Basic Construction Materials
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Module No # 10
Lecture No # 48
Pavement Materials 2- Part 2

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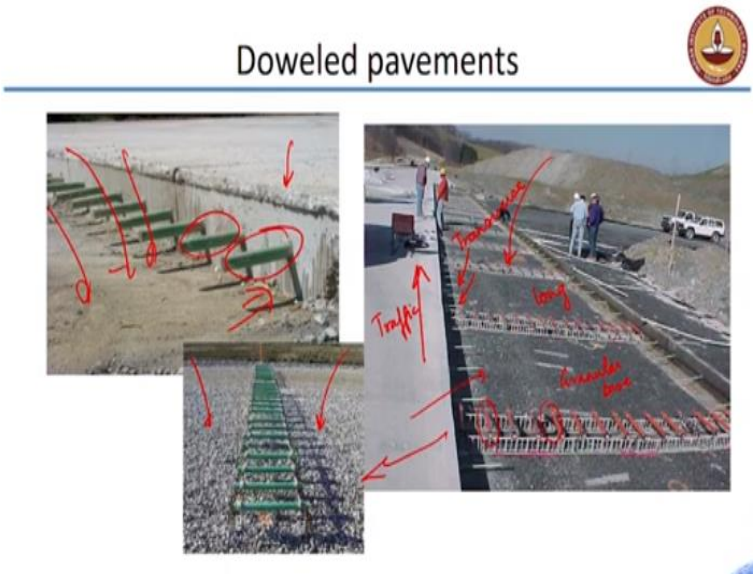

That is exactly what is been shown here. This is one of the slabs and at the joint you provided these Dowels and you will be casting the next concrete in this location so that it is simply connect to the adjacent slab. This is an example of a roadway pavement which is being just made. You see the granular material at the base and the concrete is going to be poured on the top of this**.**

And they already defined the location of dowels in the direction of traffic, so this is the traffic direction. They have defined and they placed the dowels already before putting the concrete. Then they will be putting concrete on the top here, filling up the concrete on the top. Now, dowels are provided to connect the slabs in the longitudinal direction.

So this is the longitudinal direction. You can also have dowels provided in the transverse direction. So dowels are also provided to connect the slabs in the transverse direction. So both ways there is good load transfer between one slab to the next. So that is the use of a doweled pavement. Again, a closer view is shown here, these dowels are placed exactly where the joints are supposed to come between adjacent slabs. So, then you are pouring

concrete on the one side and then pouring on the other side just like what is shown in this case.

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Of course, a continuously reinforced concrete pavement is nothing but a regular reinforced concrete slab which has reinforcement in both directions. It is got reinforcement in both directions, which is what you see here. In a closer look, the reinforcement is actually extending in both directions, so here, there are no joints. See the roadway surface; there are no joints in the concrete. That is because the shrinkage and thermal effects are taken care of by the reinforcement directly.

You do not need to provide joints and provide dowels across joints. So here, the bottom picture you see before the construction process, you have the reinforcement mat which is been laid out and then these are small not really cover blocks, they are called chairs to ensure that you can increase the height at which the reinforcement is placed. You do not want to place directly on the ground, because it should not be in the surface contact with the ground otherwise it will corroded.

It is usually placed directly in the center of the rigid concrete slab. So to place it in the center you need to raise it above the ground and to raise that you need arrangements which are called chairs which are made with steel essentially to make the steel mat to sit a few centimeters above the ground level. See most pavements or pavement thickness is typically about 150 to 200 millimeters or sometimes it could be 300 also, so 150 to 300 mm.

In most cases when we are talking about highway pavements you are closer to 300 mm. When you are talking about drive ways outside the building which are only going to be taking the load of 1 or 2 vehicles, in those cases obviously you can reduce the thickness. So you need to design the pavement so that the thickness is controlling the extent of stress that can be felt by the concrete.

So remember I told you that the concrete has to behave like a slab to resist the loading of the vehicles. So the thicker the slab the greater will be its moment of inertia in the direction of bending. The greater the moment of inertia, the lower will be the stress that would be felt by the concrete. So, we need design it appropriately so that the does not concrete crack in tension.

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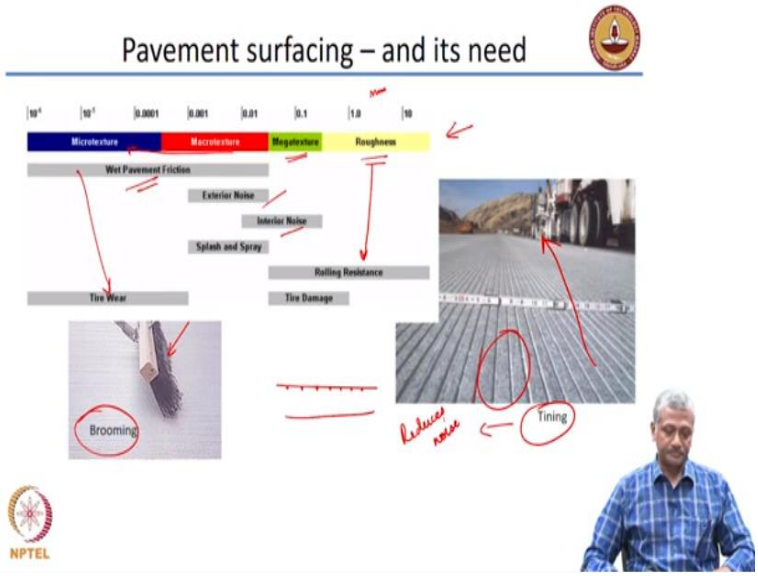

Now, in some cases the concrete pavements after completion of the slab placement or concrete placement and finishing, you have to provide texturing of the pavement surface. Remember we talked about this briefly in the concrete chapter also. After finishing, there is some texturing that is done. This is one example of the texturing called as brooming.

So, this broom which has very rough brissils is rubbed on the top surface of the concrete. So concrete is not completely hard that point of time. It is not achieved its final set so it can be altered, the surface can be altered by a brooming and this brooming ensures that you get a good grip on the road surface when the pavement moves on it. You then have another aspect called Tining.

Tining is after the concrete surface is become hard we take this sort of a grooving not very hard, but somewhat hard we take this grooving tool and cut a groove on top. This is not a cut rather but this just a small groove that is provide on top. So, this is your pavement, I am just providing a very small groove at small distances. This is not a crack, this is not a joint, but this is just a grooving done on the pavement surface.

So, we are talking a few millimeters, may be about less than 5 millimeters of the groove actually created in the concrete surface. And you see that this is the direction of traffic and the tining is done along the direction of the traffic. What is this Tinning do? It helps in providing first of all a good grip especially in the case of wet conditions. When the conditions are wet, the tining helps to increase the grip of the tire on the surface.

So, it is very good to do for concrete pavement. So depending upon what you need in terms of the performance you can have different types of pavement textures and that is what is shown on the top here, different pavement textures. For example roughness is of the order of a few millimeters (1 to 10 millimeters). This is called roughness basically which is the order of 1 to 10 millimeters. Then you have what is called mega texture which is about 0.1.

And as you go smaller and smaller you going to macro texture and micro texture. So, what are these textures? What kind of performance are these textures affecting? Roughness obviously affects the rolling resistance. Micro texture is what is responsible of the wearing of the tire slowly. Wet pavement friction is taken care of by micro and macro textures that you give or of this order.

So you need to ensure that the sizes of the tining grooves that are given are of this order to provide the right level of holding on the pavement surface. Exterior noise and interior noise which are caused because of the interaction of the tire with the pavement can also be related to the texture of the pavement. So sometimes this tining also helps to reduce the noise. So again all these aspects, textures, can be taken care of on the surface by providing all these inputs.

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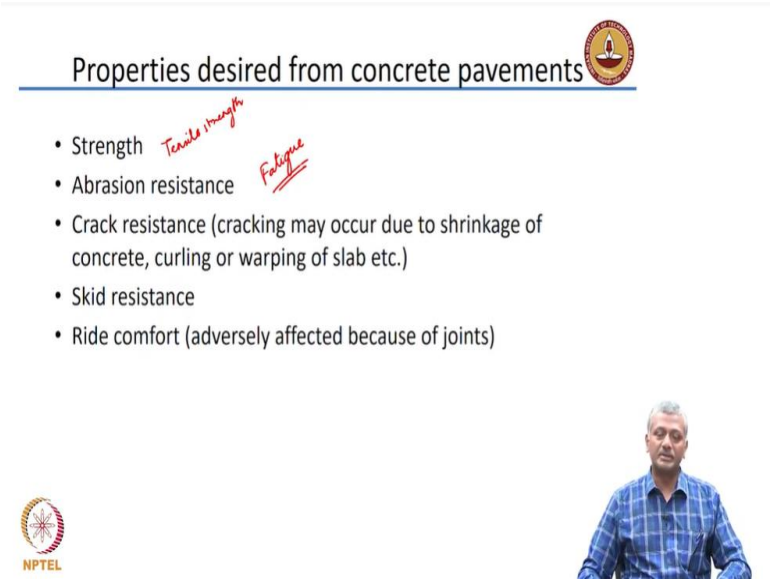

Now just like asphalt pavements we had some specific properties that we desired from asphalt pavements. In concrete pavements what do we need? Obviously we need strength, mostly we need tensile strength. We also need abrasion resistance because as the vehicles are moving continuously on the surface concrete will continuously get abraded. So, abrasion resistance and fatigue resistance also needed.

Because in buildings we do not really take fatigue but here we have to also take up fatigue resistance. Cracking resistance is very important. Cracks as I said may happen because of shrinkage of concrete, curling or warping both are which are related to heat and moisture. Skid resistance is important on a concrete surface and also of course the riding comfort. Now because these joints are present, the riding comfort on a concrete pavement is sometimes not as good as that you find on a flexible asphalt pavement.

So very often what is done in countries abroad is that even though your main structural pavement is actually a concrete rigid pavement, they sometimes use a surfacing of asphalt concrete on top the concrete pavement. They put surface layer of asphalt concrete on top of the concrete pavement. So that is an interesting example of a composite sort of pavement deck. So, these are the properties you want from typical concrete pavements.

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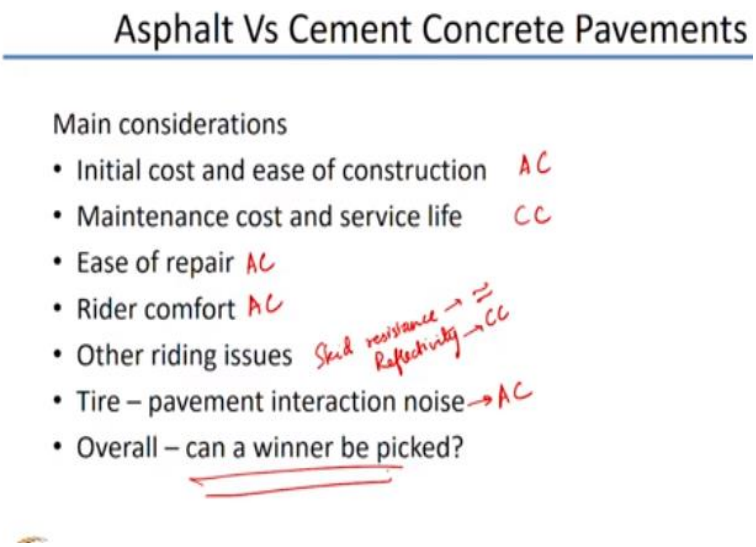

Just to give you a bird's eye view on why one should consider one pavement on top of the other pavement? The main consideration with respect to choice of one over the other is initial cost and the ease of construction. I already talked about this briefly earlier, the initial cost and the ease of construction both point towards a benefit for flexible pavement made with asphalt concrete. Cost is low and it is very easy to construct as to cement concrete pavement.

Now to the maintenance costs and service life, how long is the pavement going to serve satisfactorily? And in that case the concrete pavement is the winner. So here you have asphalt concrete, here you have cement concrete. So, because it is easy to maintain over a long period of time, if you done a good job of the construction the maintenance costs of the cement concrete pavement is not much at all.

On the other hand, asphalt concrete because of its polymeric nature of the asphalt and its capability for getting degraded because of multiple affects; you can have lot of issues with maintenance. Now in ease of repair, you have asphalt concrete which scores. We talked about surface recycling, we talked about surfacing itself.

In some cases, you may see that in your neighborhood whenever your road payment gets damaged and a VIP is visiting, you immediately have in the night some sort of a contractor who comes there and just put some new surface, just the thin asphalt layer pavement on top. They have not repaired any damage; all they have done is resurface the road. So, ease of repair and refurbishment of a damage pavement is much better in the case of asphalt concrete.

In the cement concrete, if the pavement slab breaks or starts cracking you have to remove the entire thing and put up new thing back it is not easy to repair it in that case. Rider comfort, how comfortable are the riders inside? We talked about this earlier in concrete pavement, when you joints, it affects the comfort of the rider. So, it is not good from that perspective and again here the asphalt concrete pavement basically scores.

There may be other riding issues like skid resistance, in some cases reflectivity also may be an issue. When you are driving in the night, the asphalt concrete pavement which is black may not reflect unless of course the polish on the surface is good and the aggregate are able reflects some light. That is why need to provide all those markers or indicators to ensure that people are moving in the right lane.

Concrete pavement on the other hand, reflectivity is better. So we need to consider issues like skid resistance, reflectivity and so on. Here, skid resistance probably more or less equal and reflexivity is better with cement concrete pavement. Tire pavement interaction noise, the noise generated when the tires interact with that pavement. That noise is generally much lower for asphalt concrete. So, asphalt concrete pavements are more silent as oppose to cement concrete pavement so a lots of noises generated.

That is why you have to do a texturing on the cement concrete pavement. So question now is can a winner be picked between asphalt and cement concrete? The choice is obviously dependent on the person who is using the pavement. Now if I am the agency or the client like Municipal Development of Corporation in a City, I need to make a choice. What is more important for me?

Is the ease of application or ease of repair, initial costs and all those are important or is it the maintenance costs in the long term performance of this pavement that is important? The other aspects when we are talking about pavements in the city, is that often times we have our water lines and electricity lines under the pavement. When we have an asphalt concrete pavement it makes that all that much easier to do this to access the pipes underneath and then resurface the road.

Cement-concrete again, a lot of effort is involved in actually breaking open the concrete. So there are lots of these things to consider in order being able to properly choose between cement concrete and asphalt concrete pavement. So I will not give my own opinion here but I

will leave the choice all of you to really think about it from different perspectives. From user's perspective, from the operation perspective, operation and maintenance perspective, from the owner's perspective like the National highway authority of India NHAI.

From their perspective what do you think should be the ideal way to construct the pavement is it asphalt concrete or is it cement concrete?

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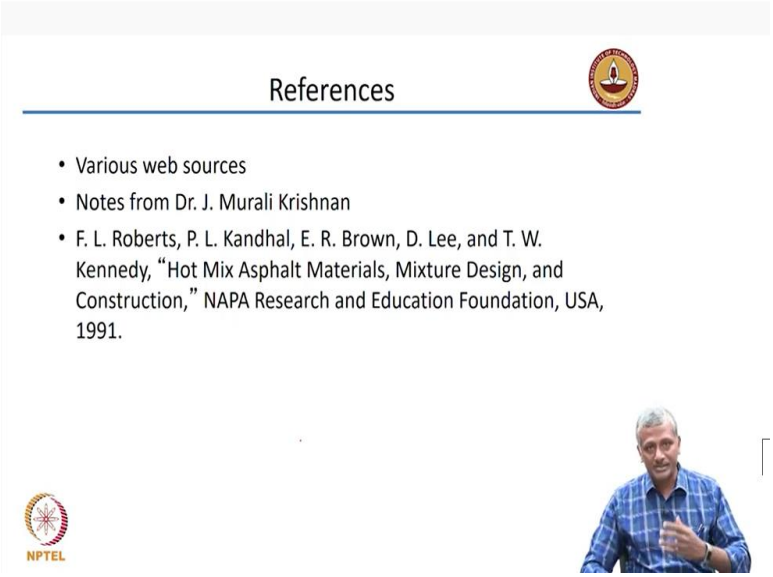

So, with that we will complete this chapter and also this is the last chapter in this course. I hope this course has been very useful for you and it will build up your foundation for higher level courses in civil engineering. I am also providing some references here. There are lots of references on asphalt concrete that you find in conventional constructional materials books also. But of course understanding asphalt is critical from the point of appreciating the way that asphalt concrete pavements behave.

So, I would really urge you in case you are interested in asphalt to take up higher level courses in transportation materials to really satisfy that desired to learn about asphalt. So thank you all very much and it is really been wonderful for us to bring up this course for all of you and hope that it is useful for all of you. Thank you.