Course on Design of Steel Structures
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Lecture 60
Module 12
Design of Slab Base

Todays lecture will be focused on design of a slab base. So in last lecture we have discussed about the design procedure of the slab base where the load is transferred from the super structure to sub structure and how to decide the dimension of the base plate that is the length, width and the thickness of the base plate that has been discussed. So today we will first discuss about the design steps means what are the steps we will follow to design a slab base and then we will go through one example to understand it properly.

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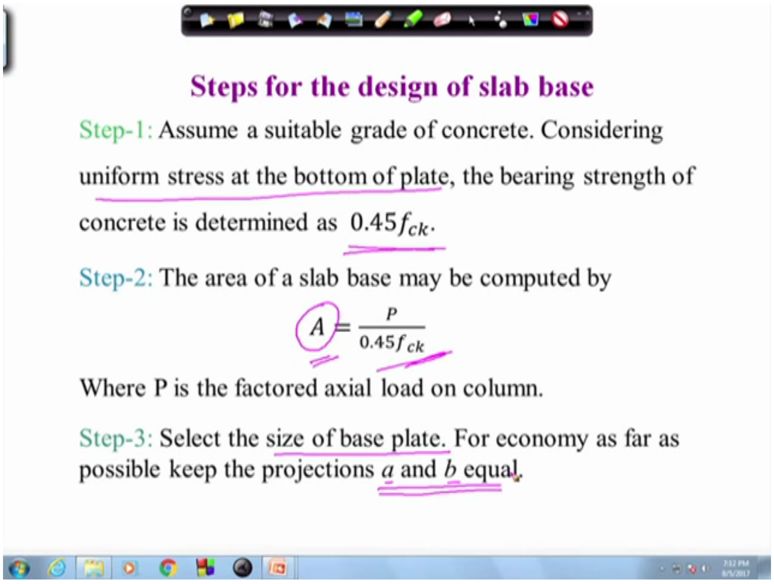

So first we will consider a grade of concrete which will be provided for design of the slab base so once we know the grade of concrete we can find out the bearing strength of the concrete which will be dependent on the grade of concrete and bearing strength of concrete as we know it is 0.45 fck and also we will consider the uniform stress at the bottom of the plate. So if we consider uniform stress at the bottom of the plate then we can find out the area of the slab base as the load divided by bearing strength.

So load means the factored load factored axial load on the column which is P and bearing strength of the concrete is 0.45 fck. So from this data we can find out the required area of the slab base. So on that basis we can select a size of the base plate, so for selecting size of base plate we have to keep in mind that projection of A and B should be kept as much as possible equal because if we can keep A and B equal then we can find out the economical size of the base plate, right that means the thickness of the base plate will be the minimum.

Therefore we will try to arrange the base plate in such a way that the A and B the projection in two directions A and B are kept as much as possible equal, right.

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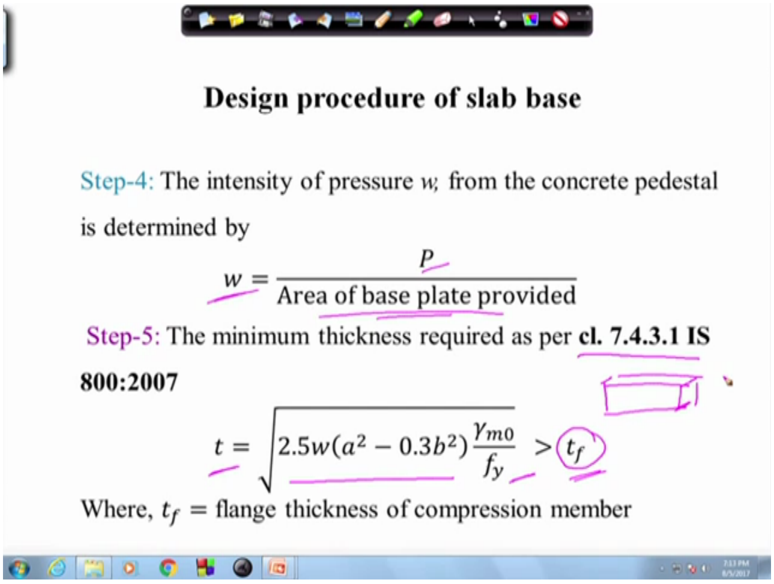

So once we find out the size of the base plate that means length and width then we can find out the actual intensity of pressure w because actual intensity of pressure w will be the load divided by the area of the base plate. So the intensity of pressure from the concrete pedestal can be found from this formula that is P by area of the base plate. And then the minimum thickness required can be found from this clause that is 7.4.3.1 of IS 800:2007 where the minimum thickness is given as square root of 2.5 into w into a square minus 0.3 b square into gamma m0 by fy.

So from that we can find out the minimum thickness and that has to be greater than the flange thickness of the compression member otherwise we have to take atleast the flange thickness of the compression member. So this is how we can find out the length, width and thickness of the base plate, right. So this we can find out.

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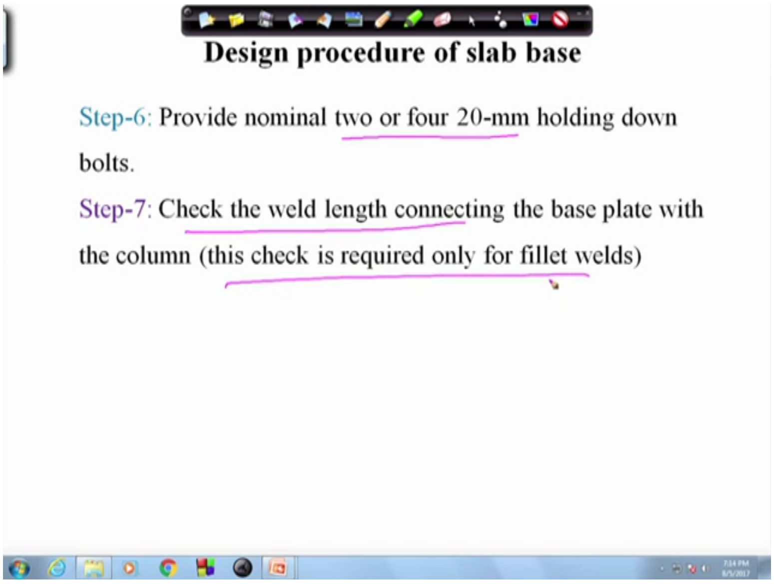

So after finding out the dimension of the base plate we will go to the step 6 where we will provide nominal two to four 20-mm holding down bolts just to hold the the column in proper position on the base plate, right this is true of axial axial compression load however for moment we have to design that. If moment is there then we need to design that how many bolts are required that will come later.

Now in step 6 again in step 6 what we can do we can check the weld length if we are going for the weld connection then we will check the weld length connecting the base plate with the column and this check is required only for fillet weld means for fillet weld we have to check this, okay.

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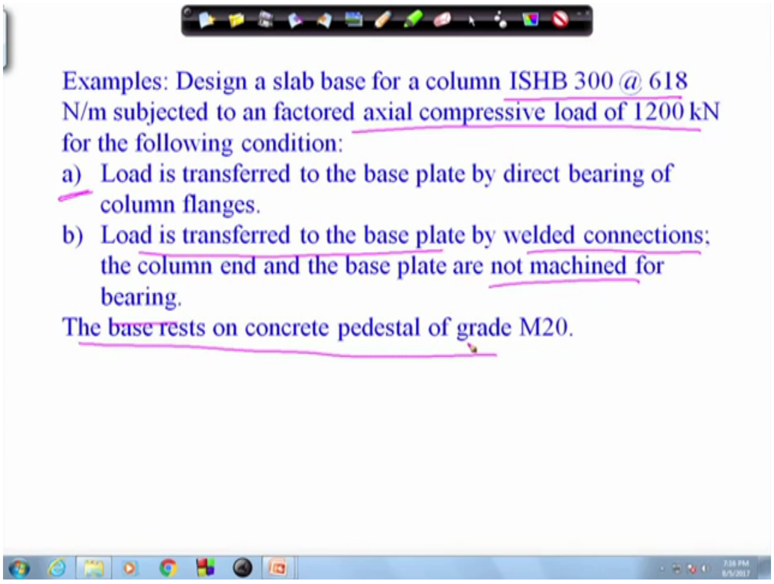

So considering these steps we will try to solve one workout example where the example is like this that design a slab base for a column ISHB 300 at 618 newton per meter subjected to an factored load factored axial compressive load of 1200 kilonewton for the following condition. So factored load is 1200 kilonewton and condition is first condition is that load is transferred to the base plate by direct bearing of column flanges, okay so direct bearing of column flanges if load is transferred then how to design.

And in second case is if load is transferred to the base plate by welded connections, so the column end and the base plate are not machined for bearing that means for this case 2 is when the column end and base plate are not machined for bearing that means the load is transferred to the base plate by welded connections, so there are two cases we will consider and for designing this we have assumed that the base plate is rested at the concrete pedestal of grade M20, so M20 grade of concrete is used. So with this data we will try to design the base plate for both the cases.

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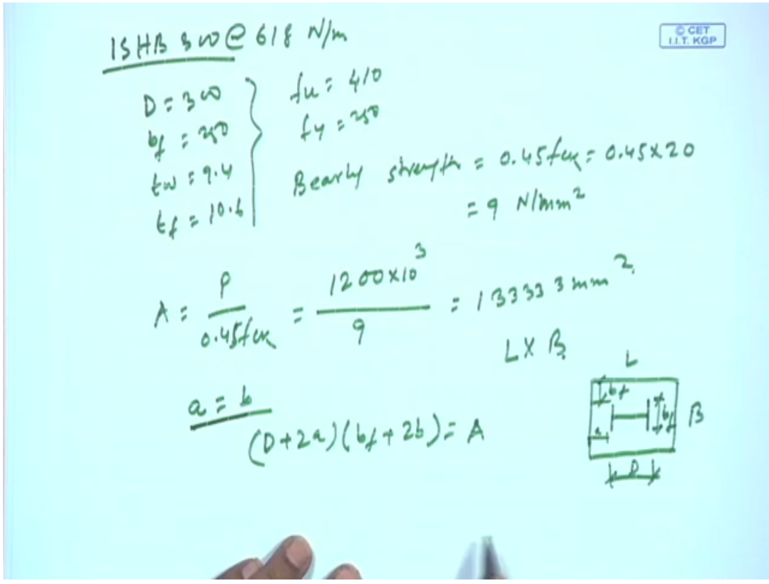

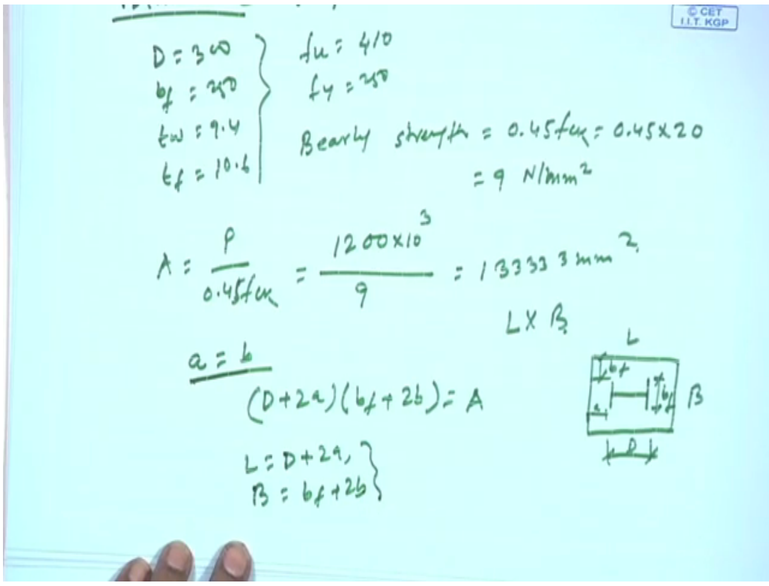

So what we could see here that we are using ISHB 300, right so ISHB 300 at 618 newton per meter. So the column size if ISHB 300 then we can see that the depth of section is 300, width of the flange is 250 and thickness of the web is 9.4 and thickness of the flange is 10.6 this data we can find from table 1 of SP 6, so from SP 6 this data has been noted and also we know for Fe410 grade of steel fu we can use as 410 and fy as 250 MPa and for M20 grade of concrete the bearing strength we can consider as bearing strength as say 0.45 fck that means 0.45 into 20 which is coming 9 newton per millimetre square, right so bearing strength we can find out as 9 newton per millimetre square.

So now we can find out the required area of the base plate, so area of the base plate we know that is P by 0.45 fck, so P is the factored load which was given as 1200 kilonewton so factored load divided by the bearing strength that is 9 which we have calculated 0.45 fck, so this is becoming 133 millimetre square, right. So now we can provide a rectangular base plate of length L by B, right and now as I told that if we assume the projection equal that means if we assume the projection length a and b equal then we can obtain a optimized thickness the minimum thickness we can achieve.

So to do that what we can do we can find out the a and b from this that is say D plus 2a into bf plus 2b is equal to the total area because if we see the base plate so if this is length, if this is B width and if this is I section so we can find out and this is D and this is bf, right. So so length will be here, length will be D plus 2a and width will be bf plus 2b so the total area length into breadth will be this.

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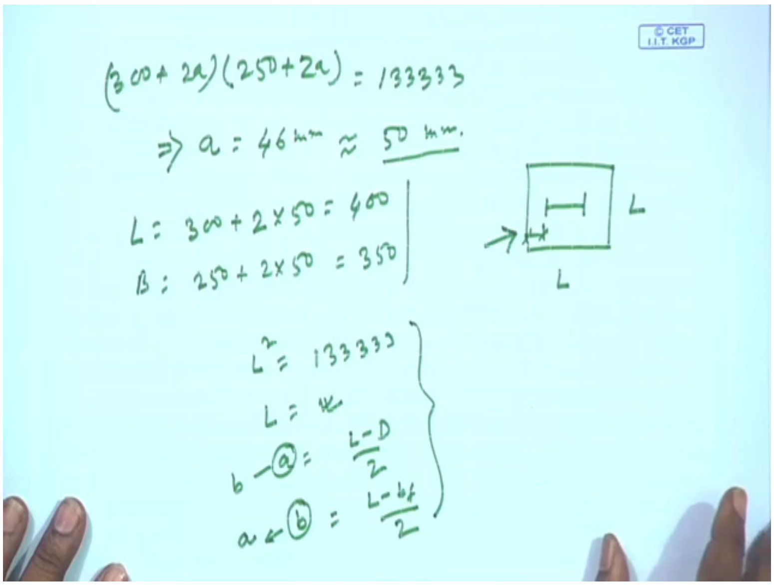

So now if we put this value we can find out 300 plus 2a into 250 plus 2a because a and b we kept same is equal to 133333, right and from this finally we can find out the value of a as 46 mm and we can consider little higher side say 50 mm. So the projection we can make as a and b as 50 mm. So length will be 300 plus 2a 2 into 50 so this is becoming 400 and breadth will be 250 plus 2 into 50 is equal to 350 so length and breadth of the base plate is defined.

In other way also we can do what we can do that if we consider a square base plate then say suppose this is L, this is L then we can find out L square is equal to the total area say 133333 and from that L we can find out. So once we find out L then the projection a we can find out L minus D by 2. Similarly the projection along b we can find out L minus bf by 2, okay right and if we see this is bigger than this we can consider as a and if this is smaller than we can consider as b that means bigger one will be considered projection a and smaller one will be b because accordingly the formula has been derived the larger one will be a, right.

So here now as we have considered projection same so length and breadth of the base plate are not coming equal is coming 400 by 350 and as I told in other way also we can do by considering length and breadth equal that means square base plate that is also possible.

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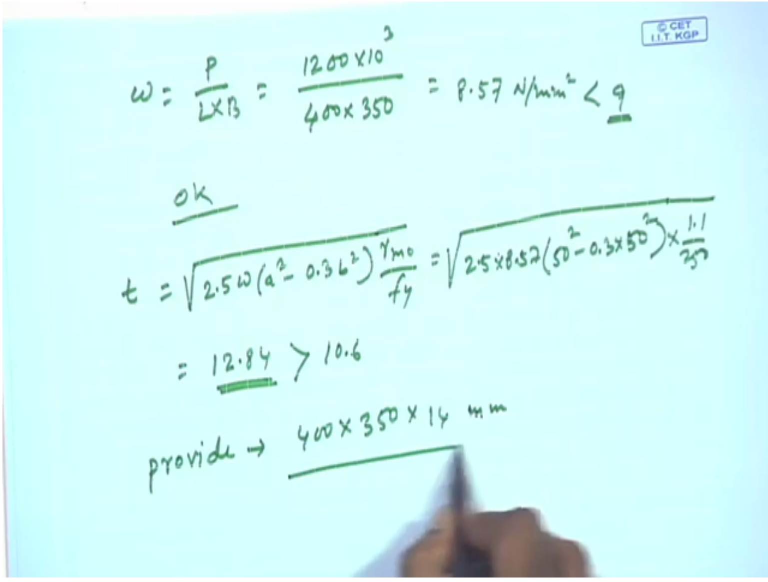

Now bearing pressure we can find out, so bearing pressure will be load by area so now we have provided the length and breadth of dbase plate which has been decided already. So based on that we can find out the bearing pressure of concrete that will be 1200 kilonewton is the load by area as 400 into 350 so we can find out the value as 8.57 newton per millimetre square which is less than 9 9 is the 0.45 fck the bearing strength of the concrete so it is okay, right so the size of the base plate that is length and breadth of the base plate is okay.

Now we have to find out the thickness thickness of base plate we can find out from this formula which is given in clause 7.4.3.1 that is 2.5 into w into a square minus 0.3 b square into gamma m0 by fy. So if we put this value we can find out 2.5 into w we got 8.57 a square minus 0.3 into b square, right into 1.1 by 250, right. So from this we can find out as 12.84 which is greater than the flange thickness of the compression member that is 10.6 so this is okay this 12.84 is okay. So we can provide a base plate size as 400 by 350 by say 14 mm, okay. So base plate size this is how we can decide that is 400 by 350 by 14.

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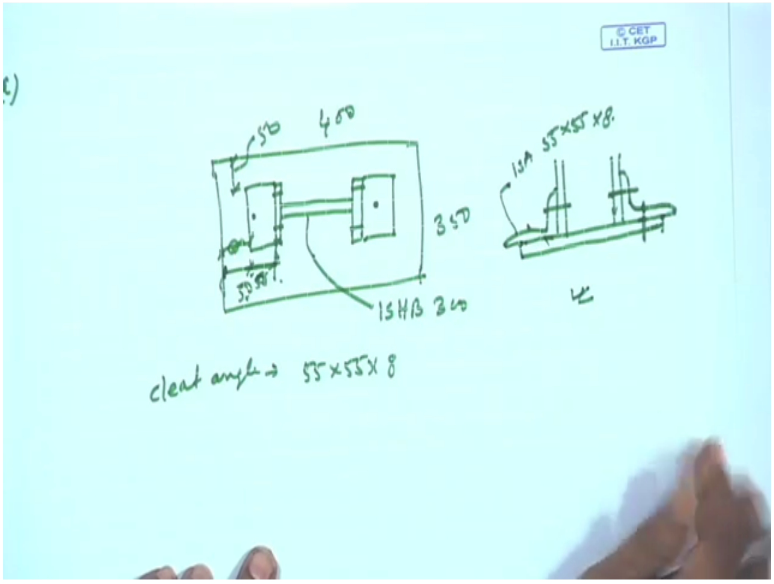

Now we will come to the two case, one is in case a that is load is transferred to the base plate by direct bearing. So if load is transferred to the base plate by direct bearing then we can provide a nominal size of the cleat angle. So if we see in the plan the design will be like this so this is I section and we have provided a nominal size of the cleat angle, right and nominal number of bolts also we can provide. So this is 350, this is 400 the base plate size, this is ISHB 300 the bolt and the size of the nominal size of the cleat angle cleat angle size we are considering say 55 by 55 by 8. So this is 55, right and this is how and this is becoming 50, this is becoming sorry, this is 50 and this is becoming 50 from here to here it is 50, okay.

So cleat angle I can see here, right so if I provide 55 so it will be little hanging position, so this is like this, right say ISA 55 by 55 by 8. So as there is no bending moment and it is completely machined for perfect bearing therefore we will not design the cleat angle against moment. So however to keep the column in position we are providing 2 cleat angles of this size, okay. So this is how one can design for case a.

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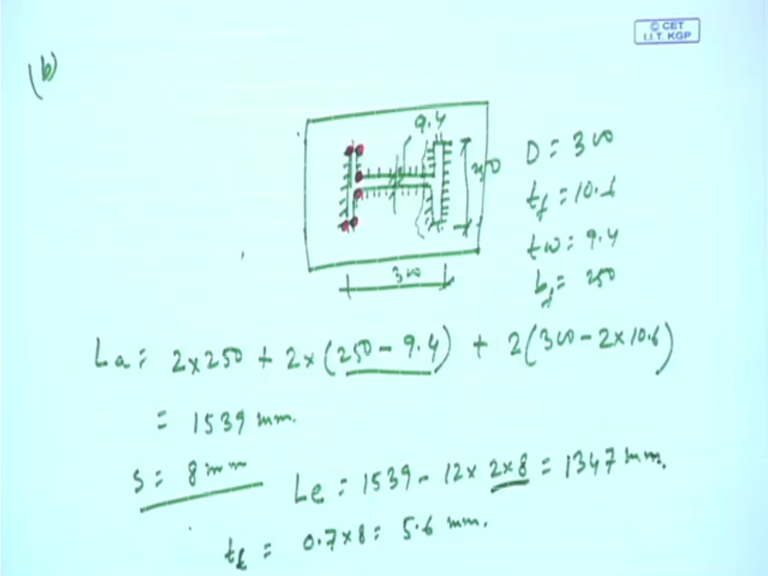

And for case b we have to design say for weld connection if we do as column end and base plate have not been machined for perfect bearing so the load from column will be transferred to the base plate through the weld connections. So if we see the weld connection so base plate is connected with the column so the weld connection throughout is periphery. Now I have to find out what is the total length available for welding and what is the required length to withstand that load, right.

So length available for welding around column profile we can find out because here D is equal to this is 300 and this is 250. So La will be 2 into 250 plus 2 tw that is 9.4 this is 9.4, right. So 250 minus 9.4 will be this distance plus the web web will be 2 into 300 minus 2 into flange thickness tf that is 10.6, okay because tf is 10.6 and tw is 9.4, right and bf is equal to 250.

So from this data we could see that available length is 1539 mm and if we provide say size of the weld let us provide say 8 mm and we will see whether this is sufficient or not. And here we could see that total end returns are 12 total end returns we are going to get 12, 4, 5, 6, 6 into 2 12. So if we have total end returns 12 then effective length of the weld say Le we can find out 1539 minus 12 into 2 into 8 because end return will be 2 into S, okay. So from this we can find out the total means sorry the effective length for the weld available is 1347 millimetre.

And here we can find out the throat thickness of the weld as 0.7 into 8 0.7S so that will be 5.6 mm so throat thickness is 5.6 mm.

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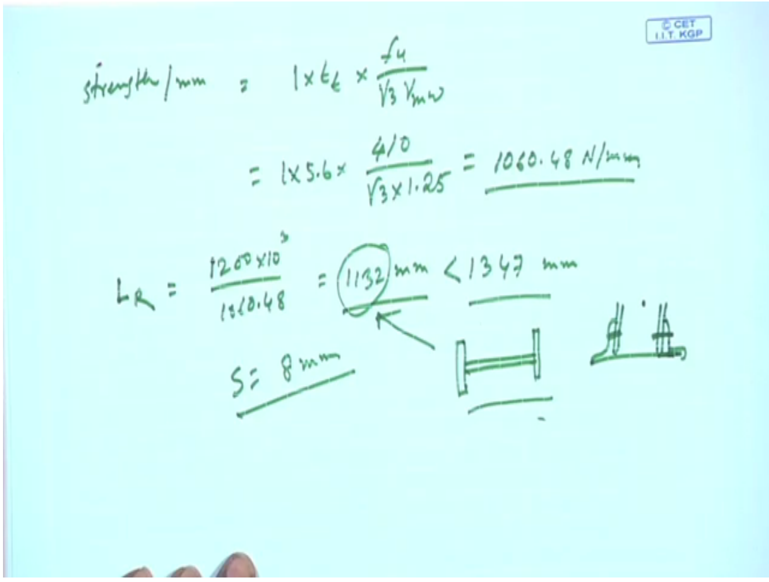

Now I can find out the strength of the weld so strength of the weld per millimetre length will be 1 into tt into fu by root 3 gamma mw. So 1 into tt is 5.6, fu is 410 root 3 and gamma mw we can assume as 1.25 for shop welding, okay and for field welding it will 1.5, so this is becoming 1060.48 newton per millimetre. So strength of weld per millimetre length is becoming this. So required length of weld length required means required length of weld will be load by strength of weld 1200 into 10 cube by 1060.48 so required length is 1132 mm. And effective length available is 1347 millimetre, so it is okay.

Because if we use 8 mm size of the weld then the required length is 1132 mm and we have available length 1347 millimetre so this is okay that means the size of the weld is okay. So what we can do means the what design we can do that the size of the weld we can provide 8 mm and of 1132 mm length. So length will be provided evenly means this length of weld will be distributed evenly of 1132 mm, okay.

So since the base is subjected to only axial compressive load and there is no moment so it will not be subjected to any tension in any parts of its any of its parts so we can provide two number of 20 diameter bolt to keep that base in position that means the similar way we can put two number of bolts to keep in position, right two number of bolts 20 diameter bolts we can keep so this is how second case can be designed, okay.

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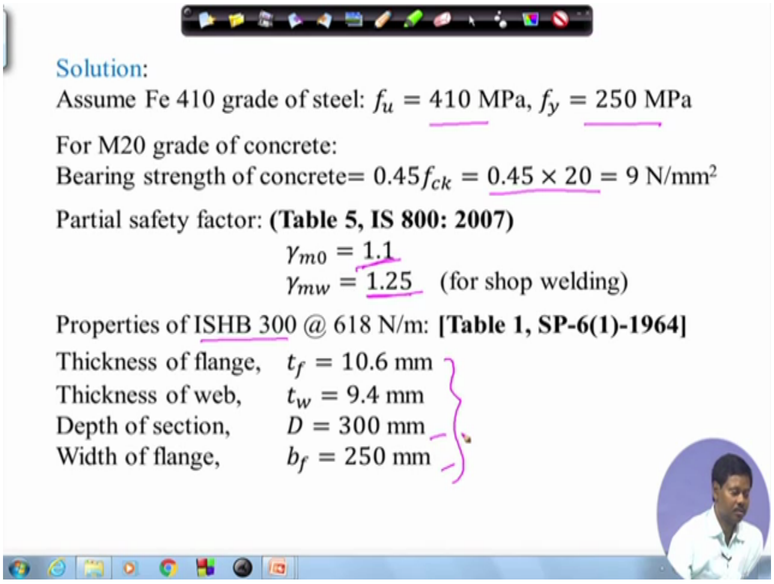

So coming to the power point presentation what we have discussed I will just go through the presentation the same thing so that it will be clear to us. So if we see that for the Fe410 grade steel Fe was considered as 410, fy was 250 and the bearing strength of concrete we have considered as 0.45 into fck that is 9 mm 9 newton per millimetre square. And partial safety factor for shop welding we have considered shop welding gamma mw as 1.25 and gamma m0 is 1.1.

And properties of ISHB 300 can be obtained these four properties are required four dimensions that is thickness of flange and thickness of web as well as the depth of section and width of flange. So these properties will be useful, right.

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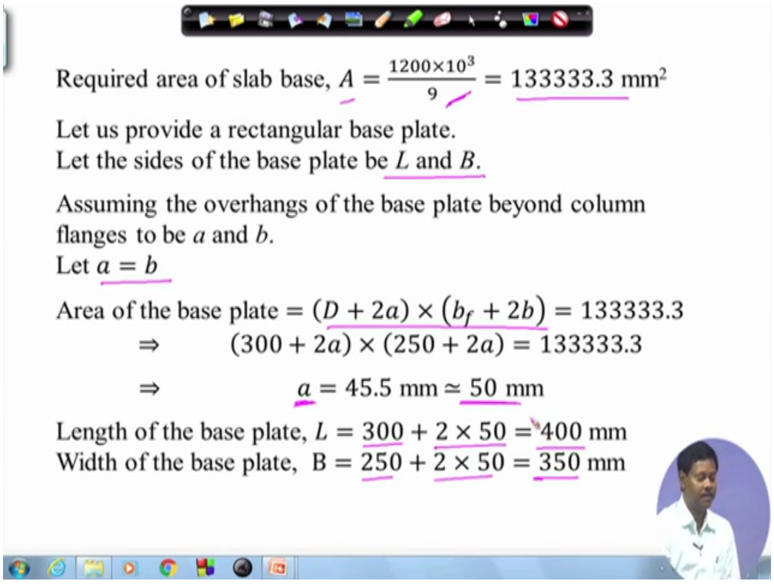

After that we will find out the area of the slab base that is A is equal to P by 0.45 fck, so the required area of slab base can be found and if we provide a rectangular base then say side of the base be L and B and if we assume the overhang of the base plate beyond the column equal that means a and b are equal then the area of the base plate we can make equal with this to find out the overhang position of a.

So to equate D plus 2a into bf plus 2b as this we can finally find out the overhang length a and overhang length a we are going to provide 45, right. So length of base plate will become finally D plus 2a and width will be bf plus 2b so 400 by (35) 350 length of base plate has been provided sorry length and width of the base plate has been provided.

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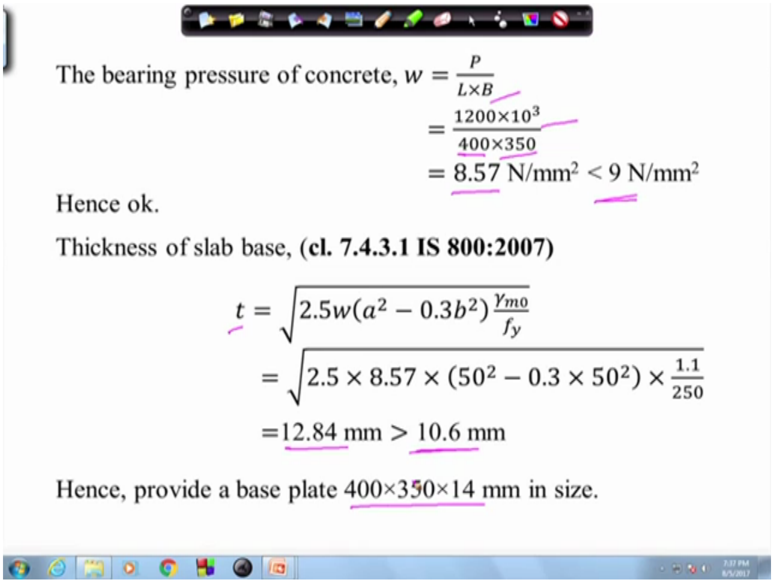

Then the bearing pressure of concrete we can find out that is w is equal to P by LB, so P is 1200 kilonewton and length is 400, width is 350 so the bearing pressure of concrete we can find out 8.57 which is less than 9 9 is the bearing strength of the concrete that is 0.45 fck. And then we can find out t that is thickness and that will be is coming 12.84 which is greater than the tf thickness of flange as 10.6, so we can provide a base plate of 400 by 350 by 14 mm size, okay.

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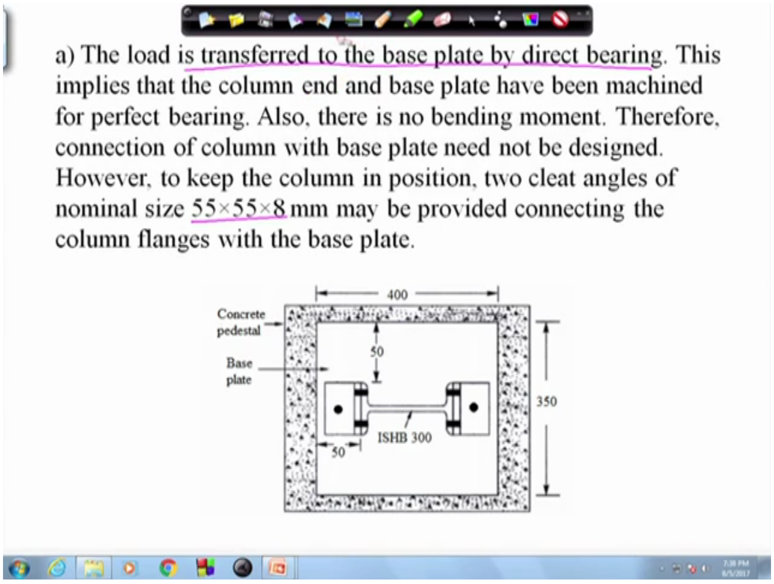

So once we find out the size of base plate now we will connect the base plate with the column. So there are two cases one will be load when it is transferred to the base plate by direct bearing so in this case as there is no moment so we can provide a nominal number of bolts and a nominal size of the cleat angle, so here we are providing nominal size of the cleat angle as 55 by 55 by 8 and two numbers of bolt of 20 mm diameter, right.

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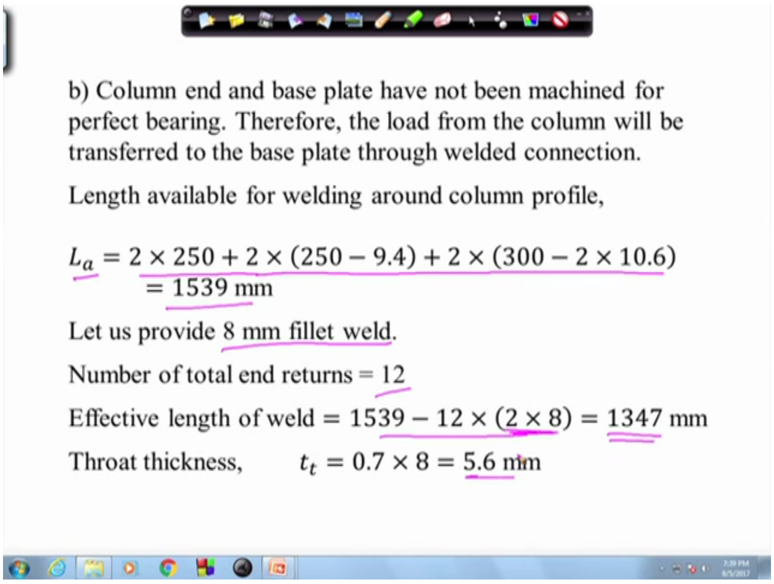

So in similarly in case of b where the column end and base plate have not been machined for perfect bearing there we have to design the connection due to the concentrate load. So for designing that we will see what is the available length, so available length we have calculated along the periphery of the column section which is coming 1539 millimetre and if we use 8 mm size of the fillet then we can see that effective length of the weld is reduced to this because of the end return because we have 12 end return and end return length will be 2S 2 into size of the weld so we can find out finally the available effective length of the weld is 1347 mm. And the throat thickness of the weld is 0.7S that is 5.6 mm.

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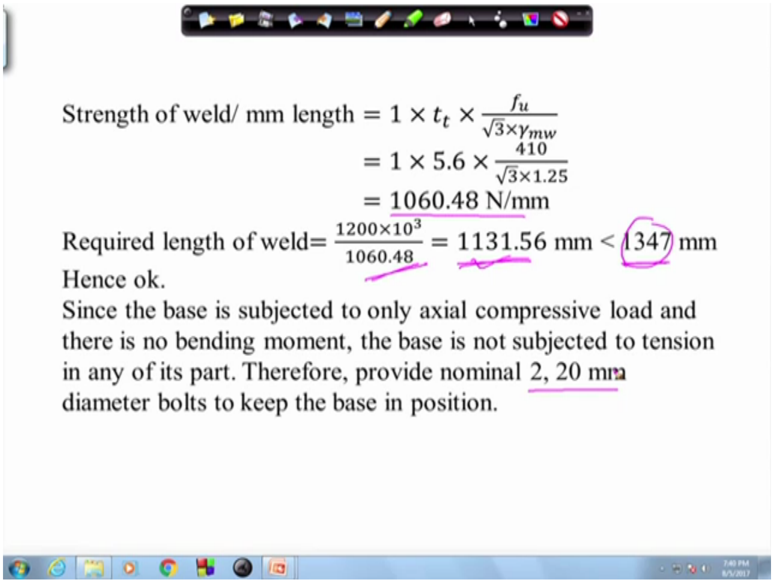

And on the basis of that we can find out the strength of weld per millimetre length as this, right that is length strength per millimetre length that is 1 into tt into fu by root 3 gamma mw. So after putting this value we can find out the strength as 1060.48 newton per millimetre and required length of weld will be so the required length of weld will be this P by strength load by strength so required length is this and available effective length is this, so it is okay, right.

And if we see the available length is less than this then what we could do then in that case we have to increase the size of the weld so that the length of weld can be kept less, right. So in this way we can find out the required length of weld and we can distribute the length of weld evenly throughout its periphery and fulfilling this total required length of weld. And as the base is only subjected to axial compression so so we can provide the nominal 2 number of 20 mm diameter bolt to keep the base in position because here there is no tension as there is no bending moment in the member. So this is how for two cases we can design the base plate in this fashion, okay.

So in this example what we could see that if a concentric load is applied on the column then how to design the base plate that we have seen. In next lecture we will see when the column is under eccentrical load. So for eccentric load how the base plate will be designed that will be discussed in the next class, okay. So I think for your attention for this class, thank you.