Engineering Metrology

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Lecture - 25
Laboratory Demonstrations: Gear Vernier

Good morning welcome back to the Laboratory Demonstration session, in the course Engineering Metrology. So, the next instrument I have picked here is Gear Vernier. This gear vernier is very similar to the vernier calliper.

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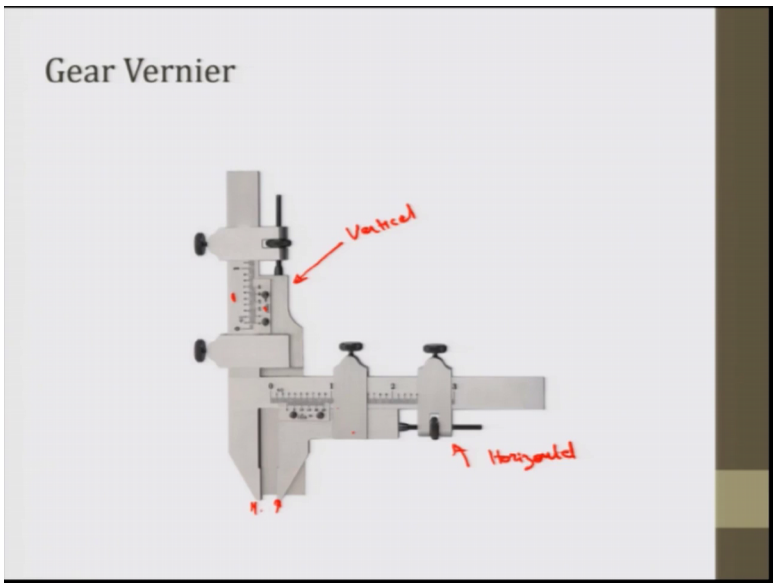

So, the difference is that is it is having 2 scales; one is the vertical scale, another is the horizontal scale ok. So, we have the main scale and vernier scale both the scales here and we have 2 jaws here.

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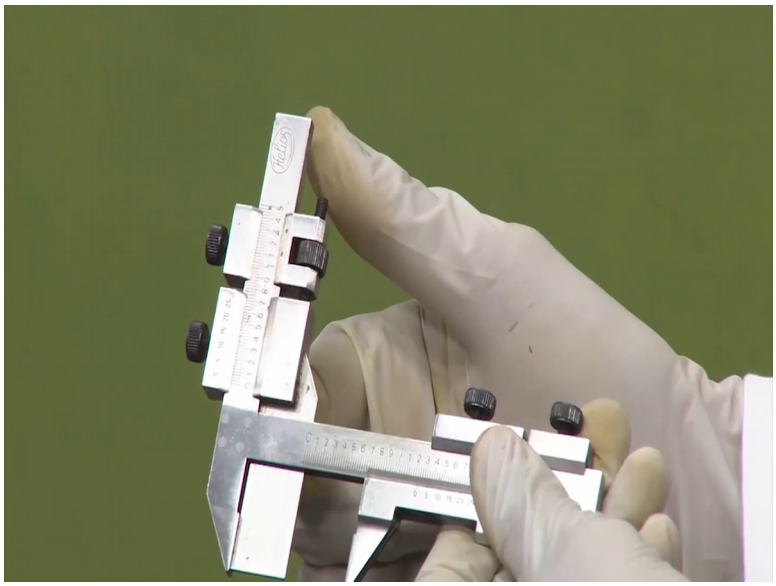

So, we can see that there are 2 jaws and the jaw that is connected to the vertical plane, vertical scale is having a plate attached to it, this is plate attached to it. The purpose of this plate is that when we will try to measure the dimensions of the gear, this will lock towards the outer diameter of the gear.

We will just show you right now. And, there is another horizontal scale, when I close the horizontal scale you can see that there is slot here in the horizontal scale. And, this plate can move inside the slot, this plate can move inside the slot. So, this is horizontal scale, this is vertical scale. So, the vertical jaw I can say the horizontal jaw; however, this is calliper only. So, you can see that this distance or the distance of the plate from the tip of this jaw, this is about 1 mm this distance is about 1 mm ok, this is a small distance here.

This 1 mm is already calibrated in the instrument, if I close it here, you can see that 0 here is coinciding with not 0, but first reading that is 1 mm this is 0 is coinciding with the first reading not the 0 ok. So, this is the adjustment that is made to adjust this length. So, this is coinciding with the first reading here. However, if I remove my horizontal scale it can extend further. So, if I touch it with a surface plate, if I touch it here completely then lock my screws. Now, we can see that this is exactly flat and here the 0 is coinciding with the 0 ok, but our purpose is to measure the feature of a gear exactly gear tooth. So, when I insert it so, this 1 mm adjustment is here.

Now, to find the least count you can see that they have 25 divisions on the vernier scale. And, also it is interesting to note that on the main scale between 0 and 1, there are 3 there are actually 4 divisions. In general we have 5 divisions between 0 and 1, but here we have 4 divisions 1 2 3 and 4, 1 2 3 and 4. So, you can see that the last reading is coinciding with 6.1. Actually, this 0.1 is the adjustment here. So, it should actually coinciding it has to actually coincide with the 6 reading. So, 6 into 4 24 and this is 25.

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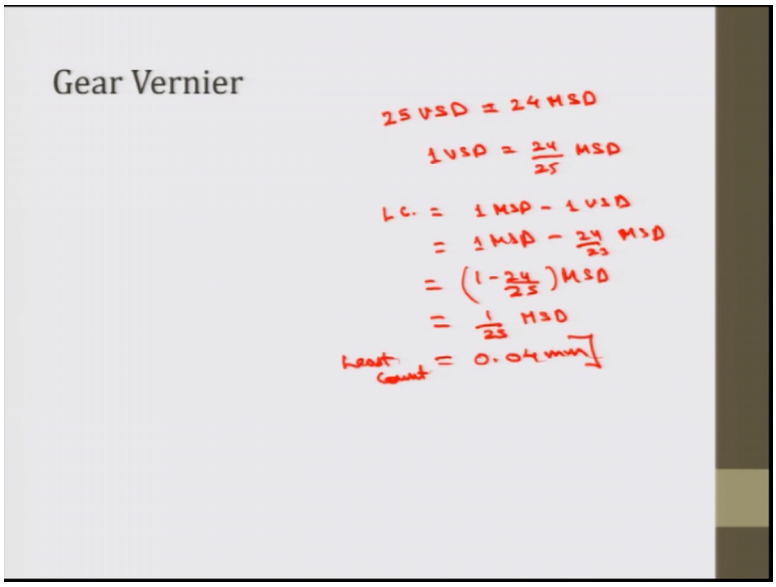

So, I can calculate the least count, the least count of vernier calliper we can see that 25 vernier scale divisions is equal to 24 main scale divisions, which means 1 vernier scale division is equal to 24 by 25 main scale divisions. Therefore, least count which is equal to 1 main scale division minus 1 vernier scale division, which is equal to 1 main scale division minus 24 by 25 main scale division, which equal to 1 minus 24 by 25 main scale divisions, which is equal to 1 by 25 main scale divisions, main scale divisions which is equal to 0.04 mm, this is our least count.

So, we can see that on both the scales on the vertical and the horizontal scales on both the sides, we have similar types of vernier scales, similar types of divisions. The only difference in the vertical scale was at that the first division was not coinciding. So, it was an adjustment to make this plate enter into the horizontal scale. So, we have got the least count. Now, I have got a gear here.

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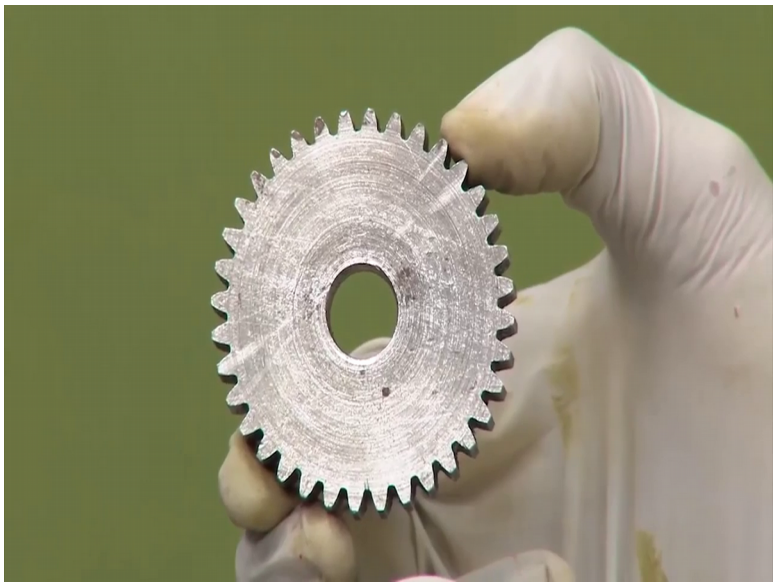

This is a gear, which is having outer dia, that we have this is actually gear manufactured in our manufacturing science lab in IIT Kanpur only. It is it is actually manufactured on a milling machine using the indexing attachment, the number teeth is equal to 36 outer dia is equal to 57 mm.

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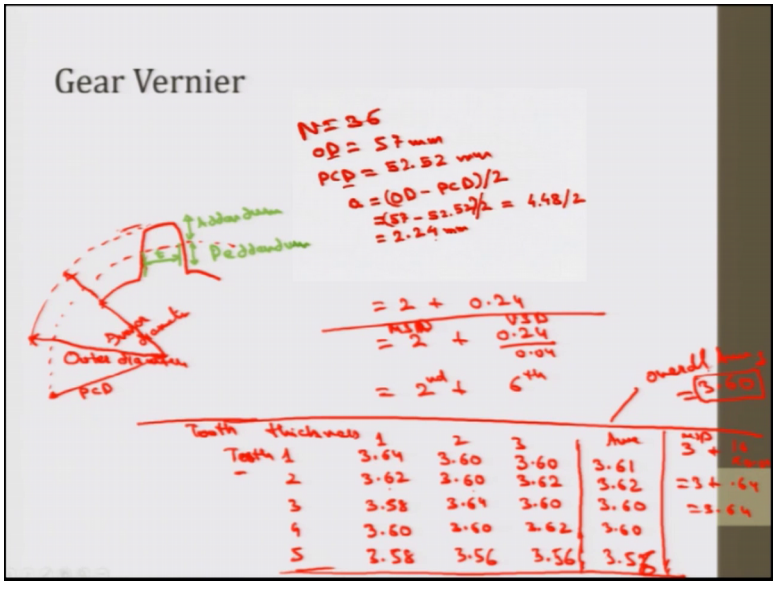

So, as we know the gear terminology. If this is a gear tooth ok, this is our inner dia, this is a centre ok. Let me consider this as a centre this is inner dia and this complete or from here to here this is outer dia and in between here we have pitch circle diameter.

So, pitch circle diameter is a diameter of roller, which would rotate in the similar way as the gear rotates. So, it is actually a dia where the mean dia of the contact between the 2 machine gears. So, we need to check the depth or the thickness here this value, this value thickness t at the pitch circle diameter. So, for that purpose we can use this gear vernier. So, first I need to see what is the value of addendum? Let me see first: what is the value of addendum this length is actually addendum, this is taught before this is deddendum. So, the value of deddendum would be altered dia minus pitch circle diameter.

So, the pitch circle diameter of this gear is 52.52 mm so; that means, if we need to calculate the addendum, addendum is the difference of outer dia to pitch circle dia and it is half of it. Actually, because this is the diameter an addendum this if we see if I put a centre here this is the radius ok. Addendum will be the point from centre to radius this distance would be radius distance.

So, if I put addendum as a addendum is equal to 57 or better I will put the formula first it is outer dia minus pitch circle dia divided by 2, which is equal to 57 minus 52.52 by 2 ok. This comes down to 8 4 4.48 by 2, which is equal to 2.24. Now, we know the value of addendum and now we can fix the vertical scale to this location. So, at the depth of 2.24 from the outer dia I will try to see the thickness of the gear tooth. So, first what I will do? I will try to fix this height. Actually, you know this can be inserted here, this can be inserted here.

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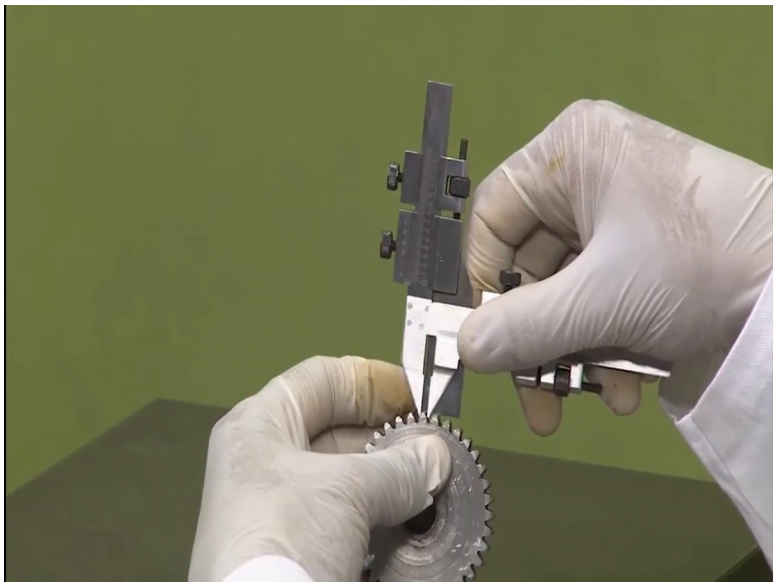

So, we need to see the thickness at the pitch circle diameter, which is the major diameter and whatever wear tear happens to the gear, is generally the pitch circle diameter has bears the maximum wear ok. So, first I will fix my vertical scale to 2.24. So, 1 mm is already there ok. So, I will try to take it a little forward then, the second reading and for 2.24. Now, this is 2.24 this is 2 plus 0.24, this is equal to 2 plus 0.24 by the least count 0.04 this is equal 2 plus ok. Actually, this is main scale reading, this is main scale division I would say this is vernier scale division. So, second division of the main scale and 6th division I put second 6th division of the vernier scale.

So, 6th division after the second division of the main scale has to coincide. So, I will take it, it will forward from the second division. After, that 6th division 0 1 2 3 4 5 6th division has to coincide. So, it has to be a little fine adjustment I will take it closer to the 6th division lock, this fine adjustment screw clamp. So, using fine adjustment screw, I will try to match this 6th reading yeah lock it so, almost perfect.

So, now this height is 2.24, which is the length of addendum and when now when I insert my gear vernier to my gear, it will reach the pitch circle diameter ok. Now, I would like to see the thickness here. First is the sample selection. I like to select a few teeth's 1 2 3 4 5 ok. Let me say I will select 5 or 6 teeth, which are at a equal equidistance apart ok. I have marked them with chalk here. This 6 teeth I will select this is the selection of the teeth also along the axial direction this was along the radial direction, along the axial direction I will take more than one reading 1 2 3 may be 3 readings per gear. So, let me try to take this reading on this first tooth here. So, I will take it forward, it is almost locked lock the clamping screw with fine adjustment apply appropriate force not very large force, not very large force and not very loose apply appropriate force. So, that it touches properly it has touched properly. Now, I lock this thing and note the reading.

So, we can see that after I have locked the both this screws here. So, we can see it and it has exceeded the force reading of the main scale this one reading of the main scale is actually 1 mm ok. After exceeding the force reading it, what reading of the vernier scale is coinciding with the main scale I need to see? So, the 16th reading 0 1 2 3 4 5, 16th reading sorry it is exceeding third reading here on the main scale. After third reading the 16th reading, because they were only 4 divisions ok. They have only 4 divisions it is exceeding the third reading here.

So, after third 16th reading is coinciding here is coinciding here. So, the value of the thickness of the tooth is tooth thickness ok. I will pick teeth 1, tooth 1, tooth 2, tooth 3, tooth 4, and tooth 5, reading number 1 2 and 3 ok. So, the first reading for the first tooth is I will do the calculations here it is actually 3 in the main scale reading plus 16 into 0.04 this is equal to 3 plus 16 fours are 0.64 is equal to 3.64. So, this reading is 3.64.

Similarly, I can pick the same tooth and take the reading at the centre. Let me loosen this clamps ok. Loosen it, again the same principle I will touch it with the fixed scale first and tighten the finite adjustment screw clamp, using finite adjustment screw apply the moderate pressure here ok. Actually, it has to be kept properly like this not in hand. The best way to do it is to lock it in a press vice or in a machine vice we will when we will lock it in machine vice it will not move.

So, we will do it like this I lock it locking it, checking the reading again, you can see that it is again exceeding the third reading, but this reading the sensitivity the further to towards the second place of decimal or the towards the might vary. So, let me see wiring parallax error the reading that is coinciding is wow it is 15th reading, 15th reading is coinciding of the vernier scale with the main scale. So, let me note down this value.

For the 15th reading this value would come to equal to 3.60 ok. And 5 ok, I have put the numbers here 1 2 3 4 and 5. So, as I do not mix the teeth's in the further observations. So, I am just checking the first teeth I have checked it at 1 point ok, at this end at the centre. Now, I will try to check it at the third point. For the third point again I will loosen the screws open my calliper and touch the this is kind of a fixed jaw now touch the fixed jaw take it this further ok, take this further then lock this, then apply appropriate force then lock this screw now the screws are locked.

Now, let us check the reading again. So, it has again exceeded the third point third division on the main scale. Now, let me see which is the coinciding point here, wow again the 15th reading is coinciding; we need to see both the scales here the 15th reading of the vernier scale is coinciding with the reading of the main scale ok. The 15th reading is coinciding ok. This is actually close observation, you can wear some spectacles if you like because there are if you can also use some lens magnifying lens to see this. So, 15th reading is coinciding.

So, it is interesting to note that the readings are quite close here. So, for the 15th reading again this value is 3.60. So, this average 3.64 plus 3.60 3.60, this average comes down to about 3.6 1 ok. This is average you can call it group average. Now, I will just take a small break and make other calculations, do other readings and just note down here, then we will see that how is the gear behaving.

So, I have saved some of your time on taking the readings from 5 teeth here and 3 observations each tooth is taken. So, you can see that in the second tooth 3.62 3.60 3.62 in the third tooth 3.58 3.64 3.60. So, we can see the observations the 5th tooth is a little outlier ok. We can see if I calculate the average here, its average would be close to 3.57 for the 5th tooth ok, for the second tooth it would be close to 3.62 only. This is actually 3.56 close to that and for the third one it will be close to 3 point close to 3.60 this will be close to 3.60 again.

So, based on this I am not calculating the exact overall average I can just say that the overall average or the mean is equal to is close to 3.60 ok. So, based on this the first thing is that 3.60 is my thickness of the tooth at the pitch circle diameter ok. So, this is the overall mean. Now, what is the variation, we I can see that the 5th tooth is a little deteriorated. So, this more wear and tear in the 5th tooth some time these that there is some voice like tick tick tick voice comes and there is a knuckling, or certain reason for that might happen, but we can see that ok, this is the weak point.

We have picked now teeth number tooth number 5 is the weak point and if it further decreases, it can exceed the limit exceed the acceptable limit this value. So, this is the use of vernier calliper also I think I can use the same data I have generated a very beautiful data here. So, I can use the same data in statistical calculations as well. So, I can use the average overall average I have 5 groups and we have this group size as well as the group size is 3, 3 readings per group. I can use the same readings, which we have generated, we have generated a primary data here. And, I will take this to the statistical analysis to find the group means to find mean, median, mode range all those things we will tell you there.

So, this is the application of the gear vernier, we can actually gear vernier is not essentially used while we manufacture the gears. It is used while inspection, when the machines are running and during inspection we can see that which gear if some of the

gears is showing some play or some voice is coming. So, we can just check that is that tooth deteriorate is the wear and tear enough to replace that or not for that gear vernier can be applied.

So, the precaution the guidelines could be similar as we had before for the vernier calliper and for the other instruments cleaning over the instruments, then placing instruments properly, then pressure, then proper calibration, 0 error all those things have to be suggested. So, this was about the gear vernier. So, I will take a break here again and we will meet in the next part of the demonstration, we will pick another instrument to discuss.

Thank you.