

Module 1

Lecture 4

— Challenges in SHM

(1) Foremost challenge

is to develop and demonstrate the STM technology

- which can be useful to maintain the structural integrity with improved reliability and durability

(2) Unlike conventional non-destructive techniques (NDT)

a single technology of STM cannot be suitable for all applications

- depends on various factors
- material
- component geometry
- damage scenarios

(3) Outcome of STM - should be reliable

- sometimes, it may trigger unwanted maintenance, which may become expensive
- It may also sometimes create spurious warnings
- degrades confidence level on the strength of existing structures

(4) optimization of structural design on the basis of

- acquired (monitored) data through STM
- data, acquired through STM should be fairly accurate & robust

(5) Major concern is the cost of STM scheme

(6) Owners of structural system, even if it is Govt undertaking, should be convinced with the need of STM

- public funding - on a major investment
- it should produce, reasonably advantageous outcome
 - economic perspective too
 - safety perspective
- it should be producing results, that are debatable and comparable to regular maintenance approaches

(7) major challenge is STM

- damage detection

- locating damage (on/in)

- its scalability

- its prospective benefits

- its consequences

(8) major challenge is STM

- reliability & robustness of the sensors

- life span

- adaptability to working environment

- successful substitution to the
perce network

Additional challenges in SHM scheme

(1) Damage identification is civil structure & mechanical structure is one of the major challenges

Damage is defined as

- change in material properties
- change in geometric characteristics of the system
- This also includes change in boundary conditions and system connection
- which can lead adverse effect due to non degradation

The above complexities can be handled using NOT tools

- helpful in identifying damages @ Global level
- damages on the structure, as a whole can be identified
- but cannot be precisely located @ the local level on each member

for RCC structures, this problem is more serious

- increased compliance
- arising from embedment steel in concrete
- one of the recent approaches - SPR
- statistical pattern recognition

Damages

are generally initiated @ material level

- defects & flaws

- under certain loading conditions, these damages tend to propagate

- they can result in system-level damage

- Main concern is not the system-level damage

- it is the component-level damage

Damages

do not refer to loss of system functionality

If the system functionality is lost, it's called
as failure

Prevent the system to perform its optimal operation

Damage

- degrades the performance of the system
- It doesn't affect system functionality completely.
- Damages can be add repair

failure

- total loss of functionality
- need to rehydrate
- reconstruct the system

System is to avoid failure

Damage to the system (civil structural systems)

can occur in 2 scales

-(1) long-term time scale

(2) short-term time scale

- corrosion

(1) due to impact load.

- fatigue

short load

(2) aircraft landing.

SHM - as a process of

implementing damage identification
strategy

This process involves the following:

(1) Observation (Monitoring on a continuous scale)

(2) Assessment

- To determine the current state of the structural system
- based on the collected data of damage scenarios
 - specific features identified for quantifying damage
 - statistical analysis tools which are used to quantify damage

Non-destructive Evaluation (NDE)

- primarily used to characterize the damage and check for severity - there is prior knowledge of the damage

(2) STM Challenges is oil & gas industries

- oil platforms - generally inaccessible for damage inspection
 - vibration-based damage identification has been tried (early 80's) in oil platforms

major challenge is

- damage location is not known
 - because magnitude of the one of platform is not accessible for measurement
- Common solution is to simulate the damage scenario using numerical model in software
- Example the severity to interpret the damage

Major concerns of using vibration-based damage detection is oil platforms

- (1) Machine noise - created by the platform - interferes with the measured vibrations
- (2) Instrument deployment is hostile environment - challenge

- (3) faulty-mass representation - which arises due to marine growth

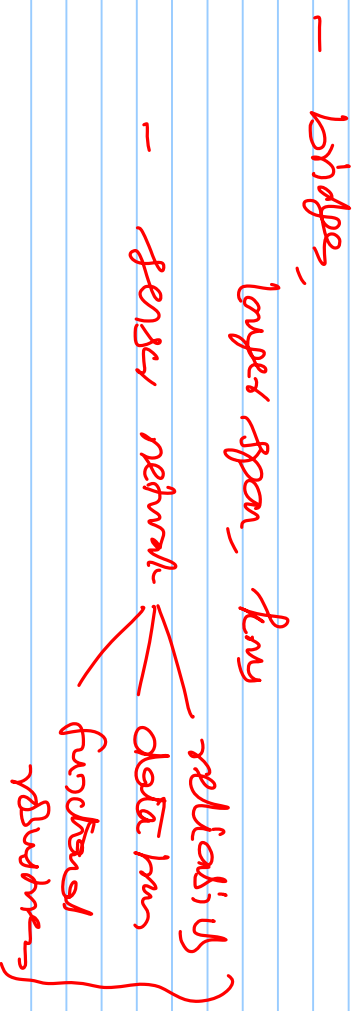
(ω_n) - is the main parameter damage is character

$$\omega_n = \sqrt{k/m}$$

- (4) Varying hydro-dynamic mass — ^{varies} from the fluid storage variation
- (5) Variation in foundation conditions
- (6) absence of wave force or excitation is hydrodynamic

The above factors (concerns) have limited (reshaped) water
system is oil industries (oil production platforms)

One of the major concern is that
physical size of the structure



Summary →

challenge is STM process for various industry

- optimal position of sensors to decide their layout
- network of sensors — to ^{inter-}connect them for onward transmission of data
- identification of features, sensors to run small programs (detect loads)
- Algorithm / acquire data to differentiate changes caused by damages & those caused by the environmental loads

- development of statistical methods to
disseminate features of a
damages & undamaged systems

1