Design of Steel Structures

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Module - 8
Column Bases
Lecture - 1
Column Base Part-1

Hello. Today, I am going to start a new model, which we will focus on column bases. Now, a building or a industrial structure which, consist means which is undergoing load; that has to transfer safely to the soil. So, this is also an important aspect that how safely we can transfer the load on building or structure to the soil. So, this part is carried by the base column base right.

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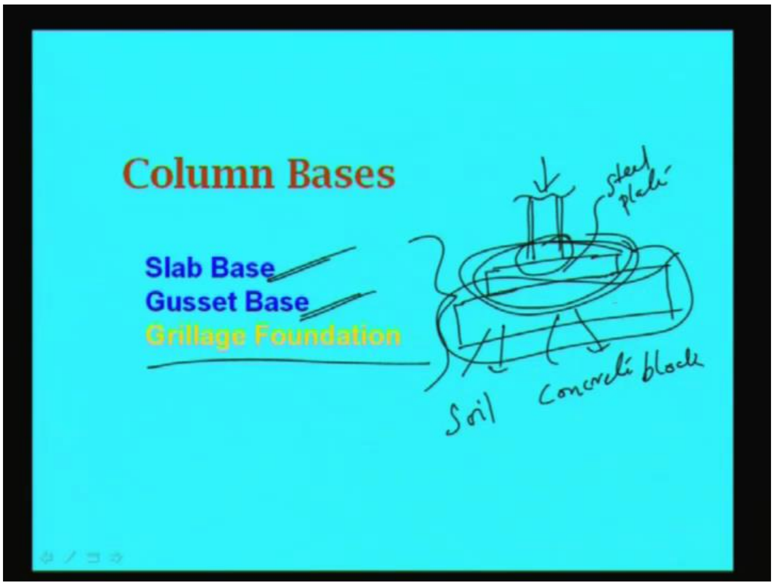

Three type of column base generally we used; one is slab base, which is called where load is little less. And then gusset base, where load is high and generally when the moment is also coming into picture eccentricity is coming into picture. And then another is grillage foundation. This generally nowadays we do not use, but still I will give a overview of grillage foundation also. So, this last module; will consist of 2 lectures and in 2 lectures I will try to cover these aspects.

In fact, designing of slab base or gusset base or grillage foundation is almost similar type and basically we have to distribute the concentrated load coming from column to base to soil. So, when the load is coming from column; that load has to transfer to the soil, how do we make it? First generally what we used to do. We used to first make say this is a column, now this column is resting on a base plate, which is called base plate; some plate, some thick plate we are going. To put to disperse the concentrated load, say load is there to disperse into this area.

Then after that we are putting in a bigger area of concrete base right concrete block. So, this is steel plate and this is concrete plate concrete block right. So, then it will be transferred to the soil. So, in this way, in generally we use to transfer. Now, how to join this column and this steel plate; this is 1 aspect. What should be the dimension of this steel plate so that, the steel will be able to carry that plate will be able to carry that much load; this aspect we have to see. Then what should be the dimension of the concrete block, which would be able to carry that load, which is coming from the steel plate. And then the dimension has to be decided on the basis of the soil bearing pressure.

So, the concrete block dimension will be means dimension in plan that length and width of the concrete block has to be decided from the bearing pressure of soil. Similarly, the steel plate dimension has to be decided from the bearing stress of the concrete, which we are going to use. So, in this way step by step we have to see, in what way? The load can be transferred safely to the soil. So, these aspects we will discuss right.

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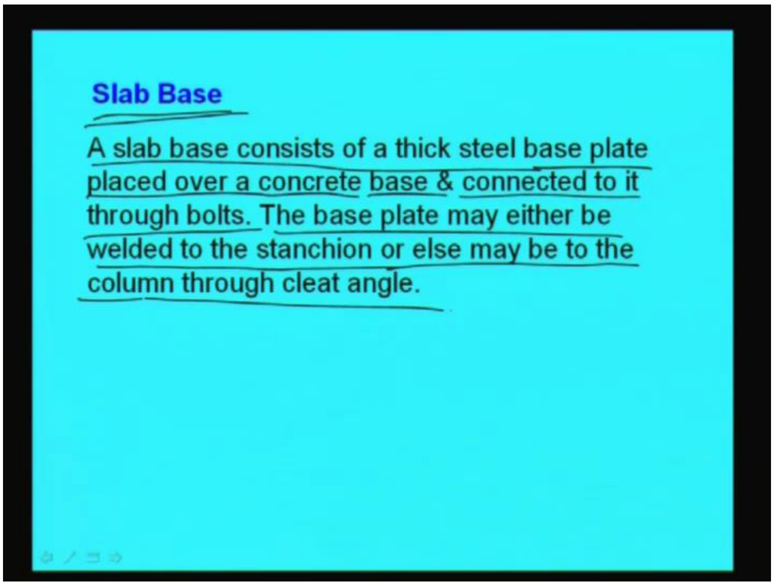

Now, first let us discuss on slab base, which is the simplest way to transfer the load from superstructure to slab structure, from upper part to lower, means lower part means to soil finally. Like a slab base consists of a thick steel base plate, placed over a concrete base and connected to it through bolts. The base plate may either be welded to the stanchion or else maybe to the column through cleat angle. So, through cleat angle we can make stanchion, we will provide and it may be welded it may be bolted or riveted, whatever means as per the requirement, as per the availability, as per the advantage of the site condition etcetera, we have to see what sort of connections we will be going to do right.

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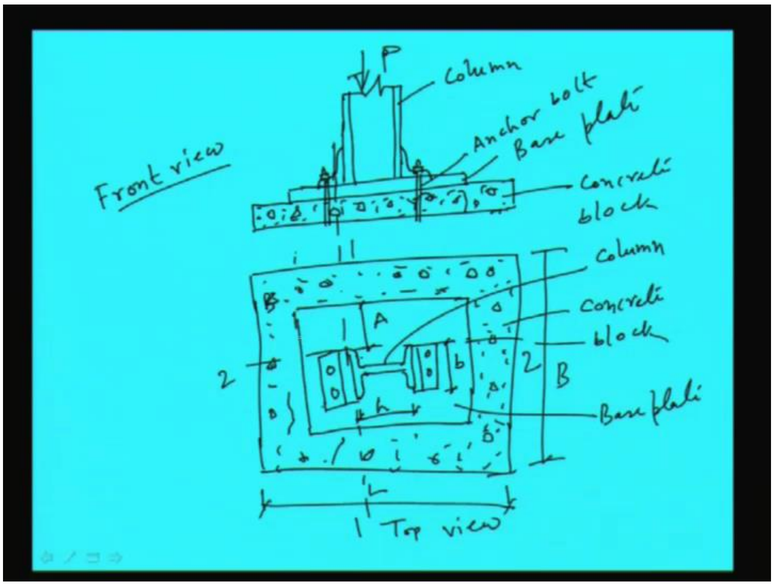

So, first let us see; how does it look like. Say if we see in the side view or front view, it will look like this. Say if this is a column right, now column is carrying load say P, now on that we will put a plate, which is we generally term as base plate right. Then we will put a concrete block right. Now, thickness of the concrete block, thickness of the base plate; all these things will be decided from the calculation. That I will show. And this has to be joined through some cleat angle right. So, this is column right and this is base plate and this is concrete block right. So, this is the concrete, we are going to provide right.

Now, this will be connected through some anchor bolts. We may say this as anchor bolt right. So, dimension of those things will be decided during design of the system right. In this way, the means if we see the front view, it will look like this front view. Now, top view if we see, this will look like this. So, this is the … if we see, this will be base plate right. So, these are the concrete block, in top view I am trying to see right. I am drawing this because; this will be required for calculation. So, let us draw in a final way.

Now, this is the column, say column is placed like this, say I column has been given. Now, the size of the base plate will depend not only on the load, but also on other factors like size of column and other things right. So, this is column. Now this is generally made by anchor block. Similarly, in this side also it will be right. Now, this is the length of the concrete block and this is the width of the concrete block. This is concrete block and this is the base plate. In top view we are showing right.

Now, this is we know is the size of the section I section, we use to tell h and this is the width of the flange that is termed as b right and this is the column right. Now, the critical section will be here, say in 1 1 right. So, this is critical section will lies here. Similarly, in this direction critical section is lies here. So, I am giving this as 2 2 and this as 1 1 right. And let us make these distances say a and these distances say b, let us termed as like this. Now, force is there. So, in this way we have to calculate.

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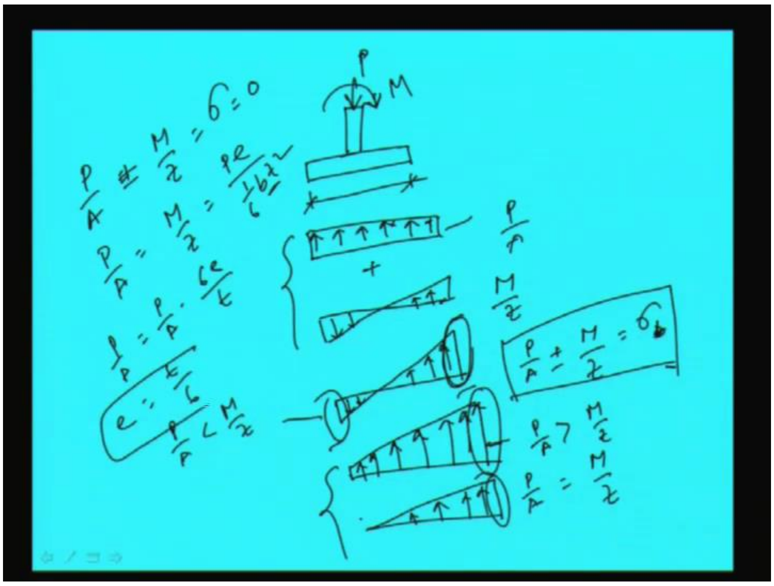

Before going to calculation, let me show the overall diagram that, say suppose force and moment is coming from column right. Now, we have a base plate right. So, what will be the pressure will develop here. If I see this will be a uniform pressure will develop right. So, with magnitude this is P by A. If P is only there right and if area is this 1 means area of this base plate right. Now, if moment also is acting, then we know that, due to moment again such type of pressure will develop, that is like this right. So, this will be M by z right.

So, now, if we add these 2 means resultant will become; either say like this means P by A plus minus M by z that will be sigma b right or sigma, the stress developed at any point will be like this. So, stress distribution will be in this way. Or if P by A is much more than M by z, then this will become like this. If P by A is greater than this will be developing like this right.

So, due to eccentricity of the load or due to development of moment, this will develop right. Otherwise 1 another case may happen just when P by A is equal to M by z in this case, here in left side it will be 0 and here if P by A is greater than M by z right. And here P by A is less than M by z right. So, there are 3 cases will develop. So, in this way stress will develop. So, when we will be going for design, what we have to see is that, the maximum stress, maximum stress where it is going to develop.

So, maximum compressive stress is developing here, maximum tensile stress is developing here. So, what will be the value right. And in for these 2 cases we can find out the maximum stresses in this way and we can make it right. And we know that we can find out the P by A if we means plus minus M by z is equal to sigma. If sigma is 0 that means, P by A is equal to M by z right. M by z means we can write Pe by z means 1 by 6 bt square right. So, if we divide P and A is equal to bt, then what will happen? So, P by A is equal to P by A into say 6 e by t right. So, we can write e is equal to t by 6.

So, critical condition is e is equal to t by 6. So, that we have to see, whether it is coming greater than t by 6 or less than t by 6. In this way we have to make it. Now, let us see the diagram whatever we have made here, how to calculate the maximum stress coming and how to design the base plate and the concrete based dimension.

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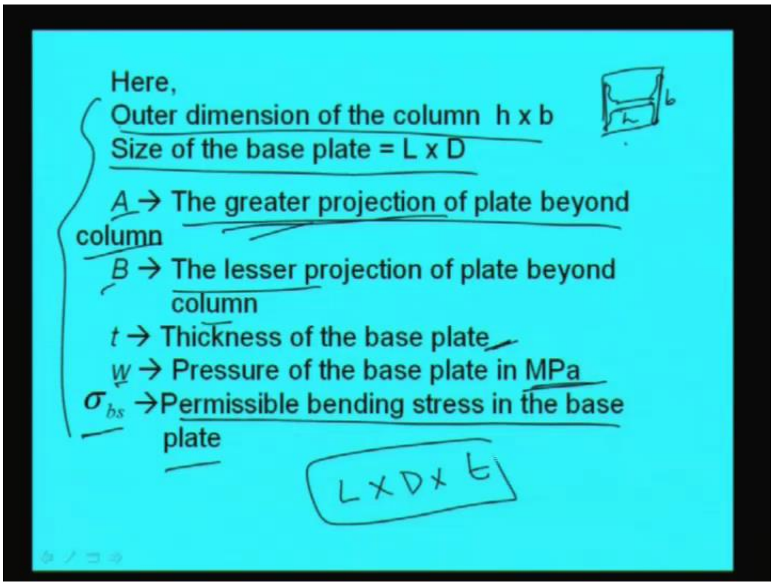

That means, first let us assume some parameters like; say outer dimension of the column as we told h and b means, if this is b and if this is h. So, this outer dimension of the column will be h by b. And size of base plate, let us consider as L by D right. And the greater projection of plate beyond column, let us denote as A this 1. And this position we are denoting as b, the lesser projection of plate beyond column right. And t is the thickness of the base plate. And w is the pressure of the base plate in Mpa. And sigma bs is the permissible bending stress in the base plate. So, these are the some parameter, which will be required for calculation of the dimension of the base plate right.

Remember this A and B is the projection of plate beyond the column right. 1 is greater projection means in greater direction and another is lesser 1. And t is the thickness of the base plate. Now, we have to find out L value, D value and t value of the base plate right.

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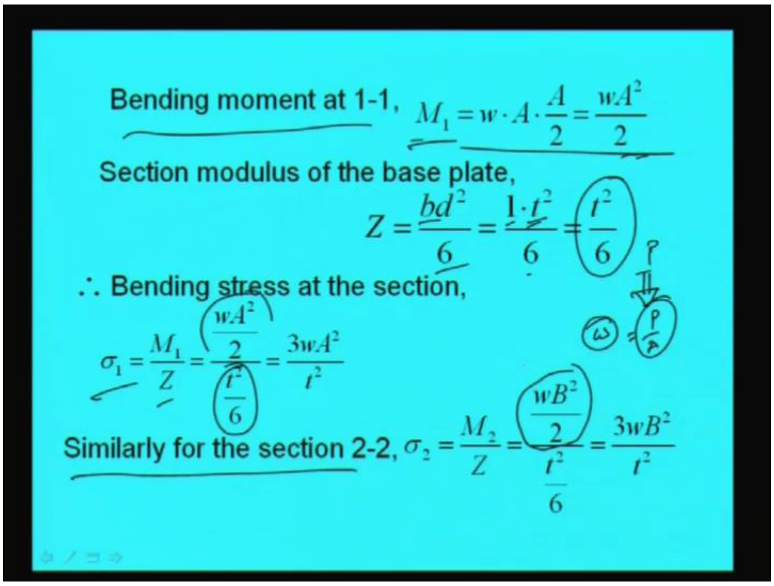

So, what we will see the bending moment at section 1 1 will become because this will be w x square by 2.

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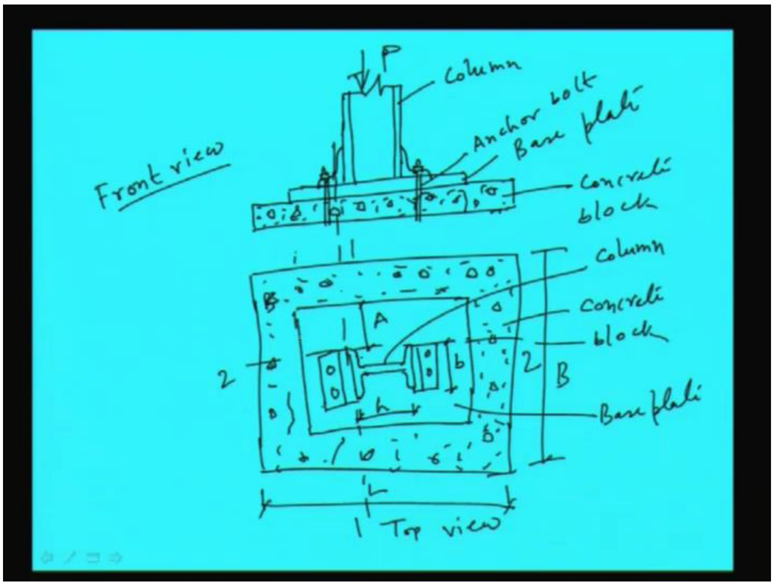

If we see w, if w is the uniformly distributed load, then w into A is this A square by 2. This will be the maximum bending moment here. Similarly bending moment in this direction will be w b square by 2. So, w A square by 2. Now, the section modulus will become bd square by 6, here b is nothing, but we are taking a unit value right. So, 1 into t square, t is thickness of the base plate as we told by 6; that means; t square by 6. So, section modulus we are going to find as t square by 6 and moment is developing as w A square by 2.

So, bending stress will develop sigma 1 is equal to M 1 by z. M 1 is w A square by 2 and by z is coming t square by 6. So, this will become 3 w A square by t square right. So, bending stress at the section sigma 1 will become 3 w A square by t square. Remember here only concentrated load is applied, there is no moment, assuming only concentrated load and the column is applied right.

In fact, for base slab generally, we use means we use base slab only for concentrated load. And when the eccentricity will be there or the moment will come into picture, in that case generally we use the gusset base and when the load is very high. That we will come later right. That is why the pressure on the plate is coming w, which is uniformly distributed which is nothing, but P by A right. So, in that way we will calculate right.

So, similarly in section 2 2 this will become M 2 by z, M 2 will become similar way w b square by 2 and z will become t square by 6. So, 3 w b square by t square. So, bending stress at the section at the critical section is becoming 3 w A square by t square in 1 in one's direction. And in section 2 2 we are getting 3 w B square by t square.

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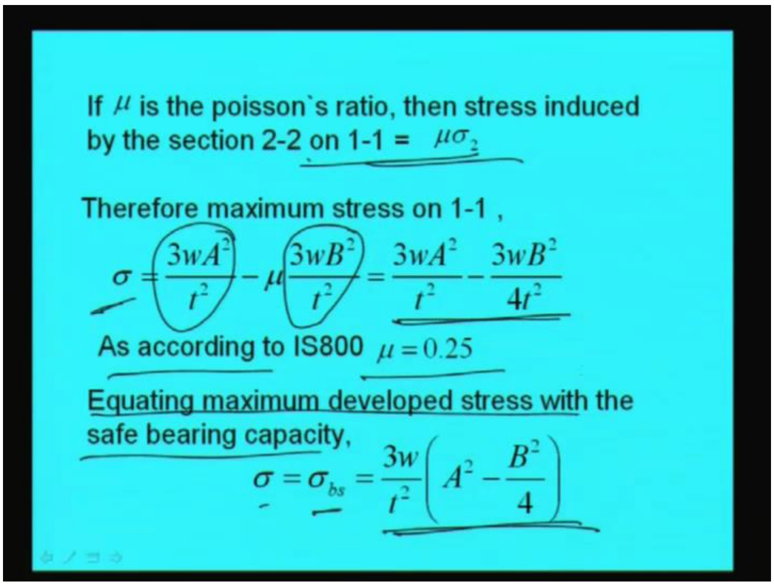

Now, if mu is the Poisson's ratio, then stress induced by the section 2 2 on 1 1 can be written as mu sigma 2 right. The stress induced by the section 2 2 on 1 1 will become mu into sigma 2. So, what will happen? Sigma value will become that, sigma at section 1 1 minus sigma at section 2 2 means mu into sigma because, this is the stress induced on 1 1 due to the section 2 2. So, if we put those values, we will get the value like this that, 3 w A square by t square minus mu into 3 w B square by t square.

Now, as per IS code, we will see the Poisson's ratio is generally taken as 0.25. So, if we put the value of 0.25 in this equation, we will get this value; that is, 3 w A square by t square minus 3 w B square by 4 t square right. Now, if we equate this with the bearing capacity of the plate, then we will get sigma is equal to sigma bs is equal to this right. This is the value of this 1; 3 w by t square into A square minus B square by 4 right. Now, we can find out from this equation of value of t thickness right.

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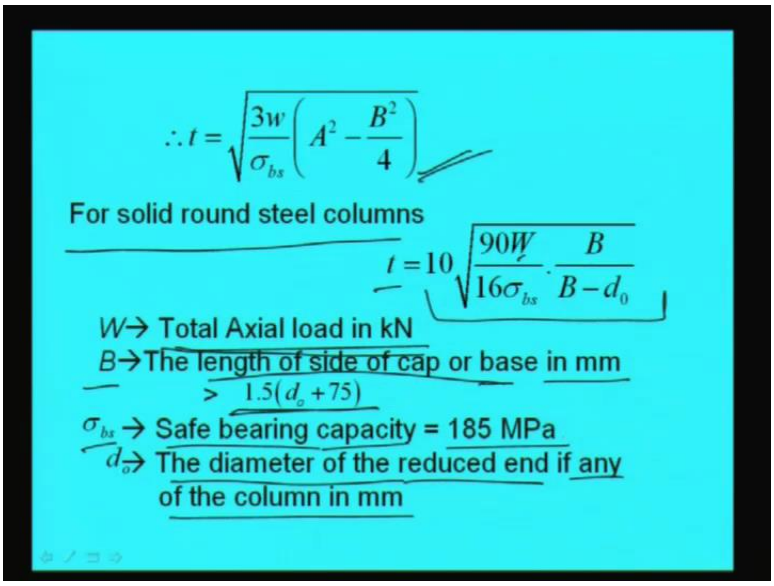

So, thickness will become square root of 3 w by sigma bs into A square minus B square by 4 right. So, thickness of the base plate can be find out from this. Now, for solid round steel columns, the thickness can be expressed in this way; 10 into square root of 90 W by 16 sigma bs into B minus B B by B minus d 0 right, where this W is total axial load in kilo Newton total axial load in kilo Newton. And B is the length of side of cap or base in millimeter and it has to be greater than 1.5 into d 0 plus 75. What is d 0? d 0 is the diameter of the reduced end, if any of the column in millimeter. And sigma bs is the safe bearing capacity of the steel, that is, 185 Mpa. As per codal provision, this value of sigma bs is 185 Mpa.

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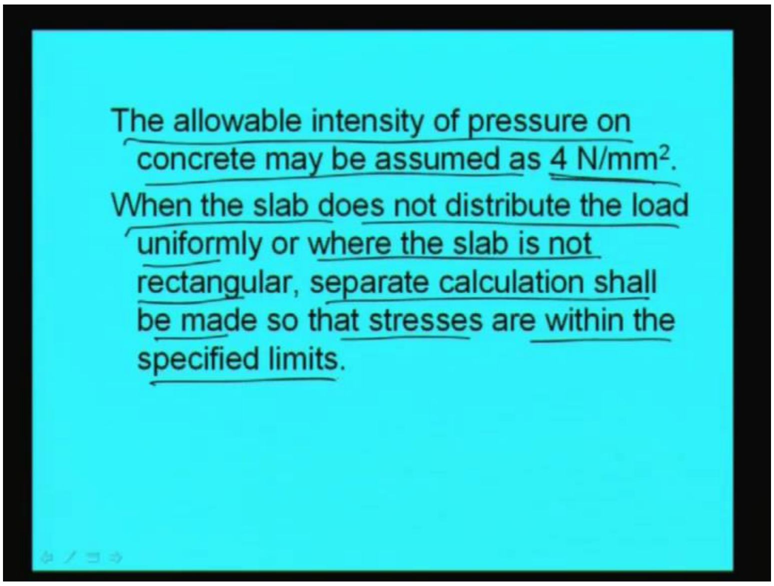

Now, the allowable intensity of pressure on concrete may be assumed as 4 Newton per millimeter square because, in general we assume 4 Newton per millimeters as allowable stress in concrete, allowable intensity of pressure in concrete we assume this. Now, when the base slab does not distribute the load uniformly or where the slab is not rectangular, separate calculation shall be made, so that stresses are within the specified limit. So, whatever we have shown here, the that thing will not happen, if the slab does not distribute the load uniformly or where slab is not rectangular, then we have to calculate accordingly and if moment is there also right. So, case to case it may vary. The simplest case just we are showing here right.

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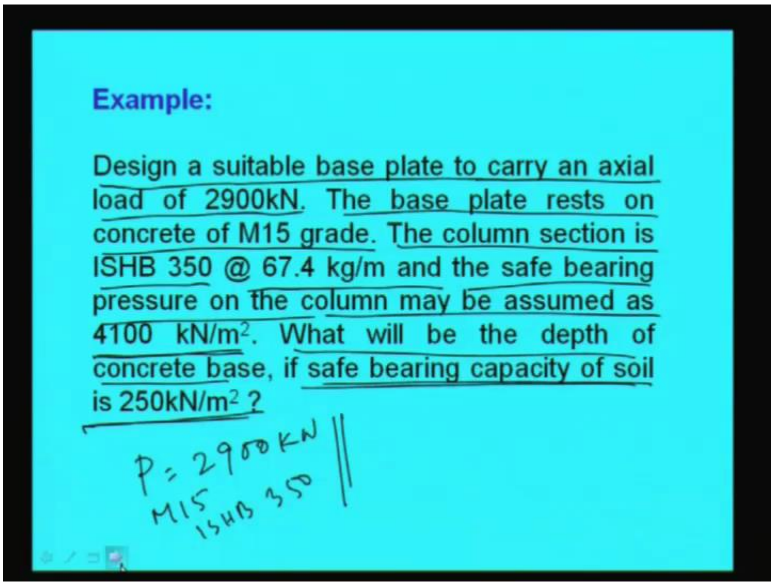

Now, this will be clear if we go through 1 small example. Whatever discussions we have done here, through that we will go through 1 example then you will be cleared right. What is the example? That is design a suitable base plate to carry an axial load of 2900 kilo Newton. So, axial load P is equal to 2900 kilo Newton. The base plate rests on concrete of M 15 grade concrete, the plate is resting on M 15 grade of concrete. The column section is ISHB 350 at 67.4 kg per meter. So, the column section size is given that is ISHB 350 right.

The safe bearing pressure on the column may be assumed as 4100 kilo Newton per meter square right. The safe bearing pressure on the column may be assumed as 4100 kilo Newton per meter square. What will be the depth of concrete base if safe bearing capacity of soil is 250 kilo Newton per meter square, if safe bearing capacity of soil is considered as 250 kilo Newton per meter square? So, we have to find out the depth of concrete base means; the dimension of base plate and the concrete base right. So, with this data let us try to solve this.

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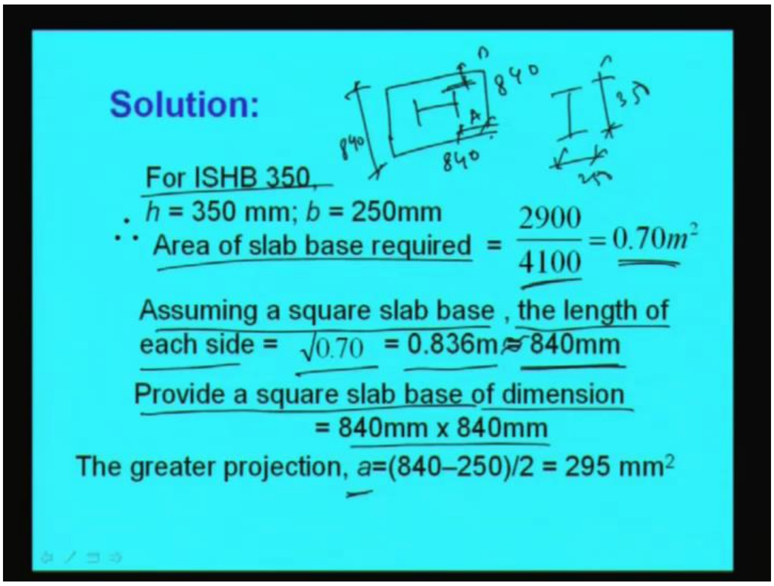

So, what we will do. As we know the section whatever we are going to use for the column is ISHB 350. So, the h value means depth of the column means, if this is the thing, then this will be 350 and b is 250. So, area of base required, now area of base required how much it will be, the load by area the load by the safe bearing pressure right. The column may be assumed this safe bearing pressure and column may be assumed 4100 and load is 2900 kilo Newton, right. So, we can find out the area of slab base as 2900 by 4100 that is 0.7 square meter, right.

Now, assuming a square slab base, the length of each side will become square root of 0.7 that will be 0.836 meter, which can be made as say 840 millimeter right. So, let us provide a square slab base of dimension 840 by 840 millimeter right. So, as we know this if this is the column, then base plate we are going to provide as 840 by 840. Now, we have to find out this projection A and B A and B right. So, the greater projection A is how much it will be, 840 minus this is 250, this is 840 and this is 250. So, 840 minus 250 divided by 2, so greater projection that will be 295 millimeter square right. Greater projection, we can find out in this way. Similarly, in fact, this should be named as A right, because otherwise it will mix up.

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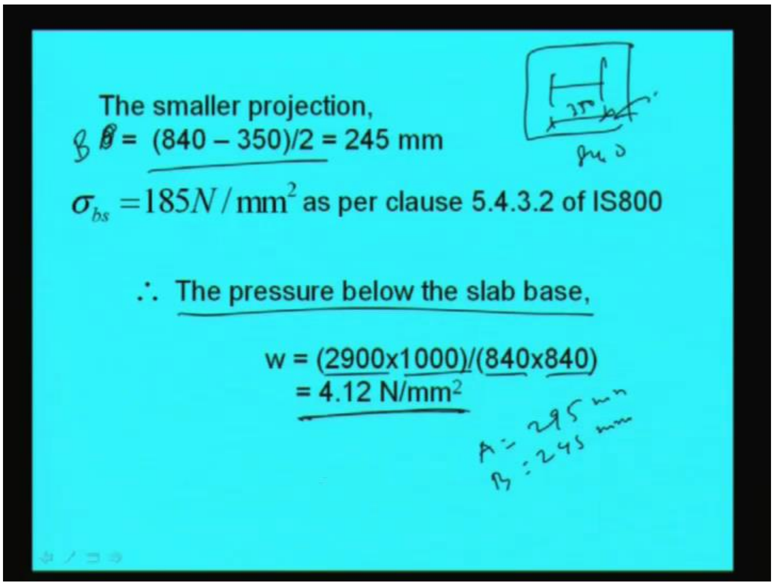

And the smaller projection say B right, B will become 840 minus 350 by 2 because, in this direction what will happen, if base plate is 840 and if this is 350 then this will become 840 minus 350 by 2 and calculating this, we will be getting 245. So, we are getting A is equal to 295 and B is equal to 245 millimeter right. Now, the pressure below the base slab, we can find out, what will be the pressure below the base slab. The load by the area of base slab, load is 2900 kilo Newton. So, we are making Newton by 840 into 840. So, this becoming pressure becoming 4.12 Newton per millimeter square. So, pressure below the slab base is becoming 4.12 Newton per millimeter square right.

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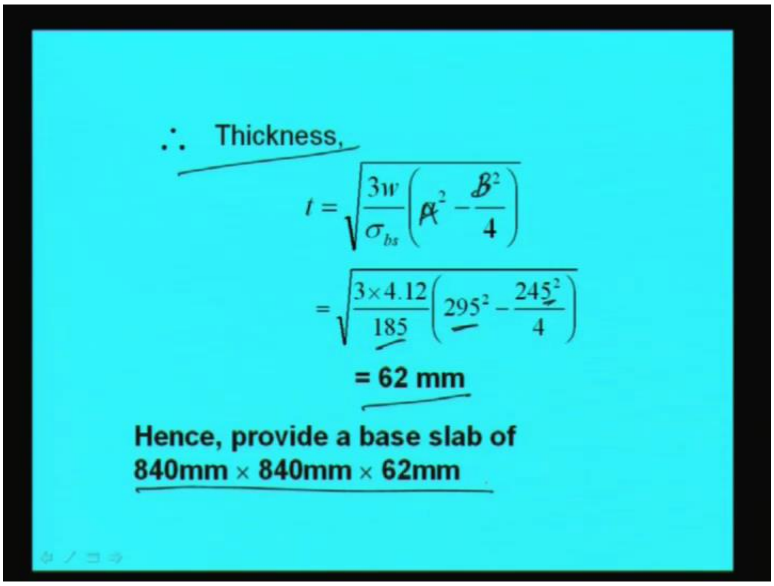

Then what we will do, other thing is the thickness. So, thickness we can find now because, now we know the pressure w is 4.12. So, on that basis, we can find out the thickness from the formula. If this is A and if this is B, we can write t is equal to square root of 3 w by sigma bs into A square minus B square by 4 is equal to square root of 3 into w is 4.12 and sigma bs is 185 A is 295 and B is 245. If we put those values, we will get thickness t as 62 millimeter. So, the base slab which we need to provide is 840 by 840 by 62 millimeter right. So, we can provide a base slab of 840 by 840 by 62 millimeter. So, in this way we can find out the dimension of the base slab. Now, what we will do.

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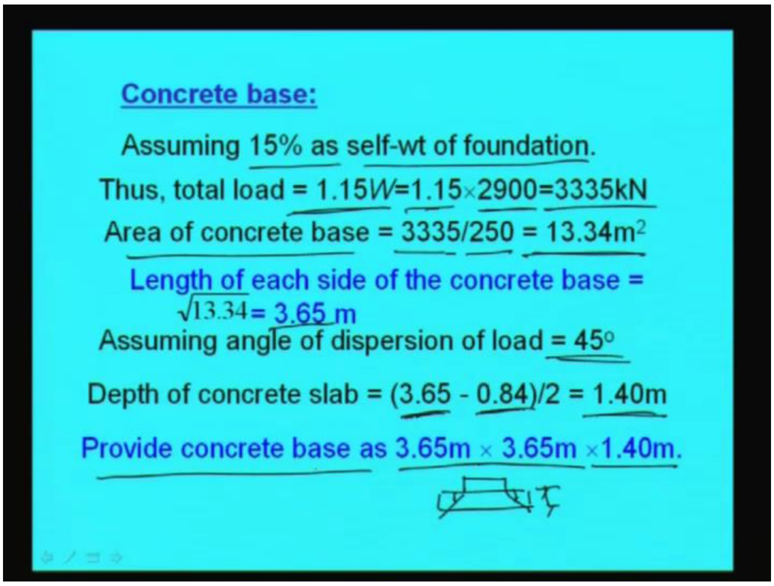

Now, we will find out the dimension of the concrete base right. So, in case of concrete base what we will do, we can assume say 15 percent as self-weight of the foundation. So, total load will little increase, that is, 1.15 W, 1.15 W means 2900 kilo Newton, so 1.15 into 2900 that will become 333335 kilo Newton right. So, area of concrete base will become 3335 by 250 because, 250 is the allowable pressure. So, 3335 by 250 that is 13.34 meter square. So, area of concrete base is becoming 13.34 meter square.

So, length of each side of the concrete base will be required square root of 13.34 if it is a square block. So, that is becoming 3.65 meter, right. Now, assuming angle of dispersion of load at say 45 degree then what will be the depth of concrete slab. Because, you see if the load is dispersing at an angle of 45 degree then we have to find out the depth. So, that dispersion happens properly right. So, depth of concrete slab will become say 3.65 minus 0.84 this is the length of the concrete base and this is the length of the base plate. So, this by 2 that is depth of concrete slab will become 1.4.

So, provide a concrete base as 3.65 by 3.65 by 1.4 meter. So, this will be the dimension of the concrete base. So, in this way, very easily we can find out the dimension of the concrete block as well as the dimension of the steel plate to carry that much load. So, what we are seeing here.

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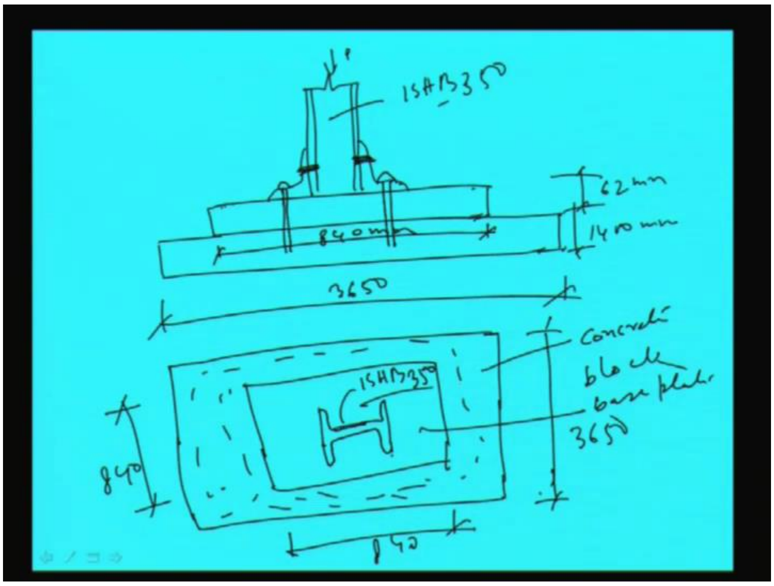

That if we draw the final outcome, we will see this is a. So, this is base plate right, then this is I am not going later, I will come means how to make connections right. So, here it is P was there this is ISHB 350. So, this is becoming how much 62 millimeter and this is 1400, 62 millimeter. This is not in scale 1400 millimeter right. And this will be the 3650 meter concrete length and width and base plate length and width will become 840 millimeter right.

Now, we have to provide some bolt here and here, we have to provide some anchor bolt. So, in this way we can make it. And if we see in the plan, we will see in this way. It is not becoming a square though it is square actually, mean this also this is also 3650. And then so this is the concrete block and this is base plate right. This is 840. Similarly this is 840. And this is 3650 ISHB 350. So, this is the outcome of the design for that load right.

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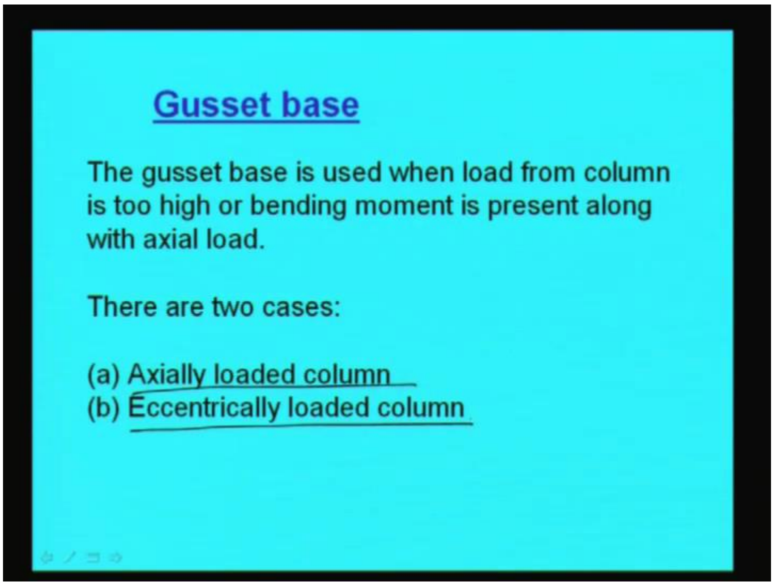

Now, we will discuss about gusset base. When gusset base is used, when the load is too high and bending moment is present along with the axial load. 2 type of gusset plate we I mean we use to design; 1 is axially loaded column, another is eccentrically loaded column. So, as we told that, in case of gusset base, generally load becomes very high, load coming from column is very high 1 thing. Another thing is the moment may present means; moment due to eccentricity will come into picture. So, to take care of these, we generally use gusset base.

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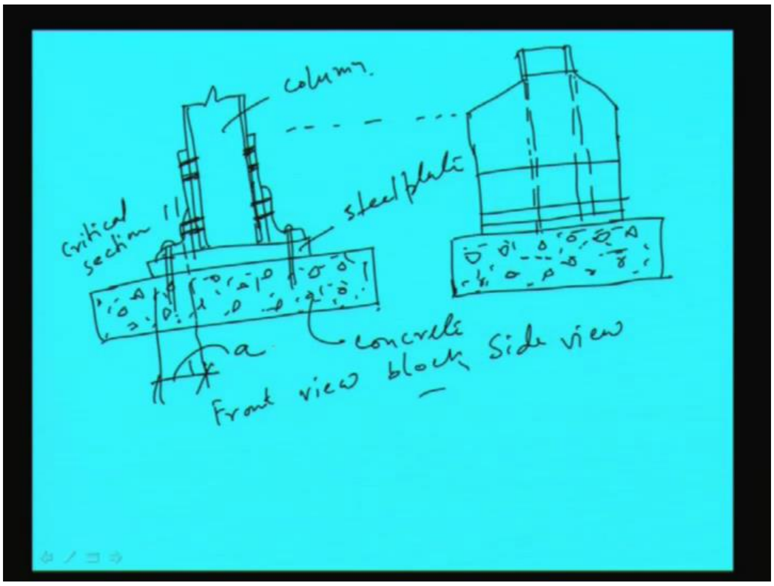

Let us see how it looks like. Say this is a column right and this will be the base plate, then concrete block right. Here we use to provide additional gusset plate here, to take care of the moment right. Now, this is front view and this the concrete block right. And critical sections will lie, where this will be in this. So, section 1 1 this will be the critical section through, which we have to design right.

Now, here we can provide some bolt or rivet right. And here also we have to provide some anchor block right, this is if we see front view. And in side view, we will see like this side view will be right. It will be and this is the column. So, this will be right, this is the column right. So, this is the concrete block this is side view and this is column. Just I will take some from here. So, this is column, this is steel plate and this concrete block right.

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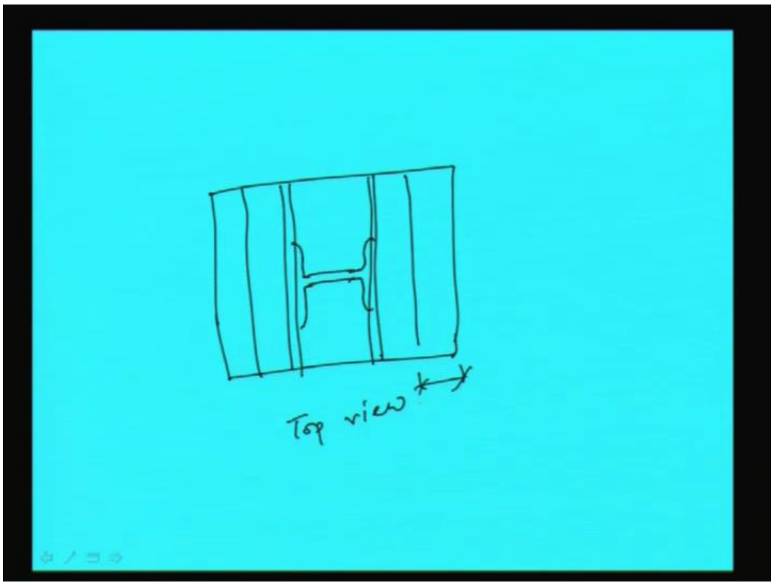

Now, if you see the top view, it will look like this. This is square, then top view will be looking like this right. And if I column is there, then it will come like this. This will be top view. And portion is a overhang portion, which is called a. In fact, here whatever we have given name means; from this critical section to this is a.

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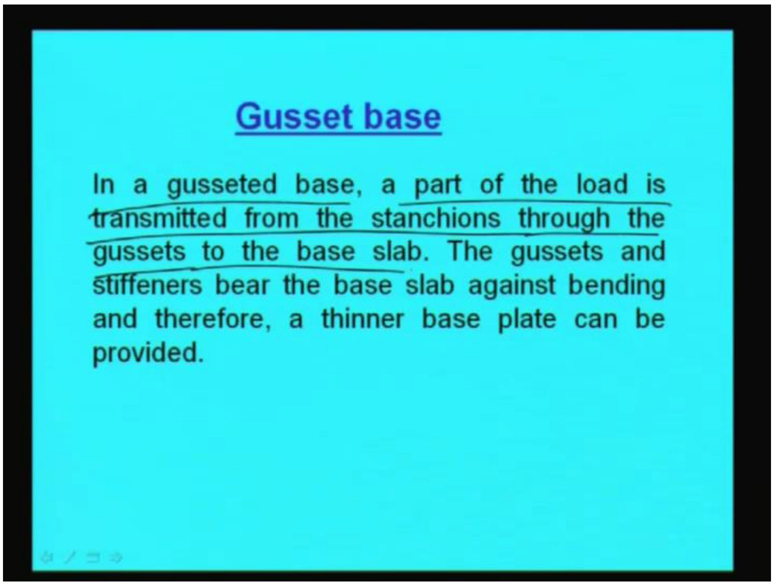

Now, in a gusseted base, if part of the load is transmitted from the stanchions through the gussets to the base slab, as we told. The gussets and stiffeners bear the base slab against bending and therefore, a thinner base plate can be provided. So, the utility is means advantage is that, the gusset and stiffeners can bear the base slab against bending. And that is why the thinner base plate means; thinner section of the base plate may be sufficient to carry that much bending and the load. That is why we use such type of configuration.

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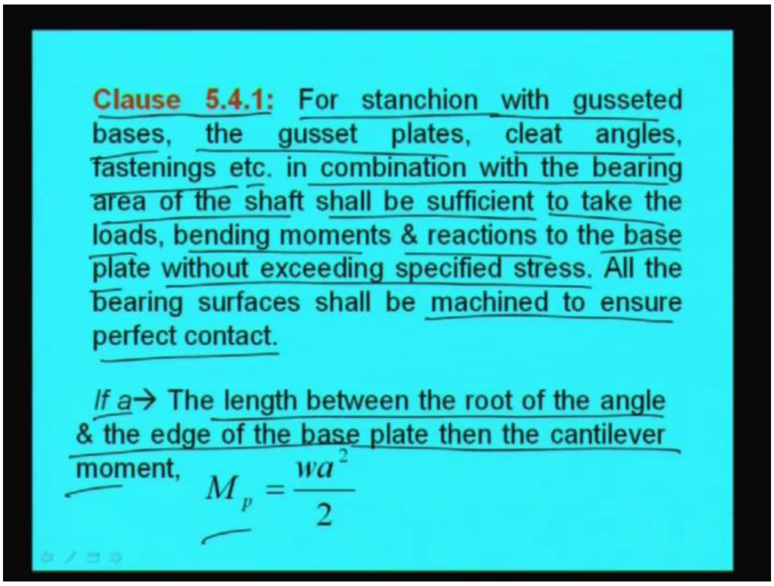

Now, in clause 5.4.1, it told that, for stanchion with gusseted bases, the gusset plate's cleat angles fastenings etcetera, in combination with the bearing area of the shaft, shall be sufficient to take the loads bending moments and reactions to the base plate, without exceeding specified stress. All the bearing surfaces shall be matching to ensure perfect contact right. So, once again I am just telling which is written exactly in the code same language, that is, for stanchion with gusseted bases, the gusset plates, cleat angles fastenings etcetera, in combination with the bearing area of the slab, shall be sufficient to take the loads bending moments and reactions to the base plate without exceeding specified stresses right.

Now, if a is the length between the root of the angle and the edge of the base plate, then the cantilever moment Mp means; that for that hanging portion, will become w a square by 2 right. The cantilever means this moment will become w a square by 2, if w is the load means uniformly distributed load is coming.

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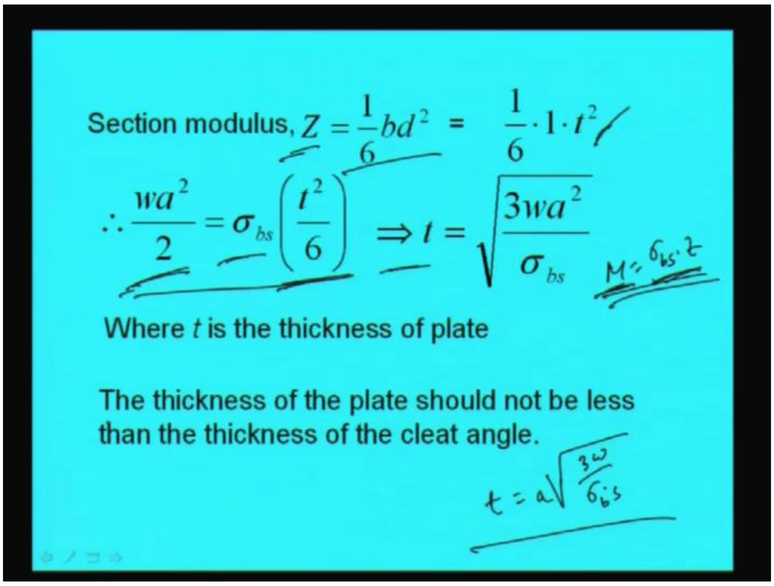

Again in the earlier case if we remember, in the same we will do. That section modulus z is can be written as 1 by 6 bd square and for a unit thickness, we can take 1 by 6 1 into t square right, where t is the thickness. So, the moment will become M is equal to sigma bs into z, where z is t square by 6. M is equal to sigma bs into z, moment carrying capacity is sigma bs into t and developed moment is M that is wa square by 2.

So, equating these 2 equation, we will get t the thickness of the plate will be square root of 3 wa square by 6 sigma bs square root of 3 wa square by sigma bs. Or we can write say t is equal to a into 3 w by sigma bs right t is equal to a into square root of 3 w by sigma bs, where w is the pressure coming in the plate and a is the cantilever portion that is hanging and sigma bs is the allowable bearing stress in plate right. That is generally 185.

Now, the thickness of the plate should not be less than the thickness of the cleat angle that we have to see; whatever cleat angle we are going to use, we are going use the cleat angle here. So, this thickness of the plate should not be less than the thickness of the cleat angle right. So, that also we have to keep in mind when we will go for designing.

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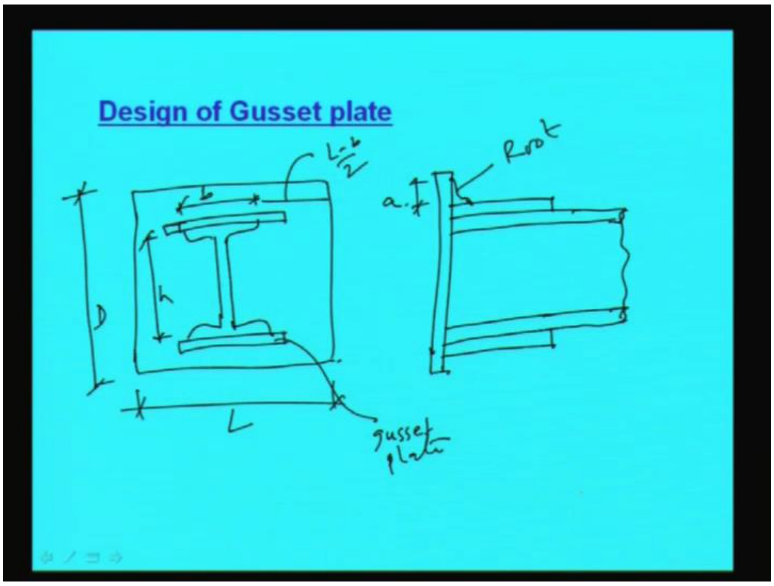

Now when we are going for design, let us draw the diagram through which we will calculate the values. Say the column is in this way it is kept right. Now, as we know this is called width of the flange b and this is h depth of the column mean section. And this is say it is L and this is say it is named as D. So, this portion will become L minus b by 2 right and this is the gusset plate right. Now, if we see from this view, this will become like this right. And this is called root and this is a right.

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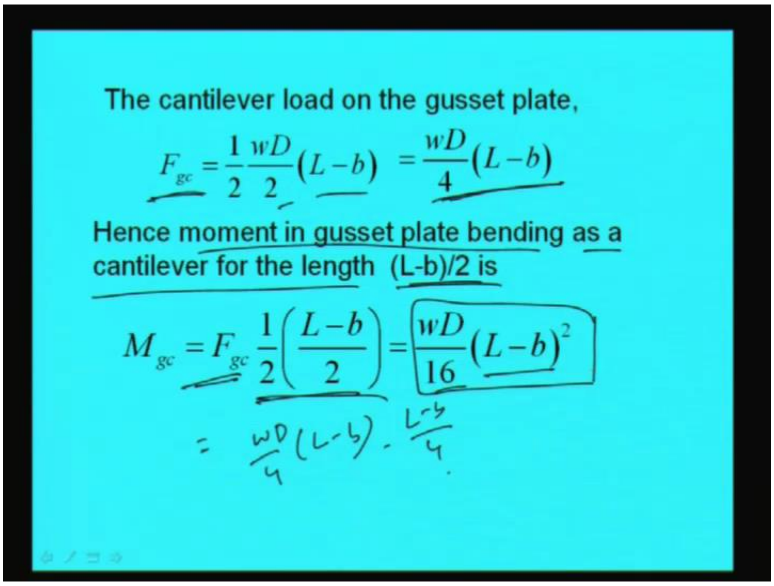

Now, if we calculate the cantilever load on the gusset plate, then we can find out that, the cantilever load on gusset plate Fgc if we termed it, then half into wD by 2 into L minus b half into wD by 2 into L minus b right. So, this will become the cantilever load will become wD by 4 into L minus b. And moment in the gusset plate as a cantilever for the length of L minus b by 2 will become load into distance by 2 right. So, wD by 4 means this will become wD by 4 into L minus b into this is L minus b by 4. So, that will become wD by 16 into L minus b whole square. So, moment in gusset plate will become wD by 16 into L minus b whole square. So, in this way we find out the moment right.

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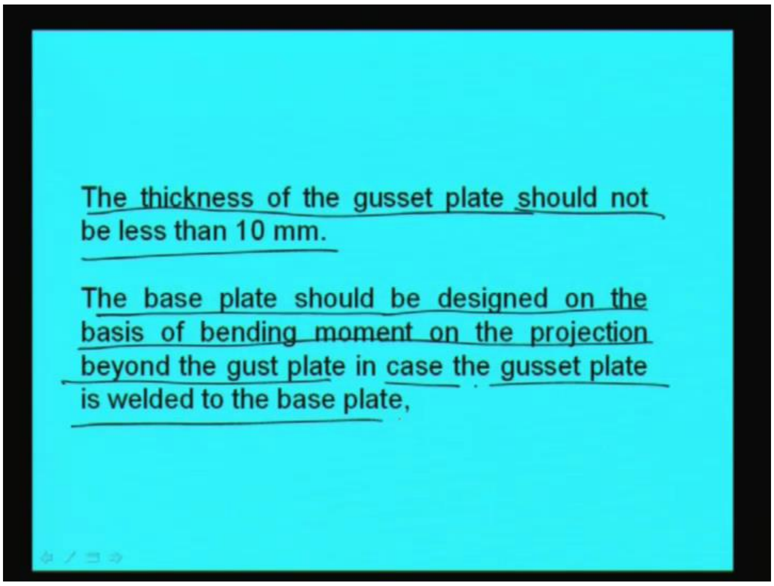

Now, the some codal provisions we have to keep in mind, while going for the designing. That the thickness of the gusset plate should not be less than 10 mm, the thickness of the gusset plate has to be at least 10 mm, that is, the codal provision is given. So, we have to keep in mind while going for designing. The base plate should be designed on the basis of bending moment, on the projection beyond the gusset plate, in case the gusset plate is welded to the base plate, in case the gusset plate is welded to the base plate. So, this also we have to keep in mind.

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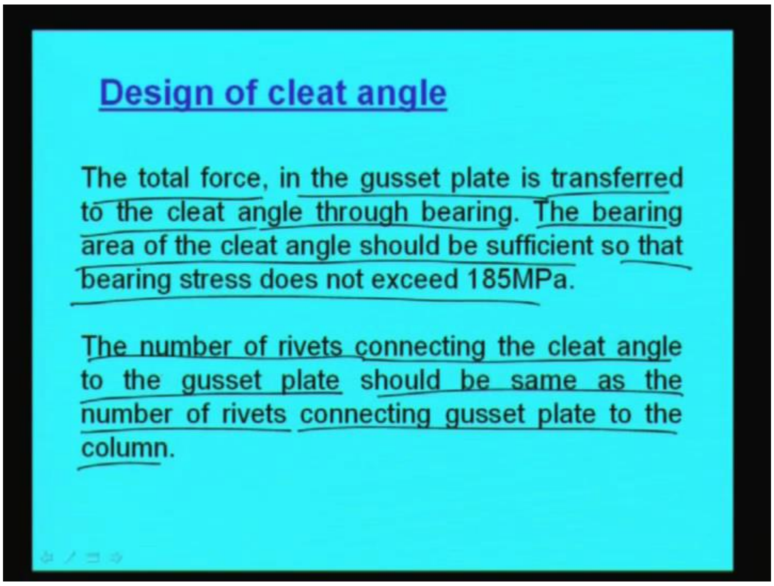

Now, another thing is cleat angle. We have to design the cleat angle. Now how do we design? That is the total force in the gusset plate is transferred to the cleat angle through bearing. We know total force is transferring to the gusset plate through bearing. So, the bearing area of the cleat angle should be sufficient so that, bearing stress does not exceed that specified stress that is 185 Mpa.

So, we have to ensure that, the bearing stress bearing of area of the cleat angle should be sufficient so that, bearing stress does not exceed 185 Mpa. That also we have to ensure. Another thing is the number of rivets connecting the cleat angle to the gusset plate should be same as the number of rivets connecting gusset plate to the column. That also we can ensure that, the number of rivets connecting to the cleat angle to the gusset plate should be same as the number of rivets connecting gusset plate to the column, right.

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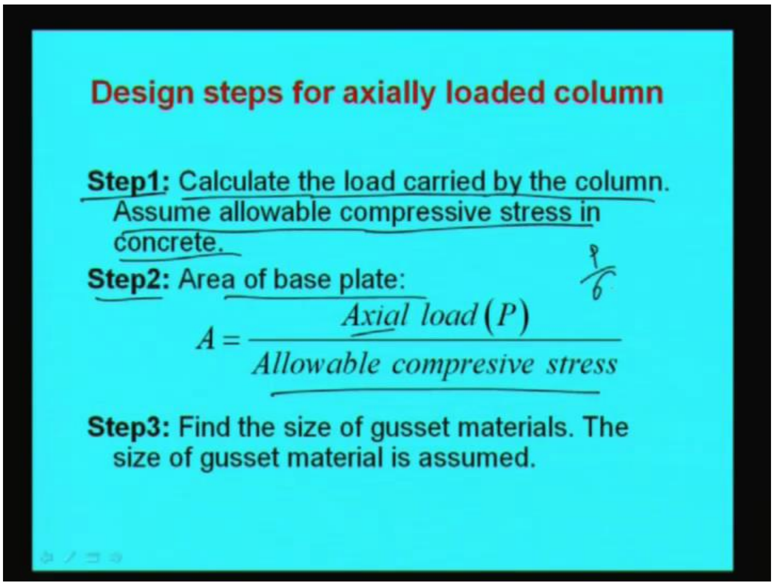

Now we will discuss about the steps, design steps for axially loaded column. There are 2 type of as I told for gusset plate design; 1 is axially loaded column, another is axially loaded with moment right. First let us see the axially loaded and in case of moment only the stress point of view it will be changing. So, little change will be there. So, if we follow the step by step design, then it will be means easy to make design process in systematic way and to find out the desired design of the gusset plate right.

So, in first step what we do. We will calculate the total load carried by the column. So, whatever total load is coming from the superstructure on the column means; column is also superstructure means whatever total load is coming to the column, first we have to calculate. And also we have to assume allowable compressive stress in concrete. That allowable compressive stress how do we assume, it depends on the grade of concrete, what type of grade of concrete we are going to use on that.

Next we can find out area of base plate, that is, simply axial load by allowable compressive stress means P by sigma right axial load by allowable compressive stress. So, in this way we can find out the area of the base plate. Now, in step 3 we can find the size of gusset materials.

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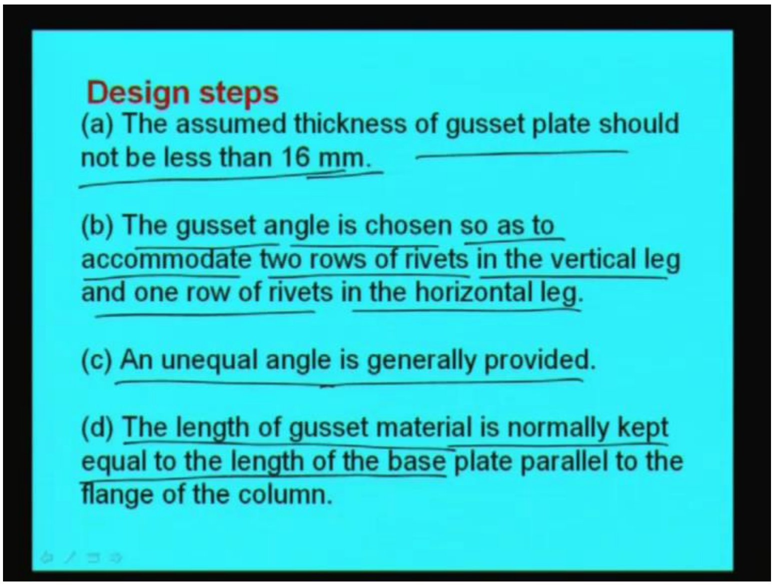

The size of gusset material can be assumed. And in this way, we can find out the size of gusset materials. First is the assumed thickness of gusset plate should be should not be less than 16 mm assumed thickness of gusset plate should not be less than 16 mm. This is first. Second is the gusset angle is chosen so as to accommodate 2 rows of rivets in the vertical leg and 1 row of rivets in the horizontal leg right. So, 1 row of rivet will be in horizontal leg and 2 rows of rivet in the vertical leg. And generally, we use an unequal angle unequal angle we generally use. The length of gusset material is normally kept equal to the length of base plate parallel to the flange of the column right, parallel to the flange of the column.

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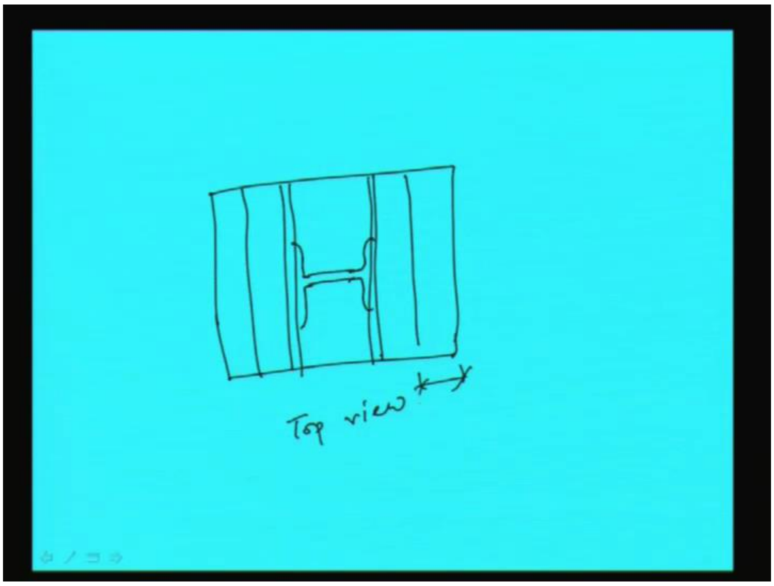

That we have shown in the picture if you remember you see, this one the length will be same with the gusset plate length right. So, the length of gusset material is normally kept equal to the length of the base plate parallel to the flange of the column.

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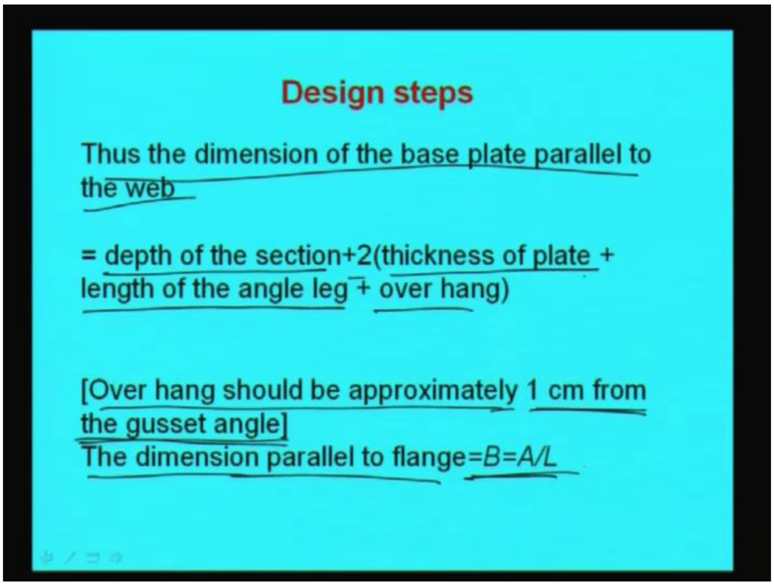

Thus the dimension of the base plate parallel to the web will become how much? That is the depth of section plus 2 into thickness of plate plus length of angle leg over hang. So, in this way, we can find out the dimension of base plate parallel to the web. Dimension of the base plate means; length or width of the base plate parallel to the flange of the column.

Parallel to the web of the column will be depth to the section plus 2 into thickness of plate plus length of leg angle plus overhang. Now, overhang should be approximately 1 centimeter from the gusset angle. That also we have to also ensure that the overhang should be approximately 1 centimeter from the gusset angle. The dimension parallel to flange angle will become in this way that, A by L, the moment we shall find out the value of L we can find out value of B because, A we know right.

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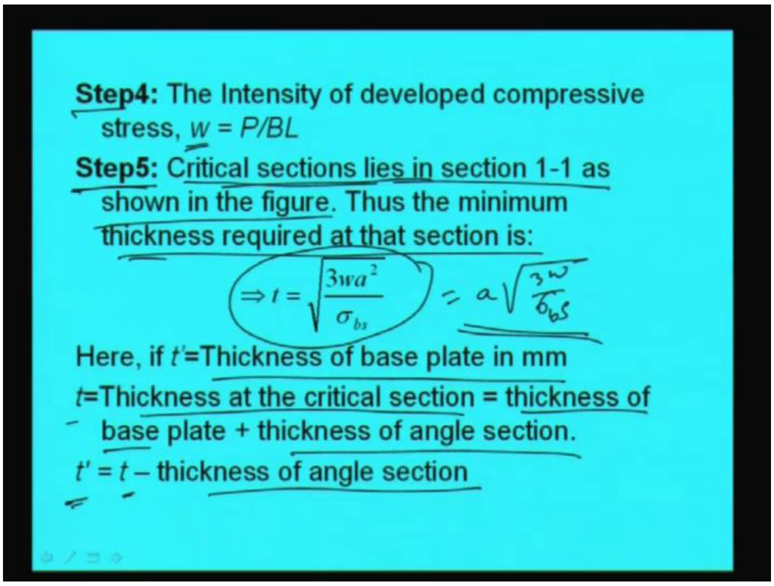

So, in step 4 what we will do; we will find out the intensity of developed compressive stress. And that will become w is equal to P by BL right, where P is the load coming from the column and B and AL is the dimension of the plate right. So, in this way we can find out the intensity of the developed compressive stress. In step 5 what we will do; we will find out critical sections as it is lies in section 1 1 as shown in the figure. In figure we have shown where the critical section will develop that at section 1 1, I have marked there

So, critical section will lies at section 1 1 and accordingly we have to find out the thickness, that is, the minimum thickness required will be from this formula. That we have developed already that, t is equal to square root of 3 wa square by sigma bs or we can write a into root over 3 w by sigma bs right. So, thickness of the gusset plate the minimum thickness required will be this right. Here if the t dash is the thickness of base plate and t is the thickness at the critical section will become thickness of base plate plus thickness of angle section. So, t dash will become t minus thickness of angle section right.

So, we can find out the value of t and we know thickness of angle section, then we can find out this t dash the thickness of base plate in millimeter. So, we can find out the base plate details, that mean, dimension LB and t dash right. So, in this way we can make it.

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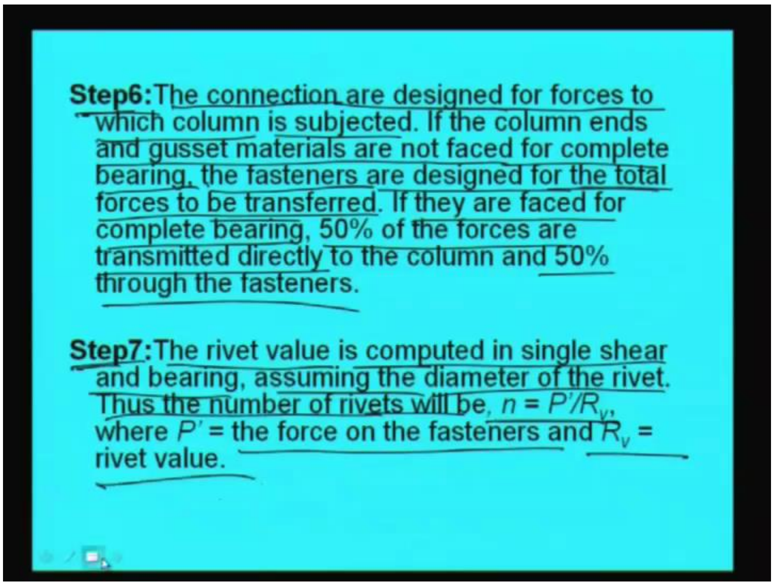

Now, in step 6 what we will do. In step 6, the connection are designed for forces to which, column is subjected. Connections are designed for forces to which column is subjected. If the column ends and gusset materials are not faced for complete bearing, the fasteners are designed for the total forces to be transferred. If they are faced for complete bearing, then 50 percent of the forces are transmitted directly to the column and 50 percent through the fasteners.

So, if they are faced for complete bearing, then 50 percent will be transmitted directly to the column and 50 percent through the fasteners. And if they are not faced, then the whole load will be transferred through the fasteners right. The fasteners are designed for the total forces to be transferred. So, in this way we have to do. In step 7 what we will do. The rivet value is computed in single shear and bearing, assuming the diameter of the rivet. So, we can find out the rivet value, whether it is single shear means; it will be single shear and in bearing and we have to find out the rivet value. Rivet value how do we find out we know the lesser of these 2 right.And then we can find out the number of rivets. So, number of rivets will be n is equal to that P dash by Rv, where P dash is the force on the fasteners and Rv is the rivet value Now, what will be the value is that 50 percent or full that will be depending how it is faced, how it is assumed for designing right. So, in this way we can compute the number of rivet right.

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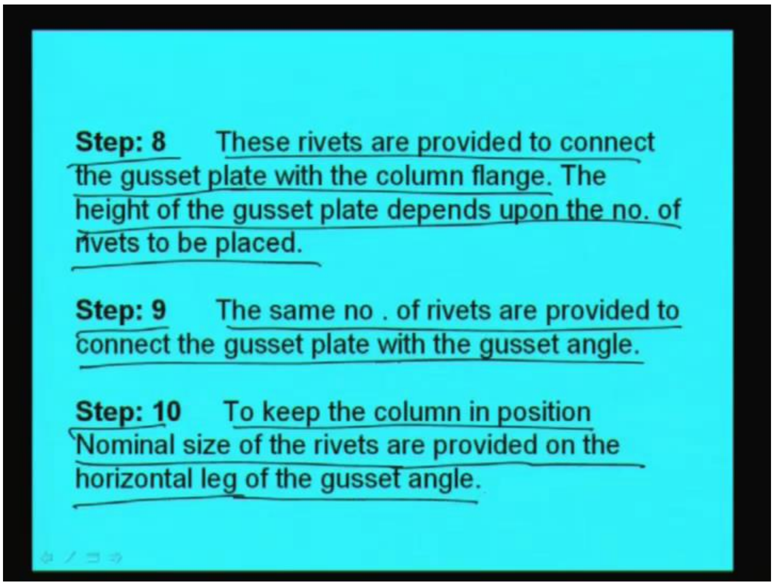

Next what we will do. In step 8 we will find out that these rivets are provided to connect the gusset plate with the column flange. These rivets are provided to connect the gusset plate with the column flange. The height of the gusset plate depends upon the number of rivets to be placed; height of the gusset plate will be depending on the number of rivets to be placed. So, we will decide the gusset plate height on the basis of number of rivets and we have to give minimum pitch minimum edge distance.

So, in this way, we will find out finally, the height of the gusset plate. In step 9 what we will do. In step 9, we will find out that the same number of rivets are provided to connect the gusset plate with the gusset angle. Whatever we have found the number of rivet; that same number will be provided to connect the gusset plate with the gusset angle right. And in step 10, to keep the column in position, nominal sizes of the rivets are provided on the horizontal leg of the gusset angle right. To keep the column in position, nominal sizes of the rivets are provided on the horizontal leg of the gusset angle.

So, these are the steps which we have to follow, for designing a gusset base. So, the design steps of both the cases we have told. So, only we could not solve the example of gusset base, which we will do in next class and I think then it will be clear. So, with this I will have to conclude today's lecture.

Thank you very much.