Note Title 4/25/2018

Module 3

Lecture 5:

Sensor requirements and data acquisition

Note Title 4/25/2018

Example: offshore structures

- offshore structures operate under high risk factor
  - due to kind of process (exploration & production)
- They need to be monitored
  - Novel in their type
  - topside mechanical systems are custom designed
  - Their failure (even down-time, for repair) cause economic loss.
  - Strategically important

Note Title 4/25/2018

SHM is

(1)
- preventive maintenance approach
- dependent on continuous monitoring of the structure, under time-varying loads

(2) It is difficult to carryout traditional inspection through NDT or visual inspection
- structure is huge
- partially submerged in (sea) water
- certain members of the structure cannot be inspected

Note Title 4/25/2018

An automated, continuous SHM scheme is necessary

- damage analysis can be carried out to ensure operational (and functional) safety

In areas where VI is not possible (piles, foundation members etc) one should examine these members through simulated numerical models

- a few scaled models of the same platform can be examined experimentally

- There is a correlation need to be established b/w the observations made @ lab scale and that of the real scale.

Note Title 4/25/2018

Numerical modelling of offshore platforms for deploying STEM system.
certain assumptions and approximations are adopted
— procedure more convenient

i) Varying mass is not linked with marine growth, equipment & fluid storage (which, otherwise is temporary)

ii) Variable submergence leading to change in buoyancy, & mass of the member is not included
— this will influence the energy dissipation of the system, significantly

Note Title 4/25/2018

Brincker et al. (1995), certain factors that govern the design of monitoring system for offshore platforms (Loland & Dodd, 1976)

i) sensors should be able to withstand environmental uncertainties

ii) proposed SHM scheme should have financial advantages over the manual inspection method (traditional)

iii) Vibration spectrum should remain stable over a period of time

iv) Normal sea state and wind excitation should be used to extract the natural frequency of the system

v) Above-water measurements should be used to identify the mode shapes

Note Title 4/25/2018

Various vibration-based monitory sensors & technology (Optical applicable)

	Physical parameter	principle of the sensor	Technology
(1)	Acceleration, Velocity displacements	Inductive sensors	Conventional
		capacitive sensors	MEMS technique
		piezo-electric sensors	
(2)	Magnetic field	-	Magneto-resistance (large size)
	Magnetic resistivity		
(3)	optical properties	photo-electric sensors	. Fibre-Bragg Grating
		optical fibre sensors	- Fabry-perot interferometer
			- Intensity-based sensor

Note Title 4/25/2018

(4) Acoustic ✓ - ultrasonic probes

Sensor performance

- Quality of data is HW dependent the performance of the sensor
- Common factors that governs the selection of sensor
  - Data format
  - precision & accuracy
  - linearity of the data
  - dynamic range of the variable
  - cross-talk
  - durability
  - maintainability
  - redundancy
  - cost of the sensor

Note Title 4/25/2018

SHM involves

- detection & tracking

During detection, sensor is prepared to read the data, and correlate the data with the sensitivity of damage.

(2) approaches to carry out the above work

(1) Most common:

Deploy sensors (or) array of sensors is a network with commercially available components in the market

- Major disadvantage is that "Existation of the structure will be limited to range of frequency of the array of sensors"

physical Quantities are measured without any definite of damage

- assumption here is that measured data will be sensitive to the damage (Farrar et al' 1994)

- It also has an assumption that damaged & undamaged structures are subjected to a similar kind of excitation (very serious limited)

- The same strategy is employed is real time which will measure the data and analyze the data for damage-sensitive features.

Alternatively,

Quantify the damage before developing the sensing system

How do you quantify the damage?

Through Numerical simulation, model is prepared and results available from the simulation, prior to the occurrence of damage are used

- type of damage
- possible extent of damage
- location of damage

} design the sensor system based on the simulation results

- Vital parameter, to design the sensing system
  - Extract damage features from the data
    - Statistical pattern recognition (SPR)
    - Is the governing factor to design the acquisition system (Flynn, 2010)

Additional requirements are updated
- changing condition of the environment
- operational conditions

helpful to predict the initial detection of damage (simulation)
- improves the quality of damage detection process is SHM

Acquisition system

Type of data to be acquired
- defined to design the sensor network

(2) types of data
- kinematic
- environmental

Quantities

Summary

- sensing requirements for strategic structures
  - offshore platforms (Ocean structures)
- design of sensing system is done based on the anticipated damage level in a given structure