Pavement Materials
Professor Nikhil Saboo
Department of Civil Engineering
Indian Institute of Technology, Roorkee
Lecture: 58
Mix Design of Pervious Concrete (Part-2)

Hello friends, in the last class, we were discussing about the mixed design of pervious concrete. However, we were not able to complete this topic given the time constraint.

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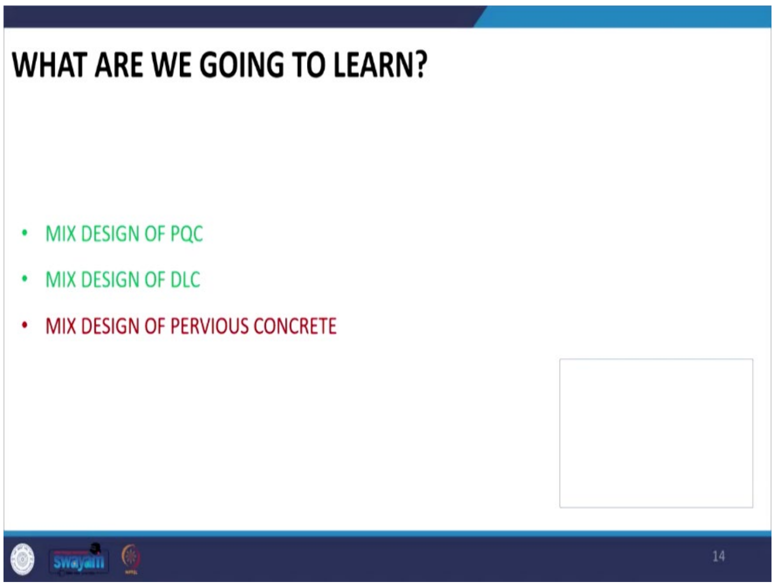

And we will try to complete this topic today. And we just need to solve two simple problems and we will discuss few aspects that are related to pervious concrete the final touch on pervious concrete.

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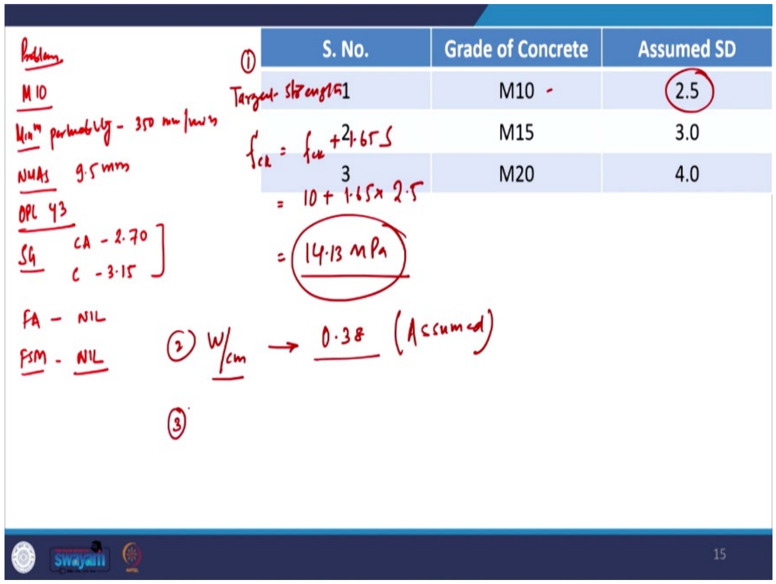

So, let me quickly write down the inputs that are required in the mix design problem we are going to solve. For this mix proportioning let us assume that we are designing an M10 concrete the minimum permeability that is required is 350 mm per minute. The nominal maximum aggregate size in our problem is 9.5 mm. We are using OPC 43 grade cement here. Specific gravity of coarse aggregate is 2.70 and cement is 3.15.

We are not using any fine aggregate and then also the free surface moisture is not present in the coarse aggregate. So, let us know with these inputs let us now proceed with the steps. So, as we have discussed, the first step is to calculate the target strength. So, f'ck = $F_{ck} + 1.65 \times S$. This is 10, 1.65 and S we will get from a table.

So, for M10 you have 2.5 as the standard deviation, so, 2.5, if you solve this we get the value as 14.13 MPa So, this is our target strength. Now, we go to the next step where we have to decide the water cement ratio. As we discussed that typically the value can be chosen in a particular range empirically. So, let us choose the value is 0.38 here. So, this is assumed and then we have to select the void content.

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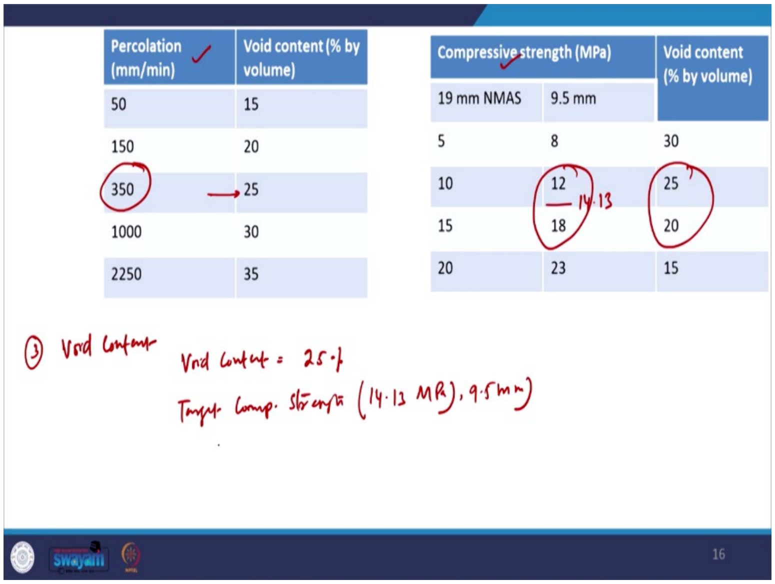

So, if you remember I discussed that void content can be selected in two ways depending on the permeability criteria as well as compressive strength. Our minimum permeability requirement is 350 mm per minute for corresponding to that we have the void content as 25 percent. For the target compressive strength that is 14.13 M Pa and 9.5 mm nominal maximum aggregate size.

So, you see we are somewhere here between 20 and 25. So, we will have to interpolate for 14.13. If you do the interpolation with the steps of which we have already discussed you will get the void content as 23 percent approximately. So, void content is 25 percent here, 23 percent here let us take the average value. So, we can take 24 percent as the void content. Now, the next step is to calculate the volume of the paste.

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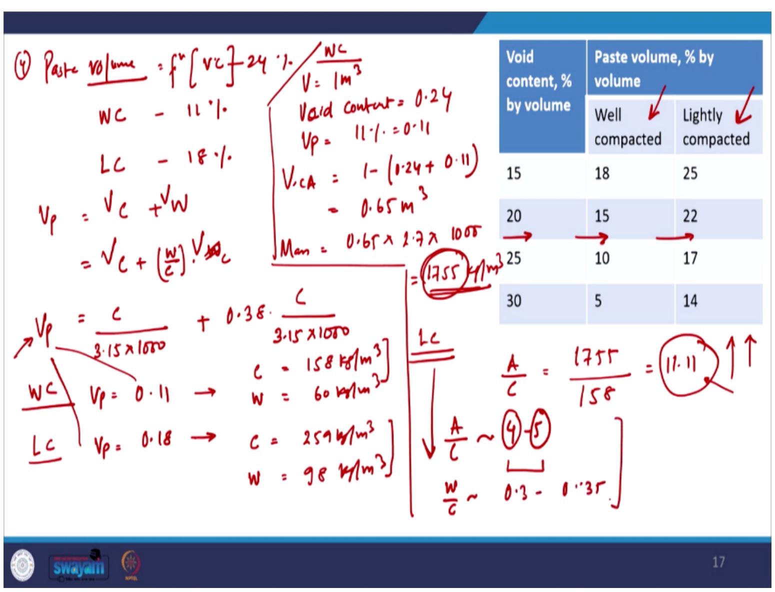

So, paste volume is a function of void content which is 24 percent in our case, however, there are two cases. We can design corresponding to well compacted condition or lightly compacted condition. So, for I am writing well compacted as WC here, lightly compacted as LC here. So, for well compacted condition 24 percent is somewhere here. So, our value will be somewhere here. We have to do the interpolation.

So, we will see that this is equal to 11 percent and this is equal to 18 percent. Now, we have the paste volume Vp. This is equal to the volume of the cement plus volume of water. Volume of water can be written as w/c × volume of cement let me write this as Vc and Vw for clarity.

So, $V_C = \frac{C}{3.15 \times 1000}$, w/c which we have taken is equal to 0.38 volume of sorry this is volume of cement. So, volume of cement again becomes equal to $\frac{C}{3.15 \times 1000}$, so, this is the paste volume. So, paste volume in the first case is equal to in the well compacted condition. So, well compacted condition, Vp = 0.11. In lightly complicated condition, Vp = 0.18.

We put it here and we calculate the cement and water content. So, cement content in first case becomes equal to 158 kgs per meter cube. The water content becomes equal to 60 kg/m^3. In the second case the cement content becomes equal to 259 kg/m^3 and the water content becomes equal to 98 kg/m^3. So, you can do these calculations. So, we have got the proportion of cement and water.

Now comes the part where we have to calculate the proportion of coarse aggregate. So, again there are two conditions well compacted. Let us this first to understand. So, volume of concrete is 1 meter cube, volume of void content is equal to 24 percent, volume of paste is equal to 11 percent. Therefore, volume of course aggregate becomes equal to (1-0.24)+0.11 this becomes equal to 0.65 m^3. We can convert it to mass very easily using the value of specific gravity 0.65×2.7 was the specific gravity into 1000 conversion.

This becomes equal to 1755 kg/m^3. So, we have now all the proportions. So, I am not going to do it for lightly compacted. The calculation will be same. You can do it yourself. Here an important point to note here is that you see if we calculate the aggregate to cement ratio here it is basically how much, $\frac{1755}{158}$.

So, this is equal to almost 11.11 which is a very high value and this may not give us a pervious concrete mix with enough strength. So, as per experts in this domain, they suggest that the aggregate to cement ratio should be kept only around 4 to 5. So, that strong pervious concrete can be designed that to with the required minimum permeability criteria. And similarly, the water to cement ratio can be somewhere between 0.3 to 0.35. So, this is a point which I wanted to make here.

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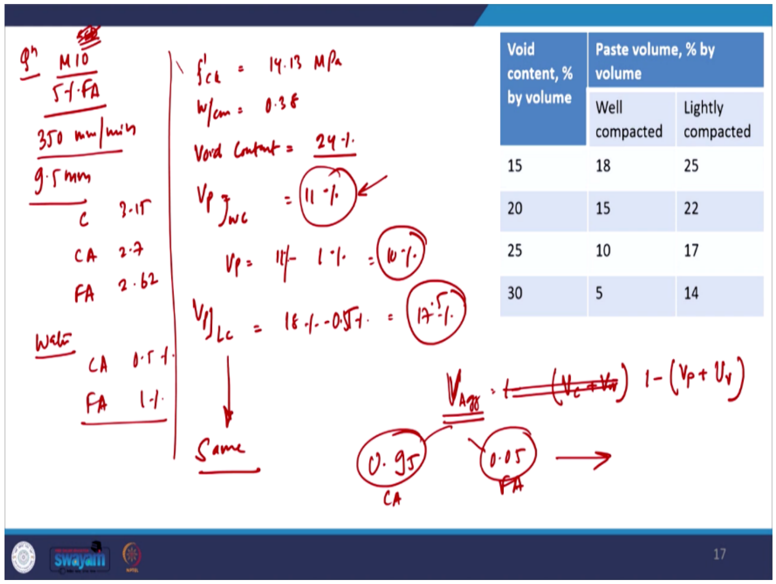

We can solve another problem. I will just introduce the problem though I will not complete the steps because these steps will be repetitive in nature. So, here let us say we are going to design similar pervious concrete, but now, let us incorporate fine aggregate and see where the steps will differ when we use fine aggregate. So, let us say we are using designing M10.

We are using 5 percent fine aggregate, 350 mm per minute is the minimum permeability requirement, 9.5 mm is the nominal similar to what we have done previously. Now, we have cement coarse segregate fine aggregate. This is 3.15. This is 2.7. Let us say that this is 2.62. water absorption also now we will have two values, coarse aggregate 0.5 percent, fine aggregate 1 percent. In the previous problem which we have solved, we have seen the calculations.

So, those calculations we are again in SSD condition and using the water absorption value of the coarse aggregate you can calculate in dry condition as well and I think we already know how to do that. So, this is you know just to inform you that those steps we are remaining which we have not specifically discussed here today. So, again the steps remains the same. You first calculate f’ck value will be same here because the values are same.

Again water cement ratio let us assume the same value no change. Void content is not affected by the presence of fine aggregate. So, it remains the same average of two conditions volume of paste in well compacted condition was 11 percent, but we cannot continue with this value, because now we have fine aggregate in the mixture and if you remember we had to reduce this value by 2 percent for every 10 percent inclusion of fine aggregate.

Now, since the fine aggregate is 5 percent now, therefore, the paste volume will be reduced by 1 percent and the paste volume becomes equal to 10 percent. Similarly, in case of lightly compacted one it was 1 percent for every 10 percent. Here we have 5 percent. So, we have to reduce by 0.5 percent. So, (18 percent -1 percent) So, 17.5 percent.

So, this way is the major difference in the step other than this everything will remain the same only at the end when you are calculating the volume of the coarse segregate once you get the volume we do not call it as the volume of coarse aggregate we will call it as the volume of aggregate that will be 1 minus volume of paste plus volume of voids.

And this volume of aggregate now 95 percent will be coarse aggregate and 5 percent will be fine aggregate and now after this we all know how to proceed in these steps. So, I think these steps are clear to you and that is all for today. With this we have completed our second last module on concrete mixtures and in the next class we will discuss the final module which is on alternative materials in pavement engineering. Thank you.