Drilling and Blasting Technology
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Lecture – 13
Drilling Pattern – 2

Let me welcome all of you to the 13th lecture of Drilling and Blasting Technology course. In this class we will continue our last lecture the where we are discussing Drilling Pattern.

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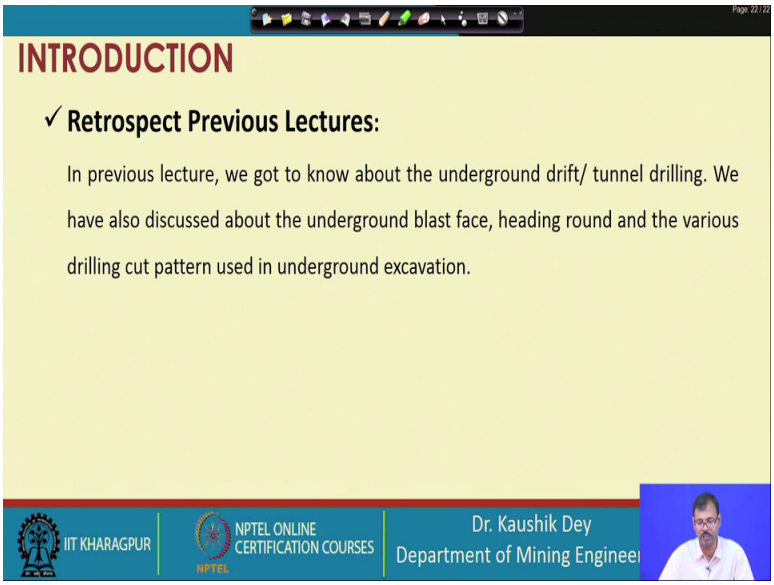

So, we will continue the drilling pattern, but let us retrospect what we have carried out in the last class. In previous lecture, we got to know about the underground drift and tunnel drilling. In fact, how the underground drilling is little bit different from the surface drilling, that also you have discussed in the last class.

So, in underground drilling, we have we need to create one additional free face first before we excavate the main rock. So, basically this drilling pattern which we are discussing is only for that area, where the additional free surface has to be created. So, this different patterns are basically designed to create another new free face for carrying out the blasting for the remaining rock mass.

So, we have discussed about the underground blast face heading rounds those different terminology has been discussed in the last class. And in last class we have already discussed wedge cut and pyramid cut. So, wedge cut basically the cut where the wedge has to be formed first for creating an initiation of a new free surface area, then that has to be widened. So, that complete wedge was discussed in the wedge cut pattern. Pyramid cut is basically a double wedge cut, where both the horizontal and vertical wedges are created to carry out the new surface area.

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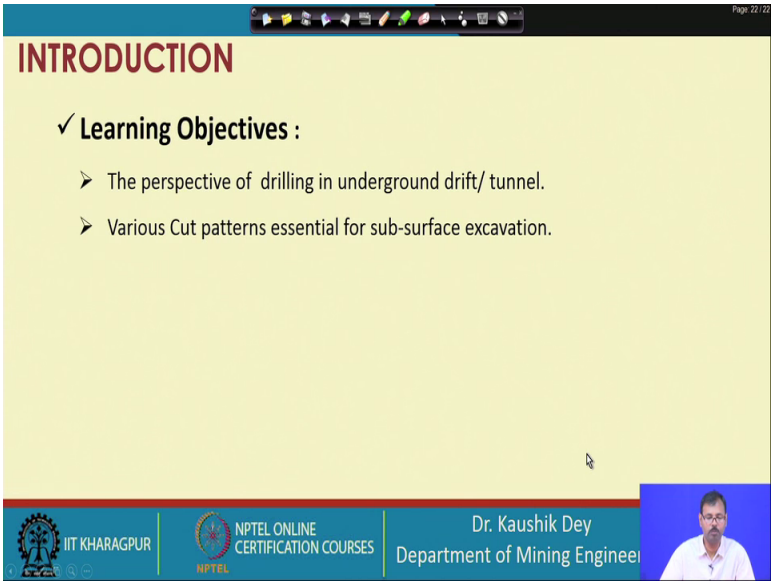

So, basically we have discussed that one let us all again look what was our objective of for this lectures. Our objective was to understand the perspective of the dealing in underground drift and tunnels with particular reference to the different cuts. So, the various cuts presents essential for the subsurface excavation blasting are being discussed in this lecture.

So, basically our objective is to understand this cut from these lectures. And so, far we have covered already up to pyramid cut.

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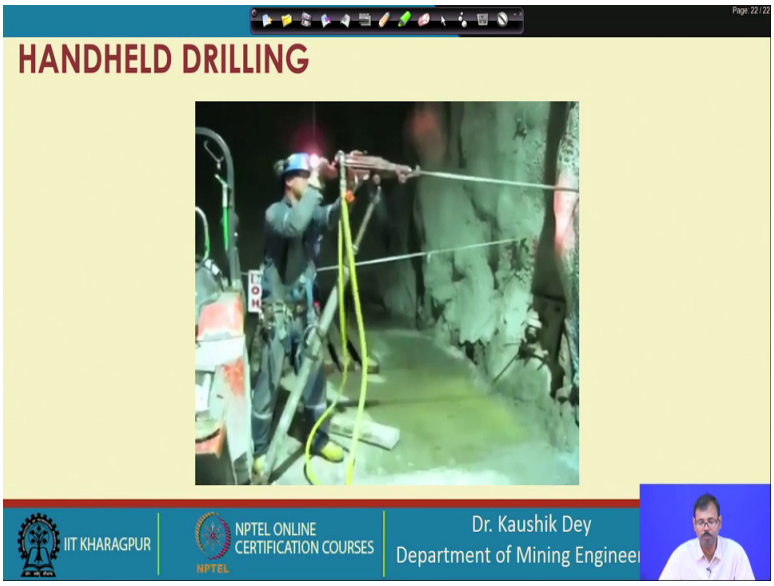

But before starting this main lecture, let us observe 2 videos. One basically showing us, this is the manual drilling. Say most of the times you will find out that in underground, the sufficient room space is not there. That is why heavy machines are not allowed to be used or there is no scope of using heavy machines. So, most of the time drilling etcetera are being carried out manually. So, this is one jackhammer drilling; manual jackhammer drilling is being carried out, to take the load of the machine basically this air leg is being used.

So, what is happened? This basically creates a little bit problematic situation, where the drilling control of drilling length control of drilling direction is very very problematic. As the manually it has to be carried out of 2 to 3 persons are being engaged for carrying out drilling. So, that giving proper directions is very very problematic in case of manual drilling.

However, if you look into the second video, where mechanized.

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Where mechanized drilling is being carried out, you will find out the accuracy of the drilling angle, operational excellence, accuracy on the drilling length.

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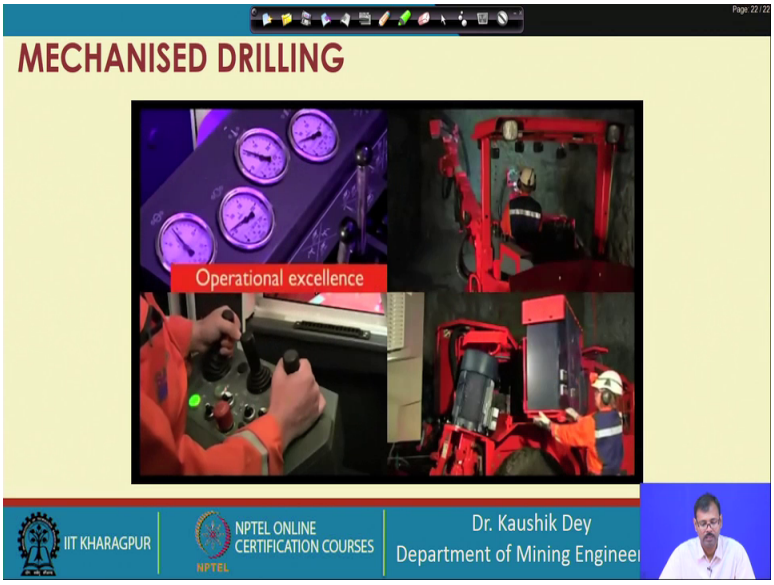

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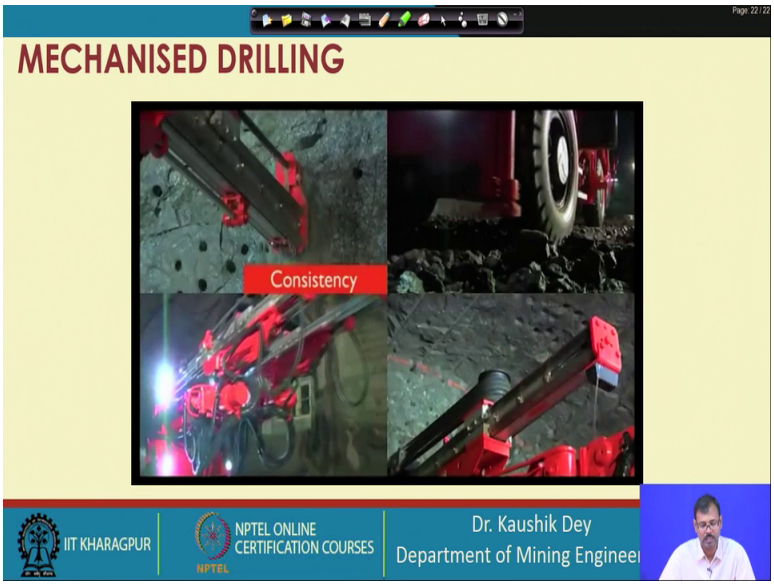

All these are consistency in the feeding in the feed pressure and achieving the constant.

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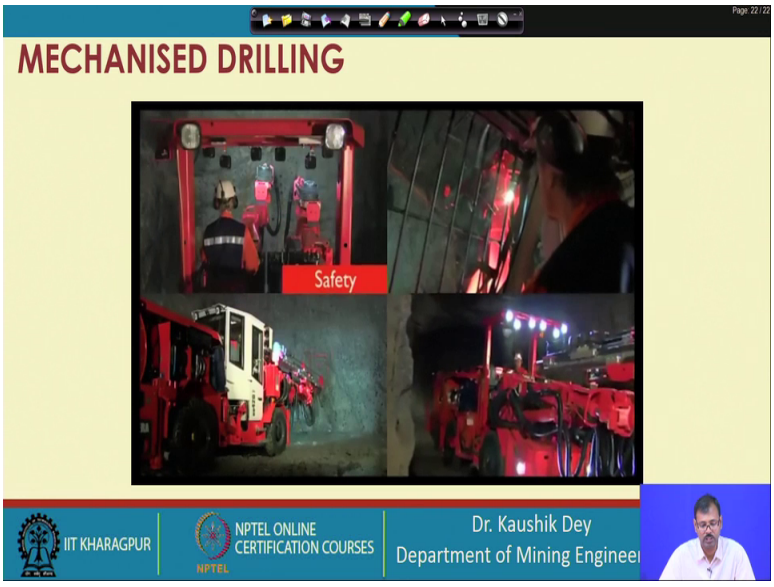

Penetration rate all these are possible to achieve if we are having mechanized drilling system.

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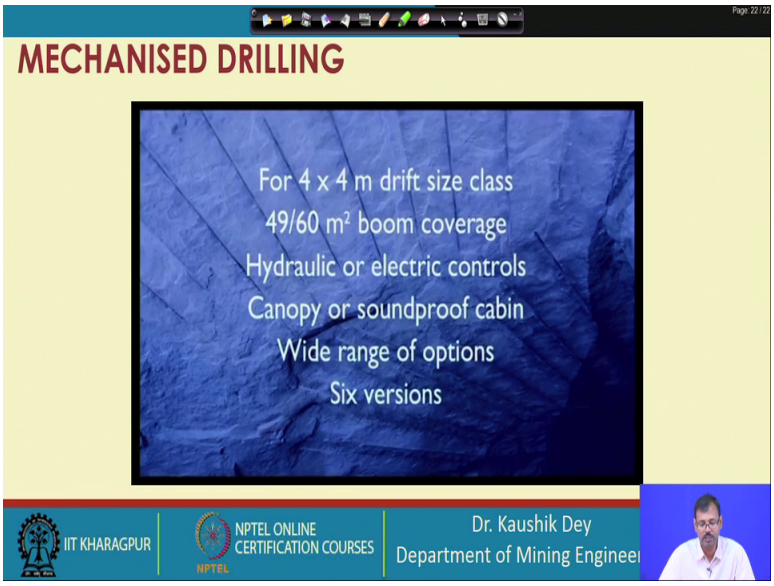

In fact, nowadays modern underground drill machines are available; where computerized drilling is carried out automated drilling is carried out with multiple boom rigs. So, multiple rigs are available in fact, tunneling etcetera where 100 square meter blasting has to be carried out faces are available blasting has to be carried out, 8 boom jumbos are also available to carry out drilling and blasting there.

So, you can see this is the boom jumbo. In this 2 boom jumbo there are basically 2 drilling rigs. You can see this is one drilling rigs, another drilling rigs is in the site. So, simultaneously 2 holes can be drilled. And as it is mechanically operated drilling length may be more.

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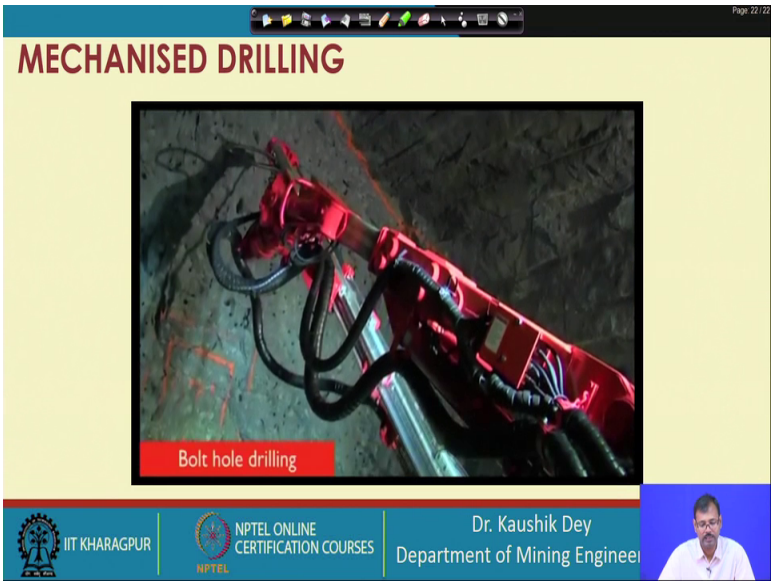

As the machine is very very computerized and hydraulically controlled, the angle can be monitored by the operator proper angle can be given. Suppose, in last class we have discussed wedge if the 60-degree wedge angle is required; that 60 degree wedge angle can be achieved if it is carried out using this type of computerized machine.

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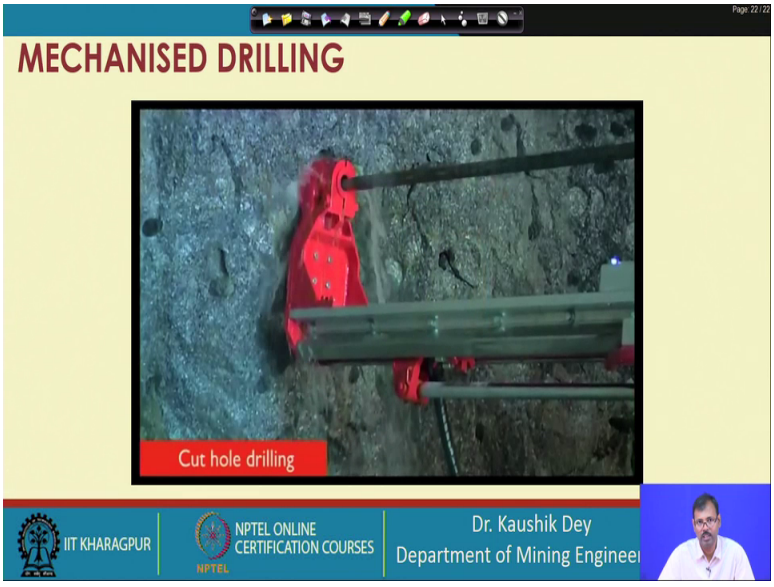

But while it was carried out by the manually, that person may not properly has the knowledge about the 60 degree he may come out with a 45 degree or maybe 70-degree angle instead of 60 degree.

So, the total blast forma performance may be affected because of the poor drilling.

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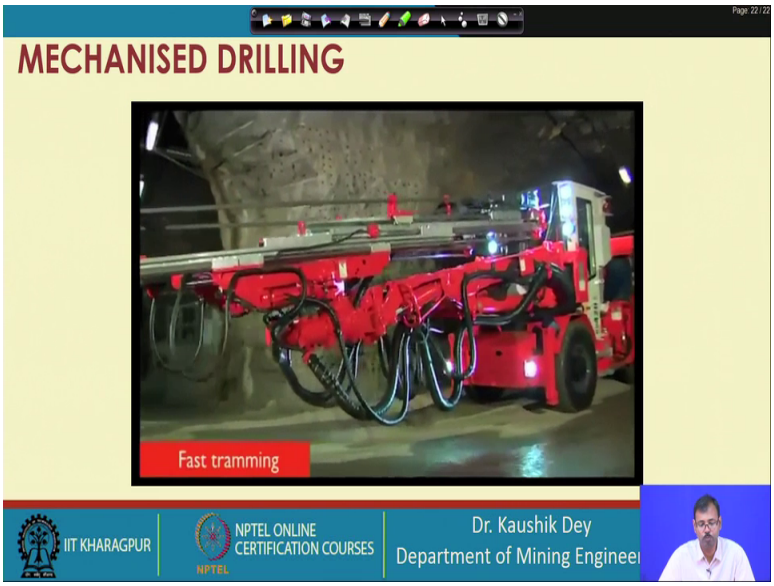

So, with the invent of this drilling machines underground drilling become easier, but till date the problem is that these machines required large dimension openings. So, at least 4 meter by 4 meter or 4 meter by 5 meter room space is required for operating of these machines. So, that is the essential requirement of these machines; that has to be followed while drilling has to be carried out using these machines.

So, as for our knowledge, we have understood that presently the mechanical drilling is possible to carry out in the underground mines with invent of the new modern drilling machines.

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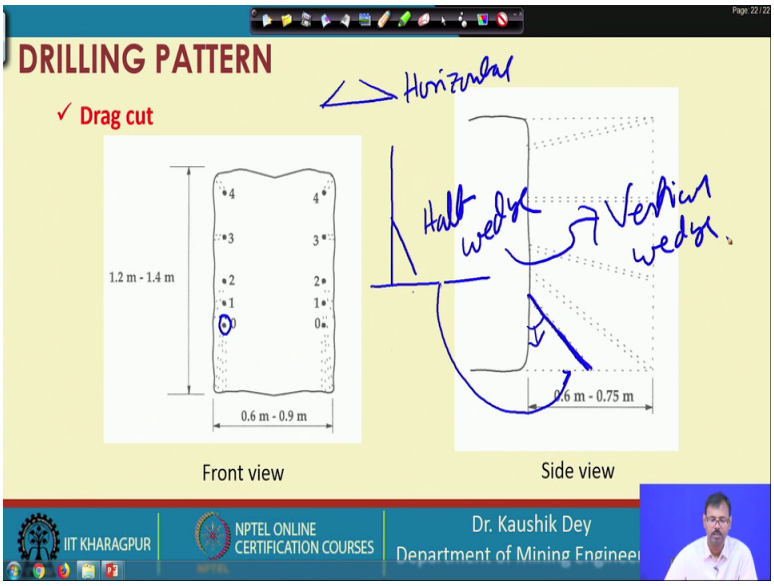

So, that is benefit we can think of drilling a number of holes we can think of drilling 100 holes in a face which is not possible for the manual drilling condition.

So, let us continue with the drilling pattern. Last class we have stopped in the pyramid cut, which was basically the double wedge cut. Wedges are given in the vertically and horizontally. In today's class let us start with the drag cut. Drag cut is basically a half wedge cut. So, we have seen the double wedge cut pyramid cut, but drag cut is basically a half wedge cut; where the angle is given vertically.

So, you can see the first drill hole, you can see the first drill hole which is drilled is angling towards the downward, and this is the angle, first angle first wedge angle is given. So, that means, in pyramid cut we have noticed this one. This was the pyramid cut, this was the wedge cut horizontal wedge in pyramid cut there was horizontal wedge as well as the vertical wedge. So, this is horizontal wedge, this is vertical wedge, and if you are looking at this, you remove this part, let us remove this part first. So, you see this part, this part is this one, this is the hole. So, this is the first hole has to be created.

So, this is basically the half wedge; where the wedge is vertical wedge. So, basically in other word you can say drag cut is a half wedge cut; where the wedge is vertically formed. So, basically in drag cut the first hole is created here.

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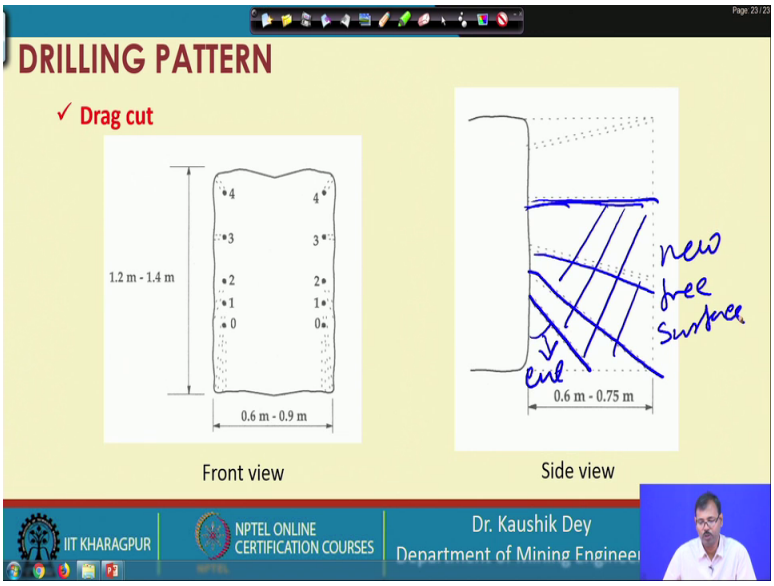

So, this is the first cut, then cuts are spreaded with these holes. So, finally, this is the position; where the new free surface is created.

So, in drag cut it is a half wedge cut, where particle wedges wedge holes are drilled. And a new free face free surface has to be created here. So, this is a special type of wedge cut you can say, and drag cut is basically practiced in a case where the soft rocks are available.

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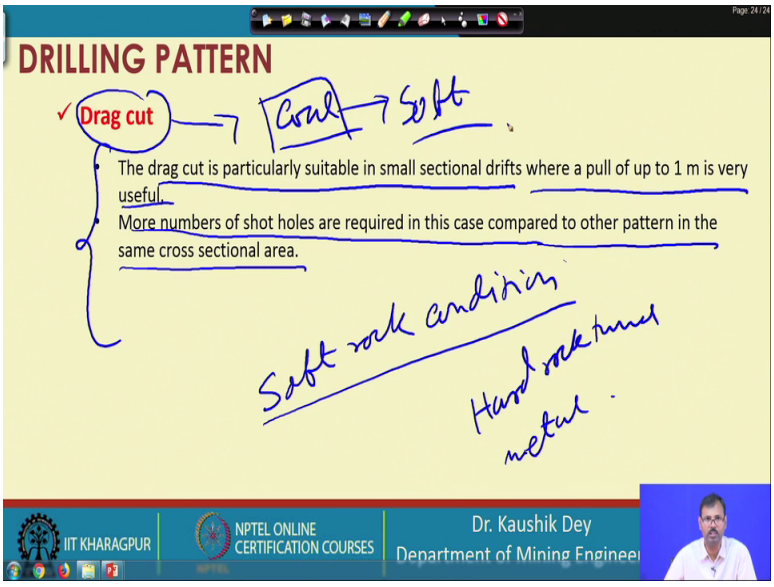

Drag cut is particularly suitable in small sectional drifts, where a pull of up to one meter is useful. More number of shot holes are required in this case compared to other pattern in the cross sectional area. And this is useful for the soft rock condition. In fact, you will not observe the practice of drag cut in any hard rock tunnels, or in most of the hard rock excavations; like, metalliferous, mines excavation.

Sometimes drag cuts are practiced in coal excavation because this is very soft in nature. And that is why drag cut is practiced in those cases as the coal is very soft, and the number of rows required in the drag cut is less. So, that is why as it is half wedge cut the number of delay requirement is also less. So, using that is why the drag cut may be used in case of coal excavation in the underground.

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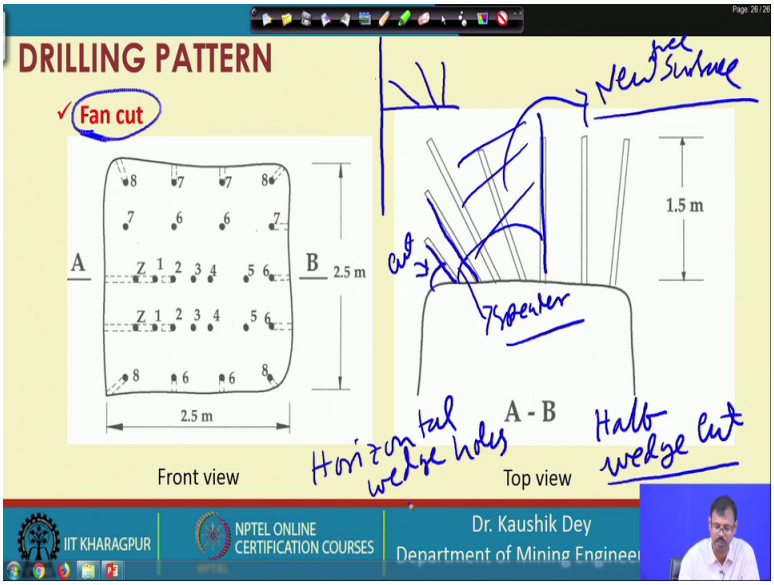

Similarly, another half wedge cut is possible where the half wedge is formed in the horizontal wedge. And that cut is called fan cut. So, basically in fan cut this is the horizontal wedge, these are the wedge spreader. So, if you cut it from the middle, then erase it erase the rest part, erase the rest part, you can see this will look, this will look similar to this where this is the first cut angle. Then these are the cut spreaders, and gradually it is coming till this where the new surface, new free surface is created.

So, basically this is fan cut you can consider another half wedge cut; where the horizontal wedge holes are drilled. So, basically fan cut is another half wedge cut where the horizontal holes are drilled. So, basically if you rotate fan cut in 90 degree angle you

will achieve a drag cut, or if you rotate the drag cut in 90 degree angle you will get a fan cut. So, basically fan cut and drag cut, these 2 are basically half wedge cut, but only these are perpendicular to each other.

So, basically drag is basically the vertical holes, vertical half wedge holes. So, as it looks like dragging the material as we drag the material. Like that way so the formation is that is why it is called drag cut. Fan cut it is horizontally so if someone use a some paper to give air to himself, the way it he waves that one it is similar to that as; this is moving like this way, this is moving like this ways, like giving some air to himself. So, that is why it is called fan cut.

So, basically fan cut and drag cut, both are half wedge cut and that is why their applicability is more or less similar.

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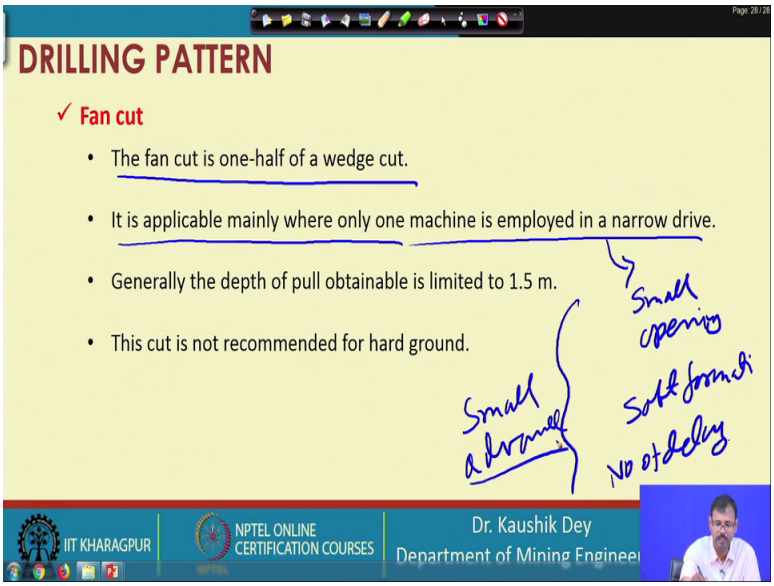

Again the fan cut is another half wedge cut. It is applicable mainly where only one machine is employed for narrow drive. That means, the small openings small opening soft formation, number of delay requirement is less, and also small advance is targeted. So, in those cases fan cut and drag cut both can be used.

So, basically the applicability of this fan cut and drag cut is more or less similar, where you can use fan cut the same place you can use drag cut also. But often fan cut results little bit better over the drag cut, because the confinement of the charges are more or less;

not against the gravity in case of drag cut it is against the gravity, but in fan cut it is not against the gravity, that is why their performance is little bit better over drag cut. So, basically these are more or less same, but useful for only for the soft rock formation.

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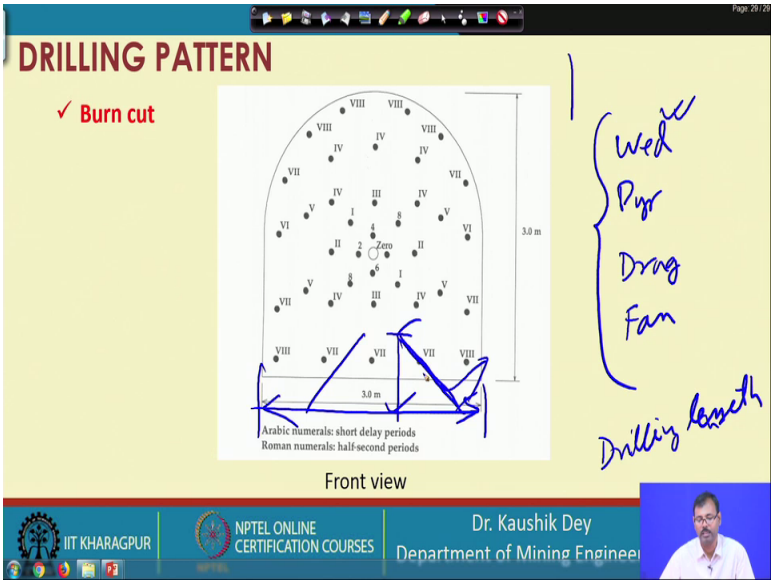

Now, let us see the burn cut. So far whatever cut we have discussed wedge cut, pyramid cut, drag cut and fan cut, all are basically the different formation of wedge cut only. And as we have discussed during the wedge cut, the main drawback of the wedge cut is that the drilling length is basically governed by the dimension of the area, dimension of the cross sectional area. Otherwise these wedges cannot be formed. So, main portion of the cross sectional area is basically taken by the formation of wedge, that is why this drilling lengths are or the advance lengths are basically restricted.

However, in burn cut this problem can be overcome, what is carried out in the burn cut? A centrally large dia hole is created which act as a free face for the adjacent holes. So, the basics of burn cut is that all the holes; if you look into the side view, all the holes are horizontal.

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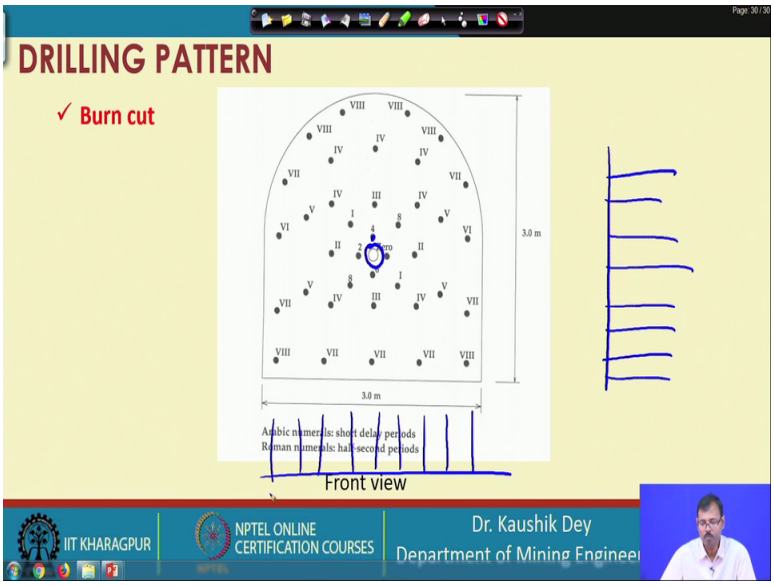

If you look the plan view all the holes are parallel. So, basically parallel horizontal holes are drilled in the burn cut, there is no angle drilling

So, basically the key of this is that, if you redraw this one this portion only this person we try to redraw, then you will find out there is a empty hole, this is the empty hole large dia empty hole.

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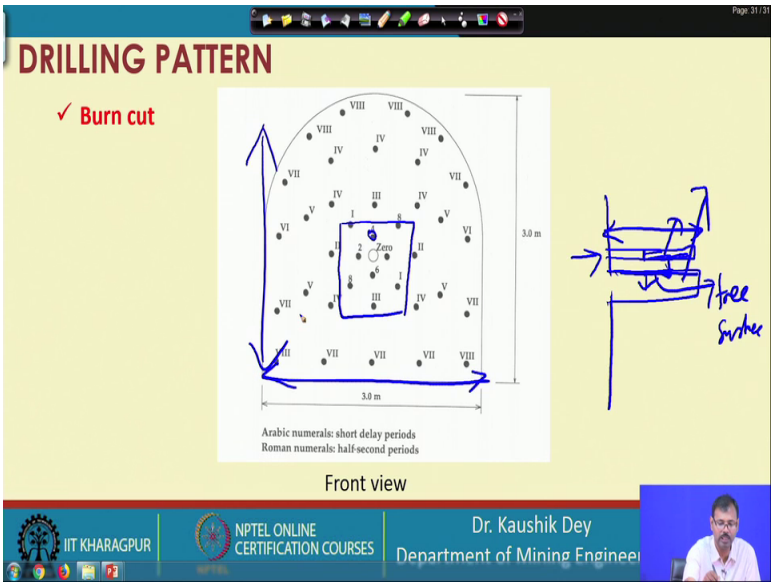

And very adjacent to these very adjacent to this hole, there is a small dia hole which is filled with explosive.

So, this large dia hole which is kept which is kept empty act as the free face, this act as the this face, this face act as the free surface, free surface for this explosive. So, this explosive observe one free surface at this position once surface at this position, and that is why it can act like a similar manner which is observed in the surface drilling and blasting.

So, this is basically essential in burn cut to keep one empty large dia hole which can act as a free surface for it is adjacent loaded or charged hole. And that is why the drilling length the length of drilling does not depend on the face dimension. Does not depend on the face dimension like wedge cut.

So, this is the benefit of using the burn cut. In fact, theoretically burn cut can be designed up to infinite drilling length, but that can be carried out that may be supplemented with that in finite diameter of empty hole also. So, that is the essential requirement; that means, the drilling length can be designed suitably with this suitable design to with suitable design to the empty dia hole.

Let us observe the basic of this burn cut in this video.

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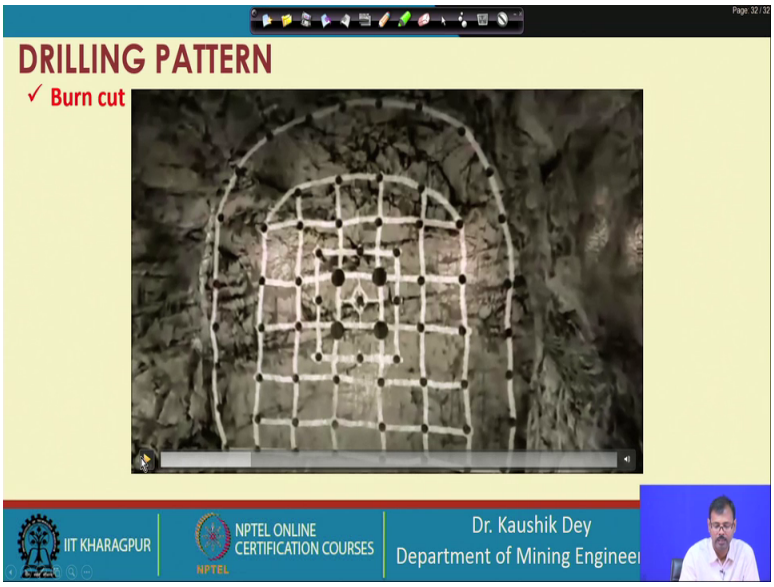

So, in this video there is a little bit modification. Let us see here what is carried out? A central hole, a central hole, a central charged hole is placed which is surrounded by 4 empty holes; that means, this central portion rock you may consider is surrounded by a

empty hole which can act as a free face for that. So, this is the little bit modification carried out what we have discussed in the last slide. So, you can see the first hole is charged, but the empty holes are remained un-charged, this is practically how it is being carried out you can see. This is called pipe charge or good it charge. Sorry, this is a basically cut with charge.

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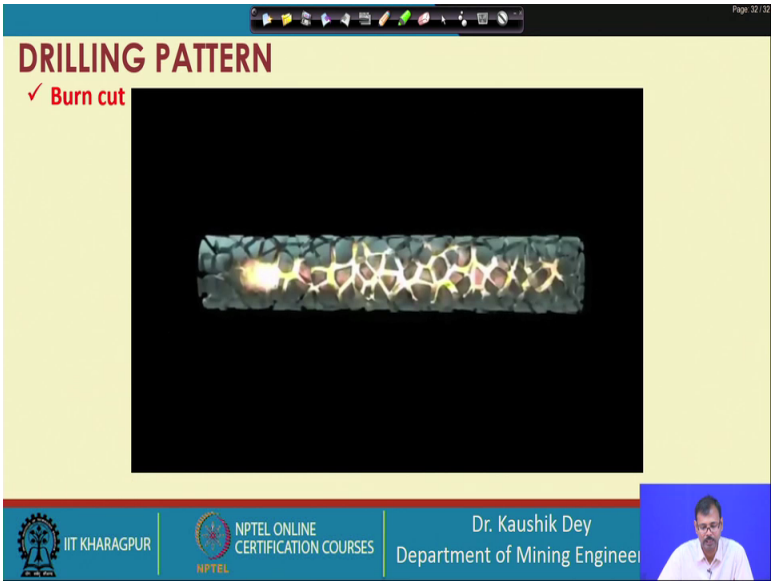

So, the first hole is blasted, you can see, this is the explosive. So, the moment explosive is the exploded.

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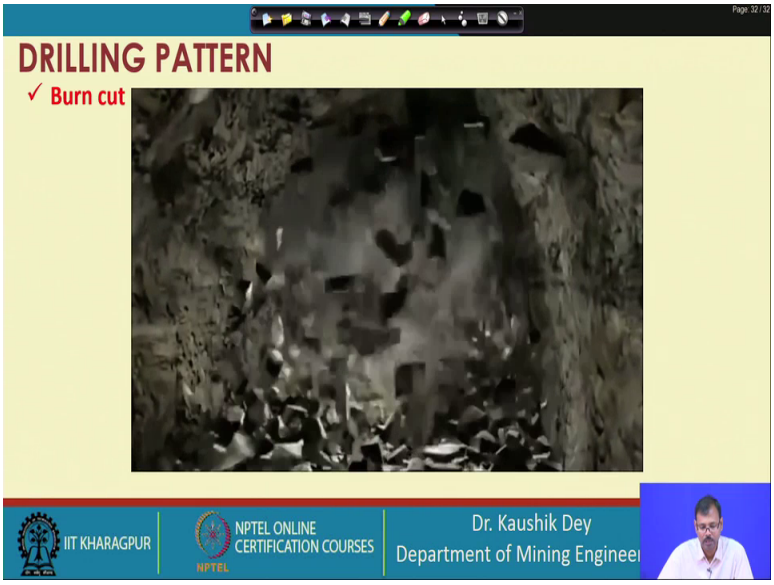

Firs the central portion of the rock; that is, disperse fragmented because the empty holes are basically acting as the free face to the first hole

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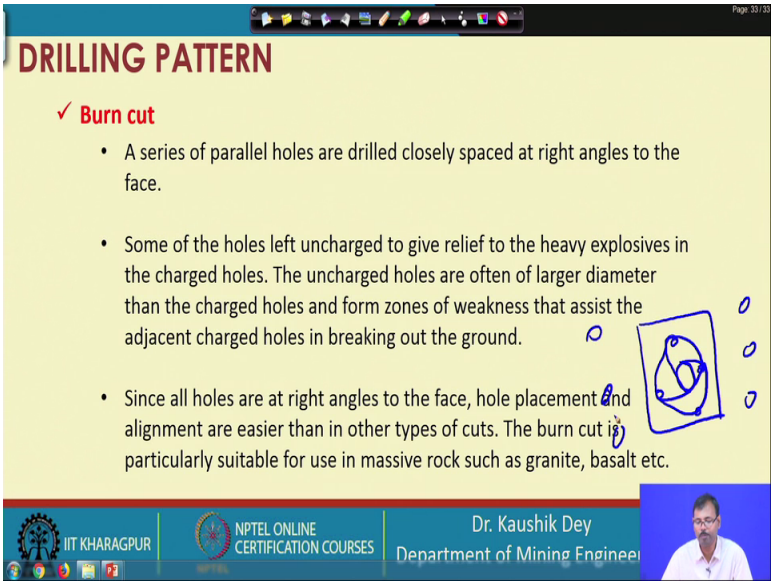

So, let us observe what is there in the burn cut. In the burn cut a series of parallel holes are drilled closely spaced at right angle to the face. Some of the holes left uncharged to give relief to the heavy explosive in the charged holes. So, basically that uncharged holes act as the free face to the first few charged holes; then the uncharged holes often of large diameter adjacent to the charge hole. Since all holes are at right angles hole placement alignment are easier than the other types of cut. And it is very very suitable for very very hard rock condition also.

So, basically if you again look into this, the basic idea of the burn cut is first to create a very very large dia empty hole. Then a charged hole has to be placed adjacent to the empty hole. Then you blast that one so that a new surface area is created like this. Then another charged hole has to be blasted, considering this is the empty hole which will act as the free surface for that hole. So, the new free surface will be created like this. Then the next charge hole has to be placed here. These free area now act as the free surface for that. So, the new free area will be created like this. Then another one will be created like this. So, simultaneously the free surfaces will be increased, maybe up to a particular cut area, then the rest holes will operate as the stopping holes.

So, that is the basic principle of the burn cut and that is why this burn cut is very very popular and very very commonly used specially in the civil tunneling drifting, where the large perimeters has to be blasted and the faster completion of the project is very very essential.

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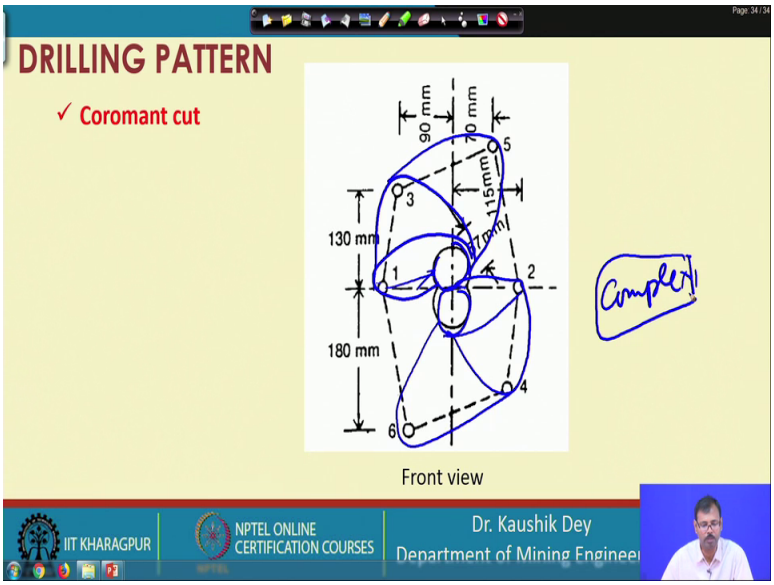

In fact, we will learn in our during our blast design part we will learn more about the burn cut in that section, but in this class let us stop for the burn cut up to this. But there are 2 more cut coromant cut is basically a double spiral burn cut. If you look into this into the detail, there are 2 overlapping empty holes, this is one hole, this is another hole. And if you look into this one is little bit closer to this one. So, basically the free surfaces are being created like this. And this one is a little bit closer to this. So, the free surfaces are created. And by this way the cut area has been created. So, basically this is a double spiral burn cut is basically considered as the coromant cut.

But what the little bit complex, complexity in it is design; because of the complexity of it is design coromant cut is not that much popular, mostly burn cut is being followed, but coromant cut is also often practiced in the actual practical field. But their use is very very limited, most of the time we use the burn cut

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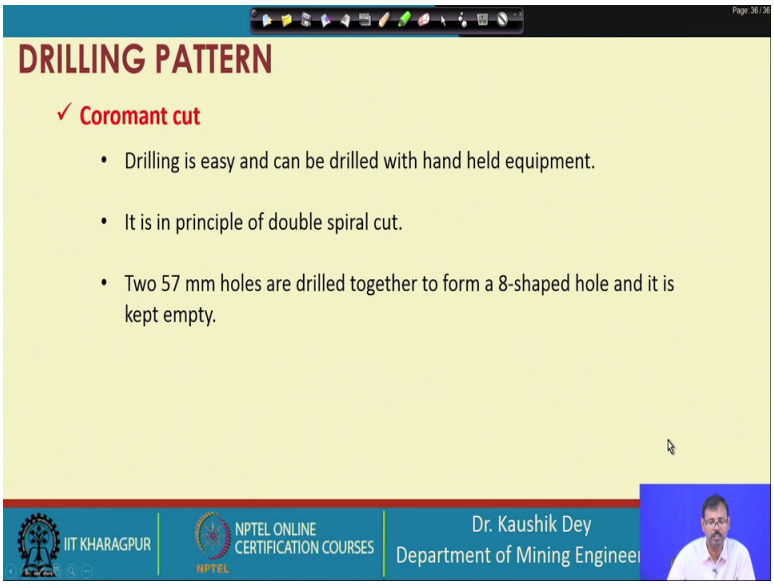

So, basically coromant cut drilling is easy, drilling can be done with handled equipment. It is a principally a double spiral cut, and 2 large dia empty holes has to be drilled in the center so that sufficient empty space has to be provided for the charged holes.

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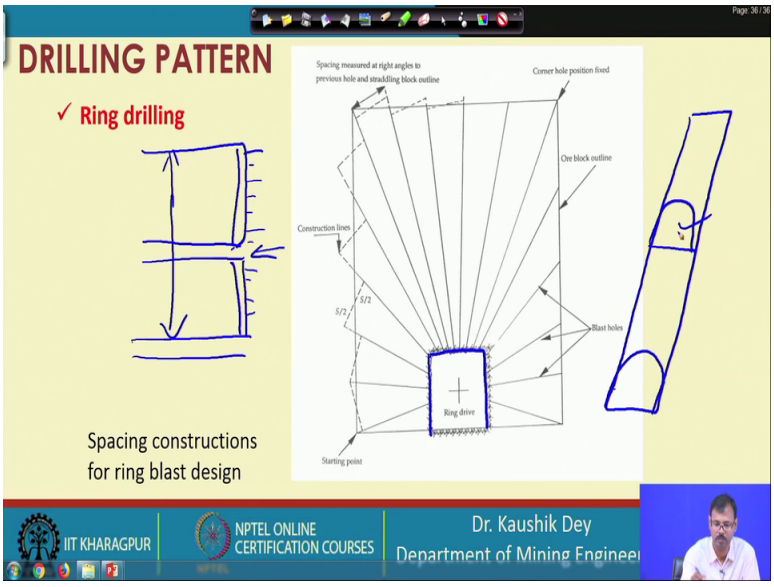

Ring drilling is not basically a cut drilling. But ring drilling is often practiced in the stopping of the mines, specially sub level stopping in the BCR method also in those cases also, ring hole drilling and blasting gallery method also ring hole drilling is carried out. Basically if you look into the ring hole drilling, the principle is like this. If this is the

drift which is supplemented by another drift in the below ground below level and this complete portion of rock, this complete portion of rock has to be blasted together, then ring drilling is practiced.

So, what is carried out in ring drilling, this acts as the free face for the ring drill holes. And the holes are drilled in all the direction. So, suppose if you look into this from if you look into this from this direction. This is the opening. Then the drilling has to be carried out like this manner; that means, if this is the deposit, this level, this is this level, this is the lower level, then sorry let me redraw it.

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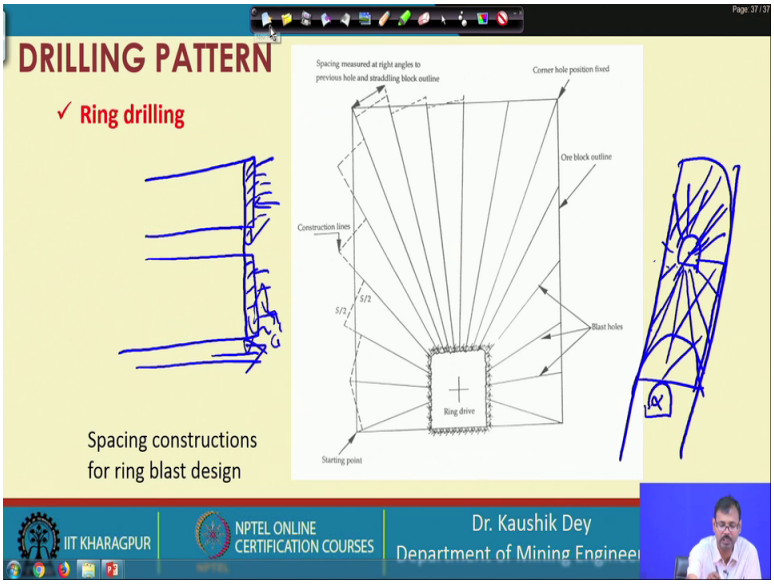

So, this is that earlier level, and this is the lower level. So, this level is this one, this level is this one.

Then the drilling has to be carried out in a ring manner in all the direction. So, that this complete area this complete rock volume has to be fragmented and deposited in this area. So, this complete portion of rock will be fragmented and will be deposited as a fragment in this position, and the loading machine can take out this material. So, ring drilling is a special type of drilling carried out in the underground. But it is not a cut drilling this ring drilling is carried out as the excavation drilling where the already existing free face. So, this free face is already available in the front direction. In that case ring drilling is basically practice. So, one free face is at this area side, another free face is that this side.

So, all the holes are basically having the free faces. But the production rate which is achieved by the ring drilling is very very high.

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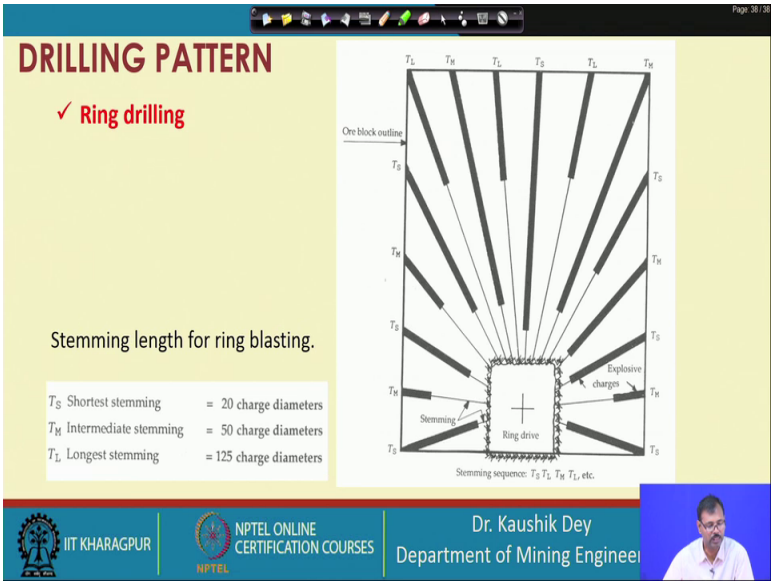

So, basically this is the designing of the ring drilling. T S is the shortest stemming, T M is the intermediate stemming, T L is the longest stemming. These are the design conditions we will discuss all these things in the blasting part, but blast design part.

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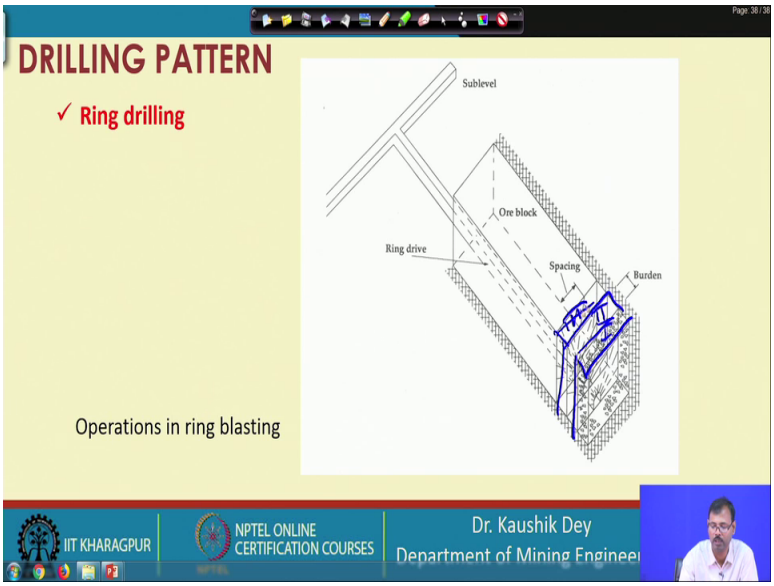

And this is how this each slices are excavated by the ring drilling, each slices are excavated this is one slice excavated by one ring drilling, this is another slice excavated

by another ring drilling, this is the third slice. So, this is slice 1, slice 2, slice 3. So, these are the different slice excavated in the ring drilling.

So, let us stop our drilling pattern in this lecture. We will discussed we will continue our drilling technology in the next class also.

Thank you.