Design of Steel Structures

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Module - 3

Eccentric Connections

Lecture - 3

Eccentric Connection with Load Perpendicular to Plane of Riveted Joint

Hello. Today's lecture we are going to focus on the eccentric connection with load perpendicular to the plane of riveted joint. In last lecture, we have focused our discussion on riveted joint with the load acting on the plane of riveted joint. Here we will see if the load is perpendicular to the plane of joint how it behaves. In last lecture, we have discussed in details and we have shown how to design a riveted joint with eccentric load, when this load is acting on the plane of the riveted joint.

In last to last class, we have shown little bit about the analysis of this type of joint. Today, we will show more details and other type of joint also; means whether if rivet is hot driven or rivet is cold driven, in both the cases how design will be affected, how the analysis will be going to do. So, all these things we will discuss in details.

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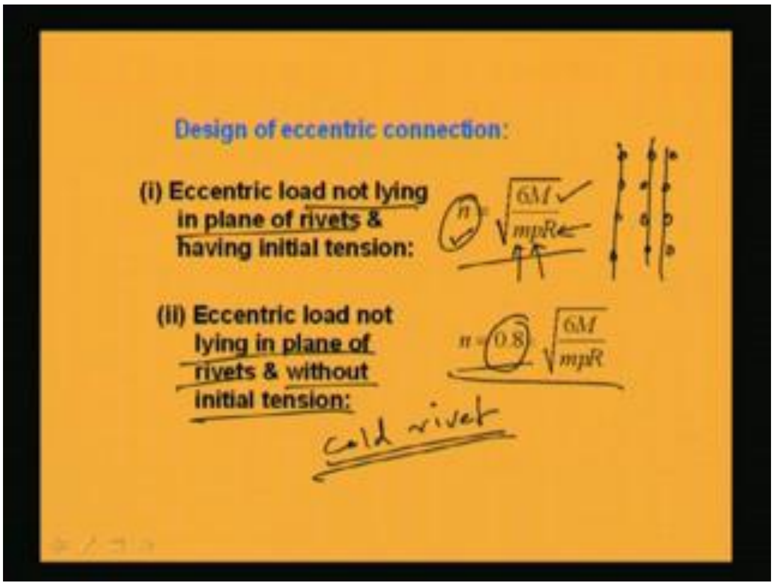

Now for design of eccentric connection when the loads are not lying in the plane of rivets, we have seen earlier also that we can assume this formula that n is equal to root over 6 M by mpR, where M is the moment due to the eccentric load, and R is the rivet value, and p is the pitch, and m is the number of column in which rivets are placed. Suppose rivets are placed like this. So, in this case m will be, say 3 because one line, two line and three line.

So, m will become 3. So, in this way you can find out the approximate number of rivets to start with the design. So, with the assumptions of this many rivets, we will start design, we will find out the stresses in different way; that means sigma t f calculated and tau we have calculated. Then we will see from both the cases whether it is becoming less than the allowable or not.

Similarly, if the load is not lying in the plane of rivets and without initial tension; that means if it is cold rivet; if it is cold rivet, then the number is going to reduce a little bit, because the strength of the rivet will be acting in such a way that the joint as a whole will be more stronger. So, if it is cold rivet, then we can reduce little bit number of rivets. So, we can multiply 0.8, say percentage of reduction; 20 percent we are going to reduce.

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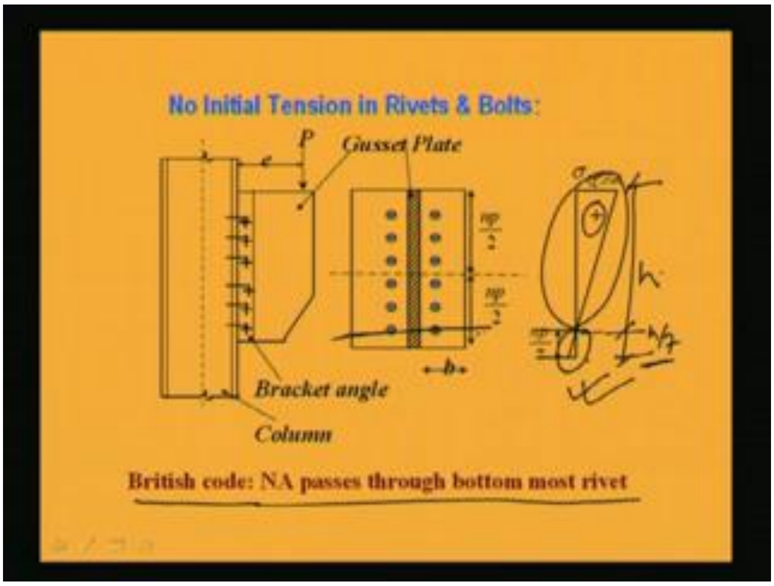

Now before going to start the analysis, we will see that as I have told earlier also that the neutral axis we are assuming that it will be if the total depth of the joint is h, the section is h, then h by 7. The neutral axis is assumed to be at h by 7. This assumption has been made by US code and as well as our Indian code also is also following this assumption that at h by 7, this neutral axis will move.

So, if we consider the neutral axis here, then accordingly we can find out what will be the stresses developing in different places, and what will be the stresses developing below the neutral axis. And above the neutral axis, generally stress will develop positive; that means tension, tensile stress will develop and below the neutral axis, the compressive stress will develop.

So, we have to make equal of total compressive force is equal to total tensile force. So, from this two equilibrium equation, we can find out the neutral axis depth properly, and we can find out other details. Another way of calculation is that which proposed by the British code is that neutral axis passes through the bottom most rivet. That means they are considering that neutral axis is passing through bottom most of the rivet. So, if we consider like this, then the other details can be calculated accordingly. So, there are two type of analysis, two codes have been suggested. We are going to focus only on this that US code whatever it is proposed; we are going to follow this.

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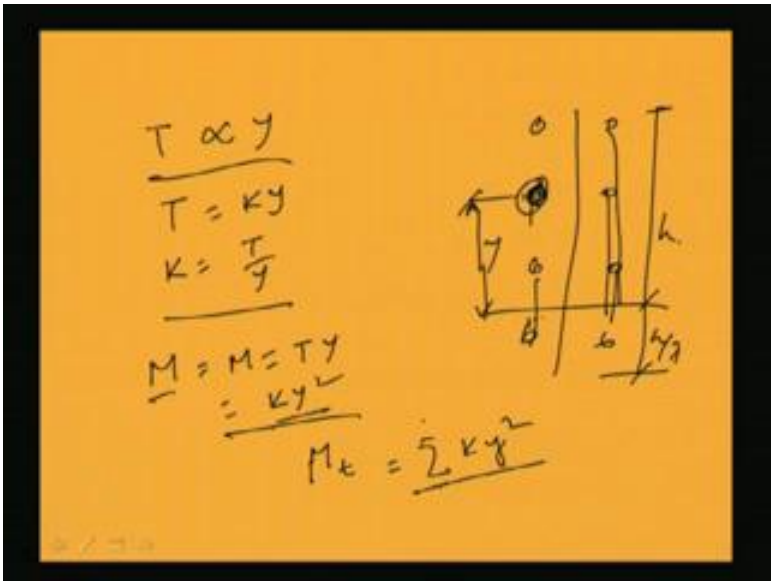

Now if we see if rivets are like this it is placed, so suppose is like this. Now, say tensile force this is the, say h by 7 and this is suppose h. So, tensile force its assumption is that that tensile force is varying with the distance of y. That means if y is this distance, say in this rivet if y is this distance, then tensile force in this rivet will be proportional to y. T varies y. That means I can write T is equal to k into y, where y is the distance from neutral axis to the rivet, and k is the proportional constant.

So, k I can find out from this. For a particular T value whatever tensile force is developed and the y the distance from the neutral axis to the rivet if we have, then I can find out the value of k. Now the moment of resistance due to this tensile force can be written as M is equal to T into y. So, this will become k into y square. So, in this way I can find out the moment of resistance.

Now for a particular rivet, I am getting the moment of resistance as k into y square. So, total moment of resistance will become if I write M t total moment of resistance. Then it will become k into y square because this is k y square, this is k y square, this is k y square, this is k y square, this is k y square, like this it will go on. So, summation of k y square where i means, it will vary from number of rivets; means from i is equal to 1 to n, where n is the number of rivet. So, in this way I can find out M t is equal to k y square.

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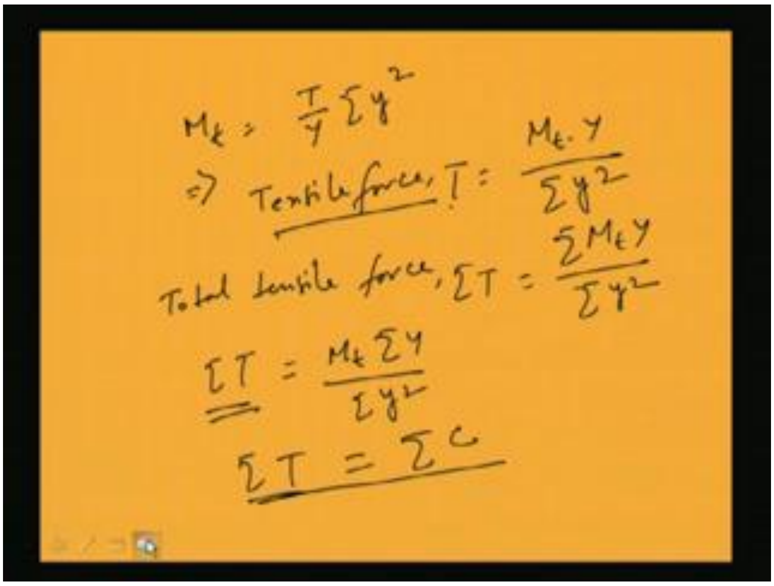

That means M t I can write in place of k, I can write again T by y. So, M t is equal to T by y into summation y square. So, means theoretically I can write the tensile force in this way tensile force T will become M t into y by summation y square. So, tensile force can be calculated from this. Now total tensile force I can write that this is a tensile force for a particular rivet. So, total tensile force this also can be calculated.

Total tensile force, say total tensile force maybe summation of T. So, this will become M t into y by y square, where M t is the total moment. So, I can write total tensile force is equal to M t into summation y by summation y square, right. So, this is the total tensile force. Now for equilibrium equation, we can write total tensile force is equal to total compression force; that means total tensile force will be equal to total compressive force.

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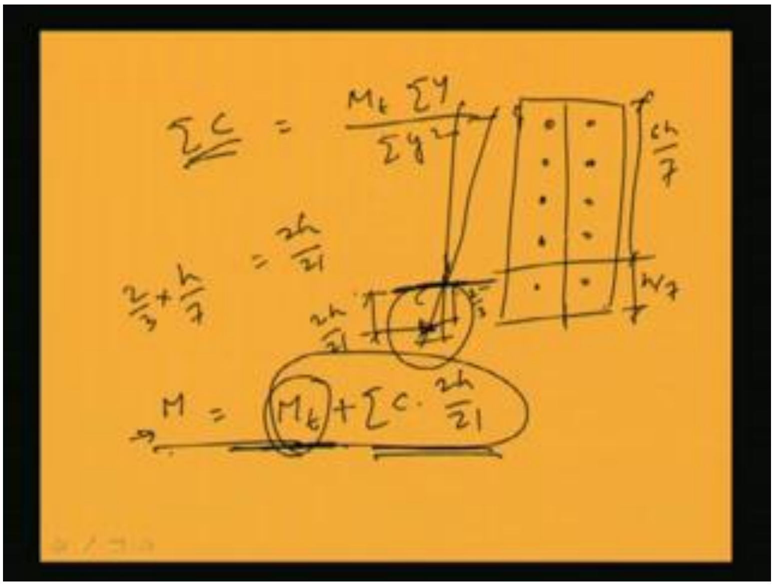

So, with this equilibrium equation we can write that total compressive force will become nothing but same that is M t into summation y by summation y square. So, in this way I can find out the total compressive force. Now if I see the diagram that if rivet groups are like this and suppose these are the plate. Now this is the neutral axis where it has passed. So, this is basically h by 7, and this is basically 6 h by 7; this is the assumptions.

So, from this I can say that we have seen when the stress distribution we used to do, we have seen that this will go like this way; this will go like this. So, what will happen? That this compressive force will be total in this area and this will act at two-third of this distance two-third of total distance. That means these compressive forces which are coming this one total c; this will act at a distance of two-third of h by 7. That means two-third of h by 7; that means 2 h by 21, right. So, this distance will become basically 2 h by 21 in which the total compressive force will act.

Now I can make that moment at about this neutral axis if I found out the moment that moment, sorry. The moment can be found out as total moment due to these tensile forces plus the moment due to these compressive forces that is summation c into 2 h by 21. That means the moment about the neutral axis if I want to find, which is basically the external moment means external moment will be moment resisted by the rivets in tension plus moment resisted by the rivets and section in compression. So, addition of all these will become the total external moment.

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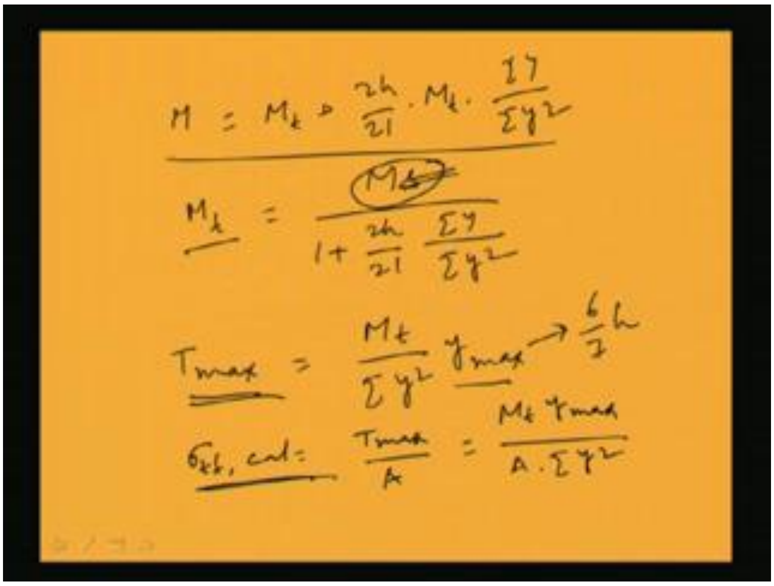

So, M t will become basically M will become M t plus 2 h by 21 into M t into summation y by summation y square if I put the value of summation c. So, this will be the M. So, from this equation I can find out the value for M t again, which is M t is M by it is coming 1 plus 2 h by 21 into summation y by summation y square, right. So, what way we are seeing here? That M t is nothing but the moment due to the tensile forces, which is coming into the rivet, and M is the moment which is resisting by the entire rivet group or moment which is coming from the external.

So, the external moment which is applied can be used for calculation of the total moment coming to the rivet groups in tension. So, in this way I can find out. So, now again I can find out that T, say maximum T; maximum T will be developed where? Maximum T will be developing here because this is the maximum distance. So, T max will be basically we have seen M t by summation y square into y max. Y max is the maximum distance at the extreme rivet.

So, in this way I can find out the T max that maximum tensile force developing in the rivet at the extreme rivet. And what is y max? Y max will be 6 by 7 into h, because this is h by 7. So, y max will be this is the 6 h by 7. So, y max will become this one 6 by 7 into h. So, now I can find out the tensile stress due to tension in rivet; that means sigma t f calculated can be find out which will become T max by h. That means M t into y max by A into summation y square, where A is the area of a rivet. So, from this I can find out the tensile stress at the extreme rivet.

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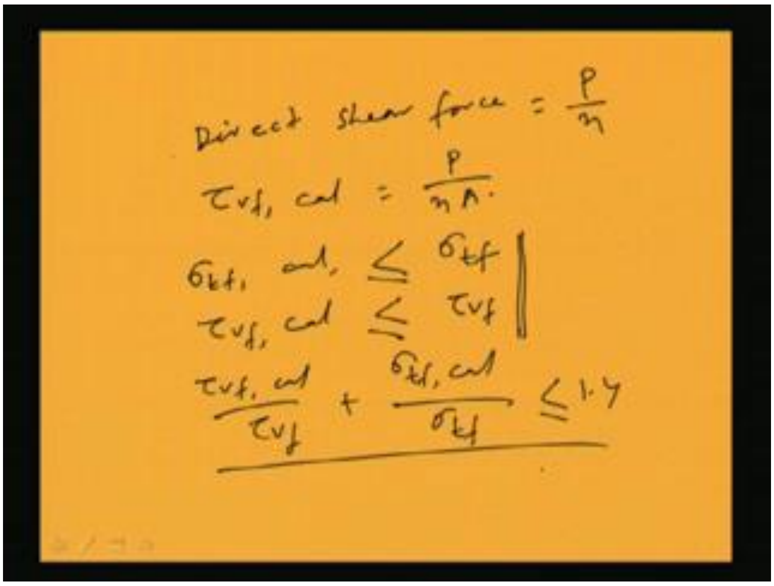

Similarly, I can find out the direct shear force we can calculate; direct shear force that will be P by n, where n is the number of rivet, and P is the force. So, tau v f calculated can be found out by P by n into A, where A is the area of rivet. So, in this way I can find out sigma t f calculated and tau v f calculated. So, from this, this has to become less than the allowable tensile stress due to bending, and this has to become less than the allowable shear stress that is tau v f. This has to satisfy; this is one.

And combinedly the equation which we have done that also has to satisfy; that is tau v f calculated by tau v f plus sigma t f calculated by sigma t f less than equal to 1.4. So, this equation also has to be satisfied. So, in this way if all these are satisfying then the design is okay. So, in this way we can find out the extreme rivets which are coming the maximum stresses and whether it is more than the allowable stresses or not that we can find out.

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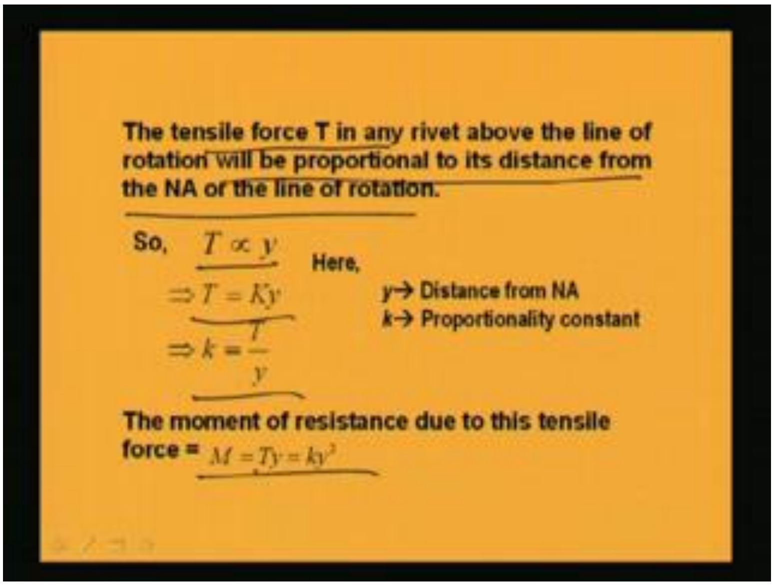

So, what we have seen let me summarize once again. That first we have considered that the tensile force in any rivet will be proportional to the distance from the neutral axis of the line. So, first we have considered that T varies y; that means T will be equal to k into y, where k can be written as T by y. So, in this way I can find out the moment at that particular rivet is developing as M is equal to T into y. So, T again I can promote as K into y. So, K into y into y that means k y square.

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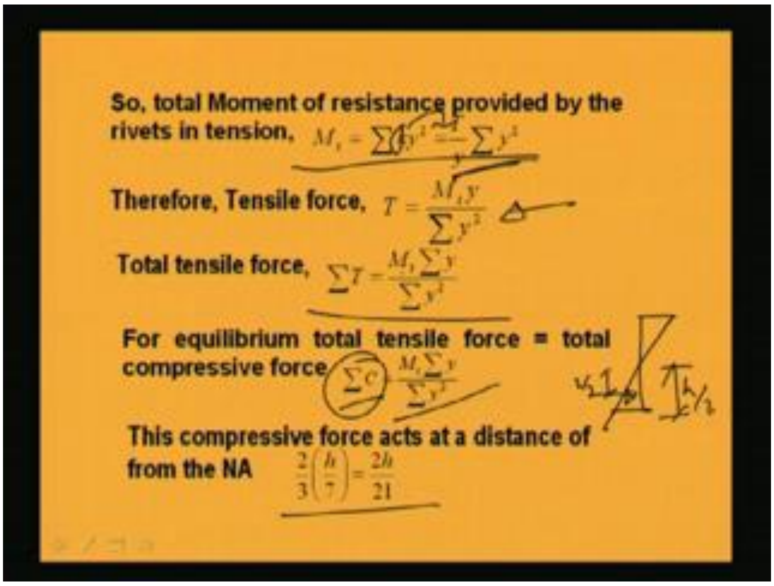

So, total moments similarly I can find out that summation of k y square and if putting the value of k as T by y, we can write T by y into summation y square. And similarly, the tensile force can be found out from this formula that M t y by y square. Then total tensile force also can be found out by summing all the moments. So, total summation will be M t into summation y by summation y square.

Now as from the equilibrium equation we can say that total compressive force is equal to total tensile force. So, we can write summation T is equal to summation c is equal to this. That means the total tensile force whatever it is coming that maybe made equilibrium as means equal as summation c. And this total compressive force has to pass through the two-third of h by 7, because if we see the stress diagram, this is something like this. And this is h by 7, and compressive force will work two-third of this distance. So, this is how we are getting, finally 2 h by 21.

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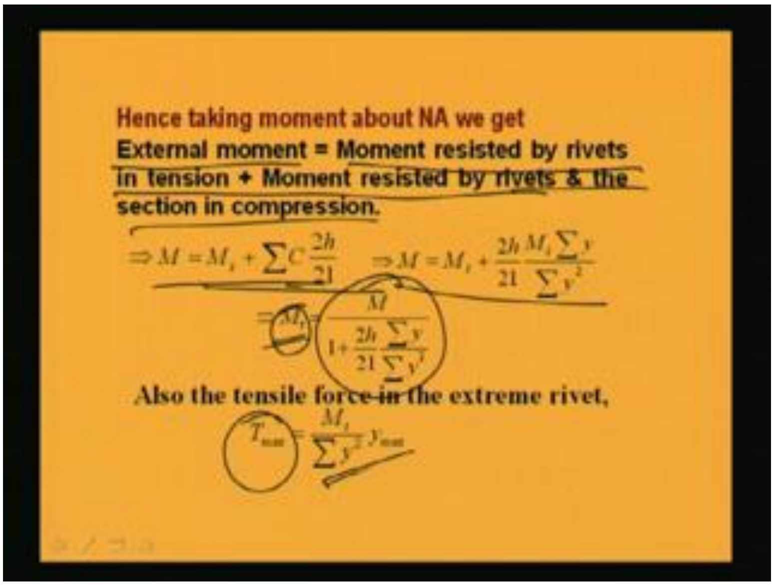

So, with this we can find out the total moment. That means the external moment we can make equilibrium as moment resisted by rivets in tension plus moment resisted by rivets and the section in compression. So, total moment we have summed here. So, from this I can find out the M t; M t is the total moment due to tension. So, M t which is developing in the tensile rivet can be found out from this equation, and similarly T max the maximum tensile force developed in the extreme rivet that also can be found out from this.

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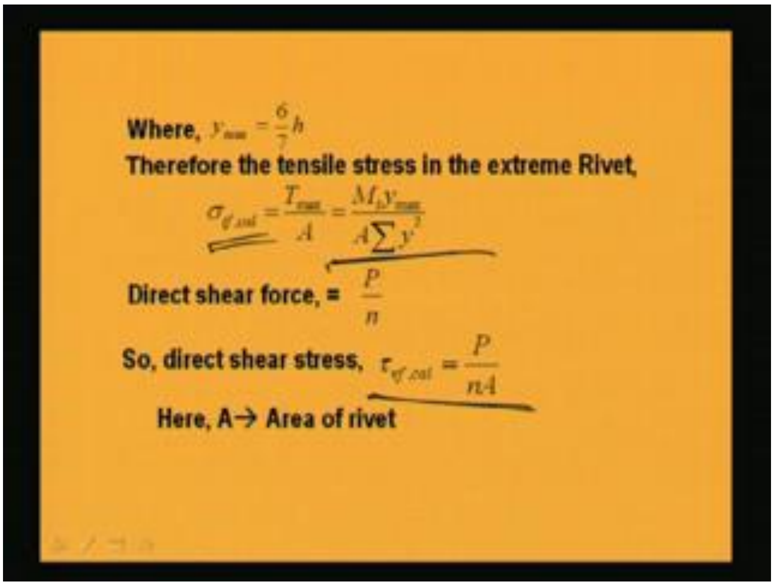

So, in this was I can find out that sigma t f cal. So, in this way I can find out sigma t f cal and tau v f cal from which I can make it. So, all this will be clear if we go through one example.

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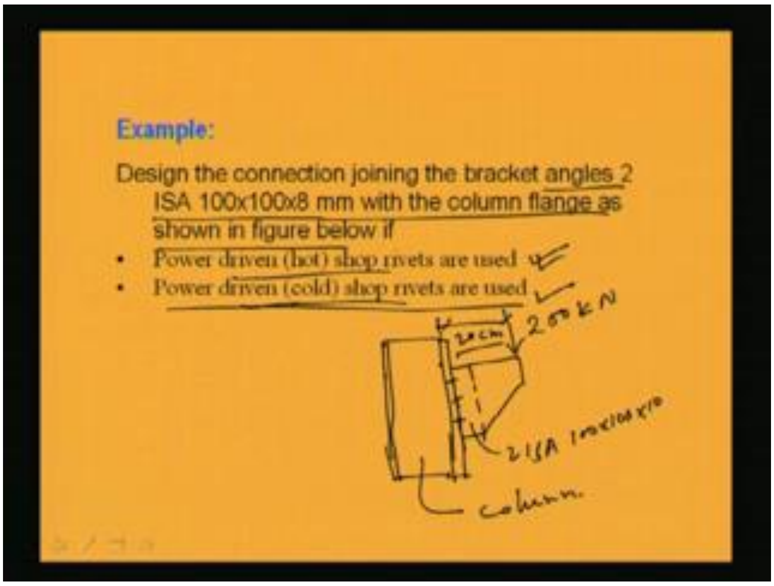

Now let us see this example that designs a connection joining the bracket angles 2 ISA 100 by 100 by 8 mm with a column flange as shown in the figure below. If power driven shop rivets are used and if power driven cold shop rivets are used. That means we will solve this problem using first power driven hot rivets and then power driven cold rivets.

So, we will see how the calculation is going to vary and how to design for the hot rivet and for cold rivet.

Hot rivet means the neutral axis is at the mid of the connection at the CG and cold rivet means neutral axis will be at h by 7 if h is total depth, then h by 7. So, in this way we have to do. So, let us see the connection. Now, say rivets are connected like this means perpendicular to the plane of the joint. So, we are going to provide some rivet here. And this force is acting 200 kiloNewton with an eccentricity of, say 20 centimeter, and these are the two angle of 100 by 100 by 10 with the column, right.

So, the load is given at a 20 centimeter away from the connection. So, basically eccentricity is 20 centimeter. So, the moment will develop due to this eccentricity, and we have to find out the number of rivets its spacing, its total driving and whether with those spacing the joint is safe or not. So, these things we have to find out. So, let us see how to make it.

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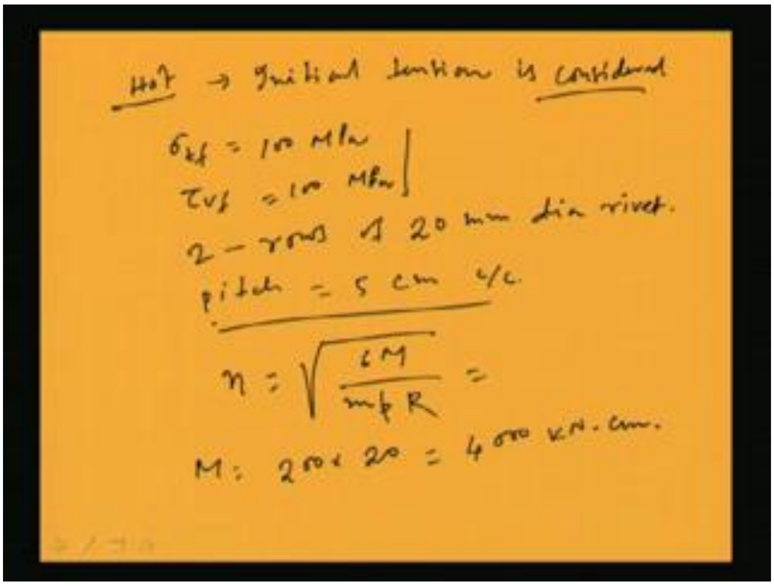

So, first thing is that we are considering power driven rivet. That means initial tension is considered, because of hot driven rivet, initial tension will be there. So, we are considering initial tensile is there, okay. So, for power driven shaft, we know from the codal provision that sigma t f will become 100 Mpa and tau v f with 100 Mpa; these are the things which we know from the codal provision.

And let us assume that we are going to use two rows of 200 mm diameter of hot rivet, okay. And let us assume the pitch distance as 5 centimeter center to center, okay. So, pitch distance we are considering 5 centimeter and two lines of rivets has been given. So, we can find out the total number of rivets as from this formula 6 M by mpR. So, from this I can find out, right. Now here what is M? M is moment which is developing that is 200 kiloNewton into 20. This is eccentricity. So, this is coming 4000 kiloNewton centimeter; this is one.

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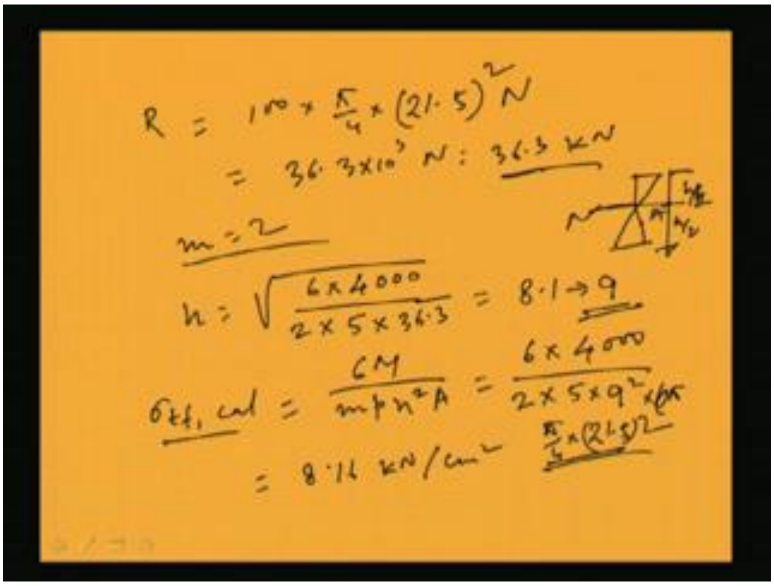

Second thing is rivet value. Rivet value will be tau v f; that means 100 into pi by 4 into d square. 200 mm diameter of rivet has been used. So, its gross diameter will be 21.5. So, from this I can find out Newton. This will become 36.3 into ten cube Newton; that means 36.3 kiloNewton. So, rivet value we have. Now here m will become two because two line of rivet has been provided. So, all the values now we have. So, I can find out the value of n. Six m.

M means this is 4000 kiloNewton centimeter by mpR. M is 2; p is considered as 5 centimeter, and R is 36.3 kiloNewton. So, from this I can find out n as 8.9. That means we have to provide at least nine rivets per line, okay. So, we will consider that nine rivets we are going to use. So, what we will do now? Now we have to find out sigma t f calculated.

For hot rivets where the initial tension is considered, we have assumed that the neutral axis is at the h by 2 distance; that means at the middle position. This is h by 2; this is h by 2. So, this is neutral axis. So, with that we have found equation earlier that sigma t f calculated can be found out as from this equation m p n square into A. So, if I put the values of all those, I will get 6 into 4000 by 2; m is 2; p is 5, and n is 9, and A is nothing but I can write pi by 4 into 21.5 square A. This is A

So, after calculating these values we will get, finally this is as 8.16 kiloNewton per centimeter square. So, sigma t f calculated we are going to obtain as 8.16 kiloNewton per centimeter square, right.

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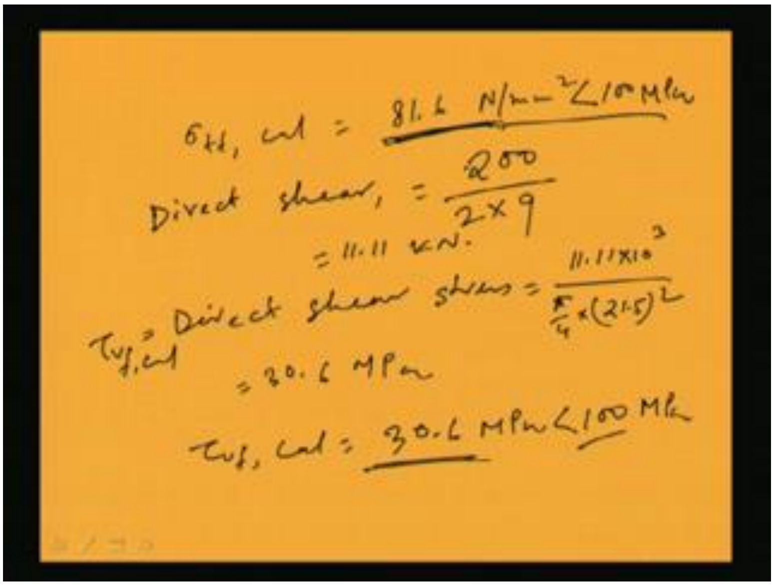

Now that means sigma t f calculated will be 81.6 Newton pe9r millimeter square. If I change the unit it will be 81.6 Newton per millimeter square. Now, again direct shear we have to find out. Direct shear in each rivet can be found out as the force was 200 kiloNewton and number of rivets is 2 into 9. So, this is coming 11.11 kiloNewton. So, direct shear we can find out from here; this is kilo Newton.

So, shear stress due to direct shear stress shear or shear stress due to direct force will be this by area. That means 11.11 kiloNewton means 10 to the power 3 by area. Area is pi by 4 into 21.5 square, right. So, this will become 30.6 Mpa. This is nothing but tau v f calculated. So, tau v f calculated as obtained as 30.6 Mpa. So, sigma t f calculated as 81.6 and tau v f calculated as 30.6. So, this is less than the tau v f which is 100 Mpa allowable shear stress, and this is also less than 100 Mpa allowable tensile stress due to bending. So, individually these are okay.

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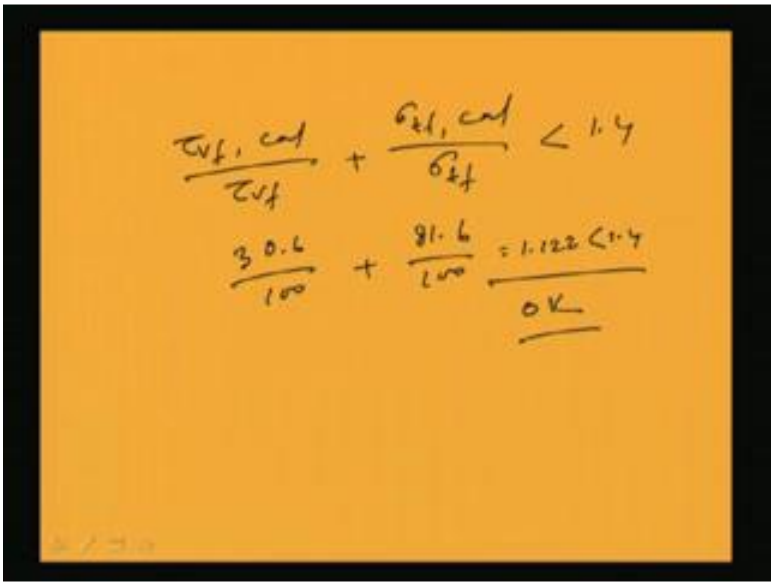

Now, jointly we can see that this equation has to satisfy tau v f calculated by tau v f plus sigma t f calculated by sigma t f; this has to become less than 1.4. So, if we put the values; this is tau v f is 30.6 by 100 plus 81.6 by 100. This is coming 1.122 which is less than 1.4; that means it is completely okay. So, in this way I can make it. So, now the thing is that we have to design; means design means we have to make all other specifications; that means we have to draw the connections.

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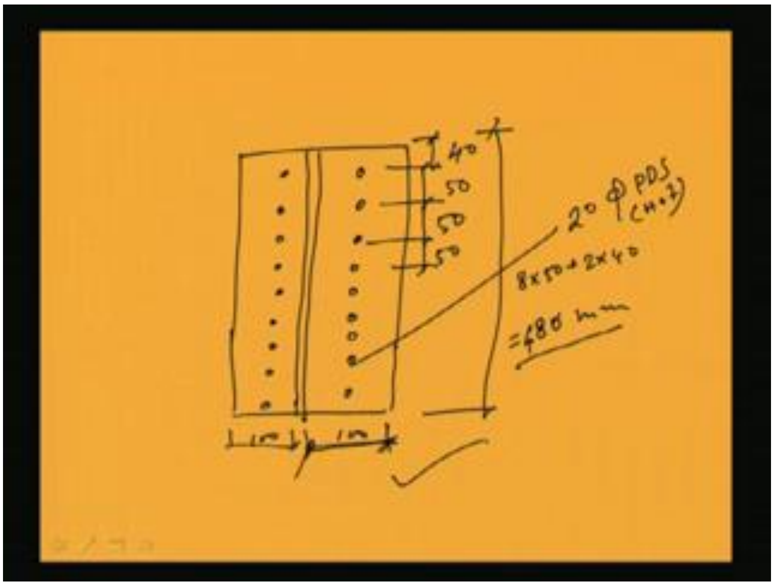

So, how to do? That we know that connections as it is a two angle ISA it was told. So, its width will be ISA 100 by 100 by 10 it was. So, this is 100, and this is also 100. Then let us assume the edge distance as 40, and pitch we have already considered as 50. So, nine rivets are there; so one, two, three, four, five, six, seven, eight, nine. So, in this way I can provide nine rivets in this place also three, four, five, six, seven, eight, nine.

Now the pitch distances has been considered as 50, and let us assume the edge distance as, say 40. Whatever we can make there is no problem; only thing is we have to see the codal provisions, and we cannot violate the codal provisions; that we have to check only. So, these are all 50. So, the total distance will become total distance means this will become totally 80 into 50 plus 2 into 40. So, this distance will become 480 millimeter.

So, the total effective depth of the joint will become 480 mm with a spacing of 50 mm. These are 20 diameter PDS power driven soft rivet and this is hot; that means initial tension is considered. And this is the 100 mm width, because ISA 100 by 100 by 10 has been considered. So, in this way the design can be made. So, now in the last scene what we have seen that the value is coming 1.122.

Now if it becomes more than 1.4, then it is needless to mention that we have to redesign it. Redesign means we have to basically change the number of rivet. Change means increase the number of rivets. So, how much value is coming, depending on that we have to decide how much increasing we will do. Whether one or two rivet we will increase or four; it depends on how much more than 1.4 on that basis. And of course, it is based on the designers experience also. So, in this way we can make it.

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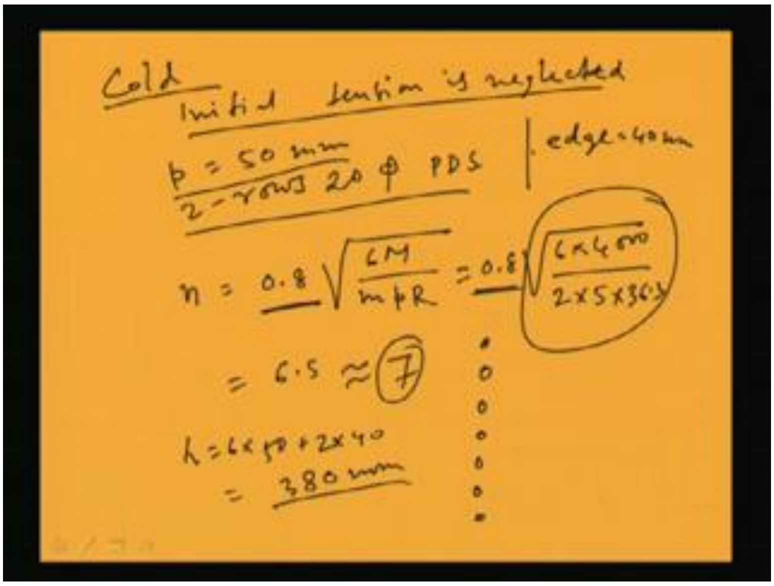

Now another example we will do that is cold rivet; means same example with the assumptions of rivet as cold; that means initial tension is neglected. So, if initial tension is neglected, how to calculate? So, what we will do? So, similarly we are considering the pitch distance as 5 centimeter means 50 millimeter center to center and two rows of 25 power driven soft rivets. These are the assumptions means we have considered.

So, like earlier cases this two you are considering and edge distance that also we are considering as a 40 mm, right. So, now we can find out the value of n which is coming from this formula. Now you just look that extra factor 0.8 has been multiplied with this because of the cold rivet as we told earlier. So, now all other things are known. So, 0.86 M we know M was earlier we have calculated 4000, and m is 2, p is 5, and R is as usual 36.

So, these all values are given earlier calculated earlier. Now we just multiplied with 0.8. So, after calculating this value, we are going to get 6.5; that means you can use a number of rivets per line as seven, right. So, if we use total number of rivets as seven, then how we will make it let us see. So, seven means one, two, three, four, five, six, seven. So, the total depth h will become how much? That means 6 into 50 plus 2 into 40. So, total depth will become 380 mm. So, the dimension of the connections can be decided from this that 380 mm we are going to decide.

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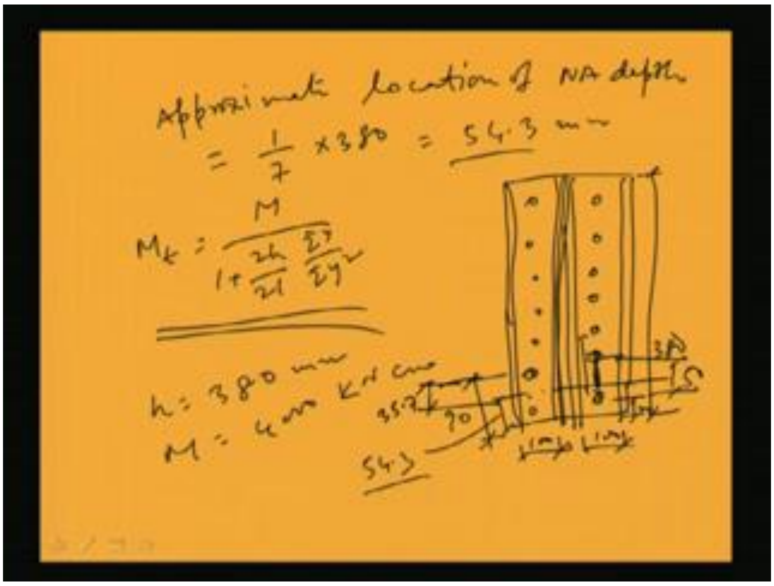

So, now the assumption is that approximate location of neutral axis depth, this will become how much? One by seventh of 380; that means this is coming 54.3 mm. So, neutral axis depth is coming here, right. So, if we see the joint, this will become something like this. This is 380 and there are two. So, 2 ISA 100 by 100 by 10 has been used. So, these are 100 and these are 100, right. Now neutral axis depth will be. So, total number is we have considered as total number of rivet as seven; so one, two, three, four, five, six, seven; one, two, three, four, five, six, seven. So, 1 by 7 means 54.3; that means this is 40, and this is 50. That means 90; this is 50. So, this distance is 90.

Now neutral axis depth has been assumed as at this point; that is 54.3, right. So, that means the neutral axis is lying above one rivet, okay. Above one rivet the neutral axis is lying at 54.3. Now from the earlier formula, we can find out M t. M t is nothing but M by 1 plus 2 h by 21 into summation y by summation y square. So, from this formula I can find out the M t. Then T, T max, then sigma t f cal. So, basically the main calculation is to find out the M t.

Now find out the M t means we have to find out we know h, h value we know that is 380. M we know 4000 kiloNewton centimeter. This is 380 millimeter. Now other two parameters we have to know that is y and y square summation y and summation y square. What is y? Y is the distance of a particular rivet from the neutral axis. That means this is one y; this is another y, like this we have to know.

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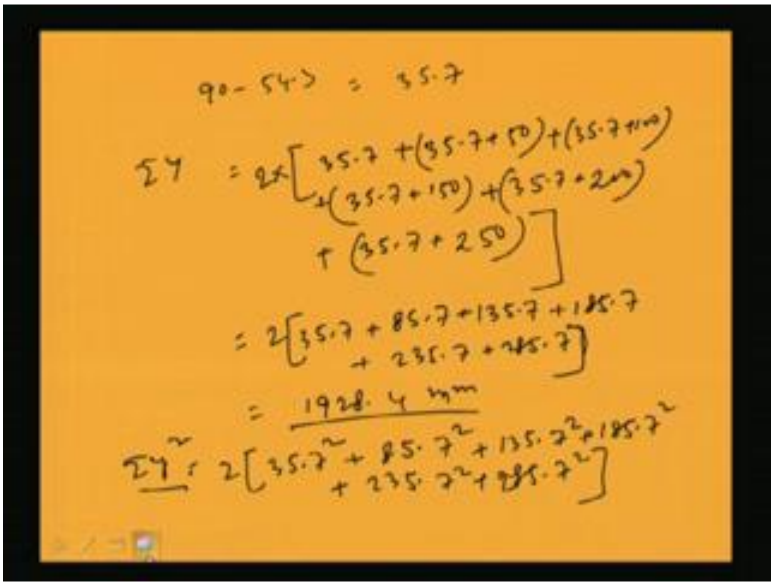

So, the first rivet this one if we consider which is just above the neutral axis that depth will be coming 90 minus 54.3 that is 35.7. So, this is becoming 35.7 this distance, neutral axis depth to first rivet above the neutral axis 35.7 mm. So, summation y will become 35.7 plus next will be 35.7 plus 50 second rivet. Then it will be 35.7 plus 100, then it will be 35.7 plus 150 35.7 plus 200. So, one, two, three, four, five; another one 35.7 plus 250; so this will become total y, and two lines are there.

So, two into this; so if we calculate this, we will get 2 into 35.7 plus 85.7 plus 135.7 plus 185.7 plus 235.7 plus 285.7. That means this is becoming 1928.4 mm. So, summation y we could find out. Similarly, I can find out summation of y square. Summation of y square will be nothing but 2 into similar way 35.7 square plus 85.7 square plus 135.7 square plus 185.7 square plus 235.7 square plus 285.7 square. That means y square y square like this we are making. So, summation y square also we can find out from this.

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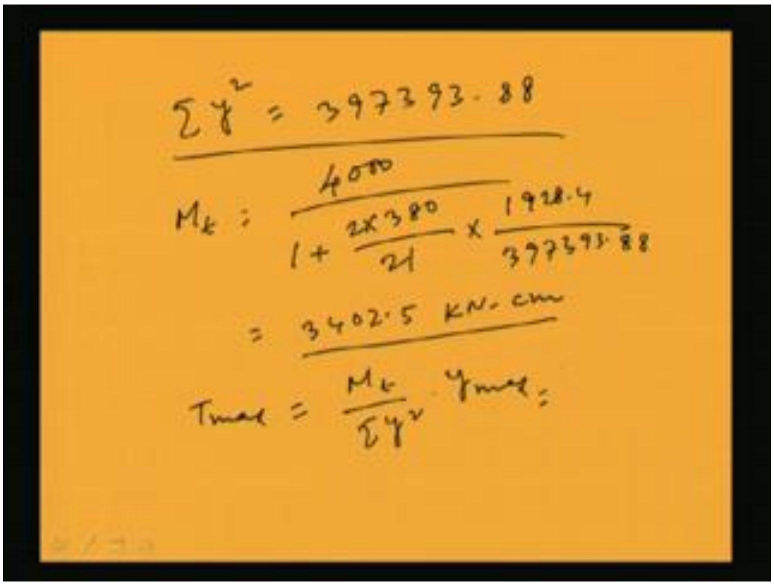

That means after calculating this, we will get summation y square as 397393.88. The viewers may check the calculation. This calculation maybe wrong because I have done by calculator; if I press wrong button, then definitely results will come wrong. So, you please check this. So, M t will become now M by M means 4000 by 1 plus 2 h. H means 380 by 21 into summation y. Summation y is 1928.4 and summation y square that is 397393.88, right.

So, from this I can get 3402.5 kiloNewton centimeter, right. So, in this way I can find out M t. Now what will be the maximum tensile force at the extreme rivet? That will be M t by summation y square into y max as per the formula we have seen. So, if I put those values 3402.5 into, okay, in next page I am just doing.

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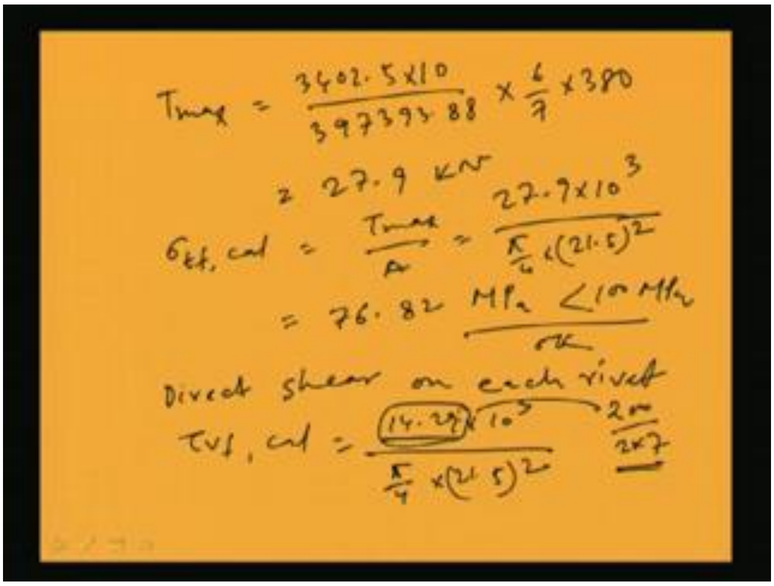

So, T max will be 3402.5 into this is kiloNewton centimeter; if I make it into millimeter, I can multiply 10. Then summation y square is 397393.88 into y max means 6 by 7 of h. H means 380. So, from this calculation we will get the value as 27.9 kiloNewton. So, I can find out sigma t f calculated as T max by A. So, 27.9 kiloNewton that I am making Newton by pi by 4 into this is the area of the rivet. So, from this I can find out the value as 76.82 Mpa which is less than 100 Mpa. So, this is okay.

And again direct shear on each rivet has to find out. Direct shear on each rivet that can be found out as tau v f cal is equal to 14.29 into 10 cube because the shear force earlier also we have calculated this as 14.29 by pi by 4 into 21.5 square. This 14.29 can be calculated from the total load divide by 14. This is coming basically total load was 200 by 2 into 7 because total number of rivet is 14. So, from this I can find out.

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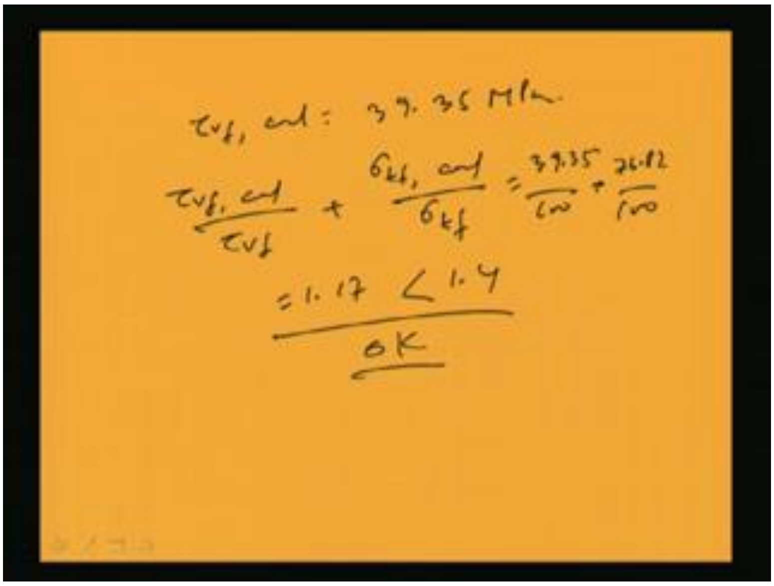

So, after calculating this, I will get the results as tau v f cal as 39.35 Mpa, right. So, now from codal requirement, I have to find out tau v f cal by tau v f plus sigma t f cal by sigma t f is equal to 39.35 by 100 plus 76.82 by 100. This is becoming 1.17 which is less than 1.4. So, this is okay. So, the design is okay; the configuration of the joint whatever we have made that is okay. So, in this way we can check. And now if this is not okay; means if this value is coming more than 1.17, then we have to increase the number of rivet.

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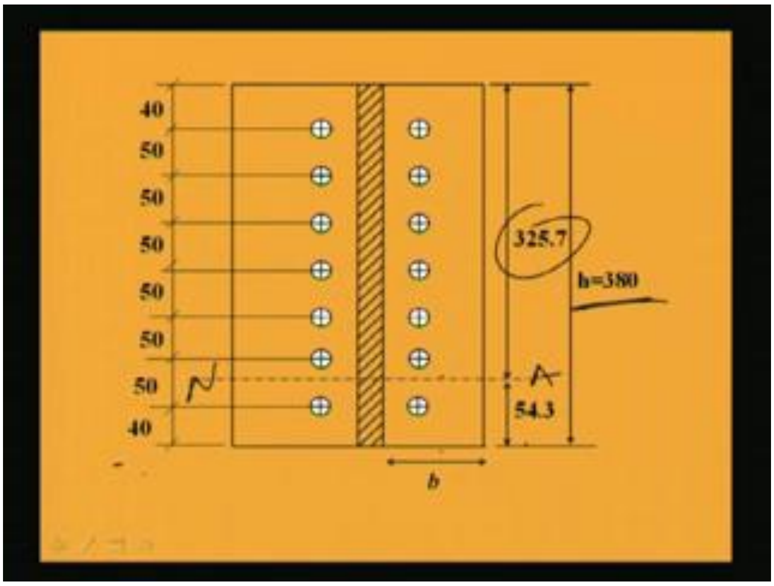

So, the details will be like this; Say, neutral axis is going at a distance of f54.3, and in this way we are calculating. H is equal to 380, and this is the dimension. So, this is the way how to calculate the rivet stresses at different places considering the rivet as cold, okay. That means no initial tension is assumed. Now the same thing can be done in an accurate manner little bit accurate manner. Means here we have considered the neutral axis depth as h by 7 distance particularly, but it is not exactly h by 7; that also we can rectify, then we calculate. So, that process just I am going to discuss here.

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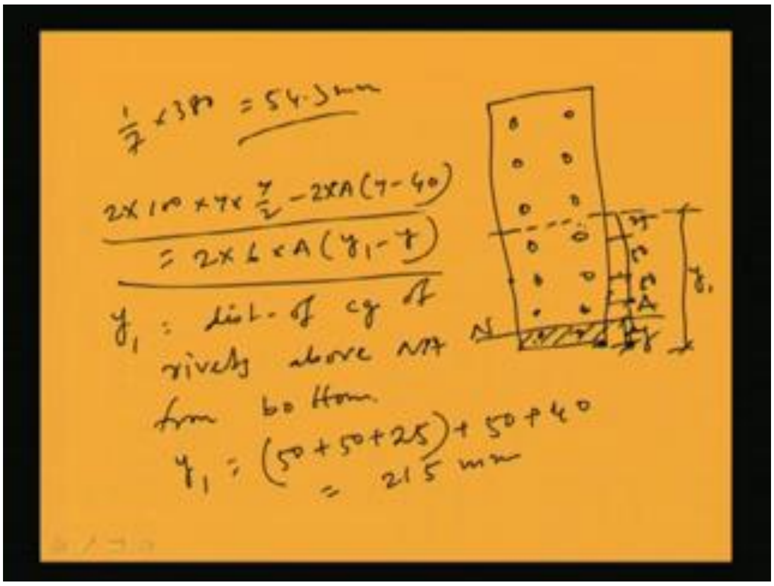

Suppose, say this is a rivet joint we have. So, we have total number of rivets we know that is 3 3 6 7, three, four, five, six, seven. And the approximate neutral axis depth we have calculated that is 1 by 7 into 380; that means 54.3 mm from bottom. Now to calculate the actual neutral axis depth which is y distance above the means from the bottom. If neutral axis depth is y, then we can write 2 into 100 into y into y by 2.

This is this portion minus 2 into A into y minus 40 because of the two rivets which is lying here. That should be equal to two into rest rivet six into area of rivet into y 1 minus y, where y 1 is equal to distance of CG of rivets above neutral axis from bottom. That means rest six we have neutral axis depth here. So, distance will be from bottom to here; this is okay. So, we have to calculate first up to this distance, then this, this, this. So, this will become how much? That means 50 plus 50 plus 50 by 2. This is 50 50. This is 25.

Then this is again 50; from here to here 50 and then 40. So, y 1 will become 50 plus 50 plus 25 plus 50 plus 40 which is becoming 215 mm, right.

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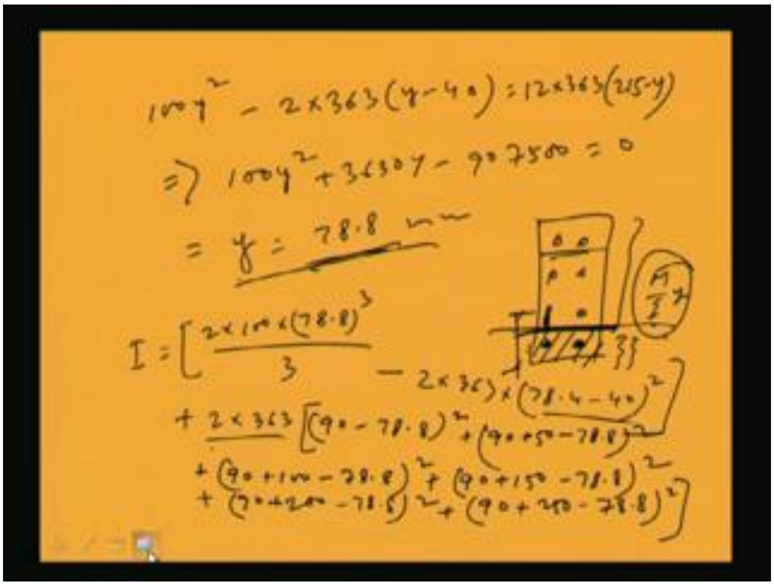

So, the equation of y to find out y, final equation will become 100 y square minus 2into area means 363; that is pi by 4 into d square into y minus 40 is equal to 12 into 363 into y 1 means 215 minus 1, okay. So, from here I can find out the equation as 100 y square plus 3630 y minus 907500 is equal to 0. So, from this I can find out y is equal to 78.8 mm.

So, what we are seeing here that the neutral axis depth which have been assumed that at h by 7 is not correct that is 78.8. In the earlier method, we have assumed the neutral axis depth is at h by 7, but in this method we are more accurately we are doing that this is not h by 7, but this has to be 78.8 closer to h by 7, okay. So, if h by 7 we know, now what we will do?

Now if rivets are there means I am not just making the exact number. So, if neutral axis is here. So, this is the compression zone, and this is the tensile zone. So, when I will be going to find out the stress I have to know M by I into y. So, I have to know I the moment of inertia of the effective area. So, moment of inertia has to found out. So, what will be that value? That will be first is for this portion.

For this portion what we will do? That is 2 into 100 into this y is 78.8. Then cube by 3 means b d cube by 3 basically about this area we are going to take this minus this two rivets are there. So, minus 2 into area is 363 A r square into 78.4 minus 40. R is basically this. So, this is one because of the lower part plus the upper part. Upper part will be 2 into 363 because 363 is the area of the rivet.

Then Ar square two rivet in each line. So, 2 into area into r square; r square means this is 90 means this is totally 90; so 90 minus this distance. So, what we will do? That 90 minus 78.8 whole square plus 90 plus 50 minus 78.8 whole square plus 90 plus 100 means next level minus 78.8 whole square. That means 190, then 90 plus 150 minus 78.8 whole square like this we will go on means up to, okay. Plus 90 plus 200 minus 78.8 eight whole square plus 90 plus 250 minus 78.8 whole square. So, this will be the total moment of inertia.

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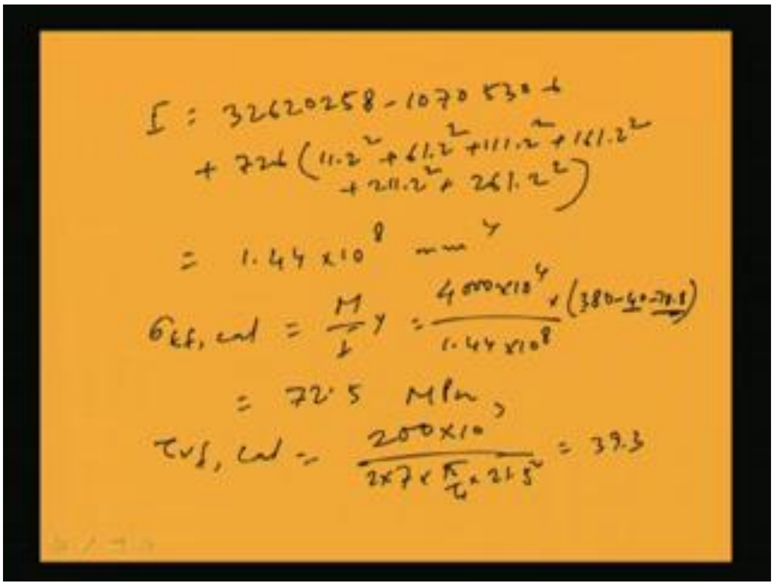

That means if I make this will become something like this. I is equal to 32630258 minus 10705306 plus 726 into 11.2 square plus 61.2 square plus 111.2 square plus 161.2 square plus 211.2 square plus 261.2 square. So, from this if we calculate we will get this is around 1.44 into 10 to the power 8 millimeter to the power 4. So, in this way I can calculate.

Now, it is easy to find out the sigma t f. Sigma t f calculated means tensile stress due to bending, right. That will be basically M by I into y. So, M is 4000 kiloNewton I am making kiloNewton centimeter; that means if I make Newton millimeter, then this will be by into 10 to the power 4 by 1.44 into 10 to the power 8. This is I into y means total is 380 minus 40 minus 78.8, because neutral axis depth is 78.8 from bottom, then 380 minus this minus edge distance.

So, from this I can find out 72.5 Mpa. So, in this way I can find out this value. Other thing is tau v f calculated. This will become basically the total force is this 200 kiloNewton by number is 2 into 7 into area is pi by 4 into d square; that means this is coming 39.3 Mpa.

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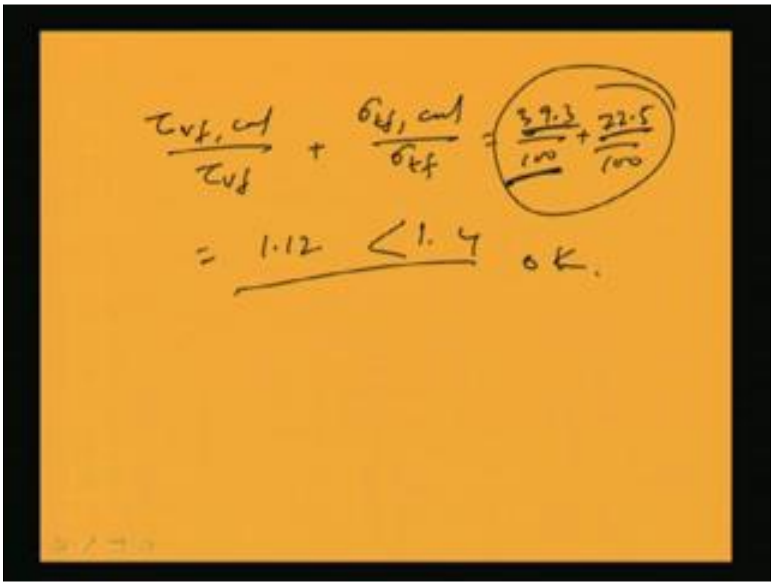

So, in this way I can find out the total value this tau v f calculated by tau v f plus sigma t f calculated by sigma t f is equal to 39.3 by 100 plus 72.5 by 100. Now you see this means tau v f has to be less than 100 and sigma t f also has to be less than 100 first thing. Second thing is this total summation should be less than 1.4. This is coming around 1.12 which is less than 1.4. So, I can make it as okay. So, in this way I can check.

So, the second method for the cold driven rivet is more accurate than the earlier one because here the neutral axis depth has been calculated accurately. In other process, neutral axis has depth has been considered as h by 7, but definitely it is not exactly at h by 7; it depends on the other issues. So, that has to be calculated properly. So, if we want to calculate properly, we have to follow the second method.

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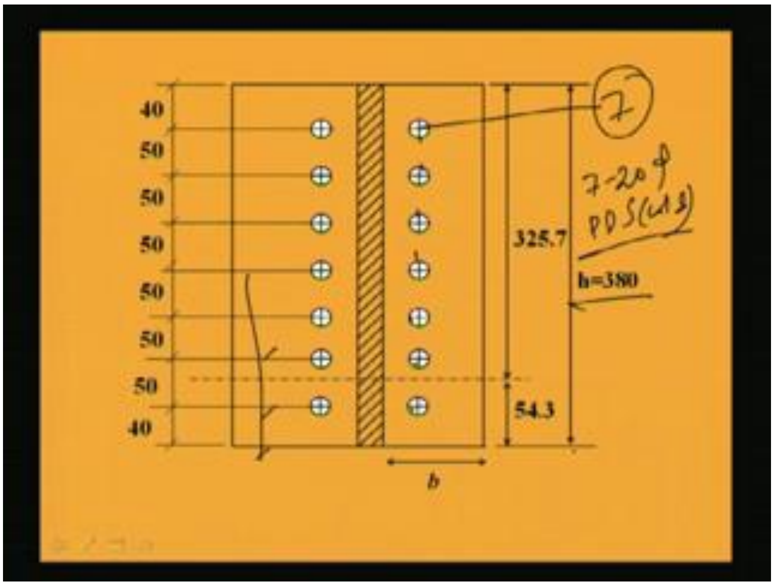

So, now we can make the diagram that we need seven number of rivets. So, one, two, three, four, five, six, seven; seven number of rivets has been used and seven number of 25 power driven shop rivets cold has been used, where the total depth will become 380 mm. And the distance between rivets and edge distance has been given in this that is 50mm, 40 mm and so on. So, in this way we can make. So, this is all about the design of riveted joint. Riveted joint can be designed in this way.

First we have to see whether the joint is lying; means load is lying on the plane of riveted joint or perpendicular to that, on that basis we have to decide. And again if it is perpendicular to the riveted joint, then whether it is cold rivet or hot rivet. So, on that basis we have to design. Next class we will see about eccentric joint considering welded connection, how to connect through weld we will see in details.