Theory of Production Processes
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Lecture – 11
Gating system design: Types of gates

Welcome to the lecture on Gating System Design. In this lecture we will discuss about the introduction to gating system and the different types of gates.

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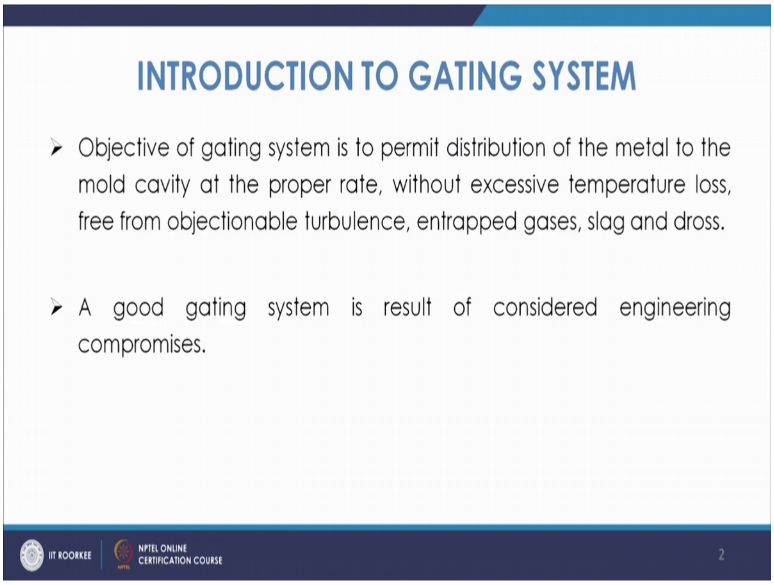

So, coming to the gating system what is the gating system basically as we discussed that in casting the liquid metal has to flow and it has to flow through certain network and then through that network ultimately it has to reach inside the cavity. So, the all those channels basically they are part of the gating system. So, this is basically that ultimately that it has to pass through the gate.

So, that is in gate before that it is basically first of all poured in the pouring basin from there it comes at the in the runner via the sprue, down sprue. So, through that it comes then it goes via runner through the gates it enters into the casting. Now, since the metal has to flow and metal is in liquid state even it at higher temperature. So, there are challenges associated and the challenges are regarding the quite entry of the liquid metal into the cavity. At such a high temperature of liquid metal you know that at higher temperature you have the chances of the absorption of gases into the liquid melt then the liquid metal if it has a very high specific gravity it has higher density or it is heavy in that case if it falls and if the channel is not properly designed then that may result in to erosion and that erosion may result into further different kinds of defects because of these eroded particles.

So, these are the parts which are to be taken care of. But anyway first of all let us see what is a gating system. So, what is the objective of the gating system? Getting system is its objective is to permit distribution of metal to the melt cavity, to the mold cavity at proper rate the rate should be proper it should not be too fast or too slow, if it is too fast then in that case they may lead to the erosion or it may lead to other problems like aspiration or so, then you have without excessive temperature loss.

So, as we discussed if the pouring rate will be quite slow in that case the metal will move at a slow rate and then it may lose its temperature in between. So, once the metal loses its superheat and if it comes to its solidification temperature or even below that the solidification may premature solidification can occur somewhere in between and the casting cavity may not be fully filled. So, there may be excessive temperature loss that has to be avoided free from objectionable turbulence.

As the liquid metal is flowing through certain path and it is flowing at a particular velocity at a higher velocity it has the chance of having turbulence that turbulence may be caused maybe because of the adverse situations adverse pressure gradient situations. So, there may be turbulence and that turbulence may lead to the you know sucking of air or aspiration of air from outside that may lead to the spoiling of basically the liquid metal in certain cases mainly those metals which are prone to getting oxidized quickly. Then entrapped gases you know you have gases which may be entrapped. So, you will have to see that they are not entrapped the gases should get the chance to come out either through the mold or from the other route it has to go out so that if they are trapped and if they are incoming I mean trapped and in that case they may form the gaseous pockets inside the metal.

Many a times you have the slag and rosses which are formed either during the entry of the liquid metal or they may come along the liquid metal from the pouring base inside. So, these slides and rosses should also be minimum because ultimately they are going to be a part of the cast. So, you have to see that you should not have the slag or the dross.

So, getting system basically ensures that you have basically the entry of the liquid metal at proper rate, you have minimum of the temperature loss, you do not have objectionable turbulence, you do not have entrapped gases and slag or dross. So, basically you as we know there are many things and many a times if you try to achieve one thing in a proper way it may basically not be that much good for other aspects like if you see that if you try to build a very you know temperature which very very smooth, if you try to have very very smooth in that case may be that if you provide very fine surface finish there may be you know fusion at the subsurface casting.

So, there you have to see many aspects you may have to have the course splash course or there are many things. So, basically you will have many engineering compromises in between and your ultimate aim will be to see that the aim with which you are coming or you are going to have a good casting that should be you know fulfilled. So, that is what the main aim of getting system is.

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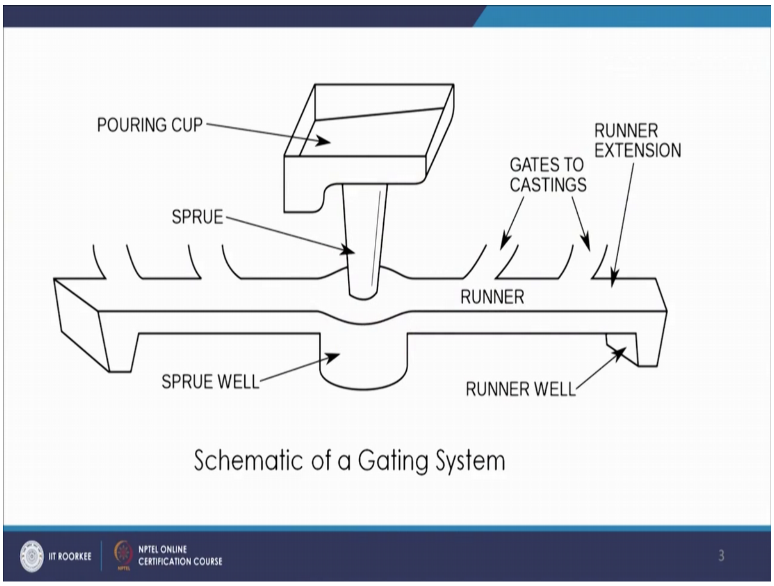

This is the schematic of a propagating system as you see from here in the figure the you have the pouring cup where the liquid metal is poured then this liquid metal will come through this vertical you know channel you see here the you have this kind of pouring cup.

So, liquid metal will be here and slowly metal will come and slowly it will enter it may. So, happen that if it is of the same you know width then the entry may be more rapid, but in this case here you have dam shaped of structures. So, in that case slowly the liquid metal will enter into it and then the liquid metal will come into this sprue well. So, this is sprue well will further redirect this, momentum is quite high. So, this is arrested here and then it is redirected towards this runner. So, then in this runner you will have further you have the casting here. So, you have the in gates and through the in gates the liquid metal will go into through the different in gates into the cavity and apart from that you have the runner extension this is the runner extension this side in this side. So, that is also another well. So, this is basically to take into account the arrest of any dirt particle which is coming out.

So, any impurity which is going out, now due to the it has the momentum here is a velocity here it will go here and if it is the heavier particle then it will basically be settled here it will go and get trapped into this bottom portion. So, that is how you have also the provision to and trap the impurities which are heavier. So, you are ensuring all the things.

Now, the thing is that you ensure everything you ensure that you have the quite entry of the liquid metal for that you see that you have the runner it will come here and then slowly it will go into the runner then it will go enter here you have to see that there should not be turbulence or there should not be aspiration because of the turbulence for that you make this sprue taper.

So, that is one of the principle of making this spool taper. So, that the sprue runs full and you do not have any aspiration taking place here. Also you proportion these runners and gates also accordingly so that you know channel runs full and you do not have any probability of having any expedition or turbulence.

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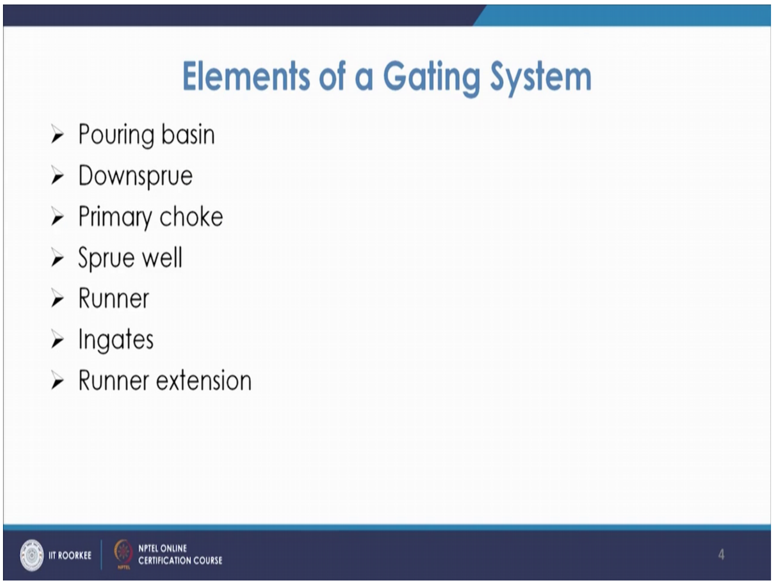

So, as we discussed as we have seen in the picture these are the elements of a gating system you have the pouring basin then you have down sprue then you have primary choke. So, basically in the gating system this is the portion where you have the minimum cross section that is choke. So, basically choke is the one which controls the flow.

So, basically choke is normally available, normally positioned at the bottom of this proof. So, in that case after that it will see that the flow is set. So, from here choke which basically controls it is the point where you have minimum cross section and then you see that the flow is established in the domain so that is what choke is. Choke maybe at in further downstream also it may be in the downstream direction. Now, if the choke is here then this is the minimum dimension, so you will have larger dimensions towards this side and if the choke is towards the flow if you choke maybe or in this direction somewhere. So, that is in that case you ensure that this is running full.

Now, in this case you have the minimum dimension and the dimension increases. So, based on this you will have basically different type of gating system that is pressurized and unpressurized. In the pressurized gating system you will have this choke coming somewhere down the stream, not here, but unpressurized means. So, pressurized you will have choke here. So, you ensure that this is all full because once you have minimum cross section here you ensure that this whole section is completely full and in this case that may not be ensured. So, you will have the minimum cross section here and then runner and then gate dimension depending upon its areas ratio of this area to the total runner area to total in gate area that ratio is known as the gating ratio so that we will see later. So, depending upon this position of the choke you classify this as sometimes pressurize or unpressurized gating system.

Then you have the sprue well. So, sprue well will be there at the bottom of the sprue which rest the momentum initially which is coming in the downward direction and it has to basically divide that it has to change the direction of the incoming fluid which is in the downward direction and it has to basically channel it in the horizontal direction. So, that is the position of that is the purpose of this sprue well there, then from the sprue well it goes through the runner and from the runner it has you have the in gates.

So, it will pass through the in gates and go into the castings. On our extension already we have discussed runner extension will be required to trap the impurities of the casting. Apart from that you have other components in the elements of gating systems. So, that we will discuss slowly that we have 4 different types of gates you may have different components in the gating system which have some specific purposes maybe for sometimes relieving the pressure for sometimes taking the impurities. So, arresting the impurities these are the basically uses of these elements.

Types of gates. Now, you have three types of gates according to you know the type I mean type is based on where they enter into the casting cavity. So, according to the position or end of entry of the molten metal into the mold cavity you have 3 types of gates one is parting gate, bottom gate and top gate. So, as discussed as you know the parting gate means it is the motor metal entry is at the parting line of the casting. So, if you have this casting here the metal enters at this place so that is parting that is why it is known as parting gate.

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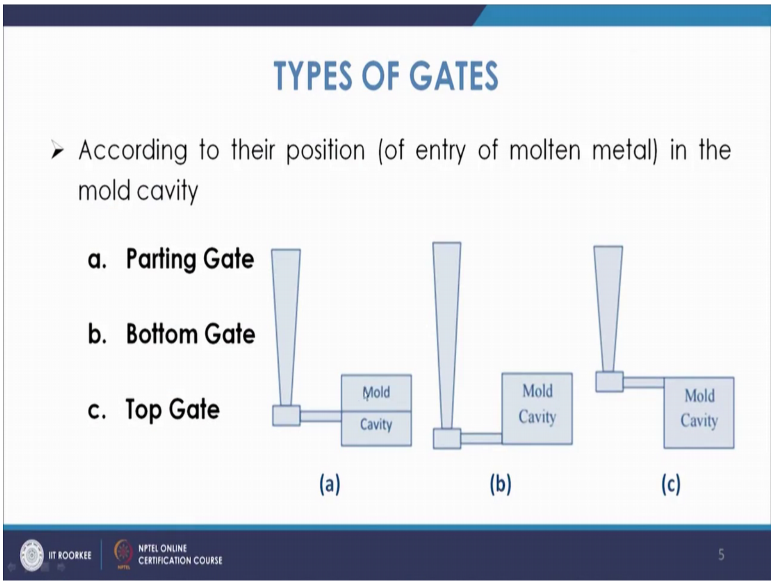

Then you have if the metal is entering at the bottom of the cavity then in that case it is known as bottom gate. So, it will be entering through the drag half of the mold and that way it is known as the bottom gate and if it enters out the top portions of the mold cavity then it is known as the top gate of top gate.

So, you have these 3 types of gates by parting gate, bottom gate and top gate. Now, it has its own you know characteristics as you see in the case of top gate the first metal will enter and it will go at the bottom and then slowly this metal will come and the level of metal will go on increasing. So, what will happen, the hottest metal will be at the top and the coldest metal will be at the bottom because the metal which has already gone into the cavity it has touched the walls it will start solidifying. So, basically in this case you see that you have the hottest metal at the top and coldest metal at the bottom, from the sideways also solidification taking place. So, basically the directional solidification achieved if the riser is placed at the top suppose in that case you can you can ensure that there is directional solidification, solidification starting from the bottom going towards the top ending near the riser. So, this way is the rationality is achieved.

In the case of top gating you have certain disadvantages also, that since the metal is falling directly. So, it will have the large momentum and it will fall on the surface it may erode the surface of the casting, so far especially for heavy and you know material like or for the material with high specific gravities with the fall you will have to have certain arrangement so that the erosion chances are less. So, this is one of the disadvantages in case of top gating, but it is simple and in four simple shapes we go for top getting it has varieties it has different varieties that we will discuss later.

Then coming to bottom gate, so in the case of bottom gate what we do is the metal will enter from the bottom. Now, as we see in the case of top gating you have the chances of erosion of the liquid metal it falls from the top also while falling it may react with the air sometimes they may oxidize or so many times that my situation may also come. So, anyway, but the main problem is that in case of the materials which are heavy you know it is better to enter from the bottom half. So, there is no chance of any kind of mold erosion and the metal will slowly go up. Now, in this case the entry is certainly not at very high velocity you have the entry going on and then slowly metal will reach. So, that problem is gone, but the thing is if you look at and the more hot metal will be at the bottom and the cold metal will go slowly at the top.

So, this basically they said this one disadvantage in that sense that the directional solidification is not that way naturally achieved. So, this is one of the trait of the cold this bottom gating then you have the parting gate. So, parting gate as you know that metal will come it will enter then once it comes to that level then metal slowly will go up. So, this is basically depending upon the situation you may have this parting gate which can be used for feeding the liquid I mean liquid metal into the casting it is the you have both top as well as bottom gating practice taking place in the same initially you have top gating case. So, the second of the lower half will be first of all filled and then it will be like the bottom gating case. So, that is part parting gate.

So parting gates, now these gates enter the mold cavity along mold parting line. So, as we know that the parting gates are defined based on this assumption that the liquid metal is entering at the parting line of the mold. So, parting line is that surface which separates the top molding box that is cope and the bottom molding box that is drag. Now, in the parting gate you have may use many devices like skim bobs or relief spruce shrink bobs core inserts, dam in pouring basin etcetera. Now, you once you have the parting gates in the in that on that way you may use these devices which has the different purposes like you have a skim bob which is there to relieve the pressure or you can have the collection of the impurities. So, that way and like you have shrink bob also it is used sometimes which is use as a function of slag or dross collector and also metal reservoir to feed when the casting shrinks.

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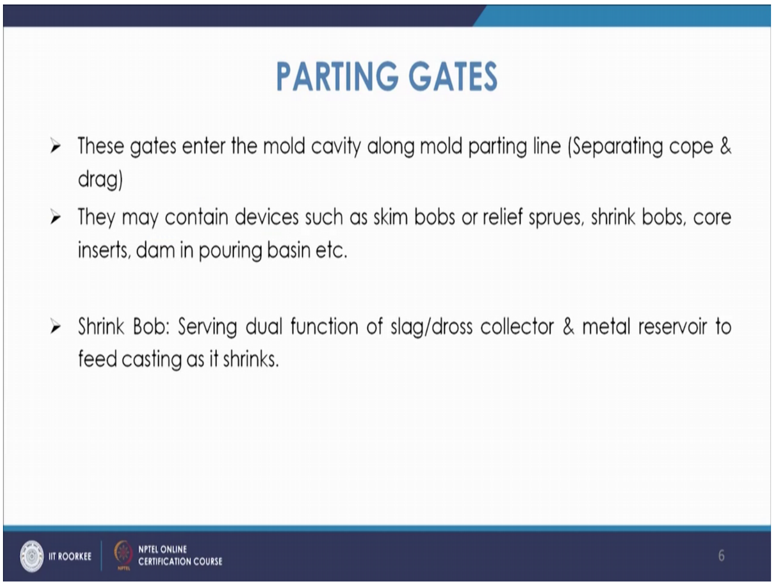

So, this way you have different kind of the parting gates. Let us see the example of these gates.

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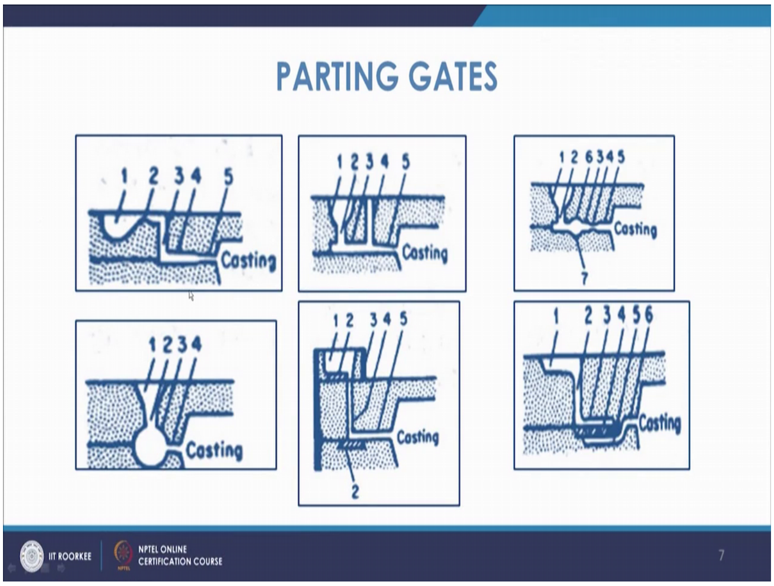

Now, see here in this case you have use of the dam here. So, metal will come and then slowly it will enter and go into the cavity. So, this way the metal enters into the cavity. Now, in this case as you see this is a relief sprue which is given here and this relief sprue will basically relieve the pressure from this into this channel. So, you have this is a pouring basin, you have the dam the use this is the sprue and here you may have the use of skim bob then you have you this is here the relief sprue used, here you have skim bob both in the cope as well as in the drag portion.

So, that basically works as first is to relieve the pressure and then also collecting the impurities either in the top or in the bottom. So, if the impurity is lighter it will go and get trapped here and if the impurities is heavier it will go and get trapped here. So, this way you will have the use of these devices. This is the case of shrink bob where you have basically the both function as we discussed the u in case of shrinking as well as also to the relive you know as we discussed it as the slag or dross collector and then feeding when it shrinks.

Now, in these cases you if we use the inserts coded inserts and these inserts basically are used to avoid the erosion of sand when the metal basically falls on it. So, this way and then you have other like sprue, you have the pouring basin, you have ultimately coming to the casting. Now, in this case here the metal gets filtered through its strainer core is there and metal will come and through the strainer core it will come first here and then you will enter into the casting. So, you will have the provision of basically filtering the liquid metal and entering into the cavity.

Then you have the bottom gate. In case of bottom gate the metal enters into the cavity at the bottom of the bottom of drag half of the mold. So, normally it is advocated for steel castings particularly to reduce erosion and gas entrapment and to prevent splashing. So, many a times when we and the liquid metal falls from the top after hitting the surface it splashes.

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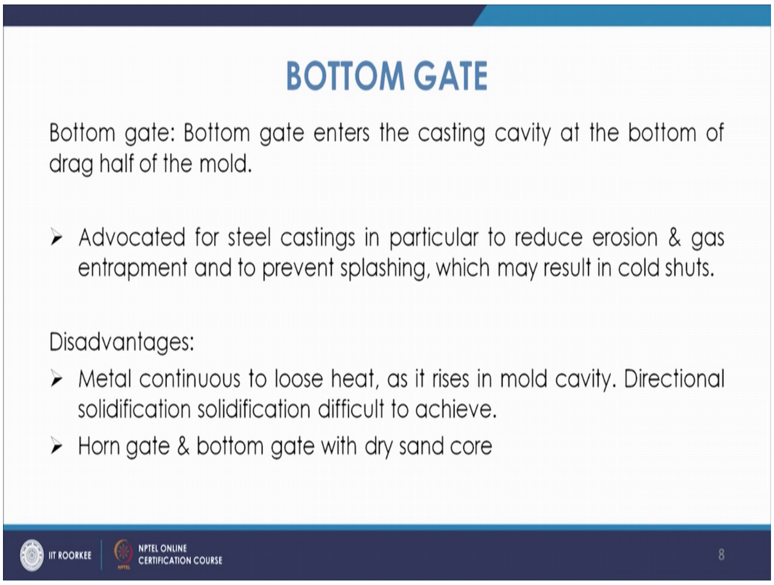

So, that way the splashing will result into cold shots and that may lead to the different kind of undesirable structures in the and the solidified structure because that may be the impurities in the form of or there may be the problem of you know coherency of structure in the solidified product. So, that plasm is avoided if we go for the bottom gating. So, it will come and it will enter into the casting.

But then in this case metal will continue to lose heat as it rises in the mold cavity. So, that is why as we discussed that in this case solidification the excess solidification will be difficult to achieve. Now, in this case as we discussed that higher temperature metal will be initially coming up and slowly that becoming cooler this will go at the top. So, a external solidification will be difficult to achieve. You have the it is also varieties the horn gate and bottom gate with dry sand core so in that case you have dry sand core and this is the example of horn gate these are the varieties of the bottom gating.

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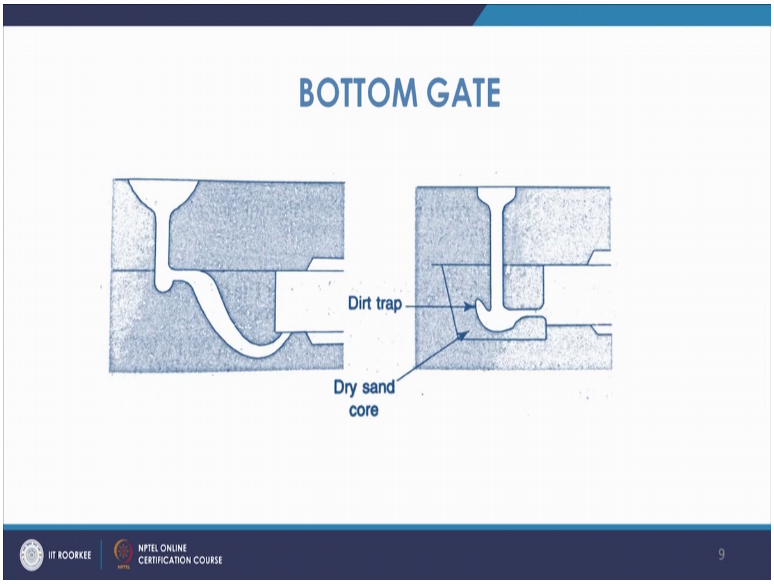

Now, one of the disadvantage of this horn gate is that you may have the fountain type of effect when it metal will come it will come and have the fountain kind of effect so that may lead to some problems. So, this is the one of the disadvantage with bottom gate.

Then you have different varieties of top gates, top gate means the metal is entering from the top it is poured down the head or riser of the casting, so you have them from the head itself it is poured down.

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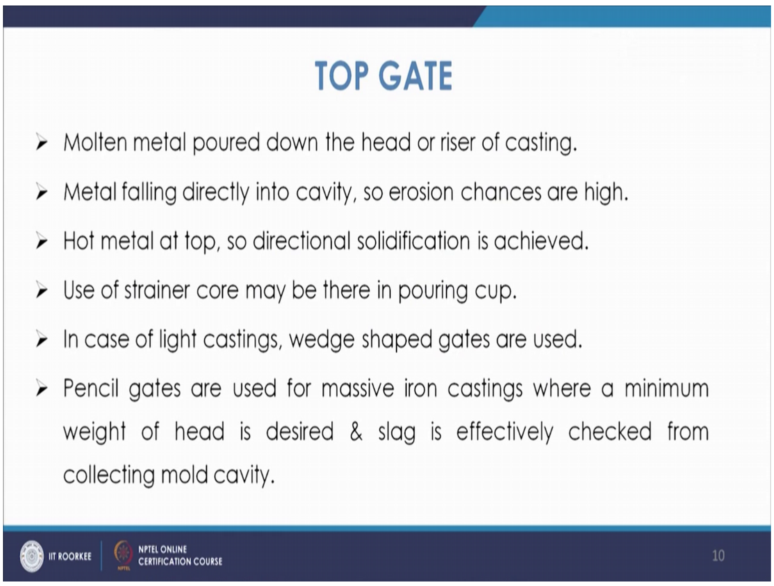

Metal will directly fall into the cavity. So, erosion chances are higher. Hot metal is at the top. So, you have the achievement of directional solidification easily. Since you are sending the metal from the top you use strainer course also in the pouring cup. So, that if there are any impurities they get basically strained at the top itself. In the case of light castings we use the wedge shaped of gates, so we will see the different shape of gates. Then we also use the pencil gates which are used for massive iron castings where the minimum width our head is desired and slag is effectively checked from collecting into the mold cavity.

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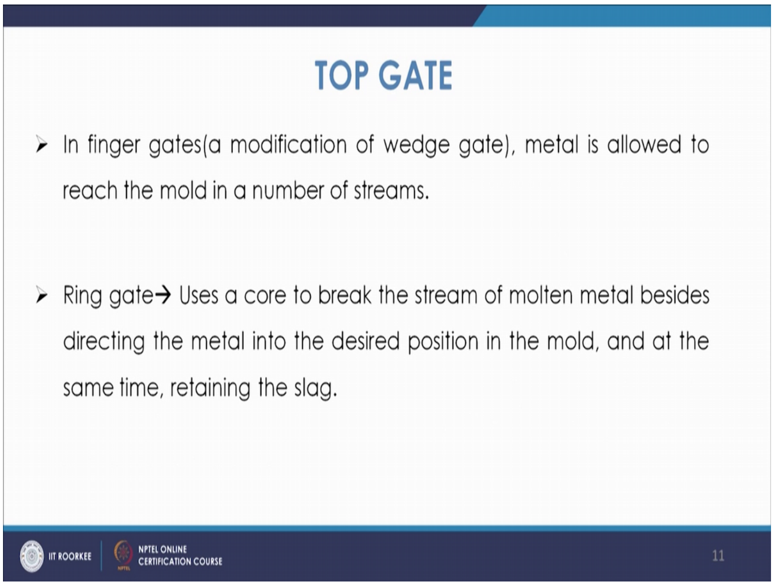

So, we can see the picture for the different types of gates of the top gate variety. Now, you have again the finger gates which is the modification of wedge gate the metal is allowed to reach the mold in a number of streams. So, that is a variety of finger gate. So, we can see here you will have this is the finger gate, this is the finger gate.

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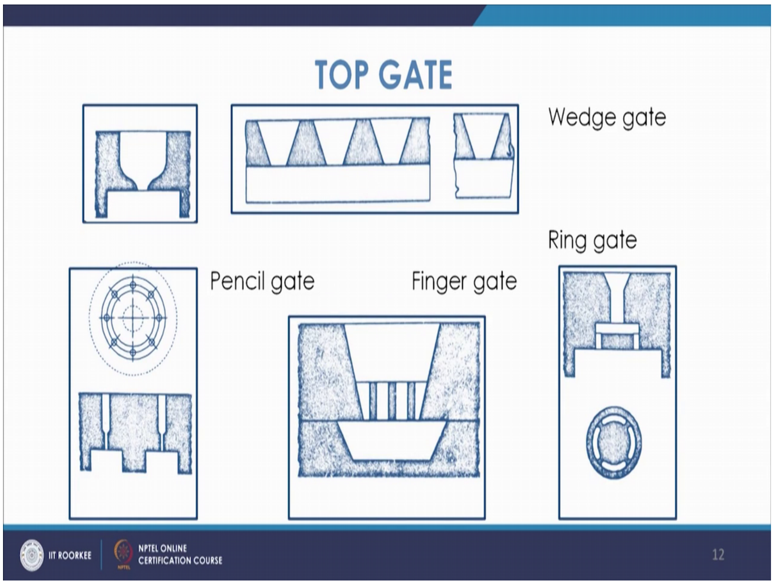

So, if you see that this is a modification of wedge gate and metal will be allowed to reach the mold in a number of streams as you see here you have different. So, it is a wedge gate itself here you see a wedge gate, but then you have different streams you have put in that is known as finger gate.

Then you have ring gate, so for the ring type of structures. Here use a core to break the stream of molten metal besides directing the metal into desired position in the mold and it also retains the slag. So, that way you have a ring gate as you see this is the ring type structures you have metal entry from these places. So, this is the kind of these are the different types of top gates which are used for these you know for the gating practice which is normally used. Now, also in these cases apart from, will you can discuss more you can study more about the different types of gates.

Let us come to the next important you know element of the gating system that is choke. So, choke is basically the smallest area in feeding channel which controls the flow rate into mold cavity and controls the pouring time. So, as we discussed that once you have the smallest area after that the flow is stablished. So, normally it will occur at the bottom of the sprue so that there is early establishment of proper flow characteristics. So, sprue bottom will be normally known as choke, but then you will have may have choke even in the downstream you may have after the sprue well also you may have the choke wherever you have the minimum cross section that is known as choke.

So, then what is the gating ratio. So, as we discuss that when we talk about the choke which is choke into the bottom of the sprue in that case basically from there the flow is established. So, that will be minimum area and the later on that is area of the runner or area of the in gates there will be larger than that area. So, the ratio of that area sprue area to total runner area to total in gate area normally there is ratio define that is known as gating ratio. So, now, depending upon the position of the choke you may have this classification as pressurized or nonpressurized.

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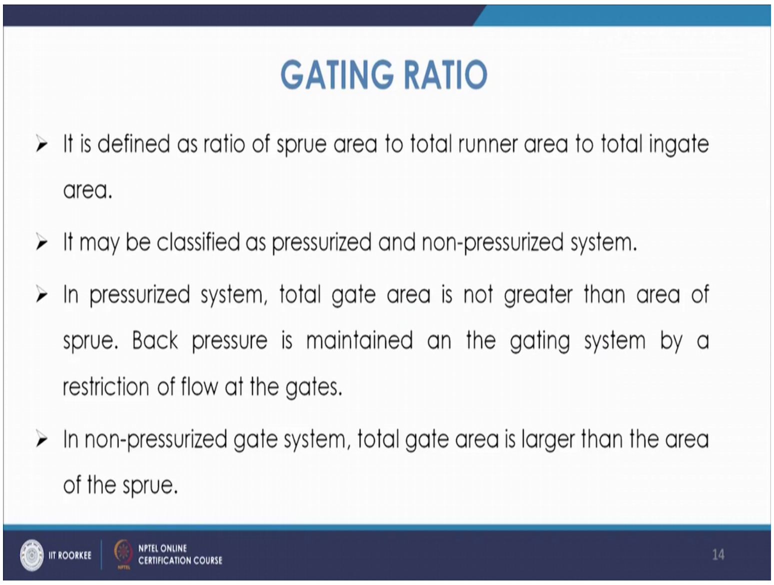

So, in the pressurized system it is defined as the total gate area if it is not greater than the area of the sprue. So, if the total gate area if it is not greater than the area of the sprue then the back pressure is maintained on the gating system by restriction of flow at the gates. So, that is basically you know pressurized gating system and in the non pressurized gating system the gate area is larger than the area of the sprue.

So, if its sprue area is minimum in that case it is non pressurized gating system otherwise if it is not the minimum then suppose if the gate area is minimum then it is a pressurized gating system. Like you may have the something like 4 is to 8 is to 3. So, it will be a case of suppose the minimum is towards the gates. So, that will be a pressurized gating system. Similarly if the minimum is here 1 is to 2 is to 1 or 1 is to 2 is to 1.2 or 1 is to 2 is to 3, these are the cases of pressurized gating system.

So, basically depending upon the kind of metal you are pouring in depending upon its nature you are basically deciding what kind of gating ratio should be selected. Many a times you have now, in the case of if you look at the pressurized gating system in the pressurized gating system you ensure that the channel is full it is the back pressure is maintained and the channel will be completely full. So, there will not be a chance of separation of the liquid metal from the sidewalls in the runners. So, when there is no chance of separation there will not be any chance of aspiration. So, for those cases these pressurized systems work well, but there in pressurized system there will it will go with high velocity and will enter. So, that is that aspect is to be seen.

Then in that case and in other case in the non pressurized system when the liquid metal has through a choke, where the choke is having minimum at the sprue bottom. After that the surface area is high up in the area is higher, so there is no possibility that is that the whole channel is not running full. So, if it is not running full in that cases if the properly the proper dimensioning is not carried out there is charge that there may be aspiration there will be separation of the liquid metal from the surfaces. So, that will lead to certain aspiration or turbulence or that may lead to spoiling of certain metal which are easily prone to getting spoiled. So, these are the basic example I mean difference between the pressurized and non pressurized gating system.

Most of the metals you know it has been seen that you use these pressurized gating ratio or non-pressurized gating ratio system may be for different metals you can use with proper care of other parameters. So, that is how this gating ratio is maintained.

Thank you very much.