Metrology
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Lecture – 36
Geometrical Tests On Pillar Type Drilling Machine

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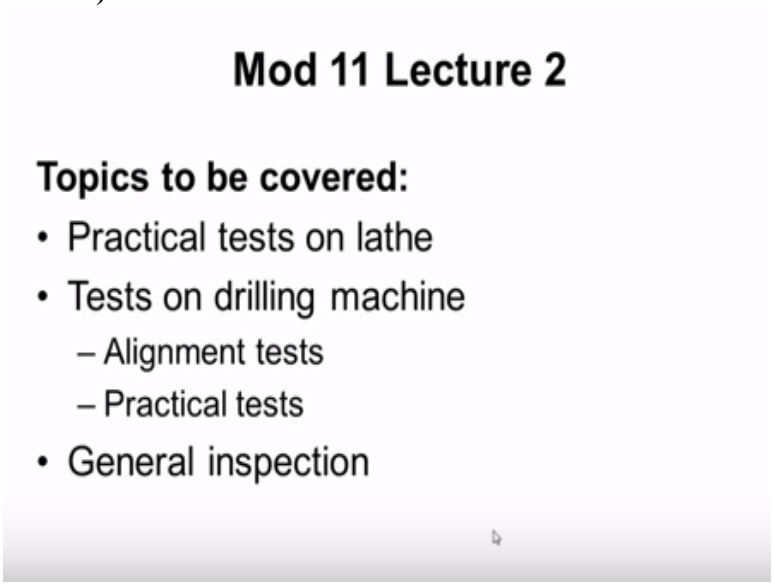

Welcome back to the lecture series on meteorology. Now we will start the module 11. lecture number 2. In this lecture we will be covering the topic practical test on lathe in the previous lecture number one we have discussed about various alignment test in this lecture. We will be covering some aspects of practical test, conducted on lathe.

And then we will move on to pillar type drilling machine under this we will be covering the alignment test practical test and then we will cover the general inspection of machine tools.

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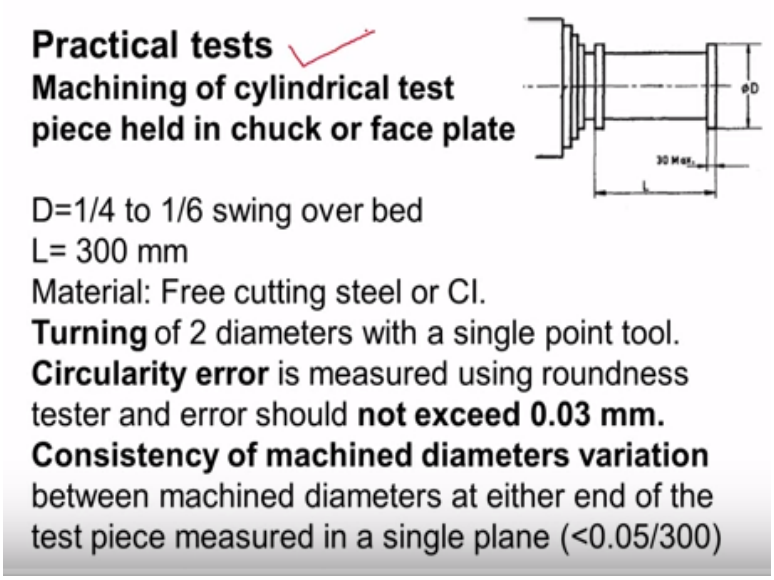

Now we will discuss about the practical test conducted on engine lathe in which the work piece is mounted in a chuck or faceplate. Mounted on the mouth of the late spindle and machine comprises in which phasing and turning are performed and the machine accuracy is tested. In this diagram you can see work piece of length 300 mm mounted in a chuck or faceplate the diameter of the work piece is 1/4 to 1/6 of swing over bed.

If swing over bed is 100 mm then we can take the work piece of diameter of 25 mm and we can fix the work according and we can turn it so length of turning is 300 mm as we can see here 2 diameters machined with maximum 30 millimeter. The work piece material can be free cutting steel or cast iron and 2 diameters of turning using a single point cutting tool.

After that circularity error is measured using the roundness tester on both the diameters and the circularity error should not exceed 0.03 millimeter and then the consistency of machined diameters connected to variation are also checked what is the diameter in the first diameter and what is the diameter in place and then what is the variation that is to measure. The error in the diameter variation should be less than 0.05 millimeter/300 millimeter length.

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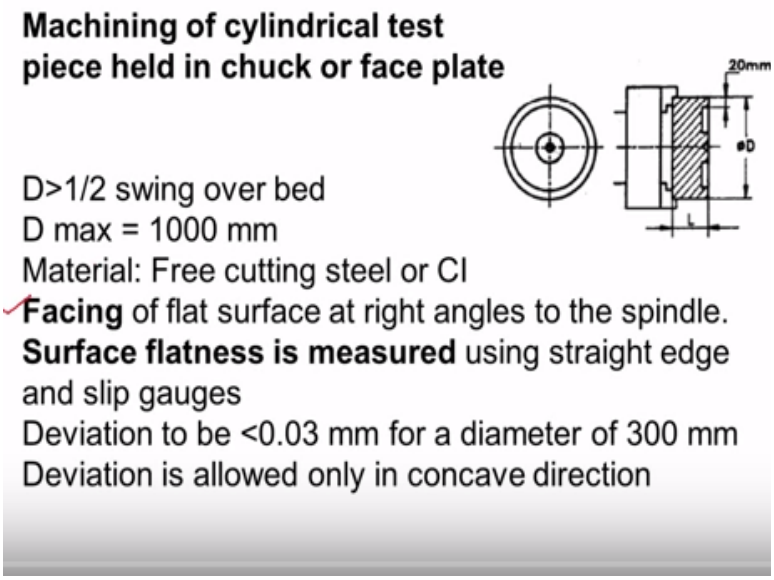

Just now in the 2nd test facing operation is performed. Here the work pieces mounted in a chuck or faceplate. That the diameter of the work piece is should be greater than half of swing over bed. If swing over bed is 100 millimeter then the diameter of the work piece should be greater than 50 millimeter and D max should be 1000 millimeter if swing over bed is more than this particular size and then the material work piece material free cutting steel or cast iron.

The facing operation is performed using a single point cutting tool the tool moves perpendicular to the spindle axis as shown here. And then the surface flatness is measured using a straight line edge and slip gouges. The deviation in flatness should be less than 0.03 millimeter for a diameter of 300 mm and deviation is allowed only in concave direction and all the important text that is practical test that is conducted in the threading operation on a cylindrical work piece.

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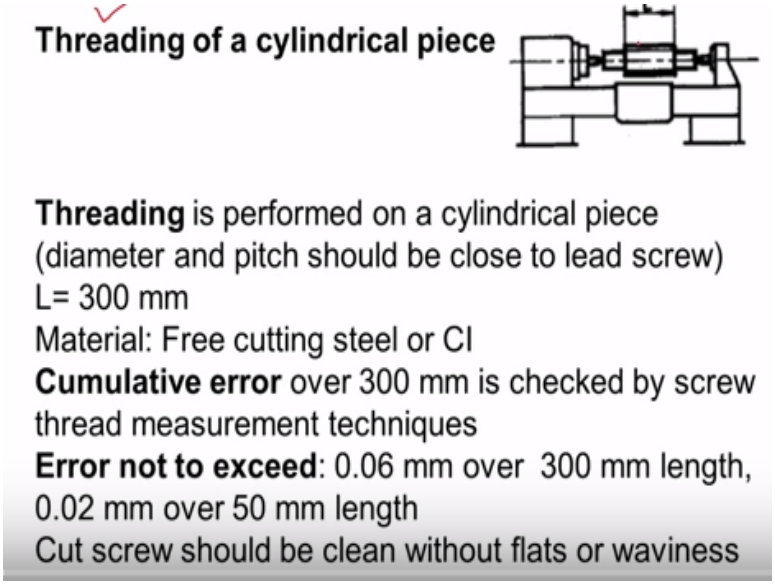

Official work piece of sufficient length is placed between the centre and the screw thread is cut overall length of 300 mm the diameter and the pitch that is but should be close to the lead screw again and the material the work piece material can be free cutting steel or cast iron and after cutting the thread it is checked for cumulative error.

Over 300 mm thread which is cut using cumulative error is checked using screw thread measurement techniques error relative error should not exceed .06 millimeter over 300 mm length or 0.02 millimeter over 50 millimeter length the screw thread that is cut should be clean without flats or waviness

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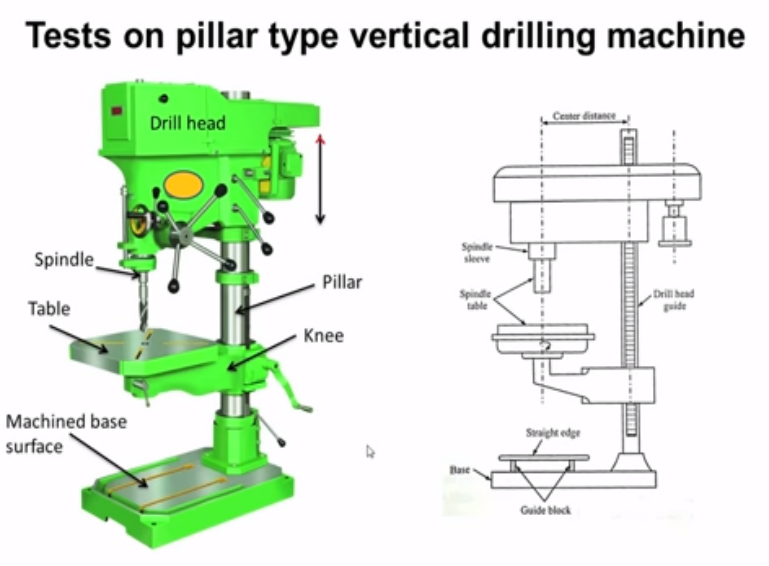

Now let us start discussion on various test conducted on pillar type vertical drilling machine. In this photograph, we can see the appearance of pillar type vertical drilling machine, so this is the pillar round column which supports various parts of drilling machine and this is the base on which vertical pillar is mounted now this is machined base surface you can also see the slots for mounting the work pieces and then they have the machine.

The table surface and the need that supports the table and there is the clamp in the table for clamping the table by loosening the camp we can rotate the table and we can move up this up and down to accommodate the work piece of different sizes and moving the knee up and down we have the rack and there is a lever to move the knee up and down and this is the drill head and this drill head can be moved up and down over the vertical pillow.

This drill head houses the spindle, the electric motor, which is used to rotate the spindle and the cone police or the gearbox our house in this build ahead to accommodate the work piece of different height again we can move the knee and table up and down or we can also move up and down this drill head if you have the very larger work pieces.

We can rotate the table and need to the other side you can directly mount the workspaces on the machine base surface and we can perform the drilling operation. now various test are conducted to check whether alignment is proper or not some test or whether the machine based surface flat or not and the machine table surface is flat or not or if there is any error whether it is concave or convex.

Whether movement of the spindle is perpendicular to the table surface or base surface whether the running of the spindle is true or not whether the movement of the drilling head is parallel to the spindle axis such that such things are tested in alignment test conducted on drilling machine.

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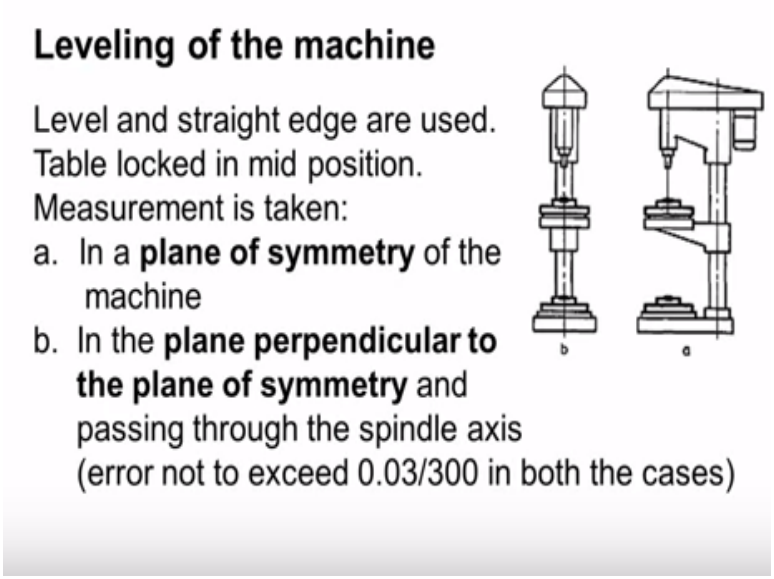

Now we will discuss about the leveling of the drilling machine before conducting any alignment test it is very essential to check whether the machine is properly levels or not or leveling to check the leveling freight level and straight edges are used table and me or log in middle position and then the straight edge is placed on the table surface over which spirit level is placed and then the reading is taken.

Similar procedure is repeated on the base machined surface and the measurement is taken in a plane of symmetry of a machine as shown here and then in a plane perpendicular to the plane of symmetry and passing through the spindle axis as shown in figure B in both the planes there should not exceed 0.03/300 millimeter.

Now if the error exceeds this value or we can always insert thin plates below the base plate and we can adjust the level if the machine is not levelled properly the pillar will deflect and undesirable stresses are introduced in the pillar which is not desirable.

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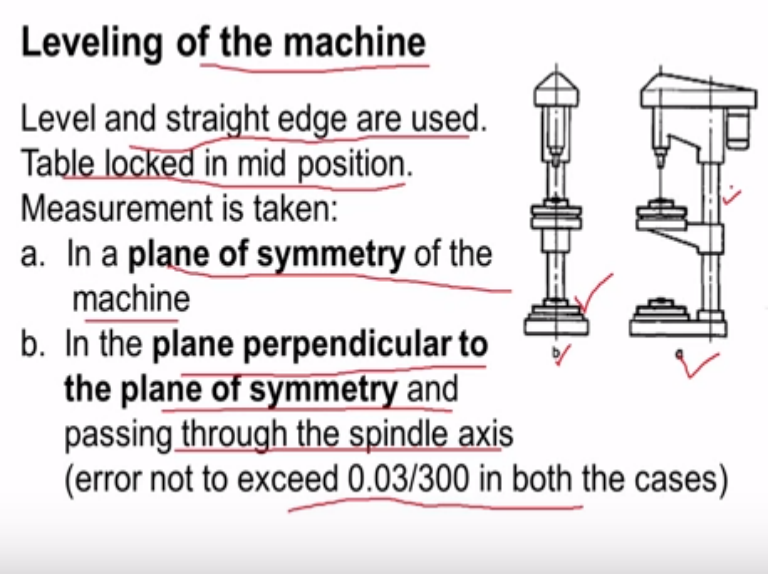

Now we are going to conduct the flatness of the table surface also the flatness of the base plate of the machine. Bass plate of the machine of the mission the surface is also t slots and it should be pillar and we have to check whether this base the machine base is flat or not for measuring the flatness we can use the precision level or which is shown here or we can you straight edge and gauge blocks along with the feeler gauges these instruments can be used to check the flatness.

The test is performed by placing the precision level at different position along the x direction and also y direction and we can note down the reading which will indicate whether the base plate is flat or not. We can also use straight edge and gauge blocks. Gauge blocks can be placed on the machined surface like this over which we can place the straight edge and then this gaps can be filled by inserting the feeler gauges which will give the flatness of the bass surface.

The similar procedures are repeated on the table surface also. Now the error the flatness error should not exceed 0.03 mm for any measuring length of 300mm and the surface should be flat or if there is any deviation the surface should be concave only. So the surface should be like this. If the surface is convex then when we place the work piece on the convex machine table base plate and when we clamp it due to the clamping force the work piece will tilt it may tilt.

Like this or it may bend like this. To avoid this the error should be concave only. If there is convex shape like this in the lathe machine is done, so that the table surface or base surface becomes flat.

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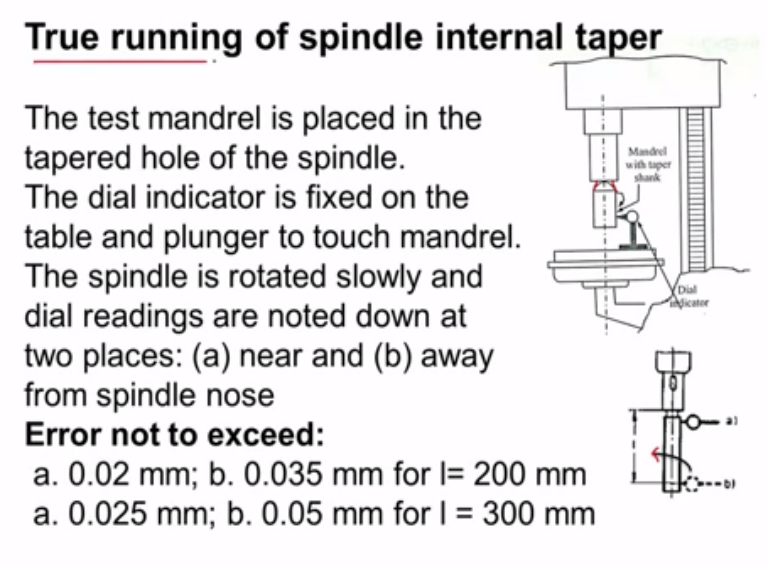

Text, now other important test that is conducted is true running of spindle internal taper here we have the spindle of the drilling machine this is the spindle and inside there will be tapered board this is the axis of the spindle. Now the spindle internal board or internal taper should run through this .insert the drill bit in the taper so if this internal taper is not true then the drill tool will wobble it will verbal and we do not get a proper drill hole.

There may be hole drilled or the hole size increases because of the wobbling of the drill tool. So the true running of the internal taper of a spindle is very essential to test the true running. We have to use a mandrel. Test mandrel of maybe 200 mm or 300 mm length. We have to insert the test mandrel into the tapered hole.

Then the dial indicator plunger should touch the mandrel and the magnetic stand off of the dial test indicator to be placed on the table. The spindle is rotated slowly and that dial readings are noted down at 2 places one near the spindle and then away from this spindle away at a distance of L.

Now there through running error should not exceed 0.02 mm or near the spindle nose 0.35 millimeter at a distance of 200 mm. If we use 300 millimeter mandrel then the near the spindle nose the error should not exceed 0.025 mm and at a distance of 300 m the error should not exceed 0.05 millimeter.

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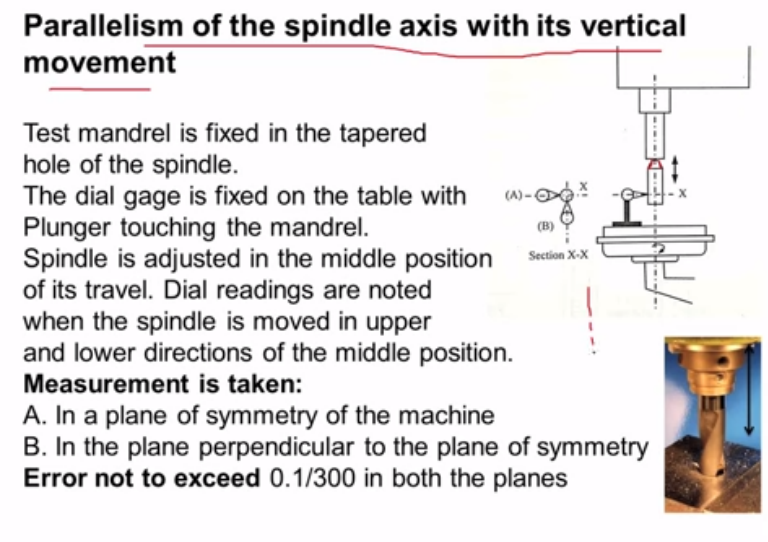

Now we will discuss about the parallelism of spindle axis with its vertical movement spindle we move up and down for feeding the drill tool into the work piece the movement vertical movement of the spindle should be parallel to its axis. If the access this is the spindle axis and the spindle movement is at some inclination then what happens is when we see the tool we get a hole at some inclination of we do not get the drill hole.

But the whole will be drilled at some other angle. So in order to avoid this the spindle axis the movement of the spindle should be parallel to its axis. That we can check using the test mandrel hand dial indicator. Test mandrel is fixed in to the tapered hole of the spindle. That dial gage is fixed on the table as shown here.

The plunger of the dial indicator should touch the mandrel as shown here spindle is adjusted in the middle position of its travel and then dial reading are noted. When the spindle is moved in upper and lower directions from the middle position so when the spindle is moved up what is the reading and when the spindle is moved down from the middle position what is the reading that we have to note down and this experiment will be repeated in both directions or in plane A.

In plane B in the plane perpendicular to the plane of symmetry in both the planes error should not exceed. 0.1 per 300 mm movement of the spindle.

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Now you can see the operator is checking whether the movement of spindle is parallel to its axis or not the plunger dial indicator is in contact with the spindle. And dial indicator is mounted on the machine table. Now the are operator is slowly retracting the spindle and is noting down the readings from the dial edge.

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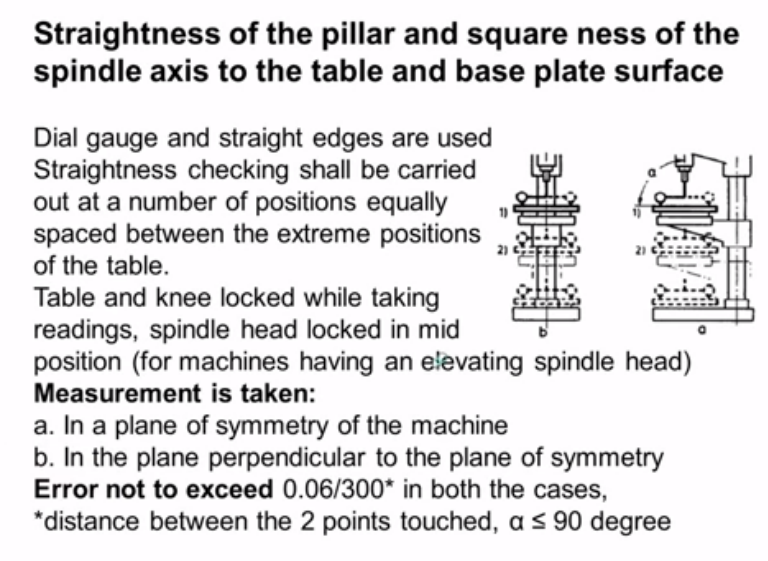

Now we will discuss about the test that is normally conducted straightness of the pillow and square of the spindle access to the table and base plate surface. The pillow should be straight otherwise when we move the spindle knee or spindle head to accommodate the work pieces of different height period then the if the pillar is like this then the cause of this error and the straightness.

When we move the spindle head it most like this and then the axis spindle axis will not be perpendicular to the table surface because of this we get holes at angles instead of the false perpendicular to the surface of the work pieces so before you see or accepting any machine tool we should check for the straightness of pillar also the square ness of the spindle axis to the table.

Whether, the spindle axis is perpendicular to the table surface or the base surface that also we should check. If it is not perpendicular again we get holes inclined to the top surface we would not get the holes perpendicular to the surface. Now let us see how we can check the straightness of the pillar and square ness of the spindle axis the dial gauge and straight edges are used for conducting this test.

Straightness checking shall be carried out at a number of positions equally spaced between the extreme positions of the table. Let us see here the table and the knee can be moved to different positions to accommodate the work pieces of different sizes so it is necessary to conduct the experiment different positions of the table while taking the readings it is essential that the table and the knee should be locked.

We get to move the table and get then knee to get the particular position. Say one. The dial indicator stand is mounted on the spindle and we should see that the plunger of the dial touching the straight edge surface kept on the table surface or the base surface. And then slowly we have to rotate the spindle to 180 degree and in between we should take the reading.

So this procedure the difference in reading from reading at place to this difference gives all the requirements of the spindle access to the table surface to the base surface. Checking the plan as we have to move the spindle head to the middle position and it should be locked and then square ness can be conducted. So this is possible if the machine is having the elevating spindle head specifically and measurement is taken into 2 planes.

In a plane of symmetry of the machine and in the plane perpendicular to the plane of symmetry and error should not exceed 0.06 millimeter per 300 millimeter so 300mm is the distance between the 2 point touch that is the distance between this. And this point is 300 mm and in the case of plane of symmetry of the machine position the angle between the table surface or the shaded surface and the spindle axis should be less than 90 degree or equal to 90 degree.

Reason is if it is alpha equal to 90 degree we get holes perpendicular to the work piece like this

and the angle is if there is any error in the square ness of the angle should be less than 90 degree that means the front edge of the table should be upwards like this so this is the table surface or the base surface the front end should be upwards the reason is when the drilling process forces front edge tilt like this and the error is minimized also.

Other reason is when due to the cutting forces this spindle head tends to bend upwards like this and then he tends to nullify square ness error because of the alpha should be less than 90 degree or equal to 90 degree.

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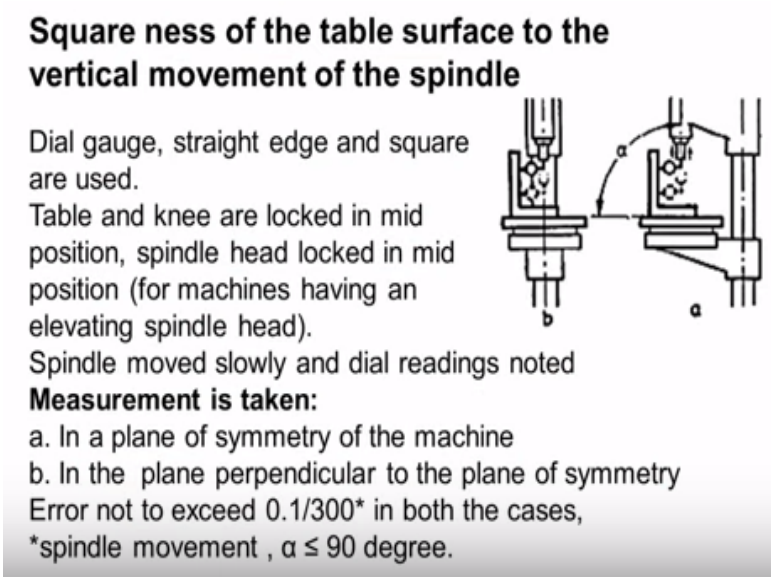


Now another test is square ness off the table surface to the vertical movement of the spindle dial gauge, straight edge and square are used to conduct this square ness test. Now the spindle axis and the spindle will be moving vertically up and down and now this movement vertically will be perpendicular to the table surface, if there is any error we do not get 2 perpendicular to the surface of the work piece.

Now while conducting this experiment table and knee are locked in the mid position. The table and the knee should be moved to the middle position of the pillar all ok also spindle head should be locked in the mid position for machines having an elevating spindle head the spindle head should also be moved nearer to the position and then it should be locked.

The straight edge is placed on the table machine table over which the square is placed. And the magnetic stand of the spindle is placed and the dial indicator plunger should touch the vertical surface of the square initially the reading is taken in this position in number 1 and slowly the spindle is moved up and then at the distance of 300 mm the second reading is taken then the difference gives the square ness error of the measurement is taken in 2 planes.

In a plane of symmetry of the machine in this position and in the plane perpendicular to the plane of symmetry and passing through the spindle axis, now error should not exceed. 1 mm per 300 mm in both the planes, and again if alpha this angle alpha should be less than or equal to 90 degree. The reason is explained in the previous test.

Now this square ness of the table surface to the vertical movement of the spindle head for some machines having an elevating spindle head so where in the spindle head can be moved on the pillar so this movement of the spindle head should be perpendicular or it should be square to the table surface In order to check this dial gauge, straight edge and square are used the street it is placed on the table surface over which over the square is placed.

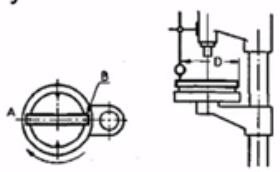
As shown here and the magnetic stand of the dial edge is placed on the spindle and the plunger should touch the surface vertical surface of the square. While taking reading table and knee are locked in with position and spindle head should be locked while taking readings that means spindle is more to the position 1 and the plunger is adjusted to 0 and it is unlocked and it is slowly moved up then here it is locked and then the secondary reading is taken.

So the distance between the position 1 and position 2 is normally 300 millimeter .so measurement is again taken into planes, in a plane of symmetry of the machine and in the plane perpendicular to the plane of symmetry . The error should not exceed. 0.1 per 300 mm in both the planes and its all for the angle alpha should be equal to or less than 90 degree reason we have already explained.

(Refer Slide Time: 29:45)

Camming of the rotating table

Dial gauge and straight edge are used.
Set the straight edge approximately in a diametral plane of the table.
Touch a point A on straight edge, then touch a point B after rotating table by 180 degree
Repeat the experiment, setting the straight edge in another plane perpendicular to the preceding one.
Lock the table before taking reading.
Error not to exceed 0.05 for D=300 mm



Now let us discuss about the camming of the rotating table. Some machines will have this rotating table facility. Now this rotation is required whenever we want to drill holes in a circular pattern the table rotating table of the tilting machine say we have a work piece on which we want to drill some holes in circular pattern like this.

So during that time there will be any camming or wobbling of the table if there is camming of the table then the geometrical accuracy of the holes and the pattern will be lost. So in order to conduct in order to check whether the camming or not use dial gauge and straight edge we have to keep the street it on the table as shown in the here and then the magnetic stand of the dial indicator on the spindle head.

The plunger of the dial indicator and bearing is touching this straight edge. So it will touch like this then we have to take the reading at point A and then we have to rotate table to unclamp before taking the readings we should clamp the table we should clamp the table and we take the table reading here and then unclamp the table and rotate the table at 90 degrees. Now the plunger will touch the straight edge on Point B.

The difference in reading will indicate whether there is camming or not. This procedure is repeated setting the straight edge in another plane perpendicular error should not exceed 0.05

millimeter for d is equal to 300 mm, where d is table diameter. If there is camming we have to machine the whole which guides the table.

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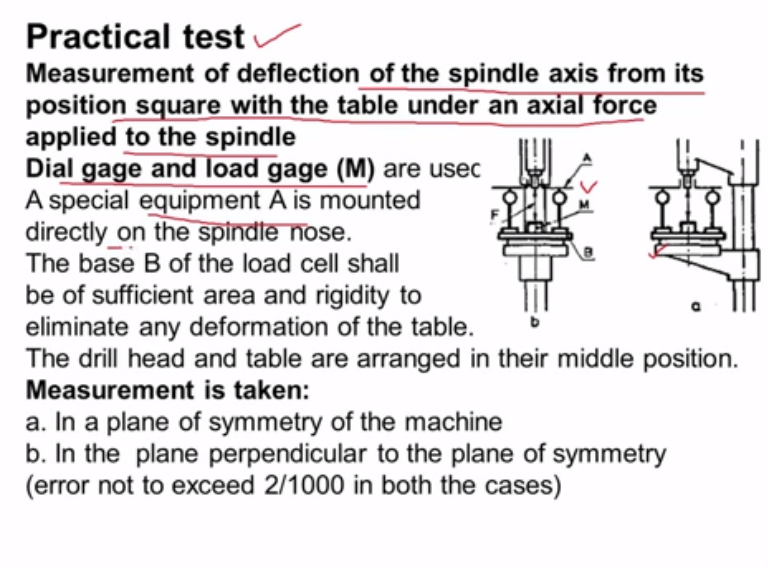

Now let us discuss about the practical test that can be conducted on this type of drilling machine. Actually it is measured the deflection of the spindle axis from its position via with the table under an axial force applied to the spindle or for conducting this experiment we use dial gauge and broad gauge.

So we have to keep the load gauge on the table of the drilling machine as shown here load gauge should be co axial with the spindle axis. This load gauge is capable of measuring what is the axial force on to the spindle nose and then a special equipment A which is shown here is mounted directly on spindle nose. The spindle nose is like this and a special equipment A which looks like this is mounted on the spindle nose so this is special equipment A.

There is a provision for mounting the equipment a on the spindle nose. Now it is mounted on the spindle nose. Then we use the dial gauge for measurement of deflection so we have to keep the magnetic stand on the machine table and the plunger in touch the special equipment A. And now we apply the axial force on spindle nose because of the axial force the spindle head will deflect like this.

So along with that the special equipment you will also deflect like this and now what is the reading of this dial gauge and what will be the reading of the dial gauge can be noted down the difference gives the deflection of the spindle. So this experiment is conducted into plane, in a plane of symmetry of the machine as shown here and in the other plane.

Which is perpendicular to the plane of symmetry as shown in B and that particular plane will pass through the spindle axis during the measurements we have to arrange the drill head and the table in the middle position and they should be clamped properly. The deflection error should not exceed 2/ 1000 mm in both the cases.

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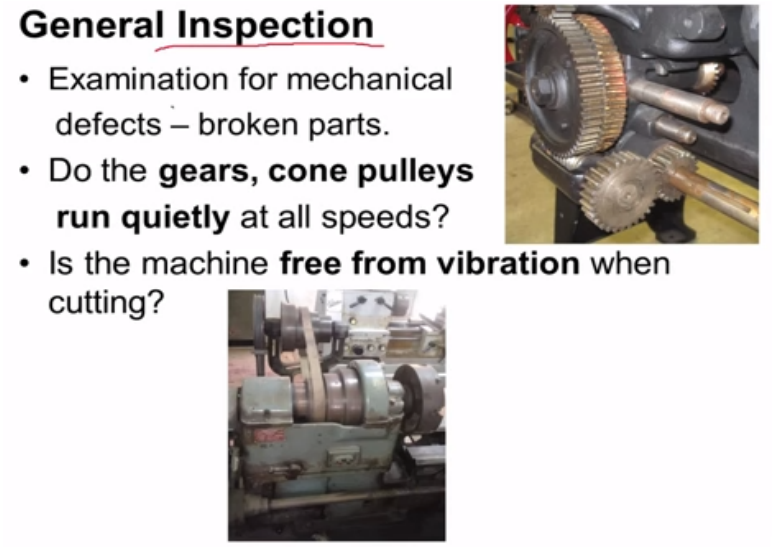

Apart from conducting the alignment test and practical test on machine tool while purchasing the new equipment the new machine tools we have to do some general inspection on the machine tool that we will discuss now. We should examine for mechanical defects in the machine whether all parts are in good condition whether any broken.

What are there that we have to check if there are broken for we have to arrange for replacement and the whether the gears all the gears and cone pulleys runs quietly at all specified speed. We have to arrange all setting combination for gear as well as cone pulleys and we have to run them and we should see whether the running is smooth or not. Is the machine free from vibration when cutting actually we have to conduct a cutting experiment.

We have to mount the work piece and the tool to cut the pieces and to check whether any vibration is there or not if there is any vibration we have to check the settings alignments so that vibration level is reduced.

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Then we should see whether all the listed speeds and feeds are available. we can see many spindle speed like 1170 rpm, 385 rpm and lowest speed such as 165 rpm, 90 rpm they are mentioned in the display we should do the settings of the gear and we should use in an appropriate speed testing device to check.

Whether spindle is running at a specified speed and we should also check whether all the listed speed or available similarly we should check for the availability of different feed rate as mentioned in the manual or in the display. For example the feed rate of 0.73 millimeter per revolution is mentioned and 0.606 millimeter is mentioned.

So we should actually do the required setting and then we should check physically whether the saddle of the cutting tool is moving that the specified speed and similarly we should do some threaded operation to check whether do we get the specified which values of or not.

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Now is the machine adequately guarded? Guarding of the machine also we should check. We can see the different kinds of guarding are used in the machine tools the guard provided for lathe and other type of guard transparent guard provided on the lathe this is the guard provided for the pillar type drilling machine and the guards for milling machine.

So we should check whether machine tools are properly guarded and whether visibility of getting operation is proper or not also we should check or reachable of various switches provided and color coding, whether proper color coding is used in the switches. Example reachable of emergency button on and off on such things can be checked where there is easily reachable by the operator and we should also check whether proper colour coding is used or not.

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Then we should also check for reachable of various levers and operating wheels we can see here in this particular lathe on the saddle many wheels are provided for moving the saddle and many levers are provided on the head stock and then the levers are provided on the bars and we should check whether the these leavers and operating wheels is easily reachable by the operator and all the levers on the operating wheels are can be operated smoothly or not that we should check the easiness to operate so for all levers we should check.

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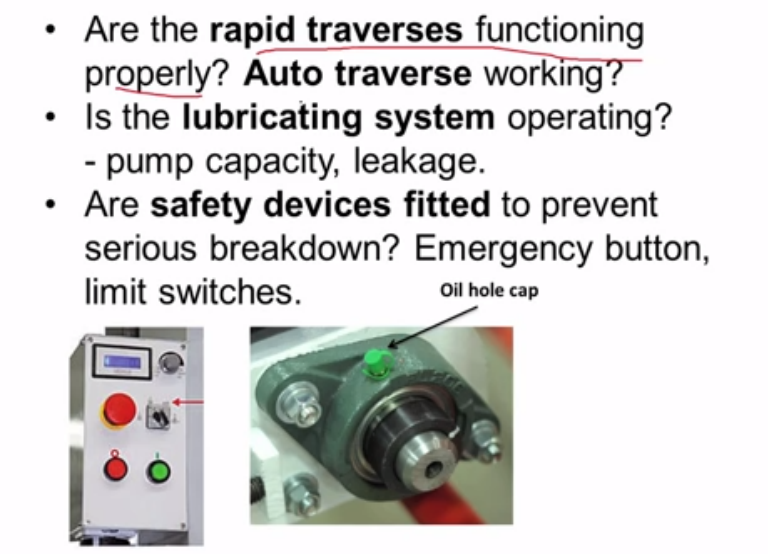

Now or the rapid traverses functioning properly and whether auto traverses is working or not if such facility is provided on the machine tools we should check functioning of rapid traverses and auto traverses and whether the lubricating system are working properly or not what is the pump

capacity used whether that is adequate to pump the oil and there are any leakages in the pipeline all such things.

We should check and or safety devices is fitted to prevent serious breakdown safety devices such as emergency but and limit switches we should check whether they are properly working and whether the high hole is properly kept or not that we have to check otherwise the dust particles May enter into the oil hole so that the performance will be affected.

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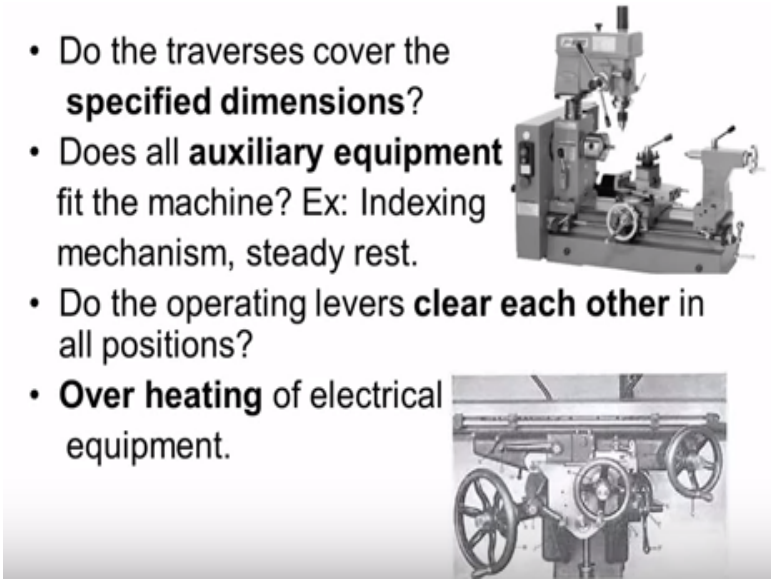

And do the traverses cover the specified dimensions various services are provided to the machine tool and whether all the traverses cover the specified dimension should actually run and check for this specified availability of the traverses and does all auxiliary equipment the machine the auxiliary equipment such as indexing mechanism whether they are properly fitted whether they are present or not such things are checked and do the operating levers clear each other in all positions.

We can see here in a particular machine tool many levers are provided, many wheels are provided whether they are clear each other in all the operating positions are whether there is any whether levers are touching at some position that we have to check whether there are any

electrical equipment or proper cooling arrangement is made for equipment whether there is any overheating of the electrical equipment motors that they have to check.

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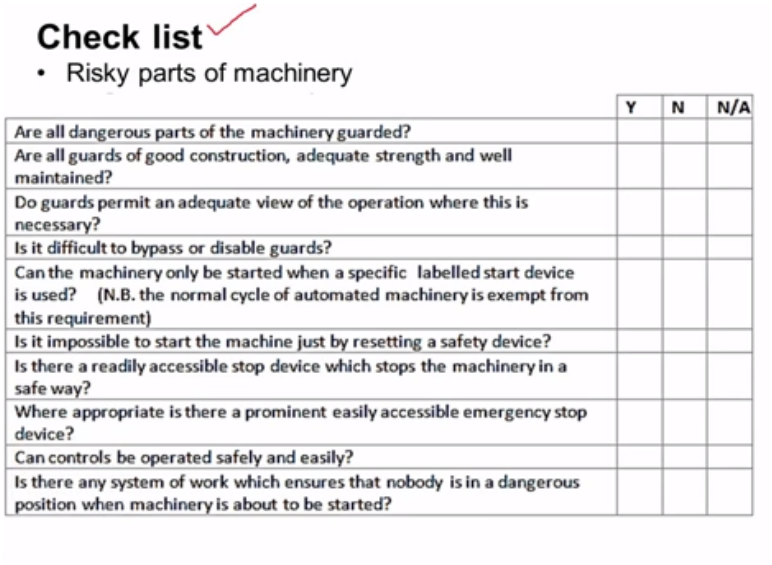

	Y	N	N/A
Are all dangerous parts of the machinery guarded?			
Are all guards of good construction, adequate strength and well maintained?			
Do guards permit an adequate view of the operation where this is necessary?			
Is it difficult to bypass or disable guards?			
Can the machinery only be started when a specific labelled start device is used? (N.B. the normal cycle of automated machinery is exempt from this requirement)			
Is it impossible to start the machine just by resetting a safety device?			
Is there a readily accessible stop device which stops the machinery in a safe way?			
Where appropriate is there a prominent easily accessible emergency stop device?			
Can controls be operated safely and easily?			
Is there any system of work which ensures that nobody is in a dangerous position when machinery is about to be started?			

Sometimes we can use checklist to check the machines to conduct the general position of the machine tool search one such checklist is provided here for risky parts of the machinery so this will indicate whether the proper guarding is provided or not or all the dangerous part of machinery guarded if the recording is proper they can check here put a tick mark here and not provided we can put a tick here.

If the particular question is not applicable we can put the tick mark here so like this we should check for all the items are all guards of good construction adequate strength and well maintained whether guarding provided is of adequate strength or not that we have to check. Do guard permits and adequate view of the operation where this is necessary with the transparent guards are provided or not proper visibility. Is it difficult to bypass or disable guard sometimes the operator disable the parts and try to run the machine, which is very dangerous.

Such thing we should check, can the machinery only be started when a specific labelled chart device is used and is it impossible restart the machine just by resetting a safety device and is there a readily accessible stop device which stops machinery in a safe way assessable stop

devices such as emergency button the positioning of the button the colour coding of the button such things we should check.

Where appropriate is there a prominent easily accessible emergency stop device provided can control be operated safely and easily and all controlling levers me whether they are easy to operate whether they are safe to operate is there any system of work which ensures that nobody is in a dangerous position when machinery is about to be started so such things should be carefully checked by using the checklist.

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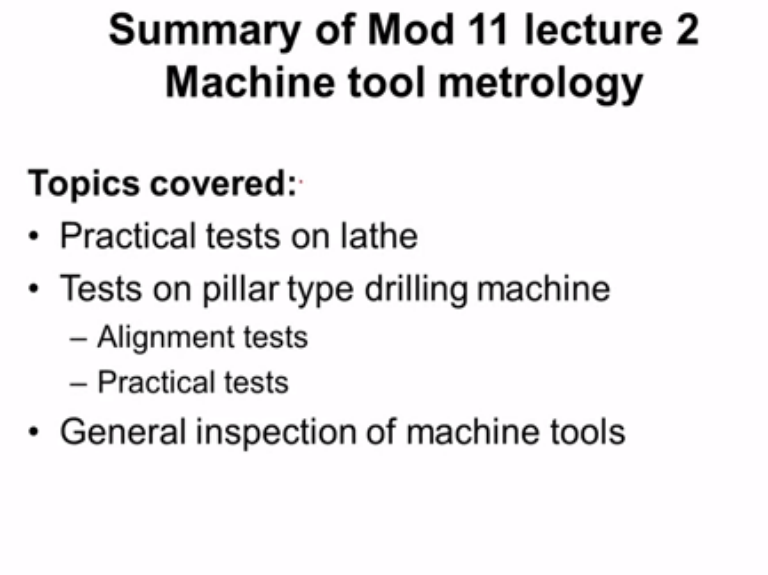

Now with the general inspection of the machine tool, we will conclude module 11 lecture 2, in this lecture number 2, we discussed about the following topics practical test on lathe and various tests normally conducted on a pillar type drilling machine, alignment test, we discussed practical test we discussed and apart from that we also discussed about the general inspection of machine tools one should do on machine 2 with this we will conclude this lecture. Thank you.