Design of Steel Structures.
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Lecture-42.
Design of Batten Plates using Weld Connection.

Today's lecture is basically the continuous of previous lectur, e in previous lecture we have gone through one example for design of Batten system using bolt connections. Now the same example we carried out using weld connections, in case of weld connections how the batten depth is going to change that will be demonstrated and then how the weld length will be distributed and how the weld size will be obtained those things will be discussed through this example right.

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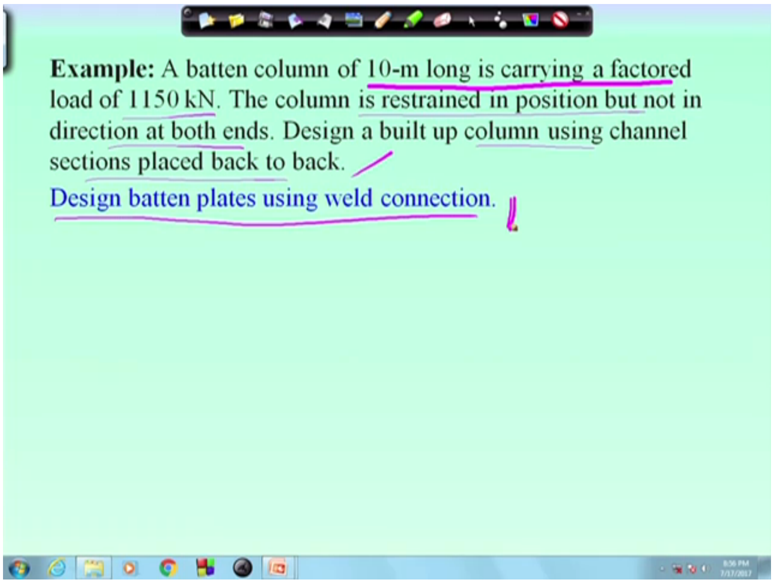

So first part I very quickly I will go through very quickly and the repetition whatever is there with the previous class I will just quickly go through and then the weld connection what I discuss asap. So the example is same the, a batten column of 10 metre long is carrying a factored load of 1150 kilo Newton. The column is restrained in position but not in direction of both ends. Design a built up column using channel sections placed back to back. These are common and now design batten plates using weld connections.

So before coming to this portion I will just quickly go through the design of batten plates because in design of batten plates certain dimensions should be changed that we will see and then we will come to this.

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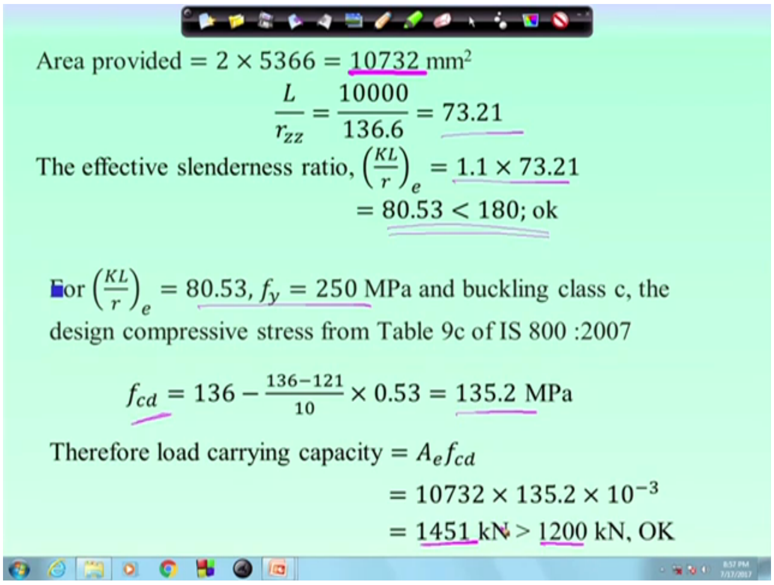

So very quickly if we go through we will look that plenty same that 10,000 millimetre, load is 1150 kilo Newton, so required area we can find out by assuming certain design compressive stress, that is 125 MPa, then to achieve this area we can try with ISMC 350 whose relevant properties are given these are same what we have discussed in earlier class.

Now area provided is this and L by rz we can find out and we can check the effective slenderness which is 10 per cent more in case of batten is ok or not. And in this case we could see that effective strength analysis you know 80.53 which is less than 180. So it is ok and for this slender issue and if I 250 grade of steel we can find out the fcd value so fcd value we got 135.2 and the load carrying capacity as a result we can find as 1451 kilo Newton, which is greater than 1200 kilo Newton. So the chosen section whatever we have chosen is ok.

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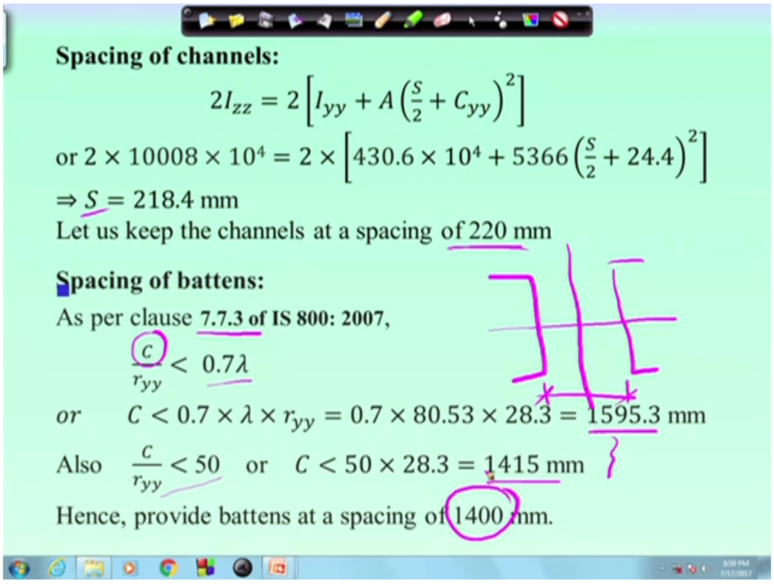

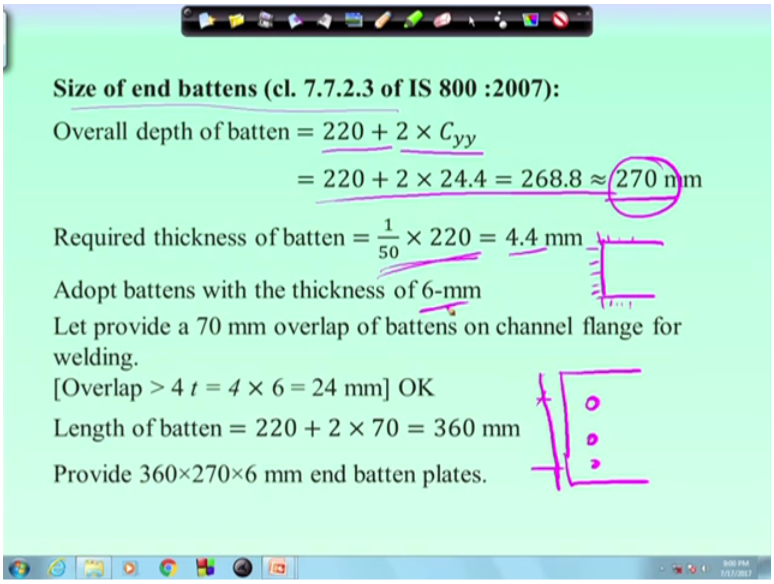

Now we have to find out the spacing between two channels. So if we provide two channels back to back, then we need to provide means we have to provide the spacing in such a way that the moment of inertia about yy direction and moment of inertia about zz direction becomes same. So equating this I can find out the spacing as 218, whereas we have provided spacing 220 mm. So once spacing is decided now we can go for designer batten. So as per clause 7.7.3 we can find out the spacing between two batten that C, C we could find out from the condition that C by ryy should be less than 0.7 lambda as 1595 millimetre.

And from C by ryy less than 50 mm we could find 1415 millimetre. So we can provide lesser of this so we can assume the batten spacing as 1400 mm right. So now we will go to find out the dimension of the batten. So for end batten as per the clause 7.7.2.3 we can find out the overall depth as this 220 + 2 into cyy that is 270 mm right. So overall depth we could find out. Remember in case of bolt member means bolt connections we had to find out overall depth from the effective depth, so effective depth is the distance between extreme means centre to centre distance between extreme bolts right.

+ 2e is equal to overall depth but in case of weld connections we do not need that means overall depth and effect depth will be same because there is no edge distance right. So here overall depth is becoming 270. If you remember the earlier case it was quite high, the overall depth was higher so as overall depth is h less so required thickness is also becoming less.

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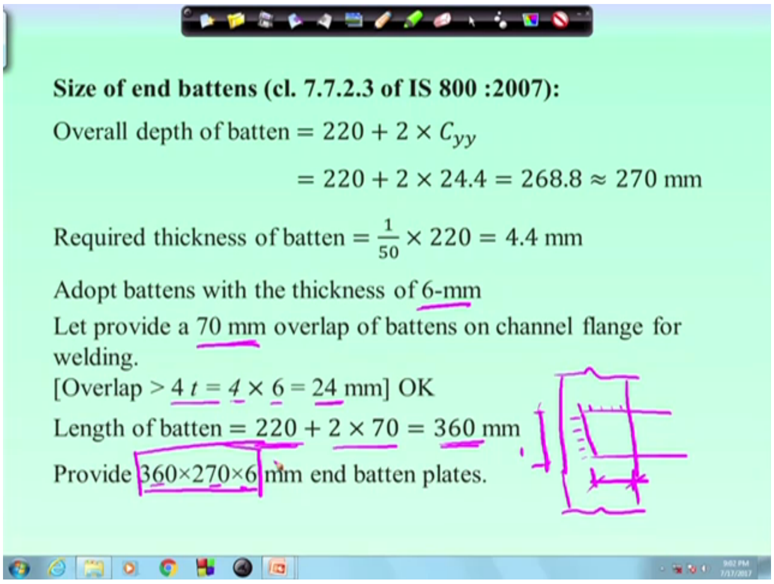

So 220 by 50 that is 4.4, so we can provide 6 mm right similarly so the batten depth and batten thickness has been changed with means with compared to the bolt connections. Now let us provide the overlapping. Say suppose this is a column section and we are providing certain batten say we are providing batten here, so this is the overlapping distance right this is the. Now this overlapping distance we can assume say we are providing 70 mm overlap of battens on flanges ok.

And in this overlapping we have to check that overlap should be greater than 4t that means 24, 4 into t means 6 mm, here t was 6 mm we have consider so 24 mm. So length of batten now will become 220 + 2 into 70, 220 is the spacing between two channels section, so this is becoming 360. So the batten plates size becoming 360 by 270 by 6. Now we compare to the bolt connection we can see the batten size is becoming quite less in terms of length, depth and thickness.

Three things are reducing right so we can achieve the means from equivalent point of view we can achieve the lower cost for weld connections when we are going to provide batten member with weld connections. Now in case on intermediate batten we will means will consider same that is 3 fourth of 220 + 2 into cyy, so that is becoming 201.6 which is more than 200, so we can provide say overall distance as 220 mm.

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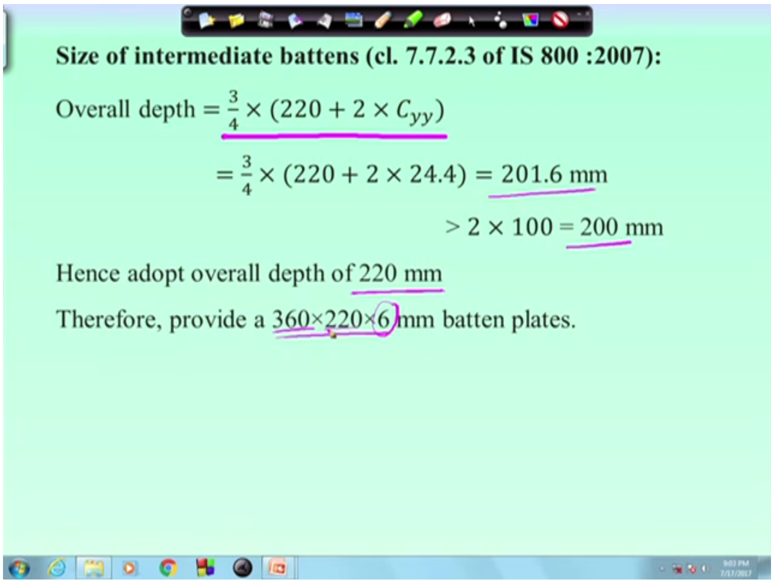

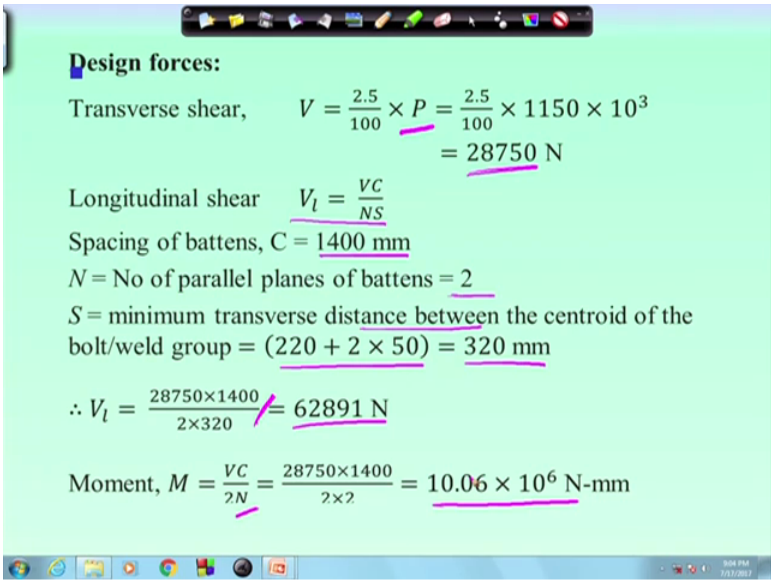

So in this case the details of the batten dimensions will be like this that 360 by 220 by 6. That means we are keeping thickness same because overall depth is not changing that much and length also is keeping same only overall depth we have reduced right. Now design process, so design process as we have calculated earlier here also we will get similar magnitude like 2.5 per cent of the compressive force will be the design force. So transverse you will get 28750 Newton now longitudinal shear we can get from this formulae that is VC by NS where C is equal to the spacing between battens that is 1400 mm which we have calculated earlier.

Number of parallel planes of batten in this case is 2 and S is the minimum transverse distance between the centroid of the pole bolt or weld group that is 220 + 2 into 50. So S we have this is we are considering 320 ok. So Vl we can consider as VC by NS so 62891 and moment also we can find out VC by 2N so 10.06 into 10 to the power 6 Newton millimetre. So this is same as we calculated in case of bolt connections.

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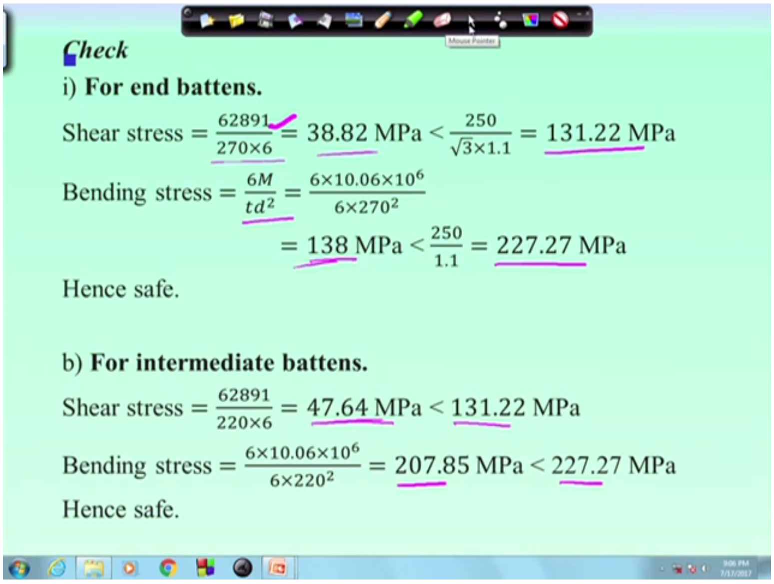

Now we will check so checking also we can see that shear stress is coming shear force divided by cross sectional area 270 by 6, so this is becoming 38.82 MPa which is less than 131.22 MPa so it is ok. Similarly bending stress we are getting 6mm by 3d square which is 138 MPa and permissible is 227 MPa so it is safe. And similarly for intermediate batten we have to check, so for intermediate batten the stress, shear stress is coming 47 which is less than 131 and bending stress is coming 207 which is less than 227, so it is ok.

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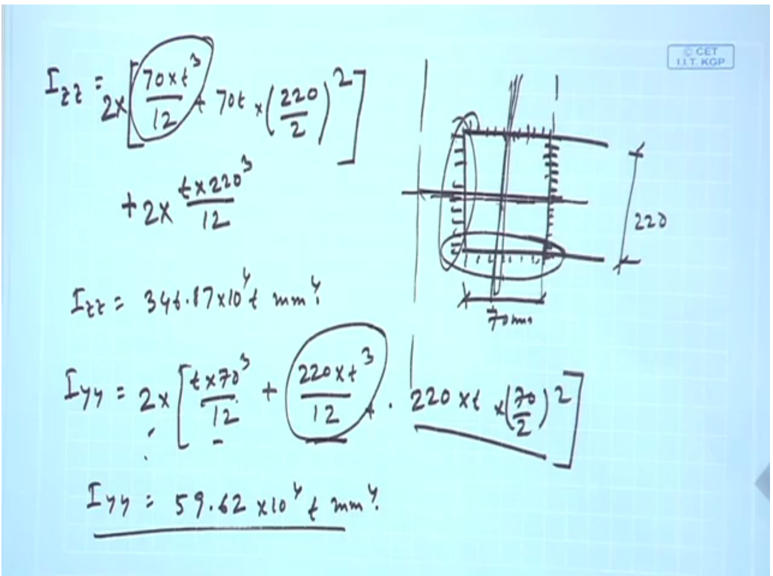

So intermediate batten and end battens are ok from the stress point of view. Now we do the connections we go for the design of connection ok. So if we do the connection we will see say this is the column member where 70 mm length is overlapped and we are providing weld connection in in all four sides right weld connections in all four sides.

So now I have to find out Izz and Iyy right. Here as I provide in all four sides so cg distance will be the middle of this length and this length right. So Izz if I find I can find Izz as 70 into t cube by 12 + 70t into this value is 220, 220 by 2 whole square right into 2 those two sides. So 70 into t cube by 12 + ar square into 2 + t into 220 cube by 12 into 2 ok.

Now I can neglect this value the t cube will be much less, t is the thickness of the throat thickness of the weld here t is a throat thickness of the weld. So if I neglect this value as it is negligible then I can find out the value of Izz as 346.87 into 10 to the 4 t millimetre to the 4. Similarly Iyy value also can be calculated, so Iyy value will be 2 into t into 7 cube by 12 + 220 into t cube by 12 + 220 into t into 70 by 2 whole square into 2 right.

So t into 70 cube by 12 that is Iyy and constant is so t into 70 cube by 12 this one, + 220 into t cube by 12 is this one + ar square and into 2 because in two sides right. So again here also I can neglect this value because the throat thickness t is quite less compared to other dimension. So Iyy value can be calculated as 59.62 into 10 to that 4 t millimetre to 4 so Iyy value we have calculated like this.

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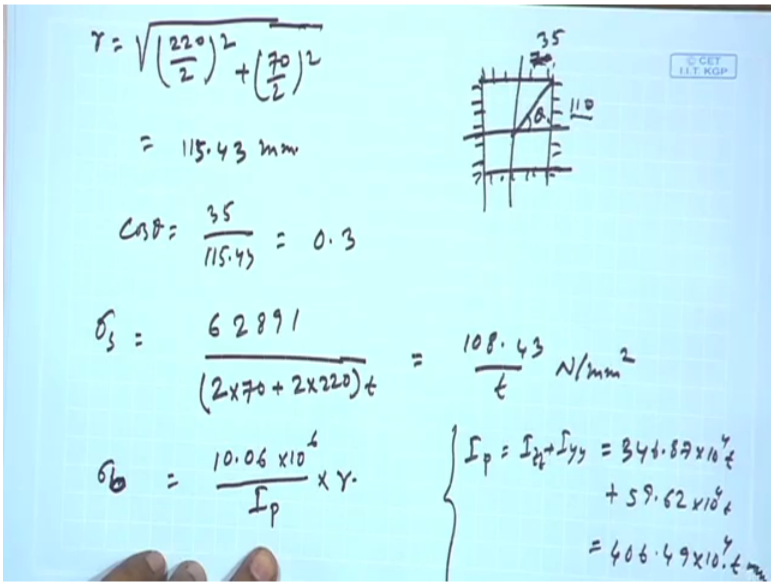

Now to find out the stress developed stress at the extreme end of the weld I have to find out the r the radial distance, so that r will become 220 by 2 whole square + 70 by 2 whole square right. Because if I see r will be r will be at the corner so this is any corner because all corners will be same, so this is 70 and this is 110 right. So this is becoming 115 sorry this is 35, 70 by

2 so 35 and this is 110, so this will become 115.43 millimetre and cos theta will become 35 by 115.43, if this is theta then cos theta will be this that is becoming 0.3.

So now direct shear stress if I say sigma S as per clause 10.5.9 that will be shear force 62891 we have calculated earlier by the cross sectional area of the weld area, so that will be 2 into 70 + 2 into 220 into t right. So this is becoming 108.43 by t Newton per millimetre square. Now shear stress due to bending versus sigma b I can find out, so that will be m 10.06 into 10 to the power 6 m by Ip, Ip by into r ok. So here Ip will be equal to Izz + Iyy right. So Izz is 346.87 10 to the 4t + Iyy is 59.62 into 10 to the 4.

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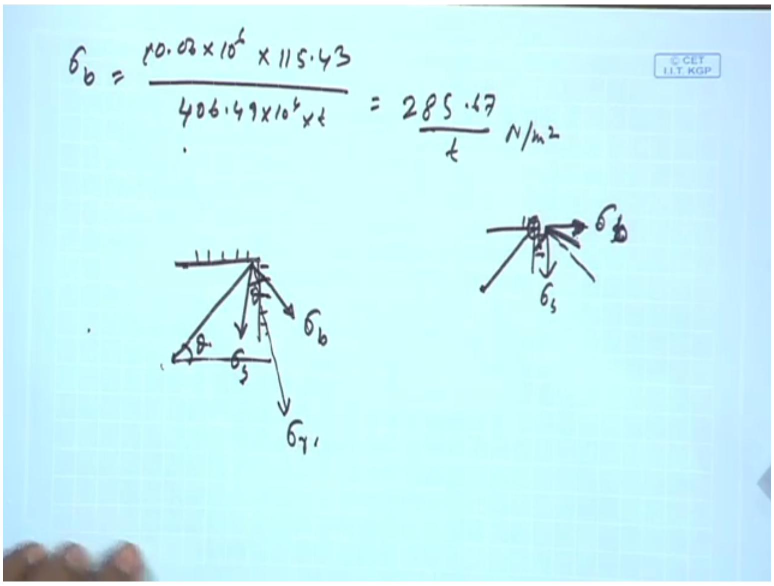

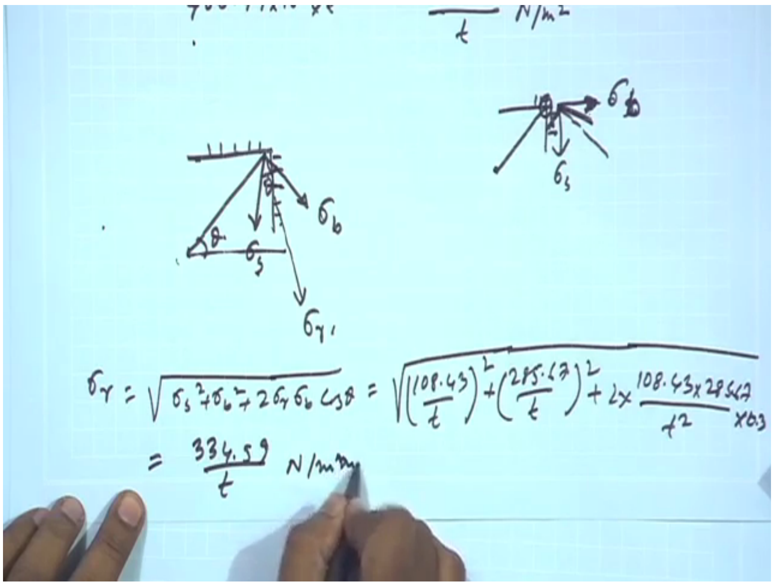

So this is becoming Ips polar moment of inertia as 406.49 into 10 to that 4 into t millimetre to the 4 right. Therefore so I can find out the value of sigma b from this equation. So if I put this equation so stress due to bending moment will be 10.06 into 10 to the 6 into r is 115 point 43 which we have calculated that is an extreme distance of the weld by Ip is 406.49 into 10 to the 4 into t. So this is becoming 285.67 by t Newton per millimetre square.

So now combine stress I have to find out now if I see I have calculated at this point the shear stress sigma S shear stress sigma S and bending stress sigma b, so I have to find out the combine stress right. So this is not exactly sorry this will be like this perpendicular to this, I am drawing once again say this is the weld connection and this is the cg so this will be the bending stress and this will be the shear stress. Now this is theta so this will be theta so combined stress will be this sigma r right.

So sigma r I can find out as sigma s square + sigma b square + 2 sigma r sigma b cos theta so if I put the value 108.43 by t + 285.67 by t + 2 into 108.43 into 285.67 by t square into 0.3 ok. So if I calculate I will get the value as 334.59 by t Newton per millimetre square right.

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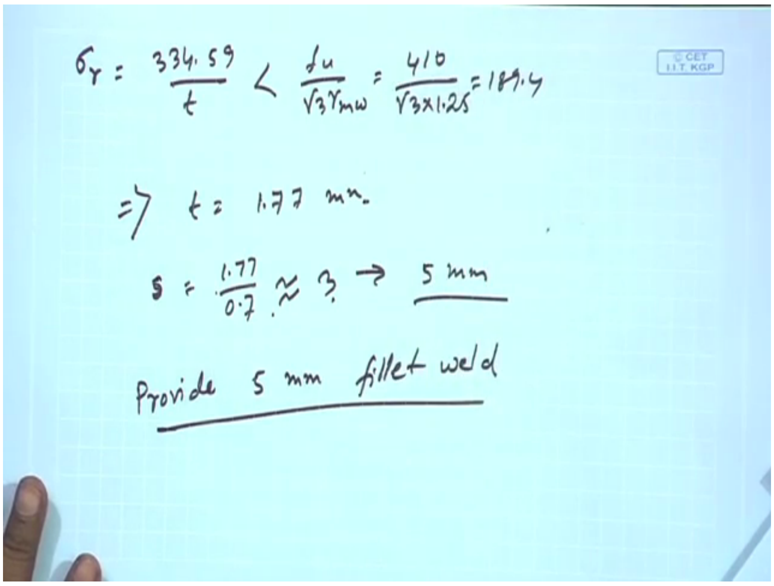

So the combined stress say resultant stress sigma r we got 334.59 by t which should be less than fu by root 3 gamma mw and these value will be 410 by root 3 into if I use shop weld then 1 point 25 gamma mw 189.4. So from this I can find out t as 1.77 millimetre right. So t as 1 point, so size of the weld I can find out size of the weld right, so size of the weld will be 1.77 by 0.7 ok. So it is around 3 so I can provide say 5 mm size of the weld right. So provide S as means size of the weld as 5 mm weld right. So this is how I can calculate the weld size right, now I can means I will see the detail design means diagram of that design as this.

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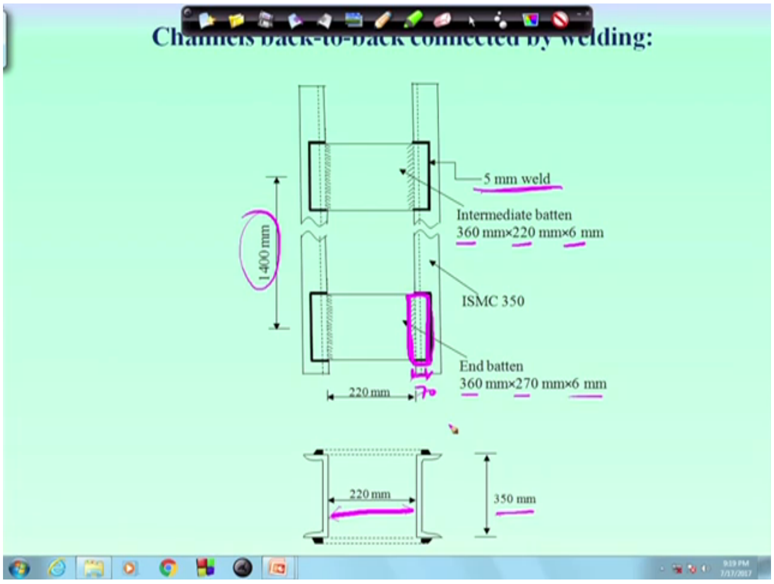

So here if you see h the spacing between two channel section it was decided earlier 220 channel size was decided. Now h weld section we are using 5 mm weld size of the weld as 5 mm and this is the overlapping distance that is 70 mm and end batten size is 360 by 270 by 6 mm and the intermediate size is 360 by 220 by 6 mm. and the spacing between two battens are 1400 mm right. So and we are providing four sides welding right and overlapping is 70 mm.

So from this example what we have seen that in case of weld connections we have to maintain certain minimum overlapping distance and once overlapping distance is decided based on that we have to find out what is the moment of inertia of the weld connections. And about zz and about yy direction, then I will I will find out the polar moment of inertia, I will find out the distance of the extreme weld and its angle of inclination from the cg of the weld group. Then I can find out the shear stress of that weld and bending stress of that point.

Once I get shear stress and bending stress I can find out the resultant stress and that resultant stress should be less than the weld strength, so from that I can find out the thickness of the weld and then I can find out the size of the weld. So for that particular overlapping and for that particular h arrangement of the weld the size is calculated. Now size may be different if I change the arrangement of the weld. So according to my choice I will design, whatever I will consider according to that size of the weld will be calculated and it will come right. So this is all about the design of batten system considering weld connection considering bolt connection which I have discussed in earlier lecture. Thank You.