Surface Mining Technology
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Lecture 59
Closure of Surface Mines-I

Let me welcome you to the 59th lecture of surface mining technology course. This is online NPTEL online certification course. So, we are now almost at the verge of closing our course. This is the last chapter or last topic you can say in which we will discuss the closure of surface mining.

In fact, I strongly believe as a mining engineer, we should not be considered as a mining engineer if we are not able to successfully close a mine. So, that is why opening of the mine is important. We have to carry out our business after opening the mine that is also important but after the business, we cannot leave the mining area as it is as we have carried out the digging. We need to successfully close the mine.

So, unless and until we are completing this chapter closing of surface mine, the surface mining technology course cannot be completed. So, this is our final topic. There will be 2 lectures on this. These 2 lectures will be closure of surface mine 1 and 2. So, in this lecture it is just the introduction to understand the important of the mine closing.

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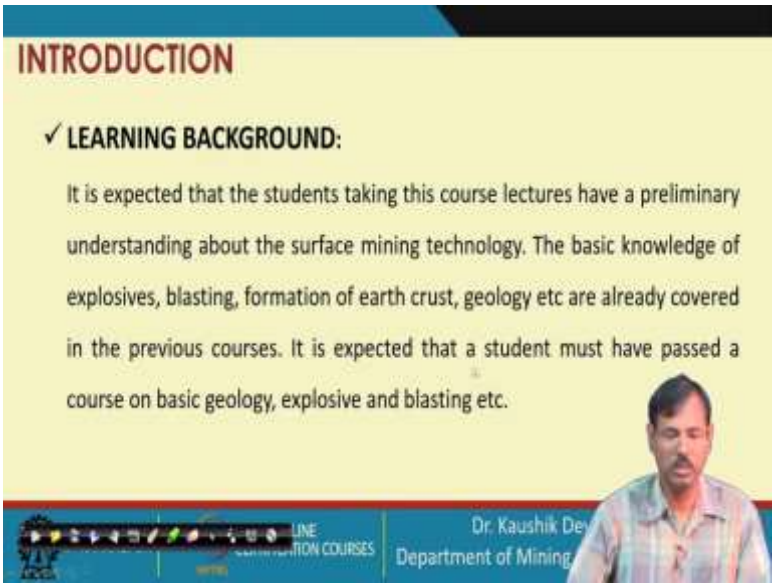

But before this let us look back the requirements that this is the learning background of surface mining technology course.

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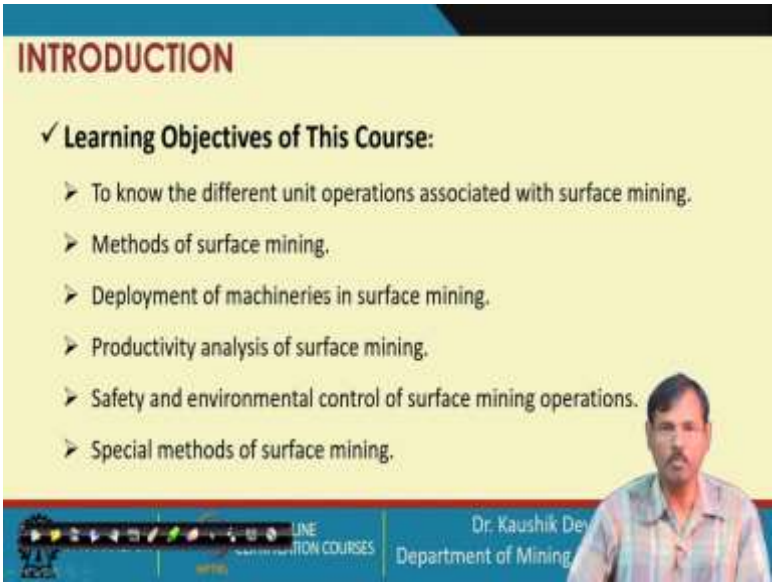

These are the learning objectives of surface mining technology course.

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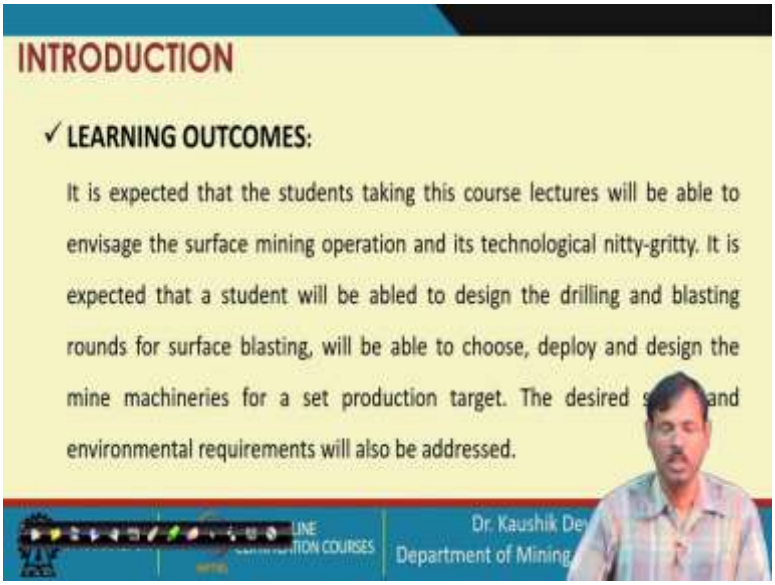

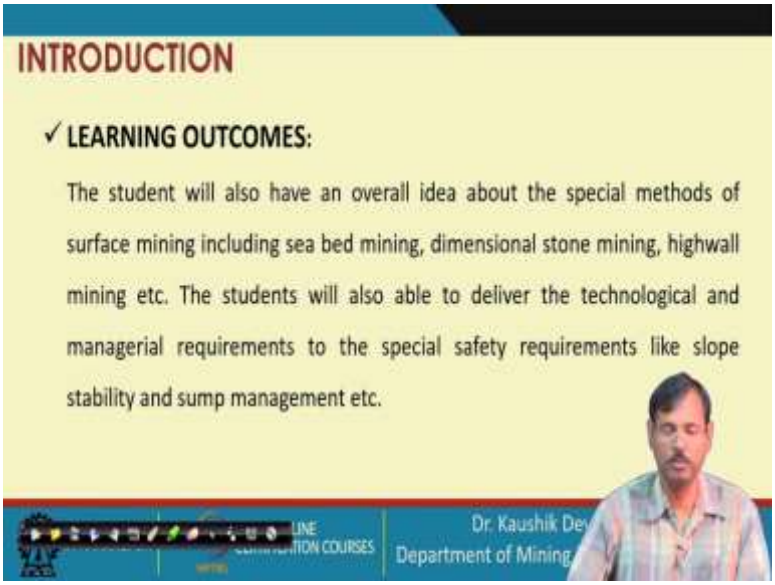

These are the learning outcomes of surface mining technology course we are expecting from the participants.

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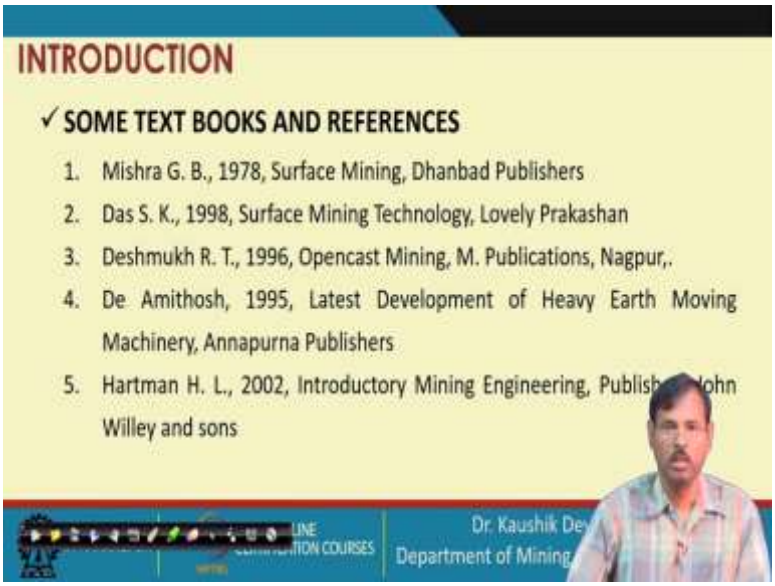

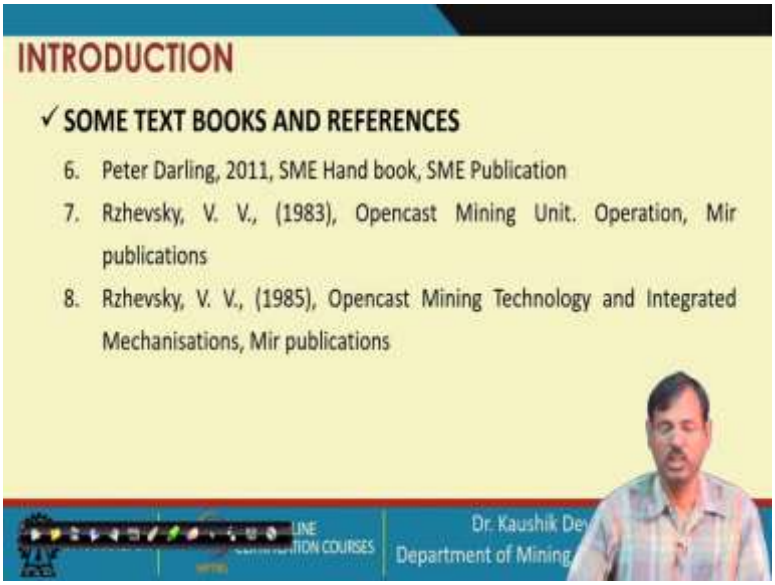

These are the some of the textbooks and reference books.

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And this is the retrospect of the previous lectures. Almost all the topics are covered. Phases of mining a deposit, opening of surface mining through the box cut, then drilling technology, blasting technology, excavation by ripper, excavation by shovel loading by shovel-dumper combinations then surface miner excavation by surface miner then excavation by dragline, bucket fill excavator, high-wall mining, haul road construction and maintenance inland surface transportation then the dimensional stone mining, the proposed or expected technology for the seabed mining, deposits under the seabed all these are covered.

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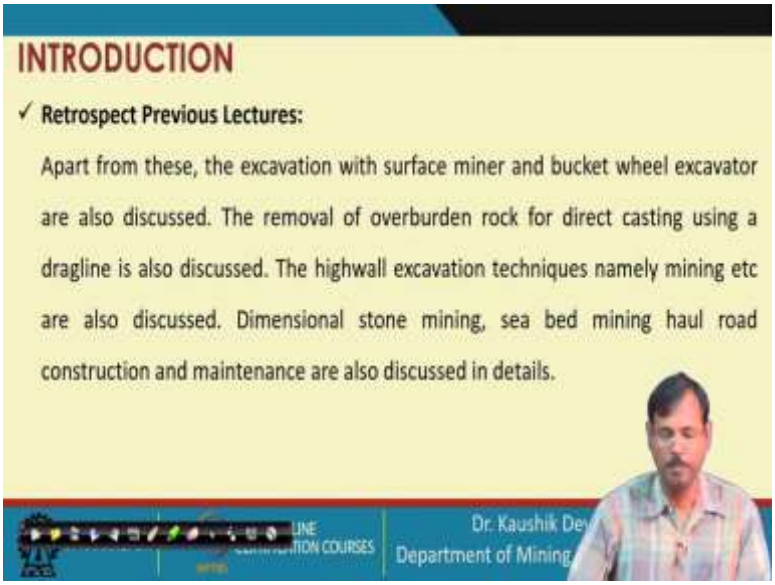

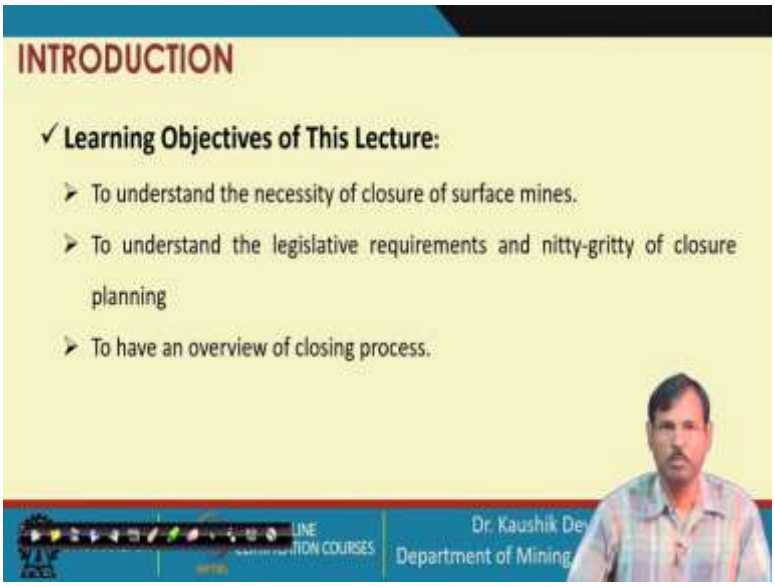

Now, we are in the last part. That is the how to close the mines and for this we set our objective, for these 2 lectures of closing the mine, mine closure, to understand the necessity of closure the surface mine, to understand the legislative requirements and nitty-gritty of closure planning and to have an overview of the closing process. These are basically set as the objective of these lectures.

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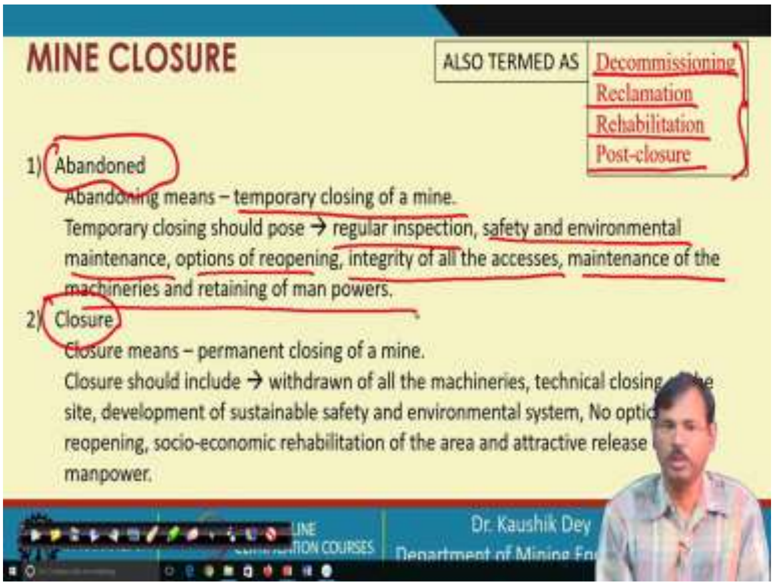

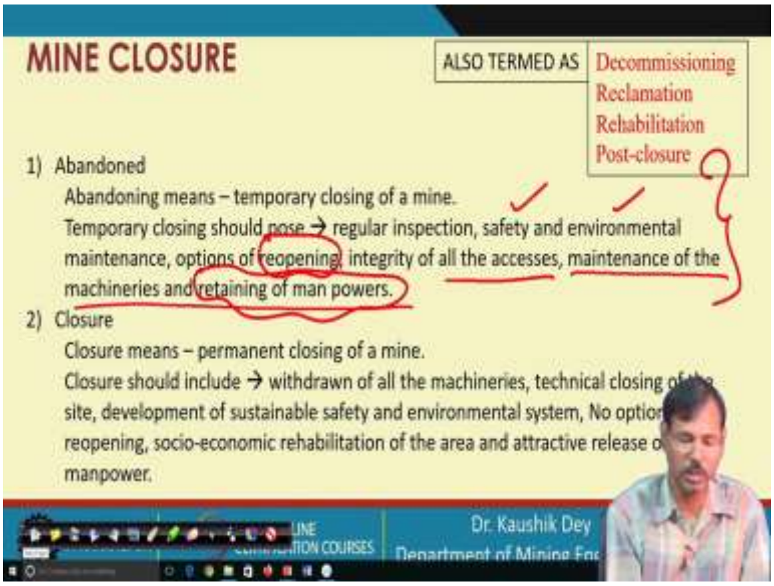

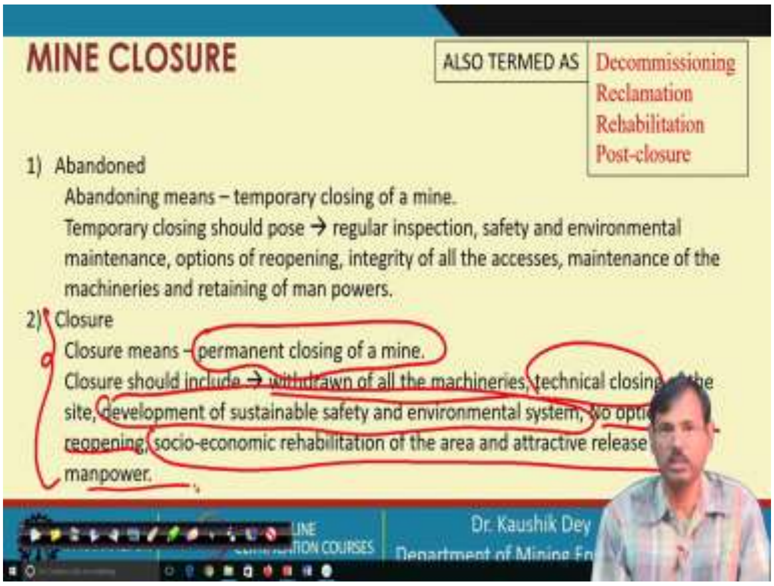

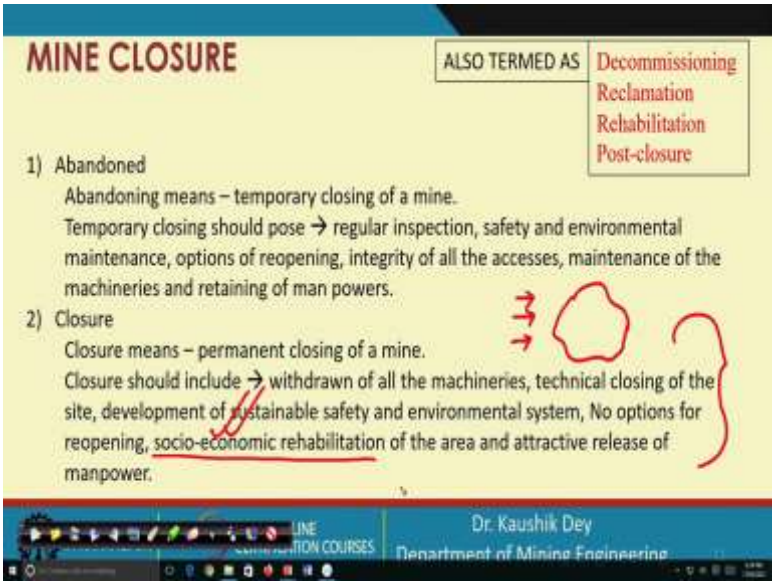

Now, mine closure. This is also often termed as decommissioning, reclamation, rehabilitation, post-closure. Basically, there are little bit differences in this terminology. But more or less these technology are interrelated. Closure is basically considering all the aspects whether it is decommissioning, whether it is reclamation, whether it is rehabilitation of the area and the nearby area and post-closure maintenance and looking after the area is also considered as a part of the mine closure.

Now, there is a distinct difference between the abandoned and closure. Abandoning means it is a temporary closing of the mine with an optimism that it could be reopened at a later stage. So, temporary closing should pose the regular inspection, safety and environmental maintenance, options of reopening, integrity of all the accesses, maintenance of the machineries and retaining of the man powers.

So, these are very, very important and especially countries like India etc. these last parts are very, very important that the maintenance of the machineries and retaining of the man powers. It is not that we are in dearth of man powers. There are so many people are available. But the retirement of that one means their wellbeing has to be maintained during the period of abandonment also.

So, that is why this is very important when the mine is abandoned with an optimism that it will be reopened and in those cases, the mine accesses should be maintained, the mine should be accessed, inspected periodically and the other aspects that safety, environmental features has to be observed and reopening chances should be observed, should be calculated based on the market price of the material, new technology, which can be possible for making the mine

profitable, and if any other aspects are there maybe socio-economical or maybe socio-political aspects are there, which are the basic reasons of the abandonment, may also be incorporated or may also be reconsidered during this process.

But closure is a permanent matter where there is no temporary closing, it is a permanent closing. And the permanent closing means we have to withdraw all the machineries, we have to close the mine technically, we have to develop the sustainable safety and environmental system, so that the effect of mining should not continuously degrade the area and no options for reopening. We should not keep the reopening options that must be closed and that is why the socio-economic rehabilitation of the area as well as of the manpower is essentially required and this part is very, very important for countries like India.

Say this part is important, the reason is that once a mine is carried out the profile of the area is changed in terms of geometric, in terms of socio-economic way, in terms of socio-political way. That means if a mine is opened in a remote area, the local people who are there earlier, they had a limited source of income maybe cultivations etc. They had households etc. without electrification all these things. Now, with the development of the mine, their socio-economic status has been uplifted a lot. Every households in the nearby they are now earning from the as they are having the jobs with the mine, good salaries they have drawn. They are having their house are electrified along with that they are now accustomed with the mobiles, they are now accustomed with the televisions all these facilities now they are having.

Earlier they are having the limited education to their family. Now, their families are also significantly educated. They are also significantly uplifted. Now, the moment the mining is withdrawn from that area, we cannot allow those local people to go back to their earlier life, neither they can sustain with their earlier life anymore. Now, they are habituated with the air conditioning system. They are habituated with the mobile data. They are habituated with the internet service. Now, withdrawing all these facilities and keeping them with any good source of income is not socio-economically acceptable.

So, all these points are very, very important during the closing of the mine and that is why post closure the system has to be developed in such a way so that the alternative resources can be generated. So, these things are very, very important and those must be considered during the closing of the mine. And one thing is mandatory once the mine is closed means all the entries has to be closed permanently. There should not be any further access to the mine

for the common people is allowed. So, that is very, very important and that must be practiced when the closing is carried out.

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Now, let us have some look into some of the photos. This is a mine reclamation after the closure. You can see the differences in this and this is an abandoned colliery at Indianapolis and this is the situation after this, so this is the closure, so mine was like this that was converted to this and this is the abandoned mines. No changes have been made because there is a likely chance these mines will be reopened in the near future for further exploitation.

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MINE CLOSURE

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This is an animated video, which is basically showing the lifecycle of a mine from the planning stage how the mining will be carried and how that will be closed this is showing in an animated way in this video. This is a case of British Columbia and here this mine is proposed to be carried out at this place. So, this is a completely animated video. So, this is the proposed mining leasehold area where there are some of the natural streams are available. This stream is the bigger stream is having some fish species etc.

The small streams are not having those species and the proposed mine is, that will be 23.4 million pounds mines are there, 16 years of mine life is proposed at this place and the mine is basically considering the economics of the part and based on that economic because closing cost is also a part of the economical considerations, financial appraisal of the project in that case the closing cost must be considered. So, this is the expected mining area and in this

expected mining area how the construction of the camps, construction of the plants will be made. So, these are basically considered in this case.

This is the plant. This is the residence. These are made and this is the proposed mine. So, after the mining this will be the final pit layout. The final pit layout is being shown. From the mine the material will be taken by the trucks, the trucks will dump the material on to this transporting system and these are the basically after refining this whatever the waste, the waste material will be dumped there. There are some water bodies.

So, these water bodies are protected through these dams. So, that will not come and finally coming to the mine. So, these are the this complete area will be filled with the refinery waste or the processed waste and this portion the water will be accumulated in the mine whatever water will come and that can be treated in the mine. So, this mine can act as a good water resource at this place after the mining.

So, this is the proposed mine after this the excavation that is the after the ultimate excavation of the mine this will be situation and in post mining, after refilling this, this will be again allowed to become a water reservoir after the decommissioning of the mine. However, these 2 dams will remain at this position because these 2 waterways will be considered as the water resource and that will be carried out. So, this is a 31 billion dollars proposed closing cost is expected for this mine and this is considering the complete lifecycle and how the closing of the mine can be carried out that is also emphasized in this video.

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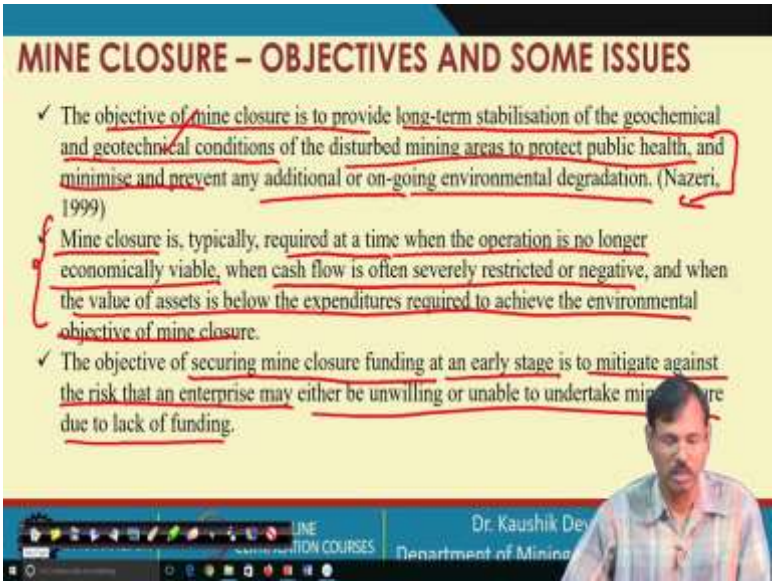

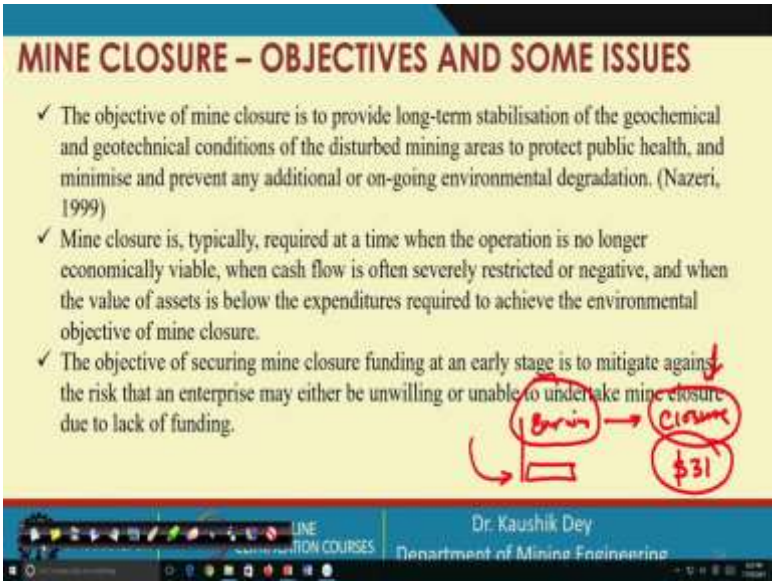

So, mine closure we must understand what are their objectives. The objective of closing a mine is to provide a long-term stabilization of the geochemical, geotechnical conditions of the disturbed mining areas to protect public health and minimize and prevent any additional or ongoing environmental degradation.

That means we should close a mine in with the objective that we will provide the long-term stabilization of the geochemical and geotechnical conditions and there should not be any disturbance or harm to the public health and environment because of the mining activities or because of the closing activities of the mine.

So, mine closure is basically required at a time when the operation is no longer economically viable. So, cash flow is negative and value asset is below the expenditures required to achieve the environmental objective of the mine closure. So, this is the point at which the mine closing can be thought of and mine closure funding needs to be secured from the early stage to mitigate the risk of an enterprise unwilling to unable to overtake the mine closure due to the lack of funding.

This part that means the financial assurance is also very, very important and essentially required during the closing. That means a mine is started. Mine has started earning and from this time onward a part of this must be kept for the closure because when the closure has to be carried out at this stage that time earning is in negative condition and no fund will be available for closing.

So, to avoid that situation the closure fund must be ensured beforehand and you have seen in the last animated video, the closure estimated cost was found dollar 31 billion and that has to be estimated at ensured during this earning stage itself so that the desired closing can be made. So, all this financial calculation has to be made in consideration of that and grading down that to a net present value level so that is very, very important task that is the financial analysis of the closing is very, very important task and that must be carried out.

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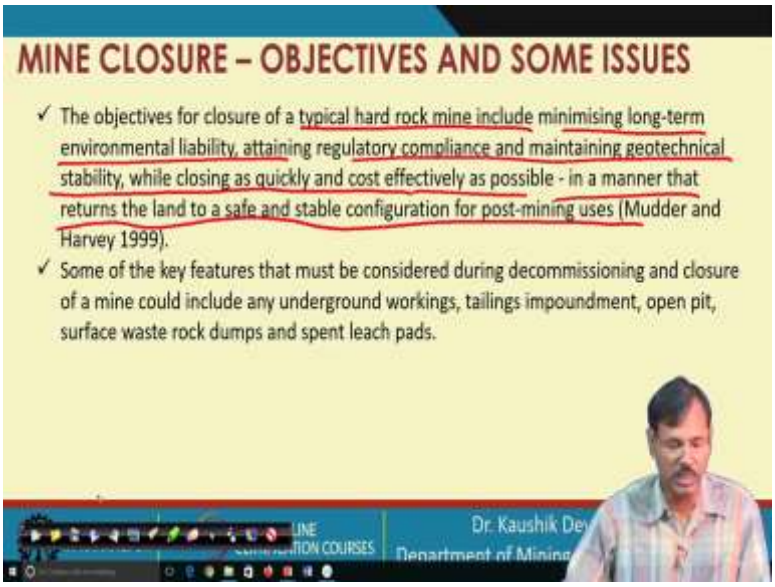

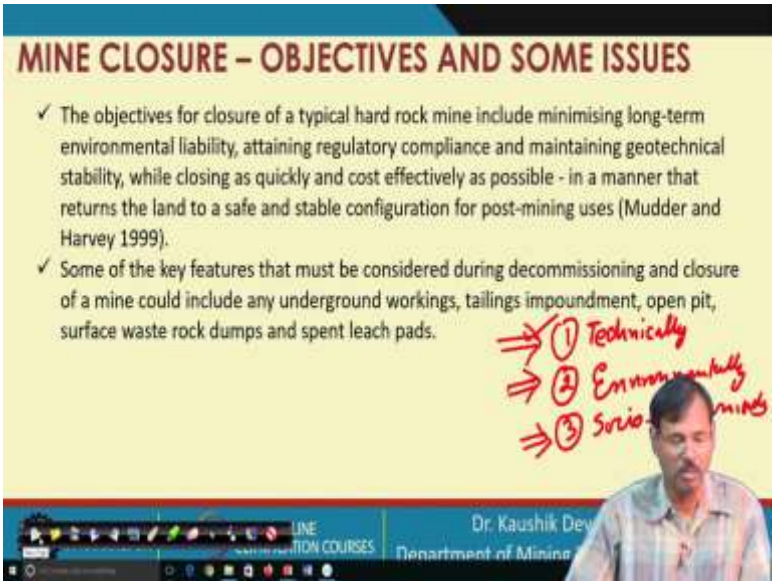

Objective for closure of a typical hard rock mine includes minimizing the long-term environmental liability, regulatory compliances, maintaining geotechnical stability and cost effective as possible in a manner that returns the land to a safe and stable configuration for post mining uses. So, basically our objective in mine closing is that it has to be technically

closed. It has to be environmentally closed and it has to be socio-economically closed. This socio-economically term is not that much required for the overseas countries where the threat socio-economic threat to the residents are not that much but the countries in developing countries or highly populated countries these risks are very high.

Technical closing means, there should not be any technical problem in the future that means there should not be any fall of the slopes, there should not be any problem in the entries of the mine, those things should be properly closed. There should not be any future subsidence, all this should be considered when the technical closing is considered that means all the things has to be withdrawn properly, decommissioned properly. The land use pattern, which is changed that should be properly carried out, proper technically carried out is considered as the technical closing.

Environmentally means, it should not be kept in such a position, the continuous environmental degradation will be made that means suppose it is generating acid mine drainage, it will continuously generate the acid mine drainage. So, all those things have to be prohibited and that closing must be carried out so that any further environmental degradation or environmental generation of environmental contaminants should not be there from the mine and third one is socio-economic we have already discussed that the closing must be such that it is acceptable for the socio-economical restoration or it is not restoration, socio-economical acceptance of the closing. So, these are the consideration, tailings impoundments, open pit, surface waste rocks, these has to be taken care of properly.

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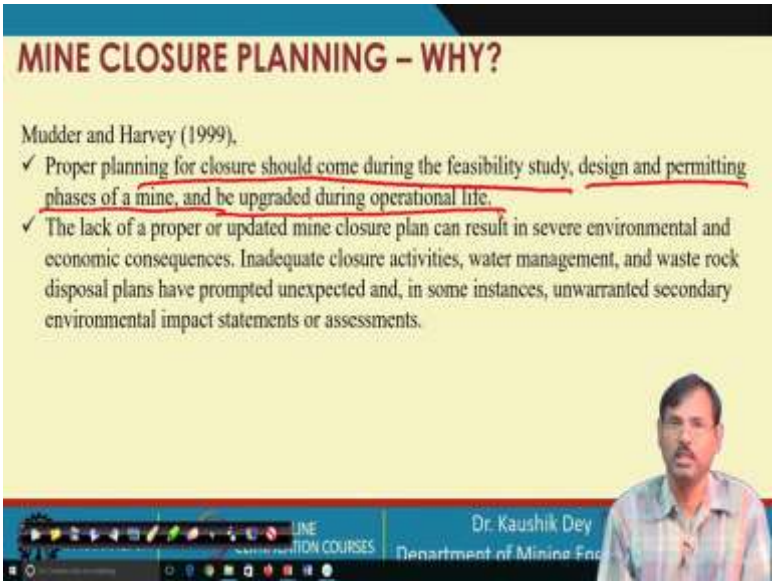

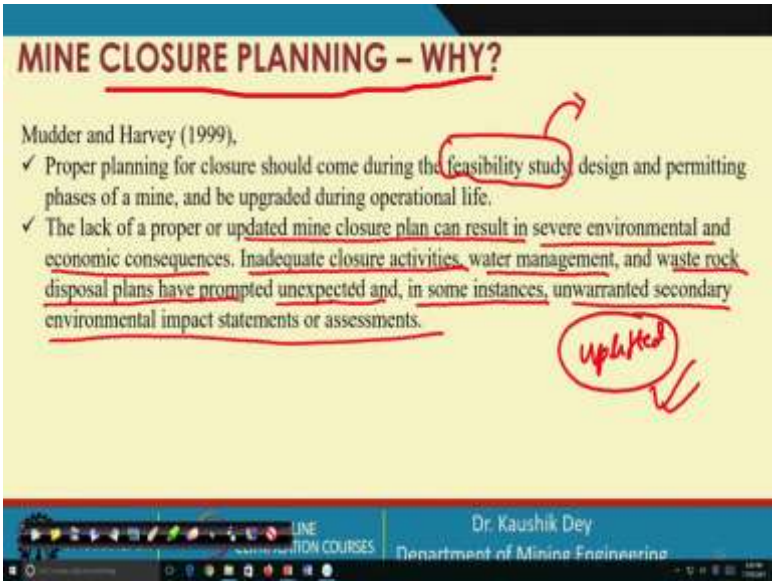

So, why planning of the closing is required? Proper planning for closure should come during the feasibility study as just you have shown in this video, design and permitting phases of a mine and be upgraded during the operational life. That means what will be the future closing. That means in the previous one it is found that it will be a good source of the water resource. So, that has to be considered during the feasibility study itself and so that the proposed design, which is made for the closing, the financial implications of that should be addressed in the feasibility study and accordingly the financial commitments has to be maintained.

And during the period of this operation of this mining operation, this may be upgraded or this may be uplifted that means suppose the first in the first case it is considered that the say the dump area has to be planted with say teakwood. This is the say suppose one consideration was made but later on it has been found instead of teakwood, if the mango tree has to be planted that will be the better one.

So, that much of changing may be allowed but the no major changing that the dump which is kept that one that has to be refilled or that has to be transported, this type of major changing is not allowed in that stage but minor upgradations may be allowed during the operation of the mining life.

So, lack of proper or updated mine plan can result into severe environmental and economic consequences, inadequate closure activities, water management, waste rock disposal plans, have prompted and unexpected and in some instances unwarranted secondary environmental impact statement or assessment. So, that is why this closure planning is very, very important

and it is a mandatory part during the feasibility study without this the mining cannot be possible.

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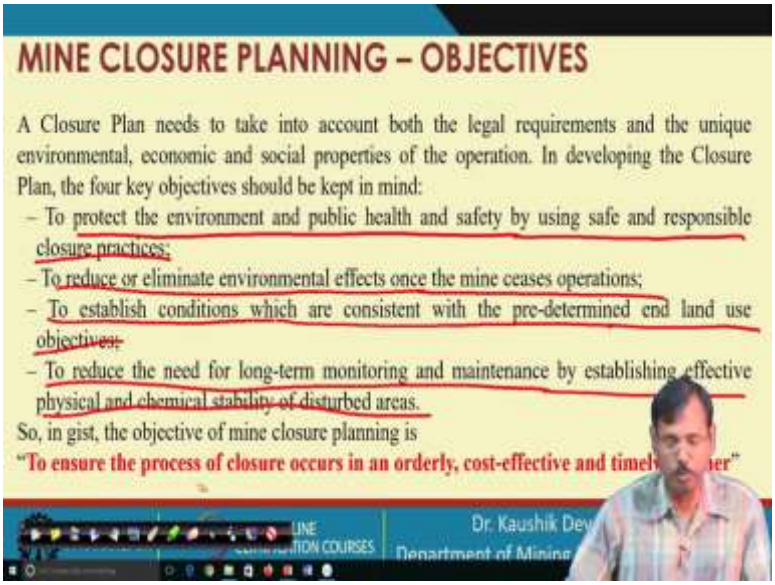

Now, closure objectives are to protect the environment and public health and safety by using safe and responsible closure practice to reduce the or eliminate the environmental effect once the mining operation is ceased and establish conditions, which are consistent with the pre-determined end land use objectives to reduce the need for long-term monitoring and maintenance by establishing effective physical and chemical stability of the disturbed areas.

That means the land, which is disturbed that is closure means it has to be settled in such a way it need not to be it need not to be monitored or controlled for a long term. It may be that environmental activities, that physical activities, microbes activities, phytoplankton activities, zooplankton activities, water activities. All these may be monitored for a some time but it cannot be monitored for lifelong.

So, that is why a sustainable a self-sustained environment has to be created after the mine completion in that particular area so that that can standalone. So, to ensure the process of closure occurs in an orderly cost effective and timely manner is very, very important and an important objective of the closure.

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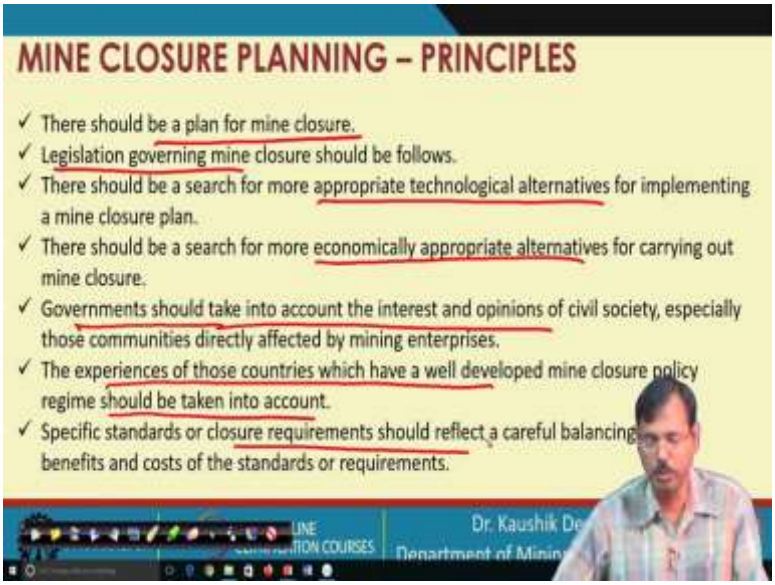

So, the closure principles there must be a plan for closing, legislative requirement has to be fulfilled. The appropriate technology and alternative should be adopted, economics must be observed so that financial analysis can be made, government interest and opinion should be considered, well-developed examples of the well-developed countries should be taken and the standards must be properly maintained so that the cost can be accommodated in this case.

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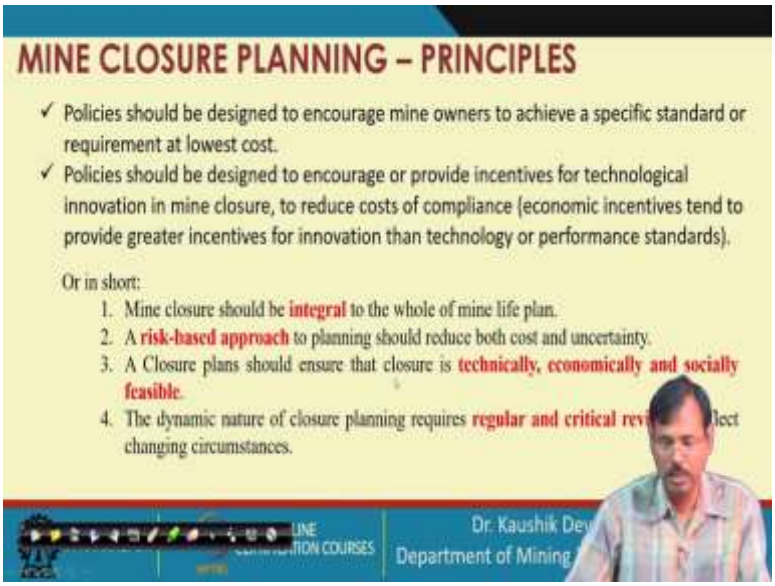

So, these are the principles.

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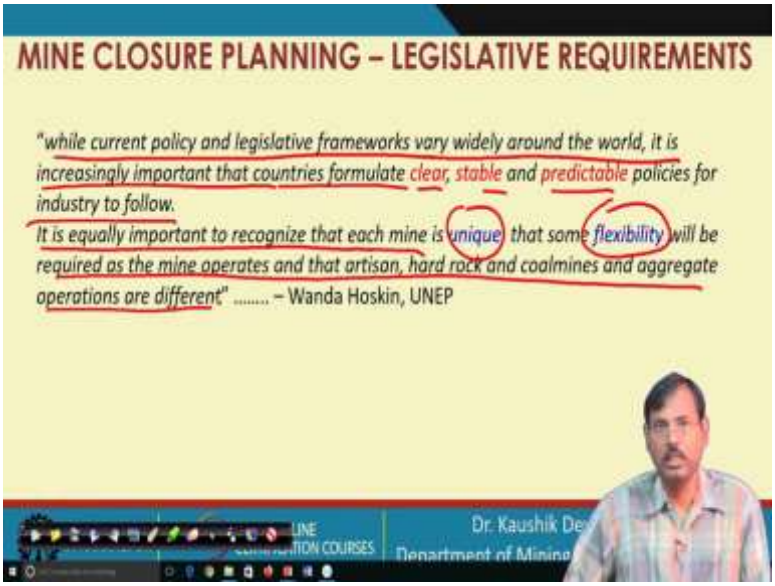

Now, the part, which is very important. While current policy and legislative frameworks widely around the wall it is increasingly important that countries formulate clear stable and predictable policies, for industry to follow. It is equally important to recognize that each mine is unique and should have some flexibility while the closure planning is being carried out. That means if government is having the policy say if a surface mine is made the mine has to be refilled again then it is a difficult policy cannot be handled because the rock is excavated from the mine. Again, it has to be refilled means another mine has to be created.

So, this will be a never-ending process and that is why it cannot be followed so there should be some flexibility. Suppose a mine is carried out in the area, where the availability that quantity of rain is limited the surface mine can be used as a water storage system in that place. In some places where the other facilities are there, surface mining can be converted into a good park or so and that can be utilized later on. There are many examples are there which can be carried out in similar way and that is practiced in those cases.

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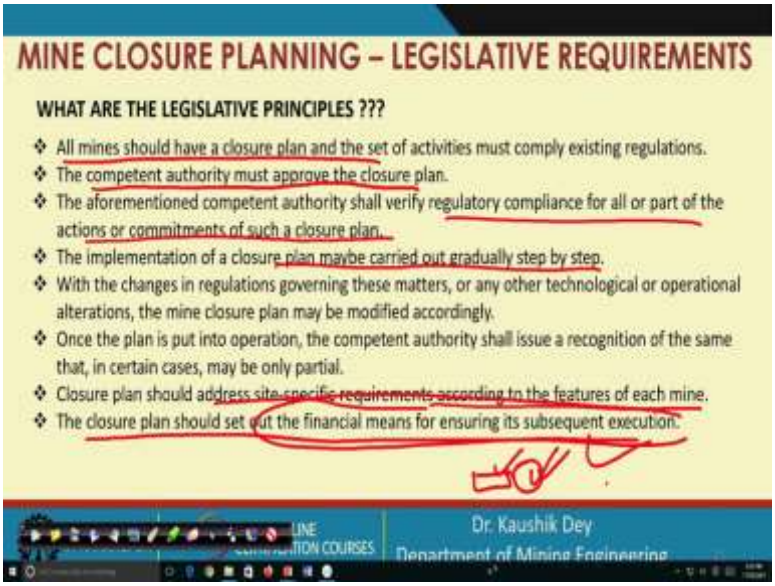

So, what are the legislative principles? Currently the principles are taking all mine should have a closure plan, the government competent authority or the apex body should approve that one, the commitments must be cleared in the closure plan. Closure plan implementation should be carried out step by step and that steps must be very clear and those evaluation should be very clear and the very, very important part is that it should size specific requirement must be addressed and financial means must be very clearly indicated in this.

That means, this is the closure cost, that means today, when the mine is being opened that time only we have to declare the closure cost is this much after the 30 years and or you can say this is the closure cost after the 30 years whose net present value is this one and that is why we are accommodating this much of fund for the closing activity. So, this is the financial assurance, financial assurance must be carried out before the commencement of the closing.

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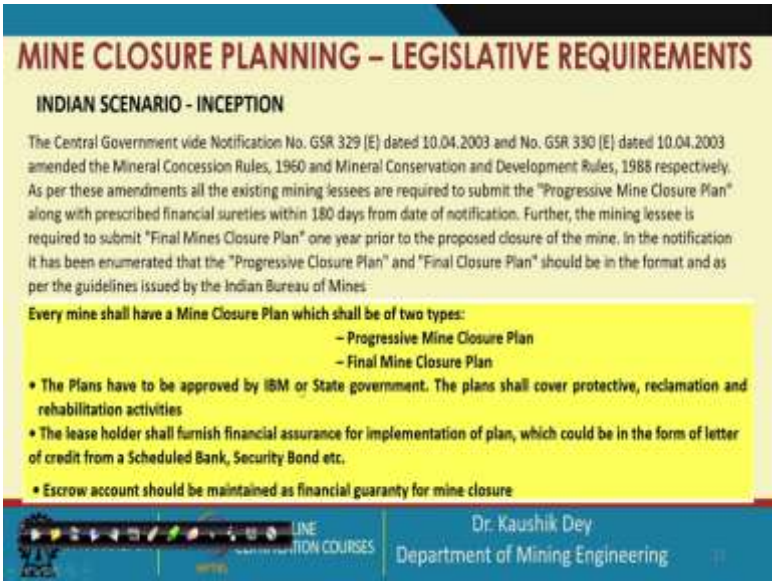

So, this is the legislative requirements. This is the Indian scenario and we will continue this Indian scenario in the next class. Thank you