Manufacturing Processes - 1
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Module - 1
Lecture - 11
Sheet Metal Working – Equipment

A warm welcome to all of you in this session on sheet metal working equipment, before we start our discussion on different type of equipment that is used in the sheet metal processes. We will just review what we have discussed in the various aspects of metal working. After that we will move on to the different types of equipment, that is used in sheet metal working operations. So, before we start our discussion, this is a just a brief review of what we have discussed till now.

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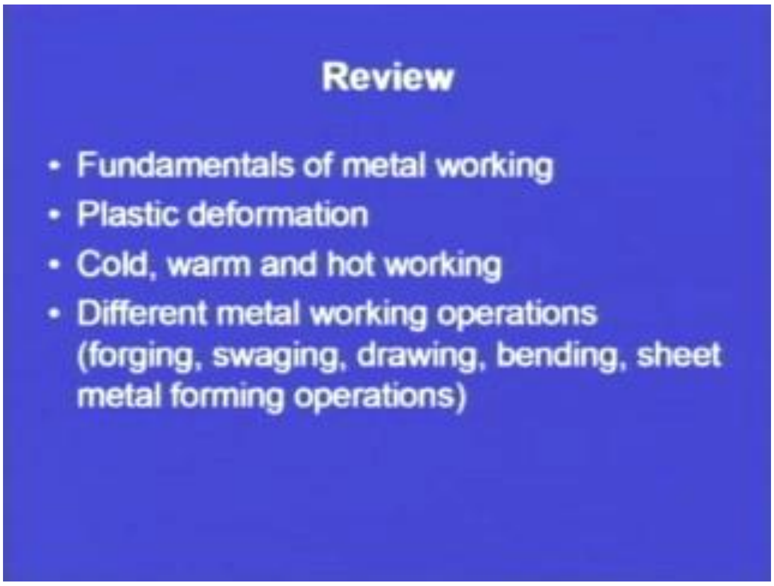

We have discussed, fundamentals of metal working, in which we have seen, how the plastic deformation takes place. The fundamentals of plastic deformation were studied. Then, we discussed different types of metal working processes. In different types of metal working processes, we discussed regarding the cold, warm, and hot working operations. Then we studied the relative advantages and disadvantages of cold working, because cold working has certain advantages, it also has certain disadvantages. So, similarly the advantages and disadvantages of cold working were compared with warm working.

And then there are little advantages and disadvantages of warm working were compared with the hot working. So, in a way, we tried to justify that, what type of process, we should select for our operations. Suppose, we have to do the forging operation or depending upon the final requirements of the product. We have to make a decision that, what is the type of working process, that we have to select or the type of working requirement.

For example, sometimes we may go for cold working operations; sometime we may go for hot working operations. And depending upon, what do we want to finally make? What are the properties? What are the mechanical properties? What are the physical properties of the product? That we are designing, that we are making, using the process of metal working. We have to make a decision, whether we are going to go for hot working operations or we are going for cold working operations.

In between the two, there is another intermediate operation that is a warm working operation, which combines the relative advantages and disadvantages of both, cold as well as hot working. Then, we discussed different types of metal working operations. In which, we discussed, what is forging, what are the different types of forging operations. Then, we discussed what is swaging; we discussed what is drawing. In drawing, we saw tube drawing using a mandrel. Then, we discussed, in sheet metal operation also, we discussed, what is the drawing operation?

Then we discussed bending spring back action was discussed in the discussion on bending. Then, we discussed the different sheet metal forming operations, in which we saw what is nibbling, what is notching. So, all these things have been discussed. Now, we move our attention towards the equipment; that is used for carrying out these types of operations. Now, in our last lecture, when we ended, we were discussing the type of die and punch arrangement that is used in the blanking operation.

So today, in order to give continuity to our discussion on the equipment. We will again, start our discussion from the basic die and punch type of arrangement for a blanking operation. And then subsequently discuss different types of die and punch mechanism, and die punch arrangements; that can be used to convert a sheet metal raw material into a final product.

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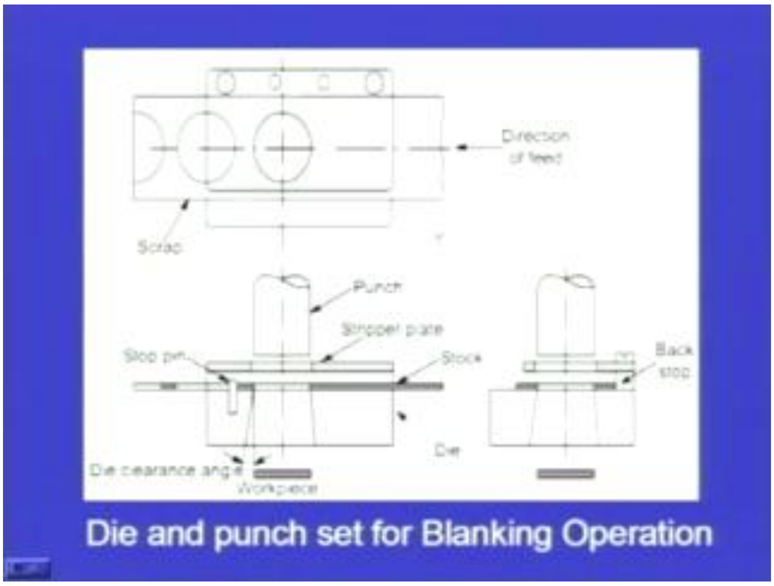

So, coming on to the die and punch type of arrangement that is used in blanking operation. So, this is the diagram, which was discussed earlier also. So, this is die and punch set for blanking operation. So, just in order to give you a brief overview, how the diagram has been labeled, we can see that this is the direction of feed. Direction of feed gives that, in which direction, the sheet metal is being fed. So, different types of feeding mechanisms are there, that we will discuss towards the end of this session on sheet metal operations equipment.

Then, this is the scrap, this portion, and within this, this circle, that is the final product, that we have made. This all, is the raw material, which is being fed, and this is the final product that we have made. The punch has blanked out a portion from here, which is this; this portion has been blanked out. If we see the other the three views of the process have been shown. So, this is the top view; in top view we see that the direction of feed of the sheet metal, the raw stock that has been fed, then we see, this is the punch. We can see the axis is directly aligned, this is the punch. So, the punch is going down.

And, this is the stock, this is the stock that has been fed, in the front view, we are seeing like this, this is the stock. Now, here the important point to notice that, this is the stop pin. So, why this stop pin and this back stop, there are two important points, this is the stop pin, and this is the back stop. So, why a stop pin and back stop has been provided. Back stop and stop pin have been provided, in order to give the exact location of the sheet metal, under the punch. When we design a product, we know from, where we are going to blank out the raw material. So, this is the work piece that we have blanked out; this is the blanking operation that is being carried out.

So, we need exact location of the point, where the punch will go and act, and will perform the blanking operation. In order to, locate the work piece on the table or on the top of the die, where the blanking will take place, this stop pin, and this back stop are important. Then, we see that, there are die clearance angle that has been provided. Now, this is the die clearance angle, and we can see this is a angular clearance, that has been provided. It is not the linear clearance; it is the angular clearance and angle is given here, that is the die clearance angle.

Now, these are the important labeling or these are the important points that have to be considered in a die and punch set for blanking operation. Then we see this is the die, this solid portion, this is the die, this is the die opening, where the punch is acting. And then another point, that is the striper plate, why the striper plate has been provided. This is the striper plate, this total, this, and this. Now, we have seen that, when this punch will go down and it will blank, this work piece. Sometimes, there is a tendency, when the punch retracts its path, some of this stock may tie to lift up.

So, if this striper plate is not provided, the stock will has the tendency to get lifted with the backward stroke of the punch. In order to avoid that, we provide a striper plate, whenever the punch is retracting the path. And, the stock is somehow, it attaches to the punch may be, because of the lubricant layer or because of any other phenomenon or mechanism. This striper plate is provided, so that, this stock is striped of the punch, when the punch retracts its path. So, this is the basic operation of die and punch set, which is used in the blanking operation.

So, now we have seen, with the help of the diagram. We have tried to understand that, what are the different types of operations, that takes place, in with the help of die and punch, in the blanking operation. And, what are the different important aspects that have to be taken into mind, that have to be taken into consideration, if we want to make a good quality product using the blanking operations. So, whatever we have discussed with the help of this diagram, we will just have a review of that in the form of a simple text.

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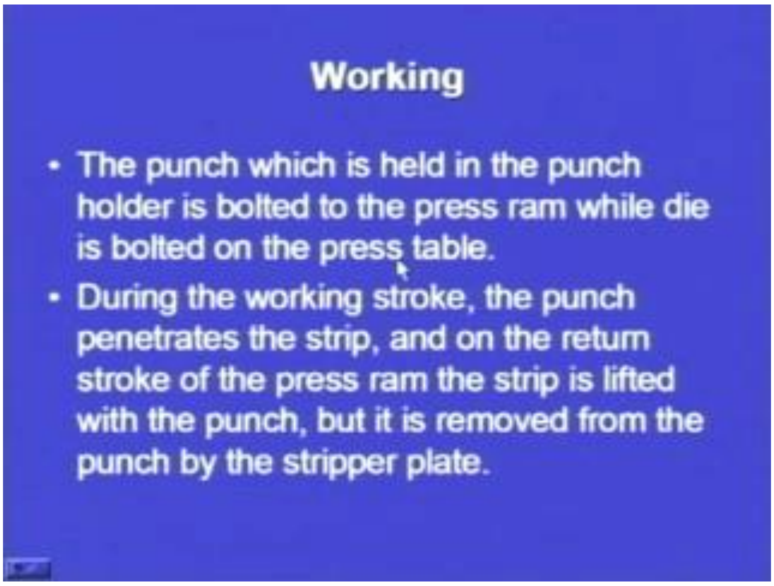

The punch, which is held in the punch holder, is bolted to the press ram while the die is bolted to the press table. Now, this operation will be carried on a press. So, that press, different types of presses are there; that we will discuss in the subsequent lecture. But here, we can only try to understand that here the punch, which is held in the punch holder, there is a punch holder, which holds the punch, and it is bolted to the press ram.

So, there is a ram, which will go up and down. So, the press has a mechanism, which has a ram and the punch is bolted to this ram, and this has a reciprocating motion like this, and the die is bolted to the press table. So, there is a table, on which we will place the die. So, the punch will be bolted to the ram of the press, and the die will be bolted to the press table.

Now, during the working stroke, now working stroke means when the ram is coming down. So, during the working stroke, the punch penetrates the strip, penetrates the strip means that the strip is the raw material, that we are using, that was called stock also. So, whatever raw material we are using, the punch is coming down, and it penetrates the strip. And, on the return stroke of the press ram, now press ram we are calling, because the ram is the portion of the press, and that is why we are calling it the press ram.

Now, and on the return stroke of the press ram, the ram is coming up, the strip is lifted with the punch, that already in the diagram I have explained that there is a tendency, that the strip may get lifted with the punch. But, it is removed from the punch by the striper plate. So, this point very clearly illustrates that why a striper plate is required in our die and punch set for blanking operation.

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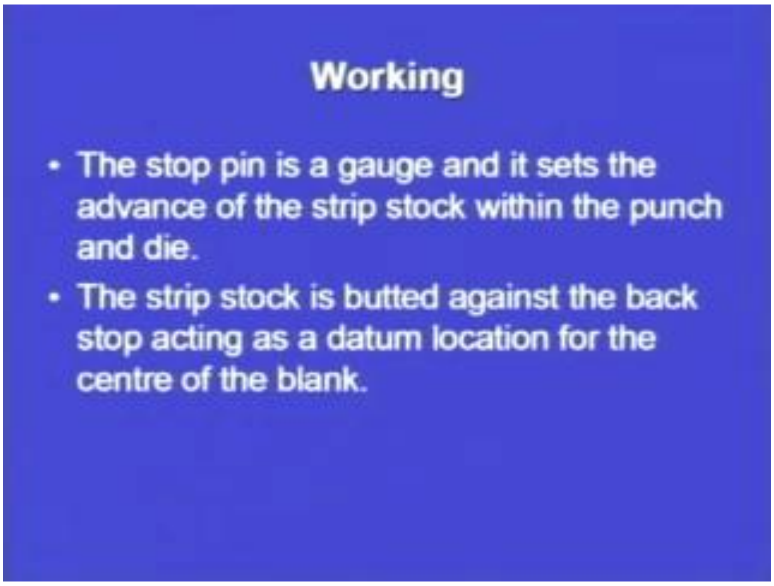

Now, the stop pin is a gauge, and it sets the advance of the strip stock within the punch and die. Now, stop pin already I have told, it acts as a gauge, and it guides that, how much stock should be fed into the die and punch assembly. Because, we have to exactly locate that, where the blanking has to take place. The strip stock is butted against the back stop, acting as a datum location for the centre of the blank.

Now, we have to locate the exact centre of the blank, where the blanking has to take place. So, these two important points that is the stop pin and the strip, and the back stop. The stop pin and the back stop, these are the two important gauges, that are used to a certain, the exact positioning of the strip on the die, so that we know that at what particular position, the blanking is going to take place.

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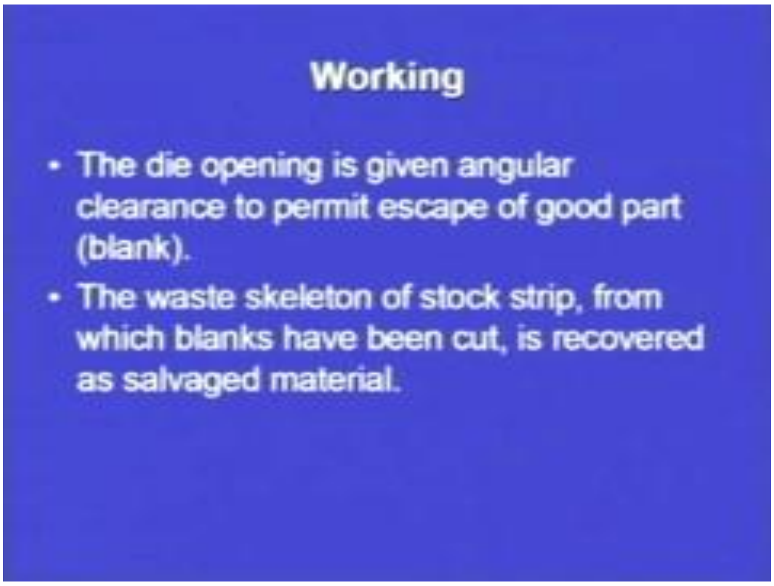

Now, the die opening is given angular clearance to permit escape of good part. Now, the good part, here in case of blanking, is the blank. If we are doing the punching operation, it is opposite to that, whatever portion is coming out is used as a scrap, and whatever portion in which, we are doing the punching is finally used as the final product. So, they are opposite to one another, but we are here discussing, die and punch type of arrangement for the blanking operation. So, the die opening is given an angular clearance, to permit escape of the good part.

So, here in case of blanking operation, the good part is the blank that is coming out. So, in order to have an easy escape of the blank, we provide the angular clearance. The waste skeleton of the stock strip, that was seen in the diagram, the material that is going out, after the circular blank has been cut from which the blank has been cut, is recovered as a salvaged material. So, whatever material is left, that is the salvaged material, and it is the waste material, in case of blanking operation.

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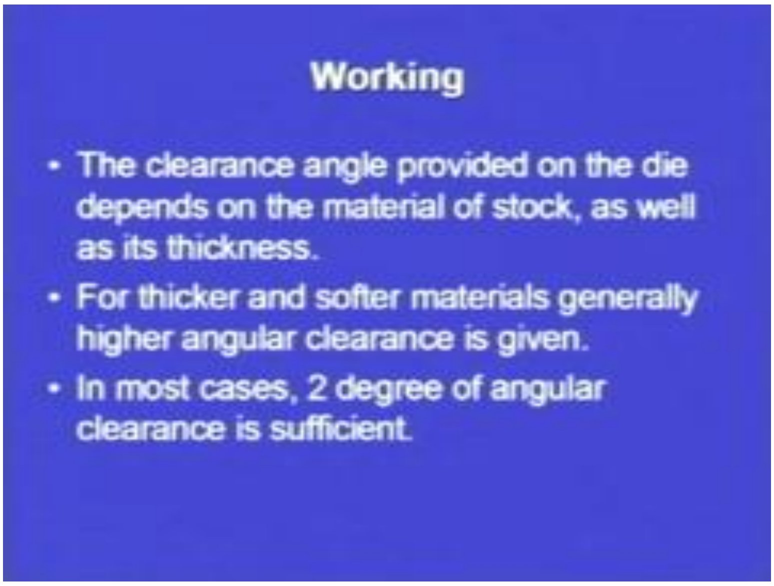

The clearance angle provided on the die depends on the material of stock, as well as its thickness. Now, very clearly, two points have been mentioned here, that we have to provide the clearance. It is providing the angular form like, it is provided a clearance angle is given, and it is provided on the die. And how much angle has to be given, it depends on the material of the stock. The stock out of which, we are going to form or we are going to produce our blanks or the final product, as well as its thickness.

So, there are two important points that have to be addressed, while we perform the blanking operation, and when we give the angular clearance. Now, the clearance is given on the basis of two important aspects, these are the material, out of which or the material of the strip or the material of the raw material of which we are going to form the blank or on which we are going to perform the blanking operation, as well as the thickness of the raw materials.

So, these two important points have to be taken clear of. For thicker and softer materials, now, first point is the thickness. So, if the thickness is more or the sheet is thicker, and the material is soft, generally higher angular clearance is given. So, depending upon the first point, two important points have been addressed here, that is the thickness is important criteria as well as the material is another important criteria. Now, if the material is very, very soft and it is thick, then we have to give higher angular clearance.

So, what will happen as question may be there, that if we do not give higher angular clearance, what is going to be the problem. The problem is, that the quality of the blank or the quality of the final product, that we are going to get, will not be according to the desired specifications, will not be according to the desired quality standards or quality procedure or quality specifications. So, for thicker and softer materials, we have to provide higher angular clearance.

Similarly, in most of the cases, two degree of angular clearance is sufficient. So, there is a broad guideline or there is a rule of thumb, which can be used, which is that, if we are going to give angular clearance in die punch set, in case of a blanking operation. We can go for two degree of angular clearance. So, angular clearance is must in order to have a easy ejection of the blank or that is the good part.

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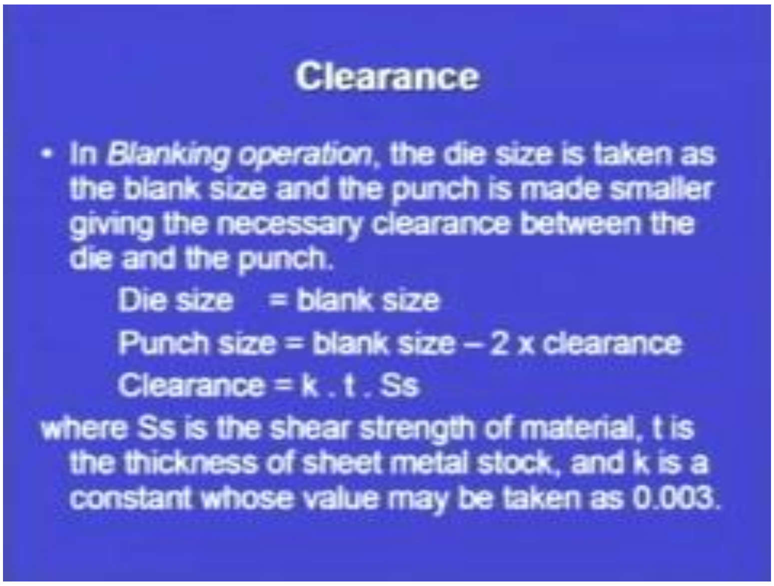

Then coming on to clearance, in blanking operation, the die size is taken as the blank size, and the punch is made smaller, giving the necessary clearance between the die and the punch. Now, we will compare that, how the clearance has to be given in blanking operation, as compared to the punching operation. So, here we can see, that in blanking operation, the die size, the die size means the size of the die, the opening in which, we are performing the blanking operation is taken as the blank size. Now, blank size is the final size; that we are going to produce.

So, the final size will be equal to the size of a die. So, the die that we are designing, we first make a die and then we perform the operation. Now, when we design the die, we will keep the size of the die, as the blank, that we want to produce, and the punch is made smaller. So, here the punch is smaller as compared to the size of a die, and the necessary clearance between the die and the punch is provided. So, here the clearance is provided on the punch, and the blank size is directly equal to the die size.

So, here on you screens, you can see that the die size is equal to the blank size, in which case, it is in the case of a blanking operation. The punch size, while designing a die and punch set for a blanking operation. The punch size is equal to the blank size, that is the size of the blank, the final product that we want to make minus two times, the clearance. So, whatever clearance that we want to provide, the punch size will be blank size minus two times the clearance that has to be provided.

So, we can hereby, design that the die size, what should be the exact size of the die. So, suppose we know that, what is the final size of the blank? We know that, what is the final product? That we are going to make on that the depending upon the size or specifications of the final product. We will take a decision that what should be the size of our die. Similarly, depending upon the type of operation, if it is blanking, we will give the clearance on the punch.

So, the punch size will be calculated using the blank size, which already we know, that what is the final product, what is the size of the final product that we are aiming for what, that we are designing, that we are trying to produce, using the sheet metal forming operations, we know, what do we want to make? Now, depending upon that size, we will calculate the punch size, the punch size will be given by blank size minus two times the clearance.

Similarly, what is the value of clearance, how much clearance has to be provided? So, we can calculate it mathematically. So, the clearance is given by K multiplied by t multiplied by Ss, now what is K t and Ss. Ss is the shear strength of the material, t is the thickness of the sheet metal stock. So, this t is the thickness of the sheet metal stock, and K is the constant, whose value may be taken as 0.003. Now, K is the constant, so t is the thickness and SS is the shear strength of the material.

So, already we have discussed that the clearance, how much clearance has to be provided. Basically depends upon the two important aspects, now what are these two important aspects. These two important aspects are the thickness of the raw material, as well as, what is the type of raw material that we are using. So, the material may be varying, depending upon the type of the material chosen for making the final product. We have to decide that, what is going to be the final punch size, die size, because clearance directly depends upon the shear strength of the material.

Now, shear strength will vary, according to the different materials that are chosen for making the final product. So, whatever we have discussed, that two important aspects are there, that have been clearly depicted in this mathematical formulation, where we have seen, that clearance depends upon shear strength as well as the thickness of the raw material or thickness of the sheet metal stock.

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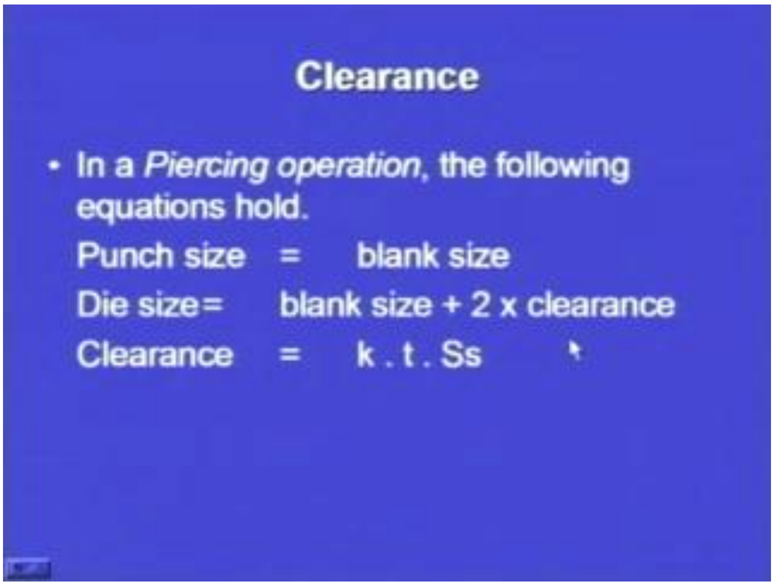

Now, in case of a piercing operation, already I have told that, we will discuss the clearance in aspect of blanking operation, and clearance in aspect of piercing operation. So, if we are going for a piercing operation, the following equations will hold good. The punch size will equal to a blank size. So, what was happening in the previous case, where we were performing a blanking operation? We were giving a clearance on the punch and the die size was equal to the blank size.

But, here the punch size is equal to the blank size, this is, it is opposite to the blanking operation. And, then the die size is equal to the blank size plus two times the clearance. So, basically what we are doing, we are providing the clearance on the size of the die. So, whatever size of the blank, we are making, we are slightly increasing the size of the die by how much, by two times the clearance. So, die size, die is given the clearance here, because blank size plus two times the clearance.

And the clearance is again calculated using the same formulation that is K multiplied by T multiplied by the shear strength of the material. K is a constant, already we have discussed, then what is t, t is the thickness of the sheet metal stock. So, what we have discussed regarding the clearance and, because the clearance has to be provided, why it has to be provided. In order to, facilitate the easy removal of the blank, and in most of the cases, it has to be given as two degree. Then, in case of blanking operation, the clearance is provided on the punch.

And in case of the piercing operation, the clearance is provided on the die size by increasing the size of the die, from the blank size by two times the clearance. So, that die size will be bigger than the blank size. In case of the blanking operation, die size will be exactly equal to the blank size. So, this is the importance of clearance like, we have to provide the clearance, if proper clearance is not provided, the quality of the final product that we are going to get will not be according to our desired levels or according to the desired quality standards.

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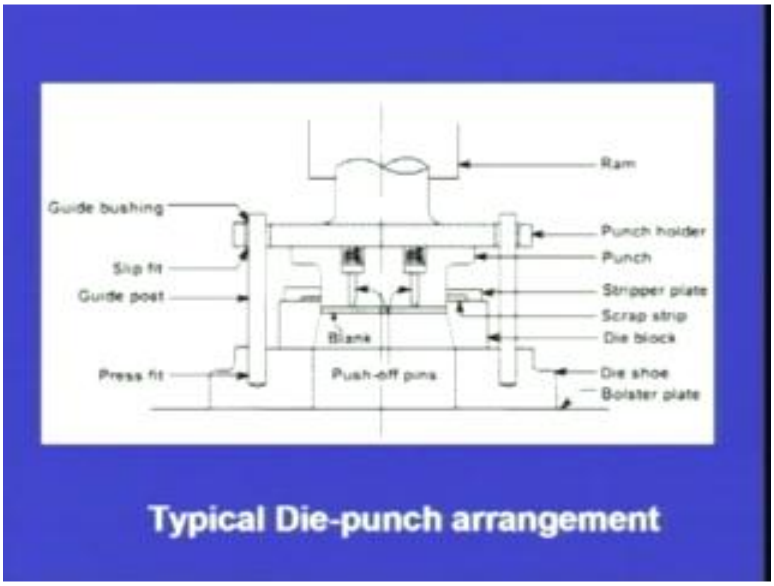

Now, we come on to another important diagram that is showing us a typical Die- punch type of arrangement. Now, in order to understand this, let us first of all see that how the diagram has been labeled. We know that this type of operation will be performed on a press. So, there is a ram which spokes the punch, this is the punch holder you can see, this hashed portion, this is a guide bushing, the punch is supported here, this is the punch, labeling you can see, this is the punch. Then, these are the push off pins, two pins are there, they may be spring loaded. Then, there is a blank, that is the final product; that we are going to make.

Then, this has been press fit here, this is the bolster plate, on which the whole arrangement is there, this is the die shoe, this portion, next portion, this is the die shoe. Then, there is a die block, this is the die block, here you can see die block is there, again there is a striper plate, this is the striper plate. And then punch, punch holder, already we have discussed. So, now in this type of a arrangement, the punch comes down, and this is the raw material that has been supported here and it forms a blank.

So, with the movement of the ram, with the movement of the punch, the punch comes down and then finally, it forms the blanking operation, and this is the blank final product that has been formed here. So, in this, we can see that, again there is a clearance that has been provided. And sometimes, because of the lubrications that is provided, in order to facilitate the easy operation. This blank, that has been formed, has a tendency to stick with the punch, just to understand, like if the punch has been lubricated there is a lubrication that has been provided on the punch, and the punch is coming in contact with the plates.

Suppose, this is the dies, this is the stock or this is the plate that we want to punch, and the punch is coming, and it comes in contact with this, and then it goes down, and it forms the blank. We have provided the lubrication or grease or any type of lubricant on the top of the plate. So, now when this sheet metal or this plate, on which we are performing the operation, if lubricant has been provided, when the operation has been completed, and the punch is coming back.

There is every particular possibility, every possibility that, because of the lubricant, because of the attachment or because of the thin layer formation between the punch, as well as between the blank that has been formed. The blank has a tendency to get lifted with the punch. So, these push off pins, these two pins, which have been provided. First one is this, second one is this, with the arrows very clearly, it is depicting the push off pins. These push off pins are spring loaded, and they act as the ejector pins for the blank.

If in any case, that blank gets attached to the punch, this push off pins being spring loaded will just push the blank down. And the blank will be coming out or will not be attaching to the punch, and we will be getting the blank or the final product that has been formed. Another important point, the striper plate again is provided here. So, when the punch comes back, it has a tendency to lift the remaining raw stocks. So, in order to avoid that, this striper plate has again been provided. So, this is a typical die punch type of arrangement that is used for a blanking operation. So, there are other types of arrangements also, which we will discuss subsequently.

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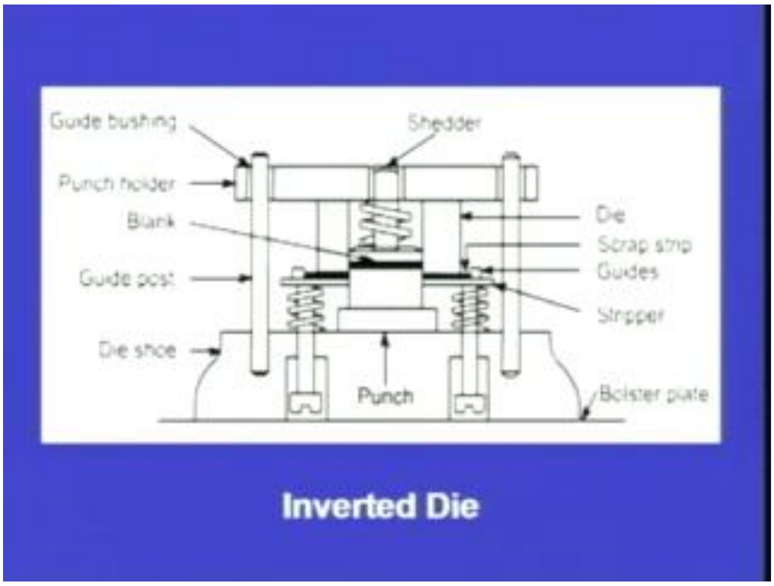

Now, this is the case of inverted die. Now, inverted die we can see, in case of a normal arrangement, which was shown in the previous slide, this is the normal arrangement. We see that the ram and the punch, the punch is at the top, and the bolster plate, the die shoe is there on the bolster plate and the die is at the bottom. So, the ram is bolted to the punch, and the punch is coming from top and the die is being placed on the table. But in case of inverted die, we can see that this is the bolster plate again, but this is the punch.

The punch is not coming from top, this is the guide bushing, similar to the one that was used in the previous case. Then, this is the blank, this is blank, this is solid portion, this solid portion that is the black solid portion is the blank. Now, this is the guide post, this is the die shoe, this is the punch we can see, that the punch is connected to die shoe in case of inverted die, and this is a shedder, and this is the die. So, important point to note here is that the die is not directly on top of the bolster plate or is not connected to the die shoe; it is connected to this particular punch holder.

This is the die, this portion and this portion, and this is the blank, which is been formed in between the die. Then, again a striper has been provided, because the punch, when it comes down or this pushes the punch down, this particular blank, the stock that is remaining, this blank has been formed. This is our final product; this is the final product that has been formed. But, this portion, that is the scrap or the skeleton of the material or the salvaged material that is remaining, has a tendency to get lifted with this punch.

So, in order to avoid that a stripper plate, a stripper, this is a stripper, this particular portion and this particular portion. This stripper will act in a similar fashion as was being it, as it was functioning in the previous case. So, whatever we have discussed, we have seen in case of this inverted die. We will just try to study it in a very plane basic language that is what, we are discussing, so that, we are able to understand the ((Refer Time: 26:50)) of a diagram.

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Now, inverted die is designed with the die block, fastened to the punch holder. Now, we can see, where the die block is fastened to the punch, this is the punch holder and die block. This is the die block, in which we are forming, this is fastened to the punch holder; already we have seen this. And the punch fastened to the die shoe, in the diagram clearly I have told, that there is a die shoe and the punch is fastened to the die shoe. Now, during the downward stroke of the ram, the blank is sheared from the strip.

So, the blank is the final product that we are making here, it is sheared from the strip. So, the operation that we have discussed sheet metal forming operation, that the shearing is one of the important operations. So, the blank, that we want to form is sheared from the strip, the blank and shedder are forced back into the die opening, which loads a compression spring in the die opening. So, in the die opening, there is a compression spring.

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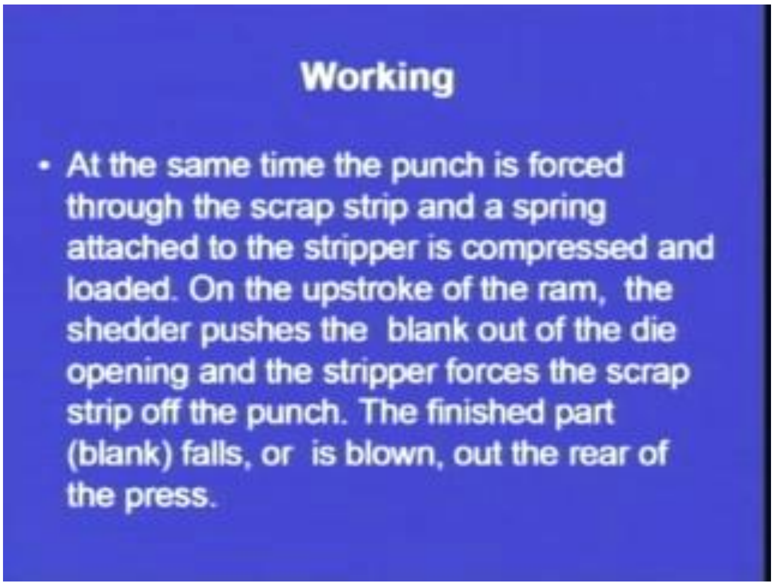

At the same time, the punch is forced through the scrap strip and a spring attached to the stripper is compressed and loaded. So, the stripper, there is a spring, that is has been associated with the stripper on the up stroke of the ram, the shredder pushes the blank out of the die. Now, on the upstroke of the ram, the ram is going up to the top, the shedder pushes the blank out of the die. The shedder will push the blank, outside the die and the stripper forces the scrap strip off the punch.

Now, why the stripper was used, it forces the scrap strip of the punch, because this, whatever sheet metal has been left or whatever is the skeleton of the material that has been left or whatever is the salvaged material, has the tendency to get lifted with the punch. So, in order to avoid that lifting mechanism or in order to strip off that material from the punch, a stripper is used. So, very clearly it has been depicted here, in this particular point. The finished part blank, falls or is blown out of the rear of the press.

Now, whatever final product has been formed, it either falls or it is blown out of the rear of the press. So, it is blown out, out of the press. So, we have seen that, there are two types of arrangement, first one is the typical die set arrangement, and the another one is the inverted type of arrangement, where the die is not associated or not bolted to the die shoe, but the die is bolted to the punch holder. Then, the punch is associated with the die shoe or is bolted to the die shoe.

So, there are different types of arrangement, now depending upon, what are the final requirements, what are the final types of accessories that are required, or final types of accessories that are available with us or whatever are the final types of presses that are available with us. We have to make a decision that, what type of die punch type of arrangement, we have to use. So, that we are able to make the product according to the desired requirements and the desired specifications.

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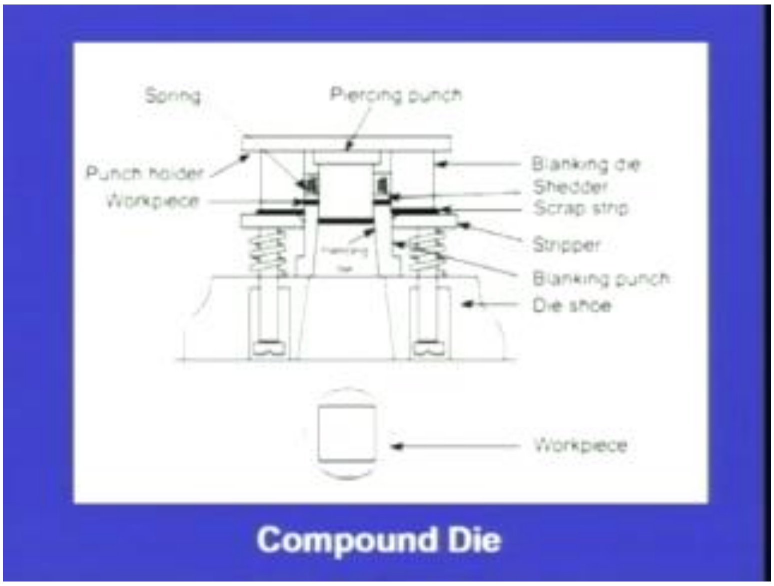

Then, this is another important type of arrangement that is compound die. In case of compound die, we will see, this is a piercing punch, as was in the normal case, this was the piercing punch and it will act from the top. Then, this is the piercing die we can see, these are the two phases of the die wall, this is a piercing die and this is a piercing punch. So, it is very easy, that there is a die, there is a punch, and there is a raw material in between the die and the punch. So, when the punch is coming down, there is a die opening and it is piercing the material.

But, important point to note here is that, there is another arrangement that has been in incorporated into this diagram. Now, what is that, we will see that, this is the blanking die; there are two types of dies that are there in this diagram. So, we can very easily understand that, this is the piercing die, this one, which will help in the piercing operation, then we also have a blanking die, this is the blanking die, this and this. So, where are the blanks coming out, we can see, this is the work piece, this particular and this particular.

So, two operations are taking place simultaneously, there is a piercing punch, which is performing the piercing operation with the help of this punch, and these two dies. And, these two die sets are also acting as punch for the blanking operation, and this is the blanking die, that is there. So, this is spring loaded we can see, and blanking punch, so this is the blanking punch. So, this is acting as a piercing die as well as the blanking punch. So, there are two operations simultaneously taking place, in case of a compound die, a piercing operation as well as a blanking operation.

So, the die that is acting as a die, in case of the piercing operation, is acting as a punch in case of a blanking operation, we can see very clearly, it is written blanking punch and this is the blanking punch and this is the piercing die. So, two operations, wherever we need, because always we have to justify the cost, may be considerably higher as compared to the other die-punch type of arrangement. So, we have to justify it with a very high production rate. So, here we can see the two operations are being performed simultaneously.

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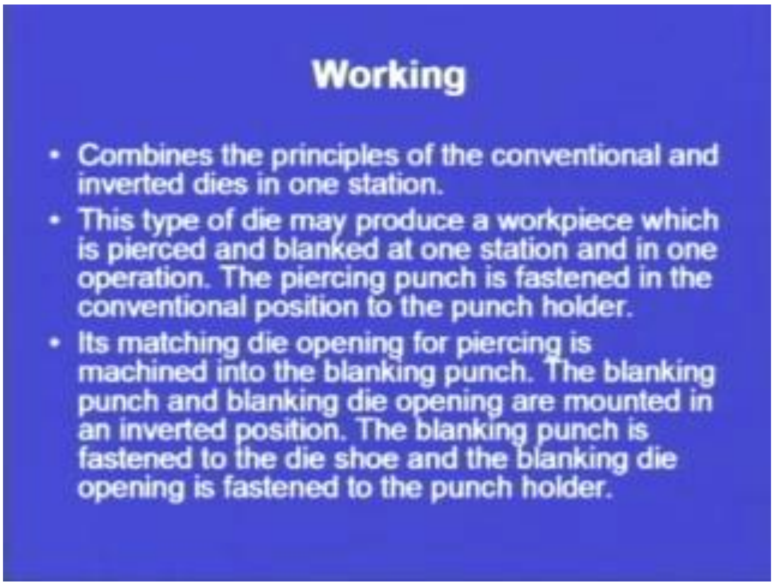

Now, in order to, understand this in the better possible manner. The compound die combines the principles of the conventional and the inverted dies in one station. So, if we are able to combine the conventional as well as the inverted die operations that can be performed with conventional and ((Refer Time: 32:52)) dies at one station, our productivity, as well as the production rate is going to improve. Then, this type of die may produce a work piece, which is pierced and blanked at one station, and in one operation.

The piercing punch is fastened in the conventional position, as we have seen in conventional die punch type of arrangement, wherever the punch is fastened here also, the punch is fastened at the similar position. And, what is that position? That is the punch holder. So, the piercing punch is fastened in the conventional position; that is to the punch holder. Then, its matching die opening for a piercing is machined into the blanking punch. So, there is a blanking punch that we have seen in the diagram, inside the blanking punch, whatever is the piercing die that is machined into the piercing punch.

The blanking punch and the blanking die opening are mounted in an inverted position. So, there is a conventional position, and there is an inverted position also. So, the blanking punch and blanking die opening are provided in the inverted position. So, initially, we have seen, there are two types of die-punch types of arrangement. The first one was the conventional type, the second one was the inverted type and third, particular arrangement that we saw was of a compound type, in which we were seeing that, there are two types of operations, that are taking place simultaneously.

So, what are these two types of operations? These two types of operations were the piercing and the blanking operation. So, in case of blanking operation, as you can see on your screen, the blanking punch and blanking die opening are mounted in an inverted position. The blanking punch is fastened to the die shoe and the blanking die opening is fastened to the punch holder. So, blanking operation is taking place in a inverted position and the conventional piercing operation is taking place in the conventional mode, that is the punch is coming from top and it is performing the punching operation.

So, we have seen that, in case of a compound die, we are able to perform two different types of operations at a similar station, at a simple place, at a single station. So, in our, in whatever product that we are making that is the combination of these two operation. So, the improvement can be noted in terms of production as well as in the complexity of the final product that we are designing or that we are intending to produce using a die and punch type of arrangement or any sheet metal operation that makes use of die punch type of arrangement.

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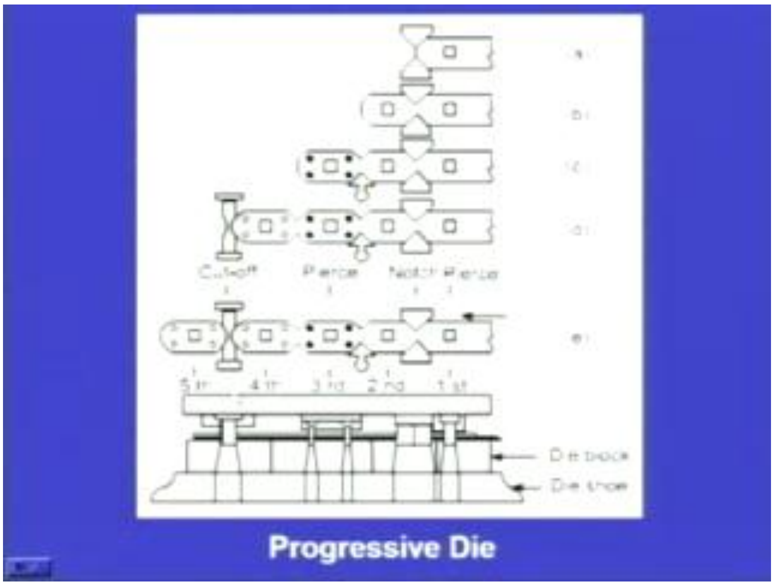

Now, this is another type of die, already we have seen that there are three types of die; that is the conventional die, inverted die and the third one was the compound die. Now, this is the fourth type of die; that is the progressive die. Now, in progressive die, what is the need of the progressive die that we will see in the subsequent, when we discuss, whatever we will see in this diagram. We will discuss all those things, again to have a review that, what this diagram finally gives us.

Now, here we see that our final product, I will start from the last particular diagram that is the diagram E. So, here there are five important stages, first one is stage A, stage B, stage C, D, E. Now, this is the die block you can see, this is the die shoe. Now, we can see that the die block has different openings here. Now, depending upon the requirements, we can design it, whatever is the final product that we want to make. We need to have square holes; we need to have square recesses; we need to have circular holes; whatever we need to have V type of notches.

Now, depending upon, what is the final requirement, we can design, this particular process or this particular progressive die arrangement. Now, we can see that, there are different stages, already we have seen. Now, in the first stage we see that, this is the square recess that has been produced, so this is the first stage. Second stage is an idler stage, in which this is the dies; this is the material that is being fed. So, this is the top view that has been shown, this is the front view, which has been shown.

In top view we see, this is a plate, on which we want to make our final product. Now, what is going to be our final product, this is the final product that we want to make. Now, in our final product we see that, there is a square opening. Then, there are four holes one, two, three and four, and then there is a particular shape, that are the V type of notches here, if we make and then again we make this type of arrangement, this is the final product that we will get.

Now, there are different stages, as we have seen, first, second, third, fourth and fifth. So, in case of first particular stage, we are making a square opening here. Then, this material is fed forward and then we know that in first particular operation, a square has been formed here, and a V notch has been formed here. This is the, it has been produced, this particular shape has been produced using these two arrangements. Now, when we feed it further, this was cut in the first, this particular section was cut in the first operation only and this was cut in the first operations.

Now, in second, it is just idler. So, again we get these two shapes here, when this goes here, we get the shape and this particular section in third stage, we are producing four holes, in third stage four holes have been produced. Again, the strip is moved forward, and then we perform the cut off type of arrangement. So, there are different stages. So, we can say, this a progressive die, in progressive die, this is the die block, die shoe and there are number of operations are performed in case of a single die.

So, an important point to note here is that after the last stage, we will get final product after every stroke, because from here, we have started the formation. So, when we are performing operation on this, the similar operation is getting formed here also, a one, if here we are producing four holes in one stroke, here also we are producing this square recess. So, square recess is also getting formed. So, when it is a continuous operation, when we get this final product, the second final product is also ready, after the fifth stage or after that final operation, we will get the fifth part, this particular part.

Then, this is also getting ready, then this will reach here, means the process will be a continuous process. Initially, we will not get any final product, when we start the process. We are feeding the stock from here, only one or two operations are being performed here, but when the process starts continuously, every stroke will produce a final product. So, the productivity here will be considerably higher, as compared to the other operations or other die punch type of arrangement. So, progressive die is used, where we need to have a very high productivity.

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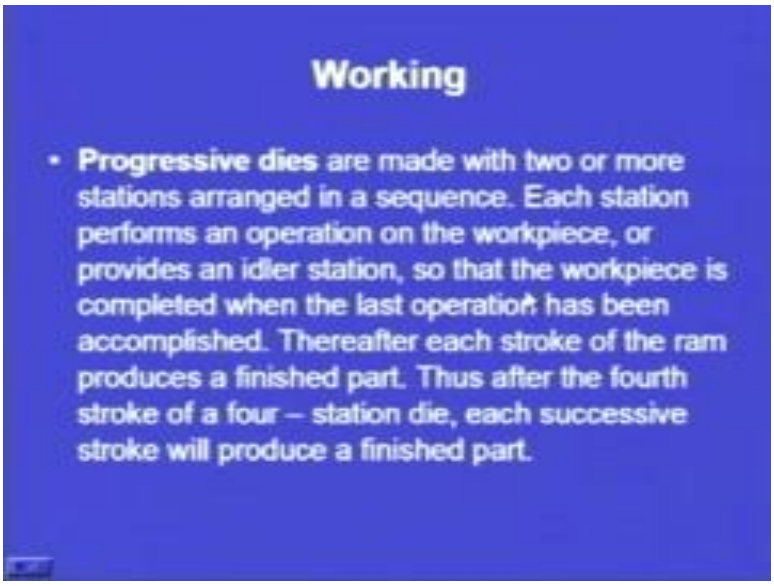

So, now we will try to understand that, what is the basic working of the progressive die? Now, progressive dies are made with two or more stations arranged in a sequence. So, already we have seen, we are making a square recess, we are making V type of grooves, we are making circular holes. So, depending upon different types of operations, different dies are arranged in a sequential manner. So, progressive dies are made with two or more stations arranged in a sequence, one after the other. Each station performs an operation on the work piece. Now, each station will perform an operation, we are producing holes, we are producing notches.

Now, depending upon, whatever we want to make, each operation will be performed at each and every station or provides an idler station. So, it is not that all the time, we are going to produce using a, we are going to perform an operation only. Sometimes, the operation can be an idler operation also, so that, the work piece is completed, when the last operation has been accomplished. So, when the last operation has been accomplished, we will get a final work piece. Thereafter, each stroke as in the diagram I have explained, once we are going to get one particular final product, after that each stroke will produce a final product.

Thereafter, each stroke of the ram produces a finished part. Thus, after the fourth stroke of four- station die, each successive stroke will produce a finished part. So, this is one example, which where we have taken that there are four strokes that are taking place, a four station die is there. So, each stroke of the ram produce a finished part, thus after the fourth stroke of a four station die. So, here we have different stations arranged sequentially. So, if there are four stations, one, two, three and four.

So, after the four stations, each successive stroke will produce a finished part, as we have seen in the diagram that different operations are getting performed at different stations. And once, one final product has been made, each stroke will produce a final product. So, the productivity or the major point to address or the most important point to address here, is that the productivity or the production rate or the production volume. If we use a progressive die is considerably higher, as compared to the other operations.

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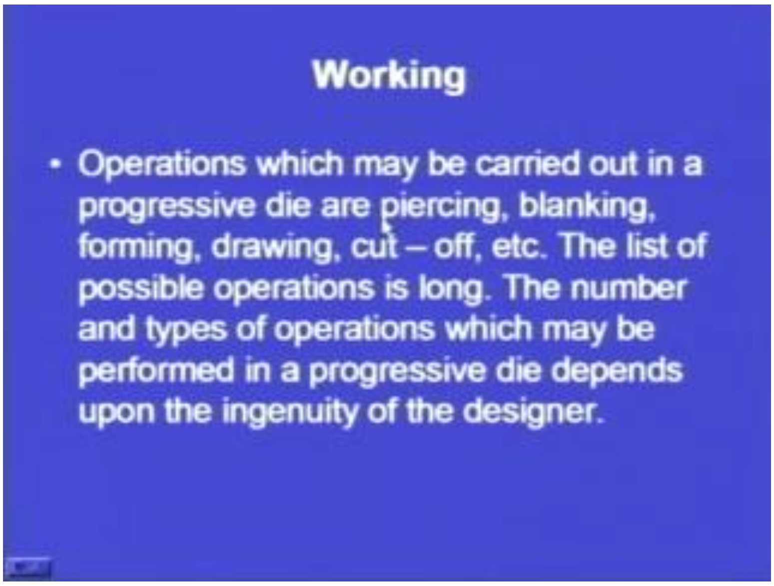

Now, operations which may be carried out in a progressive die are. So, what are the different types of operations, that we can perform using a progressive die? These are piercing, blanking, forming, drawing, cut-off etcetera. Now, these are some of the operations that can be performed using a progressive die, the least of possible operations is long. So, these are not the only operations that we can perform using a progressive die. There are other operations also, which can be performed using a progressive die.

The number and type of operations, which may be performed in a progressive die, depends upon the ingenuity of the designer. Now, the important aspect here is the design of the die. Now, progressive die has to be designed, depending upon the final product that we want to make. Now, what are the different types of operations that can be performed? Already in this point, we have seen that, we can do piercing; we can do blanking, forming, drawing, cut-off, different operations can be performed, in case of a progressive die.

But, now it depends that, how innovative, how creative the designer is, so that, he designs the die, that different types of operations or the most complex of the parts or the most intricate parts can be processed, using the progressive die. So, how much intelligence or how much creativity, the person has or the designer has, will render this particular type of die-punch arrangement, suitable for making very complex and very intricate sheet metal parts.

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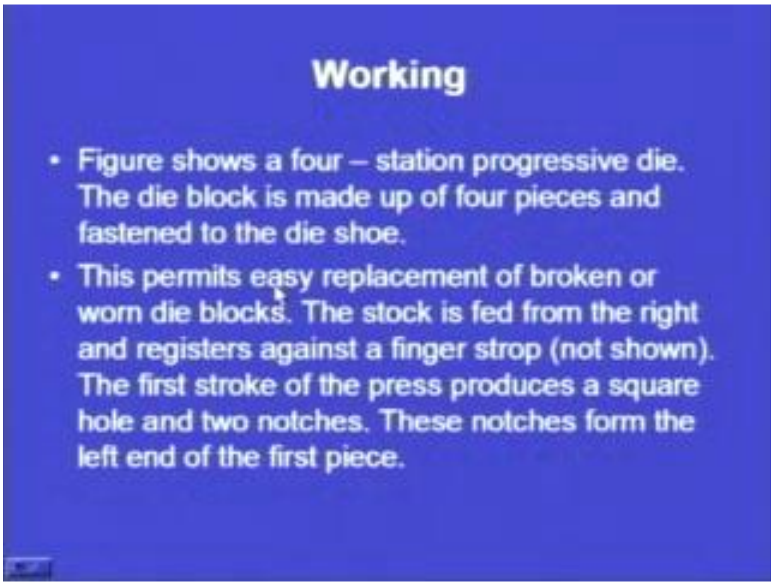

Now, the figure that we have discussed, show the four - station progressive die. The die block is made up of four pieces and fastened to the die shoe. So, in the diagram, we have seen that there were a die shoe on top of a die shoe, there were different portions, different die blocks that were there. So, we were forming different operations; we were making holes; we were making a square recess; we were making a V type of notches. So, all that was being performed in a single progressive die set.

So, we have seen that, there was a four - station progressive die, the die block is made up of four pieces. So, four pieces were there and they were fastened to the die shoe. Now, this permits easy replacement of broken or worn die blocks. So, what is the advantage of using this type of an arrangement? So, this permits easy replacement or broken worn die block. So, always we have seen, always we have addressed, these problems or whenever we use a die type of arrangement wear is there.

So, when wear is there, after them particular number of cycles, after then particular life of the die, we have to replace the die. So, if we are placing individual die blocks on the top individual die blocks. Then, we are able to produce that, we are able to replace it in a very easy manner. So, die shoe will remain stationary, there are different die blocks that have been put. Now, if any particular die block has been worn out, it can be very easily replaced. So, this permits easy replacement of broken worn die blocks.

The stock is fed from the right and registers against a finger strop. Now, in our diagram, we have not shown that, there is a finger strop. So, whatever feed has to be given or whatever input has to be given in the form of the raw material, it has to go and stop at a particular position, so that, the required operation is performed. If we are not providing a stock, then we do not know the, where the operation is going to be performed.

So, the stock is fed from the right, the stock here refers to the raw material. So, the raw material that we have to provide is fed from the right, and it registers against a finger stop. There is a finger stop, where this will go and stop. The first stroke of the process produces the square hole and two notches. So, we have already seen in our diagram, that the first stroke will produce a square hole and two V types of notches. These notches form the left end of the first piece.

So, as we have seen in the last step, that was the E stage or the last stage, that there are two V notches. So, this forms, the left end of the final product that we will get. So, initially, we are making two V notches and a square hole with the help of first die block, but that will be used, when we get the final product. So, when the left side of the final product has already been processed, at the first stage itself.

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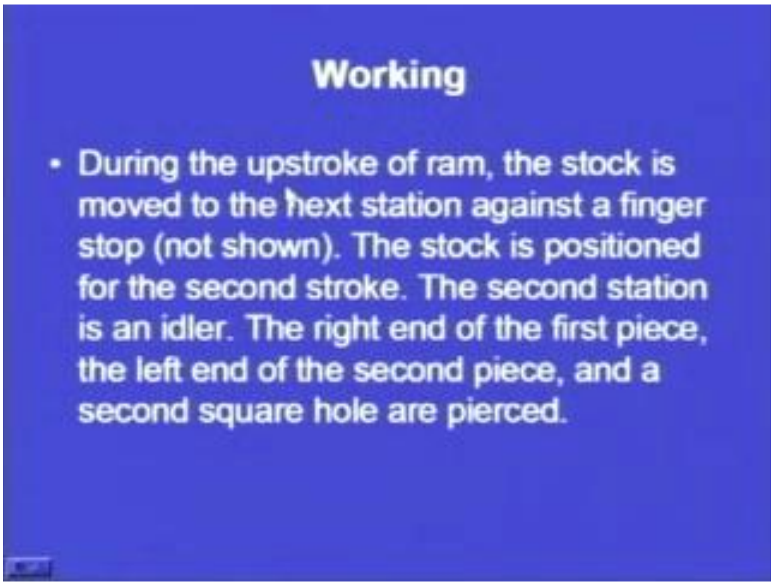

Now, during the upstroke of the ram, so when the ram comes up, the stock is moved to the next station against a finger stop. So, when the ram comes up, it has performed its operation, what was to be desired, what was what operation it has to perform. It has completed its operation, it comes back and the stock is moved to the next station against a finger stop, again here, the finger stop has not been shown. The stock is positioned for the second stroke; the second station is an idler, the right end of the first piece.

Now, the right end of the first piece, and the left end of the second piece, and a second square hole are pierced. So, in this particular portion, this is idler stroke, we are not getting too much operation here, but here on the first operation is also getting performed with the idler operation. So, what was the first operation, we were getting two V notches, and we were getting a square hole.

So, when the stock has been moved forward, the second particular raw material is getting ready, when the second particular finished product is getting ready. So, first has moved to the second, and the other material that is used, is come, is coming to the first position. So, in first position, what the first die block, we are performing the operation and the second one is the idler station.

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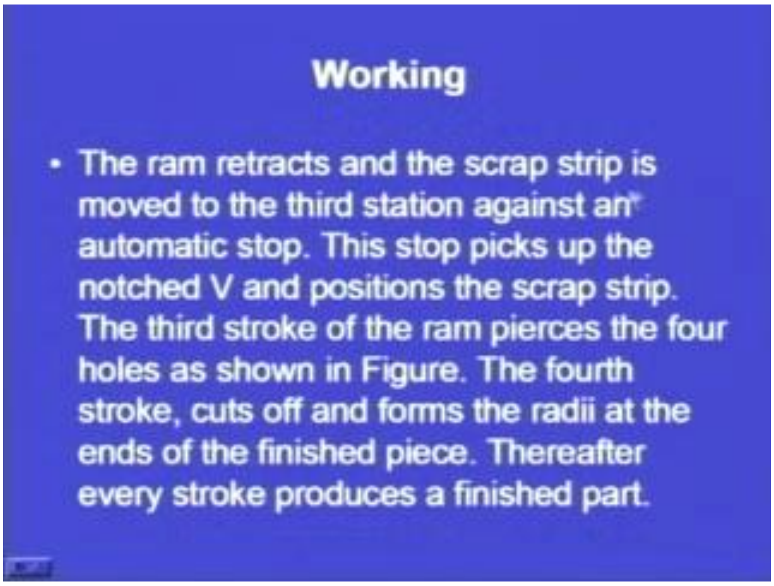

Then, the ram retracts and the scrap strip is moved to the third station. So, two stations already past, we go to the third station, and there is an automatic stop. The stop picks up the notched V; already we have made notched V shapes at the first stage itself. So, this stop picks up the notched V and positions the scrap strip. Now, positioning, already I have been discussing, that it is very, very important. If you do not position our raw material at the exact location, then there are every chances that, we may not get the final quality or we may not get the desired specifications of our final product.

So, this stop picks up the notched V and positions the scrap strip. So, positioning is very, very important. The third stroke of the ram pierces the four holes as shown in the figure. So, again we are making four holes here. The fourth stroke cuts off and forms the radii at the end of the finished piece. So, the fourth stroke will cut off and form the radii at the end of the finished part. So, there was a radii at the end of the finished part, there were four holes, there were the radii at the end of the finished part, there was the square recess, and there were V notches at the end.

So, all this is our first final product that has been produced at the end of the fourth stroke. After that, every stroke will produce a final product why, because whatever raw material is being fed, it is undergoing the operations subsequently. So, when the material has reached the third stage, it has already got performed two operations, at the first and the second stage. So, when it reaches the last stage, already all the operations that were required to convert it from a raw state to a final state, have already been performed on top of that.

So, when, as soon as the fourth operation will be complete, we will be able to get the final product. So, initially four strokes or three strokes are required, to make a final product, depending upon the die blocks or depending upon the stations that have been arranged in a sequence, but once one product has been made subsequently every stroke will produce a final product.

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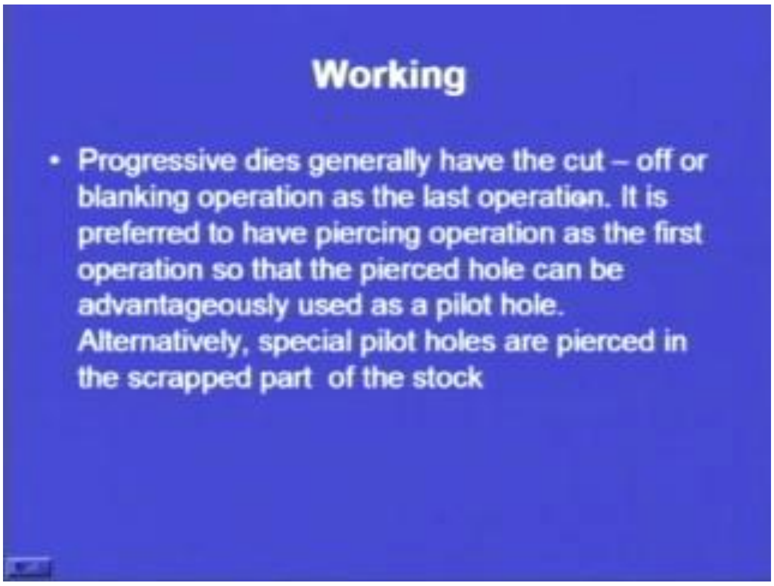

Now, progressive dies generally have the cut - off or the blanking operation as the last operation. So, generally, when we design, there is the rule of thumb, that we put the cut off or the blanking operation, as the last operation. It is preferred to have piercing operation as the first operation, so why the piercing operation, as the first operation, as the first operation, so that, the pierced hole can be advantageously used as the pilot hole.

Now, this can be one particular guideline, that already we have seen, that positioning is also very, very important. So, if we pierce a hole at a first station only, then this particular hole can be used as a pilot hole or it can be used as a guide, so that, we can a certain, the proper positioning at the subsequent station. So, it is preferred to have a piercing operation as the first operation. So, that the pierced hole, the hole that has been produced using the piercing operation can be advantageously used as a pilot hole.

Alternatively, special pilot holes are pierced in the scrapped part of the stock. So, otherwise what we can do, we can alternatively produce pierced holes. So, that this can be used as a pilot hole in the subsequent operation, but these holes will not be produced in our final part. If the final parts do not have a pierced hole, we cannot make a hole, just for using it as a pilot hole. Then, we will make holes in the scrap and finally this will be used for the purpose that we have already discussed earlier.

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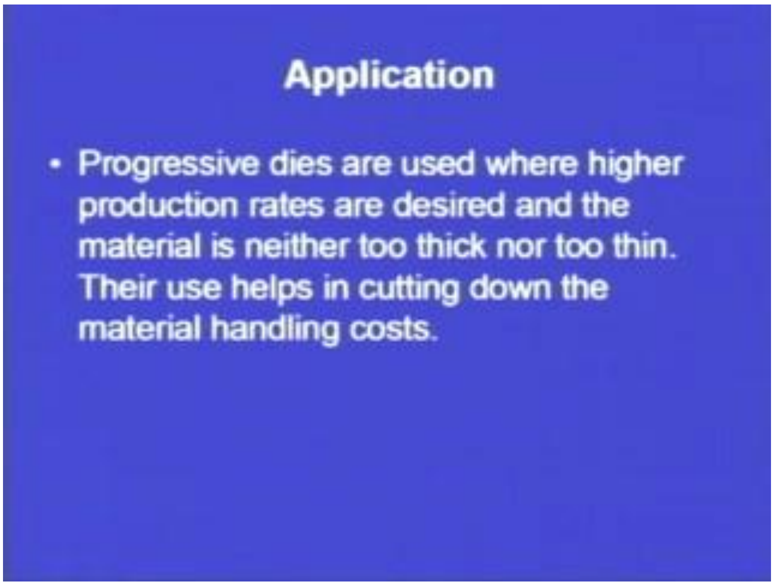

Now, coming on to the applications of progressive die, now where the progressive die can be used. So, our progressive dies are used where higher production rates are desired. So, already we have seen that, if you add on to the cost of the infrastructure or the cost of the equipment, then we have to justify it, with the help of the production volume. If we are investing too much of money in the infrastructure, and we are not making too many products, then we are at a loss. So, the break event, that will come, will come at a very large gap or after long, long time that nobody wants.

So, here progressive dies are used where higher production rates are desired, it is very true. If higher production rates are desired, we can go for heavier investment or higher investment or more investment. So, that whatever cost, we are investing in procuring a progressive die or designing a progressive die or manufacturing a progressive die, should be justified with the higher production volume. And the material is neither too thick nor too thin then there is a limitation on the material also.

If the material is very thick, then also progressive dies are not suitable. If the material is too thin, then also, we are not going to get the desired product quality or the desired specification level. So, the material should be in between, it should neither be too thick, it should neither be too thin. Their use helps in cutting down the material handling costs. Now, another important aspect or another important point that has to be addressed, in case of progressive dies, is that the material handling cost is also minimized.

If we are not arranging the stations in a particular sequence or we are not using a progressive die, what is going to happen? All these operations have to be any how performed, when we want to convert a raw material into its final product, what will happen? We will use a raw material, we will first make a square hole or a square recess then we will take it to another operation, another particular machine, where we will make a V notches.

Then to the third machine, where we will make four holes, then the fifth machine or the fourth machine, where we will give the rounding to the edges and then to the sixth machine, where the fifth machine, where we will cut it. So, what is happening? That raw material is getting shifted from one place to another place to third place to fourth place to fifth place, what is the disadvantage of this or what is the limitation of this. We are wasting our man power for moving the material from one place to another place.

Moreover, the logistics or the management on the shop floor also has to be more rigorous. Then, sometimes it may so happen, that some of the material is lying in front of a machine or is acting as a back log or the slowest machine, will act as a barrier or will act as a loop hole, for the higher production rate. So, wherever it is possible, we should go and we should use a progressive die. So, that the material handling is also minimized, and we get a product, every stroke of the operation. So, when we are making use of a, when we are getting a final product in every stroke of the operation, we means that the production rate is high, as well as the material handling, that is there is also minimized.

So, we have seen that, there are different types of die - punch types of arrangement. Very briefly, we have discussed four different types, that is first one was the conventional type, then the inverted die, then the compound die was seen, and then we have seen the progressive dies. So, we have seen that different types of die - punch type of arrangements are there, which can be used, in order to make the final product, according to our desired level.

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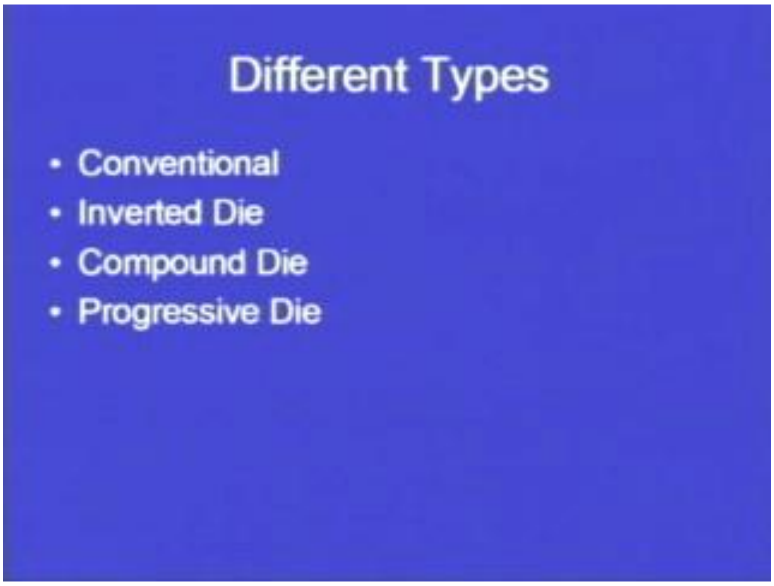

So, now we come to the end of this particular session on sheet metal working equipment. So, we have seen different types of die punch type of arrangements, what can be used to make convert a raw material into a final product, what is angular clearance, how it has to be provided, how much it has to be provided, on what factors all that depend. So, in our subsequent lecture, we will see that, what are the different die manufacturing technologies or die manufacturing techniques. We will see, how the die failures takes place, and then we will see the different types of pierces that are used in sheet metal forming operations. So, till now we have discussed all these things, after that, we will discuss on pierces, as well as on the die failure mechanisms.

Thank you.