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Theory and Practice of Non Destructive Testing

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Acoustic Emission Testing - 3

Hi everyone so we have been on this topic of acoustic emission testing and in last few lectures we have seen the basic principle of this particular technique and we have also seen the characteristics of the acoustic emission signals and in the last class you also saw a couple of examples of acoustic emission sources one of them was from a crack and the other one was from a phenomena called phase transformation in metallic systems okay so today in this lecture we are going to continue on this topic and we'll see the other aspects so first let me come back to this once again okay.

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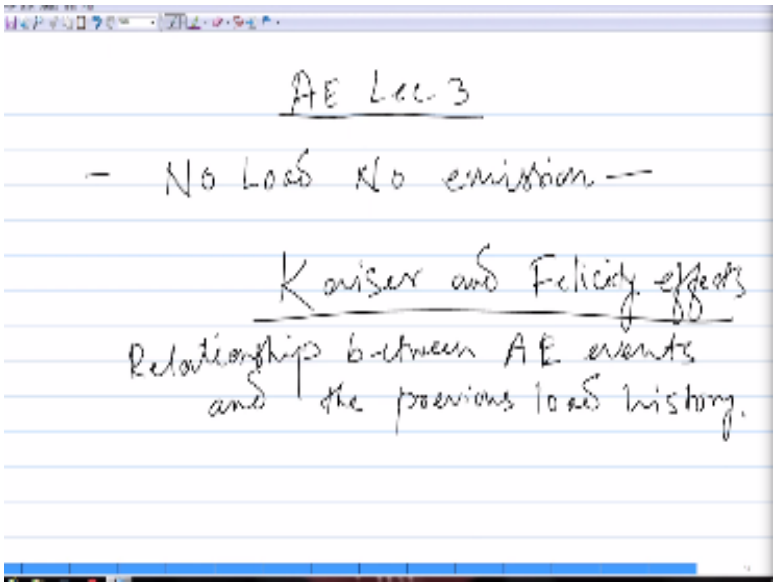

So let me come back to this because this is the most significant feature of acoustic emissions you have no load there is no emission because Acosta Commission talks about moving defects okay and for the defense mode you have to load the component of the structure okay so that means there has to be a relationship between the load and the emissions which happen inside a part okay so this relationship between the loading history and Baku stick emissions in a particular interval is given by two effects which are known as Kaiser and Felicity effects.

So this describes the relationship between acoustic emission events and the previous load history since this technique is primarily to monitor the moving defects and damages like that which are active this is primarily used for health monitoring of a part or of a system which is already in service okay so this inspection is done in a particular interval time to time okay, so during a given inspection the part will be loaded to certain extent depending on what kind of component it is.

And you know how it is used and what is the kind of load which is being applied to the system or to the part okay so that is why there is a previous load history that also has to be considered when you talk about acoustic emission events or caustic emission from apart when you are doing the inspection at particular intervals okay so this Kaiser and Felicity effects will tell you about that.

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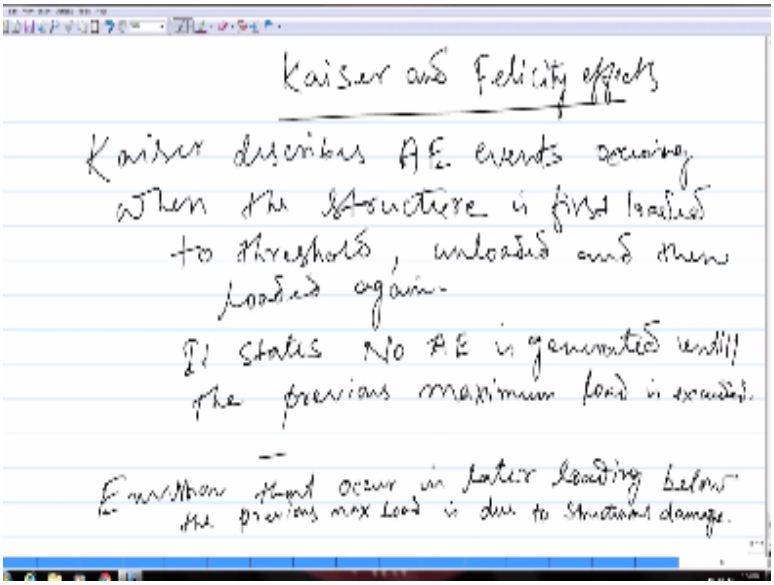

And this is how they go Kaiser effect describes acoustic emission events for a complete loading cycle that means you first load the part unload it and then reloaded and during this whole cycle if there is any acoustic emission events that is being described by this particular effect which is known as Kaiser effect when the structure is first loaded to a threshold means when it is loaded to a particular load beyond which you can expect the defect to move ok and then unload it and then load it again okay.

So as I said this is about a complete loading cycle loading unloading and reloading and it states that no acoustic emission is generated until the previous maximum load at which the emissions were obtained in the previous cycle is exceeded okay so you are you are doing it you are loading the structure and then see at what particular load the emission is occurring and then when you

reload again you have to see whether the emissions are occurring before the previous maximum load or after the previous maximum load okay.

So the Kaiser effect says that there will be no acoustic emission until the previous maximum load is exceeded and when you see that when you see that the emission events are coming only when you exceed the previous maximum load it indicates that the structure that you are inspecting it is still sound okay there is no permanent damage to it, which can compromise the safety or the function of the structure okay so that is how you get to know whether the damage is becoming detrimental for the structure or not okay.

On the other hand you see acoustic emission occurring before the previous maximum load then that will indicate that some kind of damage has happened to the structure which is causing these acoustic emission events okay so a mission that occur in the later loading below the previous maximum load is due to structural damage okay so this is how you get to know the relationship between the acoustic emission events the loading history and also whether the structure has been damaged or whether the defects are been active or not okay. So this second phenomenon that is occurrence of the acoustic emissions below the previous maximum load that is known as the felicity effect okay.

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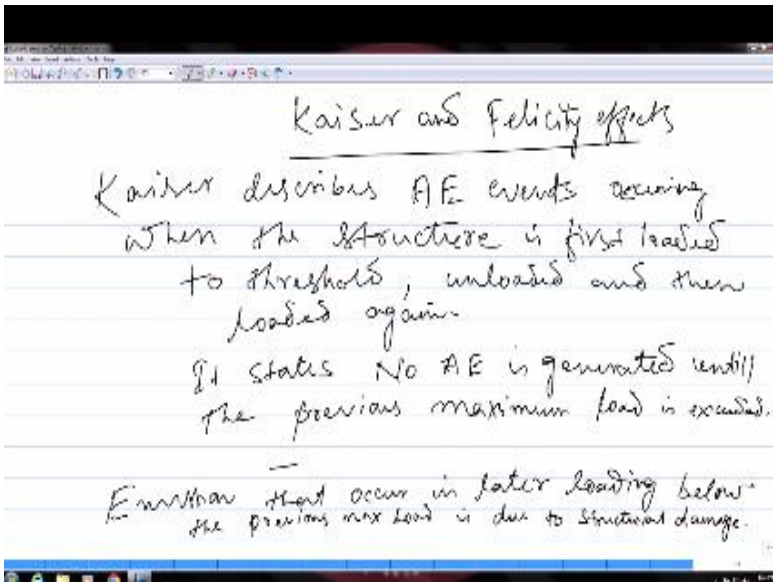

Okay so the Kaiser effect is no emission before the previous maximum load.

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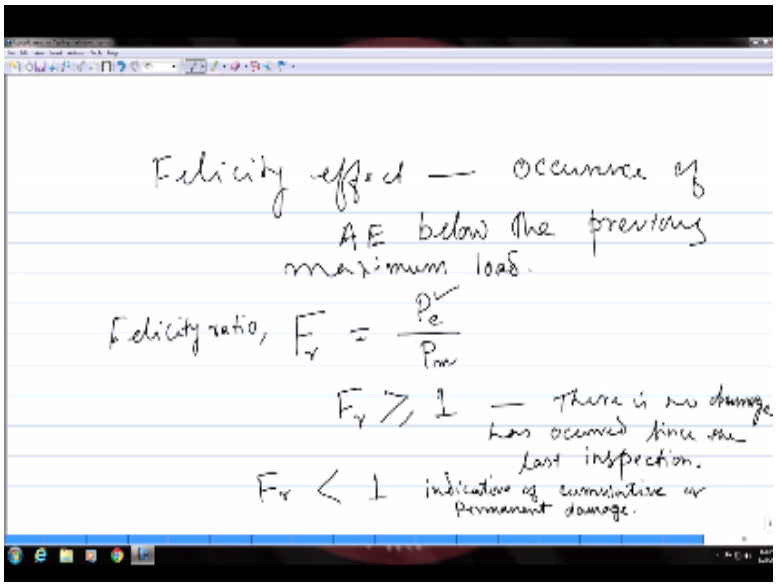

And felicity effect States emission before the previous maximum load ok so this is about damage and no damage okay no damage that is being stated by the Kaiser effect and when the structure is damaged and you have a big source of acoustic emission then that is being described by felicity effect ok so as I said this is about occurrence of acoustic emission below the previous maximum load so you can define a ratio which is known as the Felicity ratio which goes like this it is denoted as Fr and this is given by the ratio of the existing load at which you see the emission that is PE and the previous maximum load which is PM okay.

So this immediately tells you that if FR is greater than or equal to 1 then you know that the existing load at which emission is occurring it is either equal or greater than the previous maximum load and as we have already seen this means that there is no damage which has happened in this interval okay because as I said this inspection is done in a particular interval so when you're doing the inspection during that interval if you find that Felicity ratio is greater than one then you know that during that particular interval there is no damage to the structure.

Since the last inspection okay and on the other hand if it is less than one then you know that your existing load at which dimensions are occurring is lower than the previous maximum load so that

would indicate that there is some damage in the structure so this is indicative of cumulative or permanent damage this can also be represented graphically as I am going to show you right now.

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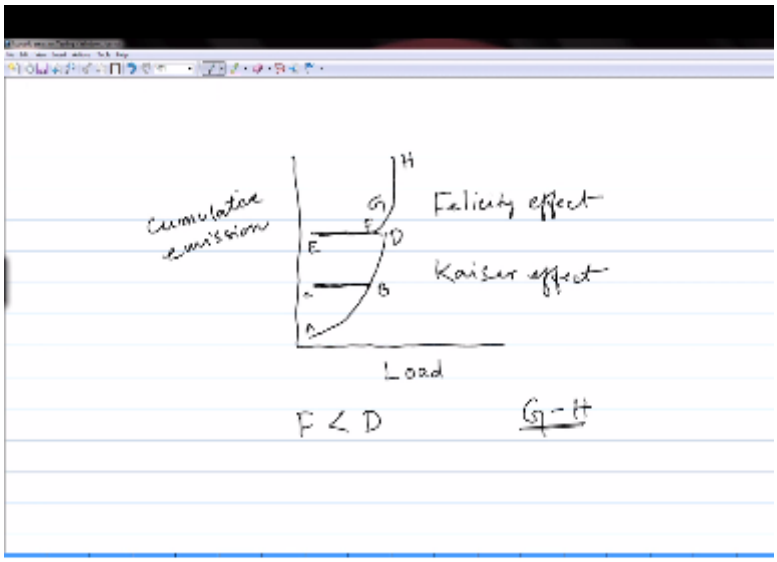

So this is about the load which emissions occurs so x axis is the load and then you see the emissions coming out at a particular load okay so as you increase the load you can expect the emissions also to increase like this so this is the loading cycle it is called that as AB okay then you unload it so BC is unloading and then you again reload it which is CB okay now depending on whether you are getting emissions before B or after be based upon that you come to know whether there is a damaged or not okay so during this loading sorry loading cycle.

Which is CB if you see that the curve is going like this that means you see further emissions only after exceeding B which is the previous maximum load then this as you know by now is the Kaiser effect we said that emissions will occur after you cross the previous maximum load and that is what you see in this case okay so let's say during the next inspection again you do the same thing so this is again unloaded so BD is the occurrence of emissions during the loading again okay.

And then you again unload which is DE and then again the D load which is ED now if you find something like this during reloading here okay in this case so this point F is less than D okay the load at point F is less than point D that means the emissions are occurring before the previous maximum load which was d in this case okay so that means this particular phenomena here is the Felicity effect which is about occurrence of acoustic emissions before the previous maximum load okay.

And then when you see this it means that the structure is already damaged and that is why you see a steep rise in the emissions although there is not much increase in the load but you still see this part is rising almost vertically okay and that is why this particular portion that you see when you have a emission before the previous maximum load or when there is a damaged in the structure then you see this GH part it is almost like happening with no increment in the load okay so that is why this is known as load hold that means the load is held at a particular value load is not really increasing but you still see lot of emissions coming out.

Which is again indicative of some kind of damage to the structure so this continuation of a mission is indicative of unstable structure or unstable structural defects okay so this is how the whole thing the Kaiser and Felicity effect can be described graphically so now if you talk about this different portions of this plot then AB is loading BC is unloading CB is reloading similarly this BD again is loading to higher loads and then you have de unloading and so on okay and then you come to a point particularly.

When the load is on the higher side when you see that the emissions are occurring before the previous maximum load so that is the point F and that's when you get to know that there is some kind of structural defects which are not stable which is making this structure unstable and generating lot of accosting emissions okay so this is how through this to effects you come to know about the structural damage and their relationship with the loading history now we will talk about the acoustic emission signal itself.

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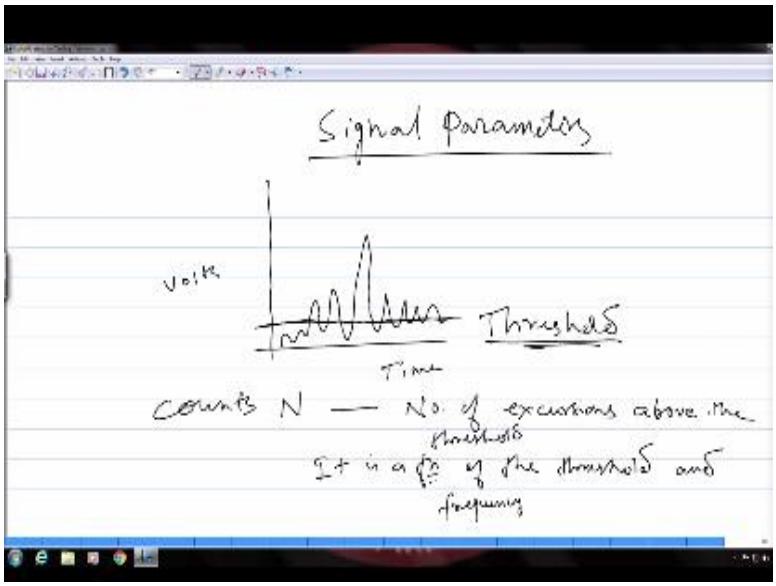

And we will see what are the signal parameters and how these parameters are used to do different things including getting indications about defects inside the part so this signal which is obtained it will be converted in terms of an electrical signal finally for the measurement system to process it and then displayed so these mechanical vibrations or the stress waves which come out sound waves from the sample which are known as acoustic emissions this will be received by the transducer and will be converted into electrical signal okay.

So here again as we will talk about little later you have a piezoelectric transducer which is going to convert these mechanical vibrations or these elastic waves into an electrical signal okay so the signal what do you finally see is in terms of volts that is what I have written over here on the y-axis and then you see it as a function of time how the signal is behaving or how the signal is changing over a period of time okay so when you do acoustic emission testing the first thing that you need to do you need to define a threshold.

And anything above this threshold only taken as a real acoustic emission signal and below this threshold that is considered a noise okay so you may find signals like this some may be below the threshold then suddenly it might go up okay so you could see a signal like this so whatever is

above this threshold which is generally user defined based upon the experience of the user are based upon the part which is being examined this threshold is defined.

And whatever you see above this threshold is considered as acoustic emission events so from this signal you can define certain signal parameters which can be used as I said for our Dean acoustic emission testing first thing is count so that would indicate about the strength of the caustic emission source and this is nothing but the number of excursions or the number of crossing you see above the threshold so all these Peaks that you see above the threshold that is considered accounts or if you take the numbers that is the count.

And this has to be a function of the threshold because that is how you count it anything above the threshold and it is also a function of the frequency and this would certainly depend on the magnitude of the acoustic emission source in fact this would indicate the magnitude of the source and it also depends on.

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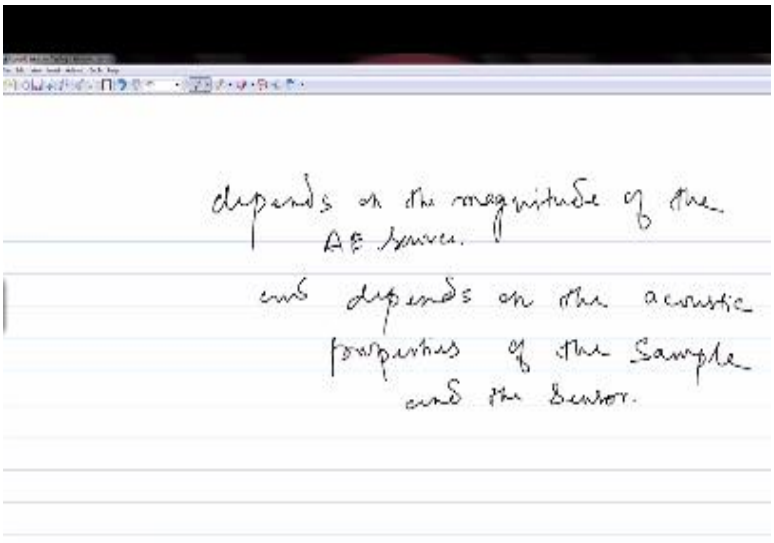

The acoustic properties of the sample and the sensors you so this is the first parameter that we defined and the second parameter is known as the amplitude or the peak amplitude you okay so.

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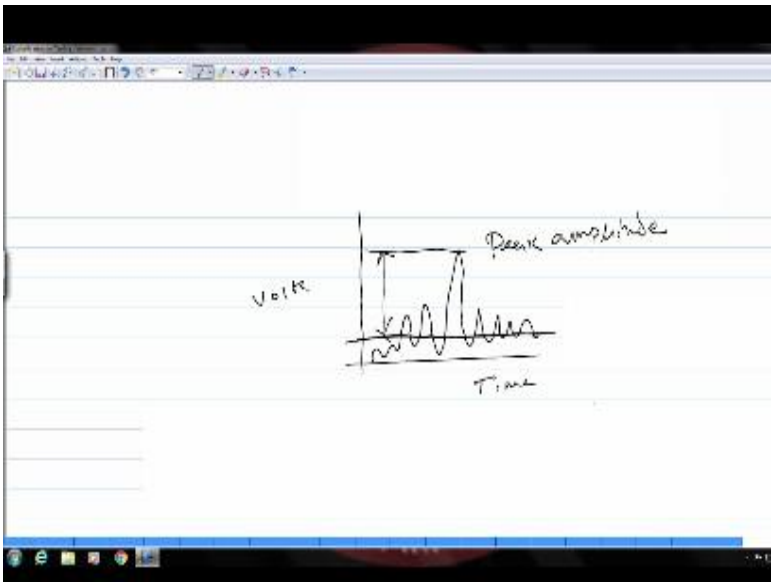

That means the maximum signal that you have which is this one in this case.

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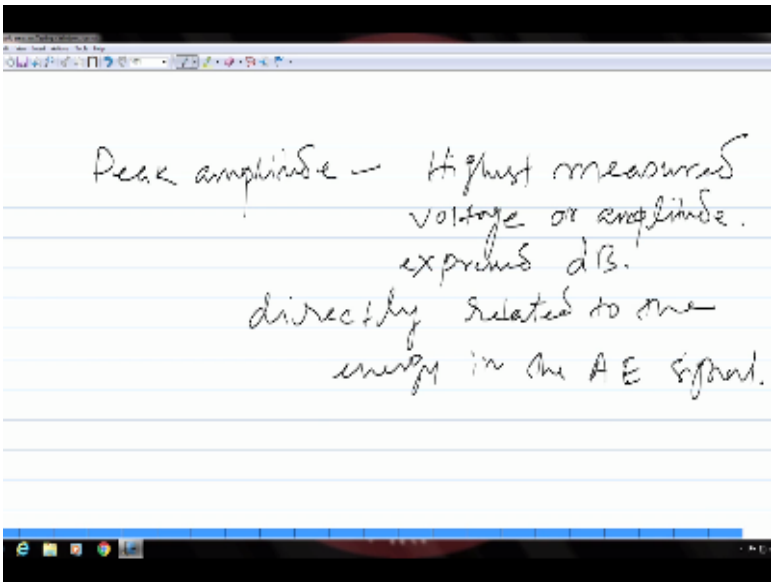

So this is nothing but the maximum or highest measured voltage or signal and since we are talking about elastic waves or sound waves coming out from the sample these are this amplitude is expressed in decibels and this is directly related to the energy in the signal so that means higher the peak amplitude is higher is the energy in the acoustic emission signal okay so there are a few more parameters which can be derived from the signal but today I will not have time to cover that so we will take it up in the next class so for today I am going to stop here I'll see you next time and then we are going to discuss about rest of the things including these signal parameters so I will stop here today thank you for your attention.

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