Metal Casting
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Module - 02
Sand Casting Process
Lecture - 02
Moulding Sands And Design-I

Good morning friends, in the previous classes we have seen the principal of the metal casting process. We have seen that in the metal casting process whenever we want to manufacture a particular component with a particular geometry, first we will create a similar cavity of the same geometry and we will pour the molten metal into that cavity. After sometime the molten metal solidifies then we remove that moulding medium and we will get the solidified casting this is the simple principle of the metal casting process.

We have seen the different classifications of the metal casting process and also we have seen a different terms used in the metal casting process and today we will see the moulding sands and design.

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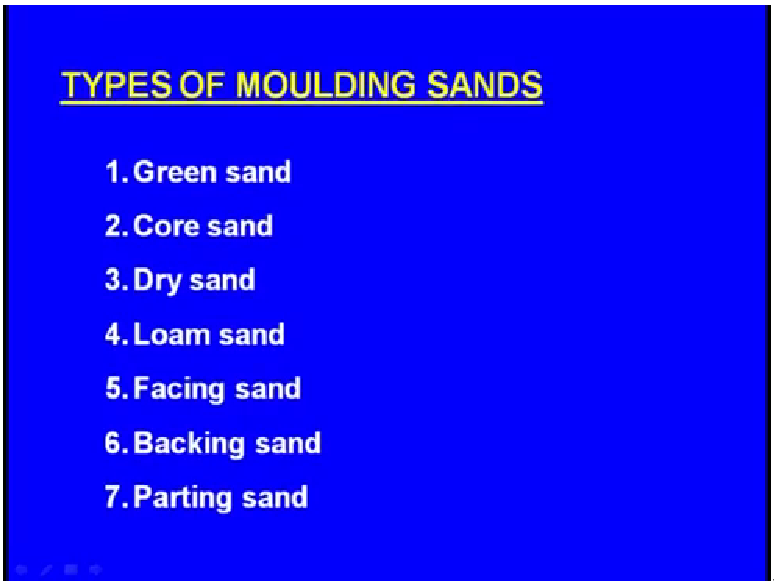

These are the different types of the moulding sands, one is the green sand second one is the core sand, next one the dry sand, next one the loam sand, next one the facing sand, next one the backing sand and finally, the parting sand.

Most of the times we hear these a words and some people may not be able to distinguish among these different to sands. Let us see what is the purpose of each and every sand which is mentioned here first let us see the green sand.

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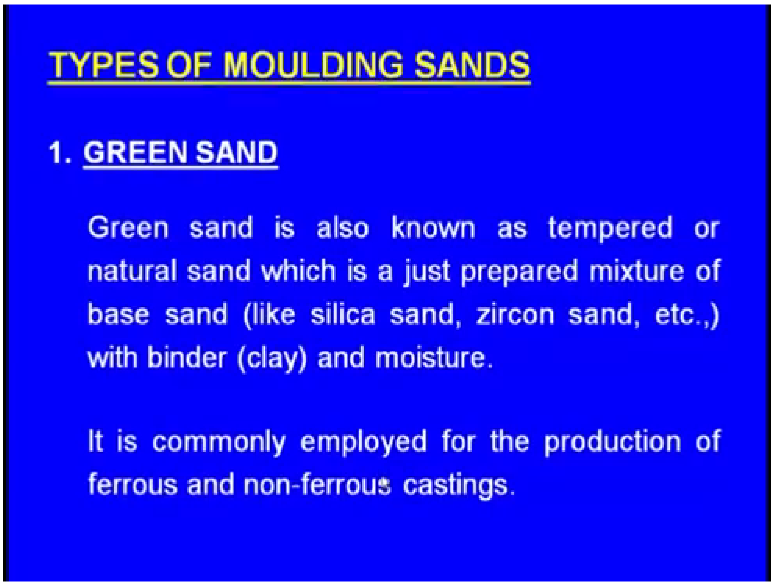

Green sand is also known as tempered or natural sand which is just a mixture of base sand like silica sand, zircon sand with binder and moisture. This is the green sand means when the moisture is present it is known as the green sand it is commonly employed for the production of ferrous and also for the production of non ferrous castings.

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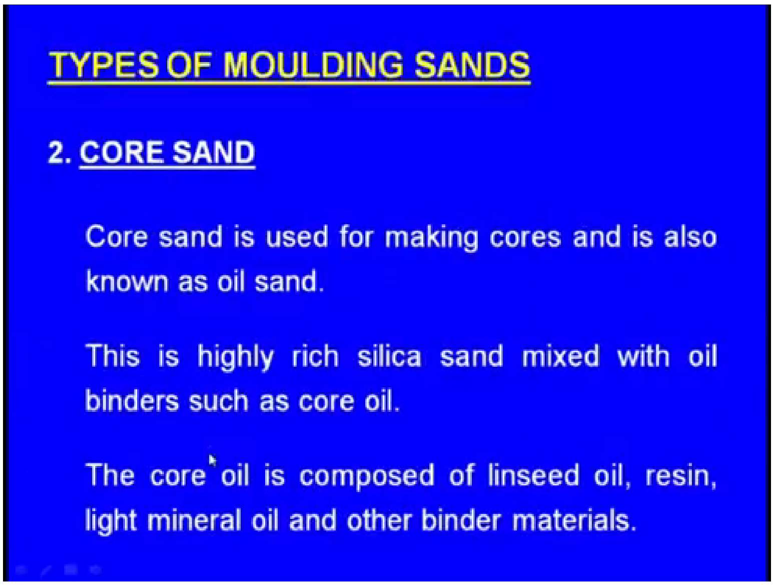

So, this is the green sand next one we will see the core sand in the previous class we have seen that core means yes it is a an object which is kept inside.

The mould cavity if we want a casting with some hollow space inside or with hollow cavity inside what we have to do we will be placing a core inside the mould cavity. So, that the molten metal does not occupy in that particular space this core is made up of the core sand. This core sand used for making cores and it also it is also known as oil sand this is highly rich silica sand mixed with oil binders such as core oil. The core oil is composed of linseed oil, resin, light mineral oil and other binder materials. So, this is the core sand.

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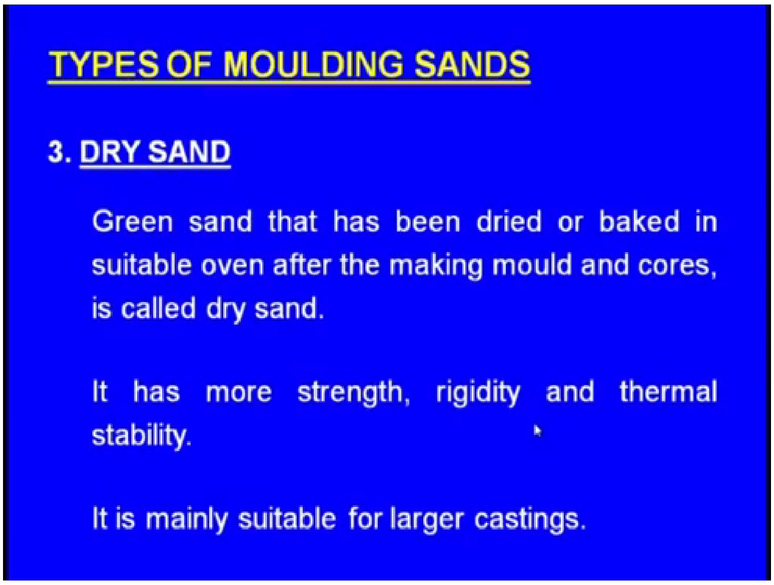

Next we will see the dry sand green sand that has been dried are baked in a suitable woven after making the mould and core is known as the dry sand sometimes if the is just now we have seen we have seen that.

If the moisture is present there we will call it as the green sand sometimes if the because of the presence of the moisture sometimes we get the defects like blow holes and porosity. So, to avoid these defects we dry this moisture then this sand is known as the dry sand. It has more strength rigidity and thermal stability and it is mainly suitable for larger castings. So, remember that the difference between the green sand and the dry sand is, green sand means almost the same composition, but it contains the moisture whereas, when we what say dry out of the moisture then it becomes the dry sand.

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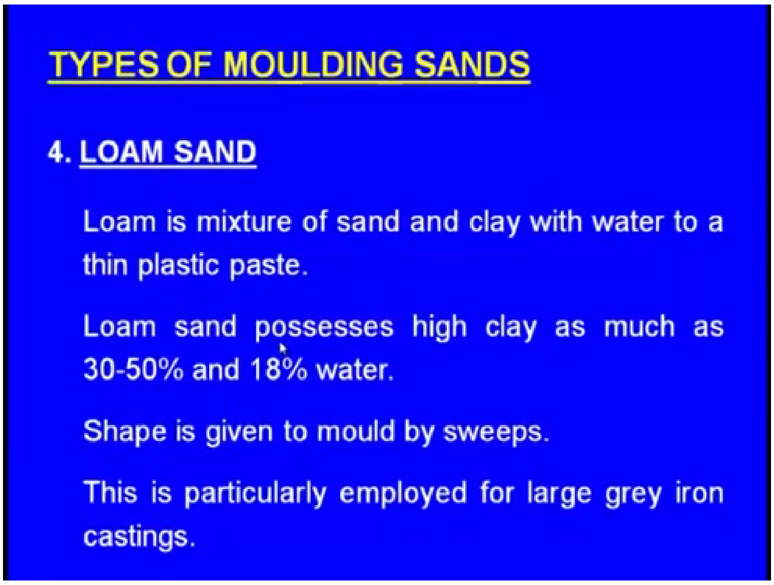

Next one the loam sand it is a mixture of sand and clay with water to a thin plastic paste.

Whereas in the case of the green sand we mix the water, but it does not look like a paste of course, it becomes a sticky, but it is certainly it is not a paste, but here the sand becomes like a paste and it possesses high clay as much as 30 to 50 and moisture up to 18 percent, this much clay we do not mix with the green sand. So, this is another difference with the loam sand and shape is given to the mould by sweeps.

So, in the case of the conventional sand moulding process we used to ram the moulding sand, we dumped the moulding sand inside the moulding boxes and with rammer we used to ram or it is done by the machine moulding whereas, here we do not do the ramming, but we do the moulding by the sweeps means there will be one sweep pattern will be there, and this as we rotate the sweep pattern a mould cavity is created inside this loam sand.

This is particularly employed for large gray iron castings; next let us see the facing sand.

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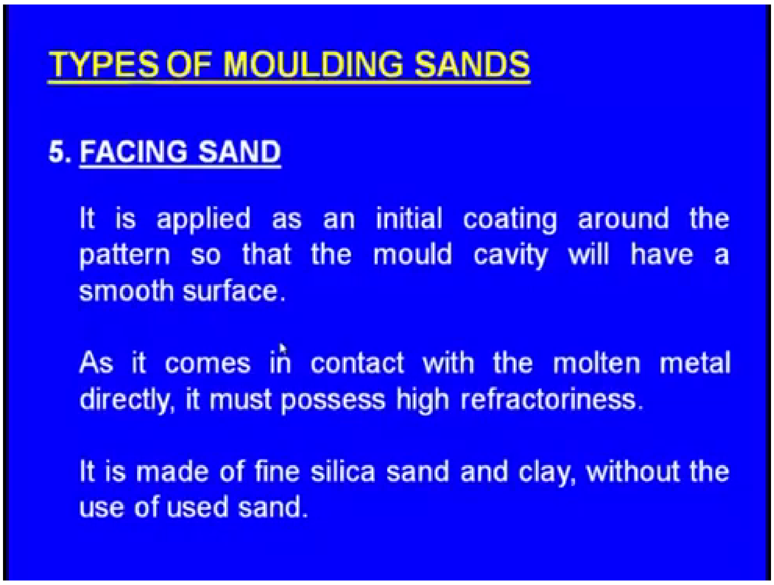

It is applied as an initial coating around a pattern so that the mould cavity will have a smooth surface. We have seen that in the previous class we use a model to create the mould cavity inside the mould means, if we want you make a particular casting with a particular geometry initially we make a pattern this pattern will have the similar geometry as that of the final component. Most of the times this model which is technically called as the pattern has a rough texture, because most of the times it is made up of the wood, because of the rough texture of the wood even the mould surface cavity surface will have a rough texture and as a result even the solidified casting will have a rough texture.

Now, we want to minimize this rough texture. So, what we have we are going to do is we are applying this facing sand over the pattern, this facing sand is a fine sand then just we sprinkle on the just on the pattern before we compact the moulding sand. Then what happens the rough texture of the pattern is minimized and over that we put the moulding sand and then we complete the ramming and. So, it comes in contact with the molten metal. So, it must possess high refractoriness means when the molten metal of high temperature is poured into the mould this facing sand layer should not burned. So, that is the important characteristic the facing sand must possess and it is made up of fine silica sand and clay, without the use of the used sand it is used only once repeatedly it cannot be used. So, this is the facing sand. So, facing sand is to improve the surface finish of the cavity and also to get a better surface finish on the solidified casting.

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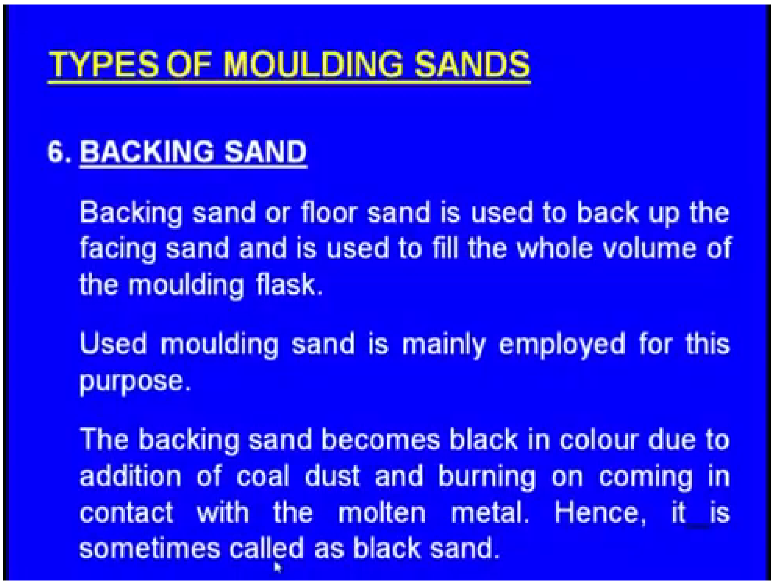

Next one let us see the backing sand backing sand or floor sand you is used for backup the facing sand and is used to fill the whole volume of the moulding flask. Now we see initially we take the moulding box and inside that we put the pattern, and one of the pattern we sprinkle the facing sand to minimize the rough texture of the pattern, then over that we put the moulding sand that is moulding sand it contains see what say valuable ingredients and costly ingredients and we do not want to fill the entire flask with the costly moulding sand. So, for that purpose for filling up the purpose we use the backing sand, it is used right it is a used moulding sand and is mainly employed for the backing purpose means filling purpose right.

The backing sand becomes black in color due to addition of coal dust and burning and coming in contact with the molten metal say we use the coal dust to improve it is strength that is why it becomes black in color and also as we it is repeatedly used and when it comes in contact with the molten metal it becomes it burns and it becomes dark that is why it is also known as black sand.

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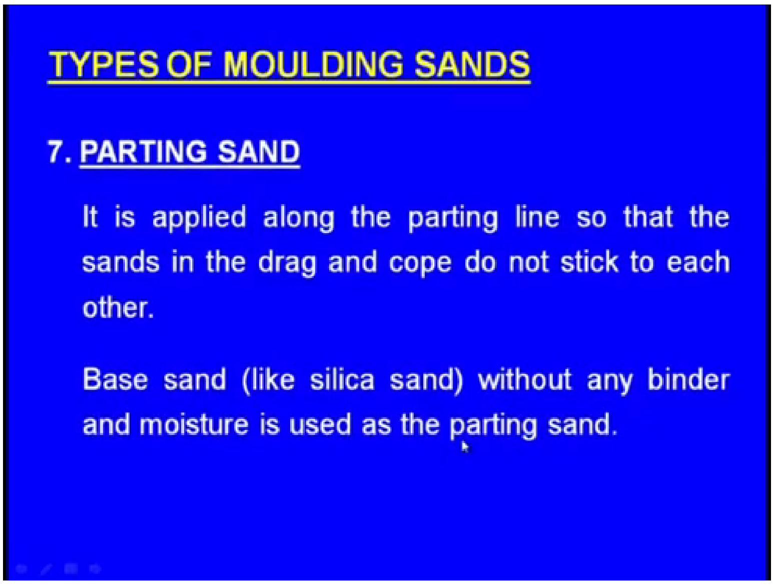

Next one parting sand it is applied along the parting line. So, that the sands in the drag and cope do not stick to each other and say we have seen that in the moulding system we generally we use two moulding boxes right the lower moulding box is known as the drag, the upper moulding box is known as the cope and we put the pattern and yes we mould the two boxes and these two mould boxes all right there in between these two moulding boxes there is a separation, because before pouring we have to separate these two moulding boxes after moulding is over, then we have to withdraw the pattern and we have to withdraw this sprue pin and the riser pin.

So, because that is why there must be a separation when we are ramming the sand, the moulding sand which is rammed in the cope box should not be stick in to the sand that is moulded in the drag box. So, what we do? Before what say after the compaction of the drag box is over then we place the cope box over the drag box and before placing the moulding sand into the cope box, we sprinkle little amount of parting sand on the what say compacted sand of the drag box.

Then we put the moulding sand into the cope box then we start ramming, then what happens the sand which is moulded inside the at cope box does not mix with the or does not stick with the moulding sand that is moulded inside the drag box. So, that is the purpose of the parting sand it creates a separation between the co cope box and the drag box. Base sand like silica sand without any binder and moisture is used as the parting sand. So, this parting sand does not contain any binder and moisture, it is a dry and clear sand.

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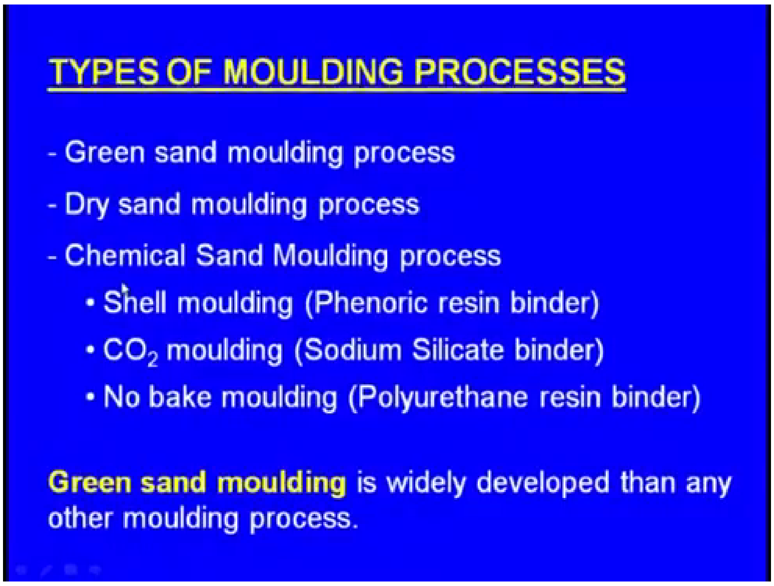

Now, these are the types of the moulding process I mean the sand the conventional sand moulding process. One is the green sand moulding process this these we have already seen in the classifications of the casting process the second one is the dry sand moulding process the finally the chemical sand moulding process under the chemical sand moulding process we have the shell moulding and carbon do carbon dioxide moulding and no bake moulding. Among these green sand moulding is widely developed than any other moulding process, because of it is simplicity and because of it is economy and a large castings can be produced using the green sand moulding whereas, with the what say CO 2 moulding and the shell moulding it is very difficult to produce very large castings.

Now, we are going to what say learn more about the green sand remember that green sand means the moulding sand which contains the moisture.

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Now, why a green sand moulding that is the fundamental question, there are there is a dry sand is also there and chemical sands are also there why.

Because first point is reasonable cost, the cost is reasonable when we use the green sand. High productivity economical and also a very large castings can be made using the green sand and this green sand of course, when we remove the moisture, it becomes the dry sand mould yes again we can manufacture very large castings and easily adaptable to manual semi auto and automatic moulding machines. Remember that this moulding can be done manually and also on the semi-automatic machines and also on the fully automatic moulding machines and this green sand can be moulded in all these cases manually it can be moulded, using semi-automatic machines it can be moulded and using fully automatic machines also it can be used, that is why this greensand moulding has become popular.

Now, this is the general composition of the green sand. So, these are the ingredients we have the base sand binder this is also known as the clay.

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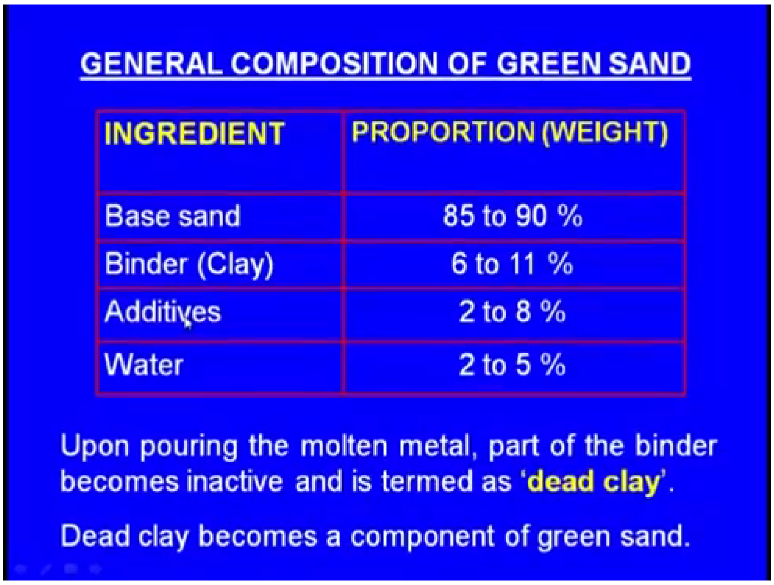

And we mix the additives and also the water base sand is say it is present 85 to 90 percent binder, which is also known as the clay it is between 6 to 11 percent. Next one we mix the additives and the proportion is 2 to 8 percent and water is 2 to 5 percent.

Now, what happens? As we what say pour the molten metal right part of the binder becomes inactive once the temperature crosses about some 500 degree centigrade or 600 degree centigrade, then it loses it is binding property. Though it is physically present it becomes inactive. So, then in such a case that portion of the binder which has lost it is property, but still physically present it is termed as the dead clay.

Now, what happens first time when we first time prepare the green sand and yes we make the mould this what say dead clay may not be present, but this sand is repeatedly used yes we pour the molten metal, the molten metal solidifies and we break the sand mould and we take the casting outside, the same sand will be remixed and it will be reused to make another mould then what happens? Previous time a part of the binder has lost it is the properties that has become the dead clay. So, dead clay becomes a component of the green sand except the first time, second time onwards there will be dead clay in the moulding sand or the green sand. So, now, we will see these are the green sand components.

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One is the base sand now let us see the components, base and first one second one the binders, binder means the clay next one be additives next one the water this would finally, the dead clay though dead clay we do not add intentionally the part of the binder or the active clay once it what say it comes in contact with the hot metal, it turns into dead clay and this is this becomes a component of the green sand. So, these are the five components of the green sand. Now we will be seeing all these components in detail initially let us see the base sand.

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What is this base sand commonly these are the commonly used to beese base sands, one is the silica sand, second one is the zircon sand, third one olivine sand.

Fourth one chromite sand fifth one aluminium silicate sands these are the commonly used base sands now let us study these sands in detail first let us see the silica sand.

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What is this silica sand? Material used for it is economic advantages and sufficient thermal resistance. So, a silica sand has got the sufficient thermal resistance means it can withstand very high temperatures and it is available abundantly on the riverbeds and also on the sea beds. If we go in the summer are to the side of the riverbeds and we can see there a what say clear sand on the riverbeds. So, this is the a silica sand and we can see these are the silica what say sand beds look like this and again we can see.

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These are the silica sand beds, now this is the silica sand components again silica sand has got three components.

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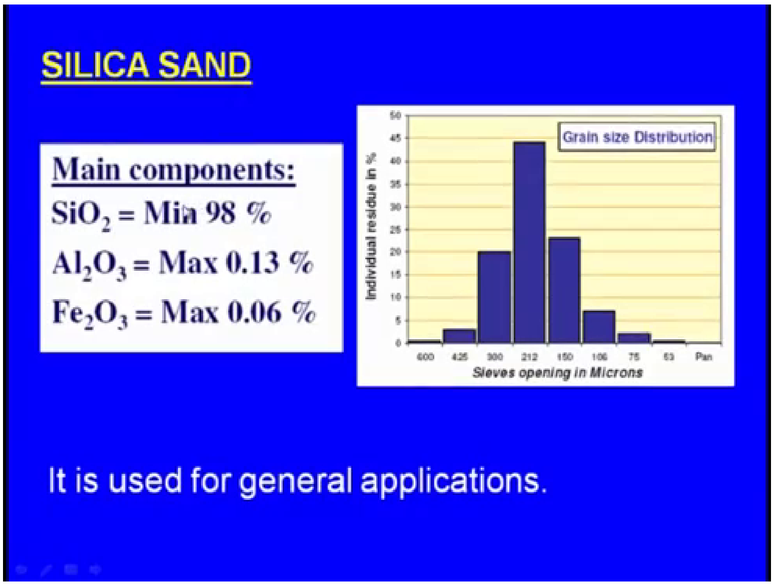

One component is silicon dioxide and it is present up to 98 percent, again it contains aluminium oxide maximum it contains 0.13 percent and also it contains iron oxide up to 0.06 percent and say this is the distribution of the silica sand and it is used for all the general applications.

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So, we have seen the silica sand what is it is source and what is it is chemical composition and what are it is properties and applications we have seen for the silica sand.

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Now, let us see it for the zircon sand. Zircon is the oldest mineral available on the earth are known on the earth. It is also very hard mineral and has a very healthy high melting point that the melting point is 3000 degree centigrade.

It has a very high melting point. So, again we can see these are all the zircon sand lumps and beds we can see here.

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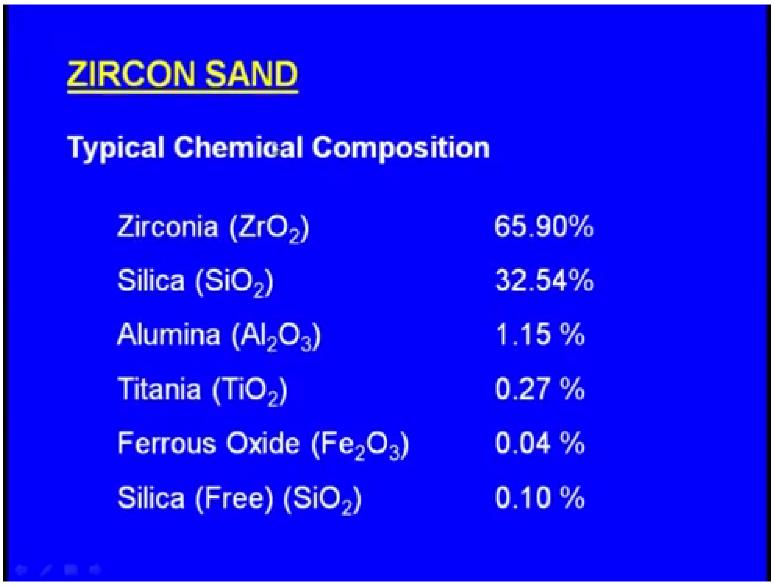

And this is the typical chemical composition of the zircon sand. The zircon sand contains the following the ingredients right. So, the components one is the zirconia Zr O2, it is up to 65.9 percent it contains. Next one it also contains the silicon dioxide up to 32.54 percent, next one zircon sand also contains alumina aluminium oxide 1.15 percent, next one it contains titanium titanium dioxide up to 0.27 percent and it contains ferrous oxide Fe 2 O 3 up to 0.04 percent

next one it contains silica right again the silicon dioxide it contains point free silica up to 0.1 percent this is the general form of the zircon sand.

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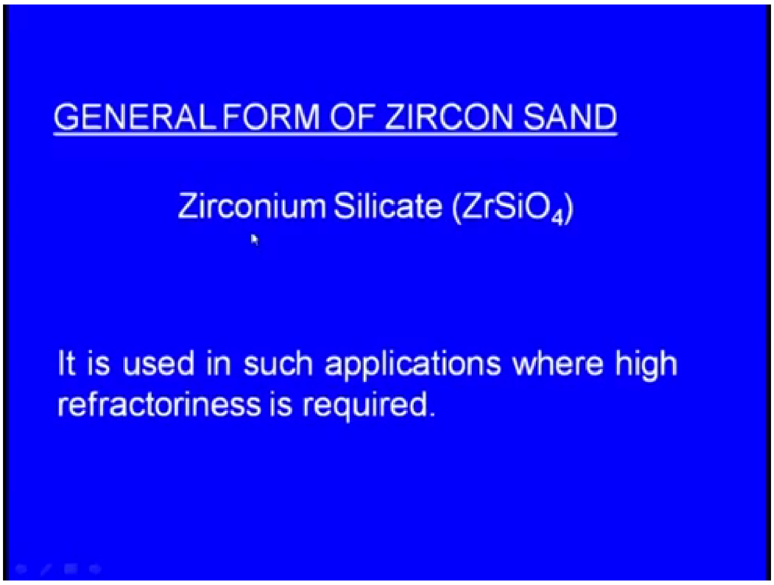

So, in general it appears as the zirconium silicate Zr SiO4 now what is it is application we have seen that the what say silica sand, that is the silica base sand is used for all the general applications what is the application of the zircon sand, it is used in such application where high refractoriness is required. Maybe if we are making a what say alloys or the metals with moderate or the loam what say making temperatures, no need for the zirconium sand we can use the silica sand as the base sand, but if when we are pouring alloys of high temperature high melting temperature.

At such times we need here base sand of higher refractoriness and just constant contains the higher of refractoriness, that is why where high refractoriness is required we use the zircon sand.

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Next one. So, we are learning about the base sands. So, we have also already seen the silica sand and the zircon sand now let us see the olivine sand.

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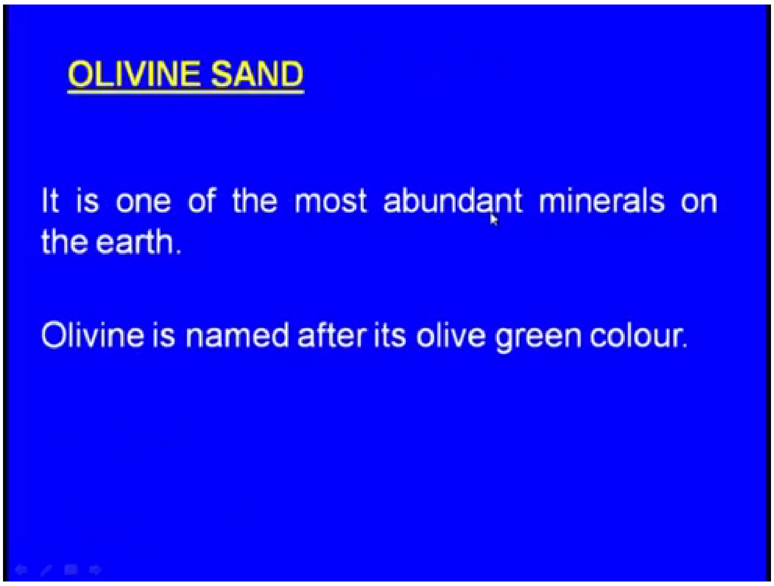

It is one of the most abundant minerals on the earth, olivine is named after it is olivine green color this sand looks green in color.

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Olivine sands source and lumps, here we can see these are the sources under lumps of the olivine sand and they look green in color that is why it is known as the olivine sand and.

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Here we can see a single grain of the olivine sand, you can see this is a single grain of the olivine sand which looks green in color and these are the grains of the olivine sand.

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We can see different sized grains are there all look in green in color, and this is the typical chemical composition of the olivine sand it contains magnesium oxide 46 to 50 percent.

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It contains silicon dioxide 41 to 43 percent, it contains iron oxide 6 to 8 percent and it also contains loss on ignition up to 2 percent maximum 2 percent.

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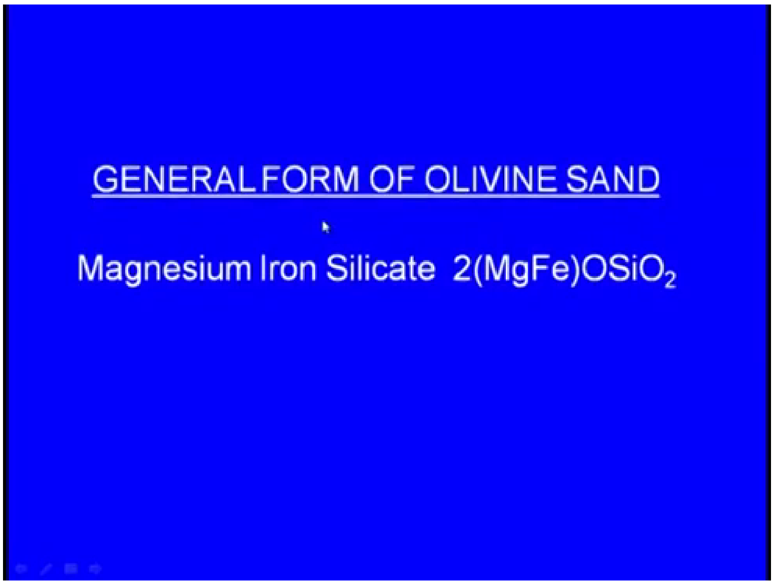

And this is the general form of the olivine sand it is the general form is the magnesium iron silicate 2 Mg Fe O SiO 2. So, this is the chemical composition general chemical composition of the olivine sand.

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And we are seen we are learning about the base sands and we have already seen silica sand zircon sand and the olivine sand, now let us see the chromite sand. Chromite is a by-product of the Ferro chrome production in the Ferro chrome alloy industries.

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So, this comes out as a by-product this is not a natural mineral.

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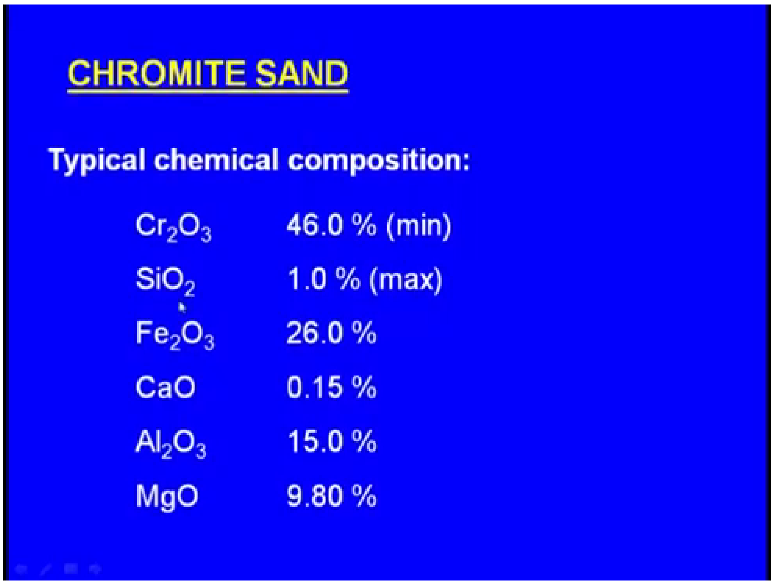

And what is the chemical composition? Yes it contains the chromium oxide 46 percent minimum, next it contains silicon dioxide 1 percent maximum, it contains iron oxide 26 percent, it contains calcium oxide 0.15 percent and it contains aluminium oxide 15 percent finally, it contains magnesium oxide up to 9.8 percent.

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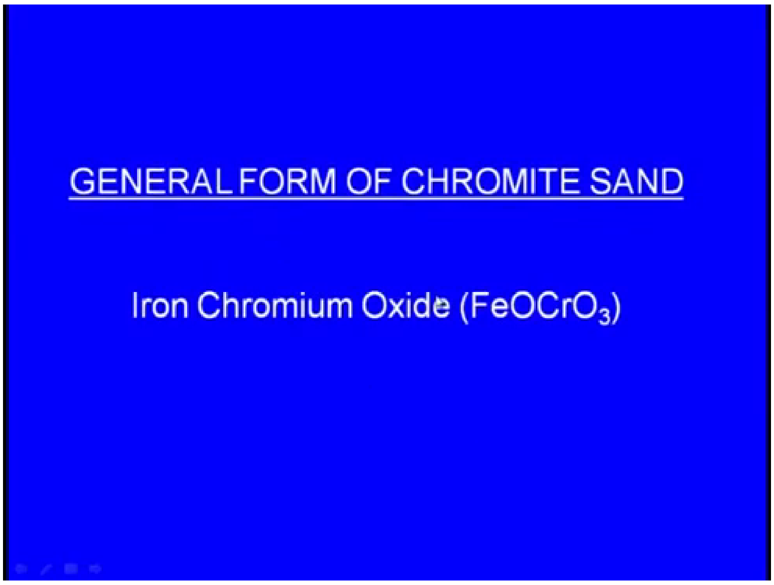

So, these are the different what say elements or the different components present in the chromite sand. This is the general form of the chromite sand it appears as the iron chromium oxide FeO C r O3. So, this is the general form of the chromite sand. We have seen silica sand zircon sand olivine sand chromite sand now let us see the aluminium silicate sand aluminium silicate right.

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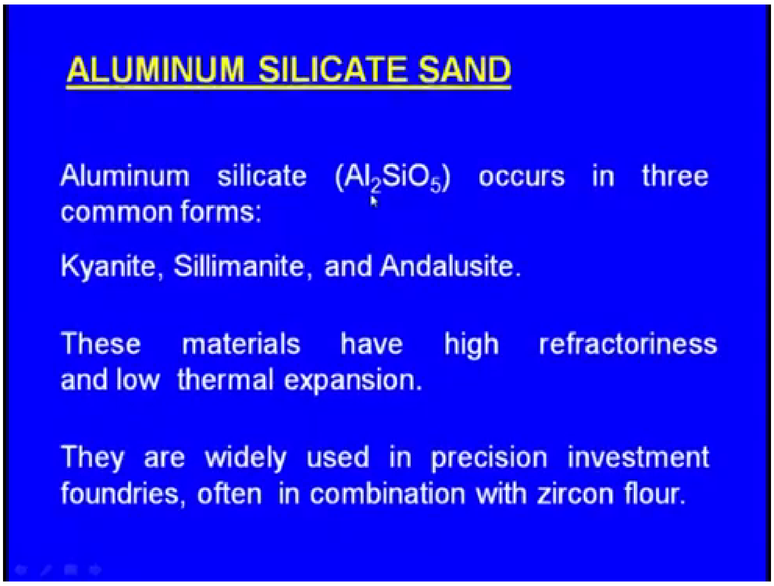

Its chemical formula is Al 2 SiO5 occurs in three common forms right one is the Kyanite, next one the Sillimanite next one the Andalusite. These three minerals have high refractoriness and low thermal expansion; they are widely used in the precision investment casting foundries and often in combination with the zircon floor right.

So, these may not be used in the commonly used in the green sand moulding, but we have seen that what say under the special casting process, there is a process called investment casting process where the pattern is made up of the wax right. So, around the wax we give a ceramic slurry coating repeatedly we will give the ceramic slurry coating, after your shell is created what we do? We heat the system and write the wax inside the shell will be drained out then we pour the molten metal into the shell right. In that process this sand is used and r all right this aluminium silicate sand in combination with the zircon sand it is used.

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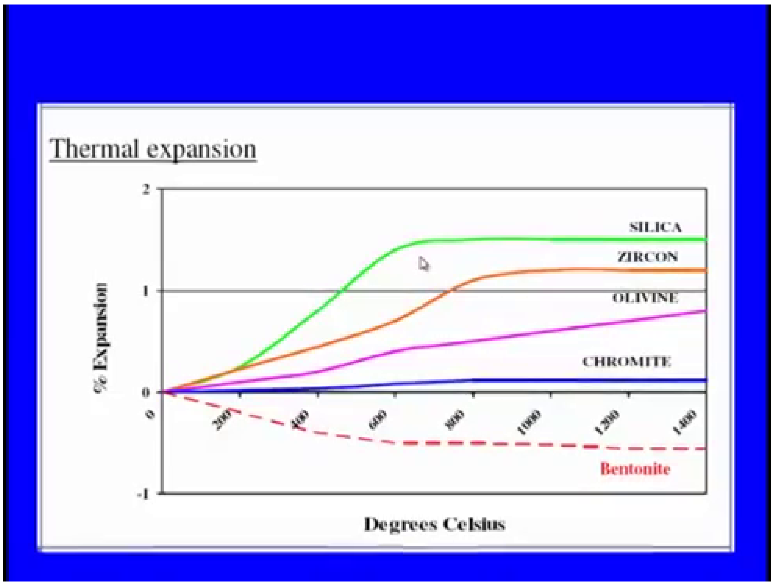

Now, let us see the what say a thermal behaviour of these sands, what happens right. So, this is the y axis is the percentage expansion and x axis is the what say pouring temperature or the temperature and it is behaviour corresponding to the temperature we can see on the y axis. Let us see the silica sand this green colored one indicates the what say silica sands behaviour, thermal behaviour now it to starts expanding what reasonably from 200 degrees centigrade onwards. Now when it comes to 600 degree centigrade what happens it reaches the maximum expansion and that expansion continues till about 1400 degrees centigrade. So, silica sand has the highest thermal expansion. Next one let us see the zircon sand the zircon sand is again it starts what say expanding right.

From 0 degrees and it what say continuously it is expanding up to 600, at about 600 degree centigrade it what say considerably what say increases expands more and yes and this is it is expansion behaviour and it is expansion means little lower than the expansion of the silica sand. Next one we will see the olivine sand this pink colored one indicates the thermal behaviour of the olivine sand.

Now, we can see here it is it is a yes the temperature is increasing it is it starts expanding yes maybe at about 600, it is more expanding and yes it is continuously expanding, but certainly it is expansion is lower than the expansion of silicon and zircon sands finally, we will see the chromate sand. Now this blue colored one line indicates the thermal behaviour of the chromite sand.

We can see up to almost up to 400 degree centigrade, there is no thermal expansion it is thermally stable and may be at about to 800 degree centigrade it will what say expands a little and it continues even after 1400 degree centigrade, it continues to be what say it contains a little expansion it shows the little expansion. Now when we compare all these sand zircon sand olivine sand and chromite sand silica sand has the highest thermal expansion and next to that zircon sands expansion is small and below zircon sand olivine sand is the one which occupies below the zircon sand and remember that chromite sand has the minimum thermal expansion it is thermally stable.

But it is costly now here we can also see this is the thermal behaviour of the bentonite. Bentonite means it is a what say binder we will see we will study about this bentonite after the sometime, now these are the base sand materials right yes.

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BASE SAND MATERIALS

	SILICA	CHROMITE	ZIRCON	OLIVINE
Formula	SiO_2	FeO Cr O_3	Zr Si O_4	2 (MgFe) O SiO_2
Specific Density	2.65	4.3	4.7	3.5
Bulk density	1.6	2.7	2.8	1.95
Sinterpoint	1730	2095	>2200	1857
Thermal conductivity	Low	High	High	Low
Reaction mold/metal	High	Low	Low	Low
Utilisation	All metals	Steel & Manganese	Steel	Steel
Disponibility	High	Very low	Very Low	Good
Price	Low	High	High	Medium

We can see here silica sand chromite sand zircon sand and olivine sand right and formula of the silica sand is silicon dioxide SioO2 and it is a specific density is 2.65 right and it is bulk density is 1.6 and it is sintering point is 1730 degree centigrade and thermal conductivity is low and reaction is high and utilization with almost all the metals it can be used and it is what say it is it has got the price is low and.

Coming to the chromite sand and it is chemical formula is FeO CrO3 and this is the specific density and this is the bulk density and sintering point is 2095 degree centigrade and our thermal conductor is high and reaction with the molten metal is low and utilization it is used for the steel and manganese castings and right it has got the higher price. Next one which is the zircon sand and it is chemical formula is Zr Sio4 and this is the specific density and bulk density and the sintering point is more than 2200 degree centigrade. A thermal conductivity is very high and reaction with the molten metal low and utilization it is used for the steel castings and price is high.

Next one this is the olivine sand. So, this is the chemical formula 2 Mg Fe O SiO 2 and this is the specific density and this is the bulk density and the sintering point is 1857 degree centigrade, thermal conductivity is low and reaction with the molten metal low and utilization it is used for the steel castings and price is medium or the moderate.

Now, we will see the binders, we have already completed the base sands and we have seen the different types of the base sands and their origin and applications and their chemical constraints we have seen.

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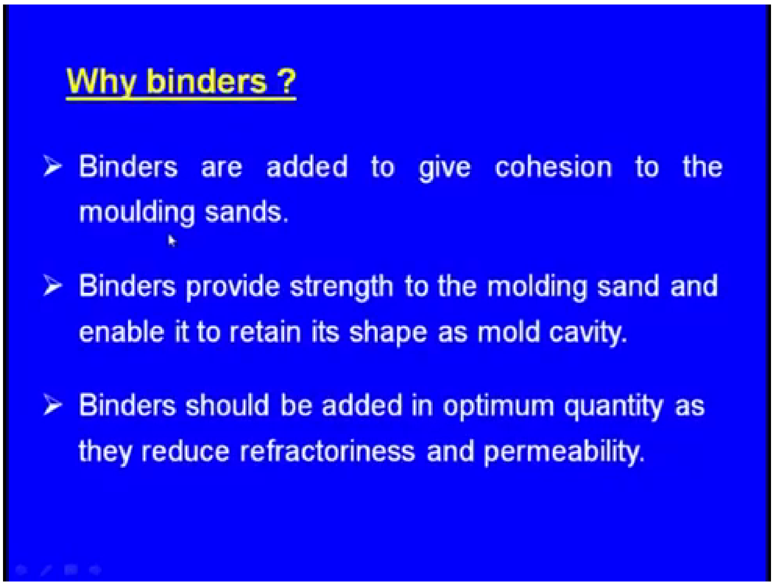

Now, let us see the binders first of all the question is why we have to use the binder. Binders are added to give cohesion to the moulding sands, cohesions means ability of the moulding sand particles to stick to each other that is the cohesion. So, the binders enable cohesion to the moulding sands.

Next one binders provide strength to the moulding sand and enable it to retain it is shape and mould cavity. It also it gives the cohesion property not only that it enables to gain strength and oh retain it is shape of we compact the sand. So, that is the purpose of the binder; next one binders should be added in optimal quantity as they reduce the refractoriness and permeability these binders are the fine powders right. So, there is a property called permeability for the moulding sand. Permeability means ability of the moulding sand to allow hot gases to pass through the neighbouring sand grains like this like this it has to enable through the neighbour neighbouring particles.

So, what happens when we add excessive of binder, it fills with those what say gaps between the neighbouring of grains and the ability of the steam or the hot gases to escape through the neighbouring grains comes down drastically, but we need it unless we add the binder we cannot get the cohesion, unless we add the binder we cannot get the strength that is why we must add the binder, but it must be optimum then and we have to balance the strength the cohesion and also the permeability we have to balance, that is why we have to add the binders in an optimum quantity.

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These are the common binders used in the green sand, one is the Bentonite another one is the fireclay next one Illite, next one Limonite, next one Kaolnite. So, these are the common binders used for the green sand mixing now let us see all these binders one by one.

First let us see the Bentonite what is Bentonite? Most of the time this is the main clay or the main binder important binder used in the moulding sand; many a times people use bento what say in the for what the word clay instead of using the clay or instead of using the binder they use the word Bentonite. So, it is so important and it has become very popular among all the binders.

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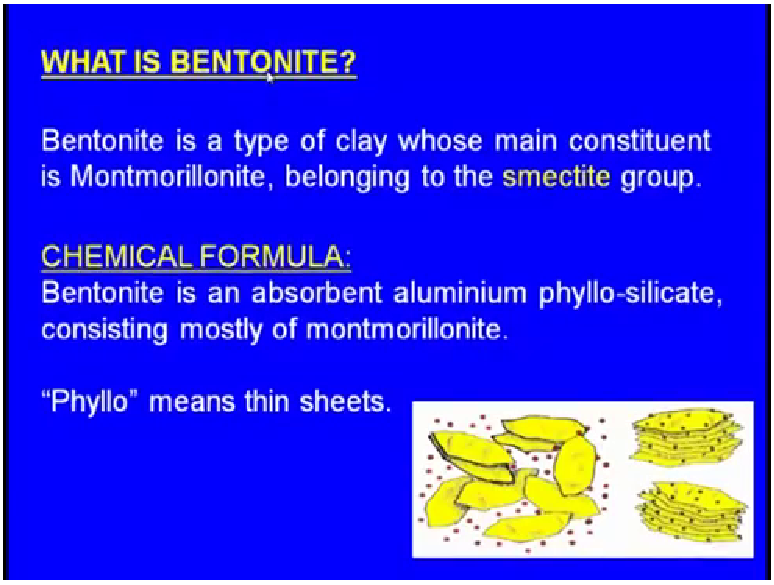

First of all what is this Bentonite? Bentonite is a type of clay whose main constituent is right montmorillonite belonging to the smectite group, and what is it is chemical formula? Bentonite is an absorbent aluminium phyllosilicate consisting mostly of montmorillonite here we can see word Phyllo. Phyllo means thin sheets means it is available in the form of thin lamellar sheets that is the physical structure of the bentonite.

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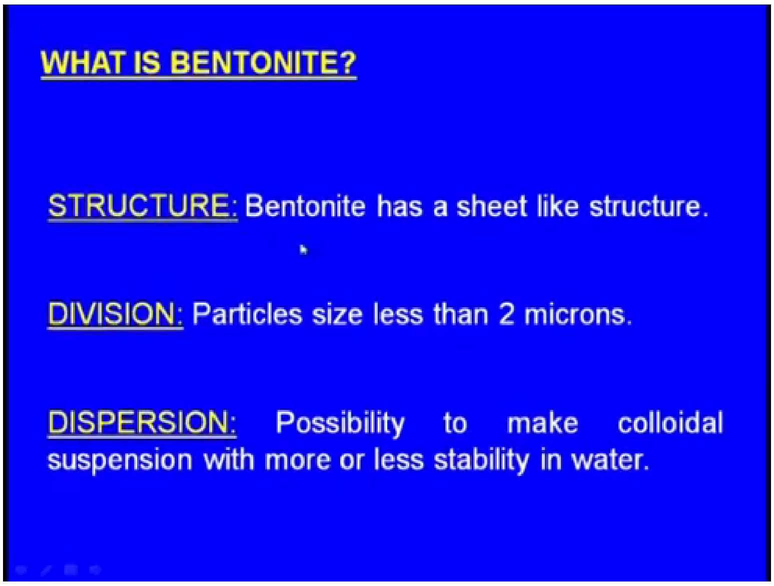

Next one it is a structure bentonite has a sheet like structure just now we have seen right and it is the division particle size is less than two microns. Dispersion possibility to make colloidal suspension with more or less stability in water. Now what is the source of Bentonite? Bentonite is a relatively soft stone formed over geological time by the natural alteration of volcanic tough due to acid or alkal alkaline rain.

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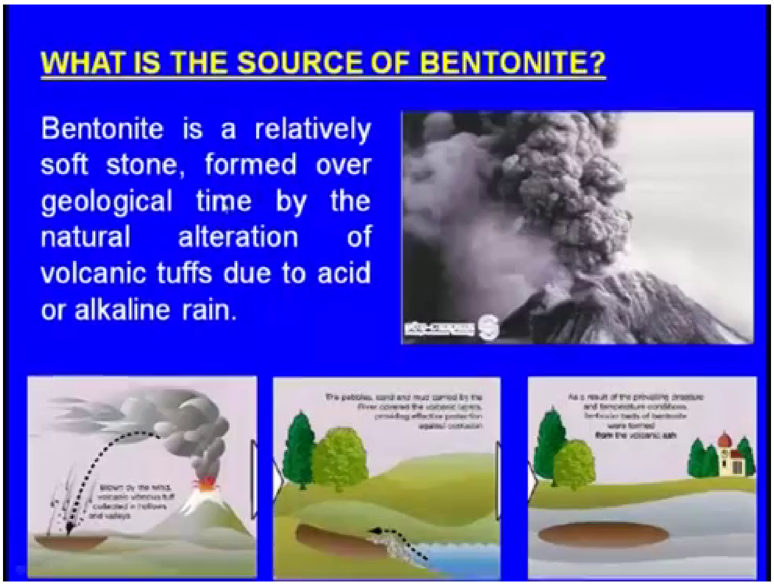

So, bentonite comes from the what say volcanic toughs. So, this volcanic say toughs are on a laid underground for several years and over that we can see acid rains or alkaline rains will be there and because of that we get the Bentonite, and bentonite will be inside the ground and we can take it out side that is the source of the bentonite and this is how we can get the bentonite.

Initially this is the mining plate. So, this mining say often we can see these bentonite mines where there is a what say previously there was volcanic eruption right.

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So, next this is the exploitation right with missionary we have to take it that material. Next one and this is this the stocking, next one it is the activation and after that there will be drying and milling finally, it is the packing. So, this is the right a bentonite from mining to the foundry right. So, here we can see first stage is the mining exploiration exploration, next one mining exploitation, next one raw um me material stocking.

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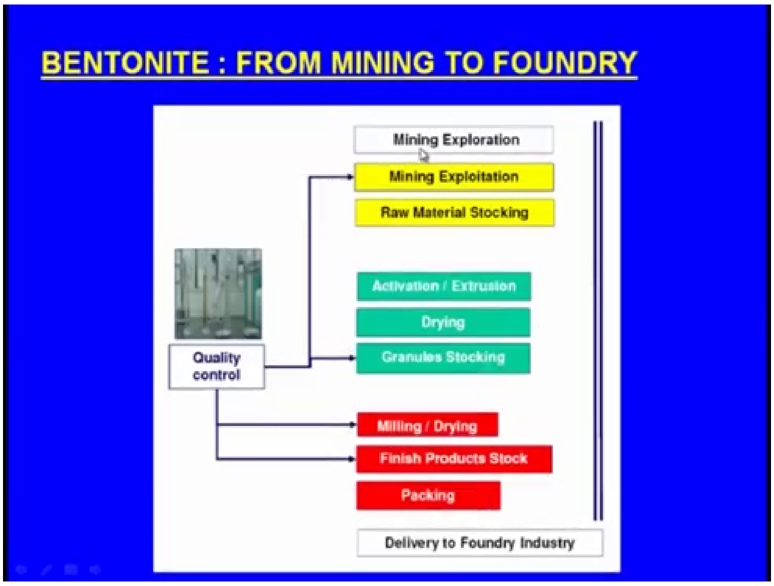

We can see here next one activation next one drying right next one stocking and finally, we can see a milling right.

A finished products to stock and packing and delivery to the foundry industries. Now the question is why it is called as Bentonite.

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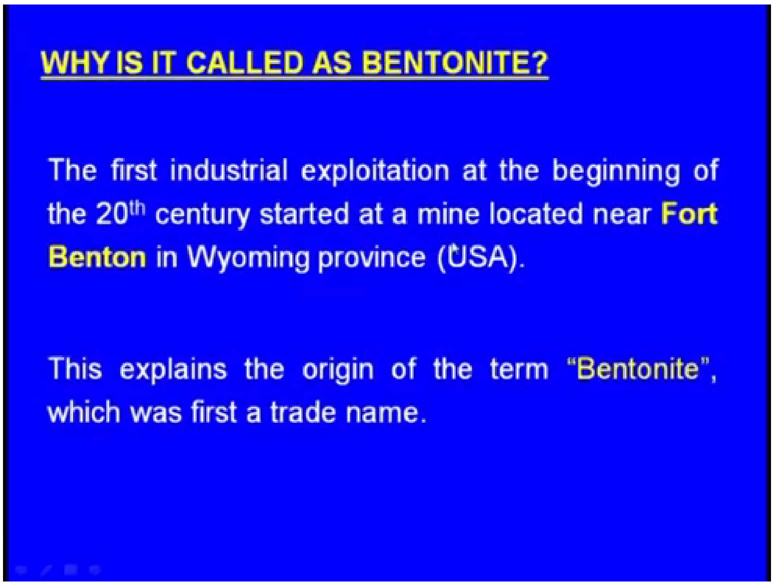

The first industrial exploitation at the beginning of the twentieth century started at a mine located near forth benton in Wyoming province USA. This industrial exploitation of bentonite was done in a place called fort benton in USA, that is why it is known as the Bentonite, this explains the origin of the term bentonite which was first a trade name.

How does bentonite absorb moisture that is the question right. So, why we are adding this bentonite this bentonite is a binder or a clay why? It what say first of all it improves the cohesiveness of the moulding sand.

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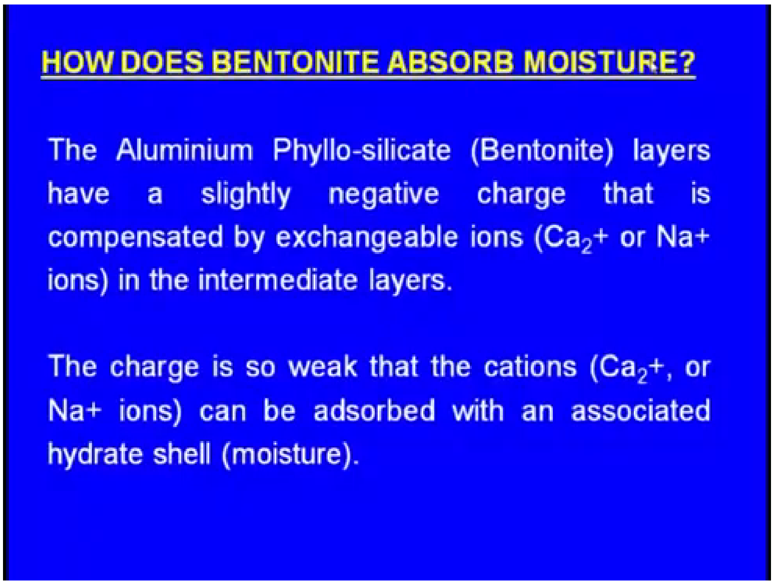

It induces the strength to the moulding sand right.

The aluminium phyllosilicate bentonite layers have a slightly negative charge that is compensated by the exchangeable ions right calcium ion or the sodium ion in the intermediate layers. The charge is so weak, that the cations calcium ions or the sodium ions can be adsorbed with an associated hydrate shell moisture; here we can see bentonite layer structure.

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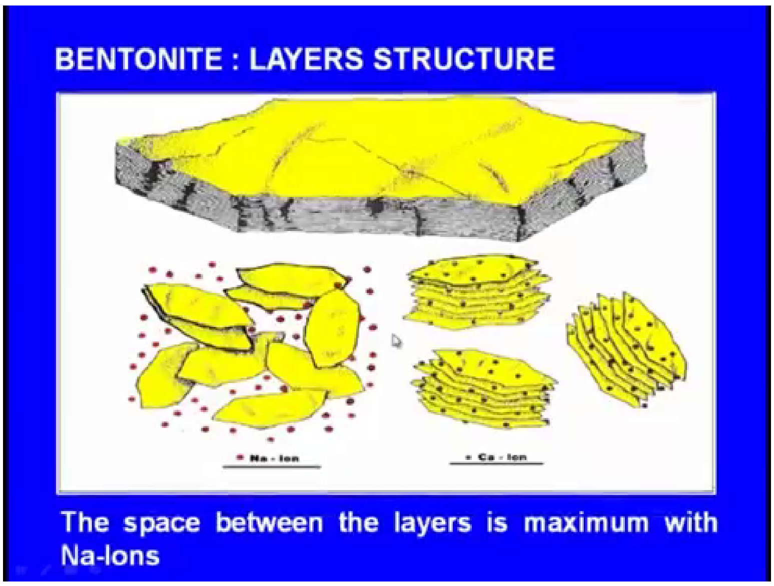

And here we can see it is present in the form of the sheet like structure layered structure and we can see this is the sodium ion and here we can see calcium ion. The space between this layers is maximum with the sodium ions how does bentonite act as a binder that is the next question, and here we can see this is a sand grain this is a sand grain and this is a sand grain and.

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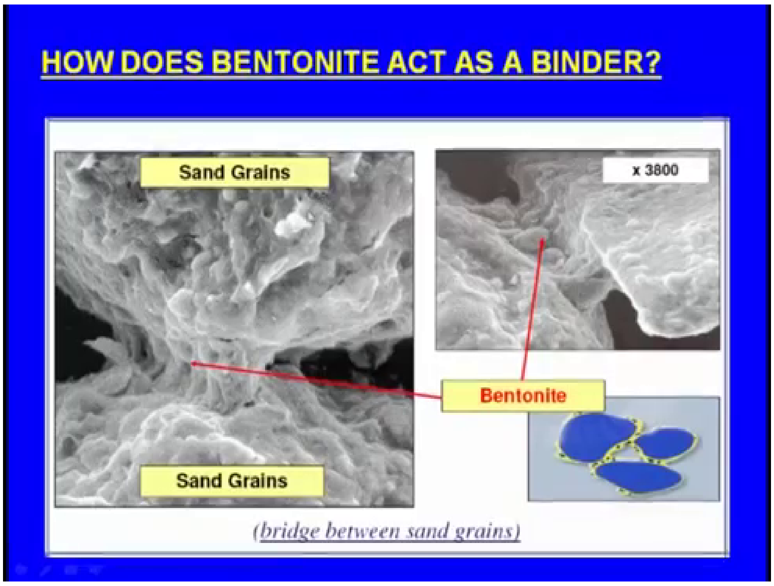

Here we can see this is the bentonite it what say acts as a bridge between the sand grain and sand grain, what say it what say holds both the sand grains together by forming a bridge and same thing we can see here also. So, that is how it makes a bridge between the sand grains and holds them together that is how it improves the cohesiveness of the moulding sand.

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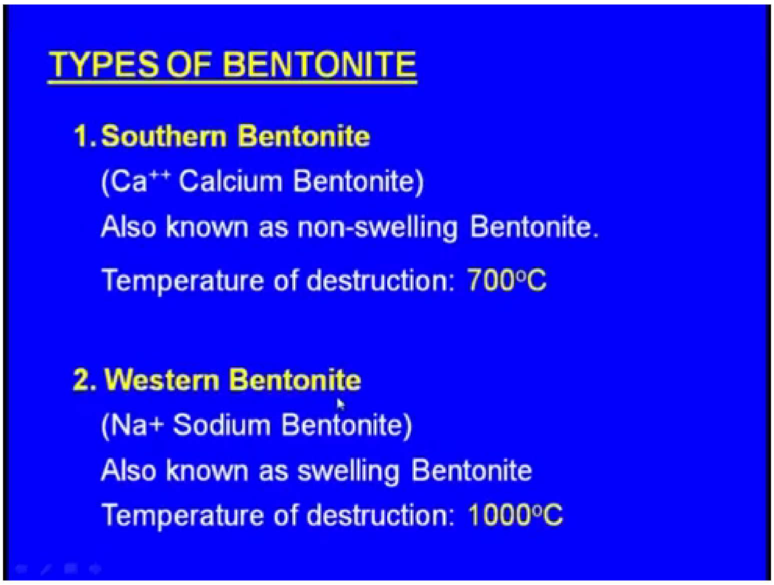

These are the types of the Bentonite; one is the southern bentonite and another one is the western Bentonite. Southern bentonite is also known as calcium bentonite it is also known as non swelling bentonite and it is the temperature of destruction is 700 degrees centigrade. Coming to the western bentonite it is also known as sodium bentonite and it is also known as swelling bentonite and it is temperature of destruction is thousand degrees centigrade.

Sometime back we have seen that that clay loses it is properties right when it comes in contacts with the molten metal yes these are such temperatures. See southern bentonites loses it is property when it is heated up to 700 degree centigrade whereas, western bentonite it loses it is property when it comes here what say when it is temperature crosses 1000 degree centigrade. Once they cross these temperatures they become the they are termed as the dead clays.

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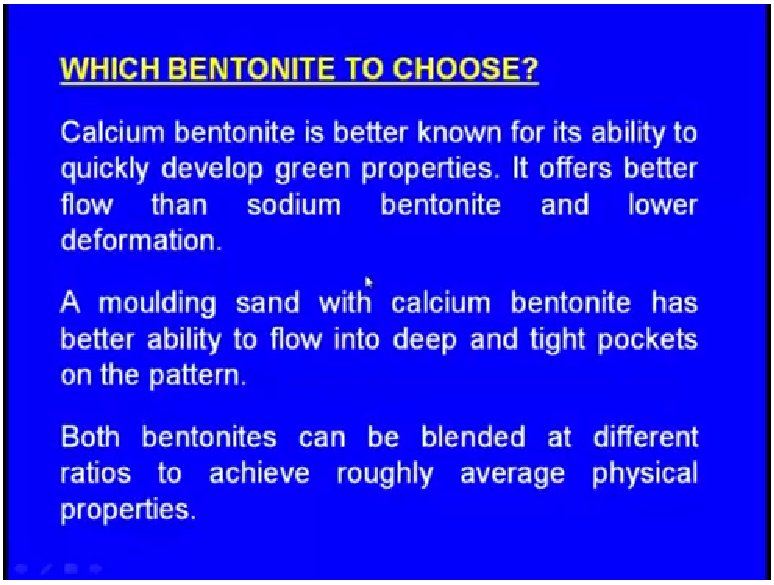

Which bentonite to choose that is the first question. We have seen that there are two types of the bentonites southern bentonite and the western bentonite which bentonite to choose.

Calcium bentonite is better known for it is the ability to quickly develop green properties. It offers better flow than sodium bentonite and lower deformation it offers lower deformation. A moulding sand with calcium bentonite has better ability to flow into the deep and tight pockets around the pattern that is why the both bentonites can be blended at different ratios to achieve roughly average physical properties. So, we have completed the bentonite.

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Next we will see the of fireclay right. So, fireclay you see a next what say binder or the next clay among the binders, it is used next to the bentonite what is this fireclay.

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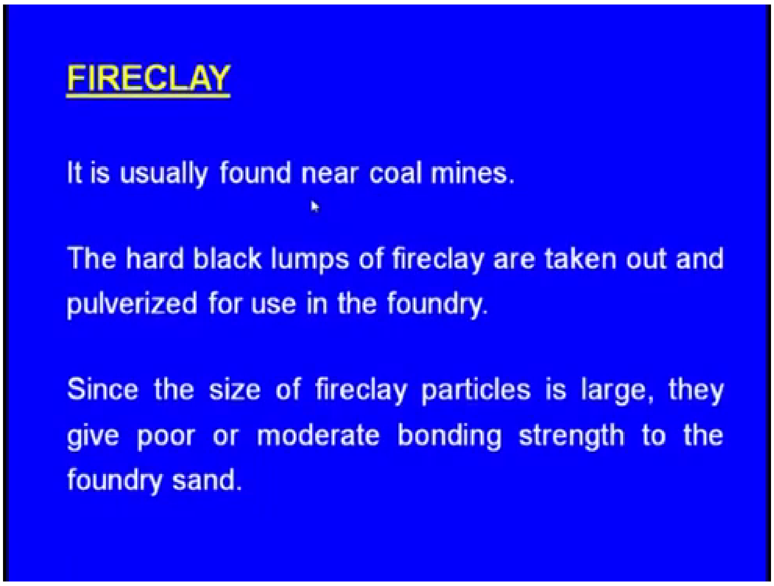

It is usually found near the coal mines right the hard black lumps of fireclay are taken out and pulverized for use in the foundry. Since the size of the fireclay particles is very large they give pour or moderate bonding strength to the foundry sand right. So, it is used all right usually found near the coal mines.

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So, this is the typical appearance of the fireclay, next one we will see the illite. Illite is found in natural moulding sands that are formed by the decomposition of micaceous materials due to weathering right. So, it is found right in the natural moulding sands.

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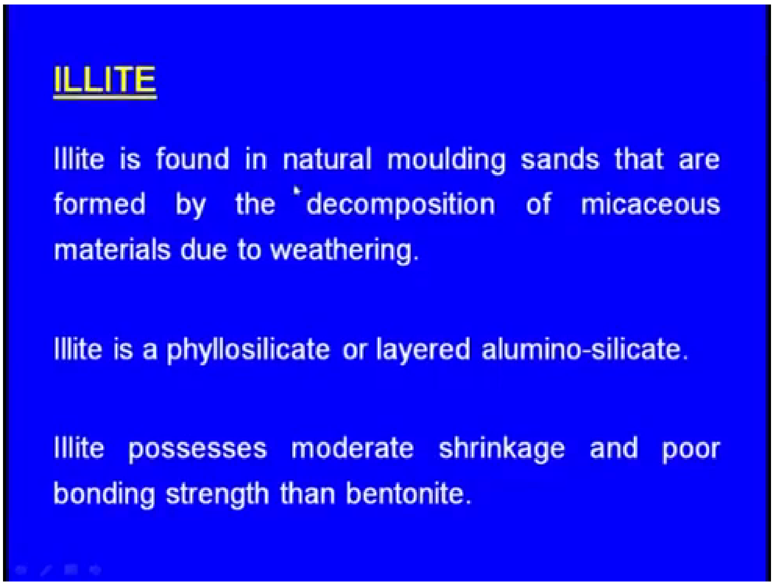

Illite is a phyllosilicate or layered aluminium silicate here also we can see the word phyllo. Phyllo means layers a what say layered on leaf like structures illite possesses moderate shrinkage and poor bonding strength than the bentonite. So, a bentonite is widely use next bentonite this illite is used.

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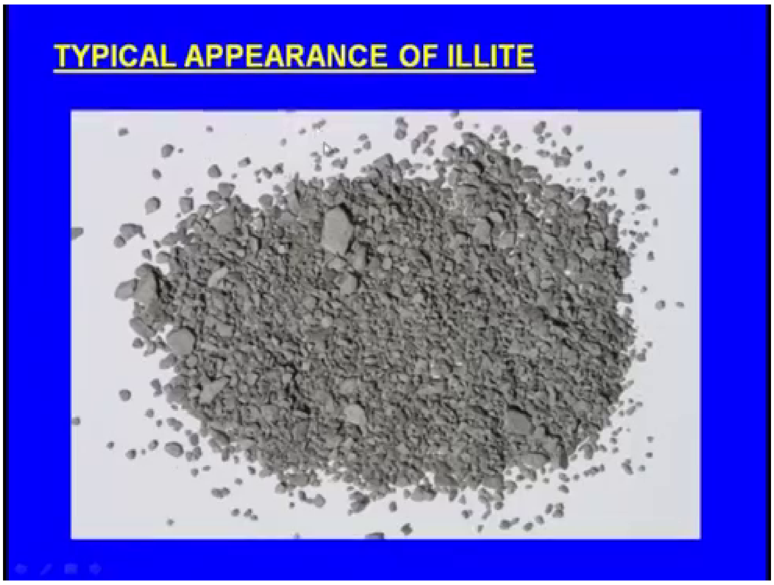

So, this is the typical appearance of the illite.

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Next let us see the limonite. Limonite is an iron ore consisting of a mixture of hydrated iron oxide and hydroxides in varying composition right. So, the chemical composition is FeO OH and n H 2 O right this n varies right and this is the limonite ore and a limonite deposit from the mine and here we can see this is the limonite deposit. So, this limonite is the another binder used for developing the strength and the cohesiveness of the moulding sand finally, we will see the kaolinite.

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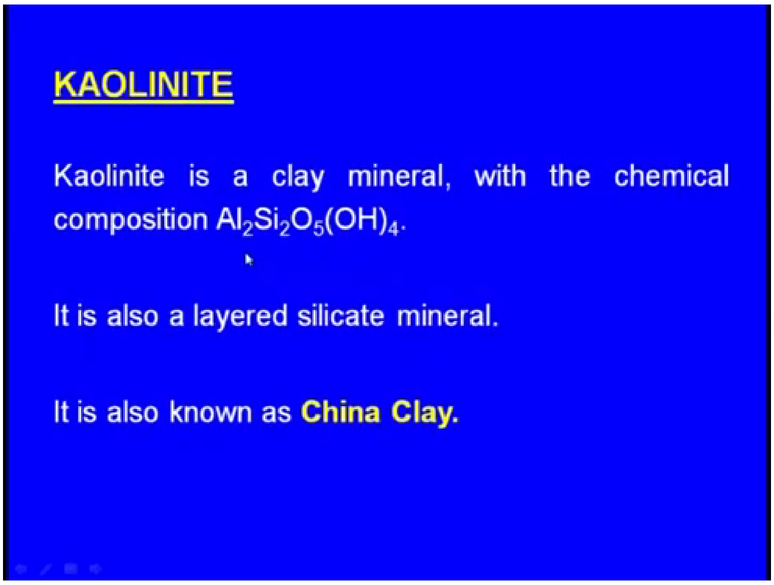

Kaolinite is a clay mineral with the chemical composition alumin Al o 2 SiO2 O 5 and in brackets it is OH4. So, this is the chemical composition of the kaolinite.

Next one it is also a layered silicate mineral like Bentonite, it is also known as china clay.

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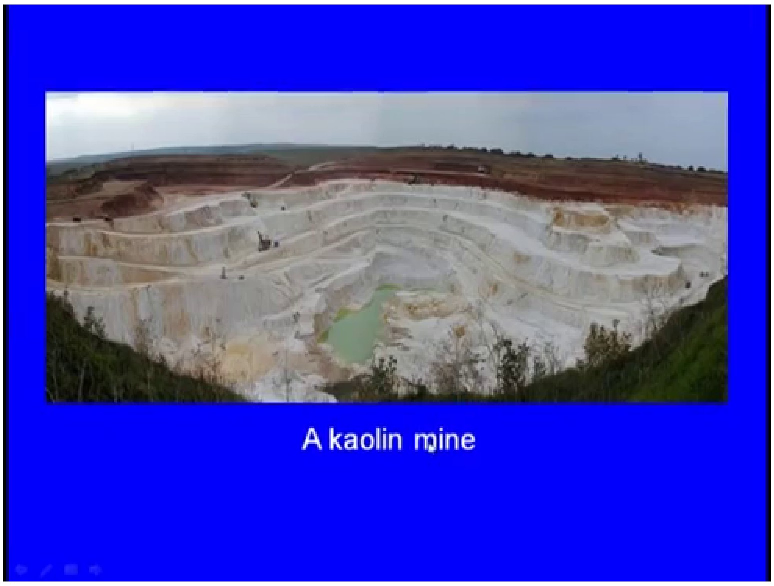

And this is the what say typical mine of the kaolin and here we can see this is all the kaolin. Friends till now we are learning about the moulding sands and we have seen the moulding sand ingredients right the base sand, the binder, the additives, the moisture, the dead clay we have seen and among this we have covered so far the base sands and the binders. We will continue with the remaining ingredients in the next lecture.

Thank you.