Mechanics of Machining
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Lecture – 18
Surface finish in machining

Hello students, today I am going to deliver 18th lecture on Mechanics of Machining. Here main focus is on the finishing processes. So, that is why it is basically surface finish in machining. Difference between machining and finishing is like this. In the machining the objective is to remove the material. So, that to provide a desired shape, but in the finishing the objective is only to finish the surface properly, if there is a rough surface I want to make it smooth.

But it is also part of machining because here also there is a removal of material. So, we remove the material by finishing in the last lecture we talked about a grinding. So, it is in the same way that grinding is used for finishing and occasionally it is used for even some large amount of material removal from a difficult to cut metal.

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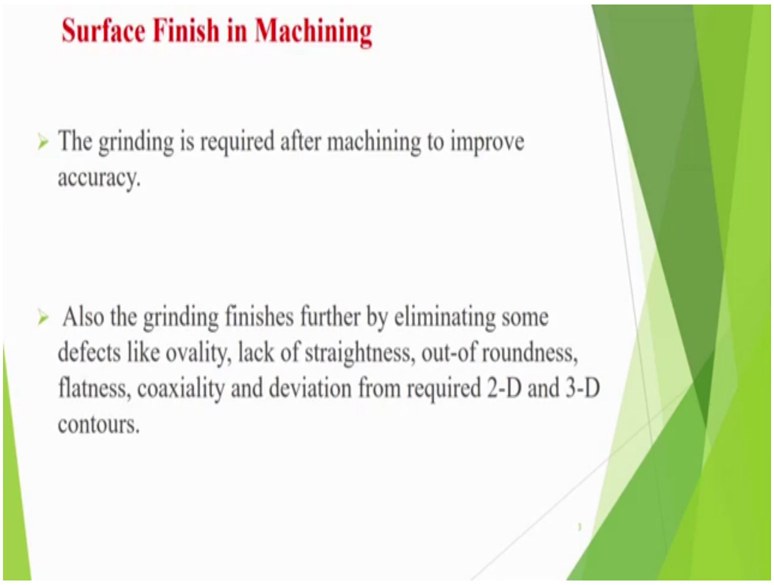

Now, here. So, grinding is required after machining to improve accuracy. Sometimes you make a component by turning operation and then after that you carryout grinding.

Also the grinding finishes further by eliminating some defects like ovality suppose it may not be completely round it may be oval shaped, but by grinding you can collect something may not be straight some dimension you make it straight it may be out of roundness, they you a flatness you want to make the surface flat coaxiality and deviation from required 2 D and 3 D contours, all these corrections in the profile are also carried out by grinding operation. So, grinding has several purposes.

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The grinding becomes unavoidable for the component, which are difficult to machine for excessive strength and hardened after machining for dimensional stability and wear resistance. There are some materials which cannot be machined properly by turning operation or by milling operation because they are very hard the same type of material can be machined by grinding. Along with the product quality productivity or MRR that is material removal rate also need to be kept in mind, which compels a compromise to some extent. You have to decide what parameter should be set. So, that I can get more productivity also and I can get more good product quality as well as more amount of material can be removed.

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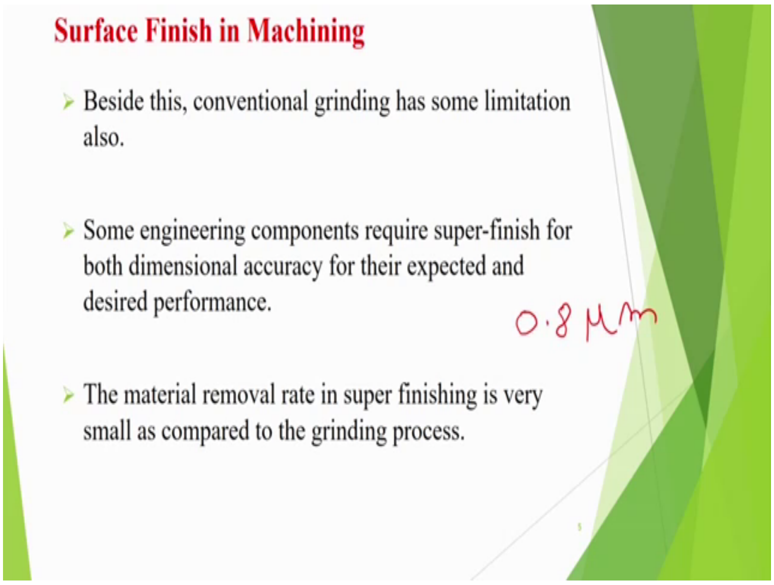

Now, in this besides this conventional grinding has some limitations also. Some engineering components require super finish very good surface finish is required you see the grinding usually can provide you the central line average roughness that is Ra value of the order of 0.8 micrometer. This is the type of surface finish achievable in grinding, but you may require much better surface finish..

So, that is called super finish. So, for that we need to have imply other processes. We need better dimensional accuracy also. Material removal rate in super finishing is very small as compared to the grinding operations. Grinding requires even material removal in grinding itself is small, but in those type of super finishing processes material removal is even much smaller.

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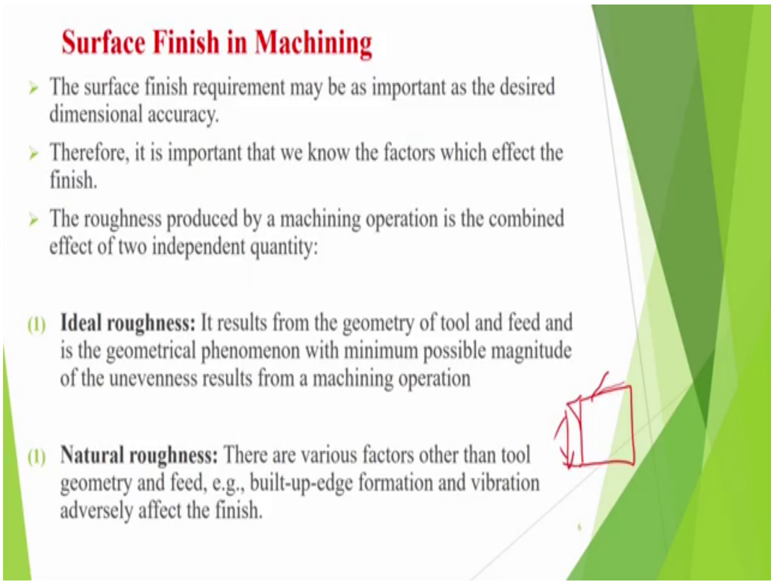

Now, surface roughness and surface finish are somewhat inversely related. If you have good surface finish; that means, surface roughness is low value. So, surface finish in machining, surface finish requirement maybe as important as the desired dimensional accuracy..

Sometimes accuracy may not be very important, but the finish is very important. For example, if you want to understand the optical microstructure naturally the top surface of a specimen should be highly polished and it should have good surface finish because I want to observe it.

But this dimension is not that important. Important is that it should be smooth. Similarly, if I want to make some object I may need very good surface finish. So, that the dust particles do not a (Refer Time: 05:32) tool that or sometimes I may need some good reflector for solar energy of application. In that case also the dimensions are important, but they are not as critical as the surface finish. So, therefore, it is important that we know the factors which affect the finish.

Roughness produced by a machining operation is the combined effect of 2 independent quantities. One is ideal roughness it results from the geometry of tool and feed and is the geometrical phenomena with minimum possible magnitude of the unevenness results from machining operation. Because of the geometry this type of surface roughness is unavoidable like if you do the milling operation we will get feed mark in turning also you will get this type of feed mark. So, these type of things have to be there, but natural roughness which you particularly get depends on many other factors. Other than the tool geometry and feed it may depend on the built up edge formation if the built up edge forms, then the surface finish will deteriorate or surface roughness will increase. And vibration, vibration also adversely affects the surface finish. So, these type of things are there.

But of course, the if there are a small vibration ultrasonic assisted machining that sometimes improve the surface finish.

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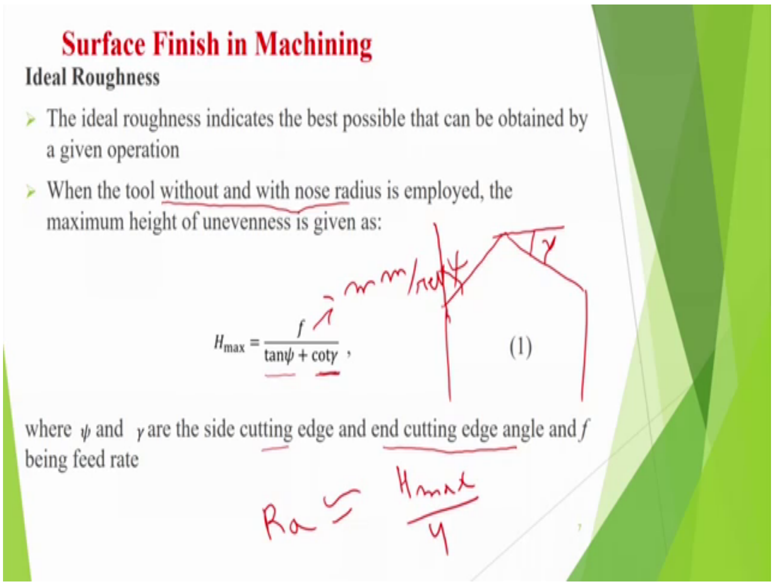

Now, surface finish in machining we have already discussed in the previous lectures ideal roughness. Ideal roughness indicates the best possible that can be obtained by a given operation. When the tool without a without nose radius is employed the maximum height of unevenness is given as when the tool without and with nose radius is employed.

So, it is it may be like this that here that if I have got a very short tool, very short tool. And then it may be turning or it may be shaping tool. And if this angle is indicated by psi which is a side cutting edge angle and if I have got this angle here. So, this is psi and this angle of this edge is actually if you have got gamma. So, top a peak to very height that is H maximum that is maximum height of unevenness is given as f divided by tan psi plus cot gamma.

So, this way it is like this, that it is a tan psi plus cot gamma. That type of thing is there where psi is the side cutting edge and gamma is the end cutting edge angle. And f is the feed rate in millimeter by evolution for turning or millimeter per stroke for shaping. So, you get f is equal to. So, x max is proportional to f. And I already told that approximately Ra can be said as H max divided by 4 that is central line average roughness is roughly like that.

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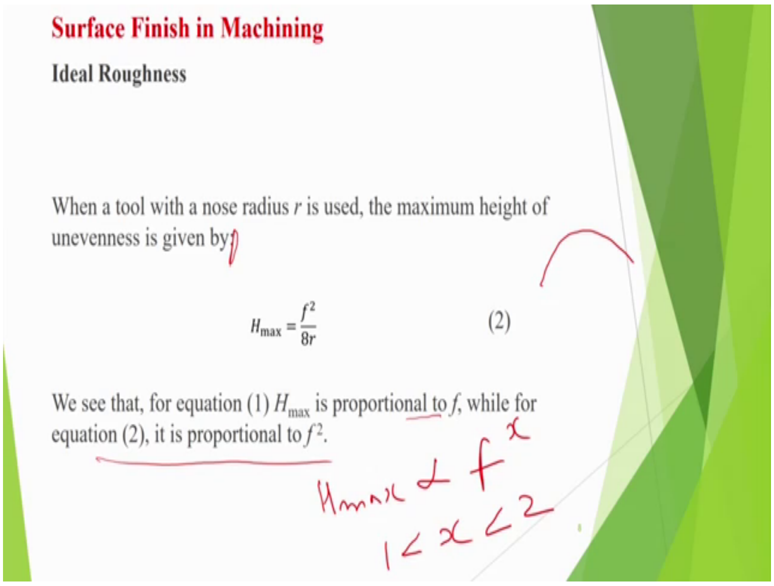

So, this relation is there, but suppose the tool is having a nose radius r and if it is of that and is it is sufficient portion is there, of the nose radius and it is machining this then the maximum height of unevenness is given by H max is equal to f square by 8 r. We see that for equation one H max is proportional to f, while for equation 2 it is proportional to f square..

I have done lot of experiments and I found that many times actual your H max we may be proportional to something f to the power x, where x is in between 1 and 2. Maybe x is equal to 1.5. So, like that I have observed. So, it depends on that type of thing means effect of f is discussed here.

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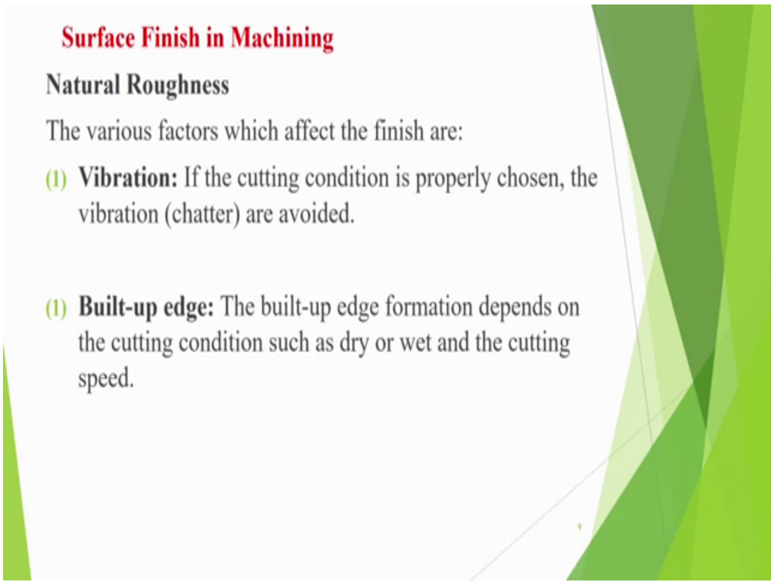

Now, surface finish in machining natural roughness various factors which affect the finish are vibration if the cutting condition is properly chosen the vibration particularly chatter, which is self-excited vibration they are avoided. And built up edge the built up edge formation depends on the cutting conditions such as dry or wet and the cutting speed. So, built up edge formation depends on many things particularly if it is a dry machining, then the chances of built up edge are more and it is a wet machining then chances of the built up edge formation may be less understood.

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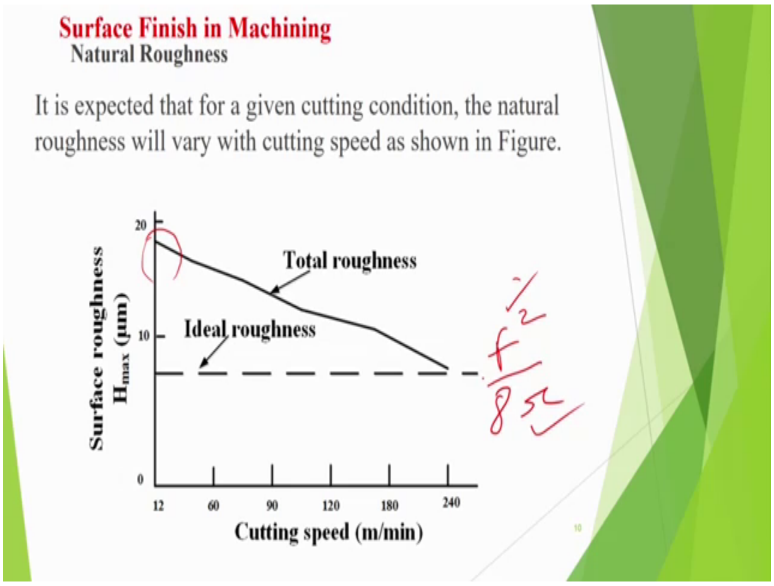

So, graphically if I observed here that surface finishing machining in we if we show natural roughness, it is expected that for a given cutting condition the natural roughness will vary with the cutting speed as shown in figure. So, it is surface roughness this is H max micrometer and this is cutting speed now cutting speed using meter per minute. So, ideal roughness is same because ideal roughness suppose it is f square by 8 r, r is the nose radius f is the feed it is not dependent on the velocity it is dependent roughness is dependent on f and r.

Whereas the total roughness maybe different. So, suppose cutting speed is less then effect of built up edge may be more. That is why here this portion is more and over all roughness is more, but as the cutting speed increases, the effect of the built up edge goes and there is no adhesion. Even the friction reduces and overall effect is that as the speed it increases. Then the roughness approaches ideal roughness so, that is why rough diagram has been shown here.

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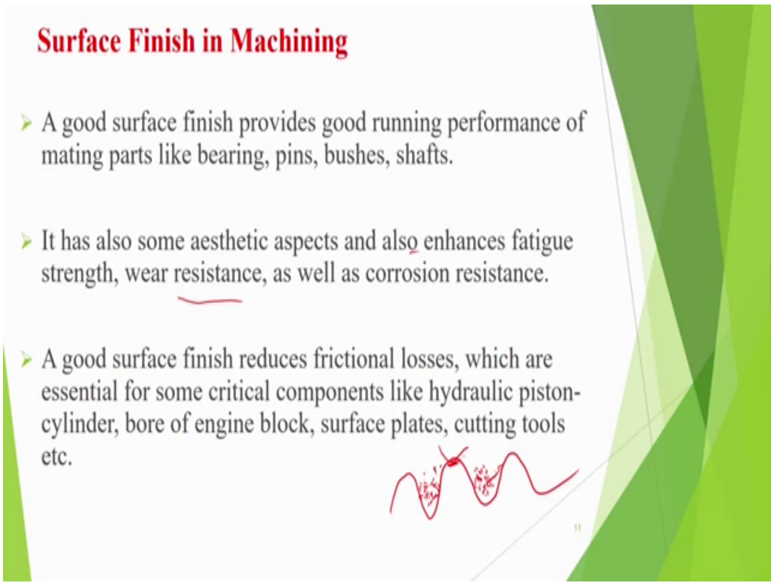

Now, a good surface finish provides good running performance of mating parts like bearings pins bushes and shaft. It has also some aesthetic aspects and also enhances fatigue strength wear resistance as well as corrosion resistance. If you have good surface finish your fatigue strength will be increased. So, that is why when we calculate the fatigue life then we use that factor that is roughness correction factor is used.

If the fatigue life suppose is something 10 to the power 5 cycle, but if the surface is rough, maybe you have to multiply that figure by 0.8 like that. Because if the surface is rough then the chances of even stress concentration, micro stress concentration they are more and in hand and they may propagate the cracks..

All that type of effect actually reduces the fatigue life. Wear resistance also gets reduced if the surface is rough because, when the surface is rough the rougher portion will come in contact with the other component and there is a lot of load getting concentrated in a small area. It causes the asperities and that is why that portion gets removed.

So, wear resistance also gets reduced. If surface finish is good, then the wear resistance gets enhanced and corrosion resistance why it gets enhanced. Suppose the surface is rough then the chances of corrosion are more because there are sides where the other environmental natter or some chemicals can accumulate on these portions and they can cause further corrosion.

Even the chances of correct propagations are more. So, stress corrosion also increases is stress corrosion also may increase. So, that is why you need a good surface finish. A good surface finish reduces frictional losses also. That is believed although in some cases this phenomena is complicated maybe sometimes you can see that a rougher surface also provides you good surface finish. It depends on so many other factor.

But in general if the surface roughness is very poor means surface roughness is very high or surface finish is very poor in that case actually the frictional losses will be more and. So, we need to worry about these tribology aspects like friction and wear in these type of situations. Suppose there is a hydraulic piston which is moving in a cylinder or suppose bore of engine, engine block is there and which piston is moving we need to have good surface finish there. Surface plates are naturally need to be very smooth because surface plates act as a datum. For other type of surfaces then cutting tools also some cutting tools we need to have a good surface finish.

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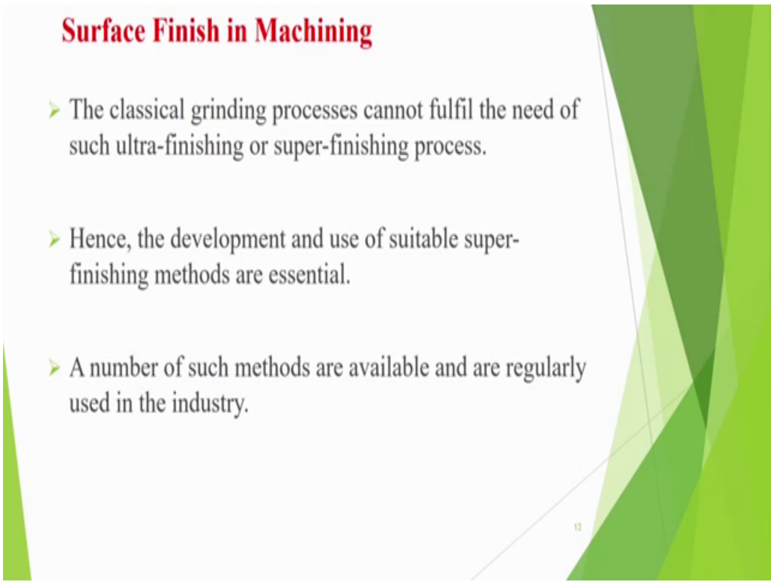

So, classical grinding processes cannot fulfill the need of some ultra-such ultra-finishing are super finishing processes. Hence the development and use of suitable super finishing methods are essential a number of such methods are available and are regularly used in industry.

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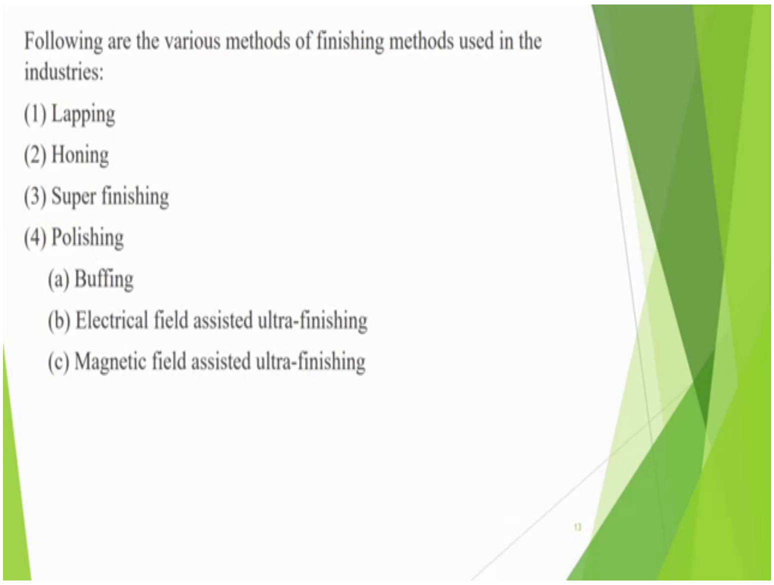

We will discuss some methods. Now apart from grinding these methods are lapping honing a super finishing polishing, lapping using a lap honing, we use a hone tool super finishing then polishing which may have different types like buffing then electrical field assisted ultra-finishing and magnetic field assisted ultra-finishing process.

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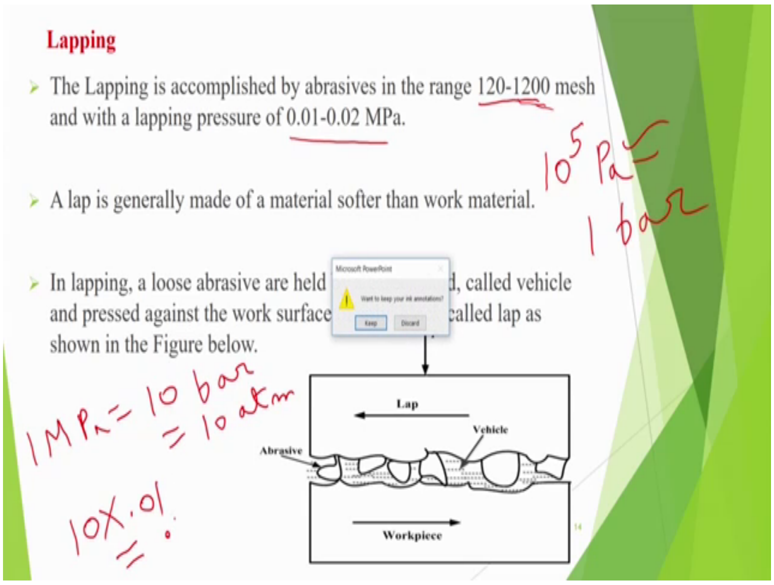

Let us discuss one by one about the lapping the lapping is accomplished by abrasives in the range of 120 to 1200 mesh and with a lapping pressure of 0.01 to 0.02 mega Pascal. So, as I told that abrasives are usually measured in terms of the numbers so, 120 indicates that it is not the size, but it is something that 120 is small particles can passed through a specified area. Usually it may be one square inch or whatever that thing it these figures may differ from a standard to a standard and 1200 means 1200 particles, can pass through the same area.

So, naturally 1200 is a smaller size. So, if the size is 1200 that abrasive will be small in diameter and 120 is bigger. And lapping pressure; that means, pressure which is applied by a lap these are the abrasives versing these are abrasives this is the workpiece in between there is some liquid and which these abrasives are suspended, it may be a viscous liquid which is called a vehicle. Vehicle means it carries the abrasives just like in a vehicle we sit.

Similarly, the abrasives sit in this liquid and then the liquid moves. So, abrasive moved from here to there. And then the pressure on the lap is applied from the top. Naturally you cannot apply very high pressure otherwise whatever thing you have produced or those dimensions will get spoiled and more than the desired material will be removed.

So, we do not want that more than desired material should be removed. We want that minimum amount of thing should be removed.

So, here lapping pressure is 0.01 mega Pascal. Suppose we say 0.01 mega Pascal or it may be 0.02 mega Pascal. You know that approximately 10 to the power 5 Pascal is one atmospheric pressure we can say 1 bar, 10 to the power 5 and mega Pascal is 10 to the power 6 so; that means, one mega Pascal is approximately 10 atmospheric pressure is a 10 bar or 10 atmospheric pressure. So, if I have got 0.01 so; that means, 10 into 0.01; that means, it is coming out to be how much that it is coming out to be 0.1; that means, basically suppose we have got 0.1 bar pressure is acting.

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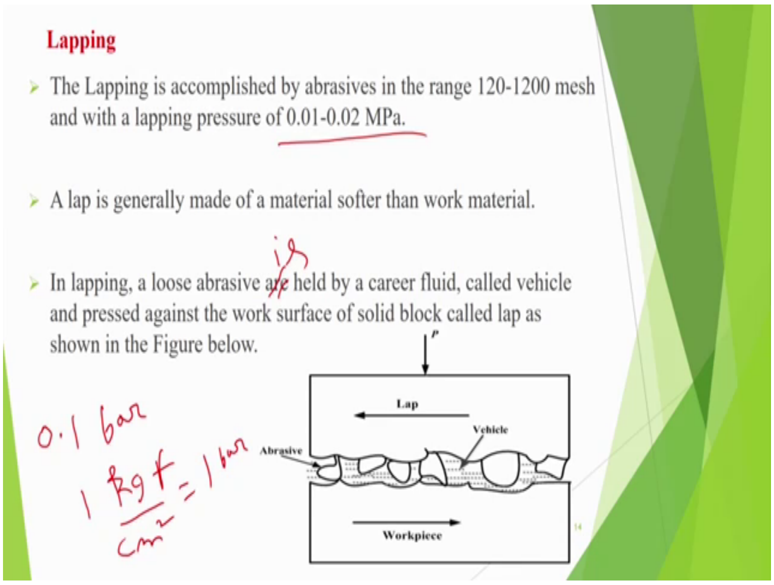

So, what is that you can get a practical idea? Suppose one kg weight is acting on a area of one centimeter square that is one kg force per centimeter square is equal to 1 bar. So; that means, if I have 0.1 bar pressure; that means, 100-gram weight is kept on a area of one centimeter square. So, that way you can get practical idea that this much type of force we require we do not require very high force; that means, if there is a area of a one centimeter square on that you require a 100-gram type of force.

And this lap which is moving in generally made of a material softer than work material why? So, that the abrasive suppose they are there, they impinge on they may embed get embedded in the lap, but not in the workpiece. And this is somewhat soft it should not be this one and this thing. Otherwise if it is very hard then these abrasives may have tendency to go to this side. And that is why this is not desired. So, lap is generally made of a material softer than work material. I

n lapping a loose abrasive is held by a career fluid, a loose abrasive is held by a carrier fluid. It is called vehicle and it is pressed against the workpiece work surface of a solid block called lap as shown in the figure below. So, that is what you are showing a putting a pressure p here and workpiece is moving in this direction may be lap is moving in the opposite direction they have opposite type of motions means there is a relative motion between lap and workpiece.

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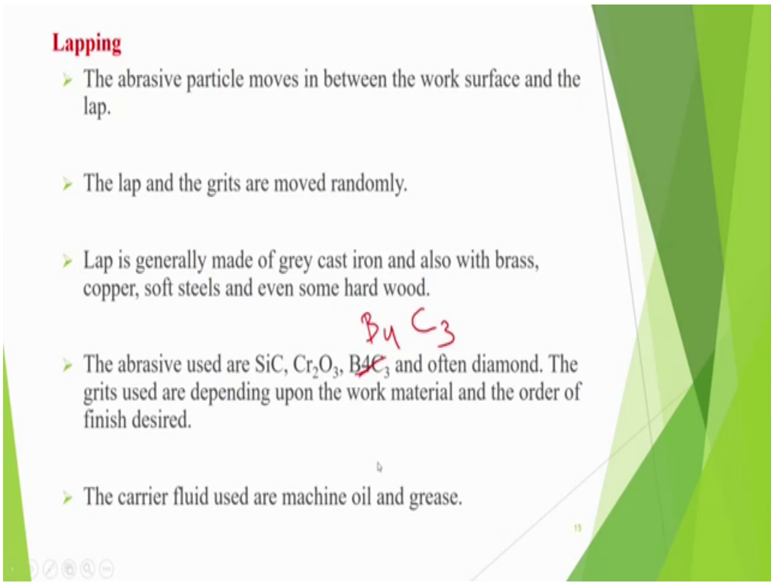

Now, then. So, abrasive particles moves in between the work surface and the lap. The lap and the grits are moved randomly usually the lap and these grits they move in the random way. Lap is generally made of grey cost iron and also with brass copper soft steel and even sometimes hard wood. These are the materials the abrasives used are silicon carbide chromium oxide Cr 2 O 3 and B 4 C 3 boron carbide. So, this is B 4 C 3. And often diamond you can have diamond dust also the grits used are depending upon the work material and the order of finish desired.

And carrier fluid used are machine oil and grease you can have carrier fluid as machine oil and grease lapping.

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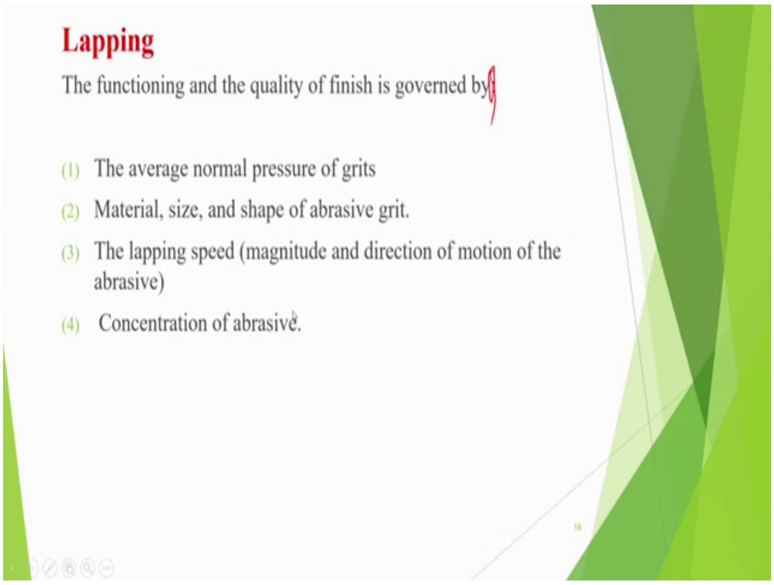

The functioning and the quality of finish is governed by the average normal pressure of grits material size and shape of abrasive grit, the lapping speed, magnitude and direction of motion of the abrasive. Then concentration of abrasive, these are the factors that which affect this finishing. So, these are the parameters which you can optimize or which you can play with you can see that how much average the pressure should be adjusted and what is that.

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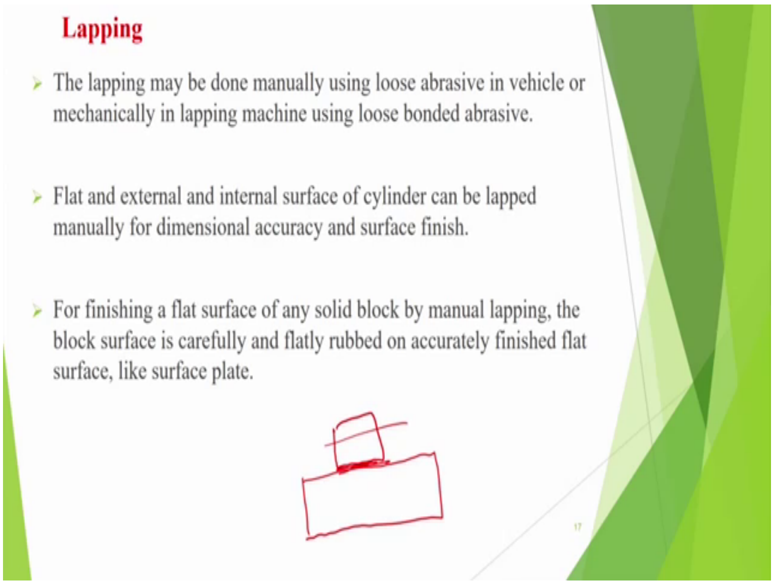

The lapping may be done manually using loose abrasives in a vehicle or mechanically in lapping machine using loose bonded abrasives. Flat and external and internal surface of cylinder can be lapped manually for dimensional accuracy and surface finish. For finishing a flat surface of any solid block by manual lapping the block surface is carefully and flatly rubbed on accurately finished flat surface like surface plate. Suppose you want to finish a flat surface then the block surface is carefully rubbed on a finished flat surface like surface plate.

Surface plate will be this one very nicely nice top surface. And then you have suppose a workpiece this workpiece, if I rub here and there then naturally the surface finish will be produced and good surface finish will be produced.

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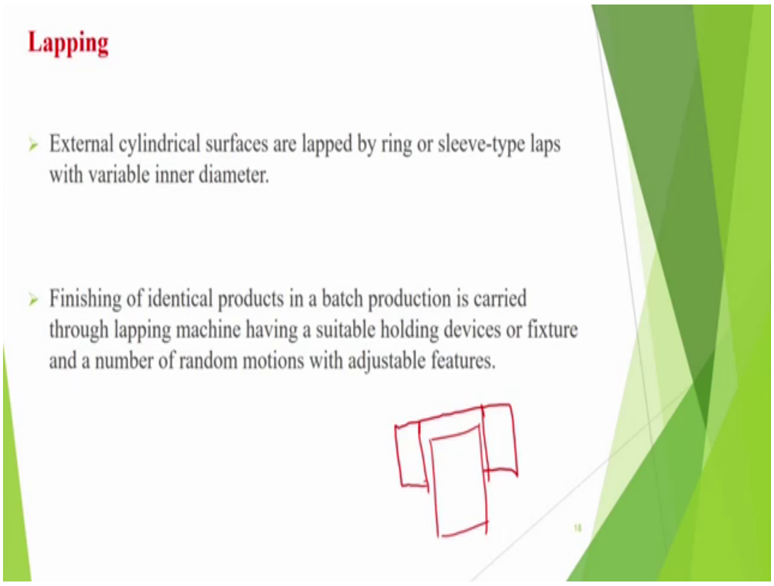

External cylindrical surface are lap lapped by ring or sleeve type laps with variable inner diameter. I can even lap the external surface of a cylinder, but I need to have a lap which may be like a ring, like a ring this type of ring you see here. It is like this and this ring diameter I can adjust somehow and then it can move. You know by some screw mechanism or something that you can adjust the diameter and then it can move. Finishing of identical products in a batch production is carried through lapping machine having a suitable holding device or fixture and a number of random motions with adjustable features that we also you carryout.

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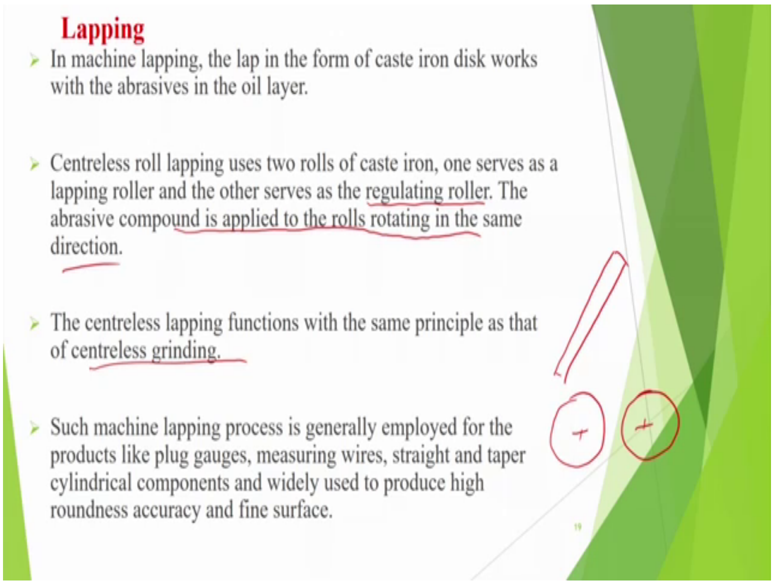

Then in machine lapping the lap in the form of cost iron disk works with the abrasives in the oil layer. In machine lapping lap maybe in the form of cost iron disk and centerless roll lapping uses 2 rolls of caste iron. I can have a long suppose I want to machine say this cylinder rod, I may have this type of rod and I want to lap it by centerless type of things. So, I like you have centerless grinder in which 2 wheels are there; one is called a that grinding wheel other is regulating wheel, and I provide some angle to the that one wheel. So, that one component of the radial force coming on that it provides axial force and you get a feed and it moves.

So, here it uses 2 rolls of caste iron. One serves as a lapping roller and other serves as the regulating roller. Other regulates the motion. The abrasive compound is applied for the rolls rotating in the same direction. The centerless lapping functions with the same principle as that of the centerless grinding. Such machine lapping process is generally employed for the products like plug gauges, measuring wires, straight and taper cylindrical components and widely used to produce high roundness accuracy and fine surfaces.

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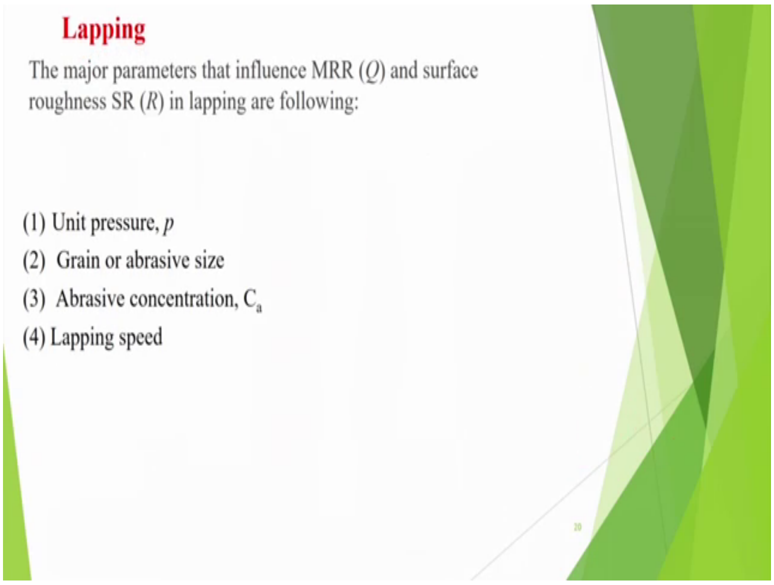

So, such type of things are there. The major parameters that influence MRR and surface roughness in lapping are following.

One is the unit pressure acting, the grain or abrasive size, abrasive concentration and lapping speed.

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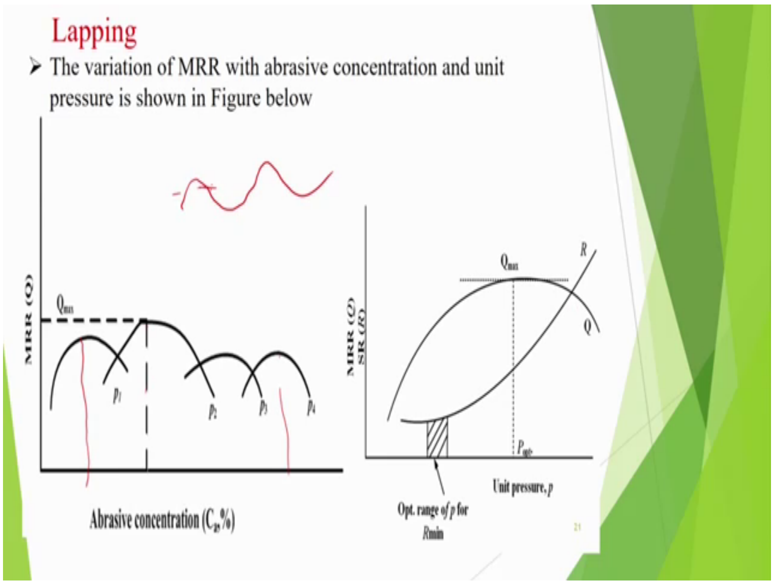

The variation of MRR with abrasive concentration and unit pressure is shown in figure below. Suppose I plot on the x axis abrasive concentration that is in percentage on the y axis it is material removal rate in terms of which is indicated by q; that means, millimeter cube per minute. And if I put a lapping pressure p 1, you see that there will be one optimum concentration at which the MRR will be maximum. That may be different if I apply more amount of pressure then abrasive concentration maybe different.

In fact, there can be one proper pressure suppose that p 2 pressure and this abrasive concentration you are getting a highest MRR. If you put a more pressure, then also MRR may not be good. Because instead of machining may be the abrasives may get impinged into this one. I want to a remove the material I want to remove unwanted material. So, I want to apply a appropriate of pressure. If I apply a very less pressure nothing will be removed. If I apply a some medium pressure it will be removed. If I apply more pressure, then also there may not be any removal rather the abrasive particles may get impinged on that.

Similarly, about the concentration. If you have very less concentration then also there will not be proper finishing, but if you have more amount of abrasive then also there may not be proper type of finishing because these abrasive particles may interfere with each other. They will not be doing proper machining rather one abrasive can slide on the other. Now about the surface roughness part suppose we see that there is a unit pressure at which the material removal rate is maximum, but the surface roughness may keep on increasing with more amount of unit pressure. Because if you apply more amount of the pressure it will try to impinge the material and it will try to spoil the surface finish.

In fact, may be you have some range of the p in which you may get minimum amount of surface roughness, but if your main objective is to have more material removal then maybe that pressure is different. So, this type of thing maybe different and as an engineer you may have to decide suitable working conditions.

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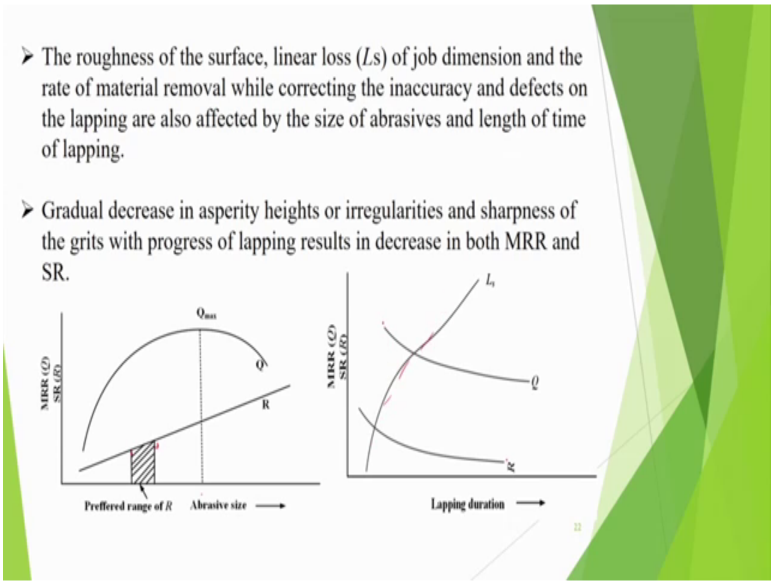

Roughness of the surface is one thing, then linear loss of job dimension; that means, the loss of the job dimension and the rate of material removal while correcting the inaccuracy and defects on the lapping are also affected by the size of abrasives and length of time of lapping. Then gradual decrease in asperity heights or irregularities and sharpness of the grits with progress of lapping results in decrease in both MRR and surface roughness.

So, I show that suppose abrasive size. You see that MRR increases with abrasive size then, it decreases there is a optimum abrasive size at which the MRR is maximum and the surface roughness in general maybe increasing with abrasive size. So, maybe you may decide I will work here and the this one. Lapping duration more is the duration you expect better is the surface finish..

So, the surface roughness reduces with the duration, but more material will be removed or dimensions will change if you machine it for longer duration. And material removal rate of course, is decreases with the duration; that means, here first material removal rate is a bit high because asperities are there high projections are there they will be easily get removed.

After that as the heights are more or less they become flatter it becomes difficult to remove them because you will thing gets evenly distributed pressure is also not very high, and this is the weight. That is why you are getting this type of shape of the figure now this is. So, we talked about a lapping now let us talk another process that is called honing.

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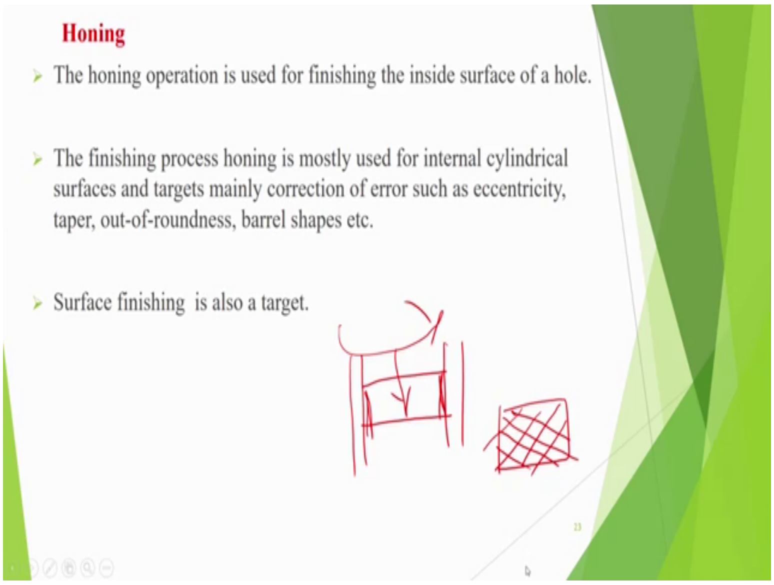

Now, honing operation is used for finishing the inside surface of a hole.

So, like you have cylinder board in which piston will move finishing process, honing is mostly use for internal cylindrical surfaces and targets mainly correction of error such as eccentricity taper out of roundness barrel shape etcetera plus honing will also produce a type of the mites surface, you see in honing usually there will be a piston suppose honing tool look at that surface it will reciprocate here. And at the same time cylinder will rotate. So, then it overall effect is that it makes a crossed hash pattern because it is moving this one it is moving and maybe then you can change the directions and it can become like that.

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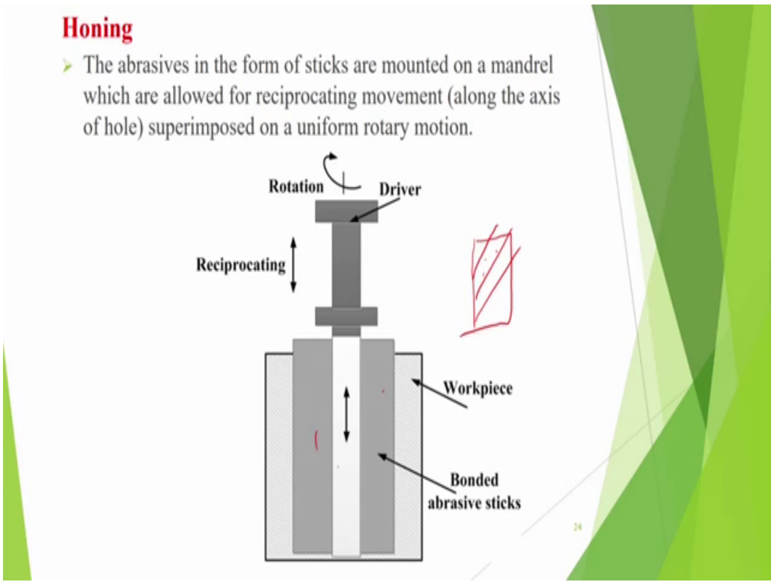

So, here surface finishing is also a target. So, abrasives in the form of sticks are mounted on a mandrel. So, this is a mandrel. This I am bonding; bonding the abrasives. These are the abrasive sticks. They are allowed for reciprocating movement along the axis of hole. So, I am moving like that and it is super imposed on a uniform rotary motion.

So, suppose I am showing that this is rotating also hone. And the hone is reciprocating alternatively even workpiece can rotate and hone can reciprocate or there can be other combination I mean to say that relative motion is important, then in that case there will be machining, but that machining pattern those feeding feed marks will be having this type of shapes..

Because something is rotating also and also it is moving down. So, you may have this type of profile which is which may be good to retain the lubricants. We get this type of goods type of things that might it surface in which the a lubricant can be retained.

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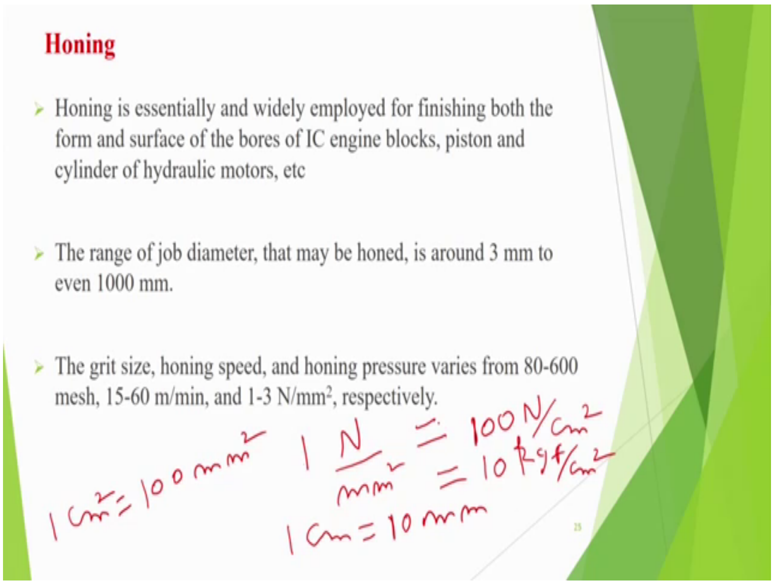

So, honing is essentially and widely employed for finishing both the form and surface of the bores of IC engine blocks piston and cylinder of hydraulic motors etcetera. Then a range of diameter that maybe honed is around 3 mm to even thousand mm mainly big type of diameter can also machined. The grit size honing speed and honing pressure varies from 80 to 600 mesh that is the size and 15 to 60 meter per minute. That is the speed of the honing and pressure is 1 to 3 Newton per m mm square..

So, pressure is usually not really high suppose I say 1 Newton per mm square. So, how much will be in Newton per centimeter square. It is same as 10 to the power; that means, 100 because one a centimeter; that means, this is 1 centimeter is having suppose 10 mm right. 1 centimeter has 10 mm.

So, one centimeter square is equal to 100 mm square. So; that means, 1 centimeter square is equal to 100 mm square. So, if my pressure is 1 Newton per mm square; that means, it is 100 Newton per centimeter square. And approximately 10 Newton is 1 kg weight. So, in terms of that it is 1 kg f per centimeter square. So, 10 kg 4 in 1 centimeter square area if I put like that that type of pressure maybe there or it may be smaller like that we put honing pressure.

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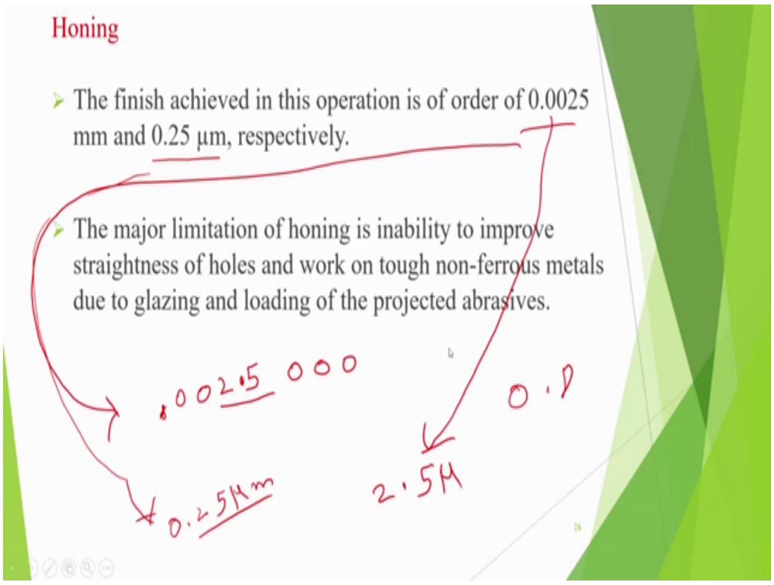

And finish achieved is of the order of 0.0025 mm suppose let me see that how much in micron 0.0025.

So, suppose we say 0 0 2 5 multiplied by thousand. So, this is like this so; that means, it is same as 2.5 micron so; that means, this one is 2.5 micron ok. 2.5 micron is really this one known not really good surface finish even grinding usually achieved 0.8, but it is set that it is of the order from here to here and 0.25 micrometer. Yes 0.25 micrometer is somewhat is small; that means, it is greater than the grinding finish and this one or it may be even smaller finish major limitation of honing is inability to improve straightness of holes and work on tough non ferrous material due to glazing and loading of the projected abrasives.

Suppose you are machining honing the aluminum now aluminum is very ductile the chips will be generated and they will clog your honing tool. So, that difficulty also comes in this one.

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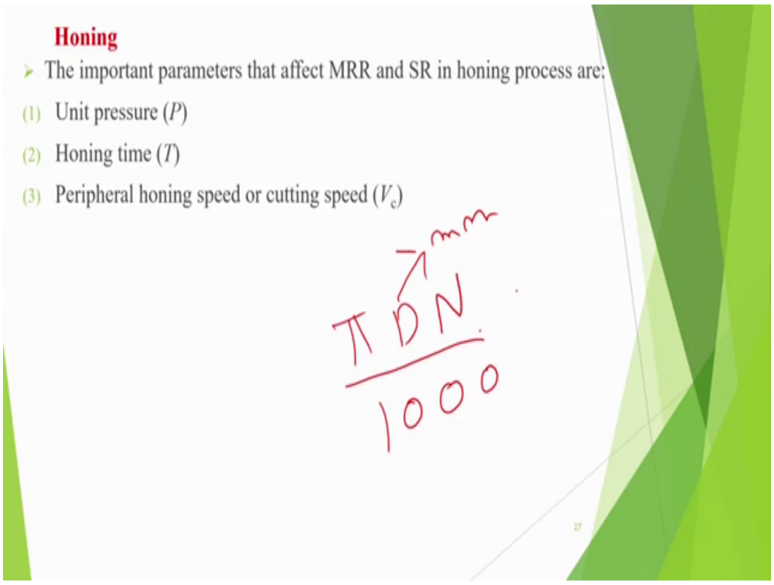

Now, important parameters that affected material removal rate and surface roughness in honing process are, one is the unit pressure then honing time then peripheral honing speed or cutting speed; that means, that what speed it is cutting. So, this is a thing if you know rpm and then you know the diameter. So, you have to use that type of formula as you use in lathe to find out the surface speed pi DN by 1000, if d is in a mm. So, to convert it into meter we divided by 1000 and this is in this 1 n is may be rpm. So, it will be in meter per minute.

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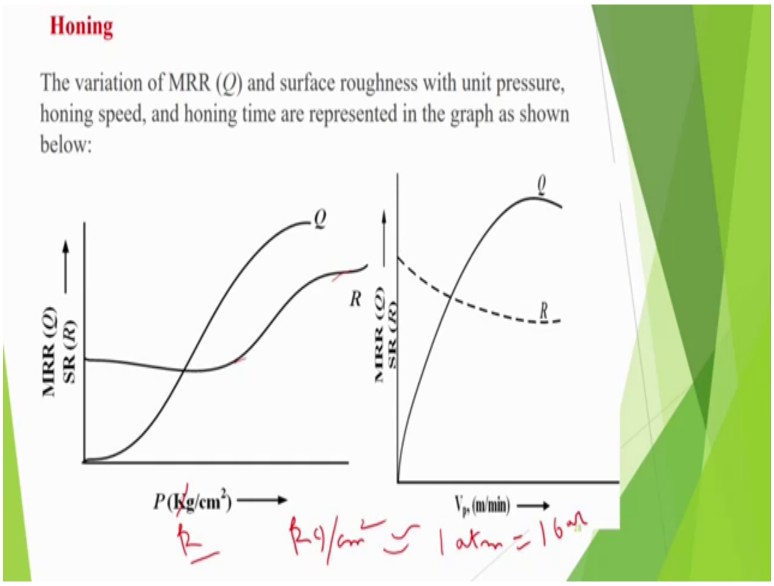

So, here variation of MRR and surface roughness with unit pressure honing speed and a honing time are represented in the graph as shown below. If it is p, I should make it k small never do that mistake k is always small kg; that means, per centimeter square. And one kg per centimeter square is approximately one atmospheric pressure, or one bar. So, here if I increase the pressure my MRR increases, but this surface roughness will also initially it will slightly decrease, but then increase..

So, do not have to put very high amount of pressure. And vp means honing speed that is optimum there is a optimum p meter per minute, at which the honing speed is maximum. And the surface roughness surface roughness decreases with the honing speed that type of thing had been shown, but after certain speed it may get saturated so.

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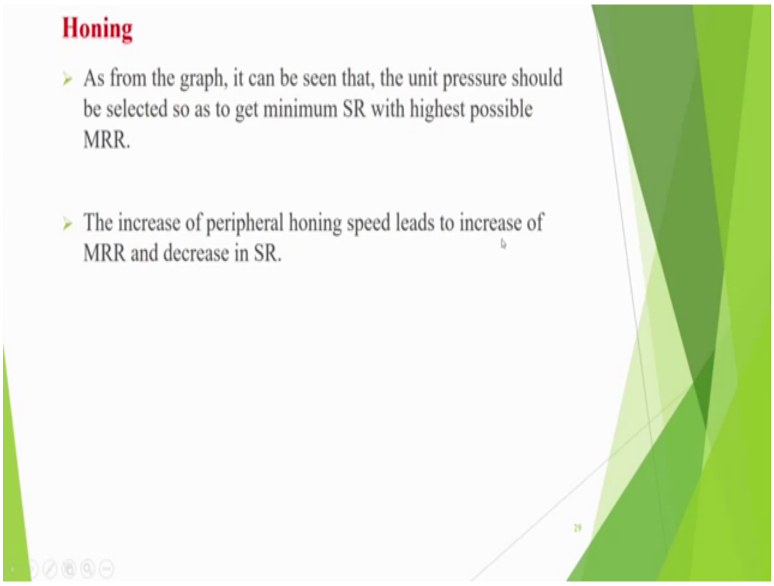

This we have shown and as shown from the graph it can be seen that unit pressure should be selected. So, as to get minimum SR with highest possible MRR we need minimum SR, but highest possible MRR are sometimes; that means, we want to minimize the surface roughness, but sometimes we do not need actually may very high MRR also. Our objective is to reduce the surface roughness not the material removal increase of peripheral honing speed leads to increase of MRR and decrease in SR that also is there. So, you have seen MRR and surface roughness both decrease with honing time.

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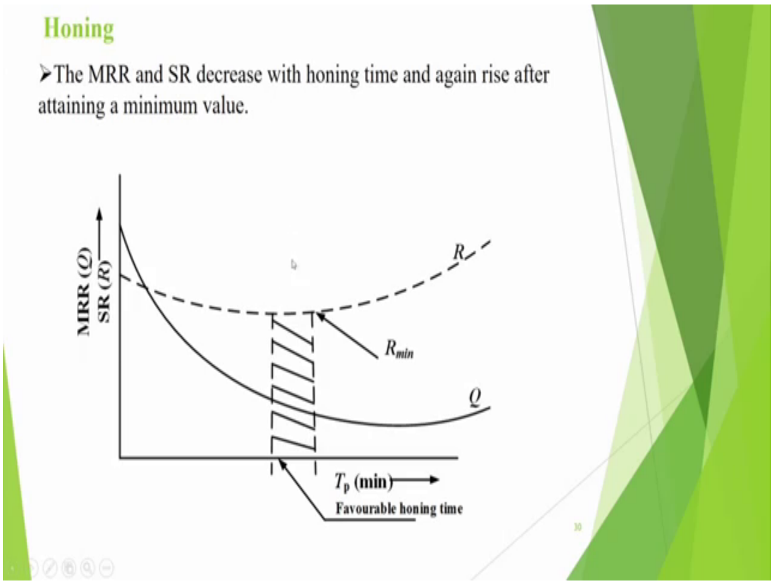

So, initially more material removal is very fast. Because rougher surfaces are there peaks are there. They get heavy stress concentration and they fracture fast after that that type of thing is not there.

And then what happens that here about the surface roughness, this is surface roughness is it is like that it is increasing that it. Initially it is decreasing with time; that means, surface roughness become less, but sometimes if there is a more amount of time then surface roughness increases that type of thing also has been observed. Why because some smooth surface which you have obtained and you are keep on honing and honing then that smooth surface will get squared. And that is why you may get this type of situation.

So, you have to understand you do not do over honing. You take a range of time between this range we stop either you hone up to this earlier depending on the type of thing.

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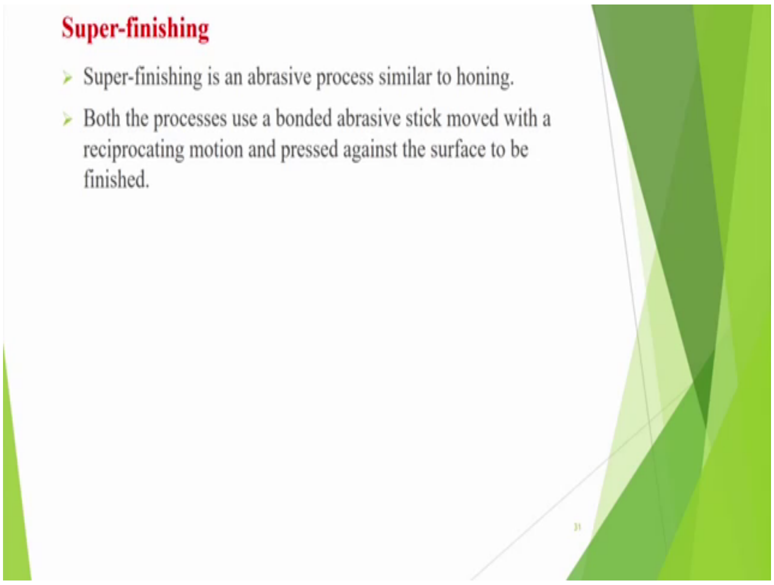

Now, we discuss about super finishing process. Super finishing is an abrasive process similar to honing both the processes use a bonded abrasive sticks moved with a reciprocating motion and pressed against the surface to be finished, then what is the difference between super finishing and honing.

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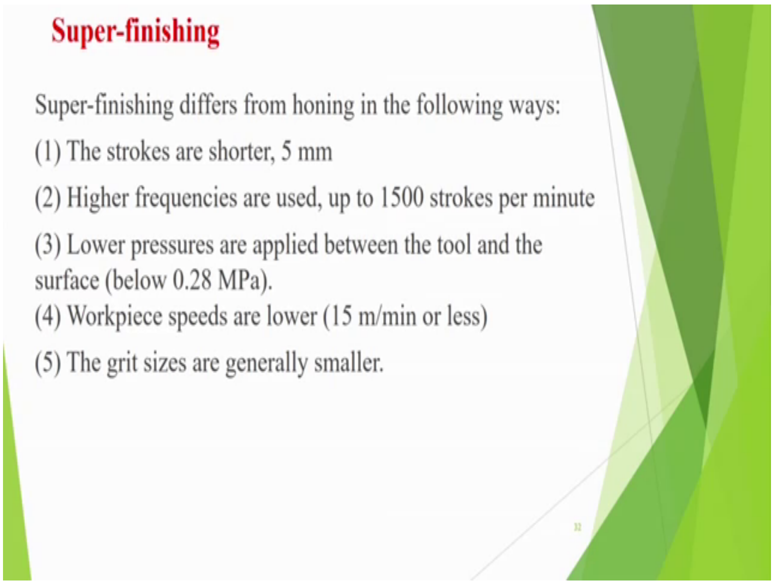

Super finishing differs from honing in the following ways. First these strokes are shorter they are 5 mm higher frequencies are used up to 15 100 strokes per minute we use, So, very high frequency then it helps in the getting good surface finish because the friction is also reduced and there is no time to get sticking or something means getting a type of welding and strokes are of course, shorter then lower pressures are applied between the tool and the surface below 0.28 mega Pascal 0.28 mega Pascal means 2.8 atmospheric pressure because 1 mega Pascal means 10 atmospheric pressure. So, 2.8; that means 2.8 kg per centimeter square.

Then workpiece speeds are lower. Workpiece will speed will not be high it will be 15 meter per minute. So, maybe your piece speed is high, but on top of this that super finishing stick that is vibrating, that is a with high speed and grit sizes are generally smaller.

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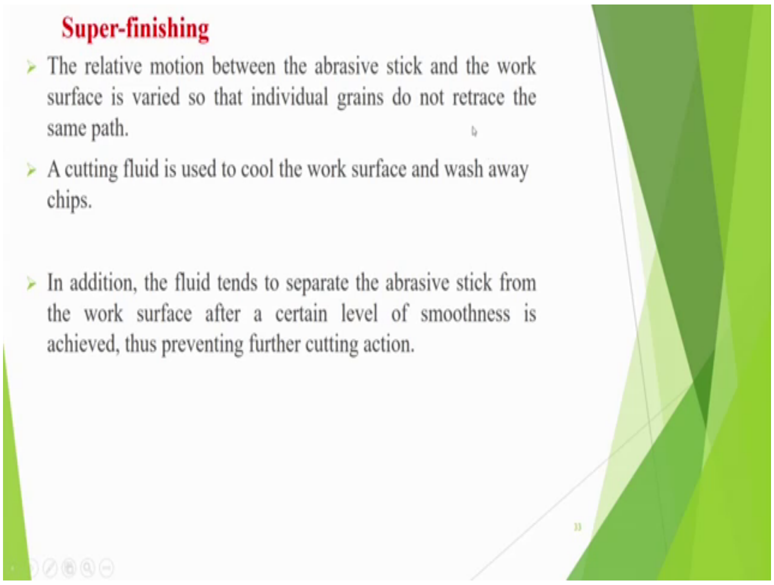

And relative motion between the abrasive stick and the work surface is varied. So, that individual grains do not retrace the same path. So, we vary that one path also we can vary cutting fluid is used to cool the work surface. And wash away chips you may be some the fluid tends to separate the abrasive stick from the work surface after a certain level of a smoothness is achieved.

Then mostly there will be abrasive stick, but it will be separated by some fluid thus preventing further cutting action.

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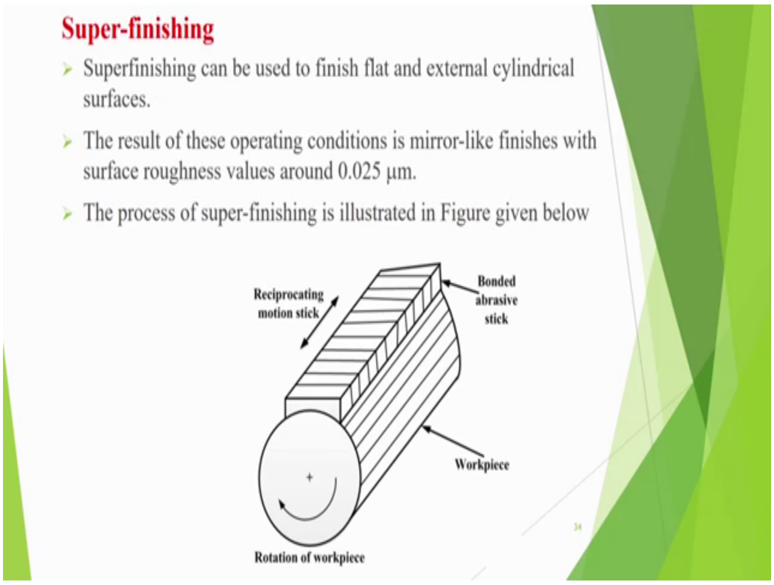

So, we are showing it here that suppose workpiece is rotating, but we have got a stick here, these are the bonded abrasive sticks and it is reciprocating. So, result of these operating conditions is mirror like finishing with surface roughness values around 0.025 micrometer that is very small. And process of super finishing is illustrated in figure given below.

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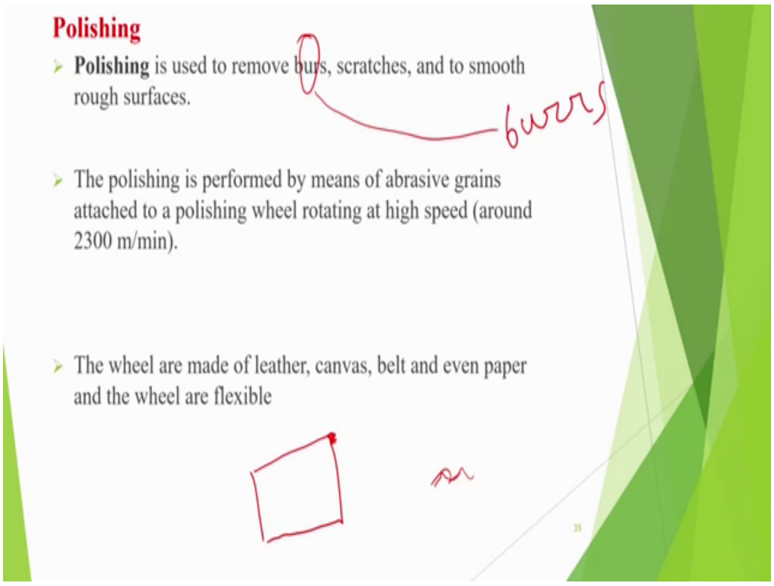

Here it is showing this one then another process is now polishing, which we use generally in metallurgy lab to see the microstructure. You also might have used it polishing is used to remove burs, I thing this spelling is wrong that should be bu double RS burs, burs all you know unwanted projection sometimes you machine suppose a block. You see here some small material will be stuck. Which can be easily removed by filing that is very loose that is called burr.

So, we can remove it we can remove scratch marks and we can smoothened the rough surfaces. Now polishing is performed by means of abrasive grains attached to a polishing wheel rotating at a high speed. So, polishing generally the speed may be very high, to 2300 meter per minute and wheels are made of leather canvas belt and even paper and wheel are flexible.

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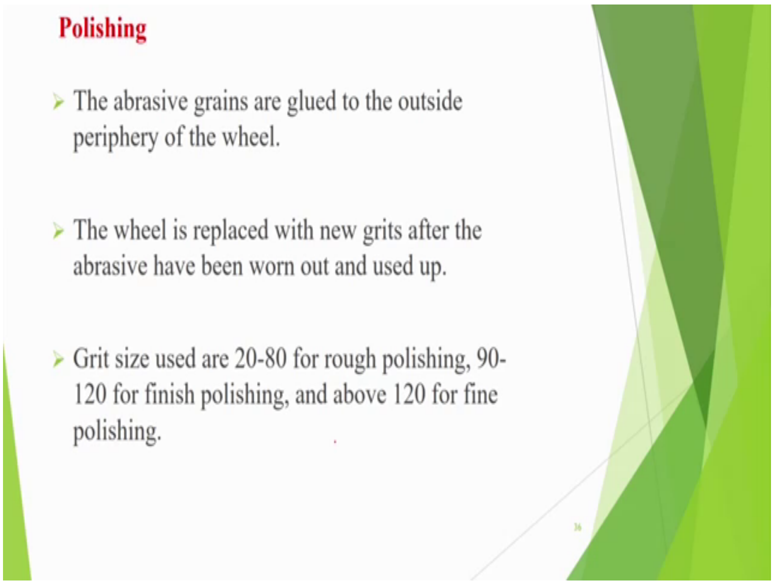

So, like that they are there and polishing in abrasive grains, the abrasive grains are glued to the outside periphery of the wheel. The wheel is replaced with new grits after the abrasive have been worn out and used up. Grit size used are 20 to 80 for rough polishing.

But then we have 90 to 120 for finish polishing, means if the finish polishing is there, then the grit size should be smaller; smaller means it is number will be big and above 120 for fine polishing.

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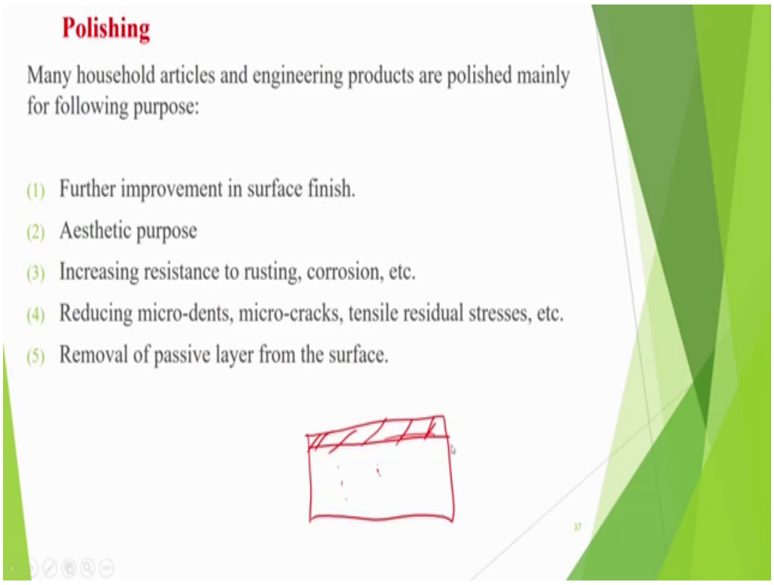

Many household articles and engineering products are polished mainly for following purpose. Further improvement in surface finish that is one objective then I need aesthetic purpose I it should look good, that is why I machine then increasing resistance to rusting and corrosion etcetera.

If I polish it nicely chances of rusting will be less. Rough surfaces have a tendency to get rusted. They get more amount of corrosion also then reducing micro dents micro cracks and even tensile residual stresses etcetera. Tensile residual stresses they cause stress corrosion tracking they are not desirable they reduce the fatigue life also..

So, tensile residual stress that portion can be removed. Sometimes by some process you have made and suppose up to this there are tensile stresses, after that there are compressive stresses you somehow you removed that layer which is having tensile residual stresses. Then the stresses may get a redistributed and you may get better results removal of passive layer from the surface that also you can do.

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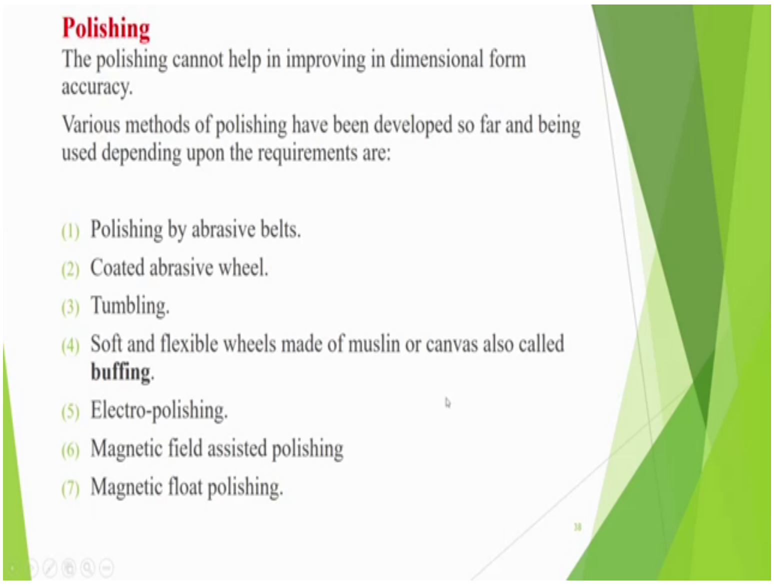

Now, polishing cannot help in improving dimensional form and accuracy because material removal is very, very small. Various methods of polishing have been developed so far and being used depending upon the requirement are polishing by abrasive belts coated, abrasive wheel tumbling, soft and flexible wheels made of muslin or a canvas also called buffing that is called buffing in material science lab..

You must have use buffing in which you have soft and flexible wheel it which may be made out of some cloth and in which abrasive particles are impinged. And it is moving this one it maybe electro polishing, electro polishing means reverse of electro deposition. It may be magnetic field assisted polishing or magnetic float polishing.

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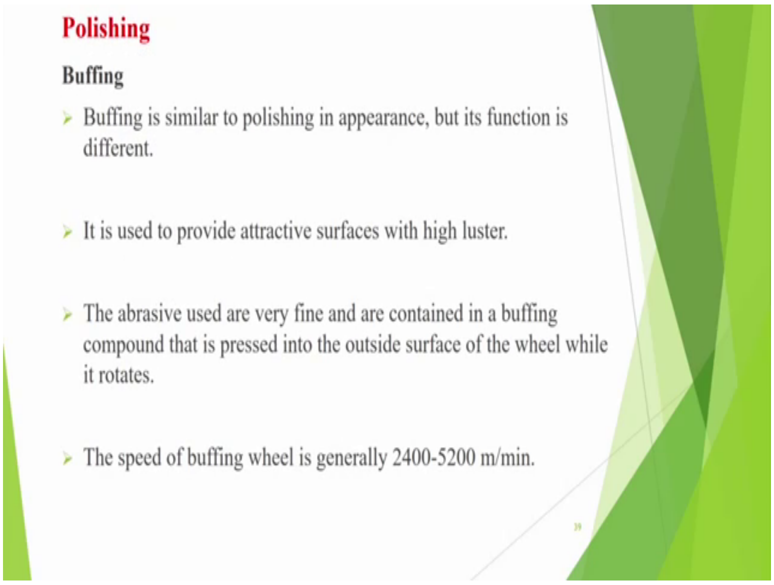

Buffing is similar to polishing in appearance, but it is function is different. It is used to provide attractive surfaces with high luster. The abrasives used are very fine and are confined in a buffing compound, that is pressed into the outside surface of the wheel while it rotates a speed of buffing wheel is generally 2400 to 5200 meter per minute.

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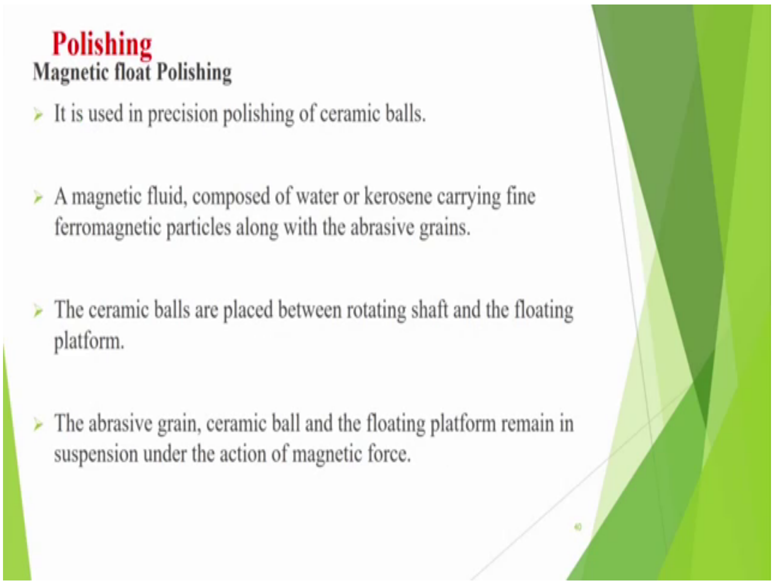

very high speed and then magnetic float polishing is what it is used in precision polishing of ceramic balls. A magnetic fluid composed of water or kerosene carrying fine ferromagnetic particles along with the abrasive grains is used.

Ceramic balls are placed between rotating shaft. And the floating platform the abrasive grain ceramic ball and the floating platform remain in a suspension under the action of magnetic force. So, this will be there.

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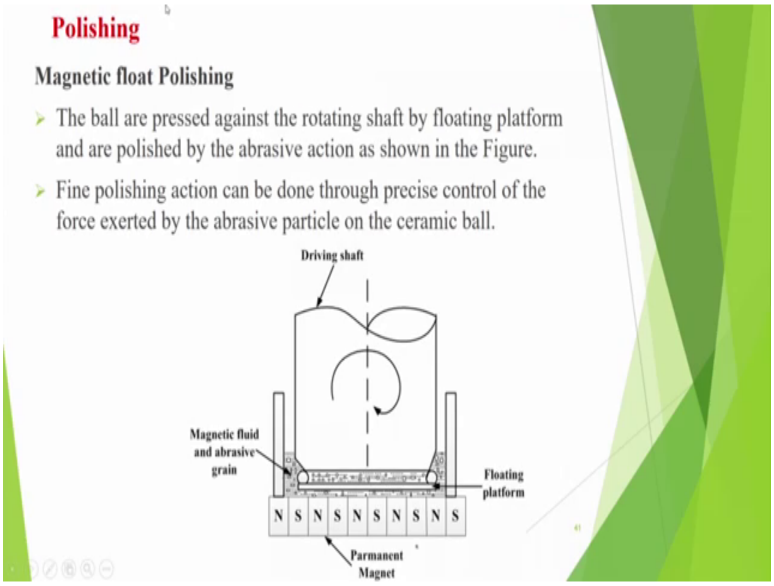

And now here like example a figure is shown. The balls are pressed against the rotating shaft by floating platform. This is a floating platform. Here it is shown this one and are polished by the abrasive action as shown in the figure. Fine polishing action can be done through precise control of the force exerted by the abrasive particle on the ceramic ball.

So, magnetic fluid and abrasive grain it is there. And this is the driving shaft and this will be it is rotating here. And these are the magnetic fluid and abrasive grains. And this one these are permanent magnets one can try electro magnet also they will control the motion.

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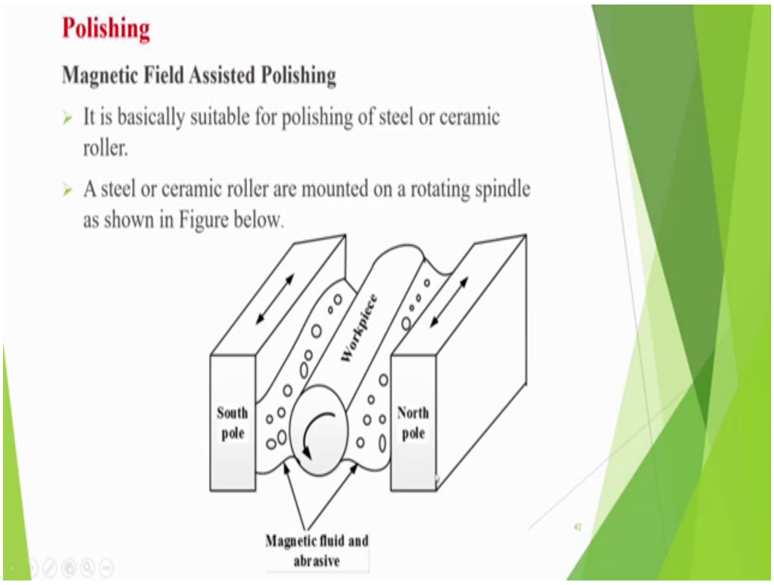

So, this way magnetic field assisted polishing. Suppose you have South Pole North Pole workpiece is rotating. It is basically suitable for polishing of steel or ceramic roller like this one. It is a steel or ceramic roller and a steel or ceramic roller are mounted on a rotating spindle as shown in figure.

And then you have got magnetic fluid and abrasives here. And movement is controlled by magnetic poles.

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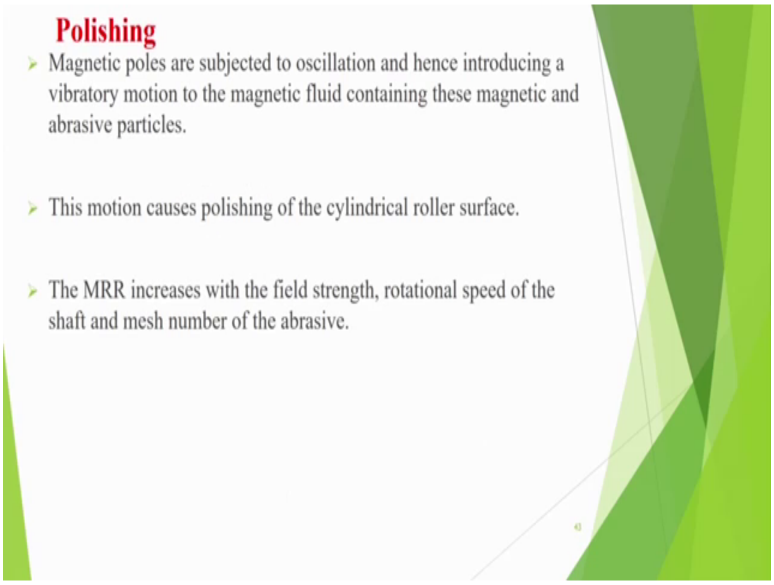

Magnetic poles are subjected to oscillation and hence introducing a vibratory motion to the magnetic fluid containing these magnetic and abrasive particles. This motion causes polishing of the cylindrical roller surface. MRR that is material removal rate increases with the field strength rotational speed of the shaft and mesh number of the abrasives.

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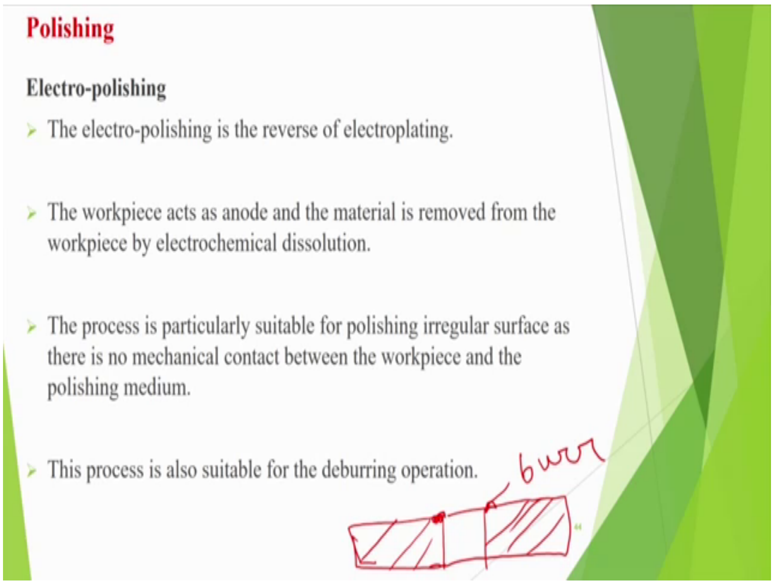

So, this one is there and then we can have electro polishing, which is the reverse of the electro plating. You know that we carry out the electro plating in which we deposit some material like we can have sometimes on brass vessels, we can have old plating which this deposition is done using a faradays principle.

But the electro polishing is the reverse of that instead of depositing I am taking out of that, like you have chemical machining electrochemical machining. So, workpiece acts as anode and the material is removed from the workpiece by electrochemical dissolution. This process is particularly suitable for polishing irregular surface.

As there is no mechanical contact between the workpiece and the polishing medium very good amount of surface finish you can obtained and process is also suitable for the deburring operation; that means, you have to remove the burrs unwanted material which automatically gets, suppose you make a hole you will see that on the outer on the hole in the beginning of the hole there you suppose there is a material and in which I have got a hole then you may have here some extra material deposited type of thing looks be just that is called burr. This material can be removed by electro polishing also. So, these are the various type of methods..

So, you I have told about surface finish. I will just end by lecture by telling one thing that initially in the drawing sheets surface, finish used to be represented by this thing. Roughly by suppose I make it like this symbol means as it is this means it is called one triangle finish.

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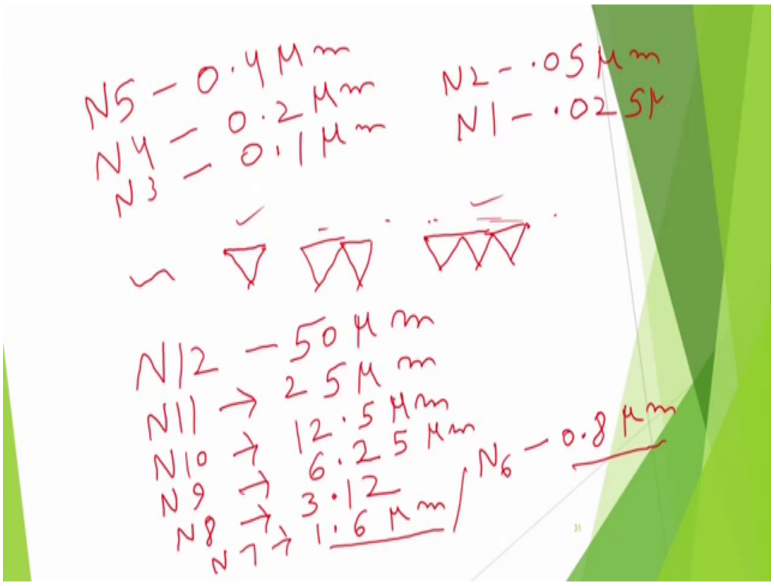

Then I used to make 2 triangle, that is 2 triangle finish and this will be 3 triangle finish that is 3 triangle finish. So, there used to be some ranges up to this it is first triangle. If the surface roughness lies between this and this, then it is 2 triangle and it is surface roughness lies between one much smaller this then which is 3 triangle means very good surface finish..

Then it was decided that the surface roughness should be expressed in terms of the 12 divisions. So, usually we used to see N 12 means 50 below 50 micrometer. If we have 50 micrometer, then it is N 12, then they used to have N 11, 25 micrometer; that means, big range is there may be if it is between 25 to 50 you still may call it N 12 this one.

But N is 11 then N 10 used to be just 50 percent of that 12.5 micrometer. Which we used to obtain by sometimes by shaping etcetera N 9 6.25 micrometer just 50 percent of that, that is usually you used to obtain by a shaper or sometimes. N 8 in milling machine shaping turning you get the surface you used to get the surface roughness of the order of 3.12 and N 7 used to be 1.6 micrometer. That is N 7; and N 6 used to be 0.8 micrometer that is grinding.

So, by this method it is easy still for need to remember this thing rather than giving values N 6, means 0.8 micrometer. Then N up to this you assume that grinding is grinding can give about 0.58, then you have N 5; N 5 means 0.4 micrometer the which you obtain by these finishing processes, N 4 means 0.2 micrometer and N 3 means 0.1 micrometer, N 2 means 0.05 micrometer and N 1 is even is smaller that is 0.025 micrometer like that. Now what is of course, we are even getting much better surface roughnesses.

So, this we will give this type of discussion or this type of if you remember in terms of N 12, 12 divisions. You start with 50 micrometer each one will be reduced by half N 11 is 25, N 10 is 12.5 then again divided by 2. So, you got and as a thumb rule you can remember grinding can give you N 6 surface roughness. And turning can give you N 8 milling also can give N 8; N 8 N 7 that type of finish you get in turning N 6 is grinding and less than N 6 you get this type of processes honing lapping etcetera which I have described.

Thank you.