Structural Health Monitoring (SHM)
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Lecture – 51
The sensor requirements and Data acquisition – Part 1

Friends, welcome to the next lecture in module-3 which is lecture-5. In this, we will talk about the sensor requirements and data acquisition for health monitoring process. We have been discussing about the necessity for doing SHM for strategic structures.

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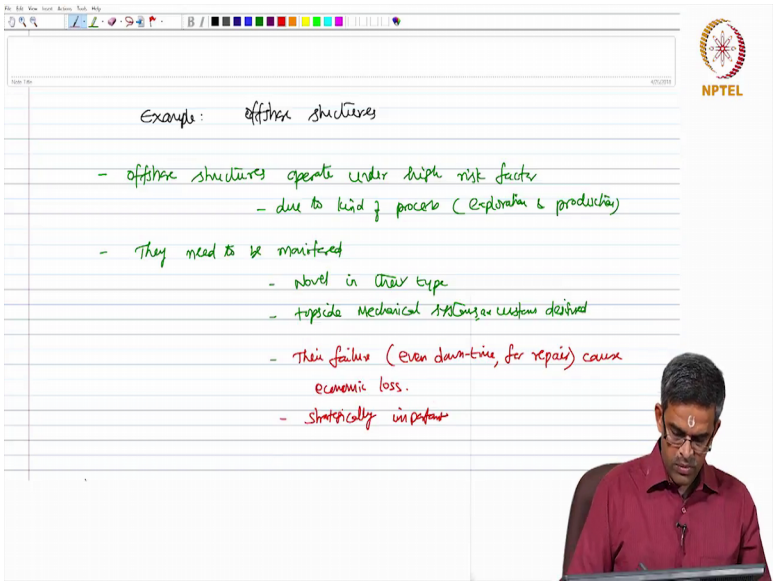

We have been discussing as an example an offshore structure. Let us extend this discussion and try to understand how the sensing requirements can change and modify and can become adaptable to suit the measurement requirements of an offshore platform or an offshore structure. We do agree and partially understand that offshore structures operate under high risk factor. This is essentially due to the kind of process which they undertake in terms of oil exploration and production ok.

Now, they need to be monitored because of various reasons. The fore more reason is they are novel in their type; and the topside mechanical systems are usually custom designed. So, to rebuild the platform, it takes a lot of effort and cooperation from multi segment multispecialty engineers and companies. Therefore, we cannot afford to lose a platform because of any human error or human oversight or otherwise because of environmental

features or the loads. The most important issue is their failure in fact I should say even their downtime for repair. Even their downtime can cause a significant economic loss. So, they are all strategically important.

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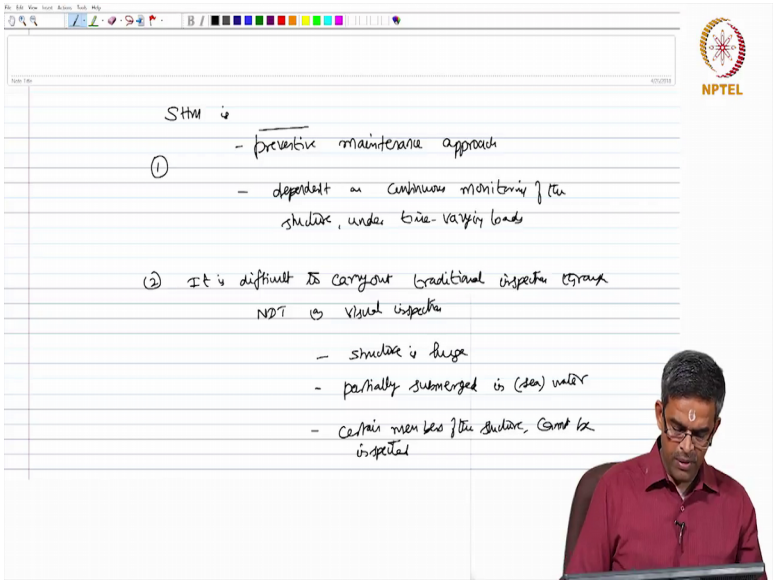

Therefore the primary requirement of such structures in terms of health monitoring is we should look for preventive maintenance approach which is essentially dependent on continuous monitoring of the structure under time varying loads that is a first issue. So, the first point is they need preventive maintenance.

The second point is it is difficult to carry out inspection traditionally through non-destructive tests or even through visual inspection. The basic reason being structure is huge, partially submerged in water I should say sea or an ocean, and certain areas are certain members of the structure cannot be inspected. There is a limitation.

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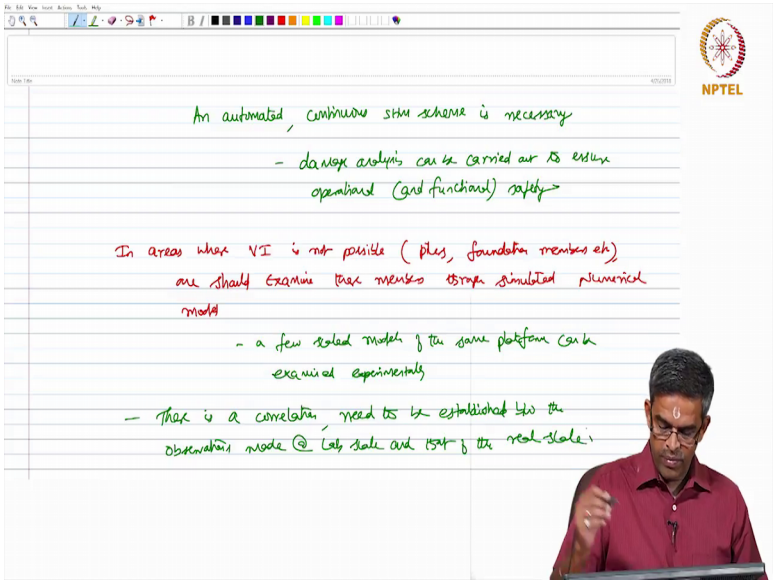

Therefore an automated continuous structural health monitoring scheme is necessary because then the damage analysis can be carried out to ensure operational and functional safety. So, now the question comes in areas where visual inspection is not possible.

For example piles, for example the foundation members etcetera where visual inspection is not possible then one should examine these members through simulated numerical model. Whereas, a few scaled models of the same platform can be examined experimentally. So, now there is a correlation required which need to be established between the observations made at lab scale and that of the real scale.

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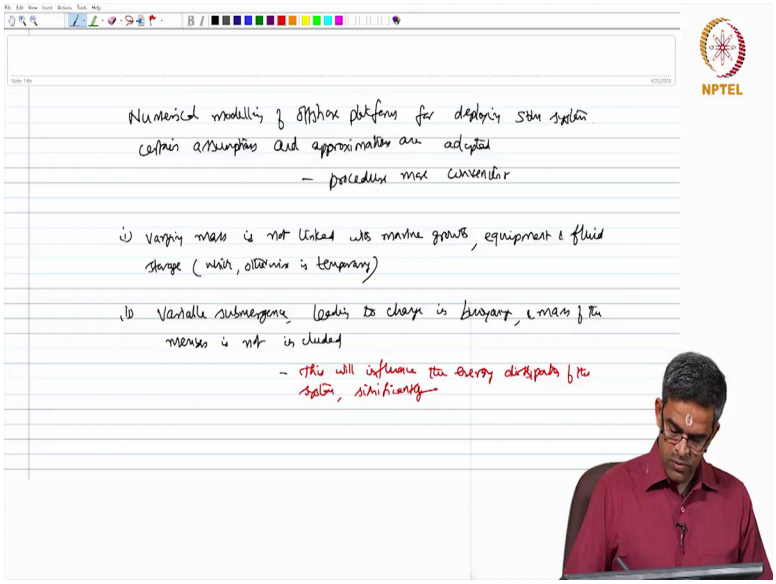

Essentially when we are interested in focusing on numerical modeling, which is required in certain cases of offshore platforms for deploying structural health monitoring systems certain assumptions are made and approximations are adopted. This is done to make the procedure more convenient.

They are, one - varying mass is not linked with marine growth, equipment and fluid storage which otherwise is temporary. The second assumption is variable submergence leading to change in buoyancy and mass of the members is not included. And it is important to note that this will influence the energy dissipation of the system significantly.

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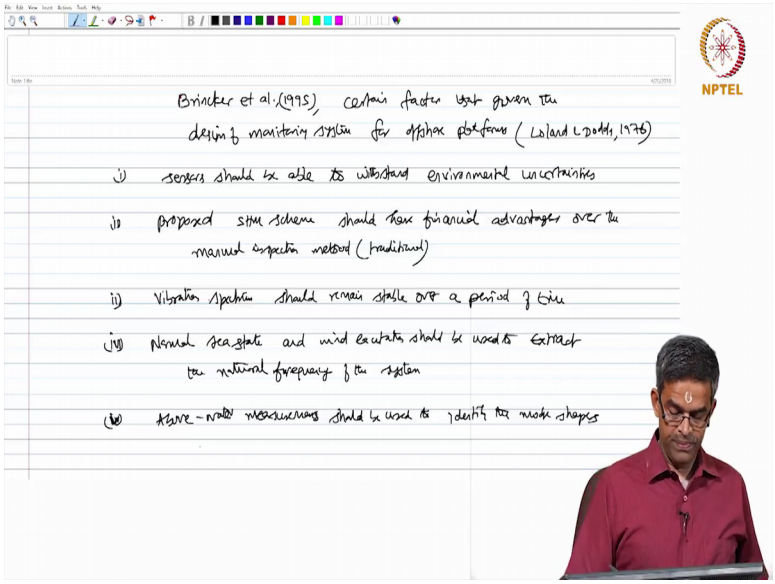

So, now as suggested by Brinker et al., as suggested by Brinker et al., there are certain factors that govern the design of monitoring system for offshore platforms, Lowland and Dodds, 1976. They are sensors should be able to withstand environmental uncertainties proposed SHM scheme that is structural health monitoring scheme should have financial advantages over the manual inspection method which is more or less traditional.

The next requirement is the vibration spectrum should remain stable over a period of time. Normal sea state and wind excitation should be used to extract the natural frequency of the system. Above water measurements should be used to identify the mode shapes, because the underwater measurements will be influenced by the buoyancy and the wave forces.

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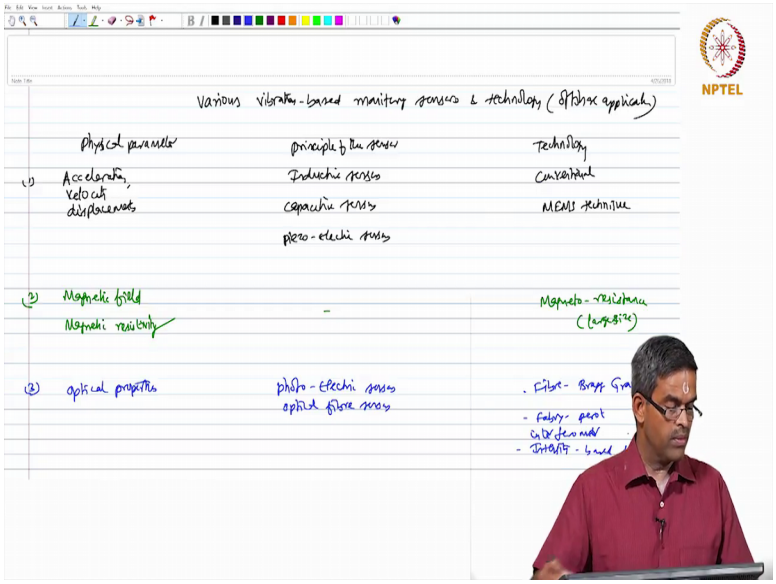

Having said this let us see a list of various vibration based monitoring sensors and technology which are feasible for offshore applications. Let us divide this into 3. Let us say the physical parameter I want to measure, principle of the sensor and the technology used. Let us say acceleration velocity and displacement or the physical parameters to be measured, I can use indusive sensors capacitive sensors, I can also use piezoelectric sensors.

The technologies I can either use conventional manufacturing technology or I can also use MEMS technique to manufacture them. The second argument could be measurement of magnetic field, and magnetic resistivity. They can be measured with magneto-resistance meters which are of a large size.

The third one could be optical properties, one can use photoelectric sensors, optical fiber sensors etcetera. The principle behind them could be fiber Bragg grating which we saw in the last lecture more in detail. Then I can also use Fabry Perot interferometer; I can also use intensity based sensor.

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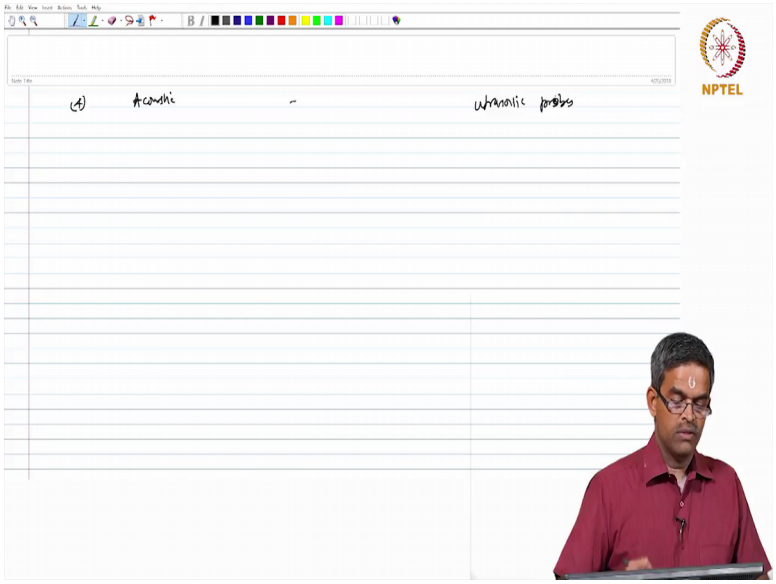

Further, one can also use acoustic type which can be ultrasonic probes. So, there are varieties of sensors which can be used for health monitoring in terms of offshore applications specifically to measure acceleration velocity displacement, magnetic field and resistivity and optical properties as well as acoustic properties of the section where the platform is installed.