Drilling and Blasting Technology
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Lecture - 10
Drilling Machines - 1

Let me welcome you to the 10th lecture of Drilling and Blasting Technology course. In this lecture we will discuss about the Drilling Machine.

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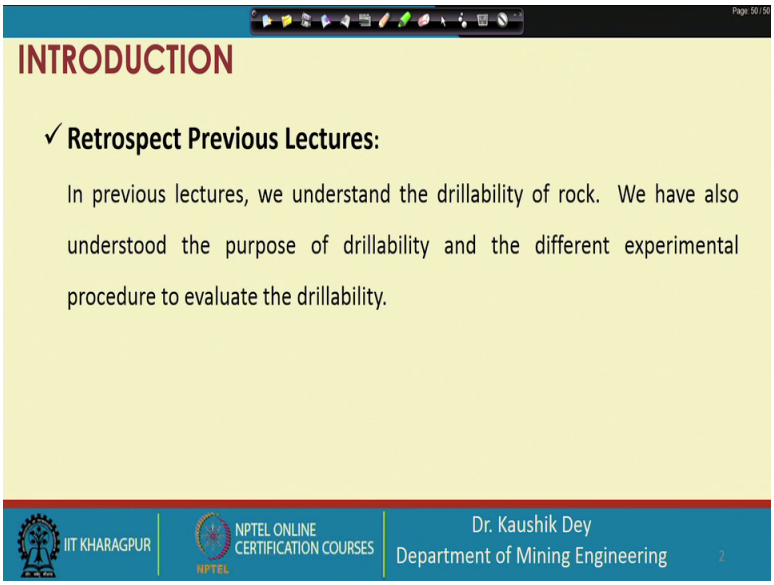

There are basically 2 lectures on the drilling machine. So, this is the first lecture on the drilling machine. Like every class let us retrospect our previous lectures. In previous lectures we understand the drillability. We have found that drillability is very very important. We understand how our machine has to be selected based on that drillability of rock.

We have also understood the purpose of drillability and the different experimental procedure to we evaluate the drillability. So, we have seen there are one is European procedure another is the Chinese procedure. Both are more or less similar procedure in a European procedure, it is carried out by the miniature drilling, where Chinese procedure it is carried out by the impact mostly impact penetration. So, that is why this is little bit more or less similar. But however, the results obtained from both are more or less similar. So, this we have already covered.

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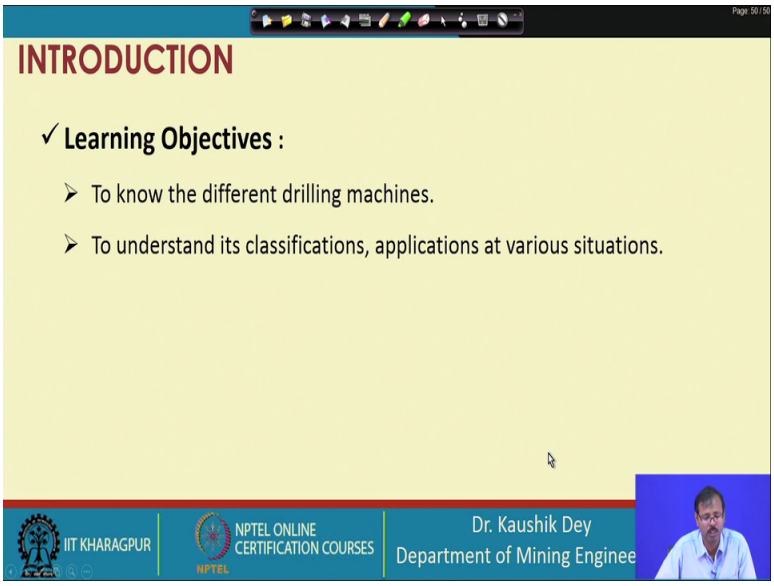

Now in this class our learning objective is to know; what are the different drilling machines available to carry out drill drilling a hole, so that we can place our explosive inside that hole for blasting purpose? And second one is to understand the classification of these drilling machines, their applications at various situations. So, this is our main objective. This objective will remains same in the next class also. On this plot objective we will try to discuss; what are the different drilling machines how they are working.

And we understand their classification also.

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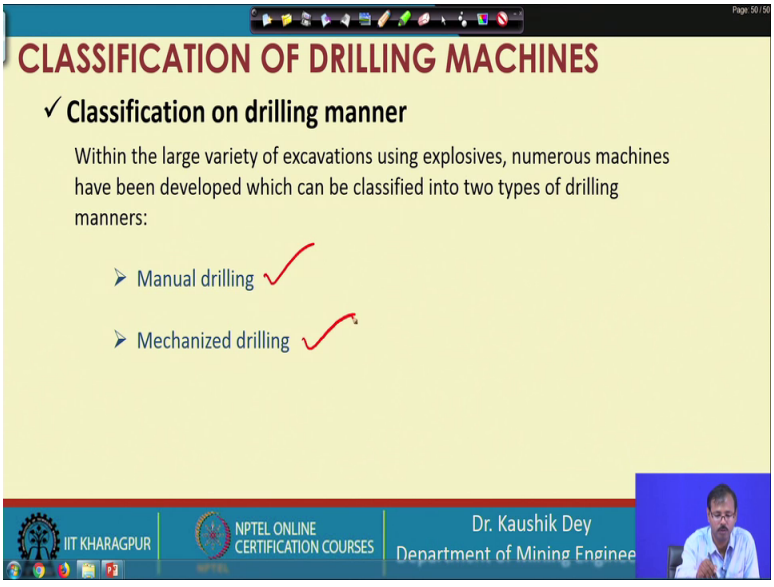

So, if you are classifying the drilling machine based on the drilling manner, it can be classified in 2 way: one is that manual drilling, second one is the mechanized drilling.

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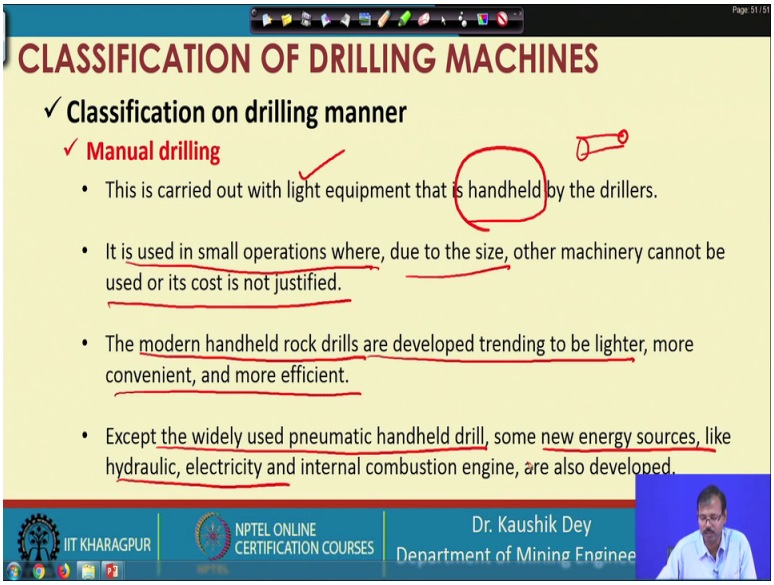

So, as it is given the manual drilling is basically carried out with the light equipment, and the drilling is carried out with the handheld operators. That means the reaction force of the drill bit onto the rock is basically experienced in the human body.

That means the human hand is which is giving the thrust that is also getting the reaction force. So, that is why this handheld equipments are drilling machines are always lightweight equipments. And a significant thrust is not allowed, because then it may damage the human tissue. So, this small operations for small operation these machines are used. These machines are used for the smaller size also. And that is why these are not very costly machines.

So, that is why as the thrust given is say limited. The diameter of the drill hole has to be limited for the manual drilling machines. The modern handled rock drills are available which are little bit lighter in weight and convenient to use. Most of these drill machines are either numerically operated or electrically hydraulically operated in the most of the cases. These are basically the major source of energy for the manual drilling machines.

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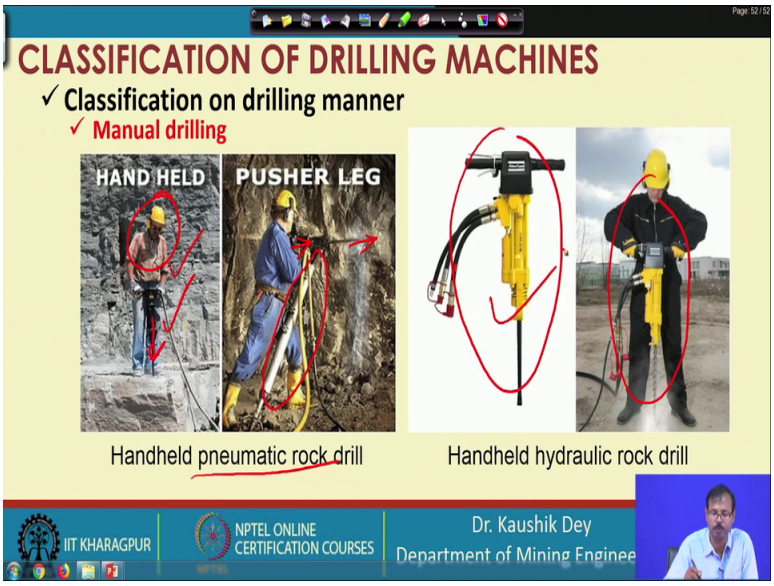

So, let us see some of the manual handheld drilling machines. You can see this is the pneumatically operated jackhammer. This is same pneumatically operated jackhammer, but you can see there is a air lake which is basically taking the weight of the drill machine. And the human being is only giving the thrust onto the drill machine, so that the drill rod receive a thrust here. In this case the benefit is that weight of the drill machine is basically the major source of the thrust. And this person is in little bit comfort position he is not have to give a thrust through his hand.

The same drill machine is also there, pneumatic drill machines are little bit heavier. But these drill machines are little bit lighter, where the motive power which is pneumatically provided here the motive power is heraldically provided in this machine.

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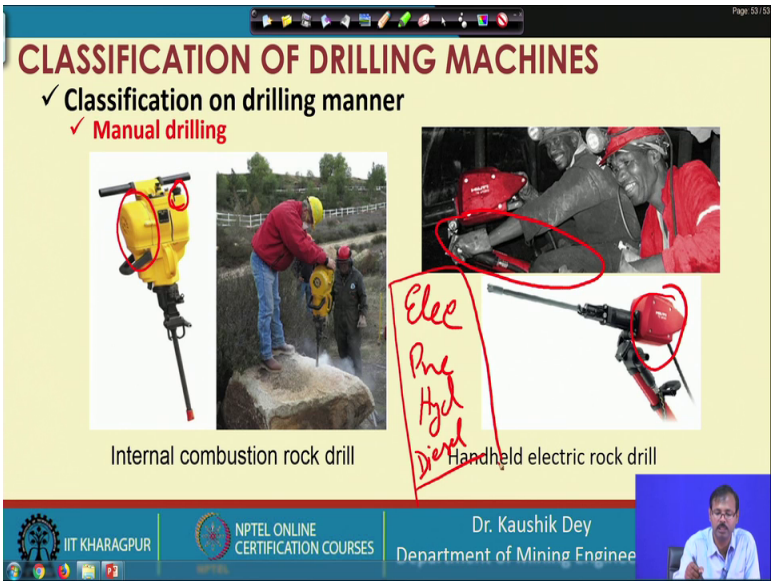

Electrical drill machines are also possible this is the internal combustion drill machine. Where you can see in the internal combustion this is the storage tank.

So, on ignition this storage tank is basically giving the source of energy by ignition of that. And so, that diesel or petrol whichever power it is, that power is converted to the energy and that is being utilized in this case. Here, the electrical power is used, this is the motor which is run by the electrical here the engine and this part is the motor, this part is the engine, and this is basically giving us the power. And this air leg is common in all the cases basically to take care of the weight of the machine. So, prime power may be electrical, maybe pneumatic, maybe hydraulic or maybe diesel or whichever it is, ok.

So, this may be the prime motive power, but that is converted to the mechanical power using this machines.

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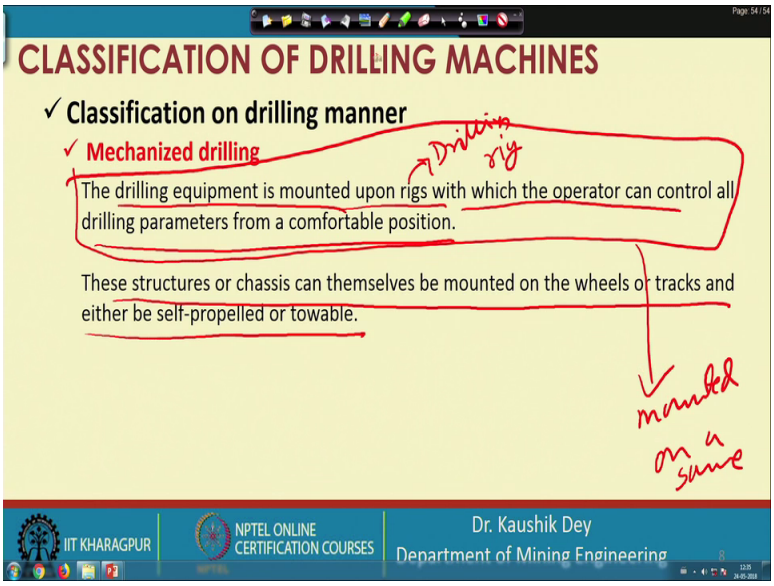

Now, the next one from the manual it is the mechanise drilling; where the large drilling equipments are used which are mounted on the rigs, operator can sit away from the rig. And control the operation of the rig from a comfortable position.

So, basically drilling is carried out by the drilling rig, drilling rig and the operation of the drilling rig is controlled from a cable or somewhere else. It may be possible that this control cabin and drill rigs are mounted on a same truck, mounted on a same platform or truck, or it may be mounted differently, the rig may be separate and the operators cabin may be separate.

This structure or chassis can themselves be mounted on the wheels of tracks, and either be self-propelled or towable. So, that is also provisions are there for the mechanized drilling.

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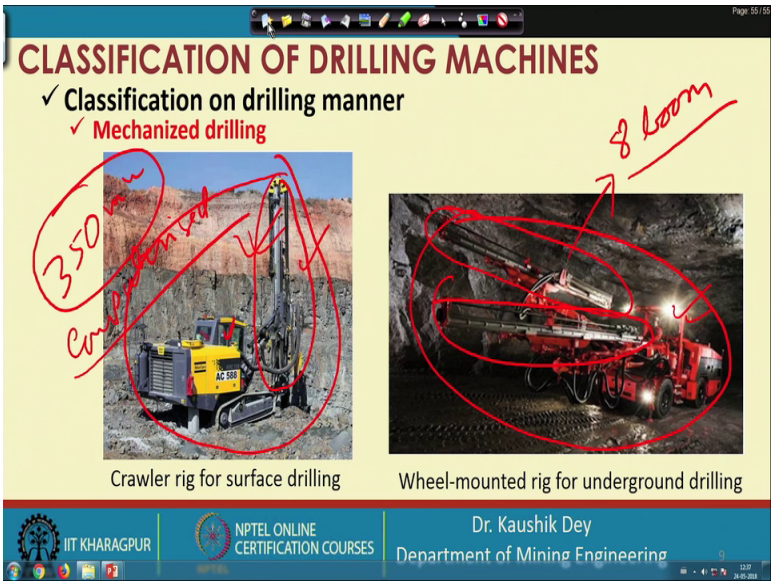

So, this is 2 cases of mechanise drilling you can see this is for the surface, this is for the underground situation, this is called jumbo drill this is the crawler mounted drill. So, this wagon wheels you can see these are self-propelled, and this is the drill rig, drill rig is containing the drill rod; which is drilling additional drill rods are also there.

And all this operation of this, movement of these are controlled by the operator in the operator cabin. Same system is there also you can see this is twin boom. Simultaneously 2 holes can be drilled here. And this is made for the underground purpose, that is why the height is kept very limited, and this drilling can be carried out in the front direction.

Angling drilling is also possible. Nowadays, most modern mechanized machines are completely computerized. So, the penetration depth, penetration rate all these are can be absorbed feed levels thrust all these can be observed or controlled by the operator. Similarly, the drilling angle is can also be automatically a controlled, same provision is given here also.

And in this drilling we can drill up to 350 mm dia holes also. Those are also possibles at this using this type of drilling. And if you see the modern drilling equipment here 8 boom jumbos, 8 boom jumbos are also available, where these are the twin boom 2 booms are here available here. But instead of 2 booms 8 booms are also available that types of jumbo machines are also available in the market. So, modernization of the mechanized

drilling has been carried out and a lot of advantage huge modern drilling equipments are also available in the market.

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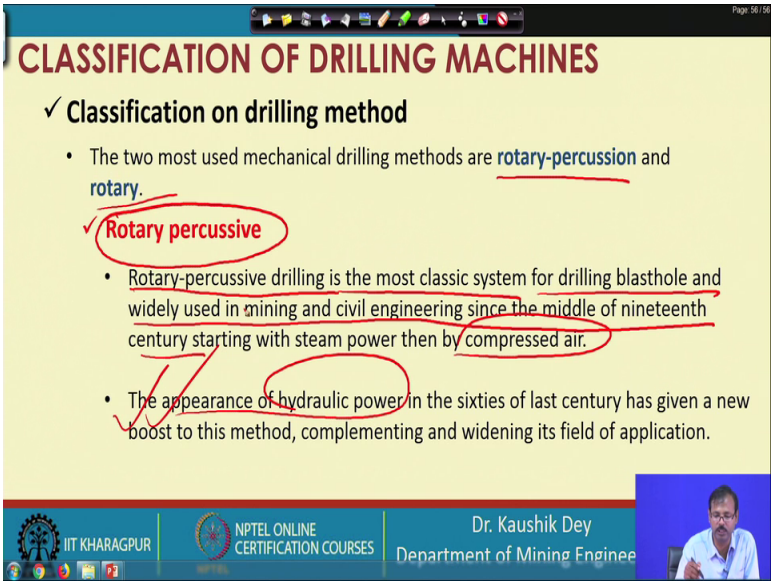

Now as we have discussed already. Drilling method can be classified into rotary and percussion. We will mostly discussed on to the rotary percussion because this is the most common drilling technique used for all the mechanized drilling. So, rotary percussive drilling is the most classic system for drilling blast hole. And widely used in mining and civil engineering since the middle of the 19th century. Motive power may be anything, the appearance of hydraulic power also modernize this uses of these systems.

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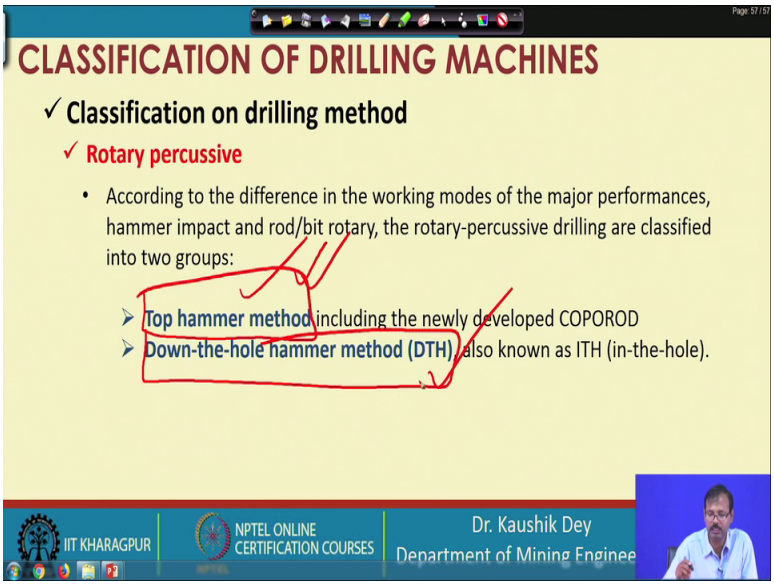

This rotary percussive drilling can be classified basically in 2 part: one is top hammer part another is down the hole hammer type. In this lecture we will discuss on the top hammer part, we will discuss the down the hole hammer part in the next class. So, let us see; what is top hammer drilling carried out in the rotary percussive drilling.

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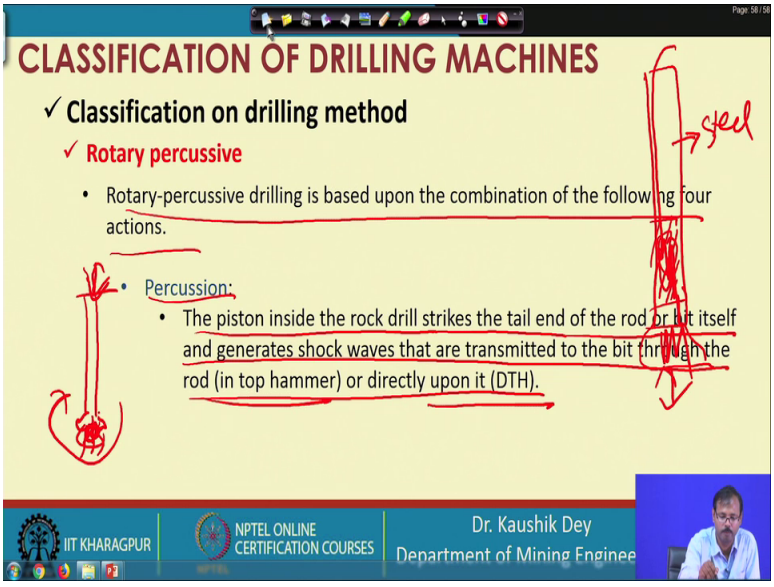

So, rotary percussive drilling is basically having 4 actions. One is the percussion, where piston inside the rock drill strikes the tail end of the rod or bit itself and generates the shockwave which transmitted through the bit or directly upon the DTH in case of DTH.

So, basically this is the drill steel, in the mount of the drill steel the bit is fitted. Hammering action is carried out here. So, the shock generated is basically transmitting here, the hammering force acting on this, crossing is carried out at this.

Then on the rotation of this the shearing of the cracked portion is occurred to so that the chip will come out. When this hammering action is carried out from the top, this is called top hammer, when this hammering action is carried out this hammering action is carried out providing a pneumatically or hydraulically hammer here. And this hammering action is carried out on the bit there is no movement of the drill steel. But for this hammer only that drill bit is oscillating and generating the shock wave hammering the rock, then it is called down the hole hammer drill. So, basically percussion is given either from the top or from the down the hole.

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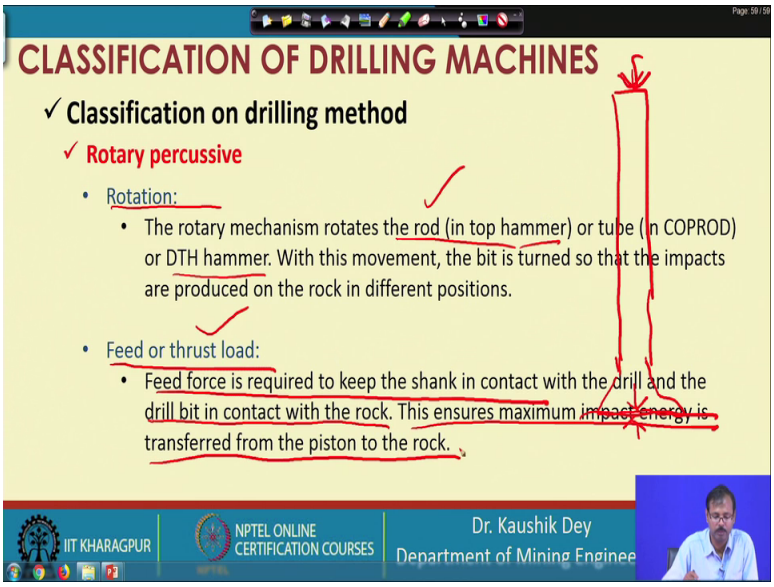

Then the rotation is given to the rod, either by top hammer or by the down the hole hammer.

Means again the rotary action is also given in the drill steel in case of top hammer and in the bit from the down the hole hammer. Often the rotary action is given for the down the hole hammer also from the top also, then the feed or thrust or the load. So, a feed forces required to keep the shank in contact; that means, a force a thrust has to be given in the top of the drill steel whether it is a down the hole or it is the top hammer.

In both the cases this thrust has to be given, so that the bit must remain in contact with the rock always there should not be any air gap. So, that is why this contact must be there and feed or thrust load is basically assuring this one. So, feed or feed force is required to keep the shank in contact with the drill and the drill bit must be in contact with the rock.

This ensures maximum impact energy should be transferred from the bit to the rock. So, this basically feed is basically required for consistent transferring of the energy from the machine to the rock.

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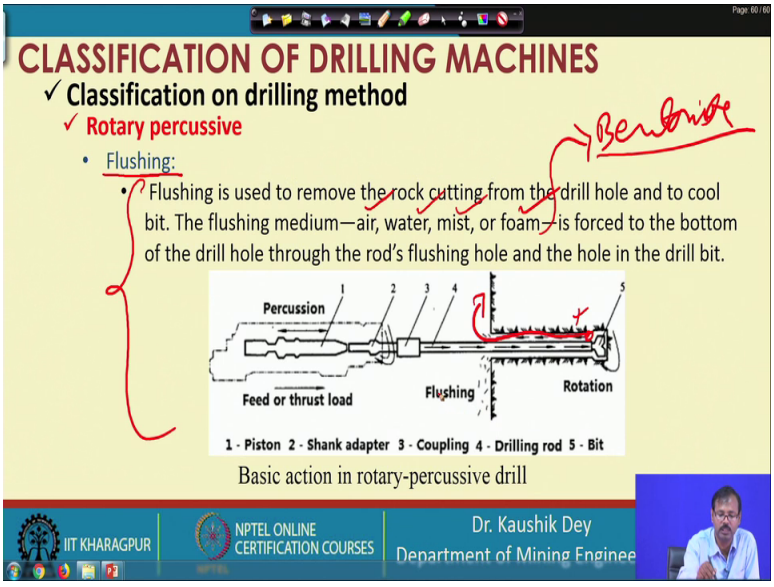

And finally, the requirement is the flushing where the cut chips the chips has to be taken out from the hole. And for that the flushing is required, this flushing most common flashing is the air, water, mist, foam often we use bentonite etcetera as a flushing medium which can be utilized for sealing the holes also.

So, our side part of the holes also, we mix bentonite in the flushing medium. So, basically these are essentially flushing is essentially required as we have discussed earlier also. This is essentially required for taking out these chips for the cooling of the drill bit, and also for repairing of the sidewalls of the holes also. So, these are essentially required flushing is essentially required.

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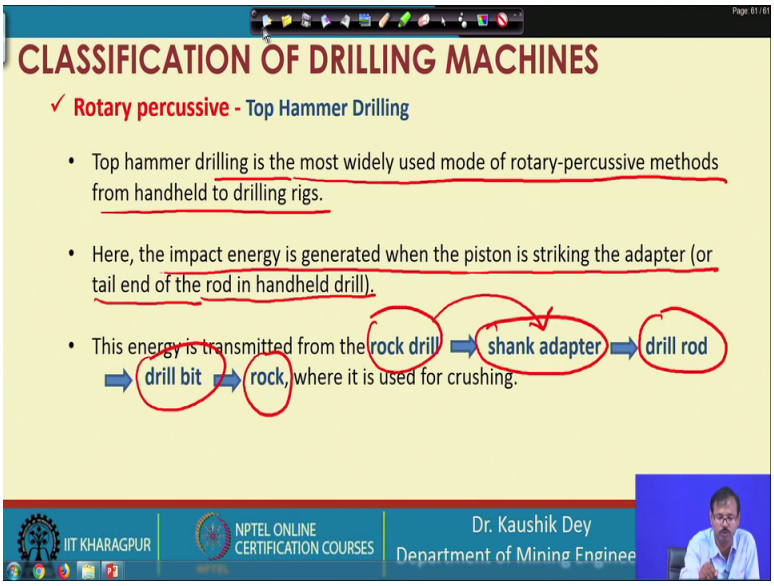

Now details of the top hammer drill let us discuss. Top hammer drilling is the most widely used rotary percussive drilling, though nowadays for the deep holes we prefer down the hole. Here are the impact energy is generated in the piston which is striking the adapter, that is the tail end of the rod. Then the rod it is transferring it is energy to the bit, and beat is acting onto the rock.

So, basically from the rock drill, from there rock drill is basically hammering onto the shank adapter. So, the shank adapter is transferring the hammering force to the drill rod, some drill rod the drill bit is receiving the force. And finally, the force is going to the.

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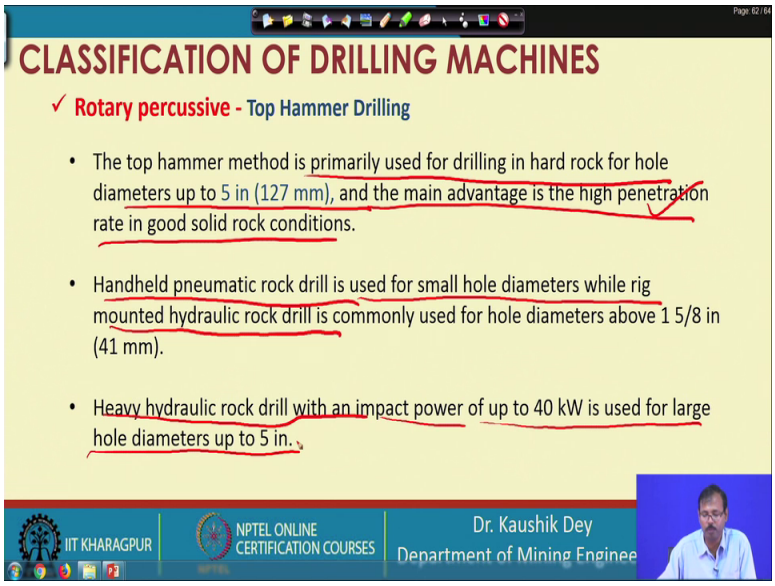

So, basically let us look into this.

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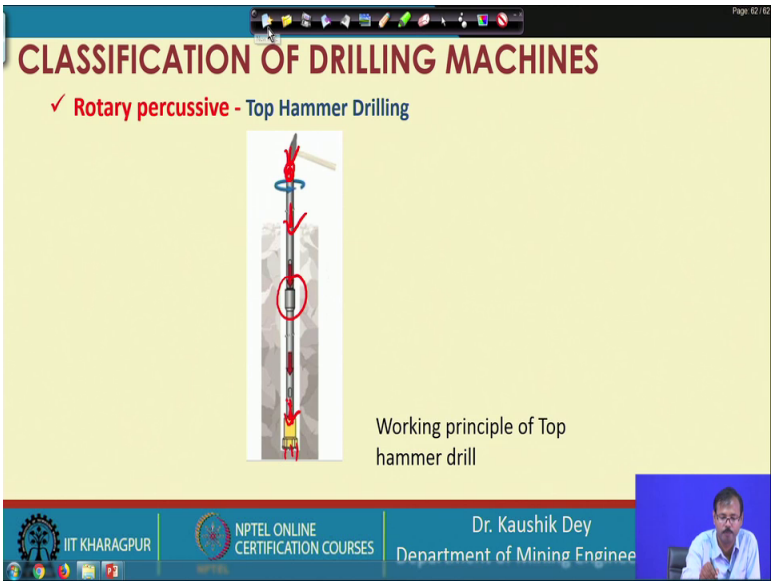

If you look into this figure you can see this is the hammering action is going on.

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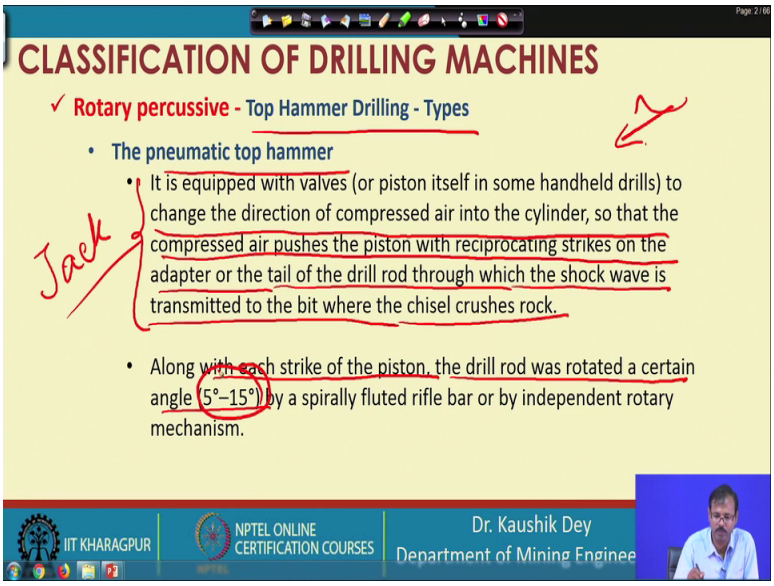

Hammering action is going on onto the top. Then this top is getting the hammering force, this is the shank. Shank is transferring it onto the rod, there may be n number of rod coupled with the coupler. Then the rod is transferring it into the bit. So finally, the bit is transferring the energy into the rock. So, the top hammer method is primarily used for drilling in hard rock and up to a limited diameter, and up to a limited depth also.

For the limited diameter and small dia holes, the performance or the penetration rates are considered good. All the handheld operators are mostly they working based on the top hammer type. Heavy hydraulic rock drills with high impact power are also used for the large holes. But the problem of this top hammer drill is that, this top hammer drills cannot be used for the deep holes.

Top hammer drill can be further classified; top hammer drill can be further classified while the pneumatic motive power is used. Most of the cases we use pneumatic motive power for the top hammer drills specially for the handle drills. These allow the change of the direction of the compressed air from the cylinder. So, the compressed pushes the piston with reciprocating strikes on the adapter or the tail of the drill rod through which the shock wave is transmitted to the bit where the chisel crosses the rock.

So, this is for handled drill machine specially for the jackhammers, this principle is used. Along with each strike, the piston the drill rod rotates a certain angle 5 to 15 degree. So, that means, the moment the drill rod is being push forward, it takes an angular rotation, it

takes an angular rotation and this angular rotation is utilized for the having the rotary action.

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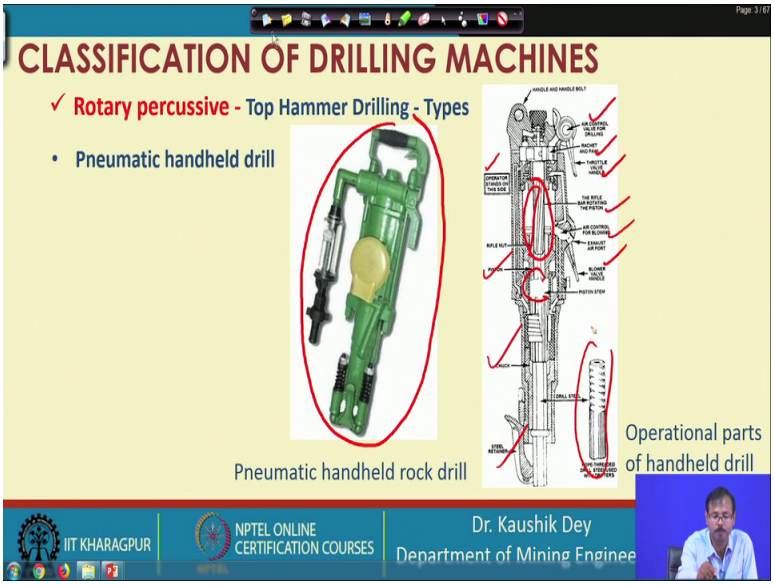

Now this is the photographs of the jackhammer you can see. And if you look into this, you can see this is the rifle bar, this is the rifle bar which is basically allowing the rotation of the piston. So, as the bar is a little bit the rotary action. So, the piston is allowed to move like this so automatically a rotation occurs into the piston. So, as it is moved in the forward direction the piston is basically allowing a little bit 5 to 15 degree rotation here. So, these are the different components, this is the air control bulb for drilling, this is the ratchet and pawl this is the operators stand on this side, this is the throttle bulb handle.

This is rifle bar we have already discussed the air controlled bulb which allows the relief or of exhaust here. Then that blower bulb, this is the piston; this is the chuck which is holding the rod. And this is the steel returner and this is the thread of the drill steel. So, this is basically different components of a handled jackhammer drill.

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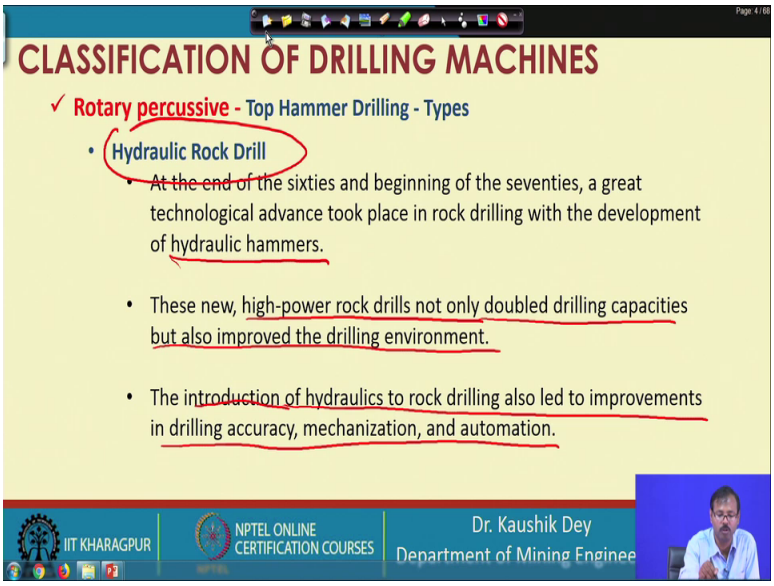

If you look into the hydraulically operated drill this is in this case we are using hydraulic oil as the motive power. And by this hydraulic hammers are became popular, this high powered rock drills doubled the drilling capacity, this also improve the drilling environment as the material is not leaked out; as the air is coming into the surface it coming into the atmospheric air that may create problem.

So, here there is no case of spilling, drilling accuracy mechanization and automations are also improved in case of hydraulically operated handled drill machines.

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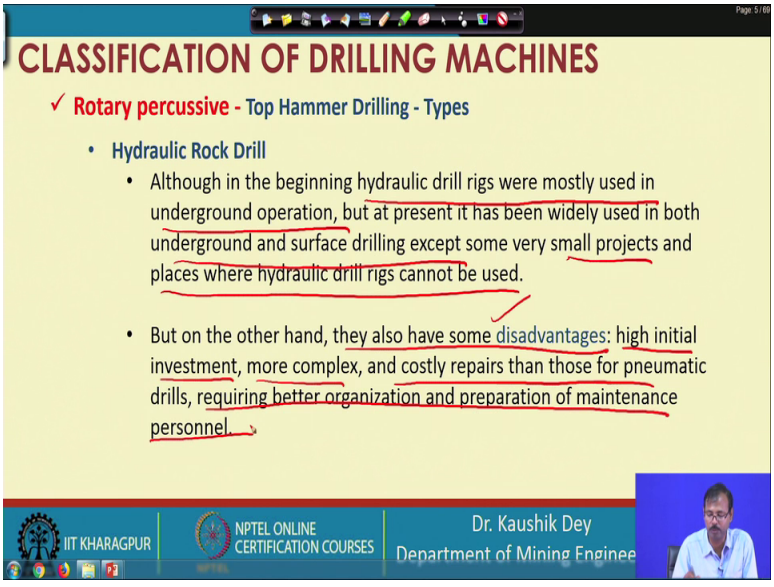

So, hydraulic drill rigs were mostly used in underground operations.

This also nowadays used in the surface drilling also. But in small project this may not be very very efficient as you have to keep a huge hydraulic oil pool. Some cases it may be advantages where high initial investment is required because of this. More complex operation is there repairing may not be that much easy for these machines, you may have some expert mechanic for that. And maintenance required maintenance for maintenance recruitment expert expertization is required for hydraulic drill handled drill machines.

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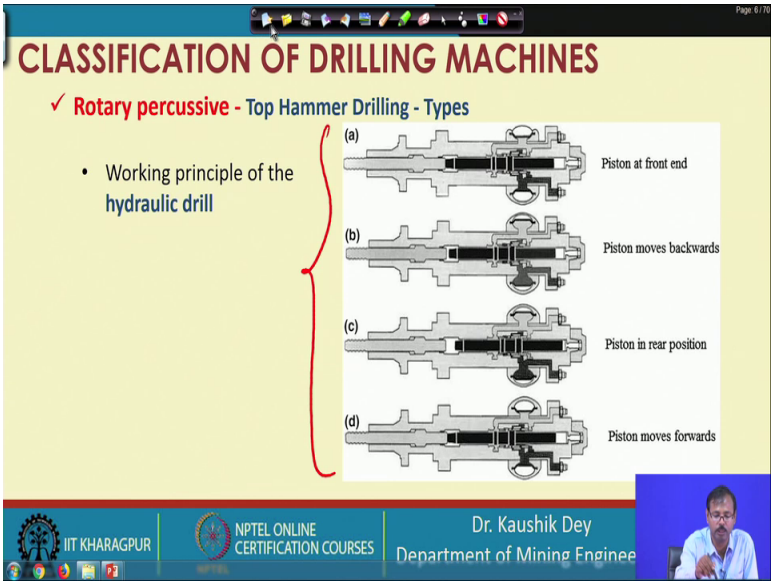

So, these are the figures of hydraulic handled drill machine. If you can see this is more or less similar to our pneumatically operated drill machine. This is the piston at the front end, this piston moves backward in this case, and this is the rare portion of the piston, and this is the piston moves forward. So, this is the schematic diagram of the hydrically operated drill machines handled drill machines.

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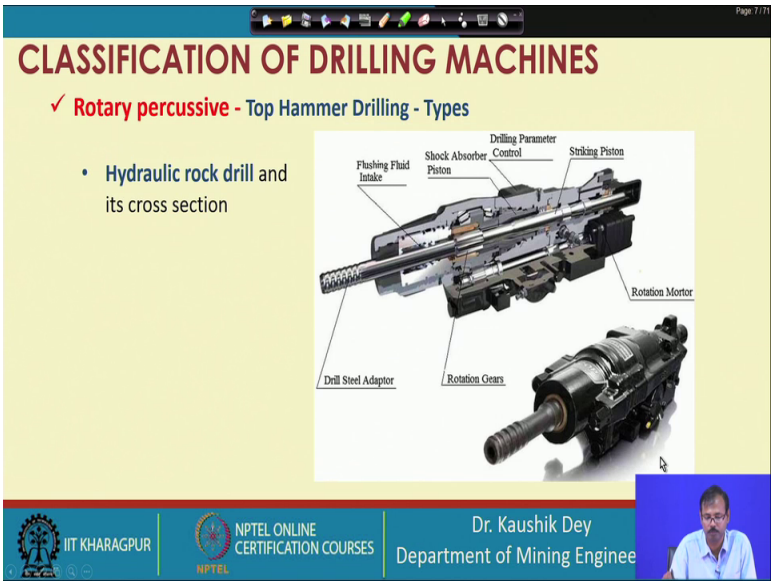

And this is the cross section you can see.

So, let us stop the top hammer based drill machines at this point. We will continue this lecture with the down the hole hammer drills in the next class.

Thank you.