Fundamentals of Manufacturing Processes
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Lecture – 15
Casting: Sand Moulding I

Hello, I welcome you all in this presentation. This presentation is related with the topic casting and we will be talking about the different technical aspects related with a Sand Moulding.

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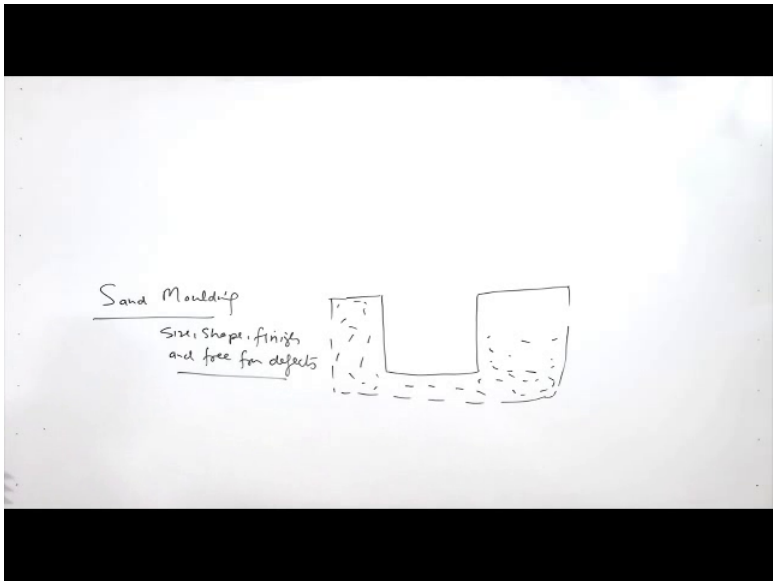

We know that the desired size and shape of the casting, which is free from the defect can be achieved by preparing a mould of the sand is prepared in case of the sand mould casting and it should have, but to have the casting which is free from the defect and is of the desired size, shape, finish, and the desired dimensions. It is necessary that the sand mould is having the certain characteristics and certain properties.

So, what are the properties which are important for making the casting with the desired size, shape, finish, and free from defects. And for this purpose it is required that the moulds have certain properties and the certain characteristics.

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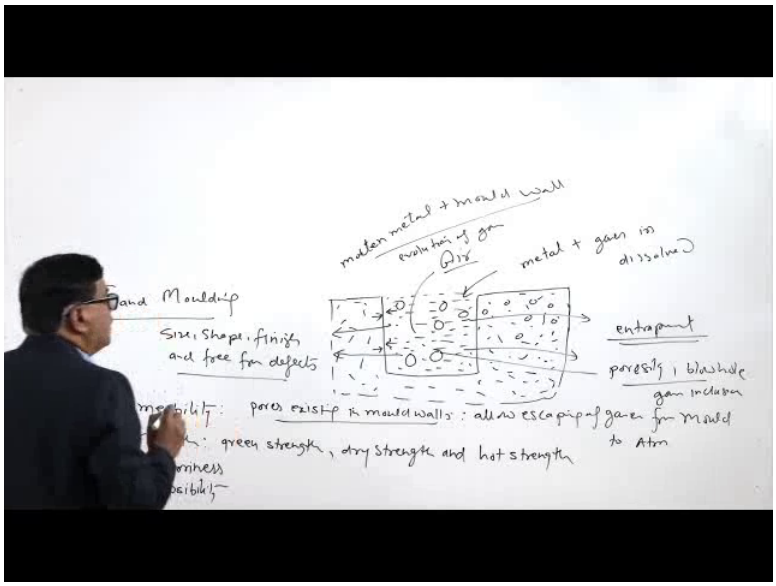

Among these, like say one of the property is one of the characteristic is permeability, another is they are the there are various conditions and under which strength is important. So, under this we have strength of the mould of course, there are different terms which are used it to for defining the strength depending upon the condition of the mould like green strength, dry strength, and each of these strength have has their own purpose and they play a specific role and hot strength.

After this another important property is refractoriness. Then we have collapsibility, so what is the role which is performed by these characteristics and why are these being considered important for making the casting which is of the desired size, finish and free from defects. We know that a permeability; permeability is about the kind of pores or whites, existing in the mould walls. So, through these pores actually allow escaping of gases from the mould to the atmosphere.

So, we know that the when molten metal is poured, into the mould; before pouring there will be air inside the mould. Molten metal being poured will be having the metal plus the gases in dissolved state in the mould. We know that at a high temperature the gases can dissolve into the molten metal. So, the gas is dissolved either in the furnace or while handling, these gases will be present with the molten metal and during this solidification these gases are released or these are rejected.

So, these gases should come out at the same time, the interaction between the molten metal plus mould wall interaction also results the evolution of the gases. So, these gases being generated due to the interaction between the mould and the molten metal these gases also should get space for escaping and these this escaping is facilitated through these pores which are present in the sand mould. So, the gases will be getting the pores or channels for coming out of the mould.

So, if the permeability or which a permeability is the characteristics which permits the escaping of the gases present in the mould due to the variety of regions such as: the atmospheric air or the gases in dissolved state which are released during the solidification or the gas is being generated due to the mould metal reactions. So, these gases must be in position to escape through the proper pores, which are present in the sand mould and if it is not so, then all these gases will have the tendency for entrapment.

So, the gases trapped in the mould wall within the mould will be leading to the presence of these gases in the casting itself. And these gases may be in presence of the fine porosity or big blow holes. These are also termed as gaseous inclusions. So, these are the defects and these presence of these defects make the casting of the lower capability in terms of the ability to take up the load or sensitivity for the corrosion or the increased tendency of the failure during the service.

So, in order to avoid such undesirable features related with the presence of the gases in the casting; it is necessary that the permeability of the mould is quite good then we will come to another important characteristic which is the strength? Strength of the mould is important certainly, because whatever is the shape of the mould that will be retained under the pressure or metal aesthetic pressure of the molten metal. Only, if the mould is of the desired strength and if the mould is not of the desired strength or a proper strength then under the effect of the metal aesthetic pressure the mould walls will be damaged.

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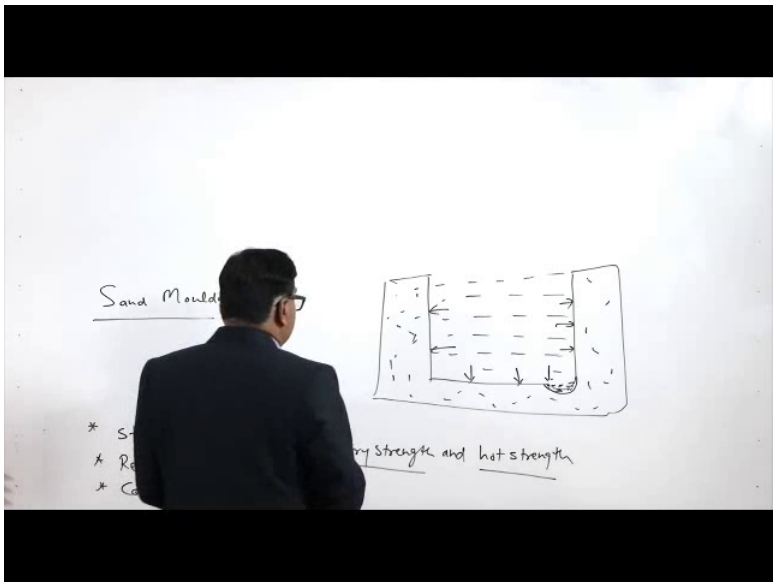

Then this damage can occur in the different forms. So, since this is the molten metal filled in the mould cavity and these are the walls of the sand mould. If the walls of the sand mould are not of the requisite strength, then they will not be able to sustain this metal aesthetic pressure which will be acting on the mould walls. And a under such conditions; there can be shifting of the mould walls or there can be; so this shift or you can say there is a change in position of the mould walls this may be all along one surface or this may be very localized depending upon the geometry and the weakness where does it exist.

So, if this zone is a poor in the in terms of the strength, then the settling of the shifting of the mould wall will be occurring and in this region and this will be changing the shape of the casting, but the under, what conditions strength of the mould is checked as per the condition. So, whenever we make the mould of the sand using like say: sand plus moisture plus clay.

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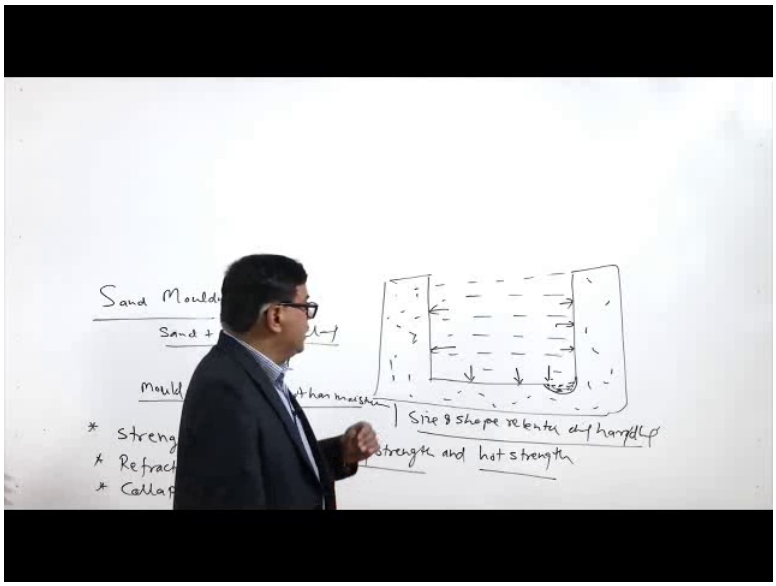

These are the three important ingredients plus a small amount of the other ingredients are also added. In order to have the desired characteristics which are specific in nature.

So, when you see this a moisture sand and the clay are mixed and then mould is made. So, just after its preparation the mould whatever strength it is there means the mould strength of the mould strength when it has moisture at that state the strength of the mould is termed as green strength. So, green strength you see we have just prepared a mould of the sand of the moulding sand and it has a lot of moisture. So, in that case the strength of the mould metals, primarily for the size and shape retention during the handling.

So, freshly prepared mould walls should not get damaged during the handling. As well as the strength of the mould also this green strength of the mould also matters when the mould is used directly for pouring the molten metal means.

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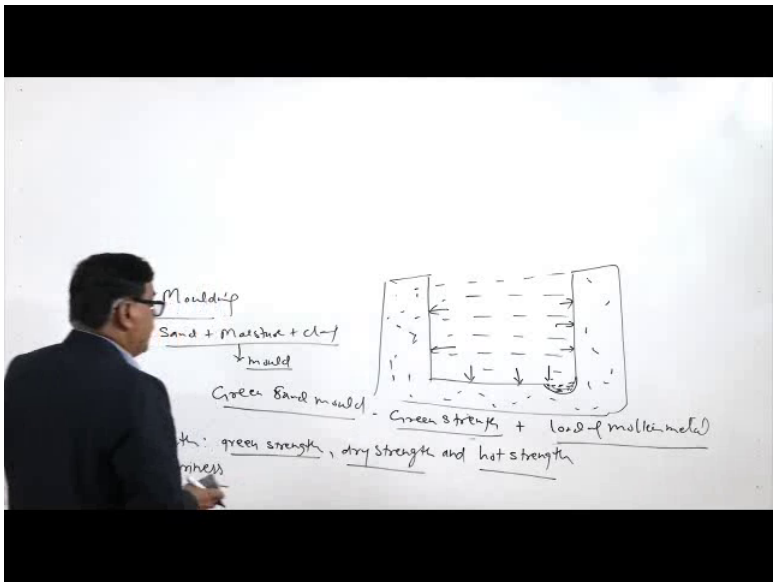

The green sand mould is poured with the molten metal directly without permitting the baking or removal of the moisture. So, in that case we freshly prepared mould is poured with the molten metal directly and after the solidification we get the casting.

So, in that situation the green strength becomes important just not just from the size and shape retention point of view, but it should also carry the load of the molten metal. So, the green strength of the mould becomes important in that case. So, green strength of the mould is the, strength of the mould when it has moisture and it is important for the two situations: one to retain the size and shape. When the moisture is present one and two: when and the retention of the size and shape especially; when the molten metal is to be poured into the mould.

So, it is also required that the mould wall should not just retain their size and shape of by on its own weight during the handling, but they should also take the load of the molten metal effectively. Another important condition in which strength is checked is the dry strength.

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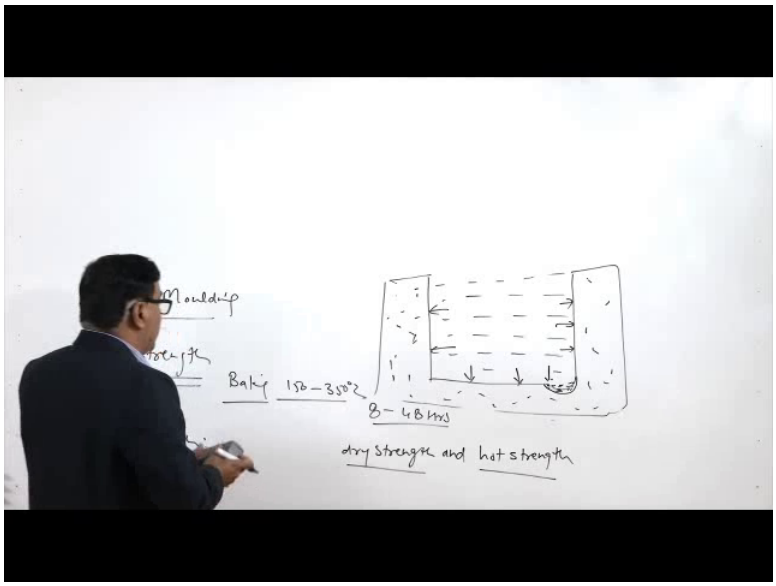

So, since the green strength becomes quite low, for taking the weight of the molten metal especially in case of the large casting.

So, it becomes important that the strength of the mould is increased. And for that purpose normally; the baking of the green sand mould is done in the range of 150 to 350 degree centigrade for 8 to 48 hours. So, purpose of this is that all the moisture is driven off and strength is increased. Once the strength is increased it can take the load of the molten metal especially in case of the large castings effectively, but this process is long.

So, the strength of the mould under the conditions when there is no moisture or moisture has been driven off at that state strength of the mould is termed as dry strength hot strength of the mould is also important because and let us understand, what is the hot strength?

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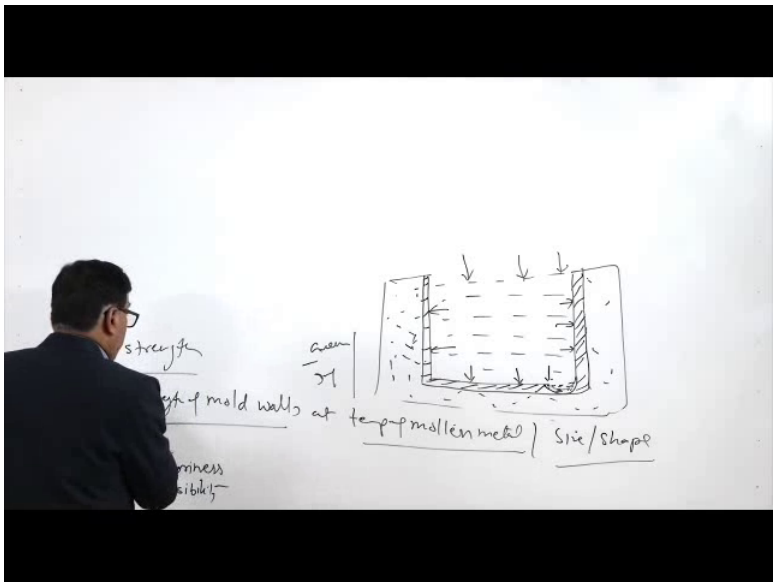

We know that whenever any mould is prepared, whether it is green or it is dry; means the green is mould when the moisture is present and dry mould when moisture has been driven off.

So, means the mould is not having any moisture, but when the molten metal is poured into the mould, the temperature of a scheme of the mould will be increasing up to the temperature of the molten metal. So basically the mould wall temperature rises up to the temperature of the molten metal. So, at that strength of the mould actually matters for carrying the weight of the molten metal.

So, strength of the mould walls at the temperature of molten metal. Actually is important for carrying the weight of the molten metal, because in any way whether it is green strength or the dry strength when the molten metal is pour there a rise in temperature of the mould wall and at that state, what is the strength of the mould? That is actually important for retention of the size and shape of the mould. So, hot strength is important and sometimes a special ingredients are added; for increasing the hot strength of the mould.

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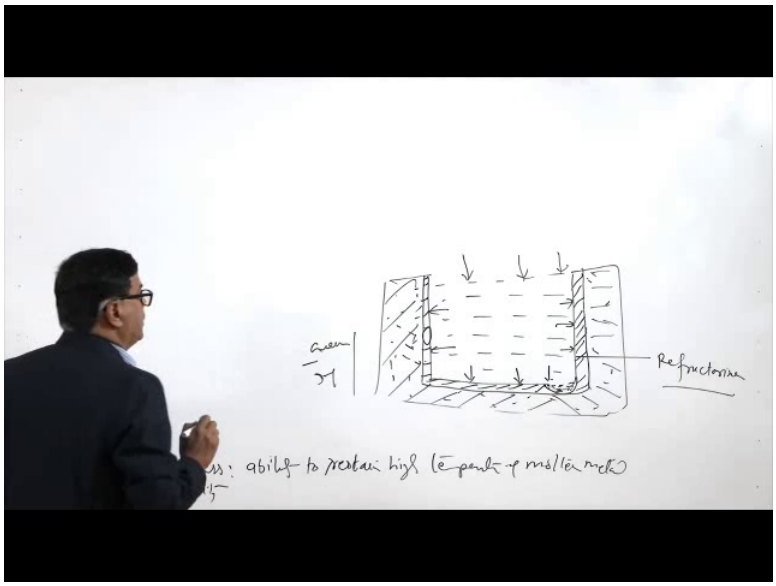

Refractoriness of the mould is about the ability to sustain high temperature of the molten metal.

And if say this is the mould prepared of the sand and if the skin of the mould or of the mould sand mould does not have required refractoriness, in that case it will start fusing as soon as it comes in contact of the molten metal. So, this fusion can be avoided only if the sand mould is of the required is having required a refractoriness means it can sustain the high temperature without getting fused with the molten metal.

Because; once the fusion of the molten a mould wall starts then it will form the part of the casting and the shape of the casting will also get modified. So, this is consider this will be a situation of the wastage of the material as well as the change in shape of the casting. So, it is necessary that refract the mould is having the required a refractoriness and it it depends upon the number of factors like the type of clay has been selected the size of the sand grains which are there and the temperature of the molten metal.

So, we need to see that there is a proper compatibility in terms of the refractoriness between the molten metal being used for a casting as well as the refractoriness of the mould. Another important factor is the collapsibility. So, collapsibility we know that of this collapsibility is important.

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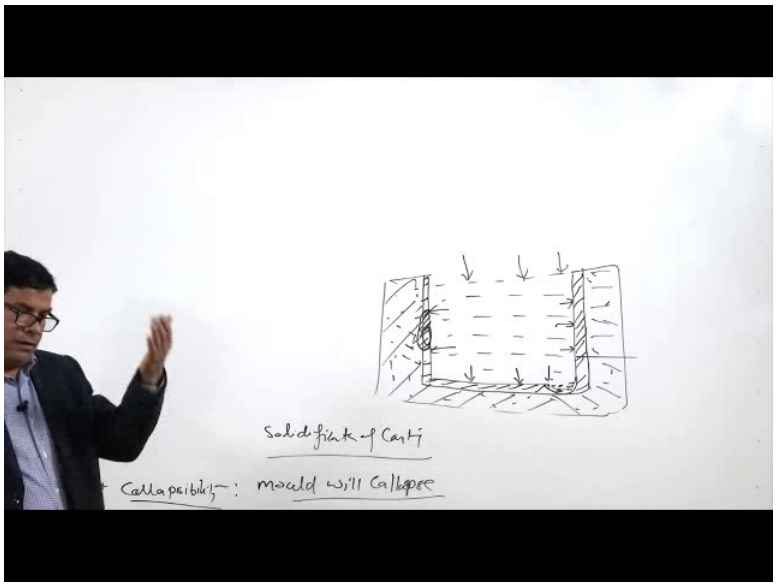

At this after the solidification of the casting, what we know that? According to this property what we expect that the mould will collapse or it will be crushed collapse. So, ability to get collapsed under either the residual stresses or externally applied stresses the mould should get collapsed. So, that it eases out the residual stresses which are being developed due to the contraction and the casting is taken out of the mould easily after the collapse.

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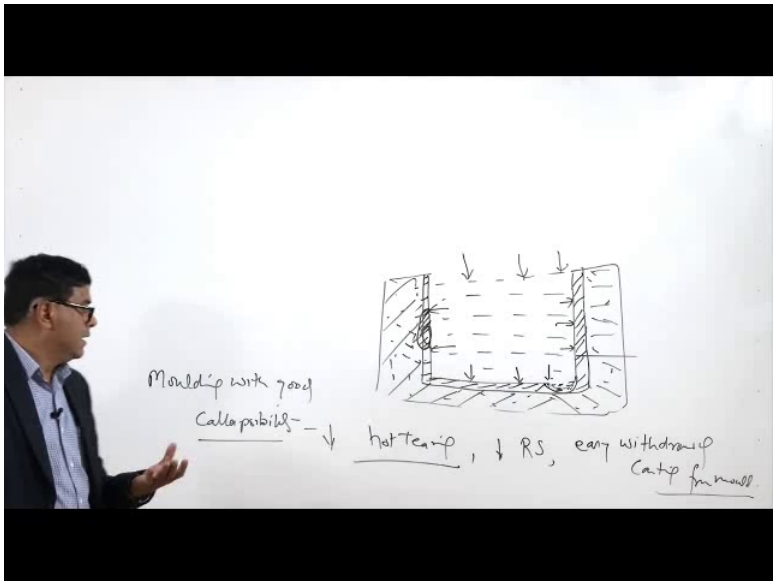

So, the moulding sand with the good collapsibility reduces the chances of the hot tearing, because and during the contraction of the casting the mould will collapse and it will. So, that it will reduce the chances of the hot tearing as well as it will also reduce the tendency for the development of the residual stresses and it will facilitate the easy withdrawal of casting from the mould.

So this is what is facilitated in the collapsibility is good sometimes like sawdust is added in the moulding sand. So, it becomes collapsible because is a sawdust will be worn out at a high temperature as soon as it comes in contact of the hot a high temperature molten metal. So, these are some of the properties, which are important for the sand malt in order to prepare the castings which are free from the defects and they are of the required size and shape.

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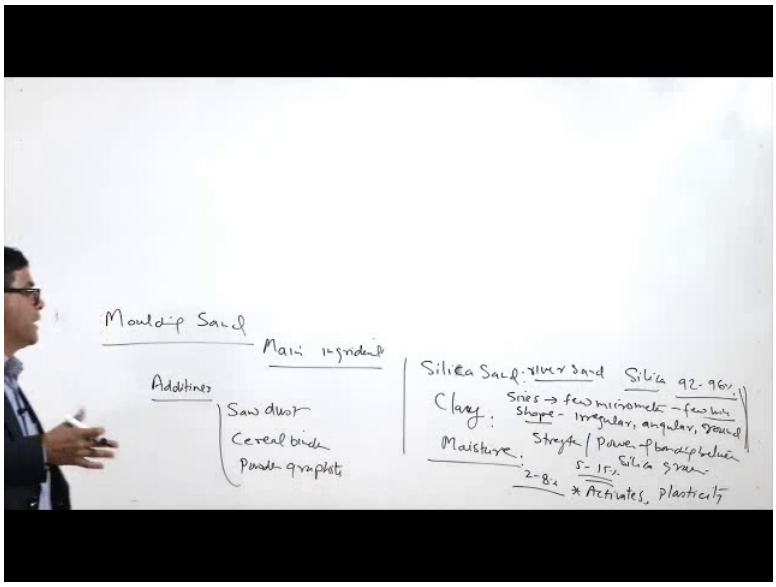

So, now we will be seeing that what are the important constituents like moulding sand; what are the constituents of the moulding sand? So, basically there are three important ingredients besides some additives. So, main ingredients are like a silica sand or the sand then clay and moisture. These are the main ingredients for the moulding sand and apart from that there are some additives. Additives are used to increase the specific characteristics; like this may be like a saw, dust, cereal, binder and the powdered graphite.

So, these are for a some specific characteristics about which we will talk later on. So, basically a silica sand this is you can say the river sand, which has the silica of 90 to 96 percent normally; and this has a variety of the sizes. So, the size may range from like say few micrometer to few millimeter and these are present in variety of the shapes. So, both these characteristics are important from the moulding properties point of view.

So, shapes may be very irregular just like this or very angular round like this these are the some of the shapes and these characteristics affect the number of properties related with the a sand mould among the clay I will talk about the sand and the way the properties which are affected by the a silica sand and then coming to the clay provides the clay provides the required strength for power of bonding between a silica grains it also. So, this is what is their bonding and moisture this clay can be added is from like say 5 to 15 percent. And the moisture is normally added 2 to 8 percent for the two purposes.

One it activates the clay for the bonding purpose and it offers the required. So, that the activation of the clay results in the proper bonding and when the washer is added appropriately it results in the desired plasticity to the sand moulds. So, that desired complicated shapes can also be realized through the through the addition of these ingredients coming to the different characteristics related with the related with these ingredients. So, like the size of the sand particles.

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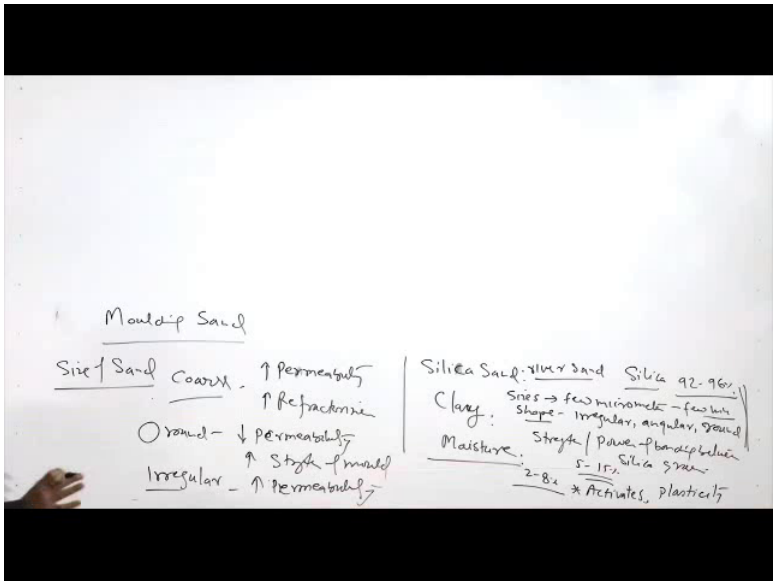

So, if the size or like, coarse sand particles results in the increased permeability, increased refractoriness, ability to sustain high temperature is good and both these are adversely affected with the fine size particles. Similarly, the angular round particles round particles they reduce permeability, but increase the strength of the mould, but irregular shape particles results in the increased permeability. So, the round particles are round; then permeability is reduced because the particles get back get packed during the moulding effectively which reduces the pore sand which in turn reduces the permeability.

But the increased packing and the closer contact between the different sand grains results in the increased strength. A irregular shape particles will be leading lot of whites and a spaces between the sand grains during the mouldings, which will be leading to the increased permeability between the increased permeability of the mould. Coming to the clay; clay is added as I have mentioned 5 to 10 percent.

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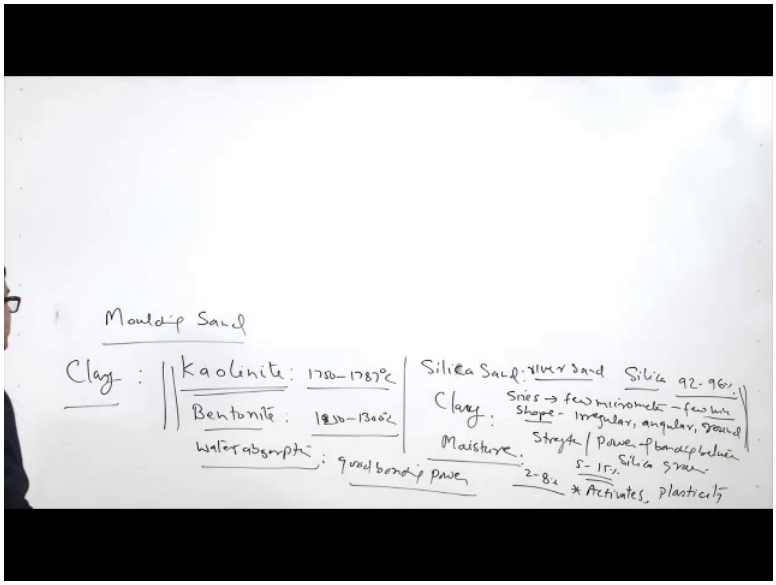

So, they are two types of the clay: one is kaolinite this is a one of the binders which has good refractoriness of like say 1750 to 1787 degree centigrade. The temperature range in which it can sustain this is the melting point above which it will be adversely affecting the mould sand properties. And another very commonly used is bentonite clay and it is of the low melting point. So, like melting point is like 250 to 13000 degree centigrade.

So, for most of the low temperature metal systems bentonite is preferred, and while for the high temperature systems or high temperature metal of the casting and the kaolinite is

preferred. The water absorption capacity of the bentonite is much better as then the kaolinite. So, this results in the good bonding power for the moulding sand that is why the bentonite is preferred over the kaoli kaolinite for the low temperature casting systems or metal casting.

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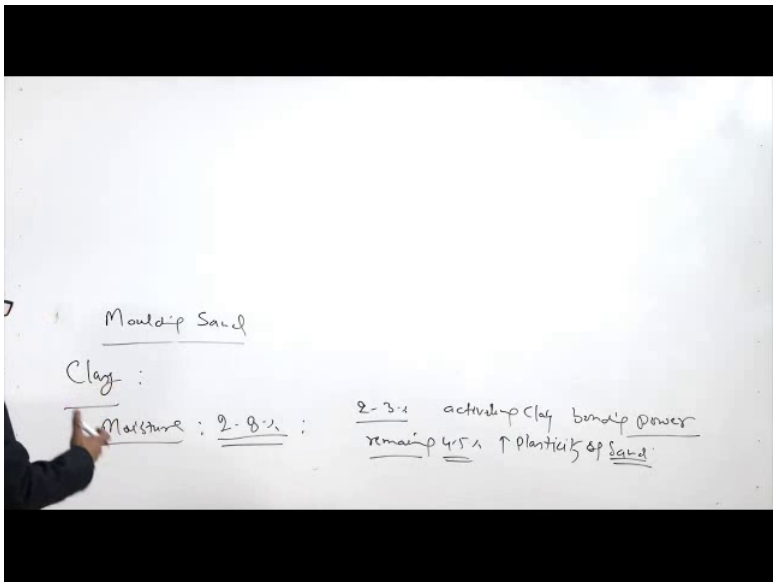

Coming to the moisture that is, another important thing so, as I have told it is a 2 to 8 percent moisture is added and about 2 to 3 percent actually moisture is needed for activating the clay. So, that desired bonding power can be realized for having the good strength and for the rest of the water remaining water up to limited amount like say remaining 4 to 5 percent is that is 4 to 5 percent helps in a increasing the plasticity of the sand mould of the moulding sand of the sand. So, that the sand follows the curve or the geometry of the pattern in order to achieve the fine integrate shapes which are desired in the casting.

So, plasticity in that way is important for realizing the shape in the mould cavity. So, here, now I will summarize this presentation. In this presentation basically, I have talked about the characteristics which are desired in the sand mould and the important ingredients of the sand a moulding sand and the way by which these ingredients affect the moulding sand mould characteristics.

Thank you for your attention.