Theory of Production Processes
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Lecture – 09
Sand molding methods

Welcome to the lecture on sand molding methods. So, in this lecture we will discuss about the steps in making the sand mold and different types of molding processes which are used in the casting process.

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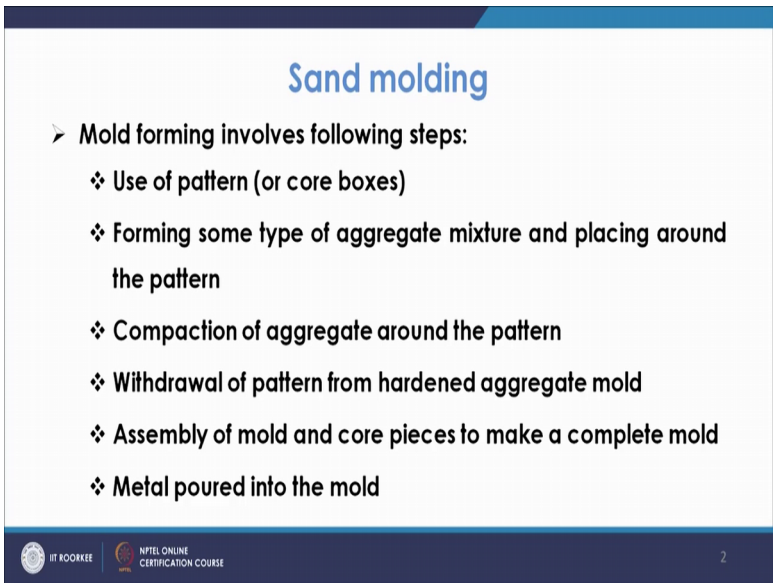

So, when we talk about the sand molding, If we typically talk about the mold making or. So, it involves the following steps which are discussed. So, first is that you have the pattern.

You prepare the pattern depending upon the geometry of the cast unit. So, you will have pattern in split or since or you will have a single pattern or so then you will have the core also made. So, you will have pattern and core then you are having some type of aggregate mixture which has to go and pack around the pattern. So, that is the molding material so that is what we have discussed in the last lecture which have finished.

So, in that we have seen that you have the molding sand and it is mixed with clay water. So, that is basically the aggregate that is mixture of the molding material that is sand and

other ingredients and that will be covered around the pattern that will be placed around the pattern. Now, after you place around the pattern you have to make it compact because when you are keeping just like that they are not compacted. So, if the metal will be going into the cavity and also it has to when you are taking the pattern out, that time it needs to have its own shape intact. So, for that you need to compact it. So, for that compacting operations are there you have ramming operations normally whenever we use the sand mold so we do the ramming.

So, we are basically compacting the aggregate that is sand plus binder plus hardener all that or plus additives they are to be compacted around the pattern. So, that compaction process goes on then after that once that compaction is over then you are going to take the pattern out from that particular structure. So, you have the pattern it is compacted from all the sides, you know you have to leave the apart in surface and you have to compact from all the sides with that aggregate mixture.

So, then you have to take the pattern out. So, that is known as withdrawal of pattern from the hardened aggregate mold, further you have the once you take out then you have the cavity ready and then you have to see further that whether you have to want to make any hole in the cast unit. So, for that you have to place the core pieces to complete the mold and once you place them once you fix the course at its positions then the metal is poured into the mold.

So, that is how these sand moulding steps are being followed.

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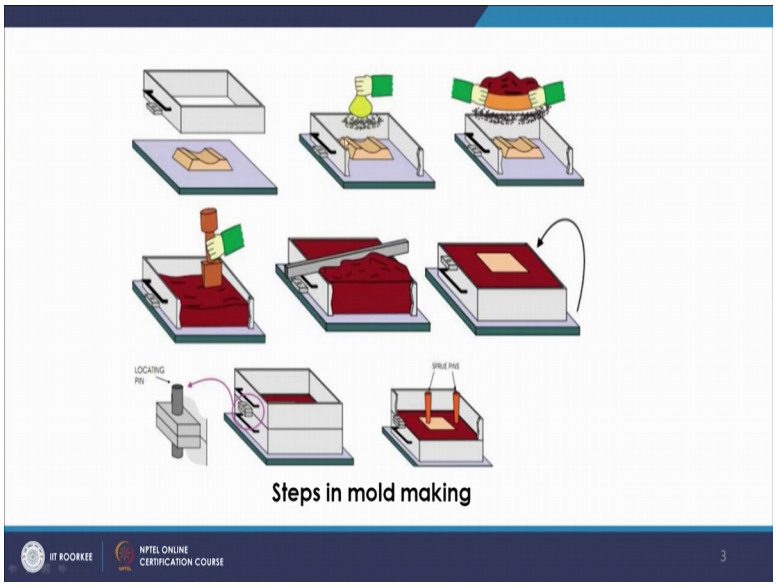

So, the figure talks about these steps in making the molds as you see that you have a pattern which is there and you put a molding box on this plate see pattern is put on the pattern plate or a board is there. So, on that you are putting the pattern, then you this box is kept after that you pour the molding material around that. So, you are pouring this molding material and then you are ramming with this. So, that is the stage of compaction so you try to achieve the compaction. So, you put certain quantity of sand into it and then further you are ramming it. So, that you get the necessary compactness. So, that it gets the strength the strength is achieved because of the compactness.

So, once you and the so once you give some amount of sand and you ram it, then certainly the volume will be decreasing. So, further you are giving extra material extra molding sand which is ready and then you are further compacting it and then extra which is left that is removed. So, this way one half of the molding box is ready, now if from that you are basically removing this pattern.

So, once you remove the pattern you have the cavity which is ready here. So, you have to invert it and then this pattern is removed from here leaving a cavity. So, this way you are making the cavity, similarly you have the second half there also you make the cavity and then both the boxes are basically you know joint and then you will have these sprue pins will be there. So, from for pouring and then it will one will act as the rey riser or. So, you are basically pouring and then you will have the runner riser cut or you may have as a

part of the pattern itself and then metal will be melted. So, that is what we discussed in this that you are doing all these and then finally, you are pouring the molten metal into the mold.

Now, we will discuss about the classifications of the molding processes.

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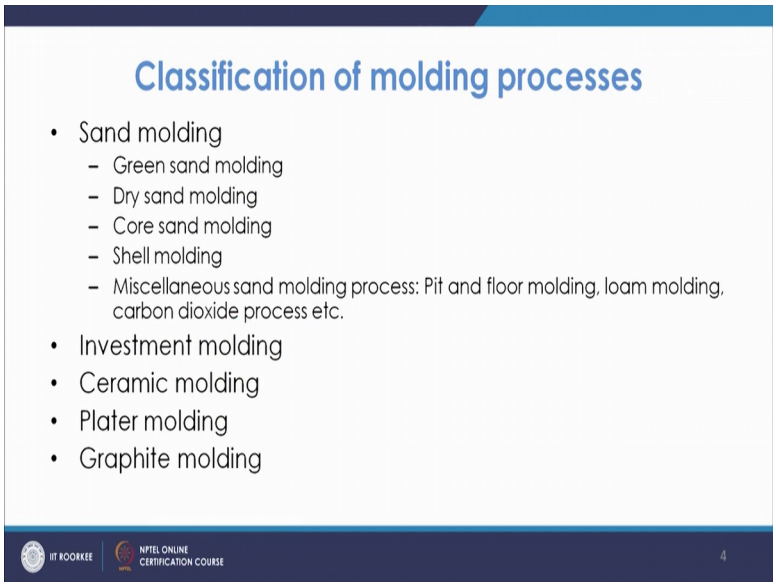

So, as you discussed we have the sand molding there we discussed about the green strength. So, similarly green means you have the moisture. So, based on that when you are doing the molding process with the green sand which has a moisture in it and the moisture gets evaporated, it gets the strength slowly because the moisture will be evaporated once the liquid metal is poured into the cavity.

So, moisture is still is there, when the moisture is there you are pouring the liquid metal into it that that is the case of green sand mold which is basically getting poured. So, that is green sand molding and then you have dry sand molding. So, here basically you dry that mold before pouring you are trying to dry it. So, you can dry it by so once you are having the green sand then you try to dry it you may allow it to dry in time with time or you may allow to pass the hot air or any heated with any heated object you can use other means to drive the moisture off. So, this way you will have the dry sand molding.

Many a times you used the core sand and for the molding, core sand is the they are also sand, but in the case of core sand normally we use the sand of maximum purity. So, they

are basically when we make the cores we do not use the clay because the clay decreases its refractoriness. So, in the case and also core needs to be more thermally stable as well as a strong so, normally cores are made by the organic type of binders where the strength is achieved because of the polymerization effects. So, once many a times we use this. So, when we do the molding by this method that is known as core sand molding.

Cell molding again here also we have the organic based polymers. So, here the cell is prepared normally used for making course, but sometimes indicate sub castings can be made. So, normally in the case of sand molding when we talk about the green sand molding processes. So, you have the binders like clay that is montmorillonite group of that clay, the sodium or calcium bentonite plays are used and also we are taking other process that we will discuss. So, in that you have the binder and hardener. So, you use clay as well as water and then some additives. So, these are in normal case in that green sand molding.

Now, when we talk about the cell molding, in the cell molding basically a cell is prepared of small thickness. So, they are normally and here the cell is basically because of the heating of the pattern and pouring the sand with binder over it, the sand will be mixed with the binder and then once it is kept over there. So, because of the heating the sand grains coated with the binder they fused they basically they get strength, they are attached to each other and develop a large strength and a sufficient thickness of the cell is formed. So, after that you take the pattern out and then you will have the cells of 2 sides prepared so that is a case of cell molding.

So, as you see we have seen the case of sand molding.

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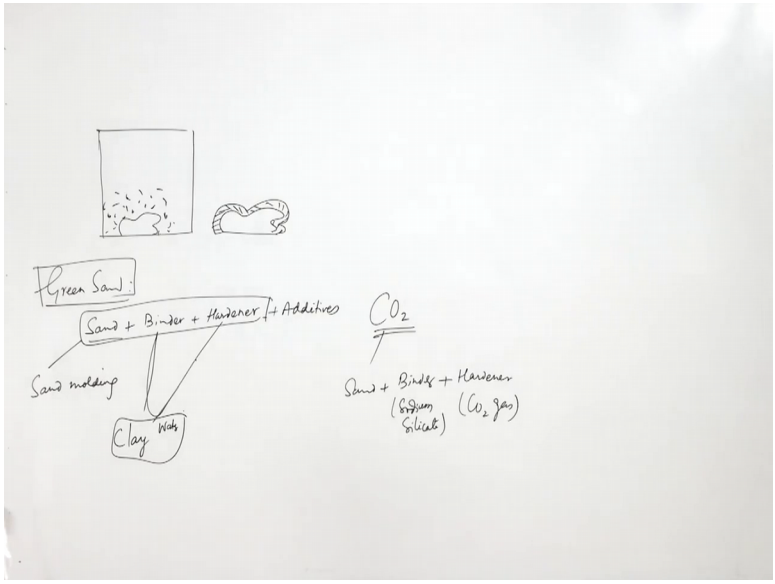

In the case of cell molding if you have suppose a pattern is there half of these. So, in that case you have a box and in the box you keep that cell up in the sand plus organic binders and then you this pattern is heated, so once you heat that. So, after sometime you will have a sale of certain thickness will be you will be achieving. So, this is the cell which is found.

Now, similarly you will have another cell of the half type now this cell is nothing, but because of the heat which is here and under this heated condition the sand which is coated with the binder that is mainly mostly the phenol formality hide or other type of (Refer Time: 11:07) based binders. So, these are used and they get so it normally thermoset polymers are used and because of the heat they get the strength and then this way your mold does not need to be very thick they are very strong and also they provide very good surface finish.

So, normally they are used for making cores because they are we are using this, here the they are very much thermally stable they maintain their integrity at even high temperatures and there is no moisture much left. So, for the cores normally the requirement is that it should be free from clay it should not liberate a large amount of gases because they are ultimately going to you know do the harm to the casting, they are from all the sides, they are basically in most of the sides mostly they are enveloped. So, certainly gases will release from the top and bottom side.

But mostly if the gases released are more by the course that is likely to create the defects. So, that is why this is how the cells are prepared as in cell molding you get the cells further these cells are fastened and then pouring is done. So, this is how the cell building is done, you have miscellaneous sand molding processes like pit and floor molding, so for this is used when you have very large size of castings.

So, normally you cast them in the pits or in the floor. So, that is known as peaten floor molding. So, you have the pattern making also of the shape you by the use of skeleton patterns or so you make large heavy you know cavities and then you do the you know casting. Low molding is there similar one which is used for very large type of castings, there is a carbon dioxide molding process. So, in the carbon dioxide molding process what is done is.

So, in the case of normal sending sand molding you use. So, when we talk about the green sand so in green sand I mean sand plus. So, you have the sand molding, you have sand plus binder plus hardener. So, that is what in case of sand molding you have not green sand when we talk about green sand means it is in (Refer Time: 13:43) state, but anyway in the sand molding this is typically happens in case of sand molding you have the sand, you have the binder, you have the hardener plus additives.

Now, what happens that when we use clay, the clay is having not very high refractoriness. So, clays are normally do not used for making the, you know cores and also you have the there is limitation of having adequate strength. So, the next type of molding processes are like carbon dioxide molding. So, here the so this binder is one is clay which is used. So, it will be clay and hardener it will be water. So, clay and hardener is basically water. So, slowly then water will be driven off and then the strength will develop. So, that was that is how binder plus hardener works.

And certainly both are working as binder plus hardener so this way this comes. Now, in case of CO 2 molding what happens we use here the sand plus binder is sodium silicate. So, we use the sodium silicate, in this case you have the some ratio of array 2 and s I o 2 sodium silicate is there and then in that you are putting the hardener as CO 2 gas. So, what is done is in you make the sand by mixing sand plus sodium silicate, certain amount of sodium silicate will be used a fixed percentage of the weight of the sand.

And then it with the same mold will be made and once the carbon dioxide gas is passed through it then there is a reaction between sodium silicate and carbon dioxide that makes silica gel and this silica gel is responsible for giving the adequate strength. So, in this case because of the passing of the CO 2 gas hardens. So, CO 2 gas is acting as a hardener.

So, I mean this way your carbon dioxide molding process is done. So, in this case you do not require to use these clays. So, he this has quite a large strength and it also self sets many a times it will if you leave it in the atmosphere it will pick up the carbon dioxide from the atmosphere and it will self harden. So, you it has certain bench life, you have to use it you cannot leave it like that because it will then harden. So, then that is again you have to remove them further you have to use it.

One of the problem is that you can sometimes many as times as re reusability is certainly limited in this you to processes and still work is going on to make it reusable because large lumps are formed which are not further reusable. So, that is CO 2 molding process, next is investment molding or investment casting. So, as we see in this case you have the pattern which is made of wax, then you apply the ceramic coating and then slowly once you have the coatings to going off the refractory particles and getting the cell thickness of certain dimension and once we have that then we fire them, to take the wax out of it.

So, this way you get a cavity and in that cavity because you have the pattern so that you have the network of all these runners and risers or so. Then you pour the liquid metal and then liquid metals gets solidified. So, this is used for precision castings, ceramic moldings simply some in the same way in the ceramic molding you have the ceramic is used and that way here also in this case. So, in this investment casting in ceramic molding normally so, in that cases you are heat extraction rate is quite slow. So, in that case they will go into the intricate cavities and you get very fine details in the case of ceramic molding.

Next is the plaster molding where the gypsum plaster is used mixed with water it sets and then you have mold prepared and then in that you pour. So, in that way the plaster molding is done, it has a property that plaster basically gypsum plaster upon setting expands. So, it takes care of sometimes by choosing the gypsum plaster of certain

expansion rate, sometimes the shrinkage can be you know countered. So, that is one of the traits of plaster molding.

Graphite is also used as mold. So, graphite you have you either you can make the graphite for that, you have graphite and plaster plastic bits and then that way you prepare by heating the graphite mold or you can have by machining of the graphite column you can have the graphite molds. So, normally they are used when you have to use them for many times. So, because it is costly, but because of its property for very precious type of castings you use the graphite molding also.

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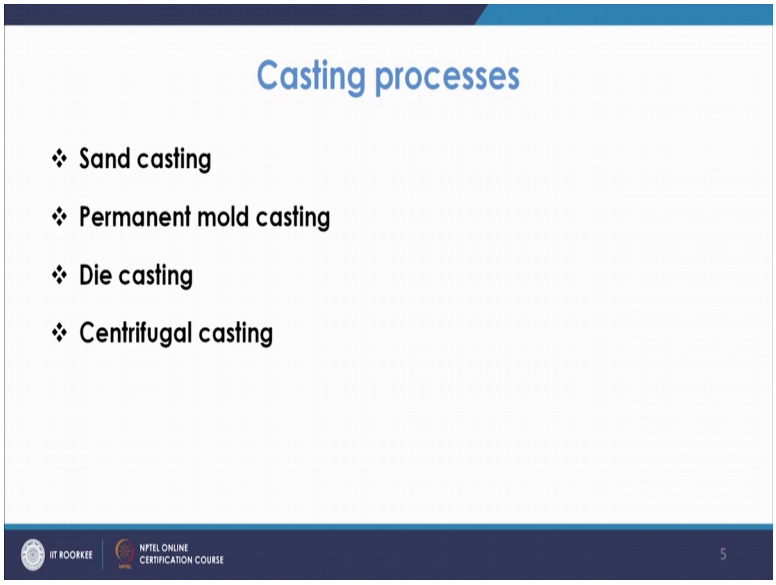

Different casting processes as we discussed we have different type of casting processes can be classified like sand casting where the molding material is sand, then you have permanent mold casting where the molding material is the permanent like metals and alloys. Then you have die casting here also you have mold made of metals the only difference between permanent mold casting and die casting is that in the case of die casting you apply the pressure, the metal is entered under the pressure and solidification takes place under pressure whereas in case of permanent mold casting the solidification takes place.

So, you are feeding the molten metal you are press you are or allowing the metal to molten metal to go inside the cavity under gravity then you have centrifugal casting. So, in the centrifugal casting you are putting the molten metal and then the mold is rotated.

So, because of the centrifugal action the metal is thrown towards the outer periphery of the mold and as a symmetric type of shapes or circular shapes or pipes or so they are cast by using this centrifugal casting. So, these are the different types of casting processes in general classified as.

Now, we talk about talking about the molding process.

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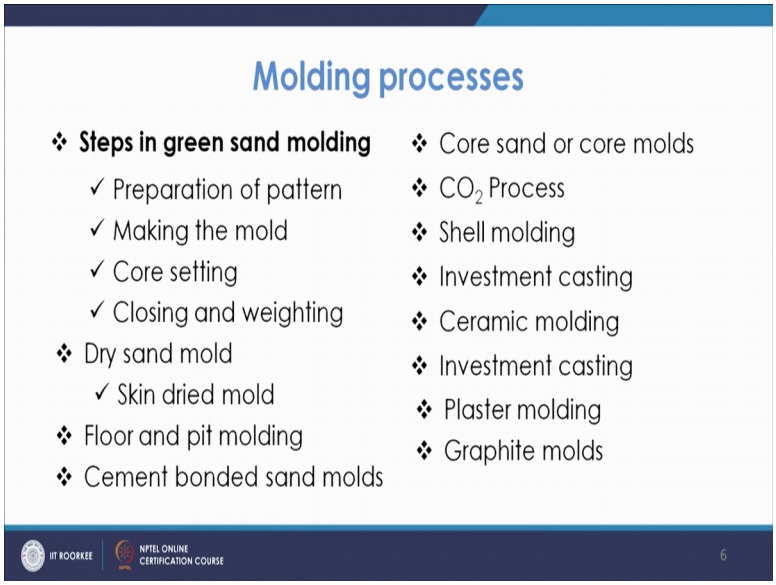

If you talk about the greensand molding in that these are the steps that is once you prepare the pattern then make the sand is that we have seen in the earlier lectures earlier slides. So, you make the mold and then core setting is done. So, code will be placed and it has to be seen that it is at proper place and closing and wetting of the cores is also seen that core should be towards the drag half otherwise it will floats. So, if it has to be in the drag of portions.

So, that you do not get most of the difficulty otherwise there may be misalignment or other problems of related to (Refer Time: 22:06) when the model molten metal enters into the cavity. Similarly, you saw in the case of green sand molding as you know after this the when the molten metal is poured in that case the moisture will be driven off and then slowly the metal will solidify and then you can take it out.

In the case of dry sand molding as you know we dry the mold and one of the way also is to skin dry the mold, skin dried moles are there where the drying is done only up to

certain depth off from the inside maybe from 3 to 4 mm or 4 5 mm of depending upon the conditions you can dry the skin and then you give the multimeter inside. So, that is known as skin dried molds, floor and pit molding we already discussed that we have very large sizes we go for floor and a pit molding sands we also use cement bonded sand molds.

So, very large the kind of objects can be cast where you use the cement and then by use of cement you are making the sand molds. Course and core molds where you use the core sand for making molds, similarly we discussed about the CO 2 process cell mold investment casting ceramic molding, we have investment casting again then you have plaster molding and graphite molds.

Now, talking about the permanent molds so, we discussed about the sand mold where how the casting takes place because once you make the sand mold then you pour after that once the casting is solidified you take the casting out. Now, what happens in the case of permanent molds?

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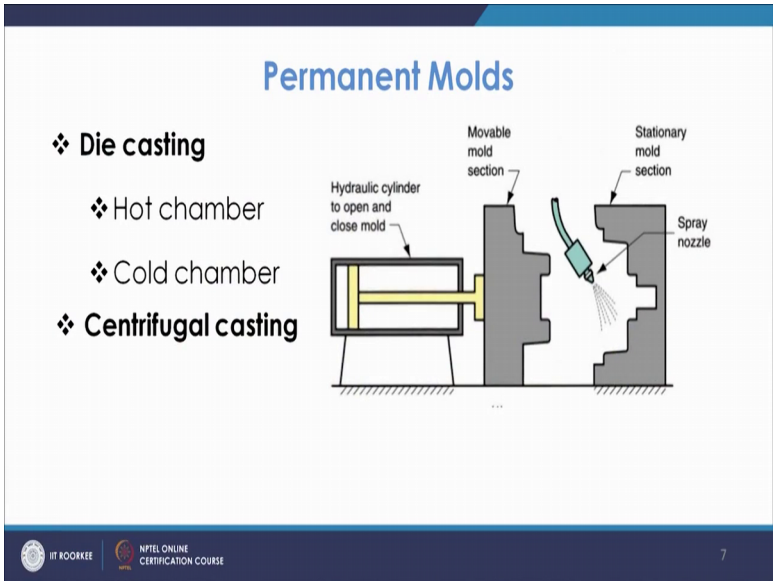

In the case of permanent molds in the metal is there as a mold you can use the course either as metal or even the sand and then metal goes into the cavity and because the metal is or molten metal is in a metallic mold itself thermal conductivity is more solidification takes early. So, it has that is known as permanent mold.

Now, you have even sometimes that this use of pressure, now in one case you have typical mold which we make in sand so you have all the runners risers and all that. So, metal will free go under gravity then you have die casting. Now, in die casting what happens that you apply the pressure so metal is fed into the cavity by using the pressure.

So, as you see here you have first of all you put some spray so that every from for every putting the liquid metal into it you spray. So, that these metal does not stick and it is ready for getting poured then you are closing it and then under pressure you are of supplying the liquid metal into it and then this pressure is maintained. So, that the liquid metal gets solidified. So, when thus you ensure that metal has solidified inside you take the plunger out and the metal is taken out.

So, this movable portion will be taken out and job cast unit will be taken out. So, that way, now it has 2 varieties, one is hot chamber and another is cold chamber die casting. So, normally the die casting is used for low melting point materials it is not suited, it is not considered suited for ferrous materials, normally non ferrous materials are cast normally for lower melting point alloys like tin, ladders, zinc. So, these are the materials which are used.

Now, in that in hot box or chamber die casting basically the pot is attached. So, the only hot metal will be there itself it will be part of the setup and from there itself directly the metal will be poured into the cavity. So, it will be basically forced into the cavity. So, hot itself it goes, in cold chamber the metal will be brought from outside where the motor metal is melted and then it will be poured into this machine. So, it will be injected into the machine.

So, very low melting point alloys they are normally done using hot chamber die casting because otherwise if they lose its super heat and quickly you cannot do the casting. So, and otherwise you go for cold chamber die casting, centrifugal casting we discussed that you have the mold in a asymmetric shape and then you put the liquid metal and then it rotates and then the solidification is taking place because of the centrifugal actions which creates a lot of pressure and then solidification takes place giving a dense structure.

Molding process equipments when we make the molds we use a different type of molding process equipment especially for ramming. As we discussed when we are very small molding then the as we saw we use the hand rammer or so, but otherwise in case of

machine molding, when we use the machines in that case you have that refer ramming you have these machines like you have a squeezing machine, jolt machine, jolt and squeeze machine and slingers.

So, what happens when you use the squeeze machines. So, you can look at the picture here.

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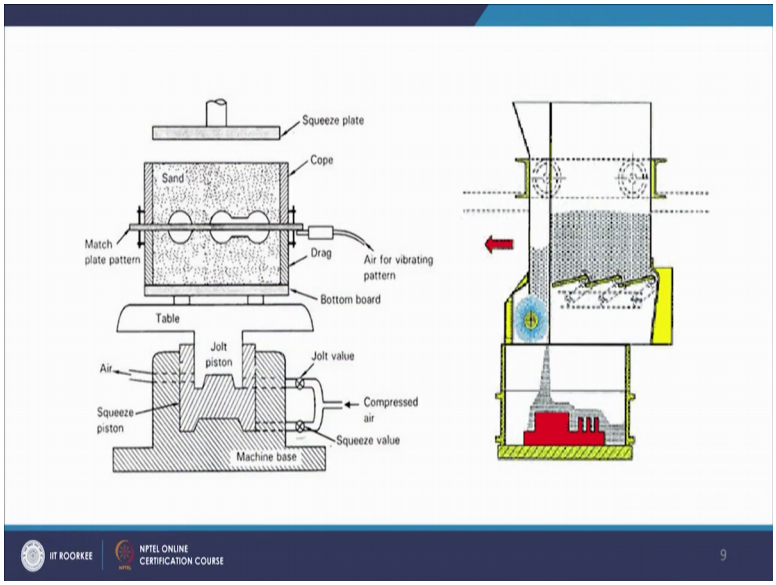

If you look at here in the case of squeezing, you have a squeeze plate that will squeeze. So, in the squeezing case what happens you have maximum you know hardness near this surface and it this will decrease slowly whereas, when you go for jolting. So, in the case of jolting this plate will be basically jolted the stable is there so it will be jolted.

So, in the case of jolting, what happens there will be more compactness around the pattern. So, in case of squeezing around the pattern there is less ramming and away from the pattern you have more ramming whereas, in case of jolting when the platform is jolted heavily to and fro up and down in that case there will be more ramming around the pattern and less ramming towards the top surface.

So, in that case you have in this 2 cases you have uneven type of ramming I mean ramming density or density distribution. So, we combine these 2 jolt and squeeze. So, that is why you have here one in squeezers, one is jolt machine then you have jolt squeeze. So, both are done. So, that in one case you get more hardness near the pattern in

one case you get more hardness away from the pattern. So, you have uniform hardness altogether you also use sand slingers where in the case of sands slingers if you look at, here the sand is thrown at a high speed around the pattern that it goes and gets compacted.

So, this way the compactness is achieved. So, sand slingers are another machine which are used for doing such operations. So, this way as we see though so these are the different sand ramming equipments which are used. So, once the ramming is done then pattern is to be withdrawal. So, with the drawer pattern withdrawal has to take place once you.

Now, this ramming density is very important because if the ramming density is not adequate in that case, either if it is very very hard then in that case the collapsibility may be the issue the other effects like the other defects like hotly error so that may arise. If it is too low then it may produce some defects like drops or putting some inclusions make the sand may go out sand may be eroded easily. So, this kind of defects may come when the there is no optimum density.

And then once you have that ready then you can go for further folding into the mold and then further you have to remove and the, you know take the material out solidified material they move the you know other things and get the metal you know cast ready. So, this is how the, we discussed about different sand molding methods and sand molding processes steps in making the sand molds.

Thank you very much.