Metal Casting
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Module – 02
Sand Casting Process
Lecture – 07
Patterns And Allowances

Good morning friends. In the previous classes we have been learning about the moulding sands and their composition, we have also learnt about the core sands and their ingredients. Now let us learn about the patterns and the allowances.

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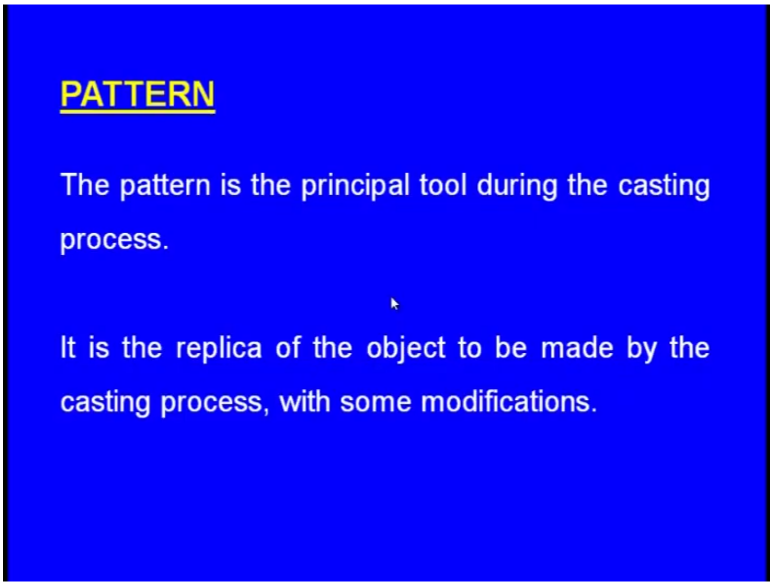

First of all what is a Pattern? Pattern is the principle tool during the casting process the one lecture and the tools and terminology we have seen that the pattern is the model for creating the mould cavity, if we want to make a particular casting a similar model we will take this model may be made up of wood metal or wax and so on.

This model will have a similar geometry to that of the casting which we want, using this model we create the cavity inside the mould this model is known as the pattern. It is the replica of the component to be made by the casting process, but not always that the pattern is exactly similar or identical to the cast component which we are going to make sometimes there may be little modifications. What are these modifications?

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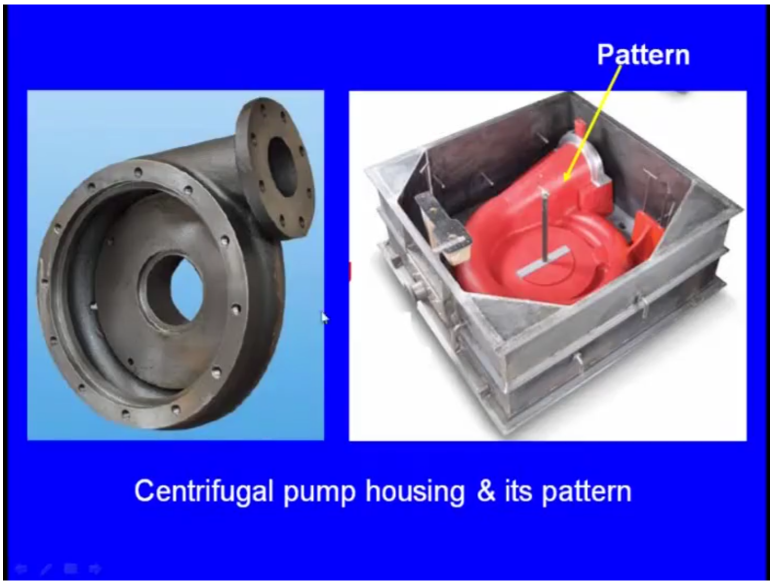

We will see now let us see how the pattern looks like say this is the centrifugal pump to be made by casting process or this is made by casting process and the pattern is like this you can see this is the pattern.

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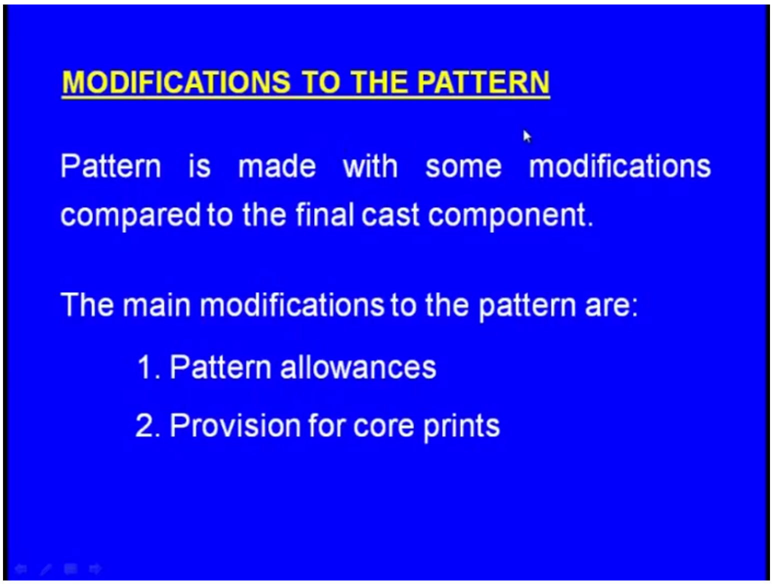

Now, these are the modifications to the pattern; pattern is made with some modifications compared to the final cast component. The main modifications to the pattern are pattern allowances and provisions for core prints. What are these allowances? Allowances means some increment or decrement to the dimension whereas, the second modification is the provision for the core prints. In the previous class we have seen the concept and importance of the core print the core print is used to support the core.

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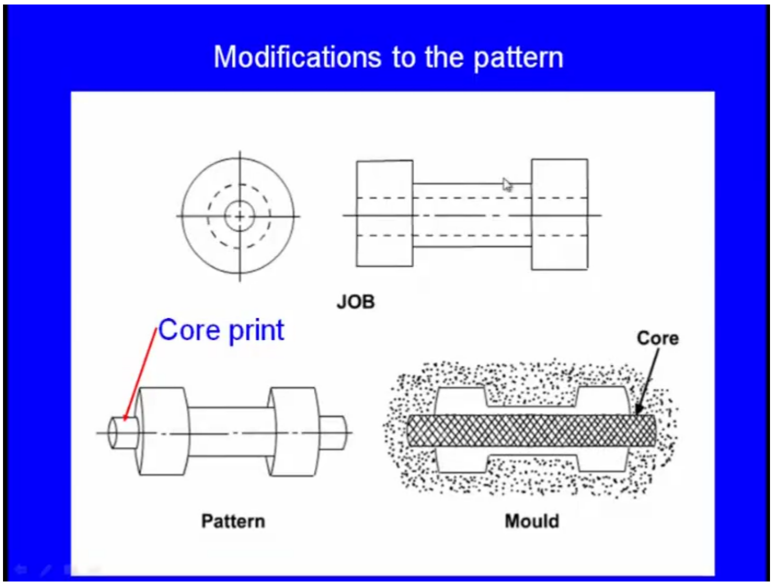

Now, again let us consider the same example which we have seen in the previous class. So, this is the component which we want this component has an axial hole. So, this is the axial hole this is the side view yes this is the axis of the job. So, to make this component we have to make this a similar cavity inside the mould. So, naturally one can think that the pattern should be similar to this shape, but here you see this is the pattern. Surprisingly the pattern it is geometry is different from the geometry of the casting which we want why there is a difference and here we can see some projection is there and here also some projection is there.

Why we have kept this projection to the pattern because so this is the mould cavity this is the mould cavity and this is the core this is the core. So, the molten metal flows around the core and after solidification we break this core that is how we get the axial hole in the cached component. Now the core actually the at effective core is it starts from this point and up to this point, but you only if we make that much core how it will be supported that is the question.

So, to support that we are making we are extending the core up to here up to here. So, this is the extended portion of the core, now where to place this even to place this. So, we are making the cavity an extended cavity is made here and extended cavity is made here;

into that extended cavity we are placing the extender portion of the core and that is how the core is supported here the extended portion of the core a what say pattern is known as the core print. Similarly the extended portion so this much portion is not part of the effective core. So, this is the core print. So, core print means it is an extra projection on the pattern to create to enable or to support the core prints of the core inside the mould cavity.

Similarly, it refers to the core print refers to the extended portion of the core also. Now these are the functions of a pattern it prepares the mould cavity it enables creation of the core prints. So, while we are making the pattern. So, these core prints we are these core prints we are not making separately while making the mould itself the core prints are made. So, the pattern has got the core prints.

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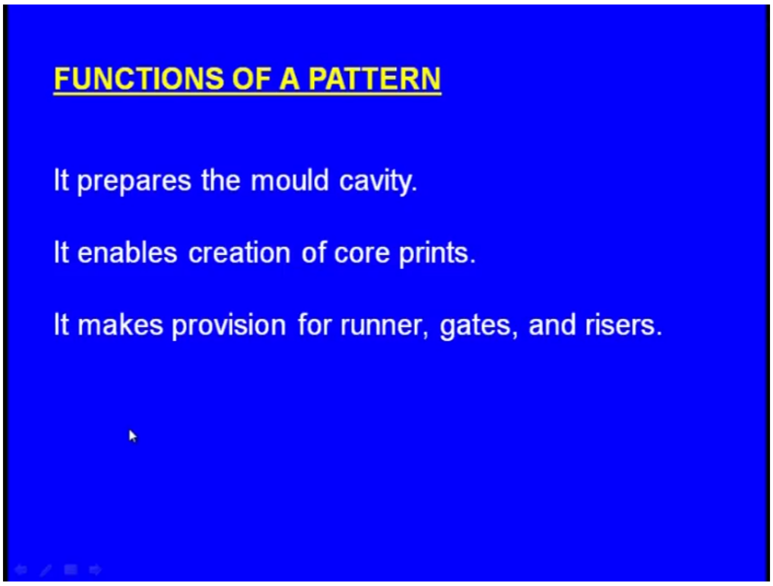

Next one it makes provisions for runner gates and risers. So, we have seen the what; say the vertical passes is there initially we pour the molten metal through the sprue, then it passes through the vertical passes this is known as the sprue.

Then it passes through the horizontal passes it is known as the runner after filling up the mould cavity it raises through the riser this is known as the riser and the pattern should make provision for the runner in gates and the riser these are the functions of the pattern. Now what are the characteristics of a pattern material can we choose any material which we find somewhere and make a pattern certainly not. The pattern material should have certain characteristics, then only we can choose that material as the our pattern.

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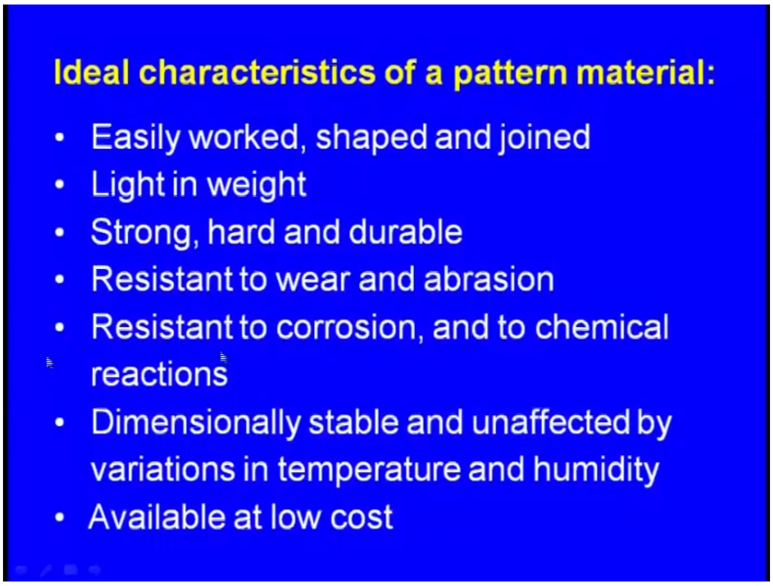

What are the; what say characteristics of the pattern material it should be easily worked shaped and joined. Sometimes the castings may have a complex geometry and we make we may take a solid block, may be a wooden block, and we must be in a position to make the required complex geometry on the using the pattern material. So, it should be easily worked shaped and joined. Next one it should be light in weight if it is too heavy handling would be difficult, next one it should be strong hard and durable.

Now, what is happening in the moulding process we take the pattern and we put it inside the moulding boxes and we put the moulding sand and we ram the moulding sand? Sometimes we apply excessive pressure and because of that the pattern should not be damaged or it is what say a minute features should not be broken. So, that is why it should be strong hard and durable; durable means we must be in a position to use it for making several castings that is the durability. Next one it should have resistance to wear and abrasion. So, as we keep using it to several times the sand particles come in contact with the what; say pattern material and they may cause wear and they may cause abrasion and the what; say a pattern material should have resistance against the wear and the abrasion.

Next one it should have resistance to corrosion and to other chemical reactions. Now what we are doing here we take the pattern put it inside the moulding box then we place the moulding sand over the pattern. The moulding sand contains moisture 2 to 5 percent moisture and if the what; say pattern is a willing to or is it is what say reacting with the what; say a moisture now it is shape will be changing it may swell or if it is a metallic pattern and it is possible that it may develop corrosion with the moisture it undergoes corrosion and some other chemical reactions can take place.

So, the pattern should have the corrosion resistance and resistance to chemical reactions. Next one dimensionally stable and unaffected by the variations in their temperature and humidity so maybe during the summer season they may expand or in the winter season, they may contact, but a pattern material that we choose for making the pattern should have the minimum variations in the what; say a variations in the temperature and humidity. Next one it may have all the required properties, but it should be available at an affordable price it is price should not be too costly these are the common pattern materials.

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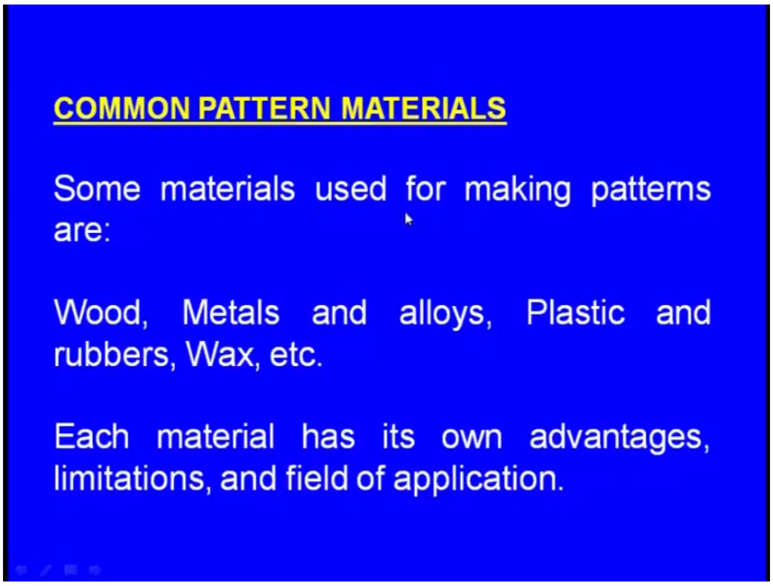

Some materials are used for making patterns or wood it is widely used pattern material. Next one metals and alloys next one plastic and rubbers and finally, wax is also used as the pattern material each material has it is own advantages limitations and field of applications.

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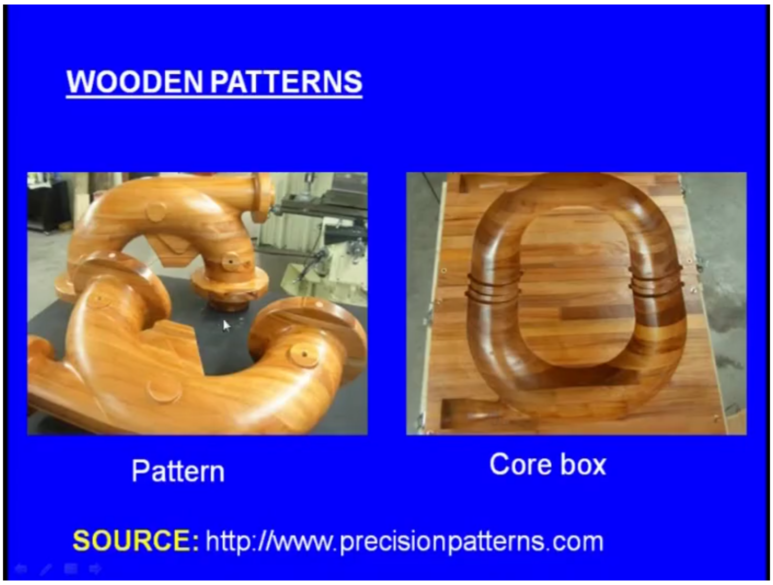

Now, these are the wooden patterns you can see this is right. So, this is a pump housing right. So, this is the wooden pattern and this is the core box of course, when we make the pattern, what say cavity using this pattern, a hollow cavity is created inside the moulding box.

Now, we need a hollow space within the housing. So, for that we make a core using this core box and this core will be kept inside the mould cavity then we get the hollow housing. So, this is a best example of the wooden pattern.

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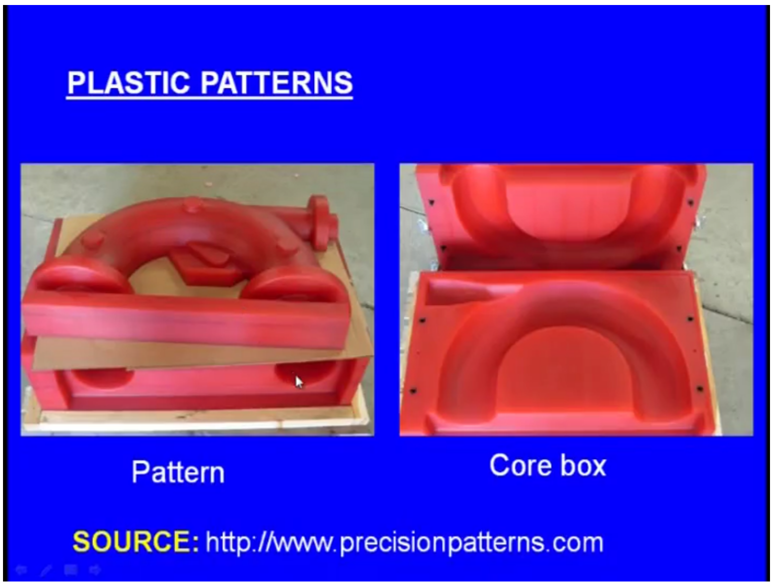

And there will be plastic patterns also yes this is a plastic pattern for the pump housing and this is the core box and here we make the core using this pattern we make the mould right and inside the mould cavity we place this core in the correct position then we get the hollow pump housing. These are the types of the patterns.

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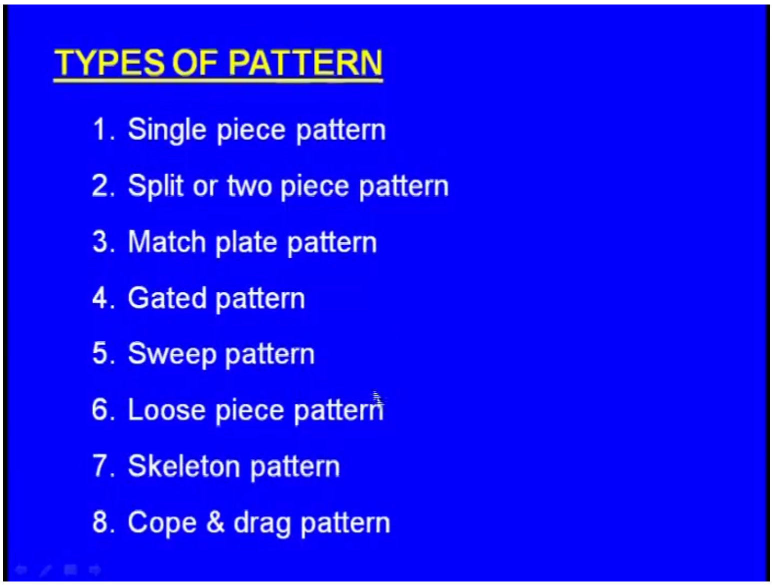

One is the Single piece pattern, second one Split or 2 piece pattern, third one Match plate pattern, fourth one Gated pattern, fifth one Sweep pattern, sixth one Loose piece pattern, 7th one Skeleton pattern and finally, the eighth one is the Cope and drag pattern. Now let us see all these patterns one by one how would do they look like. Now let us see the first we will see the single piece pattern.

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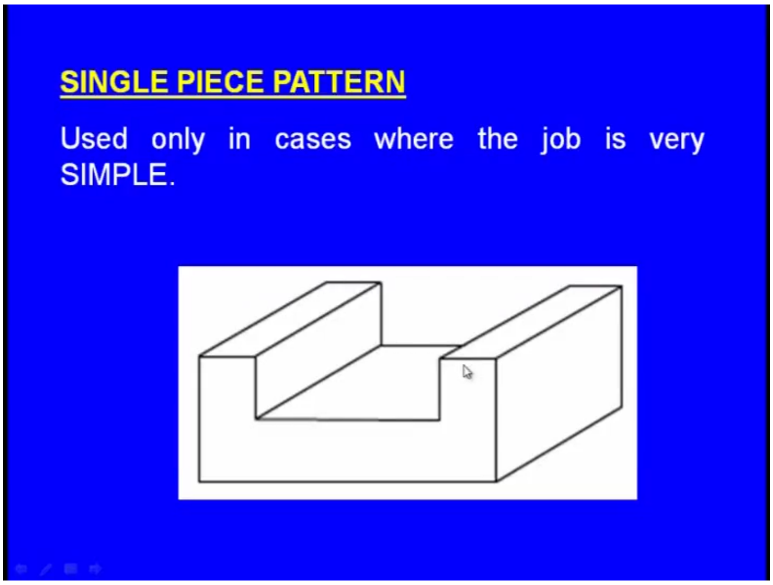

See this is the single piece pattern used only in cases where the job is very simple in such a cases we use this single piece pattern.

See the job is very simple. Now, this is the what; say a best what say application of the single piece pattern, now we want to make a spur gear using the casting process and the pattern will be like this. So, this single piece will be kept inside the track box and a a in that drag box we compact the moulding sand afterwards, we make the drag box upside down over that, we place the cope box, and we place the riser pin and sprue pin and again we compact in the cope box.

Now, in the case of this single piece pattern the mould cavity is laying only in the drag box.

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Of course, to get this what say spur gear inside we have to place the core. So, this is pattern for making the spur gear cavity. So, we have seen the single piece pattern now let us see the split or 2 piece patterns.

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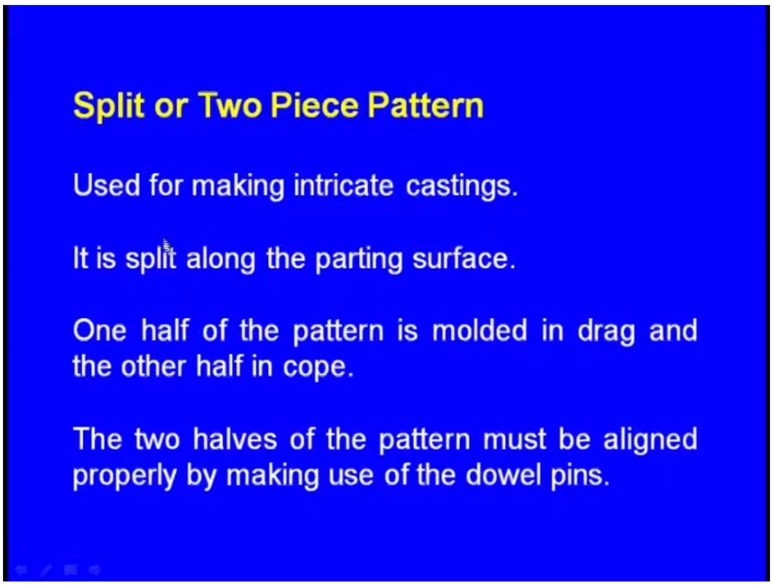

Split or 2 piece pattern is used for making intricate castings when the cavity cannot be made using the what; say single piece pattern that time we go for the split or 2 piece pattern, it is split along the parting surface means the pattern is made into 2 halves one half is what say a compacted in the drag box and their other half is compacted in the cope box.

Next one the 2 halves; halves of the pattern must be aligned properly by making the use of the dowel pins and here we can see this is the casting which we want of course, this is not the pattern. So, the yes a similar casting we want, now suppose if the what; say pattern is exactly like this a single piece pattern let us assume suppose if we put it inside the drag box and compact the moulding sand around that how can we withdraw this? In this kind of case using this single piece pattern we can not withdraw after the compaction that is why we go for the split pattern or the 2 piece pattern.

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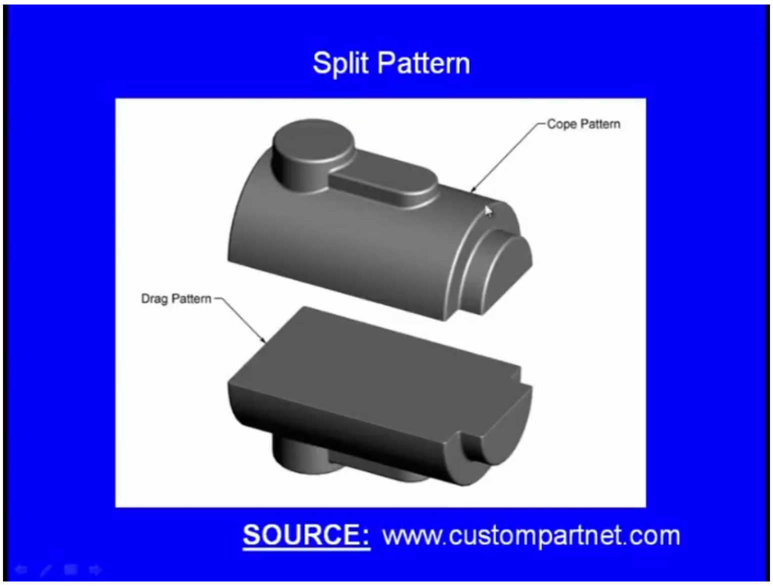

Now, the split pattern looks like this when the casting is like this the pattern will be like this. So, this is the cope pattern and this is the drag pattern means this part will be compacted in the drag and this part will be compacted in the cope, now these 2 halves can be withdrawn from the a cope box and the drag box then they both the boxes will be closed. Now what happens inside; there will be a shape hollow cavity whose shape is similar to the final cast component which we want. So, that is all about the split piece pattern.

So, again here we can see this is the what; say a pattern for making a dumbbell; dumbbell is manufactured by metal casting.

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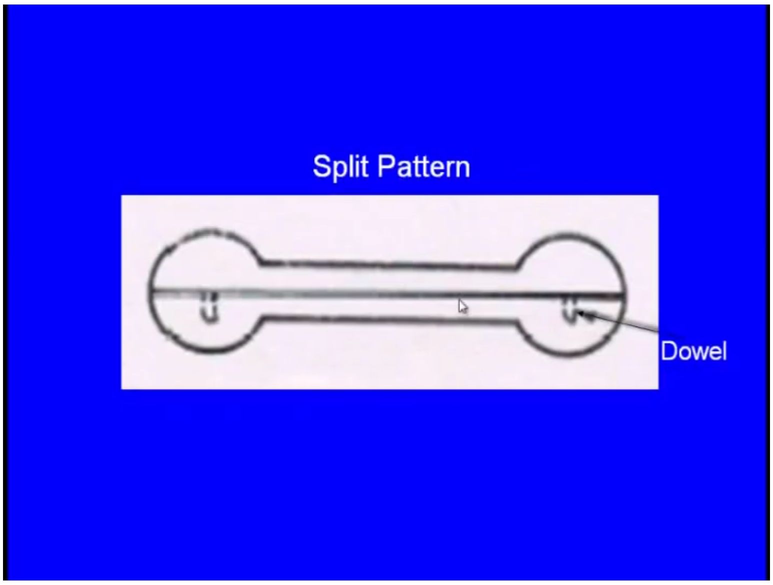

And here for making the dumbbell a split piece is used. So, this is the cope pattern. So, this is the drag pattern. Now what happens initially we put the what; say a drag pattern in the drag box and we compact the moulding sand then we make it upside down now over the drag pattern we have to carefully place the cope pattern that time when we are placing the cope pattern over the drake drag pattern there should not be any misalignment.

So, to prevent the misalignment we use the dowel pins means in the drag box there will be some holes will be there and for the what; say a cope pattern there will be pins will be there and we ensure that these pins rest in the holes of the what; say a drag pattern, then there would not be any misalignment. So, that is how we make the what; say we align the what; say 2 pieces in the split pattern now here we can see this is a dumbbell right. So, this is made by casting by using the a split pattern or the 2 piece pattern.

So, we have seen the single piece pattern and the split piece pattern now let us see the match plate pattern.

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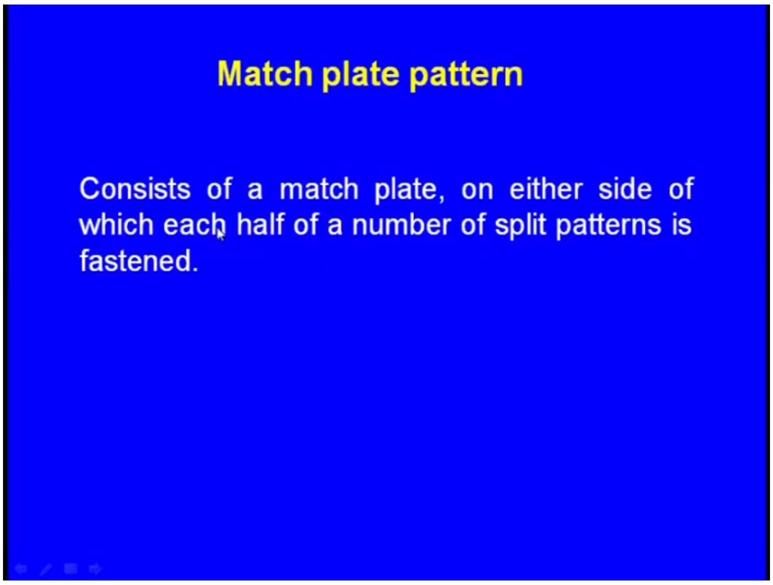

Match plate pattern consists of a match plate it is made up of it is a metallic one metallic match plate on either side of which each half of the what; say split pattern is fastened means here also we use 2 piece patterns, but the thing is in the case of these what say a split pattern or the 2 piece pattern, these 2 pieces are always independent, but here what we do is initially we make 2 pieces and we take a match plate match plate a a metallic plate thick metallic plate and at the bottom we fix the drag pattern and on the other side above the plate we fix the cope patterns and they are permanently fastened.

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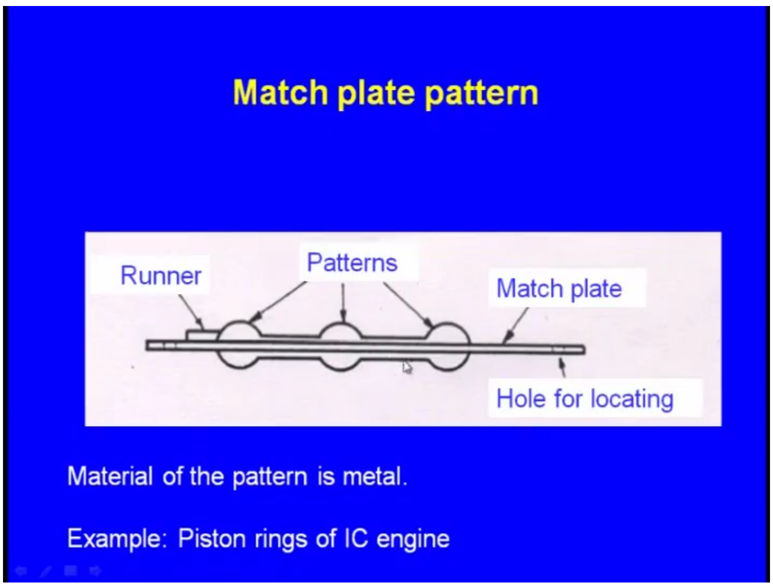

And we can see here yes this is the match plate and this is the pattern right this is the cope pattern and this is the drag pattern right and the pattern right these are the metallic patterns not the wooden patterns.

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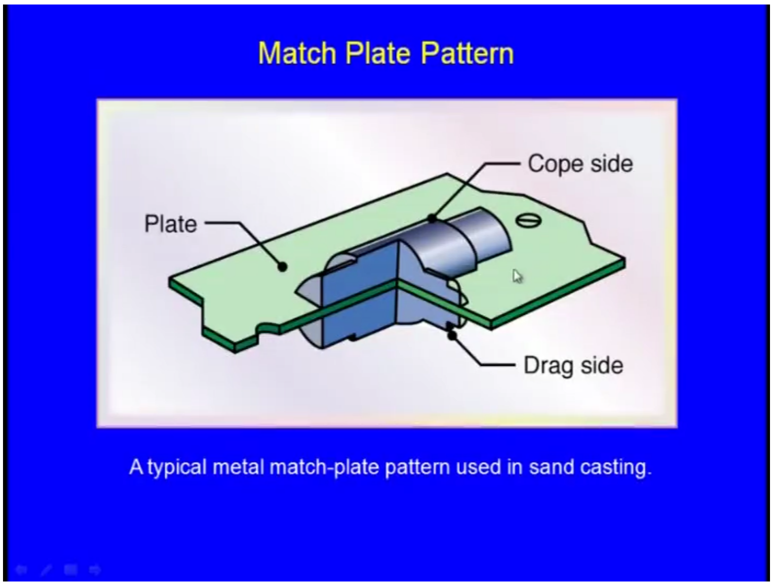

Yes, here we can see another example. So, this is the match plate a thick plate and these we can see at the bottom. So, this is the drag off of the pattern and this is the cope off of the pattern and they are fastened to the what; say a match plate permanently. So, this is the metallic assembly.

Now, what happens initially we take the what; say a drag box and we dump the calculated amount of the moulding sand into the drag box and we place the match plate on the drag box. Now what happens and we apply pressure on the match plate and the sand inside the drag box will be compacted and it will take the impressions of the drag pattern. After that above the match plate we place the cope box again we place the moulding sand and we place the calculated amount of the moulding sand again we compact it.

Now, what happens the sand in the what; say cope box will be compacted and it takes the shape of the cope pattern then these 2 what say generally it is a; this is done by the machines right. So, some vibrations are given to this match plate then because of that because of the vibrations the pattern will be withdrawn from the drag box and also from the cope box, then these 2 boxes will be separated the match plate pattern will be separated and it will be kept a aside the again the cope box and the drag box will be assembled properly then it is ready for the pouring of the molten metal that way match plate pattern offers us certain benefits means it is faster.

So, there is no question of the miss alignment and the it is used for the bigger castings.

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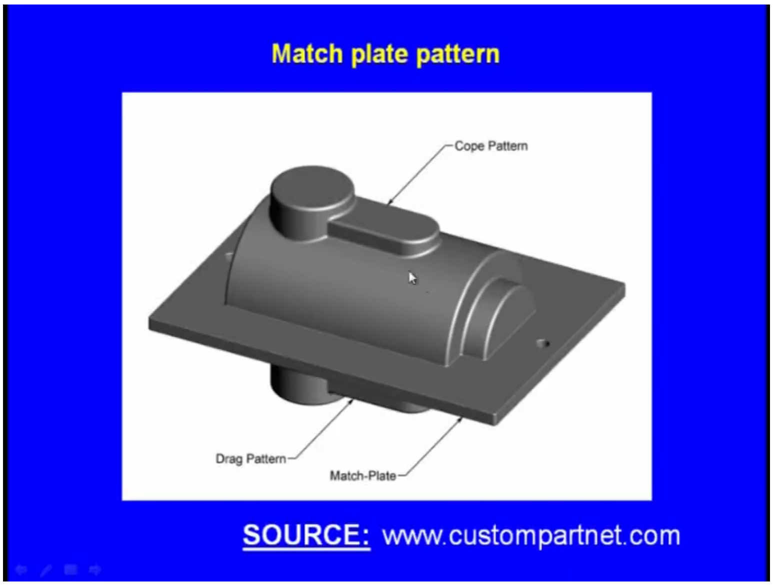

And here we can see again another match plate pattern. So, this is the match plate and this is the cope pattern and this is the drag pattern. So, these offers benefits compared to the split plate pattern. So, we have seen these 3 now let us see the gated pattern.

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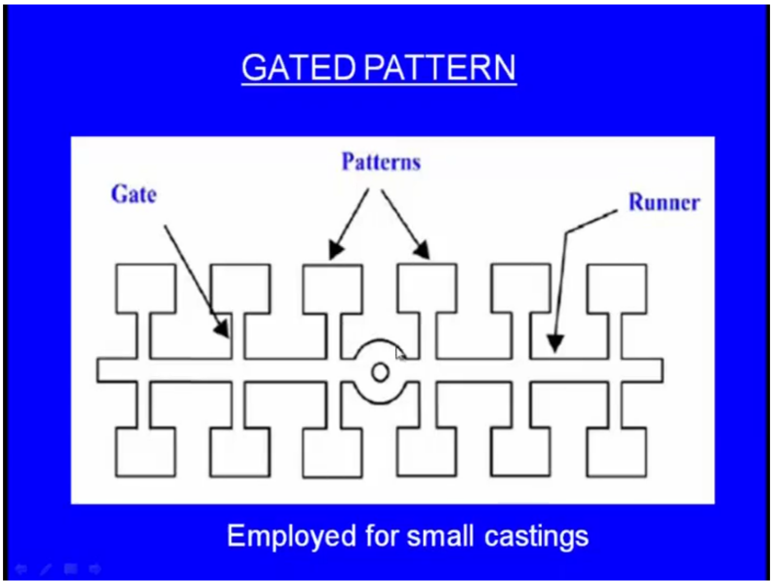

So, the gated pattern looks like this the gated pattern is used for making very small castings for example, say in a session say one has to make say some 12 small castings; means for each casting one has to use 2 moulding boxes and 2 what say one sprue pin and one riser pin and what say and one has to make the gating system and making the mould for each casting that consumes lot of time pattern withdrawal this takes lot of time.

Now, because the castings are very small now the question is why can not we make several castings in a single mould that is the concept of the gated pattern? Now we can see here so this is the casting this squared one is the casting and this is one casting this is one casting; this is one casting likewise in one moulding box we want to make 12 small castings of same geometry. Now what happens we make the pattern in an assembled way means there is a common sprue is there here the sprue is perpendicular here right. So, we pour the molten metal through the common sprue and this horizontal passes is known as the runner there is a common runner we pour the molten metal here and the molten metal travels like this and it flows into all the what; say gates finally, it fills in all the cavities.

So, that is the concept of the gated pattern. So, while making the pattern we make the pattern in an assembled way; means the pattern contains what say for making castings for several small castings it makes cavity for several castings small castings. So, this is employed for the small cast castings only, next one the sweep pattern. This is the typical appearance of the sweep pattern.

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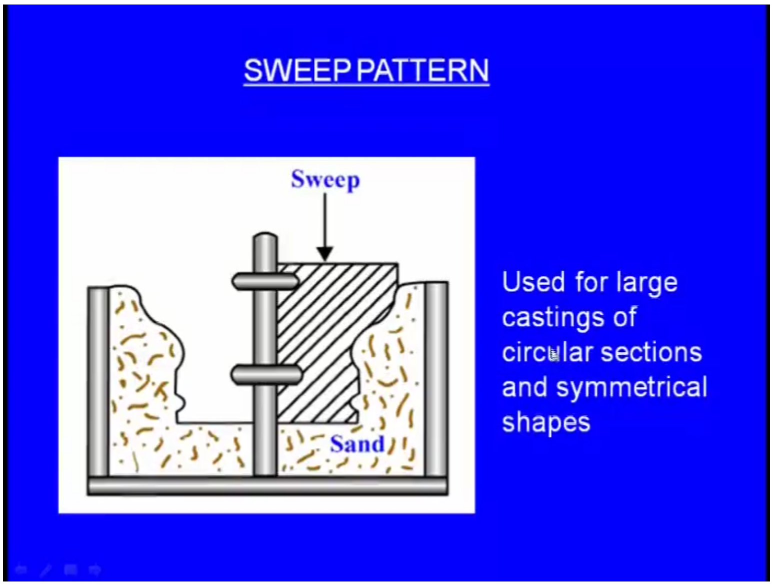

Used for large castings of circular sections and symmetrical shapes, now sometime back in the moulding sands we have seen that the loam sands we have seen right it contains excessive of clay and finally, it is what say it is nature is different from the green sand the green sand is sticking, but whereas,, but green sand does not look like a paste.

Whereas the sand used in the while using the sweep pattern looks like a paste right. So, this pasty sand is initially kept inside the moulding box. Now this sweep is a 2 dimensional pattern, just it is a 2 2 dimensional pattern now using this sweep initially right. So, we start keep rotating it we keep rotating as we keep rotate this sweep what happens a cavity is created inside this loam sand, and after this sweep is has gone completely inside then we stop rotating it then we withdraw the pattern now an what say symmetrical cavity is created inside the loam sand.

Over this over which we place the cope box then we pore the molten metal. Now what is the benefit of this sweep pattern it is a 2 dimensional pattern means the material cost is drastically coming down even making the what; say a mould is easier. So, this is how we can make the what; say mould cavity.

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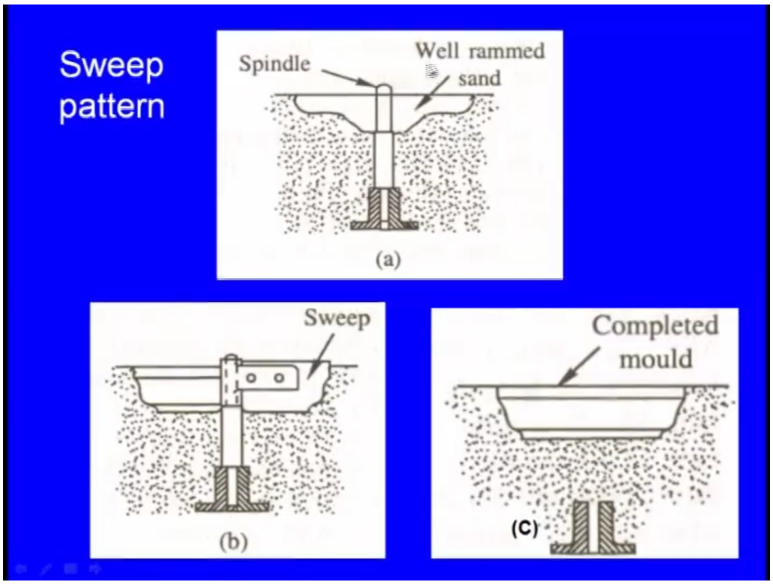

So, this is the what; say a unrammed sand loam sand right and in inside there is a spindle initially we place there will be a spindle.

Now, in the second stage we attach the sweep pattern. So, this is the sweep pattern now we start rotating it as we keep rotating that this loam sand is removed as the sand is removed we remove it and it goes inside and inside finally, a cavity is created after the creation of the cavity is over we remove the pattern and we also remove the spindle now this is the complete mould this is the cavity. Now into this cavity we can we can pour the molten metal next one let us see the loose piece pattern.

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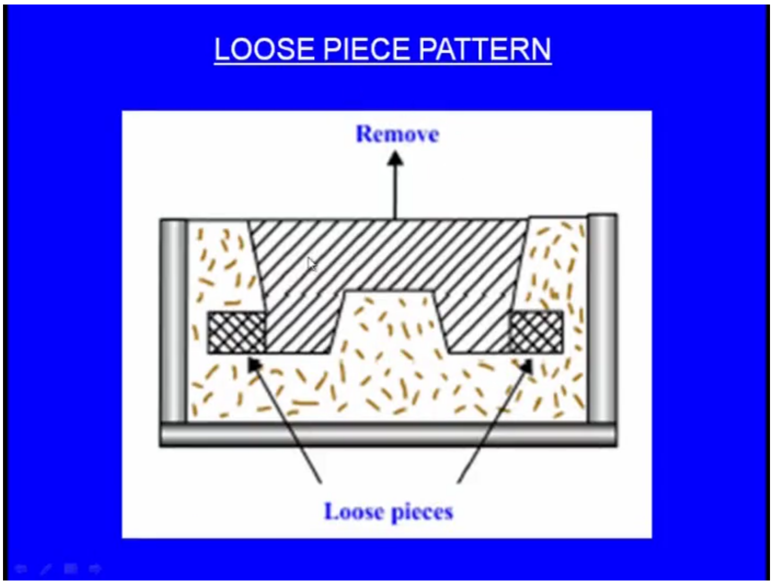

Now, this is the a typical appearance of a loose piece pattern now you see the geometry of this pattern casting. So, we want to make a casting of this shape it is like this certainly we can use a single piece pattern now we have we have compacted this in a drag box in the drag box of course, initially it is downwards we place the pattern downwards and over that we play around that we place the drag box then we compact the sand then we make it upside down now we have made it upside down.

Now, how to remove the pattern now as we try to remove the pattern this portion and this portion they are obstructing the removal or the withdrawal of the pattern. Now how to overcome this problem, now in such a case we use the loose piece pattern loose piece pattern means here we can see this is one loose piece and this is one loose piece, yes they will be kept here on this side and the one piece will be kept on this side now keeping these loose pieces close to the pattern we what say a complete the moulding process.

After the moulding process is over now we can see there will be a little tapper will be there here you which will enable easy withdrawal of the main pattern we remove the main pattern like this, after we remove the or the withdraw the main pattern this what say this piece what say it has to be moved towards left and this piece will come out this piece will come out when we move left and take it up upside, what about this piece we have to move towards right and take it outside.

So, when the loose piece pattern is used. So, in this kind of situation we can withdraw it very easily. So, that is the concept of the loose piece pattern next one the skeleton pattern. Skeleton pattern is used for making very huge castings. So, if for such a huge castings and if we use the what; say a solid pattern it will consume lot of a pattern material and the cost of the pattern will go up not only that what say the what; say handling of the pattern would be very difficult.

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Because, it will be very heavy right it will become very tedious, that is why when we are making a very huge pattern when we are making a very huge casting what is important for a pattern it is outside feature.

What is inside is matter for us inside there is material or hollow space or inside there is some other material it does not matter to us. So, we ensure that the outside surface of the pattern is perfectly made, but inside it is hollow you can see the other side of the pattern now here it is hollow, but still it is able to serve our purpose using this hollow pattern we are able to make the cavity the large cavity. So, when we are able to make the cavity with this what say hollow pattern, why can not we use this and why should we go for the solid pattern which would be expensive and which would be very difficult to handle. So, that is why in such a case we use the skeleton pattern.

Skeleton pattern means only there is outside feature inside it is hollow.

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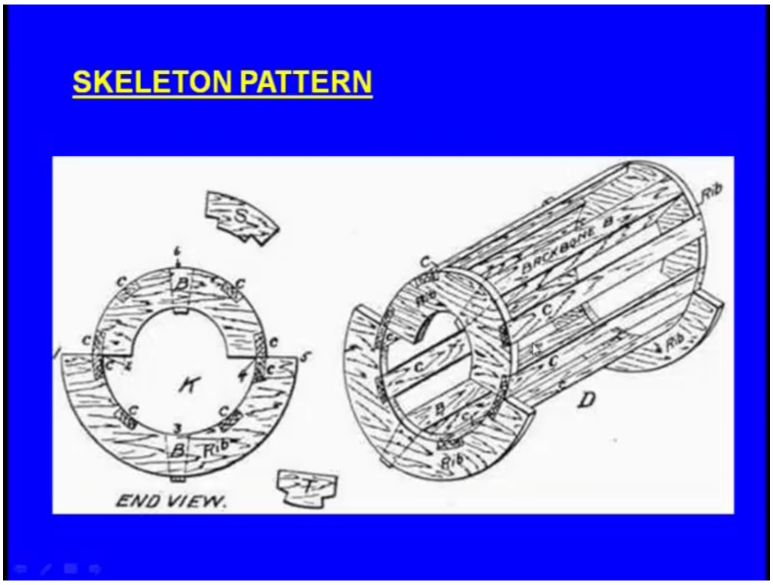

And here we can see there is another this is another skeleton pattern of course, it has got 2 halves and here we can see this is the casting which we want.

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Now for making this casting and if we have to make the what; say a complete solid wooden pattern just imagine this casting weighs tons right weight of the casting would be in some tons maybe 4 5 tons. Now the whole what say pattern is made up of the solid wood the weight of the pattern also would be very high and the handling of the pattern would be very difficult.

In such a case we go for the skeleton pattern means only outside only outwards it is it has got the required features, but inside it is hollow. So, that is the benefit and important feature of the skeleton pattern.

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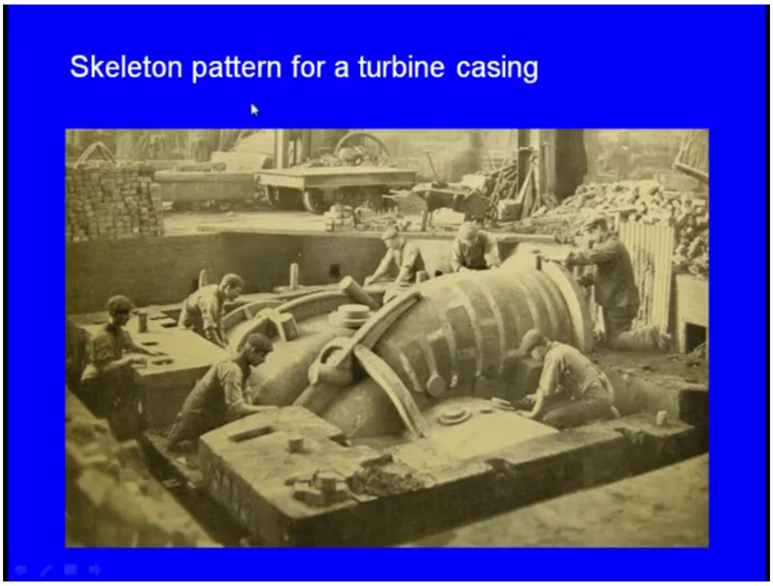

Now here we can see another skeleton pattern your big casting for a this is the pattern for your big turbine casing housing this is the yes a turbine housing will be like this and you can see several people are working around it and you can see the several and the pattern is so big.

Now, for such a what say a pattern it is not wise to use the solid pattern instead it would be wise and economical to use the skeleton pattern or the hollow pattern. Finally, let us see the cope and drag pattern what is cope and drag pattern is cope and a drag pattern they also enable creation of the what; say a runner and the riser.

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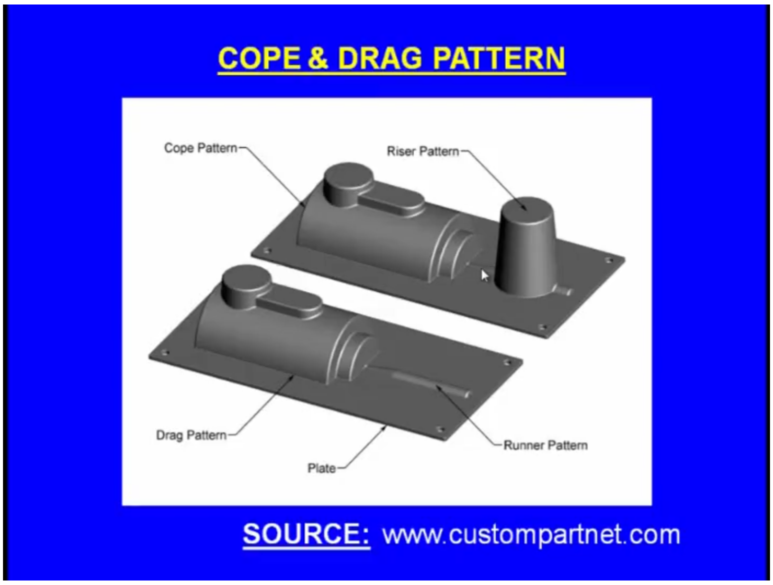

Whereas, in the case of the split piece pattern what say single piece pattern, match plate pattern, the creation of the sprue runner we have to do separately whereas, in the case of the cope and drag pattern, creation of the riser, creation of the runner, creation of the ingates all these features are included in the pattern itself means again we can see here 2 patterns are there.

So, this is the cope pattern and this is the drag pattern when we are what say a ramming the drag pattern in the drag box the required features are created in the mould cavity and this is the cope pattern and when we are using this pattern and we are we will place this inside the cope box and place the moulding sand what happens even the riser hole is automatically created the runner is automatically created; means this reduces the time which we spend for creating the riser and the runner.

So, that is the benefit of the cope and drag pattern. So, this cope and drag pattern includes the what; say a provisions for making riser and runner sorry right riser and runner. So, we have seen we have seen the different types of the patterns now let us see the pattern allowances.

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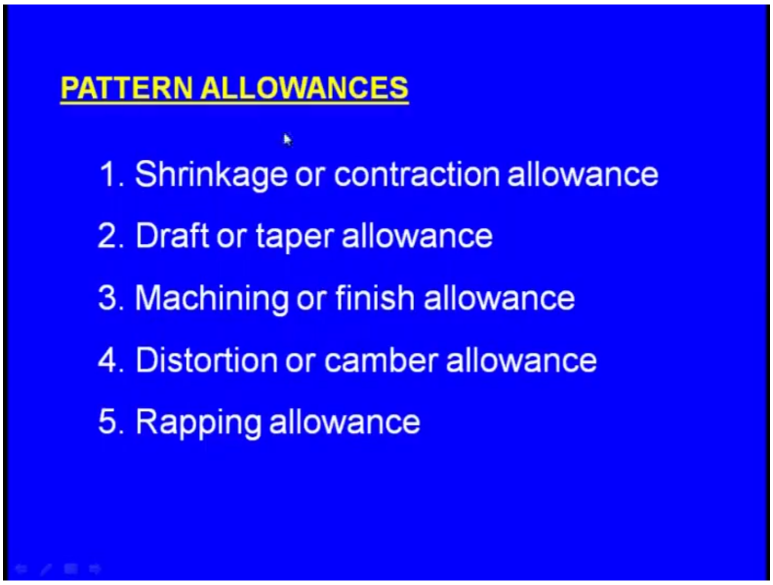

These are the pattern allowances, first of all what are these allowances; allowances means some increment or decrement to the dimension so this is known as the allowance. So, there are 5 types of allowance are there shrinkage or contraction allowance, draft or tapper allowance, machining or finishing allowance, distortion or camber allowance finally, rapping allowance.

Now, let us see all these allowance is one by one first let us see the shrinkage or contraction allowance.

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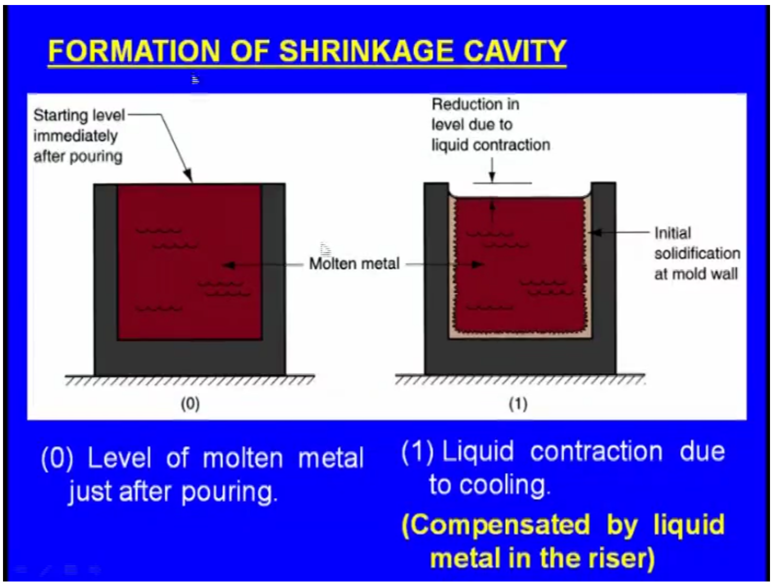

Now let us see what happens when we pour the molten metal into the mould cavity, now let us see let us this is the mould cavity, now immediately after we pour the molten metal it looks like this. May be after few minutes what will happen maybe if it is the aluminum right the melting temperature is 600 and 60 degree centigrade, but we pour it at about 700 and 50 degree centigrade. So, there are 2 temperatures in the casting one is the melting temperature at which the melting actually starts, but that is not enough to pour inside the mould cavity to pour into the mould cavity we still hate it above the melting point. So, that point that temperature is known as the pouring temperature and maybe we may pour at 700 and 50 degrees centigrade now from 700 and 50 to 600 and 60 it will be there will be a liquid cooling inside the molten metal. So, because of that there will be some contraction will be there you can see this is the shrinkage.

Initially there is no shrinkage why this shrinkage is taking place, because of the temperature drop from the pouring temperature to the melting temperature, but what happens fortunate the we have sufficient molten metal in the riser. So, this molten metal comes and fills this gap; means this shrinkage is compensated by the liquid metal in the riser now what happens yes this what say shrinkage is compensated by the liquid metal in the riser now inside there is solidification and because of that right there is again shrinkage this is known as the solidification shrinkage and fortunately again we have sufficient molten metal in the riser.

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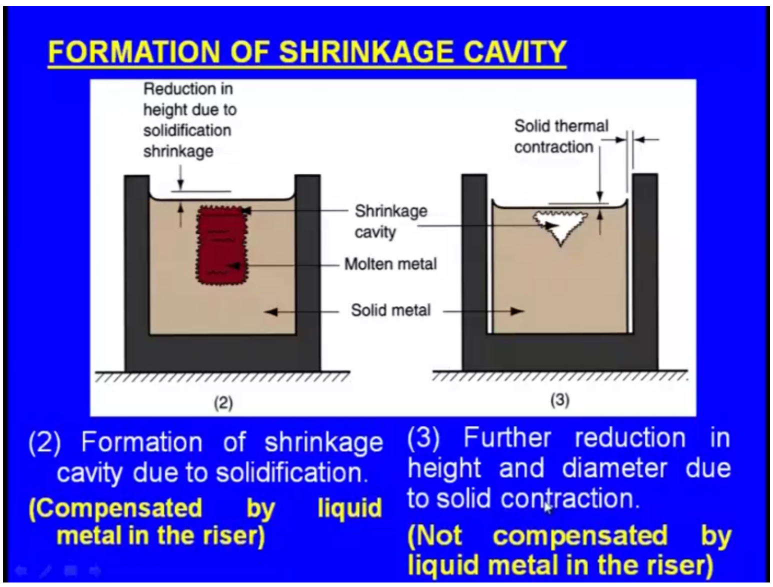

So, the liquid metal in the riser comes and fills this gap. So, this is also what say avoided right. So, the liquid metal in the riser has compensated. So, for 2 shrinkages one is the liquid shrinkage and another one is the solidification shrinkage. Now let us come now the casting has finally, solidified of course, here we can see a solidification shrinkage let us assume that it is compensated by the liquid metal has come and it has filled this gap now with the casting is completely solidified yet 600 and 60 degree centigrade.

Now, once it is completely solidified it cools down from 600 and 60 degree to room temperature maybe 30 degrees or 35 degrees that time what happens there will be reduction in the size may be the reduction in the height, reduction in the diameter, or reduction in the width. Now do you think that the liquid metal in the riser will come and fills this gap certainly not right? So, in this case the this what say shrinkage or this contraction is not compensated by the liquid metal in the riser then what happens.

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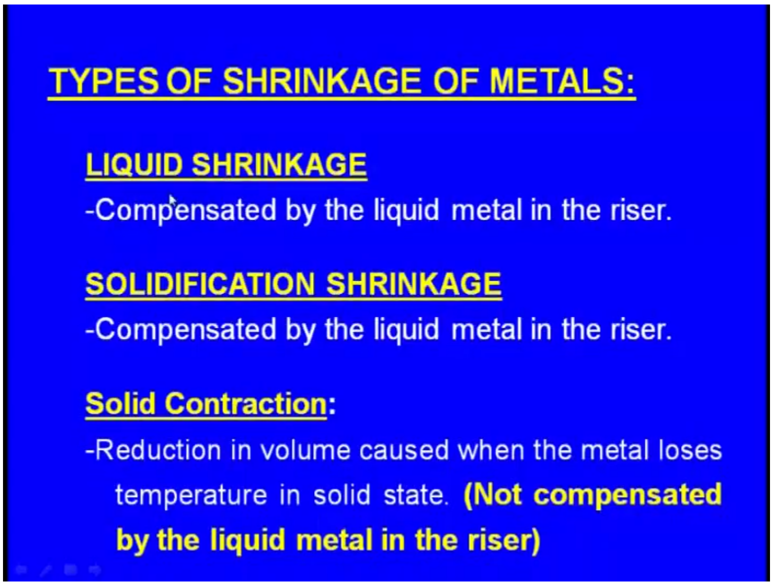

So, we can see one is the liquid shrinkage it is compensated by the liquid metal in the riser, next one solidification shrinkage this is compensated by the liquid metal in the riser and solid contraction, which starts from the what; say freezing point and ends at the room temperature ambient temperature reduction in volume caused when the metal loses the temperature in the solid state and this reduction this contraction in the size is not compensated by the liquid metal in this riser.

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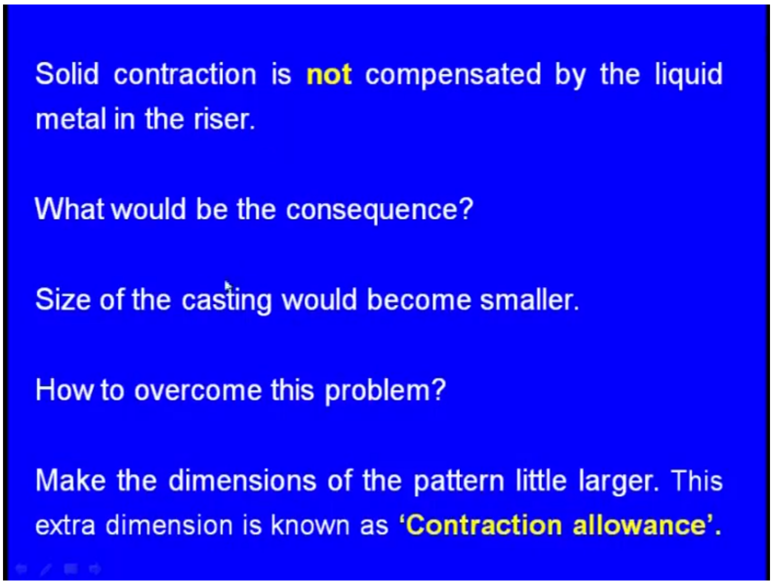

Solid contraction is not compensated by the liquid metal in the riser, what would be the consequence; consequence size of the casting would become smaller we might have design the pattern with keeping the what; say a actual casting size accordingly we have design in the pattern. Now because of this contraction solid contraction the size of the casting would become smaller, which we do not want now how to overcome this problem make the dimensions of the pattern little larger so that this extra right. So that after this contraction solid contraction is over the final size of the casting would be equal to the size of the casting which we want.

So, this increment in the what; say size this extra dimension is known as the contraction allowance. So, this is also known as the shrinkage allowance again this is different for different materials.

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SHRINKAGE ALLOWANCE FOR VARIOUS METALS

Material	Dimension	Shrinkage allowance (mm)
Grey Cast Iron	Up to 610 mm 610 mm to 1220 mm over 1220 mm	0.010 0.009 0.007
Cast Steel	Up to 610 mm 610 mm to 1830 mm over 1830 mm	0.021 0.016 0.013
Aluminum	Up to 1220 mm 1220 mm to 1830 mm over 1830 mm	0.013 0.012 0.010
Magnesium	Up to 1220 mm Over 1220 mm	0.014 0.013

When you are making gray cast iron? So, up to 600 and 10 mm millimeters the shrinkage allowance is 0.01 mm and for the same materials, when the dimension is between 600 and 10 mm to 1200 and 20 mm the shrinkage allowance is 0.009 mm and over 1200 and 20 mm the shrinkage allowance is 0.007 mm.

Similarly, when we are making cast steels up to 600 and 10 mm the shrinkage or the contraction allowance is 0.021 mm, from 600 and 10 mm to 1800 and 13 30 mm the shrinkage allowance is 0.016 mm and over 1800 and 30 mm the shrinkage allowance is 0.013 mm. And when we are making aluminum castings up to 1200 and 20 mm the shrinkage allowance is 0.013 mm, from 1200 and 20 to 1800 and 30 mm the shrinkage allowance is 0.012 mm and over 1800 and 30 mm the shrinkage allowance is 0.10 mm and when we are making magnesium castings up to 1200 and 20 mm the shrinkage allowance is 0.014 mm.

Over 1200 and 20 mm the shrinkage allowance is 0.013 mm. So, these are the allowances to be given as the a shrinkage or the contraction allowance for the different cast materials; means these allowances are to be given to the pattern while designing the pattern.

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Next one let us see the draft or the taper allowance what is this draft or taper allowance.

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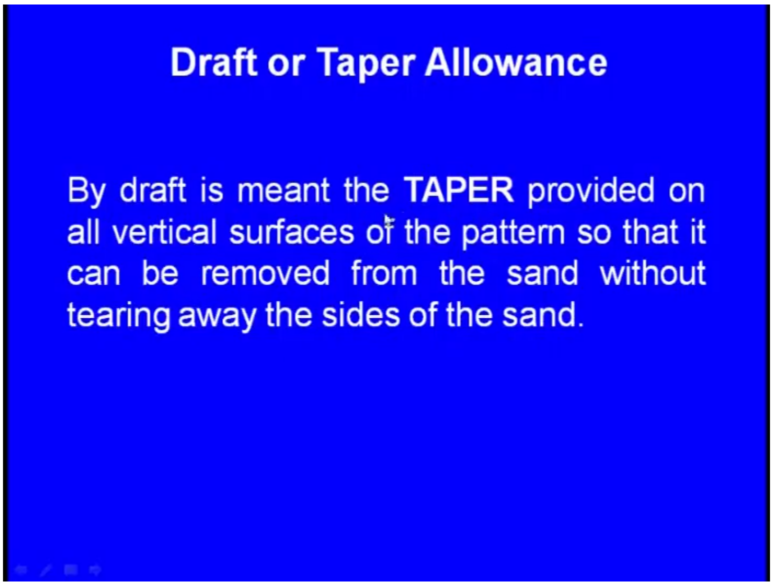

By draft is meant the taper provider on all the vertical surface of the pattern. So, that it can be removed from the sand without tearing away the sides of the sand.

When we are withdrawing the pattern the vertical surface of the pattern made tear out the mould cavity because of the friction. So, to avoid the tearing we give a taper because of that taper we can easily withdraw the pattern without causing any damage to the what;

say a vertical surface of the mould. Here we can see one case. So, this is one case and this is the mould and this is the pattern and you can see here this is the vertical portion vertical element of the pattern and there is no taper, because of that after moulding is over and they are trying to withdraw it.

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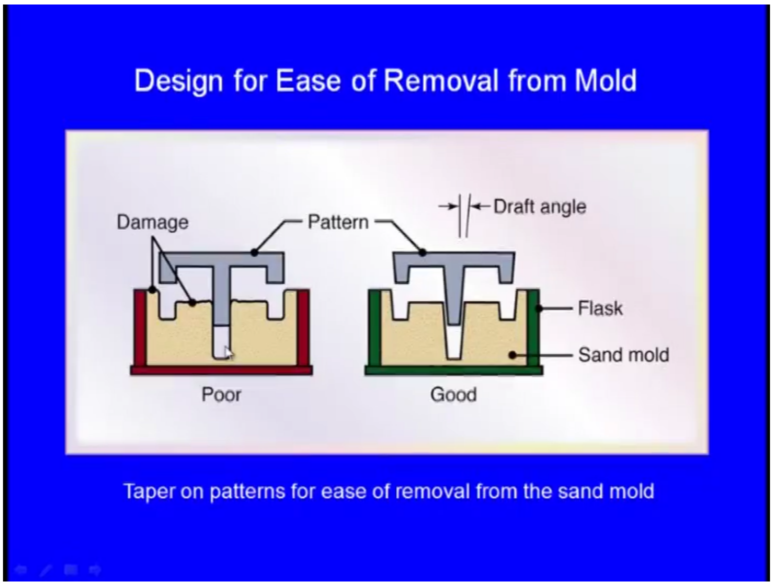

Now, what happens here this is the what; say a vertical surface of the pattern and this is the vertical surface of the mould cavity there is a friction between the pattern and the mould cavity surface and because of that friction as we are withdrawing and this what say a portion will be damaged or it may be broken. So, this has to be avoided. So, this is a poor design, now what happens here. So, this is the pattern and this is the vertical element of the pattern now a small taper is given to the pattern.

So, what happens with this pattern and when we what say compact the sand in the drag box. Now after the compaction when we try to what say withdraw the pattern, the moment we what say push it little upwards already a clearance is created between the this surface of the pattern and the surface of the cavity. Once a small clearance is created further it would not touch then we can easily withdraw the pattern completely, that is why when we give the pattern to the vertical surface or the vertical element of the pattern the withdrawal would be easier.

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DRAFT ALLOWANCES OF VARIOUS MATERIALS

Pattern material	Height of the given surface (mm)	Draft angle (External surface)	Draft angle (Internal surface)
Wood	25 25 to 50 50 to 100 100 to 200 200 to 800	3.00 1.50 1.00 0.75 0.50	3.00 2.50 1.50 1.00 1.00
Metal and plastic	25 25 to 50 50 to 100 100 to 200 200 to 800	1.50 1.00 0.75 0.50 0.50	3.00 2.00 1.00 1.00 0.75

So, this is known as the taper allowance and again these are the different what say draft allowances for the various cast materials. So, this is the pattern material and this is the height of the given surface and this is the draft angle for external surfaces and this is the draft angle for the internal surfaces and when the pattern material is wood right. So, when the height of the given surface is 25 mm right the draft angle if it is the external it should be 3 degrees and if the draft angle for the internal surfaces it will be 3 degrees right from 25 to 25 50 mm the external draft will be 1.5 degrees the internal draft will be 2.5 degrees.

From 50 to 100 mm of the what; say a height of the surface right the external draft will be one degree the internal draft will be 1.5 degree, 100 to 200 mm height the external draft will be 0.75 degree the internal draft will be 1 degree from 200 to 800 mm the external draft will be 0.5 degree the internal draft will be 1 degree. Now when the pattern material is metal and plastic right up to 25 mm the external draft will be 1.5 degree and the internal draft will be 3 degrees.

From 25 to 50 mm height the external draft will be one degree internal draft will be 2 degrees, from 50 to 100 right mm height the external draft will be 0.75 degrees and the internal draft will be 1 degree, from 100 to 200 mm height the external draft will be 0.5 degrees and the internal draft will be 1 degree from 200 to 800 mm height the external draft will be 0.5 degrees the internal draft will be 0.75 degrees.

So, these are the different draft allowances to be given for the different pattern materials.

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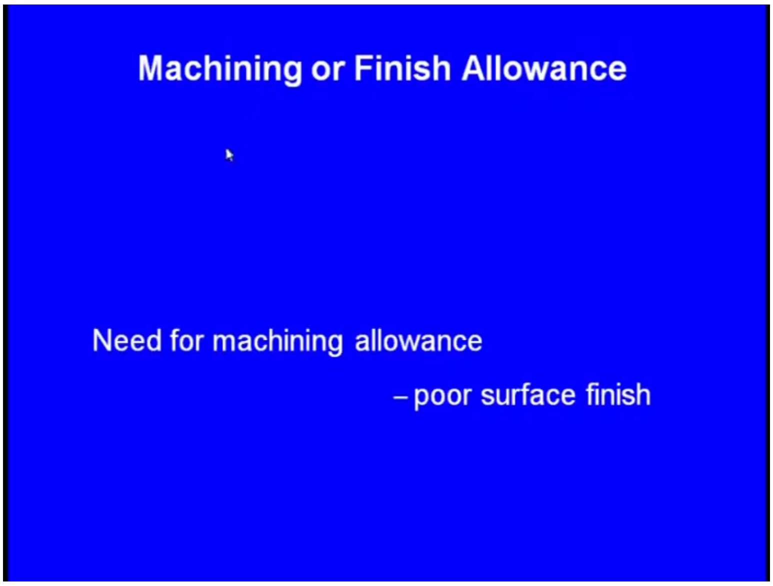

Next one machining or the finishing allowances, first of all remember that the casting after the solidification is over it has a poor surface finish why because we are pouring the molten metal into a mould and this mould is made up of the sand and the sand right cavity has a sand grains on the cavity surface, and the sand grains will have rough texture and because of the rough texture of the sand grains even the solidified casting will have the rough texture.

So, we have to minimize this rough surface or we have to remove this rough surface how to do this by machining. Now the same problem comes we have the what; say a required geometry of the casting keeping that in mind we design the pattern and after the solidification is over when we machine it again the there will be reduction in the final cast component. So, to keep the machining in our mind we have to give some increment to the patterns dimensions. So, this is known as the machining or the finishing allowances.

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MACHINING ALLOWANCES OF VARIOUS METALS

Metal	Dimension (mm)	Allowance (mm)
Cast iron	Up to 300 300 to 500 500 to 1000	3 5 6.25
Cast steel	Up to 150 150 to 500 500 to 1000	3 6.25 7.50
Non ferrous	Up to 200 200 to 300 300 to 1000	2.25 3 4

So, again these are the different allowances for the various metals right when we are making cast iron casting the what; say when the dimension is up to 300 mm the machining allowance should be 3 mm. And for the same material when the dimension is from 300 to 500 mm the machining allowance is 500 mm and when the dimension is from 500 to 1000 mm the machining allowance is 6.25 mm and when we are making cast steel when the dimension is up to 150 mm the machining allowance is 3 mm, from 150 to 500 mm dimension the machining allowance is 6.25 mm.

From 500 to 1000 mm dimension the machining allowance is 7.5 mm and when we are making non ferrous castings up to 200 mm, the machining allowance is 2.25 mm, from 200 to 300 mm dimension the machining allowance is 3 mm, from 300 to 1000 mm the machining allowance is 4 mm. Remember that these are the machining allowances this much extra increment is to be given to the pattern dimension then only after the machining is over we get the required size of the casting.

Now, let us see the distortion or the camber allowance what is this distortion or the camber allowance.

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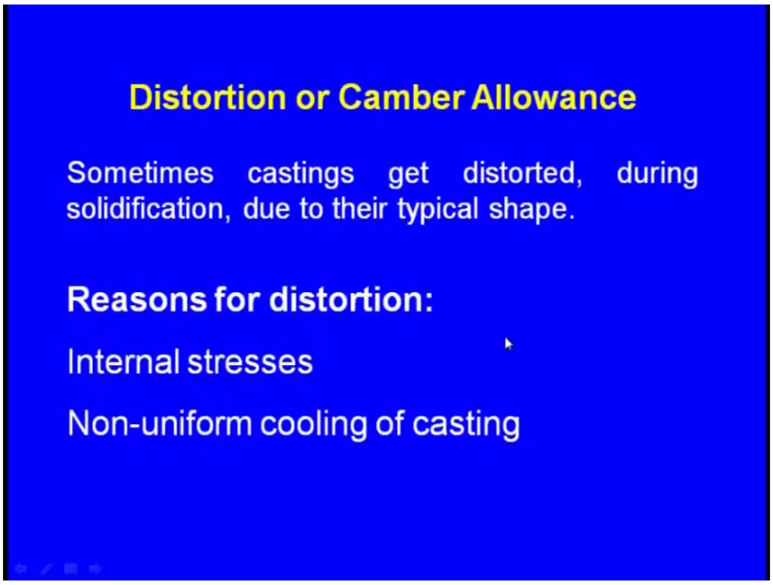

Sometimes castings get distorted during solidification due to their typical shape; distortion means what say change of geometry in an irregular fashion. Next one reasons for distortion one is the internal stresses and another one is the non uniform cooling of the casting. When the casting has what say different sections of different thicknesses the there will be non uniform cool cooling, because of that there will be what say internal stresses will be developed and there will be what say distortion.

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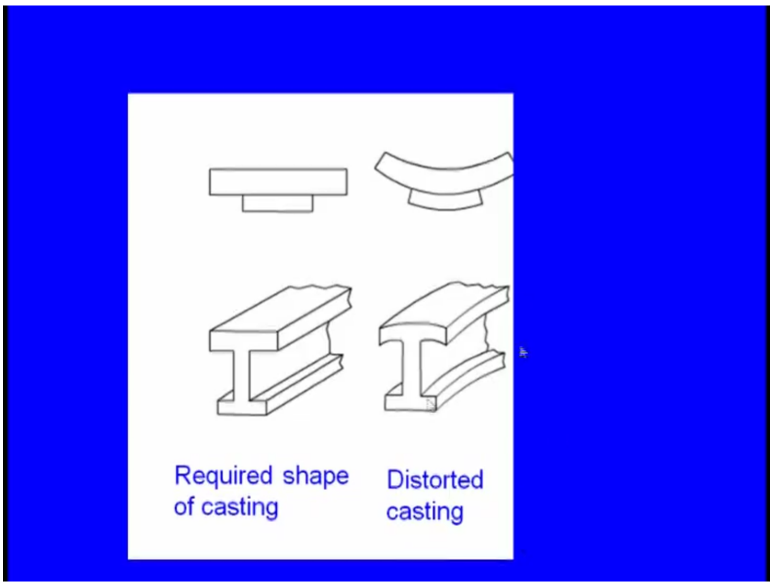

Now, we can see this is the required casting, but see here we can see this section is longer and this section is what say shorter this has solidified faster and there is a difference in cooling finally, after in final solidification it is bent like this is the distortion and this is the required casting, but after solidification it has bent like this. So, here distortion has taken place, now how to overcome this me means even when we are designing the pattern we have to design the pattern such that the cavity initially may have a different shape than the actual required casting, but after solidification because of the distortion it comes to the required shape in that way we have to design the pattern.

So, that kind of allowance is known as the distortion allowance.

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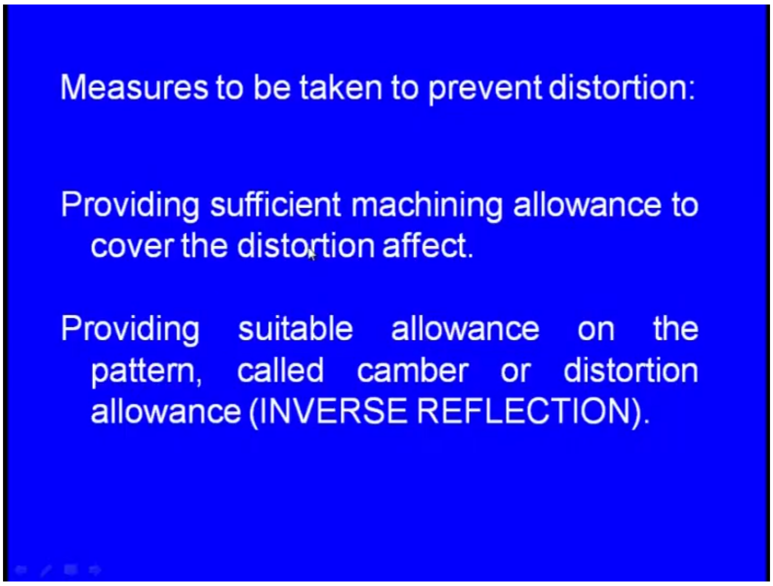

Measures to be taken right providing sufficient machining allowance to cover the distortion effect and provide suitable allowance on the pattern called camber or distortion allowance or the inverse reflection how to do this.

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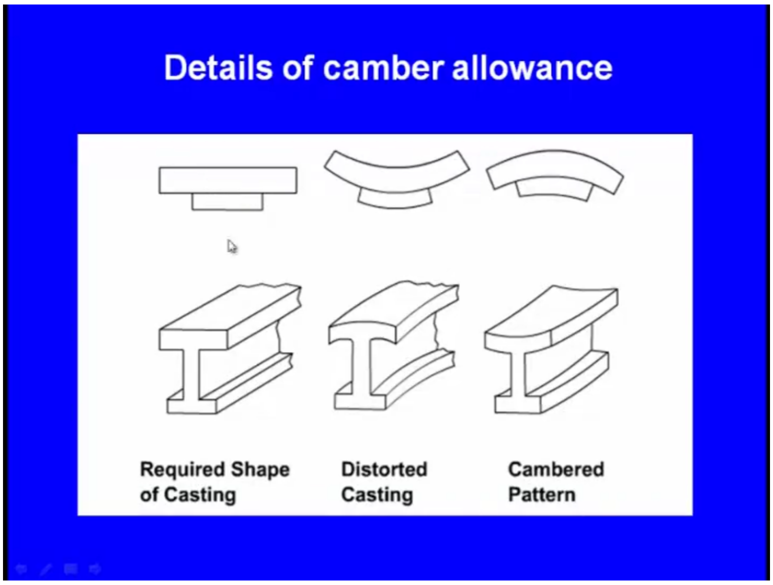

Now you see here this is the actual casting and after solidification it is becoming like this is the actual casting and after solidification it becomes like this now keeping this distortion in our minds. So, we are designing the pattern like this.

Now, we are designing the pattern like this you see the what; say shape of the patterns, the shape of the pattern is not similar to the final cast parts, but after solidification because of the distortion the shape of the casting will be same as that of the expected casting. So, this is the distortion allowance next one the rapping allowance what is this rapping allowance. So, this rapping allowance is a negative allowance, we have seen the what; say shrinkage allowance, we have seen the machining allowance, we have seen the distortion allowance.

So, these are all the positive allowances means because of these factors we what say give some increment to the pattern dimensions, but this is a negative allowance why we make what say the we make the pattern little smaller than the required one, why because after the compaction is over we have to withdraw the pattern for withdrawing the pattern what we do we use the dross pike we insert the dross pike into the pattern, then on all the sides we strike the dross pike on all the 4 sides.

So, that see the mould cavity will be little enlarged and there will be a clearance between the cavity surface and the pattern surface then we take the pattern outside. So, when so that what we are doing we are wrapping the pattern. So, we are what say striking on all the 4 sides because of that the mould cavity will be enlarged. So, keeping this what say enlargement in our consideration we make the pattern little smaller than the what; say as than the requirement.

So, this is the this reduction in the what; say a size of the pattern is known as the rapping allowance and remember that this is a negative allowance.

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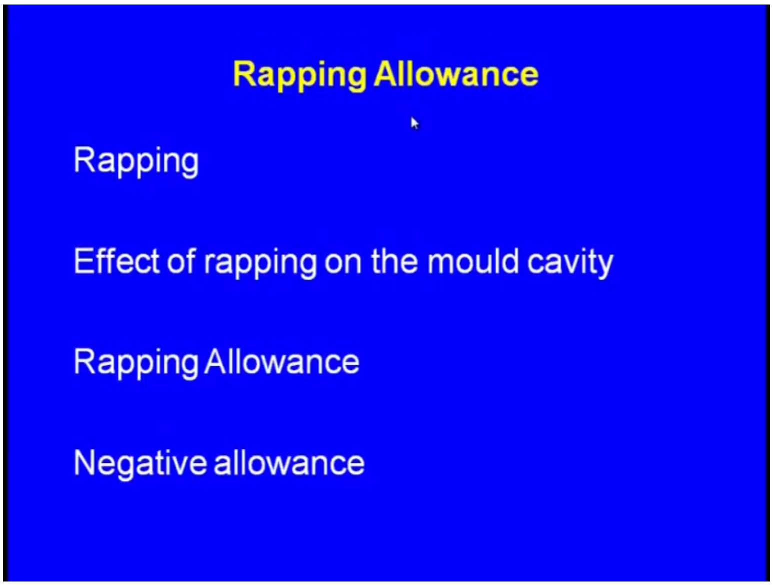

Now this let us compare different patterns.

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PATTERN MATERIAL CHARACTERISTICS

Characteristic	Wood	Aluminum	Steel	Plastic	Cast Iron
Machinability	E	G	F	G	G
Wear resistance	P	G	E	F	E
Strength	F	G	E	G	G
Weight	E	G	P	G	P
Repairability	E	P	G	F	G
Corrosion resistance	E	E	P	E	P
Swelling	P	E	E	E	E
E- Excellent	G - Good	F - Fair	P - Poor		

Pattern materials and their performances, now we can use wood as the pattern material aluminum, steel, plastic and cast iron all these are the what; say pattern materials now these are all the characteristics.

Now, these are all the characteristics of the different pattern materials E means excellent, G means good, F means fair, and P means poor. Now when we use the what; say wood as the patterns material machinability will be excellent very easily we can machine the pattern material and what say when we use the right similarly it is for the wood the wear resistance is poor. Next one it is strength is fair and it is weight is excellent means easily we can carry that is the meaning.

Next one repairability is excellent corrosion resistance is excellent and swelling is poor. Once in comes in contact with the moisture it swells that is why it is resistance against to swelling is poor. Next one when we use the aluminum as the pattern material machinability is good wear wear resistance is good strength is good weight is good means easily we can carry that is the meaning, next one repairability is poor corrosion resistance is excellent, next one swelling is means resistance against to what say swelling is excellent, next one when we use the steel as the pattern material machinability is fair wear resistance is excellent strength is excellent weight is poor means it is heavy we can not carry it easily.

Next one repairability good next one corrosion resistance poor why once in con comes in contact with the moisture right what happens it gets corroded; next one swelling there is no swelling. So, that way it has got excellent swell what say resistance against the swelling, next one when we use plastic cast the pattern material machinability is good wear resistance is fair strength is good weight is good easily we can carry repairability is fair corrosion resistance excellent it does not react with the moisture.

Next one swelling no swelling so on that gun it has got excellent swelling resistance, next one when we use the cast iron as the pattern material, machinability is good wear resistance is excellent because it has got the higher resistance against the wear, next one strength is good weight is poor means we can not carry it easily to different places that way it right on that angle it is poor, next one repairability is good corrosion resistance is poor because once in comes in contact with the moisture it gets corroded that is why it is resistance against corrosion is poor.

Next one what about resistance against swelling excellent no question of swelling when it comes in contact with the moisture so these are the different pattern material characteristics. Friends in this lecture we have seen the pattern and the purpose of the pattern we have seen and the different types of the patterns we have learned and different pattern allowances to be given and we have seen and different pattern materials also we have seen and finally, we have learned the performances of the different pattern materials we have seen. So, we will meet in the next lecture.

Thank you.