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Theory and Practice of Non Destructive Testing

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Acoustic Emission Testing - 4

Hi everyone right now we are on the topic of acoustic emission testing and in last couple of lectures we have already discussed about the basic principle and few other aspects about this particular technique and in the previous lecture we have seen two effects Kaiser and Felicity effects which talked about the relationship between the previous loading history and the acoustic emission events and then we also learned how these two particular effects indicate about presence of active defects when they develop inside a structure in a given interval okay and then we also just started these signal parameters and two of the parameters.

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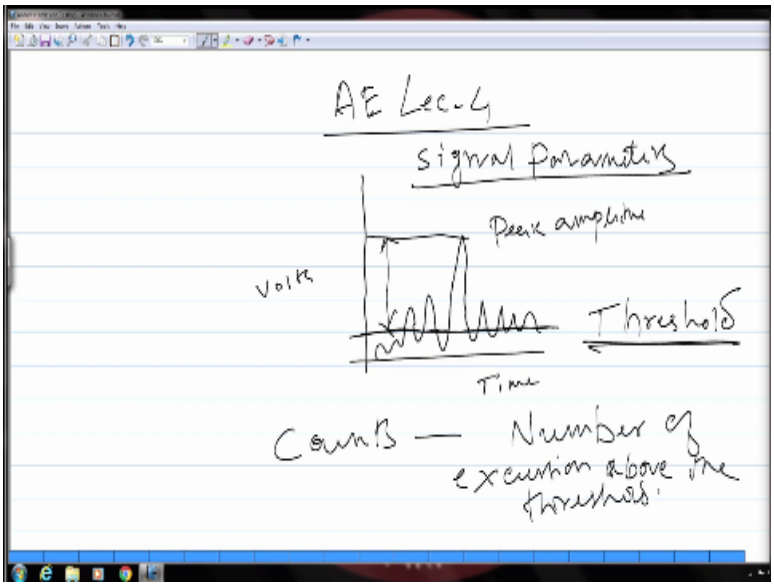

We discussed in the last class if you remember so this is what we started about the signal parameters and today we will continue on this and learn about the other parameters okay so if you remember I told you that the first thing that you need to do you need to define this threshold and above this threshold whatever signal you see that is taken as an actual acoustic emission signal and below this threshold whatever you get that is considered as noise okay so that is the first thing which is done this threshold is user defined based upon the experience of the user or based upon the kind of part you have or the kind of defects you are expecting and soon okay.

And the first of the parameters which was count we discussed this in the previous class it nothing but the number of crossings or the number of excursion that you see above the threshold okay so this is primarily this Peaks that you have which are above the threshold and count is a parameter which will depend on certain other aspects that also we have discussed and the second parameter is known as the amplitude or the peak amplitude okay so that means the maximum signal that you have which is this one.

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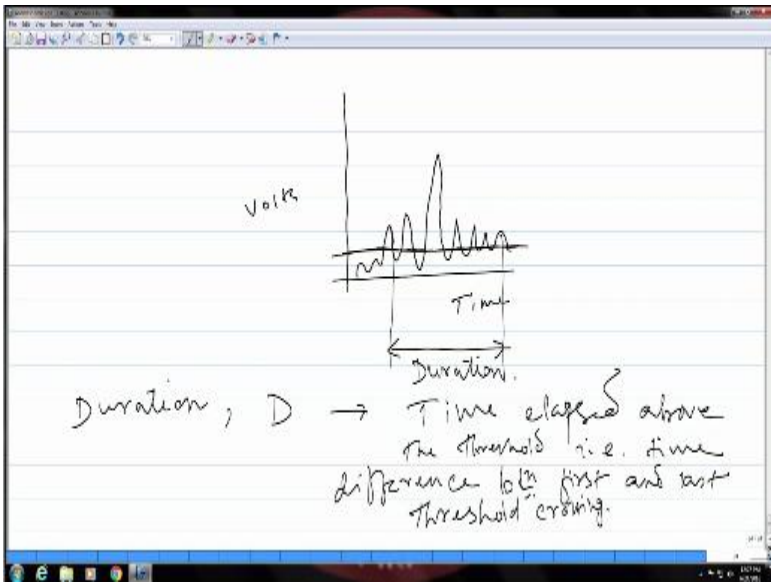

Now if you consider the time which is elapsed between the first crossing and the last threshold crossing that means the time above the threshold if you consider that that particular time interval is known as duration so this is another parameter duration which is indicated by D so as I said this is a time elapsed above the threshold so that means this is the time difference between the first threshold crossing and the last one as we have already indicated in the diagram okay this parameter duration this is quite useful while you are doing acoustic emission testing.

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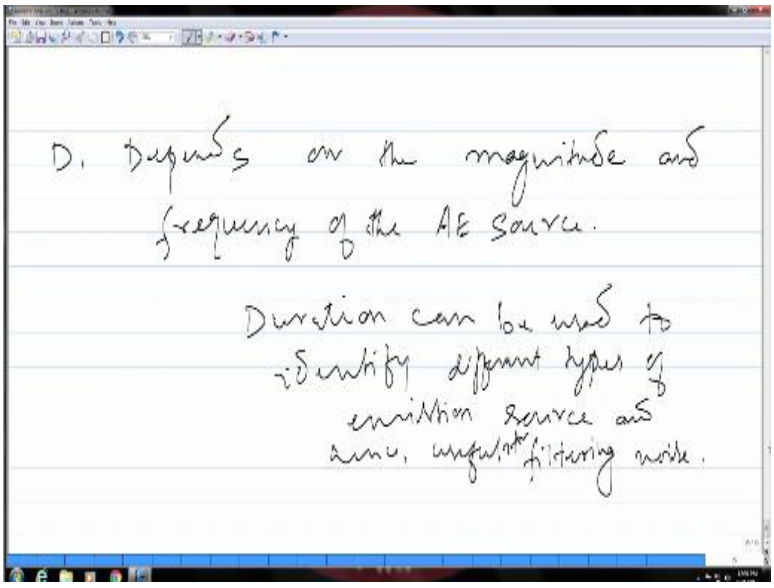

And it depends on duration depends on the magnitude of the acoustic source and it also depends on the frequency of the source and as I said this is a very useful parameters which can be used to do a few things while doing acoustic emission testing for example this parameter can be used to filter out the noise because duration can be used to identify different types of emission and as a result this can be used to identify noise that means emissions which are coming out from some other source which are not related to the defect okay and hence useful for filtering noise.

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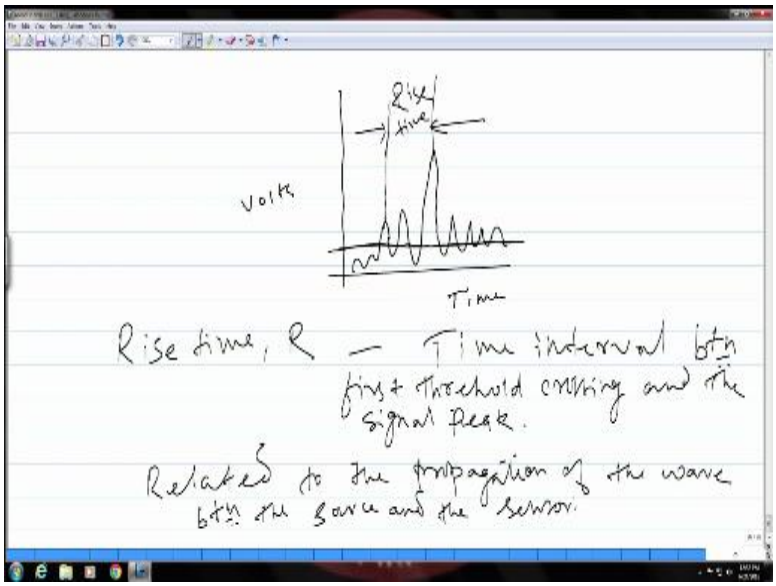

The next one that we have is known as rise time which is written as R and this is the time interval between the first threshold crossing and the peak so this is the rise time so this particular parameter is related to the propagation of the acoustic waves between the source and the sensor and hence this can be used to qualify the emissions to qualify the signal and as a result this can also be used as a criteria to filter out noise okay.

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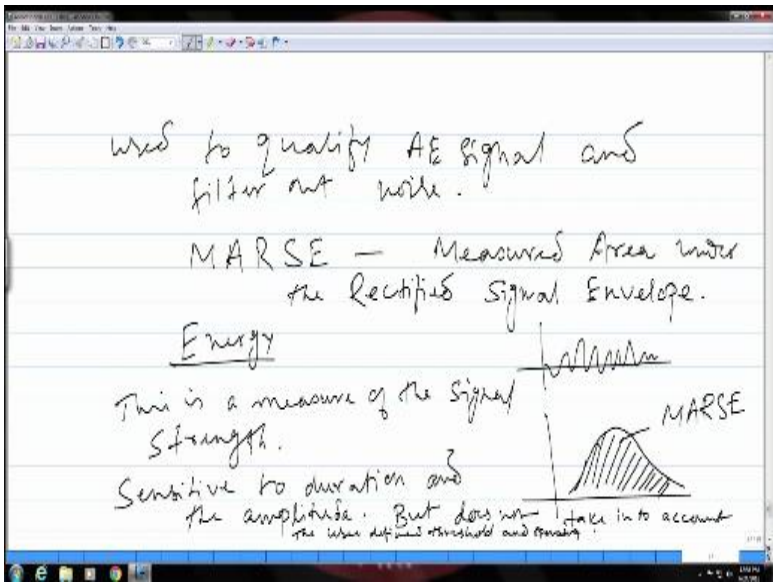

So these are some of the parameters of the acoustic emission signal and as you could see many of these parameters are quite useful particularly identifying the signal whether it is coming out from actual acoustic emission events are not and filter out the noise which may come from some other sources which are not related to defect okay so we will talk about that little later as to how some of this parameter or at least one of these parameters can be used to filter out the noise from the emission signal but there is one more parameter which will indicate about the size of the source or the energy of the source and this is known as MARSE and if you expand this stands for measured area under the rectified signal envelope okay.

So what you do in order to get this parameter that signal that you have you rectify it okay you smoothen it get a smooth signal out of it by rectifying it and if you are measure the area under that rectified signal that will give you this parameter which is related to the energy in the signal okay so that means if you have a signal like this has to be first rectified so you need to make it smooth like this and now if you measure the area under this rectified signal this is the parameter MARSE okay.

So this tells you about the energy levels in the acoustic emission signal so this is also the measure of the signal strength and this particular parameter is sensitive to duration and the peak amplitude or the amplitude but it does not take into account the user-defined threshold and the operating frequency.

Okay so these are the different parameters with regard to the acoustic emission signal now since we have learned about the basic principle the signal and the other aspects so now we can go ahead and see the measurement system and the data how it is displayed and how that effects are interpreted.

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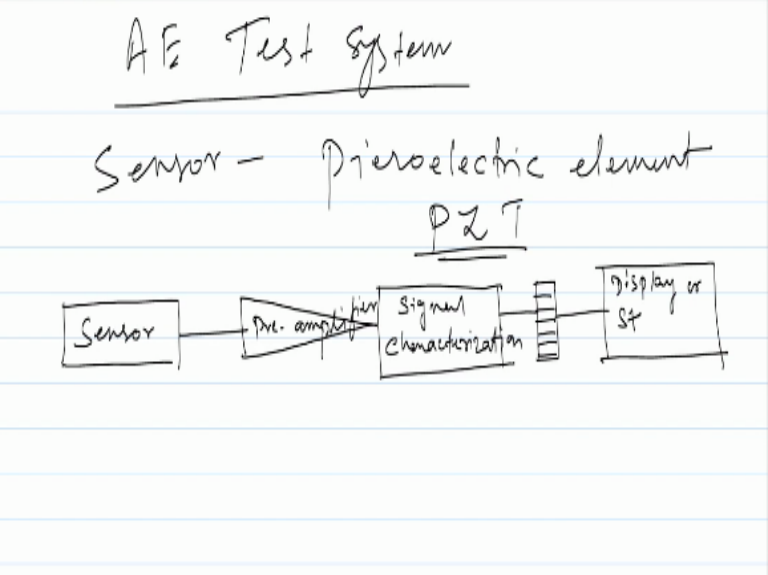

So if you talk about the measurement system the major component here is the sensor which can convert this elastic stress waves which are coming out from the sample into an electrical signal which can be shown on the display and can be interpreted in terms of a defect so that is the main component here and of course you have that electronic circuit and other things the amplifiers and so on in order to amplify the signal and characterize it and finally displayed so the sensor here also is made of a piezoelectric element like what you have in an ultrasonic transducer, so this lead Zirconate Titanate piezoelectric elements can be used in the sensors.

So first you collect the signal by the sensor which is sent into a preamplifier first and then through the electronics in the system you characterize the signal that means you identify the signal and see the quality of it whether it is coming out from actual acoustic emission events or there are lot of noise and things like that so that is called the characterization of the signal and then finally you send it to the display system either through a single channel or you can also send it to multiple channels.

Or depending on what kind of sources you have how many Acosta chemisette events is being picked up by the sensor and so on okay so for a particular defect or for a particular acoustic emission event you can collect a number of heat you can collect a number of signals and you can send them through multiple channels to the display system which will finally display the signal and give you an indication about the defects and damage inside the component okay.

So these are the main components open a test equipment and now we will see how the data is displayed how it is collected we have seen it before also it is through the piezoelectric sensors which will convert these stress waves into an electrical signal that is what will be collected and characterized and then finally it will be displayed okay so in order to characterize the defects or in order to know about the presence of defects we need to see what kind of display we have and how this display is interpreted in terms of the presence of defects okay. So let us see that now.

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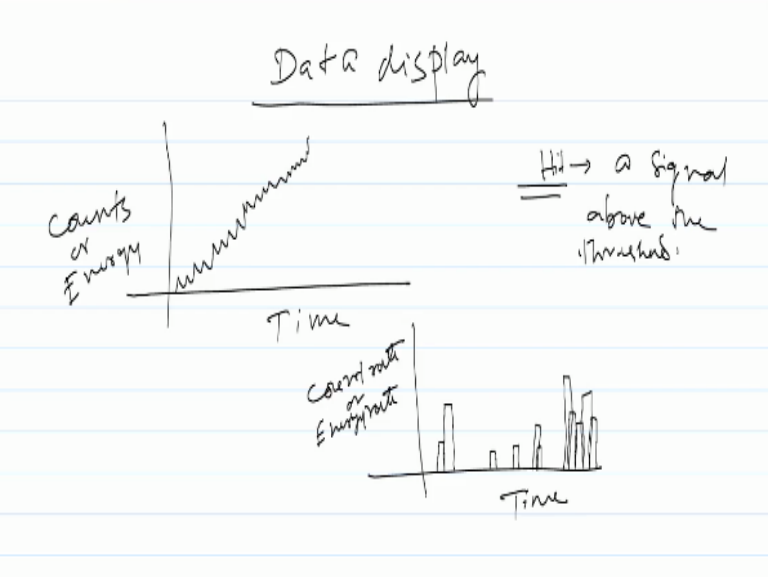

So this data can be displayed in various forms for example you can take the count so this is the parameter that we have already talked about or you can also take the energy this also we have seen how it is obtained from the signal and then plot it against time okay so if you see the plot it will look like this so as the time increases the emissions are also supposed to increase like this sometime a heat system is also used and by heat we mean a signal it is above the threshold okay so whenever you count the signal it is taken as a hint if it is above the threshold and if it is below the threshold then it will be counted as a noise okay so this number of hits will also give you the count or the count rate and in fact instead of plotting count versus time if you take the count rate that is a better representation of the data.

Because then it will tell you at a particular instant what Is going on inside the component so this is over a period of time so this is kind of accumulative but if you want to know the instantaneous results or what is happening at a given instance then you need to better plot it in terms of the count rate or energy rate, so as I said then you would be able to know that in a given instance at a given time how much acoustic games and events or acoustic signals are coming out okay so in some other instant you could have a signal like this like this or like this.

And sometimes you may notice lot of signals coming out so this would indicate that at this particular instance lot of acoustic emission events are occurring inside the sample that means something must be going inside the sample okay so that is how if you plot the data in terms of the count rate it provides you the instantaneous picture .

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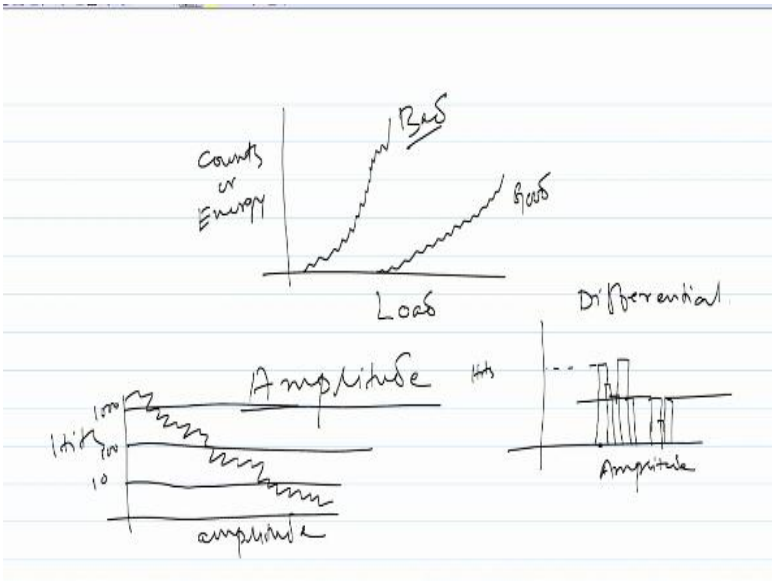

Then the data can also be plotted as a function of load because load is one of the major parameter as we have talked about before which is responsible for generating this acoustic emissions so you can plot this account again or the energy as a function of load okay and this will give you a picture about the occurrence of Acoustic emission simply by looking at the curve itself you would be able to know that you have lot of emissions happening or you have you know lower amount of emission happening.

That means if you look at the slope of the curve that itself would indicate what kind of damage is occurring inside the component so you might have a curve like this which is very steep and then on the other hand I could have a curve like this so in one case it is very steep the slope is very high and in the other case it is gradual the slope is lower okay so when you have this kind of

gradual increase in the emission with respect to the load then that would indicate that the structure is good that it is not damaged.

On the other hand if you see that if you increase the load a bit you are getting lot of emissions and as you keep increasing the load more and more emissions are coming out at a very high rate then that would indicate a bad structure or a damaged structure okay so this is how looking at the slope itself you would be able to know whether the structure is damaged or not okay then you can use the amplitude also because this is again directly related to the size of the source so this signal amplitude can also be used as a parameter to have a display.

And then you can you know characterize it and find out about the indications of the defects and damage inside the structure so this amplitude can be plotted in two ways one is you see how many heats are there with a particular amplitude so let us say this is the amplitude and the y-axis is the number of eight so in one case you could plot to see how many heats you have with a given amplitude like this okay so for this particular amplitude this many hits you have okay so like that.

So we will have different number of hits with different amplitudes like this when you plot it as a function of the amplitude okay like this so this kind of plot when you see the heat with a given amplitude is known as a differential plot okay on the other hand if you see how many heats are there above a particular amplitude then that kind of plot is known as a cumulative plot so let us say you have a different numbers of heat.

So then you see how many hits are exceeding a particular amplitude so that curve will look like this so if you see for example above this amplitude how many are there then above this amplitude how many are there and so on okay so if you are plotted in this fashion where you see a number of hits exceeding a particular amplitude then this will be known as a cumulative plot okay, so these are the two different types of plot when you use the amplitude to display the data okay.

And how you get an idea about the defects or damage in this particular case is if you see number of its at higher amplitude so if you see an increase in the number of its with high amplitude then that will indicate a damaged during the loading okay, so depending on this whether you are getting large number of hits with the high amplitude or you are getting you know lower amplitude heats on larger number based upon that you would be able to take a call whether some kind of damage has happened to the structure or not when it is loaded okay.

So this is how the data is presented the data is displayed in different forms in case of acoustic emission testing and with this I am going to stop here today and we will again meet in the next class and we will see some other aspects also and with that we can close this particular topic as well so I will stop here today I will see you next time thank you.

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