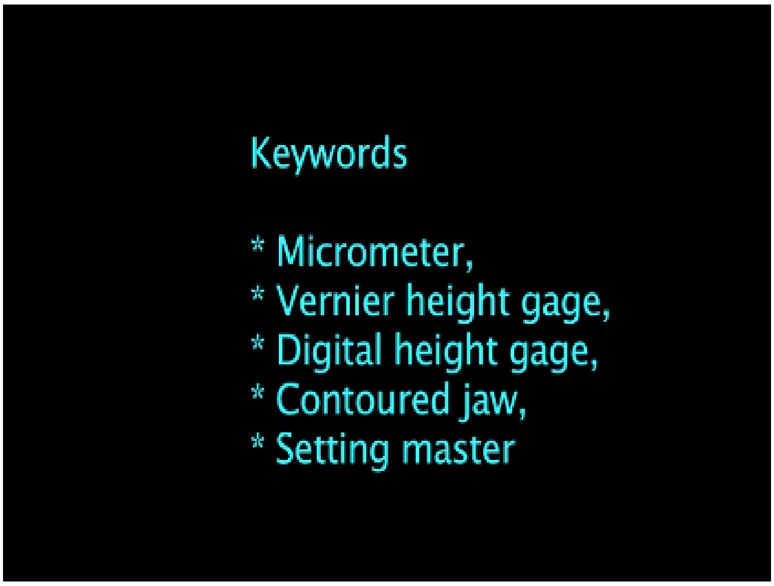
Metrology

Prof. Dr. Kanakuppi Sadashivappa
Department of Industrial and Production Engineering
Bapuji Institute of Engineering and Technology-Davangere

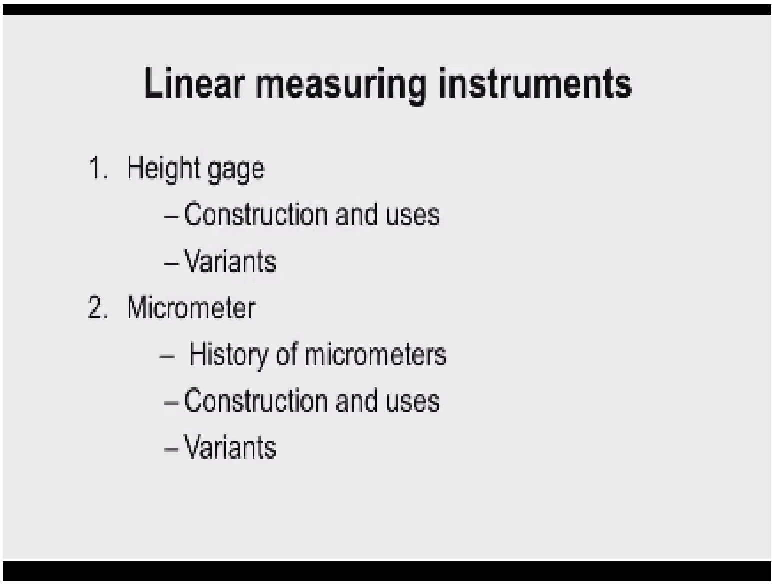
Module-2
Lecture-3
Height gauge, micrometers

(Refer Slide Time: 00:14)



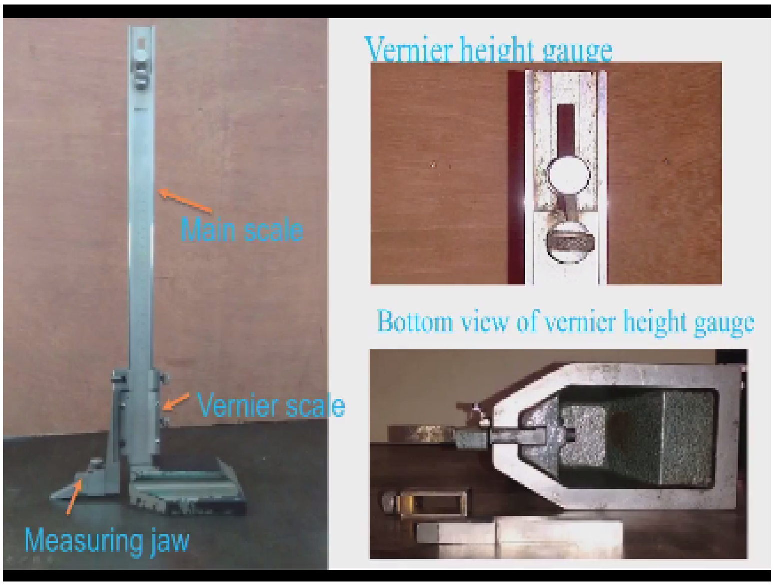
I welcome you all for this lecture of module 2, in this session we will study about the height gauge and micrometre.

(Refer Slide Time: 00:35)



The construction of height gauge and various applications of height gauge and what are the different types of height gauge, those things will study similarly in the micrometre we will the study a little bit about the history of micrometre and then we will move to the construction and various uses of micrometre and then we will study the variants of micrometre. Now let us start our discussion with height gauge.

(Refer Slide Time: 01:12)



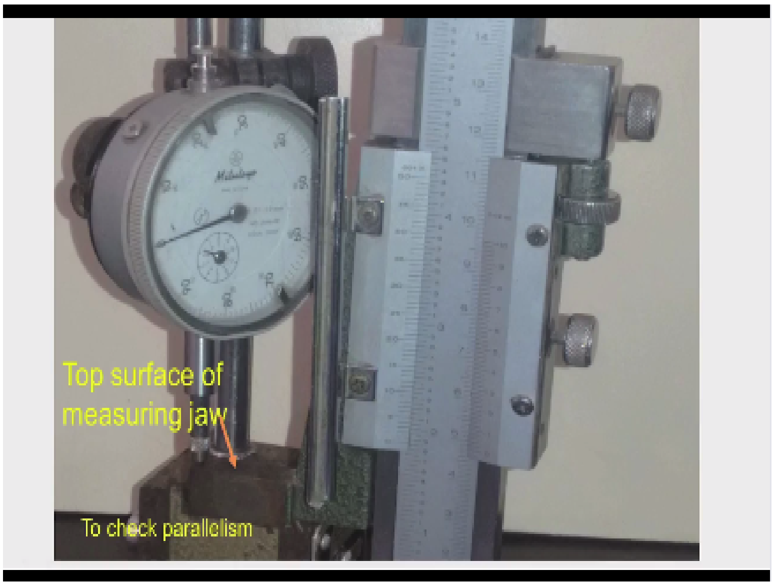
So this photograph shows A vernier type height gauge , I will just explain the different parts of the vernier height gauge, this is the main scale this is the column of the vernier height gauge and on the column we have main scale, one side we have metric scale and other side we have the English scale, now you can see here we have some arrangement for lifting the scale for sliding this scale up and down.

The details of this portion is shown in the figure we can see the screw and can see the met, by rotating the net the main scale can be move up and down, this is needed for making the 0 adjustment and then coming to the one year part how we have one side mirror cover near and on the other side English vernier we have a screw for clamping the measuring head to the beam and similarly there is a screw for moving the measuring jaw up and down.

I can see here carbide tipped scriber is fixed to the measuring jaw and there is a clamp for fixing the carbide tipped jaw to the measuring jaw, so by rotating the screw we can clamp the scribe to the measuring jaw. This is the base of the vernier scale vernier height gauge and the bottom view of the vernier height gauge you can see. So this is a ground finished surface at the centre it is relieved and then this portion is a bottom of the beam.

And screw by means of screw it is fixed to the base and here I can see the clamp which is used to fix the scriber if record by tip scriber, this scriber can be fixed to the measuring jaw with the help of this clamp.

(Refer Slide Time: 03:34)



Now we can see the close view of vernier height gauge, we can see the vernier and the screw for fixing the measuring jaw to the beam and then there is a screw we can initially we have to screw this and then back to operate this screw for find the adjustment of the vernier and then we can see the scriber has been removed, clamp has been removed and now they are giving the top surface of the measuring jaw.

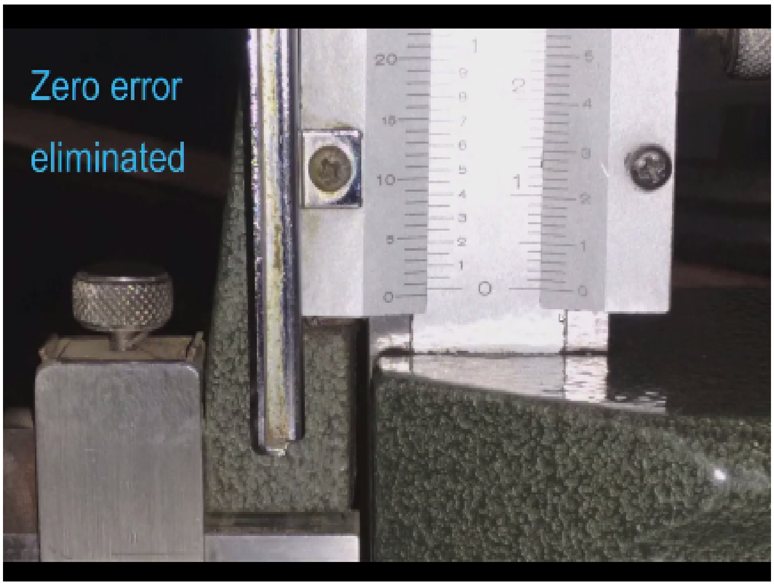
Now it is very essential that the top surface and the bottom surface is a measuring jaws should be parallel and these two surfaces top and bottom surface of the measuring jaw should be parallel to the datum surface within 10 microns. So that you can check with the help of a dial indicator. Now you can see the dial indicator is fixed to the column of magnetic stand and spindle is in contact with the top surface the measuring jaw.

Now we have to make 0 adjustment, then just touches the top surface is measuring jaw, now slowly we have to move this dial indicator towards the vernier height gauge and then we should note down what is the reading. So this reading should be less than 10 microns.

(Refer Slide Time: 05:18)

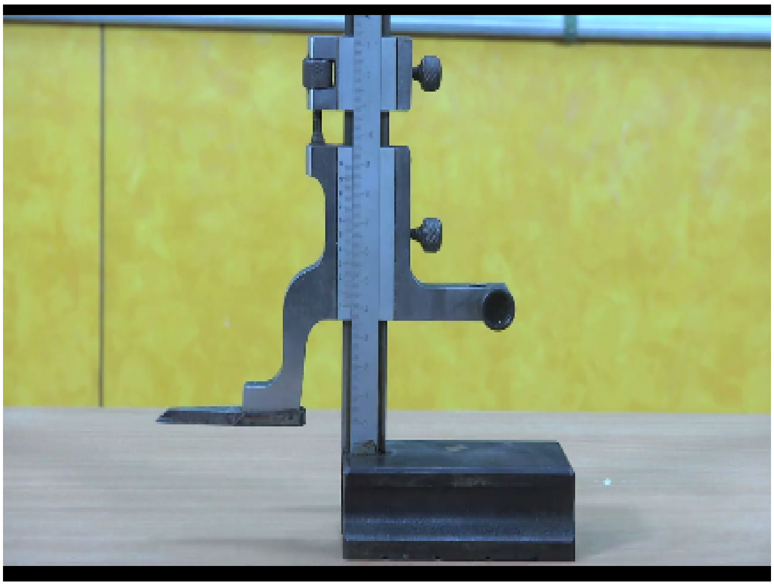
Now checking for zero error in vernier height gauge, now we can observe here the main scale zero line is here and this is a zero line of the vernier, now they are not coinciding even though the scriber is in contact with a datum surface the scale is showing some reading. So this server should adjust by lifting the main scale as I have already discussed.

(Refer Slide Time: 05:53)



Now you can see here we have lifted we made some adjustments in the height of the main scale and now there is no zero error.

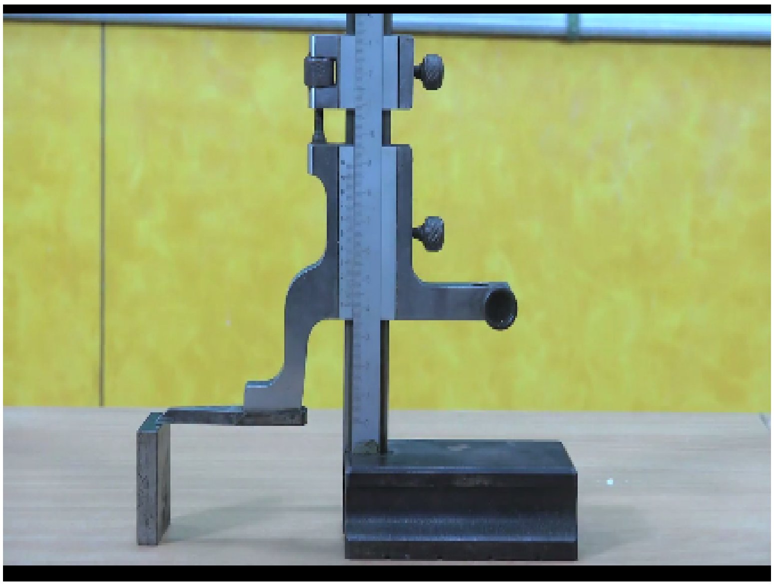
(Refer Slide Time: 06:06)



Now let me explain the vernier height gauge, this shows the vernier height gauge, this is a base of the vernier height gauge and then the main scale vertical bar this is vertical bar and you can see the main scale the resolution of this main scale is 1 millimetre. Now you can see the range of this instrument it is zero to 300 millimetre and dispersion is the measuring head and we have the vernier scale here and now this is the scriber attached to the measuring head.

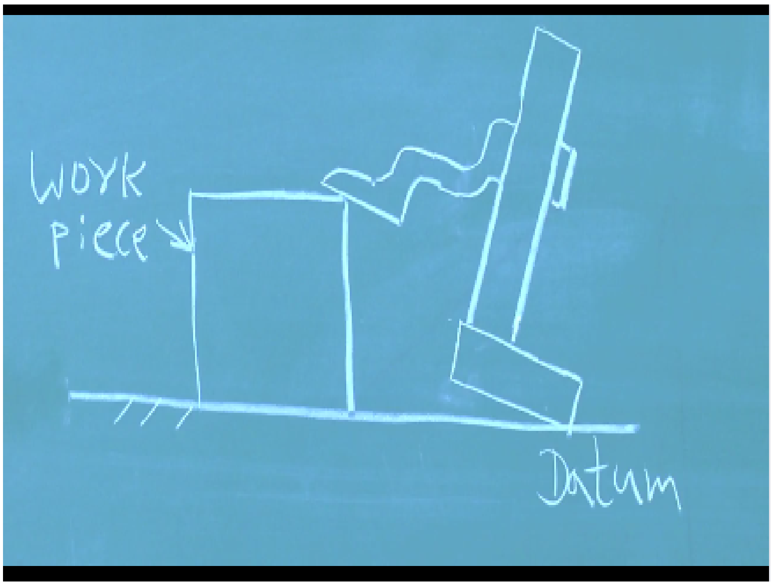
And you can see carbide tip here and it can be used for describing the lines on work pieces and is can also be used for measuring the height of the purposes. Now I will explain how to use this for measurement of height of a work piece, I am taking work piece here and we should initially check proximity what is the height of the work piece in the steel rule, and then we have to adjust the gap between the datum and at the bottom surface the scriber.

(Refer Slide Time: 07:22)



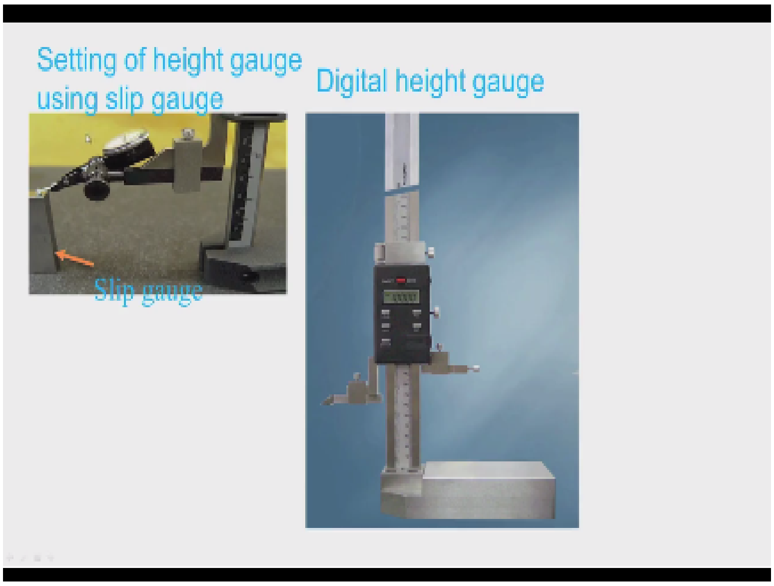
And then we have to lock the measuring head using this screw and then this is a fine adjustment screw and I am just operating the screw, so that the measuring the scribe is just moved on and it just touches the work piece. So they feel of the operator is very very important here, we should not apply the overpressure here, if over pressure is applied what happens is this bass will move up as shown on the blackboard.

(Refer Slide Time: 07:56)



Now I am operating this, so it is just touching the work piece, now I will read the scale, this a zero reference, now it is 40 millimeter on the main scale and now we have to see what is the coinciding division 15 division is coinciding with a line graduation on the main scale. That means 15x0.02 is 0.3, so to the main scale reading the value that is a 40 millimeter we add that the reading of the vernier this point.

(Refer Slide Time: 09:02)

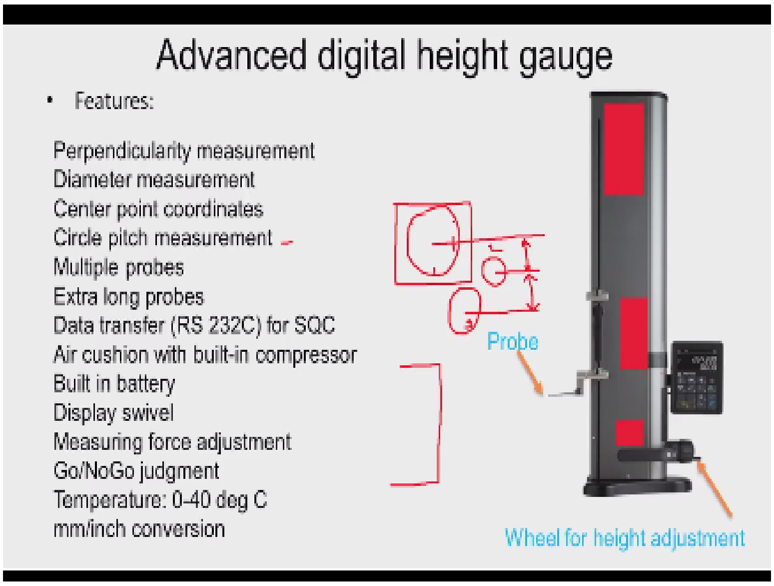


So the height of the work piece is 40.3 millimetre, now you can see setting of height gauge using slip gauge. So initially we have used a slip gauge and we have used lever type dial indicator and any required height can be set using this arrangement. So we can use this slip gauge and there is a 40 millimetre. So now we have to adjust that move the measuring jaw, so that this reads 0.

So in that case we have set the height gauge to 40 millimeter diameter and then we can use this setting for the comparison purpose to check the height of other work pieces. In that case they are using a vernier height gauge as a comparator and then we have digital height gauge, we can see the base of the digital height gauge and beam of the a digital height gauge. Now here instead of vernier we have a digital read out.

We have hold option for holding the data point and then we can fix the tolerance values ok. So we can quickly take the reading because of the digital display. Also there is a provision for transferring the data to computer via RS 232C for data transmission and this will be useful for statistical quality control.

(Refer Slide Time: 10:52)



Now there are some advanced digital height gauge as a photograph of advanced digital height gauge is shown here. This is the base of the height gauge and his a column and beam of the height gauge and then we have beam for height adjustment beam, we rotate this depending upon the direction in which we rotate the props will move up and down, I can see the measuring folks here.

We have arrangement for fixing multiple probe, one more probe we can see here, so both the probes can use a together. Now this is a display unit for displaying the data, what are the various features of this are such a advanced digital height gauge, we can see the perpendicularity measurement. This instrument can be used for measuring the perpendicularity.

I will just write some simple sketches, say we have some work piece like this, so we can fix a probe here and we have to move the probe towards the work piece and we have to just touch the work piece and then we have to move the probe up and again we have to just touch the work piece, then there if there is any difference that get perpendicularity measurement. Similarly we can use this for diameter measurement, say we have work piece with a hole like this.

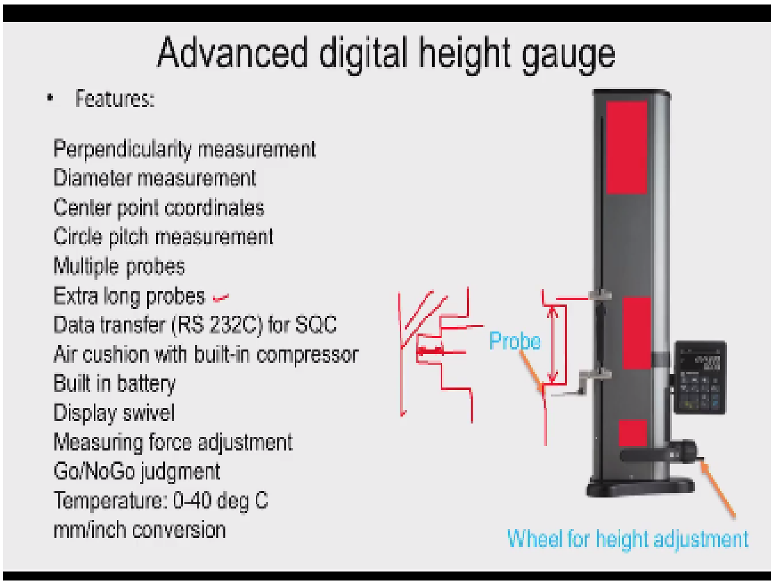
So this is the work piece with a hole, now what we can do we can move the probe and we can make a contact here, first contact, second contact some here, and third contact. Then these 3 data are supplied to the microprocessor attached to the instrument which will calculate the diameter of the hole and it also calculate coordinates of the centre point and then circle pitch measurement, say we have some 2 to 3 holes like.

This is first hole, this is the second hole and then say we have third hole, so now the diameter of all the three holes we can measure and now we want a pitch circle pitch that means what is the decision centre of a circle and in the centre of a second circle and the centre of the circle, what is the pitch, what is the distance between the centres of different circles for that can be calculated the microprocessor will calculate the data and display the circle pitch measurement.

And then the multiple probes can be used together, now we have fix one probe here and we can also fix one more probe here together we can use both of them together we can use for that measurement becomes very fast and just write a rough sketch, say we have some work piece like this. So there is a projection in the work piece. Now I want this distance to be measured, so this the distance to be measured.

Now what we can do we can rotate wheel so that this prob contact with the surface and then again we rotate table in the other direction so that they probe that is fixed here will make contact with this. So that the difference between these two surfaces, so for check with the measurements we can use the multiple probes and then we can also attach extra long probes, say we have some work piece like this ok.

(Refer Slide Time: 15:41)



Now we need to measure the diameter of hole diameter of the fall and also we need to measure the distance between the surface and surface that is death of in a hole in this case we can always fix extra long probes, and then probe will come here it'll make contact and then we can remove the airport inside the hole, So that the difference in reading is the depth, also that extra long frock can be used to measure the diameter of the inner hole.

So this is about extra long probes, so the probes are available in the length of 100 millimetre and 200 millimetre like that. Then data transfer facilities are provided for statistical quality control, the purpose all the data I measure data can be applied to a computer where in the excess of surface are available, so the data can be used for processing and other important feature of such a device is air cushion with built-in compressor.

Now the weight of this will be like 25 kg or 30 kg, so it becomes heavy, a lot of effort is required to move this instrument over the surface plate. So to make it easy for moving the sliding the instrument air cushions are provided at the bottom of the base, so and it is the built-in competitive its own built in compressor and national come up compressor not necessary. So because of this arrangement we can easily slide the vernier height gauge and surface plate.

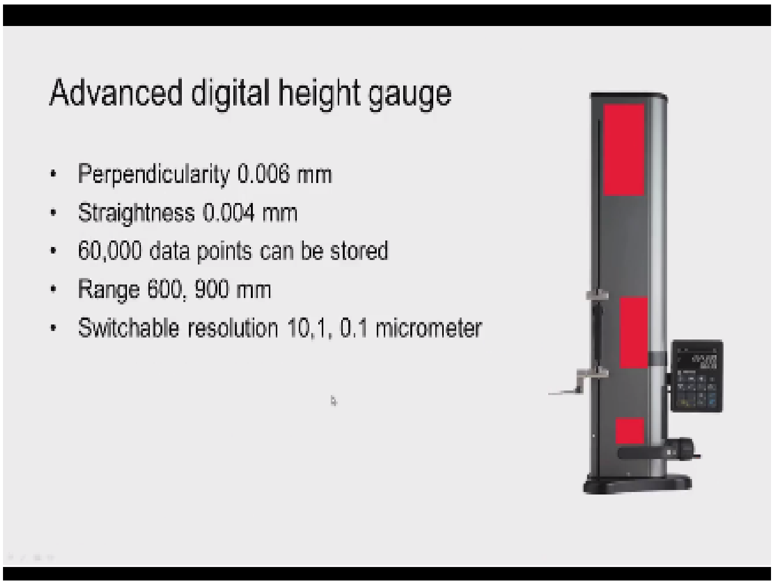
And other a beautiful future of this instrument is whenever by mistake operator tries to move the height gauge beyond the surface that is available in the surface space, immediately there will be air locking the instrument will be gets clamp to the surface plate, so that it will not fall and then we have built in battery facility depending upon usage the slide will be like 500 or 1000 like that.

And then we have swivel display, so this display can be swivelled, it can be swivelled like this, so that they breathing becomes easy and then measuring force just meant facility is available in this depends whether it is of material like rubber plastic or hard material like metal we can adjust the measuring force, it can be a force can be like 1 Newton or 2 Newton or 3 Newton and measuring work piece and we can adjust measuring force.

And another very important feature is go, nogo judgement is possible. So any physical quantity example high diameter etc, we will have some tolerance and those the tolerance value we can feed a to the instrument and then when we make the actual measurement the microprocessor check whether that measure quantity is within the tolerance or not. If they measure quantity is within the tolerance specified then it will indicate that is acceptable work piece is acceptable.

If it is beyond the limits, it indicate that be rejected by displaying some red colour. So like this we can use this instrument for pick a judgement like limit getting type of work and then this can be used working the temperature ranges from 0 to 40 degree Celsius, so within that ranger we can use without making any external compensation and the mm/inch conversion is possible, this can be used for measurement of distances in the metric system as well as in inches system.

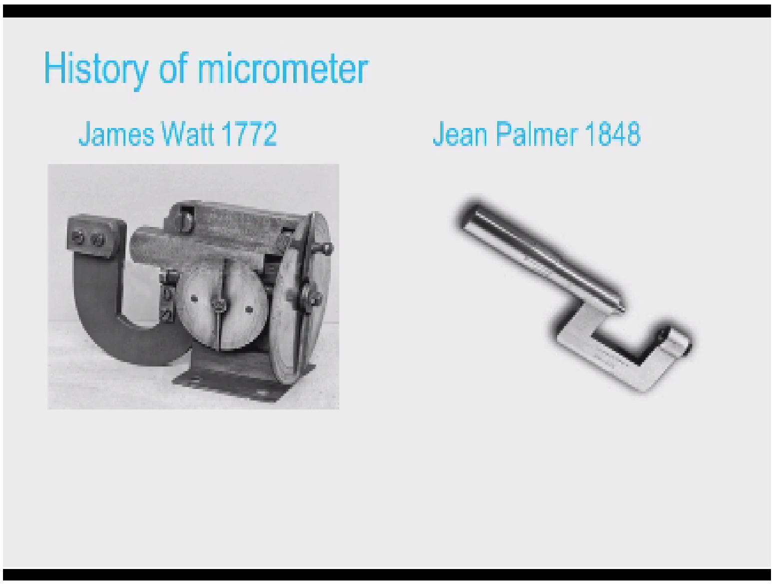
(Refer Slide Time: 20:23)



Now there are some more perpendicularity of this height gauge is 0.006 millimetre, that means range these instruments available with the range of 300 millimetre, 600 millimetre, and 900 millimetre and over the height over the full range the perpendicularity that means the surface will be perpendicular to the vertical movement and that there will be within 6 micrometre and then a vertical movement that is straightness of this such instrument will be like 4 micrometre.

And 60,000 data points can be stored in the memory of research instruments and whenever required they can be retrieved and used and the resolutions switchable relations are possible like 10 microns, 1 microns and point micrometre that means depends upon the accuracy needed we can always switch we can select the appropriate resolution.

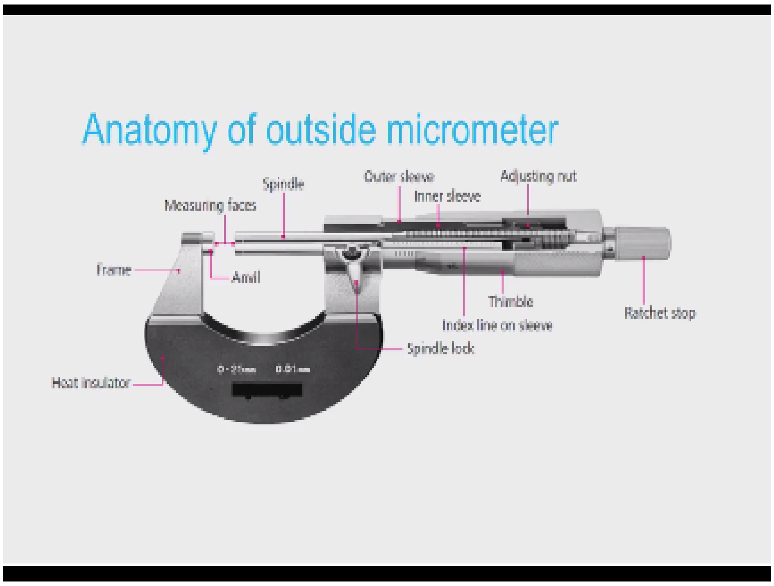
(Refer Slide Time: 21:38)



Now let us start a discussion on another very important instrument that is the micrometre. Now let us study some points about the history of the a micrometre, I can see here this picture shows a micrometre designed and developed by James Watt in 1772, we see that there are two dials are there and two points are pointers are there and then we have that u shaped body of them even now we are using a u shaped body at the micrometre variations.

And this is the anatomy to the body and this is a movable so where to keep work piece here and that move this and then by reading this to get dimension of the work piece and then this micrometre is developed by Jean Palmer in 1848, that means approximately after 70 or 75 years. Jean Palmer improved the micrometer, here we can see this is too huge we have to fix this micrometre to maybe a table surface by using bolts. Here this is this can be a handheld very small instrument.

(Refer Slide Time: 23:17)



Now let us discuss about the anatomy of outside micrometre, now this is the frame of the micrometre made of steel and now you can see here heat insulator is provided here have plastic material is provided here. So when the operator hold the micrometre is body temperature will not flow heat will not flow to the body of the micrometre. So that the thermal expansion the body due to the body temperature of operator will be less.

Now we have anvil fix to the frame of the micrometre and then we have the spindle which can be advantage it can be retracted inside the sleeve this is sleeve where in we have to insert the spindle and spindle has finally cut threads ok there ground thread the pitch of the screw is normally 0.5 millimetre. No this are to add a measuring faces, measuring face are very important that he treated ground and laughed and then stabilization is required for that internal stress relief.

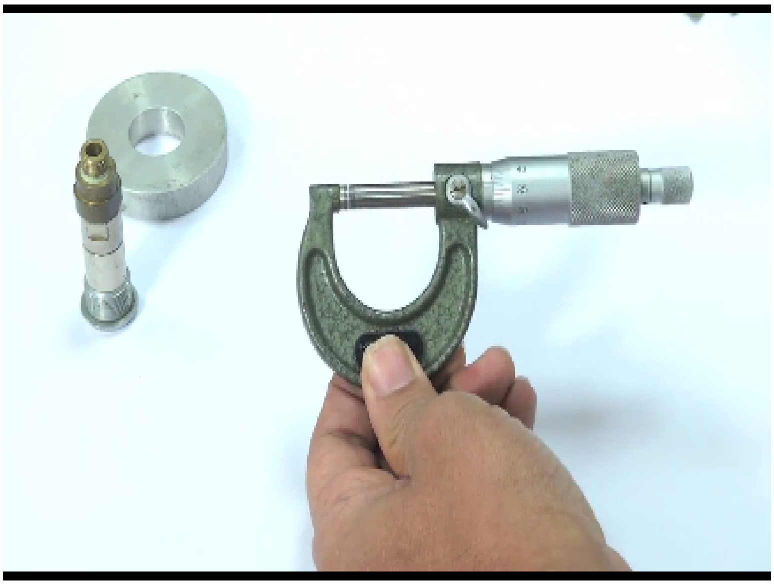
So that they were not the form and the faces are lapped and the measuring face flatness and parallelism between these two surfaces is very important, flatness and tell them can be checked using optical flats and normal flats available is 1 micron or less than that and tell them will be accuracy of the micromolar and now you can see there is a clam here spindle lock for locking the spindle at any desired location.

And now this is asleep on which we have the scale graduation is called sleeve scale or main scale, and then we have the spindle portion, so this is side of the portion so this side of the thimble right side of the thimble that they are merger easy rotation on their thimble and end of the thimble again graduation we will see about graduation after sometime and then there is nut here which is fixed to the inner sleeve.

So when we rotate the thimble, thimble is rigidly screw, when we rotate the thimble this screw will move in and out that means the spindle can be advanced towards the anvil or it can be retraced, now sometimes due to continuous usage then maybe some clearance between the screw and nut. So we have to adjust the clearance for that there is an adjustment net when we rotate the adjustment that they clearance between the main nut and screw will be reduced.

And then and slackness are should be eliminated and then we have a ruptured stop arrangement to apply uniform measuring force, we will see the construction of this ratchet later.

(Refer Slide Time: 26:56)



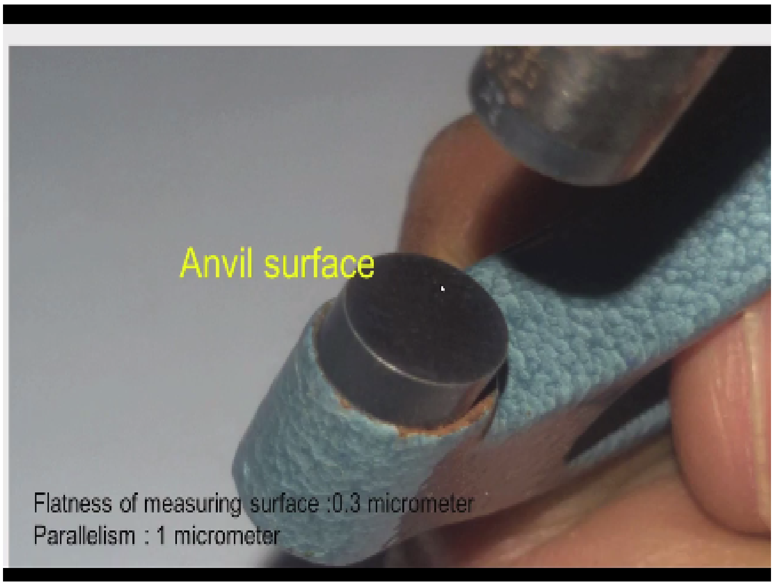
Let me explain how to use a micrometre, this is the frame of micrometre we can see the trip shaping the so that it becomes a bit and then here the range is mentioned 0 to 25 millimeter and then the resolution of this instrument is 0.01 millimetre we can see the carbide tipped anvil and carbide tipped spindle. The clamp for clubbing the spindle, the thimble sleeve and catch it, now before using this micrometre we have to clean the face this anvil face.

And spindle face with a clean cloth and smooth paper, so that dust particles and high layers are removed and then we have to unclaimed spindle and slowly we have to rotate the thimble like this and then we operator there till we get one or two clicks now we have to observe the reading now you can see the reference line and this is the 0 on thimble and it is not coinciding with 0 on the sleeve.

That means there is some zero error, we have to eliminate this 0 error before using this instrument, for that an arrangement is provided when you rotate this micrometre so this is a back side view we can see back side of this sleeve there is a small hole, now a spanner is provided with a micrometre now we have to use this spanner and we have to operate the you have to rotate the sleeve in proper direction.

So that the 0 error is eliminated, now we can see 0 error is eliminated and now this instrument is ready for using.

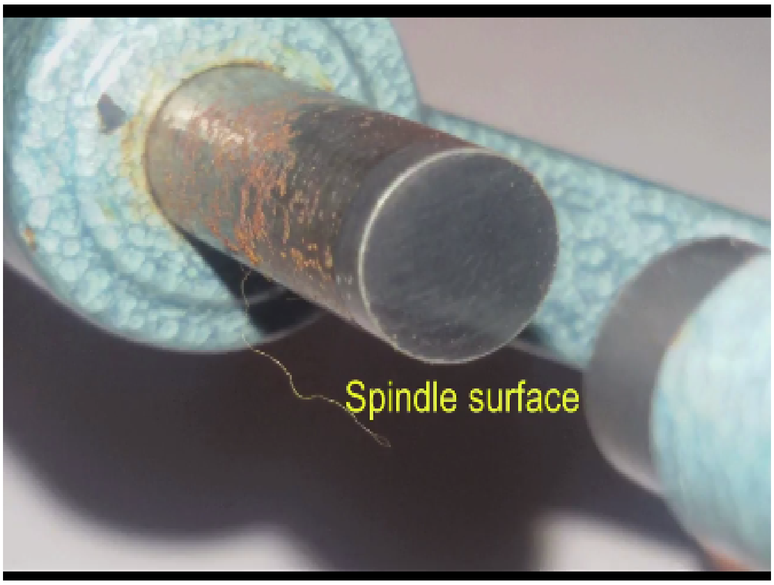
(Refer Slide Time: 29:30)



Now we can see the anvil surface low of the anvil surface, sometimes you know carbide tipped and surfaces also available, so that there is less. Now flatness of measuring surface measuring surface is very very important the ground and laughed and flatness there will be below less than 1 micrometre and the spindle surface and the anvil surface should be parallel. If there is any paper inclination then there error will creep in.

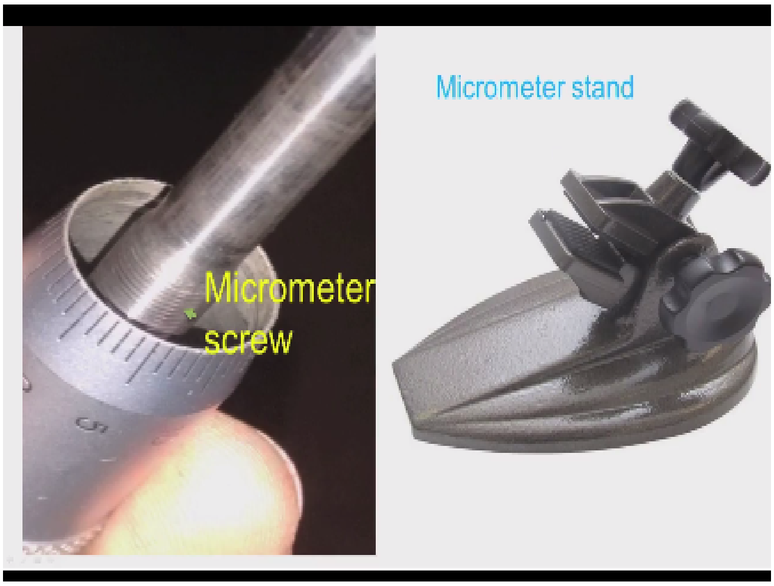
So it is very essential that these two surface and surface and measuring surface should be parallel and parallelism of less than 1 micron is maintained.

(Refer Slide Time: 30:26)



The parallelism and the flatness can be checked using optical flats, so this shows a close view of spindle surface. So it is very essential that we should maintain all these essential instruments whenever they are not in use for a longer time we should apply a petroleum jelly to all the important parts of the moving parts of the instrument that was not provided kerosene.

(Refer Slide Time: 31:36)



Now there has been removed out of the sleeve now you can observe the ground very find the picture of the metric micrometre will be normal and 5 millimetre and I can also clearly see the paper on the surface and also see their graduation very clearly and micrometre stand and we can clamp it and intonation of this can be adjusted by rotating this now. So whenever required we can use a micrometre stand.

If the work piece is very heavy when we have to hold work piece with both the hands then in that case micrometre stand will be very useful.

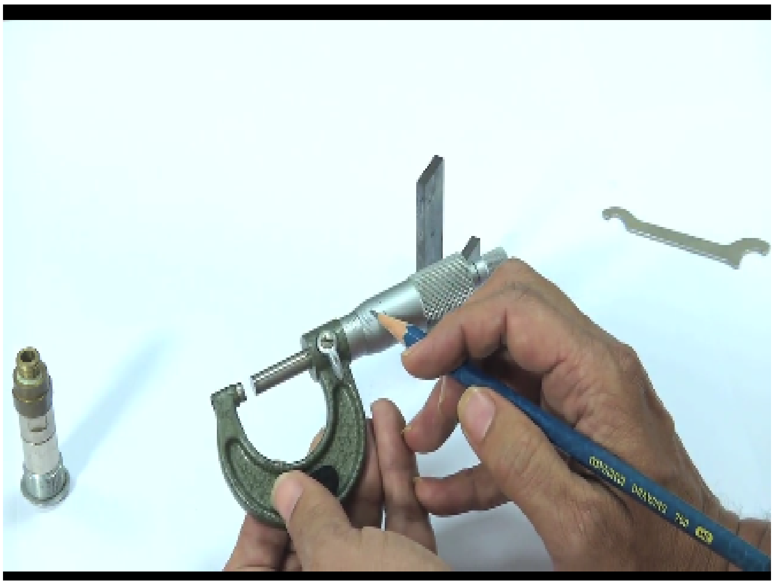
(Refer Slide Time: 31:59)

Now some micrometer can observe here, this is the adjusting nut and then we have main nut, so the main nut has both internal and external thread inside also there are threads and this will be meeting with main screw of the micrometre and outside of the main nut we also have a threads, so we rotate this adjusting nut you can see here the slots are provided and using the spanner we can rotate this adjusting.

We can rotate this nut, so in main nut we have slots slot circuit, so when we rotate the nut the main that gets compressed and it embraces the main screw and hence there is any clear that is eliminated and backlash eliminated and then the ratchet mechanism disassembly I told that is used to apply uniform measuring the force, when the measuring topics in present value which is decided by the spring we can see spring here.

So this spring tension decides what is the amount of force is applied on to the work piece normal it will be like 5 Newton, 6 Newton and 7 Newton and since we apply uniform pressure ratchet mechanism is used when they talk exceeds the limit which is decided by the spring I can see here this these two part 1 acts as ratchet and other acts as paul, so the part this fall will sleep and hence ready for that moment of the spindle will stop.

(Refer Slide Time: 34:02)



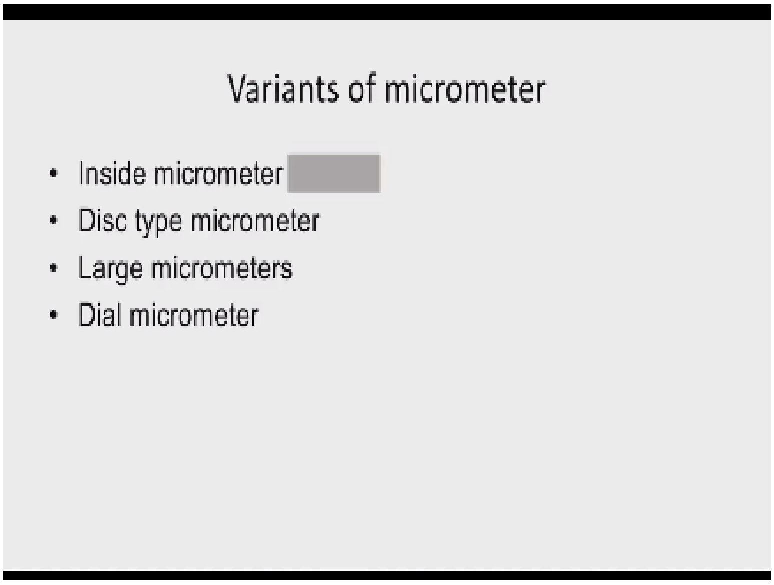
This is how the uniform pressure is applied on the work piece, how we can use micrometre to measure the thickness of this plate, I am keeping plate on the datum surface and then I am moving the micro metre towards the work piece and then slowly we have to operate the thimble, now the spindle is advancing and is moving towards the work piece, it is moving towards the work piece.

Now it has just touched to work peace and giving using the ratchet I am pressure and then I am cramping the spindle slowly we have to remove the work piece now we have to take the reading, now main scale is 0, 1 2, 3, 4. So 4 millimetre and then on the thimble we have 0 one second, second graduation is coinciding that mean second graduation means 2x0.0 and that is 0.02. So the thickness of this plate is 4.02 millimetre.

Now we can measure the outside diameter of work piece I am showing the measurement of measurement of OD of this portion, so now they work period between anvil and spindle. Now only had to put it in the reverse direction has been done is moving towards the work piece and now it has just touched the work piece, let me operate that and then we have to clamp the spindle slowly we have to remove the work piece to read scale.

So the main scale 0, 5 millimeter, 10, 11, 12, 13 and then 13.5, 13.5 and then thimble reading 45, 46. So this reference line is between the 46 and 47 will take 46, 46 into resolution that is 0.01, so the thimble reading is 0.46 , so 0.46 we have 2 main scale reading that is 10, 13.5, 13.5+0.46 that means 13.96, 13.96 is the diameter of the work piece.

(Refer Slide Time: 38:13)



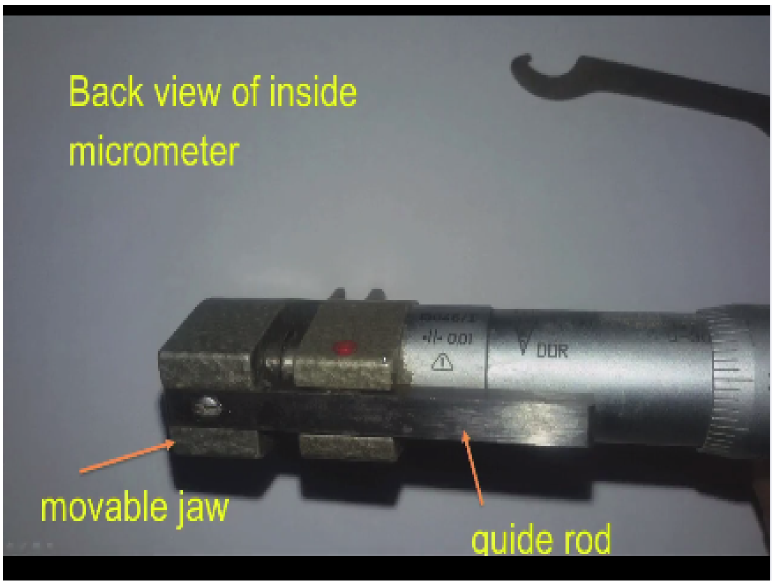
Now let us see the variants of the micrometre there are various kinds of micrometre is available in the market. Now let us study this inside micrometre and disc type micrometre and the large micrometre and dial type micrometre.

(Refer Slide Time: 38:35)

Now shows front view of inside micrometre I can see this is sleeve on sleeve on the main scale, and then thimble and ratchet and now this jaw fixed to sleeve and when the spindle moving the rotate the spindle moves in and out depending upon the direction symbol. So to the spindle moving caliper or moving jaw is fixed. So in this case this part of the jaw, this job will move and this is fixed to the sleeve.

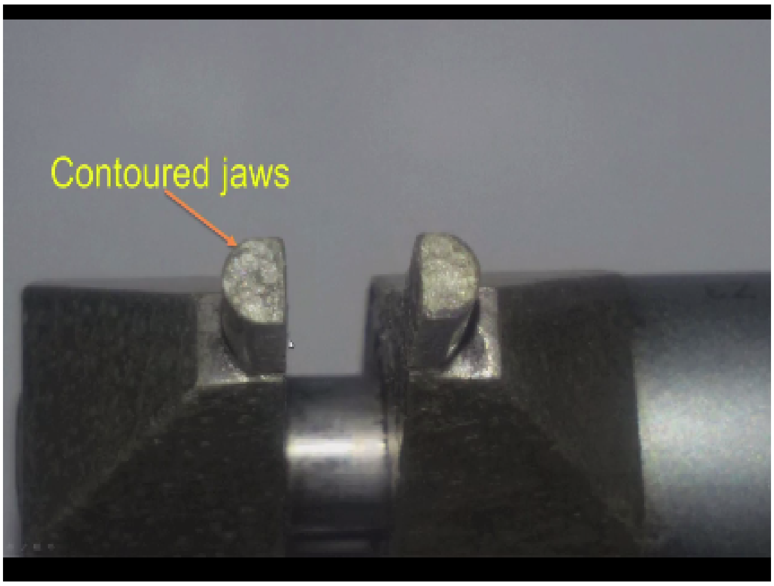
And now we can see the range of this instrument it is 5 millimeter to 30 millimetre that is a range and then you can see the markings on this sleeve so it is in the reverse direction, so this is 10, 15, 20, 25, 30 like that. So between two graduation here single moment will be supplements and below they have marking, so this will give 0.5 millimetre readings, various ranges are like 75 to 200 mm 0.01 resolution available.

(Refer Slide Time: 40:08)



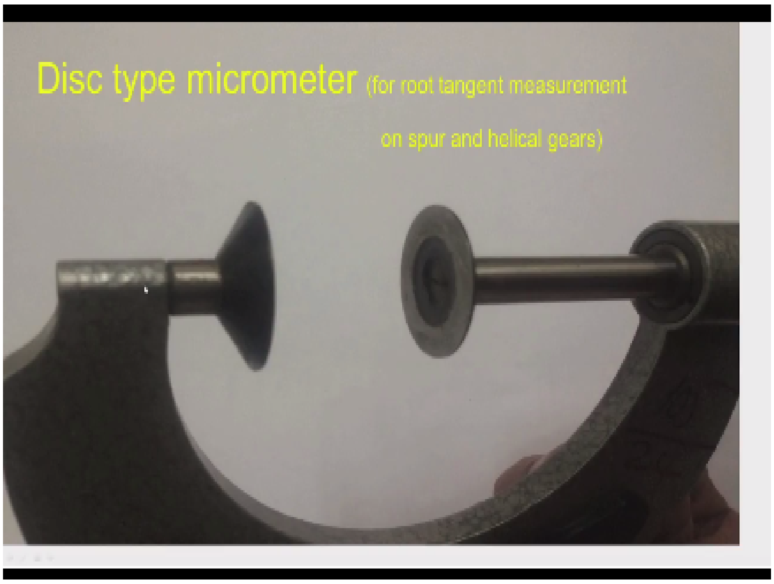
So here thimble graduations are visible. Now this is the back view of inside micrometre is used for measuring the inside dimensions like the distance between groove or inside the hole diameter for such things that. Now what we can see in this photograph there is a guide rod ok and this guide. So when we move the thimble this movable jaw will move and this is guided by this guide rod and guides.

(Refer Slide Time: 40:54)



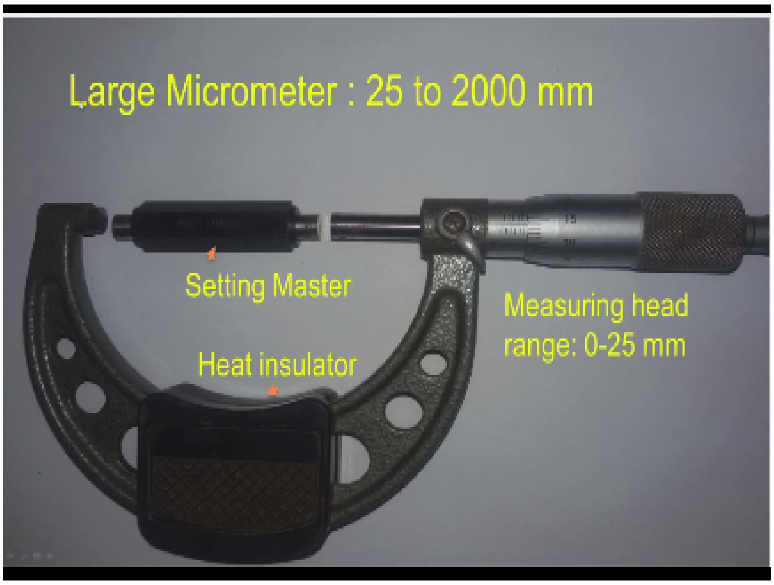
The resolution of this instrument is 0.01 millimetre, now you can see here the jaws of this instrument that contoured or radiused, so this is necessary when we want to measure the inside hole diameter. So if you have a flat surface then we can see the example here I will write some sketches. So this is dead inside so this is the hole, if you have the flat ajw contact will be like this contact will that this much here will occur in the measurement.

(Refer Slide Time: 42:06)



Because it is radius jaw the contact will be like this and then did not be any error, so this is the reason why the radius is providing the jaws. Now another variant is disc type micrometre is used for measurement of spur gear and helical gears. This detail of this will see the appropriate module when we discuss about the gear measurement.

(Refer Slide Time: 42:23)



And let us learn something about a large micrometre, now the very large micrometre are available with range 25 to 2000 millimetre, now one thing we can observe the measuring head range remains same 0-25 millimeter and then we used to set the distance. For example in this case the we have the setting master of say 25 micrometer, now we have to insert place the setting master between anvil and spindle.

So that the spindle is just touch the surface and then we setting will be 25 micrometer because they are using 25 micrometer fitting master and then if the work piece is greater than 25 micrometer, then we can use this instrument that means the range of this instrument become is 25 to 50 micrometer with this 25 micrometer setting master. Now we have to place the work piece here and then we have to rotate the thimble then take the reading.

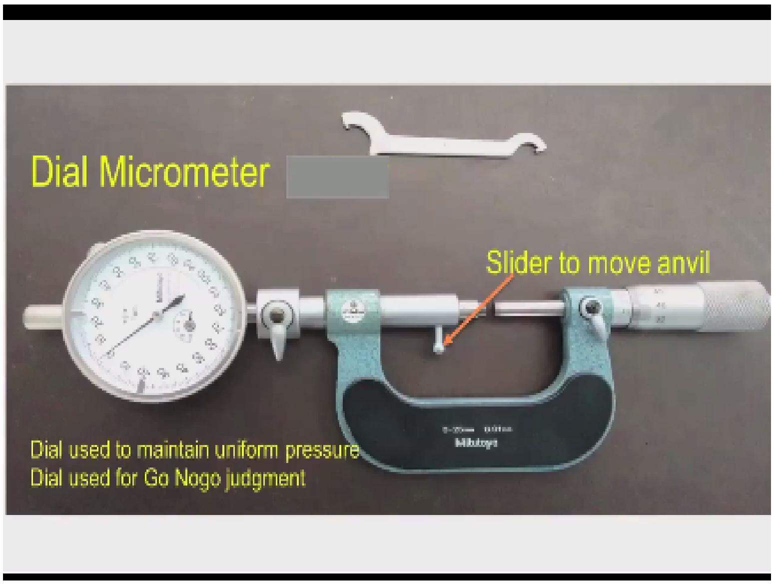
And this reading we have to add the size of the fitting master then the work piece size, and we can observe insulting there is provided here. So we have to hold a micrometre at this grip in selected heat insulator so that body temperature in not transferred to the body. When we hold the micrometre for a longer time like 20 minutes and 30 minutes and if we heat insulator is not provided the body temperature will it will get transferred to the body and then expand.

(Refer Slide Time: 44:29)

And then the measurement, now various sizes are setting masters are available in the range of 25 to 2000 millimeter size in fact of 25 millimeter, so we can given up the work piece size we have to select the appropriate setting master and we had to set the micrometre and then we have to use, again these setting master, the flatness of the master surface is 0.3 micrometre or less than that the ground and lapped.

So that the flatness very good flatness is achieved. Also the parallelism between this working for face at this working surface is very very important and it is maintained by car to make a micrometre less than 2 micrometre parallel is maintained. So that they will get good accurate measurement.

(Refer Slide Time: 45:28)



This is another variant to of micrometre wherein we have the body and then spindle anvil, this person is common micrometre and we have the moving and the important feature of this micrometry is anvil also move in and out and there is a slider to move the animal in and out and at the other end the dial is fixed. So the moment of anvil also can be fixed by using this clamp and then moment of spindle of a can be a figure so it can be using this clamp.

Now what is advantage of using this dial, see dial can be used to maintain uniform pressure in the absence of ratchet the dials are provided, so that when we rotate the thimble the now we have the work piece here when the rotate and spindle moves, and then the force is applied to the dial indicator and then the pointer moves, so by noting down the amount of rotation of the pointer we can maintain uniform pressure of the work piece.

That is one thing other thing is dial can be used for nogo and go judgement that mean sometimes the actual size of the a work piece is not required what is required is the weather the work piece is acceptable or not, whether it is in the range and such case we can insert the work piece here and then we can move we can move the anvil inside by operating the anvil and operating the slider.

And then we can keep the work piece here and then we can release this slider, so that angle moves towards work piece and then we have to know what is the reading. If the reading is within the limits the work piece is accepted, if it is beyond the work piece is rejected. We conclude this session, in this session we discussed about the height gauge, different types of height gauges and the construction of height gauges and what are the various uses of height gauges.

And we also discussed about 10 micrometre, the history of the micrometre construction of micrometre what are the various types of micrometre, in the next session will continue the discussion on other types of micrometres, thank you.