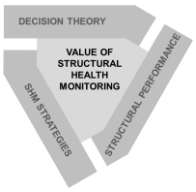

GLOSSARY OF TU1402

A

Accuracy: difference between the result of the measurement and the actual value of the mesurand (this is frequently provided by manufactures).

Acoustic emission: non-destructive passive method of monitoring which makes use of the elastic energy released when a material undergoes a change at the atomic scale, such as plastic deformation or cracking. Piezoelectric sensors attached to the surface of the structure detect the surface waves caused by these events and produce a voltage output. Signals which reach any sensor with amplitude greater than a user defined threshold are recorded and subsequently stored on an AE acquisition system.

Adverse state: state in which a performance criterion is not met.

Asset: infrastructure (resource) with economic value that an individual, corporation or country owns or operates.

Asset management: broadly defined, refers to any system that monitors and maintains things of value to an entity or group. It may apply to both tangible assets such as buildings and to intangible concepts such as intellectual property and goodwill. Asset management is a systematic process of operating, maintaining, upgrading, and disposing of assets cost-effectively. Alternative views of asset management in the engineering environment are: the practice of managing assets to achieve the greatest return (particularly useful for productive assets such as plant and equipment), and the process of monitoring and maintaining facilities systems, with the objective of providing the best possible service to users (appropriate for public infrastructure assets).

Availability: the probability that a component or system is functioning at a time t.

B

Bayesian decision analysis: probabilistic framework to quantify the utility and decision attributes (e.g. costs, benefits, consequences for human safety).

Bayesian decision theory: is based upon Utility theory (Von Neumann & Morgenstern, 1947) and is formulated in reference (Raiffa&Schlaifer, 1961). It represents a probabilistic framework to quantify the utility and decision attributes (such as costs, benefits, consequences for human safety). It is differentiated between a prior, posterior, pre-posterior and a Value of information analysis.

Bayesian updating: it takes basis in the Bayes theorem.

Benefit: a benefit constitutes a decision attribute associated with a gain.

C

Capacity: ability of a member or a component, or a cross-section of a structure to action without mechanical failure e.g. bending resistance, buckling resistance, available ductility.

Condition assessment: the process of reviewing information gathered about the current condition of structure or its components, its service environment and general circumstances, allowing a prognosis to be made of current and future performance, taking account of active deterioration processes and actual damage and, if appropriate, predictions of potential future deterioration processes and future damage.

Consequence: outcome of an adverse event including human, economic and environmental contributions.

Conjugate distributions: prior and posterior distribution functions are from the same probability distribution family.

Consequence class: categorization of the consequences of structural failure.

D

Damage: change in the condition of the structure that can affect the structural performance unfavourably.

Damage assessment: process of ascertaining the severity of the damage to a structure.

Damage characterization: process of ascertaining the time of occurrence, physical location and the size of the damage.

Damage detection: process of ascertaining whether the damage to structure exists or not.

Damage feature: quantifiable property or pattern sensitive to damage. It can be either directly monitored (e.g., strain) or extracted from monitoring data (e.g., modal characteristics from accelerometer measurements).

Damage feature extraction: extracting a quantifiable property or pattern sensitive to damage from monitoring data (e.g., modal characteristics from accelerometer measurements).

Damage identification: in addition to damage detection, localization and assessment, damage identification includes ascertaining the cause of the damage and its consequences.

Damage localization: process of ascertaining where the damage to structure is located.

Damage prognosis: prediction of remaining useful life of a damaged system.

Data acquisition*:* sampling and processing of monitored data.

Data analysis: transformation of data into an applicable information.

Data cleansing: the process of identifying and correcting corrupted or erroneous measurements from a data set. Typical examples of refers to identifying incomplete records (missing data), incorrect values (outliers), or inaccurate values due to temporary malfunctioning of the monitoring system or its components (sensors, communication lines, etc.). The corrupted data is mostly removed, and sometime modified or replaced using some pre-defined algorithms.

Data-driven approach: data interpretation approach performed utilizing computer algorithms to calculate or recognize damage features from measurement datasets. They do not need building a physical model of the structure.

Decision analysis and theory: see Bayesian decision analysis.

Decision options/alternatives: decision options or alternatives represent decision scenarios for which the utility and/or decision attributes are quantified. In the context of the quantifying the value of Structural Health Monitoring (SHM) decision alternatives may constitute different SHM strategies encompassing e.g. technology, locations and algorithms.

Decision tree: tree-like graph or model of decisions and their possible consequences, including probabilities and costs or utilities.

Degradation: worsening of condition with time (see also Deterioration).

Demand: request (resistance, ductility,…) coming from all the actions applied to the structure.

Deterioration: process that adversely affects the structural performance, including the reliability over time; it can be caused by various reasons, such as chemical, physical and biological actions.

Direct risk: the risk associated with consequences directly related to the structure, engineering system or its immediate users, such as physical damages in a structure, or injuries and fatalities caused by structural failures.

E

Error (systematic)*:* value that remains constant when measurement is repeated under the same conditions.

F

Failure: insufficient load bearing capacity or inadequate serviceability of a component of the system or of the whole system.

Fault detection: fault detection, isolation, and recovery (FDIR) is a subfield of control engineering which concerns itself with monitoring a system, identifying when a fault has occurred, and pinpointing the type of fault and its location. Two approaches can be distinguished: A direct pattern recognition

of sensor readings that indicate a fault and an analysis of the discrepancy between the sensor readings and expected values, derived from some model. In the latter case, it is typical that a fault is said to be detected if the discrepancy or residual goes above a certain threshold. It is then the task of fault isolation to categorize the type of fault and its location in the machinery. Fault detection and isolation (FDI) techniques can be broadly classified into two categories. These include Model-based FDI and Signal processing based FDI.

Filter: electronic device or mathematical algorithm to process a data stream by means of separating the frequency components of signals.

I

Information: knowledge gained by means of measurement(s), analytical, numerical or empirical methods related to the decision scenarios.

Information (sample): knowledge that describes a realization of the value or state of a random property.

Information (perfect): knowledge that describes the true value/state of a deterministic property.

Indirect risk: the risk associated with consequences that follow from a failure event, but are not direct consequences. These are consequences associated with loss of system functionalities. These include business interruptions due to failures in transportation or energy networks.

Inspection: on-site non-destructive examination aiming to assess the actual condition of the structure.

Inspection (qualitative): on-site examination of parameters that relies primarily on words such as surface condition (good/bad), visible deformations (yes/no), crack patterns (diffuse/regular), etc.

Inspection (quantitative): on-site examination of parameters that relies primarily on numbers such as crack length, corrosion area, etc.

L

Life-cycle (action): long-term action that extends over entire lifespan of the structure, from the construction until the decommissioning or dismantling.

Lifetime or life-cycle cost*:* sum of all recurring and one-time (non-recurring) costs of the structure over the lifetime.

Likelihood: a general concept that expresses qualitatively (e.g. high, medium, and low) or quantitatively (e.g. frequency or probability) the chance that an event may occur in a specific time period.

Limit state: state beyond which a structure no longer satisfies the design requirements.

M

Maintenance: technical intervention during the service life of a structure aimed to preserve its required performance.

Measurement: process to determine a value (if quantitative) or status (if qualitative) of a parameter.

Model-driven approach: data interpretation approach performed comparing the responses of a structure with those of a predicted model (analytical model or finite element model) based on physical and mechanical characteristics of a structure.

Model uncertainty: a basic variable related to the accuracy of physical or statistical models.

Monitoring: procedure related to observation or measurement of structural conditions or actions or structural response.

Monitoring system*:* technical system (including hardware and software) that allows to collect information related to the parameters of interest.

N

Non-destructive testing: off-line local method after damage detection.

P

Performance criteria: quantitative limits, defining the border between desired and adverse behaviour (i.e. failure criteria). *NOTE: In context of Limit State Approach, performance criteria are the* threshold values *that describe for each limit state the conditions to be fulfilled.*

Performance indicator: parameter describing a certain property of the structure or a certain characteristic of the structural behavior.

Performance modeling: process of simulating various system loads against varying system configurations by using a mathematical model.

Performance requirement: a condition used to describe a required service quality with regard to specific performance goal, established by means of performance indicator(s) and associated performance criteria with constrains, related to service life and reliability.

Periodic monitoring*:* repeated action over time by means of a temporary monitoring system on a structure towards the collection of measurements for a short period of time.

Periodic monitoring (triggered): collection of measurements by means of a programmed criterium, usually a predefined threshold related to a parameter that is being measured which triggers the data recording (e.g. observation of accelerations).

Permanent monitoring: continuous action over time by means of a permanent monitoring system on a structure towards the collection of measurements for a long period of time.

Portfolio: group of assets sharing a common set of characteristics (e.g. structures, in general, with a permanent monitoring system installed, bridges from a specific concessionaire, corroded metallic bridges).

Posterior decision analysis: a decision analysis with additional information. For more detailed information see reference (Raiffa&Schlaifer,1961).

Posterior distribution function: probability distribution that expresses the knowledge about a parameter after relevant evidence (e.g. new data) is considered.

Pre-posterior decision analysis: a decision analysis with unknown information. For more detailed information see reference (Raiffa&Schlaifer. 1961).

Prior decision analysis: a decision analysis with known information. For more detailed information see reference (Raiffa&Schlaifer, 1961).

Prior distribution function: probability distribution that expresses knowledge about a parameter before some evidence is considered.

Probabilistic deterioration model: a predictive model of deterioration, which considers prediction uncertainty by modeling parameters and/or deterioration states as random variables or random processes.

Probabilistic risk analysis: a formal approach to computing the risk of a system, based on probability theory.

Probabilistic risk assessment: a probabilistic risk analysis followed by an appraisal of the risk.

Probability of Detection (PoD): chance of detecting a failure, which is generally expressed as a *PoD* curve that relates the likelihood of detection to a parameter related to the failure.

Proof loading: test to demonstrate the fitness of a load-bearing structure.

R

Reference period: period of time used as a basis for assessing the statistical parameters of time dependent variables and of the target reliability.

Reliability: ability of a structure or a structural member to fulfil the specified requirements, during the planned working life.

Reliability index: reliability indicator (substitute for the probability of failure).

Repair: technical intervention on a damaged or degraded structure aimed to restore its required performance.

Resilience: is the ability of a structure to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Risk: expected value of all undesired consequences (direct and indirect); it combines the probability of failure and related consequences.

Risk analysis: a formal approach to computing the risk of a system**.**

Risk-based inspections: a systematic approach to plan and perform inspections, in which inspections are prioritized according to their effect on the system risk. The RBI approach aims at optimizing the sum of cost (of inspection and maintenance) and risk (due to non-treated damages).

Risk management: coordinated activities to direct and control an organization towards the minimization of occurrence of potential risks.

Robustness: ratio between the direct risks and the total risks, (total risks is equal to the sum of direct and indirect risks), for a specified time frame and considering all relevant exposure events and all relevant damage states for the constituents of the system.

S

Safety: the condition of a structure being protected against failure, damage, design errors, accidents, or harms, in both causing and exposure.

Sensors: device that allows the observation of a parameter of interest by means of known correlation between the parameter and an electric/optic parameter (e.g. electric strain-gauge, fibre optic sensor).

Serviceability limit state: condition in which a structure or component becomes unfit for service and is judged to be no longer useful for its intended function under normal usage.

Standardization: process of implementing and developing technical standards.

Strain gauges: device used to measure strains. Jargon synonym for “electrical resistance strain gauge”.

Strengthening: technical intervention on a structure aimed to improve its performance.

Structural Health Monitoring (SHM): the process of identifying the presence and quantifying the extent of damage in a system based on information extracted from the measured system response.

Structural integrity: the ability of structural components to act together as a competent single entity.

Structural performance: behaviour of the structure or one of its members usually quantified by means of a quantitative parameter (e.g. reliability index, ratio between resistance capacity and action effect).

System identification: process of building mathematical models of dynamic systems and of estimating physical parameters from observed data.

T

Threshold: boundary defined to compare different states.

U

Ultimate limit state: condition in which a structure or component becomes unfit for service and is judged to have reached its ultimate capacity.

Ultrasonic technology: non-destructive inspection method based on the Lamb waves, ultrasonic elastic waves that propagate along the surface of plates and can be generated and acquired using piezoelectric transducers. The ultrasonic interact with obstacles/flaws/borders in the structure and reflect back to the transducer. The comparison between the initial and reflected signal gives information about the obstacles/flaws/borders

Uncertainty: imprecision of a parameter which can be classified by their origin, namely (i) model uncertainty, (ii) statistical uncertainty, (iii) measurement uncertainty (error) and (iv) human and/or organization error.

Uncertainty (epistemic): imprecision due to a lack of knowledge, which can always be reduced by means of new knowledge (e.g. acquired by measurements).

Uncertainty (aleatory): imprecision due to pure randomness, which is an inherent property of an uncertain parameter.

Usage monitoring: the process of acquiring operational loading data from a structure or system, which preferably includes a measure of environmental conditions (e.g. temperature and moisture) and operational variables.

Utility: quantitative measure (often related to a monetary-based parameter) related to a certain procedure/decision that has been implemented.

Utilization ratio: ratio between design action effect and design resistance.

V

Value of Information: numerical difference between the expected benefit (utility) estimated with the implementation of the SHM and the expected benefit without implementation of the SHM.

Vulnerability: ratio between the risks due to direct consequences and the total value of the considered asset or portfolio of assets considering all relevant exposures and a specified time frame.

W

Working service life (design): assumed period for which a structure, or a part of it, is to be used for its intended purpose with planned maintenance but without major repair being necessary.
Working service life (residual): remaining period for which an existing structure, or part of it, is to be used for its intended purpose with the implementation of the maintenance plan.

X

X-ray technology: non-destructive inspection method based on the use of X-rays to detect variations of density in the material which is a function of the amount of radiation that passes through.

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