**Experimental Physics I**
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**Lecture - 21**
**Demonstration on the experiment of Young's modulus of mettalic bar and data collection**

We are in second year lab of Department of Physics of IIT, Kharagpur. So, we will show the experimental setup for measuring the Young modulus of a bar or beam. So, the shape of the material we have taken in form of bar.

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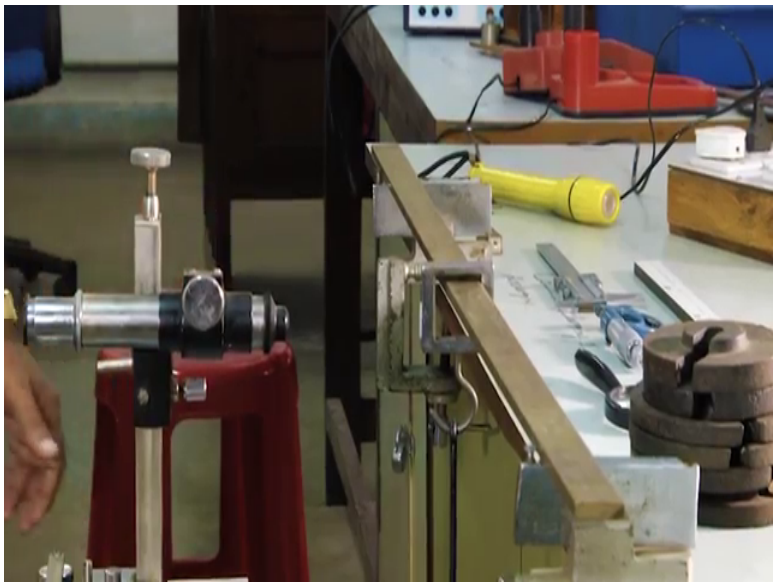

So, this here you can see this, this is the bar. So, this young modulus, we will find out of the material of this bar. So, it is basically young modulus is independent of the shape of the material. So, you can take in shape of wire means cylindrical form; you can take also in form of this bar. So, there are two method as I mentioned is, one is Searle's method, there we take the metal in form of wire. And this is the flexure method in this method we take the material in form of bar.

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So, this is a bar. This is a bar basically and its length is around 1 meter, 100 centimeter. So, it has length say L, capital L. And it has breadth, so this is the breadth. And it has thickness, so this is the thickness. Thickness d, breadth B, and length is L. So, in flexure method, what we do? We select we select a certain length of the bar. This bar is kept on the sharp edge knife edge two knife edge.

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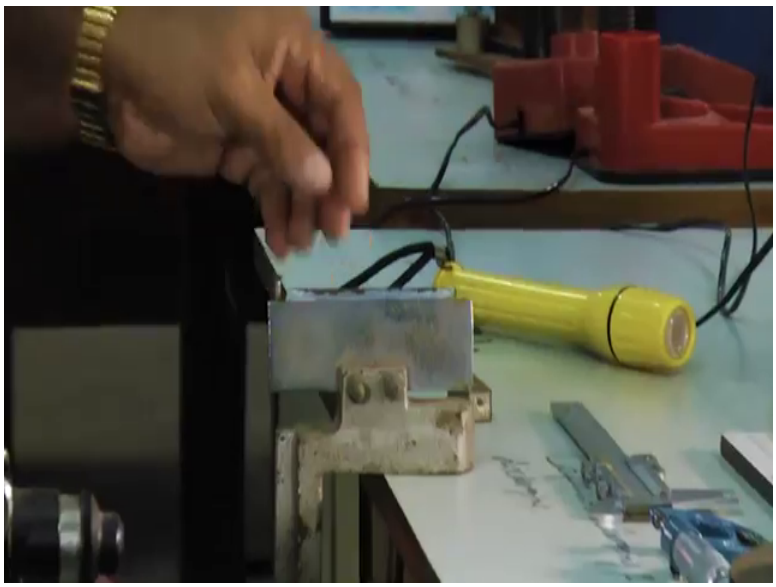

So, here this two knife edge one and this is another one ok. So, on this knife edge we keep the bar symmetrically basically symmetrically. So, this experiment will repeat for 2

to 3 length.

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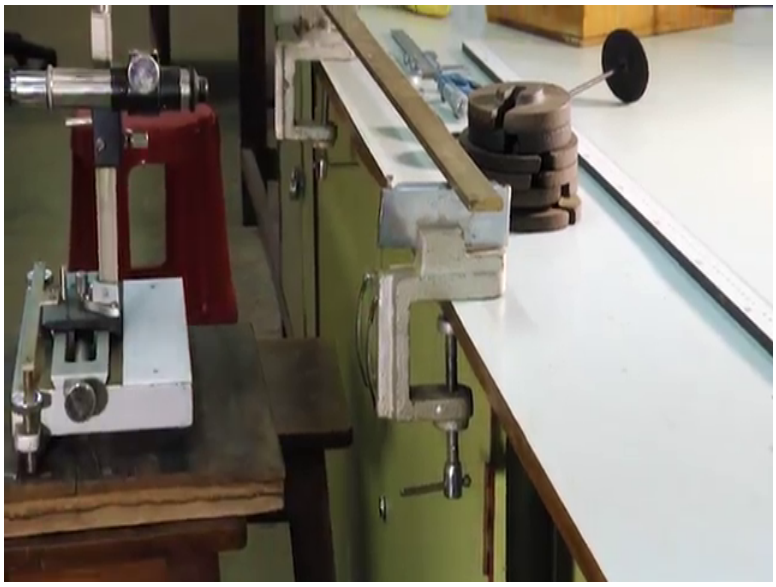

So, we can select the length just moving these knife edge; so that I can show that we can move it. So, basically just we have to loosen it, and yes, then we can move and adjust the length. So, initially say I will select the length say 80 centimeter. So, I need to measure the length this meter scale or centimetre scale.

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So, I have centimetre scale. So, here this 100 is basically 100 millimeter 10 centimeter.

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This 20 centimeter, 300 millimeter means 30 centimeter.

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So, between these two knife edge, I will here I have put as say this edge is at 10 centimeter, this other edge if it is 90 centimeter, then it will be 80 centimeter. So, it is a slightly less than 80 centimeter.

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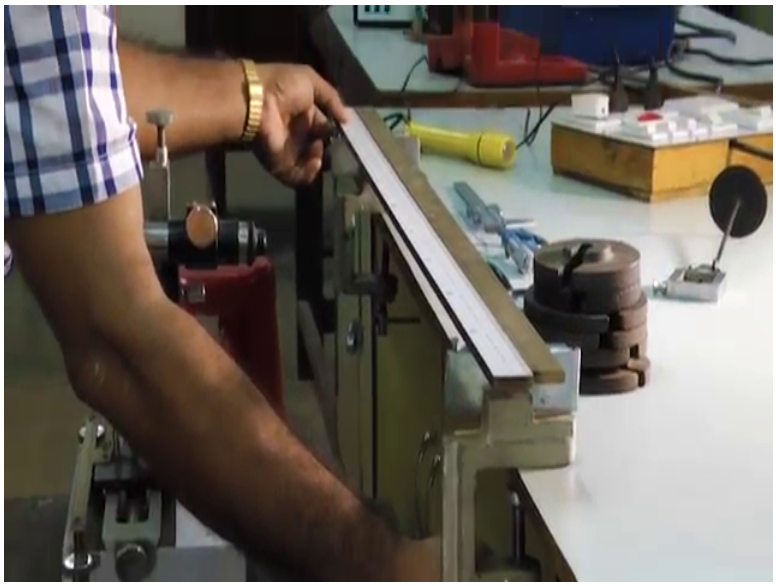

So, I have to just adjust the length moving this one knife edge. So, I put it at 90 centimeter; and this other end I will put at 10 centimeter. So, 90 minus 10, so this length is now 80 centimetre, so between these two knife edge the distance is 80 centimeter.

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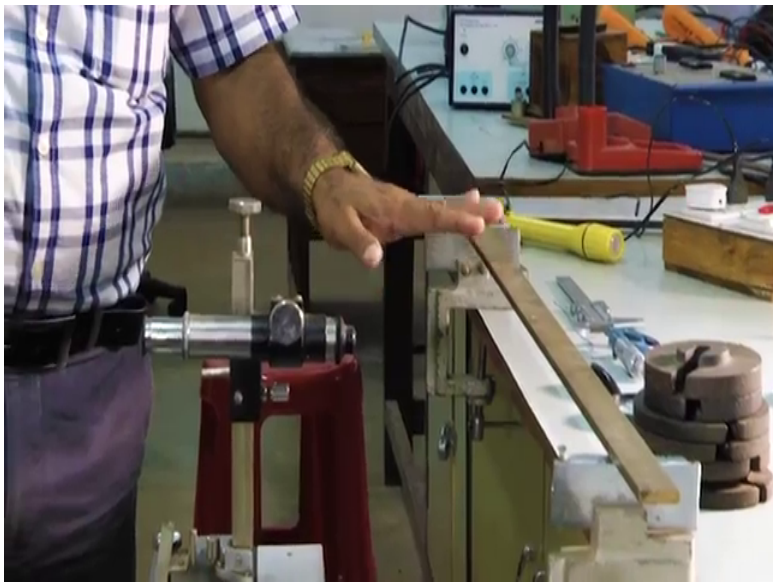

So, now this effective length of this bar is 80 centimeter for our experiments I will put it symmetrically ok. So, first we have to choose length, so that I have chosen 80 centimeter. Using the meter scale the least count of this meter scale is basically 1 millimeter, so that we have to note down; so that we have to note down. So, this scale have the least count is

1 millimeter means 0.1 centimeter.

So, next we need to know the breadth of this bar. So, for that, we will use slide callipers, we will use slide callipers. Why we will use slide callipers why not we will use the this meter scale? Because this in this case we have scope to use a better least count instrument or tools. Because for measuring the length I cannot use this slide callipers, because this length is very large and appropriate tools is some meter scale so that is why I have used. And also this least count of meter scale 1 millimeter compared to the length 80 centimetre. So, this error effective error will be very small over this length ok.

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So, for this for measuring the breadth of this bar, we will use slide callipers. So, I have discussed about the slide callipers. So, first we have to find out the least count of the slide callipers right. So, how to find out that? I have told you earlier; in earlier class. So, just you measures, then you measure the breadth of this of this bar at least at three to four points.

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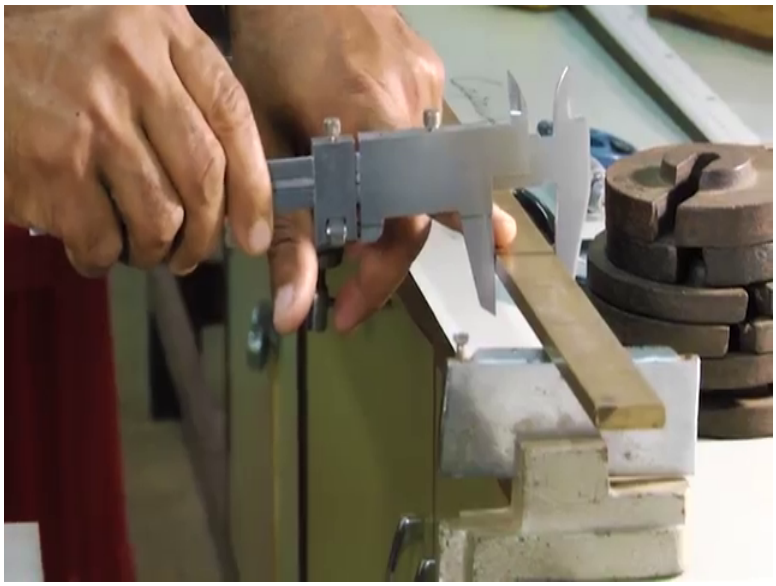

So, at this point you measure the breadth, and then you measure the breadth at this at the middle point, and then you measure the breadth at this point ok. So, then you note down these all three readings. And from there we have to take we have to take basically, so I think it was just opposite direction I showed you.

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But is basically if we if I show you the front side, so you can see the scale ok. So, here you should take the reading for this width at this position ok. And then as I told in middle position, and then this another end you can take this reading. So, how to take reading that

already you know I have discussed. So, using the using the slide callipers, we have to find out the breadth of this bar ok.

Next we have to find out the thickness of this bar, thickness of this bar. So, for that again you can use the slide callipers, but we will prefer to use screw gauge, because screw gauge have better least count. Slide callipers have least count is a 0.01 centimetre; and screw gauge has least count 0.001 centimetre ok.

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So, here I have scope to use these screw gauge so that is why I will prefer to use the screw gauge. Again this screw gauge about screw gauge I discuss so how to find out the least count of the screw gauge. So, it has linear scale as well as circular scale. So, just use your knowledge as you learn from earlier class.

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So, find out the thickness or depth of this bar. Again you take 3, 4 reading at different places ok. So, at this place what is the reading we find out, how to find out that I have discussed. Second you take this another position, you take this at another position and then also in third position or fourth position ok. So, this way you measure the length, breadth and depth for this bar ok. And so I have taken already this reading for this one, so that I will show of later on, and discuss how to analyse the this data and calculate the calculate the young modulus ok.

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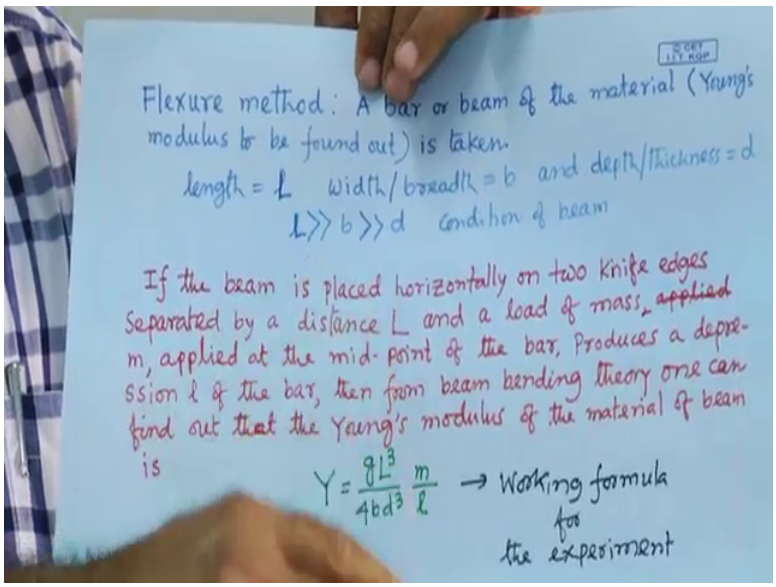

So, now next job is as you know this working formula as I told you that for this Young's modulus working formula is Y equal to g L cube means length cube divided by 4 b d cube then m by l. So, already we have measured L ok, and then we have measured b and also d ok. So, there is a again reason to use this screw gauge for measuring d because this power of d is 3. So, this error will be basically in measurement of this d is 3 times of the least count ok.

So, whenever any parameter have higher power, so you have to be careful for measuring that parameter because this error will be multiplied with this power ok. So, now next measurement we have to do m by l. What is m and what is l?

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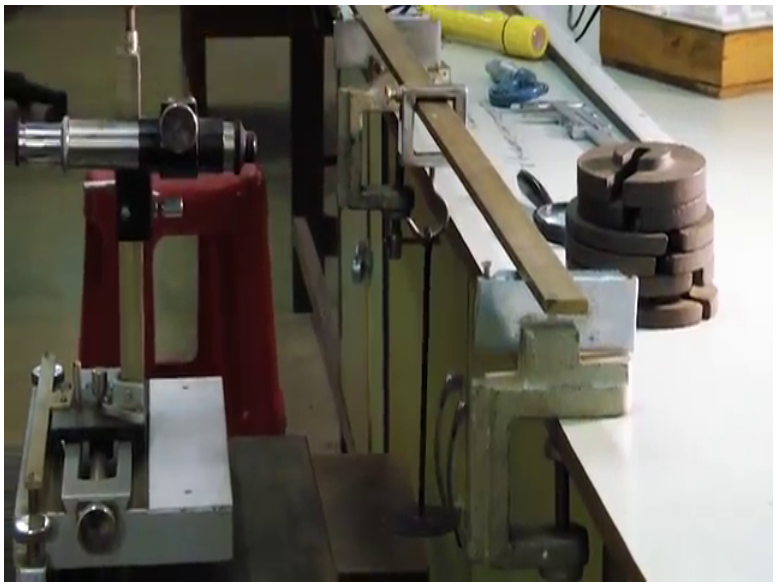

Basically in flexure method we in flexure method we here this just, we will so this one we have to put at the middle. So, this is the basically indicators for measuring the depression that is small l whatever I showed. So, we will we will just load or apply different mass on it means so this force gravitational force will be mg. So, for different gravitational force, there will be depression of this bar, and there that depression we have to measure. So, this is the main task of this experiment.

So, we will apply different mass. And for that different mass what is the depression that we have to find out. So, this one we have to put exactly in middle of this bars means between these effective length. So, so I have to again use the scale, again I have to use the scale, it was 80 centimetre. So, I have to I have to find out this basically position of

40. So, it is the 500. So, yes in this case it is the 500, because 100 I have taken at one edge so 900 is another edge. So, middle position will be at 500 millimeter or 50 micrometer, so approximately not approximately accurately one can find out. So, this position will be at the middle of the bar ok, this position will be at the middle of the bar. So, I think I have to place properly, so that it should be free it should be free. Now, I have to measure the depression for different mass.

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So, for measuring depression, we will use this instrument. This is basically is travelling microscope. It is a travelling microscope means if this microscope this one, it can travel vertically or also it can travel horizontally. So, just I will show you I think I have to loosen it.

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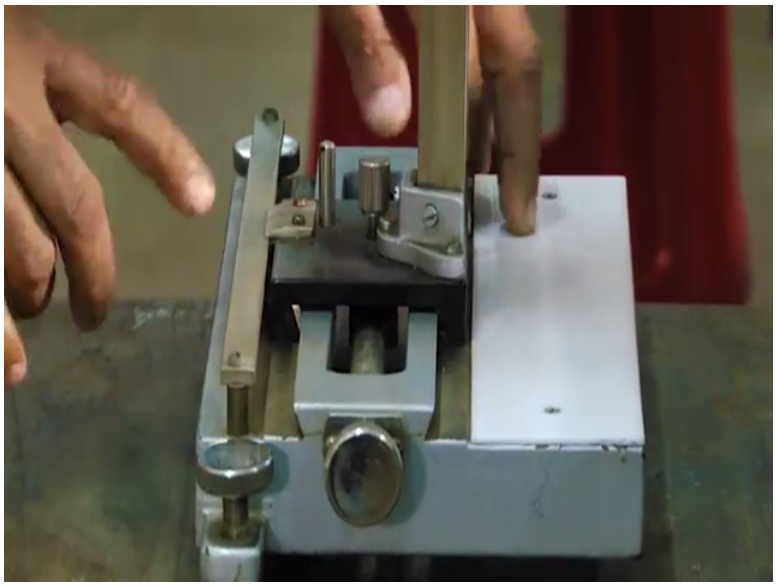

And then this basically you can just move it, move it and you can measure the basically here there is a scale.

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Here one scale is there ok, horizontal scale. And with this scale there is a Vernier scale ok. So, this is just like slide callipers ok. So, this is the horizontal scale; also we have vertical scale, we have vertical scale here.

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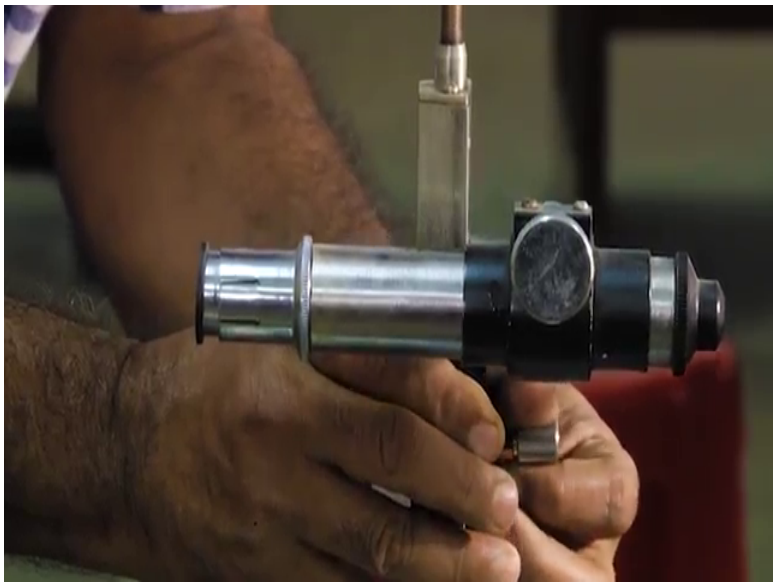

So, for vertical movement, you can just loosen this screw, and take your position, take your position, and then tighten it. So, here there is a I will show you; I think here there is a vertical scale.

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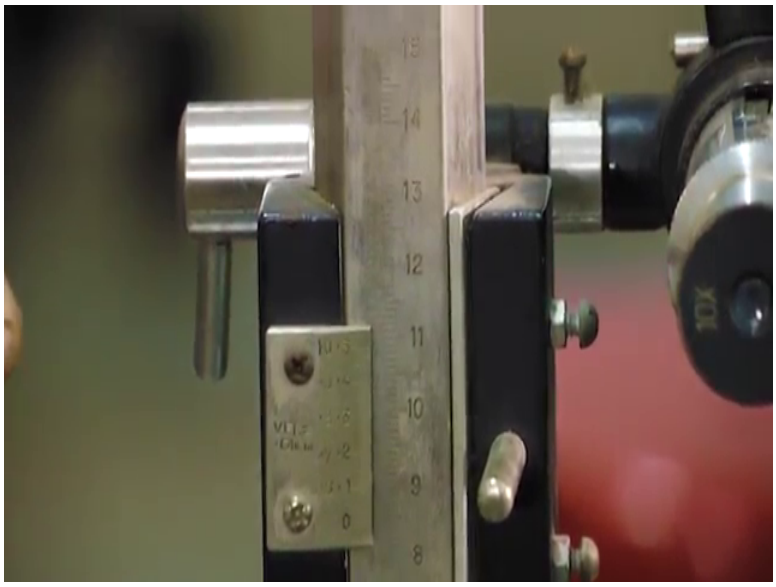


Here there is a vertical scale again this linear scale, and this another main scale and this vernier scale ok. So, both of the scale have again like this vernier slide callipers, we have to find out the least count vernier constant. And here you can see here this total division in vernier scale there are 50 divisions, there are 50 smallest divisions. And if you see this

main scale, one smallest main scale in this case is it is a 0.5 millimeter. So, your vernier constant will be 0.5 millimeter divide by 50 division. So, it will be 0.01 millimeter means zero yeah I think 0.5 divided by 50. So, it is 1 by 100; 1 by 100 ok. So, it is 0.001 centimeter ok.

So, whatever the screw gauge I told this in our screw gauge we have least count is 0.001 centimeter. So, this scale also have the same least counts, so that means it has better least count than the then our slide callipers. So, whatever slide callipers I showed you probably, it is the better one.

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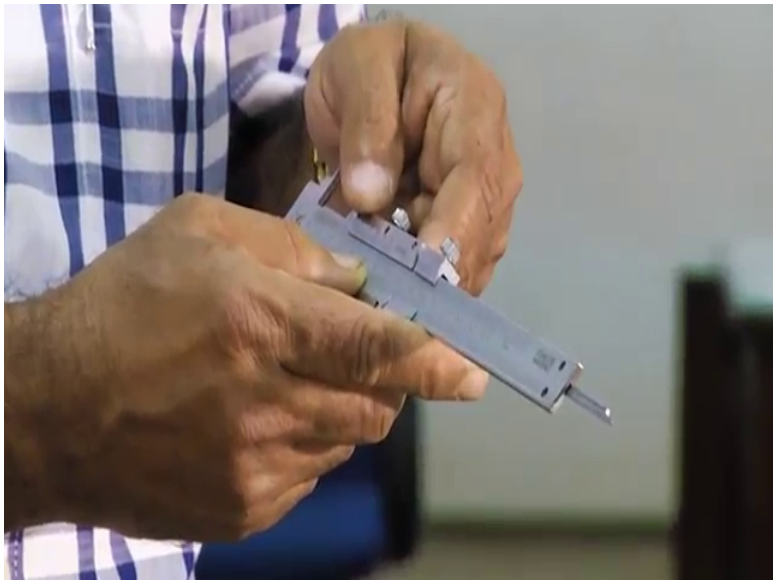

I think this slide callipers have the vernier constant of 0.002 centimeters ok. So, so even this one is better least count having better least count because it is 0.001 centimeter. So, this is so using these travelling microscope, we will find out we will measure the depression of this cantilever ok. So, for measuring this, what we have to do first we have to focus the indicator, here there is a indicator, here there is a one cross point.

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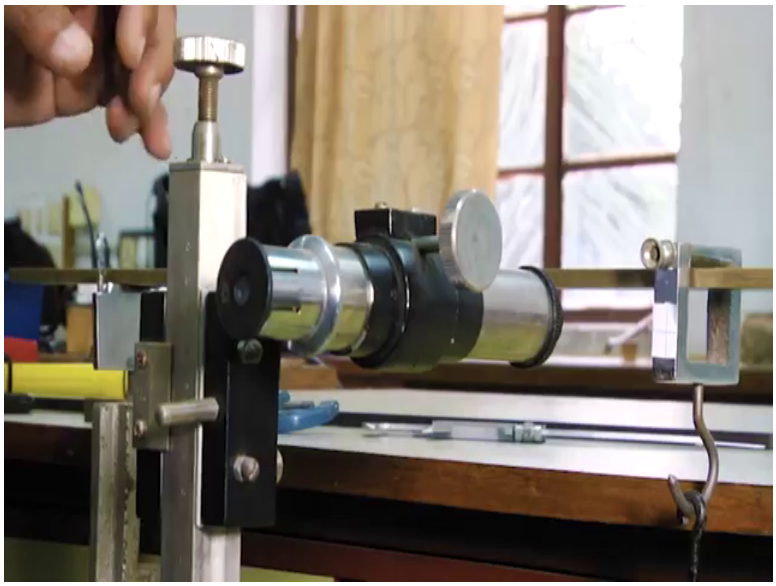

So, we will measure the depression versus load means we will apply different weight, and for that what is the depression that we will measure. So, for that here we have arrangement.

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This here one cross you can see ok. So, we will focus our microscope at this point ok. So, then for that so we have to focus this microscope at this point; so it is already we have kept in focus ok. So, there is a crosser in microscope eyepiece, so that crosser will coincide with that other this cross point, so that I have kept it that; I have kept it ok. So,

then we have to take this reading, we have to take this reading. What is the reading so that is the initial reading we will take here from?

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Yes. So, here we have vernier scale, then zero of the vernier scale, basically zero of the vernier scale is here, and zero of the vernier scale is here yes. And it is the, this main scale reading I have to take. And this it is the is 9, and then it is between 9 and 10. So, then we have to see the, we have to see the we have to see this yes. So, we have to count the division.

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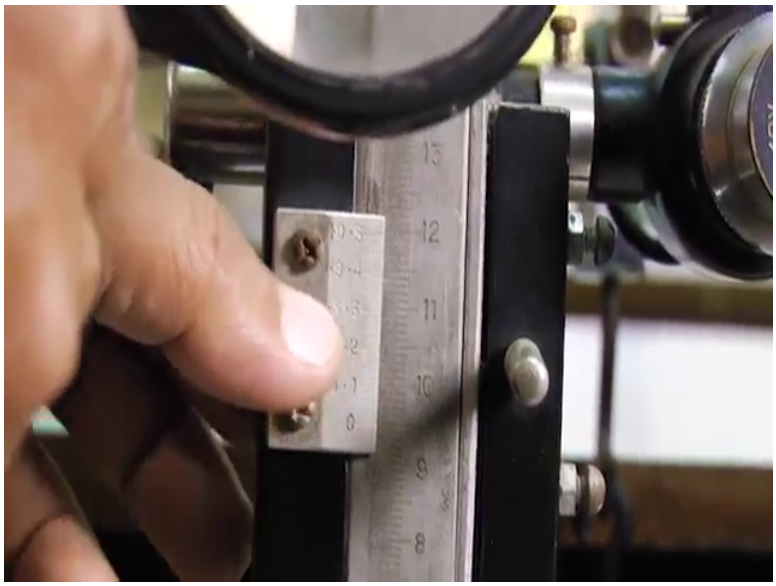

So, I can see here approximately it is 9, it is a 9, yes, I think yeah it is a 9.2, 9.2, and then yeah it is around 9.2. So, we have to take this reading carefully. And find out the vernier this which vernier coincide with the main scale that we have to find out anyway. So, this is the procedure to take this reading from this scale. So, these after taking this reading, we have to note down ok, we have to note down fine. So, this is the initial reading. So, without applying any mass without applying any mass, what is the initial reading, so that we have to note down. And then I will apply a mass.

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So, I have mass here. These all have 500 gram. So, we have six mass here. So, each are having these 500 gram, each are having 500 gram. So, we will just put one mass first this is the 500 gram ok. So, this is the 500 gram ok. So, now I have to take again reading; I have to take again reading ok. So, you see this cross wire this is not now coinciding it has gone up. So, basically this depression is downwards, but in microscope we see this vertical image.

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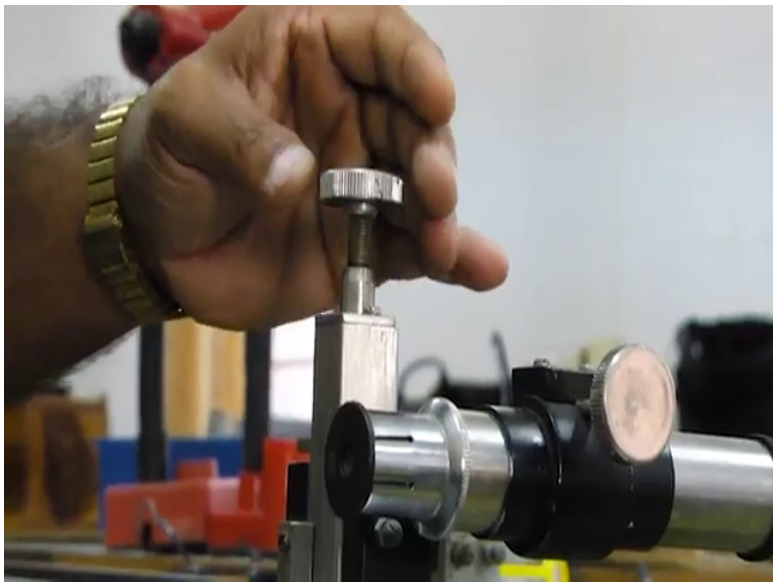

So, as if it has gone this cross position has gone up. So, I have to take basically this microscope that it is a slightly off. So, I can use this very fine movement using this one, so that is what I have to do. Yes, now if I put this way, then actually I am taking down, but image is going up, so that is why, yes, it is now coincide ok. Then again we have to take reading main scale reading and vernier scale reading, so then note down that one ok. So, then I will go for next mass, I will go for next mass and put there.

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So, now it is a 1000 gram means 1 kg.

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So, for that again I have to move it to coincide with this with this indicator here, this cross position. And we will take the reading from main scale and Vernier scale. So, this way we just increase the mass we increase the mass again this it is a for 1.5 kg, then again we have to take reading. So, this way for at least for 5 to 6, for 5 to 6 mass we will measure the depression. So, we will have 5 to 6 reading means mass this load versus depression. So, for each load what is the depression, so that they will we have to make

means these the for different load different mass.

So, from here we have taken whatever the reading. So, now, from that reading, we have to do some calculation. And then for 500 gram what is the depression. So, we have to take basically difference between these two reading. So, always we have to minus this initial reading from this your reading when you apply it mass. So, that way for different mass, you will get the depression. So, your table is ready now for different mass or load, what are the depression.

Now, this next work will be the plotting of the graph of these two mass versus or load versus this depression ok. So, you plot depression in y-axis, and mass or load at a along the x-axis. And then from there basically you will get you will get straight line. And from that straight line, you have to we can find out calculate the gradient of slope of this straight line. And from that slope basically we will use this slope to calculate the Young's modulus, so that how to how to how to make table, and how to calculate the young modulus that I will discuss in details in next class ok.

So, I will stop here. So, I think this is the live demonstration of this experiment as well as also we will discuss about the other experiments. I think we will try to show you all experiments in our laboratory and that will be useful for you.

So, thank you for your attention.