Surface Mining Technology
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Lecture 17
Technology for Surface Blasting – III

Let me welcome you to the 17th lecture of Surface Mining Technology. We are discussing about Technology for Surface Blasting. This is the third lecture in this segment. We have already covered two lectures related to the influencing parameters of the surface blasting technology, and we have seen the design guidelines given by different researchers for carrying out trial blast design.

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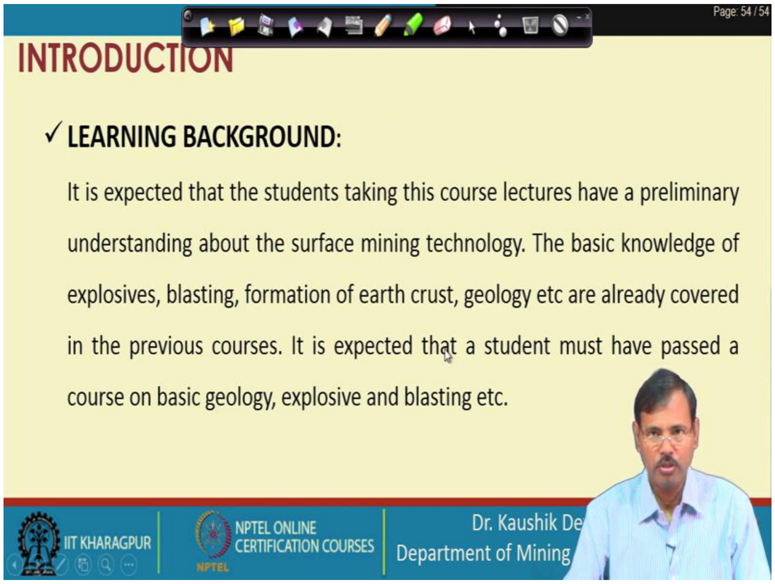

So, as we do in every lecture, this is the learning background for the surface mining technology course.

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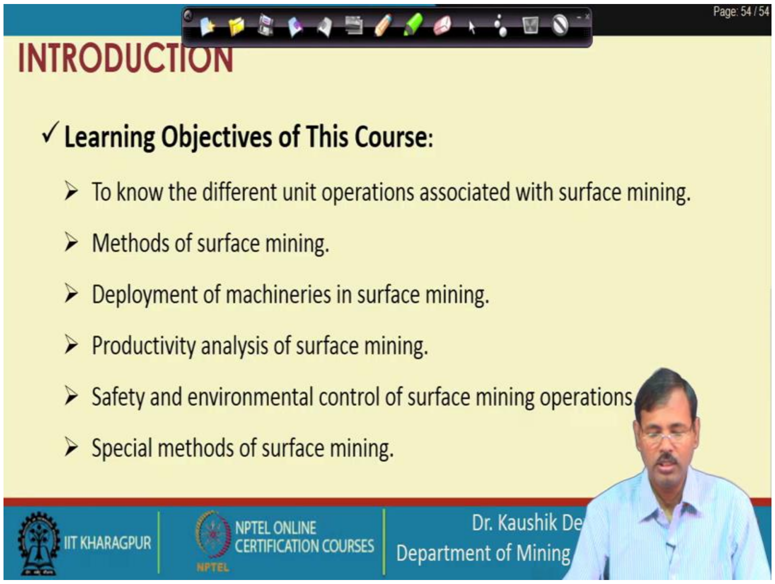

This is the learning objectives of this course.

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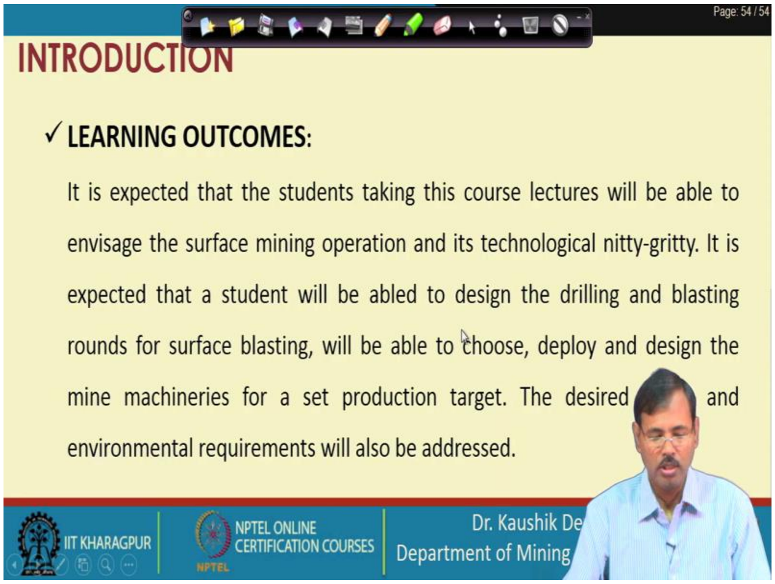

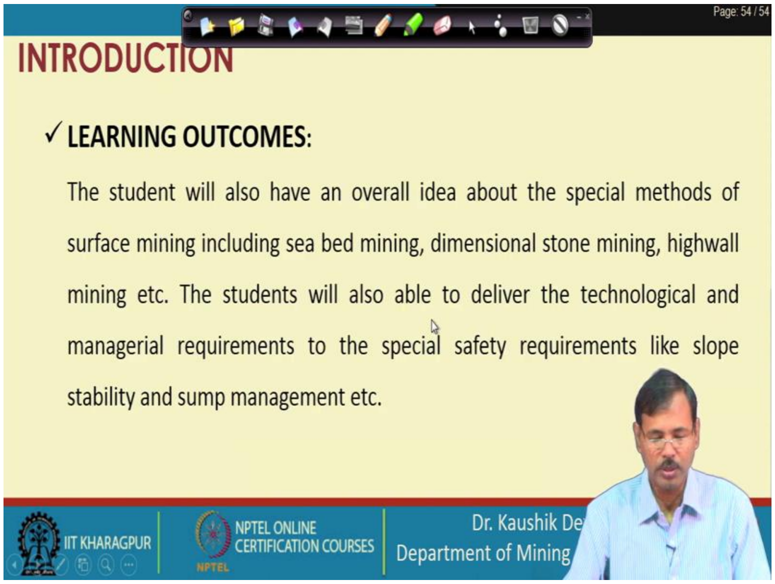

And this is the learning outcome expected from a participant of this surface mining technology course.

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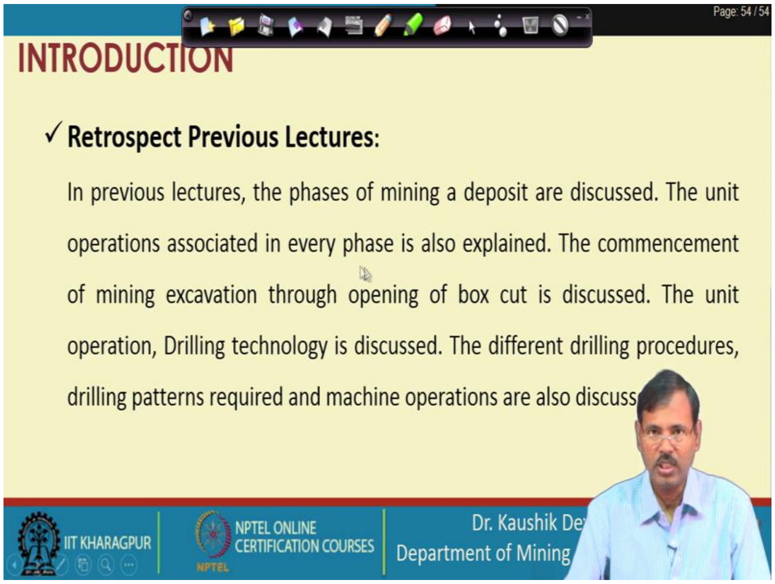

And this is the retrospect of the previous lectures. We have already discussed the phases of mining a deposit, and we have discussed the unit operations of every phase and how we are deciding based on the achievements there. We have discussed the commencement of surface mining using box cut. We have discussed the unit operations like drilling technology, and we have started our surface blasting technology.

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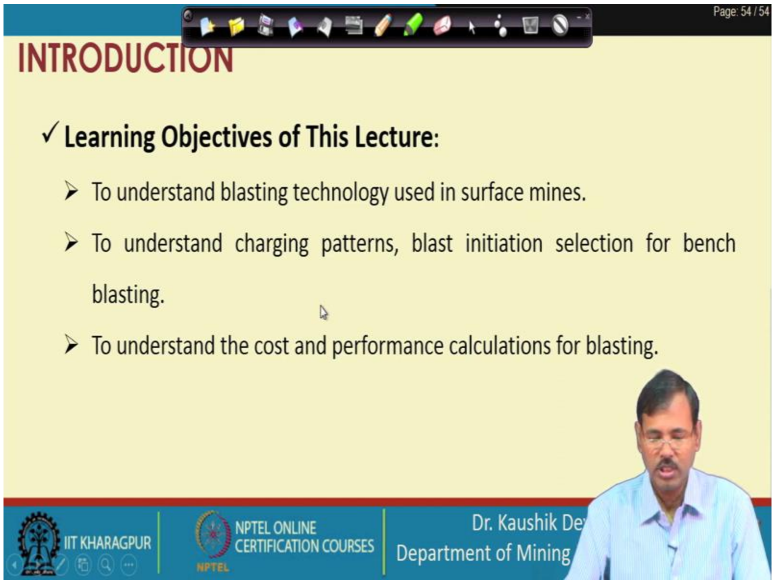

And the objective of this surface blasting technology part is to understand is blasting technology used in a surface mine, to understand the charging pattern, blast initiation selections for bench blasting, and we will estimate the cost and performance of the blasting operation in the surface mines. So far I have discussed that we have covered the design guideline given by the different researchers that are covered.

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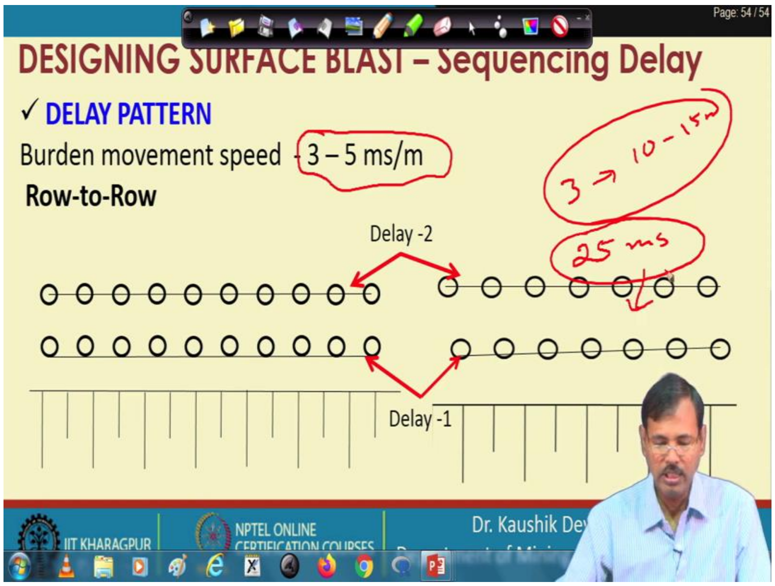

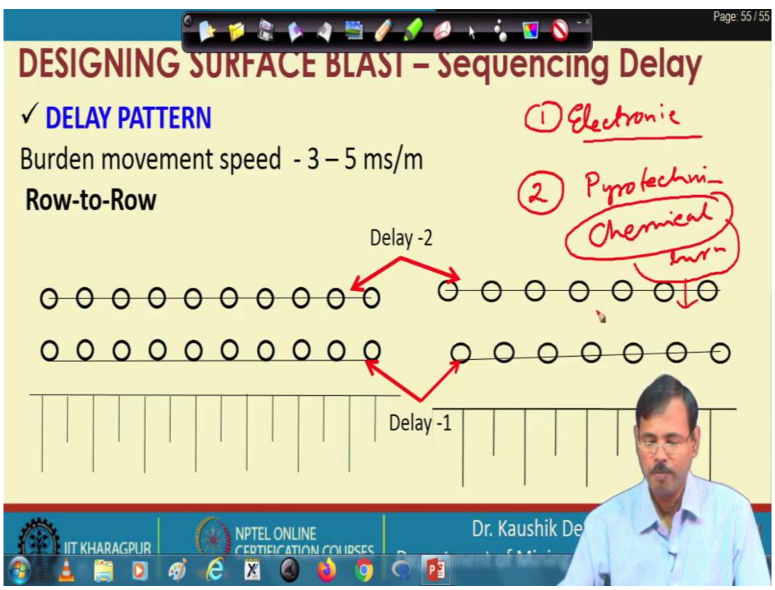

And we have discussed the delay pattern provided for blasting of the row to row and v-cut pattern. We have discussed these, and there we have considered that this delay is provided based on the burden movement, which depends on 3 to 5 milliseconds per meter of burden. So, if you have a 3-meter bench, you must consider that a 10 to 15-millisecond delay must be provided there.

So, based on that, a number of commercial delays are provided; short delays are provided with a multiple of 25 milliseconds. But on our observations and research, it has been found we are providing delay with two systems, either electronic delay, in which an operation of a loop gives the digital delay. The second one is the pyrotechnic delay, where a chemical is allowed to burn and to burn of this one that as consuming some time the delay is provided. So, it has been found that the electronic delays are very, very accurate.

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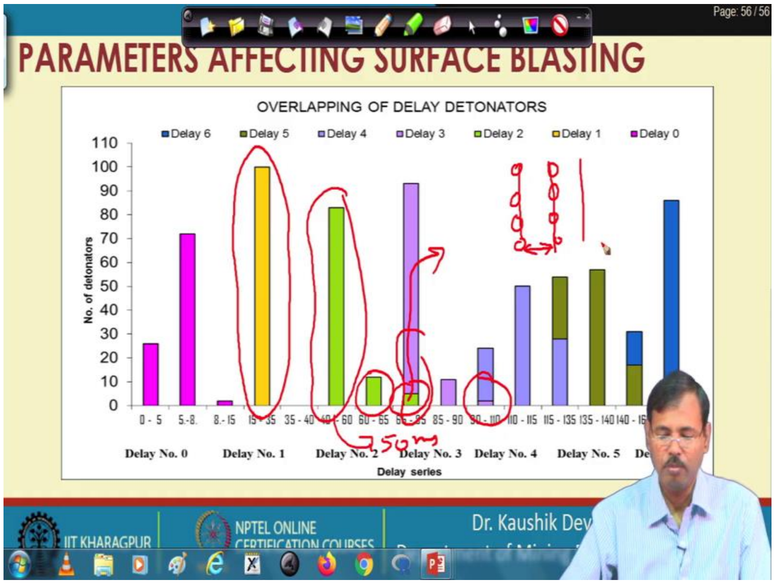

But the pyrotechnic delays have some scattering, which is why the chances of overlapping are there. So, that means the delay, which is expected to be blasted at 25 milliseconds, are blasting between 15 to 35 millisecond. But if you are looking at this one the delay which is expected to blast at 50 milliseconds is basically having some scattered, some occasions it is scattered and may blast at 66 to 85 milliseconds also and that is creating a problem that it may go to blasting at 75 millisecond which is at the same time the delay number 3 is also blasting.

So, whenever this delays are provided to these holes, the considerations of the scattering of delay must be carried out and that is why, there should not be insufficient delay should not be provided between this. So, that is the essential requirement and that must be considered while the delay is provided in the blasting.

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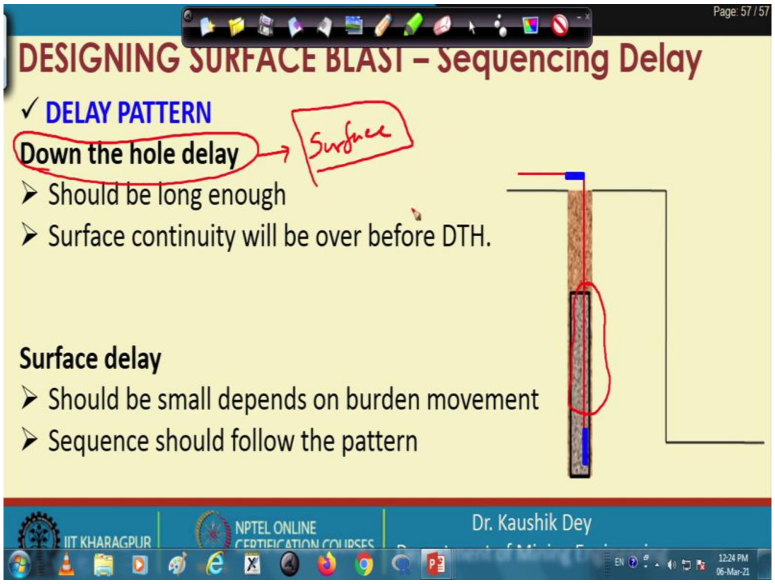

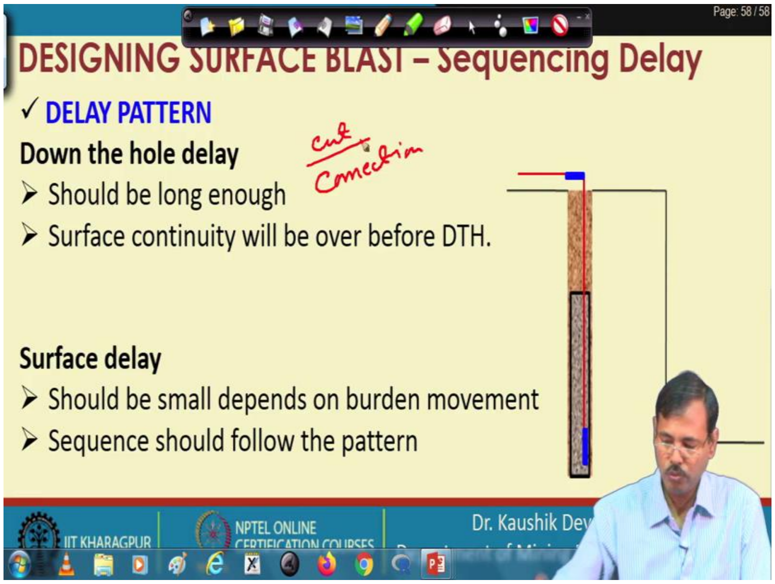

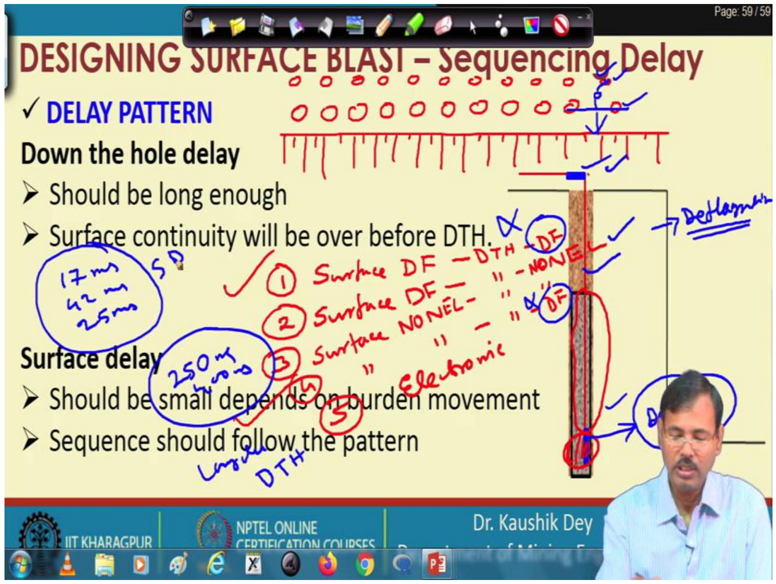

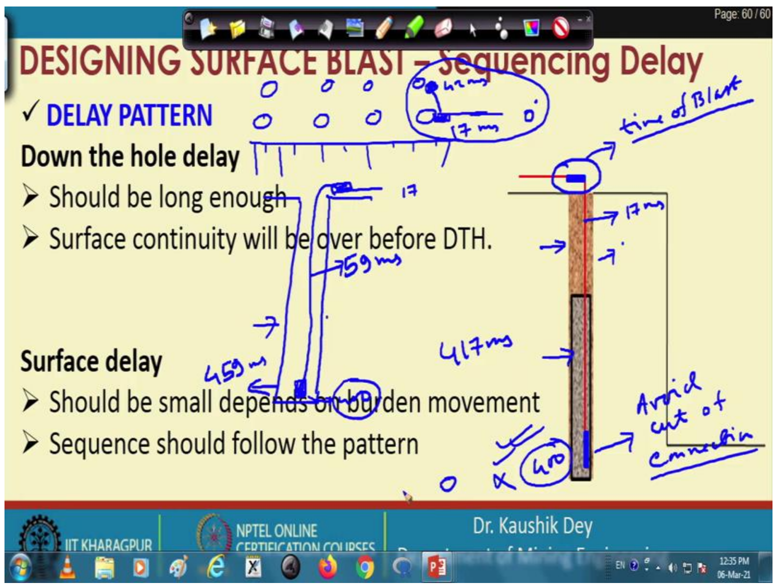

Currently, we have a Nonel system; in Nonel the delay is provided, and using the Nonel we are avoiding the deflagration of the explosive at this position. So, in using the Nonel system, we are having down the hole, provision for giving down the hole delay. This is very useful for the surface blasting because surface blasting generates huge size boulders and allows the boulders to fly over the area. So, we need to have the down-the-hole delay to avoid the connection and cut up the surface connection. So, what is carried out here, this is carried out here in two ways.

If, let us draw the plan view of this one. So, these are the holes, and we have options. The first option is that we will connect these holes using detonating fuse. So, the surface connection is the detonating fuse, and down the hole connection from the surface to the bottom of the hole, this connection is also detonating fuse.

So, DTH, Down The Hole connection is also detonating fuse. This is the first option. The second option is to go for surface connection detonating fuse and down the hole connection Nonel, down the hole connection Nonel. The third option is that surface connection Nonel, down the hole also Nonel and the fourth option is surface connection Nonel, down the hole DF, and the fifth option is that we use an electronic detonator.

If we are using an electronic detonator, there are no surface connections; the electronic detonator directly reaches the bottom of the hole. Now, if you are looking in the first case, the first case these holes are surface connections are detonating fuse, down the hole also detonating fuse. So, what is happening if we place our primer cartridge at this position initiated by the detonating fuse? Then while the detonating fuse is running here, it is basically deflagrating at this position.

The same thing occurs if you are doing the fourth one also. The deflagration of the explosive occurs by using the detonating fuse as the down-the-hole connection. But surface detonating fuse connection gives us the option to go for the row to row blasting, but remember it generates huge noise or air overpressure that may create a problem. So, this is the problem. So, in both cases, this detonating fuse in the down-the-hole connection is advised to avoid this one because 20 to 30 percent explosive may be lost due to deflagration.

Now, second is the use of the Nonel. We can use the Nonel in these two cases, either the surface DF Nonel or the surface Nonel, and down the hole Nonel. So, this picture showed the surface Nonel, this is the surface Nonel, or there may be a surface detonating fuse at this position. So, if a surface detonating fuse is there, it takes the initiation from the detonating fuse and makes it to initiating the primer cartridge in the autumn. So, using the Nonel down the hole; is avoiding the deflagration, it is avoiding the deflagration, and that is very, very important.

Now, the electronic detonator is the direct one. Whatever we are providing, the delay can be provided there itself, and by that way, we are guiding the time of blast of that particular hole. So, that means this hole will be blasted ahead of this hole that is guaranteed by the providing the delay.

So, basically, delay is provided to the hole. So, before the blasting of that hole, the other holes that are in front of that hole for creating the burden should be blasted ahead. So, that means this hole must be blasted ahead of this one that is created by providing a delay between these two. So, that is the purpose of providing the delay.

Now, whenever we use the Nonel, we have the option because Nonel, you convert the shock to a flame, then again flame to the shock. So, as it is providing flame to the shock in the delivery end of the Nonel, there is the option you can provide it delay at this position, and this delay is utilized either at this part or at this part or both. So, commercially, all the Nonels are coming with a delay, but characteristically down the hole, Nonel delay and surface Nonel delay are different. How is it different?

The commercially whatever is basically manufactured in this case Nonel, surface Nonels are coming with the delays of 17 milliseconds, 42 milliseconds, and 25 milliseconds. These are the three delay possibility the surface Nonel and down the hole Nonel is coming with a delay of say 250 milliseconds, 400 milliseconds, something like this. So, these are significantly very large delays. So, you can say long delays are provided, long delays supplied in the down-the-hole Nonel, long delay with the down-the-hole Nonel and short delay with the surface Nonel.

So, what is the basic purpose of that? The basic purpose of this is that these delays guide the time of the blast and this delay is a long delay provided to avoid cut off the connection. How is that carried out? Say we are having, again let us draw the surface part. Now, suppose this hole, this is the surface connection we have met, this is the Nonel, this is the surface connection, and this is connected from this with another surface connection.

So, suppose this portion provides, let us consider 17 ms delay, and this says 42 ms delay, now per se 42 ms delays. So, that means this Nonel has taken at 0 time. It delivers the down-the-hole Nonel at a 17 ms time, and this down-the-hole Nonel is 400 ms delay consider. So, this explosive is now blasting at 470 ms time. So, this is 17 plus 400. Now, for this hole also, this whole the delay is becoming, that means if you are drying the second hole of this one at this position, this is the down the hole Nonel, and this is the surface Nonel this one.

So, this surface Nonel is receiving; the surface Nonel receives at 17 ms. It is delivering here at plus 42 ms. So, this is 59 ms, and it is delivering at 459 ms. So, that means it is easy to understand. This 400 ms delay does not have; this 400 ms delay does not have any role in the charge up blasting.

If you deduct this one, you can consider it is blasted at 17 ms, and this is at 59 ms, which we are providing with the surface delay. So, that means this 400 delay does not have any change because the time difference from this to blast of this one is the simple one that is the 42 ms which is the delay we are providing between these two 417 to 449. So, the time difference is not significant, but this one is significant. What will happen if we allow this to blast? We allow this to blast without this, so we are blasting it at 0; then, this one will blast and let us clear it using the red pen.

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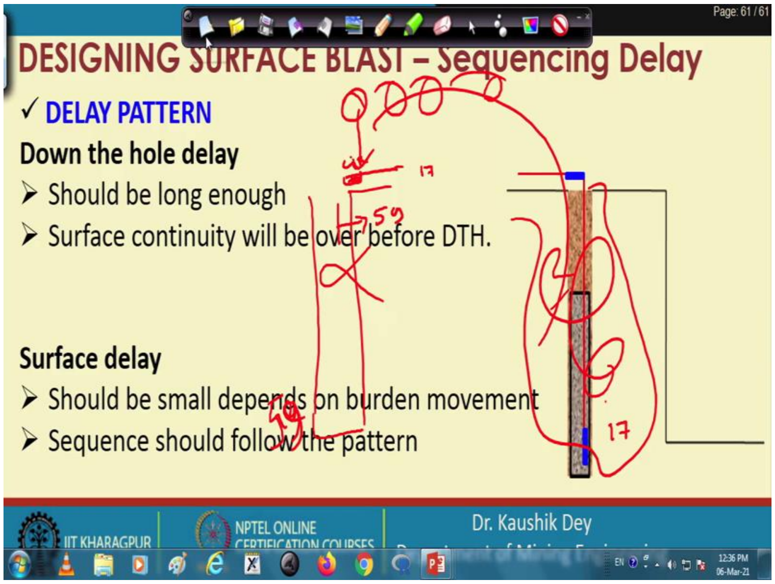

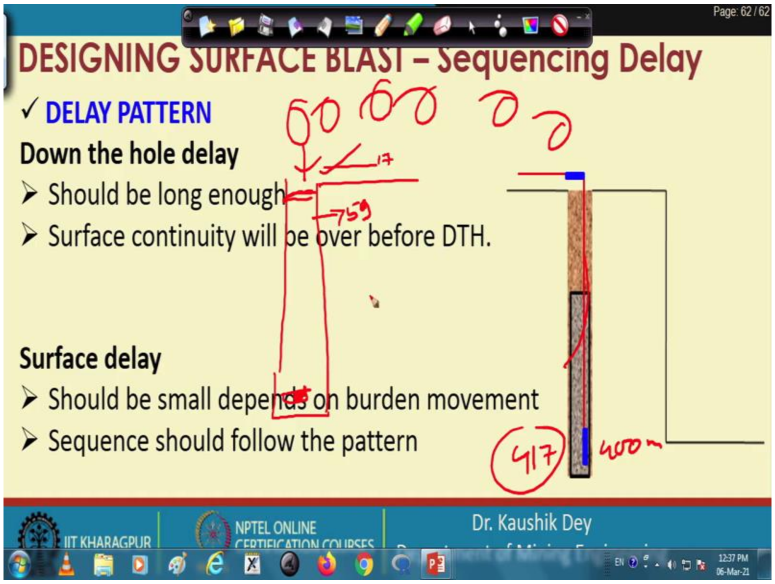

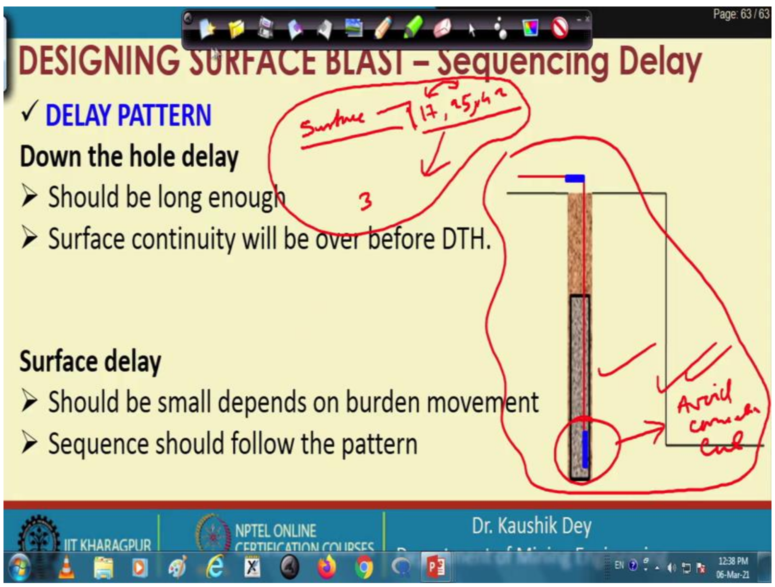

So, this will blast at 17 ms, and whatever we have drawn for that earlier one is now blasting at 42 ms, 59 ms. This is 17 ms we are blasting. This is 42 ms we are blasting. Now, what will happen in 17 ms? It will blast this portion of rock and will fly onto this. Here the charge we are providing here is 42 ms. So, this is receiving at 17, this is 42, which is why it is delivering at 59.

Now, at 17 ms, we are blasting it. So, the 17 ms rocks will be in the air so that they may drop onto this, and it can be cut. But now it can cut, so if it cuts this connection, then it will not blast. So, to avoid this connection cut, we provide that additional 400 ms here. So, in the previous one we saw, this is receiving at 17 and delivering at 59.

So, when at 417, when it is blasted, and it allows the rocks to fall on this, fall at this by that time the connection is over here and the connection is at this position only. So, there is no chance of connection cut at this position. So, that is why this down-the-hole delay is provided to avoid the connection cut.

Now, this is very important, and the surface delays, surface Nonels cannot be used as down the hole Nonel that is the available 17 ms, 25 ms and 42 ms which are. There are two reasons behind this. One is that the first reason is that these are only three variables. You do not have further any more variables for this, and the second is that you cannot match with this and this. This is the problem with this, and that is why if you are using the same, you are not achieving your desired target of this one.

So, this is not practical. This is not judicial to use. You must go for using the down-the-hole Nonel separately. Do not use the surface Nonel as the down-the-hole Nonel, and these surface Nonels are designed based on that consecutive use of this one. So, this is very, very important to be remembered.

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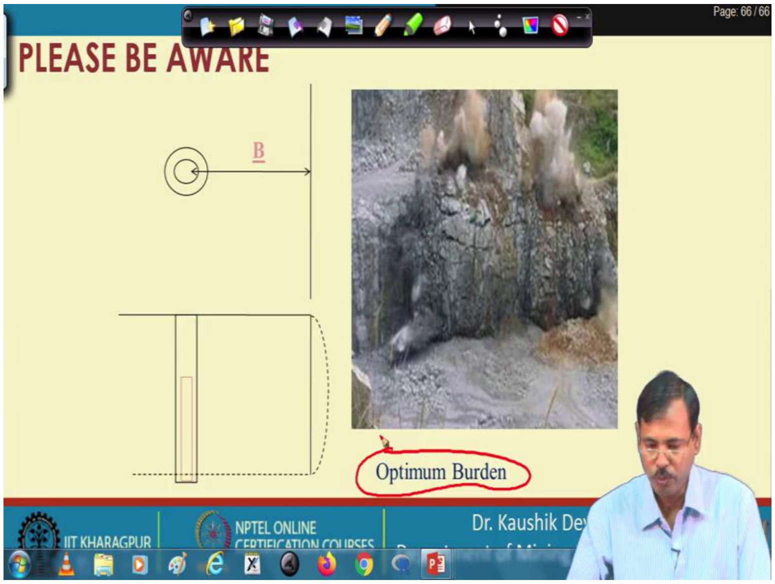

So, these are a few statements related to caution you. The optimum burden is very, very important. It would help if you insisted on achieving that one using the trial blast methods. The consequences are also explained in the previous drilling and blasting technology class.

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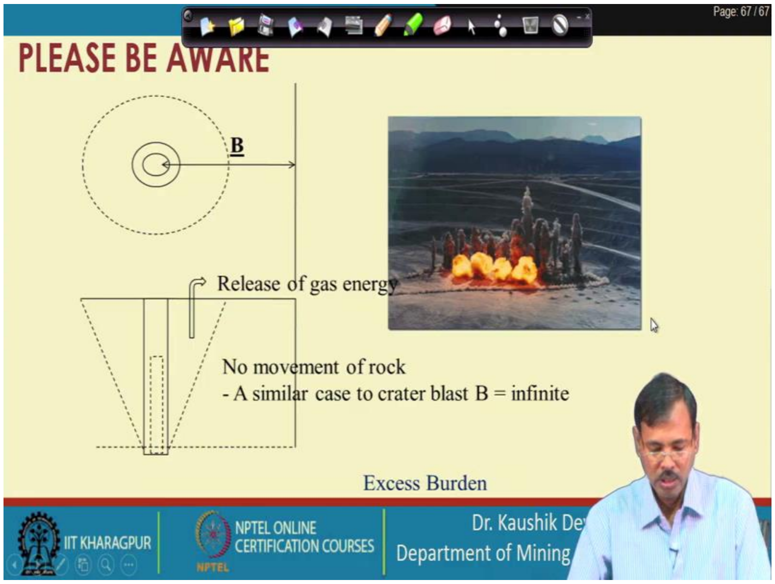

The excessive burden may result in these things.

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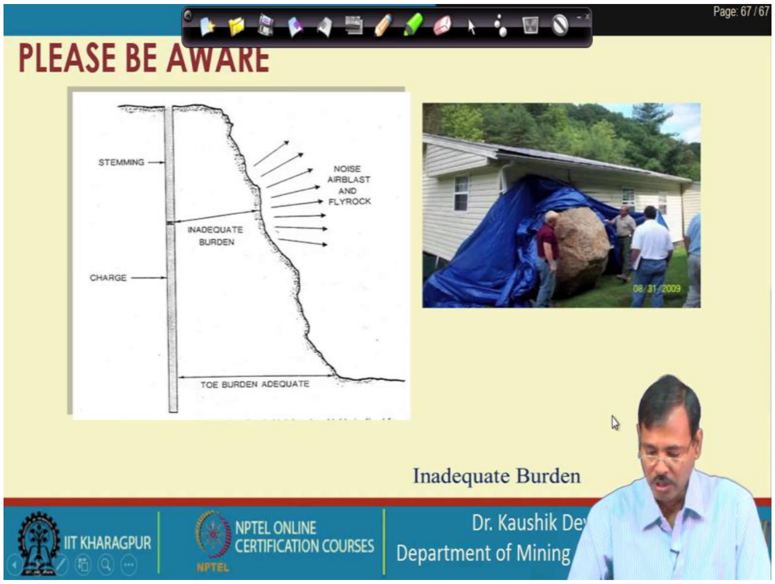

Flyrock may be generated because of the inadequate burden, and these are few the important part.

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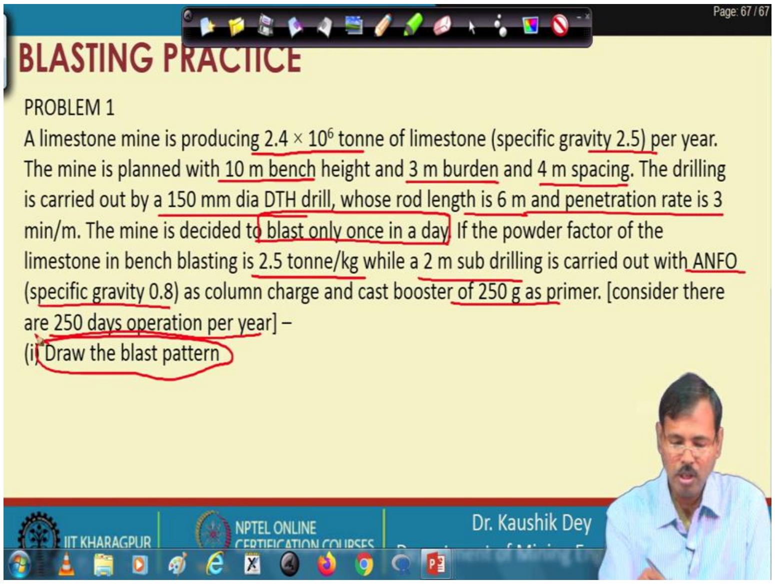

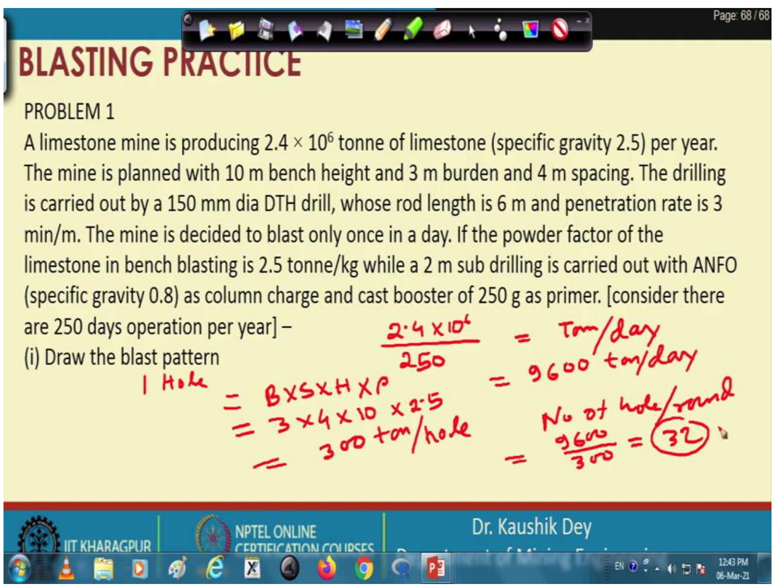

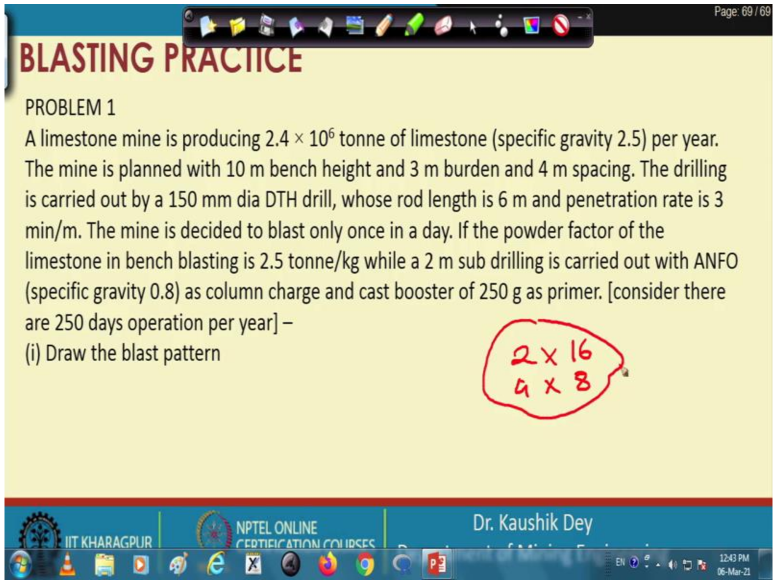

And let us solve one problem for designing a blast for actual mining conditions. Say in this problem it is given a limestone mine is producing this one with the specific gravity of this one, bench height is given, the burden is given, spacing is given, drill diameter is given, rod length, the penetration rate is given because we have considered it is from the drilling part.

This is the decision of the mines, as frequent blasting is an unwanted matter. Blasting is expected to carry out once a day only. Powder factor is also given, and sub-drilling is given. The specific gravity of ANFO is used as a column charge, and a 250-gram booster is used as primer charge is also given there are 250 days of operation, but your target is to give a blast pattern to the mine authority.

So, let us solve this one. The production target is 2.4 into 10 to the power 6. We have to go for 250 days of operation means we can go for 250 blastings. So, we can blast 250. So, this is the tonnage we have to produce per day, whatever we are getting from this. So, this is the first one. The next part is that, so let us know if we can get 9600. So, this is the production target per day and if this is the production target per day, let us see the yield from one hole.

The production we received is burdened with spacing into bench height in one hole. This is in a meter cube. If we multiply it with density, we will get the tonnage. So, our burden is 3 meters, spacing is 4 meters, bench height is 10 meters, and row is 2.5 meters. So, this is 300 tons is the production from one hole.

So, the number of holes to be blasted per day is what we have to carry out once a day. So, this is per round also you can consider. So, per round or per day is. You may have more number of rounds, but that is also unwanted because it creates the duration of the blasting. So, the number of holes to be blasted is 32.

So, we have to carry out the blasting of 1 round of 32 holes for that particular mine for every blast. Now, this has to be blasted. So, 32 holes either we can have two holes, two rows of 16 holes or four rows of 8 holes, or similarly we can have three into 11 also all these possibilities are there. We can think of that options and accordingly we can provide the delay.

So, that part will come later, but let us first consider how and what the charge quantity will be. So, the yield from one hole we have seen is 300 tons. Our power factor is given 2.5 tons per kg. So, the kg of explosive to be provided is 300 divided by 2.5. So, that means 120 kg of explosive is coming to be provided in the hole.

Now, see what the linear charge is? You have already seen linear charge concentration. Linear charge concentration is nothing but pi D square by four into l into the concentration is rho of explosive. So, l is 1 in this case. So, it is pi D square by four into rho. So, that is pi into 0.8, 150 mm.

So, 150 mm is 0.15 into 0.15 divided by four and into 0.8 specific gravity means 800 if you are converted into kg. So, whatever it is coming, it is probably around 14 or something like that. We will see in the next slide the salt portion is there. So, this is the charge per charge quantity per meter of the hole. So, the charge column length that l in the hole will be 120 divided by linear charge concentration. So, whatever value it will come, it will probably come around 8.5 meters.

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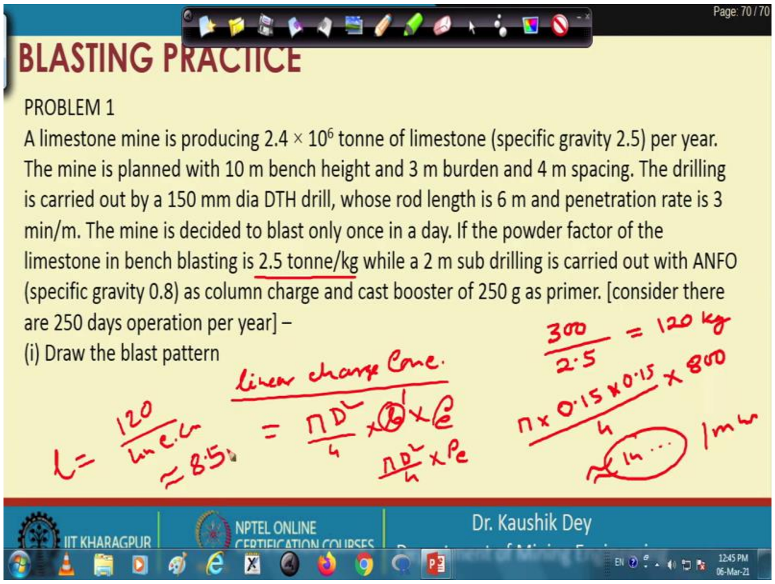

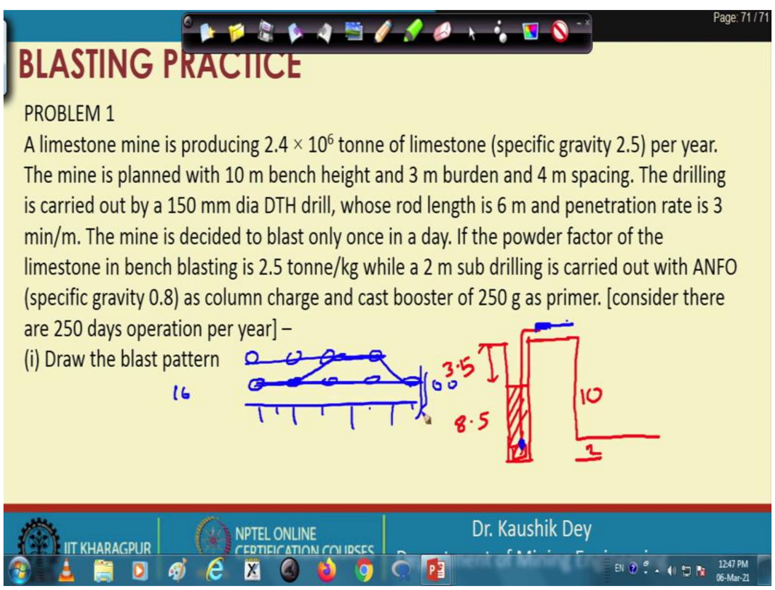

So, if l is coming 8.5 meters, then we can expect if this is our blast hole, then this is 10 meters, this is sub-drilling is 2 meters, and we are providing a charge of 8.5 meters and the stemming. Obviously, it is 3.5 meters. So, this is the section of the hole. Now, we have to provide this booster with the Nonel.

This is the booster, and we have placed a Nonel here. This is also connected with Nonel, or you can have any other type of connection. So, this is the section of the hole, and you have to draw whatever is the way you are providing. This is 16 numbers, 16 holes, and two rows. So, if you are providing row to row delay, you have to provide row to row delay. If you are using surface Nonel and down the hole Nonel, whether a v-cut or an extended v-cut, you have to provide that one in the solution.

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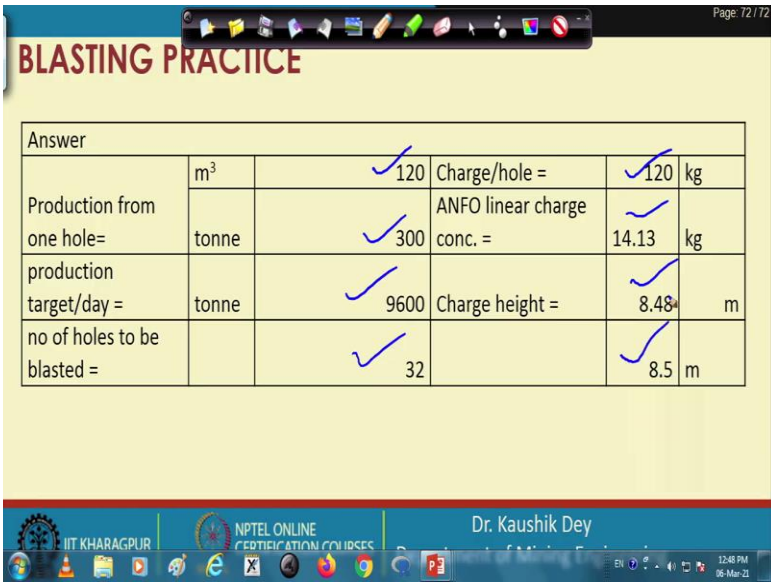

Answer					
Production from one hole=	m^3	120	Charge/hole =	120	kg
	tonne	300	ANFO linear charge conc. =	14.13	kg
production target/day =	tonne	9600	Charge height =	8.48	m
no of holes to be blasted =		32		8.5	m

So, now, let us look into this calculation. You can see these are the answer given here. Production from one hole is this much of meter cube, this much of ton. The production target per day is this one, the number of the holes to be blasted. This is the charge per hole required depending on the powder factor. This is the linear charge concentration. So, the charge height is this one. So, this is the charge height.

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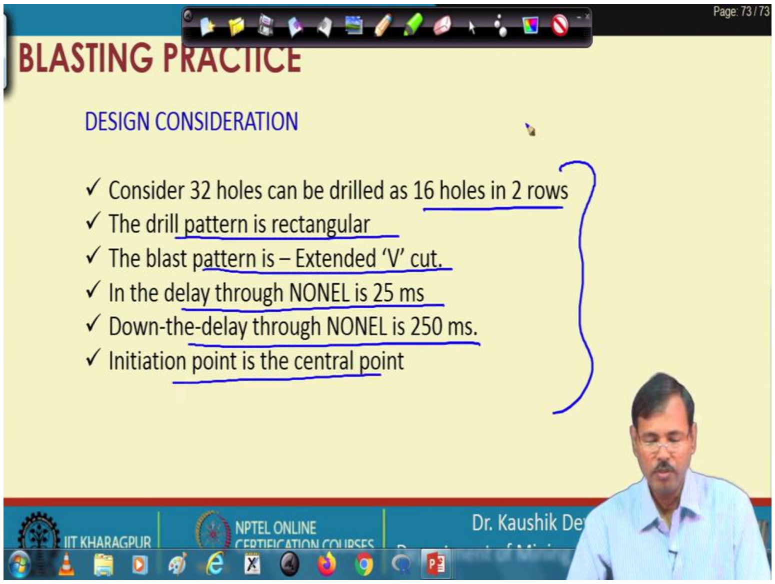

So, in consideration of that if we are considering this design criterion, if we are considering this design criterion 16 holes of 2 rows, drilling pattern is rectangular, blasting pattern is extended v-cut, delay through Nonel 25 millisecond, down the hole Nonel 250 millisecond, initiation point is the central point if we are considering this.

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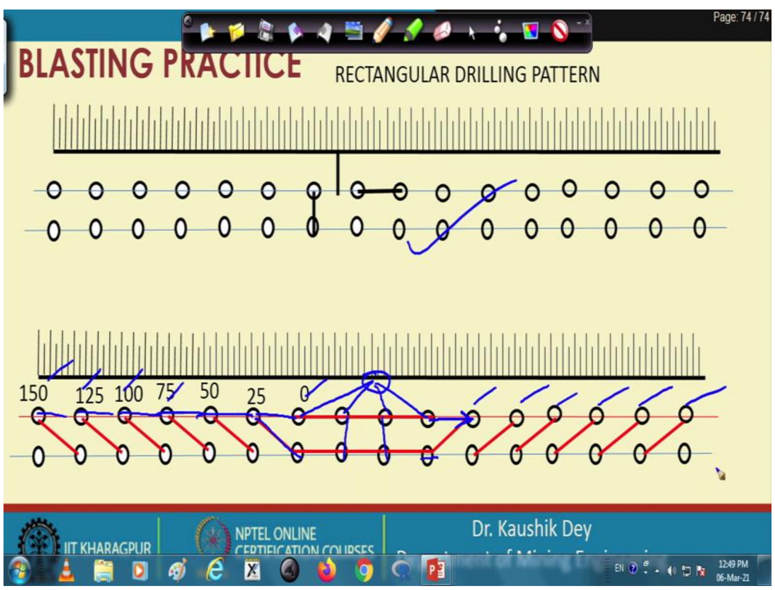

Then this is the drilling pattern, this is the drilling pattern shown here, and you can see this is the blasting pattern and this is 0 centrally placed from where this is 25-millisecond Nonel, 25-millisecond Nonel, 25-millisecond Nonel, 25-millisecond Nonel, 25, 25 and further 25 is used at this position. So, similarly, these all Nonels from these are basically tied together and initiated using an electric detonator. These are initiated from these Nonels to this 25 ms surface Nonels. These are basically drawn from these Nonels to the other Nonels.

So, these are the 0; these are the 25, 25, these are 50, these are 75, 100, 125, 150, similarly 25, 50, 75, 100, 125, 150. So, like this way, it is continued, and again you may have a 25 or maybe 42. If you are having that, in that case, you have to continue like this. So, this is the blat pattern.

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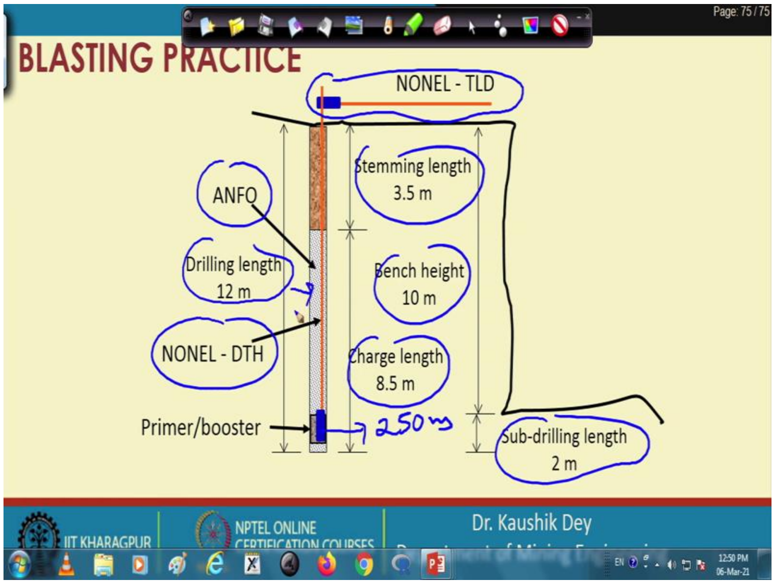

And this is the section. You can see how the section is provided. Nonel TLD of 25 ms, Nonel DTH of 250 ms. This is the stemming length, bench height, and charge length; 8.48 is considered as 8.5. This is the sub-drilling length. The primer booster is provided along with the mouth in the mouth of the Nonel. This is the DTH Nonel.

This is the drilling length, and this is the ANFO provided in the charge column. So, this is the complete design of this. There may be an alternate design to this. You may think of a different initiation system. Maybe instead of that extended v-cut, you can have a v-cut, you can have a row to row blasting, you can have different compositions, you can have a detonating fuse in the surface, and you can have an electronic detector. So, you can have your design based on that. So, this sample blast design is shown here. Thank you.