Testing of Functional & Technical Textiles
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Lecture - 14
Testing of Fibre Reinforced Composite Materials (contd.)

Hello everyone. So, we will continue with the non-destructive test methods for composite materials. We will start with another method which is Radiographic Inspection. This technique is exactly same as that of the orthopaedic doctors use for analysing any damage in our bones, any cracks present in our bone. So, similar technique is being used here.

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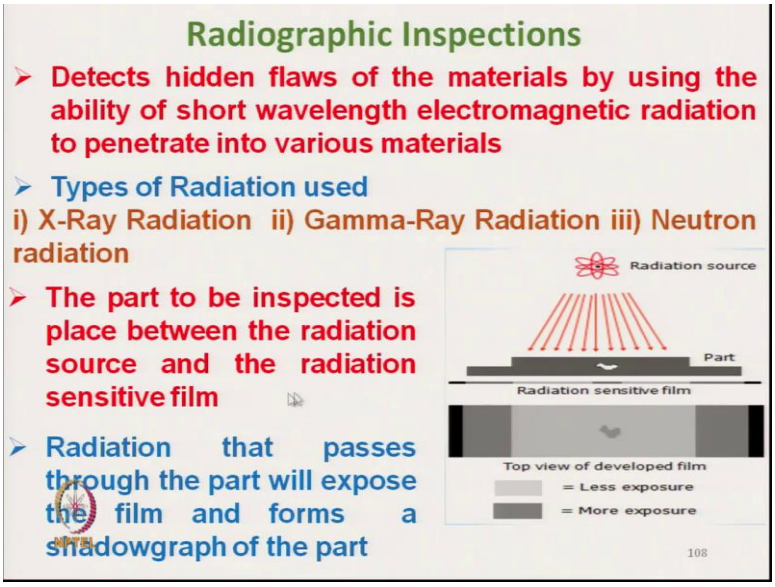

So, to detect the hidden flaws of composite materials by using the ability of short wavelength electromagnetic radiation like X-ray, gamma ray or neutron radiation to penetrate into various materials. So, this is the schematic diagram, here the source of radiation like X-ray or gamma ray; so the material is projected here. This is the material part where this portion, white portion is showing it is a defective portion. And this short wavelength electromagnetic radiation will pass through the composite material and on other side there will be a radiation sensitive film like in case of X-ray, X-ray film is used.

Similarly, here radiation sensitive film is used and if we see the top view of the developed film here, the defective portion where the higher quantity of higher amount of

light is reached; it is shown by the darker region were more exposure was there and in normal portion the exposure was less. The part to be inspected is placed between the radiation source and the radiation sensitive film at the bottom. The radiation that passes through the part will expose the film and form a shadow graph of the part, this is the shadow graph.

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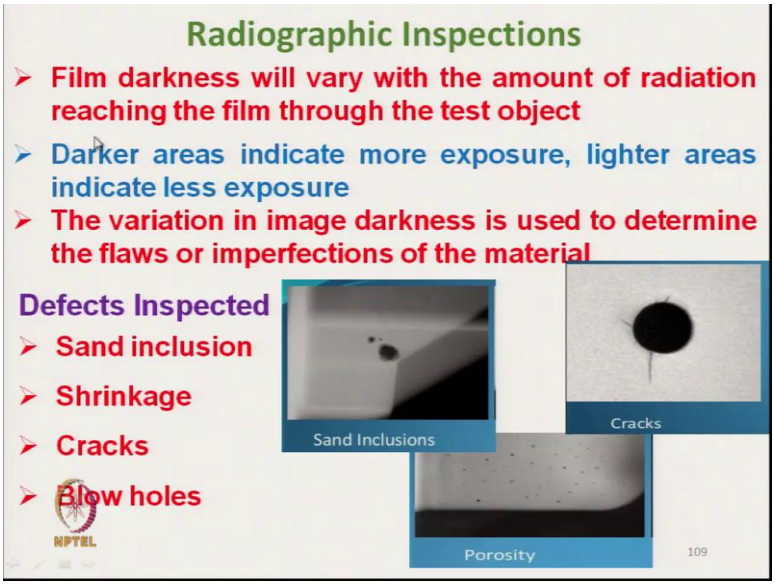

The film darkness will vary with the amount of radiation reached on the film through the specimen. The portion where the more exposure will be there, will be darker and the lighter areas indicate less exposure. The variation in the image that is the darkness of the image is used to determine the flaws or imperfection of the material.

So, if there is no defect present in the material, the depth of the image will be uniform there would not be any variation. Defects inspected that, there are different types of defects which can be inspected using the radiographic inspection technique are sand inclusion. If there is any sand particle inside the composite material so, we can detect using this technique, we can detect crack, we can detect shrinkage or we can detect blowholes in the material.

So, this is the crack, it showing the crack inside the material by darker zone. This is the normal portion, but at the edge, at the surface of this normal portion there are cracks which is not visible; which is inside the structure and as the cracks are there, the more the exposure was there and that is why, it was showing in darker zone. Similarly, sand

inclusions or porosity, see if there are void content so, the exposure will be more and it will show as dark spots.

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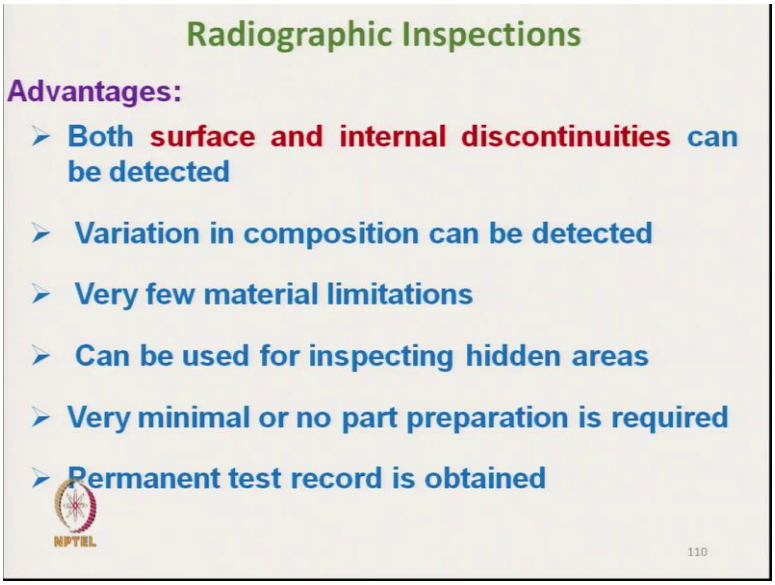

The advantages of radiographic inspection are both surface and internal discontinuities can be detected. So, in case of any discontinuity in the internal zone of the composite or in the surface it can be detected. Variation in composition can be detected. Very few material limitations; so, it can be used for wide range of materials. Can be used for inspecting hidden areas, very minimal or no part preparation is required; so, we do not need to prepare any part like other methods. Permanent test record is obtained; so, we can get permanent film which can be referred in future also.

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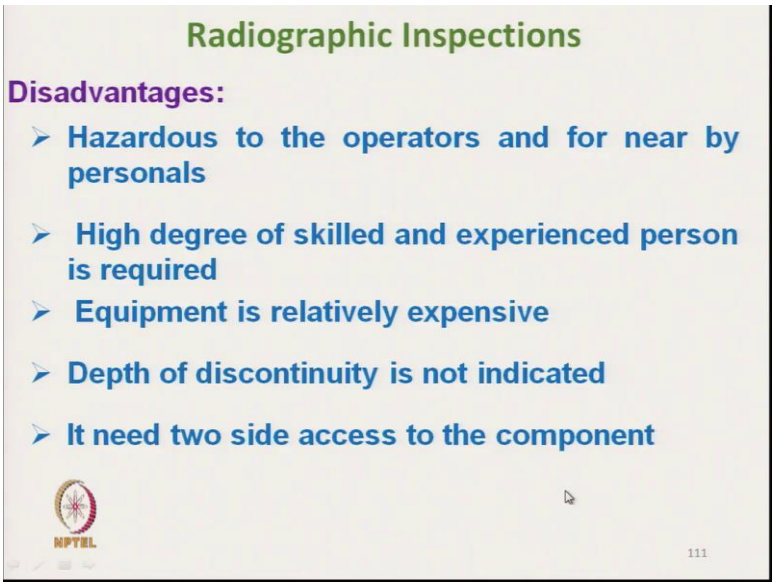

Main disadvantage here is the, it is hazardous like X-ray is hazardous for human health. So, it is operator sometime is under threat of hazardous ray, high degree of skill and experienced person is required, equipment is relatively expensive, depth of discontinuity is not indicated which is important. So, the presence of defect or crack can be identified, but at which depth, it is very difficult to indicate. It need two sides access, one side the projection and other side we have to have the film. So, the structure where we cannot access both the sides, this technique cannot be used.

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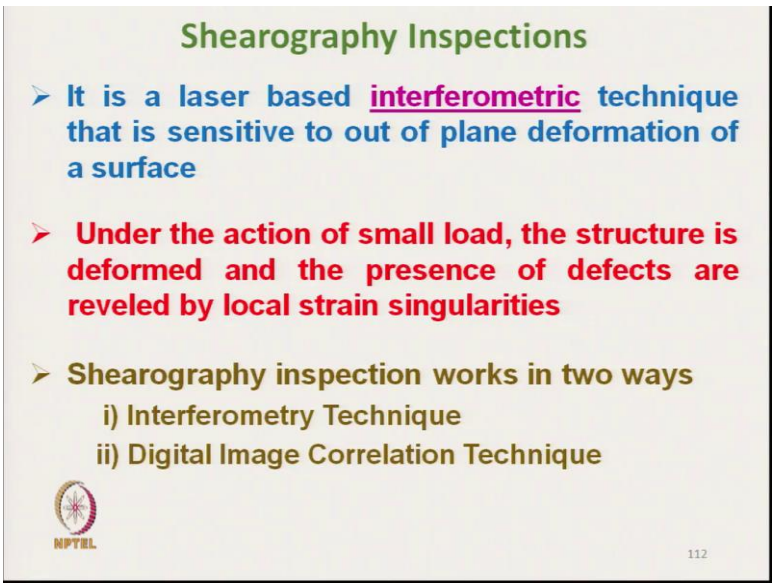

Next technique is shearography inspection. Here, it is a laser based technique which is laser based interferometric technique that is sensitive to out of plane deformation of a surface. So, we have to deform the surface by applying small load and we measure the changes in the structure.

So, under the action of small load, the structure is deformed and the presence of defect are revealed by local strain singularities; what does it mean, if we change the load; small load if there is any defect like crack, the dimension of crack will change and by taking the photograph, we can identify the dimension of the defect. Shearography inspection works on two ways, one is interferometry technique another is digital image correlation technique.

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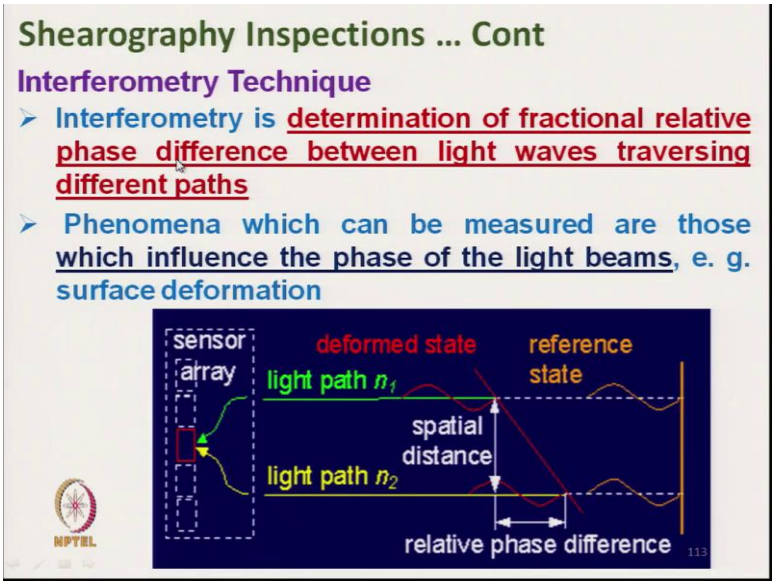

So, first we will discuss the interferometry technique. So, this is determination of fractional relative phase difference between light wave traversing the different path; that means, if the light is passing through the laser; it is laser technique, it is passing through the material in normal portion, it will pass through a particular pattern and in the defective portion, the light will pass through the material with the certain phase difference.

This relative phase difference indicates the defective portion. The phenomena which can be measured are those which influence the phase of light beam, that is surface deformation. So, if there is any surface deformation that will affect the phase of light

beam.

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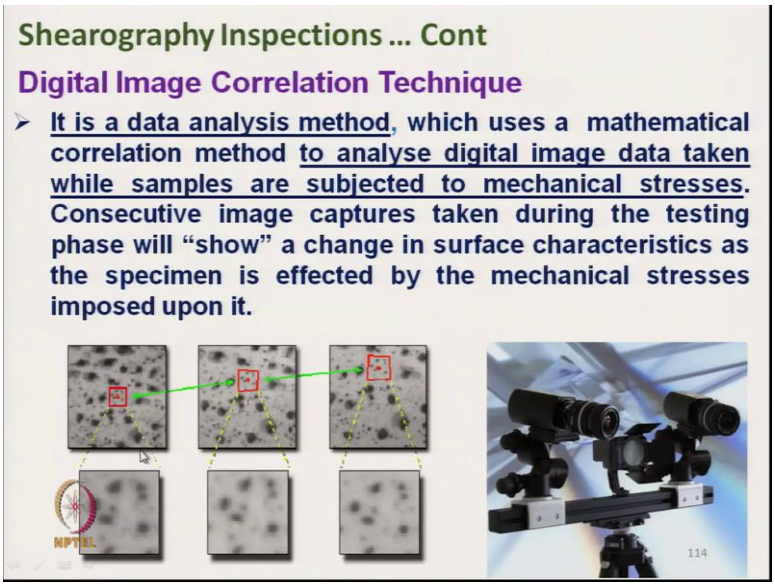

Next is that, digital image correlation technique. It is a data analysis method, which uses a mathematical correlation method to analyse digital image data; so, this is the digital image is there. The digital image data taken while samples are subjected to mechanical stresses; that means, the defect is there the material is subjected to mechanical stress by small quantity of load and the defect is captured, using image analysis technique.

The consecutive image captures taken during the testing phase with that will show a change in surface characteristics as the specimen is effected by mechanical stress imposed upon it. So, that once the mechanical stress is imposed, the specimen defect, the dimension will change and that will be captured.

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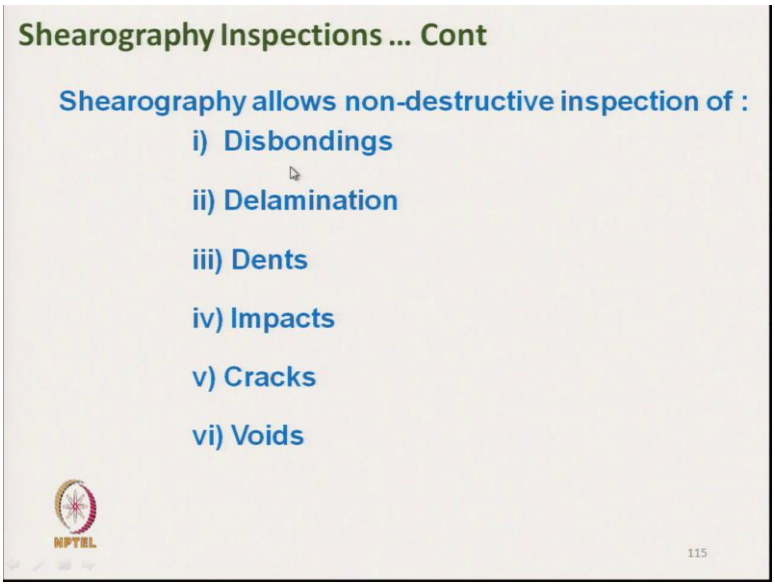

The shearography allow, non-destructive inspection of disbonding, delamination, dents, impacts, cracks and voids. So, this disbonding, delamination, this we can only identify, if we apply small quantity of load; small amount of load and that will be captured by images and we if we can compare the images we can identify the type of defects.

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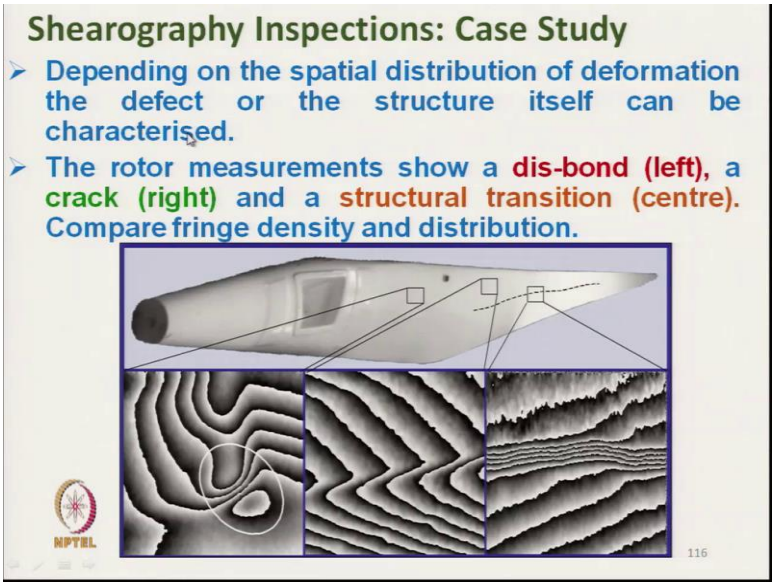

So, this is one case study depending on the spatial distribution of deformation the defect or the structure itself can be characterised. This is a rotor structure, the rotor measurement show a dis-bonding at left, this is the dis-bonding and crack, this is the

crack portion, this is the dis-bonding portion and structural transition, this is the structural transition portion.

So, and the fringe density and distribution is captured. So, from the distribution of cracks or this dis-bonding portion, so we can get idea about the type of defects. So, density of this layers or this dis-bonding effect we can get the idea of the defect.

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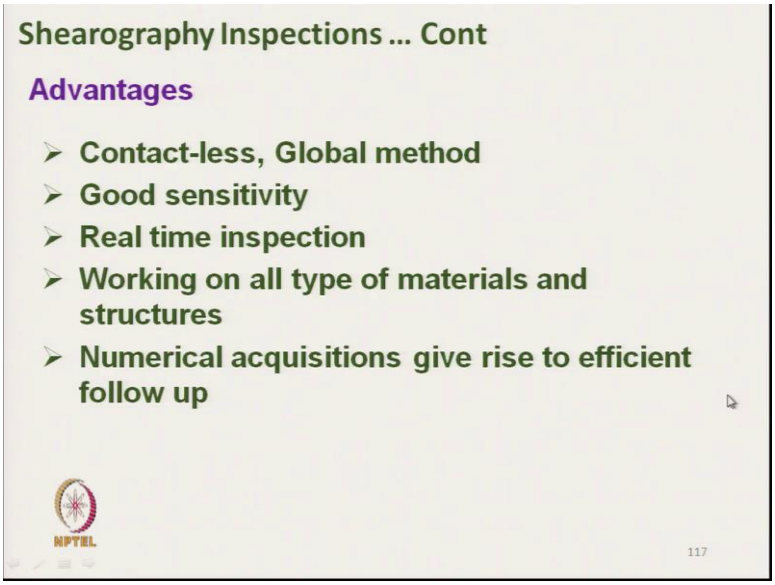

So, the main advantages are, it is contactless, global method, good sensitivity, real time inspection, working on all type of material and structure numerical acquisition gives rise to the efficient follow up. So, here in this method, we can actually identify different types of defects. In other non-destructive method, we can identify that the presence of defect, but here we can identify, we can separate, we can segregate the type of defect also.

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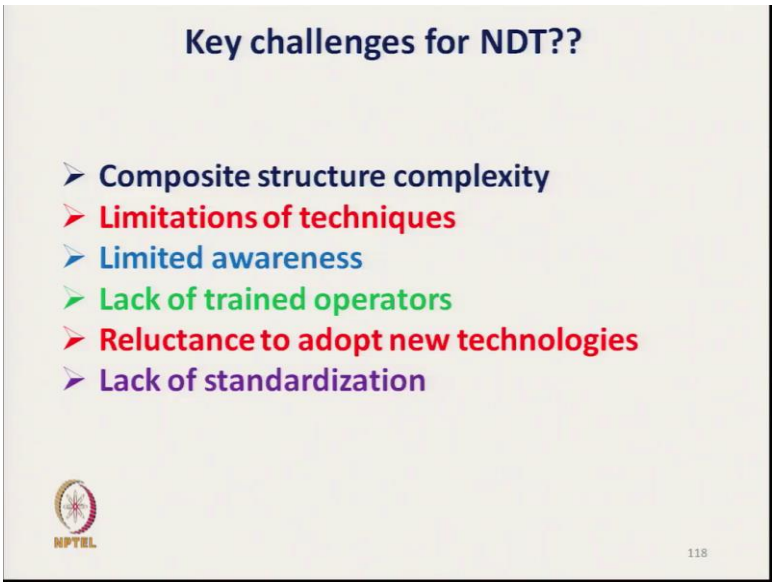

So, this is all about the non-destructive test methods and the main challenges of non-destructive test are the composites structure complexity; so, the structure of composites are complex and once the complex structure is there, Non-destructive test method, is it is very difficult to test. So, for plane structure, normal structure or simple structure we can test the non-destructive test, but the challenge is that most of the complex structure needs non-destructive test.

And the limitations of technique; so, the techniques which we have discussed, they have their own limitations and awareness of this techniques are limited people do not aware are not aware of this techniques, they do not know about this technique, we have to make them aware. So, that they can use this techniques, lack of trained operators are there, so this techniques need trained operators.

And main problem is that, reluctance to adopt new technologies because it is a, this technologies are not that straightforward, not that simple and expensive technique. So, people are reluctant to adopt this technologies and lack of standardisation. So, due to the lack of awareness, lack of knowledge the standardisation is not there. So, to use these non-destructive techniques, we have to actually overcome all these challenges ok.

Now, we have reached the end of this session, we have discussed different test techniques of composite material, that is the matrix, the reinforcing material and composite material; in composite we have discussed, the destructive test method and also

non-destructive test method.

So, we will end this session, in next class we will start new technical textiles, new test methods for technical textiles till then, thank you.

Thank you for patient listening.