Drilling and Blasting Technology
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Lecture - 33
Blasting results – 1

Let me welcome you to the 33rd lecture of the Drilling and Blasting Technology course. And, in this lecture we will start our Blasting Result part, where we will try to evaluate our different blasting result to understand the performance of a blast.

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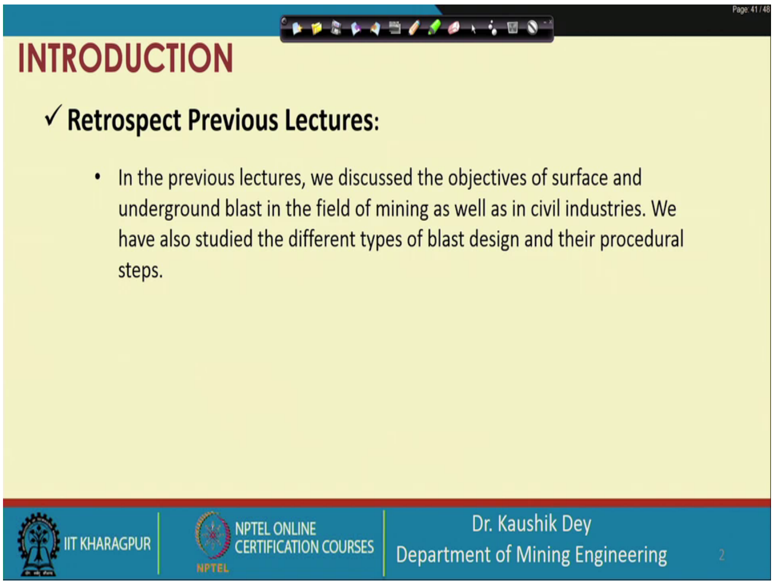

But, like every class what we do let us retrospect what we have learnt so, far on this. . So, far we in our previous lecture, we discussed about the objective of the blasting, which is carried out in the surface and underground cases. And, it is carried out blasting is carried out for mining and civil industries and the objectives are different in both the cases. We have also studied the different types of blast designed and their procedures and their procedural steps so, that the design can be made to achieve the desired result from a blasting.

So, the important part is that the result is important which is essentially required for which the blasting is being carried out. So, the blasting result is very very important.

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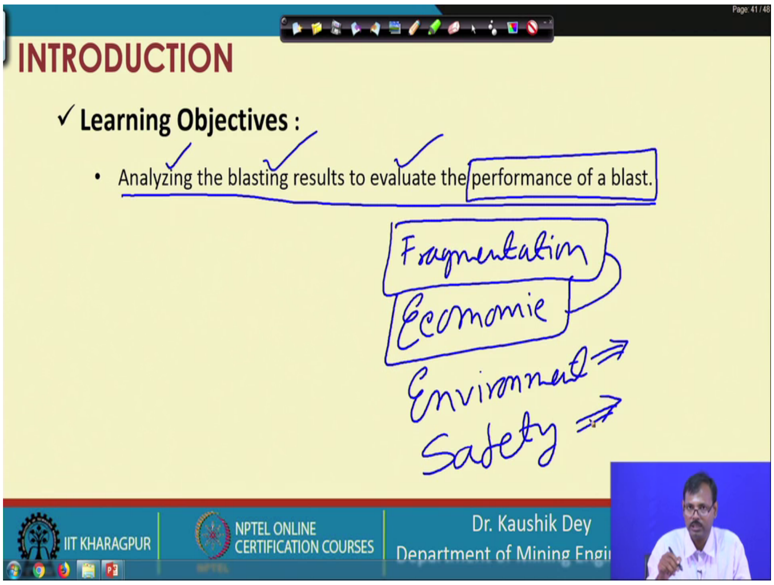

In fact, the objective of our present lecture is basically to understand the blasting results. So, objective of this class which will continue in the next few classes also is basically to analyze the blasting results. So, that we can evaluate the performance of a blast and as we have discussed what are the objectives? Our objectives are to fragmentation, our objectives are to economic blast, our objective is also to reduce the yield effects to the environment, and to achieve the desired safety in the total blasting process.

So, our primary objective to achieve the desired fragmentation and the desired fragmentation must be achieved with the lead down economic constant. And, while we are doing this achieving fragmentation within the limited cost, we should not give much impact on the environment and the total procedure should not be unsafe it should be safe enough. So, this is the requirement of a blast and our objective is to essentially evaluate these performances so, that we can analyze whether our blasting is good or not.

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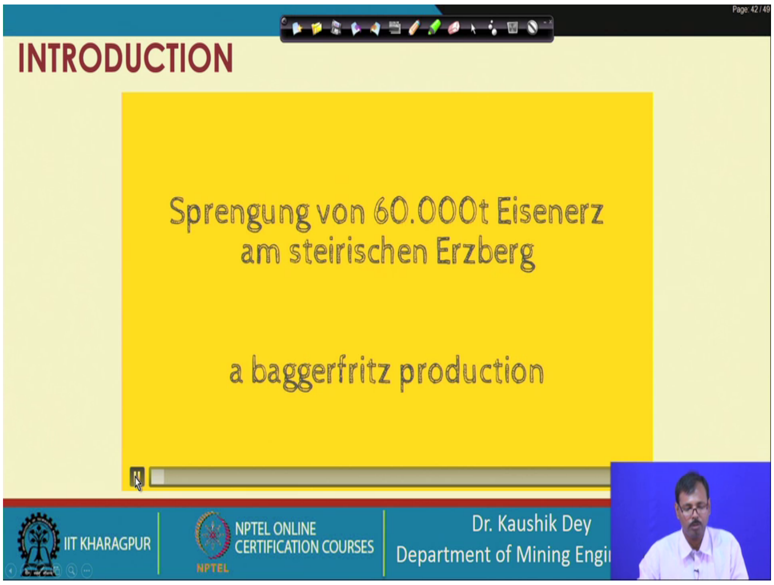

So, like every class we generally start with a video. So, let us observe this video in which you can observe a very good blasting initially in a real timeframe, then it will be shown to you in a slower phase so, that you can understand, how the blasting is carried out here?

So, this is basically this blast is basically categorized as a very good blast. If you look into this is the phase, this is the real time blasting is carried out. There is absolutely no stemming ejection, Mach profile is very good fragmentation is very good, if you see it in the slower phase, in between you will stop it for a while. Say, let us stop the video at this position and you can see that there is no stemming ejection, there is no flame come out from the mouth of the holes. The movement of the rock is very fine; you can see the fragmented rocks are of very good fragmentation smaller sized fragmented rocks are there. And, if you see the throw is also very good there is no fly rock generated from the blush, or fidgety particle is not going out of the blast.

So; that means, the overall performance of this blast may be considered as a good blast. So, that is why this high speed photography is a tool, where we can get a very good picture of the blast and you can understand that this blast is a it may be considered as a good blast.

And by this way we will understand, how we will evaluate different performance of different blasts?

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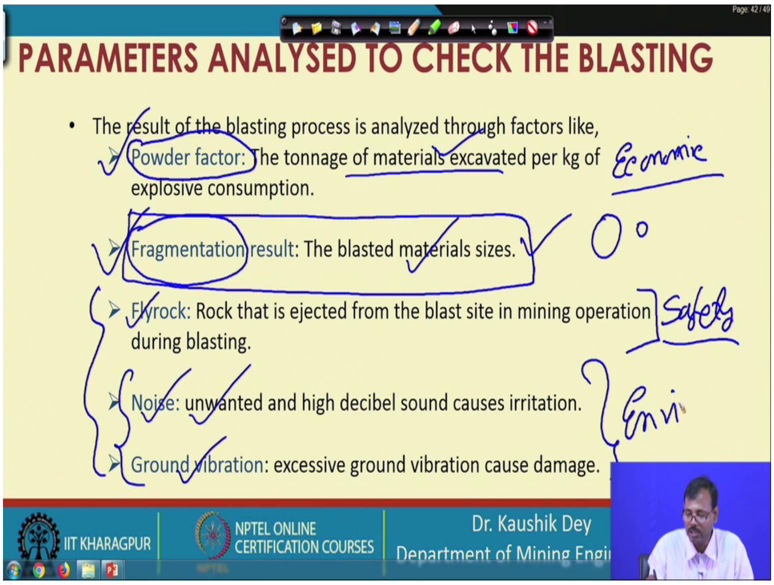

And, let us see what are the parameters, we need to analyze to check whether our blasting is good or not? And, our first parameter is called powder factor. This is also called charge factor or specific charge which basically nothing, but a an economic factor which dictates the economy of a blast, where it is expressed the tonnage of material excavated per kg of explosive consumption. That means, it is an economic term and; obviously, there is more term use here for the type of or the dread of fragmentation.

So; that means, the powder factor will be evaluated only when the fragmentation is in the satisfactory position, in that case only powder factor is evaluated and it is basically giving us the economic term of a blast, whether the more cost is required for the blasting or less cost is required, that economic analysis may be carried out from this powder factor.

Next one is the fragmentation; fragmentation is basically the size of the blasted material. In fact, when we will discuss it in this class at a later stage we will understand, this fragmentation is basically the size of a boulder formed from a blast. And obviously, there is will be a heterogeneous distribution of these sizes. And, there may be few particles of very finer sizes there may be few particles of very large sizes. And, there are other particles which are in between the large and the finer sizes. So, this fragmentation of the rock is basically the fragment size distribution of the boulders, which are formed in the blasting.

So, this fragmentation analysis is very very important. In fact, this fragmentation is the prime objective of a blast, because we want to fragment the rock mass into a smaller sizes and this size of this requirements are different depending on our different use of the fragmented rock. It may be a larger where we want that lump size should be required in our plant or something like that, it must be finer where the mineral has to be liberated from the ore. So, all those cases are considered when we are distributed we are considering the fragment size distribution.

So, basically this is the economic term, this is the desired result which you want and this all are the other terms this is the safety one and these are the environmental considerations. So, fly rock is basically the rock, which is ejected from the blast site unwantedly unwillingly and you can say it is a fugitive of rock practical, which is moving out and that may hit anyone may be human being, may be the cattle's, may be the structures, and may create damage or the injuries or to or the death of the person or the cattle.

So, this is a very very important one considering the safety of the safety of the blast, performance of the blast, and this noise which is basically generated because of the air overpressure that the shock wave generated moving through the air the noise is generated. So, this is the unwanted sound, which is important which is generated should not annoy the nearby resident.

Next one is the ground vibration which creates the vibration of the ground, that may damage the nearby structures, that may create annoyance to the flora and fauna and that is why these 2 are very very important environmental parameter that needs to be taken care of during the blasting. So, basically these are the performance one must consider while they are discussing the blasting process or evaluate the performance of a blast.

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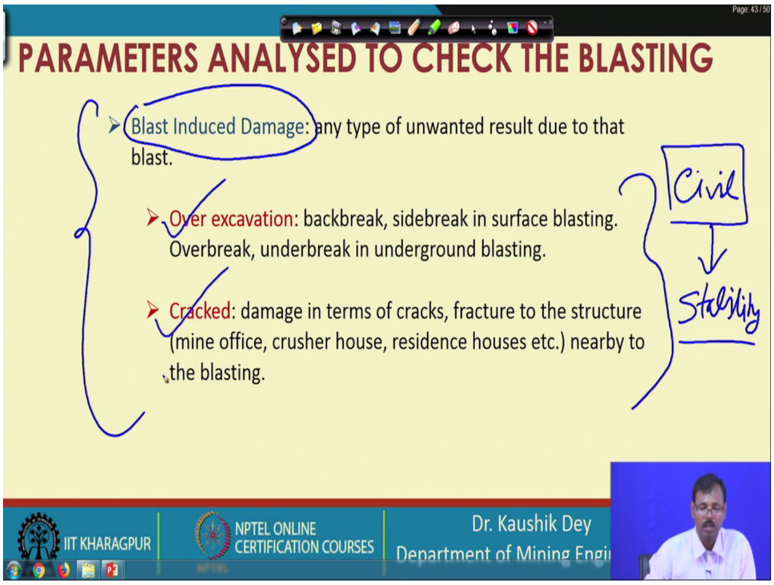

So, let us start with our few more parameters are there. This is one very very important considering the effect on the remaining rock mass that is how much damage is occurred to the remaining rock mass? One is called over excavation, another is considered as the cracked formation in the remaining rock mass that may result in into the destabilization of the area. And, that is another important point often considered especially in case of civil engineering, where the structures are built by the rock excavation blasting should have an large or very high life expected life, and that the that is why the stability is very very important in those condition this may this parameter may become very very important.

So, these are some of the performances, which need to be considered during the evaluation of the blast performance.

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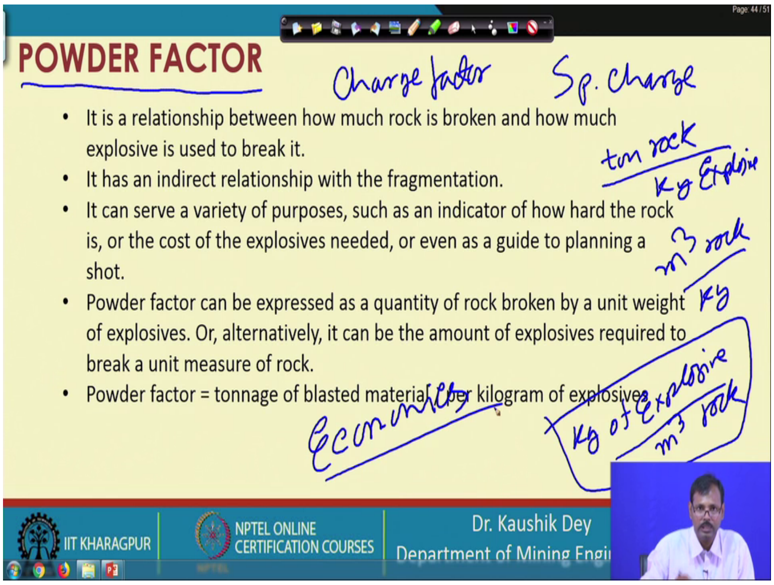

So, now for the first let us consider the first parameter, which is nothing, but the powder factor this is also called charge factor. Also called specific charge and this is basically a direct relationship which basic gives us the idea, that how much explosive is required to blast a certain amount of rock?

So, basically this is expressed in the tonnage of rock produced per kg of explosive. Some cases it is also expressed in terms of that meter cube of rock produced per kg of explosive of or in the reverse way, it may be expressed that the kg of explosive required kg of explosive required to excavate 1 meter cube of rock.

So, whatever it is basically the idea is same. The idea is that it is basically dictating the economics of the economics of the blast. So, basically it is giving us the idea about the economics of the blast.

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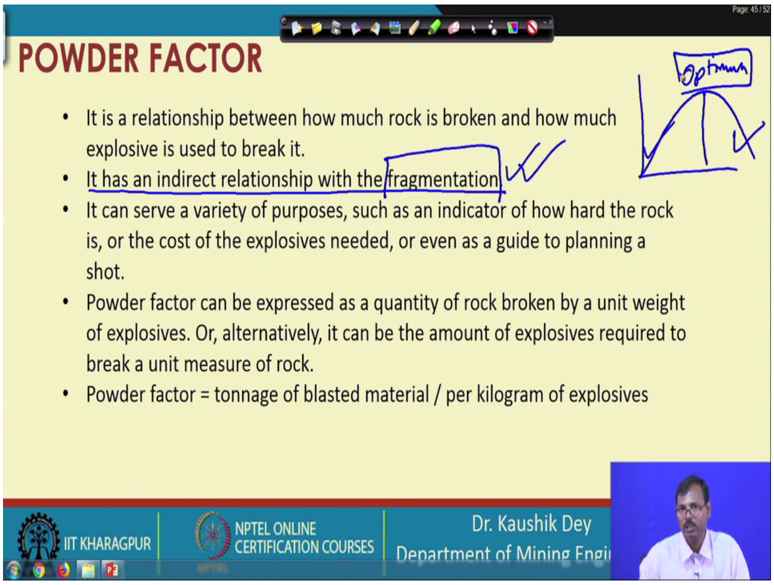

And, this is also dependent on the fragmentation; that means, if we are giving less amount of charge; that means, less amount of shockwave is being generated which basically fragmenting the rock in a larger fragment size. So, if we are in using less amount of explosive, then the fragmentation achieve is a coarser fragmentation and that is why that may gives us some different powder factor term, which is giving us basically a deviating us from our target. So, this powder factors specific charge or charge factor these terms are important only when the fragmentation achieves fragmentation achieves are satisfactory.

Basically it has been observed, that the powder factor is having a curve like this where this is gives us the optimum point; that means, the fragmentation is not satisfactory in this position also fragmentation is not satisfactory in this position also. And, in this position that charge amount will became the satisfactory and we achieve the optimum fragmentation in this case.

So, that is why this fragmentation is very very important and it is having a relationship indirect relationship with the powder factor. So, powder factor must be considered or must be calculated only on that case, where the fragmentation achieved is of our satisfaction and in that case only will calculate the powder factor.

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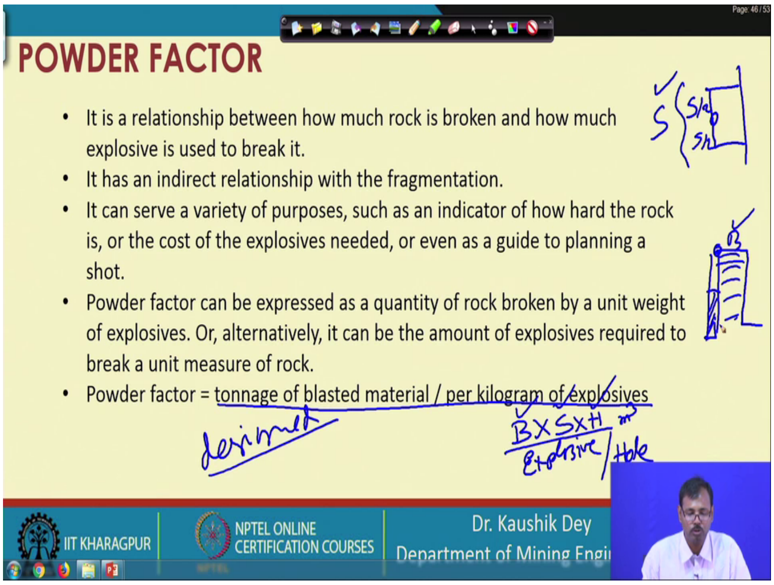

Generally, what we do theoretically we consider the powder factor is nothing, but the tonnage of blasted material per kg of explosive. Designed powder factor is another term designed powder factor is another term, which is considered as tonnage of material is nothing, but the burden into spacing into bench height that is giving us the meter cube of material. It may be converted to tonnage using the specific gravity of the rock material. Dividing, it by the explosive charged in that particular hole.

So, basically it is considered if this is the hole and this is the burden then up to this explosives are placed. So, that explosive quantity placed here expressed here and the material excavated is considered this one, which is having if you are looking at to the plan view having an influential area of this which is nothing, but the S by 2 at this side, S by 2 at this side. So, this is nothing, but an S spacing distance.

So, basically that is why the total volume of material excavated by blasting this hole is burden, into spacing, into bench height, dividing it by the charge placed in that hole may be considered as the designed powder factor for that particular blasting. However, actual powder factor may little bit deviate from this design powder factor, because in blasting over excavation which we have already discussed in our previous slide or under excavation may occur. So, our actual achieving powder factor may be deferred from the designed powder factor. So, that is also another important part one should consider.

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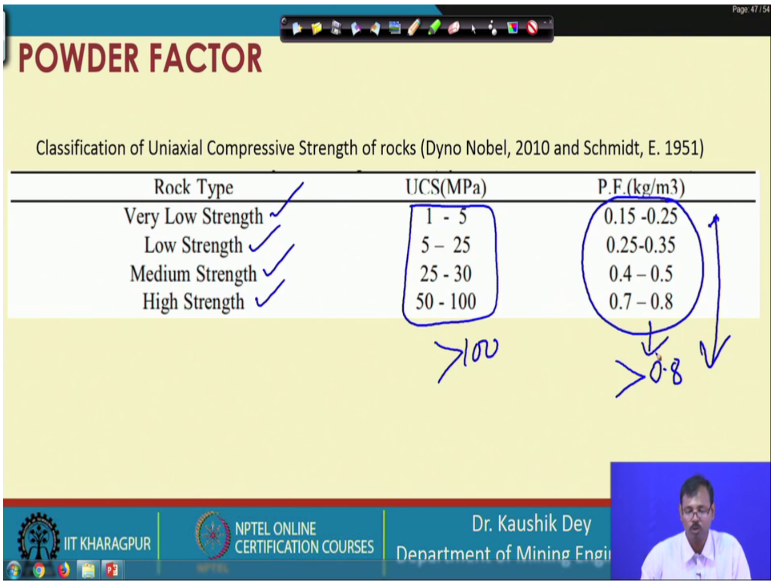

Dyno Noble and smith in 1951 they have given some idea about the powder factors expressed in kg per meter cube; that means, in charge factor for low strength rock very low strength rock, low strength rock, medium strength rock, high strength rock. So, they are powder factor they are finding out in terms of this where low strength high strength are expressed up to 1 to 100 MPa. And, for the greater than 100 MPa this may continue and you can see this is in the increasing order; this is in the increasing order. So; that means, this will increase 0.8 a kg per meter cube of charged quantity requirement for the more stronger law.

However, with changing of the explosive with changing of the explosive loading system, this may a powder factor may also influenced by those properties which has to be taken care of.

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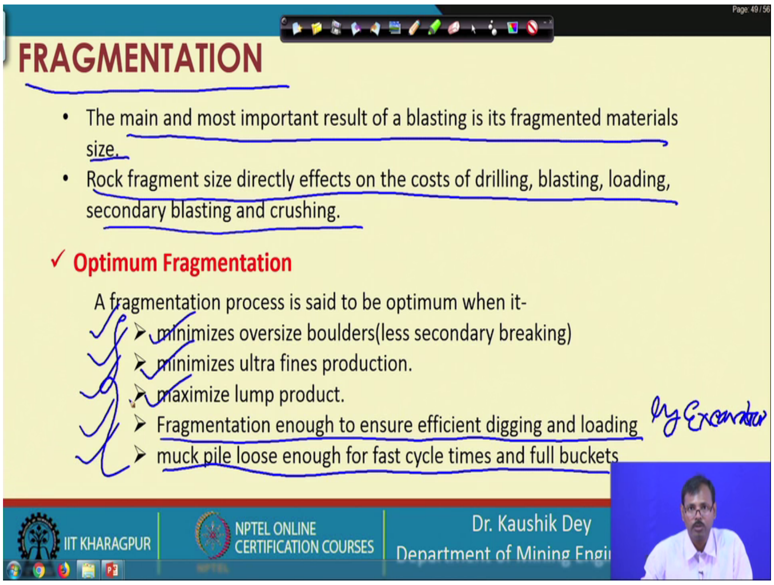

The next part next influencing parameter is fragmentation, which is basically our prime objective. The prime objective of the blasting is basically the fragmentation and the main and most important result of a blasting is it is fragment size; rock fragment size directly affects the cost of drilling blasting loading secondary blasting and crushing.

A fragmentation process is said to be optimum when the oversize boulders are minimum, ultrafine productions are minimum, lump sizes are maximum and it is fragmentation enough to ensure that efficient digging and loading by the excavator or excavating machine, and muck pile must be loose enough. So, that the bucket can be filled very fast and that is why very good performance of the excavator or performance of the shovel can be achieved.

So, a fragmentation is basically give us an idea from this. So, if you ask one very very experienced miner, whether this blast performance is good or not without any measurement taken out by the different measuring techniques, which we will discuss a person may say fragmentation is good only looking at these 5 points.

So, if the person experience person is looking at this 5 point observing that the oversized boulders are generated are less numbers. And, in general it is considered if it is less than 5 percent, then it may be considered as a good blast ultra-fine generation are also less, because the airborne fines are less lamp sizes are very good uniform fragment sizes are observed and shovel can perform better on this muck profile is also very good for the performance of the shovel. So, considering this an experienced person may tell that this fragmentation is very very good.

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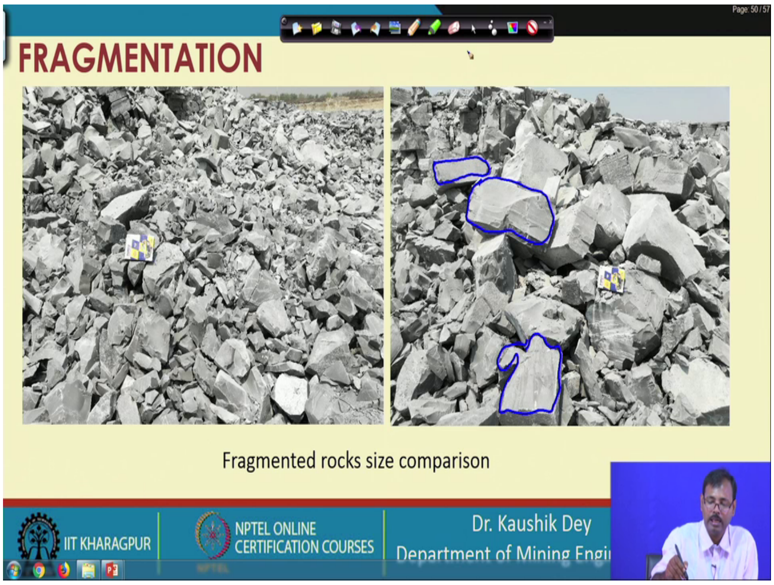

But, where is they where is the measure of this fragmentation, you can see these are the sizes of different boulders. These are the sizes of different boulders and it is essentially required that one should know the size of individual boulder, while he is trying to assess the fragmentation.

So, basically the technique of measuring this is to try is to analyze the size of the each and every boulder. So, that an average size distribution may be achieved from this we will discuss this in the next slide also.

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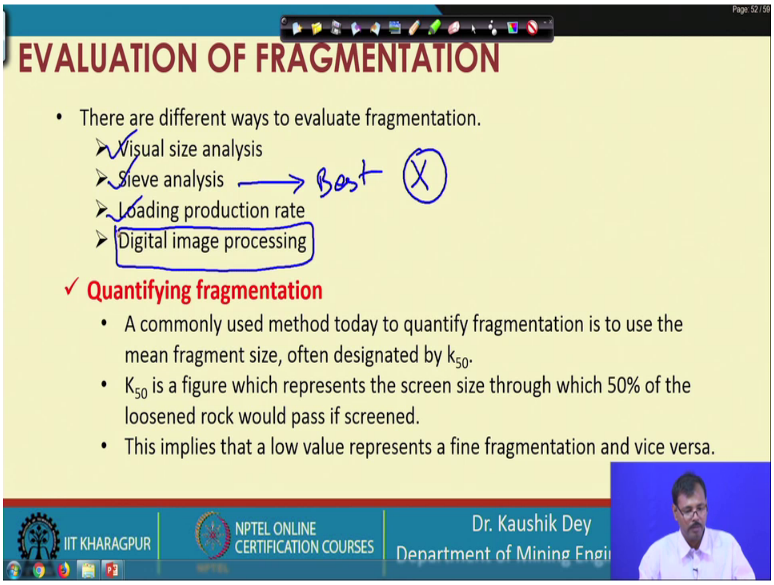

So, this measurement of fragmentation can be carried out by visually which I have already discussed an experienced person can tell this fragmentation is good by observing the fragment size from the top. The best way to achieve the most accurate fragment size distribution can be achieved from the sieve analysis, while if different size of sieves are placed and the amount of material which is retaining on each screen will analyze. And finally, we try to achieve the fragment size distribution in between the screen sizes.

So, this is very very important and this basically gives us the most accurate this is the best method of analyzing the fragmentation. However, the problem is while we are having bigger sized boulders like 1 meter cube or 1.5 meter cube size boulders. Placing those boulders on a sieve or go for analyzing the sieve analysis having that big size of sieve, then the mechanical power is required to check that sieve. All those criticality is there and it is almost practically impossible to carry out sieve analysis for a blasted muck profile blasted muck. So, blasted fragmented rock muck cannot be sieved by the sieve analysis. So, that is why though it is the best, but practically carrying out this exercise is almost very very impossible. So, that is why we discard the sieve analysis in most of the blasting cases.

Another, estimation like visual size estimation, which is carried out is the loading production rate, that is another indirect method from which we can understand whether our fragmentation is good or not. The most commonly used method is basically digital image processing. In last slide we have seen the in last slide we have seen this is basically the photographs of the fragmented rock mass.

So, basically in our digital image processing we take this type of photographs and we go for analyzing these photographs through image analysis technique, which is now presently available, which is now recently available in the electronic world.

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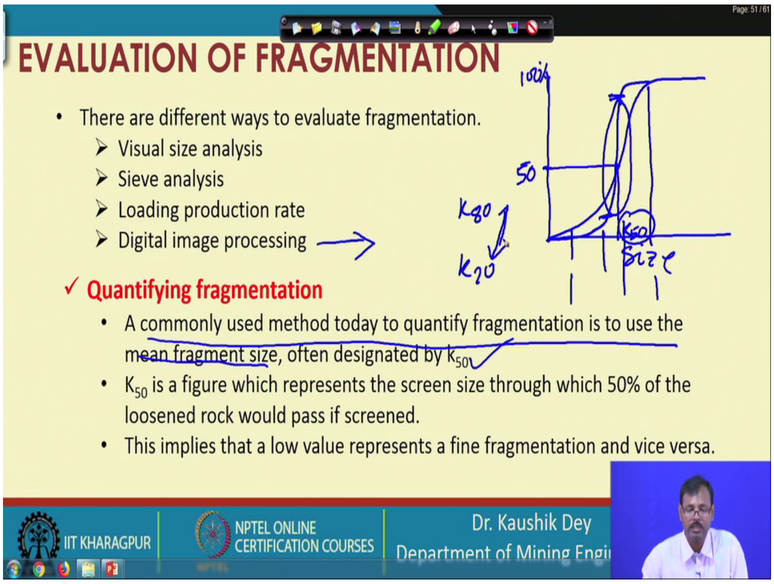

So, basically we go for image analysis of these photographs through different software's. And, what this software do they try to trace out the edges from these images and they consider the equivalent area, which are created by these edges.

So, basically this is the most commonly used method today to quantify the fragmentation. So, that we can get the mean fragment size which is called k 50 and also the distribution of the size, say this is the material which is basically this is the cumulative mass, this is the size and say this is the 50 percent.

So, this is basically the average fragment size. However, there may be another distribution possible like this, where average such distribution is same average size is same, but the distribution is different. So, the most of the boulders achieved are in this range; that means, from this range to this range whereas, here the distribution range is little bit wider.

So, not only the mean fragment size is important, fragment size distribution is also important and that is why. Nowadays the k 20 and k 80 is also important and the line joining this k 20 and k 80 is basically considered as the measure of fragment size distribution. So, that is why not only the mean fragment size is important, but also the fragment size distribution is also very very important, while we are analyzing the fragment size.

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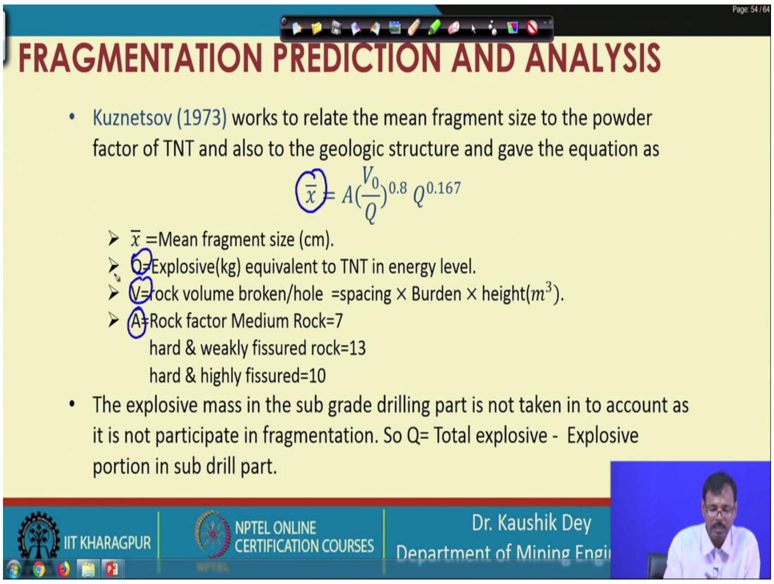

So, this is a the first model which are given by the Kuznetsov to get the mean fragment size and this depends on the rock factor, the volume of rock broken and the explosive charge quantity required equivalent to TNT. So, this is the first model which is given by the Kuznetsov. So, this Kuznetsov model was given in 1973.

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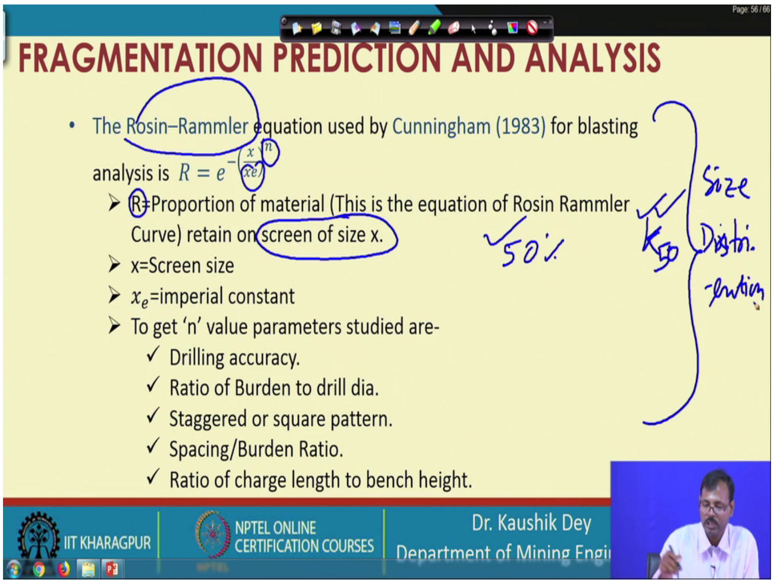

And, later on in 1983 the most popular model was given by the Rosin-Rammler, where R is the proportion of material here is expressed in terms of an exponential function, R is the proportion of material which may be retain on size X screen, size X screen using this 2 empirical constants and this one these 2 constant they found this is exponents it is an exponential function.

And, if the R is considered as the 50 percent then the value achieved by this X is considered that that value of X is considered as the k 50 size. So, for r is equal to 50 percent the value of X achieved is basically the k 50. So, this Rosin-Rammler equation is basically designed this is basically designed to get the fragment size distribution, which we have discussed in the last slide distribution which is very very important.

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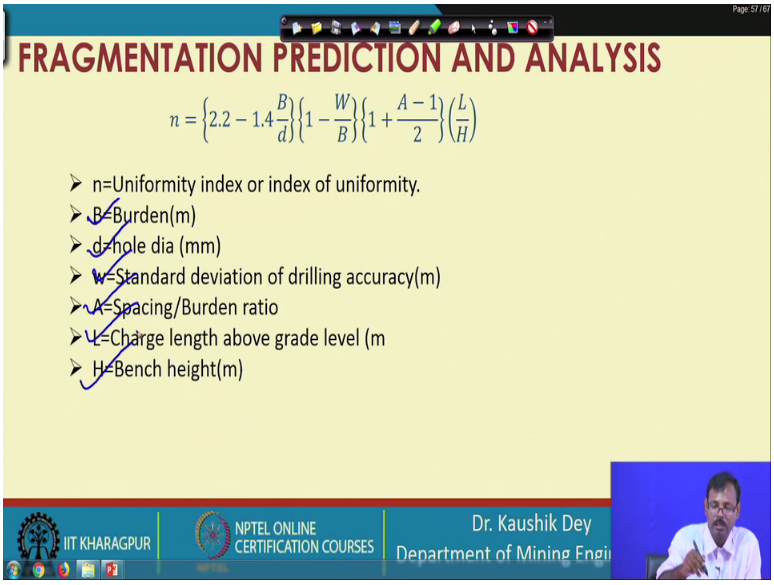

So, that is why this is very very important. This n the constant N is basically not actually constant this is called uniformity index, which basically governed the slope of that k 20 and k 80 and that uniformity index, may be estimated as a function of burden, hold hole dia, standard deviation of drilling accuracy, spacing by burden ratio, charge length bench height like this these are the influential parameters for the uniformity index.

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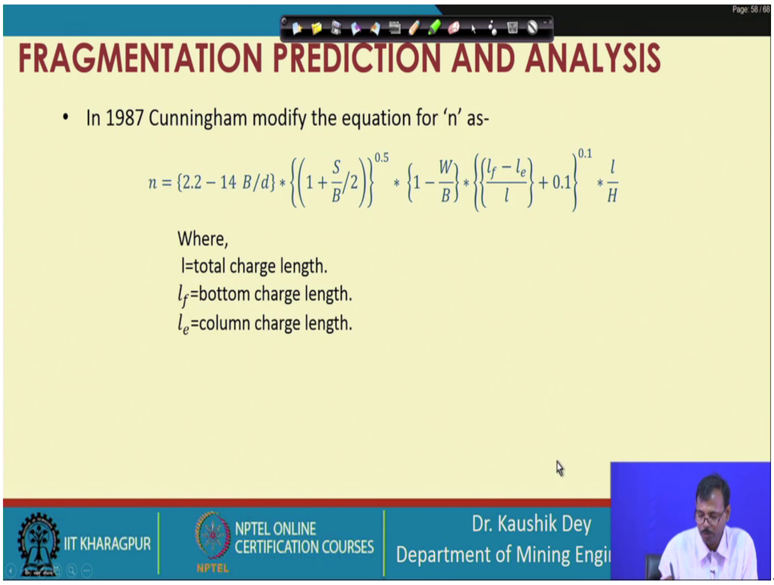

These are some other estimations for uniformity index.

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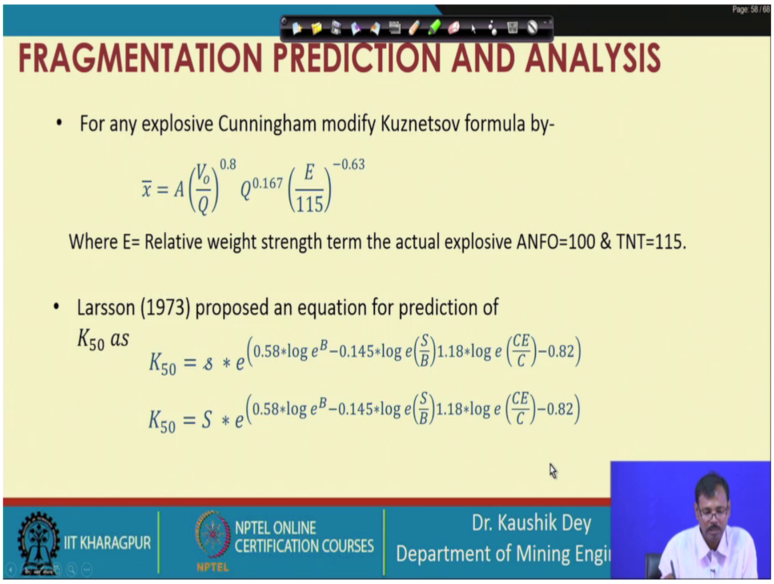

This is the modification of the KUZ Ram model where different formula are given.

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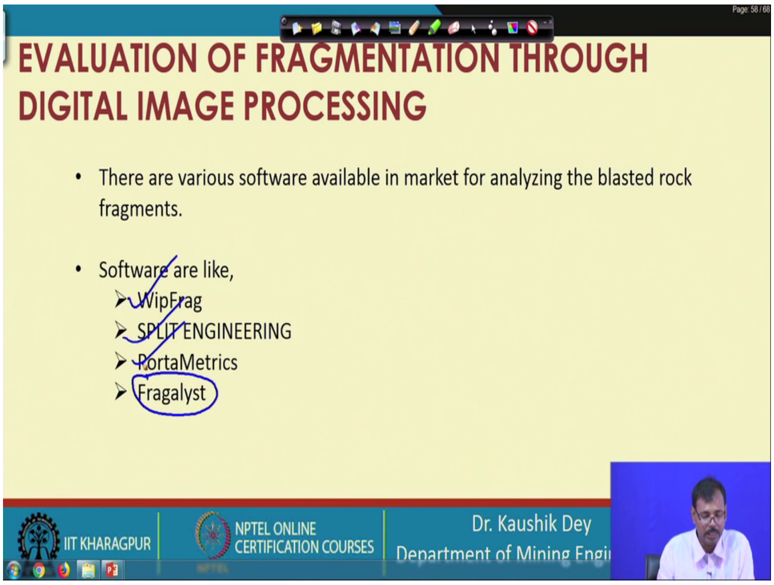

Now, presently there are N number of software's available for fragmentation analysis, WipFrag, SPLIT, Portametrics and in India CIMA for us designed this fragalyst software. So, we will look into this software a little bit at this position.

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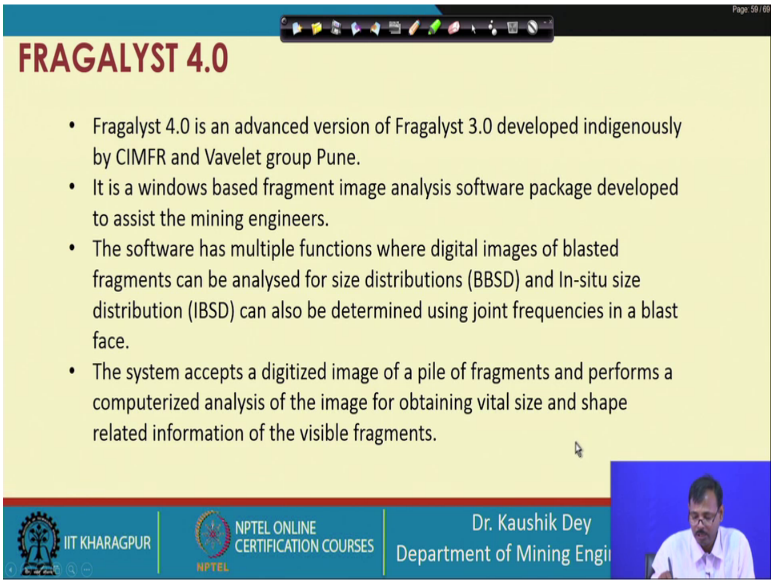

So, this fragalyst 4 is basically evaluating the same way the fragment size distribution.

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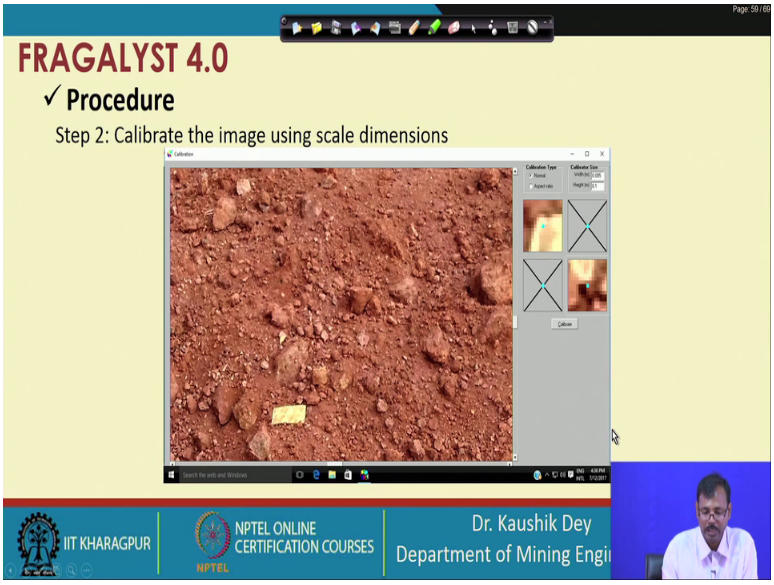

This is the step one where the figure have to be uploaded, then the uploaded figure the scale has to be calibrated thus for calibrating the scale, these 2 corner points must be selected. So, that the scale along the X axis, scale along the Y axis may be fixed by the software.

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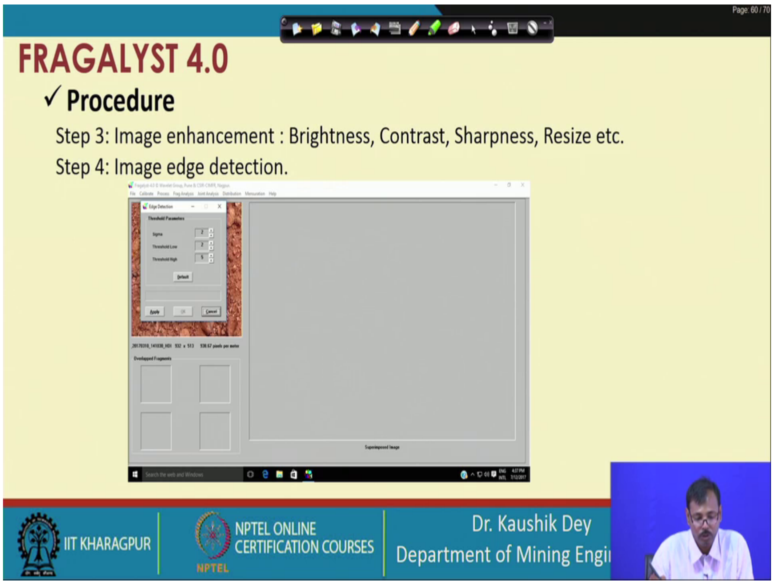

Then, the threshold parameters of sigma value has to be given so, that the edge detection techniques can be easily followed with the contrast on the image.

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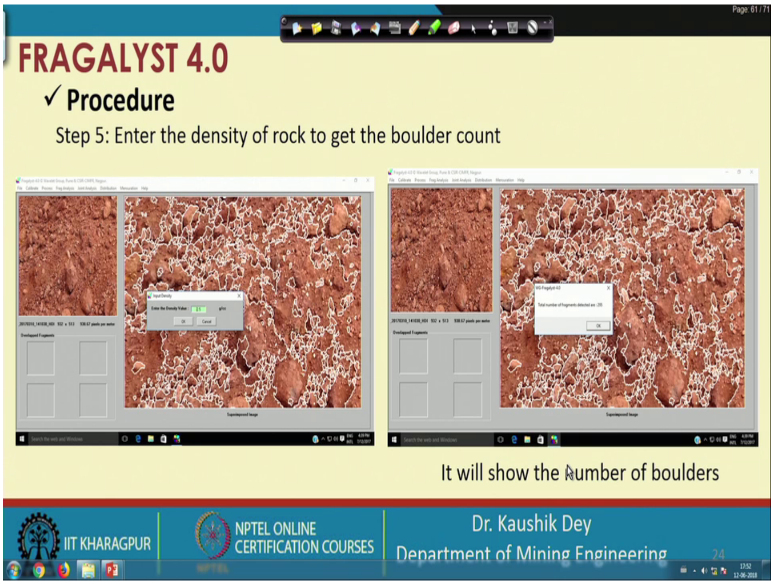

Then the edge will be automatically selected. Every time it is user has a given facility because automatically the edges may not be created detected properly. So, the user has the option to manually select the edges using the cursor in the software. So, that it can be accurately selected.

And, after selecting this one the equivalent area under this as the scale is already given there, the equivalent area under this is computed by the software. So, by this way the area is considered and the size is calculated from that area.

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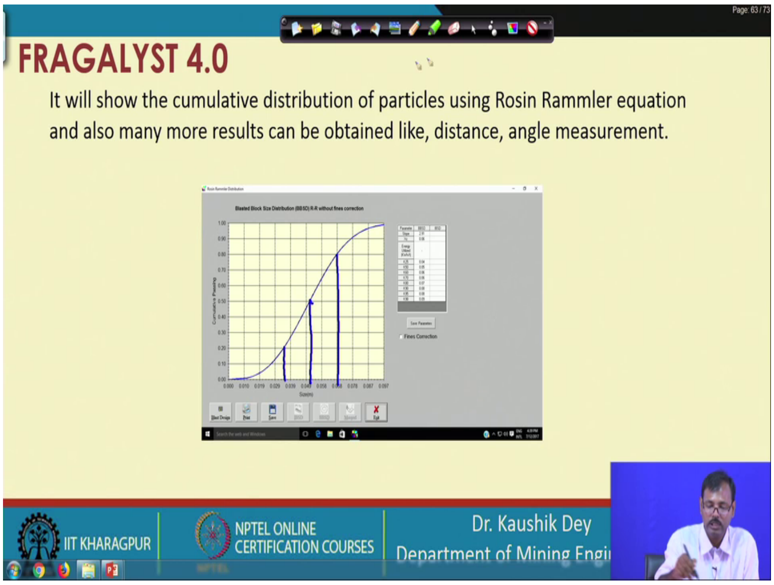

Then, the size distribution curve is prepared from where the D 50 sorry this D 50 this D 50, then this is D 20 a k 20 and this is k 80 can be sorry k 80 sorry 1 minute let me clear it again. This is the D 20, k 20, this is the k 50 and this is the k 80 may be achieved from this such distribution curve.

So, this is the Fragalyst software the principle is same for the WipFrag also let us observe this video of WipFrag.

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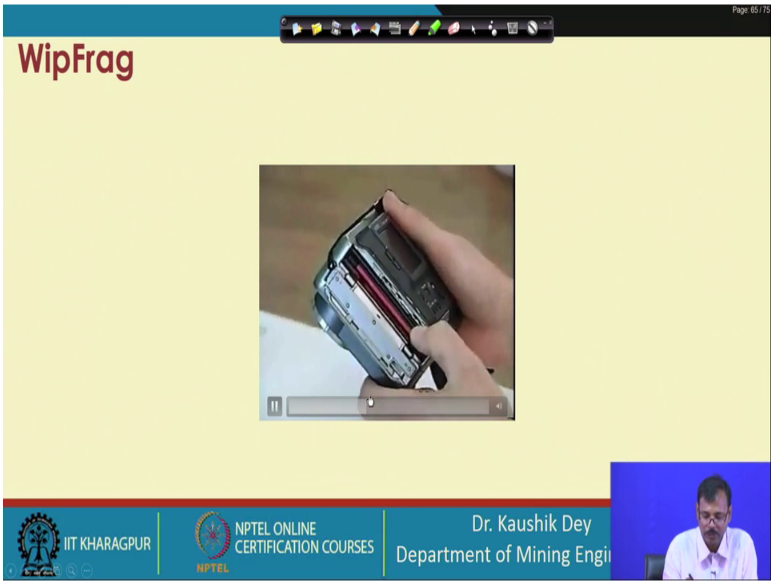

You can see the photograph is taken in the mind.

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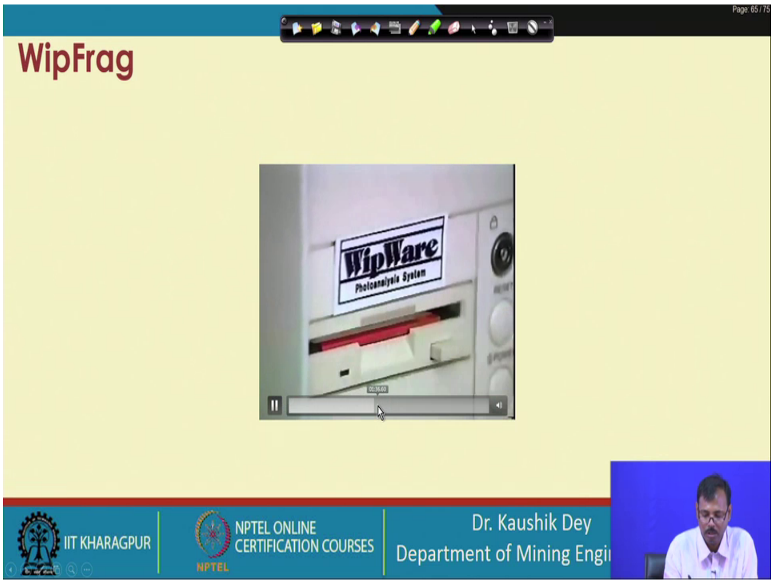

Then the photograph is loaded, and the fragmented rock picture is there this is the scale.

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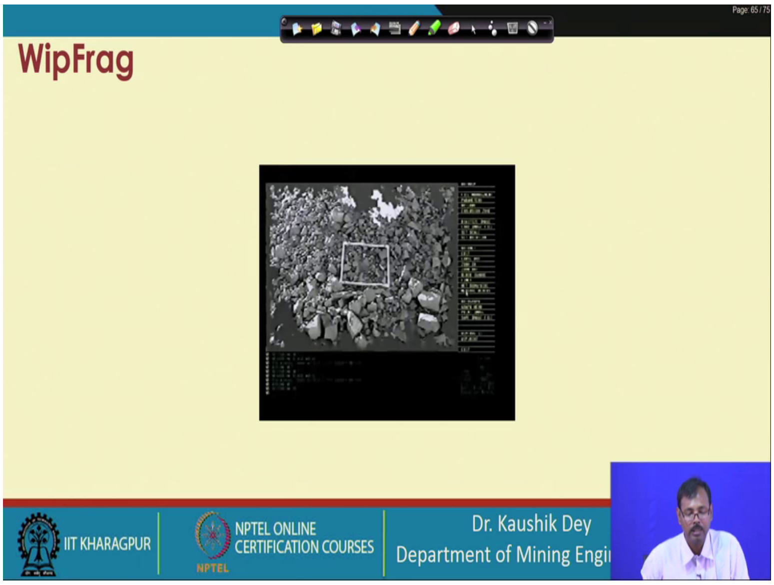

So, the scale is selected the scale is given; now the edge detection is carried out by automatically by the software.

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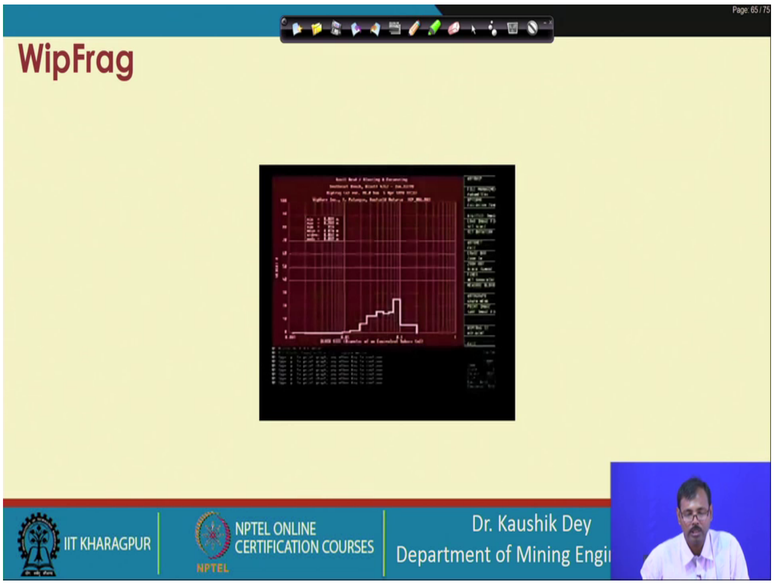

And then the fragment size distribution curve is made. So, the basic principle is more or less similar the different techniques are used for the edge detection the accuracy of these software's depends on the edge detection technique carried out.

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So, nowadays with the modern edge detection techniques the software's perform very well in most of the cases and it also depends on the type of material also. So, basically this is the method we carry out for the fragmentation analysis I expect, that you carry out more reading on different blasting from different blasting books specially SME handbook, then the books of Jameno, then the books of Professor Bandary. So, you can carry out more reading from those books. And, let us stop this lecture at this position we will continue this lecture in the next class also with the other with the evaluation of the other parameters.

Thank you.