Farm Machinery

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Lecture – 22
Design of a Seeding Equipment: Part – II

Dear students, I welcome to you to my lecture number 22 which is Design of Seeding Equipment Part-II. In fact, you must have seen that we discussed over the last 5-6 lectures in which we talked about the different seeding equipment, where may be a seed drill or a planter or a pneumatic planter and things like that including even vegetable planters.

Now, here we would like to learn about the different designs which are involved in a for these a equipment. Well, we will go into the components one by one you have seen the in the previous in the class we have talked about the hopper. And, after the hopper then where we keep the either the fertilizer or the a seed we need to meter that to the soil level or into the farm. Now, what is the idea behind doing that? What is the mechanism involved in that? What are the components made of? What is the mechanics behind that?.

Everything needs to be learned as an engineer because, then this will help you in working out a new design. Supposing you are thinking of modifying the design or you are thinking of a completely new seeding equipment. Then you will think of this as the base and then you will go ahead with incorporating the new designs, which we think to be tested or to be incorporate it for betterment of the seeding equipment or for better efficiency of that equipment.

So, in this regard let us follow the slides which I have put together here. In fact, there will be a lot of mathematics involved and that is why the slides have put across and we will go very slow in this so, that you can understand. And, definitely during the process when we will have the assignments etcetera at that time, you can learn about any difficulties you have faced or any clarifications that you require could be taken care of at that time. So, let us go to the second slide.

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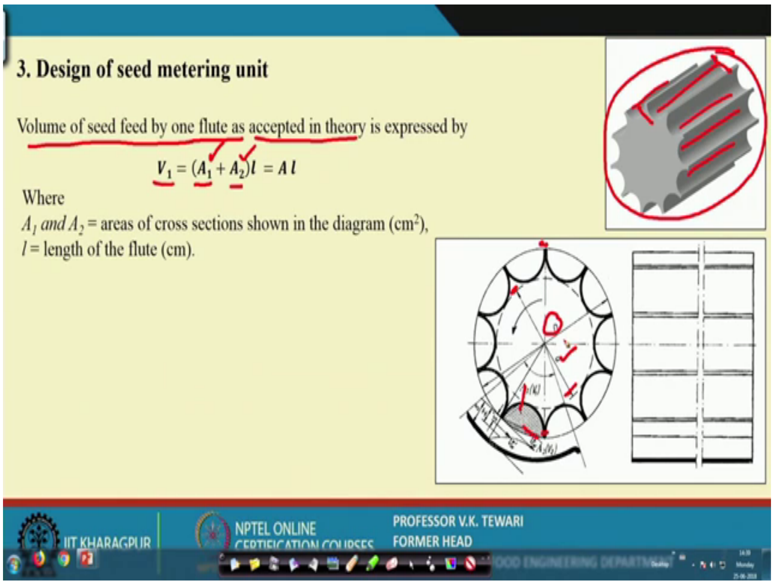

Design of seeding seed metering unit. Well, first is the seed metering unit because we know that the hopper is the one, where we have the whole material the seed or the fertilizer. We are talking of seed here let us consider it only and seed.

So, in the seed hopper we need to have the metering mechanism. Now, how to design that? See what happens is we would have decided that what is the seed rate to be given in a certain field as for the design or as per the requirement of the crop and, what is the spacing that we would like to maintain? What is the speed at which we would like to operate our equipment or the structure drawn equipment or the seeding equipment which we have.

So, when we are talking of these definitely we must have an idea about what is the volume, what is the volume of seed which is being fed through that small unit. And that unit is known as seed metering unit; that means, we will meter the seed right from the hopper to the a last point which is the soil in the farm. So, we are talking of the one which is very popular the one which is very popular is the fluted roller type.

Now, there are other types we will talk of them at a later stage, but then we will discuss more about fluted roller type, which is very widely used. In fact, this is the one where now lot of modifications have been done and people have changed their the material also; so, that they damage the seed is minimum. So, that germination will be higher etcetera. So, we have taken the metering unit as a fluted roller type.

So, the fluted roller type this is the fluted roller type is the one which we have decided. These are the flutes which you can see here, these are the flutes which are there inside which the whole seed falls. Now, we have decided that this total volume which will be there inside is not necessary not exactly that we can calculate. So, there are ways by which we can calculate and how do we calculate.

See here we are talking of V 1 the total volume, volume of seed fed by one flute as accepted in theory as expressed by V 1 is A 1 plus A 2 into l, l is this length the length of from here to there; this is the total length of the flute. So, A 1 is in area of cross section shown in the diagram l is the length now. What are those A 1 A 2? Now, you see if you come to this particular slide here then we see that this is the area A A 1, which is shown over here, this is the area and this is a small area which is A 2.

Now, this area because what happens the whole thing is there inside the hopper and when it is in the hopper these flutes so, they will be filled up and, how much is the material which is carried inside this is the one which is of question and which is important to us. So, we say that will certain portion will be there in the flute and certain portion will be slightly more than that or slightly maybe lesser than that; we do not know what it would be.

So, we would like to find out this A 1 plus A 2. We tell that we will be editing I will put that this is an addition from the actual groove and then extra whatever comes. So, for that we will have V 1 is equal to A 1 plus A 2. And once l length is multiplied so, you know that this is the area the volume of the cylinder which will come into area and to length will give you the volume in the cylinder. So, now if the so, here if we see the whole thing in this then we find here that there are 2 a diameters or the 2 cylinder diameters.

One is the outer one which is here you can see this the outer one from this point to this point over here which is called D then the other one which is dotted one from here and if to this which is small d. So, these are important to us because, we will be requiring this to find out as to how much is the material which has gone. And, we will be interested in finding out from each flute what is the amount of material. And once we know the number of flutes, once we know the speed at which this flute is moving with respect to the ground wheel we will be in a position to find out how much is the total volume. So, this is how we will proceed. Let us go to the second slide.

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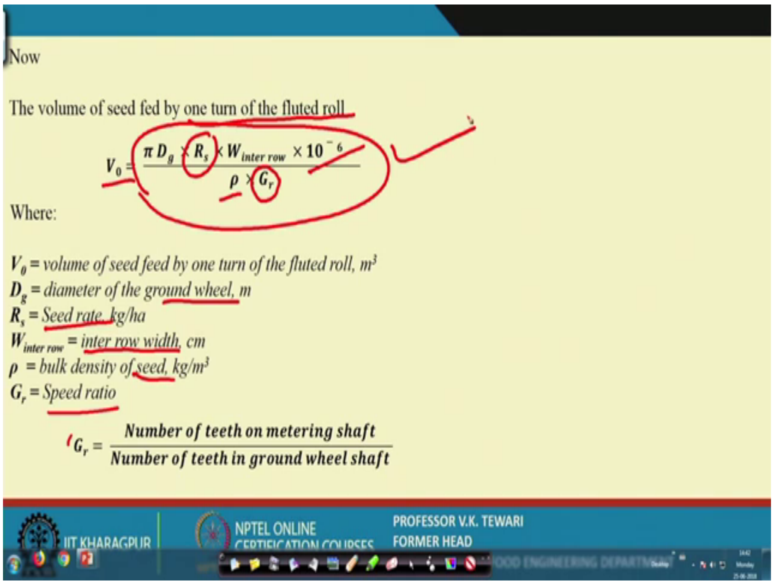

The volume of the seed by one turn of the fluted roll right. Now, fluted roll you have seen that the fluted roll had several flutes. So, when the fluted roll is turning once, what is the total volume taken. That is now, you see here volume of seed feed fed by one turn of the one turn of the fluted roll. So, V 0 here this depends on then what D g diameter of the ground wheel.

Yes, it will depend on a diameter of the ground wheel. Then W is the inter row, this is the inter row width inter row width between the rows of the plant. Then R s this R s, this R s is seed rate seed rate which has been defined or designed for that particular crop because, it will vary from crop to crop and from condition to condition and requirement to requirement.

Then D g we have target of diameter, this here ground G r this is the speed ratio, G r is speed ratio. Now, a speed ratio between what? Speed ratio because we are interested that when we are taking power from the ground wheel, how much is the ground wheel rotating and how much is the rotation of the metering shaft. So, G r is therefore, number of teeth on metering shaft by number of teeth in the ground wheel. It is just number of teeth or you say the speed. So, the ratio of that is the one which is G r.

So, once we take this into consideration by taking into the taking to consideration the units as well, this is 10 to the power 10 to the power minus 6 also comes into picture where volume is given in meter cube. So, the total volume of the seed fed by one turn of the fluted roll so, it has been how many turns are there and how many number of flutes are there in that. So, we need to understand this part of it there while, we are trying to find out what is the total volume of seed which has been fed by one turn of the fluted roll. So, it takes care of the ground wheel diameter, the seed rate at which it is designed.

And, then the inter roll width between the crop and density of the seed of course, density and seed because we are talking with respect to the total volume. And, the here the seed rate is in kg per hectare kg per hectare. So, definitely we have to talk of the bulk density which is in the rho here. So, then taking this if you calculating you will find that, this volume is given by this particular this particular formula right. So, the volume of seed fed by one turn of the fluted roll V 0 is given like this. Now, let us go ahead.

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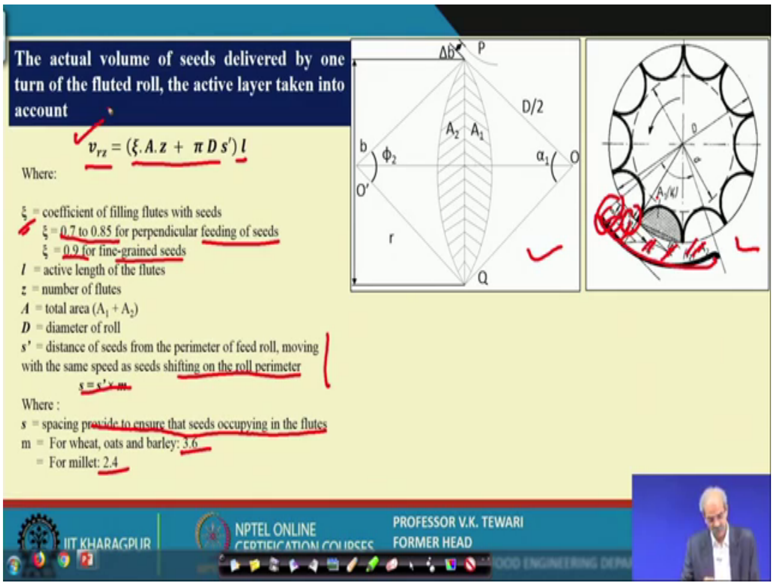

Well we have seen there is a 2 figures, in this figure and this figure. Now, the actual volume of seeds delivered by one turn of the fluted roll, the active layer taken into account of course now what is this? We had talked of that V 0 is something else here. Now, what happens is that the coefficient of filling flutes with seeds xi. Now, what happens generally we are thinking that, this will have enough filling and there would not be any place in the flutes left for the seeds.

This will be completely filled this is what we feel, but this generally does not happen. So, we find that this coefficient of filling flutes with seeds is varying from 0.7 to 0.85 for perpendicular feeding of seeds and 0.9 for fine grained seeds. Yes, it is like this therefore, what comes to us is the total area which we had got earlier A 1 plus A 2. The area which we have gone has shown you there this A 1 and A 2 which was there in the figure and here also we can. So, this is the A 1 and this is A 2, here A 2 this one.

So, A 1 plus A 2 area. Now, z is the number of flutes. How many flutes? Yes, definitely because the number of flutes are important we are talking of the total flute one rotation of that and how much we have got. What is the total volume? We assumed that everything will be filled up, but that does not happen and that is why we have incorporated effector xi, l is the actual length of the flutes that is known to us earlier. D is the diameter of the roll; well the D is the diameter of the roll, which has been told earlier dist.

Now, here there are two important things: we need to look into this s distance of seeds from the perimeter of the feed roll, moving with the same speed as seeds shifting on the roller perimeter. Now, you can see here that s dash this s dash this is this is s dash if you with see this s dash here is important here. Because, this s dash is the distance of seeds from the perimeter of the feed roll, from the perimeter of the feed roll what is how much is that amount because, we do have the, with the same speed as shifting on the roller perimeter.

Now, s is equal to s dash m where m is what, m is for different seeds. So, what exactly we get is because we are getting the through this s dash we are getting this total s. Now, this s talks of how what will be the total amount of material which will be inside this, this area. You can see that from here to this under this area under this area. And therefore, now we have this s spacing is spacing provide to ensure that seeds occupying in the flutes.

What is the total lemma? What is the complete amount of seeds provided there? Will be m times this s dash and m is well for m this is of course, from literature we have found the people have done research and on that basis we got that m for wheat, oats and barley is 3.6 and for millet 2.4. So, if you can take this than the amount s, s here the which will be above the into the fluted role, you will get that value of s which is m times s dash. And, s dash this is distance of the perimeter is distance from the perimeter of the feed roll.

So, if we have this now go back to the equation here v rz v rz here is talking of xi times A times z, where z is the number of flutes, A is the area it were total area and xi is one which we consider that it may not be completely filled up certain portion is filled up plus pi D s dash. Because, pi b is the total diameter which comes out over here and then the s dash is the one, which is above it. So, pi D s dash is the total distance actually, this will be total here.

And, then if we multiply the whole distance into l we are going to get the total volume because, this will talk of the area this D and s dash is area this is also area. So, this total will be area into this length will give you the value of volume of seats delivered by one turn of the fluted roll, active layer taken into account. This is the value. So, if we understand this part of it now, we go ahead because we are interested to find out how much is the area or how much is the volume of the seat which is above than the fluted role.

Because we would like to know the total amount which is falling it is essential. That we may think that we are seeding 120 kg per hectare and then we find that because of the faulty design of the fluted roll we do not get that. So, we have to be very careful about this part.

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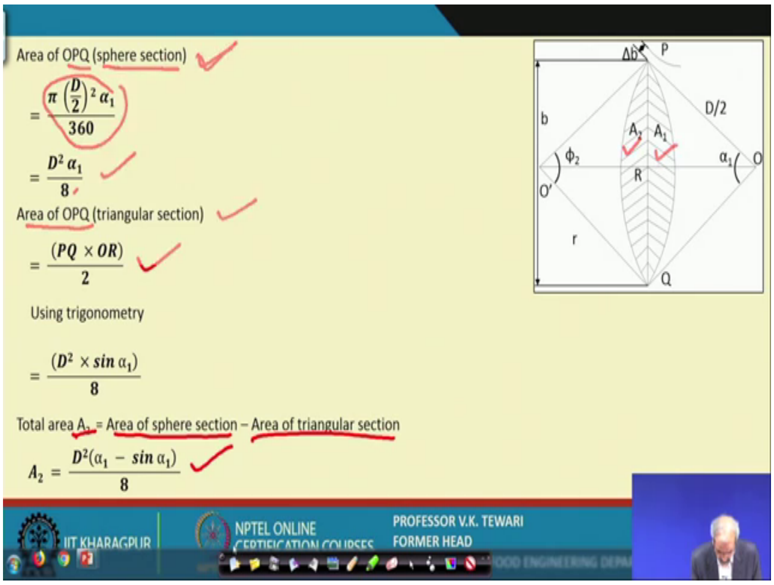

Well, we need to know this what are what are those actually, we would be interested to find out what is this A 1 and A 2, which I had shown you in the earlier; what you had shown you A 1 and A 2 in the earlier figure. So, this is these are the values A 1 and A 2. How do we find this? How do we calculate these for out of the diagram which we have given? Now, you see that we have in order to find out this A 2, what we have? We have O P and Q; this is the OPQ which is a spherical section. So, this is sphere section OPQ is the total a section area which we are getting.

Now, this area is nothing, but is equal to this from the formula direct formula of spheres here. Now, which comes out to be D square into l 1 alpha 1 by 8 where, alpha 1 is this. This alpha 1 if you go if you see the earlier figure, this alpha 1 was the area was the angle which is covering the whole portion of the of one of the flutes, one of the flutes.

So, then D square into alpha 1 by 8 this is the value which talks of OPQ. Now, in order to get this we must they are the subtract this from O angle triangle OPQ. So, we must subtract the area of this from here. Now, what is the area of O triangle OPQ? The angle of the triangular area OPQ is nothing PQ into OR by 2 which is nothing, but half base into altitude.

So, we are talking OR is this, then PQ is this who are base into altitude this will give you this area. Now, using the geometry then we are finding out what are the values of OR PQ etcetera and taking into consideration this alpha 1. So, totally then area A 2 can be found out from subtracting this subtracting form out of this we have subtracted this. Now, these are given here.

So, area of sphere section minus the area of triangular section will give us A 2 and this A 2 taking into consideration, this angle alpha 1 we are getting A 2 is given by this here. Now, we need to find out A 1 also because, these two are the ones which are important to us. So, how do we go to find out A 1? We will follow a similar methodology as we have done in this case, that we will have O dash P Q here and then O O dash P and Q triangle here. So, similar thing we will do and try to get the values of A 1 right.

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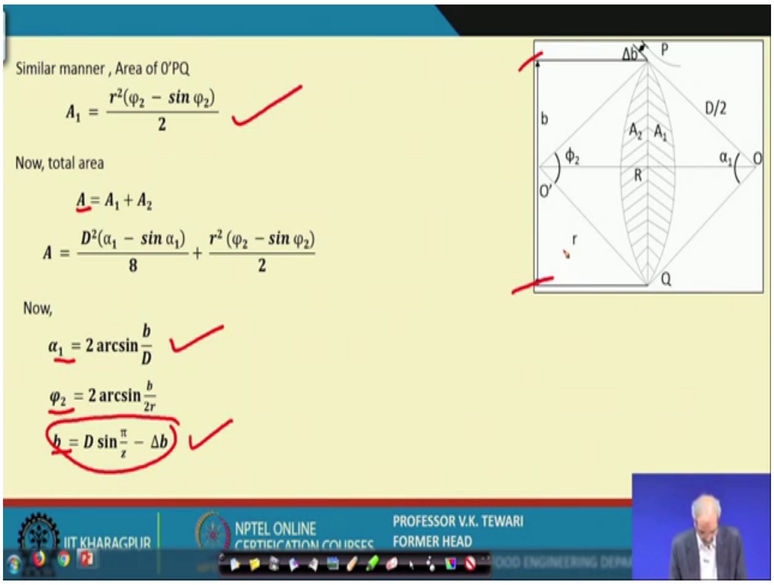

So, in the similar manner as I said we are getting the value of A 1 which is which is this. Now, if you work out you will be in a position to get this, you can phi 2 is the imaginary angle as it is as we have taken with respect to alpha 1, this is phi 2 angle. So, this phi 2 is now we will get eliminated with the trend trigonometry and then ultimately what we are getting with respect to A 1 and A 2 is A 1 plus A 2 here which is the total area A.

Now, A 1 we have got already D square into alpha 1 minus sin alpha 1 divided by 8 plus this is r square. In fact, if you take this into diameter you will get the figure 8 over here also, but we are taking this as the radius. So, we are getting here phi 2 minus sin alpha phi 2 here. And, now alpha 1 which we have got here with respect to b and D, we will get these values this is b here. And, this is the value which is D they total into half D. Then so, b is known to us b is the diameter which has been already said and this is half of this over here.

So, alpha 1 is this then phi 2 is this. So, b is equal to D sin pi by z minus twice b. Now, this is the value which we are getting about b, this distance from here to there. So, we are now in a position to get everything with respect to two total area what we have and we know the length. So, once we know the length and area we will be in a position to get the total volume yes.

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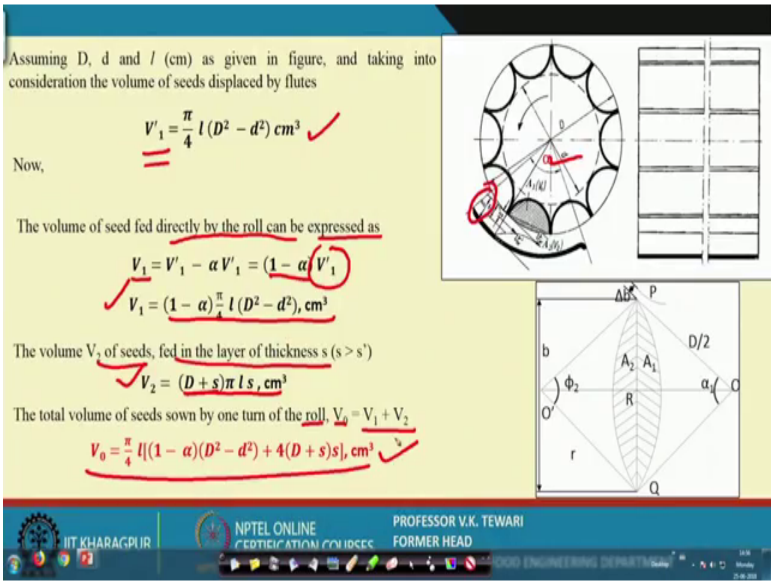

So, assuming D which has been told to you the d and small l has given the figure and taking into consideration all the aspects of seeds displaced by the flutes, when it is there inside the hopper we get if a diameter sorry a volume which is V 1 dash pi 4 this here. Now it is nothing, but pi D square by 4 into l, this is the volume which we are we are so, on we have shown here over here.

Then the volume of seed fed directly by the roll can be expressed as, now what how much is the one which is fed by the roll. Now, with you so far we were talking about how much is there inside the a roll flute fluted roll and then how much is being delivered because, this has a meaning. It fully may not be delivered because this is continuously moving. So, what do we get yes we find that this V dash V dash 1 which is nothing, but pi D square by 4 into l and taking into consideration both the diameters; the inner diameter and the outer diameter we actually get this.

So, what we get is alpha here V 1 dash V 1 is nothing, but V 1 dash minus alpha times V 1 dash. Because, we feel that this is the angle alpha this is the angle alpha, this angle considers from here to there this is the angle alpha this angle alpha here. So, alpha times V 1 dash here. So, V 1 is V 1 dash minus alpha times that means 1 minus alpha into this. Where now, if you want to find out the value of V 1 dash because, this is V 1 dash here and V 1 dash we have already found out.

So, if we find out V 1 then this will nothing, but 1 minus alpha here times V 1 dash which is given over here. Now, this talks of the volume V 2 of the seeds fed in the layer of thickness s, the small layer of thickness s which we had we had shown over here. So, in this layer this is the thickness which has been shown in this layer s. So, what is the total volume then, diameter D plus s definitely. So, diameter D plus s here into pi D, then now this is l, l is the total length and s here will talk of the thickness of that. So, thickness of the layer which we had discussed earlier s dash.

So, what we are getting is total length into thickness and then the diameter. So, we will get this as the volume V 2 volume V 2 therefore, the total volume of seeds sown by one turn of the roll, is V 0 which is nothing, but V 1 plus V 2 and then we have got V 1 over here and we have got V 2 over here. So, once we add these we are getting the total volume of seeds sown by one turn of the roll. So, we are now in a position to see how much is sown by one turn of the roll, fluted roll here and this is the total volume.

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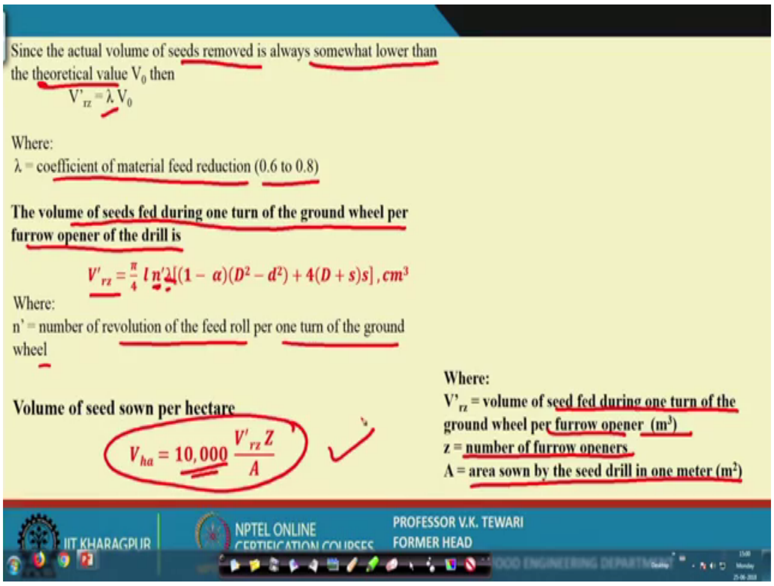

Well, since the actual volume of seeds removed is always somewhat lower than theoretical value. Yes, this is another thing which I we have been talking right from the beginning of the design here. That we feel that the fluted rolls will be properly filled up to the brim when the and they are am tied the whole thing it will be complete, but those things do not happen. We have seen that there is a small hump amount of seed which will be there; it is also possible that the total volume may not be emptied in to the seed tube.

So, that is why there is a feeling that the, that seed removed is always somewhat lower than the theoretical value. We think theoretically this is the value, but it will be slightly lower yeah. Let us say how much is lower a figure lambda. So, this is the coefficient a material feed reduction. Yes, there is a assumption here and there is quite likely this assumption. Because, on the basis of what experience we have seen in the field or you might have also seen you will see when go to the laboratory classes. Or when you take a seed being tube and or a seeding equipment and go to the field you will find and if you make a transparent system by which you can see from outside you will see what happens. So, that is why we say that actually it does not fall that much so, we are making an assumption.

Now, these are engineers way of looking at things because, as an engineer you would like to be as realistic as possible about the design. So, therefore, we think that a slight reduction of the order which is varying from 60 to 80 percent or 0.6 to 0.8. And therefore, this lambda enters into picture about for the total volume of seeds fed during one turn of the ground wheel per farrow opener of the drill.

Now, this comes into picture then because we had talked of that there will be a slight reduction. So, this lambda now comes here. So, this lambda has come, we have already said and n dash is the number of revolution of the feed roll per one turn of the ground wheel because, there is a ratio between the ground wheel and the metering shaft. So, this ratio depending on this ratio we will have a number of revolutions.

So, this revolutions also comes into picture and accordingly then the volume of seed which comes is V dash rz. And, if you want to convert this to per hectare the total volume sown per hectare is nothing, but this here which is the volume of seed fed during one turn of in meter cube. Then the number of furrow openers because these per furrow opener. So, the number of furrow openers will give this much and then area sown by the seed in meter square.

So, if you take this you will find that this comes into hectare because, we have a dimension here 10,000. So, 1 hectare is nothing, but 10 to the power 4 and that is how then the total volume shown per this is this is value. So, ultimately then we are now in a position to find out or while designing a seed metering a mechanism particularly in this case of fluted rod we have designed and we have taken all considerations as to what should be the value.

How much is possibility of filling up the flutes? How much is the possibility that it may not filled up or how much is the possibility that all will be not employed or full will be implied m m tight. This we need to look into actually and that is what we have considered as an engineer. Now, we will think of this at a later a stage may be a problem, when we take up a problem we can discuss more and more and try to understand this.

Thank you.