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Theory and Practice of Non Destructive Testing

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Ultrasonic Testing - 8

Okay so in the last class we saw the calibration blocks and we learned how these blocks are given a particular number and from that number you could not only identify the block but you could also get the dimensions of the block and also the flat bottom hole that you have to calibrate the instrument okay so in this class today I will see how these blocks are used to do the calibration okay. So we will first takeoff the distance amplitude calibration and then we'll go on to see the area amplitude calibration okay so first let us start with the distance amplitude calibration.

So for this what you need to do first you need to select a particular block number and in case of distance calibration that block is number five block.

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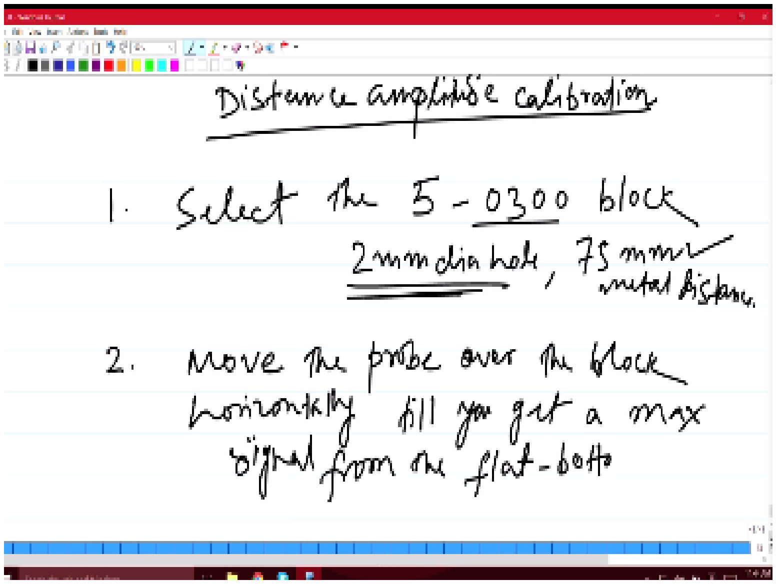

Which is this one okay so the first step is take this block okay so what is this block now you can easily identify what kind of block is this is having a flat bottom hole the diameter of it is 5/64 of an inch or two mm okay and the metal distance in this case as you could see from these four numbers is three inches or 75 mm okay, so you have a 2 mm diameter hole and 75 mm of metal distance in the first block that you have selected in order to calibrate the distance okay.

So now what we are going to do we are going to keep this whole size constant and then very this metal distance by selecting other blocks and collect a number of data points in terms of the distance okay so we will collect the intensity of the Cos coming out from this flat bottom holes as a function of metal distance okay, so with that data we can plot a curve which can be used for calibrating the distance so take that block this number 5 block and do this.

Now take the ultrasonic probe and move the probe over the block horizontally so from one side of the diameter to the other side horizontally you move it till you get a maximum signal from the flat bottom hole okay so you have to move it because you need to get the maximum signal out of this flat bottom hole that means your ultrasonic transducer flow should be right above the hole so that you get a maximum signal okay. And once you get that maximum signal you need to adjust it to one-fourth of the maximum height.

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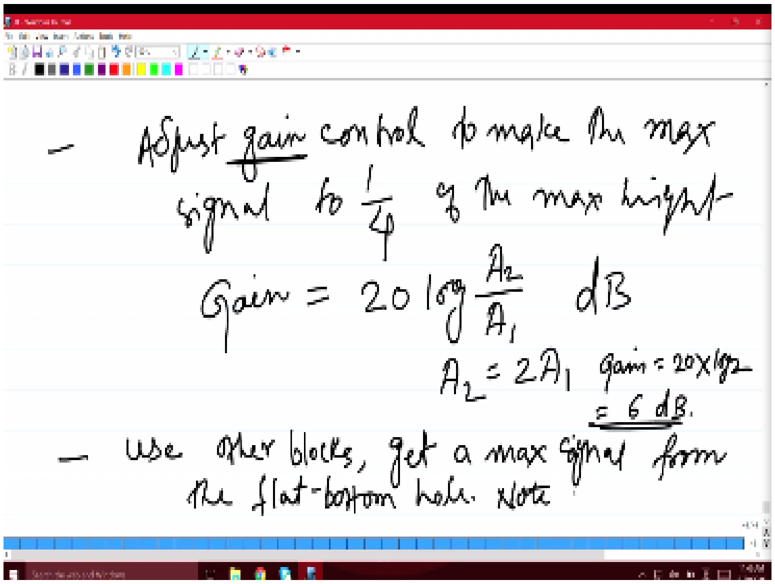

And that you can do by adjusting the gain control that you have in the instrument so bring down this maximum signal to 1/4 okay 1/4 of the maximum attainable height or metal or attainable intensity that you have so you need to do it by using this gain so that means at this point in time I should also tell you what do you mean by gain and how you control it again as the name suggests you may all know this is to increase or decrease a particular intensity or an amplitude of a signal okay.

So in this case the gain is about increasing or decreasing a sound wave signal and it is defined in this case as20 log a 2 / a 1 that means a 1 is the initial amplitude and if you increase it to a 2 so the ratio the log of this ratio x 20 is the gain in sound waves it will be in terms of decibel for example if you increase the amplitude twice okay then gain will be20 x log 2 or 6 decibel okay so this is how gain is defined and there will be a knob on the instrument so through that turning that now we can add just again you can either increase or decrease it okay.

So in this case we need to decrease it by adjusting the gain so that the maximum height of the echo that you got from the flat bottom hole that should be brought down to one fourth of the maximum height okay so that is how you set the control first the gain control and now once you set this gain control and make it one fourth of the maximum height you use the other blocks the other metal distances that you have and after that for the other blocks you do not touch this gain control okay.

So the gain control is set only once in the beginning for the first block and when you obtain the egos from the other blocks okay in those cases you simply need to note down the height of the eco which is coming from the flat bottom hole without adjusting the gain control okay so that is the next step you take the other blocks but in this case also you need to get a maximum signal from the flat bottom hole and once you get the maximum simply note the height of the peak without adjusting the gain control okay.

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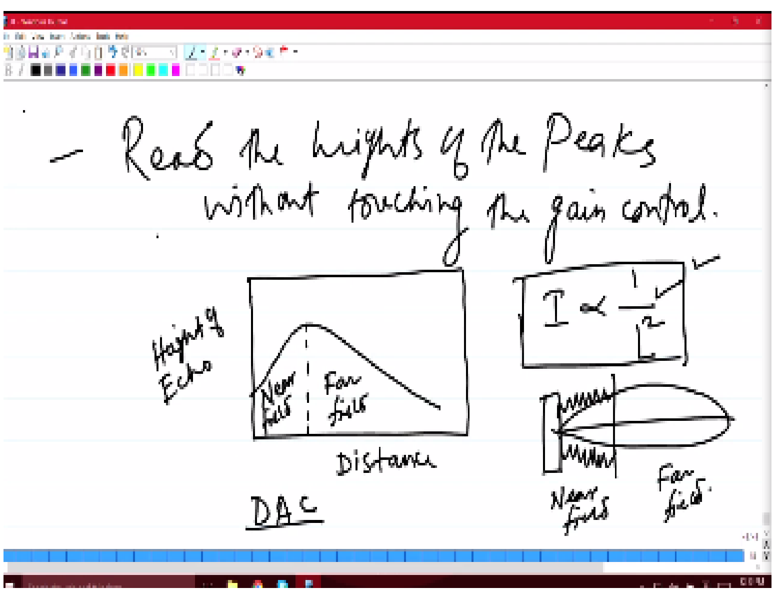

Yeah so that is a next step read the heights of the peaks after getting the maximum signal from the hole for each of the other blocks without touching the gain control so once you collect the data or the intensity or height of the peaks of the egos coming out from the flat bottom hole as a function of the distance then you can take this data and draw a plot okay so that plot will look like this so this height or intensity of the peaks or the Eco from the flat bottom hole that is plotted as a function of distance okay.

Then you will get a curve like this if you plot this which will look like this okay but any intensity with respect to distance goes by this particular relationship that means the intensity is inversely proportional to the square of the distance okay so if I be the intensity and L be the distance so this will be the relationship but in this case you could see first it is increasing then going to a peak and after that only it is decreasing okay.

So after this point it is not really following this particular relationship only beyond this point it is following that relationship and decreasing okay so that means along this line you have two different regions which are behaving differently with respect to the intensity as a function of distance okay, so can you guess what these two regions could be from what we have discussed so far particularly in the nature of the beam which is used to do ultrasonic testing.

So let me explain to you so if you remember in the ultra sonic beam we have seen this the shape of the beam is something like this and then close to the probe we have seen that there are a lot of fluctuations and this particular region is known as near field and the other one is far field okay so in the near field there are a lot of fluctuations so even after transmitting the probe will still vibrate for sometime okay and by that time if any echo comes back to it would not be able to receive.

Because any transducer when it is transmitting cannot receive okay so for the probe to receive the egos these all the vibrations that you have so die down completely okay so that means in the near field if the eco is coming from a very small distance from the probe then the probe will find it difficult to receive that eco okay on the other hand if the eco is coming from a larger distance within the near field then the receiving will be better and the signal intensity will be higher okay.

Signal intensity which is being received by the probe within the near field then in that case will increase as the distance is increased within the near field okay so that means in this case this region that you have where you see that the intensity is increasing with increasing distance is the near field because as I told in the near field if you increase the distance the receiving is better because the pro will have longer time for all these fluctuations to come down and then it will be ready to receive okay.

So as you increase the distance in the near field the receiving would be better and the signal intensity would be higher okay so that that is exactly you see in this in this distance amplitude curve okay and that means the other side that you have the other region that you have that is the far field wherein it will follow this particular relationship because in the far field there is no question of any fluctuation so when you are in the far field the signal intensity of the egos will decrease as the distance is increased okay.

So that is why the curve the DLC curve or the distance amplitude correction curve looks like this it first increases as a function of distance then it decreases okay so this was about distance amplitude calibration or distance amplitude correction now let us go ahead and see how the area calibration is done okay so we could use the same blocks.

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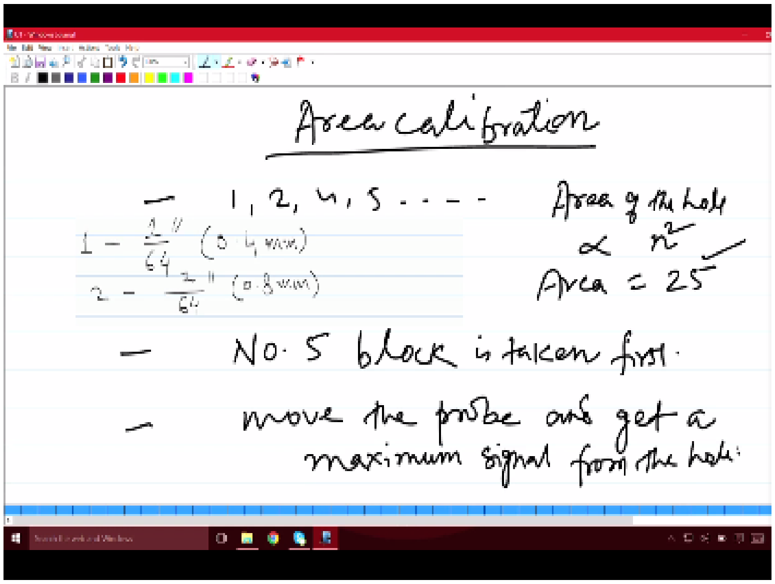

But for calibrating the area as I would have said before also you need to keep the metal distance fixed and you have to vary the size of the hole or the area of the hole okay so let us see how the area calibration is done so in case of blocks which are used for calibrating the area Lee a single number is given like 1 2 3 4 5 and so on okay this is according to the size of the hole that you have because in this case as I said you need to vary the size of the area of the hole and the numbers are given in such a manner that the area of the hole is proportional to this the square of the number okay so for example if you have selected a number 5 hole then the relative area will be 25 okay.

So this is how you can collect the data or collect the signal intensities from this whole as a function of the area by simply providing the square of this number as the area actually these numbers are given in accordance with the diameter of the holes in terms of one by sixty fourth of an inch for example if the number is 1 then you know the diameter would be 1 by 64 inch or0.4 mm similarly to will be 2/ 64 inch or0.8 mm.

And so on okay so now you can easily correlate why the area of the hole is proportional to the square of the number okay so in this case what do you do like what we have done for calibrating the distance you first select a particular block so in case of area calibration the number 5 block is first taken so that is your first data point and as I said this for this block the area of the hole to be 25 because as I said the area is proportional to the square of the number. So take this a number 5 block move the probe and get a maximum signal from the whole okay.

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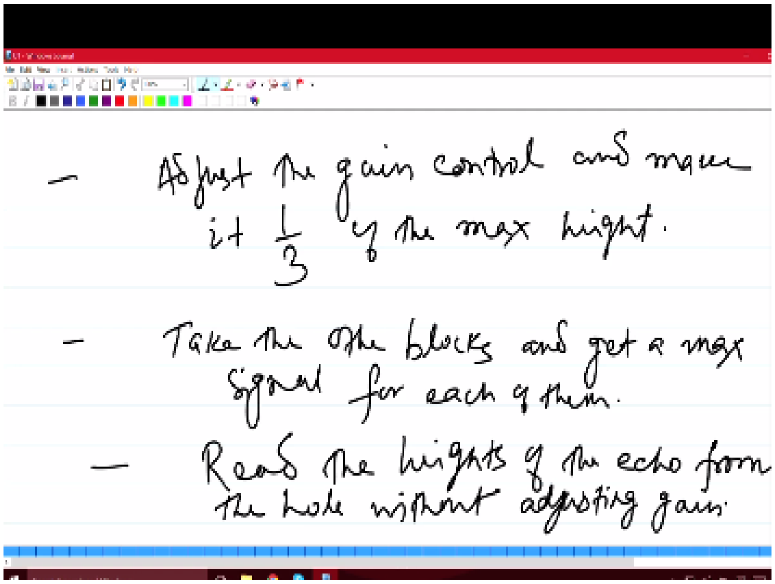

Once you get the maximum signal adjust the gain control and make it one third in this case of the maximum height of the eco okay so in case of a distance calibration we saw it was adjustment was done up to one-fourth of the maximum height and in this case we do it up to one-third of the maximum height and next like what we have done before also take the other blocks and get a maximum signal for each of them and then next is read the high of the eco for all other blocks the eco from the hole without adjusting the gain okay.

So this is how you collect the data you first take a particular block which is number five in this case get a maximum signal then adjust the gain control make it one third and four rest of the blocks you simply get the maximum signal from the flat bottom hole and note down the height of the echo's okay so this is how you get the data the intensity of the eco as a function of area of the holes.

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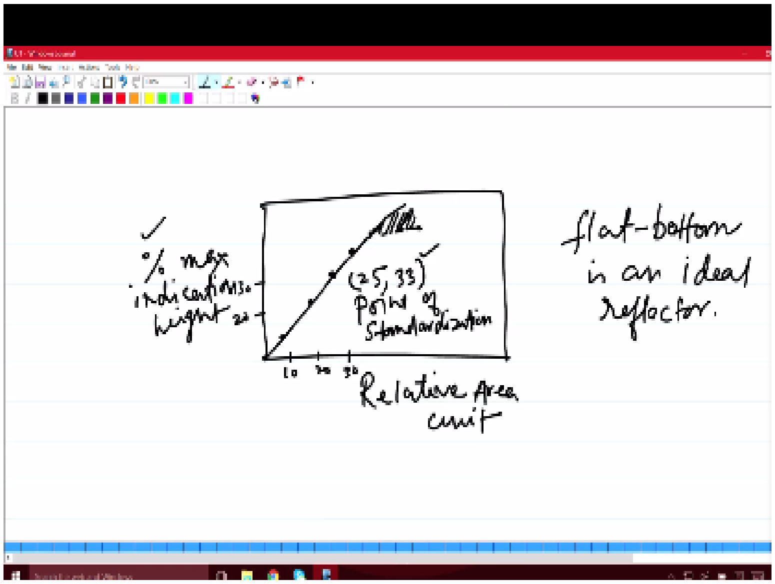

So now you need to plot it so plot the heights so in this case we can plot in terms of percent of maximum indication height as a function of relative area relative area because the area is proportional to the square of the number relative area unit then the curve the plot will look like this okay so in this case the first data point if you remember was for one-third that is around thirty three percent so let's say this is 20 and this is 30.

So it was and it was for a number five block so this relative area is proportional to the square of the number that means the first point was 25 and 33so it was somewhere around here okay so this is your first data point which is25 33 because we have plotted in terms of percentage in the y axis so that is thirty-three percent in this case or one-third and x axis is the relative area which is the square of the number of the block.

So this was for number five block which means it is 25 okay so first what you do you draw a curve or draw a straight line through this point and the origin okay so since your reference point or the point with respect to which you are standardizing the whole thing is this, this particular point is there foreknown as point of standardization okay and then you see rest of the point show they are where they are falling.

Whether they are falling on this curve or if there is any if you note any deviation if there is any deviation you simply have to note that deviation for a particular hole size and when you do the test this is the correction that you need to provide okay for that particular size one thing you should remember here you are getting some idea about the size of the defect because that is what the idea is in this case okay you have calibrated the area by using these holes and now while you are doing the actual test.

If you get a signal whose intensity is matching to the intensity of any of the holes then you could say that the size of that flaw is close to the size of that particular hole okay but one thing you should remember this flat bottom holes that we have introduced by precisely drilling okay is an ideal reflector but the actual flaws are not ideal reflector okay so what does that mean that means the idea of the size that you are estimating from this particular curve is the lower limit of the size of the flaw okay.

So that means the size if it is matching with the whole you can say that the size of the flaw is at least equal to that particular hole whose eco intensity is matching with the eco intensity of that particular flow okay so it is at least equal to that it may be bigger than that but we can say that it is at least equal to the size of that particular hole okay so this is one thing that you should keep in mind that size that you estimate from this particular calibration curve is the lower limit for the actual size of the floor okay.

Right so this is how using this set of blocks you would be able to calibrate the instrument the ultrasonic instrument for distance and for area so when you calibrate the instrument for distance the advantage that you have let me tell you apart from you know to make it free of error that is the first objective of doing calibration but in this case the another advantage that you have when you calibrate the instrument for distance is that.

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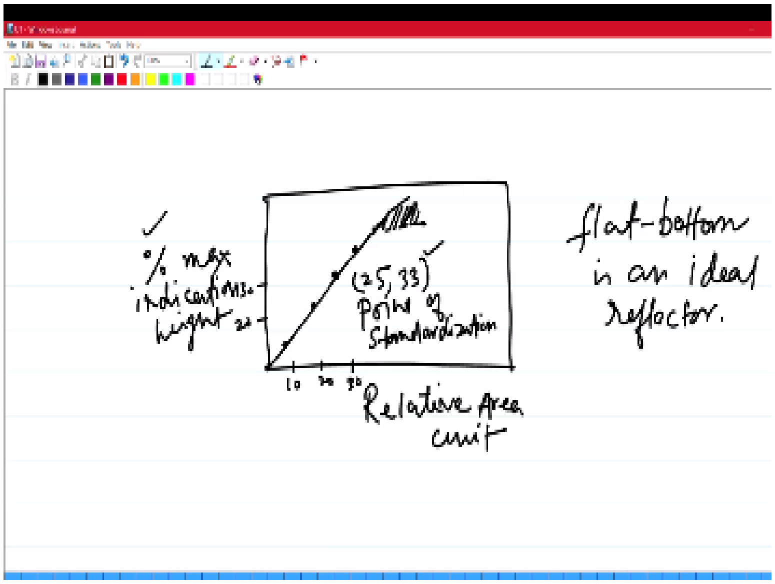

You would be able to get some idea about the depth or location of the defect if your instrument is properly calibrated okay because this time base that you have in the display so this is the initial pulse this is the back wall and x-axis shows you the time the time at which the eco's appear k to the probe or the eco's come back to the probe so this time can be converted into distance if you know the velocity of sound wave in the material which is being tested.

And most of the time it is known because in most of the common metals alloys and many other materials the velocity of sound is known so if you provide the velocity of sound this time can be converted into distance because we know distance is velocity into time okay but in this case the other thing that you should remember okay this has to be divided by two because the waves are going back and forth it is going here hitting the reflecting interface which could be the back wall or any other defect or flaws.

And then coming back okay so this is going back and forth so that is why when you calculate the distance it has to be divided by two okay so that means once you give this V as an input to the instrument this time base can be converted into depth or distance and now if your instrument is properly calibrated with respect to depth or distance then you could see what depth a defect is appearing so that is where the defect is line which you could see directly on the display itself okay.

So this is the advantage that you have when your instrument is properly calibrated similarly if you calibrate the instrument for the area then as I said you would be able to get some idea about the size of the flaw at least the lower limit of the size okay so by doing the calibration you are not only getting error-free results but you also get to know or you get some idea about the location of the defect and some idea about the size also okay so ultrasonic testing in that sense provide you some quantitative information.

Also although it is primarily a qualitative test but through this kind of calibration and this kind of calculations you would be able to get some idea about the depth teach the defects are located and also some idea about the size of the floss okay so this is how calibration helps you but as you could see in this case this is primarily for a normal probe okay which is going perpendicular to the surface like this but there are many scenarios in which you have to use an angle pro you have to use an incident angle.

And for that case also you need to calibrate the instrument and as you would have realized by using this kind of simple cylindrical block you cannot calibrate the angle pros because here there is no incident angle as such so that means when you want to use an angle probe you need some other kind of reference block or calibration block which would be able to calibrate the angles as well okay so that is what we are going to talk about next as to how to calibrate angle probes and what kind of calibration block is available for calibrating the new probes okay but for today this is all I will have I take that up in the next class but for today I will stop here thank you for your attention.

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