Metal Casting
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Module – 02
Sand Casting Process
Lecture – 08
Steps Involved In Making A Sand Casting

Good morning friends, in the previous classes we have been learning about the moulding sands, core sands and the patterns. Now, in this lecture let us see the steps involved in making a sand casting. So, these are the steps involved in making a sand casting.

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The first step is the pattern making, the second step core making, third step moulding with the moulding sand, next one melting and pouring, next one after we melt and pour the molten metal after sometime the molten metal solidifies inside the mould, after solidification we have to break the sand and take the casting outside this process is known as knockout, after knockout we do the heat treatment, but this is an optional it depends upon the case and the application of the casting, the next step is cleaning finally, the inspection then it will be shipped to the customer.

Now, we will be learning a little bit more about these steps. First let us see the pattern making. So, in the previous class only we have learned about the different types of the

patterns and the elevenses to be given to the patterns and the materials of the patterns we have seen. So, in the same way depending upon the geometry of the casting depending upon the what say case and the size of the casting we have to choose the right what say pattern and with the right material. So, that is about the pattern making.

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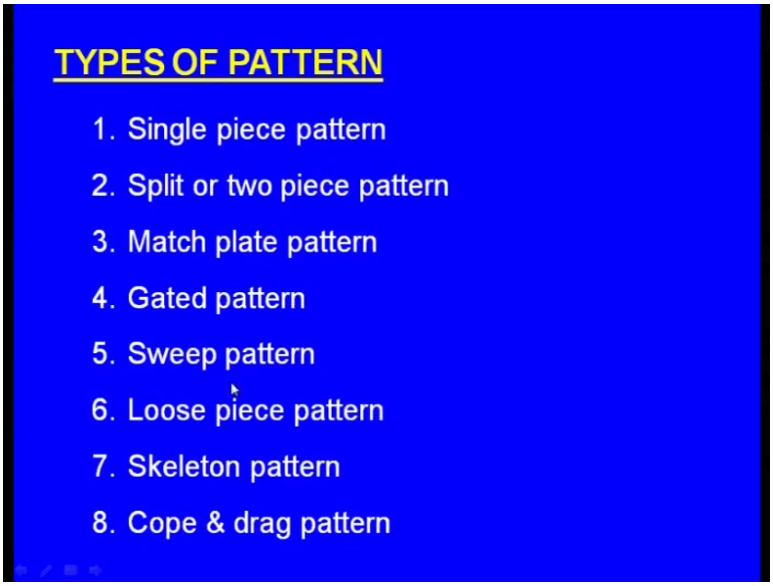

So, these are all the different types of the patterns we have seen in the previous class right.

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So, now, we any of these patterns we have to make the next step is yes here we can see this is a big pattern right sometimes patterns are even given what say painting. So, to enhanced their life here we can see this is the pattern of your pump housing and we can see yes it is being painted at the final stage of its preparation. So, that is all about the pattern making.

Next one let us see the core making. Core making also we have seen is two lectures before and we have seen the different ingredients of the core sands and right different materials used for the core sands additives right and core coatings and types of the coatings we have seen. So, similarly and depending upon the case depending upon the casting we have to choose the right core material and we have to make the right core.

Next one is the moulding. So, this takes time and this has to be done with extreme care with extreme skill. Let us see the steps involved in the moulding process. First of all it is broadly classified as the manual moulding and machine moulding. Moulding can be done manually this skilled labor used to do this right they put the pattern inside the moulding box and they take the green sand and the compacted inside the box. So, this is done manually, but this requires skill and this moulding can also be done using moulding machines. So, this is known as the machine moulding.

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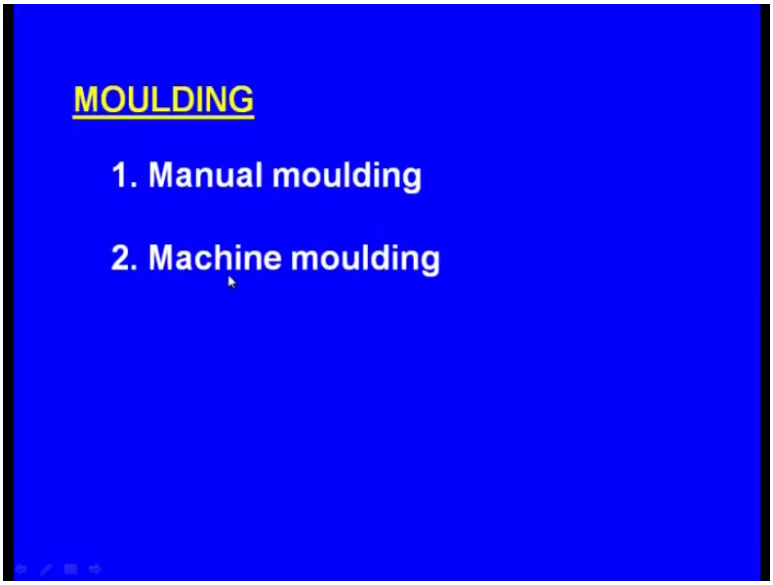

Now, let us see first the manual moulding, the different steps involved in the manual moulding, how to carry out the manual moulding now we will see. Here you can see first

of all moulding of the drag, drag means lowered moulding box what we have to do. So, we have two mould the drag box and we have mould the cope box also.

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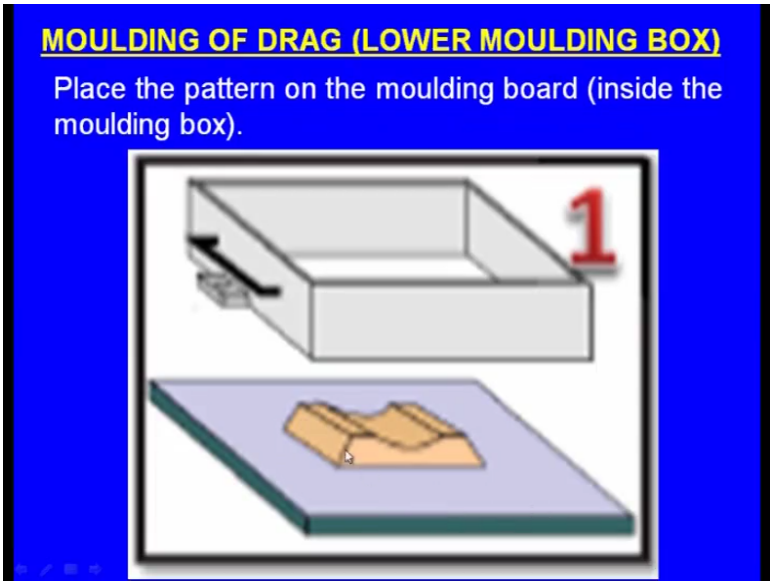

Now, this is the drag box and this is the moulding board and this is the pattern. So, initially we have to take the moulding board and on the moulding board we have to place the pattern then we have to place the drag box around the pattern and on the moulding board. So, that is the first step.

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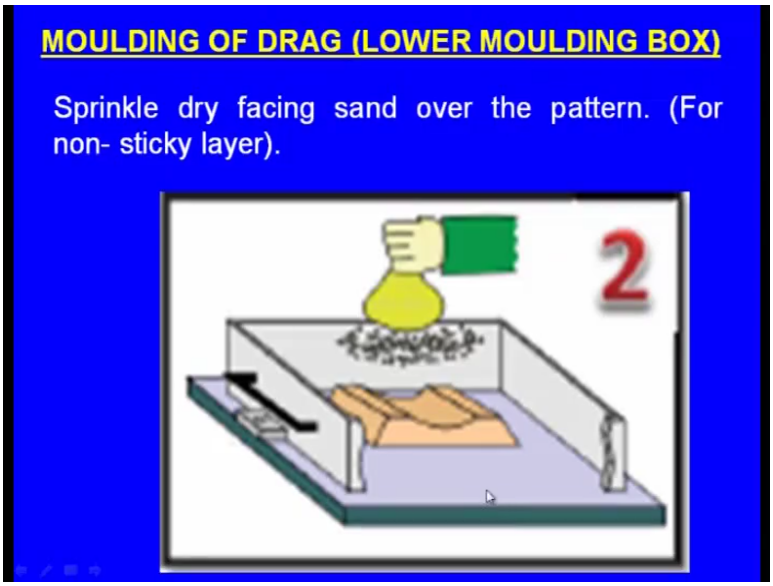

Second step now we can see here this is the moulding board over the moulding board, we have kept the pattern and around the pattern we have kept the drag box, now we have to sprinkle dry facing sand over the pattern for creating a non sticky layer why we are what say sprinkling this dry facing sand. So, this is a carbonaceous sand, fine sand very fine sand then what we what happens when we sprinkle this sand around the pattern because afterwards we are going to place the moulding sand on the pattern. So, the moulding sand contains the moisture and it is possible and it is also contains the clay and the additives.

So, and we will be compacting the moulding sand over the pattern it is possible that the moulding sand may be sticking to the pattern and while withdrawal of the pattern it may break the mould cavity. So, we do not want such thing to happen that is why we are creating a non sticky layer between the pattern and the mould and the moulding sand. So, we will be sprinkling this dry facing sand. So, this is the second step.

Next one after what say sprinkling the carbonatious facing sand over the pattern now we are facing the moulding sand over the pattern. So, this is this red colored one is the moulding sand. So, with the both the hands they are putting the moulding sand into the moulding box. So, this is the third step.

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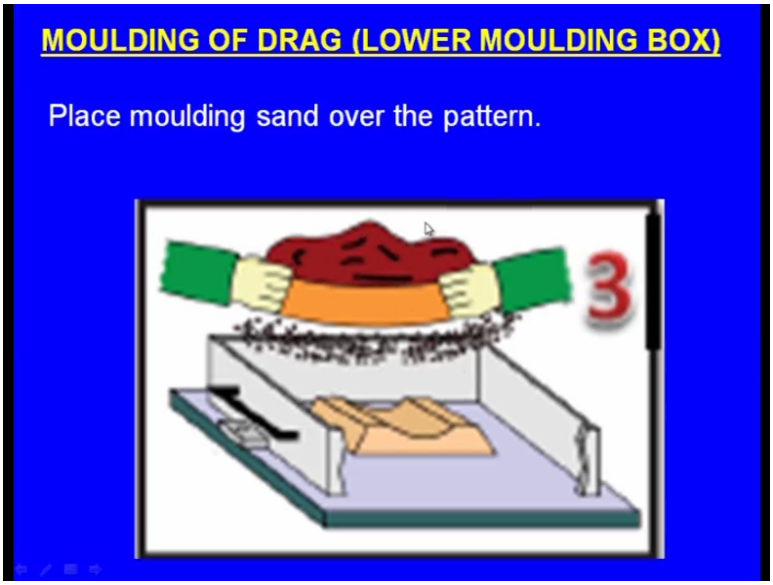

Now, after placing the sufficient moulding sand arrow above the pattern and inside the drag box now the sand has to be compacted. So, this is the rammer you see this is the hand rammer using the hand rammer manually it has to be rammed all over.

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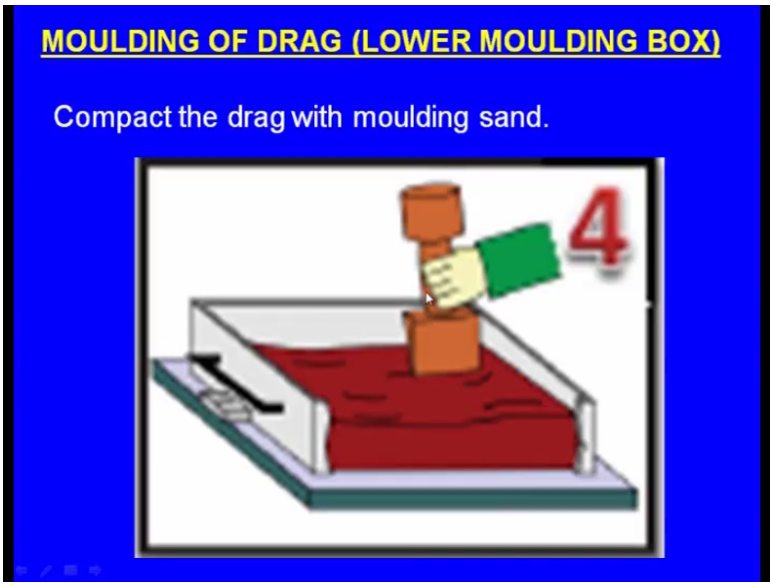

Initially around the pattern then at the corners of the box then everywhere it should be a rammed and it should be rammed till the moulding box is full and the moulding box should be compacted with the moulding sand.

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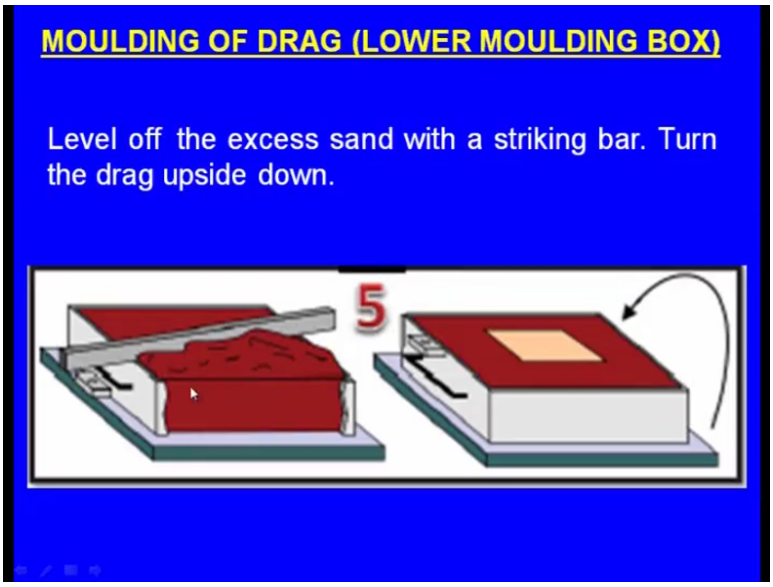

Next one what happens, as we keep compacting the moulding sand at one stage the sand will be excess the excess sand must be leveled off the excess sand must be removed for that purpose we are using a striking bar you see this is the striking bar. Using the striking bar we have to level off the excess sand. So, that the level comes in exactly with the level off the moulding box. So, this is the level off the moulding box even the level off the moulding sand is same as that of the level off the moulding box.

After what say leveling the excess sand what we have to do? We have to make the pattern box ups and down because remember that the pattern is now on the moulding board now we will be turning it ups and down, so what happened; say we have turned it ups and down now this pattern has come upwards. So, this is the pattern.

Now, with this the moulding of the drag box is over. Now we are starting the moulding of the cope box. What to do, how to do the moulding of the cope box? Now this is the drag box, this drag box we have already compacted with the moulding sand, inside yes there is moulding sand and the pattern is at the center now over the what say drag box we will be placing the cope box right.

But the thing is sometimes it may not be aligned properly. So, to ensure that there is proper alignment. So, we use the locating pins are these are also known as the dovetail pins means both the cope box and the drag box have handles like this.

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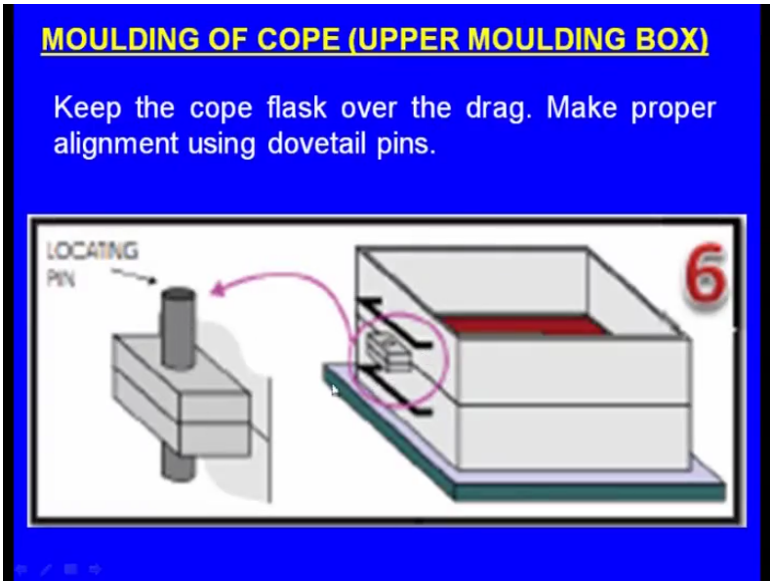

You can see here these are the handles. So, these are magnified here these both these handles have a hole of a particular diameter and we will be inserting the locating pin or the dovetail pin into that hole then what happens, when we insert that pin into those holes there will not be any misalignment the cope will be perfectly aligned over the drag box.

Now, we have to place the sprue and riser pins. So, when we are compacting the cope box remember that we have to make a provision for the sprue passes, sprue means the vertical passes of the molten metal and it goes through the sprue then it passes through, the runner of course, runner will be creating manually right then it fills the cavity then it rises through the riser hole.

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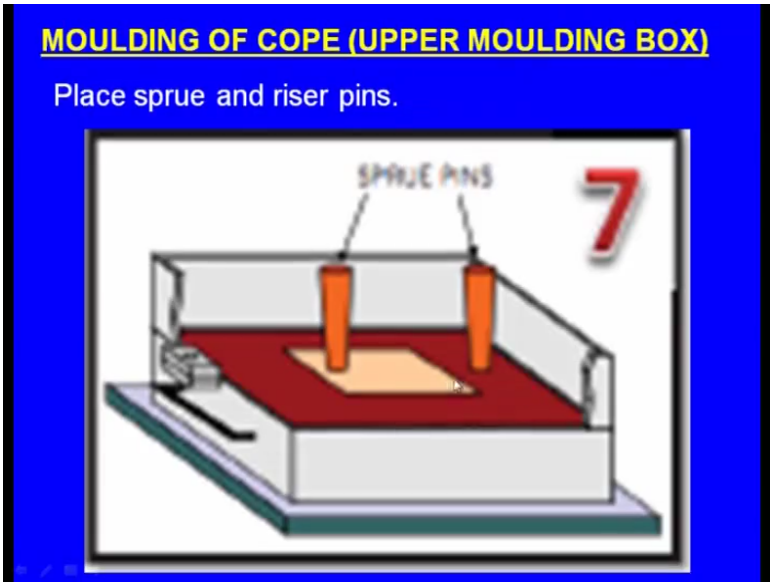

So, we have to create frozen for sprue and the riser. So, this is the riser pin and this is the sprue pin. So, these are the wooden pins. So, we will keep them above the what say drag box. If it is this sprue pin it is just outside the pattern, if it is the riser pin it is a almost at the center of the pattern above pattern. Now this is the cope box now again we start timing the moulding sand.

Now, you see then we have to compact the cope box with the moulding sand. Here we can see the cope box is also compacted same way place the moulding sand and take the rammer and remit all over around this sprue pin around the riser pin compacted and once the sand level is excess take the strike bar and level off the excess sand.

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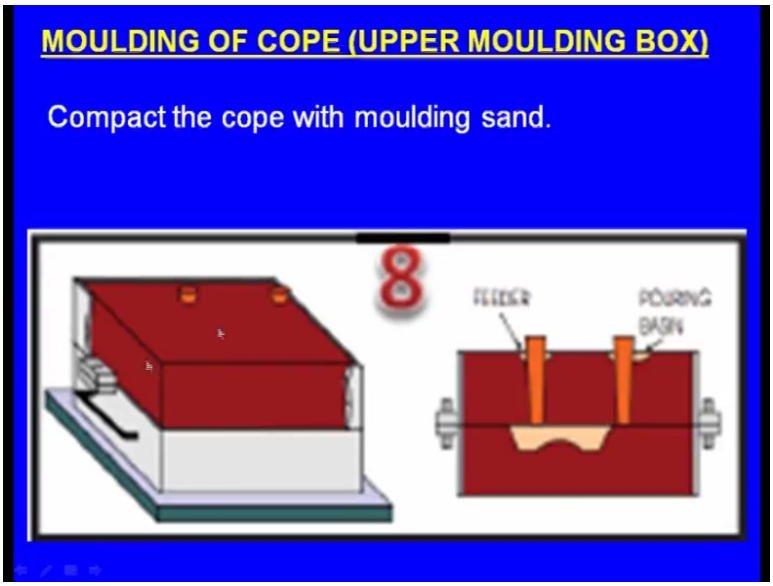

Now, after the sand is leveled off we can see the mould is like this the mould in the cope box is like this. And if we see the section the section looks like this see this is the drag box and this is the cope box and this is the pattern and this is the sprue pin and this is the riser pin. Now what we have to do? Inside remember inside these two boxes pattern is there, sprue pin is there and the riser pin is there and we have to withdraw them. In order to withdraw this first we have to separate them.

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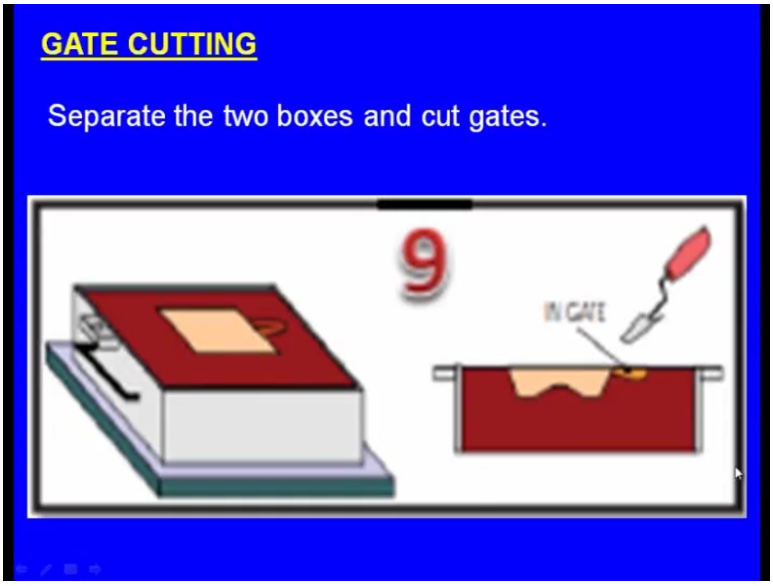

So, we are separating the cope box and the drag box. Now we have separated, after separating is the cope what say this is the drag box the drag box looks like this right. So, here only the drug box only this is not the cope box the drag box is here shown the section. So, we can see at the center this is the pattern. Now we have to cut the gate using the gate cutter this is the gate cutter, here we are cutting the gate then we have to withdraw the pattern.

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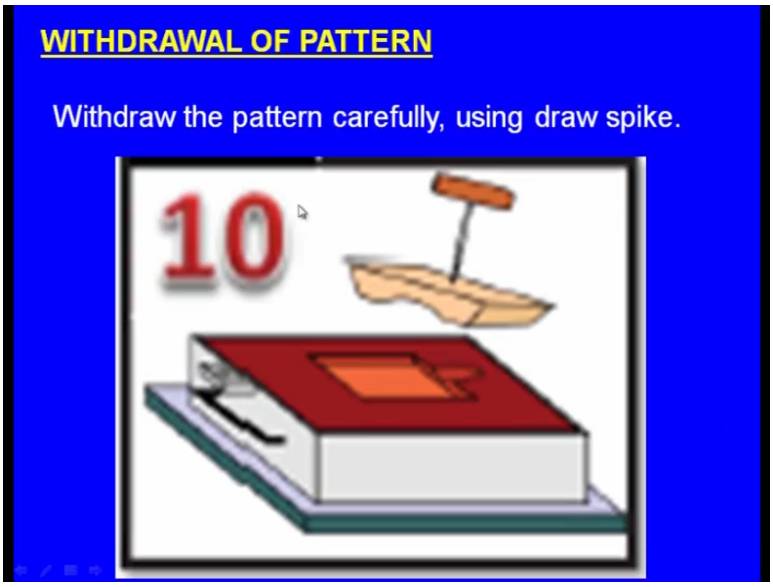

See this is the withdrawal of the pattern. So, this pattern must be withdrawn very carefully, for that purpose what we do we use a what say draw spike. So, this is the draw spike. So, the draw spike is a long what say pin right at the end it has a screw. Now we what say see that the screw little bit goes inside the pattern, then what we do we ramp the pattern on all the four sides that is why there was a rapping allowance in the previous class we have seen.

So, when we are rapping the pattern the mould cavity expands a little bit on all the four sides. Then there is a clearance between the pattern and the mould cavity then using the draw spike we have to carefully withdraw the pattern. Now the drag box is free from the pattern.

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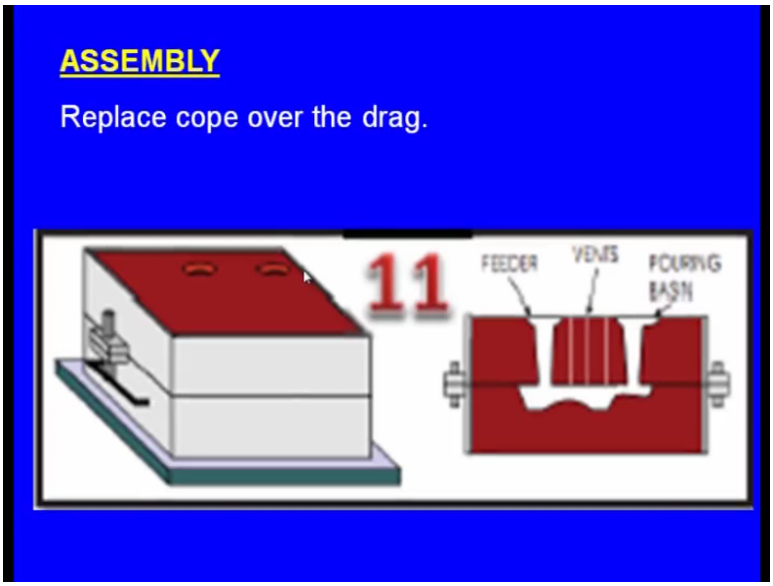

Similarly from the cope box we have to remove the sprue pin and the riser pin. Generally this sprue pin and the riser pin will have a tapper and because of the tapper and it is easy to withdraw them. So, now, in this case we can see even this sprue pin and the riser pin from the cope box are withdrawn.

Now, this is the section of the total mould right. So, this is the drag box and this is the cope box right. So, this is the mould cavity, this is the mould cavity. This is the pouring basin and this is the sprue the we pour the molten metal like this and the molten metal goes this way and it fills the cavity then it passes it rises through the riser, riser is also known as the feeder.

Now here we can see vent holes you can see these are additionally created using the vent pins because the riser is there the riser hole enables the escape of the hot gases only during the filling, once the mould cavity is filled with the molten metal it cannot allow any escape of the hot gases at such times these vent holes will help us to escape the hot gases. That is why using the vent pins we are creating the vent holes. These vent holes are created from the outside surface of the mould and such that they touch the inner surface of the cavity. So, that is all about the manual moulding.

So, we have seen how to cope the what say how to ram the drag box and how to ram the cope box and how to withdraw the patterns and how to withdraw the what say riser pin and the cope sprue pin and how to cut the gate and again we have to assimilate. Now that

is about the manual moulding. So, let us see little bit about the machine moulding, machine moulding is used for the larger castings.

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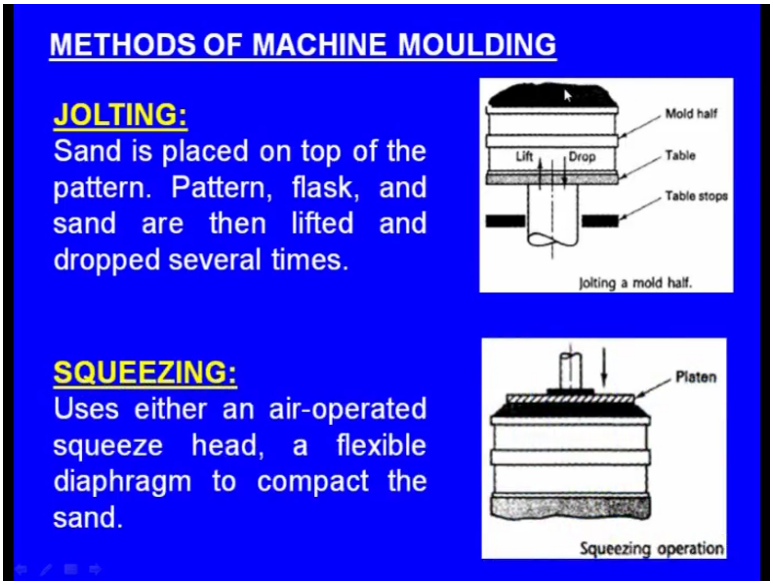

Now, friends let us see the methods of the machine moulding. In the machine moulding, one of the important machine moulding process is the jolting right, in the jolting what happens this is the moulding box yes inside the we place the pattern and this is the moulding sand we place the moulding sand.

Now, here there is a table stop right it is a strong table stop is there and the machine raises this box and suddenly it falls down again it raises and suddenly falls down and because of this repeated raise and for what say fall down raise and fall the moulding sand which is placed in the moulding box will be compacted and this will be done within few minutes and this can be used for the what say moulding larger moulds.

Then the next one we see the squeezing and the squeezing is also a faster method and this is also used for the making larger moulds and these are the moulding boxes and inside this pattern and of course, we place the sprue and the what say riser pins and we place the moulding sand you see here. So, we place the calculated amount of moulding sand. Now, here there is squeezed platon is there this squeeze platon will be coming from the top and it squeezes the sand which is above the moulding box and this pressure is applied hydraulically and this is a very high pressure and because of that the moulding sand in the box will be squeezed and it will be compacted tightly. Then we separate these

two moulding boxes and the pattern is withdrawn by creating vibrations to the pattern. So, this mould mean both the cases the moulding is done within few minutes.

And there is another machine called jolt squeeze machine right and one more is there that is the sand slinger machine.

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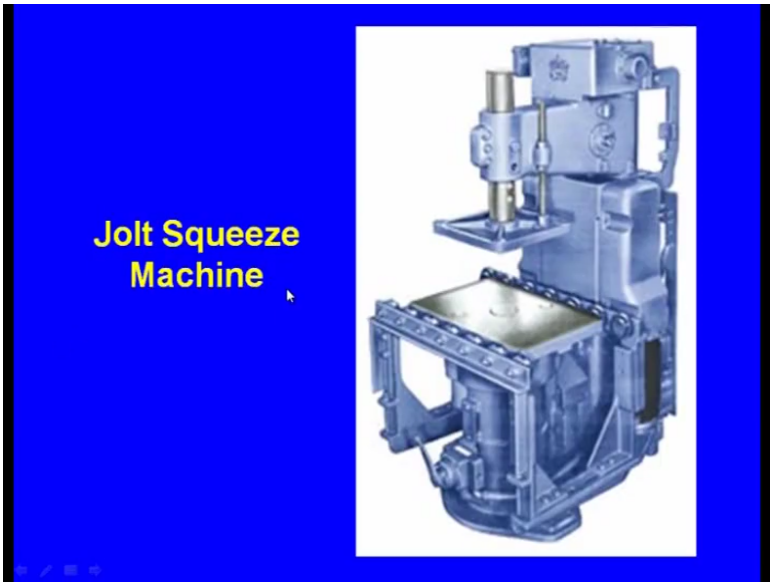

What is this sand slinger machine? We here, we can see this is the moulding, these are moulding boxes this is the drag box and this is the cope box and this is the pattern.

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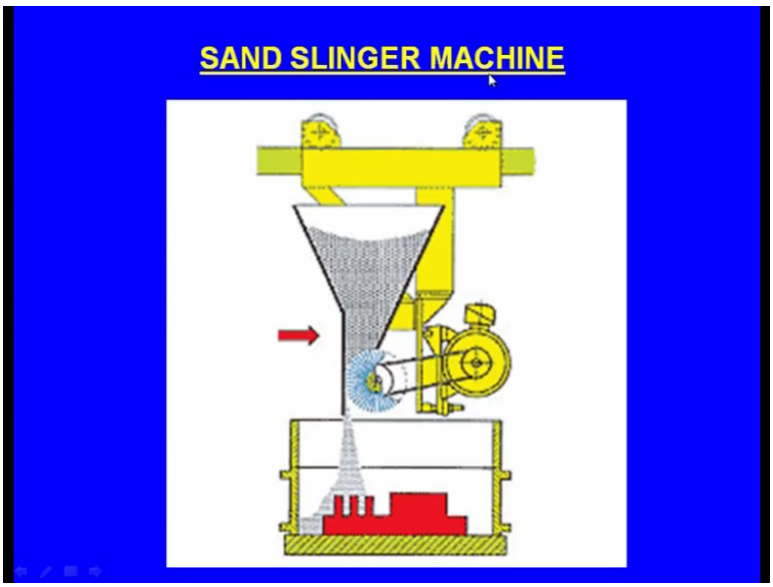

And here we can see the sand is here the moulding sand and there is a system which ensures that the sand will be falling above the pattern with a high pressure at a very high pressure.

Now, you see the sand is falling on the pattern at a high pressure as the sand is falling on the pattern because of the pressure it will be compacted while it is falling above the pattern. So, after on time that what say moulding box will be full with the moulding sand if there is any excess sand that will be leveled off. So, this is the sand slinger machine.

So, here we can see this mechanized what say foundry where there will be moulding machines will be there and the moulds will be moved automatically to the place of pouring. So, we have seen so far we have learnt about the pattern making, core making, moulding now let us see the melting and pouring.

So, these are the important furnaces used in the melting - crucible furnace, cupola furnace, electric arc furnace, induction furnace, resistance furnace, rotary furnace and reverberatory furnace.

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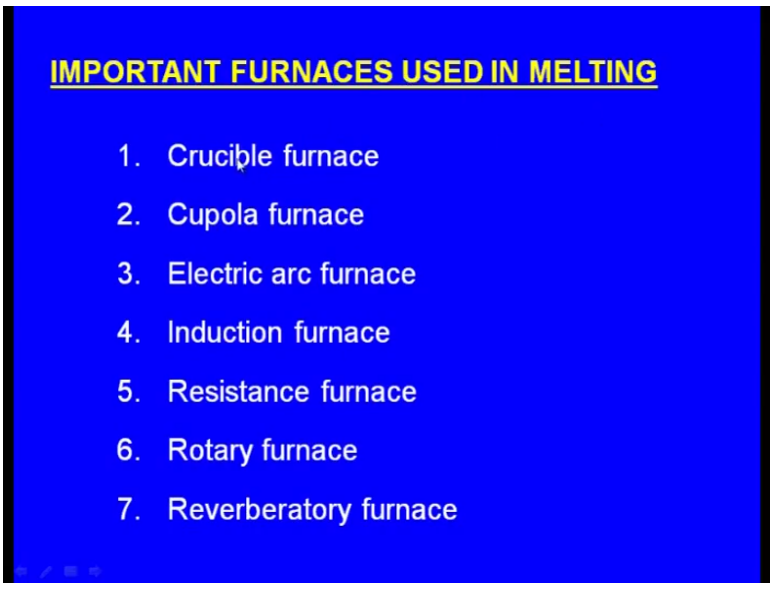

Using any of these furnaces and again some furnaces are suitable for certain metals and certain alloys. So, depending upon the alloy and depending upon the size right we have to choose the right furnace and we have to melt the metal and after we melt the metal we do the pouring, and after pouring the metal inside the mould solidifies, after the metal

solidifies we have to break the sand and take the casting outside this process is known as knockout. And here you can see this is the after pouring right we have broken the sand and this is the casting which has been taken outside. So, this is a knockout process right.

Here you can see this is a casting which is just brought outside the moulding sand after breaking the mould right casting after knockout with the runners and risers still attached. Remember that when we do this a knocking out process there will be metal will be solidified in the sprue also, metal will be solidified in the riser also, metal will be solidified in the gating also. So, these solidified projections will be still attached to the casting when we do the knockout. So, afterwards we have to cut them and we have to separate them from the casting.

Next one the process step is the heat treatment. So, this is an optional process it depends upon the application. So, these are all the different heat treatment process right.

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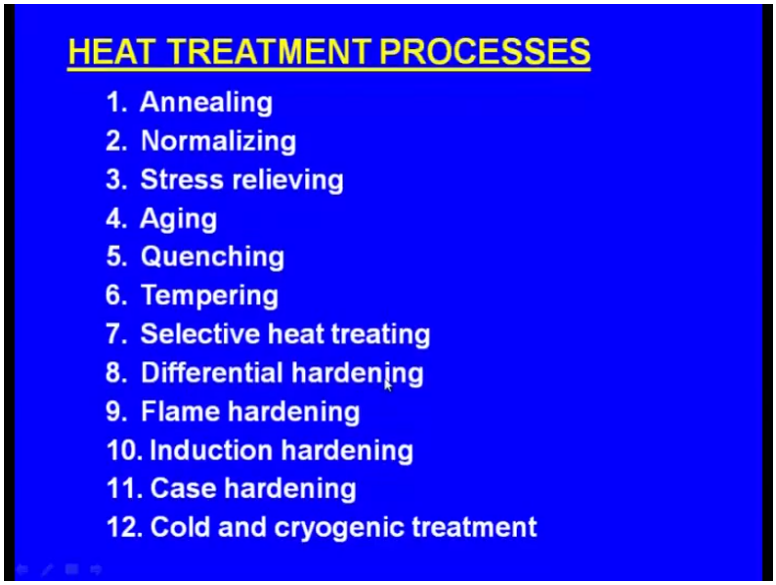

So, all may not be used may be anyone what say process can be used that to it is the optional right annealing, normalizing, stress relieving, aging, quenching, tempering, selective heat treating, differential hardening, flame hardening, induction hardening, case hardening, cold and cryogenic treatment. So, these are the some of the important heat treatment process. So, we can use any of this to enhance say certain properties.

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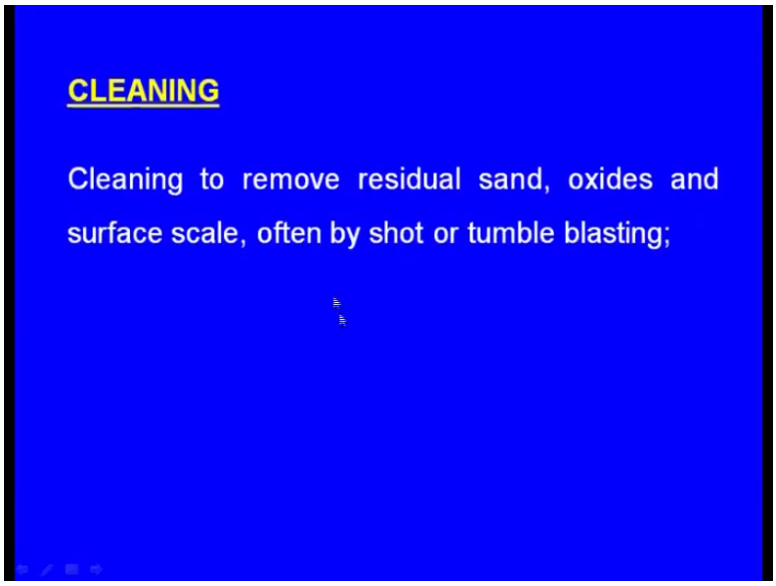

Next one the cleaning. After we do the knockout right after we give the heat treatment process the casting should be cleaned. So, this cleaning is to remove the residual sand though we have broken the sand taking the casting outside still some sand particles are attached to the casting. So, this residual sand particles are to be removed and some oxides will be there on the surface right some scales will be there and these are to be removed this is done by short or tumble blasting.

There are other process called pneumatic blasting means what say air will be released at a very high pressure and with this high pressure air will be exposed to the casting, and it will be made to fall on the casting say then all the residual sand particles oxides will be removed.

Next one finally, the inspection right. So, far the inspection is very important because the casting may look very what say perfect outside, but internally it may have some defects, internal cracks or the what say blow holes or the shrinkage cavities may be inside for that purpose we need to inspect the casting. So, these are the common inspection methods one is the visual inspection it will enable us to find out the external defects.

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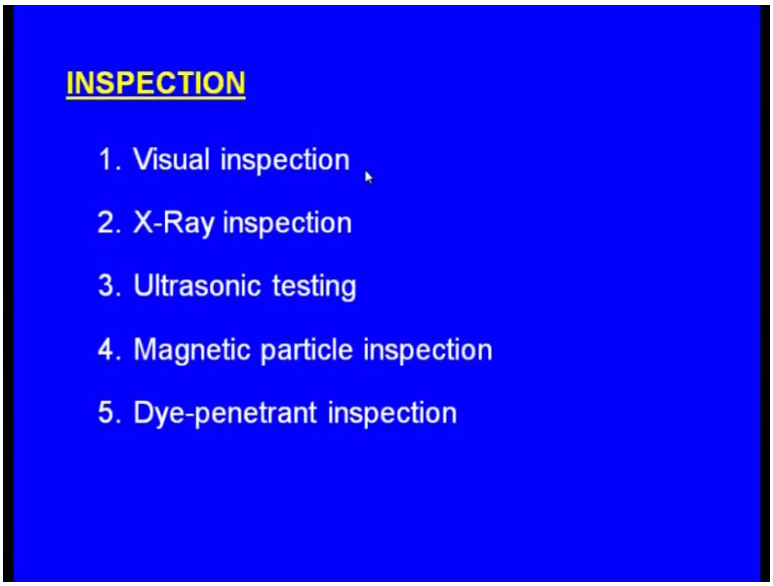

Next one x ray inspection in internal defects can be identified. Next one ultrasonic testing, using this we can identify the internal defects. Magnetic particle inspection testing, using this we can identify the say small cracks which are on the surface of the casting, but are not visible to the naked eye. Next one dye-penetrant inspection sorry this magnetic particle inspection can also be used for finding out the internal cracks.

Now, this dye-penetrant inspection this can be used for identifying the what say cracks that are on the surface, but are not visible to the naked eye. So, with that we are completing the inspection. Afterwards if any painting is required the painting will be done then the casting will be shipped to the customer. So, these are the important steps we can see in a table form. So, this is the moulding and a pattern making core making and gating system. So, they all are done parallel to the moulding right.

So, this is the mould and using the sand we do the moulding and here we are melting the metal and here you see we are pouring the molten metal into the mould and solidification takes place and here we get the solidified casting and that casting has to be taken out by doing the knockout operation it is also known as shakeout operation. Then there is a heat treatment process again this is optional that is why we can see like this and next one cleaning and finishing and a additional heat treatment if required it will be given next one the inspection right. So, that is all about the sequence of the steps involved in making a sand casting.

Friends now let us go to our laboratory and we will see the demonstration of all the steps how the mould is made right and how the metal is melted and how it is poured and how it the casting is taken out we will have a demonstration now let us see a demonstration in our laboratory.

Friends now we are the foundry engineering laboratory of IIT, Roorke we have been learning about how we prepare the green sand. We have seen that the ingredients of the green sand are been base sand, the second ingredient is the clay, third ingredient is the additive and the fourth ingredient is the moister of the bottom. So, all these ingredients will be mixed to gather in a machine called sand motor. So, this is the sand motor. You can see it has got a cylindrical drum and it has got two roller are there one roller is here and another roller is here and inside there are two plates are there.

Now, when we drop all the ingredients of the green sand and this will rotate in the roller will be rolling warm up the ingredients of the molding sand and the blades will be sprue pin so that no sand will be left out without getting mould. So, this is how we prepare the green sand. Now I request mister Anil Kumar Dhiru a research scholar in our department to come here and show the green sand preparation mister Anil Kumar Dhiru please come here.

Yes.

So, please show me yes this is the base sand.

Yes.

So, this is the main ingredient of the green sand. So, this is the base sand in fact, this is the silica sand. So, the silica sand looks like this. So, this is the main ingredient of the green sand. Next one we will see the second ingredient that is the clay. So, this is the clay you can see yes, this is the bentonite and I have already told you the what say source of the bentonite and from way it would be comes and its classifications and this is the bentonite the bentonite looks like this. So, this is the clay, this induces the what say cohesion between the sand purpose.

Next one we have seen the third ingredient the third ingredient is the additive right. So, this is the we have already seen different types of the additives and today we are using

the coal dust, the coal dust looks like this. What is coal dust? Coal dust is the pulverized coal. So, this is the third ingredient and the fourth ingredient is the moister, moister will be added. So, we have what say kept these in the proportions, these proportions we have already seen earlier now we are going to add all these ingredient in this puller sand puller and we will prepare the green sand now he will be doping the base sand into the sand puller yes.

So, we can see that is a small what say showel a this is a small showel in his hand which is use to carry the sand. Now, he has completed doping the base sand in to the motor. Next he will be doping the bentonite (Refer Time: 30:25). Now he is doping the bentonite, this is the bentonite. Next he is doping the coal dust the additive into the system into the motor, this is a coal dust. Now this is the water calculated amount of water he is pouring into the motor.

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Friends until now we were bullying the green sand right, we have taken all the ingredients of the green sand and we have moulding to the sand motor now the green sand is ready. So, this is the green sand ready for moulding.

Friends until now I was explaining you how to prepare the green sand mould what are the stages involved in the preparation of the green sand mould. Now we are again the foundry engineering laboratory of the IIT, Roorkee. Now we will see a demonstration how to make the green sand mould and we have miss Kyathi she is a M.tech's scholar

and we have mister Ganpath Rai and he is a research scholar and they will be showing us the demonstration of the green sand mould. And before that I will try to show you the important tools of the green sand moulding.

Now, you can see here. So, this is the moulding box and this is the yes this is the drag box this is a metallic box you see it is opened at the top and bottom. So, this is the drag box now you can see here this also a moulding box metallic box it is opened both at the top and bottom. So, this is the cope box.

Next one. So, this is the pattern which we are using in the today's demonstration. So, this pattern is similar to the component which we are going to produce next one. So, this is the rammer, sand rammer and this is another rammer this is the round rammer and when we are making the mould we need to make the sprue hole and also we need to make a riser hole. Here you can see two pins one can be used as the riser pin and the other one can be used as the sprue pin.

Next one and this is a draw spike, I told you the withdrawal of the pattern is very important so manually if you if you try to withdraw the pattern it is very difficult that is why we inside this draw spike into the pattern then with, we will moving pattern. And this is the vent pin of the compacting sand inside the moulding boxes to ensure that the hot gases escape from the mould we make tiny and narrow holes in the mould. So, for that purpose we use the vent pin, with the vent pin we make narrow box. So, this is the brief introduction and this is the squared for cleaning purpose right.

So, this is the brief introduction of the tools now we will go for the demonstration of the green sand mould, now Miss Kyathi and Mister Ganpath Rai will show us the demonstration of the green sand mould.

That is a pattern and this is the moulding box and she has kept it pattern inside the moulding box now she is sprinkling the facing sand. So, this is the facing sand very fine sand you can see that is the facing sand. So, that after that we will be what say operating the moulding sand this moulding sand should not stick to the pattern and the moulding box.

Now, there are putting the green sand into the moulding box, initially the box should be filled to some extent not fully and see she is ramming, initially the ramming should be

done at the corners then slowly the ramming should be coming inside. Now, the initial compaction is over, now we are putting more and more green sand into the moulding box. Again the compaction, now you can see she is using the round rammer.

Remember that the compaction should be uniform no way it should be irregular. Now you see we have compacted the moulding box with sand, now you can notice that the sand is more there is excess sand. So, this excess sand has to be removed using the striking bar. So, this is the striking bar with which she will be removing the excess sand.

Now, the compaction of the drag box is over now she is sprinkling the parting sand on the drag box, this parting sand will happens so that we are going to what say compacting the cope box the sand in the cope box and with the sand in the drag box will not stick to each other for that purpose we have stickle the parting sand. So, these are the bentroots.

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Now, the moulding box will be made ups and down you see it could be made ups and down. So, that the pattern comes upwards you see now heels the pattern this is the pattern the sands come out. Now how this will be placing the cope box and the again will be compacting the sand in the cope box.

Parting sand.

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Again that is the parting sand. So, that is the one is the riser pin and other one is the sprue pin. The location of the riser pin and sprue pin is very important. Again you can see the standing (Refer Time: 45:25). Care has to be taken for that the sand around the sprue pin and the sand around the riser pin are compacted very carefully. Again the excess sand is being removed using the striking bar.

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Friends until now the compaction of the sand put in the drag box and coke and column. Now we are removing the pins the riser pin and the sprue pin, that should be done with extreme care. Now we are cutting the pouring cup above the sprue so that it will an appears to pour the molten metal very easily. So, that is the pouring hole. Any excess sand or rue sand will be removed by using the swap, this is the swap again she is making the vent moulds to facilitate easiest step of the hot gases from the mould.

Now, the step means we come to separate the two boxes and inside (Refer Time: 53:20) that the pattern is inside, the pattern means the withdrawn and also we need to cut the (Refer Time: 53:27). She is applying the water around the a pattern so that the withdrawal of the pattern would be easier.

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Now, she is using the draw spike to withdraw the pattern. Yes, how she is withdraw the pattern carefully (Refer Time: 54:12). Now she has withdrawn the pattern yeah he (Refer Time: 55:31) say moulding stamens actually prepared. Again you will be closing the two boxes. Now she is making the gate, she is cutting the gate, see care has to be taken while cutting the gate around the sprue around the sprue.

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So, this is the gate cutter and there it should be limit inside the surface and this side we have the risering. So, we are linking a passes for the riser.

Now, gate cutting is over again we are replacing the cope over the drag.

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Now, you see again the cope box is kept over the drag and we have to separated and if we have kept the cope over the drag and to ensure the proper arrangement of the drag and cope and here we can see and these are all the dovetail pins are there right here is the dovetail pin and here is the one dovetail pin and they will be cutting us two properly arrange the two boxes.

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Next we will see the pouring of the molten metal into this mould.

Friends until now we have seen how to prepare the green sand mould, now the green sand mould is ready now it is ready for pouring let us see how to pour the molten metal into the mould. We have with our (Refer Time: 59:32) Misses Saroj Sen Patnayak and she is a research scholar in our department and Mister P K Sharma and he is a technical staff in our laboratory and they will show us how to pour the molten metal into the mould.

You can see that is the molten metal some stack is there at the top. So, that has to be removed.

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So, that is a graphite (Refer Time: 60:46) in which we can see the molten metal, that is the aluminium that is the aluminium. So, that is the pouring cup he is pouring through the pouring cup you see and it fills the cavity then it rises through the rise.

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Hence now you can see most you can see withdraw poured molten metal through the pour for and it has drawn to this sprue and it has entered into the mould cavity then it has raise to the riser. So, this is the metal it has raised through the riser. So, that is how we

used to pour the molten metal into the green sand mould. After some time it will be solidified then we break the sand and take the casting outside.

Friends until now we have seen how to make the green sand mould, we have processing how to pour the molten metal in to the mould now when we have we have pour the molten metal into the (Refer Time: 61:51). Now the molten metal is solidified.

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Now, I request Misses Saroj Sen Patnayak the research scholar and Mister Sukram the technical staff in our laboratory to carry out the shakeout operation. Shakeout operation means we have to break the sand and take the solidified casting outside. Now we will see the shakeout operation.

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We can see the solidified casting inside, but remember that the metal is also solidified in this sprue and the riser hole which are cant the part of the casting these are to be cut and separated. This is the solidified casting.

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You can see this is the solidified casting and this is the casting this is the casting and this is the metal which is solidified in this sprue and this is the metal which is solidified in the riser. Later we have clean the casting and wing the cutting here. So, that these unwanted portions will be removed from the solidified casting.

Friends until now we have seen the preparation of the sand mould pouring and solidified casting finally, we have seen the shakeout operation. With that we are closing the how to the different steps involved in making the sand casting.

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Friends now the shakeout operation is over we have broken the sand mould and we have taken the casting outside. So, this is the solidified casting you can see this is the actual casting, but this is the pattern which is solidified with the sprue core and this is the metal which is solidified with the riser. So, later these are the cut here, so that we will get the required casting.

Friends now we have remove the metal is solidified in this sprue and the riser. Now this is the final casting, after removing the unwanted projections and unwanted the sprue and the riser. So, with this we are completing the procedures for making the sand mould. So, in this lecture we have seen how to prepare the sand mould, we have seen different steps involved in making the sand mould and we have seen how to pour the molten metal into the mould. And we have seen the shakeout operation how to break the sand mould after the solidification is over then we will may cutting the unwanted metal which is solidified in the sprue and the riser finally, we have obtain the required casting.

Thank you.