Structural Health Monitoring (SHM)
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Lecture - 47
Fibre Optic sensors-Part 2

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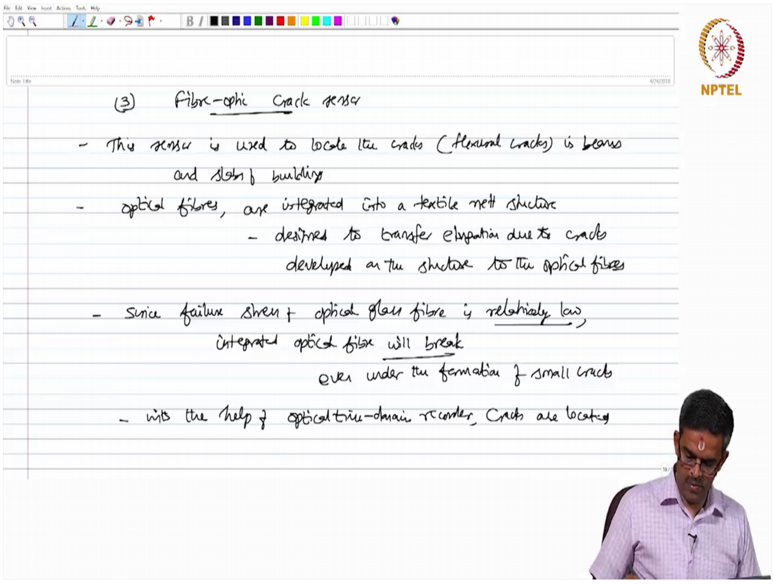

The third one is a very interesting device which is actually Fibre-optic crack sensor. This sensor is used to locate the cracks; essentially the flexural cracks in beams and slabs of buildings. Optical fibres, are integrated into a textile nett structure which is designed to transfer elongation due to cracks, develop on the structure to the optical fibres.

Since, the failure stress of optical glass fibres is relatively low, integrated optical fibre will break even under the formation of small cracks. Then, with the help of optical time-domain recorder, cracks are located.

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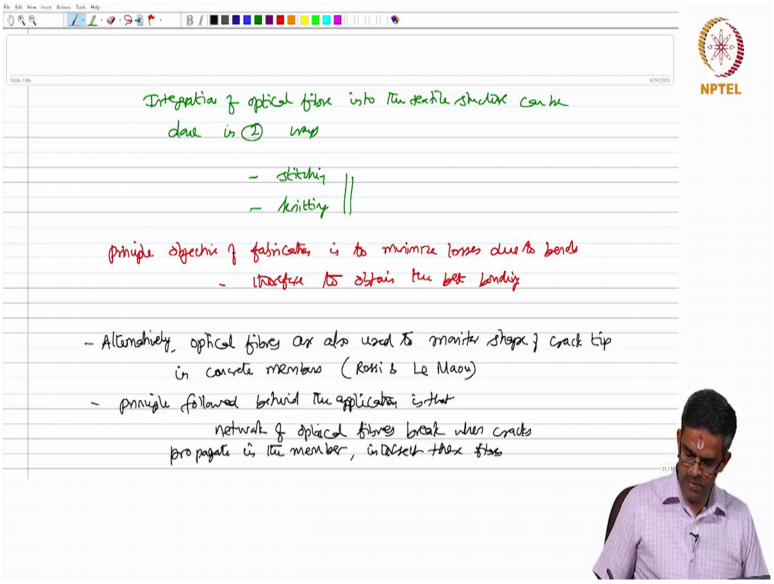

Integration of the optical fibre into the textile structure can be done in two ways. You can either stitch the fibre to the structure or you can do knitting of the fibre to the structure. The principle objective of fabrication is to minimize losses due to bends and therefore, to obtain the best bonding. Alternatively, optical fibres are also used to monitor shape of the crack tip in concrete members.

In this case the principal used, principal followed behind the application is that network of optical fibres break when cracks propagate in the members, intersect these fibres.

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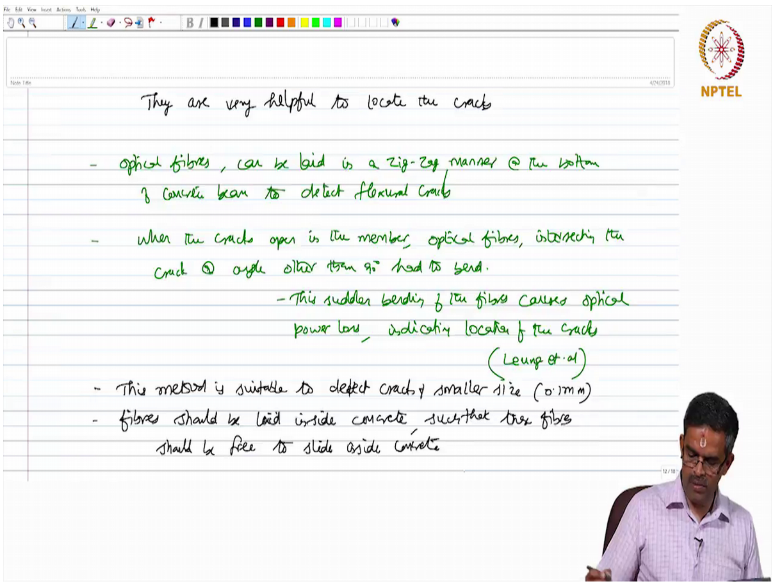

They are very helpful to locate the cracks. Alternatively, optical fibres can be laid in a zig-zag manner at the bottom of the concrete beam to detect the flexural cracks in the beam. When the cracks open in the member, optical fibres intersecting the crack at an angle other than 90 had to bend ok; and this sudden bending of the fibre causes optical power loss indicating location of the cracks.

This method is very highly suitable to detect cracks of smaller size. Let us say about 0.1 millimeters. Optical fibres should be laid inside concrete, such that these fibres should be free to slide inside concrete.

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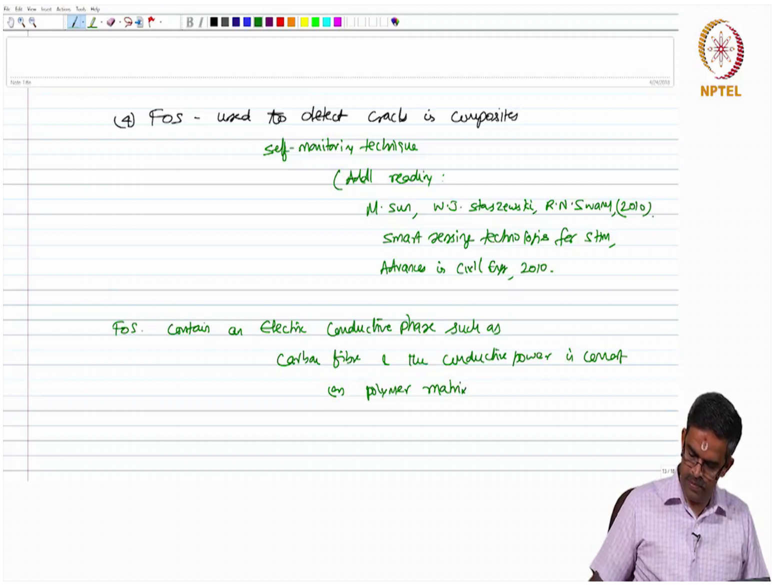

Alternatively, there are fibre optic sensors which are also used to detect cracks in composites. They are otherwise called as self-monitoring technique; Additional reading can be seen from.

Let us see how these kinds of sensors work? These fibre optic sensors contain an Electric Conductive phase such as carbon fibre and the conductive power in cement or polymeric mix.

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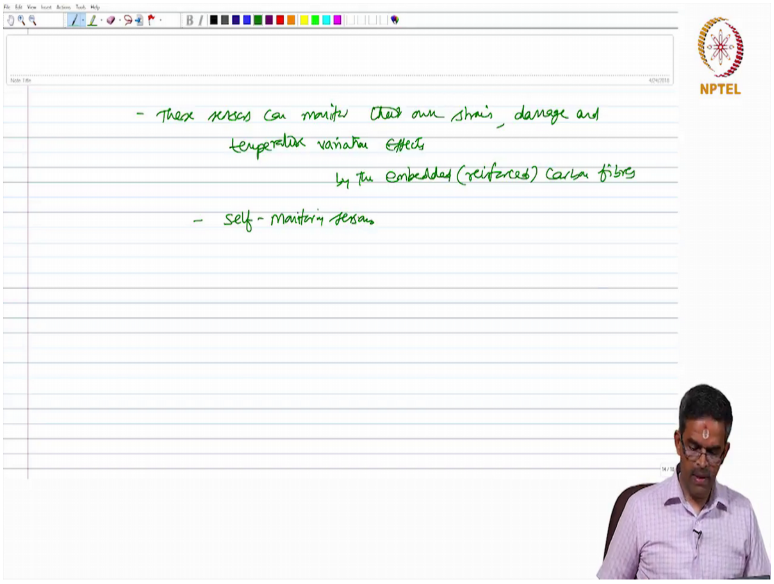

These sensors can monitor their own strain, damage and temperature variation effects by the embedded or reinforced carbon fibre which acts as self-monitoring sensors ok.

Let us quickly see, what are the different composite, which has different Electric conducive material and what is the matrix?

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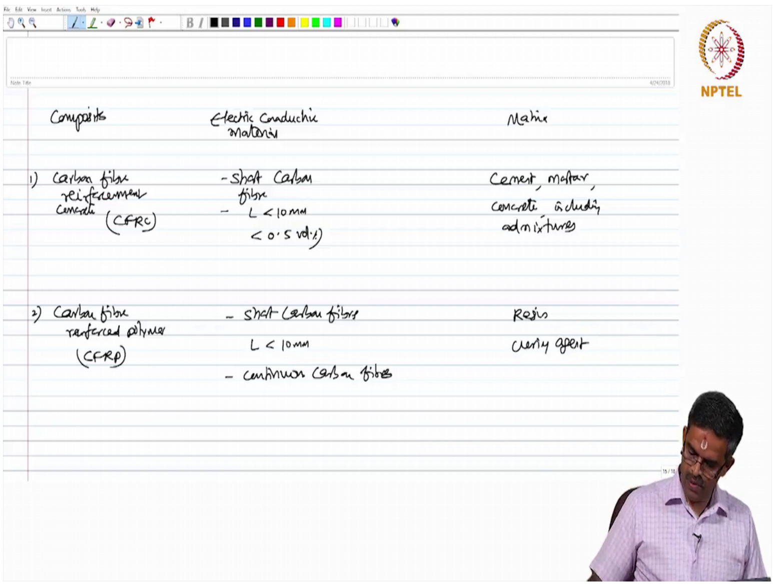

The most popular is carbon fibre reinforcement which is reinforcement concrete which is c CFRC. It contains short carbon fibre. Short in terms the length is less than 10 millimeters and the volume is about 0.5 volumetric percentage in the mixture. The matrix used is cement, mortar, concrete including add mixtures.

The second kind of reinforcement composite is carbon fibre reinforced polymer CFRP which again has short carbon fibres. The length is less than 10 millimeter. Sometimes it is also fabricated with continuous carbon fibres. The matrix agent used is resin and curing agent.

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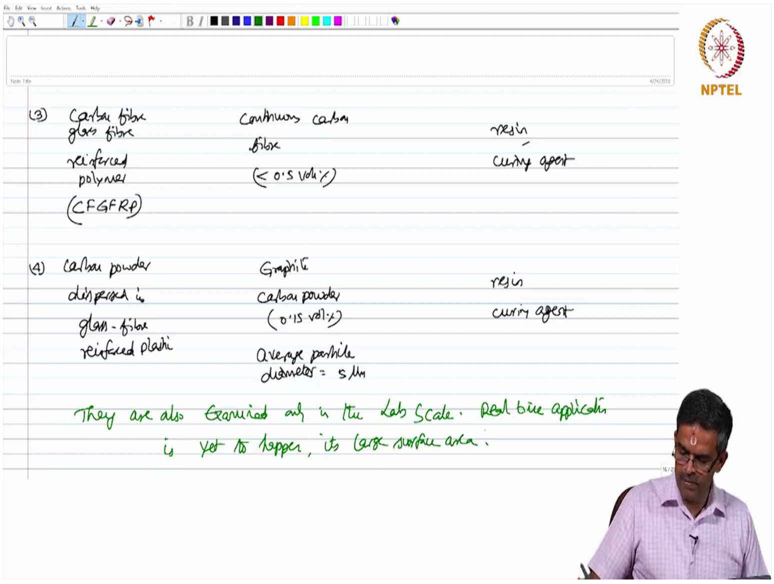

The third type of fibre reinforce composite which is self monitoring is carbon fibre glass fibre reinforced polymer which is carbon fibre glass fibre reinforced polymer which actually has continuous carbon fibre. The mixture is having about less than 0.5 percent volume percentage. Resin and the curing agent are used as the matrix.

The fourth one uses a carbon powder disbursed in glass-fibre reinforced plastic. This has got a graphite carbon powder. The mixture is about 0.15 percent volume and the average particle diameter used is about 5 microns. The matrix use this resin and the curing agent.

So friends, these are different kinds of composites which act as self monitoring sensors, but more interestingly, they are all examined only in the lab scale. A real time application is yet to happen in sense of its large surface areas.

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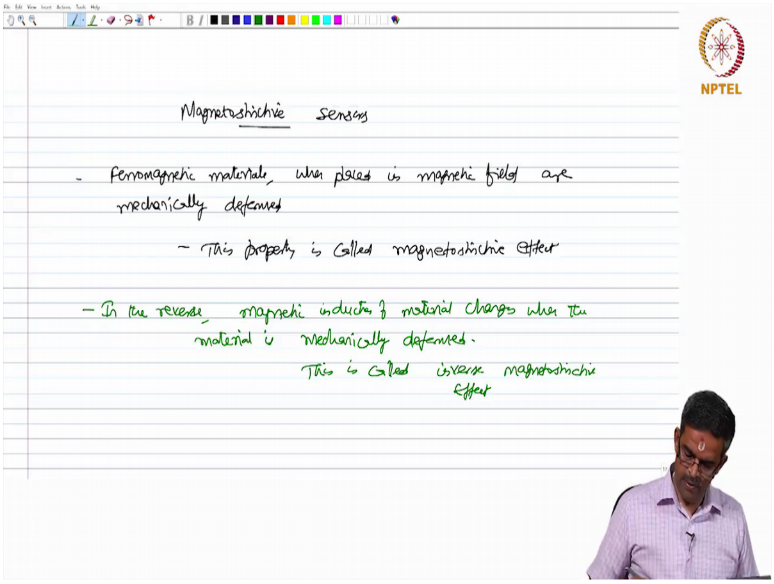

The next kind of sensor we have is Magnetostrictive sensors. Ferromagnetic materials, when placed in magnetic field are mechanically deformed. This property is called Magnetostrictive effect. In the reverse, magnetic induction of material changes when the material is mechanically deformed. This is of course, called inverse magnetostrictive effect.

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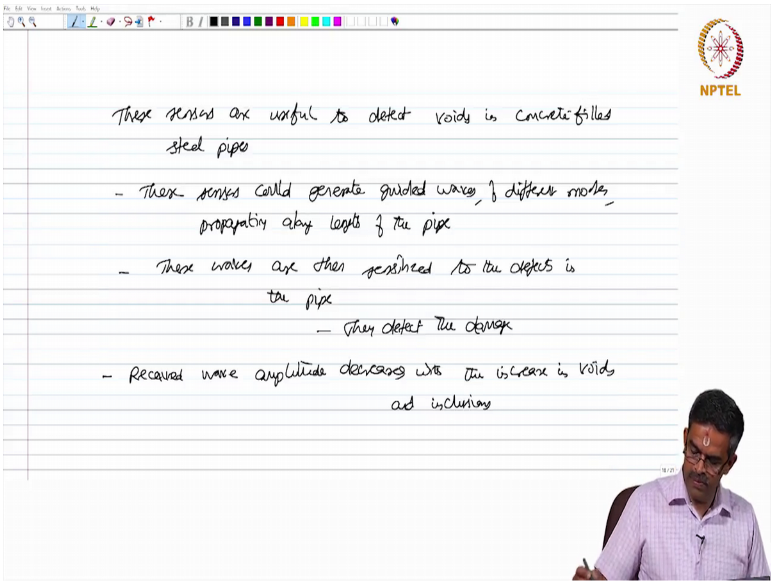

These sensors are useful to detect voids in concrete filled steel pipes. These sensors could generate guided waves of different modes propagating along the length of the pipe.

These waves are then sensitized to the defects in the pipe and they detect the damage. The received wave amplitude decreases with the increase in voids and inclusions.

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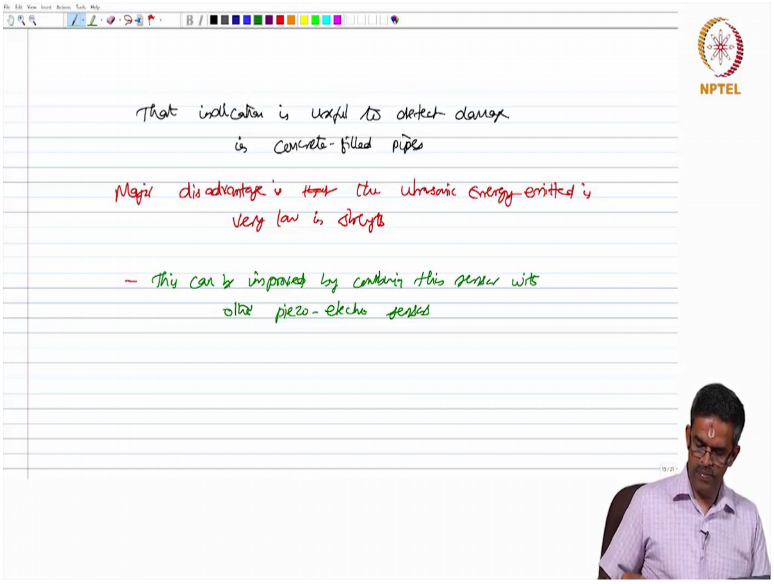

And that indication and that indication is useful to detect damage in let us say concrete-filled pipes. One of the major disadvantages of this sensor is that the ultrasonic energy-emitted is very low in strength. Of course, this can be improved by combining this sensor with other piezo-electric sensors.

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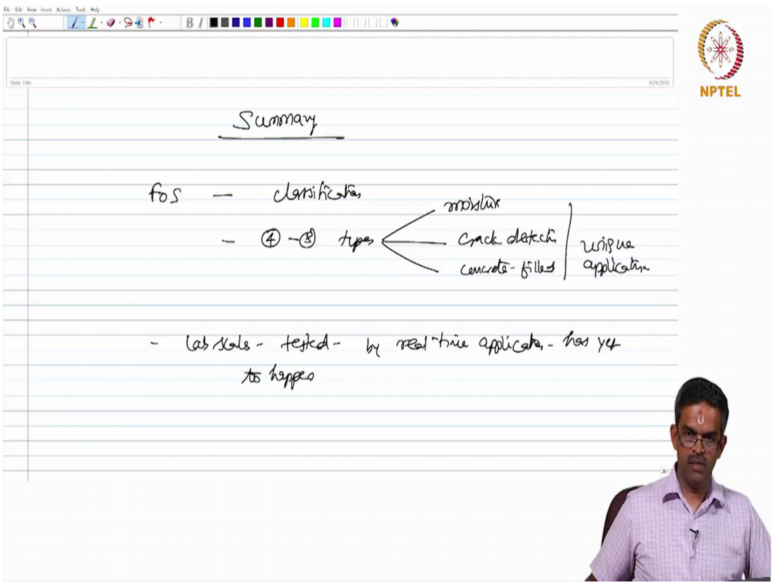

So friends, in this lecture we spoke about fibre optic sensors, their classification, about 4 to 5 types of these sensors; used for moisture ingression, used for crack detection, used also in case of concrete filled pipelines which are all of unique applications and very useful. Some of them are on lab scale. Researchers have examined and tested them that a real time application in terms of large projects has yet to happen.

In the next lecture, we will talk about smart sensing. How sensors can become smart to do health monitoring for structures and their applications in unique structures like off-shore structures.

Thank you very much. See you in the next lecture. Bye.