Forest Biometry
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Lecture – 39
Recap – 1

[FL], now that we are nearing the end of this course and your exams are close by let us have this class and the next class as recap or revision sessions.

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So, let us begin the first recap session.

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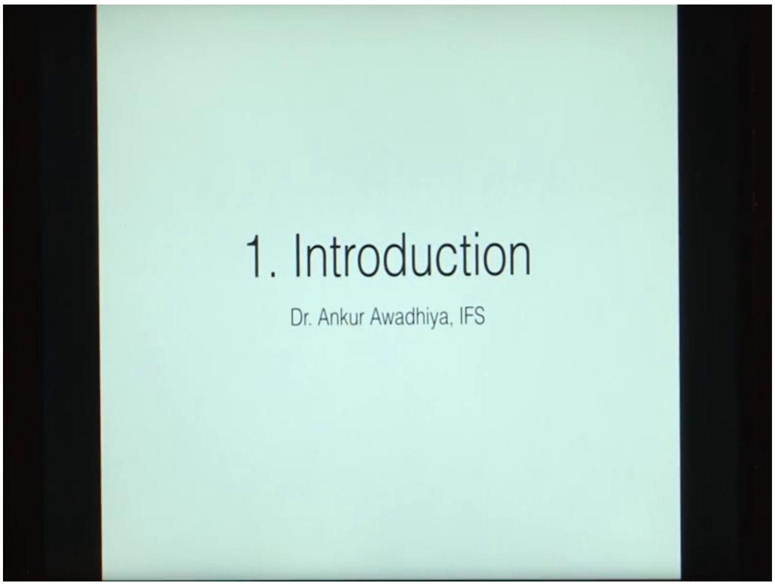

So, we began this course with the introduction, in which we looked at what do we do in forest biometry.

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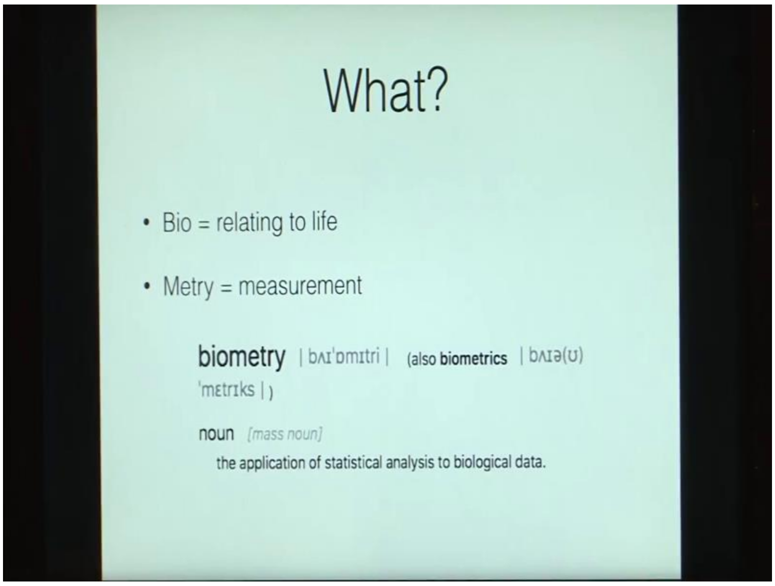

So, it was that our forest is a land covered with trees and undergrowth, it is outside biometry is a measurement that is related to life, so we are essentially measuring the parameters that are related to the life in the forest.

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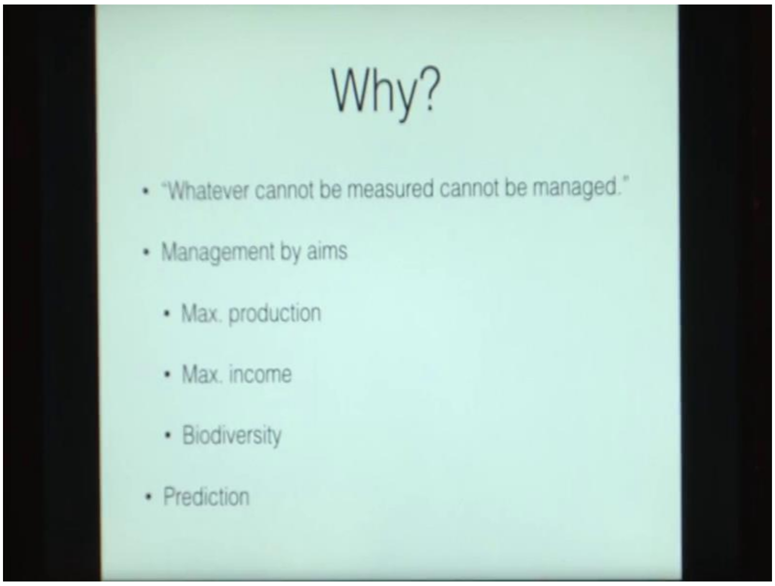

Why do we do it? Because we need to manage our forest stands for different purposes, and we need our measurements, so that we can properly manage our forest.

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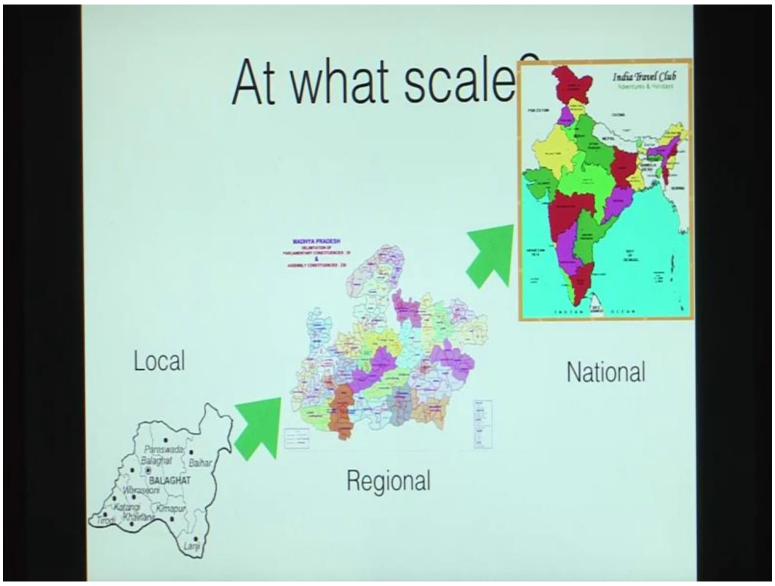

We do forest biometry at different scales. So, one instance you can measure a small forest that is in a local region, you can take district wise measurements, you can take regional managements or state wise measurements or you can even go for a national or an international level of biometry for say things like carbon sequestration global warming and so on.

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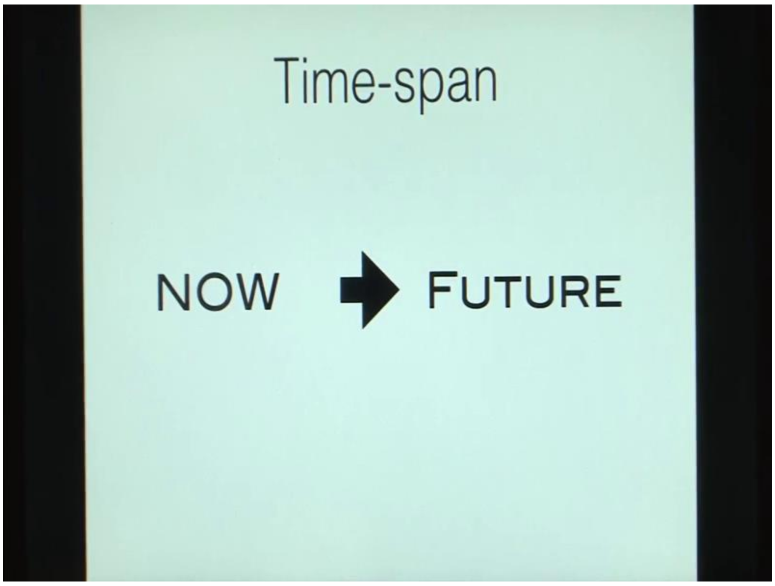

The time span is now as well as future. So, you can take measurements now and you can use it to predict the future. So, that is the utility of forest biometry.

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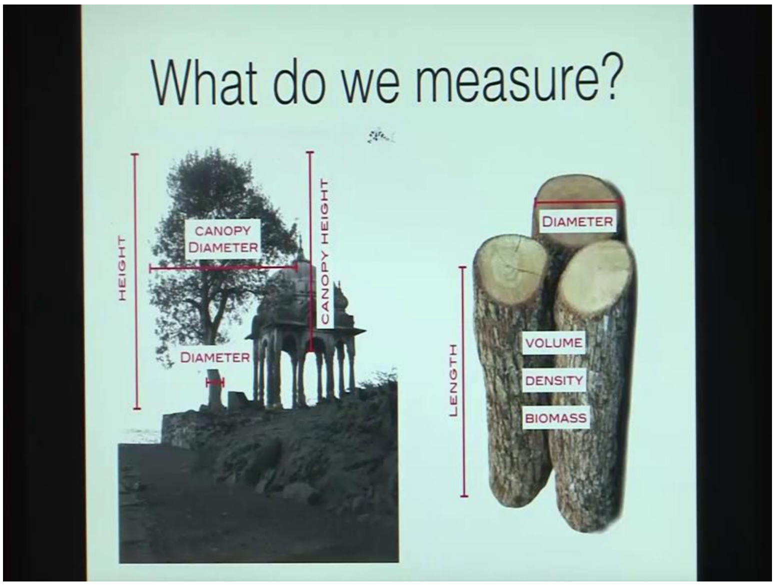

Now what do we measure in the case of forest biometry? We measure a number of things that we have already seen. So, those are the canopy diameter, canopy height the diameter of the tree, the height of a tree the length of a log, diameter of a log volume of a log density biomass also in this case we can look at the canopy cover and the canopy closure we know the difference between both of these.

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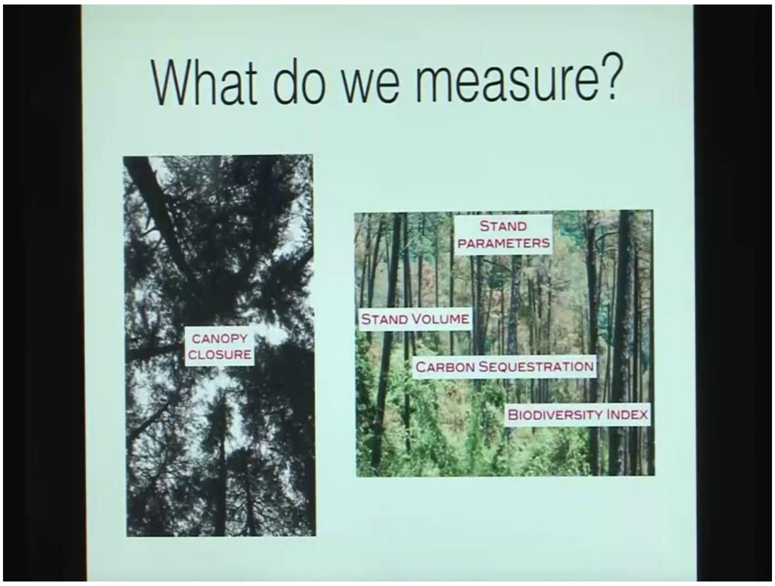

And also we can look at the stand parameters like stand volume carbon sequestration bio diversity index.

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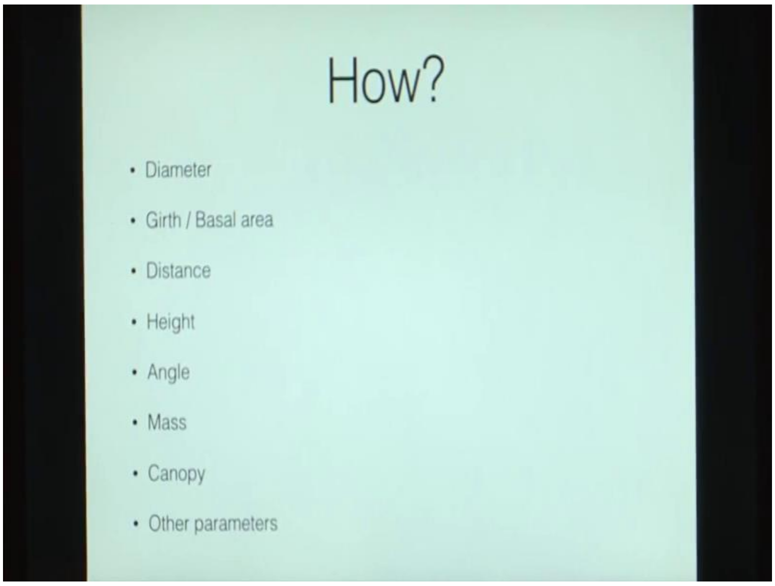

We measure a number of values that we have seen in this course, we use a number of equipments.

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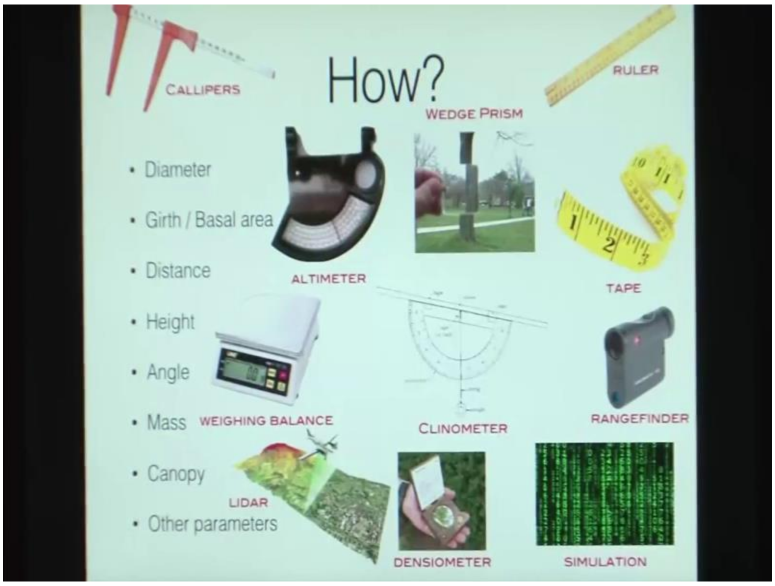

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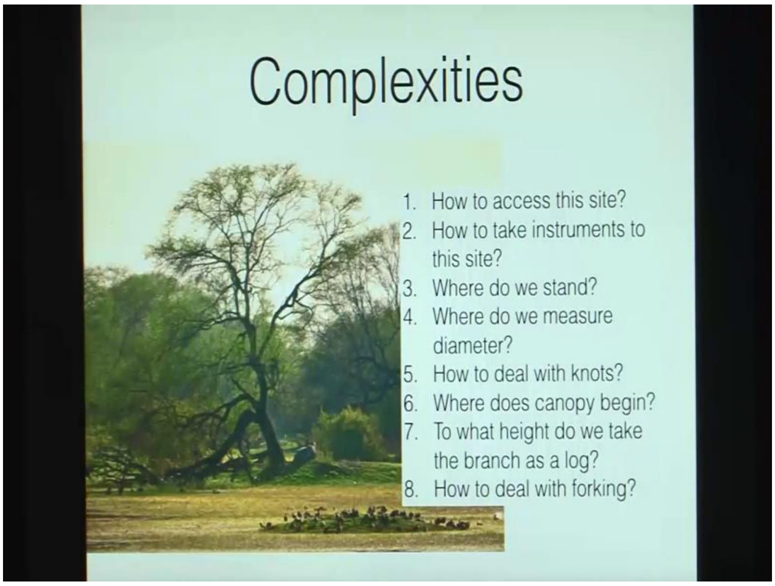

There are also a number of complexities that are involved, that we have seen where do we go to measure the height of the tree, what are the different ways of measuring heights of these trees, what are the standard places at which we measure heights, what does diameter at breast height and so on.

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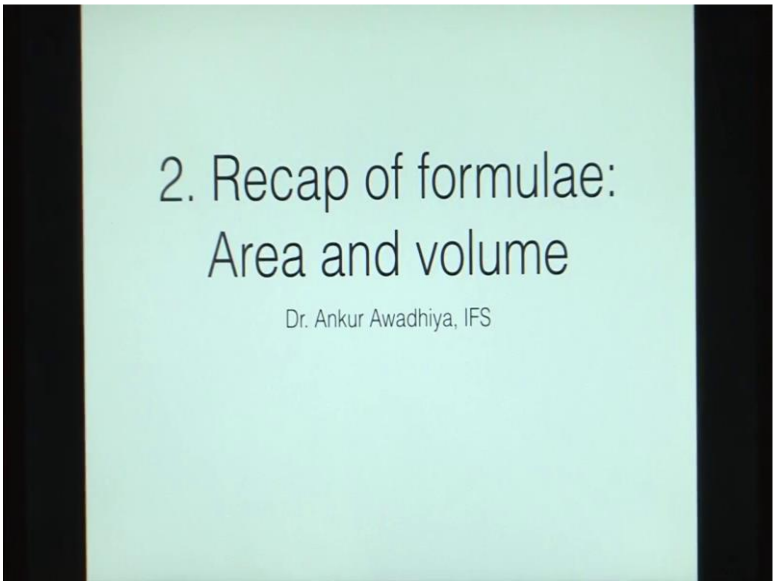

In the second class we looked at a recap of formulae for area and volume.

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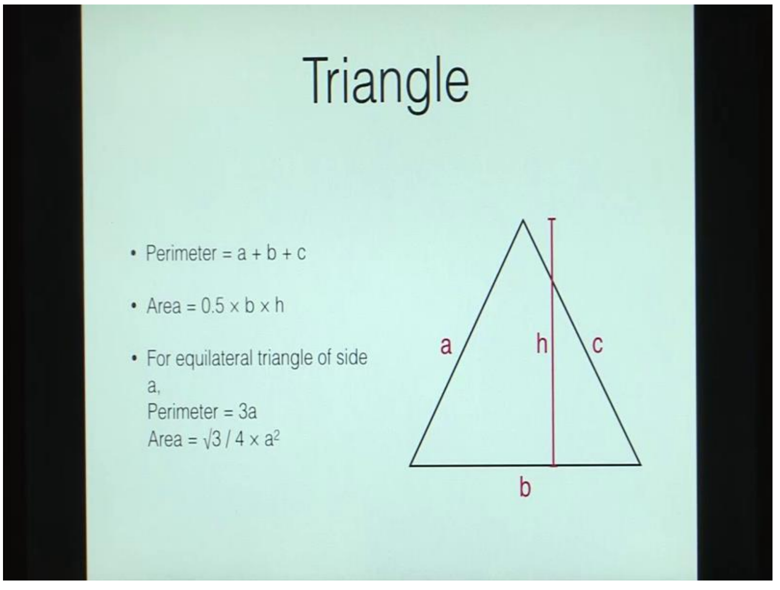

So in the case of a triangle, the perimeter is the some of the sites the area is half of base cross a base and height. In the case of an equilateral triangles the perimeter is 3a the area is root 3 by 4 a square.

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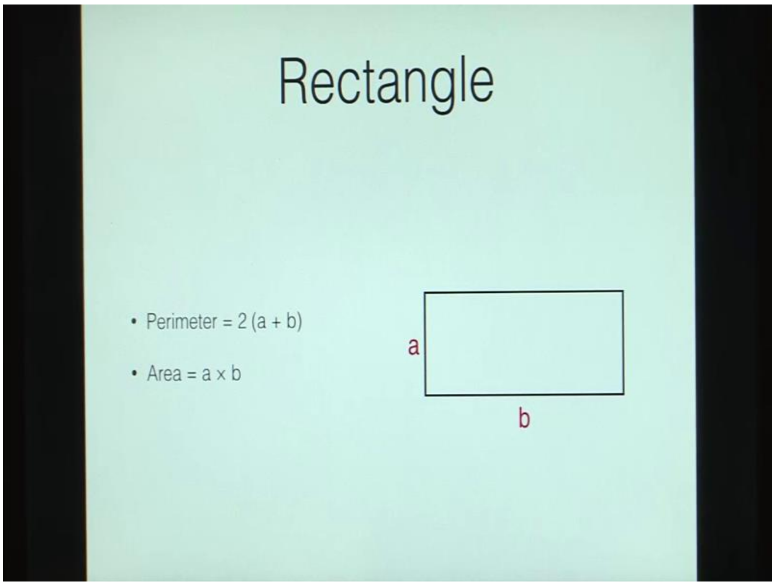

In the case of a rectangle the perimeter is twice of a plus b, the area is a times b in the case of a circle.

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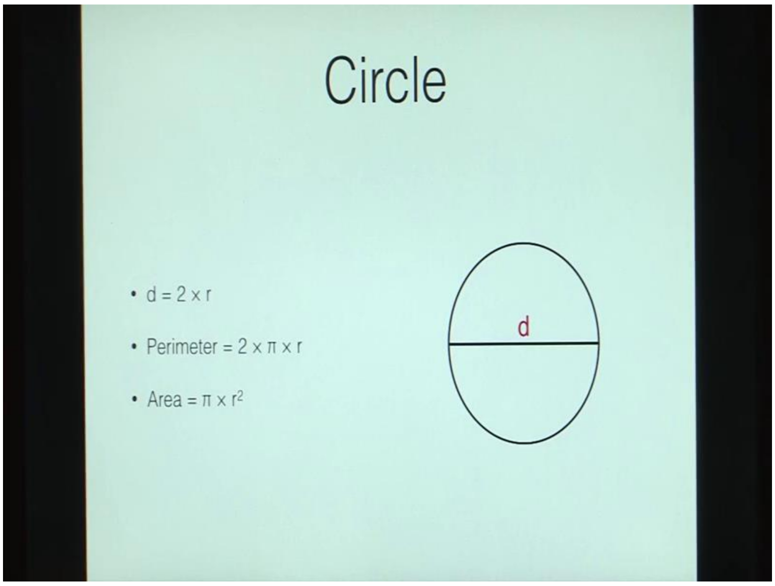

We have diameter is twice of the radius perimeter is 2 pi r area is pi r square, in the case of an ellipse with these two axis 2 a and 2 b.

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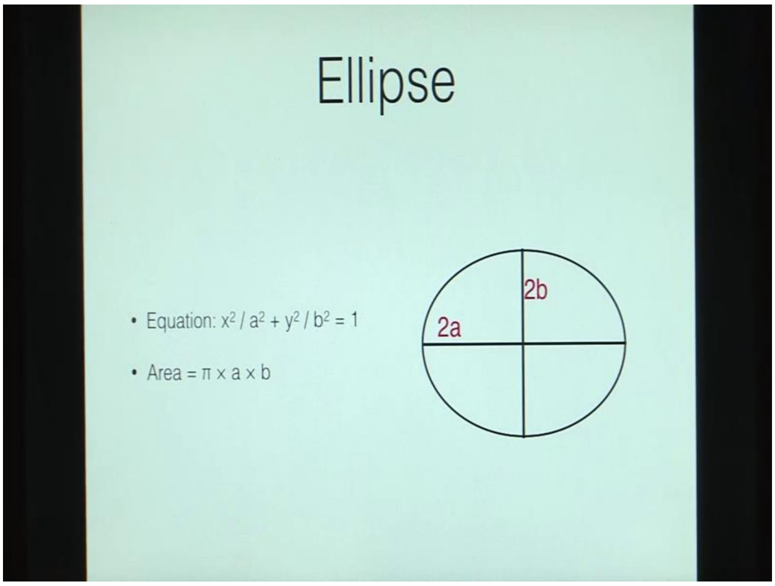

We have the equation of the ellipse as x square by a square plus y square by b square is 1, the area is given by pi times a times b.

So, in the case of most trees we take their cross sectional areas as either circular or elliptical.

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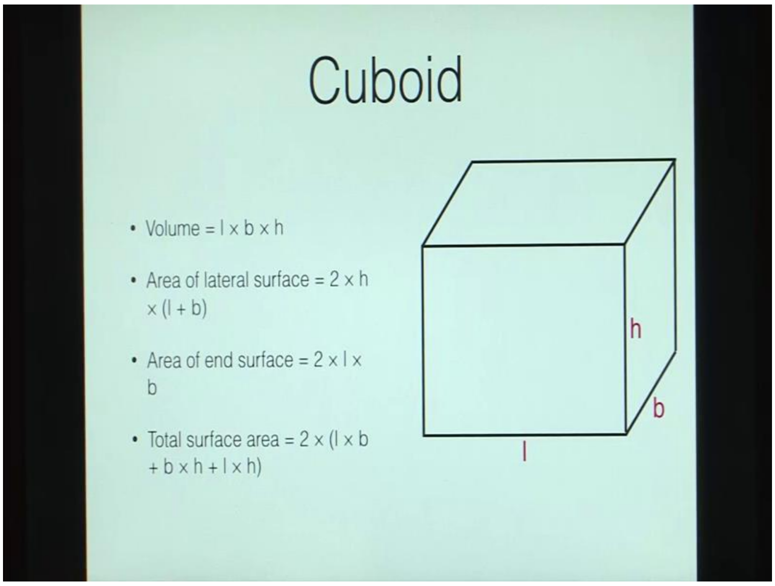

Now in the case of a cuboid we take the volume as length times breadth times height l b h, the area of the lateral surfaces is the area of a these rectangles that are making the lateral surfaces. So, 1 2 3 on the back and 4 on this side, area of the end surface is this area plus the area of the bottom surface, the total surface area is the sum of all these areas.

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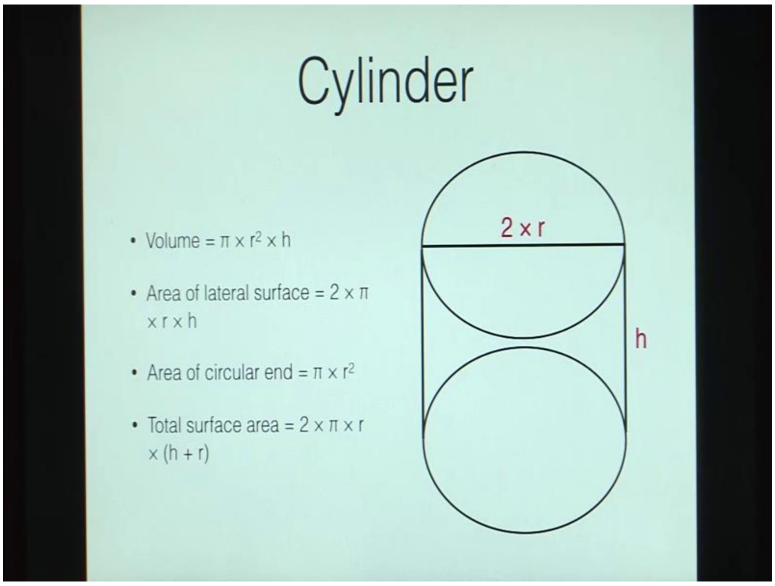

In the case of a cylinder, we have volume given by pi r square h, the area of the lateral surface is 2 pi r h.

So, we used this equation of volume when we were taking our stem to be of a cylindrical shape or form, now we also know the area of the circular end and the total surface area. So, area of the circular end is used to calculate the basal areas.

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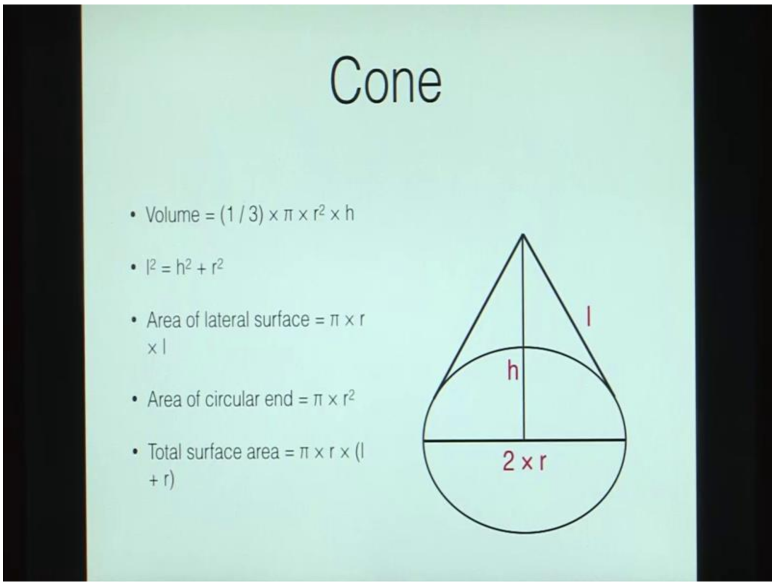

Now in the case of cones, so this conical shape is used in the case of canopies volume as 1 by 3 the volume of the cylinder, and the lateral surface area is pi r l and the end surface area is pi r square giving us our total area of pi r l plus r.

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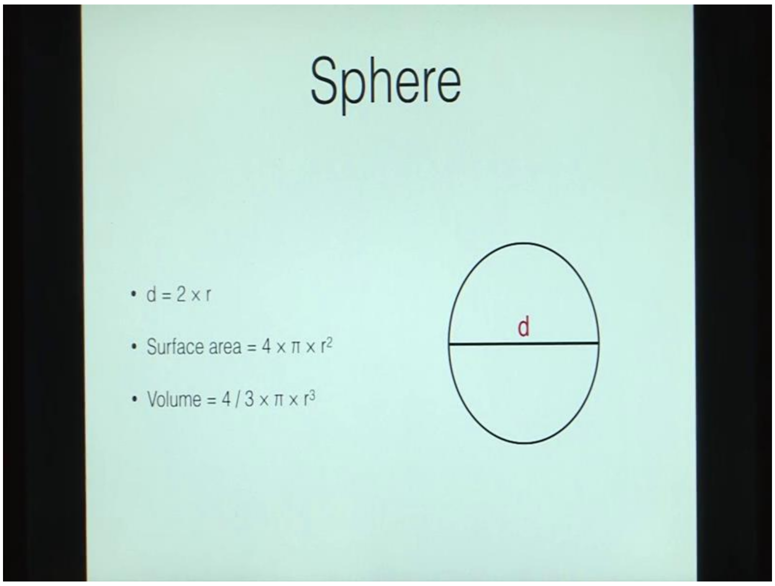

Now, in the case of a sphere the diameter is twice of radius, the surface area is 4 pi r square and the volume is 4 by 3 pi r cube.

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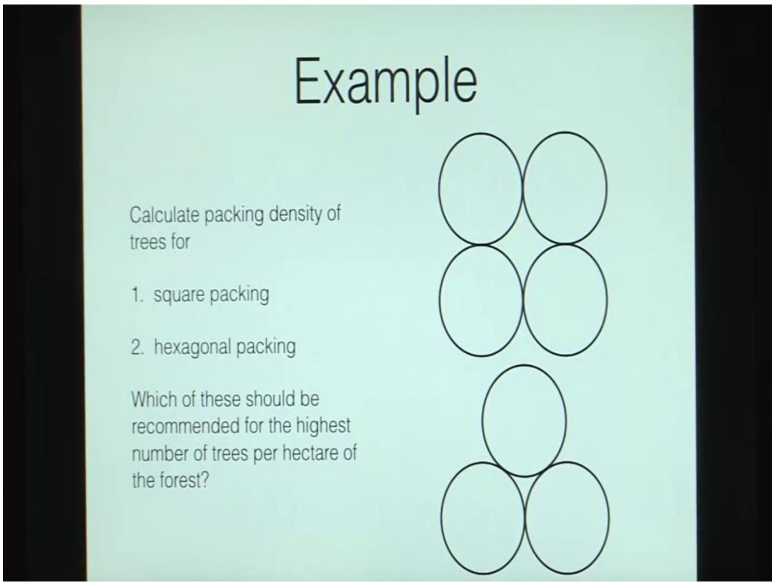

Now we used these equations to calculate the packing density of trees in a forest. So, we can put our trees in a squarish packing or in the case or we can put it as hexagonal packing in which they form an equilateral triangle and we calculated the packing density for both of these.

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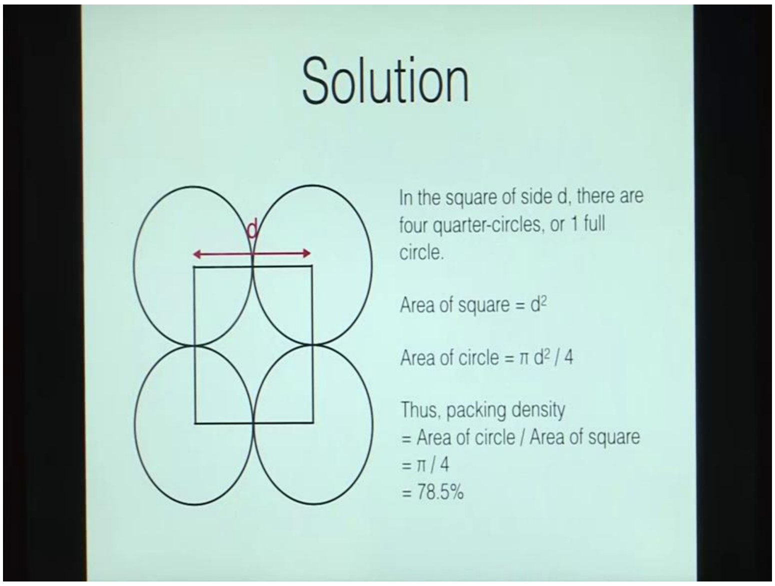

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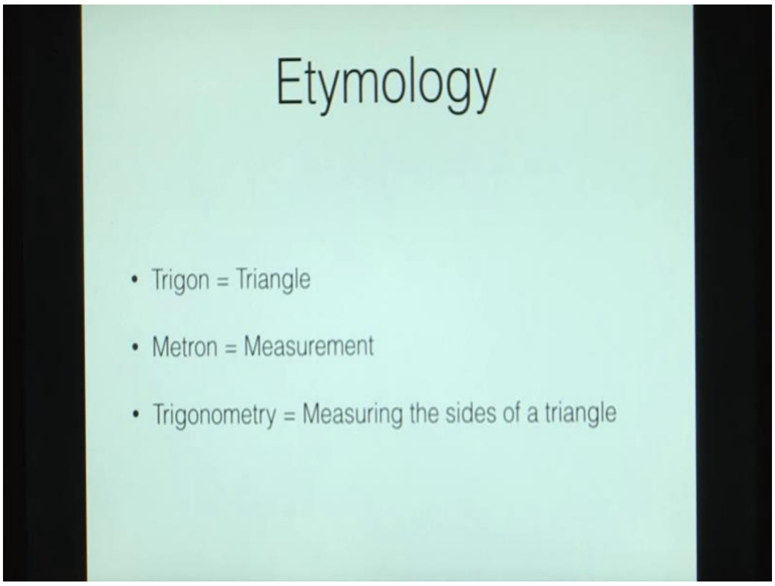

Now, next we did a recap of trigonometry, in which we looked at what this word means, it means measuring the sites of a triangle.

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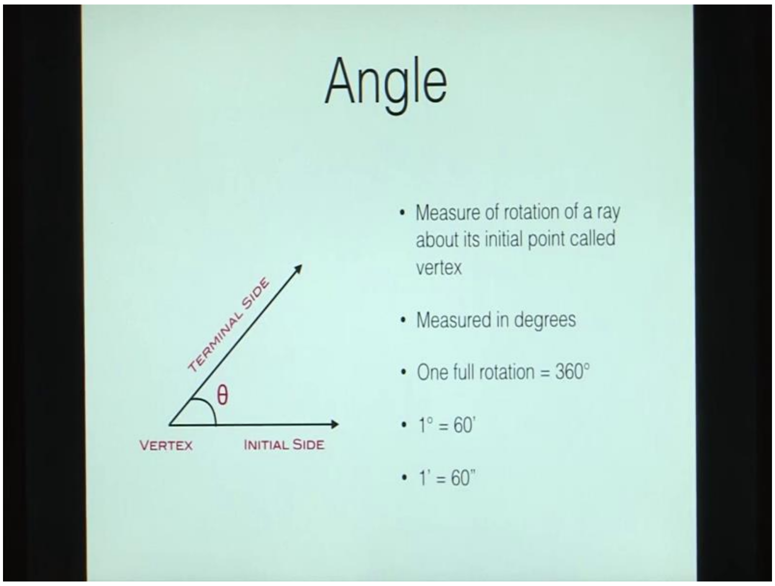

We defined what an angle is.

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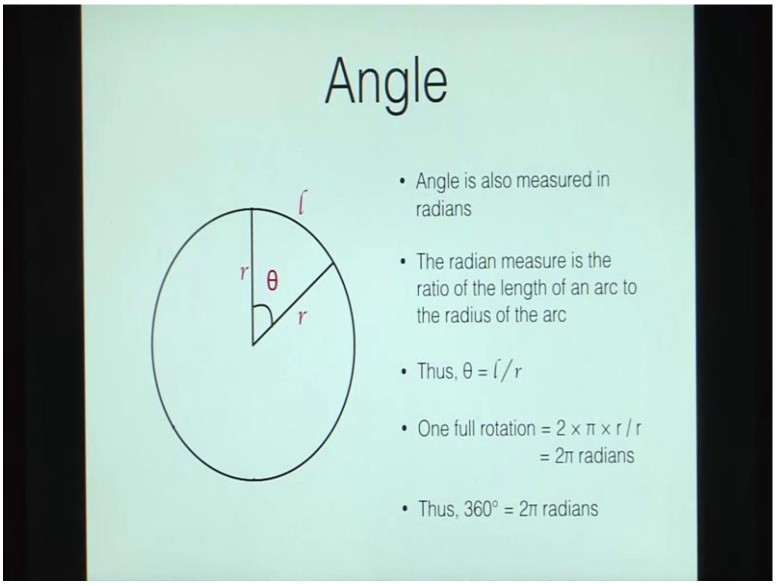

It is measured either in degrees or in radians.

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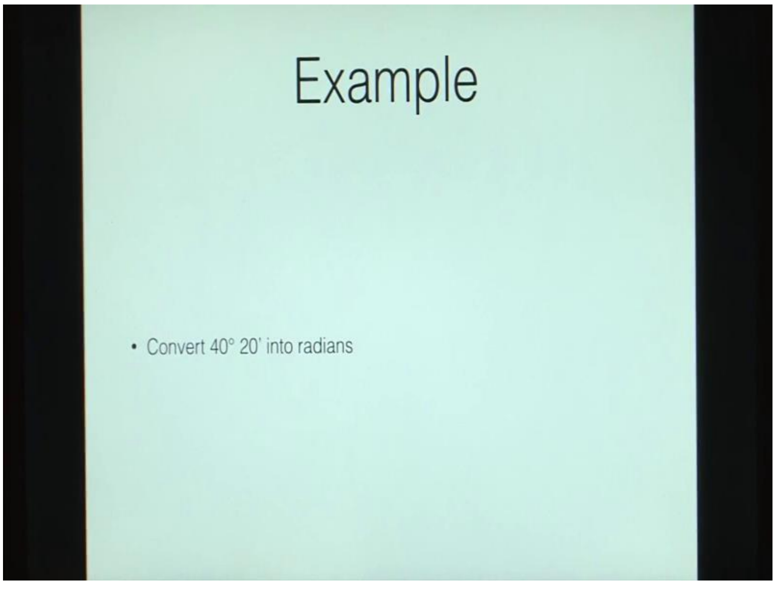

And we can convert a degrees into radians and also radians into degrees.

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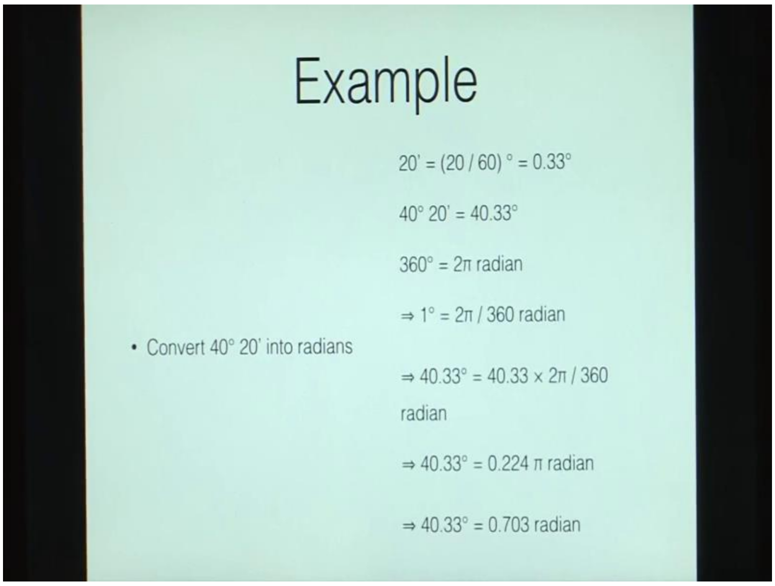

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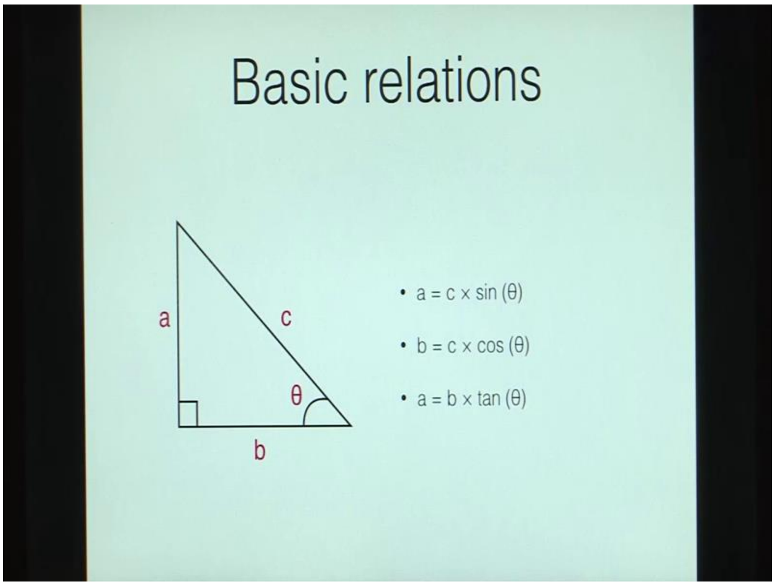

Next we saw some basic relations what is sin theta cos theta and tan theta. So, sin theta is the perpendicular divided by the hypotenuse, the cos theta is the base divided by the hypotenuse, tan theta is the height divided by the base and tan theta is something that we use most frequently when we are trying to measure the heights of trees.

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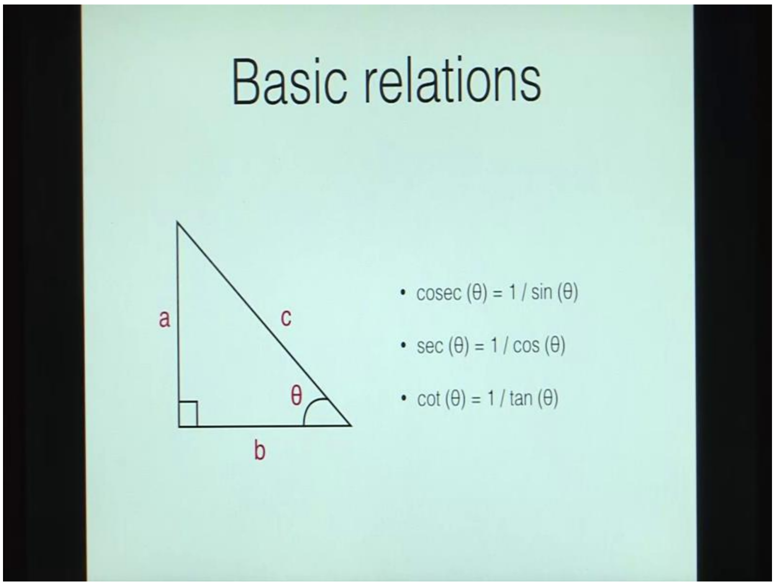

We also refined some other values cosec secant cot theta.

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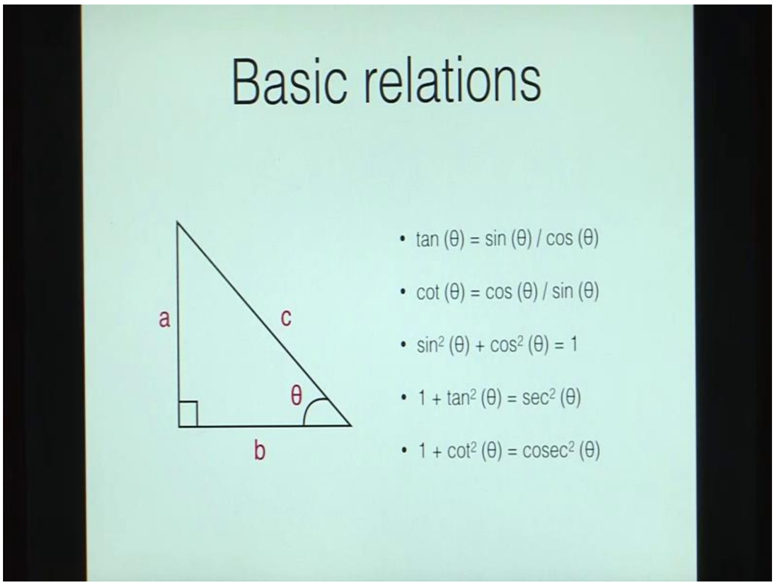

And these basic relations between these various values we also.

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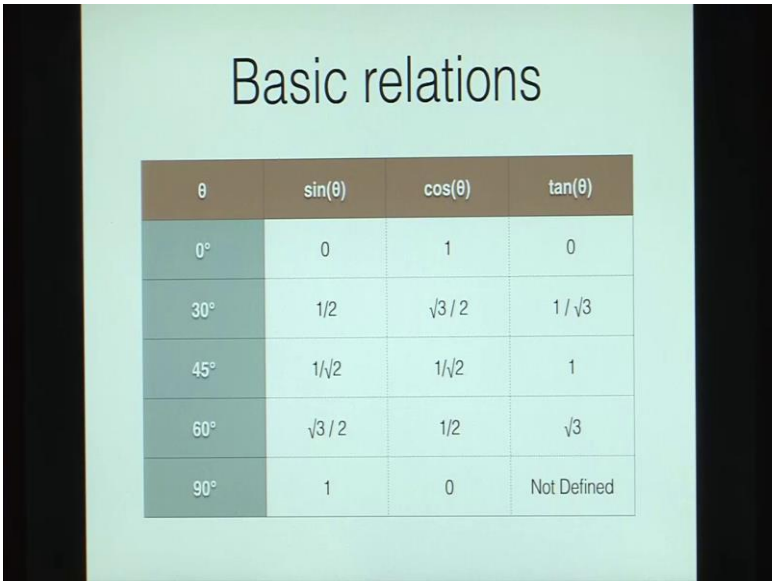

Looked at these some these standard values. So, now, you can measure you can just remember one thing. So, for these standard angles 0, 30, 45, 60 and 90 your sin theta is 0 half one by root 2 root 3 by 2 and one in the case of cos you write it in the opposite direction. So, that is also goes as 0 half one by root 2, root 3 by 2 and 1 and you can calculate the your tan values by dividing the sin values by the cos values. So, at 0 by 1 as 0, half by root 3 by 2 is 1 by root 3 and so on. So, these are some values that you should remember.

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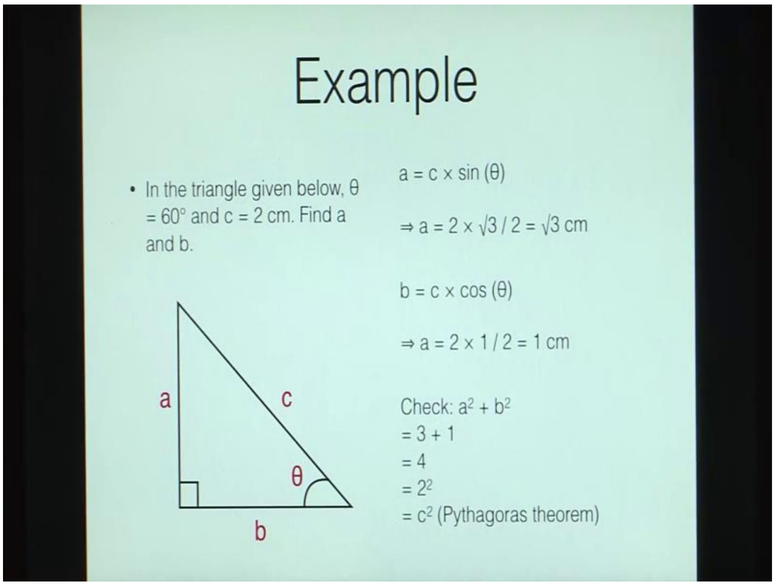

Then we did some problem statements in which we could find out the sides of a triangle using a trigonometry.

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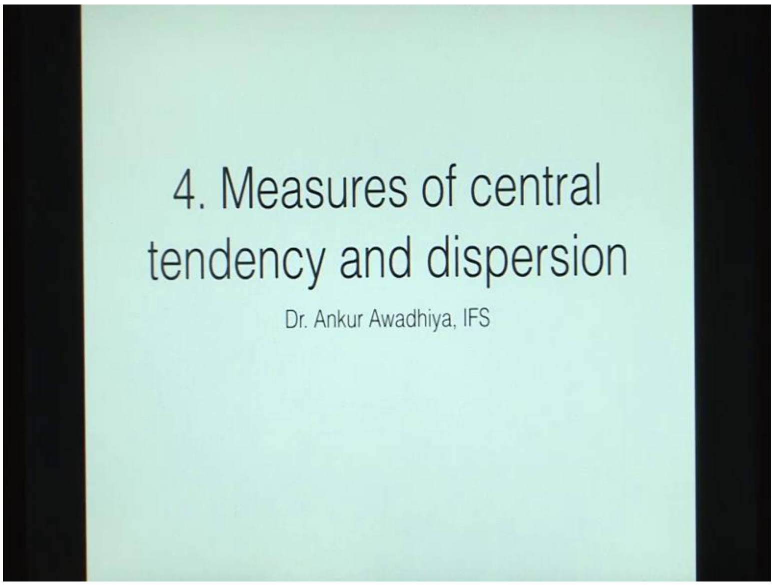

Next we looked at the measures of central tendency in dispersion.

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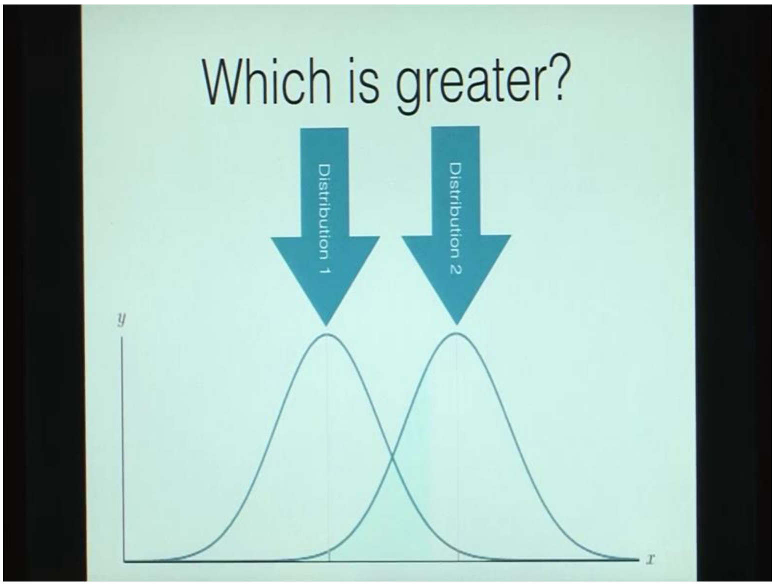

So in this case we wanted to say which of these curves is the larger curve.

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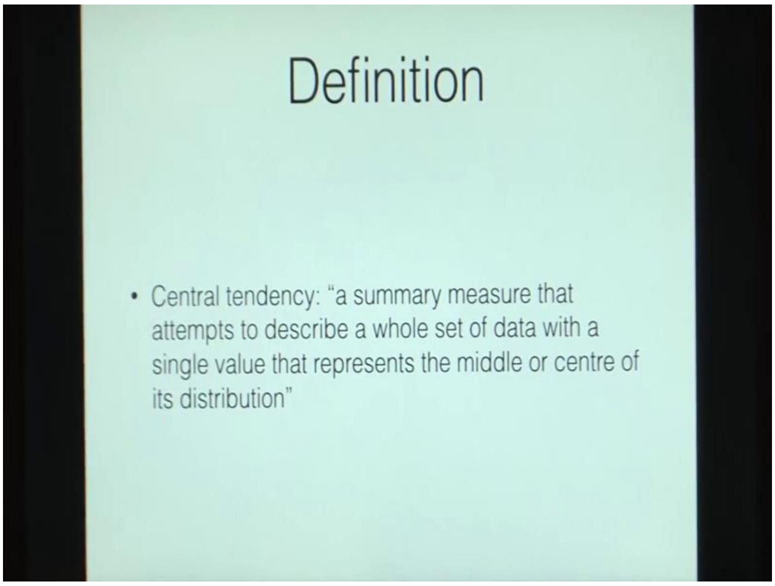

We defined central tendency, which were mean.

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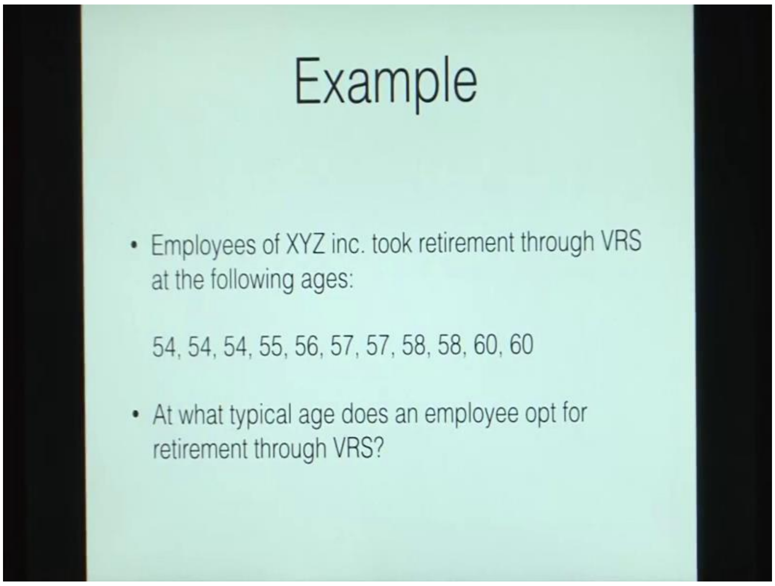

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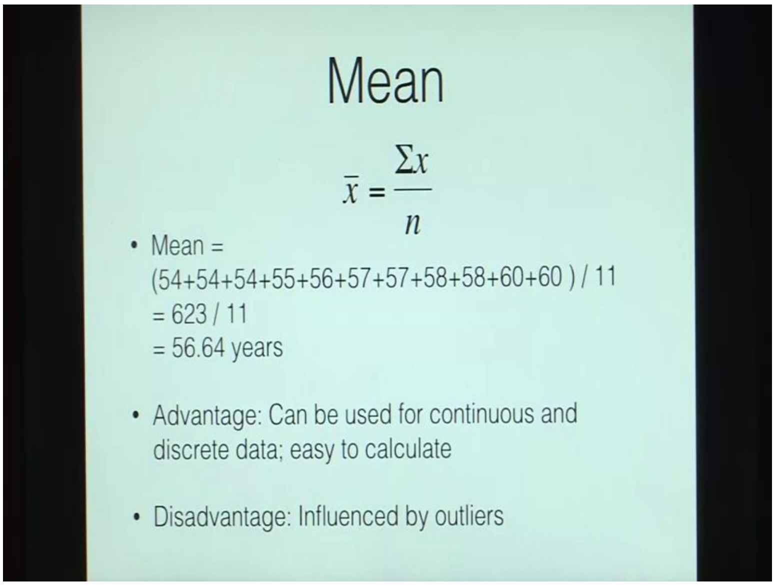

So, mean is the sum of all the values divided by the total number of values.

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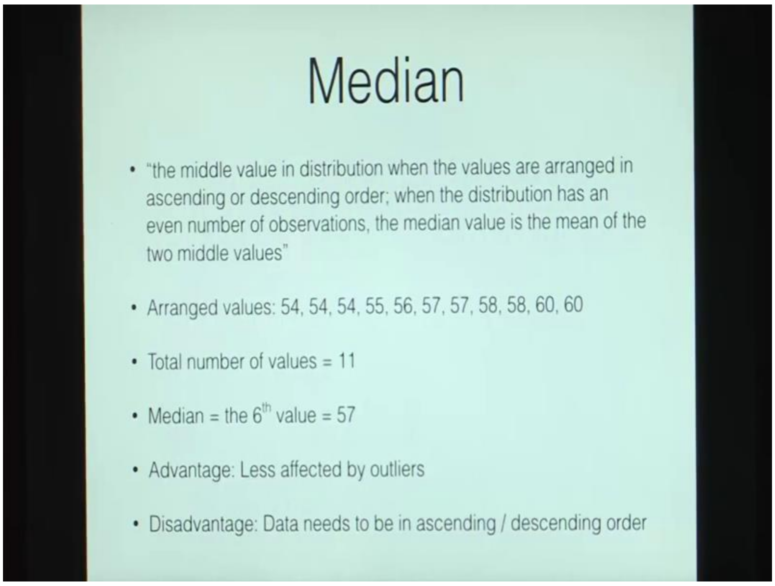

We also defined a median which is the central value when you arrange things in ascending or descending order.

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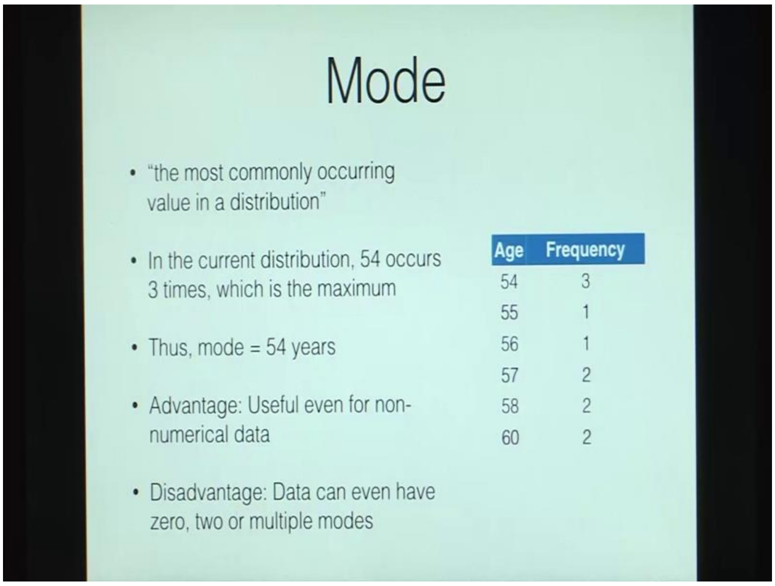

Mode is the value that appears most frequently, but your values might be unimodal, bimodal, trimodal or even multimodal in some cases.

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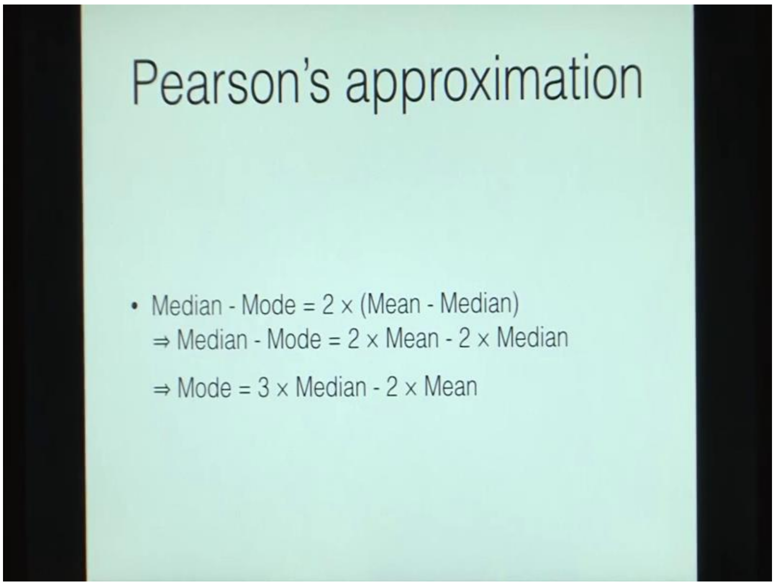

We also looked at Pearson's approximation that says that mode is 3 times median minus 2 times mean.

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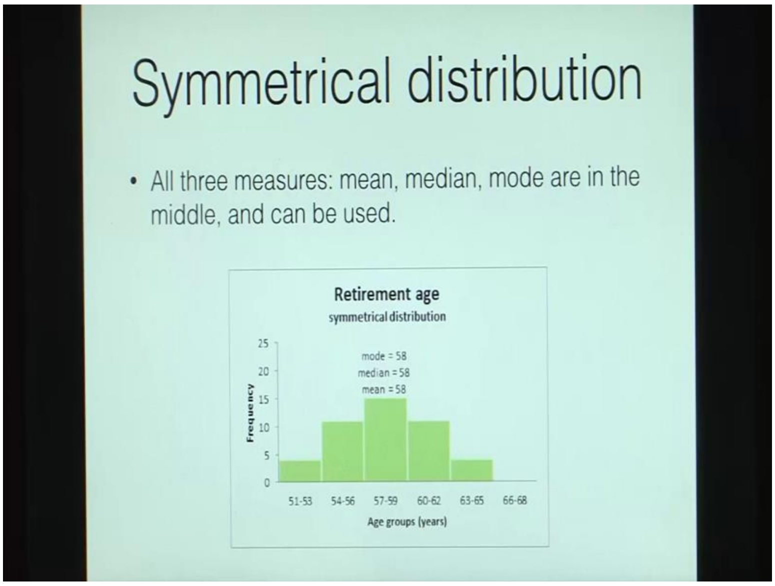

We also looked at symmetrical distributions in which we can use any three of these mean median or mode as the middle value.

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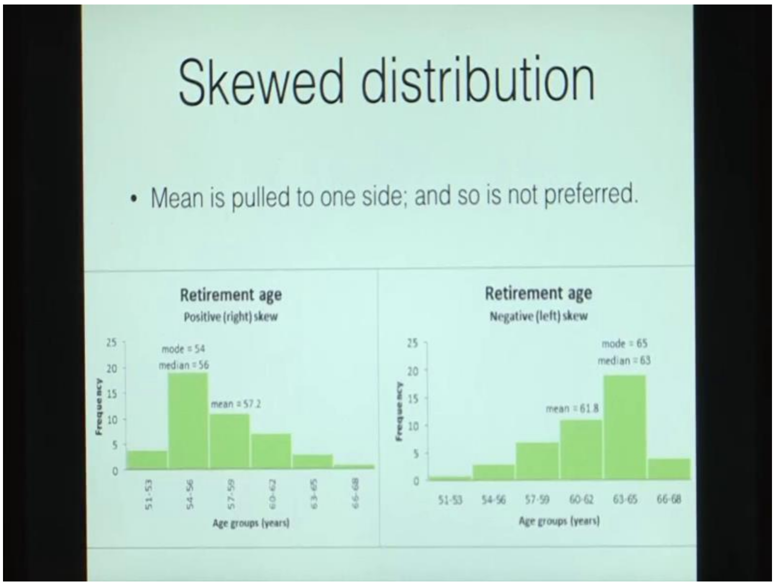

And in the case of squid distribution because mean is pulled towards one side, and so, it does not show us the most representative value and so, it is not used in these situations.

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We also looked at dispersion which tells us.

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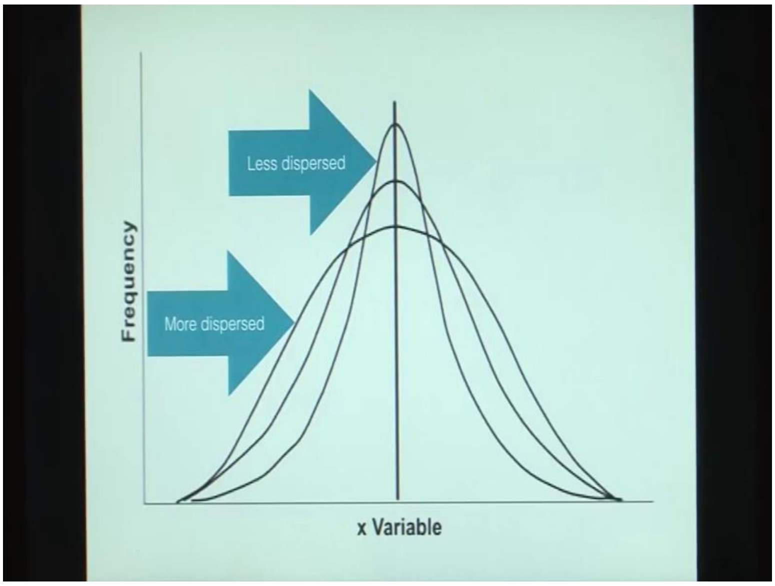

This spread between the values.

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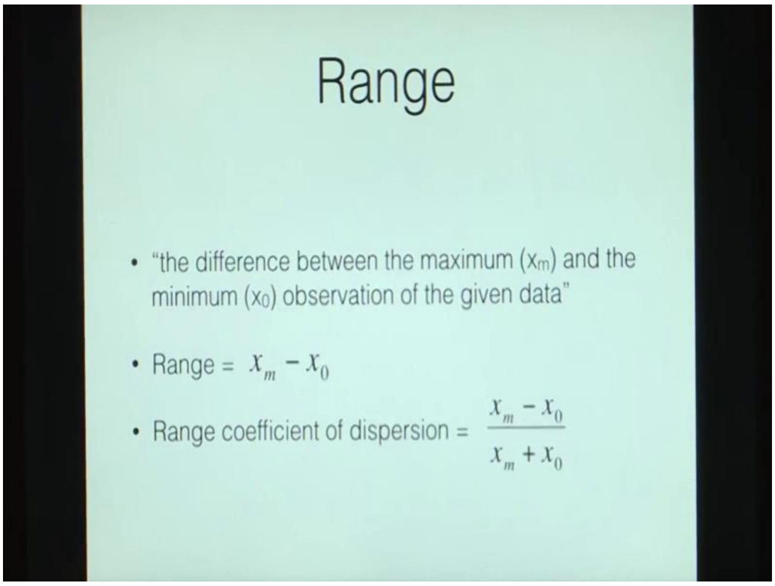

So, we looked at range which is the maximum minus the minimum value, the range coefficient of dispersion that is the maximum minus minimum divided by maximum plus minimum.

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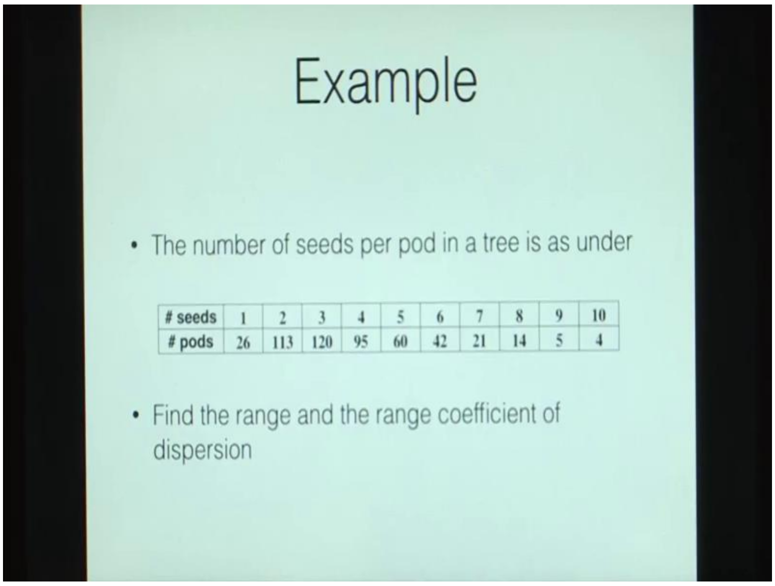

So, we also did some examples for this.

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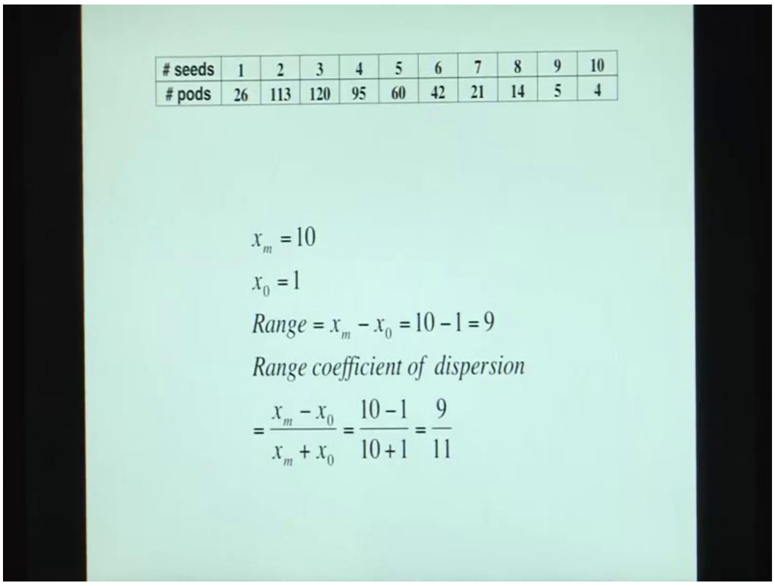

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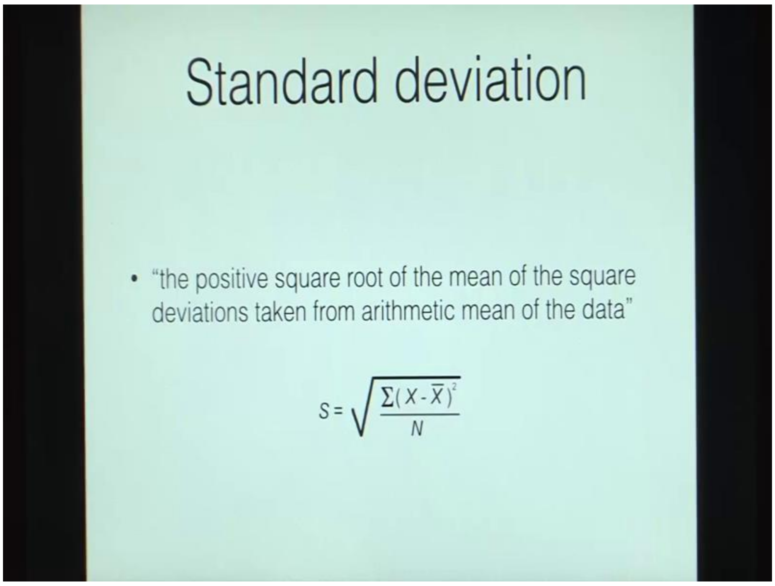

We also looked at standard deviation S, S defined as square root of sum of the squared of a deviations around the mean divided by the total number of values.

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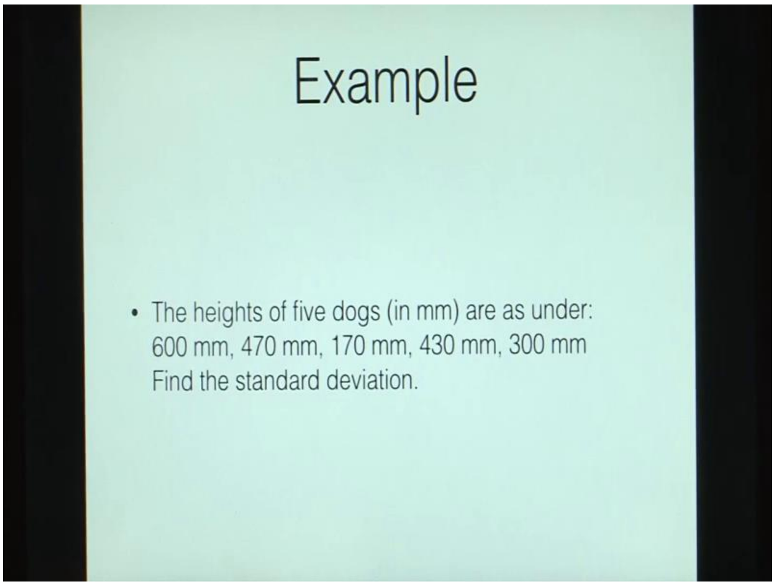

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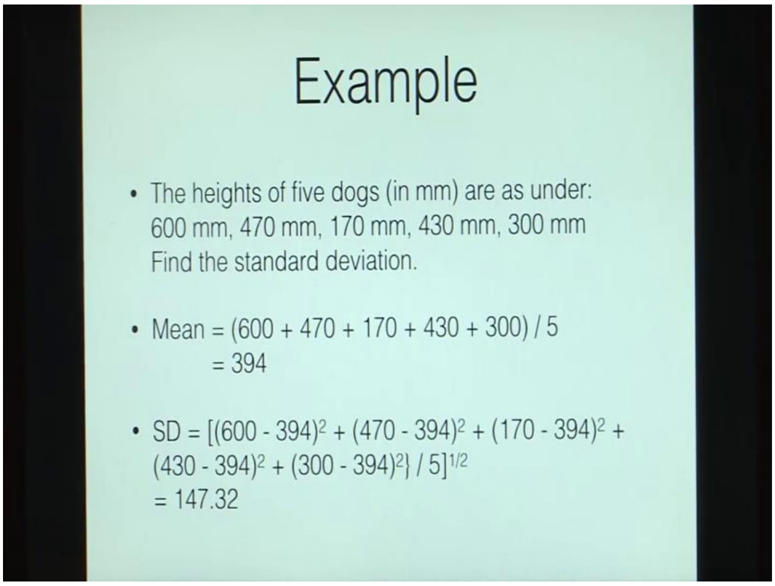

We also calculated some examples and we also looked at, what it means in the physical sense.

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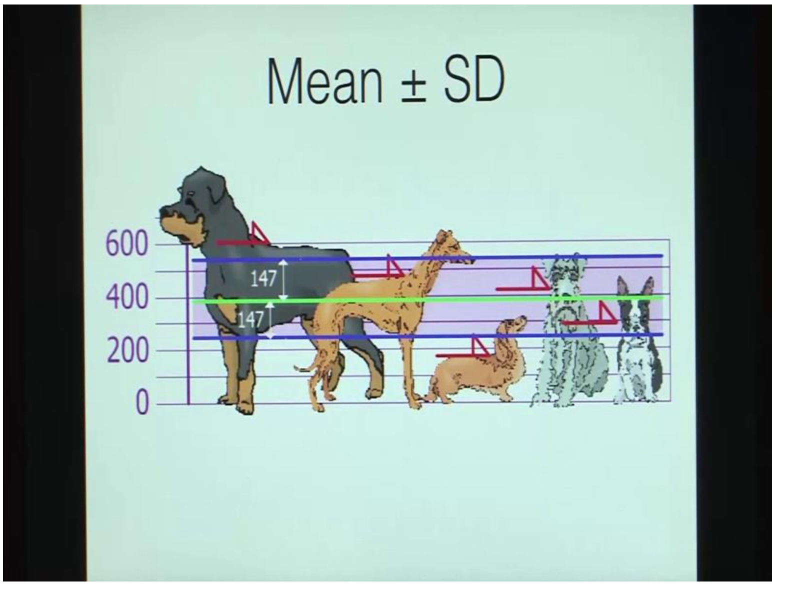

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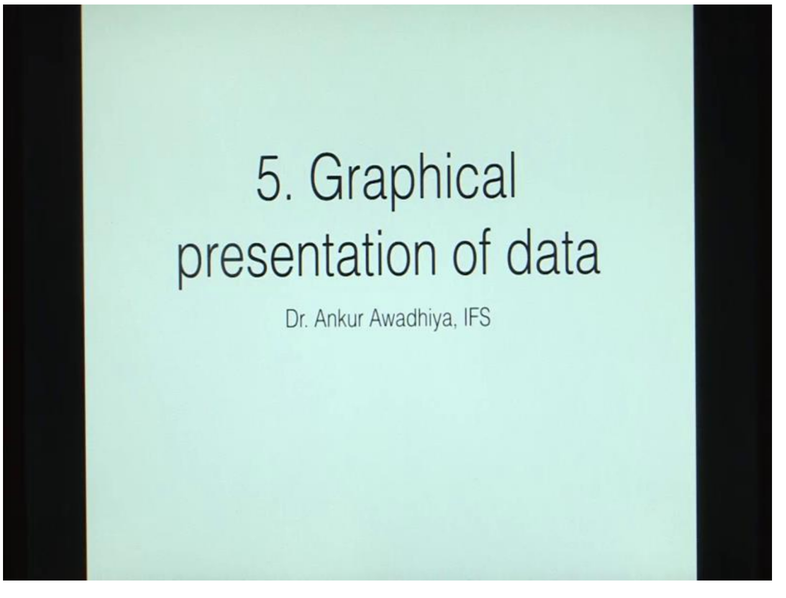

Next we looked at the graphical presentation of data.

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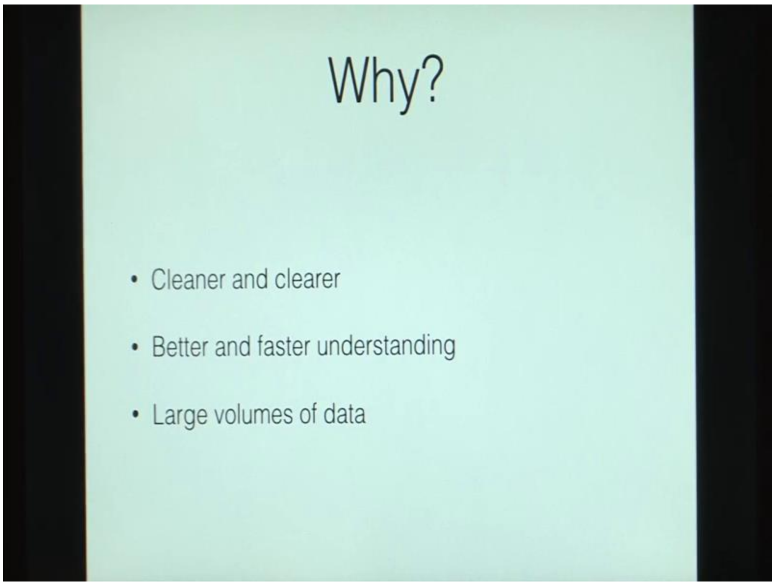

So graphical presentation is used because it is clearer and an cleaner, it permits better and faster understanding and you can show large volumes of data to be processed very quickly.

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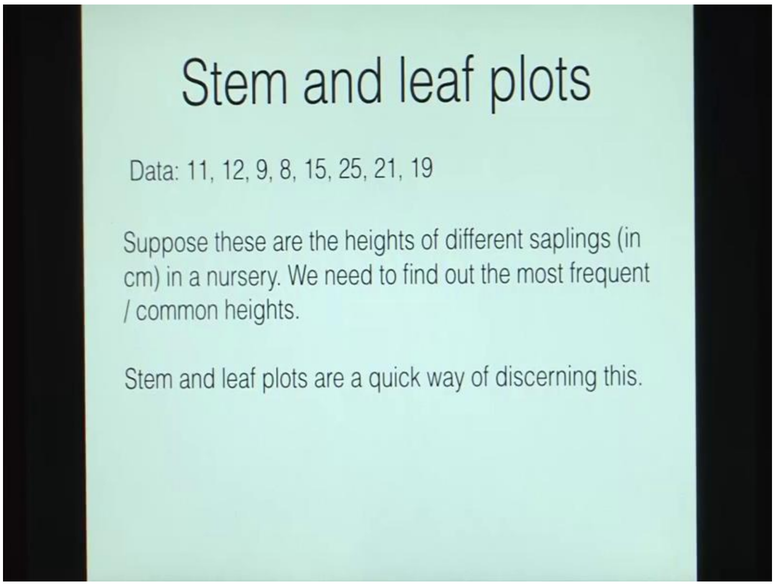

So, we looked at stem and leaf plots.

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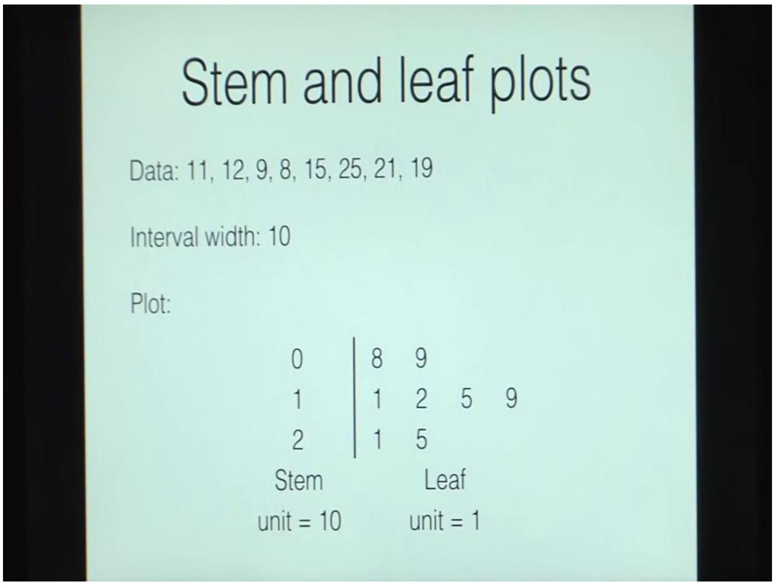

So for instance here we developed stem and leaf plot from this data, and we were able to say that this value is showing a. So, this a width of 10, values between 10 to 20 are the most frequent values in this case.

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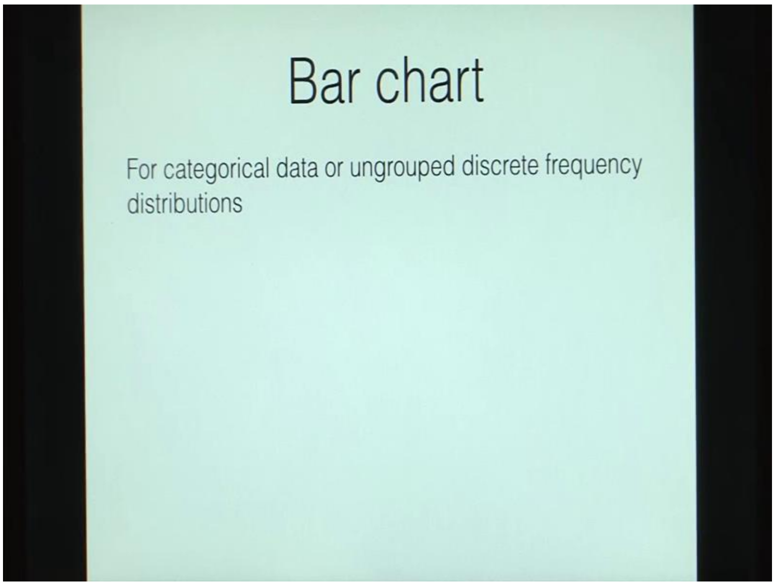

We also looked at bar charts.

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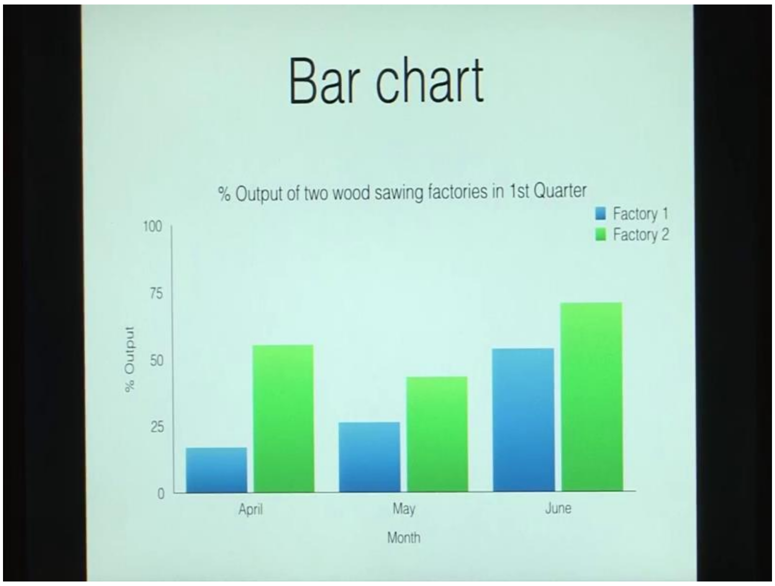

Histograms.

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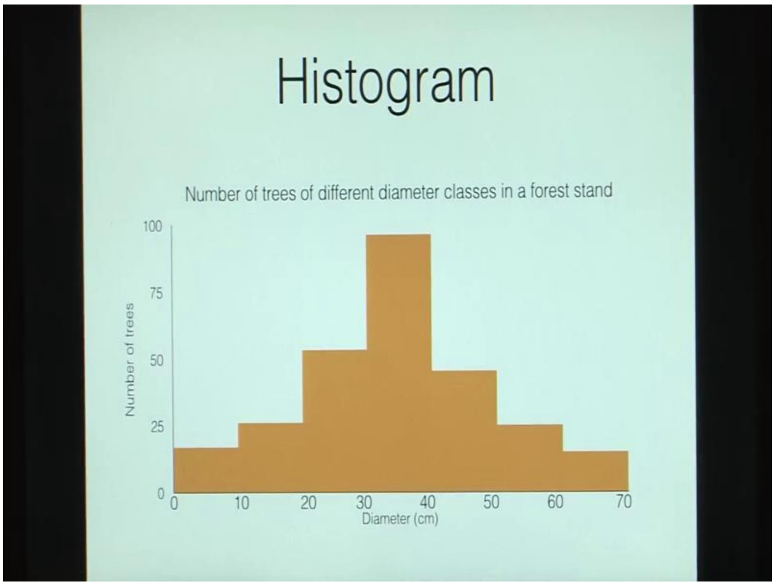

Line graphs.

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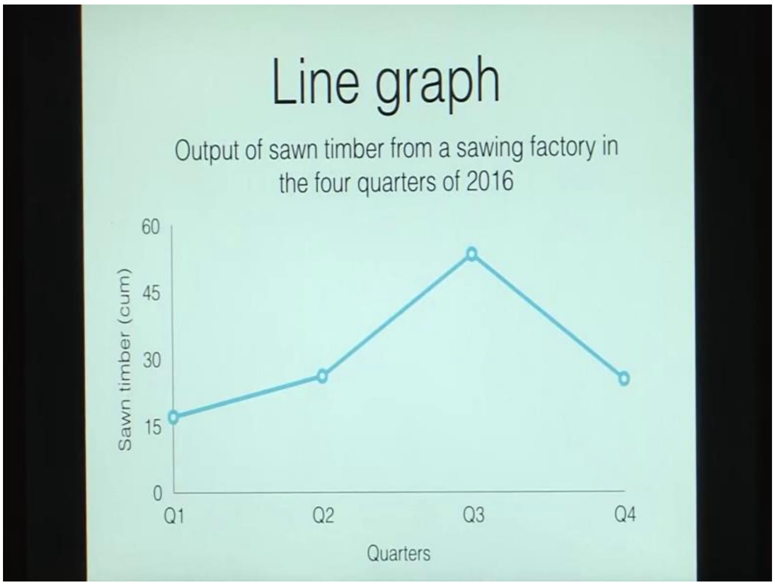

A cumulative.

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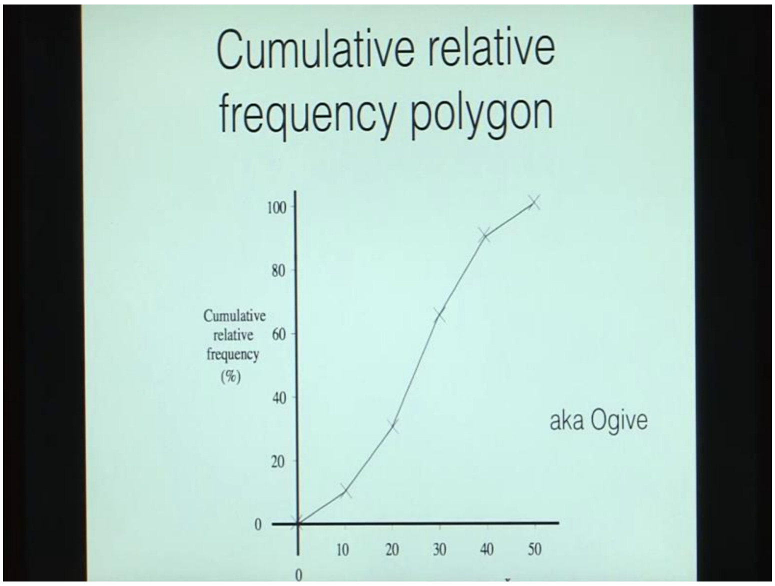

Relative frequency polygons or Ogives multiple bar charts.

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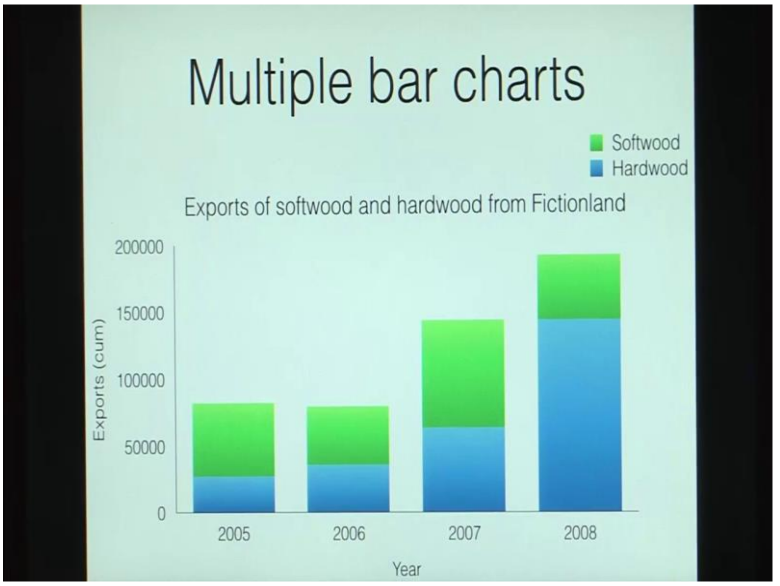

Scatter plots.

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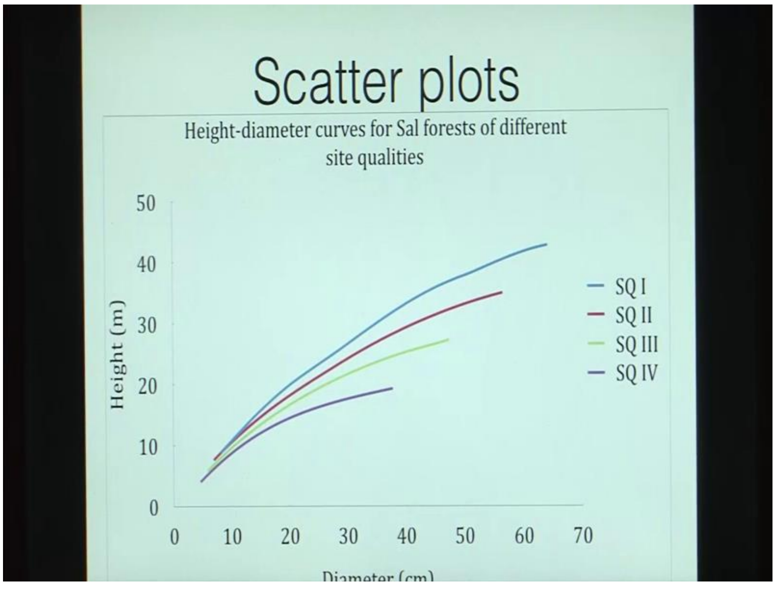

That we have used later on, and also pi charts.

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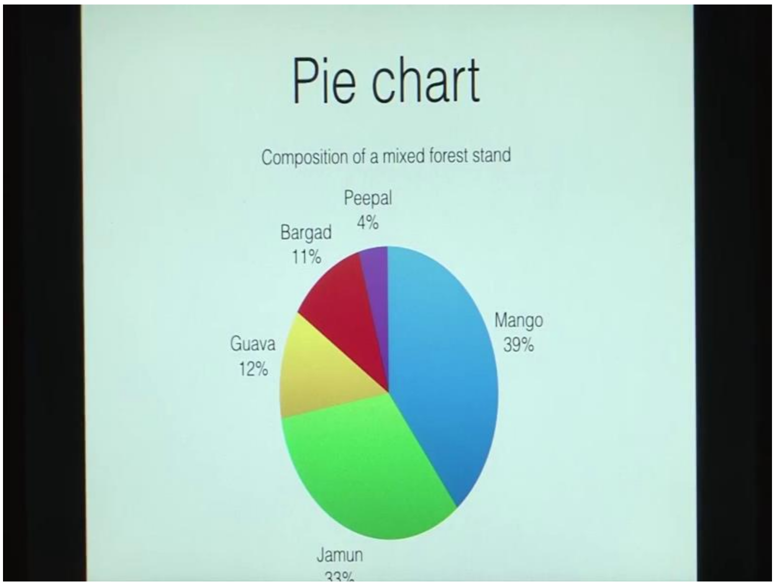

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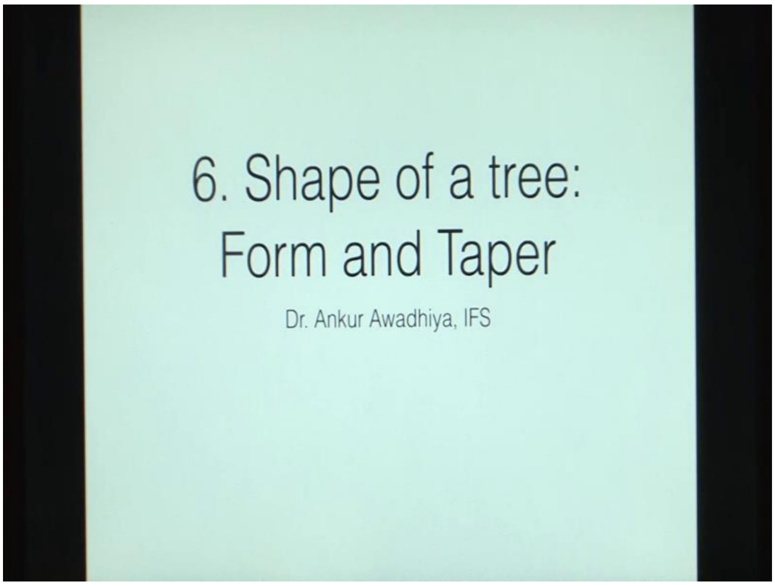

Next we went to see the shape of a tree in the form of its form and taper.

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So, essentially if you look at any tree the diameter goes on reducing as you go upwards. So, that is known as a taper.

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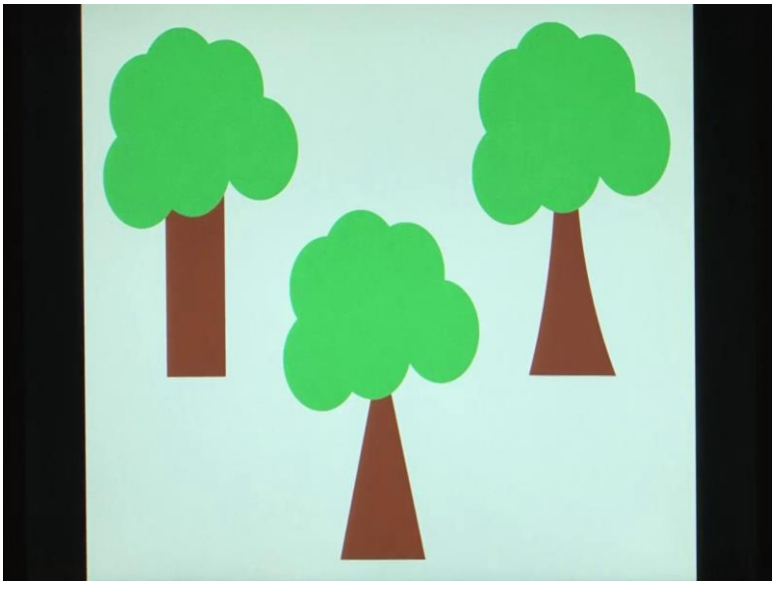

And form refers to the shape of a tree.

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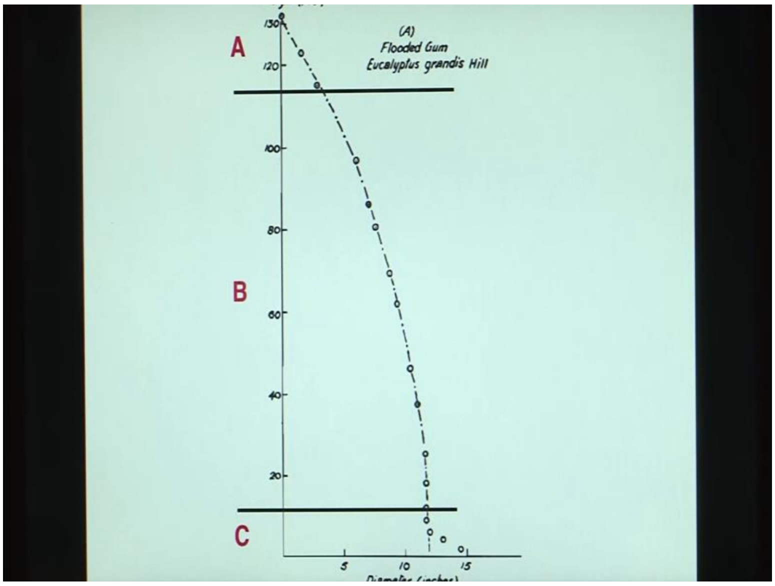

So, a shape of a tree is found out by a plotting it is a diameters at various heights, and we saw that we could divide a tree into three portions the upper is.

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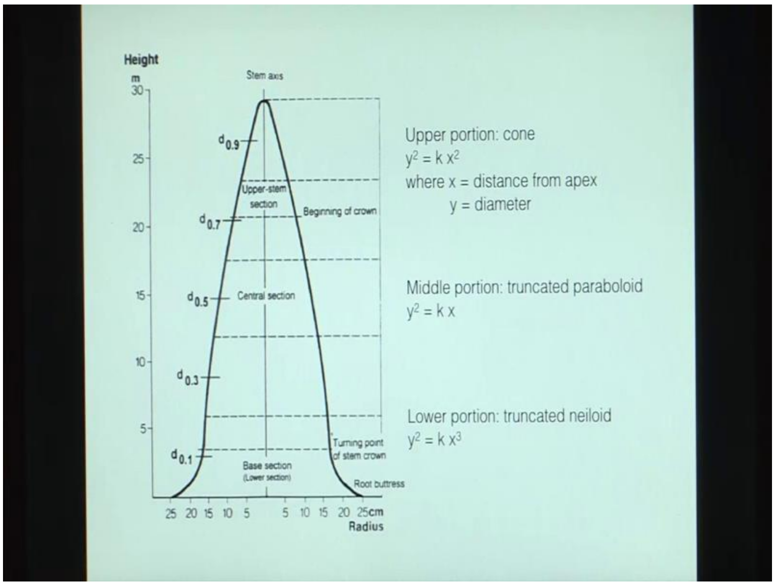

The conical portion followed by a paraboloid portion, followed by a neiloid portion or it could error truncated neiloid portion.

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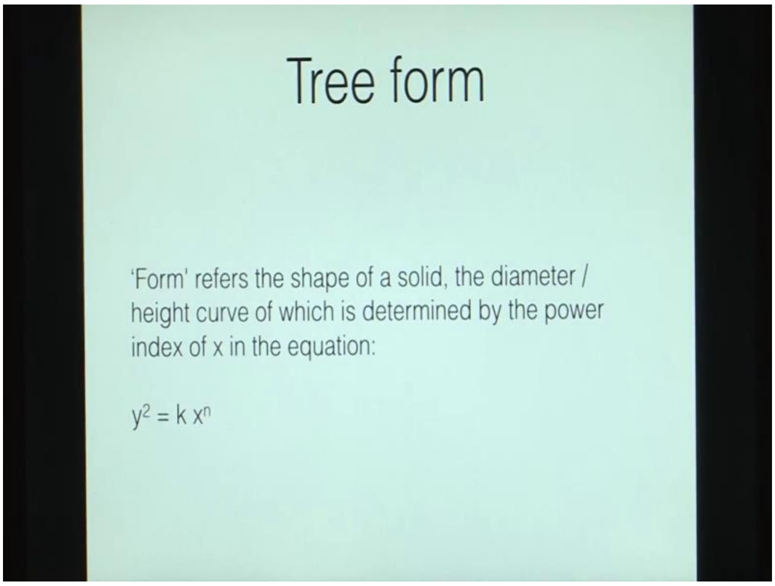

So, tree form is the shape of the tree which is the index of X in this equation, Y square is equal to k X to the power of n.

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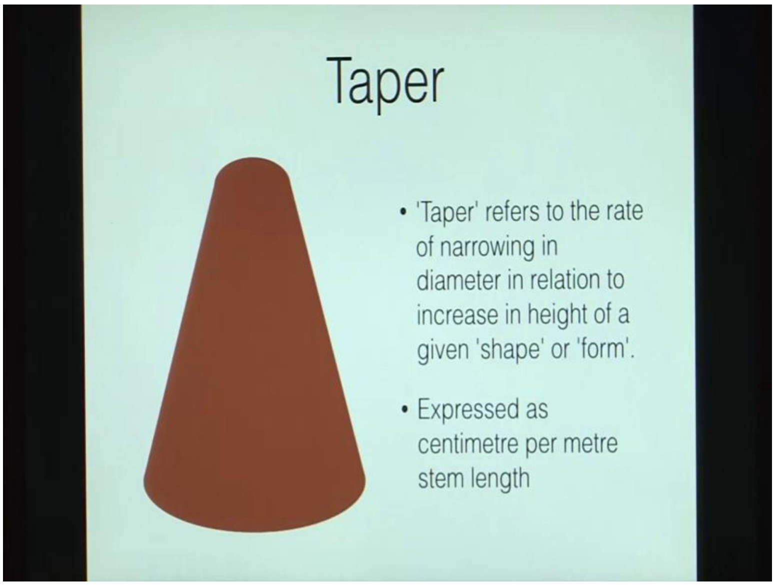

Taper is the rate of narrowing and we saw that a taper varies in different conditions in if trees are close together.

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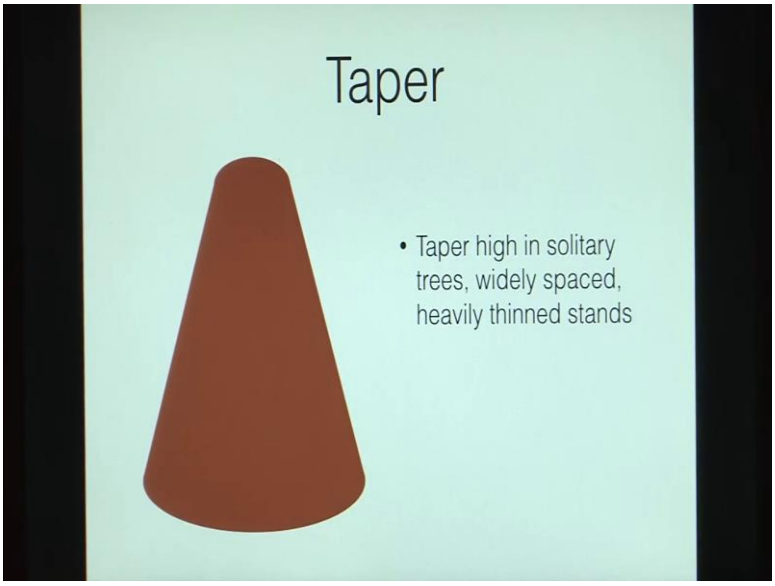

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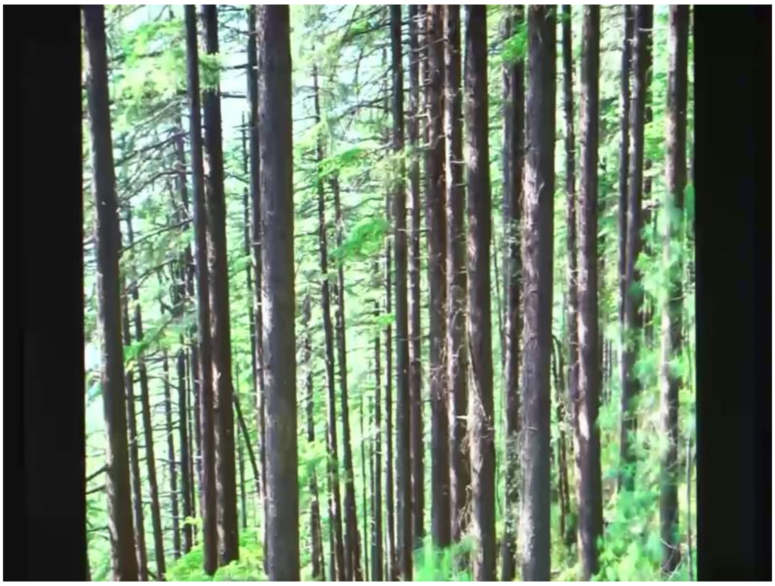

Then your taper will be less; whereas, on a windy location the taper will be high.

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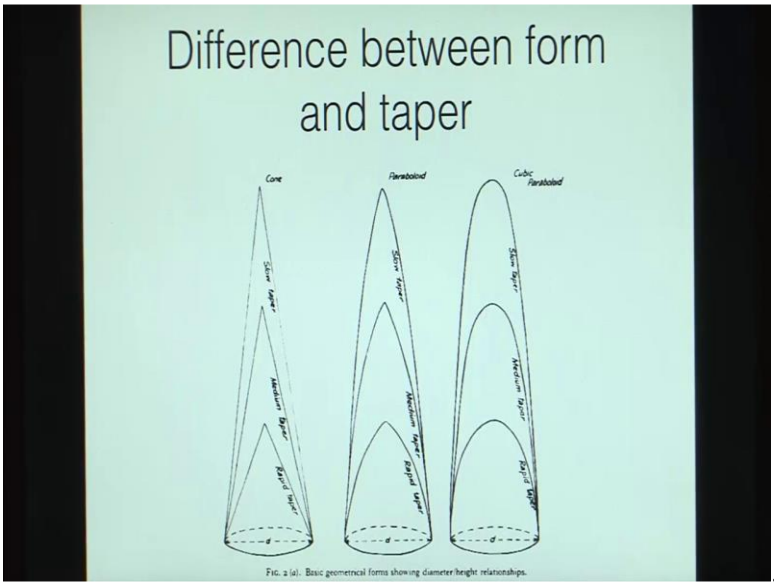

We looked at the differences between form and tapers. So, essentially form tells you the shape of figure and taper tells you how quickly or how slowly does that shape go towards a point.

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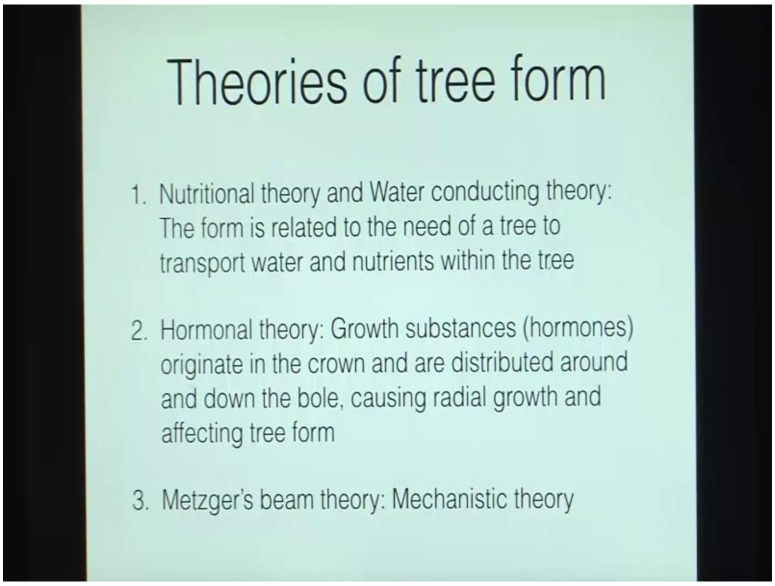

Then we looked at theories of tree form nutritional and water conducting theories hormonal theory and the Metzger’s beam theory.

So, in the case of nutritional theory and water conducting theory, the form is related to the need of a tree to transport water and nutrients within the tree, in the case of hormonal theory the hormones are generated at the tip of the tree and then they are distributed down and around the bull which causes difference in its growth and we also looked at Metzger’s mechanistic beam theory.

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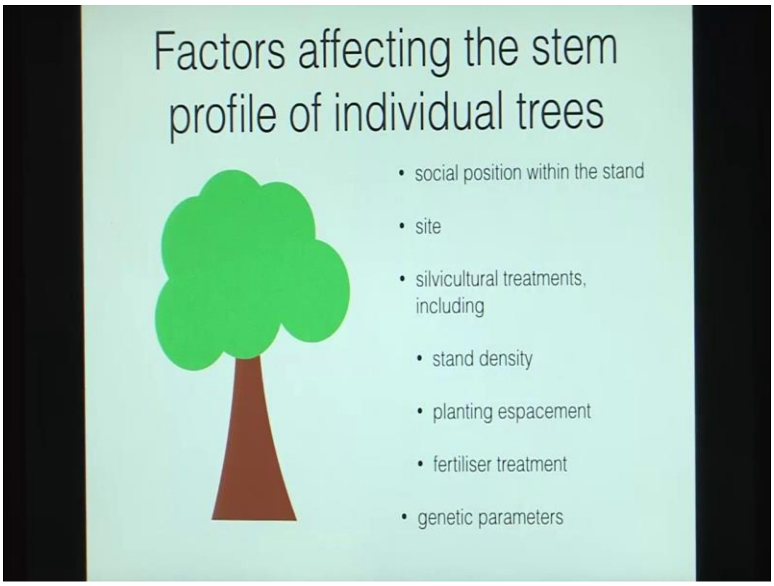

Then we saw a different factors can affect the stem profile of individual trees.

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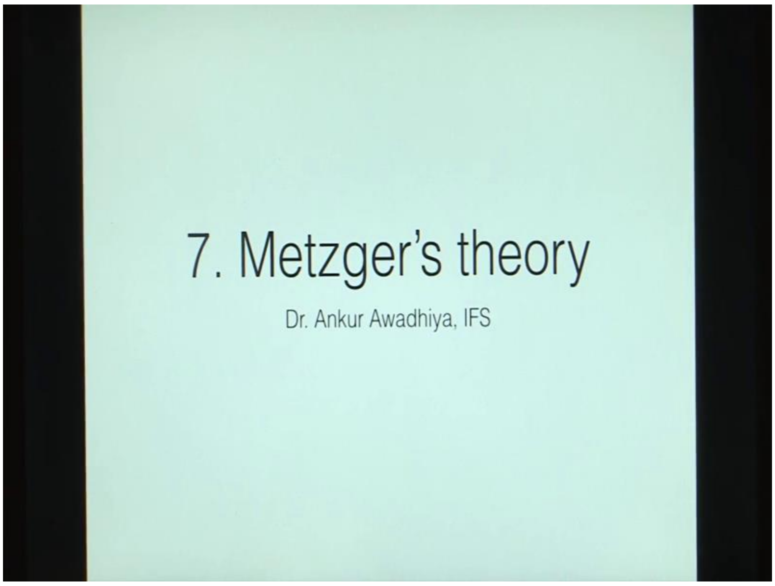

Next we went into Metzger's theory in greater detail.

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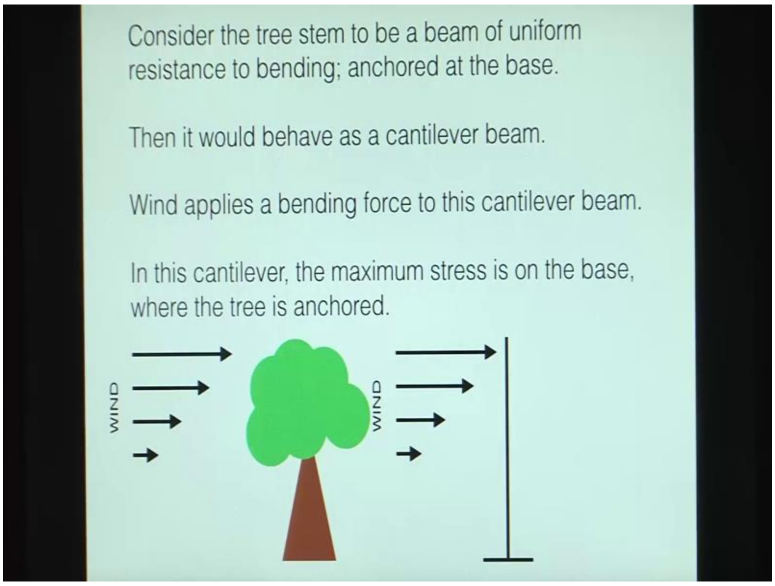

So, in this case a your tree was a considered to be a beam of uniform resistance to bending that is anchored at the base. So, it acts as a cantilever beam, and this beam is subjected to wind pressures and these pressures lead to stresses and because your tree has this uniform resistance to bending. So, it can be toppled to its side and the maximum amount of stress will be at the base.

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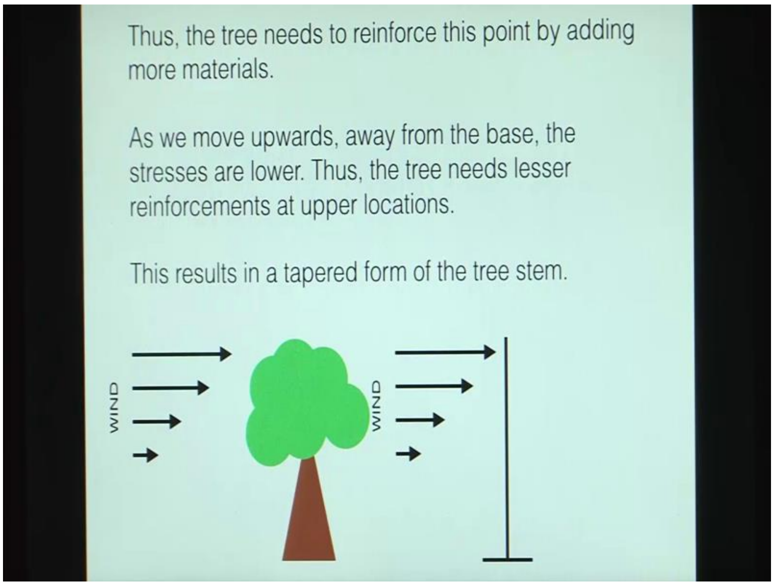

And to counteract that your tree goes on depositing substances near the base. So, the base becomes broader, the diameter goes on increasing towards the base and decreasing towards the top.

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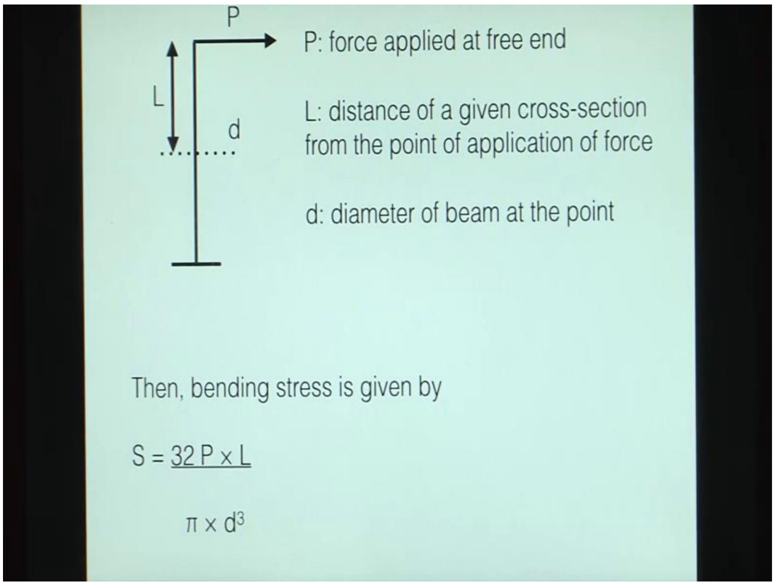

Then we also looked at how we can derive the shape of a tree by using this mechanistic beam theory. So, we looked at this stress.

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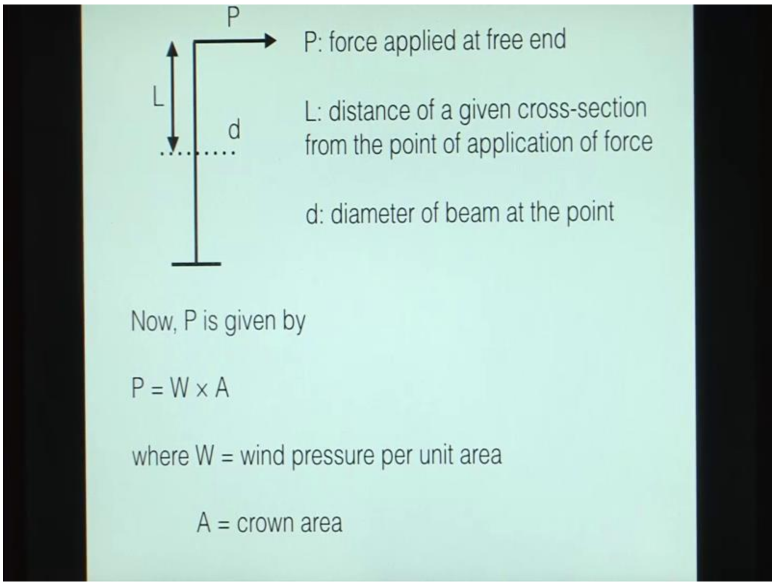

Now a pressure is given by your wind pressure multiply. So, your force is given by wind pressure multiplied by the area.

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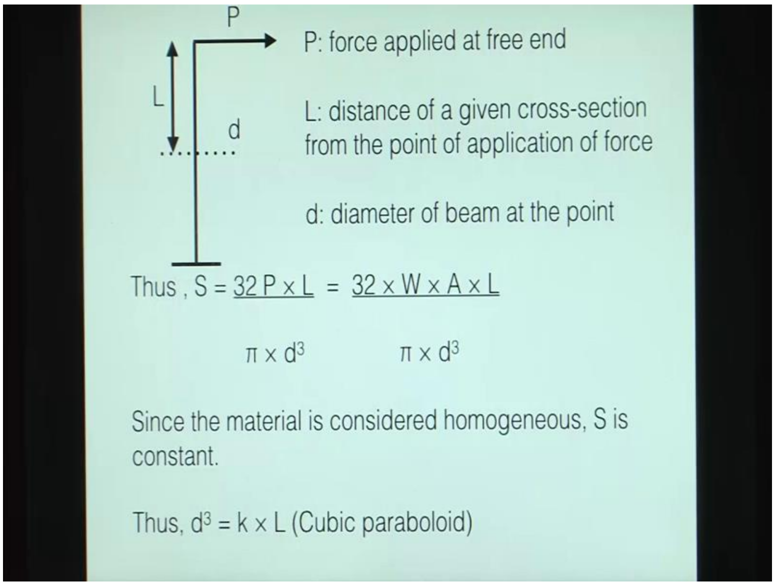

And we use that to get the shape of a tree in the form of a cubic paraboloid and we used Metzger theory to explain why these trees are having a less amount of taper.

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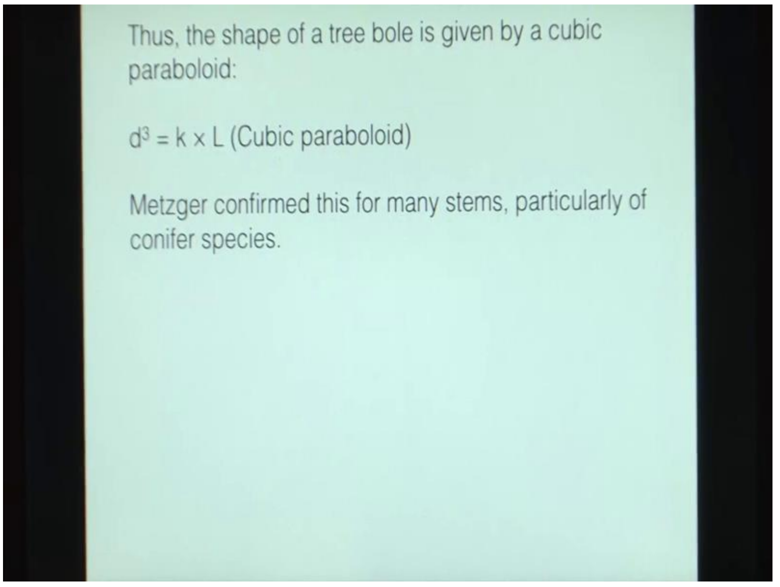

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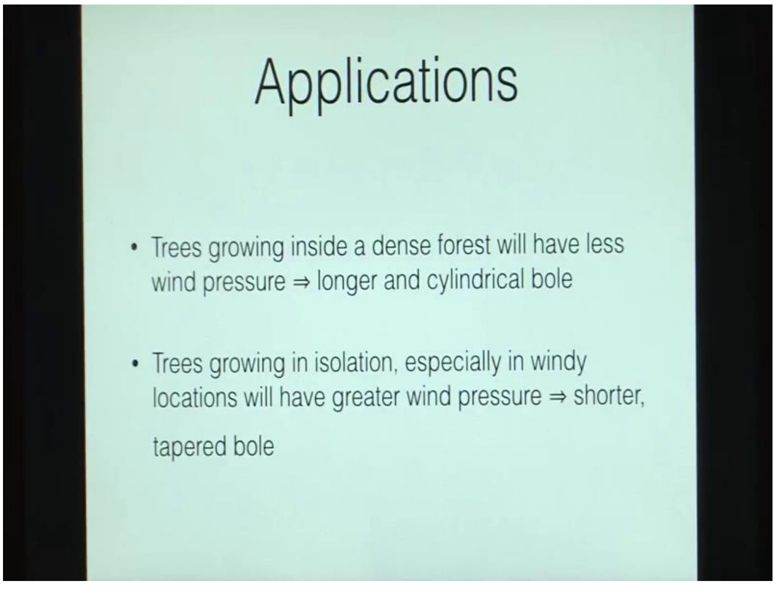

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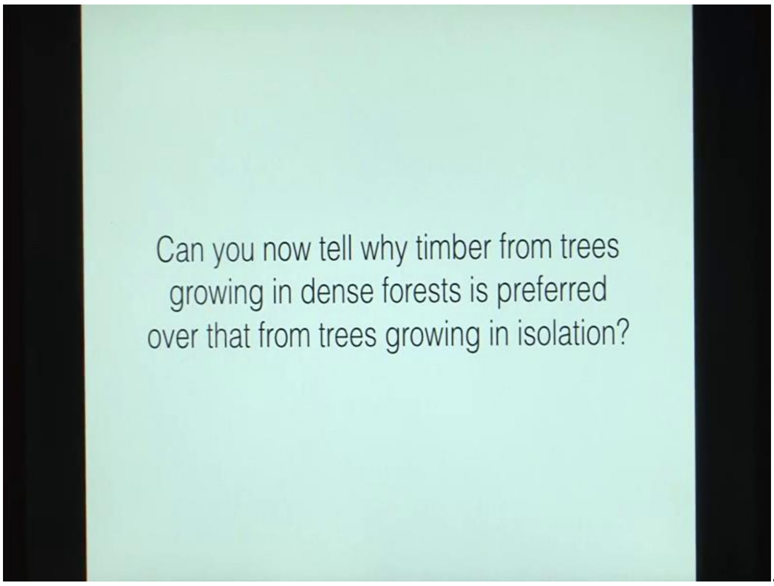

Whereas this tree is having a greater amount of taper and this is also used in the case of forest management because trees that are growing in dense forest have very less amount of taper they are more cylindrical and. So, more volume of material from that tree can be utilized and so, they are preferred over trees that are growing in isolation.

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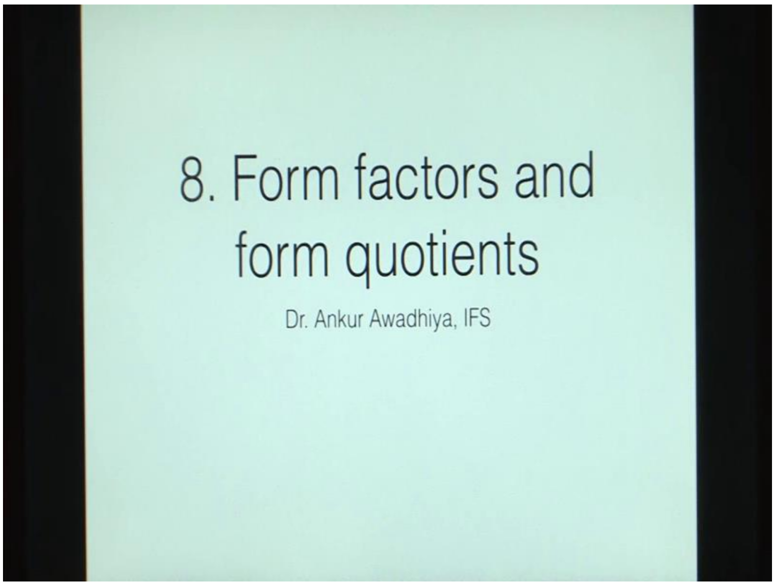

In the next class we looked at form factors and form quotients.

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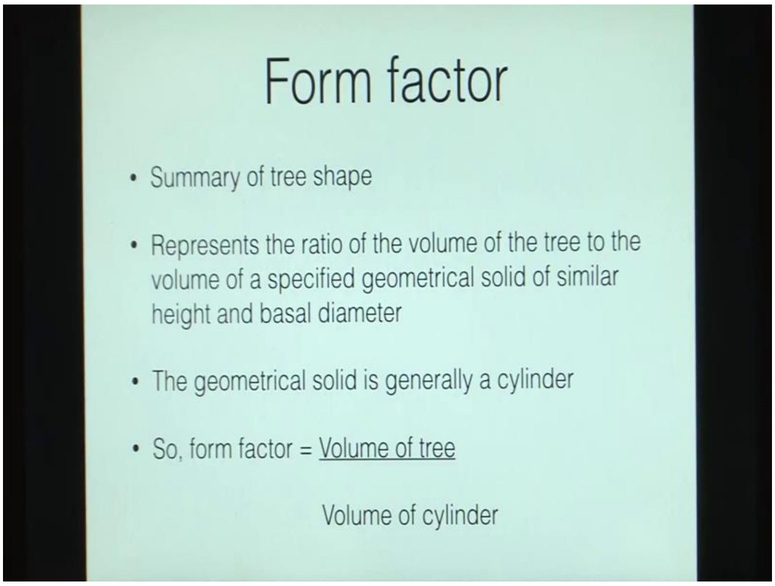

So, we used form factor as a summary of the tree shape, and we defined it as the volume of the tree divided by volume of a cylinder. From where do we take the values of the diameter and height of that cylinder gives us different kinds of form factors.

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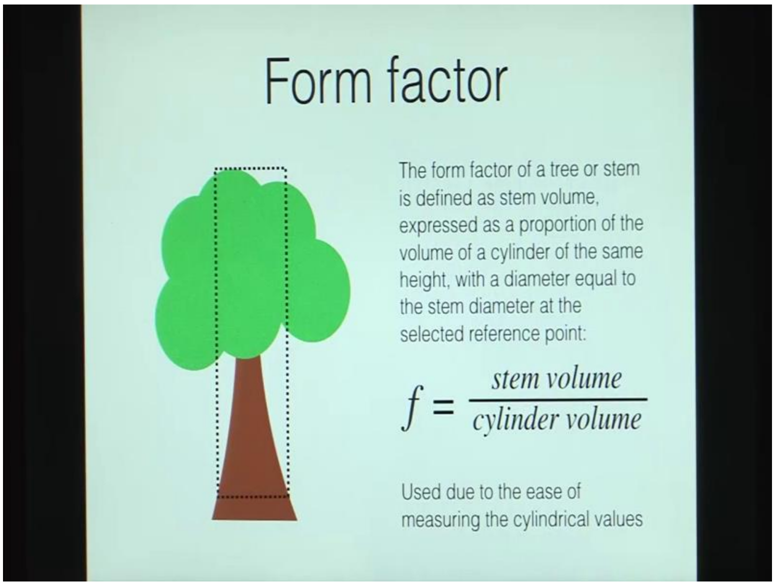

So, form factors stem volume by the cylinder volume we took.

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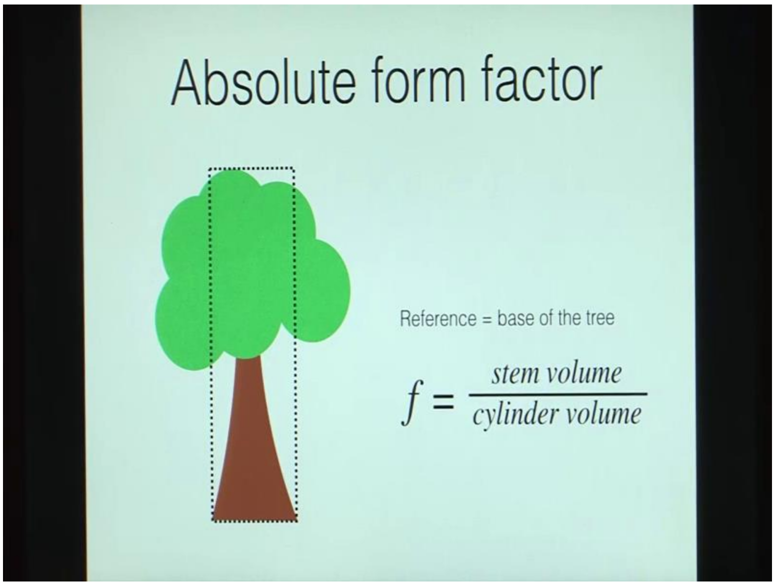

The absolute form factor in which your basis of your cylinder is taken at the base of the tree or the reference is taken at the base of the tree will looked at the artificial form factor that is the most commonly utilized form factor also called as the false form factor or the base the breast height form factor, in which your reference was a cross section at the breast height.

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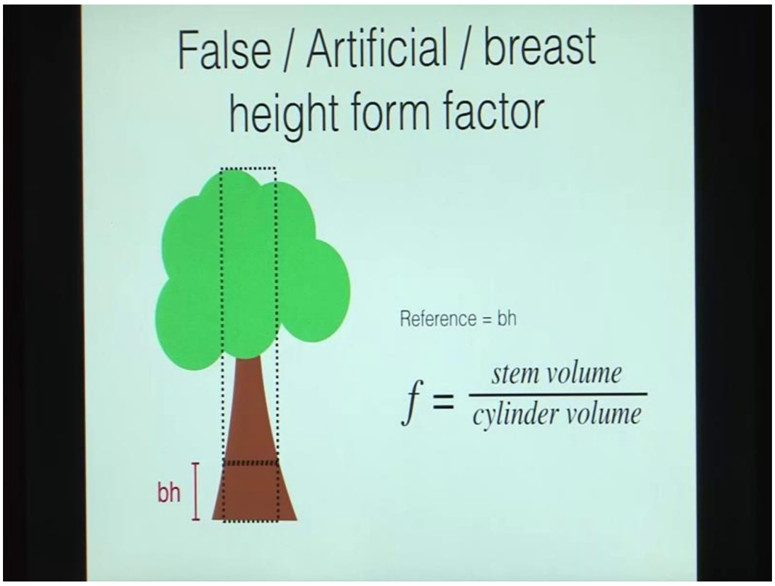

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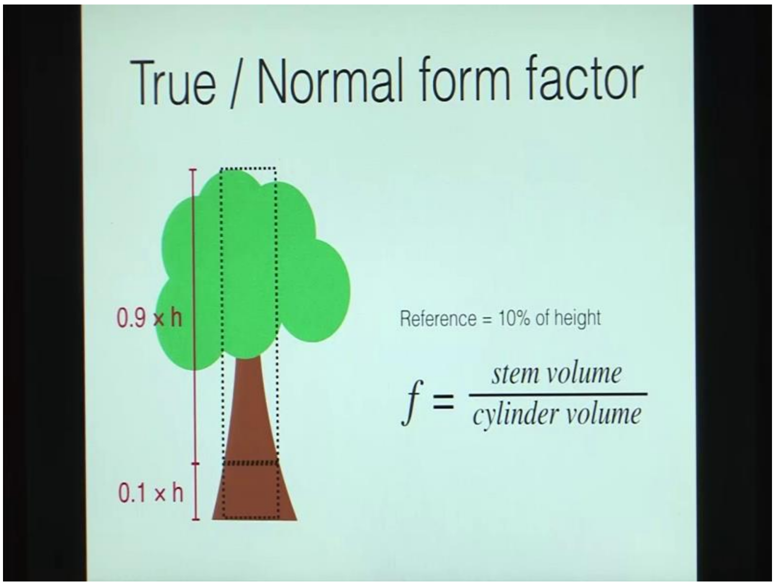

We also looked at true or normal form factor in which you are reference was a percentage of the height and what is the utility of form factors?

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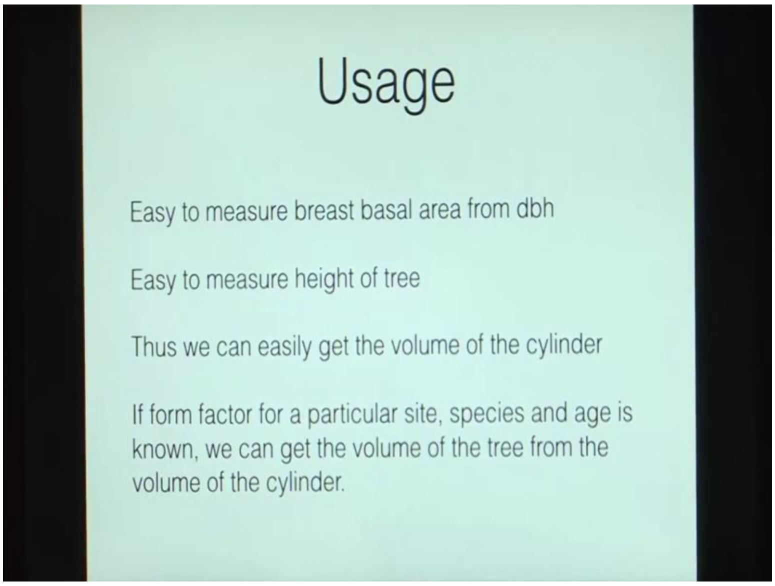

Well it is easy to measure the breast basal area from your dbh it is easy to measure the height of the tree. So, we can get the volume of the cylinder and if you know the form factor, then we can get to the volume of the tree itself.

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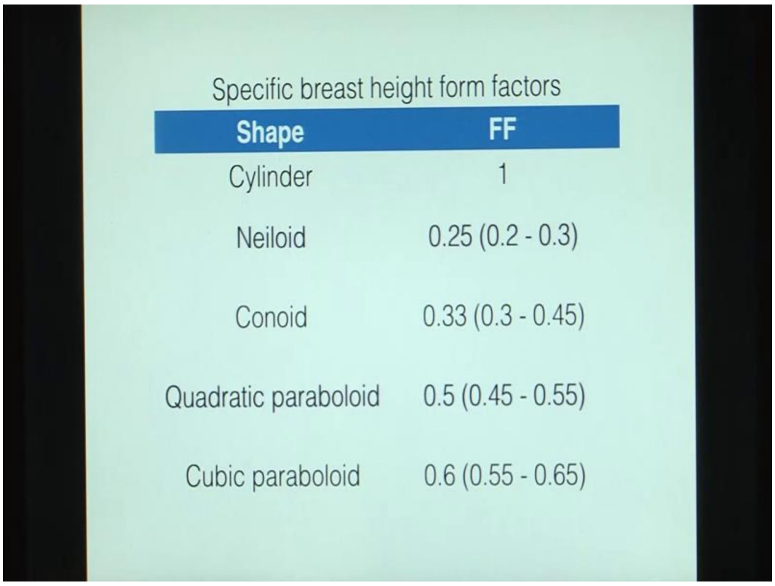

So, we also looked at specific breast height form factors next we defined.

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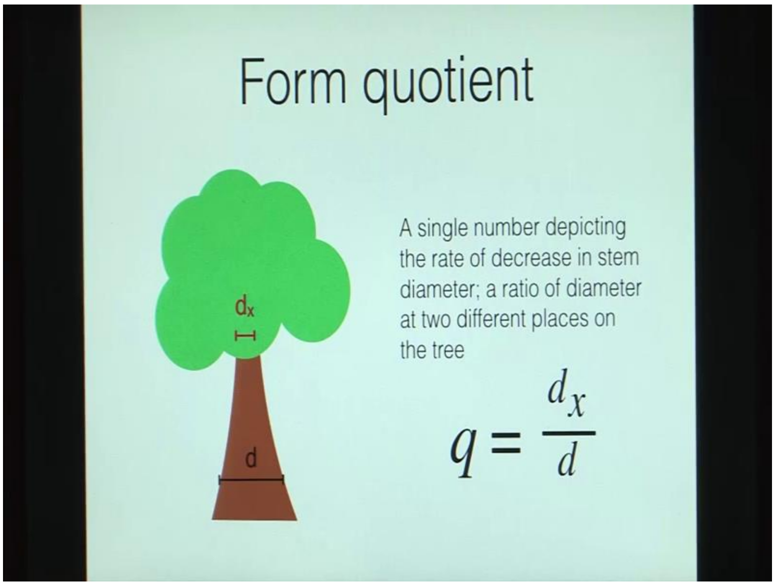

To a form quotient as a single number that depicts the rate of decrease in a stem diameter.

So, it is the ratio of the diameter at two different places on the tree. So, we defined false form.

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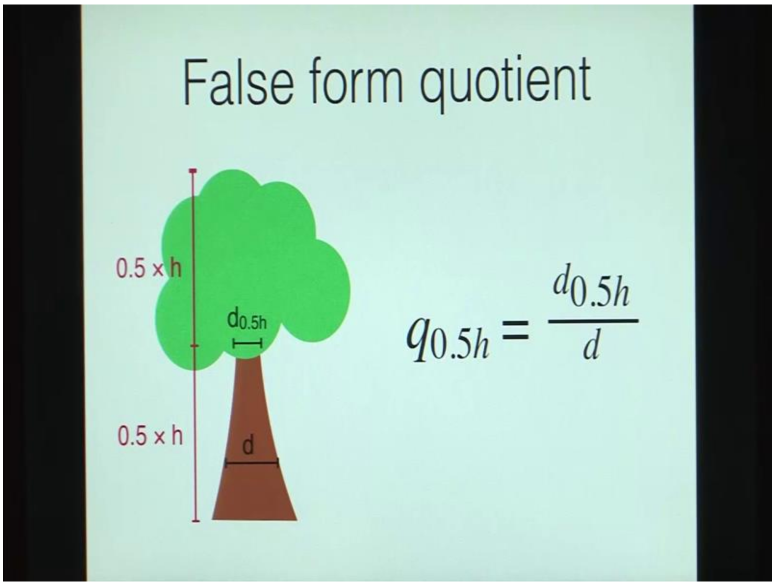

Quotient as your diameter at half the height we defined two form.

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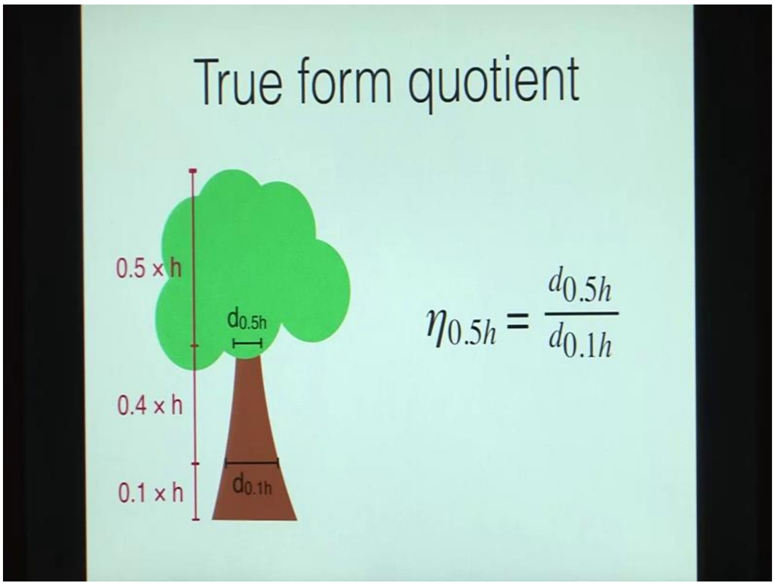

Quotient as the ratio of two diameters at two difference percentages we also looked at Mitscherlich form quotient and also Hohenadl's form quotient.

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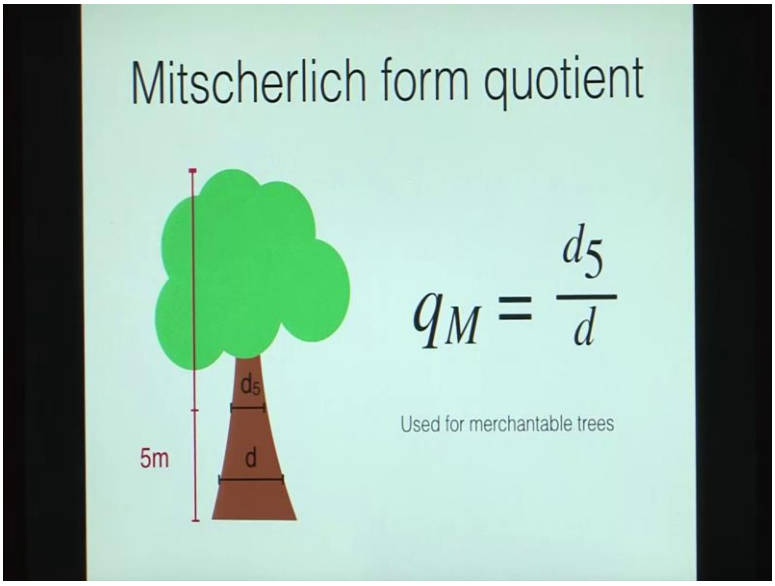

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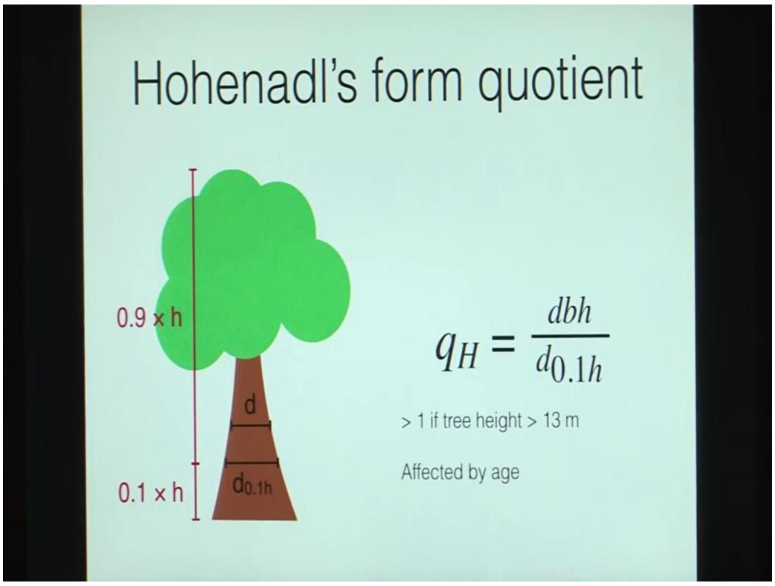

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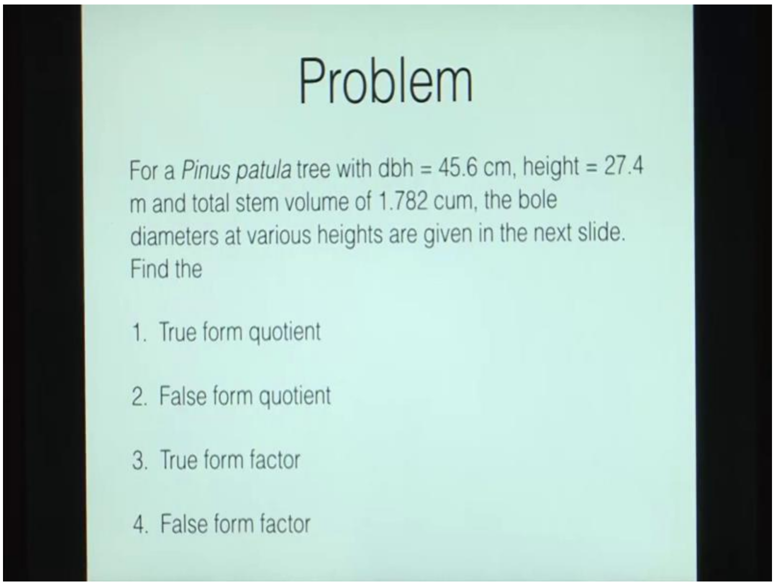

Then we looked at a problem statement in which we were given the dBh height, and the stem volume and the diameters at various heights and we were able to calculate the form quotients and the form factors.

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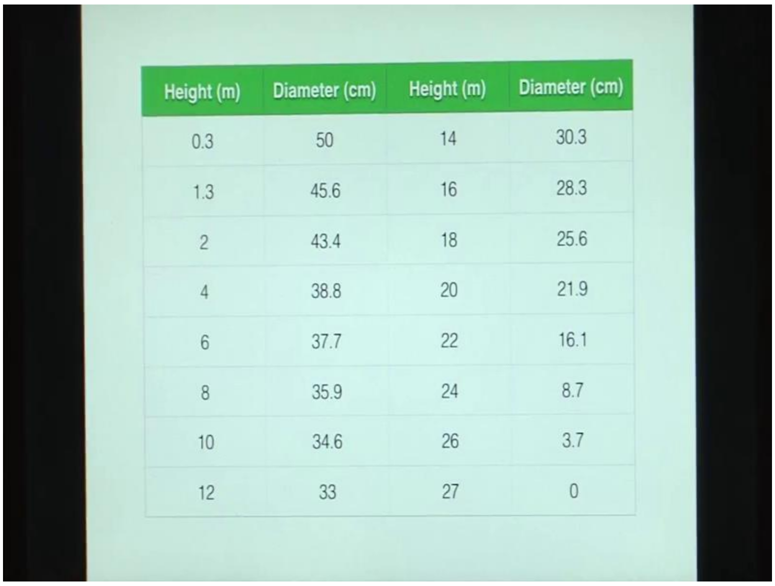

Height (m)	Diameter (cm)	Height (m)	Diameter (cm)
0.3	50	14	30.3
1.3	45.6	16	28.3
2	43.4	18	25.6
4	38.8	20	21.9
6	37.7	22	16.1
8	35.9	24	8.7
10	34.6	26	3.7
12	33	27	0

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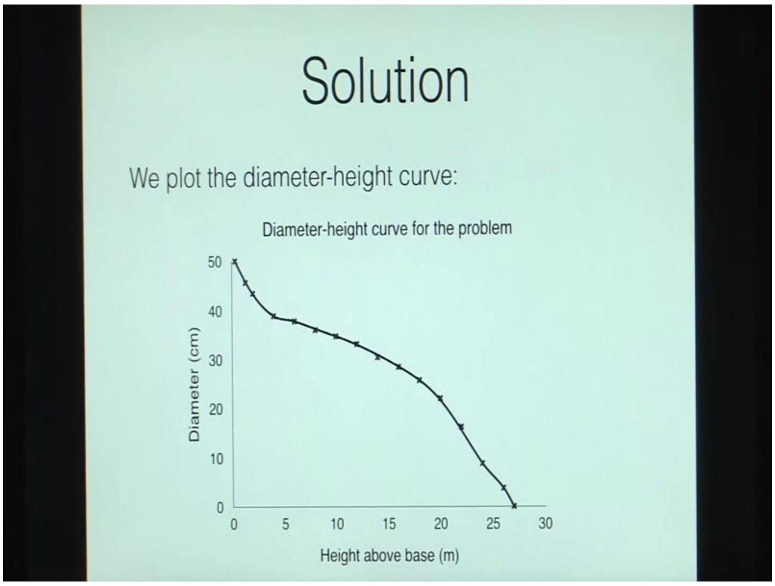

By plotting it, getting the presentative diameters at different height and then getting the form factors and the form quotients.

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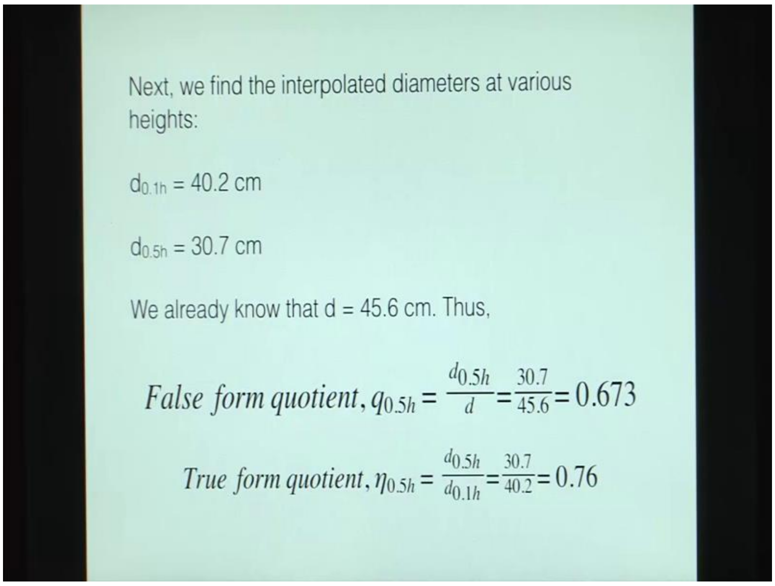

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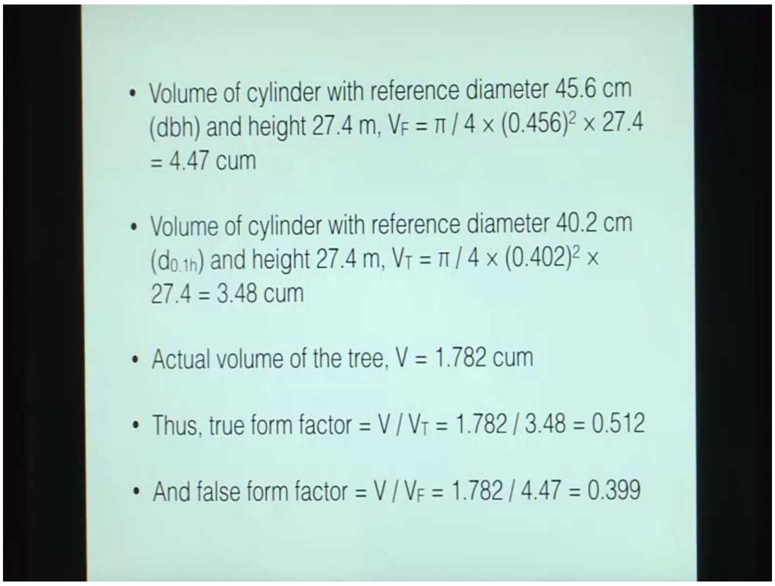

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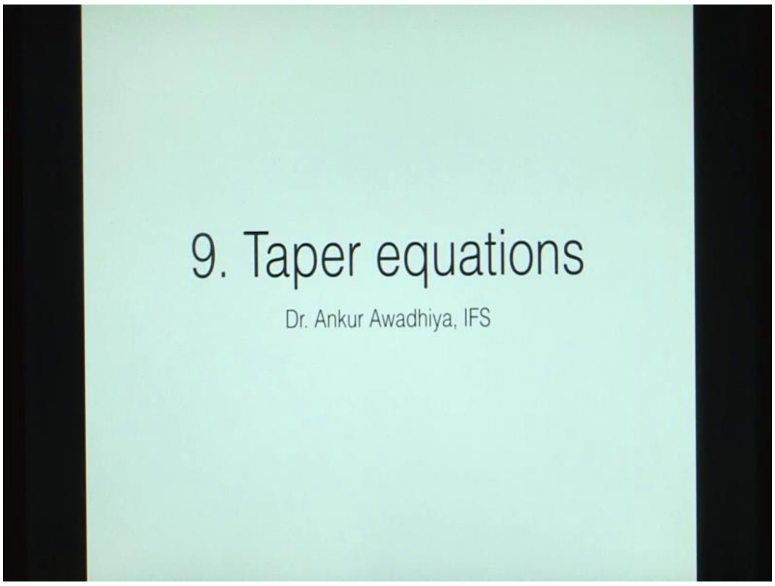

Next we looked at taper equations. So, taper is defined as the Change in stem diameter between 2 points, divided by the length of the stem between those 2 points.

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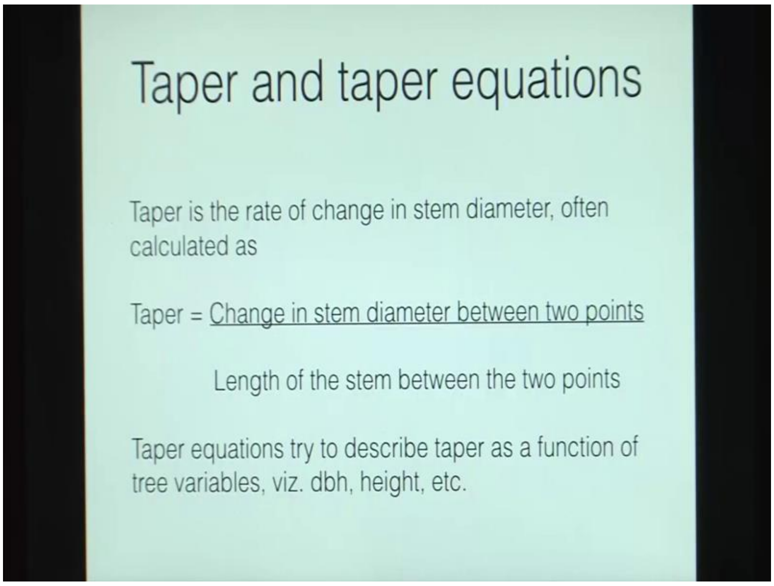

And we looked at these taper equations in which you are a diameter at different heights was given in terms of diameter at the reference height mostly the breast height.

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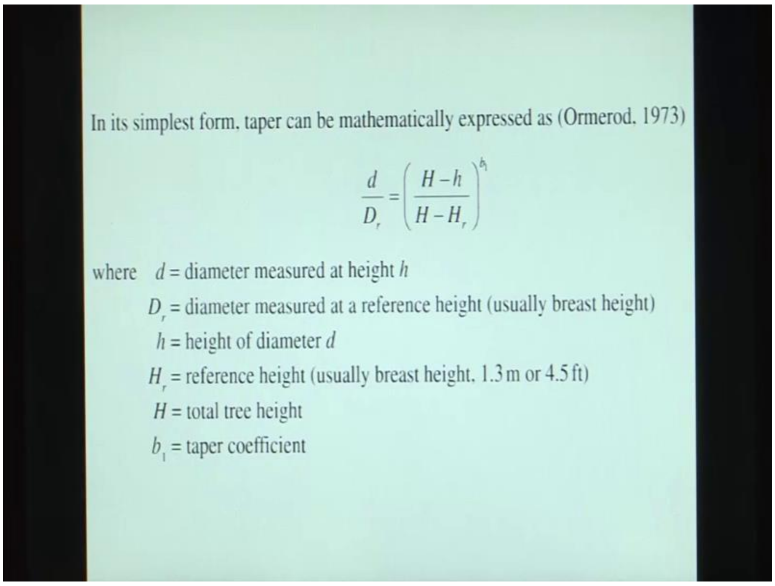

In the form of this equation in which we measured height and we took the height of the reference and the height of the tree.

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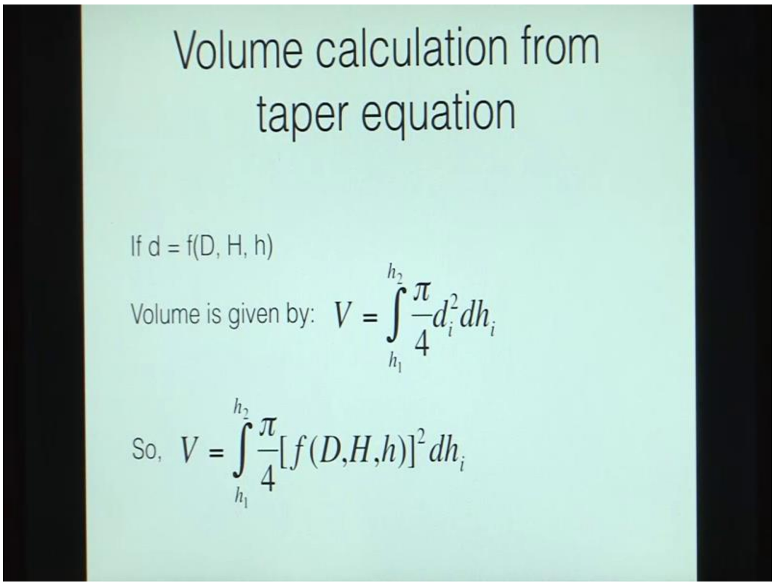

So, a taper equation is useful because you can calculate volume from the taper equation and it can be.

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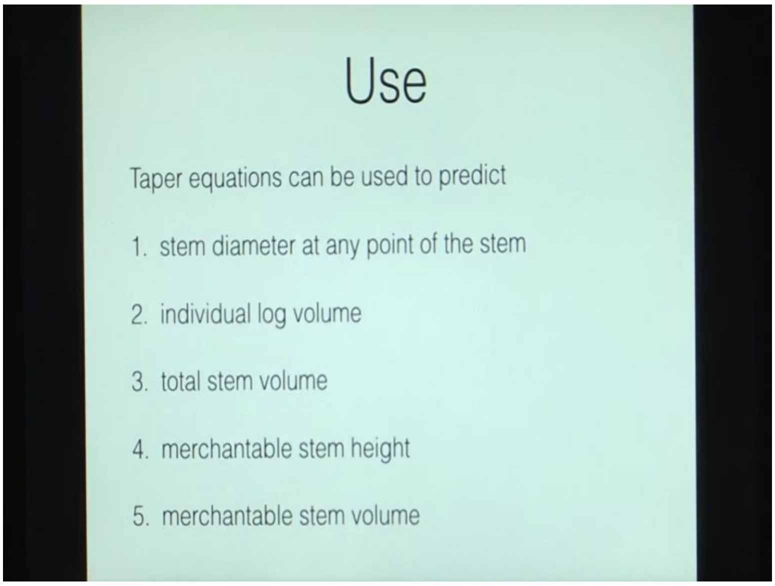

Used to predict a number of things for instance if your tree is decreasing in diameter as we go up. So, if we want to measure the length of your of the commercial timber we can get it from there, if you wanted to get the volume of commercial timber we can get it from there individual log volume stem volume merchantable stem height and so on can be found out using the taper equations.

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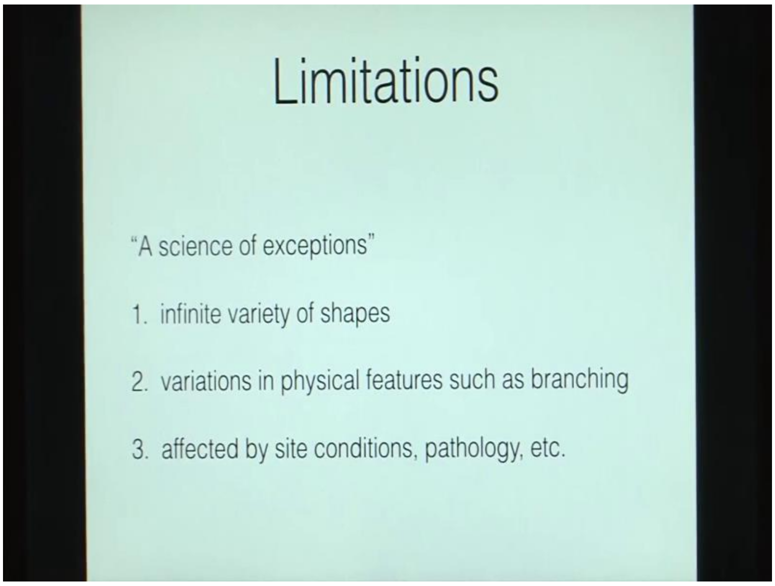

However it has some limitations because of the exceptions we also looked at.

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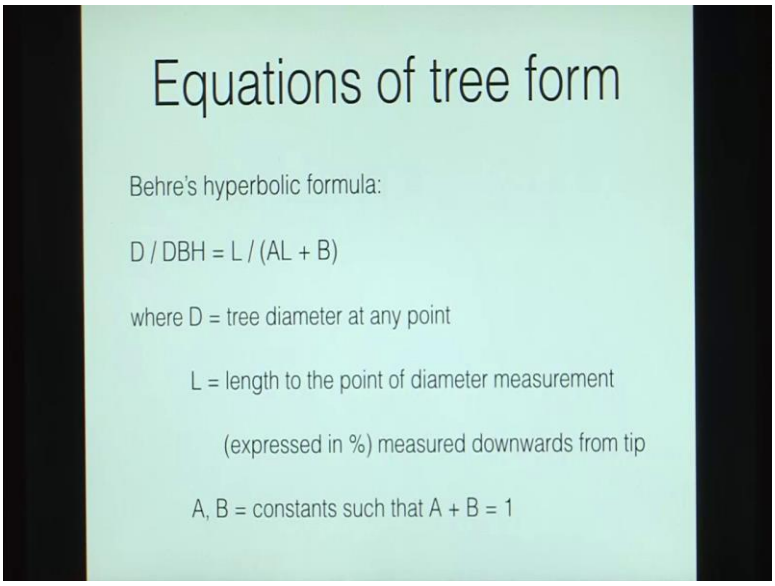

Equations of tree form in which we looked at two major equations one was Behre's hyperbolic formula and the second one was Hojer's formula.

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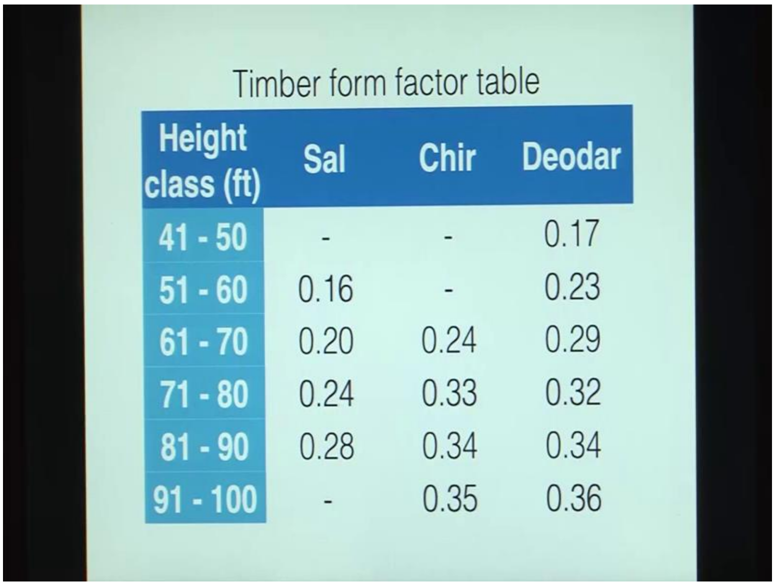

And we also looked at some form factor table and the taper tables.

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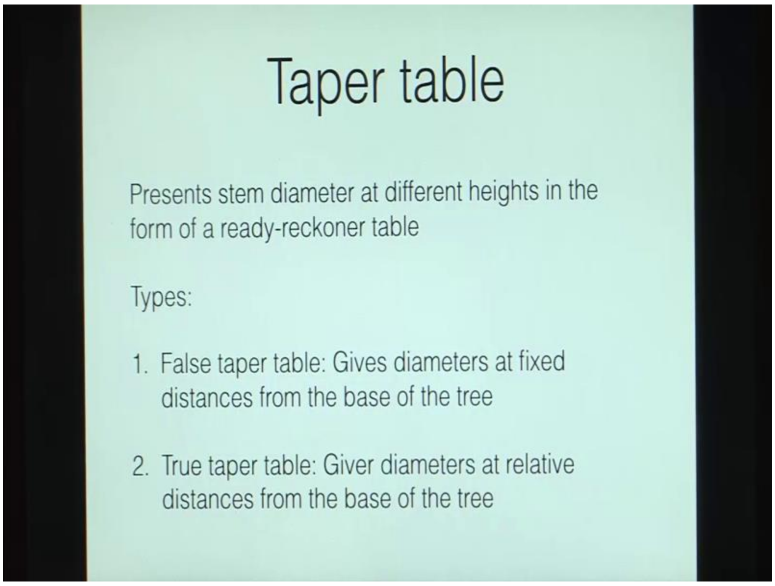

So, in the case of taper tables we have two kinds of taper tables falls taper tables and the two taper tables.

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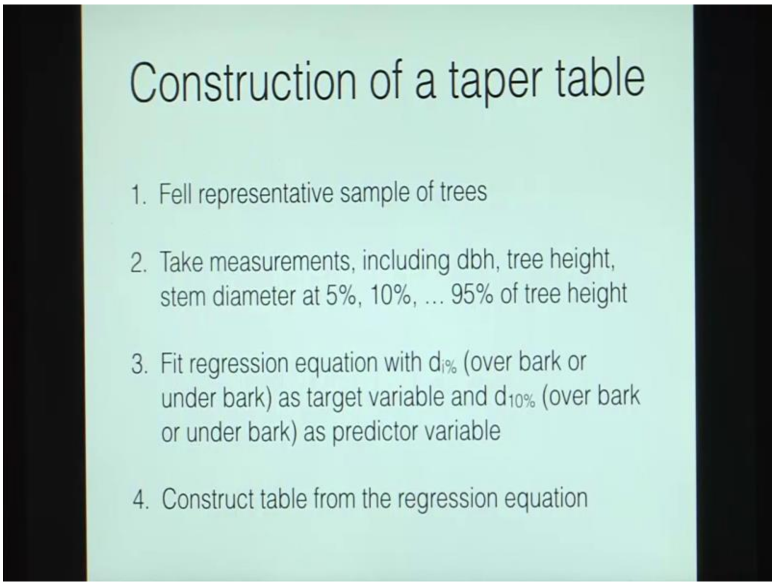

We also saw how a taper table is constructed and they are also of two other way another way of classifying the taper tables, is in these two types ordinary taper tables and form class taper tables.

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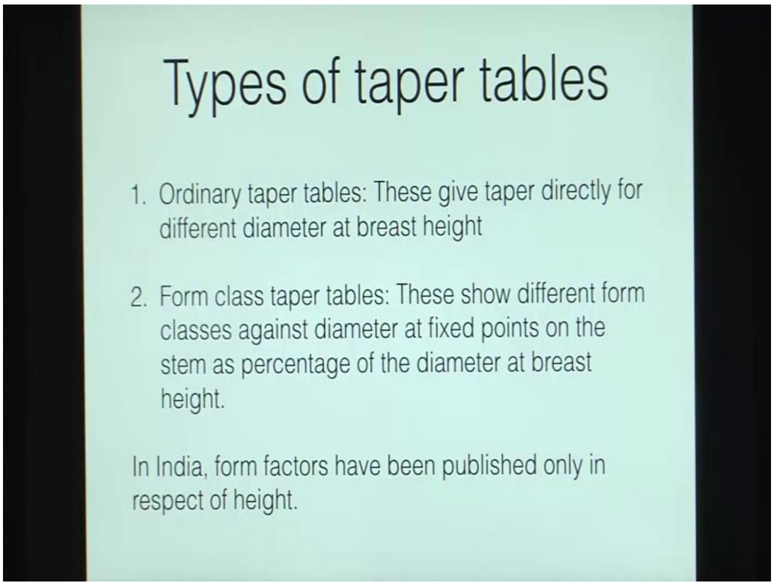

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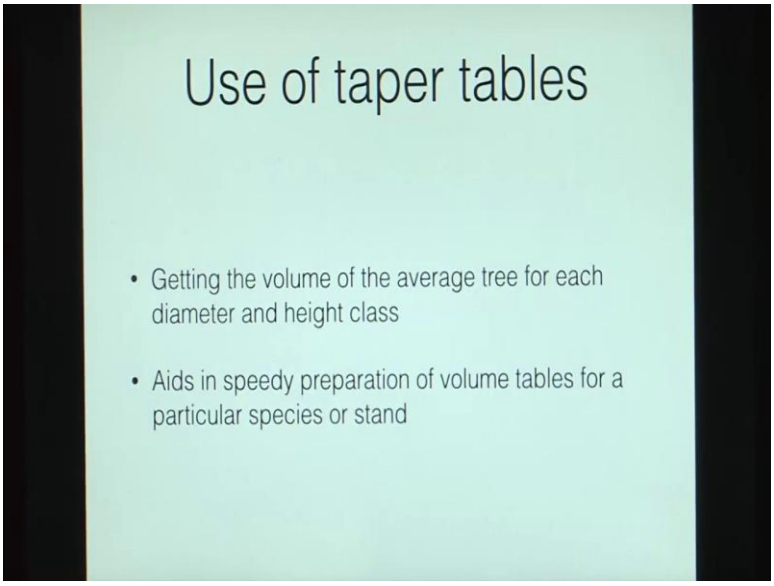

And then it is the use of taper tables is to get the volume of an average tree from each diameter and height class, and thus two to prepare a volume table. So, volume table we also looked into greater detail later in the course.

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At making the cuts.

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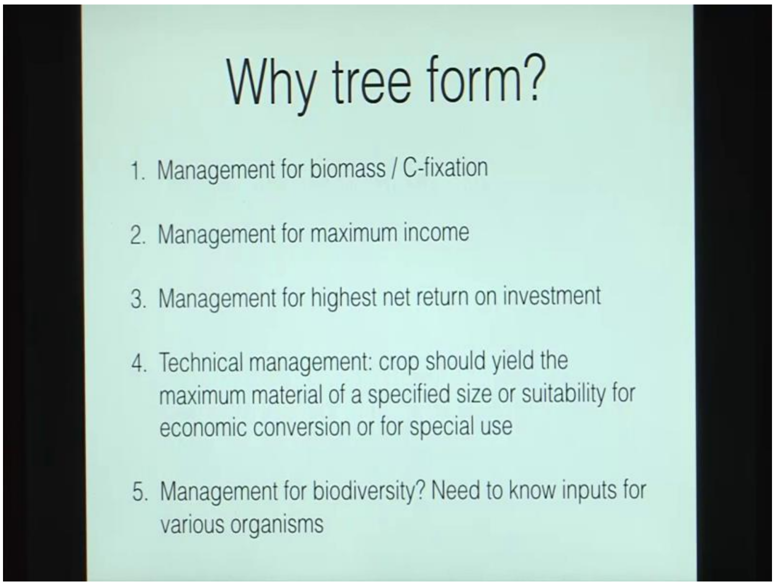

So, why do we go for a tree form what is the perfect tree form.

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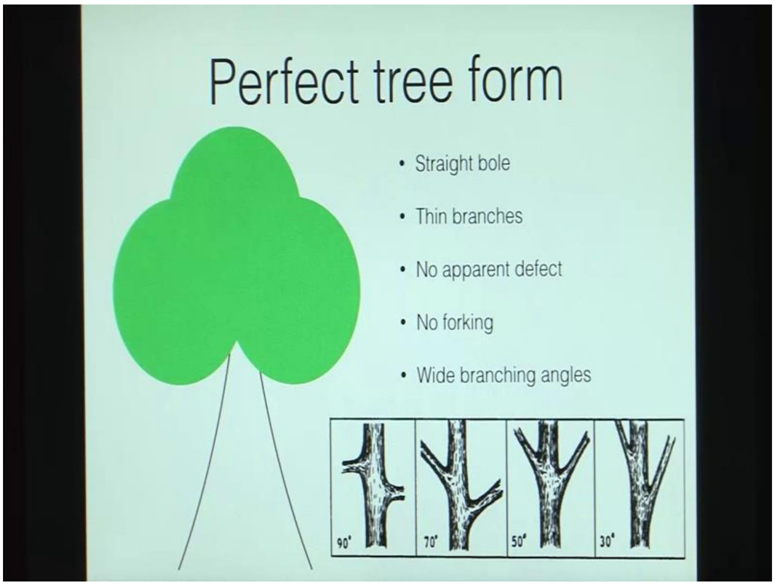

So, a perfect tree form is a tree in which your tree has a straight bole thin branches no apparent defect no forking and wide branching angles. So, that maximum amount of the volume of this tree is usable we also looked at acceptable tree forms and unacceptable tree forms.

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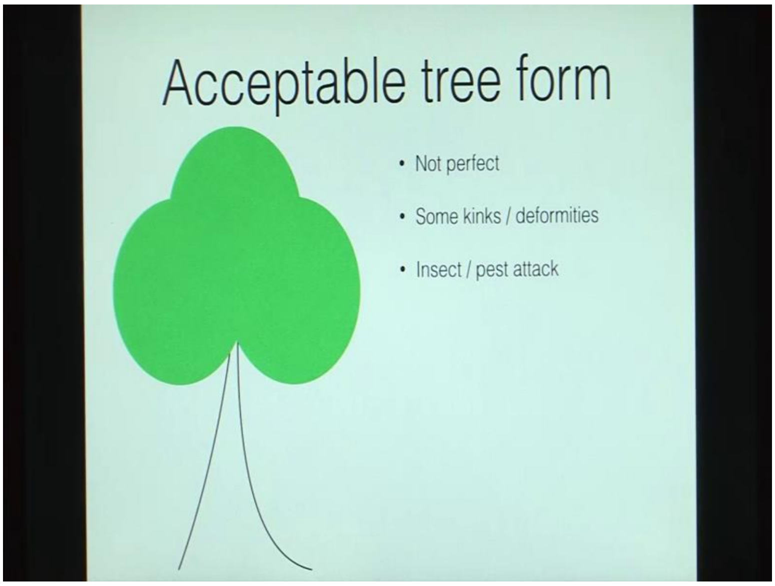

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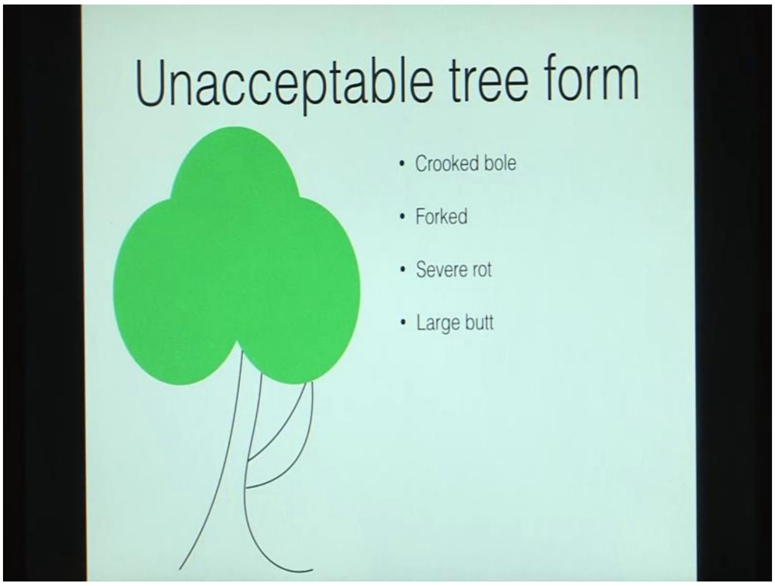

And then we looked at this problem in which we learnt how a tree is cut for measurement purposes.

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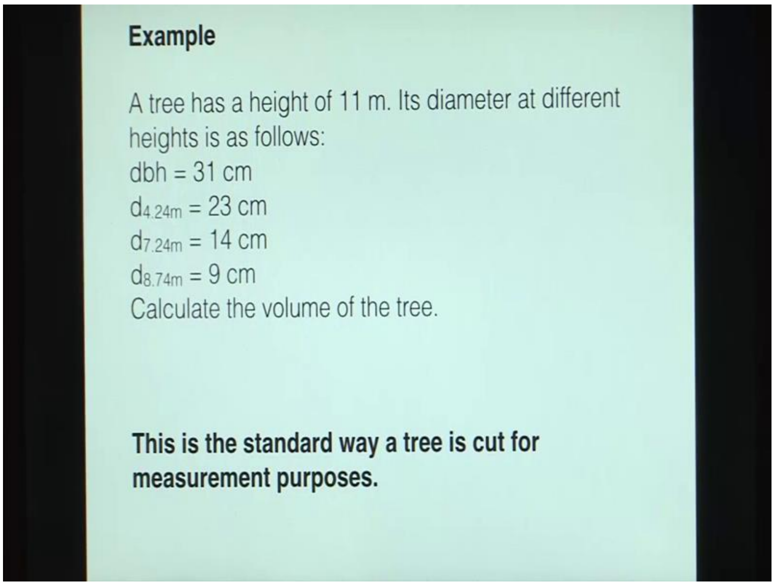

So, we measured diameters at these reference locations we divided.

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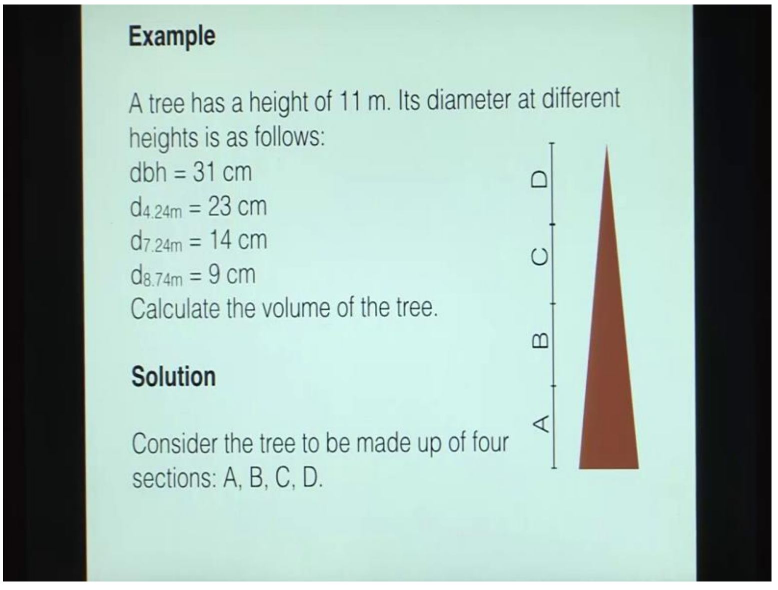

Into sections in which your first section A is twice the breast height and all the other sections are 3 meters and your top section is a cone. So, we measure these diameters and then we can calculate the volume of the tree by this method.

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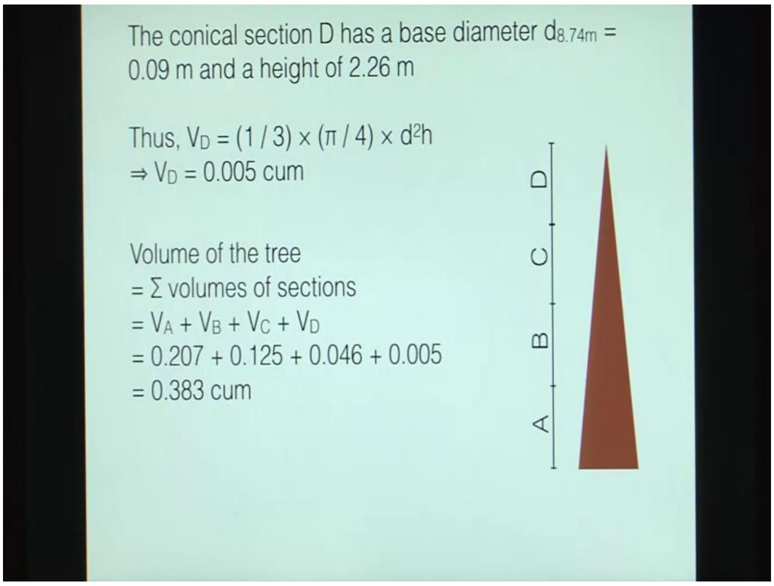

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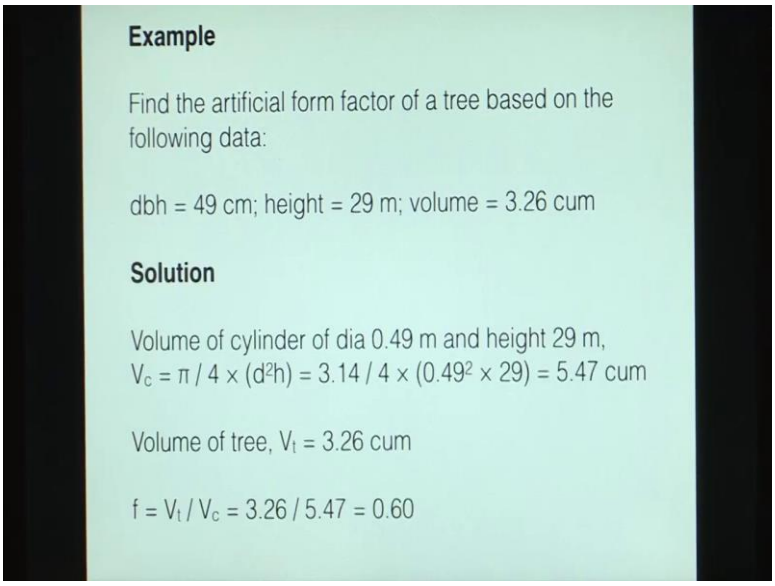

We also looked at the calculation of artificial form factors and we also looked at the Cross section of a tree in the next lecture.

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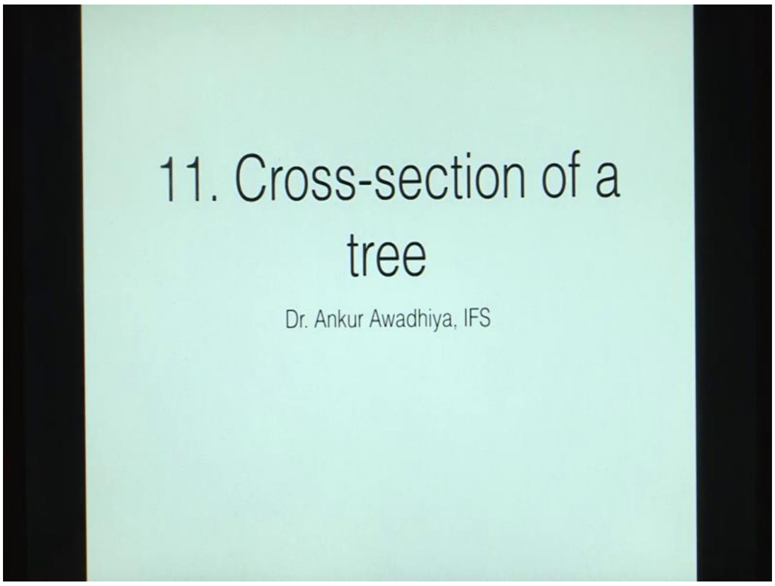

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So in the case of the cross section of a tree we saw that there is a difference of colors in this wood.

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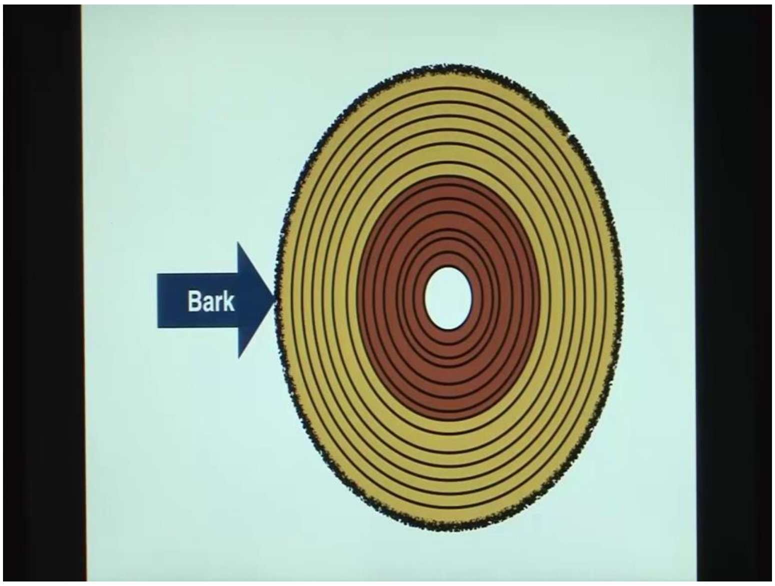

So, in this case we have defined a number of portions. So, we bark as the outer most portion followed by. So, this is what bark is.

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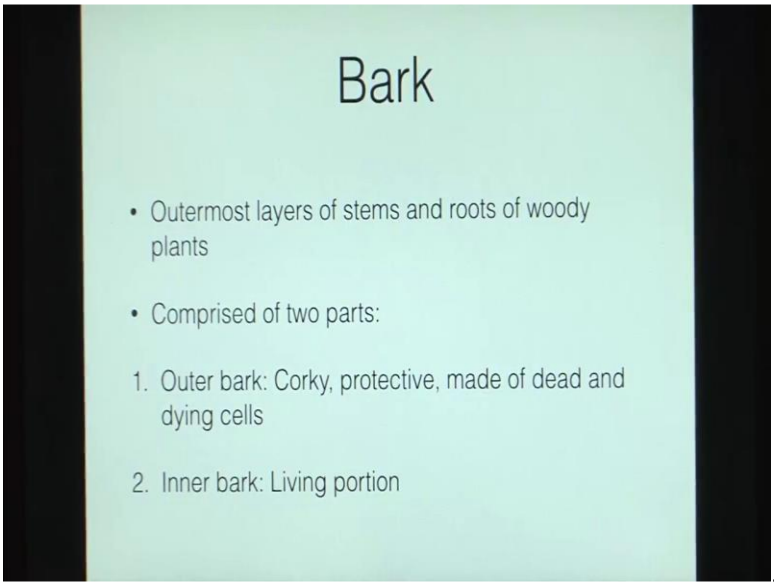

So, it is comprised of outer bark and inner bark it is followed by Sapwood.

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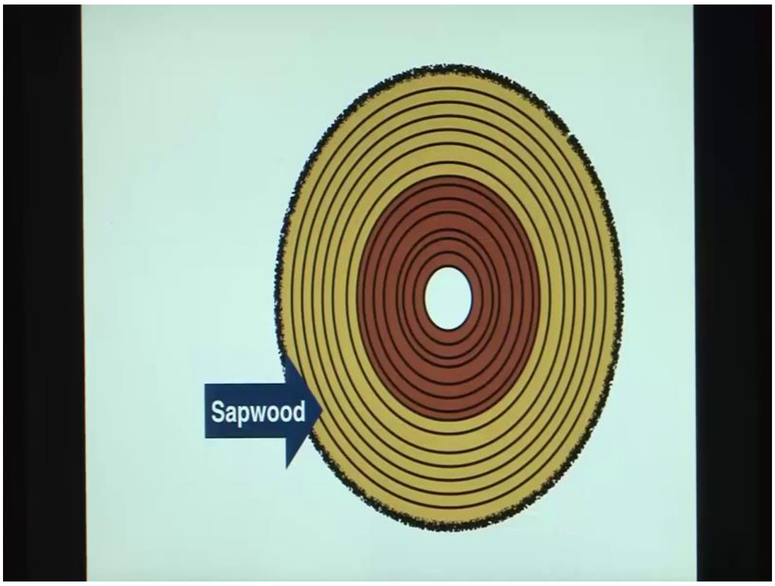

Sapwood is the light colored portion of your stem. So, in this case this is the sapwood this is the heart wood which is the darker color portion.

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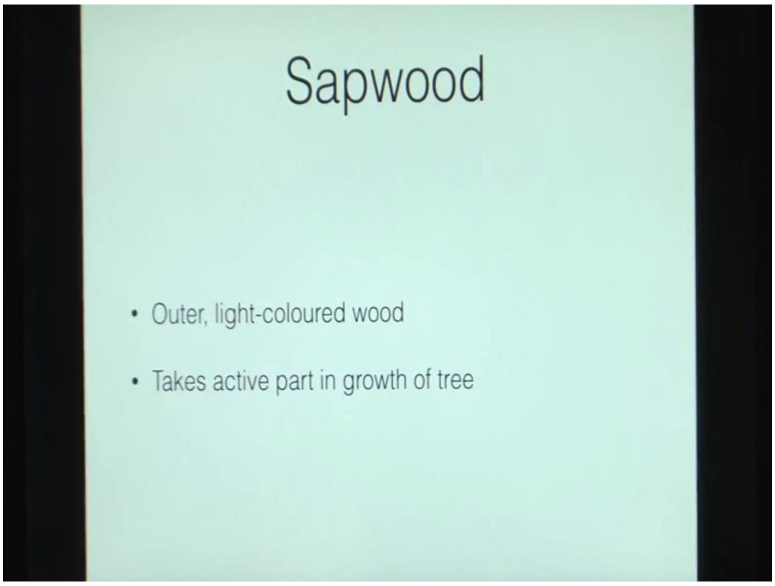

So, sapwood takes active part in the growth of the tree whereas, heartwood that is this darker portion it is a physiologically not active in the growth of the tree we also have pith.

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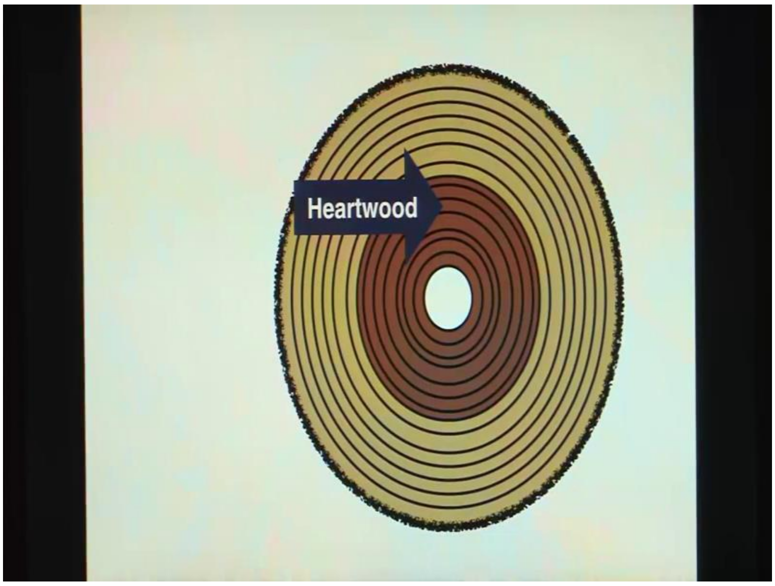

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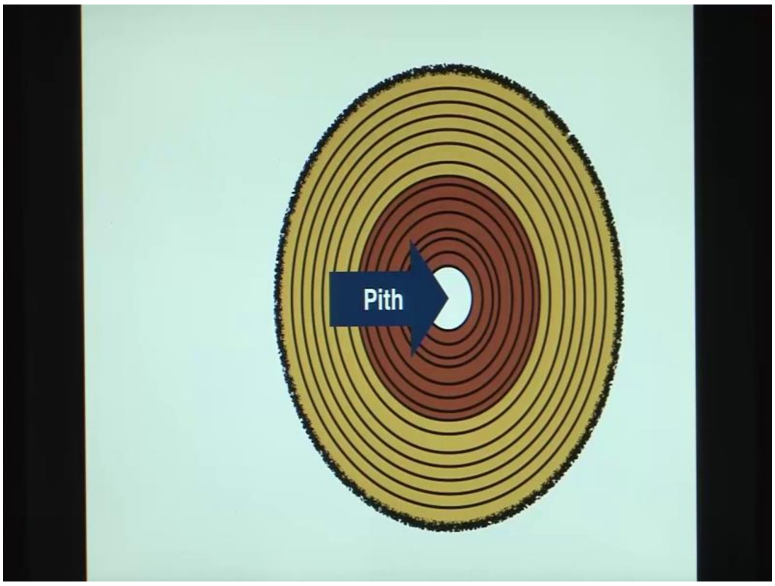

Which is the soft inner most core found at the center of the tree, and which has different shapes which might be oval, round irregular or squarish shape we also looked at growth rings, growth rings.

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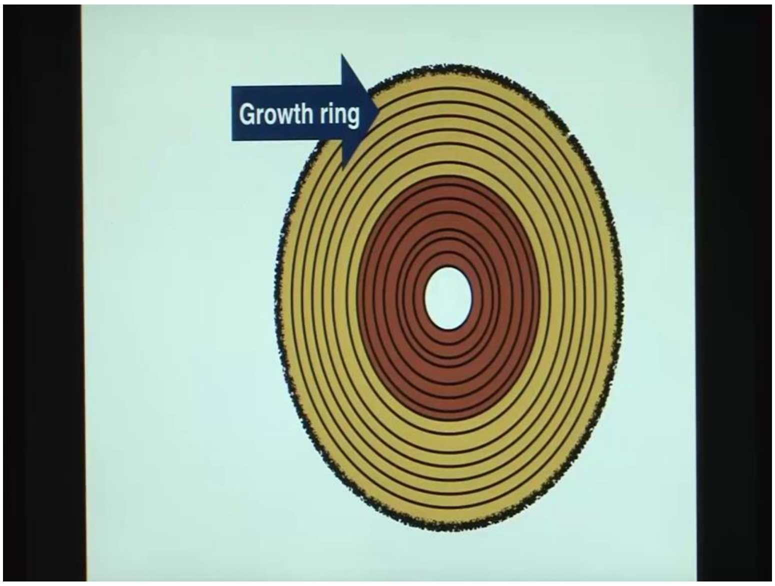

So, in this case also you can see these rings that are formed. So, these are the growth rings growth rings are formed annually.

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And there are also known as annual rings and they are formed because of change in growth speed during different seasons of the year, and these are used in dendrochronology which is the scientific study of dating tree rings. So, this is your tree.

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Now, when you have you have logs then you take measurements outside.

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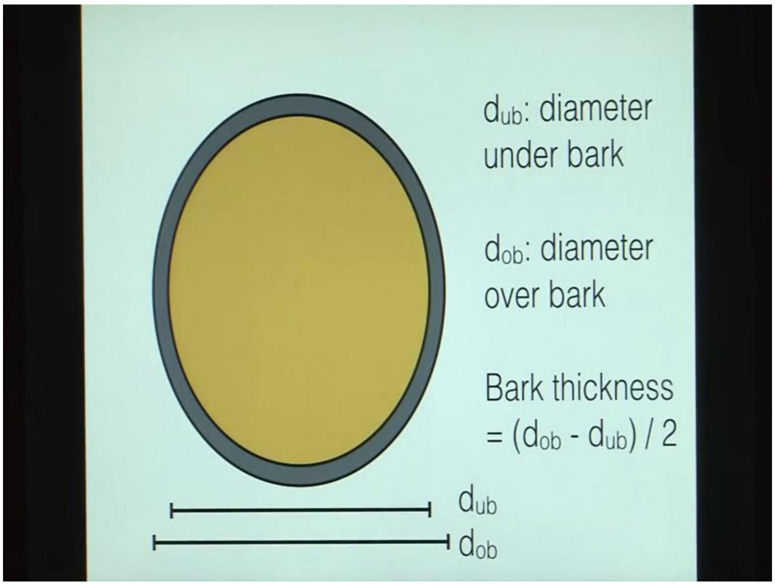

So, you take measurements of diameter over bark and the diameter under bark and. So, you can also get the bark thickness.

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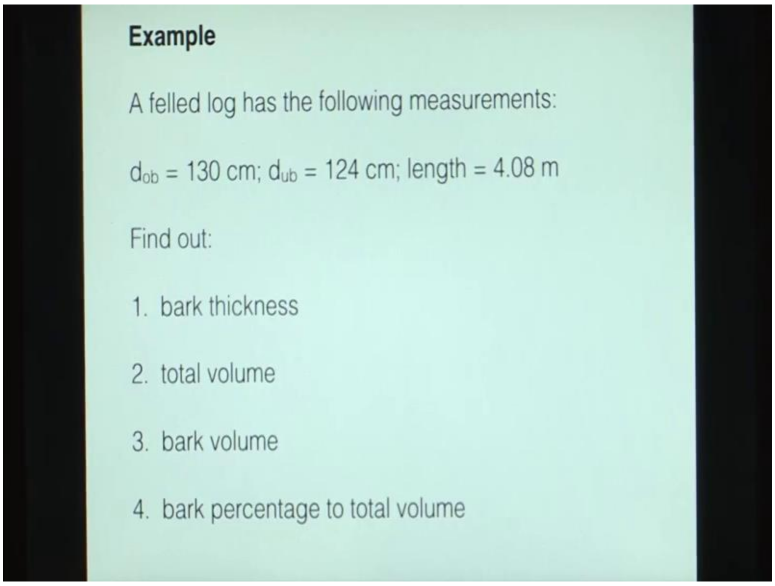

Then we looked at this problem in which we were given the over bark diameter the under bark diameter and the length, and we were able to calculate the bark thickness the total volume the bark volume and the bark percentage to total volume.

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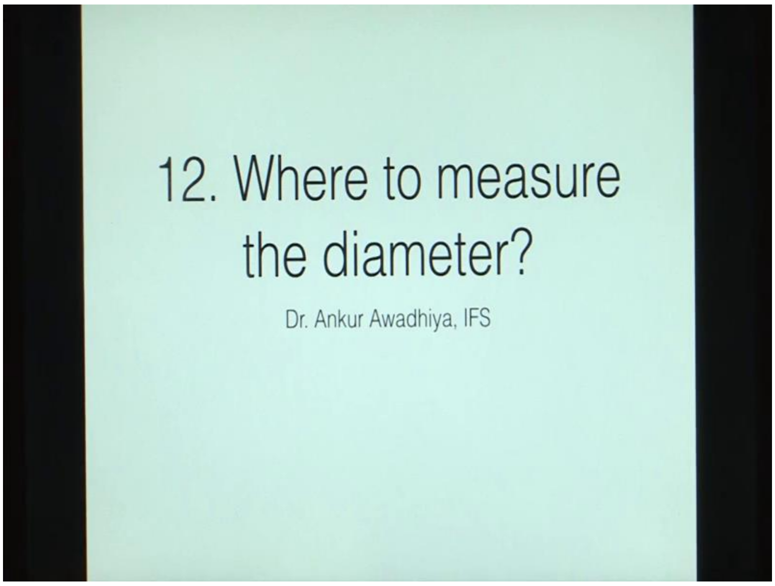

Next in a lecture 12 we looked at where to measure the diameters, because your trees are tapered.

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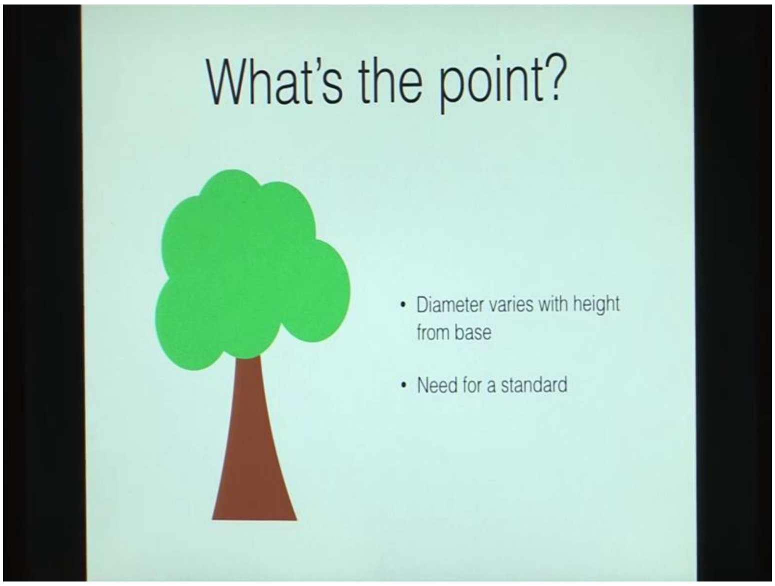

So, the diameter is different at different heights. So, we need to define a height.

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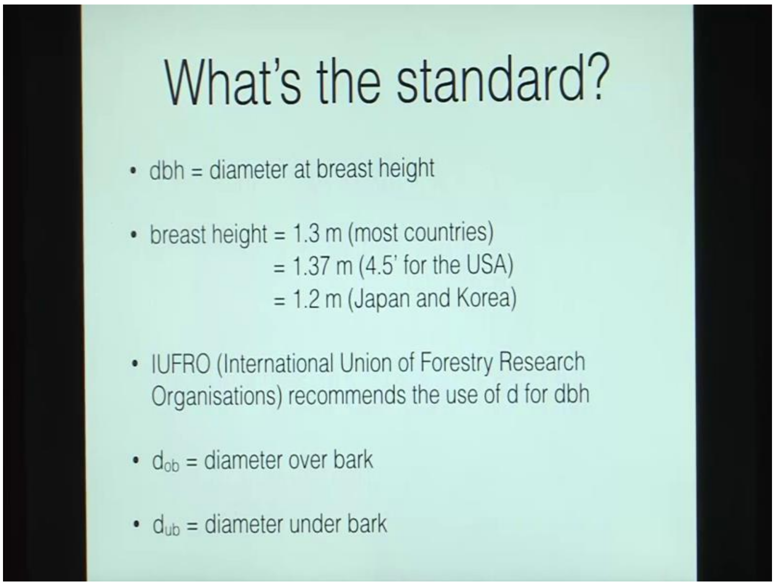

And that height is defined as these values in different countries, in our country we have 1.37 meters as the breast height and the diameter is traditionally measured at the breast height called as dbh or d which is the diameter at breast height.

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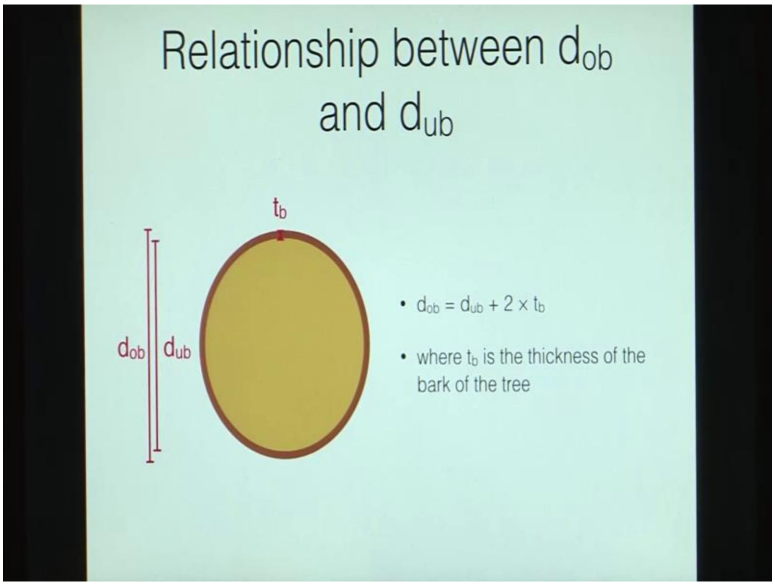

Then we looked at there a relationship between the over bark diameter the under bark diameter and the bark thickness, we looked at these formal rules.

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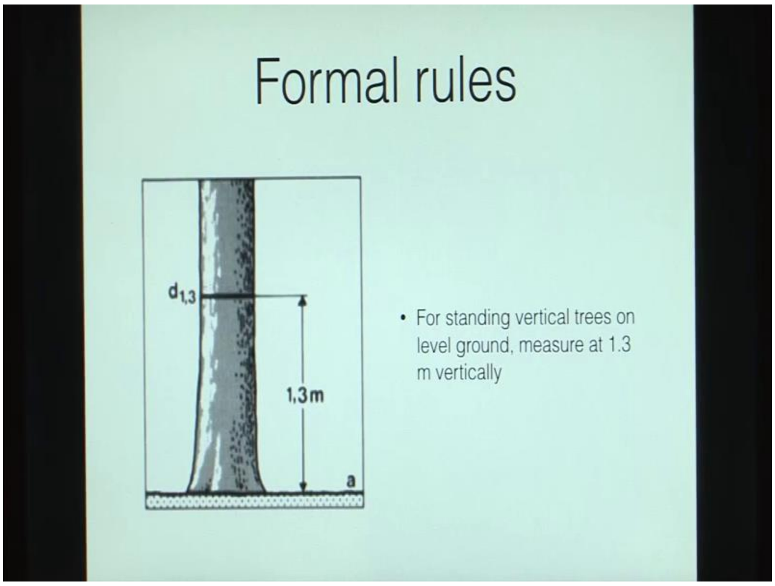

So, the height is measured at the breast height.

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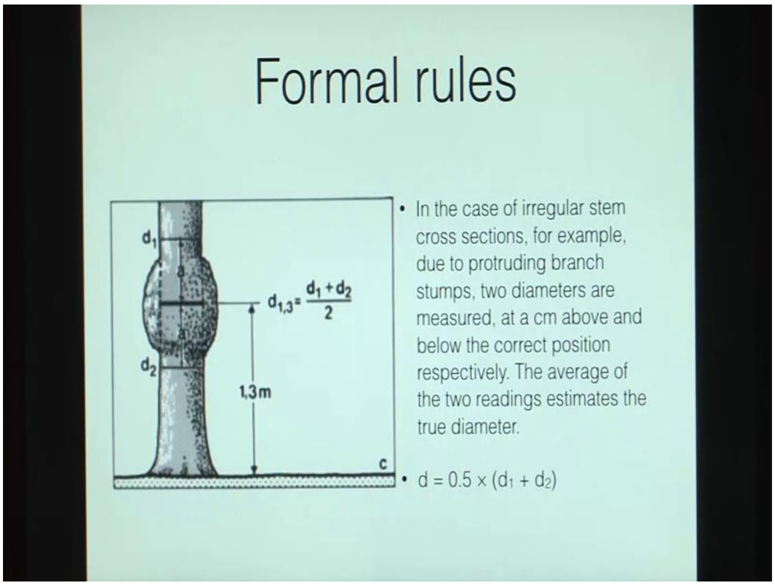

If your tree is on sloppy ground then the upslope portion is from where you are going to measure the this 1.37 meters, if you have a bulge then you take a reading above the bulge and a reading below the bulge and then take the average of both of those readings if your tree is sloping.

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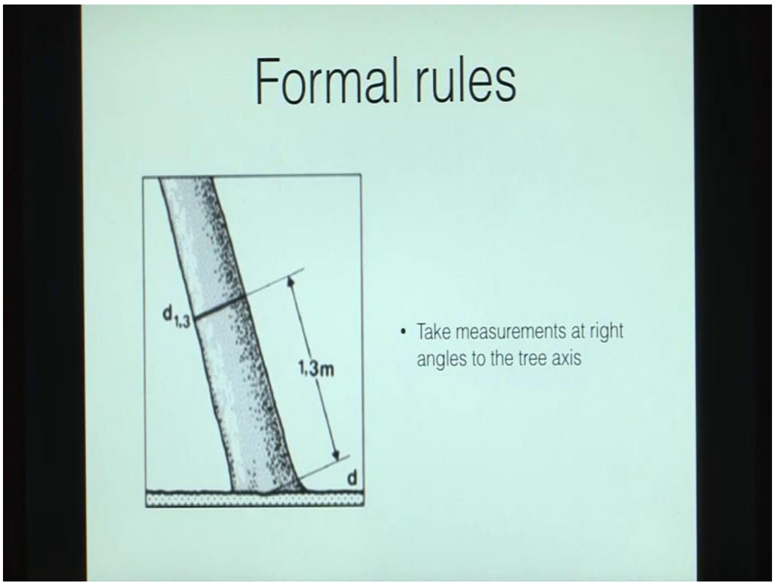

So, in that case you take measurements at right angles to the tree axis as in the case of this tree.

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If your tree has a buttress then you take a measurement above the swelling as in the case of this tree.

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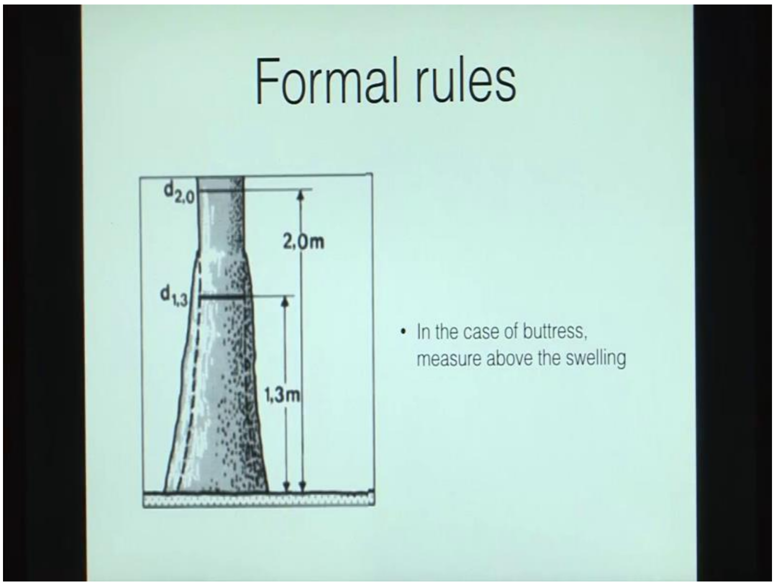

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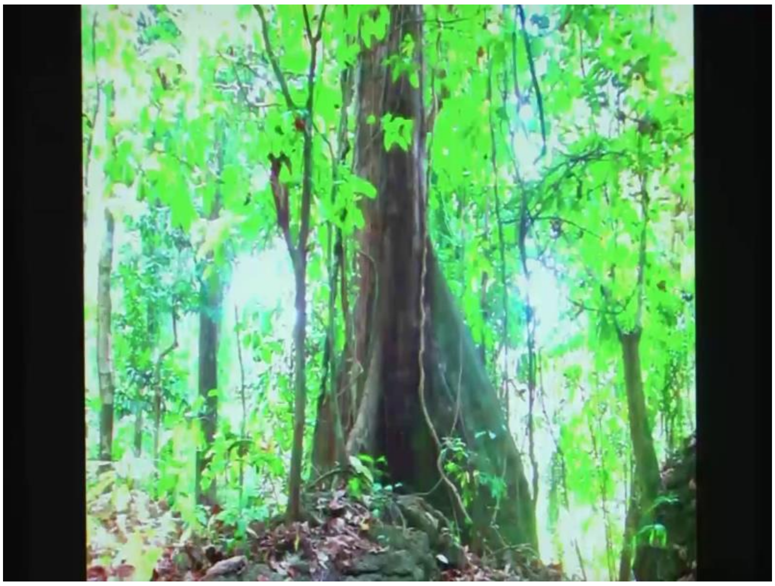

This tree now if your tree is having forking.

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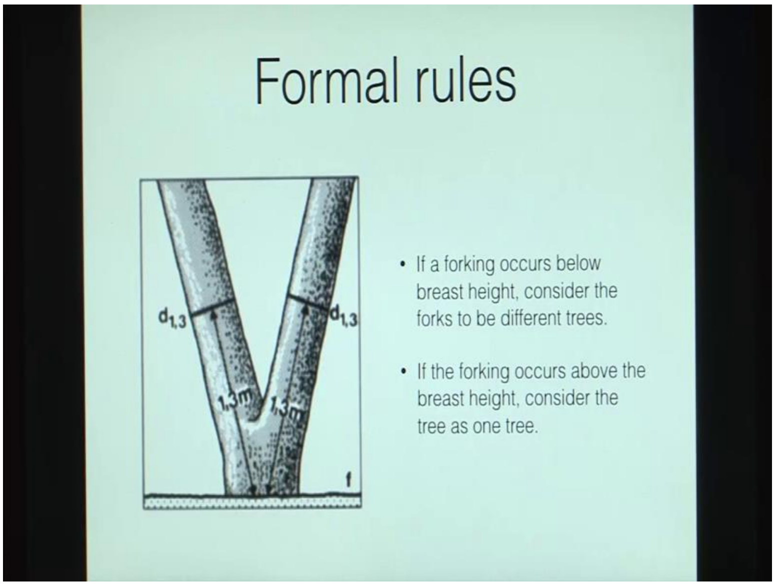

Then if the fork is if the forking starts a before a height of breast height then you take it as two trees or else you will take it as one tree.

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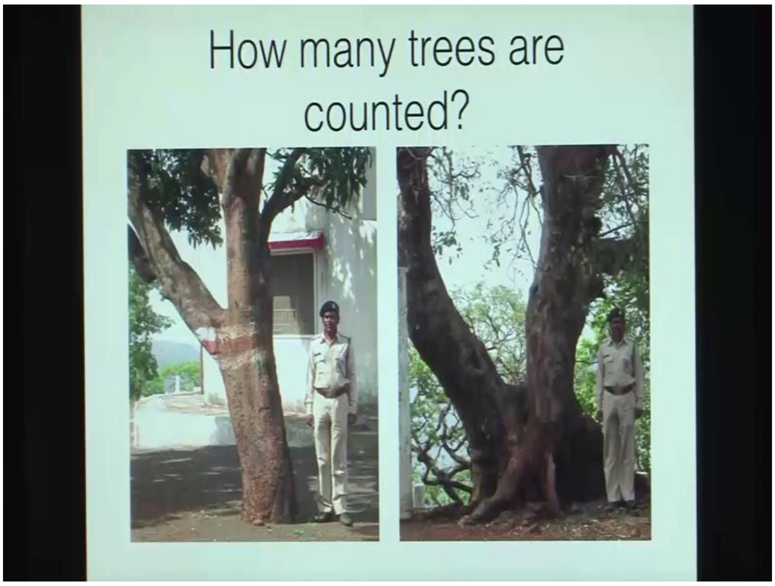

So, in this case in the left side figure it is one tree whereas, on the right side figure it is two trees.

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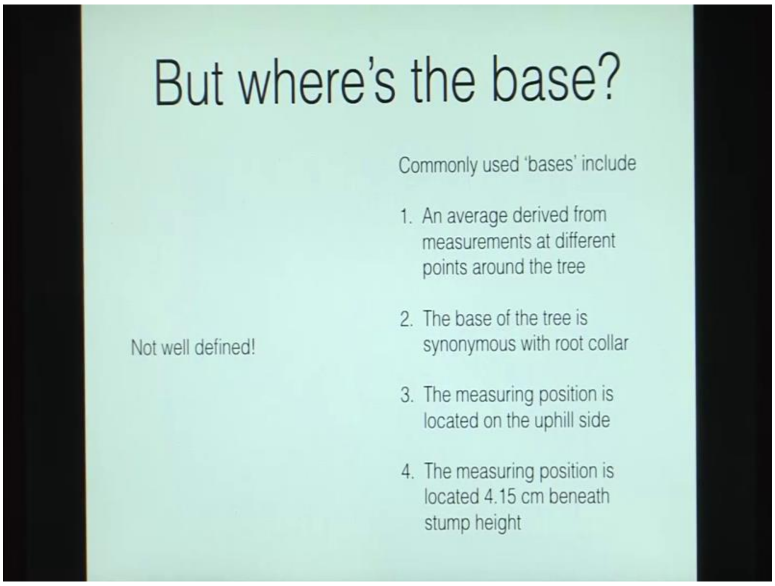

Now, bases not very well defined.

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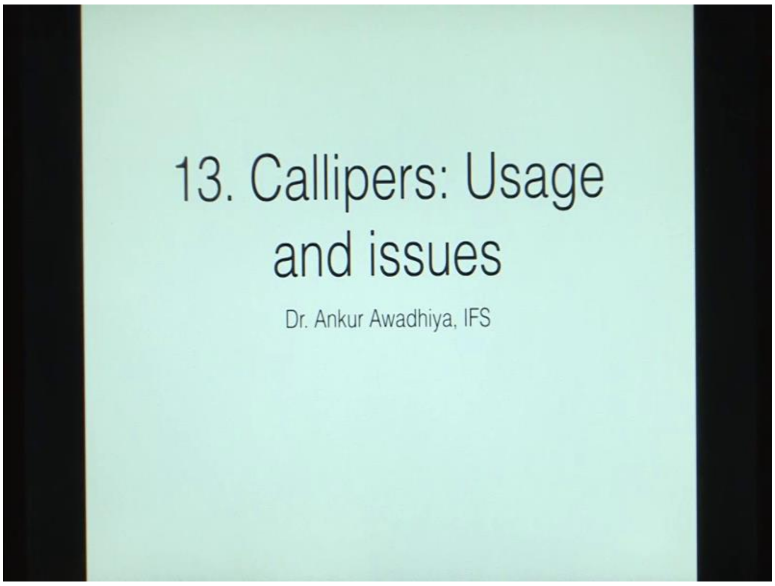

Now in the next class we looked at calibers their usage and issues.

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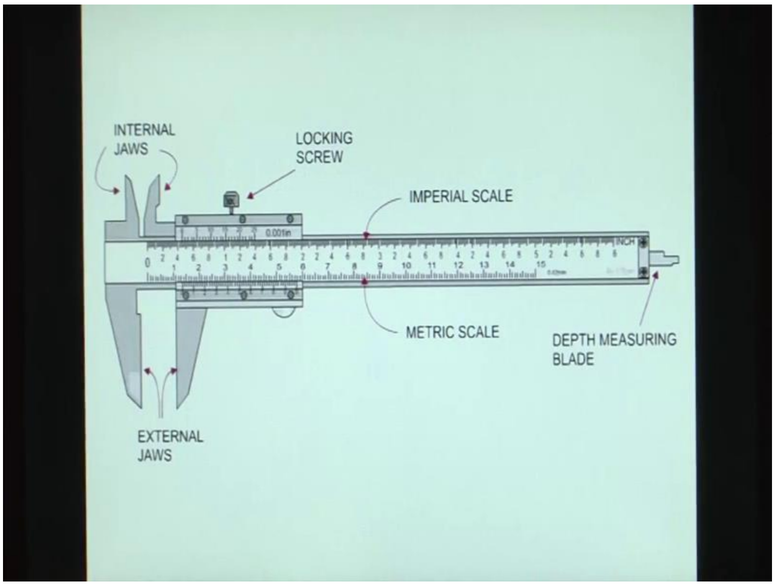

So, a caliber is very similar to a Vernier caliber. So, this is how it looks.

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It is made out of either wood or made out of aluminum, it has two jaws one is called a fixed jaw one is called a moving jaw and the moving jaw can be tightened by a screw.

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And it is it can be used to measure the diameter of the tree at the breast height and in some cases, your when the cross section is elliptical or even irregular.

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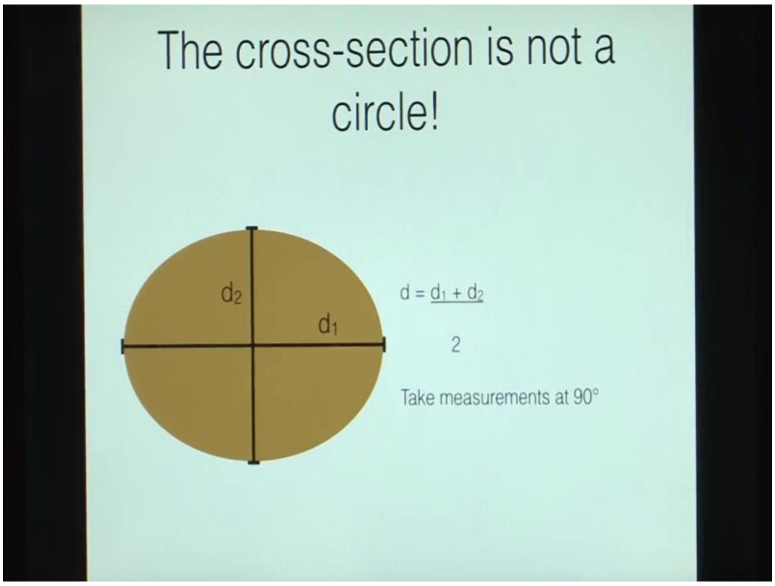

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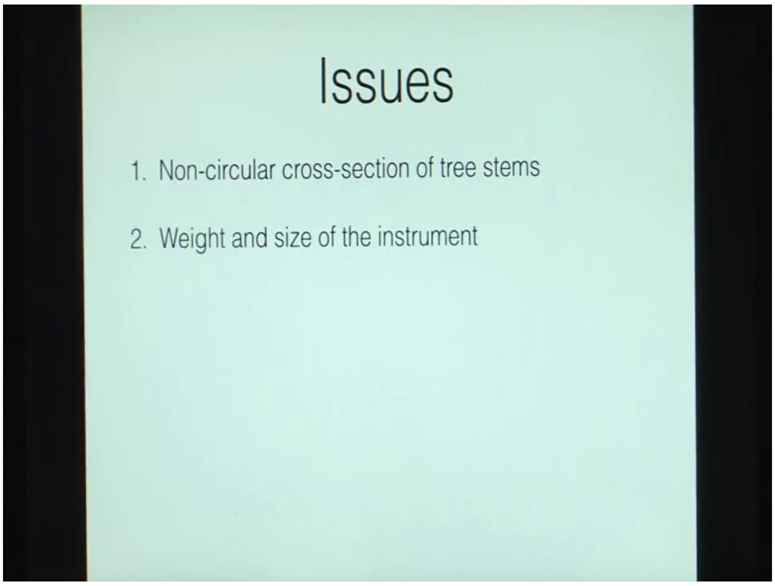

Then it is difficult to take readings with this, the instrument is bulky.

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Then it is, so this is how you carry it in a forest and you can see that the size of the instrument is roughly equal to the height of a person then in some cases you might have 0 error on your device, so that needs to be corrected every time in some cases you might have a plane the in your instruments.

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So, in which case both the jaws are not parallel to each other then we looked at some advantageous and some disadvantages of the calibers.

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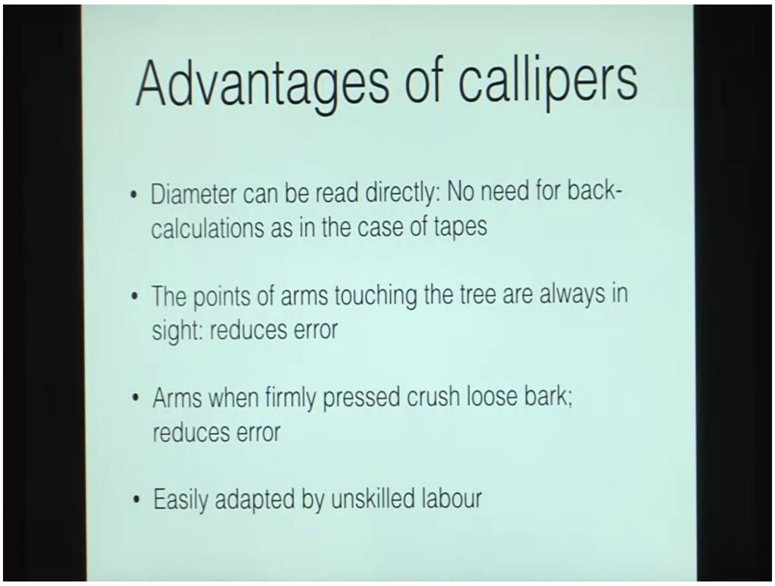

So, in the case of calibers the diameter can be red directly there is no need for back calculations. So, for instance if you take the girth readings from a tape then for finding out your diameter you need to use the equation girth is equal to pi times d. So, when you divide it by 3 0.14 you will get the diameter in the case of calipers you can get it directly then the points of arms that are touching the tree are always in sites. So, that reduces error they also crush loose bark and we are more interested in the diameter under bark, it is easily adapted by unskilled labors. So, you can directly use it to get the diameter classes and not a directly diameters.

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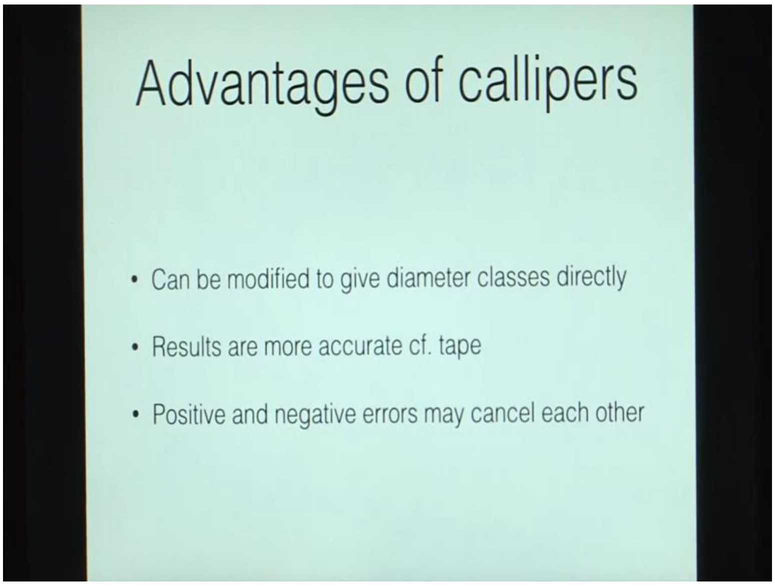

By painting your scale in different colors it can be modified to give diameter classes directly the results are more accurate as compared to tape and positive and negative errors because they are both they are in the device. So, they might cancel each other, but also there are some disadvantages.

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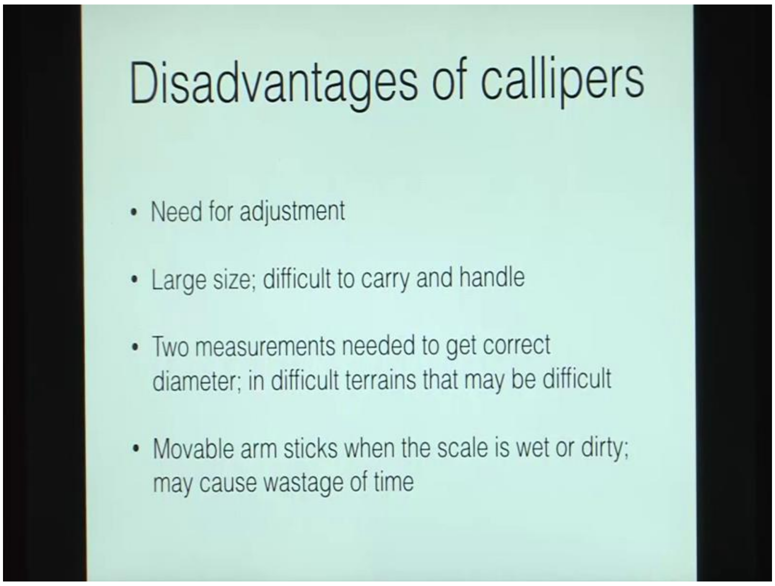

There is a constant need for adjustment the size is large it is difficult to carry its bulky ,then you need two measurements whereas, in the case of a tape you require only one measurement, and then the movable arm because it is a mechanical device. So, if the movable arm sticks when the scale is wet or dry. So, wet or dirty. So, in that case it might cause wastage of time.

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Then in the next class we looked at tapes.

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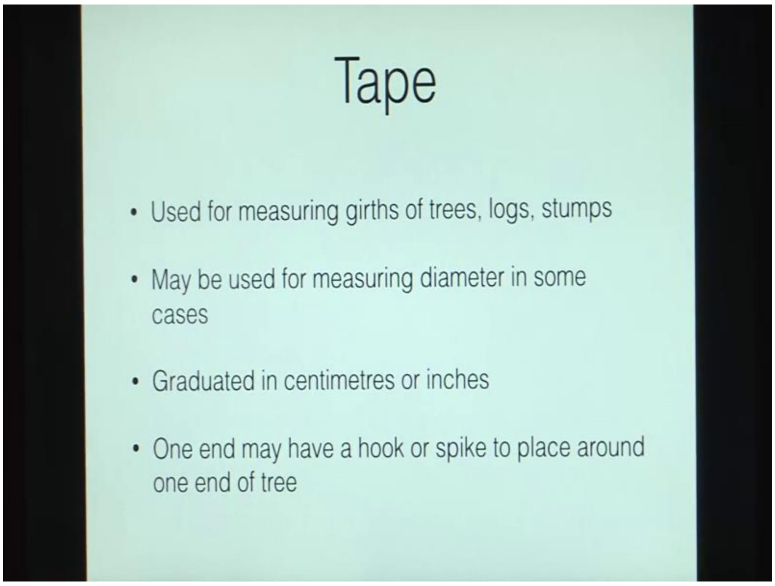

So, tapes are used to mostly in the measurement of girths and you can also measure the diameters of the ends in some cases. So, you can use an inch tape or a centimeter tape, and they might also have a hook or spike at one end.

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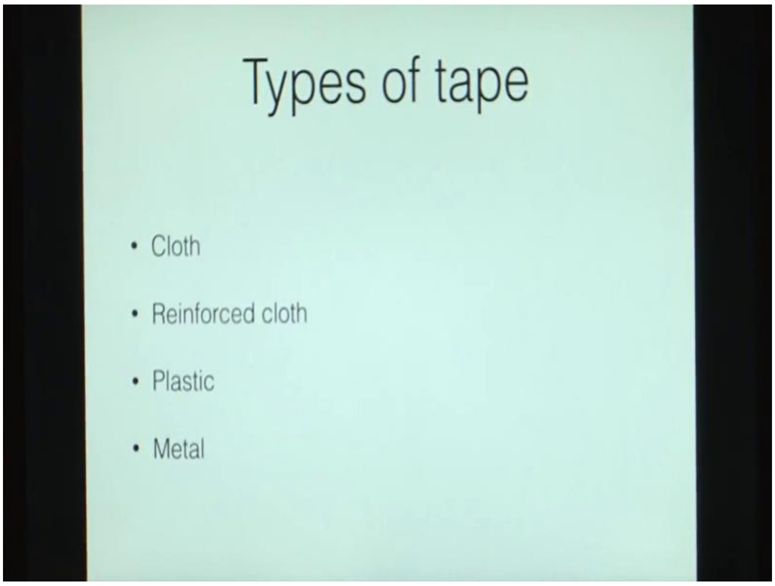

So, we looked at the types of tape cloth reinforced cloth plastic and metal tapes their advantages and disadvantages.

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So, a tape can be used to measure horizontal distances, or vertical distances or the girth.

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However, there are some care in the usage. So, it must not be very old.

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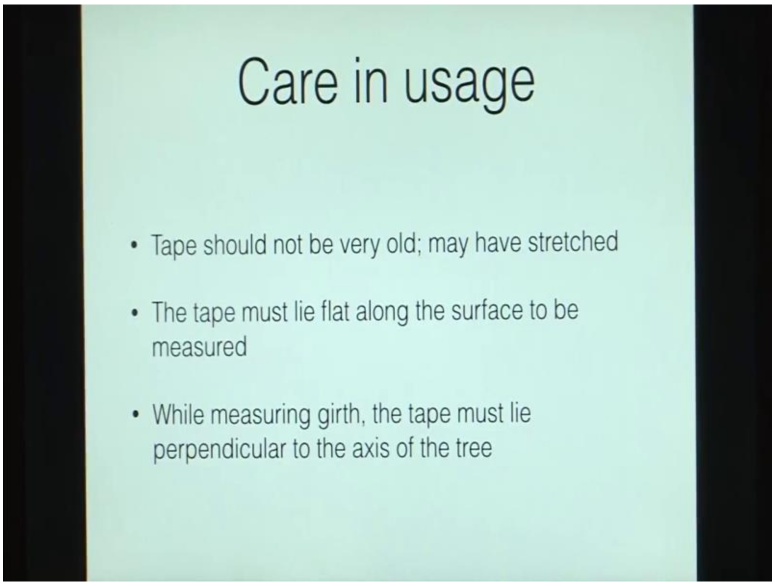

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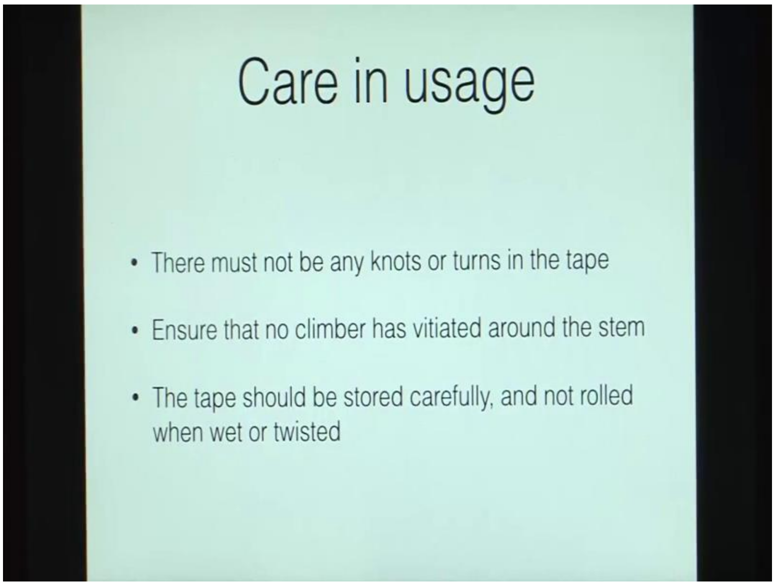

Because an old tape might have stressed or at surface might have become freed and it must lie flat along the surface, it must be perpendicular to the tree axis there must not be any knots or turns in the tape as we saw in this figure.

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So here we have a tape that is showing a knot. So, in this case the girth that will measure will be greater than the girth of the tree, then there should not be any climber that has gone along with the tree and it should be stored carefully.

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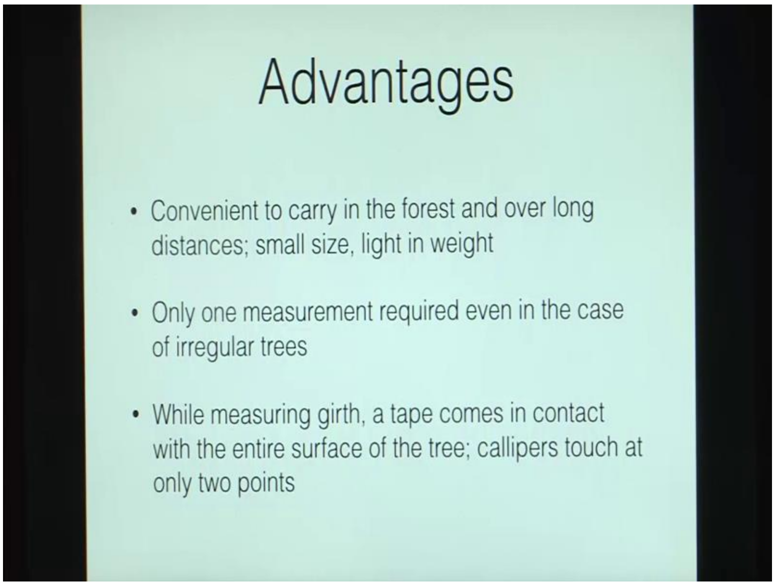

Then we looked at some advantages unlike calipers it is very small and its very light. So, you can easily carry it in your pocket, only one measurement is required in the measurement of girth it comes across it comes in contact with the entire surface of the tree.

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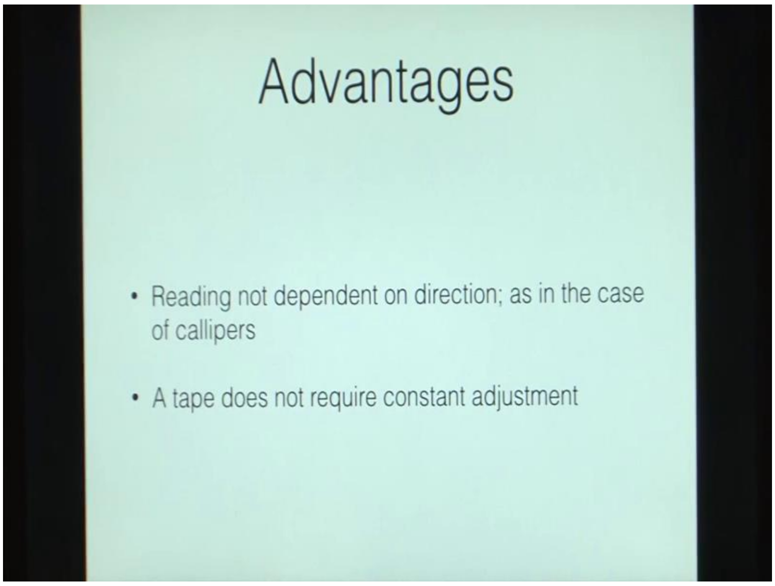

Then the reading is not dependent on direction as in the case of calipers if your tree had an irregular cross section. So, your readings might be highly direction dependent and it does not require any adjustment because it is not a mechanical device.

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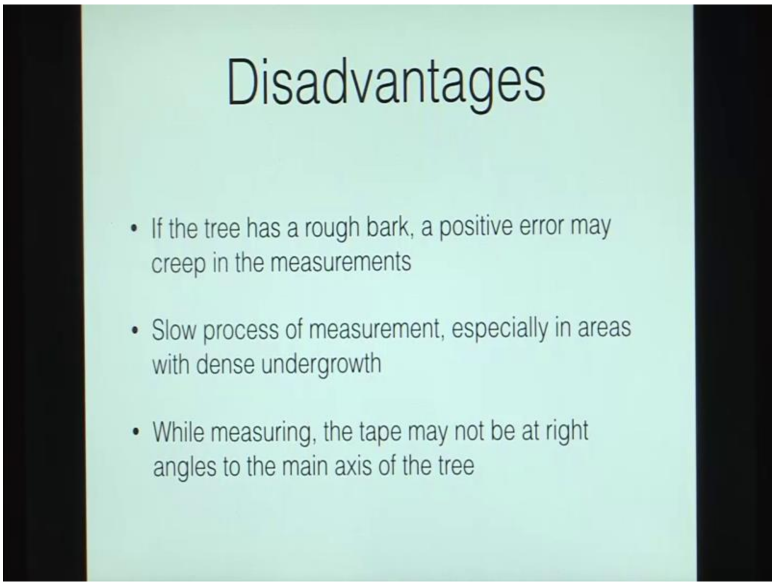

On the other hand if your tree has a rough bark then might give you a positive error, it is a slow process of measurement especially in areas with dense undergrowth where it is difficult to go around your tree completely, at the same time your measurements have to be taken at right angles.

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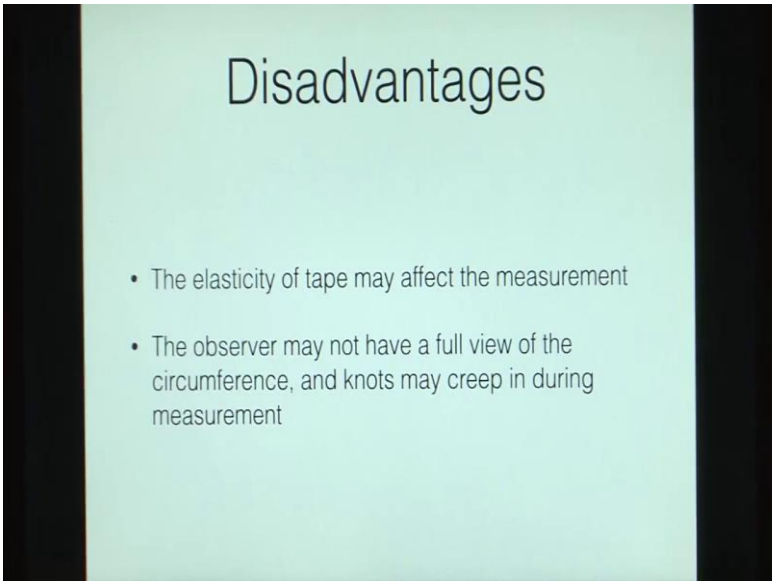

So, that needs to be taken care of the elasticity of the tape might affect the measurement, and the observer may not have a full view of the circumference. So, some knots may creep in during the measurement.

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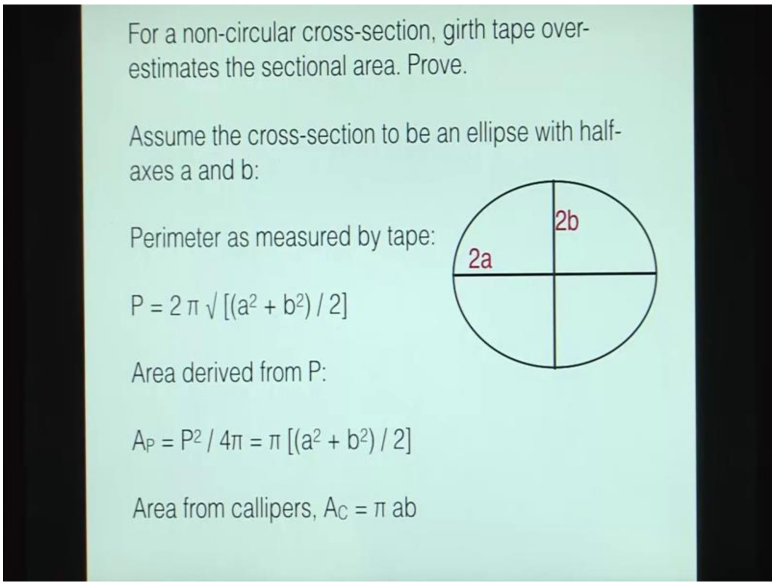

Then we looked at this problem, for a non circular cross section the girth tape over estimates the sectional area. So, this is one thing that we need to keep in mind when we are comparing the cross sectional areas as measured using a tape and as measured with the calipers.

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Next we looked at the measurement of bark and growth rings.

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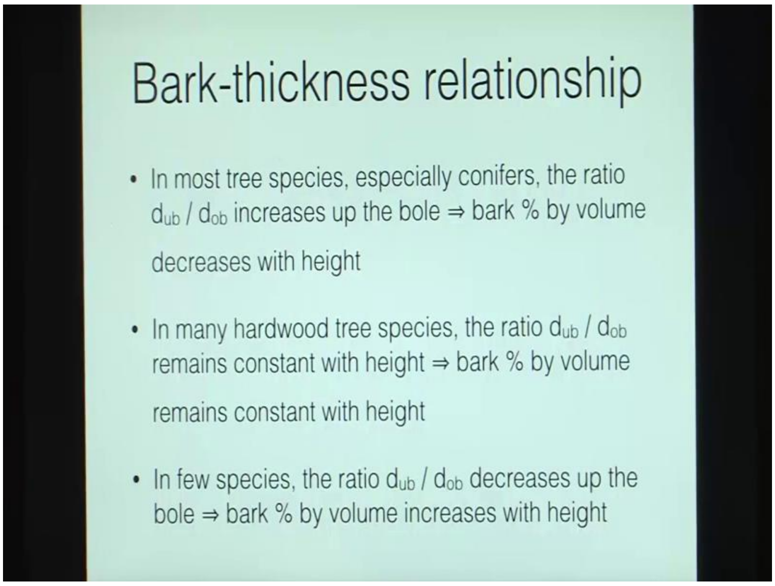

So, bark and thickness relationship was seen, now bark thickness is measured with a Swedish bark gauge or with a bark probe.

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Then we looked at their limitations.

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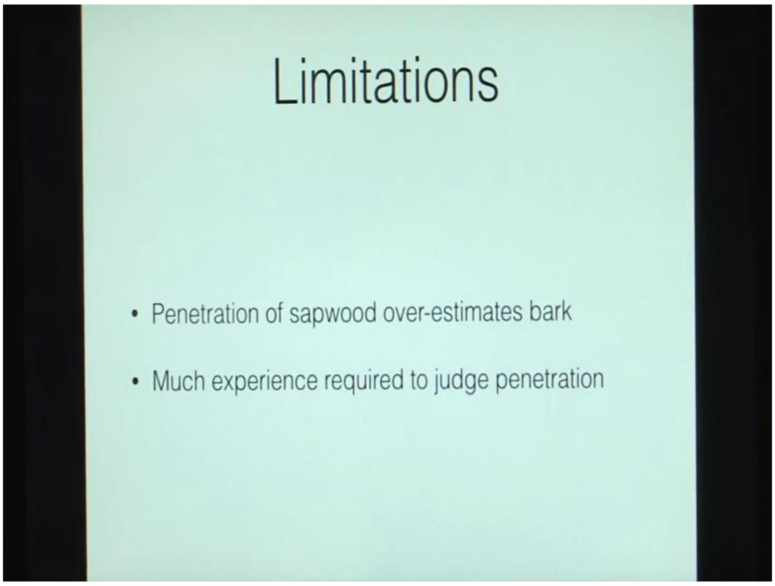

Because they might even be penetrating into the sapwood, thus overestimating the bark and. So, quite a lot of skill and experience is required to correctly judge how much of penetration needs to be made.

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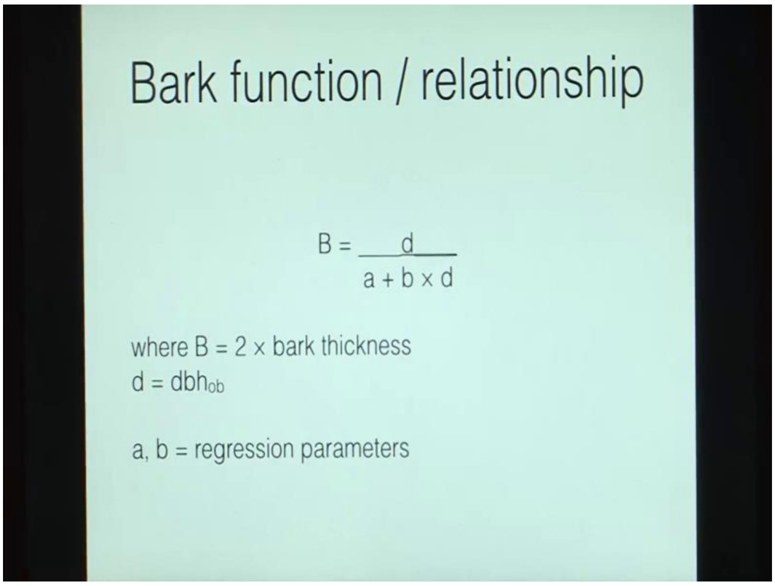

When we looked at bark function and relationship, as compared to the diameter at breast height and the regression parameters.

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Table of bark relationship for Pinus radiata

dbh_{ob} (cm)	2BT (cm)	%	dbh_{ob} (cm)	2BT (cm)	%
12	1.5	12.5	30	4.7	16
14	2.0	14	32	4.9	15
16	2.4	15	34	5.1	15
18	2.8	16	36	5.4	15
20	3.1	15.5	38	5.6	15
22	3.5	16	40	5.8	14.5
24	3.8	16	42	6.0	14
26	4.1	16	44	6.2	14
28	4.4	16	46	6.4	14

Then next we looked at an incremental borer.

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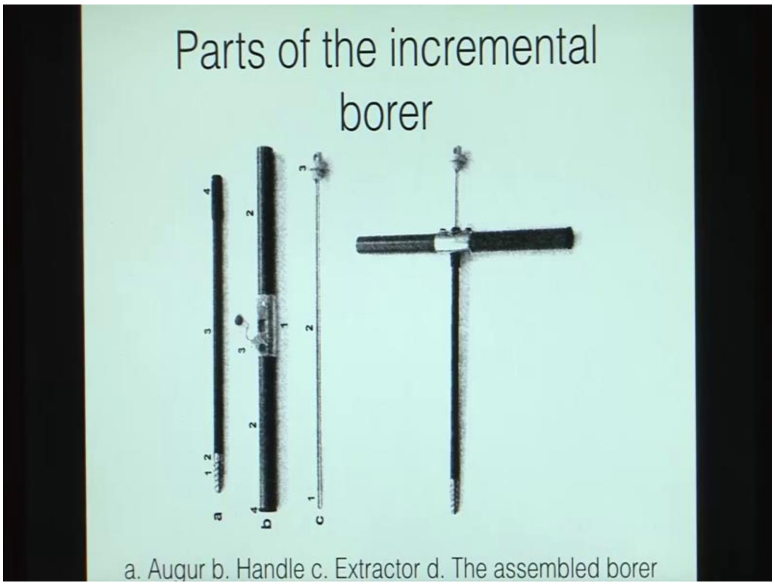

That has these three parts auger handle and the extractor and all these three can be join together to get your assembled borer.

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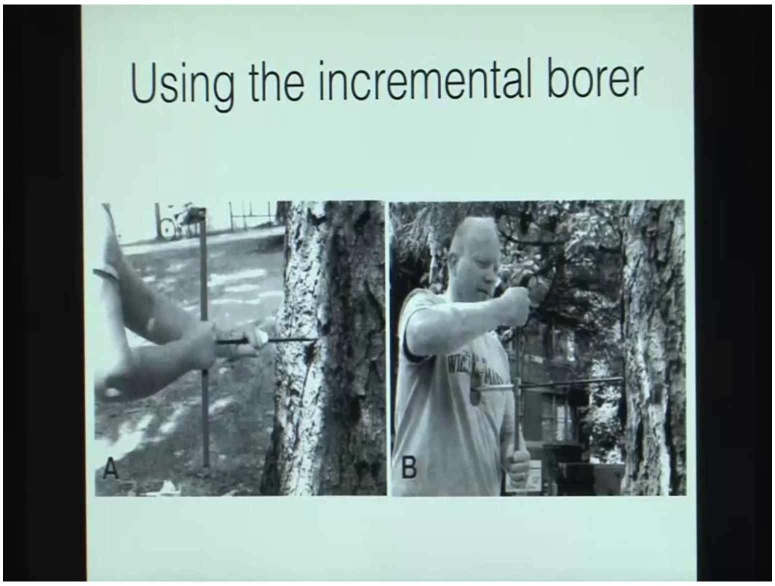

This is how an incremental borer is used and when you get your sample outside from the incremental borer, you can very easily measure the rings that is used in dendrochronology.

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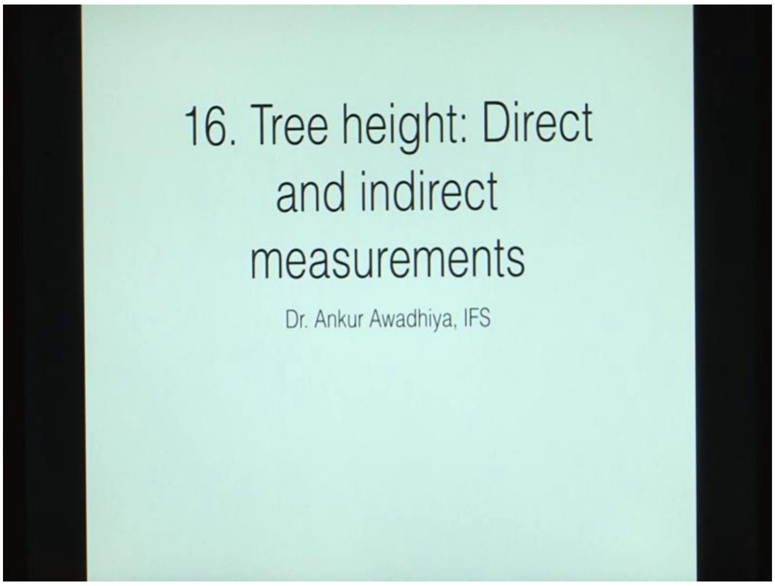

Next we looked at the tree height the direct and indirect measurements. So, we looked at how.

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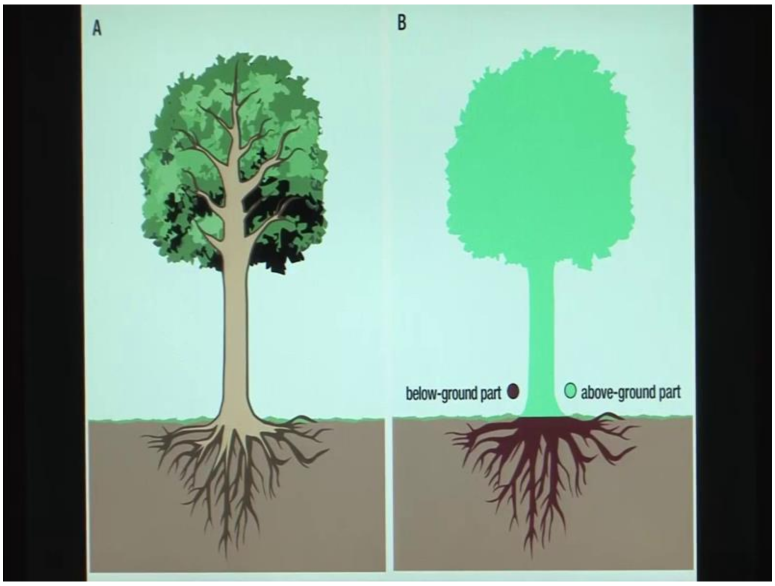

A tree is divided into various portions, the above ground part the below ground part.

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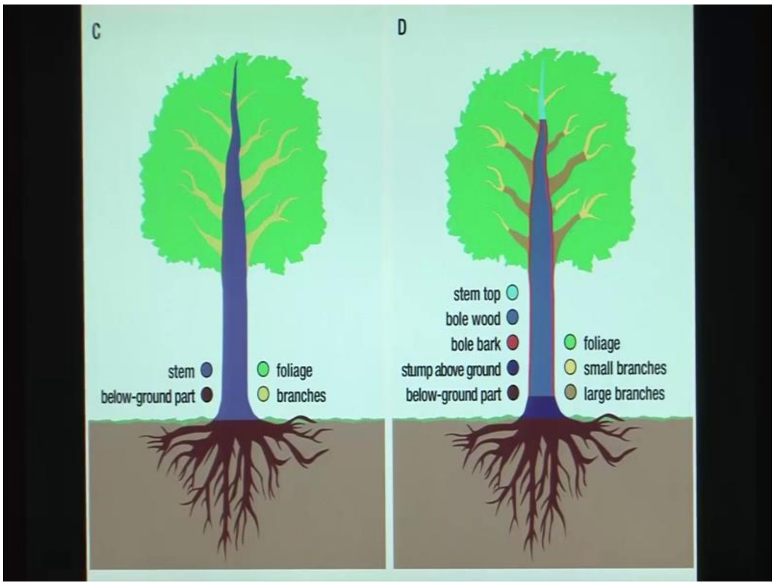

The main stem the branches and so on.

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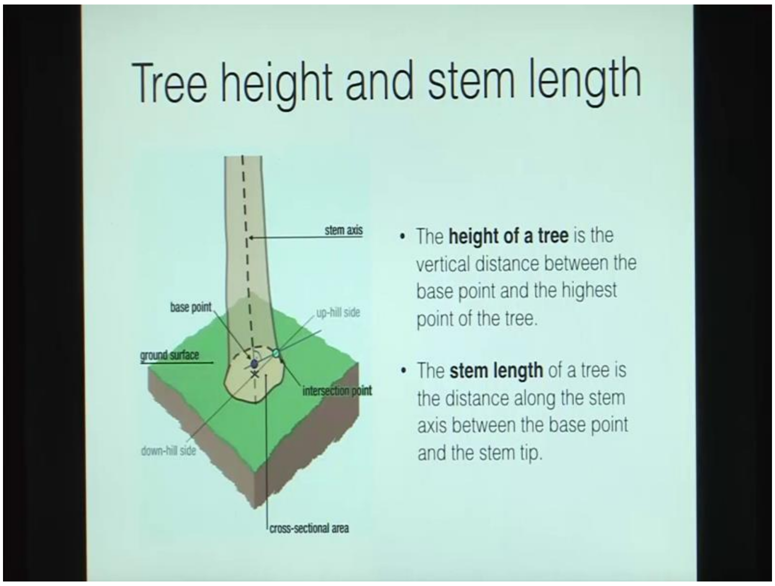

We looked at the difference between the tree height and the stem length and different situations.

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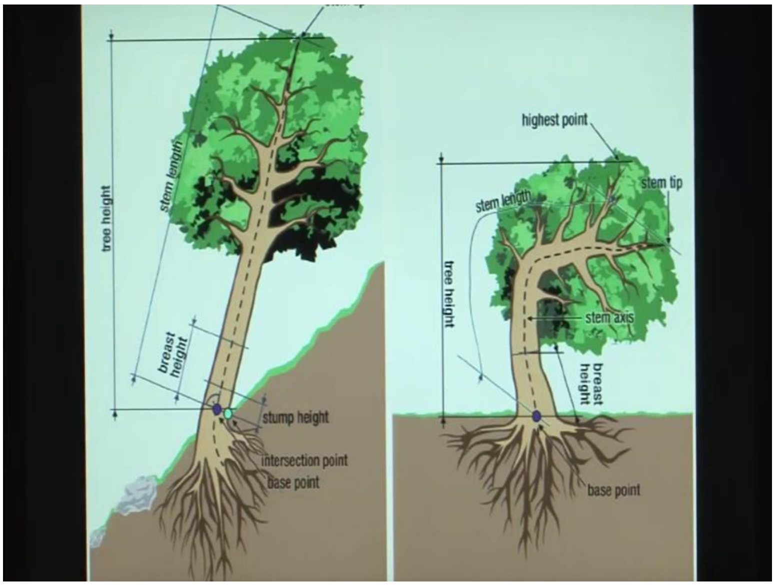

Then we also looked at the merchantable tree height.

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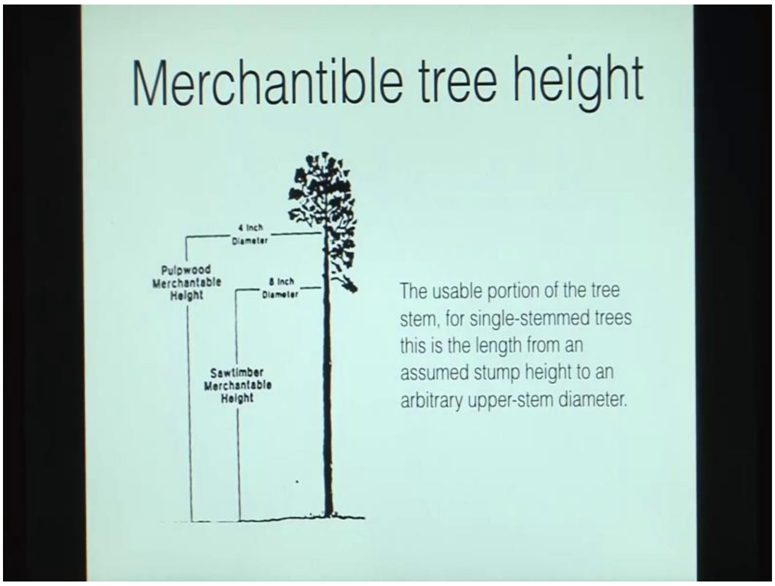

Then things like bole height, total height and the canopy length.

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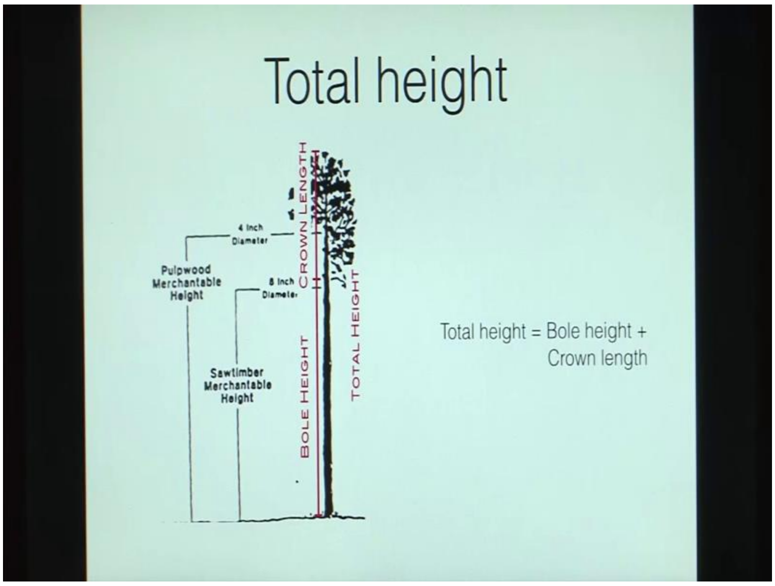

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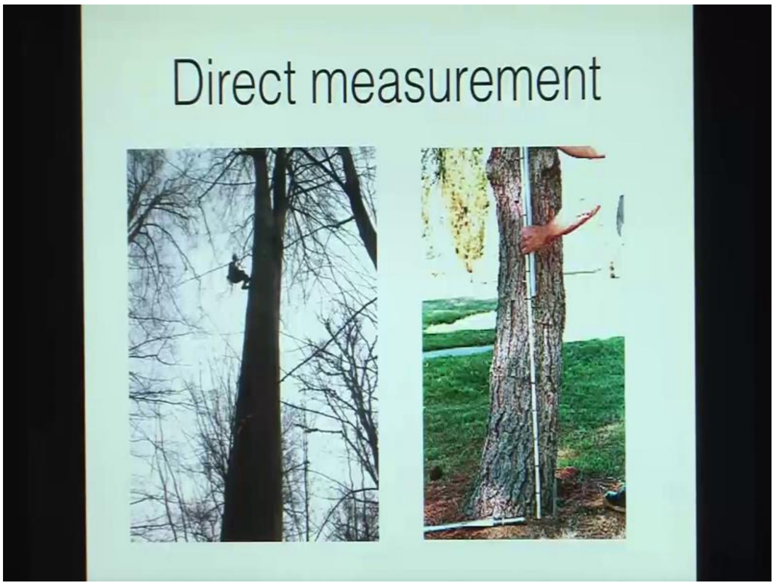

Then in the case of direct measurement you can go on top of a tree and then throw a string with some beta directs to it, and the length of this string when it when the weight is touching the ground and this string is (Refer Time:28:29). So, length of the string will give you the measurement of the tree or you can use a scale directly along the tree to get a direct measurement.

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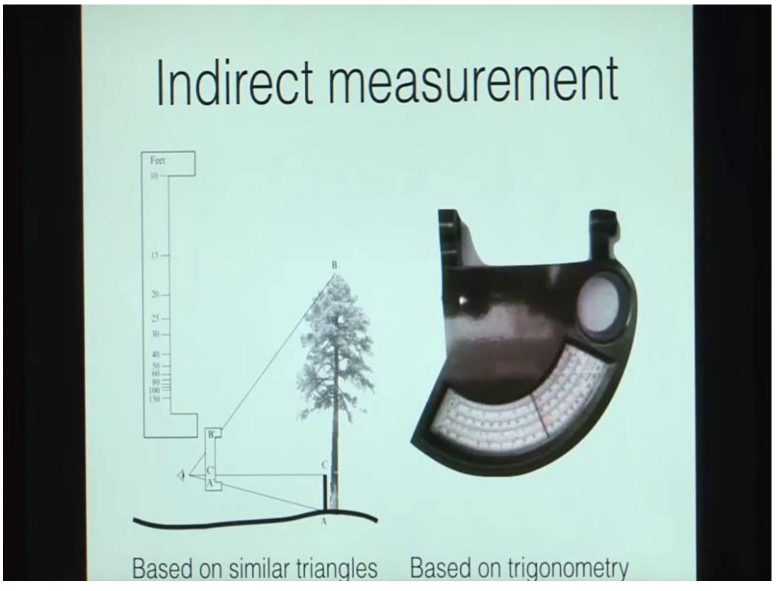

In the case of indirect measurement you can use your principles of similar triangles or principles of trigonometry to measure the heights of the trees.

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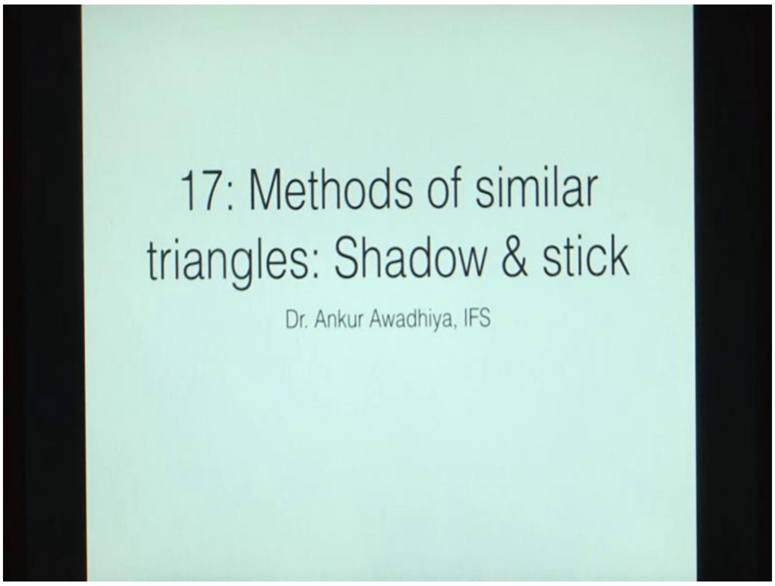

Next we looked at the methods of similar triangles the shadow and the stick method.

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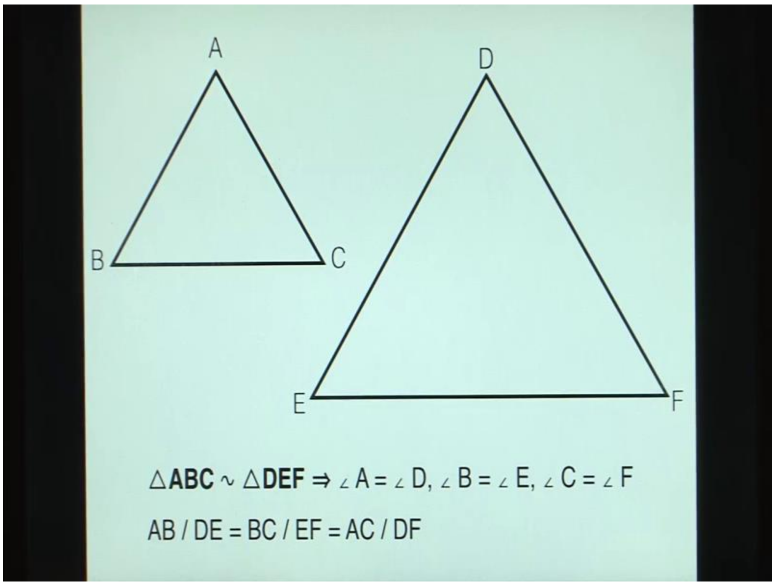

So, in the case of similar triangles there the lengths of the corresponding sides maintain a constant ratio.

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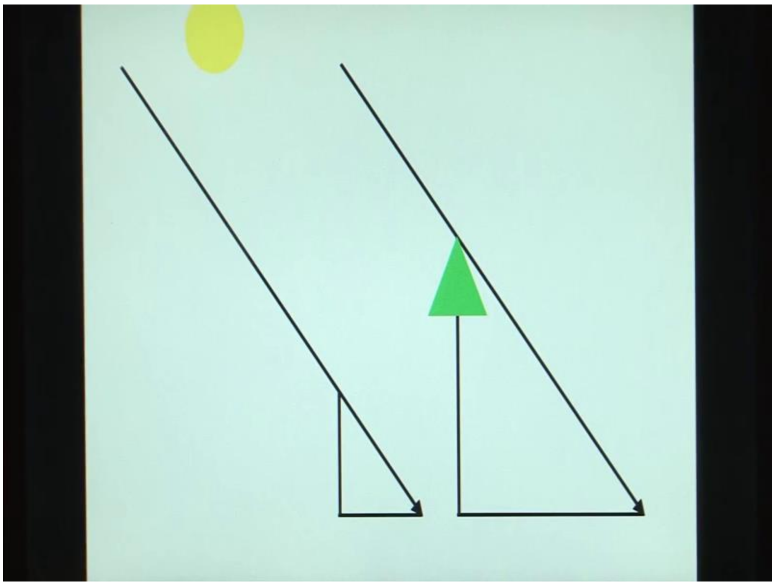

So, we look at this single Pole method which your observer holds a pole and that is it makes this these two similar triangles.

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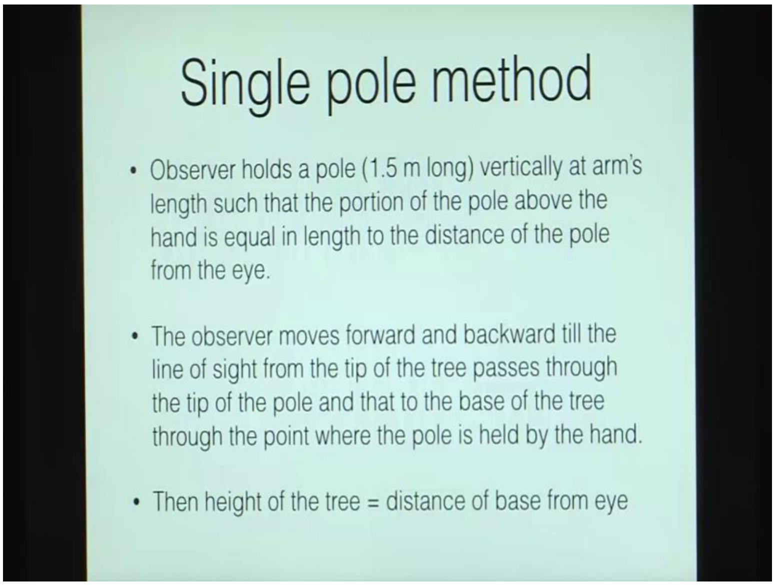

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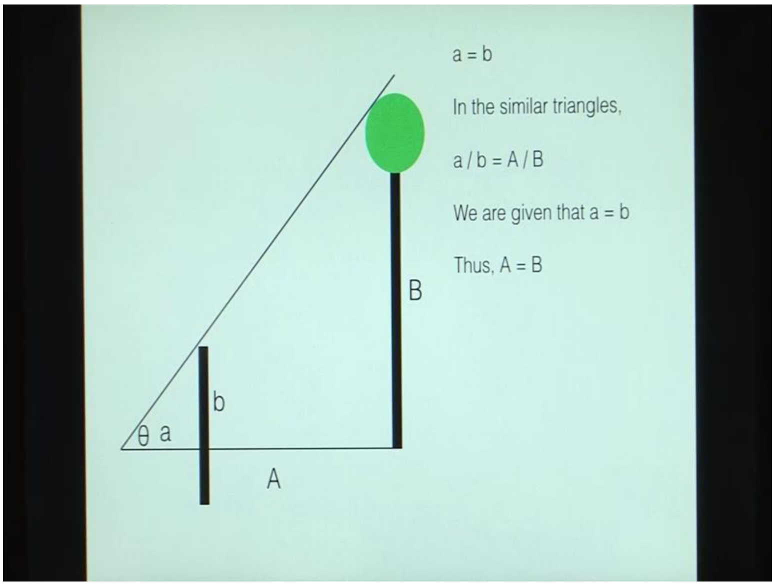

So, you can get the height of the tree as a constant ratio of the sites of the triangles and when a and b are the same. So, capital A and capital B will also be the same.

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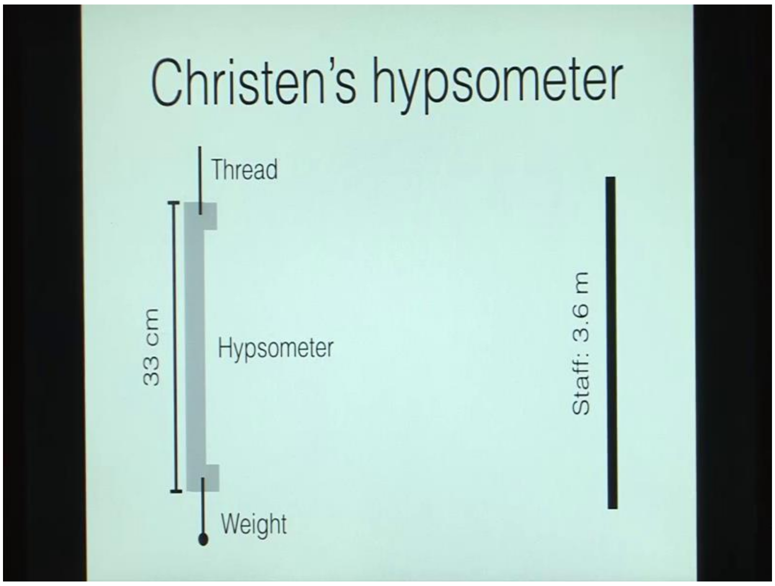

We also looked at this instrument called christens hypsometer is a which is which can be made out of any material even card board.

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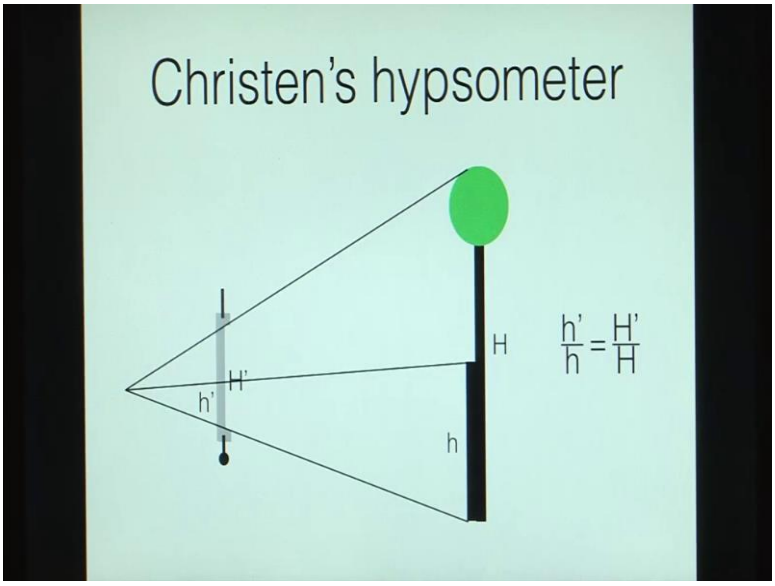

So, in this case we use it with a pole and we get the readings for h and H prime and we can use this equation to get the height of the tree.

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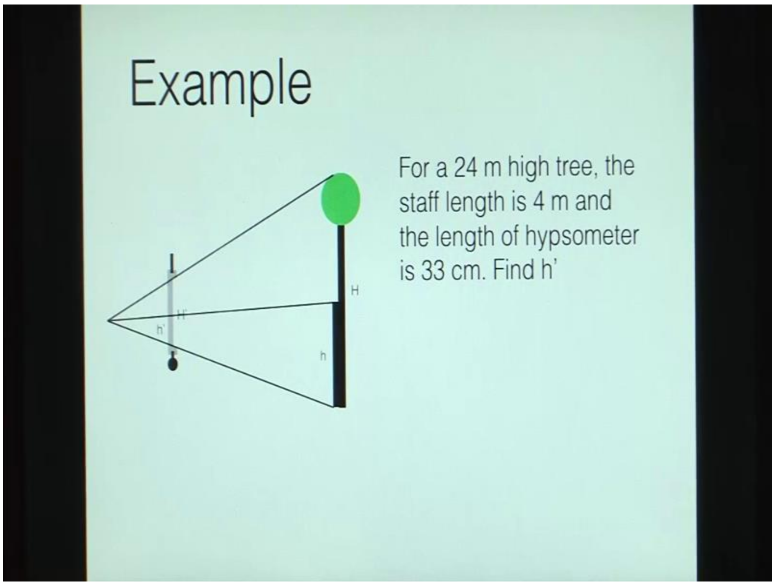

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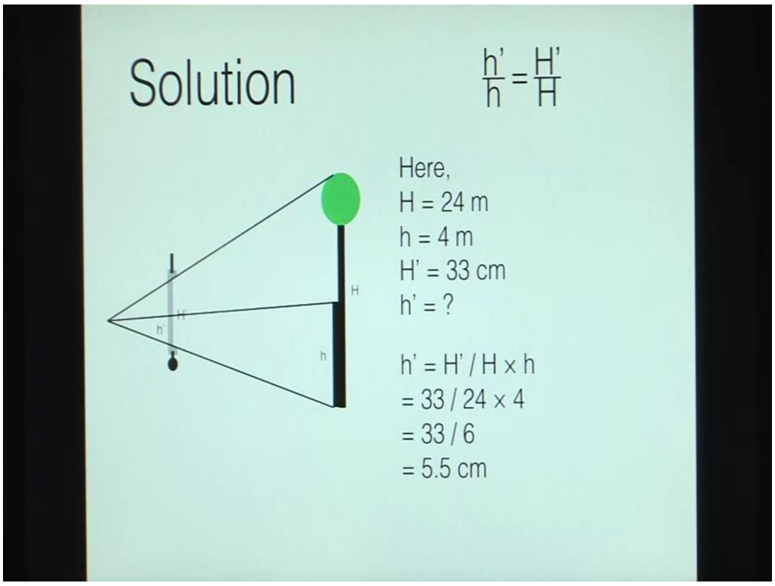

Next we looked at its advantages.

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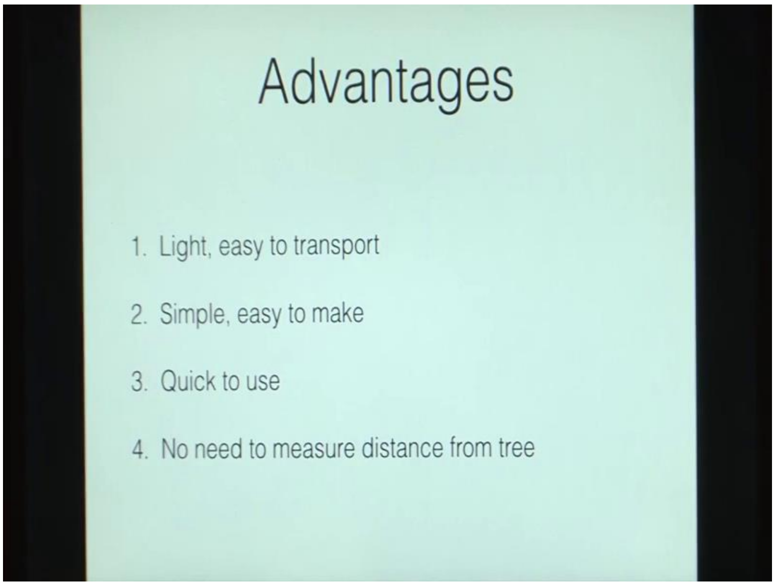

It is light and easy to transport simple and easy to make quick to use and there is no need to measure the distance from the tree.

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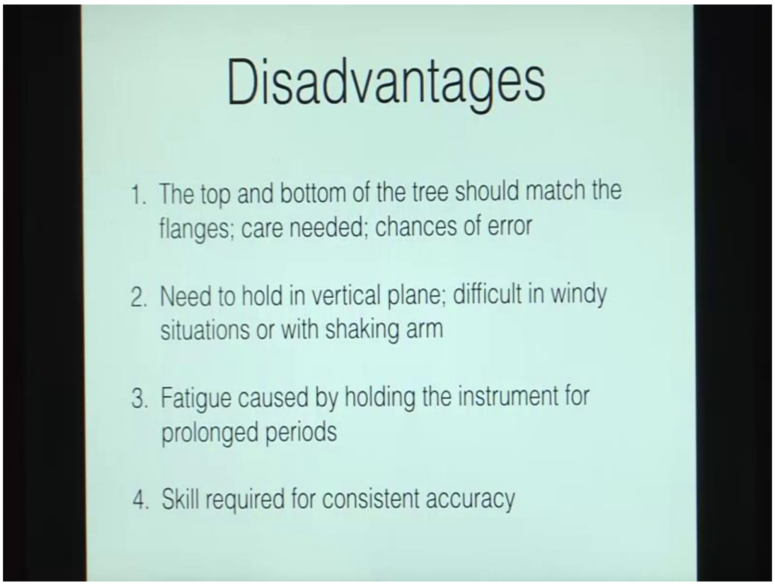

But at the same time your require quite a lot of skill and you need to keep it study and vertical even in the case of windy situations.

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Next we looked at distance measurements with foot tap and range finder. So, if you do not have any instrument.

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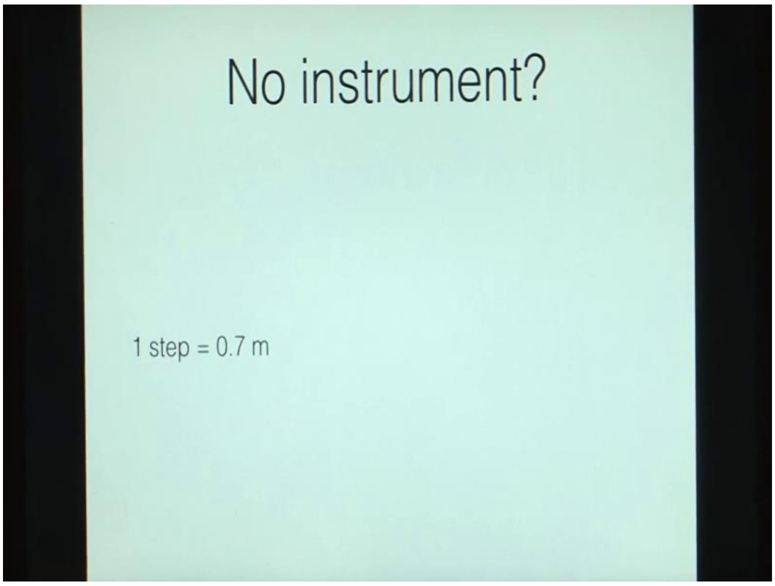

Then you can approximate one step to be equal to 0.7 meters, you can use a tape to measure horizontal distances or you can.

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Use a range finder to measure the horizontal distance.

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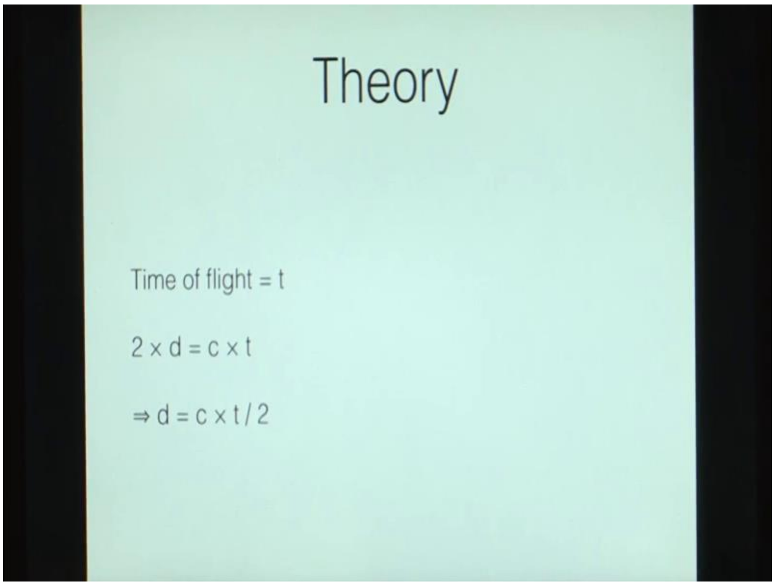

We looked its theory. So, twice of distance is equal to the time of flight multiplied by the speed of the wave that you are using. So, you can either be using light rays as in the case of a laser range finder. So, in that case your speed is equal to the speed of light that is 29979 to 458 meters per second or you can you can go for an ultrasonic range finder in which your speed is equal to the speed of sound that is 340 meters per second.

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We also looked at a demonstration of how these range finders work next we also saw how we can measure.

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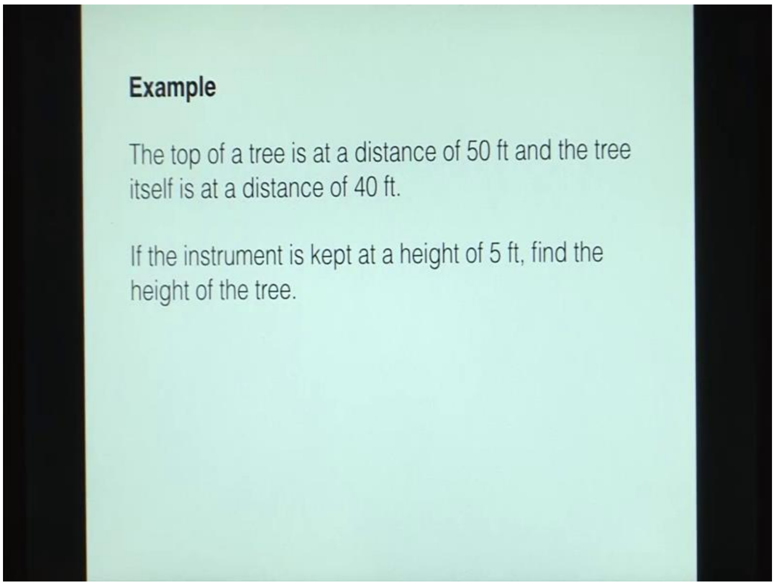

The height of a tree just by using a range finder and pythagoras theorem.

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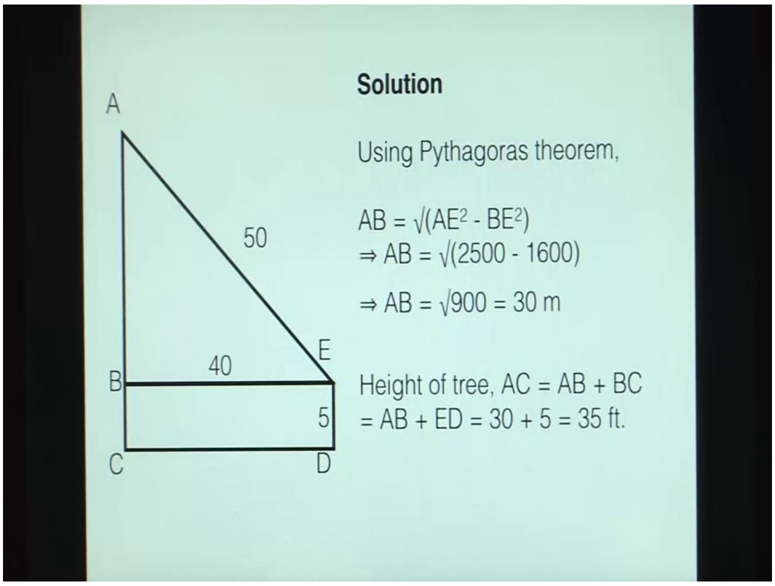

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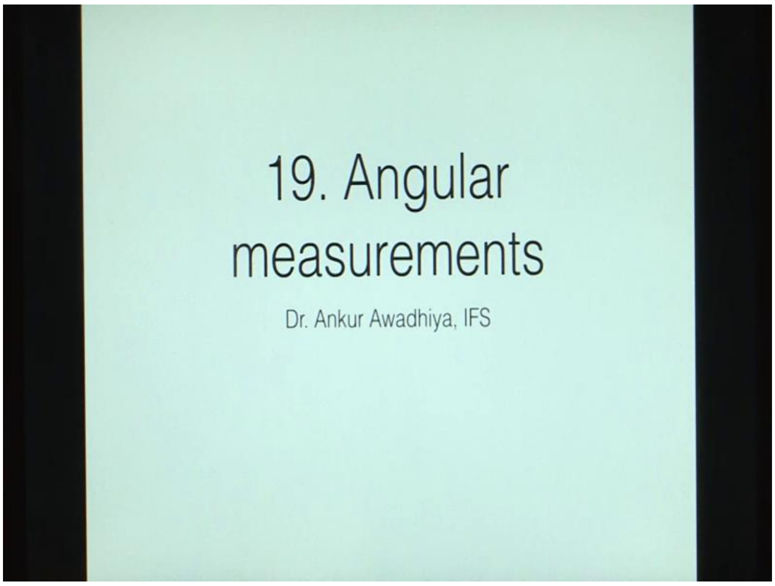

Next we looked at angular measurements.

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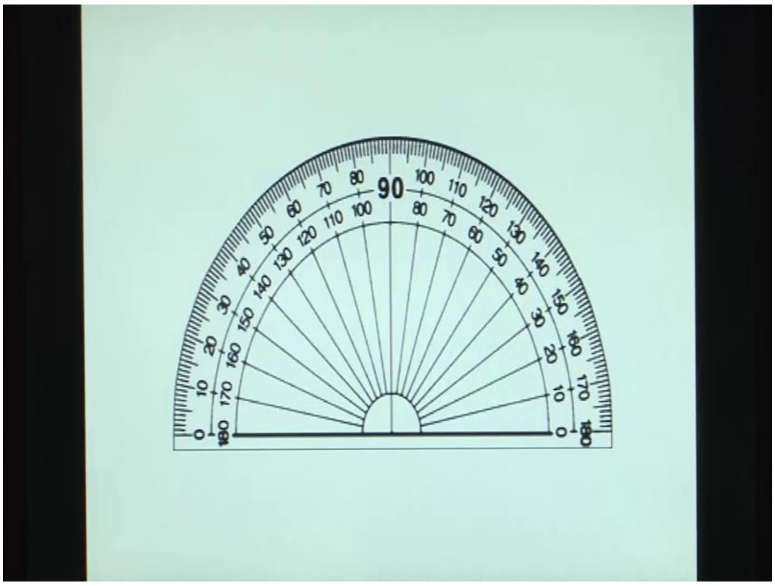

So, we saw that we can use a protector for angular measurements, and if you want to get the angle of elevation or depression then we can attach string to our protector.

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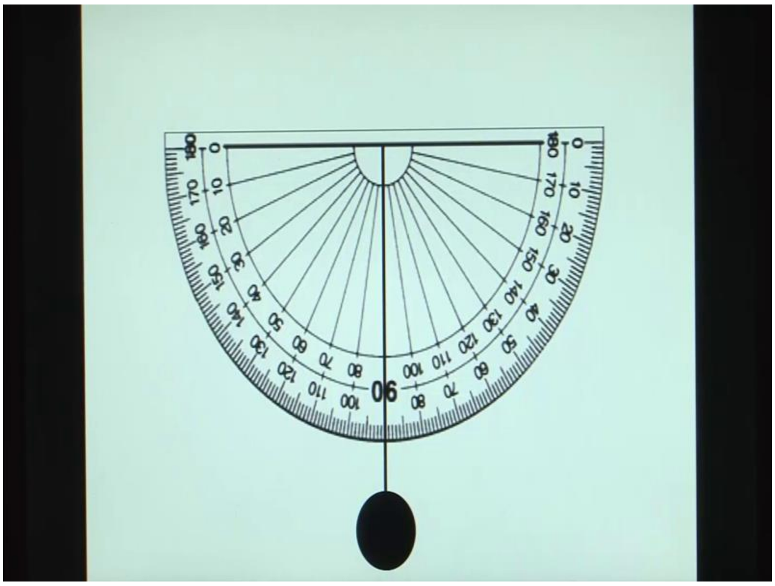

And a weight below which can keep our string tightened and in this case the angle that we measure is the angle of elevation or the angle of depression.

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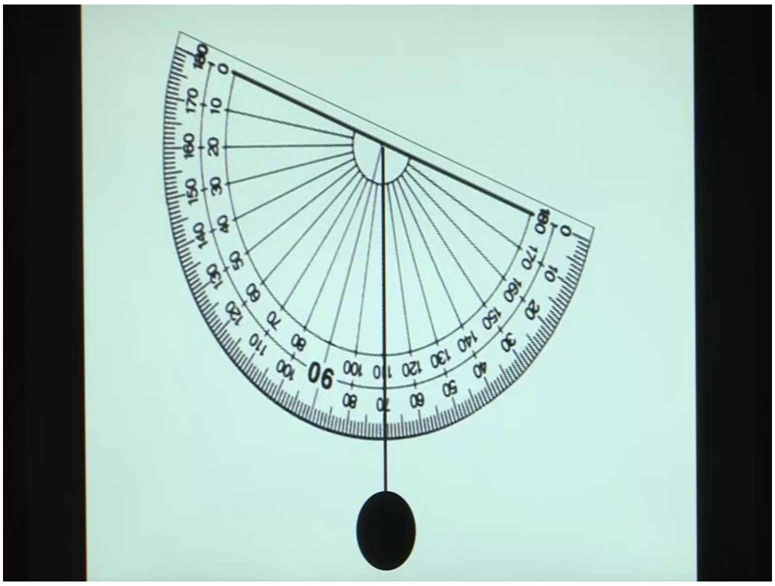

Then we also looked at some problems in which we saw that when you have a tree that has a lean.

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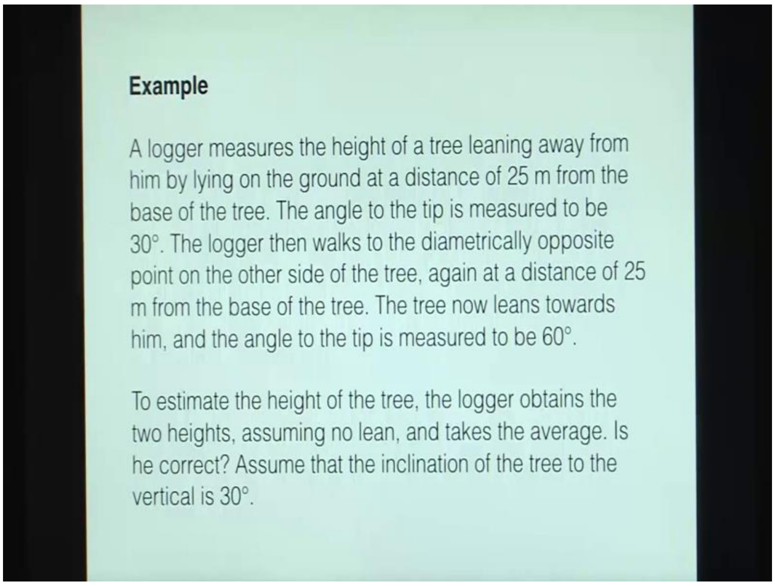

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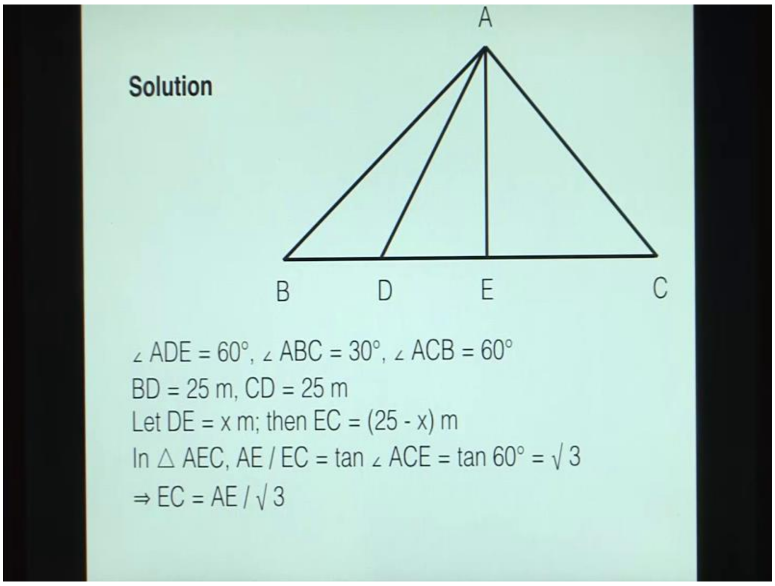

So, in that case you cannot take the readings from both the sides and then average them out, but you need to use principles of trigonometry to find out the correct height of the tree.

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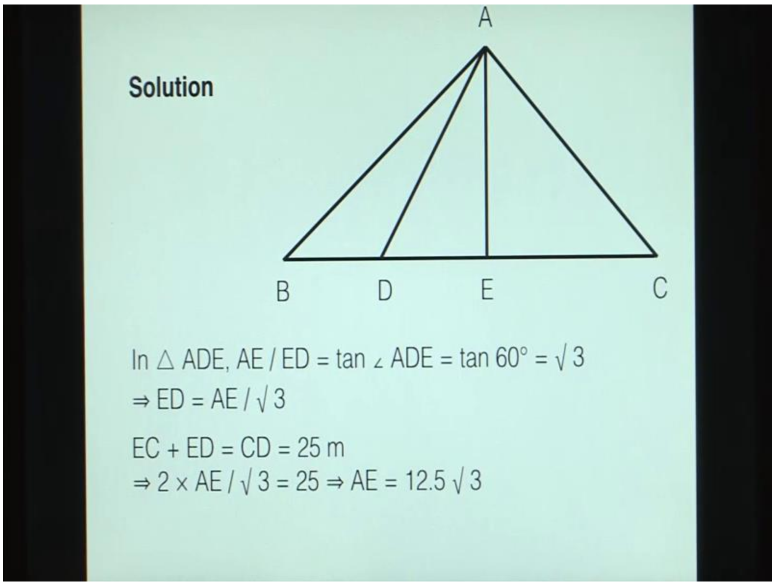

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Then we also looked at this instrument called Haga altimeter that makes measurement of these distances heights and angles very easy.

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So, you measure distance along the ground.

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And then you use this instrument to look at the top of the tree and then you can use these two buttons two either keep your pointer in a freely moving condition or you can fix your pointers.

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So, that you can get the angle and it also gives you tan theta multiplied by your distance for two or three different distances, in which you can directly get the height of the tree. So, that is all for today and will have another recap session in the next lecture.

Thank you for your attention [FL].