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Theory and Practice of Non Destructive Testing

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Ultrasonic Testing - 10

So we are back again on this topic ultrasonic testing and today we will see some applications but before that let me also talk a little bit about what kind of displays you can see in ultrasonic testing there are two or three different types of displays that can be shown on the screen and depending on the requirement one of these displays can be chosen the most commonly used the display is in terms of the amplitude and the time that we have been seeing so far and that particular display or the C scan okay. So let us talk about them also and see how they look like.

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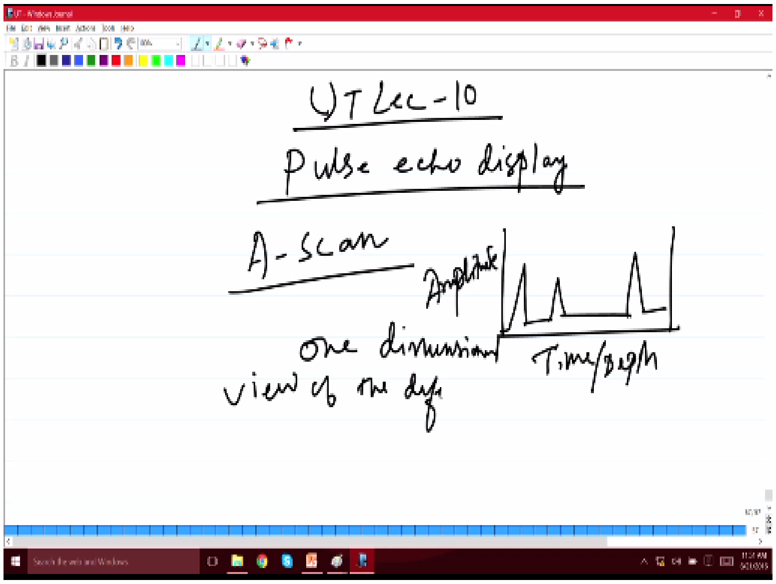

So as I said this A scan we have already seen which is a display like this amplitude plotted against time or depth and you see the signal in terms of a deflection of the time base or a peak like this okay so this is A scan so this is one dimensional view of the defects.

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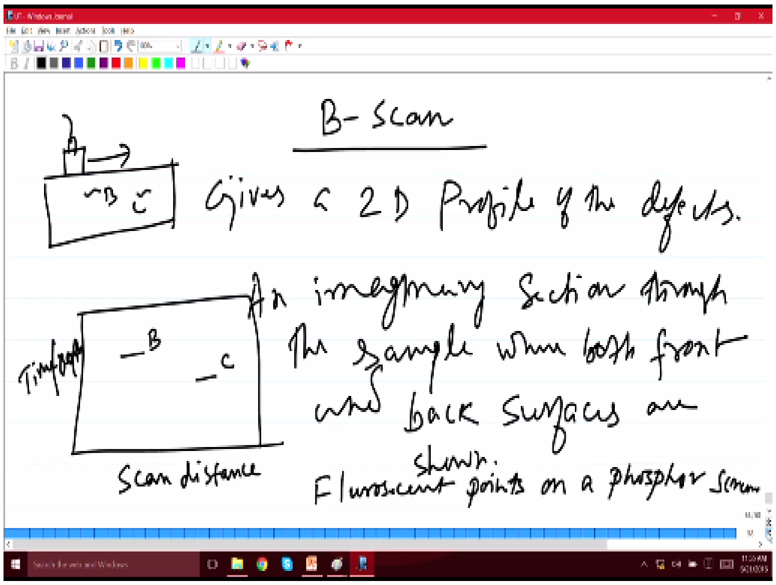

Then you have B-scan and in this case this gives you a 2d profile of the defects and this display is basically an imaginary section through the sample wherein you can see both the back and front surface and you will see at what their defects are lying when the defect eco appears on the display okay so that is how it generates that 2d profile of the defect okay so this is what it is and if you look at the displace the display will be like this so the time or depth in this case now will be in the y axis because as I told the depth will be directly shown on the display and this x-axis now will be scanned distance okay.

So this will be shown on a fluorescent screen and you will see the defect eco as fluorescing points coming into the display and staying there for some time so that you have enough time to see and visualize them so let us say if you have a sample like this and you have two defects at two different depths and now you have taken this probe and you are moving the probe on the surface so the moment it goes over these defects then you will see them coming in this display at that particular depth like this okay because as I said this is an imaginary section through the sample where you can see the depth where you can see both the front face and the back face or you can see that there so this will come as you know fluorescent points on a phosphor screen so instead of the oscilloscope screen that you have case of A scan in this case you have a phosphor screen with these defects signals will come and florescent at the particular depth where the defect is lying okay. So this is how the displays in this case in the case of B scan and the other one.

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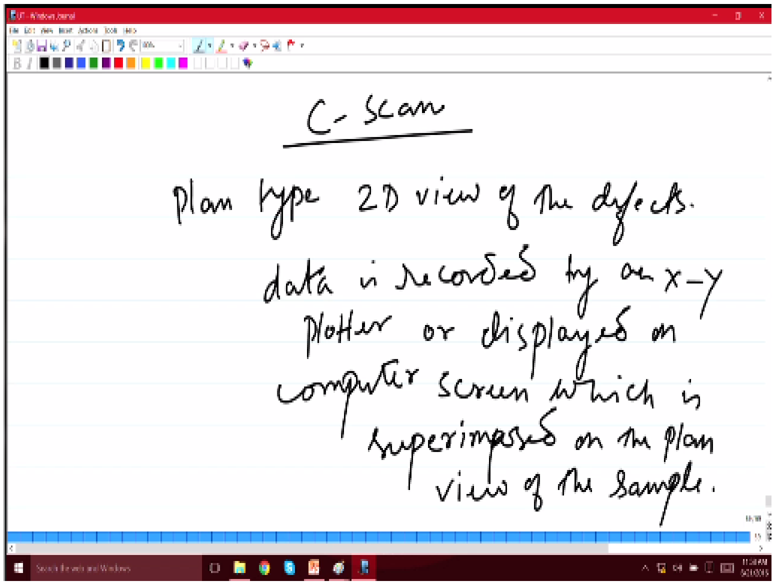

The next one is C scan and in this case you have one type / 2d view of the defects and in order to generate that this has to be plotted either on an XY plotter so the data is recorded by an XY plotter or it can be also shown on a computer screen which is superimposed on the plan B of the sample okay so you record the data and the neither you can plot it on XY plotter or you can show it on a screen which will be superimposed on the plan view and that is how this plaint type B will be generated but in order to create.

That in this case the data has to be recorded as a function of each of the reflecting interfaces unlike the previous cases where you simply send the ultrasonic beam and get an eco from defects or from the other surfaces in these case you need to collect the eco as a function of for the position of the reflecting interface okay and in order to do that you need to move the probe in a particular fashion like this.

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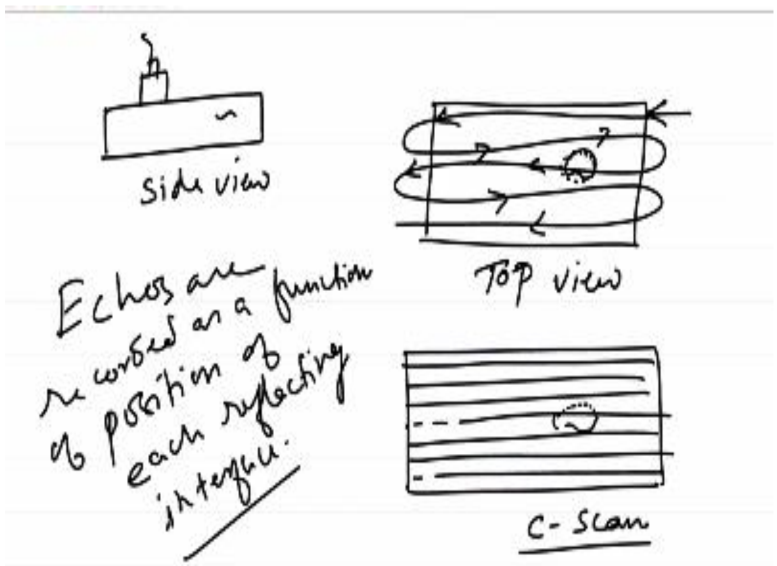

So let us say there is a defect on this sample so this is the side view of the sample and the top view is something like this, so in order to generate that plan type view of the defects you need to collect the data as I said as a function of the position of each of the reflecting interfaces and in order to do that you have to do the scan following a particular pattern like this so you have to go like this in a zigzag manner like this.

And so on okay so if this defect if you see the 2d view it may be something like this and now since you have collected the eco as a function of each of these reflecting points okay you will see a 2dtype of view in the display when it is finally displayed on the system okay so this is the cease can view this is how it will look like so it will show that top view of the plan view and you will see a profile of this defect at that particular location okay.

So as I said the in this case the ECO are collected recorded as a function of position of each reflecting interface and with that you will get a scan and a view like this so these are the different types of cans or views displays in case of ultrasonic testing.

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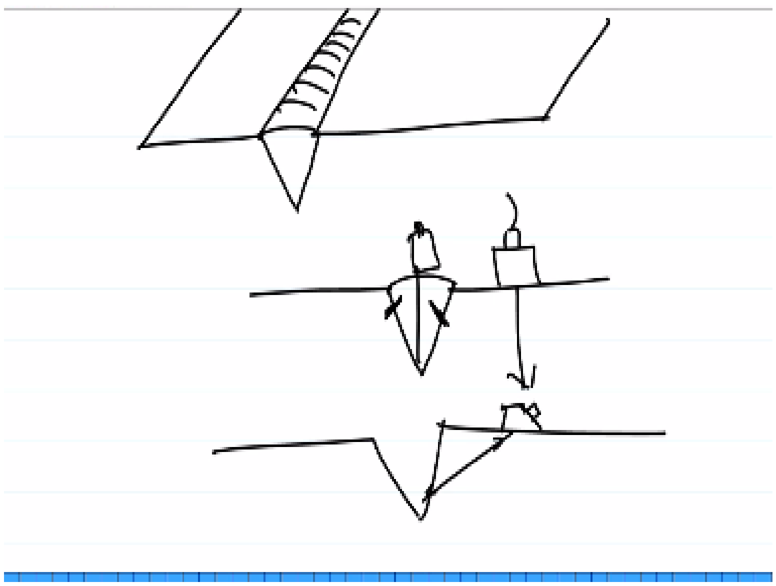

Now we are going to see a very useful application of this particular technique which is for inspecting the welds okay welding and entity they go like handing globes okay whenever you do a welding process it is followed by NDT so that you find out if the weld is sound or not if there is any welding defect or not okay and many times you would have seen a welding joint like this okay where these two plates are joint across.

So this is the weld okay and if you see the view so this is across this interface okay these two plates are joined so this will be the wait okay so in this case as you would have realized you cannot use a normal probe because in that case it will simply go like this even if you keep it on the top of this there are this surfaces the welding join is here so it is not appropriate to use normal probe in this case okay.

So what we need to do in this case we need to use an angle probe so that you would be able to inspect these surfaces like this okay so when you have a scenario like this.

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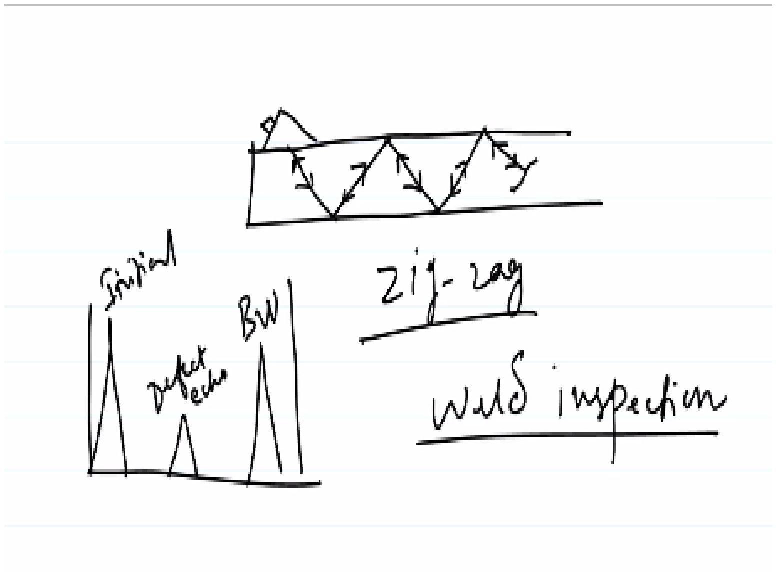

Where it is send at a particular angle what is going to happen is this is going to reflect back and forth like this, so first it will reflect from the back wall and then it is again go to the top surface and then again come back like this and so on okay so that means that back wall ECO that you see in case of a normal probe you are not going to see that in this case okay so this eco will come back only when it encounters an interface which could be a discontinuity or a defect.

So when it encounters an interface reflecting interface then it is going to reverse the direction and follow the same path and we will come back to the probe and that is where you get an eco from a discontinuity which is present in the path of this beam which is going in a zigzag manner like this because of that incident angle okay so that means in this case as I said you do not have the back wall each we have used in case of normal probe as the reference okay.

So if you remember our reference was always this back wall signal this was the initial pulse and this was the back wall and we use this back wall as the reference and we said that anything coming before the back wall like this is a defect but in this case we do not have the back wall because the back wall signal is not going to come since it is going to go in a zigzag manner like this, so that means for welding section where you do it by angle probe.

You need to find some other reference which can be used like the back wall signal okay so let us see in this case what is that reference that we can use to characterize defects and find out the defect eco on the display.

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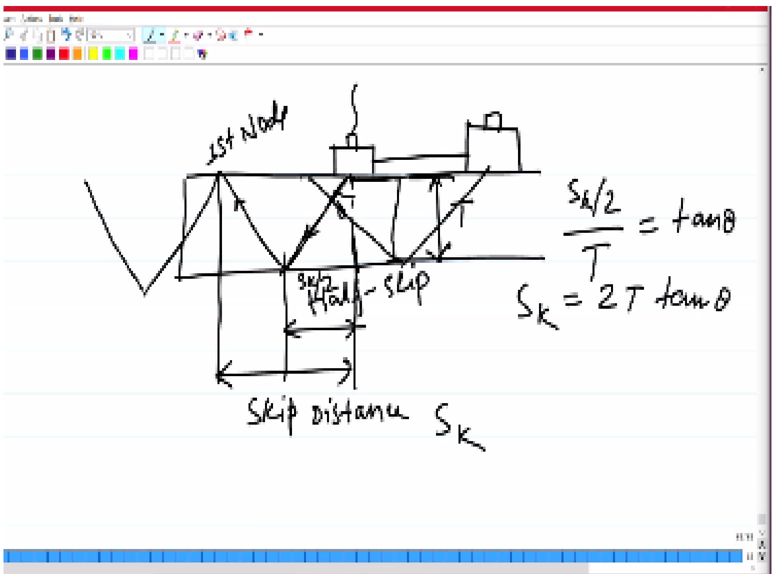

So this is the incident angle and it will hit the back wall and then again go back to the top surface so this point when it is coming back to the top surface again is known as a node so this is the first node and then we will be having second third and so on okay so the distance between this first node and the probe is known as skip distance okay, so this point where it hits the back wall that is half of it so that is half skip okay and if the thickness of the sample if it is T then you could see that this if we call this skip distance as sk.

So you could see this sk / 2which is this distance by t is equal to tan θ which gives you the skip distance as 2t tan θ okay, so this is how you can find out for a given thickness and for a given beam angle what will be the skip distance okay so what you need to do in case of inspecting a weld is to keep this probe at hop skip and when you do that you could see that it will go all the way to the bottom of the weld and then you have to move it to full skip because when you move it to full skip from hop skip then it will go all the way to the top okay.

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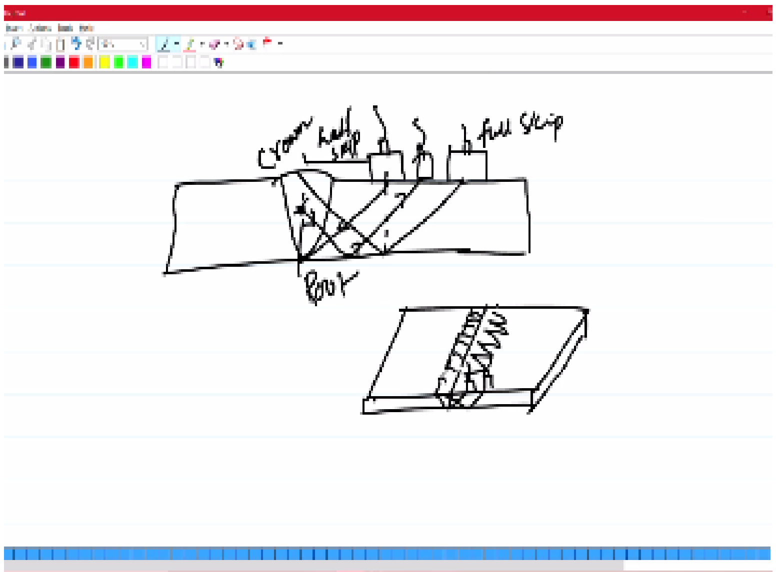

So if you see it in case of the weld let us say the veiled is like this so when you keep it at half skip then this will go all the way to the down and this will hit the route okay and then when you move it to the full skip then it will go all the way to the top okay so since you need to inspect the entire weld from the root to the crown so this is your route and this is the crown or the top you need to move it from half skip to full skip because as you could see when you move it from half skip to full skip that is going from bottom to all the way to the okay.

So if you had somewhere in between here then it will go to somewhere in between into the weld and if there is any defect then at that defect interface this will reverse the direction as I said before and then it will come back to the probe okay so that is why in this case first of all the reference is the half skip and you need to move the frog from half skip to full escapes so that you can cover the entire world from the root to the crown okay so when you do the inspection this is how you need to move the probe.

So let us say this is the well that you have over here okay, so this well they are going to inspect and you need to keep that pro fast at the half ski so then it will go to the root and then you have to move it to full scale as you do the inspection okay, so for the entire well you need to do this you need to move in this fashion you have to move from half to full half to full like this it may not be the exact skip distance but you need to ensure that you are covering a distance which is from half to full skip distance.

So you need to move your probe that way as I showed this particular diagram so that you do not miss out on any portion of the way okay, if you do this removing the probe from hop skip to full skip you can you will be covering the entire weld as I said from top to the bottom okay so this is how you should do a weld inspection by using ultrasonic angle probes and in this case your reference will be half skip for example if you have any defect near the root you can see it with respect to the half skip let me show you that.

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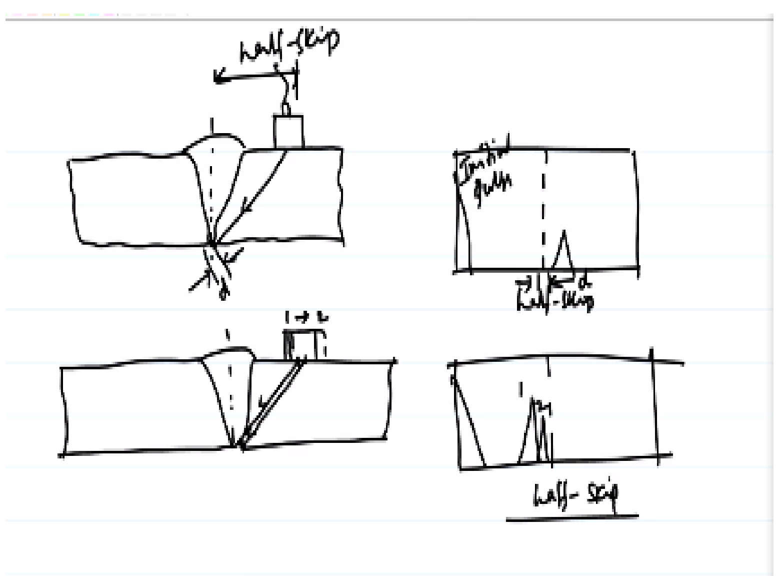

Okay so this route has a particular round kind of safe and let us say the root diameter is d okay and if you keep the probe at half skip then this will go to the root and you will see on a display you will see a signal like this so here also the first thing that you see is the initial pulse and then you will have the half skip distance that distance is known for a given angle and a thickness and in this case you would see since it is going all the way to the half skip we will see the eco from the root at the half skip in this fashion okay so that means this particular distance is the root diameter d okay.

So this is how in case of weld inspection by angle beam probes the reference will be the half scale let us say for example if you have a defect let us say you have some kind of root cut or lack of fusion due to which there is some improper fusion between the plates and at the root there is a opening like this so in that case if you keep your probe again at the half scheme so even before it goes to the road it will encounter this defect okay.

Because there is now an opening and now if you see the display your initial pulse and the half scale and it will appear before the half ski because now although you have kept it at half skip distance but it is not going all the way to the root since there is a defect over here and opening over here so it is stopping it is encountering that interface which is before the root and then it is going back to the flow.

And that is why you will see this defect eco coming just before the half screen you can confirm it with that whether it is a root cart or a lack of fusion kind of defect if you move this a bit to let us say a new position like this okay so in that case this will also move closer to the half scale so if the first position was one and then you have moved it to two then this is corresponding to one and this will be corresponding to two okay.

So by moving this you can confirm that at the root there is an opening or there is a defect due to which you see this eco coming before the hop skip and as you move little bit away from hop skip distance this eco is also moving towards the half scale okay so this is how the half skip distance act as a reference in case of weld inspection okay.

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So if you have any defect or something into the weld let us say over here or over here inside the weld if you have any defect and then you keep it in the hop skip it goes to the root and then as you move away from the hop skip it is in between half scape and full skip if you keep it then it can go and encounter these defects which is inside the wave and the moment it encounters this defect interface as I have said before this will reverse the direction and come back to the probe and that is how you will see the defect eco with respect to the half skip distance.

So the defect people now should appear after the half ski because in this case as you would have seen here this distance is more than half scape so in order to get a signal from the defects which are inside the well or which are in between the top and the bottom of the well then you have to keep the probe more than half scape and that is how the defect will appear after the half scape in this fashion okay.

So this is how the half skip distance will serve as a reference for inspection of welds by ultrasonic testing right so now we will see some more applications of this particular technique and then we can close this chapter.

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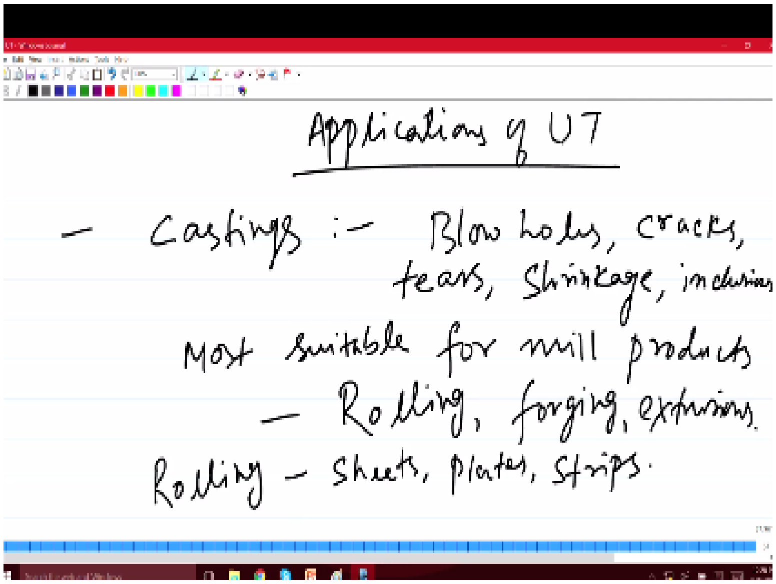

Weld inspection we have just now seen but this can also be applied for castings for defects like blow holes cracks test shrinkage so these are the most commonly occurring casting defects inclusions etcetera okay but ultrasonic testing is most suitable for mill products which are given some kind of shape by a metal forming process like rolling forging extrusion and so on so these are called the mill product.

So the defects that you encounter during this metal forming processes such as rolling forging and extrusion those kind of defects can be easily inspected by ultrasonic testing for example in rolling like you can have this kind of products see it then plates strips okay and there are different kinds of rolling defects which can be inspected similarly in extrusion also the kind of X ocean defects that one encounters those can be inspected by ultrasonic testing welding.

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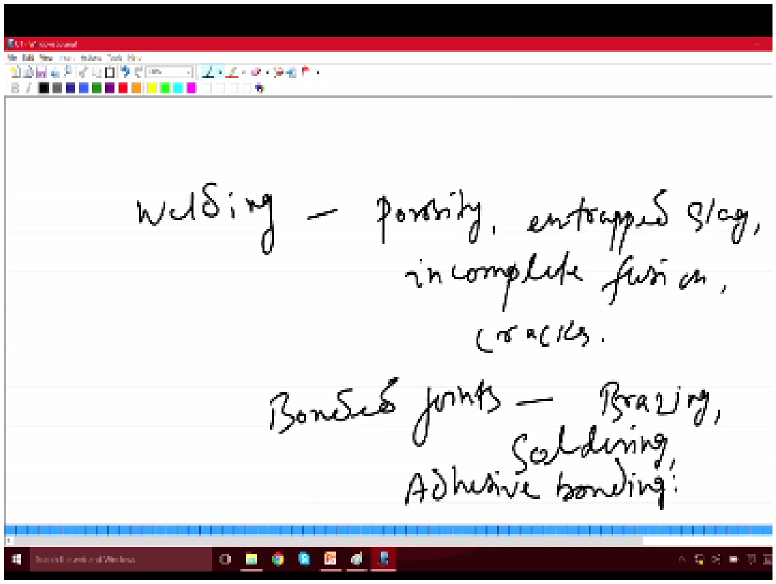

We have already seen so these are the kind of welding defects that can be found out by this ultrasonic technique tracks and so on okay then bonded joints also to find out the soundness of the joint whether the joint is good or not there again ultra sonic testing is very useful like if you have this breast or soldered bracing or soul during joins or adhesive bonding so in all these cases in order to find out whether this bonding is good or not the soundness of the bonding whether it is good or not are the ultrasonic testing can be utilized okay.

So these are some of the applications of the technique there are many more but these are some of them so this will bring us to the end of this particular technique and before we close this chapter let us summarize and see what all we have learned for this particular thing.

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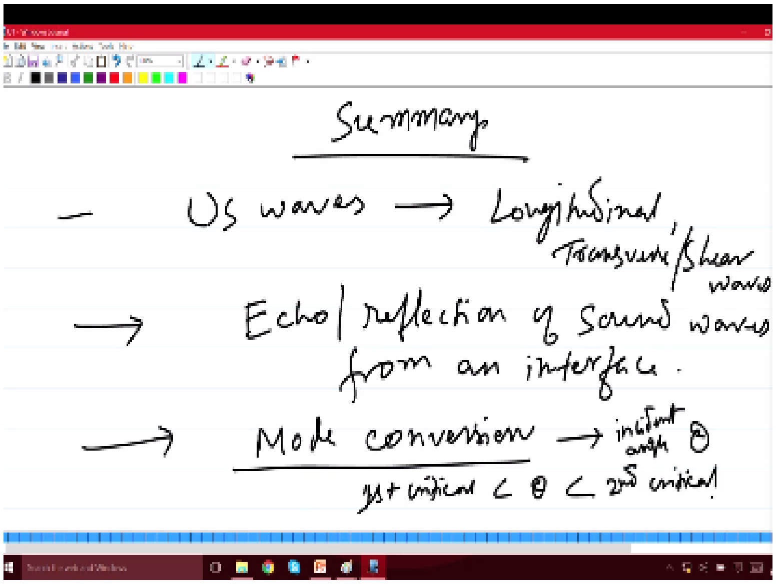

So first we learned about the basic nature of ultrasonic waves and then we saw different types of waves like longitudinal and transverse or shear then we went on to see the basic principle of this particular technique which is eco or reflection of sound waves from an interface which could be the discontinuity or the defect itself okay so then we talked about something called mode conversion when you send the waves at an incident angle a part of the longitudinal wave can convert into shared wave.

And then I told you that if you want to do ultrasonic inspection by using angle beam then it is better to exclude the longitudinal wave and keep the share wave and for that we saw that the incident angle has to be between the first critical angle and the second critical angle and we derive this first critical and second critical angle based upon Snell's law.

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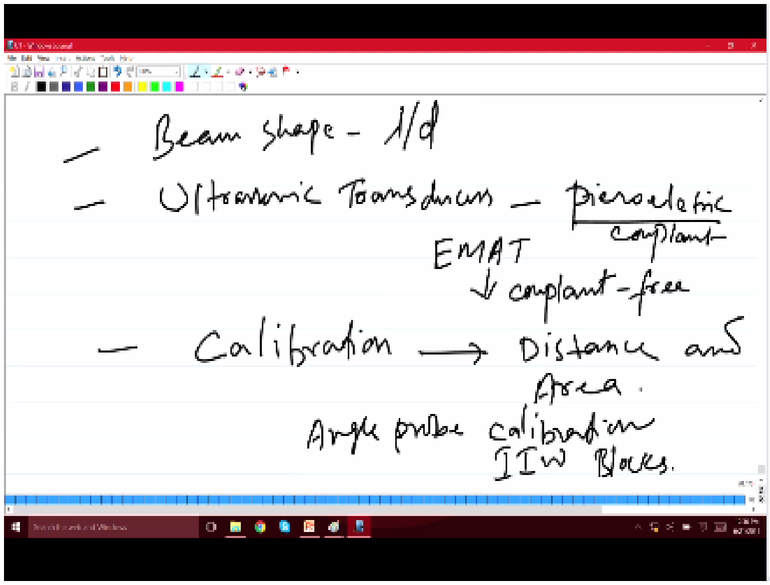

And then we learned about different types of transducers and the construction of the transducers so you learn about two types one was piezoelectric transducers which are also known as electro acoustic and then we have seen one more type which are known as EMAT or electromagnetic acoustic transducer so in this case we saw that you need a couple ant so it is a couplant operation okay we before that we also learn about the beam shape which depends on this particular ratio λ r/d in λ is the wavelength of the sound waves and D is the size of the transducer.

And then we saw that for all practical purposes for all practical cases in wherein the D is much larger than λ the beam becomes a directional and takes up a shape which resembles kind of a searchlight okay then we talked about a very important aspect of auto sonic testing which is calibration and then we learned how distance and area calibration are done and in this we have also seen how the angle probes are calibrated using the ilw reference block so these are the different aspects that we have learned about this particular technique and with this we can close this particular chapter so I am going to stop here today I will see you next time with a new topic till then bye, bye and take care.

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