**Drilling and Blasting Technology**
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**Lecture – 20**
**Explosives accessories-3**

Let me welcome you to the 20th lecture of Drilling and Blasting Rechnology course. In this lecture we will discuss about the Explosive Accessories. And we are discussing this lecture in the last 2 classes also.

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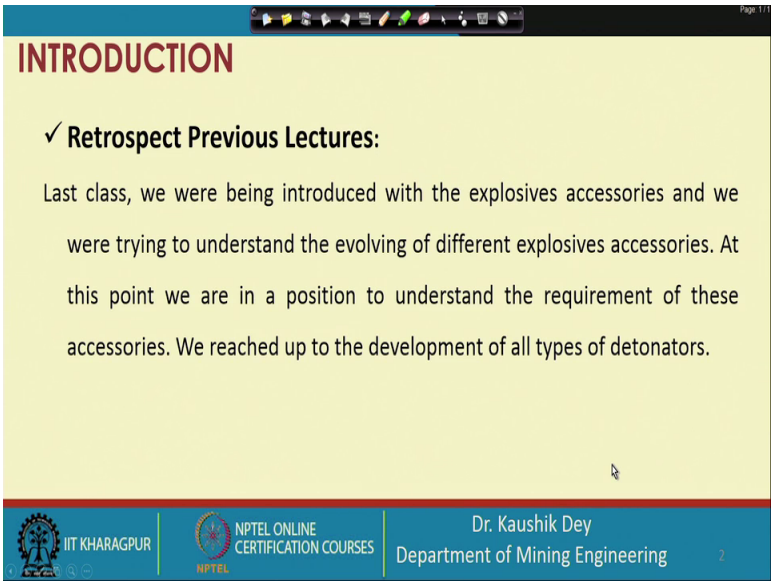


So, like every class let us retrospect what we have discussed already. In last few classes we are being introduced with the explosive accessories, and we are trying to understand the evolving of different explosive accessories. At this point, we are in a position to understand the requirement of these accessories, and we reached up to the development of all types of detonator.

So, up to detonator we have discussed about the development of explosive accessories.

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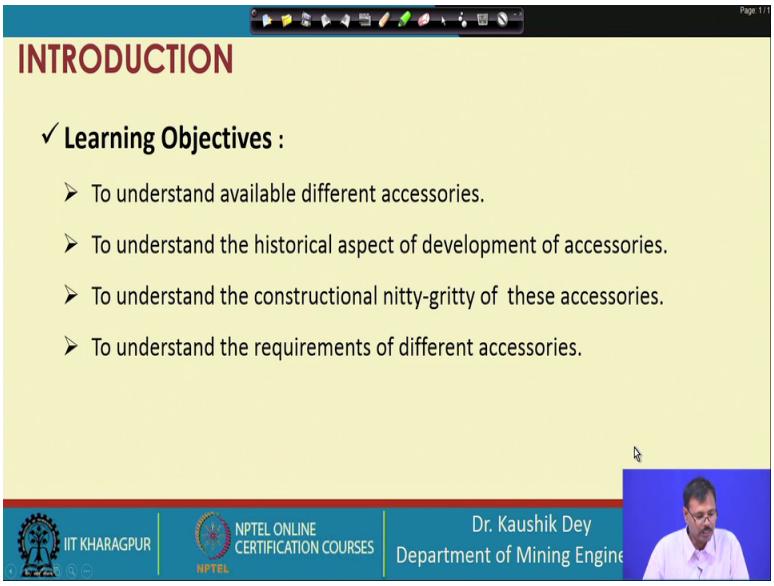


And will our learning objective we will remain same for this class also. That means to understand the available different accessories to understand the historical aspect of development of these accessories. To understand the constructional nitty-gritty of this explosive accessories, and to understand the requirement of different accessories why they are being introduced.

So, on this learning objective we will start after the detonators what are the other accessories which are developed in the blasting process.

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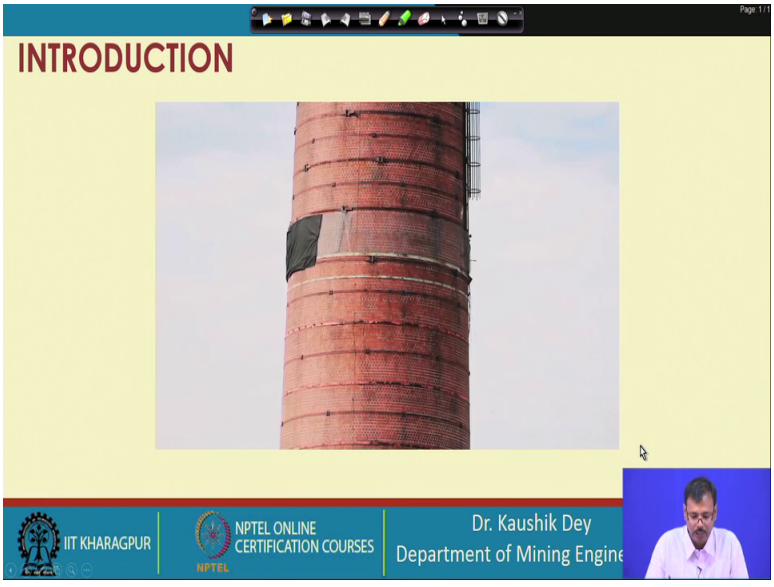

But in last class we have discussed the detonator.

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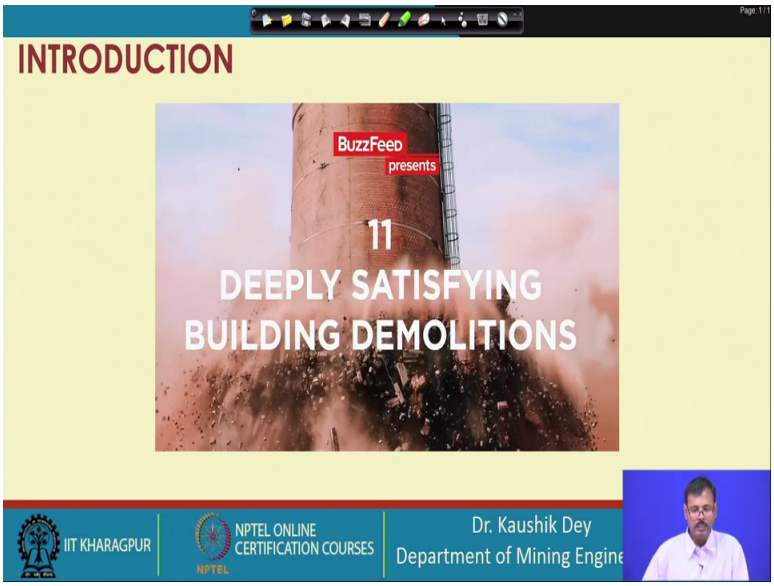


And in this detonator we have seen the delay is very very important.

Let us observe this few video where demolition is carried out demolition of different buildings are carried out using explosive. And you can see the building is being exploded on a different time frame at different position so that the explosion will be carried out, but the displacement will not be significant for this demolition of this building.

So, in this video you can see, the buildings are being exploded gradually from the bottom to the top direction and from the center to the outer outward direction, so that the movement of the building must be inside one or towards the inner part of the area.

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So, basically that is the principle which is practiced in the building demolition.

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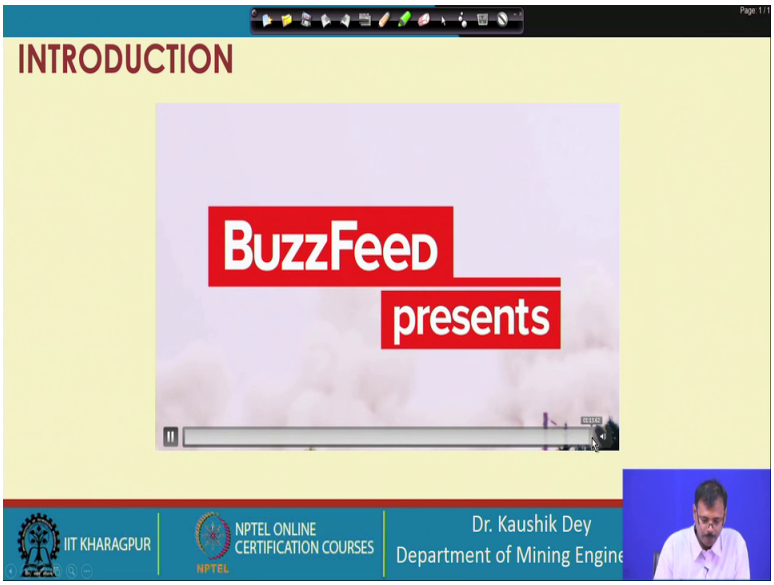


And if you see the next video which I am going to show you, that you can see in a slower time pace. So, that you can easily understand that there is a basically time gap between the explosion of the different a position where the blasting is being carried out. You can see, in this long tower the explosion is being carried out, you can see the gradually from the bottom part the building is being exploded and the top part is exploded at a later stage.

So, the building there is no lateral movement of the fragment pieces in the building. That is why it is not scattering in a longer distance and the side by, nearby other buildings are in very very safe position if you look into this video.

Let us observe another video.

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In this video, also you can see in a slow pace manner. First it will be shown you in it real time scale so that you can see the demolition is being carried out a very fast. So, that may give you the impression that maybe the complete building is being blasted simultaneously. But basically that is not the case if you see it is demolition in a different a time scale, that is in the very slow paced manner.

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So now you can see it is of 1 4th speed of the original video is taken, one-fourth of that speed you can see. You can see this is the first shot is being blasted, then the second shot third fourth. So, gradually the building is being demolished, and the different part of the building is being blasted at different time. But all these are possible, because of the invention of the delay detonator. So, you can now very easily understand why delay detonator is very very important and the scattering of this delay are also very very important which we have already discussed in the last class.

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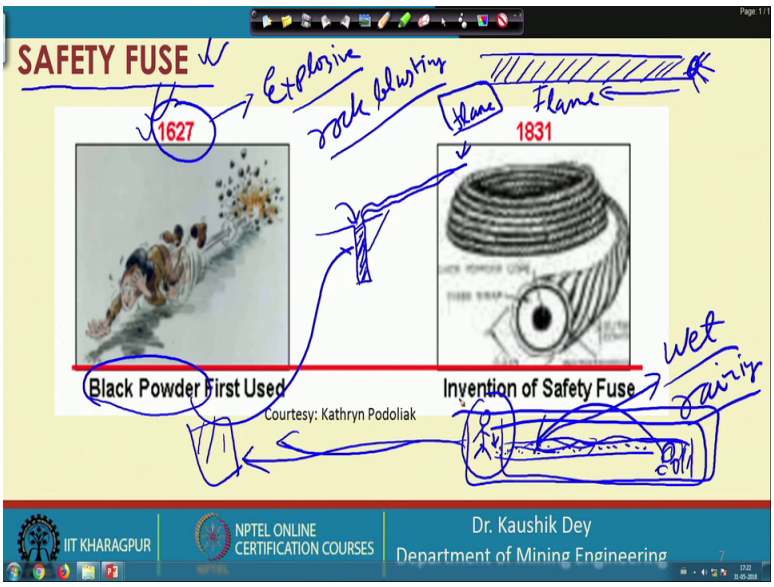

But after this detonator let us discuss about the explosive other accessories. The first explosive accessories which was found very very essential is the safety fuse. So, safety fuse is nothing but a cap below under that cap the gunpowder is just placed. So, you know the gunpowder is a very very low explosive. And the purpose of using gunpowder is only to transfer the flame, to transfer the flame from one place to another.

So, safety fuse was very very essentially required for the safety of the purpose. If you ask me why then I can tell you, you know in the 17th century if I try to be presses in 1627 the first time we started using explosive for rock blasting that is in mining purpose. Before that the explosives are used only for the war purpose or for amusement purpose that is being used. And that time the only explosive was available was the gunpowder or black powder was the only explosive.

So, when it was tried to use first time for rock excavation in mining, what they try to use this one? They create some hole using chisels and fill that hole with the black powder. And from that they drop black powder up to a distance where they are try to give the flame. And after giving this flame to the gunpowder that is generally laying like this on the ground laid like this. The person who the person who gives the flame at this position, then flood away or run away from the place as early as possible to hide in a shelter, prior to this flame reach up to this hole which is drilled at this position, and which is filled with the gunpowder.

So, this totally total process depends on few thing. First is that the distance of the shelter from where that person is running, and the time is being taken by the flame from reaching at this position to this position where finally, the explosion will occur, and the fragmented rocks will jumped up to the longer distances. So, this total process was uncertain. And another problem was there if the ground condition is wet or it was raining, then the chances of extinguishing of this flame was very very high.

Even if wet condition thus gunpowder will lose it is flame carrying capacity, and that is why the total blasting process became not that much confirmed one uncertain. And that is why the total process is not that much significant.

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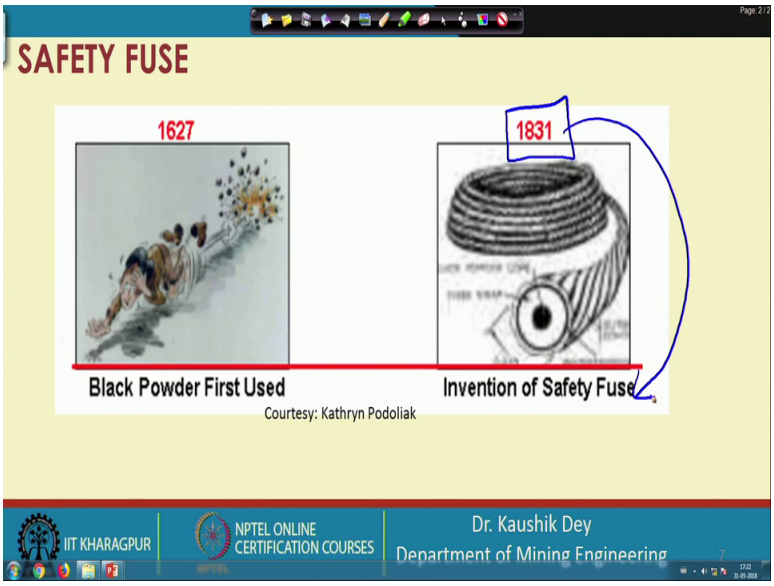


In 1831 to overcome this problem in 1831; the safety fuse was invented which is nothing but which is nothing but the waterproof cap, where the black powder core was wrapped by a fiber wrap.

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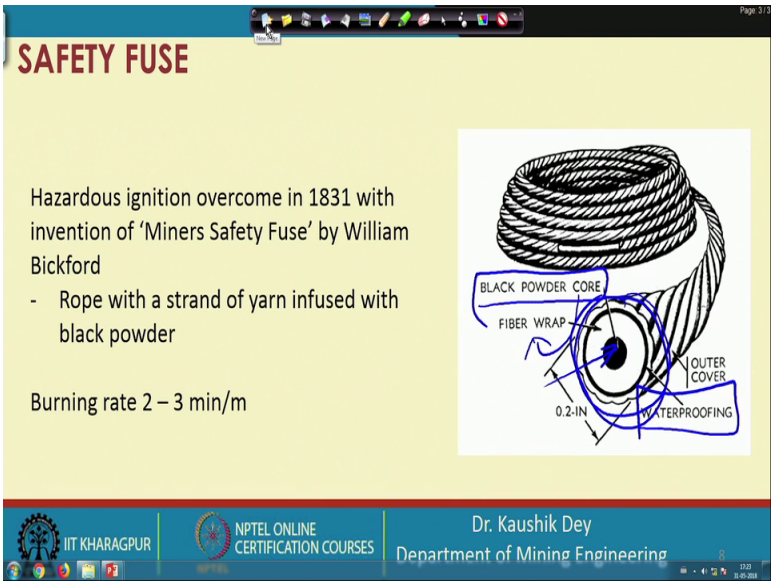


And that is why the total process the flame is being basically carried out through the through the inner core which is the black powder, and the total process is remain waterproof. And that is why it is not affected by the wet condition of the ground or the rain water.

So, this invention was very very a important.

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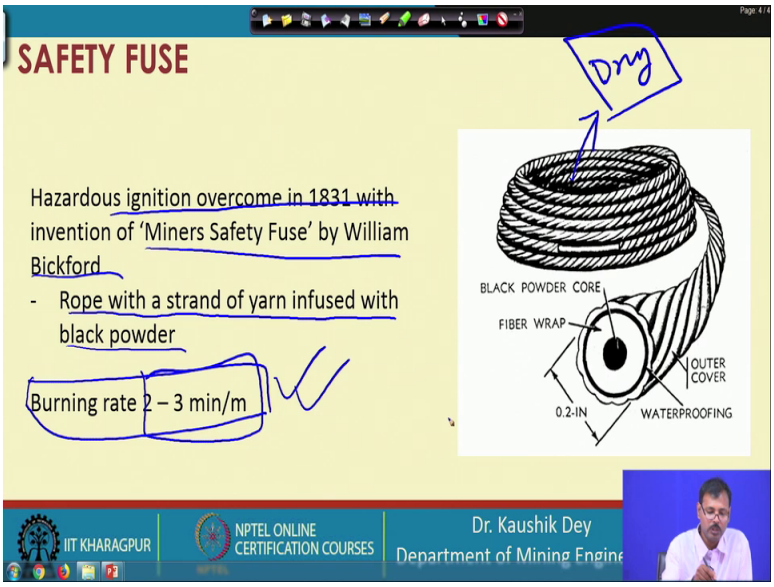


In 1831 this was invented by the William Bickford; where a rope with a strand of yarn infused with black powder. Presently, the use of black powder is very very a use of safety fuse is very very limited. Generally, we try to use electrical initiation system, then also to avoid the induced or premature explosion in the electrical detonator often we use safety fuse as the in initiator of the blasting if the condition is dry. In that case generally we go for using this one.

And presently the burning rate of this safety fuse is kept 2 to 3 minute which is more or less constant and that is why that can be suitably used for the safety of the removal of the persons by giving this time span. So, safety fuse is another very very important blasting accessories.

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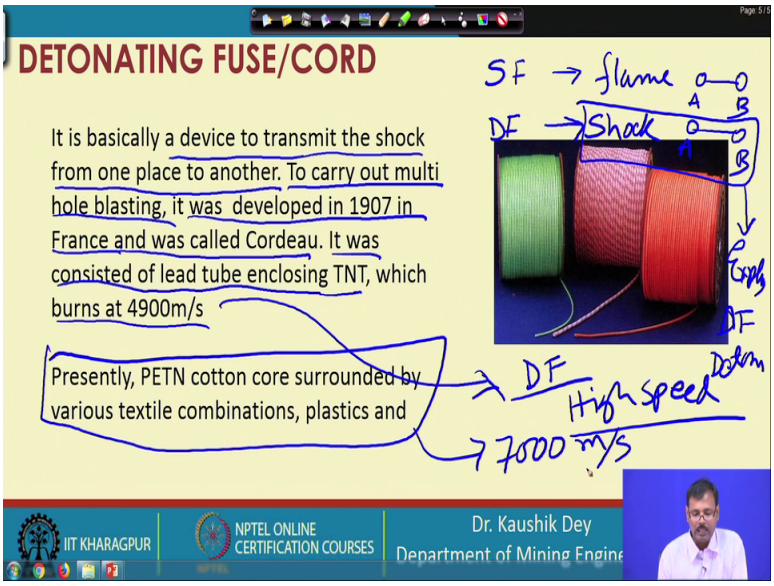


And that is in general is being used since long time it is almost 200 years now.

The next accessories which are developed is detonating fuse, detonating fuse is basically a device is a device to transmit the shock from one place to another. So, basically in safety fuse we are transmitting, safety fuse we are transmitting flame from one place to another place in detonating fuse which is also called detonating cord, the flame is the it is not the flame it is the shock is being transferred from point A to point B.

So, basically the shock which is initiated by the detonator or by other means is being transferred by the detonating fuse up to the explosive, or to another detonating fuse or to another detonator. So, this is the purpose of using detonating fuse, and this is essentially required to carry out the multi hole blasting. In fact, the detonating fuse or detonating cord was developed in 1907 in France as and was called Cordeau.

So, in that time it was consisted a lead tube enclosed by enclosing TNT, which burns at a speed of 4900 meter per second. So, that means, the bod or the shock is being a traveled through this detonating fuse at very high speed. So, that is the first characteristics of this detonating fuse. And when it was initially initiated or developed that time TNT was used which was showing the speed is speed of 4900 meter per second. Well, presently we are using PETN which basically shows us a speed of transfer shock transfer or the velocity of detonation, approximately 7000 meter per second.

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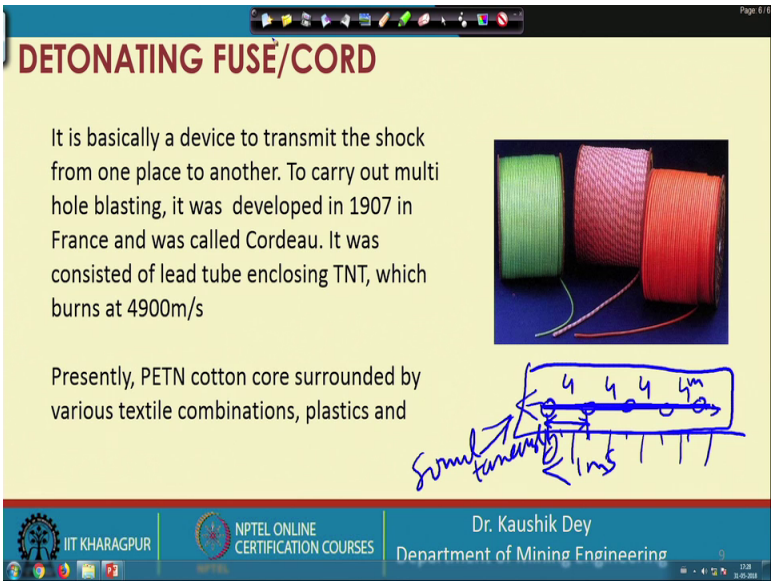


So, in that condition, suppose we are having multiple holes considering this is the free surface area. And we want that this holes to be blasted at one round or at one instant. And the separation of this are say consider at 4 meter, then if we are using a detonating fuse to connecting these holes. So, the time delay or time gap between the initiation of this part and this part is becoming less than 1 millisecond and that is why one millisecond. And that is why you can consider the all these holes are being blasted simultaneously.

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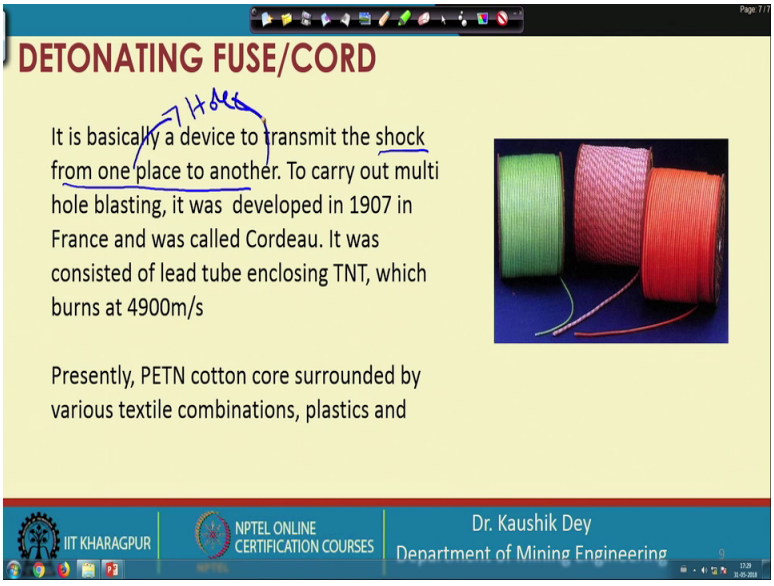

So, that is why detonating fuse is used for transmit shock from one place to another, or you can say one blast hole to another blast hole. And we can consider this there is no time gap between for this time gap time span is required for this transmission.

So, that is why the detonating fuse is popularly used as a carrying material of shock from one hole to another hole or from the detonator to the blast hole.

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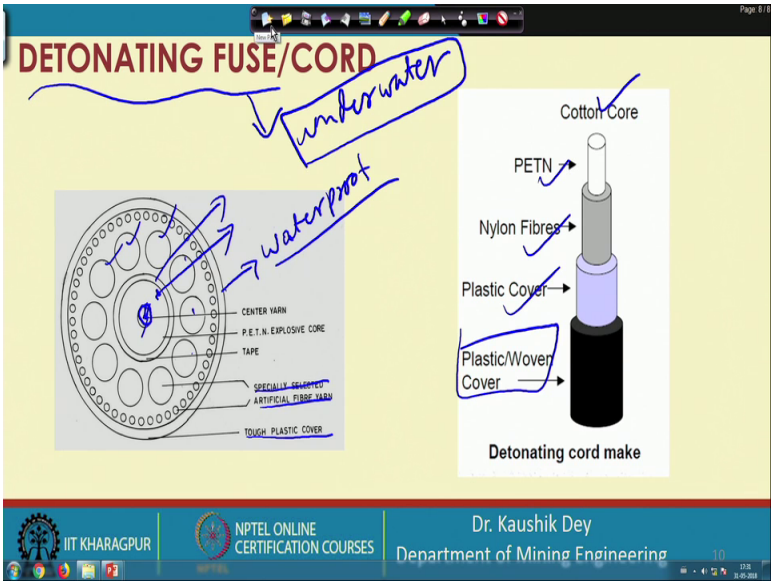


If you look into the constructional details of the detonating fuse or detonating cord, you will find out there is a central yarn, this is the central yarns place, then the PETN explosives are wrapped around that central yarn. Then the first wrap cover or tape is provided, then specially selected artificial fibers yarns are provided, these are those. And then finally, the plastic cover is provided to make it a waterproof.

However, as PETN is not that much deteriorate with the wetness or it is not that much water sensitive. So, that is why detonating fused may be sufficiently used in underwater condition also. The effect of water on the detonating fuse for the transmission of shock is almost negligible. So, you can see this one cotton core then PETN, then nylon fiber plastic cover, then maybe another plastic cover for the double protection that is the normal constructional features of the detonating fuse.

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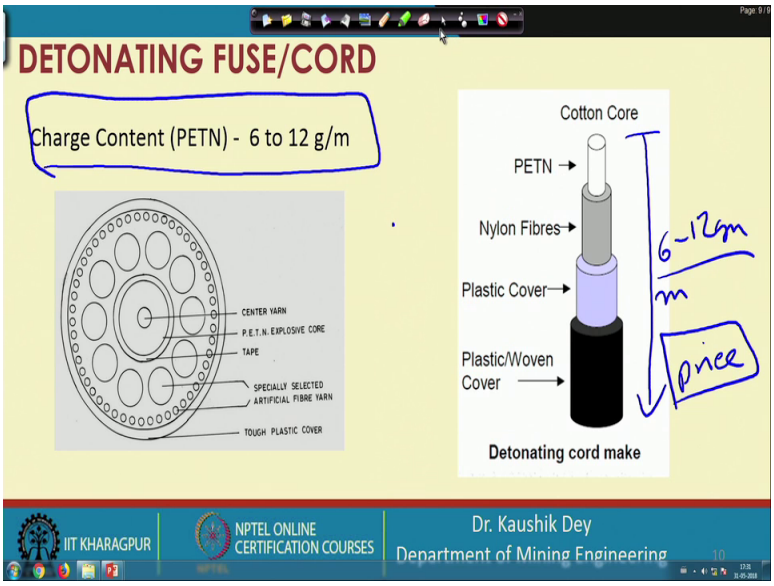


Normally A detonating fuse is expected to have 6 to 12 gram of PETN in it is power meter of length. In it is power meter of length 6 to 12 gram of PETN is expected to be they are. So, that is why this also limits the as the quantity is very less, that is why this also limits the price of the detonating fuse. So, detonating fuse is almost very very cheap foil it is required. That is why we can use detonating fuse very freely in the mine.

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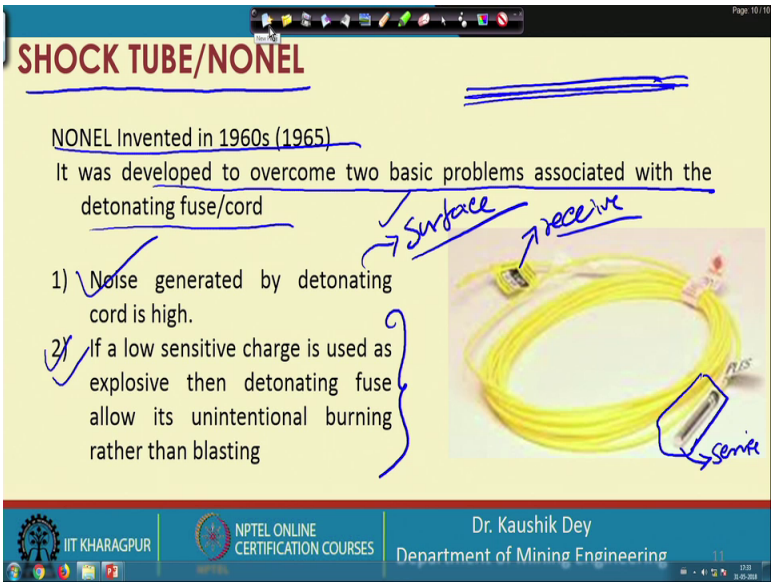


Recently there is a modification occurs in the detonating fuse, and this modified detonating fuse is called SHOCK TUBE or NONEL. Let us first tell you what is

NONEL. NONEL is basically a plastic tube like detonating fuse. Inside it that finally, grant PETN is there. You can see in one (Refer Time: 19:29) of it is mouth a detonator is there. So, this is the service end, this is the receiving end; where it receives the shock from another detonating fuse or another NONEL or from the detonator.

This NONEL was developed in the year 1960's 1965. And was developed to overcome 2 basic problem associated with the use of detonating fuse. The first problem is the generation of noise which is very high in detonating fuse or caught, when the detonating fuse or cord is used in the surface as a surface connector between the mouth of the holes.

So, this is the first problem, what is the second problem? Then the second problem is basically a little bit difficult too difficult for you to understand, but as we have already discussed the explosive.

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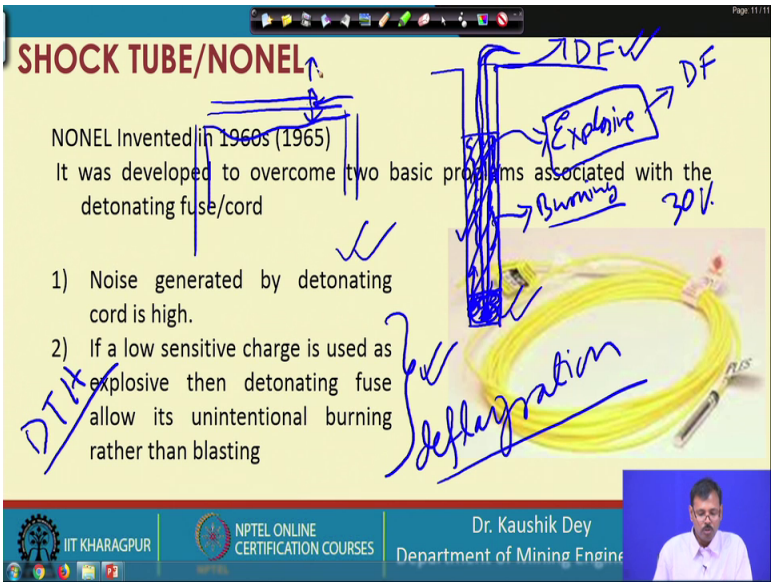


You can easily understand this part that there are say suppose this is a hole. And we have placed some explosive at this position. And our intention is that we will provide the initiation to the explosive in it is bottom part.

So, we connect these with the detonating fuse at this position. So, if we are using detonating fuse to initiate the explosive, but the explosive is not sensitive to the detonating fuse to be blasted or to be initiated. So, the explosive is basically not cap sensitive explosive or not that much sensitive explosive; that is, the low sensitive

explosive which can be initiated by a higher soft pressure which cannot be generated by the detonating fuse. So, in those cases we provide some cap sensitive explosive at this position; which can be initiated by the detonating fuse and the detonating fuse initiate this cap sensitive explosive which generate the desired detonating pressure to initiate the main explosive.

So, in if we are using this type of this type of condition for our blasting purpose. And for that we are using detonating fuse as the initiator. Then what will happen? When detonating fuse is carrying the initiation and the initiation is traveling at this position then during this traveling the surrounding non cap sensitive explosive we will try to burnt out, but not initiated. So, this started burning, but not initiated not generating the shockwave and this phenomena is called deflagration. This phenomena is called deflagration which is the burning of explosive, but not the initiation of the explosive.

So, that is why this burning of explosive occurred which is unintentional and often we may loss up to 30 percent of the explosive in deflagration at this position. So, what is the problem? Now the problem is we are using detonating fuse which is a very good, initiator for the cap sensitive explosive. So, the detonating fuse is going to initiate the cap sensitive explosive which is placed at the bottom in order to achieve the bottom initiation.

But while the detonating fuse is ascending it shock up to the bottom of the hole, while it is traveling it is deflagrating the explosive which is non cap sensitive. And, we are losing a good quantity of explosive in deflagration.

So, this is one of the very biggest problem while we are using detonating fuse as the down the whole connector. As the d-th down the whole connector, if we are using detonating fuse this is the problem occurs. Noise generation occurs from the detonating fuse while we are using the detonating fuse as the surface connection between 2 holes as that shock is traveling from the in the detonating fuse, and it is close to the air. So, the shock from detonating fuse will transfer to the air very easily. And then the noise or air overpressure is created, because of the blasting of the detonating fuse. So, these 2 problems creates problem in the practice using of detonating fuse in the mind. Noise creates the annoyance to the nearby inhabitants. And down the hole detonating fuse using creates the loss to the explosive unintentionally.

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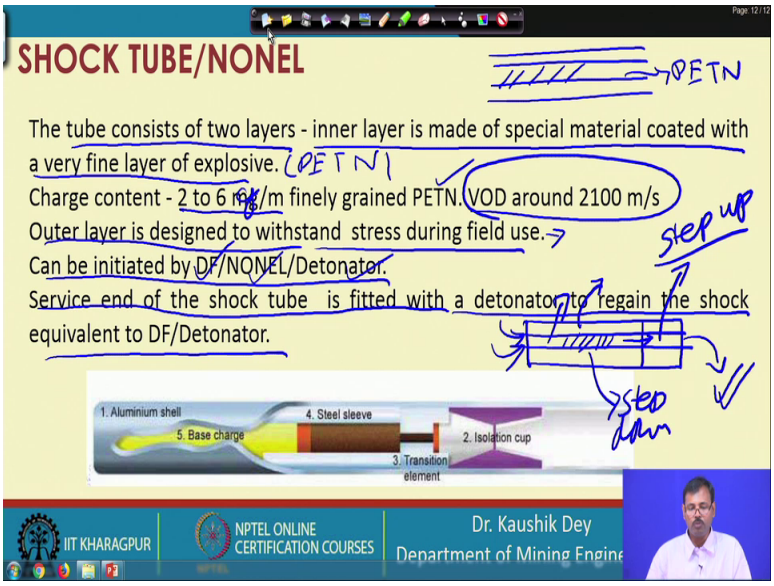


And basically NONEL is developed to overcome these 2 problem. And let us see; what is the basic structure of the NONEL. The NONEL is having basically a tube consisting of 2 layers: inner layer is made of special material coated with a very fine layer of explosive that is also PETN.

So, basically NONEL is having 2 layers, this inner layer is filled with finely grained PETN. The charge content of this is 2 to 6 milligram per sorry it is not milligram 2 to 6, gram per meter of finely grained PETN. And it is VOD is around 2100 meter per second. Outer layer is designed to withstand the stress during the field used. And these also act as a muffling also. The receiver part is such that it can be initiated with the detonating fuse service end of the NONEL or by a detonator. And service end of the SHOCK TUBE is fitted with a detonator to regain the shock equivalent to detonating fuse or detonator.

So, that means, basically NONEL is a if this is the NONEL, this is the receiving end, this is the serving end. So, NONEL is basically a step down, this is a step down device; where the shock presser which is received from the detonator or detonating fuse is converted to a reduced shock pressure so that the shock is not strong enough to break this plastic coating also. And this is very very low shock very very low VOD material, and that is coming to it is service end; where again it is step up, where again we step it up so that it can gain it is detonating pressure of the desired amount so that it can initiate a cap sensitive explosive.

So, that is why basically DET SHOCK TUBE or NONEL is basically a step down step up device that can be used suitably in the blasting purpose. Now let us see how it can overcome the 2 problem which we have already discussed; we encounter while we are using detonating fuse.

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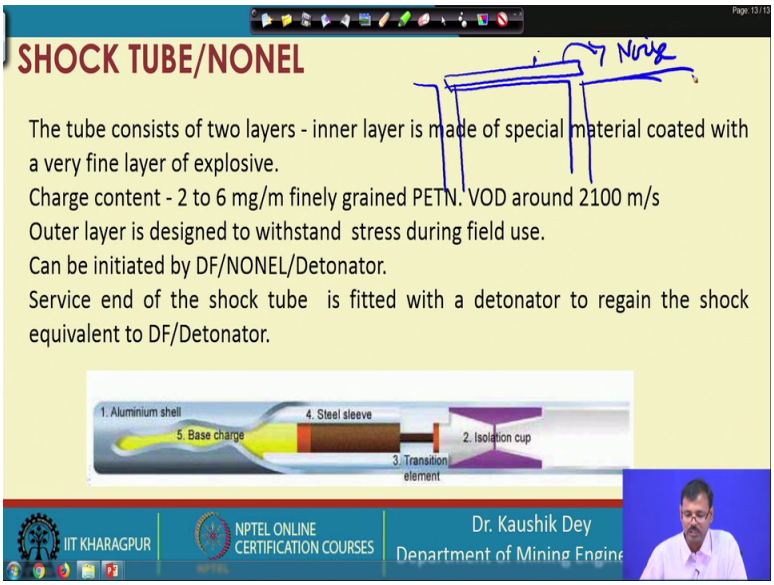


Suppose we are using NONEL as the surface connection.

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Earlier we used to use a detonating fuse have from this place to this place. And as the shocks are high large amount of shocks are coming out from detonate a detonating fuse, it is going to the air and creating the air overpressure or noise shock pressure in the air. But, as the detonating NONEL SHOCK TUBE is having a low generates a low shock pressure, even that cannot break the plastic cap. That means, plastic cap act as a muffling element to that shock pressure.

So, the shock from the NONEL coming to the air is insignificant. And that is why it cannot generate large amount of noise and the nearby inhabitants cannot have a noise because of this noise. So, basically this is suppressing the noise, and that is why often the NONEL if it is used in the surface is called noiseless trunk line delay, because the noise generation is limited if we are using NONEL as a surface connection. So, the first problem is now solved while we are using NONEL.

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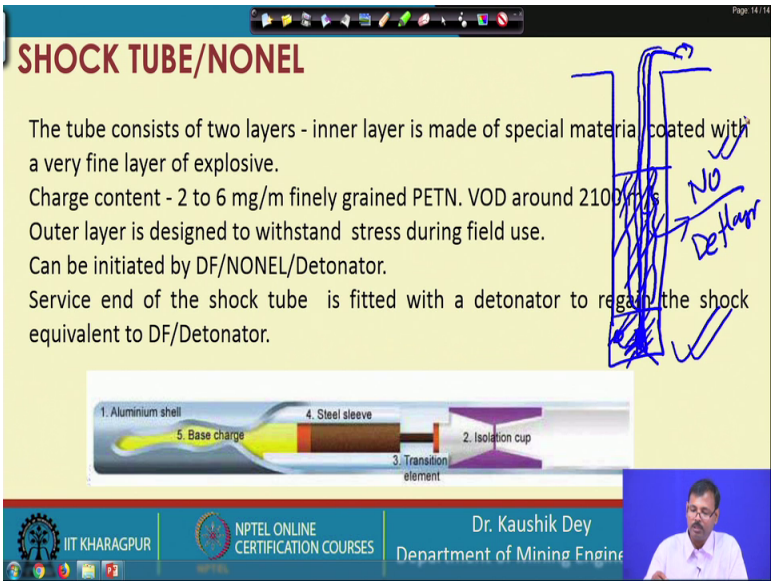


Let us see how it is helping us in case of second problem. In the second problem we are having a cap sensitive explosive here. Then we are having some non-cap sensitive explosive here. And we are connecting it through a NONEL, this is the receiving end, this is the service end where a detonator is fitted to regain the detonating pressure.

So now the shock is being transferred, now the shock is being transferred through the NONEL cap, the bod is very low. And as it is very low, it cannot pass through the plastic cap significantly so that deflagration or burning as the flame is also not unable to come out, the burning of x plug explosive near that cap is not possible.

So, there is no deflagration. So, there is no deflagration occurred to the explosive, but shock is able to transfer from the surface to the NONEL a surface to this point, where the detonator is there and that detonator blasts with that shock. As it blasts it initiate the cap sensitive explosive placed at the bottom.

So, we have significantly achieve the bottom initiation. There is no deflagration, there is no wastage of explosive. And that is why the NONEL can overcome the second problem also. So, this basically the development which assured us there is no problem in the noise generation, there is no problem related to the deflagration also.

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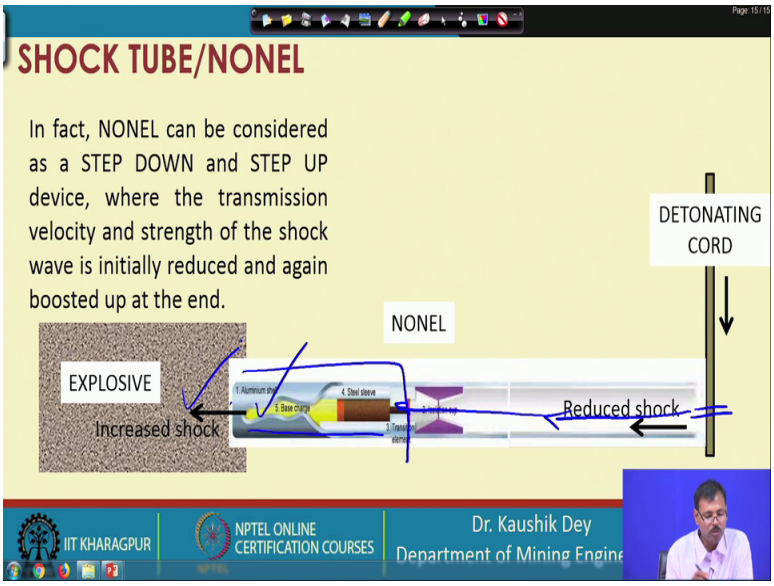


So, you can very easily understand what we have discussed. NONEL can be initiated with a detonating cord: It can be initiated with a detonator also. Then it can be initiated by another NONEL also. Then the reduced shock is transferred to the NONEL tube, then it reaches to this is basically the main detonator part, where it basically treat the shock as a flame, and that flame is used to initiate the base charge of the detonator which finally increased shock is given to the primary explosive.

So, that is why the consideration of NONEL as a step down step up device is very very useful for our practical use.

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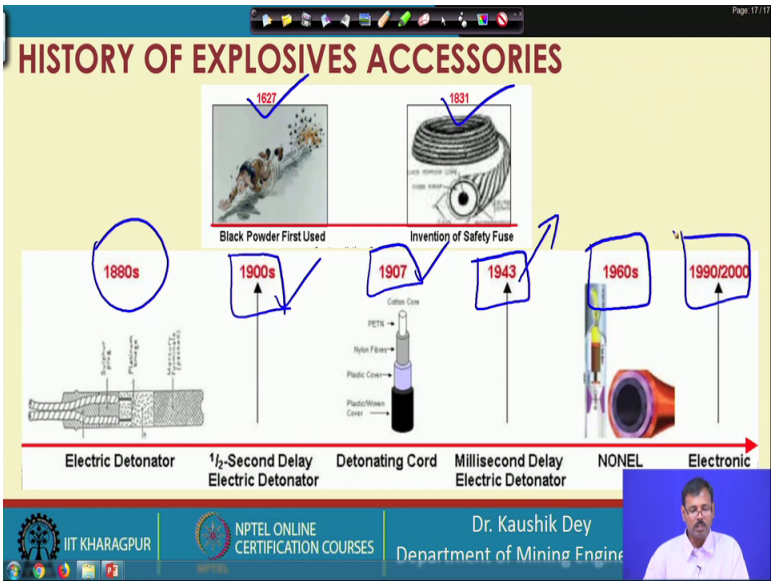


So now finally, let us look into the development chronology of the development of different accessories, but before discussing this let me explain you 2 thing. One is that we have not discussed about the exploder, or you can say the blasting module which you use for the in a blasting of the electronic detonator.

So, these 2 we are not discussing, because that is only the electronic device created for giving the desired current to the system. So, that is why we are not discussing that 2 part, but that is also used in the blasting. So, if you look into this we use blasting in the mind 1627. The first accessories developed is the safety fuse, for the safety purpose in 1831.

Then from low explosive we convert our self to the high explosive in 1863 with the invention of dynamite by sir Alfred Nobel, then the for that we need to develop the detonator. So, the detonator was developed in the 19 sorry, 1863 dynamite then the detonator is also developed in the 1863 for initiating the dynamite. Then electric detonator was devised in the 1880's.

Then the delay detonator first come the half second delay detonator; obviously, it takes 20 years for the Nobel to develop this one. So, 1900 half second delay detonator comes. Detonating cord was developed in 1907 so that no individual detonator is required in the each hole. So, multi row blasts multi hole multi row blasting becomes very very easy by 1907. Millisecond detonator comes in 1943

So, which basically enable asked to use the explosive in very very efficient manner for the underground rock excavation also. NONEL comes in 1960s to avoid the problems. Electronic detonator comes in 1990s you can say 1965 basically to avoid the scattering of the delay. In 2005 the final one which is not given here, the remote control detonator has come, or cordless detonator has come; where no surface connection is required, you can directly insert the detonator in the explosive and that can be remotely blasted.

So, this is basically the chronology of the history of the development of the history of explosive accessories.

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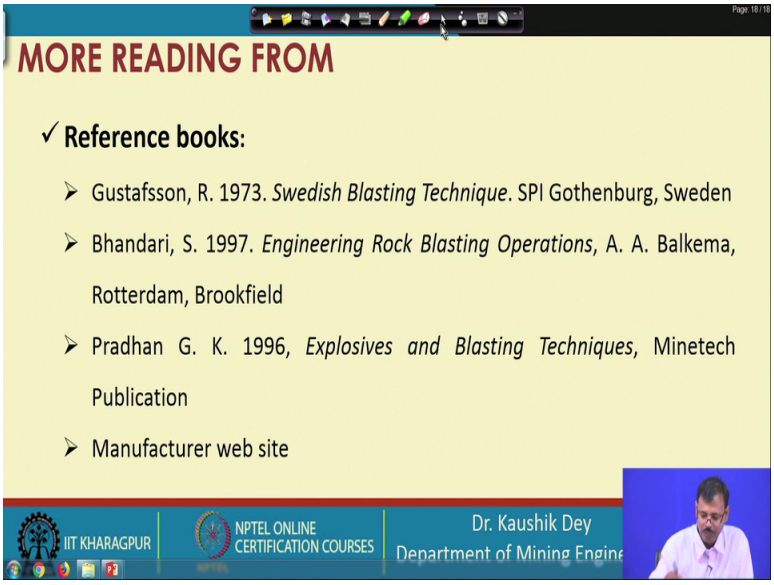


So, let us stop this class at this position. We you can have more reading from the reference books of this one. You can have I strongly suggest you must go through the different manufacturer website, the most modern developed explosive properties most modern developed accessories properties will be known to you.

So, let us stop at this position.

Thank you.