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

**Lecture - 69**
**SHM design for BSLRP-Part 1**

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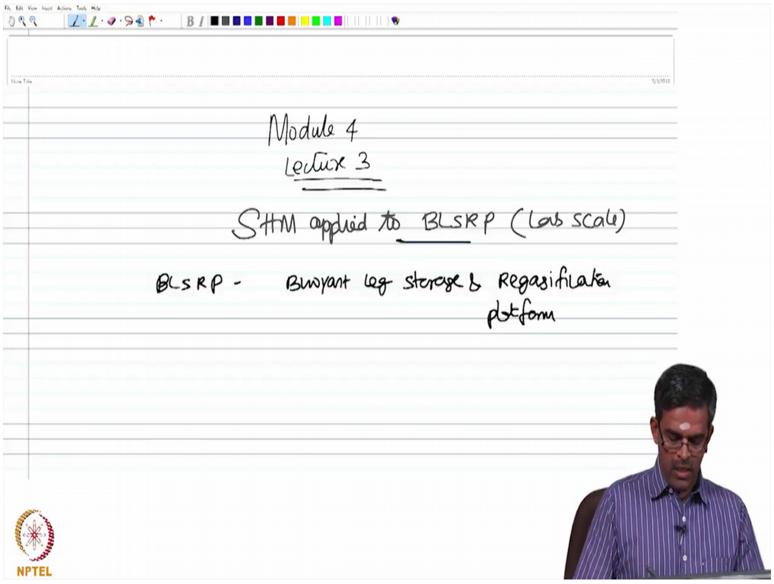


Welcome to the third lecture in module 4 here, we are going to talk about the structural health monitoring applied to BSLRP in the lab scale. So, we already seen in the last lecture the advantages the structural configurations of the buoyant leg storage and regasification platform. Let us quickly see the advantage of the buoyant leg storage gasification platform BSLRP has a circular disk circular deck sorry.

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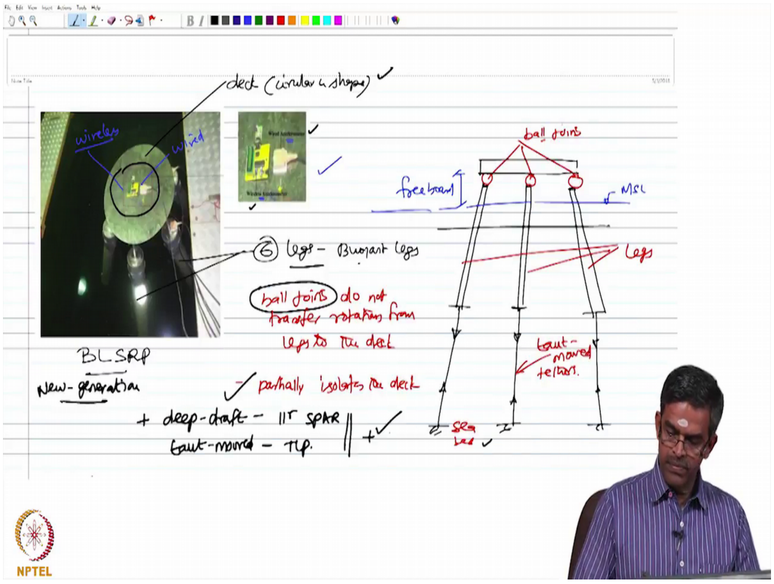


Which will be connected to 6 buoyant legs, which are connected along the circumferential periphery of the deck at equal spacing, the buoyant leg and the deck will be interconnected by a ball joint, each one on above each buoyant leg, ball joints do not transfer the rotations from the leg to the deck therefore, the deck is partially as related from the ball joints, as you see from here.

And the buoyant legs are connected to the seabed using taut moved tethers. Therefore, this is a combination of a deep draft system, similar to that of a spar and a taut moved system, which is similar to that of a tension leg platform. It derives both the advantages and it is a new generation platform, which is not at commissioned this is in the conceptual stage yet.

So, we made a lab scale model of this particular structure at IIT Madras, in the Department of Ocean Engineering and, then we try to do the health monitoring measurements on this using both wired and wireless sensors. So, one can see here that the wired accelerometer and the wireless accelerometers, both are fixed on the deck and of course, the buoyant legs are connected by the sensors, which are a waterproof which are kept on the side of the buoyant legs to measure the inclination. As well as their strain measurements which are required for measuring the performance of the buoyant legs under the action of wave loads.

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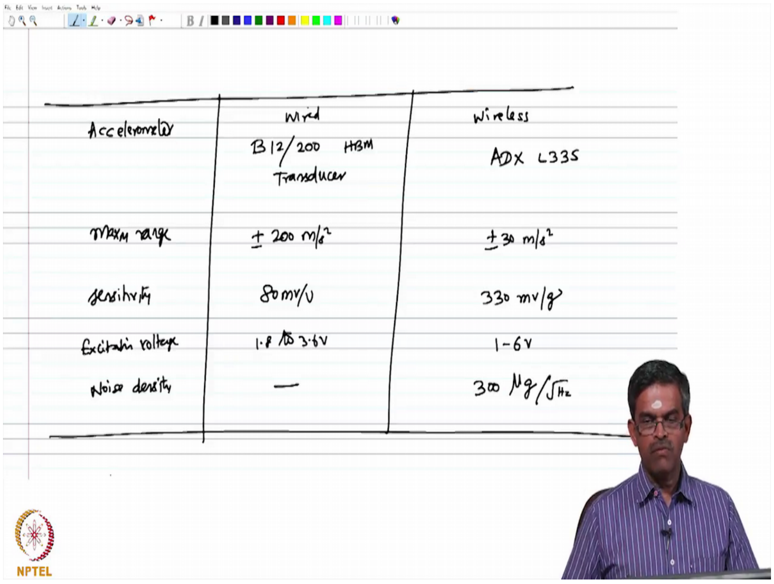


So, now the question is what kind of sensors have been used a variety of sensors have been used for this problem. The accelerometer which is two types one is from wire and, one is for wireless. The wired one is B 12 200 HBM transducer. Whereas, the wireless one is AD ADXL 335 model, the maximum range which it can cover is about plus minus 200 meter per second square, as far as wired sensor is concerned. As far as wireless is concerned, it is plus minus 30 meter per second square. The sensitivity of both of these type of sensors are different this is about 80 millivolt per volt, whereas this is highly sensitive 300 millivolt per gram.

It works on a different excitation voltage, wired sensors work at 1.8 to 3.6 input voltage whereas, this works from 1 to 6 voltage. If you compare the noise density, we all do agree that wired sensors directly transmit the measurements through wires, or cables therefore, there are no noise which is present when you acquire the data using wired sensors, but when you talk about wireless sensors, they have a noise density which is 300 hertz.

So, this is what the specification of the accelerometer, which has been used in the present study which were discussed in the last lecture as well. So now, the platform is subjected to wave action measurements are taken using both wired and wireless sensors.

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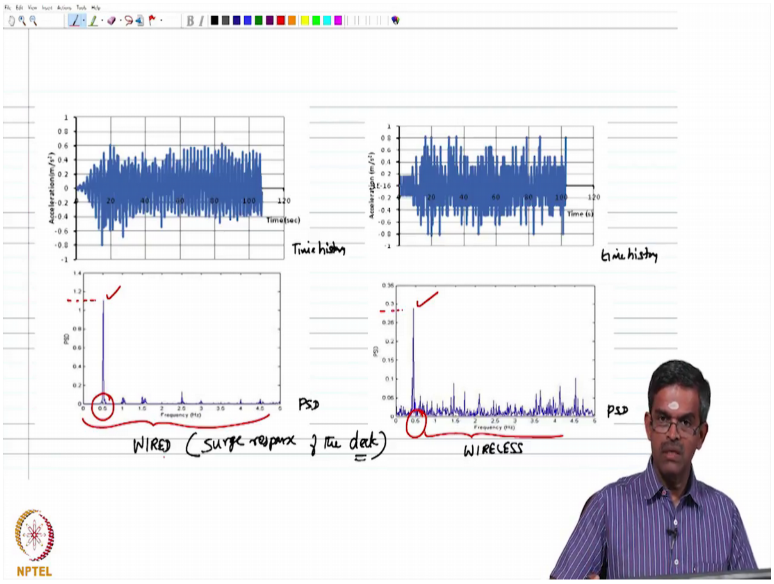


Let us look at the typical measurement this has been obtained using wired sensors. And this has been obtained using wireless sensors ok, these are accelerations plotted from the deck in the surge degree of freedom. In both the cases, the top one is showing the time history and the bottom one shows me the power spectral density function. Similarly, the top one here shows me the time history of the wireless sensor and, the corresponding power spectral density function of the surge response measured on the deck using accelerometers ok.

Now, let us compare these two data and see that one can easily observe, when you talk about wireless sensors, there are multiple peaks there are multiple peaks, which you can note down for a wider band range from 0.5 to 5, but there are no spikes as far as wired sensors are concerned, in both the cases one can see here that the peak is measured or observed at close to 0.5 hertz, which is true in both the cases. So, there exists a very good similarity in terms of qualitative measurements, in both type of sensors used in the study.

However the intensity of measurement varies compared to both of them. So, let us try to see what would be the merit, or demerit, or comparison of using a wireless sensor with that of an wired sensor quickly.

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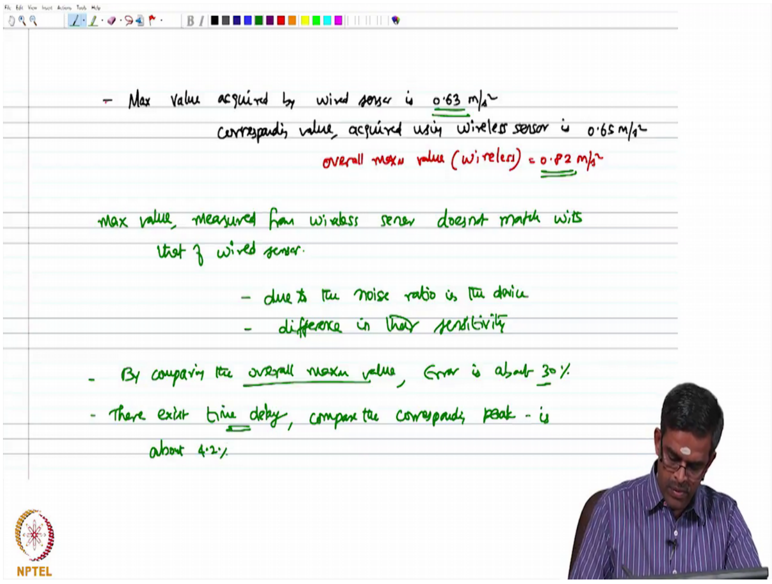


So, there are some observations in this particular case, the maximum value acquired by the wired sensor, is at sorry is 0.63 meter per second square ok, 0.63 meter per second square that is the maximum value occurred. The corresponding value acquired using wireless sensor is 0.65, you can see here it is about 0.65 meter per second square, where the overall maximum value, in wireless sensor is 0.817 that is 0.82 meter per second square.

So, it is very clear that, the maximum value measured from the wireless sensor, does not match with that of the wired sensor ok. The value is 0.82 whereas, in this case only 0.63. This is mainly due to the noise ratio in the device that is one reason, second is it can be also due to the difference in the sensitivity. Now, we comparing the overall maximum value please understand, we are not comparing the mean value overall maximum value, the error is found to be about 30 percent. There is also a slight time delay between this. So, there is or there exists a time delay, when you compare the corresponding peak.

One can see here in the corresponding peak maybe are about 20 close to 20, whereas in this case it is slightly away from 20 that is the lag. So, there is a time delay comparing the corresponding peaks at both the signal and, this time delay is about 4.2 percent.

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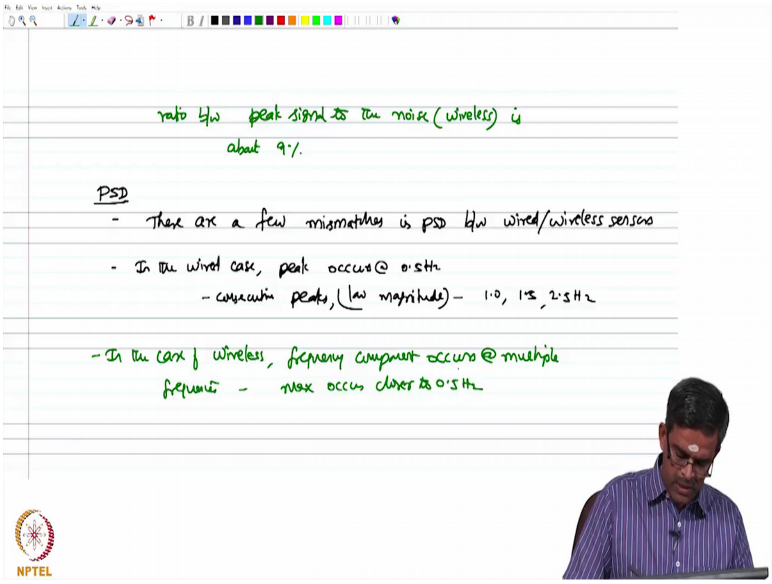


Further, the ratio between the peak signal to the noise, in case of wireless is about nine percent ok. So, these are all the differences which we got by comparing the readings of wired and, wireless sensor which is a measurement of acceleration in the surge response of the deck.

Now, by comparing the power spectral density function, which is also available here, by comparing the power spectral density function, there are few mismatches in the PSD's between the measured values of wired and wireless sensors, ok. There are you can see here, there are there is no signals of vibration, but here there are lot of noise signals present in a bright white band ok, there is a mismatch. However, in the wired case peak occurs at about 0.5 hertz and, consecutive peaks of very low magnitude ok, occurs at 1 1.5 and 2.5 hertz, you can see here 1 1.5 and 2.5, ok.

But in the case of wireless sensors the frequency component occurs at multiple frequencies. However, the maximum occurs closer to 0.5 ok. You can see here the maxima, occurs closer to 0.5, where there are multiple frequencies peaks occur at multiple frequencies.

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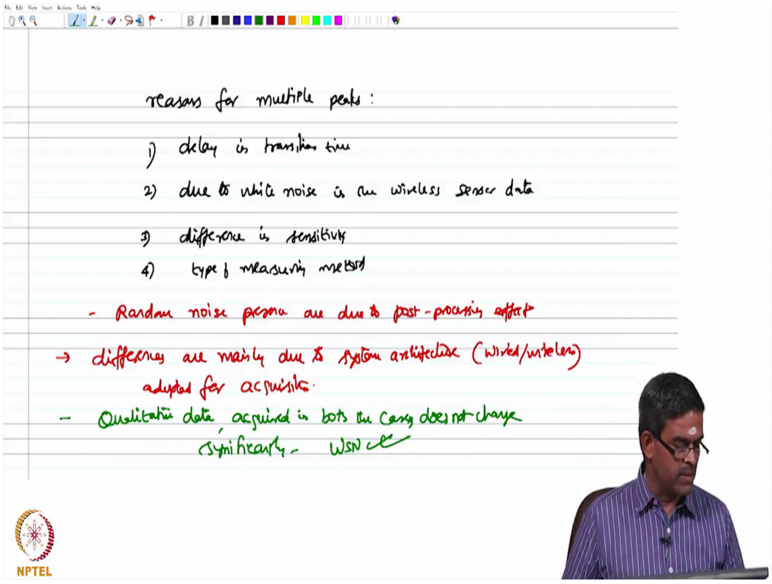


The reason for this could be could be one delay, in transition time because, wired sensors are directly measured and obtained in the data acquisition system whereas, wireless data has to be transferred translated to the acquisition system. So, there could be a delay in the transition time, it can be also due to the white noise in the wireless sensor data, the 3rd could be difference in sensitivity and 4th could be type of measuring method. It is very important to see that the random noise presence, or due to the post processing effect. So, one can write that the differences what you see here are mainly due to, the system architecture between the wired and the wireless, adopted for acquisition.

So, interestingly qualitative data, acquired in both the cases, does not change significantly. So, it means the attempted wireless sensor networking is partially successful because, it depicts the value what you have from the wired sensors.

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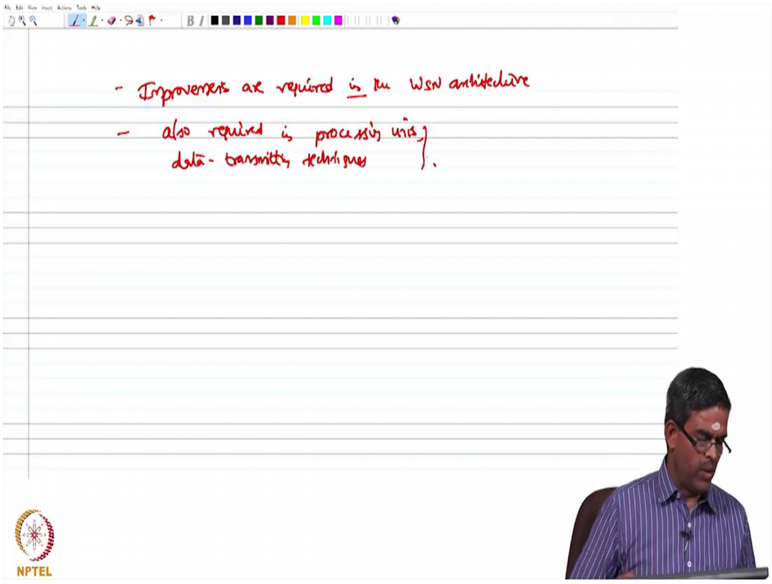


Improvements are required in the wireless sensor network architecture comparing the wired sensor as a base, improvements are also required in processing units, data are transmitting techniques, etcetera because the time lag everything can be avoid.