Principles of Casting Technology

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Lecture – 07
Technology of Patternmaking
Pattern types and Allowances

Welcome to the lecture on Technology of patternmaking, in this lecture we will discuss about different types of pattern and the different allowances which are used on the pattern. Let us discuss first about the different types of pattern, and in that category we have these many varieties of the types of pattern like single piece pattern, split pattern or two piece pattern, gated pattern, cope and drag pattern, match plate pattern, loose piece pattern, follow board pattern, sweep pattern and skeleton pattern.

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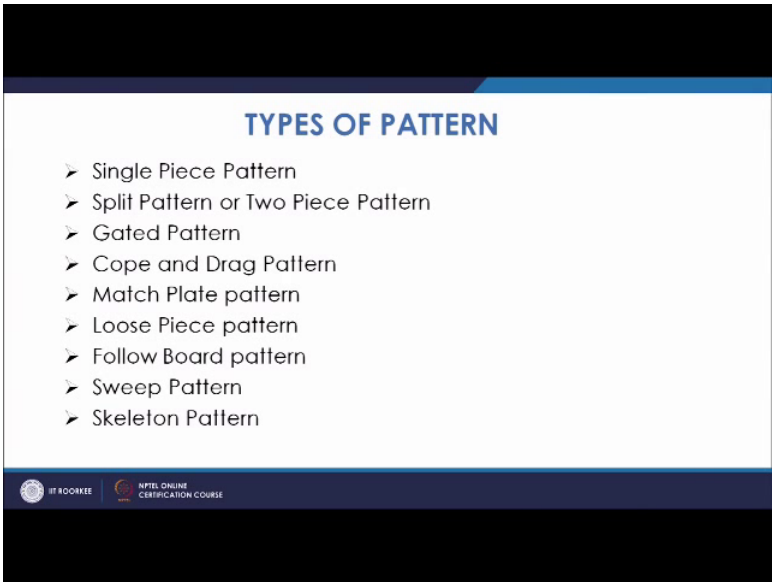

Now, let us see one by one, what are these patterns.

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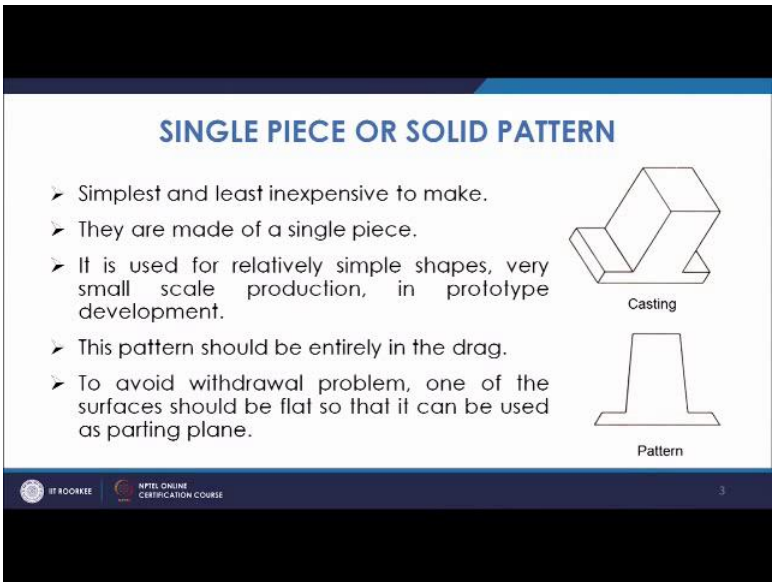

The single piece or a solid pattern, this is a very simple shape of pattern, when you need to have the casting in one of the boxes like; suppose we are doing in the drag itself you are making the casting cavity. So, you have a simple shape of this casting and you can have the pattern of this shape keep in the drag itself so that there is no problem in withdrawing it and once you withdraw, the single part of the pattern you get the cavity which is having the same shape as the shape of the casting. So, you need not have to have any kind of getting or runner or so, and simply in such cases you get the pattern type is known as solid pattern. It is simplest and least expensive to make made of single piece, used for relatively simple shapes, and it is should be entirely in the drag and you do not have any problem in withdrawing it, and one of the surfaces as to be made flat that it can be used as parting plane and you can withdraw it.

Next is split or two piece pattern. Now, when you have a shape which cannot be withdrawn with ease, it is not possible to withdraw it once you have put inside the molding material. Then in that case you will have to divide the pattern or the casting in such a manner, that you can take the two half or so separately. When contour of the casting makes it, it is withdrawal difficult, from the mold or the depth of the casting is too high in the that case the pattern is split in two parts, and then it is known as the split pattern and they are basically there has to be proper alignment between the two parts, so for that there are pins.

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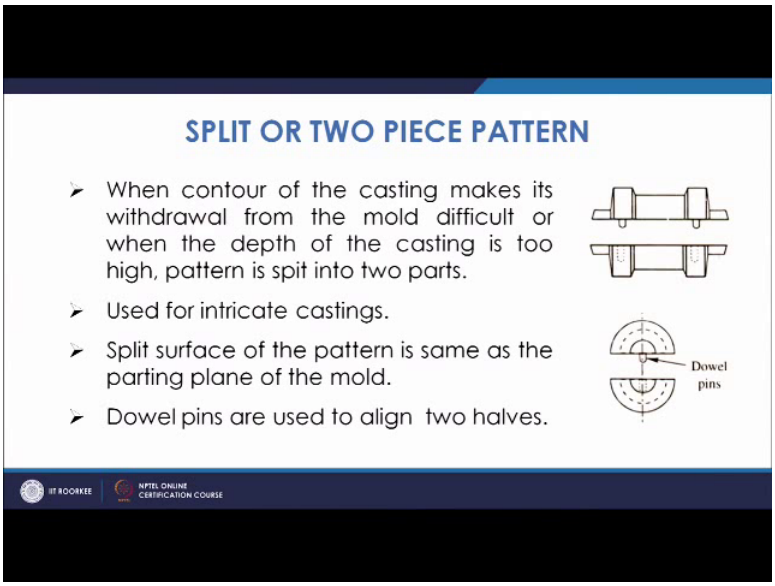

So, they that are pins are dowel pins, they are used so that, there is proper alignment between the two parts and these are known as a split or two piece patterns and this surface split surface will be taken as the parting plane of the mold.

Next is gated pattern. We know that in casting there is gating system. Now, the thing is you have to have some system by which the molten metal once poured, through that system it goes and goes into the cavity. It is an improvement over the simple pattern, where gating and runner system are integral part of the pattern.

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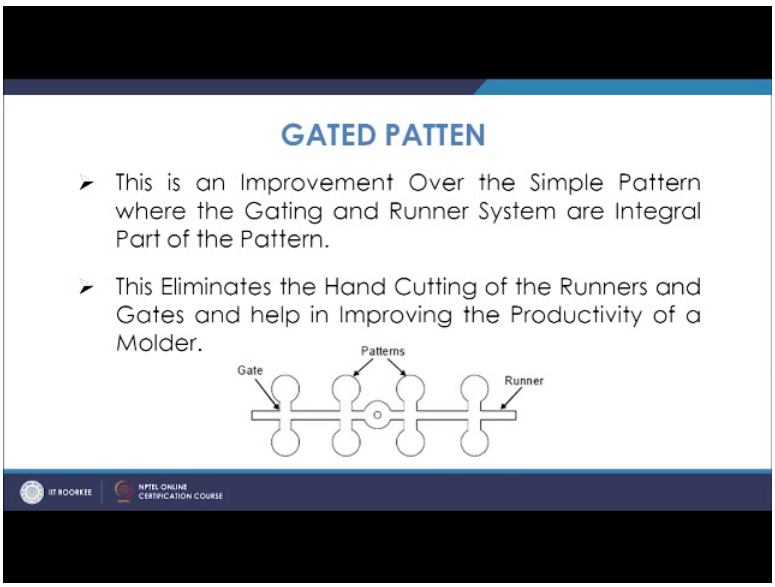

In the normal case when we talk about the split pattern, or we talk about the single piece pattern in that case the gating part or the runner part are made by hand. In that case, you have to rely upon the accuracy with which, this runners or gates are cut by the person who is making it, but you can make it an integral part of the pattern, so that once you take the pattern out of the mold, you have automatic a gate system and metal once poured through that it will come and go to the respective pattern. This is a part of pattern and that is why it is known as gated pattern, because this pattern gives you automatic gate that is why it is known as, the gated pattern it eliminates the hand cutting of runners and gates and improves the accuracy and productivity.

Cope and drag pattern: Now this pattern is basically, this is suitable when you are making going for mass production of castings. Now, in this case when large quantities are to be produced you are going to do this, another specific property when you use this type of pattern is that, there are two part one is cope part, another is drag part, and this is normally for heavier size of castings when you have may have the problem in handling them.

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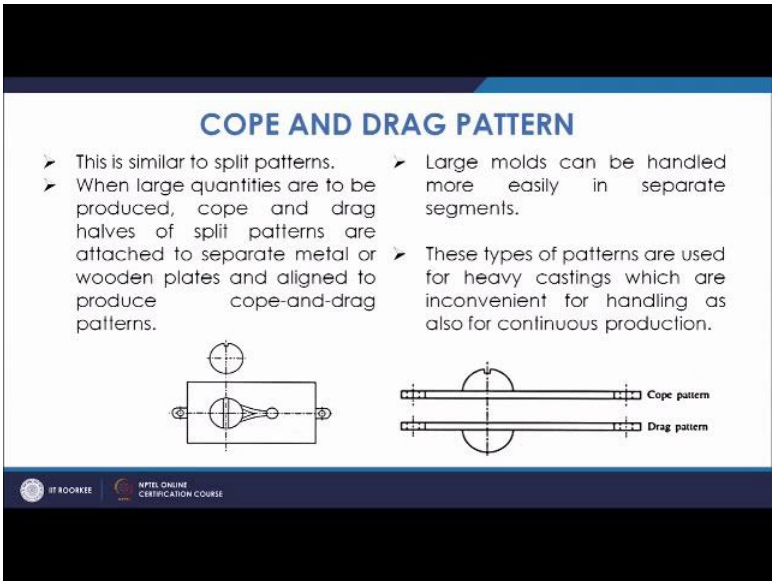

So, what you do is you have basically two boards, one will be used for making the cope pattern, another will be for making the drag pattern, and then you are basically matching them. So, basically since it is heavier if you are trying to make on one itself, on both sides that we will discuss later, we have another variety known as match plate pattern. In

this case, you have this cope part and you have this drag part. On the cope part, you make the cope portion of the pattern, on the drag part you make the drag portion of the pattern, you do the molding material keep it here and do the ramming make that parts and then ultimately you are matching them and doing the casting.

So, large molds can be handled more easily in separate segments, you have two segments that can be handled these types of patterns are used for heavy castings, which are inconvenient for handling as also for continuous production. So, basically for these two types of productions you use cope and drag patterns, you have two separate pattern plates which are used for cope and drag sections.

Now, here you have match plate pattern where you have a single pattern plate. In the case of cope and drag pattern, since the pattern is heavier it is very difficult to handle them on a single pattern plate. So, in this case you have a match plate on the both side of this you have the patterns. The cope part as well as the drag part on top and bottom side. What is done is? Once it is kept on the first part given the mold and it is rammed by machine and the next time it is again inverted and the second drag part is made and then further they are aligned to make the whole cavity.

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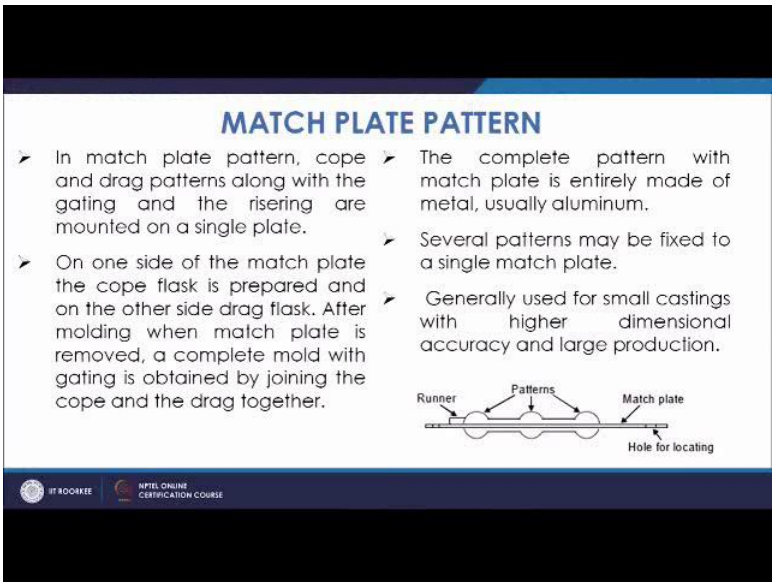

So, the only difference between the match plate pattern, and the cope and drag pattern is that in the cope and drag pattern you use separate pattern plate, match plate, where you one plate is used for making the cope pattern another is used for drag pattern in the case

of match plate pattern, you have the same match plate which is or plate which is used for making the pattern for both the halves cope as well as drag.

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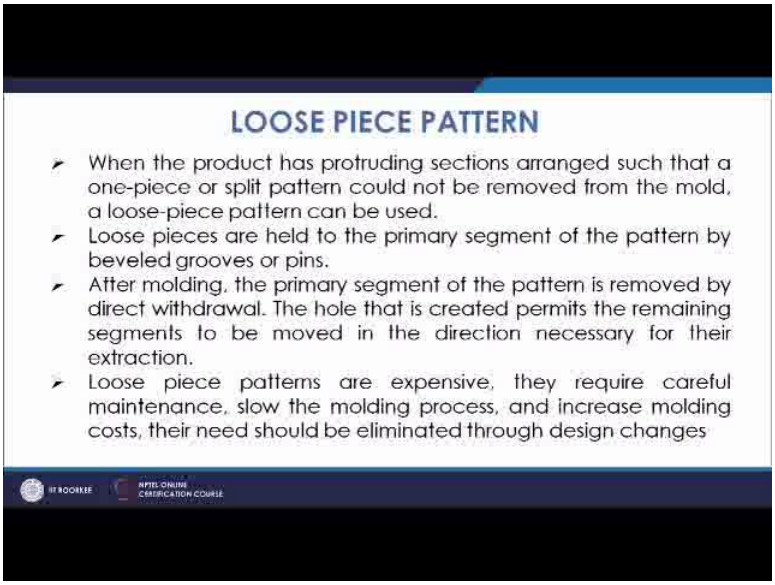

Next type of pattern is, loose piece pattern. So, basically many a times you have the cavity, to be made in such a manner that are certain portion if you make the pattern in a unified way it is difficult to take the pattern out in those cases, you are providing very loose piece of the pattern material at that place which can taken out separately so, that the whole pattern from the cope or the drag portion can be taken out separately.

So, in the cases of protruding sections, when one-piece or split pattern could not be removed from the mold, in that case you use the loose-piece pattern basically, they are held to primary segment of the pattern, by beveled grooves or pins. So, basically you have the primary segment of the pattern, through and they are connected with some pins or so, these loose pieces they are further removed. After molding primary segment of pattern is removed by direct withdrawal, the hole that is created permits the remaining segment to be removed in the direction of necessary for their extraction. So, we can see from this figure, you can see that this portion if you need to have a cavity here and if you give the pattern this shape this pattern cannot be taken out; this pattern cannot be taken out from here if this is the part of the pattern. So this is a loose piece, you take this out and then further you take this out. This is a loose piece which is given, that you have the ease in withdrawing it.

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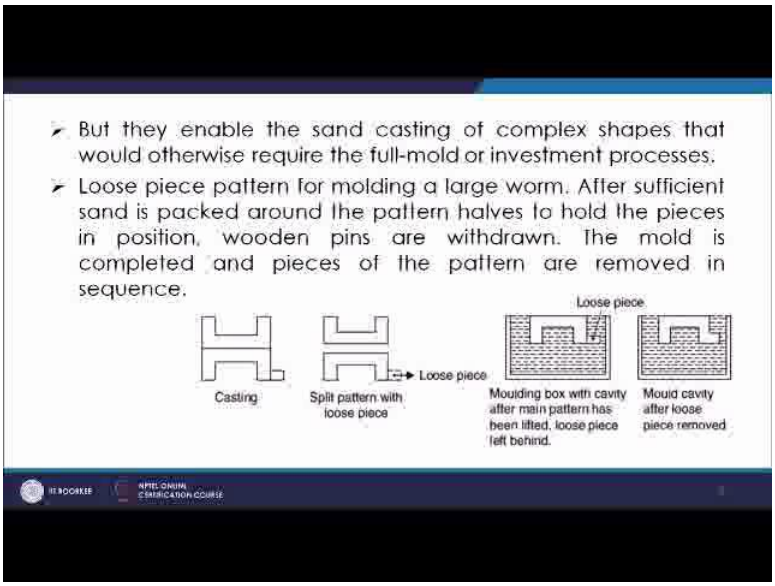

They enable the sand casting of complex shapes that would otherwise require the full mold or invest. So, otherwise you will have to go for very complicated or specialized type of casting process, and that will be costly.

Loose piece pattern, for molding a large warm here it is shown. If you look at this is the loose piece, if you have not use this loose piece your pattern will look like whole shape and taking it out will create damage, to the mold at this point. So, basically what you do is your pattern is taken of this shape, and then you have a loose piece here, after withdrawing this pattern, you can take this loose piece also out. So, you have a cavity form of total shape. So, this way you can avoid the use of a specialized type of casting process like investment casting, or even the full mold casting which are basically costlier versus of costing process. It is shown here by example, how you use the hold piece, this loose piece and you can further use them you can take them out and then do the casting that finally, you get the cavity of this shape. So, this way you have the use of loose piece patterns.

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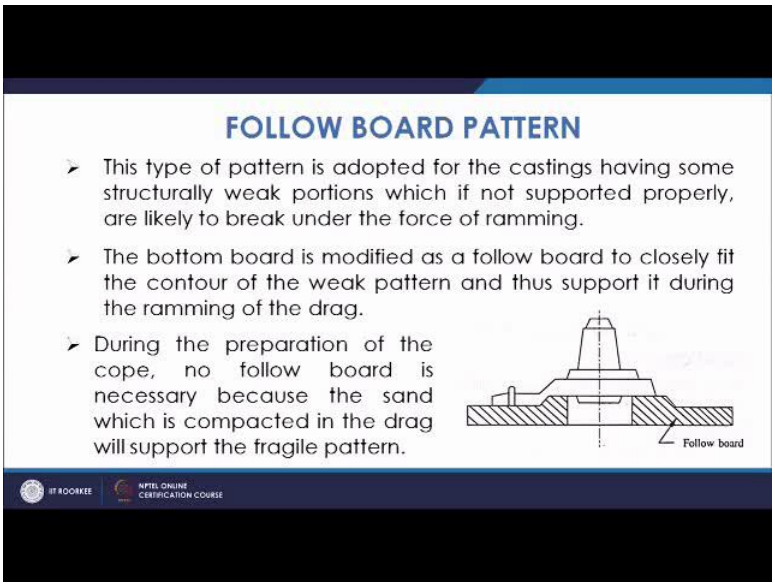

Another variety of pattern is the follow board pattern. Many times it is so happens that certain part of the pattern is somewhat fragile or the section is thinner, in that case if you do the ramming, this portion may damage suppose here, this portion will be quite fragile it will be weak. So, you have to use a follow board in those cases. So, you adopted for castings having some structurally weak portions which are not supported properly are likely to break under the force of ramming. So in those cases, you use this follow board type of patterns, bottom board is modified as a follow board to closely fit the contour of the weak pattern and support it during the ramming of the drag. During the preparation of cope, no follow board is necessary because the sand which is compacted in the drag will support the fragile pattern. This is since we are using this follow board on this name, this type of pattern is known as follow board pattern.

Another type of pattern is sweep pattern. When we use the axi-symmetric type of or cylindrical shape of castings, and larger castings in that case, basically making a full pattern of solid pattern of that shape will be very economical. So, basically we use a sweeping method that the pattern can be made by that. It is used to sweep, the complete casting by means of a plane (Refer Time: 13:05) sweep we have a sweep here, and this basically is used to sweep all the sand from all the sides.

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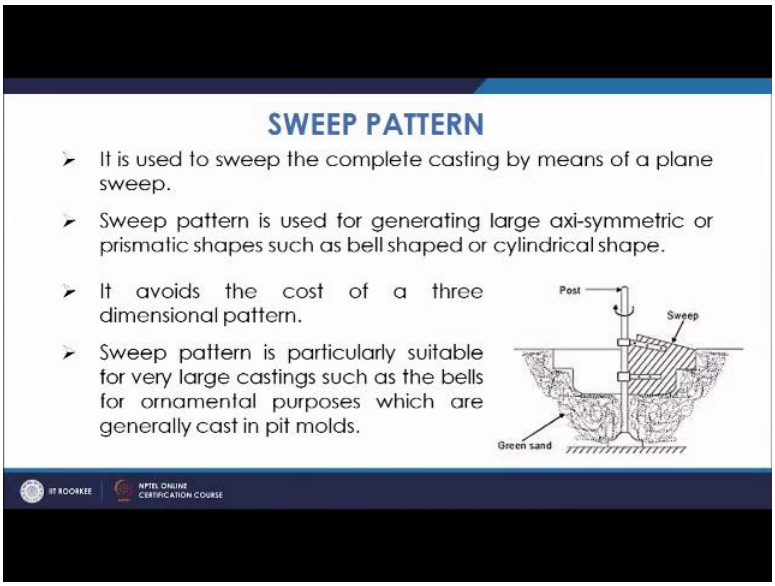

It is basically used for axi-symmetric shapes, and once you have the sweep of certain shape and if you rotate it along a vertical axis, on all the directions you will have a cavity bed of this shape on all the sides and in that basically you can do the casting.

So, basically it serves a large amount of pattern material which otherwise would have added to it and decrease the productivity of the process. Then you have skeleton pattern many a times you will use the skeleton pattern which is made of strips of wood for building the final pattern by packing sand around the skeleton.

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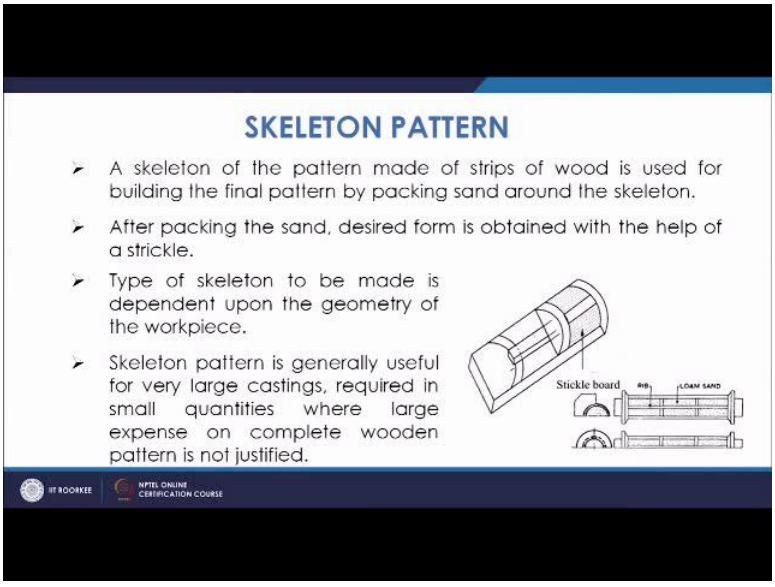

After packing the sand, desired form is obtained with the help of stickle is used and then once we pack the sand this desired form is obtained. Type of skeleton to be made is dependent upon the geometry of the work piece, many a times you do not have the pattern, you do not want to make it you have to only make one-piece and it is a large pattern in those cases, this skeleton patterns are useful to save the cost. It is generally useful for very large castings, required in small quantities when large expense on complete wooden pattern is not justified. So, you make this skeleton of it and then you use it as a pattern. So, this is about the pattern types.

Now, we are coming to pattern allowances. We had discussed, that pattern is a replica of the mold with certain modifications and this modifications are nothing, but they are all says which are to be provided on the pattern. These modifications are the different types of allowances and these allowances are shrinkage allowance, draft and shake allowance, machining and filling or finish allowance and distortion allowances.

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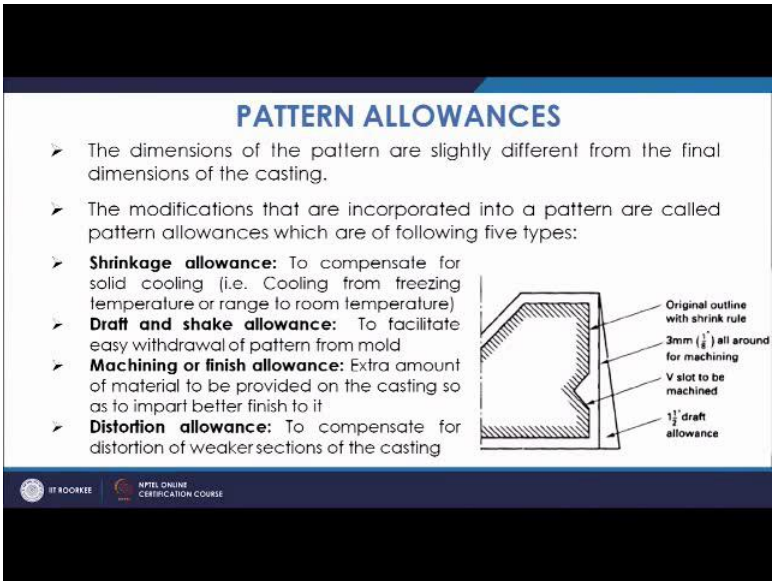

So, basically because the casting dimension and the pattern dimension are not completely same, that difference is known as allowance. Now, that depends upon what kind of molding methods or pouring methods we are using and that will dictate, what kind of allowances you need to provide like, the shrinkage allowance it is compensating the shrinkage which occurs because of the decrease of temperature of the molten metal, with time or during solidification. Draft and shake allowance is required basically, related to

the withdrawal of the pattern from the mold. Machining or finish allowance is given, so that a proper adequate surface finish can be obtained on the casting surface.

Distortion allowance is on those cases when you have the casting as a structure which may bend or which may distort under the casting conditions in those cases allowances are provided. So, we will discuss them one by one first of all shrinkage or contraction allowance.

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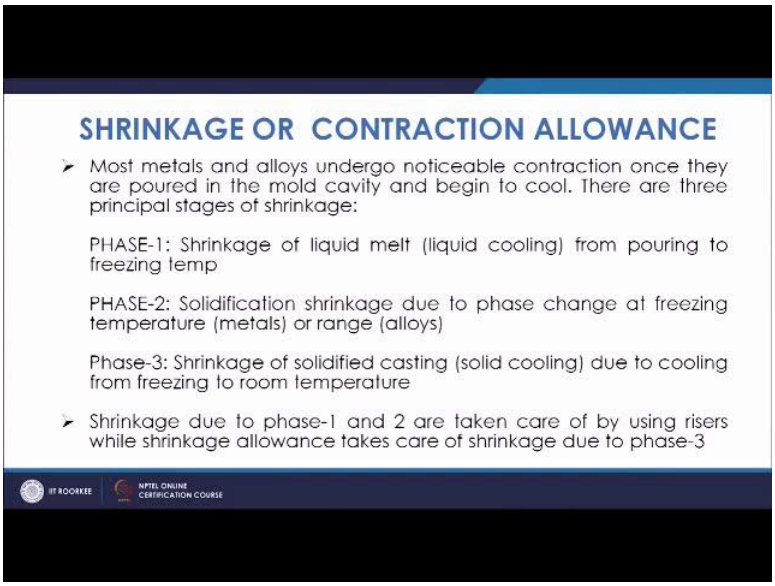

We have seen the solidification process in the solidification process we have seen that metal once goes into the cavity and if it an alloy. So, it goes under three stages.

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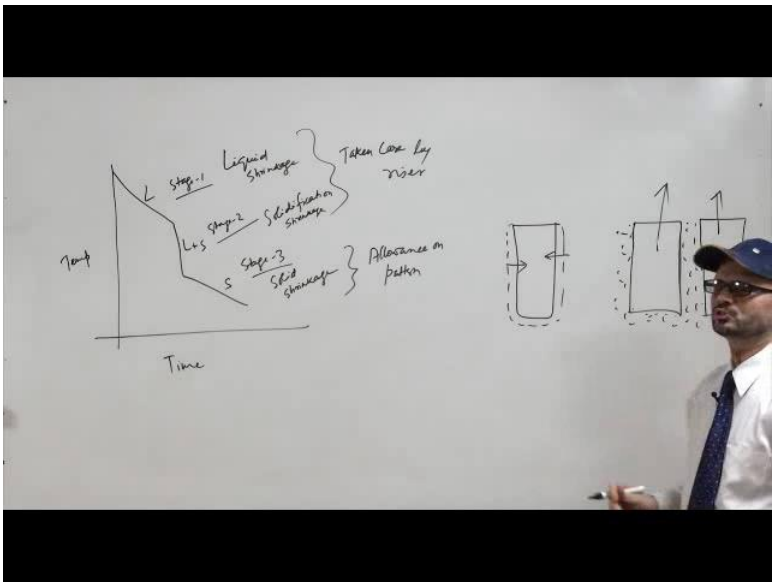

This is liquid, this is liquid plus solid and this is solid stage. Now, under this these stages there is decrease of temperature so, basically because of the decrease of temperature there is shrinkage.

Another reason is that, when there is conversion form liquid to solid state the volume basically will be the density increases. So, from liquid to solid state the density increases and volume decreases, there is shrinkage and this shrinkage has to be taken care of by providing the allowances. Now, this is stage-1, this is stage-2 and this is stage-3. This is known as the liquid shrinkage, this is known as the solidification shrinkage and this is known as the solid shrinkage.

This liquid shrinkage is nothing, but the shrinkage which occurs when the temperature is decreasing from the pouring temperature to the solidification temperature or liquidus temperature. From here to here, when till the solidification is completely complete, this is solidification shrinkage and once it as come to it is solidification solidus temperature, then coming to room temperature it is known as solid shrinkage.

The shrinkage between this and this, they are taken care of by riser and this is done by the allowances, allowance on pattern. So, this allowance is nothing, but the shrinkage allowance. So, most metals and alloys they are going under contraction when they are converting from liquid to solid state, and there are different phases 1 from liquid shrinkage is there, phase-2 is solidification shrinkage, phase-3 is solid shrinkage or solid

cooling and one and two is taken care of by riser, where as third is taken care of by providing the allowance.

Now, the shrinkage is normally may be varying from two to three percent to five percent. So, that much normally it is in the range of three percent, this much volume has to be supplied, that when it shrinks it is taken care of. So, that is why this shrinkage allowance is provided. To produce a desire (Refer Time: 19:38) dimensions the external dimension of the pattern must be more slightly larger that when it shrinks, it comes to the original dimension. If a core is to be used form a whole or interior cavity, it also must be made oversized to compensate for shrinkage.

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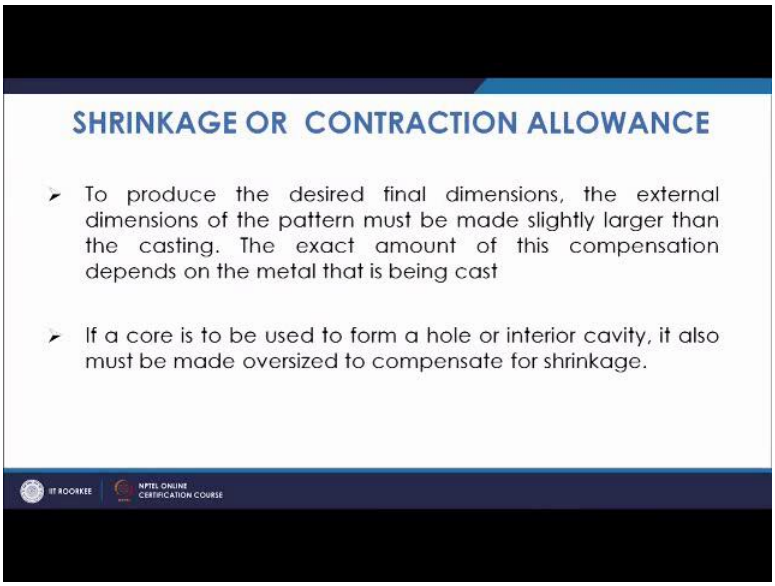

If you have a core, in that case also this core as to be made oversized so, whenever it shrinks it comes to it is original dimensions. So, we are making earlier of this shape, that once it shrinks it comes to it is original shape. Then next type of allowance is draft allowance, this draft allowance is provided on the vertical surfaces. We need to provide certain allowance so, that when we have to take it out the vertical surfaces are basically in contact with the mold. So, when you have a pattern like this and it is contacted in contact with the molding material, now when we take it out there is friction on these surfaces and on the corners there is chance of having damage. So, in that case you need to have some draft, some taper, which is basically helping it to take them out.

So, once you take it out there is no damage on these portions, this draft is given on the vertical portions, so that can easily take them out. So, to facilitate pattern removal, if the pattern contains surfaces that are perpendicular to the parting, line or parallel to the direction of pattern withdrawal friction between pattern and mold is there.

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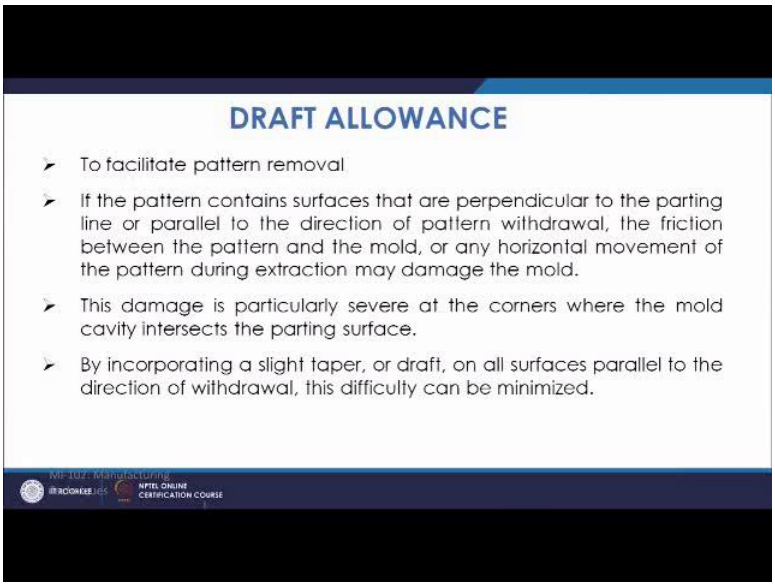

So, that may damage the mold, even at the corners it is more severe. So, you need to be careful in providing certain allowance, that it can you can take it without damaging the mold. So, you give a slight taper may be one degree to two degree. So, that it can take and that depends upon the dimension of the vertical surface.

How much taper you need to provide? So, that you can withdraw it with is without damaging the mold. So, this is the example of providing so, you have such surface you provide that draft.

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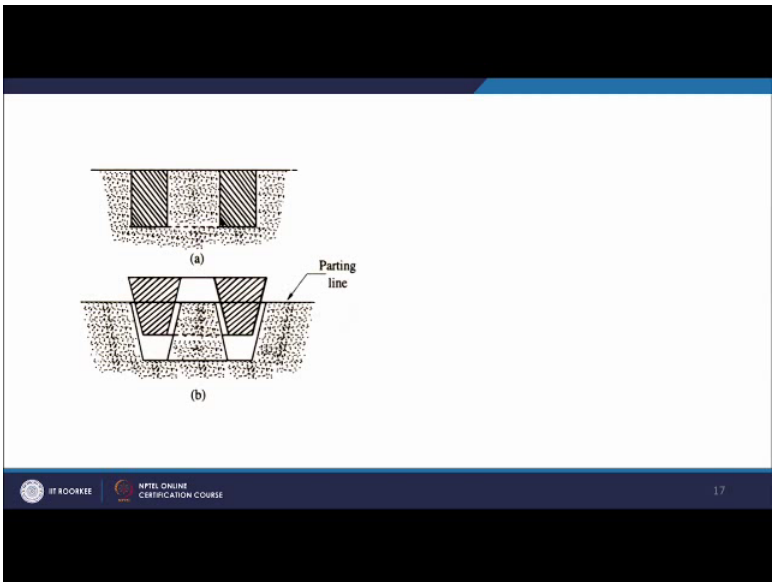

So, that you can take it out while there is no damage and there is no damage to the mold. Amount of draft will be determined by size and shape of the pattern, depth of cavity method is used to withdraw the pattern, pattern material, mold material and molding procedure. Like, if you have larger size and shape you have to provide respectively somewhat higher, may be depth of cavity is more draft as to be little more, method used you are doing it by hand or by machine that also matters, pattern material whether it is wood or metal, because it will effect or it will be instrumentory seeing what is the cohesion or what is the attraction between the sand grains and the pattern material, because that is also an important parameter because that will either assist or it will create some difficulty in getting removed.

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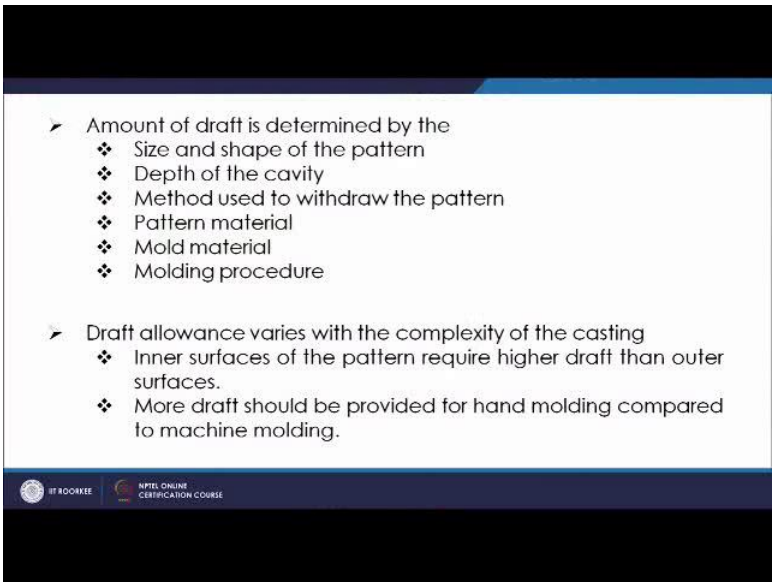

Mold material that is sand or metal or so, and then molding procedure. So, that is machine molding or hand molding or so. Draft allowance varies with complexity of the casting, you require inner surfaces of the pattern require higher draft than outer surfaces and more draft should be provided for hand molding certainly because the accuracy is cannot be expected to be that high in case of hand molding. So, these are the typical values of the draft angles you can see you have the angle from 3 to 2.5.

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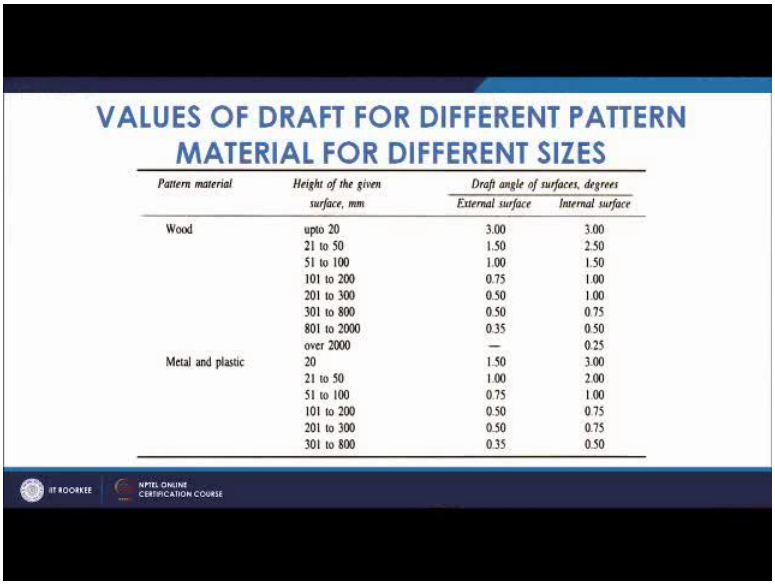

Pattern material	*Height of the given surface, mm*	*Draft angle of surfaces, degrees*	
		External surface	*Internal surface*
Wood	upto 20	3.00	3.00
	21 to 50	1.50	2.50
	51 to 100	1.00	1.50
	101 to 200	0.75	1.00
	201 to 300	0.50	1.00
	301 to 800	0.50	0.75
	801 to 2000	0.35	0.50
	over 2000	—	0.25
Metal and plastic	20	1.50	3.00
	21 to 50	1.00	2.00
	51 to 100	0.75	1.00
	101 to 200	0.50	0.75
	201 to 300	0.50	0.75
	301 to 800	0.35	0.50

So, this is the normal values of the draft which should be provided based on the height of the surface it depends upon the height of so, vertical height of that surface. So, you may have the particular problem also, where you can have the example how the draft is calculated based on the angle and you can see using the 10 of the angle it gives you certain dimension by which you can see that what should be the draft. So, out of top dimension will be more and bottom dimension will be little less or so, in the external part and the internal part it will be reverse.

So, that the easy removal of the pattern from the mold. Then there is allowance known as shake allowance, shake allowance is nothing, but when you try to take the pattern out of the mold, this pattern is initially given a shake. So, that it which the molding material which is there a stuck to this pattern, it basically looses it or the intimate contact is somewhat decreased for that it is somewhat, shaking on the lateral sides.

So, once you do that basically it makes the cavity size little bit higher. So, cavity is made oversized this is a type of negative allowance. Because anyway you have to take the pattern out, so you will have to shake it during the process of shaking the cavity becomes little bigger. In that case, you will have to; to have the pattern of somewhat smaller dimension that once you shake them, the cavity of required dimension can be found out. So, in some casting process like sand casting before withdrawing the pattern is rapped or shaken all around, the vertical faces to enlarge the mold cavity to facilitate it is removal.

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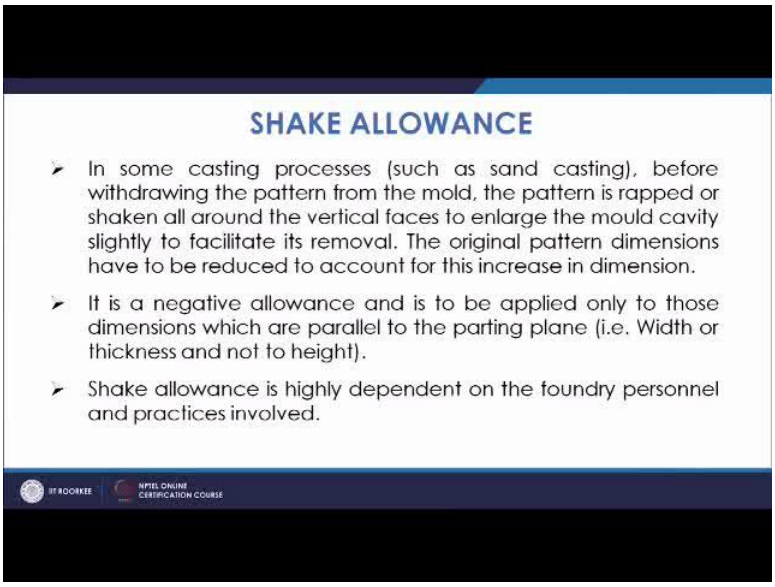

So, this way the original dimension is increased, that is why we give a negative allowance. So, that once you enlarge it you can have the casting of proper dimension. It depends upon the a skill of the foundry personnel and who is practicing it if it is a very expert person he may be knowing the intricacy and he may, give there is small amount of shake allowance and if it is a in the voice person who is learning he will shake it little more, that shake allowance will be more.

Machining or finish allowance, as we know once the pouring is done the mold material may be sand of different finesse that will affect the quality of the surface. Now, also the type of metal which you are pouring, that depending upon the specifications which is required by the manufacturer you need to have a certain degree of finish. Now, for that you will have to finish the surface and finishing is nothing, but removing the extra material from the cast material. So, basically you have to oversize the material. So, that you have to remove some extra material and that is why that giving extra allowance that is known as machining allowance.

So, you have to provide a finish allowance, ordinary sand casting will have referred surfaces, you need to give more machining allowances, where as if you use the metal mold you need not to provide, that much of machining allowance because metal molds will automatically give you a better finish. In that case, depending upon the molding material used you need to have the machining allowance. Ferrous material, when we melt the ferrous materials the normal tendency is that you also have the skins or scales that basically is removed. In that case, you have to have extra material so, that once you remove the scales you do not get the under dimension of the product. So, for that you provide the extra material.

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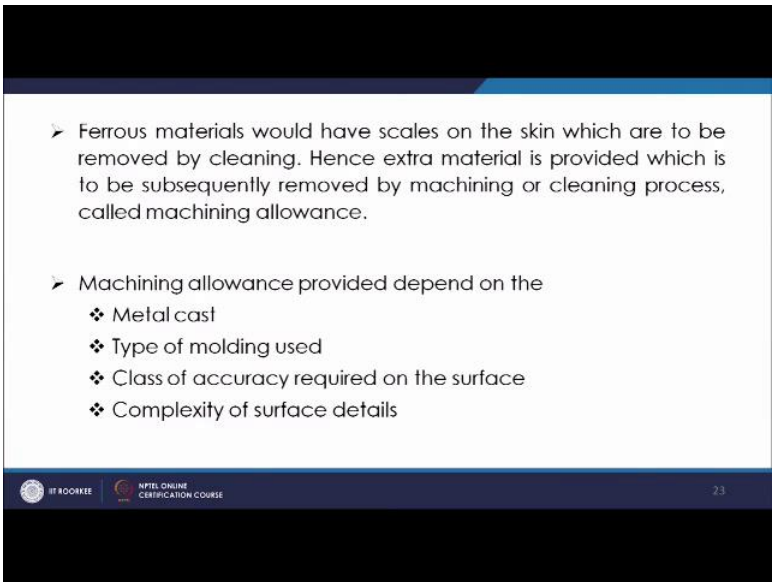

So, machining allowance depends upon metal cast, which is which metal you are casting, type of molding used, class of accuracy and complexity that we have already discussed. What kind of material you are using? What kind of accuracy we want? All these things are required. One way of reducing the machining allowance is to keep entire casting in drag flask that dimensional variation of and other defects due to parting plane are reduced.

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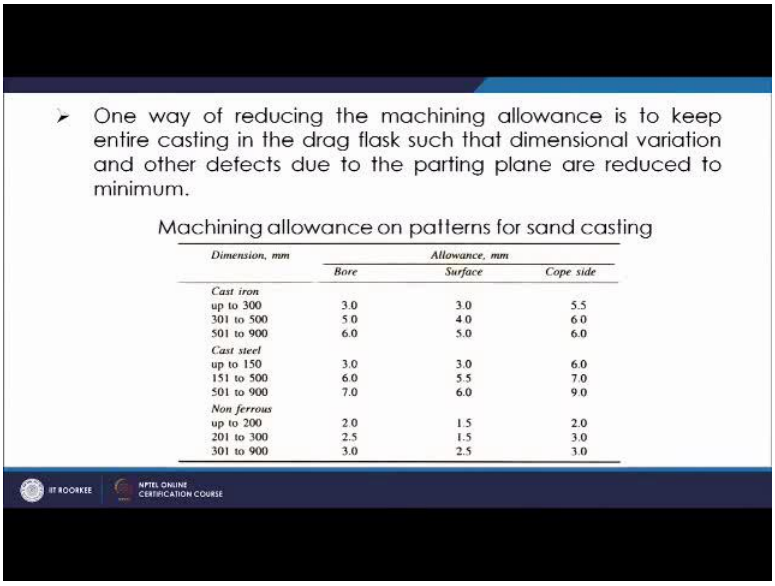

This is one of the ways that you do the casting in the drag part itself, there are certain data given for machining allowance you can see depending upon the dimension you have certain part in the cope and surface and the bore portion. So, this is normally used for centerizing the allowanced values in machining.

Then, another variety is distortion allowance; this tells that there are certain in cases when there is automated distortion of certain part of the casting. Due to the shape of the casting, certain part either they get bored down or they may be bored in the upper side. Now, mostly they will bored down because of the larger weight of the or heavy weight of the metal. In those cases you will have to provide in allowance in the upper direction or you have to bend the casting in upper direction. So, that once it takes the shape in the lower direction you get a flat surface. So, metal when just solidified very weak and also when we talk about certain kind of sections, because of the sections shapes are so, when you have metal in a hot state they are normally weaker.

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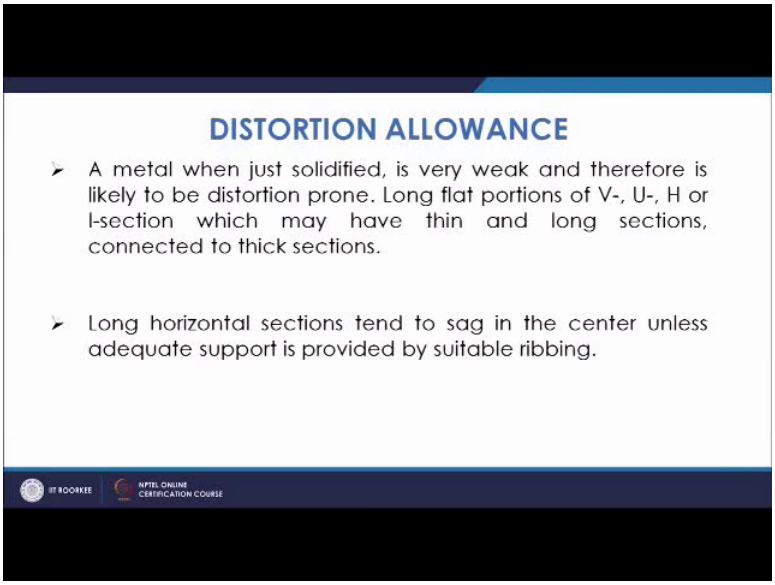

So, they try to deform, they try to distort, so all for that you need to provide certain allowance that is known as distortion allowance you can see that if you are your pattern is like this.

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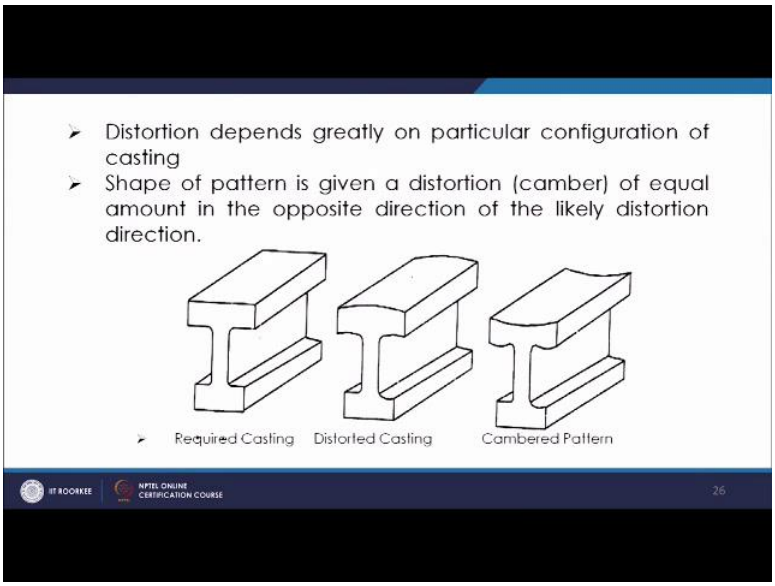

And if you are casting it, this portion will go down and your casting will look like this which will be having a concave type of surface. So, if you make the pattern like this and once it goes you will get a flat surface. So, this is known as a camber allowance or a distortion type of an allowance. These are the different kinds of allowances which are used in case of patternmaking, which we are using while calculating the final dimension of the pattern and, that helps in getting the proper size of the casting.

Thank you.