

Structural Health Monitoring (SHM)
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Lecture - 43
Part - 2: Crack detection in Composites

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Crack detection in Composites

- Composites generally resist the loads by the layered structure
- In case of formation of through-thickness cracks, their propagation in composites are resisted by the presence of reinforcement fibers.
- Hence, Cracks grow parallel to the surface
 - @ the interface between the layers
- They are generally initiated by
 - i) fabrication imperfection
 - ii) unable to resist fatigue loads

Generally, resist the loads by the layered structure. In case of formation of through thickness cracks, their propagation in composites or resisted by the presence of reinforcement fibers. Cracks grow parallel to the surface especially at the interface between the layers. They are generally initiated by one, fabrication imperfection and unable to resist fatigue loads.

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In the conventional NDE, ultrasonic probes are used to sense the additional echoes to capture these surface parallel cracks

- P waves will be reflected by delamination of layers
- This will be an indication of crack development, parallel to the surface, which causes delamination in composites.

Pulse-echo method can also be used for crack detection in composites

In such case, an appropriate guided wave (Lamb wave) must be chosen to detect the crack

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On the other hand, in the conventional non destructive evaluation, ultrasonic probes are used to sense the additional echoes to capture these surface parallel cracks. P waves will be reflected de lamination of layers and this will be an indication crack development, parallel to the surface, which essentially causes de-lamination in composites.

Pulse-echo method can also be used for crack detection in composites. An appropriate guided wave that is lamb wave must be chosen to detect the crack, because we know on the crack detection depends on the wavelength, amplitude, phase difference and the dispersion, ok.

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It is seen that

- Lamb waves show better reflection from the through-thickness cracks
- they should be less dispersive

Advantages

- 1) better reflection ensures a strong signal for crack detection
- 2) less dispersion ensures compactness and convenience to interpret

Wide application of pitch-catch method are seen in

- { Pipe lines
- { closed conduits (tubes)
- { cables etc

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It is seen that lamb wave show better reflection from through thickness crack. In fact, they should be less dispersive.

So, the advantages could be better reflection ensures a strong signal for crack detection, less dispersion ensures compactness convenience to interpret. In various places wide applications of pitch-catch method are seen in closed conduits that is tubes cables etcetera.

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NDE - Embedded phase arrays

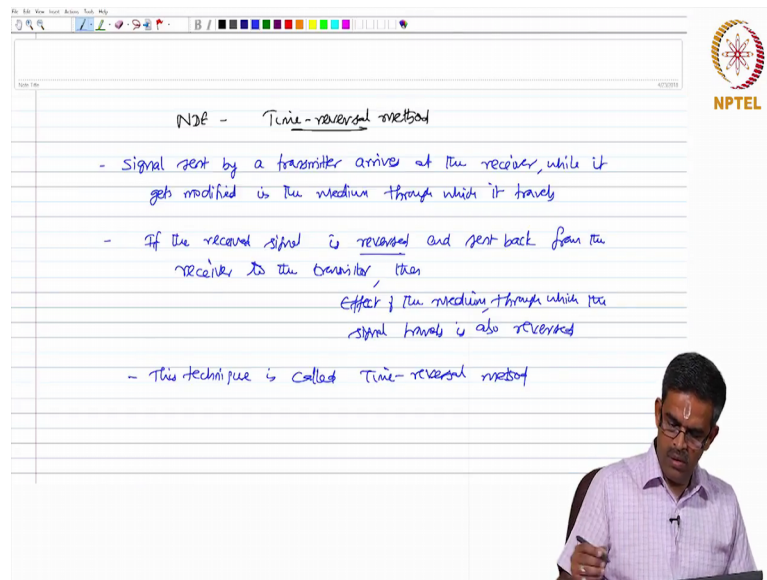
In this technique, real-time phased array systems are used

- Transducers to inspect very thick specimens
- Reinforced concrete slabs of deck of a bridge
- with p-wave

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NDE is also uses another method technique called embedded phase arrays. In this method or in this technique they have transducers to inspect very thick specimens, reinforced concrete slabs of deck of a bridge with p-waves.

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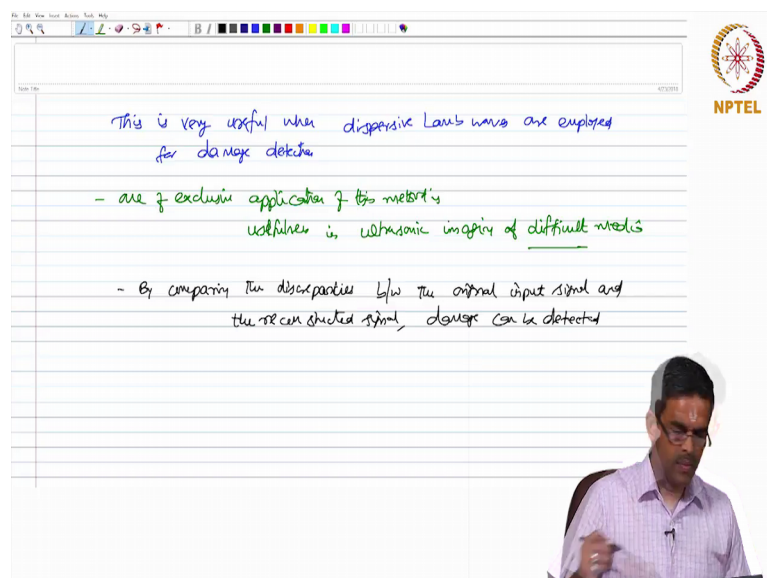


NDE - Time-reversal method

- Signal sent by a transmitter arrives at the receiver, while it gets modified in the medium through which it travels
- If the received signal is reversed and sent back from the receiver to the transmitter, then Effect of the medium through which the signal travels is also reversed
- This technique is called Time-reversal method

Time reversal method, while it gets modified in the medium through which it travels. If the received signal is reversed and sent back from the receiver to the transducer or to the transmitter, then effect of the medium through which the signal travels is also reversed is called time reversal method.

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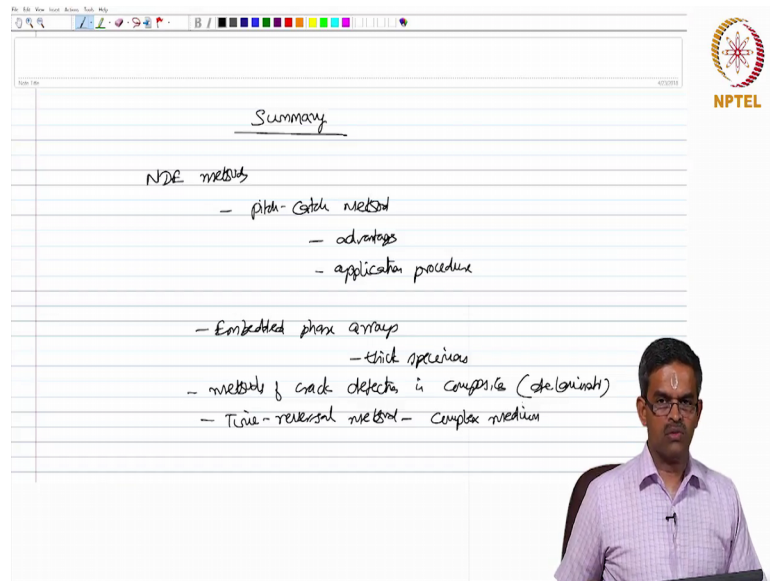
This is very useful when dispersive Lamb waves are employed for damage detection

- one of exclusive application of this method's usefulness is, ultrasonic imaging of difficult media
- By comparing the discrepancies b/w the original input signal and the reconstructed signal, damage can be detected

This is very useful dispersive lamb waves or employed for damage detection.

Exclusive application of this method is usefulness ultrasonic imaging of difficult media. By comparing the discrepancies between original input signal and the reconstructed signal damage can be deducted.

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Summary

NDE methods

- pitch-catch method
 - advantages
 - application procedure
- Embedded phase arrays
 - thick specimens
- methods of crack detection in composites (delamination)
- Time-reversal method - complex medium

In this lecture we learnt about new NDE methods, like details about the pitch-catch method, its exclusive advantages and application procedure, embedded phase arrays, thick specimens. We also learnt about methods of crack detection in composites in terms of de-lamination, we learnt about interestingly the time reversal method which is useful in complex medium.

With this, we conclude the lectures on the second module. We move on to the next module, where we will explain about sensor technologies and their applications and layer design as useful to structural health monitoring in infrastructure engineering.

Thank you very much and bye.