Introduction to Machining and Machining Fluids
Dr. Mamilla Ravi Sankar
Department of Mechanical Engineering
Indian Institute of Technology, Guwahati

Lecture - 07
Lubrication and Surface roughness in Machining

Now, we will move to another one that is called a lubrication and surface roughness in machining processes. In the tribology surface roughness in machining, we have seen chip tool tribology we have already seen in the previous class, and the tool workpiece tribology and sticking and sliding zones we have seen up to this one.

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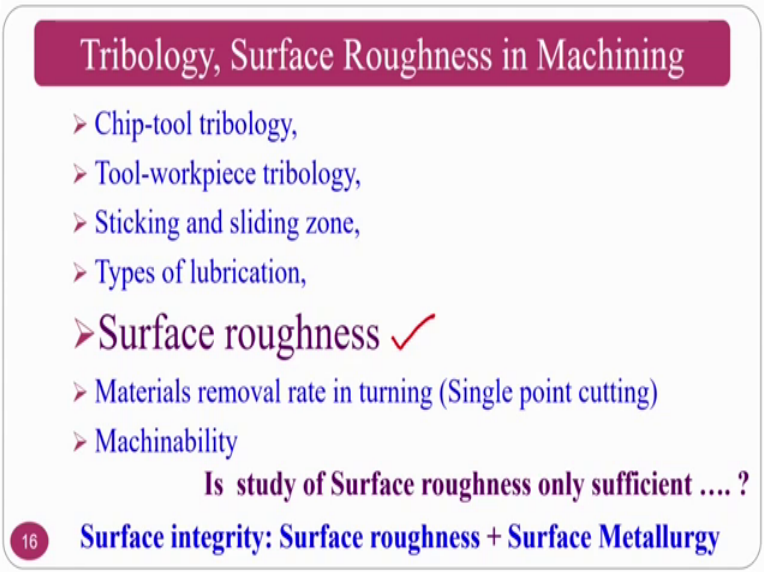

And we are going to see the types of lubrication why the lubrication is required in the machining process, why only the lubrication from the point of tribology is most important that all we will see here and followed by the surface roughness, mostly in this class we deal these two things ok

So, types of lubrication the lubrication and surface roughness in the introduction to surface roughness as well as surface roughness in the machining process ok, that is what we are seeing here. So, you can see the types of lubrication first we will see this one ok.

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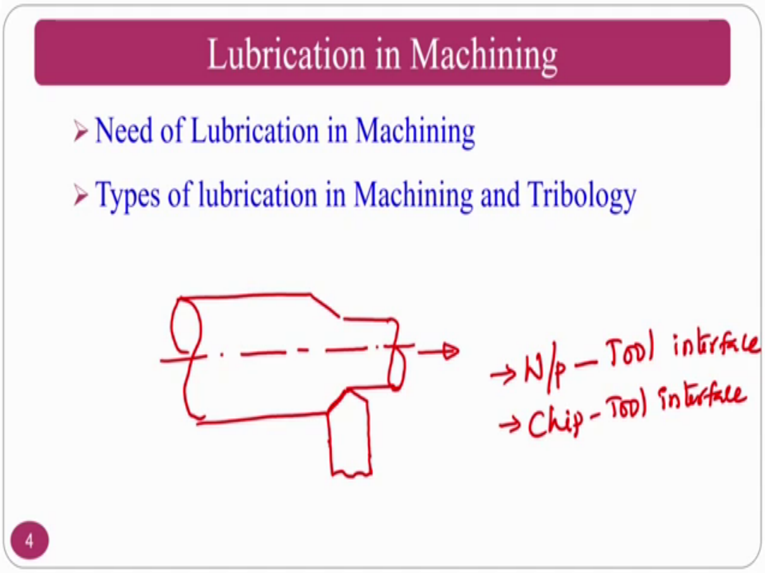

So, we will look into two aspects whenever we talk about the need of lubrication and types of lubrication. See I am talking about lubrication ok. So, I am not talking about the cooling aspect. So, why I am talking about the lubrication is whenever there is a friction between the workpiece and tool.

Normally there is a frictional heat development and all those things you will if you have a lubrication ability or if you are lubricating properly that friction will not come I assume that, if I have a workpiece, if I have a tool here if the proper lubrication is not there between flank surface and the final product that is coming out if the proper lubrication is not there what will happened the wear of tool will takes place ok; that means, I am talking about the workpiece and tool interface ok.

If the lubrication is provided in the chip tool interface also if you are providing in this two also what will happen? So, the frictional heating that we have seen in the previous class will be now. What I mean to say is that there are two types of heat because of the plastic deformation that is taking place at severe level that is the main cause of the heat generation at the same time frictional heat between chip tool as well as a tool final product also will takes place you can eradicate the second one by providing the lubrication, ok.

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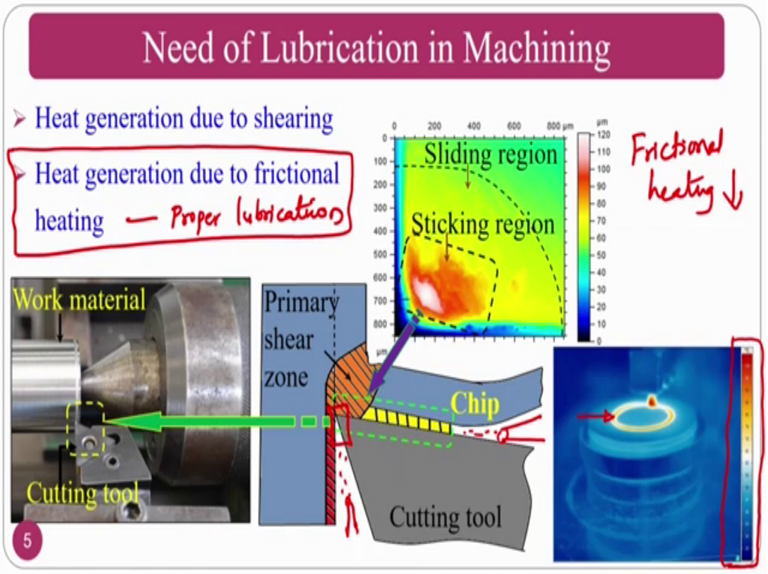

So, need of lubrication if you see the need of lubrication heat generation by the shearing that is what I am talking about a shearing, plastic deformation, severe plastic deformation, this is a major culprit generates the heat that by conversion of mechanical energy into the thermal energy. The second one is heat generation due to frictional heating that is what I was talking about which you can eradicate by the action of lubrication ok.

The second one which is given here you can eradicate this by giving proper lubrication. You can avoid this by proper lubrication action ok. So, if you can provide a proper lubrication chip tool interface you can reduce the frictional heating. If you can reduce this region this region proper cooling you can put jet here and you can through here at the same time you can also put a nozzle here and you can send here. So, these are the two options where you can overcome the heat generation by the friction ok.

You cannot overcome by the heat generation by shearing that is plastic deformation you may not, but however, you can control this frictional heat ok, at the same time coming to the tribological aspects which you have seen yesterday also, this is a frictional heat and the temperature that is developed. See if I can put a lubricant on this track what will happen the temperature that is showing on this column the which is showing the column you can reduce ok.

So, the blue color shows lower temperature the yellow color shows slightly higher orange color and red color shows slightly up. So, you can reduce this one ok. On an average the bottom line of this slide what I want to tell you is if you can put the proper lubrication into the machining zone in the flank surface, as well as a rake surface the best thing that you are going to get is you can reduce frictional heating that is heat generation frictional heating you can reduce actually ok.

So, that is what the bottom light of this slide is consider this support the need.

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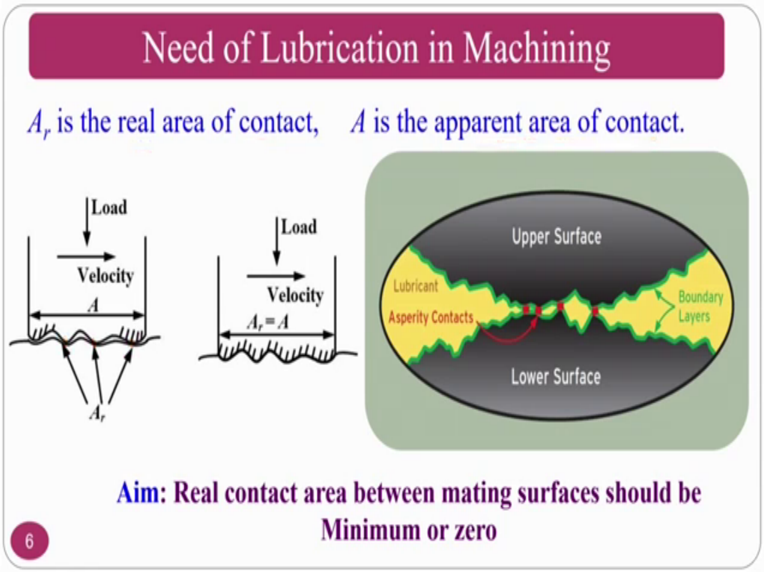

And another one how to understand this is if I am if you have seen in the previous class what I am talking about this A r is a real area of contact as well as a is the apparent area of contact ok, if you are seen. So, if normally if I want real area of contact my aim as a mechanical engineer or a manufacturing engineer my aim is that the real area of contact between my tool chip is should be zero or minimal; that means, that I am sending a lubricating layer or a cutting fluid that in between these two surfaces that is what I want ok.

So, here the real contact area is these points, but still I do not want these points also. So, for that purpose normally lubrication is used ok. So, if I am using a lubrication, how. So, if you can see this real area of contact these are the real are of contact, but still I do not want this. So, that is what my ambition. As a manufacturing engineer if I want to reduce the tool layer on the rake surface as well as in the flank surface I do not want the contact.

But on the flank surface at the cutting edge you will always will have the contact because it is the portion that involves in the machining operation.

So, in terms of this is a crater wear and in terms of rake surface what I want is I want completely two independent separated by a lubricating film, whether it is a thin film, whether it is a thick film or anything that is what I want. If it is a thick film that is well and good if it is thin film still it is good ok. So, now we will see about what are these films and all those things ok.

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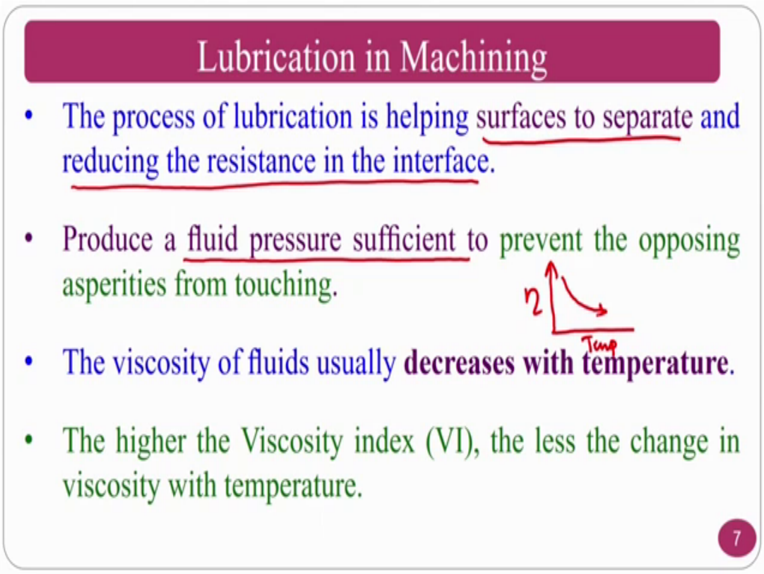

Lubrication, lubrication in the machining the process of lubrication helping the surface to separate this will separate the surfaces that is called one is a tool surface, another one is a chip surfaces or the flank surface reduce the resistance of the interface ok. So, that it will reduce the resistance in the interface ok.

So, to produce the fluid pressure sufficient to prevent opposing asperities from touching; that means, that I am sending in the previous slide if you have seen if I have to send this in between two surfaces my aim is always to separate these two that is what I am talking about ok.

So, the viscosity of fluid decreases with the temperature. Normally if you increase the temperature this is the temperature this is the viscosity of your normally it will decrease because the viscosity will go down. If you see in terms of the polymer if you see in terms of gels and all those things what will happen if a semi solid polymer is there if you increase the temperature what will happen the viscosity will come down. Because the intermolecular force of attraction between these polymer molecules will goes out normally the cutting fluids are these are also petroleum based products where these are also can form the small small plasticizer like of polymers. So, this is the same analysis that you can see here ok.

So, higher viscosity index a less change in viscosity if the viscosity index is high what a particular fluid what will happen the change in viscosity normally will be less that is what you say ok.

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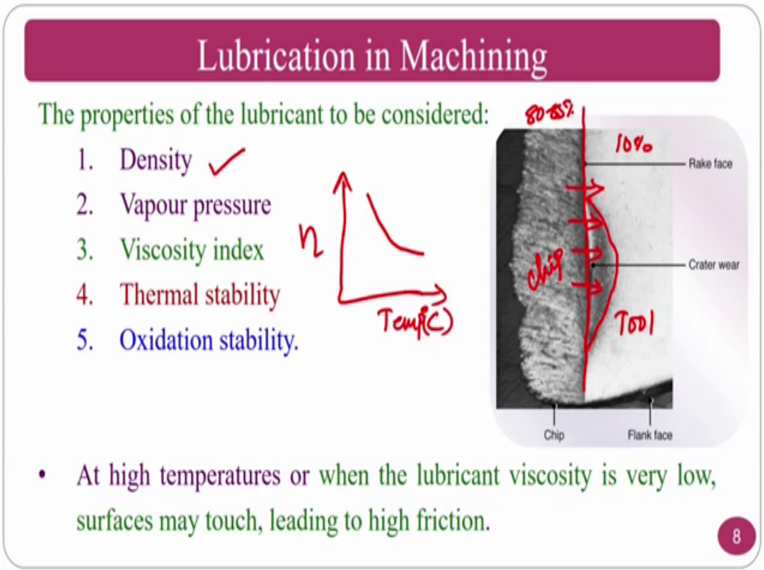

The properties of the lubricant as I was telling you if as a manufacturing engineer my aim is to send that a cutting fluid or lubricant between these two surfaces; If I can send between these two surfaces that is good for my machining so that the tool wear do not come this is the crater wear that is coming on this one it is called this is a tool since this is chip basically ok.

If I can send a layer of cutting fluid which is dominated by the lubrication I can overcome the frictional heating between chip under tool normally chip carries 80 to 85 percent what I was telling of the heat generation. So, already workpiece is carrying ten percent approximately. So, the heat conduction takes place like this at the same time frictional heat also takes place if I can putting lubricating film what will happen the film as you have seen in a previous slide it will observe the temperature and become low viscous ok.

So, if it is a low viscous better flowability will be there for the lubricant, at the same time it will have a conduction heat transfer between tool and the lubricant from one side chip and a lubricant from another side. So, it will act as a barrier which takes the temperature or the heat that is generated in between the tool chip interface that is what my ambition in using the lubricant.

So, the properties of the lubricant can be considered normally density should be optimum it should not be too dense if it is too dense what will happen the cutting fluid cannot go that is why normally the mineraloids are clubbed or blended with the water, so that the viscosity will come down. So, vapor pressure and viscosity index thermal stability and oxidation stability should be better. So, so that it will have a good properties ok, but a high temperature when the lubricant viscosity is very low the surface may touch leading to friction there is a another problem ok.

Whenever if I am using a cutting fluid if the temperature is very high, what will happen? The temperature is very high. So, as you have seen the viscosity will come down in the previous slide also you have seen the temperature, viscosity it will come down if it is coming down what will happen there is a chance that mating surfaces will come may together and again the wave takes place. So, it should have proper density even though you are giving high temperatures you should not become like a too thin fluid ok. So, that is normally companies will take care of these things and you should rightly choose your lubricants for your application.

For example if you are expecting two materials that is bit assume that you want to choose a carbide tool what just any mild steel are any slightly better than the; so ai si 4340 or something. What will happen? You have to choose what will be the cutting fluids based on the temperature expected from the literature. You see the temperature what is the temperature that is reported in the literature, can this cutting fluid can sustain my temperature (Refer Time: 13:54). So, that the viscosity we should not go down completely and mating surfaces will come and destroy the tool it should not happen ok. So, one should take care about this.

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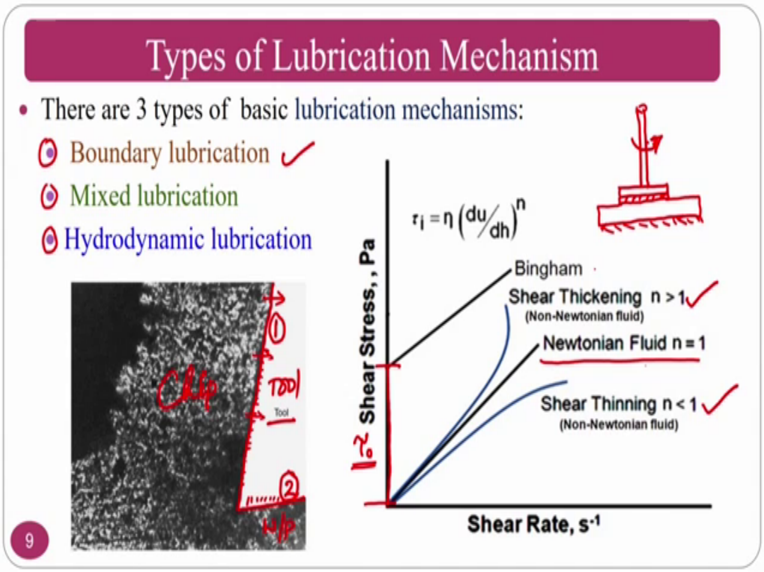

So, types of lubrication if you see one is a boundary lubrication, second is a mixed lubrication and third one is hydrodynamic lubrication these are the 3 lubrications are there ok. Why I am talking about these lubrications? I need in the two zones flank surface and workpiece, this is called workpiece region. This is chip, this is any how tool is there I need to lubricate these regions ok. This is the one region, this is the second region ok.

Let me erase this one, this is the region one and this is the region two ok. So, I want to lubricate these regions. If I can properly lubricate these regions the temperature going into the tool will be enormously reduce ok. So, for that purpose we have many types of fluids that is called shear thinning fluids Newtonian fluids shear thickening fluids and Bingham plastic fluids these are the fluids

So, how do we define all these fluids is one thing normally Newtonian fluid you will have always a straight line. So, shear rate versus a shear stress; obviously, it will be unity type where n equal to 1, if n is less than 1 it is a non Newtonian fluid having shear thinning nature. What you mean by shear thinning nature? For example, to understand what is shear thinning what is shear thickening and all those things. I have to explain you the reo meter. So, if I have a reo meter it is the top plate where it can rotate ok. So, bottom plate will be there, I am just having a fluid film here, this is the fluid film and you have a bottom plate fixed bottom plate ok.

So, this is a fixed bottom plate I am putting a fluid in between and I am rotating the top plate ok. So, the top plate is rotating. What will happen? I have a fixed bottom plate in between I am putting my fluid whatever the fluid I am just my rotating the top plate as the shear rate increases what will happen if the viscosity goes down that is called shear thinning fluid. If I am increasing the rotational speed of my top plate; that means, that my shear rate is increasing ok. So, if I am increasing the shear rate if the fluid viscosity is increasing that is nothing, but shear thickening fluid that is the difference about the shear thinning fluid and shear thickening field, if it nothing is happening it is a Newtonian fluid.

Now, what is the Bingham plastic fluid? Normally Bingham plastic fluid if you see here up to this portion it is there is no change; that means, that this is called yield shear normally yield shear. So, for example, if you take the paste, if you just squeeze it if you put it like this assume that this is a tube paste tube just if you put like this it may not come at on its own you have to press it is squeeze it, until unless you do not give certain tress on it will not come that is nothing, but this one the minimum. You have to give minimum. So, that the flow starts that is nothing, but the Bingham plastic fluid normally they will say Bingham fluids ok.

So, this is about the different fluids which are used in the lubrication in terms of whatever the lubricants the petroleum industries are giving us.

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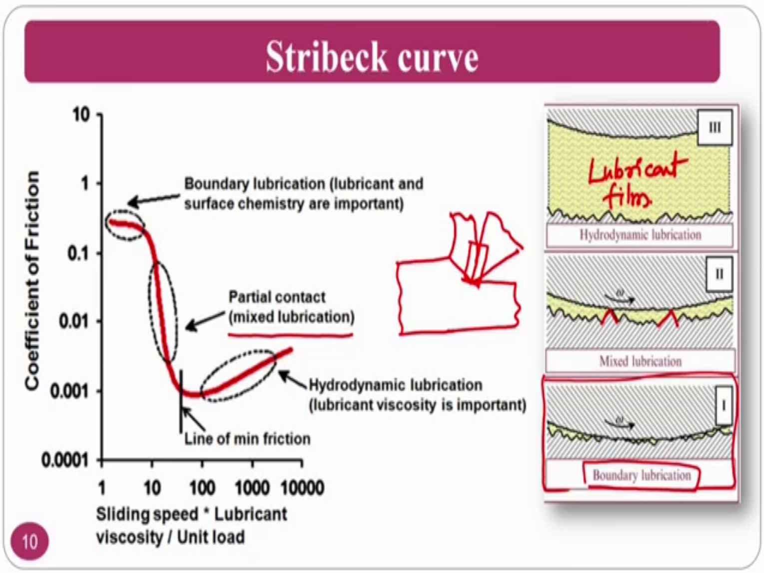

Stribeck curve is the normally explained curve in terms of lubricating in bearings the same analysis you can take in to the metal cutting also ok. Assume that I have a chip tool interface ok, this is the interface that I am talking about ok, this interface I am talking about. This interface can be anything whether it is a boundary lubrication mixed lubrication or hydrodynamic lubrication that now I am going to talk about where the how to achieved in this one what is the types of lubrication that are going to takes place in this region ok.

So, in a boundary lubrication if you see the boundary lubrication this is the boundary lubrication that means, this is the one boundary lubrication. What is a lubricating is here the dominating is the metal to metal surface ok. If I am telling about tool versus chip, so dominating thing is my chip asperities are in contact with my tool; that means, I am talking about completely the sticking region ok. There are two regions of the tribological regions the machining surface one is a sticking region another one is a sliding region. So, I am talking about the sticking region ok.

So, next comes partial contact that is called a mixed lubrication only big big asperities come in contact, but there is a thin film of lubricant layer will be there that is called mixed lubrication ok. So, you can see here big asperities are in contact; that means, there is a variation in surface roughness on the tool which we will see as well as we have seen already in the previous class. This variation of the tool the high peak surface roughness of the tool will have contact and remaining portion you will have a thin film of lubricating layer. Since you have a contact of lubricant with the both the surfaces at the same big asperities are there that is why it is called mixed lubrication asperities plus lubricant.

In the third one is hydrodynamic lubrication which is nothing, but you have a thick film of lubrication there the asperities do not come you can see here completely lubricant film is there ok. This is about the hydrodynamic lubrication. Anyhow we will see the stribeck curves different different ways some people explain in a different ways some people will explain the different way and other things.

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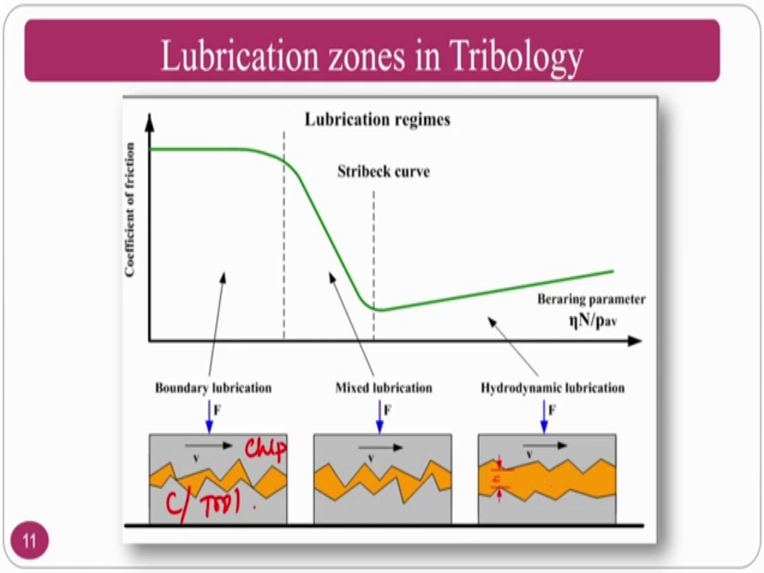

Here you can see the same thing coefficient of friction how it will vary here the boundary lubrication normally we will have a dominating effect of the surfaces to surface. Assume this is a chip surface this is the tool surface 13 tool basically. So, because the chip is moving at a velocity there is a relative motion between two surfaces where the dominating is between chip as well as a tool here both lubricating film as well as the asperities of the both the surfaces here dominating by the lubricating film ok.

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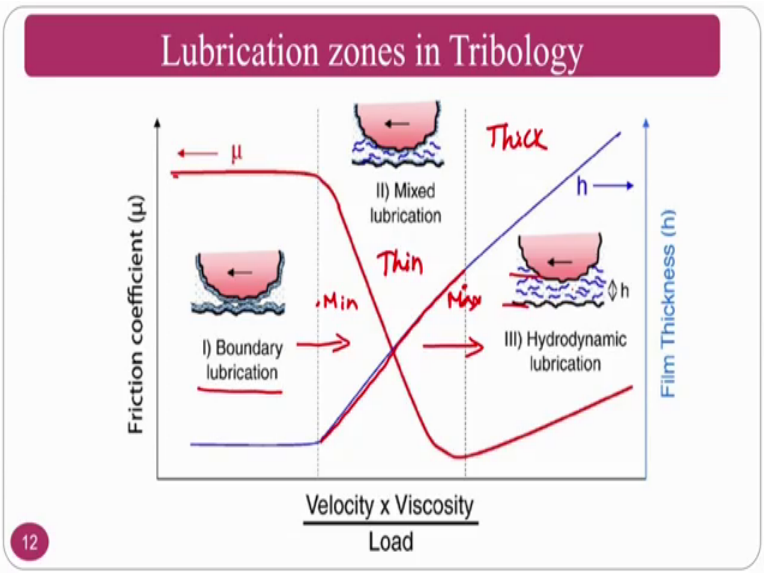

You can also see a friction coefficient how it will drastically goes down and the film thickness increases both are con converse to each other. If you see the coefficient of friction in the value lubrication because of the mating surfaces two mating surfaces are there because of the two mating surfaces of chip as well as tool the it will be very high coefficient of friction is very high.

Whenever the mixed lubrication comes the it will drastically comes down because you will have completely a small small portions of the nanometric asperities which are very very big will only in contact, but thin film will be there. So, the transition between solids to solid 99 percent thin firm contact gradually increases the film thickness gradually increases if you are moving from boundary lubrication to hydrodynamic lubrication. Here it is a thin film, here it is a thick film the transition of the thin film here the thin film is minimum here it is minimum here it is maximum ok.

This is the thickness that is normally observed at the start off hydrodynamic film that is why the coefficient of friction enormously decreases and at the same time you can see the film also thickness is gradually increasing, if it is increases that is good. So, hydrodynamic film normally it will we have a slightly increases because viscosity will come into picture and all those things ok.

That is why this lubricating film is required as a manufacturing engineer I want the hydrodynamic lubrication between my mating surfaces that is a tool and workpiece or chip and tool. I want it, but practically it is not possible most of the time what you are going to achieve is mixed lubrication ok.

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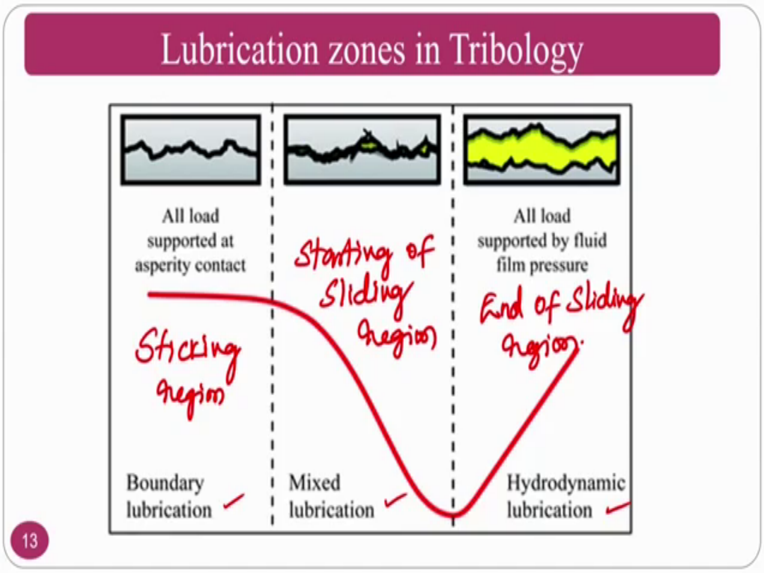

So, if you see here in the metal cutting operation if you normally see in a sticking region, and the starting off sliding region and this is end of ok.

Stribeck curve normally explain the 3 things what is a boundary lubrication mixed lubrication and hydrodynamic lubrication. Sticking zone obviously, as I was explaining again on it has a metal to metal contact. So, there is nothing like fluid cannot enter into that region because solid to solid contact is there in the sliding region if there is a relative motion. In the sliding region because of the fluid flow the lubricant that is send at high pressure or you will occupy some of the regions and still there is a asperities come into picture. So, asperities plus lubricating film will be there that is about the start of the sliding region and end of the sticking region ok.

Coming to the sliding region ending on to the free end you will have always the hydrodynamic lubrication. But as a manufacturing engineer I want to increase the pressure of my pumps, so that I can inject into the sliding region entire sliding region I want to make the sliding region like hydrodynamic lubrication. At the same time I also want to make the sticking region as minimum as possible by penetrating my lubricant or cutting fluid into the region of sticking region.

So, as a manufacturing engineer I want I do not want a sticking region, but practically it is not possible. So, only thing is that I can minimize the sticking region.

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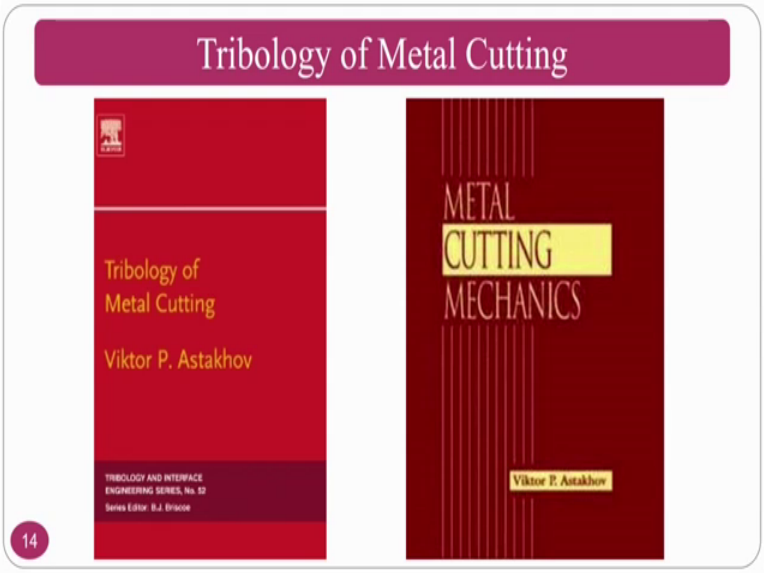

So, now, if you see the tribology a of the metal cutting what are all the things that if at all you want to study more about this tribology and all those things. You can go through this tribology of metal cutting by Professor Astakhow, he is a one of the great professors who normally explain the practicality of the metal cutting processes. Even though I am I have not thought completely of this book I just have the glimpse of these books. So, if you want more details about the tribology of metal cutting or mechanics of metal cutting and all those things you can follow these books ok.

Now, we are moving into the surface roughness in the machining process. So, the surface roughness is the final thing that everybody see on a product assume that I want to see a particular product. So, I will see how beauty this product is. So, how do we explain? You I have to explain from the point of its surface roughness surface roughness give you good life at the same time good aesthetic appeal to the product and all those thing, that is why a customer want a good product.

Suppose if I want to give a customer a good product you have to give him a better surface roughness better surface roughness means you have to produce low surface roughness; that means, that better surface higher surface finish there is nothing quantitatively a surface finish normally qualitatively you can say the surface finish, but whatever you can measure is the surface roughness ok.

So, the surface roughness is one of the important, but for roughnesses they are finishing process also to not waste much production time people will also use the machining process itself give the better surface roughness. That means, that lower surface roughness by decreasing the field increase in the speed decreasing the depth of content all that there are some parameters one has to play initially you got with more depth of cut and field gradually you reduce it, reduce with high speed and all those things. Having a better tool this is what one has to do ok.

Let me come into this one. So, we are coming in to the surface roughness because we have done the types of lubrication and other things ok. So, just now we have completed this one ok. If the surface roughness is the only factor that you look at the product probably not ok, you also need to look many things that is such as surface metallurgy and all those things, that is why nowadays concepts are coming with surface integrity ok. Surface integrity does mean it is deals with the surface roughness that is nothing, but the surface morphology at the same time surface metallurgy not only you see the surface roughness you how to also see the metallurgical aspects of the metal that is finished ok.

Assume that I have a product which having very good surface roughness; that means, that a very very low surface roughness, assume that it is having a heat affected zone. That means, that recastly and heat of thermally destroyed layers you cannot use it in the whenever you do the machining operation you should take care that there should not be more temperature in the machining region so that there will not be any burning marks on the product.

Even though surface roughness is very good if you are burning marks are there on the surface; that means, that that may not be possible to put into the practical application, that is why you should look at surface integrity of that particular product ok.

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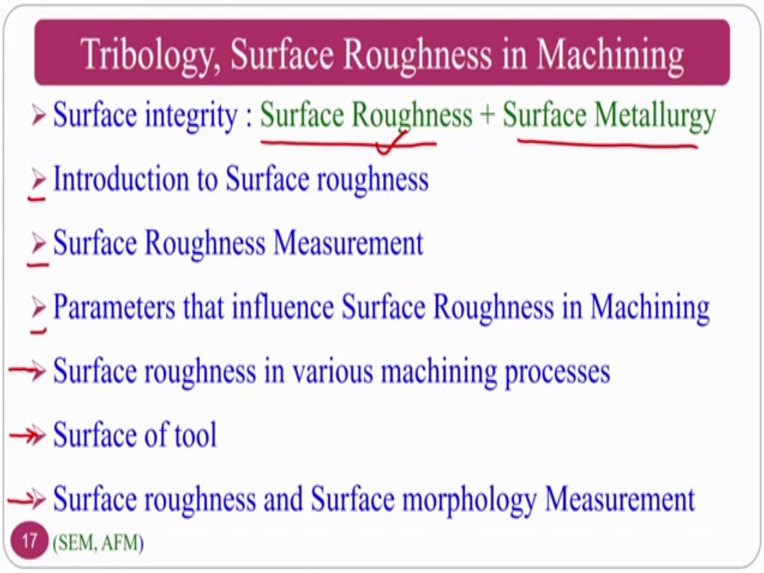

The surface roughness, what we will look at it is surface roughness and surface metallurgy that is because we are dealing with only mechanical aspects, so we deal with surface roughness mostly. But however, just I gave you the glimpse what is the requirement of surface metallurgy ok.

Introduction to surface roughness we will see then we will followed by the surface roughness measurement practical parameters that of at the surface roughness in the machining. Just we see at the same time we see the surface roughness in many various machining operations we will see ok. Surface roughness and the tool how we it will affect surface roughness on the workpiece and all those things ok. Till tool we may see today.

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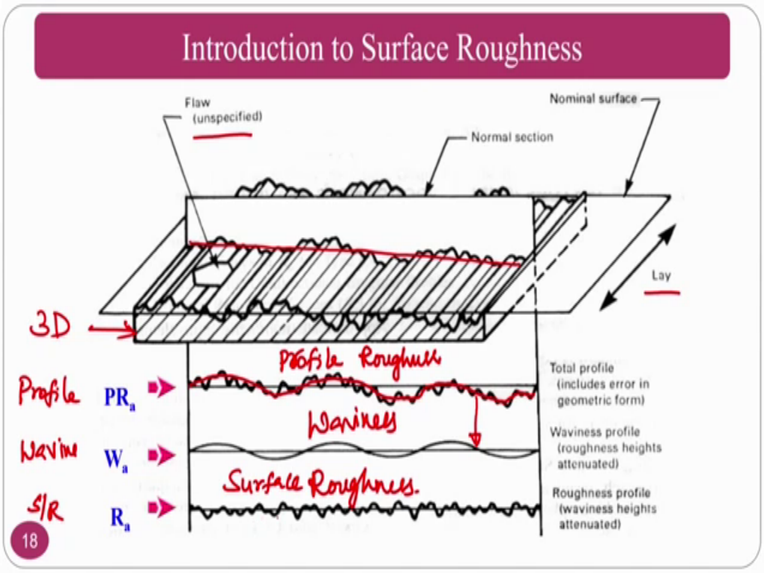

So, introduction to the surface roughness, the surface roughness if at all if you have a 3 disc space if you just see there are three things one is profile roughness, waviness, and roughness surface roughness ok.

So, we will, for a surface particular surface there are some other things that I will come which is lay, which what is mean by flaw ok. So, what you mean be lay, what you mean by flaw, these are all things will come later. If I have the surface if I just want to measure the surface in a two-dimension this is a three-dimensional surface 3D surface and I am measure I am putting a line across this one and I am measuring the surface roughness ok.

So, whatever the original profile that I am going to get here is profile roughness this is called profile roughness, profile surface roughness, I can say sorry let me not confuse much. So, it is called profile roughness. And you can divide this profile roughness into two things one is waviness another one is surface roughness ok. If this high amplitude thing is waviness and this is called a roughness that is called surface roughness ok.

So that means, I have profile roughness I can divide into waviness which is if I see a profile roughness this is like this, ok. So, the which you can divide into two things one is a waviness and what the roughness things are there on which are superimposing and the waviness is nothing, but the surface roughness ok. So, this is about the 3 things ok.

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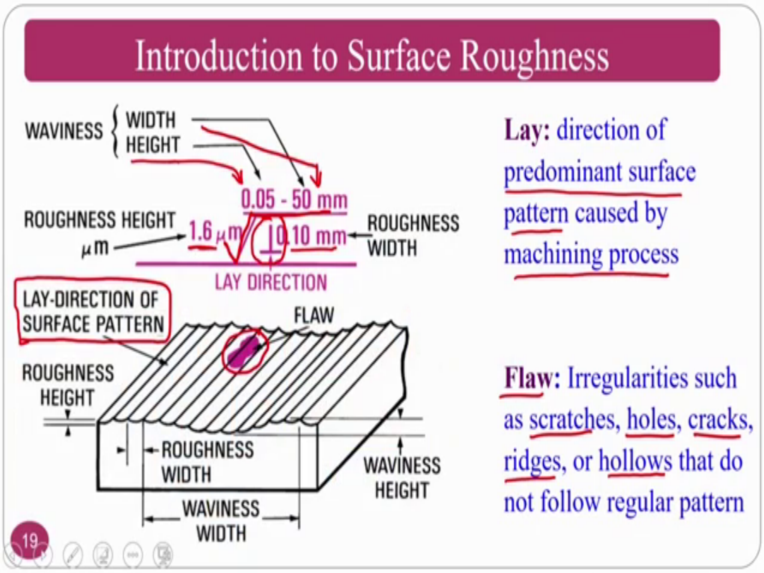

Now, we will come to what is a lay. So, lay in the previous one which is called it is a predominant direction of the surface roughness ok. So, or predominant surface patterns caused by the machining process is nothing but the lay ok. Flaw, normally flaws are nothing, but if you see here a flaw is there this is the flaw is nothing, but the scratches holes cracks ridges or a hollows that are presenting on the surface which are not as a part of machining process ok.

Just to we want what is the lay of machining processor lay is nothing, but the predominant surface predominant direction of the surface it mean defer from machining process to machining process in a turning process you may get the circular factor that is speed marks in the grinding operation you may get a straight line, a surface pattern that is what is written here, the roughness height roughness width waviness width these are all the things are there.

However, you can represent the surface roughness in terms of these things normally the surface roughness will be explained like this ok. So, the first thing is surface roughness height here it is mentioned, surface roughness width is this one this is the direction normally this will show the perpendicular direction and the waviness width as well as waviness height this is the height and this is the width of the waviness ok. So, these are the things that you represent in this one, ok.

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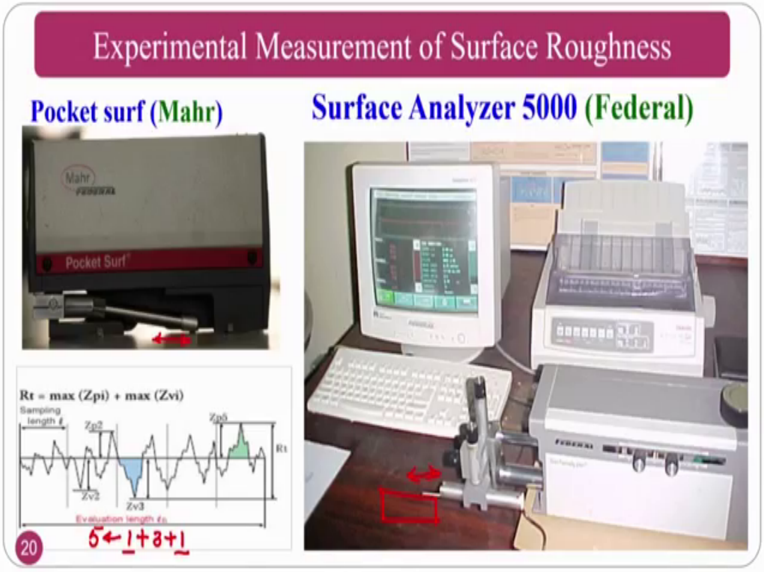

Experimental measurement normally how do you measure? So, there are two things if you see few years back like ten to 15 years back we used to have the contact sur type of surface profile emitters. For example, pocket surf is the one of the thing that is developed by mark is one of the companies.

So, later if the surface analyzers are the federal surface analyzers if at all I want this pocket one it is a portable one you can take to any place and you just assume that I want I am doing a lath operation is a big rod if I want to measure the surface roughness at different levels just you have to put on the top surface and you just measure it ok.

So, in some surfaces like grinding and all those things you can bring the work pieces and we can use the surface analyzer which is shown here federal surface analyzer just you place your workpiece here and you just a movie and it will give you the surface roughness, ok. Here also probe is there just it will reciprocate and it will give ok. How it will give the values? Normally if you see pattern the evaluation length is the length of the travel of the my contact for fellow meter probe ok.

So, it will move complete distance. How? There are different ways you can specify the evaluation then are normally you can give the sampling there is a standard procedures are there I am dividing into 5 zones in 5 zones. First zone plus 3 zones plus last one zone the first zone and the last two zone it will not consider for in the surface roughness measurement because it is starting the probe is starting initially from the zero velocity and it is going at the same time in the last one it is has to come to 0 because the velocity is the certain velocity and it is coming to 0, ok.

So, that is why first and last it will not consider it will consider the 3 things and normally it will give that is what some of the books explain and many noncontact nowadays people work on the noncontact type surface profilometers, ok.

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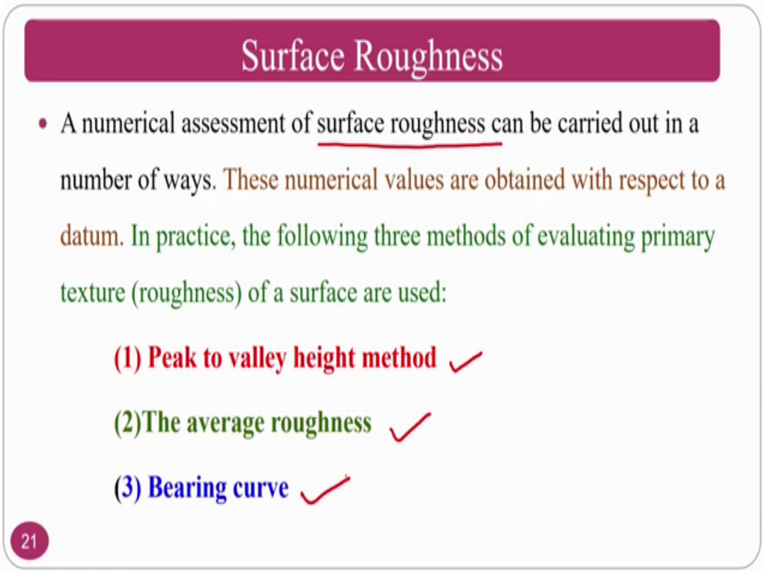

So, the surface roughness it is a numerical assessment of surface roughness can be carried out by the number of ways one is the numerical values are obtained with respect to a data ok. So, there will be a data normally according to that normally you will take. So, the following 3 methods are there, one is a peak to valley method and average roughness method and bearing area curve method ok.

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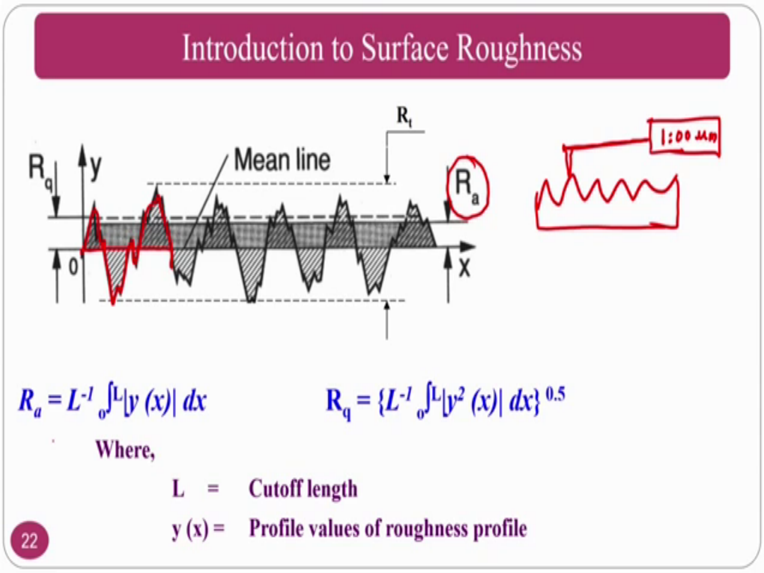

So, anyhow since we are talking about the surface roughness just to we talk about only the roughness. So, if you see here. So, this is the mean the surface. Just you make a I have a random surface on which my probe is moving and it will give mean the value. So, what is going to happen inside? That will obvious will be a doubt in the surface roughness, assume that I have a surface on which my probe is moving and it will give you certain value ok. Assume that it is giving micrometers. How it is going to give? Now, it will draw a mean line where the area above the mean line is equivalent to area bellow the mean line ok, there comes the mean line ok.

So, now I have a surface this surface for example, just I am drawing up to this one only. So, once I completes what will happen it notes the area above the curve equals the area below the curve. So, we try a mean line with the reference to that mean line it will give all values ok. So, normally whatever you measure is average that is called CLA value that is how do you measure I will explain you; another ok.

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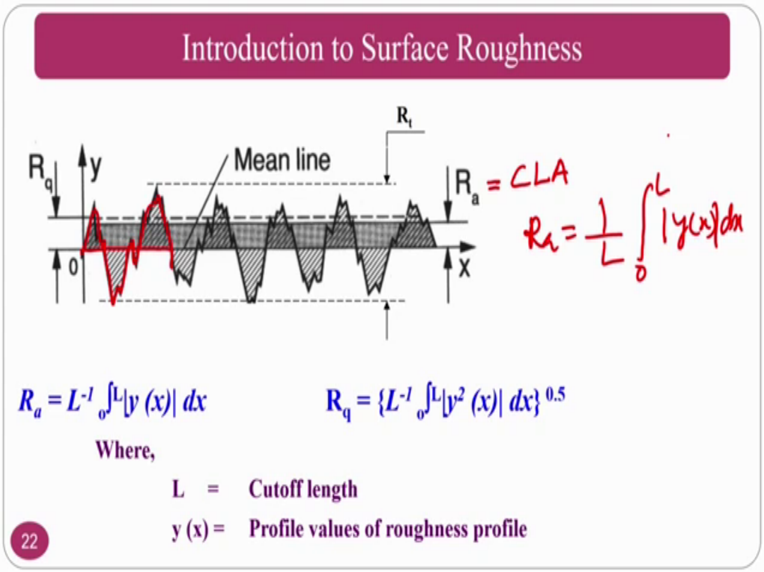

Is R a where R a is nothing, but the central line average value it is called a CLA, R a is nothing, but central line average value central line average CLA ok. How it will we do you? Normally R a equivalent to here whatever is given the same thing I am writing 1 by L integral 0 to L mod y of x into dx ok. Why I am taking mod because values normally we come in the negative direction. So, if I take mod basically I am going to take all the positive directions only ok.

R q represent root mean square value ok. So, the difference where we will get between R a and R q is if the surface roughness is very high. In that circumstances the square root values will go up and R q normally slightly higher than R a value that is why most of the countries will follow R a as their standard parameter for the surface roughness, ok.

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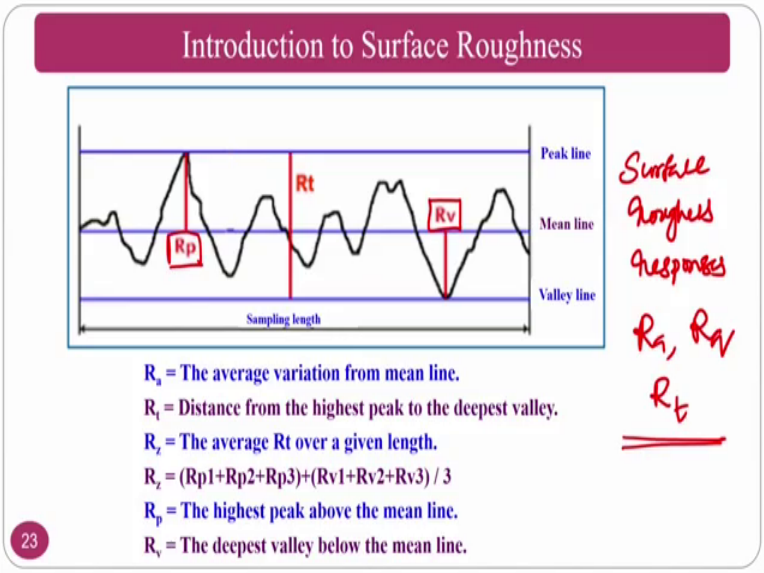

The other parameters normally if you see R p that is mean line to the maximum peak and R v mean line to the minimum value, that those are the two things R p is nothing, but the maximum peak to minimum value that is R p plus R v, this is maximum peak to minimum value.

So, the parameters normally are the responses surface roughness responses that one can observe is this responses are R a, which is central line average value, R q that is root mean square value and R t which is nothing, but a maximum peak to minimum valley ok. These are the three things that one can consider.

If somebody is doing the research in the metal cutting area, so you can consider this on the workpiece with respect to feed with respect to depth of cut and with respect to type of cutting fluid and speed of your workpiece; that means, workpiece rotational speed or a cutting speed you can vary its volume of the good parameters because always the customers want the better surface of this ok.

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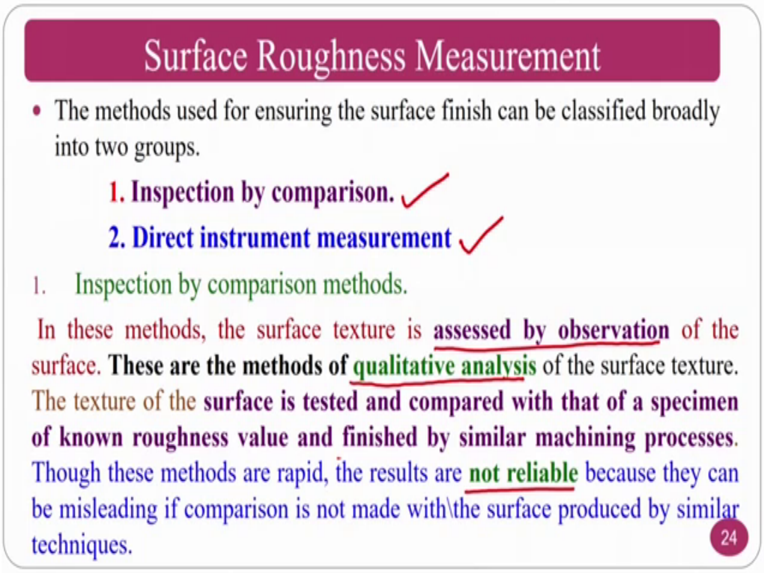

The surface roughness how do we measure? Normally by inspection method one another, one is direct measurement one so, but the problem with the inspection method is that this is assessed by the observation ok, by observing you can tell this may be this. So, it is basically a qualitative thing I mean to say I have a product ok, this product is good I cannot say this product is a the surface roughness is one micron, but you can say it is good is it. That means, I am comparing with respect to some other product which is there ok. It is a qualitative statement, I said I am a good person, means that I am comparing to certain person and I am saying at I am a good person ok. So, I am bad person.

So, this is just a comparison that is what the quality to assessment, whether for a particular person is a good or a bad it is a qualitative assessment. I cannot say 10 percent good, 10 percent bad or something ok.

The texture of the surface is tested and compared with respect to the specimen of known surface roughness value finished by the similar process. Normally what it will be done is it will be tested by the with respect to a product that is already done by the same machining process if something is there with respect to the turning operation, you have taken a new (Refer Time: 44:44) sample and I can have to say whether it is good or not good with respect to a masterpiece that is done by the same input condition hence of that machine ok. Then I can say whether it is good or not its qualitative good, ok.

But this is not a label because the comparison may not be produced by the similar technique sometimes a product is developed by the turning process sometimes the product is developed by the some other process. If at all you want to compare then it will lead to a misleading, that is why you have always go for the quantitative measurement ok.

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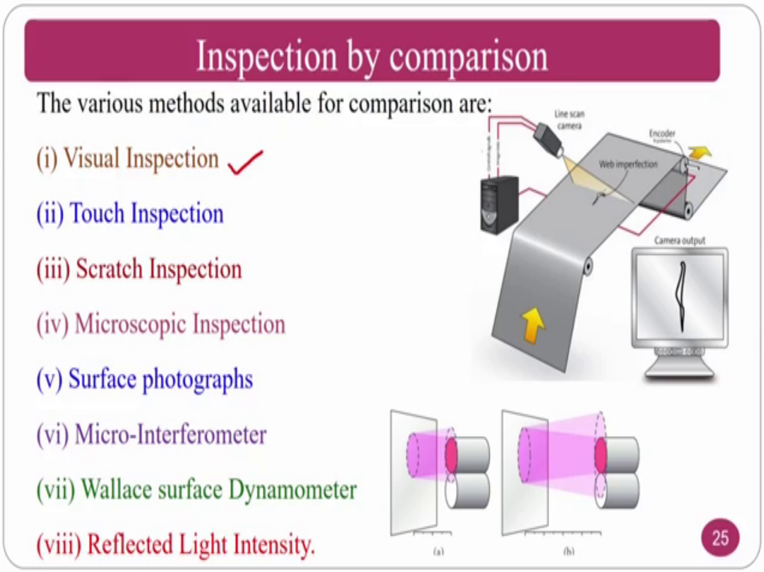

So, inspection by comparison normally visual inspection, touch inspection, scratch inspection, microscopic inspection, surface photographs, micro interferometer, Wallace surface dynamometer, reflected light intensity.

These are the things normally you can use, these are the techniques normally in olden days people are using nowadays I do not think these are still exist for a qualitative assessment in a mass production you can go ahead with these processes. But if at all you are looking for a nano rough surface roughness are some these type of roughnesses this process of inspection may not work ok.

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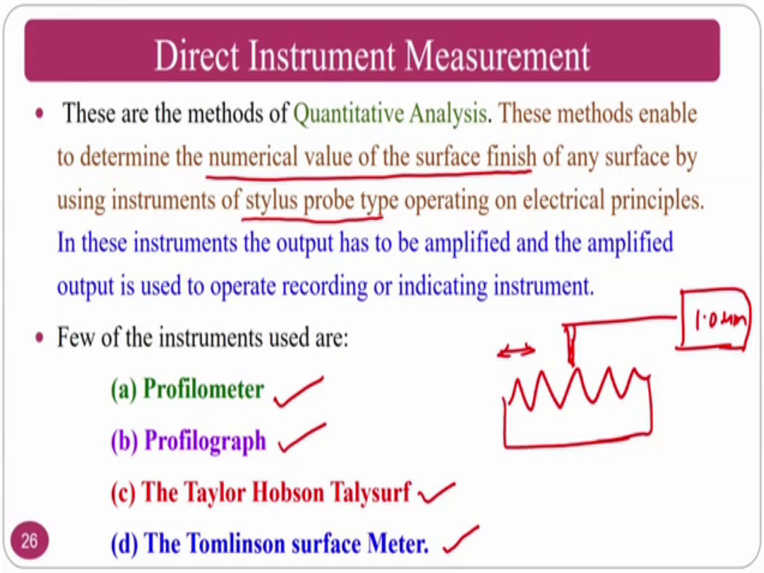

To go to the better surface roughness measurements there are quantity to analysis methods that are called a direct instrument methods this determine the numerical value of the surface finish directly it will give you whether it is a 1 micron, whether it is a 10 micron or something it will give you, ok. Where nowadays it will have a direct probe method where stylus will be there stylus will reciprocate which you have seen in the measurement technique where evaluation and then the all those things I have explained.

So, the probe will reciprocate on surface. Like this is the surface probe will be there and it will reciprocate and it will give you the quantitative value, that is about the about the this method, ok.

So, the surface profilometer is there, profilographs are there, Hobson Talysurf is there, and surface meters also there. However, I will go through only few things ok. The same thing previously we have seen. So, this is a pocket surf, but I want to tell you the difference between the previously the same slide and this slide is this is the stylus method where is the probe method direct contact is there ok.

So, this has its own limitation if the probe this is the probe. Normally, this is a probe you can see a small one is there here also we cannot see the probe this will reciprocate on the workpiece and it will give the value ok. So, this is the both the contact type of surface roughness measurement. So, but problem with this one is it cannot give me the 3 dimensional surface roughnesss and at the same time it may not give me in the nanometric level it can give. But may not be that much accurate for that purpose there are 3D surface profilometers where noncontact or of surface roughnesss are there.

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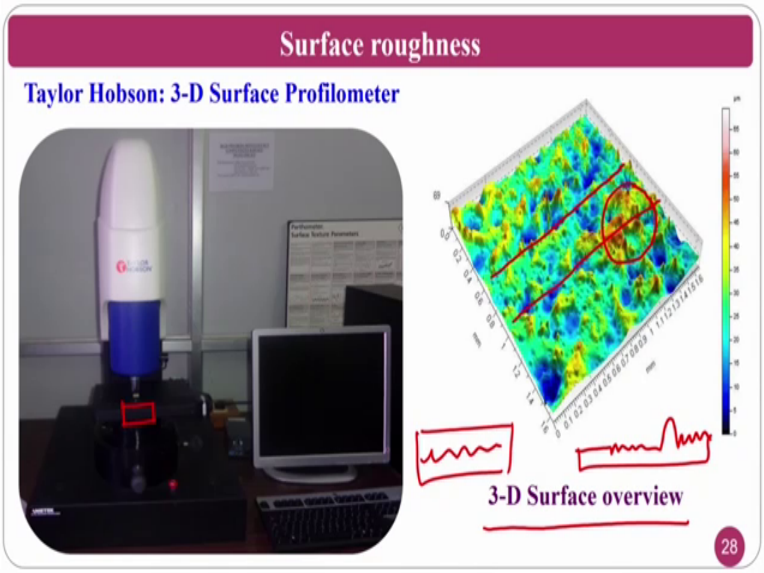

You can see the Taylor and Hobson where this is a eyepiece, you can keep your workpiece here and you can just put the it works on the interferometry principle there is a white light interferometry method it will use just it will passed and it will receive this and it will give you the 3D view of the surface roughness.

You can see how beautifully the surface roughness is and from here if at all I want to measure a line scan if I want to measure here I can take a profile like it will give me a profile like this. If I want to measure here since the peaks are dominating here I can get a profile like this, since peaks are there I will get a profile like this. So, I can get 3D profile as well as from 3D profile by putting a line scan I can get the surface roughness in a 2D across that line. So, that is the beauty about the a noncontact type of surface roughness ok.

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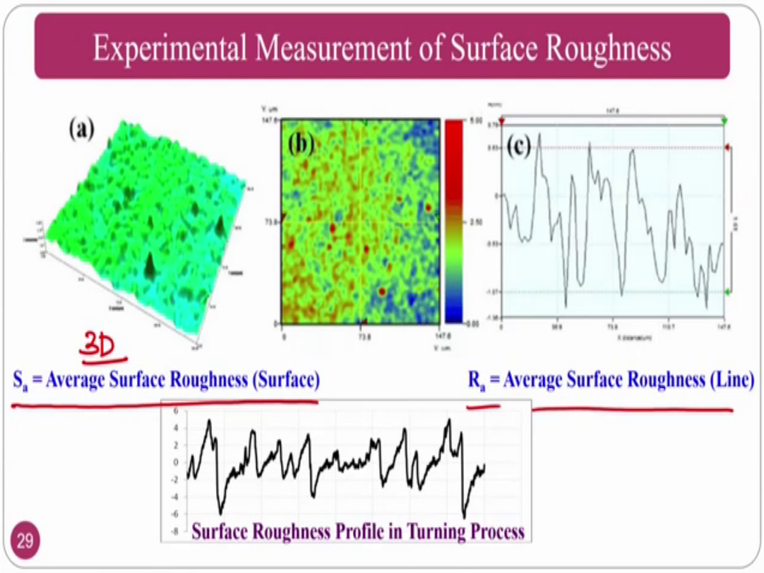

This is the 3D image where you can see here 3D image you can get the 3Ds average surface also. If at all I want I do not want the 2D a line scale I want completely area what is surface roughness still I can get it. So, that is called a normally they will its some above the people they will take indicate about that is multi surface average surface roughness. So, normal you will get if at all I want I just take a two-dimension of this one ok. This is like a two-dimension where average surface roughness is done ok.

So, typically how the surface roughness in the lath turning process look like is this one ok. So, representation of surface roughness how to represent the surface roughness, whether it is military surface whether it is a turn surface and all those things how do you represent in the practically ok. So, this is, this symbol or the interpretation ok.

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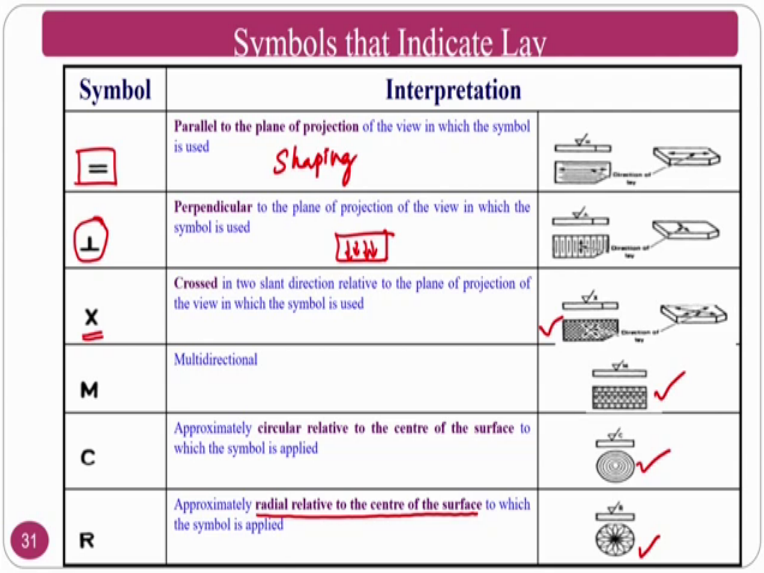

This normally whatever here it is is that it is a parallel to the plane projection normally it will give you the parallel surface. For example, it is shaping ok. Perpendicular to the plane projection this symbol shows perpendicular to the plane projection if my surface is there and they if and I am doing like this ok. So, this is the perpendicular surface.

And crossed this shows the crossed one normally if you see that crosshatch pattern in the honing process you will observe multinational, M stands for multi directional and the C stands for circular in to toward the center you can see here, at the same time R represent the radially relative to the center of the surface ok. This is radial surface.

This is the circular one, this is the multi direction, this is the is the crosshatch pattern and the parallel and perpendicular. These are the interpretation of the symbols in the lay how the predominant direction of surface roughness that one can explain ok.

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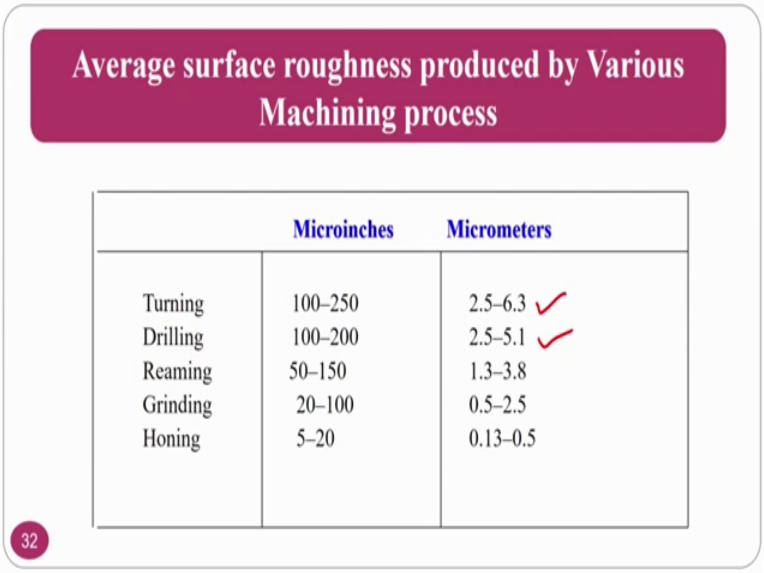

So, normally the surface roughness in the turning operation in micrometers you can see here these are the ranges 2 to 2.52 this is the old values, very old, we have taken from the world book. So, these are the slightly higher side. However, we in a normal if you see nowadays with the sophistication of the equipment and all those things these values can still go down.

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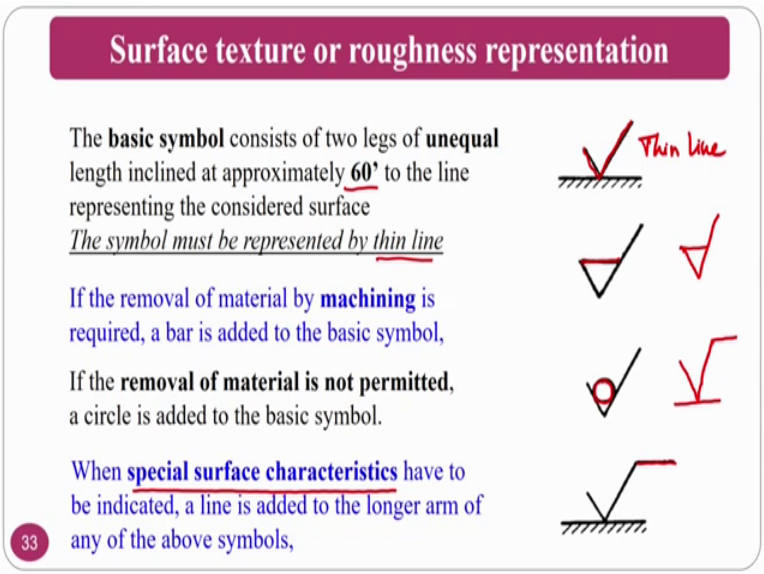

So, the surface texture or the roughness representation, so the basic symbols of the surface roughness representation is like this. If you see the basic symbol consists of two legs these are the two legs are there are unequal which is approximately at the 60 degrees, and this is represented by a thin line basically compared to the baseline normally it will represent by a thin line, ok.

So, with this line now I have this one, so if at all if I am removing the material; that means, that metal cutting is taking place this particular portion will come ok. The material removal is not permitted then you have to say it is not permitted by writing a zero symbol ok.

There special surface characteristics indicated normally if you call you want to indicate you have to write a this one. So, this is a simple this is the surface roughness representation, basics surface roughness representation. If I am want the machining this one, if I do not want the machining then I want to remove this one then I have to write like this one, if I want a special type of process just want to write this one ok. This is about the representation, basic representation ok.

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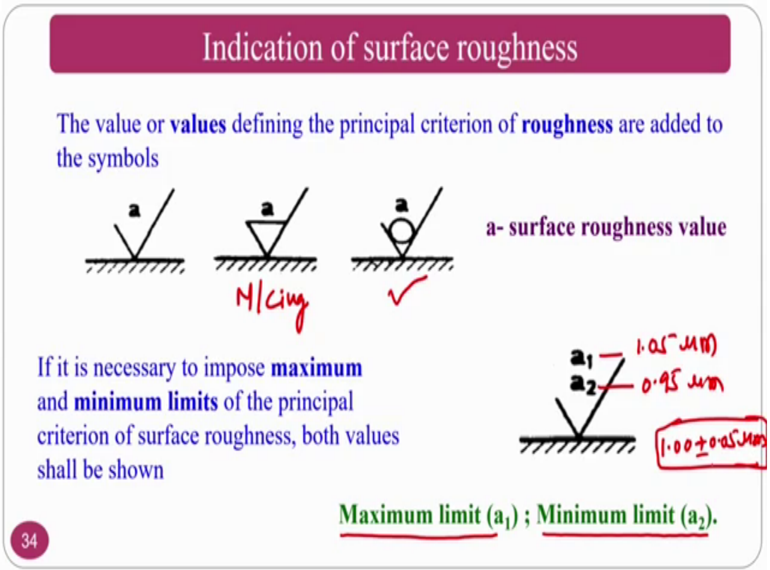

So, if the values defining the principle roughness is an added normally if you are having a surface roughness value normally if you represent the surface roughness value is a you will represent like this if you are representating the surface roughness by machining process you represent this one. And you should not remove any material, but I want the surface roughness value a then this is the process this is what you want to explain, ok.

So, if what all some people are writing a 1 and a 2 instead of a; that means, that one represent the maximum limit another one represent the minimum limit.

Normally, if I say a particular product I want 1 micron, nobody can give me 1 micron exactly because no process is 100 percent perfect that is why you always say I want 1 micron plus or minus plus or minus 0.05; that means, that the person can make the component between 0.95 to 1.05 microns that flexibility should bigger. So, I can say here it is 1.05 micrometers and a 2 is minimum limit that is called 0.95 micrometers or 1.00 plus or minus 0.05 micrometers that is what I can specify so the operator can do properly, ok.

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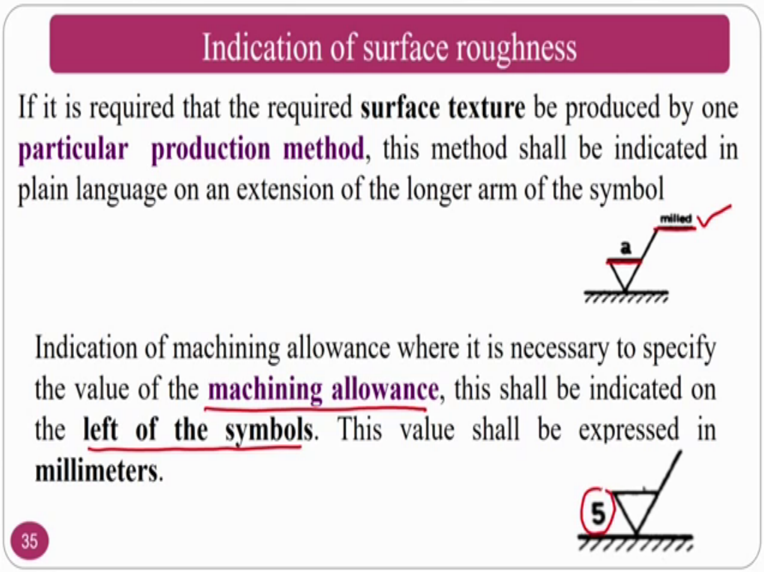

So, if at all I want to say that it has to be done the surface roughness is a and this should be done by the machining process because of this symbol and the machining also I am going to specify that this should not be made by the turning process or a grading process it has to be done by the milling process. So, I will also confirm that I want the surface roughness a by using the milling process that I will explain.

So, if I am indicating some value here the indication of the machining allowance where the necessary to specify a value that is called a machining allowance this shall indicate the left of the ok. If at all I have explaining some of the machining allowances that I will explain in terms of by putting a value in front of the surface roughness.

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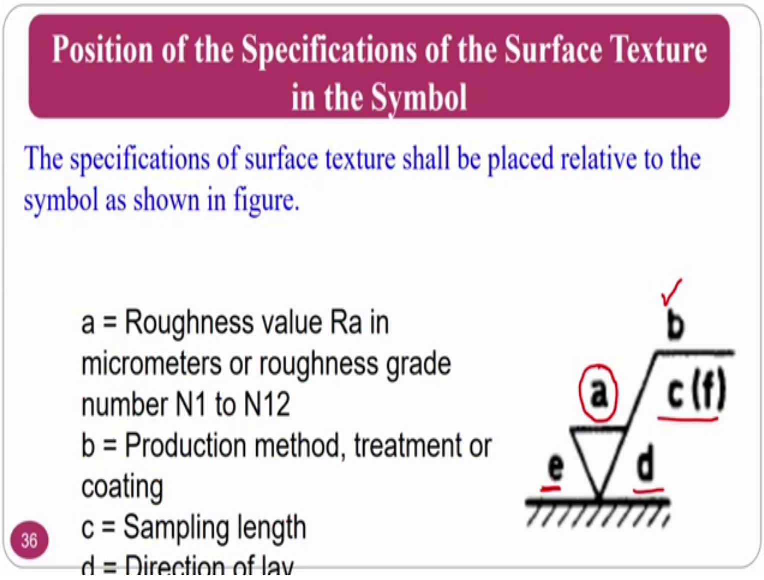

That is overall if at all I want to mention how I will mentioned the surface roughness value R a is this one the what I have the roughness I want to mention. The production method or a treatment or a coating assume that I want to go by the lay that is turning process I will mention in place of b, and c sampling length and d is direction of the lay ok. What are the allowance that I want to give I can give here ok.