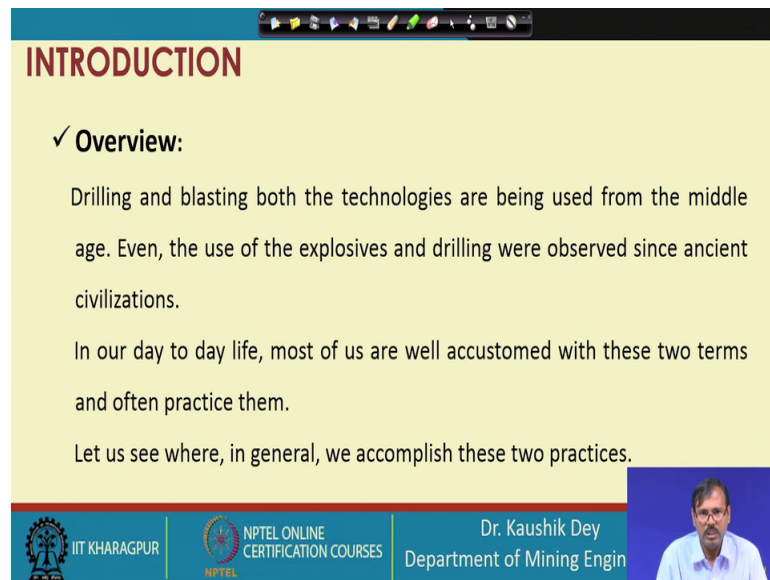


Drilling and Blasting Technology
Prof. Kaushik Dey
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Indian Institute of Technology, Kharagpur

Lecture – 01
Introduction to Drilling Technology

Let me welcome all of you to the introductory class of Drilling and Blasting Technology. Basically this course is a first level course. This course is now being offered for either to learn afresh or to refresh your knowledge whoever already passed out this subject.

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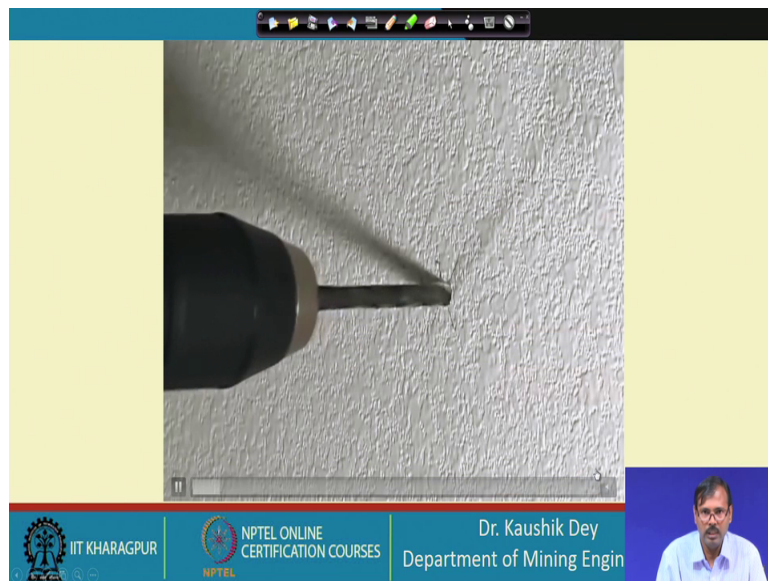
The slide is titled "INTRODUCTION" in red text. Below the title, there is a section labeled "✓ Overview:" in black text. The text in the overview section reads: "Drilling and blasting both the technologies are being used from the middle age. Even, the use of the explosives and drilling were observed since ancient civilizations. In our day to day life, most of us are well accustomed with these two terms and often practice them. Let us see where, in general, we accomplish these two practices." The slide has a yellow background and a blue header. At the bottom, there are logos for IIT Kharagpur, NPTEL Online Certification Courses, and a photo of Dr. Kaushik Dey, Department of Mining Engineering.

Basically let me share you about the overview of this course. The movement we are talking about drilling and blasting, something comes into your mind say these two terms are very common and all of you are very accustomed with this term. Drilling means all of you know that you are basically drilling something, creating a hole, blasting means you are exploding something.

If you look into back to our history, we will find out the drilling and blasting both the technologies people were using very commonly since the middle age. Even history says that the explosive and drilling, both were used in the ancient civilization also. If you look into the method that first drilling is carried out in the field to tie the cattle's by drilling a hole, by hitting the bamboo or a wooden piece in to the ground, soft soil by hitting it on above it.

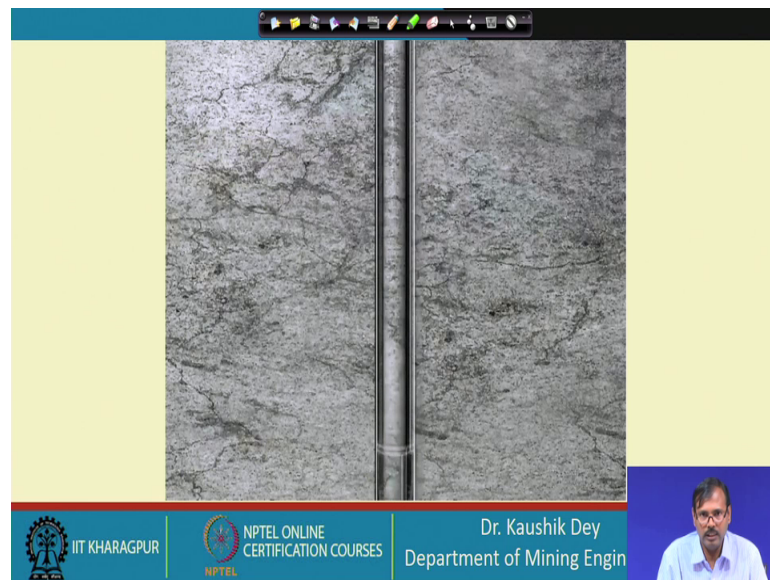
So, these are the raw technology were carried out in the ancient time to create the drilling and later on, it is modernized and nowadays we are carrying out very huge drillings and still if you are looking into the matter that you will find out in our day to day life, we are using this drilling often in regular basis. So, let us see how in general we are accomplishing these two practices and as there are two terms drilling and blasting, let me introduce to the first, introduce you to the first term that is the drilling.

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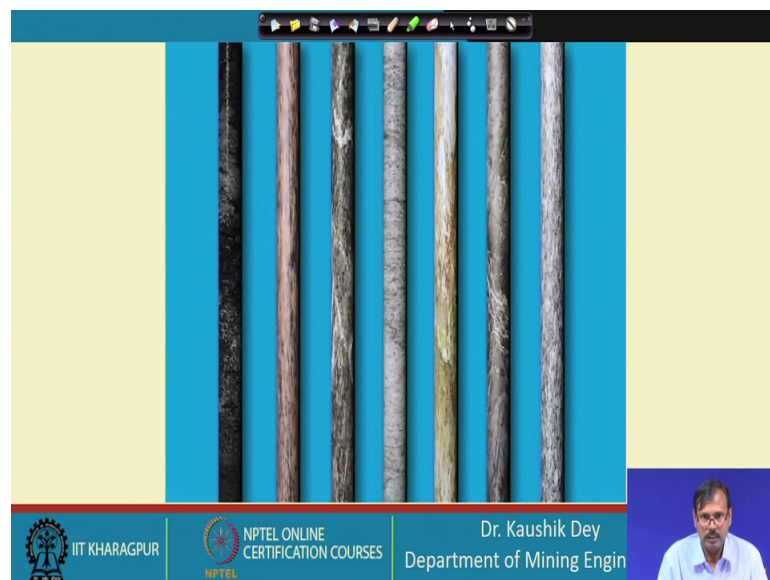
So, let us get some knowledge about drilling, say this is the drilling we are carrying out for creating a hole in wall.

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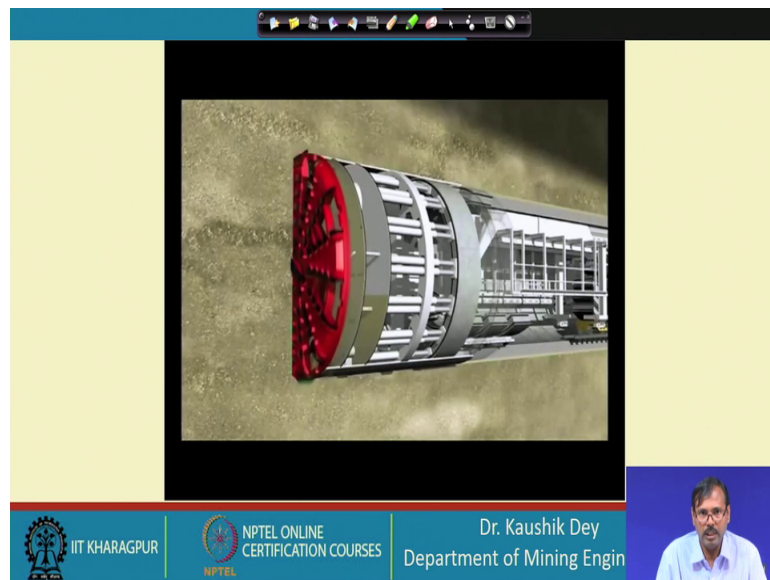


Then, this is the drilling you are carrying out for taking the rock code samples, then we are, these are the samples we are taking out.

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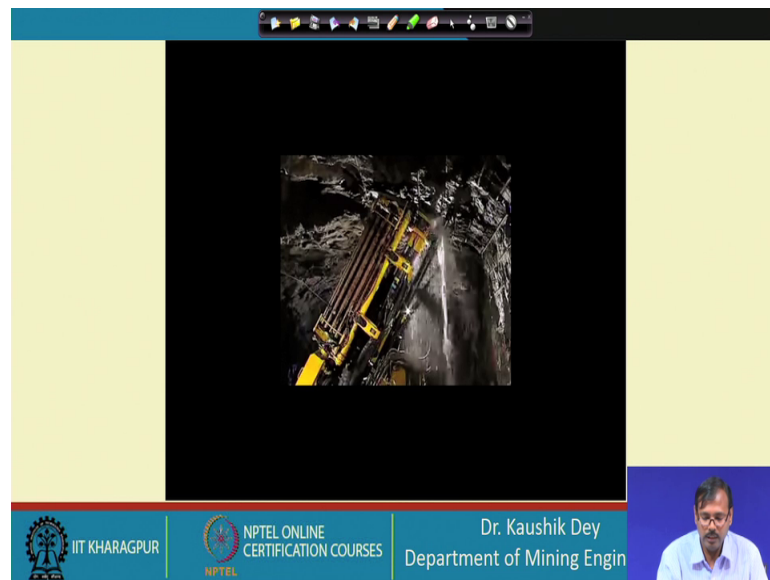
Then, this is a very large drilling which is carried out to develop the tunnel.

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This is the drilling we are carrying out for creating a hole in the rock so that can be blasted.

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So, basically drilling is being carried out for several purposes, several uses are there.

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INTRODUCTION

✓ **Drilling Overview** contd.:

So, we can understand that drilling is basically the technology of creating a hole.

And the challenges are lying in the technology of creating a hole with, the variable factors like, 'diameter of hole', 'length of hole', 'driven through what medium', 'how fast the holes will be driven' and 'what is the economics'.

Drilling we are carrying out drilling for excavating the rock by creating a space for placing the explosive, drilling we are carrying for tapping the water, drilling we are carrying for supporting the structure. So, like that way you are carrying out drilling in different way in different places.

Let us see where our technology is nowadays going? If you see we are trying to drill something, we have to select some machines, we have to carry out drilling, but the

challenges are that we have to decide what should be the diameter of the drill, we have to decide what should be the length of the hole, we have to decide, we have to drive the drill hole through which it may be a soft soil, it may be a rock, it may be very hard rock, it may be through a metal casing and these are the problems we have to address while we are thinking of drilling something for some special purpose and we have to consider all these things while we are thinking of the drilling how fast we have to drill it because these are time limit jobs. Then, what is the economics if we are spending more on the drilling? Then, it may not be accepted one in the other site, it may not be accepted by the client. If we are spending more suppose we are trying to drill one oil rig and if you are spending more on drilling the oil rig, then the project may not be successful.

So, people may not be interested of drilling the oil rig if the drilling cost is very high. So, all these parameters are basically creating the influencing the different factors while we are deciding something.

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INTRODUCTION

✓ **Drilling Overview** contd.:

With the invent of modern machines, fantastic achievements are observed.

Worlds longest drilled hole: **Sakhalin-I Odoptu OP-11 Well** (offshore the Russian island Sakhalin) – Oil borehole, 12,345-metre-long made in 2011



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As this is the overview, let us see how far we have achieved so far. So far we have achieved in terms of drilling technology, you can see the longest drill hole which has been drilled by the human being is Sakhalin-I oil borehole which is 12,345 meters, that means more than 12 kilometers long drill hole has been made for extracting the oil from the site.

So, this has been made in Russia, made by them for offshore oil field and this project was completed in 2011, but you understand that this has some good economic because this drilling cost was sufficiently made up by the recovery received from the oil sectors.

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INTRODUCTION

✓ **Drilling Overview** contd.:

Worlds deepest drilled hole: **Kola Superdeep Borehole** 12,262 metres (40,230 ft) in 1989 and still is the deepest artificial point on Earth. (Experimental)

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There are problems also where you will find that ancient Soviet Union, they have made a drill hole which was completed in 1989 and that is also more than 12 kilometers long. It is 12,262 meters and the purpose of this drill hole is that it is only made for the experimental basis to know the earth crust temperature variation in the earth crust. For all these scientific analysis, they have made this long drill hole and it was taken more than 20 years of drilling and this hole was covered up in the top shield in the top, but still it is existing in 2007 and so far you are considering this is the deepest artificially created point on the earth.

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INTRODUCTION

✓ **Drilling Overview** contd.:

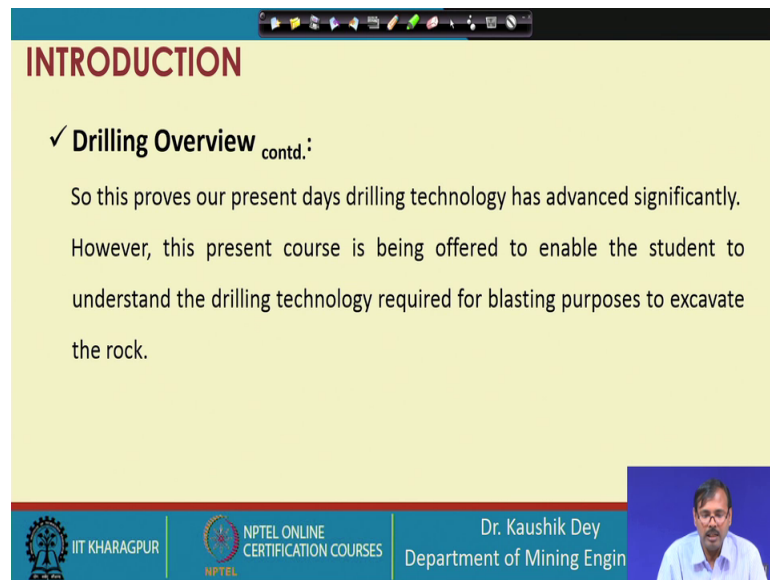
Worlds biggest (diameter) drilled hole: **Orlovski Tunnel, Russia** 19.250 metres
(diameter) in 2011 and driven by TBM

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So, that means we have significantly achieved that considering the depth of drilling, but if you are considering the diameter of the drilling, then the tunnel boarding machine which is a special type of drill machine designed for the horizontal drilling, they are creating huge excavation in the horizontal drilling and the picture which is shown to you now this is a picture of Orlovski tunnel of Russia which is having a diameter of 19.25 meter. You can observe that there are 3 tier roadways that is 3-line roadways are available inside the tunnel and that is in 3-tier basis.

So, this is the largest diameter drilling example in this world. So, that means not only in the depth, but also if you are considering the diameter of the drill hole, we have achieved significantly. That means, the present days technology which are available to us can drill huge diameter holes, can drill huge length of holes and that is why it is now in our hand that we can use this drilling technology suitable for our different use, but our present topic is related to the drilling which is required for the excavation purpose.

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INTRODUCTION

✓ **Drilling Overview** contd.:

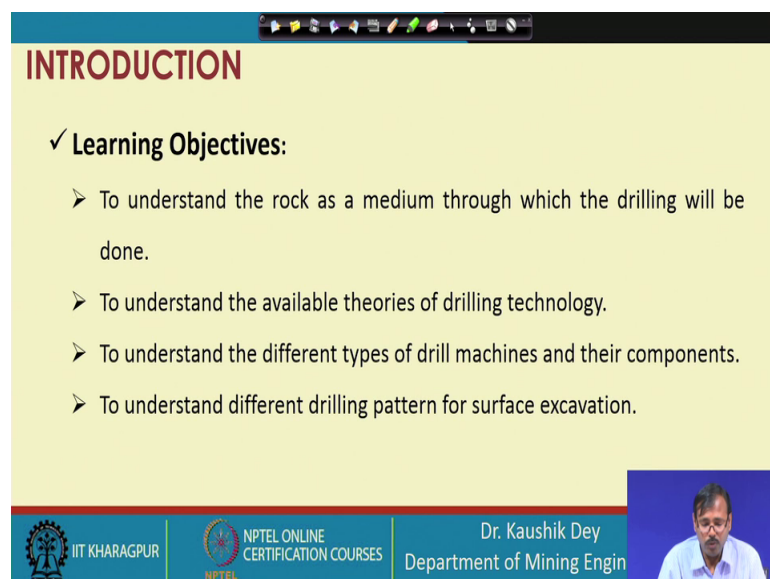
So this proves our present days drilling technology has advanced significantly. However, this present course is being offered to enable the student to understand the drilling technology required for blasting purposes to excavate the rock.

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What is this excavation? Excavation means we need excavating the rock for different purposes. It may be the excavation requirement for taking out some minerals from the mine, it may be the excavation requirement for trenching purpose, it may be the excavation requirement for taking creating some underground space. So, this excavation requirements are the requirement of the civilization where we need to address the space for the human beings or the different purpose of human beings.

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INTRODUCTION

✓ **Learning Objectives:**

- To understand the rock as a medium through which the drilling will be done.
- To understand the available theories of drilling technology.
- To understand the different types of drill machines and their components.
- To understand different drilling pattern for surface excavation.

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So, this course is basically designed for giving you the knowledge about the drilling in which you will learn that how the drilling is being carried out, but everything is for the rock excavation purpose. So, if you look into the learning objectives that in this course, what is the objective of our learning specifically for the drilling technology, then you will understand that this course is designed, so that the student should understand what the rock is which is acting as a medium through which we are carrying out the drilling. That means, we have to carry out the drilling, but the drilling has to be carried out in the medium, it may be if you are carrying out a drilling in the wall, then the wall is the medium. If you are carrying out a drilling in the rock, then rock is the medium and if you are carrying out the drilling in the soil, then the soil is the medium.

So, as we are pointing towards the excavation of the rock, that is why this subject is drilling and blasting. So, this drilling is basically for excavating the rock where we are providing the space further explosive and that is why this drilling is creating in the rock only and that is why this rock is the medium. So, first we need to understand what rock is, so that we can consider that rock as a medium; depending on the characteristics of the rock, not on the type of the material, but depending on some physicommechanical properties of the rock, so that it can be considered as a generic medium.

The second learning objective is that we should understand the available theories of the drilling technology say there are different, basically drilling is the creating of hole by the interaction of a tool and the medium. This tool is nowadays basically the mechanized cutting tool. That means, the metal based cutting tool. So, this metal based cutting tool is basically acting on to the rock medium and their interactions are basically resulting into the hole.

So, basically we have to understand how this rock is a drill tool and the rock are interacting with each other and how we are applying the force on to the rock tool, so that the holes can be made. So, that is why the understanding of these theories of drilling technology is very important and we are covering this objective in this subject. Second is, next is that understanding the different types of drill machines and their components.

In fact, there cannot be one generic machine which can address all the needs of different types of drilling. So, drilling can be classified based on its diameter, based on its length, based on its purposes. So, all these based on based on what? Rock is medium and it is a

passing through. So, there are different influencing parameters. So, one generic drill machine cannot address all the requirements.

So, what is our need? We should know for which condition which type of drill machines are required and how they can be deployed, how they can be designed. So, this objective will address that purpose, so that the student will understand; what are the different types of drill machines are there, what are their components and how those components are working for creating a drill hole.

The next is the understanding of different drilling pattern which is essentially required for the surface excavation. So, now basically it comes that how we are placing our number of holes in the rock mass, so that we can get an easier way to excavate the rock. So, basically this is the positioning of the drill holes, this is the alignment of the drill holes. You should understand the requirement of this; you should understand the designing of this in this objective.

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INTRODUCTION

✓ **Learning Objectives** contd.:

- To understand different drilling pattern for underground excavation.
- To calculate the performances of a drill machine
- To calculate the economics/financial appraisal of drilling technology
- To select the most suitable drill machine.

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Next objective is to understand the different drilling pattern for the underground excavation. The earlier one is for the surface excavation. The next one is for the underground excavation. There is a characteristic difference between the underground and surface excavation. The main difference is that in the surface excavation, we are having two open faces. One is in the top one direction and another is the front direction

whereas, in the underground excavation purpose only one face is available, that is the top portion is blocked.

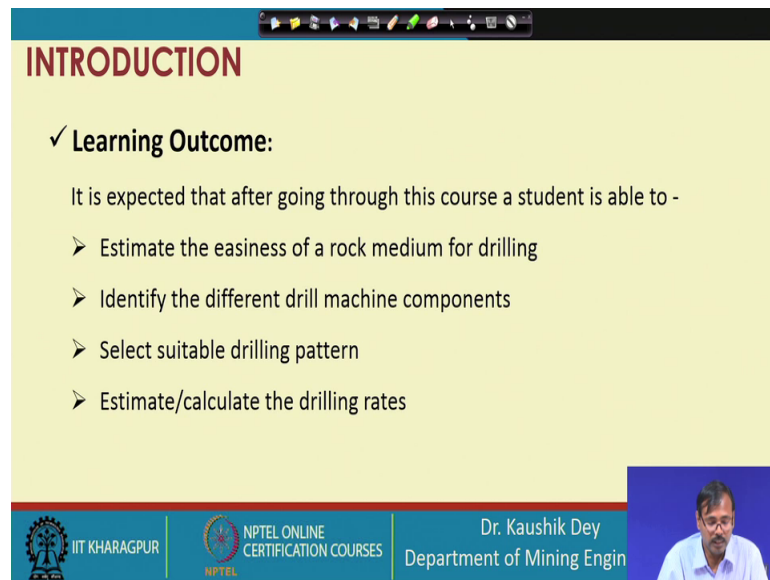
So, that is why the drilling pattern system requirement is entirely different from the surface to the underground. Next is that say we are deploying drilling machine. Now, we know which drilling machine has to be deployed, what will be the drill requirement, how many is the drill requirement, but we should know the performance of a drill machine. That means, if we are deploying x machine on to the y rock in z condition, then what performance that x drill machine will give if the condition will be different. Obviously, the same drill machine will give the different result in that case. Similarly if you are deploying a different drill machine on that y condition x rock and z condition, obviously that performance will be different.

So, the student should understand that how to calculate the performance of a drill machine while you are trying to deploy that machine, so that can finally come into the design part of the machine.

Next is the important one that is the economics or financial appraisal of the drilling technology. We are excavating rock for addressing some economical benefit. So, this is our requirement, we are addressing the rock, we are excavating the rock for addressing some purpose and that is why obviously this should be profit making one. So, our drilling technology should not be a costly one, so that our total excavation cost became more than the return we are assuming from that excavation. So, that is why this economics or financial appraisal of the drilling technology is very important here. We need to know how to calculate the different heads of the accounts like say earning cost, operating cost, manpower cost and overhead cost. All those costs has to be calculated to identify the financial appraisal of a drilling technology.

Then, the most important one which is essentially required, that for a requirement of an excavation situation, how we will select the most suitable drill machine. So, that will address the performance that will address the financial constant in that particular case.

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INTRODUCTION

✓ **Learning Outcome:**

It is expected that after going through this course a student is able to -

- Estimate the easiness of a rock medium for drilling
- Identify the different drill machine components
- Select suitable drilling pattern
- Estimate/calculate the drilling rates

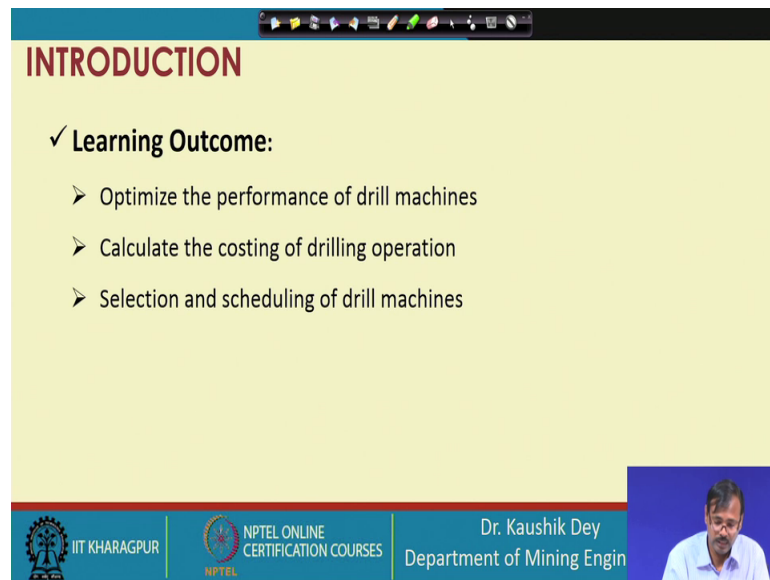
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So, this is the essential requirement and I expect that while a student is able to attend this course, he must estimate the easiness of a rock medium for drilling. He must identify the different drill machine component, so that he can address how those components are creating the holes, how these components are performing during its life time, what are the requirements, which components are more consumables, he should be able to select a drilling pattern, which type of rock medium, which type of drilling pattern should be adopted in case of surface excavation, in case of underground excavation, how this drilling patterns will be selected, what will be the effect if the conditions are very erratic, if the rock strengths are erratic throughout the drill length, how that can be handled. All those requirements selection, requirements has to be addressed by the students after passing out from this course.

This is important that he should estimate, calculate the drilling rate, so that he can schedule the drilling job, he can schedule the manpower requirement, he can schedule a drill machine allocations in different places and that is why this drilling rate estimation is very important.

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INTRODUCTION

✓ **Learning Outcome:**

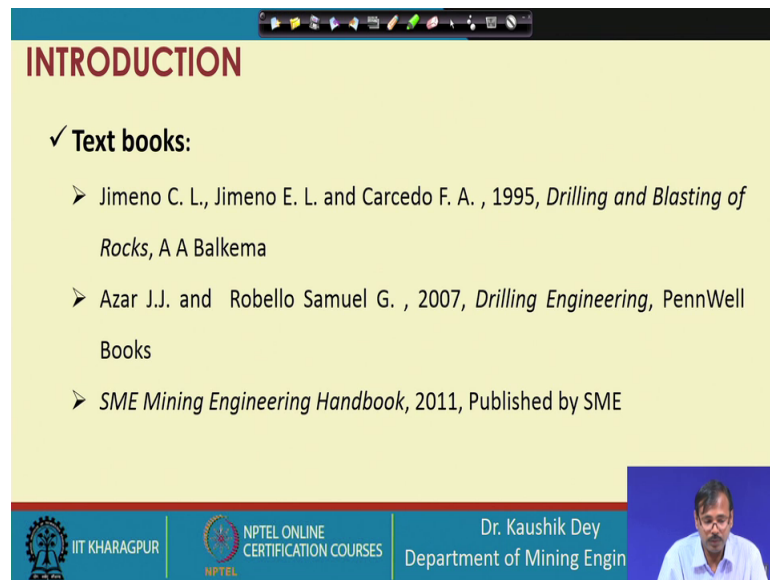
- Optimize the performance of drill machines
- Calculate the costing of drilling operation
- Selection and scheduling of drill machines

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Optimization of the performance of the drill machines are very very important and this can be done only by selecting a suitable machine for a suitable rock type. This can be only addressed if a student is selecting the drill machine, allowing the drill machine to operate on a proper condition say like the fixed pressure given must be of fixed type, then the fixed pressure given must be of that required type, the changing of the fixed pressure, changing of the thrust given to the drill beat must be suitable as for the rock condition. All these requirements are there and that has to be addressed by the student. So, he should learn how to optimize the performance of the drill machine. Then, calculate the costing of the drilling operation is very important. Unless and until the unit operation of this drilling technology cost can be determined, then the overall operating cost cannot be determined. So, drilling costing is very important.

Selection and scheduling of drill machines is very important also. This will basically optimize the overall cost.

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The slide is titled "INTRODUCTION" in red text. Below the title, there is a section for "Text books:" with a checkmark. Three bullet points list the following books:

- Jimeno C. L., Jimeno E. L. and Carcedo F. A. , 1995, *Drilling and Blasting of Rocks*, A A Balkema
- Azar J.J. and Robello Samuel G. , 2007, *Drilling Engineering*, PennWell Books
- *SME Mining Engineering Handbook*, 2011, Published by SME

The slide footer contains the IIT Kharagpur logo, NPTEL Online Certification Courses logo, and the name and department of Dr. Kaushik Dey. A small video inset of the speaker is visible in the bottom right corner.

That is why this is essential requirement for the drilling and I expect that after going through this drilling and blasting course, the student, they will get exposed to the learning objectives, then they will get the sufficient knowledge to address the learning outcomes and these are the text books available. Most of them, these books are available in the internet, most of these books are available in most of the libraries, these are online available. These are the text books addressing most of the part of the drilling technology which are being covered here and this is the reference book which the students should follow.

Thank you.