Forest Biometry
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Lecture – 10
Making the cuts

[FL]. In this lecture, we are going to synthesize and summarize what we did in the previous lectures of this week and also, look at some numerical examples. So, let us begin with why do we need a tree form.

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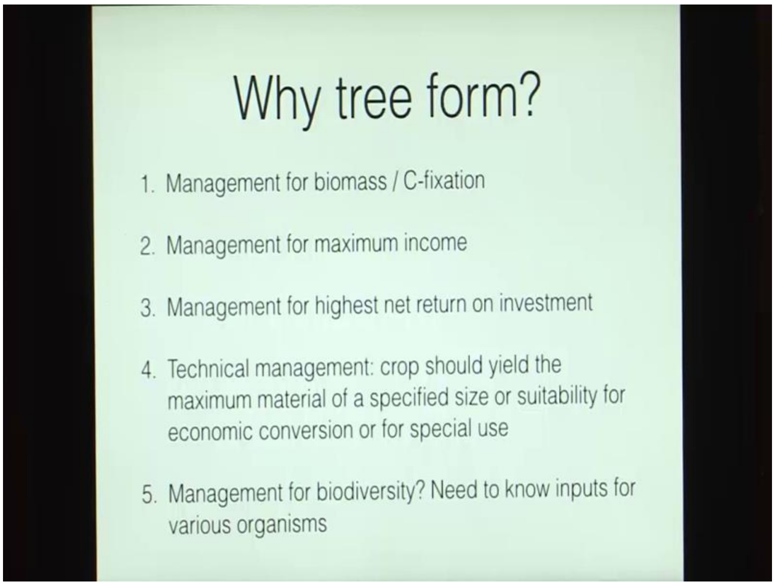

So, as we saw in the previous lectures and as we can see in this slide, a tree form is needed for a number of different purposes. We require it for the management of biomass or carbon fixation. If we wanted to maximize the biomass, if you wanted to manage a tree stand for maximum income, then too we require information about the tree forms because we will need trees of merchantable heights which we shall be able to predict using the Taper equations.

We can also be managing a tree stand or a forest stand for the maximum net return on investment.

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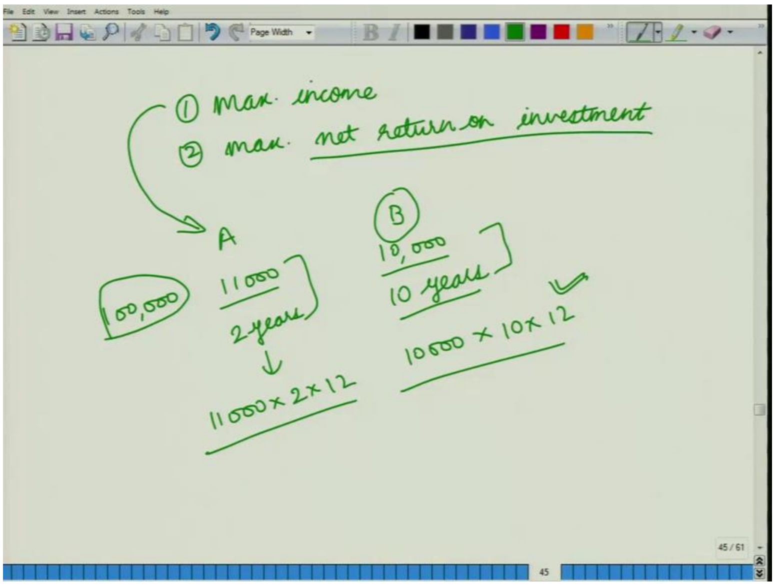

Now, there is a difference between maximum income and maximum net return on investment. Now, to understand the difference between maximum income and maximum net return on investment, consider two policies given by banks. So, in the first policy if you say you have got two plans i.e. plan A and plan B. In the first policy if you invest say a sum of 100,000 rupees, you will be getting every month an income of 11000 rupees whereas, in this plan B you will be getting an income of 10000 rupees every month.

However, the plan A also stipulates that you will be getting this income for say 2 years, but in the case of plan B, at the end of 2 years, all of your principal sum has extinguished. In the case of plan B say you will be getting it for 10 years and at the end of 10 years, your net investment has vanished. Now, if we looked at maximum income, so income would tell us that at every time t say every month we are in the case of plan A, we are getting an income of 11000 rupees whereas, in the case of plan B, we are getting only 10000 rupees.

So, if we wanted to maximize our income, we would be choosing plan A whereas, if you looked at maximum net return on investment. So, in the case of plan A, you are getting a total return of 11000 multiplied by 2 years multiplied by 12 months. In this case, you are getting 10000 multiplied by 10 years multiplied by 12 months. So, obviously the net return that you are getting out of plan B is much greater than that of plan A, maybe to do that in the case of plan B, you are getting it over a longer time span. In the case of plan A, you are getting it on a shorter time span.

Now, we can also be managing our forest stand as we can see in this slide for technical management. Now, what do we mean by technical management? Technical management means that a crop should yield the maximum material of a specific size or suitability for economic conversion or for special use. So, to give an example in the case of technical management, you might be having a forest stand that has to be managed for the needs of timber merchants or maybe for the needs of shipbuilders. So, in the case of a forest stand that is being managed for timber merchants, you might be requiring smaller size of trees, but in the case of a forest stand that is being managed for shipbuilders, you might be having a requirement of larger sized trees. So, that is called as a technical management.

We can also be managing a forest stand for the maximization of biodiversity. So, that is what we are doing in the case of our protected area say national parks or wild life sanctuaries. So, in the case of national parks, you are not allowed to harvest any tree, but at the same time we leave those trees out there in the national parks to be used by a number of organisms. So, for instance when a tree is living, it might be a host for a number of insects may be when any particular tree has died, it becomes home for termites.

So, those are also part of biodiversity. So, we might be managing a forest stand for maximization of biodiversity, but there too we need to understand how much of biomass is available for each species of biodiversity. So, there too it is essential to know how much biomass is there or how much volume is there in your forest stand of different ages.

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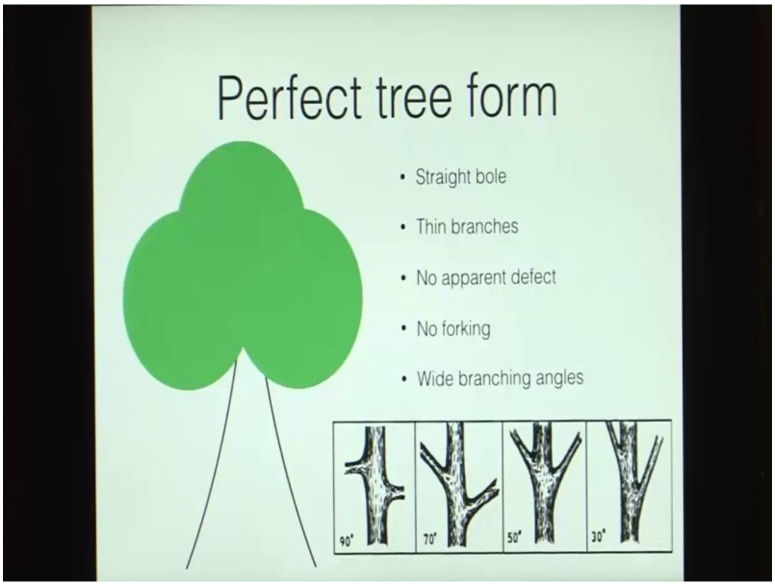

So, that was a brief of tree forms. Now, there are some things as we can see in the slide called perfect tree form. Now, a perfect tree form in the case of a merchantable tree, it would mean that you have a straight bole.

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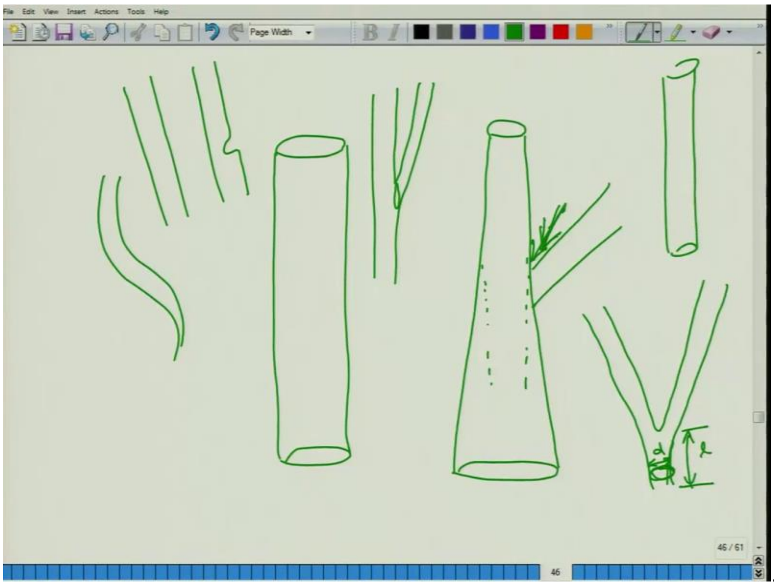.

So, we would prefer those trees that are cylindrical in shape or even if your shape is not completely cylindrical, it should have a very less amount of taper. So, this is a straight bowl. At the same time, we do not want any branches because if there are branches here and when you process this timber, when you cut it like this, you might find some physiological defects at these points where you had branches before. So, you should either not have any branches or you should have very thin branches. At the same time, there should not be any apparent defect. Now, there are a number of defects in the case of timber. So, for instance in the place of having a straight timber, you might be having a crooked timber.

So, that is a defect or you might be having a timber that has a hole in between that is also a defect. So, in the case of a perfect tree, you should not be having any apparent defects. At the same time, you should not be having any forking. Now, in the case of a forking, what happens is in place of having this straight bole, your tree might appear something like this. So, in this case, this timber which is one of the thickest timbers that can be extracted from this tree, this has a very small length of this small l.

So, if you have a tree that has a very prominent forking, it does not consider the perfect tree form. At the same time, any branches, any thin branches that you should also be having wide branching angles now. So, as we can see in the slide, this bottom parallel it shows you the branching angles of a number of branches. So, the first one is 90 degrees in which your branches are perpendicular to that of the bole. In the second case, you have 70 degrees branches.

So, that is less than 90 degrees, but it is very far apart from the tree. So, in that case when we have these defects, they will not be very prominent, but if you had a branch that went at a very acute angle, then this portion would be having a very large amount of defect.

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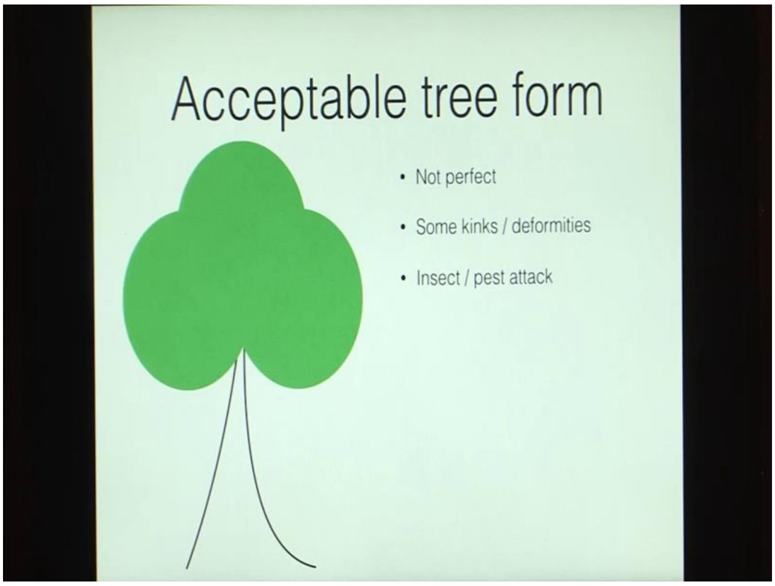

So, that is not considered a perfect tree form. Next we have an acceptable tree form. An acceptable tree form is not perfect. It has some kinks or deformities. It might even be having some insect or pest attack, but it is acceptable. So, we can use it for some purpose, but then we have unacceptable tree forms.

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An unacceptable tree form could mean a tree that is highly crooked. Highly crooked means that these trees in place of moving like this, it might be going like in a serpentine manner for instance. So, this is a crooked tree or it might be having a huge amount of forking or a severe rot or a large butt. So, that would be considered an unacceptable tree form. So, let us now look at some numerical problems.

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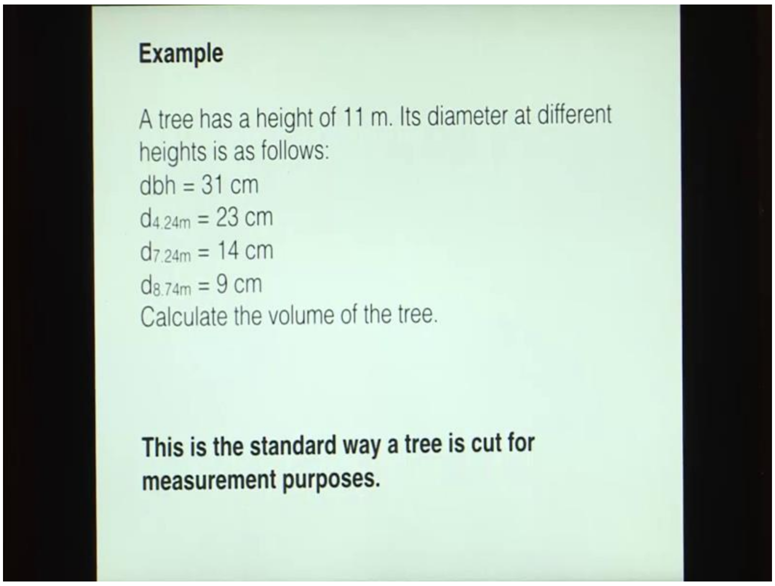

So, this is an example problem. A tree has a height of 11 meters, its diameter at different heights is given and we need to calculate the volume of the tree. Now, this is an example situation, but this tells us the standard way in which a tree is cut for measurement purposes.

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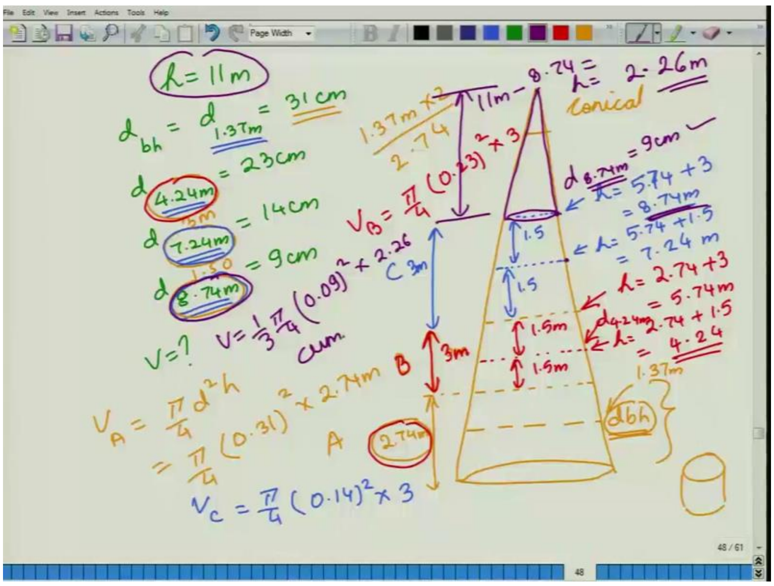

So, let us now try to solve this problem. The total height of the tree h is equal to 11 meters and its diameter at different heights is given the diameter at breast height or the diameter at 1.37 meters is given as 31 centimeters. The diameter at 4.24 meters is given as 23 centimeters, the diameter at 7.24 meters is given as 14 centimeters, the diameter at 8.74 meters is given as 9 centimeters and we need to calculate the volume.

Now, the first thing that we need to understand is why do we have these particular heights. Now, this 1.37 is the standard height, it is the breast height. So, we can understand this, but then why should we measure a tree at these heights is the question. So, to understand that let us make a tree. So, as we know the topmost portion is going to be conical and in any case we are going to measure the dbh. So, these are two things that we know about a tree. What about these lengths? So, if we can see if 7.24 minus 4.24, it gives you 3 meters.

Similarly, you are 8.74 minus 7.24; it would give you 1.5 meters. So, now let us try to understand why we measured this tree at these heights. So, now let us divide our tree into four sections. So, here we have a dbh. Let us take another section that has a height that is twice that of dbh. So, you had the first height as 1.37 meters, the second would be 2.74 meters. So, this is 2.74 meters. So, now if we considered this section, let us call it section A. So, if we considered this section, it has a length of 2.74 meters and its center point is the breast height that is 1.37 meters. At the center location, we know the diameter; we know the height of this log. So, can we now find out the volume of the section? So, volume of section A considering it to be a uniform section, we can use this central diameter.

So, let us consider this to be nearly a cylinder because this is a very small height. So, we do not expect quite a lot of tapering. So, now let us try to calculate the volume. It would be pi by 4 d square h which in this case would be pi by 4 here, d in the central location is dbh which is 31 centimeters. So, 0.31 meters square into height is 2.74 meters.

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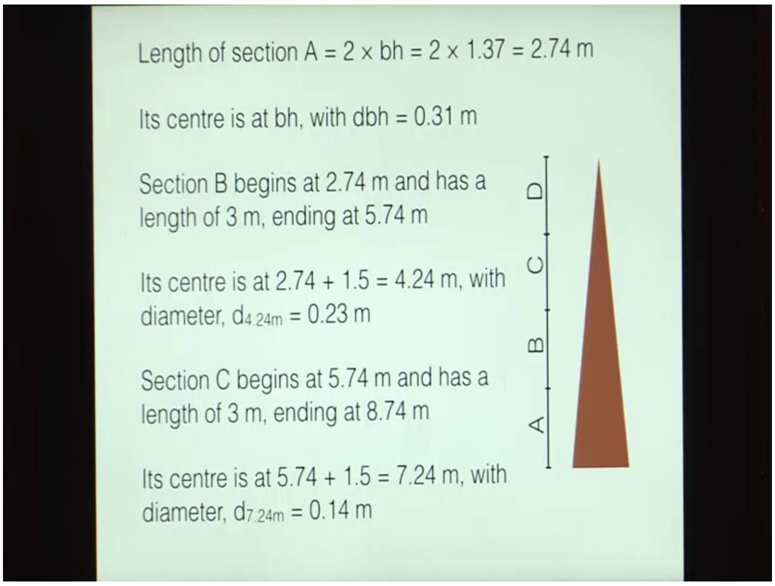

So, this would be the volume of section A. Now, in the case of section B, it would have a length of 3 meters. So, this is section B. It uses another color for it. Section B has a total length of 3 meters.

So, what is the height at this point? So, here you will have the height is equal to 2.74 plus 3 is equal to 5.74 meters. Now, what is the central portion? Because this is 3 meters here, you have 1.5 meters and here also you have 1.5 meters. So, what is the height here? The height is 2.74 plus 1.5 is equal to 4.24 meters which is the second height that we are given. So, we know the diameter at this point which is D 4.24 meters. We know the central diameter; we know the length of the log.

So, we can now calculate the volume of section B as pi by 4, here your D would be 0.23 meters square into height which is 3 meters. Now, let us consider another section. Now, this section called section C. So, this section would again be having a height of or a length of 3 meters. What is the height at this point? This point would be this height 5.74 plus 3 is equal to 8.74 meters. Consider the midpoint. At the midpoint, your height is this height which is 5.74 plus 1.5 because this is 1.5 and this again is 1.5.

So, this is 7.24 meters which is this height. Now, wanted to calculate the volume of section C, it would be pi by 4 into d square. D here is 0.14 square into 3. So, we can calculate this height. Now, at this particular point we have a height of 8.74 and this height is given here. So, let us now use another color for it. This height is given here as

8.74. So, we have also measured the diameter at this point. So, diameter at 8.74 meters is equal to 9 centimeters.

Why we have already measured the diameter at this point? Why do we need to measure the diameter at this point? This is because we can now consider this top portion to be the cone. So, in the case of this cone, we have the bottom diameter which is given as this. Now, the next thing that we need to figure out is the height of the cone. Now, we are given that the total height of the tree is 11 meters; the height of the base of this cone is 8.74 meters. So, can we now figure out the height of the cone? The height of the cone would be 2.26 meters.

So, if we know the height of this cone, can we figure out its volume? The volume would be 1 by 3 pi r square h or pi by 4 d square. D here is 0.09 meters square into 2.26 in cubic meters. To sum up we have divided our tree into four sections.

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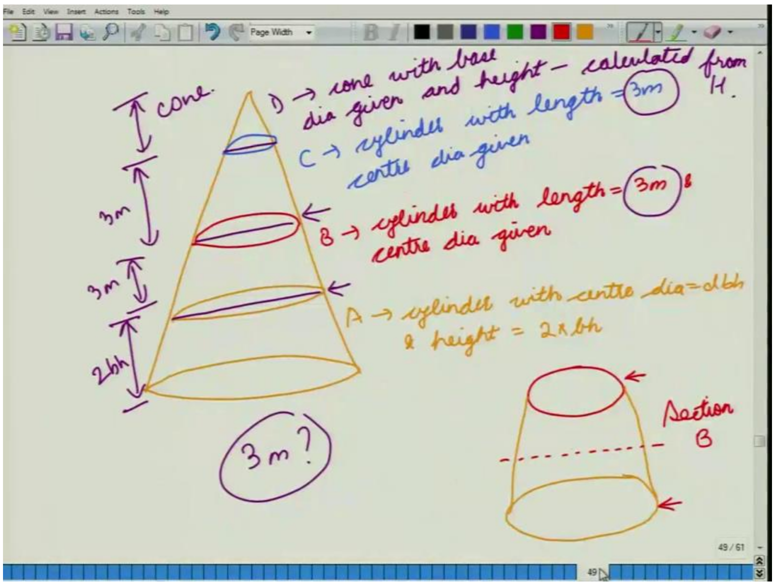

So, as in this figure your section A is a cylinder with center diameter is equal to dbh and height is equal to 2 into breast height. Your section B is also a cylinder with length is equal to 3 meters and centre dia given.

Next as in the previous figure, we have our third section C which is again a cylinder with length is equal to 3 meters and the centre dia given our fourth section D is a cone with base dia given and height that can be calculated from total height of the tree capital H.

Now, one question that arises is why do we use this length 3 meters? What is the significance of using 3 meters? Well, it turns out that most of the logs that are harvested from the tree for merchantable purposes have the length of 3 meters.

So, when we are measuring a tree, when we are trying to calculate its volume, if we chop its logs in such a fashion that the length were 3 meters, then we would be able to use them as well we would be able to sell them. So, this is the significance of 3 meters. Now, if you are given any such problem, the first section would always be having a height of twice of breast height. You could be having n number of sections with a height of 3 meters.

So, in this case we had only two sections, but we could be having n number of sections. The topmost section would always be a cone whose base diameter would be given and whose height would be given because we are cutting the tree at these points. So, in the case of this section say in the case of section B, what you would be doing is, you would be making a cut here and a cut here. So, you have two cuts. So, to use the same colors, this is your section B. So, you have made a cut here and made a cut here. So, once you have made these cuts and once you have this log at hand, you can always measure the central diameter.

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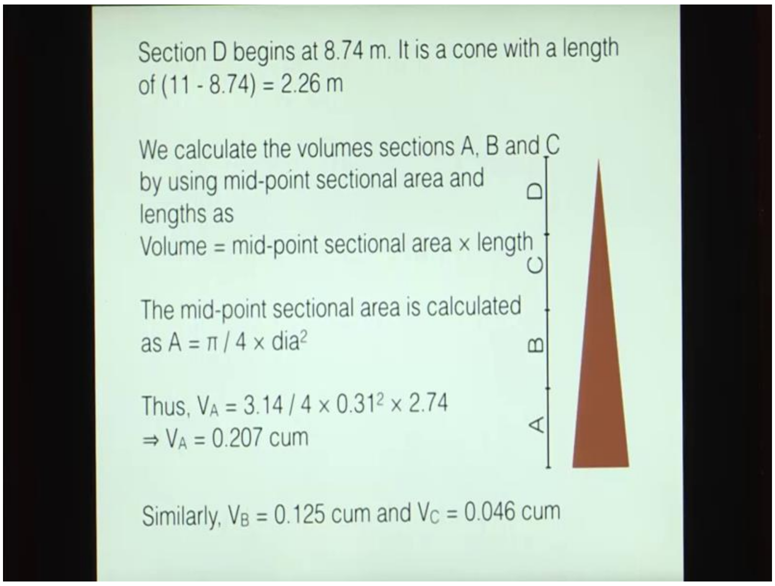

So, the central diameter would be what was given to you in the problem. So, this is how we are going to make the cuts.

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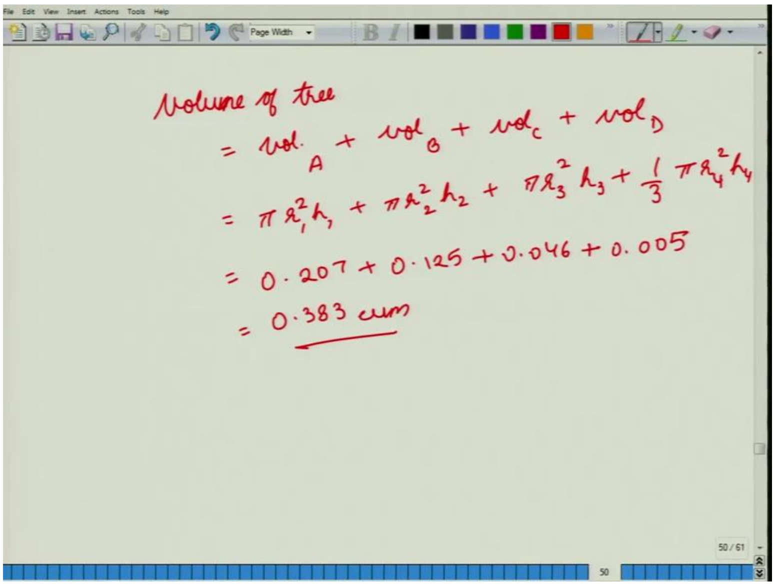

So, if it did all the calculations, we would find that the volume of tree is equal to volume of section A plus volume of section B plus volume of section C plus volume of section D.

So, the first case is a cylinder. So, you used pi r square h. So, r 1 h 1 plus pi r square h plus pi are 3 square h 3 plus the fourth section is upon pi r 4 square h 4.

Now, in our example case we have already calculated these volumes in terms of these formulae. So, if we computed these, we would find that at 0.207 plus 0.125 plus 0.046 plus 0.005. So, the total volume is 0.383 cubic meter.

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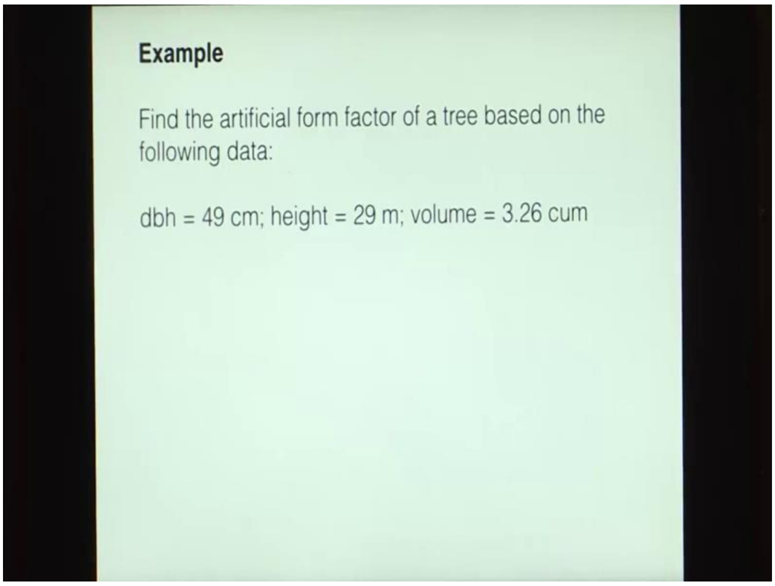

So, this example tells you how we make cuts out there in the forest for measurement purposes and also, how we calculate the volumes once we have made those cuts. So, let us now look at another example.

Now, this example as you can seen on your screen is find the artificial form factor of a tree based on the following data.

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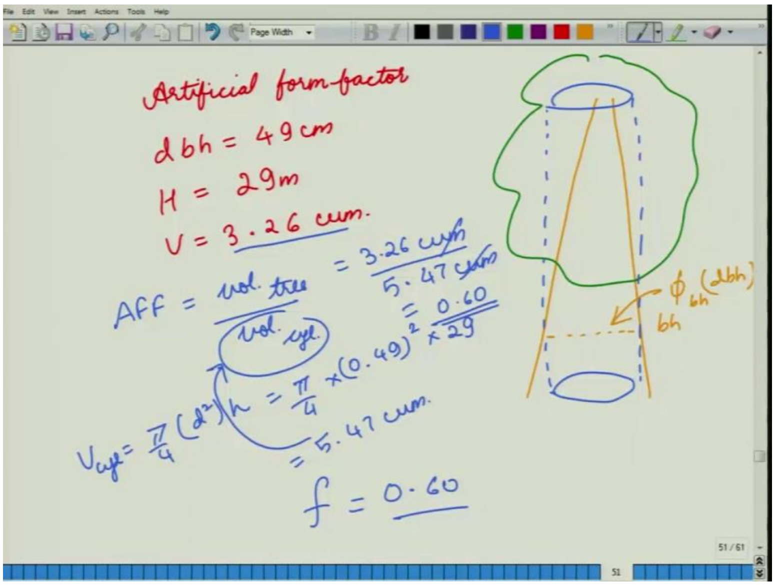

So, you are asked to find out the artificial form factor. Now, what is the artificial form factor? As we saw in the previous slides, an artificial form factor is the breast height form factor in which you take the volume of the tree, you take a cylinder whose diameter is the same as your diameter at breast height and the height equal to the height of the tree. You divide the volume of the tree by the volume of the cylinder and the value that you get is the artificial form factor.

Now, looking at the question you have dbh is equal to 49 centimeters height of the tree or let us represent it by capital H is equal to 29 meters and the volume of the tree. So, now you know how to calculate the volume as is the previous example. So, here you have the volume of 3.26 cubic meters and you are asked to find out the artificial form factor. So, how do we get the artificial form factor? We consider this tree, we consider the breast height. So, you know the diameter at breast height or the dbh. So, at this point we draw a cylinder with diameter is equal to dbh and height is equal to the height of the tree and we divide the volume. So, the artificial form factor would be the volume of tree divided by the volume of the cylinder.

The volume of tree is given to you 3.26 cubic meters. How do you find out the volume of the cylinder? It is on the volume of cylinder is pi by 4 d square h. So, here it is pi by 4 into d is 0.049 meters into 29 is equal to 5.47 cubic meters. So, we put this value here. So, it is 3.26 divided by 5.47 cubic meters. This get canceled out is equal to 0.60. So, the artificial form factor f is equal to 0.60. Again now how are we going to use these values? If we knew the form factors for a representative group of trees and we can very easily measure the dbh and the height of a tree, we could use this form factor to calculate the volume of the tree.

Thank you so much for your attention. [FL]