Manufacturing Process-I

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Module - 1
Lecture - 9
Sheet Metal Operations - 3

A welcome to all of you in this third particular lecture on Sheet Metal Operations 3, as you can see on your screens, the title of the lecture that is Sheet Metal Operations third session. We already had two sessions on sheet metal operations in which we discussed various sheet metal operations. We have already gone through some of the basic principles of sharing, notching, nibbling and lancing, piercing and then we discussed what sheet banding is, we have seen in detail. Then we started our discussion on drawing in the last lecture.

So, we have just initiated the discussion on drawing which will be carried forward in this particular session and then we will complete the drawing operation. We will see what is embossing, what is coining and then what the various types of die punch are, types of mechanisms or arrangements or machines that can be used for sheet metals operations. After that we will see what various ways are in which we can manufacture a die or what are the various operations for die manufacturing. Later on we will see what the die failures are, different types of die failures. So, initiating our discussion on sheet metal operations 3, carrying forward from wherever we left in the last lecture. We will discuss what the basic principle of drawing.

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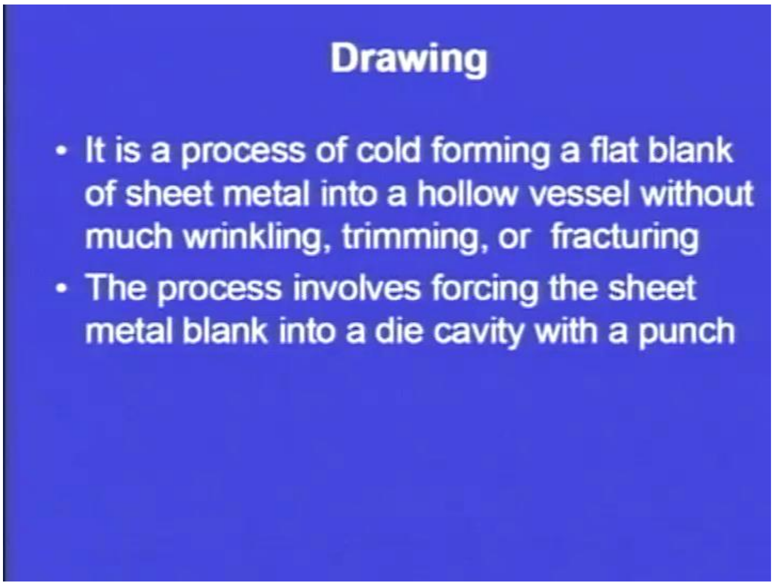

Now, this is the drawing operations. Drawing, it is the process of cold forming a flat blank of sheet metal into a hollow vessel without much wrinkling, trimming or fracturing. So, this we have discussed in detail that the limiting factor here is the wrinkling, trimming or fracturing. The process is a cold forming process, and the flat blank of sheet is converted into a vessel or into utensils or into any desired shape which is required. Then, the process involves forcing the sheet metal blank into a die cavity with a punch. So, again a punch and die arrangement will be used in order to convert the flat blank into the final shape. The final shape will depend upon the requirements, and the specification of the product that we are aiming for.

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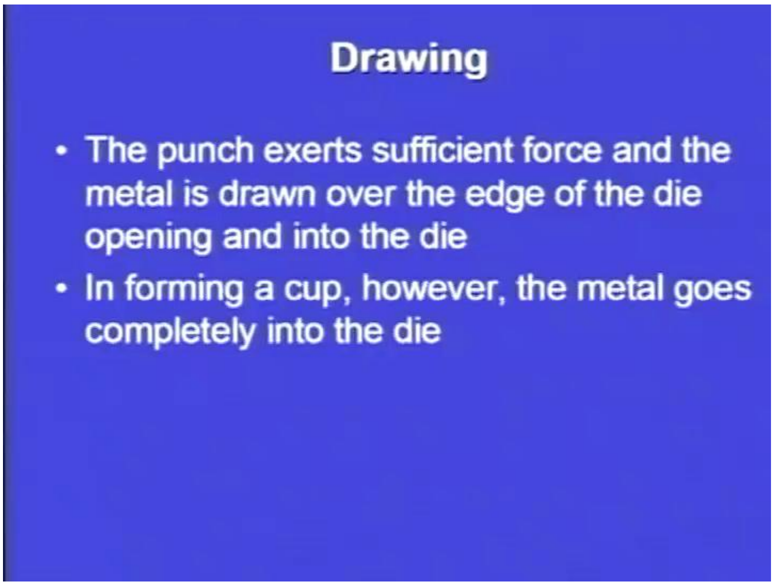

The punch here exerts sufficient force and the metal is drawn over the edge of the die opening and into the die. So, the punch will exert. Suppose this is the punch, this is the flat blank. So, the punch will come, and it will exert a force on the die blank which will go into the die cavity and form the die cavity. Now, the die cavity will be exact replica or may have certain geometrical features that we want to have in our final product. Sufficient force here means that the force should not exceed a particular limit. If the force exceeds a particular limit, there is every chance that the sheet may crack or some kind of fracture or catastrophic failure may take place. Moreover, the operation has to be done at a particular speed. If we are not maintaining the particular speed and there is an impact, then under that impact force of the punch, the sheet may crack.

So, there are number of limiting factors, number of process variables that have to be controlled in order to successfully draw a flat blank sheet in to a hollow vessel or into a required shape. For example, in forming a cup, the metal goes completely into the die. So, forming operations are important operation out of which drawing is also one of the most important operations, and now we are discussing the drawing operations.

Till now we have seen what the drawing operation is, and there is a punch die type of arrangement, there is a flat blank of sheet metal which is given that desired shape by applying sufficient force with the help of a punch. That die gives the shape to the final vessel or the final product. We will try to understand this with the help of a simple diagram.

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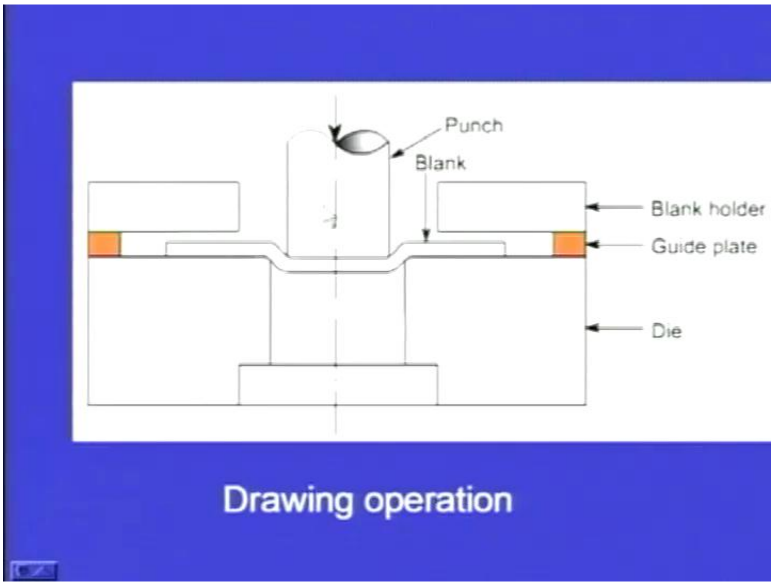

This is the punch, this is the blank. Here we can see this is the blank, this is the punch and why this counter bore portion is there, that we will see in our discussion at a later stage. This is the blank holder which supports the blank, and this is the guide plate. So, there is a punch basically and there is a die. This is the die, and this is the punch. The punch will exert a sufficient force on the blank and try to give it the desired shape.

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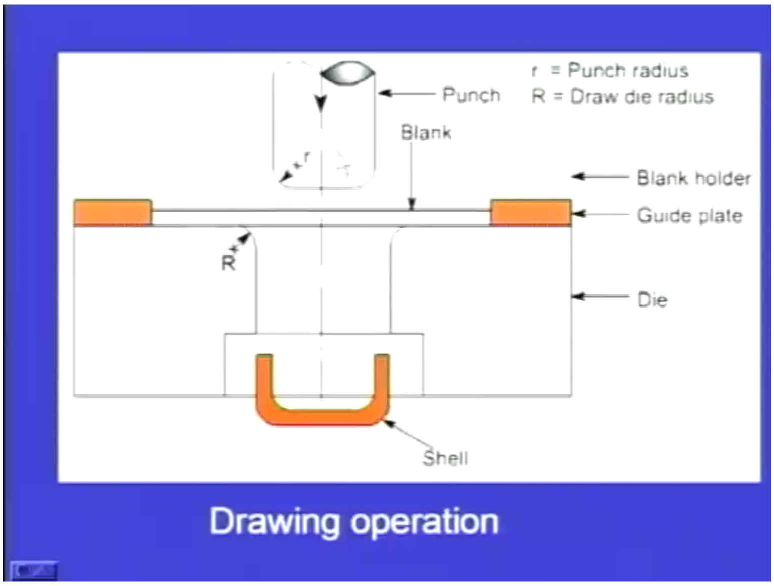

Now, this is an operation being completed. The punch has been withdrawn. As in a withdrawn position, this is basically the shell that has been made and this is the counter bored portion. Why that counter bored portion is provided already I have told we will discuss in this lecture itself. This is the die and then, there is a guide plate and there is a blank holder. Here there will be a blank holder, which will hold the blank in place.

Another point to note here is the radius that has been provided. This is the punch, there has been a radius. This is a radius that has been provided here. Moreover a radius has also been provided on that die surface here. See this is the radius, capital R. This is small r on the punch. So, here we see that a radius has been provided on the punch as well as on the die. Why this radius is provided we will see.

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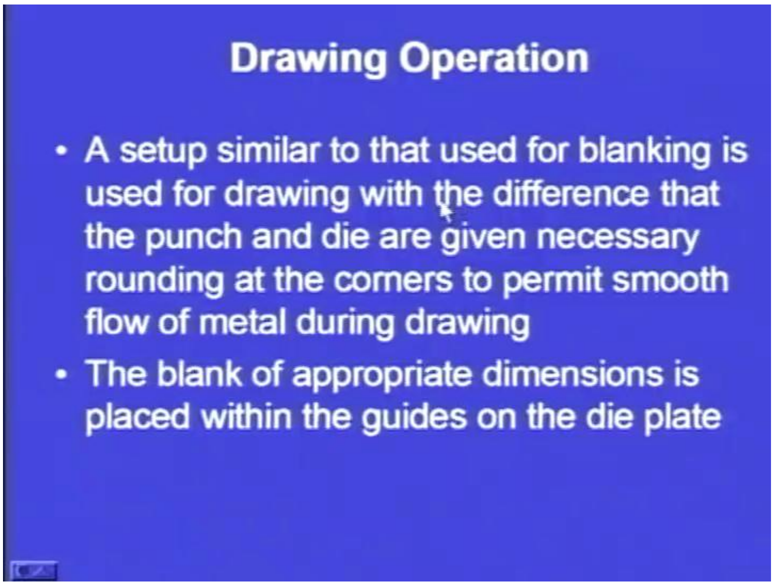

Now, drawing operation uses a setup which is quite similar to that used for blanking, and there is a slight difference in the setup that we are using in blanking as well as that we are using in a drawing operation. A setup similar to that used for blanking is used for drawing with the difference. What is that difference? The difference is that the punch and the die are given rounding at the corners in the diagram. We have seen that small r and capital R are the radii that have been provided on the punch, and the die surface respectively. So, given rounding at the corner, permits smooth flow of metal during drawing.

So, while we were seeing the diagram, I have told that why this radius is provided we will see in subsequent slide. So, here we have addressed the solution or address the problem that why that radius is provided. That radius is provided for the smooth flow of metal into the die cavity. In case of blanking operation, we form a slug or a slug is formed or a blank is formed. Here that blank or complete sharing is not going to take place. The complete sharing is not taking place.

The metal is deforming under the force of the punch to give the desired shape as is required where for that deformation, the metal has to enter into the die cavity, and when the metal flows over a rounded corner, the chances of any type of failure, any type of crack, any type of fracture are minimum. In order to facilitate the easy flow of metal or the sheet metal into the die cavity, these rounded portions are provided. Moreover the blank of appropriate dimension is placed within the guides on the die plate. So, the blank is of appropriate dimension. What is that appropriate dimension, we will see in the subsequent slide.

So, depending upon the final volume, the final shape of the product that we want to make, we can take a decision that what should the appropriate dimension of the blank size or the flat sheet metal which has to be used for getting the desired accuracy as well as the desired shape as well as the desired dimensional control over the final product. Now, in case of the drawing operation, the punch descends slowly.

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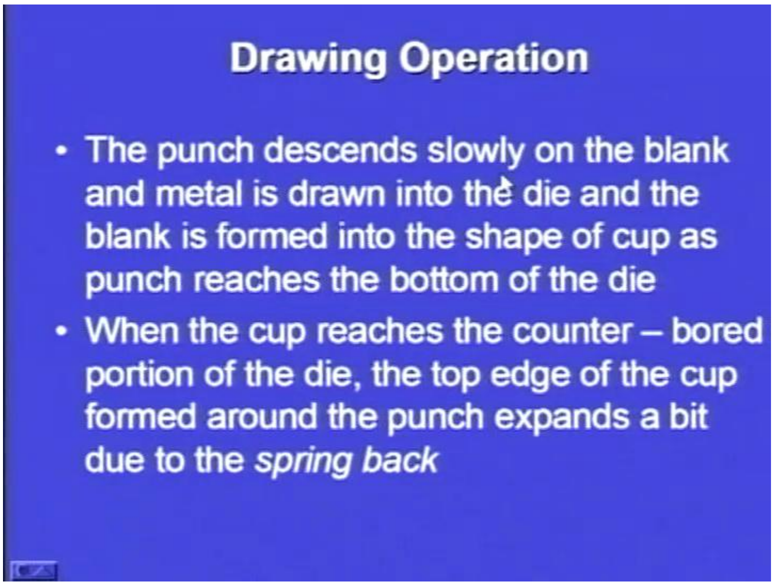

Already I have told that the speed of the punch is also very important. If the punch comes at a very fast phase and hits the sheet metal, it is going to create a hole or it is going to pierce into the sheet metal. That is not required. This is not a piercing or punching operation. It is a drawing operation. So, the speed of the punch has to be controlled, so that the impact is not there. It is not an impact phenomenon or impact process. It is a process where gradually the punch has to give a shape to the sheet metal. So, the punch descends slowly on the blank and metal is drawn into the die.

So, when the punch comes in contact with the blank, it exerts a sufficient force and the blank is forced into the die, and the blank is formed into the shape of the cup as the punch reaches the bottom of the die. So, when the punch comes in contact with the sheet metal blank and it exerts a sufficient force, the metal goes into the die and takes the form of a cup and takes the shape of a cup as the punch reaches the bottom of the die.

Now, comes the important point that why that counter bored portion was provided. Now, when the cup reaches the counter bored position of that die, the top edge of the cup formed around the punch expands a bit due to the spring back. Now, we see that there is blank when a punch is coming in contact with the blank. It is forcing the metal into the die cavity. Now, when the punch reaches the bottom and the process has been completed, the cup that has been formed, it opens up slightly.

Why that opening up takes place? It is because of the elastic recovery which we call as the spring back action. Now, because of the spring backs slight opening of at the edge of the cup that has been formed that takes place. Now, because of that spring back as it opens up while the punch retracts its path back or the punch moves up this particular cup that has been formed, strikes against that counted bored position and fall down. So, when the cup reaches the counter bored position of the die, that top edge of the cup formed around the punch expands a bit due to the spring back action.

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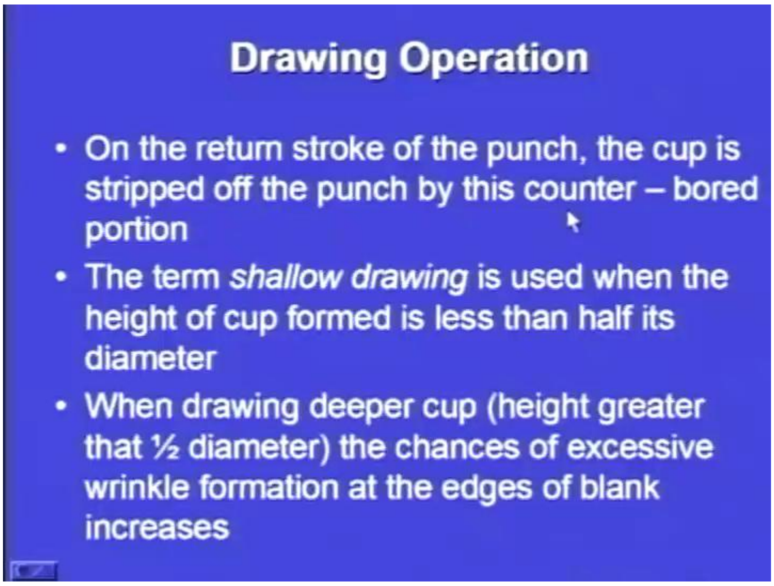

As I have already explained on the returns stroke of the punch that when the punch is coming up, the cup is stripped off the punch by this counter bored position as the cup has opened a bit. The edge of the cup has opened because of the spring back action. When the punch retracts back or comes up, the counter bored position will help in the stripping up of the cup that has been formed with the punch. Otherwise, if this portion is not there, the punch, the cup that has been formed and is attached to the punch, sometimes the cup may be attached to the punch. Why? It is because suppose we are using a lubricant, then because of the thin film that is developed between the cups as well as the punch, the cup may be attached to the punch and it may try to come up with the punch that is not required. So, stripping up of the cup is required which is easily facilitated by this counter bored portion.

Now, we try to address another term that is shallow drawing. The term shallow drawing is used when the height of the cup formed is less than half its diameter. So, it is very easy to understand that whenever the height of the cup that has formed is less than half its diameter that particular process or that particular drawing operation is called shallow drawing. Now, when drawing a deeper cup that is when the height is greater than half times the diameter, the chances of excessive wrinkle formation at the edges of blank increases.

So, whenever we are going for shallow drawing, there are chances that no wrinkling will take place, but whenever we are drawing a deeper cup where the height is greater than half times the diameter, the chances of excessive wrinkling may be there or excessive wrinkling may take place which will limit the use of the cup or even if the cup has been formed or even if the shape has been formed, it has to be subjected to a subsequent trimming or a machining operation in order to give an acceptable quality level to the wrinkles or to the edges of the cup.

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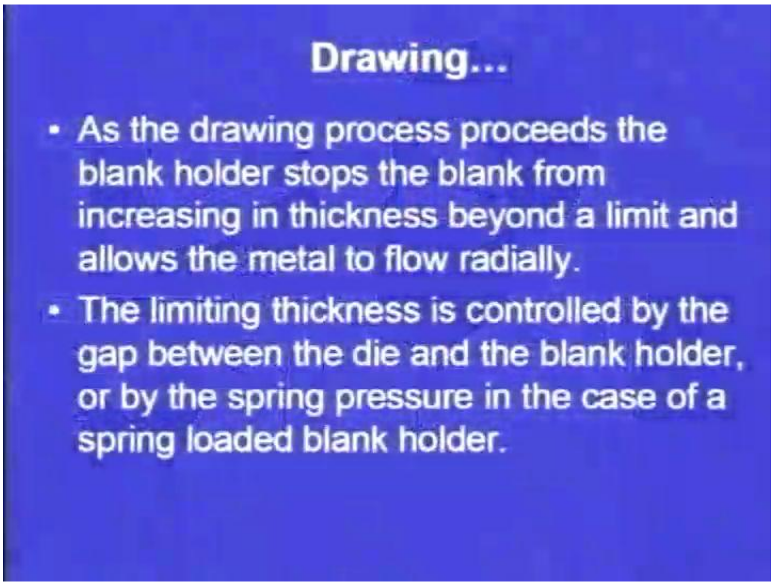

Now, as the drawing process proceeds, the blank holder stops the blank from increasing in thickness beyond a limit, and allows the metal to flow radially. So, it is very clear, very plainly it has been written as the drawing process proceeds, when the drawing process precedes the blank holder. Now, we see that in the basic figure of drawing process, there was a label that was depicting the blank holder.

So, why was that blank holder present there? The blank holder stops the blank for increasing in thickness. So, there are chances that the thickness of the blank may increase or it may decrease. So, in order to check that increasing of the thickness of the blank, this blank holder is provided and it checks the increasing of the thickness beyond a limit and allows the metal to flow radially. Now, the metal has to flow radially. So, it allows the metal to flow radially, and check that increasing the thickness of the sheet or the thickness of the blank.

That is why a blank holder is provided on the blank. Then, the limiting thickness is controlled by the gap between the die and the blank holder. Now, there is a blank holder. There is a die surface in between we are placing the blank, or the sheet which has to be deformed which has to be drawn into a usable item. Then, the gap is adjusted between the die as well as the blank holder or by a spring pressure in case of a spring loaded blank holder. So, now the blank holder which is there, suppose this is the die surface on top of that there is a blank holder, this blank holder can be spring loaded also. Now, this gap has to be adjusted between the die surface and the blank holder. So, this can be adjusted in any number of ways. It can be adjusted using a screw type of arrangement, or it can be adjusted in case of a spring loaded type of a blank holder.

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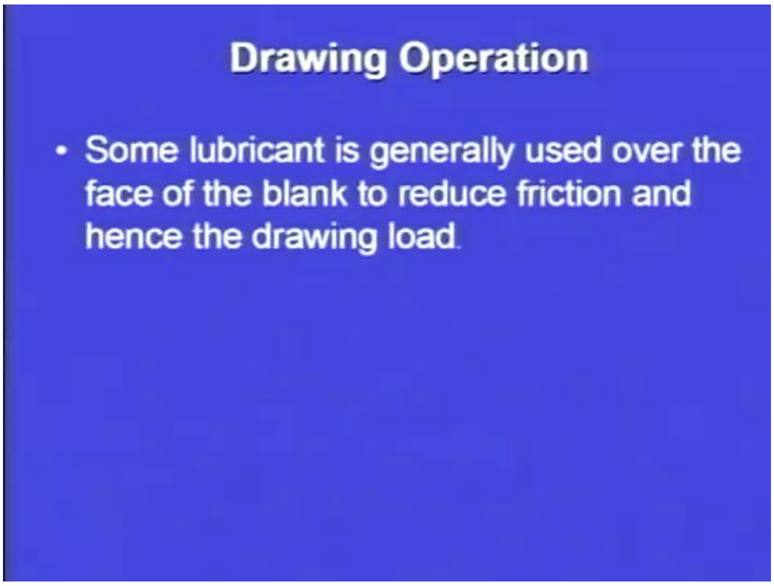

Now, in case of a drawing operation, some lubricant is generally used over the face of the blank to reduce friction and hence, the drawing load. So, already we have discussed that why the cup is attached to the punch sometimes because there is a lubricant on the face of the blank, and when the punch comes in contact with the blank because of the lubricant, a thin film of attraction, thin film may develop in between the punch and the blank, and when the process is completed, it may stick to the punch surface.

So, that is one of the limiting points of using a lubricant, but the lubricant is required. Why it is required? It is because it generally is used over the face of the blank to reduce friction and hence, the drawing load. So, drawing load is reduced as well as the friction is reduced, thereby lubrication is an important aspect of the drawing operation.

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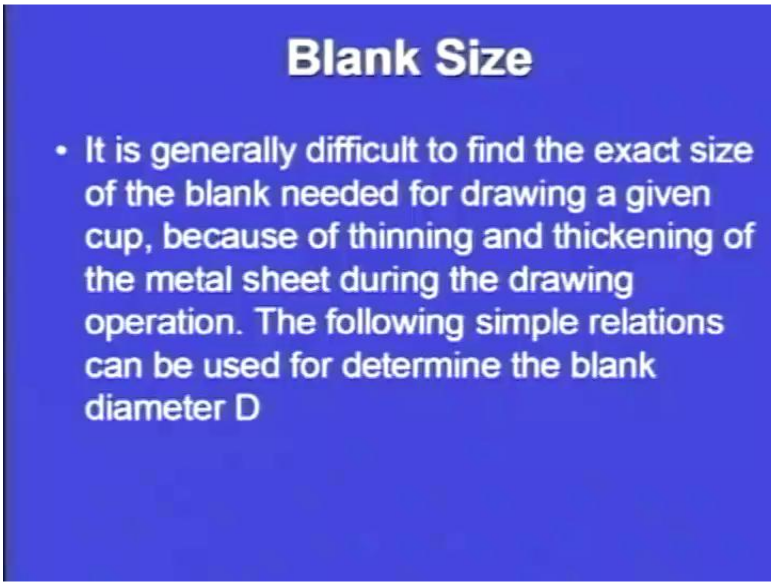

Now, what should be the appropriate blank size? Now, blank size is important. Why? Because whatever shape that we want to make depends upon the blank size. Suppose we take a smaller blank size and whenever we press it with the help of a ram, the space that we get may not be complete shape because the appropriate metal is not the sheet is not there. So, the size of the blank also plays a very important role. So, it is generally difficult to find the exact size of the blank.

Suppose I take this much size blank and I use a punch. Suppose I punch it like this. Now, the final shape that I will get depends upon the size of the blank. If the blank is of larger size, then sometimes some metal is left out and it will be some kind of wrinkling may appear on the edges. Moreover if the size is very small, I may not get the exact shape that we want to make. So, it is generally difficult to find the exact size of the blank needed for drawing a given cup because of thinning and thickening of the metal sheet during the drawing operation.

Now, sometimes the sheet may become thin at some particular sections, and at other particular sections, the sheet may become thick. So, this thinning and thickening action of the sheet, metal sheet usually makes it very difficult to exactly get the size of the blank. That is required to form a cup. There are simple relations that help us to determine the blank diameter D. So, using some mathematical equation, using some mathematical relations, we can estimate that what should be the diameter of the blank size for making our final product. Although it is difficult because of thinning and thickening of a metal sheet at some particular sections, but still using analytical or mathematical formulation, we can sometimes arrive at appropriate value of the diameter which should be required for forming a cup.

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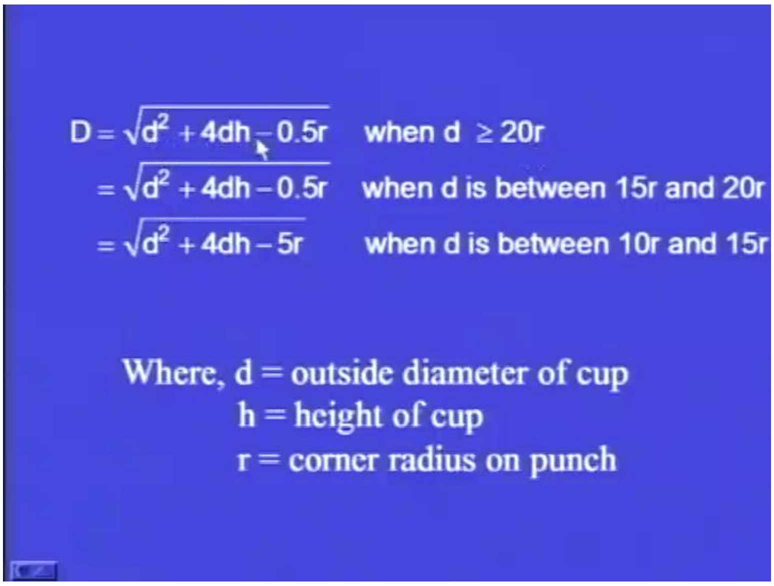

Now, these are some of the formulation or mathematical formula that can be used to get the blank size diameter. Now, d is the diameter of the blank size. The following simple relations can be used to determine the blank diameter d. Now, blank diameter capital D, it is equal to square root of d square plus 4 times dh minus 0.5 times r. Now, this particular equation we will use when d is greater than equal to 20 times r.

What is this r? What is d? What is h? D is the outside diameter of the cup, h is equal to height of the cup, and r is equal to corner radius on punch. When we saw the basic drawing operation, we have seen a corner radius is given. A corner radius is given on the punch. Moreover a radius is also given on the die surface that was given by capital R. So, this is that small r that is the radius that is given on the punch. So, r is the corner radius on the punch, h is the height of the cup and d is the outside diameter of the cup.

Now, depending upon these features, we can very easily calculate that what should be the appropriate dimension or the diameter of the blank size. Now, capital D depicts as we have seen the blank diameter. So, blank diameter D can be calculated as square root of d squared plus 4 times dh minus 0.5 times r. What are this d, h and r, which we have already seen. Now, this equation will be particularly used when d is greater than equal to 20r. So, when the outside diameter of the cup is greater than 20 times, the corner radius of the punch that particular situation under that particular condition. We are going to use this particular relation for calculating the blank diameter.

Similarly, another equation that is square root of d square plus 4 dh minus 0.5 r. This particular equation we will use when d that is the outside diameter of the cup is between 15r and 20r. That is 15 times the corner radius of the punch, and 20 times the corner radius of the punch. So, whenever the outside diameter of the cup is in between 15r and 20r, we are going to use this particular relation to calculate the blank diameter.

Similarly, there is another particular condition that is when the outside diameter of the cup is between 10r and 15r, and that particular condition we are going to use this relation that is the blank diameter capital D is equal to square root of d square plus 4 times dh minus 5 times r. So, once again just to summarize what is dh and r, d is the outside diameter of the cup that is small d we are talking now. Capital D gives the blank diameter. Small d is the outside diameter of cup, h is equal to the height of the cup, and r is equal to the corner radius on the punch. So, we can see that although it is quite difficult to estimate that what is going to be exist blank diameter for a given height of a cup that we want to form, but still using this mathematical equation, we can easily estimate that what is required, what the size of the blank diameter required to form a cup.

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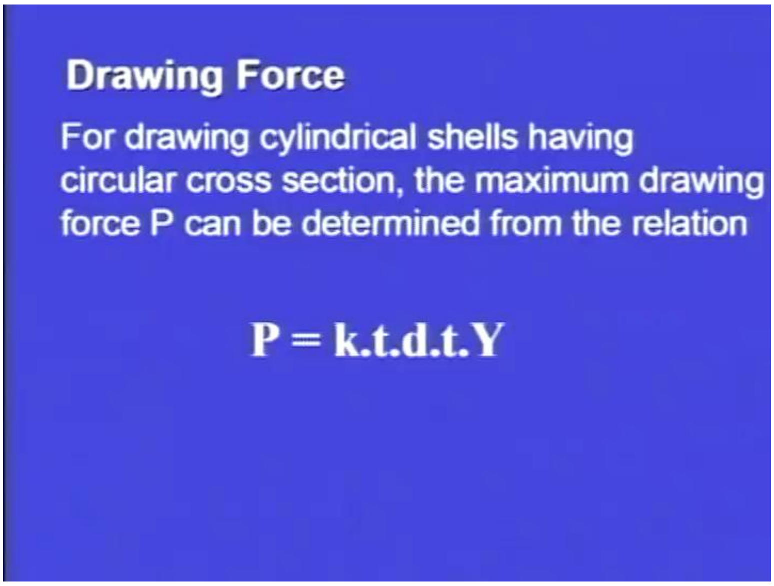

So, we have seen in case of bending in the previous lecture that a bending force is required to bend the sheet metal at a particular angle. Similarly, a drawing force is required for drawing operation for drawing cylindrical shells having circular cross section. So, we are talking about cylindrical shells only which are having circular section, the maximum drawing force P. So, capital P denotes the maximum drawing force can be determined by the relations. So, this is the relation for calculating the drawing force. Now, this is given by capital P that is the drawing force is equal to k multiplied by t multiplied by d multiplied by t multiplied by Y. So, there are some parameters. What are these parameters that we will discuss now.

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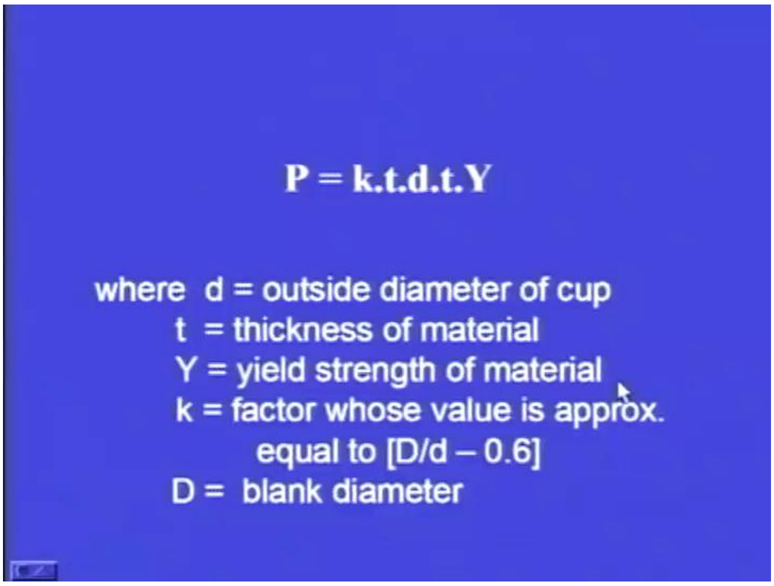

This is the equation. D is the outside diameter of the cup, t is the thickness of the material, Y is the yield strength of the material, and k is the factor whose value is approximately equal to D by d 0.6 and capital D is the blank diameter. So, this capital D, this is the blank diameter and small d is the outside diameter of the cup. So, depending upon this drawing force, we can calculate.

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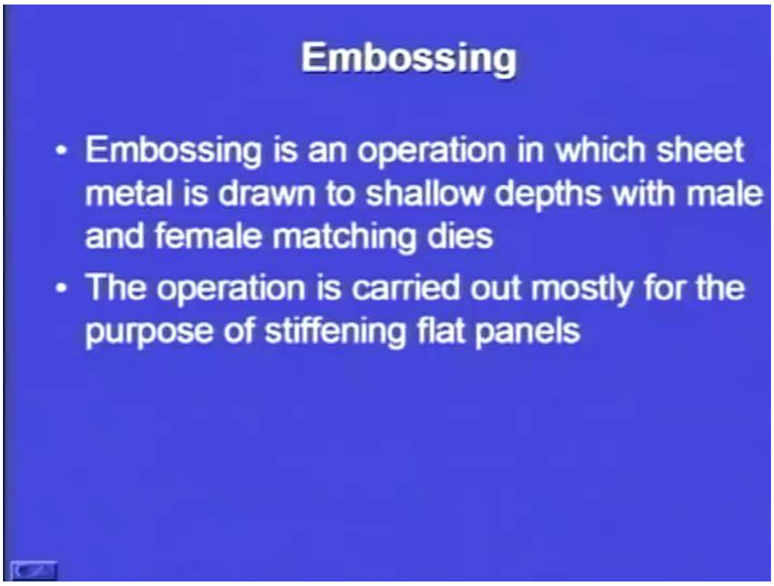

Now, we have seen that what is the drawing force requirement, we have seen what the drawing operation is, what are the different types of drawing operations we have seen.

Then, we have seen that there is a force that is required for drawing a metal, then we have seen that what is the size of the blank diameter that should be required, we have seen that their mathematical formula according to which we can calculate that what should be the blank diameter for a given height, and outside diameter of the cup that we want to make.

Now, finishing our discussion on the drawing operation, we will now shift our attention to two other important processes of sheet metal operations that are embossing and coining. So, what is basically the embossing process. Now, embossing is an operation in which sheet metal is drawn to shallow depths with male and female matching die. So, the depth in case of embossing is not too much in case of drawing. We have seen that depth is substantial, but in case of embossing, the depth will be too much. It will be a very shallow depth. So, embossing is an operation in which sheet metal is drawn to shallow depth. Already I have told the depth will not be as comparable as was in the drawing operation, and with male and female matching dies.

So, here male and female matching dies will be used whereas, in case of drawing operation where we wanted to have an appreciable depth, we were using a punch and die type of an arrangement. Here we will use a male and female type of matching dies. We will try to understand it with the help of a very simple diagram here. We will have a male and female matching die. In between we will have a sheet metal, and on that we will have the conformer embossing.

Now, where is the use of this? Operation is carried out mostly for the purpose of stiffening flat panels. So, if flat panels are there and if we want to stiffen, then if we want to increase their stiffness, then we can go for stiffening of flat panels with the help of embossing operation.

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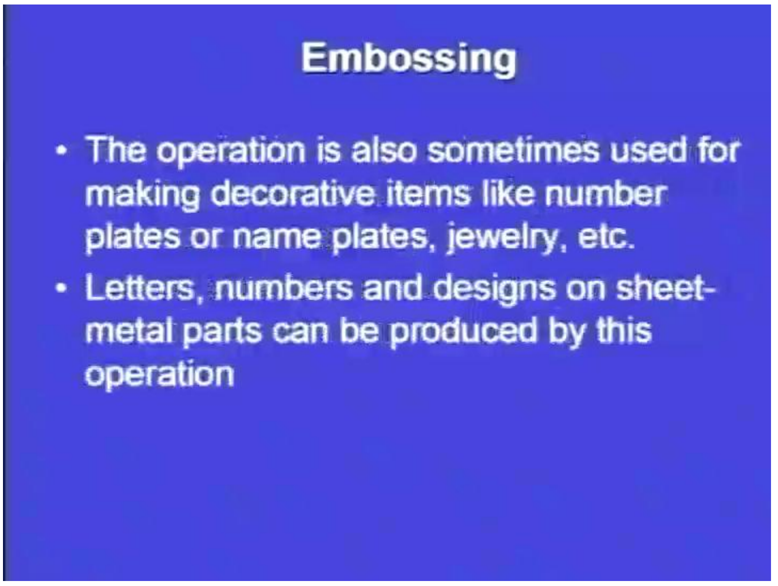

The operation is also sometimes used for making decorative items like number plates or name plates or jewelry. Sometimes we might have seen that some number plates of some of the vehicles have some embossed number. So, they have been raised. So, in the particular plane of the sheet we see that some numbers are raised. So, the raising of the numbers is called embossing.

The increasing at that the depth is a shallow depth. Depth is not too much. It is considerably less as compared to the drawing operation. So, the operation is also sometimes used for making decorative items like number plates, or name plates as well as jewelry items. So, letters, numbers and design on sheet metal part. So, sheet metal part, there can be number on sheet metal part, there can be certain design sheet metal part and sometimes we have some decorative. We have seen that in our houses we have some decorative paintings etcetera, some decorative images of Gods that have been embossed on the sheet metal can be produced by this operation. So, we can have letters, numbers embossed on the sheet metal. So, this is a diagram where we see that this is the work piece.

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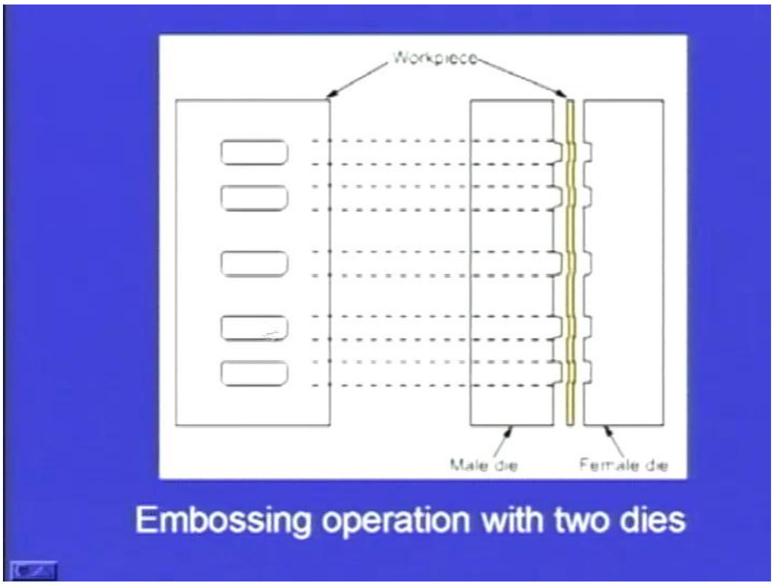

This colored portion, this is the work piece and this is another section of the work piece, and these are some of the areas which have been embossed. So, these can be any number or these can be any alphabets. So, depending upon what do we want to have on a sheet metal, what we want to print on the sheet metal in the embossed manner, we can select a particular male and female type of die. So, this die here we can see this is a male die, this is a female die and in between we place our sheet metal. So, whenever this male and female part will meet, we will have embossed portion here. So, the sheet metal will be embossed.

So, this is embossing operation with the help of two dies that is the male die as well as female die. So, here we can see that the work piece has been embossed. These are the embossed sections, this particular section as this dotted line show the position of the section on the sheet metal. This is the complete sheet metal. This is the section where embossing has taken place. This has been clearly outlined here with the help of this dotted line. This is the particular section here in this view, and this is the section in the other view. This is the section, which has been embossed.

So, this is the basic of the embossing operation that we can carry out on sheet metal in order to print letters or number or some decorative paintings etcetera. So, that was all that we discussed regarding the embossing operation. So, after embossing, we are going to address another important operation that is coining operation.

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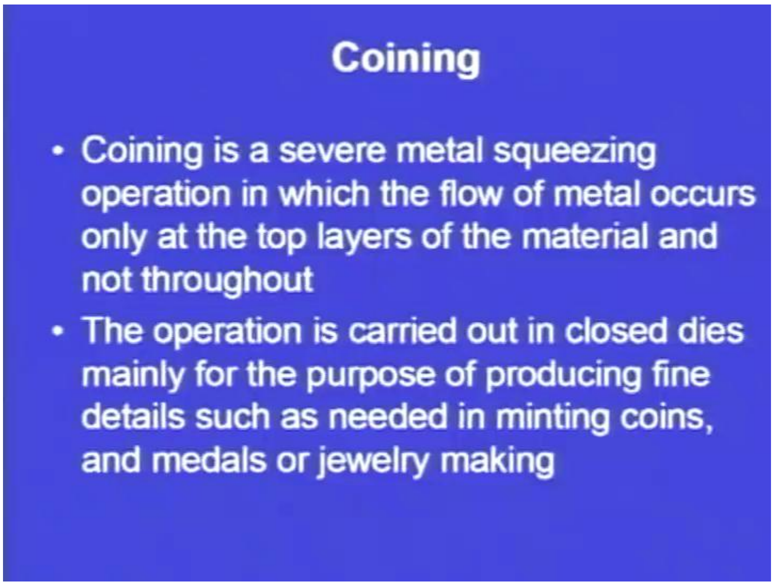

So, coining can also be done on sheet metal. So, coining is a severe metal squeezing operation in which the flow of metal occurs only at the top layers of material, and not throughout. So, in case of coining, only at the top layers only the deformation or the flow of metal will take place. It will not take place throughout, only at the top layer and it is a severe squeezing operation. So, too much of pressure will be applied in order to impact very intricate details on the surface of the sheet metal.

So, the operation is carried out in closed dies mainly for the purpose of producing fine details, such as needed in minting coins and medals or jewelry making. So, very fine details when we have to imprint on to the surface of a sheet metal, we will go for the coining operation. So, we can take out a coin, new coin from a pocket and see that there are so many fine details on the coin. So, how those details have been imprinted? Those details have been imprinted using a closed die type of a metal forming operation under a high value of loading. High value of loading means that the pressure exerted is very high in case of coining operation.

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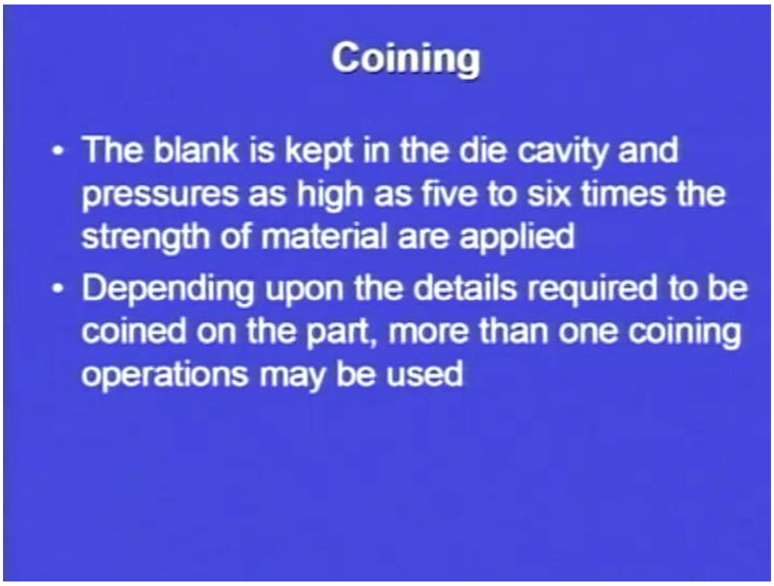

The blank is kept in die cavity, and the pressure as high as 5 to 6 times this strength of the material are applied. So, the pressure requirement or the forces that are exerted on the sheet metal are extremely high in case of the coining operation. Now, depending upon the details required to be coined on the part more than one coining operation may be used. So, now this depends on what is the final requirement, what is the final specification of the product that we want to make out of the coining operation. We have to make a decision that whether we have to do it in one particular go only, or we can take a number of go for a number coining operations. Now, what is the basic difference between a coining and embossing operation?

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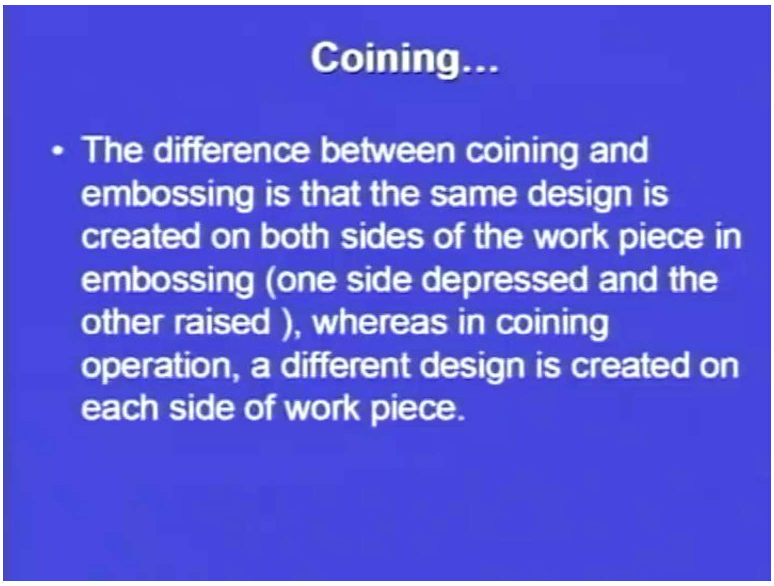

The difference between coining and embossing is that the same design is created on both sides of the work piece in embossing. One side is depressed and the other is raised. So, we have seen in the basic diagram of the embossing process that there is a male as well as a female die. The male die has some protrusion, sorry and the female die has some. Now, this protrusion will go into the die cavity, or the cavity on the female die and in between sheet metal will get the shape of the protrusion, but here in case of the coining operation, a different design is created on each side of the work piece. We can see that if we take out a coin. On one side there is another design, on another side there is another design.

In case of embossing, this on the male die the protruding portion will go into the cavity, opposite cavity on the female die and in between sheet will get the desired shape. So, the basic difference between embossing and a coining operation is that in embossing, we will get similar type of design. On one side, it will be raised and on another side, it will be cavity whereas, in the case of the coining operation we will get different design on the different sides of the coin, or the different sides of the part that we are coining using the process of coining operation.

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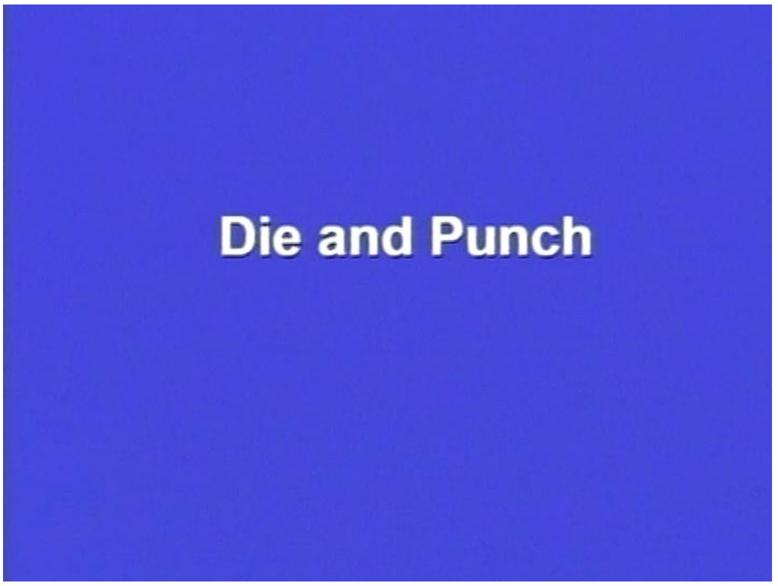

Now, we come on to another important aspect of metal forming that is die and punch. We have been discussing different types of metal forming operations in metal forming operations. We discussed what the different types of sheet metals are forming operation. In sheet metal forming operation, we have seen the different types of die and punch arrangement are there. If sometimes the die is given a radius to ensure the smooth flow of the metal into the die cavity, we see that there is a blank and that blank is punched. When using the punch, we apply sufficient pressure. The metal flows slowly into the die cavity and then, that radius is provided on the die. So, there are different types of mechanisms where the punch and die are used. So, we will try to address and we will try to understand what are the various mechanisms of die are and punch assembly, or die and punch operation.

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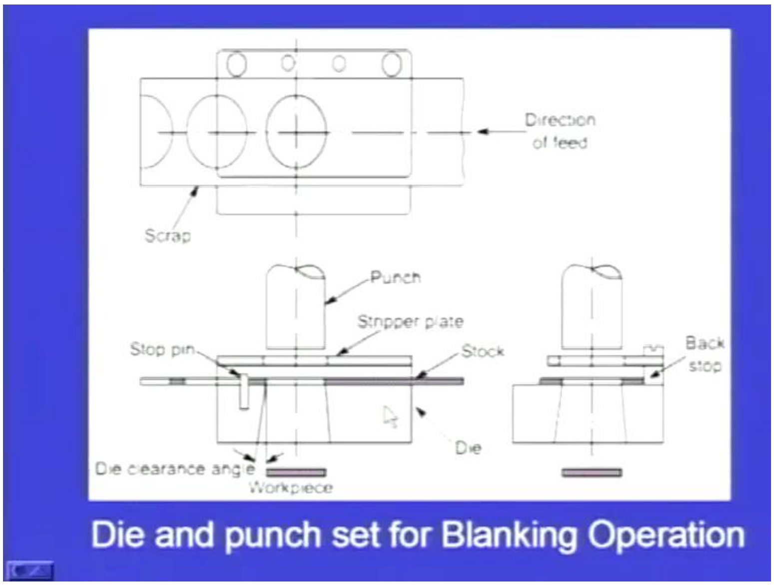

Now, this diagram we have already seen when we saw the basic principle of sharing, when we discussed what is punching and what is blanking. We have seen this earlier also, but here we would like to understand this in a bit of greater detail. Here we see if we closely observe this particular diagram. Three views are given of the operation if you see. This is the basic view. We have a punch, this is the punch. One point to note here is although most of you might have noted this is die and punch set for blanking operation.

So, if some of you have not noted the point, I would like to illustrate it that the edge here, the edge of the punch, this particular point. Suppose I call it a, and this particular point b a, and b are very fine. These are very fine edges with no radius that has been provided. This is a blanking operation mind you. Now, this is the die. The die is also shown here. This is the die and this particular point suppose I call it c, and this particular point we call it d. Now, c and d also have not been provided any radius point a, and b on the punch and c and d on the die have not been provided any radius whereas, in case of a drawing operation, there was a small r that was small radius was provided on the punch.

Similarly, a capital R, a radius corresponding to capital R was provided on the die surface. Why was that provided? In order to have a smooth flow of the sheet metal into the die cavity with the exertion of force with the punch, but in case of blanking, no such diameter on or the radius on the punch as well as the radius on the die have been provided. Now, we can see that this is the basic die and punch blanking operation. Now, this is the direction of the feed. Direction of the feed means that this is the blank, or the stock here we call the blank as a stock in from which we have to make our blanks. Now, this work piece that is we have made. So, this is the stock that is fed from here in another view of the same diagram. We can see this is being fed from here.

So, this is the scrap. We have seen after the punching whatever we get is a scrap. In case of blanking operation, in case of punching operation, this would have been the work piece, but in case of blanking operation, this is the scrap. So, now you see this is the axis and this is the punch. Now, punch is making the work piece out of this stock. This is stock is being fed from this direction. Now, when the stock is being fed from this direction, there is a position where the blank has to be formed. Now, this is the existing position where the punch has to go and form the blank.

Now, how to locate this particular metal sheet at that particular how to secure this particular metal sheet at that particular position? We have a stop pin type of arrangement here. Here we can see this is a stop pin. From this direction when we feed the stock, this will go and hit this stop pin which will stop the feed of the metal, and on top of this, there is a punch, there is another arrangement for existing positioning of the sheet under the punch or the centering of the sheet under the punch. What is that? If we see another view of this particular diagram here, we see there is back stop. This is the back stop. So, this particular center where the blanking has to be done, we will locate using this back stop as well as this stop pin.

So, stop pin and back stop are used for exact securing of the metal sheet at a location under the punch, where the blanking has to be carried out. Moreover here we can see that there is a die clearance angle. This is the die clearance angle. So, why this die clearance angle is provided? This is the angular die clearance. You can see that it has been specified in term of an angle. So, die clearance angle, or the angular clearance why this is provided? This we will see and we will try to understand it.

Another important point is that there is a stripper plate that has been provided here. Why this stripper plate is provided? When the punch after performing the operation of blanking it comes up, there is a tendency that it may try to lift this stock plate along with the punch. The punch goes in this direction, performs the blanking operation and then, it retracts its path. This is the path of the punch. When it retracts it path, there is a tendency that this stock may get lifted along with the punch.

In order to avoid that kind of a lifting, there is a stripper plate that will strip off this stock from the punch. So, the important point that we have noted here in this particular diagram we will see, and we will review this. We will summarize this again, but here when the diagram is there on your screen, you can see what the important points we have addressed here.

This is direction of the feed, then this is scrap that is forming, this is the work piece that is forming, this is the punch that is forming the blanking operation, then there is a stop pin and there is a back stop to secure the existing position of the work piece or the stock on the table or the die and then, this is the die on which the stock is there. So, in this way we are able to produce the blanks which are our work pieces. So, this is the die and punch set for blanking operation. Now, we will try to understand it or review this process.

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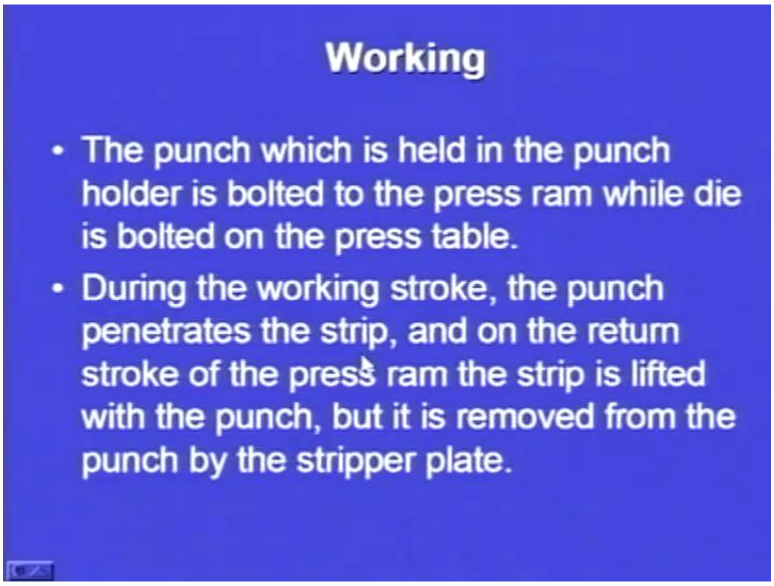

So, how this process is working? The punch which is held in the punch holder is bolted to the press ram while the die is bolted to the press table. So, this die is bolted to the press table which is not shown in this picture. So, this all operation will be carried out with the press. There are different types of presses, which are used for sheet metal forming operations. In our subsequent lectures, we will give due attention, we will have a discussion on the different types of presses. We will classify the presses depending upon a number of parameters. That will be discussed in the subsequent chapters, but here we can just understand.

We can say that this punch is attached to ram portion of the press and this die is placed on the table of the press. So, the punch which is held in the punch holder is bolted to the press ram. There will be a press ram to which this particular punch will be fastened, and while the die is bolted to the press table, there will be a table of the press on which the die will be bolted during the working stroke. The punch penetrates the strip. This punch will penetrate the strip and on the returns stroke of the press ram, the strip is lifted with the punch.

Already in the diagram I have told that when this punch retracts its path, the strip or the stock may get lifted along with the punch. So, when on the returns stroke of the press ram, the strip is lifted with the punch. Whenever this happens, it is removed from the punch by the striper plate, so that stripper plate that was proved over the die as a stripping mechanism for stripping of the stock from the punch. So, we have seen that the design is such that the stock is not lifted the punch. Then, the stop pin is the gauge and it sets the advance of the strip stock within the punch and die.

Now, there is a punch and a die, and we have to feed the metal strip or the metal stock or the sheet metal. So, when we feed the sheet metal, it has to go and stop at one particular section, and this particular stop pin will act as a gauge, and it will help to secure the positioning of the sheet metal just below the punch where the blank has to be produced.

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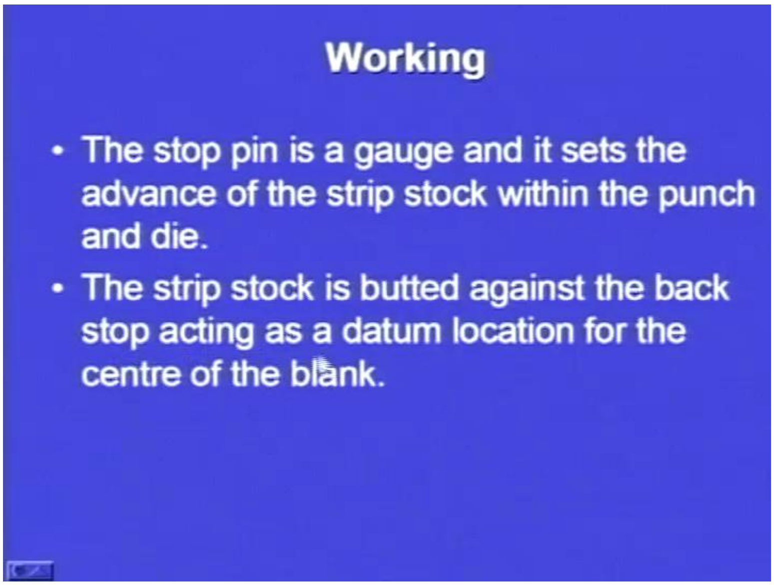

The strip stock is butted against the back stop acting as a datum location for the center of the blank already. When we were looking at the diagram we have seen that there are two important arrangements, that is one is the stop pin and another is the back stop. So, this back stop and stop pin helps to secure the position of the sheet metal at its appropriate location, where the punch has to come and perform the operation of blanking.

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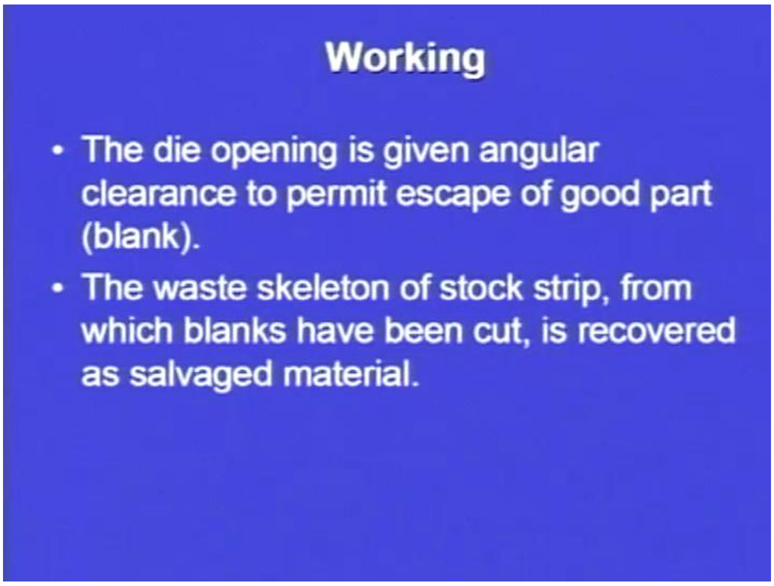

The die opening is given angular clearance. I have shown that angular is given to the die opening to permit escape of the good part. So, the good part here is the blank. So, a sheet is being blank with the help of a punch, and the blank that is formed with the punch is the useful product in case of the blanking operation whereas, in case of the punching operation as we have already discussed in our first lecture on sheet metal operation that was sheet metal operations 1 that in punching, where the other portions or the other portion that is left is the usable part, but in case of blanking, the blank that has been punched is the usable part or that is the good part.

The waste skeleton here we are calling it as a waste skeleton, but in case of punching, this will be a usable part that will be the finished part. So, the waste skeleton of the stock strip from which the blanks have been cut. So, blanks have already being cut and blanks are our work pieces. Well, blanks are jobs that we want to make out of the blanking operation. So, whatever is the waste material or the waste skeleton of the stock strip is recovered as the salvaged material. So, whatever is the sheet that particular portion that has been left over is salvaged.

So, one particular example of this type of operation although not in case of sheet metal operation or sheet metal forming is there is large blank of rubber, out of which the different chapels or different footwear have been stamped out. So, that can be one particular example of shift stamping operation in which whatever has been stamped out is our final product, and the remaining is the waste product. Now, the clearance angle provided on the die depends on the material of the stock as well as its thickness. Now, how much angle to provide, why the angle is provided we have already seen, so that the blank can easily come out of the die, but how much clearance angle should be provided that depends upon the material.

Now, sheet material can be made up of number of different types of material depending upon what is our final requirement, or what is the final product that we want to make. Now, whatever angle has to be provided that depends upon the sheet metal, or the material of the sheet metal as well as it depends upon the thickness of the sheet metal.

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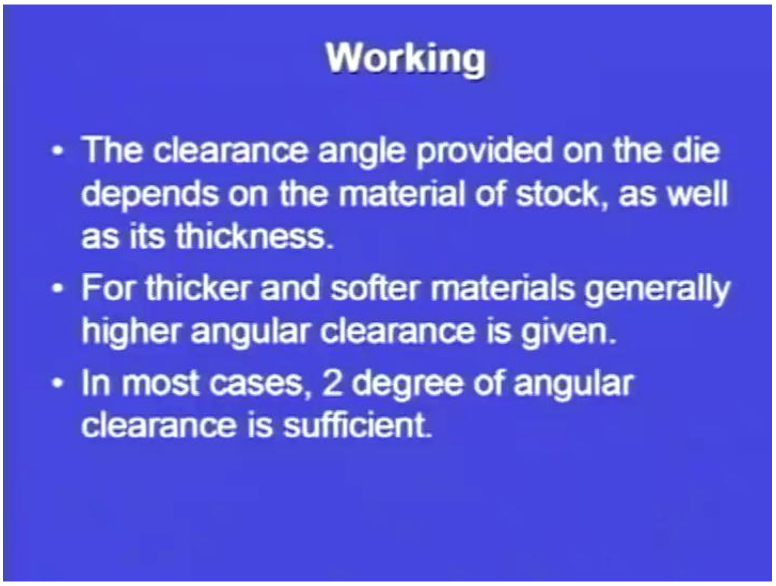

So, the clearance angle provided on the die depends on the material of the stock as well as its thickness Now, for thicker and softer materials, now depending upon the material means it can be a hard material, it can be a soft material, it can be a ductile material, malleable material. Depending upon the qualities of the material if the material is thicker and it is a softer material, generally high angular clearance is given. So, if the material is thicker, suppose the sheet thickness is considerably higher as well as the material is soft, then we will have a higher angular clearance whereas, in most cases, 2 degrees of angular clearance is sufficient.

Now, angle will always be specified in terms of degrees only. We cannot specify the clearance in terms of millimeters here. The clearance that is a general trend that 2 degrees of angular clearance is sufficient in most of the cases. Now, we will see the importance of clearance now in blanking operation.

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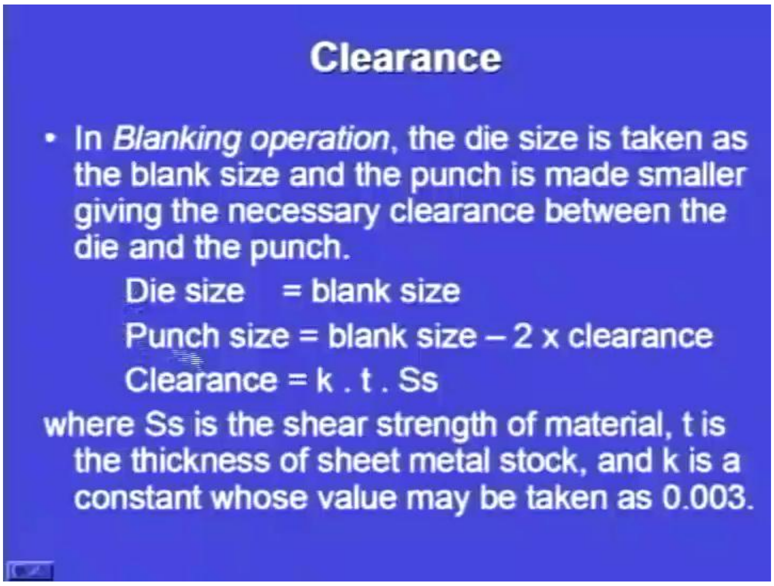

The die size is taken as the blank size. Now, blanking operation we see that the die size, there is a size of the die that has been provided in the very first diagram, we saw that there was size of the die, and there was angular clearance that was given by an angle alpha that was provided for the easy realize of the blank. Now, in blanking operation, the die size is taken as the blank size that is blank size is our final size that we are preparing that we are manufacturing here. So, the die size that we are die opening that we are providing at the top will be equal to the size of the blank that we want to produce.

So, the die size is taken as the blank size, and the punch is made smaller giving the necessary clearance between the die and the punch. So, here we can just see that in case of blanking operation, the die is made exactly to the size of the blank. Moreover the punch is given the clearance. The clearance is always given on the punch. Now, we can see that in case of the blanking operation, die size is equal to the blank size. So, whatever is our final product, it will be equal to the die size will be equal to final product that we want to make, but where we are going to provide the clearance. The punch size is equal to blank size minus 2 multiplied by clearance two times that clearance.

Now, the clearance, what will be the value of the clearance that can be calculated using the simple formula that is k multiplied by t multiplied by shear strength. Now, Ss is the shear strength of the material. So, we can see that clearance is also dependent upon the material of which we are going to make the blank. Why? Because in deciding upon the clearance, the shear strength of the material is coming into picture. So, depending upon the shear strength of the material, depending upon the thickness here, we can see t is the thickness of the sheet metals stock. So, depending upon the thickness and depending upon the shear strength of the material, we have to decide that what is going to be the clearance and what the size of the punch is because the size of the punch is also dependent upon the clearance.

So, we calculate the clearance using this simple mathematical equation that is clearance is equal to k multiplied by t multiplied by Ss. So, we have seen that we have shear strength. Here thickness of the sheet metal here, and what is k? K is a constant whose value may be taken as 0.003. So, depending upon a constant, depending upon a thickness of the sheet material, depending upon the shear strength of the material, we can calculate the clearance, and when we know what is the clearance that has to be provided for this particular material and for this particular thickness, we can decide on the size of the punch, and die size will be exactly equal to the blank size.

So, depending upon our final product that we want to make, we can make a decision regarding the size of that die. We can also make a decision regarding the size of the punch. The clearance will be provided on the punch, and the die size will be equal to the blank size. When we are talking about the blanking operation, but this scenario may change if our operation is changing. So, we have seen that what the importance of clearance is in the blanking operation. So, in blanking operation, we have seen the die size is equal to the blank size, but this may change when we are performing another operation.

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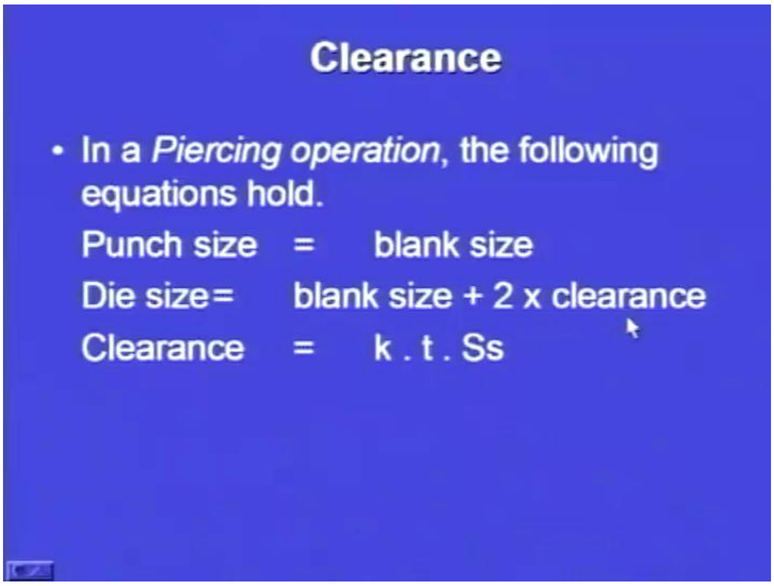

For example, in the piercing operation, the following equation hold the punch size is equal to the blank size. So, this is exactly opposite to what we have seen in the blanking operation. In blanking operation, we saw that the die size is equal to the blank size, but here we are seeing the punch size is equal to the blank size. Moreover, the die size is equal to the blank size plus two times the clearance. So, here we are providing the clearance on the size of the die whereas, in case of the blanking operation, we were providing clearance on the size of the punch. Here we are providing the clearance on the size of the die as die size is equal to blank side plus two times the clearance.

Now, clearance again can be calculated as k multiplied by t multiplied by Ss. So, what is k t and s? As already has been discussed for the blanking operation, the clearance is given by the constant k multiplied by the thickness of the sheet metal multiplied by the shear strength of the metal that we are using for making the piercing operation. Now, we can see that in piercing operation, the following equation hold good that I have already been discussed. We have seen that when we compare a blanking operation and we compare a piercing operation, the clearance plays an important role where the clearance has to be provided. Either it has to be provided on the punch or it has to be provided on the die that depends upon the type of operation that we have chosen for our final making our final product.

So, hereby we come to the end of this session on the Sheet Metal Operation, 3rd session, Sheet Metal Operations 3. So, we have discussed in today's lecture, we started our lecture from wherever we left in the last lecture. We started the discussion with drawing, we just reviewed what has been discussed in the last lecture, and then we discussed some of the final details regarding the drawing operation. Thereafter we discussed what is embossing. Then, we discussed what is coining. After coining, we started to discuss that die and punch mechanism. Very first die and punch setup for blanking operation was seen how blanking is done, what are the various parameters, what is the angular clearance where the clearance has to be provided, what is the importance of clearance and all that was discussed in this session on Sheet Metal Operations-3. Now, in the next lecture, we will cover some other types of die punches type of arrangements.

Thank you.