

Metal Casting
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Module - 01
Introduction And Overview
Lecture – 04
Overview Of Different Casting Processes-III

Good morning friends, in the previous lectures, we have seen the moulding sand and its ingredients. We have learned that moulding sand contains the base sand and the second ingredient is the binder or it is also known as the clay, the third ingredient is the additive; fourth grade ingredient is the moisture. And yeah once we mix these ingredients and as we keep pouring the molten metal, as we keep reusing the sand what happens? Part of the clay becomes dead; dead clay because the pouring temperature is about to say 700 to say if it is these are the aluminum alloys and it goes up to 1800 degree centigrade if it is the steel.

Now, at such high temperature right the part of the clay near the mould cavity becomes dead clay, means it loses all its properties and it becomes the dead clay and as we keep reusing this moulding sand, the content of the dead clay increases. Not only that we must remember that the moulding sand is subjected to most critical and tough situations, what is the pouring temperature? The pouring temperature of the aluminum is between about to 750 degrees to 800 degree centigrade what about steel? The pouring temperature is between 1700 degrees to 1800 degree centigrade, at such high temperatures the moulding sand may collapse or it may not offer us the required properties that are why it is very important for a founder man to learn about the moulding sand properties. In this lecture, we will be learning about the moulding sand properties.

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<u>PROPERTIES OF MOULDING SAND</u>	
1. Refractoriness	8. Dry Strength
2. Permeability	9. Hot Strength
3. Cohesiveness	10. Hardness
4. Adhesiveness	11. Collapsibility
5. Flowability	12. Friability
6. Plasticity	13. Durability
7. Green strength	14. Compactability

The properties of the moulding sand are one is the refractoriness, second one permeability, third one cohesiveness, fourth one adhesiveness, fifth one flowability, sixth one plasticity, seventh one green strength, eighth one dry strength. Ninth one hot strength. Tenth one hardness. Eleventh one collapsibility. Twelfth one friability. Thirteenth one durability and finally, the fourteenth one is the compactability. So, these are the most what say required properties of an ideal moulding sand.

Now, let us learn about all these properties one by one, first let us learn about the refractoriness.

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REFRACTORINESS:

It is the ability of the moulding material to withstand the high temperature of the liquid metal to be poured.

SIGNIFICANCE:

Moulding sand with poor refractoriness may burn during pouring and the casting surface may be damaged.

The degree of refractoriness depends on the quartz content (SiO_2), shape and grain size of particle.

What is the refractoriness? It is the ability of the moulding material to withstand the high temperature of the liquid metal to be poured. Just now I have told you that the pouring temperature is a very high temperature. If it is aluminum the melting point of aluminum is 660 degrees centigrade and the pouring temperature will be between 750 to 800 degree centigrade. If it is steel the pouring temperature is about 1750 degree centigrade at such high temperature, a molten metal of such high pouring temperature when it is poured into the mould cavity what can happen? It is possible that the moulding sand may burn, but a good moulding sand should withstand this high temperature and it should not burn and it should not be damaged, it should withstand this high temperature till the entire solidification is over, this property of the moulding sand is known as the refractoriness. What is its significance? A moulding sand with poor refractoriness may burn during the pouring and the casting surface may be damaged. If the moulding sand does not possess this refractoriness property what happens, when we pour the molten metal at a high temperature the part of the sand in the mould near the mould cavity surface, will be burned and it will be damaged.

Finally the surface of the casting will be damaged. The degree of the refractoriness depends on the quartz content that is the silicon dioxide shape and grain size of the particles. The next property is the permeability what is this permeability? It is the ability of the moulding material to allow hot gases to pass through it, once we pour the molten metal remember that the moulding sand contains the moisture. Once we pour the molten

metal immediately the moisture comes in contact with the molten metal and spontaneously, it turns into vapor and this vapor has to escape to the atmosphere through the mould how it can escape? Between the neighboring grains there will be a small gap will be there clearance. So, it will be escaping through the neighboring mall what say sand grains.

So, this is the permeability means it is the ability of the moulding material to (Refer Time: 06:03) the hot gases to pass through that medium. It is possible that some sands may not possess this good property; now what happens if the hot gases do not escape through the moulding medium to the atmosphere? They will be accommodated inside the moulding cavity, ultimately the moulding cavity will have the gas defects inside the what say surface are on the surface. So, we have to ensure that the moulding sand kind possess this good property called the permeability, right.

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SIGNIFICANCE OF PERMEABILITY

An **increase** in **permeability** usually indicates a more open structure in the rammed sand.

If the permeability is too high, it will lead to penetration defects and rough castings.

A **decrease** in **permeability** indicates tighter packing of sand.

If the permeability is too low, it could lead to blowholes and pinholes.

An increase in the permeability usually indicates a more open structure in the rammed sand. If the rammed sand is a more open structure then naturally the permeability will be more it allows more and more hot gases and steam, because it is a not rammed what say tightly. If the permeability is too high then what will happen? It will lead to penetration defects and rough castings, naturally even the permeability is too high means what? The what say sand grains are not compacted very tightly, they are loosely compacted means between the neighboring sand grains there is large clearance is there, and now the we

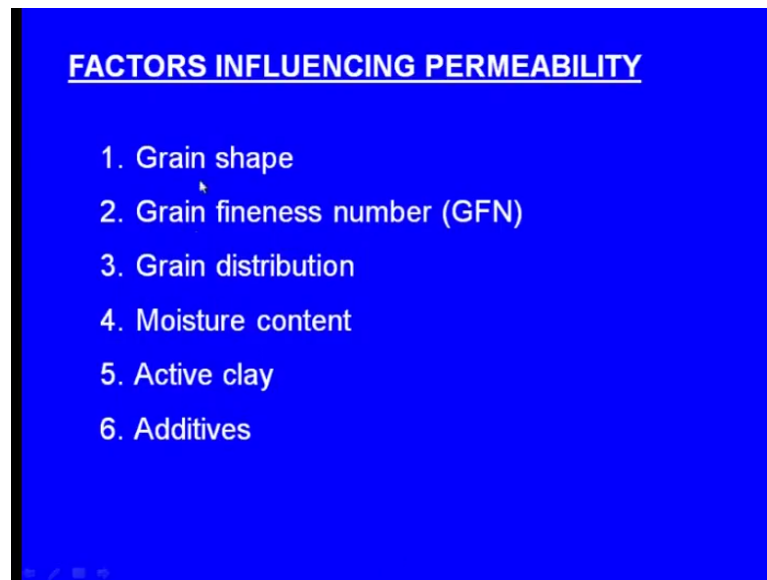
pour the molten metal and the molten metal its viscosity is very less because of its high temperature it can penetrate anywhere and it penetrates into the clearance between the toes and grains neighboring sand grains and it goes inside and inside and it causes a makes a fin, this is the penetration defect.

So, if the permeability is too high means the structure is more open means, it will lead to the penetration defects. Not only that what happens to the mould cavity surface because we have a not rammed it properly tightly, it is loosely ram the mould what say cavity surface will have a roughs structure rough what say texture because of that even the casting will develop a rough surface that is why the permeability should not be too high. Next one yes a decrease in permeability now let us see what happens if the permeability is too low, indicates tighter packing of sand naturally when we packed the sand very tightly what happens? The clearance between the neighboring sand grains will be very minimum, in such a case the hot gases may not be able to pass through the neighboring grains in such a case there is a decrease in the permeability.

So, what if the permeability is too low, it could lead to blowholes and pin hole defect yes the steam cannot escape through the what say sand medium to the atmosphere, the hot gases cannot escape to the atmosphere through the sand medium finally, they will be accommodated inside the mould cavity and finally, on the casting surface there will be blow holes large-large what say air bubbles will be there or pinholes will be there small-small what say a sized what say holes will be there on the casting surface. So, that is what can happen if the permeability is too low.

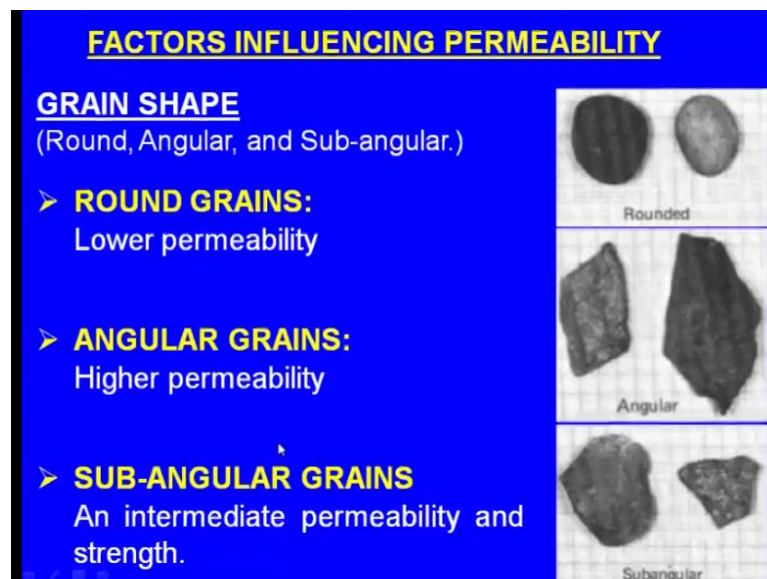
So, one has to maintain the permeability such that it is moderate neither it should be too high nor it should be too low.

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These are the factors influencing permeability, one is the grain shape next one grain fineness number GFN, next one grain distribution, next one moisture content, next one active clay and finally, the additives now let us see how these factors influence the permeability.

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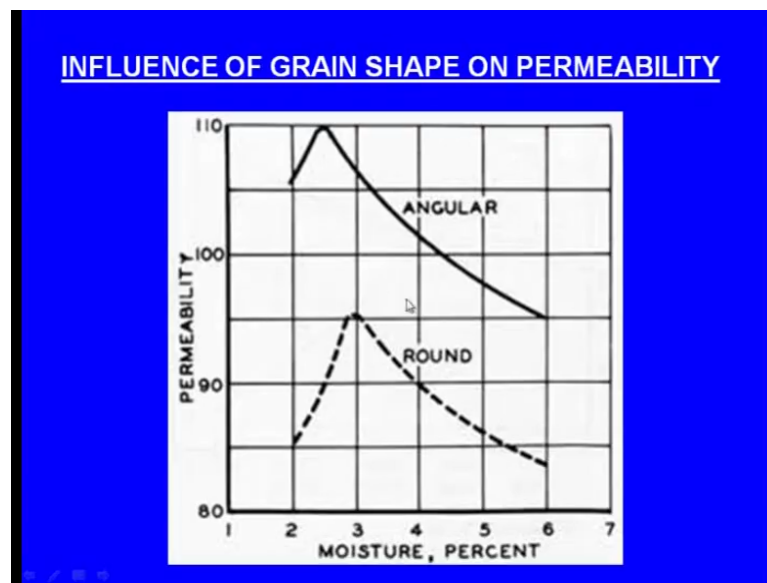


Let us see the grain shape; first of all you must remember that the sand grains are broadly they can be classified into 3 types. One is the round grains, second one angular grains, third one sub angular grains. Here you can see these are the sand grains these are the

round grains and here you can see these are the angular grains and these are the sub angular grains.

In the case of the round grains we get lower permeability whereas, with the angular grains we get the higher permeability whereas, with the sub angular grains an intermediate permeability and strength we get. Now let us see this graph influence of the grain shape on the permeability.

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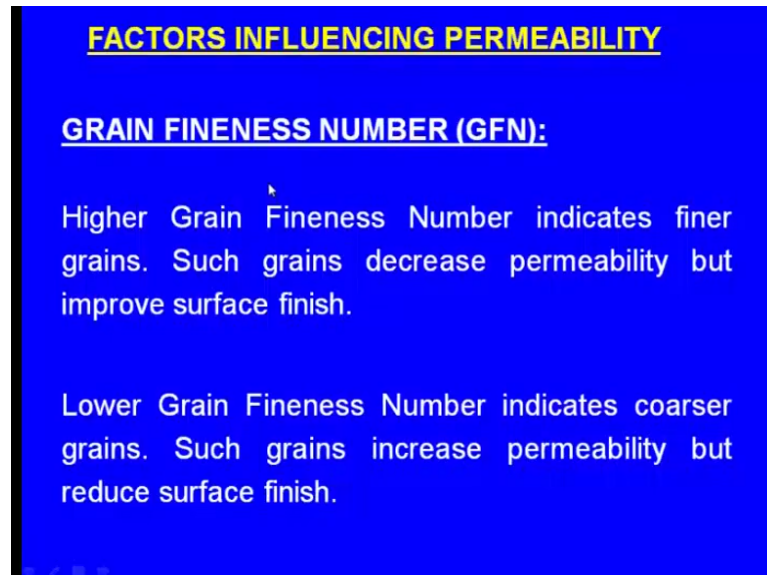


Now this is the; this curve indicates the round sand grains whereas, this curve indicates the angular sand grains. Now this x axis indicates the moisture content and the y axis indicates the permeability. Now let us consider the round grains, as we increase the moisture its generally yesterday, we have seen that the moisture content varies from 2 percent to 5 percent yes where it starts from 2 percent, as we keep increasing which up to 3 percent, it is increasing, but once it is 3 percent, as we keep increasing the moisture content permeability is coming down means the permeability will be maximum at about 3 percent of the moisture.

Similarly, let us consider this one angular grains right the moisture content starts from the 2 percent when it is about 2.5, the permeability is maximum. Once the moisture content is more than 2.5 percent the permeability is slowly coming down. So, this is the what; say influence of the grain shape on the permeability. So, if from this graph we can

know that angular grains offer the higher permeability, next one let us say the grain fineness number.

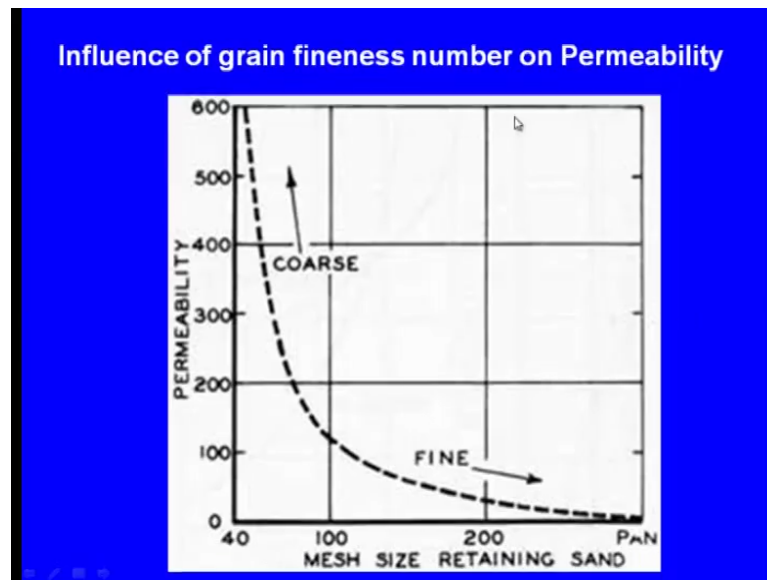
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Grain fineness number indicates the finer grains right. So, means if the grain fineness number is high, it means the sand grains are finer grains. If the grain fineness number is low means the sand grains are larger grain it is are coarser grains such grains these fine grains decrease the permeability, but improve the surface finish naturally when there are fine grains right. So, what say hot gases cannot escape very easily, but surface finish will be very good.

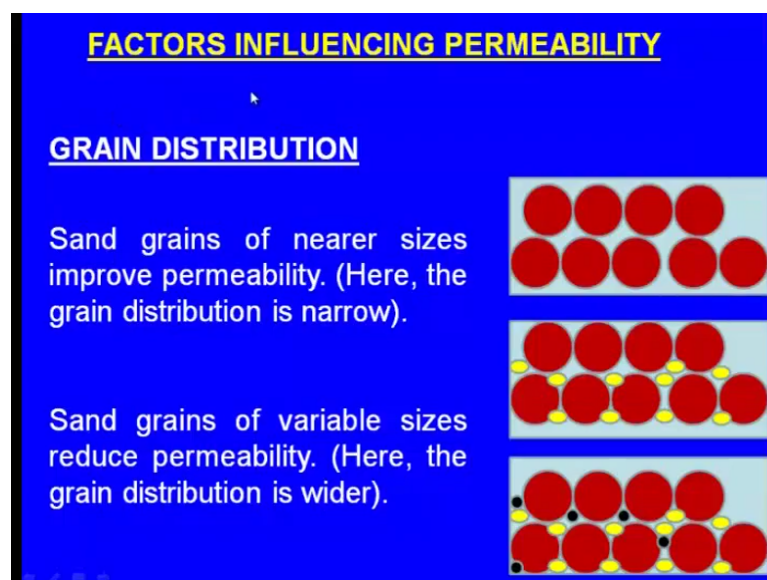
Lower grain fineness number indicates coarser grains such grains increase permeability yes because their coarser there is more clearance between the neighboring sand grains. So, more gases will be escaping through the medium, but it reduces the surface finish what happens to the surface finish? Yes because these are the larger grains they create a rough surface or rough texture near the mould cavity accordingly, even the casting will have a rough surface.

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Now, let us see this graph influence of grain fineness number on the permeability. Now you can see this side is the coarser grains and this side is the finer grains right. So, as say the size of the what say sands are becoming finer and finer what is happening? The permeability is coming down. So, this craft tells that the finer sand grains offer lower permeability whereas, the courser sand grains offer higher permeability.

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Next one; let us see the were under this factor influencing the permeability grain distribution, what is this grain distribution? In a what say sand there will be different

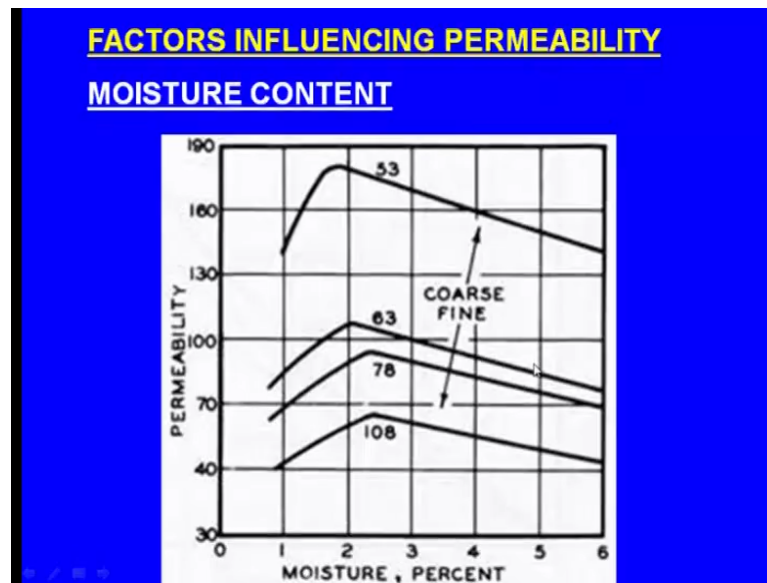
sizes of the sand grains will be there right maybe larger sand grains will be there, medium sand grains will be there, smaller sand grains will be there and very fine sand grains will be there. Now in the first case you can see the distribution is only what say once what says size is there, sand grains of nearer size improve the permeability you here you can see only similar sizes are present in this what say sand.

Let us come to the second case, second in the second case 2 types of sizes are there you can see these are the bigger grains and in between the clearance there are small grains. Now what is happening if that be the case? Means here the sand distribution is little wild, now what is happening previously there is more clearance here. So, the hot gases can easily escape, but in those clearances now the smaller grains are occupying now what happens? These blow these small grains block the passes of the hot gases that is how the permeability comes down.

Now, let us see the third case, here you can see 3 types of the what say sand sizes one is the bigger size and this is the medium size and this is very fine says, at least in the second case literally clearance is there through that clearance hot gases were passing, now even in this little clearance these second what say very fine sand grains are occupying then what happens? The clearance will be minimum and the ability of the hot gases to pass through these sand grains will be extremely minimum means in the third case, the sand distribution is very larger very sand large grains are there medium sand grains are there very fine grains are there means distribution is very wider distribution.

So, sand grains of variable sizes reduce the permeability, next one what about the moisture content influence of the moisture on the permeability.

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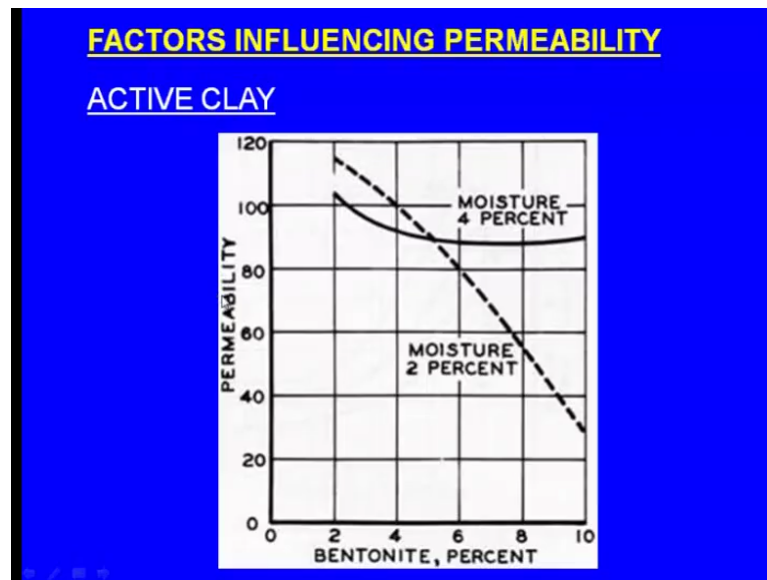


So, here we can see in this graph this is the moisture content and this is the permeability right. So, these numbers indicate the grain fineness number, remember if the grain fineness number is very high that indicates that there are very fine sand grains there, on the other hand if the grain fineness number is very low it indicates that the sand grains are very larger or very coarser.

Now, we can see this is the grain fineness number 108 means this is a fine sand. So, the permeability is very low and again it varies with the moisture content, when the moisture content is 1 percent it is like this, but as we keep increasing at about 2.5 percent it reaches the maximum permeability and slowly it again comes down and as we see what say a grain fineness number is decreasing, the permeability is increasing. In each case here the permeability for what say grain fineness number is 78, even in this 78 you can see the moisture content is 1 percent and it slowly increases, but once it reaches about 2.5 percent and again it is decreasing and same is the case with the other grain fineness numbers also.

So, from this graph we can know that as we increase the moisture content from the minimum amount, the permeability will be increasing to a certain level. Once it crosses above to 2 percent or 2 and half percent again as we keep increasing the moisture addition the permeability will be coming down.

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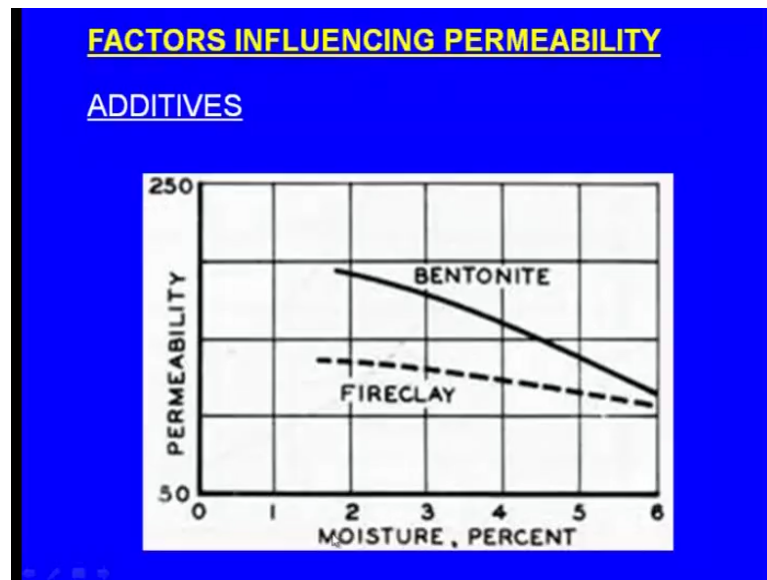


Now let us see the influence of the clay on the permeability, here we are telling means because we are ignoring the dead clay. So, we are talking about the active clay right.

So, among the in the previous lectures we have seen that among the clays right. So, bentonite is the most popular clay. So, here. So, here we can see this x axis indicates the bentonite percent and the y axis indicates the permeability. Now we can see this is the 2 percent moisture and say when the moisture content is 2 percent, the permeability is this much at about 115 like that, but as we increase the bentonite content what is happening to the permeability? It is gradually decreasing means what we can conclude with the what say increase in the bentonite or with increase in the clay content, permeability gradually comes down because this bentonite what say is a fine particles. So, they occupy between the clearance of the sand grains that is how they block the hot gases or the what say steam.

Next one same is the case with the this is the for what say 4 percent moisture, we can see here also with the increase in the bentonite or the clay content, the permeability is coming down. Next one let us see the influence of additives on the permeability right.

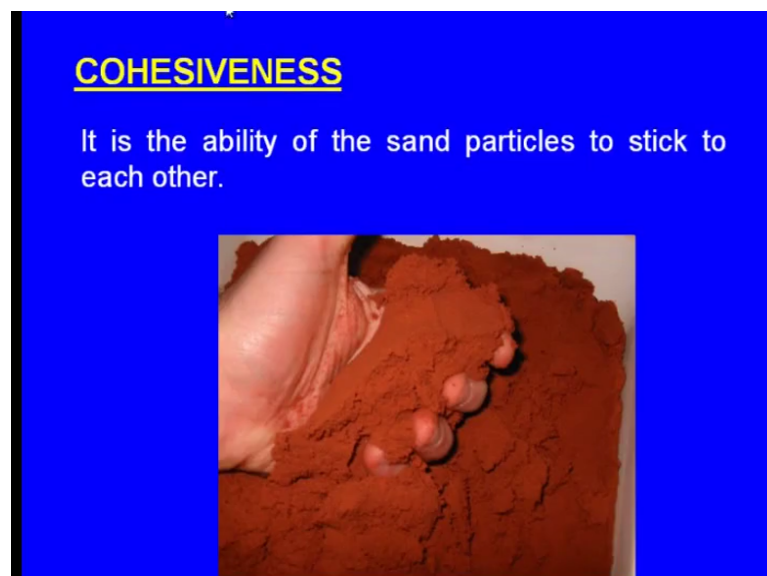
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So, here this is the moisture content and this is the permeability right of course, this is the bentonite and this is the fire clay which is an additive and so, what is its influence on the permeability? When the moisture content is 2 percent right. So, the permeability is this much as we what say increase the moisture content and right with the per what say the permeability is coming down. So, this is the effect of the additives on the permeability.

Next one let us see the cohesiveness, what is this cohesiveness?

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It is the ability of the sand particles to stick to each other right here even if it is what say held like this. So, once we press it, it should take the same shape after we press it should not go back to its original shape, that is the cohesiveness the ability of the sand particles to stick to each other.

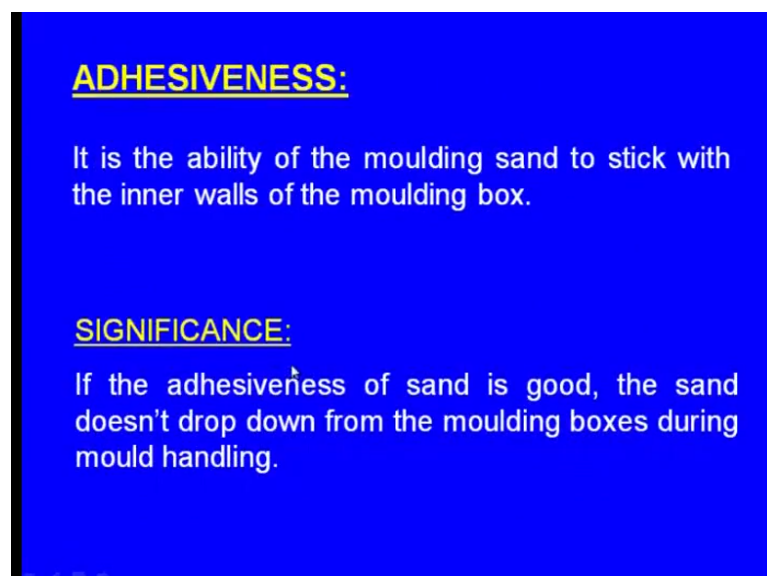
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What is its significance? A sand with good cohesiveness does not break after the moulding and during pouring that is the significance of the cohesiveness.

Next one let us see the adhesiveness.

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It is the ability of the moulding sand to stick with the inner walls of the moulding box, that is the adhesiveness means cohesiveness means it is what say binding between the what say sand particles whereas, adhesiveness means binding between these sand particles and the walls of the mould box and what is its significance? If the adhesiveness of the sand is good the sand does not drop down from the moulding boxes during the mould handling. Yes if there is no adhesiveness right what happens? We compact the sand in the moulding sand and yes we hold the moulding box with the handles as we are carrying suddenly the mould may drop down, because there is no binding between the moulding sand and the walls of the moulding box means there is no adhesiveness.

So, a good moulding sand should possess this important property, good property that is known as the adhesiveness next one let us see the flowability.

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FLOWABILITY:

It is the ability of the moulding sand to flow and get compacted all around the pattern and take up the required shape.

FACTORS INFLUENCING FLOWABILITY:

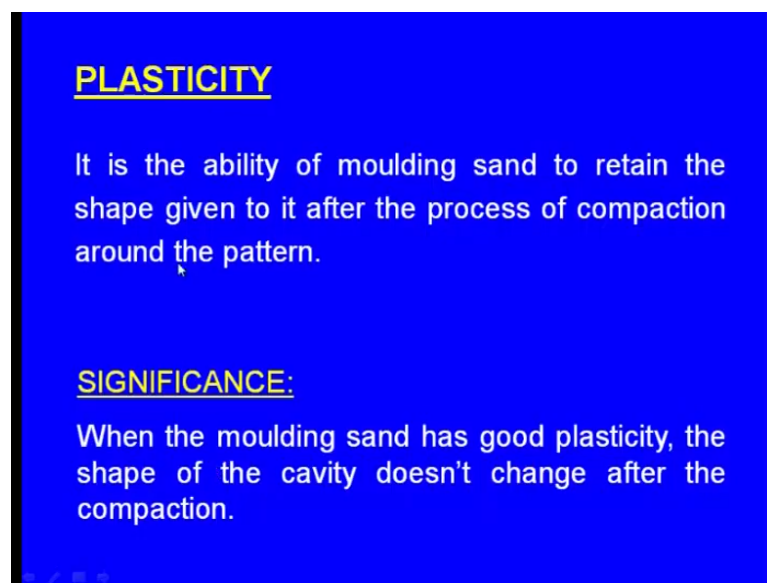
- Round grains increase flowability.
- Excessive binder (clay) decreases flowability.
- Excessive additive like cereal reduces flowability.

It is the ability of the moulding sand to flow and get compacted all around the pattern and take up the required shape. Sometimes the pattern may have a what say a very fine features and it may have a very complex features, if it is not a good moulding sand it just what say takes a rough what say compaction around the pattern what about the fine details? It may not to occupy strictly around the fine details, there may be complex details maybe there just it occupies around the complex details, but it may not strictly occupy around the complex details, then what will happens? With such a pair what say moulding sand we with draw the pattern and we pour the molten metal we finally, in the

casting we cannot see the required features, but a good moulding sand should possess this property the flowability means where as we keep ramming the what say sand, it should strictly occupy around the fine details around the complex details and it should reproduce the what say patterns details on the casting that is known as the flowability.

Now, what are the factors influencing the flowability? Round grains increase the flowability, excessive binder are the clay decreases the flowability, excessive additive like cereal reduces the flowability, next one let us see the plasticity.

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PLASTICITY

It is the ability of moulding sand to retain the shape given to it after the process of compaction around the pattern.

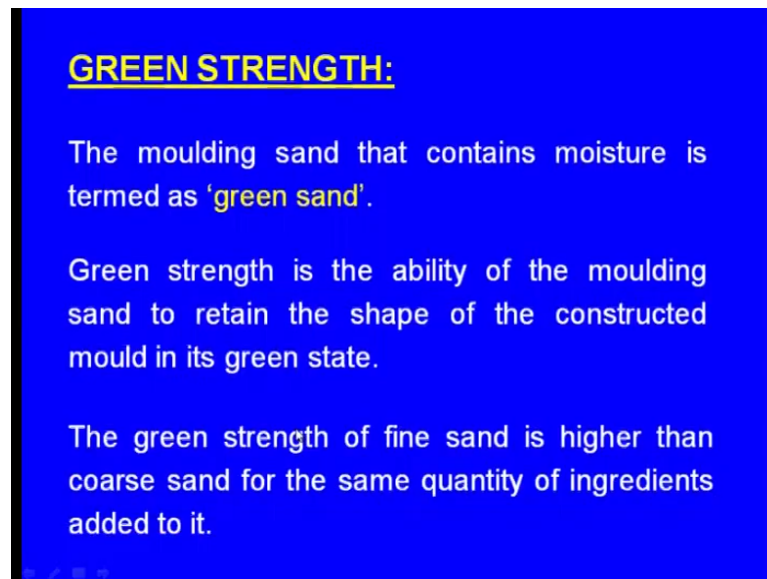
SIGNIFICANCE:

When the moulding sand has good plasticity, the shape of the cavity doesn't change after the compaction.

What is plasticity? It is the ability of the moulding sand to retain the shape given to it after the process of compaction around the pattern. Yes we take a pattern and around that pattern we what say place the moulding sand and we compact it and we compact tightly then we withdraw the pattern. Now if it is not a good moulding sand oft we withdraw the pattern, the shape may change that be the case we may not get the required geometry for the casting, but a good moulding sand should strictly retain the shape given to it and the shape should not alter after the pattern is withdrawn, the shape should not alter during pouring, the shape should not alter during solidification that ability that property is known as the plasticity right. So, this is the significance, when the moulding sand has good plasticity the shape of the cavity does not change after the compaction, not only after the compaction during pouring it should not change, during solidification it should not change.

Next one let us see the green strength.

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GREEN STRENGTH:

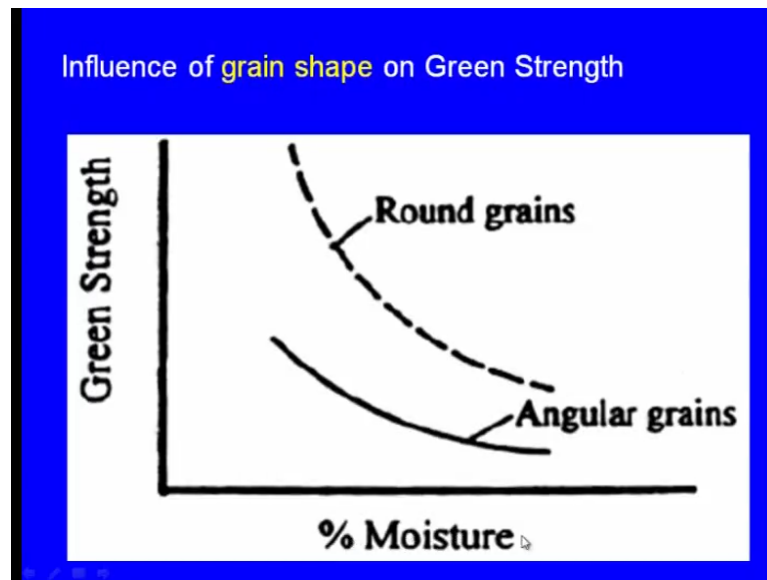
The moulding sand that contains moisture is termed as 'green sand'.

Green strength is the ability of the moulding sand to retain the shape of the constructed mould in its green state.

The green strength of fine sand is higher than coarse sand for the same quantity of ingredients added to it.

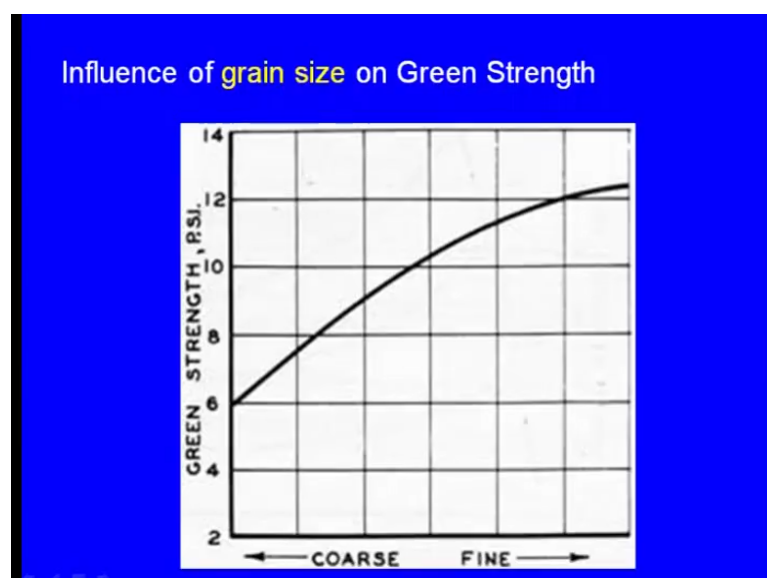
First of all in the previous class; we have seen that green sand what is the meaning the green sand. Green sand means the moulding sand in which the moisture is present right the moulding sand that contains moisture is termed as the green sand right now what is this green strength? Green strength is the ability of the moulding sand to retain the shape of the constructed mould in its green state means when the moisture is present it should what say retain the shape given to it. Next one the green strength of fine sand is higher than the coarse sand, and if we use 2 as what say 2 sands one is the fine sand and the other one is the coarse sand, naturally the core find sand will have a better green strength for the same ingredients added to them. So, this is the influence of what say green shape on the green strength.

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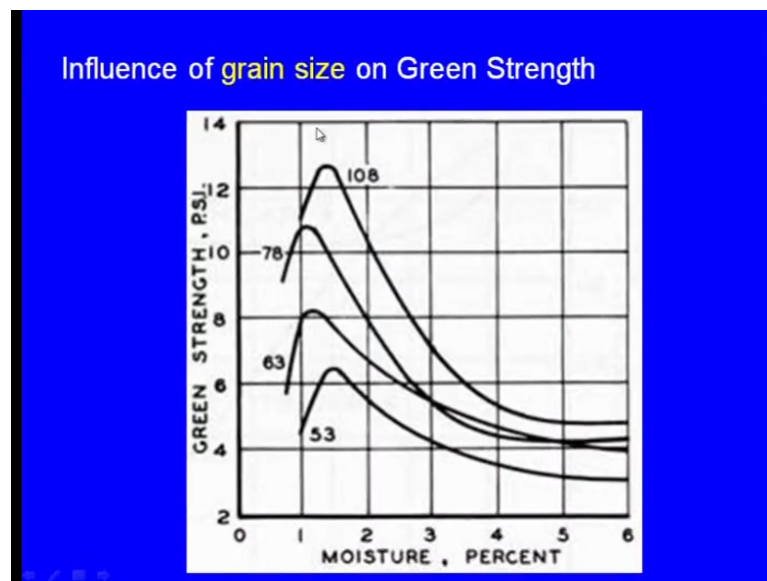
Here we can see this is the moisture x axis and the y axis shows the green strength right. So, for the round grains as the moisture is increasing right you see it is gradually decreasing with the increasing the moisture and this line indicates the angular grains. For the angular grains also with increase in the moisture the green strength is gradually decreasing. But when we see these 2 graphs what we can conclude the round grains offer better green strength compared to the angular grains. Now this is the influence of grain size on the green strength previously, we have seen the influence of the grain shape now this the grain size.

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Now, you can see here this side the left side indicates the coarser grains the right side indicates the fine grains. Now of course, yes we are starting the here what is happening from the coarse grains, as the sand becomes finer and finer what is happening the green strength is gradually increasing. So, what does this graph tell us? As the what say sand becomes finer and finer or as we use finer and finer sand, the green sand will become more and more that is the information we can obtain from this graph.

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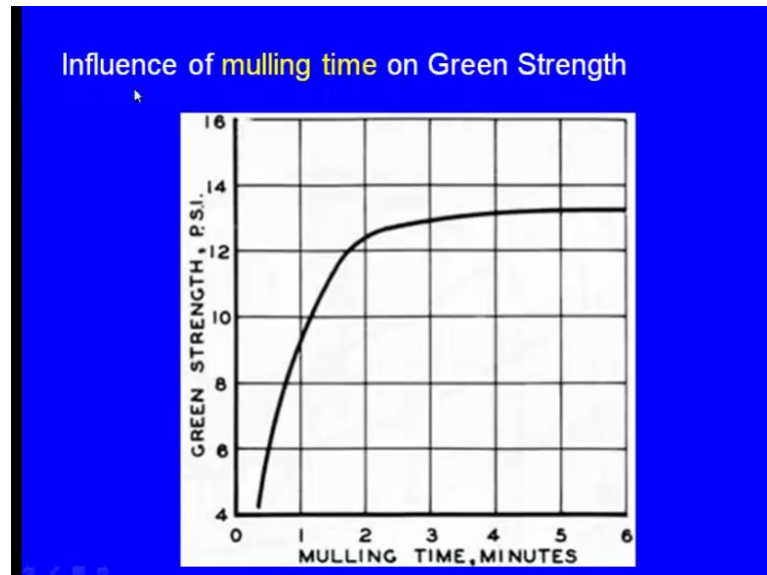


Next one influence of grain size on the green strength. Now yeah in this graph we can see what say the green strength of different sands of different what say grain fineness; now you can see here four graphs are there, this graphs grain fineness number is 53, this for this graph for this sand the grain fineness number is 63, for this sand the grain fineness number in about 78, 78 and this is 108 what is this grain fineness number? I have already told grain fineness number if then that number is high, it indicates a finer sand.

Now, you can see here this is the sand whose grain fineness number is 53 means this is the coarser sand. This is 63 somewhat what say finer sand and here we can see the grain fineness number is 78 this is still finer and 108 and it is more finer, but of course, we as the moisture content is increasing at once stairs the permeability green strength will be maximum and it is gradually coming down, but when we look at these four graphs what we can understand? A sand of higher grain fineness number offers better or higher green

strength or a sand of what say very fine sand a finer sand offers a better or a green higher green strength.

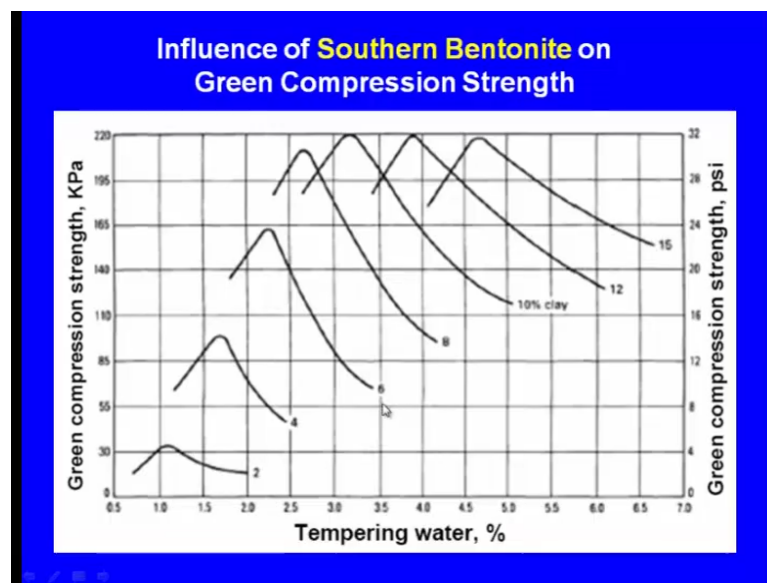
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Next one influence of the mulling time on the green strength what is this mulling? Mulling means we there will be a sand muller will be there right. So, we place the all the ingredients the base sand, the what say clay are the binder, the additives the moisture all directly in the required proportion we put them inside the what say muller and we rotate it the muller has 2 blades and 2 rollers; as the rollers are rotating as the blades are sweeping the sand they are no what say well nourished all these ingredients, this is known as the mulling. So, this mulling has an effect on the green strength.

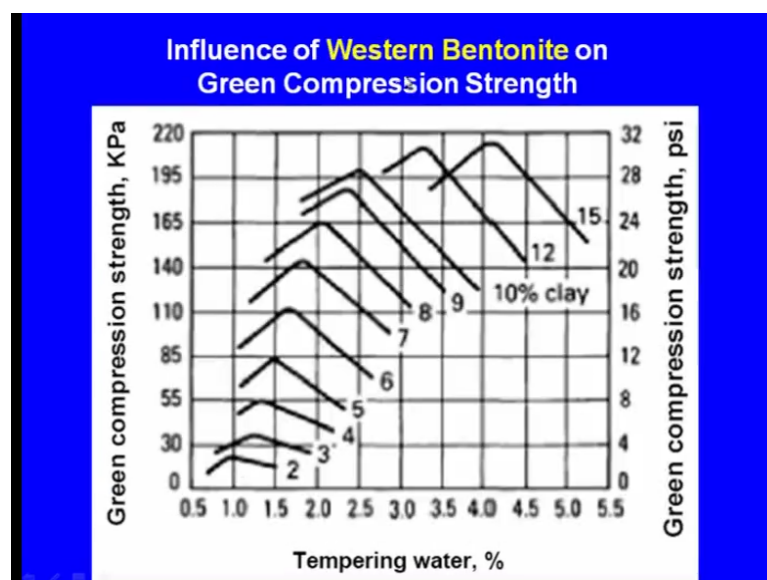
Let us see this x axis indicates the mulling time, the y axis indicates the green strength as the what say mulling time is increasing right. So, this is the time in minutes, it starts say about say of minute say when it reaches about 2 minutes we get the maximum green strength. Beyond 2 minutes even if we further mullet there may not be considerable hike in the green strength, there are what we can learn from this graph and again the green strength there are what say we can measure it in 2 ways, one is the green compression strength and the second one is the green shear strength.

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Now, you we can see here this is a graph right the influence of the southern bentonite on the green compression strength. In the previous class we have seen that bentonite is the most popular clay or it is the most popular binder, again this bentonite is divided in is 2 types right among the 2 types, one is the southern bentonite and the other one is the Western bentonite, right.

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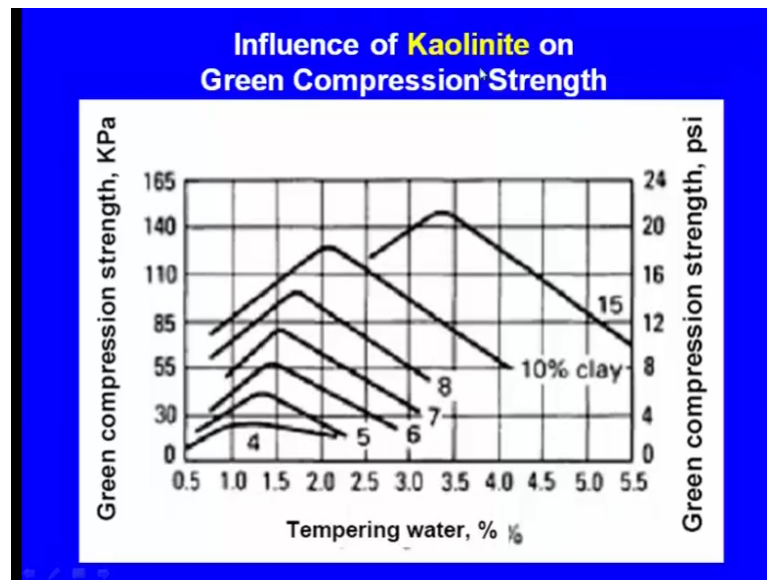
So, influence of the southern bentonite on the green compression strength and here we can see the x axis is the tempering water and the y axis is the green compression strength.

Now, what is happening is. So, as we increase the what say a moisture content, gradually it is increasing and it is coming down right. So, that is say the all these all indicate the clay percentage is here they have added 2 percent clay, here this is a 4 percent clay, 5 percent clay and 12 percent clay 15 percent clay and so on. In each case what is happening is the moisture with increasing the moisture content the green compression strength is increasing and then it is coming down, but when we consider all these curves what we can learn right. So, a what say a higher bentonite content use the higher green compression strength that is what we can learn from this graph.

Now, this is the influence of the western bentonite on the green compression strength and here we can see the x axis is the what say tempering water and the y axis is the green compression strength and here we can see what say different 2 graphs representing different clay additions clay here the clay is the western bentonite and the same thing is happening here as we keep increasing the moisture content, it raises and it comes down it rises and it comes down that way when we consider all these what say curves together, what we can know with increase in the western Bentonite, the green compression strength increases that is the what say inference from this graph.

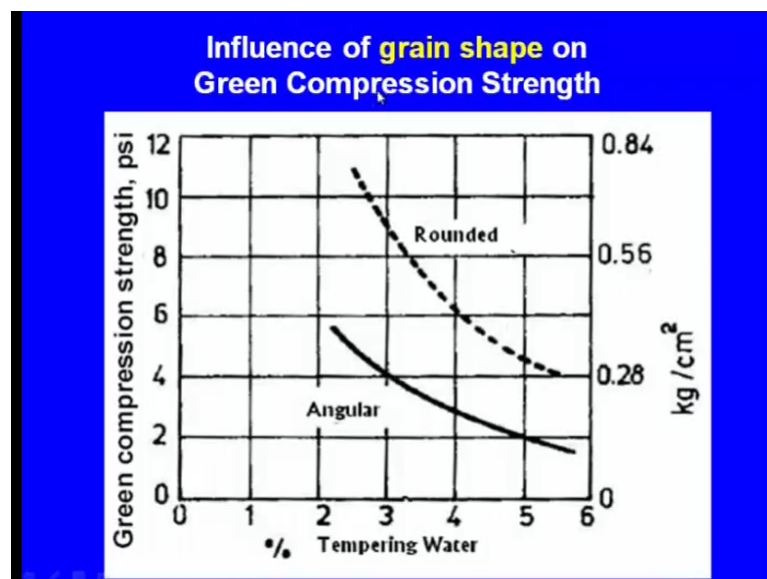
Next one influence of kaolinite on the green compression strength.

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So Right. So, this is another binder now let us see yes this is the x axis is the tempering water and y axis is the green compression strength and we can see different curves are there and each curve represents the a particular clay content. Now as we increase the what say moisture content, it is the it is increasing and it is coming down it is increasing and it is coming down. But when we compare when we consider all these graphs together what we can know? With increase in the addition of the kaolinite, the green compression strength will be increasing.

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Next one influence of grain shape on green compression strength. Now here we can see these are the what say this curve indicates the angular grains, this curve indicates the rounded grains and this is the x axis is the tempering water and y axis is the green compression strength. Now as we increase the water, water content for the angular grains the green compression strength is gradually coming down and same thing is happening with the rounded grains also. As we increase the water content, the green compression strength is gradually coming down, but when we consider both these graphs what we can know? The rounded grains offer higher green compression strength right. So, this is the influence of the grain shape on the green compression strength.

So so, for we have learned say all these properties we have seen among the properties of the moulding sands next one let us see the dry strength. What is the dry strength? Just now we have seen that green sand means the moulding sand in which the moisture is present and into that mould, we pour the molten metal and within few minutes the moisture will be evaporated the mould becomes dry maybe in the presence of the moisture the moulding sand may possess the strength which we call it as the green strength, but in the absence of the moisture the sand may not possess the required strength to hold the molten metal are to hold the shape of the cavity, but a good moulding sand should possess the strength even in the absence of the moisture, this is known as the dry strength.

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DRY STRENGTH:

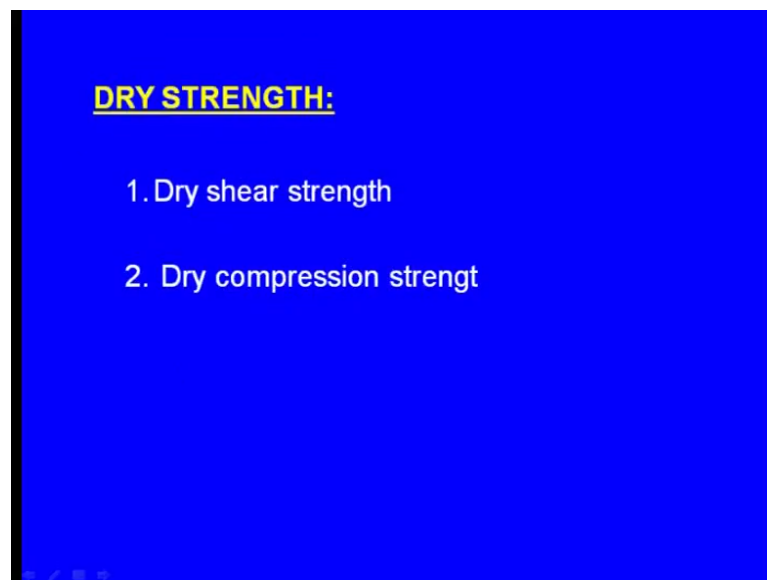
It is the ability of the moulding material to retain the exact shape of the mould cavity in the dry condition (when the molten metal is poured in the mould) and to withstand the metallostatic pressure of the liquid material.

Dry strength is increased by mixing of additives like **dextrin**, etc.

So, it is the ability of the moulding sand or the moulding material to retain the exact shape of the mould cavity in the dry condition when the molten metal is poured into the mould and to withstand the metallostatic pressure of the liquid metal. Not only that it in the absence of the moisture, it should contain it should what say it should contain the same shape and also it should withstand the metallostatic pressure of the liquid metal. Now dry strength is increasing increased by the mixing of additive like dextrin, and the previous class we have seen that we mix the additives along with the clay, why? These additives offer us the some special properties and the minimize the defects.

So, when we add the dextrin, the dry strength will be increasing.

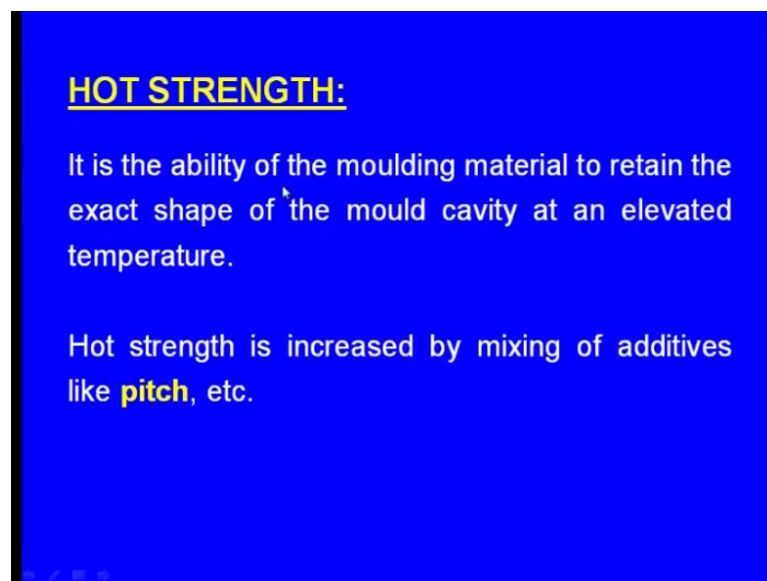
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Again this dry strength can be measured in 2 ways, one is the dry shear strength and the other one is the dry compression strength. So, far we have seen up to dry strength next one let us see the hot strength. What is the hot strength? We have seen the green strength, green strength means strength of the mould in the presence of the moisture are the ability of the mould to what say retain the shape in the presence of the moisture next do that we have seen dry strength what is that ability of the mound to retain the shape and to accommodate the who what say molten metal in the absence of the moisture. Immediately after pouring of the molten metal within a few minutes, the moisture will be dried out, but this molten metal will be in the cavity for about 1 hour for about say at least about 20 minutes to half an hour it will be in the liquid state.

Now, not only that definitely there is no moisture, there is there is what say we cannot say it is the green strength not only it is dry, it becomes very hot the temperature of the mould becomes very high. In such a state maybe just immediately after pouring in the absence of the moisture, it may have the ability to hold the shape and to accommodate the molten metal and to with stand the a what say this pressure from the molten metal, but when the temperature raises up, it may not have the strength. But your good moulding sand should possess the strength even when its temperature is very high that is known as the hot strength.

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It is the ability of the moulding material to retain the exact shape of the moulding cavity at an elevated temperature.

Hot strength is increased by mixing of additives like pitch, and pitch is one of the additive. So, when we mix the pitch along with the what say moulding sand ingredients. So, this hot strength will be increasing.

Next one let us see this hardness, it is the ability of the moulding sand to resist any inadvertent and unwanted deformations after the process of compaction around the pattern.

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HARDNESS

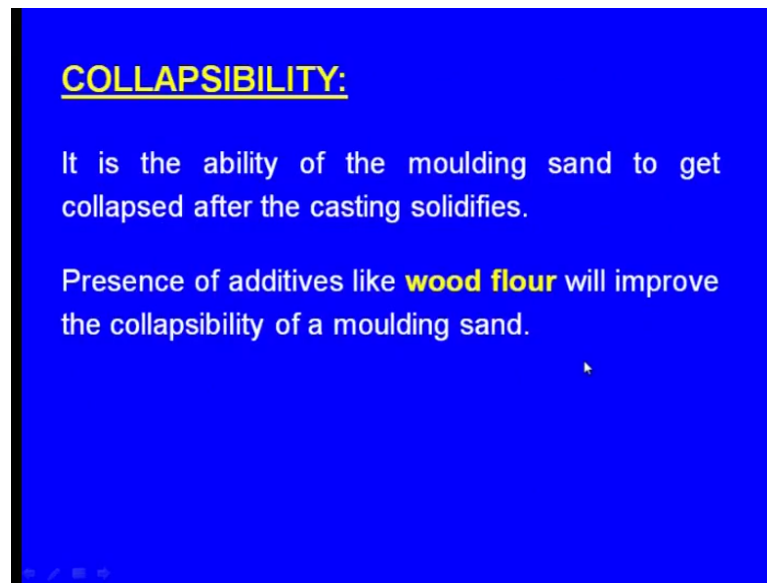
It is the ability of the moulding sand to resist any inadvertent and unwanted deformations after the process of compaction around the pattern.

Hardness depends upon degree of ramming, clay content and moisture.

Yes we what say put the pattern inside the moulding box and we place the moulding sand and we compact it and we ram it, and after that we take the or we with draw the pattern from the mould.

Now, the mould should have the ability to resist any unwanted deformations, maybe unwontedly , someone may try to what say push it or what say hit it in such a case if these are the what say what say these are done at a moderate pressure, the mould what say shape should not change right. So, this not be any deformation to the shape of the mould cavity, this property is known as the hardness. Hardness depends upon the degree of ramming clay content and moisture next one let us see the collapsibility.

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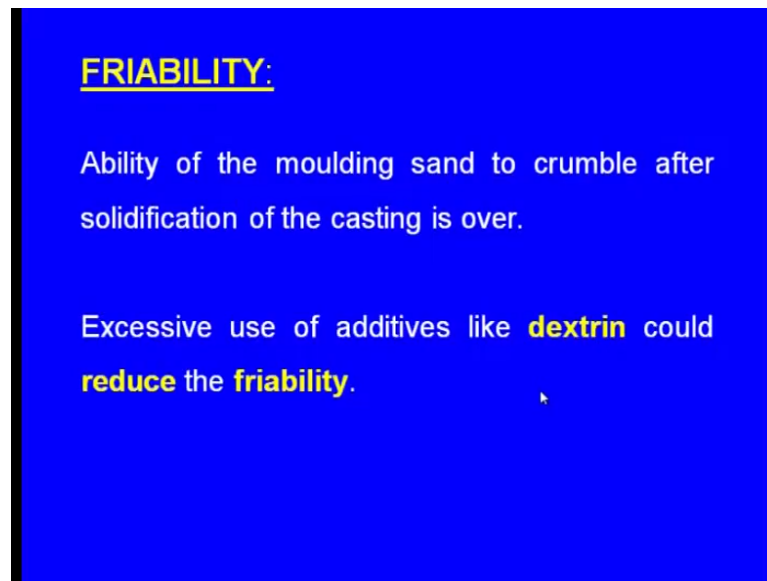
What is this collapsibility? It is the ability of the moulding sand to get collapsed after the casting solidifies. Now what we do during after this solidification is over? We make the mould then we pore the molten metal into the mould after sometime the molten metal solidifies, and after solidification what we do we bake the sand to take the casting outside.

Sometimes the casting what say the moulding sand will be so, hard that we have to put extra or extreme labor to what say break the mould and to take the casting outside. In such a case the moulding sand has poor collapsibility whereas, a good moulding sand should have a good collapsibility means it should be easily breakable after the casting has solidified. Now this is very important the moulding sand should possess the green strength, it should possess the dry strength, it should possess the hot strength at the same time it should possess the collapsibility otherwise what say breaking the mould or this is known as the shakeout, it is also known as knock out, this process becomes extremely tough. Now we a good moulding sand should possess good collapsibility means it should be easily breakable. Presence of additives like wood flour will improve the collapsibility of a moulding sand, in the previous lecture we have seen the above about the wood flour what is this wood flour? This is the pulverized wood its a wood powder and what about its shape? Its shape will be a fine powder and sometimes it sometimes and few particles will be as big as a rice grain. Now these what say a particles of the wood flour will be occupying between the neighboring sand grains, and because of the presence of the wood

flour the collapsibility will be improved we can easily break the moulding sand after the solidification of the casting.

Next property is the friability what is this friability? It is the ability of the moulding sand to crumble after solidification of the casting is over what is this?

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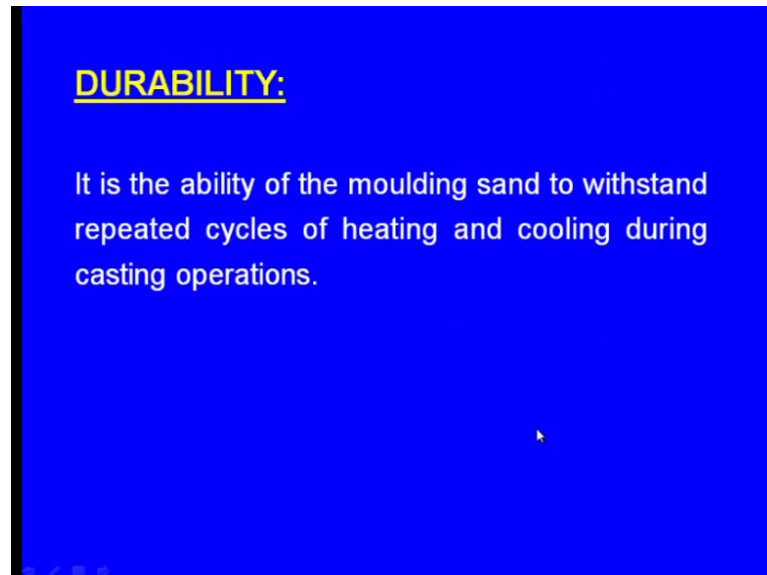
Just now we have seen the collapsibility; yeah the collapsibility is looking similar to the friability. Collapsibility generally it refers to the mould if we are able to break the mould into 2 pieces then it has the mould collapsibility. Once we make it into 2 pieces or 2 or 3 pieces yes we can take the casting outside various friability is different, friability means generally it refers to the core. Suppose we place a core inside the moulding sand, these cores are kept to get the hollow cavity since during the casting these cores are also made up of some special core sand, this core sand we will be studying in the next lectures.

Now, unless it is not enough for us to break the what say core into 2 pieces, if we can make the core sand into 2 pieces it is not enough we should be in a position to make it into small small pieces, then only the entire core will come out that is the friability right.

So, that is the ability of the moulding sand to crumble after the solidification of the casting is over now how to improve this property? Excessive use of additives like dextrin, could reduce the friability. We have seen dextrin is one of the important additives of the sand ingredients right moulding sand ingredients. So, one should not use

excessive dextrin. If once this dextrin is what say excessively used the property of the friability will come down, next one the durability what is this durability?

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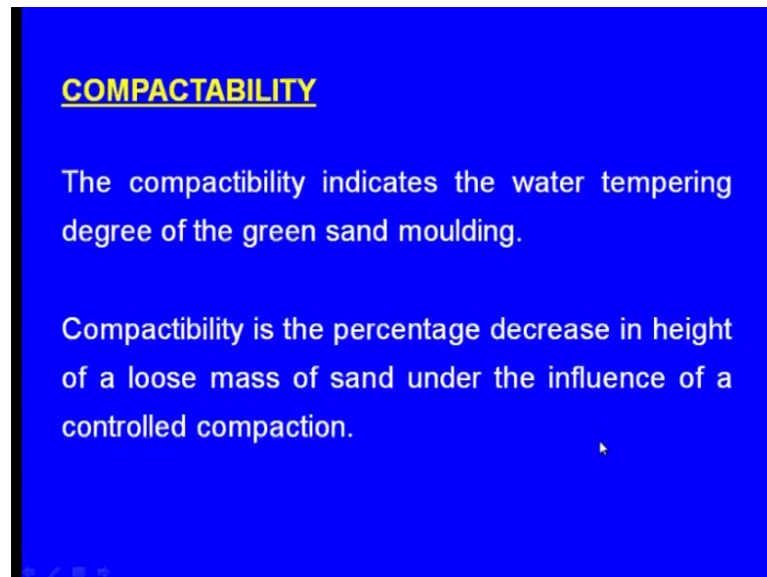


It is the ability of the moulding sand to withstand repeated cycles of heating and cooling during the casting operations. Now what we are doing in the metal casting? We mix the ingredients of the moulding sand, we make the mould, we pour the molten metal the molten metal solidifies after solidification is over we break that sand, the sand is totally dry in such a state. Now we take the casting outside, we clean the casting the right then what we do? Again this sand will be reused it will be mixed with the water a little more what say clay or the binder will be added, again it with the hole all this what say sand will be what say placed inside the sand muller and it will be temper, again a mould will be created again we pour the molten metal and after solidification we break it and we take the sand again, again we temperate and this process keeps on going on and it goes on like this, but if the sand does not have a good durability property what happens maybe? After we use it for 2 after 2 or 3 times, the sand may not offer the required properties.

But a good moulding sand should possess this durability property means even when we are using it repeatedly using it means what is happening? We are moulding it, then it is subjected to high temperature then it cools down, then we break it, again it will be we mix the water means it is subjected to cooler conditions, we temperate and this cycle

goes on with all this what say complicated cycle, the sand should not lose its properties this is known as the durability. It is the ability of the moulding sands to withstand the repeated cycles of heating and cooling during the casting operations finally, let us learn about the compactability what is this compactability?

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Compactability indicates the water tempering degree of the green sand moulding right compactability is the percentage decrease in height of a loose mass of sand under the influence of a controlled compaction. Maybe we take the loose sand and put it in side a what say container and try to what say give somewhat say jerks to what extent it will be compacting that is the compactability.

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High compactability could result in:

- Improved dimensions
- Better casting finish
- Less mould penetration
- Gas / blow / pinholes
- Brittle mould surfaces
- Expansion problems
- Difficult shakeout

So high compactability could result in improved dimensions right a better casting finish and less mould penetration. So, these are the benefits I can say, if the moulding sand has got the higher compactability.

Now, these are the drawbacks of gas or blow or the pinhole defects may arise or brittle mould surface may be there or expansion problems will be there and finally, difficult shakeout or the knockout problem will be there, if they sand possess the high compatibility.

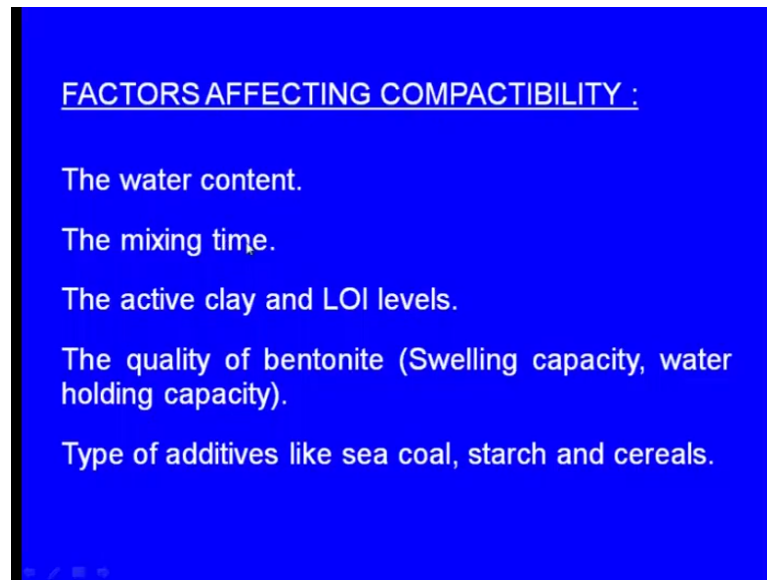
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Low compactability could result in:

- Friable edges
- Crushes – inclusions
- Mechanical penetration
- Cuts and washes
- Cope drops
- Oversize castings
- Rough surfaces

Low compactability could result in friable edges, next one crushes or the inclusions, next one mechanical penetration, cuts and washes, cope drops oversize castings and rough castings, factors affecting the compactability, water content. The second factor is the mixing time or the Mulling time.

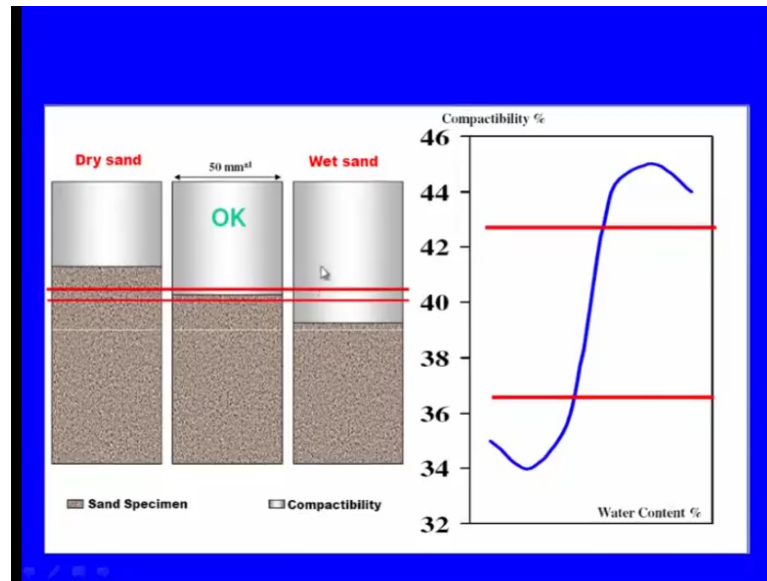
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The third factor is the active clay and the LOI levels means loss on ignition.

Next one the quality of bentonite right next one the type of additives like sea coal, starch and the cereals. So, these factors influence the compactability and here we can see we can better understand this compactability right.

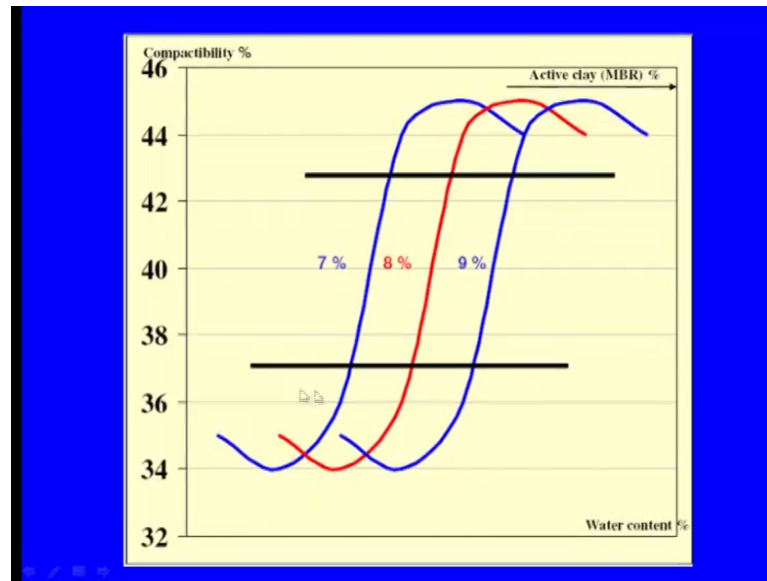
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So, the dry sand is what say place inside a container and loosely inside like this. So, this is a what say specimen, specimen tube. Now say it is given some kind of what say jerks or the what say it is a ram right. So, the sanding is compacted up to this level and with further ramming right it has come to this level.

Now, we can say in the second case the compactability is what say average in this what say right in this case the what say compactability is average and in this case the compactability is very high means, it is able to get compacted very high that's why the third case the compactability is very high.

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And here we can see yes this is the compactibility this y axis and this x axis indicates the water content and these 3 curves indicate the different clay additions.

Now, what is happening is, now as why as we increase these what say clay content right. So, even this compactibility will be increasing. Friends in this class or in this lecture we have seen that the a good moulding sand should possess certain important properties and we have seen that. So, these properties are refractoriness, permeability, cohesiveness adhesiveness, flowability, plasticity, green strength, dry strength, hot strength, hardness collapsibility, friability, durability and compactability and we have learnt what these properties are and what happens if the moulding sand does not possess these good properties and we have seen what are the factors influencing these probe what say properties and how to improve them. And in the next lecture let us see how to measure these properties. So, our next lecture will be what say moulding sand testing.

Thank you.