring** can deliver early warnings, reduce risk, and support smarter maintenance decisions for **critical assets** – helping to protect availability, safety, and long term asset performance.

Early warning of potential structural issues

HBK Monitor360 enabled earlier identification of abnormal behaviour, supporting proactive investigation and intervention.

Greater confidence in maintenance decisions

Ensemble analytics reduced uncertainty and false positives compared with single model approaches.

Actionable insight from complex data

Advanced data fusion and analytics transformed raw sensor data into clear, interpretable indicators.

Support for condition based maintenance strategies

The solution helps asset owners move away from reactive inspections towards predictive, data led maintenance planning.

Scalable and future ready

The HBK Monitor360 based approach can be extended with physics based models to further enhance diagnosis while focusing analytics effort on the most critical regions of the structure.