Metrology
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Module-05
Lecture-04
Non-contact type surface finish measuring instruments

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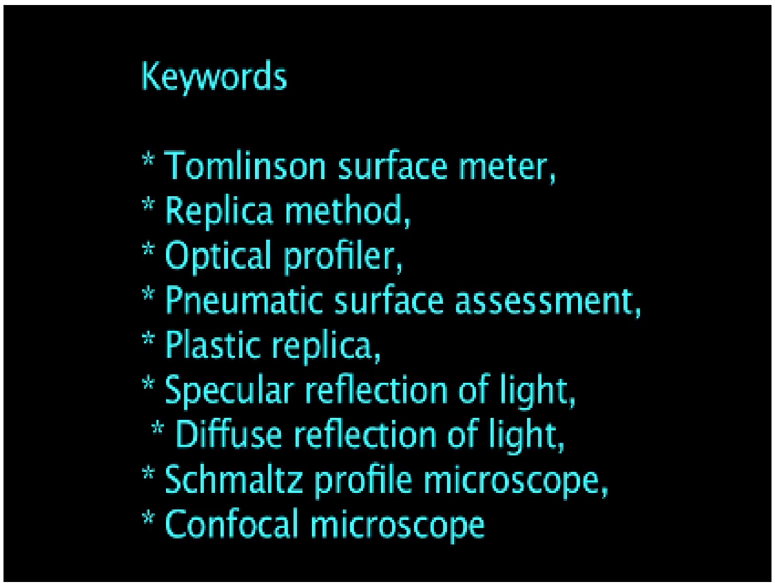

I welcome you all for the module 5 lecture 4, in this lecture we will be discussing about Tomlinson surface tester which is a contact type of measurement method and then we will move on to non-contact methods to various non-contact methods like optical systems and a microscope surface measurement using microscope and then the pneumatic method of surface finish measurement doors and contact methods will be discussing.

And then we will also see what are the advantages of non-contact methods and then what are the relevant ISO standards pertaining to the surface finish measurement that also we will see and then what are the common mistakes one does during the measurement of surface finish we will discuss about common mistakes and then what one should take so that the surface finish measuring instrument will be in good condition those things we will be discussing.

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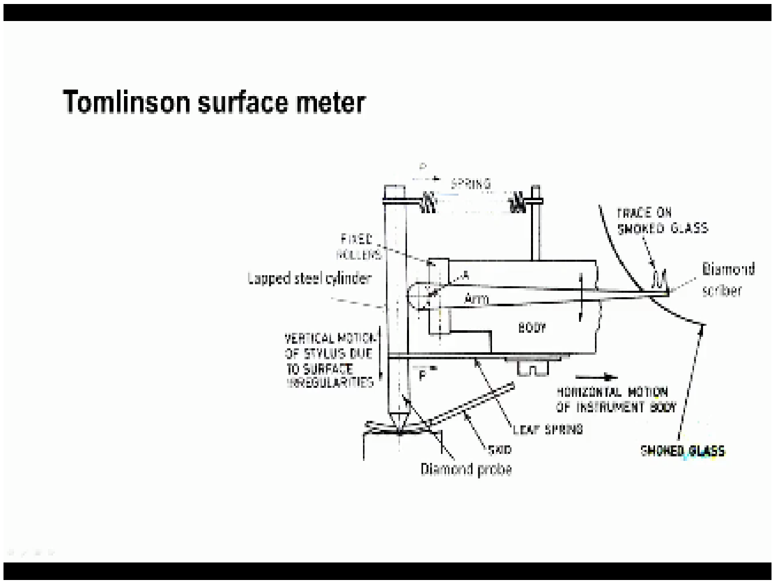

Now let us study how Tomlinson surface is constructed and how it works in order to measure the surface finish, you can see the diagram we have a vertical lab steel cylinder one and half which has a diamond probe which will be in contact with the surface to be measured and then the lapped steel cylinder is pass into the body of Tomlinson surface metre using the leaf spring and then spring is provided at the other end of lapped steel cylinder.

Now on this provided to the cylinder A which is in contact with the lapped vertical steel cylinder and the other end of the horn has the diamond scriber which is in contact with smoked glass. Now during the operation the body of the Tomlinson surface tester is made to move on the work piece surface and because of the asperities present on the work piece surface. This lapped steel cylinder will move up and down.

And this emulsion is converted into rolling action of the arm with the help of the horizontal cylinder A. So the other end of arm we have this diamond scriber which is in contact with smoked glass. So when the cylinder move up and down the diamond scriber scratch make scratches on the smoke glass. So the both the horizontal motion of the instrument body and vertical motion of the lapped cylinder or combined here to get the profile surface profile.

So the vertical motion of the lapped steel cylinder is magnified by using longer or where are the horizontal motion is not magnified. Now we cannot take this profile and if acquired it can be further magnified and then the various parameters can be calculated. So this is how Tomlinson surface metre works.

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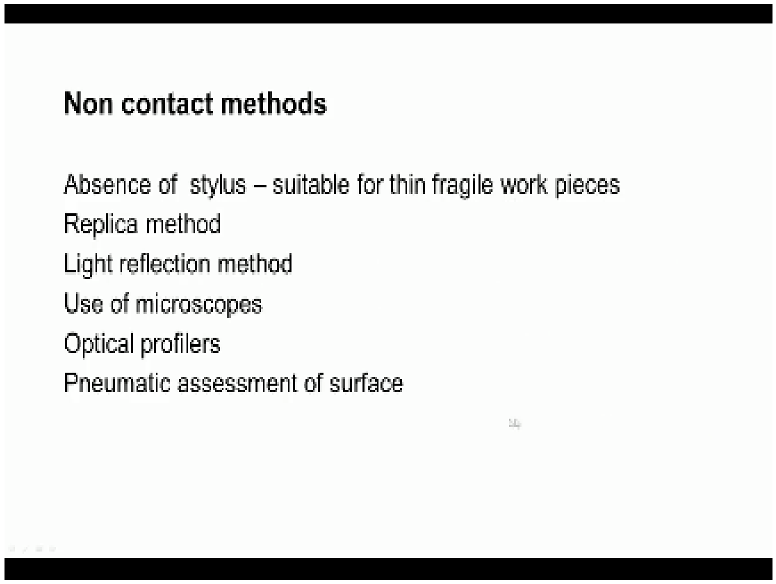

Now let us move on to the various non-contact methods that are available for the measurement of surface finish. Now we should understand here we will say non contact method the stylish is not present. So the non contact methods very much suitable for a normal engineering components or also they are suitable for thin and fragile work piece measurement of surface and thin fragile work pieces.

So that are different methods of measuring surface finish by non contact method available today we have light reflection method and then we can use microscope for measuring the surface parameters and then the optical profile that are developed for measurement of the surface along a line or they can be used to measure the surface finish in a particular area and then we will also discuss about the pneumatic assessment of surface finish.

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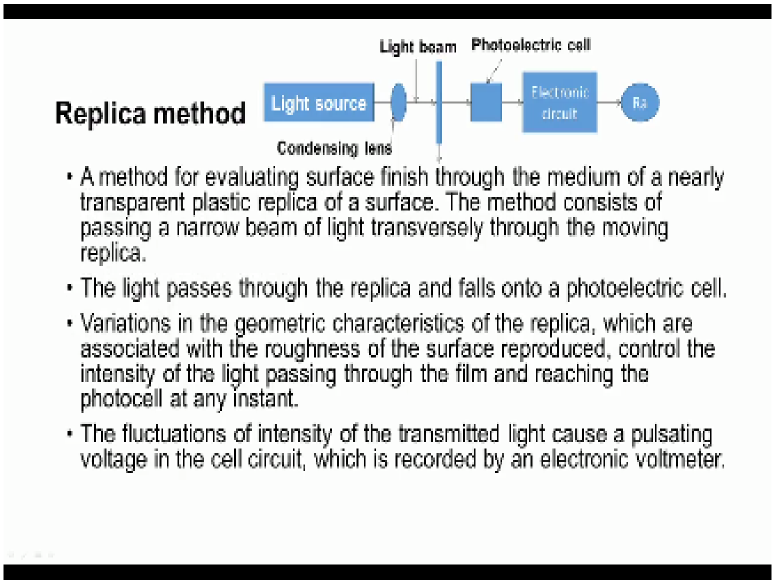

Now let us study the replica method you can see here we have a schematic diagram to show the construction of a setup used to measure surface finish by replica method, so we have a light source and a condensing length and then this is the specimen the plastic replica specimen and then the light is the made to fall on the replica and then it will pass through the specimen and then the transmitted light will fall on the photoelectric cell.

Depending upon the intensity of the light falling on the photoelectric cell the current that is generated will very and generated current will supply to electronic circuit for processing and finally we get the roughness parameter. Now the due to the asperities that that are present on the surface of the replica the light intensity will vary and hence the current generated will also vary. The fluctuations of intensity of transmitted light causes pulsating voltage in the cell circuit which is recorded by the electronic voltmeter and which will directly give the roughness parameters.

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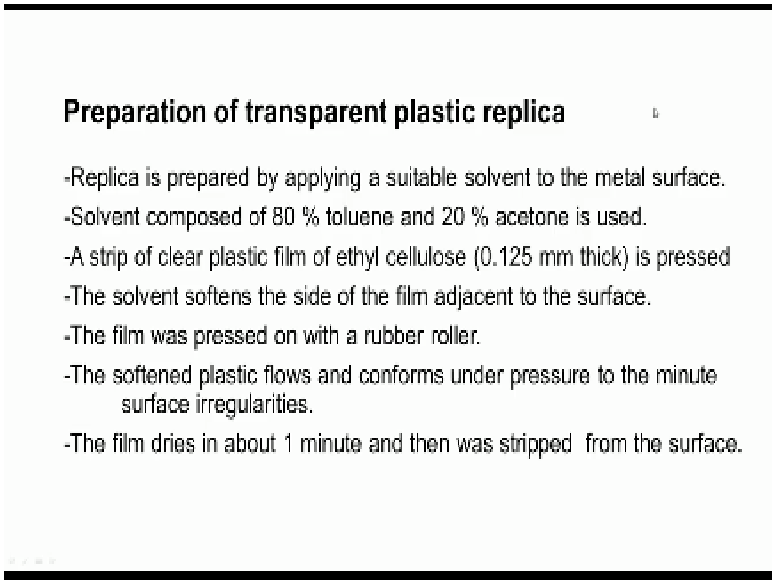

Now how we prepare a transparent plastic replica, now these are prepared by applying a suitable solvent to the metal surface it is under question and then the solvent is composed of 80% toluene and 20% acetone, it is the spread on the surface of metal, a strip of clear plastic film of ethyl cellulose of about 125 millimetre micrometre, 125 micrometre or 0.125 micrometre thick plastic sheet is pressed on the metal surface which has the coating of the solvent.

And the solvent softens the side of the film which is in contact with the surface and then a rubber roller used and it is moved over the plastic film, so that plastic film adjacent to the surface. The soft and plastic floes and confirms under pressure to the minute surface irregularities present and a little surface. The plastic film drive in about 1 minute and then it stripped from the surface.

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Preparation of transparent plastic replica

-Replica is prepared by applying a suitable solvent to the metal surface.

-Solvent composed of 80 % toluene and 20 % acetone is used.

-A strip of clear plastic film of ethyl cellulose (0.125 mm thick) is pressed

-The solvent softens the side of the film adjacent to the surface.

-The film was pressed on with a rubber roller.

-The softened plastic flows and conforms under pressure to the minute surface irregularities.

-The film dries in about 1 minute and then was stripped from the surface.

Now what is the procedure of getting the surface finish values in this replica method, initially we have to prepare the plastic replicon explain and then you should be mounted on to the measurement setup and the replica is move vertically down and there is a light source, so light is made to fall and a photocell passing through the replica voltage that is generated by a photocell varies, due to change in light intensity which is due to varying geometric characteristic.

Now change in the voltage is the measure of surface roughness and the proper calibration is to be made, so that their replica method can be used as standard specimens can be used for calibration update etc.

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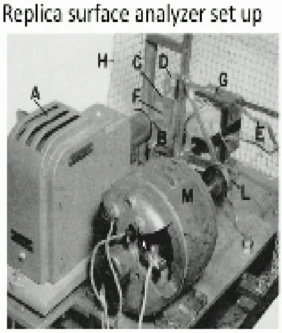
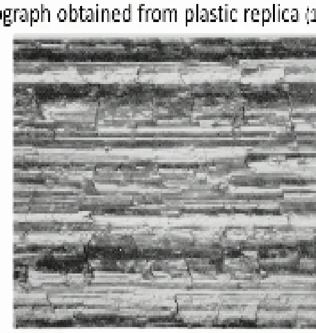
Replica surface analyzer set up



Micrograph obtained from plastic replica (100x)



Source: Harry K. Herschman, 1945

Now this photograph shows the setup a replica surface analyser setup this is a light source through which light bill there is a window through which light fill out and then we have condensing length so light is made to fall onto the specimen, this is the a specimen, so this specimen size will vary depending upon the surface it is to be tested. So if we require very long surface to be inspected then we have to take a little longer plastic film and they should be there application be prepared and then it is mounted in this setup.

Now you can see here there is a electric motor and then there is a belting the arrangement for moving the replica up and down. Now the light will passed through the replicon it will fall on a photocell. So this is a photocell depending upon the intensity of light falling on the photo sell the current is generated will vary and that is passed to the electronic circuit and finally there is an electronic metre which will give us the surface characteristic and this shows a micrograph plastic replica.

This si actually the plastic replica can magnify view of plastic replica can clearly see this asperities and then the tool marks lay clearly seen this replica.

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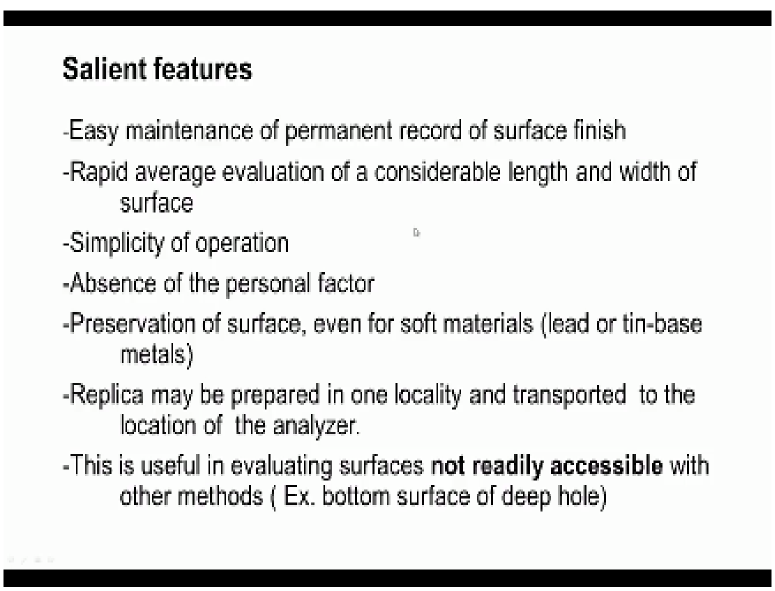

Now what are the features of this replica method, it is very easy to maintain a permanent record of the surface finish, so that the plastic replica can be stored along the period and then rapid average evaluation of considerable length and width of the surface longer length and longer but if area is to be analysed then we can prepare the replica requirement and the evaluation parameters can be calculated easily and quickly.

The operation is a very simple and there is no presence of personal fact, there is no skill is operator skill is required and the resolution of surface replica for longer duration is possible and a replica may be prepared in the locality and it can be transported to the place where the analyser is present, we need not have to transport the work piece itself, we can prepare the replica and replica can be transported to the place where it is analysed.

So this is very useful in evaluating a surface which are not readily accessible with other methods. For example we have work peace like this and now we need to analyse their surface roughness of the bottom surface is a very deep hole say that is something like 15 millimetre or 1600 millimetre, see a normal instrumentation not possible to measure surface finish. In that case we can prepare replica and then replica can remove from this place and then it can be analysed.

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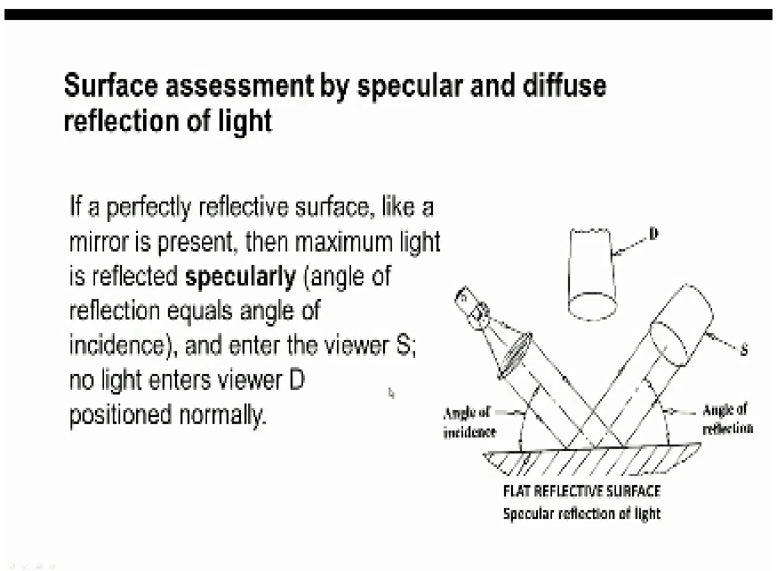

Now we will move on to the various optical method under the non-contact method are we have surface assessment by light reflection and now we see here we have the two types of reflections specular reflection of light wherein the angle of incidence of light is equal to angle of reflection of light, at this condition is satisfied then say it is spicular reflection of light. So this is possible if I have a absolute smooth surface like a mirror surface.

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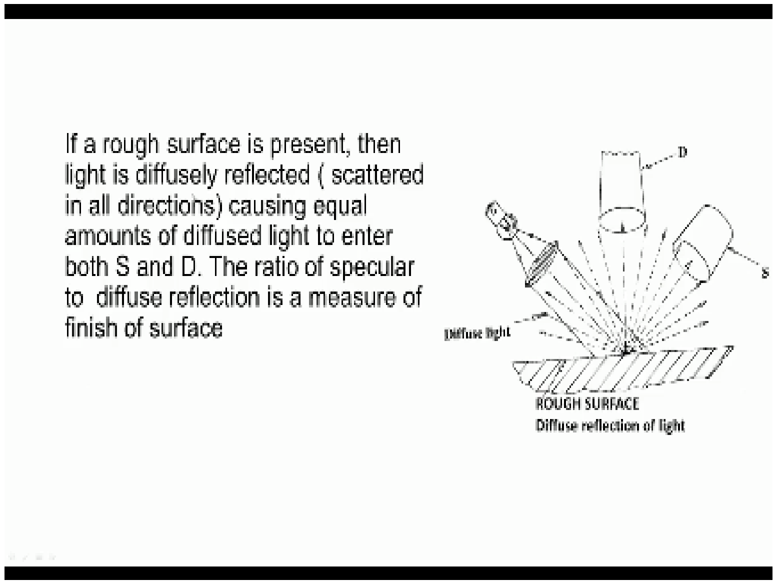

So if you have any mirror very fine surface then they all the most the light falling on the surface gets reflected back, it will pass to the view but yes and no light will fall on the viewer D. Now if the surface is rough we have a rough surface and then the light gets scattered, now this is known as diffuse reflection of light, in all direction the light gets scattered and some light will fall on the viewer and some light will fall on the D.

Now the ratio of specular 2 the diffuse reflection is the measure of finish of surface, that means what is the amount of intensity that is collected here and what is the amount of light that is intensity of light is selected here. If you take the ratio so that is the measure of surface finish. So in this way we can use optical method to check the quality of surfaces.

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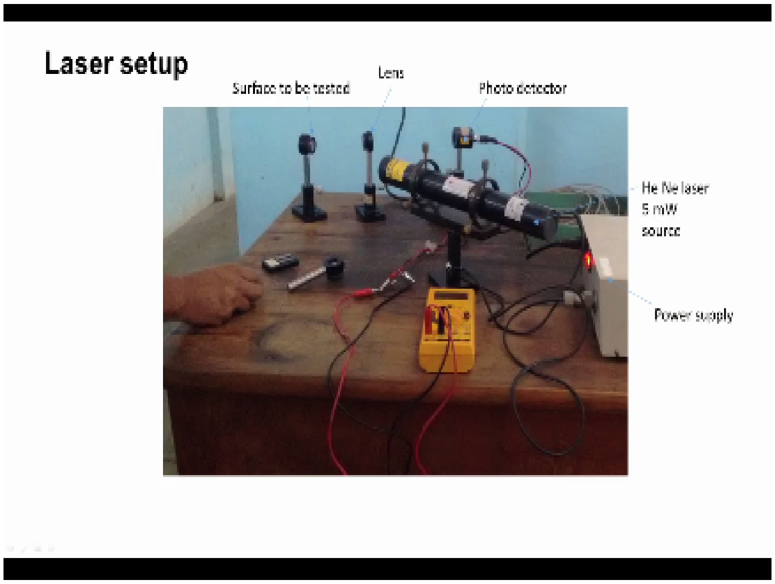

Now based on this light reflection we will see a simple experiment to see how we can measure the roughness of surfaces, a nice photography can see we have a laser tube, gas laser tube in this is a Helium neon laser with 5 nw laser source and then I can see here we have a detector photo detector and you have the optical lens to focus the light onto the photodetector. So this is a power supply for the Helium neon source and the detector output is connected to the millivolt meter.

And also see we have to calibrate this button light reflection method setup using the standard surfaces we have two surfaces with N3 and N5 finish using the standard surfaces calibrate setup and then we can put the surface to be tested here and there the amount of light that is falling on photodetector will vary depending upon the scattering. Now the laser will fall on the surface to be tested.

So here initially where to keep the standard surfaces and for entry surface what is the amount of light intensity and what is the corresponding that we have to record similarly we have to use some to 3 standard surfaces and then depending upon the roughness the light intensity light falling on the photo it changes accordingly the millivolt will vary. Now we have to remove the standard surface and where to keep the surface to be tested here and then they if it is rough day light in scatter like this.

And some amount of light will fall on the photo editor and what is the output shown in the millivoltmeter that should be a recorded. Now say for N2 surface we have some X1 millivolts and similarly and then we have N2 surface N3 grade surface, so we have X2 millivolts and then for N4 grade surface we have X3. Now we have to keep the surface which is to be tested here and say the voltmeter reading is between this X1 and X2.

Then that indicate that the surface finish his between N2 and N3. So like this way initially and then we can use this setup. Now we will conduct an experiment to show how the laser setup can be used to evaluate the surfaces.

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Now let me explain how we can use the laser system to measure the roughness of surfaces. Now we can see the various components of the laser system, we have this longer tube the gas laser Helium neon gas laser fibre believe what and this is the power supply for the gas laser and can see a tube is placed in the stand to keep the laser tube, now you can see the standard specimen.

So standard specimen we have to use for celebrating this system, so we have two surfaces here, one is N3 grade surface and another is N5 grade surface, using these 2 standard surfaces we can calibrate the laser system.

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Yeah so one is N3 and another is N5, then you can see here we have a reflecting mirror, so which will reflect all the surface all the light has a very smooth surface. So all the light falling on this incident light will be reflected back that is a specular reflection and now you can see work pieces, we have to measure the thickness of the ground surface for which we are using the laser system.

And we can also see the multimeter, the photo detector output is given to this multimeter and then we can read voltage that is generated by the detector in terms of reports, and this is the place where we have to keep the standard work piece is reflecting surface where to keep the standard surface and then we have to remove the standard surface and then there to keep what pieces whose surface finish is to be measured.

And the light will fall laser will fall on to this reflecting surface and the surface to be tested and then it is reflected and then it will pass through the collimating lens and then they are reflected light will fall under photodetector. So depending upon the light intensity falling on the photodetector it is generated voltage which is connected to the multimeter and we can read what is the amount of voltage that is generated which is dependent on the surface finish.

If the surface is very fine like mirror, so the intensity that is falling on their photodetector is maximum and we get to the maximum reading here if you put a very rough surface scattering will be there and only little light is falling on the detector, so the voltage is water generator is less. So once we calibrate the system using standard surfaces we can check we can inspect the surfaces whose surface finish the finish and measure it.

Now you can see the anvil we have to adjust so that the light can fall on this and gets reflected on to the detector, so now I am adjusting the angle now you can see the light is falling on the lens and then it is falling on the detector, and now you can see the detector yeah now it is falling on the detector, so once the light falls on that since we are using a mirror the maximum intensity will fall on the detector.

And can see the voltage generator is maximum that is 0.395 millivolts, so the light is falling on the photodetector, solid-state photo detector. Now I have removed the reflecting surface, now I have put the work piece to be inspected, so now we have to adjust the inclination, so the light can fall on the detector, So proper alignment is very very essential in this case.

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Now on calibrating the system using the standard surfaces we can see we have 2 surfaces and 3 and 5 and I am keeping the standard surface in position and I am adjusting the inclination, so that light falls on the detector, I can see the laser light it is spread scattered because of the surface roughness, now I am doing the alignment yes light is falling on the lens and then on to the photo detector.

I am adjusting the orientation of detector, now adjusting the height of the detector, so that light passes in detector, now you can see the reading this point 266 millivolts, and 26 millivolts yeah, now again I adjusted the alignment, now it is 0.288 millivolts and 0.313 millivolts, 0.314 millivolts, now this is N5, N5 surface is kept in position, now N5 is rougher than N3, so more scattering will be there.

So now the voltage heavy voltage is 0.294, we can see I am taking this surface to be inserted and keeping that in position, I am adjusting the orientation you can see the light scattering because of more rough surface, I am doing the alignment we have to adjust the height and inclination of these various elements, so that maximum light falls on the detector, I am adjusting the height of the detector.

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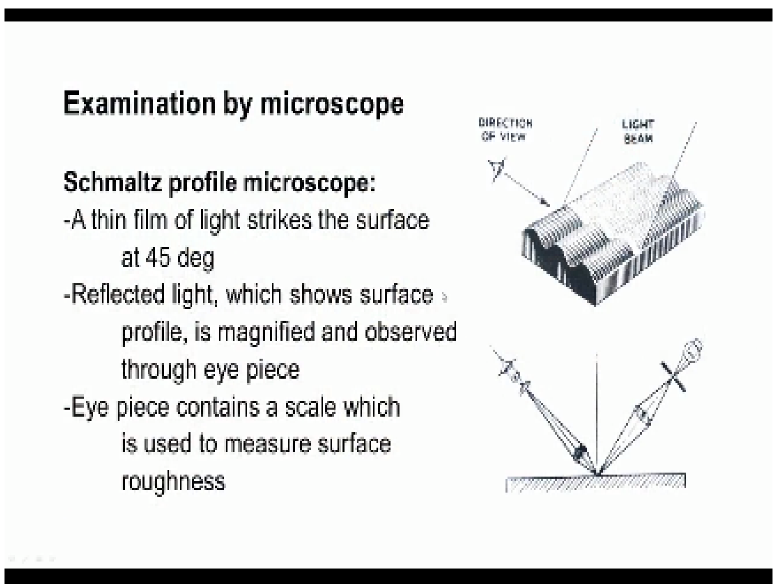

Yeah now you can see light is falling on the detector, and you can see the voltage that is generated 0.306 millivolts. Now we will move to another method of non-contact method of surface finish measurement, we can use the microscopes for measuring the quality of the surfaces, and this is known as schmaltz profile microscope, the element is like this, this is the work piece for which we have to measure the finish of this particular surface, and now a thin film of light is made to fall on the work piece again.

We have very thin skid here, and the light is made to pass through that slide and it fall on the work piece surface and now the light gets reflected. So reflected light will show the surface profile and this reflected light is magnified and observe through eye piece, so the eye piece contains the scale which is used to measure their surface roughness, that means what is the distance between pecan valley those things can be measured using the eye piece.

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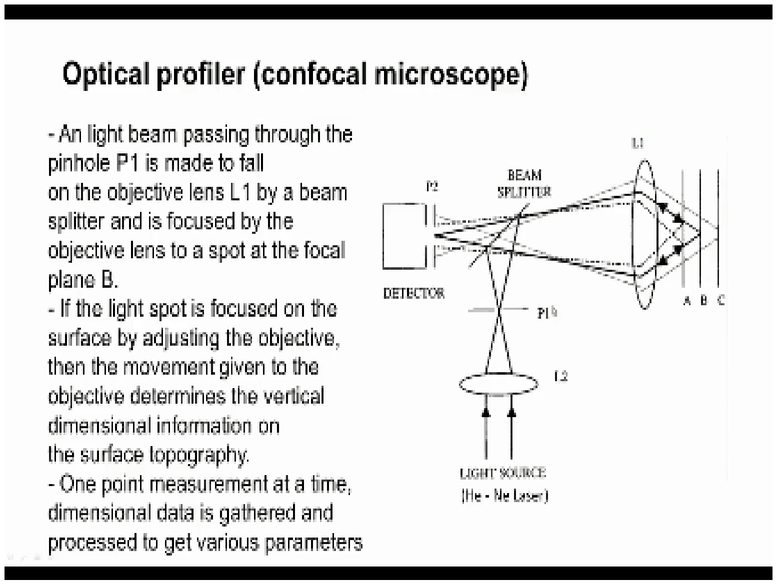

Now we will move to another optical method known as optical profile, this is also known as confocal microscope or confocal scanning microscope since they scanning process is used in the microscopic method. Now the arrangement is shown here, so we have got two lenses this is the objective lens L1 and then we have a light source Helium neon laser light show and then there are collimating lens to collimate the light source.

So the light will pass through the pinhole one and then I using this beam splitter light is made to fall on the objective lens and then it gets focused, so let here, and then this is the work piece surface to be tested. If the work piece surface is exactly at the focal point of the objective lens, then the light gets reflected and then it will pass through the pinhole number 2 and then it will fall on a detector.

In the work piece surface exactly at the focal point then maximum intensity of light will fall on a detector. Now if the work piece surface is at a place other than the focal point say it is somewhere here at position C. So now it is not focused so reflected light I will get started and only a small quantity of light will fall in the detector, so intensity of light will be less if the surface is not at the focal point now by moving the objective in this direction we can always make the light to focus on the work piece surface, we can I remove the lines are we can either move on surface to be tested.

So it is easy to move the lens, so in order to move the objective lens PZT is used, so the amount of movement that is needed to focus the light on the work piece surface is measured using this PZT, now what we can do it is we should understand that this is this is a system wherein at a time one point is inspected that means after getting the light intensity for a particular point then the work piece is the moved.

For that we can use in XY table or have a cylindrical surface the surface of the cylinder is to be checked so in that case we can use the motor electric motor to rotate the work piece and then the light is made to fall on the surface. So but after taking the reading this work piece is rotated and again the other it is inspected and point by point we have to get the data. So the dimensional data that is gathered for a particular area is club together and it is the process to get the various parameters like roughness parameters or various parameters or there from here to work piece can be computed.

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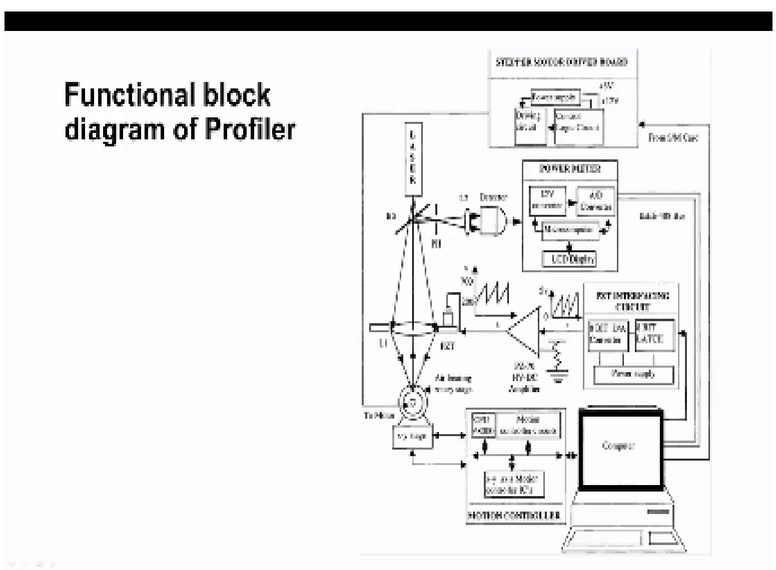

Now this is a functional block diagram of the profiling system we can see the various components involved in this setup, so we have the XY table for moving the work piece and for moving work piece we have motion controller and then we have a bearing rotary stage to rotate the physical object, air bearing is required so that it runs smoothly and with least amount of run out and it is a motor to rotate the children there or if it XY table then it will be having 2 motors 1 for X direction and Y for moment.

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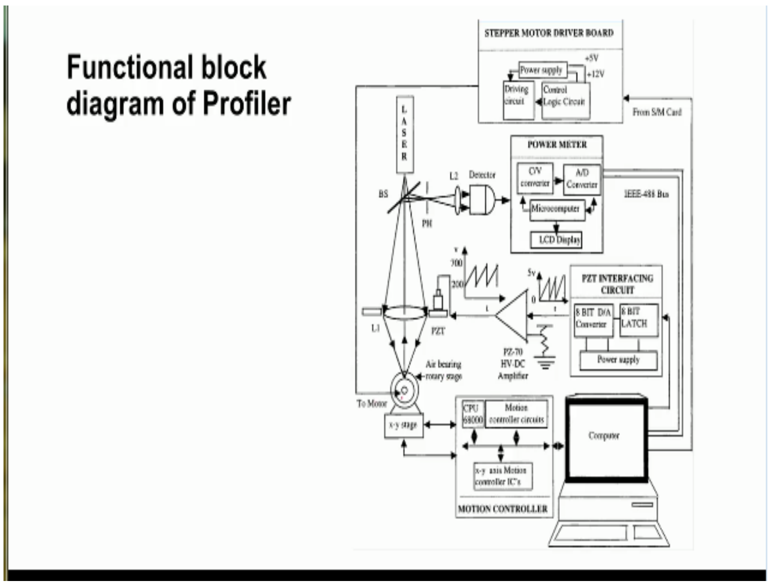

And there is a motor to rotate the cylindrical object or if it is xy table then we will be having two motors one for x direction and movement one and for y direction movement. And now you can see here we have the objective lens which is fixed to the PZT. So, for focussing the light on to the surface we use the PZT and using the PZT the lens can be moved up and down for focussing purpose.

And is PZT movement it is connected to the computer via this PZT interfacing circuitry. And then we have the gas laser source and then being splitter and then another lens the light will pass through this pin hole. And it will fall reflected light will pass through the pin hole at is made to fall on the detector via the lens L2. And then light intensity is measured in terms of microwatts.

So, there is a power meter to measure the wattage of delighting stream in terms of wattage, so again it is connected to the computer. And then for moving the stage and then rotating the work piece we have stepper motor driver bore. So, this shows the various components of the profilo meter.

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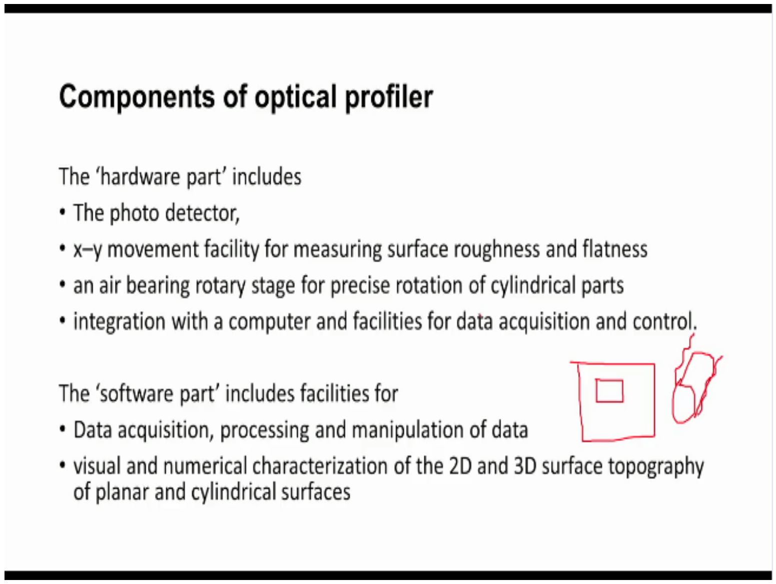

Now so, we have hardware components like photo detector and then x-y table and the uh a motor to rotate the work piece. And air bearing for smooth rotation of the work piece and then all these are integrated to the computer via proper interfacing devices. And then there is a data acquisition card and then the software consist of data acquisition software. And processing and manipulation of data in order to find in order to compute the various parameters.

And then we can get visual and numerical characterisation of 2D and 3D surface topography of flat surfaces as well as cylindrical surfaces. So, we can get if it is flat surface a particular area can be scanned. And what is the roughness of this particular roughness or flatness of form error in this particular area. It can be calculated in terms of various parameters if it is cylindrical surface then also we can find what is the cylindricity what is the error in the form. So, some 3 dimensional parameters also we can get by using these profilo meters.

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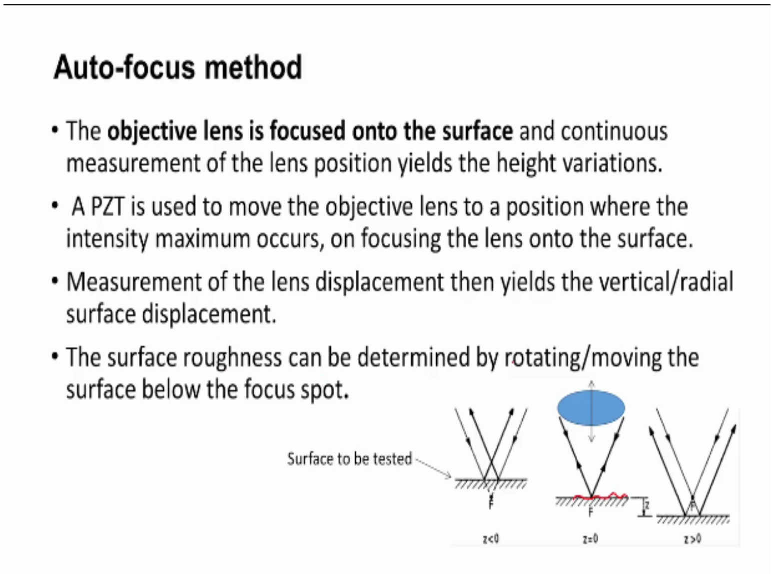

Now in this method we have two methods one is called auto focus method and other one is called light intensity method. In this auto focus method the objective lens is focused onto the surface. You can see here we have the surface which is to be tested and we have three conditions. So, here the surface to be tested is above the focal point. That means the light reflected will have little amount of intensity.

And here the surface to be tested is beyond the focal point again the light intensity will not be equal to maximum where as in this case the surface to be tested is exactly at the focal point of the objective lens. So, in order to focus the light on to a particular point on the surface. We need to move the objective lens using PZT. So, measurement of lens displacement by what amount lens moves up and down that measurement is the vertical or radial surface displacement and the surface roughness is determine by rotating or moving the surface below the focus spot.

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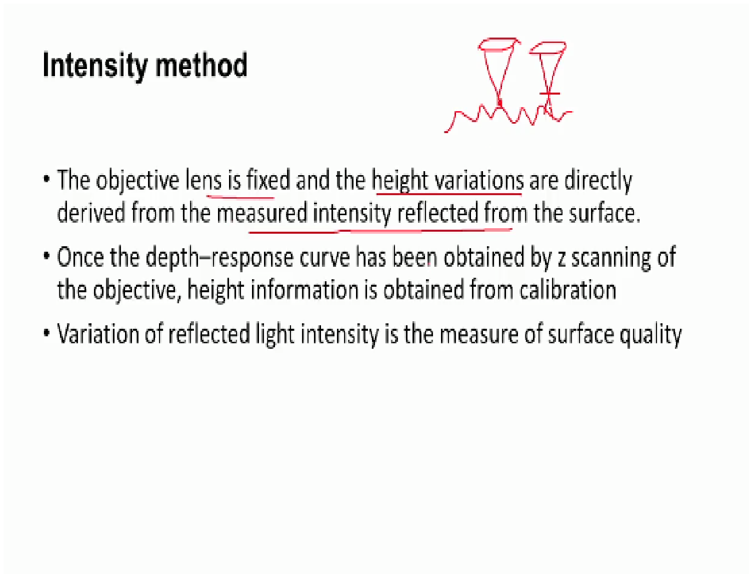

Now in the intensity method the objective lens is fixed it is not moved and due to the variations of the asperities and the work piece. The lens is fixed if a particular point is at exactly at the focal point. And the maximum the reflected light intensity will be maximum if the point a particular point is not at the focal point. You can see this is the focal point somewhere here where as the point on the surface is somewhere here.

So, the reflected light intensity will not be maximum so, depending upon the asperities reflected light intensity falling on the detect will vary. So, those variations in the light intensity they tell us they give us the height variations on the surface of the work piece. Now what we have to do is we have to collect all the measured intensities reflected intensities. And then we have to manipulate those data. And then we can find the roughness parameters.

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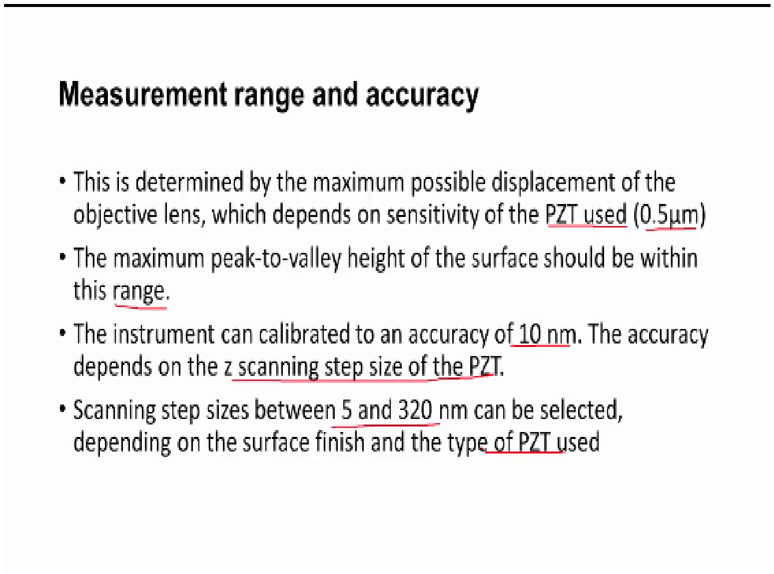

So, now the system software that is used in profiler like this have five modules so, there is a measurement system control and data acquisition element of the software. And the various filtering filters are used to remove the unwanted elements. So, if you want only roughness the vividness can be eliminated. If we require only vividness parameters then roughness parameters can be eliminated.

So, for that various different kinds of filters are used a datum characterisation algorithms is also used the software. And analysis and numerical characterisation is possible using the software. And then visual characterisation such as 2D and 3D plots can be obtained we have very high data acquisition rate of 40000 to 60000 data per hour is possible. So, the optical method of measuring the roughness will be quick.

Now what is the measurement range and accuracy in such a system so, these measurement range is determine by the maximum possible displacement of the objective lens. In other words what is the maximum amount of movement of the PZT that is used. So, typically 0.5 micrometer ranges are available and the maximum peak-to-valley height of the surface should not exceed this range. That means if peak-to valley height roughly we know accordingly we have to select appropriate profile meter which will accommodate that range.

And then the instrument it is very essential that we should calibrate the profile meters with standard specimens. And these systems can be calibrated to an accuracy of 10 nanometre. The accuracy of the method measurement method depends on the Z scanning step size of the PZT. Now scanning step sizes varies between 5 and 320 nanometre. So, if we require very finer step size an appropriately we have to select the PZT that is used.

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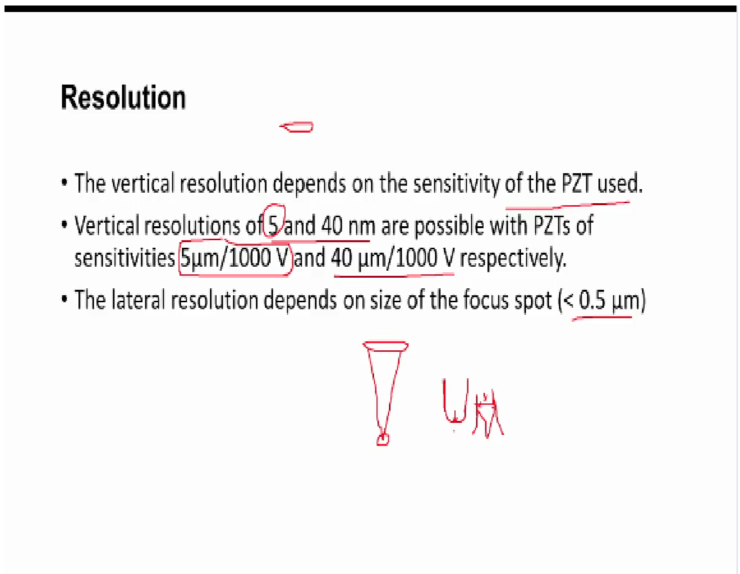

So, what is the resolution of this setup the vertical resolution depends on the sensitivity of the PZT that is used. So, vertical resolutions of 5 and 40 nanometre are possible with PZTs of sensitivities 5 micrometre/ 1000 volt and 40 micrometre/1000 volt respectively. So, if we this a PZT with sensitivity of 5 micron per 1000 volt then the vertical resolution that means the least value by which the objective lens can be moved will be 5 nanometre.

So, the lateral resolution depends upon the size of the focus spot. So, now we have the objective lens and then we get the focus spot focus. So, the lateral resolution it depend upon what is the focus spot. So, typically 0.5 micrometre spot sizes are available if the size is 2 big then the lateral resolution will also be less. So, this is something like the stylus in a probe in a stylus type instrument.

So, we have the conical stylus with radius of maybe 5 micrometre or 10 micrometre if the as per valleys the width between two value is less than say 5 micrometre. And if the stylus size is 5 stylus radius is 5 micrometre then it will not enter. The same thing happens in this is analogous to the size of tip radius.

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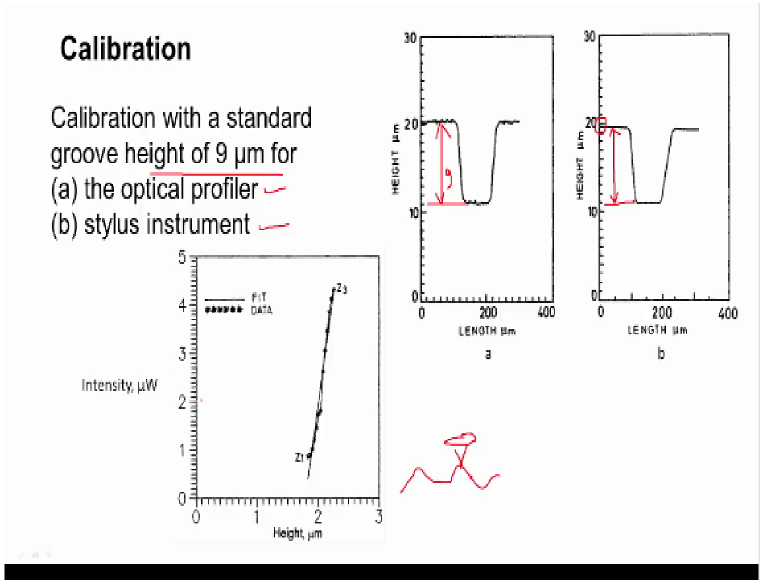

Now it is very essential that before using such a system we have to calibrate the system here you can see the calibration is carried out using a standard groove with groove height of 9 micrometre. So, this is the calibration result of time by optical profiler and then this is calibration curve obtained by stylus instrument. Now we know that the groove size is 9 micrometre now you can see here after measuring that groove you can see here.

So, this depth this depth is 9 micrometre similarly in the stylus type instrument is approximately equal to 9. So, there is a small amount of error here and then the reflected light intensity is measured in terms of micro word. We can see here the reflected light intensity in terms of micro word varies from 1 micro word, 2 micro word like this and corresponding height of the point.

So, depending upon the light intensity as the light intensity varies the height of the point also varies okay. So, like this we have to initially calibrate this system and then we can use for assessment of the surface.

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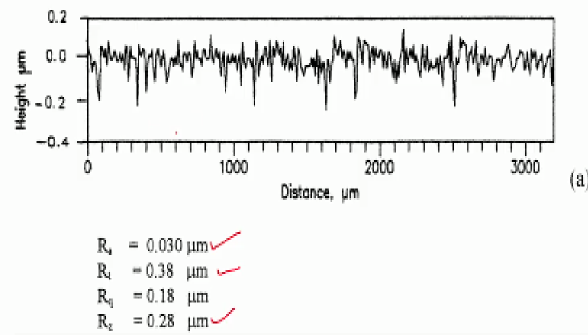

Surface profile of a standard ground surface obtained by autofocus method

Now this is one result obtained by the optical profiler profile meter now this is the surface profile of standard ground surface obtained by auto focus method okay. Now the x axis is distance in terms of 1000 micrometre, 20,000 micrometre like that. So, small division indicates 100 micrometre and this is the peaks and valleys on the surface. So, after the manipulation after crossing the data Ra value for calculated to be 0.03 micrometre.

And Rt value is 0.38 micrometre and Rz value is 0.28 micrometre now the same surface was checked with stylus instrument and then the comparison was made.

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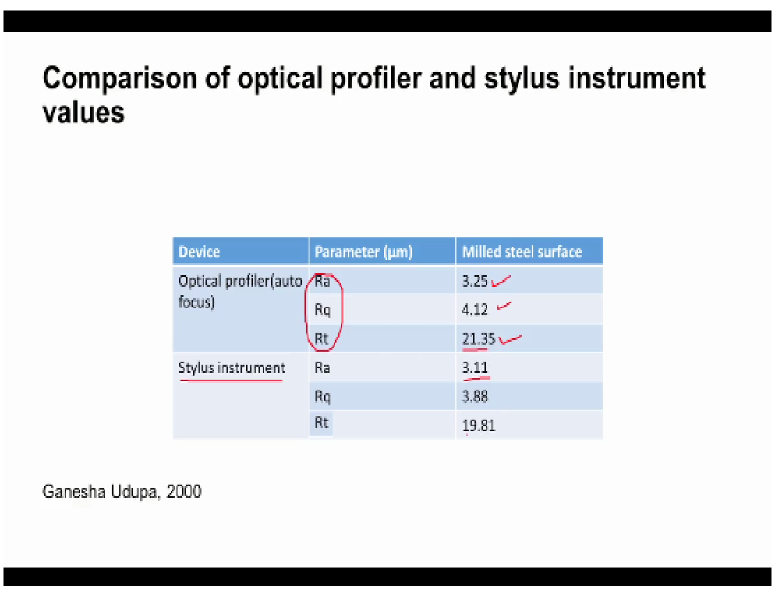

Comparison of optical profiler and stylus instrument values

Device	Parameter (µm)	Milled steel surface
Optical profiler(auto focus)	Ra	3.25
	Rq	4.12
	Rt	21.35
Stylus instrument	Ra	3.11
	Rq	3.88
	Rt	19.81

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We can see here comparison of optical profiler and stylus instrument values. So, these are the result obtained by optical profiler okay Ra value this is for a particular milled steel surface Ra value was 3.25 micrometre and Rq value was 4.12 micrometre and Rt is 21.35 same surface was checked using the stylus you can see here Ra values are most same 3.2 here and 3.11 with the stylus instrument and Rt value is 21 and here it is 19.81.

So, like this we can always compare the different systems how they behave that can be checked. Now we will move on to another non-contact method of measurement of surface finish.

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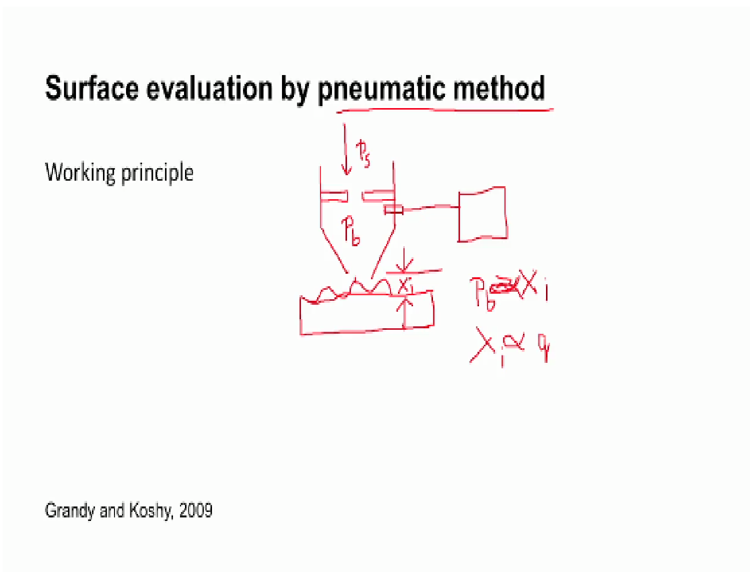

So, this is pneumatic method so wherein compressed air is used for the measurement of surface finish the working principle is like this. So, we have will be having a nozzle like this okay. And then the compressed air is supplied here with supply pressure of Ps and there will be a control RFS. And then this is the work piece surface which is to be tested. So, the nozzle gap between the nozzle and the work piece surface is Xi.

If the gap Xi is very small then the back pressure here will increase if the gap is more pressure will be less. If the gap is less pressure will be more. So, the variation of the back pressure is dependent on the surface characteristics. If the gap is less then pressure will increase. So, this pressure variation can be monitor or measured using piezo electric transducer. And the variations in the pressure frequencies pressure pulsation are given to the computer for analysis purpose.

So, this is the working principle so, the surface pressure pulsation depends upon the gap between the nozzle and the work piece surface. So, Pb is proportional to the Xi it is and Xi is proportional to the surface quality q.

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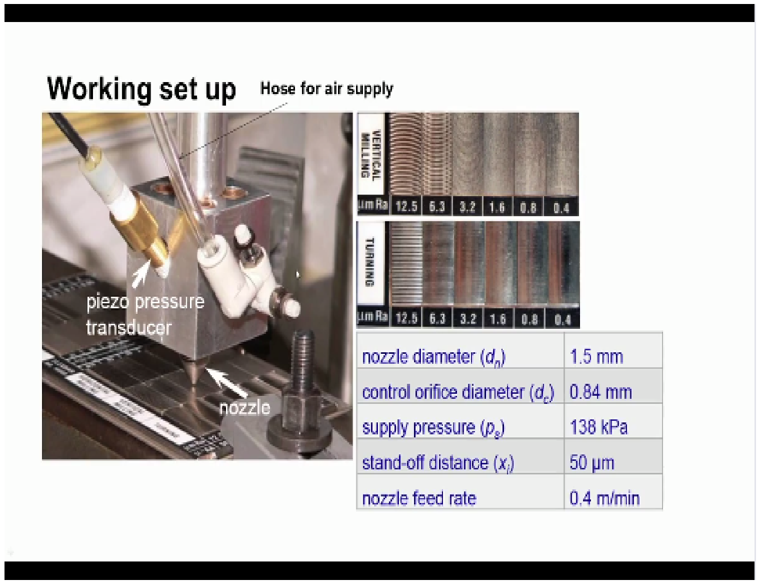

Now this photograph shows the working setup you can see here for calibrating the system the standard surfaces are used here different surfaces like surfaces made turning and then vertical milling. So, like that with varying roughness where used to check the working of the setup once the setup is calibrated it can be used for measuring the surface finish of unknown surfaces now the nozzle diameter is 1.5 millimetre.

So, this is the nozzle through which there is discharge of air so, nozzle diameter is 1.5 millimetre and control orifice diameter is 0.84 millimetres. And supply pressure is approximately 140 kilo pascal and the stand-off distance Xi is 50 micron. So, this will varying depending upon the variations in the surface. And nozzle feed rate is 0.4metres/minute either the nozzle is moved or the work piece is moved for conducting the measurement.

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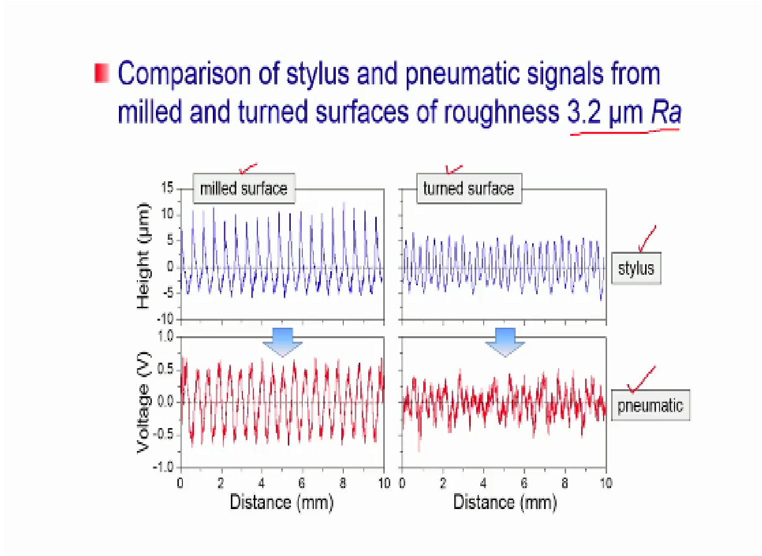

Now these pictures show the comparison the stylus and pneumatic signals from milled and turned surfaces so, we can see here milled surface and then turned surface of roughness 3.2 micrometre Ra. So, standard surfaces are used for calibration purpose so, these are the results obtained by using stylus instrument and these are the results obtained by pneumatic surface instrument. So, output is in terms of voltage and this can be converted into roughness value.

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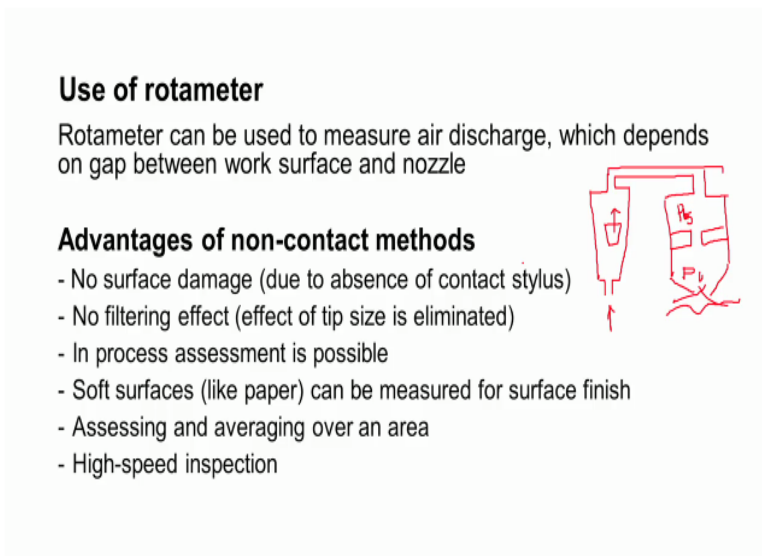

Now instead of using a piezo electric transducer we can use a rotameter. So, this is the rotameter with float so, air is allowed to flow like this. And then air escapes from here and then we have the nozzle here with the surface with the control orifice okay this is Pb, this is Ps, and this is Pb. So, now if the gap is less then the flow rate flow of air is restricted. If gap increases then there is free flow of air, air flow increases. And then float moves up and the position of the float indicated the roughness value on the surface.

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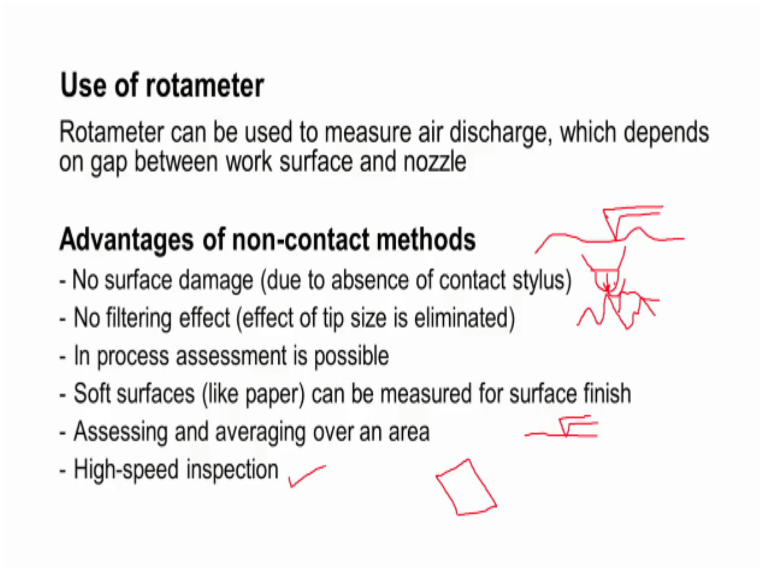

Now let us see what are the various advantages of non-contact methods so, since there is since no contacts stylus is present in these non-contact methods. There is no surface damage occurring on the surface in the contact type what happens is we move the very sharp stylus on the work piece surface.

So, there is possibility of a scratch appearing on the surface. So, in non-contact method such problems are not there and then there is no filtering effect since the stylus is absent in the conventional stylus type due to the size of the stylus. So, this is having a diameter of say 5 to 10 micron because of this it will not enter into the very narrow valleys. So, there is a sort of filtering mechanical filtering effect in conventional stylus type methods.

So, in the non-contact methods such problems are not there in process assessment of this surface is possible. Since there is no contact between setup and the work piece so, when the machining is going on we can check the surface finish. Soft surfaces like paper, plastic etc., can be measured for surface finish. So, if we try to check the surface finish of soft surfaces using stylus.

So, the surface may get destroy and then assessing and averaging over large areas can be assessed, evaluated and averaging can be performed. And these non-contact methods are methods with high speed.

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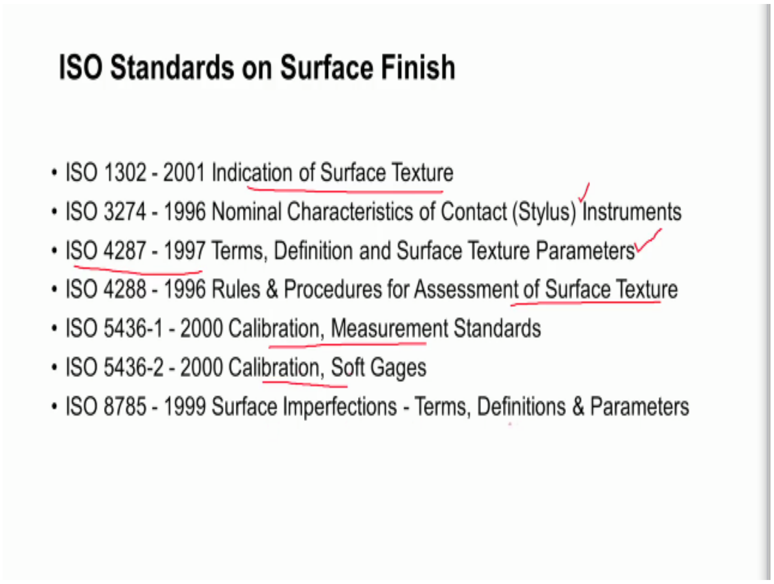

Now let us see what are the variation ISO standards available on the surface finish. So, we have ISO standards which will tell us about the indication how to indicate this surface texture and the technical drawings and then nominal characteristics of contact type instruments and then what are the various terminologies and definition and surface texture parameters. So, these standards they explain the various roughness parameters waviness parameters.

And motive parameters and then the hybrid parameters etc, etc., the all definitions are given in these standards and then we have standards for rules and procedures for assessment of surface texture. That means how to setup the instrument how to set the work piece, how to select the various parameters like top length, suspect length etc., etc., and then how to calibrate the instruments what are the various measurement standards that are available.

And calibration aspect of the instruments and what are the various imperfections on the surface there definitions and parameters are also explained in these standards.

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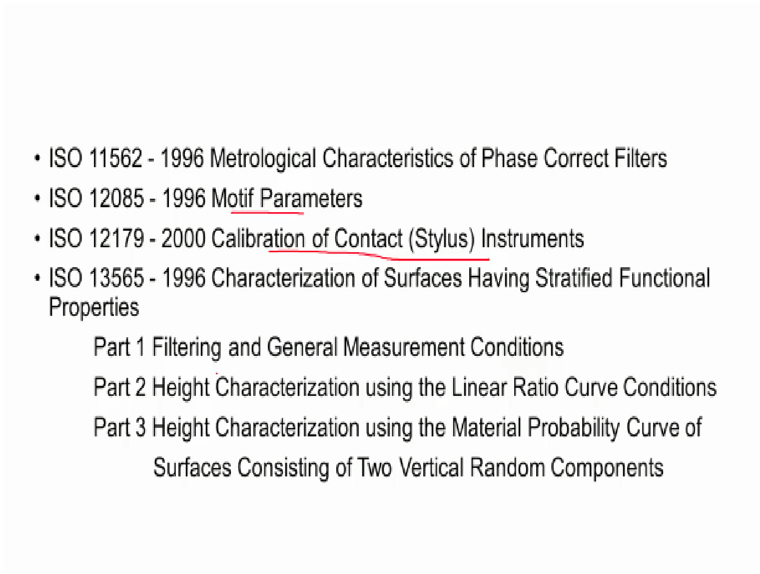

And there are standards to cover the motif parameters and then regarding calibration of stylus instruments standards are available so, like this the various ISO standards are available. So, which will help us assessing the surfaces.

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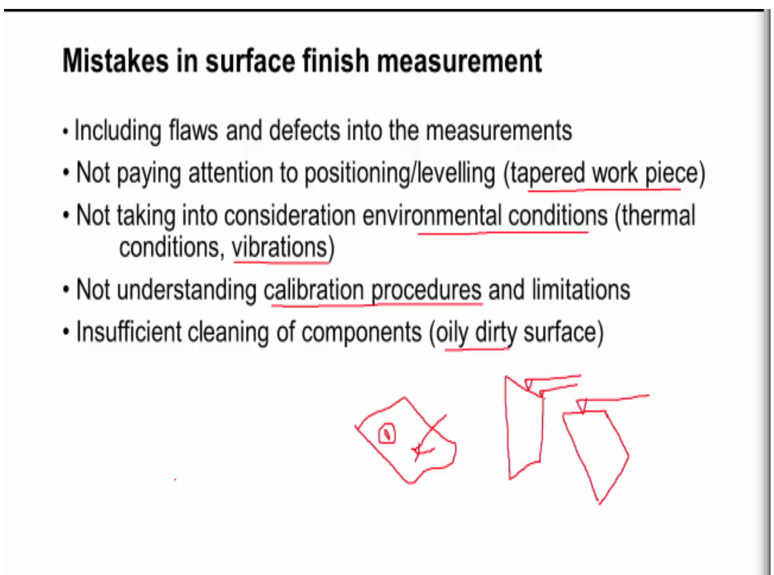

Now let us see what are the common mistakes made during surface finish measurement as per the standard we should not include the flash during measurement of surface say for example say we have a surface like this. And somewhere here there is flow like maybe there is a bore or there is a crack or there is a glow hole. Initially we should visually we should check the surface. If necessary we should use magnifying lens and we should check the surface if there are surface flash like this such area should not be used for assessing in the surface roughness.

We should a select surface where no visible surface defects are present if we include the flaws then we get some result which should not be useful. Then not paying attention to positioning and levelling of the work pieces. So, positioning of the stylus on the work piece and the levelling of the stylus on the work piece they are very important if we do not level the stylus of the probe on to the surface properly then will get aeronious results.

So, this is very important in the case of tapered work pieces. For example say we have a work piece like this and this surface finish we want to measure. Then now if we allow the stylus to move like this then instead of measuring the surface finish it will measure the taper. So, what we have to do is we should properly align position the taper work piece like this. So, that the surface is parallel to the movement of the stylus.

So, for that various fictures work holding devices are available and we should use them. And properly we should position and level not taking into consideration the environmental conditions like thermal conditions say we have we want to measure the finish of a engineering components which is just made that it is machine just now. And now it is in the very hot condition so, we should allow the component to cool down to the normal temperature at then.

We should go for surface assessment if the work piece in hot condition and if try to measure surface finish what happens is the due to the heat it is expanded work piece is expanded. So, in such case we should not take the result we should allow the work piece to cool sufficiently and then only we should clean the surface properly. And then we should use appropriate instrument to check the surface.

Similarly the external vibrations say we are conducting the measurement at some place wherein some external vibrations are induced maybe in the next room we have a forging machine or some machine is making lot of noise and vibration. So, those things will also be included if you measure the surface in the vibrating conditions. So, we should see that proper vibration isolators are used before we conduct the measurement.

And then the all the instruments should be calibrated properly at regular intervals using the standard specimens then only we should use the surface finish testers. Otherwise if in the tester is in the un-calibrated status and then if you try to use then measurement result will not of any use. And then insufficient cleaning of a components that is the surface is very and it is very dirty.

If that is the we should not go for measurement we should thoroughly clean the surface of the work piece maybe using some chemicals and we should allow it to dry and then only we should take the measurement.

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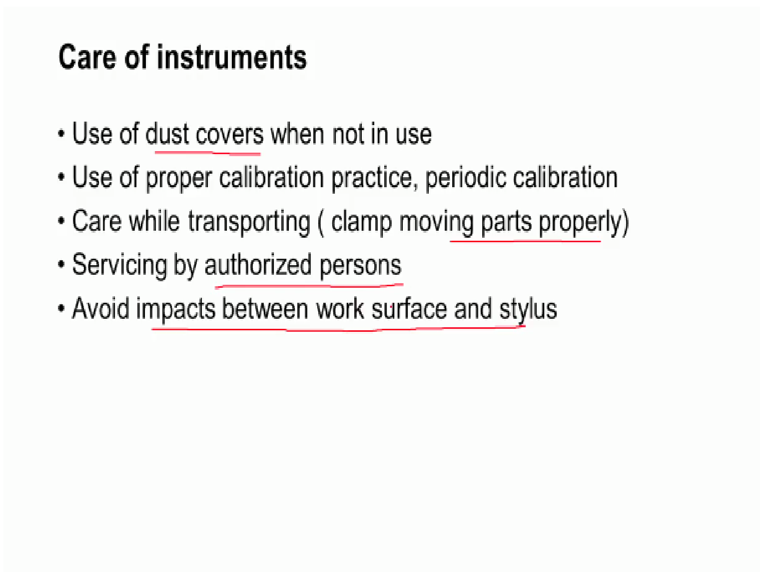

Now what type of care one should take so, that the instrument sophisticated measuring instruments or surface finish textures will be in good condition. So, use of dust covers will not in use say the surface texture is not use maybe for 1 week or 1 month it is in the unused condition. Then we should use dust cover, so that dust will not fall on the instrument. And then use of proper calibration practices and the conducting the periodic calibration, this is very very important.

So, that the instrument will be in good condition and whenever we transport the instrument from one place to the another place they should be packed properly. All the moving parts should be properly clamped maybe we should follow the instructions given by the manufacture of the instrument. And as per instruction we should properly clamp them. If the moving parts are not clamped, then what happens is during transit the moving parts may move in and out.

And because of that they may get bend. So, they become useless, so to avoid such things proper care should be taken while transporting the instruments. And always servicing of the instrument should be carried out by authorized persons unauthorized persons should not be allowed to do the servicing of the instruments. And always this is very essential that impacts between work surface and stylus should be avoided.

We should not allow the stylus to fall rapidly on the surface the diamond point may get destroy may break. So, such things should be avoided.

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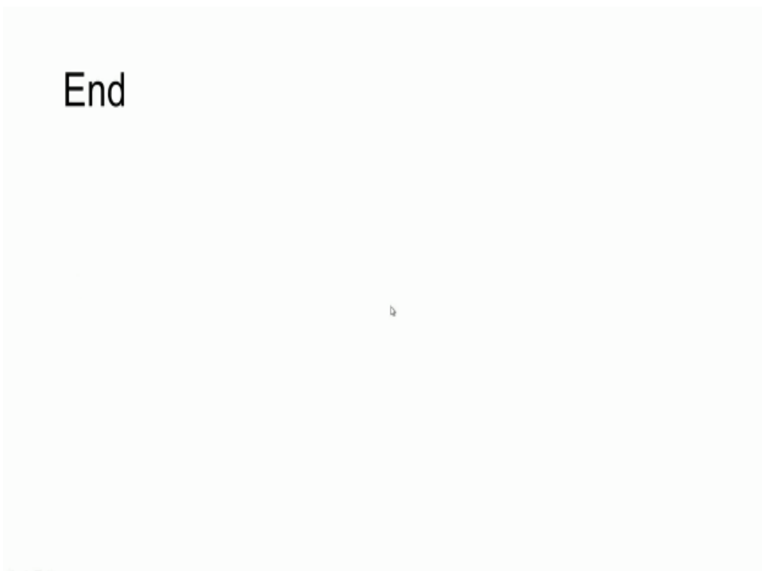

Now with this let me conclude the session in this session we discussed about tomiling and surface tester. And various other non-contact methods of measurement of surface also we studied about various ISO standards available on the surface finish and then we learnt about the common mistakes done by the operators while using the surface measuring instruments and what are the care to be taken to see that the work pieces that the instruments will be in good condition. So, with this let me conclude the session Thank you.