Principles of Metal Forming Technology

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Lecture - 21
Classification of metal working processes

Welcome to the lecture on Classification of metal working processes. So, we will discuss about the different types of manufacturing processes basically the metal working processes. So, in that basically we will try to see the processes based on you know type of forces which are applied. Now, if you look at if you have an overview of these manufacturing processes, you have many kind of manufacturing process like, you have casting you have farming that we will discussed then we have machining further you have for the joining processes.

So, and then you have power metallurgy another things. Now, we know that in casting also again you have you can classify that in different type similarly the machining or the welding processes are defining the different ways. So, we will have a an over view of those criteria which can be huge for classification of metal working processes and we will see that how they are different from each other? So, as we know that we can once you have any shape you can change that shape by some processes one is the certainly the metal working process.

So, if you have a shape which is with you and if you have a change in shape either you can do it by working or you can do it by removing the extra part. So, that is the way and if you have 2 or 3 small pieces then also you can join it, but that is different. So, the thing is that you can do it either by plastic deformation. So, that certainly you apply the force then that force will certainly change it is shape, but again that shape will be change will be permanent or temporary that depends upon what up to what extent you have changed all applied the forces.

So, as you know that when we go for the metal farming technology normally in that case we are trying to see that the material is deforming plastically. So, you have to going for plastic deformation or you go for the machine machinings methods where you remove the material. Now, the thing is that why we go for these metal working processes the thing is that when we cast the material in that case there are certain inherent, you know

defects which are more probably there inside a cast product, which is normally cast through a normal route. And, the main you know defects which we in counter are basically the defect related to gaseous, you know presence like you may have the different types of gaseous that may be present inside.

So, certainly in that case you need to you know you need to be at to ensure yourself that these gasses are not there and for that either you reject it or then you go for the forming process where, if you have the smaller you know cavities in side and what you do is you further heat that and then you go for the forming process. In that case what happen there are chances, that these you know defects on the small hole force which are there they are welded together, when you form them when you roll them or force them or so.

So, this way their properties are enhanced. Further the another advantage of the metal working process is that you try to get fibers structure on the material, and that material basically is specifically used for some specific purpose in a better way than the cast one. So, so that way depending upon the type of use, you have to see that which type of process will be used. So, that you get a fibers structure of the required type.

So, that way these are the basic you know requirements or you can say necessities also if you try to see the example of very thin sheets. So, the sheets which there which you see on the roof or now a day thin curve it sheets are used, if you try to think about it how they are made you see it is strength they are quite you know high strength materials.

And, it is very difficult to make it through a casting route because the thickness is very very small and when you are trying to cast it because of the very thin I mean a very low thickness. And because of the large surface area it is very difficult to cast them, because as soon as you cast they try to you know get heated I mean get cooled and you would not get the sufficient strength in that case you will have the brittleness or you may have lot of defects possibilities and all that.

But, they are used you can see that they are numerous in used and this is possible only by forming process. Where, when we form the sheets by the cold rolling method first of all hot rolling method of the thicker sheets then you know and then when it comes to a smaller thickness then you go for the cold rolling of the materials. So, that way we try to see that you get a very very thin type of sheets and they have very good properties. So,

the thing is that you required these processes, which have lot of inherited advantages and they are more and more popular.

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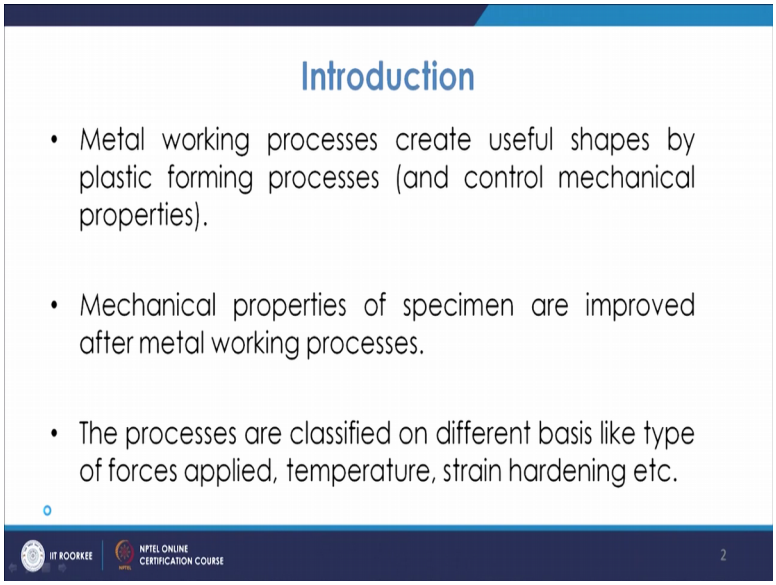

So, what we see is that the metal working processes create useful shapes by plastic forming processes and control mechanical properties. So, the thing is that we not only change the shape, but also the mechanical properties are improved, when we try to do the forming there are improvement in the mechanical properties like the gain the strength. And, and you are able to shape the material in the required you know shape which is not otherwise possible for some materials to be you know shaped in by other methods like casting or so.

So, this way and you also control mechanical properties, because once you are able to see that these inside, you have not proper diffusion of materials not there is no not homogeneous distribution inside or there are presences of the defects small force or gaseous you know reasons, all these things can be remove. And, once you remove them in this case you are likely to get the better properties mechanical properties of specimen are improved after metal working processes.

So, that is one of the aim along with a change in the shape the properties are basically improved. So, so that is the advantage big advantage of these processes. Now, the thing is what we discuss that although we have you may change the shape by some other routes, but then you it has other inherent advantages and that is why we go for such

processes. Now, in this lecture we will try to discuss the process classification based on different types of forces, which are applied. Now, the thing is that they are may be different classification, like type of forces applied as you know that the type of force normally, which you apply is the compressive force in most of the cases and in some cases tension force also.

But, then under what you know action of stress is under what combinational stress is the things are you know deforming the specimen is getting deformed that that clarity should be there in the mind. So, normally like if you look at the rolling or the forging processes there you apply the compressive force and source coming under directly the direct compression type of processes.

Similarly, you have some stress forming process where you apply tension forces. So, we will discuss about that, then temperature is a very important you know parameter based on which you can classify these processes. And, you can do the deformation at higher temperature or at lower temperature. Now, at higher temperature we have seen we have studied that higher temperature the flow stress requirement is less. So, you are able to deform it more easily you have to apply less stress to do the deformation at on the temperature is higher, whereas when you do the deformation at lower temperature.

So, in that case certainly the flow stress requirement will be higher. So, you require a an equipment with which can you know impart larger you know loads, which can put large load on the specimen. So, so these are so, based on that at which temperature you are carrying out these forming process, that can be you know classified based on temperature.

And, normally that is the hot working or cold working or warm working depending upon what temperature range you are working? And, how it is associated with it is melting temperature, because, certainly at the melting temperature before that only you have to deform. So, and then it will have certainly and there is a range in which you should work where I mean depending upon the metal, because there are many constrains. If, you go to higher temperature side, you have other resources related to the activity and other things. Similarly, strain hardening like many a times you required that with deforming or it also should be harder.

So, it is done at lower temperature then in that case strain hardening occurs. And, otherwise in certain case the strain hardening does not occur. So, based on that also there may be classification of these working processes.

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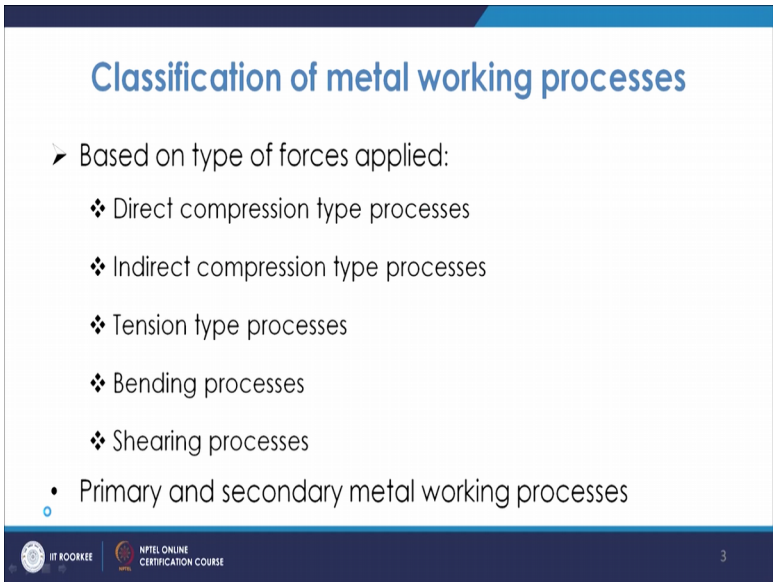

Now, we will discuss about the different type of metal working process, which are based on the type of forces applied. So, what type of forces are applied and what condition the material is deforming, based on that you have following type of you know forming processes.

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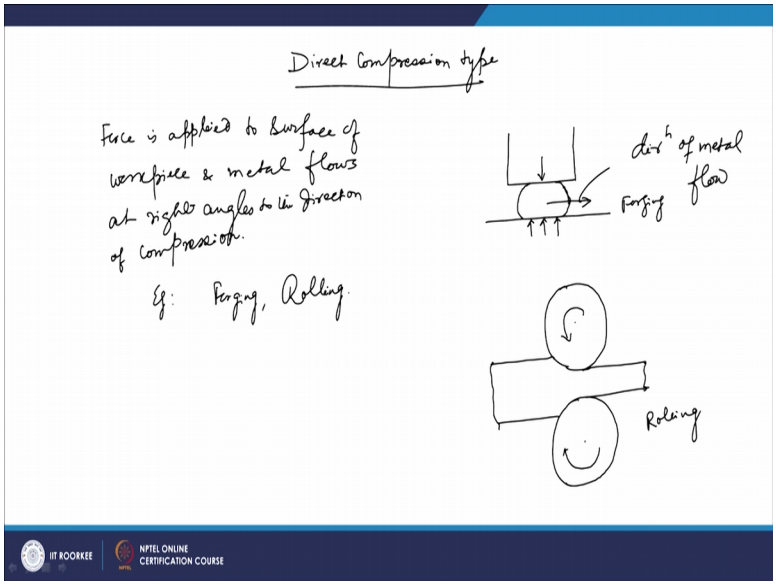

So, one is direct compression type process indirect compression type process the next one then you have tension type process, bending type process, and then you have shearing processes. So, these are the different types of classification based on which you can defined the different forming processes.

So, first of all you have the direct compression type. Now, the direct compression type means you are applying basically. So, normally the examples, if you when we discussed that we do the rolling or would you suppose when we do the forging. So, you have the die and you have the work piece.

So, you have a work piece here and then you apply the forces here. So, there will be reaction process from here. Similarly, you go the rolling. So, if you take the rolling in that you have 2 rolls. So, not easily quite, but actually it to be circular one so, these are the 2 centers which are in one line. And actually the slab or the billet or so, is coming into inside the rolls and at this point and the roll is ruling like it is moving in this direction.

So, this will be moving in the opposite direction. So, this way and this way you have so, this is your forging and this is rolling. So, in this case what happens that the compressive force is applied directly to the work piece. So, this is the work piece and this is the work piece. So, here what you see is that you apply the compressive force on the work piece. And, the there is movement there is deformation so, there will be movement of the metal flow to the right angle so.

So, in this way if you see applying the pressure in this direction and metal is flowing towards this direction. So, this is your direction of metal flow. So, my direction on metal flow is at the right angle to the direction of the compressive forces. Similarly, here also you are applying the you are applying the trying to compress the material and material flows perpendicular to that direction and then ultimately, it passes and it passes through this roll and then it goes. So, this way you define these direction direct compression type of forces and the examples are forging a rolling.

So, in this case the force is a applied to surface of work piece and metal flows at right angles to the direction of compression. So, this is about the direct compression type of forces and examples are forging and rolling. The next type of the metal working process based on these forces which are applied is the indirect compression type.

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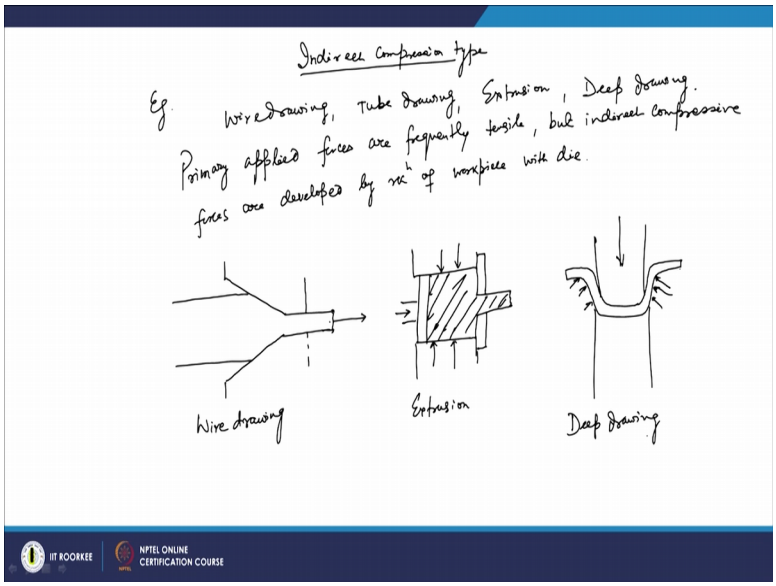

Now, in this case what happens that like, example is in this case your example includes the wired drawing or tube drawing or extrusion. Now, in these cases the primary forces which are primarily applied they are the tensile forces. However, the indirect compressive forces are developed and basically the flow of the material is because of these indirect compressive forces, which are developed at the suitable point in the because of the reaction of the work piece.

So, in this case you can say you showed example is wired drawing, tube drawing, extrusion, deep drawing. So, in these cases the primary applied forces are frequently tensile, but indirect compressive forces are developed by reaction of work piece with die.

Now, in these cases as we discussed that if you take the example of extrusion or in the deep drawing also you are applying the so, basically you are applying the at those that point in subjected to the tensile forces primarily we are applying the tensile stresses, but then the point where the work piece and the die they are meeting, they are because of the reaction and there is large indirect comprehensive processes are developed and this basically reaction value.

So, they are the stress value which is to very high value and in that case and there will be failure of the material. So, you can have the examples suppose you take the example of wired drawing. So, what happens that in the case of wired drawing you can have such,

you know die now in this case suppose you have 1 billet like this. Now, in this case if you try to draw the wire.

So, you are a stretching you are basically pooling from here. So, this is how you apply from there. So, this is the example of wired drawing now if you look at in this. So, what happens that you are although applying the tensile stress, but here once it comes and when you are a basically you know pooling it. So, at this interface basically where because of the in direct comprehensive forces, the reaction forces between the die and the work piece. Here, the large you know indirectly compressive stresses are developed and because of that the material fails compressive deformation takes place and so, material will be coming out.

Similarly, if you look at the example of extrusion so, extrusion goes like this. So, you have you know this is the billet this is you are billet which is to be extruded and you have the die. So, and from here basically you have so, basically this is to be. So, you have this way it will move and this is how doctors will be like.

Now, in this case what we do is for the here again we apply the force from here. So, as you see that you apply the force and then the material is extruded through this and in this case. So, your applying a forces from here. So, there will be reaction forces you know reached at this process and then the material will fail.

So, basically this is what is happening in the case of extrusion and the material deforms and comes through this cavity. So, this way your this is the example of indirect you know compression type of process similarly you have also deep drawing. So, in the case of deep drawing what happens that you have you have such a kind of. So, what happens again you have punch here and that basically is applying the pressure in this fassion, now if you look at so, you have the die here.

Now, in between you have the clearance and here basically the stresses are in generated. So, they are indirect compressive stresses and because of which the material fails at that point and there will be deformation of the material and it will take certain shapes.

So, this is the example of the indirect compression type of processes and you have a wired drawing extrusion of deep drawing under this category.

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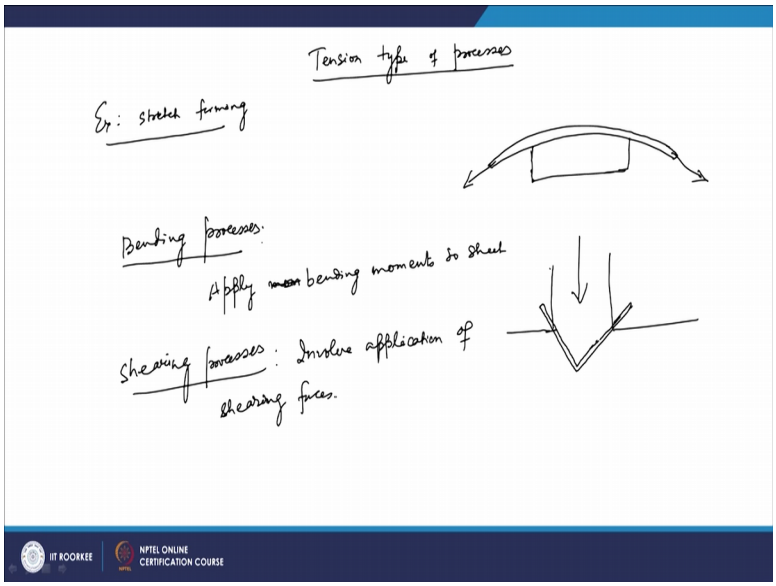

Then further you have the tension type of process. Now, in this case you apply the specimen I mean specimen is subjected to the tensile type of force and under that only it deforms. So, the example is the stretch forming. So, basically what happens that when we discussed about the indirect compression type of forces in those cases in one of the principle direction the compressive stresses, which we applied these are the very high value and that is why the material deforms?

So, that is how metal will be flowing under the action of the combined stresses, and that is why in the since in the one of the principle direction there will be large value of the compression force.

So, the material fails now in the case of tension type of process now the example is stretch forming now in this the example is that suppose you have strip like this. So, you have when you are applying. So, you are applying firm block here it is holding in this for block. And, then you are applying the stresses from the tensile stresses under from here, and then because of the tensile stress developed tensile type of force, which is applied the material will be elongated there will be deformation of the materials. So, that is why it is known as under the tension type of processes, similarly you have the bending processes.

Now, in this case; so in you apply. In fact, in this cases you apply the bending you know movement apply bending movement to the sheet. So, basically all the bending

applications, which are done on the sheets also so, that is suppose you have to bend some material. Now, you have to bend in this case so, you will have a punch like this. So, you have a punch of this shape and then from the here you apply this pressure and that way you develop this bending.

So, this way there will be bending of the component, which is done the in such cases you apply the bending movement. Similarly, many a times we need the shearing operation. And, basically the cutting of the sheets or many a times you need certain hole to be made in certain sheets, all these are based on the shearing operation where you have blade from the top and you have a blade at the bottom and then and there will be some gap in between them and based on that you will be cutting these shearing you know shearing these components.

So, you have shearing type of process. So, so they involve application of shear forces. Now, these forces are sufficient in magnitude so, that the rapture the material and then in that case you will have the plastic deformation of the material. So, there are certainly certain you know things that up to work point what will the area at which the shearing stress is applied and then with what magnitude you have to apply this force. So, that the rapture of the material takes place.

So, that way the shearing takes place in such processes. So, this is about the different types of the processes, which is classified based on the you know and these type of forces which are applied. Now, again you have another classification that is primary and secondary metal working processes.

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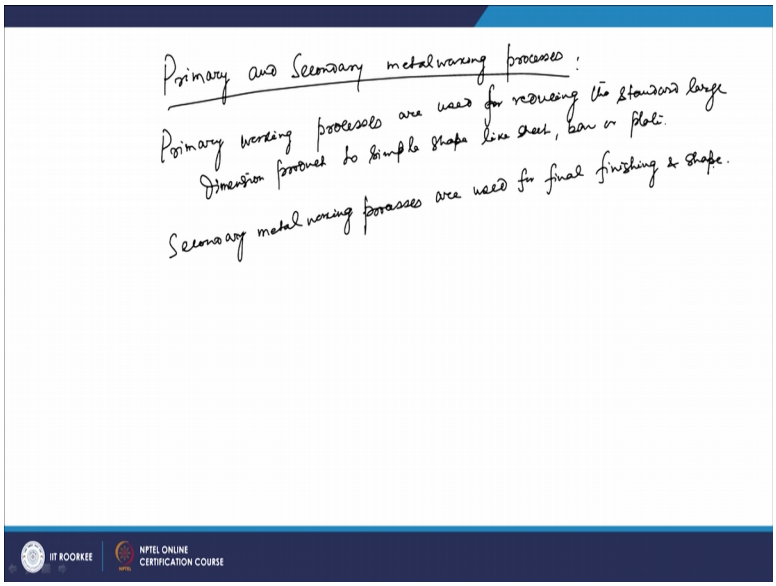

So, if you go to the further you have primary and secondary metal working processes. Now a basically the difference is that when you are doing the bulk forming of the operation bulk forming operations are there they are under the a primary operation, where you have larger shaped you know billet us or slabs are there you have ingots which are to be further you know converted into slabs or billet us or so.

These are the basically under the primary forming operations. So, you can we can define it as the primary one, primary working processes are used for reducing the standard large dimension products to simple shape, like sheet bar on plate. So, as you know that you have the processes where you make the ingots or you have the slabs in you made in the slabing mains, then you have the hot working. So, all these are basically the a primary metal working processes. Whereas, if you talk about the secondary working processes. Now, the thing is that when you are making the product to final shape.

So, those processes which are used for making it to a to making giving it the final shape they are known as the secondary metal working processes. So, secondary are used for final finishing and shape. So, basically what is there that those sheet metal operations, which is done basically for giving the final shape or the final finish that is they are coming term in under these secondary metal working processes.

So, most of the sheet metal or wired drawing or tube drawing all these processes are under the category of secondary metal working processes. Also a many times we call

these primary working processes, as the processing operations and the secondary metal working processes as the fabrication. So, this is the basically another name to this primary and the secondary metal working processes there is a another term that is your deformation zones so, basically when you do the deformation of the material.

In that case you are required to the confine yourself in a zone, where the deformation occurs you have heat transfers going on you have lubrication and all that. So, that a deformation zone and you study in that zone to study the different you know parametric variations different, you know pressure temperature or stresses calculations and all that.

So, we will discuss about the analysis of these metal working processes; I mean mechanics of metal working processes and the analysis methods in our next lecture.

Thank you very much.