

Structural Health Monitoring (SHM)
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Lecture – 10
Advantages of Structural Health Monitoring- Part 2

(Refer Slide Time: 00:25)

Successful deployment of SHM using various Non-destructive Evaluation (NDE) techniques

Basic components of SHM

- Sensing
- actuators
- smart structures
- materials
- computational systems
- signal processing

NDE

NDE is a vital component, integrally connected to structural health monitoring

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Friends, now let us talk about successful deployment of Sstructural Hhealth Mmonitoring using various non-destructive evaluation techniques. Let us quickly recollect what are the basic components of SHM. The basic components of SHM or sensors, if I am having active system, then actuators, then smart structures, smart materials, computational systems signal processing etcetera, of course, statistical models.

There is a small overlay of NDE with the basic components of the system so, this represents non-destructive evaluation. So, non-destructive evaluation is a vital component integrally connected to structural health monitoring.

(Refer Slide Time: 02:51)

NDE techniques - recently deployed - very useful

I HELP Hybrid Electro-Magnetic performing Layer

This method is an alternate to a fully-integrated Electro-magnetic technique, which is quite expensive

- By embedding the Network of conductors in the material

(or)

bonding the network of conductors on the internal surface of the structure health monitoring is carried out

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Having said this let us see what are different NDE techniques, which are recently deployed and found to be very useful; we will also see some of more details in the next module.

The first method which has been seen is indicated as HELP. HELP is expanded as Hybrid Electromagnetic Performing Layer. This method is an alternate to your fully integrated electromagnetic technique which is quite expensive.

So, help is somewhat reasonably economically viable. What you actually do in this is by embedding the network of conductors in the material or by bonding the network of conductors on the internal surface of the structure health monitoring is done.

(Refer Slide Time: 05:29)

In this process

- a grid, which is a sensitive magnetic field is created
- This field is created by an external electromagnetic antenna which crosses the structure
- This is made of conductive composite
(ex: epoxy composite, carbon composite, etc)

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In this process a grid which is a sensitive magnetic field is created. This field is created by an external electromagnetic antenna, which crosses the structure; this is made of conductive composite.

For example, epoxy composite, carbon composites, etcetera. So, it is an embedment of network of conductors either on the material itself or pasted externally on the surface of the structure.

(Refer Slide Time: 07:17)

II Ultrasonic Vibro Thermography

- Lamb waves are used to generate ultrasound
- The embedded piezoelectric patch, with a help of camera monitors the surface thermal field
- This field is produced by interaction of Lamb waves with the structure's surface defects (cracks, fibers, delamination, etc)
- This is very helpful to study delamination in composites

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The second method which is very common and very successful is ultrasonic vibro thermography. In this case, lamb waves are used to generate ultrasound the embedded piezoelectric patch with a help of camera, monitors the surface thermal field.

This field is produced by interaction of lamb waves with the structure having defect some defect this defect can be a crack can be a fissure can be your delamination etcetera. Some kind of defect or disorder, essentially this technique is very helpful to study delamination in composites.

(Refer Slide Time: 09:48)

lock-in shearographic imaging of ultrasound

shearographic imaging is created/generated by piezoelectric patch which is embedded on the surface of the structure

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The third method is also very useful yes:- lock-in shearographic imaging of ultrasound. Shearographic imaging is created, or I should say generated by again a piezoelectric patch; which is generally embedded on the surface of the structure.

So, the above three methods discussed which are all non-destructive evaluation are very advanced and very helpful in assessing the actual control and health of the structural system to a larger extents.

(Refer Slide Time: 11:18)

Classification of SHM methods

classification depends on the techniques used for damage detection

There are 4 levels of damage identification (Rytter, 1993)

Rytter A. 1993. Vibration-based inspection of civil engineering structures, Aalborg, Denmark

Level 1	determination of damage in the structure
Level 2	" of geometric location of the damage
Level 3	Quantification of severity of damage
Level 4	prediction of remaining service life of the structure

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Now, friends let us see how do we classify SHM methods. Classification of SHM methods essentially depends on the techniques used for damage detection. So, first let us understand that there are how many levels of damage.

There are actually 4 levels of damage identification, Rytter 1993 vibration-based inspection of civil engineering structures. Aalborg Denmark, level 1 is determination of damage in the structure. Level 2 is determination of geometric location of the damage. Level 3 is quantification of the severity of the damage, and level 4 is prediction of remaining service life of the structure after damages occurred.

(Refer Slide Time: 14:00)

Summary

- critical issues of deploying SHM process
- salient/exclusive advantages of using SHM scheme
- components of SHM - Embedded/Integrated with NDE tech
- Advanced NDE methods
 - monitoring health of composites
 - mechanical systems
- levels of damage - SHM classification

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So, friends in this lecture, we learnt what are the critical issues of deploying SHM process in various type of structural systems. We also understood; what are the exclusive advantages of using structural health monitoring scheme in variety of structures. We also see how the components of SHM get embedded or get integrated with non-destructive evaluation techniques.

We also seen a few advanced non-destructive evaluation methods, which are very helpful especially in monitoring the health of composites and mechanical systems. We also understood; what are the different levels of damage and based on the damage how SHM methods can be classified. We will discuss further details of this in the coming lecture.

Thank you very much.