Mining Machinery
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Module - 01
Lecture - 03
Introduction to Machine Elements

Welcome, today in our this lecture on Mining Machinery, I hope you have now studied about this introduction of mining machinery. Now, in this class we will be discussing about the Machine Elements. So, all these mining machinery they are made of number of machine elements.

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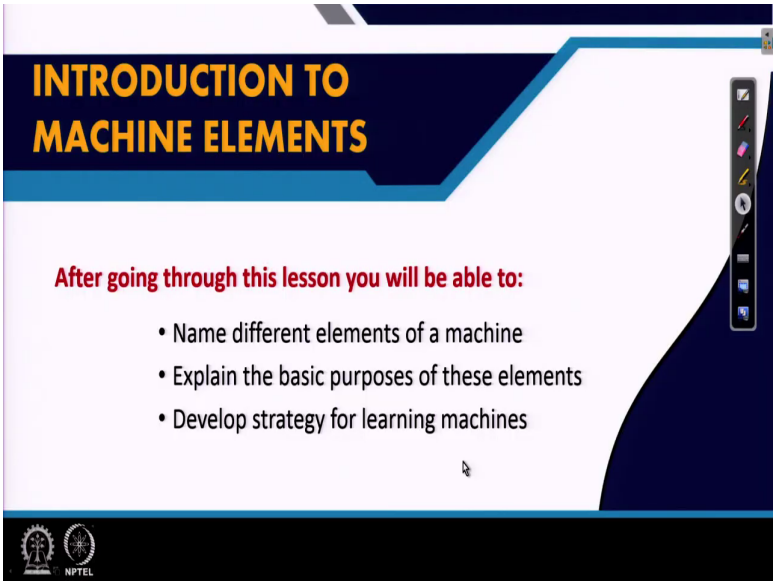

So, I understand that you have studied your basic mechanical engineering and electrical engineering part. So, before going to the discussions of the machinery we will have to just

know that what are the important elements that makes these machines. And we have discussed about how the mining machinery are different from other machinery, we have discussed about the special requirements and characteristics of this machinery.

So, this machines are built and designed the with certain components. Now, how those components will be working? To know much better way we will have to have a basic understanding of the machine elements though we are not going to the design aspects of these elements, but just for a general information you must go through these areas. After this lecture you will be able to name the different elements of a machine and you will be able to explain the basic purposes of these elements.

And also you will have to develop a learning strategy for this mining machinery. How in which way you will be exactly getting your expertized developed on using the knowledge of mining machinery for real life business.

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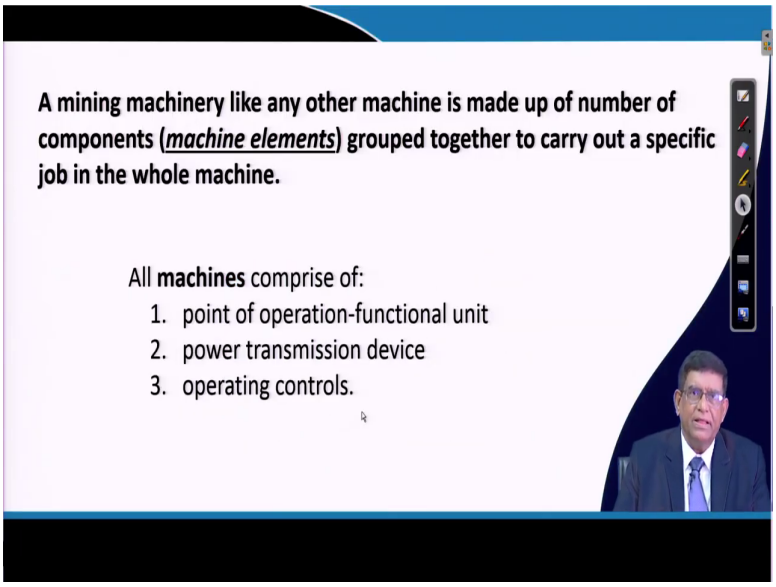

So, for that you know that mining machinery like any other machines is made of this component which we are calling it as a machine element. Now, the machine exactly it is made up of some point of operation or functional units. So, that is say any machine see even if you talk of your sewing machine, in that what is there? There is a point of operation is the needle which is moving up and down and that is the main functional unit.

And there is a power transmission system is there in your sewing machine when the tailor is pedaling from there how with a you can see that is there is a belt or a rope to use for transmitting that power and ultimately that your power from the pedal is coming to the needle and then there is a operation control. You can see that in a sewing machine you can adjust that what should be the length of the that needle work.

So, that means, there is a in any machine whether it is your washing machine, whether it is a truck or whether it is a mining machinery. It will be comprising of it is a point of operation where the main functional elements will be interacting with your purpose and then there will be a power transmission and operating controls.

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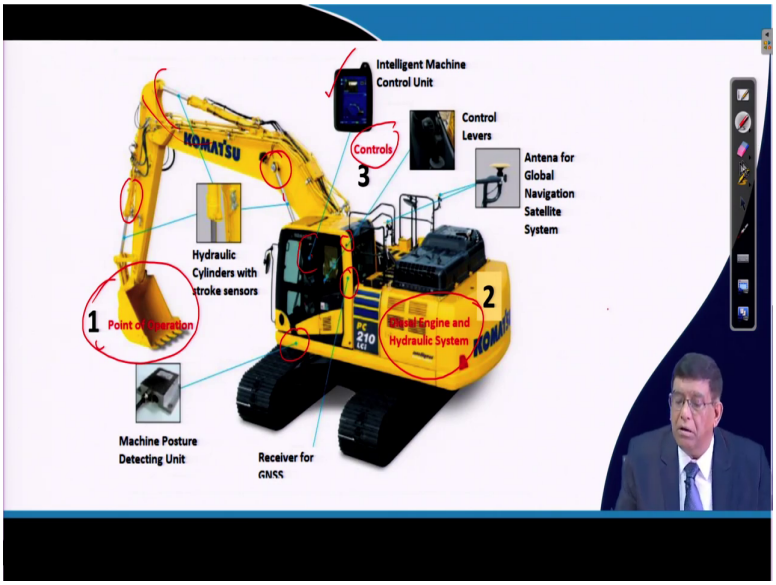

Now, if we see a mining machinery or it is also a construction machinery of a modern excavator this Komatsu company, that say one of the biggest mining machinery manufacturing company which have developed. Now, all this man less that is automated trucks and many other things that they have introduced the advance technology into the machinery.

Now, you can see here in that as basic elements I told there will be a point of operations as you can see here there is a in the you can see this a point of operation here is your the bucket

so, that any excavation work will be done from here. And as I have said that control they have got a lot of things that these operators which is controlling from here they have got an intelligent machine unit which you can see here.

This intelligent machine unit is exactly operating by keeping different sensors at different places and then it exactly gives a warning and signal to the operator and then he can exactly work over here. Similarly, this whole system they have got number of things. You can see here that for controlling it there are some sensor locations at different locations these sensors are kept by which there exactly global navigation of satellite system they are getting.

So, that means, this shovel it knows that where the dumpers are there when this truck will be arriving to it. So, that it should be ready for loading then by before the truck comes it can prepare its other activities so that the optimality in the operations can be achieved.

And here the 3rd unit is your main diesel engine and hydraulic system, which is the diesel engine is here which is giving the main power and the hydraulic system is there which is exactly generating that power for working; and from there the fluid is going you can see the for whole control of this whether the boom is rising and lowering where there is a your bucket is a giving a rolling back or this reaching actions or this whole thing is a exactly giving its expansion depending on that how it is working.

So, now you understand that this you this is a you can go now through this type of machines exactly will be working on the number of different systems you can see here.

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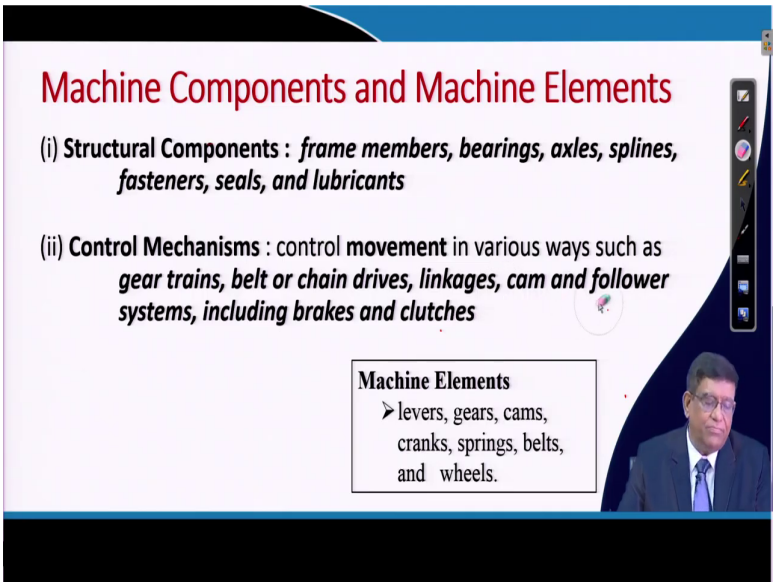

So, you can see these machine components and machine elements if you here there are different structural components and the control mechanisms. Because when we have said that is a any machines are having the main three component some structural components; that means, all this these devices all its a the machines should at to stand and to move and to walk for that a structurally it should be suitable for working and that is comprising of the frame members, bearings, axles, splines, fasteners, seals and lubricants lot of things are there in making that structure.

And that control of movement that is where we will have to how the power will be given and it will be going that is done by your this gear trains, belts, chain drives, linkages, cam and follower systems and brakes, clutches. It is the basic machine elements you might have seen over there.

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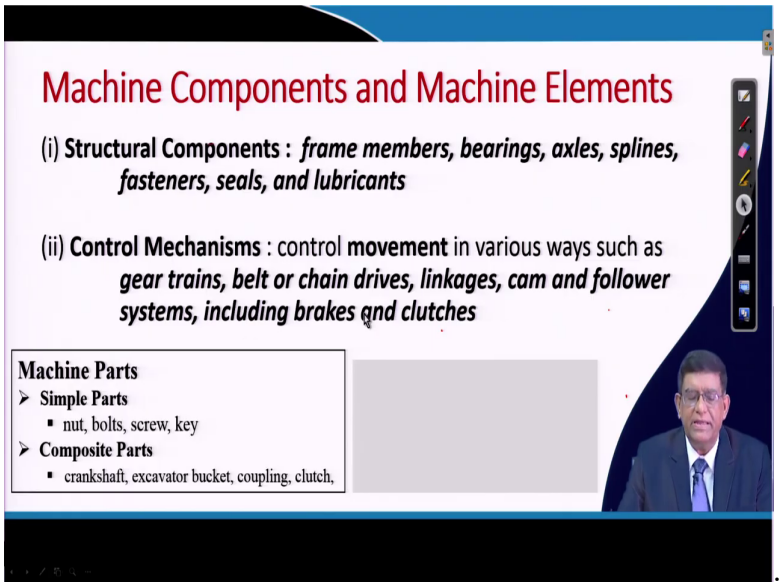

Now, see in a machine element and there are lever, gears, cams, cranks, springs, belts and wheels, which you study in your 2nd year mechanical engineering papers these elements are thought.

And then machine parts you need to know in your engineering drawing class you might have drawn this nut, bolts, screw, keys and then some of these main components of basic parts like crankshaft that excavator buckets, coupling, clutch these are some of the basic components depending on the specific machinery you will have to learn.

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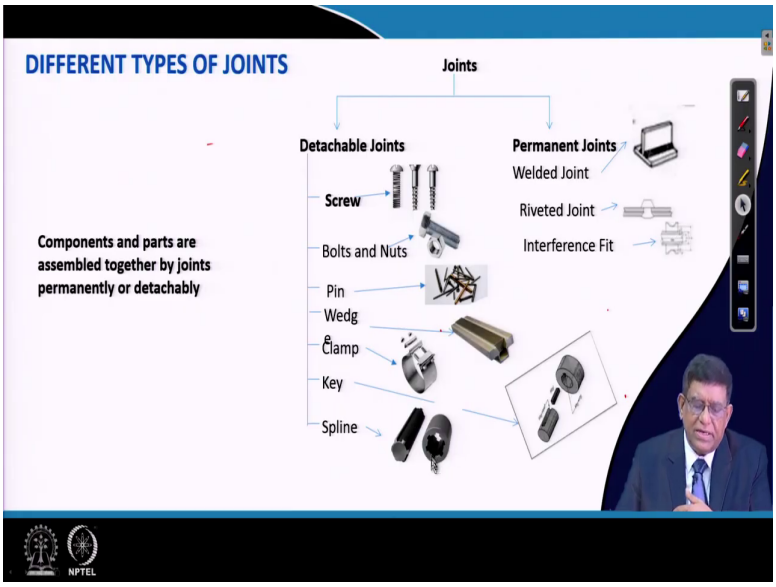

So, now while constructing the machine you will be finding that there will be different type of connections are there different parts will have to be connected together. Now, there comes these joints and while connecting or jointing these two different parts there can be a permanent joint or there can be a detachable joint. In the permanent joints you might have already heard and seen many places that the welding joints are there that is to permanently you are joining by welding.

You may be knowing that is a welding is one of the very important and very lucrative job. Exactly, a welder if he is a very good welder specific welder like under water welder they earn about more than 7000 this say dollar US dollar per year so, ordinary worker and then this a welder. If you think of that welding of difficult metals like the aluminum or aluminum alloy

they cannot be very easily welded. So, some specific special type of welding systems are there.

Similarly, some joints are there called riveted joint or interference fit these are permanently joint. And then there are some you temporarily you have all experience of this thing you know screw, bolts and nuts you have seen different pins connecting pins you have seen, I think in your watch steel watch you can see that watch different straps are connected with a small pin that is also a just a jointing different straps on your watch chain that is also by pin.

Similarly, there is a wedge, wedge type of joints are there clamps are there you have seen your clamp I think in your engineering drawing class, when you are fixing your this drawing sheet on to the board it was also a clamp. Same thing is there in a if you go to big machines and big construction sites there will be different types of clamps. Then there is a spline you can see here where two parts are to be fitted inside this there is a these are called a spline type of joint.

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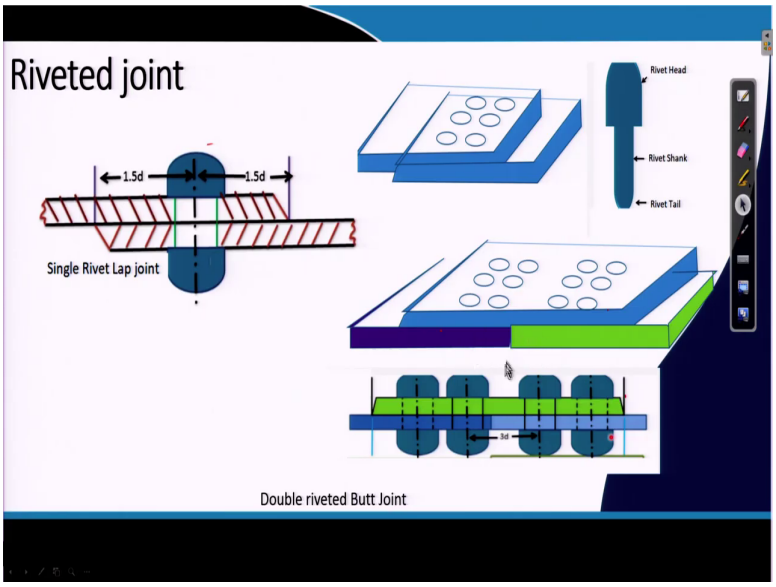

So, these different joints are there. Now, what is a riveted joint? A rivet is a small piece of item that is like that is has got a rivet head, a rivet shank and rivet tail. Now, two plates are there that is if this is to be join together that what they do? Just put this a your rivet inside and then you connect the tap shielding it over there you join it.

If you have seen the Howrah Bridge you might have seen that lot of portions are coming those are riveted joints in those which are made in the early of the 20th century. That type of bridges where constructed which are still going strong and then very good. Now, those riveted joints because in why exactly those bridges are riveted joint not welded?

Because the bridges and all that thing they undergo lot of vibrations. Now, wherever there is a huge vibration are there it is exactly the best way to give a permanent joint is the riveted joint.

The riveted joint can be by two ways one is called you lap joint when two plates are just lap overlapped each other and then you are giving a joint or it called a butt joint.

In a butt joint these plates say the green one and the violate one these two plates are to be join end to end then your what is done? A additional plate is kept over here and then we have got this two row of that your rivets are done together this type of joints are called butt joints.

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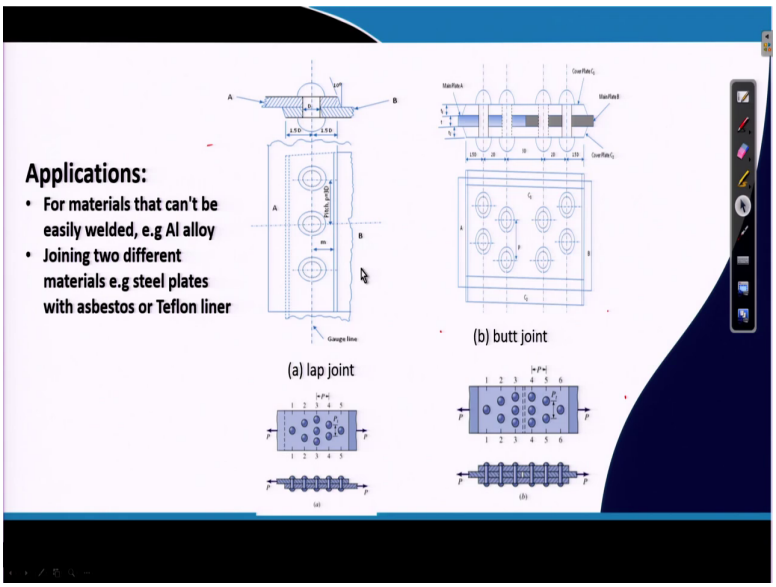

So, you can see here that the riveted lap joint and butt joints they can do that can be done the butt joint can be done giving two plates one at the top one at a bottom by that way. So, there could be a different type of requirements depending on the type of strength it is required you may have different type of riveted joints like your lap joint or butt joints.

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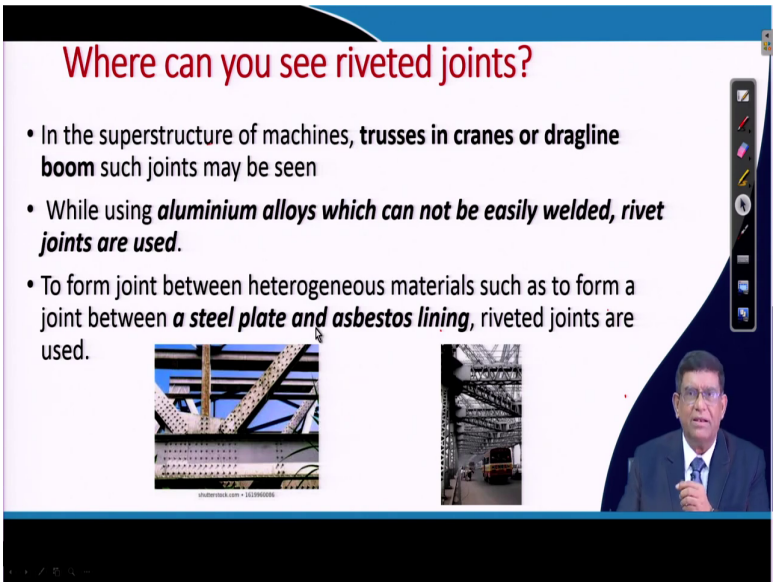

Now, can you see that this type of I think this is a Howrah Bridge you might have seen over here there you can see a lot of there is a butt joints are there. Now, this is exactly that truss or in a cranes you can see in mining machinery like you dragline where there is a big boom that many a time that there riveted joints are there, because those machines are also subjected to very high this vibration load. Now, in sometimes where you use rivet because the aluminum alloys as I said cannot be very easily welded. So, that is why the use this riveted joint.

Now, this a when you have to this is a you cannot weld if a plastic sheets and a steel plate or a steel plate and a asbestos sheet. So, that type of mix material when they are to be jointed there is a special type of welding is done there, but that in and when those special type of welding is not there they can be also riveted joint.

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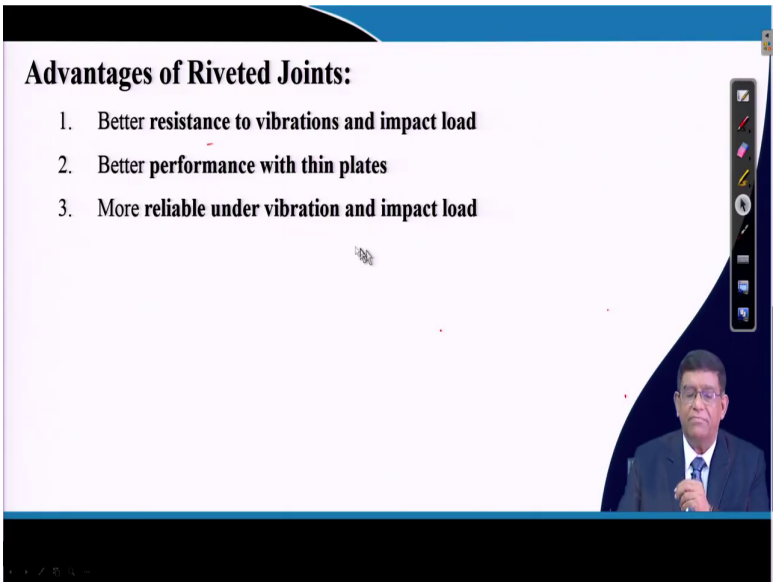

So, these riveted joints are better resistance to vibrations and impact load, better performance with thin plates, more reliable under vibration and impact load.

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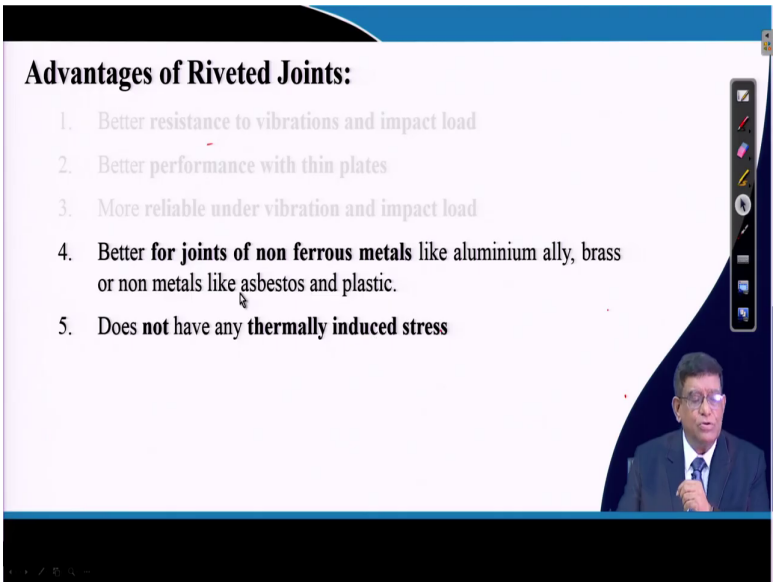

They are having also better for joints of nonferrous metals. So, does not have any thermally induced stress exactly we will find we will talk about that when you do welding it is exactly lot of thermally induced stresses are there.

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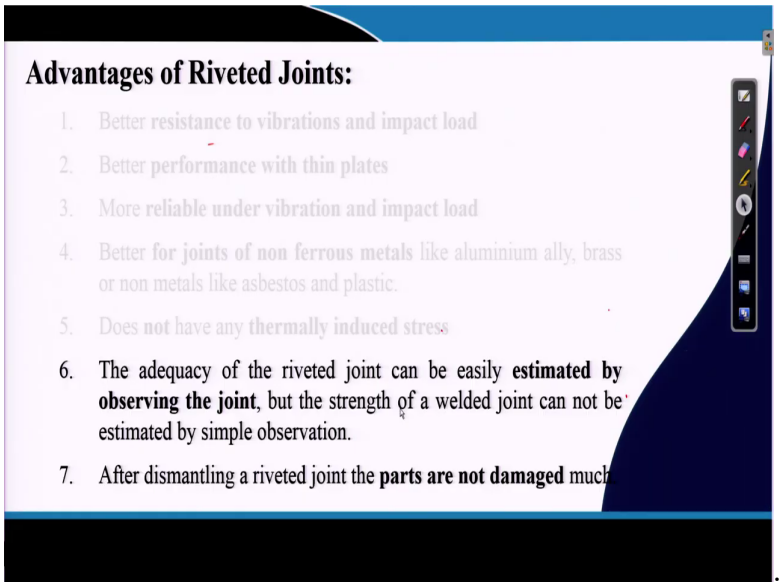

So, the adequacy of the riveted joint can be easily estimated by observing the joints. You can see the joint and by seeing that you can know that whether it is exactly or not, but in a welded joint some time there could be inside it could be very weak or it can be having some problem we do not know and then the by just simply the inspecting you may not be able to find out that a particular joint has become very weak.

Now, why these joints and then a machine is very important is I tell you a small example that sometimes I remember a bucket will excavators with that big boom one boom just collapsed because the joint they are in that particular joint where it was made it was weak there was a crack.

And when they were making a platform to repair that crack at that time when there was a pylon structures there was a boom like that and while doing this inspection for cracking this

whole thing collapse the engineers also died and that machines of about more than few crores of machines were got damaged.

So, that is why in while constructing big machines that joints are very important and you need to study these things whenever you study a machinery. Now, this when you dismantle these riveted joints parts are not damaged because you need to just take it over there, but one thing is there you will find so, lot of holes will be made.

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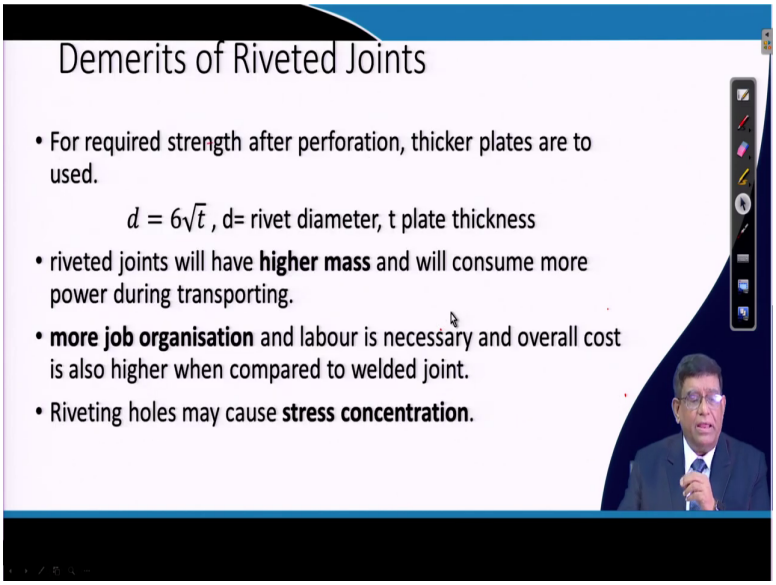

Exactly, when you make a riveted joints you were making a lot of holes in a main parts. So, that way it is the parts get damaged; moreover as you have seen whether it is a lap joint or butt joint that you use an extra plate over there. So, when you put an extra plate; that means, you are going to increase the weight of the machine. And if any machinery which is a moving

machinery if the total weight increases you can easily understand that the power required for moving machine will be increasing.

So, that is why if you are having a very riveted joints the weight of the machines will be more. So, that could be a disadvantage moreover while you are determining that what will be the diameter of the rivet it depends on the thickness of the plate by the formula as you have seen that is your 6 times the square root of the thickness. So, that is why to have a diameter; that means, additional material are more.

So, while exactly if you go for inspecting a machines and then you want to see that, whether it is really its a reliability or its a risky one to analysis you need to understand that exactly when the diameter of the rivets are properly made or not. So, when you will be studying mining machinery and particularly you want to know the safety of the machine you want to access the risk at that time this basic knowledge will be of very importance.

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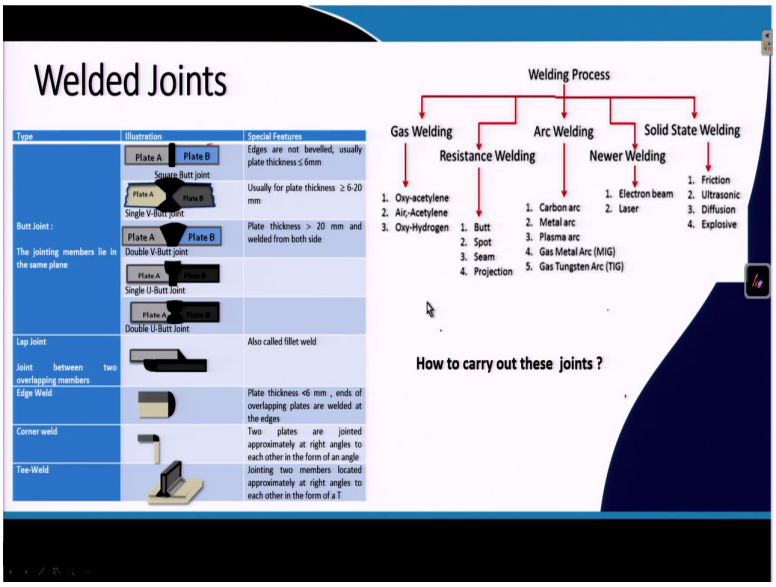

Similarly, as I said that the welding also can be done by a different ways. So, there are exactly in this a diagram you can see how plate A and plate B they can be A square butt joint that is butt joint end to end jointing is done. So, there is a B joint say these two plates have got a big groups and in that group they have done the welding over here. Similarly, there is a single U butt joint there is a group crept over here and then this your additional your welding material they have got fused over here.

So, that lap joint and butt joint and then some time tee weld that is a depending on the type of the machines you will be constructing you can have a different type of weld. Now, how to carry out such welding? How will be exactly two metal parts will be joined over here? There is a wide method wide range of methods of doing this welding over here.

You were you may be knowing about there is a gas welding, resistance welding, arc welding, newer welding, solid state welding and this whole welding itself is a subject in mechanical engineering. A lot of people they develop over here and a new techniques and new methods all the time going on say for example, now we are having say a HPD that is your plastic sheets.

Now, how the plastics can be welded there are some special devices are there. So, this is a strongest weld that is a when they used exactly tungsten inert gas it is say gas tungsten arc TIG, that is tungsten inert gas are welding it is the strongest type of weld it can be, but it is very difficult to do it to that welder he need to get this expertized and that is why they are very highly paid. Now, here many a times when many of your students that studying engineering not necessarily that they can be allow as a designer and all that thing.

If some that engineer they after 2nd year or 3rd year if they feel that they are not going to get a very good degree they can easily go for say, now with the new education policy you can go out learn welding and it will be very good to few thousands of dollar can be earned by those special type of welding.

For example, there is underwater welding I said or that plastic welding or that welding for the aviation industry or welding for the making rockets and there are some very special type of welding. Some of the thing if the one to go it say a multiple exit and entry to engineering courses some people may started that is why this welding is a good area where people can work.

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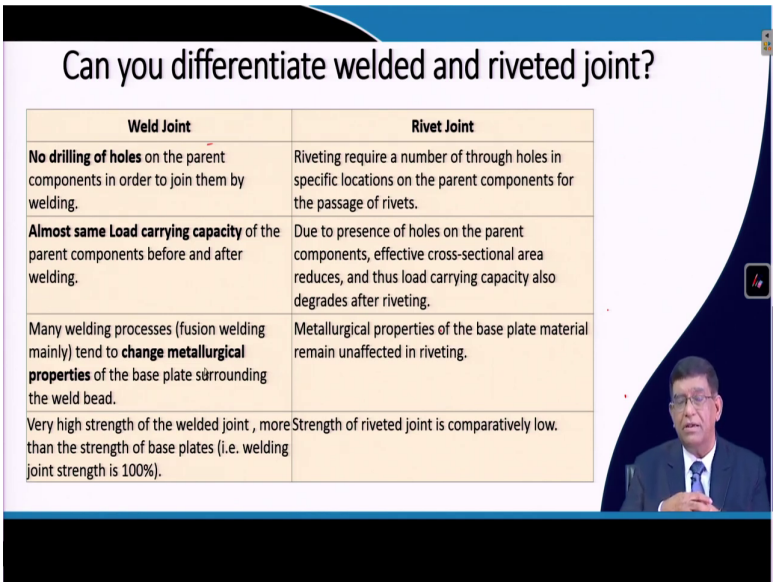

So, now you can you have we have discuss the things. So, it will be an exercise for you please make as an assignment how to differentiate the welded and riveted joint. I have already said some of the points regarding this, but that as welded joint they do not have the drilling that is why they are lighter and there is a less operation.

For if you do a rivet joint then you will have to make so many holes then you will have to make so many plates, so many precision working will be required. So, there is a larger number of man power is also required and material is also required. So, developing a rivet joint will be a very costly for any bridge or any machines.

Now there is a there the load carrying capacity that strength it normally that after the welding you may get almost that the original one, but in case of rivet it will get something reduced.

Similarly, that is your the many welding processes like your fusion welding and all they change the metallurgical properties because they subjected to very high heat and all that.

So, because of that there will be some changes you may find out that if you have studied in your engineering materials class in your 2nd year basic engineering program there you know what is a carbon steel and that steel have got different behavior when they are produced at different temperature. So, if you know that iron carbon diagram and then at a different heat there will be the steel may get change its whole metallurgical properties. So, this is a case with a welding, but such type of things will not happening in case of your riveted joint.

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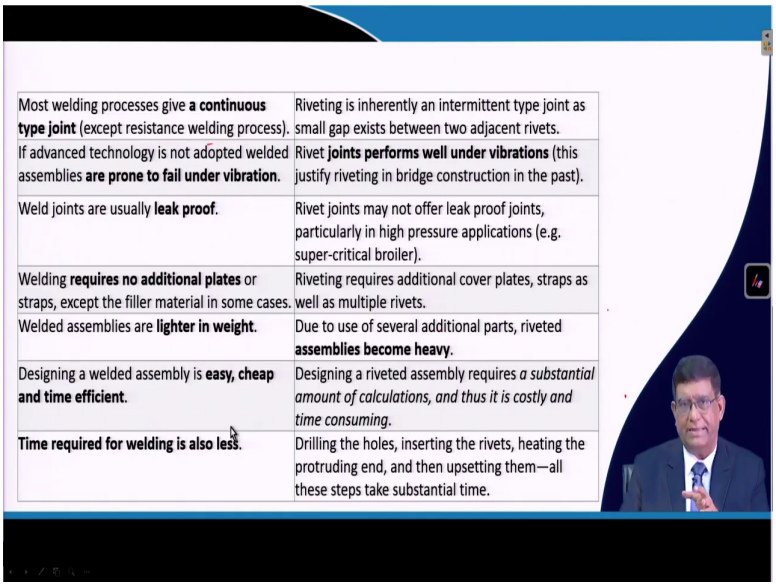

So, you can see that there are a you can get a continuous type of joint in case of welding, but in case of rivet as because you are having these holes and then that you are putting the rivet it is not a continuous one. So, that is why the welded joint will be leak proof, but riveted joint

will not be a leak proof one. So, that is a you that weight and that power consumption for the moving machines as I have already said. So, that is your more the time required for welding is less.

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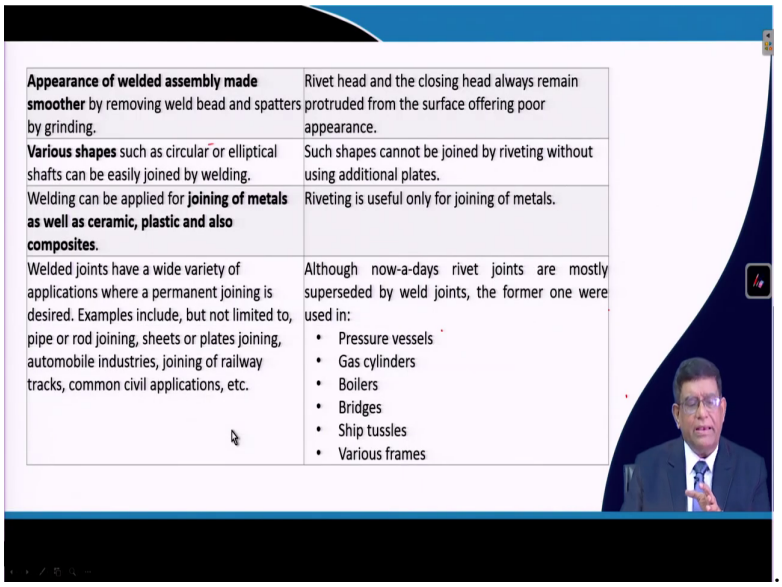

So, there are many advantages of welding at the same time there are some advantages of rivet also. So, you need to have a general idea that wherever it is selected particularly if a you are working with a company to in the designing sections then you will have to go much more over.

But if you are as a sales representative of a very big mining machinery company then when you will be working in the field people will have to be convinced about why your design is better. So, that is why you will have to have this basic information of the basic engineering information.

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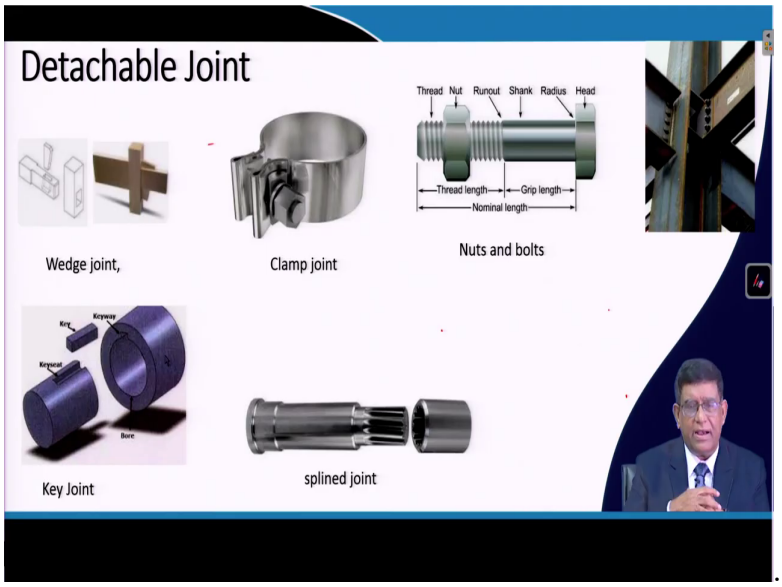

Now, that as I said that there are other joints as your detachable joints. Now, in the detachable joints you can see that there is a key wedge joints are there they have just put the wedge inside it and then they made it tight. You have seen many things in the carpentry you can see such type of joints in many tables and chairs they make without any nail they can make a with a detachable wedge joints.

Then there is a there can be key, key joints is a that exactly how a shaft and a its housing they are connected together then splined you can see there is a groups and this splines are fitting over there clamp you have seen nut and bolts you have seen. I think this type of the diagram it is shown over here, you can see that is by nut and bolts these are say in a bridge such type of joints are also there.

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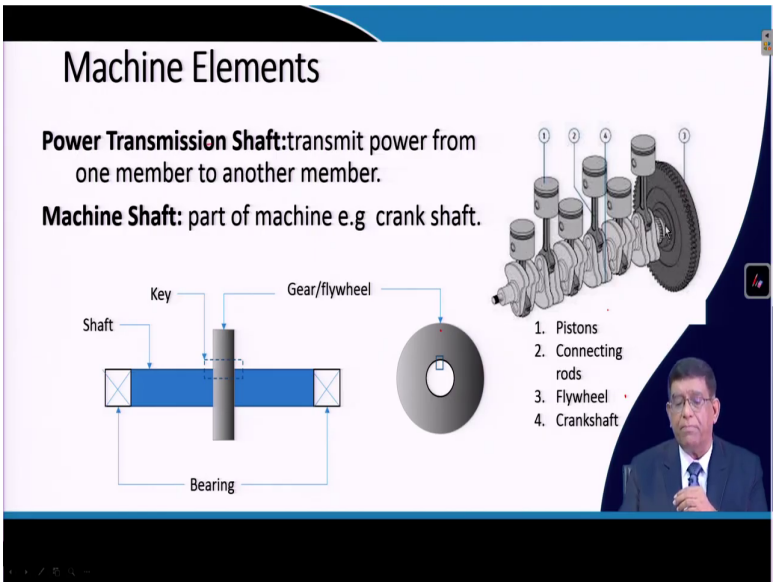

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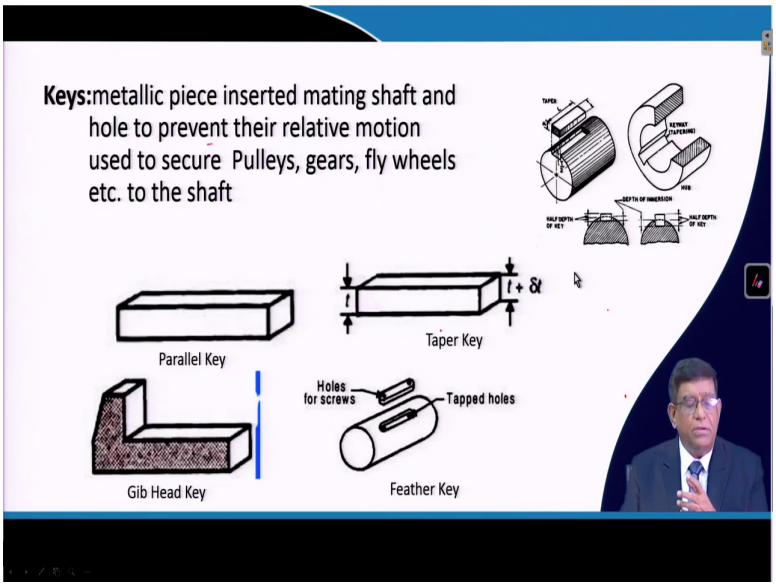

So, this is a detachable joint, but you can see here how they are designed the different type of loads, how it is coming that is only when you want to do a very specific. It may not be coming to the need of a mining engineer, but when a mining engineer to manage the mines they will have to manage the mechanical engineers and the maintenance engineers.

When they bring the maintenance engineering job properly or not you must have this knowledge behind you. Then these other elements you know that the power transmission shaft that is a the machine shaft that how exactly the power will be transmitted that is also known by the machine element. Similarly, you have seen that this a in the different elements in an engine you are having a flywheel that is your from this engine shafts the power will have to be taken to this.

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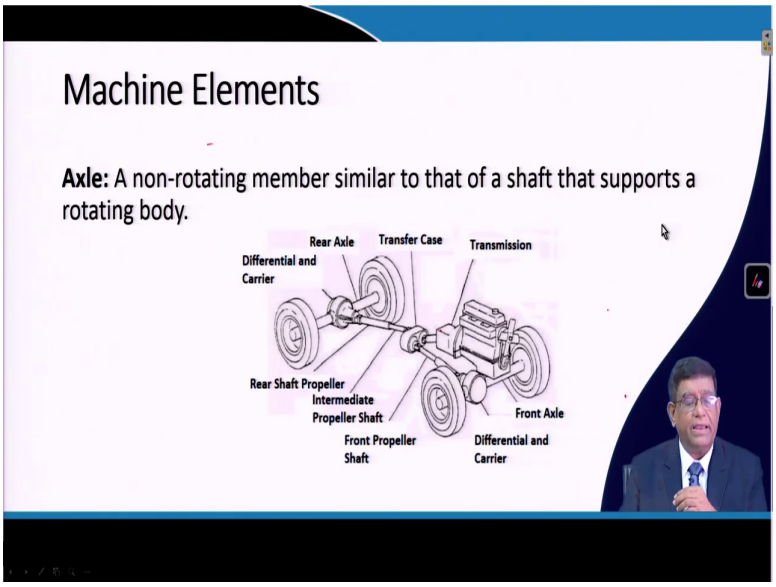

So, that you can see in the machine elements like in a car how the power is going from one end to another, you can see that these wheels are having an axial we have got a propeller shafts then we have got exactly intermediate propeller shafts can be there and then we have got the front axle that your a differential carrier. So, that again a power transmission system such type of elements are made together to work with that.

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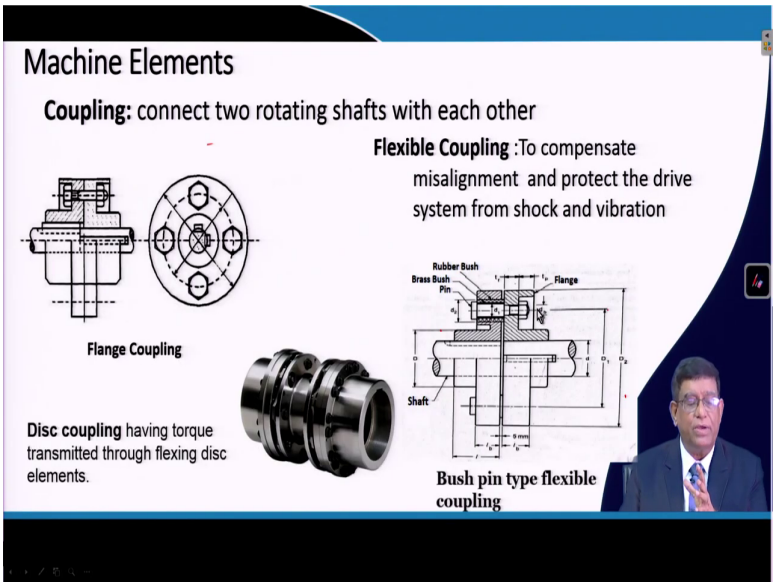

So, then other thing is there in a machines you will be having the coupling when your two rotating shaft a which are at motion if that we given a connections they called a coupling.

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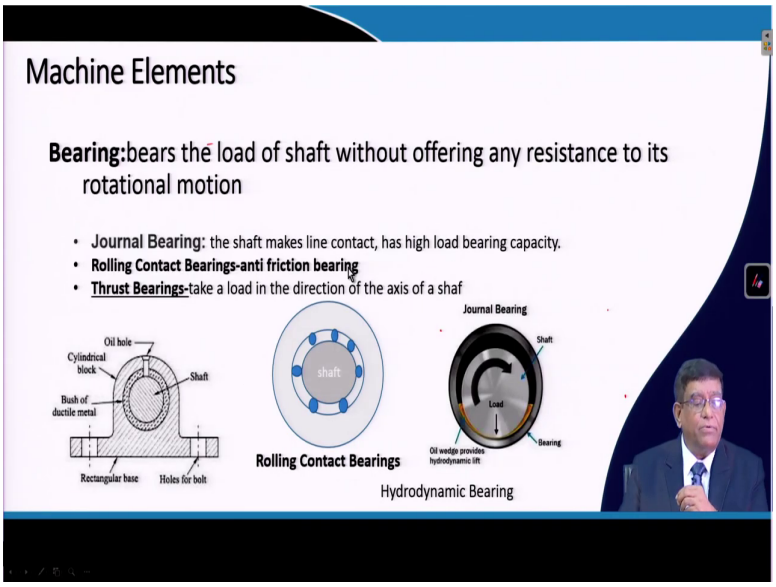

And then we have got in some cases the bearing is another part when it is a shaft is to rotate it is say there will be the frictional loss will have to be minimum. So, that is why different of bearings are there that is exactly how a shaft is mounted that is it can be a general bearing, it can be a rolling contact bearing or it can be a hydrodynamic bearing.

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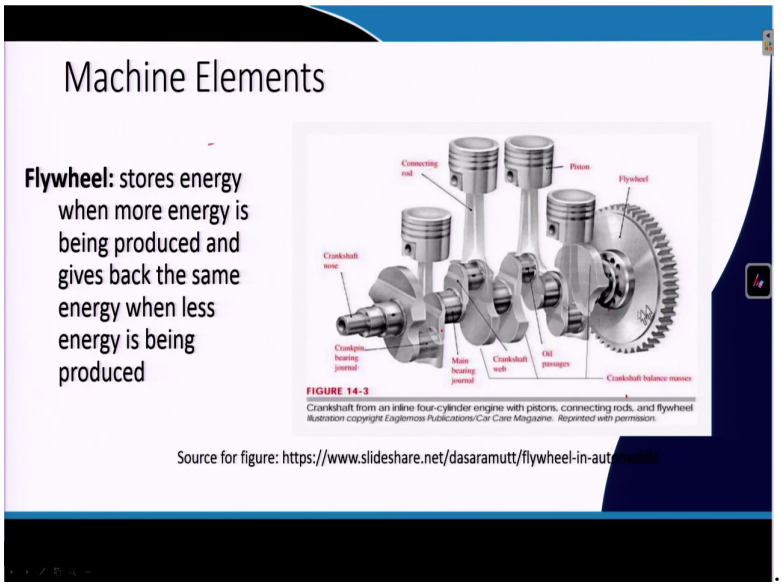

When the shaft around that the lubricant oil will be there how this type of different types of bearing how it works you need to study for this. So, that what is the purpose of this flywheel? Because this machines at different time there will be fluctuations of its emotions and all, but here from with flywheel thus power will be taken to a your transmission system and from that transmission system when it will be going to the main drive.

The component whether you are driving it to wheel or it is driving it to another machine part which could be a controllable because these engines part directly cannot if you connect the your operating part along with you cannot do. So, this flywheel this side that shaft will be connected; so, this type of things are there.

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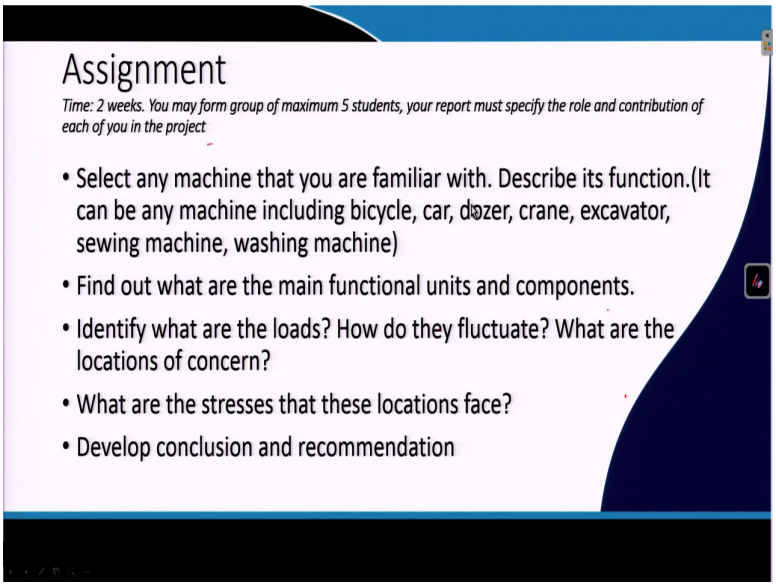

So, here another assignments I mention you will have to do it that is in a 2 weeks time you do this assignment that select any machine that you are familiar with describe its functions it can be any machine including bicycle, car, dozer, crane or anything.

And find out what are the main functional units and components, identify what are the loads, how do they fluctuate, what are the locations of concerns in that machine, what are the stresses that are in these locations. And then develop a conclusion and recommendations this is when you will be doing then ultimately you will ready for studying machinery.

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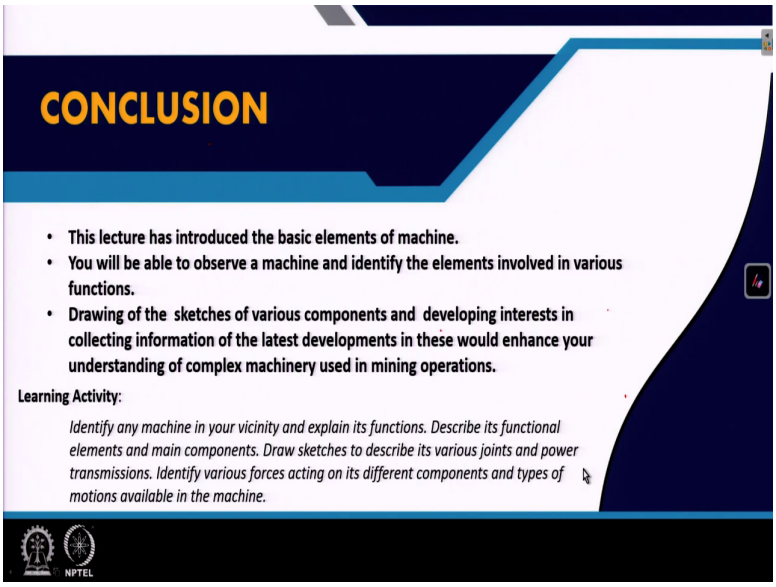

So, that is what this lecture has a introduce to you about the different machine elements and the so, that whenever you see any machine working you try to understand that what are the different parts working over there and particularly the functional element and the power transmission elements are most important. In our next class I will be discussing about some of this the power transmission systems and then this activity you please do along with that activity which I have just said.

The identify machine in your vicinity and explain its functions. Describe its functional elements and components. Draw sketches to describe its various joints and power transmission. Identify various forces acting on the different components and types of motions available in that machine.

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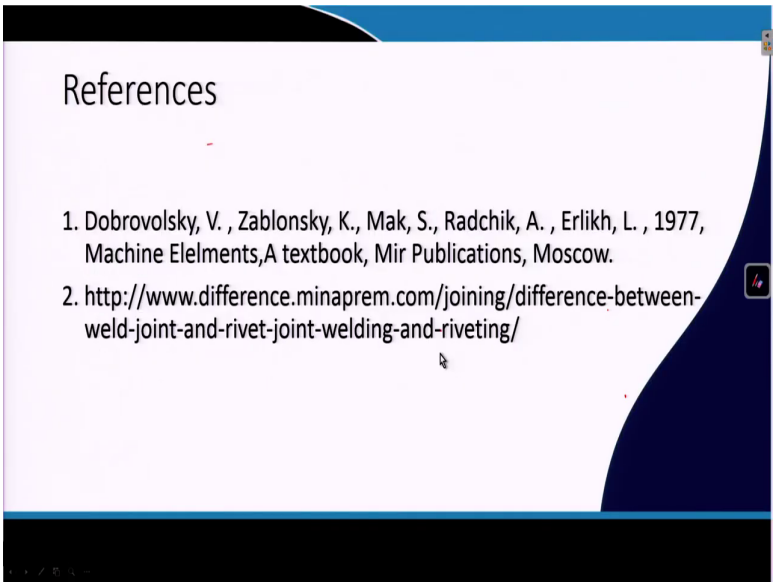

If you do that then it will be helping you to understand machines much better way. There are references as I said some of this text books are there any mechanical engineering text book or you just go to library digital library and got to this the mechanical engineering hand book and you can see that different machine elements are there.

And also in the YouTube you can find lot of things for your studies. So, I hope you have now understood that what is machine elements and why it is necessary to have a very good idea about these elements before going to start mining machinery.

We are just preparing yourself to study mining machinery where you will have to exactly do big decisions regarding productivity, safety and also the investment, capital investment how

will do in the mining industry. So, as an applied engineer as a mining engineer you will be managing the mines. So, this basic knowledge are very very important.

Thank you very much.