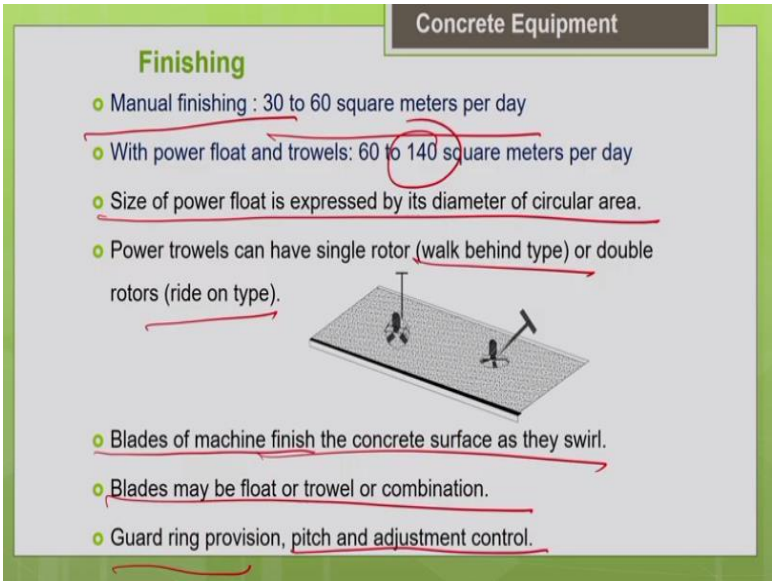
So, there are also machines to do the finishing job. We call them as power floats or power trowels. So, you can see here, it look like a spider. That is why it is also called a spider. It looks like a spider. So, basically there are rotating blades inside. See these rotating blades inside helps you to finish the concrete surface. The same machine you can use it for both floating as well as troweling.

As I told you, when you do the floating, you have to keep the blades flat. When you do the troweling which you are going to do in a delayed manner, there you need to apply more pressure. So, you slightly angle the blade and use it. So, there are provisions to there are controls to pitch and angle the blade. So, you can change the angle of the blade with the control. And you have a guard ring to protect the blades.

So, basically, this helps you to have a very high productivity. Obviously, with these machines, when compared to manual finishing with simple tools. With this power trowels and power floats, I can have a very high productivity. So, the actual productivity depends upon the size of the power trowel. It depends upon the diameter of this circular area. So, greater the diameter, you can cover more areas. So, the productivity will be high.

So, there are different configurations available. Either this is a walk behind types, simple model. There are even bigger models where the person can ride on. So, he can also sit on the machine. So, the ride on type is also available.

(Refer Slide Time: 1:21:51)



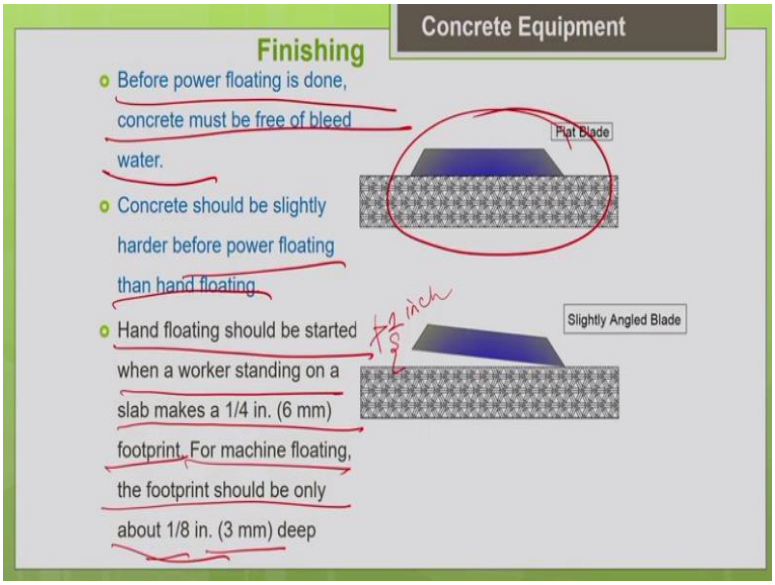
So, when you compare the productivity of the manual finishing with simple tools, you can see that manual finishing maximum productivity the finishing productivity is 60 square meters per day. It ranges from 30 to 60 square meters per day. But with a power float and trowels, you can go even up to 140 square meters per day. So, you can say that you can have a very high productivity using the power trowels and power floats.

And also you can have a very consistent good surface texture when compared to manual finishing. So, it all depends upon your project requirements. So, if it is mentioned in your contract specifications that the variation in the undulation levels accepted is very much less in that case, it is preferable to go for finishing machines like power trowels so that you can have a perfect leveling and finishing.

So, the size of the power float is expressed by the diameter of the circular area. You can have a smaller machine which are walk behind type model or you can have a bigger machines which are ride on type model. So, different models are available in the market. So, according to your project requirement, you can make the choice. So, basically the blades will rotate. And these blades help to rotating blades help to finish the concrete surface.

So, same machine can be used for both floating as well as troweling. Or, there are also separate machines for floating as well as troweling. There is a guard ring provision and pitch and adjustment control for changing the angle of blade so that you can change the angle of blade for floating and troweling.

(Refer Slide Time: 1:23:32)



So, the important guidelines you should keep in mind is, so, generally the window of the finishing period is between the initial set and final set. So, the concrete should have dried up well and it should be free of bleed water. So, then only you should do the finishing operation. Particularly when you are going to use your machines as I told you the concrete should be able to withstand the weight of the machine.

So, that is why the concrete should have hardened sufficiently. So, before power floating is done the concrete must be free of bleed water. So, when compared to hand floating or the manual floating, so, the power floating requires that the concrete should be relatively more harder. Then only power floating or power troweling is possible. Then only the concrete can withstand the weight of the machine.

So, how to test whether the concrete is ready for the troweling or finishing? Simple guidelines are available in the ACI manual. So, you can see that hand floating should be started when a worker standing on a slab makes a 1/4 inch footprint. To check whether the concrete hardness is sufficient enough to start the finishing operation using hand floating, so, what they do is if you put your foot on the concrete, the indentation allowed, the maximum indentation allowed is only 1/4 inch or 6 mm.

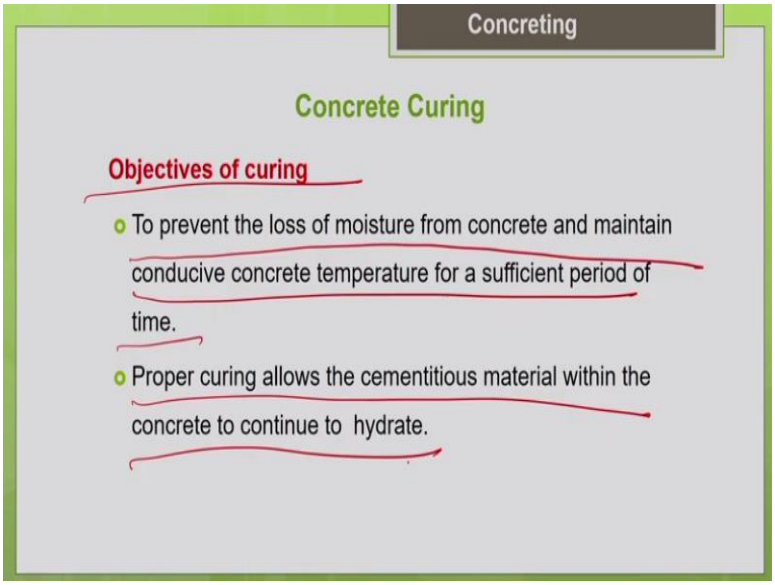
So, the indentation should not be more than this. Then only you can say that the concrete is ready for the hand floating. But in that case of power floating we shall we should be still careful. The indentation allowed is only 3 mm or 1/ 8 inch. For machine floating, the footprint should

be only 1/8 inch or 3 mm deep. So, then only it indicates that your concrete is hard enough to withstand the weight of the machine.

So, these are simple guidelines to check when the finishing can be started. You can see the picture. So, how they keep the blade flat? So, when you start the finishing job you keep the blade flat and do it. That is called as floating. For different stages of floating you just keep on increasing the angle of the blade. But as I told you the raised edge should not exceed 1 inch above the surface of the concrete.

So, for every stage of finishing, you keep on increase the angle of blade so that you can exert more pressure on the concrete.

(Refer Slide Time: 1:26:10)



The next important step in concrete making is curing of concrete. So, far we discussed about consolidation of the concrete finishing of concrete. So, now, we are going to discuss about the curing of concrete. So, why is this curing needed? So, as everyone knows the cement hydration is a continuous process. The hydration process continues for a longer time. To facilitate the continued hydration process, so, what we are supposed to do is we need to maintain the internal temperature of the concrete.

And we need to maintain the internal humidity of the concrete or the moisture content of the concrete. So, only if the moisture content is available, then only the hydration process can continue. If the hydration cannot continue, your concrete will not get the desired strength. So,

that is why it is very important to facilitate the hydration process to be continued for a longer time.

Then only you can get your desired microstructure strength and the durability of your concrete. So, but basically whatever water you have added for preparing the concrete, even that water itself is sufficient for the hydration process. So, most of the cases the water we have designed for concrete making is sufficient for the hydration process. But what happens is when the concrete is exposed to the ambient condition, the water from within the concrete will be lost to the outside environment.

So, that loss of water affects the hydration process. So, because of loss of water from the concrete to outside environment, the water is not available for the hydration process of the cement. So, that is why we need curing. So, what is the main purpose of curing? It is to prevent the loss of water from within the concrete to the outside environment. So, the main purpose of curing is to prevent the loss of water.

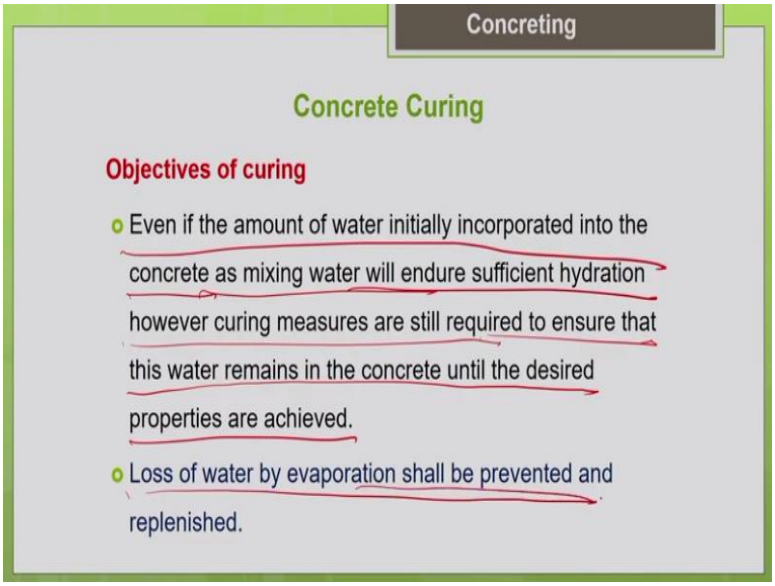
So, that the water is available for hydration and to supplement the water lost. So, whatever the concrete is lost to the environment, we have to supplement it by curing. So, that is why we do curing. Curing is nothing but we are supplying water to concrete. So, after the finishing is done after the concrete is attained the final setting we supply the traditional way is we supply water to concrete and facilitate the continued hydration process.

So, the main purpose of this objective behind supply of water is to prevent the loss of water from within the concrete to the outside environment as well as to supplement the lost water. So, what are the objectives of curing? To prevent the loss of moisture from the concrete and maintain the conducive concrete temperature for a sufficient period of time so that the hydration process will continue.

So, that the cracking will not happen should not get crack should not happen. So, proper curing allows the cementitious material within the concrete to continue to hydrate. So, since we are supplying the water to the concrete for a sufficient period of time, the hydration process of the cement will continue. And you will get your desired strength. So, as I told you, the water which were added initially for concrete making, that itself is sufficient.

But depending upon the ambient conditions, you can see that in most of the cases water from within the concrete is lost to the outside environment. So, to prevent that loss, we have to add it.

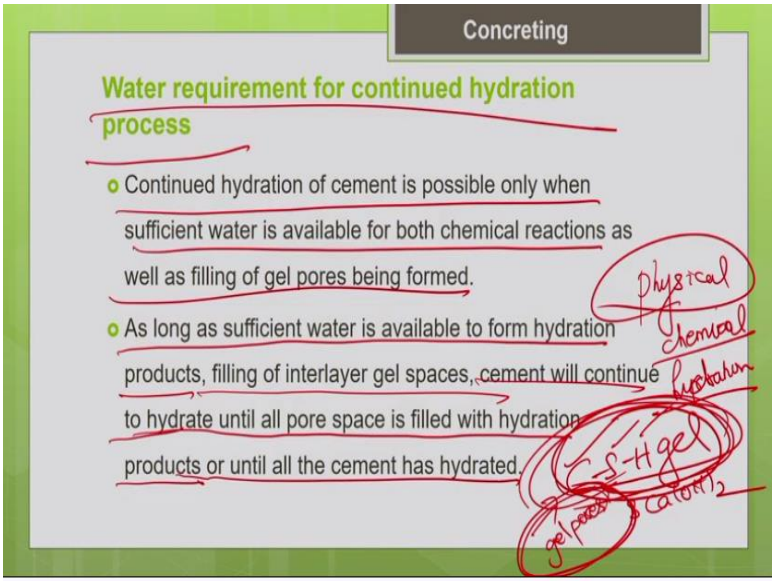
(Refer Slide Time: 1:29:43)



So, even if the amount of water initially incorporated into the concrete as mixing water will endure sufficient hydration. However, curing measures are still required to ensure that this water remains in the concrete until the desired properties are achieved. So, even though the water which you have added for concrete making is sufficient, even then you have to do curing so that you can prevent the loss of this water to the outside environment.

So, loss of water by evaporation shall be prevented by curing. And you can also supplement the water which is lost. So, that is the main purpose of curing. The main purpose of curing is you are supplying water to the concrete so that the hydration process will keep continuing so that you will get your desired microstructure strength and the durability of your concrete. So, water requirement for the continued hydration process.

(Refer Slide Time: 1:30:43)



As I just mentioned now, so, for the hydration process to continue, we need water. So, the hydration process occurs in different forms, physical hydration, chemical hydration. So, chemical hydration everyone will be knowing. So, chemical hydration is nothing but the water needed for the reaction of your cement compounds with the water to form the hydration products, so, silicates and the aluminates.

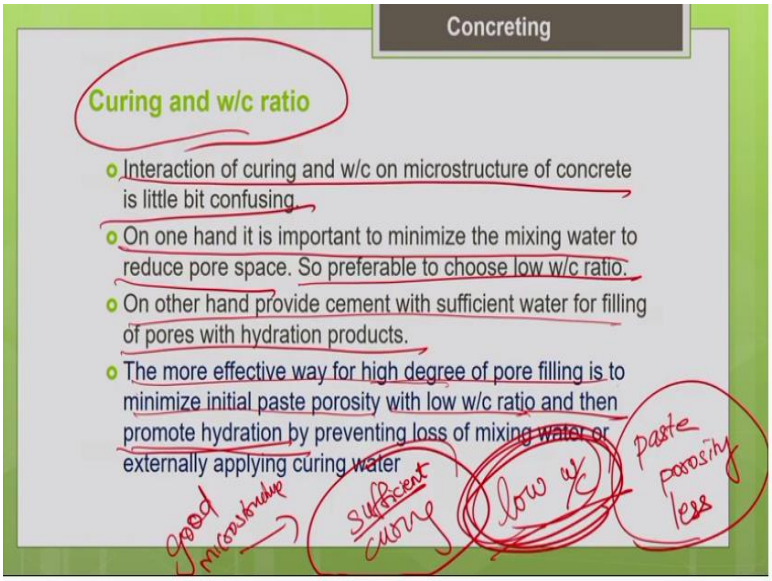
So, they react with the water and form the different hydration products. So, the main hydration products are your C-S-H gel nothing but calcium silicate hydrate and calcium hydroxide. So, there are different hydration products. The main hydration product which is contributing to the strength is your C-S-H gel, calcium silicate hydrate. So, we need water for this chemical reaction. That is chemical hydration.

And what is this physical hydration? So, when these hydration products forms, this C-S-H gel, there are lot of gel pores, there are lot of voids or gel spaces or pores in this hydration products. These pores should be filled with the water. So, that is very important. So, then only your hydration will be complete. So, that is what I said for filling of the gel pores in the hydration products also we need water. That is called as physical hydration.

So, continued hydration of cement is possible only when sufficient water is available for both the chemical reactions as well as for filling up of the gel pores which are formed in the C-S-H gel. That is your hydration product. As long as sufficient water is available to form the hydration products, filling of the interlayer gel spaces, cement will continue to hydrate until all the pore space is filled with the hydration products or until all the cement has hydrated.

So, this hydration process will keep continuing till the water is available to form these hydration products until the water is available to fill the gel pores. So, till all the pores are filled, so, this hydration process will keep continuing. Till all the cement is hydrated, it will keep continuing provided the water is available. So, this curing and the water to cement ratio the interrelation actually it is little bit confusing to understand.

(Refer Slide Time: 1:33:18)



Because on one hand we say that we need sufficient water for the complete physical and the chemical hydration of the cement. On the other hand, we say that when we add excess water, it leads to high paste porosity that will affect the microstructure strength and the durability. So, then what is the best measure to get a good microstructure? So, what is the best solution? So, the best thing is you always go for low water to cement ratio.

It is always preferable to design the concrete with low water to cement ratio. So, when we go for low water to cement ratio your paste porosity your initial paste porosity will be less. So, the paste the pores will be less. But you have to give sufficient curing for the concrete. That is very important. Though you go for low water to cement ratio, the important thing to get a good microstructure is give sufficient curing for concrete.

So, when you give sufficient curing for concrete continued hydration process will occur and all the pores will be filled with the hydration products. As the pores are filled with the hydration products you can see that the microstructure will be improved and porosity of the concrete will

be less. So, thereby your strength and the durability of the concrete will be good. So, the best thing is go for low water to cement ratio mixes.

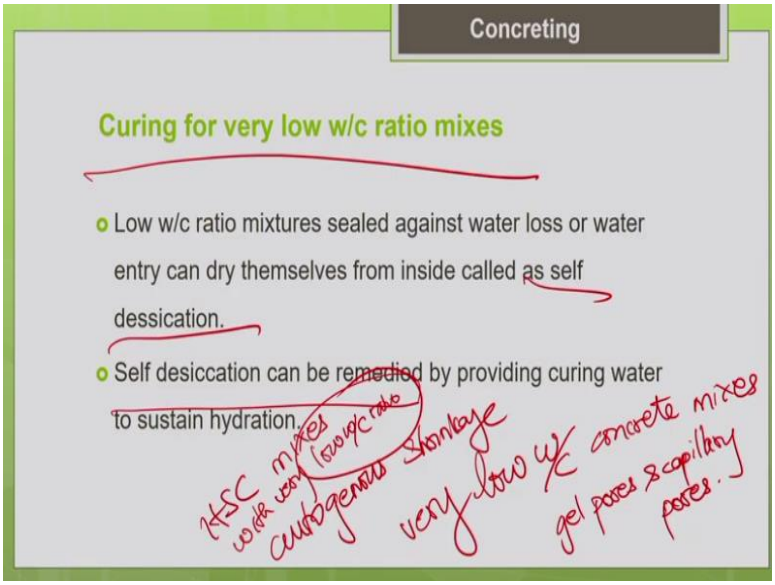
But give sufficient curing so that you will get a good microstructure. Because, your curing will ensure that the hydration will occur and the pores are filled with the hydration products. That will reduce the porosity of your concrete. And that will improve the strength and the durability related properties of your concrete. So, interaction of your curing and water to cement ratio on the microstructure of the concrete is little bit confusing as we discussed just now.

On one hand, it is important to minimize the mixing water to reduce a pore space. So, you have to reduce the mixing water because excess water will lead to more pores. So, it is preferable to choose low water to cement ratio. On the other hand, provides cement with sufficient water for filling of pores with hydration products. So, which one I should go for? So, the best thing is the more effective way is for high degree of pore filling, minimize the initial paste porosity.

How to minimize the initial paste porosity? Use low water to cement ratio for the mixes. And then promote the hydration by effective curing methods. Promote the hydration by effective curing. So, there are different ways to cure either you can apply water externally and then cure it. That is one method. And another thing is you can prevent the loss of water from within the concrete to outside environment.

There are methods for that. So, either of these methods we can go for. You can choose for curing. But generally when you go for low water to cement ratio very low water to cement ratio mixes it is preferable to go for water application methods. So, that will give you a better microstructure of the concrete.

(Refer Slide Time: 1:36:39)



That is what I told you for very low water to cement ratio mixes let us say lesser than 0.35. So, 0.3 for very low water cement ratio for high strength concrete mixes it is preferable to go for curing by external application of water. So, that will be the best method. Because what happens is if you go for methods like which just prevents the loss of water from within concrete to outside environment.

There are some water retention curing methods which we are going to discuss later. If you are going for those methods which just prevents the water loss from inside to outside, what happens is the internal drying of concrete occurs. That is called as self desiccation. Self desiccation in the sense for very low water to cement ratio concrete mixes, what happens is the water from very small gel pores and capillary pores are consumed for the hydration.

So, water from the very small gel pores and the capillary pores are consumed for the hydration process because of the limited water available. So, when these water is pulled up from all this small pores, it results in significant amount of autogenous shrinkage of concrete. So, that is called as autogenous shrinkage. This particularly happens in high strength concrete mixes. It happens in high strength concrete mixes with very low water to cement ratio.

So, what happens is, so, even from very small gel pores and the capillary pores of the water is pulled out for hydration mechanism. So, when this water from small pores are pulled out, it results in significant autogenous shrinkage in such mixes. That is a kind of self desiccation or internal drying of the concrete. So, this the remedy for this self desiccation is for this low water to cement ratio mixes better go for curing by external water application.