Mining Machinery
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Module – 04
Lecture – 15
Drilling Machines for Mining

So, let us start our discussions on the basic Machinery; Mining Machines include this Drilling Machine. Drilling is an important job in mining industry it is required for the exploration as well as it requires for your water well drilling, blast hole drilling and particularly this in the oil well sector.

Drilling is the main operations because all the production well for gas and oil wells are drilled by this method. Drilling is a particular excavation in which we make a hole. A hole is where your excavation is the diameter is comparatively or very very less than the depth; then we are having a hole is created on the earth crust.

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Now, this say drilling machines they are used widely a quite a large varieties of drilling machines are there. As you can see these photographs here this is a drilling rig in the oil industry and also in the mining industry you can see these are the blast hole drilling of different types. Here that there are mainly hydraulically operated a percussive drills or the drilling is also in the offshore where they do for the drilling for oil wells below the seafloor.

So; that means, the drilling is a technology by which the extraction of mineral is very very important. And today in this lecture, we will be talking about drilling technology and how it is being used in the mining industry; particularly for the mineral mining.

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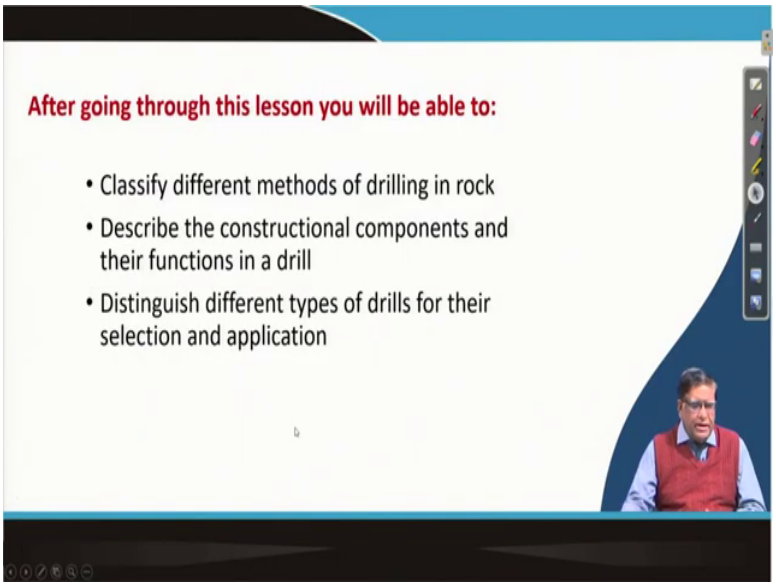

Now, here in this it is a very vast subject drilling technology is a vast object out of which a brief introduction of the things will be given over here. That is we will learn how to classify the different methods of drilling in a rock. And describe the constructional components of a drilling machine and how they function. And also we will be having a distinguish between different types of drills.

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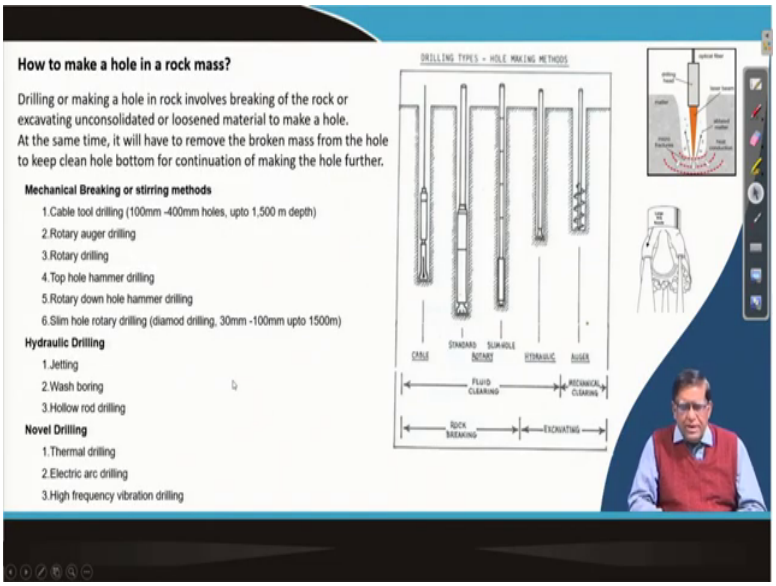

So, coming here; you can see that you can how we make a hole in a drilling or in a rock mass. So, there we will have to be you will have to dig a hole. Digging a hole means you are removing some material from here. So, the basic principle of drilling is what? We will have to disintegrate this rock mass over there.

And that whatever the debris created that debris is removed. So, by this method and then it will go on doing this. So, at what rate you are making this hole that is called the penetration rate. And then this rock must be it will have to be broken or disintegrated which can be done by different method.

One is that is your we do the mechanical breaking of the rock. Drilling can be done by loosening or breaking the rock mass and then removing the debris. Now, to loosen or break this rock mass there could be different methods.

That first is just mechanical breaking or hydraulic braking or by some new techniques. In the mechanical breaking, we have got this is called your that your rock breaking and sometimes we can just while breaking that is the simultaneously we can excavate or remove this.

So, that is why that rock breaking types and then excavating. Now, this rock breaking and cleaning it can be done in a cable tool drilling we are having a cable and then a drill bit is connected with a some much weight given attached to it and you just do a raising and lowering of it. Then when you are raising and lowering it will cut and at that time you can just have a baler collect the material from here and then send it out.

So, this is way how the cable tool drilling they do. And in case of your some the rock can be broken by a auguring action. You can see here a auger is there so when it will be rotating the rock mass it will be just mechanically get cleared up.

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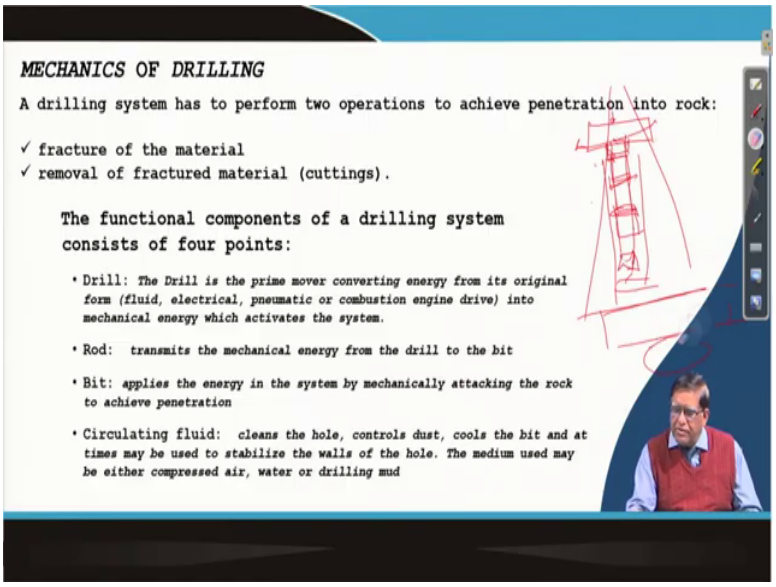

Or your when you are having a rotary a bit is there you are giving an axial thrust on it and then with this thrust you can just exactly in while doing this job you can see here you are giving a thrust over here and then you are rotating this. At this what is happening that under this axial thrust you are allowing a force to go get into this rock mass and with the rotations it is breaking the rock.

So, ultimately you are making a mechanical breaking and then you are taking out. So, like that you have got different types of methodology by which you can make the hole. Here in case of hydraulic, we can make the fluid pass through this and then there we may have a system a turbine may be here at this locations. So, that this fluid will go and it will rotate this one and we will get it a cut; so this is the way we can do this.

Otherwise, there are methods by which if your high fluid is coming and that it is coming as a jet and also this bit is rotating. So, even the hard rock they will be getting loosen broken by this that your fluid going at a high pressure and do it. And sometimes some noble technique like that new thinking is going on by optical fiber you will be sending out the laser beam.

And that laser beam will be by heat actions make the rock here too small and then we can get this that by sending air or mud or fluid you can clear this debris. So, there are various methods by which you can do the drilling operations. So, now, this mechanics of this drilling that is exactly you are fracturing the material and removing the material.

So, these two operations one is; how you cut the cut or break the material and the other one is how you are taking this out. So, for doing that there will be have to be certain mechanism to be used. Now, the rock breaking for that some bit or the tool is required that which will be interacting with that rock that is called your bit. Now, that bit will have to be connected to the rod by a rod; so, that the total energy which you are giving through the rod to the bit.

Now, this hole these two things will have to be there is a where that main machine which is called the drill where the main prime mover will be there. And then that will have to be cleared so that is why a circulating fluid will be there. So, if we see here; that means, basically a drilling systems will be having you are having a bit portions of it and then we are having a portions where you will be giving that either the rotations or the thrust.

And it will be connected with a some rods which could be as a string number of them will be connected with some sub assembly here and with a sack it will be connected and this will go inside the hole and then exactly this drill hole portions will be mounted on a machines which will be having it is own supporting mechanism.

So; that means, in a drilling mechanism we will have to provide the this drill with a prime mover which will be giving the thrust or the rotation will be transmitted by a rod to the bit. And a circulating fluid which will be sent to the hole through this either through the rod or by the annulus and then the material will be blast by which we can say it is a direct circulating or

a reverse circulating. So, the basic principle of drilling is that; cutting the rock and removing the debris as it is done over here.

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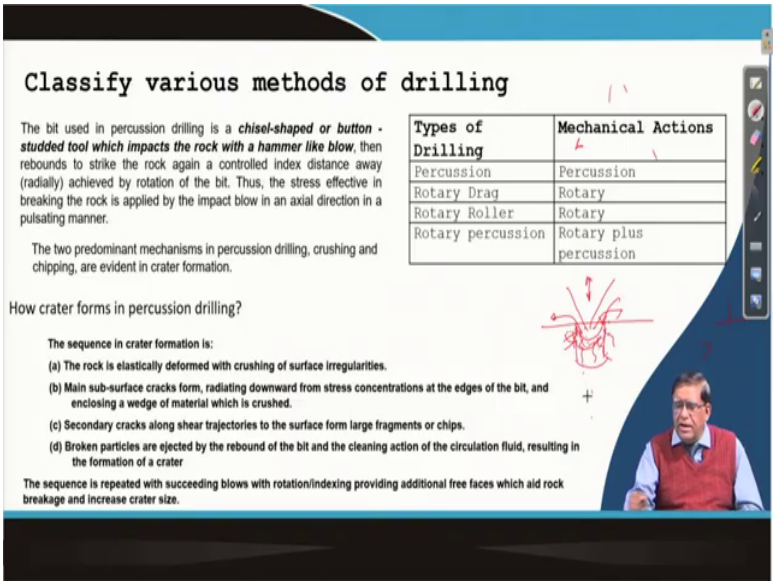

Now, the next thing is how can you classify the various methods by which you can do it. So that means, this breaking of the rock it can be done either by your percussive motion, percussive actions or that is by repeated hammering or can be done by a rotation of that exactly on the rock mass you make the bit to rotate or it can be that is a as you have seen in the in our previous class about rock tool interactions; we have said how the drag bit or the rock roller bit will be interacting with that.

So, that is what we will have to have this percussion drilling we need to know that if we give a hammering then; it will be hammering only at one locations. So, that is why whenever you are doing this hammering you will have to keep on rotating also so that fresh surface get

heated up so that the breaking become uniform you can get good debris. So, that rotations while doing the hammering is called indexing.

So, ultimately what is done in case of your percussive drilling? In a percussive drilling a rock is there you are having a bit now this bit is giving a repeated hammering action then here this rock mass will be get creating a crack and this will get broken and the sheaves will be formed.

Now, you will be sending some fluid which will be making this debris go out and then this will be going over there. So, initially a crater will formed and that crater will propagate and then you will go on making the drill hole.

So, this the sequence of this crater formation is that you can see here the rock is elastically deformed with crushing of the surface irregular surface irregularities, then the main subsurface cracks from radiating downward from the stress concentration at the edges of the bit and enclosing a wedge of material which is; crushed.

And then after that of main crack then there will be a secondary crack will get formed along the shear transactions to the surface from a large fragment of chip or some chips will be formed. And these broken particles will be because of that bit is moving over here it will get churned and much broken and that circulating fluid will be taking it out. So, this is how a percussive drill work.

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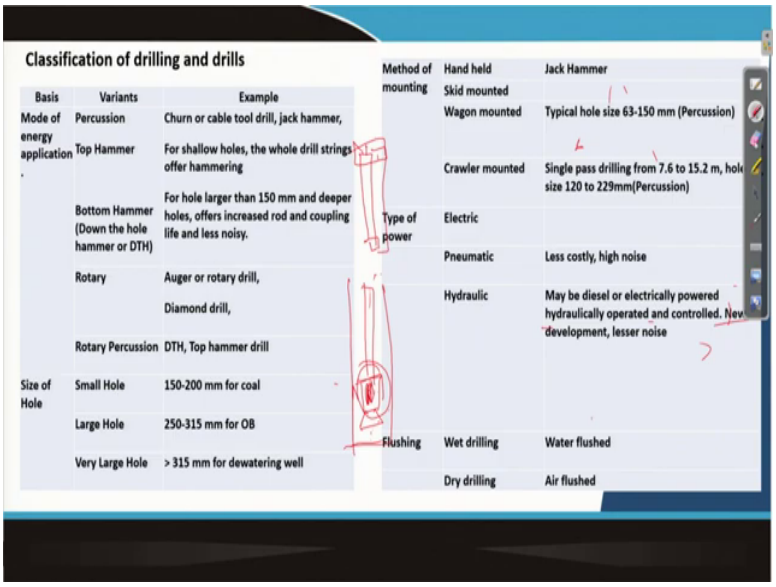

Now, if we see that there is a various way how you can classify the drilling. You can classify on the board on the mode of energy application which can be a percussion. That percussion can be given; that means, your the rod is here and that rod can be given from the top it can bring or the rod below the bit is there and only the bit part is moving.

So; that means, there could be a top hammer and bottom hammer. That is your when this from the machine stop this bit is here. Now your whole rod is exactly lifted and then it is lowered that is your from that top portion it is top hammer. And if we are having this rod and then there is a hammering action is given only here.

And your bit is connected here so; that means, your fluid is going through this and only this portion is doing the hammering. So, inside the hole inside this hole here you can do the

hammering actions only at this that is called your down the hole or bottom hammer. So, this percussion actions can be given by this.

Now, the energy applications can be on the rotary or the rotary percussion. In a rotary percussion your say for example, whenever you are taking a rock roller bit though it is rotating, but every time the teeth is moving it is giving also a hammering action. So, that in many cases when in a particularly in case of your tungsten carbide button insert bit is giving a hammering actions at that hammering actions at that time you also give on rotate reaction.

So, that way you get a both rotary and percussive motions together. Then the drilling machines it can be with very small hole; that means, your 150 to 200 millimeter for coal it is used, for 250 to 315 millimeter for drilling of overburden it is used or sometimes for water well you have got 315 millimeter.

Say for example, sometimes even you are having 700 millimeter diameter holes are drilled if you see in a Neyveli Lignite Corporation where a huge that large number of water wells need to be drilled you have got very large diameter water well drillings are done.

Now, this drilling machines can be different they can be on a skid mounted or they can be crawler mounted they can be tire mounted or that say wagon mounted depending on that you have got different. And sometimes you have got a hand held is a handle drilling you may find that in a electric drills say for example, in making a blast hole in the coal in case of a underground coal mining you have got handle electric drill.

A small electric motor is there which is having a flame proof flame proof casing is there and then a intrinsically safe circuit supplies current to that and then it does the drilling with the help of a electric motor; that is in a handle electric drill used in a coal drill. In case of your handheld jack hammer which is a percussive drill where your compressed air goes.

And then there inside that jack hammer we have got a that by controlling valves this air gives a reciprocating motion where a anvil on which a hammering action is done and you make the

drilling in a jackhammer which you might have seen on the roadside sometimes for the road repair and all the use and that is very much used in mining industry.

Then there is also we can have an electric drill, we can have pneumatic drill, we have got hydraulic drill, depending on how the main prime mover of the machine. And this flushing; that means, how you exactly that is also called sometime bailing that how you take out the debris out of the hole it can be done by water flushed or it can be by air flushed that is how it called a wet drilling or dry drilling.

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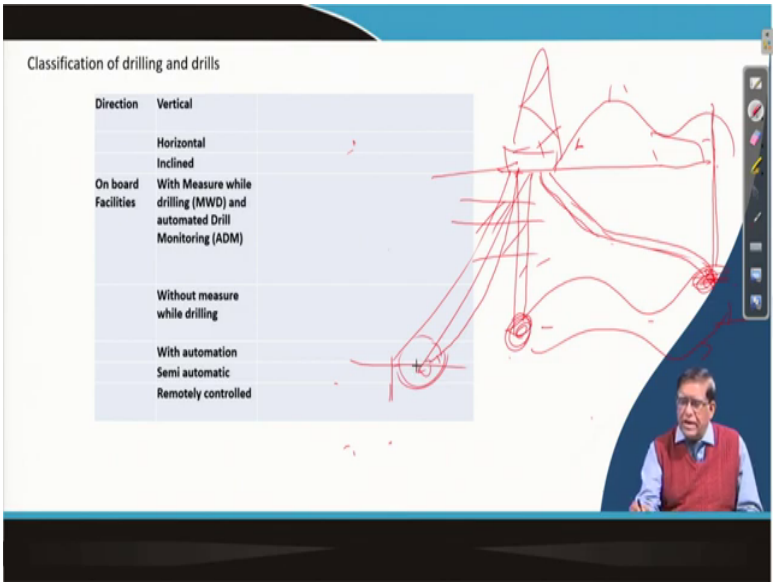

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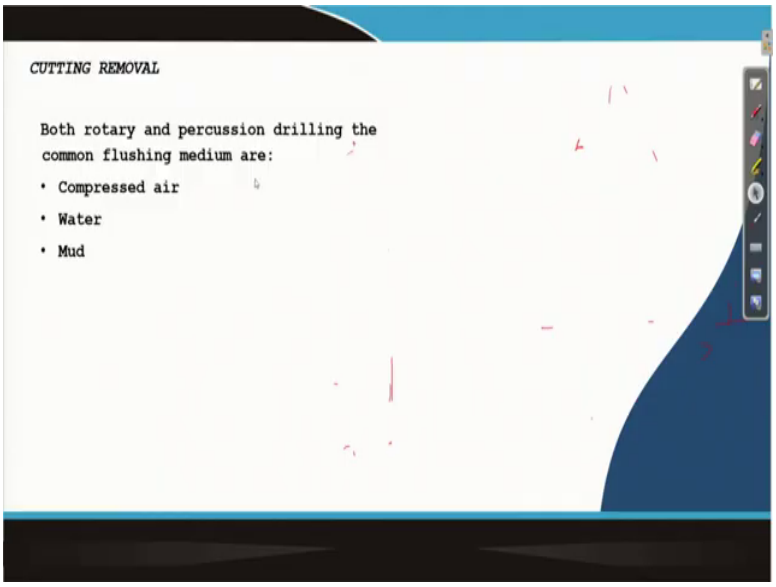

There could be how the direction of drill that is direction of drill can be a vertical drill or it can be a horizontal drill. For example, when you are going to do drilling for water or the oil well or gas well many times they it is it will be done 3000 meter or 5000 meter below.

And then if that area may be where you are starting doing the drilling you can do explorations to a long distance at a point which exactly where you will be getting over here. Say for example, you are having a that is a hill is there your target is maybe you are looking for oil at this particular portions you are looking for oil. But here because of the hill you cannot make a hill hole directly over here.

What you will be doing? You will be having your drilling rig and plate from mountain over here and then you can do a drill and you can go over here. So, that is what exactly when you are doing making a drill hole like this and then working over here. That is called your

directional drilling by you have got now the sophisticated technology by which you can do this directional drilling at this place.

But sometimes there is also do you remember that there could be a deviation. Suppose you want to do the drilling over here directly this is your target point, but these are different strata differences hardness and all that thing. If you do not take care that sometimes it happens automatically when you are drilling it is going like that. That means, you wanted to do the drilling over here.

But that you are ending up with drilling at this particular location; that is called your drill hole deviation. So; that means, when you are doing a drilling; drilling can be done intentionally the directions could be at a different place. Particularly the directional drilling will be when it is in a deep drilling, but in case of our over surface mining also, if you are doing a bench drilling over here.

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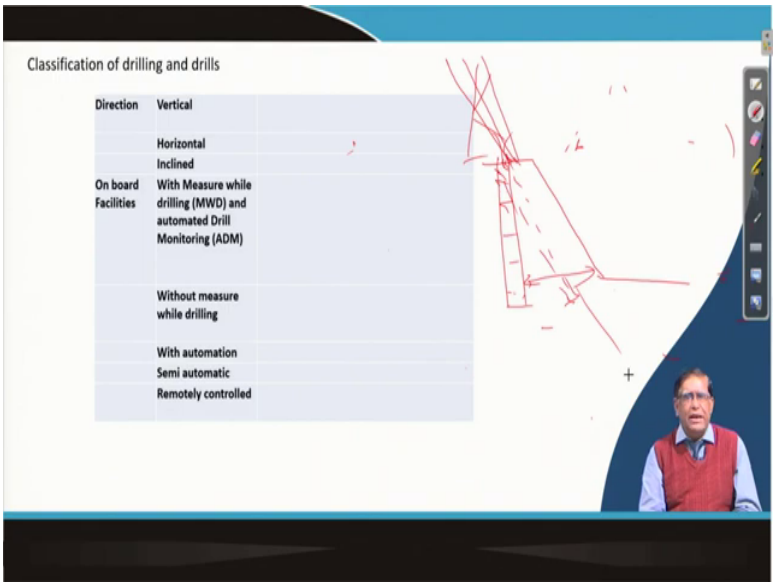

Now, if you do a drilling very straight over here what happens; when you put the explosives and you want to do the blasting here your the burden becomes more. So, that is why sometimes the drill hole need to be made at an angle drilling this is called your angle drilling.

Difference of a directional drilling and angle drilling is; angle drilling is a small distance small smaller depth of hole and we can do by just when the rig is there by tilting the rig we can go on doing the drilling. So, these are the different way the drilling machine can arrange for the requirement.

When you to a specific machines can be studied in detail, but here you understand that drilling purposes to make the hole. And then the hole drilling method can be a you can

prepare a chart by studying different drilling methods you will find some of the conventional drilling method there are non conventional drilling method.

In the conventional drilling method mainly; rotary, percussive, rotary percussive and water jetting. Water jetting one as I said that whenever the bit is there and through that bit you are having a nozzle very high pressure fluid water when it goes over there the rock fails. So, some of the not very consolidated rock can be drilled like this.

But for very deep drilling where the rock is very consolidated some type of that jetting will not be done. But there is also sometimes even a say that your sending your fuel as a jet and then making them to burn. You can just make the rock to break thermally and you can take out the this material by mud and we can do the drilling. There are novel drilling techniques can be there.

And this percussive which is the oldest one is the cable tool drilling which is nothing but just like you have seen in your village maybe number of persons they are putting a through ah a rope they take a rope and a big very heavy tool they put on doing it and then they dig well in the mines in their villages. So, that is also a cable tool drilling, churn drilling these are the old type of things.

Nowadays, this top hammer drilling which can be again and then as I said earlier top hammer drilling and down the hall hammer drillings are there. The top hammer drilling when they do there is that is odex drilling or od drilling is they are doing with a casing. That means so that when a hole is there.

Say for example, you are doing in a some of the overburden if there are lot of this is your already broken or aluminium type of material is there they will again fall back into the hole. So that means, the hole will not stand. So, there they will be making a steel casing and through that the drilling hole will be made.

So, there is a again the sometimes drilling is done for doing tunnelling purposes there is a for different type of purposes the drilling can be auger drilling. Then diamond drilling is for

taking of the core which is to do with the exploration purposes. So, that different drilling methods they can also have how to remove the cuttings in case of your drilling operation. The flushing can be done by compressed air water or mud.

In case of our mining surface mining when you are using a blast hole drills most of the blast hole drills are dry drilling where compressed air is used for flushing. Reason is our blast hole drilling hardly it goes to that is your this 45 60 meter or. So, in some of the only in the drag line phase you may go some that say 60 meter or maximum sometimes you may go 75 meter if your very modern large drag lines are used.

Normally you are having 20 meter 30 meter is the normal this. And most of the coal mining and all you may find 10 meter is sufficient benches bench height. So that depending on the bench height so in that with your compressed air you can very easily do the flushing purposes. The mud is used for your deep drilling like your oil and gas industry.

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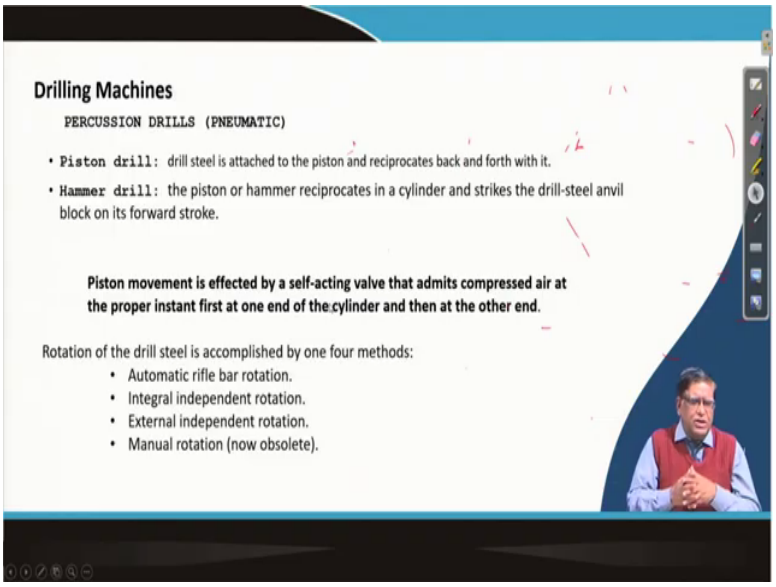

So, what is this when we say about the pneumatic drills or the percussion drill. The percussion action is given by compressed air. So, here that we say the drill steel; drill steel is the rod on which you are having at the tip the bit the bit could be a cross bit or chisel bit by which is an integral part of the drill steel and it is exactly the action is given by a piston actions.

Now, the piston movement which can be done by controlling through a valve the the that your hammering actions is controlled. Now, one thing is there in a if you have seen a jack hammer when they are doing this blowing at that time it gives a rotating, but when it is coming back that rotation is not there that is arrested.

That is why in the machine there is a provision by which you are while you are going forward you are giving a turn slightly and then when it is coming no and that mechanism which is used there is called rifle bar mechanism.

Where a helix is there through that helix it will move, but and then sothat it does not rotate in the back side that is why there is a mechanism called pawl and ratchet mechanism you will have to see that in the mechanisms if you have not studied. But it will we can discuss sometimes on your assignments you will be working on that describing the functioning how exactly the indexing is done in a say jack hammer.

So, I will request that you will be doing as an assignment study a jack hammer how this exactly percussion action is given and how this indexing is done. So, you will be knowing about the piston movement is affected by self acting valve; that admits compressed air at the proper instant first at one end and the cylinder and then at the other end it comes out when it comes it takes out the debris.

Now, the in case of your rotation; rotation the drill still is accomplished by four methods one is that is your automatic rifle bar rotation. Because of that rifle bar directions it automatically get with that that your helical groups are there it gives the rotation. And then it can be also integral independent rotation also can be given or external rotation is given and manual rotations nowdays it is not it is given.

Earlier there used to be it is a that people used to do with rope that about 100 years ago the drilling when it first started you can see the history of drilling. This they used to have the manually rotations and things.

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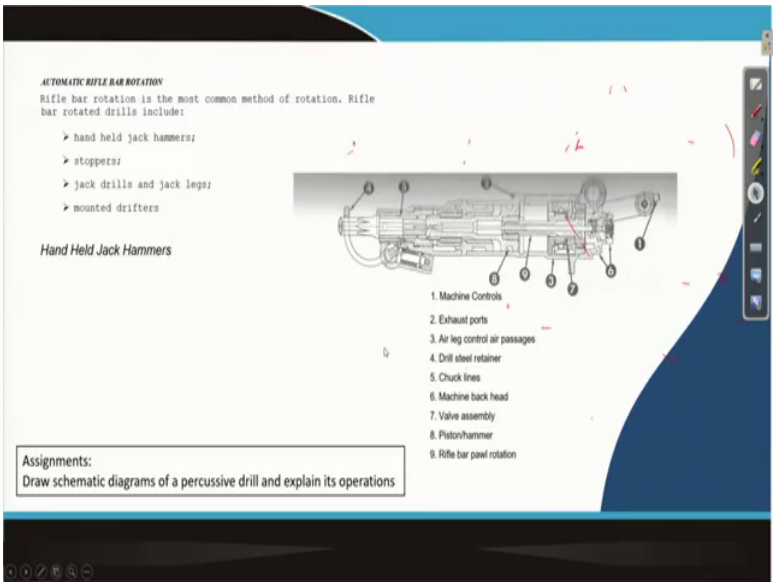

So, this is a jack hammer cross sections such type of cross sections are there in the drilling books; I request you, you can read that book of earth moving machinery or that say drilling handbooks or the SME mining handbook there you can find out. Now, this we have got the different parts are shown over here. This is an assignment that draw a schematic diagram of percussive drill and explain it is operations.

So, this you can do by referring to SME handbook or any other material. But it is a try to understand the how it works for though as a mining engineer you may not be doing the detailed design of this, but you will have to know how it exactly works.

So, there is a that main machine control where exactly you are having you are allowing the compressed air to go and come. And it has got an exhaust port and then this air leg control is suppose your the jack hammer is to be kept lifted air leg is a compressed air will be giving a suspension to the machine.

So, that the operator need not keep on holding and having this the heavy weight to be kept particularly when they are working this jack hammers in old days for doing this roof bolting and all it was used, but nowadays sophisticated roof bolters are there hydraulically operated modern machines are there.

So, jack hammer with air leg it has become almost obsolete it is very seldom it is used. But jack hammer mostly you for our secondary blasting if you are getting a very big boulder. Then in that boulder to make it again fragmented you do a small holes there with a jack hammer and put some explosive or then we do the blasting of that rock.

So, for that purposes so this jack hammer and all these things are that pictures are not necessary. So, now, there is a back head and also there is a piston hammer and you can see that this rifle bar that is where this helical groups are there and this rod moves over here.

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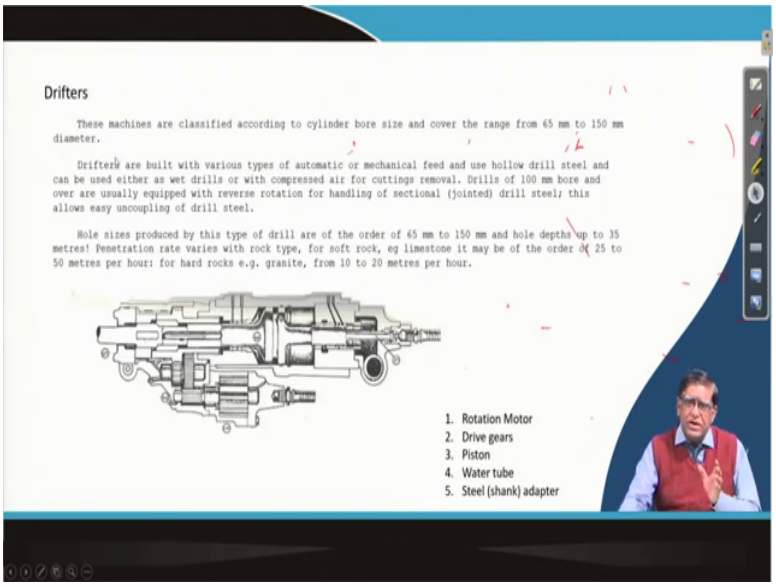

So, this is how that the drifters also another type of your percussive drill which is also used in underground coal mining sometimes in a say when there is a the rock is to be drilled through there they use this drifter it is also principle is same by controlling the valves you are giving a percussion actions.

And then you are your in a drifter when you use suppose for example, a coal seam is there and then suddenly there is a fault. Now, it has gun now again joining this seam to the other seam we will have to drill through the hard rock. Now, to do that hard rock drilling either you use an auger drilling or a drifters it is used in underground coal mining.

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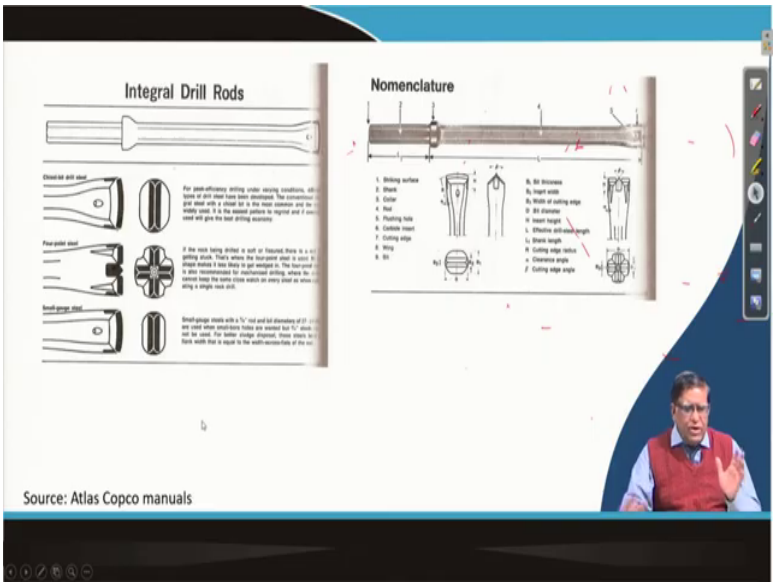

So, now as we have said that integral drill rod in percussive drilling that we are having a hexagonal drill rod like this at the end of it this is your tungsten carbide button is inserted this is called your chisel bit. And that this can be given as a two then it is called a cross bit.

Now, you can see in that rod there is all throughout there is a hole and that this hole it is coming here. So, this is the compressed air which is giving the percussive actions after that it is coming out of this. And when it is air is coming out all the debris which is formed at that bottom that will be coming out of the hole.

So, this is how exactly a drilling operations takes place. So, these are that if you see the name of this different your the other outer part it is called your shank, then you are having a collar, then you are having this tungsten carbide which is inserted over there. The overall this is this portion is called the bit and then at the side of it we have got that wing. So, this is the way how normally the this is a nomenclatures given to the bit you will have to know that.

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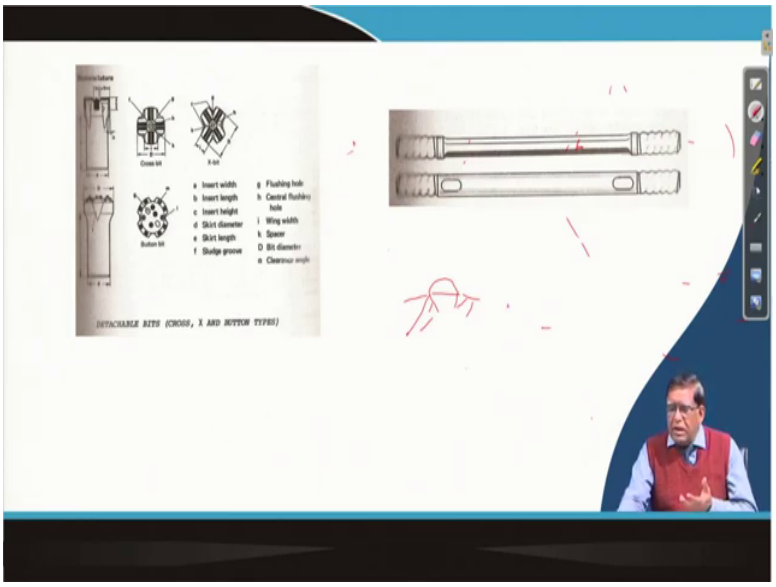

So, then there is another type of percussive bit you are seeing here. This is tungsten carbide button insert that you are having a circular that is a surface on which you are giving this tungsten carbide button. That button can be a hemispherical one button like this and it has got at that shank like this.

This portion is exactly is there under it is this portion is inside that and then only upper portion is a hemispherical one. So, there are different way this that height and diameter of that will be depending on how many number of those type of button will be there it will be depending on the your what type of rock you are get drilling through.

So, the other thing is this that in case of percussive drill that your down the hole hammer you are using this type of, but bit, but there will be a hammer actions which is again designed differently.

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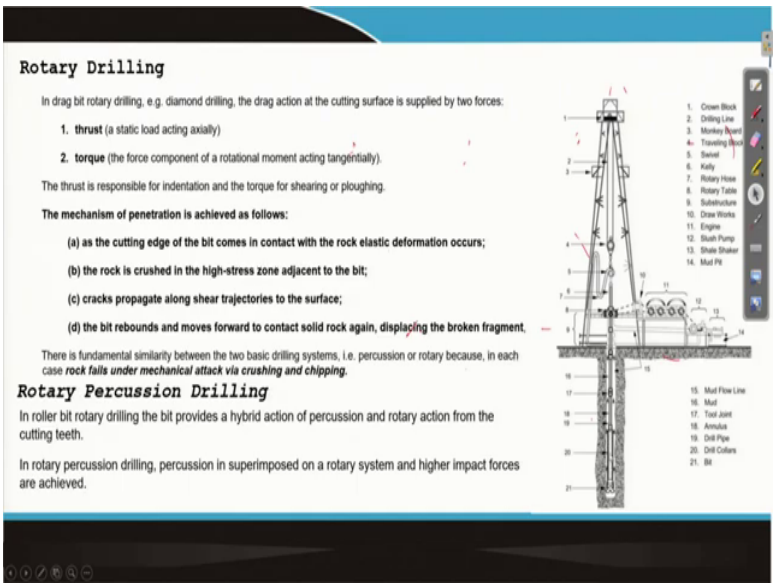

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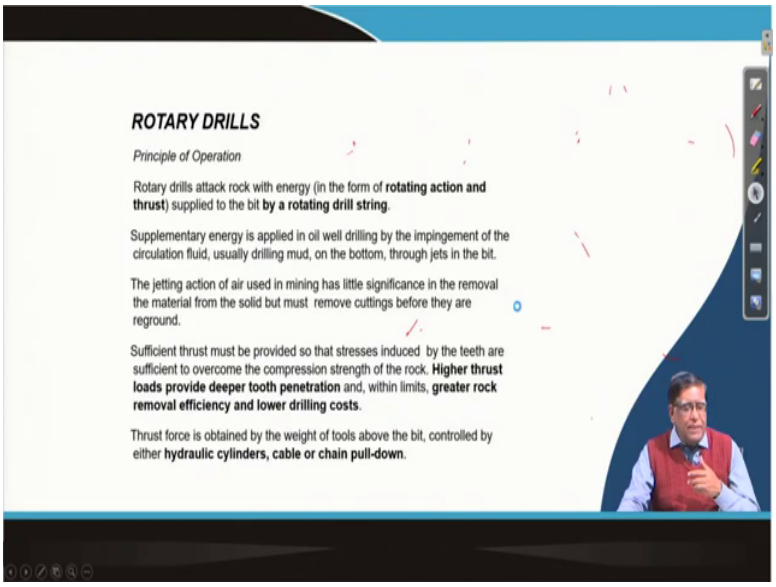

So, similarly in your rotary drill you are you can see here a drilling rig in a oil well drilling such type of rotary drilling will be there. Where there will be a crown on which this wire rope will be holding this whole thing is called drill string number of rods they are connected with this that is called sub or they are coupled together.

And at the bottom that your the drilling drill collar is there to stabilize so that it does not vibrate over there a heavy weight drill collar and at the bottom the bit is there. So that means, this drill string that is from the bit to this where it is connected at distance there is a swivel. That swivel block is it is there you can see that in pipe where the drilling fluid or mud is coming and that mud is sent through this drill string.

Now, at this point that where this drill string is connecting to the swivel that is the drill string will be rotating, but that swivel will not be rotating. So, that the pipe that hose pipe by which the mud is brought is not getting affected.

Now, this mud is coming from a mud pump and then there is a Kelly or this is the rotary table where the rotation movement is given that rotary table where exactly this the this is the rotary motor from here the rotation is imparted to the rod here. So, this type of this whole platform it is called your drilling rig.

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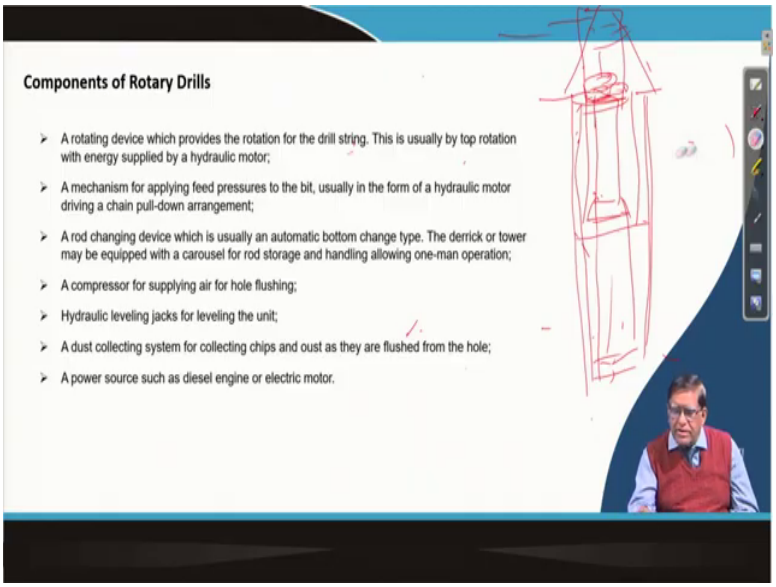

So, this rotary drills can that is your the component wise it has got a rotary device by which the rotations will be given there will be a mechanism for applying these feed pressures. There

will be that how the rod because when you start doing the drilling after doing one drilling then your rod will have to be taken up.

The second rod will be connected then that it will go. So, while they are doing the drilling operations basically in a our tire mounted or crawler mounted drill for a small blaster drilling you can see that three rods will be there. Then one rod when it will be going down after that this rod will be raised and then exactly it will that lower portion say this things goes like this. Say you are having one rod and then you are having this drill bit you have started drilling over here.

Now, when this drilling is done then from that another rod is brought and then it start rotating. And then when it will go down then now this portions will be coming over here then the third rod will be brought and it will be connected like that. As we go that is your the drill rods are all connected.

When the complete is complete hole is being done then this is taken out and then this will be your uncoupled it will stack and then this will be brought again the second one will be stacked then all the things will be there. So, when you make a drill hole you will have to go on welding the drill string by connecting rod after rod.

So, that is why there will be have to be a mechanism how to keep the rods in a drill machines and how they will have to be connected to do that is what is all arranged in the machine. Now, this the there should be the compressed air by which this air flushing will be done.

And then this suppose in your blast hole drilling you are taking a crawler mounted drilling machines. Now, the drill rod and that your hole will be straight when your the machines platform and these are perfectly perpendicular.

That means that platform drilling platform it must be horizontal, but in a undulations in the drilling field it can be at a there could be angling of the hole may take place. That is why the drill rig must have a leveling jack. So, that the drilling platform is always kept horizontal.

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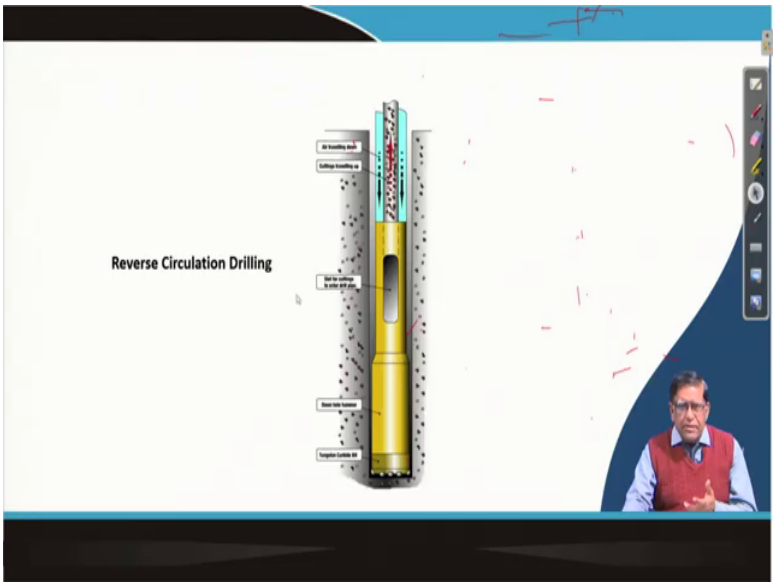

So, this is then the other thing is rotary drilling can be a reverse circulation drilling where that drilled rod your fluid is not coming through the drill rod over here. Fluid is going through the annulus and the debris is going through this rod and that is connected collected.

So, this type of reverse circulation drilling is also done. Particularly in some of the exploratory drilling where this debris to analyze and to find out where is there where is the valuable mineral or hydrocarbons or this whether they say oil bearing strata or not to be checked.

So, there these are valuable product of the drilling then it is called you will have to use this is where your to get these things to get the scientific informations of the down the art you can use this reverse circulation drilling over here.

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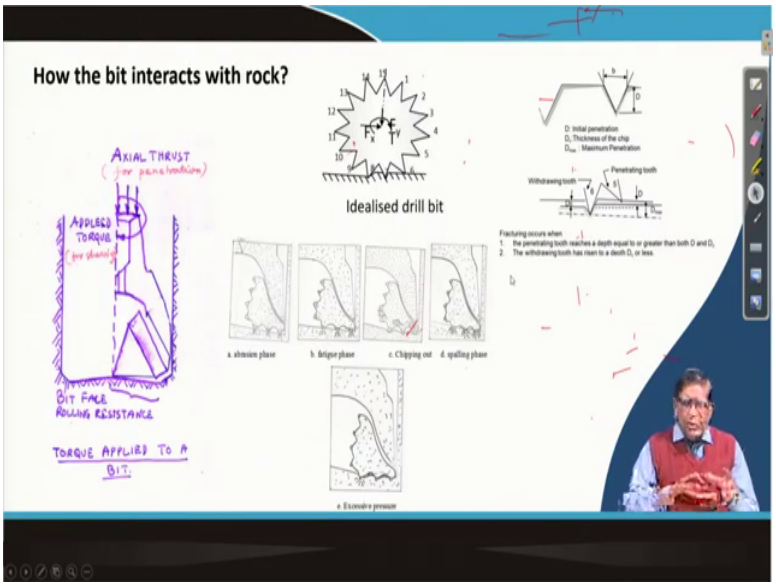

So, the rotary drilling when it works exactly the tricon roller bit. We have already discussed in the how it interact exactly on the axial thrust and then a torque is applied and this break is the rock is broken. It is just simulated as a cutting a idealized bit is nothing but a treated wheel when it is going it is under the under the axial thrust.

It penetrates and in the rotation it takes the chipsout; exactly the tricon rollers three rollers which are there. This when it will be rotating first a abrasion phase will take place then a fatigue phase then the chips will be forming and then there will be spalling and then we can have a excessive pressure.

So, the bit button can behave differently then you will have to control for the machines to give a better performance that what should be the axial thrust and what should be the RPM. If you do not select them properly the penetration rate cannot be achieved.

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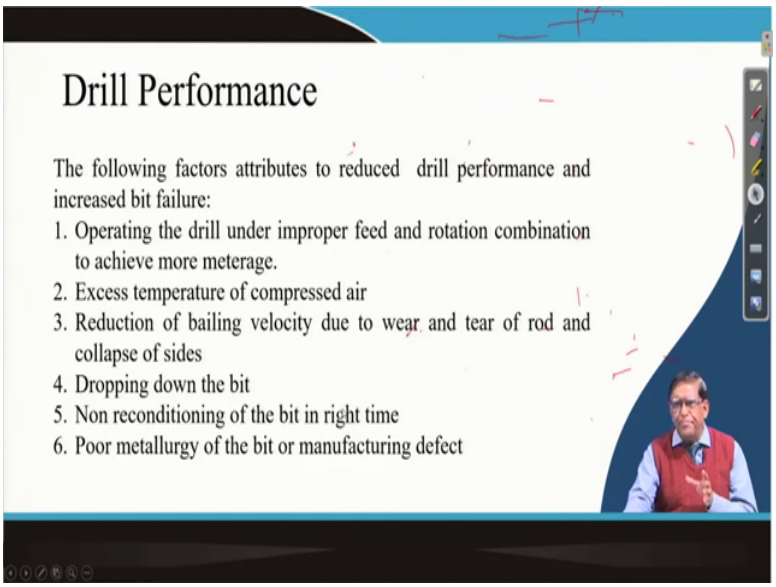

So, normally for each particular diameter of the drill hole you will have to have a specific axial thrust and a specific RPM under that combinations. And then how at what speed you are taking out the material that will be giving you the optimum penetration rate. If you are making a very fast drilling, but you are unable to take out the debris then your rod will get jammed. So, those type of drilling problems take place.

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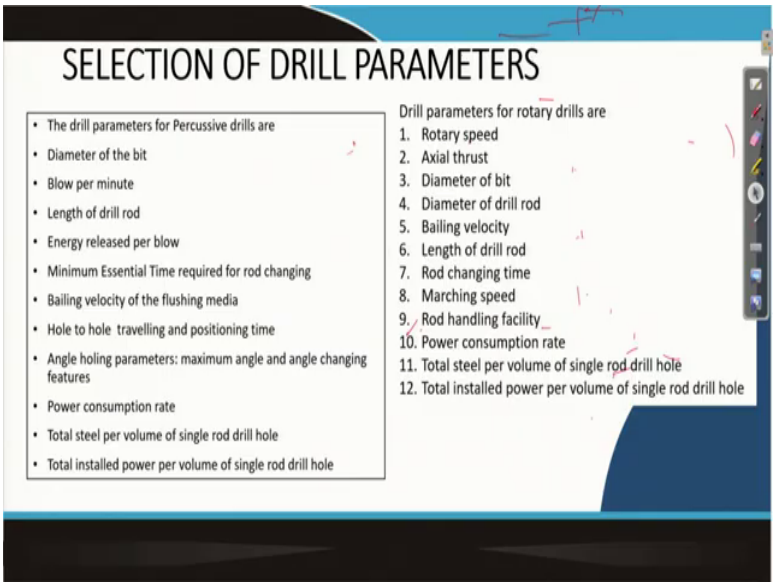

So, while you are studying about this drilling you will have to do the study the drilling parameters you will have to be selected for the proper performance and to get the proper trouble free drilling operations. Particularly in percussive drilling your blow per minute, your the diameter, that how much energy you are releasing, that how much time you are looking into it, then how exactly one hole to another hole; how you are moving and what is your power consumption these are the parameters you need to collect.

So; that means, while a drilling operations are being carried out what type of data you will have to collected so that you can get a better decisions before those all data analysis purposes you will have to know this parameter. Similarly in a rotary drilling your rotary speed, axial thrust, diameter of the bit, diameter of the drill rod, bailing velocity; that means, how the

debris is coming at what rate, length of the drilling rod. Because at what frequency you will be connecting the rod and disconnecting the rod.

Then your what will be the marching one place to another place; how the drilling is going, your power consumption rate these are the things need to be collected. So, as a result you can take up a lot of initiative in studying and researching on this.

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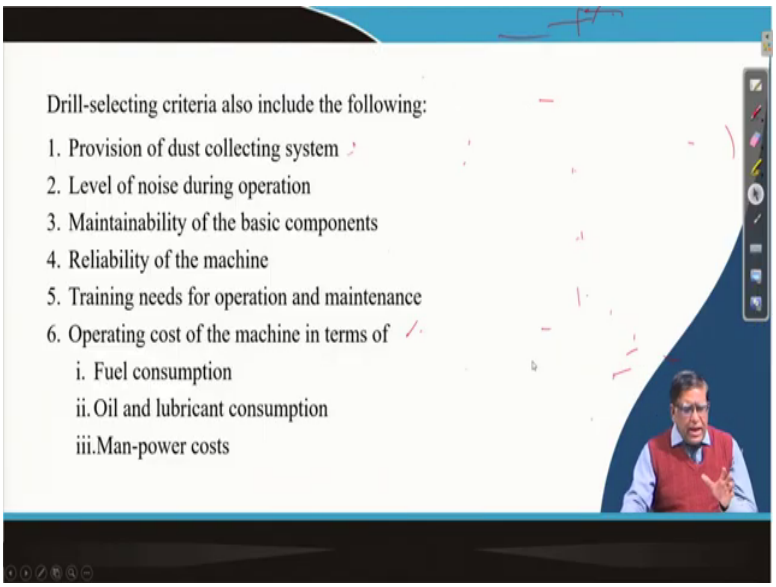

So, just a drill how we will be selecting for a particular area that whether you are doing an iron ore mining or bauxite mining or coal mining. What type of drill is required that selection is a lot of this data whatever related to the machine parameters and related to the rock.

These two parameters data will have to be collected then you will have to analyze according to the theories. Then you can go and you can find out that what will be your cost of drilling;

what much fuel will be required, how much manpower will be required, how much oil and lubricant will be required; by that only the drilling studies are done.

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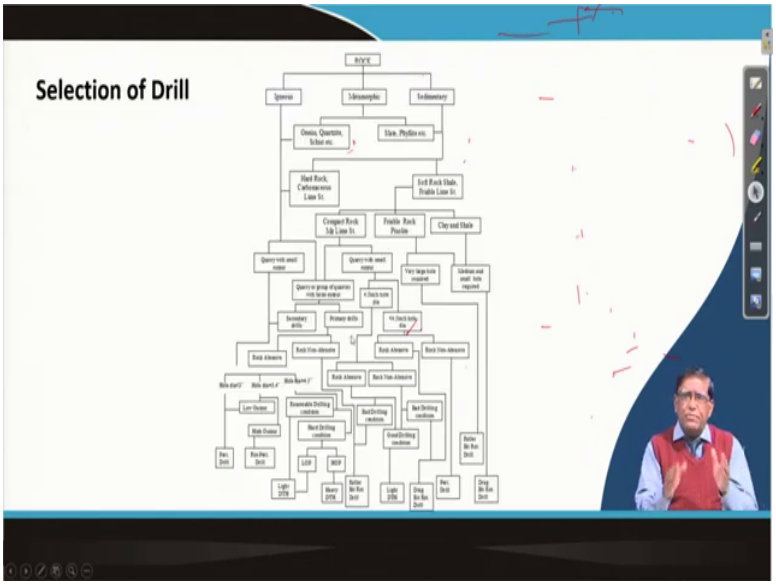

So, exactly the selection of a drill for a particular mine is a number of factors it done. So, if you can prepare such type of a flowcharts of that what are the different alternative and how they act. Then this flowchart can be converted to a computer program by which you can write down and code that is; what is a drill selection program.

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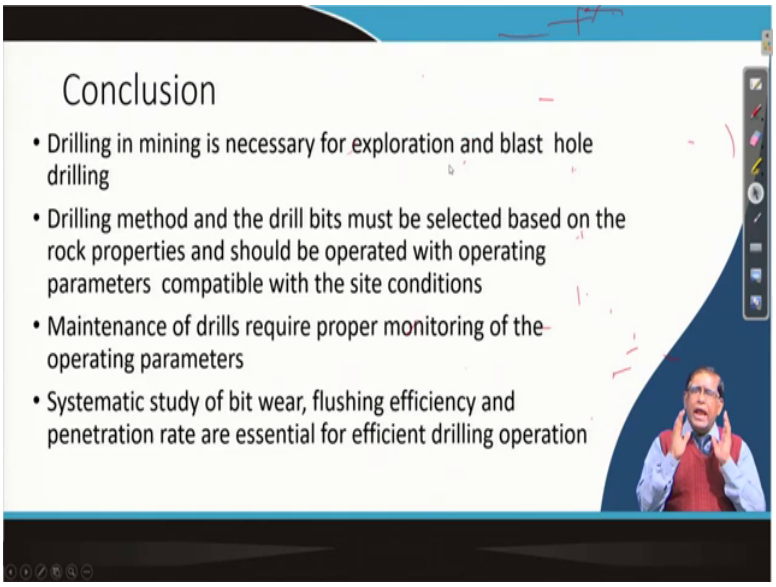

So, in a mines when you want to do a drilling operations or you need to understand that different parameters effect right from the; how the machine is designed, what are their parameters and then how it is affecting. When you can correlate them; then you can go for a really advanced or that automated mining automated drilling operations your automated decision making.

Now, the people talk about the artificial intelligence and machine learning you can apply over there provided you know the detail of it. So, it is just in a one class I have just introduced you it is a just to get your interest.

If you want to study drilling technology itself is a subject, but I wish if you are studying mining engineering at least one of the drilling machine you should study. So, there are a quite

a large number of drilling machines as I have already introduced here. So, you can take up your mini project on studying say; a blast hole drilling.

A blast hole drill can be (Refer Time: 41: 33) CP 650 or it can be old Russian drilling SBS is 250 or you can use the Atlas Copcos drill or this drill master or there are the that is your Ingersoll Rand drills that that quite a good number of drill and drilling machine manufacturers are there. It is to you please the informations are also available, but to go for specific you will have to make a sincere study and then make a systematic study.

For that you can refer any time you can contact me. And you can take up some of the assignment project that what type of mini project can be done on a drill selections or how you can do a optimization of drilling operations and how you can do exactly the performance management of drilling.

Thank you very much.