Principles of Metal Forming Technology

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Lecture – 37
Steel metal operations – I

Welcome to the lecture on Sheet metal operations, that is the first part of this lecture will be regarding few operations then in the next lecture we will be discussing about the remaining sheet metal operations. So in this lecture we are going to have the introduction about the sheet metal operations and as you know that in sheet metal forming shape is produced from a flat blank by stretching and sinking the dimensions of all its volume elements in 3 mutually perpendicular principle directions.

So, sheet metal operations basically that that is also under the category of fabrication operations, so in that you have normally a stock material is in a in the form of sheet and they are basically having small thickness. And you have to finally, give a shape like you have many type of operations which are carried out using the die and punch and may be by using the shearing operations or by bending operations by stretching operations and all that. So here the thing is that you have normally a die and a punch.

You have a punch which will be coming and you have the dies in that sense and then they are coming and then you know pressing the sheets metal ah; you know metal sheets and then they are deforming it may be because of the different you know types of stresses which you know are generated, because of the reaction of the or because reaction and reaction of the you know punch which is falling up on the sheet.

So, you will have the different operations going on, now they are classified based on many you know like you have it may based on type of stresses induced that is specific operations ah. Then you have shape of the parts produced, what type of shape you are you know producing or it may be based on this severity of the forming operations.

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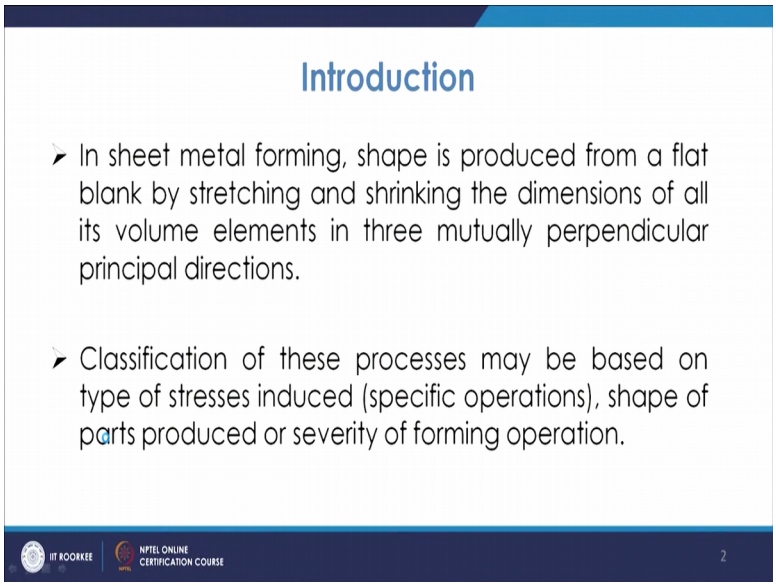

So as we know that you have you know when we talk about the severity of forming operations, so that is based on the maximum amount of bending and stretching that can be carried out or we also do on what type products we are making like that is done in the case of automotive components. So as we see that normally you have the forming is normally carried out in the plane of the sheet by tensile forces.

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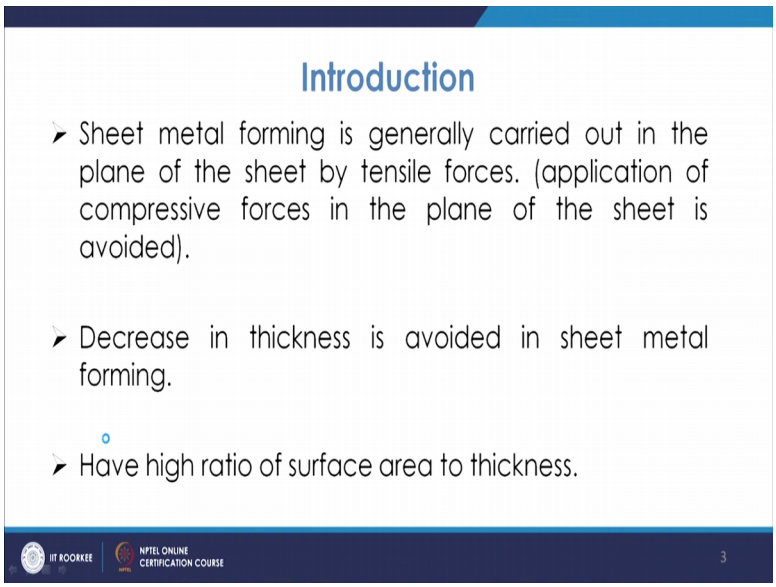

Now, in the case of the sheet metal your you know the sheet is subjected to the tensile you know forces and that is that basically does the you know deformation of in the sheet.

So normally we avoid these compressive forces because that may tend it to the buckling of the sheets, so we are not you know deforming the material under compressive force basically we are applying the you know force is such a manner that sheet is under the tensile force and then it is subjected to deformation..

So decrease in thickness is normal avoided in the case of sheet metal forming and another vary characteristic of this sheet metal operations is that; you have high ration of surface area to thickness in these operations as compared to the conventional the metal forming operations.

So, depending upon the type of parts which you are making in the case of sheet metal operations you can have you can (Refer Time: 04:44) curved parts, you may have simple type of you know shapes, you have single curves parts or you may have suppose the contoured flanges that may be also there in the case of the sheet metal operations, so you have the shrink flanges or you have the stretch flanges that can be also there.

Ah Then you have also you may have the curve sections, you may have the deep resist part, you may have the shallow resist part, so that way you have the variety of objects which can be basically obtained. So based on the type of parts you are producing you may have the different kinds of you know parts, so based on that also you can have these operations like you may have the singly curved parts.

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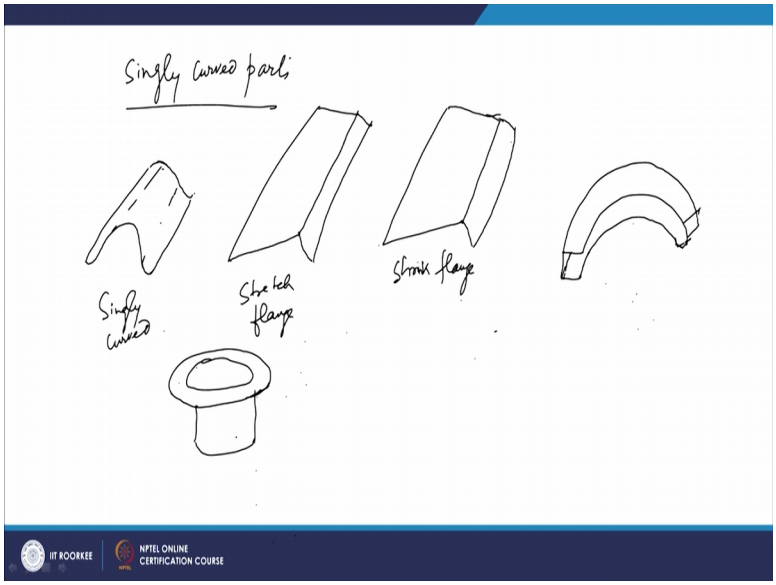

So, if you have singly curved parts so the part structure may be something like you have something like this and then that also so this way you have such kind of you know; so you have such kind of you know parts.

So that way so this type part which is produced they are under the category of singly curved parts. Similarly you may have the part which is that you know stretch flange or you have shrink flange, so that basically will be coming like when you have some constructions like this way and then if it is stretching. So such kind of parts they are basically coming under the you know stretch flange type of parts.

So, so this way so this kind of which where if you look at this sheet and this sheet, so this stress in that sense they are under the category of stretch flange type of parts. Similarly you may have the similar you know part which is there, but in this case you have you know such kind of so appearance, so you have this and further you have so you will have this kind of you know appearance. So that is known as the sink flange, so here you this you can say you can see that it is stressed outward and here it is stressed inward so that is shrunk in that direction that is known as the shrink flange type of you know structures.

You may have the curved section so you have this is singly curved then you have this as stretched flange, similarly you have this as this shrink flange you may have the curved part so you have curved sections and curved sections will look like you have this way and then you will have the this curve sections like this and then further from here also you will have this as the curved sections and in this side also you will it will go like this and from here you have these also as the curve section. So that will be the indicative of these curve section, so this way you will have such section can be produced they are under the curve section parts. Similarly you have also deep drawn cup so you have a cup which is deep drawn.

So, you may have some kind of cup which is there and then you have its you know the such kind of you know geometry that is known as the deep drawn cups. So this is something like curve section this is known as the deep drawn cup, similarly you have also some bigger section so you will have certain type of impressions at the top surface. So this way you get the different types of you know products which can be made by the sheet metal operations.

Now, coming to the further you have mostly high production volume aheet metal forming is done on the mechanical or hydraulic given pressure, so it will be single or double or triple acting pressures you have punch and die which is normally used which are they are mounted permanently in the sub press or a die set and you have basically progressive forming that; that means, that you have successive stages in forming of part are carried out in the same die on that each stroke of the press.

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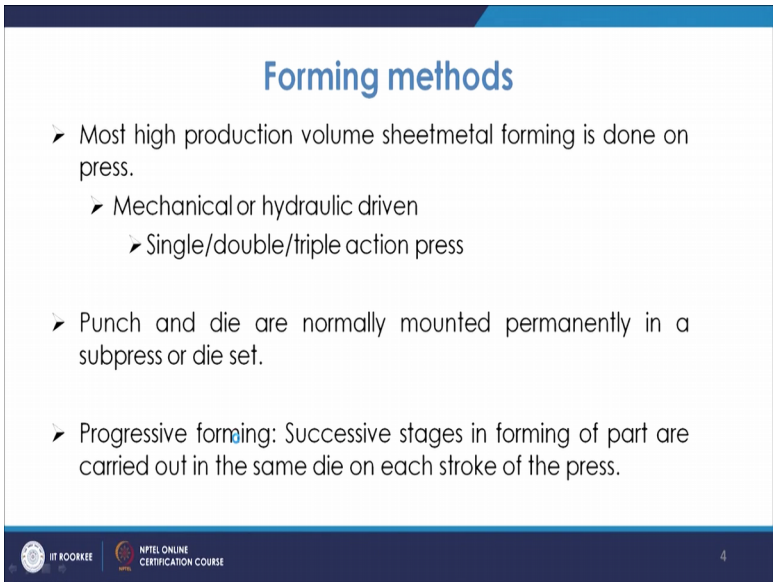

So that way you have progressive forming mostly when we go for the punching or sharing operations, so that comes under this kind of operations so that is under the progressive forming. So when the sample of the progressive forming as we discussed is this piercing and you have the blanking operations as we see, so this is a kind of punch which will be coming and it will be this is die basically.

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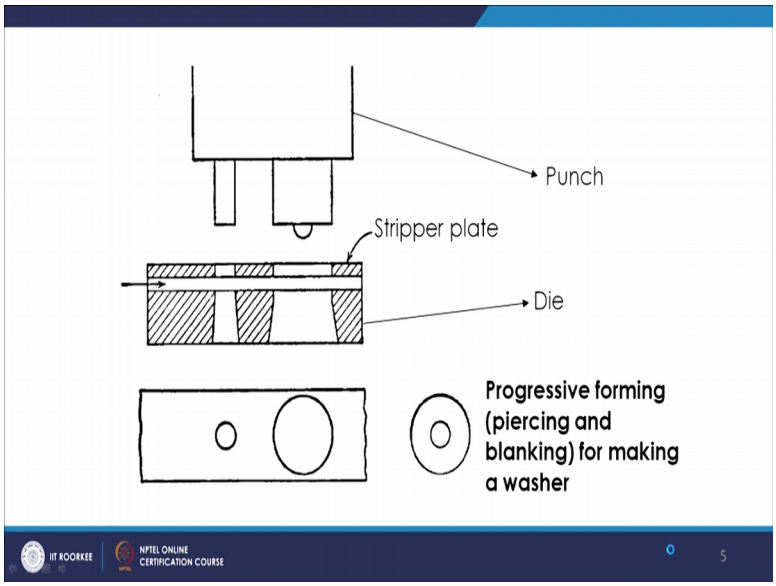

So, it will be coming and then it will be doing this you know making that part as a whole and this way you have these you know making of the washer in this part, so this is a example of the progressive forming.

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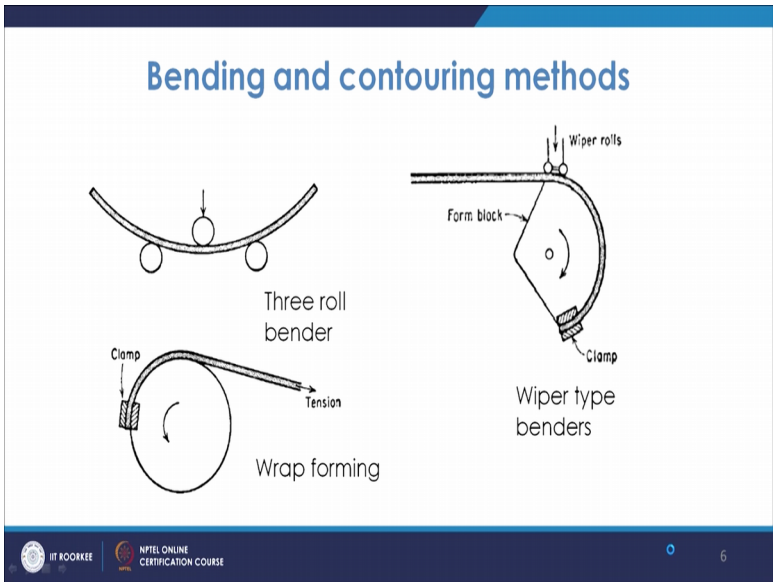

As we are discussing about the different types of you know bending and contouring methods so that is also a type of you know operation that is simple metal operation here you have you can show see that here you use the 3 roll bender similarly you have the example of the you know wrap forming. So here you have a clamp and then you are you

know applying the tensile force, so it will be rotating that way so it will be stretched and that is also you have and basically that is bent in the that form.

So, you have also in this case you have the wiper type of benders which bend you know so you have wiper rolls and this is a form block, so they accordingly they will make that bend in a particular you know shape. Now while dealing with the sheet metal operations we need to also know the behaviour of the material and in that case what happens that you need to be also giving certain allowance or certain consideration for the spring back effect because the material once it is deformed and when it is relieved, so because of that relieving of the energy. So there is a elastic whole plastic deformation also elastic plus plastic deformation so elastic part is some elastic part is further trying to regain.

So, there will be some spring back so that allowance also has to be taken and that part is to be considered while dealing with these you know operations on the you know sheet metals. Now type talking about the principle of operations which are there on the press working.

So, as we are discussing that you have before that we must know how to classify based on what kind of stresses are there and based on that stresses what how the you know different processes are classified so the classification is based on the like this. So if you have the stresses involved and if you have the operations then you may have different kinds of a stresses and if you have the sharing stress, so based on this sharing stress you may have different types of metal you know the sheet metal operations and on the basis of sharing stress you have operations like shearing, then you have blanking, you have piercing and you also call it as punching.

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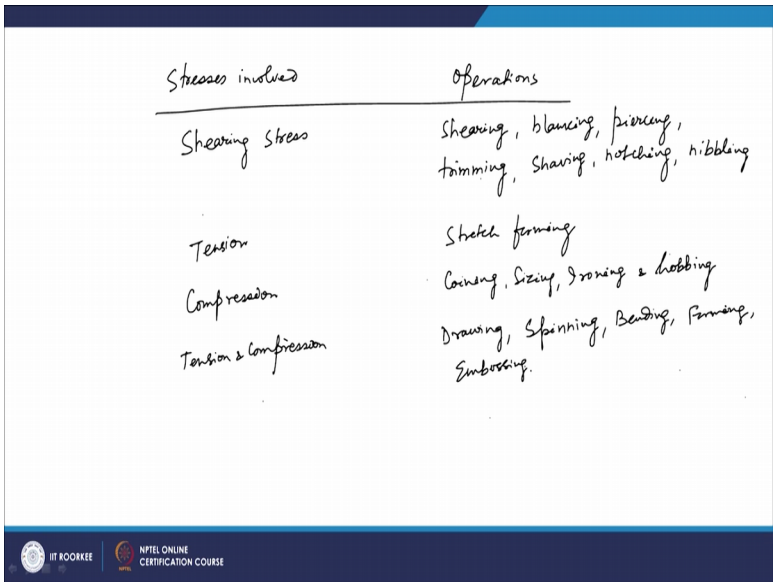

Then you have trimming, shaving, notching and nibbling. So these are the methods which are discussed one by one and is in this operations basically the shearing stress involved and because of the shearing action sharing stress involved, these operations are being carried out similarly we use the tension you know tensile stresses.

So, you apply the tensile force and in that category we have stretch forming. Then you may have the compression also, so using that compression stress or compression force completely you have some operation like coining, sizing, ironing and hobbling. So this is these are the methods these are the operations which are based on the compression stresses.

Then based on the tensile and compression both you have methods like drawing, spinning, bending, forming, embossing. So these are the different types of operations which are done on the you know sheet metals and these are the typically stresses which are you know involved for doing that you know on the sheet metal.

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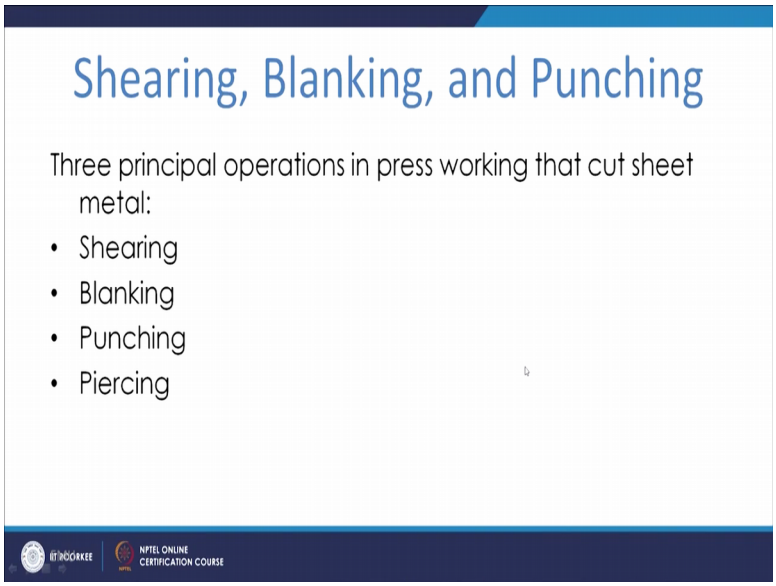

So, coming to the you know so when we talk about the shearing, blanking and punching. Now, what is there in such cases what happens in these methods so what we see that these are the principle operations which are done sharing, blanking, punching and piercing. Now what happens in normally in that so if you look at these shearing of this sheet metal between the two cutting edges so here this is the punch and this is the die and this is the sheet of certain thickness and this sheet will be you know as punch is being applied so punch is descending downward.

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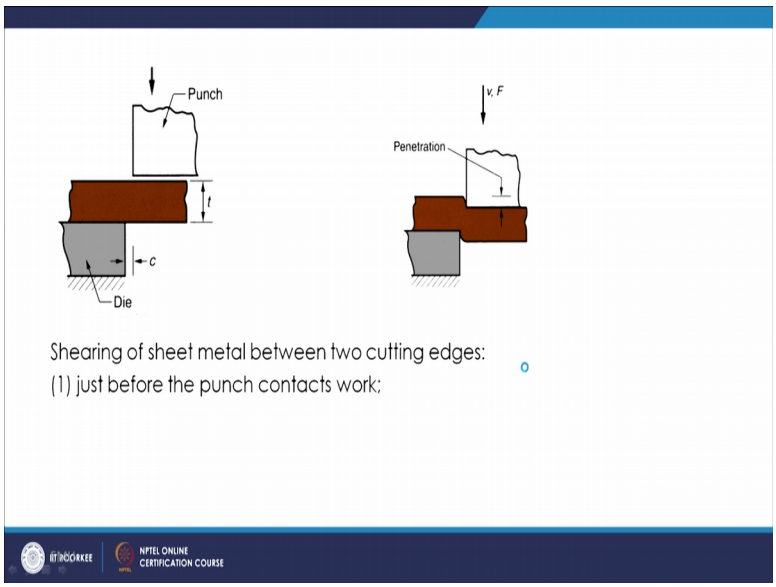

So, at this place there will be deformation at this way, at this place there will be you know so there will be trying to deform and ultimately you will have a penetration here and then ultimately the material fails and then it will be cut. So basically you have this given as the clearance and the fracture occurs you know in this zone, in this zone the fracture occurs and this will be shared slug.

So, this is coming out finally, now what happens that if you analyze so just before the punch works here it will be basically just before that punch works here and once you have the punch with certain velocity and the force then this you know it will be so here what happens that at the you know top portion basically here you will have this sheet will be subjected to some tensile and here you will have the you know compressive type of a stress which is developed on this part and here also you will have a you know compressive type of a you know stress, which is developed and because of that the earlier takes place in such cases.

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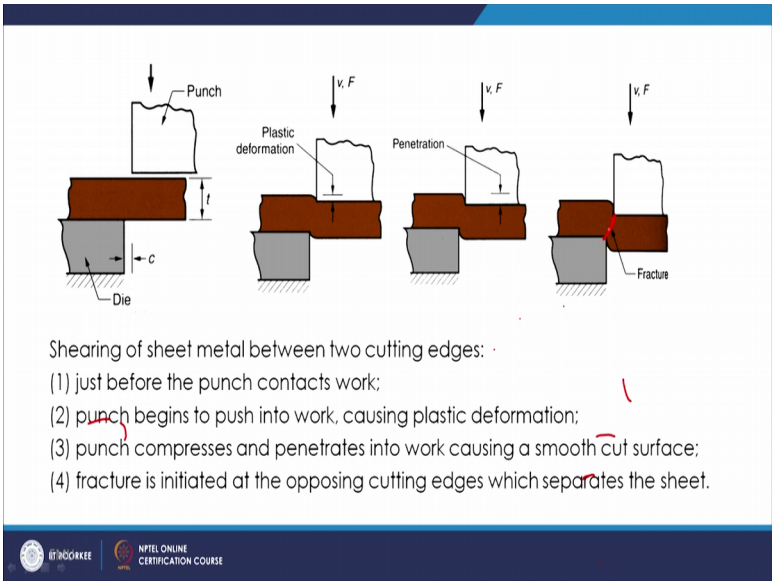

So just before the punch you know, so first is that now you look at the things how it proceeds so before the punch will be moving.

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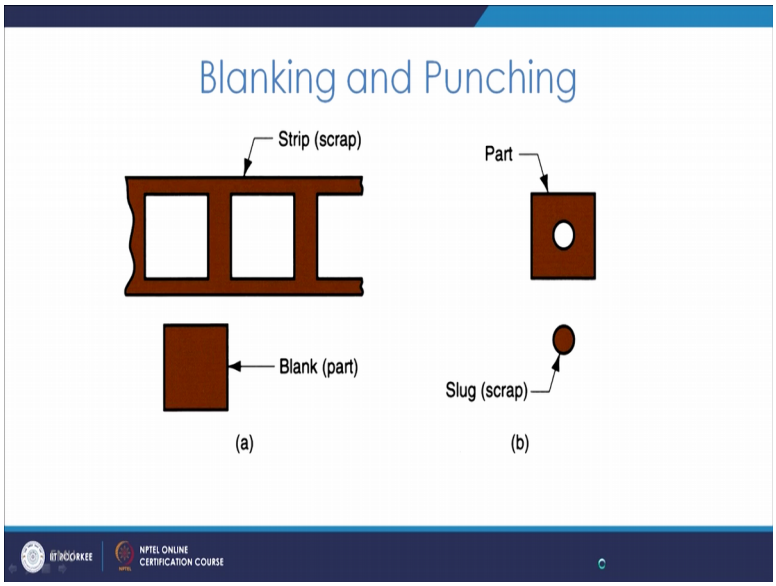

Now, here so just before the punch contacts work this is the you know this is the situation where the punch is trying to touch the work piece then the punch will be trying to push the push in to the works so that will be causing the plastic deformation.

Then after that the punch will be compressed compressing and penetrating the into the work causing smooth basically it will be causing smooth cut surface here in this case it will be causing a smooth cut surface. And then finally, finally, what we see is that the fracture as we see that this fracture here, this fracture is initiated and at the opposite to cutting edges, so that way the material will be cut and the true part will be you know separated out.

So this way this you know shearing action will be taking place in the case of this operation. Now you have basically two operations there is one is blanking and the another is you know piercing so or punching. Now what happens that now in the case of blanking have blank is your motive, so when you talk about the blanking operation so in the case of blanking.

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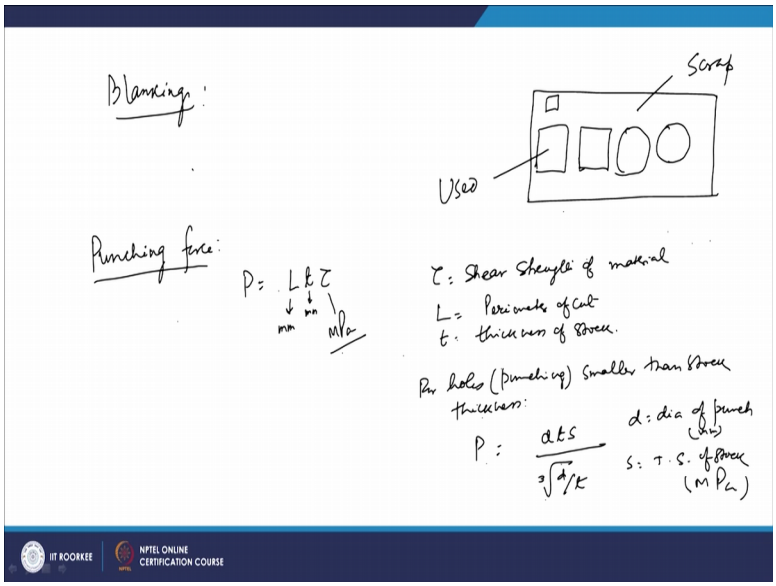

Now, in the case of blanking suppose you a sheet and in that basically you have to have a blank of certain sheet or you have a blank of certain shape, so basically when you use the punch this size of the blank is being cut and they are removed from the sheet. So then once you take such kind of you know blank from the different parts and then there may be you know all that so this part which is to be used and this part is the scrap.

So, that is the process of blanking, so as we see that in this that strip becomes the scrap and similarly when we talk about the punching. So it is basically making the whole in this sheet, so in that case in the case of blanking when you are taking the blank out this blank is going to be used further and the sheet which is there which has been blanked which has been pierced and that is of no use it becomes scraped whereas, when we talk about the punching or piercing. So in that case the sheet which is you know punched this becomes the part and the part which is coming out its of no use at that moment so that is becomes a scrap.

So, that is the blanking and punching kind of you know concept which is you know defined in the case of the sheet metal you know operations. Now what happens that in this case so in this case of punching you have this is the part and this becomes you know as a slug or a scrap which is not to be used that is the difference between the you know blanking and punching.

Now, in this case basically you have the shearing action involved and while in this punch descends down and then it will be in contact with that stock or sheet and then once it cuts then in that case there will be you know further the sheet which is there is elastic deformation.

So what happens that this stock basically coming inward and they will try to hold they will try to you know grip that you know punch, while the punch is coming upward. So that is why this clearance is provided may have the angular clearance also provided on this you know in the case of this punching or on the on the die basically.

And you have also you know the provision of having a stripper, so stripper is there so that you know the punch comes and it does not interfere further so the stoke is in becomes in contact with the punch and so that may lead to further the interfering of the process. So that is why the stripper is there and you require a certain force you know the stripper requires certain force and that stripper force will be you know portion of the perimeter of the that stock which is being cut and the thickness of the work and multiplied by I mean product of these two multiplied by a factor k. So that way this stripper force is also coming into picture in the case of is you know punching and blanking operations..

Now when we talk about the punching force so when we talk about punching force, so punching force calculation is also done and it the force is exerted by the punch so that it will be shear out the blank and from the stock. So that punching force it will be basically depending upon the area which is you know punched or the blanked and also the thickness of the material and share strength of the material.

So basically use the formula punching force will be P and that is given as l into t into tau. So this way we find the these value of the punching forces and this l is basically the you know perimeter of the work piece and then t is basically the thickness of the work piece and tau becomes the shear strength of the material. So L is the perimeter of the cut and t is the thickness of the stock.

So, L is perimeter of cut and t is thickness of stock. Now this way you get many a times this tau may be a function of the tensile strength of the material that may go as I as tensile strength of the material also and at many places may see that it will be 0.7 times the yield strength of the material multiplied by L t.

So, then may be such kind of you know expressions, when the when we are punching the you know wholes which are smaller than the cut thickness. So for wholes that is punching of wholes smaller than stock thickness so there has been some other kind of correlations or which is used.

So, p will be basically d t s upon cubic root of d by t, so basically in this case d is the diameter of the punch in mm and s is the tensile strength of the stock in megapascal. Now in this case also you have L is used in mm t is also used in mm and this is megapascal, so this tau is in the megapascal shear strength of the material. So that way you have to keep in mind the different types of different you know the correlations which are there, which is used in the case of the blanking and punching.

You have also other operations of the in the case of using this sharing stress forces or so other operations which are coming are like trimming.

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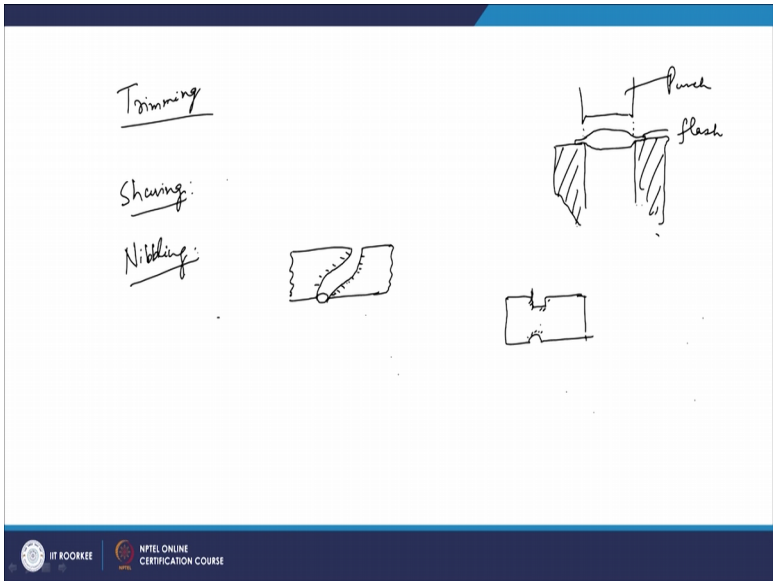

So, as we know that you know trimming is required for the force products where you have the flash found in the part in plane. So this flashes to be removed and in that case this flash are removed by the trimming operations, so in that case suppose you have force product.

So, normally these are your flashes in the case of the forced products and this part this is to be basically removed. So here from we will have the ha punch and this punch will be

you know like so this way you will have the punches it will be coming and it will be kept on the this die, so that there will be a you know die.

So and it will be basically cutting this so it will be going on the so this will be your bottom die and this is your punch and they will be coming and cutting so this process is also done using that sharing stresses involved ah.

Similarly, you have the shaving operation and this shaving operation is also one of the you know sheet metal operation and in that many a time you have the whole which are made in the internal you know portion of the whole which is made its not completely clean. So they are basically you know so there is no close tolerance. So for close tolerance whenever we do the blanking or punching, small burst are left and they are basically removed by these shaving operation.

And in that case you have those burst small burst which is left they will be removed and the next operation will be nibbling and in the case of nibbling what happens that sometimes you have the irregular type of specific contour is cut and in that the tool is you know the sheet you have to go for the you know punch repeatedly.

And you have to so when you have a specific type of a contour which is long and using the separate punch you know uneconomical in those cases you know we use, so what you do is normally you have such kind of contours are there in the sheets. So here you will have a nibbling tool and that is used for this forming operation.

So, the so the special type of a small punch so will be used and they will be repeatedly you know used a long that necessary you know contoured formation. So they will be used for making that specific type of profile, so it is when used when the contour is basically long and when you have to use the you know I mean using that separate punches average type will be unequal, that time you go for nibbling.

Similarly you have operation like notching, when you have to make a external notches then in that case we use these you know operations. So that way like this so this type of a operations when we make the notches in that so they are the example of the notching operation which is for cutting the specified small you know portion of metal towards the edge of the stock when we do, so that is known as the notching. So again as there you

have a punch it will come and cut certain part from the material. So this way you have these different kinds of the sheet metal operations in this lecture.

Thank you very much.