Structural Health Monitoring (SHM)
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Lecture - 81
Part - 1: Structural Health Monitoring (SHM) of lab scale model of TLP - IV

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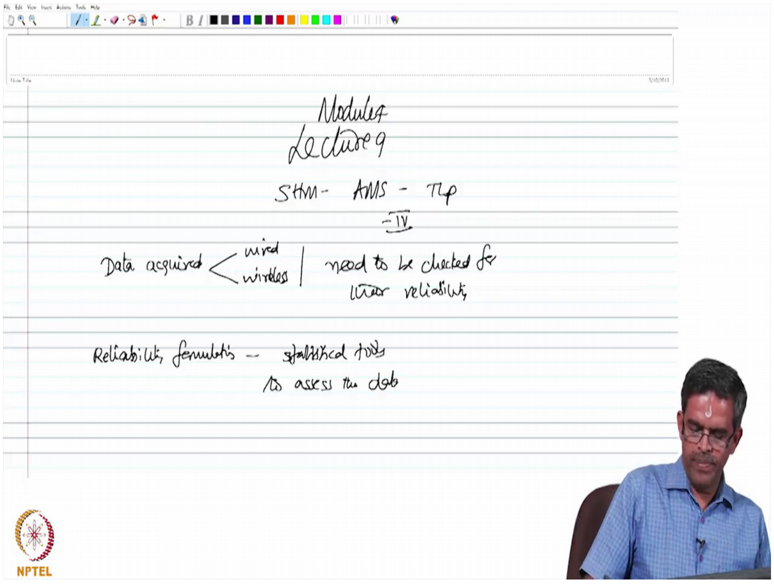

Friends, let us come welcome back to the lecture 9 in module 4; where we are continuing the Design of SHM leading to alert monitoring system for TLP this is lecture 4; so, series what we are continuing. In the last lecture we said that the data acquired from wired and wireless; both need to be checked for their reliability. So, now, the problem is a reliability formulation; so, one can use statistical tools to check or to assess the data.

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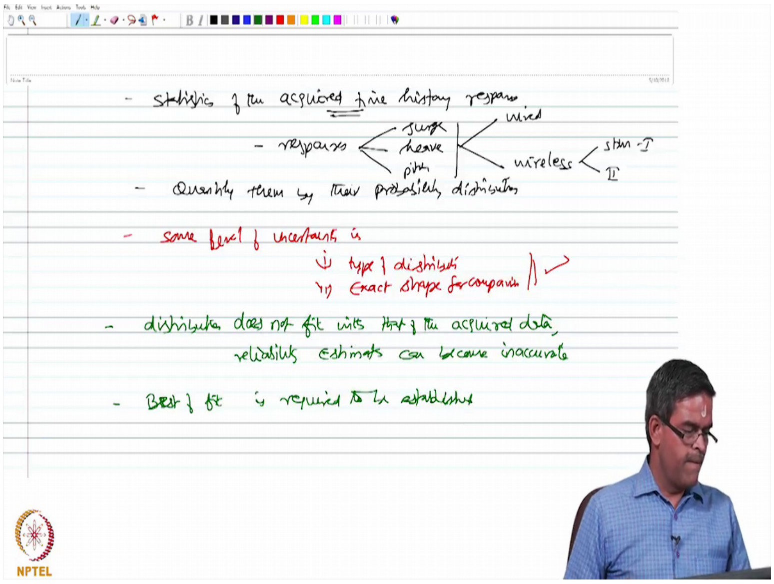

Now, statistics of the acquired time history; what are the acquired time history? We have responses in surge heave and pitch which has been taken from 2 cases wired and wireless. In fact, even wireless we have 2 SHM design 1 and design 2 ok.

So, these are the acquired time history responses; one can quantify this by their probability distribution. Some level of uncertainty in estimating the type of distribution and exact shape for comparison will exist, will be there does not fit with that of the acquired data; then the reliability estimates can become inaccurate. Therefore best of it is required to be established.

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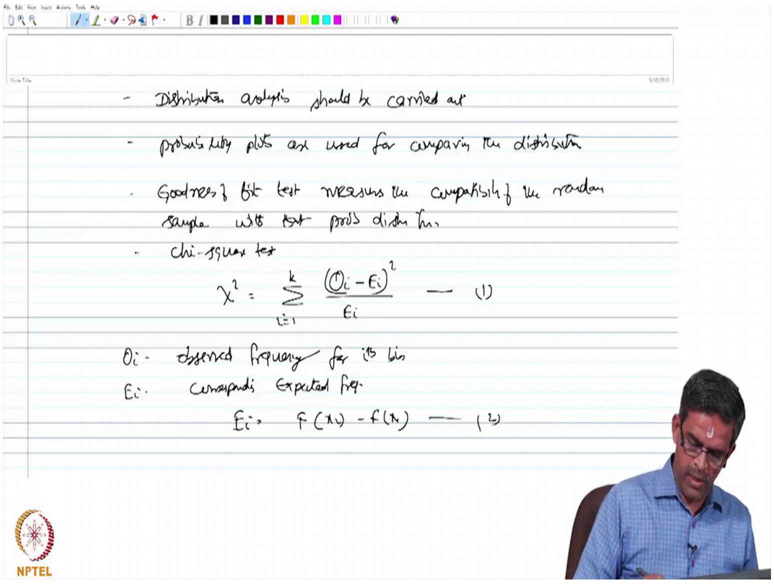

Therefore, one need to do distribution analysis and then the probability plots for comparing the distribution, the goodness of its fit tests; measures the compatibility of the random sample with that of probability distribution function ok.

One can also do chi square test, the chi square test statistics is defined like this chi square is explained as i equals 1 to k O i minus A i square by E I, where O i is the observed frequency for i-th bin and E i is the corresponding expected frequency.

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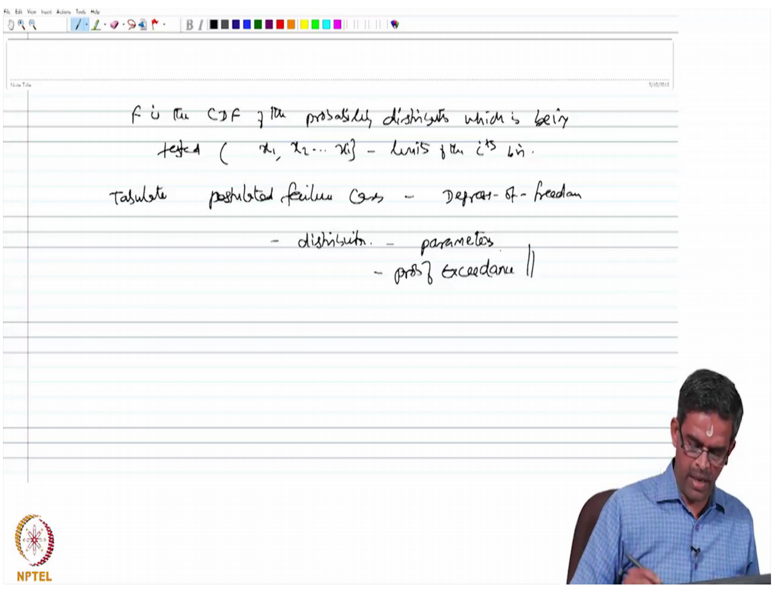

This E i is given by F of x 2 minus F of x 1 where F of F is the cumulative distribution function of the probability distribution which is being tested in the intervals x 1, x 2, x i which are the limits for the i-th bin. One can now tabulate the postulated failure cases in different degrees of freedom and do statistical analysis and fit to the best distribution, find out the parameters of the distribution and check the probability of exceedance that is idea we have done.

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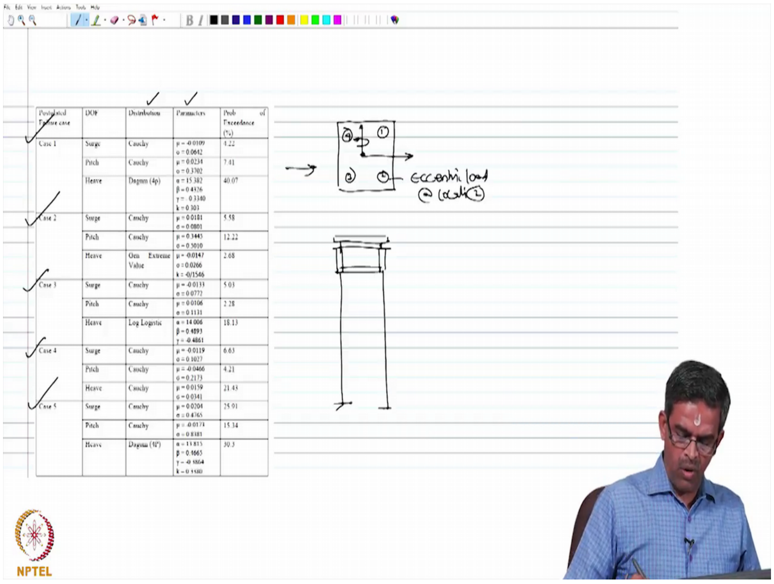

So, now this has been done for different case of failure 1, 2, 3, 4, 5 which we discussed in the last lecture; just for your recollection. If this is my plan of the TLP and this is my elevation of the TLP, this is my wave direction 1 2 3 4 this is 1 2 3 and 4; the case 1 is actually in eccentric loading at location 2 ok; place an eccentric mass.

So, that is a post related failure case and try to find out the additional responses in surge degree. In heave degree and in pitch degree ok; in pitch degree and we have plotted, I will show you the plot slightly later. So, now, different distributions are trying, different parameters for the distributions are also estimated from the time history data and the probability of exceedance has been plotted for different case of failure; 1 2 3 4 and 5 that is what you see in the screen now ok. The power spectral density plots are also done.

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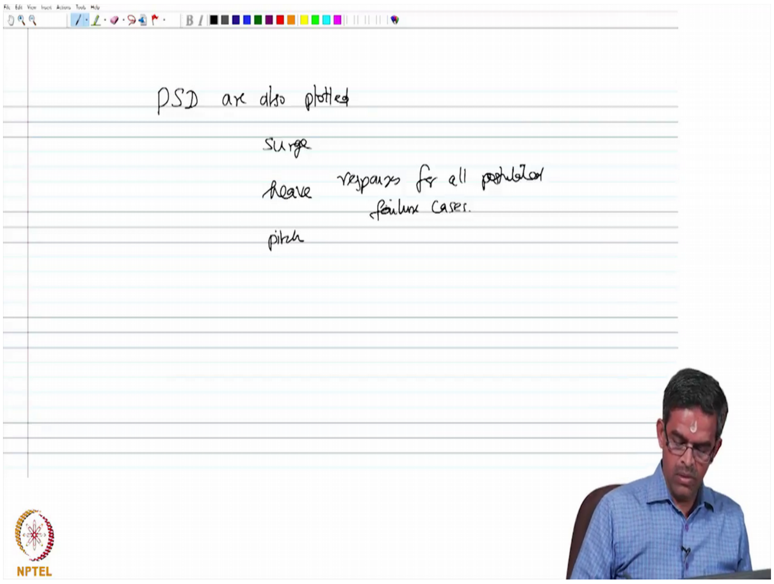

Plotted for surge, heave and pitch responses for all postulated failure cases.

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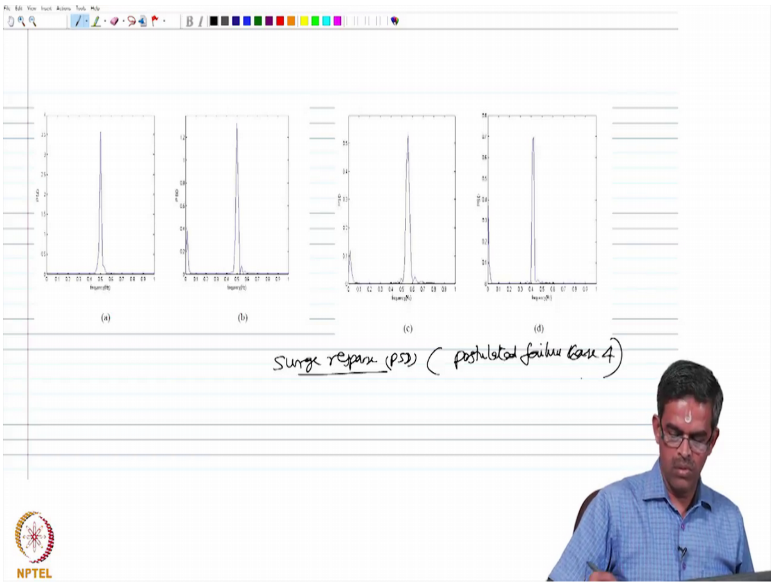

So, let us look at the curve these are all for a, b, c, d and one more curve e these 5 curves are for surge response; they are power spectral density plots for post later failure case 4 even including this is also.

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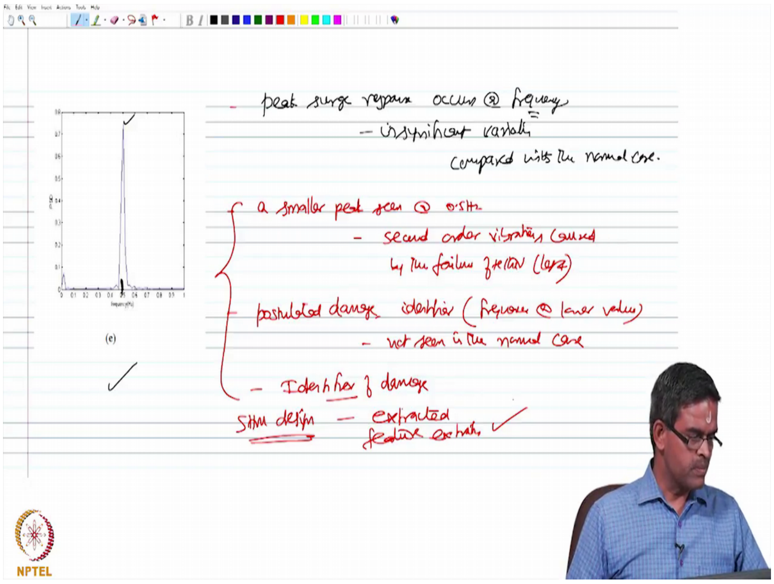

Now, by comparing these responses; surge response occurs at a specific frequency which has insignificant variation when compared with the normal case ok. We are comparing this with the normal case that is the threshold value this is the posterior damage case we will compare this data with a normal case and there is no significant variation between the frequency at which the peak has occurred, ok. This frequency there is no change because there you must have seen it is 0.51, here it is 0.5; there is no much variation in the peak. But there is a small peak seen at about 0.5 hertz which is actually due to the second order vibrations caused by the failure of the theta that is like 4. So, friends when there is a postulated damage; the identifier in this case is the frequency at lower value which was not seen in the normal case can be used as an identifier.

So, this interface program for processing the data and analyzing the processed data to extract the information is a part of the SHM design ok; that is very very important to understand. SHM design will be successful only when you are able to find out which data has to be extracted. So, what data is to be need to be extracted, what we call feature extraction ok. This interface programming need to be done by the user to train the health monitoring system so, that it can compare the data with the normal case and then identify the damage scenario and report as an alert monitoring system that is the idea ok.

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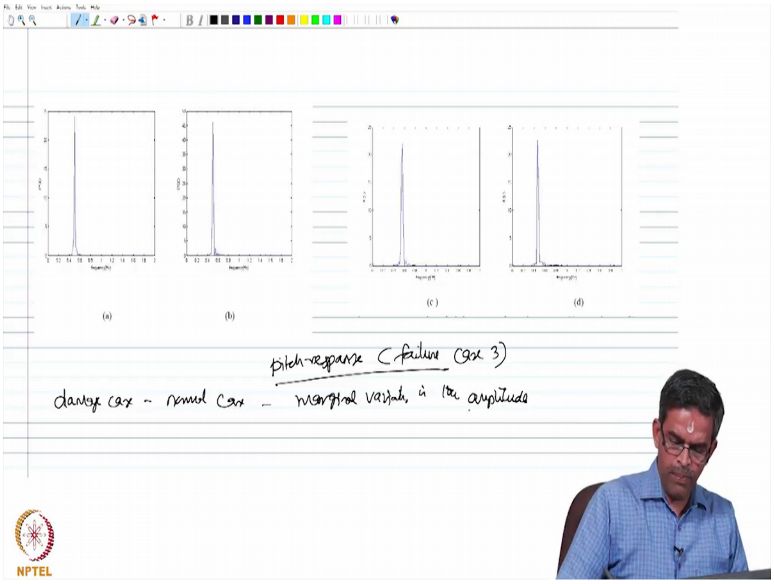

Of course, if you look at the pitch response; this is the pitch response for failure case 3, the damage case and the normal case has a marginal variation in the amplitude.

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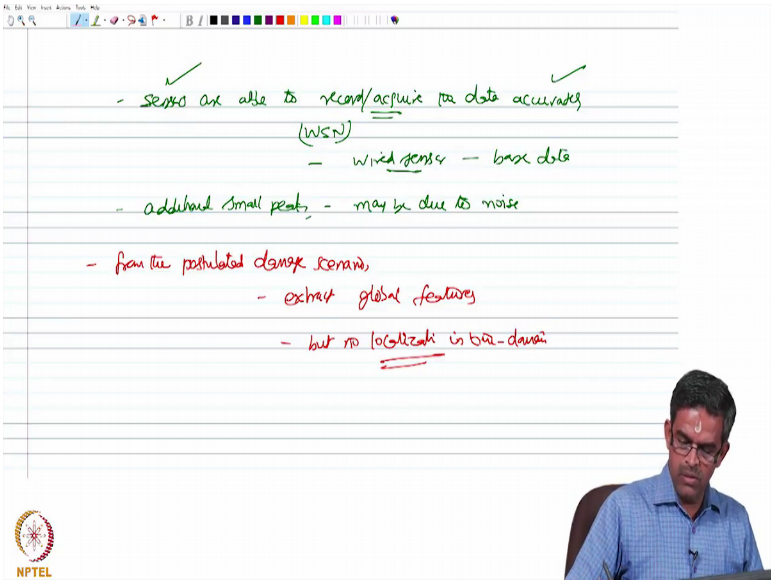

So, it is very important that sensors are able to record or let us say acquire the data accurately. Remember when I say sensors I am talking about wireless sensor networking because I am comparing this data with the wired sensor that is my base data I am comparing this with that. So, wireless sensors are able to record and acquire the data accurately that is number 1; we have seen.

Secondly, the additional small peaks as seen in the figure; the additional small peaks as seen in the figure may be due to noise generation or acquired in the data. So, friends from the postulated damage scenario. We are able to find out or extract the global features, no localization in time domain may be that is the demerit in this case.

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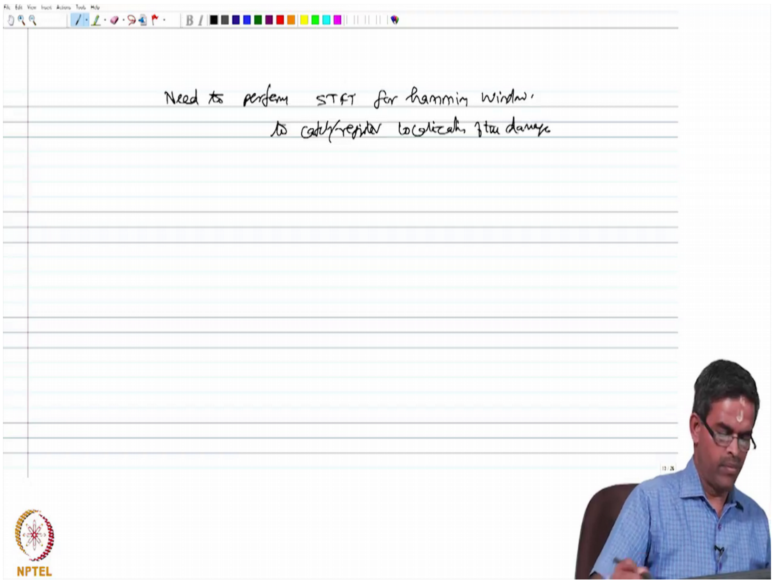

To do this one need to understand, one need to perform for a small hamming window. This will help us to catch or register the time localization of the damage.