Forest Biometry
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Lecture - 14
Tape: Usage and Issues

[FL]. Let us now have a look at the use of tapes as devices for measuring Tree stumps.

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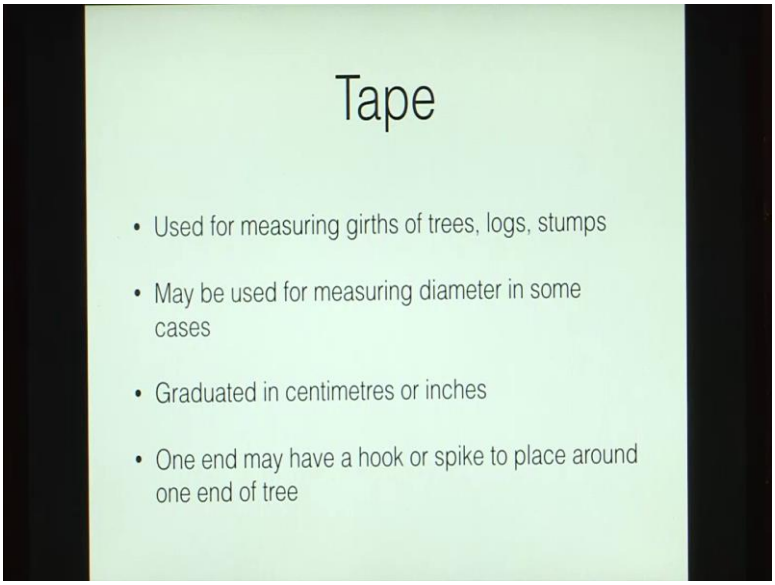

As we know tapes are instruments that are used for measuring girth of trees, logs or stumps. So, when we say girth, we are talking about the circumference. So, when we are using a tape, we will get a circumference.

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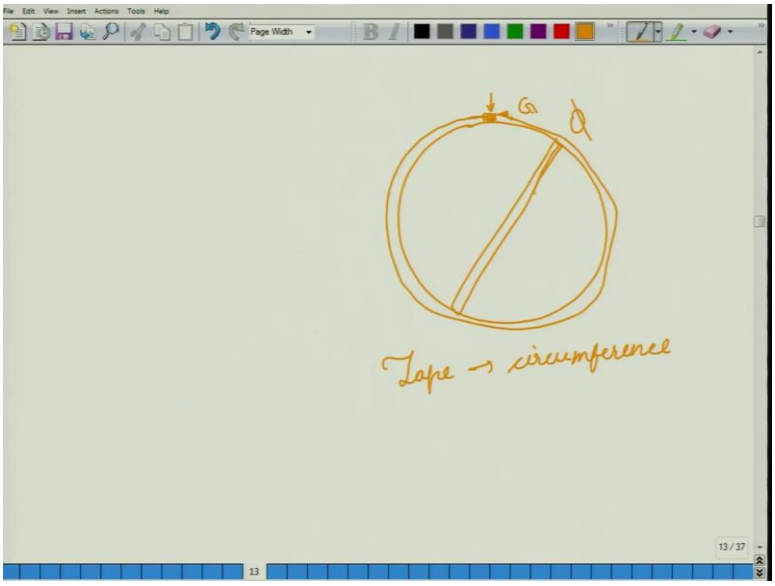

At the same time, you could also be placing the tape right across an axis to get the diameter. So, diameter can also be measured in the case of cut trees. A tape is usually graduated in centimeters or in inches and one end of it might have a hook or a spike. So, as to enable you to fix your tape at some point on the stump or on the stem, if you have a spike here, you could put the spike inside your tree stem and then, you can take the tape all around to get the girth. Tapes are made out of a number of materials.

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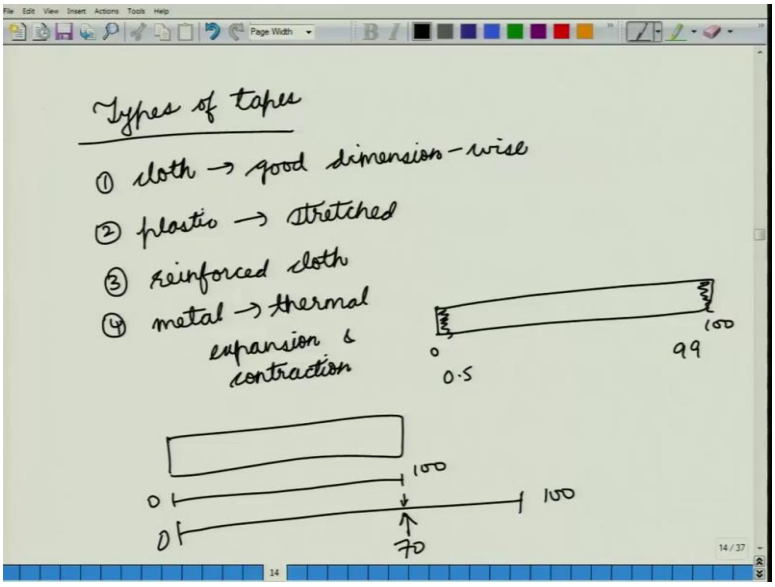

So, let us have a look at the types of tapes. You could have tapes made out of cloth. Now, the use the benefits of using a cloth is that it is very good as when we are trying to measure the dimensions. So, good dimension wise what it means is that if we considered another type of tape say plastic tape.

So, a plastic tape can be stretched whereas, it is very difficult to stretch a cloth tape. So, suppose you wanted to measure this length, your tape should have given you this reading, but if in case your tape has become stretched, then you would be getting a reading. So, suppose it goes from 0 to 100 that is your reading. So, here also you have 0 to 100, but this reading would now be somewhere close to 70.

So, in case of reading 100, you will be reading 70. You could also have reinforced cloth tapes or you could be having metal tapes. Now, the benefit of using reinforces cloth tapes or a metallic tape is that the ends of the tape do not get frayed very easily. So, in the case of a cloth tape, you could very easily damage the ends. Once the ends are damaged, your tape in place of reading from 0 to 100 might read from 0.5 to say 99, but if your tape is reinforced or it is a metallic tape, then you will not be having these errors, but the problem with a metallic tape is that it undergoes thermal expansion and contraction. So, whenever we are using metallic tapes, we need to keep the thermal expansion coefficients of the tape in mind. So, how do we use a tape?

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So, as you can see on this slide, here we are seeing a forest guard who is taking measurements along the ground. So, the tape that he has in his hands, they are made out of plastic and they can be rolled up inside the box. So, it can be used to take horizontal readings along the ground or it can be used to take vertical readings along the tree stem.

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So, for instance if we wanted to measure the breast height, when we want to get the girth, so this is how we use it.

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So, you take your tape all across the stem to get its circumference, that being said there are some cares in the usage of tapes.

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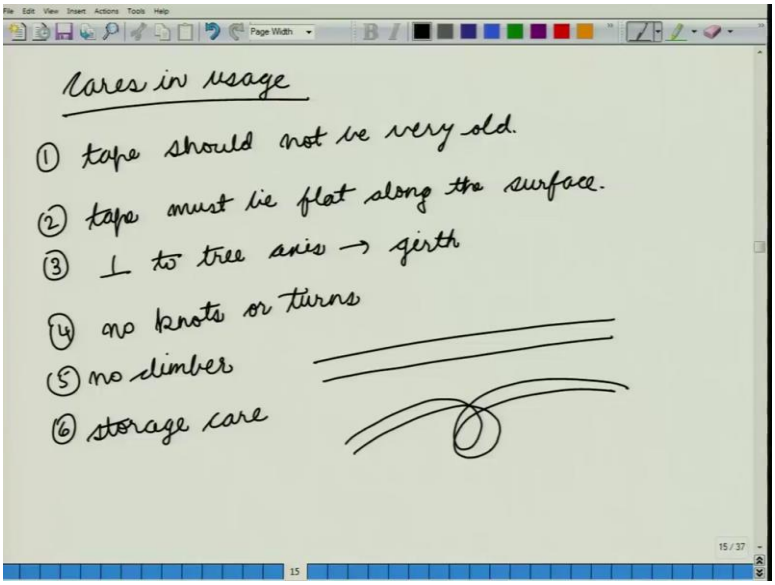

The first care is that your tape should not be very old because in the case of old tapes, they might have undergone stretching and at the same time, your tape must lie flat along the surface.

So, if this is your surface, your tape must also be parallel to the surface. You cannot have it going up and down. The third is that your tape must lie perpendicular to tree axes when you are trying to get the girth of trees. So, what that means is that if this is your tree, this is your tree axis; then your tape must go like this. If you had a tape going like this, so the girth would be greater than the original girth which is why it has to be kept perpendicular to the tree axis. Then, fourth you must not have any knots or turns in your tape which means that your tape must be flat and it must not roll on itself when we are taking the readings. At the same time, we should not have any climbers or whines in between the tree stem and the tape and at the same time, we need to have storage gear.

So, for instance when your tape is wet, it should not be rolled when it is wet or when it is twisted, so that it does not become stretched. So, here we can see on the slide.

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This is an example of an incorrect measurement. So, here we can see that the tape is rolling on itself. So, when it rolls, the diameter of the girth that you would be measuring in this case would be greater than the actual girth of the tree.

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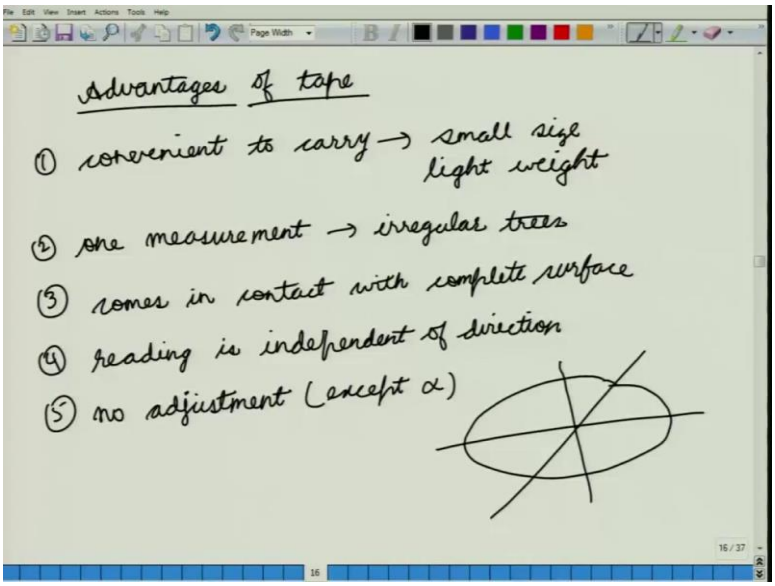

So, what are the advantages of tape? The first advantage is that it is very convenient to carry because of its small size and light weight. Now, this contrasts with the use of callipers which have a very large size and are also very heavy. The second advantage is that you need only one measurement in case of irregular trees.

So, what that means is that if you have an elliptical cross-section in the case of callipers, you would be taking two readings, but in the case of a tape, you would only be taking one reading. So, that is the reading of the circumference. Another advantage is that when we are using it in the measurement of girth, it comes in contact with the complete surface. This is as against callipers which come into contact with the trees at only two locations. So, this is a more representative sample.

Fourth, the reading is independent of direction that is if you have a tree in the case of callipers, if somebody measured it along this axis, the reading would be different as compared to this axis or maybe this axis, but when somebody is using tapes, you would have the same reading by any person who is using the tapes. Besides it does not need any adjustments, maybe except the thermal coefficient of expansion or contraction. Whereas in the case of callipers, you have to constantly adjust your device for its play for its 0 error and for other mechanical attributes.

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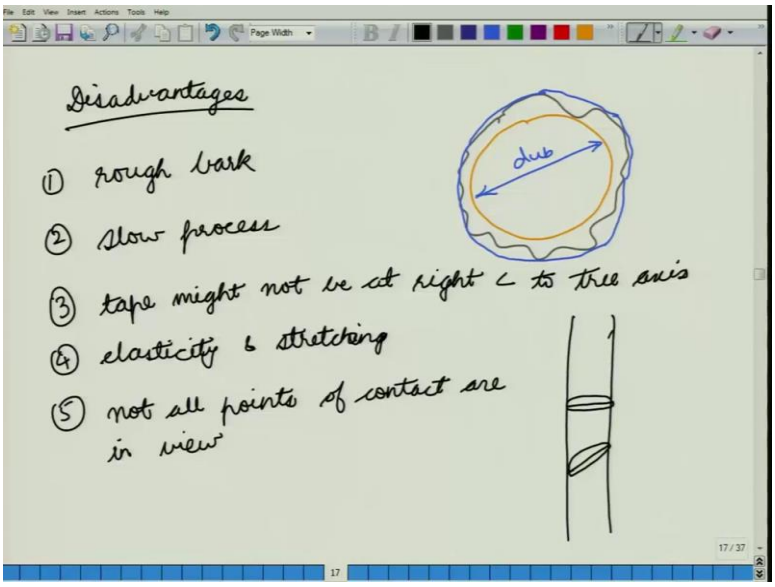

A tape also has few disadvantages. So, what are the disadvantages of using a tape? The first is that if you have a rough bark. So, suppose this is your tree and suppose it has a rough bark. So, when we use a tape, it would be going all across the hills of this bark. So, your tape might go like this in which case not only is it exaggerating over the diameter under bark that we are more interested in because it is measuring outside of the bark, but at the same time because of the rough bark, it is exaggerating that value as well.

Similarly, it is a slow process especially in areas where you have lots of undergrowth. You need to go near your tree and in the case of trees of larger diameters; you need to go all around that tree. So, it becomes a very difficult process and a very slow process when we are trying to get the girth of the tree.

The third disadvantage is that your tape might not be at right angles to tree access now it is very easy in the case of tapes to in place of taking the girth of this circle to take the girth of a circle like this. So, in that case you will be getting an increased reading the fourth disadvantage concerns its elasticity and stretching. So, if your tape is already stretched in that is it will give you a reduced reading.

Now, the fifth disadvantage is that not all points of contact are in view. So, in this case you might have a situation in which there is a vine or a climber or some ruff bark or something else that has gone in between your tape and your tree and you will not be able to correct for that because you are unable to take notice of the fact that something has gone in between your tape and the stem.

So, let us now take a numerical example.

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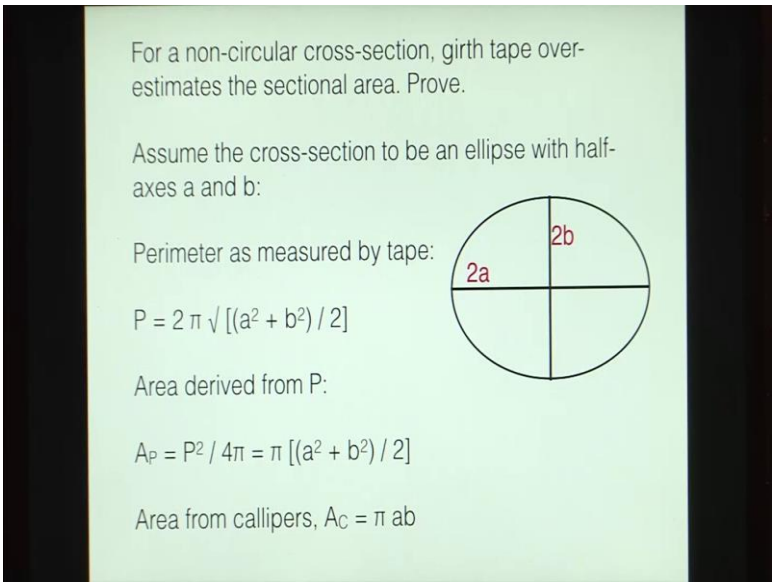

So, as you can see on the slide its says that for the non-circular cross-section, a girth tape overestimates the sectional area. We need to prove that for a non-circular cross section. So, we can assume the cross-section to be an ellipse. So, with it half axis is a and b, we

need to show that the girth tape overestimates the sectional area. What it means is that when we are trying to get the area of the cross section of the stem, if we take readings draw using a tape that is taking its circumference versus the readings that we take from callipers in which case we would directly getting 2a and 2b.

So, when we take readings using a tape, it overestimates the sectional areas compared to the callipers. So, how do we go about solving that problem?

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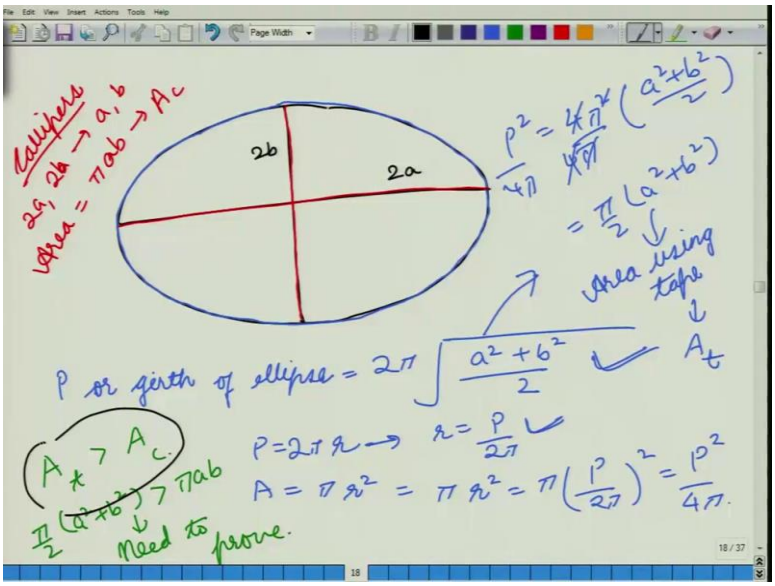

Suppose this is our ellipse. It has the two axis 2a and 2b. So, when we use a tape to measure this ellipse, we are measuring this circumference. So, this is what we measure in the case of a tape. In the case of callipers, we get this reading and we get this reading.

So, what is the perimeter or girth of ellipse? So, in the case of an ellipse, the perimeter is given by 2 pi square root of a square plus b square over 2. So, that is the root mean square of the minor axis multiplied by 2 pi. So, it is very similar to our formula for circulates 2 pi r. So, here r is given by a square plus b square by 2 its under root.

So, in the case of a circle, we have perimeter is equal to 2 pi r area is equal to pi r square. So, what is r? From the equation of parameter, r is equal to perimeter by 2 pi. So, if we consider this cross-section to be a circle and if you calculated our area using the perimeter, so remember we got this as the perimeter, but now we are considering it to be a circle. So, when we considered it as a circle, we get the radius as p by 2 pi.

So, what is the area? The area would be pi r square as pi p by 2 pi. Its square is equal to p square by 4 pi. Now, what is p square by 4 pi? This is our p. So, p square is 4 pi square multiplied by a square plus b square by 2. So, what is p square by 4 pi? You multiply this by 1 by 4 pi. So, 4 and 4 gets cancelled, pi and pi gets cancelled is equal to pi by 2a square plus b square. So, this is the area using tape.

Now, when we are using callipers tree measured 2a and 2b from which we get a and b and the area of an ellipse is given by pi into a into b. So, that is the area using callipers. So, let us call it area with callipers and let us call this as area with tape. Now, we need to prove that area using the tape is greater than area that we get from callipers, that is we need to prove that pi by 2a square plus b square is greater than pi a b. This is something that we need to prove.

So, let us have a look at this equation.

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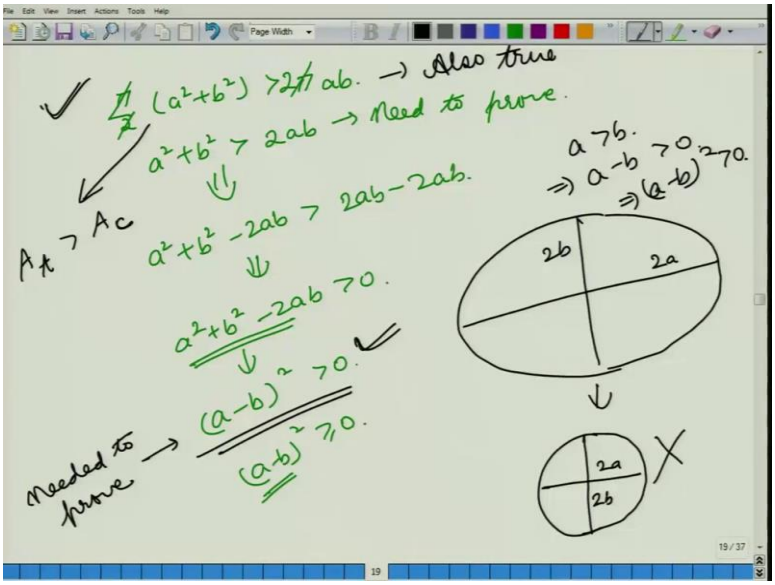

Again we need to prove that pi by 2a square plus b square. So, this is pi by 2a square plus b square is greater than pi a b. So, what we can say from this is that if you divide both the sides by pi and multiply it by 2, we have that a square plus b square is greater than 2ab. This is something that we need to prove.

This would also mean that we need to prove that a square plus b square minus 2ab is greater than 2ab minus 2ab that is a square plus b square minus 2ab is greater than 0. So,

we need to show that the lhs or left hand side is positive. What is left hand side? It is the expansion of a minus b square and we need to show that it is greater than 0.

Now, because it is the square of some quantity, it is necessarily greater than or equal to 0. So, that is something that we are sure of, but it can also become 0 if a were equal to b, but now our question started with a non-circular cross-section. So, if we have 2a into b. Suppose a were equal to b. So, in that case your ellipse would be a circle with a diameter that is equal to 2a or 2b, but we are given that it is a non-circular cross-section which means that a is greater than b.

So, if a is greater than b, that means a minus b is greater than 0 which would mean that a minus b square is greater than 0, it is not equal to 0. So, this is what we needed to prove that a minus b square is greater than 0. It is not equal to 0. So, it is not equal to 0 because it is a non-circular cross-section. So, this is greater than 0.

So, if this is greater than 0. That means, our original equation from which we started that is pi by 2a square plus b square is greater than pi ab is also true. So, this is also true. This would tell us our area measured by the tape. So, this is the area measured by the tape is greater than the area that is measured by the callipers. So, the conclusion is something that we need to remember.

If we use a tape and we get the perimeter of our tree stem and we use that to measure its area and if it is non-circular, if it were circular, then whether you used a tape or whether you used callipers, it would be immaterial. Both would give you the same results, but if it is anything that is non-circular, then your tape measurement of area would overestimate the calliper measurement of area.

Now, because in a forest we cannot say that all the trees have perfectly circular cross-sections, so when we are using a tape, the area that we will get would be greater than what we would get from the calibers. So, the callipers are the more closure reading of reality as compared to tapes.

Thank you for your attention [FL].