Surface Mining Technology
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Lecture 11
Drilling Technology for Surface Blasting- I

Let me welcome you to the 11th lecture on Surface Mining Technology. This lecture will cover the drilling technology. This is the first lecture on the drilling technology, and this drilling technology only pertains to the drilling required for surface blasting. So, this is today's topic which will get a brief overview of the drilling carried out in the mining.

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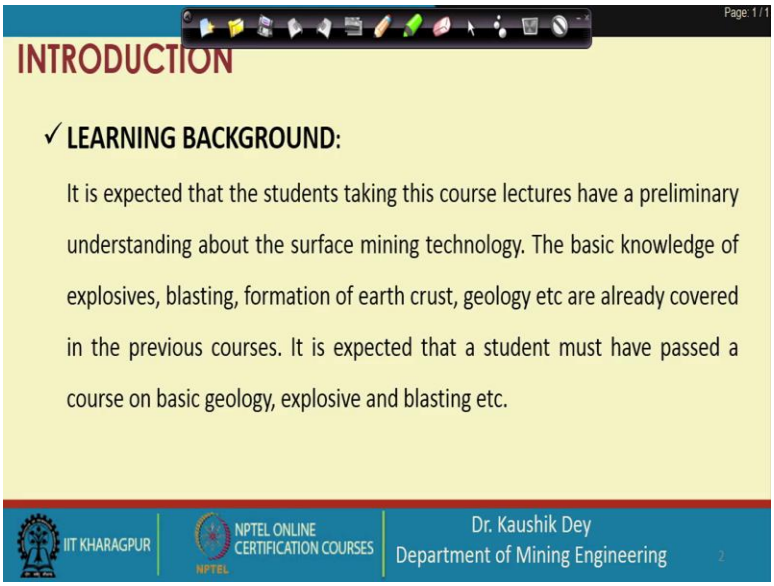

As the requirement, this is the learning background for the surface mining technology course. We have already discussed this.

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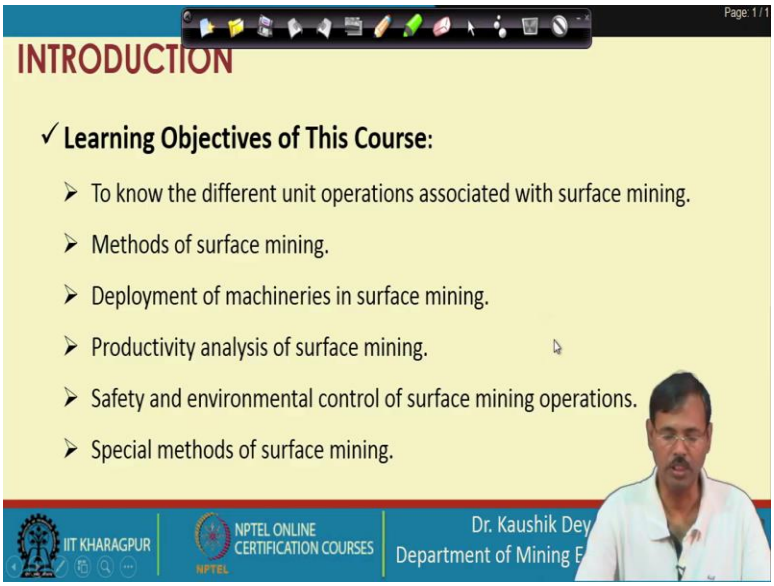

This is the learning objective of the surface mining technology course.

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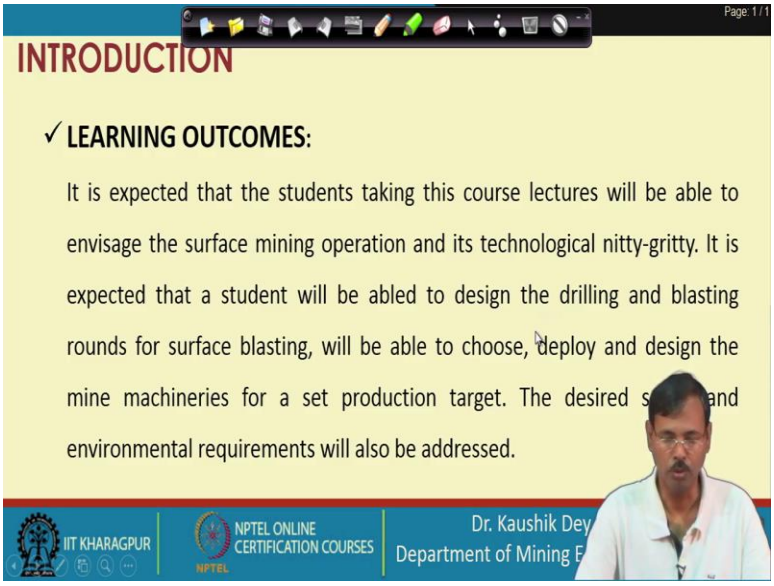

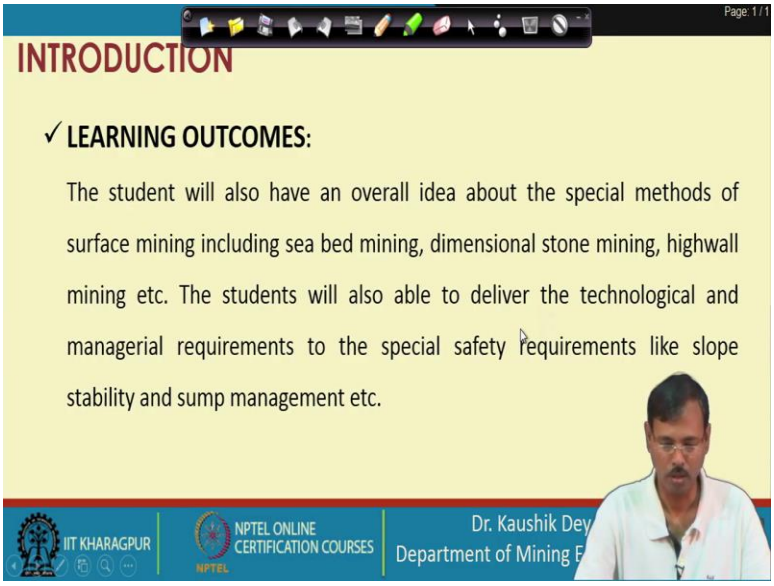

And these is our expectations from the participants who will take this surface mining technology course, and these are the learning outcomes we are expecting from them.

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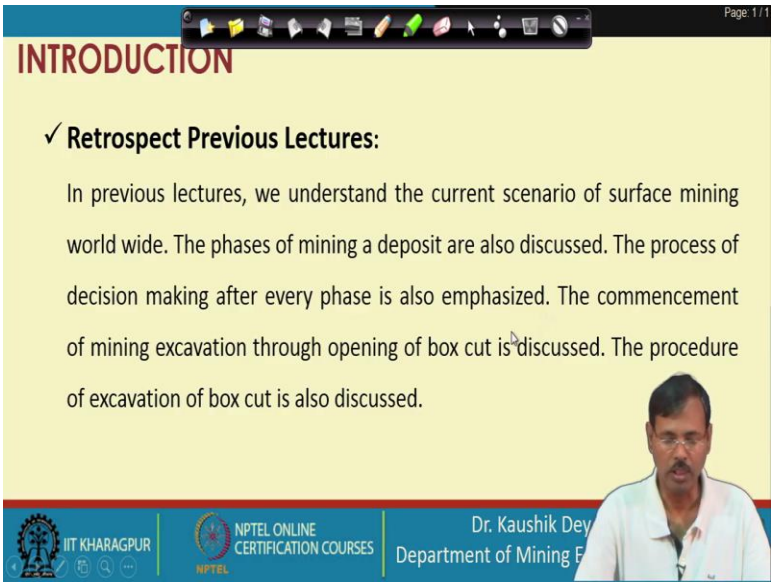

Now, let us see retrospect the previous lectures in our previous lectures. We understand the current scenario of surface mining in India and the worldwide concept then, the different phases of surface mining to exploit the mining deposits. The process of decision making after every phase is also emphasised in that then the commencement of mining is excavation through opening up box cut is discussed in details and also the excavation procedure the size and shape determination of those locations of the box cut all are discussed in the previous lecture.

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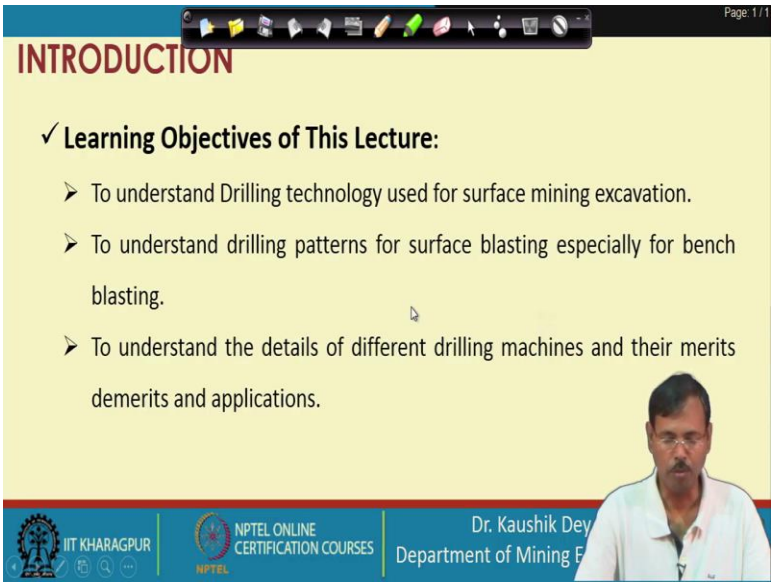

This lecture aims to understand the drilling technology required for surface mining excavation, which will mainly deal with excavation by blasting. So, whenever we carry out blasting, whatever drilling is required, we will discuss that in this lecture. Means this series of lectures, there will be four lectures on understanding the drilling patterns for surface blasting, especially for bench blasting, and understanding the details of different drilling machines and their merits, demerits, and applications in this lecture.

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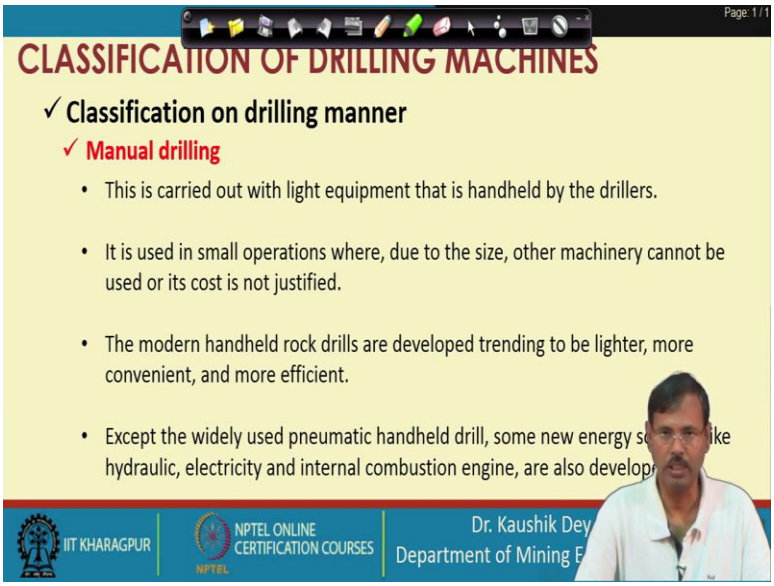

The drilling is carried out in a surface mine to place the explosive inside the rock mass. So, the purpose of drilling is to place the explosive inside the rock mass. Otherwise, we cannot reach the middle of the rock mass if we do not have an opening from the surface itself.

So, that opening is being created by the drilling process. So, if you look into this drilling, we have already discussed this in our drilling and blasting course in detail, we will get a little glimpse of that; drilling is classified in two ways: manual drilling, and the other is mechanised drill.

Manual drilling is carried out with light equipment, maybe handheld or et cetera. Sometimes some small operations were due to the size other machinery cannot be used in that case; often we go for manual drilling especially we will find out manual drilling is carried out in the hilly locations where the machine cannot move and mainly it is carried out for creating a drill hole for pumping the water or so or maybe the tube holes construction of tube holes et cetera. Modern handheld rock drills are developed, tending to be lighter and except widely used pneumatic handle deals. Some of the new energy sources like hydraulics, electricity and the internal combustion engine are also developed nowadays.

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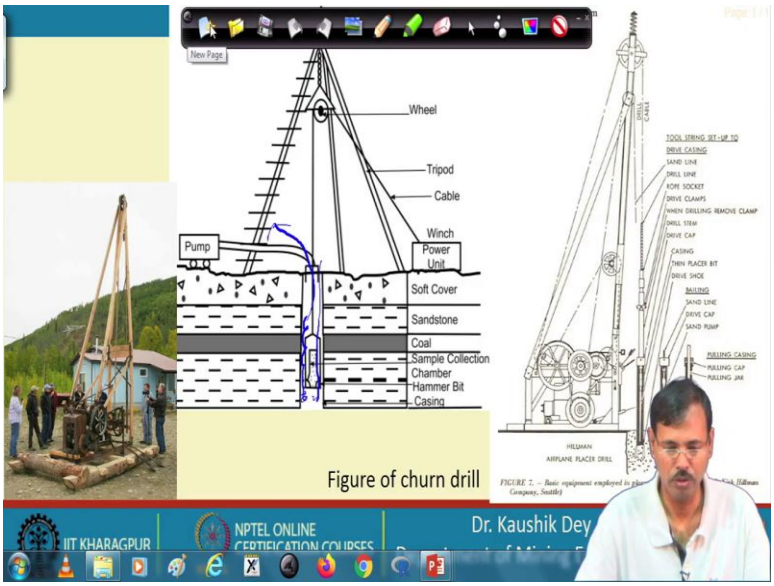

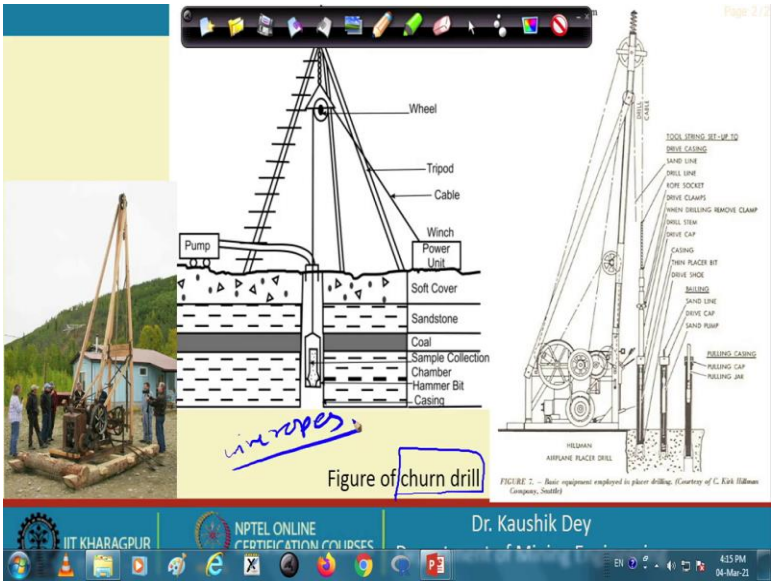

This is a picture of manual drilling. You can see the heavyweight is basically lifted and pulled down using a power unit or by using some manual method manually pulled and then dropping onto the hole it is carried out this is wire suspended rock mass. Base water is pumped out so that all the sludge or the drill cuttings coming out here can be taken out easily.

So, this is pumping in water is pumped in, and the sludge's this sludge pumped out from this. So, this is the technique carried out in the wire suspended manual drilling or maybe motor-operated wire suspended drilling. So this drilling is called Churn drill or drilling with wire ropes.

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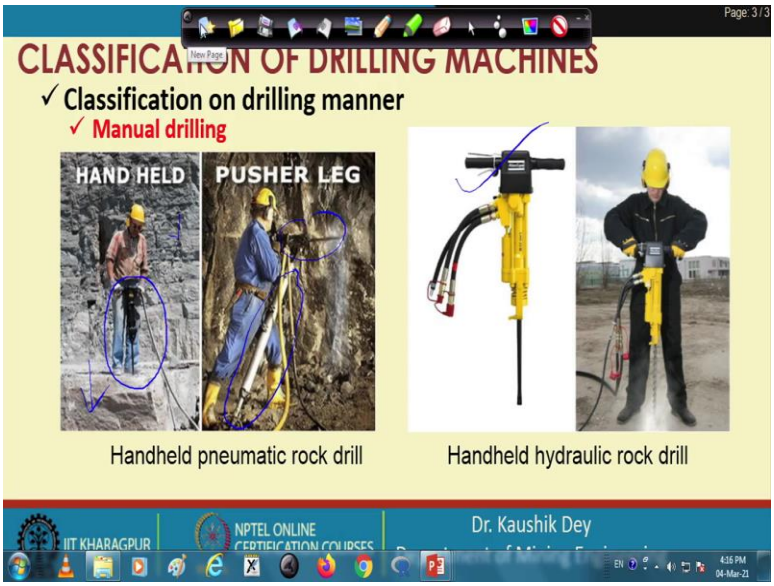

In some manual drilling, handheld drill machines are used. You can see the surface bench is being blasted with a handheld drill machine. This is in the underground mining handheld drill machine is used where the drill machine load of the drill machine is taken in pusher leg, in surface mines also if you are trying to go for drilling in the side face of the bench in that case you will need to is the pusher leg but generally in surface mines drilling is carried out particularly downward.

So, that is why pusher legs are not very common in surface mines. These are the handheld hydraulic rock drills; these are very commonly used. Apart from that in our domestic users, you will find out a number of electric drills are. A number of hammer drills are used for different purposes in our domestic cases, but these are examples of how these handheld drill machines are used in small-scale mining.

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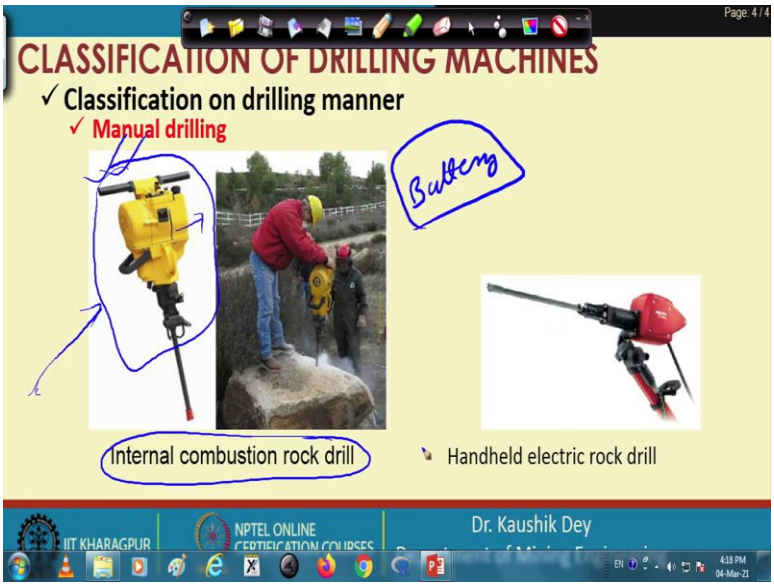

This is a handheld drill machine. An internal combustion machine is used here if you have to switch on this one—the internal combustion engine isgenerateshe the motive power, which is used for carrying out drilling. So, in an electric drill, you need to have an electrical have then electrical source, and you need to have that connectivity. Still, if you have an internal combustion rock drill missing in that case, you do not need that electrical connection.

So, it can operate in a self-sustained way. So, that is the benefit of this internal combustion rock drill. Now, it is battery operated machines are also available, which is basically switching the electrically powered handheld drill machines. So, these machines are also available, but this is more or less all these are related to manual drilling.

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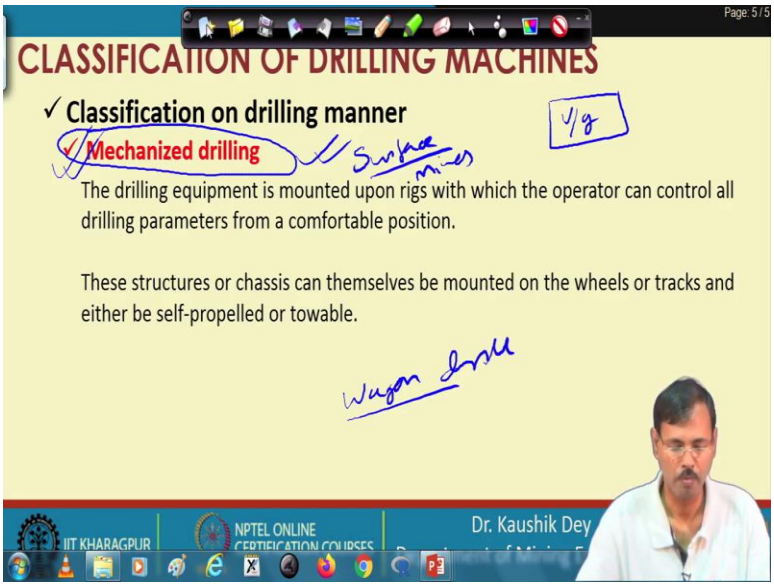

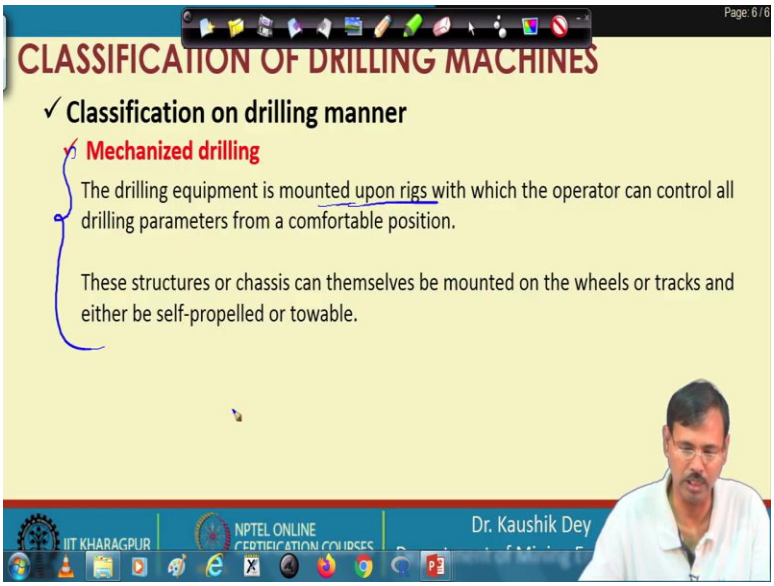

But mechanised drilling is the most popular drilling carried out in surface mines. Handheld or manual drilling is carried out for domestic use or in underground mines, where small-scale blasting is carried out. In those cases, only these are used.

So, mechanised drilling is very common for surface mines or open cast mines because our production requirement is very high, and we need to go for drilling the large diameter drill holes. So, as manual drilling is handheld, the machine should be small. Those machines are not applicable for large-diameter drilling and large diameter drilling. We are dependent on

mechanised drilling or wagon drills. In other words, these mechanical drilling is called wagon drill machines.

So, here drilling equipment is either mounted on a rig or mounted on a wagon. The operator can control all the drilling parameters from a comfortable position. This structure or chassis can themselves be mounted on a wheel or truck and either be self-propelled or is that or maybe towable. So, that is the benefit of these mechanised machines. These are self-propelled. One person or the operator has to drive its position set at a particular point, and then he has to carry out drilling in that particular place. So, that is the benefit of mechanised drilling.

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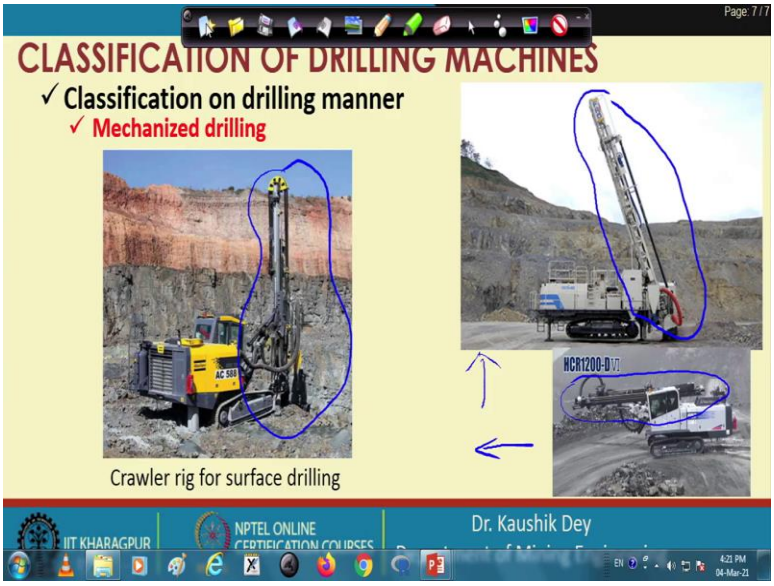

So, these are the different pictures of mechanised drilling. You can see here that the mechanised drill machine is propelling, reaching the position, and trying to fix its position. So, the drilling can be carried out and here you can see the drilling is under operation.

So, you can see that while it is propelling, its boom is basically drilling boom is basically placed like that, so that the stability of the machine can be increased. So, that is the benefit of these machines. So, wagon drills are self-propelled mechanised. These drills are self-propelled, and using this, the machine size is big, and you can go for drilling of the large diameter machines. All these previous photographs do all are taken from Google photo. In some places, references are given. In some areas, it is missed, but these are taken from Google photo.

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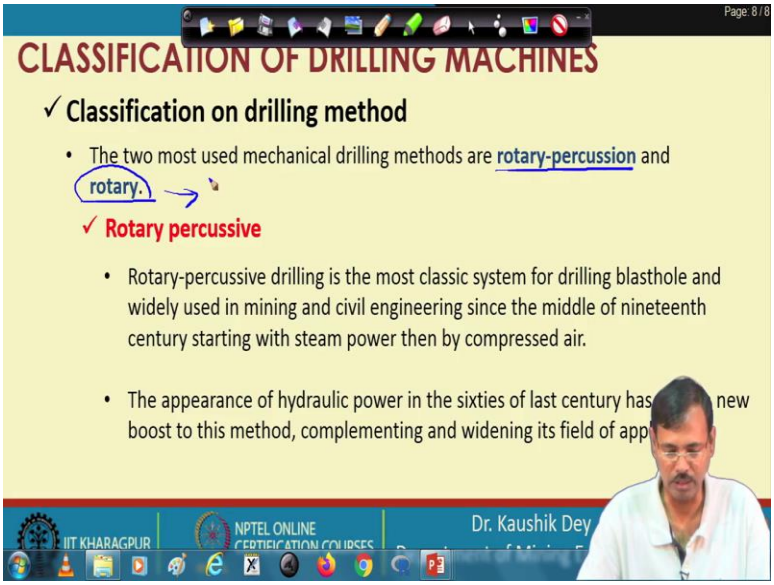

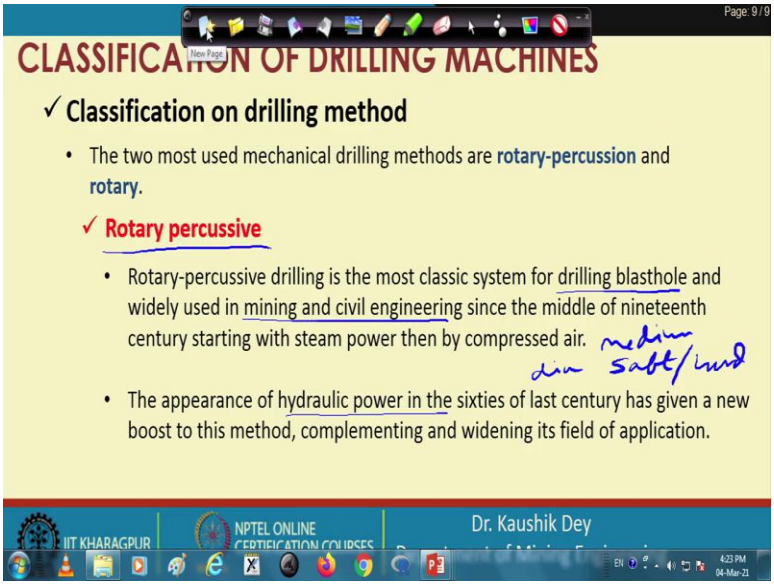

Now, classification, if you consider the mechanised drill machines, depending on the drilling method, they can be classified into two groups: rotary percussive drilling and rotary drilling. So, in rotary percussive, you rotate your drill rod along with a percussive axle, and in rotary, you are not giving any percussive action. Only the rotation is carried out under a consistent thrust. So, that allows the drill bit to be in contact with the rock surface.

So, these are the two basic drilling methods for mechanised drilling machines. So, let us discuss them one by one. The first is that rotary percussive drilling is primarily the most common drilling for carrying out these holes and is widely used in mining and civil engineering. Often, these are hydraulic powers also. It can be used for very medium size diameter holes, medium

size diameter holes, and soft to medium soft to hard rock. So, the penetration achieved is under satisfaction for this type of case, and we go for rotary percussive drilling specially designed for the hard stones.

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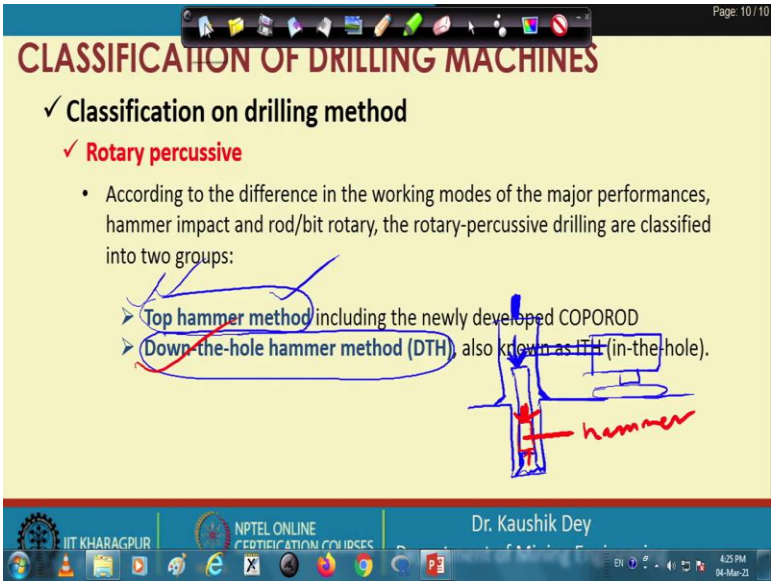

Further rotary percussive drilling can be classified in two ways. One is the top hammer drilling, and the other is down the hole hammer drilling. Top hammer drilling, where the hammering is carried out from the top of the drill bit, means, if you are considering this is the hole you are trying to drill, this is the drill bit, and this is the drill rod, and this drill rod is attached with a rig mounted on the machine.

So, the hammering action is if it is given on this drill rod, above this drill rod, if the hammering action is given on this, then it is called top hammer drill machine, but instead of doing that one, if the hammering action hammer is a powered hammer, maybe pneumatic or hydraulic or maybe electrical hammer is provided just above the drill bit and the hammering action is given by this one only by this hammer to this bit only. Then, it is called the hole hammer drill. So, there is two basic rotary percussive drilling system or is a downhole hammer is also named the hole hammer drill.

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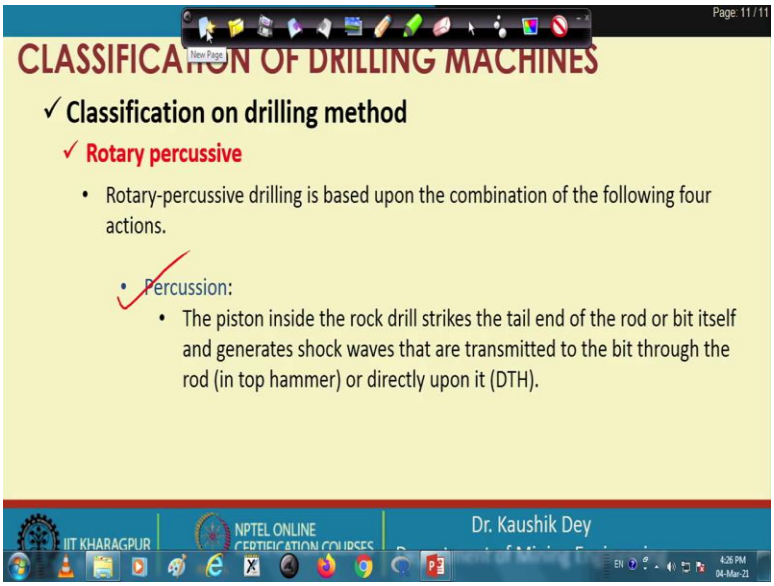

So, this rotary percussive drilling is carried out using four actions, first is the percussive action, wherein case of the top hammer, the hammering is provided on the top of the rod. In the case of the hole, the hammering is provided in the dust above the drill bit by down the hole hammer.

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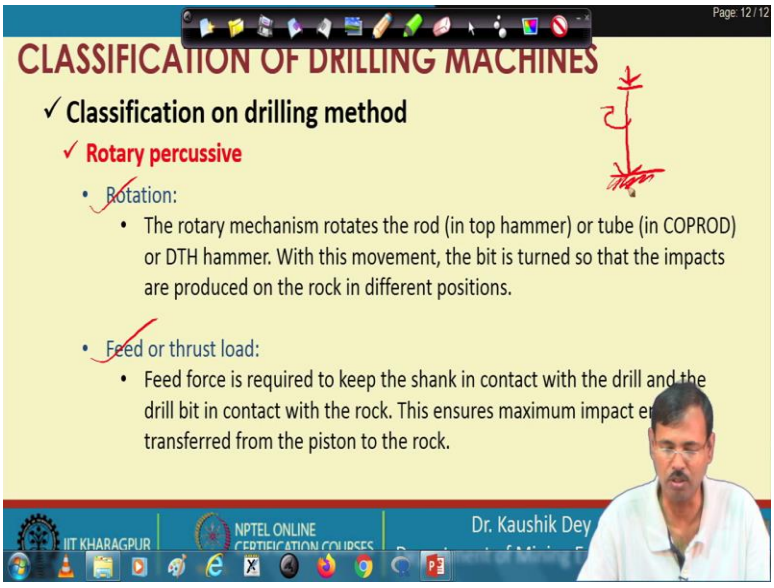

Then the next action carries a little bit of rotation. Otherwise, the circular shape hole cannot be created. So, down the moment you are hammering that one with each hammering, after each hammering action, you have to rotate the bit little bit so that you can carry out hammering

systematically in all the parts of the rock and by the way, a circular hole is also created, then the 4th action is given the feed or the thrust load that means, pressure is provided on the top of this.

So that it can always be in touch with the rock surface at this position, there should not be any gap in that and hammering is provided on that so that there will not be any false position between the hammer between the bit and the rock. So, it is always basically providing the hammering onto the rock surface. So, the thrust load or feed load is provided on that drill bit or drill rod. So, that third drill bit must be in touch with the rock at every moment.

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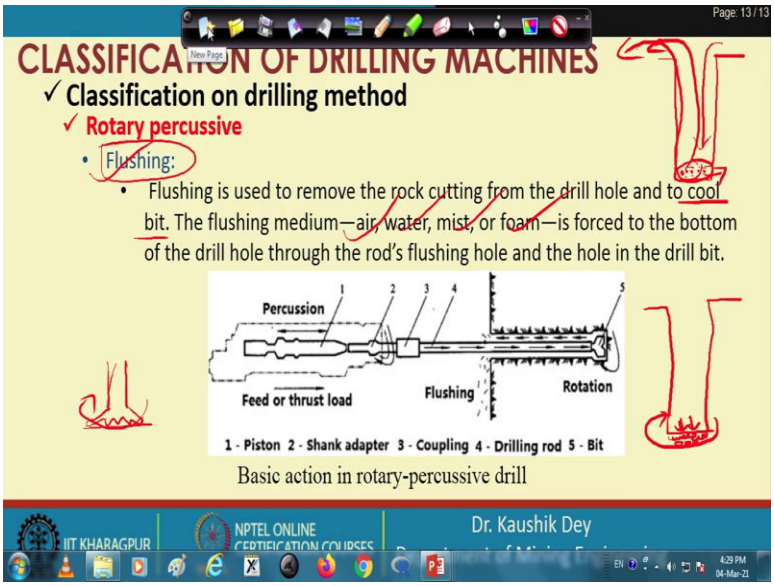

And the fourth action, which is also very important, is flushing. So, what is happening the moment drilling is carried out and this rock is being hammered? It is fragmented into smaller pieces. So, as this rock is basically cracked by the hammering fragmented into smaller pieces and then on the rotation of the same, this is basically crashed and became a powder one.

So, after crushing this one. So, after crushing this part, this will become powder one these small portions, and it is now essentially required that this portion has to be lifted. So, far flushing is required and some liquid or air. So, air, water, mist, foam, all these are different types of flushing medium those are pumped in and allowing this to taken out by the pressure so, that when it is going out along with all these sludges where or the small pieces of rocks will be taken away.

There are two purposes of the flushing: to take out that sludge or the small roc pieces of rock cuttings from the drill hole second purpose is to cool down the bit. So, the moment these bits are

consistently hammering onto this and rotating with this, a huge heat is generated here. So, if this flushing media is not provided, the drill rod and the drill bit will become very hot and distorted. So, to avoid that, one cooling of the bit is essential, and flushing media is provided at this position.

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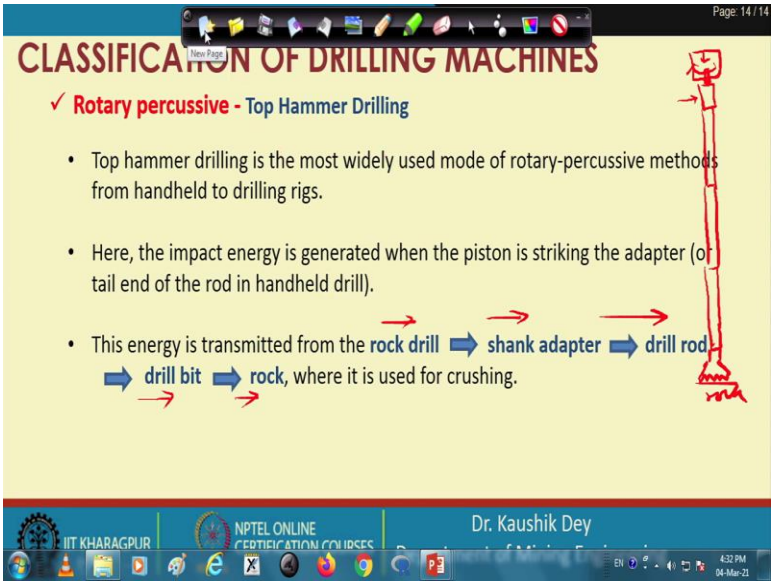

So, top hammer drilling is the most widely accepted drilling method. Generally, the energy transformation to a rock drill is from the rock drill which is generating the motive power and from there, the Hammering is provided to the shank adapter, the shank adapter is provided, or the connection is that from motive power the shank adapter is taking control then it is transferring to the drill rod. The drill rod is connected with the drill bit, and that drill bit is acting on the rock.

So, suppose you are looking at the complete rig in a rig. In that case, you will find out if this is the motor and this is the shaft of the motor whether hammering or rotation all these actions, hammering action and rotation action for top hammer it is hammering or if it is not top hammer only rotation then only rotation this action is provided into this shaft.

So, from this shaft, it is connected with a sank adapter. So, it is connected with a sank adapter from the shaft, then the sank adapter is connected with the drill rod. There may be N number of drill rods depending on the drilling length and at the mouth of the final drill rod, drill bit is connected. So, these are the drill rods, and this is the bit, and this bit is under action with the rock. So, this is the general assembly for a drill machine.

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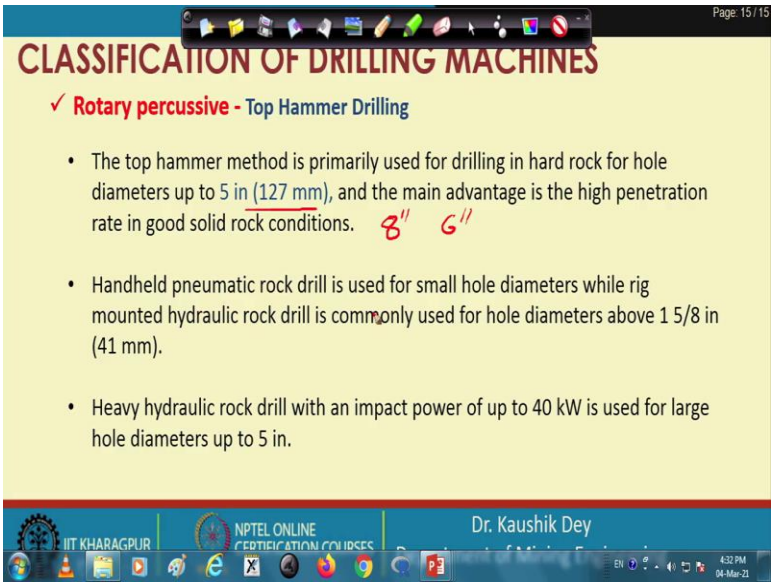

So, this is top hammer method is basically used for the up to a very a not very huge may sometimes up to 5 inch or nowadays with the increased population you can go up to 8 inches or 6-inch diameter up to this you can go for top hammer drilling. Handheld pneumatic drills are the most common small diameter top hammer drills jackhammer is a very common top hammer drilling machine.

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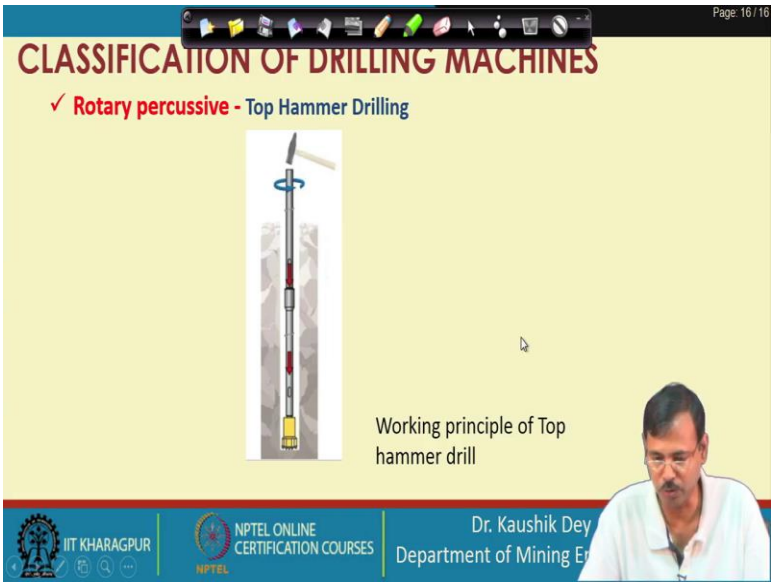

So, this is another pictorial form we have obtained from the Google photo representing a top hammer drilling.

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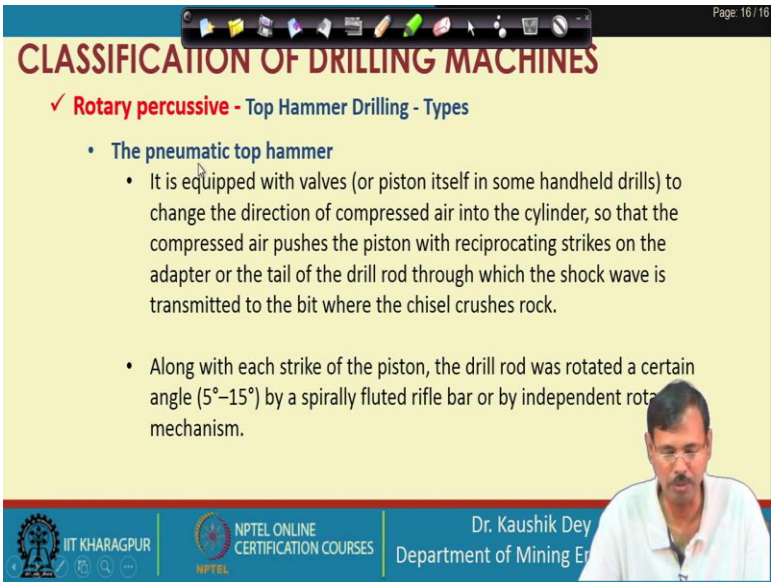

And these are the different types of top hammer drilling. We have a pneumatic top hammer type.

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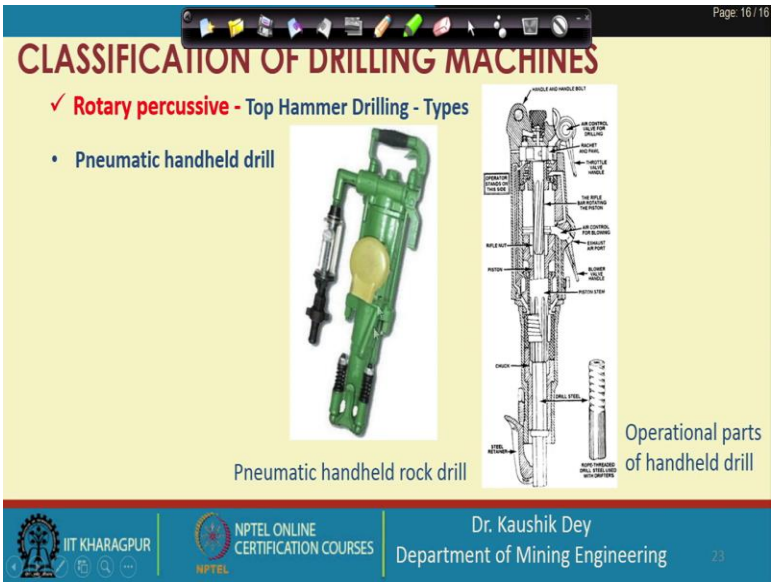

These are the jackhammer; et cetera are the pneumatic top hammer type. These are different parts of the jackhammer, as shown. This is also a complete picture of the jackhammer; all these are taken from the Google photo.

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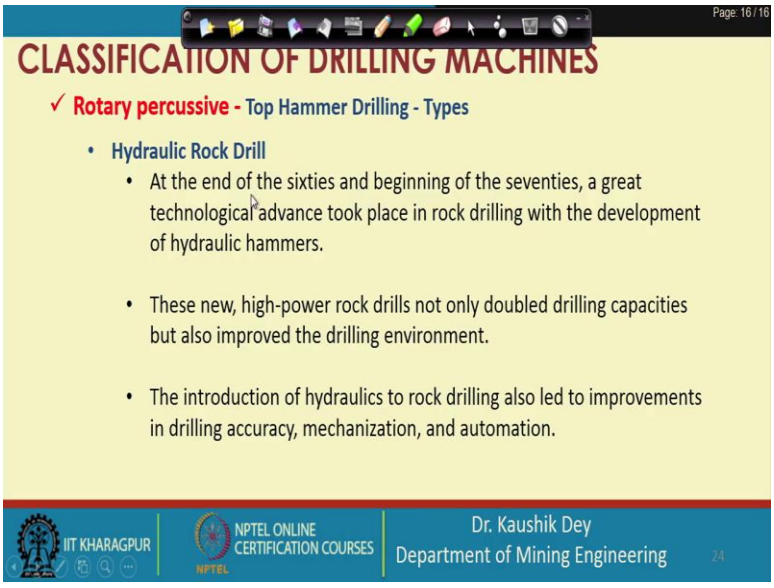

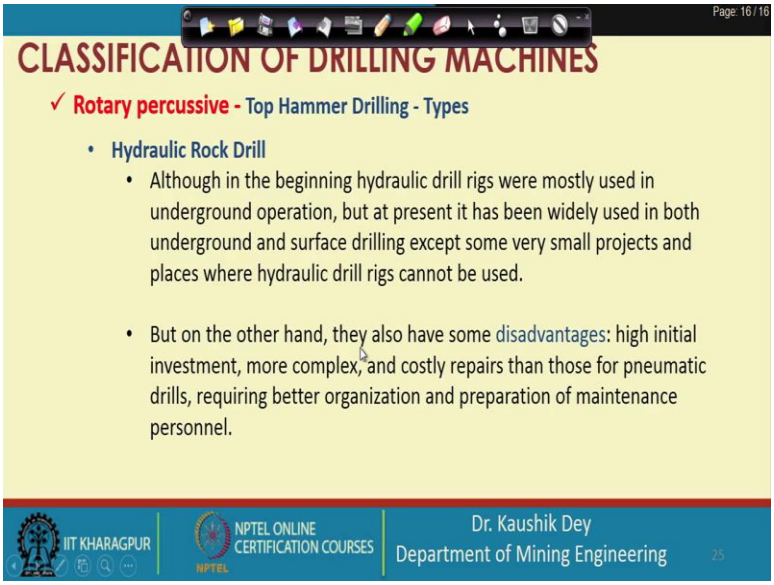

These are hydraulic types of rock drills are also available.

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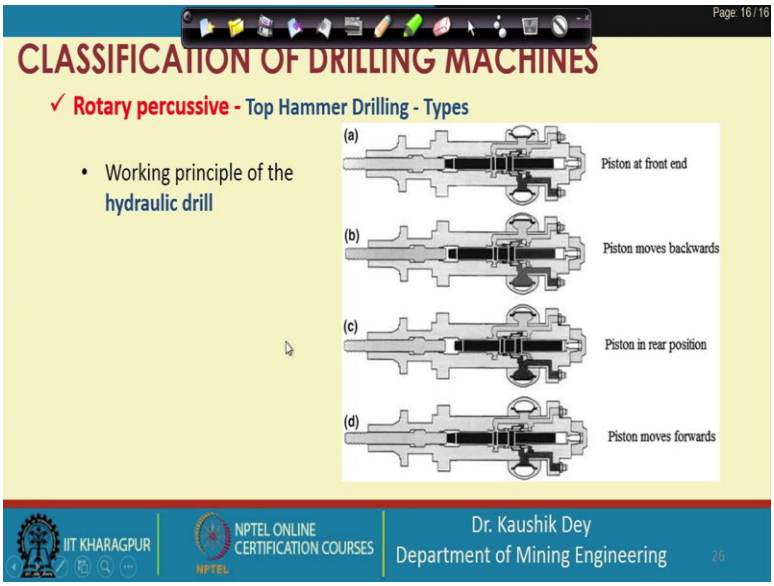

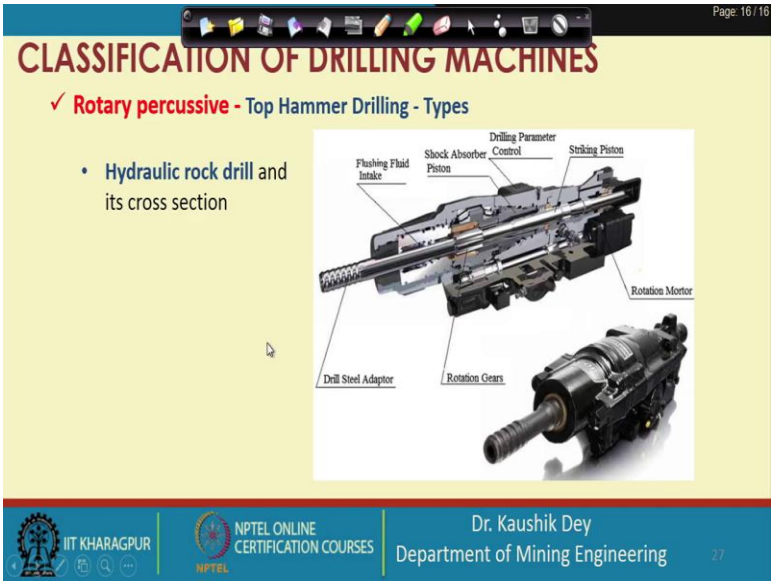

These are the hydraulics type's rock drills. Different photographs are also available on Google photo.

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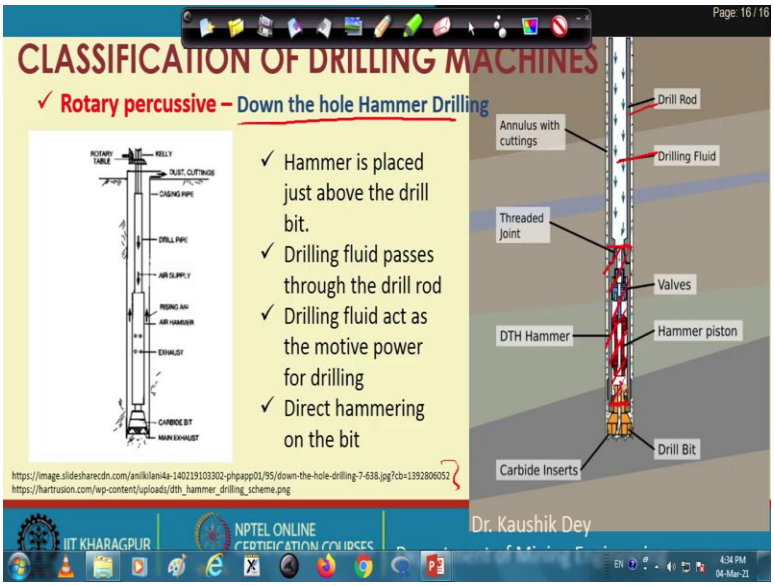

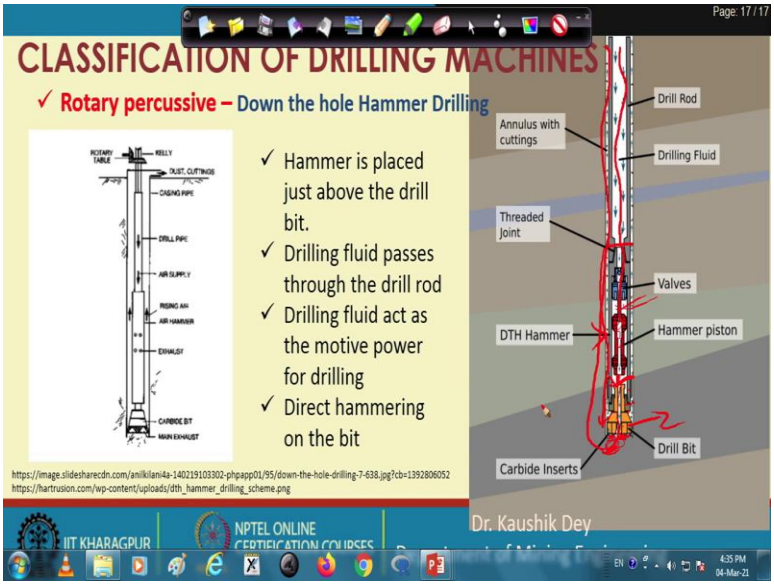

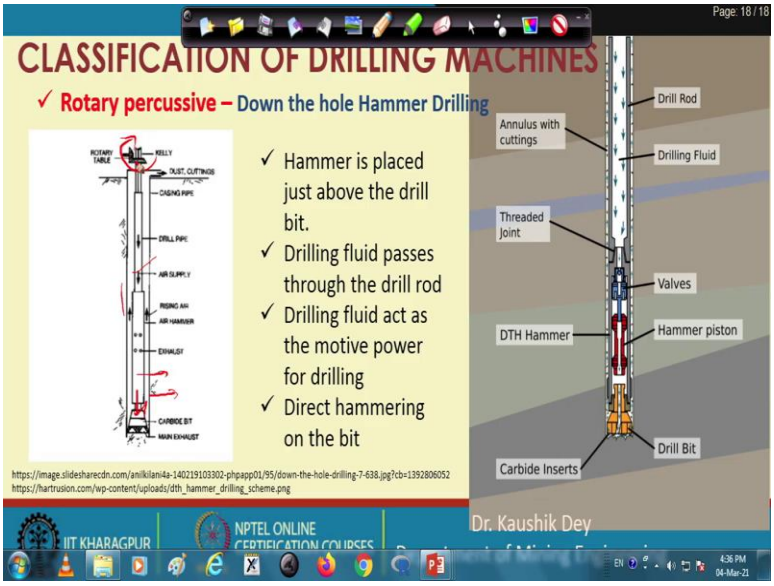

And this is the whole photograph of the down the hole hammer drill. This is the most common drill. This is the most common drilling used in mining, and you can see I have taken two pictures from Google photo these two pictures. This is one picture, this, this schematic picture. Both are schematic pictures. You can see this is the drill rod. This is the drilling fluid that is the flushing media provided through this, the non-return valve. All this hammering, this part is the hammer. This complete assembly is the hammer assembly.

And finally, this hammer is striking here. This hammer is striking at this position of the drill bit, and these are the tungsten carbide tips of the drill bit, which is hammering the rock mass here.

So, this part, this whole part from here to this part, is called down the hole hammer these are the joints of the differences. There may be an N number of drill rods.

Now, what is happening? This fluid flushing fluid is entering through this, and this fluid is pressuring this carrying out this hammering action. If it is pneumatic, then it is pneumatic. If it is hydraulic, then it is higher than this fluid is passing out through the holes of the drill bit, and whatever drill cuttings are available are then taking it out from the side of the drill rod. So, that is why the drill bit has a little bit larger die than the drill rod, and this allows the creation of some gap between the drill rod and the hole wall through the flashing media is taking out the different sludges.

So, that is very well represented in this figure. You can see this is the hammer; this is the hole wall. So, there is a gap. So this allows the movement of the drilling fluid. So, you can see this is drilling fluid. These are coming through this inside the hammer and going out from the outside the hammer. Still, rotary action is this hammering action is provided at this position. Still, the rotary motion is provided in this position, for the sank adapter at the above sank adapter is fitted.

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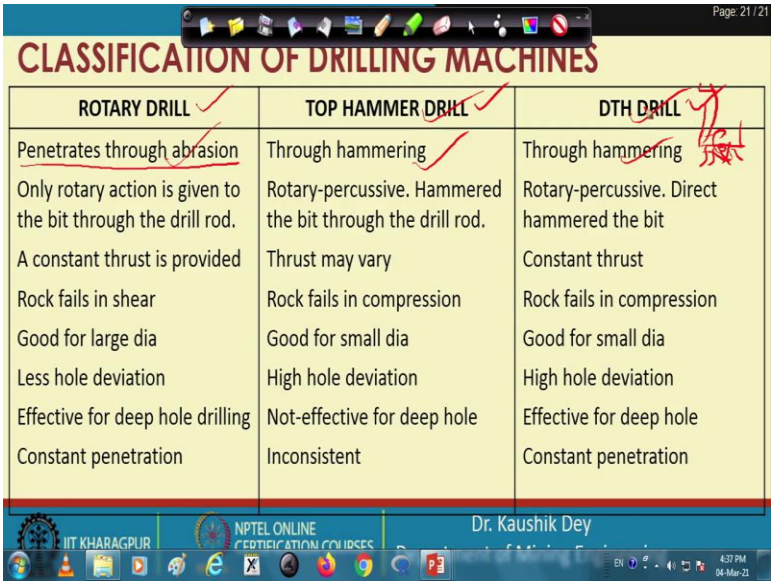

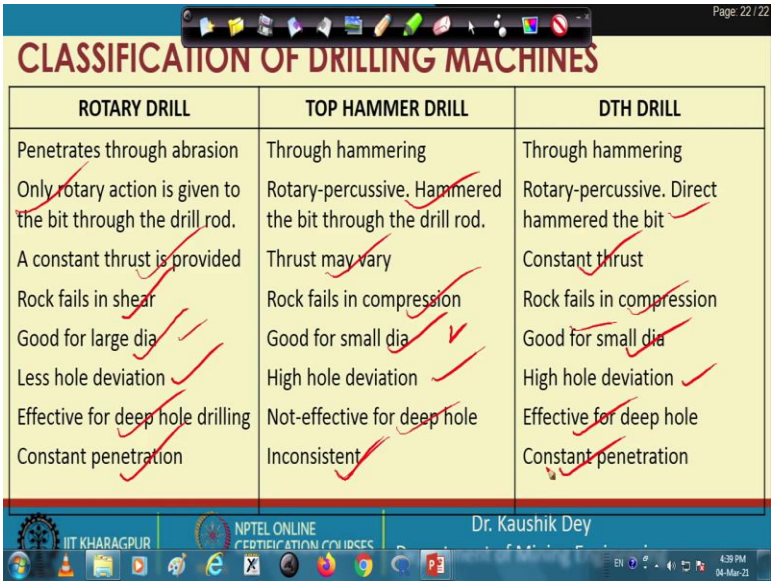

Now, if you are trying to compare these three drilling systems, we have seen we have three drilling systems: the rotary drilling system, the top hammer drilling system, and the down the hole hammer drilling system. In this case, if you look into this rotary drill is penetrating by eroding the rock through abrasion. So, the tungsten carbide tips or diamond tips are provided in the rotating rotary drill. That is the shearing of every grain of the rock, and that is why they eroded the rock and penetrated the gemstone.

So, this is basically the failure of r in abrasion where the op hammer and down the hole hammer in both cases it is through hammering after the hammering the rock at this position is fractured then these fractures; cracks are propagated then the chips are coming out those chips are under rotation of the drill bit they became crushed and became powder. These powdery chips are taken away from the flushing media.

Then, only rotary action is given to the drill tool here, mostly the hammering action givens. We also have to give the rotary action because you have to take out the material. You have to go take out the material. You have to obtain the circular shape of the hole. Also, the same cases are available here.

Here, a constant thrust is provided because weight components are also changing, but in the n down hole hammer drill, the constant thrust is also provided h. Here rock fails in shear, rock fails in comparison, and rock falls in comparison. The rotary drill is perfect for large diameter holes. This is good for the small-diameter hole. This is also good for the small-diameter hole because

this is the bottom-most person. This is in between the rotary one. This is the largest drill thrust also always carried out in the rotary action.

Here the deviation occurs is obtained this less here high deviation occurs here also deviation occurs very high because of the percussive actions. Rotary drilling is effective for the deep hole, So, for deep and large dia. holes, you can opt for the rotary drilling in the top hammer, you cannot go for rotary for deep holes because the hammering action will become inefficient, but it is a little bit effective for better deep holes for the if you are comparing with the top hammer drills. Here you can see constant penetration. Here penetration is a little bit inconsistent with the depth. The penetration may increase a little bit.

But you can also achieve the constant sorry decrease with the depth a little bit. But here constant penetration is also achieved. So, this was the more or less comparison between these three drill machines. We will stop this lecture at this point and will continue drilling for surface blasting in the next lecture also. Thank you.