Manufacturing Processes - 1
Prof. Dr. D. B. Karunakar
Department of Mechanical and Industrial Engineering
Indian Institute of Technology Roorkee

Module - 2
Lecture - 3
Metal Casting

In the previous lecture, we have learnt about the mould properties, and what the ideal properties of good molding sand are… We have seen say an ideal molding sand should posses good refractoriness, that is it should be able to withstand high temperature especially when we pour the molten metal which is at a very high temperature. The mould sand should be in a position to withstand the high temperature, and it should have good flowability, especially when we are molding with a pattern which has got complex shapes.

The molding sand should take all the details. It means it should be flowing around each and every small detail of the pattern. So, that is the flowability. We have also seen another property that is the permeability. It means when we pour the molten metal, the molten metal comes in touch with the moisture in the molding sand. That time the gases will be evolving. Hot gases, hot vapor will be evolving, and these should not stay inside the mould cavity. This should escape and good molding sand should be in a position to allow the hot gases to pass through it not in the ordinary state, even when they are compacted in the molding box. That time it should be in a position to allow the hot gases to pass through it.

We have seen another strength that is the green strength. The green strength means the strength of the molding sand when the moisture is present. When the moisture is present, it should be in a position to retain the shape of the cavity that we have formed, and another property is the dry strength is immediately after pouring of the molten metal, the moisture in the molding sand will be evaporated and the molding sand is no more green. So, in the absence of the moisture, the molding sand should have strength. It should be in a position to retain the shape that we have given to it. It should be in a position to bear the force caused by the pouring of the molten metal. So, that is the dry strength.

Next comes, the hot strength. There is a difference between dry strength and hot strength. Dry strength means the strength of the mould just in the absence of the moisture whereas, the hot strength is the strength of the mould when the mould is heated to an elevated temperature we pour the molten metal. If we are making casting of cast iron, the molten metal will be heated above 1500 degree centigrade. At that time when we pour such a high temperature molten metal, the mould should be in a position to withstand the temperature that is the hot strength.

We have also seen the collapsibility. Yes after pouring of the molten metal, after solidification, we have to take the castings outside. That time we will be breaking the molding sand. That time the molding sand should be in a position to be broken easily. We have to put little efforts to break the molding sand. That is the collapsibility, and we have also seen adhesiveness. That is the ability of the molding sand to stick on to the walls of the molding box. Yes, it should be sticking on to the walls of the molding box. Otherwise, we carry the mould from one place to another place. That time if the molding sand is not sticking to the walls of the molding box, the sand may fall down. So, that is the adhesiveness ability of the molding sand to stick on to the walls of the molding box.

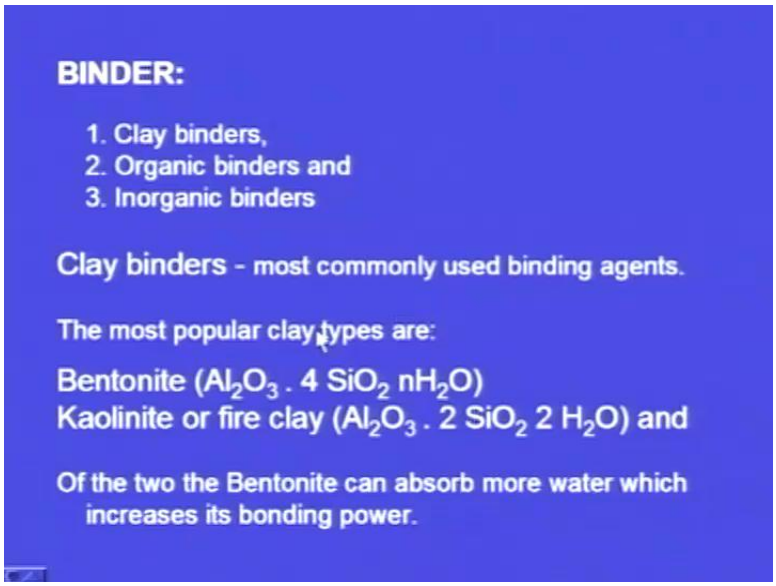
Another one is the durability. Durability means it is the ability of the molding sand to withstand repeated use every time. When we are using the molding sand, we add moisture means it is cool down, and after sometime we make the mould. Then, we pour the molten metal. The molten metal is at a very high temperature means the sand is subjected to very high temperature, and after solidification is over, we break this sand again. We recycle it for making the mould. Again we add moisture, again we are cooling down. It means the molding sand is continuously subjected to high temperature and low temperature, high temperature and low temperature. It is that time sand may fail to show good properties, but good molding sand should be able to withstand this repeated cycle of high temperature and low temperature. So, that is the durability. Now, today we will see what the ingredients of the molding sand are. We have seen the properties, ideal properties of good molding sand. What are the ingredients?

(Refer Slide Time: 06:15)

So, the main ingredients of the molding sand are one is the base sand, another one is the binder and third one is the moisture. Base sand is the major constituents or the major ingredients of the molding sand, and most of the cases, it is the silica sand. It is most commonly used base sand, and also it is abundantly available. Also, its cost is less and there are other sands like zircon sand, chromite sand and olivine sand.

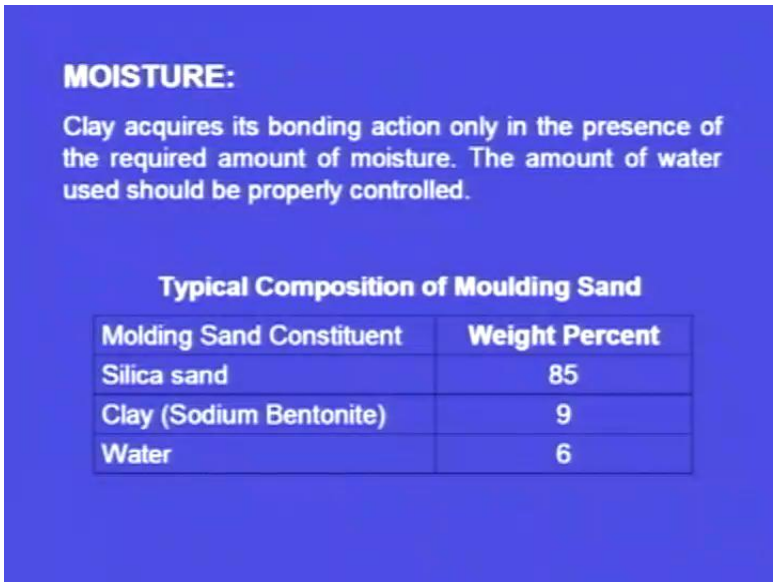
Silica sand is the cheapest sand among all these sands and it is available abundantly. So, that is about the first ingredient that is the base sand, and this is the major constituent, major ingredient of the molding sand which is about 85 percent. Next one let us see this second ingredient that is the binder.

(Refer Slide Time: 07:22)



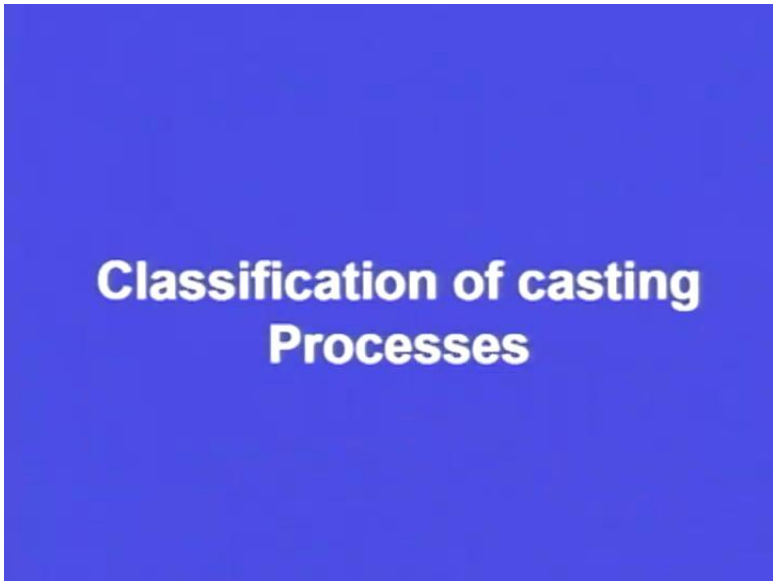
What is this binder made up of? This binder may be a clay binder or an organic binder or an inorganic binder. If it is a clay binder, it is made up of some binding agents. The most popular clay agents are one is Bentonite and its composition is aluminum oxide Al2O3 and 4 SiO2 and nH2O. So, this is the chemical composition of Bentonite and another clay binder is there that is Kaolinite. We will also call this as fire clay, and its composition is Al2O3, 2SiO2 and 2H2O. So, among these two popular binders, Bentonite is widely used. It absorbs more water. When it absorbs more water, it imparts strength to the mould. So, we have seen the first ingredient that is the base sand, and the second ingredient that is the binder.

(Refer Slide Time: 08:47)



Let us see the third ingredient of the molding sand that is the third ingredient is the moisture and the moisture is around 6 percent. Again it varies from 4 percent to up to 9 percent also it varies, but in general the water content is 6 percent. So, this is the typical composition of molding sand. So, this silica sand is around 85 percent clay are in most of the cases. We used Sodium Bentonite that is around 9 percent, and the water is around 6 percent. Sometimes we had other additives to impart additional strength.

(Refer Slide Time: 09:35)



Now, let us see the classification of the casting process. So far we have seen the molding sand ingredients, molding sand composition and we have seen the history and pattern allowances, types of patterns we have seen, but what about the casting process. In the beginning, sand casting was existence. People were using sand casting to make their hot items to make their weapons, but that was in the olden days. Later so many processes have been developed, and we need to learn these processes and let us classify them.

(Refer Slide Time: 10:27)

So, this is the classification of casting process. There are mainly four types of process, casting process. One is conventional molding process that is again classified. Second one is chemical sand molding process, and that is further classified. Third one is permanent mould process.

(Refer Slide Time: 10:49)

Fourth one is special casting process and in the conventional molding process, again we can classify it as green sand molding in which we use moisture. It means the mould contains moisture. Dry sand molding in which there will be no moisture before solidification, before pouring of the molten metal and another one is flaskless molding.

Coming to the second type chemical sand molding process and that is again classified. The first one is shell molding, second one is sodium silicate molding, and the third one is no bake molding. Third one is permanent mould process. So, in the case of the sand molding, the mould is made up of sand. Once we pour the molten metal, once the molten metal is solidified, we break the sand, and the sand and the mould is no more permanent. If we have to make another casting, again we have to make a mould, but in the case of the permanent mould process, the mould is made up of metal or an alloy.

So, after pouring of the molten metal, after solidification of the molten metal, we are not going to break the mould as we do in the case of the sand molding. We only withdraw the casting if we want to make another casting. We use the same metallic moulds, and we pour the molten metal and we withdraw the casting. If we want to make another casting, we use the same metallic moulds. We make the casting. This is in this case the mould is permanent. We are not breaking it. We can use this mould and we can use this metallic mould for making hundreds and thousands of castings. That is why we are

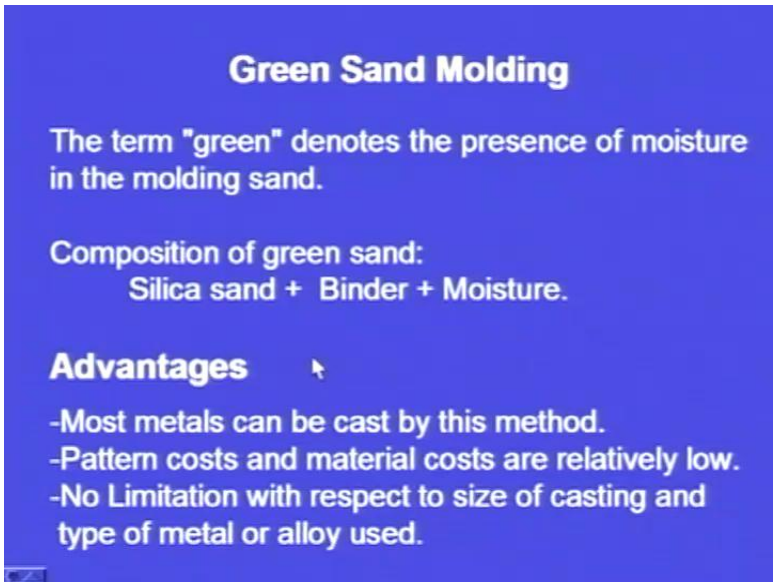
calling this as permanent mould. This again is classified into gravity die casting, another one pressure die casting.

Next one is the special casting process. Several special casting processes have been developed. We will be learning some important special casting process. First one is centrifugal casting in which we use centrifugal force to pour the molten metal into the cavity, and another one is investment casting. This investment casting is used where very high accuracy is required, where excellent surface finish is required. We use investment casting here. The pattern material is wax. So, we also call it as last wax process or precision casting.

Next one is continuous casting. Here the casting is produced continuously in the case of sand casting. We make the mould. After making the mould, we pour the molten metal. After pouring the molten metal, we have to wait for few hours during which the casting under goes solidification and cooling. After that we break the mould, and we take the casting. If we have to make one more casting, again we have to make the mould and we have to pour the molten metal and after solidification, we break the mould and we take the casting outside. So, the time required between producing two castings will be significant, but in the case of the continuous casting, there is no delay. Casting is continuously coming. So, as the name implies, it is known as continuous casting.

Next one is plaster mould. Here we use plaster of paris as the pattern material. This process is useful where good surface finish is required. Where dimensional tolerance is required, we have to use plaster of molding process, but this process is expensive. Of course, all these processes we will be learning in detail later in the next episodes. Next one is squeeze casting, next one is evaporative pattern casting, next one is vacuum sealed molding, next one is ceramics shell molding and next one is slush casting.

(Refer Slide Time: 16:02)

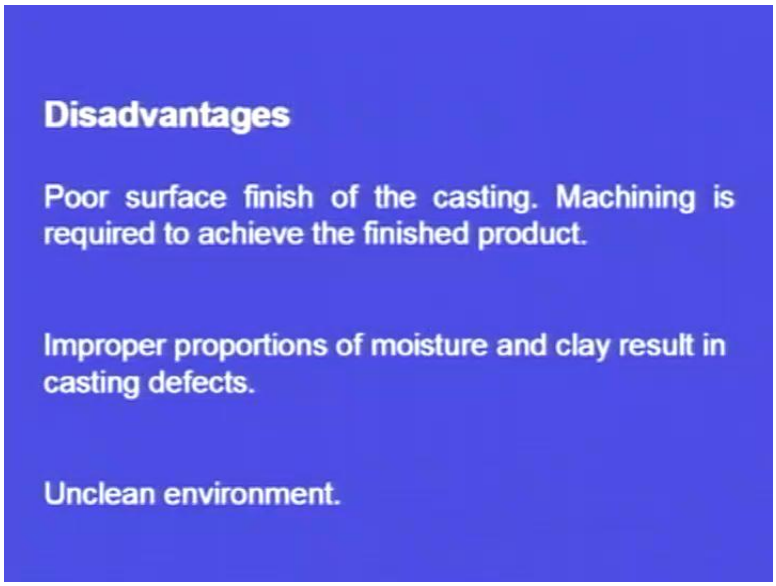


Now, let us learn something more about green sand molding. Green sand molding is the process which is widely used. In fact, it has been in practice even during BC. Our young sisters, our forefathers have been using green sand molding and it is in practice even today. So, let us learn something more about this green sand molding.

As I already told the term green denotes the presence of moisture in the molding sand, and we have already seen the composition of the green sand is silica sand in most of the times binder and moisture. What are the advantages of the green sand molding? One is most metals can be casted by this method. Whatever the composition of the pouring metal is, we can cast the component and cast pattern. Cost is very less. Most of the times, we use a wooden pattern. So, the cost of the pattern is very less and coming to the size of the casting, any big size casting can be made. Similarly, even a small size casting can be made.

So, there is flexibility in size. There are other casting processes, where there is no flexibility of size, only small castings. We can make bigger castings, but by using green sand molding, we can make any size component. So, these are the important advantages and also, another molding material is not costly. What is the molding material? It is silica sand, clay and moisture. These are not so expensive. These are abundantly available. So, the process chip and this has got some disadvantages also, green sand molding.

(Refer Slide Time: 18:27)



What are the disadvantages? There will be poor surface finish. In most of the cases, the pattern used is the wood. The surface texture of wood is not very fine. The surface finish of the pattern, wooden pattern is not very fine. Then, with such a wooden pattern when we make a pattern, what will be the surface finish of the surface of the cavity? It will be regular. It will be rough. So, to get a fine surface finish, we have to do machining operation. For that we have to spend more time, we have to spend more labor, we have to spend more money. So, this increases the time. So, this is one of the major drawbacks of the green sand molding.

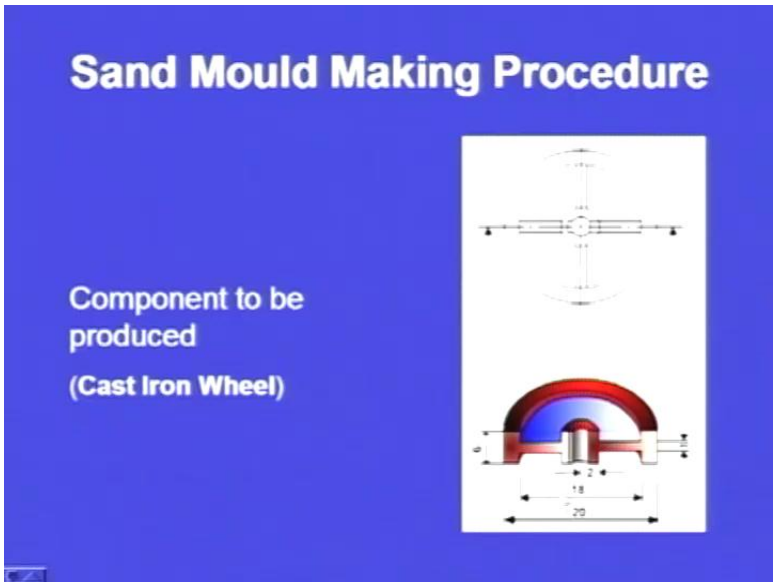
Another one we have already seen the ingredients of the molding sand. One is the silica sand, another is clay and another one is the moisture. If these ingredients are not controlled properly, then that arise problem. If the moisture is too much, it will lead to porosity. There will be blow holes and there will be defects in the casting. If the moisture is not sufficient, if the moisture is less, then the strength of the mould will not be sufficient. It may fail at any time during solidification. The sand may fall into the cavity. Once the sand falls into the cavity over that sand molten metal falls, then that leads to rejection of the casting. So, the ingredients of the molding sand that is the base sand clay and the moisture, they should be controlled carefully.

What happens if the clay is not controlled properly? If the clay is not sufficient, the binding capacity of the molding is not sufficient; it would not be good at any time. It

may fail. On the other hand, if the clay is too much, the porosity will come down after. So, pouring of the molten metal, the molten metal comes in contact with the moisture, that time vapor will be generated. This vapor has to escape the excess clay present in the mould. It prevents the escape of the hot gasses. Ultimately, the hot gasses will be taking a room inside the mould cavity. This leads to defect.

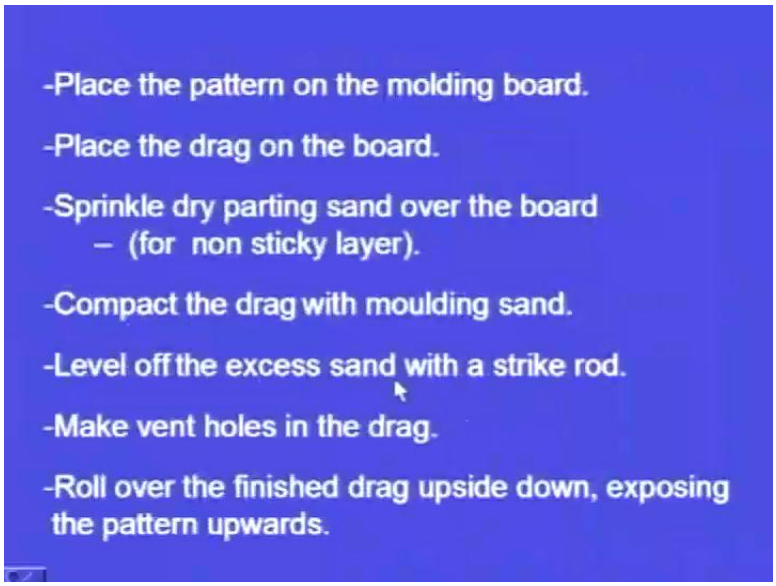
Another one is unclean environment. All the time people in the molding shop, they will be working with the sand clay mixing, the sand mixing, the clay mixing, the moisture, they will be mixing. Clay will be raising and the environment becomes unclean. So, this leads to unclean environment. So, this is another drawback of the green sand molding.

(Refer Slide Time: 21:58)



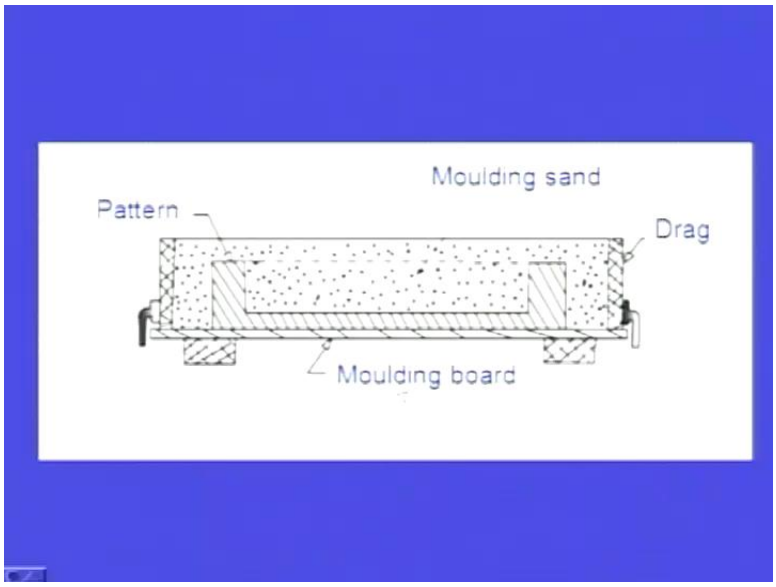
Now, let us see the sand mould making procedure. How to make the sand mould? As the green sand molding is popularly used, it is very popular. It has been in practice right from the beginning. We need to learn what are the steps involved in making a mould, in making a casting with green sand molding. Let us take a case study. So, we are making a cast iron wheel of this shape. Here the cross section is shown it is cut, but we are going to make the complete wheel. What are the steps involved? First of all, we have to use a pattern, half this shape and the pattern will be split pattern.

(Refer Slide Time: 22:48)



Next, first one is place the pattern on the molding board.

(Refer Slide Time: 22:54)



So, this is the molding board. This lower one is the molding board and it is one half of the pattern. So, initially we have to place this pattern over the molding board. Second one places the drag on the board. So, this is the drag. Drag means the lower molding flask. So, this lower molding flask which is known as drag is to be kept over the molding board.

Next is sprinkle dry parting sand over the board. So, here over the board and also, over the pattern dry parting sand we have to sprinkle. What is this dry parting sand? The dry parting sand is fresh silica sand. So, this will be free from clay. This will be free from any other dust particles and moisture. Why we have to sprinkle this dry parting sand? It is because we are going to place the molding sand over the molding board and the pattern, and after molding is over, we have to withdraw the pattern. That time the pattern should be withdrawn easily.

Since the molding sand contains moisture, it easily sticks on to the surface of the pattern, so that we have to prevent. For that sake, we take this dry parting sand and we will sprinkle over the pattern and over the molding board before putting the molding sand, so that it makes a thin layer, dry layer between the molding sand and the surface of the pattern, and the surface of the board. So, after the molding is over, this pattern can be withdrawn without any problem without sticking.

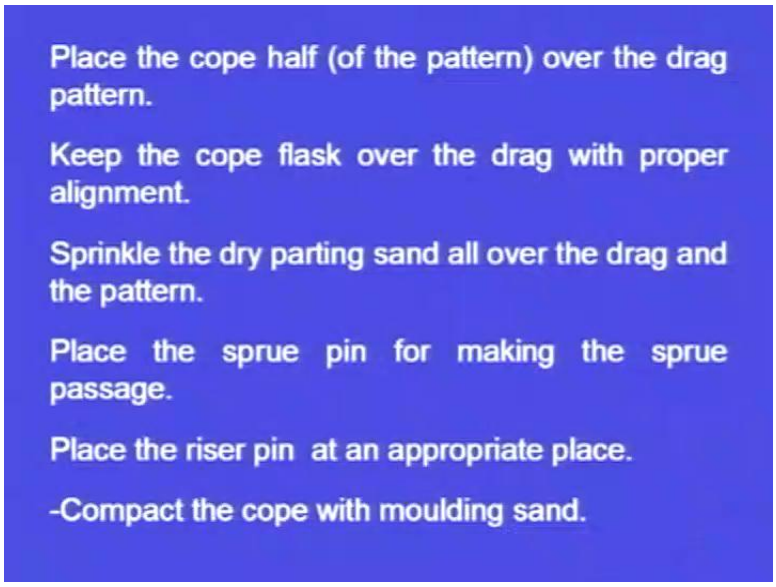
Next one is compact the drag with molding sand. So, this is the drag. Next after sprinkling, the dry parting sand then will place the molding sand here, and we will compact, we use rammers and we compact them. Of course, there are machines which are meant for compacting it. It is done manually and also by machines. Next one, when we do this compacting, there is a chance that there will be excess of sand over the molding box. So, this is the drag box. It is always difficult to exactly compact this sand up to this level. There it happens the molding sand may be more than this line. So, this excess sand is to be removed by a strike of bar. There will be some rods which are very straight, very sharp. Taking those rods, we have to strike the excess sand.

Next one is make vent holes in the drag. So, now, we have compact this sand. Now, we have to make some vent holes here. Why these vent holes? Because soon we are going to mould the other half, and after that we will be withdrawing the pattern and then, we pour the molten metal. When more molten metal comes in touch with the moisture, vapor will be generating. That vapor has to escape, but yes we have already discussed that the molding sand possess one important property and that is the permeability. So, because of this permeability, it allows the hot gasses to pass through it, but sometimes we might do wrong. We might have mixed more clay. So, it may happen that the permeability of a particular sand may be little poor. So, it is such types we have to be safe.

We have to be on safer side for that purpose. We have to make vent holes. These vent holes will be, the diameter of these vent holes will be may be 2 mm, 3 mm or 4 mm generally. So, there will be some vent pins, long pins, and thin pins. Using these vent pins, we make vent holes. We insert it in the mould and you take it out. Then, a small hole is created of diameter may be 3 mm or 2 mm. These holes will help the hot gases and vapor to escape from the mould. So, that is the purpose of the vent holes making the vent holes.

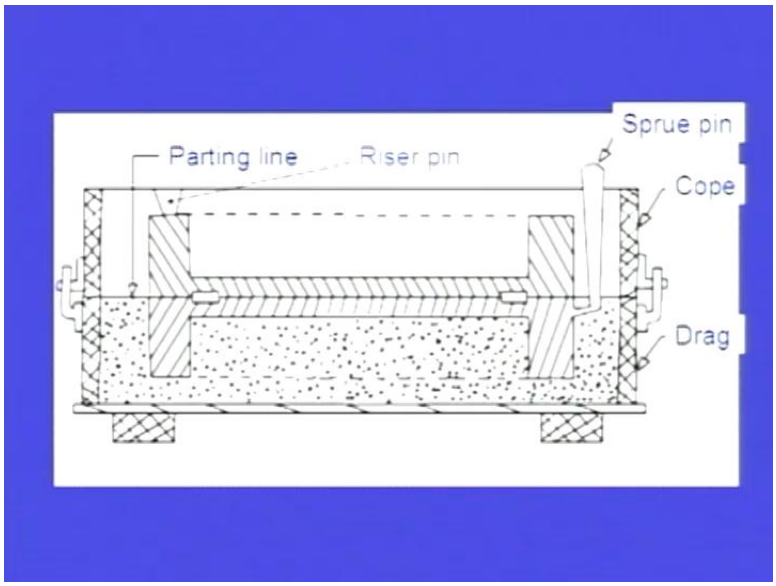
Now, after making the vent holes, roll over the drag upside down means now here the pattern is at the bottom position. You make it upside down, so that the pattern comes up and this upper portion comes down with that the molding of the drag box is complete. Now, let us see how to compact this sand in the cope box.

(Refer Slide Time: 28:34)



Place the cope of the half of the pattern over the drag pattern.

(Refer Slide Time: 28:37)



So, this is the pattern is a split into two parts. This is one half, this is another half. This half is known as the drag half of the pattern, and this half is known as the cope half of the pattern. So, after the molding of the drag box is complete, we have to place the cope half of the pattern over the drag half of the pattern, and while placing the cope half of the pattern, care must be taken, so that they will be properly aligned. For that there will be some pins, alignment pins will be there between this surface, and this upper half will have some pins and if we aligned them properly, there will be a small hole. Here that pin has to rest in the hole. When the pin rests in the hole, then the drag half and the cope half of the patterns are properly aligned.

Next one is keep the cope flask over the drag. This one is the cope means the upper molding flasks. So, this upper molding flask has to be kept over the drag. Again they should be properly aligned to ensure proper alignment. There will be dautel pins. Here we can see dautel pins, and here we can see dautel pins means this pin has to pass through this hole. There is a hole in this part. So, by using this dautel pins, we will ensure that the cope under drag are properly aligned.

Next one is sprinkle. The dry parting sand over the drag and the pattern here over the pattern and over this line on the parting line, we have to sprinkle dry parting sand. Why we have to sprinkle this dry parting sand? It is because again we are going to place the molding sand, and we are going to ram the molding sand over this pattern, and after

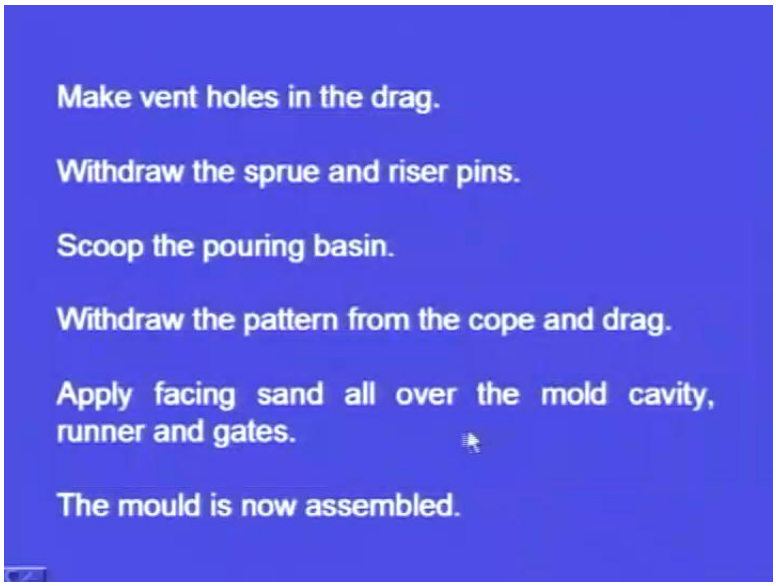
molding is over, we have to withdraw the pattern. That time there should not be sticking between the molding sand and the pattern. The pattern should be withdrawn easily, and the sand of the cope box should not be sticking to the molding sand of the drag box. For that purpose we are sprinkling dry parting sand starting from here and here, here, here, here, here, here, here we will be sprinkling the dry parting sand.

Next one is place this sprue pin for making the sprue passage. Yes we have to pour the molten metal. For pouring the molten metal, the passage is sprue. The passage through which we pour the molten metal is known as the sprue. So, here we have to create a passage for pouring the molten metal. So, for that purpose we place a sprue pin here. It is made up of wood generally in most of the cases, right. Again that has to be withdrawn.

Next one is place the riser pin in an appropriate place. Riser is required. What is this riser? I have already described in the previous class, it has got certain functions. It gives us an indication that the mould cavity is full with the molten metal. It also helps us, so that the hot gases generated inside the mould will be escaping through this hole. Finally, it has got an important function. What is that? When the molten metal in the cavity is undergoing shrinkage, at that time the molten metal in the riser will be in liquid state. This will be compensating the shrinkage. If the casting is above to become small, this helps the wanted material, the wanted metal.

So, that is the important function of the riser and we have to create a space, so that metal will be poured in the riser also. So, here is the riser pin. So, we have to place a riser pin for this purpose that is also made up of wood that has to be withdrawn after the molding is over. Next one and we also have to create the gating system, the runner and the in gates. For that also there will be gating system made up of wood that we have to place near the sprue. Between the sprue and the casting, we have to place.

(Refer Slide Time: 33:49)



Next one is apply facing sand. Before that compact the cope with molding sand after placing the sprue pin, after placing the riser pin and then, we have to put the molding sand and we have to compact it. After compaction is over, there will be excess of sand. That excess of sand has to be removed. There will be striking rod, sharp rod. With that we strike it, so that the excess sand will be removed.

Next we have to make the vent holes. Yes, sometimes the permeability of the molding sand may be poor. Permeability is the ability of the molding sand to allow the hot gases to pass through it. Yes, if the molding, permeability of the molding sand is very good. No problem. Sometimes, it can happen that the permeability of the molding sand will be poor and at such times, we should be on safe side. So, we create the vent holes as we have created the vent holes in case of the drag box. In the similar way, we have to create vent holes for this cope box also.

Next one is withdraw this sprue pin and riser pin. Here we have inserted one sprue pin, and here we have inserted riser pin. These we have to withdraw and also, we have inserted gating system for runners and in gates. Those also we have to remove, we have to withdraw.

(Refer Slide Time: 35:33)

Next one is scoop the pouring basin. So, this is the pouring basin. When we have only created the passage for this sprue, it will be like this. The hole, the entrance would not be so big. So, when the entrance is very small, it is difficult to pour the molten metal. So, we enlarge the entrance of this sprue and we call it as sprue basin. So, this we have to create, we have to cut the sprue basin. Next one is withdraw the pattern from the cope, and drag. We will withdraw the pattern, this pattern and from the drag and also from the cope. Apply facing sand all over the molding cavity. Yes, this is the molding cavity and the surface of the cavity is not smooth. It is rough because we have used wooden pattern because we have used molding sand. The surface is not smooth. So, there will be facing sand. Fine sand will be there and that sand will be applying on the surface, so that the surface of the cavity will be improved.

Next one is the mould is now assembled. This is the assembled mould, this is the drag box, this is the cope box and this is the mould cavity, this is the pouring basin and this is sprue that passes through which we pour the molten metal, and there is the runner and in gates that are not shown here, and this is the riser and now, it is ready for pouring.

(Refer Slide Time: 37:23)

Yes, the mould is now ready for pouring. So, we have seen the steps involved in making a mould for green sand molding.

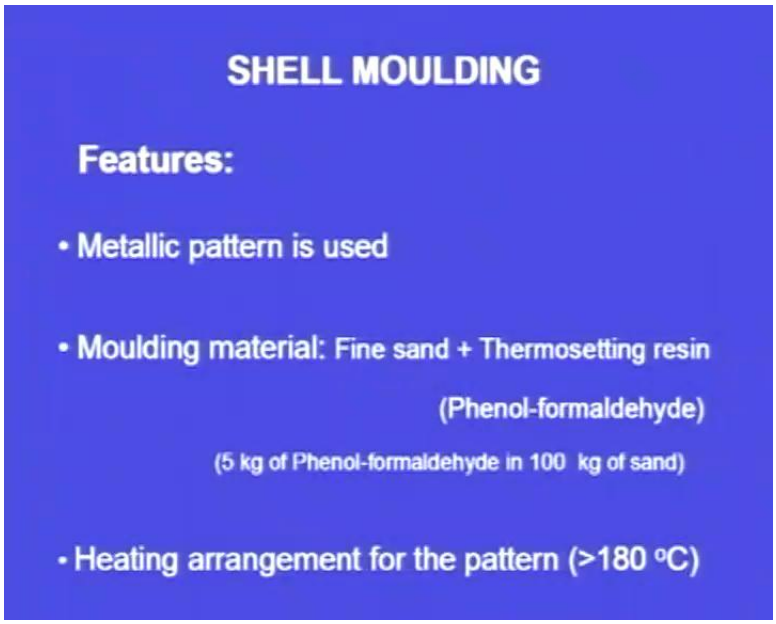
(Refer Slide Time: 37:40)

Next one is dry sand molding. In the dry sand molding, during the pouring stage, moisture is not present. First of all, why we have to go for dry sand molding? In the case of the green sand molding, moisture is present just before pouring, and if the moisture is excess, it will result in pin holes on the casting. There will be so many of small holes and this we call as pin holes. So, this is one of the major drawbacks in the green sand

molding. So, most of the times, many castings are rejected because of this presence of the pin holes.

Another one is the strength. Sometimes may not be adequate if the moisture is not controlled properly. The strength may not be adequate. So, to overcome these problems, sometimes we go for dry sand molding in which there will be no moisture just before pouring. We will be completely drying out the moisture present in the mould. How this is done? Before that there will be types of dry sand molding. One is skin drying. It means initially we make the mould and then, only the surface of the cavity we will be drying out by using gas torches or infrared lamps or by passing hot air. We will be drying just the skin of the cavity, just the surface of the cavity. In another type, we completely dry the mould. We call it as complete mould drying. So, for this purpose, we use ovens, electric ovens. We keep the mould inside the oven for few hours during which the moisture will be evaporated, and the total mould is free from moisture. Next one is let us see, the shell molding.

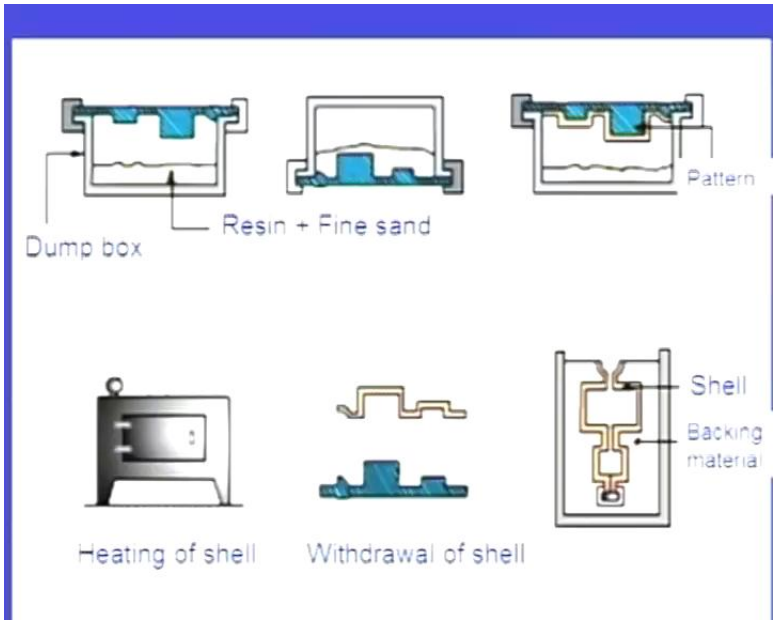
(Refer Slide Time: 40:11)



In this shell molding, what are the features here? The metallic pattern is used. The molding material is fine, sand plus thermosetting resin and usually it will be phenol formaldehyde, and in 100 kg of fine sand, we mix 5 kg of phenol formaldehyde. This acts as the resin. Since, we are using fine sand; the surface finish of the cavity will be good. The surface finish of the casting finally we are going to obtain will be good, and as

I already told the pattern is always metallic one in shell molding and during the molding process, we heat the pattern about 180 degree centigrade.

(Refer Slide Time: 41:17)

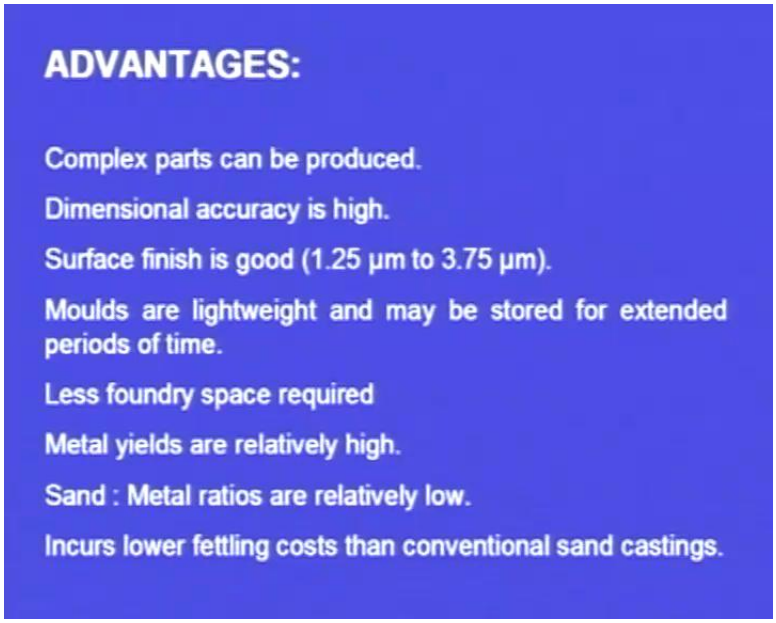


Let us see the steps involved in shell molding. So, this is the one half of the pattern, this is half of the pattern here we can see. So, this is made up of metal. Initially, there is a dump box in which there is resin plus fine sand phenol formaldehyde plus fine sand is there, and we place the metallic pattern here, and this metallic pattern is heated up. Now, we make this box upside down. The mixture of resin and fine silica sand is falling on the heated pattern and then, what happens is a small layer of the resin and the fine sand will be melting, and it will be making a thin layer around the pattern like this.

Now, again we make it upside down. Now, the sand is falling down here. Now, we can see this is the pattern, half of the pattern and a thin layer of the resin and the fine sand is sticking here. Now, this we will put it inside an oven for drying purpose. So, this shell will dried up. This we will take and put it in the oven, so that it will gain additional strength, and after that we are removing this shell. So, we have created a shell whose cavity will be similar to that of the pattern. In the same way, we create another shell using (( )). For that we do not have to use another pattern. Using the same pattern we can create another shell.

In the same way, these two shells are joined here, and they are clamped here. We can see they are clamped and here we can see the pouring basin. Through the pouring basin, we pour the molten metal and here, we can see the backing material because this is shell made of resin and the fine silica sand and when we pour the molten metal because of the pressure of the molten metal, these may break. For that purpose, we put some backing material in this box. There is some backing material. This can be sand, so that this sand will be acting as the support for the shells. They support when the molten metal is poured, the shells may not break with the support of the backing material.

(Refer Slide Time: 44:27)



Now, it is ready for pouring. What are the advantages of this molding process of this shell molding process? One is that complex parts can be produced, and another one is dimensional accuracy is very high in the case of the sand molding. The dimensional accuracy is very poor because the surface of the cavity is having some irregular surfaces, rough surfaces. Because the dimensional accuracy is not high, we give some allowance, machining allowance to the pattern, so that the casting finally we are going to obtain will be larger than the actual size and then, we will machine it. We can conclude that in the case of the green sand casting, the dimensional accuracy is not high. In fact, it is poor. We have to struggle a lot to get the corrective dimension, but in the case of the shell molding, the dimensional accuracy is high.

Another advantage is surface finish is good. In the case of the green sand molding, the surface finish of the casting is not good. Because of the rough surface of the sand cavity, because of the rough surface of the pattern, the final rough surface finish of the casting will be poor, but in the case of the shell molding, the surface finish is good. We can get a surface finish of this much order 1.25 microns to 3.75 microns, and the moulds are of light weight. In the case of the green sand molding, if we have to make 1 kg of the casting, we have to use about 4 kg of sand. So, the molding boxes will be very heavy. So, it is sometimes if we are making large castings, it is very difficult to carry the molding boxes from one place to another place, may be from molding shop to melting shop, but here the moulds are only shells. So, there weight is very less.

So, that is another advantage and another advantage is they can be stored for so much of time. In the case of the green sand molding, once we make the mould, once we assemble the drag box and cope box, within few hours we have to pour the molten metal. If we store the molding box for several days, it loses its strength. On the other hand, in the case of the shell molding, we can store these shells for even months together, may be today there may not be any requirement, but we are anticipating from order may be after 3 months we may we get an order, some 10000 pieces. So, after 3 months that time if we have to make 10000 shells, it is so difficult, but these shells can be prepared well in advance. They can be stored, so that when the time comes, we can clamp them together and straight away we can pour the molten metal.

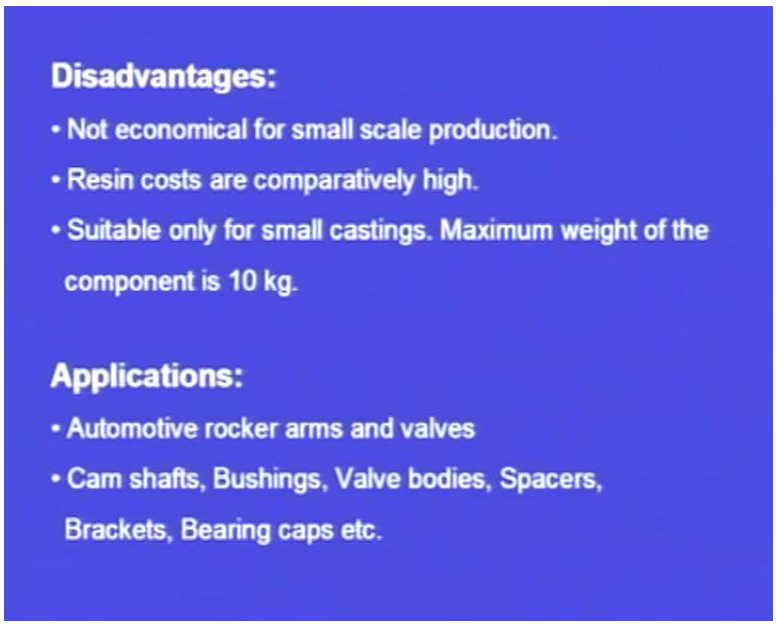
So, that is another advantage of the shell molding. Next one is it requires less space. In the case of the green sand molding, so much of space is required for making the pattern that there will be one shop pattern making shop. For making the mould, there will be one molding shop. For pouring, there will be another shop and for melting the molten metal, there will be another shop, and after the solidification is over, we break the sand and for that there will be another shop, fettling shop. After that there will be another shop for cleaning. Likewise in the case of the green sand castings, the space required is very large, but in the case of the shell molding, the space required is very less. That is another advantage.

What about the yield? In the case of the green sand molding, what is the casting yield? Casting yield means suppose if we are making 10 kg of the casting, we have to pour about 13 kg of molten metal. So, we can define this way the casting yield casting is yield

is defined as the ratio of the weight of the casting divided by weight of the poured metal, whole thing multiplied by 100. That is the casting yield. So, for sand castings, that casting yield will be between 70 percent and 80 percent, but here the casting yield will be high, and sand metal ratio is relatively low in the case of the sand casting. Sand metal ratio is 4 is to 1 means for making 1 kg of the casting, we have to use 4 kg of sand. Here how much sand we are using only to make the shell sand required is very less.

So, this is another advantage and it requires lower fettling cost. Fettling means after the casting is solidified, there will be extra projections. The metal is solidified in this roof. The metal is solidified in the gating system; the metal is solidified in the riser. These are not parts of the casting. These have to be removed. For that purpose we have to use some machining process and the cost was more. We have to put more efforts, we have to use more labor, but in the case of the shell molding, the cast involve for fettling is less compared to the sand casting and other conventional castings.

(Refer Slide Time: 51:17)



It has got some disadvantages also. It is not economical for small scale production because the pattern is made up of metal, and there will be arrangement for heating of the pattern. Suppose if we have to make only 5 castings. For making the 5 castings, we make a metallic pattern, and we incorporate heating system and after that, that costly pattern, that pattern for which we have spent more money for which we have spent so much of

efforts will be gone. So, this is not economical for small producing few castings. This is useful for large scale production and not for small scale production.

What about the cost of these resins, phenol formaldehyde? It is costly. It is not cheap like green sand. It is not cheap like clay. This is costly and this is suitable only for small castings. This is not suitable for heavy castings. The maximum weight of the casting that we can make using shell molding is 10 kg. Of course, it is giving some certain advantages. Surface finish is good, dimension accuracy is good, but we can make only small castings up to 10 kg, and its applications, automotive rocker arms and valves, cam shafts, bushings, valve bodies, spacers brackets, bearing caps etcetera, this is an important casting process which was developed during second oral form.

So, in this episode, we have seen the ingredients of green sand and we have discussed the types of different casting process, steps involved in making a green sand mould. We have discussed, we have also learnt about the shell molding which offers high dimensional accuracy, and good surface finish. In the next episodes, we will be learning about sodium silicate molding process and other casting process.

Thank you.