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

Lecture – 37
Problems – 1

Let me welcome you to the 37th lecture of Drilling and Blasting Technology course. In fact, we have already covered all the theory part which are within this syllabus that is already covered in the last lecture. So this 37th, 38th, 39th and 40th this 4 lecture, in this 4 lecture we will solve different problems which we have already discussed during our theory part. So, initially we will start in this lecture, we will start with the problems of determination of penetration rate, drilling rate then, how can determine the number of drilling basing requirements all this will be solved in this particular class.

So, let us start on discussing about the penetration rate and drilling rate if you can recall, while we have carried out this lecture in our earlier classes, that time we have already discussed that penetration rate is basically the rate of penetration; that means, the first are the drill bit is propagating through the rock mass that is called the rate of penetration.

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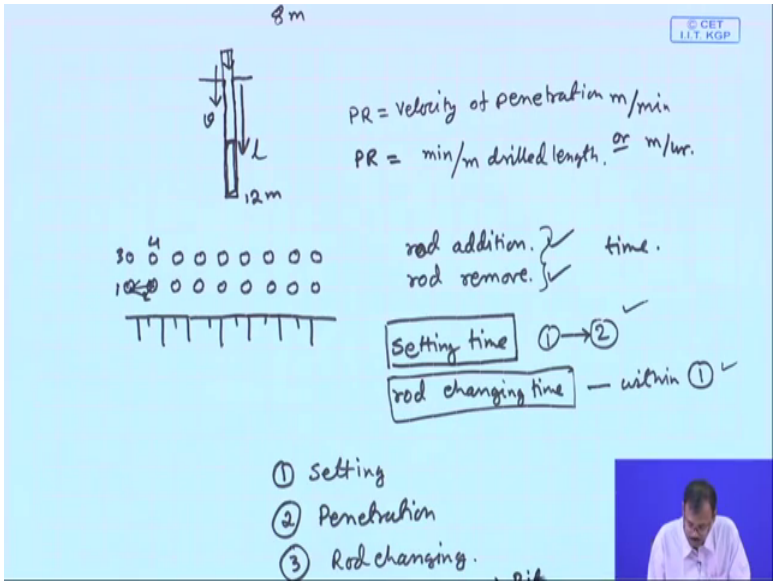

So let us see, in this case if you are considering that if this is the hole to be drilled by the drill machine the speed at which, the drill bit is moving inside the rock mass is called penetration rate.

So, penetration rate is nothing, but the velocity of penetration that means it should be expressed in terms of meter per minute or meter per hours something like that. Often it may be discussed in some opposite in inverse term that means, that penetration may be defined as velocity or inverse of velocity that is time required to achieve 1 meter of drilled length.

However if you are practically looking into the drilling of holes specially for the blast excavation you will find out. Generally, if this is the face, this is the blast face for a surface excavation case, then a number of holes has to be drilled in this face and that may be in multiple row also. So, a drill machine has to drill this hole first then, maybe this one, then maybe this one, then maybe this one. So, like that way the drill machine has to move and drill a number of holes in a particular face.

So, it is not only the drill machine required to penetrate the rock mass to achieve the drill length of l, but also it need some time to move from one hole to another hole again the inserting of one rod along with the other rod; that means, if the drill machine starts with a drill rod say this is of 12 meter length and the drill machine is possessing a drill rod of 8 meter length, then one rod has to be added with another drill rod. So, that the complete hole length can be drilled.

So, that is why there maybe rod addition, there may be removal of rod from the drill mass which is the essential requirement while the drilling is carried out. If the drill length is shorter then one road may be sufficient, but this road addition or removal of the rod addition additional rod takes some additional time. So, additional times are required in the movement and that time is called setting time the movement of the drill machine from it is 1 position, position 1 to position 2 that time requirement is called setting time. The rod addition deletion is called drill rod changing time and this is carried out during the drilling of 1 hole.

So, these are the delays occurs into the drilling total activity and this time delays are required to be included while we are considering the total complete drill cycle. So, a complete drill cycle is essentially having, first the initial setting of the drill machine on the position, second is the penetration. If the penetration is carried out only by single rod then this rod changing time is not there, but if additional rod is required for carrying out the drilling then. The delay may occurred because of the rod changing, then there

may be other delays and these delays maybe because of the bit changing, drill bit changing because of the jamming of rod, flushing. So, all these are the other delays associated in a drill cycle.

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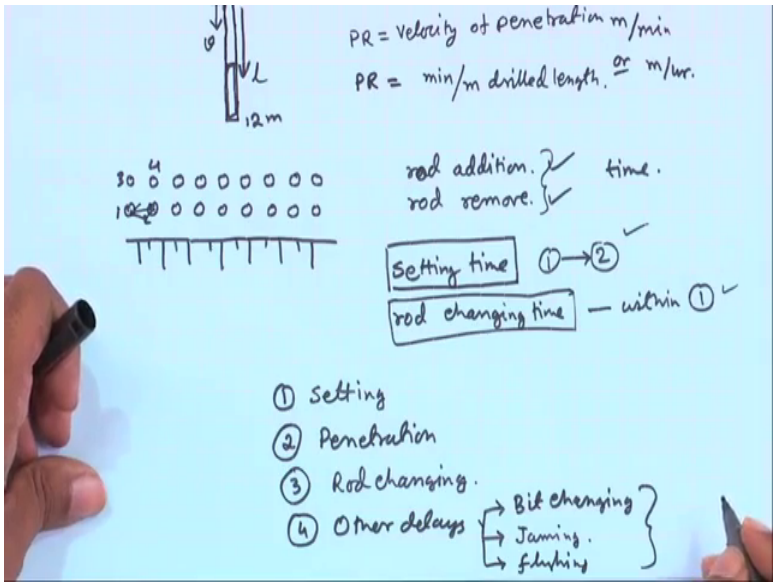

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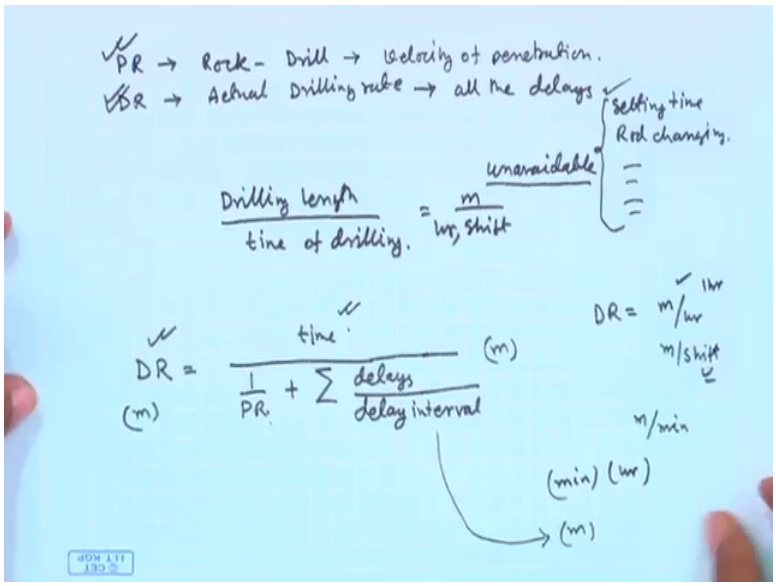

So, basically penetration rate which is nothing penetration rate which is nothing, but the interaction rock drill interaction depends on that the penetration rate is nothing, but the velocity of penetration whereas, drill rate is basically the actual drilling rate which is achieved considering all the delays which are unavoidable. So, this setting time, setting

time, rod changing time, flushing all these delays are the non penetrating hours, but these delays are unavoidable.

So, these delays are unavoidable and that is why though these are non productive, but their time must be considered and that is why penetration rate, which is the speed of the penetration is basically the higher value of the drilling rate and drilling rate may be defined as the length of drilling achieved drilling length achieved, divided by the time of drilling; that means, it may be the meterage of drilling carried out in a long hours maybe a shift or maybe 1 hour like that way, in which we consider all these delays.

And considering these the drilling rate may be estimated using this formula. Time divided by 1 by penetration rate plus summation of delays and divided by delay interval. So, this time is basically the time for which we want to know the drilling rate. So, this drilling rate is in meter and it may be considered DR is equal to in meter per hour or meter per shift, if we are considering this time is 1 hour, then it is meter per hour and if it is say shift hours this time is shift hours then it is shift.

So, basically the unit which is being expressed here is basically meter, but this can be expressed in meter as meter per hour or meter per shift by considering that time. Whereas, PR is the speed of the penetration expressed in meter per minute or meter per hour as the time, time you need we are considering in this case in the same unit it has to be expressed because this time unit and time unit must be cancelled and that is why it will be expressed in terms of meter only.

And simultaneously these delays will be also expressed in terms of minute or in hour, as we are expressing in the above one and the delay intervals must be in meter. So that the meter will remain in that up positions so that the delay interval can be expressed in meter.

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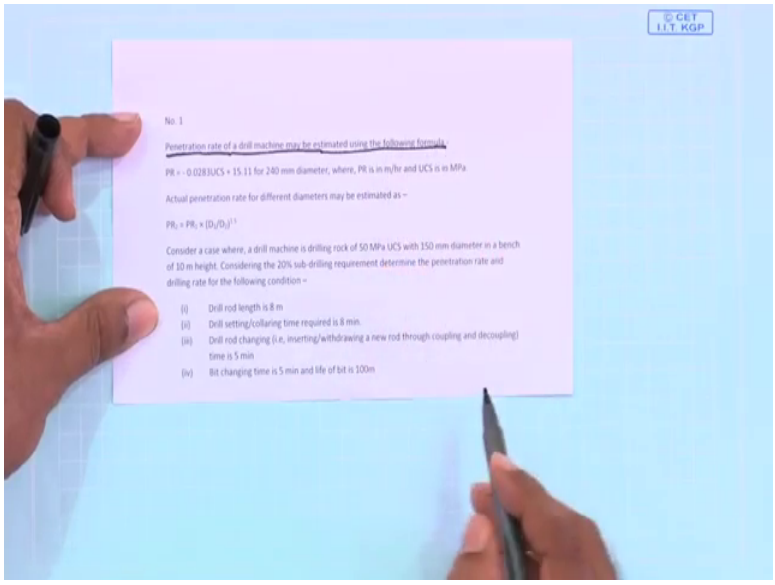

So, suppose how we will can we can use this formula if we solve one problem then probably it will be better for you to understand. So, let us consider this problem, in this problem it is expressed the penetration rate of a drill machine may be estimated using the following formula.

So, it is understood that penetration rate is a function of rock property and the machine parameter and it also depends on the diameter of drilling.

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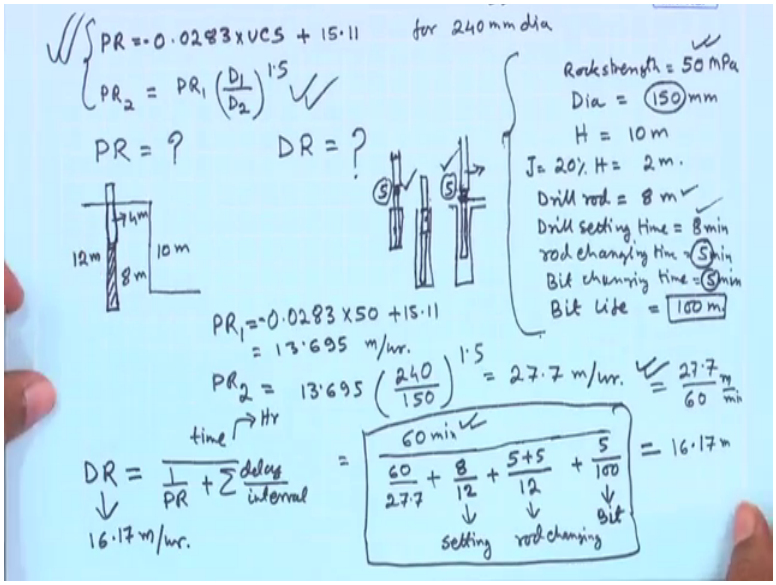

So, this property this formula which is given the penetration rate the penetration rate is given as the formula, 0.0283 uniaxial multiplied by uniaxial compressive strength plus

sorry there is a minus ahead plus 15.11 for 240 mm diameter hole for a rotary percussive drilling.

It is also expressed that penetration rate for that particular machine rock interaction varies with the diameter using the formula. So this is one formula, which is already given in this problem and the problem says that a drill machine is drilling the rock of 50 MPa. So, the rock strength is given 50 MPa, this is 50 MPa rock strength is given diameter of drilling is given 150 mm. So, this is the 150 mm diameter, bench height is given height of bench is given 10 meter, sub drilling requirement is given 20 percent of H.

So; that means, sub drilling requirement is 20 percent of H; that means, it is 2 meter, the drill rod length is given 8 meter, drill setting time is given 8 minute, rod changing time is given 5 minute and bit changing time is given 5 minute whereas, bit life is 100 meter. So, this is 8 minute meter, 8 minute, 5 minute, 5 minute, 100 meter.

So, this is the problem which has to be solved and we need to determine, what is the penetration rate? And what is the drilling rate? So, let us understand the situation this is the bench of 10 meter, we need to drill a hole of 10 meter plus 2 meter; that means, this is 12 meter in which we have our rod length of 8 meter; that means, we need to use one rod of 8 meter then another rod whose 4 meter will be used for drilling.

So, there will be an inserting of rod after 8 meter of drilling and then again while we are withdrawing this rod in the upward direction, that time the rod has to be again removed to while we are taking out this rod. So, first the 8 meter will be drilled then another rod will be inserted here and then this will be extended to 12 metres. So, this will be the 8 meter rod, this is the next 8 meter rod up to 4 meter of this is inserted.

So, this for inserting this one 5 minute is required and while we are taking it out again for withdrawing this one. The second rod will be removed away by holding this one, while we are withdrawing this rod from this. So, again 5 minute is required for this rod changing. So, basically this rod changing time is required 5 minute for one's 5 minute for another one's. So, 10 minutes are required for drilling for rod changing in drilling 1 hole.

So, let us start the start solving this problem penetration rate is directly given for 240 mm diameter using this rock strength we can achieve that PR for 250 m 240 mm diameter, it is 0.0283 minus 0.0283 into 50, where UCS is expressed in MPa plus 15.11 and that

gives us a value close to 13.695 ok. So, this is the penetration rate expressed in terms of meter per hour.

Now, our diameter requirement is 150 mm and as it is 150 mm you have to use this formula for converting this to considering this is PR 1 now our PR 1 is equal to 13.695, D 1 is 240 divided by 150 to the power 1.5. So, it is now we are getting around 27.7 meter per hour. So, this is the penetration rate we have computed using this two penetration rate formula provided to us based on the different drilling experiment by the manufacturer.

Now, we have to find out the drilling rate as we have observed in our few minutes back drilling rate is basically the time divided by 1 by PR plus summation of delay by delay interval. So, in this case let us consider this time is in hour. So, basically this delay time is in hour, means it is 60 minute and penetration rate is 27 meter per hour; that means, it may be considered 27 by 7 divided by 60 meter per minute. So, you are basically converting it into the same scale. So, it is 1 by PR, so 1 by 27 by 60.

So; that means, we can consider it is 60 by 27.7 plus summation of the delays and as we know our delays are like this, we are having one delay is of setting drill setting and that is 8 minute and setting has to be carried out in every 12 meter of drilling because, from one hole to another hole we have to move. So, this 8 meter delay time is required in every 12 meter of drilling length so; that means, the setting time delay for setting is 8 minute by 12 meter which is for setting delay for setting.

Similarly, for rod changing it is 5 plus 5, 5 for the inserting this 5 while we are taking it out another 5. So, 5 plus 5, 10 minute as we observed here rod changing time is 10 minute 5 plus 5 again that 5 plus 5, 10 minute delay time for rod changing is required for every 12 meter of drilling. So, this is delay for rod changing.

Then the final one, the 5 minute delay because of the changing of the bit is required while the bit life is 100 meter. So, this interval is also given 5 minute delay for every 100 meter of length ok. So, this is the essential requirement we should consider in this case and that is why this delay is 5 by 100 that is the total delay, which is coming this one and if you solve this one, the meter you will get considering this total expression this is for bit changing, the value you will get is 16.17 meter. So, as it is for 60 minute we can say the drilling rate is basically 16.17 meter per hour.

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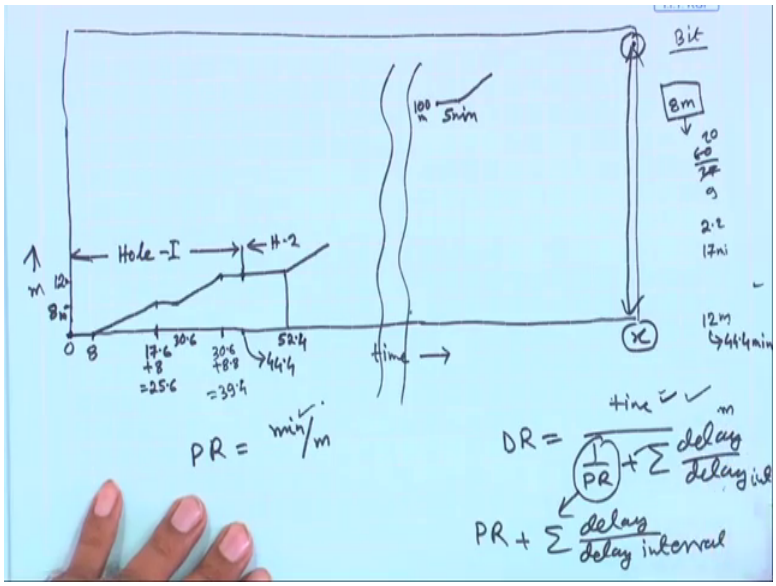

So, this is the basic idea about determining the penetration rate and the drilling rate; however, let us understand this in a better way if we draw the time diagram for this. So consider, consider this is the meter of drilling and this is the time. So, let us consider at zeroth time, we start our machine and we need as we have discussed, we need 8 minute, we need 8 minute to set the machine on it is own position.

So, there is no drilling in this 8 minute then we go for then we go for penetrating for 8 meter 8 meter we are penetrating and for using that 8 meter drill rod. So, for this penetrating 8 meter our penetration rate acts as the penetration rate is around 27 meter per hour so; that means, you can consider it takes around 4 and half minutes per meter.

So; that means, sorry it is it is taking around 60 by 60 by 27. So, this is coming around 9, this is 20. So, around 2.2 minute per meter so; that means, for carrying out 8 meter drilling it takes around 17 minute, 17.6 minute. So, it drills say this is 17.6 minute and this value is 8 meter. So, 8 meter drilling will complete in 17.6 plus 8. So, it is 25.6, this is 25.6 at his 25.6 minute time the 8 meter of drilling will be completed.

Then we need 5 minutes. So, this is the 5 minute time is required for adding the rod. So, this 5 minute time means it is, 30.6 minute then we will again go for drilling 4 meter. So, it will take around 8.8 minute. So, the next 4 meter so, this 4 meter, this is 12 meter. So, this 4 meter will complete at this position and let consider this is plus 30.6 plus 8.8. So, this will gives us around 39.4 minute.

So, at 39.4 minute time, we will complete 12 meter of drilling then, we will again withdraw the rod and this road will be withdrawn and 5 minute additional time is required for again taking out the additional drill rod. So, the drill will complete of 12 meter at this position which takes us 44.4 minute. So, for one hole of 12 meter, 12 meter hole we will complete at 44.4 minute time after starting the drilling by from initiation of the setting.

So, this is for one hole then again 8 minute of setting time is required this, 8 minute of setting time is required for the second hole. So, it will become 52.4 while, we start the drilling of the next hole like this. So, this is hole 1 up to this is for hole 2, we start this one and by this way when our say let us have the continuity suppose when we complete our 100 meter drilling that time, we have to add 5 minutes as additional for changing the bit for bit changing, this 5 minute will be added then again the penetration will be continuing in this case.

So, while we are ultimately considering this total time cycle, we will find out up to some X time. This much of drill length is achieved and which is basically expressed by this formula drilling rate is equal to time by 1 by penetration rate plus summation of delay by delay interval. Please note here if the penetration rate is expressed in minute per meter, then it must be replaced by PR plus summation of delay by delay interval.

So, basically this units should be matched, if it is minute this must be expressed in minute. If this is in, hour then it must be in hour. So, that units must be matched and ultimately this time unit will be cancelled from this one and this one and the length unit that is meter will stand at this position. So, while someone is applying this formula he must be careful for using this one. So, we will continue with the penetration rate and drill rate in the next class also.

Thank you.