Drilling and Blasting Technology
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Lecture – 28
Surface blasting-1

Let me welcome you to the lecture number 28 of Drilling and Blasting Technology course. In this lecture we will discuss the techniques of Surface blasting.

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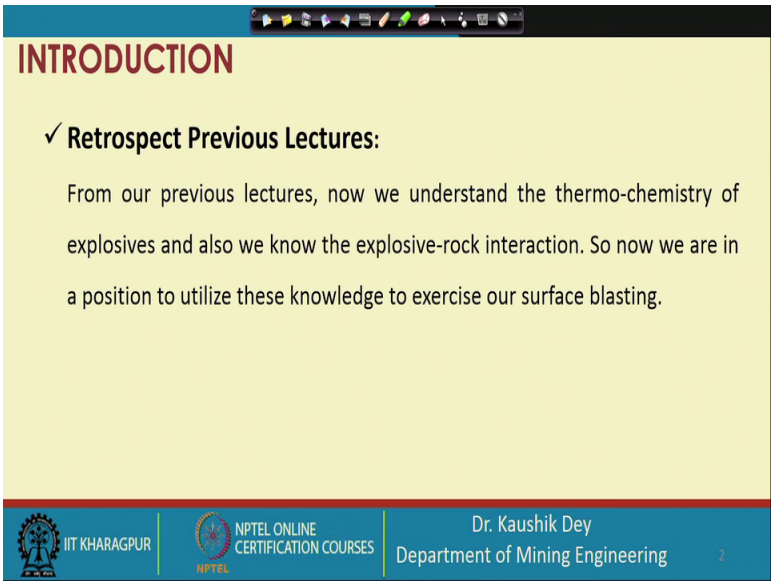

So, let us see so far what we have covered. So far we have already understand what is explosive, we have understand what are the different explosives are there, what are the different explosive accessories are there. Then we understood what are the different properties, we look into the explosive and the explosive accessories, how those properties can be tested, how the explosive can be stored. Then we understood what is the thermochemistry of explosive, means what is happened when some explosive is denoted and second is that how the explosive is interacting with the rock for fragmenting the rock.

So, so far as per our knowledge we know the thermochemistry of the explosive we know the explosive rock interaction. So now, we are in a position to utilize this knowledge to exercise our surface blasting. Surface blasting means when the blasting is carried out in the open air means, it is observed from the earth crust, then it is called surface blasting. If

it is carried out below the ground, it is called underground blasting. So, how it can be carried out in surface blasting that will be discussed in these lectures.

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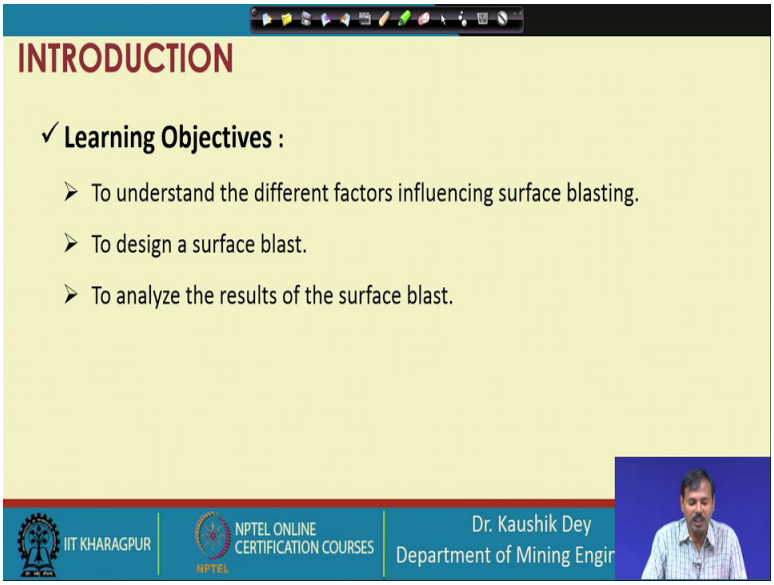

So, our learning objectives for this lecture is to understand the different factors influencing the surface blasting to design a surface blast, and to analyze the result of the surface blast. So, basically our surface blasting has to be carried out, then we have to design the surface blast, and we have to analyze the result of the surface blast. But for that we have to see our objective also, but before that let us observe this video. In this video you can have some knowledge about how the blasting is carried out in the surface; you can see a drill hole is drilled.

We are inserting the explosive which is in the cartridge which is inside this cartridge, which are inside this cartridge which are inside this cartridge. And you can see this explosive cartridge is already one is inserted, then this is the pink one is the booster the nonill is fitted in the booster. Now we are insulting the booster, because the explosive cartridge is inserted is not cap sensitive. So, the cap sensitive is the booster one. So, booster is required which is connected with the detonator of the nonill. So, the initiation comes with from the nonill. We will initiate the booster then the booster will initiate the explosive.

So, we are basically inserting we are basically inserting the, booster into the cartridge. So, we have already put some explosive there, explosive cut is there. Then we have

inserted the booster fitted with the nonill, then we are inserting the other explosive cartridge. And see you have seen a cut mark is given in the explosive cartridge. This is carried out so that the cartridge will lose it safe, and what will happen? The cartridge will take the shape of the whole.

So, basically this will give the direct contact between the explosives and the rock wall. So, for giving that one small cut is provided in the cartridge of the explosive. You can see instead of putting the cartridge explosive, we can use the bulk loading explosive this is the ammonium nitrate fuel oil ANFO drilled ANFO is being formed inside the hole. This is bulk loading explosive you can see this ammonium nitrate fuel oil which is in drilled condition is being pumped inside the hole. And this tape is measuring the basically the length of the chart (Refer Time: 04:35).

So, previously the whole length is known to us. We are trying to measure the remaining length of the after the charge length then directing that we are getting the charge length. So, basically by using this, we are providing bulk explosive these are the bulk explosive trucks, emulsion slurry and ANFO of an heavy ANFO is also used to those who are bulk loading time explosive and directly used into the hole.

So, basically this is the way we carry out the charging in the, we carry out the charging in the blast holes. And you can see this blasting is being carried out after charging connecting those holes, the blasting is carried out.

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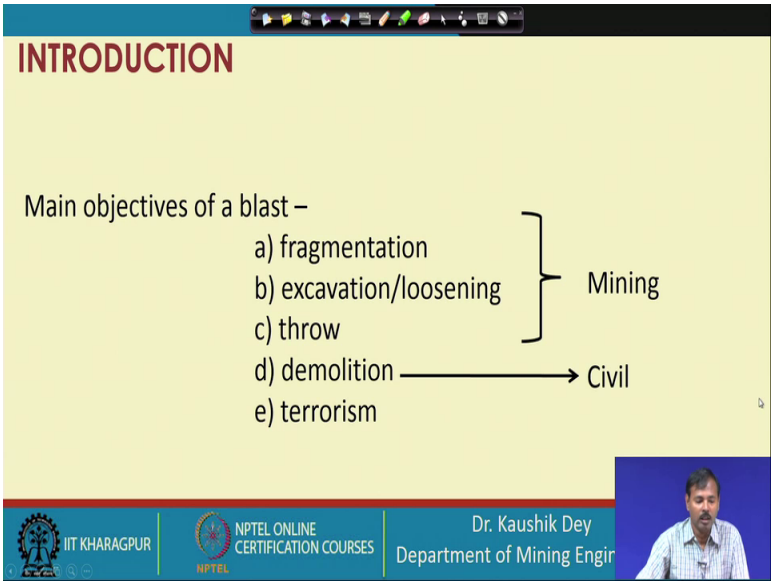

So, for carrying out blasting we should have some object. And in surface blasting while we are carrying out the blasting, our objectives are often different on type to type the blasting is carried out.

You can see in this case; the blasting is carried out maybe for achieving the fragmentation. That is the smaller fragmenting the rock into the smaller pieces. We can carry out the escavati blasting for excavation of loosening the rock. We can carry out blasting for throwing the rock mass to distance. We can carry out often for the demolition and the terrorist carry out blasting terrorizing the a world. So, our objective as a mining engineer is to carry out the blasting surface blasting for the fragmentation, or for the excavation loosening, or for saying of the blasted material.

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So, if you look into this we will find out what is there in blasting. There is a rock which has to be blasted. And how it will be blasted for that we are having the explosive. Now whatever rock is there, that is the, that is totally uncontrolled for the user because he cannot alter the rock. So, rock is basically uncontrollable factors which user cannot change, cannot alter.

And explosive I mark it as the semi controlled, because you can say you can easily change the explosive, but often it is not possible. Say, obviously the user has the right to purchase the right explosive, but what will happen often the decision may be made from the headquarter of an a bulk of explosive have already ordered purchased. Now you are

forced to use the explosive may be possible on that location that explosive may not be suitable enough.

So, the explosive is semi controlled, rock is uncontrolled, but as the blast designer or as the blaster we have to gives the desired result and this result maybe in terms of fragmentation. It may be in terms of throw of the morphine. It may be in terms of the shape of the morphine. It may be in terms of the ground vibration generated which is not hindering the people. So, the results may be of different type, but the objective of the blaster is to address those result with the uncontrolled rock and with a semi controlled explosive.

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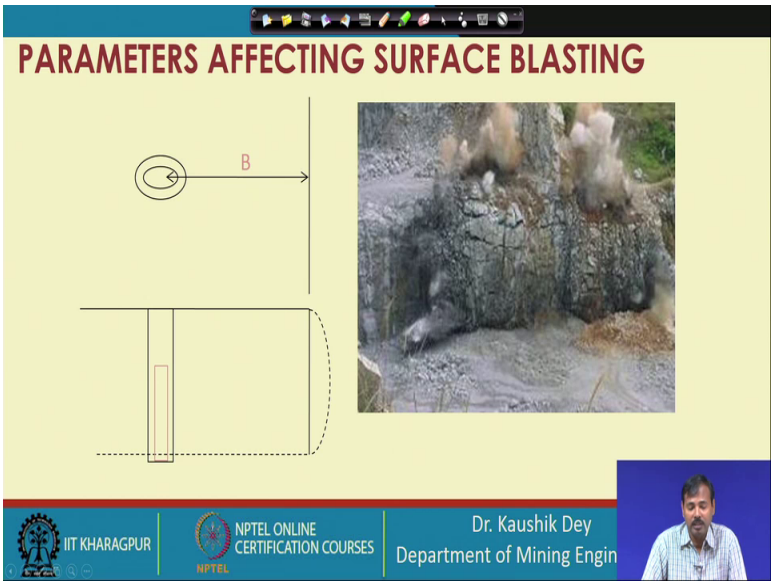

So, before carrying out a blast design in the mine to achieve the desired results, let us understand what are the different parameters that is affecting the surface blastings. We have already discussed in our rock explosive introduction part, that there is a burden that has to be decided, and the burden is depending on the explosive rock interaction. So, that is already discussed previous in previous lecture.

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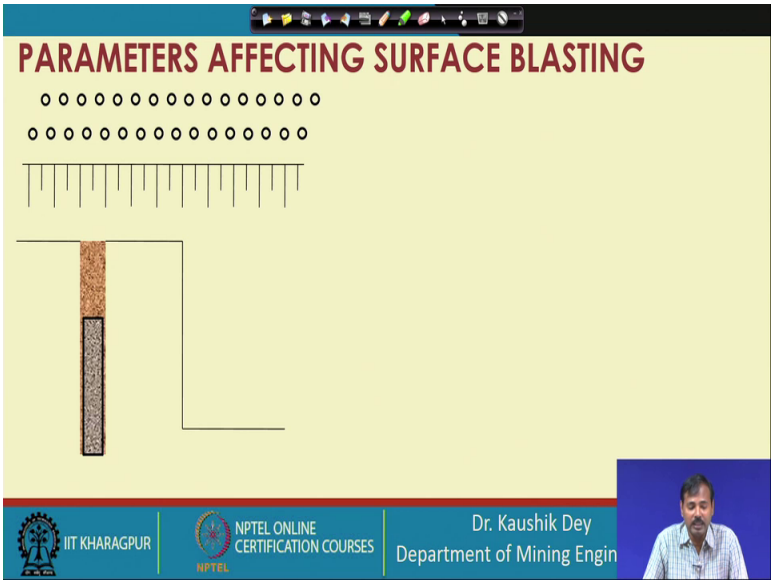

And what we carry out in our glass design? We will carry out this is the plan and sectional view. We have to give in design that what is the burden; that means, the distance from this place to this place, this is the distance.

So, this burden distance, the spacing between the hole, these are the spacing distances. The charge length, required charge length, the sub drilling requirement, the additional drilling carried out over the bench face, the stemming length requirement. And what should be the size of the blasting? What should be the number of holes? What should be the initiation patterns? So, these are the basic designing criteria to be fixed by a blast designer for surface blasting.

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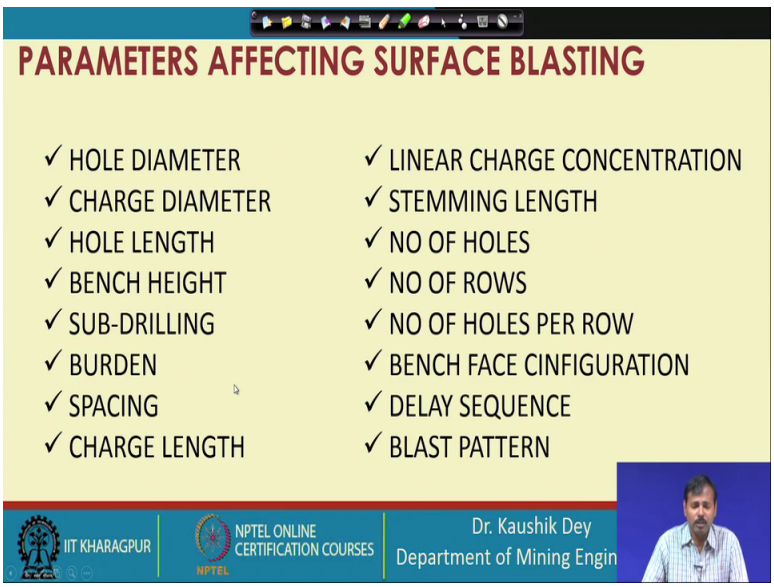

So, let us look into the details of this, our parameters are hole diameter, charge diameter say in case of bulk loading explosive. The hole diameter is same as the diameter, but in case of cartridge explosive the charge diameter is little bit lesser than the hole diameter. Then the hole length which is bench height plus the sub drilling length. Then the burden spacing charge length, stemming length, linear charge concentration that is the in per meter of hole length how much how much charge is there.

Number of holes, number of rows, this is basically giving you the idea about the magnitude of the blast; that means, in one blast round, how much material is being blasted how much kgs of explosives are used. Number of holes per row, bench face configurations sorry for that little bit spelling mistake that bench face configuration; that what is the configuration of the bench face then delay sequence and the blast pattern.

So, this is basically the parameters, which is affecting the surface blasting.

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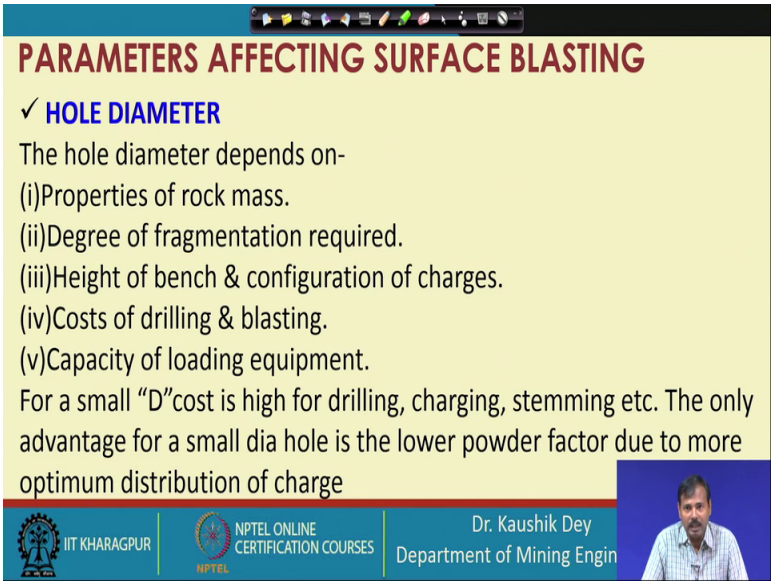

And let us go into this in one by one how these are affecting say hole diameter. So, what will happen? The diameter of hole depends on the rock mass properties. Degree of fragmentation required, height of bench and configuration of the charge cost of drilling and blasting capacity of the loading equipment.

Now, in this case, let us discuss about 2 things. First is the small dia if the diameter is less and if the diameter is more. Say suppose, if the diameter is less then what will

happen? The as the diameter is less it is containing lesser charge. As it is containing lesser charge, we have to provide more number of holes in a given space that means, the special charge distribution will be better, if the diameter is small as the burden spacing etcetera all these parameters are also less.

So, that is why charge distribution is better if you are using a small dia explosive, but this will give you higher cost of dealing, higher cost charging higher cost of stemming etcetera. But you will observe the result fragmentation is better controlled, throw of the rock is better controlled, but in other way you cannot achieve a charge production target using this because the production for blast round is very, very less.

Instead of this, if you are having if you are having a large dia hole, then you can have a large burden, large spacing; that means, the desired fragments size will be a larger size, and you should have a large making equipment which can handle those large size. But the production target can be addressed is very high; that means, for a large mines, highly productive mines, large dia blast must be carried out with larger burden of spacing. And it is also reducing the cost of drilling because the drilling requirement is less.

But as the special distribution of the explosive is less, poor in that case, you will get you will not get the proper fragmentation or lower size fragmentation your average fragmentation size will be much much higher than the small dia hole. So, that is why often we observe large dia holes for the highly productive mines. And for low productive mines we may think of the small dia holes.

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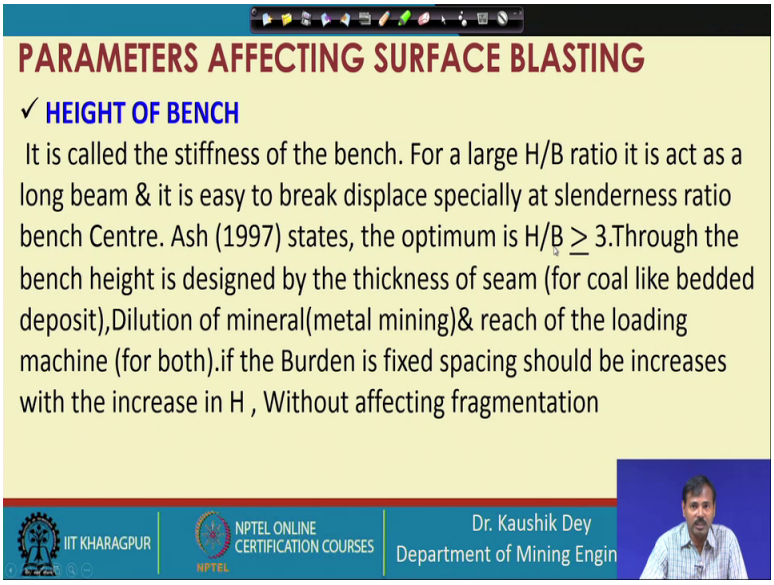

Next is bench height basically bench height is giving us the stiffness ratio or stiffness of the bench. For a large H by B ratio, it acts as a long beam. And it is easy to break the or this place this bench as the slenderness ratio of the bench is low. Basically are good for h by b ratio must be greater than 3, then the better or optimum result may be achieved.

Though the bench height is designed by the thicken of the seam for coal like bedded deposit, or sometimes it is often dictated by the capacity of the mucking equipment, then the dilution of the mineral which is allowed over the bench etcetera in case of metal mines. These are basically the parameters which also restrict or you can consider those are the constant of deciding the bench height.

But if the burden is fixed, spacing should be increases with the increase in bench height of the bench.

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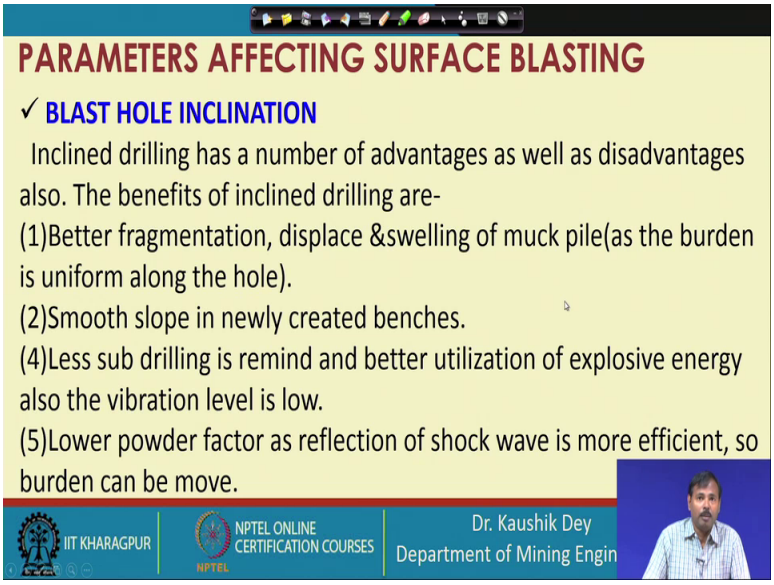

Blast hole inclination is a parameter that affects surface blasting. Often we neglect this one because the inclination of an induced more drilling error in the practical field. So, inclined drilling has a number of advantages as well as disadvantages also.

The benefits are that in inclined drilling it gives better fragmentation or throwing of the rock. It gives smooth slope in newly created benches. Sub drilling requirement is less, better utilization of the explosive energy is possible designing is also easy, because always the burden remain same along with the bench face. Powder factor is also low because of the reflection of shock wave is more efficient in case of this.

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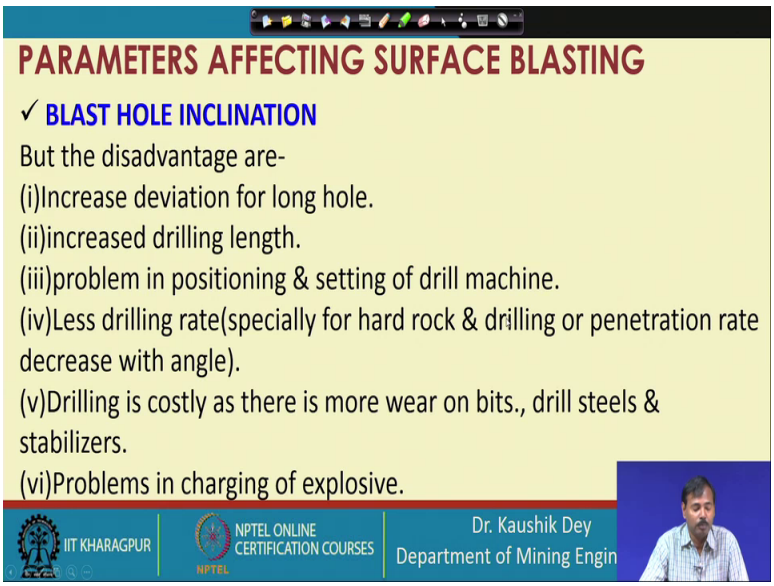

But the disadvantages is that the deviation of the drilled holes are more specially for the long holes. The drilling lengths are also more, often drilling length basically drilling cost maybe may often maybe significant in those cases this increased drilling length may alter your economics of the blasting. The drill machine positioning and the setting of the boom is very, very difficult expert bill operator is required for that. Inclined drilling, drill rates is very, very less specially for the hard rock, penetration rates are also less. And drilling is becoming costly as the wear and tear on the bits drill steels a are more.

Often if we are carrying out the charging of the explosive is the cartridge explosive. Often there may be a in jamming of the explosive in between of the drill holes that may also create the problem.

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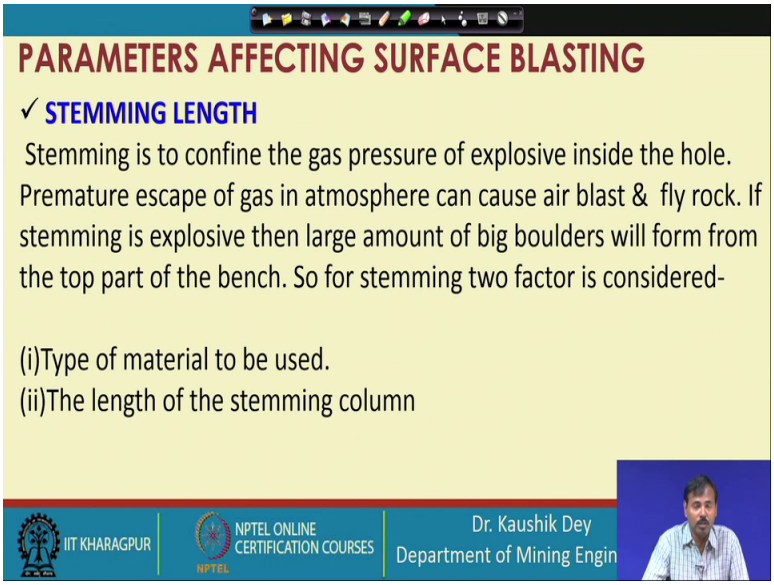

So, these are some problems associated with the inclined drilling. And that is why the inclined drilling often is not very preferred in the practical mining applications. Stemming length is basically the inert place in the hole which is filled in the inert material. Stemming is carried out to confine the gas pressure of explosive inside the hole. Premature escape of the gas in the atmosphere can cause air blast and fly rock. And we need the utilization of that gas pressure for throwing of the fragmented rock in the front direction. So, that is why confinement of those gas generated gas inside the hole is essential.

If stemming of explosive stemming if it is large, then big boulders may form in the top part of the bench. However, the stemming for considering the stemming, we consider 2 factors, one is the type of material to be used, another is the length of the stemming column.

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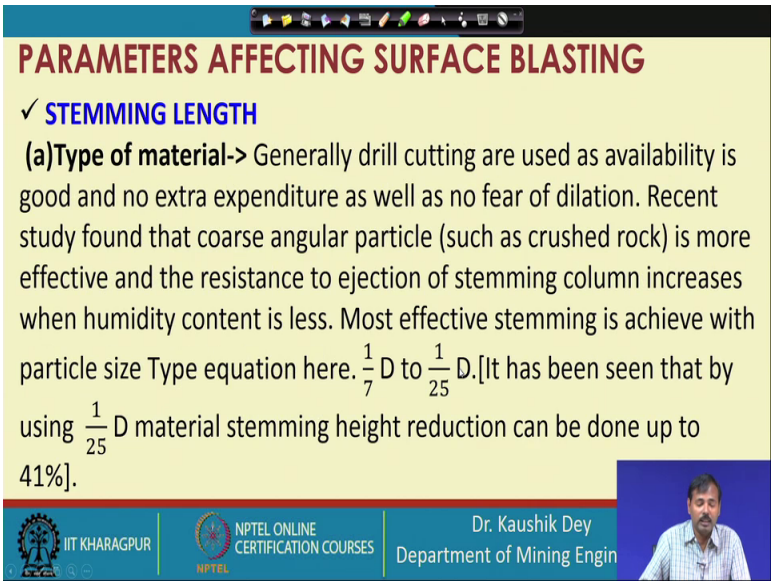

So, let look into this 2 type; of type of material generally mostly used drill cuttings as the material which is used for the stemming material. This will give us the less cost because transportation of the stemming material is not required.

Second is that it acts as the similar material with the host rock with host rock on which the blasting is being carried out. Recently study found that coarse angular particle is more effective and the resistance to ejection of stemming column increases when humidity content is less. So, that is why dry coarse and strong particle is preferred in as a type of material in the stemming material. Most effective stemming is achieved with the particle size of 1 7 D to 1 25th D if the particle sizes in that range. So, then that is acting as the best stemming material.

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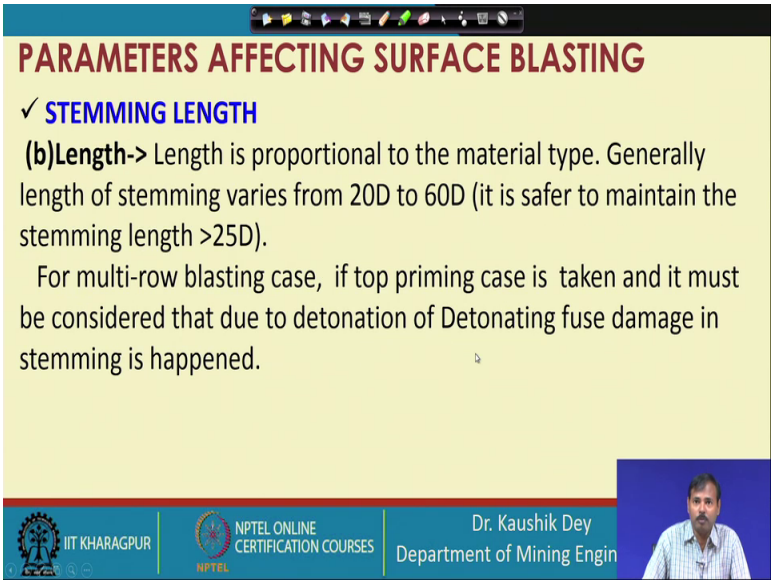

But because of easy availability of the drill cuttings, mostly we carry out the stemming with the drill cuttings only. A stemming length is in general a proportional to the material type, length of stemming varies from 20 D to 60 D this has thumb rule, when we will design we will see how it is varying. It is safer to maintain the stemming length always greater than 25 D which will reduce the chances of the stem ejection of the stemming.

For multi row blasting case, if top primings are carried out, it must be considered that due to detonation of the detonating fuse, damages carried out in the stemming. So, that is why if the down the hole initiation is carried out by the detonating fuse, that may damage the stemming significantly prior to initiating the original explosive. So, that part may be taken care of and often, it is desired that the instead of using detonating fuse as the down the hole connection. Nonil can be better preferred for down the whole connection in those cases.

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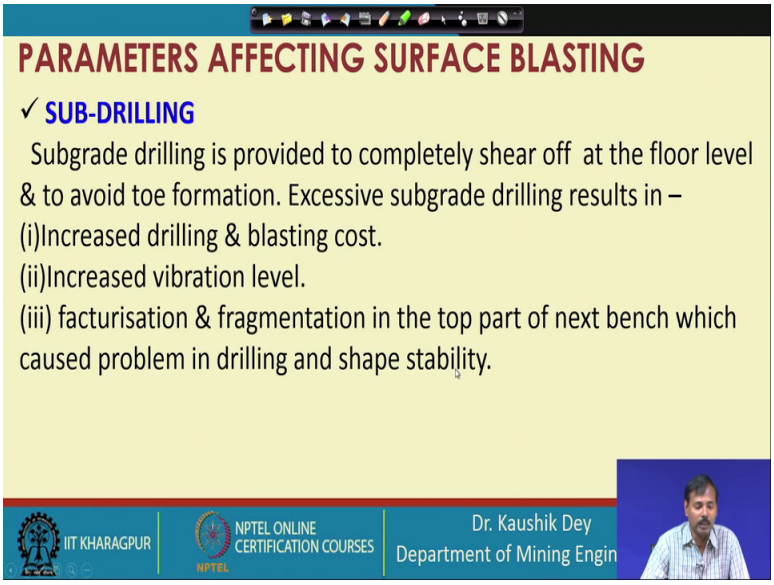

Sub drilling as we discuss already the sub drilling is the additional drilling out drilling carried out below the floor of the bench. So, this sub drilling is provided to completely shear off at the probe level and to avoid the toe formation. So, optimized sub drilling is essential because if the sub drilling length is less, then there will be toe of the shearing of up to the floor level will not be possible.

If the additional sub drilling is carried out, then the ditch may be formed in case of in the floor part. So, that is why additional sub drilling length may result into increasing drilling and blasting cost. Increase in the vibration level fracturization and frangmentation of floor part which may be the top part of the next bench. Fracturing will carried out there then the, that will create the problem while the drilling is carried out for the next benches.

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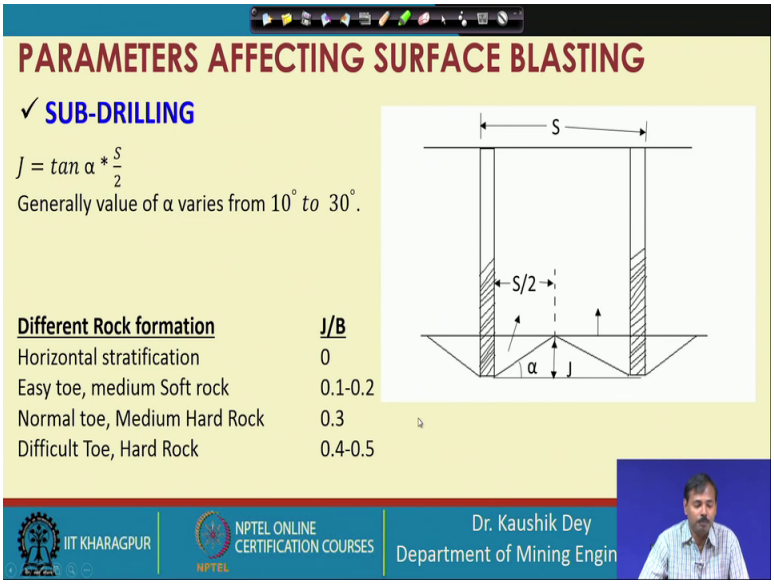

Sub drilling maybe calculated using this equation J is equal to spacing by 2 multiplied with the tan alpha where the tan alpha is varying between 10 degree to 30 degree. So, there is a thumb rule, we can see in this picture the equation is given so that considering the alpha is equal to 10 degree or between 10 to 30 degree, in the sub grade the sub grade drilling length or sub drilling length maybe calculated.

But some rules are given for the different rock formation what could be the sub drilling by burden ratio. For horizontal stratificates stratify starter there no drilling is required. This is because most of the bedded deposit or stratified cases, they are easily separable in layers.

So, if the blasting is carried out in one layer, sub drilling is not required because the toe formation cases will not be there automatically due to the shock the top the layer on which the blasting is being carried out, that will be separated from the layer which is placed in the floor level. So, as they are easily supportable that is why sub drilling is not required in the horizontal stratified layers. Specially, like coal mines like limestone mines in those cases our sub drilling may not be required. Specially for the bedded deposits.

Where the rock is soft or the toe is easy, maybe a little bit factorization allow the mucking machine to muck that one or clear the floor, or clear the toe if at all it is formed, in this process the sub drilling by burden ratio may varied between 0.1 to 0.2, because a little bit fracture will allow the excavation of the toe part or in the normal medium hard

rock it sub drilling by burden ratio may be up to 0.3. And in difficult to or a very hard rock condition, it should vary between 0.4 to 0.5.

So, basically this parameters are easily fixable from this documents.

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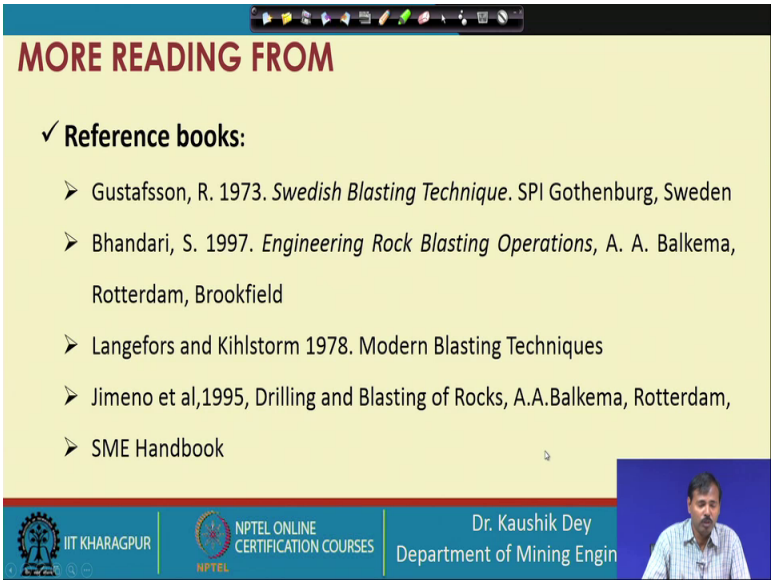

We will continue the effect of the parameters, how they are influencing our blasting results in the next class also. But before that it is desired that this additional reading must be carried out from this books Gustafsson Bhandari Langefors Kihlstorm. Basically Gustafsson and Langefors Kihlstorm carry out the blast design techniques. Specially, the Swedish blast design techniques. Jimeno Et Al is a very excellent book which described this effect of this parameters also, or as well as the good blast design also criteria is given also there in Jimeno.

And SME handbook is also covering all this part. So, additional reading must be carried out from these books. And we will continue in this topic in the next class also.

Thank you.