Surface Mining Technology
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Lecture – 48
Haul Road -III

Let me welcome you to the 48 lecture of NPTEL online certification course, Surface Mining Technology. This is the third and final lecture on haul road. And in this lecture, we will discuss on safety in haul road. In fact, safety in haul load is very, very important. Majority of the surface mine accident has been found is occurred in the haul road only.

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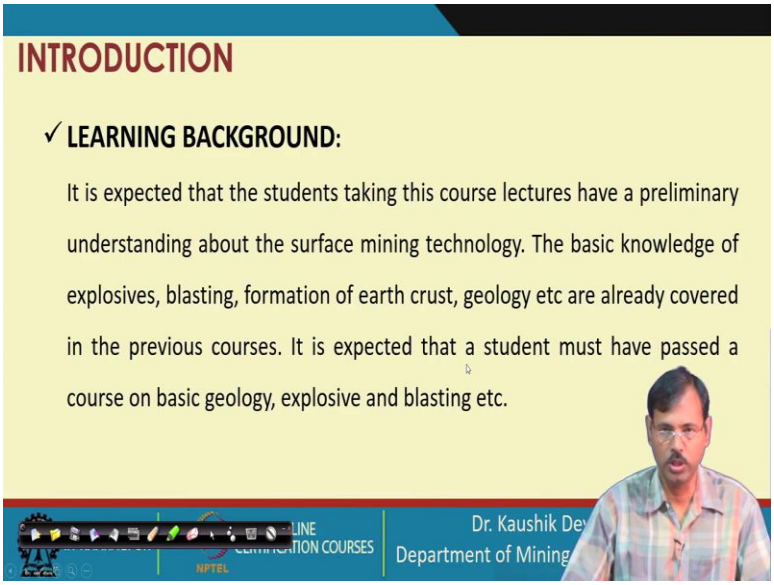

And that is why, this is very important aspect. But as every class we do, let us have a look once again into the learning background required for Surface Mining technology course.

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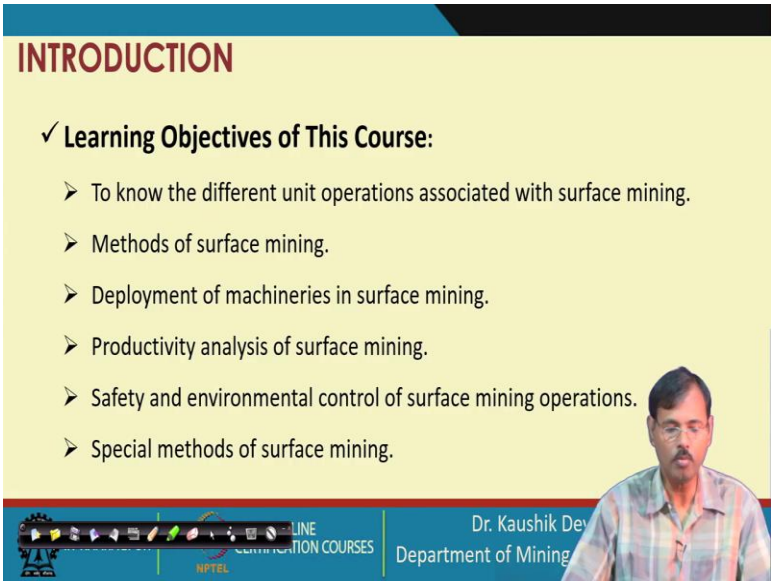

These are the learning objectives of surface mining technology course.

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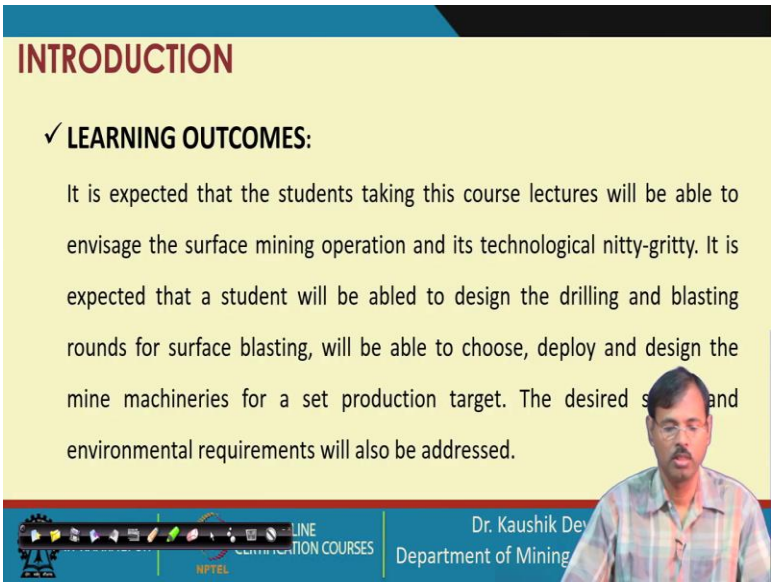

And these are learning outcomes.

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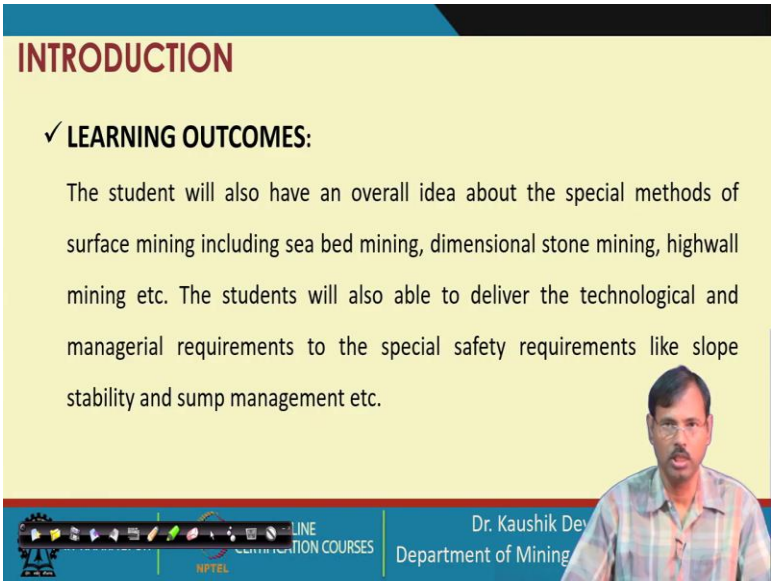

Expected from a participant who is taking the Surface Mining technology course.

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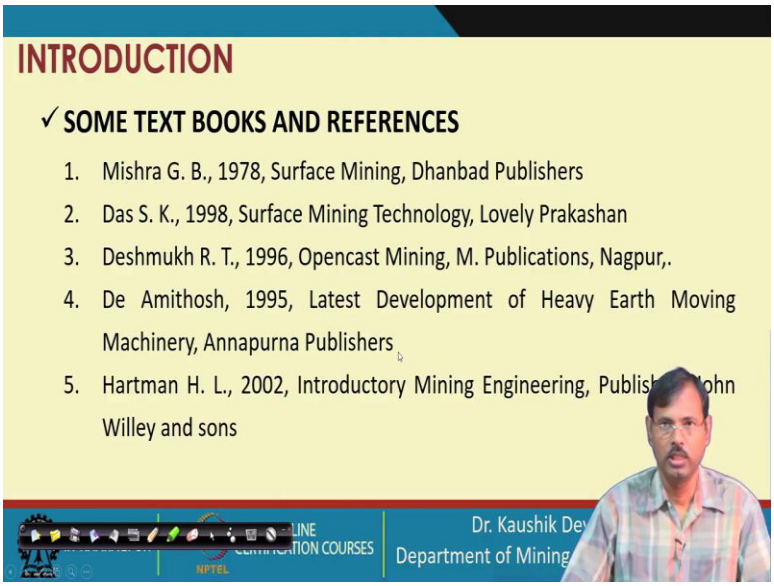

And these are some of the textbooks and references.

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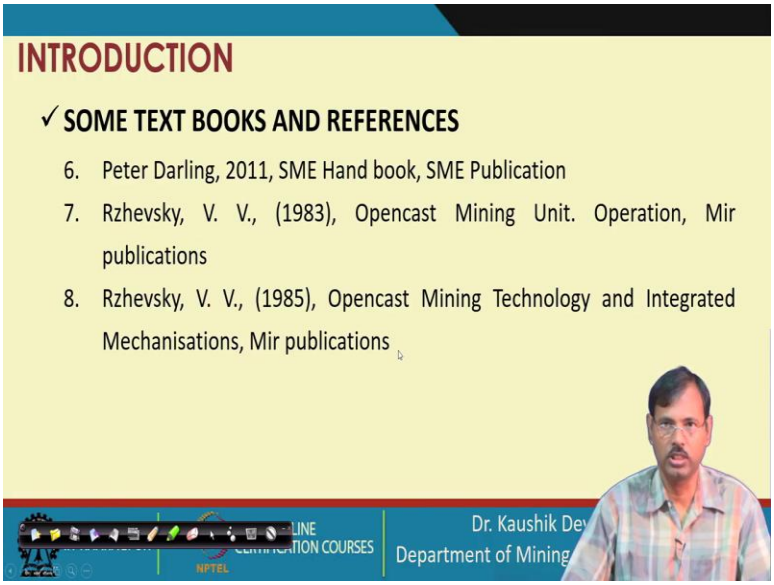

We have discussed also earlier that for this haul road construction maintenance, the book of tennant is important one and may be followed by the participant, which is available in the website also.

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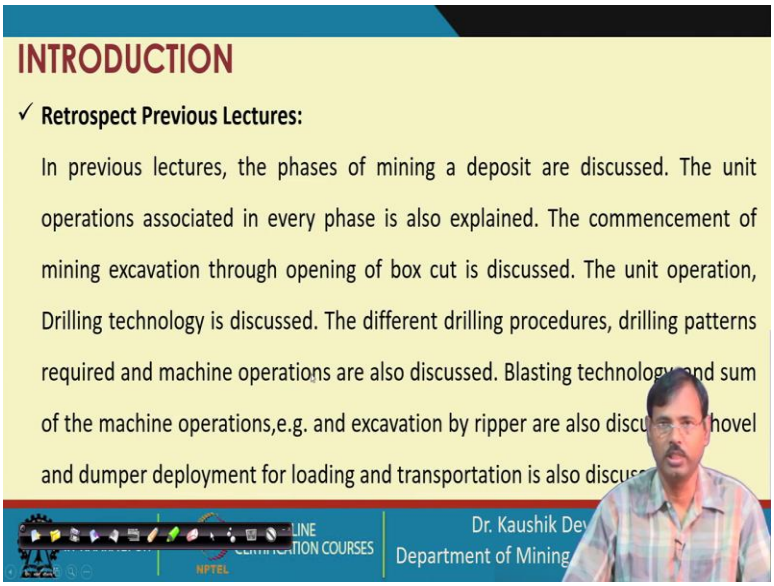

These are the retrospect of the lectures, they can try to this haul road classes and these are basically discussed for the phases of mining a deposit, the unit operations in every phases, the commencement of surface mining using opening the box cut. Then unit operations, drilling

technology for creating the hole for providing the explosive. Then the blasting technology for the fragmentation of the insitu rock mass into a sizable size, into a handable size by the excavator.

And then the excavator operations for excavating the fragmented blast muck and dumping them into the dumper or loading them into the dumper. Then the dumpers are taking that material to the destination either a dump, waste dump pit or a crushing plant or a railway siding. And this shovel dumper combinations are important, that is also discussed. And we have discussed the blast free excavation technique also.

That is ripper, surface miner, bash, bucket wheel excavator, these are discussed. And we have discussed dragline, which are used for a very high bench. And it basically carrying out the direct casting of the overburden material to the internal dumping system. So, these are more or less covered in the previous lectures.

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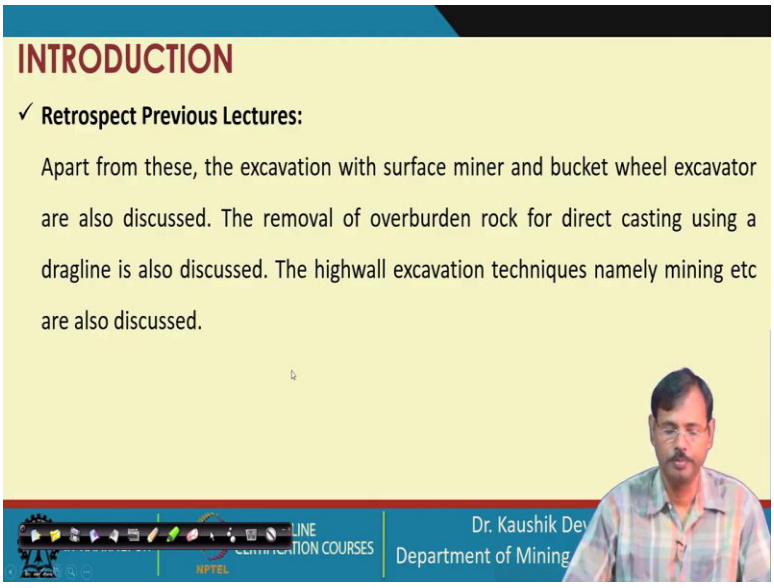

And we have also covered the high wall excavation technique, which is a recent technology for excavating the ore, locked in the pit high wall.

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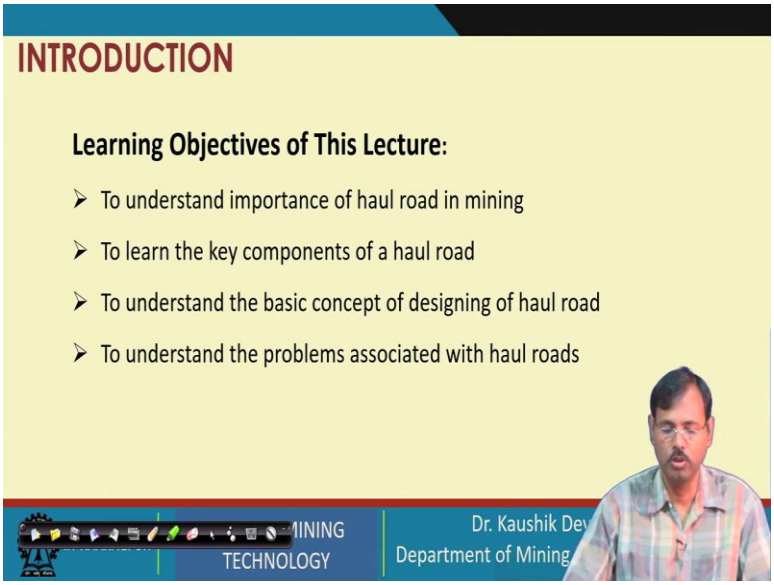

And in the previous few classes, we have covered the importance of the haul road, key components of the haul road and the basic concept of designing the haul road, these are covered. And in this lecture, we will cover the safety features required in the haul road for its operation, best operation.

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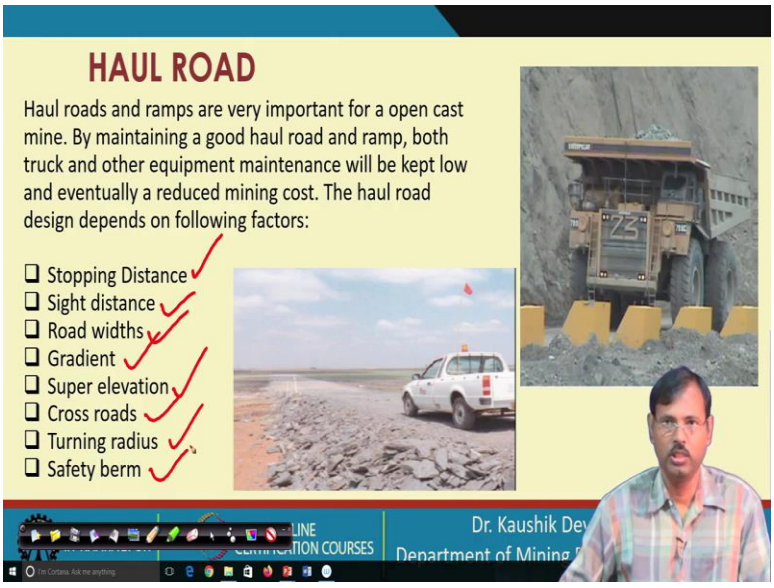

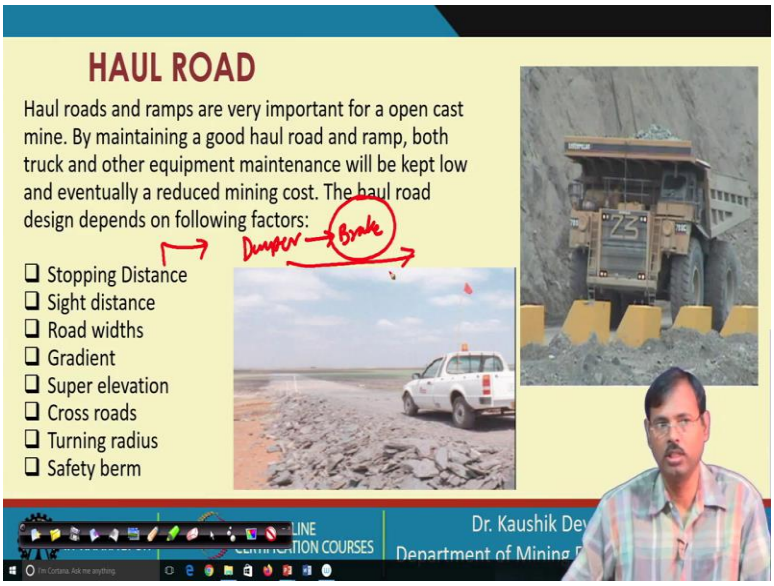

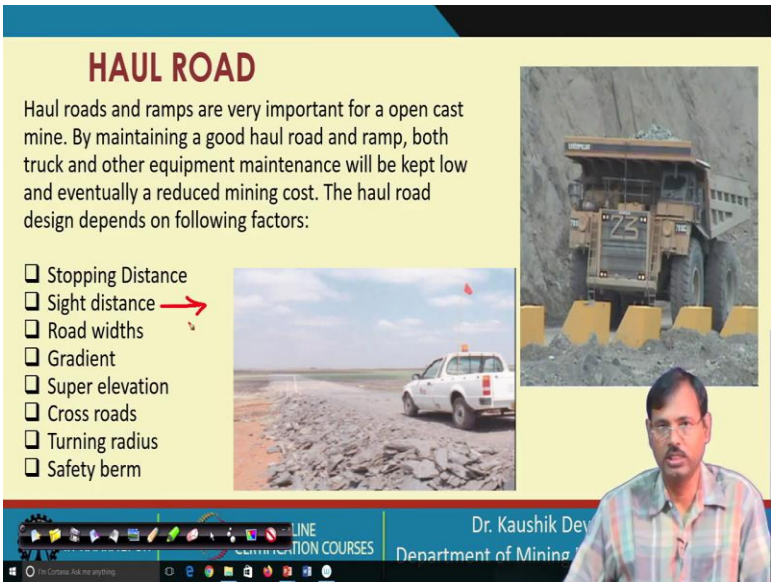

So, basically if we are discussing about the safety, in that case, we have to look into the stopping distance. We have to look into the sight distance, we have to look into the road width, gradient of the road, super elevation, crossroads, turning radius and safety berm. These are the few important aspects of a haul road which is very important. And that is basically required to be maintained for avoiding any accident in the outdoors. Now let us look into this one by one.

Stopping distance, means what? It is basically the distance, a dumper or plying machine will travel after you are applying the break, after you are applying the break then the distance covered by this is called this, moving equipment is called stopping distance. This is the stopping distance.

So, that means, the stopping distance should be maintained between two consecutive vehicles. So, that on applying the break, the operator can stop its vehicle.

Second one is the sight distance, this is basically the visibility. Visibility is having two concept, one is that because of this fog etc what is the visibility available. Second part is that, because of the turning etc what is the visability available. So, these are the important part, we will discuss in details.

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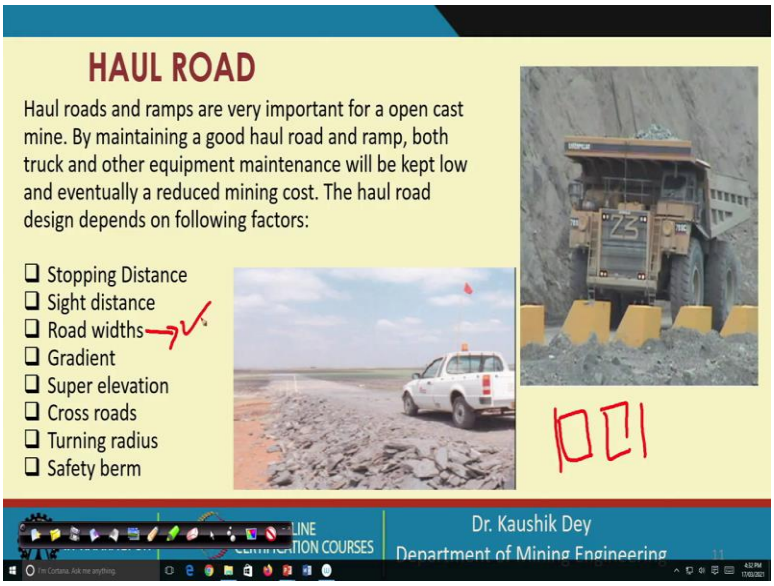

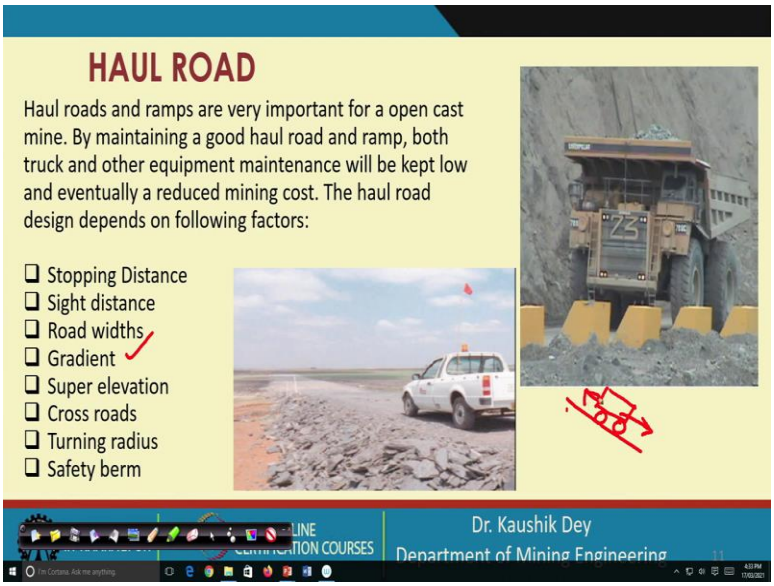

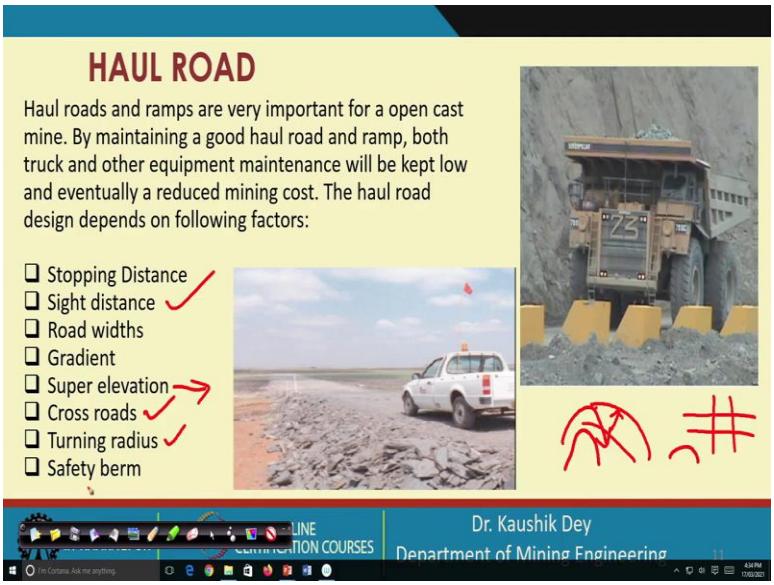

A road width is that whether we are having sufficient road width to move a number of vehicles. That means, it is the one lane vehicle or two lane vehicles, how many vehicles can be allowed that is the road width. Narrow road is basically problematic, then the vehicles have to move cautiously in narrow roads. Gradient is the tip inclination, this is the inclination on which the vehicle is moving.

It is also having different aspect, that basically if the gear system had fail then how the dumper will move on this, whether the hand break or parking break will able to address that one or not. Then or that the damper is able to withstand that gradient etc., all these are there and there are some regulatory requirements also there. Super elevation is in general provided during the turning, during the turning the super elevation is provided.

And these are the Crossroads when the road crossings are there. Then how that can be negotiated, and turning radius is the radius for turning the vehicle. And if it is steep, it is very problematic, because obviously side distance is not there. Then also the dumper cannot rotate in that speed, sometimes the dumper turning radius and road turning radius are maybe mismatching. So, all these aspects to be considered there.

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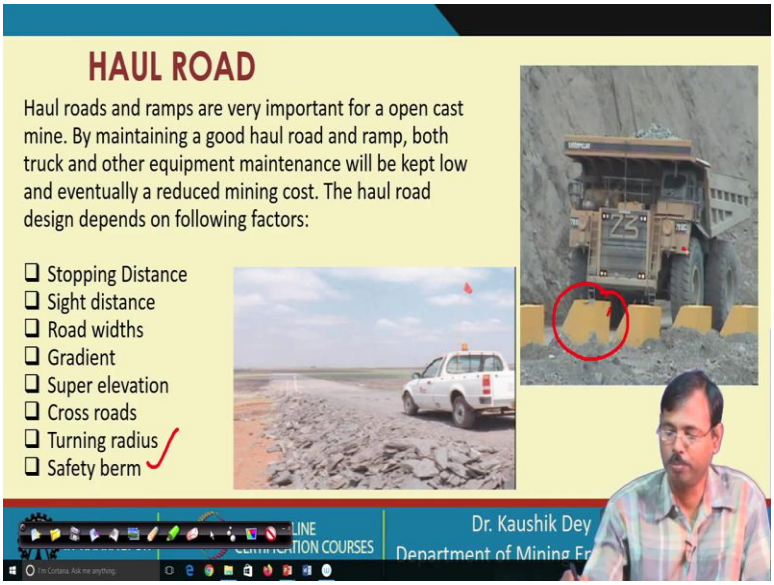

And finally, the safety berm which is, this is the safety berm which is not allowing the dumpers to topple down from this. So, this is also another important aspect to be maintained in the safety consideration of a haul road.

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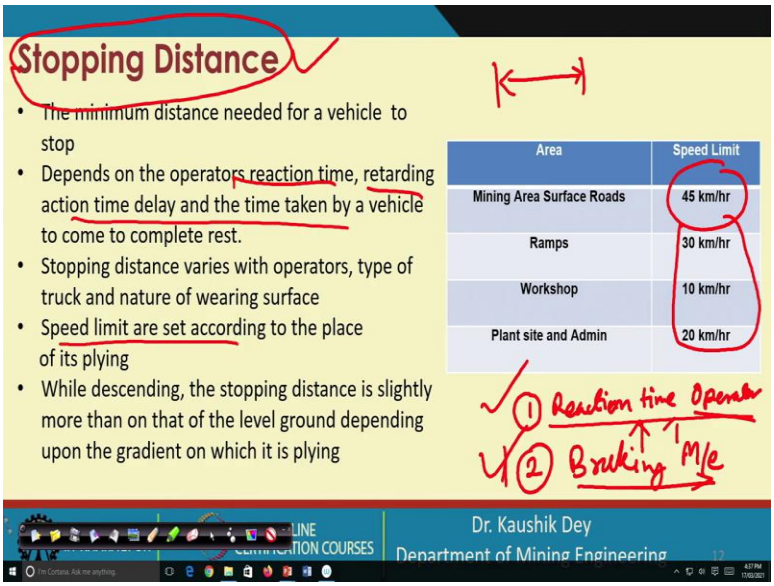

So, first is the stopping distance. Stopping distance is basically having two concept. First is that, when the reaction time, first is the reaction time of the operator. This means, when the operator is observing that the front vehicle is stopped or front vehicle has applied the break. Or it is suddenly observing there is a wall in the front or there is a road end, or road blockage in the front

then he has to apply break, but this observing and application of the break that is called the reaction time of the operator.

So, that means at t time, at t is equal to 0 operator has observed but that his nerve sense is sensing and he is reacting that I have to apply the break. So, he is started, he is starting the applying break at the time t is equal to delta t. So, this delta t time is the reaction time of the operator. So, basically reaction time is becoming more at a younger age and it is little bit became slow for the old people.

But this also comes with the conception, that is the how the eyesight is working for that particular operator. That is also very important in this case. So, this, this is basically changing from an operator to operator. And this is also depending on the sense of the operator about its breaking system. That means, operator may not be a regular operator of that dumper. So, he does not have the knowledge that the dumper is not having a very good breaking system, that breaking system may be a little bit slow.

And the sudden breaking may not possible. So, the he may apply breaks at a later stage or he may take reaction time more. In those cases, that will create the problem. So, this one point is the reaction time of the operator, second point is the breaking time of the machine. It is machine dependent, how the break is operating in that machine. So, this two is important for the stopping distance.

And this is operator reaction time and retarding action time delay. Your vehicle, second is that speed limit. So, if the vehicle is at a higher speed, obviously, your breaking distance required is more. For a lower speed, its breaking distance will be less. So, this is for this second part. And these two part must be considered.

And that is why based on that, the stop, stopping distance to be maintained between two consecutive vehicles or for any turning or uncited road, in those cases those speed limits must be provided with a board sign to avoid the accidents in the mine haul road.

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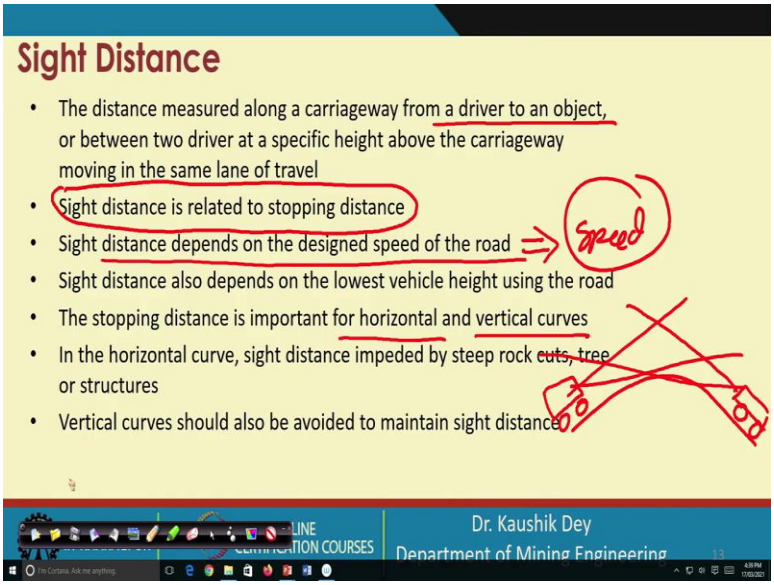

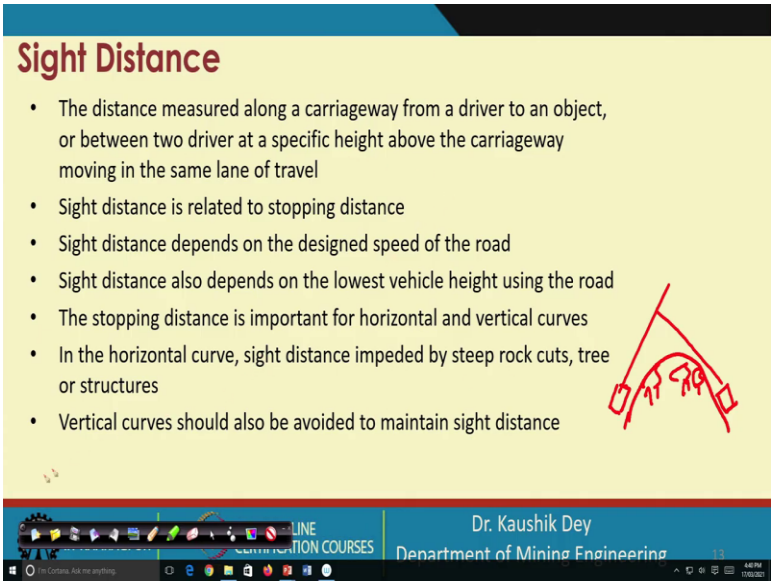

Sight distance is basically the visibility, from a driver to an object. In the very beginning, we have shown a video, which is basically showing the eye view of the driver, how the driver is able to see from his seat about the road. So, they are the visibility what in that video has been seen, is the visibility of the driver or the operator of the machine. And that is why, this sight distance is related to the stopping distance.

If you see late, you will apply the break late. So, that is why proper sighting is very important. And depending on the sighting, it is essentially required that the operator should adjust its speed of driving, depending on the sight distance. So, this is very important part and that has to be

maintained. There are different curves may create the problem in this horizontal curve and as well as vertical curve also.

In case of vertical curves, the road may be like this, then this vehicle and this vehicle cannot see each other, because their line of sight are not there. So, that is why if it is looking also like this, this is also looking like this. So, they cannot see each other. So, that is why they may not be visible to each other. In the other way, if there is a horizontal curve and there are bushes like this, then also this driver and this driver cannot see each other because their line of sight is also not matching.

So, this is for the horizontal curve, this is for the previous one, was for the vertical curve. And apart from that, in the hilly region etc. fogs are also sometimes creating problem in the visibility of the operator or that is basically sight distance.

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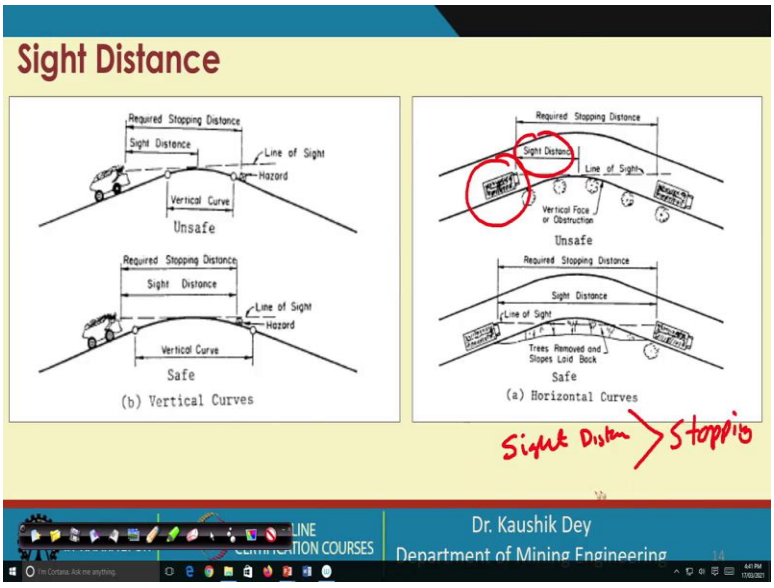

But it is always desired that the operators should maintain the speed as per their sight distance. And they must consider the sight distance should be more than the stopping distance. So, it is always required that in this particular case, the vehicle speed should be reduced such a way, so that sight distance should not be less than the stopping distance. So, always sight distance must be greater than the stopping distance. And the vehicle speed has to be maintained accordingly in each cases.

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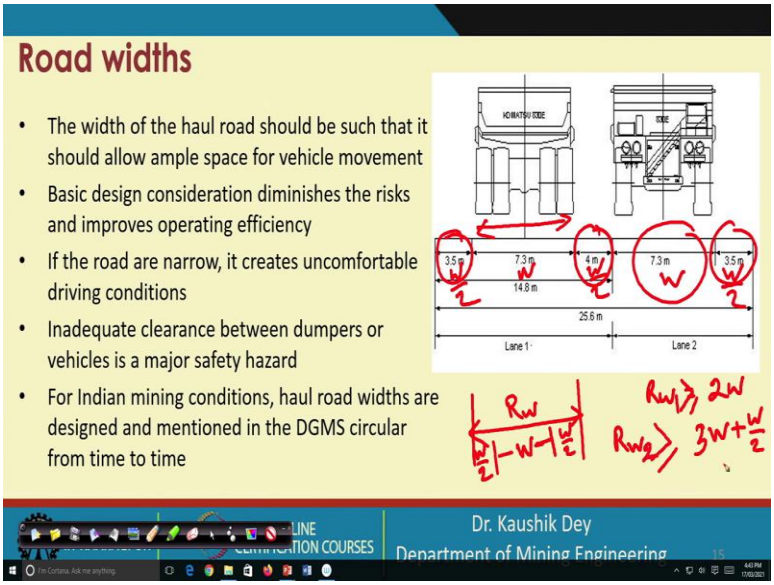

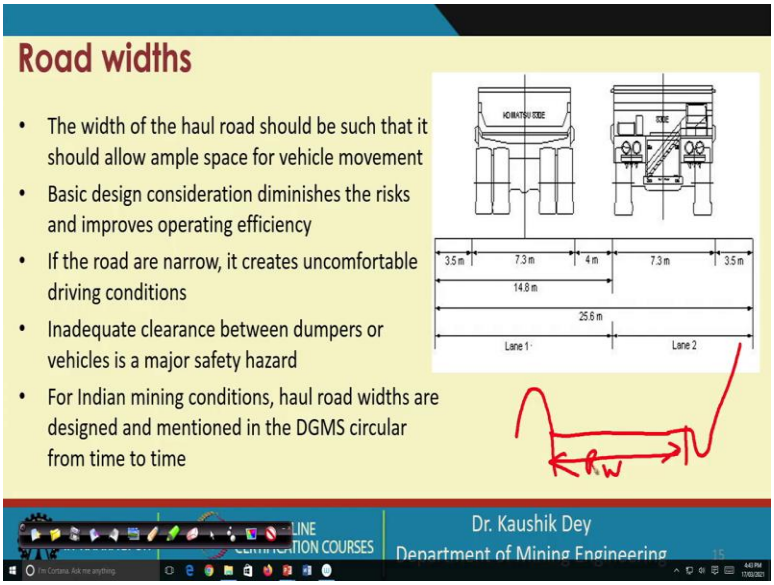

Now, this is the road width, basically if this is the seven points, this is one example taken from the tenant books 7.3 meter, so, around 3 and a half meter is kept here, 4 meter is kept here again this is. So, in general it is considered like this. If this is the available width, then we have to provide, this is the dumper width. And in both sight half of the dumper width should be kept of the clearance.

So, for the first length, it is R_w, for single length it must be greater than 2w. For double length, this is R_w, so, it is w this is w by 2, this is w by 2, this is w, this is w by 2. So, in that case it should be greater than 3w plus w by 2, for two lane road for single lane road. And accordingly,

this has, this has to be increased with the number of lengths. So, this is in general it is maintained like this way. And that is considered as very safe. And one must remember this road width is basically the plying width. So, that means this is the basically the R_w, considered for this case.

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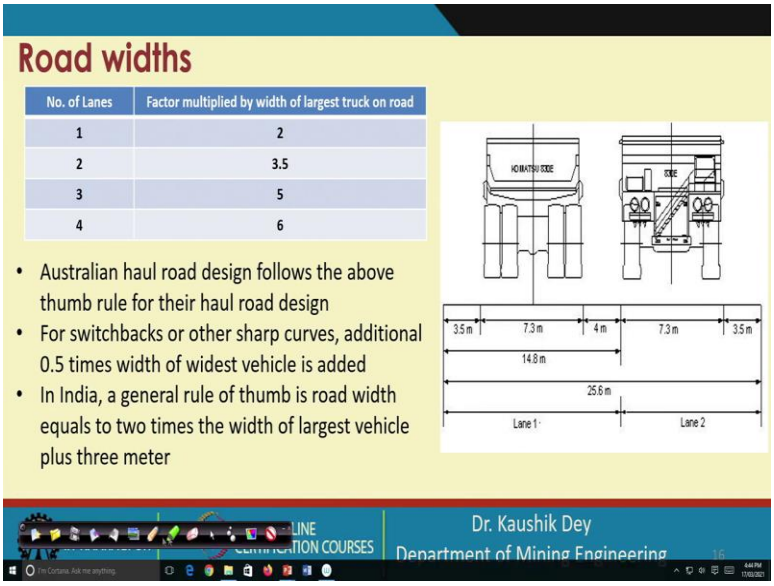

So, this is another example. So, it can be seen for number of lanes. This is the 2w, this is 3.5 w, this is a 5w, this is 6.5w. So, like that way, it can be maintained in the haul road.

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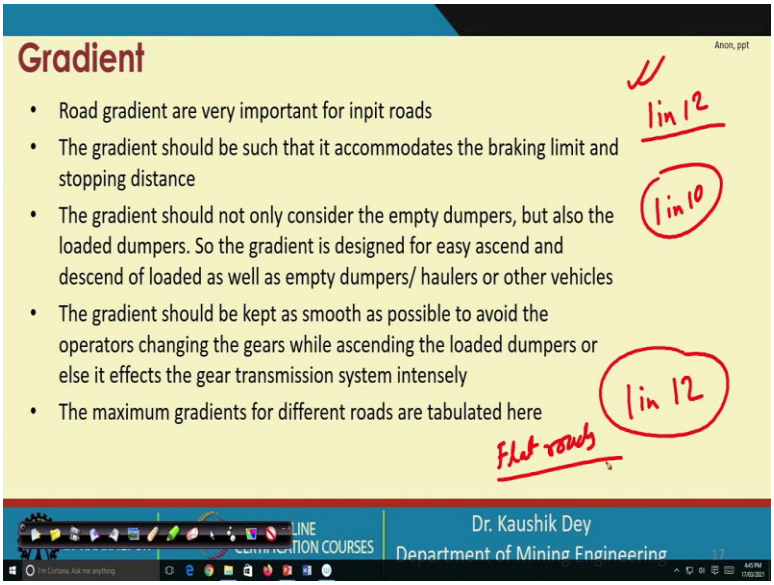

Now, this gradient is very important. And as per the rule in most of the Indian mines, this gradient is maintained at least 1 in 12. In general, more gradient than this is not allowed. So, this 1 in 12 let me write once again is in general maintained. And for a very short distance, one may go for 1 in 10 also, but in general in surface mines, 1 in 12 is popularly maintained, considered as the good. But, as much as flat roads are, flat roads are basically opted for.

In fact, in some of the mines modern designing is carried out in such a way, so, that the overburden rocks are allowed to travel on a flat road to the backfield area. So, that the better utilization of the dumper can be carried out and that system is called haul back mining. So, this is very important designing criteria. So, gradient is very, very important and that has to be properly maintained.

If the dumpers, etc are allowed to move on a higher gradient, that is basically creating the overloading of the system. As well as it poses problem when the dumpers will be under repair or dumper is suddenly got break down into the ramp. In those cases, it may create problem it may roll back also. So, these are very important aspect, that has to be considered when the gradient has to be measured.

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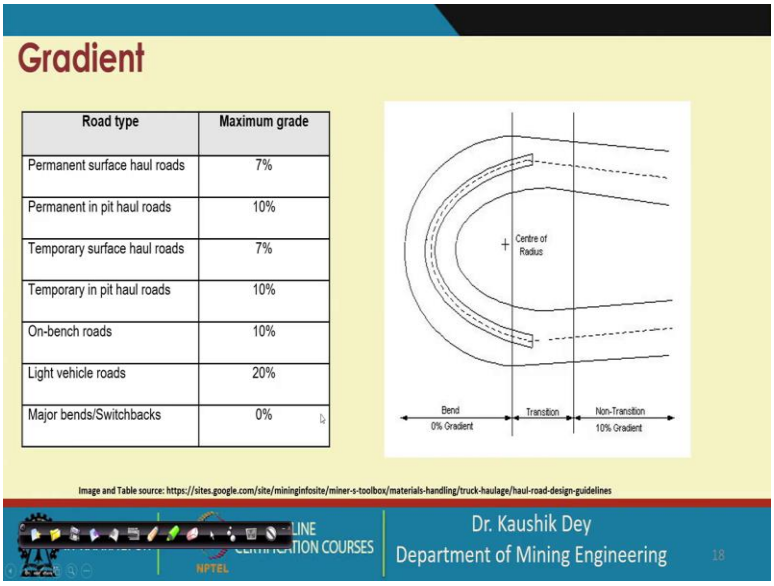

So, this is the general gradient as from this source, it is found generally for the different haul roads, it is maintained.

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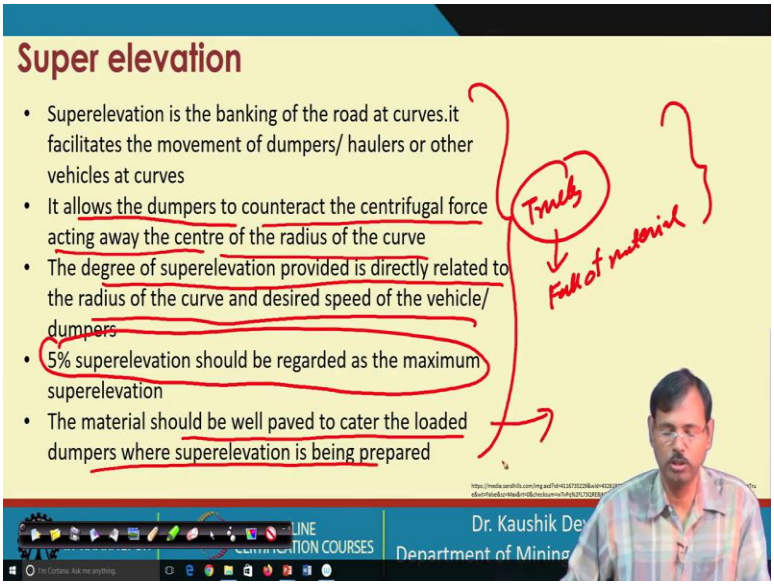

Super elevation is in general provided for the banking of the road at the curves. It allows the vehicle to counteract the centrifugal force acting away from the center of the radius of the curve. The degree of super elevation provided is directly related to the radius of the curve and the speed of the vehicle. In general, a 5 percent super elevation is provided and can be considered as the maximum. And material should be well paved to cater the load.

And as well as a very important point to be remembered here the loader, loading onto the trucks are such a, should be carried out such a way so that there should not be any fall off material from the dumpers or trucks in the super elevated curves. So, the speed has to be controlled such a way, the smoothness of the road has to be controlled such a way, and the elevation has to be controlled such a way, so that these problems can be avoided in those cases.

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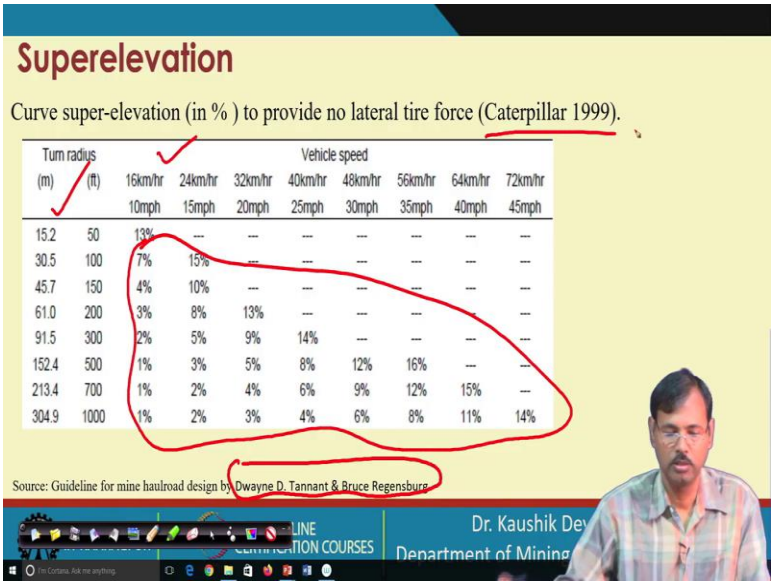

So, these are the different super elevation curve, a super elevation provided as per this reference. So, this is the turning radius and these are the speed. And this is the percentage of super elevation, this guideline is provided and this is the considering the tyre force as per the caterpillar.

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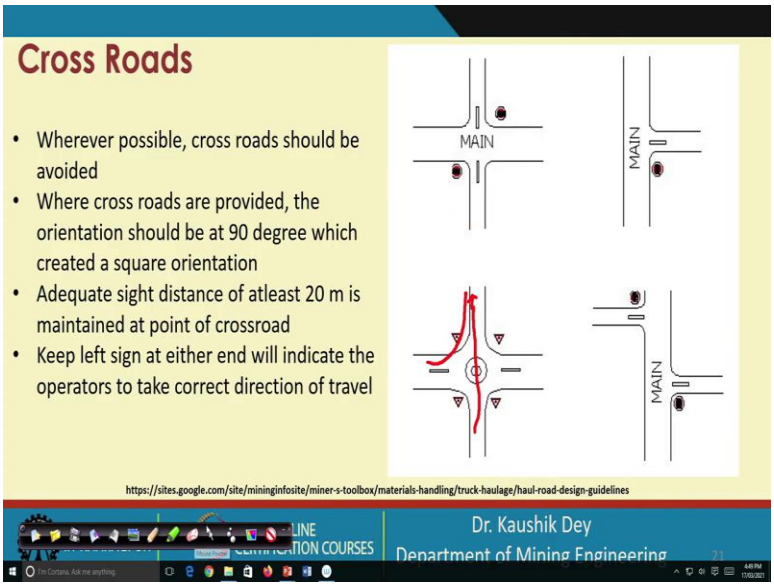

Now, the important part is the crossroad. So, these crossroads are very very critical part and they say pose a safety threat. And ideally, generally it is not expected that there should be any crossing. In fact, modern day civil roads have been found where the loops are given to avoid the

crossing of the roads and generally allowed the gradual entry of the, gradual entry of the vehicle. So, these vehicles are basically allowed to enter like this.

So, that these vehicles which is coming from here, they will meet at this position. So, direct crossing is in general avoided now a days. And that is very important, and why it is important, let us look into this picture.

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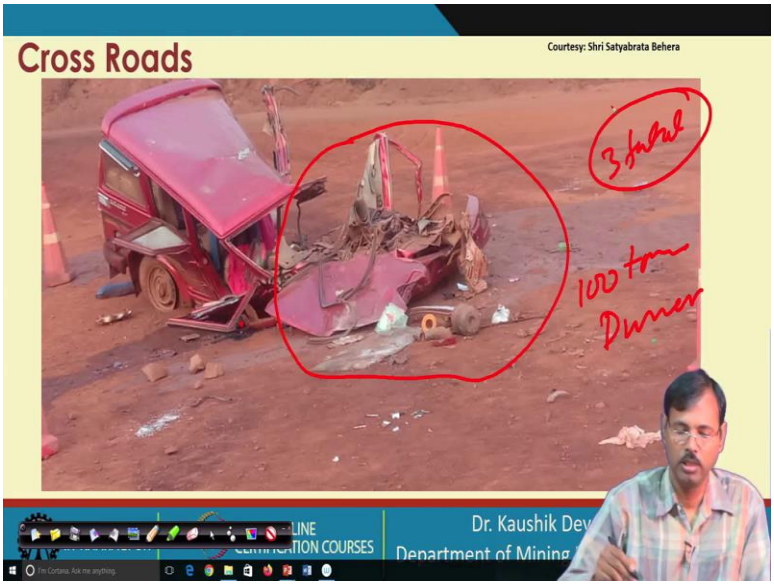

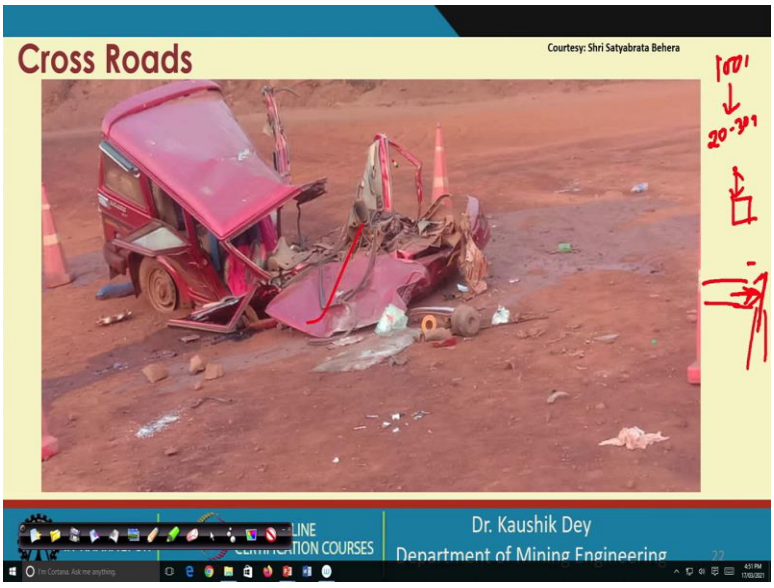

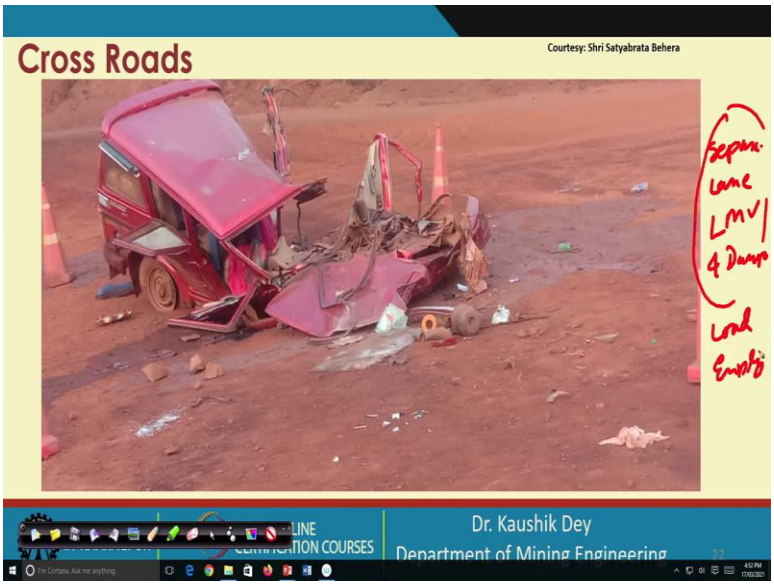

And this can be seen this is a personal car, not personal car actually that light motor vehicles which was carrying the mine personal. And this can be basically run over by a 100-tonner dumper. This happened such a way, that in the night shift, that you can see the complete portion has been away and this resulted in three fatality in this case. Now, this is happened because of the crossroad only. And as this one is moving in this direction, this one is moving in this direction.

So, they were not aware of each other, especially when this is a case of 100 tonner dumpers and etc. These are having a visibility not less than 20 to 30 meter within the dumper. So, if the dumper is at this point, an operator can see at this position which is 20 to 30 meter away from the machine. So, that is why when the dumper is at this position, it was not possible for him to see this vehicle.

So, as it was moved down, this vehicle entered at a high speed and just come into the, in between the two wheels of the, or it can entered into the dumper and the dumpers rear wheels, right over this vehicle and you can see the result which resulted the fatality also. This is happening because of the crossroads and if the crossroads would have been avoided there and probably the roads were made like this, then probably this would have been avoided in this case.

So, another aspect can be made at this position that the separate lane concept, separate lane concept for light motor vehicle and the dumpers, heavy vehicles. So, that can be another concept, multiple haul roads are also possible for the loaded and empty, loaded and empty vehicles. So,

these are the different aspects that can be considered. And that is why crossroad is very important.

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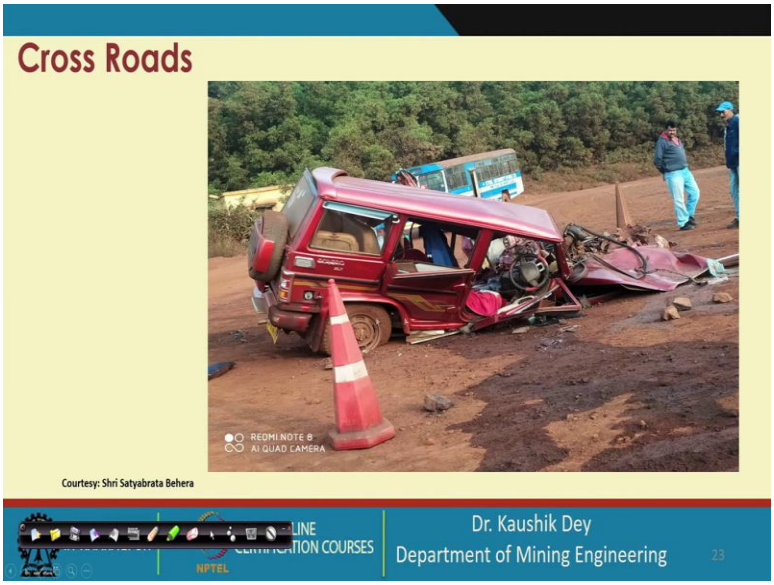

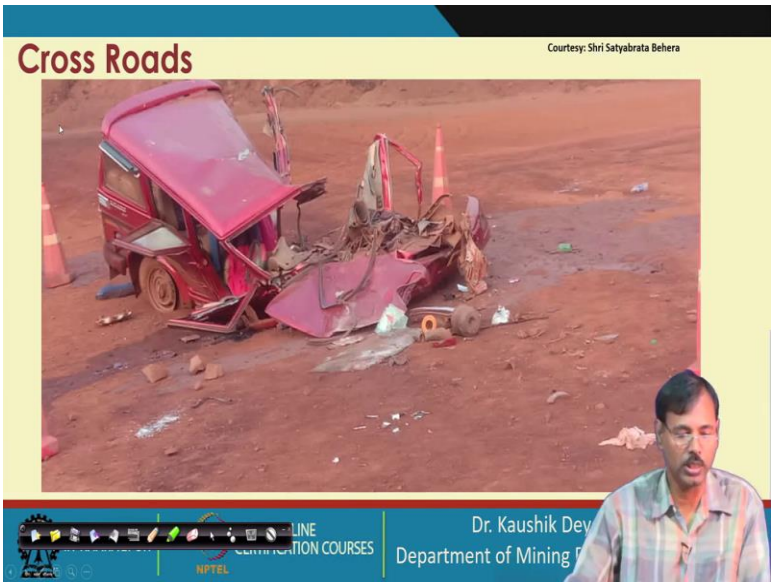

And sufficient SOP must be provided in case of, there is a cross road situation occurs. So, this is very important and this can be seen this vehicle was coming from this road and this is the other road, which is moving. So, this is the other road and this is the vehicle coming from this road.

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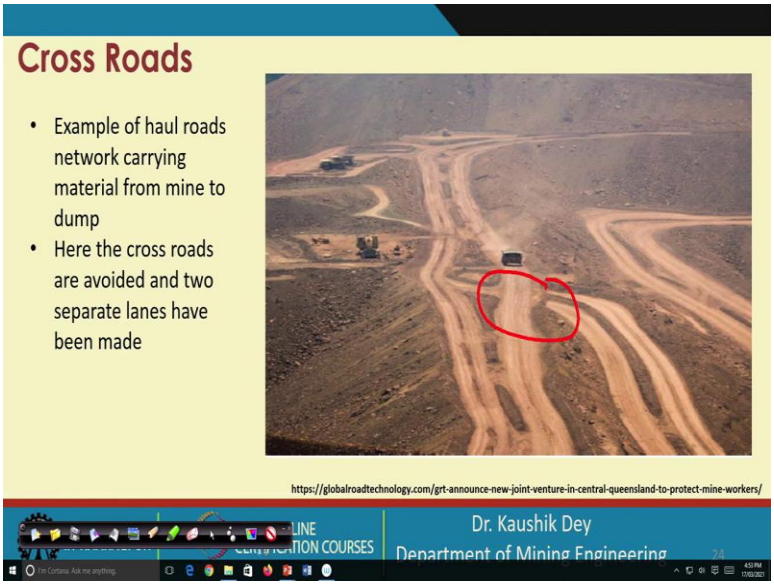

So, these are the different crossroads situations. So, this is the crossing, road crossing. This is the crossroad situation but fortunately it has a better visibility at this position.

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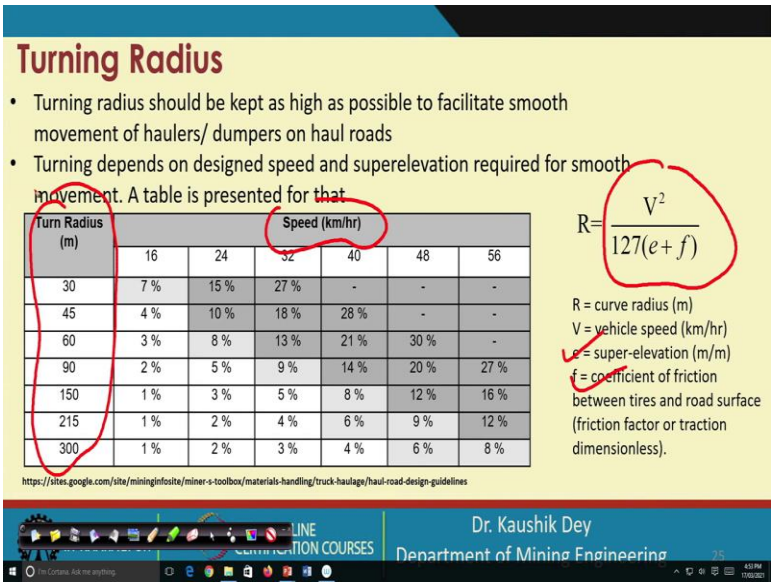

These are the turning radius, the turning radius also depends on the velocity and super elevation, coefficient of friction. And based on that, the vehicle speed should be controlled with consideration with the turning radius. And in that case, these are the super elevations, that has to be considered in the fixing the turning radius.

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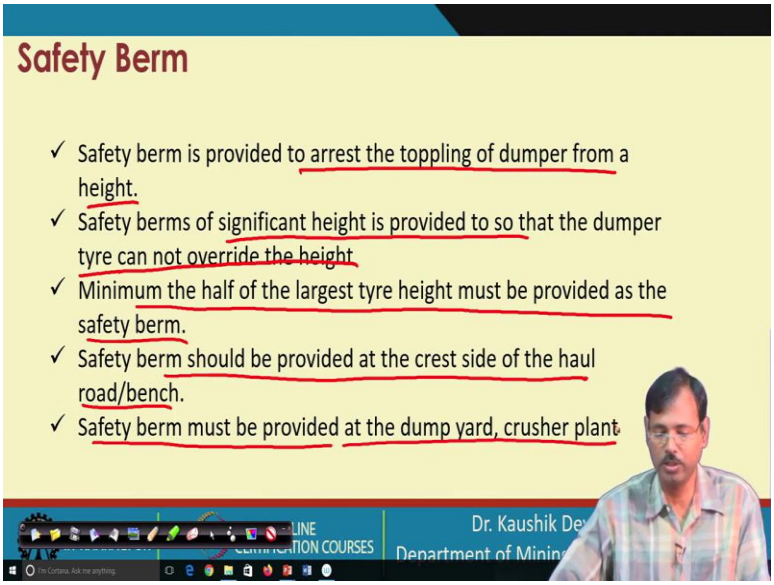

And the final one is the safety berm. Safety berm is provided to arrest the toppling of the dumpers from a height. Safety berm should be of significant height. And so, that the dumper tyre cannot override the height, minimum half of the largest tyre height should be provided as the safety berm. Safety berms should be provided at the crest side of the haul road. And safety berm must be provided at the dump yard and crusher plant also.

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And improper safety dump height may result into accident like this. So, this is the accident you can see, the dumper fall down into the crushing plant, while it is trying to unload its dump into

the crushing plant, because of the improper safety berm. This is the height, generally provided as the safety berm. So, this height which is provided as the safety berm was not sufficient in this site, where the dumper was tried to dump the material.

So, because of this improper safety berm, because of the improper safety berm, while the vehicle was tried to back it on a loaded condition, it toppled back into the crusher. So, this is the accident can be observed in case of improper safety berm. So, this is more or less about the safety in the haul road. Let us stop our lectures pertaining to the haul road. We have already covered the haul road construction, purpose of the haul road, haul road construction, haul road designing and we have also covered the safety features required for the haul road. Thank you.