Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title

Manufacturing Process Technology –part-2

Module 45
Rolling Processes

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Hello and welcome to the manufacturing process technology part 2 module 45.

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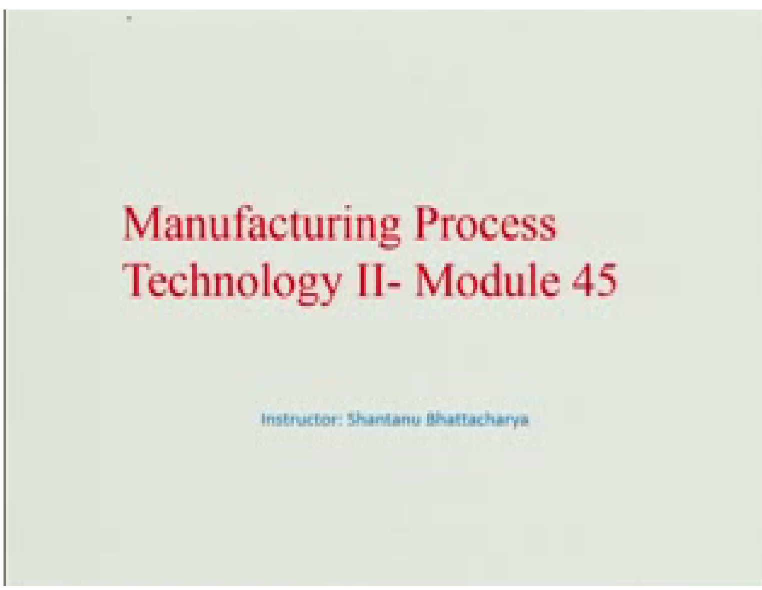

We were taking about the rolling operation and in the context of that we have started that in the mechanic in the module.

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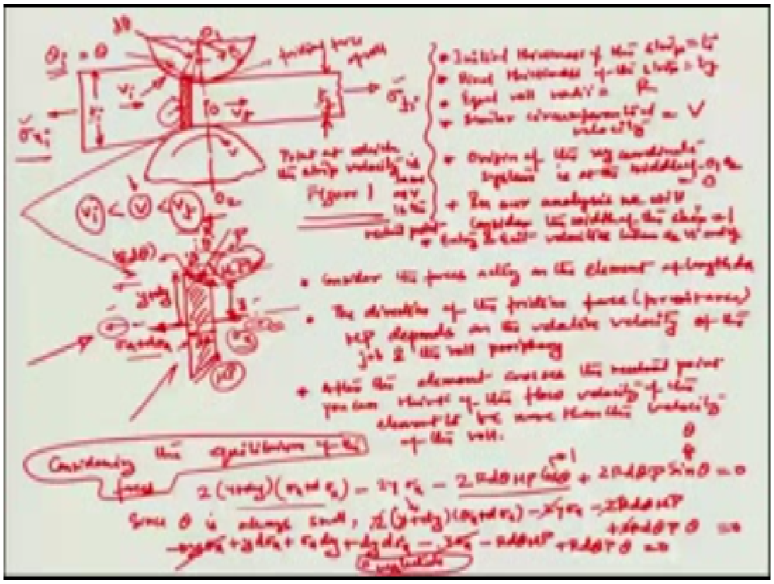

For the rolling process that in we were starting within the initial technology intensity high the resulting in the and the thickness p and we assume that there was no lead of the of the definition consideration along the plane outside the paper so there is nothing in the Y direction and in the X direction we are considering here and we have also furthered describe the process in the certain state process which would be applied the heat and the Σ Y X Y and the Σ X F roll pressure on the friction.

If the roll in the summation which would enable in the forward direction we also talked about the neutral point you know we were which would be corresponding in the accuracy in the = to the velocity that would be really in the instead were it would be the metal and it come out in the same velocity and the roll and there will be the prating and then greater than V is greater than the V I because obviously really the velocity and the design.

The velocity which is because the initial velocity V I and so V F is going to be velocity and the initial velocity and the deformation and it could be and the greater than the V and then greater than the V I also they would also light to now some of the consider and the element right here that I mention about the state of the stresses and that of the element of the various pressure etc.
Which execute and if I want to draw this half the element would actually look something like this destroyed level are appropriately and her the quantum of the spaces that would applied along the axial centre and the element is basically one stress Σ X okay and obviously this towards the final thickness side and there is and the other stress exactly in the opposite direction

and the Σ X +Δ Σ Xw2hich enables a or which is enable because of the reaction forces given by the row on the to the heat.

And because the rows are you have to remember and the lower separation and the comparison and the heat and definitely pull out and the thick sheet which is going to be fended unless on the roll and there is the additional friction and the forces and so because of the and the pressure of the roll which is actually perpendicular to the direction of the element this is the roll pressure that is the angle.

Let say which is determine by the again the you know the angle of the corresponding to the how the element is placed d and the element is ready of the roll and call as the angle in the certain of the time behind the Q obviously the whole angle which actually which is the initially certain thing in the let us say and three element and the rolling process should be the one in the continuity and the one in the certain that will be equal to the o and the particular instead the one of the roll that makes with the initial.

it will be the 0 and that will be assume in the Q and the Q I so let assume that is the particular in the drawn here and the element which is shown in and it has and the angle Q which makes and the radius of the roll and this is the point of the right about here and that in j the centre of the particular element in the respected here and the roll pressure is the p and there q will be the frictional and the effect and that will be play a round and call this is the frictional effect.

Which is actually per unit area and the pressure and that will be the force in the are and that will be applied and because of the roll and that will be the one of the that will be the such forces in the both direction which are going to enable in the keep move forward as the N of the frictional forces that will be imitated and the both side4 of the small element we further assume that the element has the portage thickness.
So basically from the neutral X and that will be the thickness of the Y which is the spread in the B X and so on the one side you know the other side her the and the dimension right here and that will be the Y +D Y as the thickness of the element happens to be the X and that is the so you just clearly here and the X and the dimension on the both sides of the rolling element are Y.

T is the element the forces acting on the element of the length the X having the forces and the balance so there are certain aspect it will consider here the first aspect that I would like to consider that is the direction of the friction forces which is represent in the P forces is presented by the P is as the power the unit area in the carrier depends on the relative velocity.

And the join and the role preferable and that is the really looked at the region right here in the rolling operation in the role is contact surface and the reliving surface as a head we can assume that in the positive absently the flow of the material and that is the moment there is a there is the crossover of the certain point over the you know neutral

And that is the rolling process okay basically what I am trying to say that after the element crosses the neutral point you have the to think of the flow velocity of the element to be more than the velocity of the roll so other words the friction is enable pried to be the neutral point and now it is disabler for the pushing process so that is the friction that would actually before the neutral point and the flow in the direction now of the higher velocity of the small element after it is crossed to the neutral point.

Would be lower element it will be move forward there is the change in the direction and the frictional force whenever the such and the element cross the neutral point this is the important point that we have to realize at this is time to and we have to also be the modeling and the manner so that up to the neutral point that is friction is shown on the tabular for the rolling process should be happen we have the neutral point is shown in the disabler or the direction of the frictional force should change from the element for the rolling process should be excited

So now look at the cross over point and what is going to be in the quantum of the forces and that will be the forces and that will be the after so let us now do the total amount of the forces let say in the quantum of the forces particular element right here considering of y the forces so we consider the equilibrium of the forces which are felt by the element right here so we have if we consider unit we consider the thick ness of the element to be unity.

So therefore this is the forces in the either direction of the element the higher thickness and the lower thickness so let us actually look at this is the force here we have twice Y + T Y and the width of the particular in the friction area interfacial area of the right we have the times and that will be okay in the right in the forces time berceuse of the reaction of the holes and that will be the ability of that gap it actually towards this direction.

And this is the direction of the arrow and that is the Σ so that is the nebular is the rolling process in the direction of the arrow first direction of the arrow and then you have obviously the frictional forces and the quantum of the which is find through the enabling the rolling we have the if triangle as we see here and that is the arc we say and that is assume to be in the curved arc and the linear portion of the whole R can be near portion.

And the front direction of the Q so we have the COS direction and the faces you are contributing forces and the frictional forces and the surfaces you had twice and the R B Q is the area of the differential forces in the multiplying with the total amount you have the frictional forces which is E p times of the remember this is the frictional forces at the direction which is at a you know I think in the incomparasion in the direction that is at the 90 – Q if I want to and also If I look at and the right here.

And that is the actually the Q you have to trying to twice there V QU P cos of the Q okay which is in the direction of the inability forces and then obviously you have the role pressure there is the direction of the component and that is the disability forces in the cases that in the comport of the P which is the angle of the 90_Q to the horizontal axis here going to be pushing in the strict out therefore this is going to be + are B Q time of the one off course length time of width is the area and the length of the width is basically unity okay.

Times of p sin (θ) cos (90-θ) so that is going to be equal to 0 always a you know we assume θ to be very small so since the θ is always small we can neglect some of the thing sphere for example of a θ can be approximated of 1 and sin (θ) can be approximated as θ itself very small number and if I wanted to change this equation is based on this assumption we have 2y+y times of σ x+dσx okay –yσ-2dθ et +2Rdθ times of θ should be equal to 0.

So therefore we can substitute we can basically multiply these terms and the formulation has given here there is a two collision which we can divided this stage because of obviously is greater to 0 okay so the 2 can rid of so we have cancellation here this the term which very small dy dσx we can neglect and we are actually left with very simplistic.

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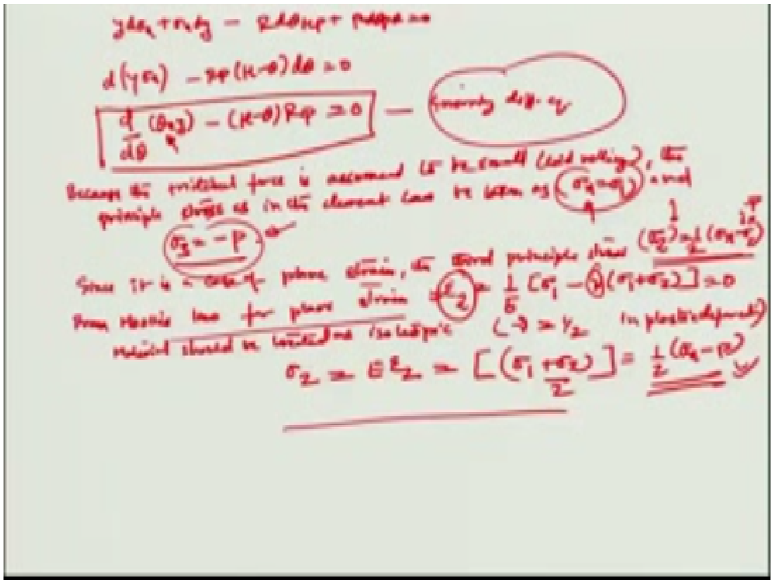

Ydσx +σxdy -2Rdθ pθ should be equal to 0 in other words I can write this is dyσx okay –Rp can be sorry this 2 Already eliminated so this just note this 2 here so we have –Rp(μ-θ)dθ =0 or in other words if we rearrange this can be in a efficient format the equation can be d/dθ(σxy)- (μ-R) or a (μ-θ)Rp=0 so this is going to be final formulation governing differential equation for this process okay. Now because the frictional force is assumed to be small particularly true for called rolling you know high tempered process is may have variation in fiction going to bud and cold rolling can be considered to be a ks were detection forces are relatively constant over time.

So the principle stresses in the element can be taken as σx=σ1 okay and obviously σ3 which is another principles in this case basically in the negative of the role pressure of the compressor to the role as on the element okay. So since of the case of planes constrains and we can find out from hooks law of planes strain the $\in_2$ in the direction of the width okay so are the third principle stress is σ2 okay is ½ of σx=σz(σ1-σ2) in this particular case okay.

So this one kind of labels are direct relationship between σx and p we have for a planes strain case how this is been arrive that the strain in the second direction of σ you know y direction in this particular case I am sorry this can be σ2 and this is obviously the we can say z actually okay. We that is how be having assuming all the stress criterion etc before this is σ2 okay. So write this down that will write σ2.

So the e2∈2 can be recorded as 1/e form hooks law 1/e(σ1-ν(σ1+σ3) because of the plane strain problem we do not assume in the significant designation in the width direction and other words the string along the in this stages of $\in 2$ sorry in the you can say the y direction $\in 2$ is given by 1/e $(\sigma 1-\mu)\sigma 1+\sigma 3$ further this have assume that the beginning of all the forming process that the material should be mostly twist dice the tropic of nature material should be treated for simplicity says isotropically in nature.

So I can easily estimate the ν are the plastic designation as to be ½ in this particular case in plastic designation so if I wanted to be substitute this value of1/2 here I would automatically be in able to have $\sigma 2$ which is actually equal to $E\in 2$ to be equal to actually $(\sigma 1+\sigma 2/2)$ and I already have in able to told you that is the compressor pressure along the z direction $\sigma 3$-p in this particular case some σx which is the linear expansive direction were all the material goes into a $\sigma x=\sigma 1$.

So we can actually called the you know whole the term as ½ of this $\sigma x-\sigma 2=\sigma z$ so σz is basically you know p right –p okay to be equal to $\sigma 2$ becomes equal to in this case ½ $(\sigma x—p)$ so we will now try to apply this expression for $\sigma 2$ that we have just obtain and also try to play around with the criteria on the in criteria to estimate what is going to be a relationship between the k value the pressure the $\sigma 1$ value and the σx value and then based on that we can estimate the σx which we can put in this particular expression by here.

We will try to close this module here but in the next module we will try to further estimate the final formulation of the governed differential equation based on be planes strain assumption and try to modify short ably using in criteria so we that like we end this particular module thank you very much for viewing me thank you.

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