Design of Steel Structures
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Module - 2
Connections
Lecture - 2
Riveted Connectioins

In the last lecture, first we have discussed different type of joints means whether it is rivet joints or welding joints or bolt joint. Such type of joints are available to connect 2 members, 2 members means either beam-column beam-beam column-column like this members has been connected means can be connected through the joints that has been discussed. Then on rivet joint different aspects of rivet joints has been discussed means, classification of different type of rivet joints. First of all what type of rivets we are going to use whether it is power driven shop rivet or hand driven shop rivet or field rivet all those things we have discussed. Then we have discussed the type of load coming into picture and type of arrangements of the rivets how we are making. And type of different types of rivets snap head means basically the rivet means type of rivets can be made on the basis of the head whether it is snap head pan countersunk or something else, those things has been shown there in details.

Today, we will be discussing on the strength aspects means how the strength of a rivet joint can be calculated. Before going to discuss about the strength of the rivet joint we will discuss the failure means, what type of failure is coming into picture and due to that failure how the strength we are going to calculate? In fact, the failure of the joint can be means made sorry the strength of the joint can be found out with the assumptions which we have discussed in the last lecture. That the friction between the 2 plate will be neglected. The stress is assumed as uniform the load is assumed to be shared by the, all the rivets equally direct shear. So, all these assumptions as we have discussed earlier on the basis of those assumptions we will calculate the strength of the rivet joint.

Again we will discuss here the codal provisions; that means what should be maximum pitch distance, what should be the minimum pitch distance, edge distance, gauze distance? All these things has been described in the code. So, those things we have to known before designing a joint. And of course, in the last lecture we have discussed the

conventional drawing how to represent different type of connections in what way in the sectional aspects and in the view sectional view. So, those things also has been discuss in the last lecture. So, those things I am not going to repeat only the classification just with a few minutes. I will be repeating, because if we know the classifications then only we will be able to find out the, what type of failure will come? And then how the strength will be calculated?

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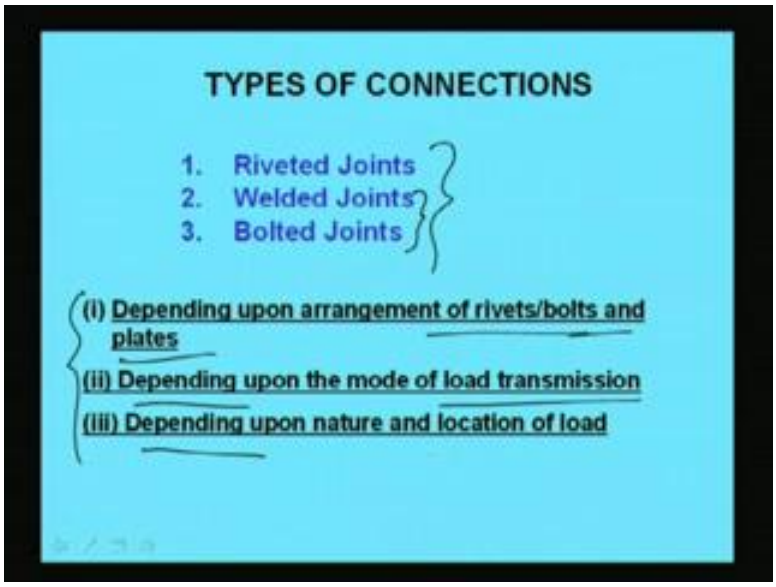

So, first is that riveted joints will be discussing. These 2 joints will discussing later welded joint and bolted joint. As we know riveted joint is a permanent in nature and this riveted joint can be classified into 3 categories. One is depending upon arrangements of rivets or bolts and plates then depending upon the mode of load transmission and then depending upon the nature and location of load. So, these 3 categories has been described in the last lecture which I am giving a small means short overview.

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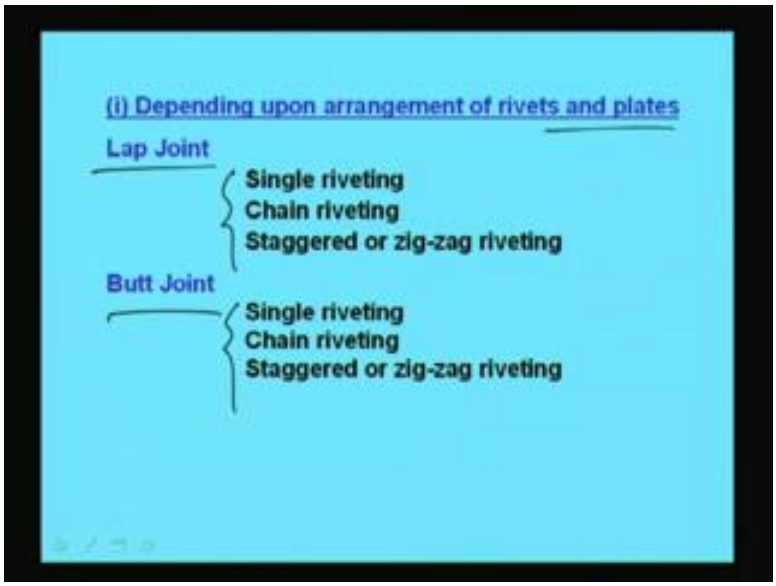

Now, the depending upon arrangement of rivets and plates we can divide the joint into 2 category; one is lap joint another is butt joint. In case of lap joint that 2 plates will be overlapped. In case of butt joint the 2 plates will be placed side by side means front to front it will be placed and additional cover will be required to connect these 2 plates. So, there are 2 type of basic category; one is lap joint another is butt joint. In lap joint again we can see that one is single riveting then chain riveting and then staggered or zig-zag riveting.

So, when we are going to calculate the strength we have to see whether it is single riveting or chain riveting or staggered or zig-zag riveting. Then accordingly the strength will be calculated, strength will be calculated on the basis of the arrangement of the rivet whether it is chain riveting or it is zig-zag. If zig-zag strength will be little more than the chain riveting if same number of rivets is placed. So, all these we will be discuss in and we will be we will seeing that how the strength are going to be calculated. And in case of butt joint, also we will see single riveting chain riveting and staggered or zig-zag riveting.

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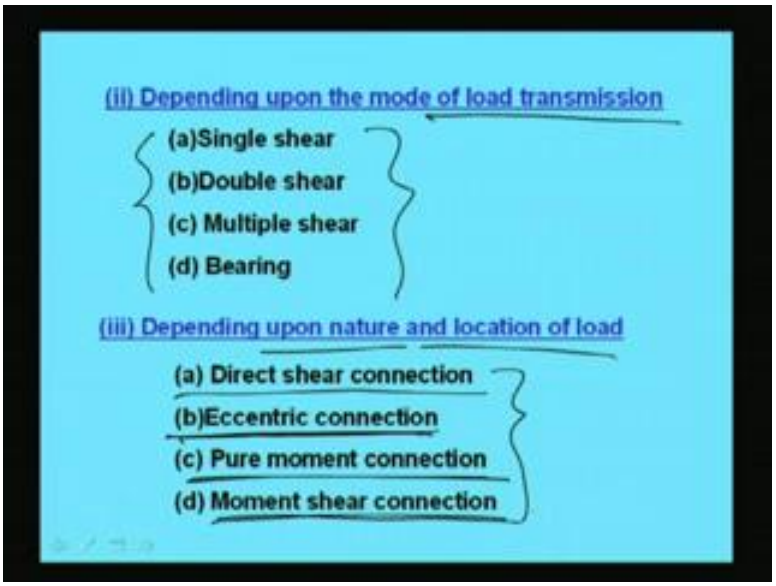

So, this we have discussed how it look like and depending upon the mode of load transmission the things can be means the joint can be classified as single shear double shear, multiple shear and bearing. So, these 4 types of classifications can be made again if we see the nature and location of the load. Then we can categories as shear connection, direct shear connection, eccentric connection and then pure moment connection then moment shear connection. So, one is direct shear connection means only shear is coming into picture; that means, concentric load. Another is eccentric connections only eccentricity is coming means eccentric connection and then pure moment connection; that means, only moment is coming into picture. And then moment shear connections; that means, the joint will be exerted moment as well as shear. So, the joint has to be designed the strength has to be calculated from the moment point of view from the shear point of view. So, accordingly we have to calculate the strength.

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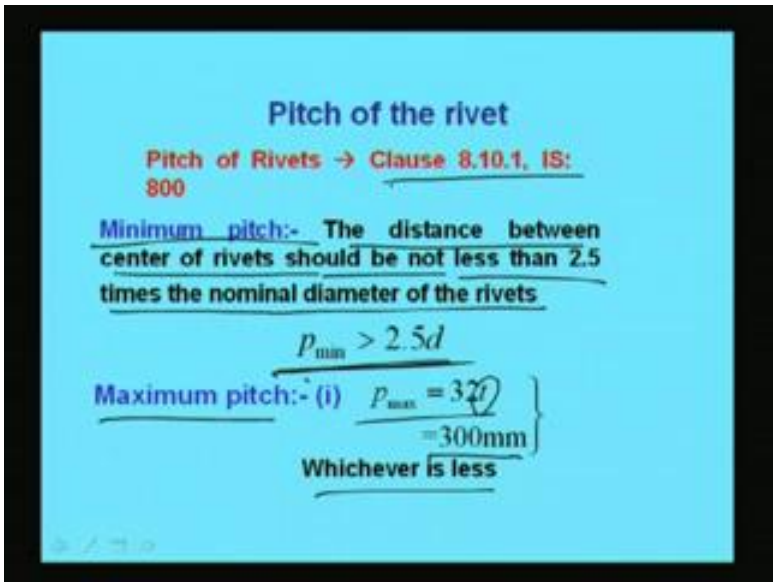

Now, as per the clause 8.10.1 in IS 800 1984 the pitch of rivets has been described. Like minimum pitch first it has been described what should be minimum pitch. The code has told that the minimum pitch should be 2.5 times the nominal diameter of the rivet. That means the distance between center of rivet should be not less than 2.5 times the nominal diameter of rivets. That means, minimum pitch should be greater than 2.5 d, where d is the nominal diameter of the rivet. So, this is the criteria which we should maintain when we will be designing the joint. Another thing is the maximum pitch. Maximum pitch also has been described means has been guideline by the code. That is maximum pitch can be 32 into t where t is the thickness of the plate and 300 mm whichever is less. Now, which t will consider t is the smaller thickness; that means thinner part of the plate. So, maximum pitch will be either 32 t or 300 millimeter whichever is less this is 1.

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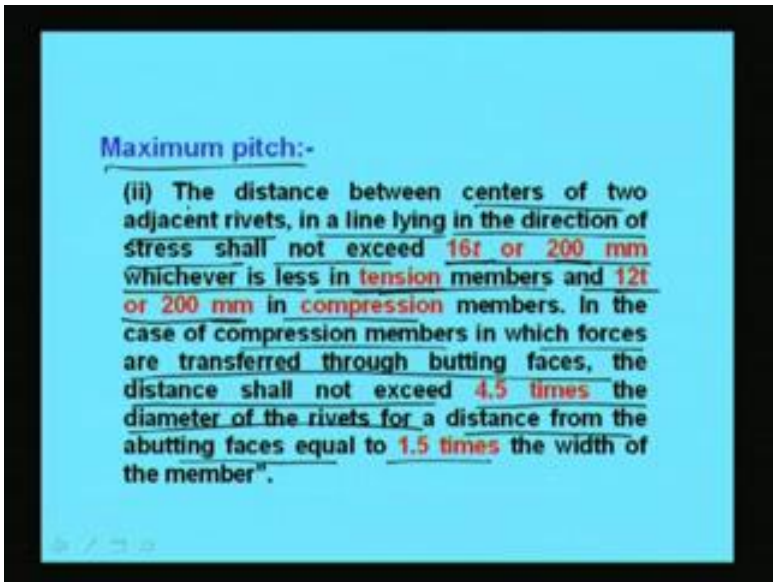

And other thing is that the distance between center of 2 adjacent rivets. That means, pitch in a line lying in the direction of stress shall not exceed 16 t or 200 mm whichever is less in tension members. So, in case of tension member it should be 16 t or 200 millimeter whichever is less and in the case of compression member it will be 12 t or 200 mm whichever is less.

So, this aspects has to be also remember that the maximum distance the P will be either 16 t or 200 mm for tension and 12 t or 200 mm for compression members. In case of compression members in which forces are transferred through butting faces. The distance shall not exceed 4.5 times the diameter of the rivets for a distance from the abutting faces equal to 1.5 times the width of the member. So, this codal provisions also has to be kept in mind while designing the joint with the rivet right. So, what we have seen in case of tension member the maximum distance should be 16 t or 200 mm whichever is for tension member 16 t or 200 whichever is less. And for compression this will be 12 t or 200 whichever is less. So, this criteria has to be remember while designing the rivet joint.

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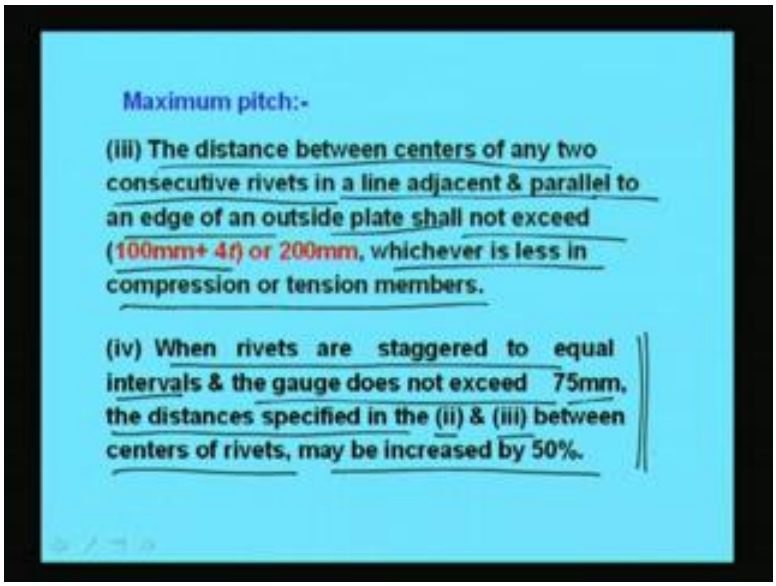

Another criteria has been given that the distance between centers of any 2 conjugative rivets in a line adjacent and parallel to an edge of an outside plate shall not exceed 100 mm plus 40 or 200 mm whichever is less in compression or in tension members. So, this also should not exceed 100 mm plus 40 or 200 mm whichever is less. Another option has been given that is when rivets are staggered to equal intervals and gauge does not exceed 75 mm gauge does not exceed 75 mm. The distance specified in the section 2 and 3 between center of rivets may be increased by 50 percent. This also is important to keep in mind while designing the rivet joints.

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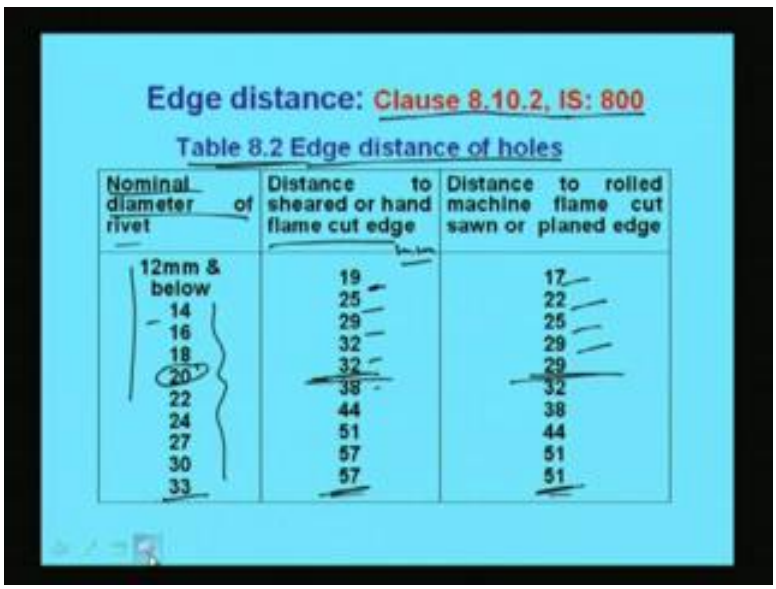

Now, code has been guided that the edge distance should have some limitations means, sorry once again this slide I am repeating now. Now, the edge distance in clause 8.10.2 of IS 800 1984 the edge distance has been given in a tabular form in table 8.2 where edge distance depends on the nominal diameter of the rivet. So, here if we see the nominal diameter of the rivet has been given here that like 12 mm and below then 14 mm 16 mm like this it is has gone. And distant to shear or hand frame cut edge. So, these distance these are all millimeter. So, this will be 19; this will be 25 like this it has been given

And distance to rolled machine flame cut swan or planed edge this has given. So, what type of rivet we are using? It depends on that and accordingly the diameter has been given and as per the diameter used we have to find out the edge distance. Say suppose in case of 33 mm diameter of the rivet the edge distance will become 57 in this case and in this case this will be 51. Generally, we will use in out example most frequently that 20 mm diameter of the rivet. So, in this case if we see 20 mm then we will see this is 32 the edge distance and here it is 29. So, we will be using such type of edge distance.

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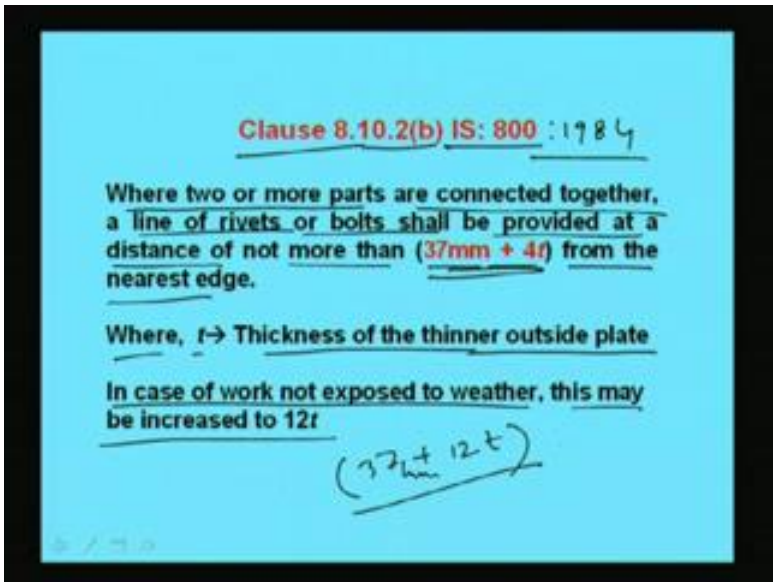

In clause 8.10.2 b of IS 800 1984 it is told that where 2 or more parts are connected together a line of rivets or bolts shall be provided at a distance of not more than 37 mm plus 40 from the nearest edge. So, this also has to be kept in mind. It should not become more than 37 mm plus 40 where t is the thickness of the plate thickness of the thinner plate. So, where t is the thickness of the thinner outside plate in case of work not exposed

to whether this may be increased to 12 t. So, in this case 37 plus 12 t millimeter means 37 millimeter plus 12 t where t is in millimeter the thickness of the thinner plate. So, in this way we can find out this is given in clause 8.10.2 b clause 8.10.2 b of IS 800 1984.

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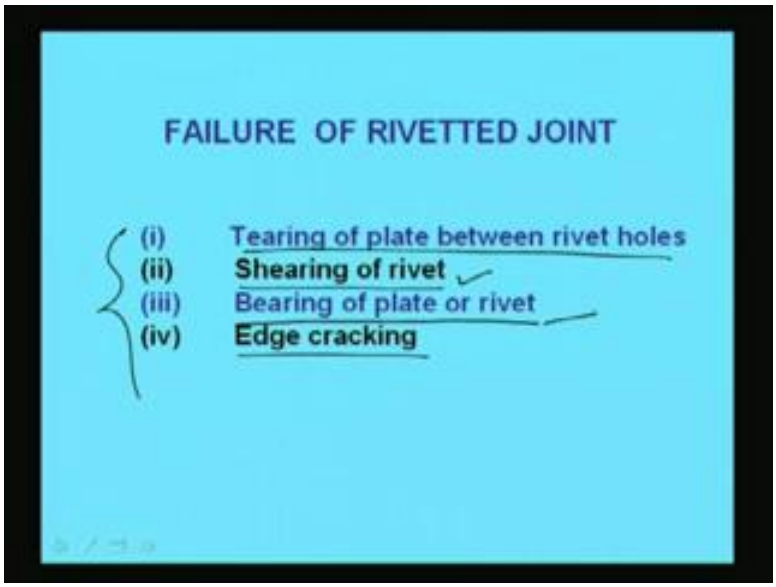

Now, we will discuss about the different types of failure of rivet. Unless we know what type of failure is going to happen? We cannot calculate the strength of the rivet. So, failure means what type of load is coming into picture and what way it is going to fail, because of shearing or because of bearing or because of tearing we have to see first. And according to that we have to find out what is the permissible stress because of bearing? What is the permissible stress of that particular rivet or of that what you call this plate because of shearing? What is the strength allowable stress? All these things we have to know and then according we can find out the strength. So, first we will see, what is the failure? How failure happens?

And accordingly we will calculate the strength of the rivet. First is say tearing of plate between rivet holes. This is one type of failure which happens. Another is shearing of rivet then means because of failure of due to shearing, another is bearing of plate or rivet, another is edge cracking. So, what type of failures we are seen? One is tearing of plates between rivets holes. So, in between 2 rivets holes it may happen that the plate is going to be teared and then it is going to fail. So, accordingly the strength has to be calculated of the joint means the plate because plate is going to fail not the rivet. Another is

shearing of rivet because of shear the rivet is may fail. So, what is the shearing stress allowable shearing stress of the rivet and what will be the rivet value on the basis of shearing. That we have to find out and accordingly the number of rivet can be calculated.

Of course, this can this will be calculated only when we know the type of arrangement. That means, whether it is lap joint or butt joint chain riveting or zig-zag riveting all these things we have to know accordingly we can find out the strength. Another failure is bearing of plate or rivet. So, the plate also may fail due to bearing rivet also may fail due to bearing. So, we have to see the bearings strength of the plate as well as bearing strength of the rivet and then we have to find out the strength of the joint. Another is edge cracking means if edge distance is not kept sufficiently then the cracking of the plate will happen due to access load, so edge cracking may come into picture. So, in that case how to resist all these things we will discuss later. So, first let us come to the tearing of plate between rivet holes, so it tears.

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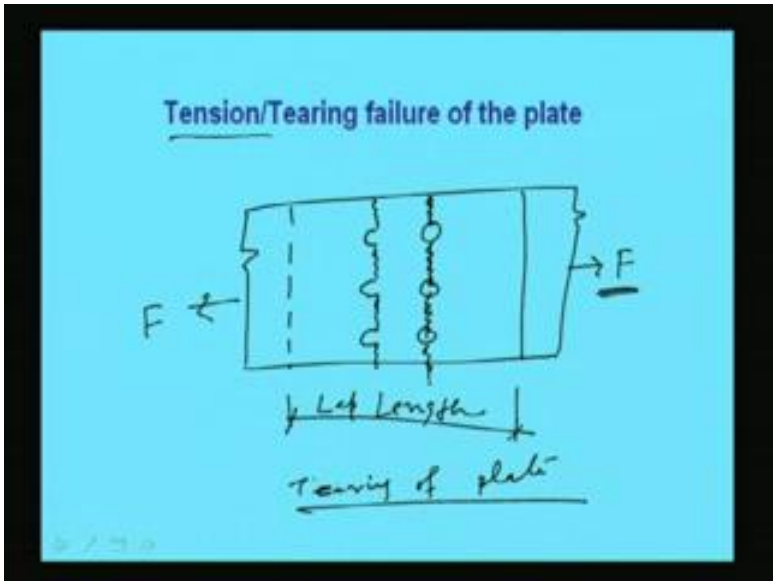

This is basically because of tension it fails. Now, suppose one plate is overlapped with another plate and is under tension say this is one plate and this is another plate and this is the lap length this is called lap length. Now, this is F, this is z. So, what can happen is say suppose the rivet is provided here say like this like this and say like this. So, now if we go on increasing the load the magnitude of the value of F then what will happen the tearing may start here? So, it may happen like this, so after sometimes what will happen.

That this will like come like this then this then again tearing. So, the plate is going to tear as a hole and the failure will be happening like this, so this is called tearing of plate. So, tearing of plate is happening, so this is because the lesser thickness of the plate or higher magnitude of the load. So, we have to find out, what is the strength means tearing strength accordingly we have to design the joint.

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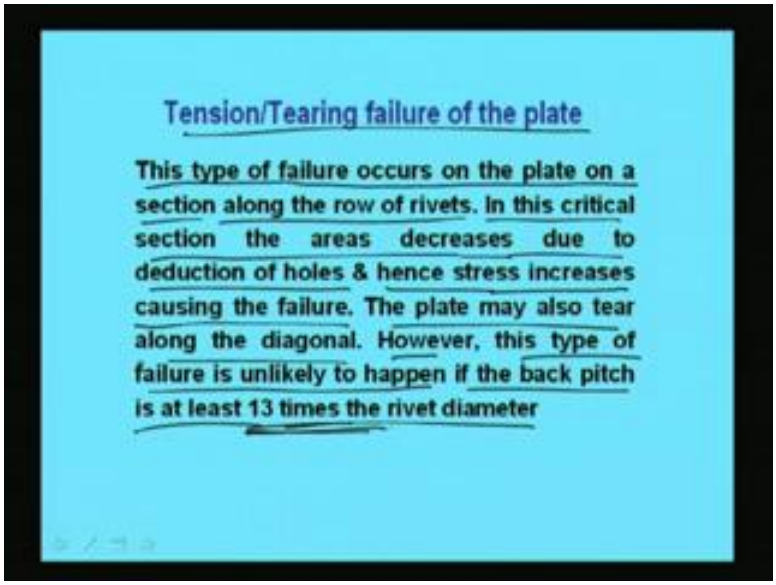

Now, let us see what is or the sorry this I will come again. So, the when the tearing happens that this type of failure occurs on the plate on a section along the row of the rivets. In this critical section the areas decreases due to deduction of holes and hence stress in stress increases causing the failure. The plate may also tear along the diagonal. However, this type of failure is unlikely to happen if the back pitch at least 13 times the rivet diameter. If the back pitch is at least 13 times the rivet diameter. So, if we keep back pitch sufficiently then this type of failure can be avoided.

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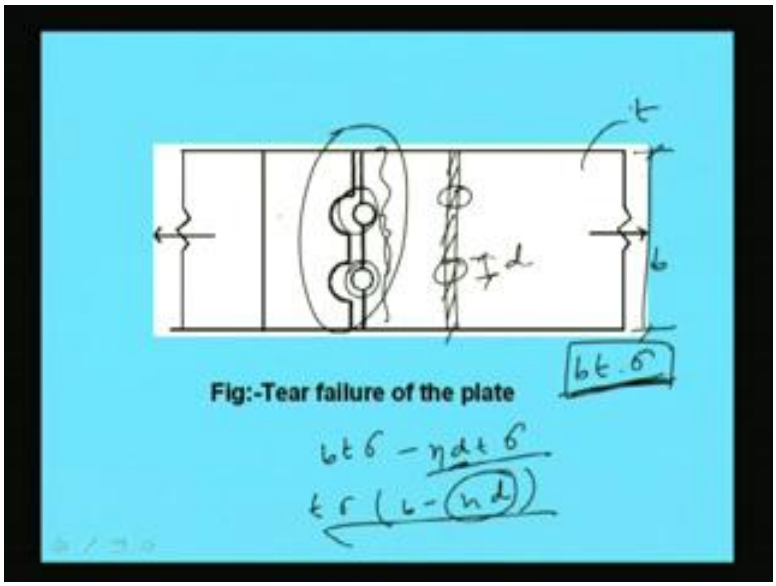

And, so what we are seen here that this failure will happen when this distance is less. In fact, means the strength of the suppose strength of the plate in this section will be what simply if this is b and if thickness is t then strength is bt into say sigma ((refer time: 22:04)) right. So, strength we can find out like this, but when we are putting whole say 2 hole we are putting then what will be the strength? Then strength will become bt into sigma minus again d into t into sigma D means diameter of the rivet hole. So, because of hole the strength of the plate is going to reduce. So, if n number of rivet is there then n number of hole will be there, so we will find out finally, t into sigma into b minus nd.

So, the strength is going to reduce, because of number of rivet holes. So, more we provide rivet the strength of the plate is going to be reduced. So, it is not that always if we provide the number of rivets more the joint is going to become strength. Joint is going to become much more stronger it is not like that. We have to see whether the plate is also capable of taking that much load or not. So, failure may happen, because of different reasons 1 is failure of rivet itself another is failure of the plate at that position. That means through that section, so this tearing happens because of the presence of the rivet hole. So, efficiency will decrease efficiency of the joint will decrease, if we increase the number of rivet holes here from the tearing point of view right.

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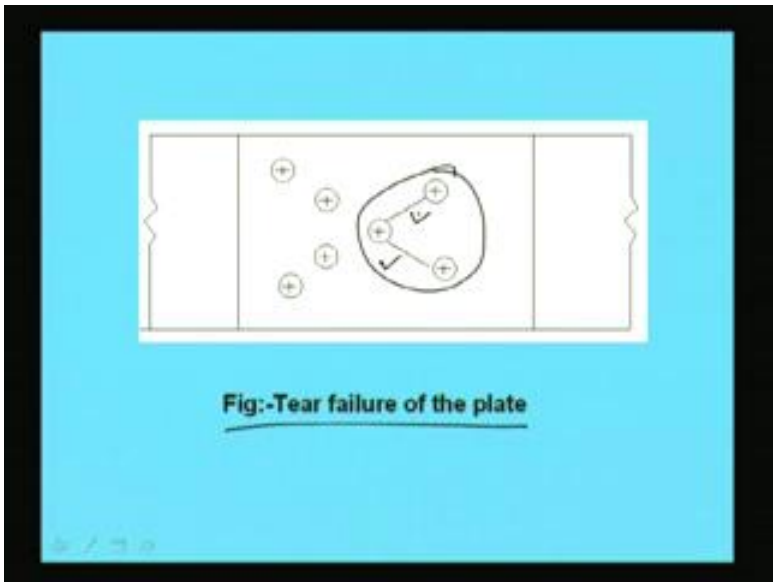

So, another chances of failure will be like this tear in failure may when it is zig-zag that also it may fail which is very unlikely the tearing may happen like this. Though it is very unlikely this type of failure also may come into picture.

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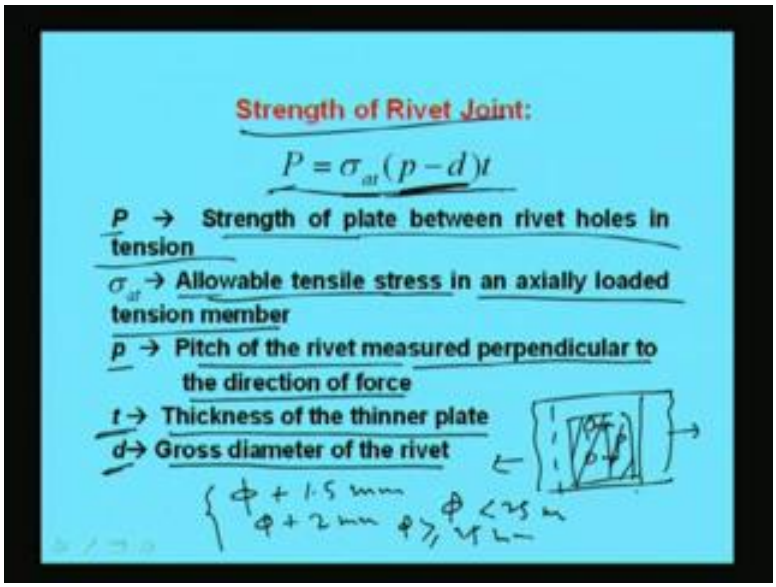

So, how do we find out the strength of the rivet joint from this. That strength will become the sigma at into p minus d into t. What is capital P? Capital P is the strength of plate between rivet holes in tension right. Strength of plate between rivet hole in tension. So, here the strength we will find out right? Now, if pitch is P then p minus d per pitch

the strength will become p minus d into t into sigma a t where sigma a t is the allowable tensile stress in axially loaded tension member. This allowable tensile stress can be found out for different type of grade of steel. And P is the pitch of the rivet measured perpendicular to the direction of the force measured perpendicular to the direction of the force. Suppose this is a plate another plate is overlapping and if this is like this and if force is like this. So, this is the P right? So, for this strength we can find out from this right and t is the thickness of the thinner plate, because thinner plate will be going to fail first thicker plate will be much more stronger. So, we have to take the thinner plate and d is nothing but the gross diameter of the rivet. Remember this d is gross diameter of the rivet not the nominal diameter.

That means this is will be the nominal diameter plus 1.5 mm if phi is less than 25 mm and this will be phi plus 2 mm if phi is greater than or equal to 25 mm. As per the codal provisions this has been given the gross diameter means the diameter of hole and strength is going to reduce, because of the presence of the hole. So, we have to means when we are going to calculate the strength of the plate we have to calculate the net area of the plate at that section, net area will be the total area minus the whole area. Area due the hole because of the presence of the rivet and hole area of the hole how do you find out? Area of the hole at that section will be d into t where d is the gross diameter of the rivet. That means, the diameter of hole and t is the thickness and this thickness will take for the thinner plate, because thinner plate is going to fail first. So, we will find out the strength of the plate due to tearing as t is equal to sigma a t into p minus d into t right.

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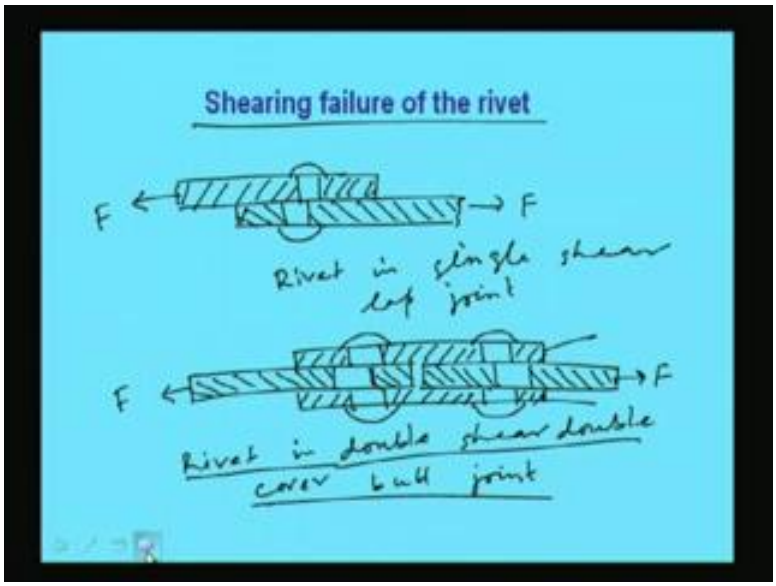

Now, we will see how the shearing failure of rivet can be calculated? First we will see how the shearing failure is happening in case of say lap joint? Say first let us see say one plate is here and another plate is here. These are under force F and say one rivet is there which is going to fail, so the failure will happen like this. So, this will be basically rivet in single shear single shear lap joint this is lap joint. Therefore, we will calculate the shearing strength of the lap joint according we will come later in details. And if a plate is given like this and another is like this means for butt joint suppose we are connecting this by these 2 plate.

And say this is the failure pattern of the butt joint say one another rivet is here and it is going to fail like this. This is one cover and this is another cover to joint 2 plates right and this is the main plate which is exerting force of F right. So, this will be rivet in double shear double cover butt joint. Therefore, if the placement of the plates are like this then it will be failed under double shear double cut means double shear will happen means shearing will happen because of 2 butt is provided means 2 cover is provided. So, accordingly when we are going to calculate the strength of the rivet we will calculate means considering this type of arrangement. So, we will show how to calculate in next slide we will come.

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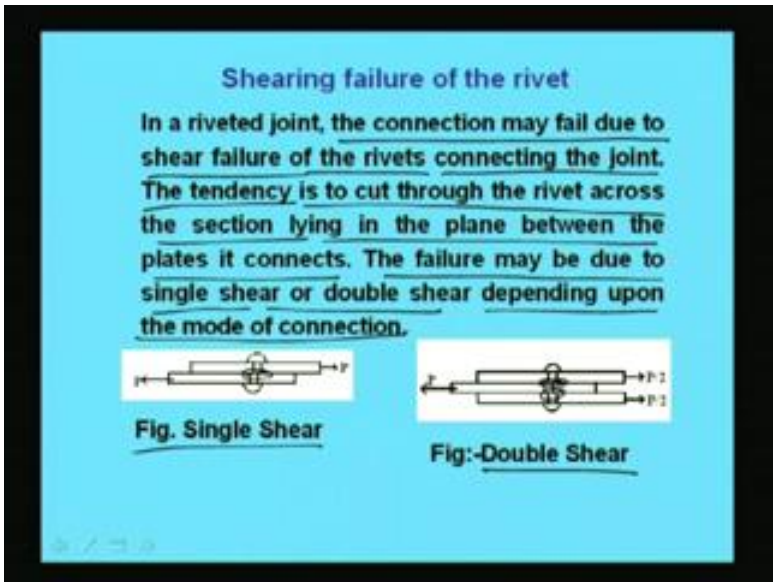

So, what we told that this is suppose single shear means only one shearing failure is happening and this same lap joint it can be called as double shear means in 2 places it is happening. So, in a riveted joint the connection may fail due to shear failure of the rivets connecting the joint. So, because of shear failure the joint may fail. The tendency is to cut through the rivet across the section lying in the plane between the plates it connects. The failure may be due to single shear or double shear depending upon the mode of connection. So, how the plates are connected? According to that the failure will happen. Type of failure will be dependent on the mode of connections how the connections has be arranged? How the plate has been arranged for the connections? On that basis the failure will be decided.

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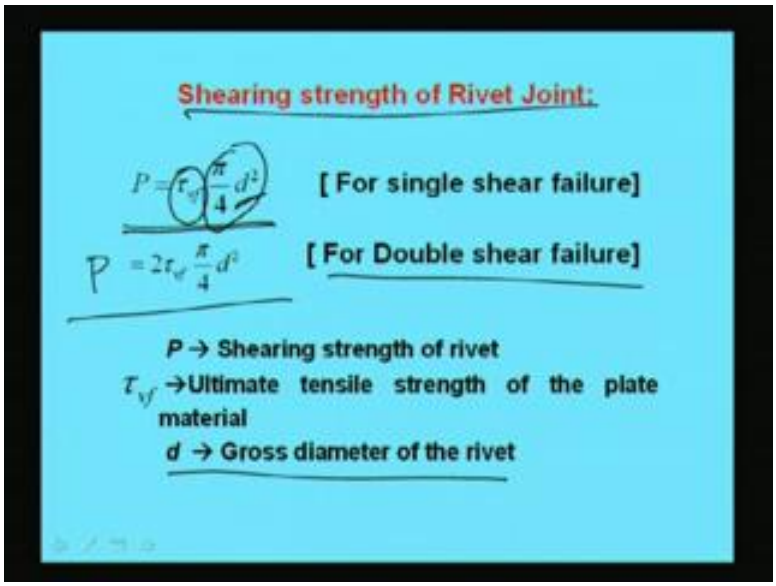

So, shearing strength now we will calculate, because we have to find out the how much shearing force can be withstand by the joint particular joint right. So, shearing strength can be calculated for a single shear as P is equal to tau vf into pi by 4 d square. That means tau vf is the ultimate shearing stress of the rivet and d is the diameter nominal sorry gross diameter of the rivet. So, this will be called P is equal to tau vf into pi by 4 d square. The area means cross sectional area of the rivet is pi by 4 into d square and tau vf is the shearing stress allowable shearing stress. So, for a single shear P can be find out as tau vf into pi by 4 into d square. And for double shear this will become this P will become 2 into tau vf into pi by 4 into d square where d is gross diameter of the rivet and p is the shearing strength of the rivet.

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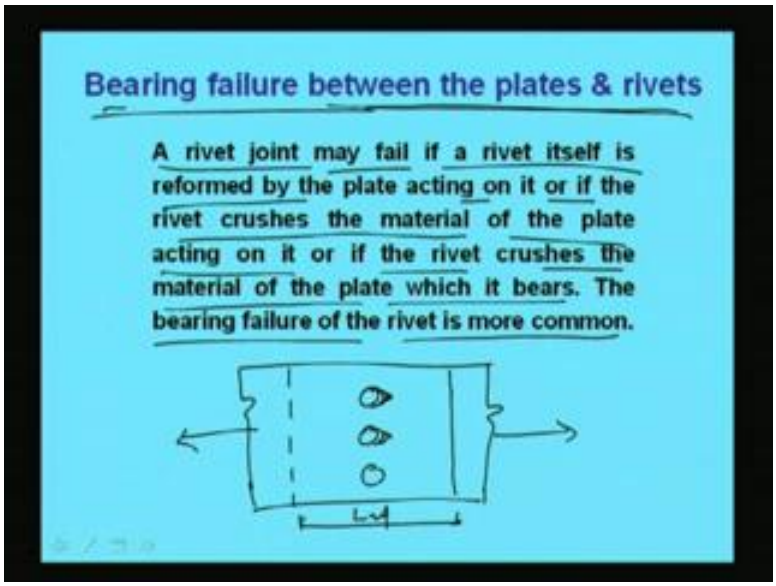

Another type of failure is called bearing failure between the plates and rivets. That means when we will be going to calculate the strength of a plate due to as once again I am repeating this slide. Another failure which we observed in the sorry once again ah, so I start Conversation between Student and Professor. So, let us start bearing failure is another type of failure between the plates and rivets. In fact, a rivet joint may fail if a rivet itself is reformed by the plate acting on it. Or if the rivet crosses the material of the plate acting on it or if the rivet crosses the material of the plate which it bears the bearing failure of the rivet is more common. How it looks like? If 2 plates are left and under tensile force then such type of failure is observed. Say these are the 2 plates which is left and if we have say these are rivet. So, due to crushes means rivet crushes the material; that means, this will be something like this. So, failure will happen like this, so this is the type of bearing failure.

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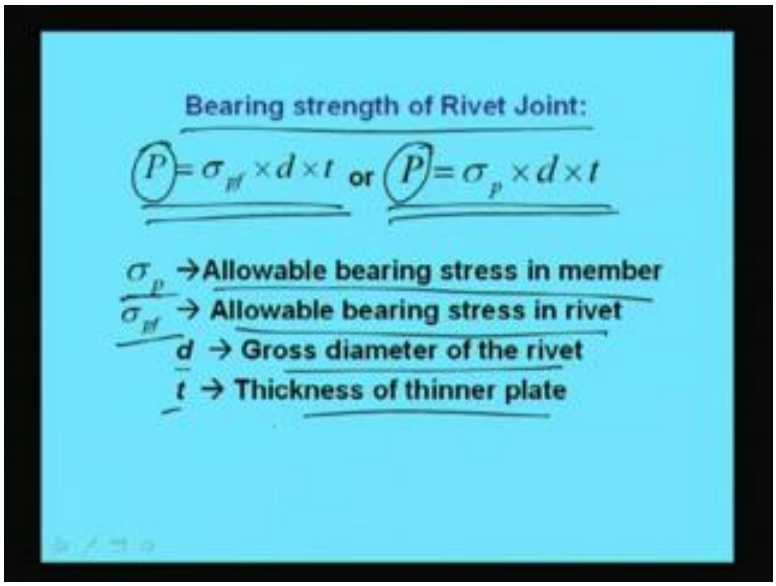

We can calculate the strength of the joint due to bearing also. And bearing failure means from the bearing failure the strength can be calculated as P is equal to sigma pf into d into t or P is equal to sigma p into d into t. Bearing failure can happens due to the failure of rivet or due to the failure of the thinner plate. So, when we are going to calculate the bearing strength of the joint we have to calculate the bearing strength of the thinner plate and the bearing strength of the rivet. So, sigma pf sigma pf is the allowable bearing stress in rivet accordingly we can find out the bearing strength of the rivet. Similarly, sigma p is the allowable bearing stress in the plate allowable bearing stress in the member. So, we can find out the bearing strength of the member. And t is the thickness of the thinner plate and d is the gross diameter of the rivet. So, accordingly we can find out the bearing strength of the rivet and bearing strength of the plate and whichever is less will be the bearing strength of the joint right?

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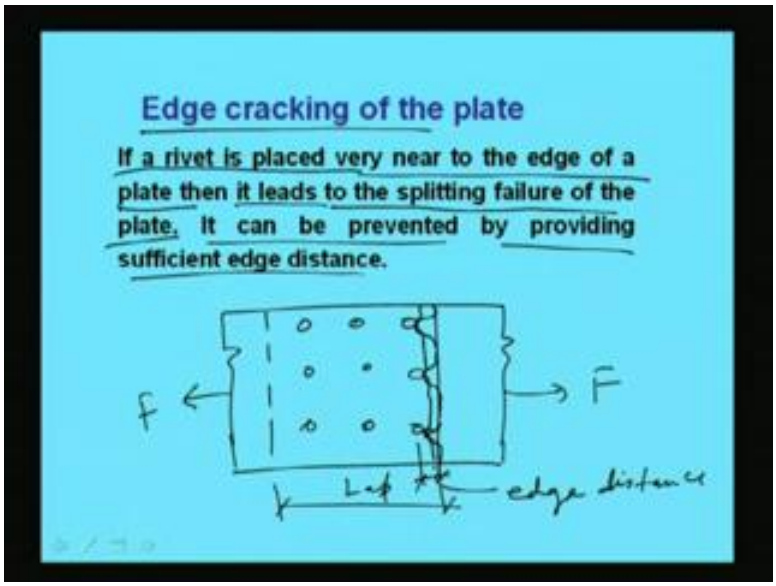

Another failure is to happen, because of edge cracking when it happens. Edge cracking happens when the sufficient edge distance is not available or is not provided during the joint design. How it happens? Say one plate is overlapped with another one and is under the tensile force and say this is one plate another plate is this and this is the lap. Suppose we need many rivets means 2 withstand that much high load. So, now, what we see that this edge distance is less this edge distance when this distance is less what will happen? This will crack; that means, this will crack like this right, so cracking will occur. So, because of less crack means like this it will finally, happens right.

So, if a rivet is placed very near to the edge of a plate then it leads to the splitting failure of the plate it can be prevented by providing sufficient edge distance. Generally, if we means follow the guidelines of the codal provisions then generally this failure can be prevented. However, if the load is very high and if we have to keep the number of rivet is very high with a certain lap distance then the edge distance become very less. So, in that case the failure of the plate because of edge cracking may happen. That is why we must keep the codal provisions and we must maintain that codal provisions. As per the codal provisions the minimum edge distance has to be provided even if possible more edge distance should be provided.

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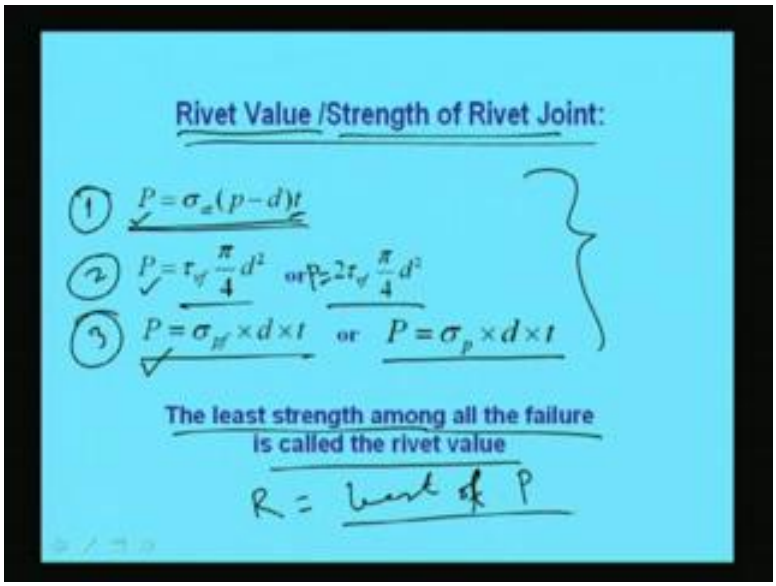

So, from the different type of failure we can find out what is the strength of the rivet joint or rivet value. So, one is that strength of the rivet joint can be find out from this formula P is equal to sigma at into p minus d into t where p is the pitch and d is the gross diameter of the rivet. And t is the thickness of the thinner plate and sigma a t is the allowable tensile stress this is one. Another is due to shearing that on the basis of double shear or single shear the value of P can be find out means strength of the joint can be find out either tau vf into pi by four d square or 2 into tau vf into pi by 4 d square.

Another is due to bearing failure the strength can be calculated as P is equal to sigma pf into d into t or P is equal sigma p into d into t whichever is less. Now, out of these all these the least strength among all the failure is called the rivet value. That means failure will happen first at the weakest 1 weakest mode. So, the rivet value means strength of the rivet joint due to bearing failure due to shearing failure due to tearing failure can be find out and least of these 3 will the strength of the rivet joint or the rivet value. So, in this way we can find out rivet value generally we denote R which will be least of P, so in this way we can find out.

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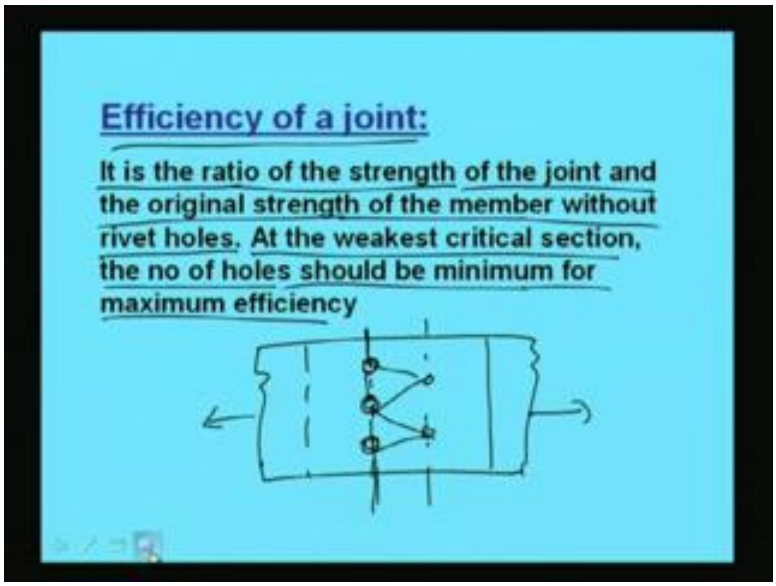

Another term which we use in case of design of a joint is efficiency of the joint efficiency of a joint. Efficiency of a joint means the joint when made with the provision of rivet what is the strength of that joint and if we do not provide the rivet means if we do not make hole what was the strength of that section. So, if we divide those ratio means if we make those ratio then that ratio will be the efficiency of that joint means we can define as it is the ratio of the strength of the joint. And the original strength of the member without rivet hole means without rivet hole what was the strength and with rivet hole what is the strength? At the weakest critical section, the number of holes should be minimum for maximum efficiency.

We have to see that at the weakest section, weakest section we have to see that number of hole should be minimum on that section. That means say we have 2 plates under tension and as usual it is left now, say suppose this is one and another one is this. So, different type of failure may happen one is it may fail like this, another it may fail in this. This will be the weakest, because deduction of hole is maximum here 3 number of holes are there. So, here it will be weakest and another sort of failure may happen like this which ((Refer Time: 41:36)) will be more stronger means stronger than this section right. So, this is the means this is how we can find out the efficiency of a joint.

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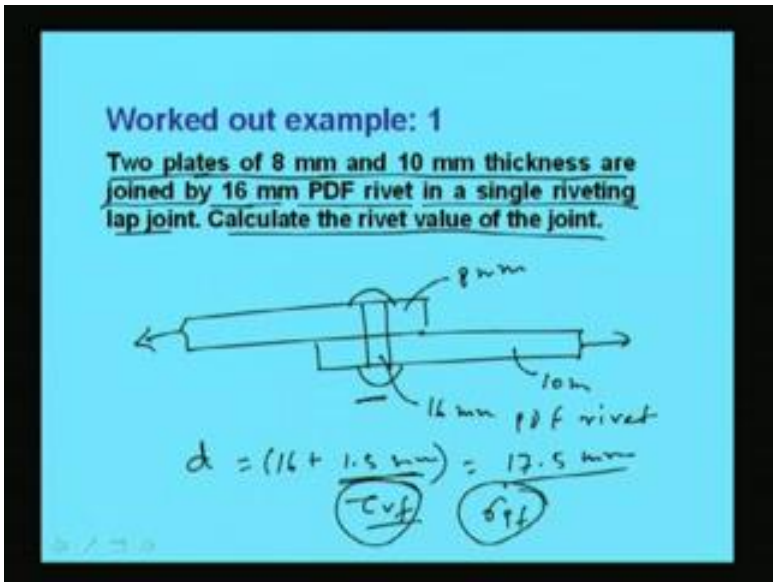

Now, the some of the worked out example if we go through then we will be able to understand how to calculate the strength of a joint. If we go through 1 or 2 worked out example then we will be able to understand. One example has been given here that is 2 plates of 8 mm and 10 mm thickness are joined by 16 mm power driven filled rivets. This PDF means power driven filled rivets in a single riveting lap joint calculate the rivet value of the joint.

So, how to calculate the rivet value of the joint, so what is there that 1 rivet is means single rivet joint is there and it is a lap joint where rivets is placed like this we have to calculate the strength of this joint. Plate thickness are given say this is 10 mm and this is 8 mm and this is 16 mm power driven filled rivet. And this is single riveting it is given as single riveting. So, what we can find out we can find out the gross diameter means gross diameter d will be find out 16 plus 1.5 millimeter. Because if diameter is less than 25 millimeter then the additional means additional dimension will be taking as 1.5 mm. So, this will be becoming 7.5 mm. And now we have other find out what is the tau vf? Tau vf and sigma pf these 2 thing we have to find out which we will be find out from the codal provision right.

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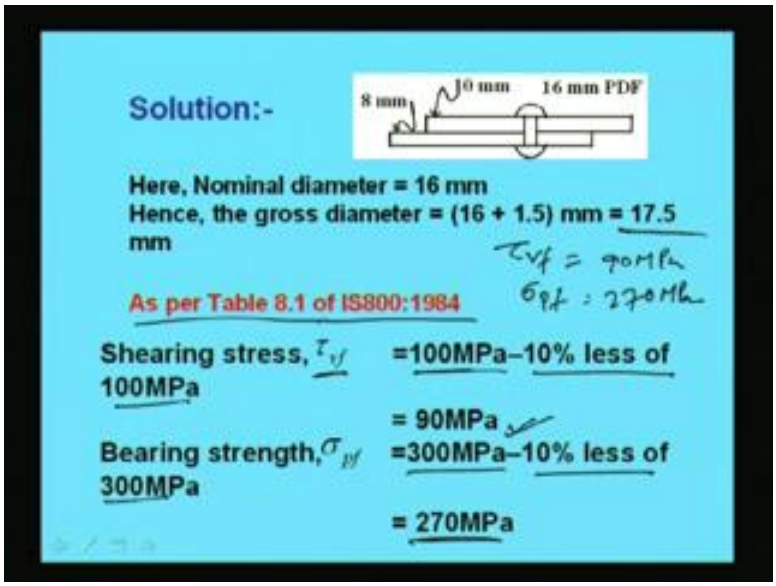

So, if we see the solution at as per table 8.1 of IS 800 1984. The shearing stress tau vf will become 100 MPa minus 10 percent less of hundred MPa; that means, for this type of rivet this will become 90 MPa as per the codal provision. And similarly, bearing strength will become 300 MPa minus 10 percent less of that; that means, 270 MPa right. So, we are getting gross diameter as 17.5 mm and tau vf we are getting as 90 MPa and sigma pf we are getting 270 MPa. This is because power driven filled rivets has been used now, what we will do.

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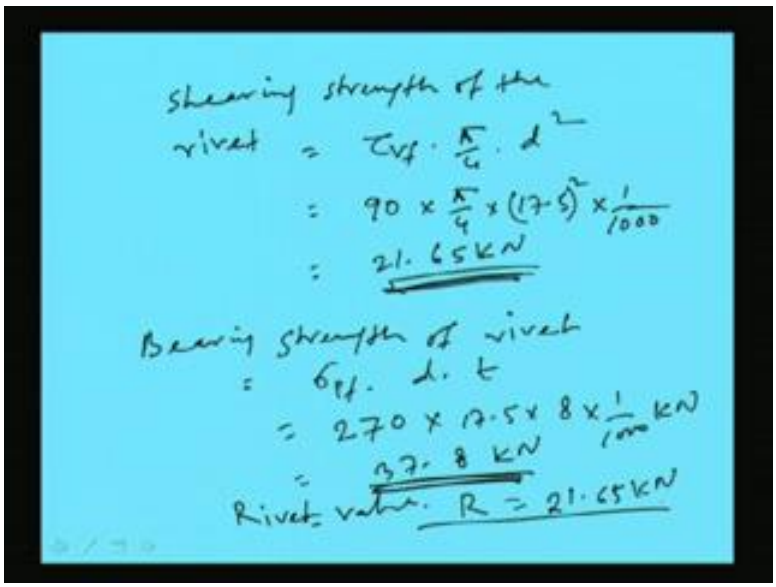

We will calculate the shearing strength of the rivet. So, shearing strength of the rivet will become tau vf into pi by 4 into d square, because this is a single shear. So, simply it will be tau vf into pi by 4 into d square. So, tau vf if 90 into pi by 4 into d square means 17.5 square right this will come in Newton, so if we divide it by 1000 will be coming as Kilonewton. So, this is coming 21.65 Kilonewton, so due to shear the strength of rivet is coming 21.65 Kilonewton. And for bearing strength will be that will become sigma pf into t into t. And the value of sigma pf as per the codal provision it leads 270 MPa and d is 17.5 and t is the thickness of the thinner plate that is 8 mm. And we are dividing by 1000 to make it Kilonewton right, so this is becoming 37.8 Kilonewton. So, the rivet value R can be find out means rivet value R will be lesser of these 2 right due to shearing and due to bearing. So, this will become 21.65 Kilonewton. So, the rivet value of the joint is becoming 21.65 Kilonewton.

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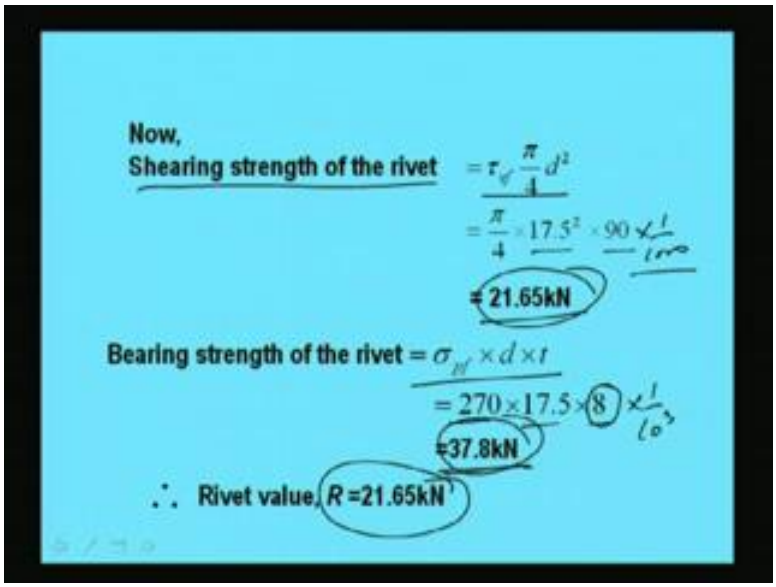

This is what we have calculated. So, shearing strength of the rivet first we have calculated as tau vf into pi by 4 d square which is coming as pi by 4 into 17 point pi square into 90 into means 1 by 10 cube which is coming 21.65 Kilonewton. And similarly bearing strength of the rivet we are getting like this which is coming 270 into 17.5 into 8. 8 is the thickness of the thinner plate, because thickness was 8 mm and 10 mm. So, thinner 1 we have taken and this is coming as 37.8 Kilonewton. So, out of these 2 we are getting the lesser 1 as 21.65 Kilonewton. So, in this way we can find out the rivet value.

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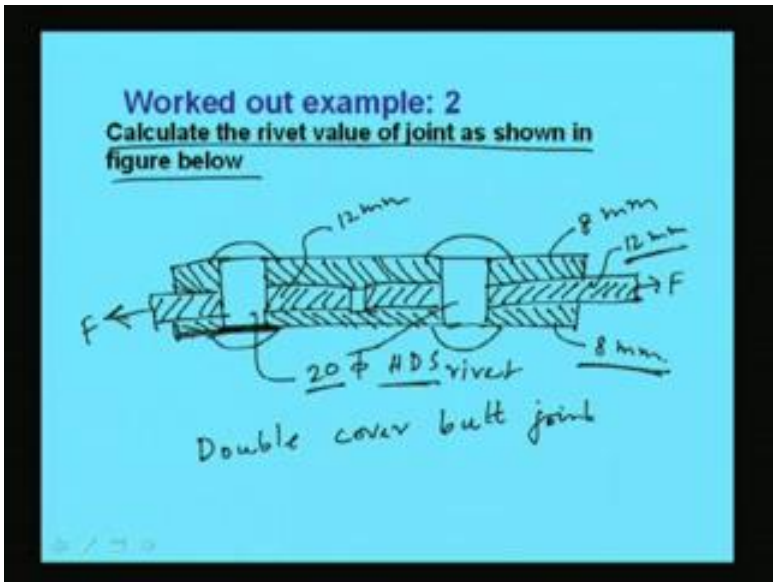

Another example will be going through which we will be able to find out the rivet value of the joint ah calculate the rivet value of joint as shown in the figure below. Let us first draw the figure then we will find out how to calculate the rivet value? Say suppose this is one rivet and this is another one say this is F and this is the main plate this is another main plate carrying tensile force of F. So, from this we are seeing that this is a butt joint. So, how to calculate the strength of the butt joint? We will see here. So, these are the 2 rivet right, so double cover butt joint double cover butt joint, now these are the cover. This covers thickness is given as 8 mm, this is another cover provided at the bottom. This thickness is also 8 mm right.

Now, the thickness of the main plate is 12 mm which is 12 mm and the rivet is 20 mm diameter hand driven shop rivet right hand driven shop rivet. This is 20 mm diameter right. So, this is the detail of the joint that is the rivet is used as 20 mm hand driven shop rivet and the extra plate which has been made that cover is 8 mm and the thickness of the main plate is 12 mm. So, here what we will calculate first? We will calculate the gross diameter.

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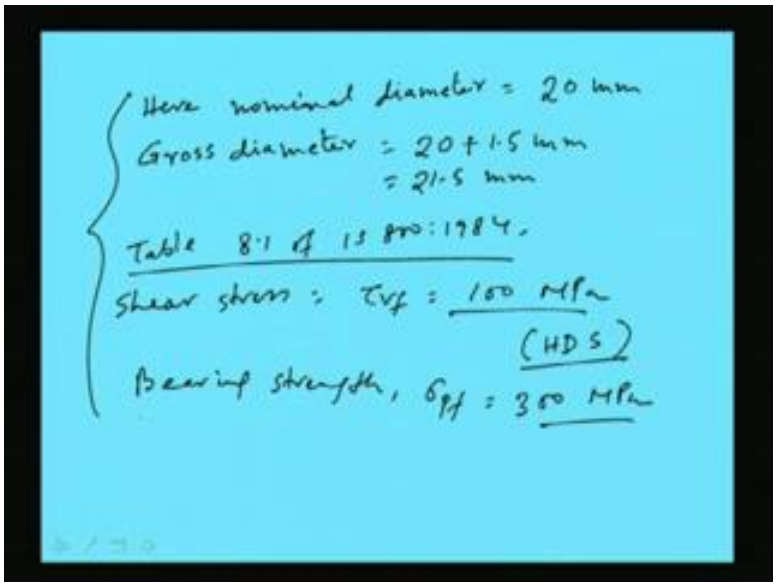

Here nominal diameter is given 20 mm. So, we can find out gross diameter as per the codal provision that will become 20 plus 1.5 this is 21.5 mm. Remember if the diameter of the rivet becomes more that 25 mm or 25 mm then this will become 5 plus 2 mm. That means clearance will be taken dimension due to clearance will be taken extra as 2 mm. And if the nominal diameter of the rivet is less than 25 mm then the additional dimension will be added as 1.5 mm. So, here it will be 1.5 mm, so from table 8.1 of IS 800 1984 we can find out the shear stress. Shear stress will become which is given 100 MPa for hand driven shop rivet we are using hand driven shop rivet that is why the shear stress is 100 MPa as per the code it is given. And bearing strength of the rivet sigma pf will become 300 MPa as per the code. These are the things, which has been given. So, these whole things are given in the code as per the codal provisions we made right?

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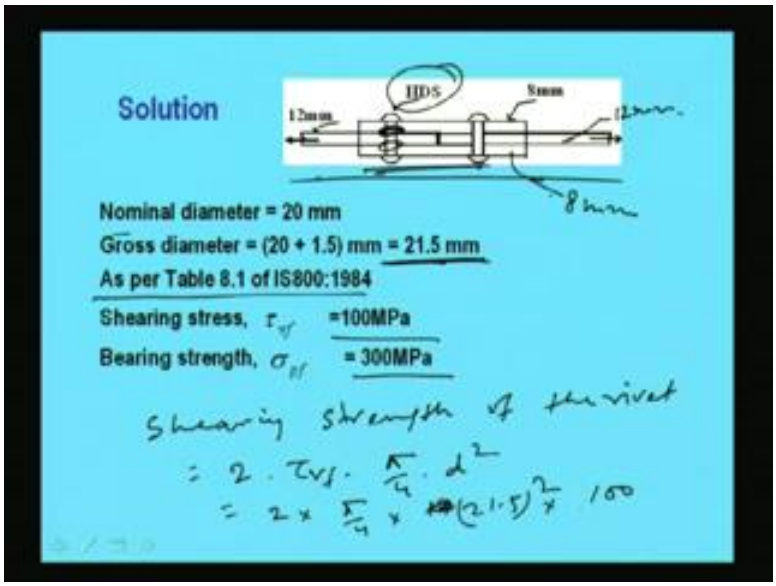

So, the problem is like this that 2 cover has been introduced of 8 mm. This is 8 mm and hand driven shop rivet has been used the thickness width of the main plate is 12 mm. And, so double cover butt joint has been made. So, accordingly we have to find out from the codal provision that gross diameter is 21.5 and from table 8.1 we found shear stress tau vf as 100 MPa and bearing stress as 300 MPa. So, we can find out strength that is shearing strength. So, here what will happen? We will see that this is a double shear because in 2 faces it is happening, so it will come as under double shear. That means 2 into tau vf into pi by 4 into d square. So, this will become 2 into pi by 4 into d means 17 point sorry 21.5 square into tau vf is 100, right.

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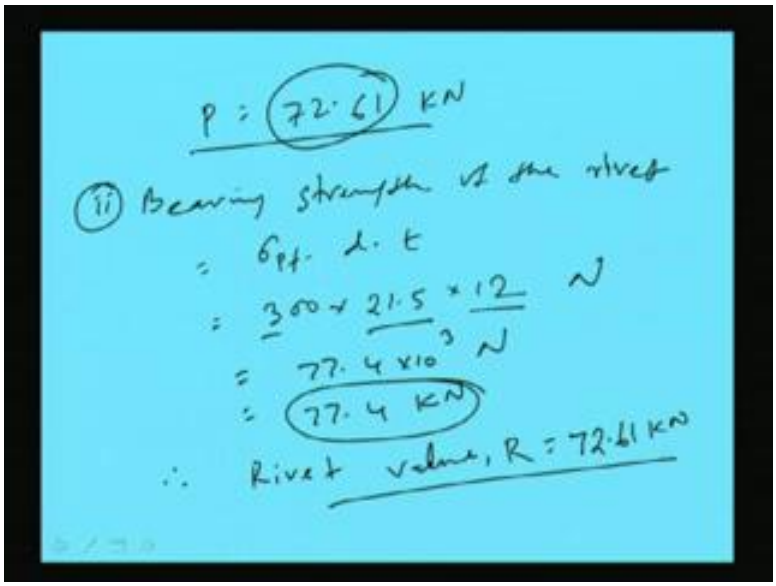

So, if we calculate we will get this is as p is equal to 72.61 Kilonewton. That means if we divide it by 10 cube to make it Kilonewton from Newton. So, the strength of the rivet due to double shearing is 72.61 Kilonewton. And bearing strength this is bearing strength of the rivet will be simply sigma pf into d into t is equal to 300 into d is 21.5 into t is 12. Why t is 12? Because if we see that this is 12 mm thickness and for the cover this is 8 plus 8 it is becoming 16. So, failure will first happen at this.

So, bearing strength of the rivet will become 300 into 21.5 into 12. This will be in Newton, so this coming 77.4 into 10 cube Newton that means this becoming 77.4 Kilonewton. So, the rivet value will become generally we denote as R will become lesser of this and these 2, because here failure is happening mainly because of shearing and bearing. So, because of shearing it is 72.61 and because of bearing it is 77.4. So, the rivet value will become lesser of these two; that means, 72.61 Kilonewton. So, this is how we can find out the strength of the joint.

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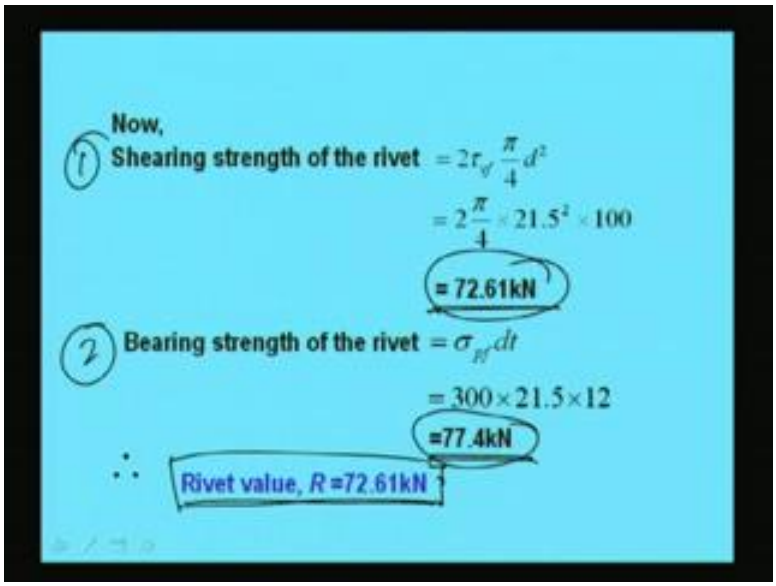

So, in this way we can find out. So, we have found the shearing strength as 72.6 Kilonewton and bearing strength which we have calculate earlier we have shown and the rivet value as 72.61 means the lesser of these 2. This is the shearing strength and this is the bearing strength. So, from these 2 we can find out the strength of the joint means rivet value basically. So, in this way we can calculate the rivet value for a particular configuration of the joint. In next class, we will discuss more about the strength of the joint using the rivet connections and then we will go for welding connection and bolting connections right.

So, in this lecture, what we have seen that how to calculate the rivet value of a particular joint rivet value of a joint? Rivet value of a joint can be found from the failure point of view. How it is going to fail, in what way it has been organized, in what way the rivet is distributed? From that we have to find out what will be the mode of failure and then what will be the strength of the rivet? What will be the rivet value? In this way we can calculate. So, with this I like to conclude here. And in next class, we will discuss about the different type of configuration of rivet. And in that way what will be the rivet means what will be the strength of the hole joint? That we will discuss in next class. With this I will I am concluding now.

Thank you very much.