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Module 2 Structural Health Monitoring

Lecture 1 : Short-term and Long-term monitoring

SHM is mandatory to assess old structures in an effective manner.

- This may be required various purposes
  - repair & rehabilitation
  - rebuilding wit assessment

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SHM has to focus on the following

(1) Inspection

(2) Investigation
- Experimental (in-situ)
- Experimental (Lab-Scale)
- Analytical (Scaled model (or prototype))

(3) Maintenance

4) Evaluation and assessment

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Glossary of Terms in SHM

(1) Ambient vibration test : is a vibration test, which is carried out for Dynamic tests in SHM, when the structure is excited by

wave
wind
traffic loads etc
any other human activities

Under normal conditions

(2) Assessment : defined as validation of structural conditions

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(3) Continuous monitoring : is usually carried out on a continuous basis to find any detrimental changes in the characteristics of the structure

4) Damage : is a change in the health of the structure in terms of its condition which decreases its performance

5) Defect : Condition-related deficiency

6) Evaluation : is a process through which the actual load carrying capacity of the structure is determined

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Inspection: is a non-destructive examination, which is carried out to find/detect defects in the structural system

Load effect. is the consequence on the structural member due to loads & forces (or)
it refers to change in the geometric system of the structure, caused by the loads & forces

Long-term monitoring It is a process of periodic (or) continuous monitoring, which is carried out over several years.

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periodic monitoring : it is non-continuous monitoring which is carried out to identify any significant change or detrimental damage on the structural system

It is important that infrastructure projects like

- bridges
- tunnels
- retaining walls
- dams
- offshore structures

} are generally subjected to over-usage in terms of service life

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But still they are used.

Main reason is due to the fact that

Re-building these structures is almost impossible
and cost of is temporary public life & huge
investment of public fund — will not recommend reconstruction

What is the solution?

problem: - These structures are averaged
- reconstruction them is impossible
- Strength reduction!

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In such cases, it is very important to know the current state of health of such structures so that their service life can be prolonged in the interest of public safety.

SHM – maintain & assessment of old, strategic structures is absolutely necessary and very important

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A critical combination of the following facts demand Health monitoring

(1) Increased loads

(2) poor maintenance

(3) Inadequacy of checks in terms of current code compliance

- All public structures demand SHM as an important process.

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- Most common way (method) of health monitoring of public buildings is visual inspection by maintenance personnel.

- This is a common practice in most of the developed countries such that public buildings are visually inspected periodically (This period varies in the range of 3-5 years)

Visual inspection has certain draw backs

(1) Deficiencies, during visual inspection can be detected only if those surfaces are accessible

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for example, in case of offshore structures,

marine growth is a very important (natural) barrier which obstructs visual inspection significantly

(2) A long gap b/w the periodic inspections can reduce safety because, structural degradation process, if faster than periodic inspection will be unnoticed.

SHM is a scheme that provides information on demand about any significant change or damage or defect that occurs in the structure

SHM - assessment / detection of defect or damage

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objectives of SHM method:

(1) structural phenomenon such as corrosion, cracking, delamination, settlement effects should be investigated

(2) Time strategy such as continuous monitoring, periodic or triggered monitoring should be advised, based on the nature of defect/damage & type of the structure

(3) Condition of the phenomenon whether it is local or global should be observed

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(A) load-effects caused on the structure should be reported

5) Evaluation method should include

Cause of failure and

consequences of failure with respect to degree of severity should be reported

- This should cover
  - structural geometry
  - material degradation
  - load data etc.

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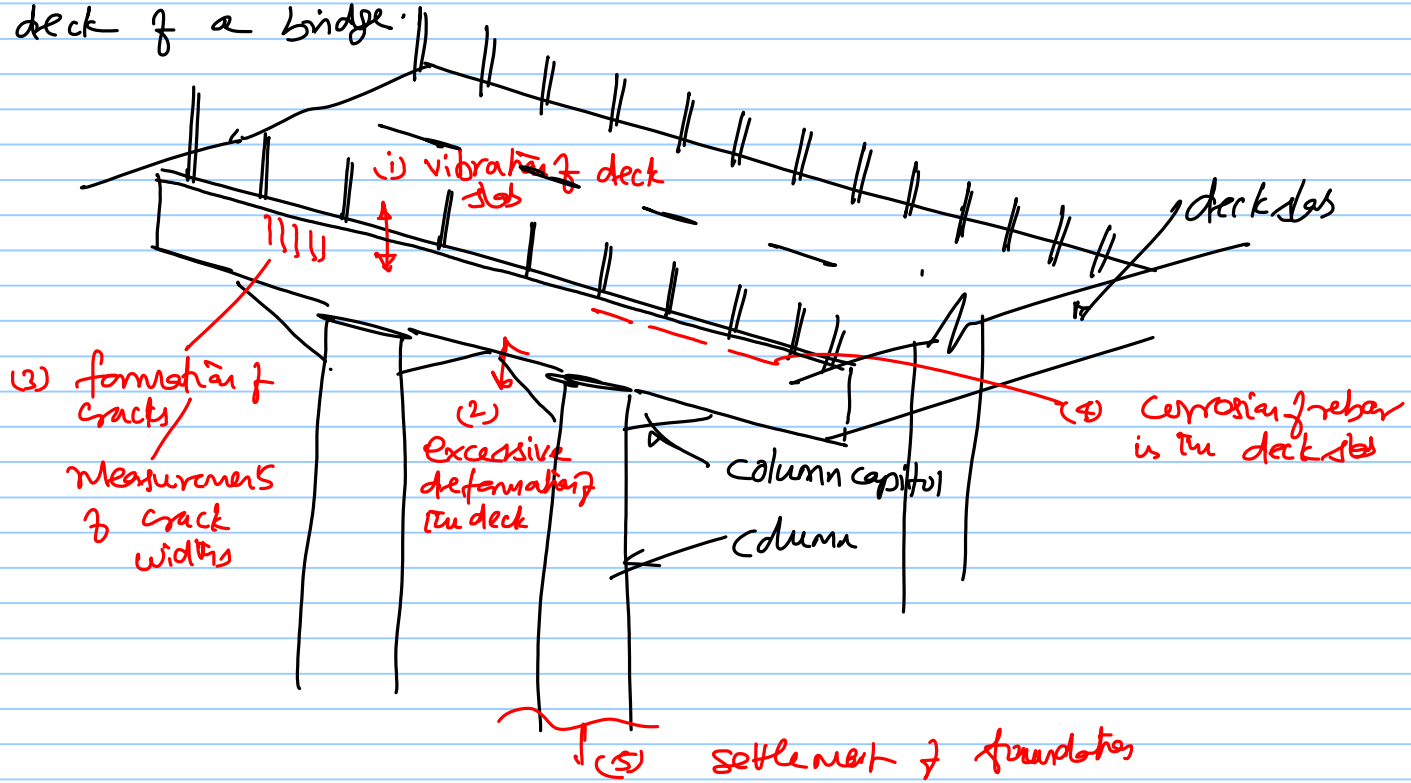
Let us consider deck of a bridge.



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Monitoring

(i) Short-term
(ii) long-term monitoring
(iii) triggered

Short-term monitoring (STM)

- can be used if the state of structure to be examined only @ specific point of time (road/railway bridge, monitoring is required only when there is a heavy traffic)

- can also be done if visual inspection shows a damage definitely
  - STM is carried out to validate/ collect more details about the damage

Most of the sensors used in STM are not robust and unable to sustain long-periodic observations. Due to this reason, sensors are used in STM only for a specific period of time.

They are generally used in "on-off" mode.

- several short-term monitoring, if repeated @ periodic intervals can be a substitute to periodic (or) long-term monitoring

Long-term monitoring

When the period of monitoring is very large, it is termed as long-term monitoring (Mufti et al. 2006)

Mufti AA, Oshima, T, Bakht B, Mohammed A, Mohamedein M.A. 2006. Structural Health of Monumental structures, proc. of European Workshop on SHM, Paris, France ISBN: 1-932078-00-6.

- long-term monitoring is carried out over the entire life of the structure.

Specific conditions under which long-term monitoring is done.

- If changes in loading are slow such as gradual change in temperature

- To predict effect of natural hazards on the structural systems
  - Earthquake, flood, hurricane etc

Triggered monitoring

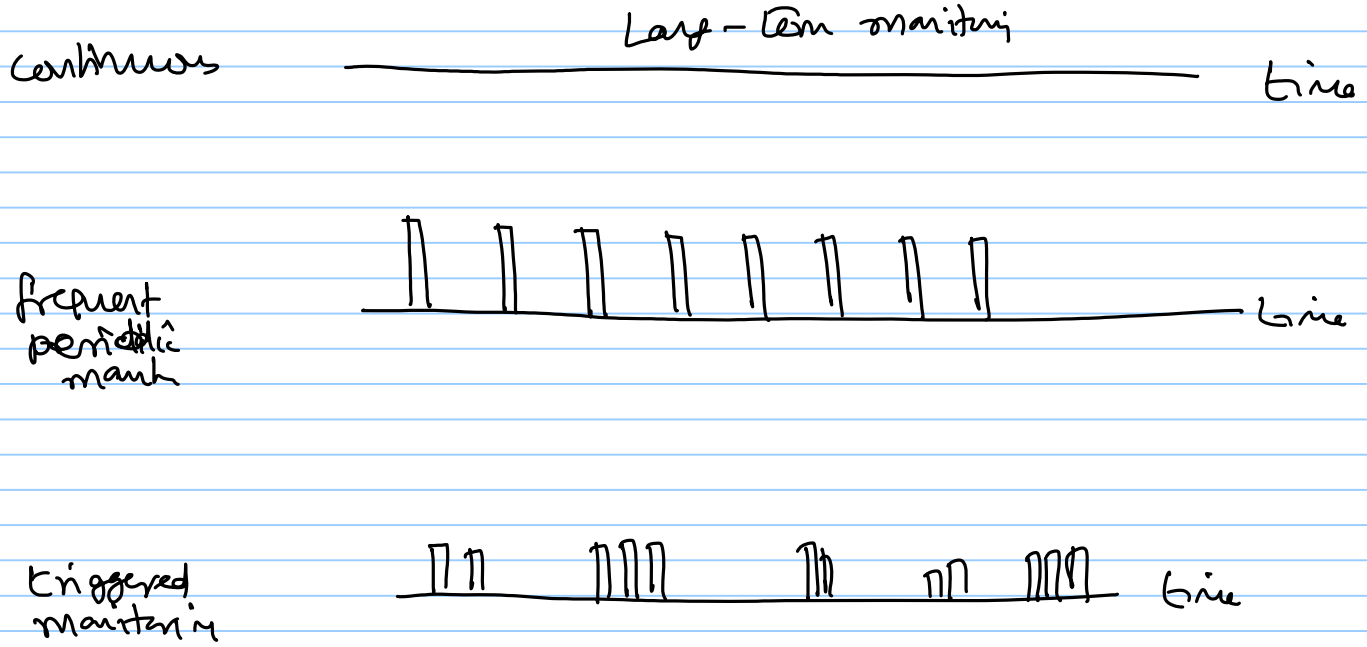
This is done when data collection is initiated by a specific event

(or)

when a parameter exceeds threshold value

- Sampling interval depends on dynamic nature of the studied phenomenon

Typical example: monitoring the vibrations when train passes a railway bridge.


Long-term monitoring
continuous
time
frequent periodic mode
time
triggered monitoring
time

Summary

- Glossary of Terms - SHM - types of motion

- short-term
- long-term
- periodic
- triggered monitor

Why SHM - is necessary for aging structures