



Structural Health Monitoring Course: Sensors, Modal Damage Detection and Alarm Thresholds



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Introduction:

Structural health monitoring of civil infrastructure, covering sensors, modal damage detection and alarm thresholds, is a five-day course for structural, asset and monitoring engineers on bridges, towers, tunnels and stadiums, ending with an SHM System Plan and Alarm Threshold Schedule for a case structure. Many owners install sensors yet receive data nobody trusts, with temperature swings triggering false alarms while real stiffness loss goes unnoticed. Nominees already specify, operate or use monitoring data and work through case files of sensor layouts, raw records and modal results. CoreConcept Training Center delivers this structural health monitoring course.

Course Objectives:

- Define monitoring objectives for a structure by linking expected damage mechanisms to measurable response quantities and decision owners
- Specify strain, displacement, tilt, acceleration and fibre optic sensors with suitable range, resolution, placement and protection for field conditions
- Design a field acquisition and telemetry architecture with sampling, synchronisation, power, storage and data quality controls
- Separate temperature and traffic effects from structural change using data cleansing, normalisation and trend models
- Identify natural frequencies, damping and mode shapes from ambient vibration and apply modal and novelty detection methods to flag damage
- Set alarm thresholds and alert levels that trigger defined inspection, restriction or maintenance actions in an asset management workflow

Target Audience:

- Structural engineering teams responsible for the integrity of bridges, towers, tunnels and long-span roofs in service
 - Asset management teams responsible for maintenance planning and intervention budgets on major civil structures
 - Monitoring and instrumentation teams responsible for installing, running and maintaining permanent sensor networks
 - Owner and operator engineering teams responsible for acting on alerts from monitored stadiums, terminals and landmark buildings
 - Consultant and contractor teams responsible for specifying monitoring on new construction and retrofit projects
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Course Outline:

Day 1: SHM Purpose, Damage Mechanisms and Monitoring Objectives

- Detection, Localisation, Classification and Severity Damage Identification Hierarchy
- Damage Mechanisms Mapped to Measurable Strain, Tilt and Frequency
- Periodic Inspection Versus Continuous Monitoring Value Comparison
- Monitoring Objectives Matrix Linking Questions to Decision Owners
- Current-State Review of Existing Sensors and Data Use

Day 2: Sensor Technologies and Monitoring System Architecture

- Vibrating Wire and Foil Strain Gauges for Static Strain
- LVDT, GNSS and Total Station Displacement Measurement Options
- MEMS Tiltmeters and Low-Noise Accelerometers for Ambient Vibration
- Fibre Bragg Grating Arrays with Temperature Reference Gratings
- Brillouin and Rayleigh Distributed Fibre Sensing Along Tunnels

Day 3: Field Data Acquisition, Telemetry and Data Processing

- Sensor Placement Strategy Using Finite Element Mode Shapes
- Field Logger Sampling Rates, Time Synchronisation and Triggering
- Telemetry, Power Autonomy and Remote Health Checks for Loggers
- Data Cleansing for Spikes, Drift, Gaps and Sensor Faults
- Temperature Compensation and Regression Normalisation of Structural Response

Day 4: Modal Identification, Damage Detection and Alarm Logic

- Frequency Domain Decomposition for Output-Only Modal Identification
- Stochastic Subspace Identification and Stabilisation Diagram Reading
- Frequency Shift and Mode Shape Curvature Damage Indicators
- Unsupervised Novelty Detection Using Healthy-State Baseline Data
- Traffic-Light Alert Levels and False Alarm Rate Tuning

Day 5: Case Study SHM System Plan for a Case Structure

- Case Cable-Stayed Bridge and Stadium Roof Record Review
 - Case Sensor Layout and Acquisition Architecture Selection
 - Case Modal Results Interpretation and Damage Indicator Choice
 - Alarm Threshold Schedule with Response Actions and Owners
 - SHM System Plan Completion and Peer Challenge
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Skills You Will Gain:

- Monitoring Objective Definition
- Structural Sensor Specification
- Fibre Optic Sensing Selection
- Monitoring Data Cleansing
- Environmental Effect Normalisation
- Operational Modal Identification
- Vibration-Based Damage Indication
- Alert Level Calibration

Why Attend This Course:

- Deliver an SHM System Plan and Alarm Threshold Schedule for a case structure to the asset owner's structures manager and maintenance planning lead
- Decide whether a frequency drop, strain trend or tilt change calls for closer inspection, a usage restriction or no action
- Avoid sensor networks that produce untrusted data, temperature-driven false alarms and missed stiffness loss on critical structures
- Coach monitoring technicians and site engineers with the sensor checklist, data cleansing rules and alert response chart

Conclusion:

Back at work, the participant presents the SHM System Plan and Alarm Threshold Schedule to the structures manager, the maintenance planning lead and the operations control room. They use it to approve sensor procurement, assign who responds to each alert level and tie monitoring results to inspection and maintenance budgets. After the first seasonal temperature cycle or first alarm event, the unit should review false alarm counts, data availability, sensor failures and whether each alert produced the planned action.

Frequently Asked Questions FAQ:

What should participants know before a structural health monitoring course?

Participants should understand basic structural behaviour and have worked with design, inspection or monitoring data on a live structure. Familiarity with spreadsheets is useful because the case work uses raw sensor records, modal results and threshold tables.

How does structural health monitoring differ from a bridge inspection or a laboratory data acquisition course?

It concentrates on permanent sensor networks, field data processing, modal damage detection and alarm logic on live structures. Inspection courses cover visual and NDT condition surveys and capacity rating, while laboratory acquisition courses cover bench rigs and test automation software.

Why does temperature matter so much in structural health monitoring?

Temperature changes stiffness, strain and natural frequencies by amounts that can exceed the effect of real damage. Without compensation and normalisation, seasonal and daily swings either mask stiffness loss or trigger repeated false alarms that teams learn to ignore.

What do participants take back from the structural health monitoring course?

Participants take back an SHM System Plan and Alarm Threshold Schedule for a case structure, with a monitoring objectives matrix, sensor layout, acquisition architecture, data cleansing rules and an alert response chart to adapt for their own assets.