Fundamentals of Manufacturing Processes
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Lecture – 17
Casting: Core and Core prints

Hello, I welcome you all in this presentation. In this presentation I will be talking about the cores and core prints which are used in a castings for making the internal features and holes, which otherwise cannot be made easily with the help of a pattern in the mould. So, those complicated internal features are produced in the castings with the help of the cores.

So, today I will talk about the cores how the cores are made what are the different types of the cores what are the properties required related with the cores. And what is the role of core print in positioning the cores in the mould so that the desired internal features and the cavities can be achieved properly a desired location of the desired size. So, that is where the core prints play an important role. So, first of all we will be talking about the cores.

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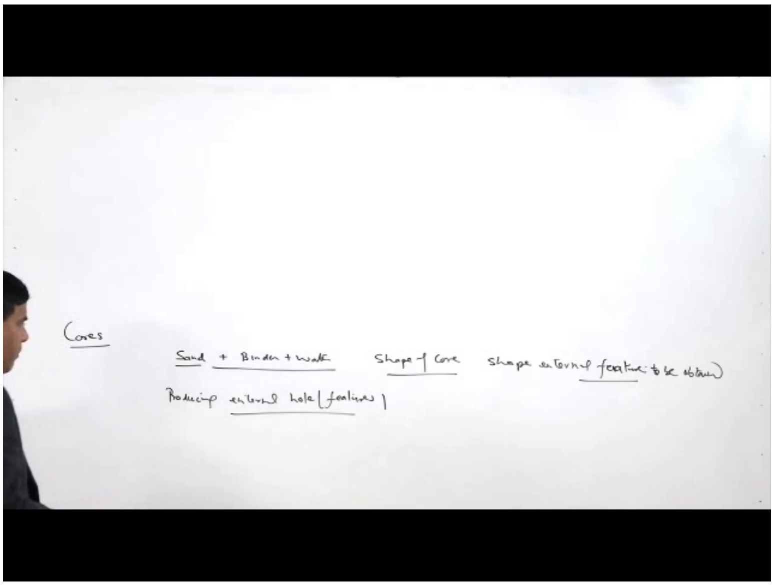

So, cores are a just like these are made of the sand plus binder plus water. So, the suitable shape of the core depends upon the shape of the internal feature to be obtained internal feature to be obtained. So, basically cores are used for a producing the internal holes and features, which otherwise cannot be produced the in the mould with the help of the patterns.

So, those features which cannot be produced using the pattern into the mould. And so, the castings cannot be produced of the desired size and a shape with the internal features. So, for those situations cores are used. So, basically the cores core is located in the mould in at the location desired so that the internal feature and the cavity can be created.

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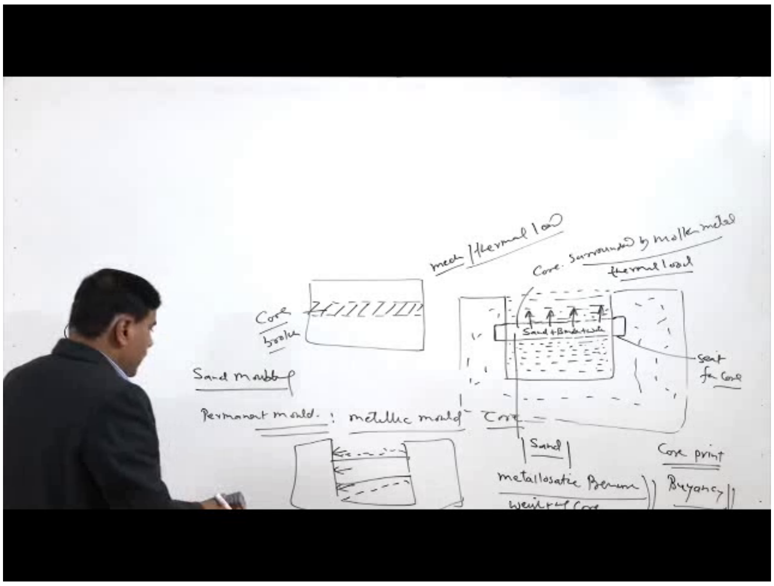

The cores are not used means are not used only with the Sand moulding for producing the internal features of course, the cores are used in the sand moulding, but not only the sand moulding also in permanent moulds cores are used. So that in the permanent moulds means these will be the made of these are the metallic moulds, and in the metallic moulds the core is positioned suitably, so that internal feature and the cavity or the hole can be produced.

So, we will see one a typical diagram like this a simple mould like this. It is a sand mould. So, what is done to make a component with the hole like this? Through hole like this can be produced with the help of the core. So, for this purpose we need to locate one core at this position suitably where it was the desired. So, basically this core made of the sand or core sand plus binder plus water. And it is positioned at the desired location.

So, this portion of the mould provides the seat for the core. So, this is provided with the help of core print. So, it is important that the size of the core print is sufficient to support the core. Especially under the conditions when there is molten metal. So, when we fill the molten metal into the mould the location, where we have core that is not filled in under that is how it will be leaving the cavity or leaving the core in this position without the metal. And this core is subsequently after the solidification of the casting is taken out. So, when this portion is solidified there will be presence of core, and this core is broken. So that hole desired hole is obtained.

If we see this normally the core is mate of made of the core sand and the density is quite low of the core a sand material as compared to the casting metals. And that is why that the forces act on to the core due to the density difference as per the volume of the metal displaced by the core.

So, the 2 types of the forces are there one is the gravitational force acting on to the core, and another is buoyancy force of the force which is trying to lift the now core in upward direction due to the a density difference because the core is generally lighter than the metal, which is used for the casting and because of this it is required that the core is able to withstand under the forces acting in presence of the molten metal. So, basically if we see this scenario the core is surrounded by molten metal, this is one. So, means it experiences more thermal load more heating as compared to the mould wall.

If we see the mould wall mould wall experiences the heat this heat is exposed to the molten metal from one side only, but in case of the core it is surrounded from all the sides. So, the kind of a heat which is experienced by the core is much severe. So, what we normally say thermal load on the core is much higher as compared to the mould walls. Similarly, the forces which will be acting like the metallostatic pressure experienced by the core, as well as the weight of the core. These 2 in combination when worked together basically there is a lifting of force due to or which is also called buoyancy force, which acts onto the core because of the density difference of the molten metal and the core material.

So, and this is much higher than the kind of a load which is experienced by the walls. So, both mechanical and the thermal load, thermal load experienced by the core is much higher than the mould walls. And therefore, it is required that the core is able to sustain these higher mechanical this mechanical loading as well as thermal loading. And for this purpose a certain properties are expected in the cores so that it can perform the function which is intended.

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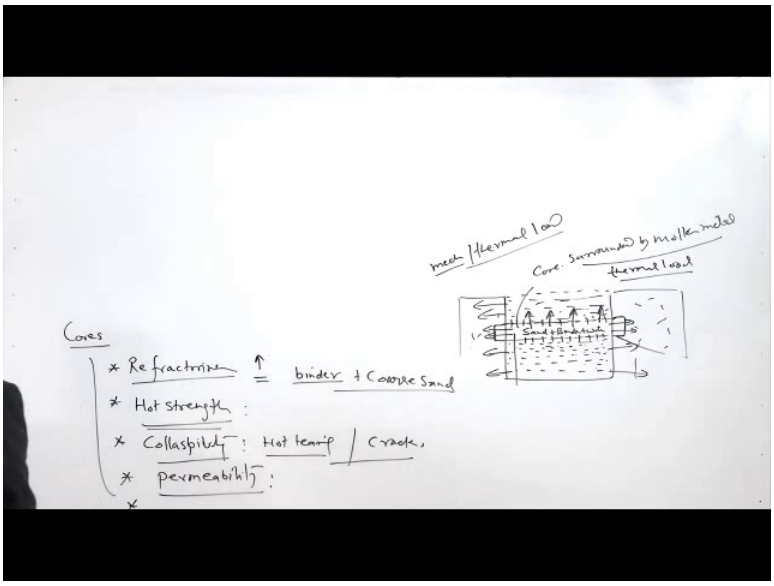

And what these properties are like it should be of the very good refractoriness it. So, refractoriness required in the core is much higher than what is needed for the moulding sand. So, higher refractoriness is needed because it experiences much more thermal loading since it is surrounded by the molten metal.

So, normally for this purpose unique binders not just the clay is used. And the coarse sand grains are used so that the better refractoriness of the core can be really I realized another is hot strength hot strength since the buoyancy force acting on to the core the kind of the mechanical loading which is experienced by the core are much more severe as compared to those which are experienced by the mould walls. And that that is why at high temperature hot strength of the core material must be better than what is there with the moulding sand.

Then collapsibility, collapsibility - collapsibility of the core material is required because after the solidification this core will be experiencing the contraction. Means the molten metal experiences the contraction and which and because of that contraction the core is pressurized from all the sides. So, it is expected that it will collapse under those conditions. And if it does not collapse then it causes the hot tearing or even sometimes the cracks are generated if it does not collapse. Then permeability is another important property required in the core sand material which is used for making the core.

Since in the case of the moulds then there is a lot of area and space through which the gases can escape, but in case of the cores the gases which are produced by the core molten metal interaction and the removal of the moisture from the core. So, these things these gases should get passes enough passes for escaping so that the porosity is not produced due to the presence of these gases. And therefore, the permeability of the core sand must be better than what is there with the moulding sand.

And here there a very limited passage is there for escaping of the gases, because from all around the core is surrounded by the molten metal. So, good permeability is needed then another important property which is required is a friability and crumbling; Friability and crumbling. So, it should break and it should crumble whenever it is required to remove the core from the solidified casting. So, these 2 properties will be helping the breaking of cores. And if it is broken easily for removal of the core then the easy clearance of the core will be possible.

So, removal of the core becomes easier when the friability and the crumblin properties of the core sand is good. So, these are the characteristics which are desired in the core sand which is used for making the core not just for the sand mould not just for the sand moulding, but also for the permanent moulds. So, another important property is that the low emission the gases which are generated by the molten metal core interaction.

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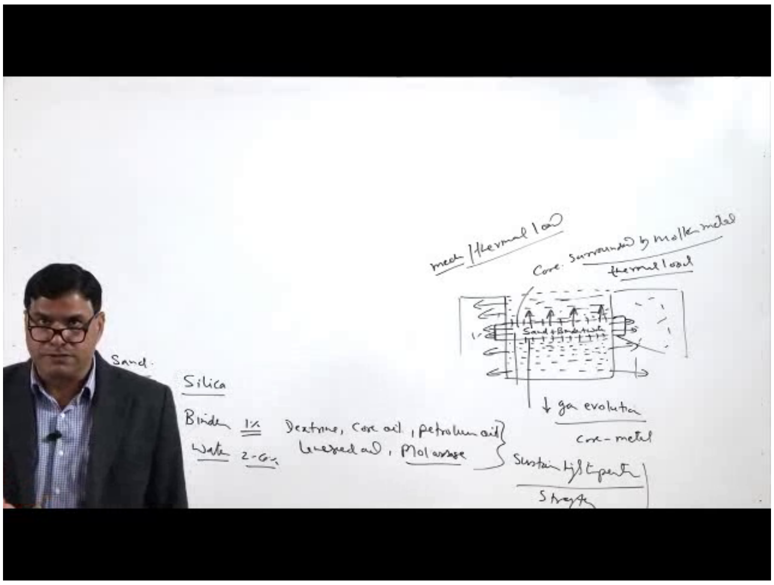

So, the less gas evolution tendency due to the core metal interaction at a high temperature means the core molten metal interactions should generate the as less gases as possible in order to avoid the gaseous defects in the casting.

Now, we will come to the role of the different constituents as I have said, core sand is basically comprises silica sand which is largely free from the clay. And another is the binder and then water. So, these are mixed in different proportions. For example, one about one percent the binder and 2 to 6 percent of the water, and the balance is silica and maybe some additives are also added to achieve the specific a set of the properties. Binders which are used normally they are like dextrin core oil petroleum oil molasses and line seed oil line seed oil and molasses.

So, these are the binders which will be able to sustain high temperature as well as they will provide the desired strength to the cores so that it can effectively sustain the buoyancy force which will be acting on to the core. So, if we will see which type of the core based on the core material or the condition of the core these there are 2 types one is green sand core.

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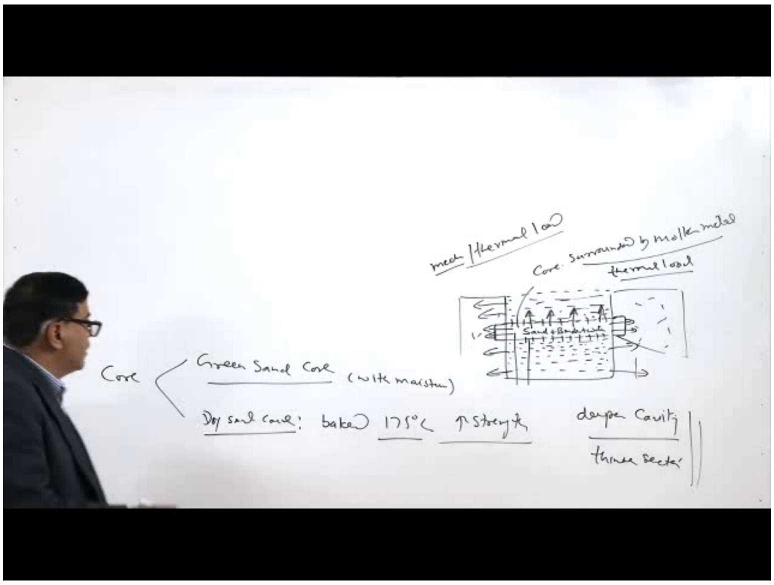

So, this is basically with moisture and another is dry sand core.

So, here since it is with the moisture. So, strength of the green sand core is less and therefore, it cannot be used means it is normally used for producing the shallow features shallow features. Because when the efforts are made for the deeper features you see the cores will have tendency to get break therefore, for the limited depth features are produced with the help of the green sand cores. So, in order to strengthen the green sand cores are baked or heated at 175 degree. So, this helps to increase the strength, and that is how it can be used for making a deeper cavities as well as the thinner sections of the finer sections. Otherwise the green sand core will be breaking down if it is used for the thinner sections, and for the deeper or high aspect ratio the cavities.

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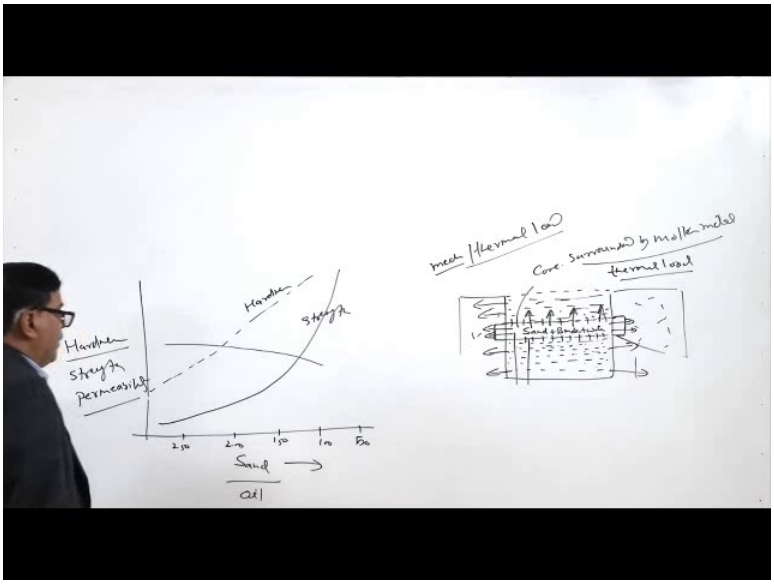

Then there is a typical diagram which shows that How the there will be change in the properties of the core with the change in the ratio of sand and the oil, which is used as a binder in the for making the core. So, like say the ratio is 250, 200, 150, 100 and 50. What it is showing that the amount of the sand is decreasing. And the fraction of the core is increasing and on the y axis we have the properties like permeability strength and the hardness. So, how these 3 will be changing permeable hardness strength and permeability.

So, as we can see with the increasing content of the binder, basically will be a holding the sand grains together firmly and reducing the pores between them. So, basically there is a tendency for little decrease in the porosity, while the hardness continuously increases with the increasing concentration of the binder. And the similar trend is also observed it is not the linear like the hardness, but there is a significant change in the strength with the increase in increase in the fraction of oil, or you can say reducing fraction of the sand to the oil or the binder ratio.

So, as per the requirement of the strength permeability and the hardness, the suitable ratio of the co of the sand and the oil can be used in order to have the properties which are a desire in the core for the desired purpose of strength and the hardness.

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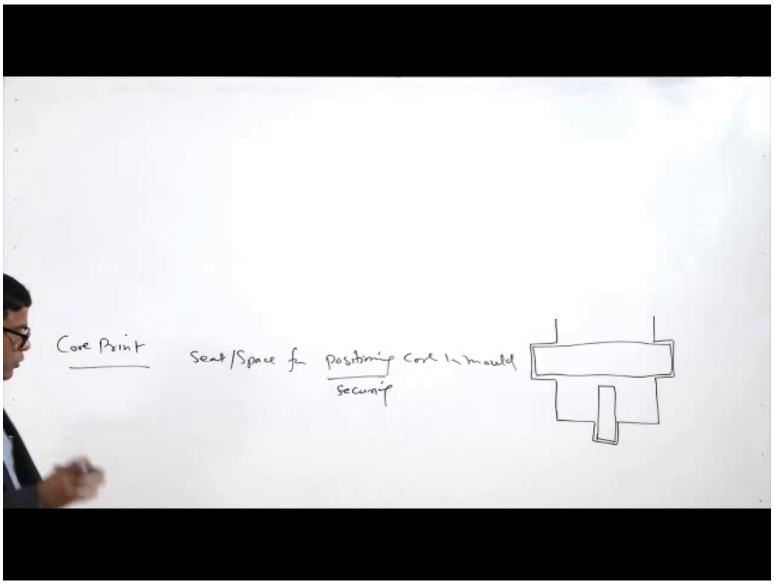

Now we will be talking about the core print. Core print basically it provides the seat or the space. Seat or space for positioning the core in the mould.

So, positioning as well as securing it is to be held properly securing into the moulds. Say so, this is the core print, this is the cavity, this is the core print. So, here this is the location where the core will be placed. So, so when it is placed properly this is one configuration there is there can be another configuration, like this if the core is to be placed vertically. So, the purpose is that the core is placed in such a way that it retains it is position it and it is position is maintained and it also carries the metallostatic pressure without disturbing the position of the metallostatic pressure of the molten metal without disturbing the position of the core.

So, for this purpose what we need that it is not just positions, but also secures the core in it is position and for that it is necessary to consider the forces acting on to the core so that you can identify what size of the core print is to be used.

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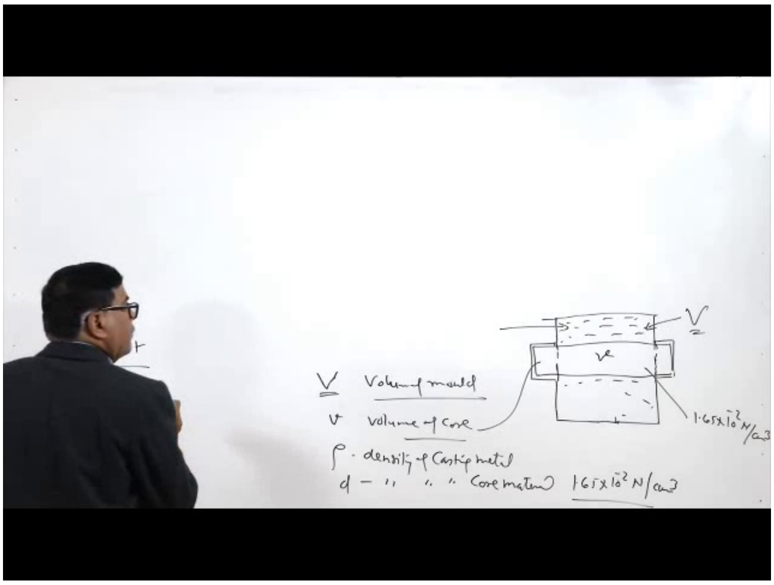

So, considering this example like say the volume of the mould this is the mould basically. And the volume of the mould volume of the mould is v. And the volume of the core so, this is capital v and then we can say small v is the volume of the core which is placed.

So, when the molten metal is filled in the cavity since the molten metal is of the higher density. So, this is what we can raise just to simplify and this is the volume of the core, small v and the capital V for the volume of the mould. So, the buoyancy force due to if the molten metal density is higher than the density of the core, which is normally low and the density of the core is normally considered like 1.65 10 to the power of minus 2 Newton per centimeter cube.

So, this is the typical value of the density of the core. So, if the density of the molten metal is high metal which is being processed forecast by a casting route if that is high. So, rho is the density of the casting metal. And say d is the density of the core material, which is considered to like 1.65 10 to the power minus 2 Newton per centimeter cube. So, to determine the forces since the density of the most of the time density of the molten metal is high. So, the buoyancy force which will be acting in upward direction.

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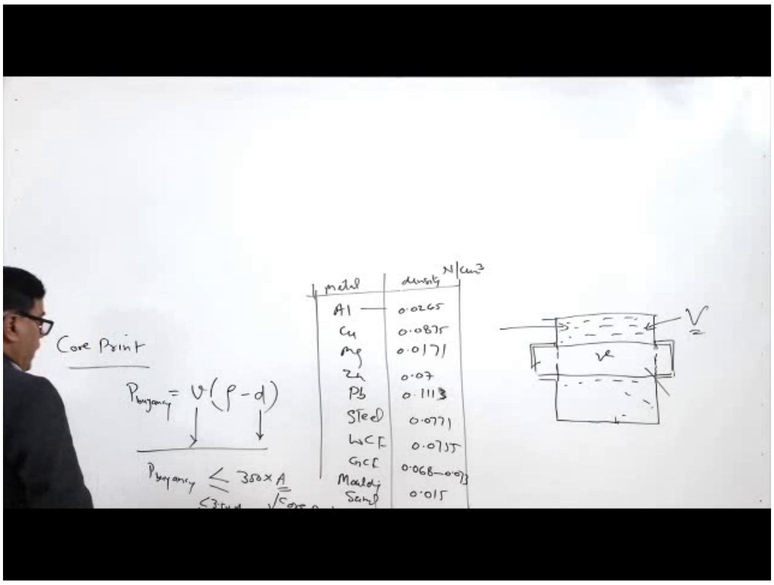

Buy buoyancy force p say will be acting can be determined from the volume of the volume of the core into. So, volume of the core, small v into the density of the molten metal minus density of the sand core, a core sand.

So, this is what is used for determining the buoyancy force which will be acting. So, we know the density of the core sand material from the calculations for such cylindrical shape of the core if the diameter is d and the length is l, which is there in the mould cavity. So, pi by 4 d square l can be used for determining the volume of the core. So, once if you know the volume of the cores and the volume of the a density of the core material to calculate the buoyancy force we just need the density of the casting metal or metal which is being processed by the casting root.

So, the difference in density will be governing for a given core size and for a given cores and material the density of the casting metal will be significantly governing the force which will be acting. So, considering the metal here and the density here Newton per centimeter cube, the density of the metal. So, I will be writing the density of the common metals which are processed say for aluminum it is 0.0265 for copper, 0.0875 for magnesium, 0.0171 for zinc, 0.07 for a lead, 0.1117, oh sorry 3. For steel it is 0 point say carbon steel 0.0771, for white cast iron 0.0755, and for gray cast iron gci it varies over a range like say 0.068 to the 0.073, and for the moulding sand not for the cold sand what for the moulding sand it is of 0.015.

So, this is what can be used for determining the magnitude of the buoyancy force. So, buoyancy force b u y buoyancy force can be determined using this if this buoyancy force comes out to be less than or equal to the 350 into A. A is the core print area. So, here it is in mm square if you want to write that in 70 meter square, then 3.5 into A in centimeter square. So, a basically represents here the core print area. If the core print area as per this is bigger than the value of the buoyancy force that is p.

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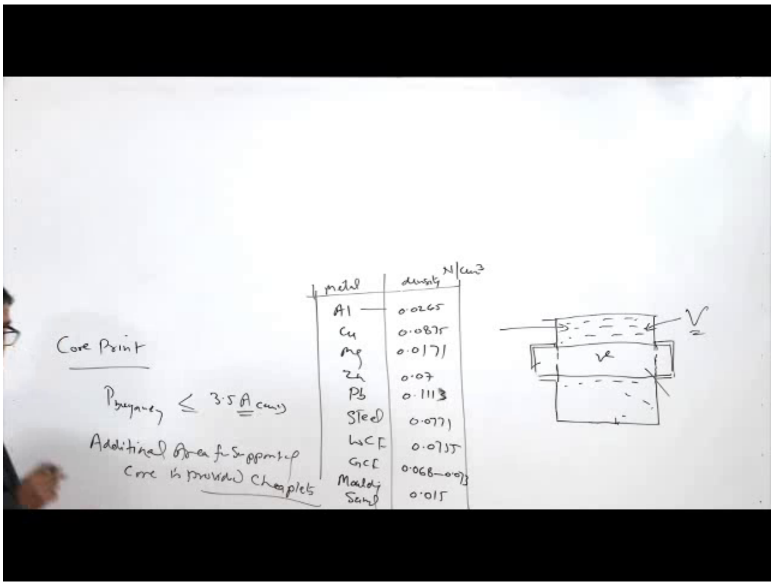

Buoyancy force is less than the 3.5 A in centimeter square then core print area is found to be enough. And if that is not the case then we need to provide the additional area, if this equation is not satisfied then additional area for support of core is provided and for this purpose chaplets are used.

So, chaplets are nothing they are the metallic pieces which are provided in the casting to provide the support so that it can sustain the things effectively, I had to support the core in the mould without getting disturbed in it is position it. So, position is maintained and it is well supported with the help of the chaplets.

So, chaplets are basically.

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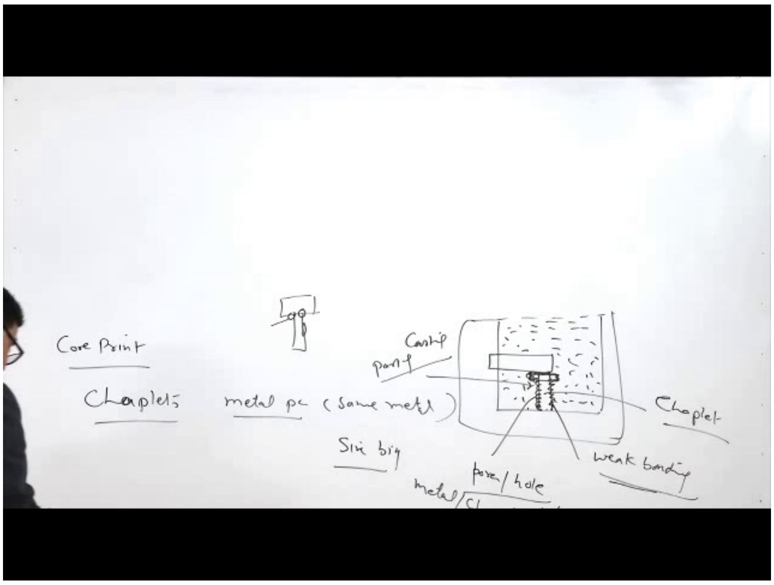

Chaplets these are the metallic pieces most of the time same metal is used for this purpose same as that of the casting. So, if the say this is the mould and the core is positioned in this manner, it is overhanging means the depth of the hole here is partial and this is the core. So, in this case we need to provide support to the core with the help of a chaplets. So, this is the metallic piece which will be used to provide the support to the core.

So, basically this will be coming in contact with the molten metal. Now what is expected from the chaplet? Since the chaplet is providing support to the core to retain it is position and keep it secure in the desired position what is desired chaplet will be providing the support. So, when the chaplet comes in contact since it is of the same metal when it is exposed to the molten metal from all around it is expected that surface of the chaplet will be melted. And will get fused with the molten metal surrounding it. So, one so if this is the situation achieved then it forms the part of the casting.

But for this the skin of the chaplet should get fused properly, otherwise there will be the weak bonding between the metal of the casting and the chaplet and which will weaken the casting as a whole. Therefore, it is desired that the size and the weight of the chaplet is selected properly so that with the heat of the molten metal it is skin is fused and forms the proper metallurgical bond, and it forms the part of the casting effectively. And if that is not achieved if like say the size is big then it will absorb a lot of heat and still you may find that the bonding between the molten metal and the chaplet has not taken place due to the lack of melting of the skin.

And in that case we may find that there are like pores, and the holes at the metal chaplet interface. So, say this is the chaplet and if due to the excessive heat requirement it has not melted then there may be pores and the holes at the metal and the chaplet interface. So, this situation needs to be avoided. So, how do we select the area of the chaplet? Area of the chaplet is selected in such a way that the for that basically we use the same equation, like if there is any unsupported load due to the improper size of the improper size of the chaplet if there is any unsupported load.

So, for this purpose we determine one we use one equation unsupported load if it is there in the situation when the earlier, equation was not satisfied like p is less than and equal to 3.5 A. If this equation is not satisfied in that case like say p is still bigger so that is what that will be the value of unsupported load and for that purpose what we do basically we determine 3.58. So, this difference of this is used for determining the magnitude of the unsupported load. And once this magnitude of the unsupported load is obtained then this is what is their unsupported load of A area. So, this will be in Newton and here it is in 3.5 into A. So, a here is in centimeter square this is equal to. So, we use another empirical equation whatever value of the unsupported load has been obtained.

So, this will be made equal to the basically here it is 29 Ac. Ac is the chaplet area which is desired and this is in mm square. So, 29 is the like the 29 Newton A load is expected to be taken by unit area of the chaplet. So, considering that 29 Ac, Ac is the area of the chaplet which is desired and it is in mm square. So, unsupported load is equated with the 29 multiplied by the ac that is the chaplet area in mm square. So, that is how we can determine the size of the chaplet or the area of the chaplet which is to be used.

So now, here I will summarize this presentation. In this presentation I have talked about the role of the cores different types of the cores, and how do we determine the core print size and what is the role of the chaplets and how the chaplet size can be determined for handling the buoyancy force effectively so that the core can be positioned core can be kept in position for producing the hole and the integral features the desired location.

Thank you for your attention.