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Theory and Practice of Non Destructive Testing

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Radiography - 5

Hi everyone so we are on this topic radiographic testing and in last few lectures we have seen the different aspects of this particular technique and we have also learned about how the image is formed on x-ray film okay and then in the last lecture we talked about the different kinds of intensifying screens which are used to enhance the quality of the image okay so in today is lecture also we are going to take off this image quality again.

Because there are a few more things particularly related to the x-ray source which will control the quality of the image and that is what we are going to talk about in today's lecture okay. So the quality with regard to the film properties how the field properties control the quality of the image all those things we have seen before as I said so today let us see what are those parameters related to the x-ray source which will control the quality of the image and what can you do to get the base quality.

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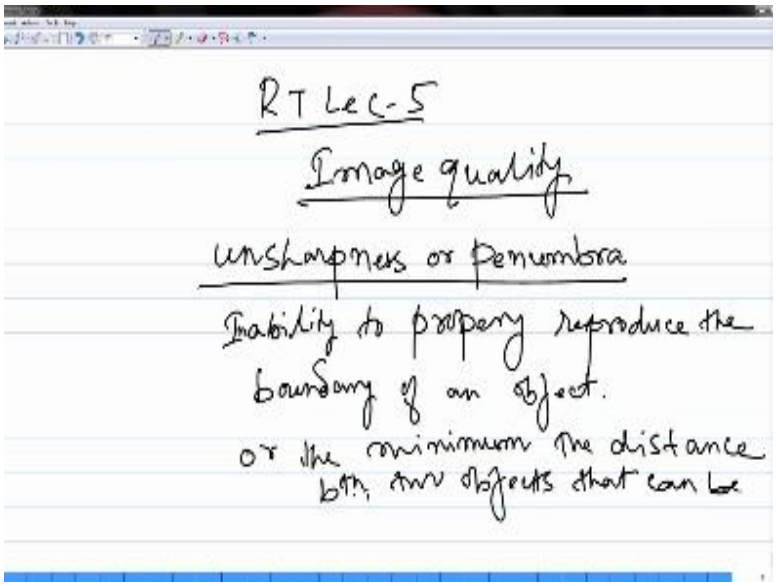

So let us see what is image quality and how it is affected by the x-ray source and then we will see what can be done to get the best quality image out of an x-ray machine if you do not have the right parameters or the right focal spot size in a given x-ray machine then the image that you get will not be very sharp okay the quality of the image will not be at its best so this inability of the instrument or the x-ray radiation to reproduce the best quality image is known what is called as un subpanels sometime which is also called as penumbra.

So this can be defined as the inability to properly reproduce the boundary of an object you or the minimum distance between two objects that can be dissolved.

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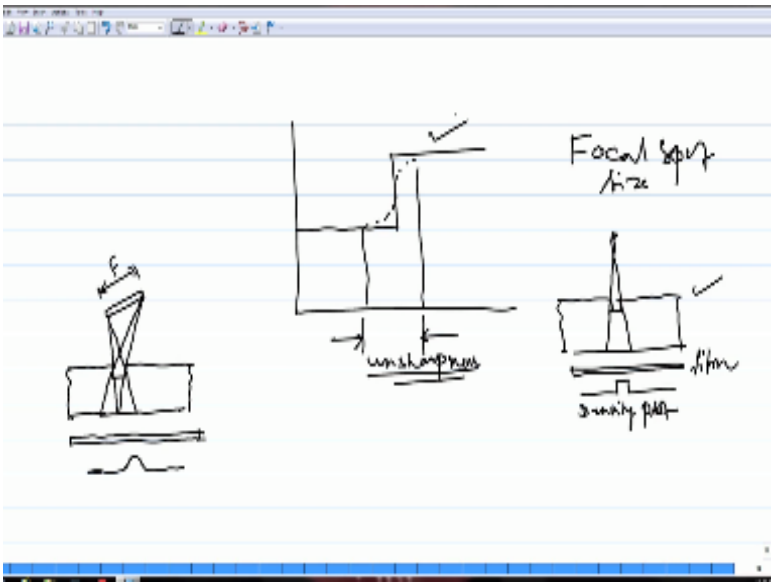

For example if you have an object and if you have a sharp change like this is our90^0 change in the curvature or in some section of the object then if your x-ray machine is not able to reproduce this third pounder e properly it will give you a diffused boundary like this instead of this sharp change so this soft change will look as a gradual change like this okay so that means you had this boundary where there was a 90^0 chain.

But when you see the image you do not see that sudden change rather it comes out as a gradual change okay so this inability to reproduce this boundary properly as we define just now is known as the un subpanels of the image okay and this primarily happens due to the focal spot size of the machine so extreme machines come with a focal spot which is having a finite size and it is not a point source right so when you have a focal spot with a given size it will act as a multiple point source okay.

So if you have a point source like this then you know that there is only one x-ray source from where all the x-ray beams are coming out and they will go through the sample and produce the shadow of the sample or the image that you see on the extra fee so if this be the point source and

let us say you have an object like this and there is a feature like this on the object and if it is a point source.

So you know that these days are coming from only one point and going through this object and the boundaries of the object and as a result when you keep the film here you can reproduce the boundary exactly like this so this is actually the density plot that you see on the image because you are collecting the photographic density from different parts of the object and that is what is being shown on the extra film image as contrast so if it is a point source there is no difficulty in reproducing the boundary of an object as you could see here.

But if it is a finite size source then because of that given size it will act as multiple sources okay for example if you have a source like this so this has a given size okay so this is the spot size F so it has multiple points because it is a it has a certain size so if you now take the same object and image it using this particular source which is not a point source then it will look like this so now the x-rays will come from different points.

Let us say we will just take up two points from here and from this point also for this boundary similarly for the other boundary from this point also it will come and it will come from the other points also like this okay and as a result of that when you see the density plot on the film this sharp boundary will appear as a diffused one like this so you will not see that charge change which is there in the boundary the other it will appear as a gradual change like what we have seen in this case also.

So this is due to the size of the x-ray source or the focal spot size okay and this particular phenomena is known as an sharpness and since it is related to the geometry of the source it can be defined by a geometric parameter so if you simply take the Ray diagrams now you would be able to get an expression for this so let us say this is the source.

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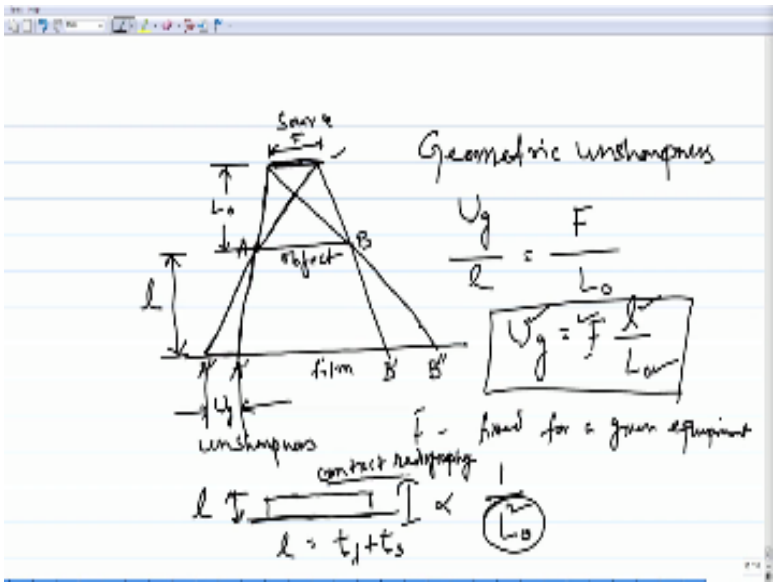

With the spot size of it and then you have the object so again because of its size it will act as multiple point swords like this so the Rays will come from multiple points and on the film this is how the density data will appear so let us say this is a and this is B so since the Rays are coming from multiple points for point A you would see if it comes from two point you will see for a single point of the object you will get two different points on the image like this four point a and similarly for point B you will get more than one point on the image.

So this particular phenomena as we have already defined is the one sharpness and it can be easily found from this geometry and since it is related to the size of the geometry of the source it is also known as geometry un subnets which is indicated as ug so this is the ug and if you consider this ray diagram and the geometry over here so if you consider this triangle this one and the other one this one.

So the height for the first triangle this one is the distance between the source and the object which will call as L not and the height for the second triangle is the distance between the object and the film feature will indicate as small L ok so now if you apply the triangle rule here for this

two particular triangle then you have base by the height of the first triangle will be equal to the base which is f for the second triangle by the height which is l not okay so from here you get an expression for ug.

So these depends on these three parameters so from here you can see how the quality or the sub nests of the image will depend on these parameters and when you vary one of them the quality of the softness of the image will vary our objective is to get the best quality image and therefore this ug has to be minimized okay and according to this particular equation you can see that ug can be minimized if you could minimize F keeping the other two same for a particular focal spot size you can either minimize L that is the distance between the object and the film or you can maximize L not.

Okay so these are the three choices that you have to minimize the un subnets and get the base quality image okay now for a given machine once you have a particular equipment for that the spot size is fixed because every machine comes with a particular spot size and you have to use that to get you know all the images so that means for a given machine your f is fixed for a given source and a given equipment.

So that means the other two parameters that you have to play around at these two distances L&L not okay so if you maximize L not that is the distance between the source and the object then your UJ will be minimized but the problem with that is if you increase the distance between the source and the object the intensity is inversely proportional to the square of the distance okay so you will compromise with the intensity okay.

If you increase the distance for example by double your intensity will decrease by four times okay, so that is why it is also difficult to change this distance between the source and the object so that leaves us with this distance the distance between the object and the film to change it and minimize it to minimize the un sharpness okay. So that means the film and the object the distance between them should be minimum and it will be best to keep the object and the film in that case in intimate contact okay.

So that this distance a lot sorry this distance L is minimized okay so in this case when you keep them in contact l will be simply the thickness of the film t r+ the thickness of the sample or of the or the object TS so since the film and the object are in contact this is also known as contact radiography right so this is how for the same for a given now a spot size by keeping the film in close contact with the object the uncertain as can be minimized and that is why the sample is kept right over the film with the help of a sample holder which I am going to show you a little later so that this distance between the object and the film is minimized.

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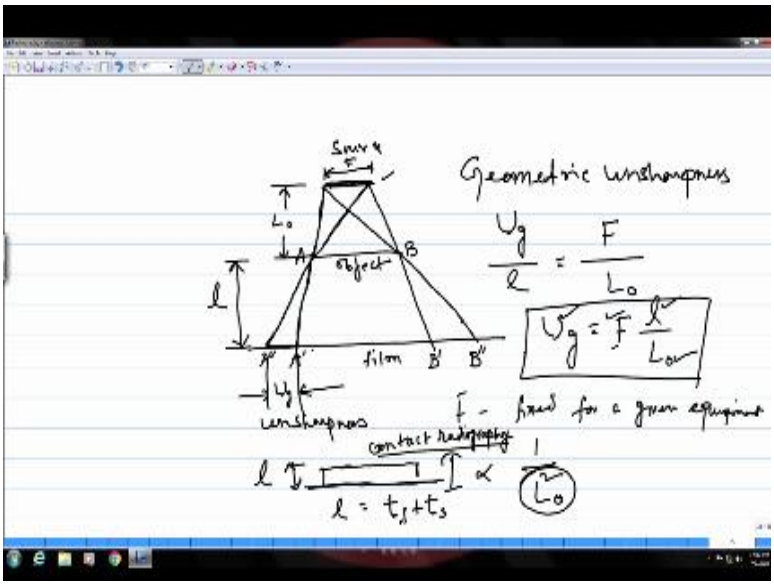

So if you talk about the spot size the conventional radiographic sources that you have the size generally varies from 1 to 4 mm okay so this is the size range in which the machines come which are generally used for industrial radiography and if you want to have smaller spot size then you to go for this mini focus instruments in which the spot size is in the range of sub millimeter from point to2.5 millimeter okay if you want to go to further down and want to get a source which is almost like a point source in that case you need to go for a micro focus unit.

Where the spot size is in the micron range from 1 to 50 micron so this kind of mini focus or micro focus sources may be needed for certain purposes for certain special requirements but the

commonly used ones that we use for industrial radiography will be having a finite size like this but the point source will have its own advantages because it will it will not give you any on softness in the image a tall okay and it will also allow you to magnify the image if you want to magnify the image in this case when you have a finite spot size so when you magnify the image min see the distance between the film and the object also increases.

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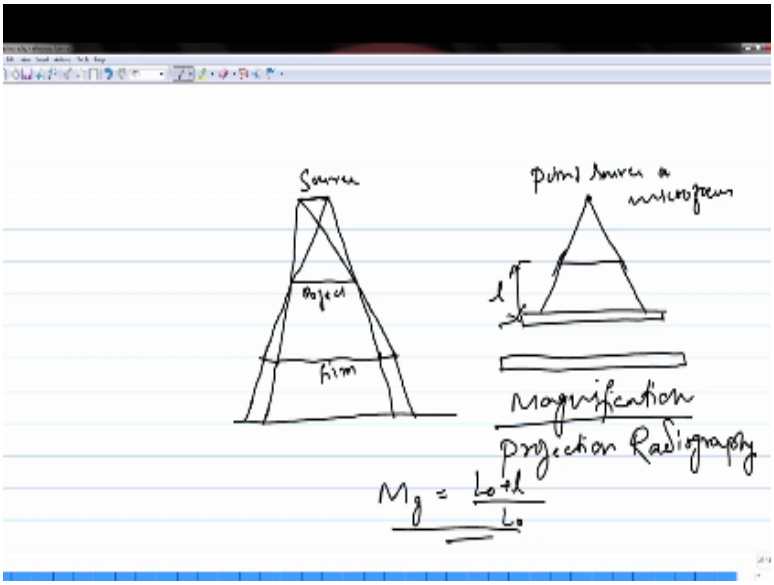

So for a finite source we have already seen how the image is formed so in this case if you want to magnify the image then you have to increase the distance between the object and the film and as you could see from here if you increase this distance then this un sharpnes is also going to increase okay so that is why in this case there is no question of magnification but on the other hand if you have a point source then in this case there is no question of any on softness so if even if you increase this distance it will only get magnified without the image quality being compromised okay .

So for point source or for micro focus you have an advantage of magnification and this is known as projects and radiography if you magnify the image and this magnification mg is given by this

distances okay so this is the advantage that you have the other advantage that you have in case of fine source is.

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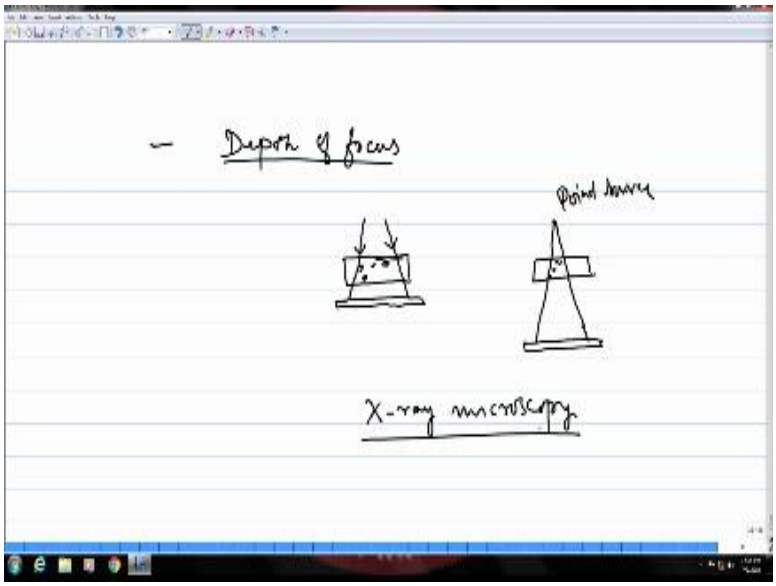

What is known as depth of focus which means after what depth can you focus the sample for a single exposure so if it is a finite source finite size source then and if you have an object like this so if you have features like this which are within this field of view they can only be focused okay so you cannot really focus two features together one which is at the top and if another one is there close to the bottom these two cannot be focused together for a finite size source so it has a limited depth of focus on the other hand if you have a point source.

Since in from the point source the Rays are going to come like this whatever comes within this, this region will be focused so you can see from almost from top to bottom of the sample you can focus in a single exposure itself okay so this provides you a better depth of focus compared to the finite size source so that is the other advantage that you have if you use a point source or a micro focus source okay so when the image is magnified by using point source the other name for that is x-ray microscopy because this magnification comes into picture when we talk about microscopy.

Where you have lenses through which you can magnify the image okay so in this case also since the point source allows you to do it allows you to magnify the image this is also known as x-ray microscopy okay so this is how the size of the focal spot will control the quality of the image so with this we come to the end of this particular lecture today throughout this whole week we have been discussing about radiographic testing so it will be good to take a summary of what we have learned in this week so let us take.

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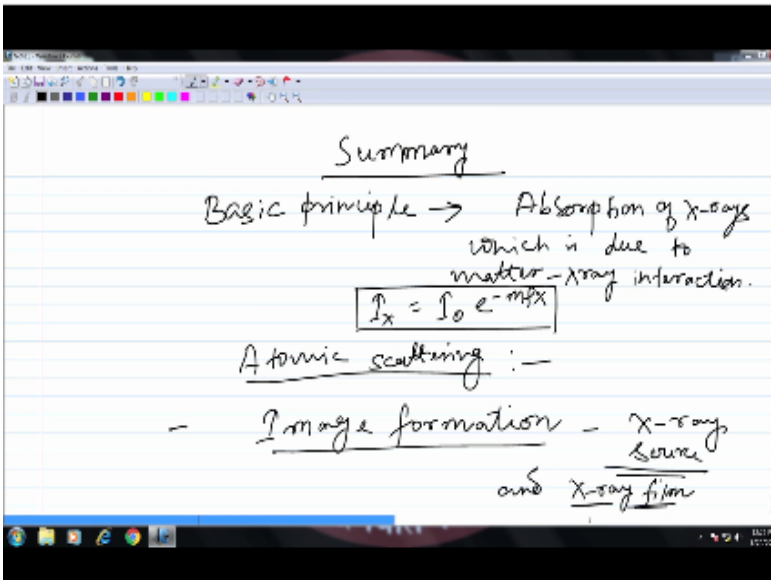

The summary of this week is lectures first we learned about the basic principle of radiographic testing where we saw that it is primarily based upon the absorption of x-rays which is due to better and x-ray interaction then we derived an expression for this absorption phenomena which is like this okay and as I said before these forms the basis for radiographic testing okay and this matter x-ray interaction with regard to that particular phenomena we saw there are different atomic scattering events.

Which lead to the absorption of x-rays and in this we have seen different types of atomic scattering events and we have also discussed about their contributions to radiographic testing and once we understood the basic principle of radiographic testing we discussed about the image

formation and in this we saw that you first need an x-ray source which is nothing but extra tube and about that extra tube also we have discussed when we discussed in the beginning about the generation of x-rays and the other thing that you need for capturing the radiographic image is the x-ray film.

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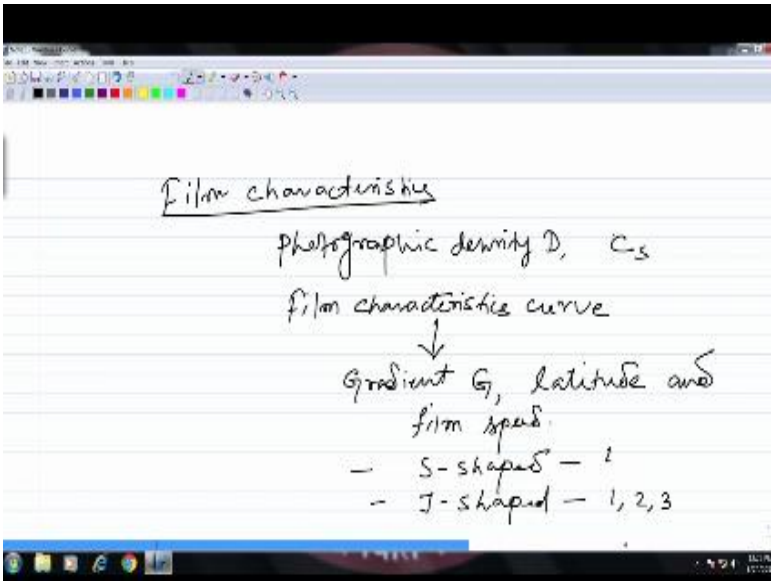

And we have discussed in detail about the extra film it's construction and its constituents how it is made and what is the main constituent in this x-ray films that also we have discussed then we talked about the characteristics of the x-ray film like the photographic density D the contrast CS and we also saw that for every film there is a film characteristic curve and from this curve you can again derive some film characteristics or film properties and those where the gradient G the film latitude.

And we have also seen how to calculate film speed from this characteristic curve okay and we have seen that there are primarily two types of car one is S shaped and the other one is J shaped the chaser the category we also saw that there are three types of films one two and three and in the s-shaped category there is type for field after that.

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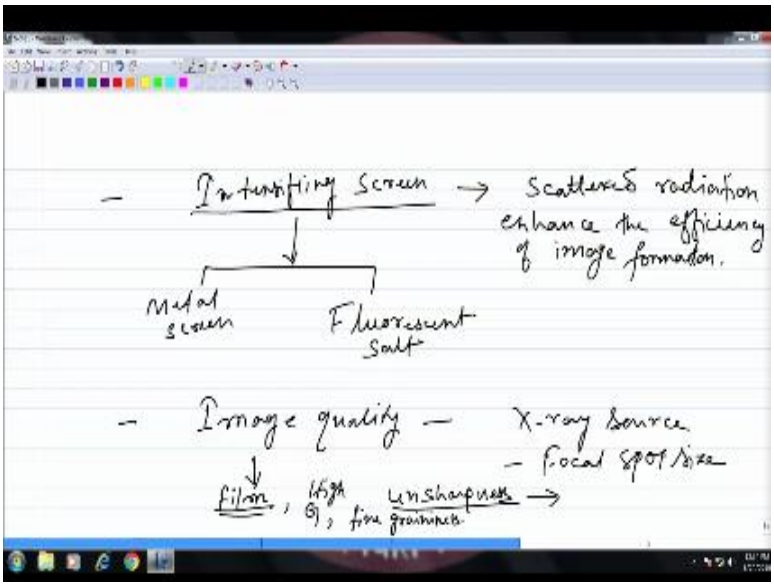

We talked about intensifying screens the basic purpose of it is to filter out the scattered radiation which is not desirable for forming the image and also to enhance the efficiency of image formation so these are the two primary objectives of using an intensifying screen and we saw that there are two types of intensifying screen one is metal screens and the second one is fluorescent salt screens after that we discussed about image quality and the parameters which control the image quality and with regard to those parameters.

We learnt that certain parameters come from the x-ray source for example the focal spot size will affect the quality of the image and we regard to that we learned about an aspect called on un sharpness which comes due to the finite size of the focus part of an x-ray source and the image quality would also depend on the properties of the film and the parameters which influences the quality of the image with regard to the film that also we have discussed.

So with regard to the film as we have discussed you need a high-g a high value of gradient and you need fine graininess okay so these are the things that we have learned so far about the x-ray radiography technique and the rest of the things that we have for this particular technique will be

taken up in the future lectures so for today this is all I have okay so I am going to stop here today thank you for your attention.

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