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Theory and Practice of Non Destructive Testing

Dr. Ranjit Bauri
Dept. of Metallurgical & Materials Engineering
IIT Madras, Chennai 600 036

Acoustic Emission Testing - 5

Last class of this topic we saw the test equipment and we have also seen how the data is presented and how it is interpreted okay in order to know the presence of active defense so here also as you would have realized by now the indications are indirect you have to interpret the results so as I said before whenever the results are subjected to interpretation and whenever they are indirect you need to calibrate the system before you can use it so in this case also we need to do that so let us see in this class today how the calibration is done and then we will see some other aspects and today we are going to finish this particular chapter.

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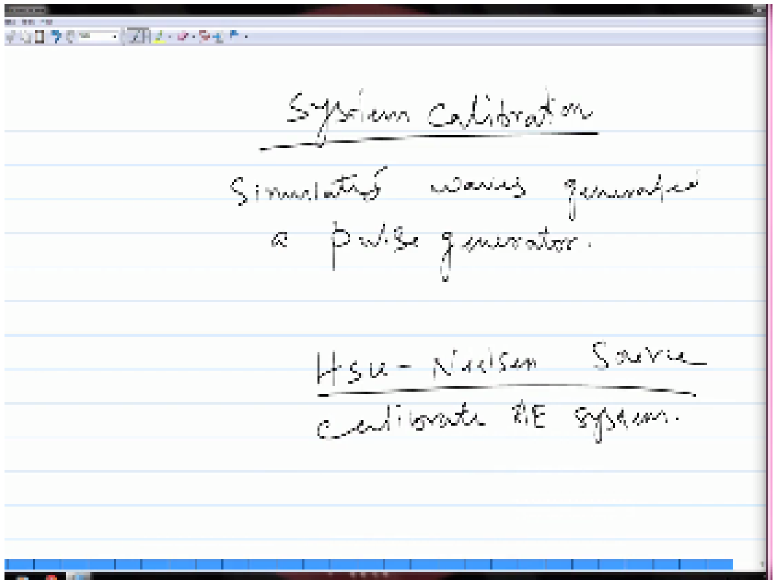

So as you would have seen before in order to calibrate a system you need to have some reference which could generate a signal which can be used as a defect signal and calibrate the instrument okay so in this case also you need to simulate acoustic waves which come out from defects okay so you have to use a pulse generator which can simulate acoustic emission which comes out from actual msn events we can use simulated waves generated by a pulse generator.

But the main difficulty in this is to simulate actual event it is not so easy okay because the actual events happened due to some kind of damage and moving defects and they generate this acoustic emission signals with particular frequencies and particular energy levels and if you want to simulate that it is very difficult to match the parameters of the signals which are coming out from actual defects okay.

So that is a difficulty it has the challenge that one would face in this case when you try and calibrate the system by simulated waves through a pulse generator okay it can still be done but there will be this concerns and limitations okay so in order to overcome this limitation these two persons came up with a method or came up with the source which is very close to an actual acoustic emission source okay so this source of this method is named after the inventors Hsu and

Nilsson so this is known as a Hsu Nilsson method or Hsu Nilsson source to calibrate acoustic emission system okay.

So let us talk about this method this is a very simple method but still quite effective you do not really need you know high-end instrument or expensive pulse generator and things like that what do you need you need something which can generate these acoustic emission events like what you get from damages or defects inside a component okay so instead of using a pulse generator why not use some damage phenomena itself that was the idea behind this particular method so that you would be able to generate waves which are very close to actual accosting a missile waits.

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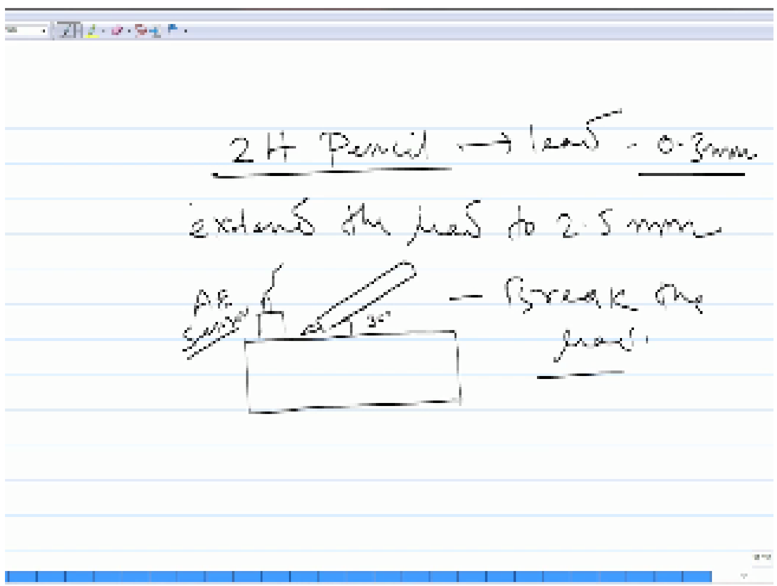

So what is done in this case all you need is a 2h pencil and you simply have to break it okay you have to simply break the lead of the pencil and due to that fracture event okay you could generate lot of acoustic emission so as I told it will be like a phenomena like a damaged phenomena which is similar to the damage and effects that you can expect inside components okay so you take this pencil and then extend the lead up to about 3 mm2.5 mm or 3 mm and this pencil lead is the size of the lead is point 3 mm so then you are take it on a surface or you can take it on the surface of the component being examined that itself can be used to break it okay.

But you have to break it at a particular angle which is a 30^0 so you take the pencil at that particular angle and break this lead by applying some pressure so when the lead is broken suddenly it will release lot of stresses and that will be released onto the surface which will generate lot of vibrations in the atoms at the surface and that is how this acoustic emission will be created and since it is coming out from a fracture phenomena this will be very close to actual acoustic emission events happening inside a component due to a damage.

So this is how they came up with this method which is a very simple yet very effective to simulate and calibrate acoustic emission systems so then you can place the sensor close to this and collect this acoustic emission waves which are generated due to the fracture of this lead and these waves now can be used to calibrate the system okay.

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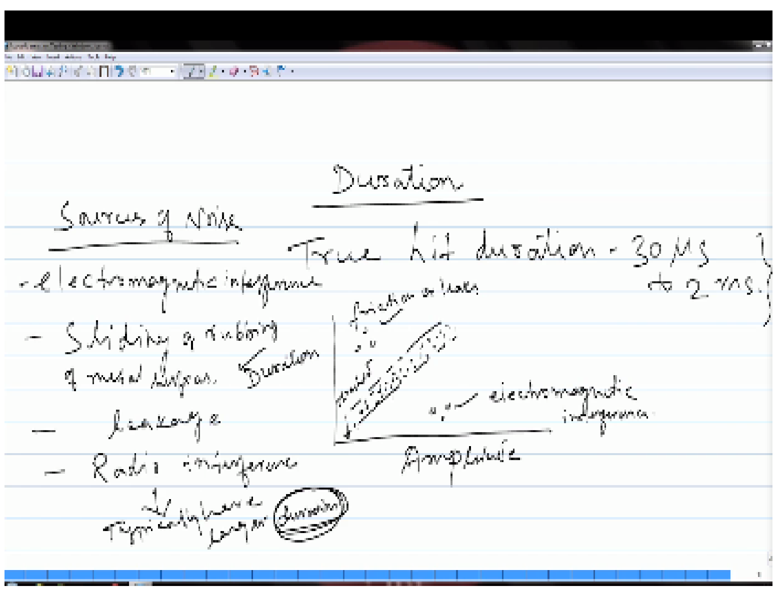

Now the important aspect about acoustic emission testing or for that matter for any other entity testing is to filter out the noise okay because we have seen in these case especially that there could be lot of noise in fact anything below that threshold which is defined is considered as noise okay and if you have a very large amount of noise in the signal then it can create lot of confusion during the testing okay so it is necessary to first identify the noise and then filter it out before you project the data onto the display system for interpretation okay.

So that is the next thing that we are going to talk about as to how to filter out the noise from an acoustic emission signal so there are different methods by which you can do it but you need to use a particular parameter which is closely related to the noise or to the quality of the signal and using that particular parameter you can first identify the noise and then using the instrument and the electronics that you have you could filter out the noise okay.

So if you remember I told you this parameter duration is a parameter which can be used to filter out noise because this is closely related to the quality of the signal meaning the duration of acoustic emission signals coming out from different sources will be different okay so since it qualifies the signal in that manner this particular parameter can be used to identify the noise okay that means if it is not matching with acoustic emission signal which are supposed to come from active defects then you could say that particular signal which is not matching the duration of actual acoustic emissions is some noise which is coming out some from some other sources.

Which are no way related to the sample and the defect inside so true heat duration or the dilution of actual to acoustic emission signal is in this range it is in the range of 30 micro second 22millisecond okay so as I said if you see a signal with other values of duration which is not in this range then it would be it can be identified as a noise okay so that is how this particular parameter as I said before can be useful to filter out the noise but it has to be done now in a particular manner through some controlled experiments and that is what we are going to see now.

So you first collect the heat or the emission signals and then plot them as a function of the amplitude so this will be the data will be in terms of the duration as I said that is the parameter that we are going to use and you plot it as a function of the amplitude okay so if you keep getting acoustic msn signals from a particular source so that signal will increase over time in size and in strength so if you consider the signals you will find them coming like this it will be very distinct and strong indications and this will be all above the threshold.

So if the threshold is defined here so the actual acoustic emission signals will be first of all above the threshold and they will have enough amplitude and they will be very strong which can be easily identified okay so if you keep plotting the duration as a function of the amplitude you will see this will lie along a band like this, all the emission signals which are coming out from actual emission events we lie along this band you might be also absorbing some discrete signals coming here and there.

For example you could have something above the band like that or you may also see something which is below the band okay like this so since these are not falling within this particular band this itself is indicative enough that although these are being picked up by the sensor these are not really coming out from actual acoustic emission events related to defects and damage in a component okay so you should have some idea about what could be those other non relevant sources of emissions which may look like actual acoustic emission events and will be picked up by the sensor okay.

So the non-relevant signals can come from sources like electromagnetic interference so if you talk about the sources of the noise it can come from electromagnetic interference sliding or rubbing of metal surfaces then you could have emissions coming out from leakage or some radio interference it could be electromagnetic interference or radio interference and this kind of signals will typically have a larger diversion compared to the duration of an acoustic emission signal coming out from defects.

So this all will have typically larger duration and that is how based upon this parameter you could identify noise like what you see here they do not fall into this band so if you see this kind of signals which are above the main band this could come from friction or leaks so this have more threshold crossing as you could see because they're above this band.

And then you can have this kind of signals which are less threshold crossing and this may come for example from an electromagnetic interference which will have less threshold crossing and different duration compared to actual acoustic signals okay so like this with the help of this particular parameter duration and with the help of this kind of plot you can identify the noise which are there in the signal and then with the help of the electronics in the instrument you can filter out this noise.

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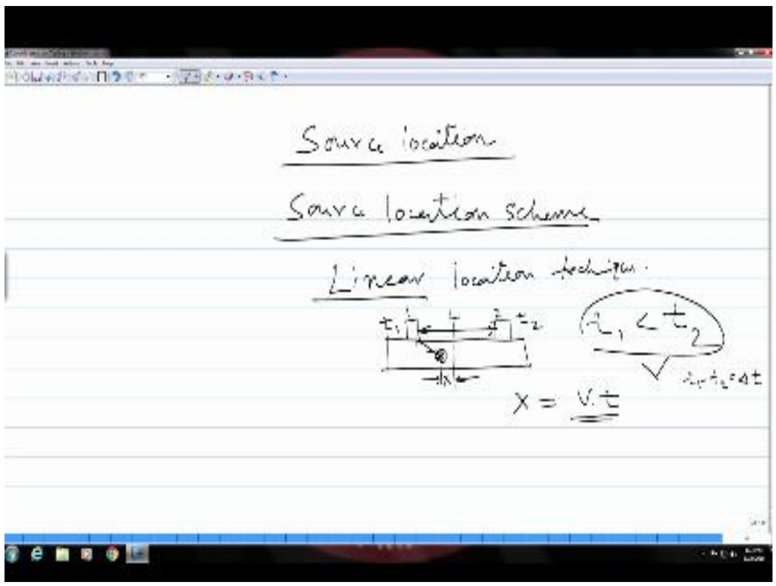

And finally characterize the actual leader and displayed so this is an important aspect of this technique to filter out the noise first and finally we will talk about one more aspect of this technique which is about source location this technique is primarily a qualitative it does not give you any quantitative information as to where the source is located where exactly the location of the source how big is the source and soon however you would be able to get some idea at least about the zone from which these emissions are coming out okay.

So that you know you could take corrective measures around that particular area where you see that lot of m's and events are coming out okay so in order to do that you need to use this method which is known as source location scheme so you can place the sensors at particular locations on the component or on the structure and then you collect the signals from them and based on at what time the signals are being received by different sensors you will be you will be able to get an idea about the location.

For example if you have a linear kind of structure you could simply put two sensors at a particular distance from each other sensor one and sensor two and let us say these are placed at a distance of L from each other so let's say if you have a source somewhere here okay you will be able to receive the signal first by the sensor which is closer to it okay so you will receive this signal by this sensor at time t1and by this sensor it will receive by time t2 so if the source is closer to a sensor 1 then t1 would be less than t2okay.

And if you have an idea about the velocity of sound waves because end of the day these waves which has generate dare sound waves so if you know the velocity of these waves inside, inside the sample material let's say the velocity is V then you will get an idea as to how far is this defect from this center line let us see if that distance is X so you get to know about X if you know the velocity because we know that velocity into time is distance and time we have already calculated so if you take the difference between t1 and t2 if you take the delta T and if you multiply this by the velocity then you will know this distance X from the center line okay.

So this is how you will get an idea about the zone or the location from where this acoustic emission signals are coming out with respect to this centerline okay so this is if you have a linear system so this is a linear location technique but you might have some complex geometry or you know the structure could be complex which may not be exactly linear so in those cases this kind of linear location technique cannot be used so if you have other complex a kind of component or structure to be inspected.

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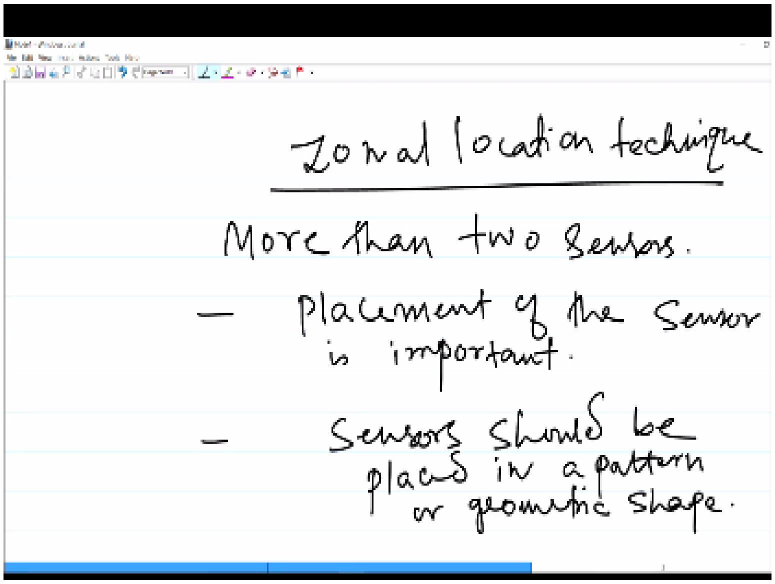

And if you want to get some idea about the location of the sources then you have to use the zonal location scheme so in the zonal location technique you have more than two sensors which are placed at different locations on the structure which is being examined and in this case the placement of the sensors is critical because where you place the sensor at that particular location you should have a potential source of acoustic emission around it.

And also in order to get an idea about the location of the zone of the source the sensors should be placed in a particular pattern or in some geometric shape so that you know how exactly the sensors are placed and what is the distance between them and so on okay.

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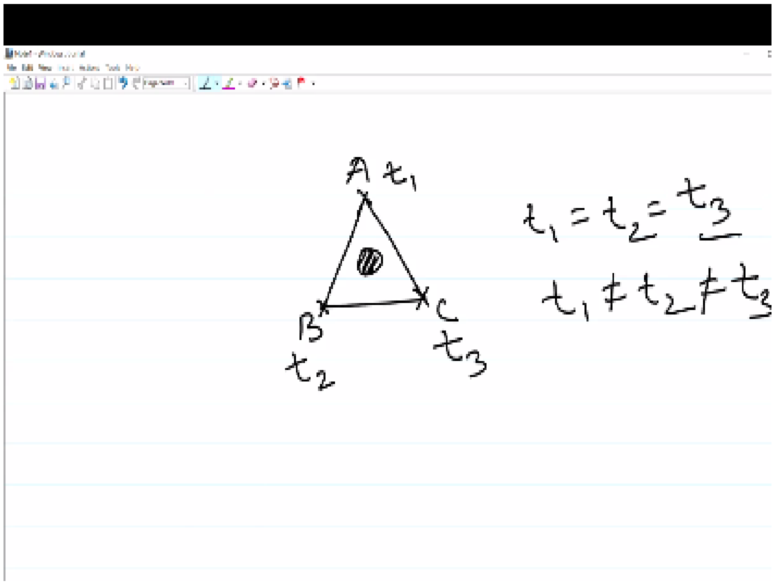

For example three sensors can be placed in a triangular fashion let's say these are the three sensors AB and C which are placed in these three locations okay so like that you should place them in a particular pattern or in a particular shape so that you know how exactly they are placed and as I said you know what is the distance between them so on so that you can identify the locations of the acoustic emission source around them once you do that then based upon the time at which these sensors are receiving the signal.

You can get an idea that within this triangle for example where could be the location of the source whether it is close to the a close to be or close to see okay let us say for example if you if the time the signal takes to reach sensor is t1and it is t2 and t3 for sensor B and C then if t1 is equal to t2 and t3 okay then you know that the source is right at the center of this triangle because all the three sensors are receiving the signal at the same time okay.

On the other hand if this x are not equal to each other then you know that this source is not located at the center and depending on weather sensor a sensor be or sensor see is receiving the signal first you can say that whether the source is located close to censor air close to censor be or close to censor see for example if sensor a this is the signal first then t1 will be less thant2 and t3 and then you can say that this acoustic emission source is possibly close to closer to censor a compared to censor be and sensor see okay.

So this is how when you place a number of sensors around particular locations this will give you an idea based upon these different times that these sensors receives the signal at and that is how the sooner location technique will indicate the zone or the location from where the acoustic emission signals are coming out so this is how you will be able to get you will be able to know at least the zones from where these acoustic emissions are coming out and accordingly you should target those areas while inspecting and taking corrective measures.

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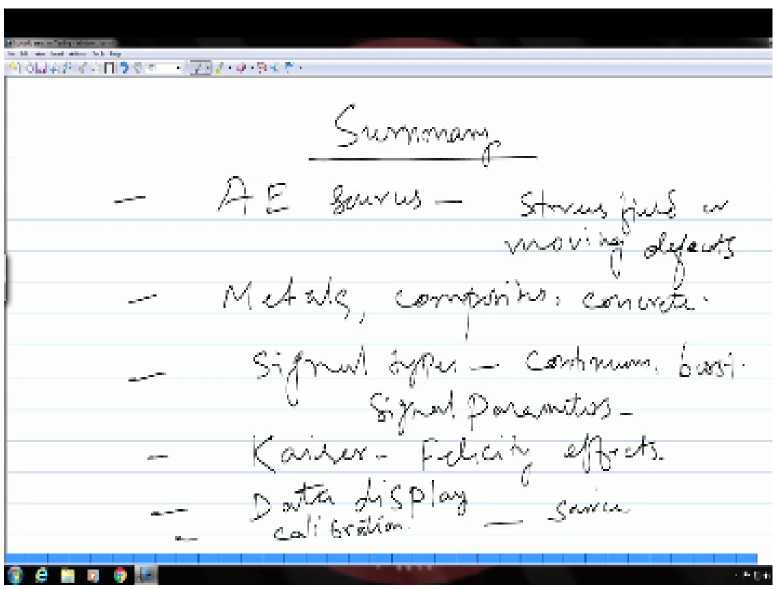

So with this we come to the end of this particular topic so let us take a moment to summarize before we close up so first we learned about the sources of acoustic emissions and then we saw it is due to a stress field or moving defects which generate some kind of elastic wave inside the material that is how these emission waves are generated okay and then we talked about the sources with respect to different kind of material and systems like in metals composites and concrete.

And we had picked up couple of examples one was in metal another was about a propagating crack and then we saw how this kind of phenomena can give rise to acoustic emission and what are those parameters which control the emission levels for a particular phenomena so we had seen that for two cases one was for a propagating crack and another was for phase transformation in a metallic system then we talked about signal types in which case we saw there are two types one is continuous and another is burst type and then we saw the signal parameters.

And also learn about how these parameters are used for doing acoustic emission testing then we talked about these two effects Kaiser Felicity effect he described the relationship between the loading history and the acoustic emission events and then finally we saw how the data is displayed in different forms we also learn about the calibration that Sunil's and method and finally we also learn about this source location schemes which can give you some idea about the location of the source if not the exact location at least it can indicate from which zone these emissions are coming out so we have learned about that also and with this we close this chapter so that means in the next lecture I am going to come up with yet another new topic so I am going to stop here today I will see you next time with that new topic till then bye, bye and take care.

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