Construction Methods and Equipment Management
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Lecture – 20
Concreting Equipment (Part 1)

Hello, everyone. I welcome you all to the lecture 20 of this course, construction methods and equipment management. In today's lecture, we are going to discuss about the concreting equipments.

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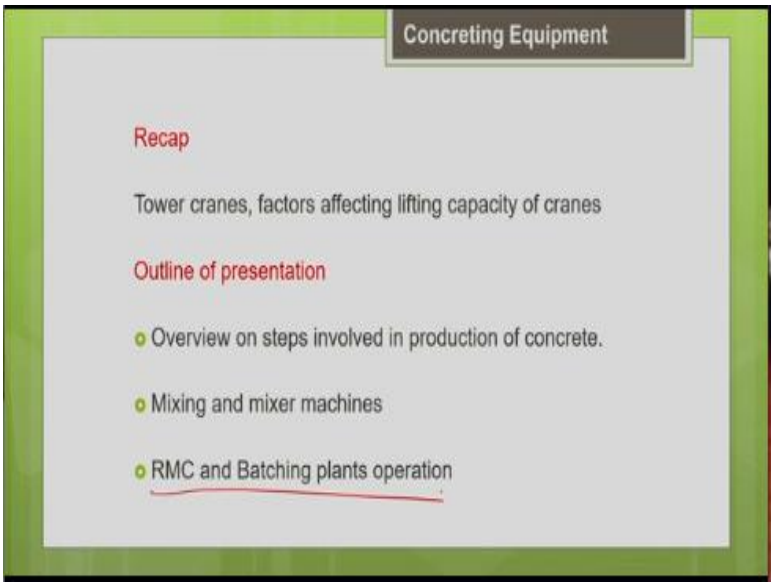

So, in the last lecture, we have discussed about the tower cranes and about the factors which affects the lifting capacity of the cranes. So, let us look into the outline of today's presentation. In today's presentation, we are going to discuss about the basic steps involved in the production of concrete. And we will be discussing in detail about the different types of concrete mixer machines. And we will be discussing operation of the ready-mix batching plant.

So, in this lecture, we are going to discuss much about the concrete. I assume that we might have been exposed to the concrete in any other material related course. So, we will be directly discussing more about the concreting equipment. But basically, as everyone knows, concrete is a composite material.

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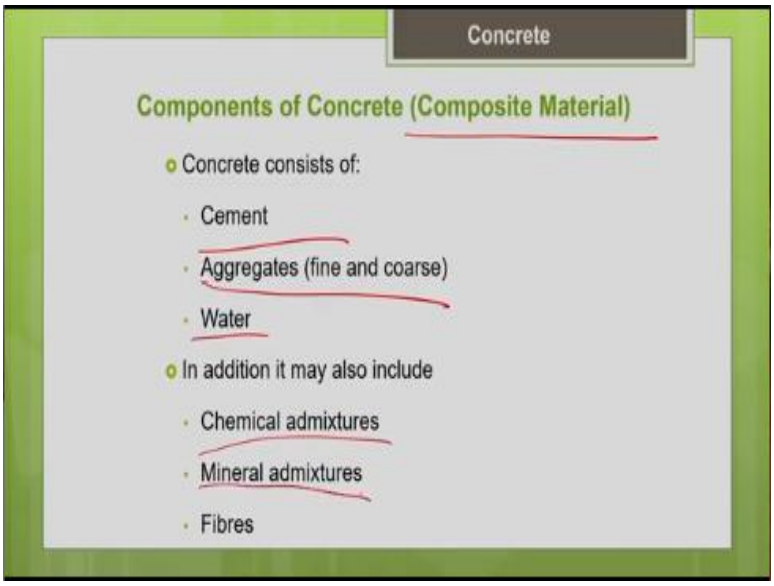

It is made up of different ingredients like cement, aggregate and water. So, other than these conventional ingredients, nowadays, we use modern admixtures also, chemical base admixtures, mineral base admixtures. So, in order to improve the performance of concrete in terms of strength, workability and durability, using different types of admixtures.

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So, now, let us look into the what are all the basic steps involved in the production of concrete. So, the first thing is to produce the concrete, we need to know the mix proportions. So, we need to do the concrete mix design or mix proportioning. So, to know how much quantity of cement, aggregate and water to be added for making a concrete of desired strength, workability and durability.

So, there are standard mix design guidelines which vary from country to country. Like, for India, we have these Indian standard guidelines, we have the ISO code guidelines for that. And similarly, we have the ACI guidelines. There is American Concrete Institute guidelines and we also have the British general guidelines. So, we can follow the standard guidelines to the mix proportioning of the concrete to get your desired strength, workability and durability.

So, once the mix design is done, the next step will be the batching. You have to measure the ingredients. That is what is batching, then mix it. So, we can use the mixer machines to mix the concrete and after mixing it, transported to the require place where you need to do the concreting work or where you need to cast your concrete, then place it, then consolidate it or consolidate is nothing but commonly adopted vibration methods to eliminate the entrapped air.

So, whatever air which is in entrap during the mixing of concrete can be removed by the consolidation process. Then finally, you finish it to the require texture according to your requirement. Then the last step will be curing of the concrete to facilitate the continued hydration of the concrete, so that we can attain the desired strength. So, these are the basic steps involved in the production of the concrete. We are going to discuss all these steps one by one in detail in the upcoming slides.

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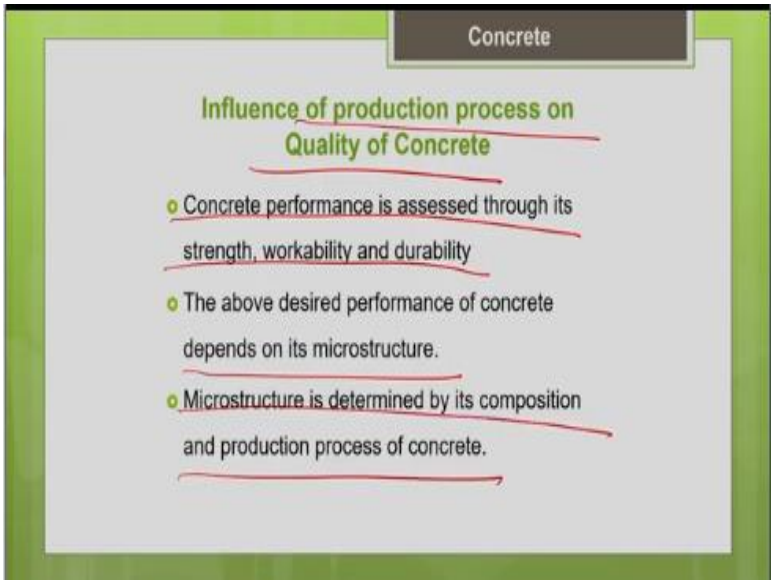

So, an important thing to be noted is that the production processes as a significant influence on the quality of your concrete. So, generally, we assess the quality of the concrete or assess the performance of the concrete in terms of its strength, workability and durability. Concrete performance is assessed through its strength, workability and durability. So, you can get your desired performance provided your concrete as desired microstructure.

So, all this strength, durability, everything depends upon the microstructure of the concrete. To get the desired microstructure, need to have a good control in the quality control in the production process right from the mix design because microstructure will depend upon the mix composition, how much quantity of aggregates and how much quantity of cement, everything is going to decide the microstructure of concrete.

So, starting from the mix design, we should have a strict control in the quantity. So, and also, how we mix the contribution, mix in such a way that you get a homogenous mix. So, there is a uniform coating of spacer on the aggregate that will result in a good microstructure. Similarly, you need to consolidate the concrete. So, that all the unwanted entrapped air is removed. So that we can get good microstructure.

So, your microstructure is going to be determined by the composition and the production process of the concrete that is why it exercise a good quality control in the production procedure of the concrete.

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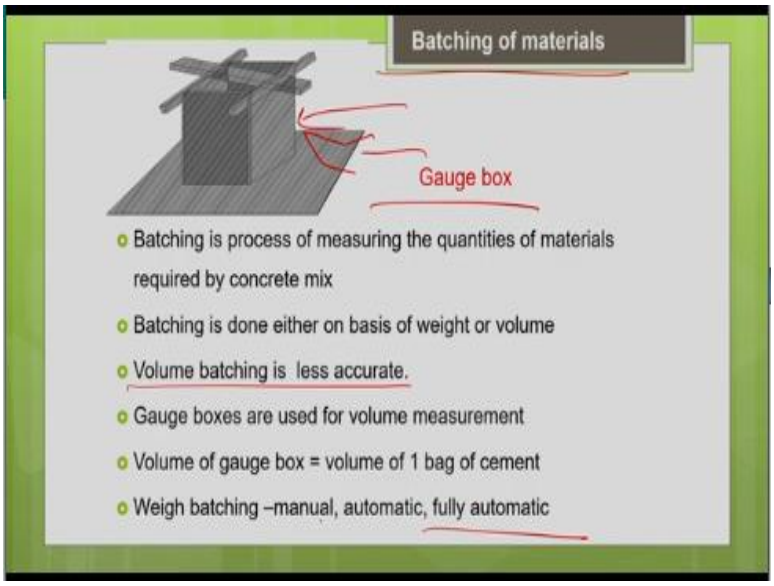

So, let us start with the first step like once you do that mix design, once you know the mix proportions, you need to first batch, do the batching of the material. Batching is nothing but measurement of your quantity of material. This, you can either do it on volumetric basis or you can do it on weigh basis. Very commonly, you can see that in the project sites, people prefer volumetric only because it is very convenient to them to measure on basis volume.

They use the gauge boxes; these boxes are standard wooden boxes or steel boxes. Volume of one-gauge box equal to volume one bag of cement. So, they use this for the measurement of the ingredients of the concrete but one thing to be noted is the volume batching is less accurate when compared to the weigh batching. So, for example, the sand which we are going to use for concrete making is that, so, you are going to measure the wet sand using this gauge box.

So, you know that sand will bulk; when it is moisture, content increases. So, depending upon the fineness of the sand, more finer the sand, it will bulk more. So, due to bulking, its volume appears more but the actual weight will be less. So, if you are going to measure the sand using this gauge box, so, what will happen? You are going to, your mix will become under sanded. Because the volume may appear right but actual weight will be less because your sand is wet.

So, that is why it is result in inaccurate measurement and your mix composition of the concrete gets affected; your mix becomes under sanded. When the mix becomes under sanded, what will

happen? It will become less cohesive and that may result in segregation of your concrete. So, all these things are fixed microstructure of the concrete, strength and the durability of a concrete. So, that is why volume batching is less accurate.

To get a good quality of concrete, we should always go for weigh batching. So, batching plan if you see always the batching of the material is done on the weight basis. So, depending upon the batching plan, in some batching plans, we have fully automated system. You just need to enter the weight of the material, weight of cement, weight of aggregate, then the exact quantity of the cement will be discharged from the cement silos conveyor, belt conveyor into the mixer machine.

Similarly, the exact quantity of the aggregate will be released from the aggregate storage bins and it will be conveyed by the conveyor and carry to the mixer machine directly. So, we have fully automated batch systems available, weighing batch systems available in the model, RMC batching plan. So, there are different types of weigh batching: fully automatic or semi automatic or manual.

So, different types of batching systems are there, but one thing you have to always keep in mind that weigh batching is always accurate when compared to the volume batching. So, it is always preferable to go for weigh batching to get a good quality of concrete.

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So, next is about the job batched concrete versus central batch concrete. So, the basic difference is job batched means you are going to prepare the concrete at a job site. Central batched concrete means, your concrete will be prepared in the batching plant. It will be prepared in the batching plant and it will be brought to the job site in RMC transit mixer. So, that is a basic difference between job batched concrete and central batched concrete.

So, when do we generally go for job batched concrete? How do you make the decision to go for whether the job batched or central batched? It may be depends upon the location of your project site. If your job site is located in a very remote place, where it would be very difficult for the RMC transit mixer to deliver the concrete within the stipulated time, then in that case, you have to go for a job batched concrete.

So, it depends upon the location of your job site. Similarly, sometimes, you can see that your jobs may be located in a traffic congested place. In that place also due to traffic delays, it may not be possible for the transit mixer to deliver your concrete within the stipulated time. So, in that case also, you have to go for only the job batched concrete.

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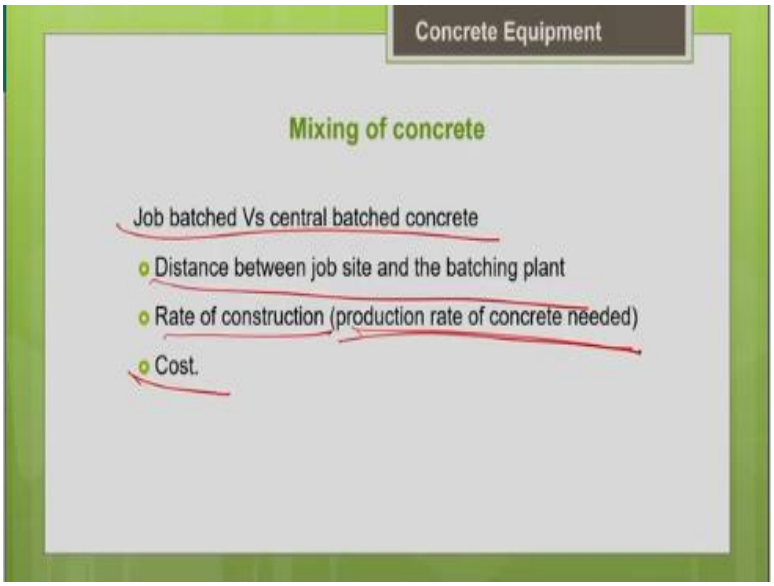

So, the decision of going for job batch or central batch mainly depends upon the distance between your job site and the batching plant. Another important thing is your rate of construction. So, how much quantity of concrete you need per hour or per day? The production rate of concrete needed

that also decides the selection of job batching or central batching. If we need huge quantity of concrete every day, the rate of construction is very high.

And the production rate of concrete needed is very high. In that case, it is always advisable to have your own batching plant at your site and make the concrete because we need huge volume of concrete on a daily basis. So, it may not be possible for the RMC batching plant to deliver to you on a continuous basis because they will be having so many customers. So, there is no assurance that you will be receiving the concrete on the continuous basis from the RMC factory.

So, if your production rate of concrete, the requirement of concrete volume needed is more, then it is advisable to have you bought batching plant at your site and produce a concrete that will be even more economical also, then on cost basis. Obviously, when compared to job batch, the central batch concrete is going to be costlier. It is manufactured in the factory under strict quality control.

So, the quality of concrete is also good when you get it from this factory, central batching plant and also at the same time, it is going to be costlier when compared to the job batch concrete. So, the economics, the budget, a project budget will also decide whether to go for job batched or central batched. So, based on all these factors, we have to make a decision whether to go for a job batched to central batched concrete.

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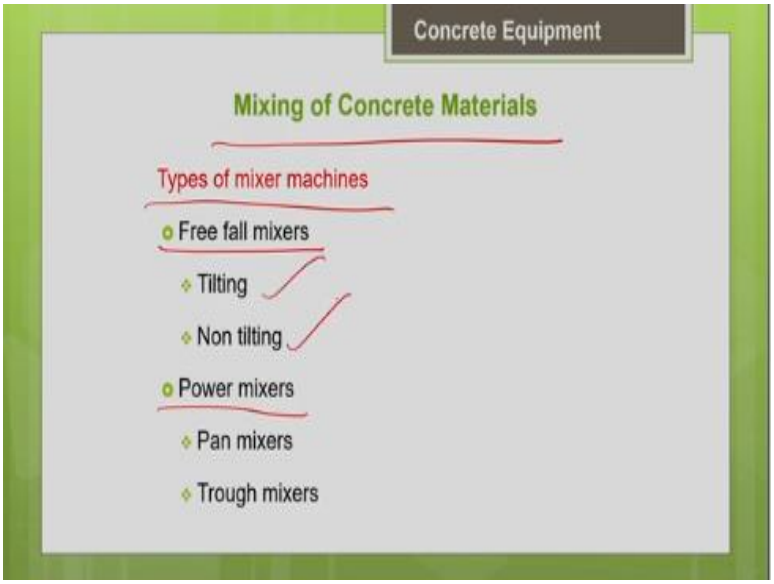

Then about the mixing of concrete: So, first, we discussed about the batching, then we move on to mixing. So, mixing of concrete, you have to spend more effort to have a homogeneous mixing of concrete. So, you should be very careful about the mixing of concrete because we should ensure that we get a homogenous mix, then only you can have a good microstructure of concrete.

As I told you, you need to have a good coating of spacer around the aggregate. So, for that, you need to ensure a homogeneous mixing. So, in some cases, you can see that people even mix a concrete with hand for unimportant works but you can see that the quality of concrete will be poor in the case. So, it is always preferable to go for the machine mixing to get a homogenous mix.

So, there are different types of concrete mixer machines nowadays available in the market. Based upon the method of mixing, there is a mechanism of mixing, you can broadly classify them into 2 categories. One is a free fall mixer; other one is your power mixer. So, in free fall mixer also is subdivided into categories based upon the discharging of concrete like tilting and non-tilting type. And power mixer depending upon the shape of the drum, you can type it into pan mixer and trough mixer. So, we are going to discuss all these types one by one.

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The first is about the free fall mixer. So, the conventional drum mixes what you see in your job site very commonly, is based on free fall mechanism. As the name indicates, the concrete here, we are going to discuss based on free fall mechanism of the material that means I can see the inside

view of the drum, you are having fixed blades. Blades fixed to the inside of the drum, you can see clearly in the picture. You can see the blades.

So, these blades, when the drum is rotating, it will help you to lift the material and drop the material at the end of the rotation. So, by lifting and dropping the material, your material gets mixed thoroughly that is what is happening. That is why it is called as free fall mixer. So, basically, your blades are lifting the material when the drum is rotated and allow it to fall at the end of the rotation. So, it keeps lifting and dropping.

So, the rotating drum as fixed blades inside it, it mix the material by lifting, dropping it. So, that is why basically this mixer machine, you should have some desired consistency of the concrete to facilitate the free fall mechanism. If the mix is very stiff or very cohesive, in that case, this mixer machine would not be compatible. So, the free fall only possible with a very stiff mix.

So, we need a slump at least 50 mm to have the free fall mechanism; suited for concrete usually with 50 slump. So, minimum 50 mm slump is needed to facilitate the free fall mechanism. So, also, this drum should not be rotated at a very high speed. The commonly adopted speed is 18 to 20 RPM. So, if you rotate it at a very high speed also, you can see that the free fall mechanism will not happen.

So, that is why we should go by the manufacturer's recommendation with respect to the speed of rotation of the concrete mixer machine. So, you have different configurations of tilting type and non-tilting type.

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So, basically in this free fall tilting type of the concrete mixers, you can see this kind of wheel arrangement, you can see. So, with this wheel arrangement, you can change the angle of inclination of the drum. So, you can change the angle of inclination of the drum with this wheel arrangement. So, that helps you to tilt the drum.

So, if you want to discharge the concrete, you can just tilt the drum, so, that we can easily discharge the concrete. So, with the tilting mixer, you can see that the discharge rate will be faster. And another important thing to be noted is; you can have a tilting hopper like this. This is called as tilting hopper. So, with the help of this, I can easily feed the material into the concrete mixer machine.

So, this will also help you to speed up the process. You can easily load the drum with the tilting hopper. You can save a time.

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So, as I mentioned earlier, the tilting mixers discharge concrete more rapidly than non-tilting. So, particularly for the concrete, the time is very critical. Once you prepare the concrete, once you add the order to the cement, what happens is, cement will start the setting that is why as early as possible, they should just place a concrete in the desired position. So, that is very important with respect to the concrete.

And another important thing is; it is a composite material. It is made up of different types of material a coarse aggregate, fine aggregate and cement. So, when you leave concrete undisturbed for some time, what happens? You can see that the heavier aggregate will settle down at the bottom. So, this is a kind of segregation. The coarse segregate will settle down at the bottom.

So, if it is settled down at the bottom, you will not be able to have a homogeneous mix. So, that is why we should not waste time. We should immediately; once the concrete is made, we should immediately discharge the concrete and carry it to the desired place. We should never waste time in the preparation of the concrete. That is why tilting is very helpful because its discharged rate is very faster when compared to the non-tilting mixer.

So, the chances for segregation is less when you go for tilting mixers. So, tilting mixers discharge concrete more rapidly. As I mentioned earlier, you can either feed the material manually or with a tilting hopper. As I showed you earlier, this is the tilting hopper. With tilting hopper, you can easily

speed up the loading process. So, we have wide ranges of drum sizes, varying from 140 liters to 2800 liters.

Accordingly, the concrete output will also range from 4 to 90 meter cube of concrete per hour. So, depending upon your equipment, you can choose a size of a drum.

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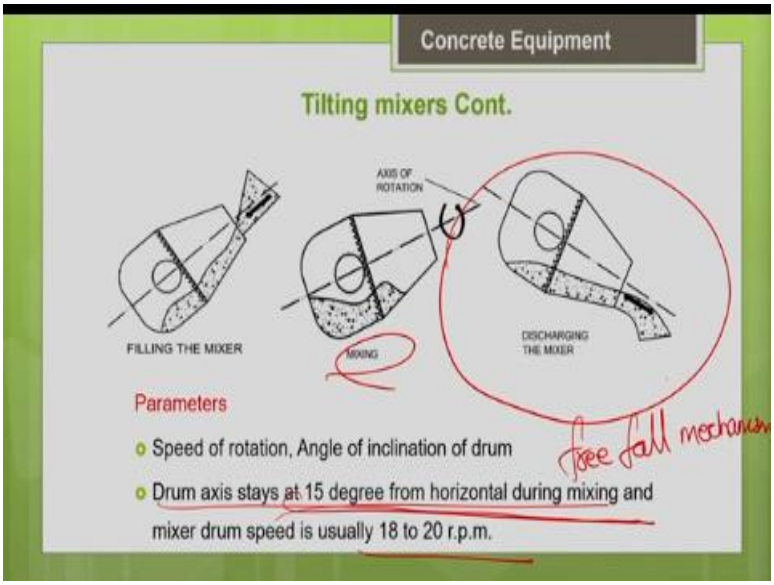

So, this schematic picture, it shows how the angle of inclination of the drum can be changed from loading position to discharging position. So, by rotating the weigh, you can change the angle of inclination of the drum. So, basically, based upon studies, they found that the drum axis should stay at 15 degree from the horizontal during the mixing. During mixing, it should stay at 15 degrees to the horizontal.

So, that is the desired angle of inclination with respect to horizontal during the mixing of your concrete. So, this is because, one basic thing as you know already is, if you keep the drum vertical, so, obviously, your blade will not be able to lift the material. So, you cannot keep the drum vertical and do the mixing. Obviously, you can also keep the drum completely horizontal.

If I keep it completely horizontal with zero degree, even that is not possible, this is because; if it is completely the horizontal, what will happen is, your blades will come in contact with more

quantity of concrete. In that case, more energy is needed for lifting the entire concrete to the full diameter of the drum. So, the energy consumption is more that is to optimize energy consumption.

The preferred angle of inclination is 15 degree from the horizontal as established based on studies. So, this is a commonly adopted angle of inclination and while discharging as you know, you can completely tilt the drum and mixer's drum speed which is recommended by the manufacturer is 18 to 20 RPM. As I told you, these drum mixers are based on free fall mechanism. So, to enable the free fall mechanism, you should not rotate it at a very high speed also.

If you rotate it at a high speed, you will not be able to get the free fall mechanism. So, and also, if you rotate it as low speed also, your productivity will be less as well as you will not get a homogeneous mix. So, we should follow the speed prescribed by the manufacturer.

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So, the next is about the free fall mixes non-tilting type. Here, I cannot change the angle of inclination of the drum. You can see that the excess of the drum is always horizontal. You cannot change the angle of inclination of the drum. Commonly, you can see this with 2 openings. So, one for feeding in the material and one for discharging the concrete out. So, this is a common configuration, you can see for a non-tilting type.

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So, you can discharge the concrete out by inserting a chute into it. You can insert the chute into the opening and discharge the concrete. Generally, for non-tilting mixers, you can see that the cycle time will be more because discharging time is more. In tilting type, you can immediately destroy the concrete. The time duration needed is less. But here, the time duration needed for discharging will be more. That is why you can see that the cycle time will be more and the productivity of these mixers will be less, relatively less when compared to tilting type.

So, you can see, there is another configuration where the drum is reversible, reversible drum. If you rotate the drum in one direction, it will facilitate the entry of the material into the drum. If you rotate the drum in the opposite direction, it will facilitate the discharge of material out of the drum. So, that is called as reversible mixers. Reversible mixers are also available in the market.

You can see **(Video Starts: 00:20:31)** if you look into the inside of the drum, you can see that a spirally arranged blades are there, fixed to the inside of the drum. So, you can see the spiral arrangement of blades. The spiral arrangement of blades, you can see the blade arrangement inside the drum. So, this spiral arrangement of blades inside the drum, what it does is; when you rotate the drum in one direction, it will pull the material inside.

When you rotate the drum in the opposite direction, it will push the material outside. **(Video Ends: 00:21:06)** So, that is why by reversing the direction of rotation, I can discharge the concrete out in

this non-tilting mixers. So, the discharge of concrete can be done by inserting the chute into the drum or by reversing the direction of the rotation of the drum.

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So, this is also one more configuration of non-tilting reversible mixer. Here, you can see, there is only one opening. So, you can feed the material into the tilting hopper and you can just discharge the material outside by just rotating it in the opposite direction. So, these are also reversible mixers. When you rotate in the opposite direction, you can discharge the material out because there will be spiral blade arrangement inside the drum which facilitates the pulling in the material inside when you rotate in one direction and it will push out the material outside when you rotate in the opposite direction.

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(Video Starts: 00:22:07) Your RMC transit mixer, it is also an example of free fall non-tilting reversible mixer. So, here also, you can see, there is only one opening. You have spiral blade arrangement inside. So, you have spiral blade arrangement inside. So, when you feed in the material, you have to rotate in one direction. So, when you want to discharge the concrete out, you have to rotate in the opposite direction.

So, these are reversible drum rotating in one direction for mixing and the direction of rotation is reversed while discharging. So, you can see the picture. When the rotation is reversed, the concrete gets discharged out. So, it is mainly because of the spiral blade arrangement inside the drum **(Video Ends: 00:22:54)**.

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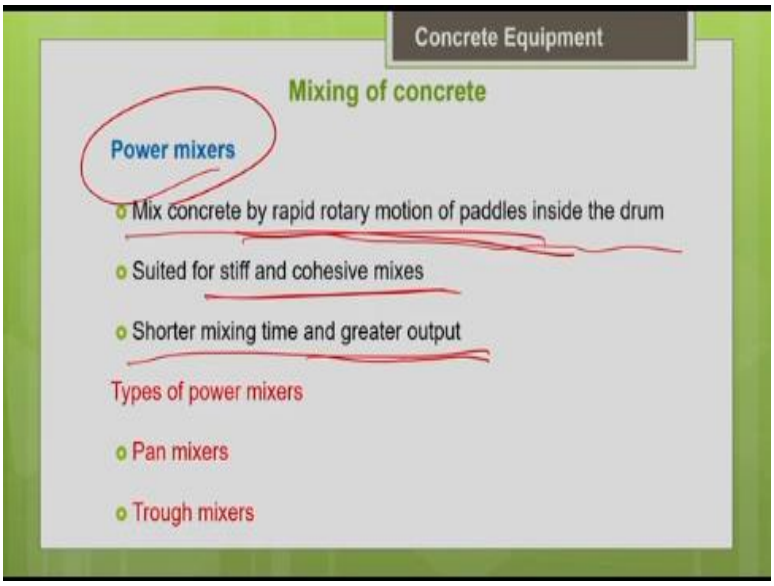

So, so far, we discussed about the free fall mixers. So, they have different categories as we discussed tilting type, non-tilting, non-tilting reversible type. So, different configurations are there. Now, let us move to the next category that is power mixer. So, here, the mechanism is different. Here, you are not dependent upon the free fall of the material. Here, we are dependent upon the rapid rotation.

So, these mixer machines will be rotated at a very high speed. So, there will be some paddles fixed to the shaft inside pan or the drum. So, these paddles will be rotating at a very high speed that enables the rapid mixing and homogeneous mixing of the concrete. So, here, you are going to mixer concrete by rapid rotary motion of the paddles inside the drum. So, this is suitable for stiff and cohesive mixes.

So, basically, you are free fall mixers as I told you, they need a slump of at least 50mm below that, it was very difficult for mixer machine to handle the stiff mix, but your power mixes can easily handle stiff and cohesive mixes, very low slump also because of the rapid rotary motion of the paddles, you can easily mix it. So, the mixing time will be very shorter here. I have a greater productivity with the power mixes when compared to the free fall mixers.

When you compare the power mixer with the free fall mixers, the same size. You can see that the productivity of the power mixer is very high because of the rapid rotary motion of the paddles inside. So, different configurations are possible with this power mixer; can go for pan or trough.

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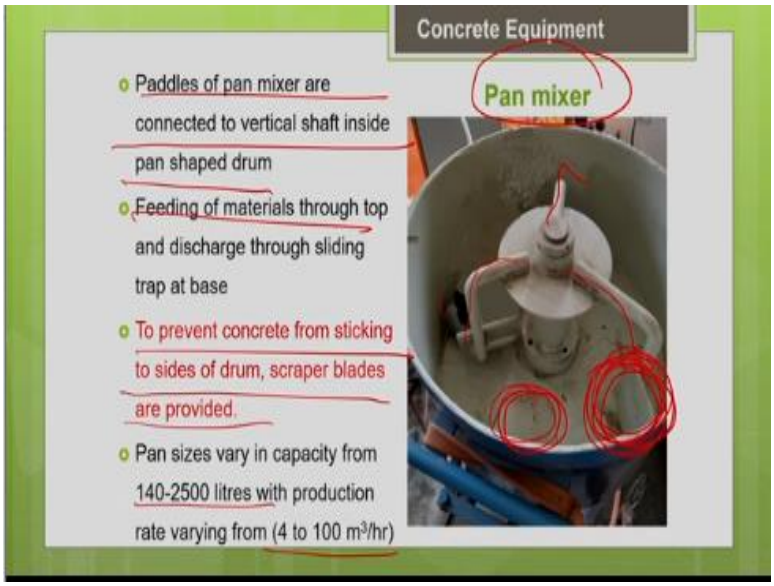

We are going to see that. First, we are going to discuss about the pan mixer. It resembles the shape of a pan. You can see, there is a vertical shaft here and the paddles are connected to the vertical shaft. So, because of the rapid rotary motion of these paddles, you can have a thorough homogeneous mixing of the concrete. Another important thing to be noted with respect to the pan mixer is, you have a blade kind of arrangement, blade or scraper attached to the inside of the drum. This is the one.

So, this prevents the material from sticking to the inside of the drum. This kind of arrangement, we do not have it in the conventional drum mixer conventional free fall mixer. Whatever we discussed earlier, they do not have this kind of arrangement. So, because of, what is the major problem is, when we make the initial trial mixes, the free fall drum mixer, what happens is the most of the paste will stick to the sides of the drum.

So, the first mix will have less amount of paste, more amount of aggregate. So, either you have to throw away that batch. So, this drawback is there. Or what you can do is, you can go for this called as buttering operation. Buttering is nothing but you should go for some trail mixes. You can just,

initially before making your actual concrete batch, you just run a trial batch with a water mix. So, let us just run a trial batch, so, that water mix will stick to the sides of the drum.

So, when you do your actual batch, then later you can see that the amount of material which is sticking to the sides of the drum will get reduced. So, this kind of buttering mechanism is needed, because we do not have any blade or any arrangement in the conventional the drum free fall mixers to prevent the material from sticking to the side of the drum. But, in your pan mixer, you have this kind of arrangement.

So, you have this blade, which prevents the sticking up material to the sides of the drum. So, basically, the paddles of the pan mixer are connected to the vertical shaft inside the pan shaped drum. You can see, the paddles are connected to the vertical shaft. The feeding of the material will be through the top and the discharge, you have sliding trap at the base. You can discharge it to this the sliding trap at the base.

To prevent the concrete from sticking to the sides of the drum, scraper blades are provided. You can see the blade arrangement which prevents the material from sticking to the sides of the drum. So, pan also have different sizes varying from 140 to 2500 liters. Accordingly, a concrete production rate will also vary from 4 to 100-meter cube per hour. It is a very big. Pan mixers are also available which are using a batching plant and precast industries. If you go for a bigger size, you can have a higher productivity.

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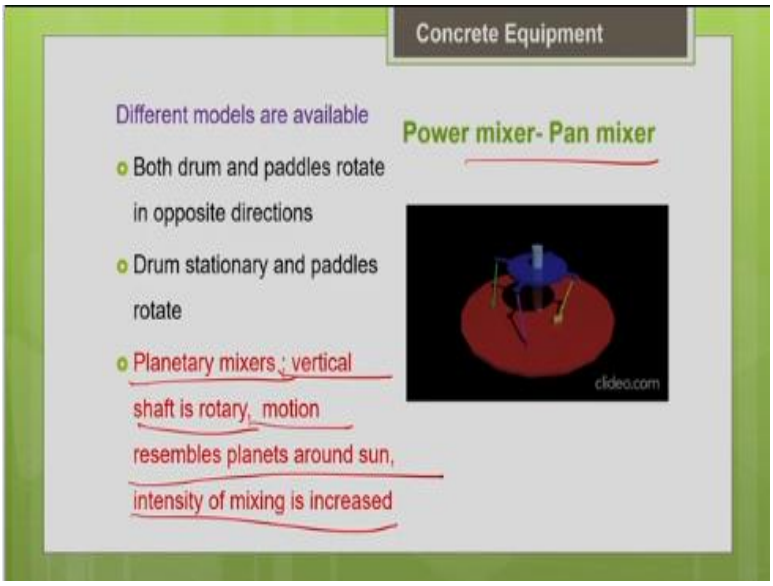

So, there are different configurations of the models available with respect to pan mixer. So, either the drum will be fixed, the paddles will be rotating or both the drums and the paddles will be rotating but in opposite direction. So, another popular model is planetary mixer. Why it is called as planetary mixer is, it resembles in motion planets around the sun, your paddles will be rotating about its axis.

You can see, the paddles are rotating about its axis around the axis of the pan. Just like the planets which revolve around the sun, the planets rotate about its axis and then around the axis of the sun. The same way, these paddles are also rotating about its axis and around the axis of the pan that is why it is called as the++ planetary mixer. So, by this kind of arrangement, you can have a better intensity of mixing.

So, the vertical shaft is rotary the motion resembles the planets around the sun. That is why the intensity of mixing is very high in the planetary mixer. So, there are different configurations of pan mixer. As I told you, you can have the drum and paddles rotating in opposite direction or drum can be stationary and paddles can be rotating. So different models are available.

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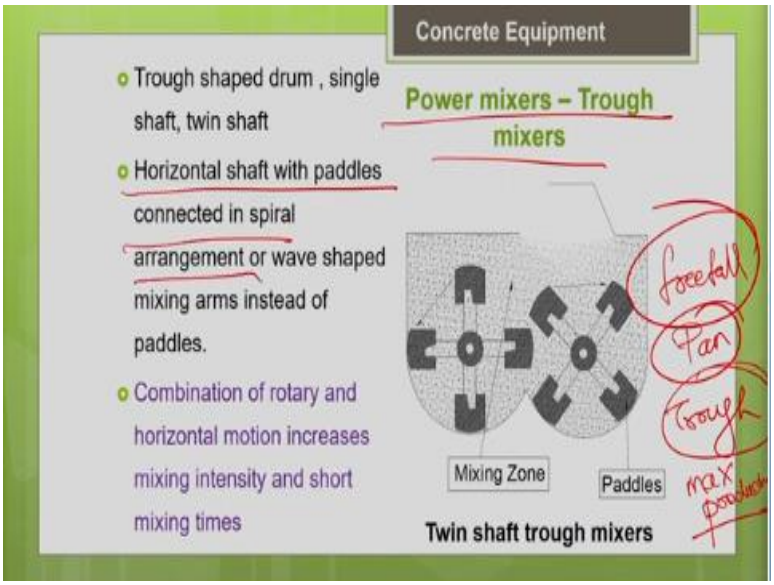

Now, we will discuss about the next type of power mixer which is tough mixer. So, it resembles a trough shaped drum. So, you can see the schematic picture of the trough mixer. You can have a single shaft or double shaft trough mixer. Early, pan mixer, the shaft was vertical but here you can see, the shaft is horizontal. You have horizontal arrangement of shaft. So, on the shaft, you can see, the paddles will be arranged spirally along the shaft.

The paddles are arranged spirally along the shaft. Either you can have paddle arrangement or you can even have a wave shaped arms arrangement. So, that will also give you better mixing. So, whenever you go for twin shaft mixer, you can see, the intensity of mixing will be very good because in the intersections zone, you will have more amount of turbulence that results in good intensity of mixing.

So, the other advantage of your trough mixer is; you can have different types of motions possible, not only the rotary motion as well as the resultant motion. Rotary and horizontal motion result in better intensity of homogeneous mix and the speed is very high. If you compare your free fall mixer, pan and trough, you can see that that trough will have the maximum productivity. Trough has the maximum productivity or the mixing time is very much shorter for the trough when compared to pan and the free fall mixers. So, mostly the RMC batching plan, you can see this trough mixer.

So, that we can have a very high productivity. So, you have a horizontal shaft with paddles connected in spiral arrangement. The paddles will be arranged in a spiral manner. I will show you a video. There, you will understand better. So, instead of paddles, you can also have wave shaped mixing arms. So, as I told you, there is a combination of rotary as well as a horizontal motion which increases the mixing intensity and it results in shorter mixing time when compared to other types of mixer machines.

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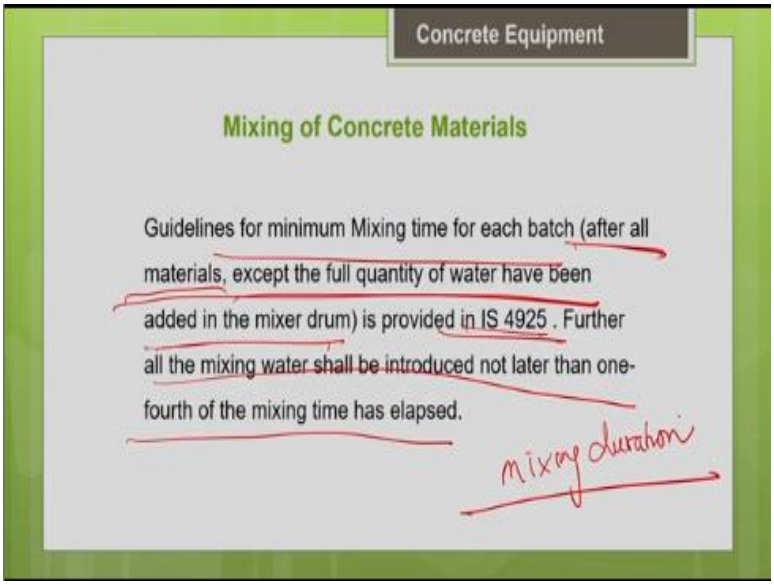

So, another important thing, we have to note here is the mixing duration. The mixing duration is very critical. We have to make sure we meet at least a minimum mixing duration as stipulated by the guidelines of the manufacturer. This is because the mixing duration needed will vary for different types of mixer machines. Your power mixer, the mixing duration needed is lesser when compared to the free fall mixer and also, the duration needed will vary with respect to the capacity of the mixer machine.

So, what is the minimum mixing time needed is given in the codal guidelines in IS 4925 for different types of mixers machines and for different capacities of mixers machines. We should follow the guidelines. So, generally, if you go for a lesser duration, then what is needed? What will happen? You will not get a homogenous mix that is a main problem and if you go for a very high duration, mixing duration also is not good because as you know that as you add water to the concrete, your cement starts setting.

So, it will result in loss of water from the concrete due to evaporation that will affect your workability of the concrete. So, extended mixing duration is also not good with respect to this setting and the workability of the concrete. So, that is why there is an optimum mixing duration for every mixer machine. So, we should go with a manufacturer recommendation. Guidelines for minimum mixing time for each batch is given in the IS 4925.

So, it will apply the mixing time actually starts after all the materials are added into the concrete mixer machine except the full quantity of water is added in the mixer drum that means your mixing time starts counting after all the materials are added into the mixer machine other than the full quantity of water because commonly you can see that the water, you add it in parts. This is because we may add some amount of water with superplasticizer, we break it into the parts because we add the water in stages to avoid the loss of workability due to different reasons.

So, that is why it is mentioned like this. So, after all the materials are added except the full quantity of water is added, your mixing time is taken into account. Another important thing, you have note here is; all the mixing water should be introduced not later than one-fourth of the mixing time has elapsed that means though, you add the water in stages but entire mixing water should be added not later than one-fourth of the mixing time has elapsed. This is a guideline available IS 4925. We are supposed to follow the guidelines.

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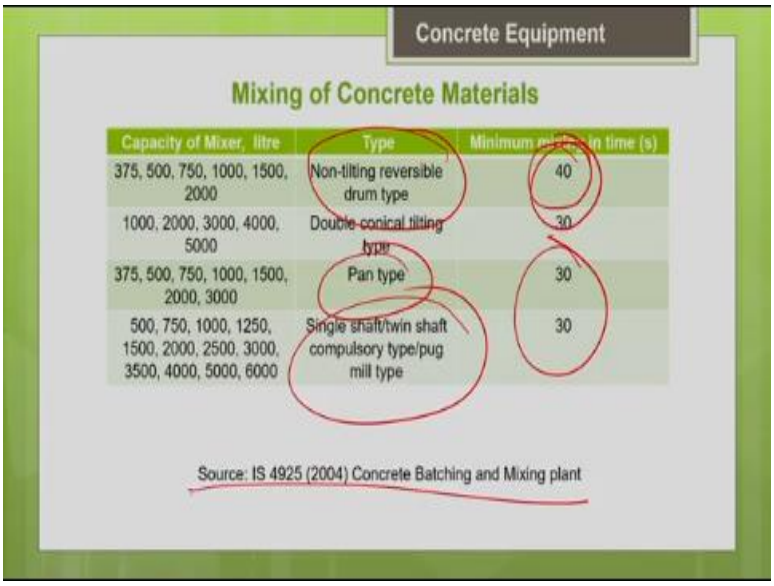

So, this is what I told you. This table is available. It is taken from IS 4925 which gives you a guideline for concrete batching and mixing. So, you can see that the mixing duration is given in seconds. It varies for different types of mixer machines. Say, for instance, if you go for non-tilting reversible drum type mixer, the mixing duration is more. So, generally, for non-titling mixer, it is more.

When compared to the pan type mixer and the shaft mixer, you can see that the mixing duration is more for the non-tilting reversible drum type mixer. So, similarly, for different capacities of mixer machines, you can note the minimum mixing time. This is a minimum mixing time given. We should never go below this.

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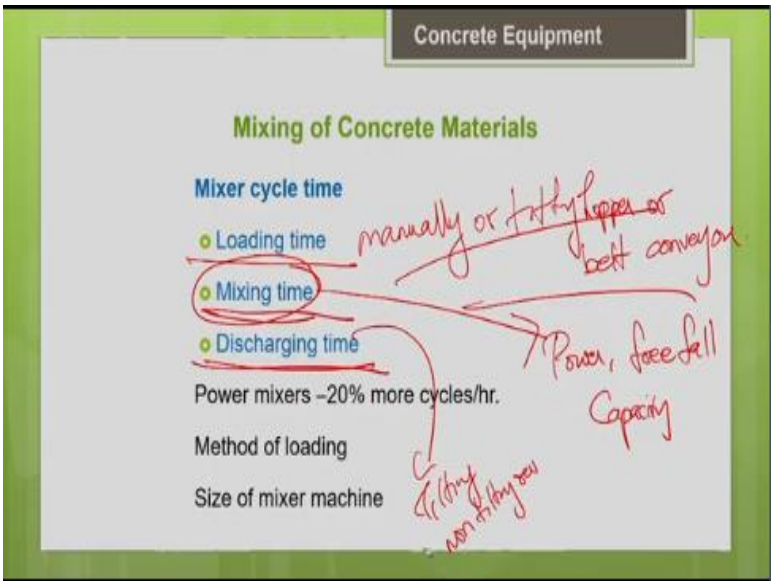

So, how to find the cycle time of the concrete mixer machines? In the earlier lectures, we have determined the cycle time of different equipment. Now, similarly, we have to find the cycle time of the concrete mixer machine also. So, what are the components of the cycle time of a concrete mixer machine? So, it is nothing but your loading time, mixing time and discharging time.

So, loading time depends whether you are going to manually feed in the material or you are going to use the tilting hopper for feeding the material or you are going to use a belt conveyor for feeding the material. So, it depends upon what arrangement you have for loading the mixer machine. Accordingly, your loading time will vary. Similarly, mixing time, it depends upon the type of your mixer machine whether you are going for power mixer or you are going for free fall mixer or what is the capacity of a mixer machine.

All these things will govern your mixing time. Then the discharging time; so, that also depends upon the type of mixer machine whether it is going to be tilting type or it is going to be a non-tilting reversible type. So, all these things will affect your discharging time. So, you have to make the calculations according to your actual equipment. So, the power mixer, you can see that the productivity as I told you, it is more than compared to free fall mixers. 20% more cycles per hour when compared to similar sized free fall mixers.

So, as I told you, the mixer cycle time will depend upon your method of your loading and your type of mixer machine and this size of mixer machine.

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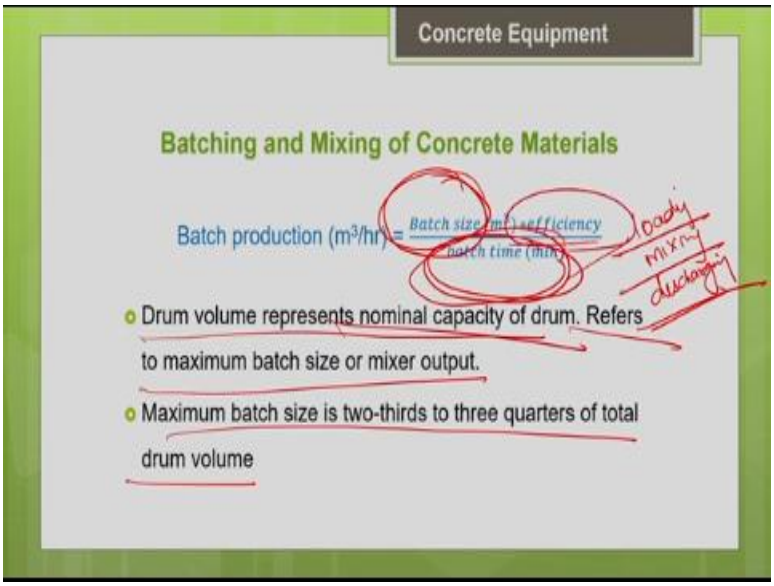

Now, how to calculate the productivity of your batch? Generally, we know that concrete is producing batches. Batch by batch, we produce it. So, how do you know the batch production in meter cube per hour? So, it depends upon your batch size and it depends upon your batch cycle time. So, batch size depends upon your drum size. So, we can never load the concrete to its full capacity.

We cannot take the total volume of drum into account to determine the batch size. We generally take only the nominal capacity of the drum, that means we generally load the drum only to its two-thirds or three-fourths of the capacity only. There should be some space for mixing. So, we never load the drum to its fullest capacity. So, we are not interested in the total volume. So, we are interested only in the nominal capacity of the drum that gives your batch size.

So, the drum volume means, we normally represent the nominal capacity of the drum which is different from the total volume of the drum. So, it refers to the maximum batch size, so that mixer output. So, the maximum batch size is two-thirds to three quarters of the total drum volume. So, you can take it as approximately two-thirds to three quarters of the total drum volume. So, you know batch size says, you know batch cycle time. How will you find the cycle time?

It is nothing but your loading time, mixing time, plus discharging time. So, for your particular concrete mixer, what is the loading time, mixing time, discharging time? You need to find it to know the batch time; then the job efficiency. So, here, the job efficiency, it depends upon your entire the equipment condition or the equipment operation. Say for example, for batching plant, you are going to find the batch productivity.

And your job efficiency will depend upon the ability of your conveyor to feed into the material into the mixer machine that is also important that is an important factor affecting efficiency. It also depends after the concrete is made. There should be a RMC transit mixer, it should come readily and collect the concrete which is going to be discharged. So, there should be RMC transit mixer which is readily available.

Availability of RMC transit mixer that also affects efficiency. So, all these factors are taken into account when you estimate the efficiency of the batch production. So normally, it will vary from 60 to 80% depending upon your batching plant or depending upon your equipment condition of the operation method.

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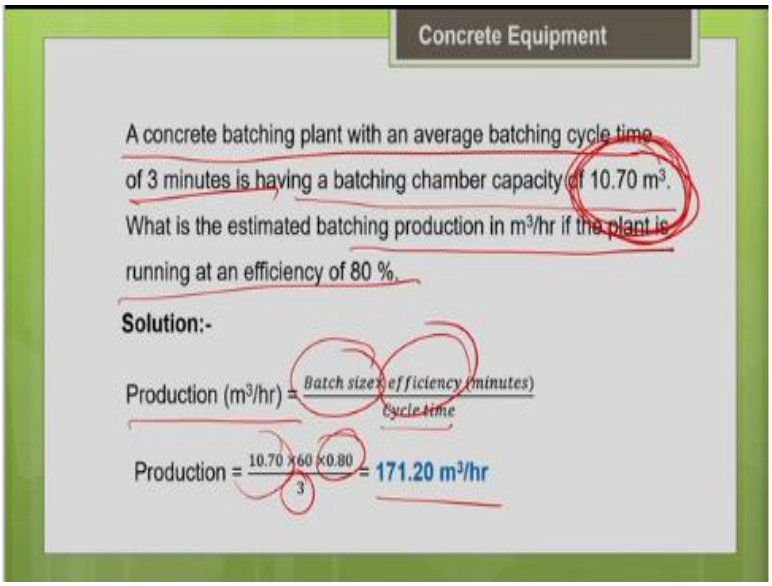

So, let us work out a simple example on estimation of the productivity of the concrete batching plant. So, a concrete batching plant with an average batching cycle time of 3 minutes. So, the cycle

time is given to you directly 3 minutes. It includes the loading time, mixing time as well as the discharging time. So, it is having a batching chamber capacity of 10.7-meter cube. So, the capacity is given. The batch size is given.

So, we normally refer to nominal capacity of the batch size only. It refers to the mixed quantity of concrete only. So, 10.7-meter cube is the capacity. So, what is the estimated batching production in meter cube per hour if the plant is running at an efficiency of 80%? So, the plant efficiency is also given as 80%. Now, you find batch production. So, you know the batch size. So, the chamber capacity, you can take it as batch size obviously as you know.

Generally, the manufacturers never give you the total volume of the drum. They give you only the nominal capacity of the drum that will represent the batch size. So, that is actually 10.7 meter cube of concrete and you should know that here, we are taking the concrete in a mixed condition, not in unmixed because the volume will be different in mixed or unmixed condition. So, that is why the mixed condition volume, we normally present, 10.7 meter cube.

$$\text{Production } \left(\frac{m^3}{hr}\right) = \frac{batch\ size \times efficiency(minutes)}{cycle\ time} = \frac{10.7 \times 60 \times 0.80}{3} = 171.20\ \text{m}^3/\text{hr}$$

So, this is how you have to estimate your productivity of the concrete batching process.

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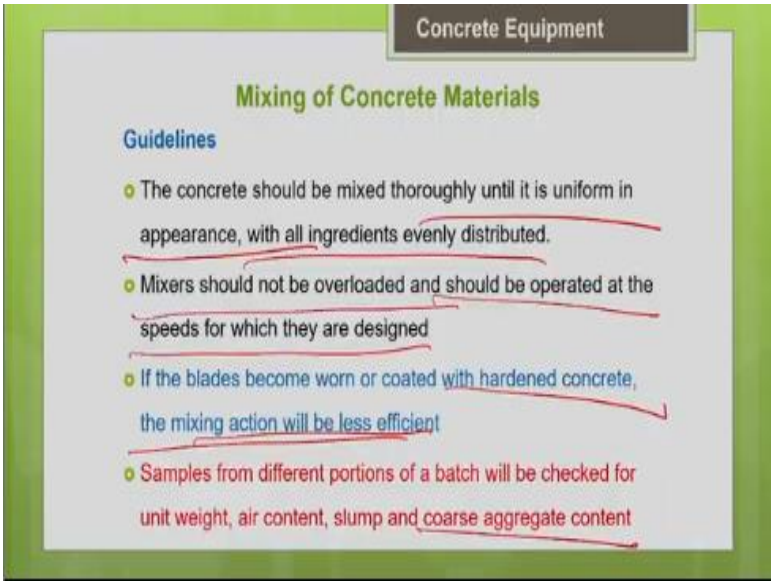

So, now, let us look into some general guidelines with respect to mixing of concrete. So, you should mix the concrete thoroughly as I told you until it is uniform in appearance. So, based on

experience by looking at the color, it says, you can make a judgment whether the concrete quality is good or not with all the ingredients evenly distributed. That the homogenous mixes are very important. That is why I told you, we should go for at least a minimum duration as prescribed by the manufacturer.

You should never go below the minimum duration. Mixers should be never overloaded. If you overload it, the mixing will not be homogeneous and it should be operated at the speed for which they are designed. As I told you, free fall mixers are designed for a particular speed. Power mixers are designed for a particular speed. You should go as prescribed by the manufacturer.

And you should clean the concrete mixes immediately. Because if your blades are going to get coated with the hardened concrete, it is going to affect your mixing action. In many job sites, you can see that blades with hardened concrete because the concrete mix is not properly maintained; not properly cleaned after every mixing process. So, you can see that the concrete is hardened. So, that will also affect mixing efficiency.

So, once the concrete is made, you have to take the samples from different portions of the batch and you should check for the uniformity. For that also, the codes are giving you the guidelines. You take the samples and check for the fresh density; check for the air content, slump, coarse aggregate content, you do the sieve analysis and check the coarse aggregate content. This, the difference between the samples should not be more.

So, what is the permissible difference that limitation is given in the coral guidelines? You have to check for that to ensure the homogeneous mix.

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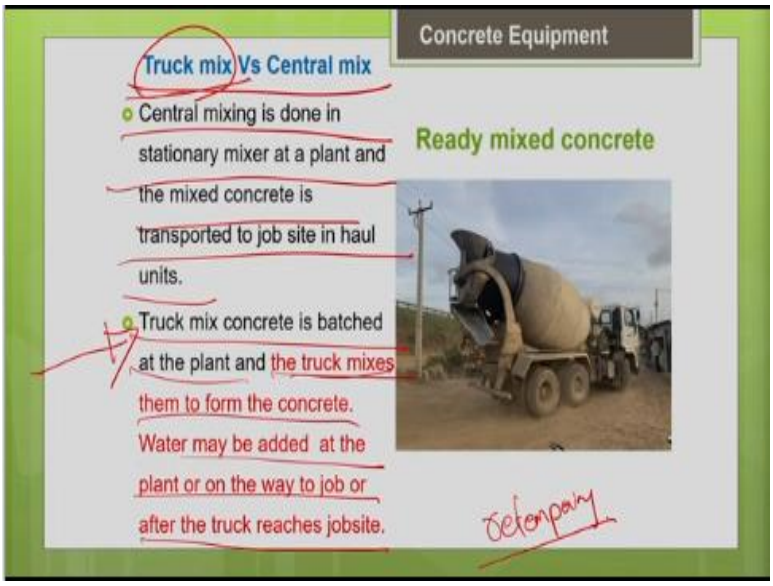

So, now, we are going to discuss about the ready-mix concrete. Nowadays, we are very commonly using the ready-mix concrete particularly for works where they emphasis more on the quality. We go for the ready-mix concrete. So, ready mix concrete, there are 2 different ways by which you can make ready-mix concrete. I mean, these are the commonly adopted ways. One is truck mix and other one is central mix.

As the name indicates, central mix means, you are going to prepare the concrete in the central batching plant and the concrete will be brought to the job site in the transit mixer that is central mix. Then truck mix means, you are going to prepare the concrete only inside the truck that is called the truck mix. So, what you will be doing in batching plant is, in batching plant, you will measure the ingredients accurately and then load it into the truck and the actual preparation of the concrete will happen only inside the truck that is called as truck mix.

So, generally, when do we go for truck mix? If your job site is located in a remote place, like if your RMC transit mixer will not be able to reach the job site within the stipulated time as mentioned by the code, in that case, we can go for truck mix. So, in truck mix, what they do is, they do not add the water. So, only the ingredients are loaded. They do not add the water immediately.

So, before the truck reaches the site, on the way, they will add the water and prepare the concrete and then deliver it at the required place. So, this kind of options available particularly where you can expect extended transit. Where the travel time is going to be, is likely to be more, in the case, you go for truck mix. You do not add the water in the batching plant. You add the water on the way to the job site.

As it nears the job site, you can just add the water and prepare the concrete. So, that is what is truck mix. Central mixing is done in stationary mixer at the plant and the mix concrete is transported to the job site in haul units. Your truck mix concrete is batched at the plant. Only the batching will do at the plant and the truck mixes them to form the concrete. Actual mixing process happens in the truck only that is called as truck mix concrete.

So, when you compare the quality of a central mix and truck mix, obviously, your central mix will give you a better quality because the mixing is done in a very efficient mixes in the central batching plant. So, that will give you a better quality, but this is only for certain cases as I told you where the transit time is likely to be longer in that case, we can go for the truck mix. So, you can add the water at the plant or on the way to the job or after the truck reaches a job site that is also possible.

See, any cases, you see that unexpectedly if your travel time is extended and if the concrete quality gets affected obviously know that the time, your concrete starts setting, your cement hydration will start and concrete start sitting. So, as a concrete loses workability, what they do is to compensate the loss of workability as the machine reaches job site, they simply add some amount of water and try to restore the slump.

This is commonly performed and that is called as re-tempering of concrete that means you just simply add the water to just recovery of lost slump. So, that will definitely affect water to cement ratio, the strength and the durability of the concrete that is why we should not do re-tempering. It is not advisable if you want to produce a good quality of the concrete. Instead, what we can do is if you know that the travel time is likely to be extended, you can withhold some amount of water, do not add the entire water.

After the mixer machine reaches a site, you can add the remaining amount of water and mix it and get the required slump. That is the better when compared to the re-tempering. So, as I told you earlier, simply just add, the water what will happen? It will definitely increase your water to cement ratio and that affect the strength. That is why re-tempering of concrete is not advisable.

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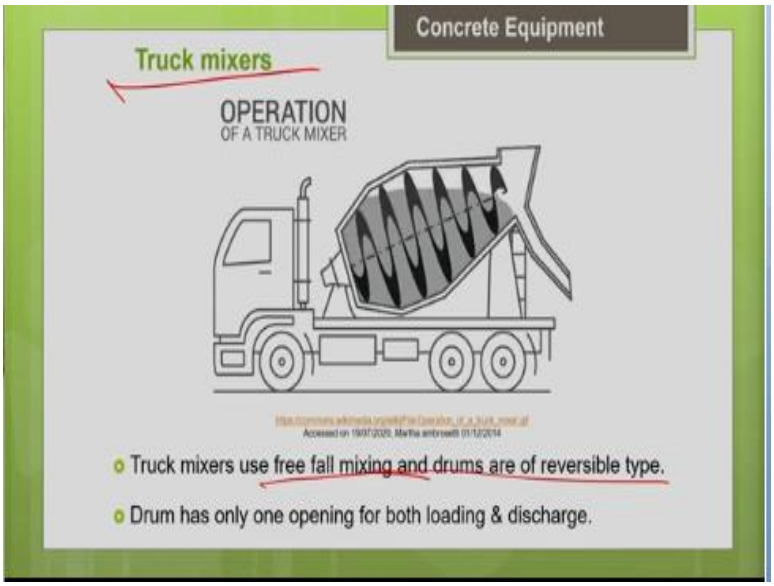

(Video Starts: 00:46:58) So, this picture, I have shown you already. So, your truck mixes comes into the category of your free fall non-tilting reversible type. So, you can see the spiral blades inside. If you rotate in one direction, it will pull the material inside, which has facilitated the loading process. If you are rotating the opposite direction, the blades will push the material outside which will facilitate the discharging of the concrete. So, it has only one opening for both loading and discharge **(Video End: 00:47:26)**.

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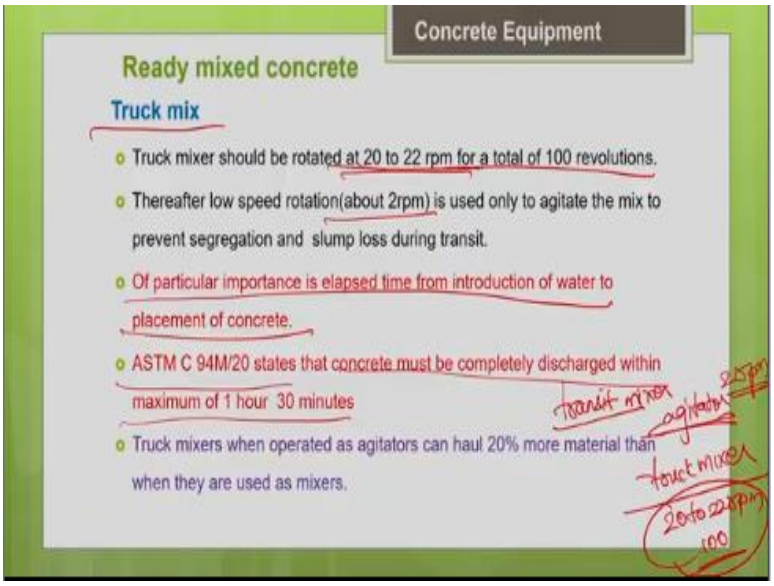

So, if you are going for truck mix, truck mix in the sense, I am going to prepare the concrete inside the truck only. So, then there are some important guidelines to be noted. As you are going to prepare your concrete inside the truck only, you should rotate at a speed of 20 to 22 RPM. Then only you can get the homogeneous mix and they should rotate for at least 100 revolutions at this particular speed. This will ensure homogeneous mixing of concrete.

So, after these 100 revolutions, then you can rotate at a speed of only 2 RPM that is just to agitate the concrete. So, that you can prevent this slump loss and you can prevent this segregation. So, this transit mixer, the transit mixer can be used as an agitator or as a truck mixer. If you are using it as an agitator, the main function of agitator is just to agitate the concrete and prevent the slump loss and the segregation.

So, there, you need a speed of only say, 2 RPM. But, if you are going to prepare the concrete only inside the truck, you have to rotate at a speed of 22 RPM, 100 revolutions. So, that is what is the manufacturer's recommendation so, to get a homogeneous mix. So, generally, when you use a transit mixer as an agitator, I can use more capacity of the truck when I use it for preparing the concrete.

So, important thing to be noted is the elapsed time from the introduction of the water to the concrete to the placement of concrete that is very important with respect to concrete. The time is very

critical. Because as I told you, once you add the water, the cement start hydrating, it starts stiffening, the setting will start. So, that is why there will be loss in workability during the transit. So, that is why we have to deliver the concrete within the stipulated time as given by the coral guidelines.

So, according to ASTM guidelines, it states that concrete must be completely discharged within a maximum of 1 hour 30 minutes. Within 1 hour 30 minutes, we have to completely discharge the concrete. So, your time is going to from the moment you add the water to the concrete making materials so, till the placement time. If the transit time is going to be extended beyond this, then the concrete quality will be poor.

You have to reject the concrete. So, that is why sometimes as I told you, when the time gets, unfortunately gets extended, people try to re-tempering the concrete because they do not want to waste the concrete. They try to re-temper it by adding some extra water. But, that will definitely affect the quality of your concrete. So, that is why for extended transit, you can even go for admixtures like retarders.

So, there are certain special admixtures retarders which are available, which helps to have extended the transit time with the transit mixer or you can even go for a truck mix where you can add the water towards the end of your journey. So, truck mixes when operated as agitator, they can hold 20% more material than when used as mixes that is I told you. The same transit mixer, I can just use it as an agitator or I can use it as a truck mixer for preparing the concrete.

If I use it as an agitator, I can handle 20% more material. I can use 20% more capacity than when used as truck mixes.

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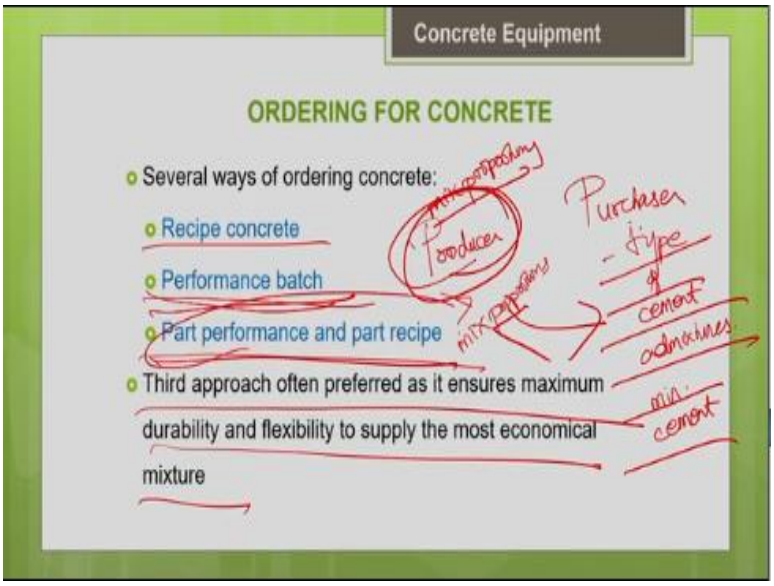

So, there are several ways of ordering your ready-mix concrete. So, let us look into the different ways of ordering. So, one is the recipe concrete; other one is a performance batch and the third one is a part performance and part recipe. Recipe concrete in the sense, you have the concrete producer and you have the purchaser. So, in the recipe concrete, the purchaser will give you the complete mix proportions.

He will give the complete mix proportions to the producer. He will tell this much quantity of cement, this much quantity of aggregate and this much quantity of water, entire mix proportions given. The only responsibility of the producer is to do the proper batching of this material in his batching plant and prepare the concrete under strict quality control and deliver it in the job site. So, that is the only responsibility of the producer.

So, the entire responsibility of the strength, the durability is taken care by the purchaser who is doing the mix proportioning in the recipe batch process in the recipe concrete method. There is another method called as performance batch. In performance batch, the purchaser will tell what is the strength needed. So, what is the performance needed? What is the strength needed? What is the durability needed? In which explosive condition, the structure is going to be put into. It should be resistant to sulphate attack, resistant to chloride attack.

So, what is the durability requirement? What is the strength requirement or given by the purchaser to the producer? So, he just mentioned only the performance requirement. We mentioned only about the performance requirement. The producer will do the mix proportion. The producer will decide the mix proportioning. So, he takes responsibility of the strength and the durability.

The producer takes a responsibility of strength and durability in the performance batch. And the third one is part performance or part recipe. The both of them have their rules in mix proportioning that means, your purchaser, he can even give suggestions on say, this is a type of cement needed, type of cement, he can give some recommendations or admixtures to be used. And he can even say at least use this much amount of cement, minimum cement requirement. So, these guidelines, the purchaser can give.

In addition, the producer will decide the remaining mix proportions. He will decide the remaining mix proportions. So, both are participating in the mix proportioning, So, that will always result in a more economical mix. So, the third approach is often preferred because it ensures maximum durability and flexibility to supply the most economical mixer. So, this is a one which is more commonly preferred, part performance and part recipe. That means both the producer and the purchaser should participate in the mix proportioning. They should give you input.

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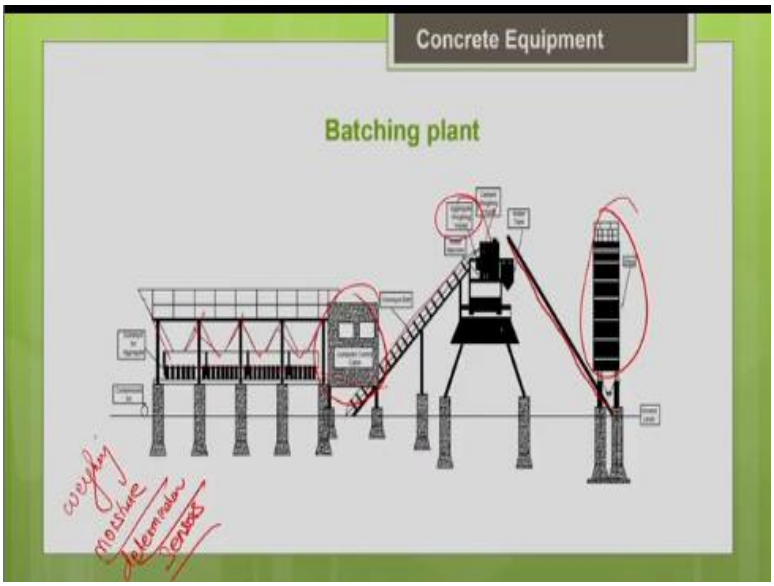

So, this picture shows a schematic image of the batching plant, concrete batching plant. So, you can see, these are the aggregate storage bins. You can see, with sloping slides, these are the aggregate storage bins where aggregates are stored. So, from here, the aggregates will be conveyed by the belt conveyor. So, the belt conveyor will take it to the concrete mixer machine.

So, nowadays, due to advancement of technology, we have lot of aggregate storage bins with different types of sensors like weighing sensors, moisture content sensors, moisture determination sensors, moisture content determination sensors. So, there are different sensors available which are provided in the aggregate storage bins. So, that will facilitate you to measure the required quantity of aggregate there itself and the measured quantity will be conveyed by a conveyor directly to the mixer machine. So, that is also possible.

So, the moisture content will also be determined accordingly the adjustments to the weight of the aggregates will be done automatically. So, everything is now under PC control. So, you have a computer control cable where you can control the entire system. So, here, you can see, the aggregates are taken with the help of the belt conveyor to the, aggregates are not going to be weighed here, you need a separate weighing vessel here to measure the weight of the aggregate before adding it to the mixer machine.

Similarly, these are the cement silos. From this cement silos, the cement will be taken with screw conveyors into the cement weighing vessel and then it will be transferred to the mixer machine.

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So, this is the real picture of the batching plant. You can see the aggregate storage bins. These are the aggregate storage bins. So, you have the belt conveyors to transfer. You have the mixer machine. You have the cement silos. So, the materials are conveyed by the belt conveyors to the mixer machine where the mixing is done.

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So, we have different configurations of the batching plant. You can also have a small batching plant, mobile compact plant, depending upon your requirement. You can see a small the cement silo, aggregate storage bins and the mixer machine. So, depending upon your job requirements, you can have a small batching plant also. So, as I told you, if your project site is very far away

from the RMC batching plant, it is preferable to have your own batching plant at your job site that will make the process more economical.

Now, let us watch a video how the concrete is manufacturing in the concrete batching plant. So, this is an animated video. **(Video Starts: 00:56:52)** So, you can see that these are the aggregate storage bins. So, this is your cement silo. You can see the cement silo. So, your cement from the cement truck is being pumped into the cement silos. So, the cement silos are filled with the cement.

Now, the cement from the cement silos is conveyed by the screw conveyor. You can see this. This a screw conveyor is being conveyed into the weighing hopper. You just weigh the required quantity of the cement before loading it into the mixer machine. So, you can see a front end loader. I use for charging the aggregate bins. It is loading the aggregate into the aggregate bins. These are the aggregate storage bins.

So, at the bottom of the aggregate storage bins as I told you, nowadays, we have weighing sensors, you can have the control over the amount of the material which is being conveyed with the conveyor to the mixer machine. So, the batched aggregate will be transferred to this hopper and then the material will be delivered into the mixer machine. So, the material is now delivered into the concrete mixer machine.

So, now, you are mixing a admixture with water. And you can see, this cement is being discharged into the mixer machine, even the water is also added into the mixer machine. Everything is added now into the mixer machine. So, this is a twin shaft concrete mixer as we discussed earlier, you can see horizontal shaft and the paddles are arranged spirally. You can see spiral arrangement of paddles along the shaft of the mixer.

So, this spiral arrangement helps you to have a homogenous mixing of the material. So, once the concrete is mixed, you can see that it will be delivering to the hopper of the RMC transit mixer **(Video End: 00:56:52)**.

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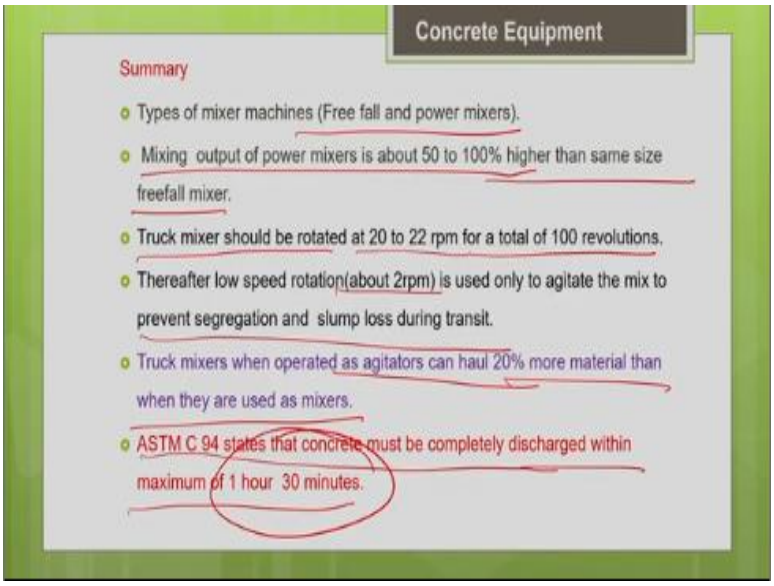

So, now, we have come to the end of this lecture. Let me summarize what we have discussed so far. So, we have discussed about different types of concrete mixer machines, the free fall mixers and the power mixers. I told you like the power mixers can give you a better productivity than compared to the free fall mixers. The mixing output of the power mixers is about 50 to 100% higher than the same size free fall mixers that is why we always use the power mixers the batching plant in the precast industries.

So, that we can have a higher productivity. So, this RMC concrete, either you can make it at the batching plant or you can prepare the concrete inside the truck mixer. So, if you are going to prepare the concrete inside your truck that is for the truck mixer, the speed supposed to follow is 20 to 22 RPM for a total of 100 revolutions. So, this will ensure that homogeneous mixing of concrete will be done.

So, if you are going to prepare your concrete in your transit mixer, so, in that case, the truck should be rotating at a speed of 20 to 22 RPM for a total of 100 revolutions. After that you can rotate it at a speed of only 2 RPM for just agitation to prevent segregation and this slump loss during the transit. So, if you are going to use transit mixers as agitators, it can handle 20% more material than when uses the truck mixer.

And we should always keep in mind that the time is very critical in the concrete making process. So, ASTM states that concrete must be completely discharged within a maximum of 1 hour 30 minutes from the moment you add the water for preparing the concrete and the moment you discharge the concrete. The time interval, the permissible is only 1 hour 30 minutes that is a maximum limit allowed.

So, accordingly only, you have to make the choice of whether to go for the ready-mix concrete or not. So, depending upon the distance between your job site location and the RMC batching plant, we have to plan whether it is possible to deliver the concrete within this particular time duration. Accordingly, make the decision.

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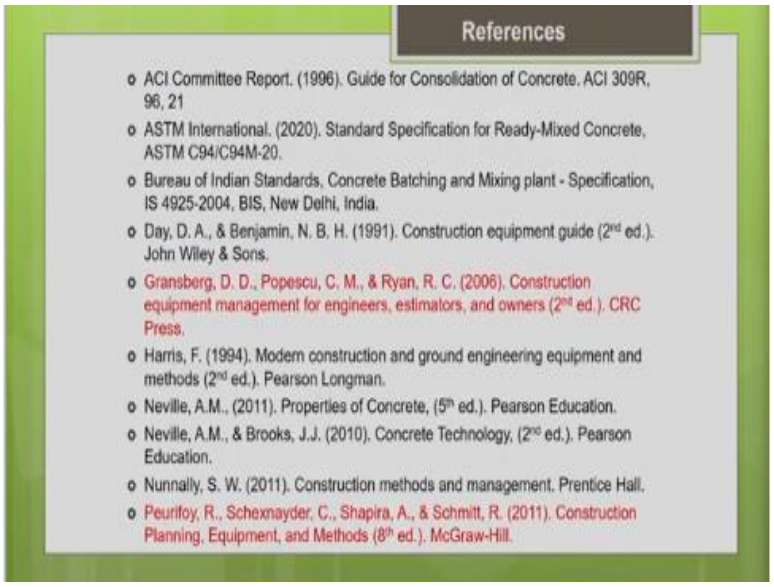

So, these are the references which I have used for this lecture preparation. In the next lecture, we will be discussing about the different methods of handling the concrete, transporting the concrete and what are all the different methods available for consolidating the concrete and the curing of concrete. So, the remaining steps involving the protection of the concrete will be discussed in the next lecture. Thank you.