Surface Mining Technology
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Lecture – 46
Haul Road -I

Let me welcome you to the 46th lecture of NPTEL online certification course on Surface Mining Technology. This lecture onward, we will start the haul road. Haul road is basically an integral part of surface mining. All the ingress and egress are carried out through haul road only. So, there will be three lectures on the haul road. So, this is the first lecture and, in this lecture, we will continue with the introduction to haul road.

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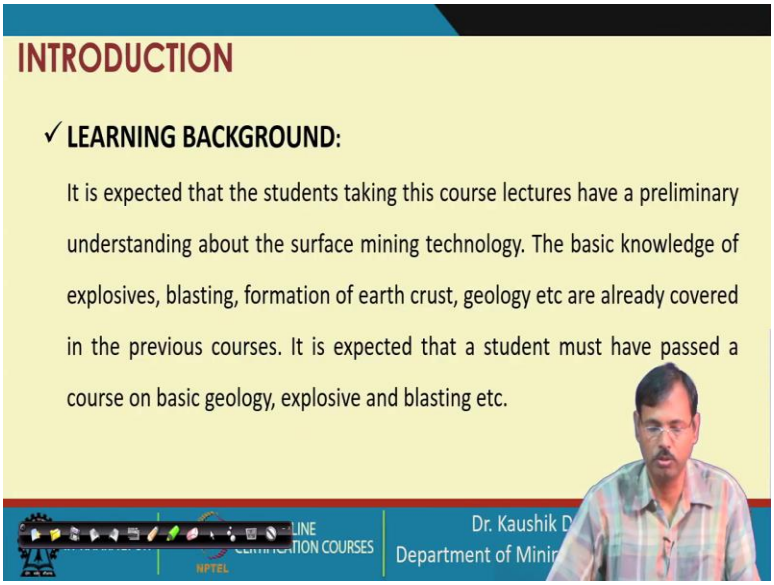

And before that, as we do really let us have one glimpse to the learning background for the Surface Mining Technology course.

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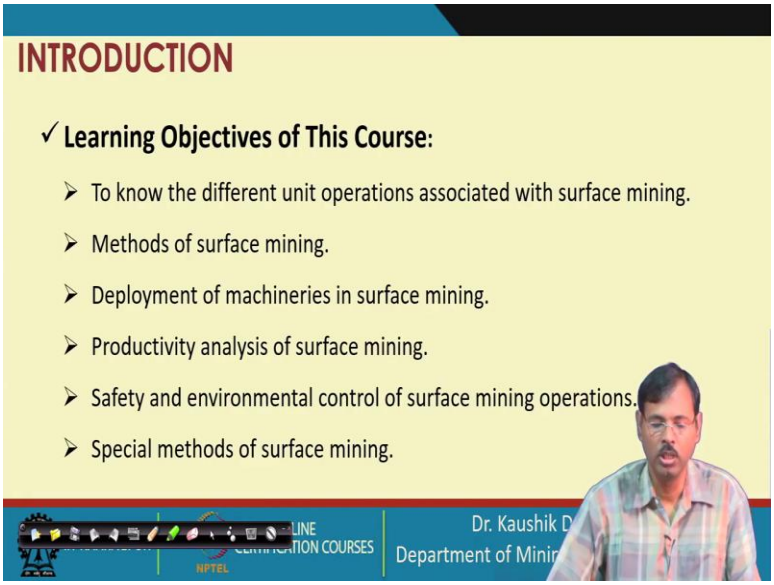

These are the objectives of this surface mining technology course.

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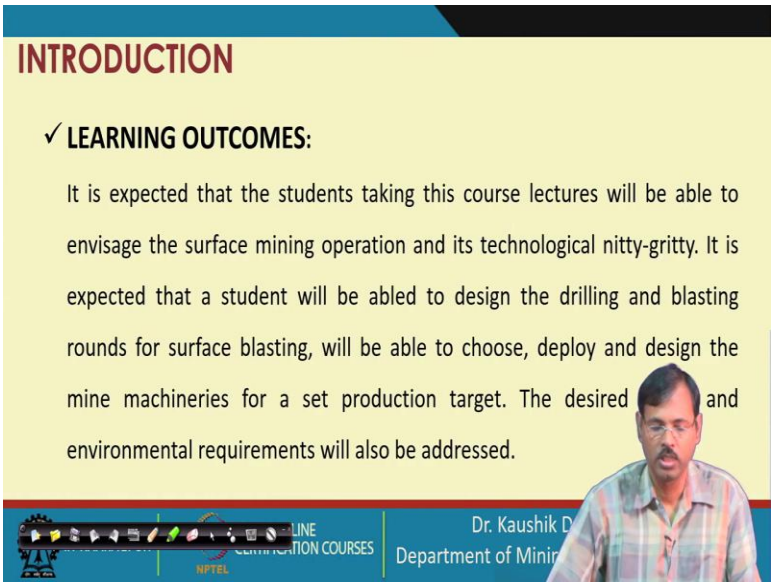

And the expected learning outcomes from the participant of surface mining technology course.

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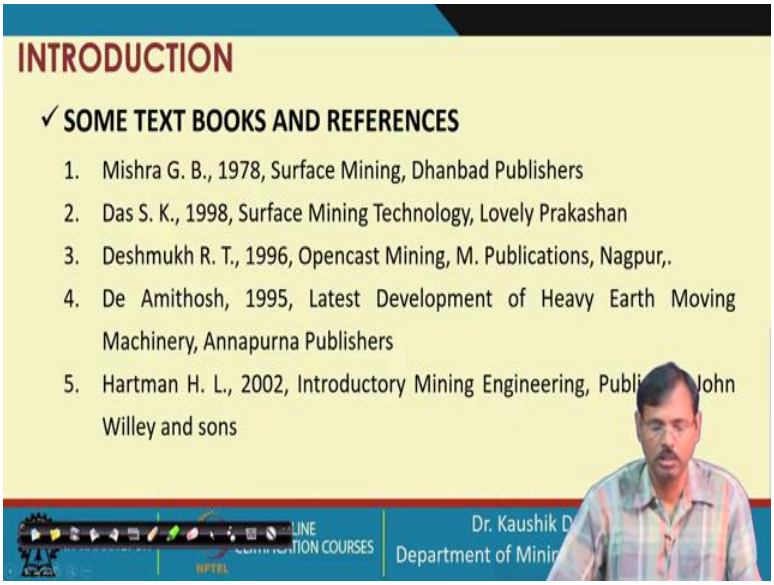

And these are the textbooks and references.

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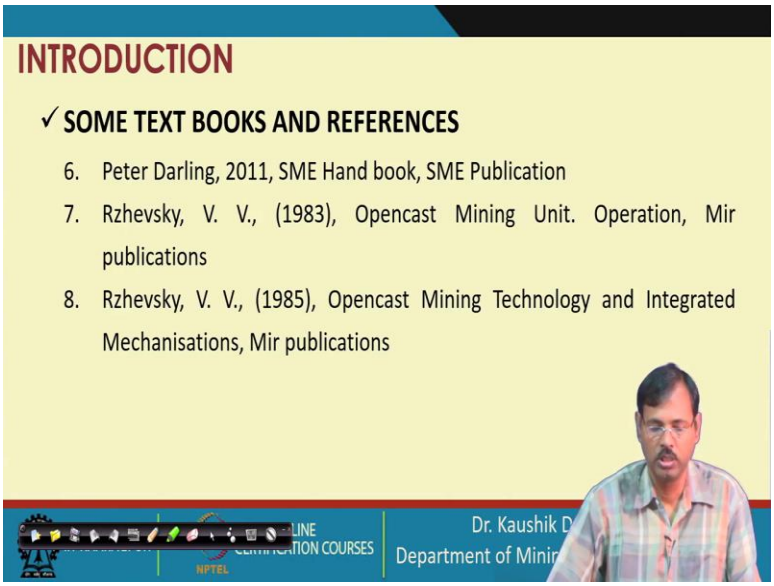

And these are few more textbooks and references.

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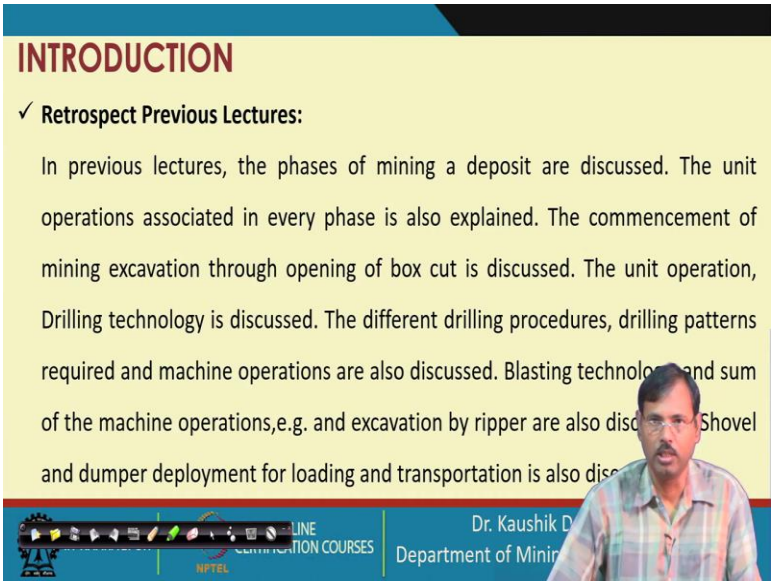

And let us see, retrospect so far up to that lecture number 45, what we have covered. So, in a concise way, we can say we have covered the phases of mining a deposit. We have covered the commencement of surface mining, through the opening of box cut. We have already covered the drilling technology; we have already covered the bench blasting technology, and we have also discussed related to the excavation of the blast fragmented rock mass by shovel.

We have discussed the transportation of the blast fragmented rock mass through the dumper. And apart from that, we have also discussed the blast free excavation techniques using ripper and using surface minor also. And we have discussed the operation of dragline, we have discussed the operation of bucket wheel excavators. So, all these are already covered.

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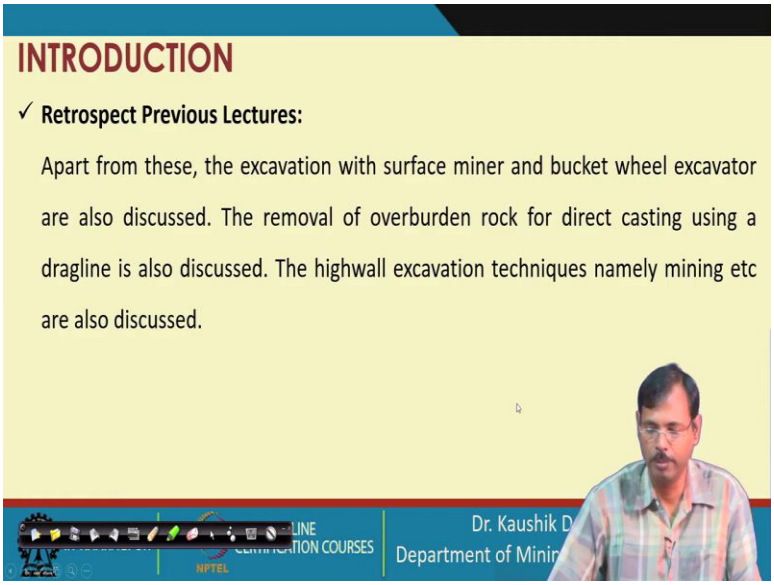

And we have also covered the highwall excavation techniques, which are recently being popular in the mining industry.

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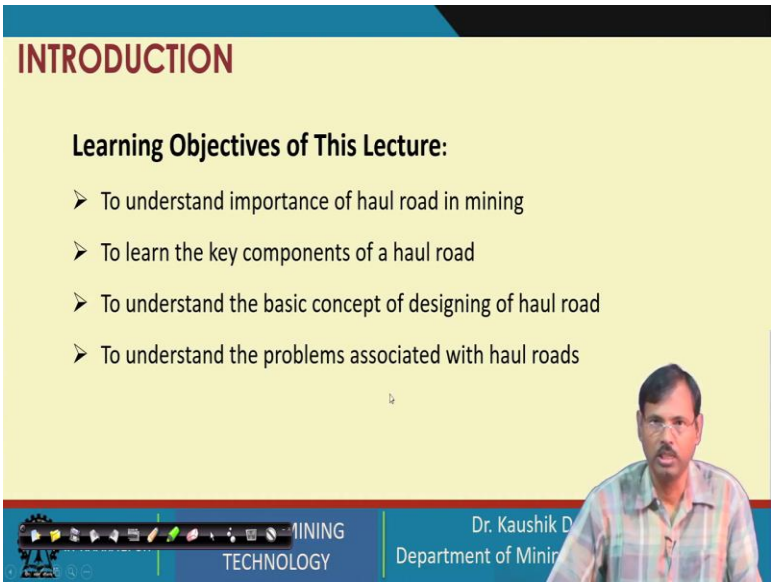

So, we will start this lecture on haul road. So, the objective of this lecture, these three lectures are to understand the importance of haul road in mining. To learn the key component of a haul road, to understand the basic concept of designing a haul road and to understand the problems associated with haul road. So, what could be the possible sources of dangers or accident, we will discuss also on those topics at a later stage.

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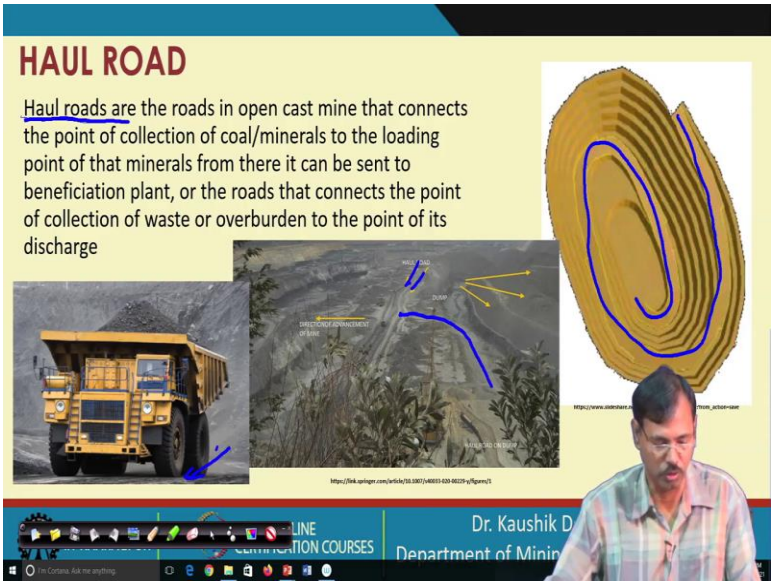

So, if we think that what is haul road? Haul road are the roads in surface mine, that connects different points in the surface mine as well as connect the surface mine with the outside of the mine. So, from pit top to the pit bottom, the access is basically provided by the road called haul road. So, the name haul road is basically for the hauling of the man and material.

So, if you can see this is the transporting equipment dumper, which is moving. And the movement is on a haul road. This is a schematic figure, how the haul road is basically provided in the mine to have a ingress. And this is a photographic view of the different haul roads. So, this is the haul road, this are some of the other connecting roads. And these are the different portions of the haul roads you can see, this are the haul roads. How the haul road is moving. So, this can be seen in these photographs.

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Now, let us have one visit sitting on a dumper, how the haul road is looked from the view of the dumper operator. And let us have that video, this video is shared to us by Satyabrata Behera. Let us look into this video, you can see this is the haul road. And this is a 100 tonner dumper. This 100 tonner dumper, the dumper is moving on to the haul road.

You can see the dumper is jumping occasionally, that means the smoothness of the top surface is not that much. Because of the temporary nature of the road, that much cost is not provided. So, it is not that much smooth, but it is tried to maintain as level as possible. And you can see the waters are sprinkled for the dust suppressant also.

And that is why, the road can be observed a little bit wet in nature. And this is the dumper which is moving you can see from the driver's point of view how the other things can be seen. So, this is the turning. So, this is called ramp of a haul road, as it is moving in the downward or upward direction. That is why it is called a ramp in the haul road. So, this is the haul road, which is made and the benches can be seen.

As this is an iron ore mine, so, you can see, the blue dust can be seen in the bench, in the front. These are the blue dust. And now dumper is approaching towards the excavator, the shovel which is loading the machine. So, it can be seen the dumper is coming onto the haul road. And the haul road is kept very wide and at the position where the excavator is working, the position is also made wide for the positioning of the dumpers properly and as well as the targeting of the dumpers in the area properly. So, this is one view of the haul road. This can be seen here.

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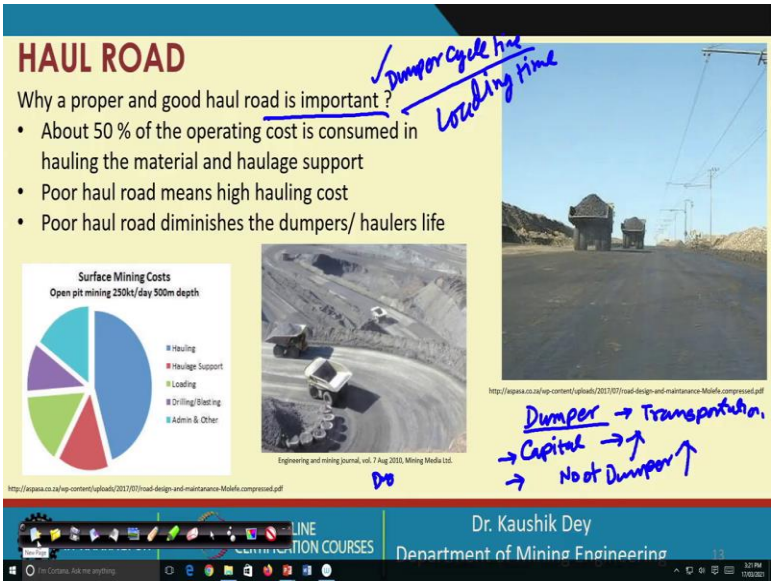

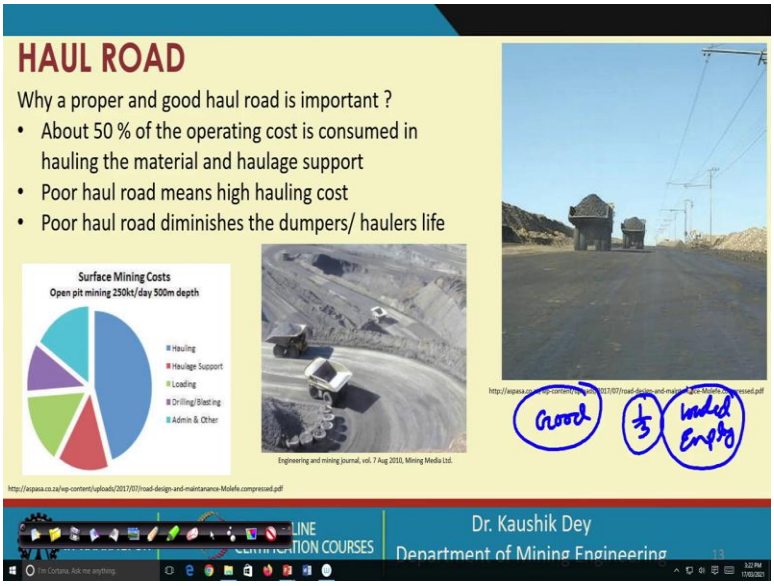

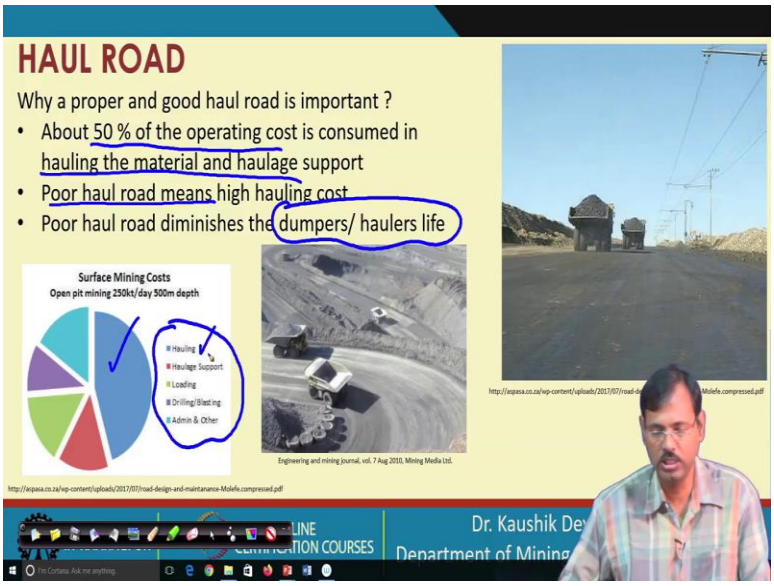

Now, why haul road is important? If you look into the costing of a mine, we have already discussed the cost of mining at different times. You will find out when the dumpers are used as the transportation medium, then transportation cost is significantly high. Why? First reason is the capital requirement for procuring these dumpers as the mode very high.

Second is that, if these dumpers are not allowed to move at a higher speed, then the number of dumpers is increasing. So, to allow the movement of the dumper, because it is increasing the cycle time. If the dumpers are moving slow, that increases the cycle time and that is why number of dumpers is increasing. Because we know, the number of dumpers is depending on the dumper cycle time divided divided by loading time.

So, if the dumper is moving, at a slow speed, then the dumper cycle time is increasing. So, the number of dumper will be increased. So, that is why we want the high-speed movement of the dumper and to have a high-speed movement, we want a good quality haul road, good quality haul road is essential in this case. Apart from that dumper transportation is also another drawback, that it is basically actual utilization of energy is almost one third in dumper transportation.

Because it is moving, loaded, returning back empty. So, that is why the energy utilization is poor in case of dumper transportation, but we can minimize that a little bit by reducing the cycle time with providing the good quality of haul road and that is basically allowing the significant savings

in the cost. So, a high operating cost is there for the material transportation. Poor haul road means the high hauling cost.

And as well as it is reducing the wear and tear to the dumper's life significantly. So, this is one figure, which can show that the hauling cost is significantly high. And these are other costs related to the drilling, blasting, administration, loading, all these things are there. But hauling cost is significantly high. And that is why a good quality haul road is very important in the mining job. So, that is essentially, everyone is targeting on this.

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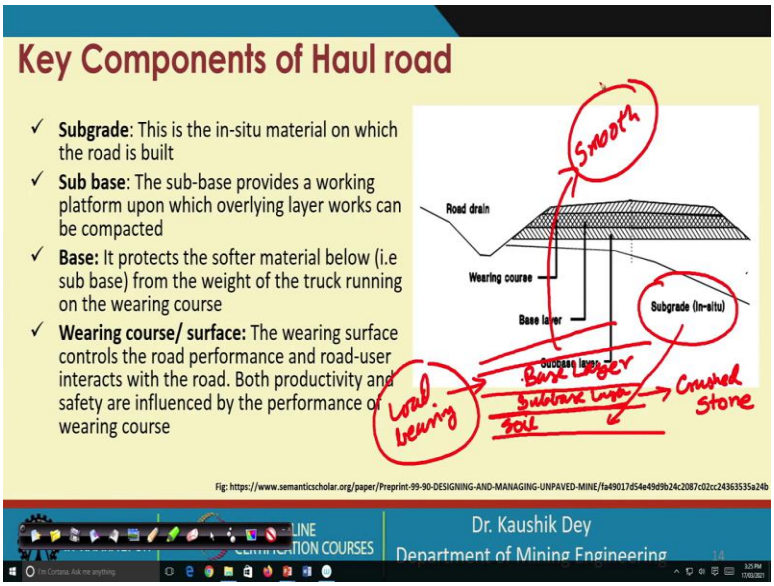

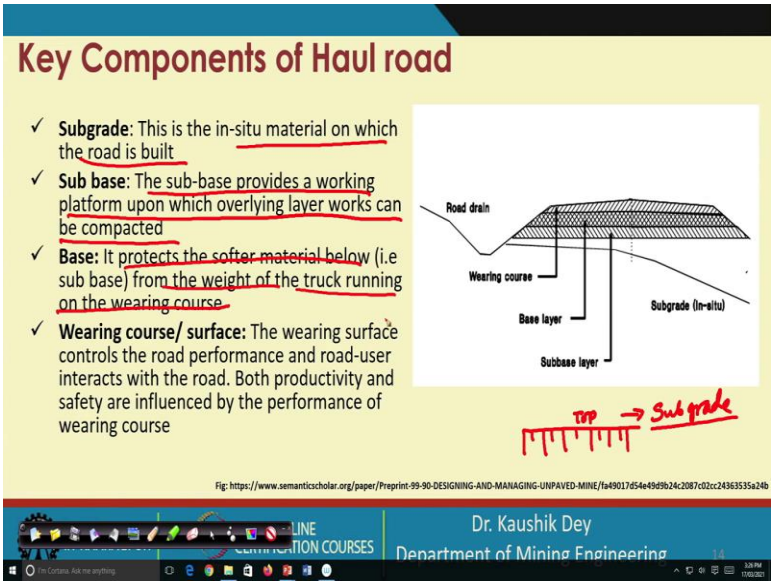

In general, a haul road is comprising four layers. First layer, the first layer is called sub grade layer. So, in this sub grade layer, if you are not looking at this currently at the mine road, just looking at a simple road, the first layer, it is basically a soil layer which is provided first. And that is called subgrade layer. Above that, a drainage layer is provided which is called base layer, which is called sub base layer.

This layer is basically comprised of, this layer is basically comprised of crushed stone. Crushed stone and after that, this layer is basically, these two layers are basically for giving the proper elevation, proper drainage to the road. The next layer is called base layer, this is basically some concrete or bituminous macadam, all these things are in general used as the base layer. And this layer is basically taking the load.

So, this is basically the load bearing layer of the haul road. And above that, we provide a layer which is for providing the smoothness. So, this basically providing the smoothness so that, there will not be any undulation. So, the smoothness is provided at the top. So, that is why this is made in the top part. So, subgrade, this is the general construction. And you can see subgrade in situ material is used on which the road is built.

So, in case of mining generally we do not provide the subgrade. We try to allow the bench top, bench top is in general considered as the sub grade for a haul road. So, this bench top is considered as the subgrade material. This is sometimes called embankment also, specially in civil road etc., where there is a low elevation, you have to provide more subgrade to have the elevation in that place.

So, this is basically providing the elevation of the road. So, in mining generally bench top is utilized as the subgrade. So, we need not to go for that one. Base is provided as a working platform, upon which overlying layers are worked and compacted. And this is in general comprising the crushed stone. Base is basically to protect the softer material below the sub base. So, from weight of the truck, which is running is basically taken by this base layer. And wearing is to provide the smoothness that we have already discussed. So, these are the basic four layer.

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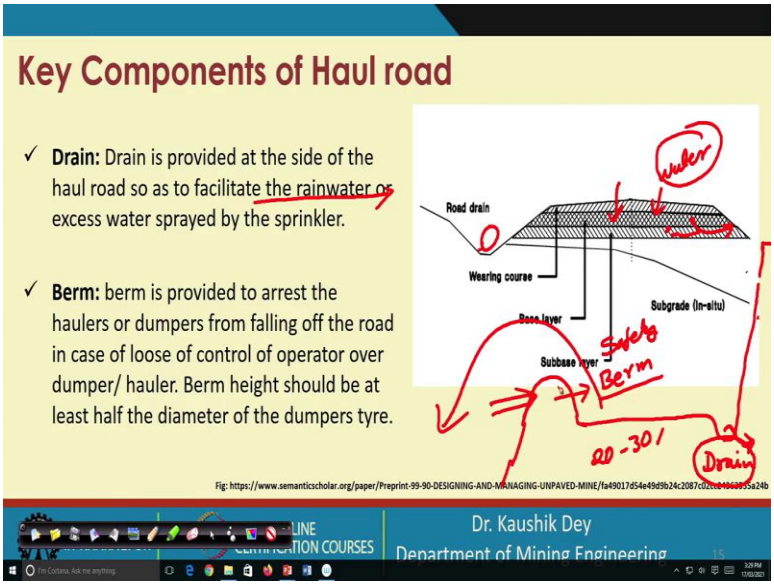

But apart from that, we also provide a drain at the side of the road. So, whenever you find out in general, you can see a haul road is drawn like this, and this is the lower bench. So, this ditch is working as the drain. And this elevation is called a berm, this is called safety berm. Now, this drain is provided for removal of the rainwater or guiding the rainwater or the any over sprinkled water, which is above this.

That is basically guided through this drain and eventually that is taken out after pumping from some pit or some places. Generally, the water is the main enemy of a road. And that is why, it is not intended that a road water should percolate inside the road. And it will take out the granular soils or granular sand part from this base, sub base and the sub grade area. To take out this granular part, washing out of this granular part is totally unwanted.

And that is why, water is not allowed in the road itself. So, that is why drain is essentially for a haul road. In fact, maintaining of the good drainage itself can reduce 20 to 30 percent maintenance cost, 20 to 30 percent maintenance cost of the haul road. And safety berm is provided, so, that no dumper can topple down from here to the lower benches. Because in that case, the damage will be significantly high.

So, this safety berm, if the dumper become a runaway, that is allowed to stuck with this safety berm and stay on that place, so that the dumper cannot fall from a height or, not only dumper any

other flying machine cannot topple from the higher elevation to the lower elevation. So, these are two essential components you will find in a haul road.

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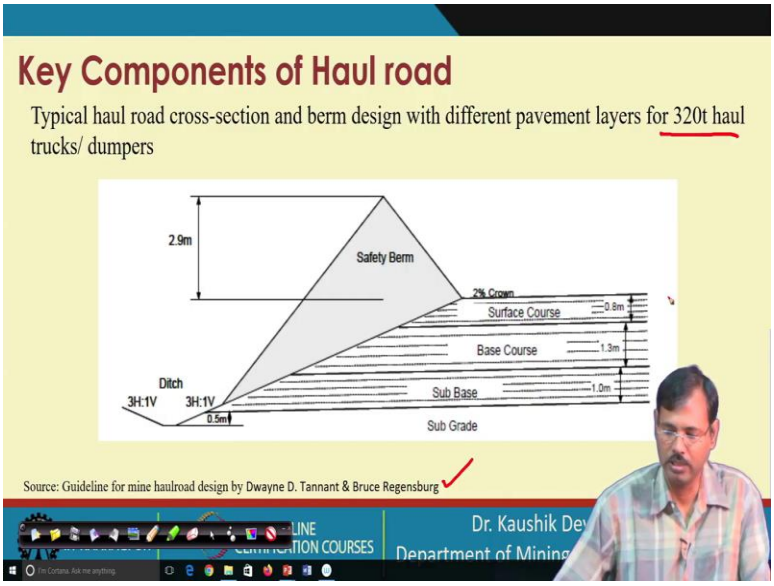

So, this is basically a typical cross section shown for a 320-tonner dumper from a case study of this book. This book is available in the website also. So, this actually, it is not book it is a basically investigation report. So, this is available and from there it is taken, it is a 320-tonner haul road design for a 320-tonner truck.

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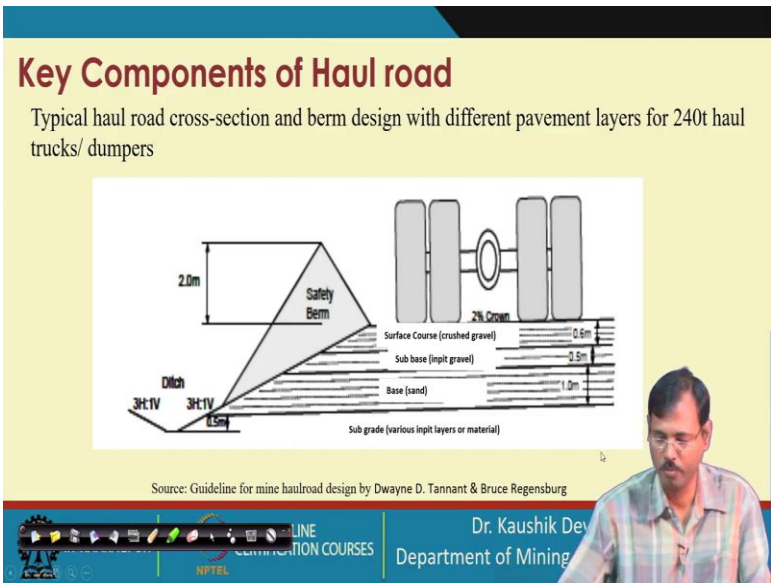

And this is for a 240-tonner truck.

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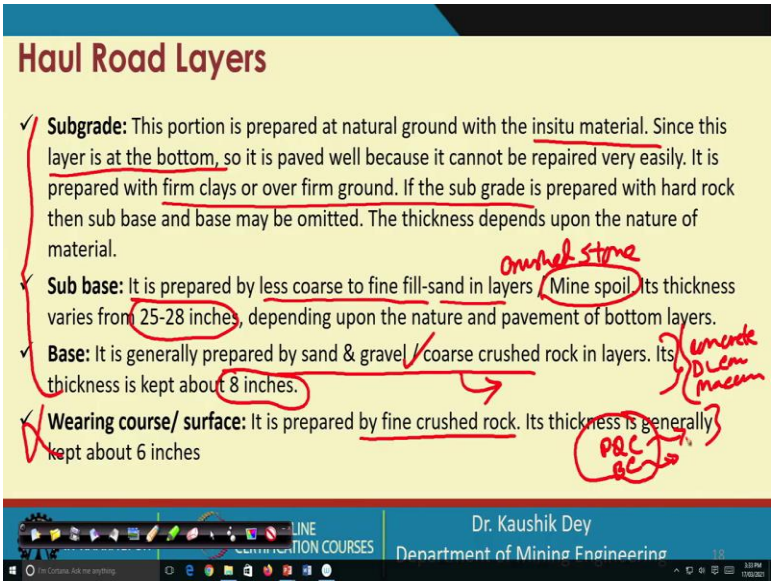

And these are the materials, which are used for making those layers. Subgrade is generally soil or insitu material, which is commonly used. And basically, it is giving a platform, so basically firm clays etc. are utilized here. Sub base is basically a course and fine filled sand layers or actually it is a crushed stone. It is a crushed stone or often mined overburden rocks are utilized here. And this is not a very thick one.

Generally, around 70 centimeters to 1-meter thicknesses in general followed in case of sub base. And base is basically for the mining condition. Base is provided a sand gravel coarse crushed rock, that is the around 8 inches thickness, that is considered as the base material which is often accompanied with some pozzolanic material so that there will be some adhesiveness in that and that can stick with each other.

But in civil road, often that concrete or bituminous macadam, drylin concrete, macadams hybrid between macadams all these are used as the base layer. And wearing surface for mining case generally prepared with the fine crushed rock so that any small holes available with the base layers, because of this relatively larger size boulders, is placed filled with this fine crushed boulders.

But in fact, in haul road you will see there is no actually wearing surfaces provided. Basically, above the sub base, the granular sub base which is provided which is a rubbed boulder, crushed boulders above that basically this fine grain material is placed to provide a smoothness, avoid the undulations and there are some cementing materials used often, clays are also used so that the smoothness can be achieved in this.

So, basically in haul road most of the cases, it is limited to this. Wearing surface is not in general provided but in civil road wearing surface either the pavement quality concrete or the bituminous concrete, these are in general used as the wearing surface, which are bituminous concrete used for the flexible road and PQC is used for the rigid road. For these two cases, these two layers are in general used.

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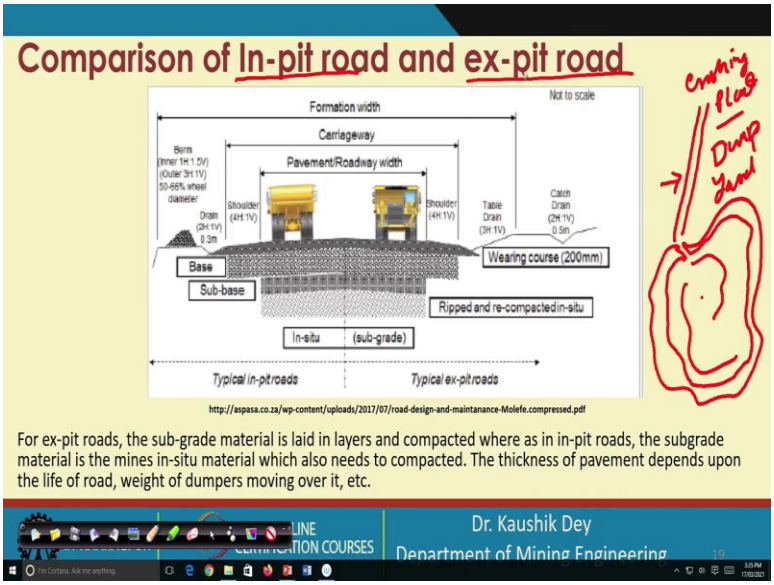

We are having basically two types of haul road; one is called in pit haul road. Another is called ex pit haul road. Suppose, we are having a mine like this, say this is the mine and any haul road which are constructed inside this mine is called in pit haul road. But the road which is constructed from the pit top to our point of destination, it may be a crushing plant or it may be a dumped yard or it may be a railway siding, whatever it is, in that case that is also called haul road but it is a ex pit haul road. There is a little difference in this, the constructional difference is huge.

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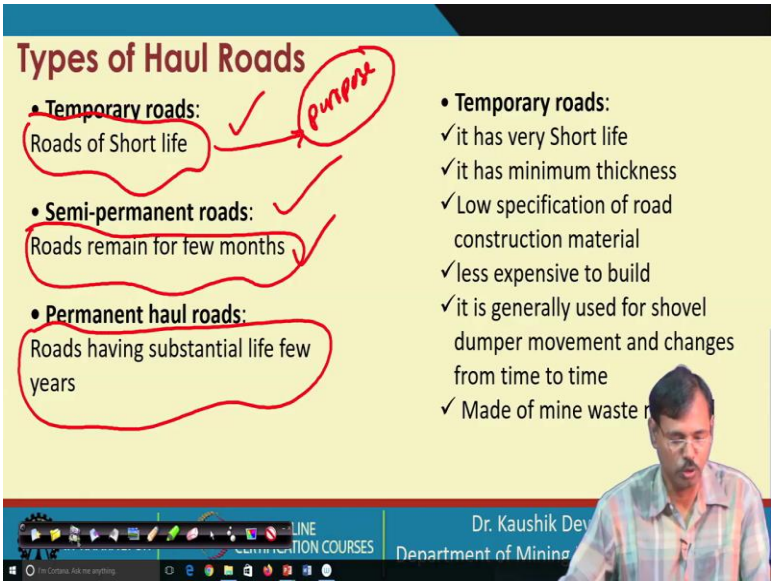

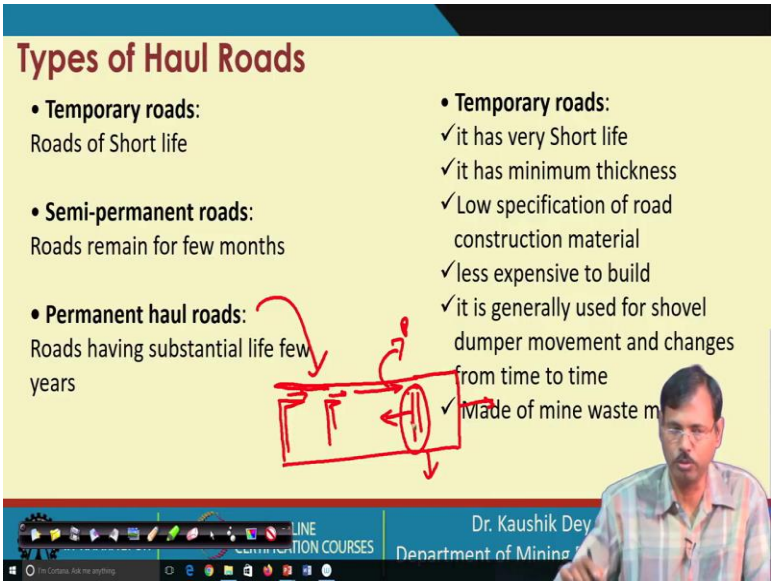

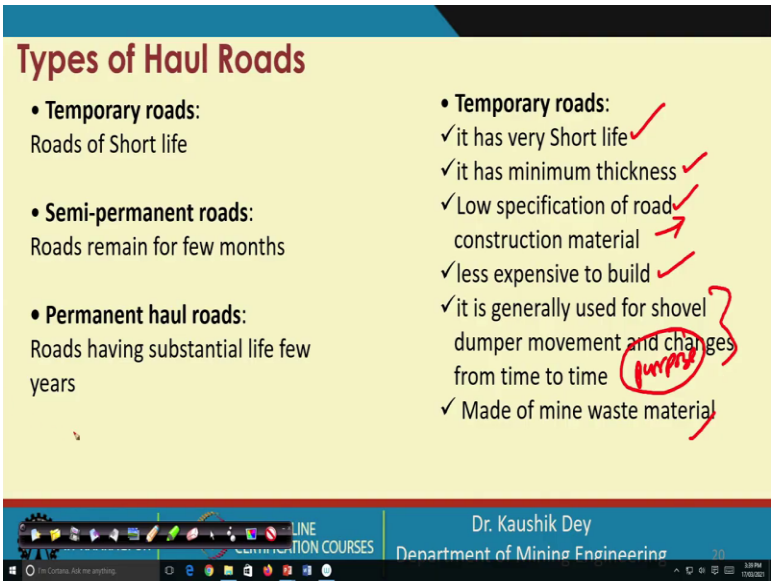

The main reason is that, ex pit haul road is more or less permanent and occasionally its locations are changed, but in pit haul roads very frequently, its position, size, all these are changed. As the mine is progressing accordingly, the haul road is also changing its position. So, based on that, haul road is basically classified in three ways. One is called temporary road, which is having a very short life.

Second is the semi permanent road, which are having some life of few months. And permanent haul road, which are having a substantial life of few years. So, in this case, the temporary roads means you are constructing a road for a particular purpose. Suppose, say you are constructing a road for a particular lower bench for constructing a sump. Then, gradually you are abandoning that one.

In future if it is required, again you are constructing that one, then it is called a temporary road. So, often it is made in some places for particularly to carry out some work. So, that is a very, very short life and this is basically made for a purpose, for a particular purpose or job. On finish of that job, the road is also disconnected or it may be re excavated and send the material outside the mine.

But semi permanent roads are the most major roads, most of the mine haul roads are semi permanent road. Those are basically maintained for a substantial period and as the mine is progressing, gradually its locations are changing. And that is why it is made in most of the cases.

And the permanent roads are basically the main road. Say suppose, if we are considering a mine like this. So, the mine is progressing in this side.

So, this is the first ramp. And gradually we are having a second bench here. So, this is the second ramp. So, like this a long haul road is made, which is as the mine is progressing, this is also progressing in this direction and gradually it is working. It is made like this, and this mine is basically moving like this. And that is why, this is a more or less permanent nature.

And this is considered as the permanent haul road. But whatever haul roads are made here, that may be a semi permanent one. After completion of that one, that is extended towards this direction. So, that is why these are called semi permanent road. So, most of the mining haul roads are semi permanent in nature. And if you look into the characteristics of this one, temporary roads are having very short life.

So, it is made of minimum thickness, low specifications are used, most of the cases only mine spoils are used for constructing these roads. These are less expensive as its life is also less. And generally, used for shovel number movement or the machinery movement for which that purpose. So, it is for that particular purpose only, this is made and most this is also already discussed.

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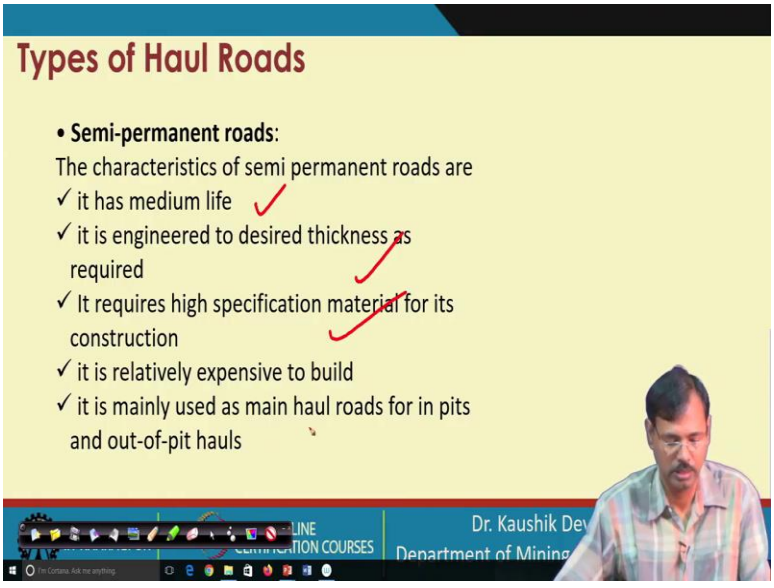

These are the characteristics of semi-permanent road, medium life, medium life engineered with the desired thickness, better materials are used and these are the other characteristics.

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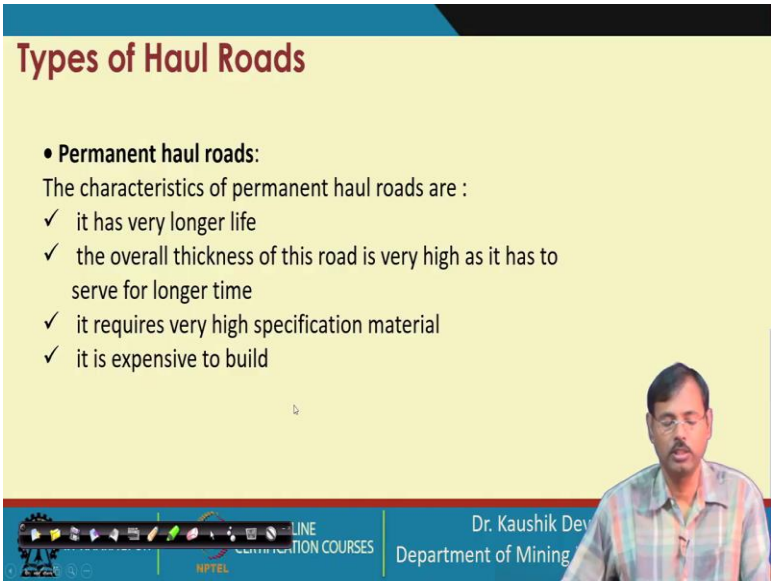

And these are the characteristics of permanent life haul road.

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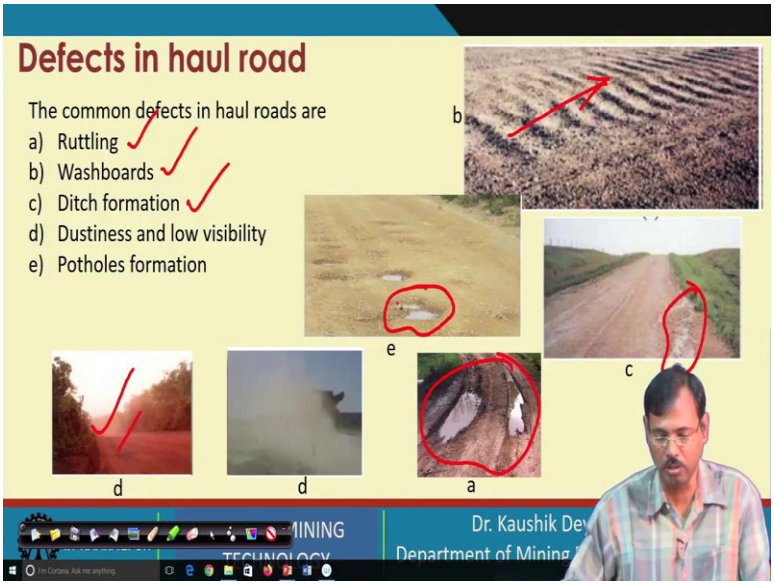

Now, we, over the period of time after the construction as the pit is under, the haul road is under operation, that time as the machineries are moving, can found a number of defects, these defects are called ruttling. You can see, this is called ruttling and this is washboards, you can see. This is

the imprecision of the tires happened in this case. These are the ditch formation. So, these are the ditch formed at this place.

And this is the dustiness and these are called potholes, where a particular potion, the holes are occurred in the haul road, that is called pothole creation. So, these are the defects in general observed with the haul road and that is why day to day maintenance in the haul road is also required.

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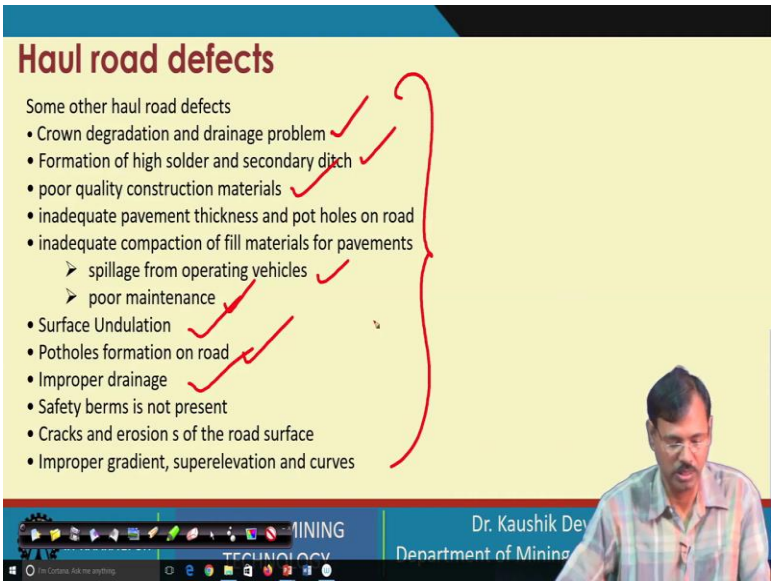

And apart from that, these are some of the other defects. You can see the poor degradation, drainage problem, high solder, secondary ditch, poor quality material, spillage from operating vehicles. So, as the loaded dumpers are moving, spillage occurs. And poor maintenance of the road, surface undulation occurs, potholes created, improper drainage. These things are also creating problems in the haul road. So, haul road means, it demands a day-to-day maintenance of the road is important.

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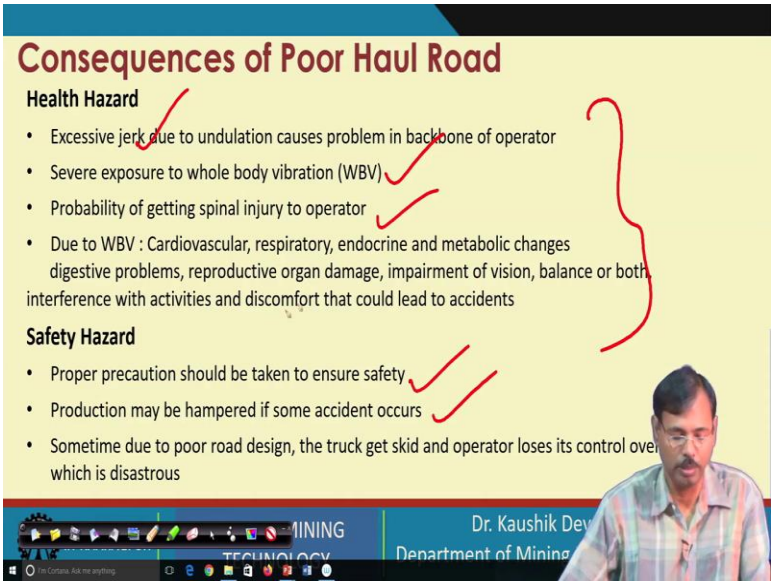

So, consequences of the poor haul road poses health hazard. Hazard poses to safety hazard and these are the problems, excessive jerk will lead to musculoskeletal disorder, whole body vibrations. Injury of the operators and apart from that, there may be other problems like material fall down from the dumper can hit someone, all these problems are occurring in this.

Apart from that, these are the safety issues, accident becoming more poor condition because the dumpers or other flying machines has more wear and tear in this case and that may create the safety hazard in the mine prone to the accident.

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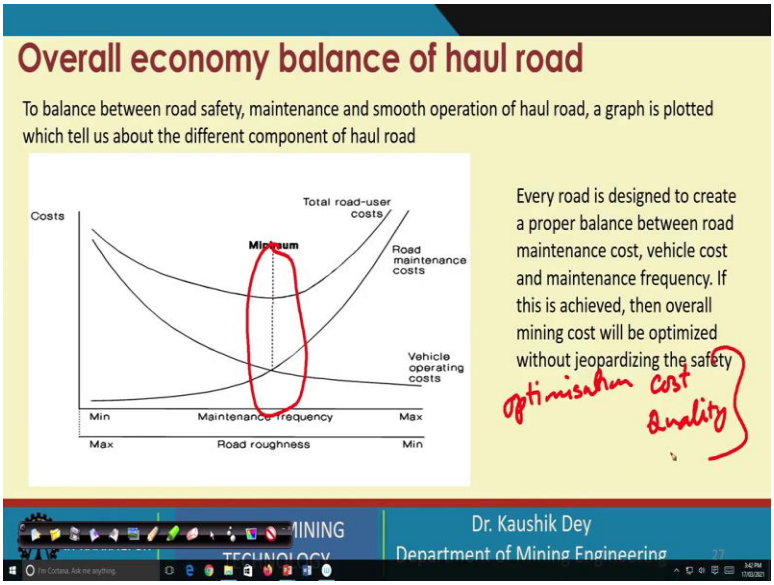

So, basically a mining management has to consider the essential requirement at this, that is the optimization of the cost. With the cost and quality, that has to be considered while the designing of haul road is carried out. So, this is very important for the construction of the haul road. So, let us stop at this position. Thank you.