**Course on Design of Steel Structures**
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**Lecture 59**
**Module 12**
**Slab Base**

Today I am going to discuss a new module which is column base, in case of RCC structure we use to tell this as a footing or foundation and in case of steel structure we will say this as a column base that means column is placed on certain base through which the load from super structure is going to transferred to the soil through this sub structure. So column base is basically consisting of column and base plate and an (())(0:50) assembly.

So this column base are two types one is called slab base and other is called gusset base. So in case of slab base we generally when the load is coming concentrically and magnitude of load is comparatively less in such cases generally we use this slab base and in case of gusset base the load is generally eccentric in nature and magnitude of load is high comparatively higher so for such cases we generally prefer gusset base. So today we will discuss the first lecture about the slab base.

Now in the column base the main function of the column base as I told is to transfer the loads from column to its foundation and for that we need a spreading area through which the concentrated load from the column will be spreaded to the soil through some medium which is called base plate that means column base will be column will be rested on the base plate so the concentrated load coming from the column will be distributed over the base plate and then base plate again will be rested on the concrete block that concrete block will be again rested on the soil. So stage by stage the load will be distributed from super structure to the soil, right.

And the slab base is basically consist of a thick plate of steel material and this thick plate is connected with the column through some angle which is called cleat angle and that connections are made either by bolt or by weld connections. And slab base as I told the basically used for means it will be suitable for light loaded column only and it will be economical if we use for light loaded column and that base plate will be either welded to the stanchion or will be joint to the column through cleat angle, right.

And design of column base plate requires consideration of bearing pressure on the supporting material and bending of the plate.

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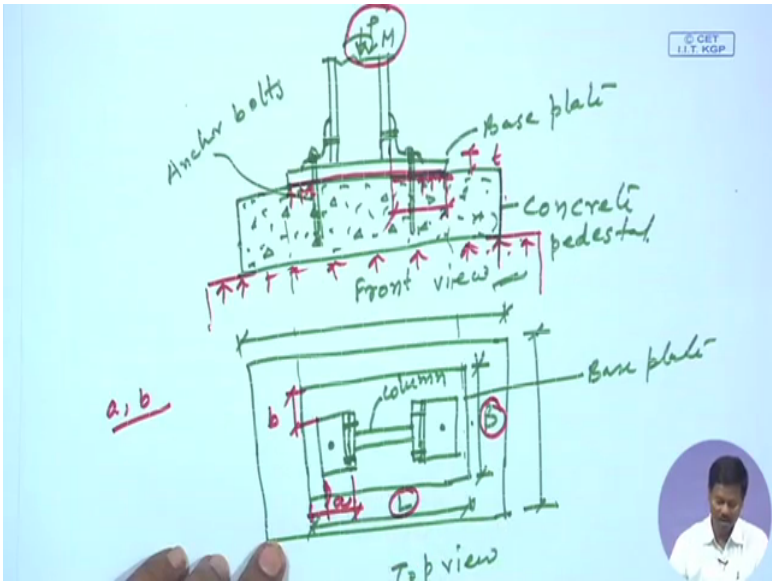


Now let us see the general assembly of the column base means the slab base so say for example in this say a I section is transferring load from the super structure say it may transfer load concentric load and also it may provide some means it may transfer some moment as well and then we provide a base plate of steel material so this is called base plate and this base plate is connected with the column with cleat angle, okay. So if it is concentrically loaded then the minimum number of cleat angles are provided sorry minimum number of bolts are provided to connect the cleat angle with the column otherwise we have to design and here we provide anchor bolts, okay.

Now after means below the base plate the load is again spreaded to the concrete concrete base this is called concrete pedestal. So load coming from base plate is again transferred to the concrete pedestal this is concrete pedestal, right so different grade of concrete may be used depending on the magnitude of load and requirement of the thickness and requirement of the dimension of the block and dimension of the plate so this is we can say this is front view means front view of the slab base if we see it will look like this and this anchor bolt will be provided to connect the base plate with the concrete pedestal this is called anchor block.

So anchor bolts also will be designed as per the requirement and if we see the same in top view it will look like this say this is called width of the pedestal and this is the length of the pedestal, right and if we see the plan of the base plate the base plate will be like this so this is

base plate and this is width of the base plate and this is length of the base plate, right. Then the column is provided say for example this I section columns its top view will be looking like this and column is connected with the cleat angle, right.

So we can provide nominal number of cleat angle bolt which will connect the cleat angle with the column, right so this is column and this this is top view. So this is the top view of the slab base slab base system and this is the front view of the slab base system. So what we need to design is one is what will be the size of the base plate that means length, width and thickness, right.

So length of the base plate we have to know and that can be found length and width can be found from the grade of concrete means how much area we need to have of the base plate so that the area can be transferred to the the concrete pedestal without any failure means sufficiently it should have so that the load is transferred from column to the concrete pedestal again the dimension of the concrete pedestal depends on the soil soil properties so we need to know the bearing pressure of the soil so according to that we have to find out what will be the length and width of the concrete pedestal required, so that the load is distributed and transferred to the soil properly, right.

So this is how the system are made and in this way we have to means design the base plate due to this concentric load and moment and this moment we can see that because of this uniform pressure from the concrete to the base plate. So here also uniform pressure will come from the concrete to the base plate because of the concentric load so the maximum bending moment will be occurring at the phase of the at the edge of the column. So the edge maximum bending moment will occur, so we need to know what will be the projection in both the direction say in plan we can see the projection from this direction it is say we can say b and projection in this end will be sorry this end will be say a, okay.

So a and b are the projection in both the axis and because of this projection the bending stress will develop bending moment will be developed at the edge and we have to calculate the bending stress and then we have to find out its influence so that we can find out the thickness of the plate accordingly.

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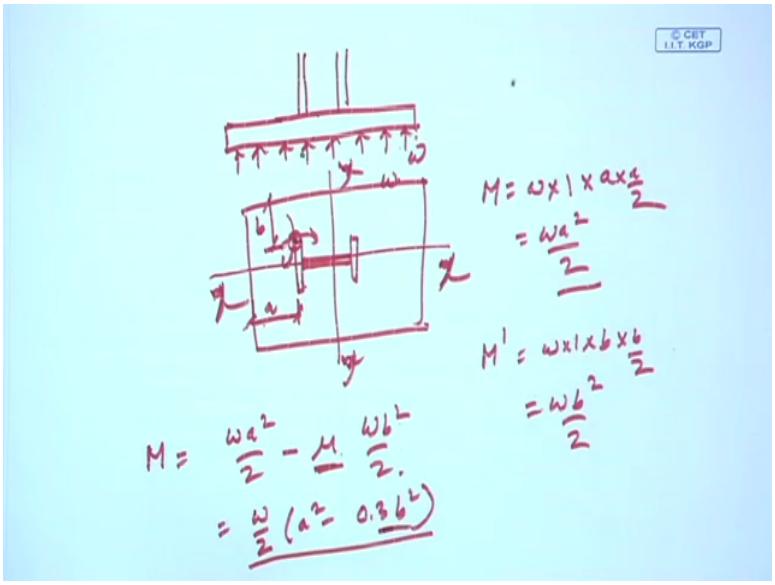


So to find out the thickness of the plate what we can do we can find out what is the bending moment coming so if we see the column is rested on the base plate and the base plate is having uniformly distributed load coming from the concrete say this is w, right and at top view if we see the column is something like this so projection means the base plate is like this so the projection will be this is a and this is b. So bending moment maximum bending moment along x axis will be maximum bending moment along x axis we can consider the w w is the length means sorry w is the unit pressure from the concrete, okay w.

So bending moment we can find out w into per unit length we can find out w into 1 into a into a by 2, okay. So w a square by 2 along x axis, so if we consider this is x and this is y so along x axis we can consider that bending moment is coming sorry this is a so w a square along x axis we can consider this, along y axis we can consider this, so w a square by 2 and in the other direction we can consider say M dash is equal to w into 1 into b into b by 2, so w b square by 2.

So the maximum bending moment at this point, at this point about two directions I can find out. So the effective moment we can find out in one direction that will be so effective moment I can find out as w a square by 2 minus Mu into w b square by 2 where Mu is the percent ratio. And for steel we can consider Mu as 0.3, so I can consider w by 2 into a square minus 0.3 b square. So maximum effective bending moment can be found as w by 2 into a square minus 0.3 b square where a is the longer projection and b is the shorter projection, okay.

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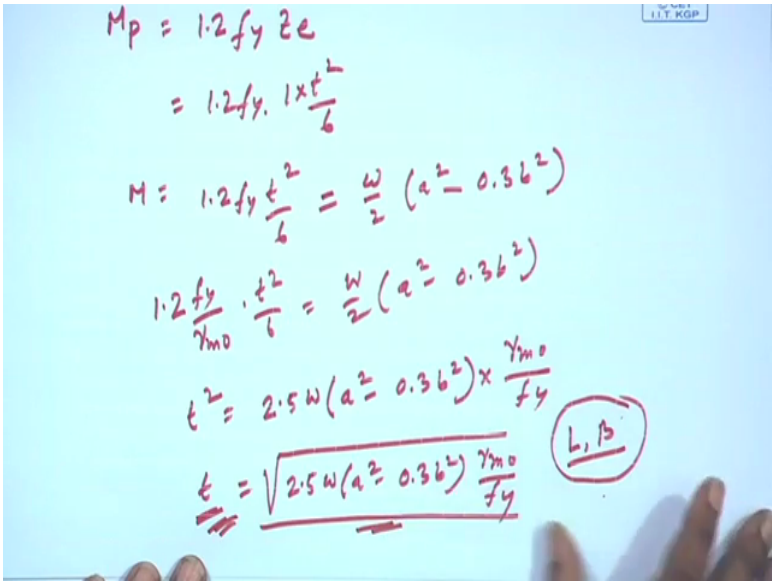


Now the moment capacity of the plate I can find out say plastic moment capacity Mp will be 1.2 fy into Ze, right. So where Ze is the elastic section modulus of the base plate so we can find out Ze as as 1 into t square by 6 for unit length Z will be bt square by 6 so b is 1 here so we can find out Mp as 1.2 fy into t square by 6, right. So now if we make equal to the load due to means moment due to the pressure than I can find out 1.2 fy t square by 6 is equal to w by 2 into a square minus 0.3 b square.

Now we have to multiply the partial safety factor so taking the partial safety factor into consideration we can consider 1.2 fy by gamma m0 and into t square by 6 is equal to w by 2 into a square minus 0.3 b square. So from this I can find out t square as 2.5 w into a square minus 0.3 b square into gamma m0 by fy or the thickness of the base plate can be found from this finally 2.5 w into a square minus 0.3 b square into gamma m0 by fy, right.

So this thickness of the base plate also is available in the code. So this formula you can find out in the IS: 800-2007 where it has been told that t is equal to square root of 2.5 into w into a square minus 0.3 b square into gamma m0 by fy. So this is how we can find out first length and width of the base plate from the pressure requirement of pressure means what is the load total load from that I can find out what is the bearing pressure of the concrete also we can find out. So load divided by bearing pressure is equal to area, so from that I can find out the length and width and also I can find out the thickness from this. So this is how we can find out the dimension of the base plate, right.

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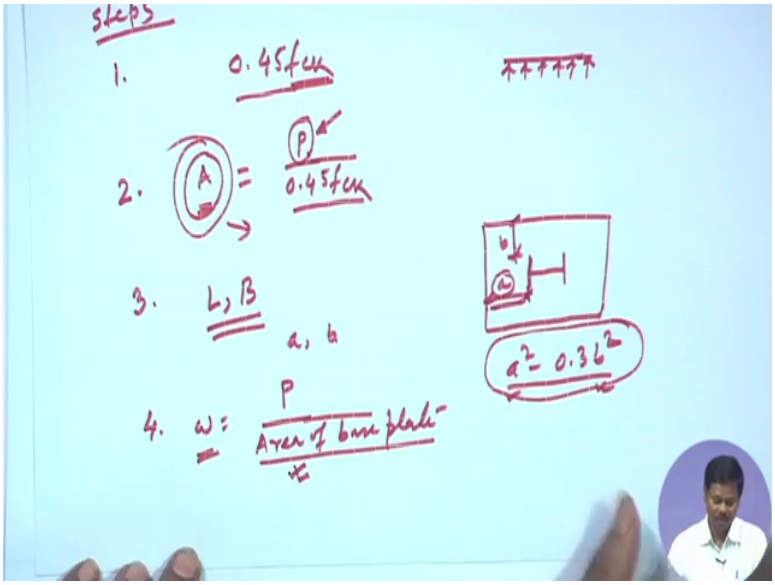


Now we will find out some certain steps we will see what are the steps required to design a base plate, okay. So if we see the steps first what we can see we can assume suitable grade of concrete means what grade of concrete is going to be consider that we will assume, okay and we are assuming that the pressure is distributed uniformly, okay because of load the pressure from the concrete is coming uniform, okay at the bottom of the plate.

So and also as per the assumptions of the grade of concrete we can find out the bearing strength of the concrete bearing strength of the concrete will be 0.45 fck. So if we assume the grade of concrete then we can find out the bearing strength of concrete. So from this what we can do in step 2 we can find out the area of the base plate so area of the base plate we can find out the total load P by 0.45 fck, right because 0.45 fck is the bearing strength and P is the total concentrated load on the column.

So the base plate area we can find out from this, okay and remember this P is the factored axial load. So we have to multiply with factored and we have to find out the P value. Now after getting the required area we can find out the size of the base plate size of the base plate means what will be the L and B either we can provide here a square base plate, right or we can provide with certain length and breadth ratio, okay and for economy as far as possible we need to keep the projection A and B equal why if we see suppose this is a base plate.

Now if this is the column then the projection A and B if it is different than the along the larger direction along the larger projection the maximum moment will occur, right. So moment will be more along the larger projection. However if we consider projection equal then what we

can find out then projection will be little less we can make and also as we know a square minus 0.3 b square the moment the thickness when we are going to find out that there are term a square minus 0.3 b square. So if if we try to keep A and B as much as equal then it will become minimum, okay. So to make economy we will try to keep the projection length A and B as much as possible equal, right.

Then in step 4 what we can find out we can find out the intensity of pressure w actual intensity of pressure w that is P by area of the base plate area of base plate. So this area of base plate is different from this because this is the required area and this we are going to provide which will be little higher and this we are providing with consideration certain length and breadth of base plate, right. So from that we can find out the intensity of pressure from the concrete pedestal.

So after step 4 we can find out that means in step 4 what we gets is we could find out the intensity of pressure on the basis of assumed value of L and B. So L and B is determined.

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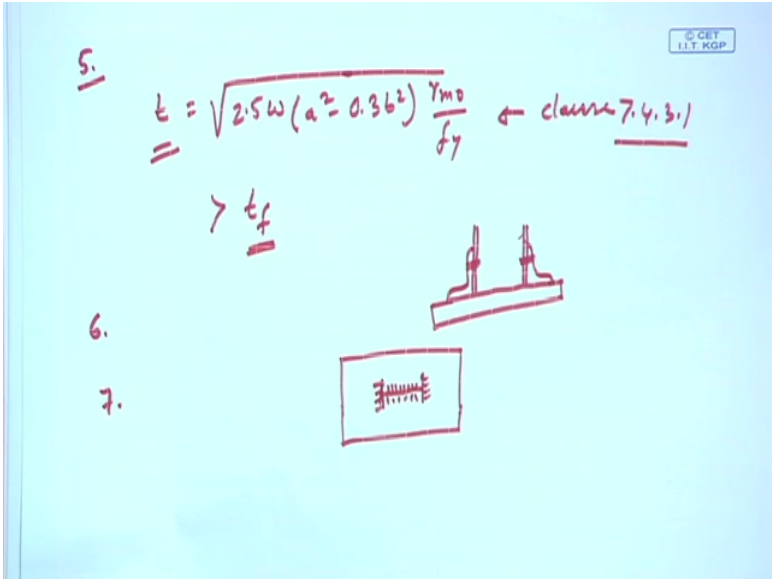


Now in step 5 we can find out the thickness minimum thickness required, so minimum thickness will be found from the formula what we have derived earlier that is 2.5 w a square minus 0.3 b square, right into gamma m0 by fy, right. So minimum thickness required on the base plate can be found from this formula which is given in clause 7.4.3.1 of IS: 800-2007, so in clause 7.4.3.1 the minimum thickness of the base plate is found and it has to be greater than thickness of the flange of the compression member.

So the thickness of the base plate atleast has to be greater than the thickness of flange of the compression member that also we need to check, right.

Then in step 6 what we can do we can provide 2 to 4 nominal bolt to for holding down the cleat angles. So what we can do so the column is rested upon the base plate, now we will provide a cleat angle in case of concreted force the nominal angle size will be provided and to hold that we will provide nominal number of bolts that is 2 to 4 of 20 mm diameter bolt, okay.

And if we provide the weld then in step 7 we can find out the weld length connecting to the base plate with the column that weld length means the we will see say for example if the column is connected with the base plate then we will find out what is the weld length available weld length and what will be the required weld length so from that we can find out the size of the weld length weld and the other things, right. So this is how one can find out the detail of the base plate, right.

So in short if we see what what we could see here is that the load from the super structure is coming to the soil through the sub structure which is made of base plate and the concrete pedestal, right. Now concrete pedestal will be decided the dimension of the concrete pedestal will be decided on the basis of the soil bearing pressure. Similarly the length and breadth of the base plate will be decided on the basis of bearing strength of the concrete. So what grade of concrete we are going to provide depending on that we will find out the length and breadth of base plate.

So once we find the length and breadth of base plate then we can find the thickness of the base plate and thickness of the base plate can be found on the basis of the moment and that moment has been calculated from the maximum means from the projection. So we will see what are the projection is there and at the column phase what is the maximum moment is going to develop on that basis we will find out the minimum thickness of the base plate required and that expression also is available in the code in 7.4.3.1 clause we can find out that formula, okay.

So once we find out the thickness of the base plate so dimension of the base plate is decided, dimension of the base plate means length, width and thickness after that we will provide for concentrated load we will provide the nominal number of bolts to hold the column in position with the base plate through the cleat angle and cleat angle size also will be nominal and then

through anchor bolt also we will we will fix the base plate with the concrete, right. So this is how step by step one can design a base plate. So in next day we will go through one example to see how the base plate is designed, thank you.