Mining Machinery
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Module – 04
Lecture – 16
Site and Rock Preparation Equipment: Scraper

Welcome, back. We have been studying Mining Machinery for Site and Rock Preparation Equipment. We have discussed about dozers, we have discussed about rippers and we also discussed about different type of drills. Today, in this class I will be discussing about Scraper.

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Now, this site preparation purposes though it is used, but it is basically a scraping machine, which is used for removal of the top soil. So, here we will be introducing this particular machine how it is used in the surface mines.

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And after going through this lecture you will be able to learn about these machines you have seen this photographs over here. And then explain how the construction of such machines are there, and then what are the different types available and then how they will have to be selected for different surface mining operations that we will discuss.

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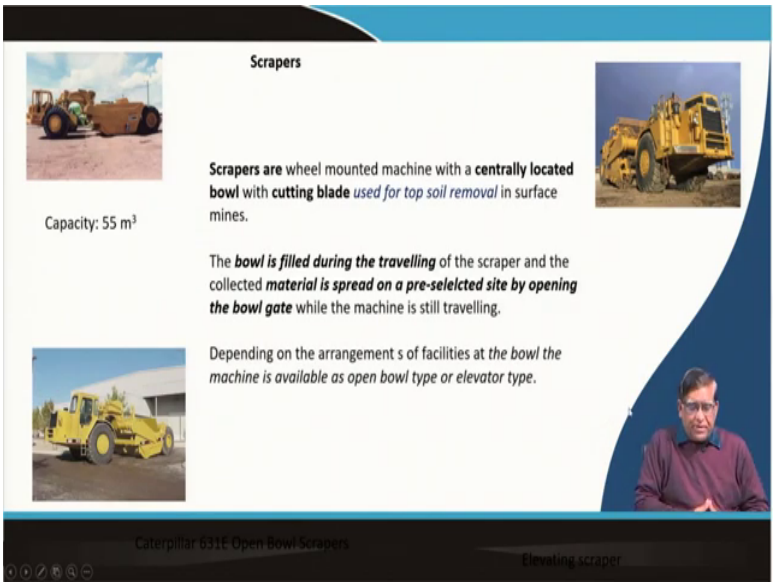

So, now what is a scraper? So, this scrapers are basically a wheel mounted machinery that is a it is a off highway wheels large diameter wheels, which are that is a wheel mounted machinery working in the mining field and it has got a centrally located bowl.

We can see here in this diagram, there is a that between these two set of wheels there is a bowl, which has got in front of it there is a cutting blade you can see here there is a cutting blade at the bottom. And, then when this machine is moving this cutting blade will be cutting this or stripping this material scraping the material and fill up this bowl.

And, then they are used for basically taking the top soil. So, you know that soil is a very, very important whenever you are going to do a surface mining, the soil pores part it is which has got the all that your vegetation supportive materials there. So, that need to be preserved and

that can be used after the mining operations are over that top soil is very very valuable material for re-vegetating that area. So, now for that purpose this machine is used.

Now, this bowl it is; it get filled when this move machine is moving, and then while it is travelling at that time it will get filled and then there is a gate here, so, by opening up that gate the material is spread. So, this machine is basically a scraping and spreading machine's and then, this machine for this particular purpose of scraping and spreading you can make different type of arrangements. And, you can add different type of facilities and with that we can get a different types of this machine.

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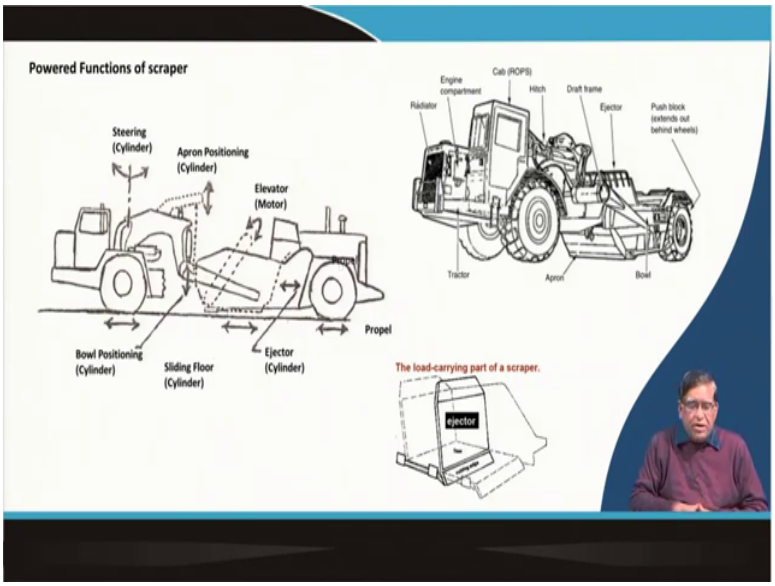

So, I think from this schematic diagram you can know that this machine what are the main powered functions in that machine in any machine whenever you study you need to know, that what are the powered motions powered functions are there. So, this is a we are having a

front part and the rear part and there we have got this there is an articulations that we are having a gooseneck type of system here, by which it is hinged at this. So, you can have a steering cylinder is here to give a steering or the direction change can be done.

And, then there is a hydraulic arrangement, so that this bowl can be positioned. So, whether it is going in a cutting position or for scraping purposes or it is for the spreading purposes. Now, there is an elevator inside; that means, the material which is cut over here it will be lifted through this and it is placed to the back so that this bucket is filled properly.

And, then there is a at the back of it suppose this is the bucket bowl inside the bowl there is an ejector so that this will be there at the back of it and when the material will have to be evacuated or spread, this ejector can slowly push the material it will be coming out of it. So, this is here a scraper that is with a elevator which is taking the material on then this with a the ejector will be moved.

So, there will be a reciprocating motion will be given and this other motion is that given to the wheel a propelling motion or travelling motion. So, we have got that motion for steering, we have got this apron positioning, we have got the elevator motions, you have got the ejector motion and then we have got this bowl positioning motions. So, these are the functions motion are there.

If you see the constructional component of this machine, from this diagram it could be clear, that front part which is a tractor part it has got the engine, radiator and all normally any automobiles part it is here. Then there is the hydraulic tank with that for the all hydraulic controls. We are having a operators cabin and then there is a hitch that with which the rear portion is getting connected over here.

And, for that a frame this cross beams frame is there. So, that when it is cutting it will be taking a tremendous cutting resistance will be coming, so that load should be properly distributed over there and there is an ejector and also sometime to scrap this machine if the

cutting force is not properly developed by the engine power there is at the back, it can be pushed by a dozer or by another scraper.

So, now you know that this is a machine, which is basically have got a centrally located bowl or apron in which there is a blade in front of this bowl and this apron can be opened and closed depending on that the material will be stored over here and it will be carried.

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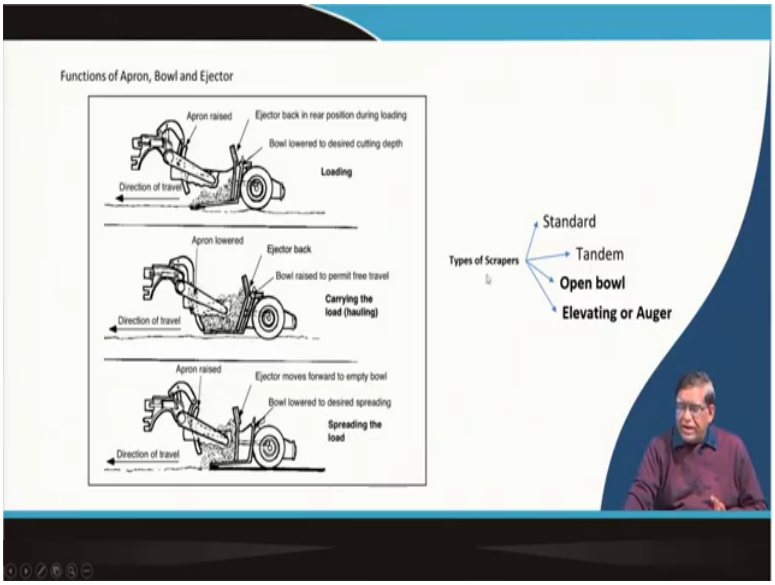

So, you can see that this how the functions are taken place over here. So, this apron which is exactly a gate for this for while this machine is moving in this direction, at that time your this blade is pushed you can see here, this is the level and here it has cut, so that level has gone down. So, this much when it is moving the material is going towards the back and it is getting filled.

Now, when this whole material will be filled over here, this apron will be lowered, so that now that is gate is closed and it will start travelling. So, that means, as a sequence of operation while cutting exactly the loading is taking place. So, for cutting and loading where from the force is generated exactly? It is that traction or travelling of the machine is allowing it to load and cut and load; after the bucket is load it is just travelling.

Now, when this material it is coming to the where it is to be spread this apron is raised, the gate is open and this as the machine will be travelling the material will be falling down. So, that is where how that the whole machine works. Now, this type of scraper depending on how you make it arrangement of filling this material, how you make this travelling and depending on that we have got four different types of scrapers.

They are standard scraper, tandem scraper, open bowl scraper and elevating auger. So, that is a elevating or auger type of scraper. So, here it is a open bowl that your bowl is open and then the material is getting filled. This is an open bowl scraper.

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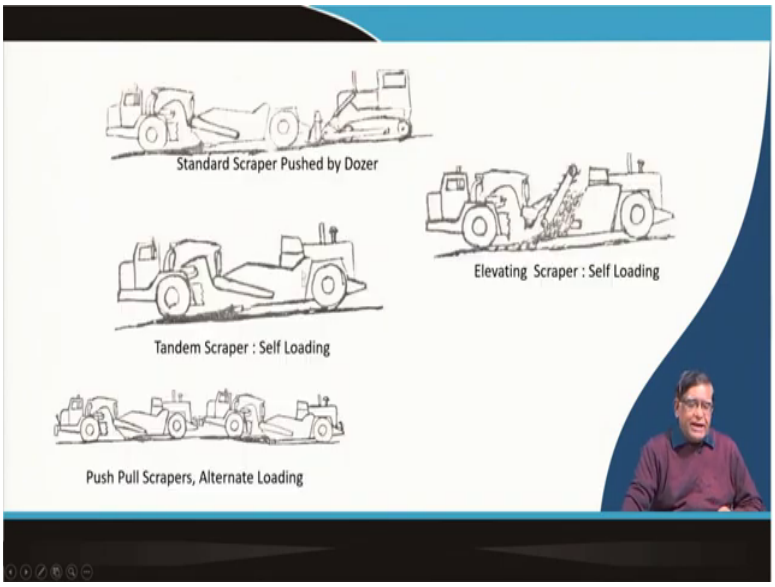

If you can see here in a standard scraper it can be pushed by a dozer. There is a dozer here and this dozer is pushing this material and then there is a tandem scraper means you have got one tractor engine here, one engine here at the back, so that the required power to cut, and load, and carry that is given by two.

Now, this type of scraper it can also handle in some of the gradient where the grade resistances are more, cutting resistances are more there only by one engine the work will not be possible. So, that is why there is a tandem. Then sometimes push pull scraper. Here exactly you can see the two scrapers are there; that is you have got this two scraper at a alternate loading, one can load another may not load over this is just only giving the pushing of it.

So, this is the way how tandem scrapers, that is two scrapers are used that both of them will not be cutting at a time. One will be cutting at that time other will be giving assistance to that. Now, as we are telling that here elevating scraper in which there is a just elevator here this elevator is nothing but just like a your scraper chain conveyor type.

Here a this elevator is having this your flight bars fitted to a chain conveyor type arrangements here, so that this material which is getting cut is getting lifted and put it to the back of it. So, now you know that constructionally there are four different type of scrapers.

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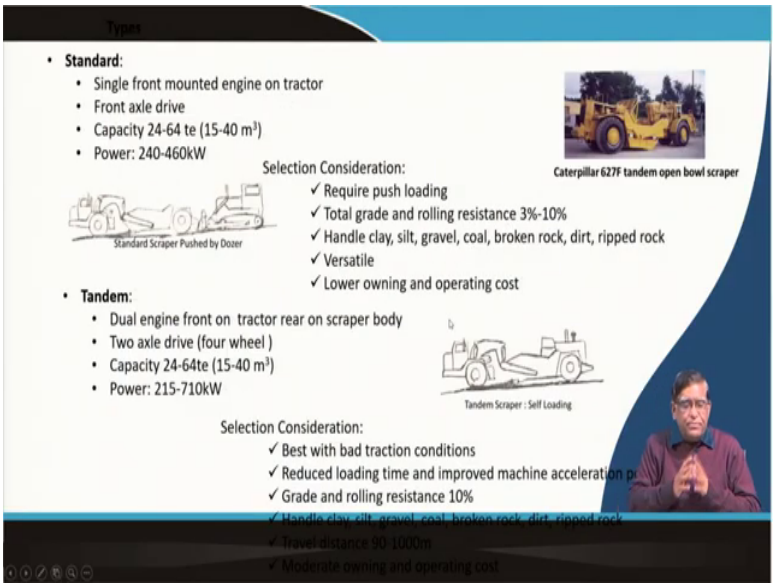

Now, if we see there in a standard scraper, the single front mounted engine on the tractor is there and drive is a front axle drive and its capacity goes to 15 to 40 meter cube is the bowl

capacity and for that the engine need to be of 240 to 460 kilowatt that is the range available in the market.

Now, where we will be selecting such type of tricks? Because this will be requiring a push loading if your cutting resistance is more because it is only with this power of 240 kilowatt it may not be able to cut. So, that is why a push dozer will be used. Now, as because it is power is less, you cannot go for a very high steep gradient it is not suggestable.

Then it can handle clay, silt, gravel, coal or broken rock, dirt, ripped rock. So, it can be used and it is a versatile machine and it is as because as small and there is a not much maintenance also will be required, it is a easily maintainable and that is why the operating and owning cost is also less.

Now, when it is a tandem; that means, where you will be having two engines definitely it is total power will be going up to 710 kilowatt and here also the size can be same thing. And, then there we are having two axle drives that front axle as well as the back axle, both that can be driven and here even if the conditions of the rock is not very good traction is not proper, there also it can work and where the rolling resistance is high, grade resistance is high they are also this tandem type of machines can work.

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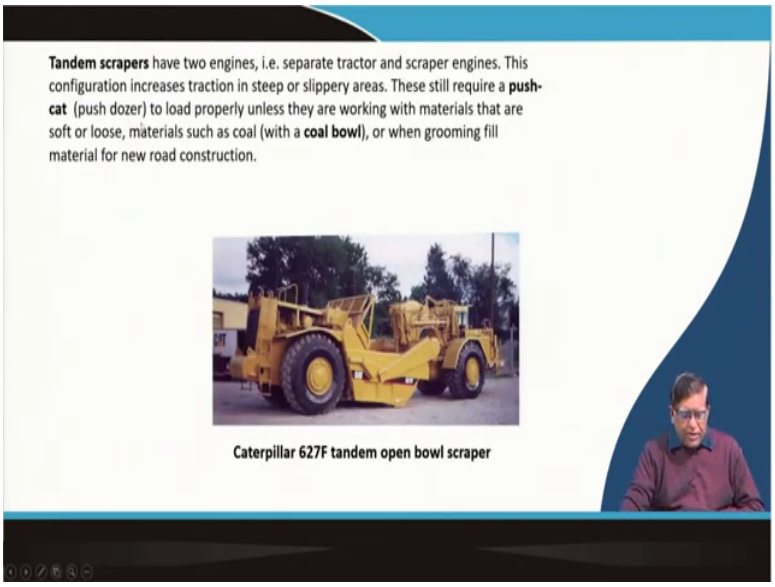

Now, you can see here a photograph of a Caterpillars, Caterpillar tandem you can see here is also the one engine, one engine here in the centrally that bowl is there. So, this type of machine can take this your top shell can be removed and put it over there.

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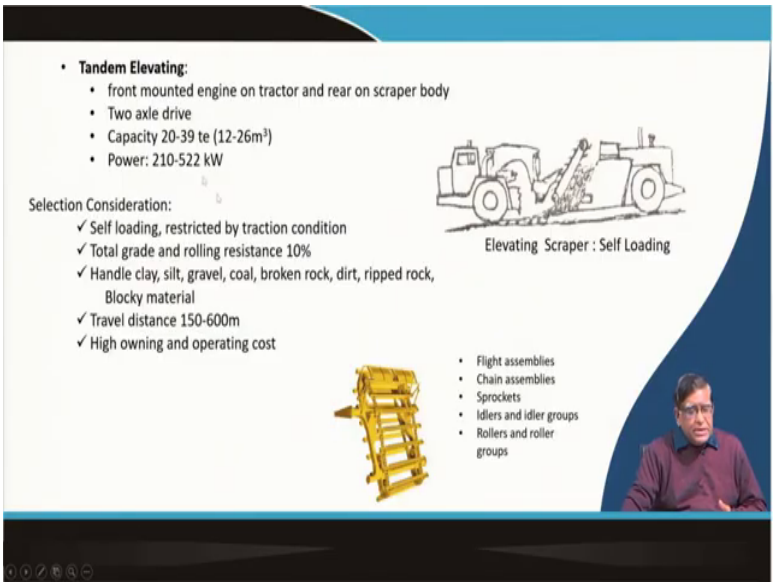

So, this in the elevating here also your a front mounted engine is there and here the capacity can go 12 to 26 meter cube is a small capacity, but it is a self loading. So, that is it is getting a properly loaded. So, bowl get properly filled and that is why the machines the productivity can be little more.

And, then it can go for travelling with load it can go up to 600 meter. So, you can remember at this by using this machine if you are to carry for a very long distance, it is not a very good hauling equipment. And that is why it should be properly the site should be seen.

Now, as I said that what is this elevator you can see here is a chain between two sprocket it is given a drive over here and between these two side chain you have got this flight bars. Now, these flight bars and this because of this bars when it will be rotating, it will be rotating in this directions. So, whatever the material is cut, here it will be getting raised and then at a, at this

point it will get thrown over here and the material gets placed in the back. So, that is a elevating scraper.

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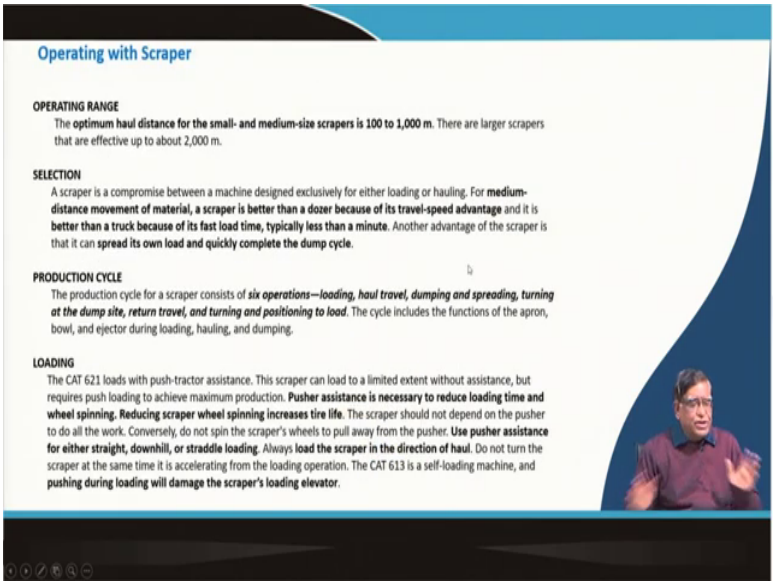

So, while you are to these machines now you have understood that, what is a scraper- scraper is having a bowl at the central at the bowl. There is a teeth for cutting the or blade for cutting the rock, there is an apron for holding the material and there is a hydraulic arrangements for raising and lowering of the apron, raising and lowering of the teeth and also for the articulations and sometimes you are having this elevator.

So, this machine how it will be operating? It can operating for the optimal haul distance for a small, it is can go even up to 1 kilometre it can do it, but depending on that how you design that particular that you are the drive system and then your suspension and all other

automobile features will have to be incorporated and you can have up to even 2 kilometre lid distance it can carry.

Now, a scraper is a compromise between machine designed exclusively for either loading or hauling. For medium distance movement of material, a scraper is better than a dozer because its travel-speed is more. If you think of a, a dozer is also cutting and then pushing the material to a distance. If you have seen that scraper ripper in a dozer what they do? That bulldozer the material is coming in front of the dozer blade and then that whole material is pushed.

Now, while material is getting pushed by the side of the blades the material may get spilled over and that is why wherever a dozer is working, you can see some wedge formations at the side, but this machine as the material is kept over here and then as it is a your wheel mounted it can run with a better speed.

Now, in a dozer if it is a crawler mounted the travelling speed is very less that is why if you take a very long distance the cycle time will be more as a result the productivity will be less. So, that is why you select a scraper in place of dozer for scraping and spreading of topsoil.

Now, there is a a dozer cannot very effectively spread the material. There also in a dozer when you doze the material you lift the blade and then the material will get spread. So, but here as because the material is there inside the bowl and that material you can push from the ejector and then you can control the opening of the apron in front of the bowl.

As a result whatever you want to make the spread the material a 2 inch thickness, 5 inch thickness that can be done in a better way. And, this a production cycle that is exactly that what is a, this machine you can say also that a scraper is a cyclic machine, the operation is in cycle; number of different small unit activity it is repeated.

So, that first thing is you can say it is just cutting that travelling, then spreading, then empty coming back, again cutting. So, this is as a cyclic as a cycle operation is there. Now, while

doing the cyclic operations the activities are loading, haul travel, dumping and spreading and then turning at the dump site, and return travel, and turning and positioning to the load.

So, this is important when you will be deploying this machine in a mine there you need to know this productivity calculation. The productivity will be depending on what? Total cycle time and in that cycle time, which operation is taking how much time you can note it down, you can calculate and then you can make your deployment strategy better.

Now, that loading as you say that loading will be basically by how it is getting cut. So, to if the; if it is a consolidated soil, the soil is hard then there will be difficult cutting. So, you will have to give a that is your push from another dozer and then sometimes you will have to use the tandem engine, so that loading it will be depending on the soil properties you will have to select whether it will be a standard scraper or a tandem scraper or with a dozer pushing things will be there.

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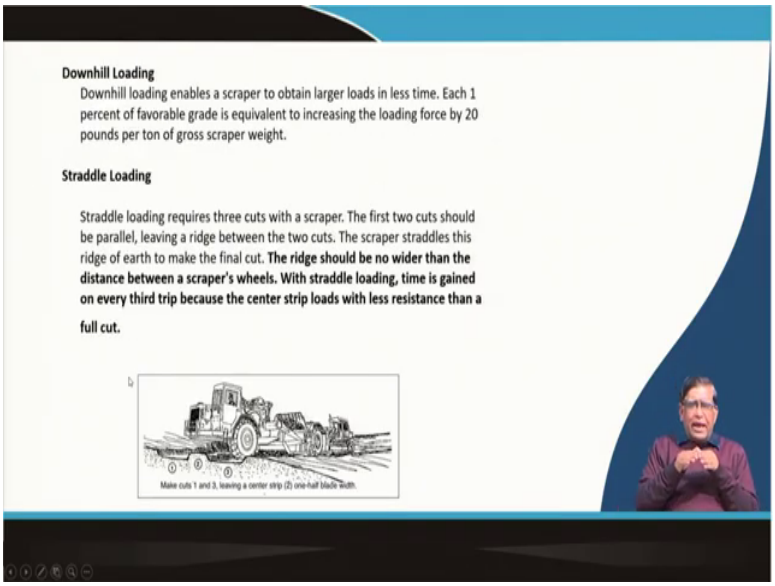

So, it is it can also while you can spread it in downhill, it can cut also downhill depending on the site situations you can find you can determine that is exactly, but a 1 percent gradient is considered as a favourable gradient. If you put it over there it is exactly get a better cutting and better hauling things.

Then, you can have a straddle loading where exactly in a straddle loading your three cuts with the scraper. Exactly this you can see that is a first cut, then it will be a second cut and third cut this part is given over here. So, this is a; the scraper the ridge are kept and then it is cutting. The ridge should be no wider than the distance between the scraper wheels. So, that in that case, it will be able to push and cut it over there by taking the material in this particular way exactly the efficiency of cutting is improved.

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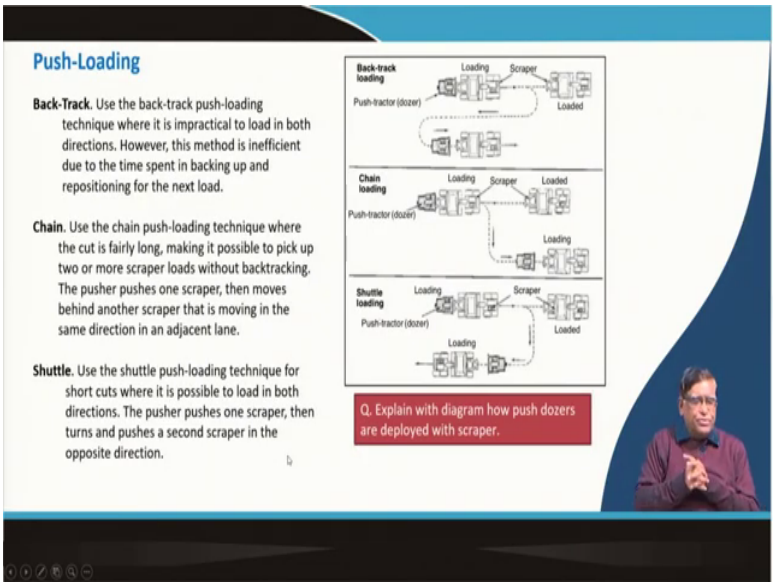

So, now when you are doing it is a push loading you can give that as a back track loading. Now, you can see in this diagram a dozer is here to push the scraper and then it gets loaded and then it just coming and that getting spreading.

So, in a chain loading that is your chain push loading techniques where the cut is fairly long making it possible to pick up two or more scrapers will load. You can see this is a chain loading they same there are these two scrapers are here and then, it is pushed by this dozer and then they are cutting it over there.

And, in the shuttle push loading technique shortcuts where this is possible to load in both directions. So, that is in a shuttle loading your both the directional loading is given. So, this is exactly you study in detail when we do a scraper mining in the surface mining paper we discuss about this. But, as a machine you must know now that these machines these components are manufactured by different companies.

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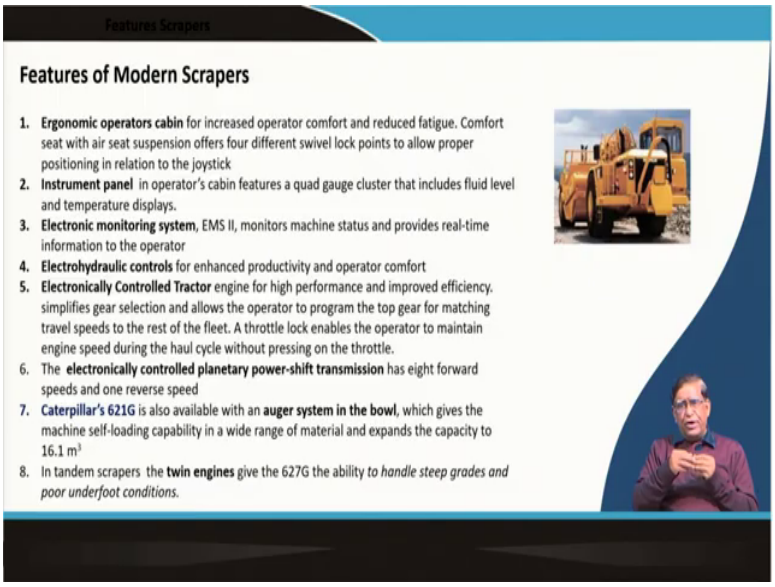

Say as we have said that Caterpillar, even the Hyundai and many other companies they are manufacturing this scrapers they put some very good important modern features. 1'st is that your operator cabin it is ergonomically designed. Now, what is ergonomically designed means for the best comfort of the operator, so that the operator is not having any fatigue or he just or else he is 8 hours operations he will be remaining as fresh as he is.

And, then there will be a lot of instrumentation panels are nowadays available because they use electronic monitoring system. That electronic monitoring system it monitors the condition of the machines and then there all these your hydraulic control are electro-hydraulic control. These are all are exactly the development of mechatronics, where there will be a sensors electronically they will be sensed and according to their, the condition the operating parameters are finalized.

And, the operators need to just take actions whether by seeing the enunciation if something is getting over hot or that is your resistance is increasing, he will be controlling the things over there. So, similarly there is a power shift transmissions which say that travelling it can give eight forward gears and one reverse gear it can be that possible.

So, similarly this bowl it can be filled with a auger type by a screw type of material will be pushed upwards or at the same time there could be the twin engines type of scraper. So, these are the features of some of the modern dozers, modern scrapers.

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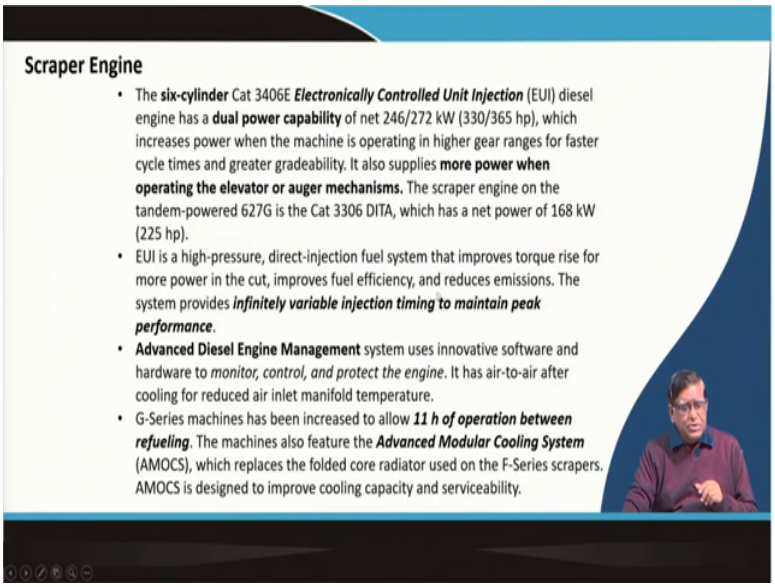

And, then the engine it is very very important there because you can see that the it is main power as to get a 250 kilowatt or maybe up to going say 710 kilowatt type of a very big

powerful engines. It go; it can go six or more cylinder engines can be used and then you will find that this type of engines are all turbocharged engines.

You have studied in your regarding the study of our prime movers that is your the that how you will be having the exhaust exactly such machines when it is working in the mines if you are not taking care of the standards then you will be ending up with a lot of pollution. Because the diesel exhaust which will be coming from such a big machines should be a proper.

That is why like in India this will have to have the Bharat IV standards that is exactly how many how many gram of that your the pollutants will be emitted that is stipulated. So, nowadays whenever you are using it you will have to see that this engine is following either Euro IV or US that III stage III that standards will have to be maintained.

So, now, that they are having this electronically controlled unit that fuel injection systems which is exactly very very efficient systems your depending on the load coming over there they will automatically find out that how much power will be required and accordingly you can achieve a good energy economy.

Now, that is what exactly all these modern particularly this caterpillar engine sections they have done lot of research you can find it out that how that advanced diesel management systems have been introduced. So, and this machine is a will have to carry a lot of fuel. So, that is why the fuel tank is also designed specially and it in it can hold that fuel for up to 11 hours of the full scale operations can be carried out over here.

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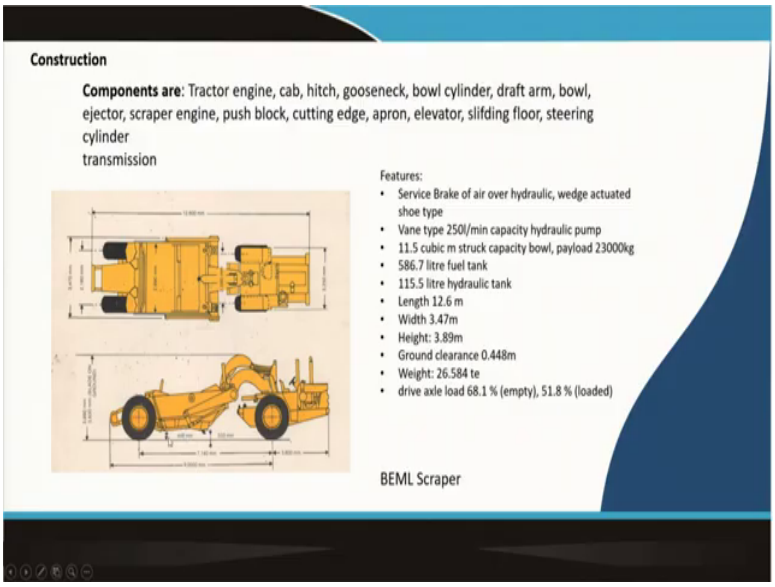

Now, in India the scraper is manufactured by Bharat Earth Movers Limited and here is a just you can see that a Bharat Earth Movers Limited, Indian made be that scraper here the components are as you can see the tractor engine is there, then this you have got the operators cabin over here and then you have got the hitch, gooseneck, your bowl cylinder, draft arm, bowl, ejector, scraper engine, push block, cutting edge, apron, elevator, sliding floor, steering cylinder. As we have discussed earlier all these are there.

You can see the dimensionally this machine is about 12.6 meter long machines out of which you are having this about that is 7 and 7.1 meter is the access to axle to axle distance of this machine. This portion is called a gooseneck, which is again having a hitch point over here. So, that the articulation is there. Because of this articulation it can have a very good manoeuvring in a small space.

So, the features are the overall height of this machine is 3.9 meter and then the ground clearance below this is your about 4.4 that is a 0.5 meter of ground clearance is there and this can be that your the bowl can be lowered below this about 5 on a 0.53 meter can lower it down. So, it can give a strip, thin strip of cutting is possible. So, what you will have to do is such type of machines you study the manuals of this machines and find out how it works.

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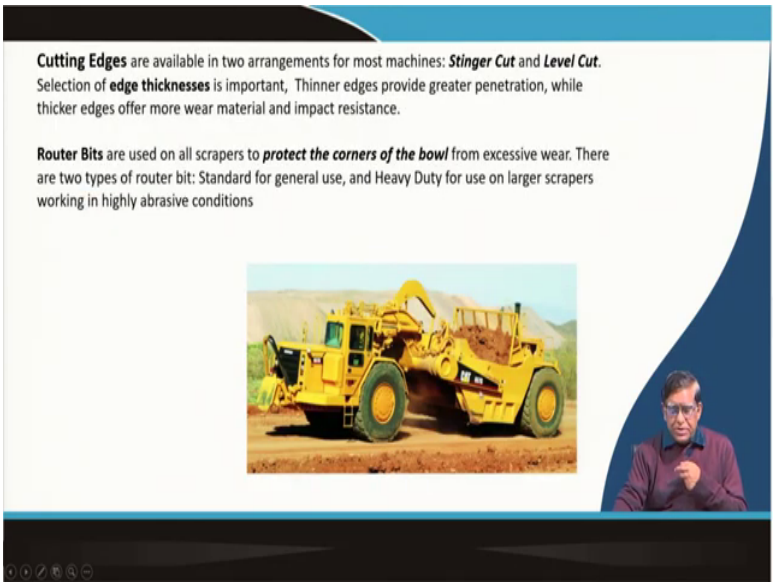

So, this is the cutting edge which is there you can see how the material get loaded over here and there is a guard by which the material should not get spilled.

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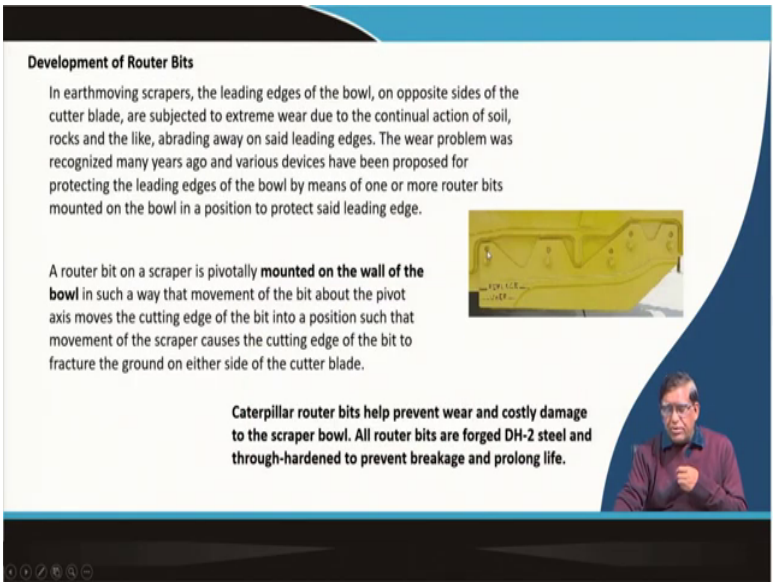

Now, there is another things that router bit because what happens here the blade this edges will get worn out. So, that is why to protect that there is a router bit over there that you can see at the in front of the cutting blade an another bit is being from the side walls fixed.

You can see here there is a holes are here. So, that if this get worn out then your this nut and bolts will be removed and it can put over here, so that it can lower down. So, this type of router bits it exactly save the or it increases the life of the corners of this blades and that bowl.

So, that if the bowl get damaged then the whole bowl will have to be replaced, but by using this router blade your damage will be only here and you can reuse it for so long time. So, you can increase the life of the bowl and also you reduce the time of that is your bowl taking out and maintenance becomes easier.

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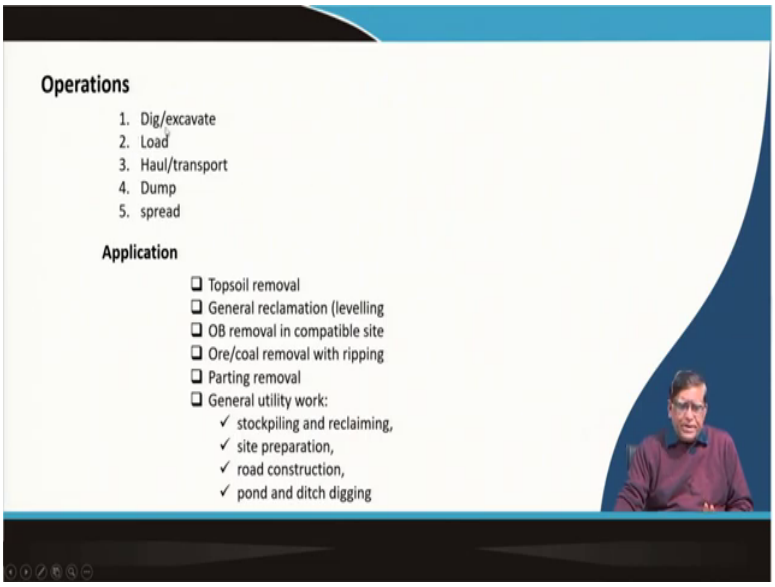

So, they as I have said already the operations are digging, loading, hauling, dumping and spreading. Its main application area is topsoil removal, general reclamation, over burden removal in compatible sites, then it can be also parting removal can be done.

So, in many general utility work also it can be used particularly in stockpiling and reclaiming, sometimes in site preparation also it can be used, it if sometimes having a scarcity you are not having a dozer, sometimes this machines can use for the road construction also. And, then in a other if you want to create a pond that is a material to be removed and loaded you can yes very nicely you can design the working phase and you can do it.

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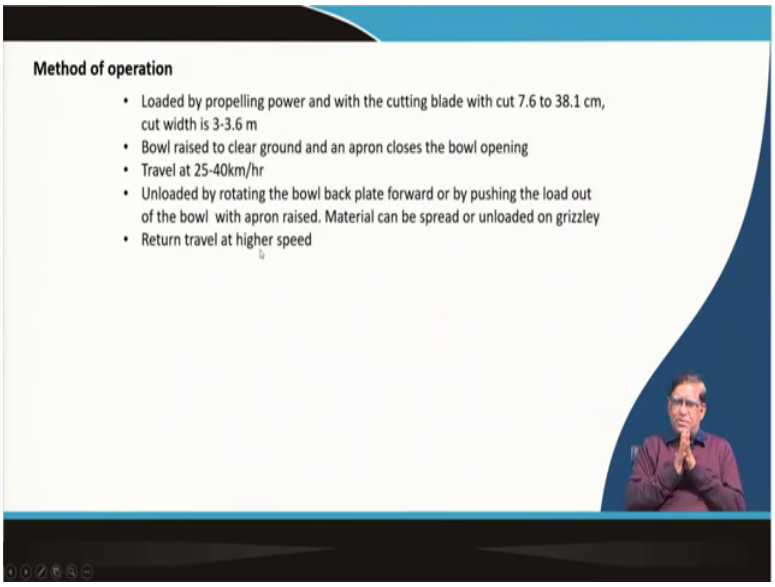

So, as a method of operation: loaded by propelling power propelling means the travelling power and with the cutting blade cut about 7.6 to 38.1 centimetre deep cut can be given with a 3 to 3.6 meter width that cut can be given. And, is a bowl is raised for the grounds and then apron closes and that it opens.

Now, while travelling it can travel at a 25 to 40 kilometre per hour so, this unloaded unloading it is done by that you are rotating the bowl back plate forward or pushing by that ejector is pushed and the bowl that your apron is removed and the material is spread.

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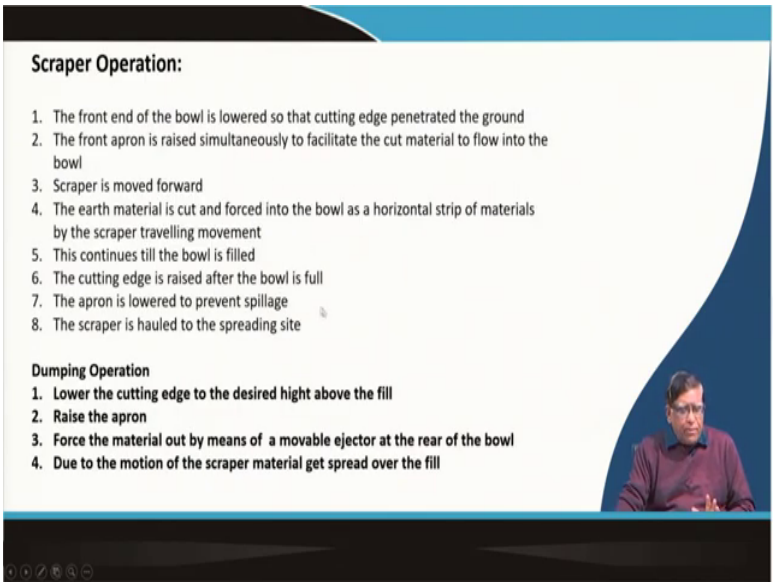

So, this operations I have already said that sequence wise you can write it down and the dumping operations how it is done you can note it down and write it in a systematic manner so that you know about this machine.

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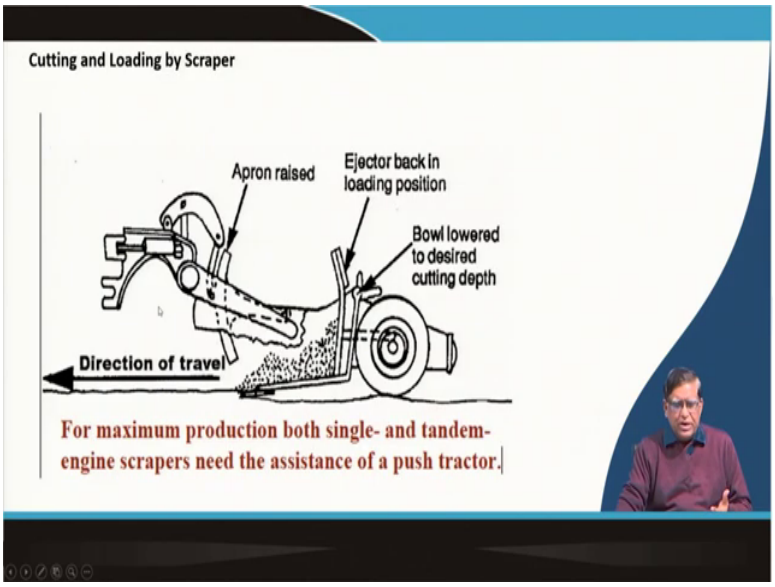

So, we have all said this once cutting and loading by scraper as I explained before you can know from this.

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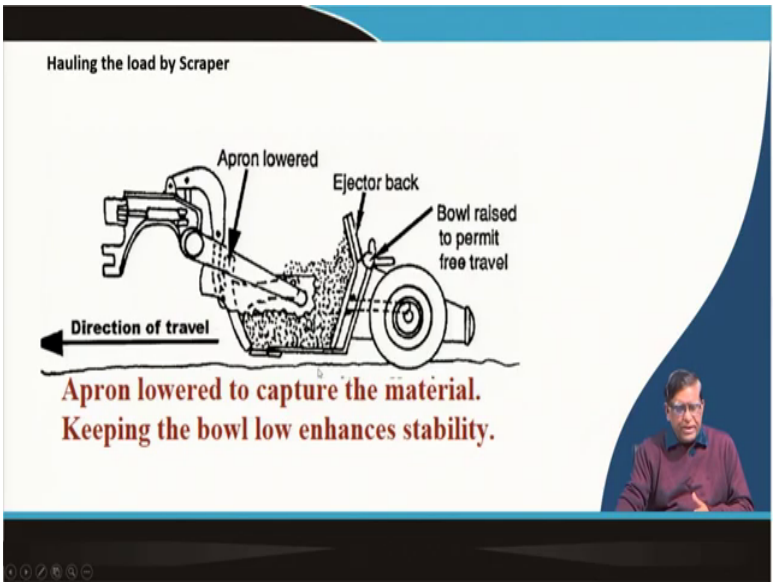

You know about now hauling and load by the scraper; it is exactly when you are moving.

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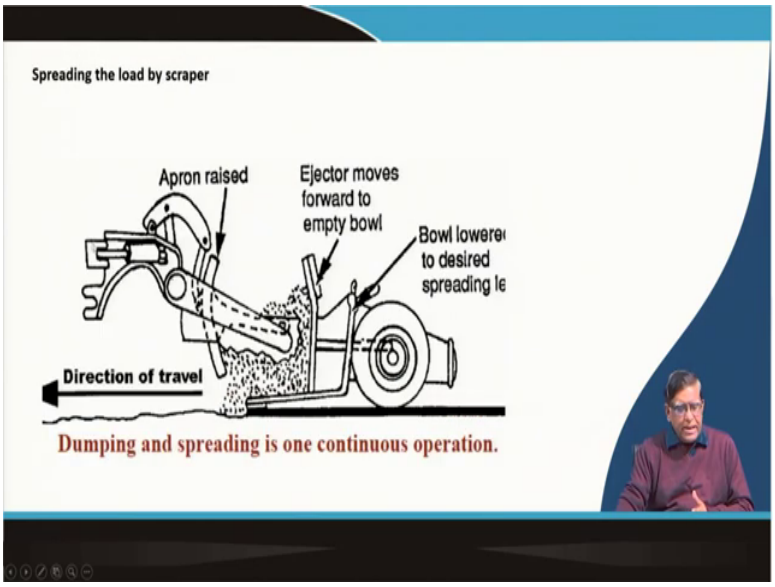

And, then you can know how it is exactly removed. So, these three operations are very very important.

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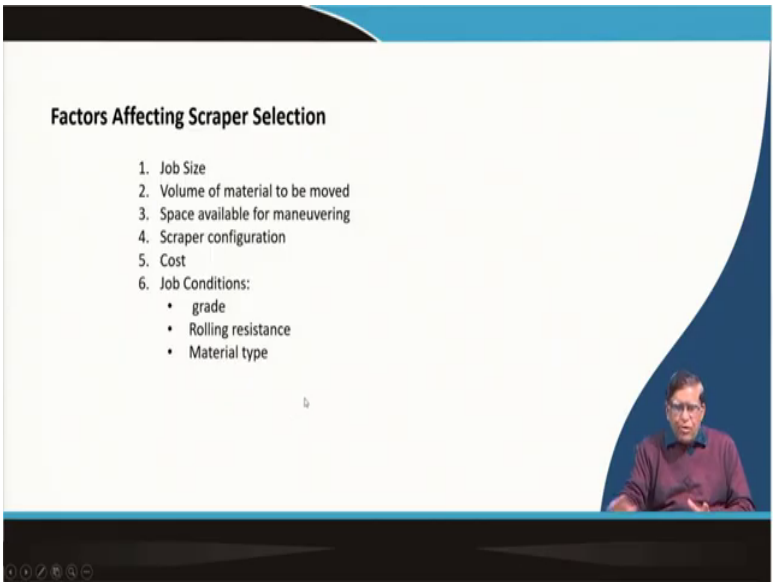

Now, how it will be it is how you will have to select for a job? By the job size, volume of the material, space available or not scraper is a that can work over there or not and how much money it will be costing for doing that all these parameters are to be found out. And, on the basis of that you can select that machine, but the job conditions mainly the grid whether it is downward or it is upward you are scraping or what is the rolling resistance and what type of material that is very very important.

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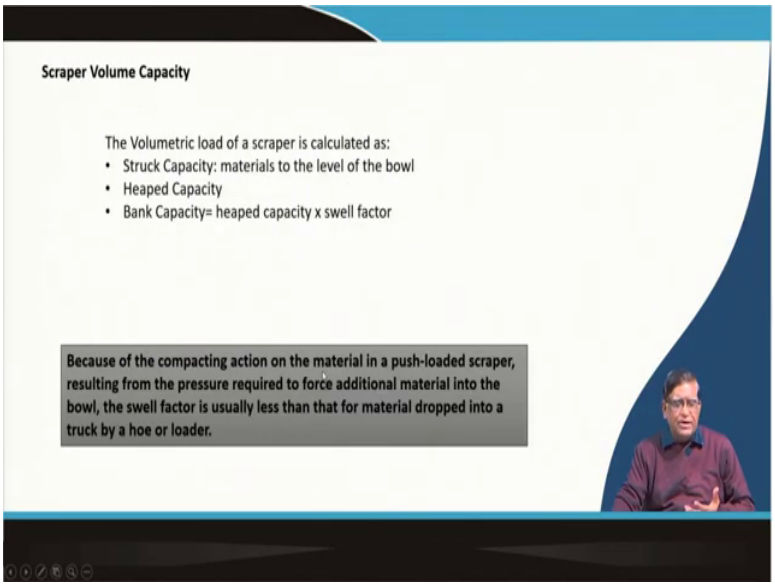

And, the volumetric load on the scraper it is calculated as a struck capacity. Struck capacity means, when you take a water in a glass, then it is just up to here that is just struck capacity, but on a glass if you put rice there will be a heap capacity. Some material can depending on the angle of repose it can be kept over there.

So, this and the bank capacity means your heap capacity into swell factor. You can see that when it is scrap say for example, you have gun 5 meter of length with a say 0.5 meter of thick, but this 5 meter 0.5 meter and if it is a 3 meter width that whatever the rectangular block you have cut, their volume will be much less, than the volume which will be coming into the bowl because after getting cut and fragmented the material swell that is called your swell factor.

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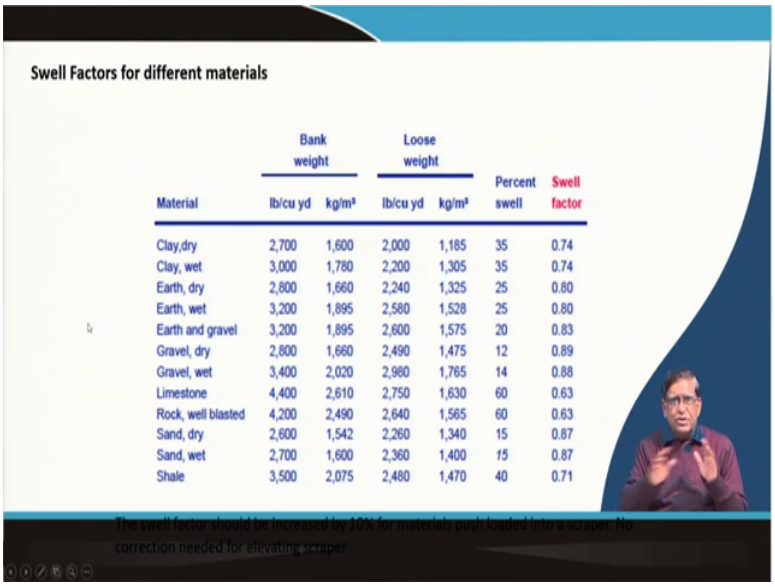

So, these are the things, which is to be taken into consideration while taking up and using a scraper. So, you can find out how exactly which type of material get how much swell- depending on that you can decide that what should be the size of the bowl.

If a material which is exactly swelling much more, then the volume of the bowl should be more for a particular design. So, how will be designing your phase for cutting by scraper and then how exactly this machine will be selected for a particular zone you will have to know this information.

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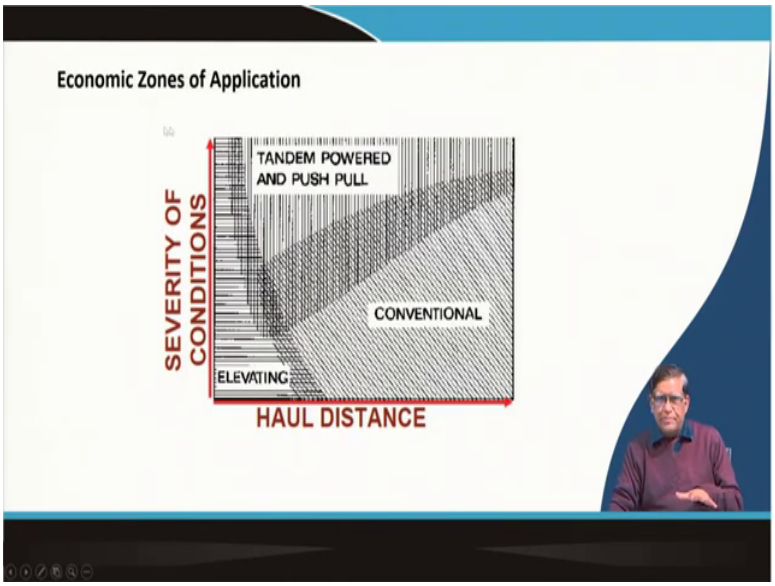

But, as a if your the severity of the site condition is very high, there your tandem and powered push pull those type of scraper will have to be used. If your haul distance is very long in there you cannot make in a very severe conditions and the severity is less and there your conventional scraper can be used.

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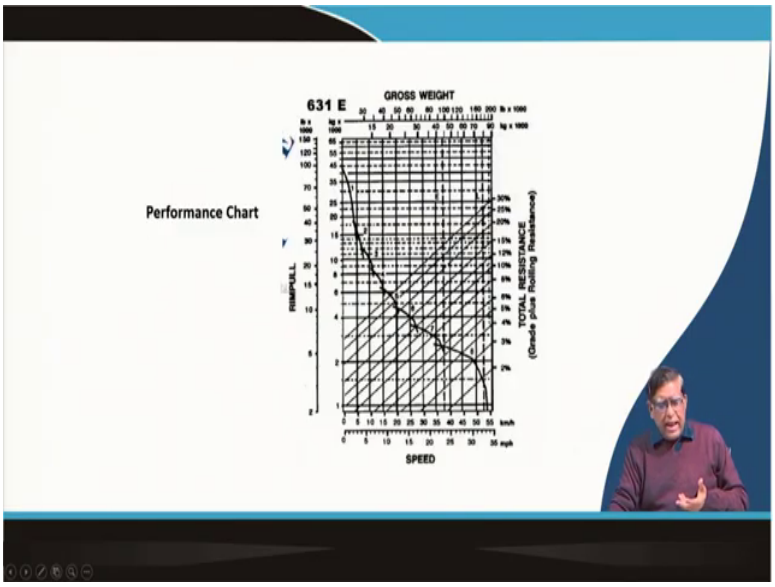

So, like this type of study you can make it depending on a particular sites. Now, the performance is you will have to select that at a different speed if it is running that you are having a 25 kilometre per hour, if the total resistance is getting your 10 percent resistance, you can see here with a 10 percent resistance your machine will be working at say gear number 6 and at that time it will be giving your that rim pull you will be getting 4 kilometre per hour.

So, like that how much and which gear you must operate that can be learned from the performance chart which comes along with the machine. So, you should start understanding such type of chart to rate and that manufacturer catalogue they gives this chart from there you can find out at which gear you must run under a particular conditions.

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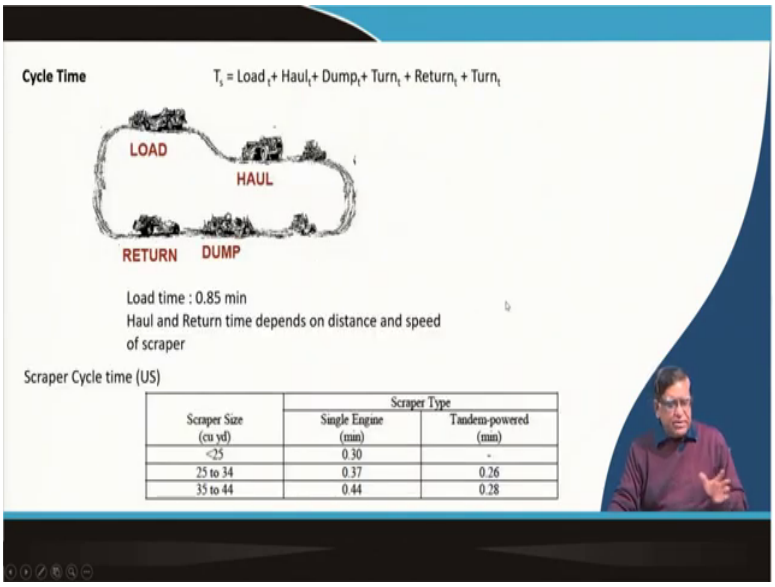

Scraper Size (cu yd)	Scraper Type	
	Single Engine (min)	Tandem-powered (min)
<25	0.30	-
25 to 34	0.37	0.26
35 to 44	0.44	0.28

So, this is how things are done, and the total cycle time as I said that is different operations there all the time if you note it down, then you can find out what is the loading time and that is required to calculate the productivity of it.

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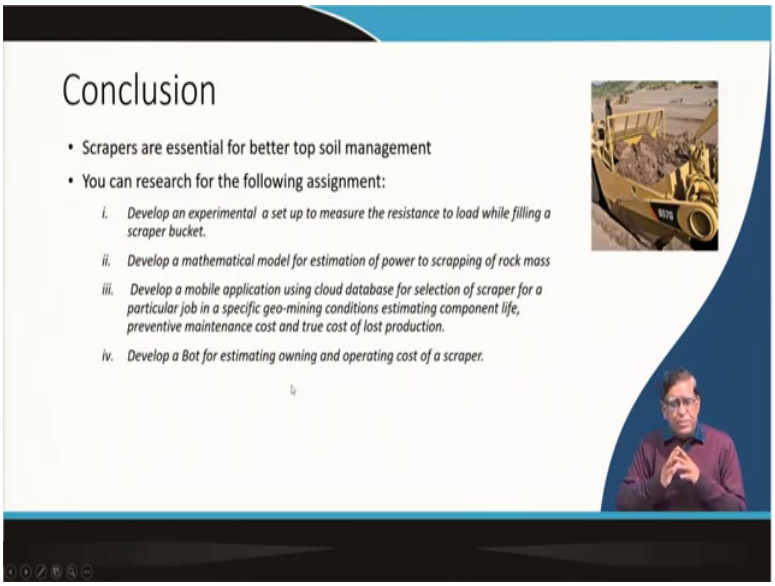

So, you have understood that this machine is a you now know what is the construction and operation of this machines, and you know also how to select this machines. So, you can do some research like that, develop an experimental setup to measure the resistance to load while filling a scraper bucket; how exactly cutting and putting it that need to be researched and you can do it. You can do a mathematical model, you can do a physical model.

Develop a mathematical model for estimation of power of scraping of rock mass: how much power will be required for doing it, how much diesel will be necessary. So, that type of energy calculation of this machines that also you can take up as a small research project. Then develop a mobile application using cloud database for selection of a scraper for a particular job in a specific geo-mining conditions estimating component life, preventive maintenance cost and true cost of lost productions.

You can do a little bit more deeper investigations in the field and do this. Or you can develop a chat Bot like your this Google, Google assistant for estimating and owning and operating

cost of a scraper. So, that means, if you are using it you can ask the Bot and it will give you the answer.

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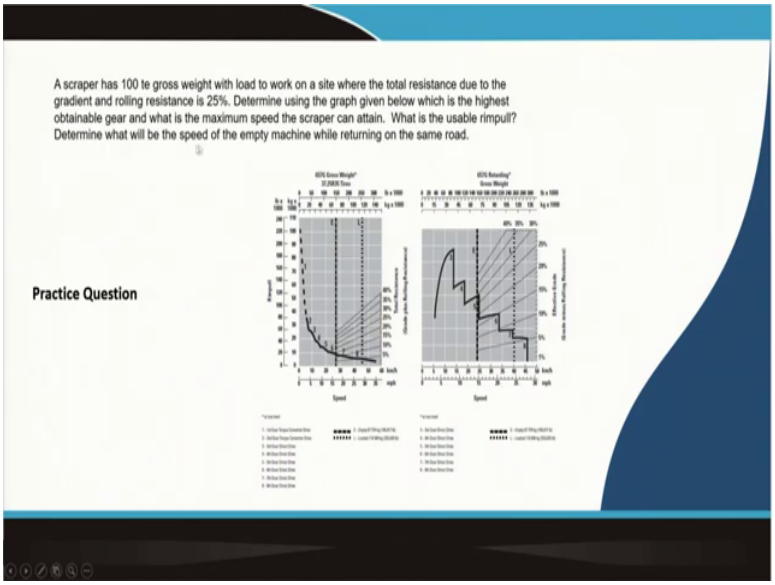

So, how will you keep the database and then how you will be putting it over there that type of applications also you can make or there is one practice questions is given over here. Please try.

A scraper has 100 ton gross weight with a load of work on a site where the total resistance due to the gradient and rolling resistances are given. Now, using this graph you find out what will be the usable rim pull and determine what will be the speed and the empty machine while returning to the same road. So, this type of problems you should solve.

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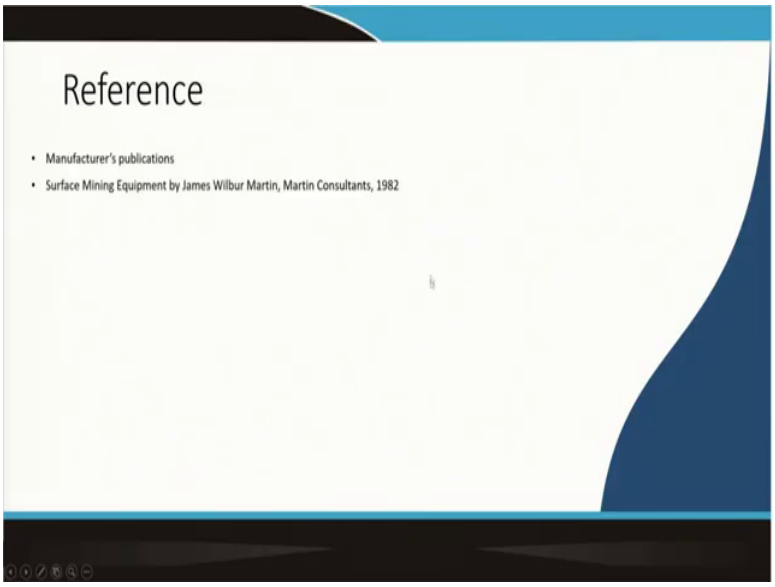

And, then you can see that different books are there and in the net also you can find lot of information's, and only thing is that you will have to make your plan, the learn about this machines.

Thank you very much.