Experimental Stress Analysis - An Overview
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Lecture - 2.4
Principle of Strain Gauges

Let us continue our discussion on overview of Experimental Stress Analysis. Now what we will do is, we will go and find out what is a physical principle each of the techniques is based on. Now I may not get into the details of how to perform an experiment or how to interpret data? My focus is only to bring out what is the basic physical information each of the techniques is based upon and we go from the technique like Strain Gauges to start with, because this is the most widely used a technique. As I mentioned earlier, in this you get component of strain along the gauge length of the strain gauge is measured. And here you have the typical enlarged view of the strain gauge and you call this as a gauge length.

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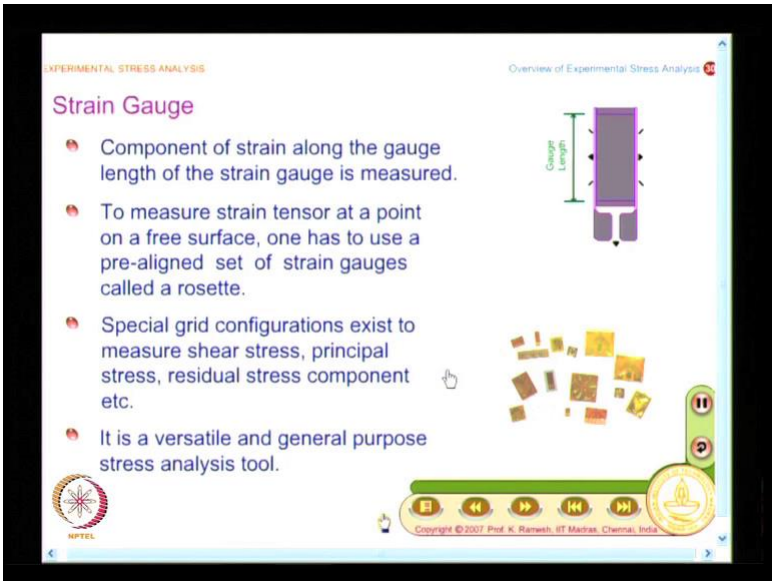

So, a strain gauge measures only component of strain, it is not measuring strain tensor. What I have is to measure strain tensor I need to have three strain gauges for you to do it

on a free surface and they have to be pre-aligned and you also have a name attach to it, if we have three strain gauges on a single based to measure the strain tensor you call it as a Rosette. What you have here is, you also have special bit configurations. You do not stop at only measurement of strain there may be require requirements where you may want to directly find out shear stress or you may want to find out principle stress, or you may want to find out the residual stress component. So, for all these cases you have special grid configuration exist. In this I am focusing my attention only on electrical resistance strain gauges.

There are many other the methods to measure strain, you have mechanical strain gauges, you have capacitance based strain gauges and we confine our attention to electrical resistance strain gauges and you have a variety of them available. What you have to understand is it is a versatile technique and a general purpose stress analysis tool because, if you are working an adverse condition then also this methodology can be used. You can use strain gauges in you know below the sea surface where you have under water pipe line or whether you have off shore platforms you can do this. Many techniques may not be able to do it.

On the other hand, if you want to find out what happens on that top of the TV tower? I can put a strain gauge; I can have telemetry and then acquire data. So it is a very versatile technique, it is very widely used and as I also cautioned you earlier, it as to be used with care.

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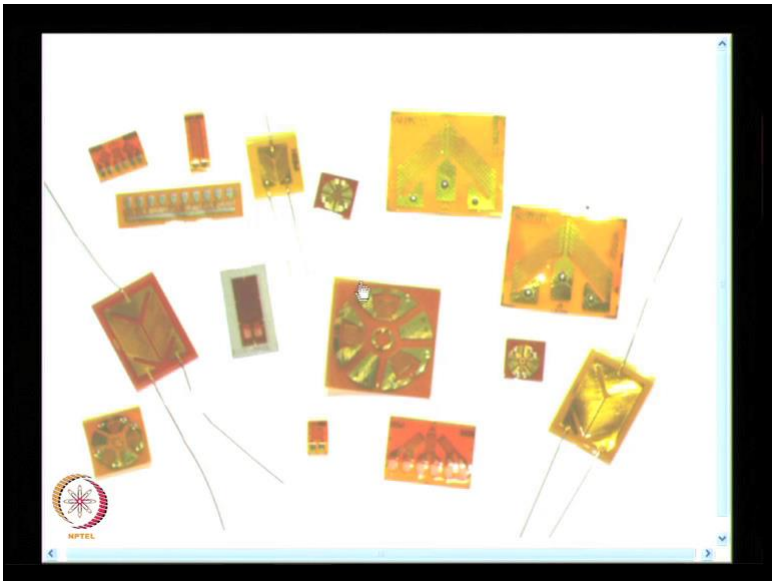

And what you see here is, you have array of strain gauges for various applications and this you have a hole, so this is meant for finding out residual stress component and I mentioned strip gauges. This is what a strip gauges; you have a series of strain gauges available in a strip. And like wise you have various grid configurations available, this is from various manufacturers who have given this.

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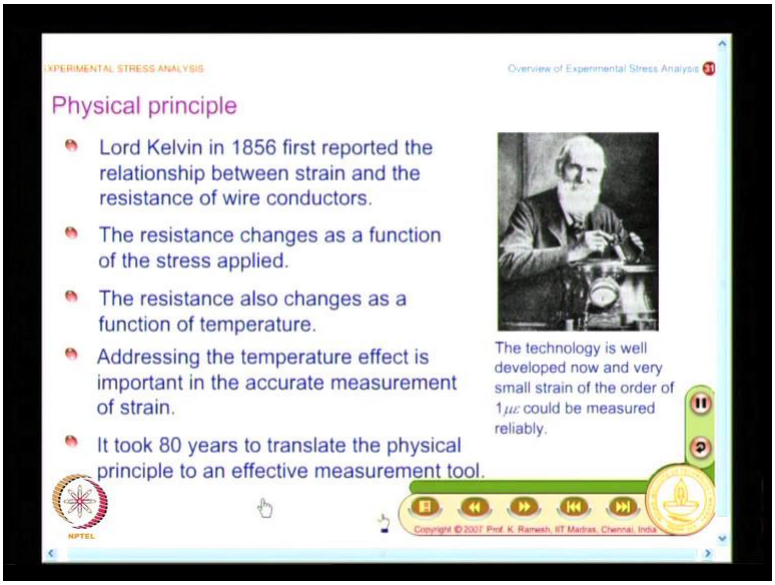

What is a physical principle this technique is based on? It was reported way back in 1856, it was reported by Lord Kelvin and he found out a relationship between strain and the resistance of wire conductors. So what he found was, when the resistance changes as a function of the stress applied. It was very exciting information. The resistance does not remain constant it is a function of stress. So it gives you a scope to measure stress or strain from this strain gauge. If it is only that then the whole instrumentation would have been much, much simpler. But what do you find, the resistance of a conductor also changes as a function of temperature.

So you have a problem, the resistance is a function of the stress applied is comfortable for strain analysis or stress analysis, but resistance is also a function of temperature gives you disturbance. If you look at the technological development, you have to look at how this temperature effect is taken care of. So what do you find is, addressing the temperature effect is important in the accurate measurement of strain. If you look at from the physical principle as a technology, it took almost 80 years to translate the physical principle to an effective measurement tool. Why this is so? Because you need to develop technologies where I delineate the effect of temperature and measure only the strain information, whatever the resistance change because of strain. It should be easily available for many people to use it and it took so much time and recently it also celebrated the 50th year of metal foil strain gauges.

What you have now is, the technology is very well developed and you can measure 1 micro strain reliably now, very precise technique. And mind you 1 micro strain is 1 into 10 power minus 6, very small quantity. That is another reason why the technology took so much time. Not only the temperature effect, you are measuring very small quantity you should be sensitive to that, you are measuring 10 power minus 6, and you have to have certain level of confidence in the measurement. That is why the technology took a very long time to settle down and now we can measure 1 micro strain comfortably.

Thank you.