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**Lecture – 32**
**The Quarter-girth Formula**

[FL]. Let us today have a look at the quarter-girth formula. Now quarter-girth formula is a formula for a quick estimation of volume. So, let us look at the formula itself before beginning it is discussion. So, this is the quarter-girth formula as you can see on your screens now.

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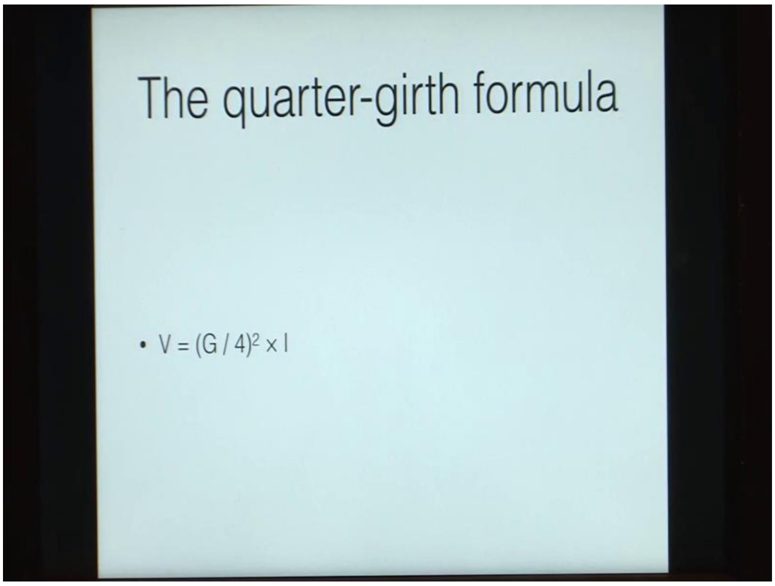


So, the quarter-girth formula is given by G by 4 square into l. Now G in this case is the girth of a solid. So, for instance if we considered a cylinder.

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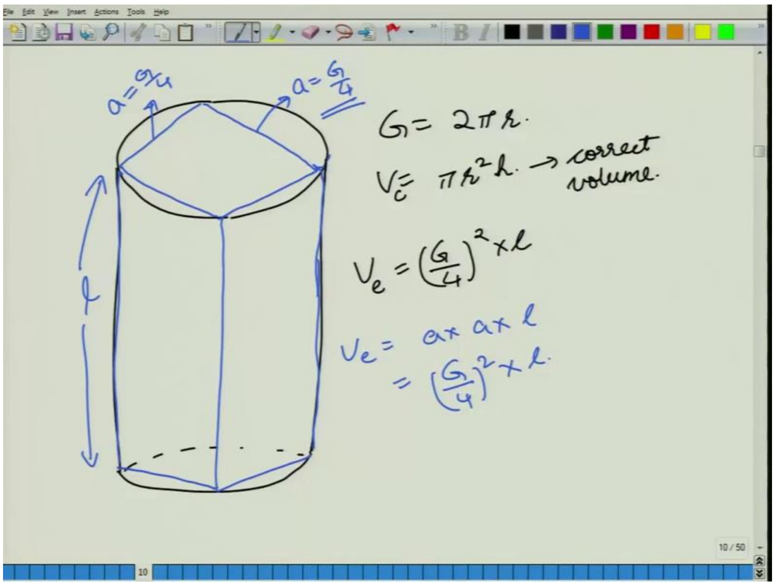


So, let us consider our log to be a cylinder. So, in this case the girth will be given by the circumference of one of it is ends which is 2 pi r. We had defined volume of a cylinder as pi r square h. So, this is the correct volume, now we are taking in estimate of this volume by considering the volume. So, this is the correct volume and the estimated volume is G by 4 square into l. So, what essentially we are doing is, if we have a girth then we are considering a squarish section of this log of h a is equal to G by 4. So, if we considered a cuboidal portion of the solid here.

So, we are considering this solid now. And this solid is a cuboid of an h G y 4. So, it has a cross section area that is the square. So, this is also a is equal to G by 4, and the length of the solid is the same as the length of the cylinder. So, the volume is given by a into a into l, because the volume of the cuboid is length into breadth into height. And because a is G by 4. So, we are writing it as G by 4 square into l. So now, if you wanted to find out how much is this estimated volume in comparison to the correct volume. So, what we want to compute now, is volume estimated by volume correct into 100 percent.

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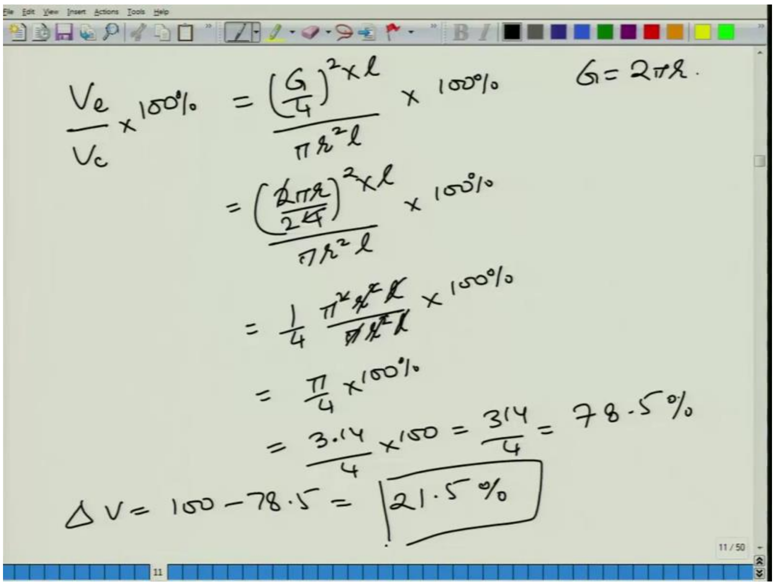

Now this figure would be given by the estimated volume is G by 4 square into l divided by the correct volume is pi r square l into 100 percent. Now G is given by 2 pi r. So, here we have 2 pi r by 4 it is square into l by pi r square l into 100 percent; so taking it out. So, we have 1 by 4 pi square r square l divided by pi r square l into 100 percent. So, r square and r square get cancelled pi and pi get cancelled l and l get cancelled. So, this value is pi by 4 into one 100 percent. Now pi is 3.14 by 4 into 100 is 314 by 4. So, approximately 78.5 percent.

So, the volume that we are computing here by using the quarter-girth formula is only 78.5 percent of the actual volume, or the difference in the volume would be 100 minus 78.5 21.5 percent is the difference between the volumes that we are computing using the quarter-girth formula and the actual formula. So, if we have so much of an error an error of 21.5 percent in that case what is the significance of using this quarter-girth formula.

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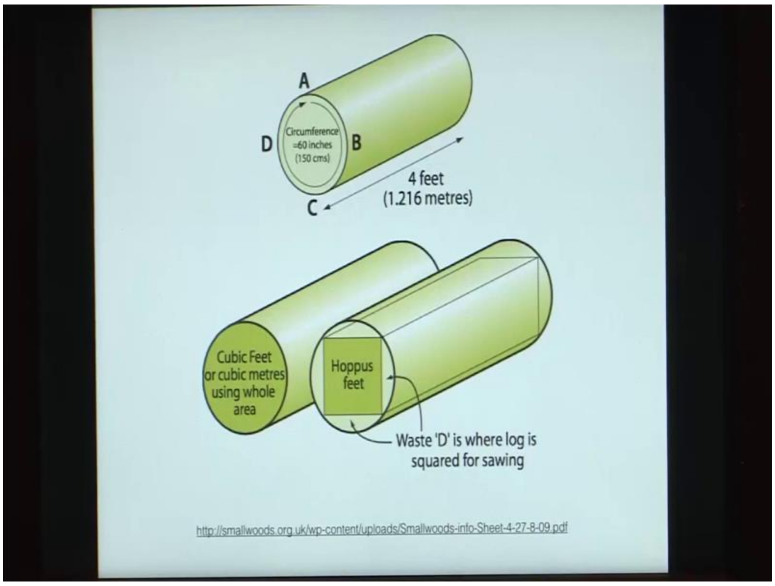


So, let us have a look at that. So, let us go to the slides now. So, here what you are seeing is you have a log that is that is in the shape of a cylinder. This is the formula I mean this is the volume that we get if we measure the complete solid, and this much is the volume that we are getting out of the quarter-girth formula, it is also known as the hoppus formula in written.

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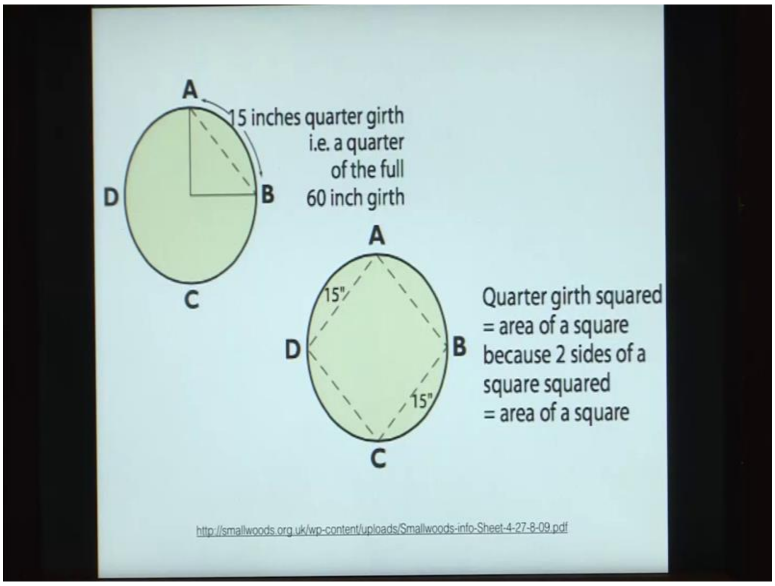

So, when we are considering this hoppus formula. So, essentially the end has been replaced by so, this circular cross section has been replaced by a squarish cross section, whose edge is given by G by 4.

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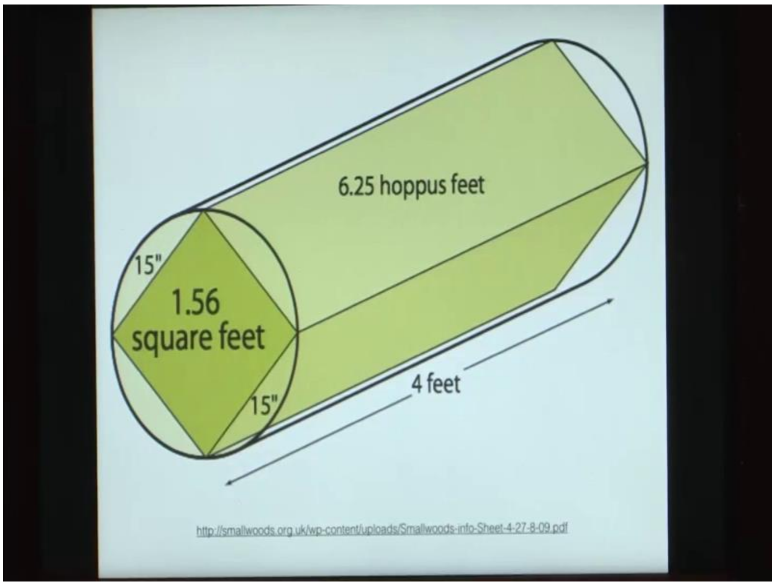


Once we have done that we are getting the cuboid inside r log. So, why is that useful? That becomes useful because once we are using our wood for any purpose once we put it through swing operations, what we require would be straight planks.

So, for instance if we look at this table. So, if you looked at this part of the table, here we have a plank. So, this plank is a rectangular sheet. The top again could be considered to be a rectangular sheet the front is again a rectangular sheet. So, when we want to use our log for any oomercial purposes, we want to have these rectangular sheets. So, if we wanted to have the rectangular sheets. So, coming back to the slides, what will happen in this case is that these d shaped sections. So, this is one d this is another d this is the third d this is the 4th d.

So, these sections would be sawn off. That is we will not be able to use those portions of the cylindrical log if you wanted to have these flat sheets of the material wood. So, if those portions have to be removed anyway. So, if you want to have an estimate of the amount of wood that is usable then hoppus formula or the quarter-girth formula gives us a very good estimate.

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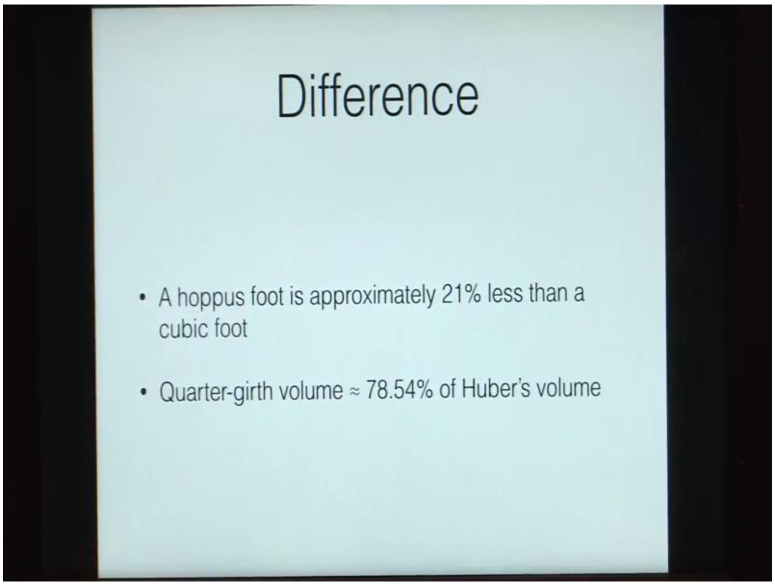


So, as we saw the difference there is a difference between the hoppus formula volume or the quarter-girth volume. And the actual volume and the hoppus foot is approximately 21 percent less than a cubic foot and the quarter-girth volume is 78.54 percent of Huber's volume.

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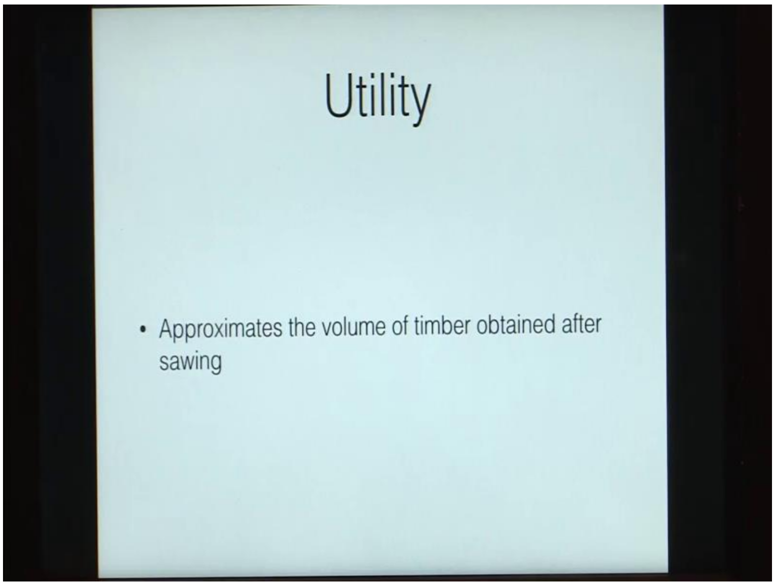


So, Huber's volume is computed from the Huber's formula as we saw in the previous class, and the utility is that it approximates the volume of timber obtained after sawing. So, how do we use this formula out there in the field?

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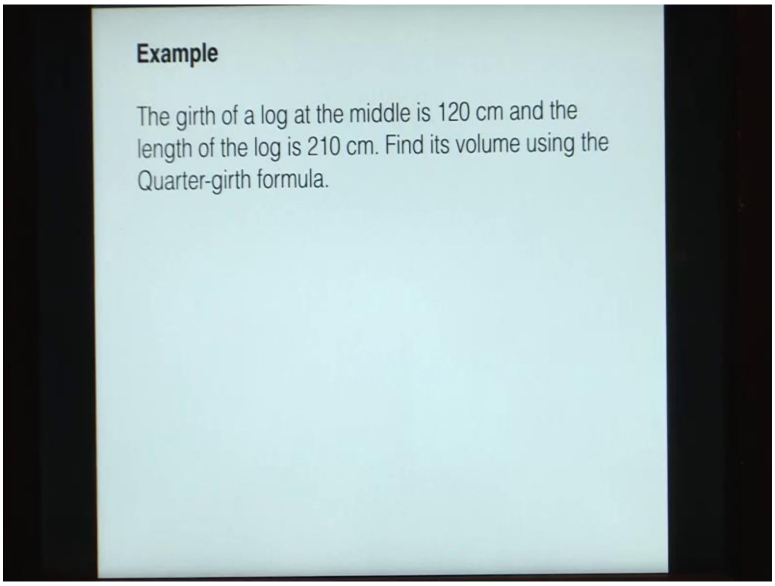


So, let us have a look at an example. So, it states that the girth of a log at the middle is 120 centimeters and the length of the log is 210 centimeters.

We need to find it is volume using the quarter-girth formula. So, we are given 2 things.

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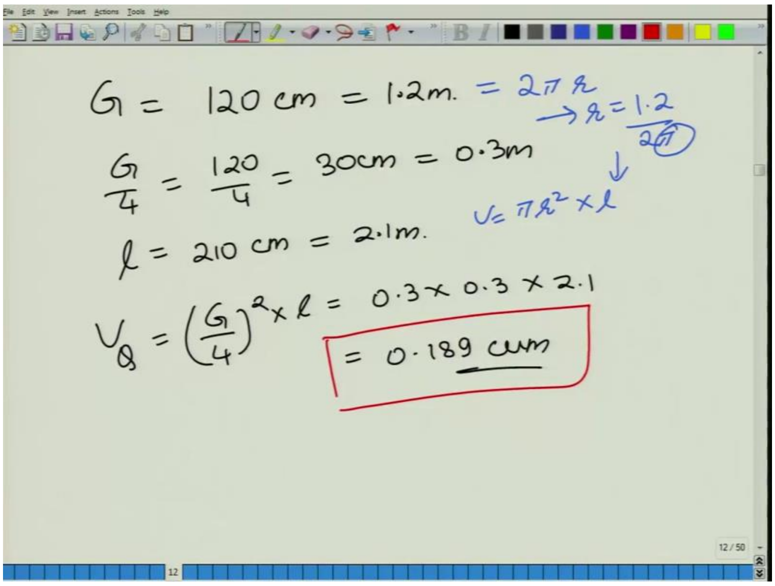

We are given that the girth at the middle is 120 centimeters, that is 1.2 meters. So, what is the quarter-girth G by 4 is equal to 120 by 4 or 30 centimeters which is 0.3 meters. The length of the log is given to be 210 centimeters, which is 2.1 meter the volume by the quarter-girth formula is given by G by 4 square into l. So, it is 0.3 into 0.3 into 2.1 which you get as 0.189 cubic meter. So now, even though we are given the girth we wanted to go to compute the actual volume we would have done it in this way. So, the girth is 1.2 meter that is 2 pi r.

So, from this we would have gotten r is equal to 1.2 by 2 pi. And then we would have computed the volume to be pi r square into the length of the solid. So, these computations are a bit involved because you have to divide it by pi. And pi being an irrational number this becomes a longest computation; whereas, in the case of this quarter-girth formula we were able to come up with the volume in no time. So, you just divide G by 4 then take a square and multiply that with a length of the solid and you get the volume of the solid with the quarter-girth formula.

So, this is an easy formula to get a quick estimate of the volume of the usable timber that we will get out of a log of wood.

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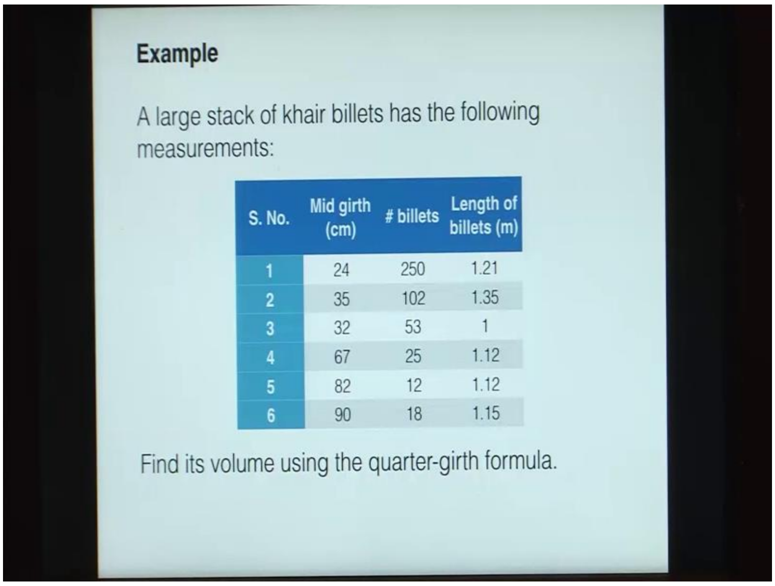


So, let us now look at another example.

So a large stack of khair billets has the following measurements. So, what do we mean by billets? Billets means fuel wood when you have (Refer Time: 10:08) in a cuboidal fashion. So, essentially it is a stack of fuel wood. So, a large stack of khair billets has the following measurements. So, we are given a number of sub stacks with the middle girth and the number of billets in that and the length of the billets is also given and we are required to find it is volume using the quarter-girth formula.

So, here again; the mid girth is given. So, G is given quarter-girth is G by 4 volume of one piece of wood will be G by 4 square into the length of the billet. So, here we have the length of the billet in this column this the g. So, you compute G by 4 then square that multiply it by the length of the billets and multiply it by the number of billets. So, by using that you will get the volume of this sub stack.

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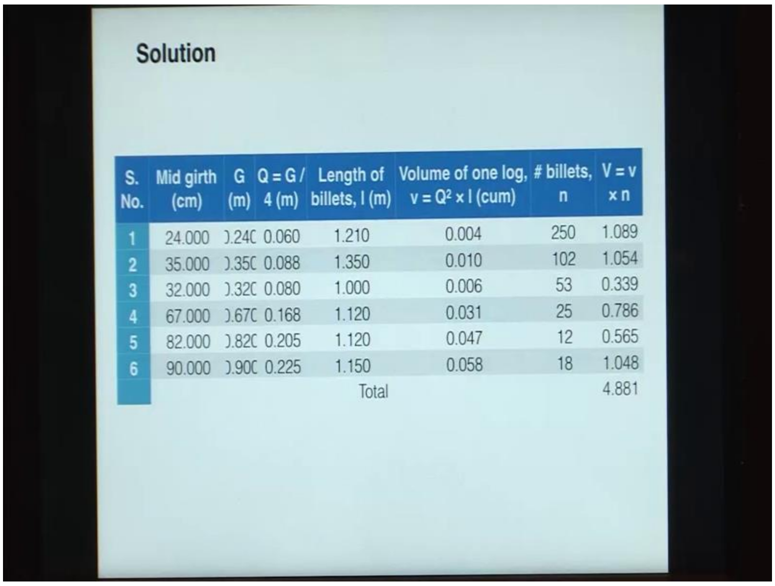
Solution

| S. No. | Mid girth (cm) | G (m) | Q = G / 4 (m) | Length of billets, l (m) | Volume of one log, $v = Q^2 \times l$ (cum) | # billets, n | V = v x n |
|---|---|---|---|---|---|---|---|
| 1 | 24.000 | ).24C | 0.060 | 1.210 | 0.004 | 250 | 1.089 |
| 2 | 35.000 | ).35C | 0.088 | 1.350 | 0.010 | 102 | 1.054 |
| 3 | 32.000 | ).32C | 0.080 | 1.000 | 0.006 | 53 | 0.339 |
| 4 | 67.000 | ).67C | 0.168 | 1.120 | 0.031 | 25 | 0.786 |
| 5 | 82.000 | ).82C | 0.205 | 1.120 | 0.047 | 12 | 0.565 |
| 6 | 90.000 | ).90C | 0.225 | 1.150 | 0.058 | 18 | 1.048 |
| | | | | Total | | | 4.881 |

And if you total all the volumes you will get the volume of the complete large stack of billets. So, this is how we are going to do it. So, we are given the mid girth. So, mid girth is given in the question. So, this is given in centimeters. So, first of all we convert it into meters by dividing by 100. Then we compute the quarter-girth. So, quarter-girth is G by 4. So, if it is 0.4, 0.4 by fold will be 0.06 0.32 by 4 will be 0.08 and so on. The length of the billets is also given in meters. So, the volume of one log will be q square into l. So, that is 0.06 into 0.06 into 1.21 that comes to be 0.004 cubic meter, the number of billets is also given. So, if you multiply this volume of one log by the number of billets you get the total volume of the sub stack number 1.

So, once you have done that you can repeat it for all the different sub stacks and if you total this volume you will get the volume of the large sub stack. So, let us now try to do this problem by hand.

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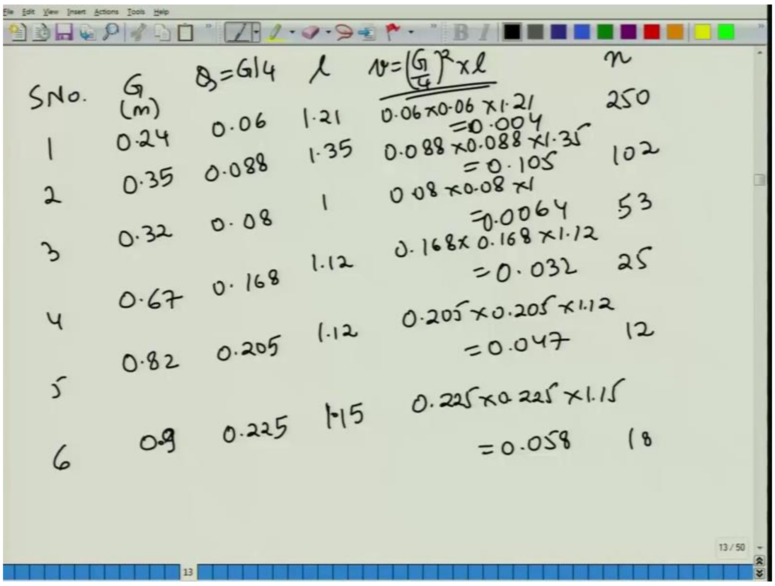


So, we are given that the serial number goes from 1 2 3 4 5 and 6. Now the middle girth that is G we write it in meters it becomes 0.24 0.35 0.32 0.67 0.82 and 0.9 meters. So, this is G in meters. So, we can find out q which is equal to G by 4. So, it becomes 0.06, 0.088 which is 35.35 divided by 4 this becomes 0.08 0.168 0.205 and 0.225 the length of the billets is also given 1.21 1.351 1.12, 1.12 and 1.15. So, the volume of a log will be G by 4 square into l. So, it becomes 0.06 into 0.06 into 1.21 this one becomes 0.088 into 0.088 into 1.35. This one is 0.08 into 0.08 into 1. This one is 0.168 into 0.168 into 1.12 this one is 0.205 into 0.205 into 1.12.

And this one is 0.225 into 0.225 into 1.15. So now, let us use a calculator. So, in the first case we have 0.06 into 0.06 into 1.21 which comes to be 0.004, 0.004. In the second case we have 0.088 into 0.088 into 1.35, which is 0.105. And the third case we have 8 8 za 64 0.006. And this case we have 0.168 into 0.168 into 1.12 which comes to be 0.032. Next you have 0.205 into 0.205 into 1.12, which is 0.047. And the last one is 0.225 into 0.225 into 1.15 which comes to be 0.058. So, this is the volume of one log. Now the number of logs is also given. So, that is 250 102, then we have 53, then we have.

25 then you have 12 then we have 18. So now, let us remove this first part. And so, we will let us remove this part. You have already computed v and n. So, next we will have capital v in cubic meter which shall be given by this small v into small n.

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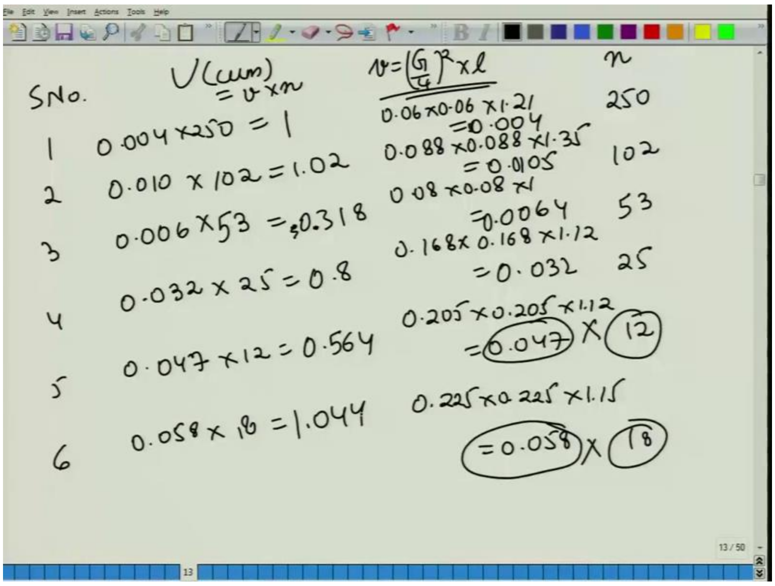


So, here we have for the first one it will be 0.004 into 250 here we will have 0.0105 into 102. Then we have 0.006 let us take it to just 3 days (Refer Time: 16:43). So, we will remove this into 53. Then we have 0.032 into 25. This one is 0.047 into 12, 0.058 into 18. So, what we are doing is we are taking this value for v this value for n and we are multiplying both of these to get this value. Here also it is this value and this value multiply to get this value. So, let us now do these calculations. So, we have 0.004 into 250 is one. Then we have 0.1 multiplied by 102, that is 1.02, then this will be 6 3 za 18 0.006 into 53 which is 0.318, 318. Next we have 0.032 into 25 is 0.8.

Next we have 0.047 into 12, that is 0.564 and the last value is 0.058 into 18, which is 1.044, 1.044. So now, that we have computed the volumes for each of these sub stacks, next what we are required to do is to compute the volume for the complete large stack.

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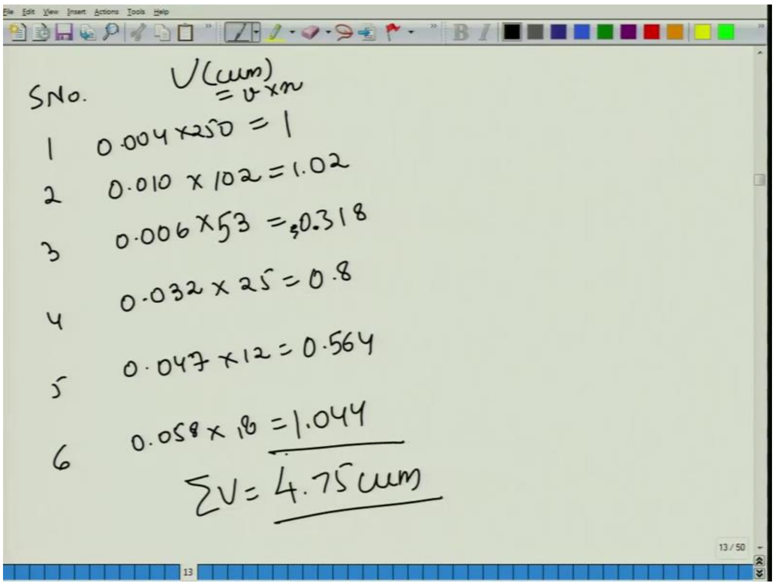


So, that volume is given by the sum of these volumes. So, the sum of the volumes is given by so, here we have 1 plus 1.02 plus 0.318 plus 0.8 plus 0.564 plus 1.044 is 4.75. So, this is 4.75 cubic meters. So, this how we compute the volume of a log is in the quarter-girth formula, and we can also compute the volume of a stack.

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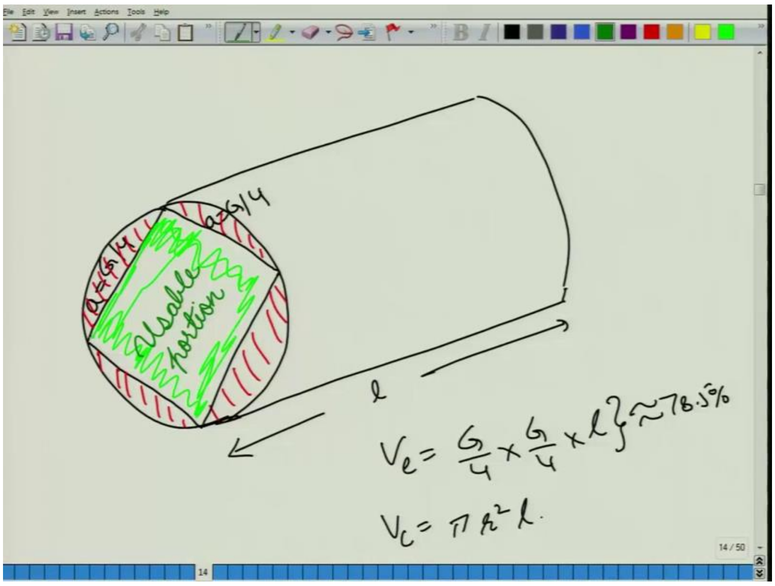


So, to summarize what we are doing here is that we are taking our log, then we are approximating it with a cuboidal cross with a cuboidal portion of it with it is end cross sections as squares of the side given by G by 4 and the length to be the same as the length of the solid.

And we compute the volume estimated is equal to G by 4 into G by 4 into l. And the correct volume is given by pi r square into l and this value is approximately 78.5 percent of the correct volume. And this is useful because when we use this wood for any applications then this portion is lost in swing operations, this portion is lost in swing operations, this portion is lost in the swing operation and this portion is lost in the swing operations. And essentially this central portion is what we are able to use. So, this is your usable portion. Now one other thing to keep in mind is that this equation was given a very long time back more than 100 years back.

So, in those days in the swing operations we were losing quite a (Refer Time: 21:11) amount of word, when we were removing these d s, but these days the modern technologies have permitted us to lose as little as 5 to 10 percent of the wood in the swing operation. So, whatever is left is also used in some other applications; however, because of it is historical roots also because it is easy to compute and also because it gives some amount of leave it to the merchandise that I have use in the wood, the quarter-girth formula is still being used.

So, this is a just one quick estimate that you can use to compute the volume of a piece of solid wood. So, that is all about quarter-girth formula.

Thank you for your attention, [FL].