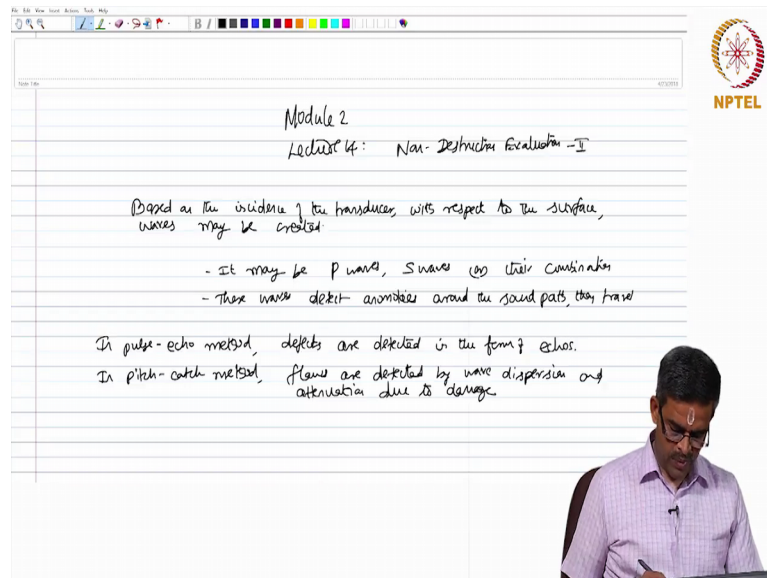


Structural Health Monitoring (SHM)
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Lecture – 42
Part – 1: Non-Destructive evaluation – II

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Module 2
Lecture 14: Non-Destructive Evaluation - II

Based on the incidence of the transducer, with respect to the surface, waves may be created

- it may be P waves, S waves or their combination
- These waves detect anomalies around the sound path they travel

In pulse-echo method, defects are detected in the form of echos.
In pitch-catch method, flaws are detected by wave dispersion and attenuation due to damage.

Friends, we will continue to discuss the last lecture in module 2, which is lecture 14. In this we will discuss the extension of Non-Destructive Evaluation as a second series lecture which is a continuation of the last lecture. Based on the incidence of the transducer with respect to the surface waves may be created it may be P waves, S waves or their combination. These waves detect anomalies around the sound path they travel.

In pulse echo method, defects are detected in the form of echos. Alternatively in pitch catch method flaws are detected by wave dispersion caused due to damage.

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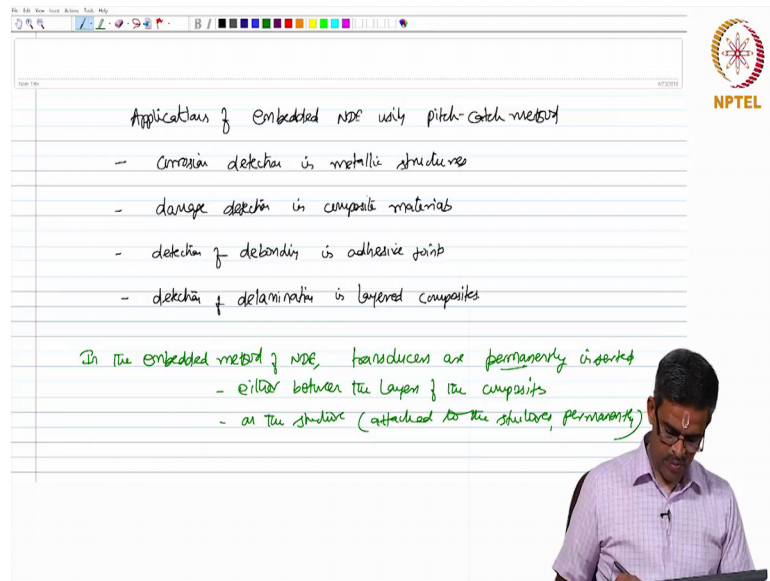
Pitch-catch method

- Suitable for embedded Non-destructive evaluation.
- This method can be used to detect the structural changes that take place b/w the Transducers
 - one transducer will be placed as a receiver
 - another transducer will be working as a Transmitter
- pitch-catch method can detect changes that are created by
 - guided wave amplitude
 - Phase difference and
 - Wave dispersion

Pitch catch method is suitable for embedded non-destructive evaluation. This method can be used to detect the structural changes that take place between the transducers: one transducer will be placed as a receiver, another transducer will be working as a transmitter. So, between the two transducers one is a receiver other is a transmitter the changes between take place between these two will be able to detect the flaws or the damages on the structure which is being examined.

Pitch catch method can detect changes that are created by guided wave amplitude, phase difference between them, and they are dispersion.

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Applications of Embedded NDE using pitch-catch method

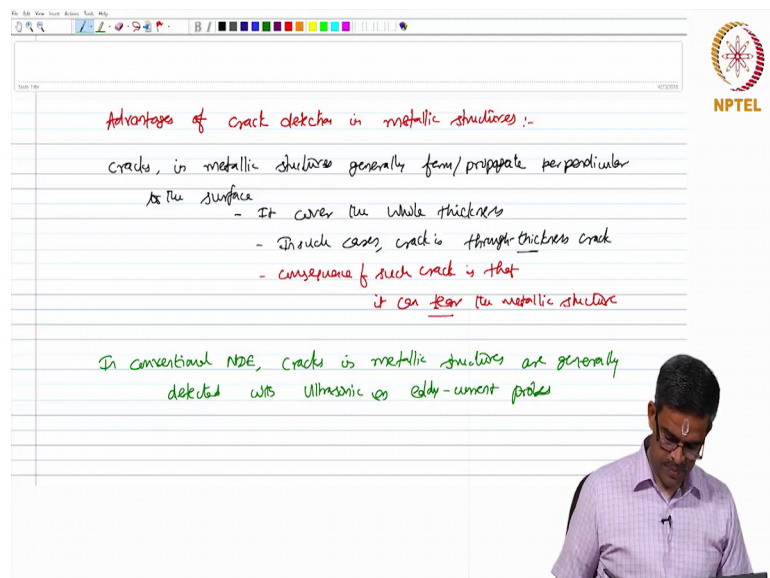
- Corrosion detection in metallic structures
- damage detection in composite materials
- detection of debonding in adhesive joints
- detection of delamination in layered composites

In the embedded method of NDE, transducers are permanently inserted

- either between the layers of the composites
- on the structure (attached to the structure permanently)

This method has the following applications: corrosion detection in metallic structures, damage detection in composite materials, detection of de bonding in adhesive joints, detection of de lamination in layout composites. In the embedded method of nondestructive evaluation transducers are permanently inserted either between the layers of the composites or on the structure; they are actually attached to the structure permanently.

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Advantage of crack detection in metallic structures :-

Cracks in metallic structures generally form/propagate perpendicular to the surface

- It covers the whole thickness
- In such cases, crack is through-thickness crack
- consequence of such crack is that it can tear the metallic structure

In conventional NDE, cracks in metallic structures are generally detected with ultrasonic or eddy-current probes

Now, let us see what are the advantages of crack detection in metallic structures. Friends, cracks in metallic structures generally form and propagate perpendicular to the surface. Generally, it can cover the whole thickness. If it covers the whole thickness in such cases the crack is called through thickness crack. The consequence of this of such crack is that it can clear the metallic structure.

In the conventional NDE, cracks in metallic structures are generally detected with ultrasonic or eddy current probes.

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- one of the limitations of this method is they can detect cracks/flaws only @ particular points.

- If one need to examine crack presence of the whole surface one should have to manually scan over the complete surface to detect cracks

- This is very tedious exercise
- possibility of overlooking a few crack locations

This problem can be corrected by pitch-catch method

One of the limitations of this they can detect cracks or flaws only at particular points: if one need to examine crack presence of the whole surface one should have to manually scan over the complete surface to detect cracks. This is a very tedious exercise, and this has a possibility of over sighting or few crack locations. This can be avoided this problem can be corrected by pitch catch method.

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Guided waves are transmitted from one location and received at another location.

Thus, the whole member/material is analyzed for

These will help to detect presence of cracks without manually scanning the complete surface.

- i) Guided-wave shape & its amplitude
- ii) phase-lag created by the end-signal
- iii) change in amplitude

In pitch catch method guided waves are transmitted from one location and received in another location. Thus, the whole member or material is analyzed for: one the guided wave shape and its amplitude, the phase law created between the end signals, and change in amplitude. This will help us to detect presence of cracks without manually scanning the complete surface.

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pitch-catch method can detect presence of cracks and also their extension, without scanning (manually) the whole surface.

- Probability of crack detection by pitch-catch method is higher than other methods. This is given by the following relationship:

$$P(\text{crack detection}) = \frac{\sum \text{cracks recorded by pitch-catch method}}{(M - N) + 1}$$

where M = # of crack events recorded by NDE methods
N = # of serial events.

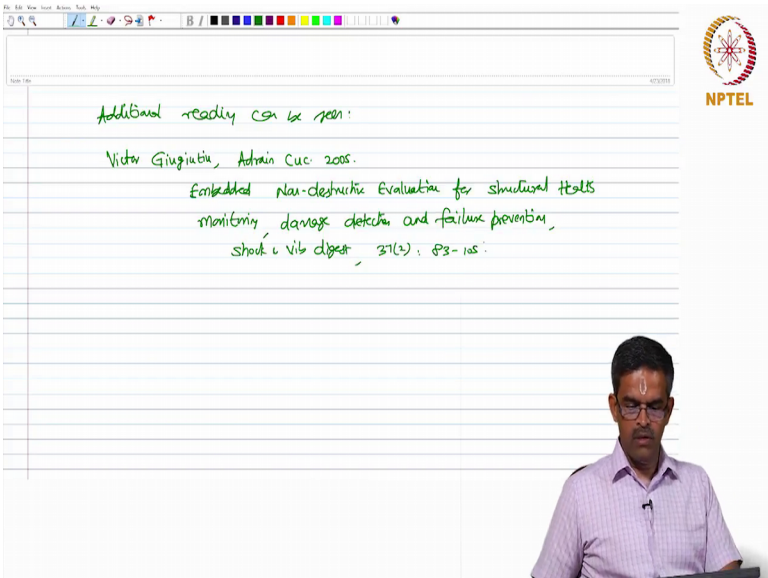
pitch-catch method is also effective in detecting fatigue crack propagation.

So, this can be seen as one of the important advantage of pitch catch method of NDE when it is used for crack detection in metallic structures. Pitch catch method can detect

presence of crack and also their extension without scanning the whole surface manually. Now there are researches who ascertain that probability of crack detection by pitch catch method is much higher than other methods. This is given by the following relationship: probability of crack detection by pitch catch method is equals to sum of cracks recorded by pitch catch method divided by M minus N plus 1. Where, M is a number of crack events recorded by non-destructive evaluation method and N is number of serial events.

It is very important to note that pitch catch method is also effective in detecting fatigue crack propagation.

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Additional reading can be seen:
Victor Giugliotta, Admin CUC 2005.
Embedded Non-destructive Evaluation for structural health
monitoring, damage detection and failure prevention,
shock & vib digest, 37(2): 83-105.

Additional reading on this subject more can be seen from the following reference: shock and vibration digest in the year 2005.