Surface Mining Technology
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Lecture 52
Dimensional Stone Mining - II

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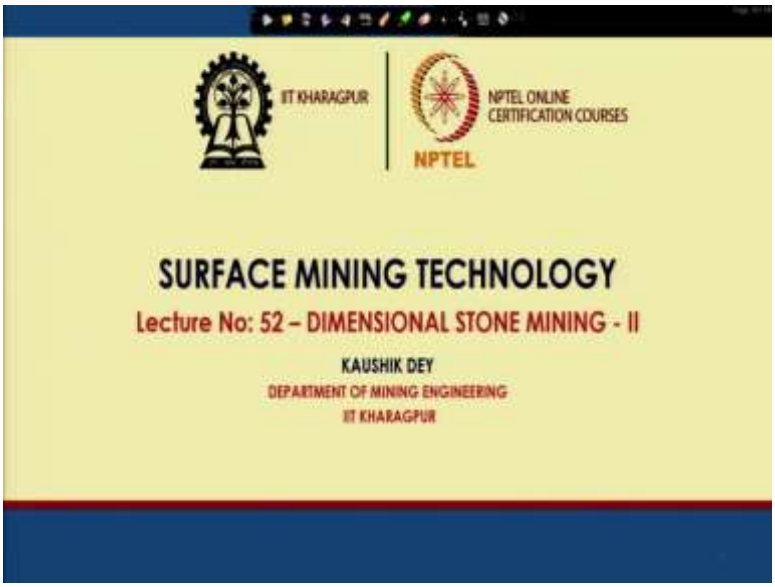

Let me welcome you to the NPTEL online certification course, surface mining technology. We are now covering the dimensional stone mining; this is the second lecture on the dimensional stone mining and this is the lecture number 52 of the course. So, this is continuation from the previous lecture dimensional stone mining lecture number 1.

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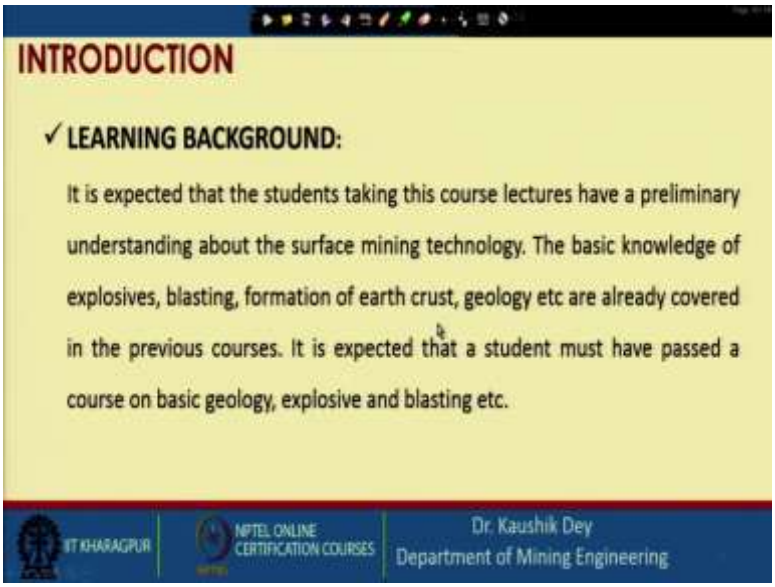

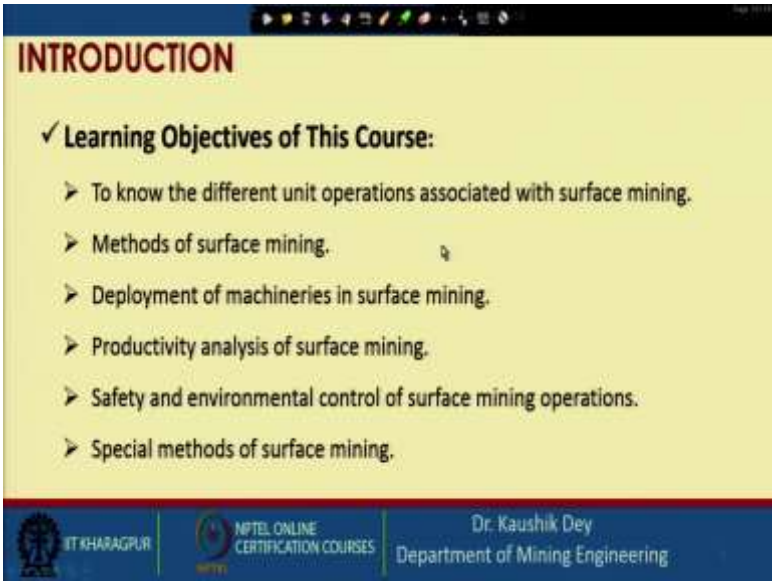

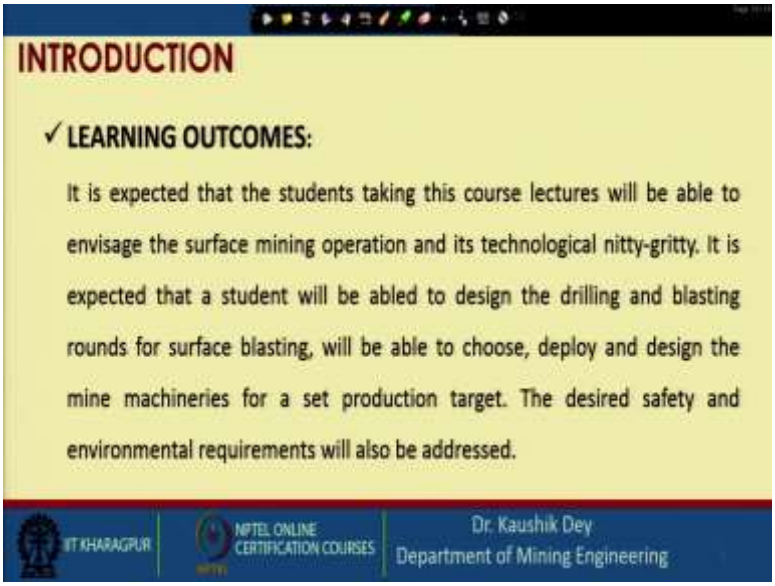

Like every lecture, let us look into the learning background required for surface mining technology course in NPTEL. This is the learning objective of surface mining technology course and this is the expected learning outcome of surface mining technology course.

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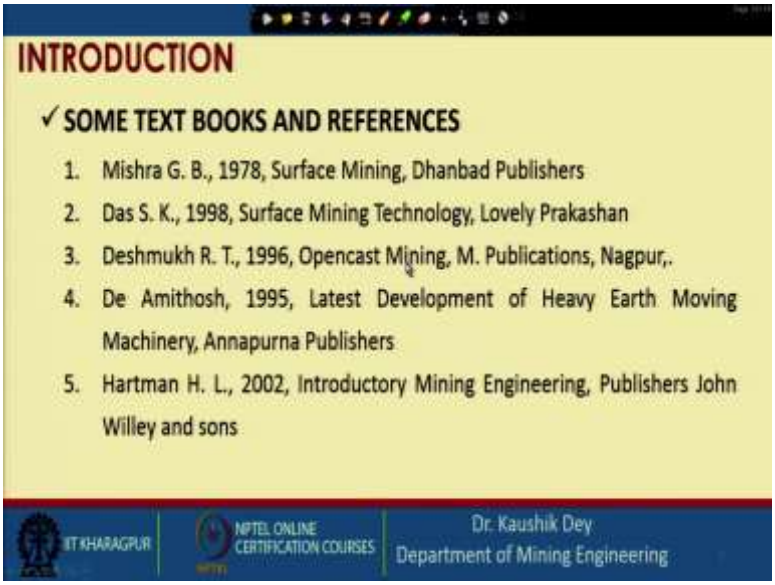

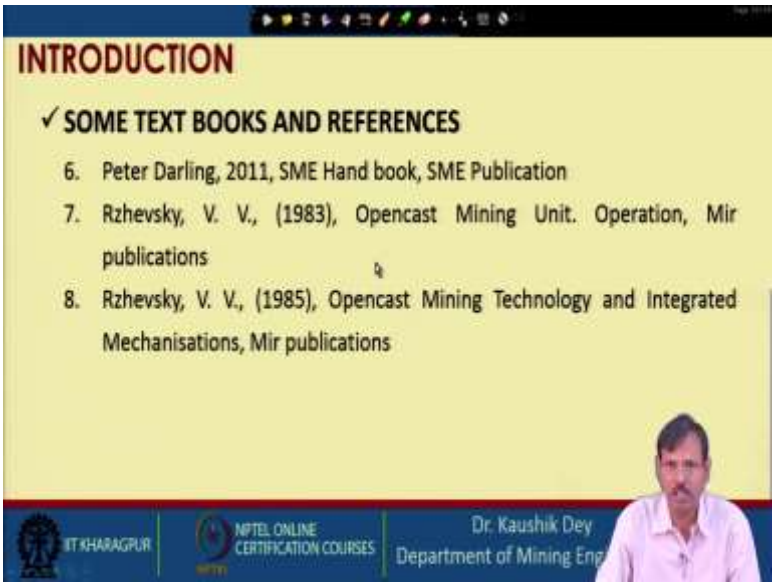

And these are some of the text and reference books which is given for the reference and self-study of the participants and apart from that for the lectures, the references are given along with the slides or at the end of the slide.

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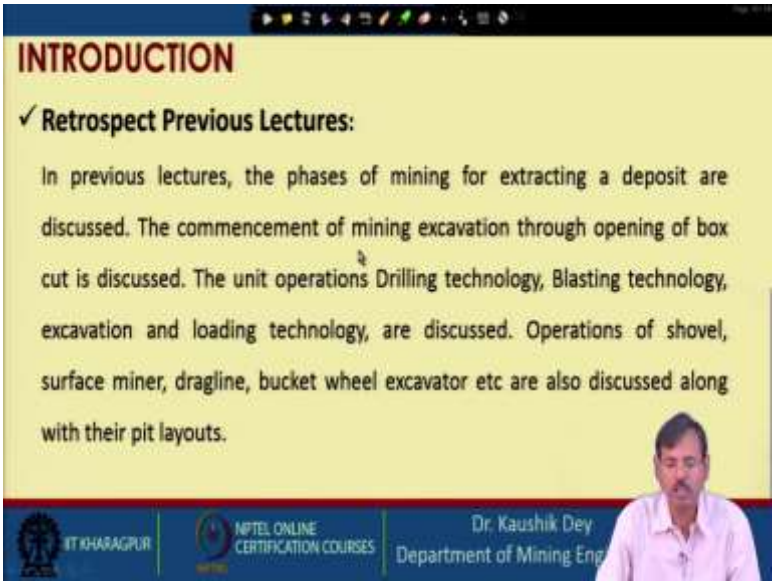

So, let us retrospect what so far, we have covered, we have covered the current status of surface mining worldwide. We have covered the phases required for mining a deposit and we have also covered the commencement of surface mining operation through opening a box cut and we have covered the different unit operations for excavation of the rock.

We have seen surface mining is basically the excavation of the rock from the surface and in this excavation, we need to reduce the size of the rock so that it can be handled easily. So, basically it is a size reduction process and different size reduction process are basically discussed in this course and it is found that drilling and blasting technology is one of the very popular course, that technology is already discussed.

And blast free technology, excavation technology is also discussed and these are basically excavation by ripping, excavation by surface miner, excavation by bucket wheel excavator and we have discussed the technology for handling the fragmented rock mass or smaller size rock mass using a loading equipment or excavating equipment like shovel, etcetera and transportation of them by dumper etcetera is already discussed in this course.

So, in last class we have started the dimensional stone mining, we have understood what is dimensional stone mining and we have understood that what are the dimensional stones and what are their perspective of current excavation and we have seen also the status of the dimensional stone mining in India, it has been found that Rajasthan is excavating almost 95 percent of the total country's production.

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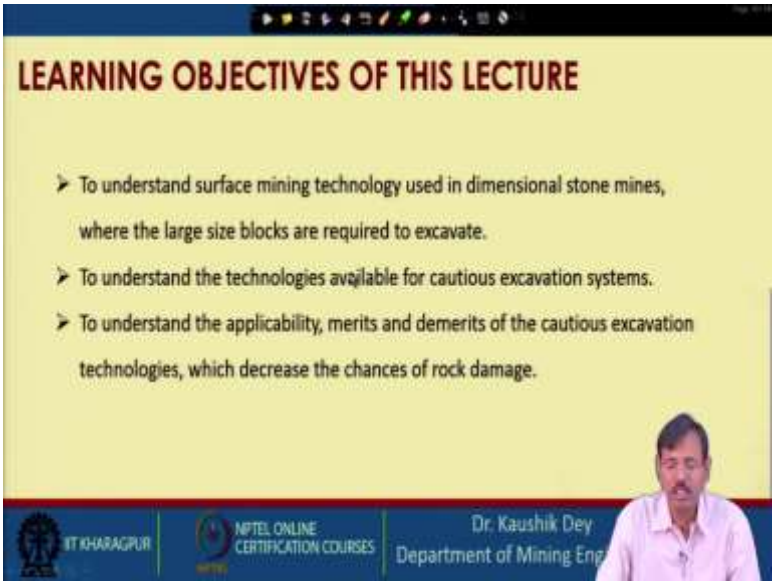

So, these are the learning objectives of dimensional stone mining, all the 3 lectures it is covered here and we will start our dimensional stone mining methods; mining methods in this lecture. But let us look at one video in which dimensional stone mining is shown, excavation system is shown, you can see it is simple, just like a simple mining system where you are excavating in surface forming the bench.

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You can see the benches are formed but excavation technology is little bit different because you have to excavate in blocks. So, these are the different technologies you can see, this is wire saw used and you are allowing the falling of the material on a loose sand, so that it cannot be damaged a lot and these are the material handling system where a scissor lift is used for lifting the material or a loader is used for lifting the material.

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And here the mine blocks are basically excavated and see the excavations are carried out along in the direction of the joints, prominent joints.

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This is the aerial view of the mine, you can see this is the diamond wire cutting and this is the handling of the blocks, see these big size blocks are basically handled either using an excavator or using a lift.

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And these are the over burden rocks which are dumped at a distance, lifts are used for lifting the large size; cranes are used for lifting the large size blocks, this is the diamond wire cutting. We will discuss all this technology in later on also, but in a nutshell, we are saying these are different technology.

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And this is the pushing of the cut block. We will see a pusher is also available, we are pushing using the excavator and you see this loose rock material sand displaced so that the rock will not damage. So, after falling also, this is not damaged because of this loose sand, say two excavators are simultaneously handling the rock block.

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And this is the slot drilling carried out and this is the diamond work cutting of the blocks. So, actually we have to avoid blasting because blasting generates huge shock wave that damages the block, so that is truly unwanted.

So, damaging of the block is truly unwanted, any crack initiated in the block reduce the commercial value of the block significantly and that is why we avoid carrying out blasting in surface mines of dimensional stone and that is why the special mining methods are adopted in which only, we go for cutting.

So, we go for cutting only and that is why these blocks are basically come out, large blocks are come out from this cutting. So, it is excavation cost becoming very, and this is the material transportation system large size trailers are used, say one trailer is carrying only few blocks.

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This is another special method of excavation where a giant saw is used for cutting, you can see this is the giant saw which is cutting the rock block. Now you can see the block is being cut using this giant saw, so this giant saw is also fitted with a cutting chain, this is the cutting chain fitted with this saw and this cutting chain is cutting the block. So, now the block cutting is complete, you can see this powder has come out of this cutting.

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And this is the diamond wire cutting is going on for this block. So, this is diamond chain saw, cutting is going on in this case. So, you can cut in the lower direction also using this diamond chains or using this chainsaw cutter. This video is available in YouTube also and this video is well explaining almost all the technology which are used in dimensional stone mining. So, diamond wire cutting we have seen and this is the chainsaw cutting.

The benefit of chainsaw is that it can cut in any direction, it can cut vertically downward, it can cut horizontally also. So, it is basically excavating a big floor block.

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This is the giant saw disk; the block is placed at a proper dimension below this saw disk and now the saw disk is allowed. So, this is giant saw disk which is allowed to cut the rock.

So, now saw disk has started cutting the marble block, water needs to be sprinkled during all the cutting whether it is by diamond saw or it is by chainsaw or it is by diamond wire, every time water must be sprinkled on the cutting device for basically two purposes, one is to dissipate the heat, if the heat will be, as the during the cutting heat is generated and on overheating those diamond may lost or chain may cut.

So, that is why to avoid that, cooling is required, cooling of the tips are required. So, that is why water has to be sprinkled, that is the first purpose. Second purpose is whatever dust is being generated that dust has to be suppressed so that the atmosphere will be good. That dust has to be suppressed along with that, the dust part has to be removed from that place, so on sprinkling water along with the water, the dust part becomes cleaned from that area, and it is drained from that area to another place.

So, by that way the cut material is also removed from that place, so that is the benefit and that is why this water has to be sprinkled on that cutting plane, so that that can cut the complete rock with environmentally and technically suitable manner.

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So, now it is easily understood this complete block is now cut in a number of small pieces, you can see this thickness of this pieces are so small and these spacers are provided between every thickness, every cut area so that it cannot be re-joined from those water sprinkled mud. So, that should not re-join that cut area, the wooden spacers are provided in those places. So, these are basically the different technology of dimensional stone cutting, you can see those cut planes at this place.

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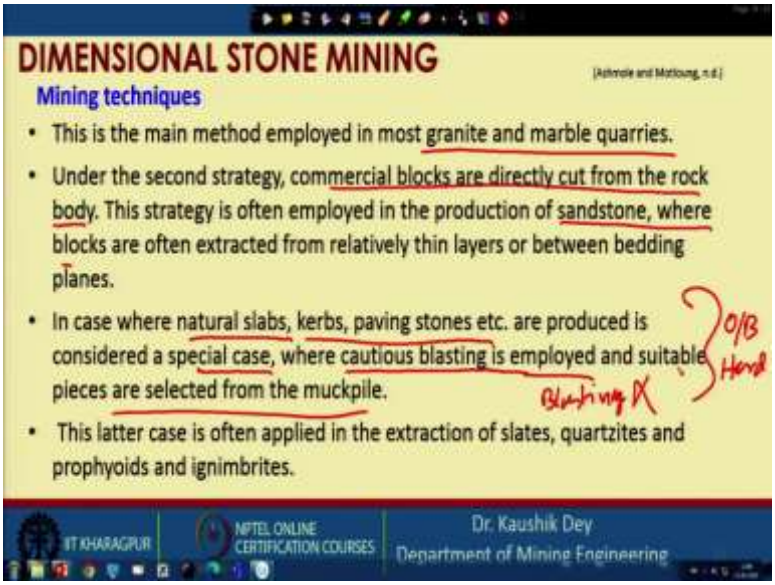

Now let us go into the details, what are the mining techniques. So, basically there are different mining techniques available, split or cut the stone into successfully smaller pieces until the final desired block size is achieved and then the dimension stone extraction conforms on two general strategies.

First is that you have to excavate a large block, then take this large block to the cutting shaft and then cut them in a smaller size pieces. So, generally first is large volume block of thousand-meter cube and so, that is loosened for primary cut is met, then step wise, that is divided into the small pieces unless the commercial block size is obtained, that is the strategy of dimensional stone mining excavation.

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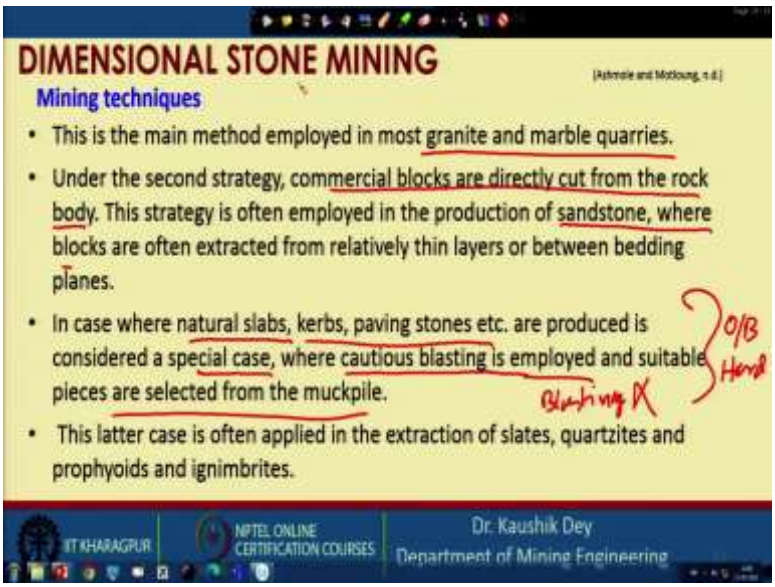

Granite and marbles are the main dimensional stones and commercial blocks directly cut from the rock mass and sometimes this is also for the sandstone blocks. In case of natural slabs, kerbs, paving stone are also produced of special cases and cautious blasting are sometimes used but this is specially used for the overburdened rocks sometimes if it is very hard, otherwise mostly blasting is prohibited. Blasting is prohibited in a dimensional stone mine.

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Now let us see, this reference is available in the website one can download it, so extraction method is basically divided in 3 parts, cutting, splitting, cautious blasting. And in cutting there are different methods, diamond wire methods, sand wire method, chainsaw, disk cutter, diamond belt cutter, flame jet, water jet, these are the different cutting systems.

There are different splitting systems where you split from the fracture, one very common method is the hammering the natural fractures with the chisel and hammer that can be one. Second one is that using very small explosive or one can go for plug and feather, expansive mortar, hydraulic wedges.

These are used where the splitting of the blocks is made from its prefix joint sets or the plane of discontinuities from which these blocks are splitted and then the 3 sets of joints or bedding planes etcetera are creating a large block then that large block is being cut into the smaller size pieces in the workshop or in the plant.

And generally, this is not a very common practice, if it is practiced, this is practiced for the low value marbles only, this practice are used because it is wasting a huge valuable product

to a devaluate product. So, that is why this is not in general very wholeheartedly supported and that is why this is not very commonly used.

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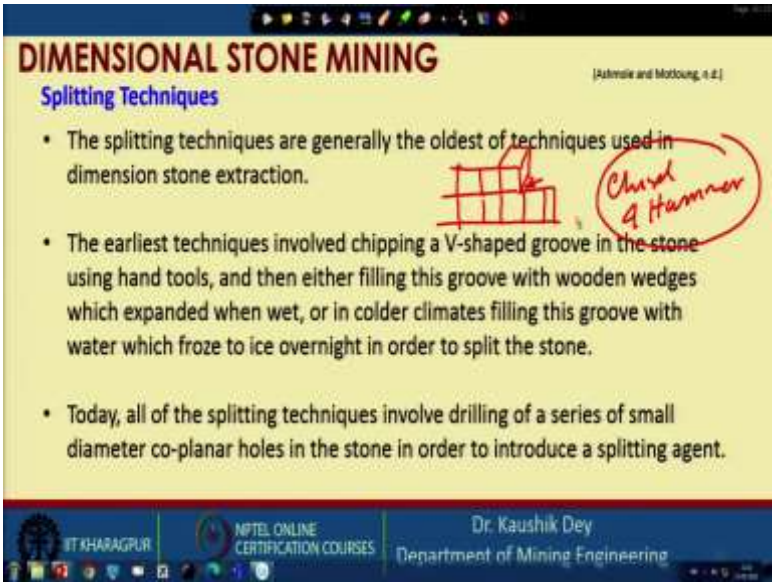

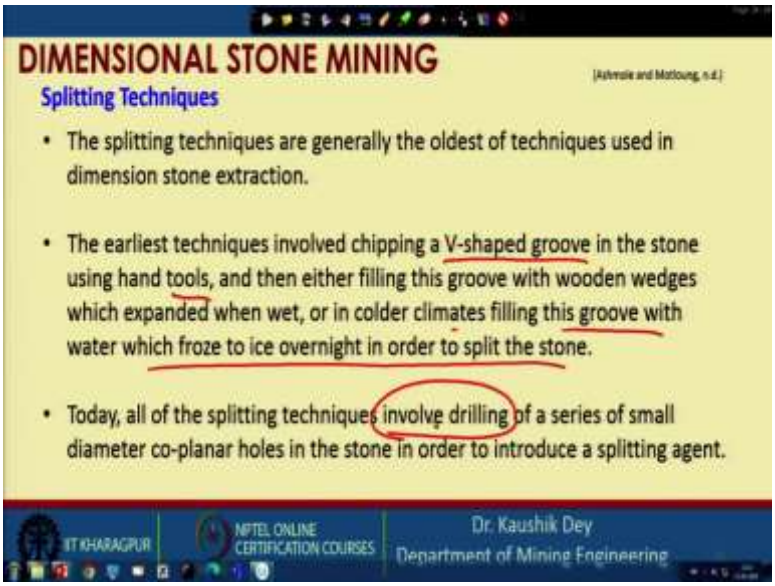

So, let us start with the splitting technique, in splitting technique this is the old technique earlier probably where the rock blocks are having joint sets like this, these are the bedding planes and having a joint set like this, in a number of places this part is chiseled and hammered by the local people to take out each block separately to use them as their building stone. So, that was the original session of that one where a chisel and hammer is used for excavation system.

So, this is basically a splitting technique, so basically from this splitting technique later on it is modified in the different considerations like V-shaped groove are made in the stone using

hand tool and filling this grooves with wooden wedges then expand them and sometimes colder climates fillings grooves with this water fridge, all these things are used for the expansion of this cracks and often the modern days splitting techniques involves drilling where the closely spaced drill holes are made and then either pushing, hammering or pneumatic hammering, manual hammering or pneumatic hammering or hydraulic hammering all the small scale blasting is carried out for carrying out a splitting from this holes.

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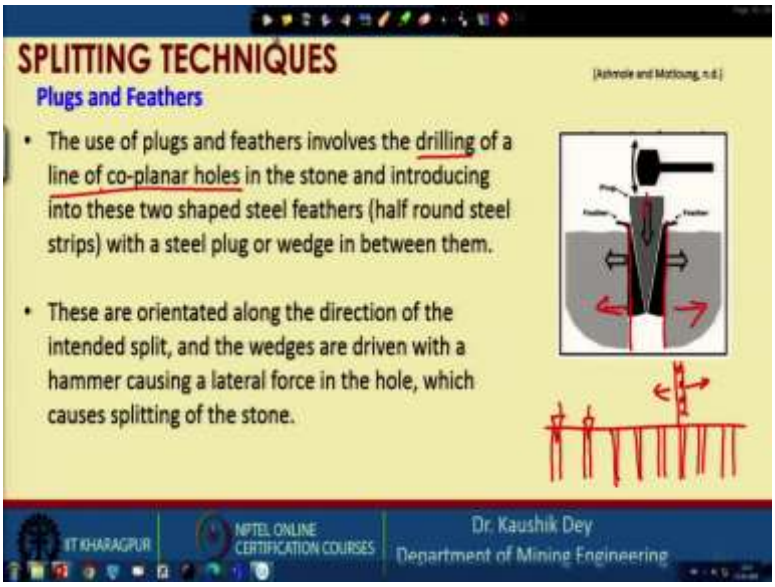

So, one common thing is that create a hole then use a plug, hammer on to this plug. So, first create a hole that act as the act as the plane of discontinuity then provide a plug, hammer that plug so that this block are allowed to split.

So, this is drilling the line of co-planar holes, so you basically carry out the drilling. So, these are the closely spaced holes which are then hammered so that if you are looking at this, these are the holes from the plan view and if you are hammering this then this block and this block these are moving in two direction and by this way, we got the splitting.

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So, we can watch a video on that, so there are fantastic videos available, you can see these are the holes made and this we are hammering this for splitting them. So, we are hammering to split them, so it is cracked; along this line it is cracked and now that block is splitted in two part. So, this is the common technology which is used but this technology is generally adopted for a low value deposits, this is the plug, this plug can be reused.

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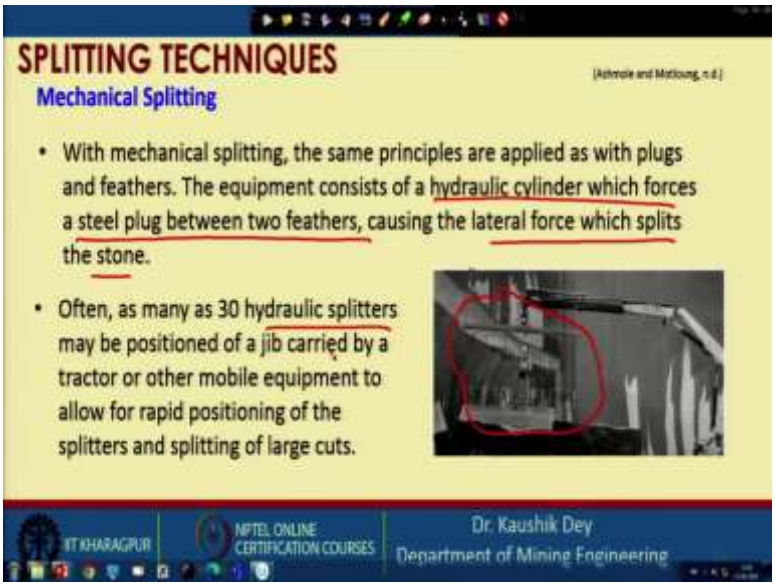

Then mechanical splitting is also possible where the hydraulic hammering or hydraulic cylinder is forced in a steel plug between two feathers and causing the lateral force to split the stone, so at a time there may be 30 hydraulic splitters are used. So, this is 1 figure available for that, which are placed inside the hole and then the hydraulic forces.

So, these are placed inside the hole and then the hydraulic force is provided in this. So, this is a mechanical splitting system, similarly in one of our videos we have seen it is a, in the first video we have seen, there is dynamic splitting which is also possible, pneumatic hammering is also possible.

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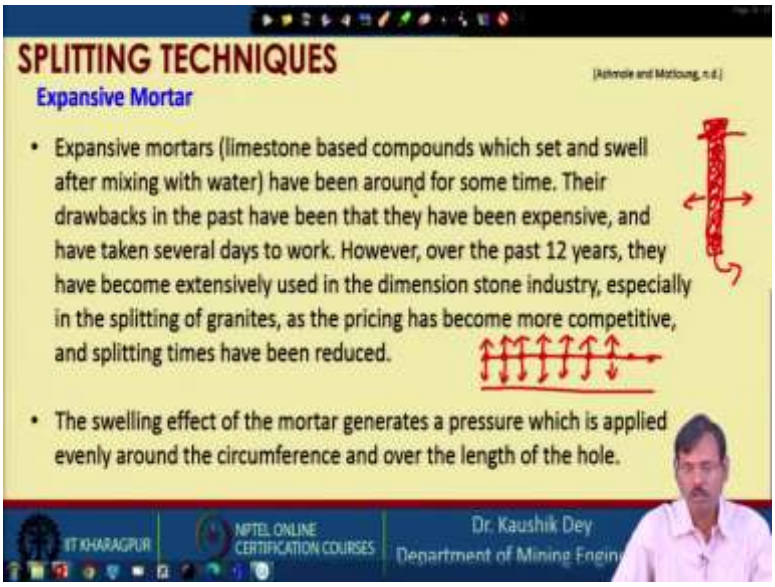

Often you can use an expansive mortar, we can see a video where these expansive mortars can be used which is a basically replacement of the explosive. In this case suppose we are having, let us have a plan view here, so we are having holes at this position which are closely spaced and this is the section of one hole, so what we do, we fill this one using the expansive cement.

So, fill this with expansive cement and after that we may plug this one and then we allow the setting of this cement on setting this increased in volume. So, while it is increased in volume, it is placed throwing this one in these two direction. So, what is happening, this one is basically forced like this. So, a crack is initiated along this line.

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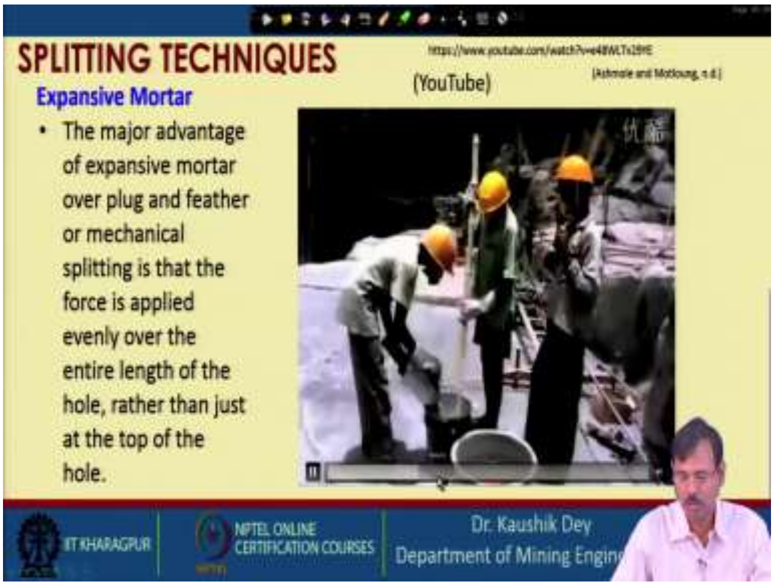

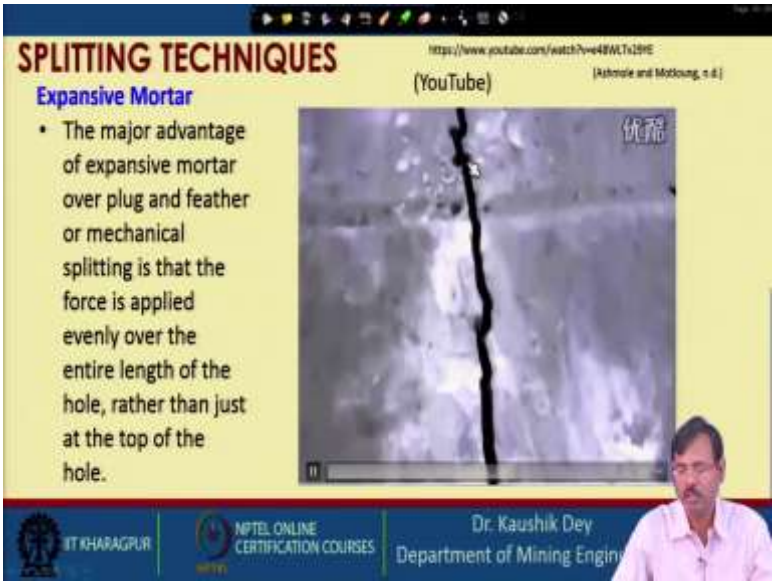

In India also our SSC cement has this type of expanding cement: the manufacturer and this is a video you can see where expansion cement, so these are the holes already made and this is the expansive mortar and this is the mortar you have to mix it with water. See the mortar is now mixed with water and now this is port in the hole.

So, this is created, a crack along this after few hours. So after few hours setting, if it is allowed then a crack is initiated along this line, these are the spacing between the holes, you can see the holes are very closely spaced and in overall you can see this is the crack which is happened in the longitudinally, you can see also this is the length of the crack along this. So now if, along this crack if the block is, will be pushed a little bit then see, if it is pushed then this is thrown away and the block is separated.

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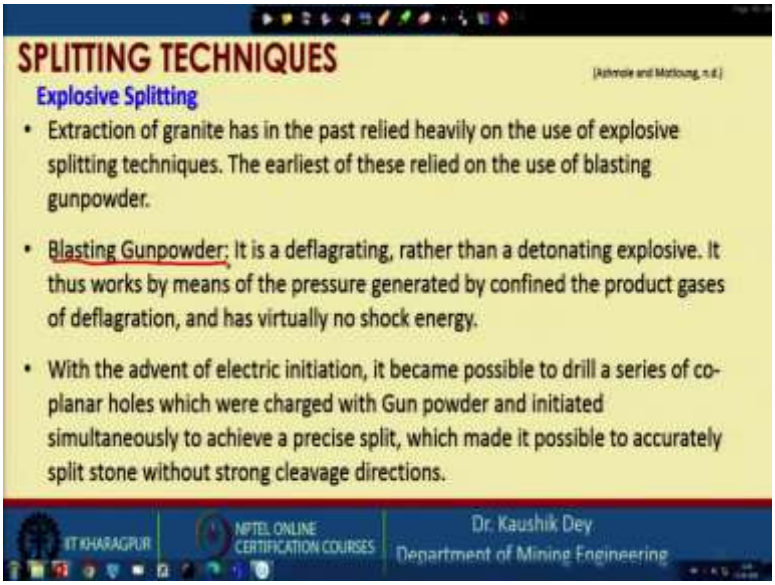

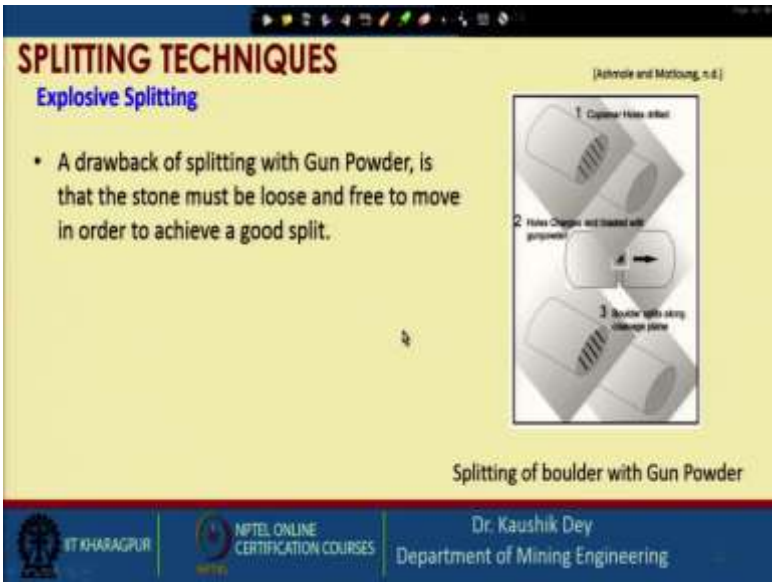

And sometimes we can use explosive splitting also. So, in the same hole we use a small quantity of gunpowder or we can use some detonating fuse small quantity of TNT, PETN, then also the cracks will be initiated in a similar way. So, that is also another technique in which the block can be separated.

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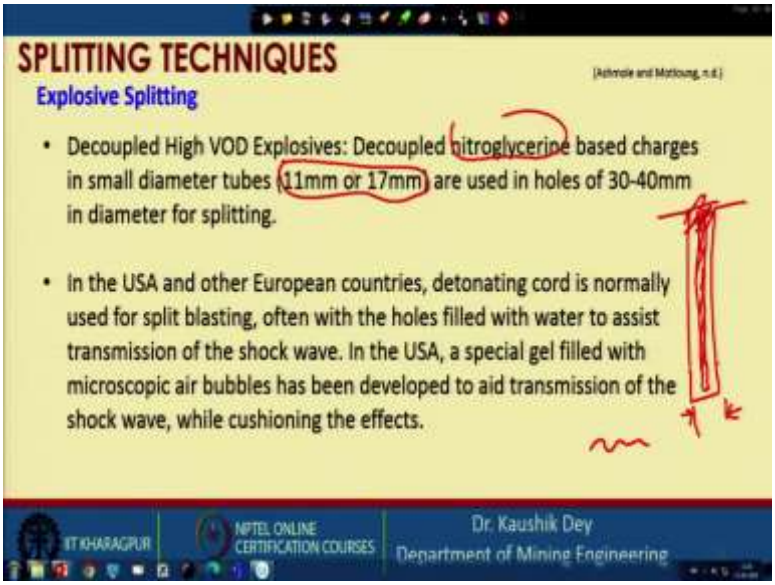

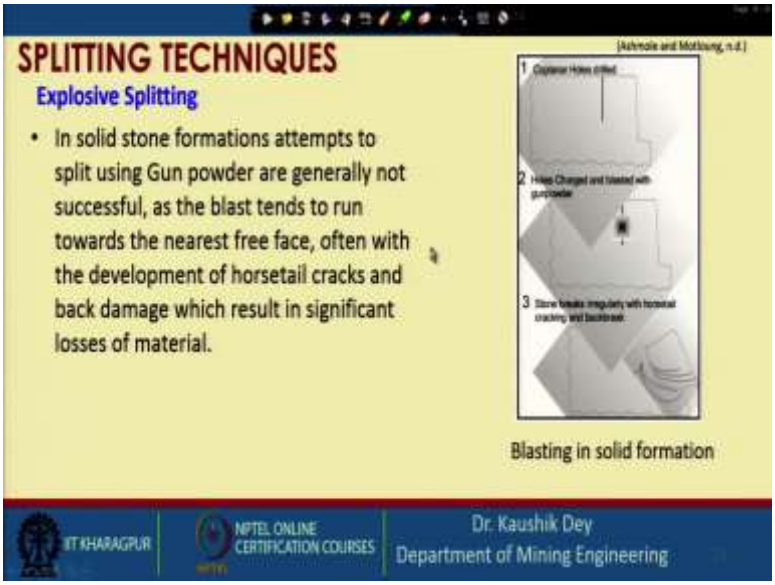

So, this is the gun powder, this is for the explosive mortar. You see small diameter holes are made, small diameter holes are made and blasted with nitroglycerine based explosive or TNT and often decoupled charge are also used. Decoupled charge means, where the charge diameter is much, much lesser than the hole diameter, so there is no direct contact of the explosive along with the wall rock.

So, the shock wave, significant portion of the shock wave cannot transfer to the wall rock but the gas pressure of the explosive is used for the splitting so that is the main objective of the decoupled charge. So, in that case, decoupled charges are often used where significant shock wave is not allowed to move into the rock mass.

So, the crack cannot be generated in this place. This is another use of the decoupled charge in explosives induced splitting. So, this is up to which we have covered the splitting part, we will go for cutting technology in the next class. Thank you!