Course on Design of Steel Structures
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Lecture 40
Module 8
Batten Plates

Today I am going to discuss about batten plates, batten plates are used when the built-up sections are carrying axially loaded axially compression load. So batten plates unlike lacing, lacing plates are placed in a inclined way. In case of batten plate the batten plates are placed perpendicular to the axis of the column that means if columns are vertical then batten plates should be perpendicular to that that means horizontally it will be placed.

Now batten plates are generally placed in both the side with equal spacing in general we prefer equal spacing and in both the side at same position we provide batten plates and minimum number of batten plates along the length of the column will be atleast three. So in the codal provision it is told, right and as I told that batten plate will be generally used when the purely axial compressions are acting on the built-up column. So for that case we generally use batten plates.

But when eccentricity comes into picture in the compression member then this does not work efficiently, so in that case we have to go for lacing member. So today my discussions will be on batten members and in case of batten member we know that means we have to know certain things about certain things like one is what will be the length of batten member, what will be the depth of batten member and what will be the thickness these three things we have to know that means dimension of the batten member, then we have to know the spacing, spacing between two batten members, then the connection between batten member and the and the main member.

So connections may be of two type bolt connections or weld connections. So what are the forces coming on the joint that we have to calculate and then we have to find out what will be the number of bolts, how bolts will be placed so all the details can be made, right.

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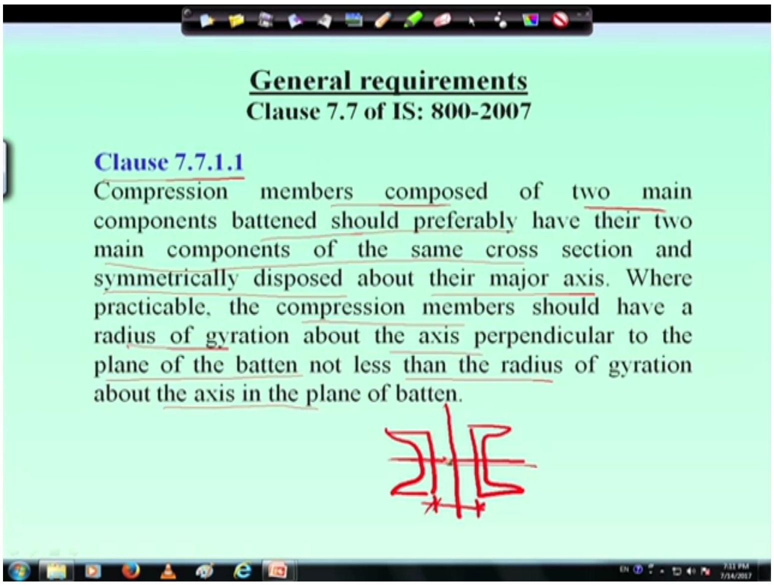

So let us come to the to some general requirements which are given in the clause in code IS: 800-2007 in clause 7.7 it is given, I will just go through this clause which I have written here. The clause number is 7.7.1.1, it is told in this clause that compression members composed of two main components battened should be preferably have their two main components of the same cross section and symmetrically disposed about their major axis, right. Where ever practicable the compression member should have a radius of gyration about the axis perpendicular to the plane of batten not less than the radius of gyration about the axis in the plane of batten.

That means as we have discussed earlier say for example that if we provide two section say channel section in this case back to back. Now this has to be provided in such a way that ryy and rxx will be becoming most mostly same or ryy should be little higher. So because we cannot change the value of rxx, rxx will be same for all the all the cases all the cases means for all spacing between these two and if we increase the spacing between these two ryy value will be increased because Iyy value is going to increase. So ryy has to be increased in such a way that the strength in both the axis become more or less similar.

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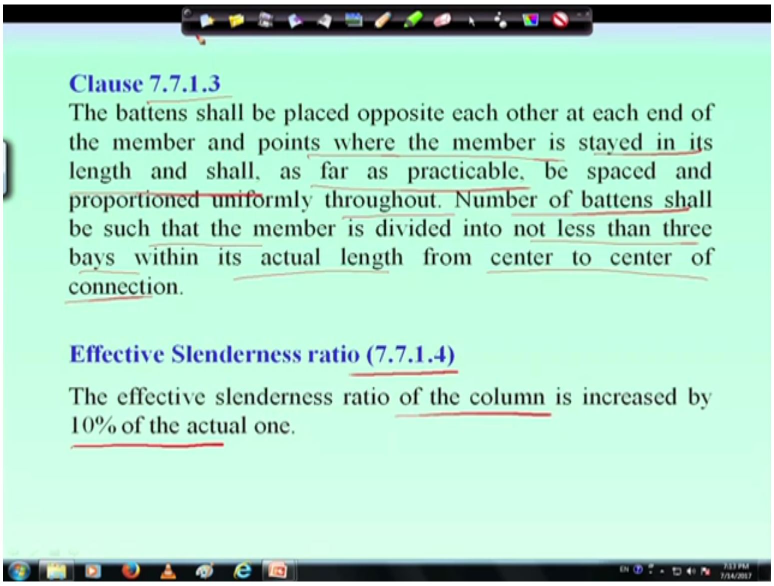

Now in next clause that is in 7.7.1.3 it is told that the batten shall be placed opposite each other at each end of the member what I told earlier and points where the member is stayed in its length and shall, as far as practicable, be spaced and proportional uniformly throughout, right. And number of battens shall be such that the member is divided into not less than three bays within its actual length from center to center of connection that means atleast three numbers of battens has to be provided along its length.

Another consider has to be remember that is the effective slenderness ratio, in case of batten member the effective slenderness ratio of the column will be increased by 10 percent, you have remember that what will be the increase of effective slenderness ratio for lacing member. So in case of batten member it will be 10 percent, so these are some codal provisions which we need to keep in mind.

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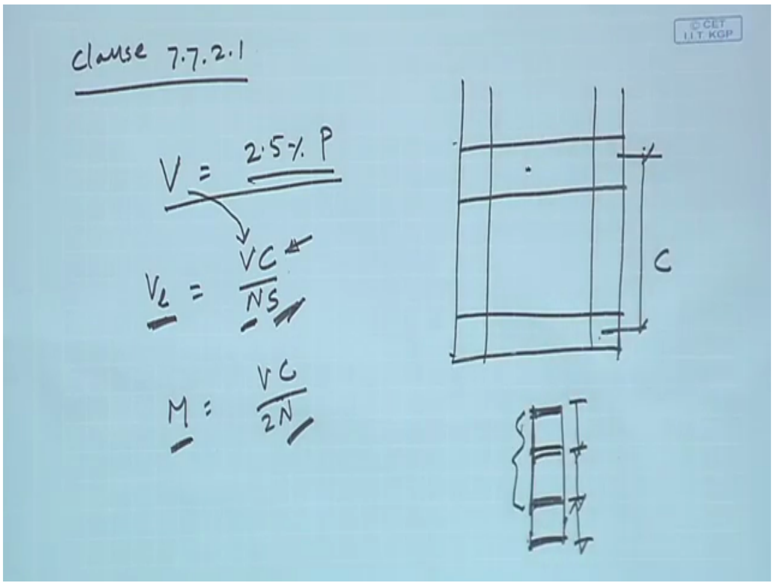

Now in clause 7.7.2 we can see that the transverse shear to the batten is considered as 2.5 percent of the axial force, right so that also has to be consider. So similar to the lacing system the transverse shear on batten member will come as 2.5 percent of the axial compressive force. Next the longitudinal shear on the batten member say Vl I can say that will be consider as means we can calculate as VC by NS, okay. So batten has to resist a longitudinal shear of Vl and a moment of VC by 2N, now what is V, V is the transverse shear force, right and C is the center to center distance of batten longitudinal C is the center to center distance of batten longitudinal means this one say suppose two sections are there then we are providing say one batten here and another batten as here, right. So the center to center distance of two battens will be the value of C, right.

And N is the number of parallel planes of batten, so how many parallel of battens at a particular elevation has been given that that number will be N. And S is the minimum transverse distance between the centroid of the bolt group or welding connection of welding connecting the batten to the main member, right and V I have told already. So Vl I can find out VC by NS and M will be equal to minimum M will be the moment at each connection that will be is equal to VC by 2N and S let me repeat again it will be the minimum transverse distance between the centroid of the bolt group, right connecting the batten to the main member. So this is how we can calculate the value of V then Vl and then M.

Now few things we have to remember while using batten members, one is batten plates are has to be provided symmetrically as far as possible the batten members has to be provided symmetrically. And at both ends we should provide batten, right batten plates should be provided both ends at the both end of the member we need to provide batten, right or tie plate. So they should be provided this batten should be provided at a points where the member is stayed in its length that also we have to keep in mind.

And another thing again I am repeating which I have told that the number of battens should be such that the member is divided into not less than three bays. So say suppose I am providing one batten here, another batten here so atleast three bays I have to provide, right and they should be spaced and proportional uniformly throughout means this spacing should be uniformed, right and minimum three battens has to be provided.

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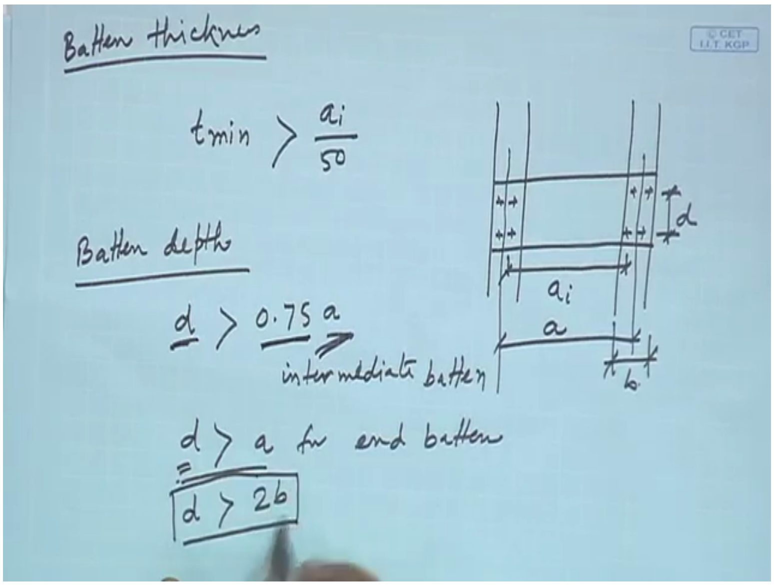

Now coming to the dimension of batten, so how to find out the batten thickness, batten length and batten depth. So thickness when I am coming which is mentioned in clause 7.7.2.3 batten thickness that minimum thickness tmin can be considered as atleast ai by 50 what is ai, ai is the distance between the inner most connecting lines of rivet or bolt or weld perpendicular to the main member that means if I connect like this two main member with a batten, so this is the batten now maybe we can connect with bolt, right. So what will be ai, ai will be the inner most connecting lines of rivet or bolt this will be ai, right and the minimum thickness should be greater than ai by 50.

Then we have to find out the batten depth batten depth, so the effective depth will be this one the center to center distance of the bolt groups means extreme bolts, right this will be the effective depth. Now this effective depth should be taken in such a way that d should be atleast greater than 0.75a okay where a is the centroidal distance of members, a is the centroidal distance so ai and a are different a will be this one centroidal distance between members, so this is a, right.

Now so batten depth should be greater than 0.75a this is for intermediate batten intermediate batten, right so d should be greater than 0.75a for intermediate batten and it should be greater than a for end batten for end batten it should be greater than a that means the batten depth should be higher at the end batten. However both I can take if if I take d as a here then it will be same and in any case d should be greater than 2b b is the width of the member in the plane of batten that means this one this is b, b is the width of the member in the plane of batten. So d should be greater than 2b, so this is how we can provide batten there.

So in summary what we can say that d will be 0.75a for intermediate batten and d will be greater than a for end batten and for any case d should be greater than 2b, so this we have to maintain.

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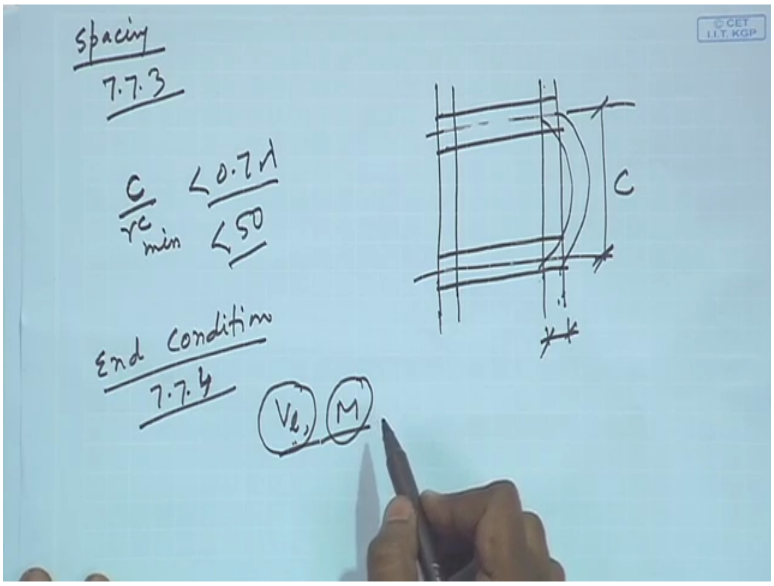

Now let us come to the spacing of the batten, spacing spacing between two batten this is given in clause 7.7.3, spacing of two batten means if we consider say for example this is one batten and this is another batten and what code has mentioned that this spacing should be uniformed throughout its length as far as possible means unless it is very means very necessary we will try to make spacing uniform. So this is called C spacing.

So this C will be in such a way that C by rc minimum should be less than 0.7 lambda and should be less than 50, right. So rc minimum I can find out rc minimum means the minimum radius of gyration of the individual section okay. So if rc minimum means rc minimum of a particular section we have to consider say for this case and I have to make the spacing in such a way that this condition is satisfied, the C by rc minimum is less than 0.7 lambda and in any case it should be less than 50 because the local to arrest the local buckling of the main member, right so these conditions will fulfil that, right.

Then the end condition end conditions are described in clause 7.7.4, right. So as I told that end conditions will be designed means the design of the connection should be made due to longitudinal shear Vl and due to moment M, okay which has been calculated earlier. So for end conditions we have to find out Vl and M then we have to find out the strength of the weld per if we consider the weld connection then per unit length what is the weld strength and what is the force coming on that on that end part, right then I can find out the length of weld.

Similarly for bolt I will find out what is the forces or stresses coming in the bolt due to moment and due to longitudinal shear and then we have to find out whether the number of bolts we are going to provide is sufficient to carry that much load or not, right.

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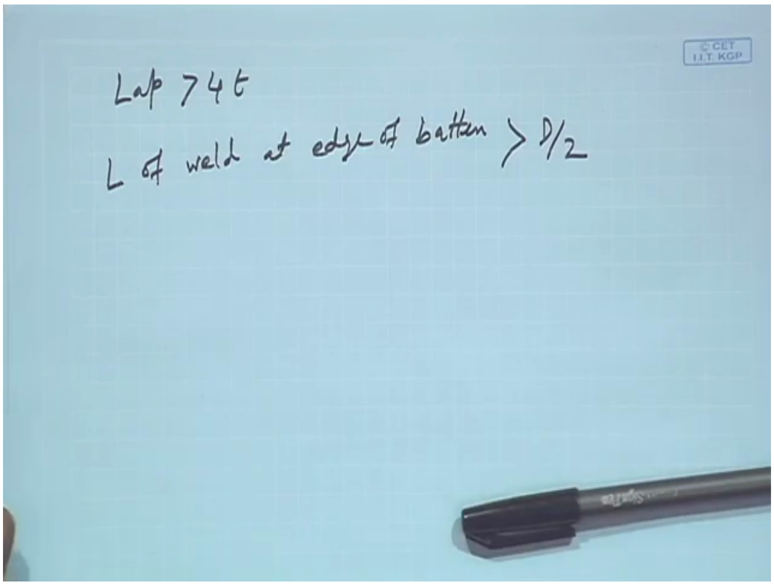

And in this clause it is told that for weld connections lap should be greater than 4t, right this is one thing and then the total length of weld at each batten total length of weld at edge of batten it should be greater than D by 2, right. Then length of weld at each each edge of batten it should be less than one third of total length of weld required and return weld along transverse axis of column should be less than 4t, I am coming into the slide which will be which will make clear, right.

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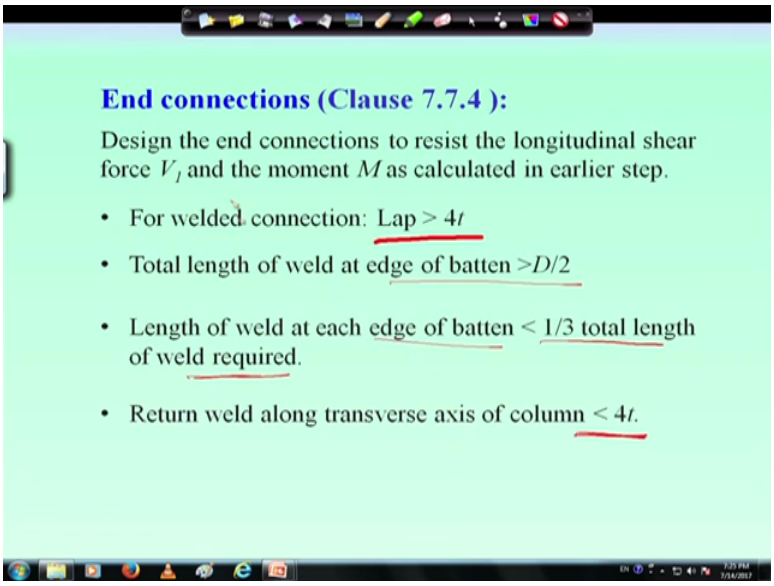

This is what I was discussing that is one is that lap should become more than 4t and total length of weld at edge of batten should become D by 2, where D is the overall depth of the batten and length of weld at each edge of batten should be less than one third total length of weld required that also we have to keep in mind and return weld along transverse axis of column should be less than 4t, so this is what we have has been given in clause 7.7.4, while designing the batten members with with the weld connection we have to keep in mind and this will be clear when we will through one example in next class we will go through some example.

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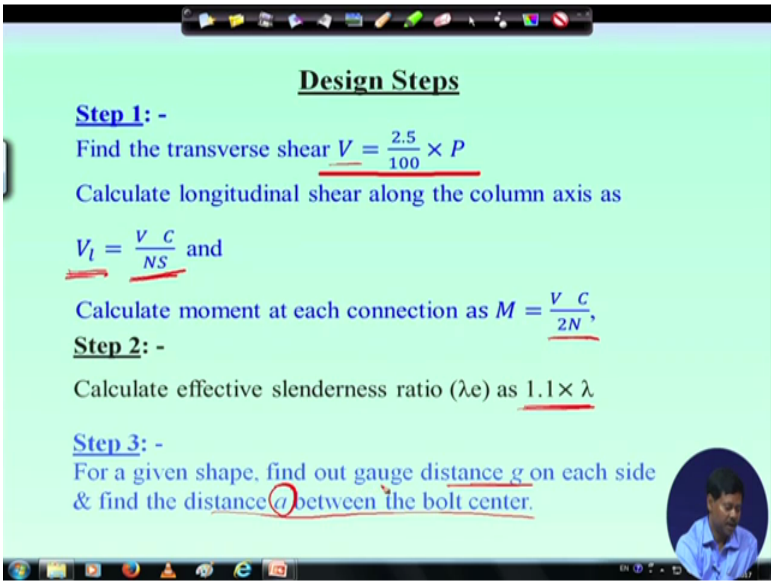

Now to summarize the things whatever I have discussed I will show few slides next, now while going for design of batten member we will see what are the steps used to be carried out systematically so that the batten members can be designed. So if I come to the steps one by one so first step what we will do we will find out the transverse shear, right. So in fact when we are going to design a batten member or we are going to do some workout example for designing of batten member then we have to follow certain steps otherwise we will not be able to do properly and we will be writing a program also in computer program so step by step we have to go through.

Therefore I have given some steps which can be followed and then we can find out the design systematically. However suppose I have given step 1 this it may be in step 2 and step 2 may be in step 1 that can be changed however I am proposing a chronological steps here where in first steps I am going to calculate the transverse shear V as 2.5 percent of axial force, right.

Then I am calculating the Vl the longitudinal shear and moment, Vl is equal to VC by NS and M is equal to VC by 2N, so we can calculate the Vl and M from the magnitude of the transverse shear. Then I can calculate the effective slenderness ratio lambda e which will be 10 percent more than the actual slenderness ratio of the column. So effective slenderness ratio of the column built-up column will be increased by 10 percent to get the effective slenderness ratio, right that is 1.1 into lambda.

Now in step 3, we can find out the gauge distance of the section because say for example say if we use channel section then we can find out the what will be the gauge distance for a particular section size and then we can find out the distance a between the bolt center between two bolts we can find out the distance okay that a a value which will be required for calculating the batten dimensions.

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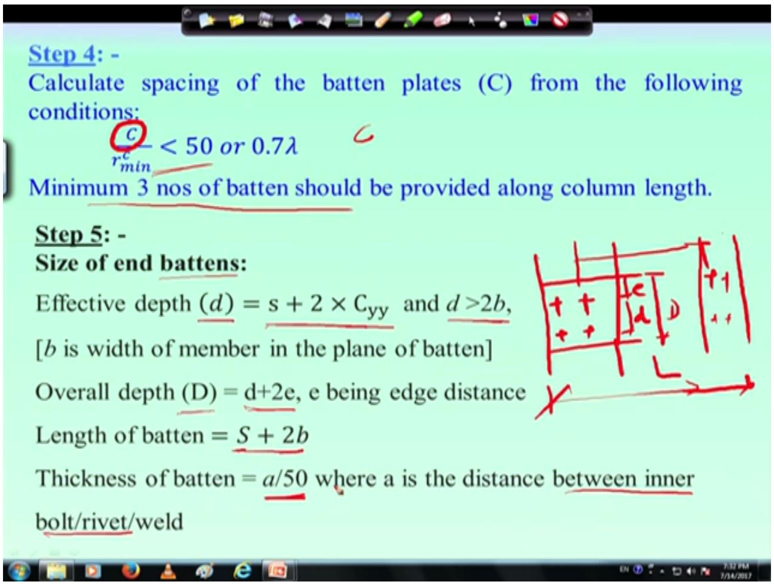

So after step 3 what we can do we can go to find out the spacing between batten plates, so for that we have to calculate the value of C from this condition that is C by rc minimum should be less than 50 or 0.7 lambda, so from that we can find out the value of C which is nothing but the spacing between two batten plates. And we have to remember that minimum 3 numbers of battens should be provided along length of the column.

Now in step 5 we will find out size of batten, right so for finding out size of batten means we will find out should depth, length and thickness. So first we will find out the effective depth which will be S bar plus 2 into Cyy this is the effective depth and it has to be greater than 2b where b is the flange width, right of the section, right. Then overall depth D can be found from this D plus 2e e is the edge distance overall depth means if I see the if batten members are connected with a column then we can find out this as overall depth and this is e and this is d, right. So overall depth will be d plus 2e, where e is the edge distance.

Then length of batten length of batten will be total from here to another end and that will be the spacing plus 2b where b is the flange width, or width of member in the plane of batten, right so length of batten can be found and thickness of batten will be a by 50, where a we have consider earlier means calculated earlier which is the distance between inner bolt or rivet, right.

So thickness of batten can be found as a by 50, where a is the distance between inner bolt that means from here to another place say for example if I provide here again then this one and this is length of the batten, right. So thickness of batten will be a by 50.

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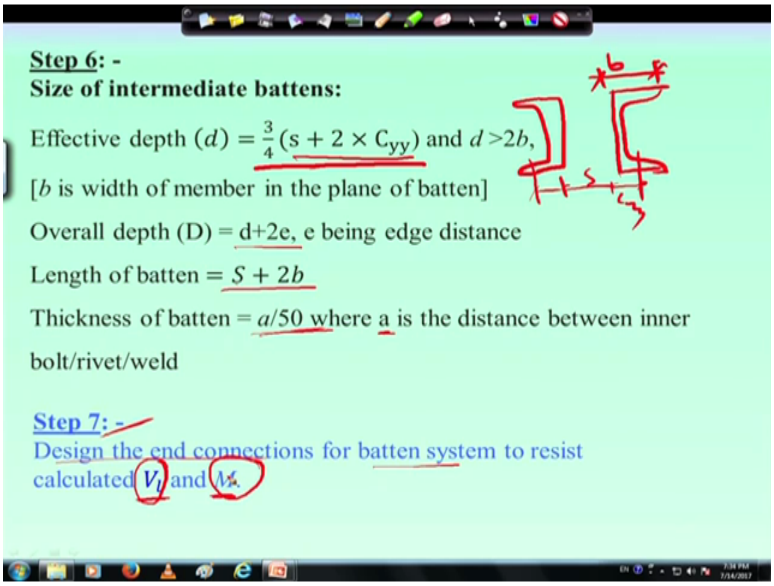

So once these are calculated we can go for next step, another thing we have to remember that calculation of depth for intermediate batten will be different. So for effective depth for intermediate batten will be three fourth of that S plus 2 Cyy, if this is the say for example if two channel sections are placed back to back and if this is the Cyy and this is S Cyy, right so effective depth will be three fourth of this this is for intermediate batten.

Remember for end batten it will be this one and overall depth similarly we can find out d plus 2e where e is the edge distance and length of batten will be S plus 2b, b is this one the flange width, okay. And thickness of batten will be similar to earlier a by 50 where a is the distance between inner bolt, rivet or weld so thickness of batten will be this.

Next is the design of end connection step 7 will be the last step where end connections will be designed for a batten system to resist the calculated value of longitudinal shear and moment. So we have calculated at the first step the longitudinal shear and moment. Now on the basis of this we will design the end connections of the batten system to resist these forces.

So these are the steps which will be used to to design a batten system, right. So in this lecture what in summary if we discuss what we have learned that certain specifications in terms of the dimension of the batten and its spacing has been calculated as per the codal provisions and code has dictated certain guidelines as per the guidelines we have provided the steps and also we have calculated means we have seen how to calculate the transverse shear, then longitudinal shear and moment on the batten plate and then we need to design the end connections the connection using weld or bolt for to resist this moment and longitudinal shear, right.

And in next class we will go through one example through which it will be clear how to design a batten, thank you.