**Bulk Material Transport and Handling Systems**
**Prof. Khanindra Pathak**
**Department of Mining Engineering**
**Indian Institute of Technology, Kharagpur**

**Lecture - 38**
**Crusher Selection and Application**

So, in our last class we discussed about the or we introduced the in pit crushing conveying system. And you now know that, what are the main components, what are their advantages and disadvantages and you know that what are the different type of systems available. Now today we will be discussing about that cluster selection and application.

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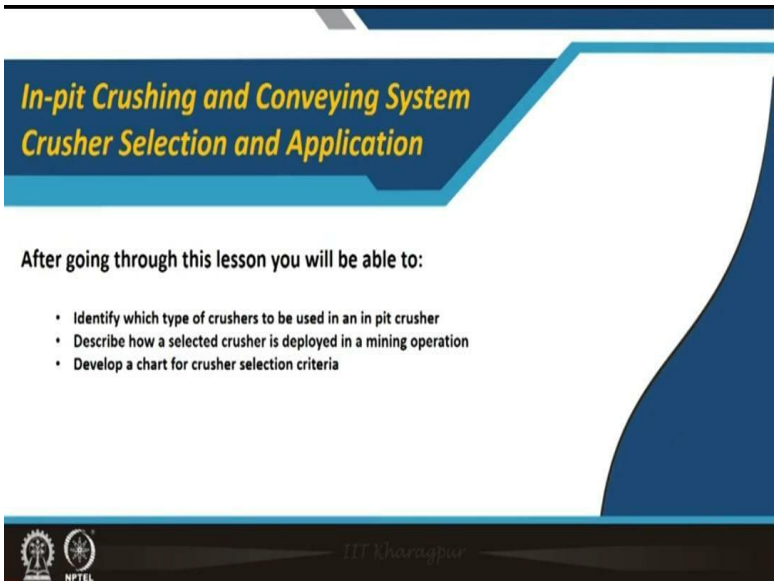


Let us look into that crusher selection and application is mainly that what type of crusher you will be using in the in-pit crusher. And then application is how you will be deploying this system in a mine. So, after this class you should be able to identify which type of pressures to be used in an in-pit crusher and then, how a selected crusher is deployed in a mining operation. And at the end I hope that you will be able to take up some activity.

So, that you can develop a chart for cluster selection criteria. And if you are interested you can make a small program to give as a guidance to selection of pressures. So, that means if you want to do some digital exercise on it, that whole knowledge which are available on the selection criteria of crushers can be brought into and make it to the mine manager digitally available by in

the form of app or in a form of a small software you can do it. That is to you if you are interested.

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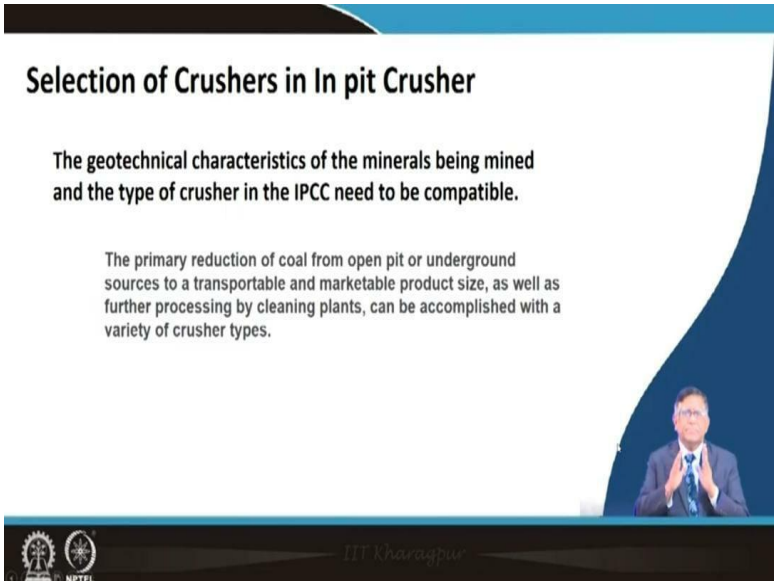


Now selection of crushers in an in-pit crusher. Now as you know that the crusher job is to break the rock that is a plastic rock. Now this rock in which you encounter in a mining are never homogeneous. So, what is there, it is often very difficult to say that the what characteristics will be coming. But however, by the study of the that is your strata that is under by doing a lot of surveying it is determined exactly what type of materials are available.

Even if it is a mixed, we know that our, okay compressive strength may change from this value to that value may if it is a coal, it may be even a 40 mega pascal or it sometimes may be 80 mega pascals so, that means a wide changes are there. Then, another thing is there, the rock mass they may have a different type of abrasivity. It can abrade the, that is your casting teeth and then the rolls whatever is there the metal may get worn out.

Then, it has got also sometimes the in-situ rock masks, they may be associated with some of the clay and other sticky material. Now that means if you are using a in the crusher a conveyor belt that conveyor belt with that sticky material how it will be there. So, when you select the crusher, we will be looking into first that whether that crusher strength it is adequate. There are two situations may arise.

One is you are selecting a crusher which exactly a very heavy you are using a lot of energy but your material is very soft or the other way you are taking a crusher which is very small it cannot break it will go on repeating doing the, to break one rock at that time next lot of material to be crushed is poured in. As a result, your the crusher from the crusher as because it has not been able to crush the material is not flowing out so there is a situation of choking arises.

So, whether you are using your crusher in an underground mine also you can have a in-pit crusher inside the in-pit a crusher may be there or in a surface mining you are having an in-pit crusher with that there. Wherever if you are not selecting the right type of crusher and right type of your feeding and evacuating system you may choke the crusher and you may end up in having lot of operational trouble.

And then that you wanted to do a better production but, you will be getting exactly and for that a case study was naval ignite corporation at one stage and I think in 1984, they 1980 to 83 they purchased a in-pit crusher for its overburden. Now that overburden blasting always used to be big lump and they thought that they will be putting it to a crusher and the crusher was purchased from Germany it was brought then installed and when it is kept over there.

The overburden there had a lot of clay and sticky nature and then they were unable to put it because, whenever they want to send it through the crusher that often get choked and then your material is not going out. The whole operational schedule it goes going down and their productivity is going down and ultimately that whole investment they made they kept it exactly not use it directly loading into the conveyor and they were getting the better services.

And ultimately, they sold it out most probably that crusher was sold to western coal field limited but afterwards I do not know what happened to it. But this is a learning lesson that whenever you select a crusher geo mining conditions and the things need to be very carefully considered.

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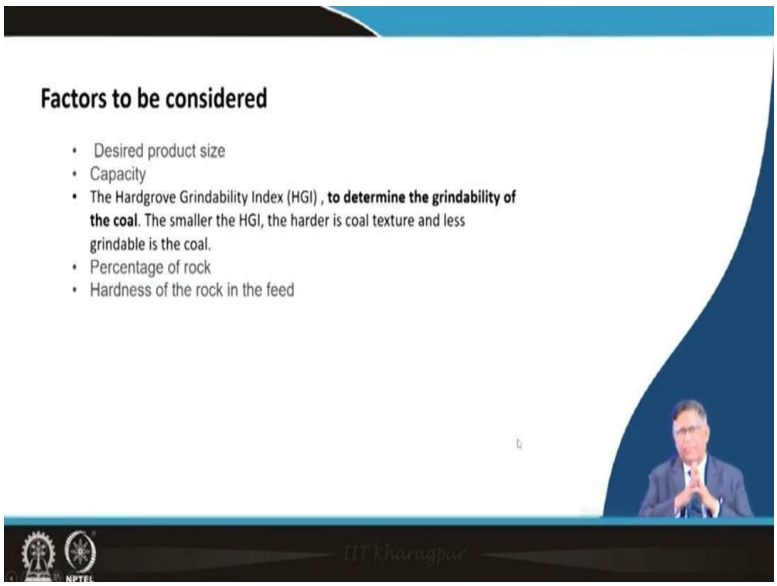


So, this desired product size that is the most important thing while thinking of a crusher and then, the capacity. That is how much ton or how much meter cube per hour will be your feeding rate that is the way that will decide what type of pressure you will be taking. Then also the grindability index that is also very important because when you do the crushing if more fines get generated, say for coal if you are doing and then your while the crushing system itself produce a lot of fines.

Then in the washing it will go into the tailings and lot of carbon may get reduced. So, that is why you will be a loser and the grindability test is always important. And this hard growth grindability index is a system you can study that, that is your if how much exactly the fines get generated. So, that means it will be have, it is depending on what is the petrographic structures and that what is the texture of that coal that is where there.

Now if that your grindability index is low that means it is having a severity of that. So, depending on this grindability index you can find out that is what type of crushers that means what is the hardness of that rock will be there, what type of crusher will be selected. Then, how much percent of rock is there, that is, the hard material how much it is coming that is another thing. And the even if the other that along with the coal, non-coal material may come, their hardness is different.

So, in a if you are using in a coal mine you will have to see that how much that other sandstone or shell may come along with it. And that sandstone and shell which is there just at the top of the seam or the bottom of the seam their hardness because otherwise what may happen the crusher may get damaged due to more hardness there because coal may be softer. So, these are the issues to be considered.

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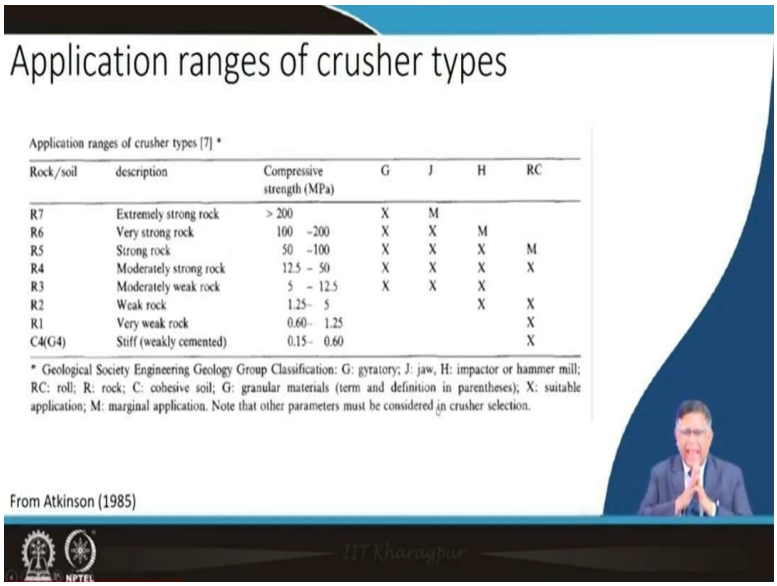


And in a hard rock mining there they use different type of rocks, say depending on the compressive strength whether it is more than 200 mega pascal then in the in-pit crusher they will have to use gyratory cursor or jaw crushers. Now, here if you use it say is a marginal application M is your marginal applications and wherever this X is suitable. So, if you are very strong rock there you can find gyratory crusher.

You can find out here the gyratory crusher is suitable for all type of things. Only thing is, there you can control the gyration that your at how, at what speed it will be moving and then what will be the gap and then control arrangements can be made. And it can give from a very weak rock moderately weak rock to hard rock you can use gyratory crusher. But if it is a weak rock hardness is a compressive strength is just only 1.25, that is a very soft rocks.

Then, you need not go for those crushers. You can use only a impactor or a hammer mill that is you have discussed in our the (()) (10:37) section. We discussed about it that the hammer mill is

there. But for more weaker one you can use a roll crusher just the roll crushers also can be assessed only to rolls. But if a little bit of medium that is your moderately weak or that you are having a moderately strong there also you can use a roll crusher but they could be having some titter rock.

So, this type of chart you should study and then you have an idea about how the different type of crushers you have seen and how they can be used.

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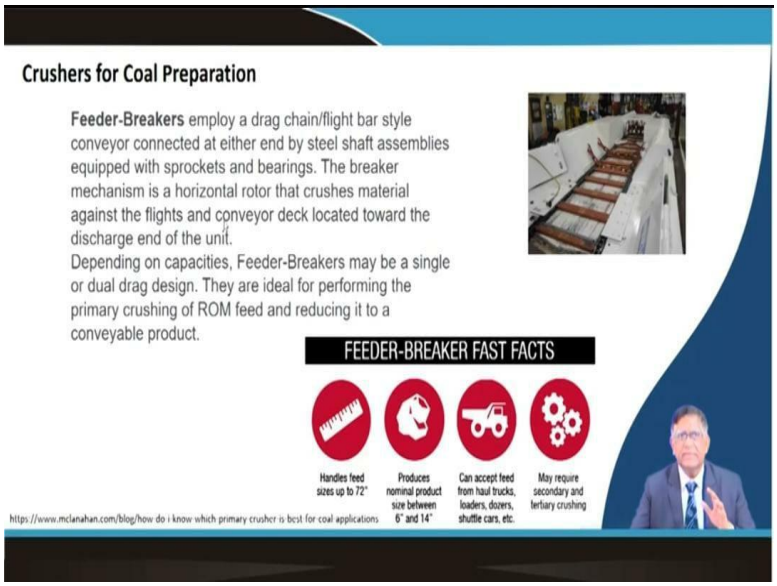


Now that for coal there are the feeder breaker. The feeder breakers are often used because if the sizes, your main sizes coming up to 72 inches big rock boulders they can be produced to six inches to 14 inches rock boulder. And then, this type of feeder where your feeder breaker there is a chain conveyor with a flight bar at the end there is a drum here you can see with two tape things.

So, the coal is coming and falling over here and that is getting carried away by this in the inside the trough. And then at this the end that your titter rock it will break by hammering actions and then the actions between the flight bar and this drum when they get trapped and with that this could get broken and it done. So, but here that is your reduction ratio is not very high and then it may require your secondary or tertiary crushing. So, this is how the feeder breaker work in a coal handling plant.

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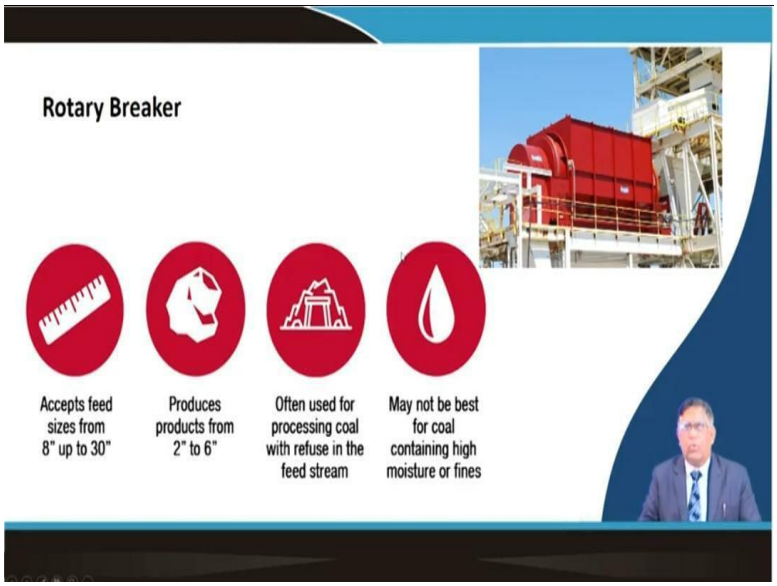


Now other type of breaker in coal handling in the coal mining they use this rotary breaker. Rotary breaker means there is a big trough and that inside this drum or a barrel the coal is fed from here and then when it rotates then by their own actions they get broken and they take it. So, here you can take the feeder size up to 8 to 30 inches of your big boulders can be put and then it produces 2 to 6 inches of that your fragmentation will be available.

And then, it is also used in the all coal handling coal washers and coal handling plants they use. So, now, they may not be best for coal containing high moisture and fines. Normally if it is a dry that is a coal inherently it may be having that your moisture content and then its petrography or it is that texture and that the structure of the coal inner that is how the materials are there exactly in the coal forming that your particles their nature how it is bonded.

If they are giving that they are susceptible to produce more fines then this process is that it may not be the good one for that type of things.

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Then there is the direct drive crusher sizer. These are, as you can see this type of crusher has these two rolls with this stitch and then they will be doing in the opposite direction rotation over here. When the coal will be coming over here, they will get trapped and crushed in between and taken up that the drives will be given directly to both these rolls. Now they can accept up to 60 inches 32 inches to 60 inches long can be taken to give you 8 inches to 15 inches.

So, about 4 is to 1 reduction ratio is available and there they can give a faster rate that high throughput capacities with low roll (()) (14:46). That is your, you need not make a very big heavy roll that it will be rolling like this and then the material it will be going out as a this type of crushers are used in some of the mobile crushers.

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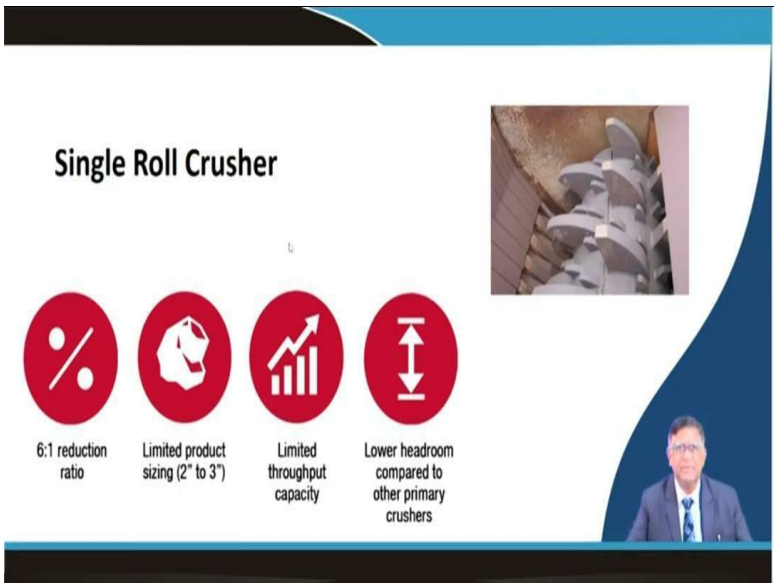


Then sometimes also the single roll crushers we discussed this crusher also in our earlier class. Here, they can get 6 is to 1 reduction ratio with the product size. It is 2 to 3 inches smaller sizes are produced from here and they have their productivity also limited, limited production capacity. Now here, that is a low head room compared to the other primary pressure. So, that means it is a small that is a single roll.

So, in a compact one thing is there that in pit crushers need to be a compact so that it can be that is installed on the mobile that is over a crawler. So, that point of view it is having a compact size smaller size and be useful in certain applications.

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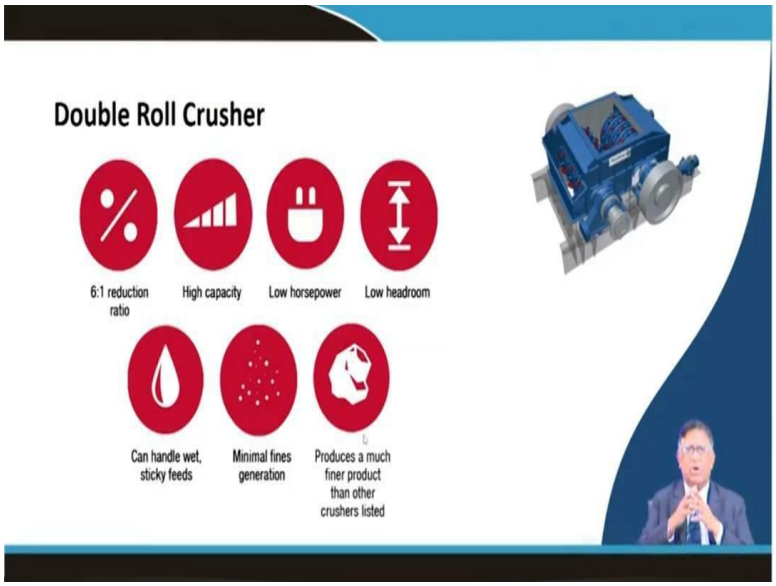

There are the most common type that is used the double roll crushers. This double roll you can see here these rolls they may be having the steeds but if the goal is very soft in that case you do not need that total say only these two rolls will be moving and they will do. So, they can get up to 6 is to 1 reduction ratio there for production capacity can be moderately high. Then your it has got a energy required is less. It also can be of a that your compact nature.

And it can handle both wet and sticky feed also it can because it is pushing through the streets. So, that is why it can handle this type of material and there the minimum find get generated and it produces much finer products than other crusher listed. So, that is a uniformity of the product is maintained through this.

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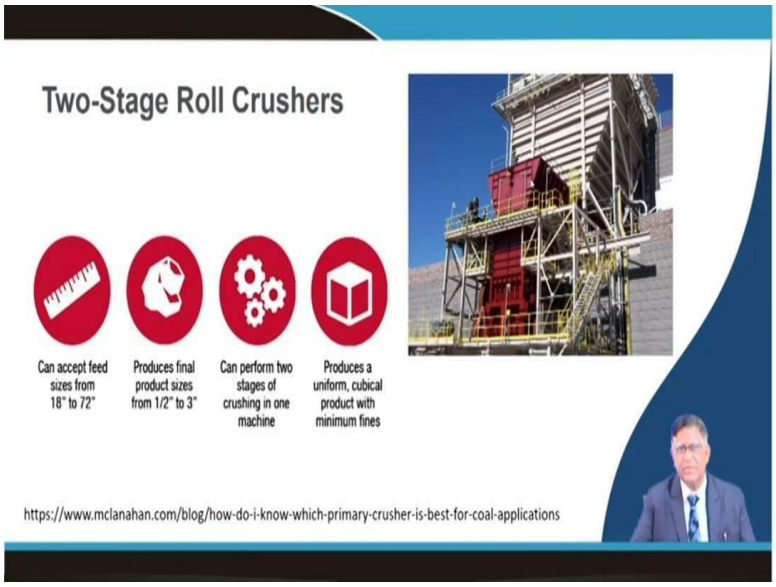


Now, these are a two stage roll crusher that is you can see here at a one stage it is done and then again a secondary stage it is done and. Then it is taking over here as a remounted fixed type of in pit crushers they can use this. Here also you can see that their sizes are 18 to 22 inches and then you can have their up to half inch to 3-inch size can be made over there. So, it is also to produce a very good size matrix that uniformity of the size can be maintained over there.

So, like that in a coal in-pit crushing conveying in a coal mine such type of crushers are used. You can see this, that mclanahan.com this is a company mclanahan. This company has

manufactured some of this, this is a of course a foreign company we have got our Indian companies also they are supplying these things you can study from the net.

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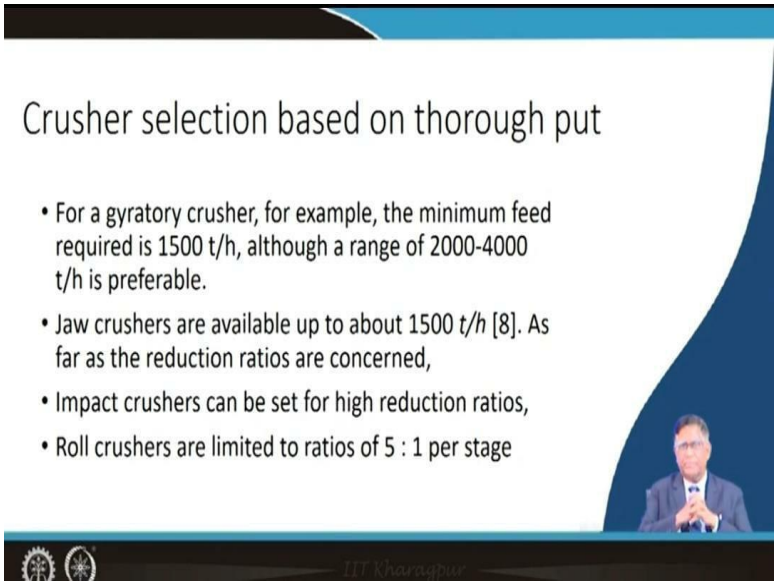


Now crusher selection is based on the through put that means for gyratory crushers. Gyratory crusher a minimum feed required is 1500 ton per hour. Now these 2000 to 4000 tons per hour is also preferable in a hard rock mining. Now this is in sub rock, now you this that ton and the volume they are also related because of the that is your that amount of volume that will be coming through the hopper and if it your density of the material is more in hard rock mining.

So, that is why the thorough put capacity when torn is it goes more. Now jaw crushers are available for 1500 ton per hour and your impact crusher can be set at a high reduction ratios or roll crushers are limited to ratio of 5 is to 1 per stage. So, that is how exactly while you are going to select you need to know how much they can and then what is the reduction ratio it does. As you know in the jaw crushers or in the gyratory crusher reduction ratio is that when you are having the jaw as a fixed jaw.

And the that your that movable jaw what is that the top size and what is the gap size their ratio is called the reduction ratio. So, you need to do for selection of the crusher define what your product requirement and then you find out from the manufacturers catalogue of different

companies, which companies are already manufacturing such type of things. And then from there you select optimally.

You do not go for prescribing things just to tailor-made for your things which can be done but it becomes costlier.

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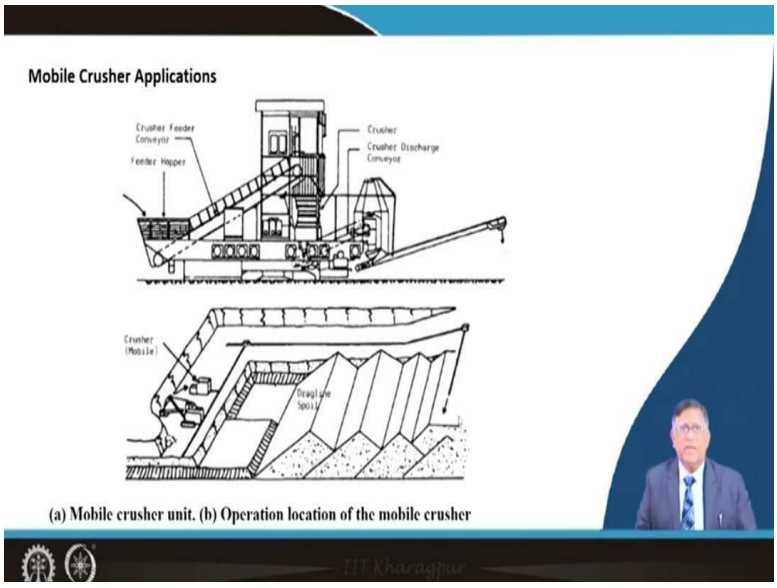


Then, how these are used as a mobile crusher applications. You can see that; this is a mobile crusher there is a hopper you are having this is your crusher feeder. There it is getting crushed and then the crust is material again it is fed by this conveyor and this is the discharge boom it is going. And that whole thing is mounted on that it can go. And then if you see that how it is applied in the mines if you are able to visualize this is your plan view of a mine.

That is your here is so well is excavating this is your blasted rock mass. Here it is excavating and then it is giving on to the hopper of this crusher. And that crusher discharge is giving to this conveyor belt and this conveyor belt is giving to the next conveyor belt which is taking over here. And this conveyor belt is transferring to another conveyor belt and from there a spreader is giving the material dumped over this.

So, this is the way we can take it if it is an over burden or that it will be spreading over here. So, this is the plan view which shows how it is applied right. So, now there is say your two benches

here you can see this is one bench of over burden and then there is another bench of over burden and then they expose the coal. Now this over burden bench it is being excavated by this drag line. Now this drag line is taking out, it is sitting over here and this over button is removed.

And then placed over here. So, this is a just a phase layout or a mine when you look at from the top with a in pit cluster location. This is important for you to note it here.

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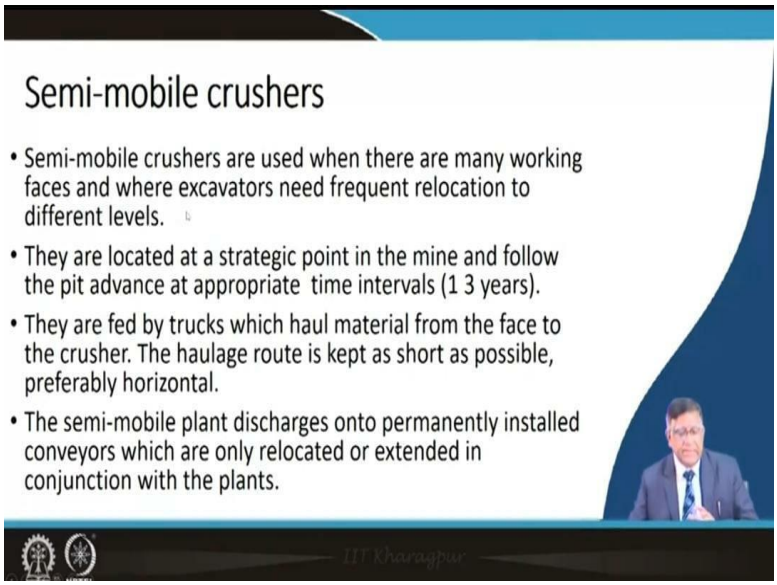


Now this is semi mobile crushers, we have already introduced you in the previous class. That semi mobile crushers are used when there are many working phases and where excavators need frequent relocation to different level. Now where the situation comes because particularly in metalliferous mine iron ore mine also that your the grade of the ore is different. Now you will have to blend always.

Otherwise, sometimes you are getting say iron ore mine your steel plant demands that you need to give as 62 to 65% of your iron oxide in the hematite. But in the mine, you may have some area has got up to 70% and some area has got 48 some areas got 58 like that. So, you will have to simultaneously mine at different places and bring it to one place and blend it and give it. So, that is why you need to excavate from different places.

There if you want to use a in-pit crusher then this will have to be semi mobile. That means it will have to sometimes from here along with the schedule to operate in another place it can also go over there like that it can go with a semi mobile type of crusher. They are located at a strategic point in the mine and then they advance at an appropriate time interval 1 in 3 years that is a it will be this 1, 3 years this block will be cut after that it will go over there so, in that way they do it.

They are fed by trucks as I already we discussed in our class and then the semi mobile plant recharge onto permanently install conveyor. This also we have you have seen the layout or that schematically we showed you earlier.

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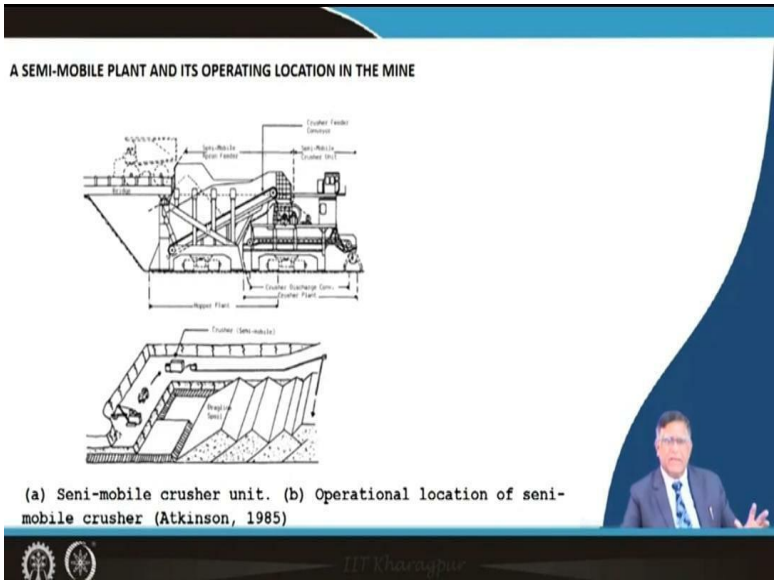


Now you can see here this semi mobile one, say this crusher your if this is a transporter if you can see here now when this normally this will be mount this is resting on each frame and the whole operation is going on. That is your truck is coming and giving this material onto the crusher from this conveyor belt. It is coming and then from here it is loading and then this is the conveyor belt on which it is loading over here.

Now it does not have its own crawler but, this transporter two things it can come and place below or here and then the lift the whole things and then they carry that is what is a semi mobile type. And this that crusher you can see over here this it is a in case of earlier one a mobile

crusher mobile in pit crusher in the previous diagram you have seen that this was the mobile one. Because it has got the crawler it was directly loaded by the that your shovel bucket.

But here, your this shovel is loading on to this truck and this truck is going and then doing it over here. Because it is mobile it can move as the phase changes in one places this can be again moved into another place. So, that means after these mines will be advancing, say instead of here if your phase is coming over here at that time your to reduce the distance travelled by the truck your this semi mobile can be placed over here. It can and then this conveyor belt can be extended and the work can go.

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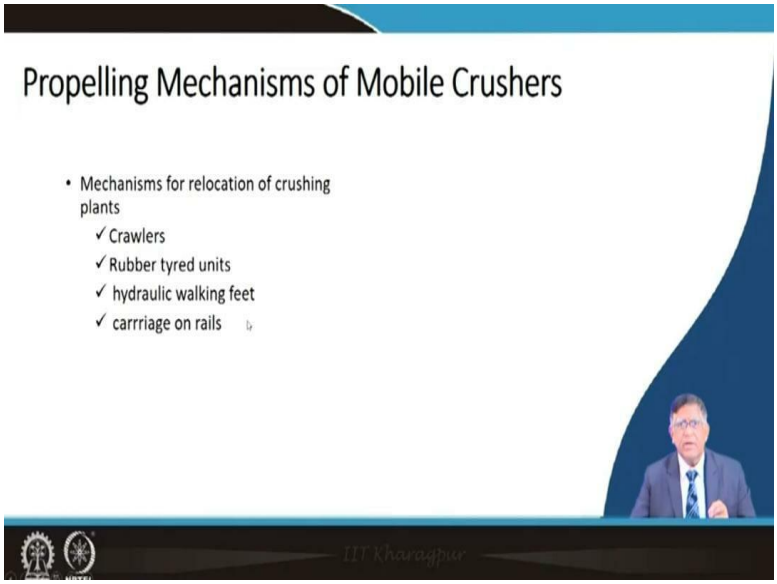


So, now as we said that the mobile crusher or the semi mobile crusher, they can have a different type of propel mechanism. As we said that it can be a crawler mounted or rubber tire mounted or a hydraulic walking feet or carries on a rails. So, this hydraulic walking that system it is also that is just you are having a walking pad and then with a arrangements of your this hydraulic your linear actuators it can be made to move over there.

So, that type of systems your whole structure is there by the side of it this walker will be fitted and it that same walker may be fitted that you can keep it. There if you are having 2, 3 crushing plant that they may be relocated at a different interval that walker can be brought fitted over there and then it will move and then again it come such type of systems are there.

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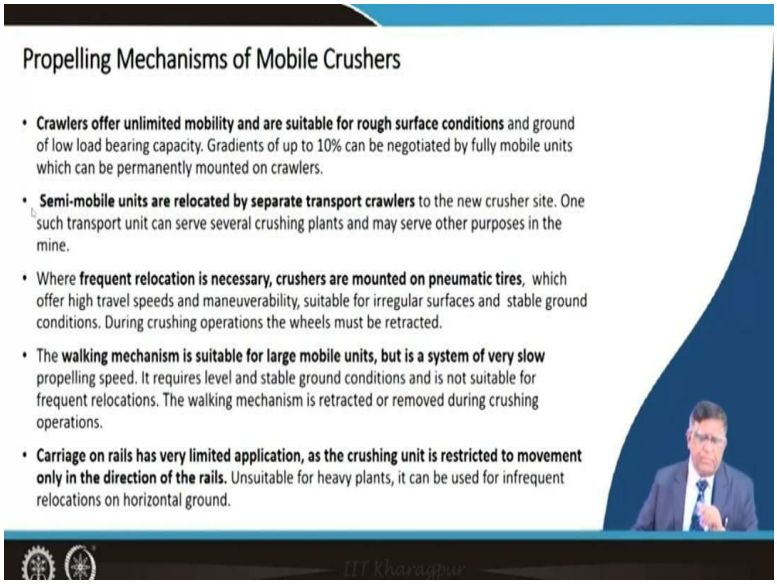


So, the propelling mechanism of a mobile crushers crawlers offer unlimited mobility you can have a very good move that is wherever you want you can take it because it is an integral of the machine. Semi mobiles are relocated by separate transport crawlers so you will have to separately you will make it. And then where frequent relocation is necessary crusher are mounted on a pneumatic tire that is also possible.

But they will be of a smaller capacity they have got other maintenance problem. Now walking mechanism is suitable for large mobile units but its system is very slow. When you are using a hydraulic worker, they will be making one stride in 1 or it may take a 3, 4 minutes for making one stride so it will be going very slowly. Now sometimes it can be been rail mounted also is possible depending on the situations, depending on the mind design such type of things are available.

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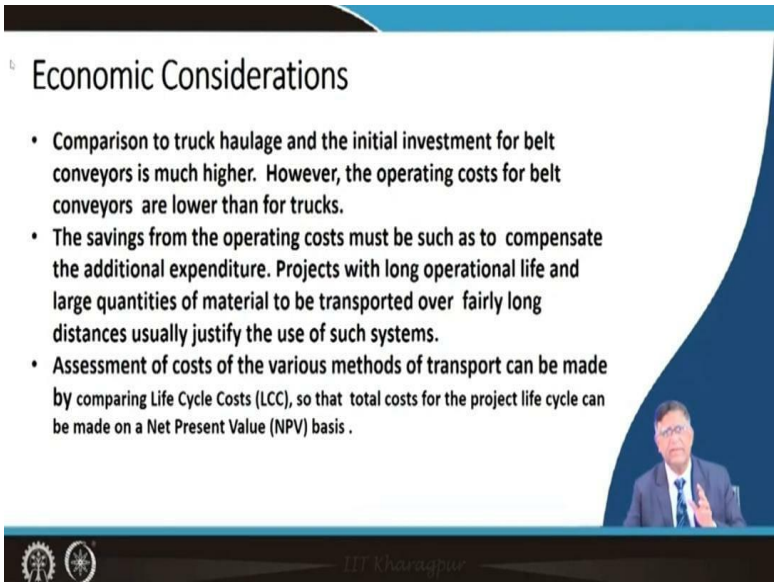


Now here you need to know just only as a general idea about that this type of machines are there and then they are deployed considering the economic aspects of it. That is your whether you are having the truck haulage, the initial investment for belt conveyor is much larger however the operating cost for the belt conveyors are lower than the trucks. That is why that when you make the economic considerations for whether you will go for a that is your in-pit crusher or not you will have to develop the economic model.

And there is not only the economics is seen only by the operational thing you will have to have a technical feasibility. Technical feasibility it may be all that but the rock is so sticky and then when you are using into the conveyor the conveyor belt. Under that conditions may be requiring more maintenance though it is operation cost may be less but you cannot meet the production at that time also it will be economically not viable.

So, that is why the savings from the operating cost must be such as to compensate the additional expenditures. That the projects with long operational life and large quantities of material to be transported over fairly long distances usually justify the use of such systems. So, this you read it carefully that where will you justify it will have to have a long operational life because if you are making a high investment then, it may take that issue.

It will take to get the return on that investment it may require longer time. So, if you are having a project a mind that is a good amount of reserve must be there so that and the market demand should be there so that for a long time you can go on applying for this. Otherwise, you will not do a very high investment over there. And then, if your transportation is say from the pit to the user is a very long distance you should.

That is a by conveyor belt is a good system when your it is become more economic when you do it for a longer distance. Now then, because if you are very long distance that truck to come back and collect and go that means cycle time will be increasing. If the more cycle time, then your fleet size will be more. So, that is why you will have to see that which is best way to make the combination and permutation of the things.

Then assessment of the cost of various methods of transportations can be made by comparing the life cycle cost. So, that total cost for the projects over its whole life can be made as a net present value basis you find it out. So, those economics part is to be considered.

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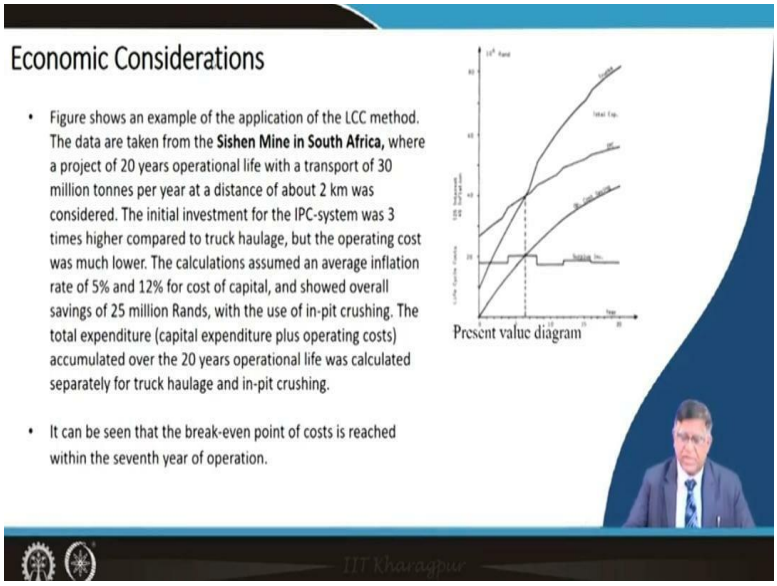


And if you see that these economic considerations you will find out that when you are the present value. That means if you are using a IPCC this is there as exactly your that on the life and your this cost you can find out that when the time the cost is going like this. So, that means

your the most optimal will be so, that is where your this point meets that is, this is exactly your a case study of a mines in South Africa.

They have seen that is your a project for 20 years of operational life, this 20 years of the life of there and then, they have got the 30 million ton of that is a per year need to be taken. And the distance was for the 2 kilometre for the they considered. The initial investment was 3 times higher in case of your IPCC. You can see here if you are not using this IPCC here initial investment is much more here.

That whatever the initial investment normally but here with the life the cost goes on increasing but, here though the initial investment was very high but after that because it is expand is a total cost it goes less. So, though with your other so truck system your initial cost was very less but that as drive goes with the production capacity achieved your cost goes on increasing. But here, in IPCC your cost does not increase at that rate.

So, after some years say about after 7 or 8 years it starts giving your as a profit compared to the other things. So, this type of analysis is done to find out that economic consideration on an investment on an selection process.

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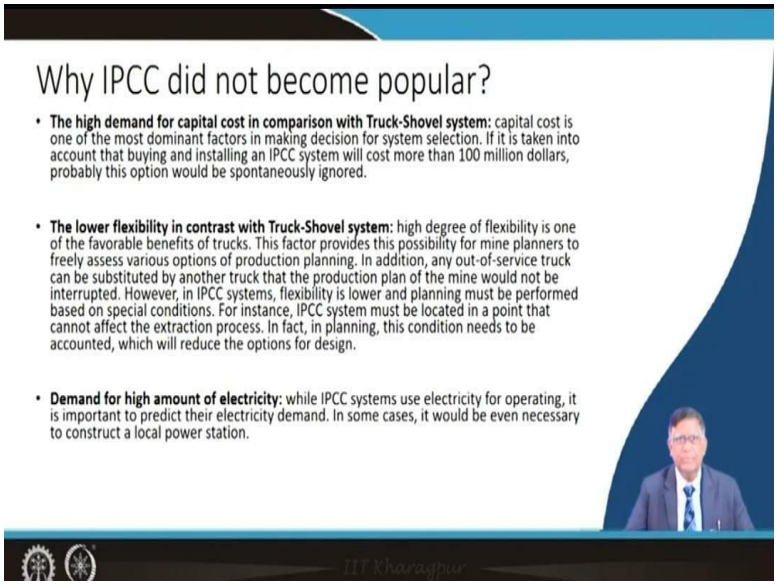

So, it did not become popular why though, it has got certain advantages, the high demand for capital cost does the main reason. Then the lower flexibility because once that conveyor belt line is split then though it is then adding or that is a following it to the phase and then the if the mines strata that is if it is not properly maintained then that conveyor belt cannot be reinstalled cannot be it is not a flexible mode of transport so, that is the thing.

And there is a high demand on the electricity though sometimes if your electric electricity supply is not reliable and not available there also you cannot use it.

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So, these are the things but over this year since 1970 this system came. You can see all over the world that in pit crushing systems are being used in Australia and then even in China in your, even in the European country, America everywhere all over the world this technology is being used.

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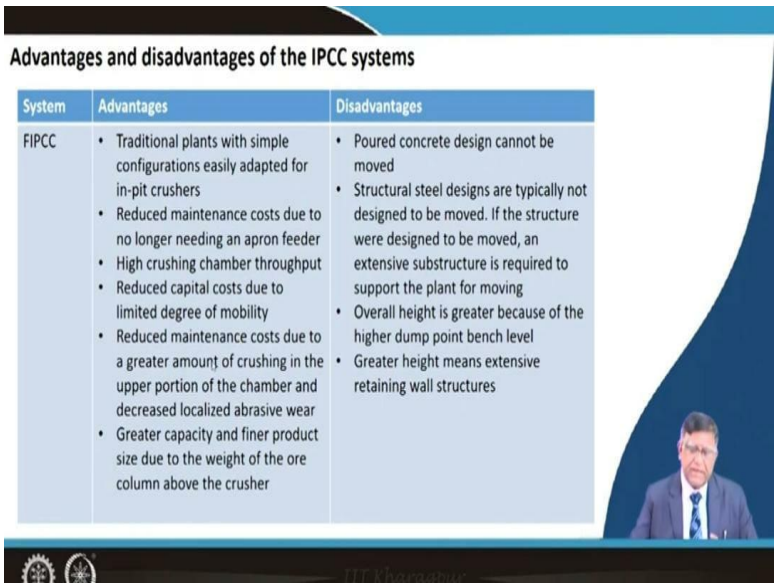


There are different advantages and disadvantages of that fixed in-pit crushing conveying system. Their advantages are traditional plans with simple configurations, easily adapted for in-pit crushers but the disadvantage is that their design cannot be moved it is at one place it is fixed over there. So, you need to do this as an exercise.

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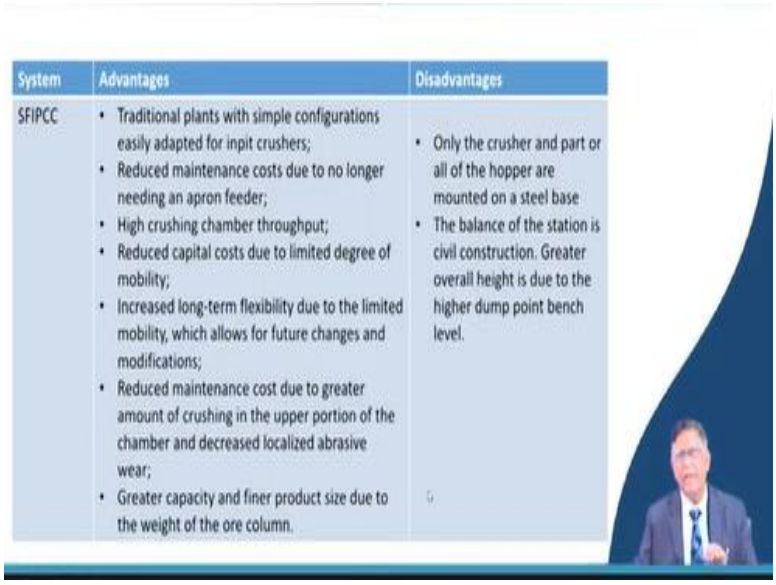


Find it out what are the semi fixed type, what are their advantages and disadvantages. You will have to go through and find out prepare your own metrics and the table and then you amongst your friends you please discuss what are these advantages and disadvantages.

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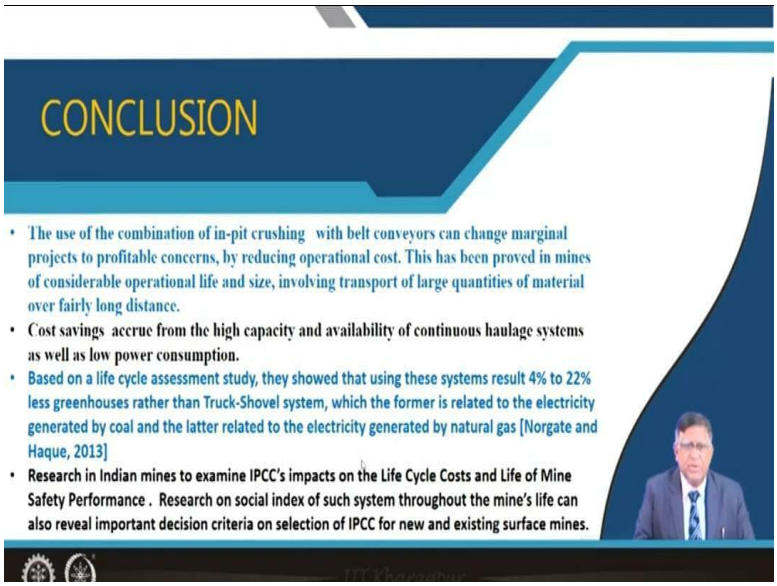


So, there are references you will have to go through that and the as a conclusions we can tell the use of combination of in-pit crushing with belt conveyors can change marginal projects to profitable constants by reducing operational cost. This has been proved in minds of considerable operational life and size involving transport of large quantities of material over fairly long distances. So, this will give you an idea that where we can think of this.

Then, cost savings accrue from the high capacity and availability of continuous solar systems as well as low power consumptions. That is low power required per ton that is your ton per kilowatt is higher compared to your other mode of transportation. Based on life cycle assessment study

they showed that using these systems results 4% to 22% less greenhouse gas. That means as we said earlier that it is having an environmentally friendly that certain studies by Norgate and Haque.

Their studies in 2013 they proved that this value up to 22% of this greenhouse gasses can be reduced. So, this is an area where you can also study how much exactly our environmental concerns in some of your mines where large quantities of number of large number of trucks are being used. And then, you can see that what type of alternative investment can be made over there. Then research in Indian mines examine IPCC impacts on the life cycle cost and life of mine safety performance.

Research on social index that means how it will be giving your societal benefit that is also another thing for comparing. And here you should know that government of India this last year have made the first mile connectivity on the ministry of coal has given the first mile connectivity. That means the one that no trucks will be flying from the mines to the your dispersed sections where it is there in the that railway sidings.

So, it is a right time that it could be through in pit crushing system or by other means how that conveyor belt will be used in the mines. It will be done already some investment has been made and then there are con true conveyor transportation have taken. But you need to see whether there the in-pit crushing system has come or not because in-pit crushers will be necessary in some of the mines whenever they are going to eliminate the truck and take the conveyor belt.

And there another most important thing you can study that there will be more than I think I assume it is I am giving a guess data about more than 200-to-300-million-ton coal will be transported from the pit to the railway loading system by conveyor. So, there which are the mines where coal will not require in pit crushing system or where it will require can be determined energy balance study will be necessary.

If your blasting that is done with a good fragmentation then your in pit crusher will not be necessary. But while doing that blasting if you are exactly creating more fragmentations that

means more fines will be getting wasted. So, that is a some coals calorific value will be lost. So, that combinations whether that how much energy is spent for drilling and blasting, how much energy could have been spent in crushing and that is a conveying.

This alternative studies research is required to my knowledge we have not conducted such research yet, thank you very much.