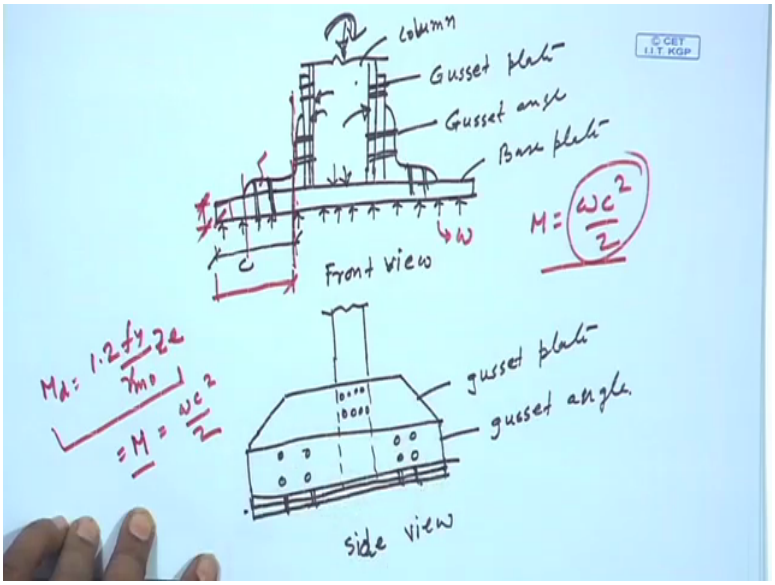
**Course on Design of Steel Structures**
**Professor Damodar Maity**
**Department of Civil Engineering**
**Indian Institute of Technology Kharagpur**
**Lecture 62**
**Module 12**
**Gusset Base**

Today our lecture will focus on gusset base. So in last few lectures we have discussed about the column base. Now in case of gusset base the column is connected to the base plate through the gusset plate. So here the load will be transferred from column to base plate not only directly through bearing but also through the gusset plate, so the load is going to be distributed to the base plate through bearing and through gusset plate and this gusset base is used when load is heavy that means the compressive load which are coming into the column is heavy magnitude or if the moment is acting on the column then if we use gusset base it will be suitable.

(Refer Slide Time: 1:22)




So it will be clear to us if we go through one diagram of the gusset base then we will be able to know how it is connected and as I told the load is transferred to the base plate partly through bearing and partly through the gusset plate. So if this is a column which are resting on the base plate now in case of slab base what we did we are resting the column directly to the base plate.

So here what we are doing we are providing additional gusset plate on the column and this gusset plate is again connected with the gusset angle, this gusset plate is connected with the gusset angle. So the load whatever is coming whether it is load, or moment, or both are transferred to the base plate through gusset plate and through bearing, okay. So in both the ways it is transferring the load and if we see here the because of the gusset and stiffness bear the base slab against bending therefore a thinner base plate can be provided means base plate thickness should be comparatively thin.

And this is the column, this is gusset plate and this is base plate and base plate is undergoing the pressure coming from the concrete pedestal because of the reaction and this is gusset angle. Now again this gusset angle is also connected to the column by the use of bolt, so here we can provide certain number of bolts and here you see the height of the gusset plate should be sufficient to take care the number of bolts because here number of bolts should be used because of the load is used the concentrate load when it becomes use then only we use this type of gusset base. So this is the front view.

And the critical section at which the maximum moment will develop is this the maximum overhang portion, so this we can say C the maximum overhang portion, right. So now this column may face for complete bearing or may face for incomplete bearing. If it is facing complete bearing then generally 50 percent of the load are transferred to the base plate directly and 50 percent load are transferred through the gusset plate and if it is not complete bearing then we assume that whole load is transferred through the gusset plate. So this is how we are going to design.

Now if we see the side view then again if we see the side view we can see how the gusset plates are connected say this is the gusset plate and this is gusset angle, then gusset angle arm thickness, then base plate, right. So here if we see that we are basically seeing the side view so bolt will be connected here with the angle in both the side and also bolt will be connected to the gusset plate which is connected here this is the bolt which is connected say here if we provide two number of bolts then two number of bolts are showing here, right and here also we can provide some number of bolts.

Say if we provide two rows then at each flange in this case we are providing 8 number of bolts in each flange, this is gusset plate and this is gusset angle, right. So basic objective of providing gusset plate is to carry the load from the column to the base plate through this

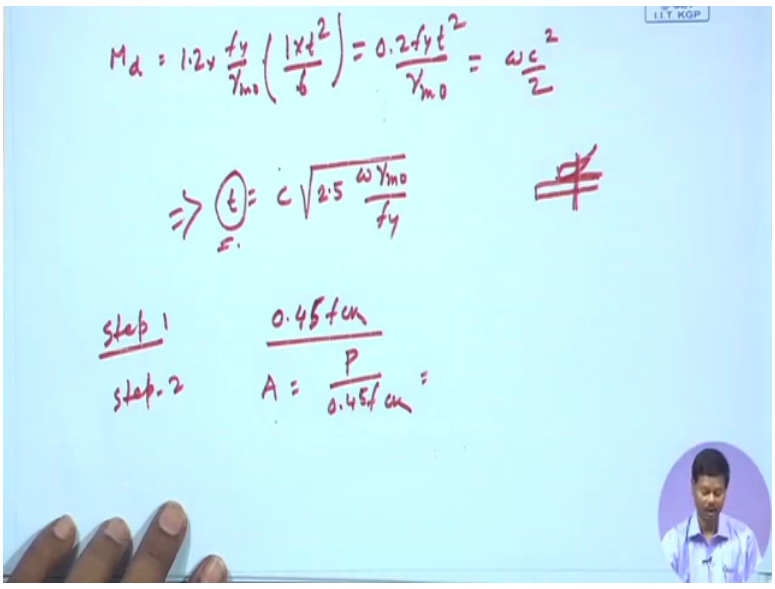
gusset plate that means the load is going to disperse not only through the bearing of the system but also through the gusset plate we are providing certain amount of load.

So here if we see this moment the maximum moment whatever coming will be calculated in this position and the thickness of the base plate can be found from the flexural strength of the base plate. So maximum moment will be M is equal to say if W is the pressure coming from the concrete pedestal to the base plate then W into C square by 2, this is W okay. So maximum moment developed will be W into C square by 2, because this will be the critical section at which the chances of failure will be there.

Now here another thing we have to remember that upto this portion the thickness is becoming the thickness of base plate plus thickness of the angle the gusset angle so it is adding, right. So basically when we are going to provide the gusset plate then the thickness of base plate is going to be reduced, so thickness of base plate will be comparatively less for such type of arrangement.

And if here as moment is less so this much thickness will be able to carry the that much moment developed. So now we have to see what is the moment developing, so moment carrying capacity of the of this of the critical section means in this critical section we have to find out what is the bending strength, so bending strength we know Md is equal to 1.2 fy by gamma m0 into Ze. So Md will be made equal to (Me) M whatever we are getting as WC square by 2. So from this we can find out the thickness of the gusset plate.

(Refer Slide Time: 9:35)



So to divide the thickness of the gusset plate we can find out say Md as we found as 1.2 fy by gamma m0 into Ze, Ze means basically so for unit length if we take 1 into t square by 6 Bd square by 6, so 1 into t square by 6 this is a Md which we are going to calculate as 0.2 fy t square by gamma m0, right and this we will make equal to WC square by 2. So from this we can derive t as C root over 2.5 W gamma m0 by fy, right.

So what is t, t is the thickness of the base plate plus the gusset angle that means the summation of thickness of the base plate and the gusset angle sorry the gusset angle whatever it is, right so this will be the thickness. So base plate thickness will be total thickness whatever we are getting minus the gusset angle thickness then we can find out the base plate thickness.

However this is true if we are going to provide gusset angle and gusset angle we provide generally when it is bolted connections but for welded connections we do not need to provide gusset angle. Therefore the thickness of the base plate will be the requirement of the base plate that means whatever t we are going to get that will be the thickness of the base plate we do not have to do anything extra, right.

Now we will go for the design of the gusset base, so step by step we will try to find out how to design a gusset base. So designing a gusset base means we have to design the base plate base plate means the dimension of the bases which includes thickness, length and breadth and once it is decided then we have to decide what will be the number of bolts required to the required for the connection of the gusset plate with the column sections this is one we will do.

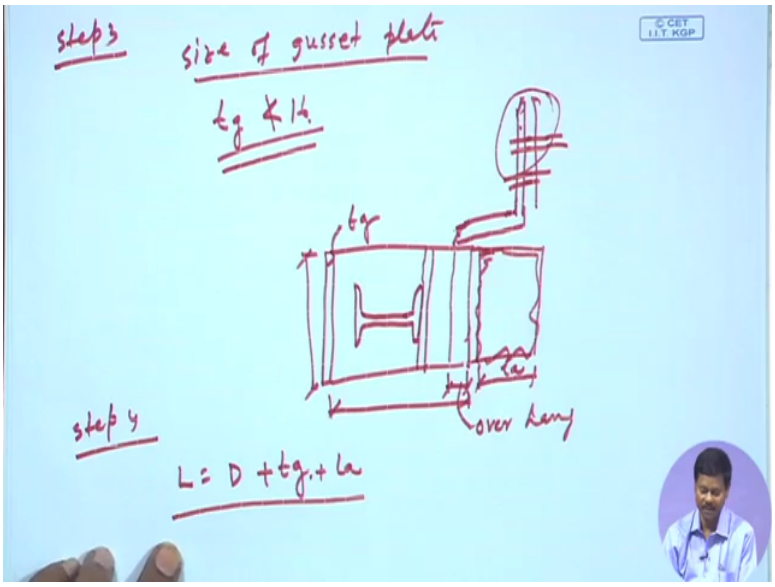
Another thing is that when we are going to provide a gusset plate we have to know what will be the plate thickness, what will be the gusset plate thickness and what should be the gusset plate size that means length and width. So these are the few things which we need to know. So in the steps when we are going to discuss we will try to address all this issue that that is dimension of the base plate length, breadth and thickness. Then dimension of the gusset plate length, breadth and thickness. Then the gusset angle its dimension and the number of bolts required for connecting the system or the weld length for connecting the systems, so these are the things. So step by step we will try to find out.

So in first step what we will do in first step we will try to find out the dimension of the base plate dimension of the base plate means what will be the length and width then thickness. So length and width if we need to know first we need to know what is the bearing strength of the

concrete because base plate is rested on the concrete pedestal, so first we have to know what is the grade of concrete and what is the bearing strength so if we know the bearing strength then we can find out the area required for the base plate.

So in first step what we will do we will find out a suitable grade of concrete then we will find out the bearing strength as 0.45 fck, right. So in first step we are going to find out this 0.45 fck as a bearing strength. Then we will find out the area in step 2 what we will do we will find out the area required area will be how much area will be P the axial force divide by 0.45 fck, right now here P is the factored load on the column.

(Refer Slide Time: 14:14)




So now we will go to step 3, so in step 3 what we will do we will try to find out so in step 2 what we find the required area. Now in step 3 we will try to find out the size of the gusset plate size of the gusset plate that means its length, width and thickness and thickness of the gusset plate generally should not be less than 16 mm, okay. So atleast we have to consider minimum thickness as 16 mm, this is what we can start with and then we can see whether this thickness is sufficient enough to carry that load or not so first we will do this.

Then we will choose a certain gusset angle, right and gusset angle dimension should be chosen in such a way that in the vertical direction the length of the gusset angle should be sufficient to carry the number of bolts, right because it will be connected with the gusset plate and the column so the the dimension of the angle should be sufficient so that so that it can withstand the certain number of means it can accommodate the certain number of bolt and

that number of bolt will be calculated from the from the total load, right so that will come means it will be clear to us when we will go through one example.

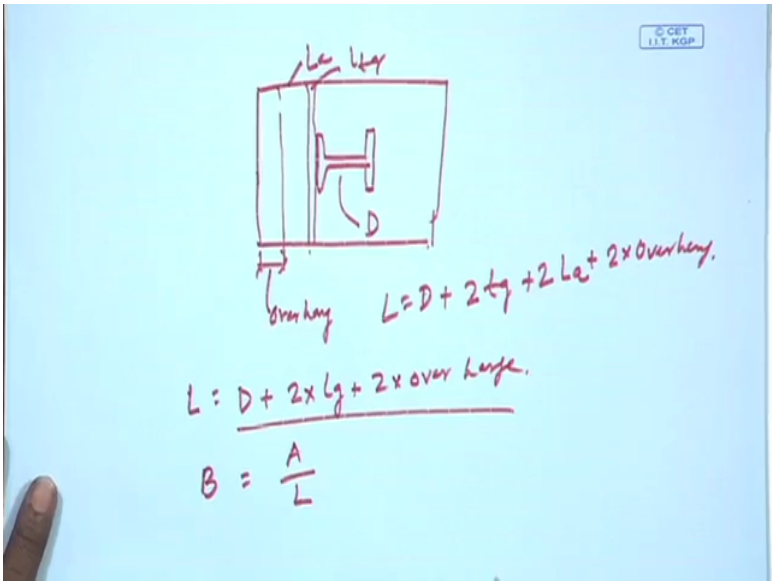
So so for finding out the size of gusset plate what we do first we will decide a thickness of the gusset plate which should not be less than 16 mm, then we will suggest some certain size of the angle gusset angle and also we have to see that gusset angle should be unequal section because the longer section has to be accommodated vertically therefore we unnecessarily we will not take the equal section we will take unequal section where the shorter section will be horizontally placed and in that way we can economized the material.

Then the thickness of the gusset angle and thickness of the gusset angle should be kept approximately equal to the gusset plate, right thickness of the gusset angle we should keep approximately as to the thickness of the gusset plate. And the length of gusset material generally we keep equal to the length of base plate parallel to the flange that means if the column is placed like this then in plan if we see that this is the length of the gusset plate so sorry length of the base plate.

So length of the gusset plate also we will keep equal to the length of the base plate, right. And for welded connection we do not need to provide any cleat angle or gusset angle that is not required because we will directly connect the things. Then we will come to step 4, so in step 4 again we have to find out the dimension of the base plate parallel to the web, okay dimension of the base plate parallel to the web that means this dimension, so what will be the base plate dimension base plate dimension we can find out say length is equal to depth of section say if this is the depth of section then depth of section we will consider plus thickness of the gusset plate if this is thickness of gusset plate tg then tg then so twice into thickness of the gusset plate because in two side gusset plate should be provided.

Then length length of the angle, then we have provided certain angle horizontally its length we know so that length say la, so la leg length of the angle and then sorry if we start from here this is the gusset plate and then leg length and then this is the overhang portion overhang portion, right. So this is how we will find out the length of the gusset plate.

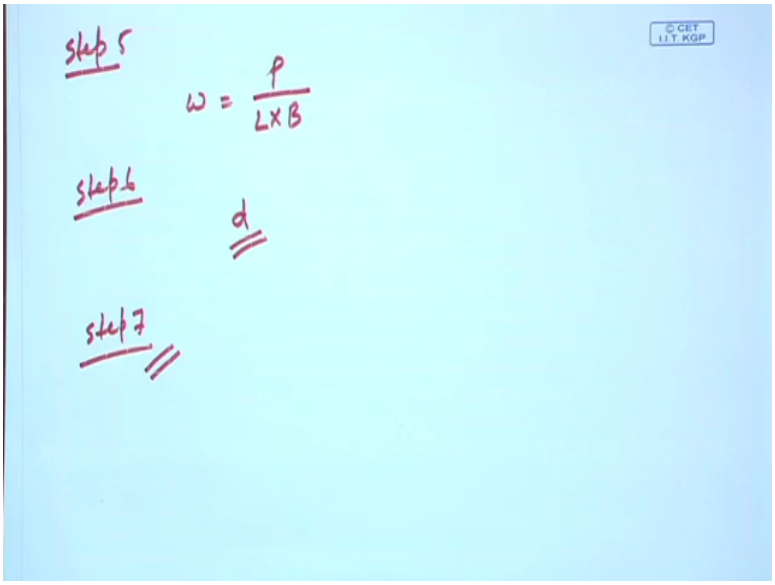
(Refer Slide Time: 19:26)




So again I am showing in a different figure so that it will be clear length of the gusset plate, say suppose length of the gusset plate is this which will be decided based on the depth of the depth of the column, then the gusset plate thickness, then the angle length, then the overhang this is overhang, this is horizontal length of the angle section and this is thickness of the gusset plate and this is D, right. So D plus 2 into thickness of gusset plate plus 2 into length of the horizontal leg plus overhang portion 2 into overhang portion overhang so this will be length.

And for welded section total length will be welded section there will be no gusset angle, so this will be total depth plus 2 into thickness of the gusset plate plus 2 into overhang, right. So this is how the length will be decided. So once length is decided we can find out the dimension of the base plate that is B so B I can find out say total area we know area by length so this is how we can find out the B also thus we could find out the length and width of the base plate.

(Refer Slide Time: 21:16)

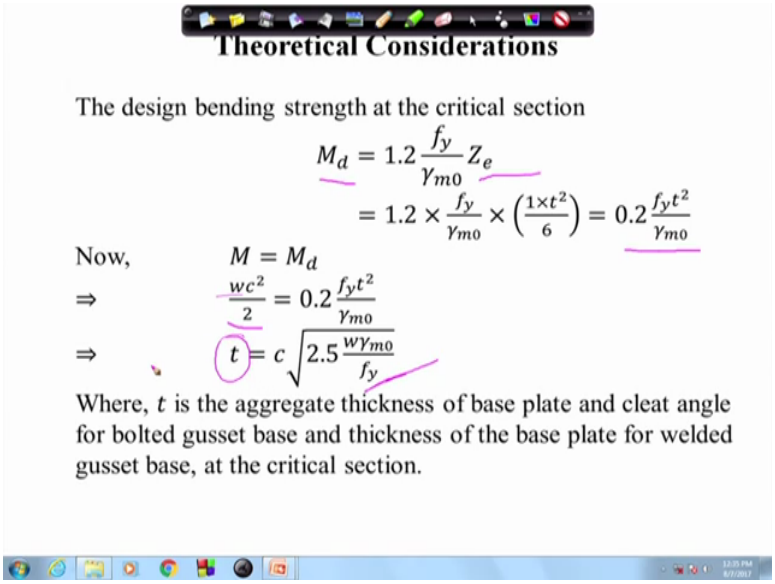



So now we have to find out the thickness of the base plate, right. So for thickness of the base plate we will calculate the intensity of pressure. So in step 5 what we will calculate that is the intensity of the pressure coming from the concrete to the base plate that is the total load divided by the area of base plate area of base plate is L into B so intensity of the pressure is found.

Now in step 6 we can find out the thickness of the base plate and thickness of the base plate we can find out from the formula which was given or we can calculate what is the critical section what is the total moment and then by equating we can find out the depth of the critical section, right and depth of the critical section will be the total depth which includes depth of the base plate and depth of the the horizontal angle thickness, right. So if the bolted connections is there if welded connection then the required depth whatever thickness whatever is coming that will be the thickness of the base plate.

Now we will go to step 7, so holding down bolts 2 or 4 in numbers and 20 mm diameter are usually provided to connect the 2 members, so this is the nominal diameter nominal number of bolts we provide, right. So this is how one can decide the dimension of the base plate and gusset plate, right.

(Refer Slide Time: 23:15)

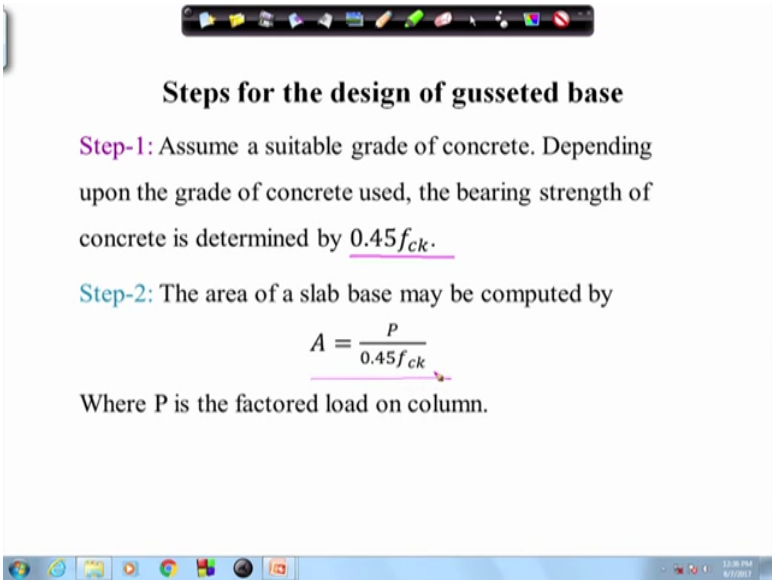



Now we will go through one example and then it will be clear to us that how to design a gusset base, right. So before going to example I will just quickly go through the same things whatever I have discussed through this power point that is I would like to summarize because then it will be much more clear to us like here we can see that that the design bending strength Md we can find out as 1.2 fy by gamma m0 into Ze which is finally becoming 0.2 into fy t square by m0. So design bending strength we can calculate.

And also the moment at critical sections we can calculate from this formula that is wc square by 2, right wc square by 2. So where c is the overhang portion and w is the pressure coming from the concrete pedestal to the base plate. So equating this I can directly find out the thickness of the base plate that is aggregate thickness which includes the thickness of the cleat angle or gusset angle along with the base plate that is c into root over 2.5 into w gamma m0 by fy, so this is what we can find out.

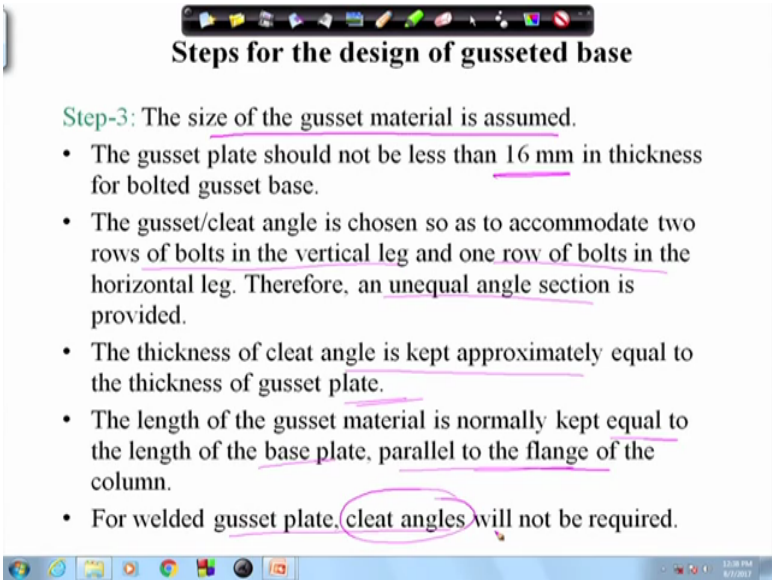
So the thickness of the base plate can be found from the flexural strength of the base plate and the thickness of the base plate can be reduced if the cleat angle is present. However if the welded connections is there then thickness of the base plate will be this one is the total thickness whatever we are getting, right.

(Refer Slide Time: 25:14)




Now the steps whatever we have discussed I am going through once again that is in step 1 first we will find out the bearing strength of concrete based on the grade of concrete which are going to be used. So if we know the bearing strength of the concrete then we can find out the area because area will be nothing but P by bearing strength. So the area of the base plate once we get we can then find out length and breadth, okay.

(Refer Slide Time: 25:47)



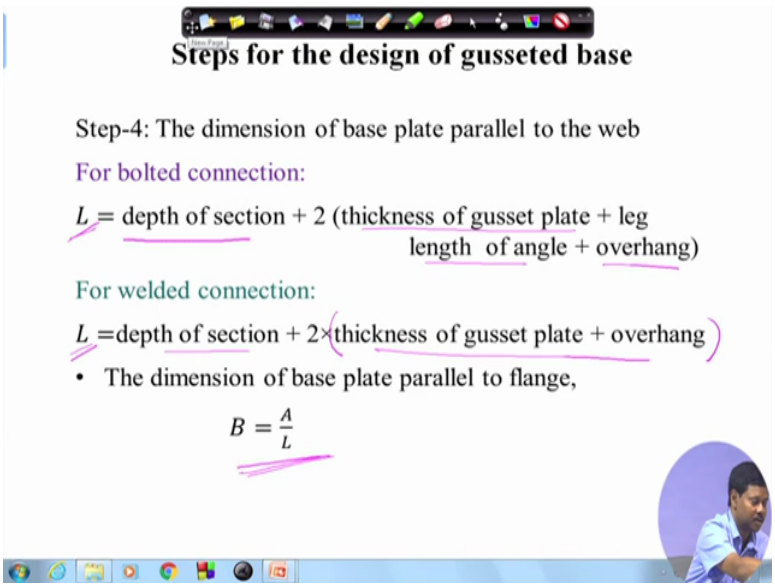

To find out length and breadth we need to find out certain other things also like in step 3 what we can do we can find out the size of the gusset material, okay. So first of all the gusset plate should not be less than 16 mm, so atleast we have to provide 16 mm gusset plate and if we provide certain cleat angle or gusset angle means in case of bolt connection then we will

provide the size of the cleat angle or gusset angle in such a way that it can accommodate two rows of bolt in vertical leg two rows of bolts in vertical leg and one rows of bolts in the horizontal leg. So we can provide an unequal angle section where the shorter directions will be horizontal and longer direction will be vertical so that the number of bolts can be accommodated.

Then the thickness of the cleat angle that can be approximately equal to the thickness of the gusset plate, so thickness will be chosen such that it will be more or less similar to the thickness of the gusset plate. Then the length of gusset material we can find out this will be in general kept equal to the length of the base plate parallel to the flange of the column so parallel to the flange of the column whatever length will come that will be considered as a length of the gusset plate. So we first know need to know the base plate length then we can find out the length of the gusset plate.

Now for welded connection the gusset plate, cleat angles will not be required sorry the for welded gusset plate we do not need cleat angle because we will be directly connecting the gusset plate with the column with welded connections so we do not need the gusset angle or cleat angle to hold the column with the gusset plate or with the base plate, right because we are directly connecting with the welded connection.

(Refer Slide Time: 28:16)

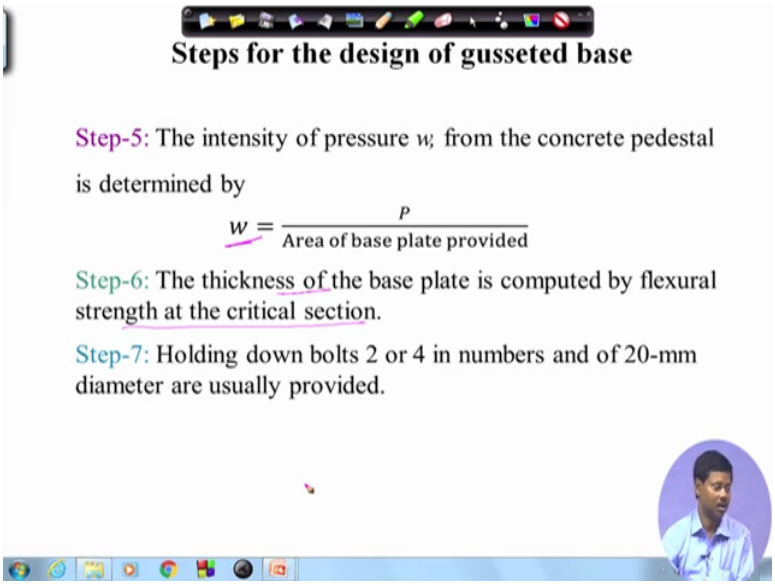



Now in step 4 we will find out the dimension of base plate which is parallel to the web so dimension of the base plate we can find out in this way that is the depth of section sorry the

depth of section plus twice the thickness of the gusset plate plus leg length of angle plus overhang, so this is what we can find out the total length.

And for welded connections this will be depth of section plus 2 into thickness of gusset plate plus overhang, okay it will be twice into gusset plate thickness plus overhang. So for welded connections length we can provide from this and for bolted connections we will provide from this where the leg length of angle will be added in case of bolted connections. So now once the length is decided we can provide the base plate length parallel to the flange that is B is equal to A by L, so this is how the dimension of the gusset base plate that is length, breadth and width are decided. So sorry length, breadth are decided.

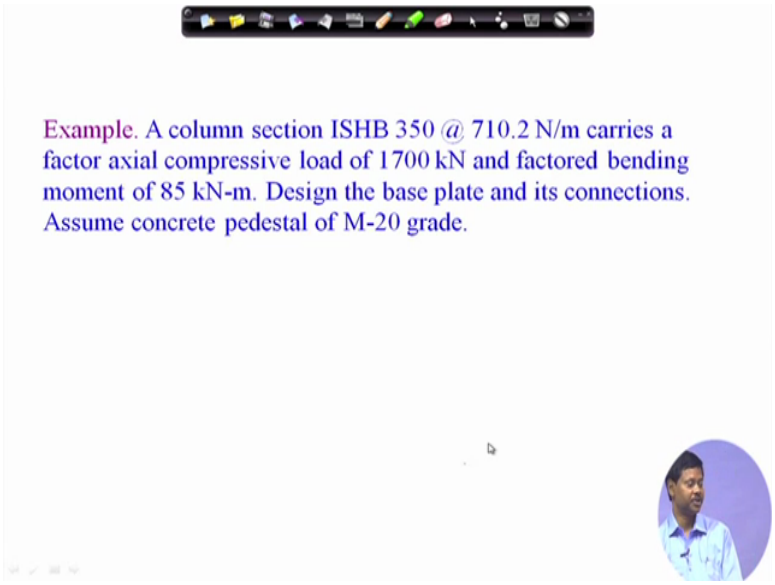
(Refer Slide Time: 29:31)




Now the thickness, thickness has to be decided from the from the pressure whatever we are getting the pressure we can calculate. So the intensity of pressure from the concrete pedestal can be found from this, right. Now the thickness of the base plate can be now computed by flexural strength at the critical section we know flexural strength at the critical section and we know what is the maximum moment coming at that critical section that is w into c square by t, c is the overhang portion.

So if we find the maximum moment at the critical section then if we equate with that design bending strength of that section then we can find out the thickness, right and then nominal number of bolts should be provided with 20 mm diameter to hold the members, right. So these are the steps which can be followed to design a gusset base, right.

(Refer Slide Time: 30:32)




Now following these steps we can go through this example, okay and this example will be working out in next day because of shortage of time we will not be able to continue this so I hope you have understood the process means how to find out the dimension of the base plate and the gusset plate and the cleat angle or the gusset angle. So these are the main members which need to be designed for the gusset base, okay. So this impact will be clear if we go through one example then it will be much more clear because step by step we will discuss that, right so thank you very much.