Structural Health Monitoring (SHM)
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Lecture - 78
Part - 2: Structural Health Monitoring (SHM) of lab scale model of TLP - II

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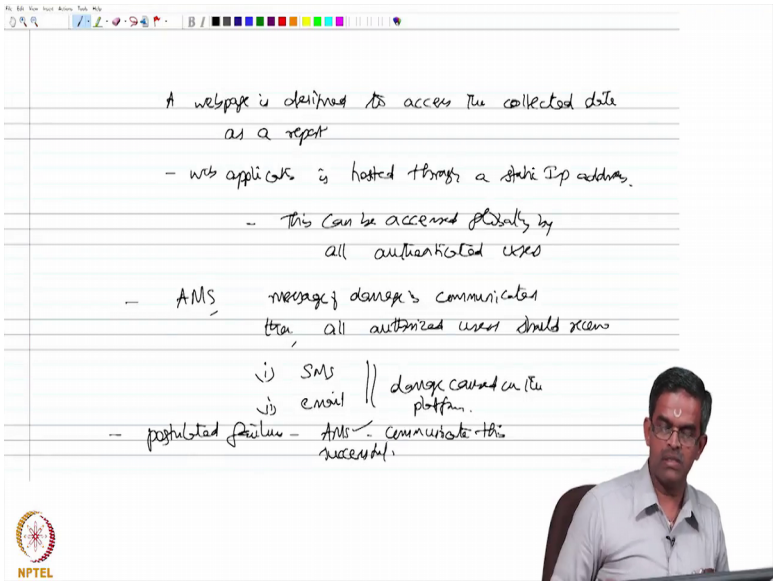

A web page design to access the collected data as a report; the web application is hosted through a static IP address. This can be accessed globally by all authenticated users. So, the requirement is when we develop an alert monitoring system, when the message of damage is communicated, then all authorized users should receive an SMS and an email about the damage caused on the platform.

So, the present study aims to do this by creating a postulated failure and checks whether electronic system is able to communicate this failure successfully. That is the idea.

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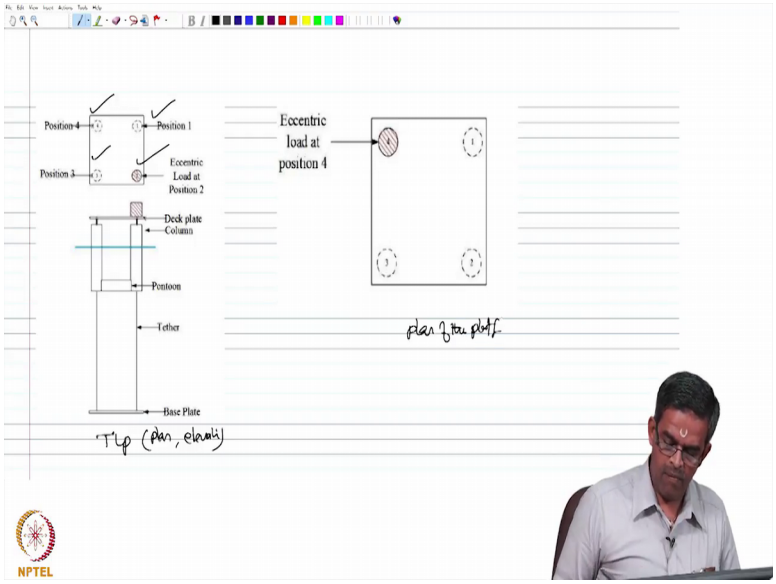

When you talk about postulated failure, one can see here, there are 4 positions of detention legs indicated as 1, 2, 3 and 4. So, this is the elevation of the platform, this is the plan of the platform, on a lab scale there is a enlarge view of the plan of the platform when you talk about postulated failure.

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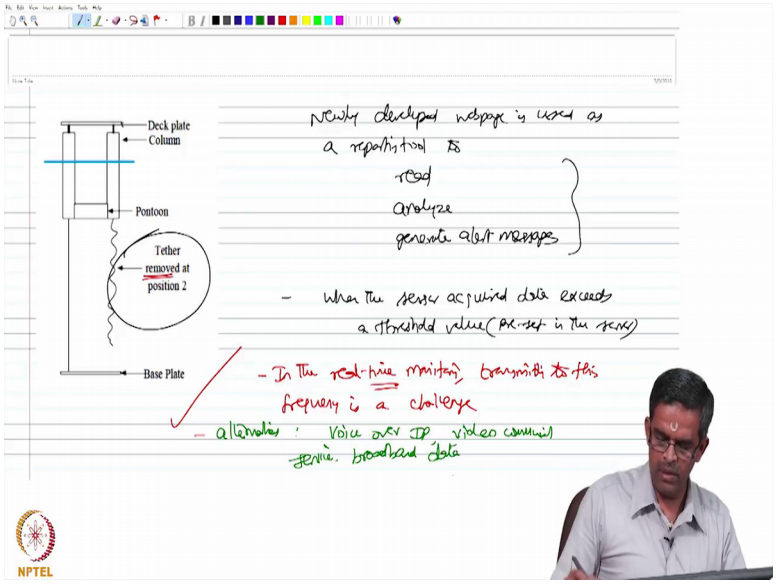

One can see here, one of the legs in a specific location will be removed so that a failure is envisaged a damage is caused, intentionally. We call this as a postulated failure and at that moment whether the damage scenario is communicated using earth monitoring

system in the system design; that is the whole challenge of the exercise what we are aiming to do it.

Now the newly developed web page is used as a reporting tool to read analyze and generate alert messages when this will happen, the question is when the sensor acquired data exceeds, a threshold value which is preset in the server in the real time monitoring transmitting to this frequency is a challenge, there is no doubt about it. We are talking about a lab scale, this is easy to install and communicate, whereas in real time monitoring, this issue can be selected tricky. Therefore, one can alternatively use voice over IP video communication service and one can use broadband data to avoid these difficulties.

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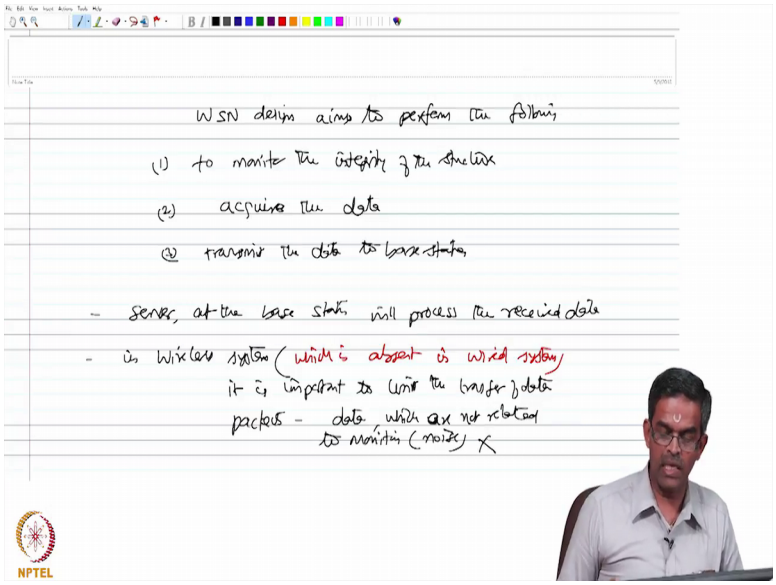

The wireless sensor networking design aims to perform the following; one- to monitor the integrity of the structure, two- to acquire the data, three- to transmit the data to base station.

Now, server at the base station will process the received data in wireless system which is different from wired system. There is a problem with the transfer the data packets, it is important to limit the transfer of data packets the data which are not related to monitoring should not be transferred that is what we say as noise should not be transferred, ok. That is a limitation we are going to check.

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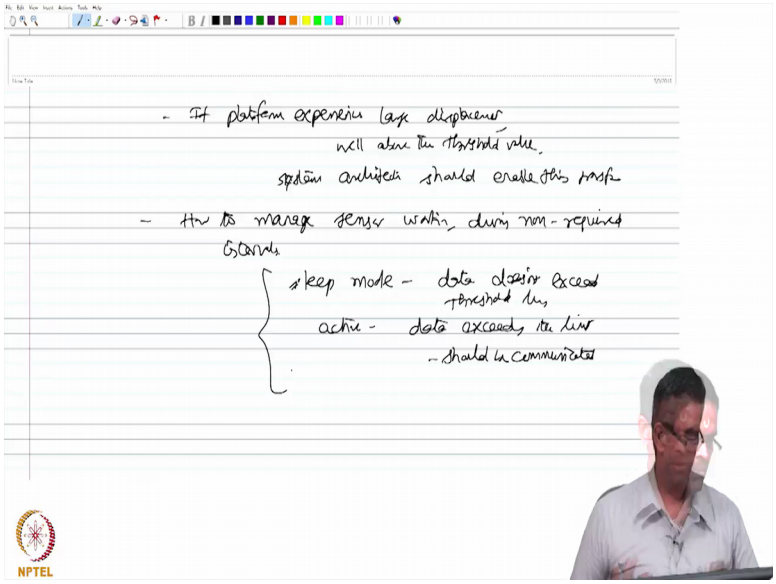

If platform exercises or experiences large displacements which are well above the threshold value, then the system architecture should enable this transfer. So, friends the challenge is how to manage the sensor working? During the non require intervals, sensor should be put in sleep mode when the data does not exceed the threshold limit, sensors should be in active mode. When the data exceeds the limit and that should be communicated that is a challenge here this kind of challenge does not happen in case of wired sensors, because whatever data you get, they all will be acquired and transmitted. So, the challenge here is 1 the power 2.

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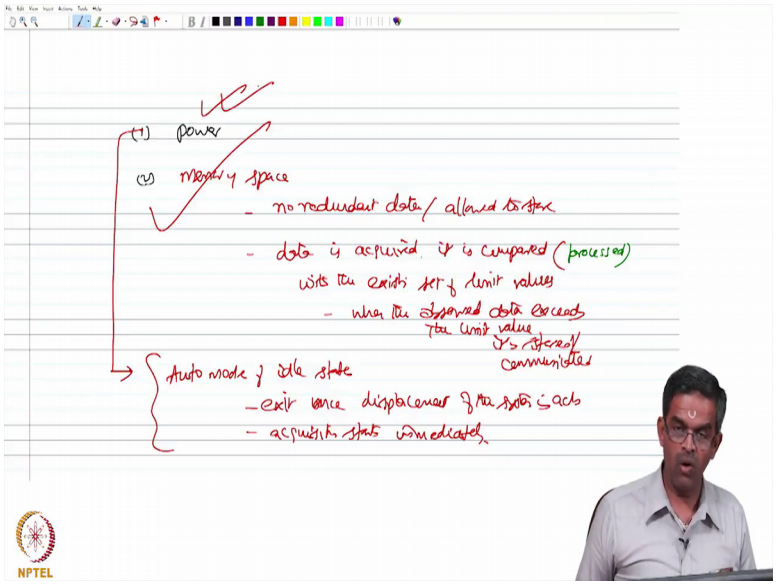

Which is the major problem is the memory space. So, no redundant data should be allowed to store.

Now, the question comes; how do you know whether the data acquired is redundant or relevant. So, the question is once the data is acquired, it is compared. So, I should use a word processed with the existing set of limit values ok. When the observed data exceeds the value, it is stored and communicated. So, that is how we can have a control on the memory space one need to operate on auto mode of ideal state, this will exit once the displacement of the system is active and acquisition starts immediately. So, by this logic and design can achieve the power saving to the sensors can also avoid overflow of memory space in the sensors.

Let us little bit go back to the threshold values which are used for activating the data transmission.

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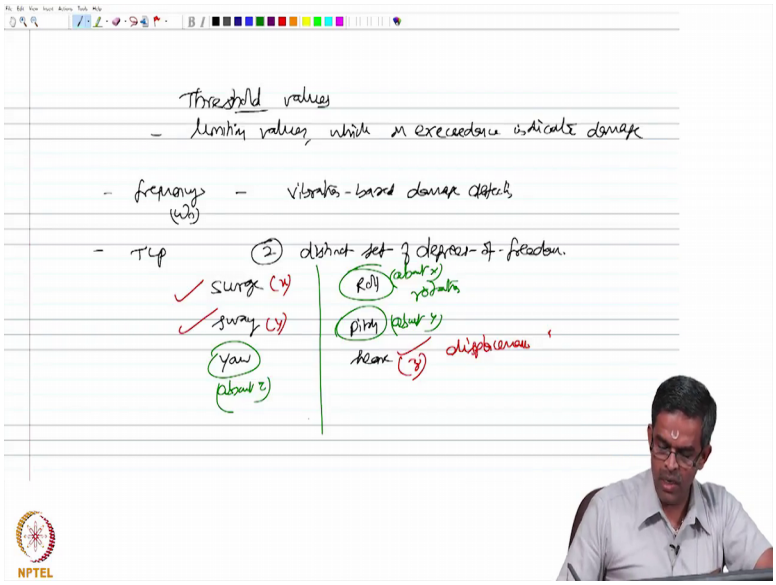

We talked about threshold values because the values need to be compared with these the threshold values are nothing but the limiting values which on exceedance indicate damage ok. So, how do you get this? For example, let us talk about frequencies of the platform we also studied in the previous modules vibration based damage detection there the fundamental frequency plays a very important role.

So, in talk about frequency of TLPs, TLP has got two distinct set of degrees of freedom as we discussed in the last lecture, surge sway and yaw roll pitch and heap out of this, these 3 are displacements along x along y and along z these three are rotations that is about x about y and about z when you do them, I do a grouping in a different manner.

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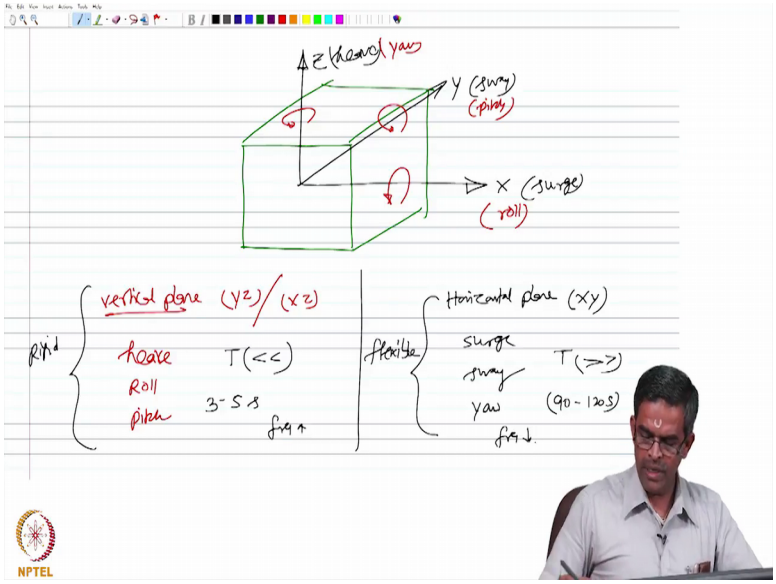

So, let us take a plane is the platform, let us take a plane mark the axis; this is x axis, this is y axis, this is z axis, you know this is going to be surge, this is going to be sway, this is going to be heap, the displacements and rotations about x roll pitch and yaw, they can also be marked with the directions. So, now, if you look at the vertical plane which is either the y z plane or the x z plane; both are vertical planes. So, look at the responses along the vertical plane, I can say heap on rotation about the vertical plane is going to be roll and pitch, ok. Let us talk about the horizontal plane the easiest horizontal plane to visualize is x y plane.

Now, the displacements along this plane could be surge, could be sway and the rotation about measured along this plane is yaw. So, friends TLPs are designed to remain flexible in horizontal plane and to remain rigid in vertical plane, it means the periods on the vertical plane motions are very very less the periods on horizontal plane motion are very very large. For example, these periods vary from 3 to 5 seconds that is the natural period of the system. Whereas, these periods vary anywhere from 90 to 120 seconds, we all know the frequencies and inverse of this.

So, this is a high frequency phenomena and this could be your low frequency phenomena ok. So, we are talking about two distinct set of frequencies which are to be measured and then compared for damage detection which is done using postulated failure that is the idea here.

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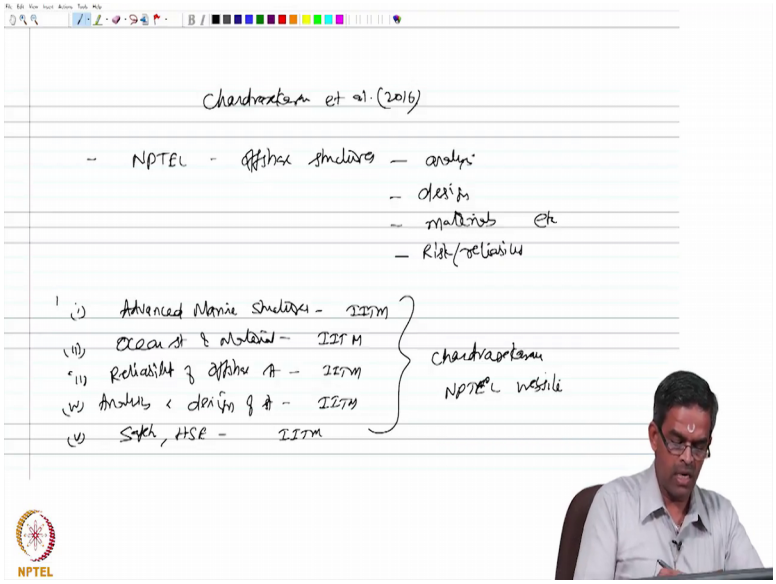

More details of this structural model can be seen at Chandrasekhar et al; 2016, there are interesting more NPTEL lectures which have discussed offshore structures, the analysis design materials risk and reliability, etcetera.

For example, you can look at advanced marine structures an NPTEL course offered at IIT, Madras, there could be second could be ocean structures and materials an NPTEL course offered, IIT, Madras; the third could be reliability of offshore structures offered at IIT Madras, the fourth could be analysis and design of offshore structures again at IIT Madras, the fifth could be safety HSE in offshore and petroleum engineering again at IIT Madras, all are offered by me and open notes are available in the literature at NPTEL website. So, for more information on the TLP behaviour; please look at these additional reading materials. We will continue discuss this design in the next lecture and look at the results; what we have obtained from the SHM.

Friends, let us look at the summary.

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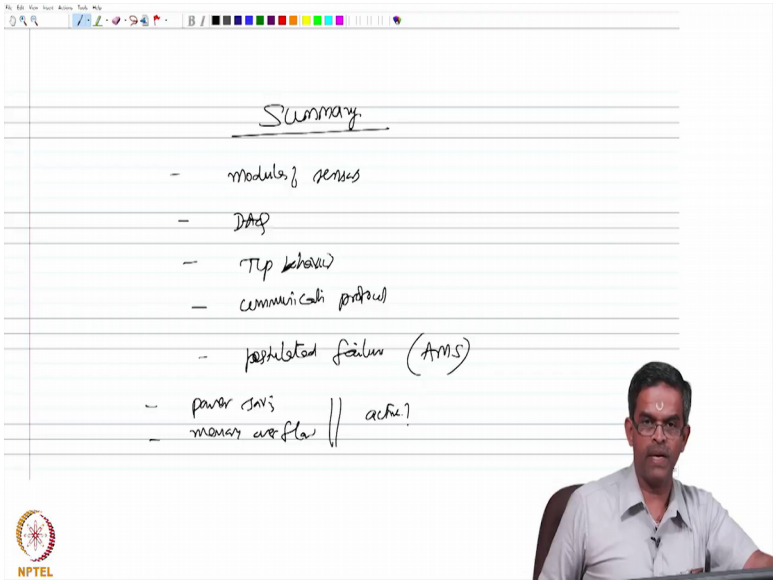

Now, in the second part of the lecture now we discussed about the modules of sensors data acquisition system, we also discussed about the TLP behaviour. Again, we discussed about the communication protocol being used, we also talked about how to understand the postulated failure. And therefore, what is the necessity for alert monitoring system we also talked about the power saving of the sensors, then memory overflow of the sensors and how intelligently, they can be made active as and when required by the design we will continue the discussion in the next lecture.

We will see the output obtain from the response and how the AMS has been designed to activate, when the values exceed the threshold limit values of the platform in the lab scale.

Thank you very much. Look forward for the next lecture. Bye.