Bulk Material Transport and Handling Systems
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Lecture – 45
Pipe Conveyor Belt: Enclosed Material Transport

Welcome students. We have been discussing about this transportation machinery and surface mines. We introduced number of different systems that are being used. Now some of the emerging areas that I already introduced in your general discussion that on the different type of transportation system by now you know that there is a pipe conveyor belt. Now this pipe conveyor belt it is an emerging technology by 2006, 2008 there were hardly 6 or 7 installations.

But today a large number of mines are adopting this new technology. So, this pipe belt conveyor and it is not a very new one it has been quite some time it is there in the different areas, but in India it was first introduced in our private sectors and then there are few installations in India.

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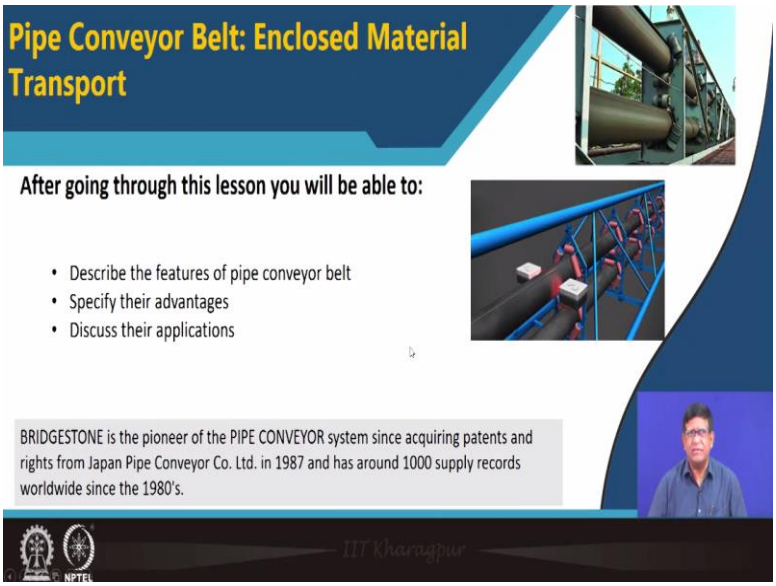

However we will be discussing here the general features of this that exactly what they are, what is this particular conveyor system. How in surface mines we can adopt this system and after this class we should be able to describe what are the special features of this system and what are their advantages and then how they can be applied in a particular mines. So, you

should know about that there are some number of manufacturers these days manufacturing however the Bridgestone they were the pioneer in this.

And in the late 80s in this system and they have been very much popular in number of places and you should study about what this system is. In the figure you can see here that what is this particular system is, you can see that this is a pipe you are seeing, but this pipe is made of conveyor belt. This belt is folded into form a pipe and then the material is carried through this.

Now that is why it is called sometimes it is called as a pipe belt conveyor or you say also pipe conveyor belt.

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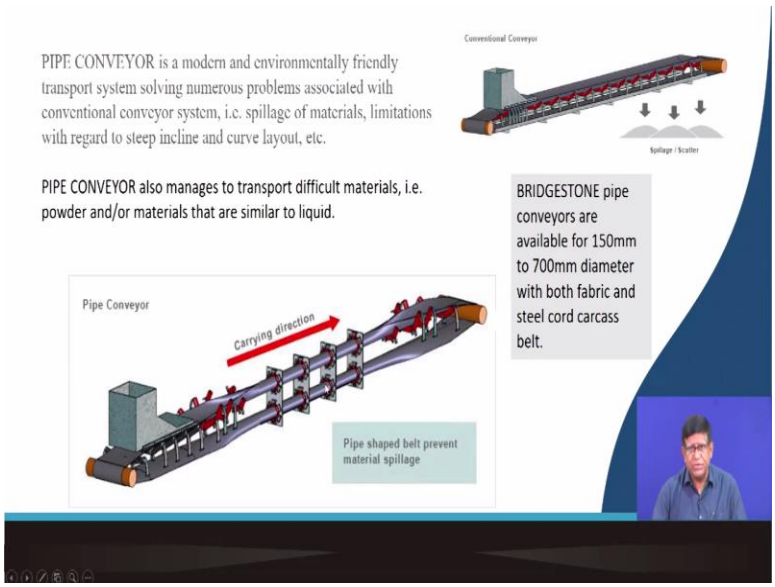

Now this originally our conventional our belt conveyor you can see it is either you are having a flat belt or it can be a trough belt and here at one side you will be giving the material and it can be discharged either at the side or at the end that is what is the normal system, but when this is a pipe belt conveyor in which what is done the material is received at the end both the ends this belt is flat.

But that belt is made in the form of a pipe it goes and at the end when it is taking a turn and again it forms a pipe so it is coming, it is travelling as a closed system. So, that is where it is called your closed conveying system in which the material is carried in this direction and discharged over there. There could be made an arrangement if you want to do at a particular intermediately there also it can be open up.

And from here you can give a side discharge arrangements can be made for discharging at a size also. So, it can take as because it is not expressed to the atmosphere even some of the toxic and other materials which are powdery material which are prone to get air borne those type of materials also can be transported over here.

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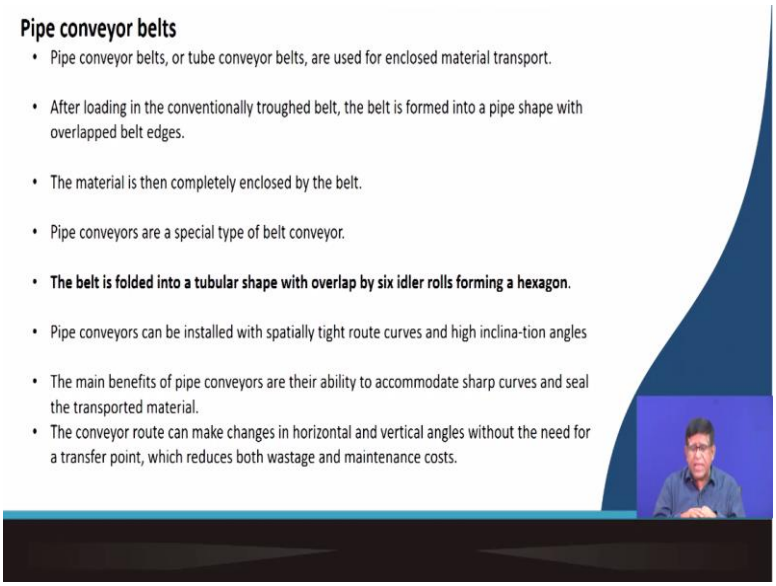

So, basically now you know that this particular system it is a pipe conveyor belt also called tube conveyor belt they are either enclosed system and it is used for bulk material transport. So, having said that you can find out that what are the different features of it, how it works that is you will be loading point and discharge point it is similar to looking like a trough belt conveyor.

There also you are having the end pulleys on the end pulleys one of the end pulley will be used as your driving pulley other pulley will be used as your tension pulley as you do in any other conveyor belt system. Now main transportation side it is the pipe conveyor as you might be now visualizing the diagram which you have just sent and there can be this belt conveyor which is used the belt will have to be a specially designed belt.

So that it can form that pipe and when you are opening and then again making a pipe for that whatever the stresses will be coming on to that belt it will have to withstand and it should be that is when you are making this to close over there at that time that should not be coming out and then it will have to be given that shape with the help of special set of idlers and this is your folding by means of 6 idlers.

So, you are keeping hexagonally the idlers are set so that first it will be going to 3 idlers and then it will be putting into 6 idler that system. Now it can be installed with a spatially tight route curves so it can be as because it is coming enclosed main area it can be inclined, it can go even a spiraling around because that is your material which will be there inside with that speed and its angle of repose so that the material will be sliding down back.

So, if you are within the angle of repose of the material and in some devices you can also think of inside the pipe that inside part you can give flights you can give some ribs so that the material do not slide by that you can increase the angle of inclination also and it can be that it is the benefit of this will be it can negotiate sharp curves because material will not be thrown out.

In any open conveyor belt if you take a sharp curves and then there is a tendency of the material which will be getting over spilled and then the material the belt can be swaying into one side and then there will be difficultly in training the belt, but in case of pipe belt conveyor it can take make sharp curves and it can take this your horizontal curve that is your curve in the horizontal directions as well as curve in the vertical direction to certain extent it can do much better than the ordinary troughed belt conveyor that is what is the claim.

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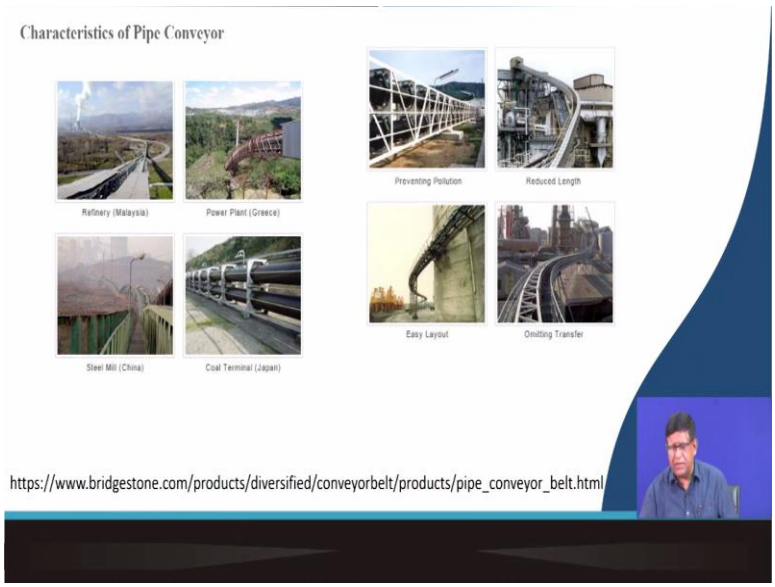

And you can see their characteristics these are all from Bridgestone leaflet you can also find out there that they are applied in different areas in the power plant in the steel mill, in coal terminal, in refinery material for the pet coke and transporting after the oil refinery that coke

which comes out that pet coke also can be transported by this then it is having the advantages as because there is no air pollution by this.

And it can be that route can be you can put it on a trestle you can make that shortest route can be designed easily and you can lay on a different layout can be given your display and you do not have many transfer points so that is why it can be a single flight to a longer distance.

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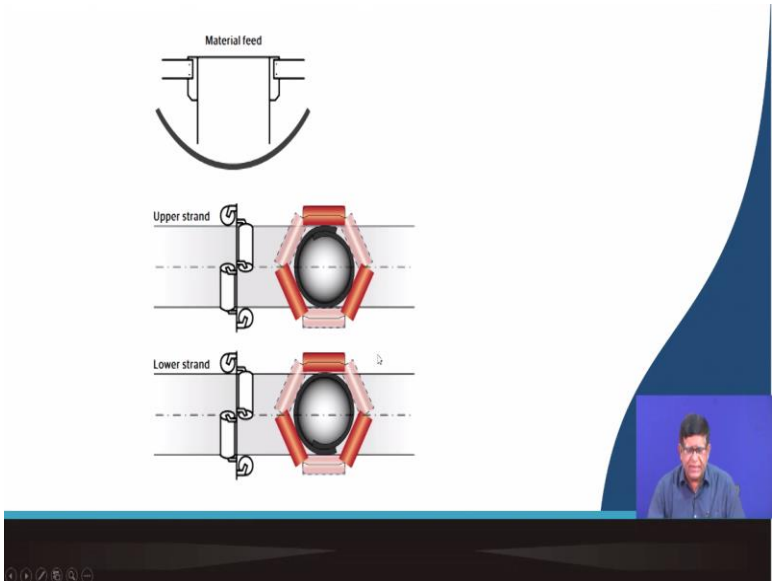

As you see that is your cross sections of conveyor as you are telling that there are 6 idlers this it the carrying side and while returning it is coming as this is return side. So, this is the way how the configuration of the belt is.

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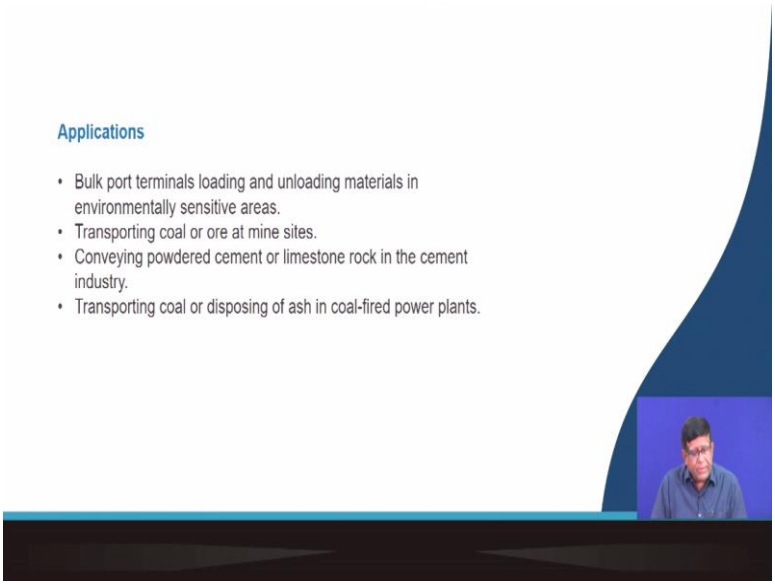

And they can be applied in a bulk port terminals loading and unloading materials in environmentally sensitive areas that is the air pollution will be reduced to a large extent then your transport of coal or ore from the mines you can very easily carry it out than you can conveying powdered cement or limestone rock in a cement industry it can be used you can dispose this is a thermal power station it can be used there could be number of places.

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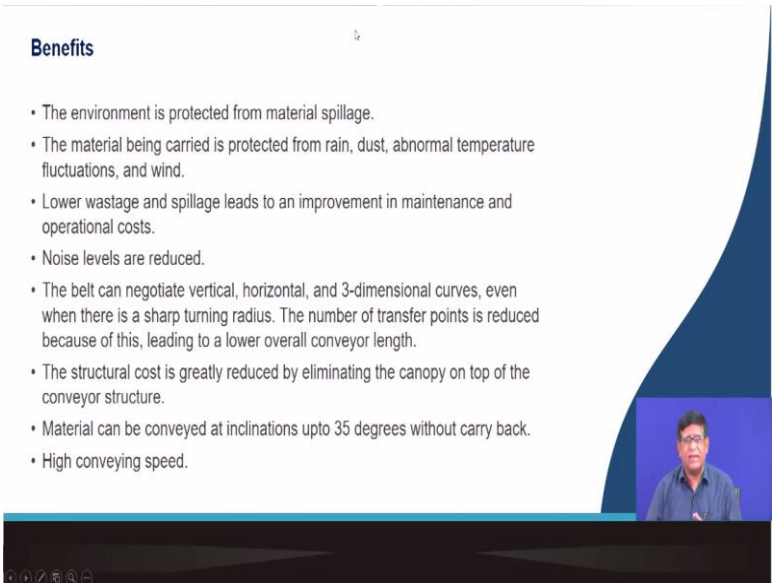

If you see the advantages as I have already said this is your environmentally friendly then it will not be affected by the climatic conditions that rain or the coal that will not be affecting much over here than there will not be spillage so there will not be wastage of the material. This system could be quieter than other systems there will not be less noise can be managed and the most important thing is you can negotiate with a conditions of the route.

That means you can get the shortest route by making this conveyor to be that is supported on different type of supporting structure or trestles then these cost that can be that is exactly the total conveyor structures their cost capital investment that of course will vary in certain cases it could be much more than the other, but if you consider the lifecycle cost than the maintenance of those structures would be less.

And as a result overall lifecycle cost could be better and it can as I had said it can be carried material up to 35 degree providing with different type of your conveyor belt that in the inclinations we will have to give inside that belt providing some flight as a higher angle and also if there is a situations where the return side there also you can bring some material for if it is required so.

So sometimes this system if we use it for underground mining then this can also be used for carrying some of the supplies for the operations like your explosives and all which are to be taken to the underground mine, you can take this return side of the belt for carrying those material and then the upper side that is your carrying side you can bring the coal. So, like that a two way utilizations can be done.

And it can be used at a higher speed so the throughput capacity total power over production capacity also increases.

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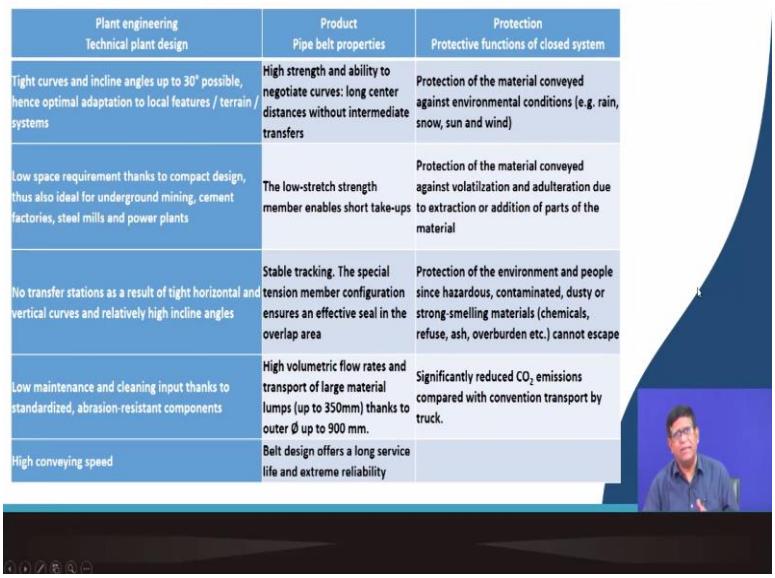

Then these advantages and benefits can be studied under this plant engineering and technical plant designed how it will be exactly effective as pipe belt properties also certain properties are advantageous and as a protections from the safety point of view also it has got advantageous. So, the route can be designed as a tight curves and inclination up to 30 degrees, 35 degrees possible and then optimal adaptation to local features terrain and the system.

You can design the system that is one big advantage. Similarly, these are your high strength and ability to negotiate curves that curve negotiation is one of the biggest advantage and then long center distances without intermediate transfer that is also one advantage because you do not need to have a transfer points and the protection of the material conveyed against environmental conditions rain, snow, sun, wind they will be affecting less.

Also you can see here that the low space requirement that is you can design very compact manner so your space required will be less and that is why as I said already from underground mine to take the material out it could be very easy. Even sometimes you can create an inclined shaft and then because you can make a narrow shaft also for transporting the material in this way.

So, if you do not need to construct a big gallery that will be your less excavation will be required, but the transportations will be possible, but it has low strand member enable short take up that is your another thing is because low stretch will be less as a result you take you can be designed accordingly, protection of the material conveyed against volatilization and adulterations due to extraction or addition parts of the material because the contamination they do not take place from the other influences do not come.

In certain specific material which can easily react with the atmosphere say, for example, you are carrying cement that if it moisture contact should not come so you can even carry in that closed environment in a much better way. So, no transverse stations as a result of tight horizontal and vertical curves and relatively high inclined angles can be negotiated. It can give a stable tracking and then the spatial tension member configuration it can be made.

So that there is a very good sealing it will not automatically that it should not come out and the material should not fall that type of things also get protected and that is we can say that it is very less hazardous system so that safety is better so it is a protection side and this is an advantage. So, another thing is that it requires low maintenance and there is no need of much cleaning operations.

So, this is also one of the big advantage and it gives a high volumetric flow rate and thus what we can see here the energy consumptions also will be much less because you can have a shortest route can be possible. So, if you see the advantage from the carbon dioxide emission point of view, energy consumption point of view and your throughput point of view this particular system is advantageous.

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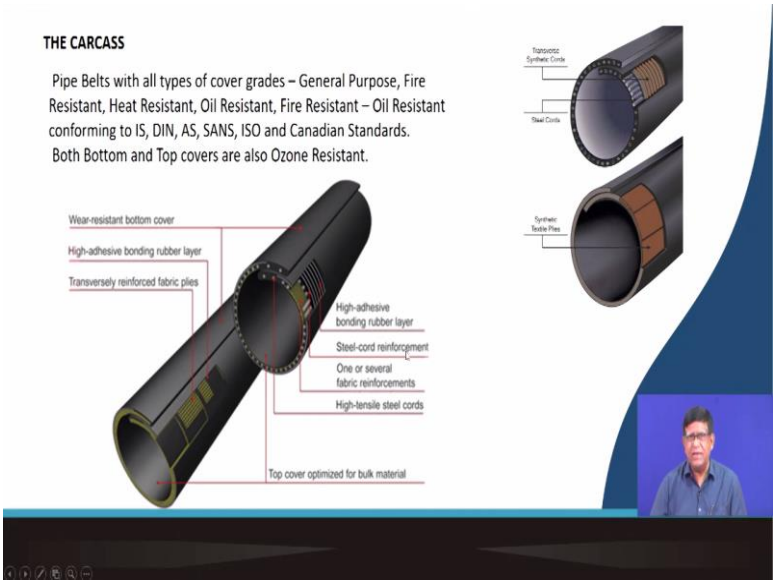

So, once you know that what exactly this belt now we have said about that this is a system we want to close it, but when you want to go for applying you need to select that what type of belt will be used over here. So, this belt can be of different grades we can make this belt just the carcass will have to be spatially designed so that it support to be formed in the form of a pipe and then certain properties which will be required like your it should be oil resistant.

It should be fire resistant and it should be confirming t the standard international standard as different country and different international standards are there that will have to be fulfilled by this belt and also while it is going in the top side or in the bottom side in certain standard they require that ozone resistant that can be done that is your belt manufacturing they take care of this.

So you can see that cross-sectionally that here they have the different type of membrane that is you can see that there are steel cords are there that is the main carcass strength is coming from the steel cord and there are transverse synthetic cords are there so by that they will (()) (17:54) and above that there are this top cover and the bottom cover and this cover is made so that it will be your fire resistance, wire resistant all that thing.

And sometimes, instead of this you can see here that all synthetic textile piles. So, we are not having the steel cord, but we are having the synthetic pile by this you are exactly making the belt to move like that. So, sometimes there could be even if you are having a very highly abrasive and very strong very heavy load and you are having a very large diameter pipe you

want to form there you will have to have this your fabric piles or you are having this is your high adhesive bonding rubber layers will be there then the steel cords will be there.

And then your ultimately this steel cords they will have to be very high tensile steel so that you can optimize it. So, both the things as in case of your conveyor belt you are having that fabric belt and the steel curve belt similarly the belts can be manufactured for this.

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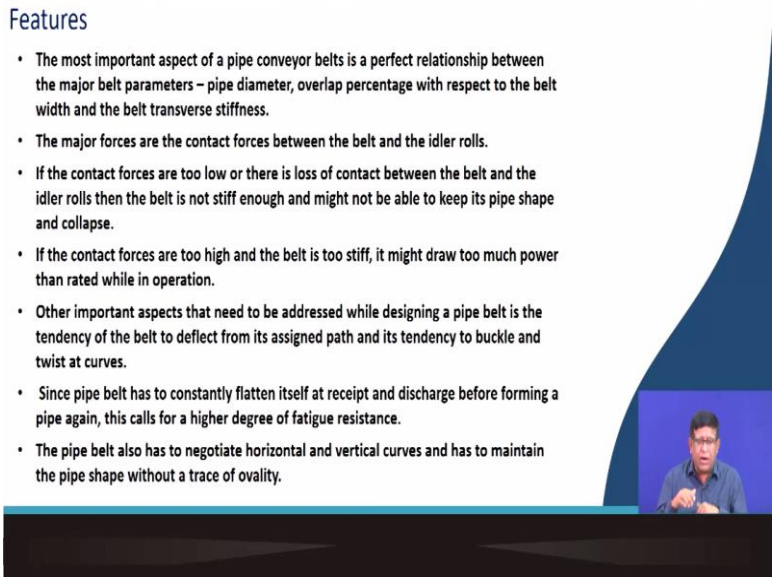

So, there are various aspects you should understand about that the most important aspect of the pipe belt conveyor is the perfect relationship between the major parameters that is when you are designing it you will have to see that what is the pipe diameter will be there and when the pipe diameter is made that means there will be some both the ends is getting overlapping over here.

And because of that what percentage will be exactly overlapping so that means depending on that for maintaining a particular diameter you will have to have that width of the belt will be coming up to there and then if that width is there and then if you have to give the trap if your overlapping person is more that means you are giving that your transverse stiffness of the belt will be determining that area.

These aspects while doing the mechanical design you will have to consider that what are the different forces that will be coming in between your belt and the idler will have to be seen. There are different researchers where you can easily have in a laboratory also the setup 6

hexagonal idlers there if it is putting in that while making the curve how that exactly the stresses are coming that experimental research they do.

And find out that how much force will be required then because forces which it will be giving over to the idler that will be coming as a total resistance, the total drive power of the belt will be coming up how much resistances are induced because of the special arrangements of the idler. Now, if this contact forces are very less than the loss of contact between the belt and the idler.

And then the belt is not stiff enough and might not be able to keep its pipe shape and collapse. If your belt is not stiff what will happen you have made this that inner one if it fall because it is not stiff then there will be true will be coming over there that means there will not be contact to this your idler and the belt then if the contact is not there then it will not exactly get the total push.

And then this will be giving a problem that material and that if it is not stiff belt is not stiff it is not getting the proper contact it may get opened up and then while taking a curve at that time this may slip and then the whole material may fall out. So, that is why selecting the belt will be a very, very important thing then if the contact forces are too high then the belt is too stiff.

It might draw too much of power because then the resistance will increase if the resistance is increased to pull it through that your more power at the end pulley will have to be provided then the other aspect that is need to be addressed while designing you have to see very carefully what is the tendency of the blade to deflect from its assigned part that is whether it has got a tendency to buckle or twist at the curve when it is taking a turn at that time whether belt is going to get a twist.

If the belt get twist then upside will become down and there if anytime lose is there then you can think of the material is going like this. Now, if it is getting a twist then it get opened up then material will fall down below. So, this is a point where need to be taken care of while at a speed and the curve and the stiffness and the contact with the idler these four point need to be very carefully designed.

Now if the pipe belt will have to be constantly flattened itself at the two ends the belt is getting exactly it is becoming that it will get flat at the end and again it will form a pipe. So, continuously the belt is exactly getting flat and then getting banned. So, what it will be there these particular that is you are applying repeatedly a force over there this will lead to give a fatigue.

So, that is why that while designing will have to see there is a enough fatigue resistance and it should be able to negotiate the curve while negotiating the curve it is the pipe shape and that should be intact. So, these are the points when you are going to do exact design and calculations you need to keep in mind.

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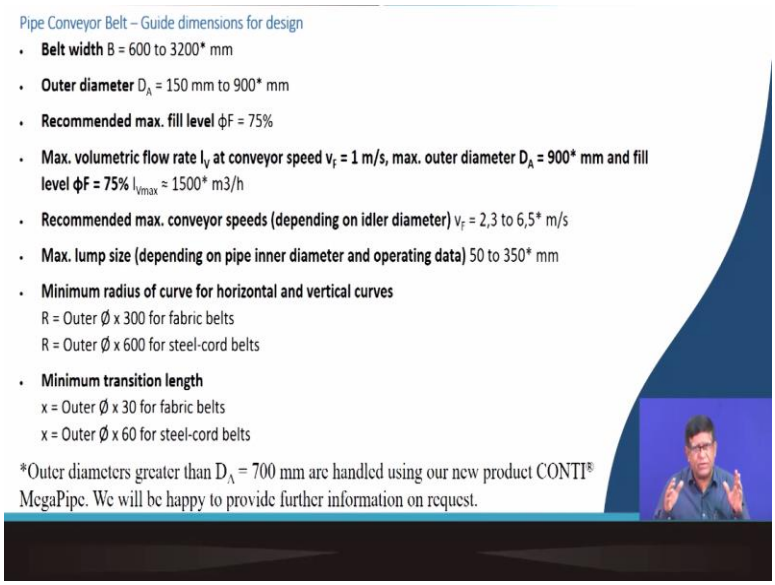

So, some basic guidelines when you want to for a particular site you want to design that belt width it is exactly can be your 600 to 3,200 millimeter depending on how much your diameter will be accordingly decided it can be your 150 millimeter diameter to 900 millimeter diameter. So, then the carrying capacity and also you need to know when such a belt is there if you are that whole material should be there within the belt.

If you are making a very big diameter, but there is a very less load is going it may give another problem. So, your fill factor should be there at least 75% that means if it is your that is your total inside area is of a circle that is pi r square and that when your material which is there what about their area these two area ratio it should be at least your 75% of the whole area of cross section should be fill by the material this is a important factor.

Now maximum volume flow rate of the conveyor and that speed that is your that these two things are very important that is your maximum outer diameter and the fill factor and with that your exactly the total amount of material which we will be carrying about 1,500 meter cube per hour. So, that speed and the cross sectional area of the pipe will have to be match properly.

Now that normally the conveyor maximum speed should be 2.3 to 6.5 meter per second, 6.5 meter per second means it is a very high speed it is moving it will be carrying a lot of material. So, sometimes even if the diameter is less, but it is moving in a very high speed then to make to get the exactly the volume rate what you want to transfer it can be that maximum run size that is one of the very important things that is your it will have to be depending on the diameter of the pipe.

So, at the time of fitting that is your feeding you should be very careful if very big boulder comes and all whole pipe maybe belt may get damaged, pipe may get blocked and then exactly the flow could be disturbed, lot of issues may come. So, that is why you should have a control on that and exactly you have blasted or how you have screened in your (()) (26:42) product only it is always better to send through this type of systems.

Then the radius as I said that your outer in case of your fabric belt your outer diameter can be 300 millimeter or in case of your steel code belt you can go for 600 millimeter than your minimum transition length means from the end flat to become the pipe this could be it is how many times the diameter that is depending on the 30 times the diameter distance should be there from the end in case of fabric belt. In case of your steel code belt 60 times the diameter you will have to take it over there.

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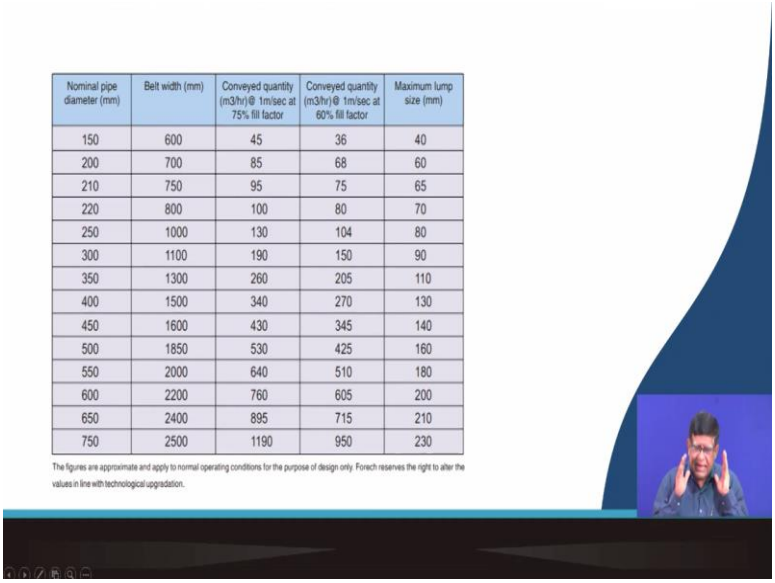

Nominal pipe diameter (mm)	Belt width (mm)	Conveyed quantity (m3/hr)@ 1m/sec at 75% fill factor	Conveyed quantity (m3/hr)@ 1m/sec at 60% fill factor	Maximum lump size (mm)
150	600	45	36	40
200	700	85	68	60
210	750	95	75	65
220	800	100	80	70
250	1000	130	104	80
300	1100	190	150	90
350	1300	260	205	110
400	1500	340	270	130
450	1600	430	345	140
500	1850	530	425	160
550	2000	640	510	180
600	2200	760	605	200
650	2400	895	715	210
750	2500	1190	950	230

The figures are approximate and apply to normal operating conditions for the purpose of design only. Forech reserves the right to alter the values in line with technological upgradation.

So, there are design charts available while you are going to design for a certain system this type of charts you must look into that for the nominal pipe diameter if you are having a 750 millimeter diameter your belt which will be around 2,500 so that you can take about 1,190 material cube material per hour at a speed of 1 meter per second which is 75% fill factor this is the minimum things you may get it over there and if your fill factor is reduced.

If you are getting a 60% fill factor your carrying capacity will be reduced as you can see over here and then depending on what should be the lump size as a 750 millimeter diameter the pipe belt conveyor can take up to 230 millimeter it should not be more than that. Such type of designed table should be considered while going for designing it.

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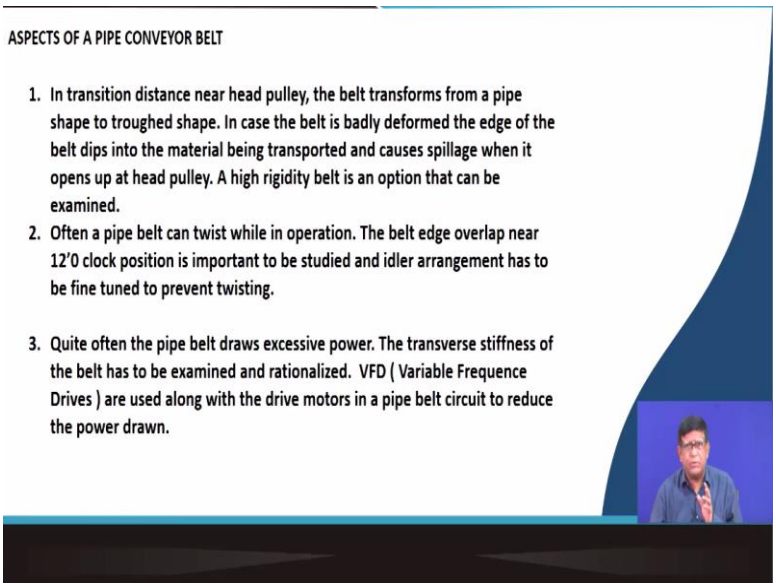

So, that what we have already told about that your transition distance that is a very important point to be noted then your twist problem should be attended so that the belt that is overlapping of the things how you will be doing that will have to be proper seen than you may find that sometimes that your power that how you will be that what type of drive you will be selecting.

So, that the power consumption is always optimal for that nowadays this variable frequency drive are being used and then your power system that will have to be proper control this is what you will find.

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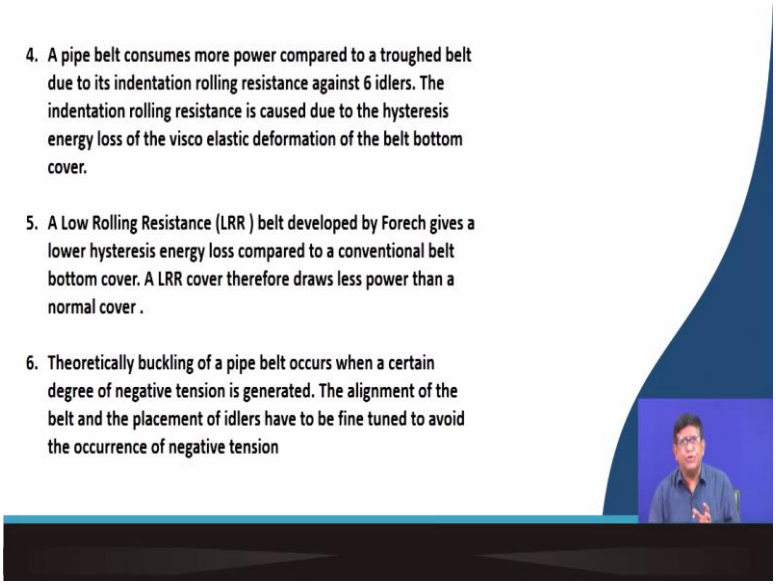

And your power consumption in case of your troughed belt and power consumption in your pipe belt that also you can compare than these what is your low rolling resistance that is also can be developed there are some conveyor belt manufacture like Forech and all they have developed a special type of belt top covering so that your rolling resistance is optimal then the pipe should not get damaged that is your buckling should not be there your carcass should not come out those type of maintenance systems are also done.

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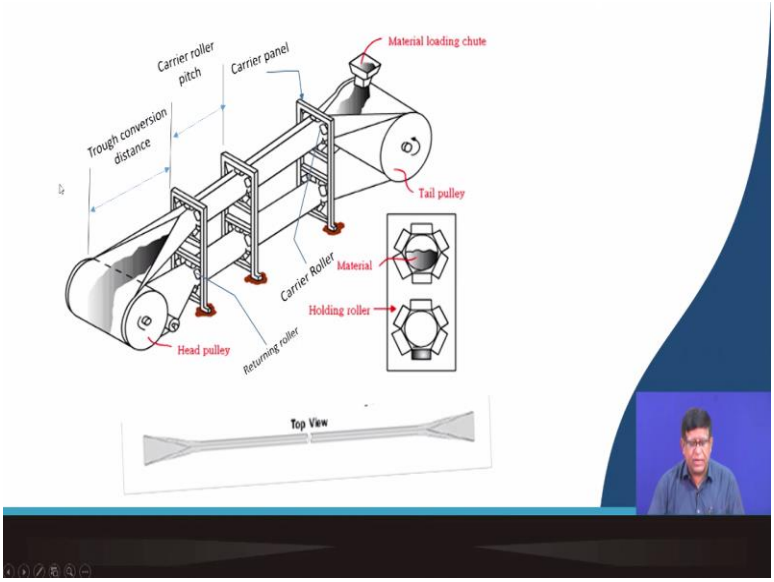

So, basically when you will be implementing this system you will be having as you said from the flat end to where it has become this is your transition distance and then the main carrying path will be there and after that again the transitions and you can see here the material is fed over here. It is discharged at this end and this screen if you see from a top view it will be both the flat and in between it is there. From this transition from this transition will have to be carefully selected.

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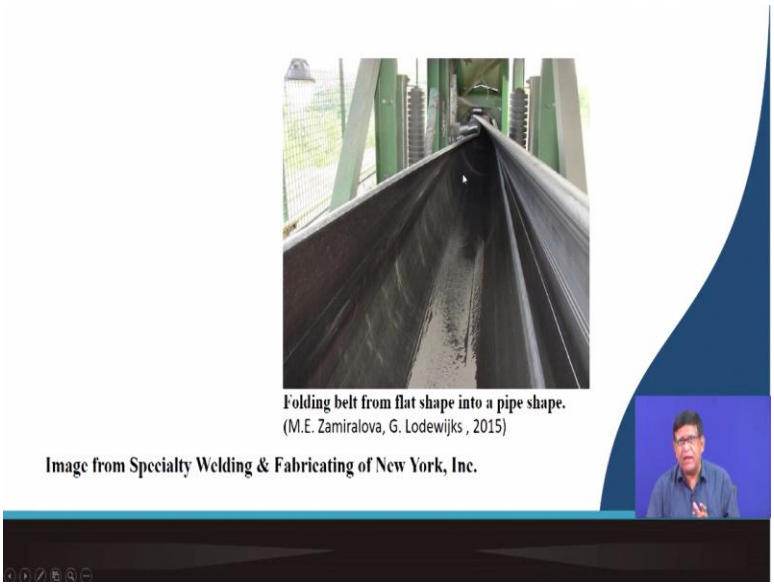

So, this is the way how from a flat opening it will become a slowly your closed type of things that folding will have to be very carefully done and for that the supporting structures and that supporting idlers they are properly selected.

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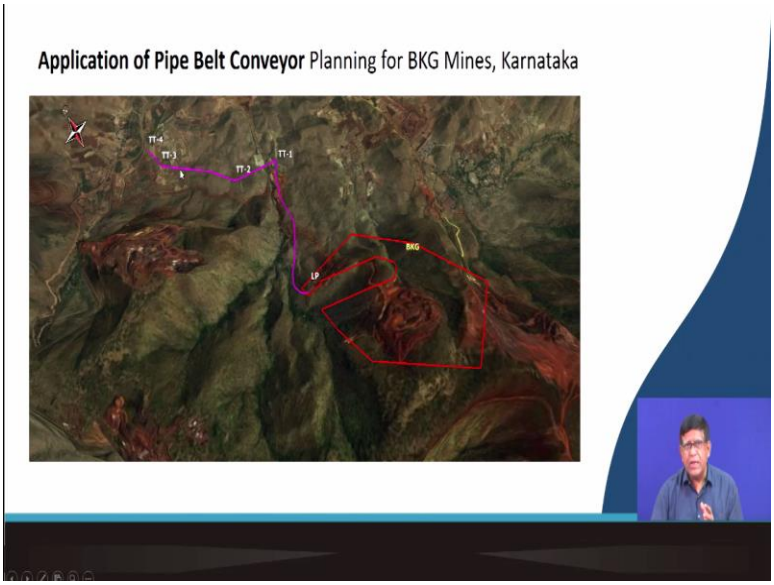

Now such type of system when we want to use in a mine that this is an example we were designing for what type of belt transportations system can be done. This is a forest land and here your mines is there at a hilltop and then there is a railway siding system which is exactly because of the terrain it is a lot of distance will have to be taken by small trucks and it was a lot of diesel consumptions.

And that whole forest is also getting affected in this area near Hampi that is in Karnataka we were deciding that what the best way could be and then how the route could be selected in such a rugged terrain and it was observed by that if you see that there are number of stations here we are thinking that from here this is a loading point that is your transverse terminal 1 from there a transfer terminal 2, transfer terminal 3 to transfer terminal 4. You are finding out this is a route.

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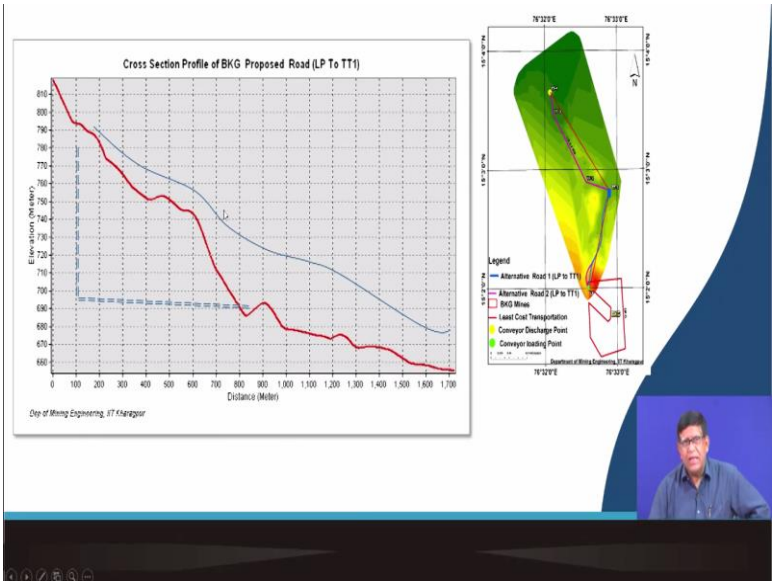

But there we can study that how the route is exactly you can see the elevation reference. Now you cannot bring any road or anything over here it will be very difficult. Now, we are thinking if we make a trestle mounted we can easily support some of a trestle over here and this conveyor belt can be given a profile like this and then we are finding on this terrain we can make that type of system.

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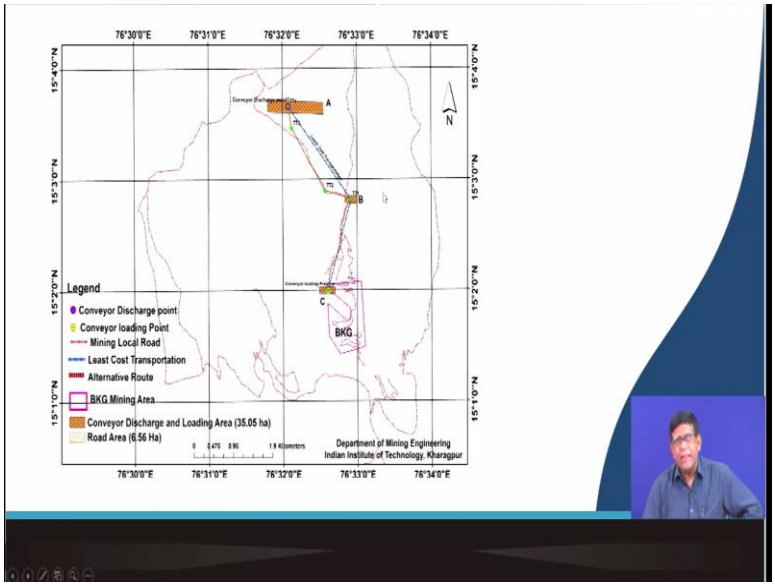

And then ultimately that area we can found out this is the shortest distance a pipe belt conveyor can be developed.

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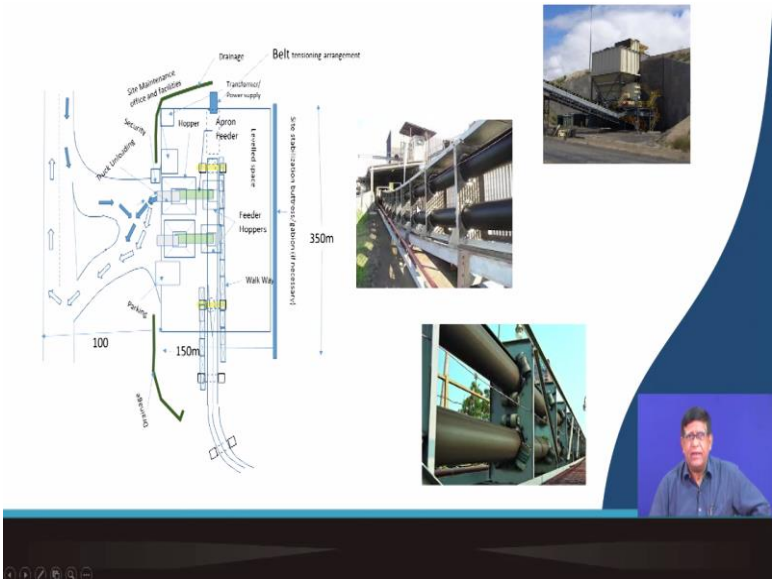

Now in such a pipe belt conveyor to be constructed over there what will be the facilities in the loading point from the trucks will be coming and then how this will be loaded into this conveyor belt by different type of where you will be having a helper there will be a total bulk material handling system over here, but here our interest is this conveyor belt it is fed over here and then it is taking the whole thing and from this concept a route will have to be done and then only the design can be done.

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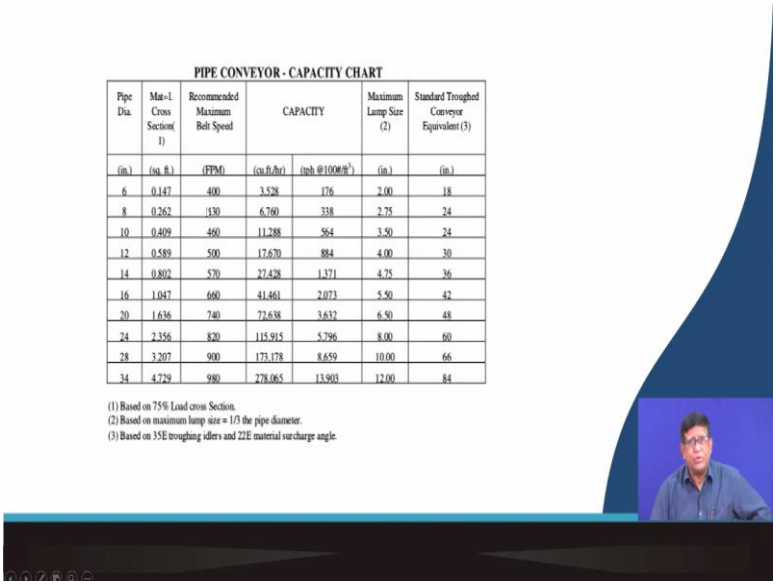

PIPE CONVEYOR - CAPACITY CHART

Pipe Dia.	Mat=1. Cross Section(1)	Recommended Maximum Belt Speed	CAPACITY		Maximum Lump Size (2)	Standard Troughed Conveyor Equivalent (3)
(in.)	(sq. ft.)	(FPM)	(cu.ft./hr)	(tph @100#/ft^3)	(in.)	(in.)
6	0.147	400	3,528	176	2.00	18
8	0.262	130	6,760	338	2.75	24
10	0.409	460	11,288	564	3.50	24
12	0.589	500	17,670	884	4.00	30
14	0.802	570	27,428	1,371	4.75	36
16	1.047	660	41,461	2,073	5.50	42
20	1.636	740	72,638	3,632	6.50	48
24	2.356	820	115,915	5,796	8.00	60
28	3.207	900	173,178	8,659	10.00	66
34	4.729	980	278,065	13,903	12.00	84

(1) Based on 75% Load cross Section.
(2) Based on maximum lump size = 1/3 the pipe diameter.
(3) Based on 35E troughing idlers and 22E material surcharge angle.

So, that capacity chart because that mine they wanted to travel or make a 700 ton per hour they wanted to transport and then we can find out that what will be the optimum solutions.

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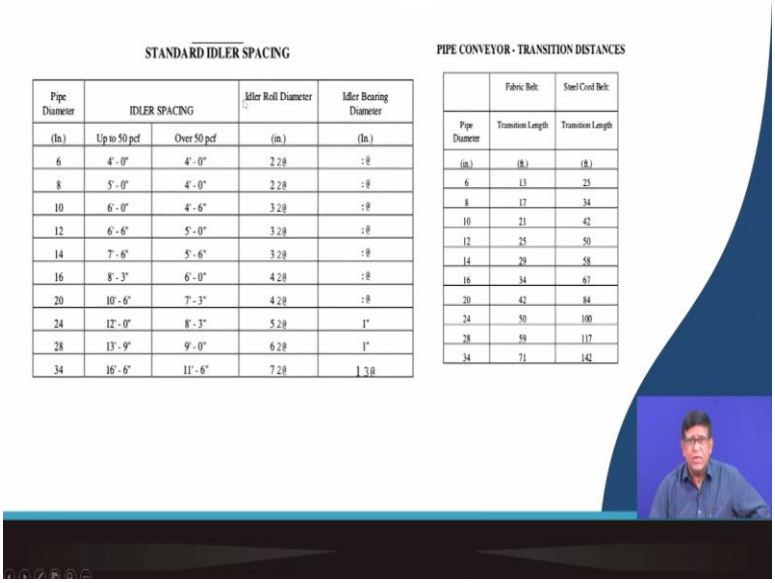

And from those standard calculations we need to find out that how many idlers will be there, what will be the spacing will be there, how many trestles where the support these are done in a real life calculation.

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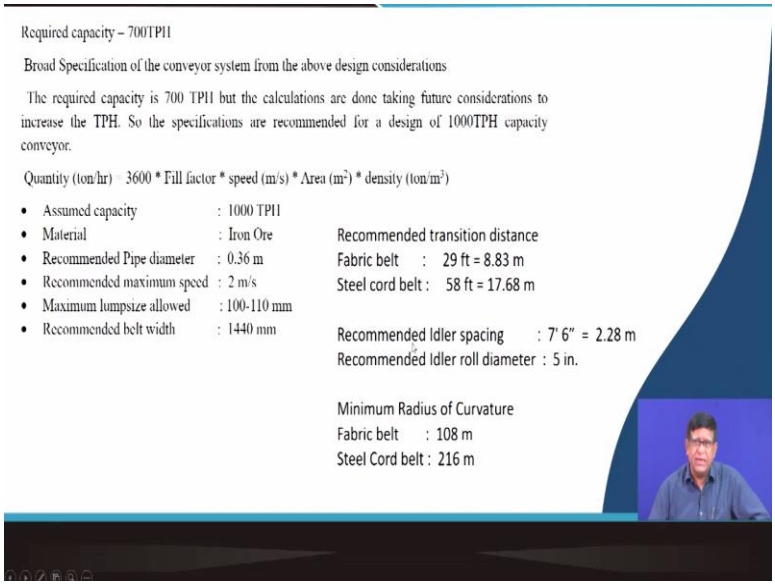

So, that the broad specimen that is for taking out that quantity say 700 ton per hour we can with the properties and all everything given we can find out a recommendation that this fabric belt of 8.8 meter that it can be used as steel cord belt of this transition distances can be taken over there and idler spacing we could find out that 2.28 meter idler spacing can be possible with a 5 inch diameter we could thought of that.

And then the minimum radius of curvature there will be maintaining in that route could be decided. So, now these type of recommendations need to be developed while you are doing it.

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So, there are number of references are there I wish that this is just an introduction of how a system for a real life applications can be developed.

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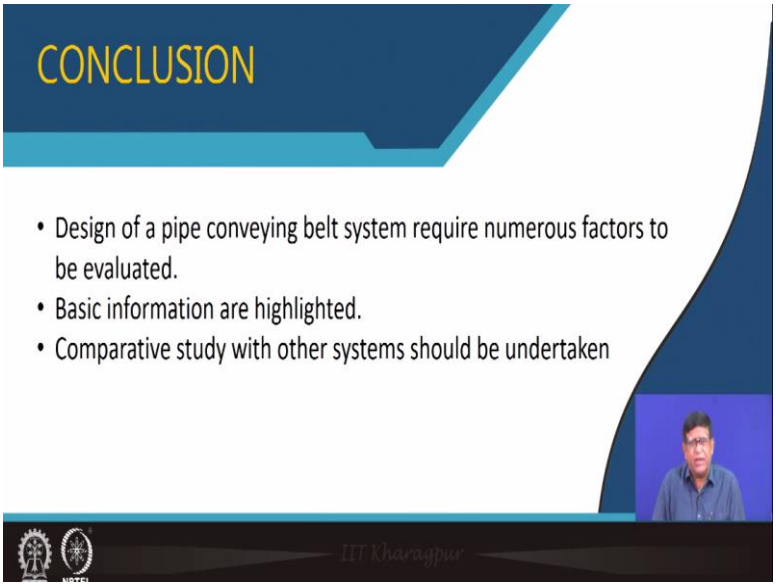

That your design of the pipe belt conveyor will require number of factors to be evaluated and basic thing is there, the capability and the strand of the conveyor belt and the route design that determining the route is the very first point and then the basic information I have highlighted over here and what is most important is whenever you are going to select a system new system we will have to have a comparative study that why we do not go by conventional truck system.

Why we do not go by conventional your other trough belt conveyor system, why do not cannot use their rope haulage or other system. So, this is an example of using pipe belt conveyor in a real life situations, however, I have not discussed here the detail designing of it which is not within our scope of our this present study, but to keep you a general awareness such type of system and then there is a lot of applicability particularly with respect to the present ministry of coals directive that we need to give this first mile connectivity.

And this pipe belt conveyor can take coal from the deep surface mines directly to the thermal power stations wherever it is there. So, there are pros and cons, but can be designed optimally. However for that our country should develop this technology for the plant, for manufacturing those types of belt and also the academic institutions will have to have the facilities for testing this type of belt for its life and other things.

So, when such type of new technology is coming, a lot of initiates should be there in the industry as well as in the academic R and D activities. Thank you very much.