Manufacturing Processes II
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Lecture No.33
Jigs and Fixtures For Machine Shops

Good morning! You are welcome to our course Manufacturing Processes –II. Now we are going to Module-8: Jigs and Fixtures for Machine Shops and the lecture today is the purposes of using jigs and fixtures for machine shops and the principle of design of the jigs and fixtures. Now what are the contents today's lectures?

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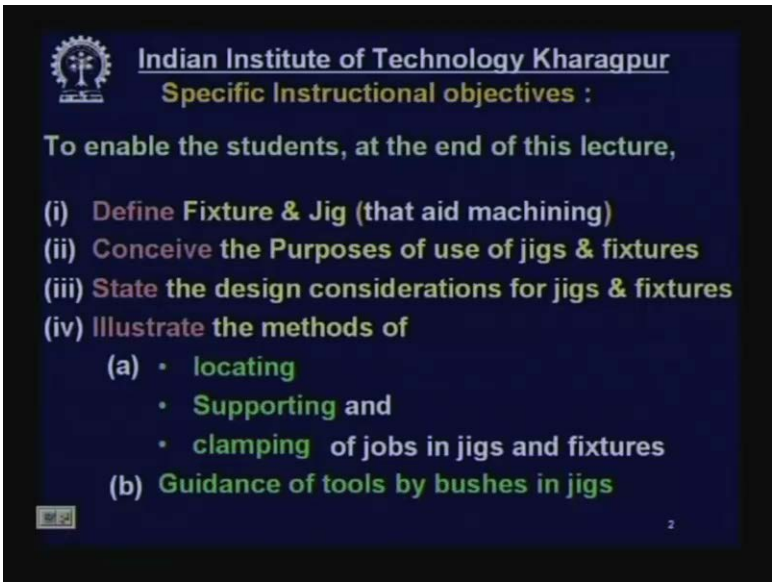

To enable the students at the end of this lecture, define fixture and jigs. So definition of fixtures and jig that are used in machine shops: Conceive the purposes of use of jigs and fixtures. Why do you use it? Then, the design considerations for jigs and fixtures and finally illustrate the methods of locating, supporting and clamping of the major activities of fixtures and jigs of jobs in jigs and fixtures and then guidance of tools by bushes in jigs. So these are the content today and next day we shall complete it by giving specific examples of design. Now the definition:

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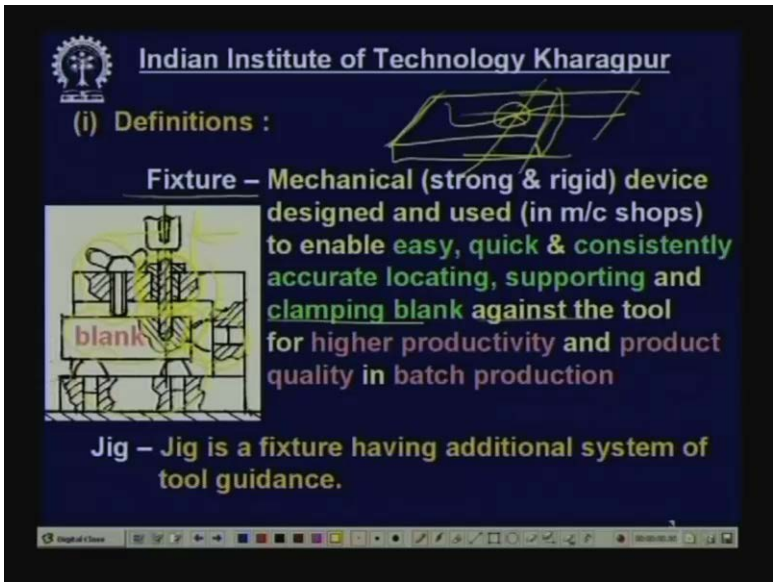

Before I am going to the definition, let us see that suppose there is a block, there is a block at one point a hole has to be made at a distance from this side and at a distance from this side through hole has to be made. Now this can be done without jig fixture and with jig fixture. What is there in fixturing or use of fixture? Here you can see, this block is shown over here this is the block which is supported on strong pins and located in z direction, then it is located the axis of the hole to be machined from this distance. So this is located by this pin and there are two more pins on the backside to locate with respect to y axis. Now the job has to be clamped. So this is clamping to hold the job tightly in position and orientation and then the drilling has to be done, but the drill is a very cylinder tool it can undergo you know run out and then inaccuracy over sizing of hole then working in poor surface finish.

So the tools of such kind need a guidance which will keep the tool study and position with respect to the job desired. Now to fulfill this condition, this requirements jigs and fixtures are used. Now then what will be the definition of fixture? It is a mechanical device, very strong and rigid designed and used in machine shops to enable easy, quick and consistently accurate that is every time it should be same easily, quickly and accurately locating here, supporting here and clamping the blank against the tool for higher productivity because this will say lot of time and product quality for repeatability and control in batch production. Then what is jig? Jig is also nothing but a fixture jig is also a fixture only difference is the jig contains one additional feature that is guidance of the cutting tool. So when fixture possesses guidance to the cutting tool it becomes a jig.

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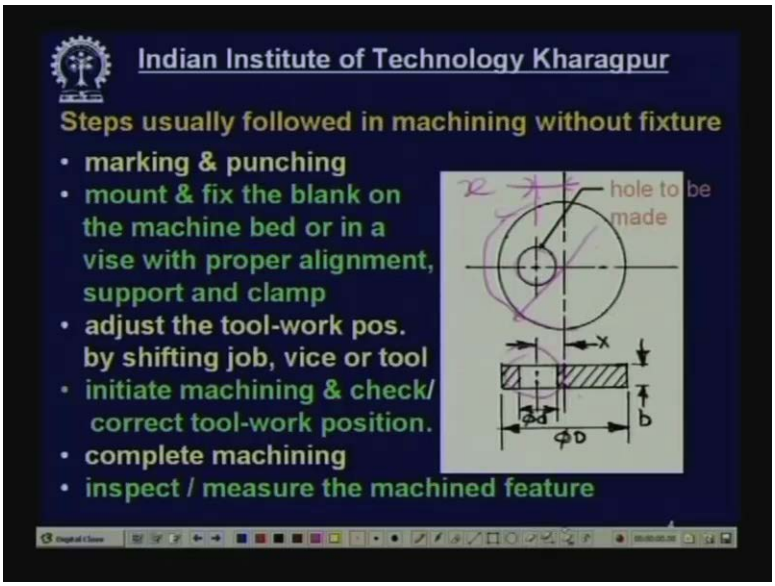

Now before we are going to design and jigs and fixtures or select or decide, we should go for jigs and fixtures. Let us have a look in to the steps usually followed in machining without fixture. Still in many industries for one or two pieces jobs are done without using any jigs and fixture and this is done with the conventional ordinary machines. Suppose there is a disk this is the disk. It is a pre-machine turn and facing all this has been done. Now a hole has to be drilled. This hole has to be drilled at a radial distance say 'x' which has which has to a maintained and is a through hole. It is a through hole of diameter say small 'd' and this diameter is capital 'D'. So this is the task. Now what will be the steps to be followed? First of all what has to be done?

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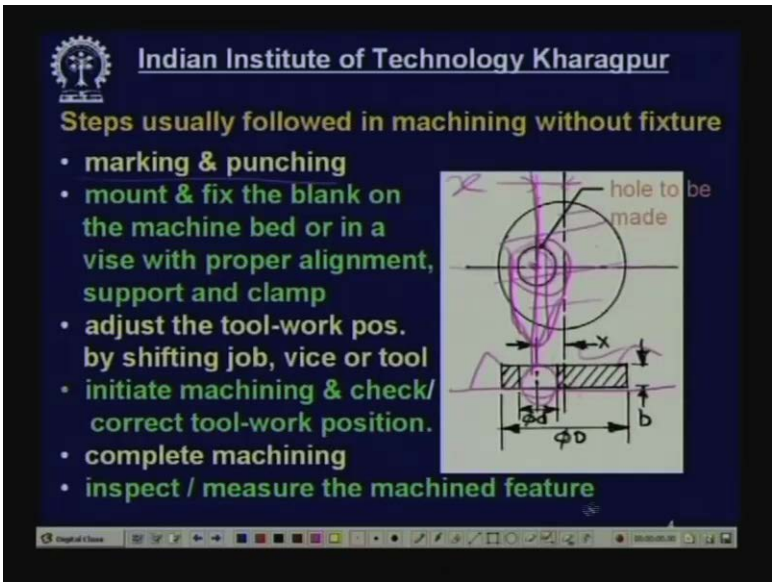

First of all, what we have to mark this surface one surface face of the job has to be marked by chalk or something whitened and then this line has to be a one radial line has to be drawn and at right angle, another line has to be drawn scratching by scratcher. So that this distance is 'x' as desired, then at this point a punch a centre punch has to be made. You know a mark permanent mark which will be the piloting the drill and then by a compas, you draw the periphery of the circle to be drawn. Now to make it permanent, this periphery has to be marked by prick punch. So it is said that marking and punching of this hole.

Now mount and fix the blank on the machine bed. So this blank has to be placed on the machine bed directly and then clamped or disk can be mounted on a vice with proper alignment, support and clamp. Now this job, suppose this is the drill position. So this job has the axis of the hole to be made should be aligned with the axis of the drill, then only it will be alright.

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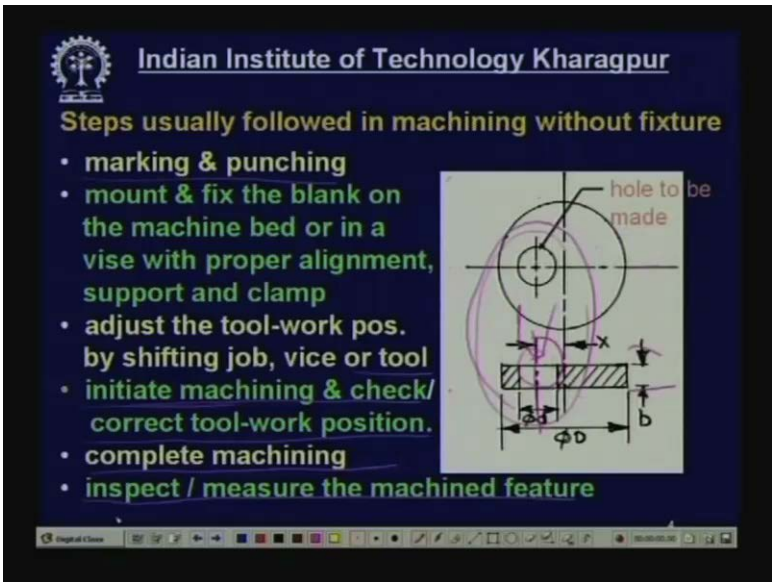

So the axis of the hole to be made and axis of the drill that has to be aligned so for that, what has to be done? Adjust the tool work position by shifting the job and then you clamp on the bed or this job mounted on the vice. The vice will be shifted along with the job to bring the axis aligned or the tool has to be moved. Suppose, it is a radial drilling machine in radial drilling machine the job is first fixed on the vice or directly on the table and then you bring the tool by tilting this radial arm in to position. Then initiate machining. Machining but immediately after starting machining, you check the correctness of the axis or position. Then, you correct it again adjust it again if required thought it is tedious but it has to be done, once you have satisfied then complete the machining work and after doing work inspect and measure everything again to check whether the job has been done perfectly or not. Now, friend you have seen that doing this work simple work it is so tedious. So many elementary works are involved each is

manually done and it takes lot of time and effort and skill of the operator which makes it very expensive and time consuming. Now what is the solution to that?

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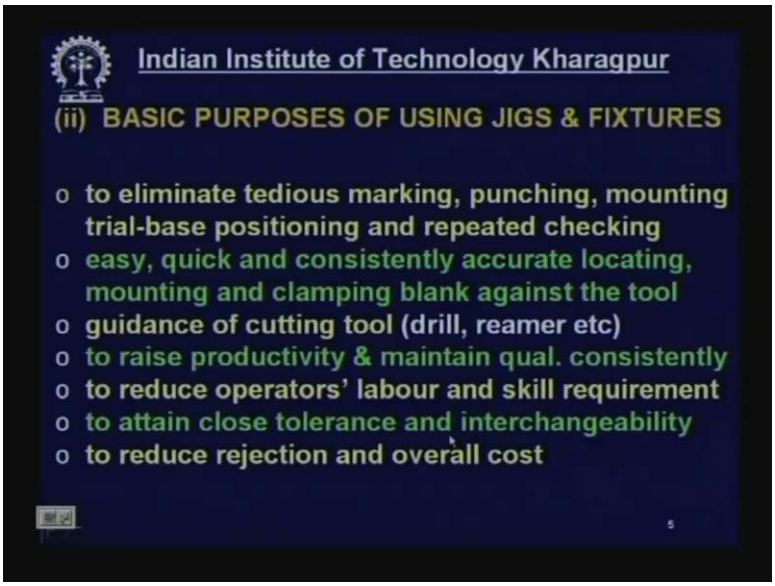

Solution to that will be the basic purposes of using jigs and fixtures. Now first of all, to eliminate those tedious activities like marking, punching, mounting, trial base positioning of the vice or job and repeated checking measurement. This tedious time consuming work have to be eliminated and that can be done by use of jigs and fixtures, easy quick and consistently accurate repeatedly accurate locating mount supporting, mounting and clamping of the blank against the cutting tool. So that it does not move at all. So this will be done easily quickly and consistently it will be so designed. In addition to that guidance of the cutting tool like drill reamer some say boring tool also special type or say counter sinking tool which are cylinder in nature because of the cantilever action.

Then, they have to be guided by bush. To raise productivity, because the work will be must faster and maintain quality consistently: so the quality will be repeatedly maintained. There will be no variation, piece to piece. To reduce operators, labor and because the labour has to do little work and easy work and skill requirement. The operator did not vary skilled worker. He can be ordinary type because he will be assisted by added by the fixture. To attain close tolerance, that is accuracy and interchangeability. So the repeatability will be maintained. Whatever tolerance is decided or apprehended, that will be repeatedly obtained in each of the job. So, those jobs which will be produced by that particular jig or fixture will be interchangeable to each other, finally to reduce rejection and overall cost. Now the economic application of jigs and fixtures;

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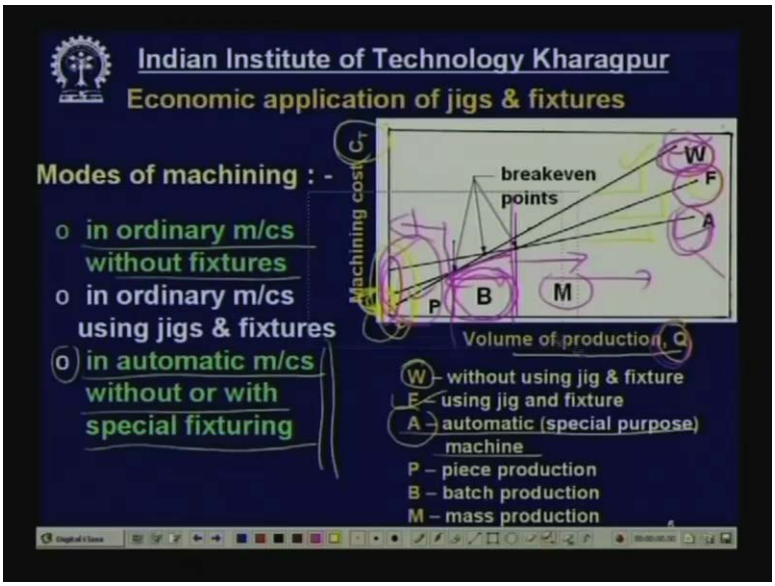

We have to see the economical aspect; shall we use jig and fixture? If you use, it will it be economically viable or justified that has to be checked. Now, how the modes of machining, suppose a lot of job have to be produced by machining. What are the possible modes? One, in ordinary machine like lathe or drilling machine or planing machine or milling machine without using any jig or fixture. Now let us come to this plot. Graphical representation which shows the machining cost total machining cost total machining cost Ct versus volume of production or number of pieces Q. Now when we consider in ordinary machines without fixtures that is 'W' this one this is the graph. This is the initial cost and this is the labour cost etcetera for which the cost is gradually increasing.

Next is in ordinary machines, but using jigs and fixtures. So some additional cost will be required to anchor the jigs and fixture say another few thousand rupees and but the labour cost will come down because it will be much faster and easier. This is 'F' using jigs and fixtures. Third one in automatic machines without or with special fixturing. Now this special automatic machines are special purpose machines where locating, supporting clamping are inherently automatically done very quickly. But, these machines are very expensive. If we do use this automatic special purpose machine, work will be done very fast and this labour rate will be very low but the initial cost will be quite large. So, these are the three conditions. So what we understand from this?

You see that so long the production size 'Q' is less, then this value less than this value, then which one is the most economic. The most economic one is mode number one that is without jig fixture. When the production size volume 'Q' is greater than this value that is a mass production, then the automatic system or special purpose machine is most automatic. So for the mass production region 'M' the automatic system is special purpose machine is economically justified. For very few pieces, that is called piece production or job order production, the conventional method ordinary machine without jig fixture is most economic. But, what about this region in between that is 'B' for batch production a

small lot. We find that in this case, the bottom most line is the is ‘W’ is a ‘F’ sorry ‘F’ that means use a fixtures let me clean it.

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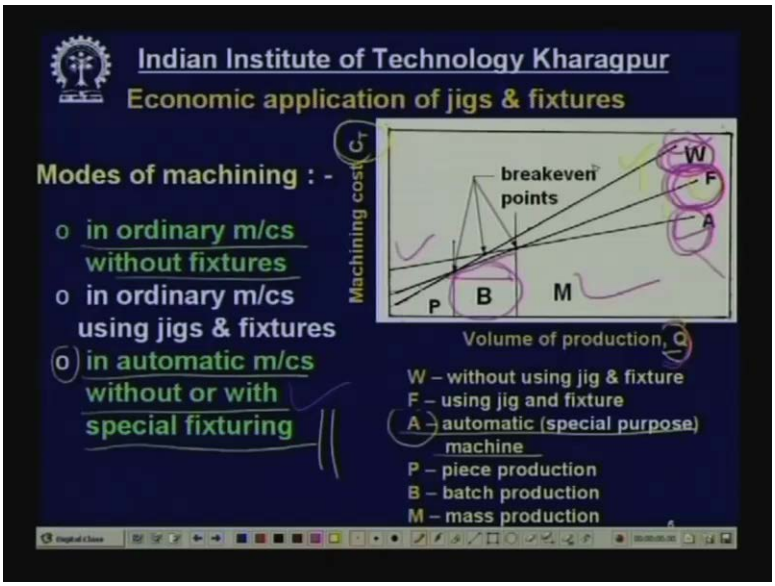

Now you can see for this batch production region, for the batch production region the bottom most line is belonging to ‘F’ that is jig fixture, so we can machine. Therefore it is clear that mode one is suitable economically viable for piece production or job order production, then automatic system is suitable for mass production because it is expensive and for batch production use of jig fixture is most appropriate. Now, the design of jigs and fixtures:

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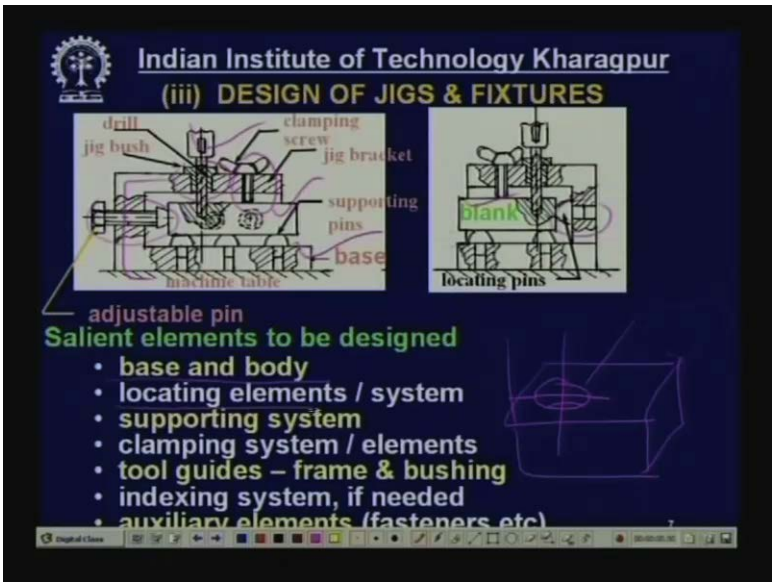

What shall we design? Which part we shall design? Let us see what are the major parts comprising the jig or fixture. Now here again you recall that, this is the work piece suppose this is the work piece were a hole has to be made at a certain distance for here and here. So, this is the blank. This is the blank on this side, a side view on which is mounted on three supports and then located by this pin and this pins and clamped here then locate then the tool, the drill is guided by the bush. So what are the basic elements involved and need to be designed? First the base, the base of this is the total fixture the base has to be designed which has to be strong and rigid and the body. Next is locating systems or elements that are this locating this one and this one. This is also work as locating in respect of 'z' direction, then supporting system. These are the supporting system which have to be properly designed, then clamping system. This is the clamping system which has to be designed and then tool guides. This is the tool guide with a bush and frame flap have to be done.

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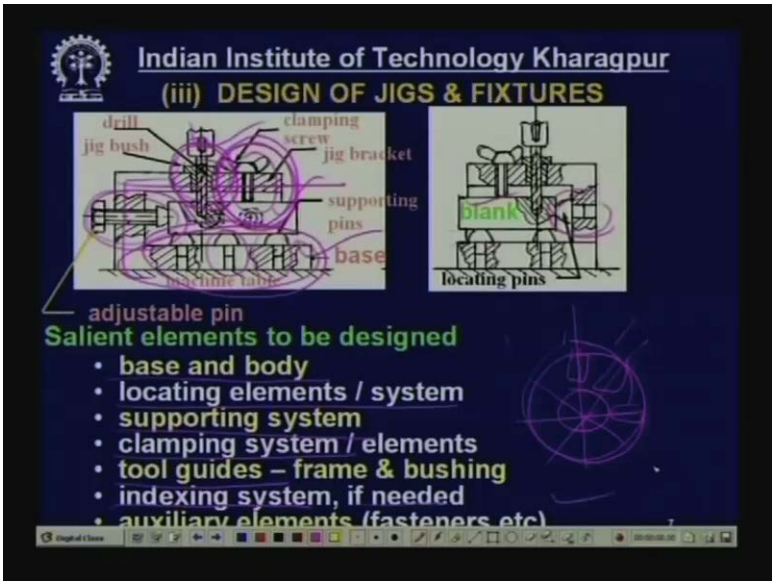

Now indexing system: Now what is indexing system? Suppose we want to do say there is a disk all right and we want to make number of radial holes. So one two three four five six, so after making one hole this has to be indexed, then you make a hole here then you make a hole here. This is called indexing. So, indexing system has to be provided if needed and auxiliary elements like nut, bolt, fasteners etcetera. So these are the elements which are involved and need to be designed and especially considered while designing.

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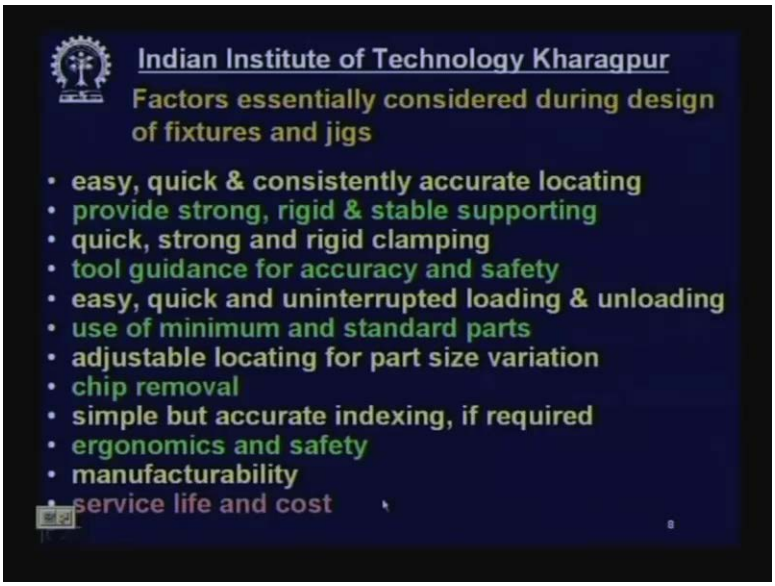

Now friend before you going to design, please remember there are certain factors to be considered before designing. Factors essentially considered during design of fixtures and jigs; what are those factors? Easy, quick and consistently accurate locating; First of all locating is a must, what is locating? Positioning and orienting the job against the cutting tool properly so that the job machining work will be done exactly at the right attitude and location. But, this has to be easily, quickly and accurately done and repeatedly then provide strong rigid and stable supporting the supporting pins are surfaces should be strong to resists the stresses to counter the stresses.

It should be rigid to prevent or reduce bending or deflection and it should be stable to preventing, toppling or shift movement, quick, strong and rigid clamping. So clamping, holding the job tightly against the cutting force and other forces it should be quick. It should be strong enough and it should also be rigid to reduce the deformation, tool guidance for accuracy and safety. Accuracy means the positioning will be accurate, the because of preventing of the run out and safety the tool will not break because of the guidance, easy quick and uninterrupted loading and unloading. Yes, the jig fixture should be so designed that the job blank can be loaded in to the fixture before machining and after machining can be removed easily uninterrupted by other systems, use of minimum and standard parts.

Yes, while designing we should consider that it should possess minimum number of parts more parts means more a larger family where there will be more chances of failure and more requirements of maintenance. So, this will increase the cost and reduce the increase the down time and also the part should be standard parts which are available already in the market as far as possible. As a result, the cost will come down and replacement cost as and when required will also be easy and less costly. Adjustable locating for part size variation: Yes, when we go for locating this one, if the part size slightly varies and this

distance of this hole from this range slightly tends to vary then the screw will be adjusted to change this position x this is called adjustable locating for part size variation.

Chip removal; Yes, it should be taken care of. The chip should not be allowed to jam at certain critical points and hamper the operation of the jig fixture. It should be so designed that chips will be automatically disposed and should be cleaned easily simple but accurate indexing if required. Ergonomics; Yes, comfort convenience of the operators and safety of the operator or the tool or the machine everything, manufacturability design such that which can be really manufactured easily, quickly and economically do not design anything which is very difficult to manufacture, then service life should be long, durable and the cost should be reasonable. Now design of fixtures and jigs;

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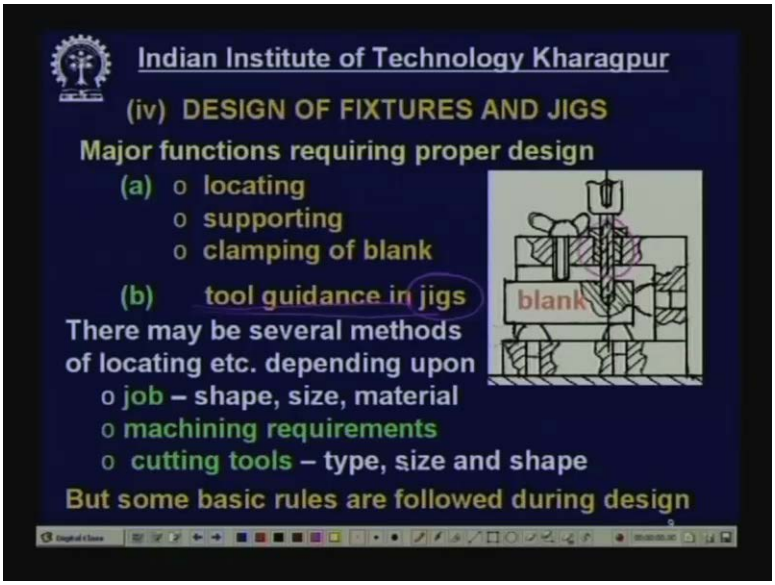

Major functions of requiring the major functions involved in fixturing requiring proper design. What are those? Locating of the blank into the fixture; Supporting the blank by supporting system, clamping or this is the clamping of the blank inside and tool guidance. This is the tool guidance, tool guidance. This has to be considered and what is the other one tool yes tool guidance is this one so these are the four activities which should be considered tool guidance for jig only when there is a question of drilling. Now friend, there may be several methods of locating, supporting, clamping, tool guidance depending upon the job, its size, its shape, the material, the machining requirements say turning, sorry the milling, shaping, planning, surfacing, drilling, boring, reaming and cutting tools. What kind of cutting tool you are using? What is size of the cutting tool and what is the shape or geometry of the cutting tool? So, there are so many so many ways of clamping, locating, supporting but whatever you do certain rules and principles have to be followed while designing for clamping, supporting and locating. Now come to locating. First, fundamental requirements for locating, supporting and clamping this entire three;

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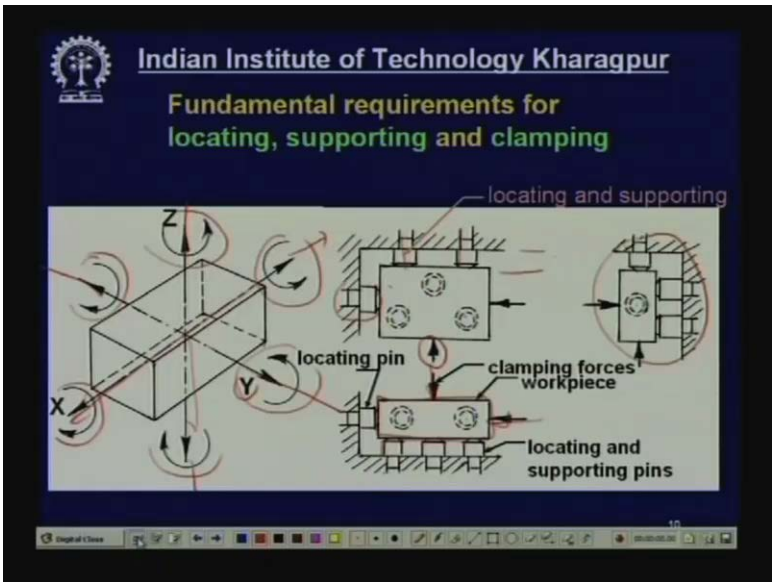

Now suppose this is the work piece or blank. This is the job which has to be machined say drilling or surfacing something but it should be when fixed that is by locating supporting and clamping, it should remain in a particular position and orientation with respect to the tool all right and secondly after locating, supporting clamping or during machining it should not move at all totally arrested. Now generally any block a solid material has got twelve degrees of freedom. What are those degrees of freedom? It can move along ‘x’ axis say in this direction or that direction, plus or minus along ‘y’ axis this direction or that direction. It can move up and down so six. It can rotate around ‘x’ axis clockwise or anti clockwise. It can rotate about ‘y’ axis clockwise or anticlockwise. It can rotate about ‘z’ axis clockwise or anticlockwise. So there are twelve degrees of freedom.

So all these twelve degrees of freedom have to be arrested by locating, supporting and clamping that is before machining how? This is the blank. So this has to be supported here on three pins say this is the top view on the top view you see the threes pins here from this side supporting and locating with respect to this distance then from this side the locating and this is the side view. Now so by this pins, we arrest nine degrees of freedom. Now if we apply a force from top clamping force, one force from this side ‘x’ direction and one force from say this side. This side, then all the degrees of freedom will be totally arrested. So, this is the basic principle to be followed first while locating, supporting and clamping. Now locating blank in jig or fixture, design principles, or the rules for locating.

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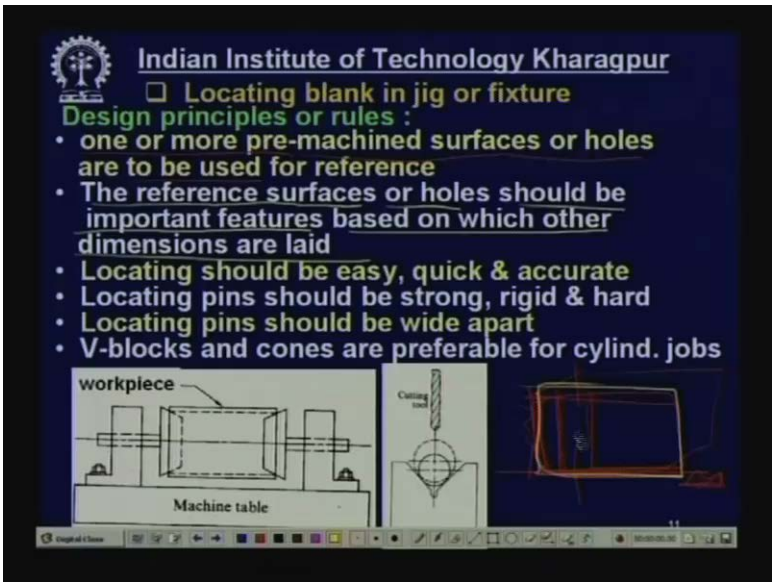

One or more pre-machined surfaces or holes are to be used for reference that means suppose, here is a block. Now first of all, it is say produced by casting or forging something all the surfaces are irregular. So first you machine one surface and bring it to the flat surface. You can machine another surface for this, using this to surface or locating, you can make some hole also initially which will be used for locating purpose. So it is said one or more pre-machine surfaces or holes are to be used for reference. This is the must. Now next is which surfaces should be selected for you know pre-machining and location. The referencing surfaces or holes should be important. Features based on which other dimensions are laid down that means if suppose,

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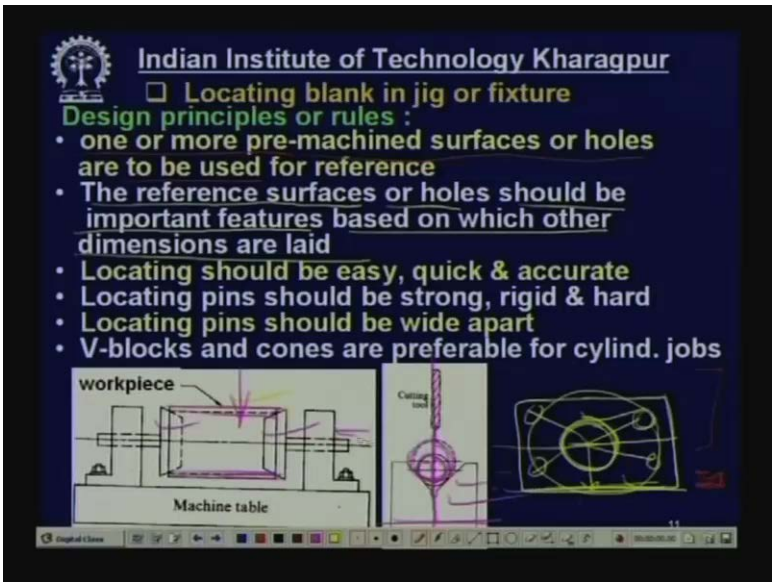

This is the blank this is the blank okay and here is a hole with respect to which other holes are dimensioned, then first of all this hole is now located with respect to this surface. So this surface has to be machined. The bottom surface has to be machined, then you machine this one. So while machining this hole, use this surface and these surfaces as locating surface and then for making all these holes use this hole and any surface has a locating because this two are important with respect to which dimensions of other pieces are laid down. Now locating should be easy quick and accurate it should be conversion. It should not be difficult, it should not take time locating pins, should be strong, rigid and hard. Why? The locating pins will be subject to stress. So it should be strong, it should be subject to deformation. So it should be rigid and it should undergo wear and tear.

So it should be hard, that is wear resistive. Locating pins should a wide apart they should not be you know very close, then the purpose will not be served V-blocks and cones are preferable used for cylindrical jobs. Now, here you see here you see there is a job is a pipe like, this is a pipe which has to be located suppose mount in a lathe for some work on a milling machine suppose one hole has to be made here. So this has to be located by two cones and apply pressure so it be located supported clamps simultaneously for cylindrical jobs here is 'V' block. So this is a rod you place it the centre of the rod will automatically aligned with the axis of the V-block and this will be clayed V-block is already kept in such a way on the table that its axis and the axis of the drill or already aligned. Now if you put rods of any diameter within limit, the axis will be always within this axis of the drilling machine drill as well as the block. So, it is called self-centering or self-locating. So you have to take this advantage. Now, continuation sight location for jobs of irregular surfaces:

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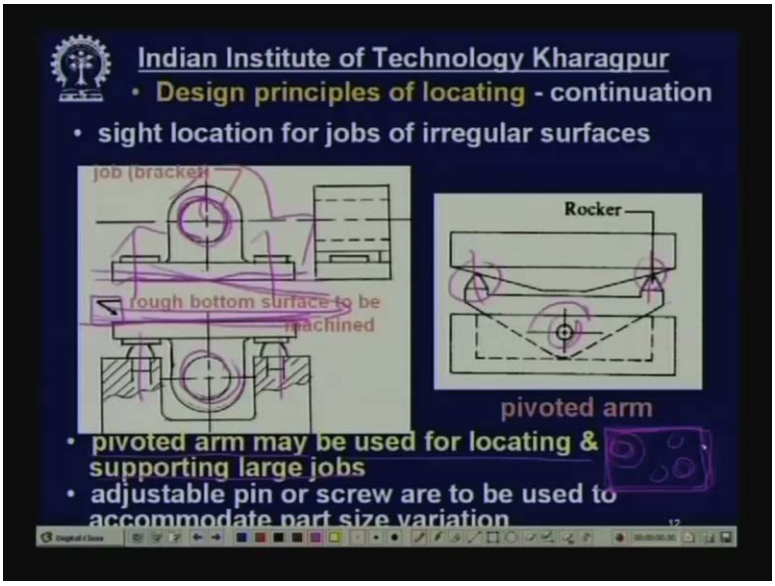

Now here is a job. You see that is a plumber block bracket. This is the flat base, this has got a flat base and there is a projection where there is a hole through which shaft passes. It may be like this, it may be like this a 3 D if we draw it will be like this. Now, first of all

this hole is very important. This is with respect to this surface, but this surface is now irregular, so this surface has to be machined first. Now when you machine the surface, it should be done very carefully, if you machine in an inclined way, then it will be erratic. So first the machine, this surface has to be machined carefully with a minimum effort, minimum material removal and so on.

So this has to be placed on two pins by inverting it and just to be clamped from side and this surface has to be machined by milling or some similar tools. Now this is sight location and then after machining this surface, this surface will be used as a locating surface for machining the subsequent features like holes and so on then you have to make a hole here, one hole here and so on. Next is pivoted arm may be used for locating and support large jobs. You know this for large job for any job in the flat surface for locating three point contact has to be there. Always the number minimum number piece is required a three points if you use more then three point, the fourth point may be or may not be in contact. But if the job is very large, one of the pin location or contact should be replaced by a double point location that is pivoted type which will be pivoted here. So these two point will be functioning equally. Adjustable pin or screws are to be used to accommodate part size variation and this has already been mentioned. Now general methods of locating:

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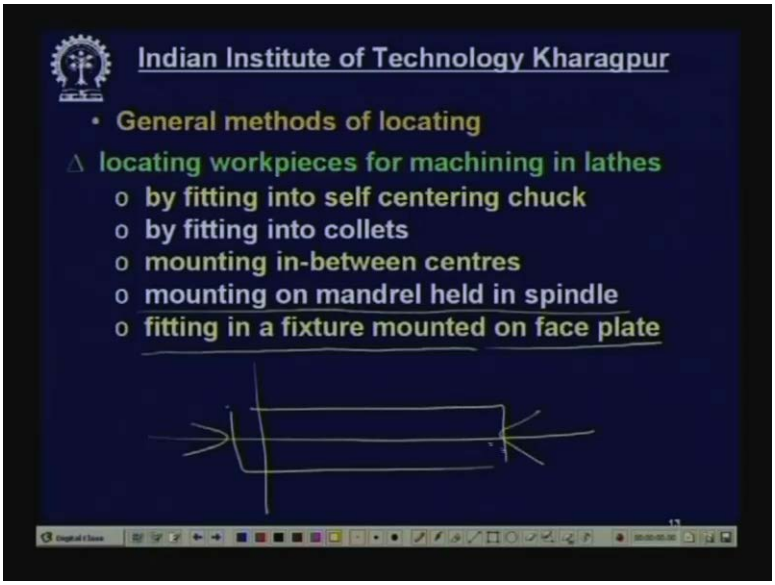

Locating work pieces for machining in lathes which are very common work by fitting in to self centering chart, by fitting in to collets, mounting in between say centre. Here is a job, you have put one centre here headstock centre tailstock centre. It will be automatically aligned. Of course, it has to be held in a position by a dog or catcher driving plate. Mounting on mandrel held on spindle. This will be shown later on and fitting in a fixture mounted on a face plate.

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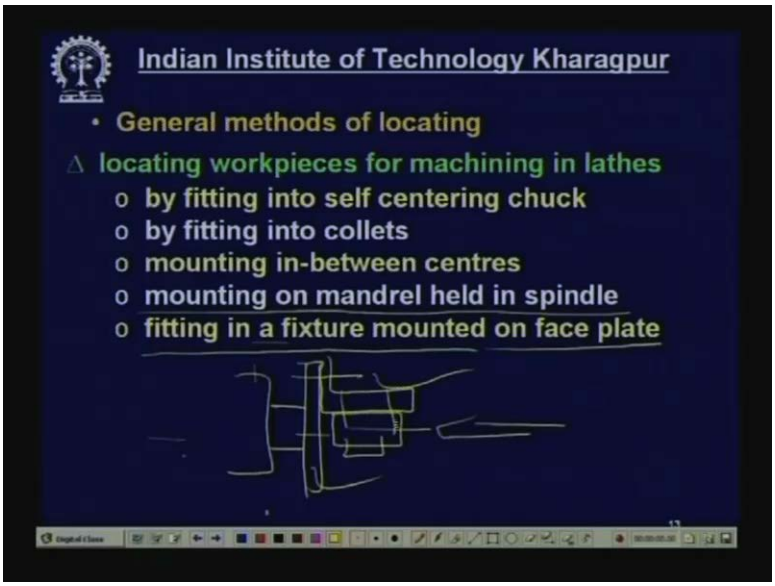

Now here, this is the face plate which will be fitted in to a lathe. Now suppose, this is the job odd shape may be odd shape and all this things are there. One hole has to be made by a drill now in a lathe. So, what has to be done? A fixture has to be mounted on the face plate and this has to be clamped on this one and then you use it. So that is fitting in a fixture mounted on a face plate. This is the face plate and this is the fixture and this is the job. So this is how it is done, locating for machining other than lathes.

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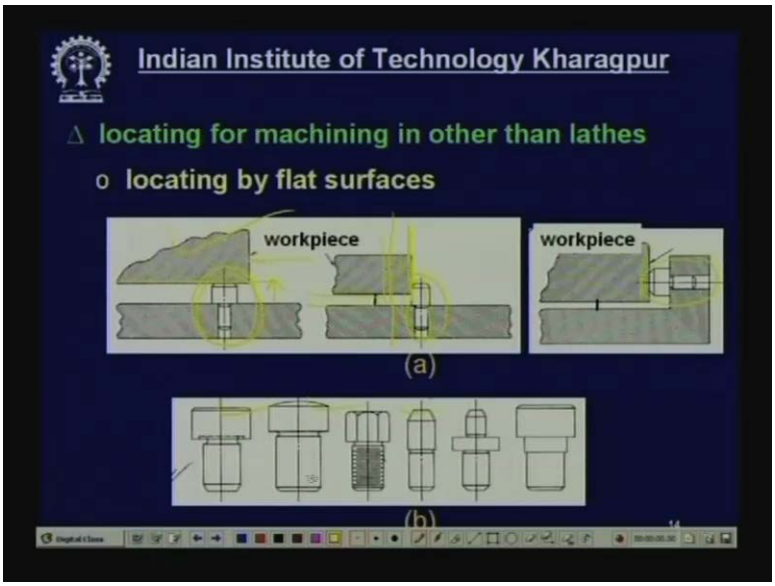

Lathes are used very frequently but but most of the work are done in machines producing flat surfaces like say milling, planing then broaching, boring, drilling, grinding and so on.

In those machines, the job does not rotate. Lathe is the only machine and cylindrical grinder where the job rotates. In other machines, job remains stationary. In those machine tools were the job remains stationary. What will be the locating system? Locating by surfaces here you can see this is the job which has to be located with respect to that at a certain height for some machining work suppose this is the locating arrangement along vertical direction. Now this suppose one hole has to be made along this axis. So this has to be located first on a flat surface and then by a pin. So this end will be arrested by a pin. This end will be arrested by pin and these pins or plugs may be of various types depending upon the requirement. You can choose these pins which are available in the market and preferably you choose standards as far as possible. Now locating by holes;

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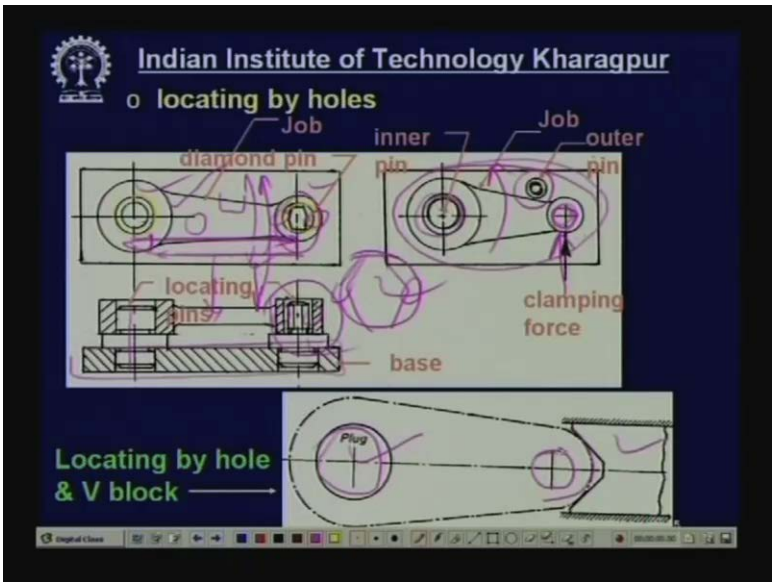

Now here is a connecting rod. Now suppose it has got two holes already. It has got two holes already one hole here and one hole here. Let us assume that one slot has to be cut here or one hole has to be made here. So first this has to be held strongly in to the fixture or jig. So, this is the plate base plate and there are two holes and two pins are fitted and on that this bracket has to be placed so that, the two plugs or pins and are in position. So that it will go neither this direction nor in this direction and this has to be clamped by a clamping force. Now you do the machining work, but one think to be noted that this distance of the holes is assumed to be fixed but it will not be not be fixed there is always a machining alignments.

Therefore a small gap here between the pin and here has to be maintained to allow this machining, this variation or tolerance. But, it can not go in this direction or that direction this kind of pin this kind of pin suppose in straight make it here and here, then you reduce here remains some gap. These are called diamond pin. So, these kinds of diamond pins have to be used. Now suppose you want you make a hole here, then you cannot use this place for locating. So this will be done by one locate. This hole is there by a locating pin and now this movement or rotation has to be arrested by a pin external pin or outer pin

and a clamping force has to be applied here. So that, all degrees of freedom of this bracket is arrested. Now you do the drilling by jig. Now the same kind of bracket if you want to make a hole here, then you can hold by a plug through a hole already existing of pre-machine and this surface will be arrested by a V-block. So this is totally arrested and now you can do this hole. Locating on mandrel or plug:

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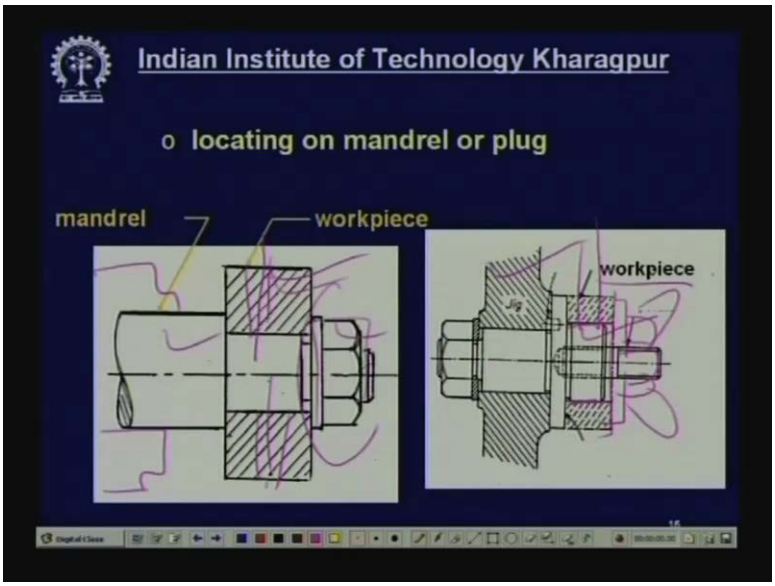

Now here, this is the job and this is the mandrel and then this will be held in the lathe or in a machine or a bracket fixture and mount the job and then by a nut you hold in position. Now you make a hole here by drilling and and then you can index it, you know and make radial hole say four, six, etcetera. Here is also the same thing. This is the work piece which is mounted on the plug. This is the plug and this matches here and this is jig body. Now, you put one washer here and then one nut. By a nut, you just tighten it and now you can do the drill and other operations supporting principles and methods design principles or rules for supporting.

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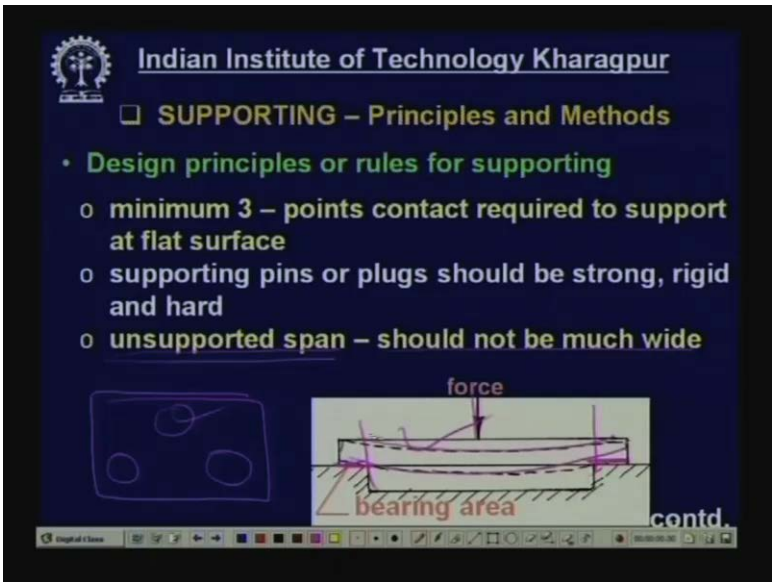

The job has to be supported strongly and rigidly on certain surfaces. First rule is that any job surface has to be placed on three pin or three contact points. So, minimum three point contact required to support has to be maintained. Supporting pins the supporting pins or plugs should be strong, rigid and hard because they have to take lot of force and stress, deformation etcetera. Now unsupported span should not be much wide. Now, suppose there is a block or bracket to be machined or a part of a machine tool. So this is the bearing surface and this is bearing surface. Now when you clamp it here on a machining force this is the tendency that this may sag and the accuracy will be lost. So, this kind of wide gap should be avoided, design principles now continuation.

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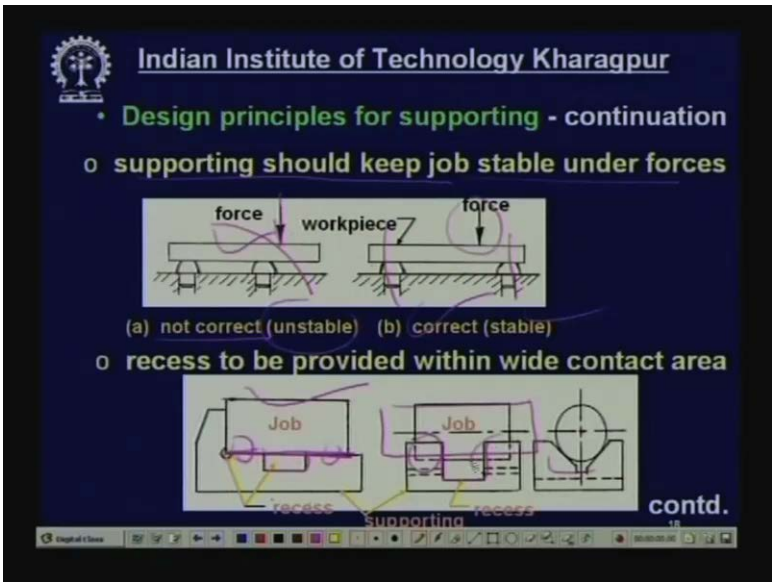

Supporting supporting should keep job stable. Now, this is the work piece. There are two supports and if you load it here, force it here, then this will topple. So this is not correct unstable and not correct. Now the force the pin has ah support has to be away from the force on both sides so this is correct and stable. Now recess to be provided within wide contact area. Now this is actually suppose this is the surface and this is the large job which is supposed to be resting on this surface, but to assure contact here and here one recess or relief has to be made here. So that contact here and here be assured and this will be more stable. It is also true for holding job long jobs on V-blocks there should be one recess. So the contact will be here and here. Now the design principles continuation:

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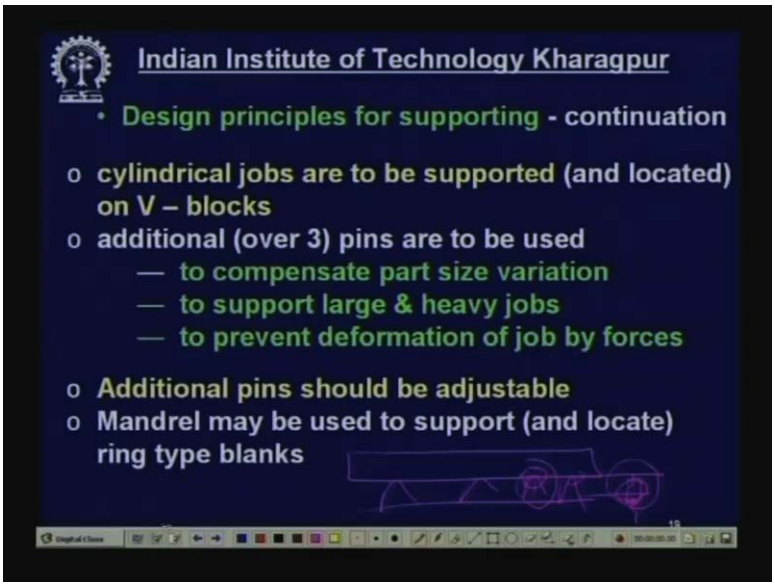

Cylindrical jobs are to be supported as usual on V-blocks. Now additional pins are to be used to compensate part size variation. If the part size varies widely, then additional pins will be required to support large and heavy jobs more then threes supporting pins will be required. To prevent deformation of job of heavy forces, more supporting pins will be required but remember the additional pins beyond three should be adjustable because the contact will be the contact will be suppose this is the block, there are three pins. This three pins are sufficient. Now, if you put another pin the contact may not be there if you force it then the contact will be lost. So the forth the additional contact should be you know such a way that there is the pin spring loaded and this will allowed to contact, then you hold it in position tightly by a nut so this should be flexible and like that it would be explained and mandrel may be used to support locate blanks which had already been explained. Now common methods of supporting:

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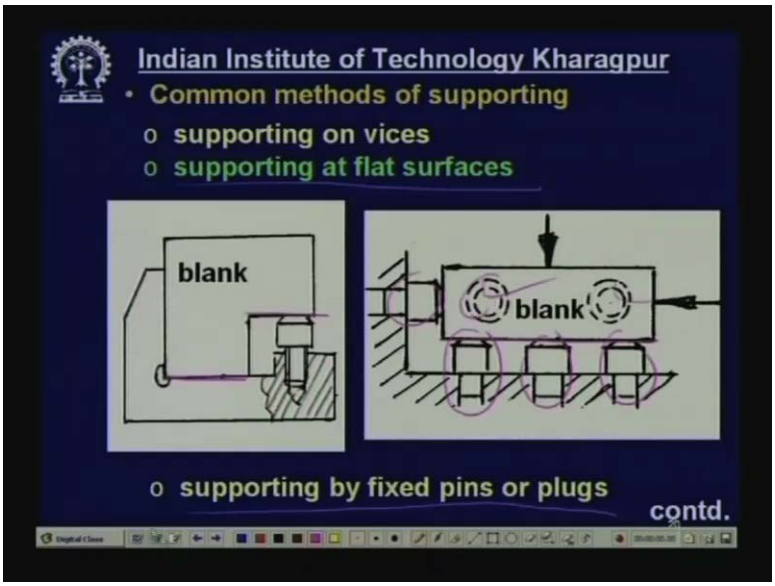

Supporting and vices which is done in say drilling machine, milling machine as usual without fixture. Of course vice can be a considered as a fixture, low level fixture. Supporting at flat surfaces; now here, the supporting the job at flat surface one and flat surface there supporting may flat surfaces. Supporting by fixed pins or plugs; now here the flat surface you know which will be supported by pins three pins and there is a one pin front two more pins on the back side and so on but this additional pins.

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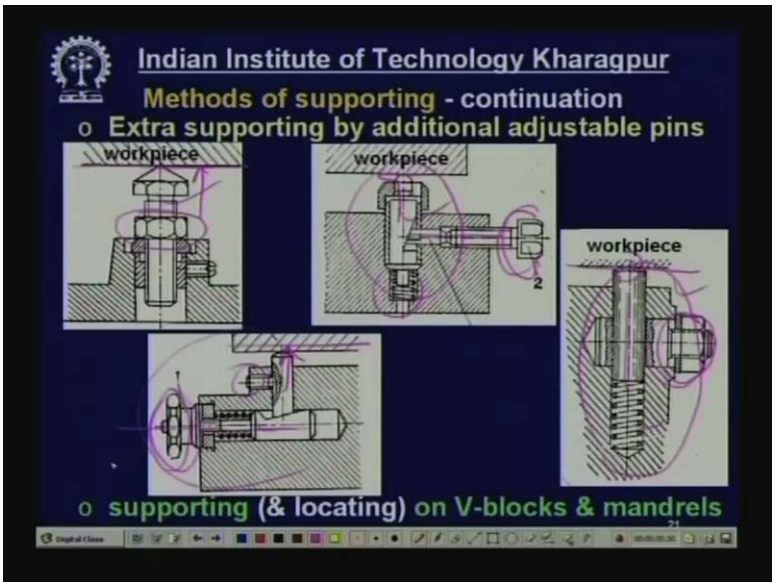

As I told already, should be flexible that means that if this be the surface this be the surface of the work piece, this pin this plug should be gradually meet the surface.

Suppose here, this is the work piece which is very heavy and this is the fourth one or additional pin and this compression spring has to used this pin has to be pressed down and after unscrewing the nut, then you allow it to come in to contact under the action of the spring. When it comes in to contact, then you tighten it. So this is how the additional pins have to be utilized. This is one here this screw has to be rotated gradually to bring this end in contact with the work piece after that this locking nut has to be used.

This is another. First of all, this has to be unscrewed this pins has to be withdrawn. So under the action of the spring, this will automatically go up and contact here then you tighten this one that will remain fixed in position. Here is another, this is the work surface you just unscrew it unscrew it and then you pull it here by operating this knob. So this will move in this direction and this will come, this will go up any contact and then you tighten it here. So this is how these are utilized. Design for clamping; Design principles or rules for clamping; you know holding tightly.

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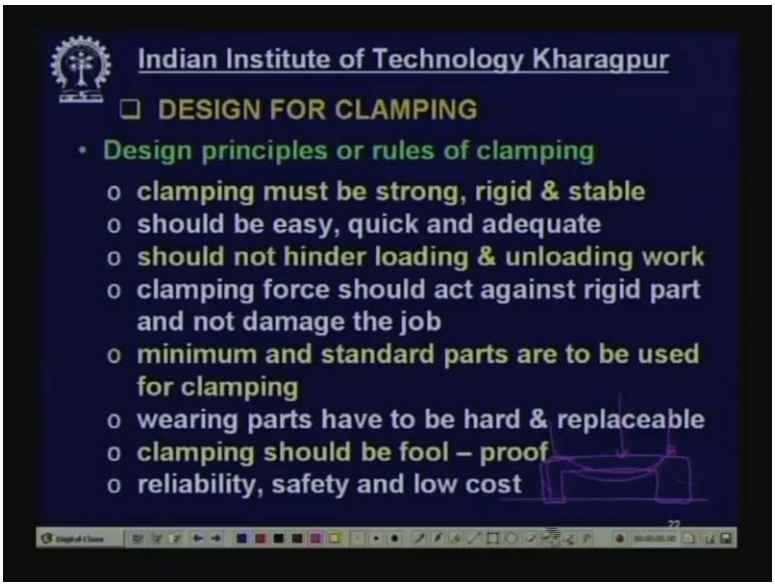

Clamping must be strong, rigid and stable. Now the strong so that it can withstand the stresses or forces. It should be rigid. Should not undergo or create deformation and it should be a stable so that, it can hold the job strongly, rigidly and there should be no additional movement within the parts of the clamping system. Should be easy quick and adequate. You know enough force can be applied to counter write the cutting forces, should not hinder. The clamping system should not hinder loading and unloading of the work. It should be so designed that loading of the job and unloading of the job from and to the fixture should be easy, uninterrupted. Clamping force should act against a rigid part and not damage the job. Suppose there is a job like this. There are rigid portion and this is the thin portion. If you clamp it here, this will undergo bending. So clamping has to be done on rigid surfaces. Next is minimum and standard parts are to be used for clamping this is already explained.

Wearing parts; the parts which undergo wear and tear because of sliding and pressing have to be hard, wear resistive and replaceable time to time whenever they wear out sufficient they should be replaced. Clamping should be fool-proof. Yes, the clamping system should be such that the operator cannot do mistake even if is absentminded or slightly you know indifferent. So he cannot do the mistake. Reliability; the work should be done reliably repeatedly safely and the overall cost should not be exceeding limit. Now methods of clamping in fixtures:

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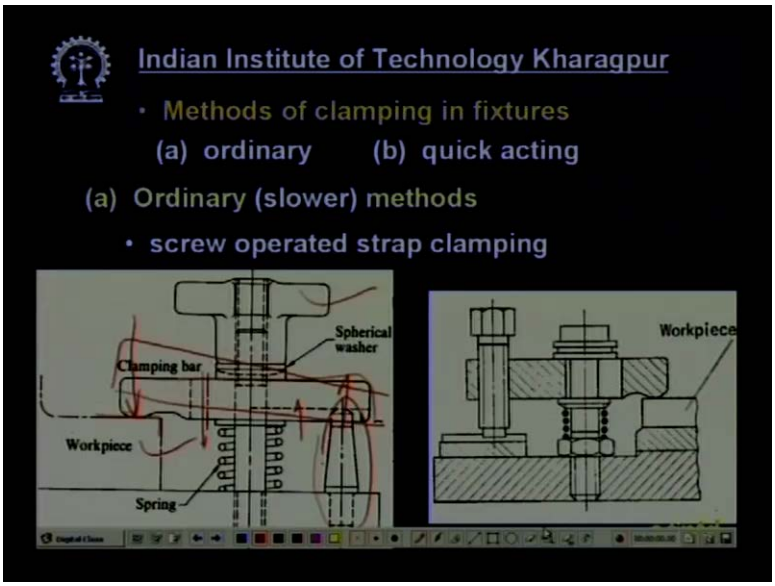

Now there are two ways of clamping. Ordinary clamping and quick clamping. Ordinary clamping you know obviously slow. Now what are the ordinary methods? Screw operated strap clamping. Very simple; Here, you can see that this is the work piece. So part of the work piece. This is the work piece and the part of the work piece where it has to be clamped. A force has to be applied that will be given by a lever and the lever is a resting on a plug or a support and then by operating this knob this will move down. So there will be reaction here and this will be force acting here and when you unscrew it, the spring will push it up. So it will go up like this and the job can be easily removed. Now here one thing is to be noted here very important because of the loading and tightening and loosening, this strap may undergo bending like this. So there should be one spherical washer.

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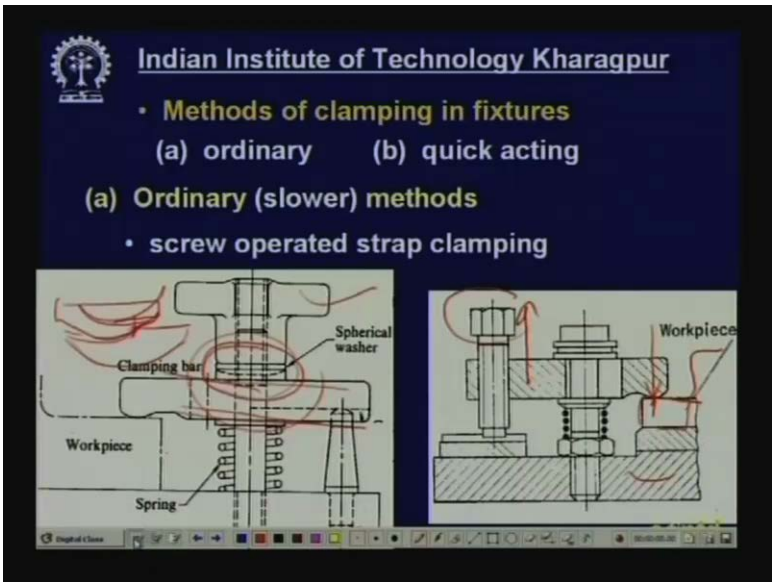

The spherical washer is like this. Spherical washer which works in another washer, which is also got one cavity like this. So this can tilt with this. So this will be taken care of. Now this is the other side, other part. So this is the screw clamping screw. If you rotate it clockwise, this strap will be raised and this will move down and apply the clamping force on this work piece, the part of the work piece on the base plate. Now clamping from side or through machining:

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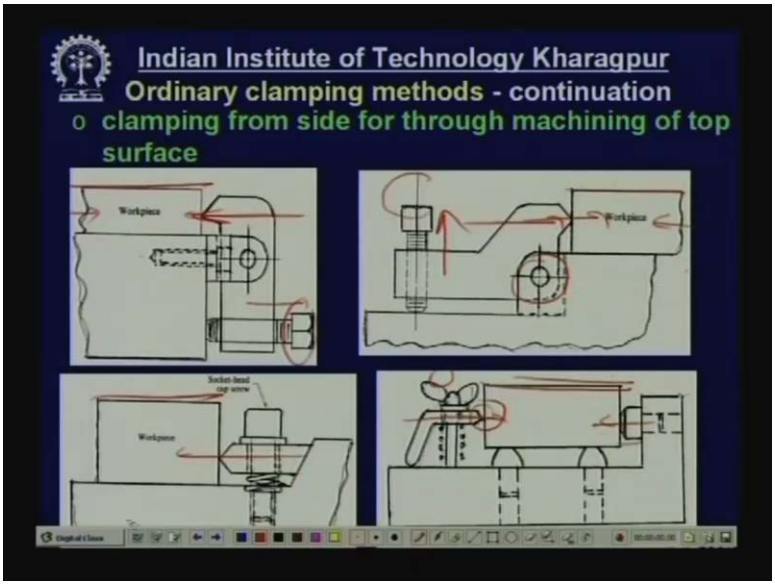

Now suppose this surface of the work piece have to be machined through machine like milling or planing or broaching, there should not be any obstruction like clamping any

thing. So clamping has to be done from side. One force has to applied here and one force from here. So one force will be there and one force from here. So this is how this will be clamped. So there are various methods like this. So that now if you tighten this screw, this strap will go this side and exert pressure here. If you screw here, this will go tend to go up and exert pressure here by rotating about this range. If you tighten this one, so this will bite here hold and bite and hold here against the spring. This is very simple and used. Clamping using swing plate;

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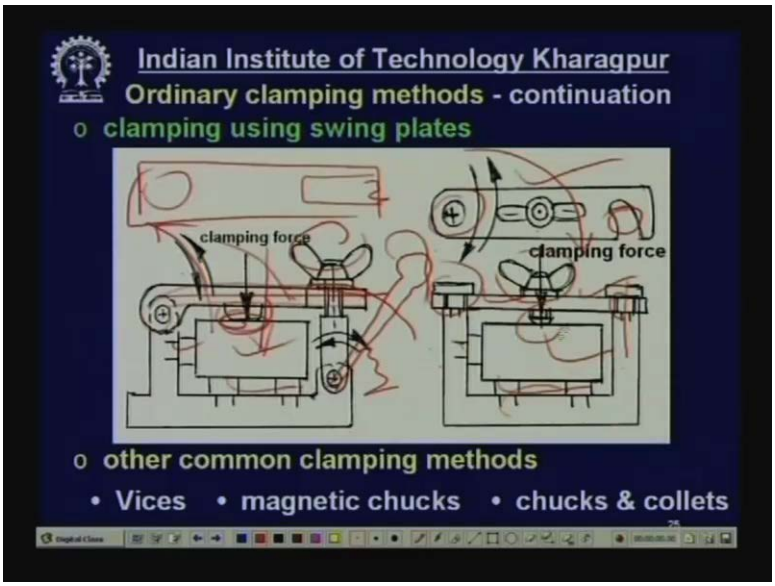

Yes, now here this is the work piece which is resting on the supporting and locating and you know now clamping has to be done. This strap, this plate or strap is swing type. So this is like this. It has got slot like this. Now this will be moved upward, then the job will be placed inside. After placing and locating this strap will be move down and from here this is open this is open here and then this is swinging type. So this locking bolt, now will remain in this position and by spring it will be held. Now when this will be pushed down, this will contact clamping point then you bring this one in position and tighten the screw. So this will remain horizontal and this end will push the job for clamping purpose and this is you know this is swinging vertically up and down. But, this is another in a system where this plate will swing horizontally, this is the top view. It is hinged over here there is a pin fixed on this frame and the job is mounted on this locating and supporting pins and then this will be bring in position and this will be a arrested here and now you operate this screw, this will clamp it. Other common clamping methods are vices, magnetic chucks, chucks and collets as usual. Now quick clamping methods:

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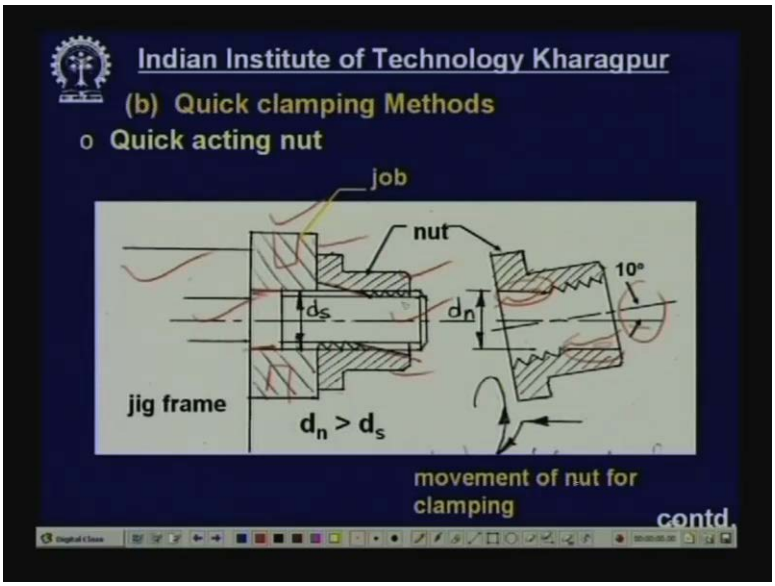

These are really followed. Quick clamp quick acting nut. How very interesting? How does it works? See, suppose this is the jig frame and this is the work piece is a ring type is a ring type work piece where suppose some radial holes have to be made by drilling like that. So there is a plug. This is the plug which is fitted in to this one semi-permanently and then this blank is fitted here on this bearing surface, then this nut has to be used. This nut is peculiar. It has got threads, but at up to certain layer the threads it was it had thread like this continuous but this one and this one are machine out. A hole was in machine that at an inclined angle say ten degree and threads from here and here have been removed. So now how this will act?

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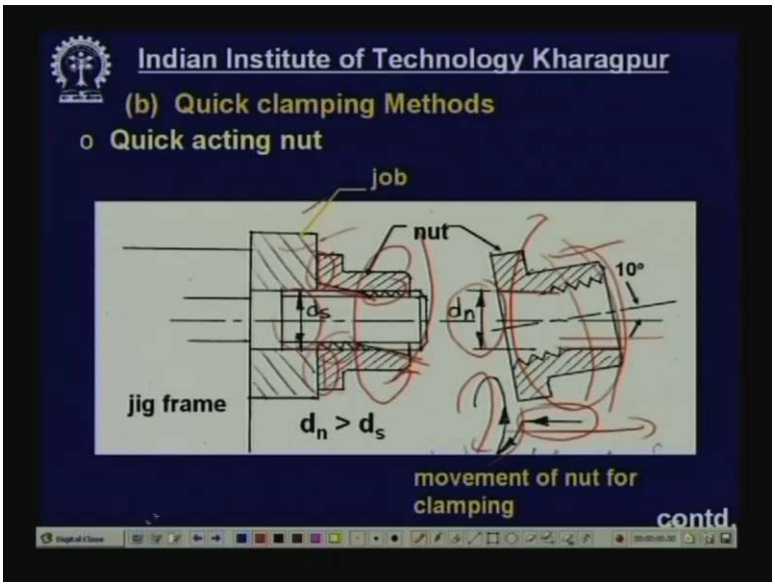

This is the nut. This has to be unscrewed now how this was fitted? During first you feed the job, then this nut from outside has to be fitted in you hold it in a tilted fashion so that this bearing surfaces where the diameter is larger than the diameter of the plug. So this we this we enter this is the movement. So you move it inside, then you straighten the nut. So you straighten the nut by tilting, so this will come in to position. Now you so there will be small gap here. Now you rotate it clockwise by half rotation. There will be maximum one rotation. This will come forward and you apply force unscrewing we just reverse you unscrew say half turn or one turn in this direction, then you tilt it to remove this contact of the thread and bring contact over the flat surface sorry the clean surface and then you push out easily. So, this is how this act moves with the half rotation only. Now the clamping using cams:

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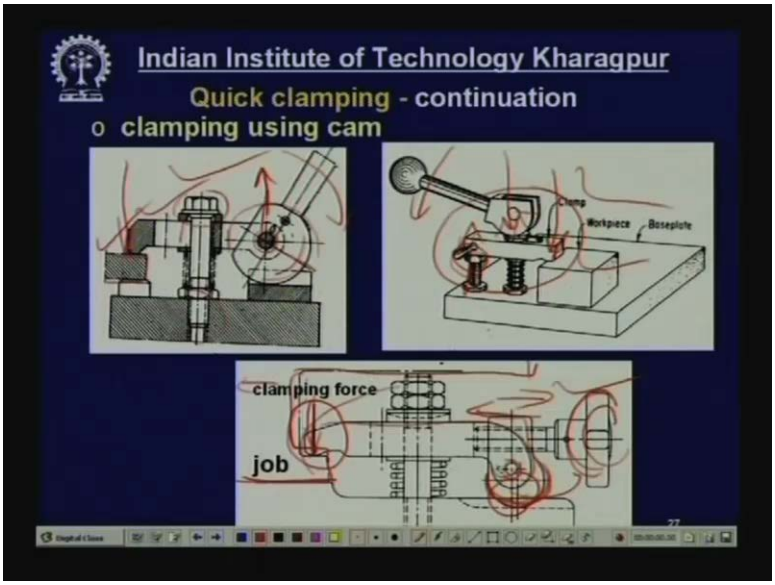

This can be easily and seen that this is the work piece. Here, the part of the work piece which has to be clamped on this rigid support. Now there is a strap which is hinged which has got hole and the centre and through which a pin passes and that is fixed on the base plate. Now this can you see this is an eccentric cam. This hole is not at the centre of this disk. Now if you move it in this direction, so this one will get in and there will be a force this will move up this pin because this larger radius tends to come in. So this will tend to go up and exert pressure on this side on the work piece. Against this, this is a hinge and this is another.

Now here you see the radial disk is gradually increasing. Now if you and move it in this direction so this will exert pressure here it is suppressing on this heal and when you press it here and this is a you know reaction so the action will be here on the job and this will clamp it. Now here you can see the clamping. Now some time what happens? Suppose this is the work piece and this is the base and now here the clamping force has to be applied through the interior. So here the system this system and this system will not be applicable because it is not accessible. It has got certain you know small gap only. So in

that case this kind of system has to be applied. What is it? This is the cam, you see this is hinged over here and this is a cam and through which a screw hole is there threaded hole and there is another piece which has got which is hinged over here which is hinged over here. Now if you rotate this screw, so this will first move in this direction and this cam will try to move in this direction but since it is a cam eccentric, this will be locked friction locking will be there under that condition you screw it and the force will be exerted here. When you unscrew it opposite direction, so this will be withdrawn and this will this this will also move in this direction. This contact will be over and this force is withdrawn and you can remove the work piece. Now the multiple clamping of cylindrical jobs:

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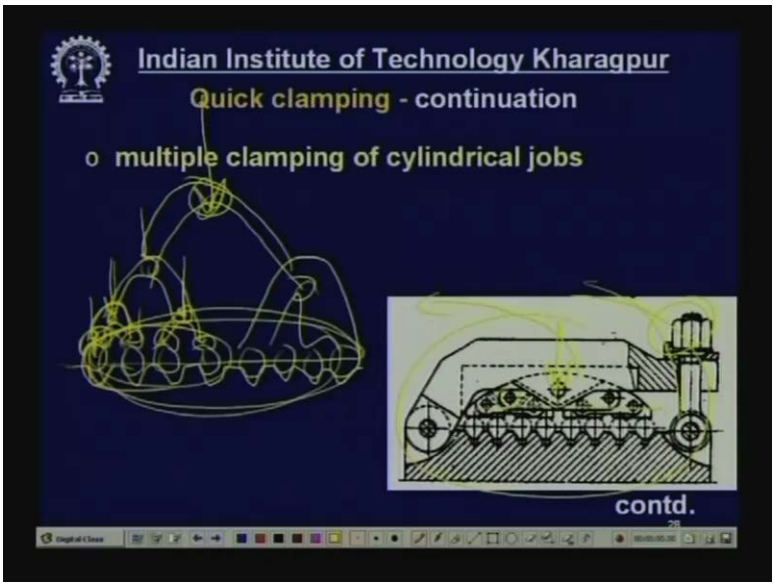

Now suppose number of the rods have to be held or pipe have to be held simultaneously. Suppose there are these are ‘V-blocks’ okay ‘V-groups’ and you put this blanks here on the V-groups. They may be of same diameter, may not be there may be slight variation in the diameter. Now, this will be held by one hinge like this. So this is the strap when this will be pressed so this will be this is the hinge strap. So this will apply force equally. Similarly you apply a strap here apply a V-group type and now there is a strap inclined we apply force here. So both this one will be now this two will be connected by another strap inclined say L type apply force here. So force will be exerted here that will be transmitted here all this four rods will be clamped. Similarly, this four will be also clamped like this.

Now if you join this two again, so by applying one force at this point, you can apply equal force on all these eight rods and this is what it looks like. So this will be shown up and move down after mounting and tighten the screw. So force will be exerted through this pin to all the pins and all the jobs.

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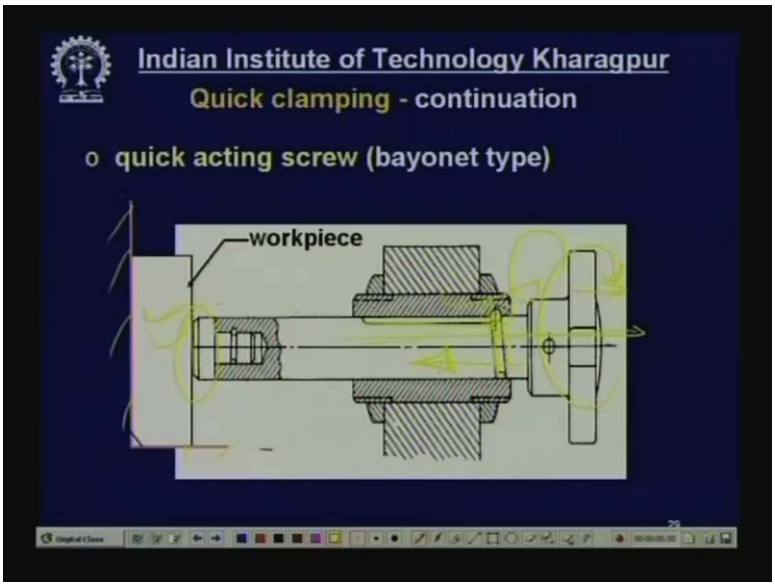

Quick Acting Screw: Now suppose this is the work piece. This is the work piece and which has to be you know clamped again this surface. Here is the screw very peculiar screw now this has got an axial slot and there is a pin part of this one on a bush. Now if you pull it at this stage this will simply come out now when you clamp it want to clamp it held hold it tightly you push it first to the maximum strength bring it in contact this pin will be here now you rotate clockwise. So this pin will be resting and this will this slot will get in to that since it the slot is inclined this will be gradually moving inside just as a screw in a nut and that will apply force here during un clamping you rotate it anticlockwise and then you bring this slot under this pin and you pull it out. So this is very quick clamping but it is exerted for used for light duty work, not for heavy for because it cannot apply heavy force. Now the drill jig bushing finally;

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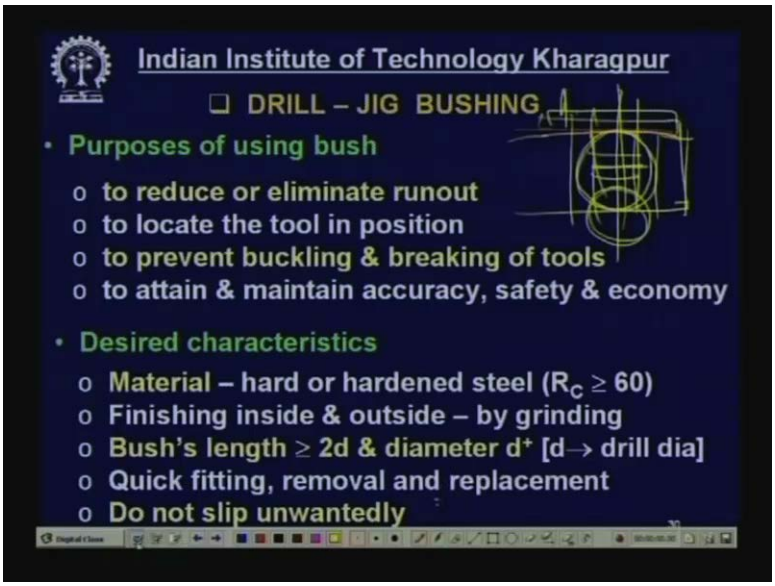

I told you that the cylinder rods like tools which rotate with a run out as a result accuracy gets lost and it may bend undergo buckling and may break because of the force. Now for these things the bushes have to be used. What of the purposes of using bush? Let me repeat; to reduce or eliminate run out to locate the tool in position with respect to the job to prevent and buckling and breaking of the tools because there is a cylinder tool under the thrust force it can break because of bending to attain and maintain accuracy, safety and economy. Safety means to prevent breakage and damage and loss. Desired characteristics of these bushes; the material should be hard or it should be hardened at the meeting surfaces R c should be above 60.

Finishing inside should be by grinding and lapping outside by grinding because it plays very important role on finishing accuracy. Bush's length the bush's length; If you apply suppose this is the bracket and this is the bush this is the bush and this is the hole. This bush's length you know this length should be double the minimum or greater than double the diameter and diameter of the hole should be equal to or greater than slightly diameter of the hole to be a made. Bush's length greater than two diameter and diameter of the bush should be d plus where 'd' is a drill diameter and it should be seen that it should be quick acting quick fitting removal and replacement do not slip unwantedly that means when the drill is taken out, this bush should not also go out simultaneously with the drill. It should remain in position that is what should be assured. Now types of bushes;

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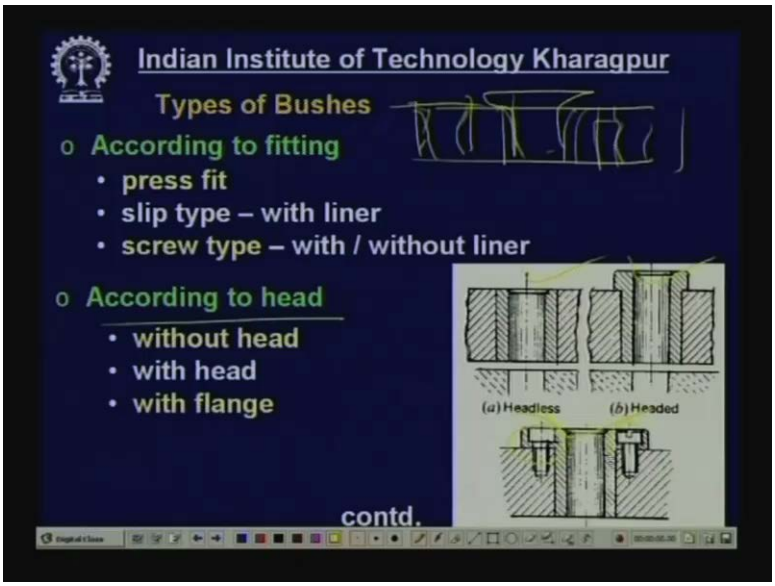

According to fitting press fit, it can be press fit slip type with liner and screw type with or without liner. So it can fitted by press fit or it can be one liner can be fitted in to that another line another strip and screw type. Say press fit type is a simply a bush press fit inside the bracket. Another slip type a liner bush and then within that another bush, screw type that will be fitted by screwing either directly or within another slip. According to head either no head or with head or with flange head which are clamped by screws. Now this shows the frequently replaceable.

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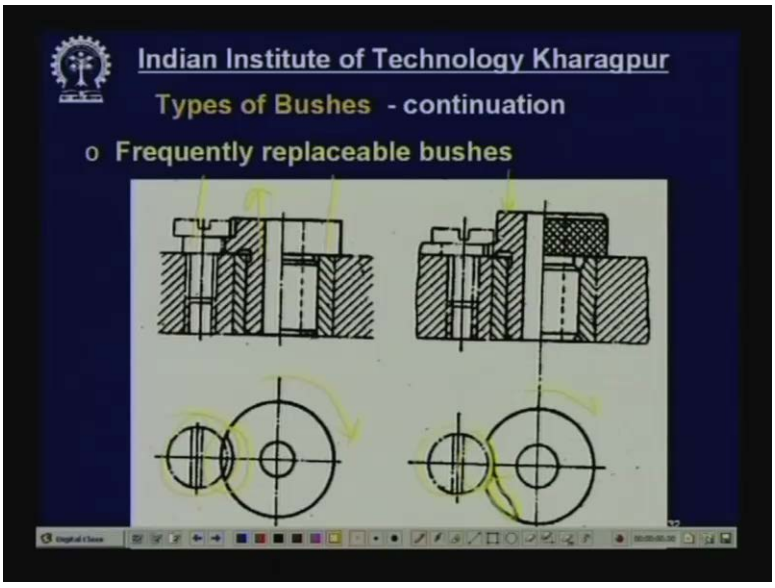

If the bush needs to be replaced time to time, then this arrangement should be there. There should be a pin. Now it has got slot or a step like this, when you unscrew this one. So this has got a step slot like this and then if you want to withdraw this, then first of all this pin has to be withdrawn, then you have withdraw it. Again you place it, then again you fit the screw to it. So this will be arrested here. So the rotation will be prevented and lift will be prevented by the screw, but if it is wanted frequently, then it should have a gap and then a step like this. So you can fit directly without disturbing the screw place this one directly like this and then simply rotates. So this end will come under this pin here and this will be arrested and this is for special type of bushes.

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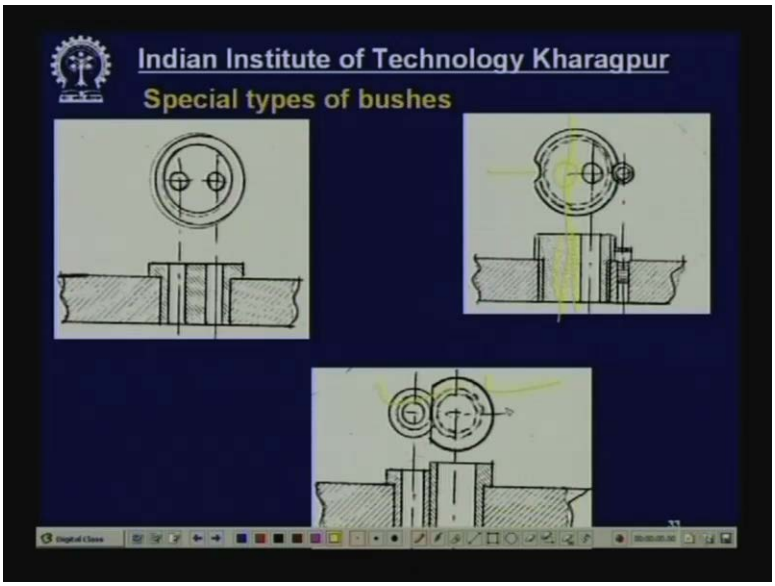

If you want two holes very close, then this kind of single bush with two holes or a bush with an eccentric hole after making one hole, this has to be tilted by 180 degree. So when this will be tilted rotated by 180 degree, then it has to be rotated by 180 degree. This hole will be coming here and then again use it make another hole side by side. This can be done by two mounting two holes side by side this is also possible. So friend, now you have seen that jigs and fixtures are so useful in batch production. This helps in basically locating, supporting, clamping and the tool guidance very quickly, easily and effectively and every time the repeatability is always maintained. The same kind of work will be done repeatedly so the accuracy will be there and it will be maintained and the worker need not exert much force or effort and he need not be very skillful also. As result the cost quality and cost comes down that is an advantage of using jigs and fixtures, but again I repeat this should be used only in case of batch production not for mass production.

Thank you.