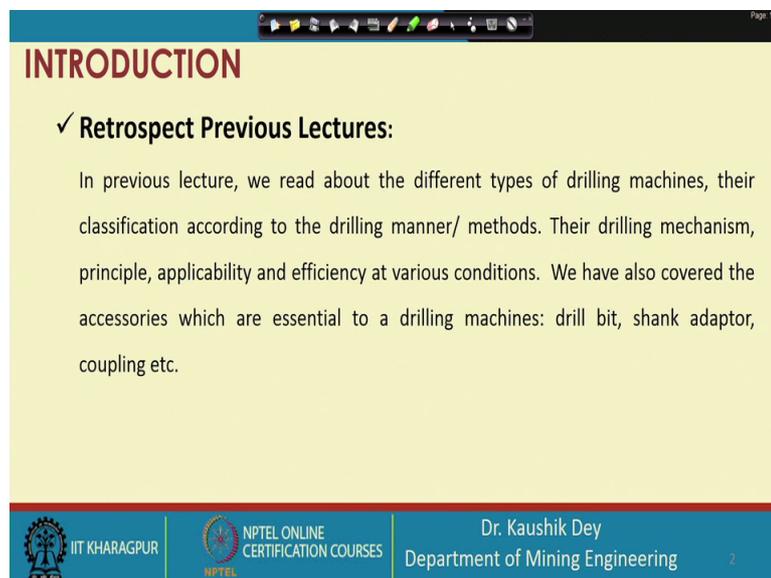


**Drilling and Blasting Technology**  
**Prof. Kaushik Dey**  
**Department of Mining Engineering**  
**Indian Institute of Technology, Kharagpur**

**Lecture - 12**  
**Drilling Pattern - 1**

Let me welcome you to the 12th lecture of Drilling and Blasting Technology course. In this lecture we will discuss about the Drilling Pattern.

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**INTRODUCTION**

✓ **Retrospect Previous Lectures:**

In previous lecture, we read about the different types of drilling machines, their classification according to the drilling manner/ methods. Their drilling mechanism, principle, applicability and efficiency at various conditions. We have also covered the accessories which are essential to a drilling machines: drill bit, shank adaptor, coupling etc.

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Department of Mining Engineering

But like every class let us retrospect the previous lecture. In last few classes we have read about the different types of drilling machines, their classification according to the drilling pattern and manner. They are drilling mechanism principle applicability and efficiency and various condition we are also discussed. We have also covered the accessories which are essential to a drilling machine like drill bit shank adapter coupling. In fact, modern drill machines are almost automated computer fitted, where it is very easy to control, every time machine is interactive with the rock condition.

And the operators are very, very a the very, very expert in operating these machines. If you look into this last 3 part that drill bit shank adapter and coupling, basically a drill machine may change it is diameter of drilling by only changing this 3 part. If they are changing will bit drill rods shank adapter and coupling, then the same drill machine can drill a different diameter drilling and drill length can be extended only by changing this

part only. So, basically one drill machine can be universally adopted for carrying out drilling in different condition, but let us we have already covered this things in the previous classes.

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**INTRODUCTION**

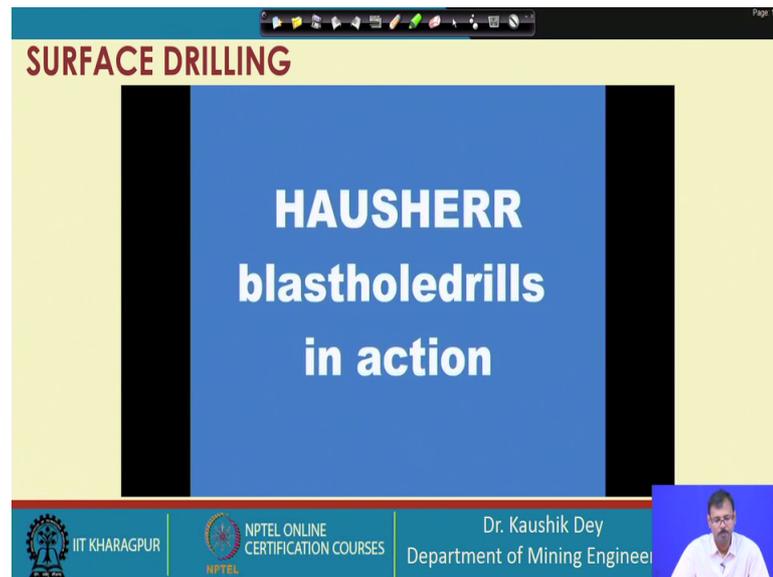
✓ **Learning Objectives :**

- The perspective of drilling in underground drift/ tunnel.
- Various Cut patterns essential for sub-surface excavation.

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Today's in today's class, we will discuss about the drilling pattern and mainly we discuss about the drilling patterns of the underground drifts and tunnels. So, our today's learning objective is the perspective of drilling in under drifts and or tunnels, and various cut patterns essentially required for the subsurface excavation in underground drifted tunnels. We will observe the 2 videos, where we can distinguishly able to define that what is the basic differences in the drilling carried out in the surface and underground condition.

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So, let us go into the next slide and look into the surface drilling video first.

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So, what we do? We carry out surface drilling where we need to carry out blasting, and the explosive has to be inserted in the hole, and in surface we carry out this drilling either vertically or maybe a slightly inclined manner.

So, what is happened? As the surface we are standing on the surface of the rock on the top part of the rock, it is very easy for us to carry out the drilling vertically because we need not to hold the heavy drill rod or dill assembly. So, that is why it is very easy we are

carrying out the drilling in vertically. And the excavations are generally carried out in benches.

That means, the vertically a number of slabs are created which are called benches; benches are basically the rocks slabs, and the drilling is carried out on the bench itself. So, basically surface drilling is carried out on the bench, you can see the mark is given. And the drill rod is kept almost vertically.

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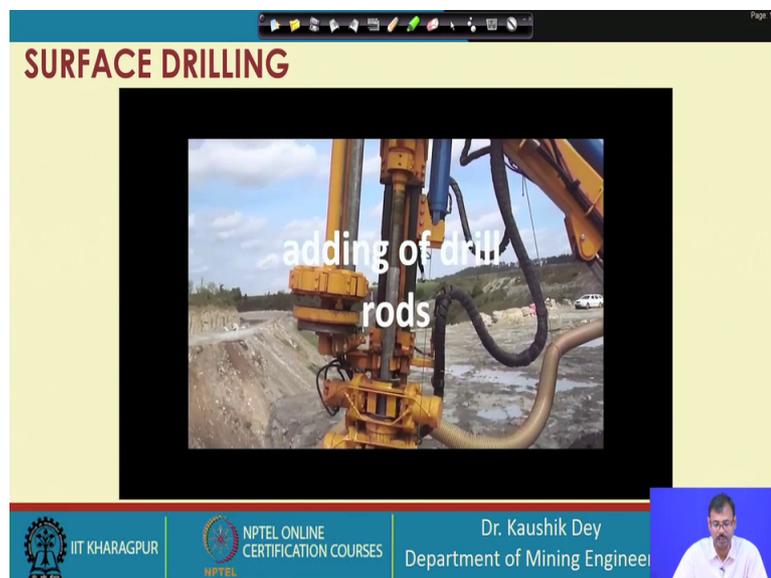
Then the rig is placed on the desired place, and the drilling is carried out either by rotary action or by hammering action you can see, it is a percussive rotary drill; where the percussive action is given along with some rotary action.

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So, mainly the excavation is a drilling is carried out with the percussion, and rotation is given for the rotary action of the drill bit.

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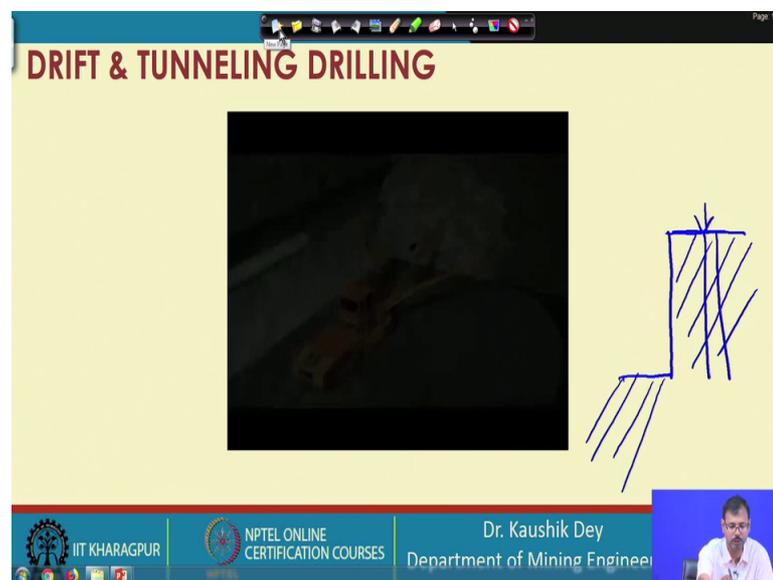


And you can see the flushing media is taking out allowing the rod to come out allowing the chips of rock chips to come out from the hole. So, basically this is the method carried out in the surface where the drilling is carried out either vertically or near vertically. So, it is very easy to carry out drilling in the surface condition, and the main difference between the surface and underground is that, in surface we are having 2 open faces of the

rock self, one is in the top part and another is the front part. You can see the front part you can see the front part, this is the face. So, this front part is free face and this top part is the, another free face. So, there are 2 free faces available for blasting this place while we are carrying out drilling

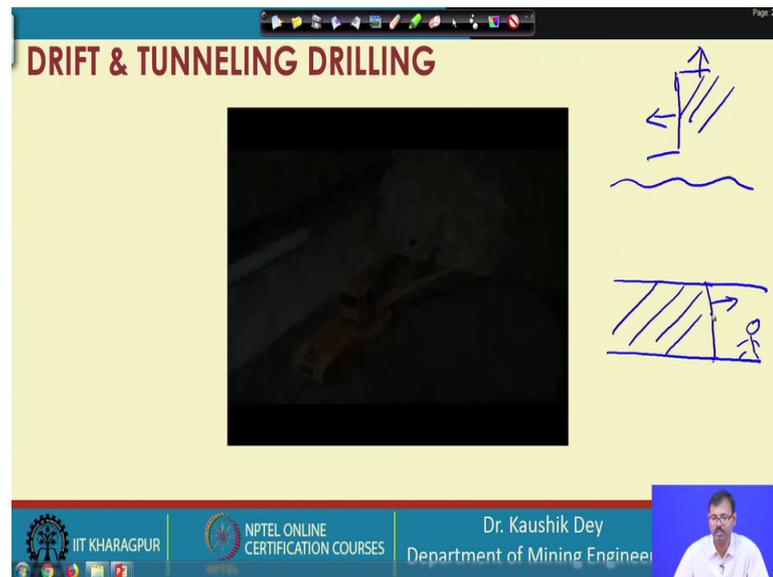
So, basically the surface drilling is little bit different, and if you are comparing that to the underground before observing one such drilling in the underground let us understand few thing.

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So, this is the rock cell, this is the one rock cell, this is another rock cell. So, we carry out drilling in this rock cell so, it is vertically drilling carried out in this rock cell or near vertical drilling is carried out in the rock cell. So, always in surface condition the drilling is carried out vertically.

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But in underground, this is the surface, this is the underground excavation is being carried out. So, unlike surface excavation where there are 2 free faces for this rock cell one is at this side, one is at this side, in the underground condition, the only one free face is available in this side.

So, the condition is little bit different from the surface to the underground, and that is why the drilling system is entirely different. So, let us observe this drilling system from this video. You can see this is the only free face available where the drilling is being carried out with the 4 boom jumbo drill. So, these are the different rigs, multiple rigs are available in this drill machine, and the drilling is carried out from these multiple rigs. Then after completion of the drilling the explosives are inserted into the hole.

You can see the explosive cartridges are inserted and then pushed by the wooden rod. The ladder is used for charging the explosive inside the hole in the top part, then the blasting is carried out, and the rock is excavated.

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**DRIFT & TUNNELING DRILLING**

TYPICAL BLASTING AND VENTILATION TIME: 0.1 - 1 HOURS

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So, new free face is created you can see the new free face is created in this place where that has to be drilled again after removal of this fragmented material.

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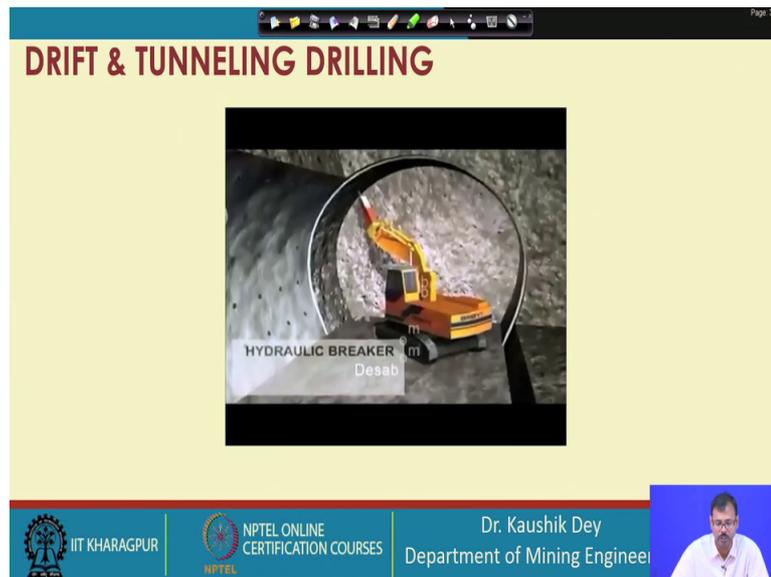
**DRIFT & TUNNELING DRILLING**

LOADING WITH LHD - Retiro de Rezaga

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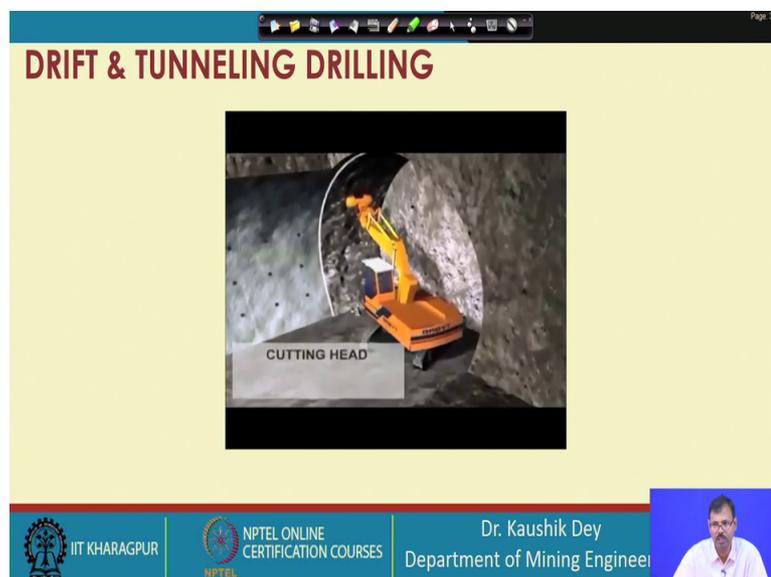
So, this animated videos are available in the YouTube you can observe a number of other videos.

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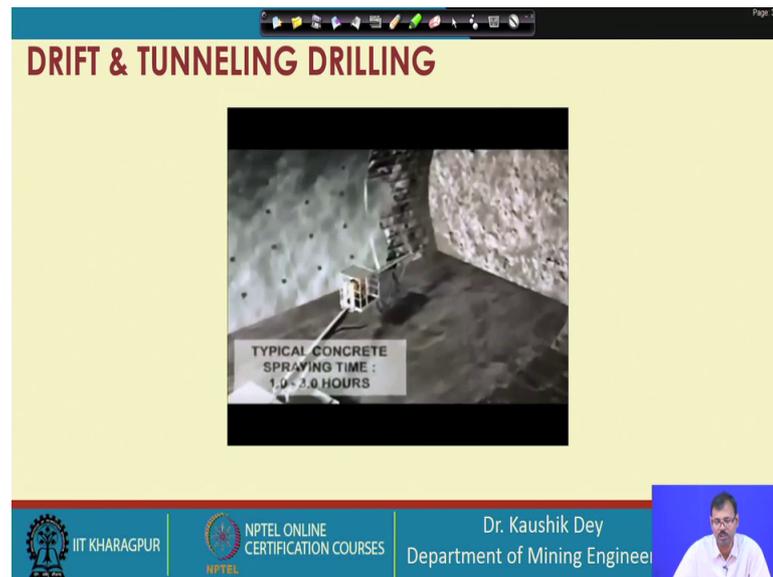
This is the dislodging of the loose rocks are carried out. So, our purpose of is to carrying out drilling in a single face in case of underground; where only single free face is available.

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So, you have to carry out the drilling in that single face only. And the problem is that as blasting in surface mines, there 2 free faces are available, we can throw the rock in front direction.

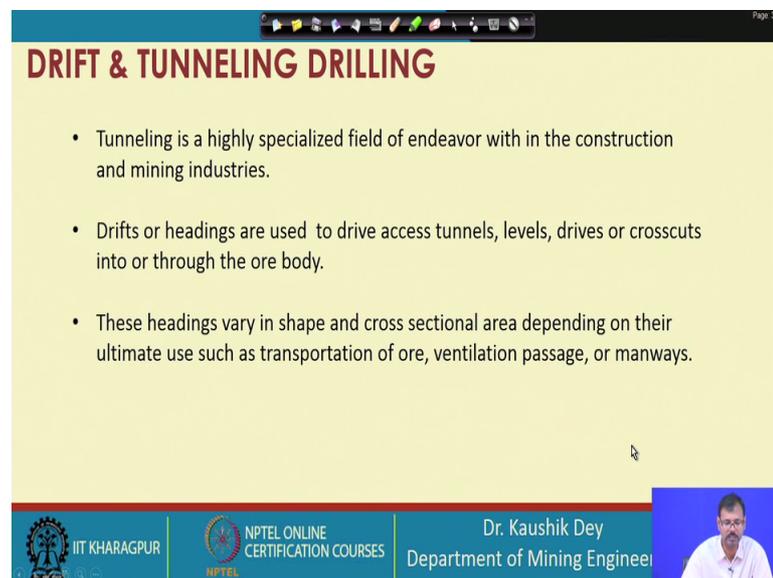
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The slide features a central image of a tunnel interior where a concrete spraying machine is in operation. The machine is positioned on a concrete floor, and a spray of concrete is being applied to the rock walls. A text box overlaid on the image states: "TYPICAL CONCRETE SPRAYING TIME : 1.0- 2.0 HOURS". The slide is titled "DRIFT & TUNNELING DRILLING" in red text at the top. The footer includes the IIT Kharagpur logo, NPTEL Online Certification Courses logo, and the name and department of Dr. Kaushik Dey.

But here only one free face is available. So, the purpose is that we have to create another free face so that the rock can be thrown on that direction.

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The slide is titled "DRIFT & TUNNELING DRILLING" in red text at the top. It contains a bulleted list of three points:

- Tunneling is a highly specialized field of endeavor within the construction and mining industries.
- Drifts or headings are used to drive access tunnels, levels, drives or crosscuts into or through the ore body.
- These headings vary in shape and cross-sectional area depending on their ultimate use such as transportation of ore, ventilation passage, or manways.

The footer includes the IIT Kharagpur logo, NPTEL Online Certification Courses logo, and the name and department of Dr. Kaushik Dey.

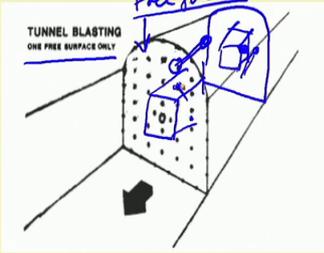
So, let us understand: what is the difference between the surface excavation and the underground excavation. So, these underground tunnels drifts are very, very specialized excavation procedures; where the horizontal excavations are carried out below the ground, for tunnelling it is for the civil purpose, for drifts headings etcetera for the mining purpose.

These headings are very may vary in shape in cross sectional area depending on on their uses.

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**DRIFT & TUNNELING DRILLING**

- The size of tunnel, type of rock and the method of working all influence the cost, but without a careful planned drilling and charging pattern, cost optimization becomes difficult.
- There are several methods which can be used for driving tunnels. For tunnel of small cross section the full face method is adopted, in which blasting round is designed to pull the full cross sectional area of the face in one blast.



The diagram, titled 'TUNNEL BLASTING ONE FREE SURFACE ONLY', shows a 3D perspective of a tunnel face. It features a grid of small circles representing drill holes. A blue arrow points to the top surface, which is labeled 'Free face' in blue handwriting. Below the diagram, the text 'Underground blast face' is written. The slide footer includes the IIT Kharagpur logo, 'NPTEL ONLINE CERTIFICATION COURSES', and 'Dr. Kaushik Dey, Department of Mining Engineering'.

And the largest equipment has to be plying on that depending on that size is also very is also dependent. And the excavation method depends on the size type of rock method of working etcetera. And for that we have to carry out the drilling operations in the mine or in the drift or the tunnels.

So, this is the these are the drill holes that to be drilled inside the rock mosque, where this is the only available free face. This is the only available free face. So, this one free face free surface is creating the confinement of the charge which are placed inside the drill hole the confinement is very high.

Instead, if we are having some excavation like this; where we are having some excavated ground like this, then the holes drilled at this position may utilize this free surface. So, the purpose of underground drift or tunnelling is that first to create a free surface centrally so, that for the rest of the holes this free area free vacated area can act as another free surface, once in the front direction another is in the this direction, can act as a free surface so that the mimicry of the surface excavation can be carried out.

Only in case of surface excavation, it is vertically in nature; here it will be change to the horizontal in nature. So, basically the purpose of underground drilling is that initially it has to be carried out such a way so that the, another free face must be created.

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**DRIFT & TUNNELING DRILLING**

- This method is adopted even up to a height of 10m, unless extremely bad ground requires short rounds. When rock conditions are good, it may even be used for large tunnels, face area of 80-100 m<sup>2</sup>.
- For other conditions, initial full face top heading may be enlarged to final shape and size using split section driving technique.

7/10m  
Surface drilling & Blasting  
1/8  
Bench & Blasting

Top heading and benching for tunneling

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Often what is happened if the dimensions are very high, very large dimension. Say this dimension may be 100 square meter, 80 to 100 square meter. So, this these are of very large dimension in that case a top portion this top portion is only excavated by using a using the similar fashion which is carried out in the underground drifts or tunnels and the rest part is carried out in a surface excavation technique. So, this is the surface drilling and blasting technique is practiced in case this is underground drilling and blasting is practiced. So, these are the different types of modification may be carried out in the underground excavation while it is practiced in the actual field.

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**DRIFT & TUNNELING DRILLING**

✓ **Heading Round**

- Blastholes drilled in the face of a tunnel are collectively known as the round when blasted at a time. They must be drilled and positioned efficiently.

*Drifts*

*APull*

*Advance/round*

FACE

ADVANCE PER ROUND (NORMALLY 90-95% OF THE HOLE DEPTH)

Advance per round of blast

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Now, let us understand some terminology related to drilling. So, consider this is the complete face that has to be blasted in one go. So, in that case we may carry out drilling like this, then this drillings are of different patterns we will discuss that in our next few hour. So, this drilling is carried out then we blast it. So, the blast holes drilled in the face of a tunnel or drifts tunnel or drifts are collectively known as the round when it is blasted at a time. So, a blast round or heading round is considered when a number of holes drilled in a same face and blasted together in a in one round one go it is called a heading round. So, this here the entire face is blasted in one round so, they are drilled first then charged and blasted.

So, there they must be drilled and positioned efficiently so that our what is our objective, our objective is to achieve the excavation. And say, we have drilled up to this and we have we are able to got an repressed excavation up to this portion, this portion is remained unbroken rock.

So, this is called advance per round or in that particular round in that particular blast round we are achieved, and advance of this of an this may go into 8 90 to 95 percent for a good blast, it may achieve much much lesser 0.5 to 0.6 times of the drilled length for a poor blast it may over excavated if the geological disturbances are there, then you may achieve more than 100 percent advance also for a blast round, if the geological disturbances are there.

So, this advance in coal mines this is called pull. So, basically this advance is the whole utilization factor, where the drilled in a blast round the advancement of the face is made. So, this objective of this blasting is to achieve the advance and that advance is achieved by a blast round if the total heading is blasted in a single round.

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**DRIFT & TUNNELING DRILLING**

*free face -> desired Advance*

**✓ Heading Round**

- The round is arranged in a pattern.
- The initial step in advancing the headings/tunnels is making an opening into the solid face to produce a void and to create a face or plane of relief as deep as it is practical. The plane of relief or void is called the cut.
- A round consists of several classes of holes.

*cutting pattern*

*cut Area*

Hole types used in a round

Labels in diagram: CONTOUR HOLES, ROOF HOLES, STOPPING HOLE, CUT SPREADER HOLE, WALL HOLES, FLOOR HOLES, LIFTERS

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Next let us understand the different terminology related to a underground drilling pattern, say for single face drifts and tunnels. So, as we have discussed our objective is to first the create a another free face as we are having a single free face here. We are having a single free face here. We should create another free face. So, that that can act as another free face for the rest of the holes. So, the free face drilling is carried out first for creating the free face, and that portion is called cut. So, basically cut is basically the area where drilling is carried out so that another free face has to be created.

So, first that another free face has to be created of desired length, the free face has to be created free face or free surface has to be created of desired advance length; Say, if the desired and if the free face the user may not able to create the free face of desired advance length, in the total blast round that advance cannot be achieved. So, in the cut area itself the desired free face length has to be desired advanced length has to be achieved. So, the drilling has to be carried out in the cut area for creating the another free face. So, first is the cut area where the drilling has. To be carried out that is cut drilling,

cut drilling pattern has to be followed cut drilling pattern has to be followed in this cut area then the cut spreaders.

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**DRIFT & TUNNELING DRILLING**

✓ **Heading Round**

- The round is arranged in a pattern.
- The initial step in advancing the headings/tunnels is making an opening into the solid face to produce a void and to create a face or plane of relief, as deep as it is practical. The plane of relief, or void is called the cut.
- A round consists of several classes of holes.

*- Initial cut*  
*- cut spreader*

Hole types used in a round

Labels in diagram: CONTOUR HOLES, ROOF HOLES, STOPPING HOLE, CUT, CUT SPREADER HOLE, WALL HOLES, LIFTERS, FLOOR HOLES.

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That means, if this is the tunnel first an initial cut is created, then that cut area has to be spreaded to achieve sufficient area so that other drill holes which are drilled in the adjacent of that area can easily utilize this free face area this free face area as the possible another free face for their blasting. So, this desired cut area has to be created so the desired cut area has to be created by the cut spreader holes.

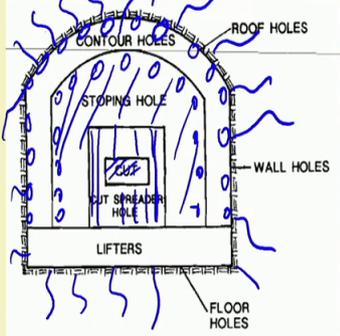
So, for a basically the cut are consists first initial cut initial cut then the cut spreader. So, cut area consisting 2 part. One is initial cut, another is the cut spreader that has to be created first for creating the another free face, and in the rest portion the blasting is as same as the bench blasting which is carried out in the surface. But in case of surface it is vertical, in case of underground it is horizontal. So, all the holes placed in this position are horizontally drilled, these are the front views are horizontally drilled so that this holes can utilize this free this free face, this face as their burden and this portion can be utilized as their free face.

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**DRIFT & TUNNELING DRILLING**

✓ **Heading Round**

- The round is arranged in a pattern.
- The initial step in advancing the headings/tunnels is making an opening into the solid face to produce a void and to create a face or plane of relief, as deep as it is practical. The plane of relief, or void is called the cut.
- A round consists of several classes of holes.



Hole types used in a round

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So, the objective of this underground blasting is first to create one initial cut, then spread that cut to have a desired free surface area, then the normal blasting as in the surface is carried out that is carried out for the rest part. So, that is the main production blasting carried out so the drilling must be carried out for the same.

And finally, the drilling has to be carried out in the periphery area; their objective is that there should not be any over excavation or over damage to the surrounding rock mass so that the support cost should not be increased. So, the production has to be carried out up to this similar person to the surface blasting, then causes blasting has to be carried out controlled blasting or controlled excavation has to be carried out in the periphery part so that the damages will not occur in the remaining underground rock mass, then that will increase the support cost. So, basically if you see the total area in the underground drift is divided in a number of part.

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**DRIFT & TUNNELING DRILLING**

✓ **Heading Round**

- The round is arranged in a pattern.
- The initial step in advancing the headings/tunnels is making an opening into the solid face to produce a void and to create a face or plane of relief, as deep as it is practical. The plane of relief, or void is called the cut.
- A round consists of several classes of holes.

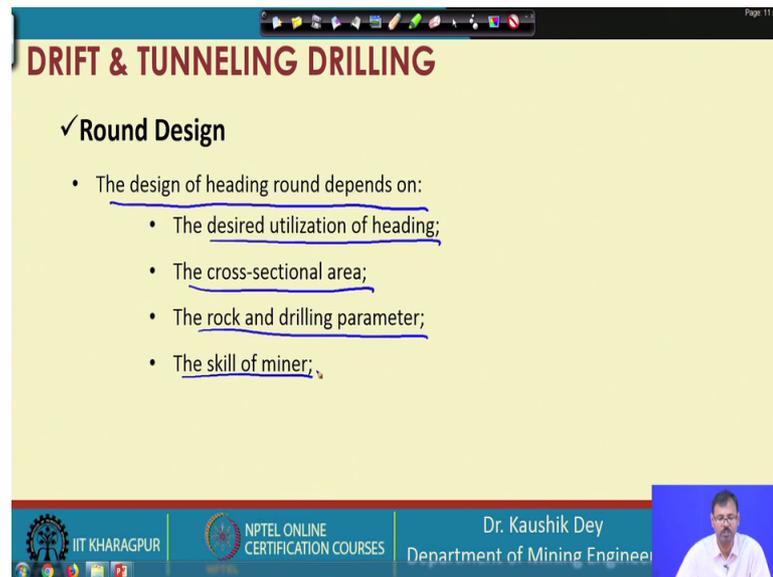
Hole types used in a round

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First the initial cut part where the first free surface is created, then the free surface is extended up to the desired length desired area so that that can accommodate the blasting carried out in the remaining rock mass by providing 2 free faces. Then the normal area of excavation; which is called stopping excavation stopping holes or easers holes, this is also called easer holes stopping holes or easer holes. So, where drilling easers wholes are drilled to achieve the main production blasting, main production excavation, then the contour holes which are basically divided in 3 part.

One is the roof contour holes. So, this is the roof control contour holes, this is the wall contour holes and lifters are basically the floor contour holes. So, these are basically the together you can say contour holes or periphery holes, which are to be drilled in a special manner and excavated blasted at in a special manner so that the damages to the remaining rock mass should not be there. So, basically this is the purpose of drilling carried out in the different portion of an underground drift or underground tunnel.

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The slide is titled "DRIFT & TUNNELING DRILLING" in a large, bold, red font at the top. Below the title, there is a section header "✓ Round Design" in black. Underneath, a bulleted list states: "The design of heading round depends on:" followed by four sub-bullets: "The desired utilization of heading;", "The cross-sectional area;", "The rock and drilling parameter;", and "The skill of miner,". The slide has a yellow background. At the bottom, there is a blue footer bar containing the IIT Kharagpur logo, the text "NPTEL ONLINE CERTIFICATION COURSES", the name "Dr. Kaushik Dey", and the title "Department of Mining Engineer". A small video inset of the speaker is visible in the bottom right corner of the slide.

So, this objective of this designing of heading round basically depending on the desired utilization of the heading cross sectional area, rock and drilling parameters and skill of the miners, because this patterns are often very, very difference. You can have a very, very critical pattern also. But the stopping holes roof holes wall contour holes floor control holes are always drilled horizontally and they give they basically give the mimicry of the surface plastic surface drilling.

The expertization is basically required in the cut holes and cut spreader holes so that the desired length of free face has to be created length of additional free face has to be created there which basically governs the advance can be achieved by a blast round. So, basically all those technical requirements or planning designing requirements are there in the designing of a cut.

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**DRILLING PATTERN**

✓ **The cut**

- The principal patterns mainly used in sub-surface excavations are:
  - Wedge cut
  - Burn cut
  - Pyramid cut
  - Coromant cut
  - Drag cut
  - Ring drilling
  - Fan cut
- Each type of cut has many variations of designs to make them adaptable to a particular formation.
- The cut must be broken and completely removed to create a void for expansion and relief. The remaining holes in the round are timed to fire in a sequence breaking to nearby created free face and allow most of the rock section to move forward into the open tunnel excavation.

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So, basically the designing of the cut is the heart of the underground drilling. And this designing of cut principally divided in the number of types, the main are the wedge cut, pyramid cut, drag cut fan cut. This is we can clubbed in a special type of excavation technique.

They are may more or less similar. Burn cut and coromant cut are more or less similar. And ring drilling is also another type of cut which is practiced. So, basically these are the different underground cut; which is created for providing a free surface to the underground drifts or diverges basically ring drilling is not for the drift and diverges. This is basically practice where already a free surfaces existing in that case this ring drilling is practiced.

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**DRILLING PATTERN**

✓ **The cut**

- The principal patterns mainly used in sub-surface excavations are:
  - Wedge cut
  - Burn cut
  - Pyramid cut
  - Coromant cut
  - Drag cut
  - Ring drilling
  - Fan cut
- Each type of cut has many variations of designs to make them adaptable to a particular formation.
- The cut must be broken and completely removed to create a void for expansion and relief. The remaining holes in the round are timed to fire in a sequence breaking to nearby created free face and allow most of the rock section to move forward into the open tunnel excavation.

The diagram shows a hand-drawn cross-section of a tunnel. It features a central rectangular area representing the cut, with several smaller rectangular holes arranged around it. The tunnel walls are indicated by curved lines, and there are handwritten numbers (1, 2, 3, 4) and arrows pointing to different parts of the cut and surrounding holes, illustrating the sequence of drilling.

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Each type of cut has many variations of design to make them adaptable to a particular formation. The cut must be broken and completely removed to create a void for expansion and relief prior to the blasting of the stopping holes. So, the cut must be blasted with a prior delay than the stopping holes; the remaining holes in the round at time to fire in a sequence breaking to nearby created free face and allow most of the section to move forward into the open tunnel or deep sections. So, that means, first the cut has to be created, this is has to be carried out in the first.

Then the cut spreader has to be carried out, that is in the second delay. Then the stopping holes that has to be third, then the contour holes, then the contour holes may be 4th fifth 6th or maybe in the simultaneously in the 4th. So, the if you are see observing there time of arrival, this has to be carried out first, then you have to give some delay for this, then again with some delay to this, again with some delay to this again it is some delay to this, then lastly this one. So, basically this is the sequence of excavation in the drilling pattern in the in the drilling carried out in the underground drifts or tunnels.

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**DRILLING PATTERN**

✓ Wedge cut/ V- cut

V-cut or Wedge cut

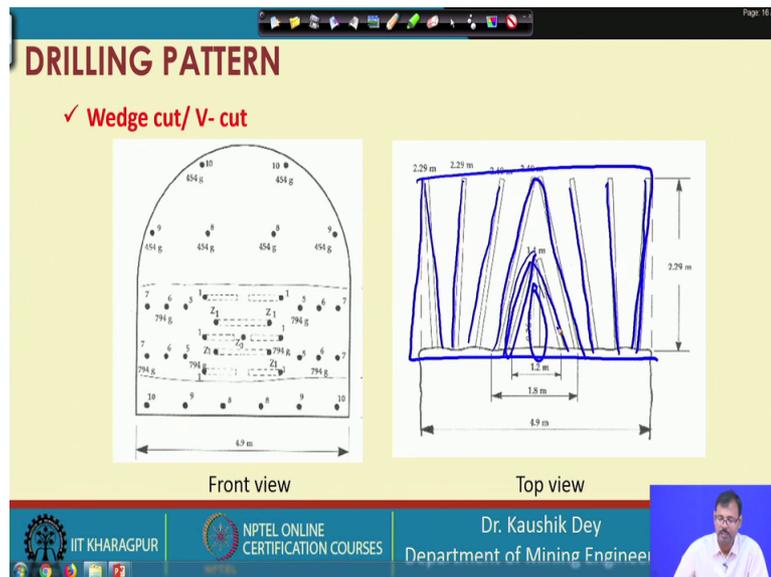
A series of V-cut or Wedge cut

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So, let us first discuss about the wedge cut or V cut, where the centrally one wedge is found to create the free surface. So, that means, if this is the tunnel cross section area drift cross sectional area. We have to create this drilling; if we are observing the plan view like this, in a manner like this so that there ends are trying to meeting each other, you can see the extensions are this direction.

So, that is why these holes are drilled in this way in a in some inclined manner. You must recall this designing of this angles we will discuss later on. So, these are drilled such a manner so that and wedge will be found. So, what will happen the moment we will insert explosive and blast it and excavation free area has to be created like this. So, this portion will be excavated in a form like this. So, that is why an wedge excavation may be achieved using this pattern.

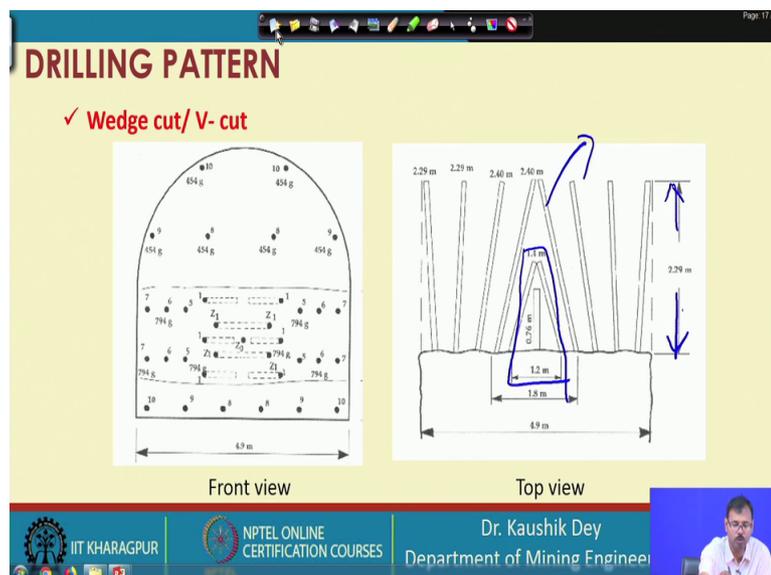
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So, basically wedge cut is also called V cut is carried out to achieve an initial excavation first, then we extend the excavation by the cut spreaders. These are the spreader holes and finally, we are able to achieve a free excavation here. So, you can see these are the different modification of the blasting, this hole is called stab hole.

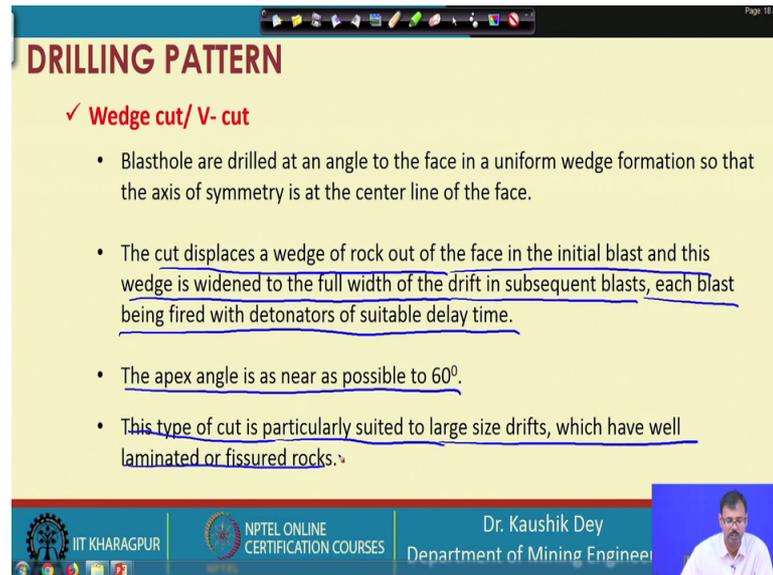
These are the short length drill hole is carried out so that gradually the advancement can be achieved, but this may exist may not exist this portion may exist may not exist we can start with this one also depending on the type of rock.

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So, these are required in the hard work formation, otherwise in soft rock formation we can start directly from this place. So, that is why you we can have a drilling like this and you can see a free face of advance of 2.3 meter can be achieved in this condition. So, wedge cut is very, very useful and very commonly used in a mining and tunnelling sector.

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**DRILLING PATTERN**

✓ **Wedge cut/ V-cut**

- Blasthole are drilled at an angle to the face in a uniform wedge formation so that the axis of symmetry is at the center line of the face.
- The cut displaces a wedge of rock out of the face in the initial blast and this wedge is widened to the full width of the drift in subsequent blasts, each blast being fired with detonators of suitable delay time.
- The apex angle is as near as possible to  $60^{\circ}$ .
- This type of cut is particularly suited to large size drifts, which have well laminated or fissured rocks.

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The blast holes are drilled at an angle to the face with the so that an uniform a uniform wedge can be formed. The cut displaces a wedge of rock out of the face in the initial blast. And this wedge is widened to the full width of the drift is in subsequent blast, each blast being fired with the detonator of suitable delay time. The apex angle is nearly kept 60 degree actually the limit is one radian. This type of cut is particularly suited to large sized drift with laminated fissured rocks. The problem you can understand as we are giving an initial angle centrally.

That means, the drilling length is basically governed by the width available in the opening. So, that is why that is the drawback of this wedge cut system, otherwise this wedge cut is very, very useful for the excavation.

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**DRILLING PATTERN**

✓ Pyramid cut or Diamond cut

Front view

Top view

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Pyramid cut or diamond cut is basically a double wedge cut. In our previous cut we have seen the wedges are there in the horizontally. Similarly, if you see from the side view, the wedges are there in pyramid cut in vertically also whereas, in the wedge cut these holes are like this. So, there is no inclination you can you have observed; in that case, there is no inclination for the for the holes horizontality of the holes in the wedge cut. But pyramid cut is basically a double wedge cut where the wedge is formed if you are observing the top view.

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**DRILLING PATTERN**

✓ Pyramid cut or Diamond cut

Front view

Top view

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In this way also and if you observing in the side view in this way also so, that is why basically a pyramid shaped shape is created centrally and then gradually that is extended. So, pyramid cut is a double wedge cut; which is most of the time followed in case of a very hard rock formation where wedge cut has to be followed. Otherwise, pyramid cut is little bit difficult to practice the, for the drilling if the manual drilling is being practiced.

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**DRILLING PATTERN**

✓ **Pyramid cut or Diamond cut**

- In this type, four or six shot holes are derived at the middle of the face which at the end to form a cone or pyramid shape.
- The pyramid or diamond cut is a variation of the wedge cut where the blastholes for the initial cavity may have a line of symmetry along horizontal axis as well as the vertical axis.
- The length of the holes are approximately 15cm more than the other type of holes.
- The charging is done mainly at the apex of these cut holes, so that it creates a face to fire the next with delays.
- These cuts are generally used for blasting hard rock mass

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So, basically if you see this type in this type 4 or 6 shot holes are derived at the middle so, of the face which at which the end to form a cone or pyramid shape. The pyramid are or diamond cut is a variation of the wedge cut, or you can say it is the double wedge cut, the length of the holes are basically 15 centimetre more than the other types of holes. The charging is done mainly at the apex so that it can create a free face.

But the difficulty here is that, the control of the drilling is very, very difficult. Unless and until there is a expert drilling crew is available which can adjust this angles that is the wedge angle of the vertical holes and the horizontal holes, the pyramid drilling is very, very difficult. So, let us stop at this position we will continue with the other cut in the next class, while we will while we will discuss the drilling pattern class 2.

Thank you.