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NPTEL Online Certification Course (NOC)

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Theory and Practice of Non Destructive Testing

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

Hello my name is Ranjit Bauri, I am from the department of metallurgical and materials engineering at IIT Madras. Today we are going to start this NPTEL course on theory and practice of nondestructive testing which is being offered under NPTEL online certification course or NOC.

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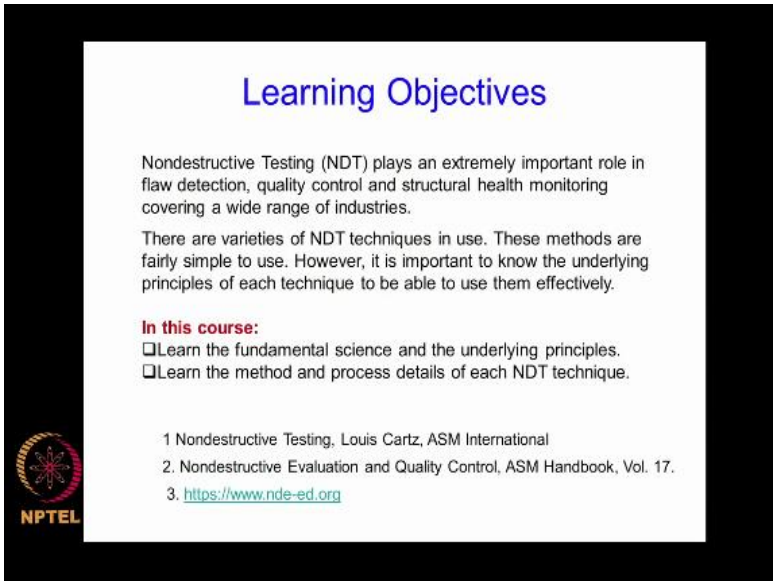

So before I start the course let me first tell you what are the main learning objectives for this course. As you may know nondestructive testing plays an extremely important role in flaw

detection, quality control and structural health monitoring in engineering components and system across a wide range of industries. There are varieties of NDT techniques which are in use, this methods are as such fairly simple to use.

However, it is important to know the underlying principles of each of the techniques to be able to use them effectively. So if you are practicing engineer or a NDT professional or looking to be one then knowing the basic principle apart from the method will surely give you an advantage, because if you know the underlying principle behind a particular entity method then you will know exactly what is going on inside when the test is being done okay.

So that is why one of the main learning objectives of this particular course on entity is to learn the fundamental basic principle behind each of the entity methods that we are going to cover. So that you develop an understanding about the science and underlying principles which govern a particular entity method okay, so that is the first objective. And the other objective of course is to know about the method, learn about the method has to how the method is done, what process is followed, what are the process parameters and so on.

So these are the two primary learning objective one is to first learn the basic principle and then to learn about the method and the process details okay. So this is how we will go about this particular course okay. And as you could see these are the two books which are listed over here that I recommend for you to follow. Most of the topics that we are going to cover in this course will be available in these two books.

The first one is on nondestructive testing by Louis Cartz which is published by ASM International. And the second one is ASM handbook, volume number 17 which is on nondestructive evaluation and quality control. So ASM handbook, volume number 17 is totally dedicated to entity, so you can follow that book also for most of the topics that we are going to cover okay. And the third one that you have over here this is an online resource, this www.nde-ed.org this also has a lot of information about the entity methods.

So these are the three references that I recommend you to follow for this particular course okay. So that is about learning objective at this point in time I should also tell you that if you have any doubt for any of the topics that we are going to cover in this particular course you can always come back to us, please feel free to ask whatever doubt you have no matters whether it is a small doubt or a big doubt you please feel free to ask and clear your doubts, clarify your doubts.

So you can either use the discussion forum that we have for every course or if you wish you can write back to me also I will be happy to answer all the questions okay.

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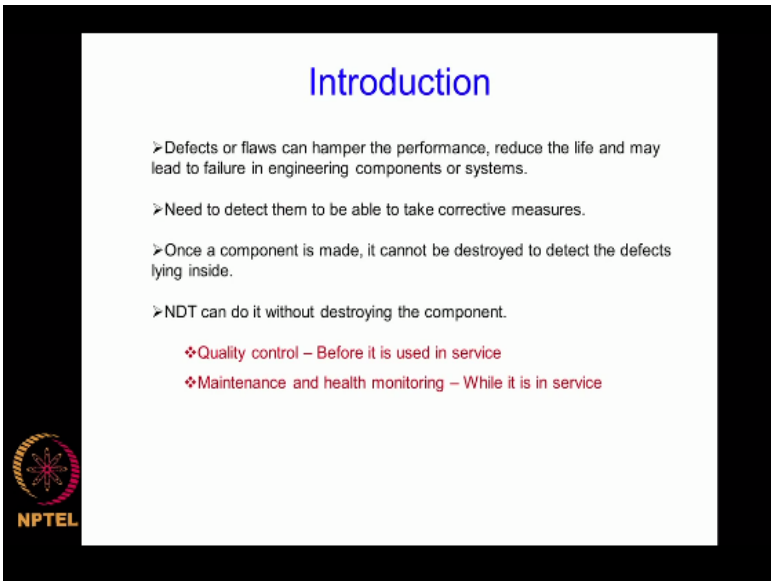

So let us start, so to begin with I want to just give you a small introduction about nondestructive testing before we actually begin the course and the thoughts defects and flaws as you know can be present inside the component or an engineering system. And if this defects and flaws if they are not addressed they can hamper the performance of a particular component or an engineering system, it can the defects can also reduce the life of the component and make them lead to failure if they are not detected and addressed okay.

So it is necessary, it is important to detect this defects to be able to take collective measure so that the performance of the system is not hampered. And you could not end up with the failure in an engineering system okay. But the thing is if once a component is made okay, you cannot destroy it, you cannot break it again to see if there is a defect inside it okay. So that is why the entity methods come into picture wherein you can detect the defect, you can detect the flaw without destroying the component okay.

So there are two primary objectives of doing entity as you could see which is listed over here in the first slide. One as I told is to ensure that when you realize a component to the market to the end user you need to ensure that the component is I free of defects and floes otherwise the performance of the component will be seriously affect okay so that is before the component is used so that is one aspect which is about quality control of a particular component or a particular product okay now when this component is being used in a particular system there also there are possibilities that some kind of floras are defect can develop during service.

Okay so there again you need to ensure that this defects and floes are detected so that the performance of the system is not affected but there again you cannot destroy or cannot disturber the system or the component to know that if there is a defect or not so there for the maintains part of it when you are mongering the health of a particular component or of a particular system or structure you have to do it without destroying or without disturbing the system okay.

So there again NDT methods come into picture where in during in service condition you would be able to check and detect if there is any floe or any damage which is developed in the system which may affect either the performance or life of the system so this is the second objective that is to maintains and do health monitoring of a given system or competent main it is in use so these are the two primary objectives of doing NDT okay.

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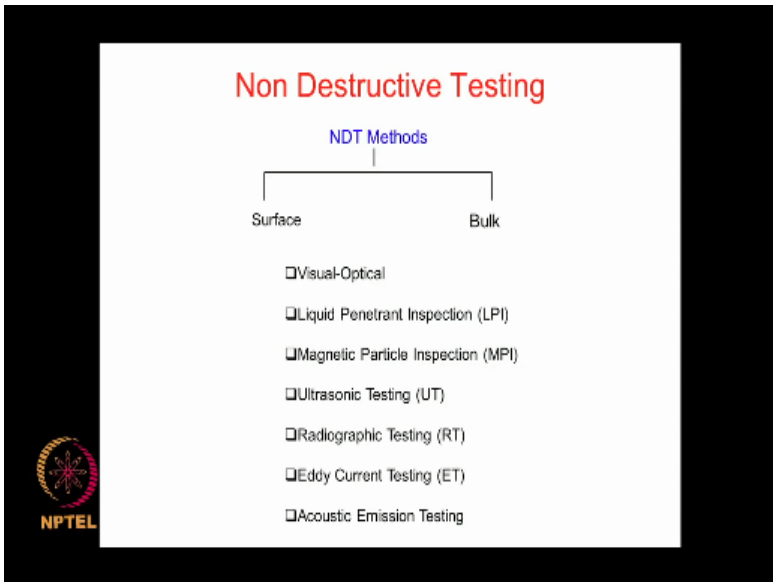

So having said that now if you come to actual NDT methods okay so as I said we are going to cover all the commonly used NDT techniques and what we are going to do in this course first we will cover the basic principle behind a particular NDT method so all the methods are listed over here as you could see so we will pick one at a time and then first cover the basic principle behind that particular method and then learn about the method itself as to how it is done what process is followed and what are the process parameters and process details okay so these are methods which will be covered in this particular course during next 8 weeks or so.

Okay so now if you talk about the methods and there classification this NDT methods can be broadly classified into two categories one is surface NDT and the other is bulk NDT okay so this depends on whether the defect or the floe whether it is looked on the surface or it is located inside the bulk or volume of the component or the material which is been tested okay so if you know before and that most of your defects are going to be limited of the surface then unit two select is surface NDT method similarly if you know that the defects are going to be inside the material below the surface then you select the bulk or volume NDT method okay.

So the different methods which are listed over here some of them will fall under the first category of surface NDT and some of them will fall under the second category for example this first one I am not talking about this first that is s visual optical I will come back to that so these are the different NDT methods so this one liquid penetrate inspection or LPI magnetic particle inspection and Eddy current testing okay so these are the methods which will fall under the first category.

That is surface NDT method on the other hand techniques like ultra sounding testing ratio graphic testing acoustic emission testing this will all fall under the second category which is bulk or volume NDT and there some techniques like for example the ultra sounding testing which can do both it can do surface NDT as well as it can also be used bulk or volume NDT okay so these are all other techniques that will be covered in this particular course and other side.

There will be two aspects one the basic fundamental principle behind each of these technique and the second aspect would be to cover the method and learn about the method more details now if you see on the top of the lost there is something called visual optical okay this is coming the list because before you do any NDT before you use any NDT technique to detect floes what you first do you try and see visually okay on the external surface of a component or other part if something is visible to the naked eye okay.

Sometime you may also want to take help of some kind of visual or optical aides which will help you out to visualize of course externally on the surface if there is any damage or defect that you can easily detect and see okay so that is why this is coming in list also or although it is not really in strict sense unity method.

But as is said that is the first thing which people will do to see even if loss or feasible external thing so we will start with that we will start with the visual optical method first and then we will go on to the other entity methods one by one as I said and then cover them in more detail okay so I will project the first slide that right now.

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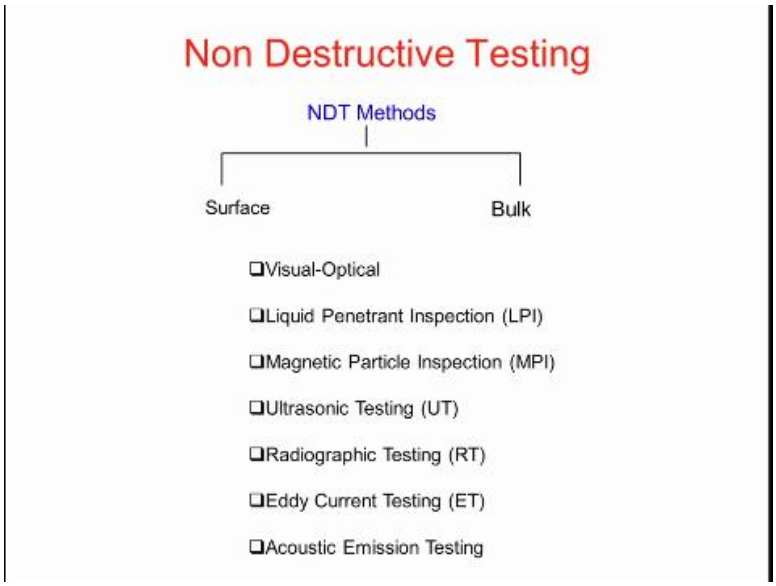

To start with the visual optical method okay.

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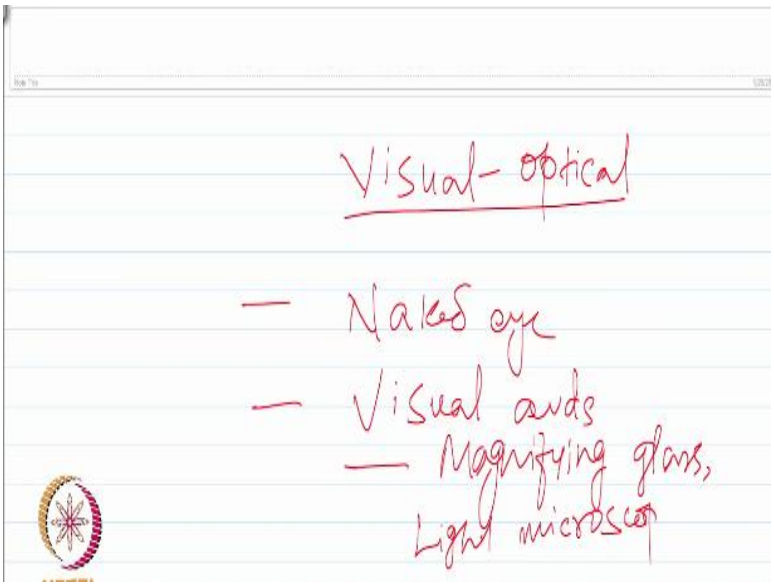

As I said the first topic of this series of lectures will be on this visual optical method that means as I said you try and see externally on the surface of the component or of a part if you could see something visually okay so if it is simply take that part or take the component and then try and say it in a well illuminated area on you know different portions called the areas and then see first of all whether you can see something by naked eye okay.

If you do not see anything by naked eye then you can the help of some visual aids for example you can use an magnifying glass which will enhance the visibility of the surface of the component and then see using a magnifying glass you try and see a something if something is visible extremely on the surface of the component or not if it is a smaller component which can be put under a light microscope then you can take that component put it under a light microscope and then you can observe it through the microscope.

With something like magnificent which will help you out again to visualize and see if any damage or any defect is visible on the surface okay so this is what you could see you and try and see with naked eye okay to you could use some visual aids which could be know as I said a magnifying glass a light microscope and things like that which will enhance the visibilities of the

surface of the component. And help you out in visualizing any external defect or any external damage okay.

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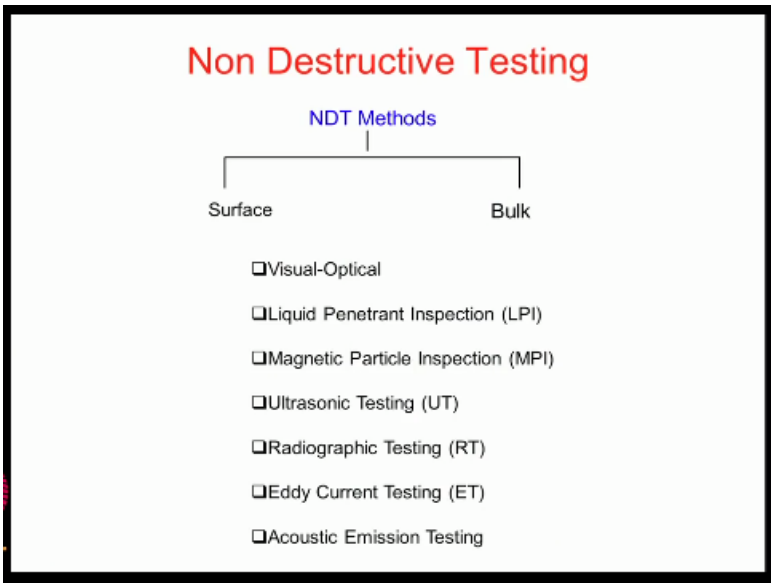

Coming back to this there could be cases when you are doing visual inspection there could be cases wherein your physical access to the area that you want to examine is limited or the visibilities is limited okay so if there are issues with the physical access or visibility for example if you want to inspect the inner diameter of the bolt hole so inside the bolt hole you cannot really see and it cannot really physically access with okay.

As an examiner so in such scenario as such case wherein you have limited physical access limited visibility then you have to use some other device for example this one which will again help you out in visualizing the area that you are trying to examine okay in cases like these kind of bore hole or bolt hole where you need to go inside and inspect the diameter so this particular device.

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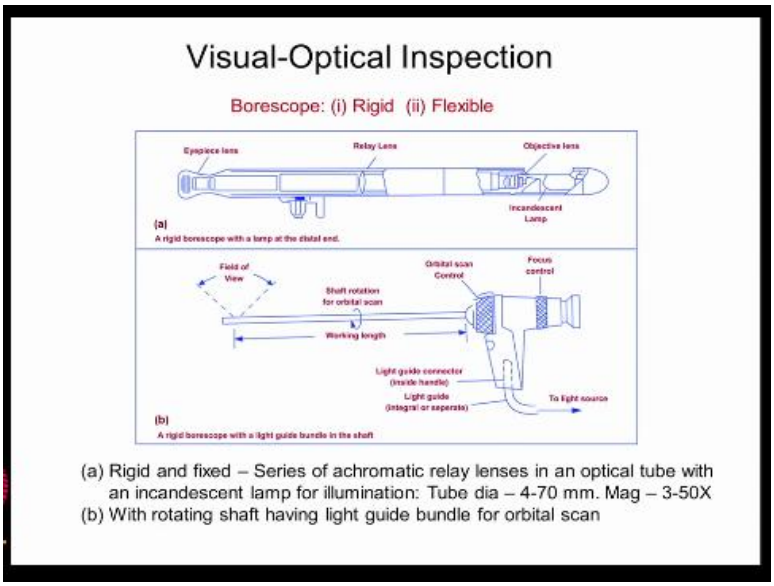

This which is known as Bore scope is very useful okay so let us talk about this in little more detail as to what it is and how it is used to inspect visually parts where you do not have direct physical access are there now visibility is limited, okay.

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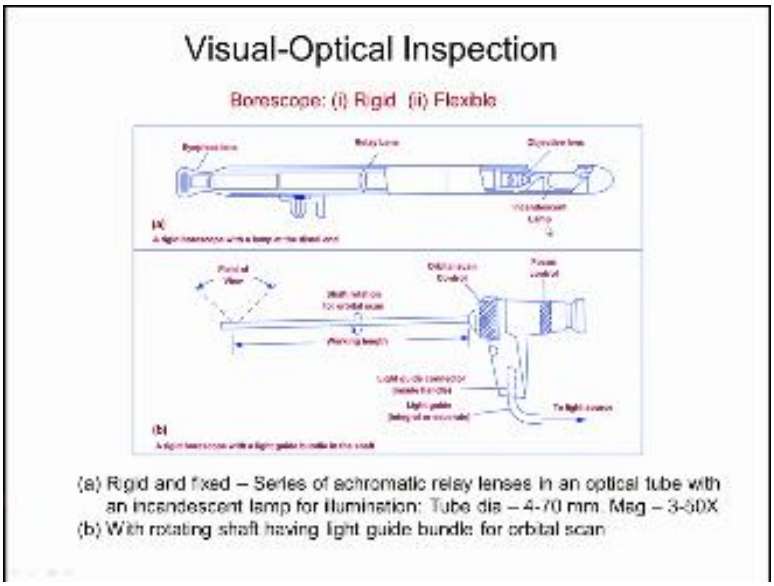

So this is nothing but a tube the diameter of which will depend on the diameter of the path or the diameter of the area that you are trying to inspect so there is a range for example, as you could see if on this there is a range from 4 to 70mm so depending on what is your part diameter you could select a particular tube of a given size, okay. so this is primarily a tube and it has two ends as you could see this one and the other one.

So end which is also known as the distill end will go inside the area which will be examine so this end should also have a light source for example in this case as we could see there is an incandescent lamp which will illuminate the area which is being examined and then it will enhance the visibility, right. And in this end you can see that there is an objective lens also which will form the image of the area that you are trying to examine, okay.

And then inside the tube we can see there is a series of achromatic relay lenses so this lenses will help you focus the light on the area to image it and then this image will be send back to this eye piece which is at the other hand, okay. So one end which is going inside the part this distillent will have the light source to illuminate the area and will also have the objective lens to form the image and then on the other hand on the other side do you have an eye piece over here through

which you see this image of the area and then inspect it try and see if you could see some external damage some surface defect and things like that, okay.

And this eye piece can be interchangeable so that you would be able to provide some magnification also to certain extend for example in the range of 3 to 50x so through that eye piece you should be able to also magnify that will again enhance the visibility of the area and help you out in visualizing damage or defects on an external surface, okay. So in terms of the flexibility or the rigidity of this tube there are two categories in this, there are two categories of Borescope the first one is rigid.

So as the name suggest in this case this tube is solid, it is a solid tube and it is fixed you cannot bend it or you cannot move it so it is a fixed solid tube and that is why this is call a rigid system. But in the rigid category itself we could have two short of categories one is completely rigid which is the first one which just now I described, and in the second one in order to broad enough the field of view you could also have on the tube which goes inside the area being examine on that tube we can provide some movement like some rotational movement.

So you could have a shaft which is basically the tube that contains the light guide bundles you know to form the image but this tube can also rotate, okay so there is a rotating shaft in this case to give you a kind of orbital scan around the area are which is been examine. So as you could see from this end so this is the end which is going inside the area being examined and because of this rotation of the shaft this light guide bundle which is inside the shaft because of this rotational motion this will provide you an orbital scan and that will in turn enhance the field of view.

So that is the advantage you have in this case over this fixed one where in you do not have any movement at all, okay. So in this case we have a rotating shaft and that will improve or broad enough the field of view as you could see from here, okay.

So the primary parts in this case are again there are two parts one is this tube which goes inside the area being examine and this primarily contains light guide bundle to illuminate the area and also do form the image so this will be connected to a light source and on the other hand like you

had in the previous case you have an IPS connected and there is some mechanical attachment over here through which you able to control this rotation or the orbital scan okay, so there is a control units small control unit over her which will control the rotation or rotation of this rotating sort.

And then at this end you have that IPS through which you see the image which is form at this end and then try an analyze if you could see something some visual defects or some visual damage on the external surface of the part. Okay so this is about the rigid kind of Borescope but there may be cases wherein.

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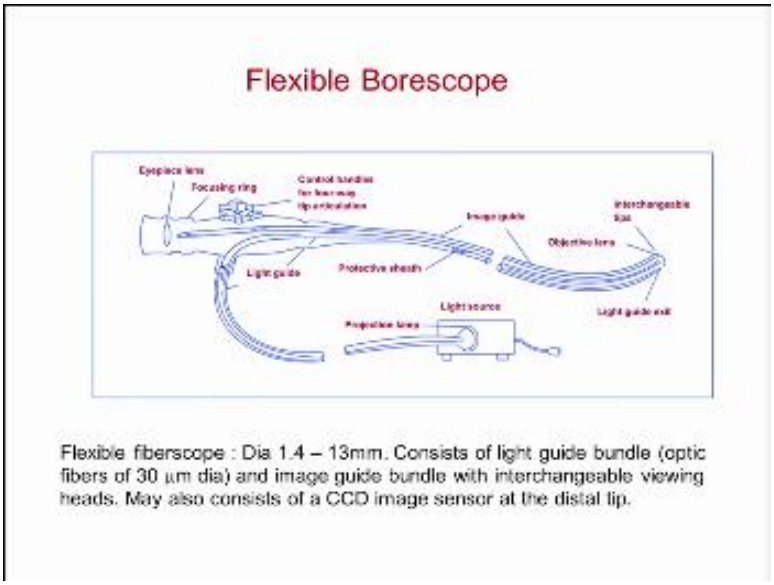

You need to have more flexibility in the same you may have to go around inside the area which is being examine so in those cases this kind of rigid system will have some limitations you know some difficulty because you need to move around here and there around the examining area, so to overcome this difficulty there is another system which is flexible Borescope as you could see this tube that you have in this case this is the flexible one okay so you can band it easily.

So that we can move around and go around and you will be able to cover different areas and go in different angles and so on okay. So this will this flexibility of the tube will help you out ion moving around and going around then cover a broader area. Okay so that our purpose here to give you more flexibility when you are examine a particular area where you do not have this classes okay.

So let us see what are the different parts of this here again what you need to do like the basic function is same you need to form and image and this end okay which goes inside the area which is being examine and this image is being transfer to the other end where you have this IPS lengths through which you see the area the image of the area and then analyze try and see if you could see some damage or defect okay.

So the basic function is same but the different parts could be different so in this case as you could see there are basically two light guide bundles one is to form the image and to carry the light to the area being examine to eliminate it and also to form the image, and there is one more light guider bundle which is known as the image guide so this both of this are made of optical fibers thin optical fibers which are of the size of around 30mm in dm okay.

So with the help of this image guide bundle and light guide bundle which is made of optic fibers you will ale to form the image first so this will be connected to a light source other side to carry the light all the way to this hand to eliminate the area and then form the image and then once the image is formed at this end and her again you could see you have objective lengths to form the image and once the image is formed this will be transfer to this image guide bundle to the IPS and then you will be able to see it and analyzing.

This will give you one more possibility of connecting a CCD image sensor at this end instead of an objective length so that you will be able to capture the digital images so if you have a digital camera and if you connect this CCD sensor at this end and the other end then you can have a digital camera and capture digital images. So this is the other advantage of this particular devise which is flexible apart from the flexibility id it also provides you an opportunity to store the images.

So that if you want you can analyze them later on also oaky so the advantage here are more flexibility border coverage and if you want you can store and save the images and if we can analyze them as in when you want okay.

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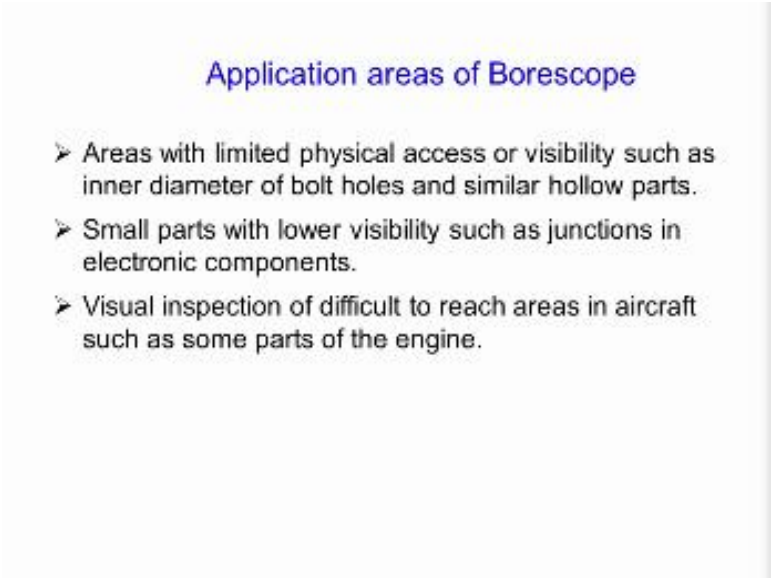

Then finally let us see what are the different application areas of this kind of devices of borescopes.

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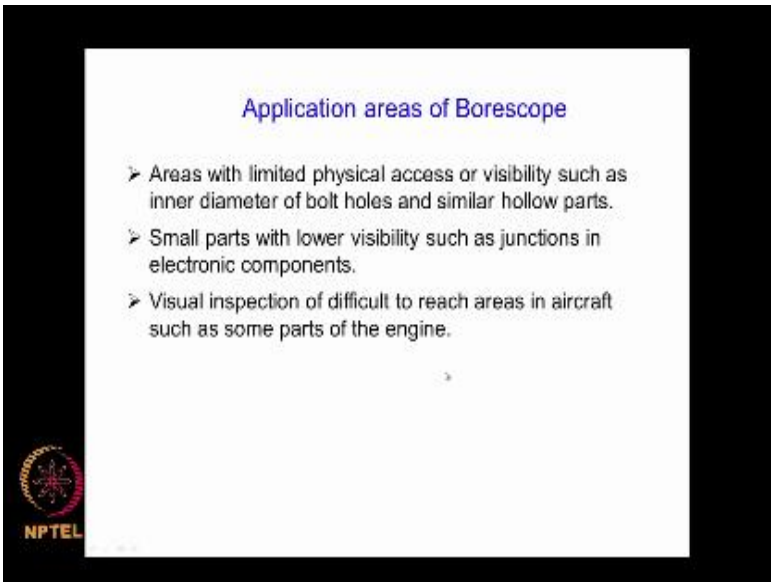

So as I said in the begging this is particularly use full in areas where we have limited physical access or you have limited visibility such as inner diameter of bolt holes or similar hollow part so in this kind of areas in you know this kind of cases were you need to go inside a hole or inside a bore you can use this Borescope to help out in analyzing the inner surface okay.

If you have parts which are very small for example junks in electronics components so these are very small junks in so there again you have problem in the visibility so in this case the visibility is limited so here again the Borescope can be used you can laminate the area first and then you can capture an image magnify a bit so it will enhance the visibility and you will be easily to see the junctions and the smaller parts like that and you would be able to.

See if any external damage and finally it can also be used for visual inspection of difficult area in bigger systems or bigger structures for example in aircrafts in parts such as some parts of the engine if you go the inner areas the engine where the examiner really does not have physical access so in those areas again this Borescope are quite useful and you can take that and you can go put that inside a hole or things like that or were you do not have physical access and then capture the image and analyse it okay.

Having said that all these are fine you can do it using some kind of mutual or optical lead or using a Borescope but this is limited to certain extent of inspection. you would only be able to see the surface and you would be able to see the external damage or not okay right at the top of the surface so this kind of inspection this visual of optical inspection is only limited to examining the external damage on the surface okay if it is physically visible then by naked eye or with the help of some kind of visual aid or some kind of optical devices like a Borescope or things like that okay.

So you cannot beyond that that means if you have something underneath if you have something below the surface or in the bulk of the component the bulk of the material which is not visible to the naked eye then this particular technique cannot be used as I told you in the beginning that is I probably are not listing this in a strict scenes in as the method because it's something not visible on the external surface this particular method cannot be used this is only for examining the external damages and things like that.

Which may be either visible to the naked eye or visible to human eye with the aid of some kind of optical or visual devises so if you want to examine which is lying beneath.

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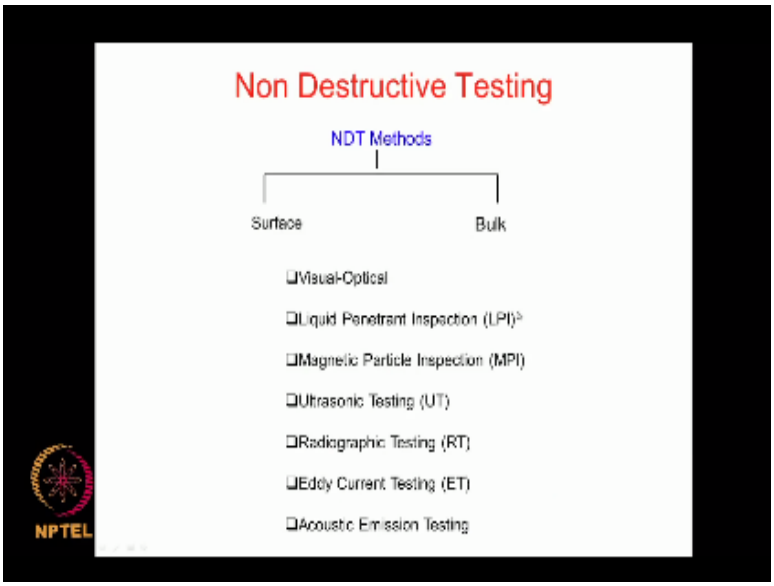

Kinetic methods that is where lies the utility on the entity methods were you can apply a particular entity method to visualize and get visibility ending essence of deflects and flaws which are not visible to the naked eye okay so that's the purpose of this particular course to see how exactly a particular entity method is applied to make visible essence or defects visible entity of essence and flaws which either on the surface sub surface the bulk of the material okay.

So this class was for the visual optical method so I will stop here today from next class onwards what we are going to do pick up this entity techniques at a time as then I have in the beginning first we will cover the basic principle behind the technique and then we will see we will learn about the method is done what is the process and the process status okay so that we are going to start from next class onwards so today I will stop here thank you for your attention.

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