Drilling and Blasting Technology
Prof. Kaushik Dey
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Lecture - 39
Problems - 3

Let me welcome you to the 39th lecture of Drilling and Blasting Technology course. And since last 2 class we are discussing about the different Problems last 2 class we have discussed problems related to drilling and we have also discuss some problem related to absolute weight strength, absolute bulk strength, relative weight strength, relative bulk strength of the explosive in the last class.

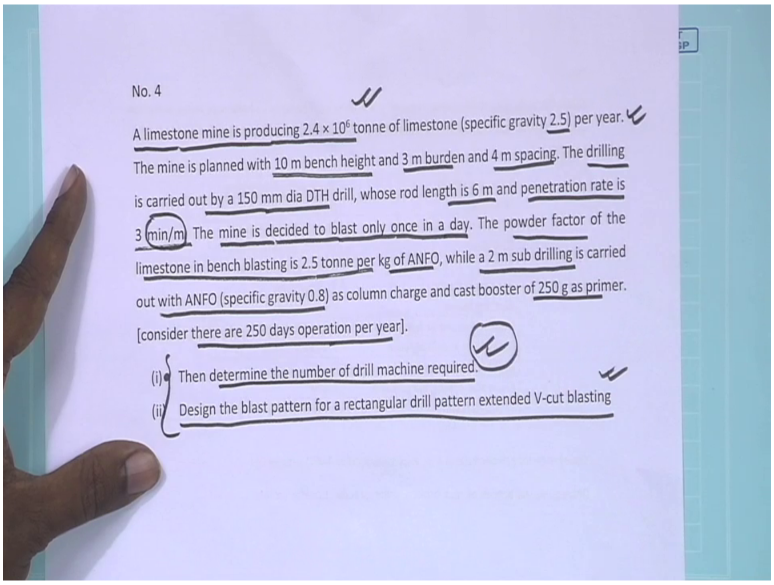
So, this class basically we will discuss about the surface blasting and how can design surface blast how we can design the economic parameters of a surface blast at along with the drilling parameters that will be in this class.

So, basically how to decide the burden, spacing etcetera for the travel blasting is already discussed. So, Langefors kihlstrom criteria or Syconus criteria those are discussed in our earlier lectures. And the in this class assuming that burden, spacing etcetera are already fixed, we will try to find out what will be the blast design for a particular case when you are applying that blast design burden spacing design in a particular blast round.

That means, the burden spacing etcetera values are fixed the total charge the charge requirement or the powder factors as per the requirement of the fragmentation are fixed. But, we have to go for orientation of the round because to address our requirement for that mining purpose, where we are basically fixing the how much material has to be blasted and how those will be taken care by the excavator etcetera considering the schedule of operation in a surface mine.

So, basically this scheduling of drilling and blasting part is the main objective of this particular lecture.

(Refer Slide Time: 02:20)



And say for this let us consider one problem and you can see in this problem we are discussing last just like last problem. A limestone mine which is producing 2.4 million tones of limestone whose specific gravity is given 2.5 and this is the production target. And the bench height is also fixed as per the requirement of the shuffle boom length, burden spacing we have already designed using the say Langefors kihlstrom criteria or from our trial blasting etcetera.

The drilling is also fixed we have found we need to carry out a 150 mm dia drill, whose rod lengths are fixed. Because, the machine is fixed and the penetration rate in this case we have already fixed it 3 minute per meter say they are take care about this unit it is 3 minute per meter. That means, 3 minute time is required for penetrate 1 meter of rock while it is drilled.

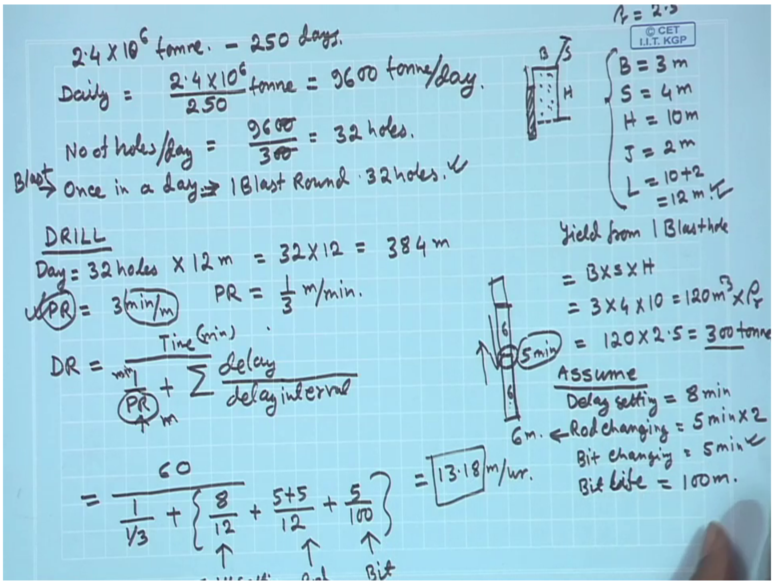
And this is the administrative decision, mine has decided to blast once in a day. That means, the daily requirement to achieve this production has to be addressed by a single blast round. The power factor of that limestone is given it is 2.5 ton per kg of ANFO. Say it is fixed for ANFO other the primer charge which is used that is not considered as it is written here you can see 250 gram primers are used for initiating the blast which is not considered in this powder factor.

So, this is the powder factor 2 meter sub drilling is required also it is mentioned, ANFO specific gravity is also mentioned and here it is given 250 days operations are there so, that we can determine the daily production target.

And the question is determine the number of drill machine required then we need to design the blast pattern for a extended V cut blasting. So, these are the 2 requirement I think this requirement is well covered in the last class. Then also we will solve this for this class also that we can get the once again we can restructure this one or we can reassess this one.

So, as per this problem let us solve this problem, first let me write down the data pertaining data given here.

(Refer Slide Time: 05:19)



Our yearly production target is 2.4 into 10 to the power 6 ton, which has to be achieved in 250 working days. So, our daily production target daily production target is 2.4 into 10 to the power 6 divided by 250 ton. So, this is if we calculate it, it is coming 4000 here at this place into 2.4; that means, 9.6 into 1000. So, 9600 ton per day is the production target.

So, this is our production target which is given in this case. Further, our blast design is more or less given here the burden is 3 meter, the spacing is 4 meter and benchheight is given 10 meter. It is also mentioned that subway drilling J is 2 meter, which leads the drilling length L is 10 plus 2 that means, 12 meter.

Now, from this data we can assess that if we blast 1 hole, if we blast 1 hole, if we blast 1 hole of burden this one, bench height this one, it is expected that this much of material will be fragmented. So, and the specific the portion of rock which will blasted at this side is equal to 1 spacing length.

So, the yield from one blast hole from one blast hole, yield from one blast hole is equal to burden into spacing into benchheight; that means, it is 3 into 4 into 10 are this much; that means, 120 meter cube. If we would like to convert into the ton then we have to multiplied it with the rho of rock, rho of rock is given here as 2.5 rho r let me write here rho r is given 2.5. So; that means, this is 120 into 2.5 that is coming 300 ton. In fact, in last class what we have already solved there also have found the similar way this is 300 ton is the yield from one blast hole.

So, let us find out how many number of holes we need to blast; required per day to blast is 9600 divided by 300 that is 32 holes. Now, you recall that in our problem it is given that we need to blast once in a day. So, the blasting frequencies blasting must be carried out once in a day; that means, in one round this imply in 1 blast round we have to blast 32 holes ok. So, this is the requirement for our blasting of 32 holes, but prior to blasting we need to go for drilling in this case.

So, let us consider the drill so, for this drilling what we need to do? We have to drill 32 holes in 1 day and the length of each hole in 1 day we need to drill 32 holes and the length of each hole is 12 meter, each hole is 12 meter. So, our drilling target is 32 into 12; that means 384 meter of drilling is required per day ok. Now, what we need to do is that we have to penetration rate is given, penetration rate is given 3 minute per meter and we have to determine the drill rate.

So, for this as for calculating this drill rate we need to know the different delay times. So, let us assume those are not given here. So, we need to assume we need to assume some delay time pertaining to the drilling. And let us consider we need to have the delay for setting of drill machine just like the previous one 8 minute. Rod changing time again 5 minute and again consider bit changing time 5 minute and as the rod length is already given 6 meter. So, rod changing is carried out 6 meter, after each 6 meter so; that means it is carried out once while it is carried out drilling.

So, rod changing while you are drilling 12 meter so, after 6 meter of drilling, 6 meter of drilling we have to insert second rod, then the second rod will allow to drill up to another 6 meter. So, this 6 plus 6 so, we need a 5 minute delay while we are carried out the drilling. Again, when we are withdrawing the rod that time again we have to untie second rod first from the first rod. So, that takes another 5 minutes.

So, basically this 5 minute is required twice when while the drilling is carried out and while the rod is being withdrawn from the hole. Bit changing time delay is given as 5 minute. So, we have to need a know you have to know the bit changing interval. So, bit changing interval say bit life let us consider just like previous class 100 meter.

So, this 5 minute delay maybe a witnessed in every 100 meter of drilling. So, like last class we know the formula for this, this is the drilling rate formula. Drill rate is equal to time by penetration rate, then plus summation of delay by delay interval.

Now, I would like to draw your attention, in this penetration rate mentioned this and this. You can see this is in minute this is in meter and this is in mini sorry this is in minute and this is in meter. So, that this minute and minute will cancel and this meter will remain here so, that we can get drilling rate in meter of specified this time hour ok.

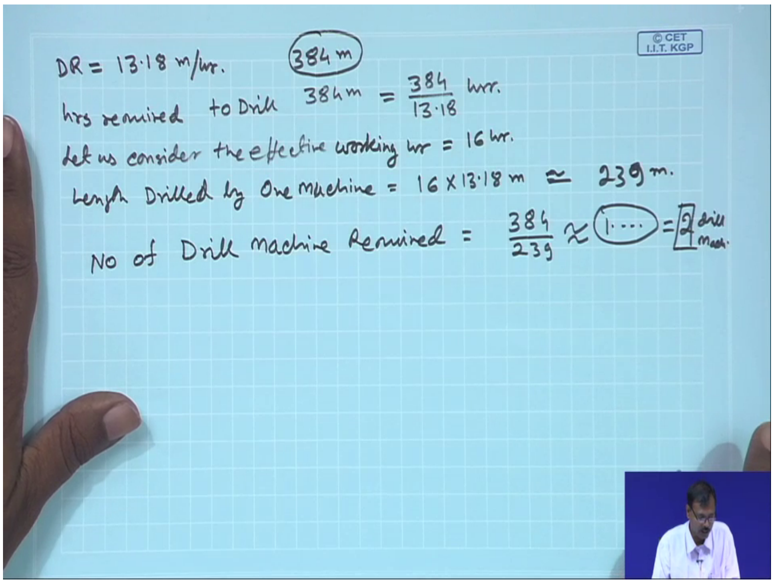
So, this penetration is basically expressed in meter per minute when we are considering it as these and it will be, but in our this problem our penetration rate is given in minute per meter. So, while we are using this formula, this penetration rate has to be converted to in meter per minute. So, in that case our actual penetration rate for these is 1 by 3 meter per minute.

So, let us put the different value in this case this time let us consider it for 1 hour. So, this is 60 minute then the penetration rate is 1 by 3, then our delay times so, our delay times comes us for us drill setting time 8 minute for every 12 meter hole.

Then 5 plus 5 rod changing time for every 12 meter hole and bit changing time of 5 minute for every 100 meter hole. So, this is you can see, this one is for drill setting time, this one is for rod changing and this one is for bit changing.

So, if you calculate this you will get the value of 13.18 meter per hour. So, as it is previously calculated by me, I know the value or you need to calculate this one, you will get this value as the value for our drilling rate so, the value of drill rate.

(Refer Slide Time: 17:55)

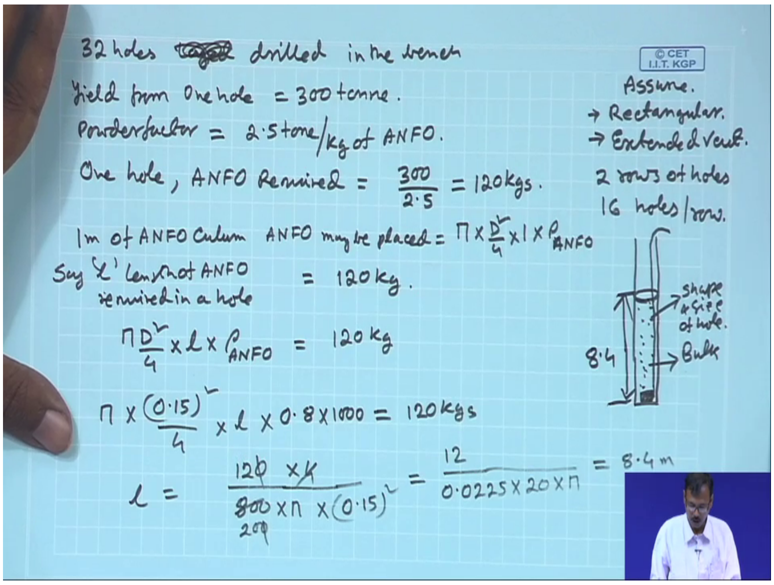


Let me write down again here is 13.18 meter per hour and let me write down some previous the values written in the previous sheet the total drilling rate requirement is 384 meter. So, the hours required, hours required to drill 384 meter is equal to 384 by 13.18 hour.

So, let us consider the effective working hour in a day available is 16 hour. Then the length drilled by 1 machine is equal to 16 into 13.18 meter and this is coming around 239 meter so, this is coming around 239 meter. So, that is why we need to drill this much of meter. So, the number of drill machine required is 384 by 239 which comes is 1 point something so; that means, we need 2 drill machine.

So, to drill 38 holes we need to deploy 2 number of drill machines in this case then only we can get 32 drilled holes for carrying out our blasting.

(Refer Slide Time: 21:23)



So, now let us go into the blasting details we need to drill 32 holes and the first decision has to be made here how this 32 holes will be laid in the bench. 30, 32 holes will be drilled in the bench and then for this let us again assume first the drilling is rectangular. And the second one the assumption as per the means as per the question is given it must be a extended V cut. Second one is the extended V cut blasting.

So, we have to assume how this 32 holes will be drilled let us consider it will be a drilling of 2 rows of hole, 2 rows of holes and each row should have 16 holes per row. So, considering this we have to lay down the holes in the bench, but prior to that we have to determine what will be the quantity of explosive to be placed inside one hole.

So, we know the yield from one hole is 300 ton, yield from one hole is 300 ton. Our powder factor is given is given in the question it is given that 2.5 ton per kg of ANFO. So, in one hole ANFO required is equal to 300 by 2.5. So, that is equal to 120 kgs of ANFO is required in one hole.

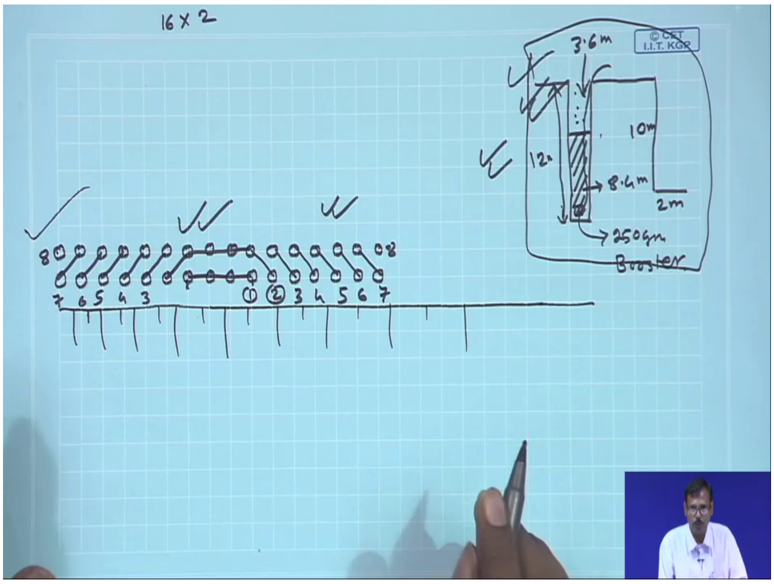
So, you know ANFO is a bulk loading type explosive. So, bulk loading types explosive means if we drill a hole then you place the booster which is the primer charge in the bottom and fill the hole with the ANFO and as ANFO is bulk explosive the explosive will take the shape of the hole. So, this will take the shape of the hole, shape and size of the hole. So, the diameter of ANFO placed in the hole is equal to the diameter of the drilled hole.

So, that is why the ANFO is bulk loading type. So, in 1 meter of ANFO column ANFO maybe placed is equal to pi D square by 4 into 1 meter length into rho of ANFO.

So, that will be the quantity of ANFO. So, if you solve this one then you will find out say consider l is the length of ANFO required in required in a hole which is equal to 120 kg. Then pi D square by 4 into l into rho ANFO is equal to 120 kgs. So, D is known to us that is 150 mm. So, this is pi into 0.15 whole square by 4 into l rho is also known to us it is 0.8 and this is 0.8 you can say it is at specific gravity. Then to convert it into the kg we need to multiply it with 1000 is equal to 120 kgs.

So, if you solve this problem you will get the l is equal to 120 into 4 divided by 800 into pi into 0.15 whole square. So, this may be equal to and you can say this is 12 divided by 0.0225 into 20 into pi and solving this you will get the value of l is equal to 8.4 meter. So, you know now the explosive charge length into the hole is 8.4 meter. So, now, let us draw the blast design which may be followed.

(Refer Slide Time: 28:45)



So, there are 16 into 2 holes so, let us consider this is the free face and these are the holes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 holes then 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. So, 16 holes of 2 rows and you have to blast it in extended V cut pattern.

So, let us consider 1, 2, 3, 4, 5, 6, 7, so, this is the 7th one 1, 2, 3, 4, 5, 6, 7. So, this 4 holes are centrally located let us blast it in one go. So, this is in delay number 1, this 4 holes will be blasted, then we may go for blasting these holes together. So, this will be the delay number 2, then all these holes will be delay number 3, 4, 5, 6, 7 and this one will be of 8.

So, similarly this one is of 3, 4, 5, 6, 7 and this may be of 8. So, this will be the delay sequence for all these holes to achieve this extended V cut pattern if you see the section of the holes. So, this is 10 meter, this is sub drilling of 2 meter. So, this is of 12 meter will we drill will we provide the explosive up to 8.4 meter.

So, this is the ANFO column of 8.4 meter, this will be the steaming, we will carry out the steaming of remaining portion; that means, 3.6 meter steaming and this will be charged with 250 gram of booster. So, our requirement is this is the blast design, this is the section of the hole and this is the surface connection of the blast. So, you can understand now if we need to fulfill the production target, then we can solve a similar problem like this way and finally, we have to give the management this surface plan of the blast and the section of the hole how the explosive will be placed.

There may be discharging or there may be different types of situation, but that has to be replaced in the section of the hole and the surface connection must be replaced must be represented in this plan view.

So, the blast design or blast pattern presentation of blast pattern or blast design means one has to give these 2 figure along with the calculations which are already shown to you. So, let us in this class at this point, we will do a similar exercise for the underground blasting situation in the next or final class.

Thank you.