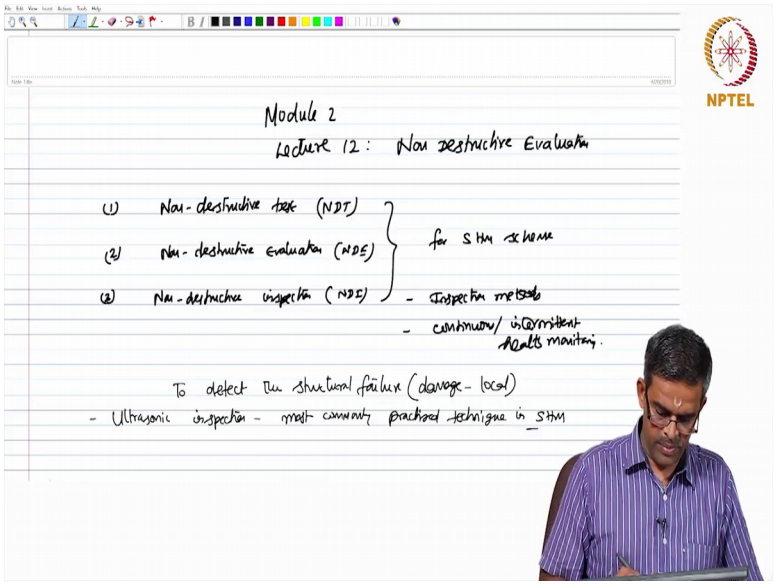
Structural Health Monitoring (SHM)
Prof. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

Lecture - 39
Part - 1: Non-Destructive evaluation - I

(Refer Slide Time: 00:20)

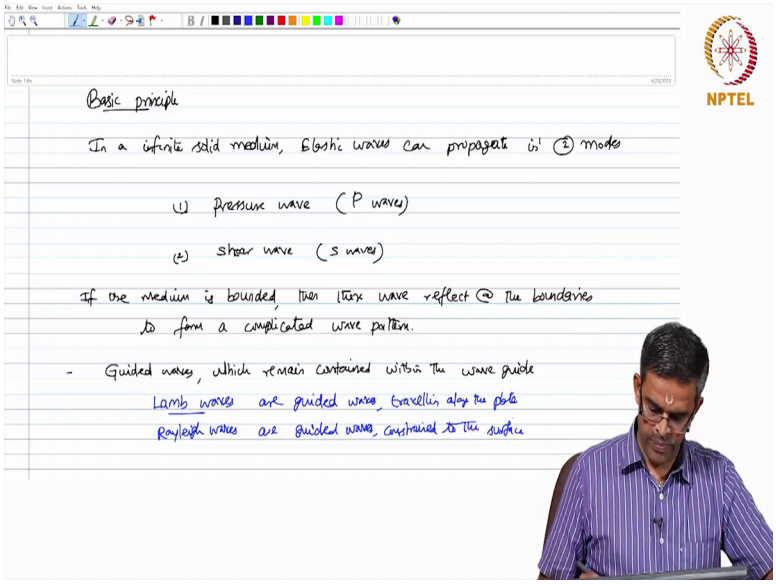


Friends, welcome to the next lecture in module 2 this is going to be lecture 12. In this we are going to talk about non destructive evaluation, which is a vital part as far as structural health monitoring is concerned. There are three components or three major areas, which can do non destructive evaluation as far as structural health monitoring is concerned.

One is non destructive testing briefly known as NDT other is nondestructive evaluation briefly known as NDE third is non-destructive inspection known as NDI. All these are very vital for structural health monitoring scheme they become part and parcel of inspection methods sometimes they also become a part of continuous or intermittent health monitoring they are essentially used to detect the structural failure or in sense local damage.

The most important methodology being used is ultrasonic inspection, which is the most commonly practiced technique, in structural health monitoring.

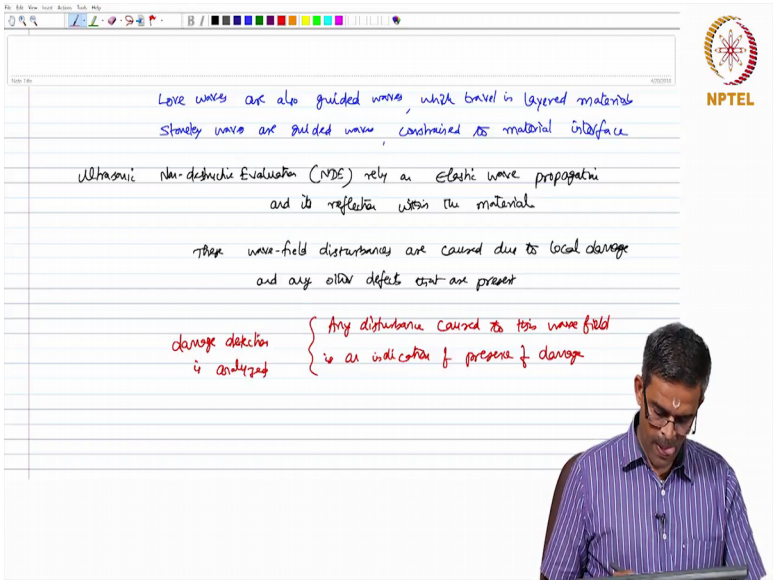
(Refer Slide Time: 02:55)



Let us see what is the basic principle behind this? In an infinite solid medium elastic waves can propagate in two modes, namely pressure waves other ways called as P waves, the second is shear waves called as S waves. If the medium is bounded with the rigid boundary, then these waves reflect at the boundaries to form a complicated wave pattern ok.

Now, alternatively there are something called guided waves, which remain contained within the waveguide. For example, lamb waves or guided waves traveling along the plate, Rayleigh waves are guided waves which are constrained to the surface.

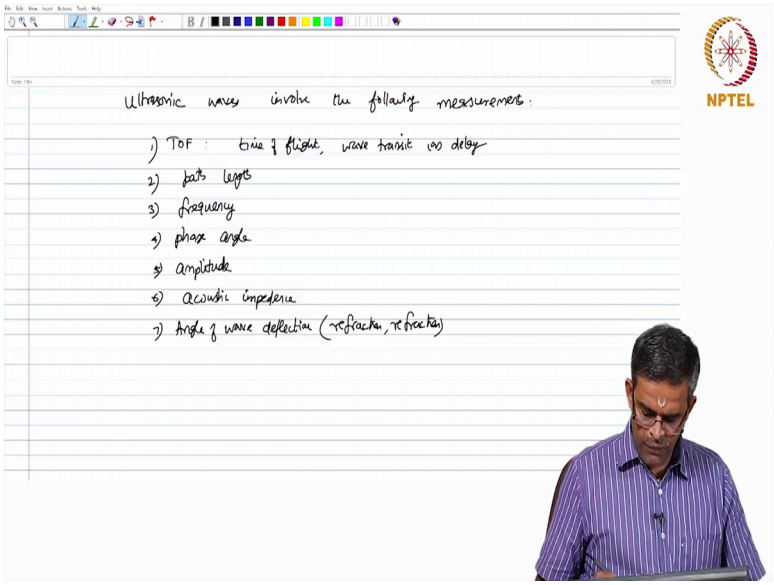
(Refer Slide Time: 05:49)



Love waves are guided waves which travel in layered materials, stoneley waves are guided waves constrained to material interface.

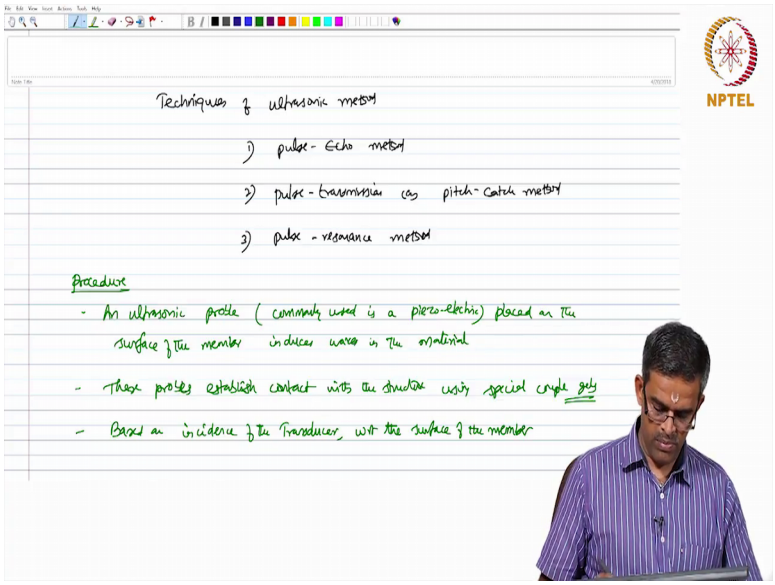
Now, interestingly the ultrasonic nondestructive evaluation, which I refer as NDE essentially rely on the elastic wave propagation and its reflection within the material. These wave field disturbances or cost due to local damage, any other defects that are present on the other hand any disturbance caused to this wave field, is an indication of presence of damage that is how the damage deduction is done ok.

(Refer Slide Time: 08:24)



Now, ultrasonic waves involve the following measurements to which talks about time of flight wave transit or any delay in the wave transmission. Second will be the path length, third could be the frequency, fourth is the phase angle, five is the amplitude, six is the acoustic impedance, seven is the angle of wave deflection it can be reflection or refraction there are different methods and techniques of ultrasonic measurements.

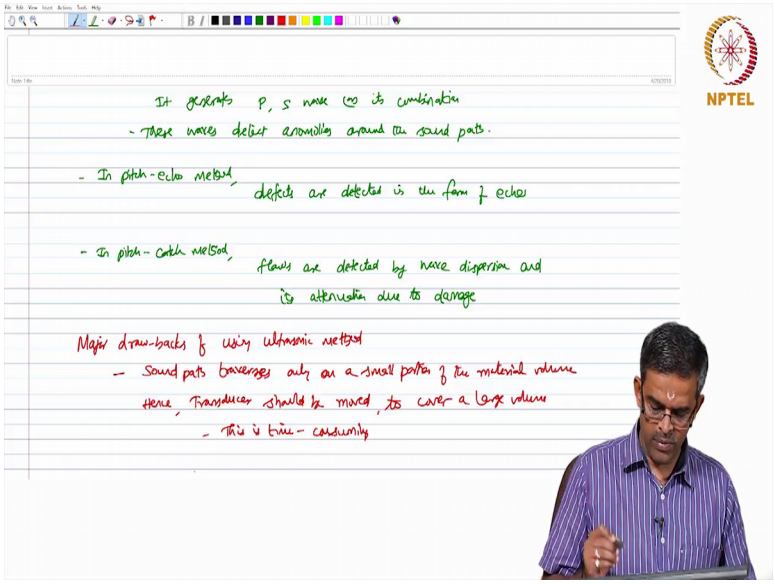
(Refer Slide Time: 09:55)



Commonly used is pulse echo method the other is pulse transmission or otherwise called as pitch catch method the third one is pulse resonance method. Let us quickly see what is the procedure followed in these methods. An ultrasonic probe which is essentially commonly used is a piezoelectric one which is placed on the surface of the element induces waves in the material.

Now, these probes establish contact with the structure, using special couple gels; now based on the incidence of the transducer with respect to the surface of the member.

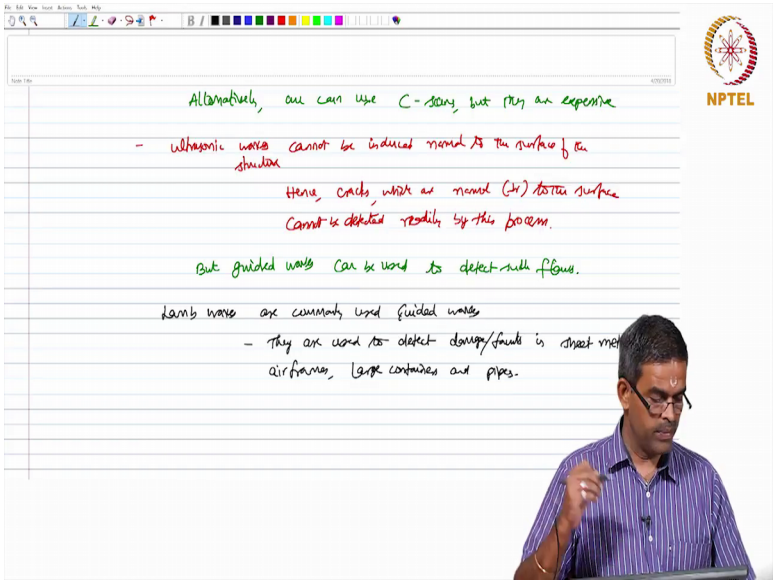
(Refer Slide Time: 12:27)



It generates P S wave or its combination. These waves which are generated by the transducers, which is in contact with the structural member detect anomalies around the sound path. In pitch echo method defects are detected in the form of echos. In pitch catch method flaws are detected by the wave dispersion and its attenuation due to damage.

Now, these methods have a major drawback let us see; what are they. Let us see; what are the major drawbacks of using ultrasonic method. The sound path traverses only on a small portion of the material volume. Hence, the transducers should be moved to cover a large volume this is time consuming that is the first issue we have. One can use C scans, but they are expensive.

(Refer Slide Time: 15:20)



The ultrasonic waves cannot be induced normal to the surface of the structure. Hence, cracks which are normal that is perpendicular to the surface cannot be detected readily by this process, but guided waves can be used to detect such flaws. For example, lamb waves are commonly used guided waves they are used to detect faults in sheet metal airframes large containers and pipes.