Structural Health Monitoring (SHM)
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Lecture – 46
Fibre Optic sensors–Part 1

Friends, welcome to the 2nd lecture in module 3.

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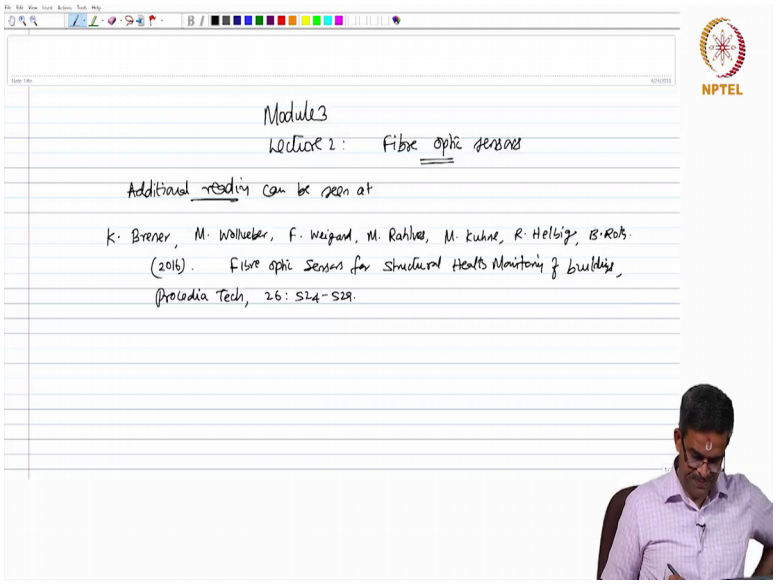

In this lecture, we are going to talk about more details on Fibre optic sensors. This lecture has additional reading reference. So, this can be seen at the Procedia Technology journal 26: 524 - 529 for additional reading.

Let us quickly see what are the principle differences of fibre optic sensor? What are the various types of the sensor and how they are actually constructed or modified for the use of various measurements for monitoring in structural health monitoring process in buildings.

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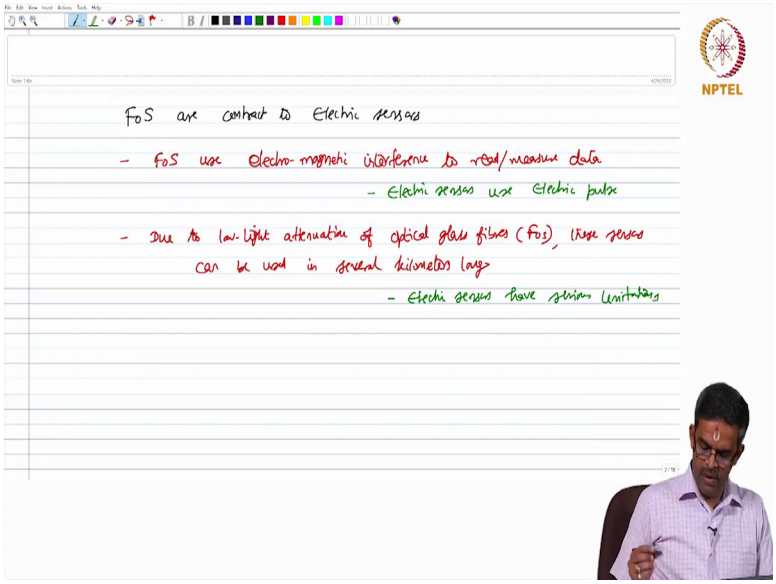

Fibre optic sensors are actually contrast to electric sensors in many ways. Let us see in principle, what are the differences. Fibre optic sensors use electro-magnetic interference to read or measure data; whereas, electric sensors use electric pulse to do the same job.

Due to the low light attenuation of optical glass fibres which are essentially used in fibre optic sensors, these sensors can be used in several kilometers long; whereas, electric sensors have serious limitations in this front.

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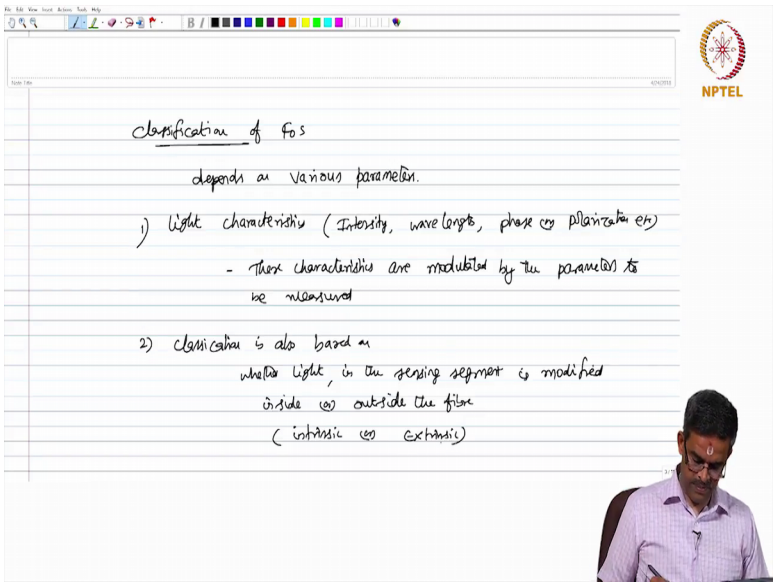

Interestingly, classification of fibre optic sensors depends on various parameters; namely, the light characteristics; that is their intensity, the wavelength, phase or polarization etc. These characteristics are modulated by the parameters to be measured.

Classification is also done whether light in the sensing segment is modified inside or outside the fibre; that is they are called either intrinsic or eccentric extrinsic.

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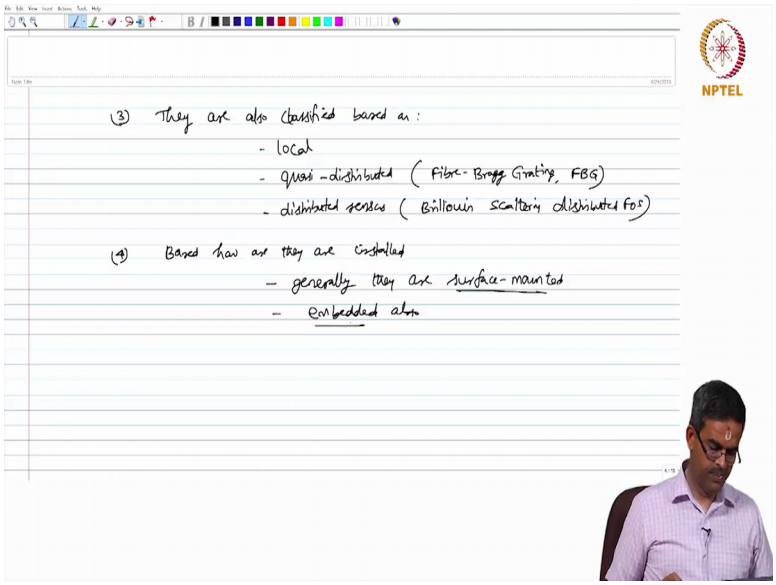

They are also classified based on whether they are local, whether they are quasi-distributed which is called Fibre-Bragg Grating that is FBG or they are distributed sensors which is otherwise called Brillouin Scattering distributed Fibre Optic Sensors. They are also classified based on how are they installed. Generally, they are surface mounted, but they can be embedded also.

So, now, we have seen how this FOS sensors are classified based upon the light which is being used for measurements; whether the modification is happening inside or outside the fibre, whether they are local quasi-distributed or distribute sensors for the entire length of the member; whether they are embedded or surface mounted. Let us now see types of fibre optic sensors which are used for different applications in structural health monitoring.

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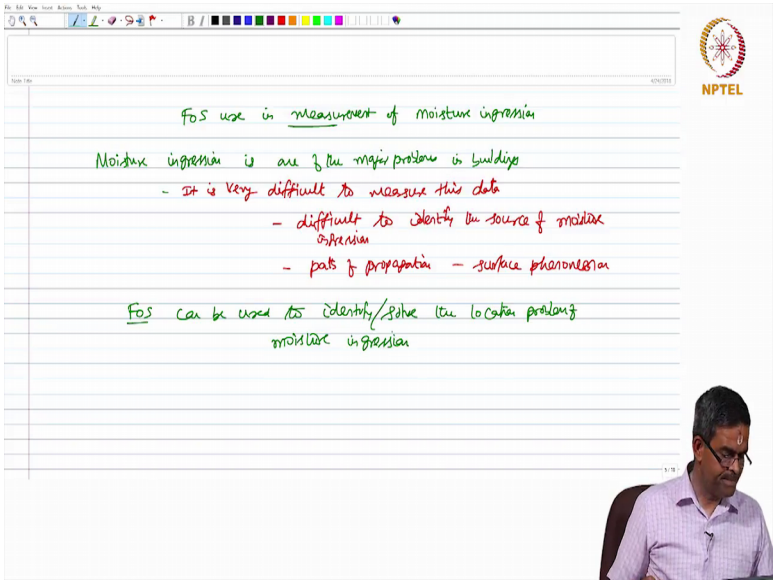

Let us talk about fibre optic sensor used in measurement of moisture ingression. Moisture ingression is one of the major problems in buildings. The most important task is it is very difficult to measure this data; that is it is difficult to measure the source of to identify the source of moisture ingression and its path of propagation.

Because this is actually surface heal phenomenon. It spreads on the entire surface and makes the surface wet. So, once the surface is wetted; it is very difficult to locate from where the origin started. Fibre optic sensors can be used to identify, solve the location problems of moisture ingression.

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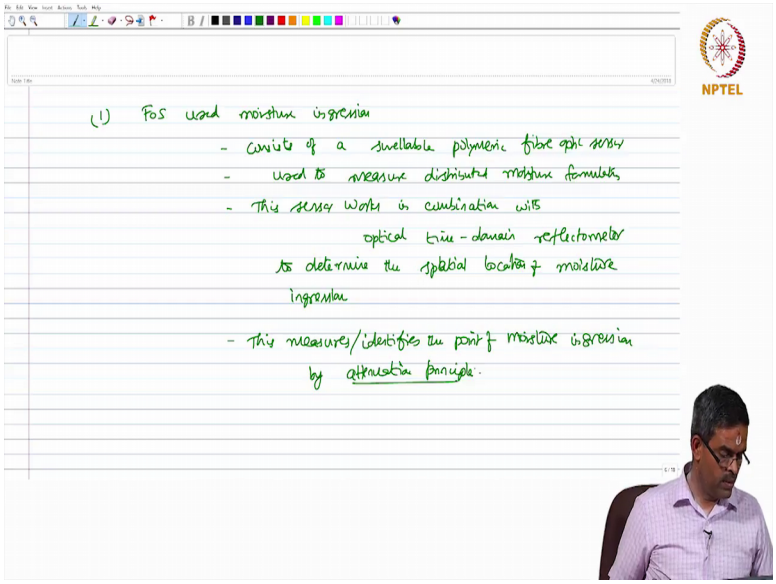

So, essentially the FOS sensors used for moisture ingression in principle consists of a swellable polymeric fibre optic sensor. This is used to measure distributed moisture formulation. This sensor works in combination with optical time-domain reflectometer to determine the spatial location of moisture ingression.

This measures the point of ingression; this measures or I should say identifies the point of moisture ingression by attenuation principle.

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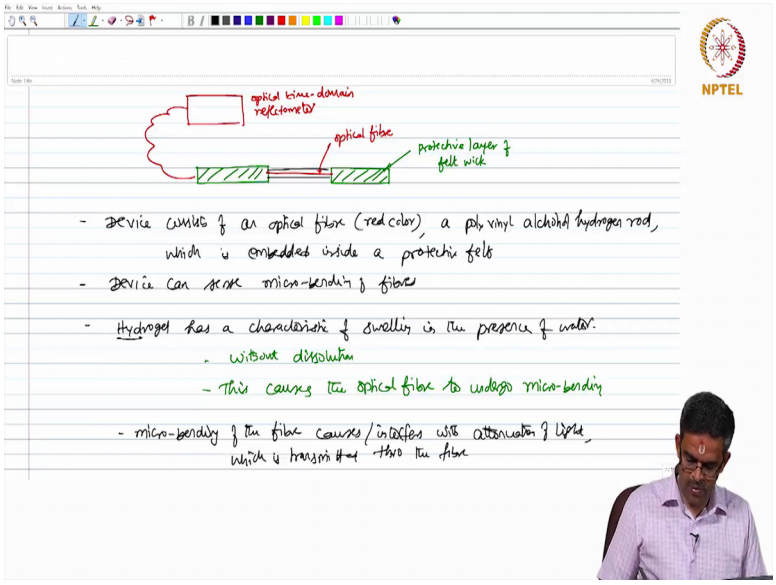

A typical sensor looks like this, which consists of a protective layer of felt wick. This is a protective layer of felt wick. This consist of a connectivity between these two which has an optical fibre embedded into it. This is the optical fibre which is now connected to optical time domain reflectometer.

The device consists of an optical fibre as you see marked in red color, a poly vinyl alcohol hydrogen rod which is embedded inside a protective felt. The device can sense the micro-bending of fibres. Hydrogel has a capacity or a characteristic of swelling in the presence of water; that is why it is called Hydrogel.

The interesting properties, it swells without dissolution and this causes the optical fibre to undergo a micro bending. Now, the micro bending of the fibre causes all it is a interfers with attenuation of light which is transmitted through the fibre. So, that is how this measures the location of moisture ingression.

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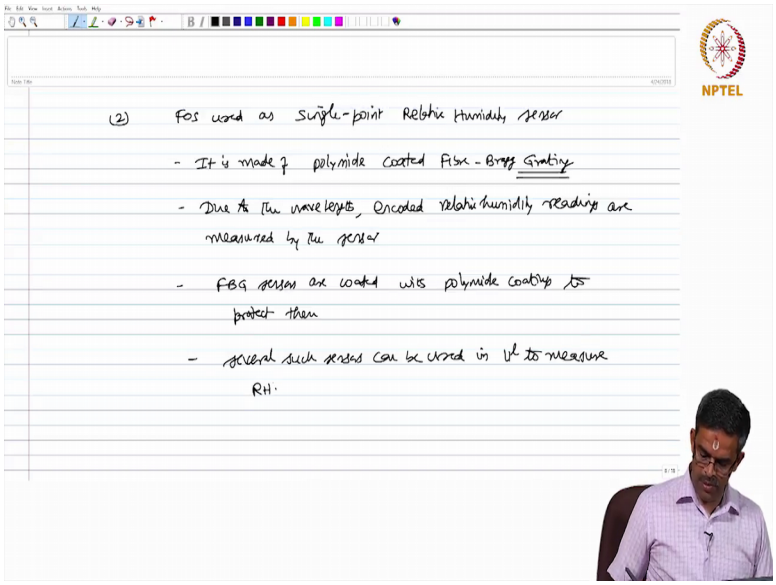

The second application which is commonly used in health monitoring related to relative humidity is fibre optic sensor used as single-point relative humidity sensor. This sensor is made of polymide coated Fibre-Bragg Grating.

It is actually grating due to the wavelength, the encoded relative humidity readings are measured by the sensor. The FBG sensors are coated with polymide coatings to protect them. Several such sensors can be used in parallel to measure relative humidity.

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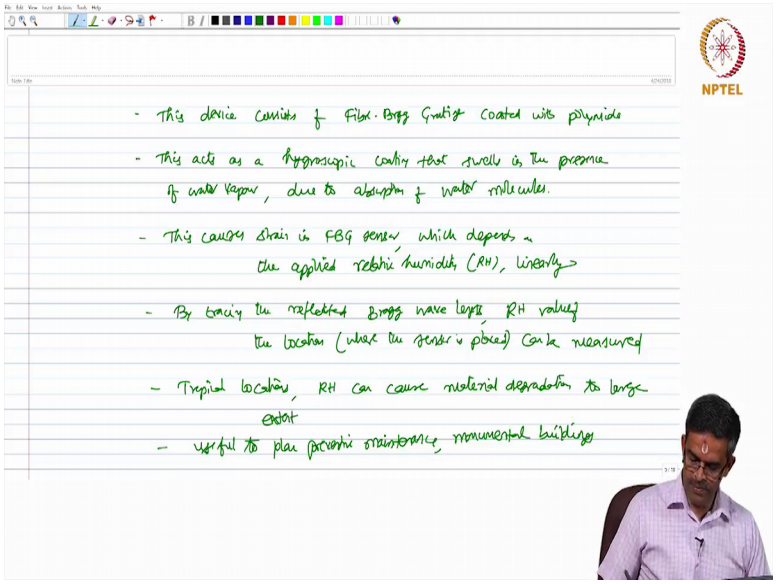

This device consists of Fibre-Bragg Grating coated with polymide. This coating acts as a hygroscopic coating that swells in the presence of water, water vapor, due to absorption of water molecules and this causes strain in the FBG sensor which actually depends on the applied relative humidity linearly.

Now, by tracing the reflected Bragg wavelength RH value of the location where the sensor is placed can be measured. This is very useful in tropical locations, where relative humidity can cause material degradation to a large extent. They are generally useful to plan preventive maintenance in case of monumental buildings.