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

Lecture – 58
Part - 2: Vibration Based damage detection

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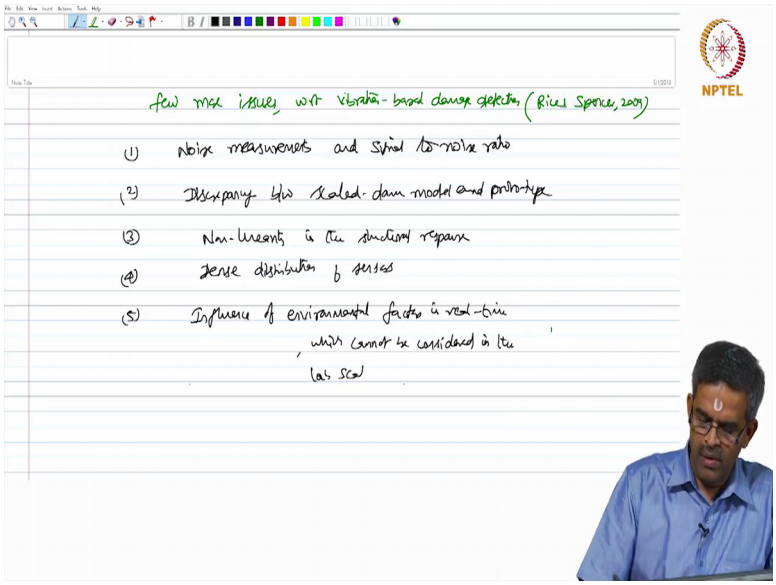

Whereas, there are few issues when you use it for Vibration Based damage detection, which is what we are following now at this moment in the design. As said by rice and spencer noise measurements ok, noise measurements and signal to noise ratio that is first issue. The second issue could be discrepancy between scaled down model and prototype, because the behavior of these 2 can be different at certain frequencies.

Thirdly, non-linearity in the structural response the structural response will remain non-linear, the fourth one could be dense distribution of sensors we are now identifying the factors, which are an important in vibration based damage detection as apply to SHM design in offshore structures.

And the last one is influence of environmental factors in real time, which cannot be considered in the lab scale is it not that is a problem here.

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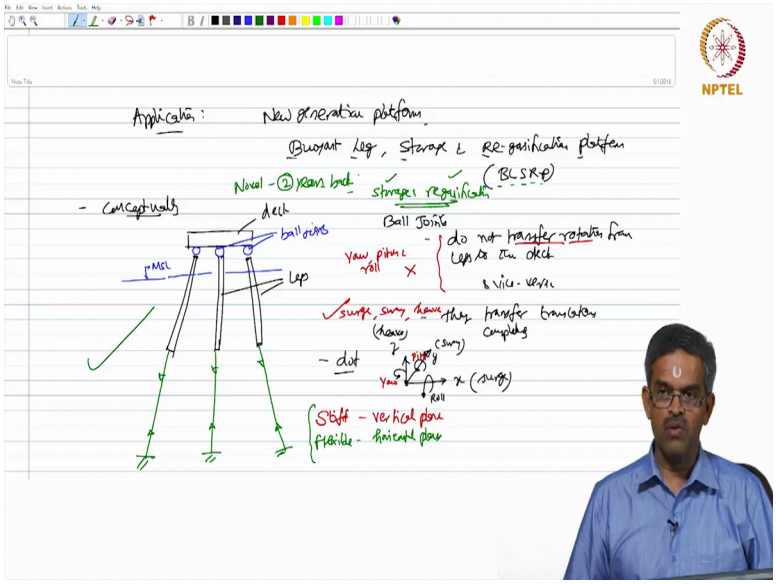

Let us try to apply this concept to a new generation platform, which is buoyant leg, abbreviated BLSRP. Conceptually BLSRP look like this there is a deck, which will be connected by the buoyant legs and these buoyant legs inturn will reposition restrained by tethers, interestingly this buoyant leg will connected to the deck by ball joints.

The important feature is that these ball joints do not transfer rotations from the legs to the deck these are the legs, this is the deck, and vice versa. The water level is somewhere here this may mean sea level, but they transfer translations completely. Let us see what are the degrees of freedom such platform has so, displacement along x, displacement along y, displacement along z ok.

So, similarly rotation about x, rotation about y and rotation about z. So, this is what we called as surge degree of freedom, we call this as sway, we call this as heave and we call this as a roll and this one as pitch and this one as yaw.

So, what do you mean to say here is rotational degrees of freedom should not be transferred yaw, pitch, and roll. Should not be transferred surge sway and heave should be transferred ok.

So, it is a combination of 2 different categories of responses ok. So, by this logic this platform will remain stiff in vertical plane and remain very flexible in horizontal plane.

So, that is a special characteristics of this platform these are what we call BLSRP, they are essentially used for storage and re gasification ok.

They are not meant essentially for production, they are meant for exploration, but essentially and more primarily they are meant for storage and re gasification, they are supported on buoyant legs therefore, it is called buoyant legs storage re gasification platform and this is a very novel concept, which came into existence only about 2 years back. There are more about of research studies conducted experimentally numerically and analytically at IIT Madras Ocean Engineering Department.

I am pioneered in doing this kind of this research in this department and therefore, we are proud that the results of these are essentially novel and newly tried and the research friend at IIT Madras, and we want to share this information in a system design through NPTEL portal for the viewers benefit.

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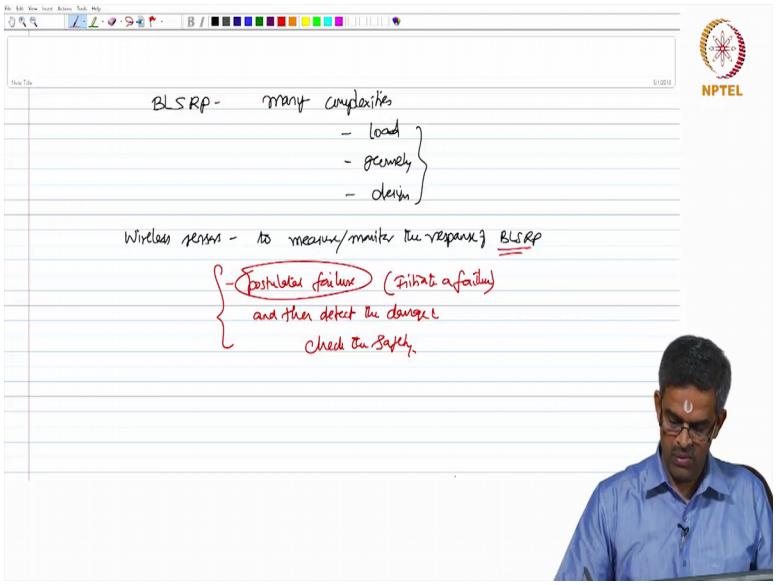

BLSRP has many complexities, which arise because of the loading condition, which arise because of the geometry, which arise because of the design itself.

So, let us try to see how do we use let us say a wireless sensors to record or measure I should say very specifically monitor the response of BLSRP. So, to do this we want to make or a create a postulated field actually the platform has not failed, but we initiate a failure and then detect the damage and check the safety that is the idea.

So, now we are examining the SHM layout design for a post related failure of BLSRP through this process we will only discuss about the design of SHM at this moment, we will talk about the response and the control algorithm later in the next module.

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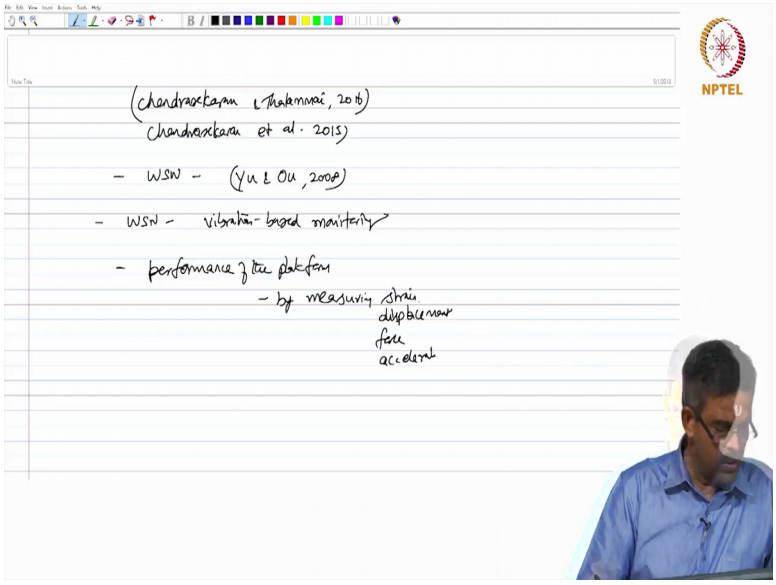

There are many pioneers for this kind of experiments, let us say you can refer to papers for more details at Chandrasekaran and Thalanmai 2016 Chandrasekar et al 2015.

For monitoring experiment using wireless sensor networking one cannot also refer very interestingly the studies conducted and recommended by Yu and Ou 2008. The recommendation for wireless sensor networking is vibration based monitoring.

So, therefore, performance of the platform of the platform is going to be examined, strain, displacement, force, acceleration, the displacement is one of the major criteria, which controls the design.

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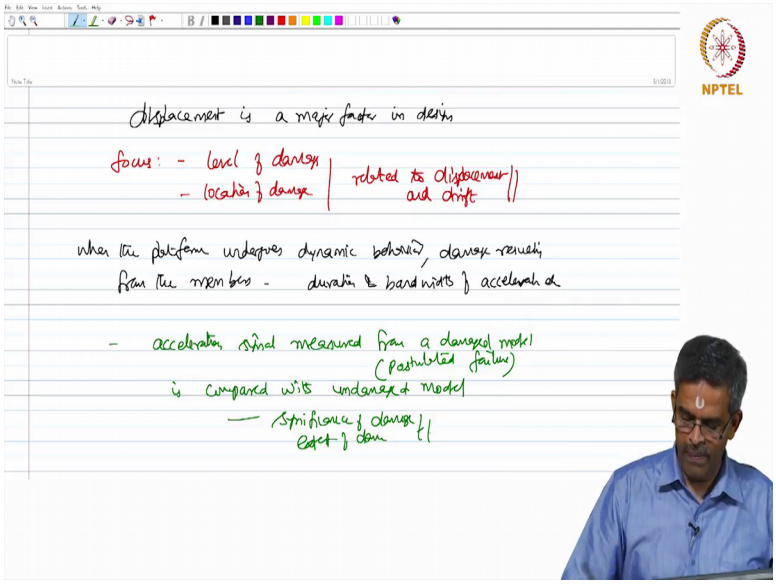

Displacement is a major factor in design of any systems why not an offshore structures as well.

So, one is interested to identify the level of damage, the location of damage, related to displacement and drift that is idea. So, when the platform undergoes, dynamic behavior damage resulting from the members may also have a different duration and bandwidth of acceleration etcetera. So, now, the primary ideas is the acceleration signal measured from a damaged model.

How can you say a damage model we are creating a postulated failure we are causing a failure deliberately ok. Postulated failure measured from a damaged model is compared with undamaged model to know the significance of damage, extent of damage, etcetera that is the idea.

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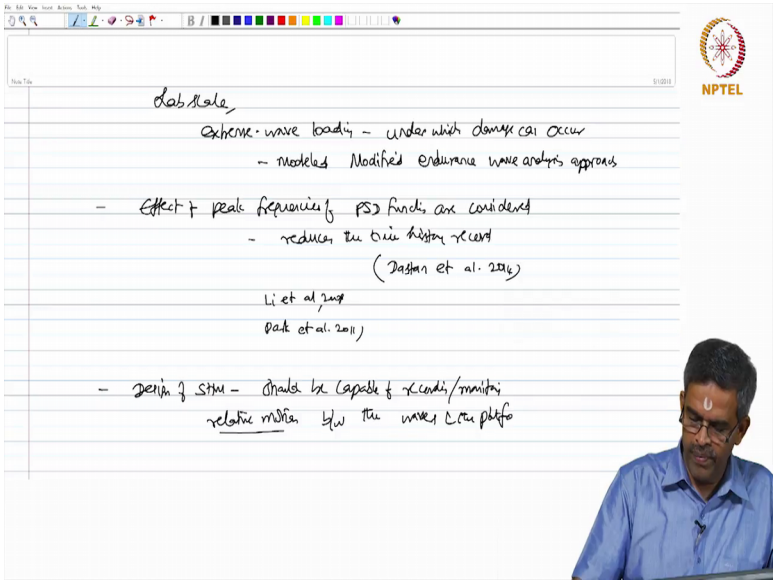

Since the study is done on lab scale extreme wave loading under, which the damage can occur endurance wave analysis approach, peak frequencies of power spectral density functions are considered, which intern reduces the time history record ok. This idea supported by Dastan et al 2014.

There is also for subsequently supported by Li et al 2008 Park et al 2011 etcetera. So, the design of SHM should be capable of recording or monitoring the relative motion that is very important between the waves and the platform.

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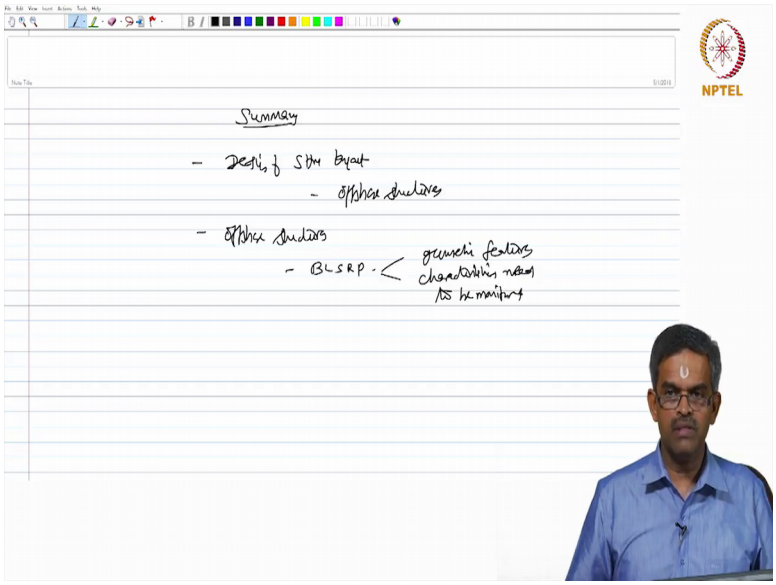

So, friends in this lecture we have tried to discuss about the design of SHM layout, as applicable to offshore structures, primary to that we wanted to know the important characteristics to be monitored in offshore structures, we took an example of buoyant leg storage and re gasification platform. We explain the geometric features of this platform, we also understood, what are the characteristics which are need to be monitored for this platform. We will continue this discussion in the next lecture to see how SHM layout can be done suit in the requirements to monitor this platform in the next lecture.

Thank you very much and bye.