Theory of Production Processes
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Lecture - 10
Coremaking: Properties and types of cores

Welcome to the lecture on core making. So, in this lecture we will discuss about the properties of core making sands and the types of different types of cores. So, as we know that we use the cores for making the cavities inside the casting, many a times in the casting you have the cavities and cavities are either generated by machining or it can be made. So, for machining you have to take the casting out and put it on a machine and then further you have to machine it. So, this is the additional you know activity which has to be performed. So, for easing that in the casting you have the provision that you put the sand at that place, in certain form that is cores and that basically that place will not be occupied by the metal so the, you will have the cavity.

So, normally whenever you have. So, normally in general you have the cylindrical holes which are there or any kind of recesses are there which are to be formed, you can use the cores. So, as it is shown that they are the materials which are used for making cavities and internal features which cannot be produced by the pattern alone. So, it is not possible by giving that geometry to the pattern or big by giving the pattern any shape. So, that you can get those kind of cavities, that is why you make the cores.

Cores are generally made of sand and are even used in permanent molds. So, normally you have the core which is made of sand and that is known as core sand. So, they are same sand as a silica sand, you can use the different kind of binders and as we know that these cores are basically subjected to more severe thermal conditions as compared to the molding sand. So, core sand has to be more pure, it has to have more defectryness also it has to have more better property then the normal welding molding sand which we use for casting.

It is even used in the case of permanent molds; so in case of permanent mold as we know that you have 2 dyes. So, the dyes will be closed then you will have solidification process finished and then every time you have to take the core out. So, core can be used even in case of permanent molds. So, as we discussed that normally it is surrounded on

all sides by the melt. So, subjected to much more severe thermal and mechanical conditions you have stresses also acting upon them. So, it should have better strength than the normal molding sand core making practice.

So, what how the core making is done in the foundry industry so for that normally we have the core boxes. So, core normally, core making is a separate section apart from the pattern making section you have a core making section where the cores are made. So, in that again we use the patterns. So, pattern will be placed over the cover box filled with sand inverted and baked and then these you will again use these sands for making this cores.

Core boxes are normally made of aluminium and then you provide the vent holes so that there is enough you know permeability, then you may use the reinforcing wires also for making these cores because for the cores you need to have quite a good strength because it is subjected to the thermal and mechanical you know stress conditions, stress states. So, the core need to be very strong because it will be from all the sides it will have the pressure of the metal working on it. So, that is how the core has to be having quite good strength.

Now, when we make the cores, so as we discussed we have the cores sand then we used the binders you have binders used for making cores. So, normally binders are the organic based binders and then once we put the binders then we are going to bake it. So, baking will be carried out normally close to 650 Fahrenheit and during the baking as the temperature goes up the polymerization process occurs and the strengthening develops. So, there is bonding develops between the cores and grains because there is binder. So, the strength is developed and that strength is quite high.

So, once we have the core baking carried out, the core will be basically ready for placing as far as the strength is concerned, but then we go for finishing of the cores means in the finishing stage we have to see that it is properly cleaned, we have to take the external surface of the core clean. So, that it does not have any impression on the side if where it is in contact with the liquid metal, it has to be sized properly, it should not be over sized or under sized because that impression you know the same impression will be on the casting dimension also, so or the dimension of the hole also.

So, you have to have the proper sizing core assembly means you have to put the core, you have to keep you know core has to be kept at the proper place then you have to see that, I mean you have to the core has to be you know tied. So, that those things are there in that then you have to inspect that cores are, cores is in every aspect cores are fine you have to inspect that this all this process is going in a good way.

Then core setting. So, core setting means you have to see that cores core is properly positioned to its place and in that basically the we have to see that proper on both side its sitting is on that using the core print that is basically with the use of pattern and on the top and bottom side we use the chaplets. So, the chaplets basically prevented them to dislocate from its position because of wind forces. So, we use the chaplets and all the core print is that space where which you get b by giving that elements in the pattern itself, but the chaplets basically are in touch with the core and they will be normally a part of the casting itself.

So, chaplets are made of the same material as that of the core, I mean the as that of the cast metal. So, you have to have the chaplets you should use the chaplets of such dimension where you should ensure that this chaplets will basically fuse with the liquid metal. So, if they do not fuse properly that is basically a source of you know defect in the case of cores. So, this core setting is that we important.

And then core knockout. So, once your solidification process is over in that case you have to remove the cores. So, cores will have some properties by which you should able be able to easily knock it out. So, you should be able to remove it with ease, otherwise if it is not easily removable, if it is gets stuck or if it is sticking to the cast surface and you have to hammer it hard or it has certain properties because of which during the casting solidification itself it does not try to have any compromise or it does not have proper collapsibility, in that case it can create the tear kind of you know phenomenon.

So, core knockout is done basically in the end of solidification, now what are the desired characteristics of a core.

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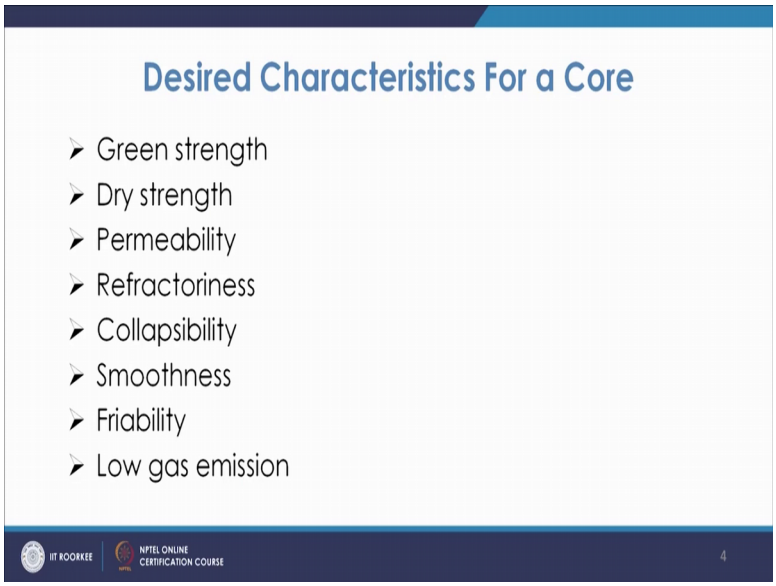

So, what we discussed, the desired characteristics of a core is that first up all it should have a good green strength, green strength means when we are making the core we have used the cores sand binder additives and yet it has to have its shape to and it should be able to withstand in that shape when we are going to bake it. So, we have to we have to send it. So, that way at that time you need it need certain strength that strength is known as green strength because it is still in the moist state or it has moisture in it.

Then you have dry strength. So, the strength which it develops after baking it or drying it so in the dry state whatever strength you develop it must have the state to withstand the pressure of the metal when the metal is coming into the cavity and it is on the sides of the cores. So, that is known as dry strength. Then permeability, so as we know that cores must have a good permeability because the core when it will be in touch with the liquid metal, in the liquid metal will be enveloping it.

So, in that case certainly there are gases evolved in this gases this would be able to you know permit through the core. So, you will have a surface from where the gases will escape. So, it must have enough permeability refractoriness as we discussed that since it is in touch with the liquid metal which is at very high temperature. So, you should see that it should not fuse, it fuses in that case it will have a undesirable and undesirable appearance at the casting surface. So, you will have a glassy kind of surface, you will

have fused surfaces, fused sand or any grain at the surface of the casting which will make the surface of the casting rough.

So, that may lead to the rejection of the casting, you have next properties collapsibility. So, collapsibility as we know that this is related to the expansion properties of the sand. So, when the, you know metal goes into the cavity and it envelops the cores are they subjected to. So, cores are when in touch with this molten metal in that case initially they will expand and then they have to contract as solidification goes away. So, that way the core also has to adapt to that condition and in that case it should you know withstand or it should support that.

So, that is done by having these property known as collapsibility. So, that is because that is achieved by having certain additives which give this collapsibility properties so this way. Then another is smoothness, smoothness means the surface should be smooth you must use such kind of ingredients because of which the surface will be smooth. So, once the surface will be smooth then only the casting surface will also be smooth.

So, that is how you can ensure that the interface between the core surface and the metal surface must be smooth. So, you will get you will have, you know I been ease in getting a surface of good finish. So, the finish allowance will be less in that case, friability is the property which can be defined as the property of crumbling easily. So, it is like when we are basically removing the codes knock out by hammering or so at that time it should easily be you know crumble, easily crumble. So, that you know it does not stick or you have not to hammer it repeatedly or with higher forces.

So, in that case this property is known as friability, then you have low gas emission. So, this low gas emission is important because if the gas emission will be more and if the permeability is not that much enough that will lead to the gaseous kind of defects. So, in that case, in the case of a the cores this is very important that your gases emission should be minimum. So, for that the proper ingredients should be selected the sand or binders should be selected in such a manner that basically the gas emission should be minimum.

So, these are the normal desired characteristics of a core. So, that you whenever you use the core you can be ensured yourself that this core is going to give the you know internal details in a proper way. Otherwise, you may have some of the strength related issues are there then it may break, refractoriness is poor means it may there may be fusion at the

surface. Collapsibility will be poor that may lead to hot air kind of defects, the smoothness will be less means you will have rough surfaces friability is more means while hammering it will not be hammer it will lead damage to the casting.

So, similarly you have, if the gas emission is more it may lead to gaseous kind of defects. So, these are the desired characteristics of a core.

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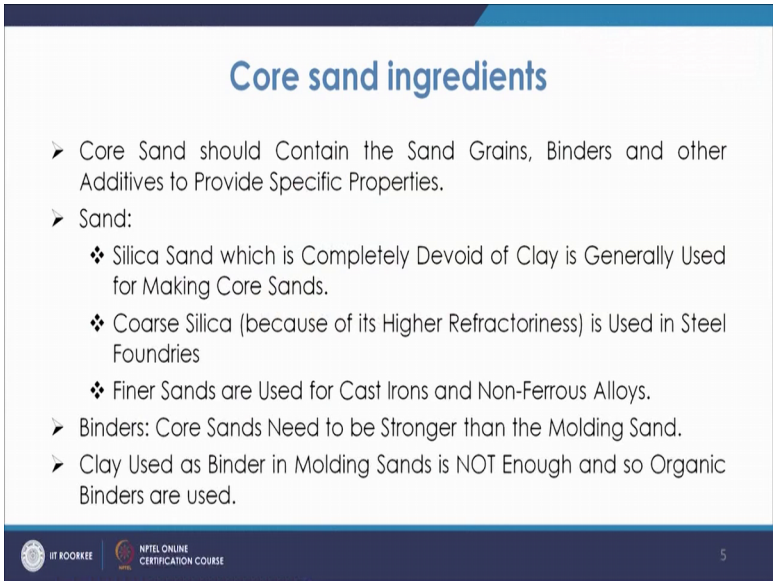

Next we will discuss about the core sand ingredients. So, as you see the core sand they contain the sand grains, binders and other additives to provide the specific properties.

So, you have as we know that in normally we have the core sand will be there, that is sand if it is there you have a binder to bind the sand grains and you have the additives to give the specific properties. The sand which we use as we discussed earlier it should be you know free of clay, there is you know reason for that because the in the presence of silica increases the amount of binder used, we use normally the organic based binders and if the silica is more than it will use the increase the consumption of binder also silica in the presence of this clay that, because clay has not that much of high refractoriness.

So, that also in that way also it is not advisable, as far as the size of the sand grains are concerned it has been seen that the cores grains have higher refractoriness. So, whenever you go for the steel foundries, in the steel foundries you have the temperatures higher as

we know that the melting temperature for steel it will be more as compared to the non ferrous materials or even cast irons.

So, core silica sand will be used for steel foundries and the final silica sands will be used for cast iron and non ferrous alloys because of the difference in the melting temperature between the 2 binders. So, we need the binders in such a way that it should provide us they good bounding for that because it has to be stronger than even the molding sand. So, you need a good binder.

Now, that is the clay will not be even very much suitable because it will not provide enough strength as a binder. So, that is why we use the organic binders in the case of making cores. So, the normally used binders which are used in the case of cores are linseed oil, core oil, resins the dextrin molasses these are the normal binders which are used you have binders as well as additives.

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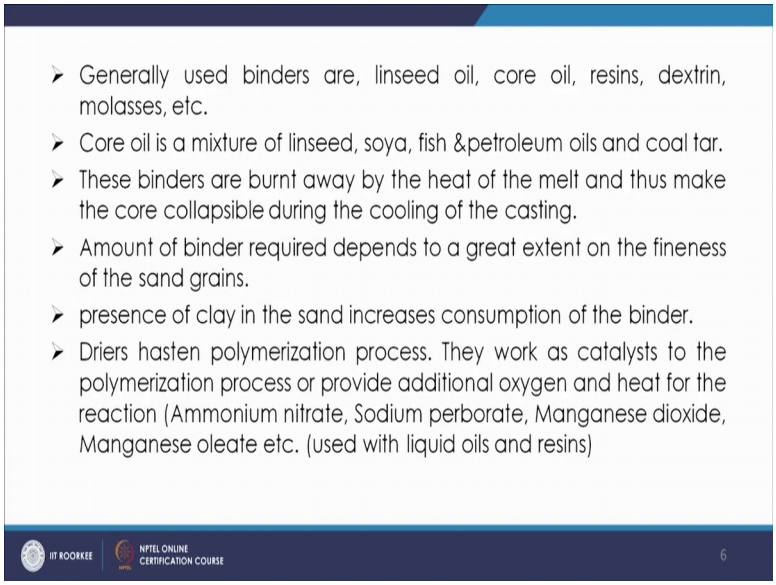

Also in that now core oil is a mixture of linseed soya, fish and petroleum oils and coal tar. So, that is core oil and these binders basically what happens they are burnt away by the heat of the melt and then once they burn then basically they provide the space and in that case they make the core collapsible during the cooling of the casting.

So, that is how collapsibility is also imparted into the casting, now amount of binder which is required it will be depending upon the fineness of the sand grains. So, sand

grains as we know you will have the different level of fineness you may have core sand or you may have fine sand and the amount of binder which will be required will depending upon whether you have core sand or the fine sand.

Also we discussed that you have if they have the presence of clay in the sand it will increase the consumption of the binder. So, that way the clay should be minimum, now you have dryers. So, that basically hastened the polymerization process. So, because once you have the organic binder used and then that the strength develops because of the reaction, chemical reaction at higher temperature where the polymerization takes place.

So, for that you use the dryers which work as the catalyst. So, they provide the additional oxygen and heat for the reaction. So, for that the once we use these catalysts like ammonium nitrate or sodium carborate, manganese dioxide or manganese oleate. So, they are basic used with liquid oil and resins and then they are basically increasing our work as catalyst which enhance the rate at which this hardening takes place. So, that is how we ensure that quickly your core is harder and you further use them.

These are the different kinds of you know additives.

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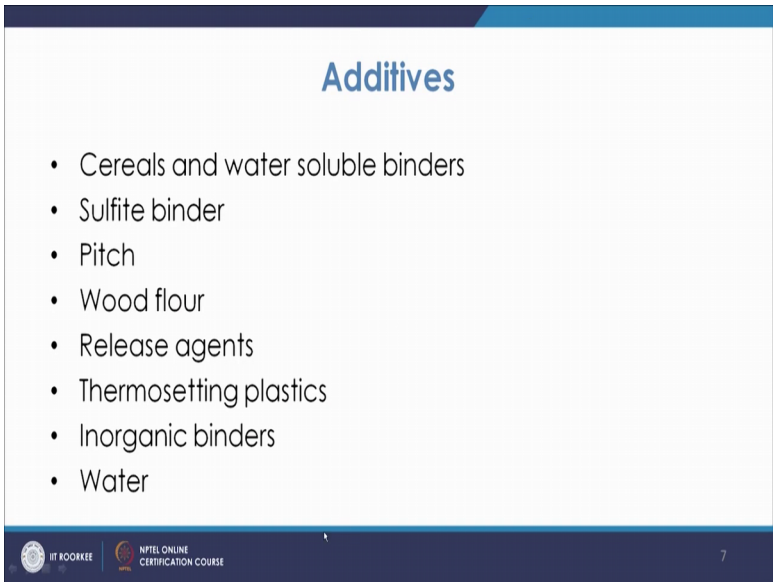

So, additives as we know, you have to have a use these additives for providing the actually specific properties. So, like you have cereals. So, they are used for giving the green strength. So, these cereals which are used they will be used as the green strength in

the core because before you go for baking it must have sufficient strength to retain its shape. So, that strength is basically imparted by the use of these cereals, you have the sulfite binder which is basically they provide the strength on evaporation of water.

So, they basically give very high surface hardness of you know during the baking. So, that is how these sulfite binders are used, you use this pitch, the pitch is used for giving a very hot strength so hot strength will be increased by the use of this pitch. Now, this wood floor the, if the wood floor is used it is used close to one percent or so, and if you use the wood floor they will be increasing the collapsibility of the you know core you have the use of even the release agents.

So, certain some hydrocarbons are used as release agents and basically they are used for so that the sand does not stick to the boxes. So, for that these release agents are so are used. So, basically different kinds of waxes silicones also used because when we have the core in the core box we are taking out at that time the surface may stick. So, you have the plastic polymers or so. So, for that we use these release agents. So, that they are not sticking we also use these thermosetting plastics basically for phenol formaldehyde we are using as the binder. So, when it is used as binder and when the temperature rises then about 200 to 400 fahrenheit of temperature at that temperature due to polymerization the strength develops.

So, that is how the strength develops in the case of these, now we also use certain inorganic binders like clays montmorillonite group of clays, silica flowed then you also use the iron oxide these are the ones which you use basically they are used for some specific purpose in some cases for hot sand development, for some cases green sand development or so and certainly some water is there as.

So, that will be as part of the binder. So, that water is used also in the case of these core making practice because normally about 2.5 to 7 percent of water is required and the green strength is basically developed. So, this is the use of water in the case of this core making. So, these are the normal additives which are used for the core making.

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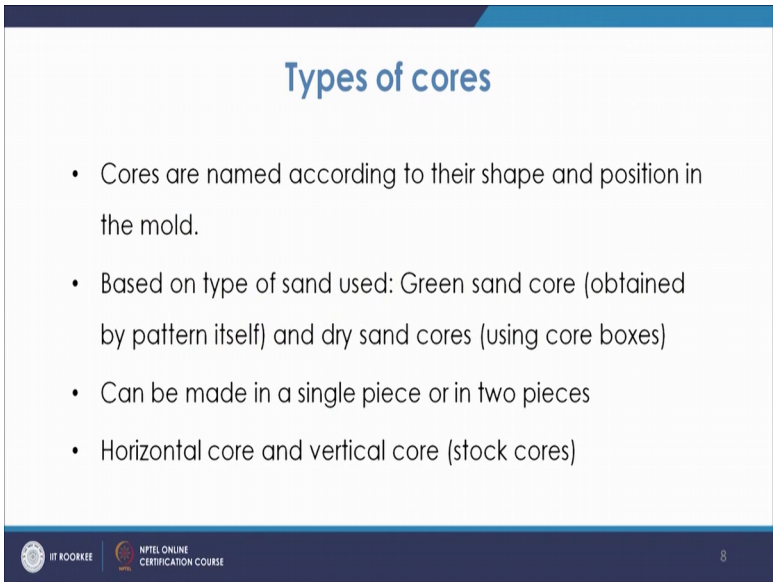

Now, next we will discuss about the different types of cores, what are the different kinds of cores which are used. Now, cores are basically named according to the shape and position in the mold. So, how what kind of shape is there, how they are used in the mold itself. So, that is how the cores are of different types. So, first up all we have type of sand used you will may have green sand core. So, obtained by the pattern itself and dry sand core that is using the core boxes. So, that you have the 2 kinds of cores, then you may have core made in single piece or in 2 pieces then you join them you paste them. So, that is also how the cores are made the horizontal core or vertical core.

So, that basically depending upon how you have positioned it inside the mold cavity, if you have kept it horizontally parallel to the parting line that is horizontal core, if you are keeping perpendicular to the parting line that is vertical core. So, you may have will see the how it looks like this horizontal and vertical core they are also known as a stock core because normally we have the use of either horizontal core or vertical core. So, we keep as a stock in the foundrys so we call it them as stock cores.

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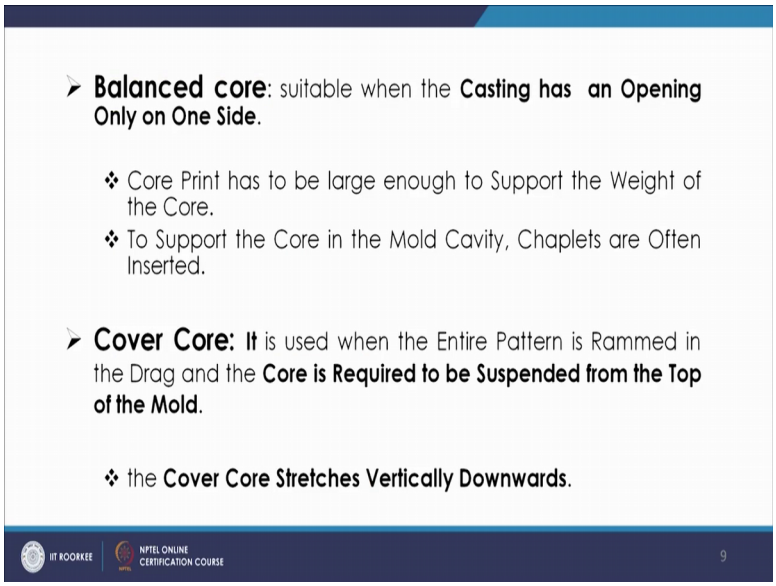

Now, depending upon the different type of shapes you have the balanced core.

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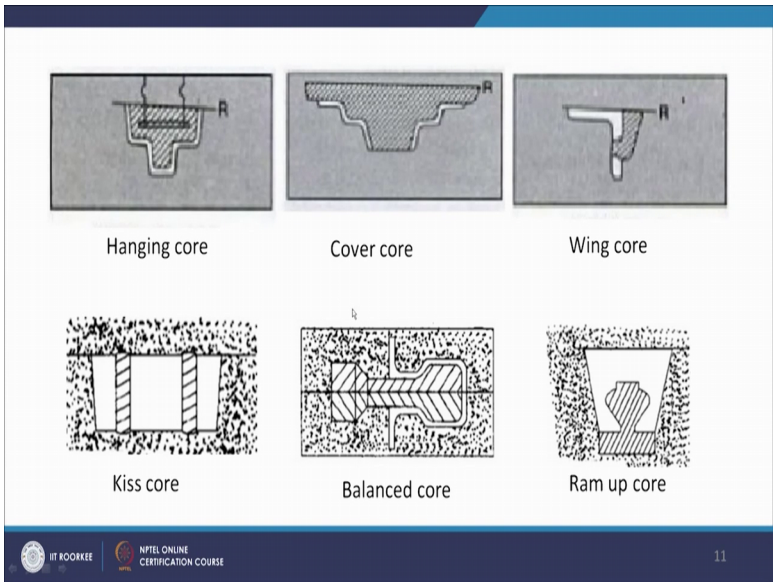

So, the balanced core has basically the opening on one side, let us look at this picture.

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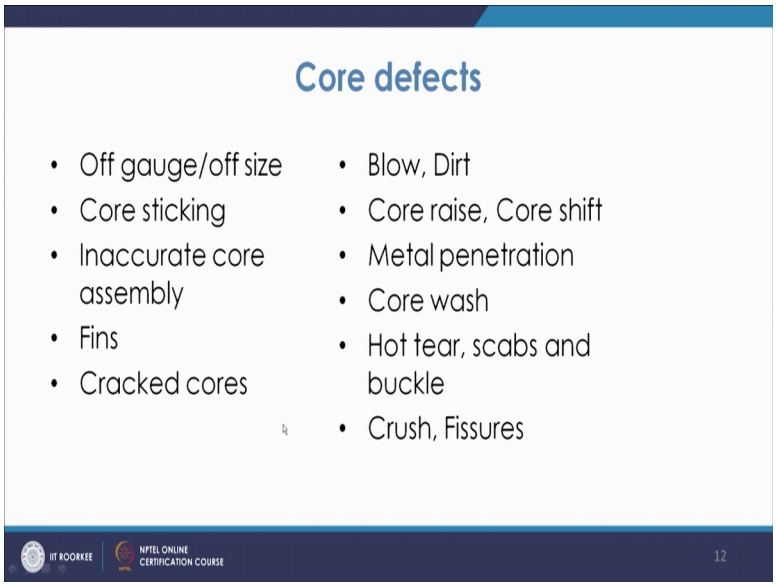

So, let us first see that how it getting defined, now balanced core is the core whose opening is there in only one side.

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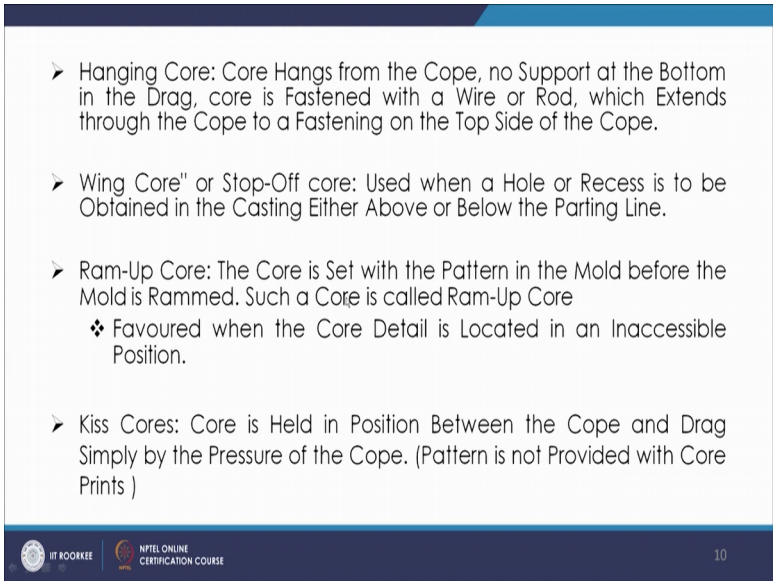

So, in one side it will be there, it has casting has an opening only on one side. So, in that case the core print has to be large enough. So, that it supports the weight of the core so, on one side. So, core print has to be quite large enough. So, that it supports the core let us look at the picture the balanced for this is a balanced core. So, as we see this is where the core is basically fixed here and it has been in the that is a core print.

So, here in the core is basically, it has support from one side only and this side is open. So, that is known as balanced core and it must be strongly basically held at this place then you have cover core. So, cover core is it is used when the entire pattern is rammed in the drag and core is basically required to be suspended from the top of the molds, every entire pattern is basically in the drag itself and it will stretch vertically downwards. So, we can see that this is the cover core where this whole core is in the drag cores and this is your casting cavity. So, this type of cavity is generated in that case. So, it is basically from the top it is kept like that so that is known as cover core.

Then you come to hanging core, in the hanging core again it will be similar kind, but it has the hanging from the coke portion. So, core hangs from the coke and no support at the bottom in the drag. So, there will not be any support in that cores cover cores you will have the support from the bottom, but here there is no support it will be hanging from the basically core portion. So, that is why it is known as hanging that is basically fastened with wire or rod and extends through the cope to a fastening on the top side of the copes, as you look at this is a hanging core here you see the core this core is hanging.

So, it has no support at the here and it is not touching. So, there is no support that it is hanging from the coke person. So, that is known as a hanging core then you have wing core or stop of cores.

So, this is used when a hole or recess is to be obtained in the casting either above or below the parting line. So, that is here when you have to make that hole above below the parting line in that case you have wing core or stop of core, it is known as then you have ram up core. So, this core is set with the pattern in the mold before the mold is rammed. So, before that itself in this core is said and that is why it is known as ram up core. So, when the core detail is located in an inaccessible position that time we use this kind of cores.

Then further you have a core known as kiss cores. So, here this core is held in position between the cope and drag simply by the pressure of the core. So, in this case using the pressure of the cope this is kept I mean touching. So, in between the cope and drag this core is basically position and it is maintaining its place. So, pattern is not provided with the core prints anyway because it is because of the support from that top and bottom side you know that is it touching.

So, that is why it is held at its own position. So, this these are the different kinds of. So, this is the, this is how it is showing kiss cores is this is about the different kinds of cores which are seen. Now, core defects there are many kinds of core defects also so you must be able to see that you should not have these defects for that you must time to time see that the parameters which are their for making the cores they should be properly controlled.

So, one is that of gays or of size you should have the core of proper size, core should not stick. So, that is core sticking in accurate core assembly proper dimension of the core core assembly should be proper fins are there, core cracking is there, then blow or dirt is there that add so that basically is maybe because of the improper you know binding of the sand grains. So, there may be in the dirt, then you have the core raids or core shift because of the metal buoyancy.

So, that you have see that the were it you have to put it proper position where the cores would be shift placed that is important otherwise core will shift from its position, metal penetration will be depending upon that what is the size of the sand particles which are making the cores. Very cores means the metal will penetrate inside and then there will be you know not proper finish of the metal on the internal side, core wash is there hot tear scabs and buckle there which is because of the poor expansion properties then you have the crusts or features which also develop in the case of cores. So, these are the different kind of core defects which are to be avoided and which are to be seen when we discuss about the core defects.

Thank you very much.