Traction Engineering
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Lecture No. 32
Traction Aids for Tractors

Hi everyone. This is professor H Raheman from Agricultural and Food Engineering Department, IIT Kharagpur. I welcome you all to this NPTEL online course on Traction Engineering. This is lecture 32 where I will try to discuss about what are the different traction aids available for tractors. When I said traction aids, the first thing which comes to our mind is why do we require traction aids? So, we require traction aids to improve the mobility, mobility of the tractor as well as to improve the tractive ability of the tractor.

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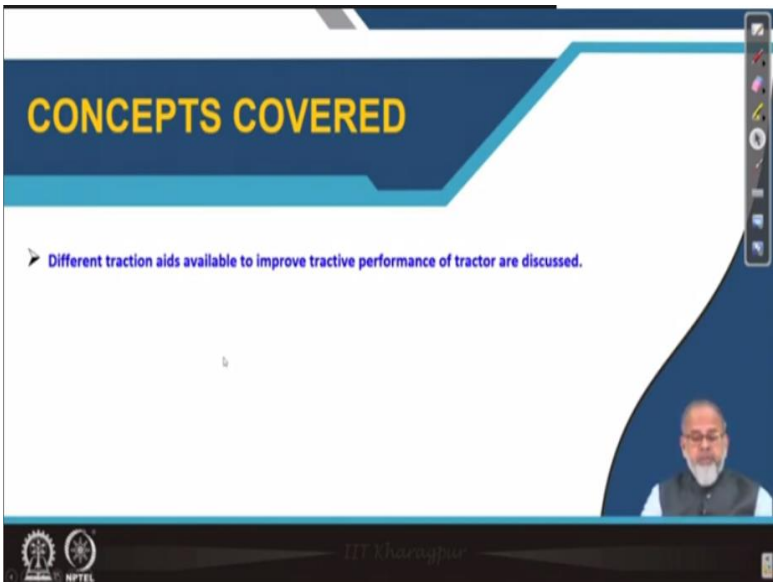

So, the soil conditions are different. So, what I will do is, I will try to discuss what are the different traction aids available to improve the tractive performance of tractors in different soil conditions.

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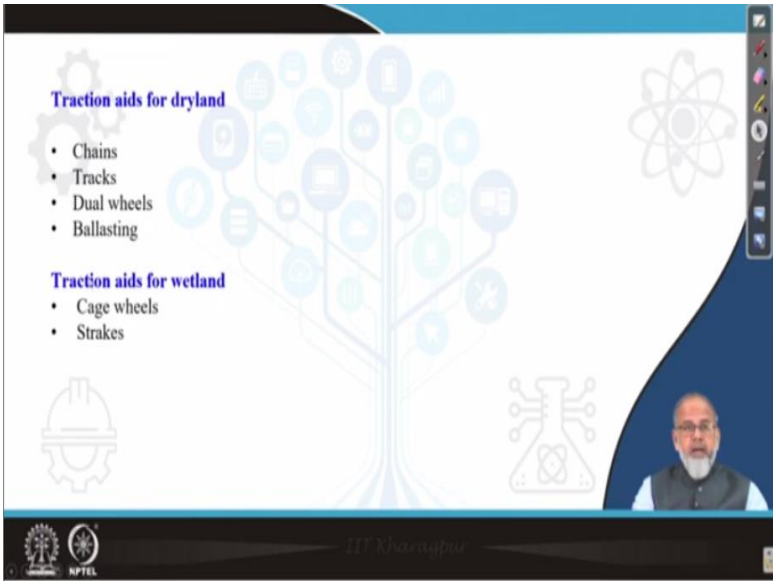

The soil conditions, basically we divide into two types. One is dryland and the other one is wetland. So, dryland, what are the traction aids available and in wetland, what are the traction aids available and also, I will try to briefly about what are the real problem in wetland and how to overcome those problems. So, some of the traction aids, which are available or which are used are chains, tracks, dual wheels, and final ballasting. And in wetland it could be cage wheels, it could be strakes. So, we will discuss one by one.

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The figure which I am showing is a chain fitted to a pneumatic wheel. These are primarily intended for off highways in conditions like mud, snow, and ice. And they are used in conjunction with tyres. So, what will happen, the chains will try to cut through the slippery

surface. That means, either it could be a layer of mud or it could be layer of vegetation. Then it obtains a good grip from the farm soil, which is lying underneath.

So, thereby, the chain is in a position to create proper grip between the wheel and the hard surface which is lying below the slippery surface. Thereby, its pulling ability is increased to the tune of 15 percent. So, these are primarily meant for forestry equipment. But in agriculture also you can apply this kind of traction aids.

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And the next thing is tracks. In my lecture 28, 29 and 32, 31, I have discussed about this track and how the track is compared with the wheels and the performance are given. So, I am just summarizing here. So, the tracks are provided with the tractors to basically increase the contact area and thereby, the contact length. As a result, the ground pressure is reduced, hence rolling resistance is reduced and the thrust which is developed becomes more and thrust is developed at lesser slip. When the contract pressure is reduced, there will be lesser soil compaction, hence, lesser rolling resistance.

But the only problem is, these are meant for increasing traction ability in dryland, not in wetland. These are not suitable for wetland. And the other problem is, if the field is stony, there is a possibility that the tracks will be damaged because these are rubber tracks. So, those will be damaged. And the third difficult is steering. When you, you are fitting this track to a tractor, you have to look at the steering so that it can take easy turn at the end of the field. That means that the headland. Otherwise, tracks are better for carrying out any operations, field operations for raising crop in dryland.

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The next traction aid is your dual wheels. That means wheels are attached side by side. What is the advantage? They provide increased ground contact area and it decreases the compressive stress which is acting in the soil. That means, there will be less compaction. So, less ground pressure due to more contact area will reduce the depth of rut, which is formed and hence, the power or the force which is required to overcome this or to ride this rut will be less. Hence, your motion resistance or the rolling resistance will be reduced.

So, this kind of arrangement will produce 40 percent increase in pull in almost all soil conditions as compared to single wheel. And, we have also discussed about, if you are selecting a dual wheel, what should be the diameter for a given width, what should be the diameter, we have already discussed while selecting the tyre?

But while selecting the tyre, only diameter will not help you. So, you have to take some precautionary measurement like, the two tyres should be of same size and the wear rate for both the tyres should be same. The state of tyres I am talking about should be same, and they should be inflated to same inflation pressure. Then only we can get the benefit of more pull. Otherwise, we may not get that benefit what I have written in the last line, there is 40 percent increase in pull.

So, we can take smaller diameter and wider tyres or bigger diameter lesser width tyre. But the condition is, this should be inflated to same inflation pressure. This should, the state of tyres should be same. That means the, if you are utilizing used tyres, then both tyres should be of same condition. These are some of the things which should be taken into consideration while utilizing dual tyres in place of single tyre.

But the only disadvantage that associate with this one is, cost will be a little higher because you are utilizing 4 tyres instead of 2 tyres in the rear axle or in the front axle, if it is a four-wheel drive tractor. So, otherwise, it is fine. That means it is giving you more pulling ability. So, you have to now check whether the increase in pull is acceptable by the farmers with the amount of increase in cost. So, that has to be taken care of. Again, these are for dry land, not for wetland.

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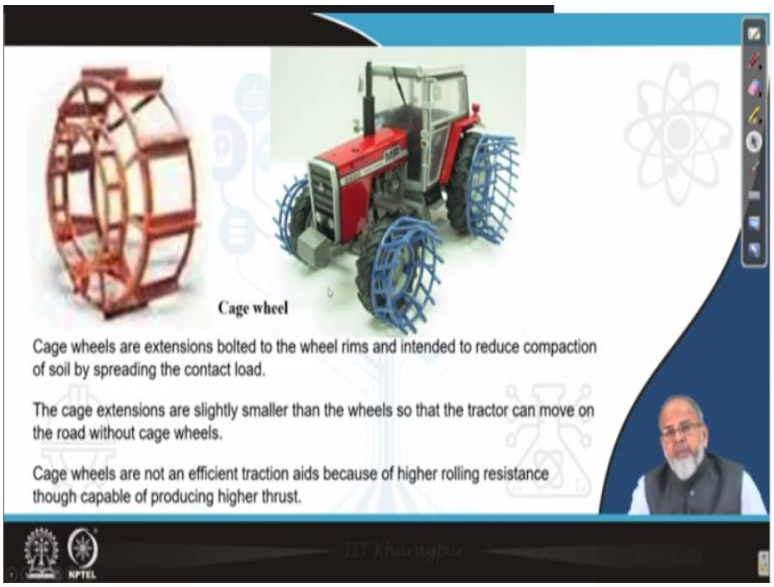

Now, I will come to specific attachments, or traction aids, those are used in wetland. The most commonly used one is your cage wheel. These are solid wheel which have lugs. They are fixed to the periphery of this wheel, and this wheel is bolted to the wheel rims. The intention is to reduce compaction of soil by spreading the contact load. And at the same time, these wheels in weight land also helps in carrying out the puddling operations.

And the cage wheel extensions, they are either attached along with the pneumatic wheel or they can be attached independently by removing the pneumatic wheel. Both are possible and the cage extensions are slightly smaller than the, if when they are attached to the tractor along with the pneumatic wheel, then the cage extensions are slightly made smaller than the wheels so that the tractor can move on the road without damaging the road. Otherwise, there will be lots of vibrations.

The difficulty which is associated in using cage wheels are, the cage wheels, they are not efficient traction aids. Why? Because it has higher rolling resistance, though it is capable of producing more thrust by interacting with the hardpan. But because of the high rolling

resistance, most of the power which is developed, that will be utilized in overcoming that. Hence, these are not very efficient traction aids.

But because in addition to develop pull, it is also helping in carrying out puddling. So, that is why people are utilizing, the farmers are utilizing these cage wheels. So, this is basically a traction aid, but in addition to traction aid, it is also carrying out puddling operations smoothly.

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Next traction aids is your strakes, both retractable and non-retractable. Strakes means there are strakes here, here, here, here. These are strakes. So, they are foldable. So, that is why it is called retractable. If they are not foldable, what will happen, because this is mounted to the rim, so, during transportation, that means movement from the shade to the field again, the strakes will be striking the road or soil surface, which will be damaging the roads and the strakes will be damaged. So, that is why people prefer or the farmers prefer to go for foldable or retractable strakes.

The function is, it produces more pull by digging into the hardpan, which is lying below the soft soil, soft soil which is present at the top in case of wetland. And the researchers have come to a conclusion that strakes on tyre are more effective than ballasting in clay soil. I have not discussed about ballasting, and so I will now discuss what is ballasting and how it is going to help in improving traction.

So, we have discussed traction aids in dry land. We have discussed traction aids in wetland. And one more thing is ballasting, which is used to control the slip. When slip is more, we can

add some weight to the tractor, and thereby, you can reduce the slip and hence your pulling ability will be increased. If steering ability is not there, that means while pulling an implement, there is a weight transfer from the front of the tractor, front axle of the tractor to the rear axle and from the implement to the rear axle.

So, when there is a weight transfer from the front axle, the minimum weight which is required for suitable or efficient steering is 20 percent of the total weight. If the weight transfer is more, then the tractor will simply float. It is really difficult to steer. So, there you add weight. So, addition of weight not only reduces slip or not only helps in improving the thrust by reducing slip, it will also help in carrying out efficient steering. So, these are some of the traction aids which we discuss. Then in wetland, there is this typical problem.

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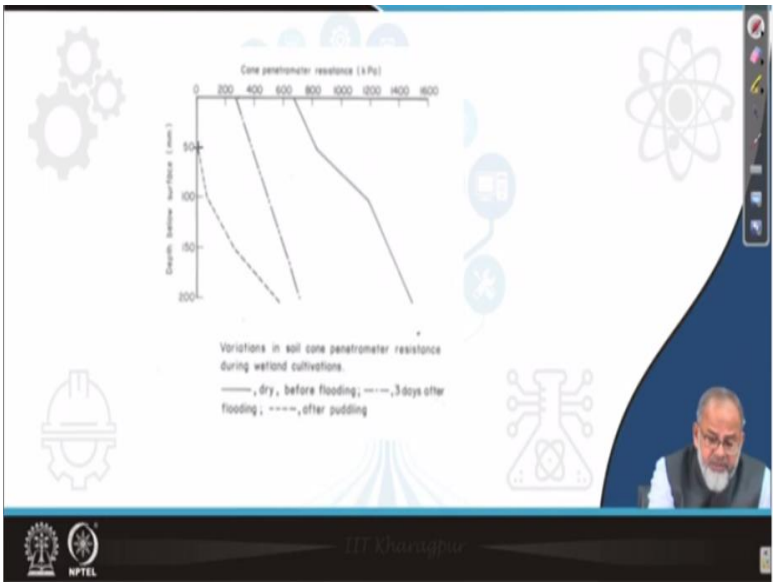

The problem is if you look at this graph, these are the soil conditions. How it is, that means strength of soil which is represented by the cone penetrometer readings are the cone penetrometer resistance which is given in kilo Pascal for three different conditions. When the soil is dry, you are getting a solid line. When the soil is flooded, and after 3 days of flooding, you will see the soil condition is this.

And after puddling, you can see the soil condition is this. So, after puddling, basically the top 50 millimeter, that means 5 centimeter soil has no strength at all. If you just put your leg, you will simply sink into the soil. So, under these conditions, we have to run some implements, some machinery. So, here the requirement is to reduce the weight, then only the equipment will float, do not sink. The moment you make it heavy, or if you add more weight, what will happen? The equipment will sink into the soil and the force requirement will increase.

So, I have given in this figure just to get an idea what is happening in the wetland and how to design the machinery so that in wetland, so that there will be no sinkage. No sinkage means lesser sinkage and hence, lesser power will be required to move that machine in soft soil. So, in order to carry out this kind of activities, some specific machines are developed like turtle tiller, boat tractor. So, I will just give you a figure.

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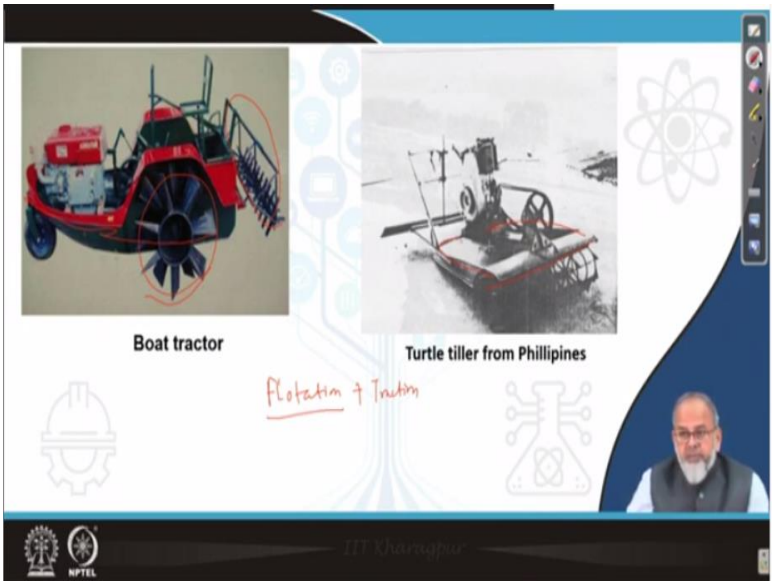

The left one is a boat tractor. The right one is a turtle tiller. The boat tractor was developed in China and the turtle tiller was developed in Philippines. Here, there is a floating device in case a boat tractor, the floating device is nothing but the boat. And the end of the boat, you can see, there is a tilling implement. And in addition to that, there is a propelling unit. That means, instead of pneumatic wheel, this cage wheels are provided on both sides. So, that will give you propelling as well as it will do churning of soil, in addition to this tilling implement.

So, the basics, this is the float, which will look like a boat. So, the drag that means force require to move in the muddy soil will be reduced. So, that is the concept. So, that means in wetland, we have to provide flotation in addition to traction. So, flotation plus traction. So, in a boat tractor flotation is provided by the boat shape chassis, and the traction is provided by the cage wheel.

Now looking at the turtle tiller, the concept is same. In the front, there is a cage wheel, two independent cage wheels, and this is the structure which is chassis, you can say. So, that is a structure which will slide over the puddle soil or in wet land. And then behind there is a leveller so that it will level the soil surface. So, this two cage wheels which are mounted in the front. They are powered, powered by taking from an IC engine. So, the entire structure

which I marked with red, that becomes a float. So, it will not allow the machine to sink further, and the front person will be dealing it.

So, these are some of the devices which are available exclusively for wetland. Because these two machines are not suitable for dryland, it will have too, too much amount of rolling motion resistance. Because the soil is soft, the shape is made in such a way that it looks like a snow skews or it looks like a boat so that the drag force, so the force required to pull this in soft soil is reduced. So, I have highlighted the machines which are available. Then I have indicated the floatation requirement in wetland.

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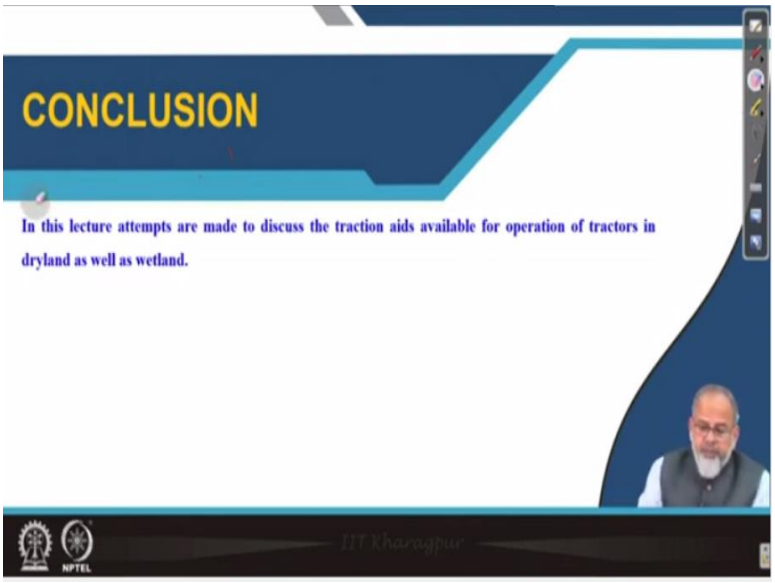

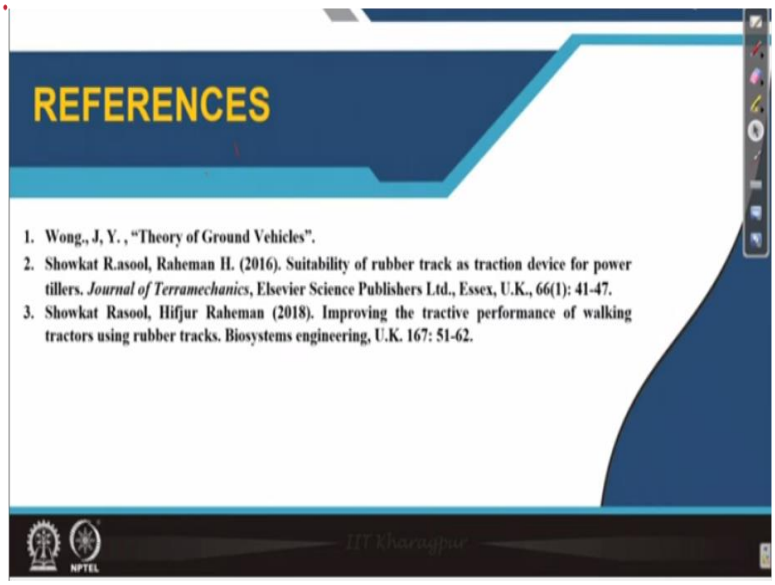

So, in brief, in this lecture, I have tried to discuss about the different types of traction aids which available in wetland, in dryland and then in in dryland also how ballasting is going to

help you in improving traction as well as steering. Literature which can be referred, thank you.