Design of Steel Structures
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Module - 7
Gantry Girders and Plate Girders
Lecture - 5
Design of plate girder

Today, I am going to work out the example which I have told in the last lecture. In last lecture as we have seen that a plate girder has to design with a certain for a certain load, which has been given and the length of the plate girder is given. So, the example was like this.

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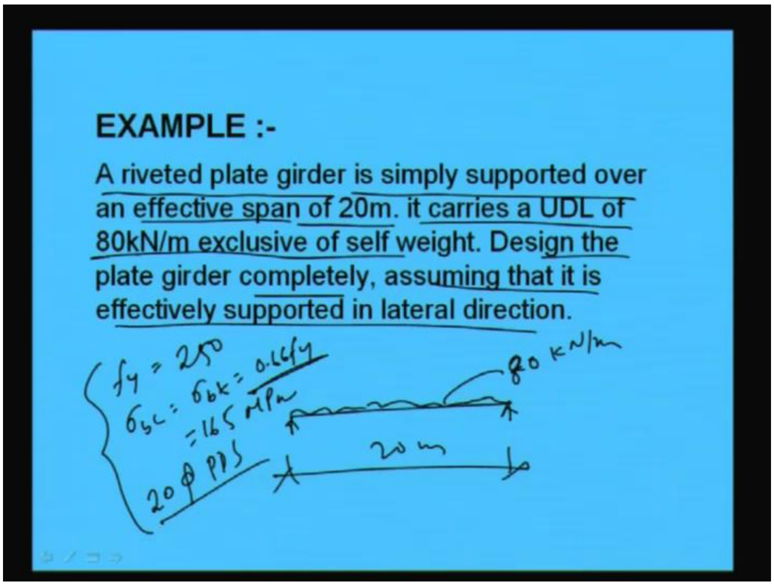

That is a riveted plate girder is simply supported over an effective span of 20 meter. So, span was 20 meter and it carries a UDL of 80 kilo Newton meter 80 kilo Newton per meter exclusive of self weight. So, this is 80 kilo Newton per meter, which exclude self weight. Design the plate girder completely assuming that, it is effectively supported in lateral direction, effectively supported in lateral direction. That means if let us consider fy is equal to 250.

So, sigma bc will be equal to sigma bt will be equal to say 0.066 fy right; that means, this will become 165. So, these are the things we are assuming. Another thing is say; we are using 20 diameter of rivets power driven soft rivets, we are going to use right. These are the things we are going to use. Now, let us start with step 1.

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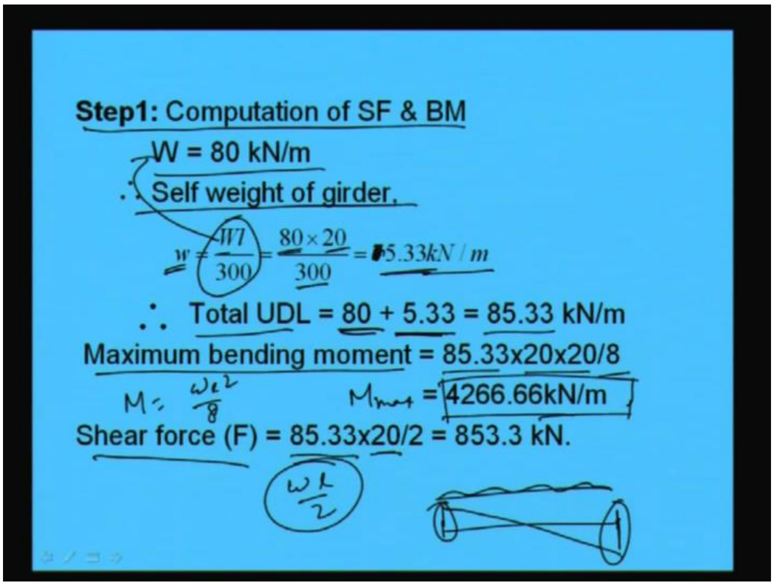

That is computation of shear force and bending moment. Now, as we know the UDL load is 80 kilo Newton per meter. And for riveted plate girder, we have calculated that self weight is as Wl by 300. So, approximately self weight will be considered as Wl by 300. As we have shown, while discussing about the theoretical part in last to last lecture, there we have shown that, W the self weight of the girder will become Wl by 300 where this W is the external load right.

So, W is 80 and l is 20 by 300. So, this is becoming 5.33 kilo Newton per kilo Newton per meter right 5.33 kilo Newton per meter. So, total UDL will become the external load plus self weight. So, 80 plus 5.33; that will be becoming 85.33 kilo Newton per meter right. So, total UDL we got. Now, the maximum bending moment you can find out. Maximum bending moment will become Wl square by 8. So, W is 85.33 and l is 20, so by 8. So, this is becoming 4266.66 kilo Newton per meter. So, maximum bending moment M max we got now. These are the data which will be required to find out the suitable section.

Next shear force. Shear force will be Wl by 2 at the support, maximum shear force will become, because for the UDL load we know shear force will develop like this right. So, Wl by 2, so W is 85.33 into l is 20 by 2. So, this is becoming 853.3 kilo Newton. So, in this way shear force and bending moment has been obtained. Next what we will do.

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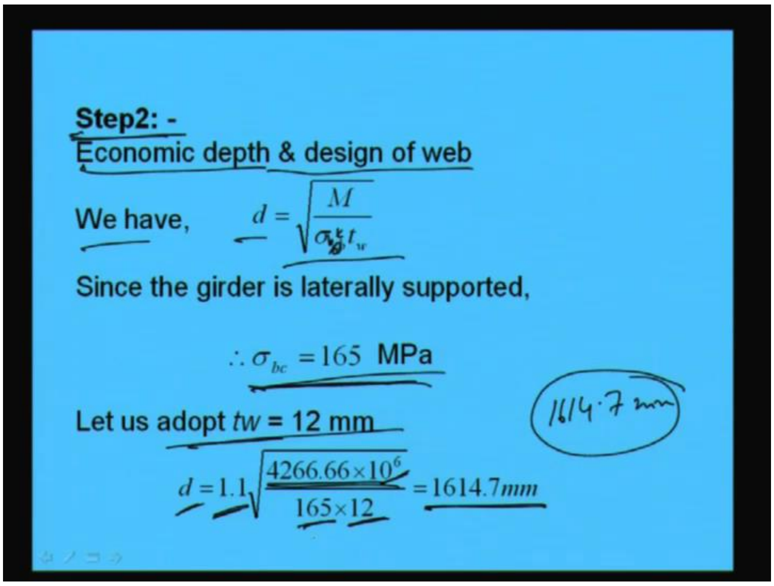

Next we will go to step 2, where we have to find out the economic depth and web means design of web. So, we will find out now, economic depth of web and accordingly we will design right. So, economic depth as we know will become M by sigma cb or bt into tw sigma bc or bt right into tw. Here sigma bc or sigma bt is 165 as it is laterally supported right.

So, if we assume sigma bc value as this and if we assume some thickness of web, then I can find out the value of d right. So, d will become M, M we got earlier 426.66 kilo Newton mete. So, to make it Newton millimeter we are multiplying 10 to the power 6 by sigma bt, that is, 165 Mpa and width of web tw means thickness of web, we are considering as 12 mm right. Now, 1.1 we have multiplied as we know because of riveted connections, we are using little higher side to be in safe right, because net area will be reducing. So, we are going to get d as 1614.7 millimeter, 1614.7 millimeter right. So, in this way we can find out depth of web.

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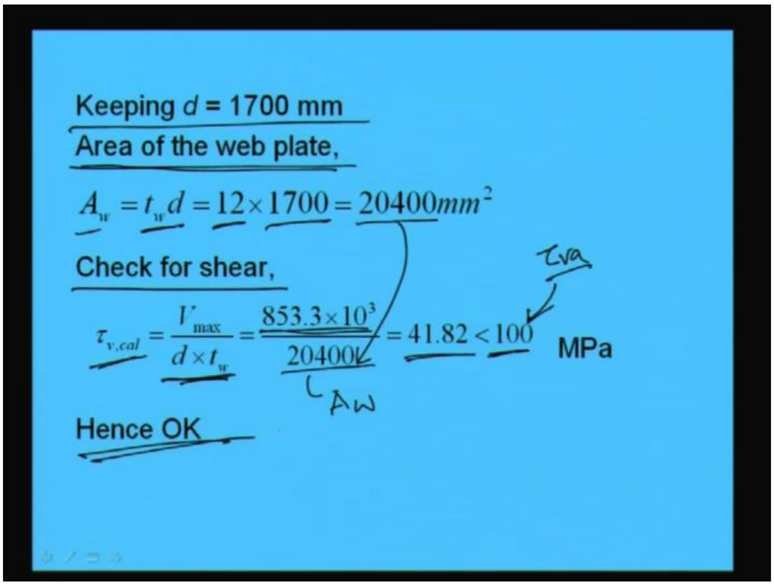

Now, we got 1614, say let us use say 1700 millimeter, we are using in a highest size right. Then, area of the web plate will become Aw as tw into d thickness of web was considered as 12 and depth we are providing 1700 mm. So, this will become 20400 millimeter square. So, area of web Aw is becoming 2400 millimeter square right. Now, check for shear, we have to check for shear, that is, tau v cal is equal to V max by d into tw right. V max we have already calculated maximum shear force, that is, wl by 2 we have calculated, that is, 853.3 into 10 cube Newton and d into tw is nothing, but Aw which is calculated here 2400 millimeter square.

So, this is becoming 41.82 and tau v allowable is 100 for to 45 to 50 for this case right. So, we are seeing that, this is less than 100 MPa. So, it is … So, the depth whatever we have considered the thickness of the web, whatever we have considered is perfectly from shear point of view on the web. So, in this way the dimension of web has been decided right, dimension of the web has been decided in this way. Next what we will do.

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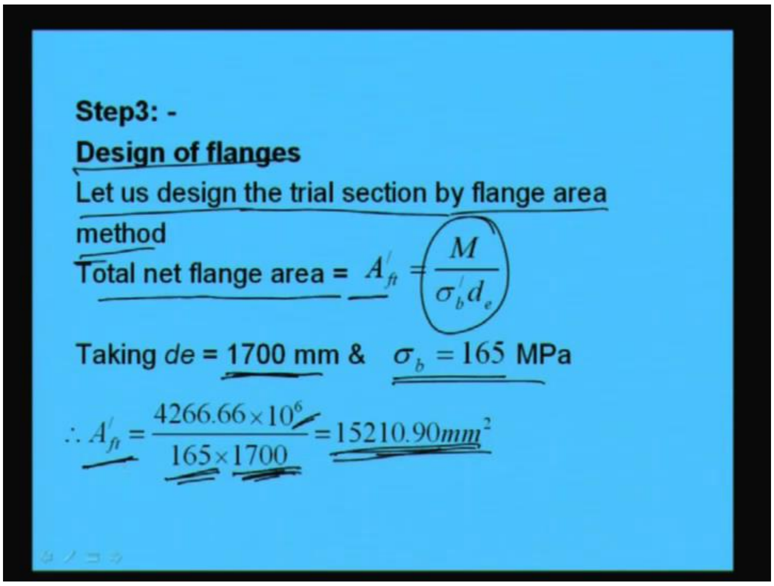

Next we will go for dimension of a flanges, means how to find out the flange width and flange thickness right. Now, let us design the trial section by flange area method. From flange area method as we know, the total length flange area we will be require A dash ft is equal to so this M by sigma b dash into de. Here sigma b dash will be nothing, but sigma b, that is, 165 MPa. And effective depth will become here so 1700 mm, with a trial section we can find out.

Now, area of flange would become M by sigma b into d. So, M is 4266.66 into 10 to the power 6 Newton millimeter by 165 MPa sigma bt and 1700 is the depth. So, after calculating this, we are going to get 15210.9 millimeter square 15210.9 millimeter square. So, in this way we are going to get the total net flange area, flange area we are going to get.

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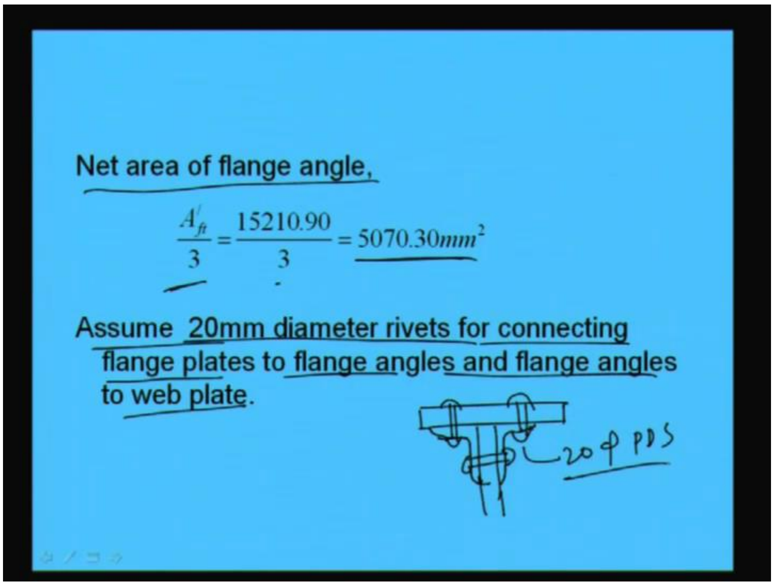

So, net area of flange can be find out now, that is, Aft by 3. So, assuming 20 mm diameter of rivets, for connecting; flange plates to flange angles and flange angles to web plate. Now we are assuming 20 mm diameter of rivets, to connect flange plates to flange angles and flange angles to web plate. That means if we see this is the flange and this is the web. So, when we are going to connect say with channel, say we are going to use 20 mm diameter rivets for connecting flange plates to flange angles right. So, this is also we are providing 20, this is also we are providing 20 flange angles to web plate right. So, all are 20 mm diameter power driven soft rivets, let us use right.

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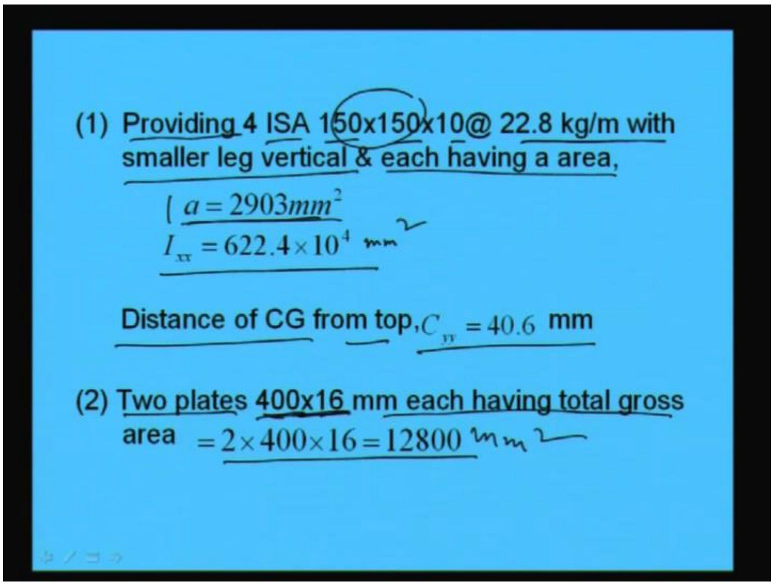

So, now let us provide 4 angle section of say 150 by 150 by 10 at 22.8 kg per meter, with smaller leg vertical and each having a area of this. In fact, here leg are same. So, there is no scope of making smaller generally, smaller leg we use to keep vertical right. So, a will become this area of the ISA section, which we will get from SP 6 the structure hand book that is given 2903 millimeter square. And similarly Ixx is given 622.4 into to 10 to the 4 millimeter square. And distance of CG from top it is 40.6 millimeter. Now, if we use 2 plates of 400 by 16 mm each having total gross area, will become this 1; 12800 millimeter square. 2 plates of 400 into 16 mm, so this will become 2 into 400 into 16, right.

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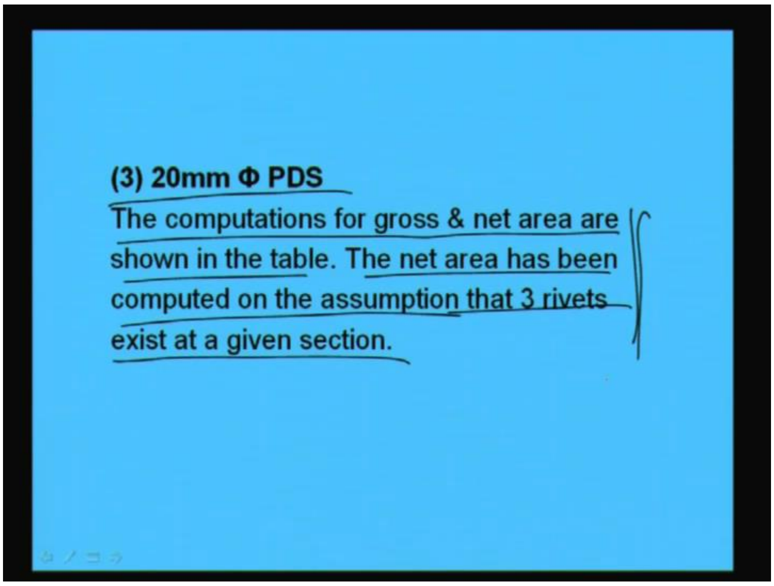

Now, for rivet, the computations for gross and net area are shown in the table. The net area has been computed on the assumptions that 3 rivets exist at a given section. So, with these assumptions, we will find out gross area and net area.

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Content	Gross area of the flange (in mm2)	Deduction for the rivet hole(in mm2)	Net Area of the flange (in mm2)
2 ISA 150 x150x10	2 x2903 = 5806	4 x21.5 x10 = 860	4946 mm²
Flange plates (2 Nos.) 400x16	2x 400x16 = 12800 $A_f = 18606$	2x21.5x(16 + 16) = 1736	11424 $A_f = 16350$
Equivalent web area Total	$\frac{1}{6}\times 1700\times 12 = 3400$ $A_{ft} = 22006$		$\frac{1}{8}\times 1700\times 12 =$ 2550 $A'_{ft} = 18920$

And these are shown here. Like say ISA 150 by 150 by 10. Now, gross area of the flange will become this. These values impact we are going to get from SP 6, so 2 into 2903, which will become 5806 millimeter square. And deduction for the rivet hole will become 4 into 21.2, 21.5 into 10 10 m. So, this is becoming 860 millimeter square. So, finally, the net area of the flange we will be getting, the gross area minus the hole, that is, 4946. So, this is how we can find out net area of the flange, this is in millimeter square.

Similarly, for flange plates, 2 number of flange plate are 400 by 16. So, the area will become 2 into 400 into 16 is equal to 12800. So, area of flange is becoming this and the deduction for hole will become this 1; 2 into21.5 into 16 plus 16 that will become 1736, because 2 plates are given right, so 1736. So, we can find out the net area as 11424. So, now we can find out that, area of flange means total area of flange. That will become how much? That will become, if we see that, this area plus this area total will become this right.

So, total area of flange will become like this. And similarly, net area total net area will become this right. So, in this way we can find out. Now, equivalent web area will become this equivalent web area; 1700 into 12 by 6 as per the formula. That will become 34800. So, if we go on adding with this again, so Aft will become 22006. And here the net area will become this 18920 right. So, in this way we can find out.

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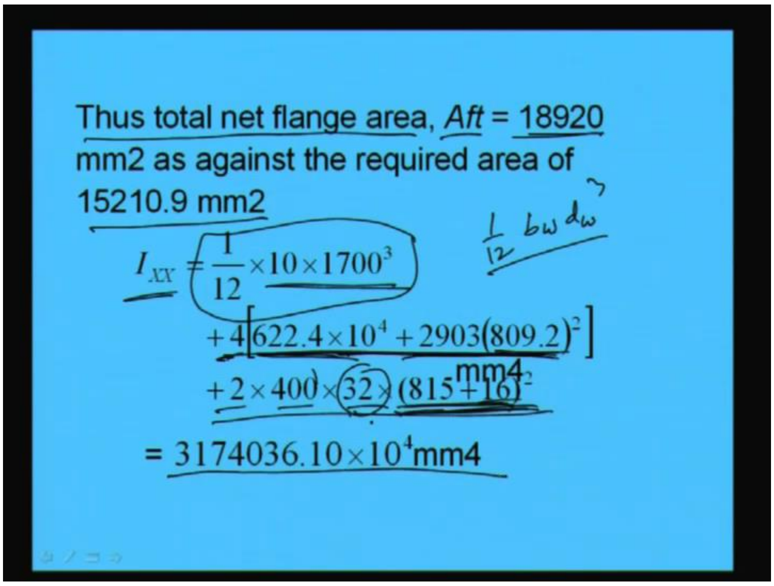

Next, so thus total net flange area Aft is becoming 18920 millimeter square as against the required area of this millimeter square right. Now, we will find out Ixx. Ixx will become what 1 by 12 bd cube b is this because of this web 1 by 12 bw into dw cube, I can say, where dw is 1700 and dw is 10. So, this plus, this is because of angle 4 angles are there. So, 4 angles its own moment of inertia is 622.64 into 10 to the 4 plus ar square right. Area of angle section is given and the distance is can be find out. So, from that, the moment of inertia due to the additional I section, angle section has been found plus 2 into 400 into 32 into 815 into 815 plus 60. This is due to additional plate, additional plate 2 additional plate of 400 width and 32 thickness 16 into 16 thickness 16 by 16 means 16, 1 another is 16. So, and the distance will be 815 plus 16 right. So, finally if we calculate this value, we will be getting this value, that is, 3174036.1 into 10 to the power 4 millimeter to the power 4. So, in this way we can find out Ixx value.

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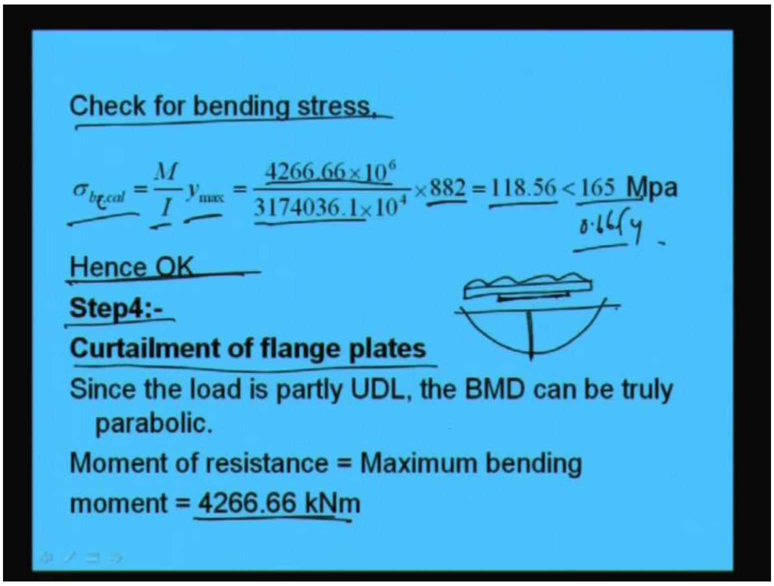

Now, what we will do. We will check for bending stress check, for bending stress. So, bending stress what will be? Sigma bc calculated or sigma bt calculated, where maximum is and in this case both will be same right. So, this will become M by I into y. So, M was calculated as this 4266.66 into 10 to the 6, earlier if you see this was calculated. And I was calculated 3174036.1 into 10 to the power 4 and y max is 882,y max is 880.

So, the values are coming 118.56, which is less than the value 0.66 fy, that is 165 MPa. So, from bending stress point of view this is. So, the flange whatever we have chosen for the girder is quite, because it is below the permissible limit. The developed stress in compression or in tension due to bending is under permissible limit, that is, less than 165 Newton per millimeter square. So, in this way we can check it.

Next what we will do, next we will go for curtailment of flange plates. As we know, because of UDL load, the moment would develop like this. So, we do not need to provide the bigger section throughout its span, because maximum moment is here. So, we can provide larger section in this central, near the center and smaller section near the support, because near support moment is going to be less and at support it will be 0.

So, to take the advantage of this moment, means advantage of the type of nature of the developed moment, we can curtail the plates at a certain distance right. So, that we can do. Now, as we know the maximum bending moment is 4266.66 kilo Newton meter right. So, moment of resistance has to make. Similarly 4266.66 kilo Newton meter right.

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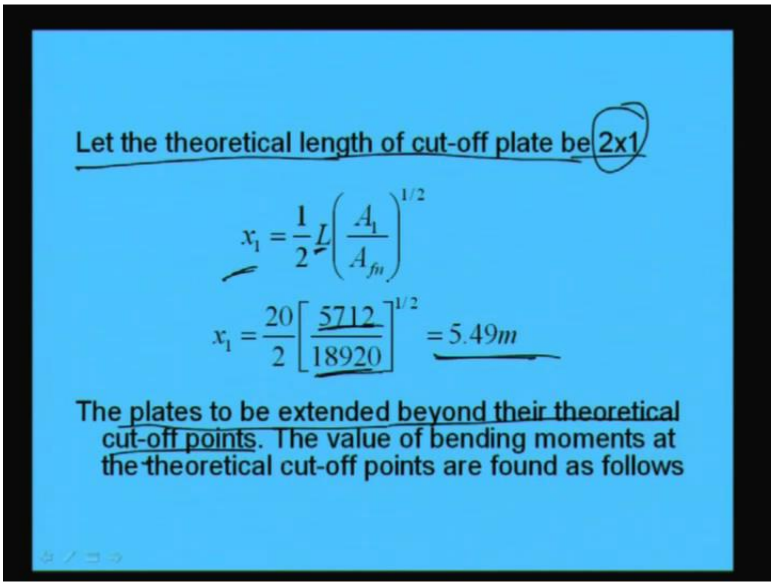

Now, let us theoretically find out the length of cut-off plate and let us consider that is, say 2 x 1. So, then x 1 we can find out, if we introduce 2 plate, then x 1 we can find out in this way. That is half into L into A 1 by Afn to the power half. So, if we put the value, L is 20 meter span and A 1 is 5712 which we have calculated and Afn also has been calculated, that is, 18920. And if we make square root of this then finally, we will get x 1 as 5.49. The plates to be extended beyond their theoretical cut-off points remember. Now plates to be extended beyond their cut theoretical cut-off points, the value of bending moments at the theoretical cut-off points are found as follows.

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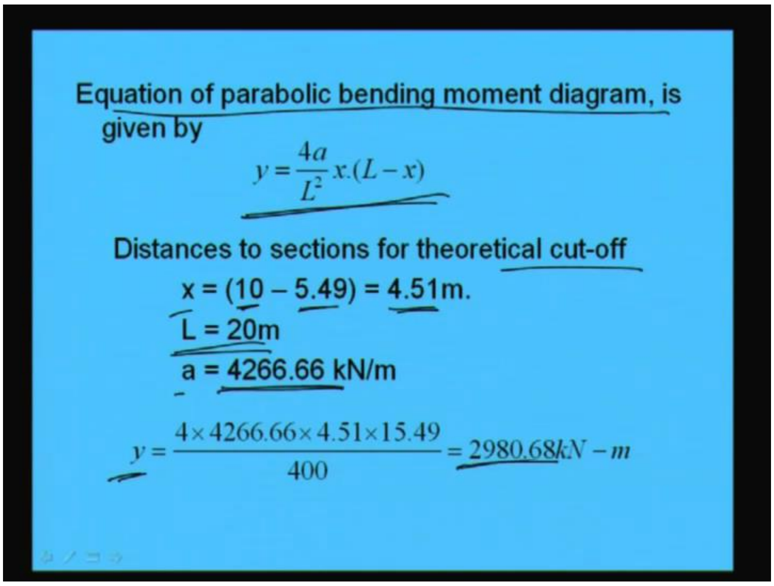

Value of bending moment we can find out from here right. As we know equation of parabolic bending moment diagram can be given here. y is equal to 4 a by L square into x into L minus x. Now, distances of 2 section for theoretical cut-off x can be found, that is, L by 2 this is 10 minus 5.49. That will be 4.51 and L is given this and area is given this. So, using this value we can find out. That is 4 into 4266.66 into 4.51 into 15.49 by 400. That will be this much; 2980.86.

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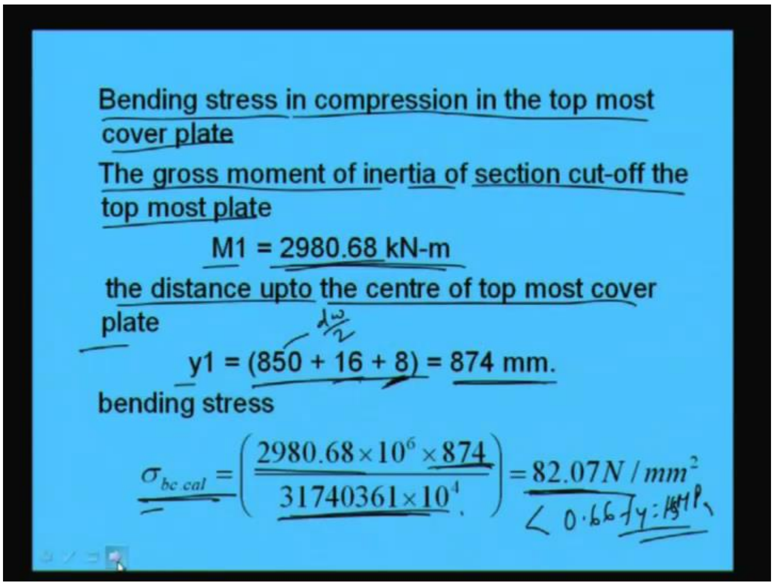

So, bending stress in compression in the top most cover plate can be find out and can be checked. Now, the gross moment of inertia of section cut-off, the top most plate M 1 will become this 1 right. And the distance up to the center of the top most cover plate y 1 will become this 850 plus 16. This is because dw by 2, that is, 1700 by 2 850 plus 16 plus 16 by 2. So, this is 874.

So, now we can find out the sigma bc calculated. Sigma bc calculated would be how much, that is, M 1 that is 2980.68 into 10 to the power 6 into y 1 by I right; M 1 by I into y 1, so 2980.68 into 10 to the power 6 into 874 by 31740 361 into 10 to the 4. So, if we calculate, we will get the value 82.07 Newton per millimeter square right. So, in this way we can find out the sigma bc cal and which is less than the allowable permissible stress, that is, 0.665 that is, 165 MPa. So, this is quite.

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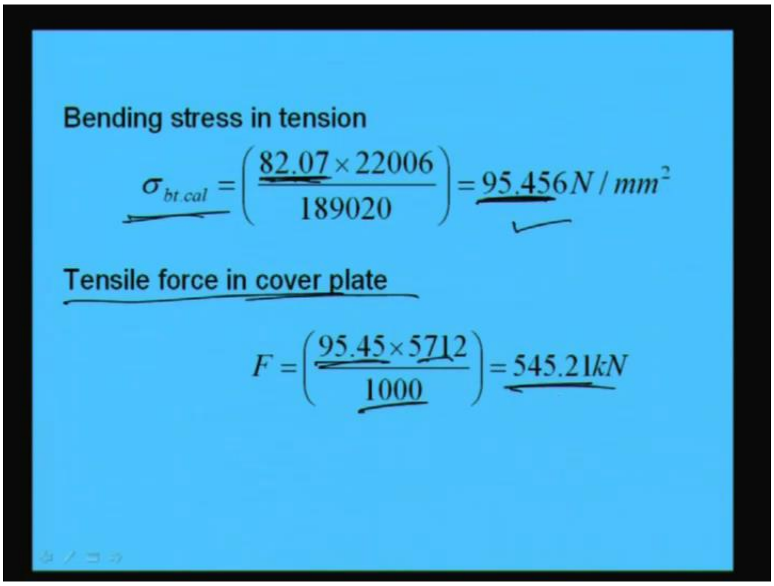

Right similarly sigma bt cal can be find out right. So, sigma bt cal when we are going to find out, we can find out with the same linearly interpolating, we can find out right. This was sigma bc cal. So, little more will be the sigma bt cal, that is, 95.456. So, this is also. Now, we will find out the tensile force in cover plate. Tensile force in cover plate will become how much? The stress is 95.456. So, this into area right by 1000 if we make it will become kilo Newton that F is becoming 545.21 kilo Newton. So, in this way we can find out the tensile force in cover plate as 545.21 kilo Newton, right.

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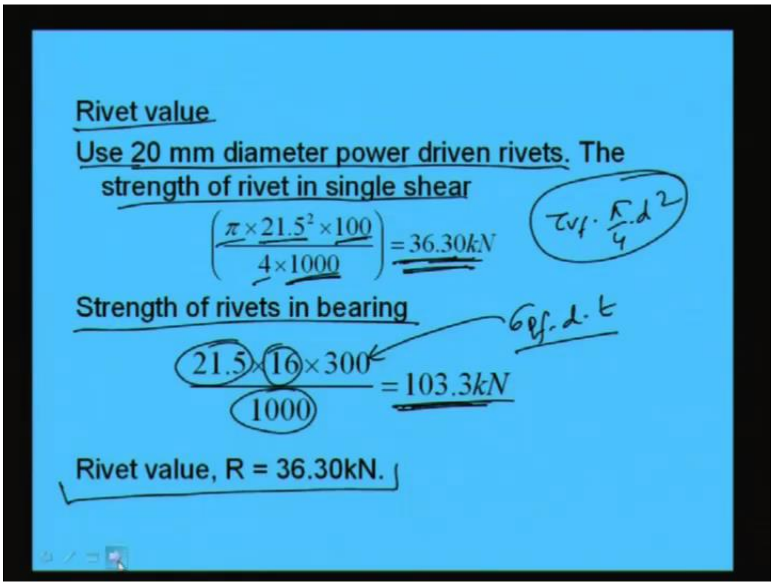

Now, the rivet value. So, if we use 20 mm diameter power driven rivet power driven soft rivet, the strength of rivet value in single shear can be find out that will be pi by 4 into d square into tau vf tau vf into pi by 4 into d square for single shear. So, pi by 4 into d square. That will be 21.5 square into tau vf is 100. And to make it in kilo Newton we are dividing 1000. So, we are getting 36.3 kilo Newton right.

So, rivet value we are going to get due to shear. And due to bearing the rivet value will become sigma pf into d into t. Sigma pf value is 300 MPa and diameter is 21.5 and thickness is 16 right. And if we divide by 1000 to make it kilo Newton, then finally, the value will become 103.3 kilo Newton. So, strength of rivet in single shear is becoming 36.3 and strength of rivet in bearing is coming 103.3. Therefore the rivet value are can be taken as 36.3 kilo Newton. So, in this way we can find out the rivet value of that with 20 mm diameter of power driven soft rivet.

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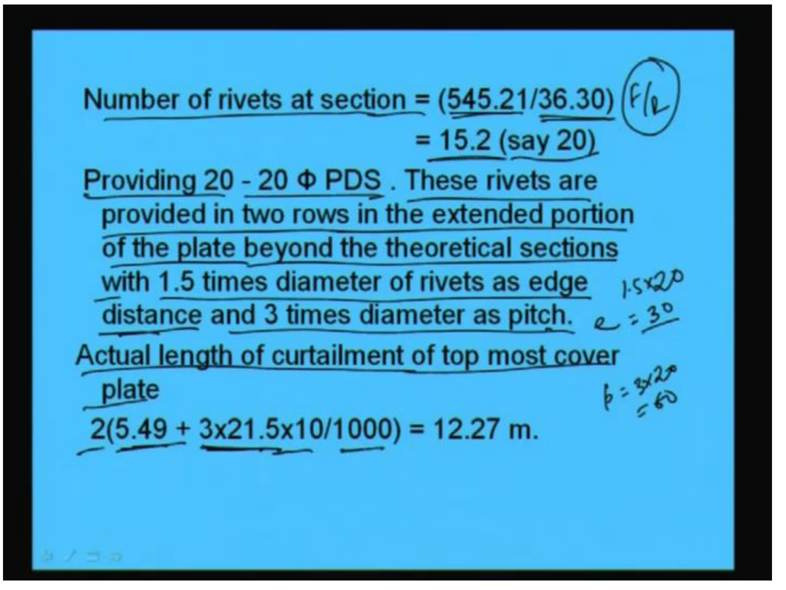

So, the moment we get rivet value we can find out the number of rivets at the section. So, what will be the number of rivets at this section? That will become the force whatever we got here right, the shear force 545.21 kilo Newton tensile force at the cover we found that by rivet value means F by R. Say from this we are going to get 15.2 right. So, we are going to get 15.2. And say let us use little high say 20 or 60 means 60 means minimum required right.

Now, providing say 20 number of 20 phi PDS power driven soft rivet. So, these rivets are provided in 2 rows in the extended portion of the plate, beyond the theoretical sections with 1.5 times diameter of rivets as edge distance and 3 times diameter as pitch distance right. So, what we are doing that, we are assuming that, 3 times diameter as pitch distance and 1.5 time diameters of rivet as edge distance. So, edge distance will become at least 1.5 into 20; that means 30. And pitch will become 3 into 20, that is, 60.

Now, actual length of curtailment of top most cover plate will become this; 2 into 5.49,that is the length whatever we have calculated plus 3 into 21.5 into 10 by 1000 for making it meter. So, we are going to get 12.27 meter.

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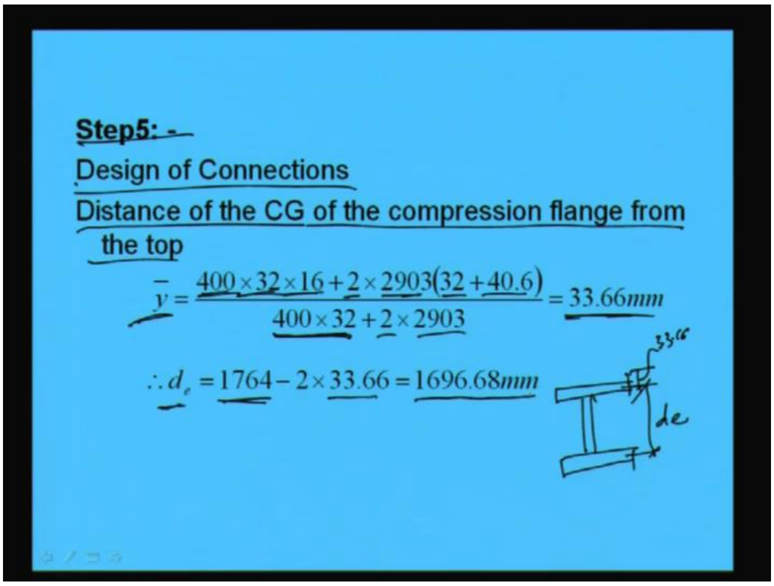

So, now in next step, so curtailment is over. Next step is the connection design. We will go to design the connections right. So, step 5 will be design of connections. Now, for that, we need to know the distance of the CG of the compression flange from the top. So, distance of CG the compression flange from the top. Now, if we see this is the plate girder. So, what will be the distance of the CG of the compression flange from the top, that will become how much. As you know, 400 is the width we have provided 400 into 32 into 16 plus 2 into 2903 into 32 plus 40.6 by the area. That is 400 into32 plus 2 into 2903, which is becoming 33.66 mm.

So, de will become 764 that is total minus 2 into 13.66, because CG distance this is 13.6 33.66, so de will become this 1. This distance between CG of the flange is de. So, that is 1764 minus 2 into 33.66 that will become 1696.68 millimeter. So, this is how we can calculate the value of de.

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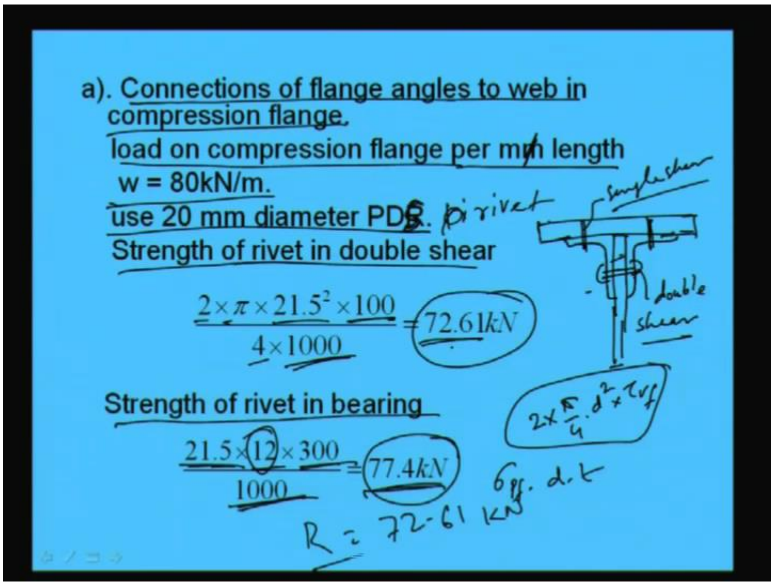

Next connections of flange angles to web in compression flange, we will find out the connections of flange angles to web in compression flange. Now, load on compression flange per millimeter length can be find out, per meter length can be find out as 80 kilo Newton per meter. Now, if we use 20 mm diameter of power driven soft rivet or power driven soft rivet, then strength of rivet in double shear will become this; 2 into pi by 4 into d square into tau f. Why double shear, because if you see say suppose this is the web and this is the flange of the plate girder, it is a top flange right.

Now, we are going to use some angle here, we are going to use some angle here right. Similar to, in the bottom also. Now, when we are connecting this flange with the angle it is in single shear, this is in single shear right. So, accordingly we have find out the rivet value. Now, when we are going to connect this, we will see this is in double shear right therefore, we need to find out the strength of rivet in double shear. This is in double shear, right.

So, strength of rivet in double shear will become, what will happen? 2 into pi by 4 into d square into tau here right. So, 2 into pi by 4 into d square, d means 20 mm diameter we have taken. So, gross diameter will become 21.5 into 100 that is tau f by 1000 to make it kilo Newton. So, the strength of rivet in double shear is becoming 72.61 kilo Newton. And strength of rivet in bearing strength of rivet in bearing will be what, that is sigma pf into d into t.

Now, d value is 21.5, t is thickness of the web right. That is given 12 mm right into sigma pf by 1000 we are making to make it kilo Newton. So, this is becoming 77.4 kilo Newton. So, in this way strength of rivet in bearing also we are going to get as this. Now, the rivet value can be find out from this 2, that is, the lesser value of these 2. So, rivet value will become here r is equal to 72.61 kilo Newton. So, in this way we can find out right.

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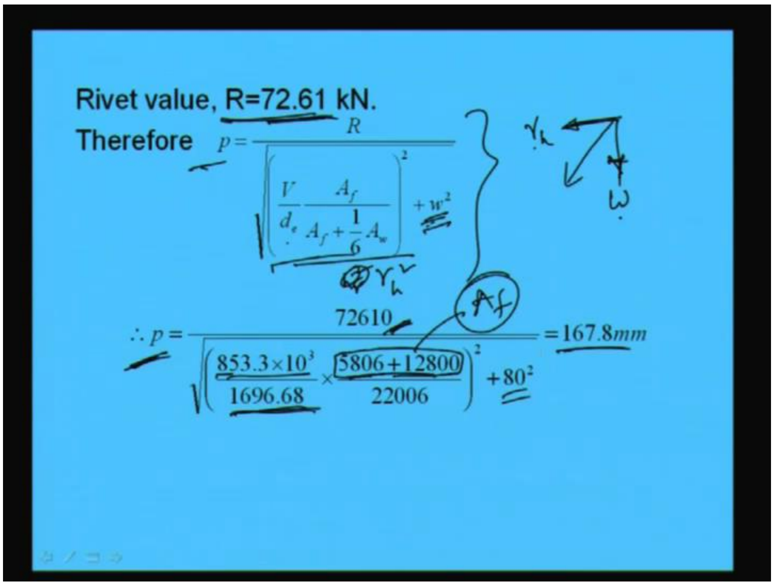

Next what we will do, next we will find out pitch. So, rivet value as we have got 72.61 kilo Newton we can find out the pitch. Pitch can be find out from this formula, which was derived earlier. In fact, this I have not derived in my lecture, which can be found from any standard book right that, how to find out pitch right. That will be this 1; r by V by de into Af by Af plus 1 by 6 Aw whole square plus w square right. This is basically horizontal force say h. And this is say rh right, because of shear r means shear force will come in horizontally, which I am giving per unit length as rh. And because of vertical load say w is coming per unit load length per unit length w and this is rh right.

So, the resultant will become this plus this, where rh is becoming V by de into Afy Af plus 1 by 6 Aw. And that we are finding out from the expression what has been done from derivation right. So, p we can find out form this value, that is, r is 72.61 kilo Newton rivet value. So, if we make in Newton, this will become 72610 Newton, by this is V, V we have calculated as 853.3 kilo Newton.

So, for Newton we are making 853.3 into 10 cube Newton right. V by de, de also we have found de is what that, the distance between CG of flanges, CG of top flange to CG of bottom flange, CG of compression flange to CG of tensile flange de. That is calculated as 16969.68. Then, 5860 into this 5860 plus 12800, that is, Af total area right. Area will become the plate area and the this flange area basically total flange area. What about flanges are there 5800 Af by Af plus 1 by 6 Aw. If we put and w is 80, so if we put all this, we will get the value as 167.8 millimeter right. So, pitch we are going to get as 167.8 millimeter right.

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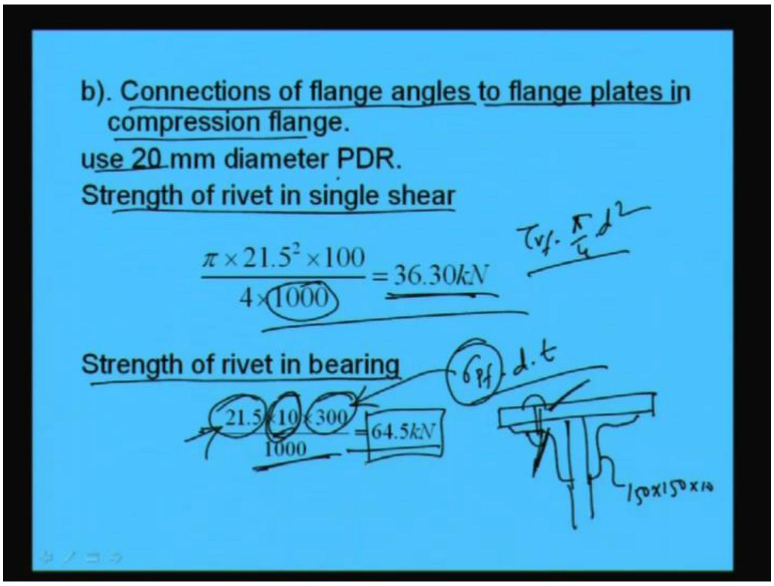

Now, we will go for connections. Now, connections of flange angles to flange plates in compression flange. Let us see how to connect flange angles to flange plates in compression flange. So, in this case also let us use 20 mm diameter of power driven rivets. So, strength of rivet in single shear will become pi by 4 into d square into tau vf tau vf into pi by 4 into d square, because this will be in single shear right. And 1000 has been divided because to make it kilo Newton.

So, in this way we can find out the strength of rivet in single shear as 36.3 kilo Newton. And similarly strength of rivet in bearing will be sigma pf into d into t. So, d is 21.5 and this is 10 mm thickness of the angle and sigma pf is this by 1000 for making kilo Newton, so 64.5 kilo Newton. Let me make clear this. If this is the web say this is the angle, now this angle is 150 by 150 by 10 right.

Now, when we are going to find out the strength of rivet in bearing, we will see we are taking 10 mm, because the thickness of the angle is less than the thickness of the flange. That is why the lesser value has been taken. That is why the value 10 has been taken. And as we are using rivet diameter as 20, so 21.5 as a gross diameter has been taken. And as usual the sigma pf value permissible stress in bearing has been taken 300 in this case. So, in this way we are going to get to the strength of rivet in bearing as 64.5 kilo Newton right.

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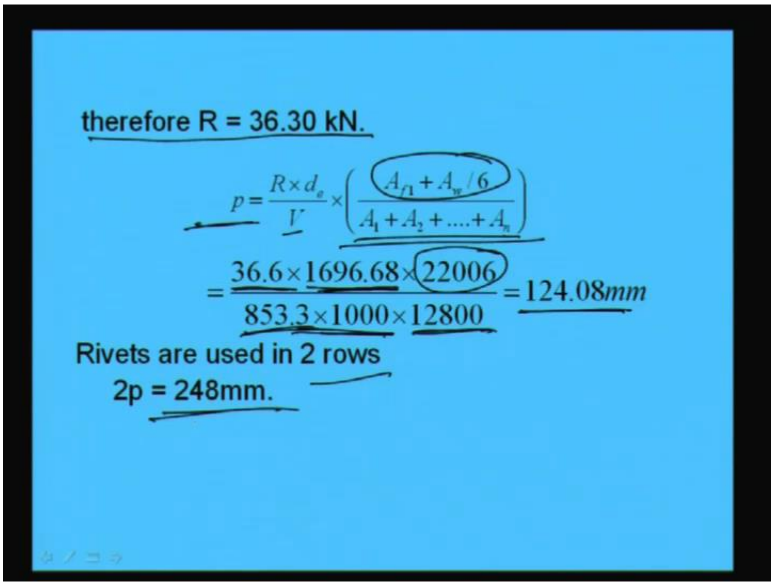

So, we can find out the rivet value finally, as 36.3 kilo Newton. Now, we can find out the pitch, pitch between the flange and the angle in compression flange right. So, pitch will become R into de by V into Af 1 plus Aw by 6 by A 1 plus A 2 up to An. In fact, this expression you will get in any standard book. This has not been derived because of shortage of time right. But here I am in fact this pitch has been derived for the weld connection. In case of weld connection I have tried to show and as in weld connection I have shown, I have not shown in rivet connection. That is why when I am taking the example I am taking example for rivet connection s that, you should have you can have some idea right.

So, pitch we are going to find. So, if we put the values say R, R means rivet value that is 36.6 by V, V we know the shear force which has been calculated as 853.3 kilo Newton. So, to make it Newton 1000, I am going to multiply right. And de is 1696.68 which has been calculated right. And the area of this total Af 1 plus Aw by 6 is becoming 22006 Af 1 plus Aw by 6 is becoming 22006. And the area of flanges are means area of plates for flange is 12800.

So, in this way, I can find out the pitch which is becoming 124.08 mm. And if rivets are used in 2 rows, then pitch will be 2 into 248 means 2 into p that will become 248 right. Rivets let us assume that rivets are used in 2 rows. So, in this way you can find out the pitch as 248 millimeter right. Next what we will do.

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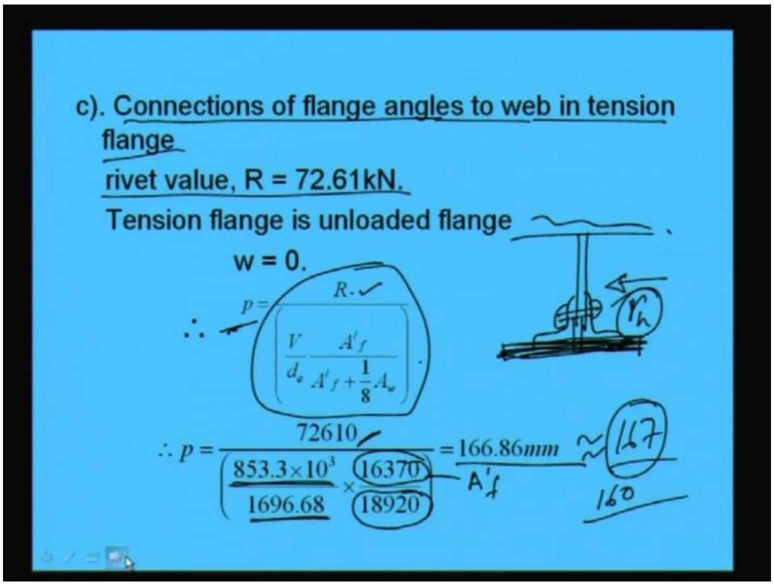

Next connections of flange angles to web in tension flange, connections of flange angles to web in tension flange means this 1. Tension we are assuming that, this is the flange this is happening at bottom right. Connections of flange angles to web in tension right. That means this 1; here tension is going to develop. So, from earlier steps we have seen the rivet value will become finally, 72.61, because we have to check rivet due to double shear, here double shear will happen and rivet value due to bearing.

So, from these 2 conditions, we will find out the least 1 as 72.61 rivet due to double shear right. And tension flange is unloaded flange. So, w can be made 0. So, p can be found simply from here right. As in tension flange, there is no load, only in compression flange load is there. So, at the top load is there. So, w means plus w that will be not there. So, only the h rh will be there that value forces in horizontal direction.

So, if we put the values, the p will become R by V by de into A dash f by A dash f plus 1 by 8 Aw. Now, putting those value R as 72.61 means 72610 Newton by 853.3 into 10 cube that is V, the shear force and de is effective depth that is 1696.68 millimeter and then A dash f is 16370, this is A dash f. And A dash f plus 1 by 8 Aw is this 1 as we have calculated earlier 18920. So, now putting all these value, the p we will get 166.86; that means, 167. Pitch we are going to get as 167.So, maybe we can use say 160 or 165. So, in this way connections of flange angles to web in tension flange can be made.

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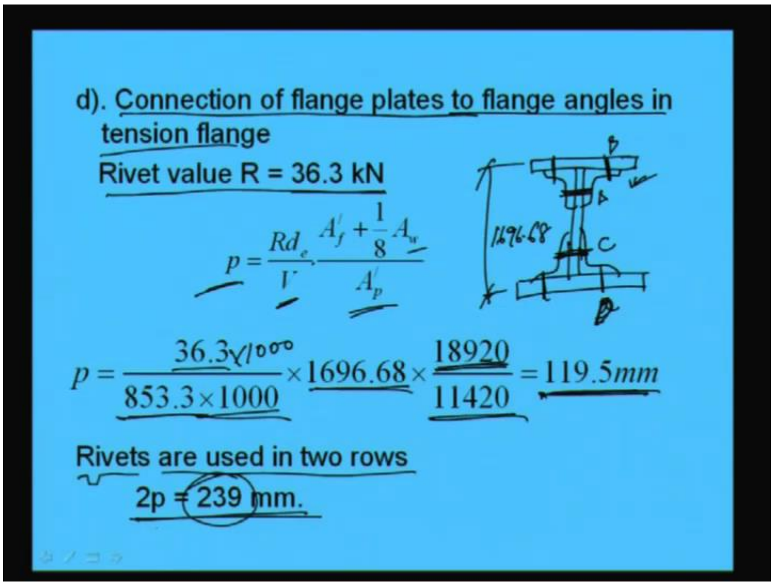

Now, we will go for connection of flange plates to flange angles in tension flange. So, this is. So, 4 cases are happening, if we see 4 type of connections are happening and we have to find out the number of rivets or the pitch distance properly right. Say in this way, it was now what will be the pitch distance here? What will be the pitch distance here? What will be the pitch distance here? So, in compression and again in tension this is 1, this is another 1, this is, connection of flange plates to flange angles in tension flange, right. This is case d, this is case c, this is case, this is case a, this is case b right.

So, 4 cases are happening right. So, here rivet value we will get 36.3 kilo Newton as earlier we have done in case of compression flange. In case of compression flange, already we have calculated the rivet value. So, we can find out the pitch. pitch will become R de by V into Af dash plus 1 by 8 Aw by A dash p right. Now, if you put those value, R is 36.3 kilo Newton right. So, that has to make Newton actually right. And V is this 853.3 kilo Newton. So, this also we are making in Newton.

Then de is given 1696.68, de is this is 1619 1696.68 millimeter. So, de we got, then Af dash plus one-eighth Aw that is given the value as 18920 and A dash p is calculated earlier, that is, 11420. So, we are going to get as 1119.5 millimeter. So, if we use 2 rows for the rivets, then the spacing will become, pitch distance will become 239. So, in this way we can find out the spacing.

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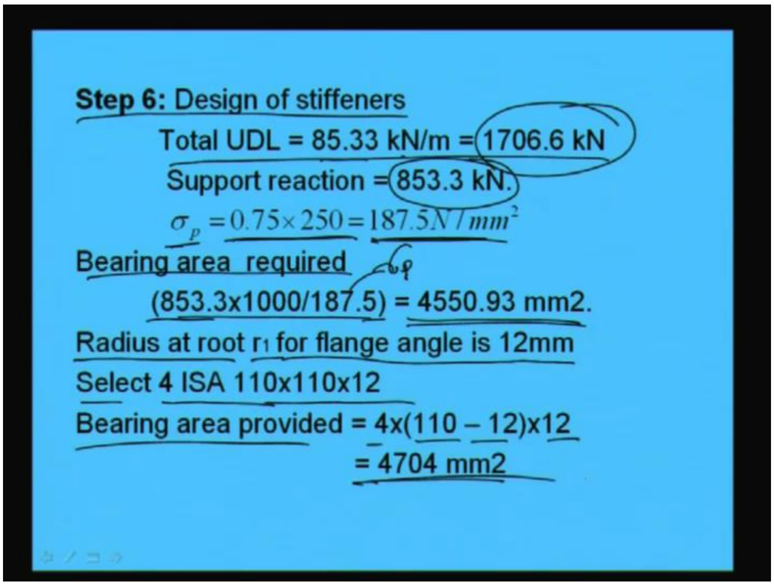

Next we will go for design of stiffener. This is the last step. So, as we know UDL load we have already including self weight, that is, 85.33 kilo Newton per meter. Then total load will become this. And support reaction as we have calculated as earlier. So, sigma p will become 0.75 into fy that is this. So, bearing area can be found from this equation that is 853.3 into 1000 by 187.5, because this is the sigma p right.

So, from this, bearing are we can find out, that is, 4550.93 millimeter square. And if we consider radius at root r 1 for flange angle will be then 12 mm. Then select a 4 ISA of 110 by 12. Then bearing area has to provide like this 4 into 110 minus 12 into 12 that is bearing area will be 4704 millimeter square.

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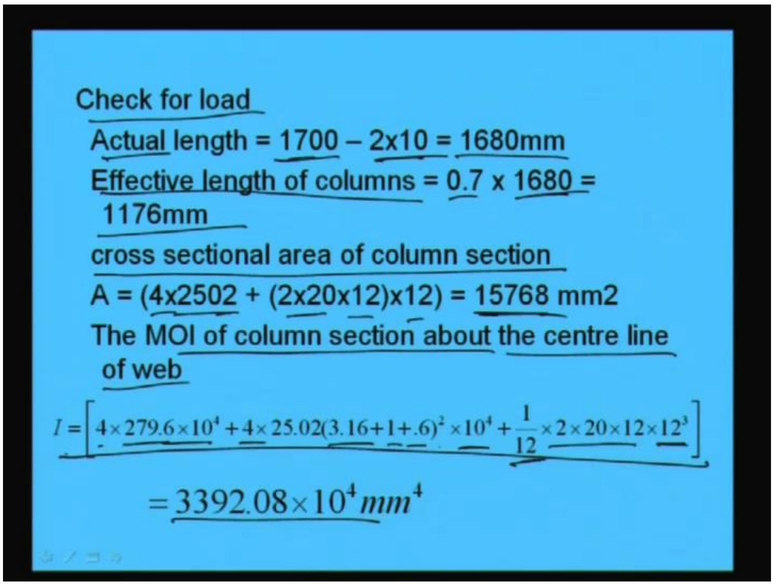

Now, we have to check for load. So, actual length we have 1700 minus 2 into 10. So, 1680 millimeter and effective length of columns will become 0.7 into 1680 that will be 1176 millimeter. So, cross sectional area will become 4 into 2502 plus 2 into 20 into 12 into 12. So, this is becoming 15768 millimeter square. And the moment of inertia of the section about the center line of web can be find out from this equation that is, 4 into 279.6 into 10 to the power plus 4 into 25.02 into 3.16 plus 1 plus 0.6 whole square into 10 to the 4 plus 1 by 12 bd cube, that is 2 into 20 into 12 into d cube 12 cube. So, I we are going to get as 3392.08 into 10 to the 4 millimeter to the 4, right.

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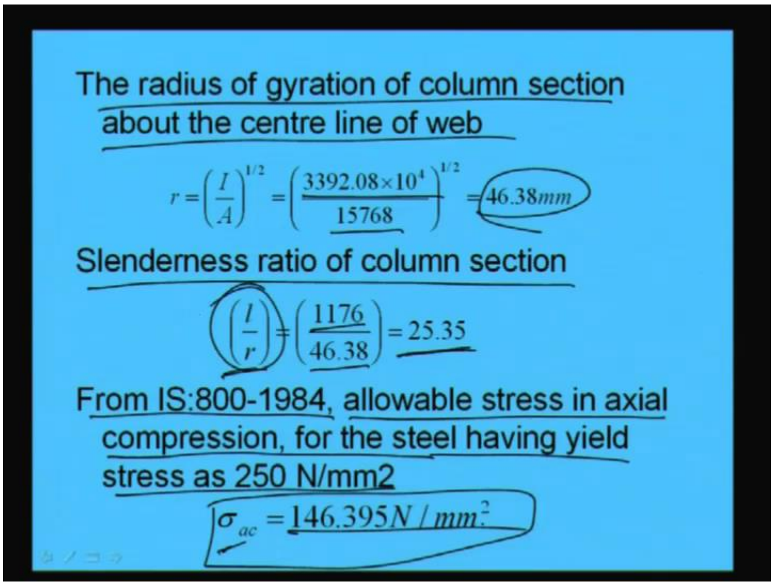

So, then what we will do. Now, we will find out the radius of gyration of column section about the centre line. So, radius will be I by A square root of I by A. So, I was found 3392.08 into 10 to the 4 and A is 15768. So, r will become 46.38 millimeter. And the slenderness ratio of column section will become l by r equal to 1776 by 46.38. That will become 25.365.

So, from IS 800 1984, allowable stress in axial compression, for the steel having yield stress of 250 ac can be found out this. So, from table of IS 800 1984, we can find out the permissible compressive stress as sigma ac as 146.395 Newton per millimeter square for l by r ratio as this and for fy 250.

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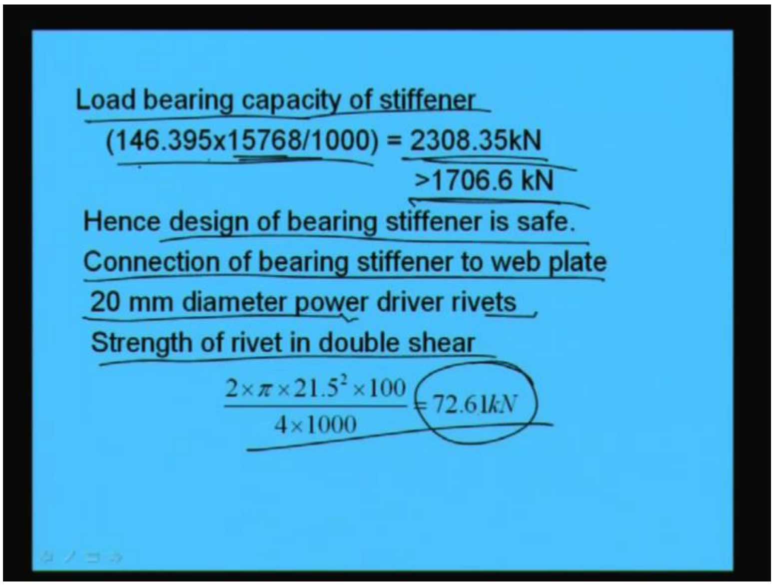

So, load bearing capacity of stiffener can be find out from this formula that is 146.395, whatever was given here right. Then this is the sigma ac into area. So, this value load bearing capacity is becoming 2308 which is greater than 1706.6 kilo Newton. So, it is; that means, the design of bearing stiffener is quite. Now, connection of bearing stiffener to web plate by using 20 mm diameter power rivets, we can find out the strength of rivet in double shear as this. Earlier also we have got, so I am quickly trying to finish right. Earlier for double shear, we know the rivet value is 72.61, right.

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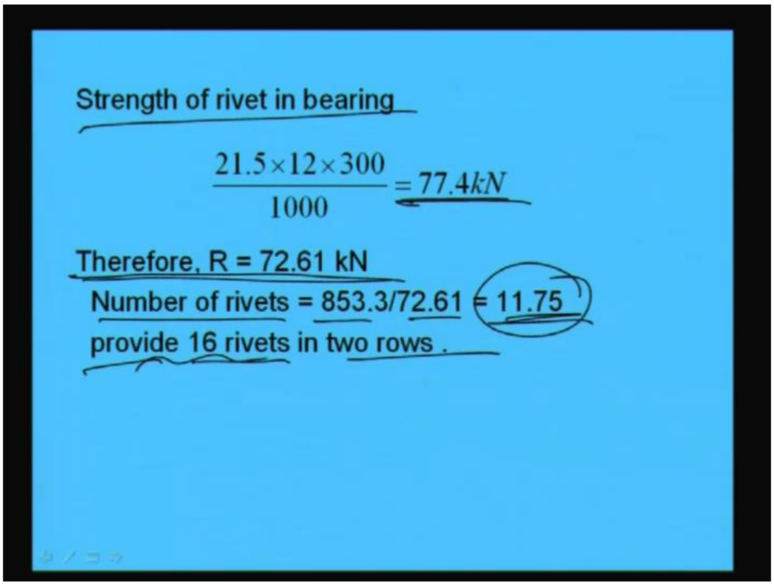

So, the strength of the again similarly in bearing, it is 77.4 that also we have calculated. So, rivet value is becoming 72.61, right. So, therefore, rivet value is 72.61. So, number of rivets we can find out load by rivet value that is 11.75. So, let us provide 16 rivets in 2 rows. So, some rivet we are going to find out, means say generally we use to provide it will higher side right.

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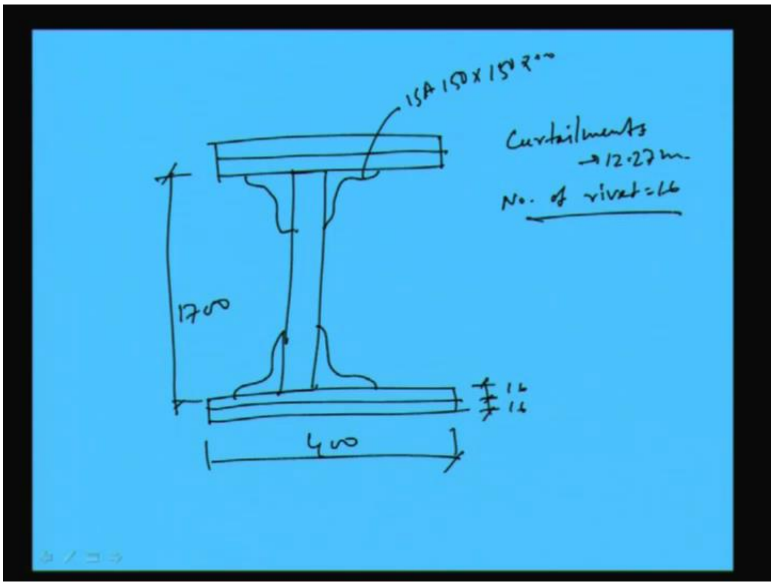

So, whatever we are getting, in summary if we see that we are going to get this; 2 plates we have provided I am not showing here the curtailment, just section at the meet, where I am trying to show. So, these are the details right now this I section is ISA 150 by 150 by 10 right. And this width of the flange is 400 and this is 16 mm 16 mm 2 plates we are providing right. And this distance is becoming 1615 or 1700 we have considered right. It was coming 16 15 and we have considered 1700. And curtailments at 12.27 meter we have done. And number of rivet where we have provided 16 little higher side we have provided right. And what else we have done?

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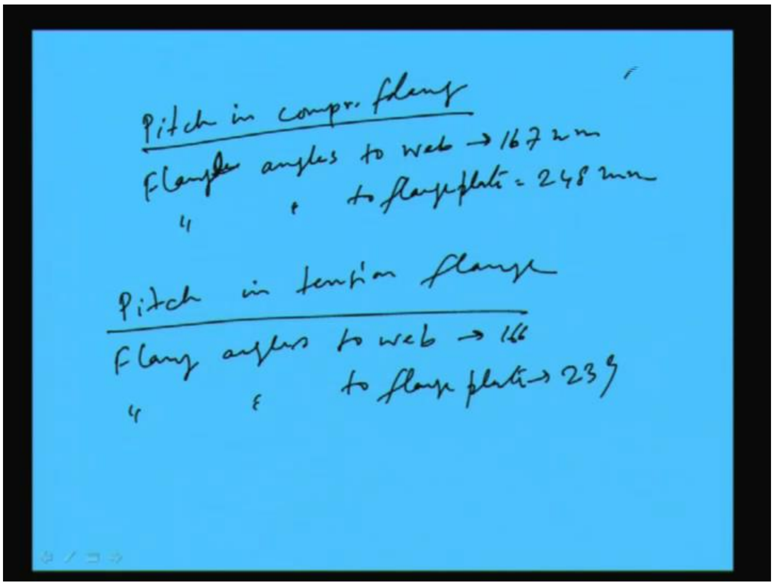

That pitch in compression flange, flange that is flange angles, flange angles to web we got 167 millimeter. Similarly, flange angles to flange plate, we got 248 millimeter right. And similarly, pitch in tension flange how do you get? Flange angles to web that, we are getting 166 and flange angles to flange plate again 239. So, these are the data we got after designing right. So, in summary if we see the design details, this is like this. So, with this I like to conclude today’s lecture.

Thank you very much for your patience to listen this lecture.

Thank you.