Indian Institute of Technology Kanpur

National Programme on Enhanced Learning (NPTEL)

Course Title
Manufacturing Process Technology-Part-1

Module-34

by
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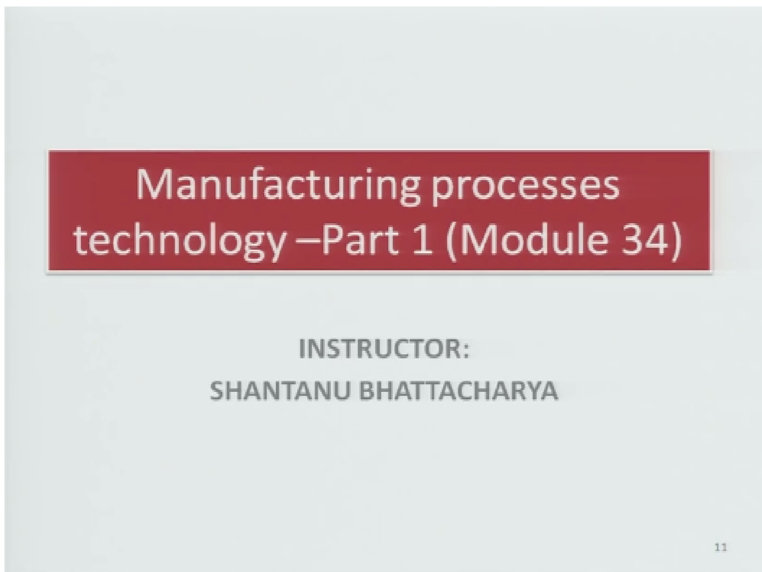

Hello and welcome to manufacturing processes technology part-1 module -34. We were talking about different peeling processes associated with the processes turning, shaping, cleaning and milling.

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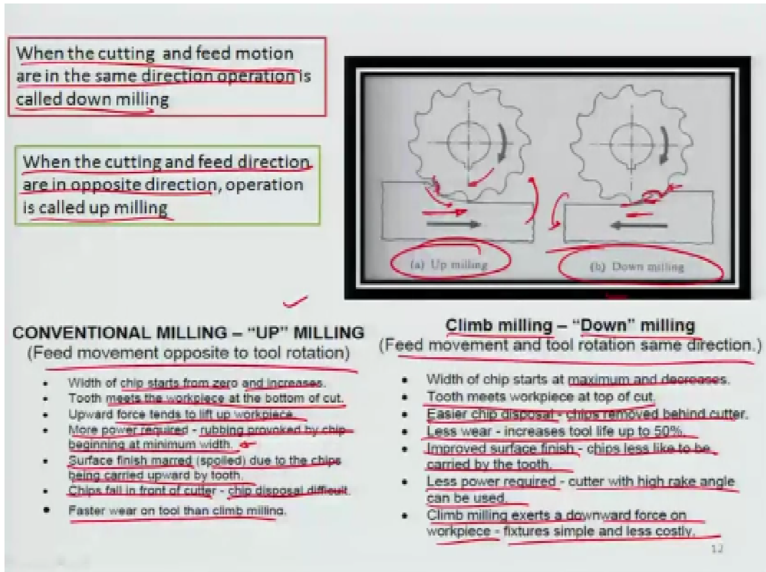

We also wanted to see about the different of kind of milling operations which are there in that context we are done earlier and we had seen a various orientation of the tool with respect to the work piece in case of slab milling, slot milling, form milling, face milling and milling so and so forth. So typically you can classify also the milling processes into up milling and down milling these are different illustration of happens.

So when the cutting and the feed motion are in the same direction the is known as down milling you can see the down milling happening here that the work pieces been fed in the certain same direction of the cutting motion or cutting action the peeling process starts with the engagement of the cutter which is rotating in the clockwise direction from the top surface to the bottom surface but pilling process in the same direction and motion of the work piece.

And simultaneously when the cutting and feed direction are in opposite direction to each other in this particular case for example the cutter is coming down in this manner and it is engaging you have to peel off and the feed of the work piece is happening exactly in other direction of the direction of cut this is called the up milling operation.

So there are various issues associated with up and down milling and you can defined them as in conventional milling which is typically an up milling process the feed movement which is opposite to tool rotation that the different orient or different main highlights here where the width of chip of the starts from 0 and increases you can see here in the up milling process that the width when you start with the first engagement is the smaller and the width keeps on increasing with the chipping action happening the tooth meets the work piece of the bottom of the cut upward force tends to left the work piece.

So there is a tendency of the work piece to go up because of the engagement. And therefore, more power is required and rubbing is provoked by the chip beginning at minimum width and the surface finish is marred or spoiled due to the chips being upward by the tooth. And chips fall in the tools of the cutter that is an another problem in this particular case which makes the chip disposal become little difficult.

Because the chip which is generate here would try to buy gravity actually come done on the finished area of the work piece. And so, therefore there is a general faster wear in the tool then the other case which is the climb milling or down milling, so this is known as the climb milling or down milling where the feed movement and the tool rotation are in the same directions where the obviously the width starts at the maximum amount increases the maximum engagement is at towards the beginning.

And then as is goes off the chip peels that is going to become the thin section of the pinning happens and the section is finally going to be as them as possible at the point of tool of the chip from the surface. So the tooth meets the work piece at the top of the cut easier to disposal, chips are removed behind of the cutter so basically you can say that atleast the finish part of the finished surface is not affected by the chip, where the chip whatever is go down in the area which is again to be cut.

So you have less wear and increases to life upto 50% that results in improved surface finish of course the chips less likely to be carried by the put into the finished zone. And so less power is required cutter the higher racked angles can be used and climb milling exerts the downward force on the work piece which is again easy for a machining situation involving lot of fixture design etc.

So in this case the fixture design cost is not by significant because already there is a down downdraft on the downward pressure on the work piece because of the relative orientation of the tools with to the work piece.

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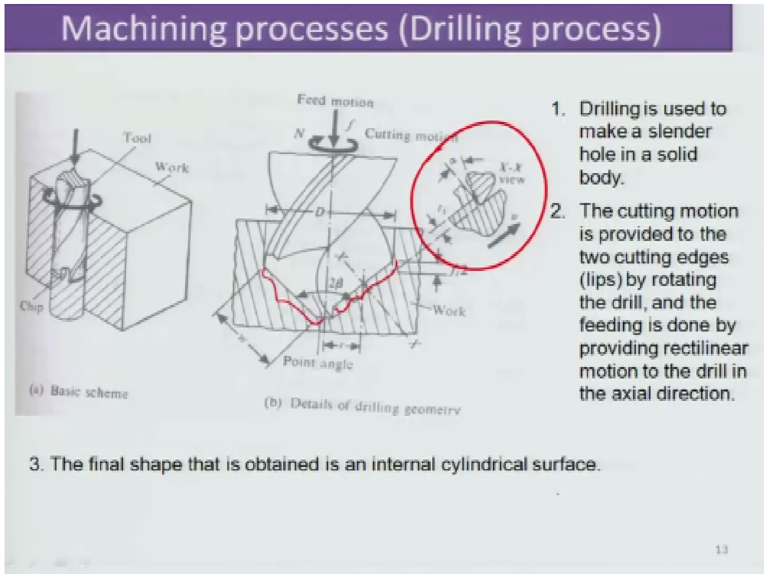

Having said that, let us now actually start looking into the mechanist aspects of drilling. In this particular case as well you can see that there is a peeling motion which is happening here by the two edges at the end of the drilling cutter and there a peeling action happening as you can see which is similar to that is happening to all the other different processes like milling or lathe or shaping, planning etc. in the same peeling action.

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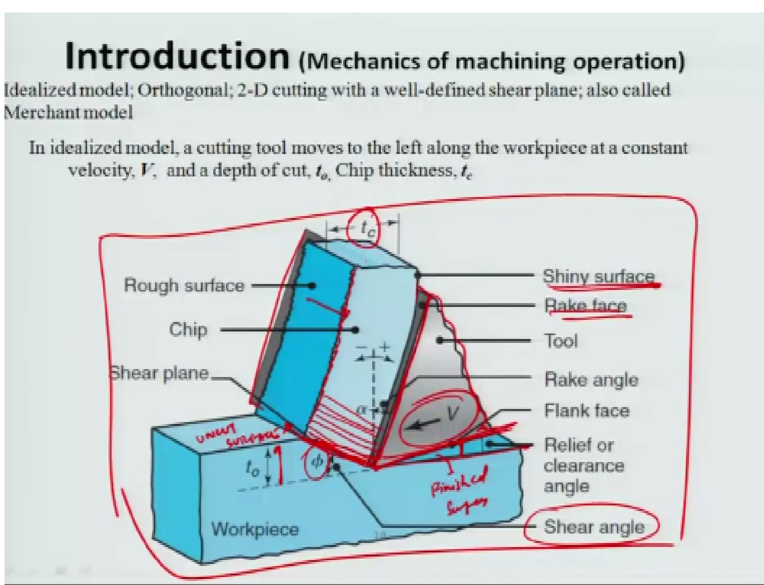

So let us now finally get into studying of this peeling action which is going on here right about expressed in this particular figure. So this is the uncut surface and you have a tool point or a tool tip which is actually a single point tip though, but then there is a cutting edge which is associated with this. And it moves with respect to the work piece in directional which are parallel to the direction of the movement of the work piece.

So the tool is in the same is in the direction parallel to the work piece, this in fact is the tool edge which is performing the cutting action. And this is the part of the tool here again and you have motion or velocity of the tool V be chipping action which been to happen this is of course a chip is being formulated. So the upper surface of chip is rough surface because of you can think of it that the tool actually tries to removed the metal of the pack of cards.

And it tries to create different sections where there are some kind of inter layers assessed we can generated because of which there is a jaggedness on the top of this chips which is being created here as you can see. And the bottom surface remains planer because it goes more so with respect to the face of the tool and so it leaves the shiny surface on the surface of the chip. So the angle at which this chip comes off the surface is known as the rack angle.

And simultaneously the face of the tool which face of the tool which rack face the chip is known as the rack face. And you have the other side of the tool which is also sort of overriding the finished surface which you can see right here this is the finished machined or finished surface of the particular drilling operation or machining operation. So here you can see that the angle which is formulated between the face here and the surface this is normally known as the relief or clearance angle.

Because if the angle is zero when peel would rub on the surface of the finished material at that would spoil the quality of surface finished related to machine you have also shear angle which basically is made by this shear plane at the central distance of time where the shearing action is happening. And is if the push of the tool is found to remove this out in this particular direction because the tool is not moving in certain relative motion respect to the work piece.

So there is going to be always angle formulated at certain angle which is probably later or less going to be the angle corresponding to the minimum power consumption for the tool and that lead to formulation of this shear. So you have the uncut thickness which is actually the area which is graced away or graced off as a chip and then there is a cut chip thickness which the t_c value here which is actually the final thickness after deformation etc of the chip that takes place on it.

And having clearly illustrated all this different parameters let us now play around the little bit with the different angle and geometries and forces that are associated with respect to machining process.

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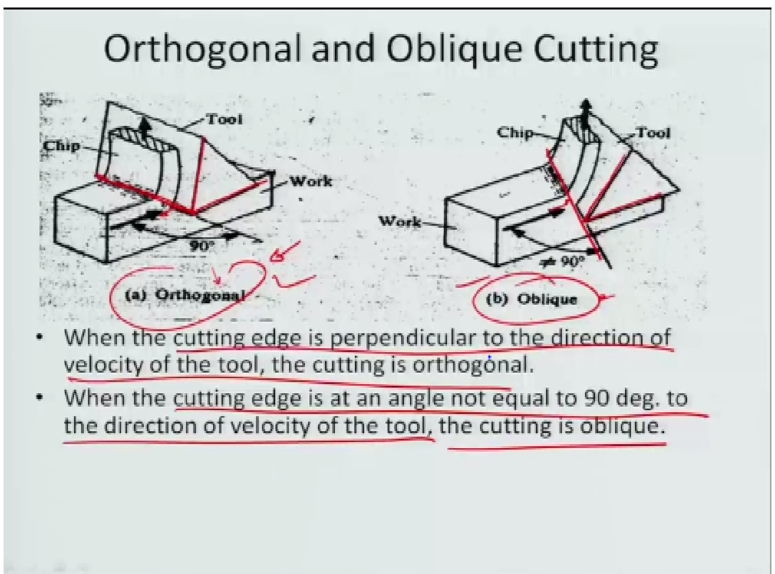

But before doing so I would just like to again sort of categorized this process as a orthogonal or oblique cutting process, when the orthogonal process is typically cutting edges is perpendicular to the direction of velocity of the tool you can see here, the cutting is exactly perpendicular to the direction of the tool motion which is actually this case I will be shown as a direction of work piece motion though.

But the tool motion can be thought of relatively moving against the direction in the work piece is moving. So in this particular direction in this tool is exactly perpendicular if it is not perpendicular as you can see here for example, the tool is moving in the oblique manner or with respect to the work piece, the work piece is moving in the straight direction here but the tool is moving in the certain angle so these are known as oblique cutting.

So when the cutting is at the angle not equal to 90° to the direction of the velocity of the tool the cutting is oblique cutting. So these two theorizations are completely different we are going to now consider the orthogonal cutting action.

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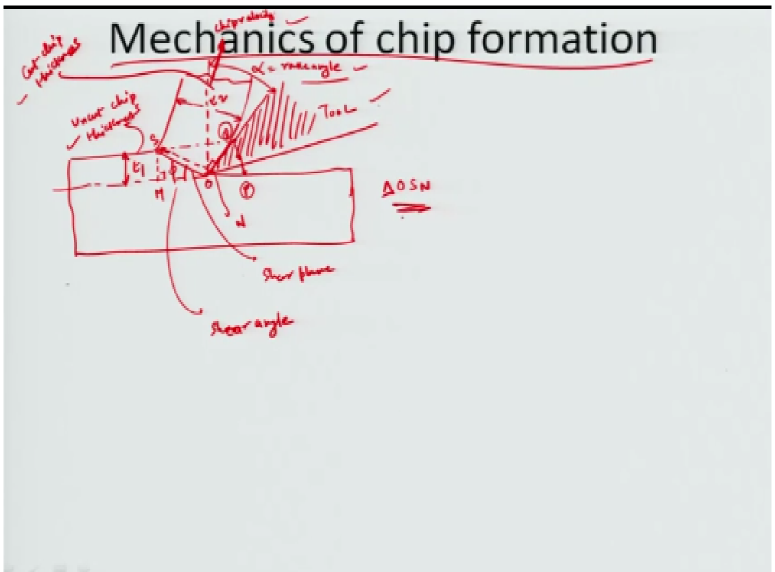

And if time permits we will do some oblique angle but by largely will focus on to this orthogonal cutting operations related to mostly used form of cutting within the industry. So let us look at the geometry aspects of how chip gets formulated. So you have a work piece here and you have a chipping process which happens in this particular zone right about here, due to which there is a formulation of finished surface which comes up.

And let us say there is a tool that I have produced here as shown by the shaded region. And obviously this tool is at an angle with respect to the perpendicular drawn at this particular chip work piece tool interface. So this angle is really the angle that the tools rake face which respect to the perpendicular and I called this angle as α, I think I have just illustrated in the earlier diagram how this rick angel or rich face can be defined.

And obviously you have a certain direction of the chip velocity which is actually the chip is moving in this direction. So I would say that the chip velocity is also in the direction of movement of the chip. And if I really take the thickness of the cut and uncut surfaces here I would extend this particular plane all the way backwards to find out what is this thickness, let us call it t_1 which is actually in this case the uncut chip thickness.

And I would now utilize this particular thickness right about here which I called the cut chip thickness t_2 okay, so this is the cut chip thickness. So having said that now you have various parameters like the uncut chip thickness, the cut thickness, the rate angle, the chip velocity, the tool so on so forth. And obviously there is this plane formulated here, which is also known as the shear plane okay.

And the angle that is they are in turn basically the shear angle, so this is the shear angle. And I would just draw a small perpendicular from this particular point here which are called S okay, which is beyond of the zone which formulation taking place. Let us this point be O, and let us call this point M. And then if I just move the perpendicular from the point S to the tool surface I call there are two points which are keep one is on the chip itself which I call the point Q, the other one is on the tool surface which I call P okay.

So we also drop another perpendicular to this tool surface right about here I this particular case. So we have one perpendicular on the axis, one perpendicular here starting from the zone where we the formulation ends on the work piece surface all the way to the tool surface, and then there is another perpendicular you want to just make on the top of the tool surface right about here from S.

And we call this point of intersection N on the tool surface, so this point right here is called N. So we have a perpendicular here on this particular tool surface, having said that now, if I look at the triangle OSN yeah.

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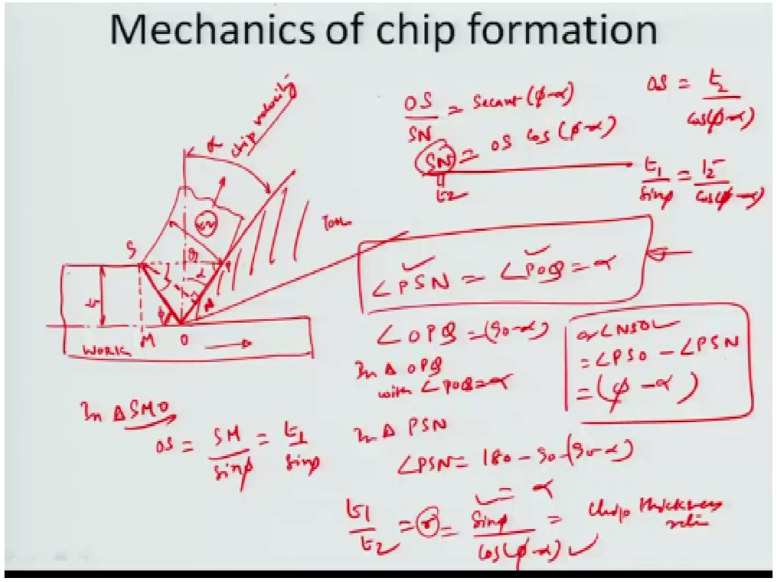

So I will just relate the figure a little bit or the sake of understanding. So you see then again the same point SONP and Q is now this point is here right about here, right about here is the vertical intersecting with the perpendicular projection of the point S on to the tool surface okay. And the shear angle here is Φ for example, this is N point where the perpendicular form has tool surface again and that is how the geometry is okay.

So if we do again the various geometrical constructions here the angle PSN which is actually, this angle right about here should be equal to the angle POQ which is actually this angle right here is α. The reason being that if I have to angle OPQ, the angle OPQ in triangle again OPQ with angle P or Q equal to α should be equal to (90-α), and with the same angle (90-α) if I look into triangle PSN which is also an right angle.

$$\angle PSN = \angle POQ = \alpha$$
$$\angle NSO = \angle PSO - \angle PSN = \varnothing - \alpha$$

The angle PSN should be equal to again 180°- (90+α), so angle PSN should be equal to 180-90-(90-α) it should be actually equal to α okay. So we have this angle PSN and angle POQ be equal be equal to α or angle NSO which is actually equal to the angle right about here should be equal to the angle PSO minus the angle PSN. And angle PSO is nothing but ϕ because these are alternate angles and they are equal to each other.

So ϕ-angle PSN it is actually equal to α in this particular case is the angle NSO. So having said that now I have two formulations here one talks about angle PSN, angle POQ and other talks about NSO. Now if I were to see the length OS divided by the length SN it should be equal to the secant of (ϕ-α). Or in other words the value SN here which is actually represented by this particular length here should be equal to OS cos (ϕ-α).

$$OS = \frac{SN}{\cos(\varnothing - \alpha)} = \frac{t_2}{\cos(\varnothing - \alpha)} = \frac{SM}{\sin\varnothing} = \frac{t_1}{\sin\varnothing}$$

So the evaluation is actually equal to t_2 if I may just recall this t_2 and this S and R parallel to each other and therefore I can say that OS becomes equal to t_2 / cos (ϕ-α). Further the triangle it proves the one of its sides is hypotenuse, and I can represent OS here from the triangle to be equal to SM/sinϕ. So therefore this SM/sinϕ further would mean t_1 /sinϕ. Thus, we have an expression t_1 / sinϕ is equal to t_2 /cos (ϕ-α).

$$\frac{t_1}{t_2} = \frac{\sin\varnothing}{\cos(\varnothing - \alpha)} = r$$

$$\tan\varnothing = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

Or in other words t_1/ t_2 which is actually a very, very important component also known as chip thickness ratio is defined now sinϕ/cos(ϕ-α). So we are going to do this take use of its time to close this particular module. In the next module we will try to go actually go head and see how this thickness ratio would be able to define the shear stresses and strain which are needed to make this chipping process happen, thank you so much.

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