Forest Biometry
Prof. Mainak Das
Dr. Ankur Awadhiya
Department of Biological Sciences & Bioengineering & Design Programme
Indian Institute of Technology, Kanpur

Lecture – 13
Callipers: Usage and issues

Today we shall have a look at calipers, an instrument that is used for the measurement of tree diameters.

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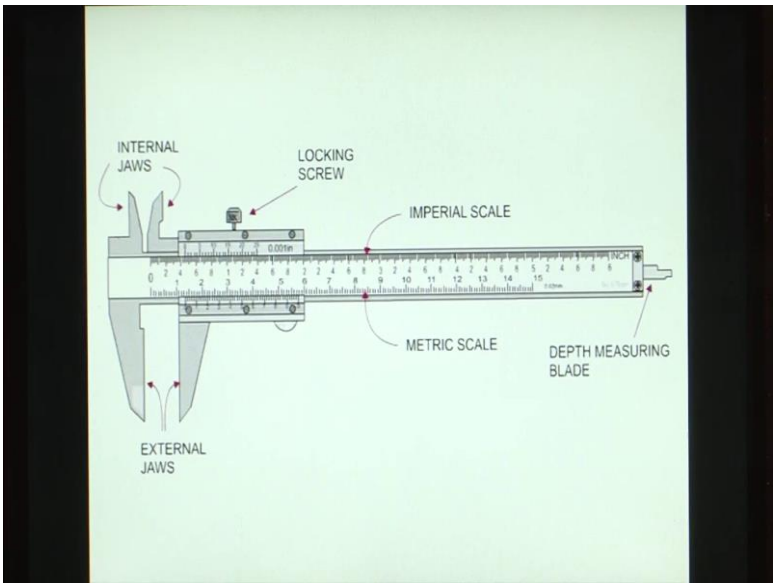

Now, as you can see on this slide this shows a vernier calliper. This is an instrument that most of us have used in our physics labs. A vernier calliper consists of internal jaws external jaws it has a scale that generally has readings in metric as well as imperial scales. It has a depth measuring blade and a locking screw. So, if we drew these callipers we would have, so we have a scale on which we have a fixed jaw.

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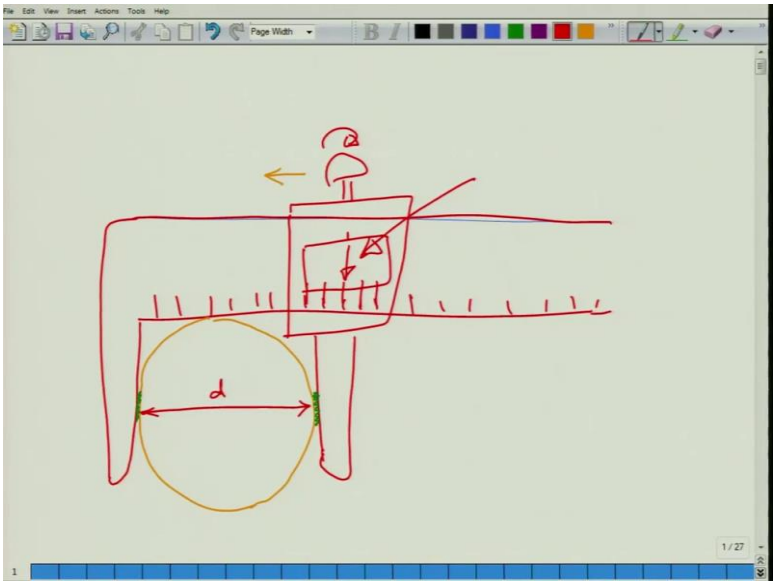

Then we have a moving jaw and a knob here. So, here we will have this scale and this jaw might have a viewing section with a mark and this would tell us what is the reading else.

Now, vernier callipers are generally used for smaller objects, in the case of trees we have a bigger version of these callipers, so these are the tree callipers.

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As you can see on this slide these are extremely huge devices. They also have a very similar construction they also have a scale a faces jaw and a moving jaw that also has a

knob. Now this knob can be adjusted. So, when you tighten this knob you fix the moving jaw and when you release it, the moving jaw can be moved.

Now, how do we use this instrument? Well we make this moving jaw moveable by releasing this screw, and then we take it to a tree and then we place the trunk of the tree between the 2 jaws. So, if we drew it here on the slide we would have your tree that comes somewhere like this. And then this moving jaw would be moved till any gap that lies in between your jaws and the tree gets removed, once that is done you will take the reading that is shown here.

So, you will get this reading, and that would be the reading of the diameter of the tree. So, this is how you measure the diameter, you can either measure your diameter directly by looking at your callipers or else the other thing that you can do is to tighten this screw. And once it has been tightened you can remove it from the tree and then you can measure it, whatever is more convenient. Though for reducing errors we generally prefer that the diameter be measured when the callipers are in touch with the tree.

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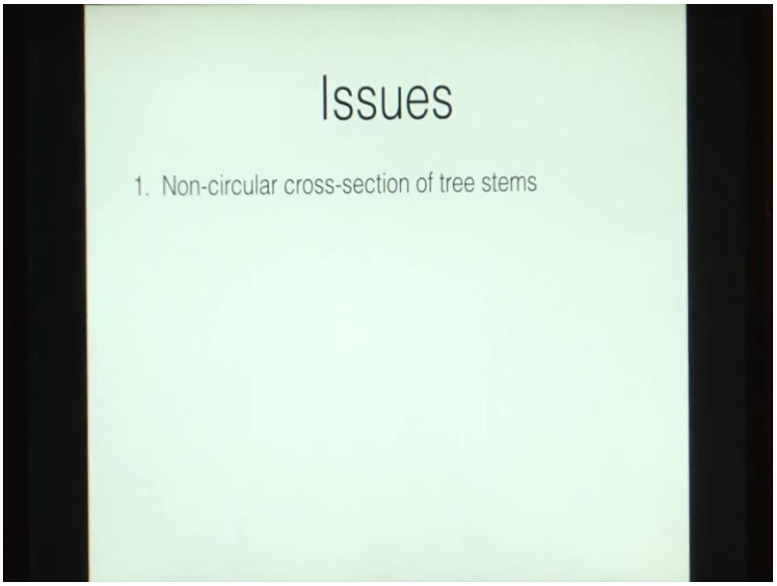

Now this instrument looks simple, but it also faces a few issues. One issue is the non circular cross section of tree stems. So, what does that mean? If your cross section was a circle.

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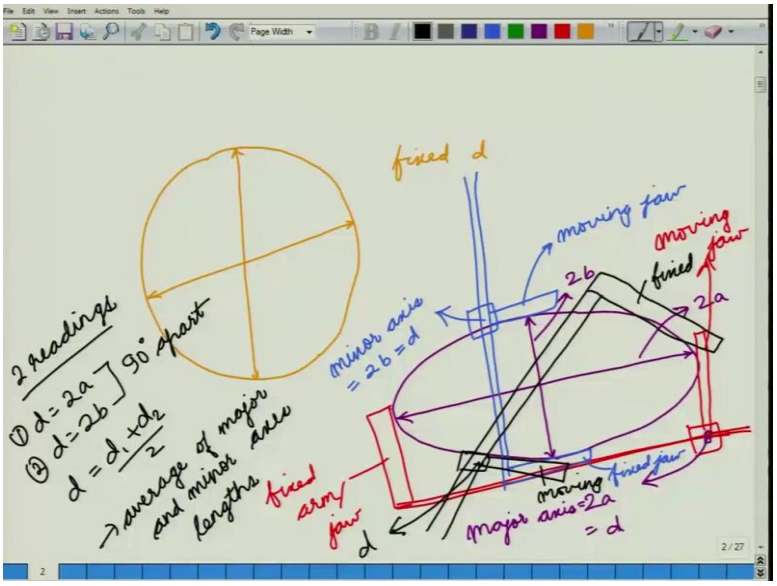

Then no matter whether you measured your diameter along this axis, along that axis or along any other axis you would have a fixed d; however, in the case of most trees the trunk is not perfectly circular it is In fact elliptical. So, as we had seen in the previous classes an ellipse is an oval shaped figure. It has 2 axes. So, we have a major axis that is the longer one that we generally represent as 2 a, and we have a minor axis that we represent by 2 b.

Now if your tree had an elliptical cross section then if you put your callipers like this. So, this is your fixed arm or fixed jaw. This is your moving jaw. So, in this case the reading that you get here this reading would be the reading of 2 a or the major axis. And that would be the diameter that you would be measuring. On the other hand if you had kept your callipers at a perpendicular location like this. So, so this is your fixed jaw, this is the moving jaw and if we got the reading from here we would be getting the minor axis, which would be the diameter that we would be measuring. Now apart from these 2 diameters you could also be placing your callipers at some other location, say if you kept it like this.

So, this is your fixed and this is your moving jaw. So, this is the fixed jaw and this is the moving jaw. Now if you got the reading from here we would also be getting a value of d, which would neither be the major axis not the minor axis, but somewhere in between. So, what do we do in these cases in the case of an elliptical tree we take 2 readings. So,

the first reading would be the major axis, the second reading would be the minor axis and we define d as d 1 plus d 2 by 2 or the average of major and minor axis lengths.

So, this is when we in which we could take the readings for trees that have an elliptical cross section. Now remember that both these readings have to be 90 degrees a part. So, this is something that we need to keep in mind; however, as you can see on this slide.

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We can have a tree with a cross section that is neither circular nor elliptical, but has a random shape.

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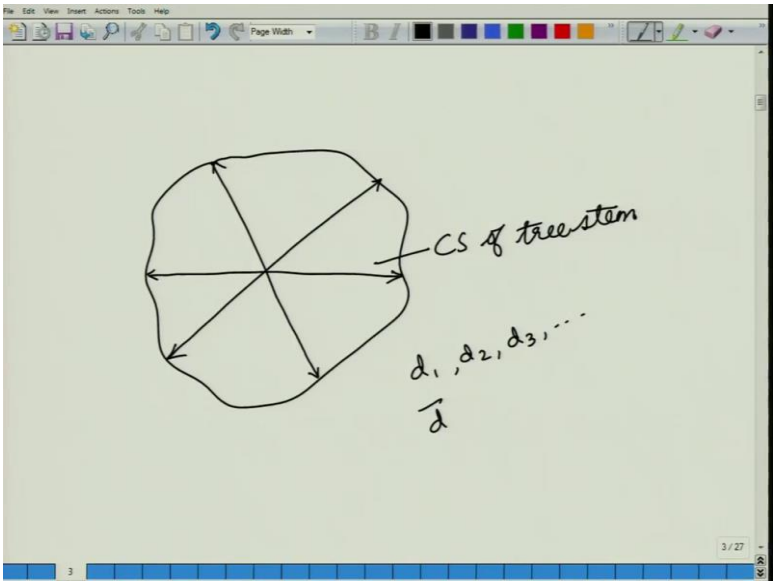

So, suppose this is your cross section of tree stem. What do we do in this case? So, here if you take a diameter across this axis it would be very different from a diameter across this axis and maybe a diameter across this axis.

So, all these diameters are very different. So, in these cases what we can do is we can take a number of diameters. So, we will take d 1 d 2 d 3 and so on, and then we can calculate an average d for the case of a irregular stems. Another issue with the use of this instrument is the weight and the size of the instrument. So, as you can see on the slide here this is how a person who needs to take this instrument to the field would take it. So, both the jaws are placed close together the screw is tightened and then it is held on one of the shoulders. So, as you can see the size of the instrument is roughly the size of a person besides it is made out of metal it could also be made out of wood, but in both the cases it is quite heavy.

So, the usage of this instrument in the field becomes difficult. Another issue is the issue of 0 error.

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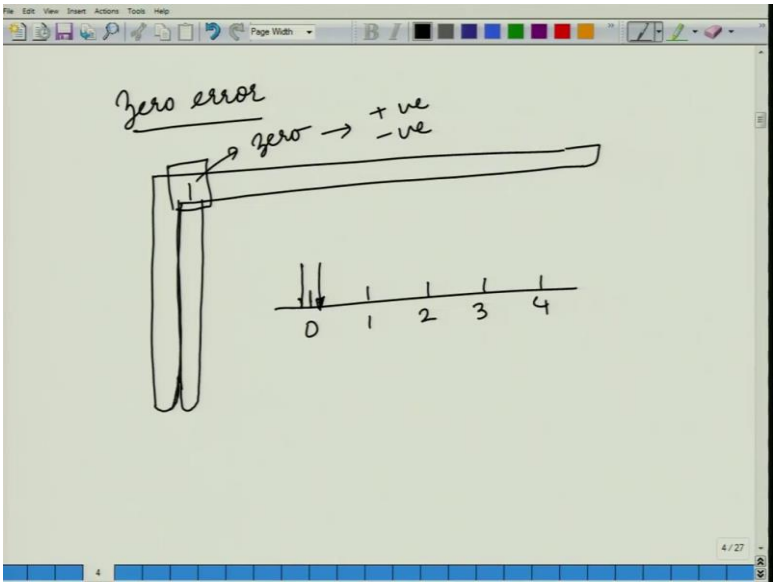

Now, what is what do we mean by 0 error; for instance if we took our instrument and we placed both jaws in touch with each other. So, in this case the reading that we get here should be 0, because both these jaws are touching each other and there is nothing in between these; however, in some cases this reading might not be zero, but might be some positive value or some negative value. What do we mean by a positive value. So,

suppose if we have this is scale. So, suppose this is 0 1 2 3 4. And if on placing both these jaws together suppose we got a reading that came somewhere here. So, it is greater than 0. So, we will call it a positive 0 error. If we got a reading to the left side of 0 we would call it a negative 0 error.

So, as you can see on the slide here. So, to figure out the 0 error you put both the jaws together and then you take the reading of what is seen on the scale. Another issue with the instrument is the issue of play.

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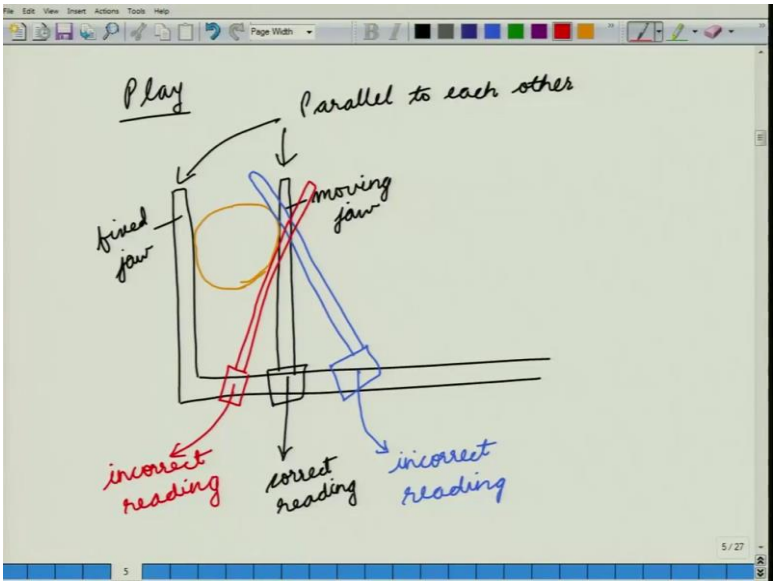

Now what do we mean by play. Play means that when you are taking the readings then both the jaws of the instrument need to be parallel to each other. So, this is the fixed jaw, this is the moving jaw and both these need to be parallel to each other. So, in such a situation, when you take the reading of the tree stem it would be the correct reading; however, in some cases your instrument might be having the play.

So, when we say a play. So, in the case of the correct reading you have a reading that comes here. So, this is your correct reading. So, in the case of a play this whole arm could swing to a side. So, it would become something like this. So, here is well you are you are trying to measure the diameter of the same tree stem, but the reading that you will be getting is the reading here which is an incorrect reading. You could also have a play on the other side. So, for instance you could have your jaw something like this. In which case you will be getting a reading here which will again be an incorrect reading.

So, the errors that are generated by this phenomenon in which you are moving jaw is not parallel to the fixed jaw is known as play. So, if we can see on the slide here, this is the amount of play that you could have on this instrument.

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So, in the first situation both the jaws are diverging from each other. In the second situation both the jaws are converging together. So, in both the these situations we will not be getting the correct reading.

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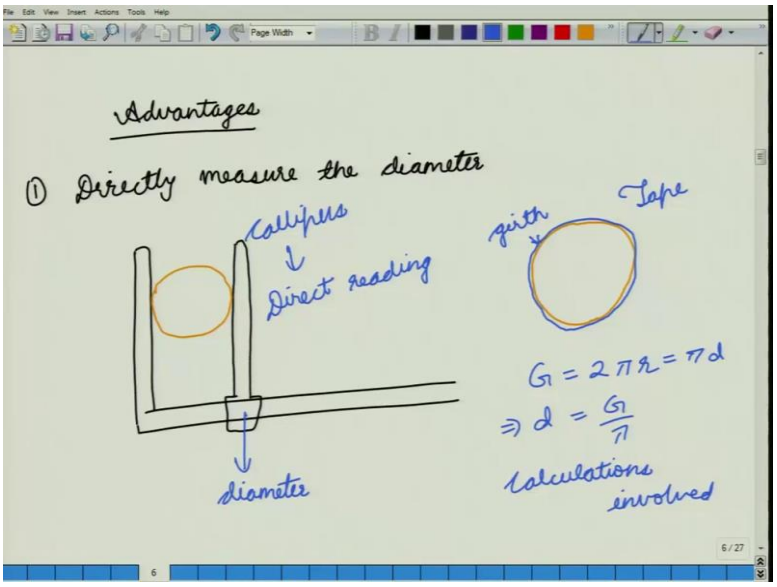

So, what do we have to do to do overcome this error we will need to adjust the instrument and this adjustment might have to be done again and again that being said there are a number of advantages of using callipers advantages.

So, the first advantage is that you can directly measure the diameter. So, what does that mean? What do we mean by a direct measurement? Well, in the case of callipers, once you have adjusted everything the reading that you get here is the diameter; however, suppose we were using another instrument say tapes to take the diameter of the same tree stem. In that case you would take a tape you would make it go all round your stem, when you tighten it and get the reading here, which would give you the girth of the tree. Then you would say that girth is equal to 2 pi r or is equal to pi d. So, you will get diameter is equal to g by pi.

So, in the case of a tape we have calculations involved, but in the case of callipers we have a direct reading. Another advantage of using callipers is that both the points of the arm touching the tree are visible to the user.

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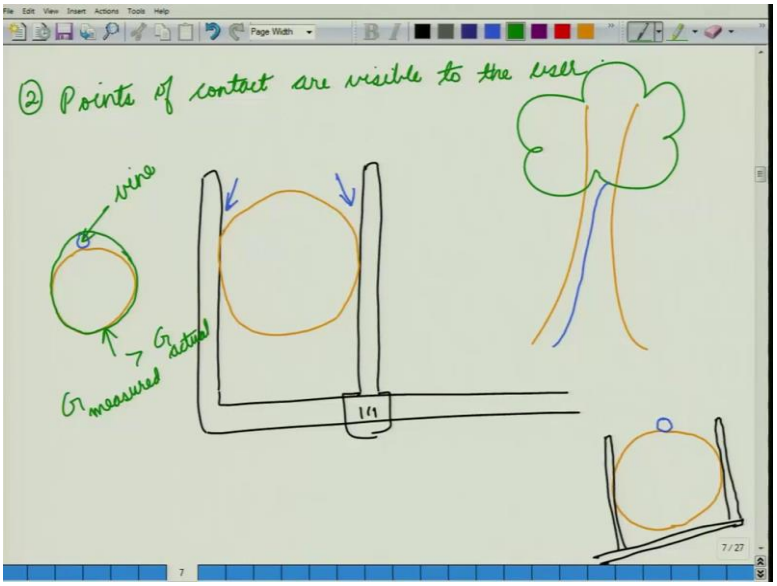

So, if these were your callipers and if you have a tree stem in between; then the user can see this point and this point. So, both the points at which the callipers are in touch with the instrument are visible. So, how does that help? Suppose we had a tree and we had a vine growing on this tree. So, a vine is a climber. So, we had a climber that is growing on this tree.

So, how would the cross section look like in that case? If this is the tree and this is a vine. So, if both the points of contact are visible, then you would ensure that you are measuring the tree at a location where you are not taking the diameter of the vine into consideration in the case of callipers. In the case of a tape what happens is that when you try to measure the girth your tape would go something like this. So, even after you have tightened your tape, you would be getting a reading that is your measured girth would be greater than the actual girth, because of this vine in between.

So, the second advantage of using the callipers is that the points of contact are visible to the user. Another advantage of using callipers is that when you are pressing the stem at 2 points.

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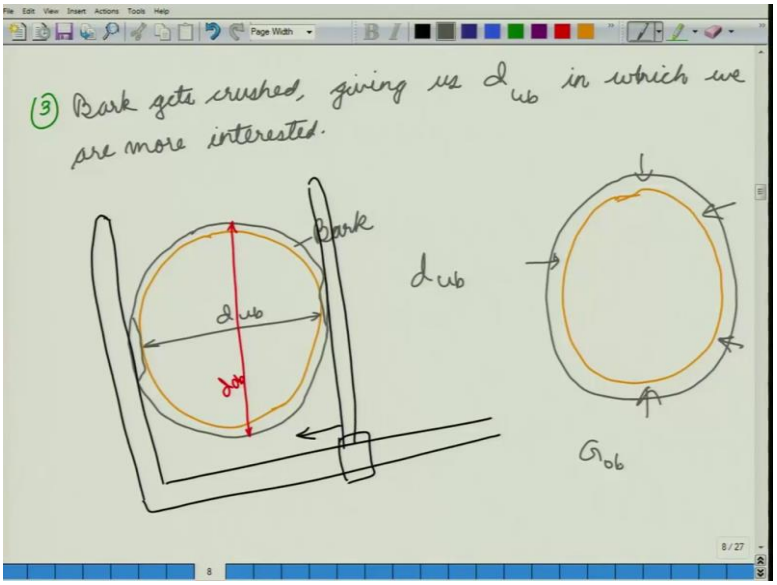

So, as you have seen in a previous lecture as well this stem would be surrounded by a bark. Now in most cases when we are talking about the harvesting of timber. We are talking about the diameter under bark. So, it is this diameter, this is the diameter under bark and this is the diameter over bark.

Now, when we are using callipers it would make a contact here, it would make a contact here and then we would try to tighten the instruments. So, we are moving the moving arm towards the fixed arm. In which case this bark would get crushed at these locations and the reading that we would be getting is close to the reading of the diameter and under bark. So, the third advantage is that bark gets crushed, giving us diameter under bark in

which we are more interested. In the case of a tape on the other hand if we had a tree with bark and in some cases it is a very loose bark, there is no way in which we could remove bark from all the sides and then take the reading.

So, the reading in the case of a tape is mostly the girth over bark, unless and until we have removed the bark. Another advantage of using the callipers is that it is very easily adaptable by unskilled labour.

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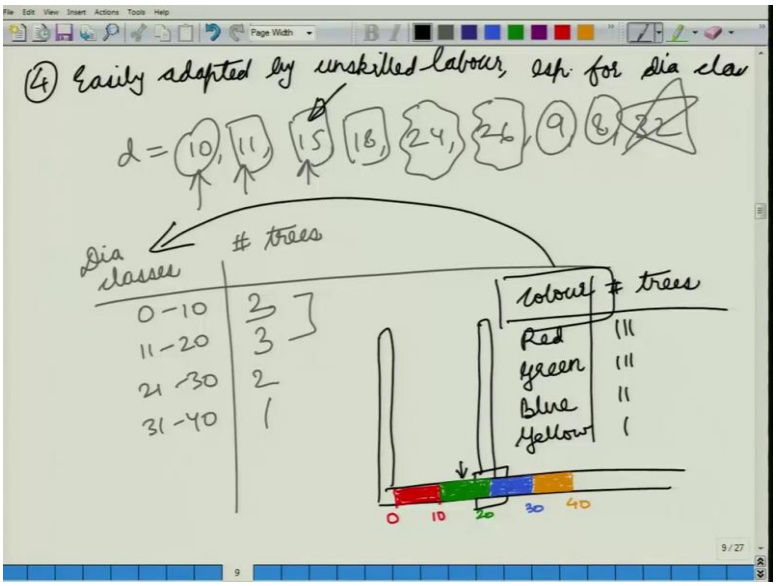

So, what do we mean by that case? Suppose we have diameter readings suppose we have it as 10 11 15 18 24 26, in most cases what we are interested in when we are trying to get a picture of our forest stand is not these individual diameters, but these diameters as put in to diameter classes. So, what would be a diameter class like? So, suppose we had some other readings 9 8 32.

So, what do we mean by a diameter classes? We could have diameters classes like 0 to 10 11 to 20 21 to 30, 31 to 40. And what we are interested in to make sense of this data is how many trees do we have in the case of 0 to 10. So, for instance and this we have 2 trees, then 11 to 20 or 1 2 3 3 trees. Then 11 to 20 has 1 2 3 3 trees. 21 to 30 has 2 trees and 31 to 40 has just one tree. So, by getting these diameter classes and the number of trees we are getting a very rapid picture of this forest that most of the trees are in the lower diameter classes.

Now if in the case we are more interested in these diameter classes if we took individual readings we would have to ultimately convert it into diameter classes. Now for used by unskilled labour it is very difficult to tell unskilled labour that they should take these individual readings and then convert it into a diameter class. So, what we could do in the case of the callipers is something very smart. So, we have these callipers, but we would place our diameter readings right here. So, we would form a band say this is the red band that goes from 0 to 10 then we have a green band. So, we can paint or scale. So, that it goes from 10 to 20 then we could have another band it goes from 20 to 30 and we could have one other color let us like this. So, it goes from 30 to 40.

So, what happens when we are trying to measure the diameters of the trees? If in case your callipers gave you a reading in the green section. So, your labour would only have to take readings like this. So, it has a color. So, you have red, green, blue, yellow and the number of trees. Now this is something in which case your labour does not need to read the instrument he does not he or she does not need to know what are the individual readings he or she just needs to see what is the color that is being shown by the scale. under the moving on.

So, in this case suppose they see that you had 3 trees in red 3 trees in green 2 trees in blue and one tree in yellow. Then you can very easily convert this data of color into the diameter classes, without having to perform any individual comparisons as to whether 15 lies in 0 to 10 or 11 to 20. So, this is automatically done the fourth advantage of using the callipers is that it is easily adopted by unskilled labour. Especially for dia classes, now another advantage of using the callipers is that in some cases our results are more accurate as compared to that of a tape. Why is that so?

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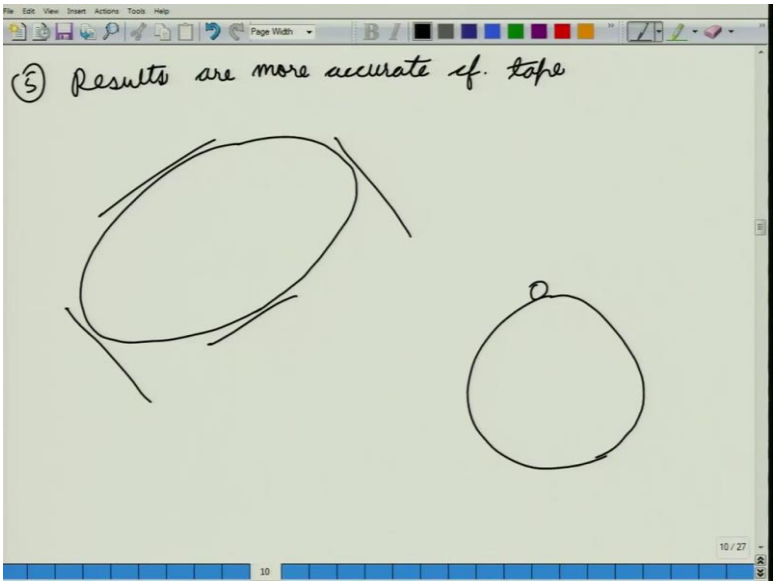

Because as we saw in the case of elliptical cross sections, we would be taking the readings of the major and the minor axis and not completely; so, the fifth advantage is that the results are more accurate as compared to a tape.

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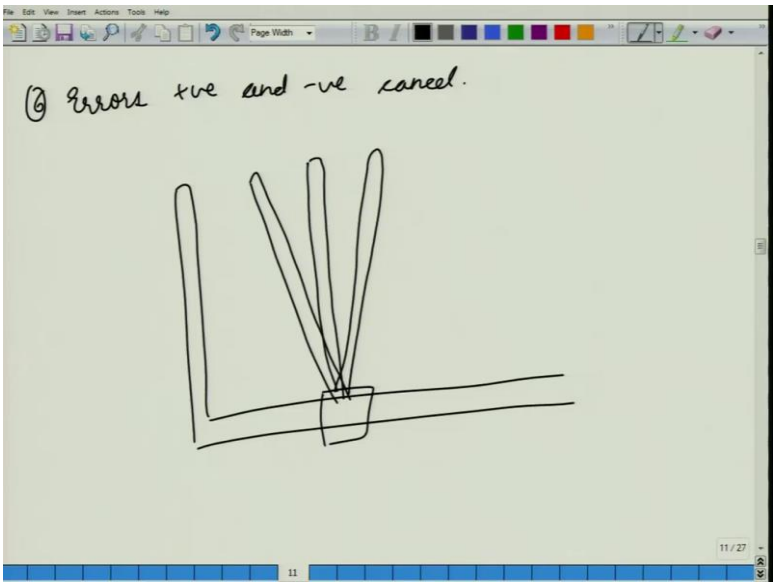

So, it is true in the case of elliptical cross sections and it is also true, when we have some vine that is growing alongside the tree stump. Another advantage is that errors positive and negative cancel each other. What is that mean? It means that because they in the case of the play in the instrument, you are moving arm could be showing you a decrease

reading the correct reading or the increased reading. So, whenever you are using the instrument all these errors tend to cancel each other when we are taking out an average.

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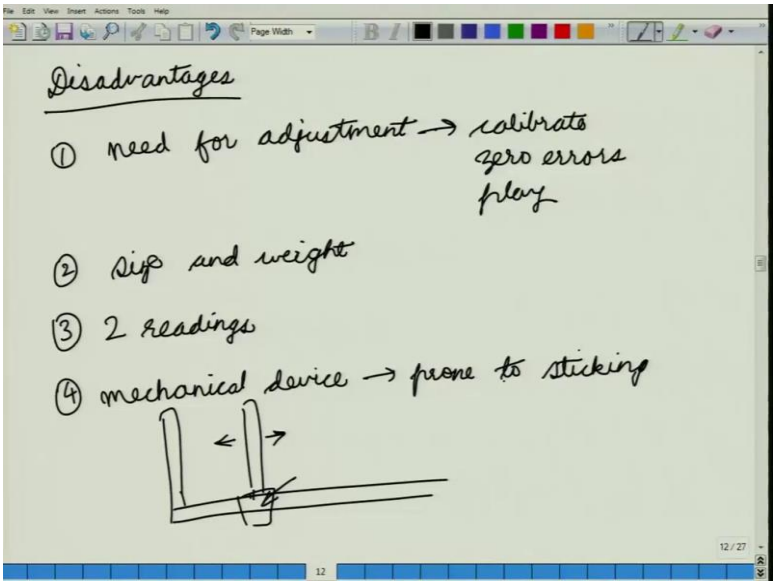

At the same time the use of callipers also has some disadvantages, one is as we have already seen is the need for adjustment.

So, we need to calibrate the instrument from time to time look at the 0 errors look at the play and so on. 2 is it is size in weight, which makes it difficult to be used in the field situations. 3 you need 2 readings in the case of elliptical cross sections which might be difficult when you are having a rough terrain. The forth is that it being the mechanical device it is prone to sticking.

So, what happens? So, this when you are using callipers out there in the field and suppose something got inside here, it might be dust, it might be some leaf litter it might be say some amount of rusting that has gone into your instrument because it is a metallic device. So, it might get rusted or for instance when you are using wooden callipers when it is exposed to moisture it might swell at this location. So, once it swells at these locations then you when usage of this or movement of the moving arm becomes very difficult. So, this causes wastage of time out there in the field. So, these are some of the disadvantages of using the callipers.

Thank you for your attention [FL]