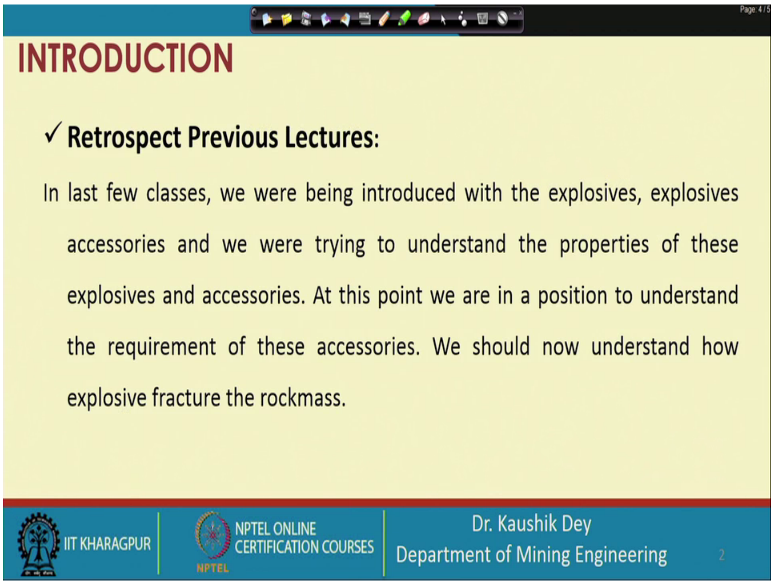
Drilling and Blasting Technology
Prof. Kaushik Dey
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Lecture – 24
Basics of blasting-1

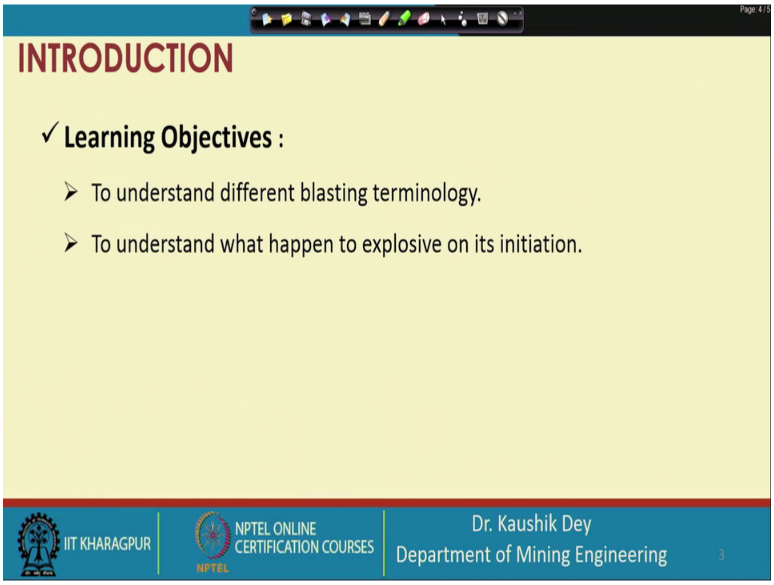
Let me welcome you to the 24th lecture of Drilling and Blasting Technology course. In this lecture we will cover the Basic of Blasting and usual let us retrospect the previous lectures.

(Refer Slide Time: 00:30)



In previous lectures we are being introduced with the explosive, explosive accessories and we are trying to understand the properties of these explosives and the accessories. And at this point we are in a position to understand the requirement of these accessories, we should now understand how explosive fracture the rock mass also. And basically we will use our previous knowledge to in this course.

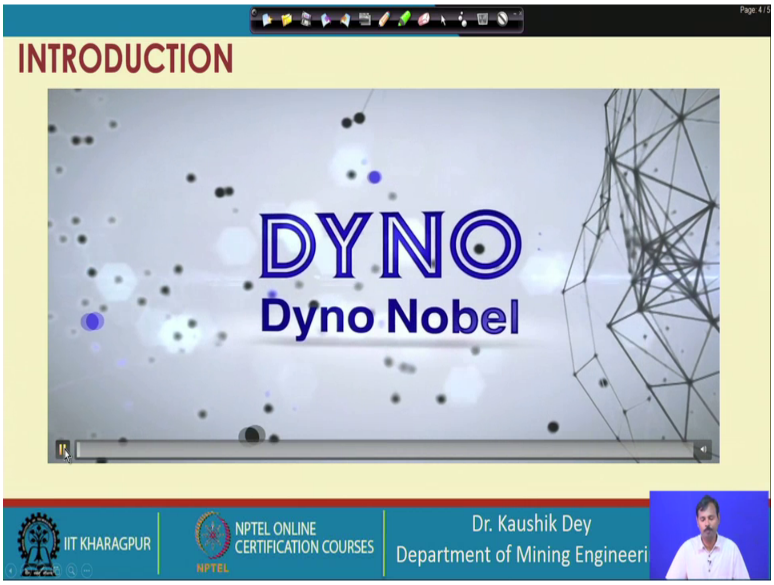
(Refer Slide Time: 01:06)



And that is why our learning objective is to understand different blasting terminology first, and then to understand what happened when we initiate some explosive compound.

And as usual let us start observe a blasting video.

(Refer Slide Time: 01:27)



Basically we carry outs this observing this video in every lecture so, that we can refresh our observe observations related to blasting. And these videos are available in the YouTube anytime you can a see n number of videos available there.

(Refer Slide Time: 01:36)

Particularly this video I have selected because this is this video is showing you in a different time scale than actually it is happened.

Say as you are observing few holes are there, which is now being initiated and the blasting is carried out. Basically this total process takes few millisecond time, but we are observing this videos in a different time scale; that means, in a very very slow speed manner. So, that is why you can observe how these initiations are carried out, how these waves are propagated, how the rock mass are being fractured, and how they are thrown in the front direction or a upper direction like that way.

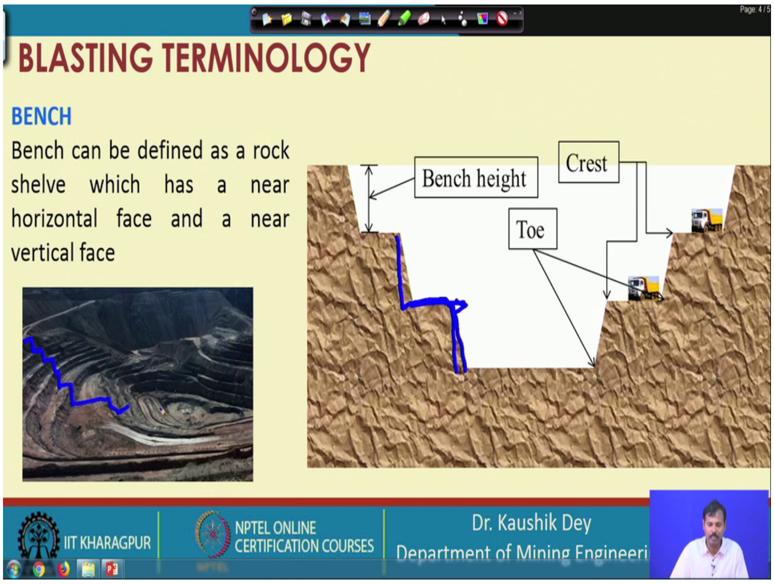
So, you can see in this video how the rock is moving in a very very slow pace, but actually it is very very is high speed one; the videos are taken in a high speed observations and then it is re shown in a very very low pace way. So now, probably you are observing the speed at which it is captured maybe 10,000 frames per second, but we are looking at those frames per frame per second.

So, basically we are looking in millisecond time. So, that is why as we are observing these are in millisecond time. We are able to see the movements of the different rocks movements of the different particular fragmented boulders, movements of the gases even if we can feel the movement of the shocks also by the wave propagation in the ground. Those are also very very visible in this case.

In this blasting we have seen that the simultaneous two faces are being blasted here. So, these videos are available from the nitro noble explosive company and this is available in the YouTube. N number of other videos are also available in the YouTube and I request that please spend some time on observing this drilling and blasting videos in the YouTube, this will give you better understanding about the different blasting technologies.

How those holes are charged, how the blasting is carried out? In this video you have seen the steaming injection is there that is why you can observe the flame which generally in most of the good videos, we will not find the flame is coming out from the blast holes. So, basically this video will give you some somewhat understanding about the blasting operations.

(Refer Slide Time: 04:44)

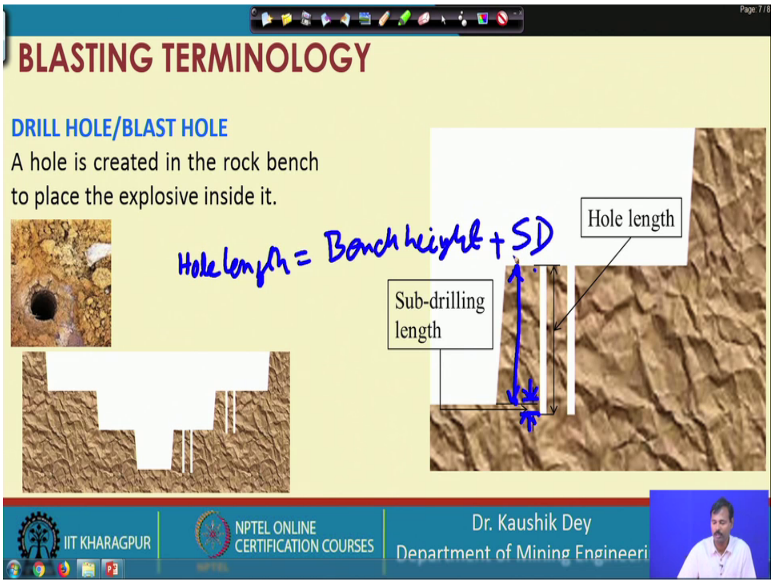


So, let us first start with the different blasting terminology and as we carry out blasting you have seen all those blasting videos, the blasting is carried out on the rock mass and how those rock mass are situated? Those rock mass are situated as it is shown in the figure. So, rock mass are situated like this and it is a tabular form and this type of rock mass positioning is called bench.

So, what is bench? Bench can be defined as a rock shelve, which has an near horizontal face this is the near horizontal and a near vertical face. So, this is the near vertical face and most of the cases when the face is under operation, you can have almost a vertical face the near vertical face is there for the stability of the bench, but in most of the practical operation size site you will find the near vertical face.

So, basically bench is a rock mass and different benches formed a mine. You can see the video of; if you can see the picture of a mine where the different benches the different benches are formed, these different benches are formed to carry out the excavation of the rocks. So, basically mining is nothing or rock excavation respiration is nothing, but the formation of the benches, and excavations of the rock form those benches. So, basically bench is the rock shelves in which we carry out our excavation.

(Refer Slide Time: 06:37)

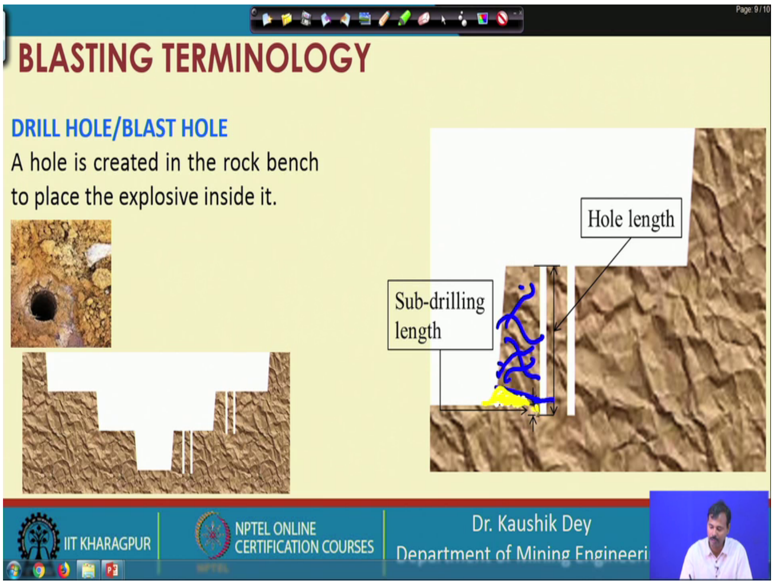


So, our next terminology what we should understand that is the drill hole. In fact, or blast hole in fact, drilling is already covered in this lecture. So, drill you know we create the hole. So, that drill hole is called a blast hole, when we insert the explosive inside the drill hole and allow the explosive to be detonated or to be exploded. So, a hole which is created in the rock beach to place the explosive inside it is called blast hole. So, initially it is a drilled hole drilled hole by getting the explosive inside that hole is called blast hole.

And if you see in the in this figure so, this is the drill hole and you can understand as this is the drill hole. You can see this is the bench height and drilled hole length is little bit more than this bench height, this additional drilling which is carried out in the drill hole is called sub drilling. So, this is the sub drilling length, this is the bench height and so, the total drill length is total hole length is nothing, but the bench height plus sub drilling length.

So, this you can ask why we should need sub billing. In fact, when will cover up the explosive rock interaction that time it will be better for you to understand this that sub drilling is essential for a bench blasting, but in this condition you should know that as we are going for some additional drilling so, it is better to get the fragmentation to the whole rock mass, so that there will not be any rock portion left at this position.

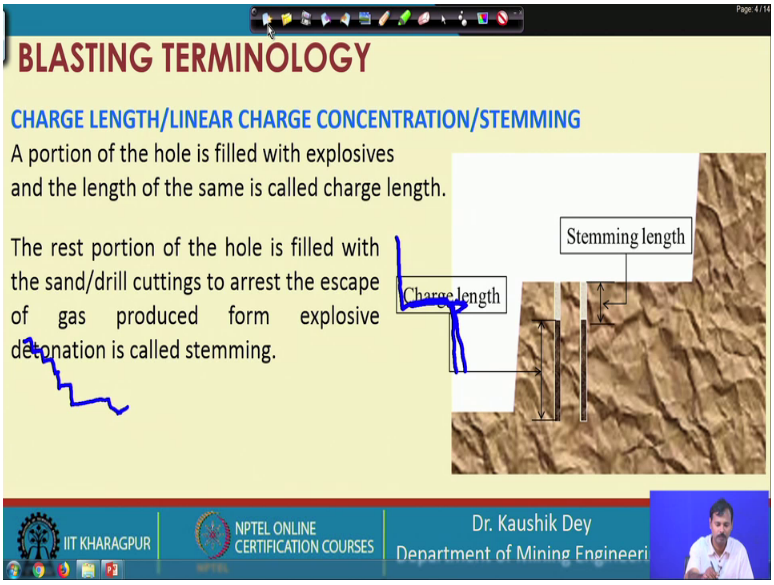
(Refer Slide Time: 08:46)



Instead of this if we c carry out drilling up to this, in this case what will happen? Our fragmentation will become like this and a portion a portion of rock a portion of rock will remain at this position, which will allow be for a ridge which will form at ridge at this position.

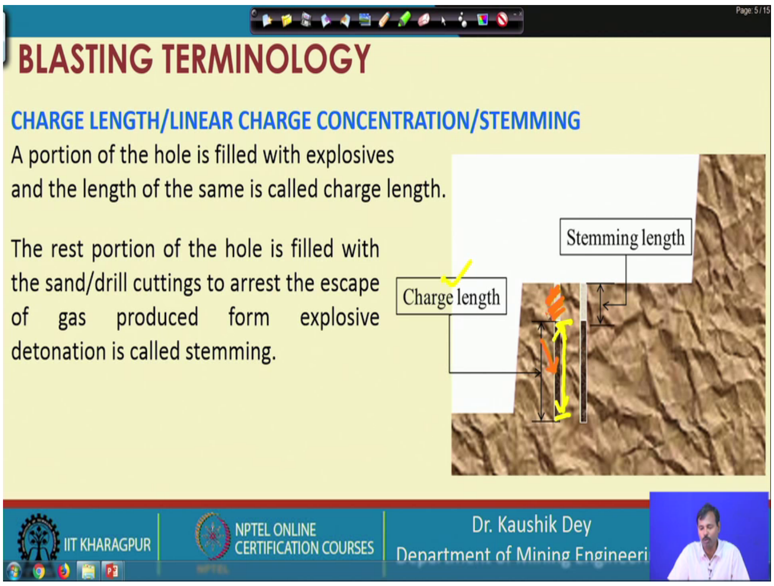
So, this portion of rock mass will remain there after the blasting, to avoid this we will go for some additional length of drilling. So, at this point this is good enough for your understanding, we will understand it in better way when we will cover of the explosive rock interaction that time it will be better for us to understand the sub drilling part.

(Refer Slide Time: 09:59)



So, the next terminology what we should know is the charge length or linear charge concentration. So, what will happen as we have carried out the drilling, you can see we have carried out the drilling and up to a certain length inside the drill hole, we have inserted the explosive and rest part we left.

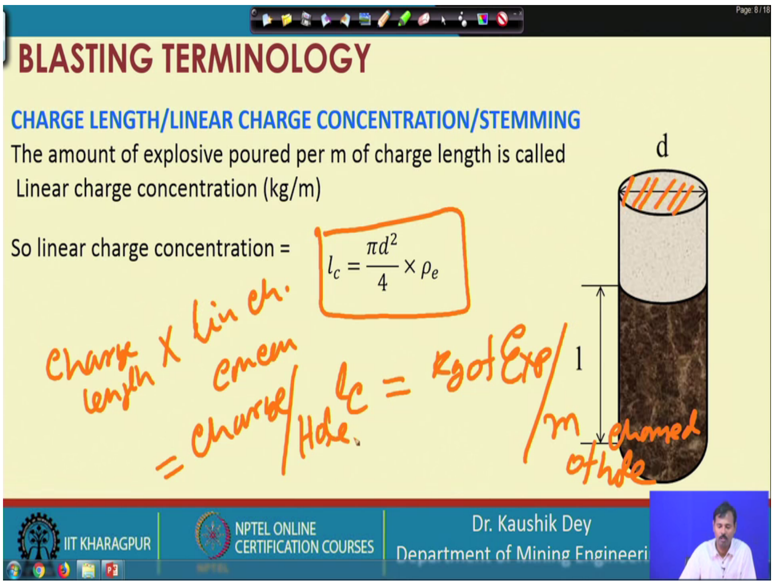
(Refer Slide Time: 10:16)



So, this explosive which is inserted into the drill hole, that length is called charge length. What will happen to the remaining portion of the hole? In the remaining portion of the hole we inserts some sandy material or some plugging system a or some plugging system at this position so, that on the detonation of explosive when the gaseous product will be formed, that should not escape from this opening.

So, what we want; we want that we should insert explosive, we should insert explosive inside the hole, the explosives are inserted here and the explosive is being detonated and the gases are kept is locked inside the hole. So, that that is why the gaseous gas pressure can be utilized for the throwing of the fragmented rock. So, for this purpose we insert explosive up to a certain length, which is called charge length rest portion of the drill hole is kept back end. And we fill that is some inert material, which is non reactive to close the opening of opening of the mouth of the hole that is called stemming length. Linear charge concentration is the term we will use which is basically show what is the length of charging of the hole or length of placing the explosive inside the hole.

(Refer Slide Time: 12:10)

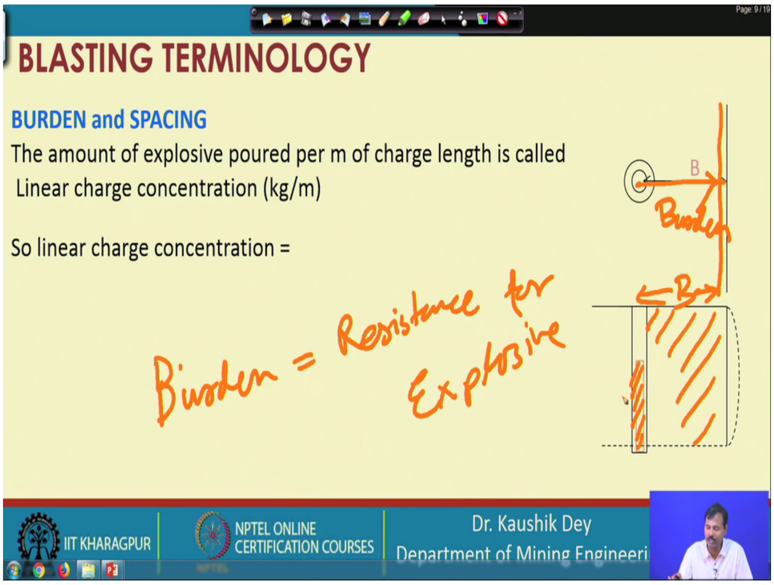


So, linear charge concentration is basically the amount of explosive poured per meter of charge length is called linear charge concentration. So, linear charge concentration can be defined using this formula, where linear charge concentration l c is equal to pi d square, d is the diameter of the hole square pi d square by 4 that is the cross section of the drilled hole and rho e is the basically the density of the hole.

So, that is basically giving l c is basically giving the kg of explosive per meter of hole, if we are considering per meter of charge poured only the charge length portion, if we are considering the one meter length as the unit. So, basically the linear charge concentration gives us the idea about that, what is the concentration we are placing per meter of the drill hole length.

So, if you are multiplying the charge length; if you are multiplying the charge length charge length into linear charge concentration you will get the charge per hole. So, kg of charge placed per hole can be calculated using the multiple using multiply multiplying the linear charge concentration with the charge length. Similarly linear charge concentration can be achieved if we know the total charge placed in a hole and the charge length by dividing the total charge with the charge length, we can get the linear charge concentration.

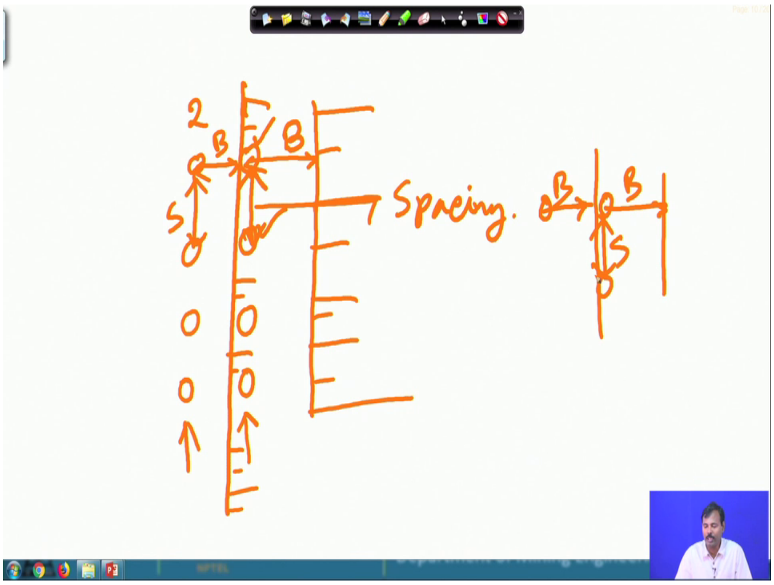
(Refer Slide Time: 14:20)



So, our next terminology is the burden spacing the amount of explosive poured per meter is called linear charge concentration and the burden. Burden is considered sorry some mistakes in the slide burden is basically the distance; the distance burden is basically the distance from the hole to its nearest free face is called burden. Basically burden can be considered as the resistance for the explosive.

Basically the purpose of the burden is that, the explosive charge explosive charge placed in the hole is of that much quantity, which is required to blast this portion of rock which is having a width same as burden. So, the explosive this charge is required to fragment the burden and the length of the bench height that much portion of rock is required to be blasted by the explosive. So, burden basically the distance from the hole to the free face is called burden.

(Refer Slide Time: 16:26)

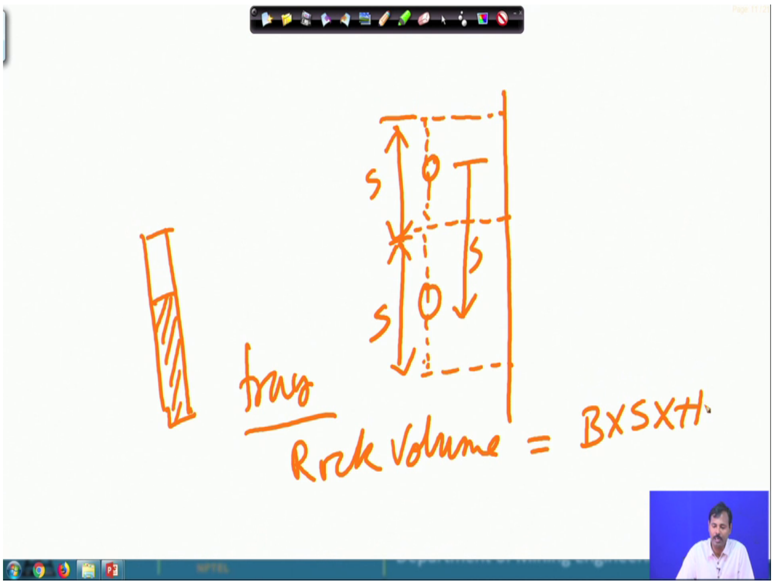


Let us draw some figure which will be better for you to understand the spacing and burden. So, this is considered this is a bench whose free face is this one and the holes are drilled in two rows this is row 1 this is row 2 ok. So, if you are considering this case, then the rock resistance from the first row of hole from this first row of hole the rock resistance is this much and this is called this is called burden.

However, if you are looking from this side, there are two holes in the first row of holes. And this is the first hole this is the second hole, and the distance between these two adjacent holes is called spacing. Similarly if you look at the second rows of hole you will find out this is the second rows of hole, and the first row of hole should be blasted ahead of the second row of hole. And so, after blasting the first row of hole using a drill at the centre you will find your free face will be shifted at this position. And thus the burden for the second row of hole will be this one similarly the spacing will be this one.

So, always the burden is the distance from the free face to the hole or the new face created for the second row of hole, the new face created from there to the second hole position. So, these are the burdens and the spacings or the distance between two adjacent wholes, which does not show any resistance. But basically where is the importance of the spacing.

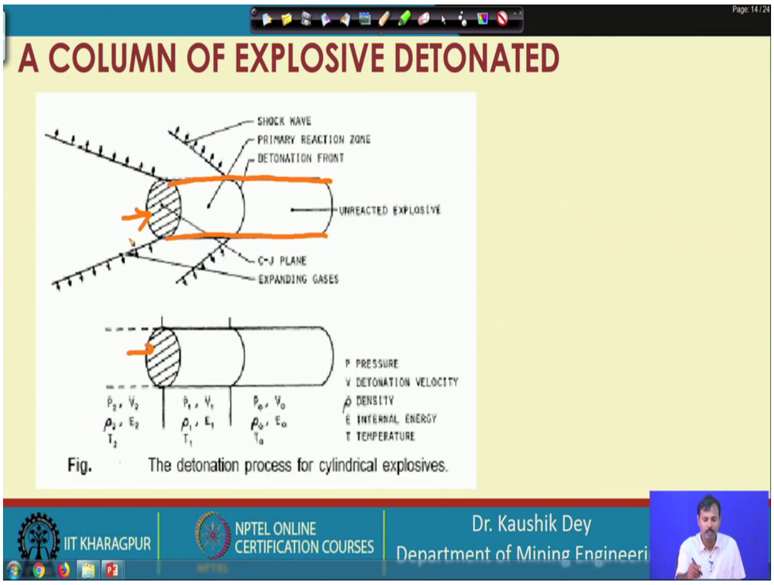
(Refer Slide Time: 19:09)



The importance of the spacing is that if you are considering there are two hole at one row, but place side by side the zone of influence of blasting for the first hole is up to this and for the second hole is up to this. So, basically this distance is spacing, which we this distance is spacing which we term as this is the distance of the spacing of the holes.

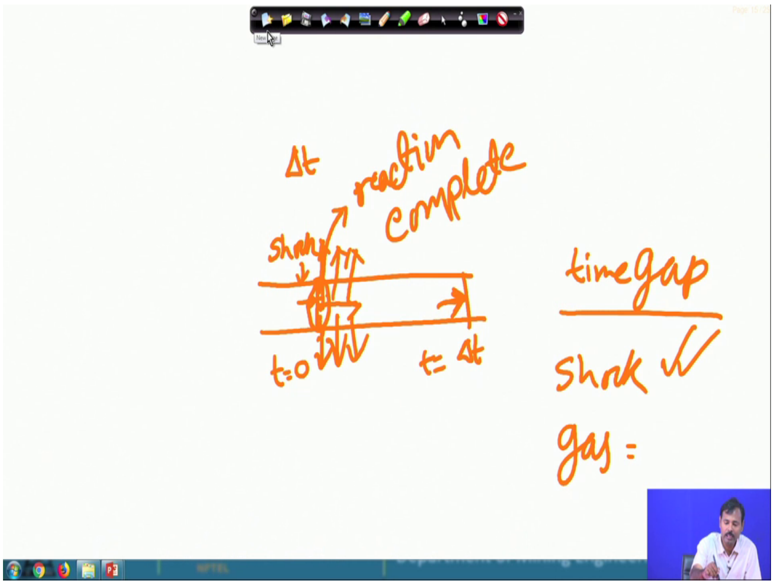
This is essentially required because we consider the charge placed the charge placed in a hole is basically fragmenting, basically fragmenting the rock volume, the rock volume which is equal to burden into spacing into bench height. So, basically spacing is the distance between two adjacent holes and burden is the distance from the hole burden is the distance from the hole to the burden is the distance from the hole to the free face.

(Refer Slide Time: 20:44)



Now, let us understand what happened when a column of explosive is being detonated. So, in this case you would say this is a column of explosive this is a column of explosive. And consider at any instant of point t the decorating font is at this position this position ok. So, let us go to fresh page draw the same diagram in that fresh page then it will be easier for you to understand say you have a column of explosive this is a column of explosive.

(Refer Slide Time: 21:50)



And at any point time anytime is instance say t is equal to 0, t is equal to 0 the shock front which is initiating the explosive is at this position. So, at t is equal to 0 your shock is at this position this is the position of the shock.

And what happened to your explosive when it is encounter a shock? Say we have already understood the explosive we have already understood the explosive accessories, and we have found basically it is not the flame the shock is basically initiating the explosive. So, what will happen to the explosive? If the moment it is getting a shock either from a detonator or from any other source, the shock is now received from the detonator to the explosive column then the shock is troubled. So, the explosive column and at point t is equal to 0 time the shock is reached at this position.

Then what will happen the explosive at this position the explosive at this position this will immediately disintegrate. The internal bonding of the internal bonding of this explosive chemicals will be a fragmented, will be destroyed and a huge quantity of shock will released will be released from this explosive position. So, what will happen at t is equal to 0, the shocks will come out from this portion of explosive as it is encountered the shocks throughout the all directions.

Similarly, it will travel to us this direction also through the explosive column also and this shock will start the initiating the explosive. So, the shock is travelling in all the direction from the explosive. And as it is moving through the explosive column, the explosive is being disintegrated and the shocks are being released in all direction from the explosive.

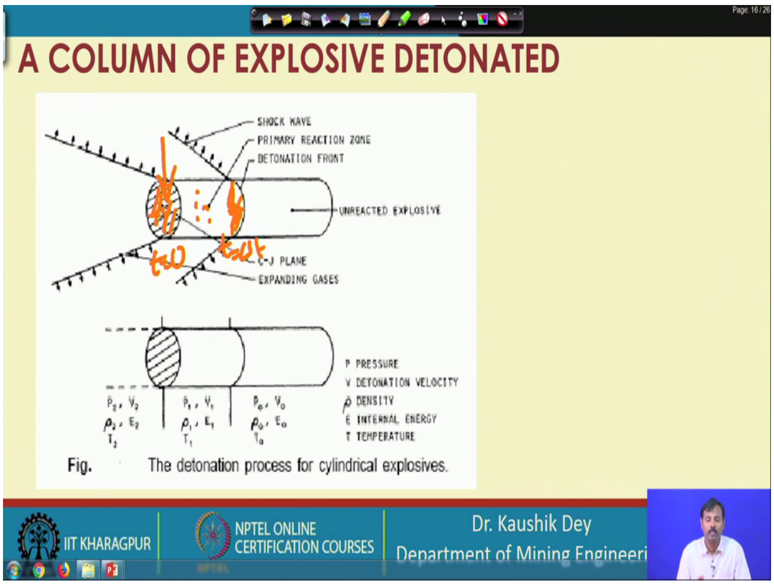
But if you are considering at this position at t is equal to 0 shock is released, the explosive chemical is disintegrated in a number of elements, but those elements are not rejoined to form the gas. So, the gaseous products which is supposed to be come out from this position is not there, only the chemicals are disintegrated into the elements shock is released the elements are trying to rejoining and shock is travelling. Say this rejoining of elements to form a gas take some delta t time, take delta time and when the total chemical reaction is complete, reaction is complete at this position by that time shock as reached at this position.

So, here t is equal to delta t, the shock is at this position by that time the reaction is complete and the gaseous products are coming out from this position.

So, what will happen as t is equal to 0 shock is released from this place, at t is equal to delta t when the shock is at this place, that time the gaseous products are coming out from the explosive. So, basically this gives the idea then there is the time gap; there is the time gap between the generation of shock and the generation of gas from explosive.

So, what will happen? The shock is released ahead of the ahead of the gas when the explosive is under detonation. So, basically this basically we are considering this, when we are who would like to know what happened if we are sending some detonation into the explosive column. And you can see that this is the shock front at time t is equal to delta t shock front as at this position T is equal to delta 0 t is equal to 0 at this position, t is equal to delta at this position, and the explosive reaction is complete at delta t time and this plane.

(Refer Slide Time: 26:56)



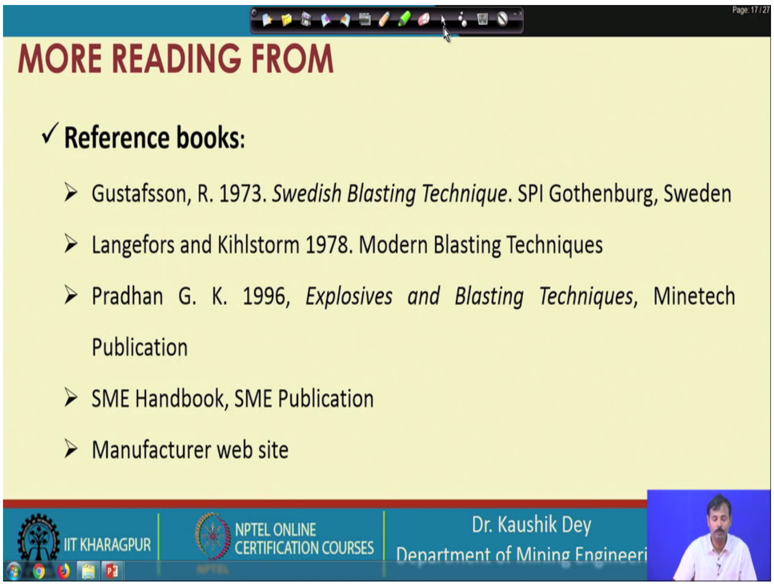
Say let me reconstruct this sentence, if in this case you can consider at any point of time you can consider the explosive column is being bounded by two plane, one is one is at this plane where the reaction is complete, another is this plane where the reaction on set as the shock front at this position. And in between these two the explosive already release the shock, but the reaction is under ongoing condition. That means, the elements are checking time to form the gaseous product. So, the basically this chamber is in one side it is the explosive reaction is complete, another side shock is on set and ahead of that the un reactive explosive column or undisturbed explosive column is there.

So, this in this chamber we can consider this is surrounded by two plane, this one plane is called shock plane this plane is. So, called C-J plane or Chapman-Jouguet plane anytime we are describing the explosive properties say detonating pressure is this much. So, all these properties gaseous and the energy released this much. So, all these properties are basically if we are mentioning to be at the C-J plane that mean think; pressure at C-J plane ah energy released C-J plane. So, all these are considered at C-J plane.

So, now basically form this lecture we understand that we understand that explosive on detonation, it is immediately disintegrated into the elements releasing the shock, the shock starting traveling all the direction. Then it take some time to form the gaseous products. And that means, the release of gas from explosive detonation is a little bit quite the release of shock

So, shock front is moving ahead in fact, today's video if you look back the video again you will find out the shock is being propagated in all direction ahead. You can see the undulation on the benches undulation on the benches because of the shock, ahead of the fragmenting and releasing of the gas.

(Refer Slide Time: 29:47)



So, that is why I request you to observe those videos and basically we are able to understand that this position the energy in the form of shock is released ahead of the energy released as the gaseous products hot pressurized gaseous products. So, shock is released ahead, and gas released after the shock is released. Basically we will use these criteria for our blasting purpose while using the explosive for the fragmenting the rock. And we are able to utilize this time gap between the shock release and the gas released from the explosive for our benefit.

So, there are few reference books, you can go through those books for understanding little bit more on this elaborations of this. I believe that you have able to understand the blasting terminology what is burden, what is spacing, what is sub drilling, what is stemming, what is linear charge concentration bench etcetera you are able to understand now, but if anyone is placing any problem they can go through the grocery, which is available everywhere ok.

Thank you.