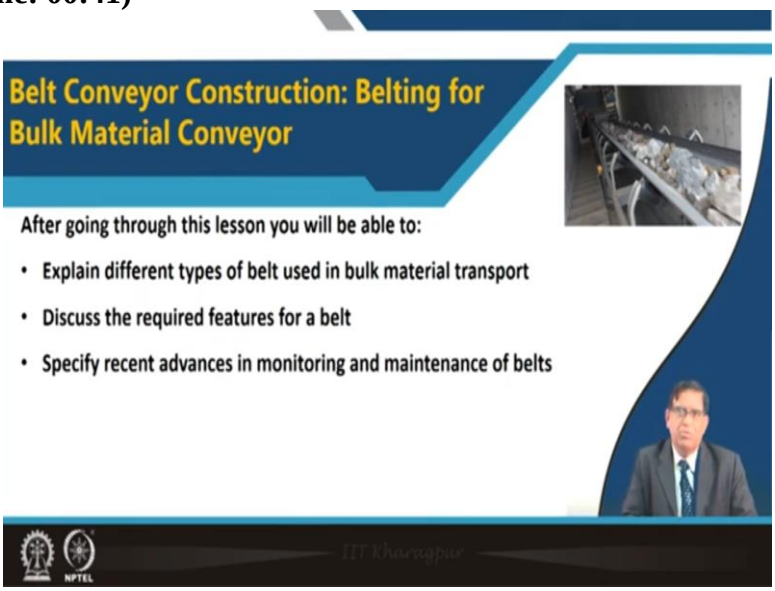
Bulk Material Transport and Handing System
Prof. Khanindra Pathak
Department of Mining Engineering
Indian Institute of Technology - Kharagpur

Lecture - 07
Belt Conveyor Construction: Belting for Bulk Material Conveyor

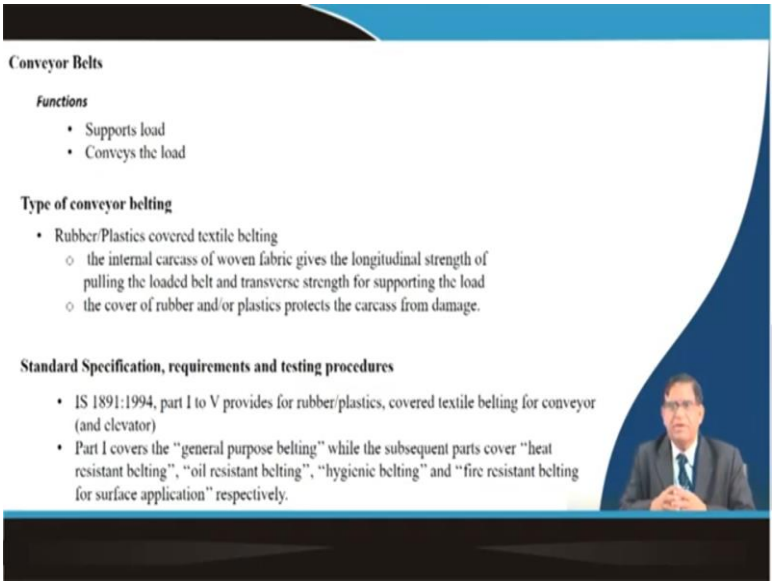
So, welcome come back to our today's discussion on the belt conveyor. In the last class we have discussed about the different types of belt conveyor. Now as you know that the main component of any belt conveying system is the belt. So, today we will be just discussing some of the important aspects of this belt.

(Refer Slide Time: 00:41)



So, that after this lecture you should be able to explain the different types of belt used in the bulk material transport purposes and also you should be able to discuss the what are the things required for a conveyor belt installation and also we will be pointing out and bringing out some of the recent developments in belt monitoring and so that you can take up some of the exercise regarding how you can improve the belt performance through advanced monitoring.

(Refer Slide Time: 01:30)



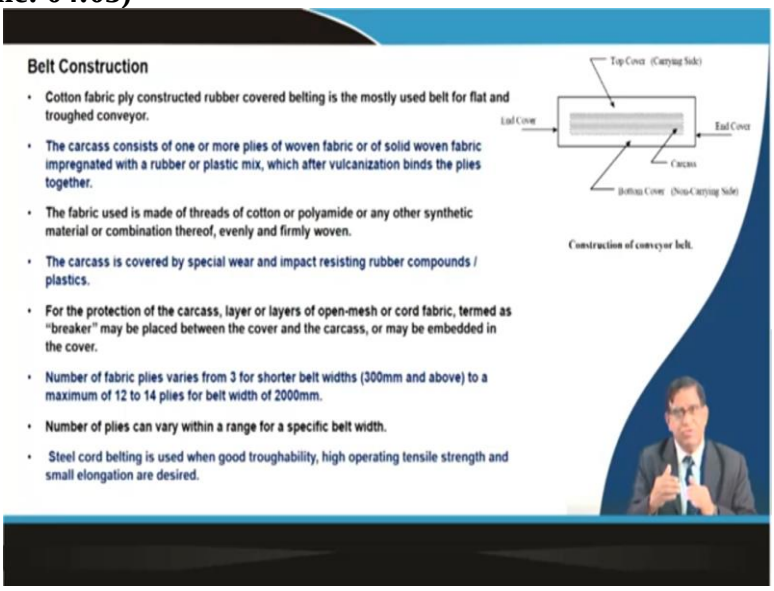
So, as you know that is a conveyor belt what are its main functions? It is exactly it will have to support the load and then convey the load and while that it will also have to for movement whatever the power required that will have to be also taken on it that is it is also working as a that is for the driving the conveyor belt it will be working as a part of this friction drive. So, it will have to transfer the power from the pulley to the belt for its motion.

So, now for doing this the conveyor belting can be made by different types of material that mostly you are having this you might be seeing the belt looks like a rubber or a plastic belt and if we see the construction of this belt there are the basically we will be having the carcass part and cover part. So, we will be discussing now what are those constructional components of a belt whether which we normally say is the rubber or a PVC belt.

But other than that there are belt conveying belt which are made of steel, steel plates and also sometimes there could be different type of constructions of the combination of chain and plates. So, those are specific conveying machinery but for the belt driven or the whether it is rubber or a PVC type of belt which you have seen in normal conveyor belt which are also covered in that our international standards.

Some of the standards you will have to look forward to that this number you may note it down IS 1891:1994 which has got 5 sections and they deal with what should be the design and what are that exactly any manufacturer who will be manufacturing some conveyor belt or whoever will be doing some of the components design they will have to follow these standards.

(Refer Slide Time: 04:03)



Now as we say that the belt constructions in the figure you can see there is a central part which is the main we say it as a carcass this carcass is the to proper strength of the belt will be coming from how structure of this carcass is made and then it has got a top cover and the bottom cover and covers. Now these covers are that which is exactly protecting the carcass and making this belt usable for different purposes are very important.

Now this cover which can be many a time some polyamide, amide then PVC then rubber different types of materials are there. And as in our previous class we discussed that there are some special purpose rubber we need to make it a wear resistance, fire resistance all these things are exactly provided with the help of having this special design of this cover part. Now if we see that the carcass it could be consisting of made of fabric.

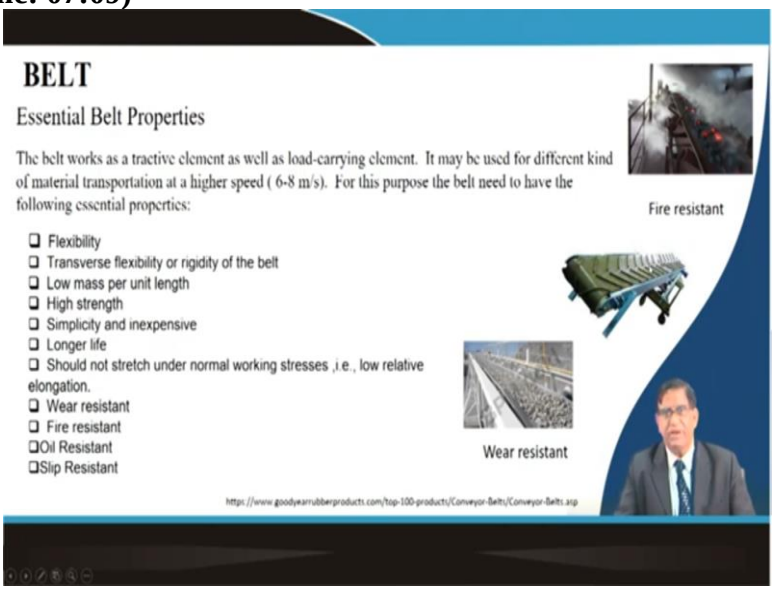
Where that be a 1 layer of fabric we take or 2, 3 layers can be made together which every layer will be said as a ply when we can have a multiply where they will be exactly combined together to give the necessary strength and then just like you are in a cotton we have got a horizontal and they say transverse member like that in any fabric this conveyor belt carcass also having these 2 members put together and giving that necessary strength.

Now there is also the protection layer when you are talking about it, it will have to be tested and then it while providing this it should retain that expected property of the belt now the belt will be moving around the pulley so it will have to have a flexibility the belt will have be on a

making a trough so it will have to withstand transverse rigidity and that this flexibility that properties should be there.

And then the belt will be having a that is it will be subjected to a tensile force. So, when it will be operating at that time it should not get elongated much. So, those properties are very, very important and for the withstanding taking the load and the thread your how many number of plies will be there how exactly the tension will be developing over there on the belt this will be coming in our belt design calculations conveyor design calculation we will be discussing with this.

(Refer Slide Time: 07:09)



But as you know here the main properties that a conveyor belt will have to give is the flexibility the transverse flexibility or rigidity of the belt that is important then your low mass per unit length one important property is if the belt weighs very if it is a very heavy then taking the load on a when it will have to be driven at that time the motor power requirement will be very high. So that is why for a given carrying capacity as minimum as possible the load or the weight per unit length of the conveyor belt will have to be made less.

And but at the same time the strength must be maintained. And another thing is it should not much elongate or it should not get stretched. So that because if it gets stretched the strength will get reduced so that why for a given load under that load it should not stretch or that your elongation should not be much at the same time when we are talking about this bulk material handling conveyor belt we will be drilling with a very highly abrasive say rock mass.

So, under those things if your surfaces prone to get worn out very quickly then you will have to replace the belt very frequently the belt replacement is say 2 types of cost because the it will be the whole system your production system will get closed because of that the time it will take a time to take the belt out and replace with a new belt. So that is why the frequency of the damages to the belt and the frequency of replacement of the belt will have to be that is very that is less exactly your time of service of a particular belt will have to be longer.

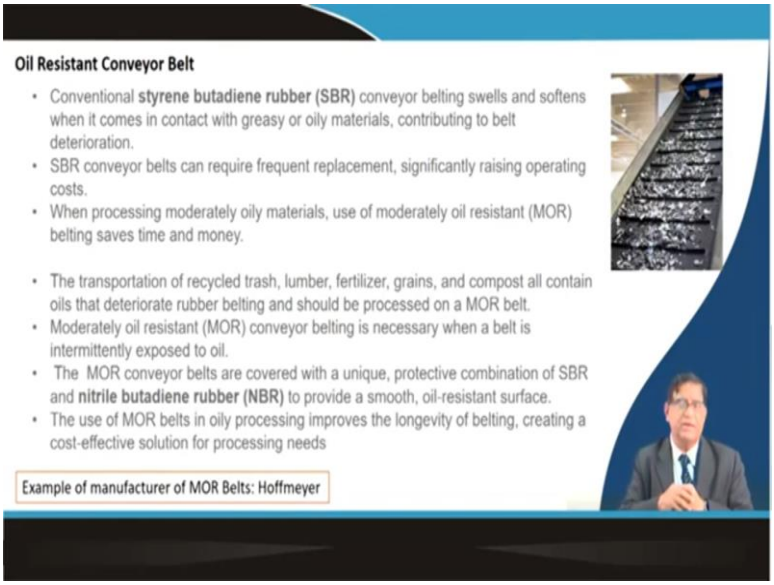
And for that it must be wear resistant material. So that the wear and tear does not take place sometimes you will be handling say in this case you can see sometimes in our mining where we are doing in coal mining, coal mining in situ they are under fire those coal will have to be mined and put it over a surface to carry. So, such type of situation that what type of belt will withstand that? So that is the challenge of having a fire resistant conveyor belt.

And a many time they say it has happened because the conveyor belt surface is made with PVC or with the rubber material and under some mining conditions if they get pulverized those pulverized mass when because of the friction that heat is generated under that heat at the time it can catch fire and such type of fire has diminished number of belts in the there are a lot of history of that is in a mining industry that conveyor belt caught fire.

So, we will have to have a special type of belt for that then also it should be oil resistant that oil resistant is some of the material some of the rubber material they exactly swell and they behave differently with oil. So that while carrying out certain materials that your conveyor belt it is should be made of such type of rubber whether or not the cover should be such that it will never get damaged due to particular specific type of oil.

And the slip resistant is as the material sometimes we will have that highly flammable material also will be carried over there. So, the material must be retained so you can see here that conveyable surface is made with a; which type of things should it has made rough and so that the material does not slip. So, these wear resistance that slip resistant, fire resistant these are the belt will have to be used.

(Refer Slide Time: 11:26)

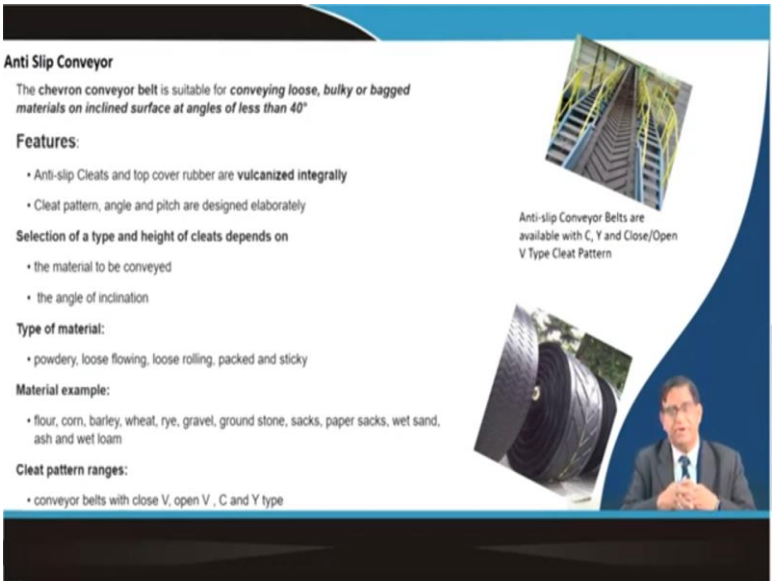


As an oil resistant conveyor belt it comes in different industry it becomes required particularly this when we talk about this SBR rubber material that is your styrene butadiene rubber if particular specific rubber it swells when it is a coming in contact with grease and oily material. So that which will be leading to a belt damage. So that is why such type of rubber are not used in some specific so where you need to handle some of this debrises and all coming from a plant.

Which is to be discarded or in the waste dump when you are material some of the solid waste materials you are carrying by a conveyor belt that type of conveyor belt will have to be designed with some oil resistant rubber. So, this is another thing is this you for moderately oil resistant belt are nowadays available which exactly use instead of this SBR they use a different type of rubber which is nitrate butadiene rubber they say it is.

And those compositions are manufactured this they say bulk material handling or as a designing a bulk material handling system you will have to look into those type of properties. So that they will be compatible with the material you are transporting.

(Refer Slide Time: 12:58)



And as I said that in the anti slip conveyor belt number of belt manufacturers they are giving C, Y and V type of the surface roughening and with that they give this glitch on the conveyor belt which exactly serve your purpose so that you can maintain the productivity because if there is a slip of the things materials flow rate will get reduced. So that is why there you will have to be careful about selecting the belt from.

Now these are depending on that what type of material to be carried your belt will have to be selected the type of material if we say the powder or loose say for example a belt for carrying conveyor or the carrying coal or a belt for carrying this some centers they will have to be different and this is where we need to take care of in designing and selecting the belting part. So, they say there are a number of industries particularly in food industries you will have to carry material like your rice.

And then sometimes your finished products and now you might be seeing that how while if you go to a factory for say Nestle where they are making this Maggie or that they are making the chips over there how these materials are being carried as they are coming as a bulk they are carrying over the conveyor belt there. Exactly the property for maintaining the hygiene the belt surfaces will have to be so that material does not get stick.

And then say and so that a remaining food product if it is touching over there it becomes dirty it will be very difficult for maintaining the quality of the food. So, there the belt surface should be very easily cleanable a different type of belts are used for those purposes.

(Refer Slide Time: 15:00)

So, we have also some of the special belts in the mining or bulk material handling in plants particularly this high angle conveyor, cable belt, RopeCon, and pipe belt which we have talked about earlier. Now they are the beams that are how this type of special belts will have to be manufactured. So, these are the belt with that your sidewall you can see that this corrugated sidewalls are given and then getting that thing with the flexibility.

Now the manufacturing process of these are very interesting that is not within our preview but you should see that now what is necessary while selecting such type of belt when they will be delivered to your place how will you store them and then when you will be going to fit them into your installations that joining these belts together that is also an area where one need to be very careful.

Because the joining the belts together is a very critical because if you do some mistake there you may face a lot of trouble in operations. This cable belt were in Nalco the main journey we talked about these belts have got a special type of the systems is they can see here that in the belt they have got a the shoe type you have got these 2 groups that means this belt will be running over this wire rope now so that this wire rope can have a grip over there.

So, these types of special designs are made for the cable belt conveyor. Similarly when you go for seeing the RopeCon where there are wheels these are exactly within the belt that is which has got as this type of sidewall belt but they are inside a shaft is gone and both sides there are these wheels and this is a static rope unless is in a cable belt. This rope is moving where this belt is having a grip over here.

But here the rope is a static rope and this wheel is moving because that with the end pulley just like any conveyor belt drive this conveyor belt is moving but instead of idlers in as you have seen in other normal conveyor belt here no idlers but this rope now the belt when it is running over the idlers, idlers in the belt there frictions will be giving some resistance and more power is required.

So, when you are using such type of belt because it is running the wheels are running with the on a wire ropes and then that can be made with some very good elastomer where the friction will be very less and there will be very less wear and tear of the wheel also and by that a huge quantity of energy saving will be there and also for the whole system there is no need of so many idlers which are a replaceable part a lot of still are getting released from the system.

So, this is a recent development last 10, 15 years it is being used in different parts of the world. So, these are the type of belt when it is to be manufactured over there the whole system exactly that it may be if we can make this type of belts more the cost benefit and sometimes some of the conveyor belt industry may get exactly getting that things become obsolete just like our tape recorder, gramophone on all those things become obsolete someday.

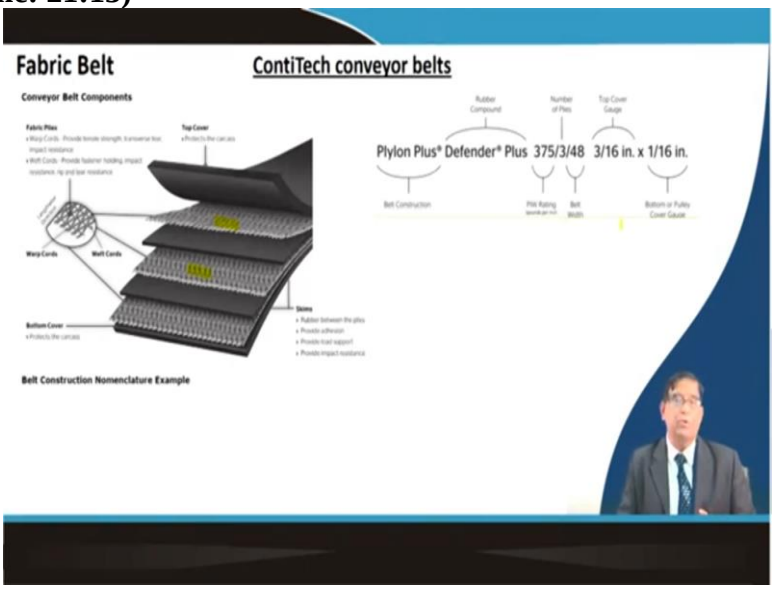
Those conveyor belts which are being used now in our minds may get obsolete because of such type of development. As one such developments has come on this pipe belt conveyor. This belt conveyor is because our for environmental protection purposes when this conveyor belt are not getting the material in the open form. Here what is being done such that you are having this conveyor belt with the idlers which are here.

They are giving us a hexagonal idler that instead of your trough idler of tree we are having a hexagonal idler where the belt is getting formed in the form of a pipe. So, this exactly within this idler when the belt will be running the belt will be running as a pipe that what happened at the end the belt comes and then they will make a just like this over here. It will be getting cover like these things it will be of course there it is such that you can fill that the material will be filling up inside here material will be here inside.

So that closed pipe conveyor but such type of belt when it is to be constructed you can see that these are all steel cord or a fabric a special type of that care have to be taken in designing. So that if it is going over there while running between the antlers and all it should not get opened when this belt is made they just they are getting pressed over there if they become loose and then if the material can spill over that will be very difficult particularly when the belt will be running and then taking a turn over there.

There is a chance or that this is the pipe will get twisted and then if they get open up material will fall down. So, they are not only the how you design the layout of the belt how you design the curve along with that the designing that is a selecting the right belt and their characteristics and properties are very, very important. So, this is one thing which is necessary.

(Refer Slide Time: 21:13)

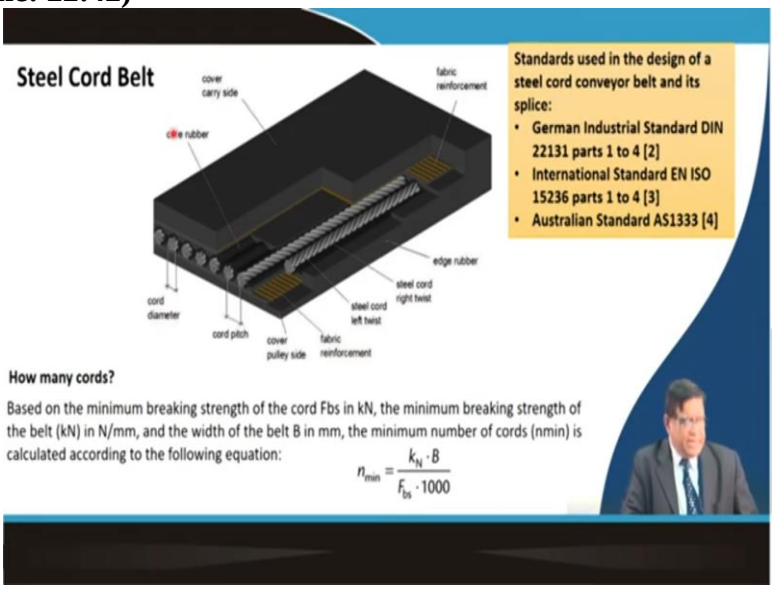


Then you can see here that the fabric belt in a fabric belt there are layers of this fabric they are having this horizontal member and the that is the longitudinal member the transverse member which is called your weft and there is a longitudinal member called your warp they are made together at just like your clothes and then there are a number of them as a layered form. And then we can see over there they say your this layer.

And this layer are fabric layer and in between there are these rubber and then this top covers are there as well as there will be the side cover. So, these types of belts are very common used in many industries. And then they are exactly the dimensions or that nomenclature it come that depending on how the belt is constructed and then what type of rubber is being

used. And then what are that exactly the rating of the materials over there and then the dimensions all are given this type of specifications are there. So, when you are in a particular installation you need to see these specifications.

(Refer Slide Time: 22:42)



Because selection of the conveyor belt and then replacement of that it will be necessary but in the other type of belt say for example in the mines where your heavy material will have to be carried out the fabric belt they may not be with standing the necessary strength for that exactly. So that is why that steel cord belts are used now in the steel cord belt you can see here that we are having a longitudinal member is steel wire rope.

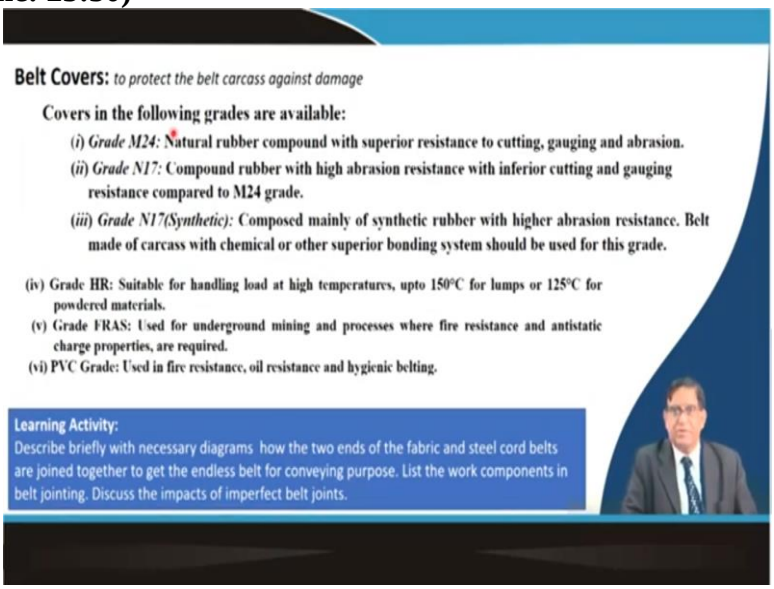
We are having this steel wire rope that your, this steel wire rope is running and then we are having a horizontal fabric reinforcement in between and then there is a you can see over here this is a we have got edge rubber, top rubber, bottom rubber and then they 2 members they are exactly pressed together. Now this type of steel cord belts which are used for example in India the first user was Neyveli lignite Corporation where they used originally about 1400 millimeter with a conveyor belt of steel cord design.

Today there using about 2400 millimeter now why such type of steel cord belts are used? Because such belt can carry 1000 ton per hour over a length sometimes more than 1 kilometer. So, this steel cord carcass they will not get elongate and but they will maintain the flexibility and rigidity equally. So, this is one of the very important belt that being used and such type of belts are mainly originally it was coming mainly from Germany.

And then there are certain standards the German standards and international standards and Australian Standards these 3 standards are followed in manufacturing such belt. Then exactly one important thing is there that how many number of cords will be necessary? The number of cords necessary will be depending on that. What is the breaking strength that is minimum breaking strength of this cord that is the steel wire ropes their breaking strength.

And depth of the belt that belt will have to have certain minimum breaking strength these 2 will be the guiding factor for determining the total number of these cords. And here this formula you can find out the ratio of this 2 breaking strength and the width of the belt that gives the total number of cords which will be there for designing of a belt.

(Refer Slide Time: 25:50)



Now the belt cover will be protecting the carcass so here you can see that there are different type of cover material because the wear resistance, fire resistance, slip resistance different material will be giving you different type of natural rubbers are used. Now the synthetic rubbers are used and also they have got different grades. So, you will have to select the material for getting this material one learning activity you can do it over this during your study time that is described briefly with necessary diagrams.

How the 2 ends of the fabric and cord this steel cord belts are joined together? Because they will be different that method is called splicing how you do the belt splicing is very, very important. Now also for jointing or the splicing is belt you will have to take a number of very careful steps will have to be taken because if you do not do it properly there will be number

of problems. So, you please make a study activity to find out that how this fabric belt or the steel cord belt will be joined together and then they will be spliced.

(Refer Slide Time: 27:10)

Now these belts will be coming with different widths in our belt calculations conveyor belt calculation classes we will be discussing how we determine the width but one thing you remember that there are standards widths available and it is always even if you calculate the required width for your particular installations. But you will have to take up from the available standard sizes from the market.

Now this belt splicing that is the 2 ends of the conveyor belt can be just connected by metal joints by clip that is called your metal fastener or belt joint clip your such type of clips are given and then we can have a 2 ends into together but most important here is that the both the ends and that they will have to be perfectly square that is when you cut it you will have to very carefully may see the alignment of it.

And then if you do not make it a perfect square you will have that the belt will get skew wrong. And then sometimes it is also called that is your cambering, cambering of the belt is exactly your when you will be if this is skewed that is there is a little difference between that is that while joining it has given a little misalignment then over a length if you put after that when you open up and put then you will see a curvature is coming.

Now if a curvature is coming that in that say particularly if I will show you hear say if a belt is laid and then you can see that this belt is having a curve type of things because of this

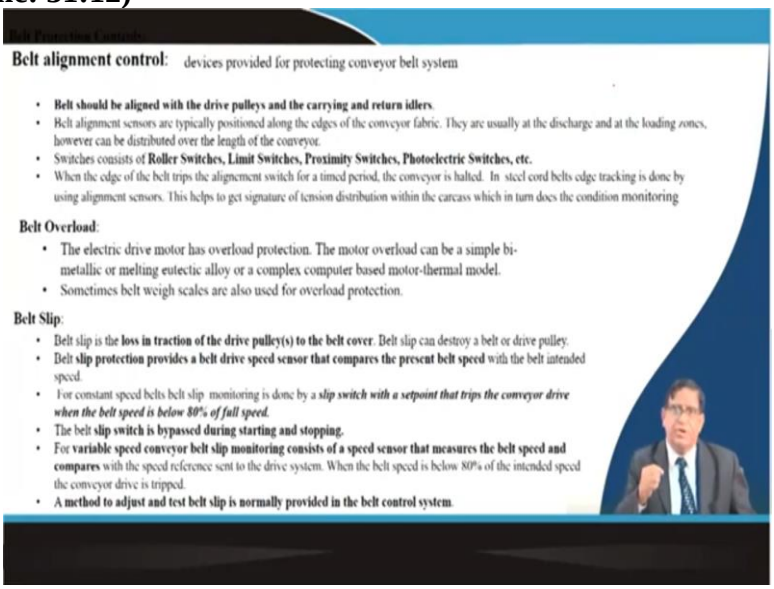
improper jointing you may see a curve like this. Now if you see here join 2 points along this distance you will find that there is some gap is coming over here. Now this exactly in perfect case it should have been a perfectly straight if you lay the conveyor belt on the ground it will look like a perfectly straight.

But because of improper jointing if you just develop that on a ground you will find that there is a curve coming over there and that this is your camper which is coming and then there is a permissible limit of that so that why you need to be very careful in joining this belt. Now the other thing is that when it is a steel cord belt your steel cord belt when they are to be joined together that you about 1 meter of both sides are stripped off and the steel cords are taken out.

And then alternate cords are cut by cutting that and then you can just match them together in such a way so that they will be laid properly. So, each of that your one, one will be cut and then this curve one will be fixed together and they will be given and then it will be vulcanized for vulcanizing that same material it will be plate and then we can do 2 type of vulcanizing a hot vulcanizing or cold vulcanizing.

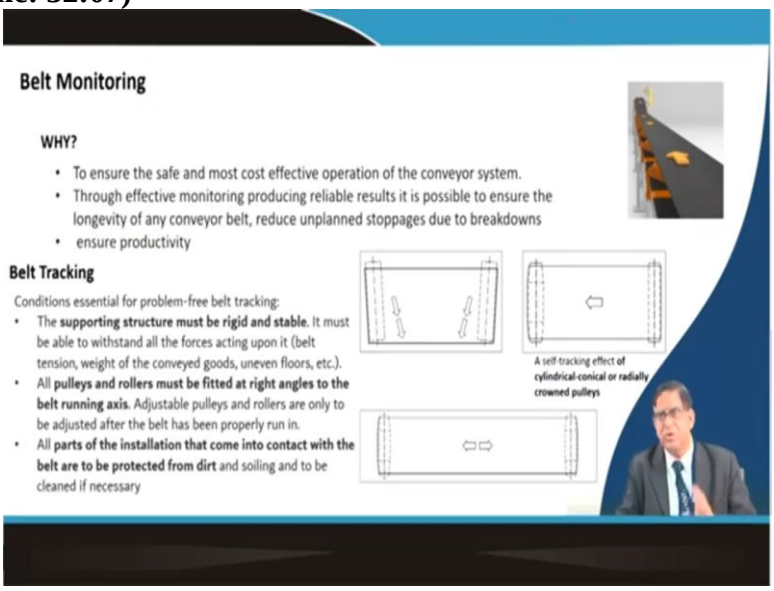
But for vulcanizing there you need to get elaborate arrangements it is a costly affair under a constant temperature and pressure the material the top cover material will be placed over there and then they will be kept for about 48 hours to 72 hours sometime and then this will become perfectly as there is a you will not be able to identify where the joint is. So, such type of very good quality jointing can be available through vulcanizing.

(Refer Slide Time: 31:12)



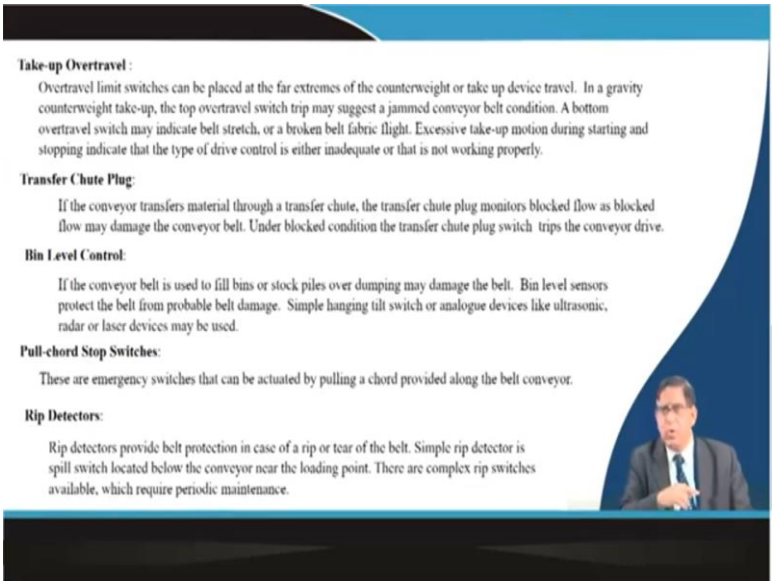
Now there is a one important thing in running a belt is your that alignment that belt will have to be properly aligned. And for that purpose your that pulley on which the both the end and pulleys will have to be perfectly that squared. So, this aspect is very good and very important for maintaining the belt we will be discussing that in our belt maintenance but the belt slip is one another problem that is if there is a that it should not slip. That means then your the driving pulley and driven pulley both should run at the same speed if it is not that means the belt is getting a slip. So that belt slip monitoring is a very, very important aspect.

(Refer Slide Time: 32:07)



Similarly in a belt monitoring you must see that there is a belt is running through means that is the central line of the belt and the central line of the that is a lines joining the centers of the 2 end pulleys should be same and then for doing that there are the method which is followed is called belt tracking in sometimes for the tracking of the belt you use that a that cylinder conical pulley at one end that will be having a self aligning force will be coming to do it over there. Now this belt tracking is a very important aspect.

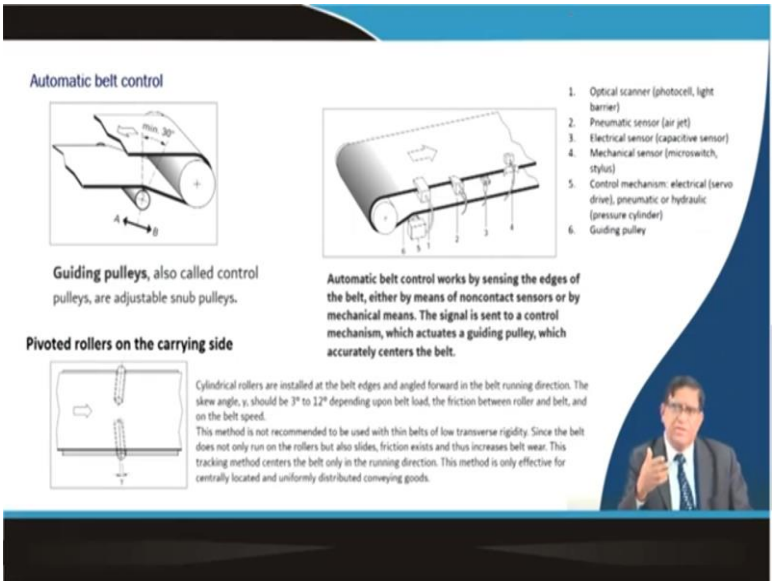
(Refer Slide Time: 32:50)



Similarly, when you are monitoring you will have to monitor about the take up over travel in the construction we said that the belt tension is enhanced by the belt take up now if sometimes the take up is coming more than this, that means the belt will be going a very high tensions. So at that time there will be damaged so because of that the tension is properly maintained. So that the take up is not come over travel that is to be monitored.

Similarly, at the transfer should there should not be any plugging that should be monitored then when it is being loaded by a bin that the material flow from there that will also to be monitored then if the belt will have to be stopped at an emergency situation at that time there is a control switches that are given at the side of the conveyor belt the cord will be there you will just pull under emergency it can trip the driving motor. And it can stop similarly if the belt get cut at some point then if you do not stop the belt then the cut will damage the whole belt at the time. So that is why they are a rip detector is very, very important.

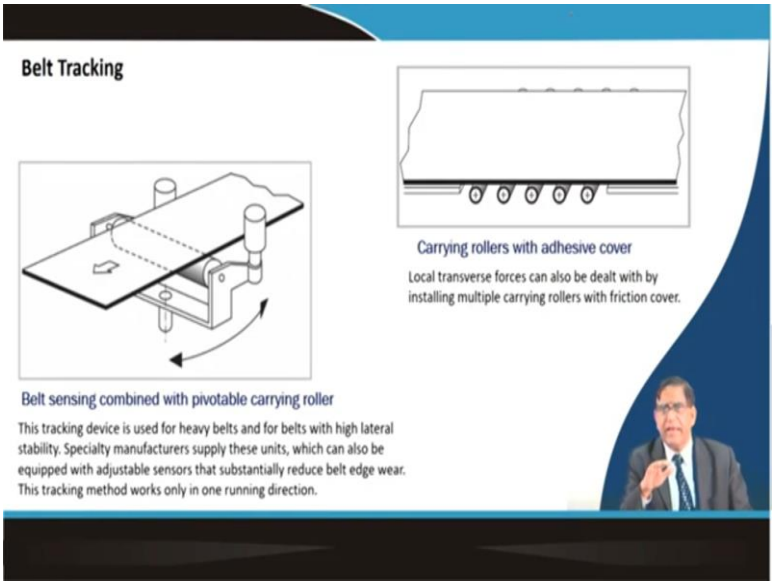
(Refer Slide Time: 34:07)



And today the modern machine instruments have come for automatic rib detector that is you can you can for controlling the belt you can have a different type of arrangement like your you can have a guiding pulley one pulley can be kept that will be guiding over there then these different type of sensors they are put together. And then if there is a; that this guiding pulley which is there as an adjustable snub pulley by proper control of that you can make the belt to run true.

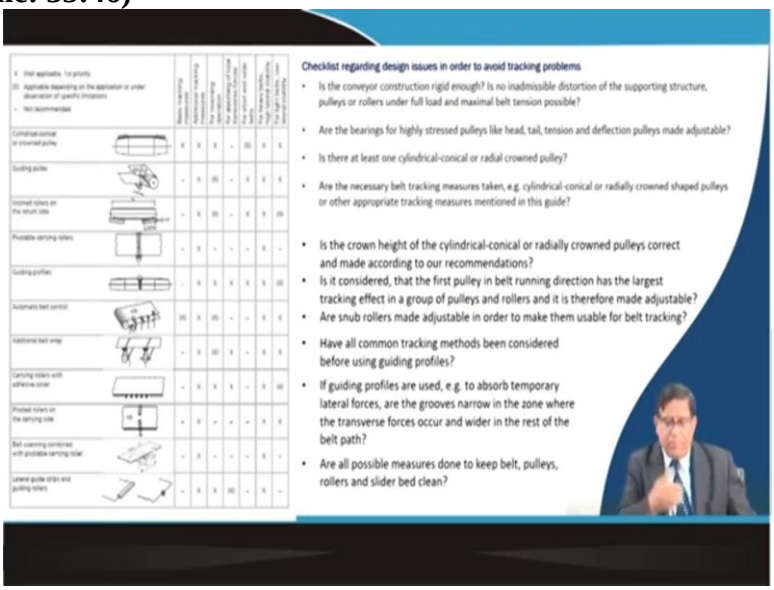
And for doing this in the automation number of sensors take the things that if it is going that is not running true and then accordingly they make the adjustment to the guide pulley and bring the conveyor belt into the proper such type of automated systems have now-a-days available then other than that some of the automatic without having much electronics and all if you put this pivoted rollers in front of that is your the first carrying roller. Then it will be guiding the conveyor belt into the through running conditions to belt will be tracked.

(Refer Slide Time: 35:18)



So, the belt tracking is a very, very important area and there such types of self aligning idlers are used for doing so that if the belt goes this way and it will be put into the proper form. So that sometimes if you are giving some adhesive roller into the carrying roller they also help in keeping the belt running true.

(Refer Slide Time: 35:46)



That means it will not be swinging to the sides. So, there are a number of systems available you can prepare such type of table in which different methods of tracking the belt and then where they are used their characteristics can be studied over there. So, this exactly while designing and while installing you should make a checklist that what are the design issues regarding the belt has been taken properly taken care or not.

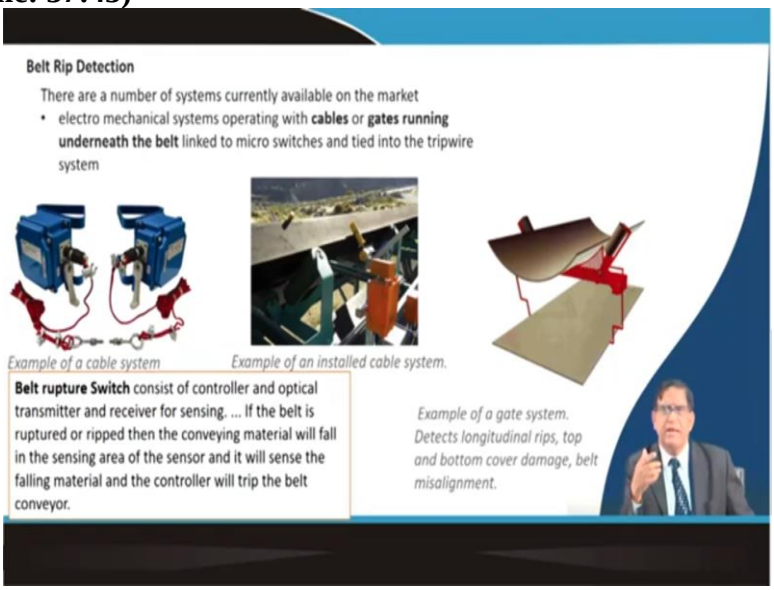
So, this type of checklist you can make by yourself but what are the type of questions you need to ask that is the conveyor construction rigid enough or it is no inadmissible distortion

of the supporting structure pulleys or rollers under full load of maximum load tension possible because if your conveyor belt run this way or that way then it will hit the structure and then the structure will get damaged.

So, have you ensured that your conveyor belt will be running true and it will not damage the structure then whether this all the bearings say in the idlers that your bearings in the pulleys in the gearbox in the motors all these things then your that tensioning arrangements wherever they are there they should be properly adjustable bearings are always prepared for now whether there is a cylinder conical or a radial crown pulley for self aligning purposes.

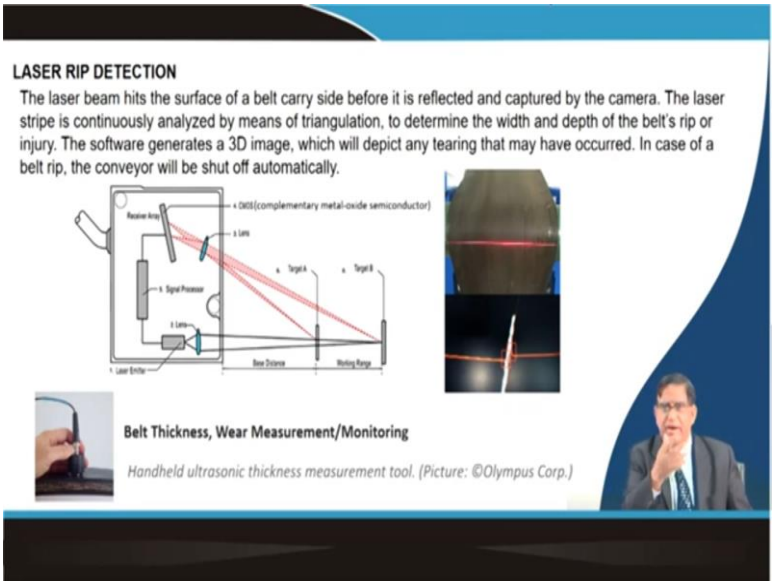
What provisions have been given? Those are exactly done at the time of whenever you do a conveyor belt installations these are things like that. Now other necessary belt tracking measures how you have been introducing different type of instruments then have all the common tracking methods being considered before using or not.

(Refer Slide Time: 37:43)



So, this is the way exactly in the work it is done but for rib detections now it is modern equipments have come for your belt rupture switch they put it over there and then if any material fall on this then they will be tripping over there. So that means if the belt is getting rupture somewhere or it got cut or made a hole if the material is falling a long cable will be placed over there it has sensors if any material is coming over there they will be exactly working to trip the conveyor belt. So, such that type of rupture switches are placed in some of this conveyor belt.

(Refer Slide Time: 38:23)

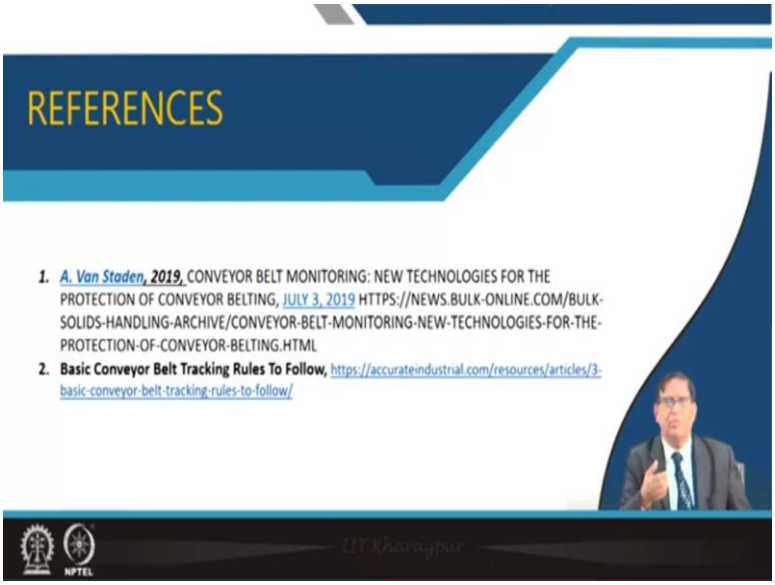


There are also methods for sensor a loop systems you can put that exactly the sensors are embedded into the conveyor belt if any damages are there then they can exactly detect and do it. So, these type of developments have taken place which you should have a look into it, it is just for your general information I am telling that this a laser rib detection is another development which has come what is done here.

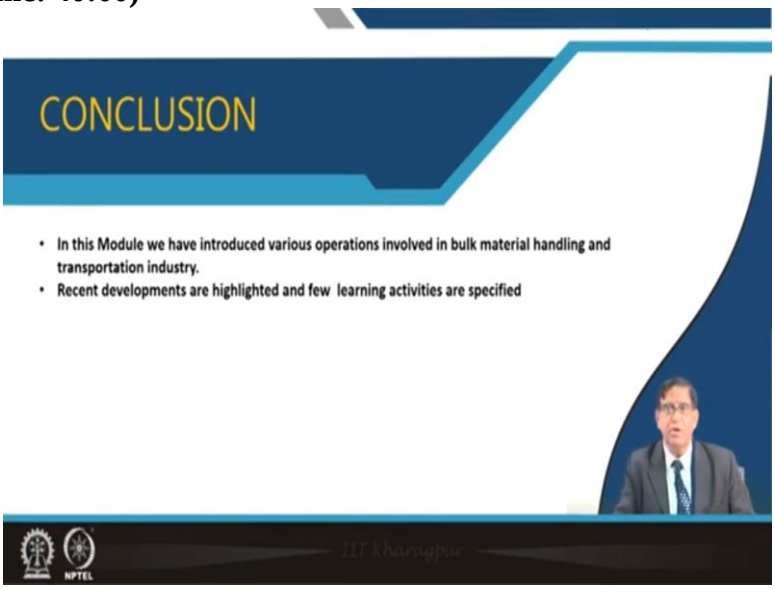
Exactly a laser beam is placed over there and if there is any crack coming in that the reflected light it will be sensed over there and from that a 3D image will be created and they will be telling a crack has appeared as soon as they will see that there is a crack they will be tripping the drive of the things and people will attend it and then they will find out. So, exactly locating that when the track is coming at the because the conveyor belt is running over the pulley.

So, at the end pulley they are giving this keeping laser beam and with that there collecting it. So, these are some of the new innovations which have come up in the conveyor belt. Similarly, there is, also acoustic sensors by which you can measure a weight and the thickness is being if the belt is getting worn out. If some of the plies are getting damaged then the thickness of the conveyor belt will reduce. So, there are ultrasonic devices for measuring this thickness and you can do it over there.

(Refer Slide Time: 39:57)



(Refer Slide Time: 40:00)



And this can also be automated to know it. So in a nutshell there are different methods of our belt monitoring has come. So, basically it is a today you have got a general view of what are the different types of belt covering necessary and also that how the present trend of development is there. But as a learning exercise you should be able to tell that in case of your bulk material handling what type of conveyor belt you will be using.

And what type of monitoring systems you must keep? So there particularly the maintaining the belt running true that means the central line joining the centers of the end pulleys and the centerline of the conveyor belt should be same and if you can run the conveyor belt in that conditions a lot of problems will get solved. So, thank you very much. I hope you will be taking up the learning exercise and then that work will be completed. Thank you.