**Experimental Stress Analysis**
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**Lecture - 26**
**Calibration of Photoelastic Coatings, Introduction to Brittle Coating**

We have come to the closing part of our discussion on Photoelastic Coatings. And in the last class you had a bird's eye view on what type of problems photoelastic coating has been applied successfully. There are 2 important issues that you need to look at. One was it is applied for a variety of base materials starting from bone to concrete to high strength aluminum alloys. This is one aspect of it.

Other aspect of it, some of the recent and most advanced technology where it is employed those problems have been analyzed using photoelastic coatings, inputs from photoelastic coatings was used in refining the design. So it is more of a current technique which is very efficiently used in Aerospace industries. We have seen quite a few examples from Aerospace industry.

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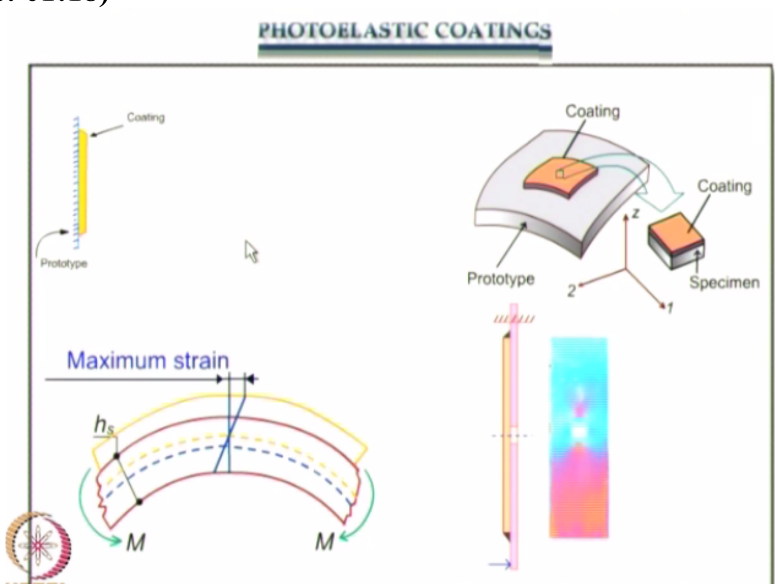


In summary, what you can look at is you have a simple optical arrangement then I said for all coating techniques the coating has to be bonded very carefully on the prototype and we also assume that strains are faithfully transferred from the prototype to the coating. And I said once you come to Photoelastic coating you have to think of what are known as correction factors, that is what is illustrated here.

I have a specimen on which I put a coating when it is subjected to bending you find there is a strain variation in the thickness of the coating. And you need to account for this variation and bring in correction factors. And finally we also saw a simple example that I have a specimen subjected to bending and you see a nice set of colors and we have already seen what is the color code in transmission photoelasticity.

And whatever the fringe ordering methodology you learnt, all those aspects could be applied to photoelastic coating as well. And one of the simplest thing what you can think of you look at this optical arrangement you have the elements shown in this fashion, I have a polarizer, first quarter wave plate, I have a second quarter wave plate and analyzer. And we have also looked at yesterday in the last class that a person was inspecting the landing gear had this Polariscope in his hand.

I will just show you the Polariscope and you will also appreciate how compact the Polariscope is. You know this is the Polariscope, you just see how compact it is and now what I am going to do is I am going to attach the light source and we will also see a one example problem how are observed conveniently. Now I have the light source attached to the Polariscope and you can see the whole equipment is so compact, I can hold it in a hand.

And what you have here is I have the light source I have the polarizer and quarter wave plate combination here. And I have the second quarter wave plate and analyzer combination here. So what I do is light goes through this so you send a polarize beam of light to the model concern and the reflected light is analyze by the second quarter wave plate and analyzer. And I would like to show the application of the Polariscope for an example problem.

And what you have here is I have the light switched on, I have the example of a flange coupling which is tighten by 4 holes. And this is a complex problem from analytical point of view, because you have assembly stresses developed. And I also keep the light source far away from the model what I have there, this is to reduce the angle of oblige, so I have the light that impinges on the model and the reflected light is viewed through the second quarter wave plate and analyzer combination.

And I see rich fringe contours and for the benefit of the viewers the human eye is replaced by the electronic camera for you to have a look at the fringe patterns. From a practical point of view these kind of problems become very important, how the bolt is tightened, what is the torque applied, they have to be maintained in the particular value, so that the fringe patterns reach in certain level of symmetry.

And also the sequence of tightening becomes very important in large fringe couplings. These are all very complex problem from analytically modeling and photoelastic coating can really reveal which information for such complex problems.

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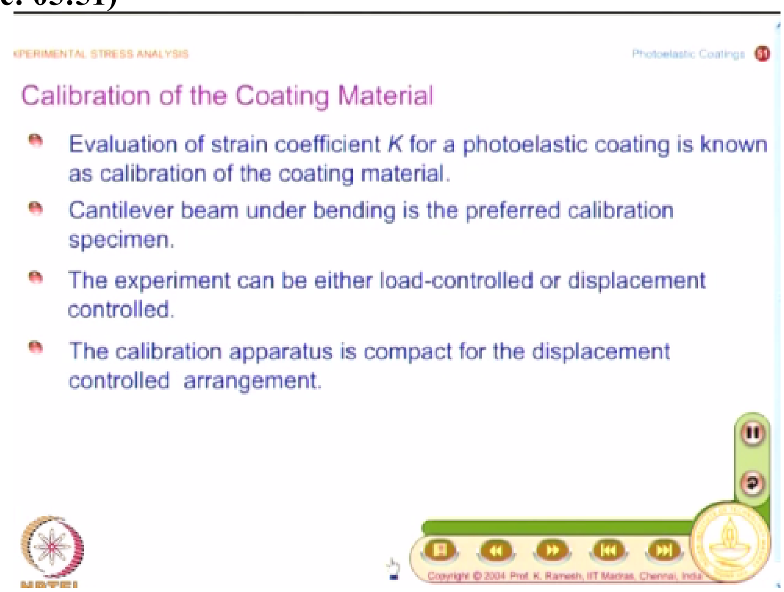


Now we move onto the important aspect that we have to do as part of the photoelastic coating test is. How to calibrate the coating material? And what is the meaning of Calibration? Evaluation of strain coefficient K for a photoelastic coating is known as calibration of the coating material. And if you look at what is most preferred calibration specimen is the Cantilever beam under bending.

And if you look later we are going to study what is Brittle coating followed by strain and if you look at photoelastic coating, brittle coating and strain gazes all are them employed coating of different kind on the surface, and for all these coating techniques you use calibration specimen as Cantilever beam. You do not select disc and diametral compression; you take a Cantilever beam and then evaluate the pertinent properties for the birefringent coating for a brittle coating and also the gaze factor in the case of strain gazes.

And the experiment can be either load-controlled or displacement controlled. And we would see that displacement controlled experiment arrangement is very compact compare to a load-controlled arraignment.

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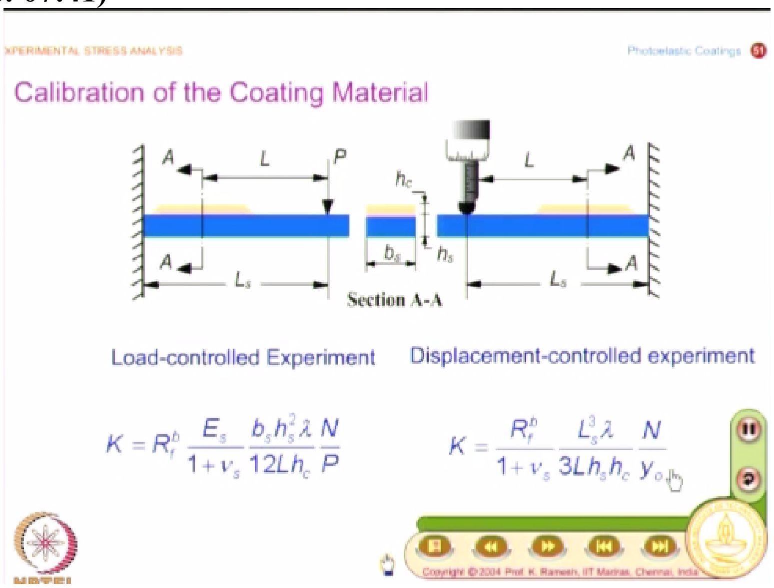


And this is how the specimen is loaded. And you need to make a decent sketch of it, it is very simple. And what I have here is a Cantilever beam on which the coating is pasted and if you watch carefully I have a bevel edge here, this is made of the adhesive whatever you do there, and another advantage of and approach like this is the coating material is very precious so you put only a portion of cantilever beam on the top is pasted with the coating, thereby you save the amount of coating material.

So you have the length of the beam length at which you are making the measurement you have the measurement like what is the thickness of the specimen and thickness of the coating and this is the load-controlled arrangement. You also have a displacement controlled arrangement. Instead of applying the load here you have a micrometer which provides the necessary end reflection.

And what you have here is when I have a load-controlled experiment the expression for K is very conveniently given in terms of the parameters of the experiment and you should notice that I have to use the Reinforcement factor for bending. If I do not use this my estimation of K would be erroneous. And what you do from the experiment is I have to find out the fringe order and the corresponding load, I need essentially the ratio N/P.

For a load-controlled experiment, from conducting the experiment apart from the geometric details I need to supply the value of N/P. On the other hand, when I come to displacement-controlled experiment the expression is recast and you have N/Y naught and Y naught is the reflection at the load – the displacement-controlled point, whatever the displacement is introduced which is taken as length LS for that distance what is the displacement, that is being used.

So what I have here is in load-controlled experiment I get the strain coefficient K as Rb Young's modulus of the specimen/1+Mu S. bs h square*lambda which is the wavelength of I used divided by 12Lhc and N/P which has to be determined from the experiment. And displacement-controlled experiment, I get strain coefficient K as Rfb/1+Mu S Ls cube lambda/3Lhs hc*N/Y naught.

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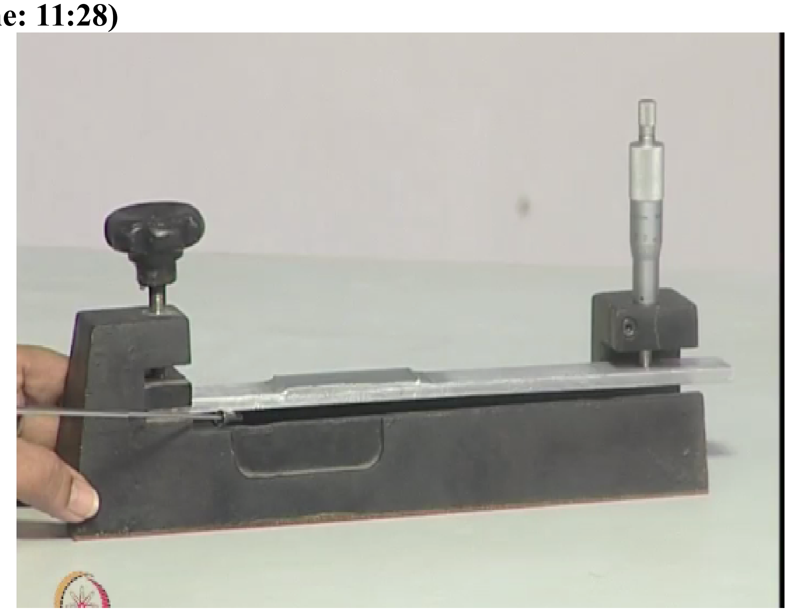

This shows the overall view of a displacement-controlled apparatus for loading a cantilever beam. And this is 6 stand and you can apply the displacement at this end by moving the micrometer appropriately. And you could rotate it and apply the load, apply the desire displacement you can also note down the level of displacement that is introduced. And what you have here is I have the specimen it is still for your benefit.

To show that you have a coating pasted, and what you can also notice is on either side the glue is applied in the manner that you have a beveled edge for smooth transfer of strain from the specimen to the coating. The whole apparatus is very compact and that is the greatest advantage. And all the coating like brittle coating all the strain gazes they use the cantilever for the measurement of pertinent parameters.

In this case we want to use this to find out the strain coefficient K and advantages you also use only a small coating material to save the precious coating material, you do not need to apply it for the entire cantilever beam, you apply it only in the region where you want to have sufficient level of stress to reveal the French pattern.

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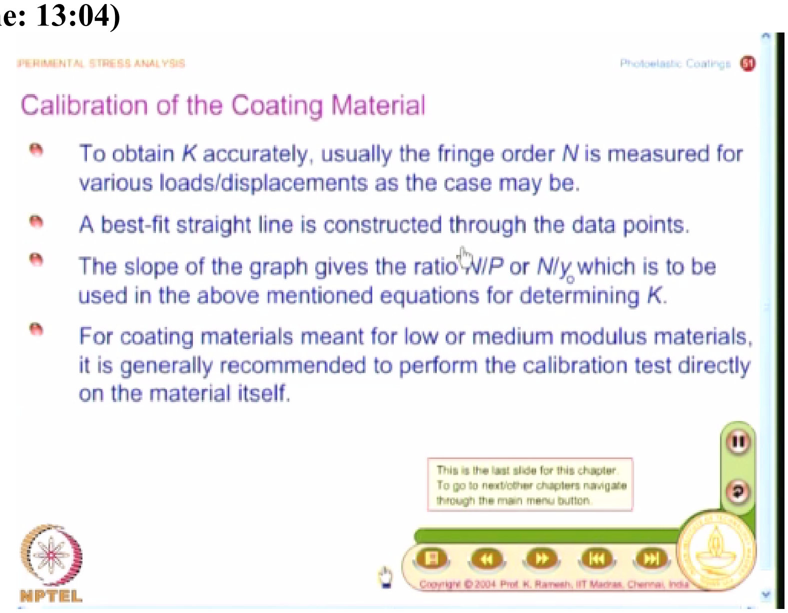


And you know, I have been saying that in photoelastic analysis the calibration constant has to be determined as accurately as possible. The same rule applies to evaluating K as well. It has to be obtained a accurately as possible. So for this you need to find the fringe order correctly and you just do not make one measurement you make various for various loads and displacement find out the fringe order, and do a graphical least square analysis.

What you do is, you fit a best-fit line through the data points collected. So from the graph you get the ratio of N/P if you are doing a load-controlled experiment, or N/Y naught if doing a displacement-controlled experiment. So you have the readymade expression available which can be used to find out what is the value of K. So for many of the high modulus coating materials and also medium modulus coating materials probably you could use simple cantilever beam.

Put the coating and evaluate either by a load-controlled or displacement-controlled, I said displacement-controlled the loading arrangement is very compact and that is a very popular loading arraignment supplied by the manufacturer also. Suppose I want to do it for the coating materials which are meant for a specimen like rubber, so I will have a very low Young's modulus value of the coating material rather than putting it on a specimen.

And then do a photoelastic coating test, it is advisable you make a tension specimen out of it, stretch it find out F sigma and from your identity between F sigma and F epsilon which we seen in earlier determine F epsilon then your K, that is what is summarized here. For coating materials meant for low or medium modulus materials, it is generally recommended to perform the calibration test directly on the material itself.

So what you do is you essentially, take a tension specimen and perform the test and get the value of F sigma. From F sigma go and find F epsilon and finally determine K. So with this we have covered all aspects of how to do a photoelastic test.

Like in transmission photoelastisity you have to find the F sigma. In reflection photoelastisity you have to find out K, K will also be supplied by the manufacturer but if the manufacturer the whatever that you have bought you are doing it the test after a long time then it is better that you recalibrate find out what is the strain coefficient K and then perform the test. Now we move onto Brittle coatings.

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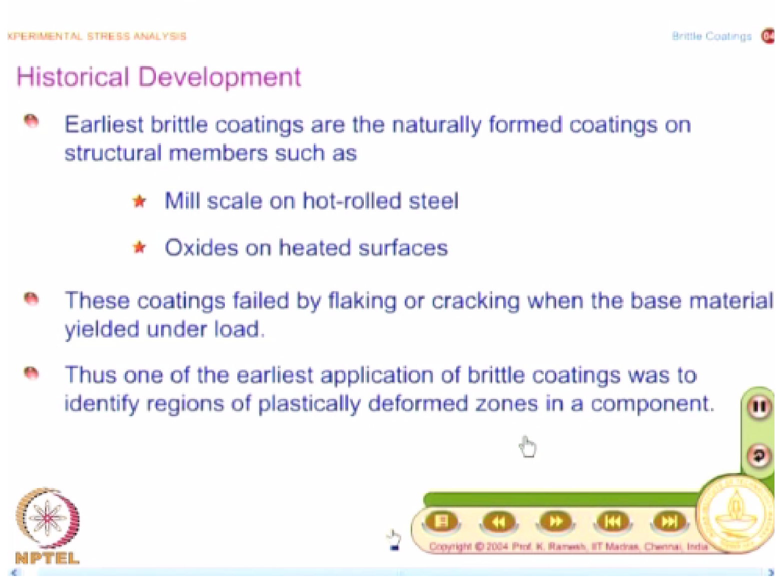


And, we have already had a bird's eye view of what brittle coating is in one of the initial lectures. You know very well that you have a coating that is put on the specimen which is brittle in nature. And this coating is allowed to fail under the application of the load and we also looked at what are ISO tactic and ISO entotic. We will see that in more detail.

And if you really look at what was the first application of Brittle Coatings, it was applied to find out when the material has yielded. And this was seen on Mill scale on hot-rolled steel. The coatings are naturally formed on structural members when you do a hot-rolling process you will have a mill scale on the hot-rolled steel. And you also had formation of oxides on heated surfaces. So the initially coatings where naturally formed coatings.

And what was the focus? I said each of the technique offer rate well in the particular range, and if you look at the first application of Brittle Coating was to find out whether there was plastic deformation, that means you are talking about very large strains. So when these coatings failed by flaking or cracking when the base material yielded under load. The focus was to identify yielding.

Thus, one of the earliest application of brittle coatings was to identify regions of plastically deformed zones in a component. That means you are talking of very high value of strain close to 2000 micro strain, the difficulties come when you want to apply to elastic problems and we have also seen that properties of the coating detect the accuracy of the technique.

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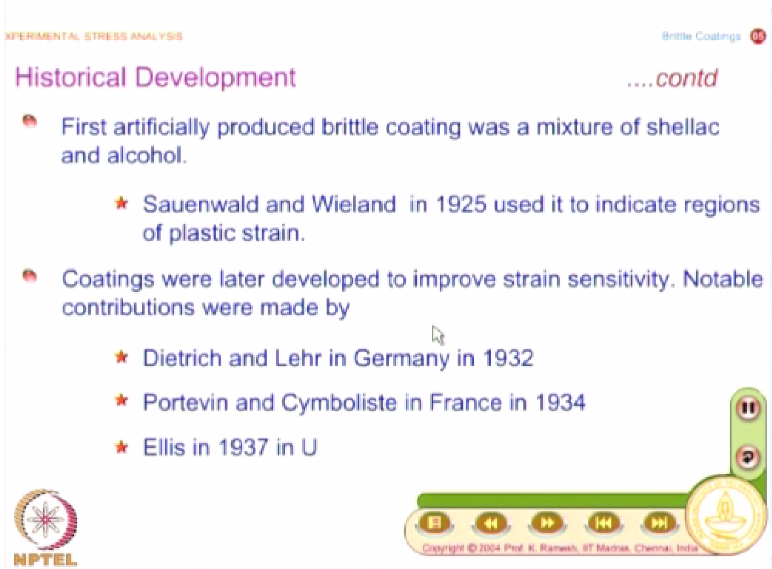


And it is desirable to look at what are the contributions by various scientists. And it is also interesting to see what was the first artificially produced brittle coating. We have seen naturally formed coatings earlier. The first artificially produced brittle coating was a mixture of shellac and alcohol. And this was used by Sauenwald and Wieland in 1925 to indicate regions of plastic strain.

And I said that, when you are talking about plastic strain you are talking of very high value of strain. Coatings are later developed to improve strain sensitivity, improves in sensitivity in the sense, the coating should fail at a lower strain, this is what you are looking at. And I have always said, any advancement in science or technology material research has always propelled the direction of technology.

So without advancement in material research you cannot see advancement in science or engineering. The same applies to development of Brittle Coatings too. So when you develop better materials I can bring down the strain level for the coating to break. And again this is not done by one individual, there are a host of researches who contributes to this, you had people from Germany, contributed in 1932, and you had people from France in 1934.

And also contributions from USA notably by Ellis in 1937. So what you will have to look at is any development is not individual centric, a team of people across the world work towards it.

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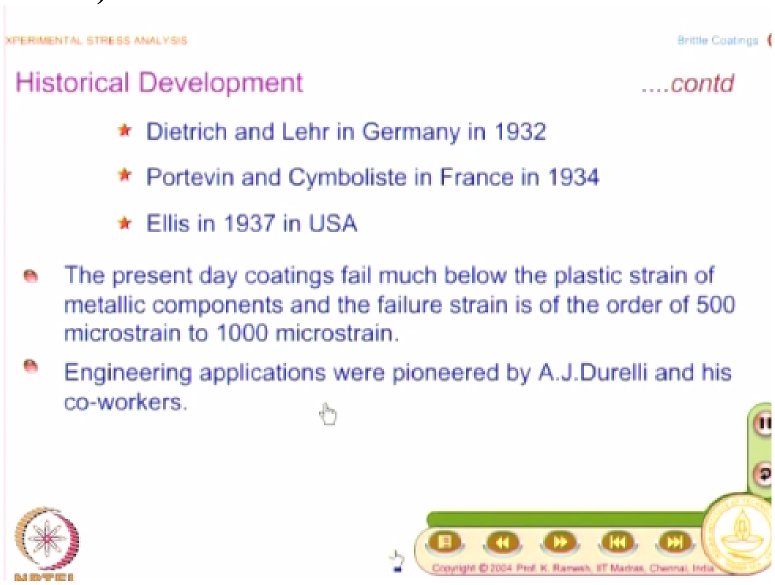


And the present day coatings fail much below the plastic strain, that is what you have to look at. It started with identifying zones of plasticity in a model and failure strain is of the order of 500 to 1000 microstrain even less. Now people say even 300 microstrain possible. So you have material research contributed to development of better coating materials which have more sensitivity for failure. Here the coating as to fail. The coating has to fail by microstrain.

And now you also have coatings below 300 microstrain. And many engineering applications were pioneered by A.J. Durelli and his co-workers. See, I said when it talk of photoelastic coatings I said (()) (22:30) was the key person who developed the countourable plastic and also developed correction factors and you have to remember his contribution. If we go to transmission photoelasticity fork was considered as father of photoelasticity, he had made significant contributions.

Similarly, when you come to brittle coatings the name that you cannot forget is A.J. Durelli. He have done several industrial problems.

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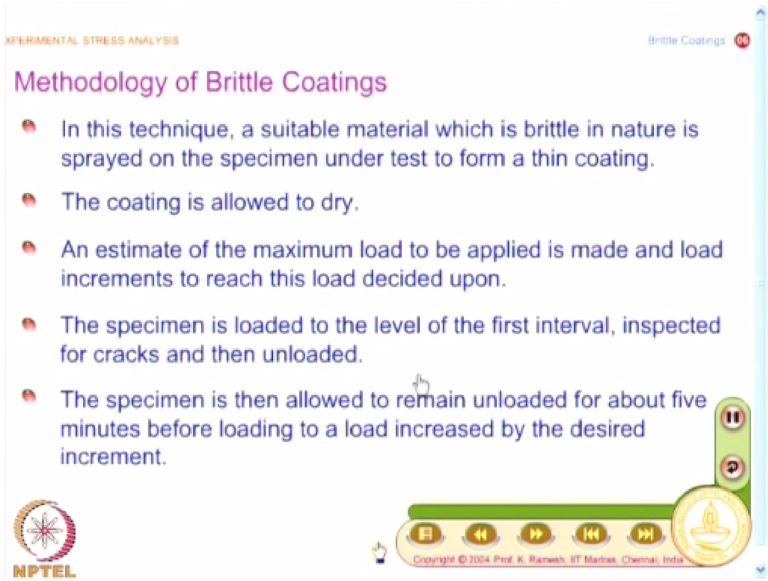


And what is the methodology of Brittle Coatings? This you already know, we are only going to refresh our old memories and in a very formal sense. So what I have is, in this technique, a suitable material which is brittle in nature that is the key point. And what way it is bonded, it is sprayed on the specimen under test to form a thin coating. So this simplifies your specimen preparation. Because I can cover large areas by a spray gun.

And I have already said brittle coating is useful technique for solving industrial problems which are very large in size and your focus is to identify zones of stretch concentration for further study. So you have to cover large areas. So in such a situation a spraying technique definitely helps. You allow the coating to dry. And then how do you load the specimen? Here the loading of the specimen is very interesting.

An estimate of the maximum load to be applied is made and load increments to reach this load decided upon. This is the peculiarity of the technique which I have mentioned earlier too. In many problems you find out for a given operational load (()) (24:40) developed. Here you incrementally load the specimen at every stage you go and observe for cracks. So it is very peculiar from performing the experiment.

So I need to find out the maximum load and also decide what are the load increments. Then what I do is I load the specimen to the level of the first interval then go and inspect for cracks and then unload it, either unload or keep increasing the load, I could do anyone of this approaches. So what we will have to look at is after the first interval you have to inspect for cracks, and the cracks what you see carry information and we have already noted that gives you principles of direction and call those patterns as ISO statics.

We will again see with an example, we will also label it and we also saw another set of contours called ISO Intatic. So the experimental approach is peculiar, estimate the maximum load, determine the load increment and you incrementally load after the first interval, look for cracks.

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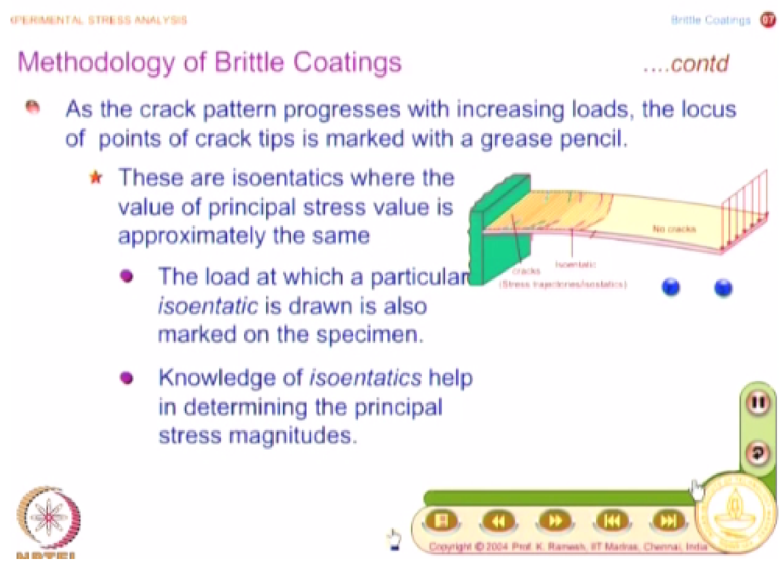


And what you have is the crack pattern progresses with increasing loads, the locus of points of crack tips is marked with a grease pencil. We will see that with the example.

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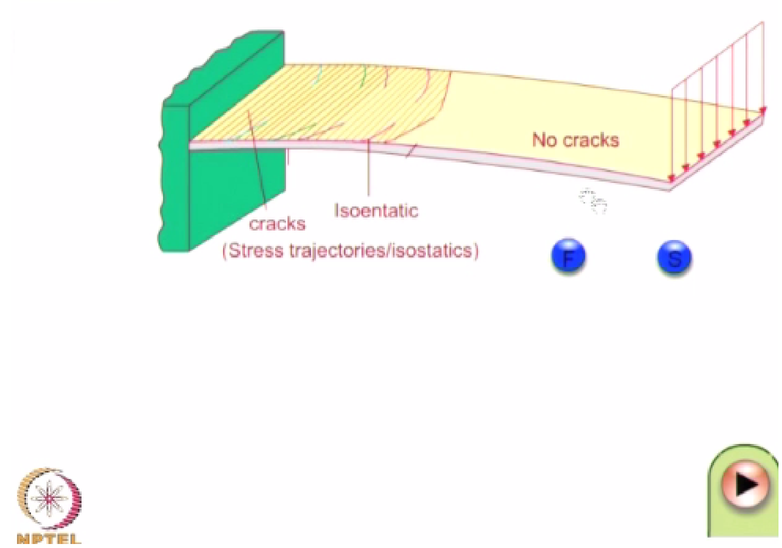

And what you have here is, I have a cantilever beam which is subjected to end load and if you watch very carefully the color of this loading will change for each increment and the same color is use to mark the ends of the cracks. So what you have is you have cracks, these are called as Stress trajectories or isostatics. And you know in the case of beam the end is heavily loaded the free end is not loaded, that is why you do not see cracks in this region.

And I will repeat the animation. And what I do is, at every increment of the load I mark the isoentatic. And isoentatic is drawn like this, because you know I have this end affects it is slightly exaggerated and you know, you have uniaxial state of stress in the case of beam. So essentially, you will get cracks parallel like this that is what you have to anticipate the crack. You have the bendings in this direction, it is perpendicular and you will have a lines parallel like this.

That is how you anticipate the cracks. Now I repeat the animation as the model is loaded. For each load the color changes the same color is used for marking the ends. And this is just exaggerated, it may not be exactly horizontal near the free edge to indicate that this kind of lines are put. I repeat the animation again, that tells you how you go about and doing the experiment. So for each increment of the load you find additional cracks are getting formed.

Which cracks are very important? What is the sensitivity of the technique? Where you have to be very careful? If I keep increasing the load I will keep looking at cracks, more and more cracks will get formed. What is important here? You should be careful to identify the first increment; it should be as low as possible to detect the first on set of cracks. Whether they have a stress concentration zone, the stress concentration zone is the one which is going to give you first set of cracks. So if the first set of cracks that are very critical in this technique.

So you have to be very careful in deciding the first load increment. It should not be very high. Then you miss which is the high stress concentration zone. So what it do is as the crack pattern progresses with increasing loads the locus of points of crack tips is marked with a grease pencil. These are isoentatics where the value of principle stress is approximately the same. And you can see this, see this animation again. You have this as the model loaded incrementally at every stage you have cracks formed and isoentatics are marked.

The load at which a particular isoentatic is drawn is also marked on the specimen. That is how you perform the experiment. Here I am not labeled the load but what I have done in the animation is whatever the color that I used for the end load the same color is used to draw the isoentatic. And if I have a record of isoentatics this helps in determining the principal stress magnitudes. You know it is decidable to proceed this isoentatic very closely I will repeat the animation.

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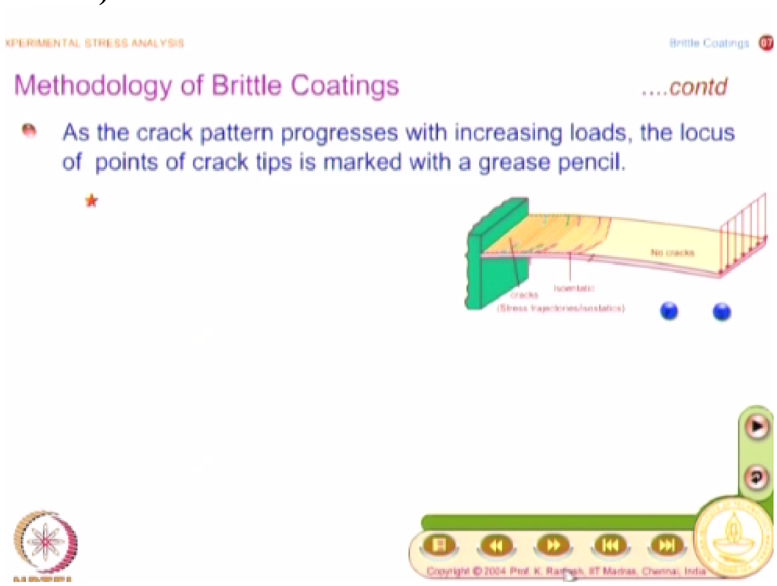


And then take a closer look at it. I have this and I also zoom it further, so what you have here is the isostatics or parallel like this and you see isoentatics of different colors which is for different loads. And what is important is then do the first set of cracks formed. It is very important. I have to be careful in deciding my load increments. So in this experiment you see isostatics as well as isoentatic.

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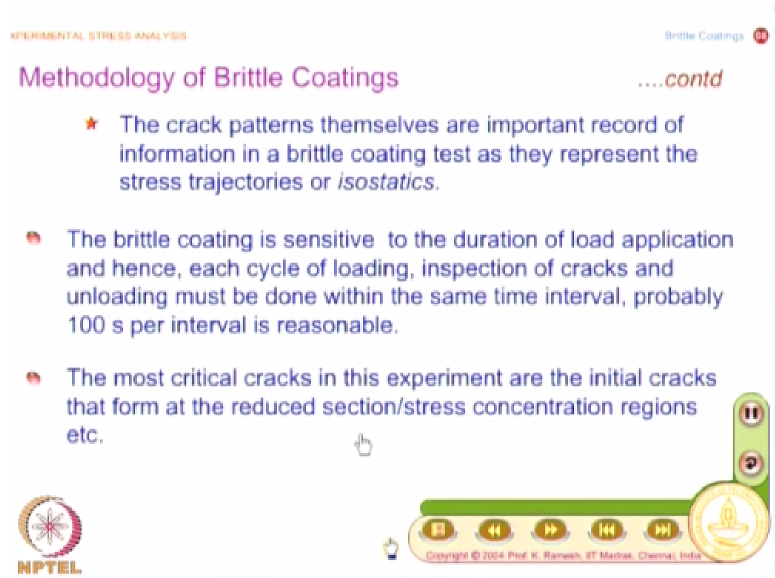


And this is what I have been emphasizing it again and again. The crack patterns themselves are important record of information in a brittle coating. They are represented and they represent the stress trajectories or isostatics. So people have developed methodologies to inspect for appearance of cracks. They have very elaborate methods – several methods are available so that you do not miss any zone where cracks are being formed.

So that itself is a separate branch where you have several methods. And another aspect which I will keep in mind is the brittle coating is sensitive to the duration of load application. So you have to have a particular cycle to follow for each cycle of loading, inspection of cracks and unloading must be done within the same time interval, and this varies depending on the coatings. It probably something like 100 seconds per interval is reasonable.

People also quote 5 minutes, so it is a function of the coating that you employ. And you will have to again remember the most critical cracks in this experiment are the initial cracks that form at the reduced section or stress concentration regions. So this is the most critical aspect of it. And another aspect is at every increment of load you must make and develop the skill to identify cracks at all regions. You do not miss the region. This has to be done very systematically.

So I essentially get isostatics and then I get isoentatic for every increment of the load.

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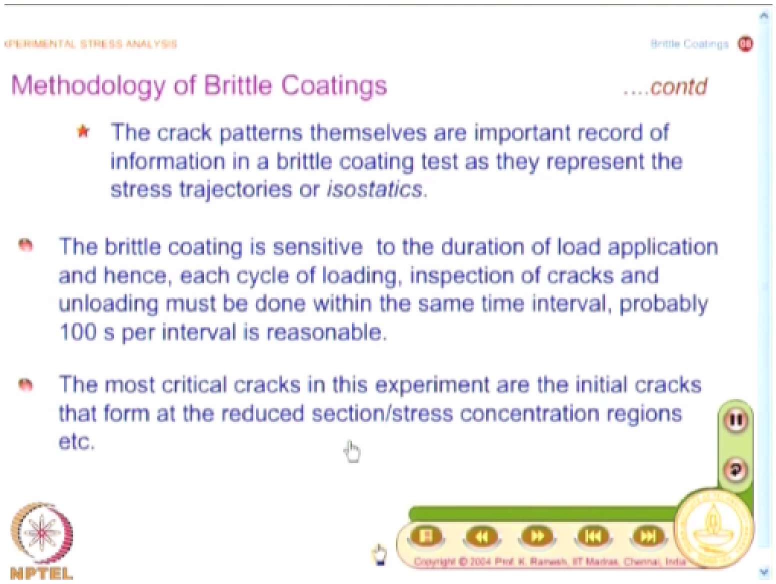


So that is what again emphasized. You need exercise considerable care in obtaining the load at which the initial cracks initiate as they represent zones of high stressed regions. See the methodology is like this. The coating is designed to fail at a particular strain level. If the crack has formed at a given load what it indicates is the strain level is at least this, it could be more than that also.

So that is the reason why you have to select the initial load small enough so that only localized regions have crack formation. Suppose I apply a very heavy load I would have lot of cracks formed, that is the issue. You have to sequentially record the formation of cracks as a function of load. So I want only few cracks at a time. So that is the success when I have the load increment appropriately decided upon.

And I have also said, experiment is anticipating results before they perform an experiment. So you have to do some calculation, it is not that close your eyes go and apply the load and then react to whatever the patterns that you see. You anticipate in a particular fashion and that has to be looked at very carefully.

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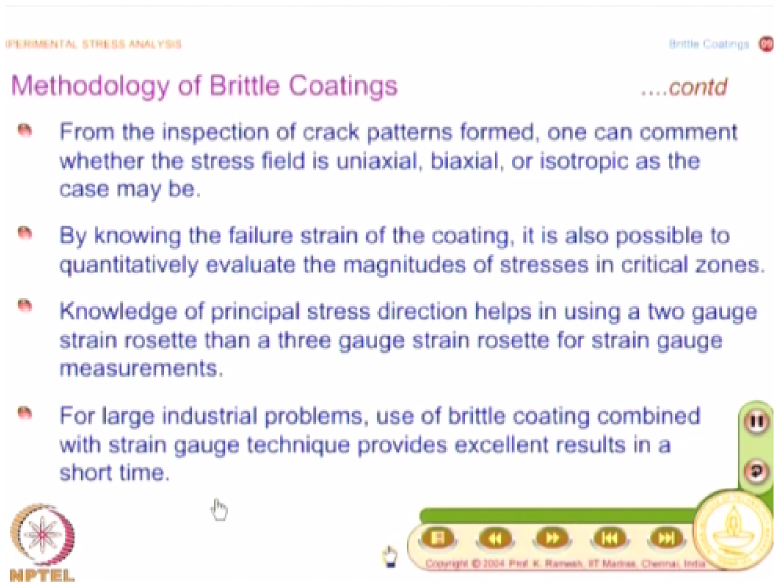


And what is important is like in optical techniques here also I see whole field information. By looking at the crack patterns formed, one can comment whether the stress field is uniaxial, biaxial, or isotropic. In fact, in some of the earlier studies even to identify zones of uniaxial, biaxial and then isotropic was an issue. It was a large problem. Suppose I know in a particular region I have only uniaxial state of stress then I can reduce the strain gauge channel that is the advantage.

Here we are not talking about you know, laboratory size problem, we are talking about industrial problems which are very large in size. And by knowing the failure strain of the coating, it is also possible to quantitatively evaluate the magnitudes of stresses in critical zones. See this is the possibility, but whether we want to use it as an experimental you have to take a local decision based on your requirement and time availability.

I have always said as experimental is people develop very complicated methodologies to extract as much as possible from a experiment. But from a user point of view, you will have to find out to what extent you want to use the experimental technique. My recommendation will be Brittle Coating is an ideal technique where you can use the isostatics to decide how to paste strain gaze in a complex structure. If I am able to reduce one channel per point, a great saving is done.

And that is what is summarized here. You have – if you have the knowledge of principal stress direction using a 2-gauge strain rosette than a 3 strain gauge rosette is possible. If I know the principals of direction, instead of a 3-gauge strain rosette I can go for a 2-gauge strain rosette. So I reduce one strain gauge per point. And the great success of brittle coatings is in conjunction with strain gauge technique the combination provides excellent results in a short time for industrial problem. This is a key issue, because that is what I always been saying.

Industry, when it approaches you it wants result yesterday. They want quickness in finding out the source of error and in such applications combination of brittle coating and strain gauges definitely helps.

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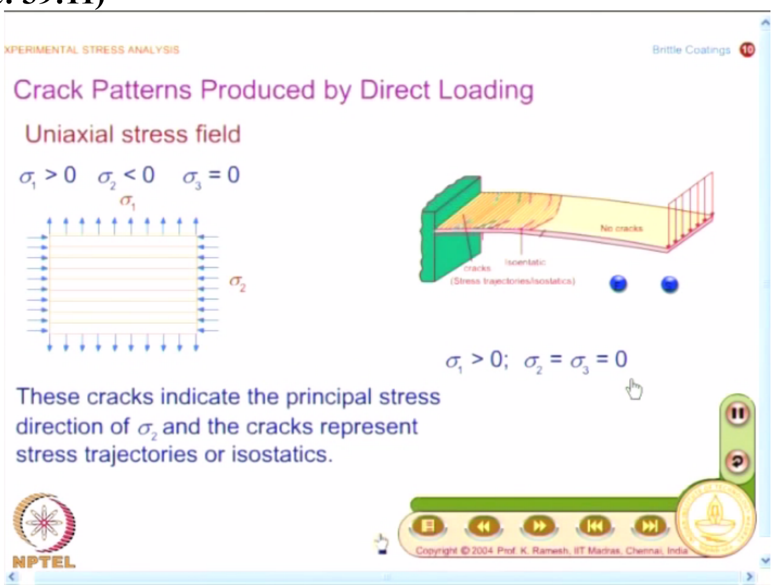


Now we look at what kind of crack patterns formed by direct loading. And this is what is shown here. Suppose I have sigma 1 is > 0 and sigma 2 < 0 and sigma 3 = 0, I have essentially a biaxial loading situation and sigma 1 is > 0, so you have cracks formed perpendicular to the direction. So by looking at that crack formed I can comment that this is a combination of uniaxial stress either I can have uniaxial stress or you have a tension compression.

And you have already seen an example of a cantilever beam. So by looking at the cracks, what do you get, these cracks indicate the principal stress direction of sigma 2, and the cracks represent stress trajectories or isostatics. Here it is shown for the tension compression, whereas here whatever the cantilever beam example which you have seen earlier essentially gives you uniaxial state of stress, sigma 1 is > 0, sigma 1 and sigma 2 = 0.

So by looking at the crack pattern I can comment whether it is an Uniaxial stress field. See we actually go around and look at, you have this whitewash, that is put on buildings and whitewash is actually a brittle coating. So by looking at the crack pattern on the wall you can comment whether I have a uniaxial loading there whether I have a biaxial loading or whether principal stress direction is same at all directions, all those kinds of comments you can make.

So from that point of view also looking at the crack pattern, gives you a insight without solving the problem what is the nature of stress field.

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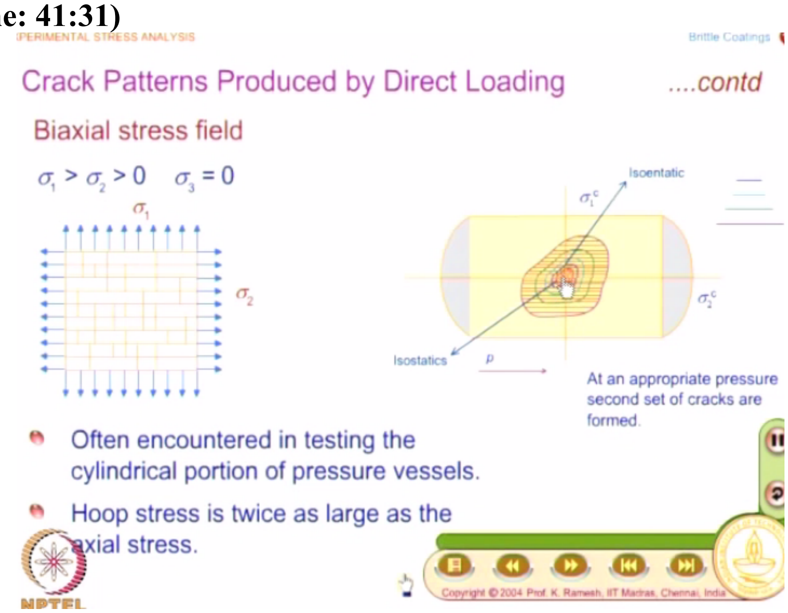


Suppose I have a tension, tension combinations, what happens? And where they have this tension-tension combination in your engineering? See engineers always deal with the pressure vessels. And once you deal with the pressure vessel you have Hoop stress as well as longitudinal stress, this is a very nice example where tension-tension combination exists, not only this, you know Hoop stress is much larger than the longitudinal stress. So only when the pressure is sufficiently increase.

Suppose for a particular pressure P, for the Hoop stress you have cracks formed, the second set of cracks will form only later, because longitudinal stresses much lower than the Hoop stress, only when it is double you will have in an ideal situation only when the loading is double you will have second set of cracks gets found. So what you have here is when sigma 1 and sigma 2 both are > 0. And this is a situation where sigma 1 was much larger than sigma 2.

So you have 2 sets of cracks formed. I have cracks perpendicular to sigma 2 as well as perpendicular to sigma 1. The mathematically analysis would become very complex, When I have biaxial loading the mathematical an applying failure analysis become difficult. But this gives an indication that you have a biaxial tension. I have a knowledge from the crack pattern that I have biaxial tension, and this you have already seen in the earlier discussion on brittle coating, the famous example of pressure vessel we have looked at.

And mind you, this is not an ideal pressure vessel, that is why you have cracks formed like this. It is not perfectly cylindrical, you have welding, you have that kind of practical issues considered for illustration, otherwise you will have cracks all over the pressure vessel. It is localized mainly because you have some sort of stress concentration there. So this kid of a Biaxial stress field is often encountered in testing the cylindrical portion of pressure vessels.

So it is of practical importance. And this is what I had mentioned that Hoop stress is twice as large as the axial stress. So first set of cracks form horizontally like this then after increase of pressure you have second set of cracks form, and that is what is shown here, we have already seen this in another earlier classes. And probably you could also see little closely. So I have this second set of cracks formed at a particular value of a pressure.

And these are all the ways that you get the cracks formed then you get the isoentatic drawn and the experiment proceed like this for another pressure you have this and you draw the isoentatic and so on.

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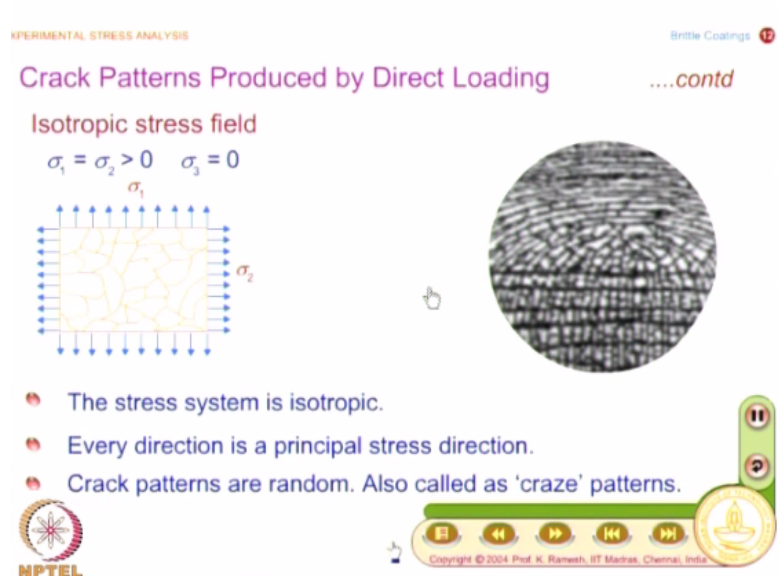


And what happens if principal direction is same which you call it as Isotropic field. Sigma 1 = Sigma 2 and both are > 0. So you have a random crack patterns. So if we come across in your buildings random crack patterns if you watch the whitewash and you find that you have random crack patterns you can immediately conclude that principal of direction is same in every direction in this zone of building which you can notice if you go and watch your house very carefully the whitewash what you have because the building gets stressed.

And you can find out by looking at the crack patterns. Comment whether it is a uniaxial field or biaxial field or sigma 1 = sigma 2. And you also have a nice example that is shown as part of a— so that is what is taken by a very special process for the case of a ring and a diameter compression, we have seen 0 fringe order, that is what it shown here.

And you see very clearly very random patterns here. This is the Isotropic point and these are all the isoentatic the thick lines are isoentatic and the thin lines are the isostatics. This is isoentatic. This isoentatic. And you see a random pattern here. The random pattern indicates that you have a isotropic stress field there. So the stress system is isotropic. Every direction is a principal stress direction because every direction of principal of direction you have cracks on all the possible directions. Crack patterns are random. And these are also called as 'craze' patterns.

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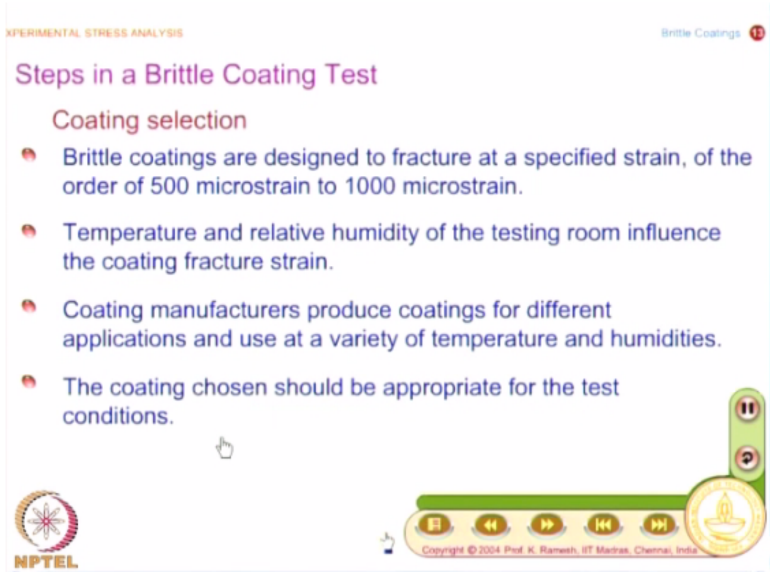


And you know, once you come to a Brittle Coating test the first step that you need to do is you have to select a coating. And if you look at any brittle coating test any supplier who supplies coatings he gives a different set of coatings for a variety of temperature and humidity. So depending on your test conditions you have to choose the coating that is appropriate for the test conditions. And I said (()) (48:00) is very, very sensitive.

So the temperature and relative humidity of the testing room or the test place because it is also an outdoor technique so you have to measure the temperature and relative humidity, that influence the fracture strain of the coating. Because all your calculation depends on what is the fracture strain, based on that only you make, and it is a approximate technique. It is applicable for a very large structure and the technique as such in approximate. That is good enough.

For industry problems, when you want to have quick answers, this kind of an approach is good enough. So the first step is you have to select a coating.

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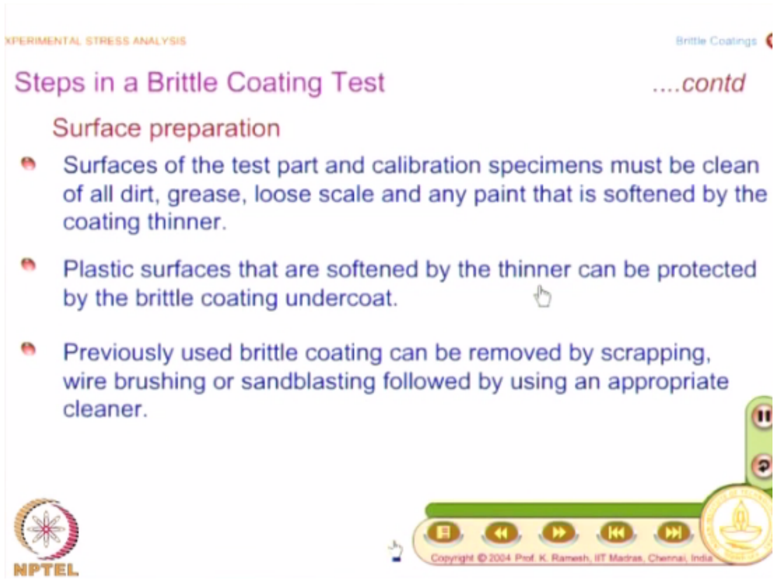


And the next step is what? In all the coating techniques surface preparation assumes important. You can actually abbreviate this and write it rather than writing full sentences like what I have wrote here. And when I have to bond a coating the surface must be clean of all dirt, grease, loose scale and any paint that is softened by the coating thinner. So that has to be done. Then what you have is you have plastic surfaces.

You can also apply it on plastic surfaces that are softened by the thinner can be protected by the brittle coating undercoat. So you need to put an undercoat and then only start using the you apply the actual coating and then do the analysis. And you also have occasions where you need to remove the earlier coating by scrapping, wire brushing or sandblasting followed by using an appropriate cleaner.

See you may also come across problems where there is a tension compression combination. And if I want to reveal the compressed stresses you have to remove the earlier coating then recoat it at the maximum load then release the load. So you have a direct loading approach and also a relaxation approach. We will develop a mathematics for direct loading then extra polluted for relaxation. So you will have occasion not only to clean the surface to apply the coating.

But you also have an occasion to remove the brittle coating that is applied which can also be done scrapping, wire brushing, sandblasting etcetera. **"Professor to Student conversation starts"** So in this class what we have looked at was, we looked at how to calibrate the

Photoelastic coating, I said you have to use a Cantilever beam as the model for finding out the pertinent parameters and I also mentioned for all the coating techniques like Brittle Coating as well as Strain Gauges you evaluate the relevant parameters using Cantilever beam as the model.

For all the coating techniques cantilever beam is a very ideal model for you do the test. Then we started discussion on Brittle Coatings, and I said it is useful for industrial problems, for larger industrial problems, though you can also find out quantitatively the value of the stress magnitudes. Mostly it is desirable to use to find out the principal direction at the point of interest, so that in strain gauge instrumentation I minimize the number of strain gauge to be pasted at a point of interest.

Even if I minimize reduce by one strain gauge I save a lot my strain gauge instrumentation. And we looked at some details of the test. We also looked at by looking at the crack pattern, we can identify whether the Uniaxial stress, Biaxial stress or Isotropic stress field. And we will continue the discussion in the next class. **"Professor to Student conversation ends"**