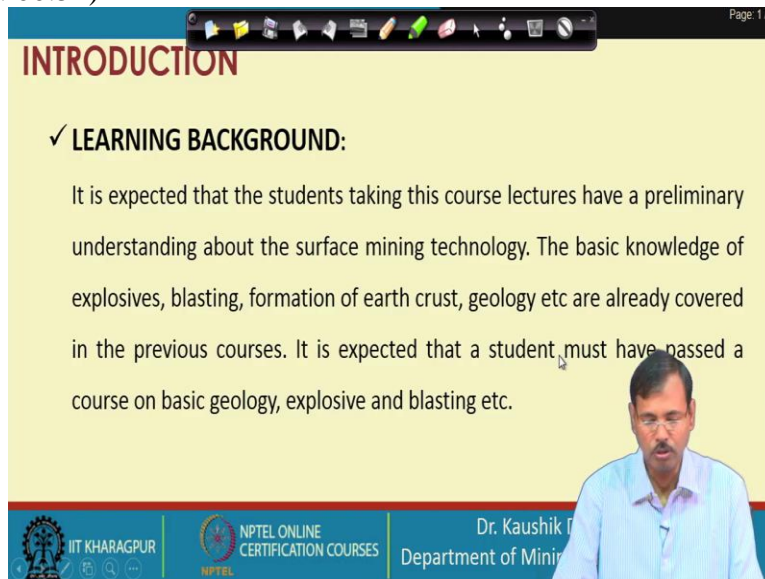


**Surface Mining Technology**  
**Professor Kaushik Dey**  
**Department of Mining Engineering**  
**Indian Institute of Technology, Kharagpur**  
**Lecture – 15**  
**Technology for Surface Blasting - I**

Let me welcome you to the 15th lecture of surface mining technology. From this lecture, we will start the technology for surface blasting; we have six lectures on this technology for surface blasting. Initially, we will understand the different parameters, then the designing aspects, and finally, the tutorials for calculating the designing parameters and calculation of the cost of blasting. So, this is the general schedule for this technology for surface blasting.

(Refer Slide Time: 00:51)



The screenshot shows a presentation slide with a yellow background. At the top, the word "INTRODUCTION" is written in red. Below it, a section titled "✓ LEARNING BACKGROUND:" is followed by a paragraph of text. The text states that students taking this course are expected to have a preliminary understanding of surface mining technology, including explosives, blasting, earth crust formation, and geology. It also mentions that students should have passed a course on basic geology, explosives, and blasting. In the bottom right corner of the slide, there is a small video inset of a man in a light blue shirt. The bottom of the slide features a blue footer with logos for IIT Kharagpur, NPTEL Online Certification Courses, and the Department of Mining Engineering, along with the name "Dr. Kaushik Dey".

**INTRODUCTION**

✓ **LEARNING BACKGROUND:**

It is expected that the students taking this course lectures have a preliminary understanding about the surface mining technology. The basic knowledge of explosives, blasting, formation of earth crust, geology etc are already covered in the previous courses. It is expected that a student must have passed a course on basic geology, explosive and blasting etc.

Dr. Kaushik Dey  
Department of Mining Engineering

So, as we go for every class, let us look into the learning background for the surface mining technology course.

(Refer Slide Time: 01:00)

**INTRODUCTION**

✓ **Learning Objectives of This Course:**

- To know the different unit operations associated with surface mining.
- Methods of surface mining.
- Deployment of machineries in surface mining.
- Productivity analysis of surface mining.
- Safety and environmental control of surface mining operation.
- Special methods of surface mining.

Dr. Kaushik D.  
Department of Mining

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This is the learning objective for the surface mining technology course.

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**INTRODUCTION**

✓ **LEARNING OUTCOMES:**

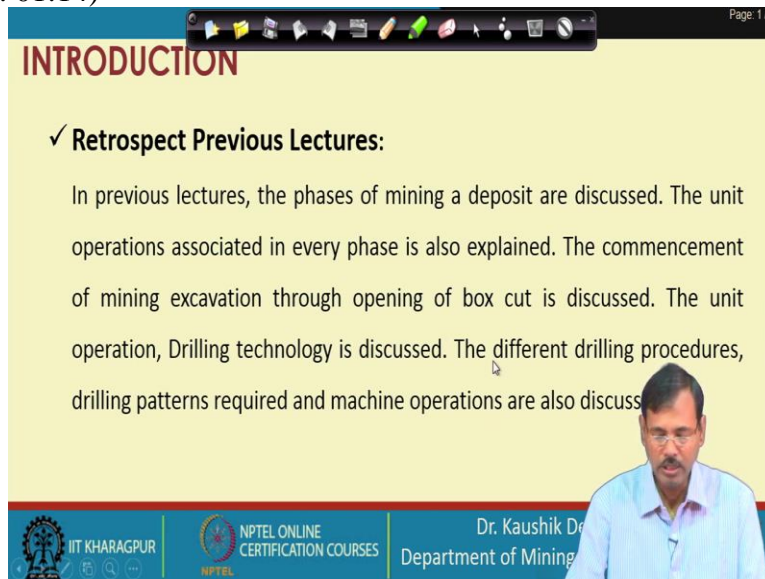
It is expected that the students taking this course lectures will be able to envisage the surface mining operation and its technological nitty-gritty. It is expected that a student will be able to design the drilling and blasting rounds for surface blasting, will be able to choose, deploy and design the mine machineries for a set production target. The desired and environmental requirements will also be addressed.

Dr. Kaushik D.  
Department of Mining

IT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES

And it is the expectation from the participants after going through this surface mining technology course.

(Refer Slide Time: 01:14)



The slide is titled "INTRODUCTION" in red. It features a video inset of Dr. Kaushik Das, a man with glasses and a mustache, wearing a light blue shirt. The slide content includes a checkmark icon followed by the heading "Retrospect Previous Lectures:" and a paragraph of text. At the bottom, there are logos for IIT Kharagpur, NPTEL Online Certification Courses, and the Department of Mining Engineering.

**INTRODUCTION**

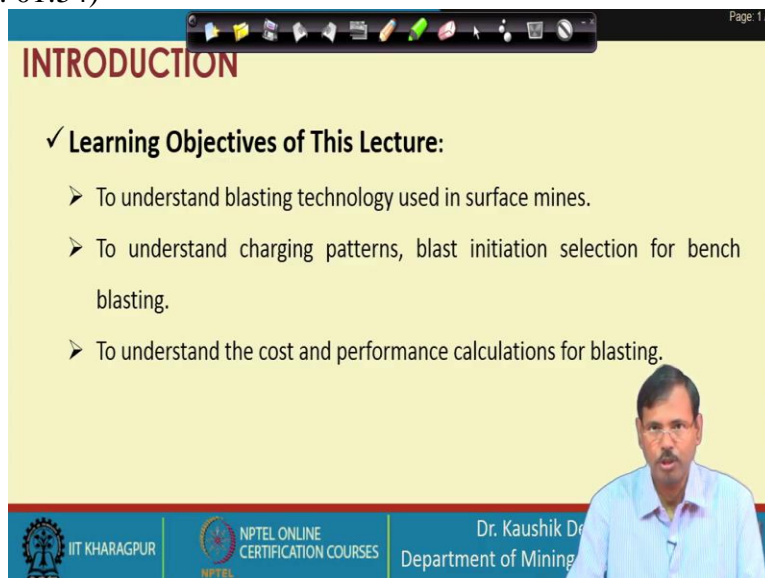
✓ **Retrospect Previous Lectures:**

In previous lectures, the phases of mining a deposit are discussed. The unit operations associated in every phase is also explained. The commencement of mining excavation through opening of box cut is discussed. The unit operation, Drilling technology is discussed. The different drilling procedures, drilling patterns required and machine operations are also discussed.

Dr. Kaushik Das  
Department of Mining Engineering

And so far, we have covered the different phases of mining operations discussed earlier. We have also discussed the problems associated with every phase and how the decisions will be based on achievements. We have discussed open, opening surface mining through box cut. We have discussed the drilling technology required for the carrying out of blasting. So, that is already discussed.

(Refer Slide Time: 01:54)



The slide is titled "INTRODUCTION" in red. It features a video inset of Dr. Kaushik Das, a man with glasses and a mustache, wearing a light blue shirt. The slide content includes a checkmark icon followed by the heading "Learning Objectives of This Lecture:" and a list of three bullet points. At the bottom, there are logos for IIT Kharagpur, NPTEL Online Certification Courses, and the Department of Mining Engineering.

**INTRODUCTION**

✓ **Learning Objectives of This Lecture:**

- To understand blasting technology used in surface mines.
- To understand charging patterns, blast initiation selection for bench blasting.
- To understand the cost and performance calculations for blasting.

Dr. Kaushik Das  
Department of Mining Engineering

So, we will start now with the technology for surface blasting. The learning objective for all this surface technology for surface blasting lectures is six lectures on this. This lecture's learning objective is to understand blasting technology used in surface mines. To understand charging

pattern, blast initiation selection for bench blasting. And to understand the cost and performance calculations for blasting. So, this is the broad objective for the lectures related to technology for surface blasting. And in this particular lecture, we will try to concentrate on the different parameters of the intrinsic parameters of the surface blasting or bench blasting technology.

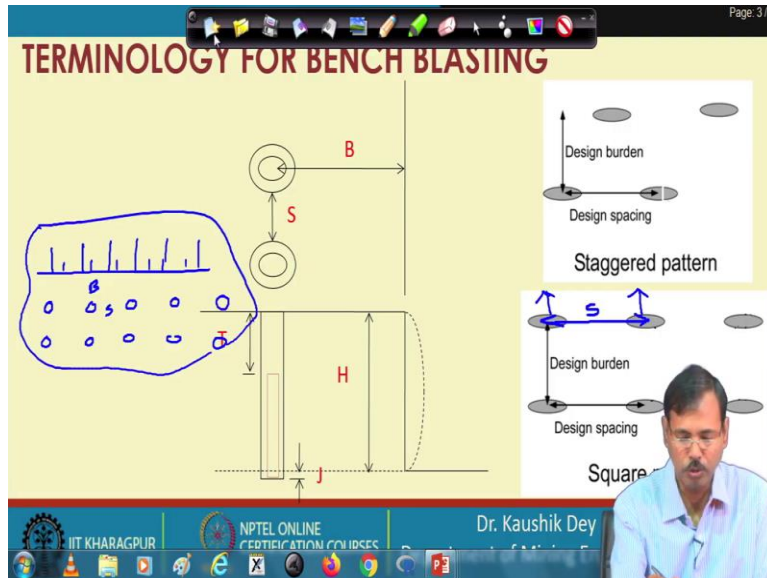
(Refer Slide Time: 02:39)

The image displays two slides from a presentation titled "TERMINOLOGY FOR BENCH BLASTING".

**Slide 1 (Page 1 / 1):** This slide features a central diagram of a bench blasting layout. It shows a vertical column of holes with a diameter  $D$  and a spacing  $S$  between them. A horizontal distance  $B$  is marked from the center of a hole to the face of the rock. A red handwritten label "Crest Burden" points to the distance from the top of the hole to the rock face. A blue handwritten label "Toe" points to the distance from the bottom of the hole to the rock face. A vertical dimension  $T$  is shown on the left, and a horizontal dimension  $J$  is shown at the bottom. To the right, two diagrams illustrate different hole patterns: "Staggered pattern" and "Square pattern". Each pattern diagram shows "Design burden" (vertical distance) and "Design spacing" (horizontal distance).

**Slide 2 (Page 2 / 2):** This slide is similar to the first but includes a video inset of Dr. Kaushik Dey. The central diagram is identical to Slide 1. The "Staggered pattern" diagram on the right is annotated with red handwritten lines and arrows, showing the relationship between design burden and design spacing. The "Square pattern" diagram also shows design burden and design spacing.

Both slides include a footer with the logos of IIT Kharagpur and NPTEL Online Certification Courses, and the name "Dr. Kaushik Dey".



So, see the terminology, see the terminology first. Then, you can see if you are drilling a hole if the hole is drilled at this position. This is the center point; if this is the centerline, then from this point to the free face line, this is the crest of the free face. So, from the hole, the distance from the center point of the hole to the free face is called burden. So, if you are measuring this at this point, it is called crest burden, crest burden. This is called toe burden. If you have more holes in one row, these are the rows we are considering. If this is the free face, then a number of holes that are almost equal are considered the row.

And the holes in the other line constitute the next row. So, if this is the burden distance, this is also the burden distance. The concept is that it is expected that this one will be blasted ahead. So, if you are, if you are looking at this picture, say this is our free face. And these holes are drilled at a burden distance. Then the following rows of holes are drilled. So, this burden distance and this burden distance will be the same or similar.

The reason is that it is expected that after blasting up this hole, this after blasting up this hole a new free face will be created at this position. It may be for a few milliseconds duration, but the new free face will be created here, then this will also be blasted. So, this is acting this also is acting just when this hole should be blasted, just when the new free face is at this position. So, the burden distance for these holes will be this one.

And this will be the same as this. So, burden distance is the distance from the hole to its free face. And spacing is the distance between two holes, the distance between two holes that have

the same burden or are being, which are considered in the same row. So, this is called spacing, spacing between two-hole holes. So, these are basically burdens and spacing.

You have to select this when you are carrying out drilling in the mine bench itself. So, you have to select your burden and spacing. And in that case, previously, if this is your free face, the supervisor has to mark the positions where the driller has to drill the holes. So, the supervisor will mark this position. And he has to maintain this burden distance and this spacing distance. So, this will be marked then the holes will be drilled almost in this, almost in the close vicinity of the mark position.

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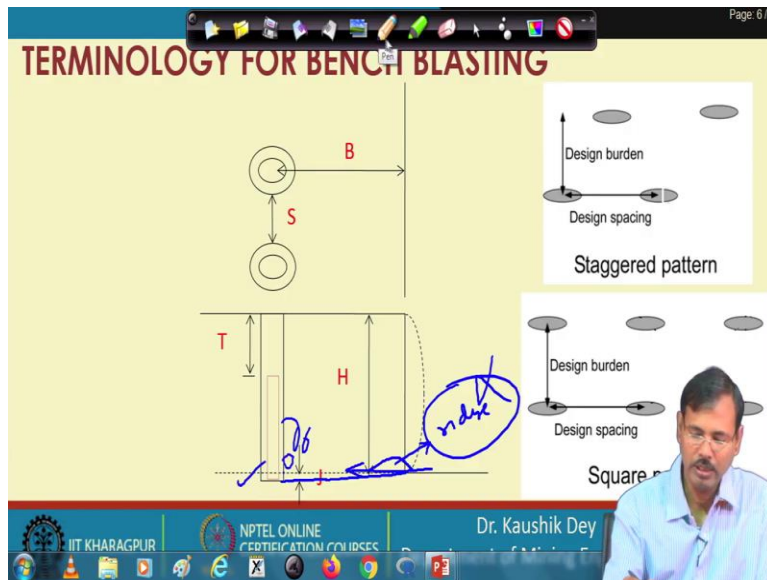
The image displays two screenshots of a presentation slide titled "TERMINOLOGY FOR BENCH BLASTING". The slide is divided into two main sections: "Staggered pattern" and "Square pattern".

**Staggered pattern:** The top diagram shows two holes in a staggered arrangement. The horizontal distance between the centers of the two holes is labeled "Design spacing", and the vertical distance is labeled "Design burden". A handwritten note in blue ink says "J = Sub drilling or Sub grade drilling". The bottom diagram shows a staggered pattern of holes in a bench, with labels for "Design burden" and "Design spacing".

**Square pattern:** The top diagram shows two holes in a square arrangement. The horizontal distance between the centers of the two holes is labeled "Design spacing", and the vertical distance is labeled "Design burden". The bottom diagram shows a square pattern of holes in a bench, with labels for "Design burden" and "Design spacing".

Handwritten annotations in blue ink are present on both screenshots. In the top screenshot, a blue arrow points from the "Design burden" label to the "Staggered pattern" diagram. In the bottom screenshot, a blue arrow points from the "Design spacing" label to the "Staggered pattern" diagram. There are also various other blue scribbles and lines on the diagrams.

The presentation is by Dr. Kaushik Dey, NPTEL ONLINE CERTIFICATION COURSES, IIT KHARAGPUR. The slide number is 4/4 for the top screenshot and 5/5 for the bottom screenshot.



If you are looking at the hole sections, you will find out the drilled hole is, in general, a little bit longer than the bench height. If your bench height is  $H$ , then you will find out your drilled hole length is  $L$ . And this  $L$  is a little bit larger than  $H$ . So, you are basically carrying out some additional drilling, which is called  $J$ . So, this  $J$  is termed as sub drilling, sub drilling or subgrade drilling.

So, this additional drilling, this sub drilling is required to avoid any ridge formation at this place. So, how is this happening? Suppose you blast this position and place your explosive in the hole up to this height. Now, this one, and as this is your free face, this one is acting like this. And that is why this portion of rock will be fragmented. If it is acting like this, a ridge is formed at this position.

So, if you will find out in a mine your bench floor is like this, then it is creating a problem. If your floor is like this, it creates a problem for the machines' movement. So, to avoid this one, you go for additional drilling so that the excavation will be carried out like this. And this portion, the rock will be fragmented, and finally, you will receive a smooth floor. And there will not be any ridge formation at this position.

So, there is no ridge formation at this position. So, that is avoided by carrying out some extra drilling. But if you are having two layers of rock, say suppose this is one bench, and this is another bench. And these are the two different types of rock, and these rocks are, and these rocks

are readily separable. And these rocks are readily separable. So, it is very easy to separate this rock; in that case, you need not go for subgrade drilling for the particular mine.

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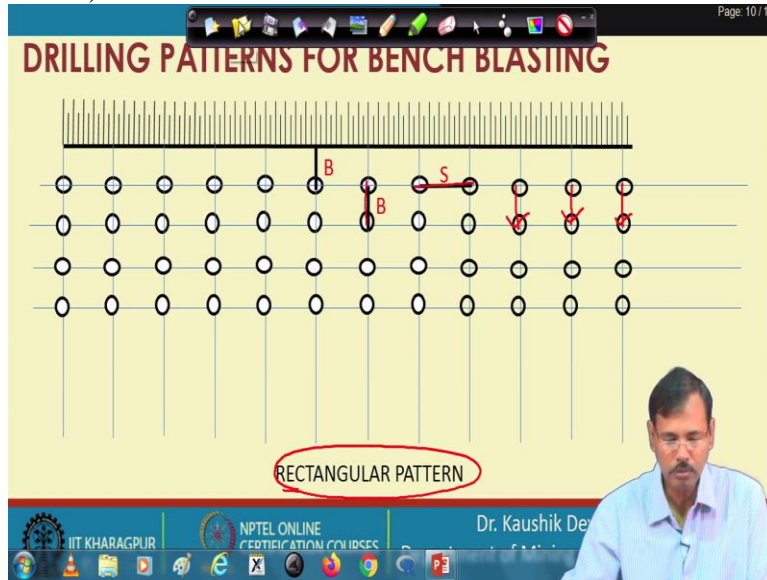
The image displays two screenshots of a presentation slide titled "TERMINOLOGY FOR BENCH BLASTING". The slide features a central diagram of a blast hole with various parameters labeled:  $B$  (burden),  $S$  (spacing),  $T$  (stemming length),  $H$  (blast height), and  $J$  (blast depth). To the right, there are two diagrams illustrating different blast patterns: "Staggered pattern" and "Square pattern", both showing "Design burden" and "Design spacing". Handwritten red annotations include "rock cuttings sand" and "Explosive". A video inset shows Dr. Kaushik Dey. The slide is part of an NPTEL ONLINE CERTIFICATION COURSE by IIT KHARAGPUR.

So, let us understand the terminology here first; this is bench height. This is stemming length, which means the portion of the hole, after placing the explosive at this position, the portion of the hole you filled with the rock cuttings, rock cuttings, or sand. This is carried out to avoid the escape of the gaseous products coming out from the explosive of the blasting. So, that gaseous product coming out from the explosive of the shot they are escaping is restricted by this filling of this area.



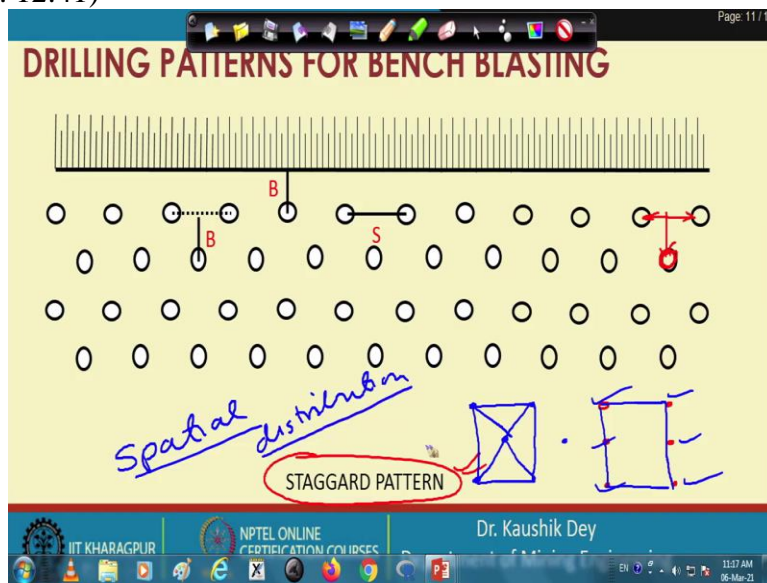
So, this is giving the confinement of this gas. So, it forces the gas to move out or pressurize this rock to move in the front direction. So, that is the purpose of stemming. So, in a nutshell, we understand what the different terminology is. In general, we use it for getting out in the blasting.

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This part we have already discussed in the drilling part. This is a; this is called a rectangular drilling pattern. The next row holes are placed directly behind the front row holes. And you can see this is the spacing; this is the burden.

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And this is called a staggered pattern, where the next row holes are placed between two front-row holes. So, in between two front-row holes, the next row holes are placed then. It is called the

staggered pattern. If you are looking at the rectangular pattern, this is a rectangular pattern. And if we are looking at the staggered pattern here. Then you can see, if you are looking at this particular formation, see here the charges are placed in a better way than this portion of the distribution. So, the staggered pattern gives a better spatial distribution, spatial distribution of explosives, and spatial distribution of explosives over the rectangular pattern.

(Refer Slide Time: 14:10)

**PARAMETERS AFFECTING SURFACE BLASTING**

- ✓ HOLE DIAMETER ✓
- ✓ CHARGE DIAMETER ✓
- ✓ HOLE LENGTH ✓
- ✓ BENCH HEIGHT ✓
- ✓ SUB-DRILLING ✓
- ✓ BURDEN ✓
- ✓ SPACING ✓
- ✓ CHARGE LENGTH ✓
- ✓ LINEAR CHARGE CONCENTRATION ✓
- ✓ STEMMING LENGTH ✓
- ✓ NO OF HOLES ✓
- ✓ NO OF ROWS ✓
- ✓ NO OF HOLES PER ROW ✓
- ✓ BENCH FACE CONFIGURATION ✓
- ✓ DELAY SEQUENCE ✓
- ✓ BLAST PATTERN ✓

Dr. Kaushik Dey

Now, let us see the least of the influencing parameters; there are a host of parameters affecting the results of the surface blasting, simultaneously the designing of the surface blast. So, these parameters are hole diameter and charge diameter. So, in our, this is the diameter of the hole, and this is the explosive charge, which is placed inside the hole in a cartridge form. So, that is the charge diameter, hole length bench height sub drilling.

So, we have already discussed these interdependent parameters, burden, and spacing. And how to identify the burden in the lecture on drilling and blasting. Technology in that course, we have already discussed the selection of burden and spacing—charge length in the hole, linear charge concentration, which is very important—then stemming length, number of holes, number of rows, number of holes per row.

These are the design requirement; this is the design requirement for planning a surface blast. And if you say, doing it for a number of 100 holes 400 holes, you have to provide the delay sequence and blasting pattern for that judiciously, and that is very, very important. So, let us look into the influence of these parameters in this lecture.

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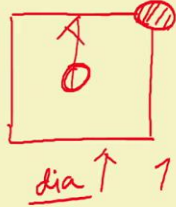
## PARAMETERS AFFECTING SURFACE BLASTING

✓ **HOLE DIAMETER**

The hole diameter depends on-

- (i) Properties of rock mass.
- (ii) Degree of fragmentation required. ✓
- (iii) Height of bench & configuration of charges.
- (iv) Costs of drilling & blasting.
- (v) Capacity of loading equipment.

For a small "D" cost is high for drilling, charging, stemming etc. The only advantage for a small dia hole is the lower powder factor due to more optimum distribution of charge



Dr. Kaushik Dey

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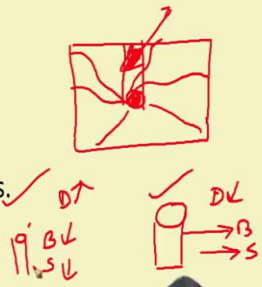
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The first hole diameter is the main parameter. And most of the designing guidelines, you will find the based-on hole diameter only. So, if you see, the hole diameter depends on rock mass properties. If you have a strong rock mass, then you need to place, you need to place the explosive, more explosive for a particular cubic meter of rock. So, in that case you need to increase the diameter of the hole.

So, this is basically with the diameter of the hole, with the diameter of the hole, you are basically increasing the charge concentration. So, if you increase the diameter of the hole, you increase the charge concentration. Because in unit area, you are giving more explosives. So, that is why you

are increasing the charge concentration with the hole diameter. So, the degree of fragmentation is also very, very important.

If your hole diameter is more, you are placing the more explosive, more quantity of explosive obviously, you have to increase your burden and spacing. You have to increase your burden on spacing, which is the influencing area. So, this burden and spacing, etc., will be increased. So, that is why your degree of fragmentation will be affected. So, if you improve the charge diameter, you increase the burden and spacing.

This will lead to the larger size of a fragmented boulder. So, if the size of the loading machines is higher in that case, we can go for a large dia of holes—then bench height and configuration of the charges. We can go for large diameter holes if the bench height is more. If it is less, we have to reduce the diameter. Cost of drilling and blasting. And this is very, very important. The capacity of the lording equipment, we have already discussed.

With the cost of drilling and blasting, you have to remember one thing: what is the drilling? Drilling is nothing, but we provide space; we provide a space inside the rock mass to place the explosive in that position. Ideally, we have to place at the central part of a cubic meter rock mass. We have to provide some quantity of charge so that it will fracture the whole rock mass.

But we cannot access the central point unless and until we create a hole from the surface to reach this position. So basically, we are carrying out drilling to reach this position. That is why after placing this explosive again, we seal this portion using a stemming material. So, that is the technique basically carried out in the blasting. And that is why you have to compromise between the combination of the drilling cost and the blasting cost.

So, if we use a large-diameter hole, we are increasing the burden; we are increasing the spacing. So, our drilling requirement is going to be reduced. But if we use a small diameter hole, then our burden and spacing both decrease. So, we are basically increasing the drilling cost. So, in this case, our drilling cost is increased, and in this case, your drilling cost is decreased.

But the effect is that if you are carrying out a small burden, with small spacing with a small diameter hole, your fragmentation will be smaller; in this case, you will get the larger fragment size bolder. So, you have to compromise between these things while designing the blast.


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## PARAMETERS AFFECTING SURFACE BLASTING

✓ **HEIGHT OF BENCH**

It is called the stiffness of the bench. For a large H/B ratio it acts as a long beam & it is easy to break & displace specially at slenderness ratio bench Centre. Ash (1997) states, the optimum is  $H/B \geq 3$ . Through the bench height is designed by the thickness of seam (for coal like bedded deposit), Dilution of mineral (metal mining) & reach of the loading machine (for both). If the Burden is fixed spacing should be increased with the increase in H, Without affecting fragmentation



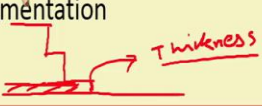
Dr. Kaushik Dey

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## PARAMETERS AFFECTING SURFACE BLASTING

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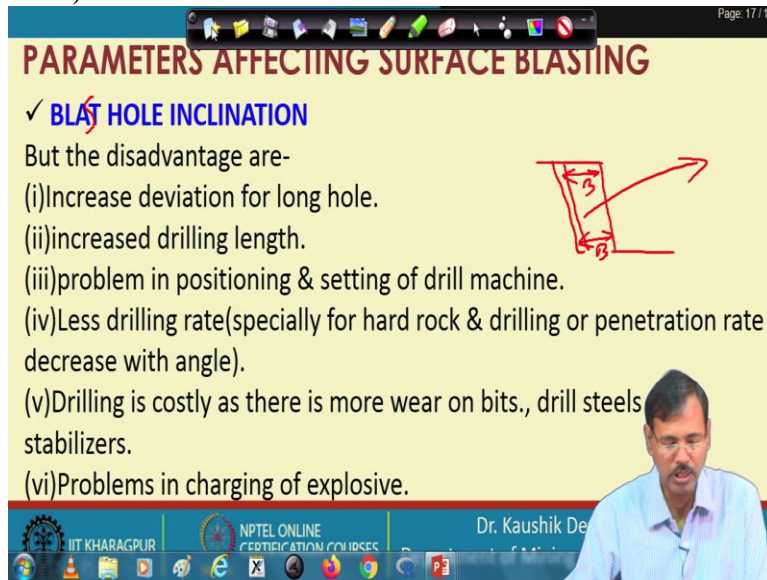


Next is the bench height; bench height dictates the stiffness of the bench. So, the H by burden ratio is considered the long beam. So, if it is creating a long beam, you can understand the long beam is very easy to break. But, if it becomes a slab like this, it is not that easy to break. So, this H by B ratio is very, very important. Ash 1997 has argued this H by B ratios should be greater than 3 for the blasting purpose.

And that is why the bench height is designated often by the thickness of the seam, like say if the coal bed suppose you are having, think, you are having overburden benches like this. But you have a very thin coal bench. You have to take this thin coal bench separately. So, in this case, you do not have an option. Your bench height is governed by the thickness of the coal bed only.

So, these are the different parameters you also need to consider while selecting the height of the bench. Otherwise, bench height is also governed by your excavator's reach, which governs the bench height.

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**PARAMETERS AFFECTING SURFACE BLASTING**

✓ **BLAST HOLE INCLINATION**

But the disadvantage are-

- (i) Increase deviation for long hole.
- (ii) increased drilling length.
- (iii) problem in positioning & setting of drill machine.
- (iv) Less drilling rate (specially for hard rock & drilling or penetration rate decrease with angle).
- (v) Drilling is costly as there is more wear on bits, drill steels stabilizers.
- (vi) Problems in charging of explosive.

The slide includes a hand-drawn diagram of a rectangular hole with an inclined line representing a blast hole. The angle of inclination is labeled with the Greek letter  $\beta$ . A red arrow points to the right from the top of the hole, indicating the direction of rock ejection. The slide also features a video inset of Dr. Kaushik De and a footer with logos for IIT Kharagpur and NPTEL Online Certification Courses.

Drill blast hole inclination, this is missing. Blast hole inclination is another important parameter. And if your bench is, having a slope angle to having an equal burden throughout the bench height, in general, you can go for a, to have the toe burden and crest burden same, you may go for an inclined blast hole. Or, if you need to throw the rock over a longer distance, you can also go for an inclined hole drilling. But, generally, incline hole drilling is not very easy. Drillers always have confusion related to that. So, that is why inclined drilling is often avoided during the actual blasting practice.

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## PARAMETERS AFFECTING SURFACE BLASTING

✓ **STEMMING LENGTH**

Stemming is to confine the gas pressure of explosive inside the hole. Premature escape of gas in atmosphere can cause air blast & fly rock. If stemming is explosive then large amount of big boulders will form from the top part of the bench. So for stemming two factor is considered-

(i) Type of material to be used.  
(ii) The length of the stemming column



Dr. Kaushik Dey

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11:27 AM 06-Mar-21

Stemming length is important because this governs the charge distribution. Suppose, to blast this rock, we need  $x$  kg, and  $x$  kg can be accommodated at this place. But what will happen in this case? This  $x$  kg is concentrated in the lower part of the rock only, and this part is completely stemmed. So, this is over stemmed, and the charge distribution is not significant.

And this portion will generate that case; in the top part, it will generate larger-sized boulders at this position. But if you have a reverse condition, when you have placed your explosive like this, this part stemming is insufficient. Then the gas pressure generated by these explosives is escaped, showing this stemming part. And then the throwing of this part may not be significant enough, and you will not get the proper blast fragmentation in that case also. So, proper stemming is also very important.

(Refer Slide Time: 24:03)

The screenshot shows a presentation slide with the following content:

- PARAMETERS AFFECTING SURFACE BLASTING**
- ✓ **STEMMING LENGTH**
- (a) **Type of material**-> Generally drill cutting are used as availability is good and no extra expenditure as well as no fear of dilation. Recent study found that coarse angular particle (such as crushed rock) is more effective and the resistance to ejection of stemming column increases when humidity content is less. Most effective stemming is achieve with particle size Type equation here  $\frac{1}{7} D$  to  $\frac{1}{25} D$ . [It has been seen that by using  $\frac{1}{25} D$  material stemming height reduction can be done up to 41%].

Handwritten annotations on the slide include a blue circle around the text "packing" and a blue arrow pointing from the word "packing" to the fraction  $\frac{1}{25} D$ .

These are the criteria for the selection of the stemming material. Generally, the stemming material fragment size is considered in the range of 1 by 7 D to 1 by 25 D. This is supposed to give the best packing inside the hole. But, one very important part is that coarse angular particle is more effective. And resist the ejection of the stemming column because these have interlocking types.

Simultaneously, another problem may occur, the coarse and angular particle on the time of hammering onto the steaming part, which may damage the nonel or the detecting fuse, in this connection, given to the explosive. So, that part must be taken care of while the stemming operation is actually practiced.



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**PARAMETERS AFFECTING SURFACE BLASTING**

✓ **STEMMING LENGTH**

(b)Length-> Length is proportional to the material type. Generally length of stemming varies from 20D to 60D (it is safer to maintain the stemming length >25D).

For multirow blasting case, if top priming case is taken and it must be considered that due to detonation of DF/NONEL damage in stemming is happened.

Dr. Kaushik De

Stemming length, we will come to the design criteria at a later stage. But in general, different researchers have given a range of 20 D to 60 D depending on the type of material depending on their own design guidelines. In general, this is practice, but different researchers have given different criteria for this.

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**PARAMETERS AFFECTING SURFACE BLASTING**

✓ **SUB-DRILLING**

Subgrade drilling is provided to completely shear off at the floor level & to avoid toe formation. Excessive subgrade drilling results in –

- (i) Increased drilling & blasting cost.
- (ii) Increased vibration level.
- (iii) fracturing & fragmentation in the top part of next bench which caused problem in drilling and shape stability.

Dr. Kaushik De

And sub drilling we have already discussed. To avoid toe formation, the sub drilling is provided to complete shear off of the floor level. But, if we go for excessive sub drilling, that may increase drilling and blasting costs because we are additionally drilling is carried out, which is

unnecessary. It may increase vibration levels also. And fracturing and fragmentation in the top part of the next bench may create the problem, which we show in the next slide.

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## PARAMETERS AFFECTING SURFACE BLASTING

✓ **SUB-DRILLING**

$$J = \tan \alpha * \frac{S}{2}$$

Generally value of  $\alpha$  varies from  $10^\circ$  to  $30^\circ$ .

Different Rock formation	J/B
Horizontal stratification	0
Easy toe, medium Soft rock	0.1-0.2
Normal toe, Medium Hard Rock	0.3
Difficult Toe, Hard Rock	0.4-0.5

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## PARAMETERS AFFECTING SURFACE BLASTING

✓ **SUB-DRILLING**

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See, the fracturing that occurs at this position may create the problem. So, we sometimes go for restricting up to this only, without sub drilling, if these two are ready and readily separable. And if this part is soft, if this material is soft, we drill up to this instead of going for sub drilling.

And initial part is stemmed fast before providing the explosive. So, that explosive will reach up to this, and this rock will not be damaged because of this explosive. So, often we go for that also. So, this is the calculation part of the sub drilling. And general, for different rock formations, the sub drilling, and burden ratio is basically governed by this thumb rule.

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## PARAMETERS AFFECTING SURFACE BLASTING

✓ **BURDEN AND SPACING**

Burden is the minimum distance from the axis of the blast hole to the free face, while spacing is the distance between two adjacent hole in a same row.

Burden and Spacing depends on the –

Hole diameter,	properties of rock,
properties of explosive ,	Bench height,
Degree of fragmentation and	displacement of muck pile.

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## PARAMETERS AFFECTING SURFACE BLASTING

✓ **BURDEN AND SPACING**

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Burden and Spacing depends on the –

Hole diameter, ✓	properties of rock, ✓
properties of explosive, ✓	Bench height, ✓
Degree of fragmentation ✓ and	displacement of muck ✓

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Now, the main part is burden and spacing. We have already seen how the burden is governed in our drilling and blasting technology lecture; there is a crust zone. Then the radial tracking zone, in blasting. And after that, this is the reflected wave, and this is basically, this is basically creating for the if you are looking at the section, this is the hole. Then the initial, this is the crush zone.

This is the cracked zone, becoming the slabbing tension zone, which allows the topple of the material. So, our burden is governed by this theory that we have already discussed in our drilling and blasting technology. So, load and spacing depend on the hole diameter, properties of explosive, degree of fragmentation rock properties, bench height, and displacement required for the muck pile.

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## PARAMETERS AFFECTING SURFACE BLASTING

✓ **BURDEN AND SPACING**

$B=25 D$  to  $40 D$  depending upon the rock parameter

However during operation error in burden application comes due to –

- (i) Marking & collaring error.
- (ii) Generation of fly rock.
- (iii) May cause air & Noise overpressure (may be air blast)

Dr. Kaushik De

We have already discussed that excessive burden creates the problem of fly rock. And also, the smaller burden creates the problem of fly rock as well. So, proper or the optimum burden must be utilized. Generally, this is the range in general; we go for actual practical mining fields we design our blast related to this.

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## PARAMETERS AFFECTING SURFACE BLASTING

✓ **BURDEN AND SPACING**

Spacing is calculated as a function of burden, delay time in-between holes and initiation geometry.

Generally Spacing= $1 B$  -  $1.4 B$   $1-2 B$

Insufficient spacing results into -

1. Excessive crushing between charges and superficial crater breakage
2. Formation of large blocks in front rockmass
3. Toe generation in front rockmass
4. Fly rock generation

Dr. Kaushik De

Similarly, this is the criteria for general; we go for spacing; sometimes, we may go for 1 to 2 times the burden. Also, we can go for spacing. Excessive spacing may result in crossing between the charges superficial crater breakage. So, all these other problems may arise if the spacing is

not chosen correctly. So, this is the difference we have seen; this is how the different parameters affect the design of a blast. So, let us end this lecture at this position; thank you.