Design of Steel Structures

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Module 8

Virtual Method and Energy Method 1

Lecture No. # 02

Column Base Part 2

An I t g person promises only what he can deliver and I t g person delivers what he promises. Hello, today I will be continuing the remaining part of the previous lecture. In previous lecture we were discussing about the slab base and then gusset place. The design procedure an 1 example of slab is we are given already. And also that design procedure of the gusset base we have discussed, but we could finish the example, work out example. First, today I will do the design steps and some example of grillage foundation, after that if you have time then the previous lectures workout example I will complete. So, as for the time permits will go on one by one. Here, I have write down the salient feature will I just read out because if I want to till many things I told take lot of time. So, just concisely I will try to discuss in terms of salient features about the grillage foundation. So, that actually in limited time, limited number of lectures at least we can discuss little more.

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So, today I am going to discuss about the grillage foundation. So, what is grillage foundation? When it is required?. Basically grillage foundation is required when the load from the column is coming very high, when it comes in case of tall building, in case of tall building columns are heavily loaded. So, in that case if you want to provide the base plate by the method of gusset base also where this is what will happen, the idea base played will becoming very high which may not be equal. And another thing is if the soil is soft is nature then the area of concrete block will be required again very high. So, area will be that is in practical. So, on these two cases scenario used to go for grillage foundation. So, first I will show, why means what type of means how it looks like, what are the forces are coming into picture, what are the design procedure for designing a grillage foundation then and workout example. After finishing this remaining time on depending on the rest of the time will go through the example which we have discussed earlier on gusset base.

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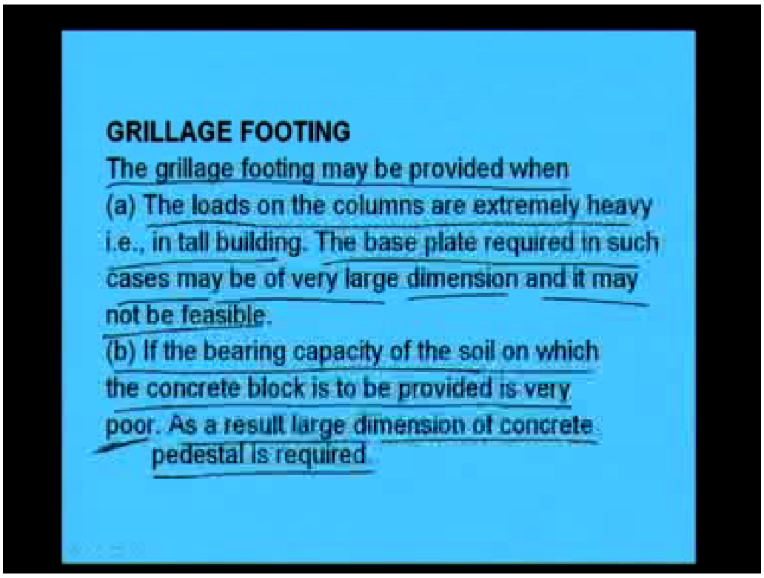

So, grillage footing may be provided when we provide that I everything here what I was telling that is the loads on the columns when it is extremely heavy in case of tall building the base plate required in such cases may be very large dimension and it may not be feasible. So, it may not be feasible because the dimension of the base plate required is so high, so large that it may not be feasible. Another thing is if the bearing capacity of the soil on which the concrete block is to be provided is very poor, if (( )) as a result large dimension of concrete pedestal is required. So, in that case also we need all grillage foundation.

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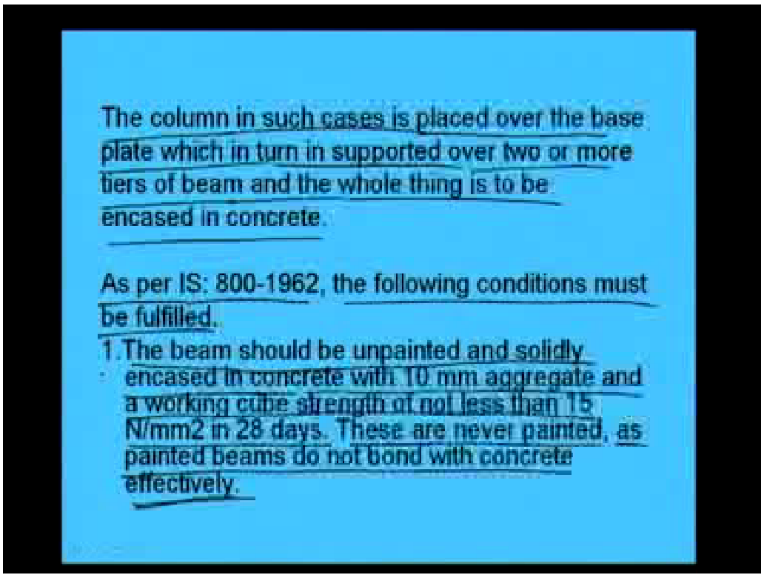

The column in such cases is placed over the base plate which in turn in supported over 2 or more tiers of beam and the whole thing is to be encased in concrete. While I will go through one diagram then I would be means able to means inform you how it loops right as per I S 800 1962 the following conditions must be fulfilled. Let us see what are the condition we have to fulfill, well requiring for the grillage footing. First is the beams should be unpainted and solidly in encased in concrete with 10 mm aggregate and a working cube strength of not less than 15 Newton per millimeter square in 18 days, 28 days. That means at least (( )) concrete has to be provided. These are never painted as painter beams do not bond with concrete effectively. So, why we are not going for painting that we understood now that as the bonding between concrete and steel will not happen properly. So, we are not going to paint it.

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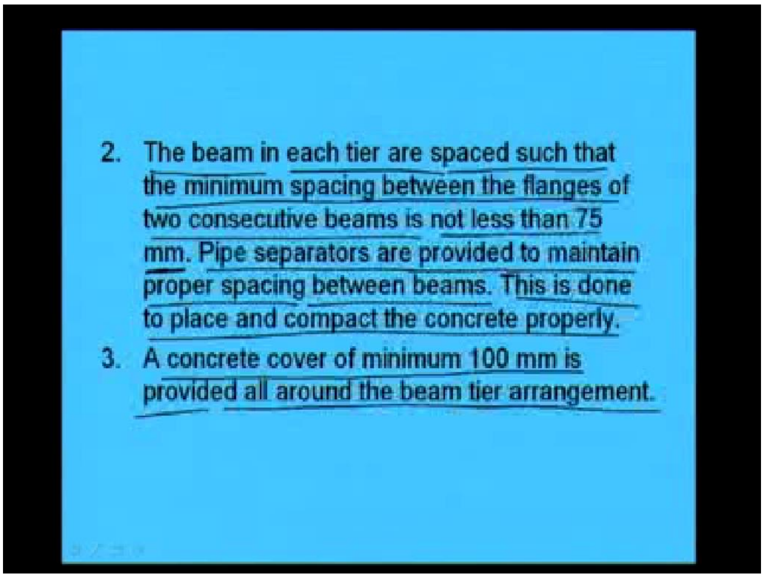

Next is the beam in each tier are spaced such that the minimum spacing between the fringes of 2 consecutive beams is not less than 75 millimeter. So, the minimum spacing between the fringes of 2 consecutive beam will be at least 75 mm. Pipes separators or provided to maintain proper spacing between beams, this is done to place and compact the concrete properly. So, to compact the concrete properly these have been means these 2 be done. Next, a concrete cover of minimum 100 mm is provided all around the beam tier arrangement, concrete cover of 100 mm is to provide all around the beam tier arrangement.

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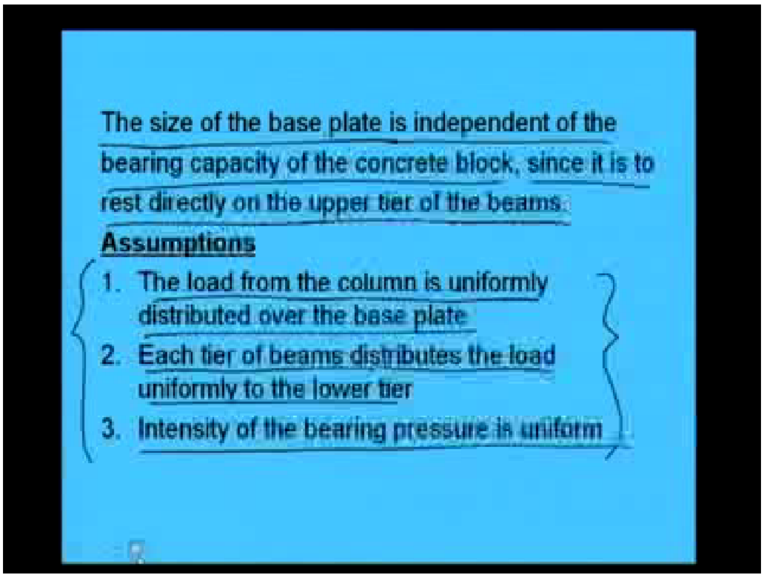

And the size of the base plate each independent of the bearing capacity of the concrete block, since it is to rest directly on the upper tier of the beam. Now, the assumptions what about we are considering for designing the grillage foundation is that, the load from the column is uniformly distributed over the base plate, this is an assumption, each tier of beams distributes the load uniformly to the lower tier and intensity of the bearing pressure is uniform, these are the 3 assumption based on which we are going to analyze and design the grillage foundation. Now, first let me show how it look like grillage foundation.

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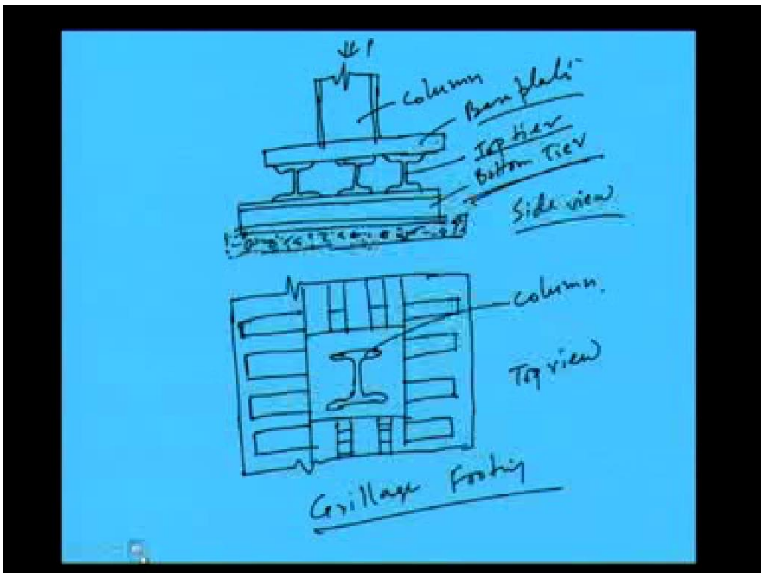

First you see the side view. So, this is 1 beam, this beam is provided and on that in we are providing another beam (( )) it may be 2 tier, 3 tier or more than that also it be happen. Now, design this is the plate which is resting on the beam, then the column is there. (( )) acting right and this is the concrete share, this is side view, you can see from the side, the top view will be something like this. So, this will be in this is direction let us a continuous. Now, say this is the column from which the load is coming. Now, the 2 tier here we are seeing the 2 tier beams are placed. So, say this will be you can see something like this then these are beams are placed.

This is top view column, this is bottom tier, this is top tier, this is base plate, this is column. So, this is how it looks, this is called grillage footing. So, in this way it has been arranged. Now, depending on the soil condition and depending on the load this number of this tier beam tier, main piece it may not be 2 tier, it may be 3 tier or more, it depends on the magnitude of the load and the type of soil on which it is placed. How the loop basically the load is going to distribute from column to the soil. So, how smoothly it can be distribute that depends how we are going to design it.

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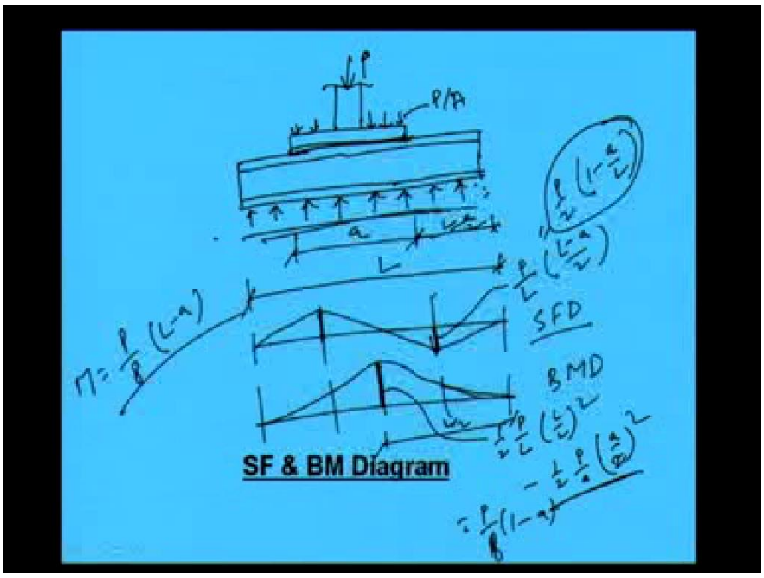

Now, before going to analyze let me show the shear force diagram and (( )) diagram of the means footing how it is coming. Say, as you know suppose load is coming shift e then it this is resting on the base plate, then what will happen and then it is going say (( ))the beam. So, well we are going to design this beam you have to know how much load is coming on this beam and how it is means where the maximum bending moment and shear force is going to occur. Said, if this is P force and area base plate j then the load whatever will be coming here means in this places, this would become P by a and the load from the beam will be uniformly distributed as for the assumption because it assuming that intensity of the bearing (( )) uniform.

So, this will become again the load by total area. This base spread dimension if you consider say this is a and that beam length is let us consider say L. Now, if you see the shear force diagram let us first draw then what will happen, the shear force diagram will be something like this. This will be their shear force diagram and bending moment diagram will be, this will be something like this. This will be bending moment diagram. Now, what will be the maximum shear force that will develop here and here as per the shear force diagram because this is the uniformly load we can consider that some supporting easier. So, if you see this will become P by L this is the uniform distributed load in to L minus a by 2 because P by a is the intensity of the pressure into L minus a by 2 this will become how much?

This should become L minus a by 2 this are totally L and this is a. So, L minus a by 2. So, this will be becoming finally, P by 2 in to 1 minus a by L. So, maximum shear force is coming this and maximum bending moment also we can find out that will become half in to P by L into L by 2 whole square because this is the L by 2 then minus half in to P by a into a by 2 whole square because of this reaction force. So, if we make this what will get finally, will find out P by 8 in to L minus a, P by 8 in to L minus a. So, maximum bending moment M we are going to get P by 8 into L minus a . So, these are the design forces which is developing under the load P. So, with this we can calculate the other things and we can find out the design criteria for the beam.

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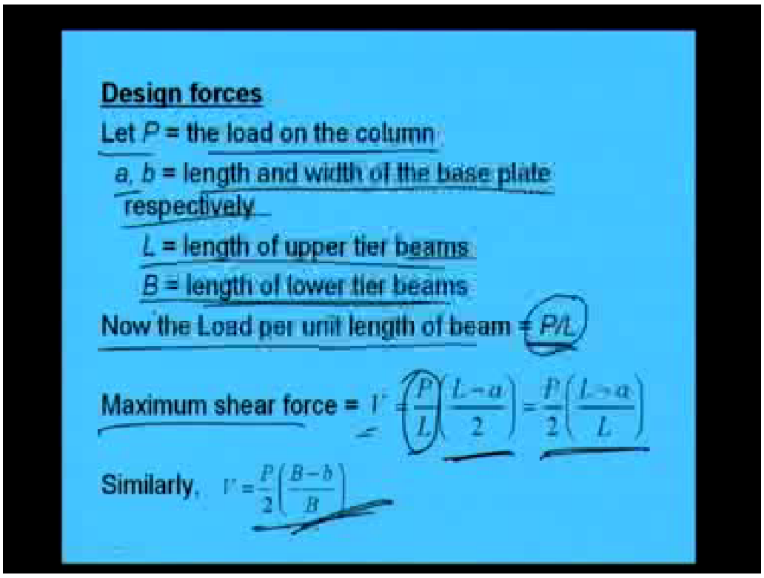

So, what will do now? So, if let us whatever a as doing let us see. Let P, P is the load on the column and a and b is the length and width of the base plate and capital L and capital B is the length, length of upper tier beam and length of lower tier beams. Then first we can find out the load per unit length of the beam become P by L, load per unit length of beam become P by L. So, maximum shear force will become v is equal to P by L into L minus a by 2 because P by L is the will be allowed into L minus a by 2 at the force will position. So, this is becoming P by 2 into L minus a by L. Similarly, on the lower tier it will be become P by 2 into B minus B by B, P by 2 into B minus B by B.

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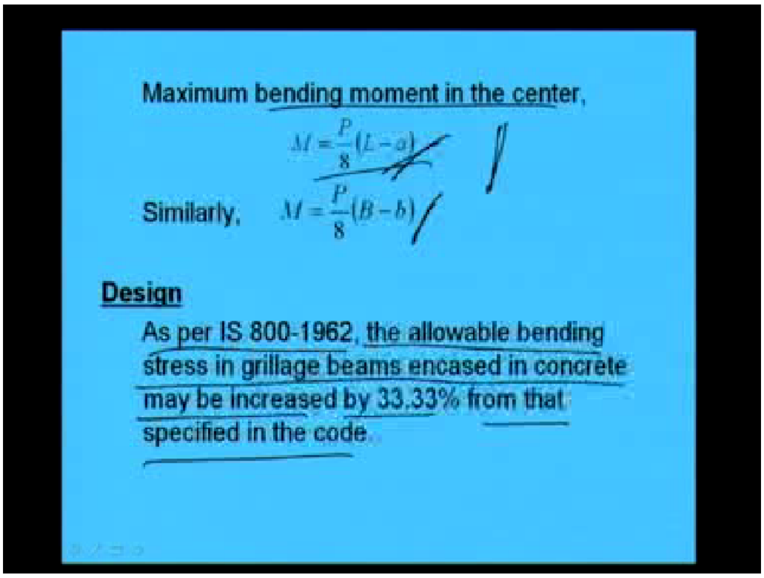

So, this is one thing. Another thing is the maximum bending moment, maximum bending moment in the center will become P by 8 into L minus a that also I have shown here how it is coming. P by 8 into L minus a. So, maximum bending moment on upper tier we can find out as P by 8 into L minus a. Similarly, on the other direction P by 8 into b minus B lower tier. So, this are the forces we have. Now, we will go for the design (( )). In fact, IS 800 1962 has depends on design process from design criteria they have cited. Like as per IS 800 1962 the allowable bending stress in grillage beams encased in concrete may be increased by 33.33 percent from that specified in the code. See, allowable bending stress in grillage beams encased in concrete may be increased 33.33 percent, is we can increase 33.33 percent from that specified in the code, this is 1 thing.

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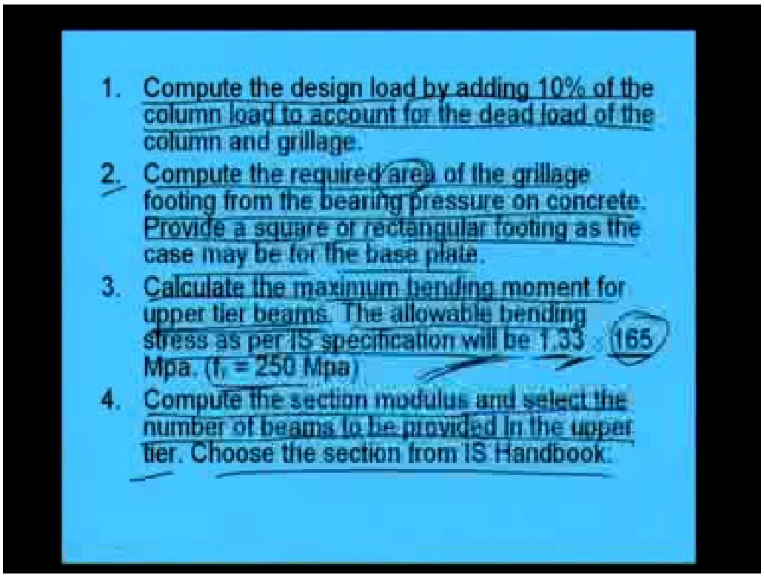

So, what will do? Compute the design load by adding 10 % of the column load to account for the dead load of the column and grillage. So, when will be go for the design. So, first what will do that compute that design load by adding 10 % of the column load to account for dead load of the column and grillage. So, what about load is coming will add 10 % more due to the (( ))of grillage and the played execetera. Then in next time what you do? Compute the required area of the grillage footing from the bearing pressure on concrete. We know the bearing pressure on concrete.

So, from that we can find out the area of the grillage footing, provide a square or rectangular footing as case may be for the base plate, as case may be for the base plate. So, either square or rectangular whatever required as for the base plate (( ))provide.

Calculate the maximum bending moment for upper tier beams. Now, we will calculate the maximum bending moment for upper tier beams. How much that is P by 8 in to L minus a, the allowable pending stress as per I S specification will be 1.33 into 165, for f y 250 because allowable bending stress we know 165 and as per the (( ))we will increase 33 % rate.

So, we will calculate maximum bending moment and will see whether it is below the bending stress or not or assuming this we can find out the section modulus. So, compute the section modulus and select the number of beams to be provided in the upper tier, choose the section from I S handbook. So, what will do to show actually know the maximum bending moment will know the permission bending stress. So, we can find out the required section modulus z, then you have (( )) and then we can find out a suitable section from the I S (( )) and then number of section means number of beam which will be required .

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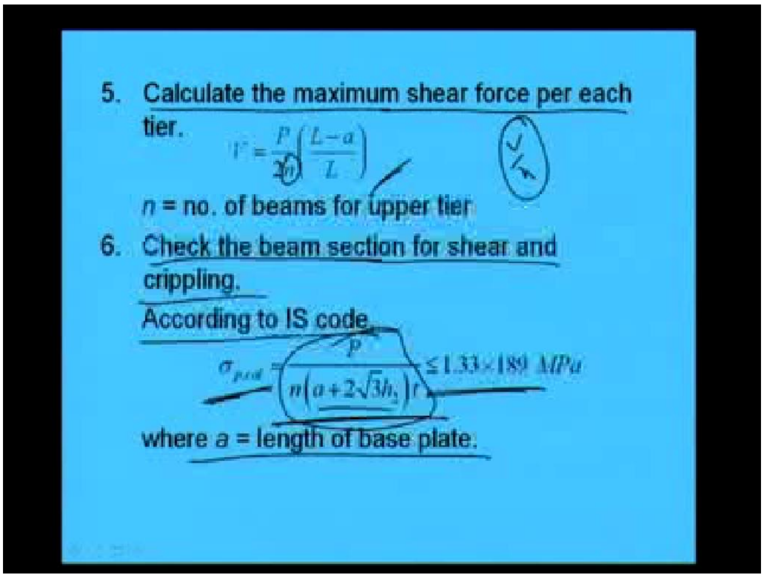

So, in this way you can make. Now, calculate the maximum shear force per each tier, calculate the maximum shear force per each tier that also we know the formula was that P by 2 into L minus a by L, for n number of tiers it will becoming by n. So, maximum shear force path each tier will become how much v by n. So, P by 2 n into L minus a by L. (( )) number of beams for upper tier. Next what you will do, check the beam section for shear and crippling, there are chances of crippling will be there, because the concentrated the load.

So, we will check the beam section for shear and crippling and according to I S code we know the sigma P calculated that will become this formula as per the (( )). In case of beam also seen that will become P by n into a plus 2 root 3 h 2 into t, sigma P (( )) will be equal to P by n into a plus 2 root 3 h 2 into t and this should be less than 1.33 to that sigma P. Now, a is the length of base plate.

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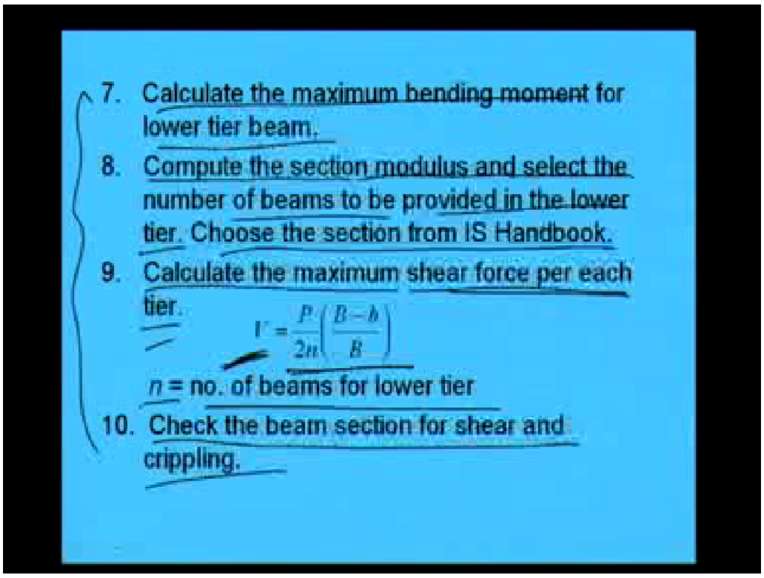

Then what will do, will calculate maximum bending moment for lower tier beam in a similar way, maximum bending moment for lower tier that is in B P and B minus b by B. So, then compute the section modulus and select the number of beams to be provided in the lower tier, choose the section for I S handbook. So, in a similar way for lower tier also you will do for a upper tier whatever we are done in same way will do for what tier and will calculate the maximum shear force for each tier that will be again (( ))P by 2 n into B minus B by B as per the formula.

So, we can find out the maximum shear force for each tier that will be P by 2 into B minus B by B where area is equal to number of beams for lower tier, then check the beam section for shear and crippling. So, same thing. So, this 7, 8, 9, 10 will be their repetition means similar way what about we have done for the upper tier will be doing for lower tier also same thing.

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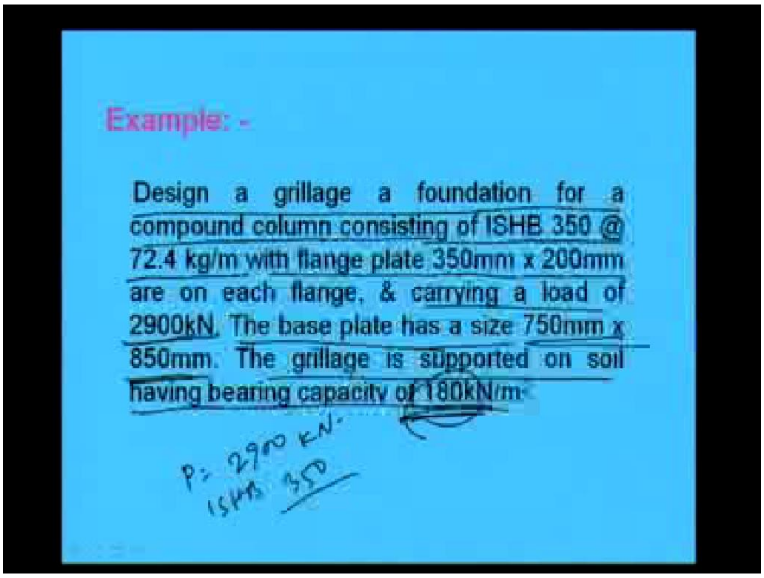

So, in this way we will perform. Now, let us go through an example through which will be able to understand how we are going to design the grillage foundation. So, design a grillage foundation for a compound column consisting of I S H B 350 at 72.4 k g per meter with flange plate of set 350 m m by 200 m m are on each flange and carrying a load of 2900 kilo Newton, the base plate has a size of 750 by 850 m m the grillage is supported on soil having bearing capacity of 180 kilo Newton or meter square.

So, this are the things we you see low bears we have kept same having bearing capacity we have changed just to see and in fact low will be very high then only this grillage footing is to meet, but still we are doing with taking same example almost same example with just little laze value of bearing capacity of soil we have taking. So, base plate size here we have see that 750 by 850 and load each carrying by 2900 where P is 2900 kilo Newton and check some column section we are taking I S H B 350 and bearing pressure in soil is 180 kilo Newton per meter square.

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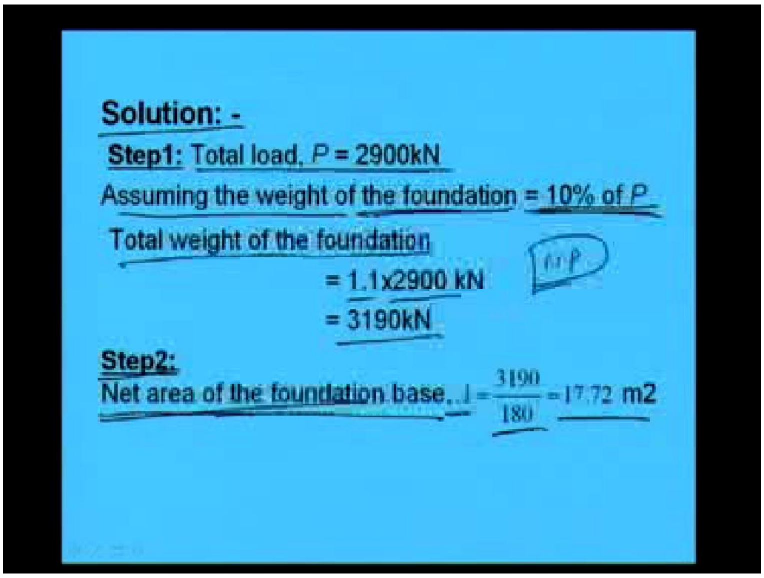

So, we will solve the problems by step by step, step already we have discussed. So, following those steps let us try to solve the same problem saying step 1 we know that the total load is given that is 2900 kilo Newton and we will assume the weight of the foundation the 10 % of the total load. So, assuming that will get the total weight of foundation as 1.1 into 2900 means 1.1 P let 10 percent we are additionally taking. So, 1.0 into 2900 kilo Newton is becoming 3190 kilo Newton. So, total weight is becoming 3190 kilo Newton in step 2 will find out the net area of the foundation base and that will become a is equal to 3190 by 180. So, this will becoming 17.72 square meter, 17.72 square meter.

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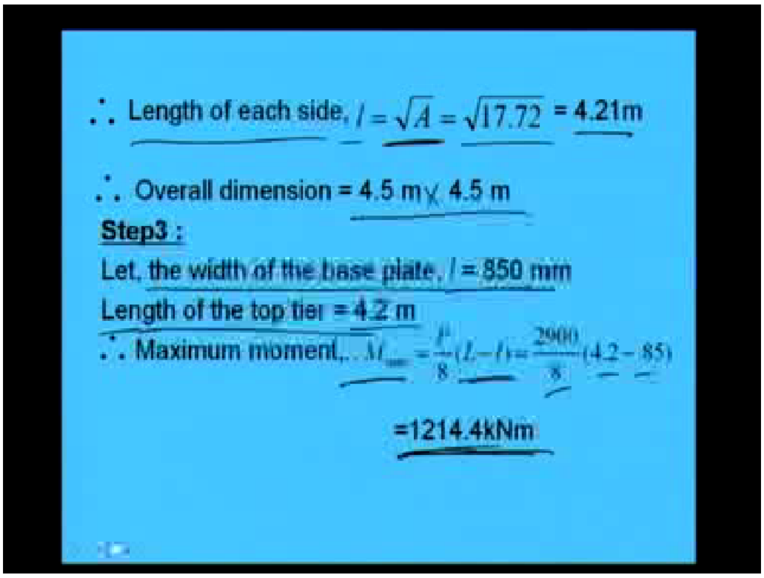

So, length of this side will become L is equal to root a provide is square size, then this will become 4.21 meter, square root of 17.72 that is becoming 4.21 meter. So, say we are providing over all dimension as incase of 4.21 let us provide 4.5 by 4.5 meter. So, size of the foundation base we are going to get as this 4.5 by 4.5 meter. So, foundation base we got. Now, will find out the base means top tier top tier details, details of the top tier. So, as the width of the base plate was giving 850, it was given 850 m m, 850 and 750. So, if it take the width of this place 850 and length of the tier as 4.2 meter, the maximum moment we can find out P by 8 in to L minus L. So, this will become 2900 by 8 into 4.2 minus 0.85. So, maximum moment is becoming this one 1214.4 kilo Newton meter. So, maximum moment we are going to get us this 1214.4 kilo Newton meter.

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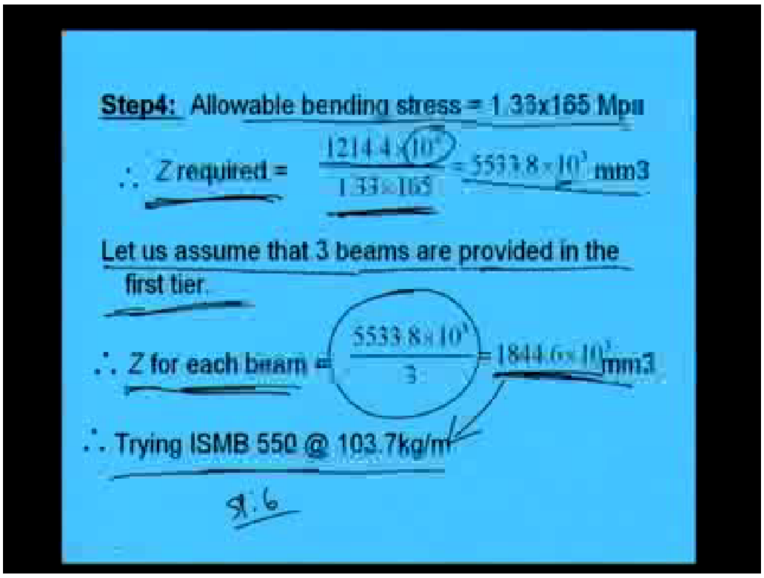

Next, what will do, allowable bending stress, allowable bending stress as we know that will be 33 % more than the actual allowable bending stress, allowable bending stress for f I 250 is 0.6685 and 0.6685 means 0.65 M p a. So, allowable pending stress is becoming 1.33 into 165 M p a. So, Z required the section modulus Z required will become m by sigma b. m we got from here 1214.4 kilo Newton meter. So, from that we can find out 1214.4 (( ))by 1.33 into 168 10 to the power of 6 multiplying because 2 convert in from kilo Newton meter to Newton millimeter, from kilo Newton to Newton millimeter.

So, after calculating this the section modulus we are getting as 5533.8 into 10 cube millimeter cube. 5533.8 into 10 cube millimeter cube. So, if you assume 3 beams then the Z for each beam will become Z by 3. If we let assume that 3 beams are provided in the first tier. That means, in the upper tier. So, the Z for each beam will be required this much and from the I S M B (( )) the S P 6 we can find out an appropriate section of the I S M B, there is the I S M B 550 we can use because j to a getting this. So, closure to that we can considered the I S M B 550.

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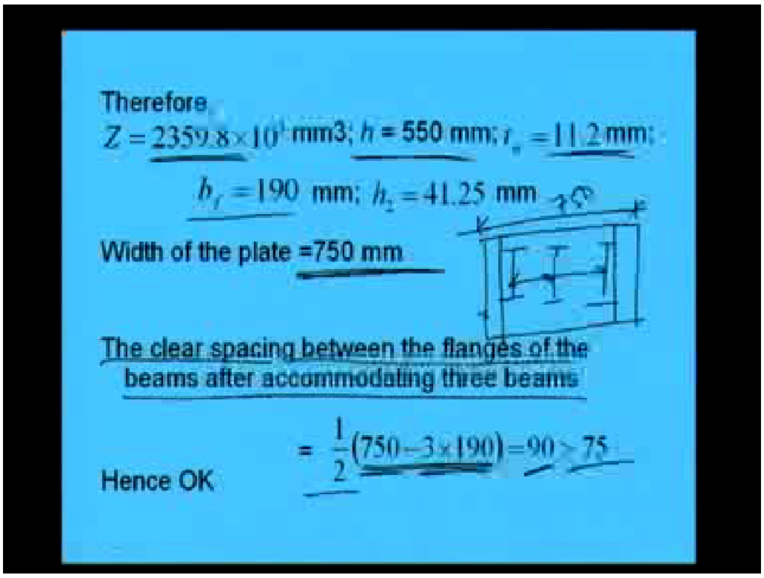

So, if you we use I S M B 550 then Z to will become 2359.8 you see why (( )) we required 1844.6 we have providing it will higher site 2359.8 into 10 cube millimeter cube and for I S M B we know height is 550 millimeter and thickness of the v b 11.2 millimeter, all these things you can find out from the s p 6 from table, width of the planes b a will be (( ))190 millimeter and h 2 able to get 41.25 millimeter and width of the plate was given 750. So, the clear spacing between the flanges of the top beams after accommodating 3 beams will become how much that is half into 1750 minus 3 into 190 that is 90 because b f is 190, you see like this 3 beams we are going to provide. So, this is total 750, this total 750.

So, 750 minus 3 into 190, 750 minus 3 into 190. So, remaining width will be 750 minus 3 into 190 by 2 means if base plate if the plate is provided exactly from here then this will be the situation and in that case the spacing will be 90 which is greater than 75 as for the (( ))we have told all already that minimum spacing between 2 beam for using tier will be 75 millimeter. So, here it is becoming 90 m m. So, it is okay because minimum is 75 m m . So, we can say that the arrangement whatever we are making is from the (( )) point of beam.

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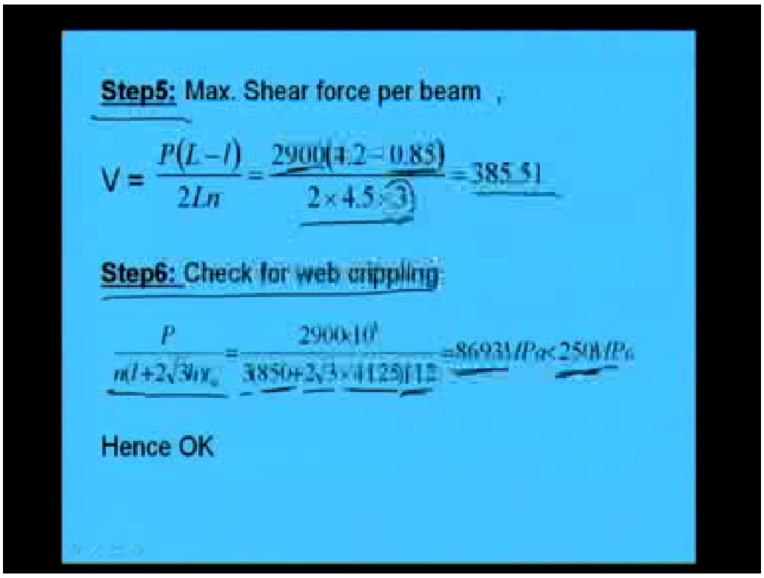

So, in next will go to state high where the beam as we check for the shear. Now, maximum shear force as for the equation you know, the shear force will be find out from in this formula V by 2 into L minus L by L into n, 3 number beams are there. So, maximum shear we can find out P was 2900 early 4.2 meter width calculated and 0.85 meter is the plate dimension. So, you can calculate by this as 385.51, maximum shear force for beam will become 385.51.

Now, we will go to step 6 where check for web crippling, for web crippling what will do we check this formula we know sigma P call that will be P by n into L plus 2, 3 h into 3 w. So, 2900 in to 10 cube by 3 into (( ))850 plus 2 root 3 into h, h was 41.25 that has giving earlier is 41.25 we count earlier in to 11.2 that is t w thickness of the width. So, from this we are going to get the (( )) 86.93 M P a which is less than 250 M P a that means, from crippling point of view web crippling point of view this is also okay. So, the section what about we are going to choose is (( )).

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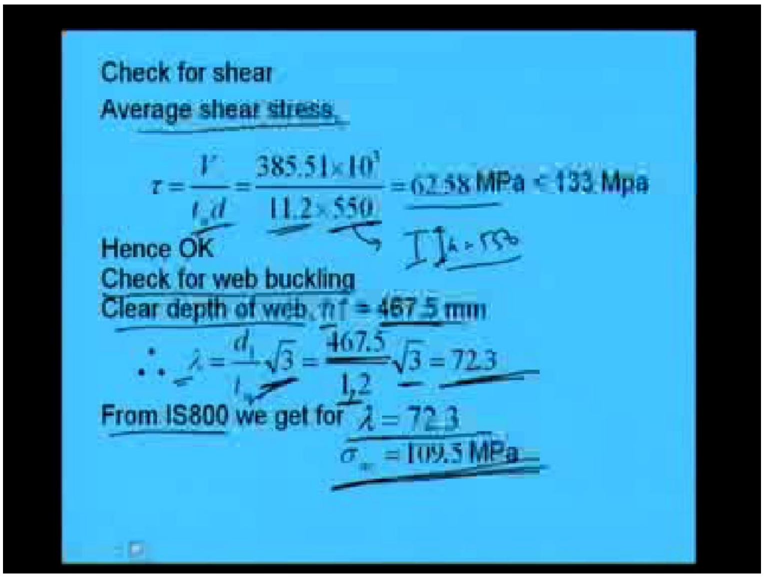

So, now, the shear stress also we have to check, the average shear stress we know v by t w d as you know the shear stress is taken care by the width of the beam. So, v was 385.51 as you calculate and t w the thickness of the width and d is the depth of web. So, if you calculate in third this is the total depth, this is the means h equal to 550. So, this is becoming 62.58 M P a which is less than 133 M P a because it should be also 33 % more than the actual, actual was 100. So, 133 M P a it should be less than 103 M P a. So, this is also okay.

Now, we go for check for buckling as you know clear depth of web is 1 that will be 467.5. So, lambda we can find out d 1 by t w root 3 as for the formula from I S code you know lambda will be d 1 by t w into root 3. So, d 1 is 467.5 by t w 1.2 into root 3. So, we are going to get 72.3 1.2 means t w become 12 because millimeter are making. So, 72.3. So, from I S 800 will get lam for lambda 72.3, sigma c value will get as 109.5 M P a. So, the sigma s allowable compressive stage we are going to get 109.5 M P a for lambda equal to 72.3 and phi equal to 250. So, in this way we can find out the sigma (( )).

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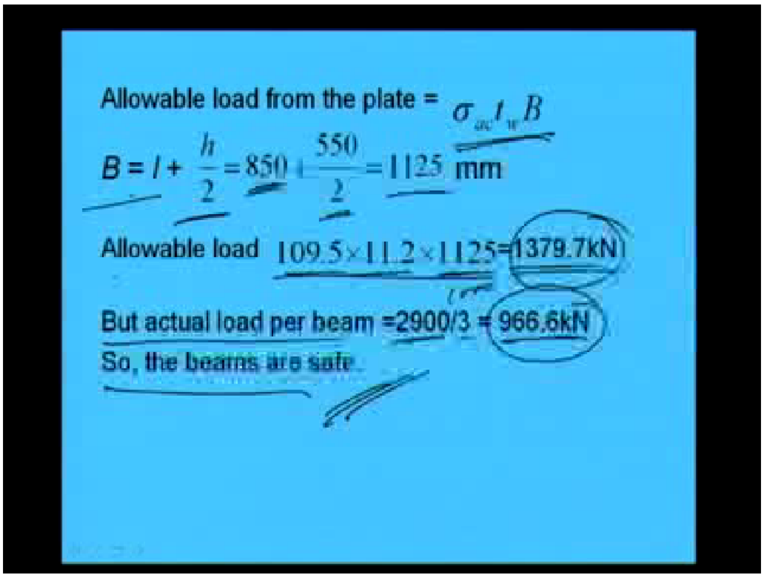

Now, allowable load from the plate will become sigma a c into t w into B, sigma a c in to tw into B. Now B will become how much L plus h by 2, L was 850 and h was 550. So, 850 plus 550 by 2 which is becoming 1125, 1125 millimeter. So, B is becoming 1125 millimeter. So, allowable load we can now find out that is 109.5 into 11.2 into 1125. So, this is becoming 1379.7 kilo Newton. So, allowable load we are going to get 109.5 into 11.2 as t w into b is 1125.

So, this is becoming (( )) by 1000 if I make this will become 1379.7 kilo Newton. Here one thing it will mistake here this should be 11.2 where t w is 11.2 not 12. So, please correct it, the lambda equal to d 1 by t w into root 3 that will be 467.5 by 11.2. So, that will becomes 72.3. However the in between calculation may have some mistake. So, you please check at your own and just going through the process through which you can do on your own also. Now, actual load for beam will become 2900 by 3. So, this is actual load. So, that beams are safe because allowable load on beam is 1379.7 kilo Newton and actual load is coming to beam is 966.6 kilo Newton. So, the beam is safe.

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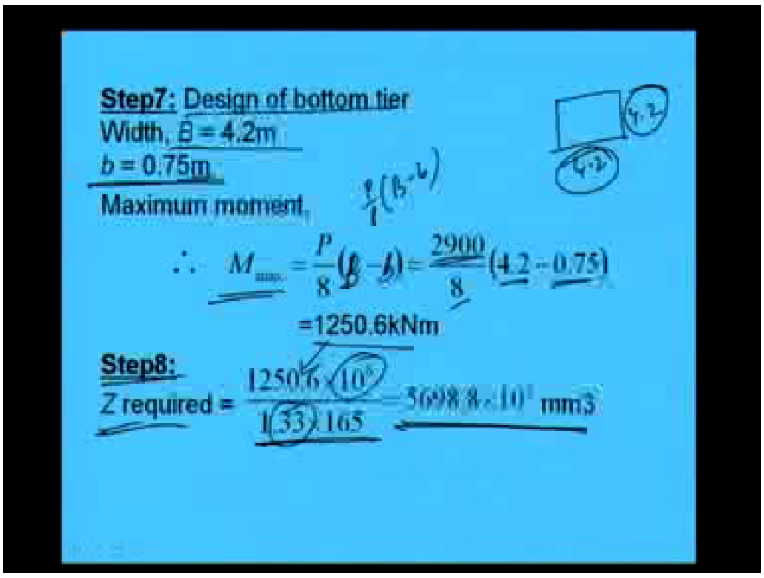

Now, in step 7 what will do same thing will do for the bottom tier, designer bottom tier. So, in case of bottom tier what will do as you know width is 4.2 meter and in that width we are going to considered not 4.5, 4.2 meter by 4.2 meter. Let us considered this one because calculation I have done in this way. However, if you consider 4.5 meter then you have to calculate the value accordingly and you will see that it is it should be also say and this be the width of the plate is 750 millimeter 0.75. So, I can find out the value, this will be B minus B power bottom tier, bottom tier it will be P by 8 into P minus 6. So, P is 2900 by 8 into B is 4.2 and small B is 0.75.

So, maximum moment is going to develop this 1250.6 kilo Newton meter. So, in state weight what will do will find out the required section modulous, required section modulous will become M by sigma B, (( )) is 1250.6 kilo Newton meter. So, that we are going to provide 10 to a 6 has been multiplied to make it Newton millimeter and by 1.33 into 165 as for the horal provision 33 % is extra we have to increased for the permissible stress. So, the required get you will become 5698.8 into 10 cube millimeter cube 5698.8 into 10 cube millimeter cube

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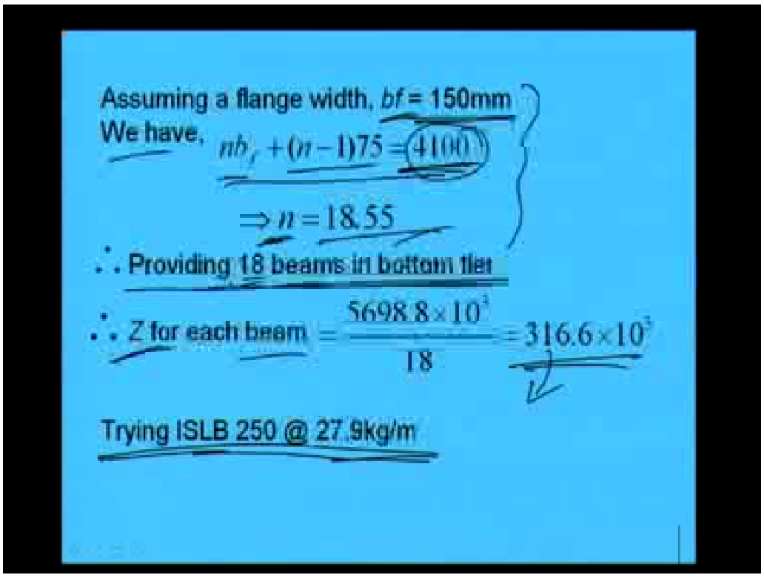

Then what will do? Now, if you assume a flange width of 150 m m then we have n b f flash n minus 1 into 75 will be this. So, from this I can find out n is equal to 18.55, number of beams you can find out in this way. So, if you provide say 18 beams in bottom tier. So, can provide. So, providing 18 beams in bottom tier how do you find out 18 beams, h probe your understood that h b f we are assuming as 150. So, from this equation it has to be total 4100. So, from this I can find out the number providing 18 beams, the Z for each beam will be required total Z by n that is 5698.8 in to 10 cube by 18 is equal to 316.6 into 10 cube. So, for this Z corresponding 6 and we can find out say I S L B 250 at 27.9 k g per meter. So, we can try with I S L B 250 at 27.9 k g per meter.

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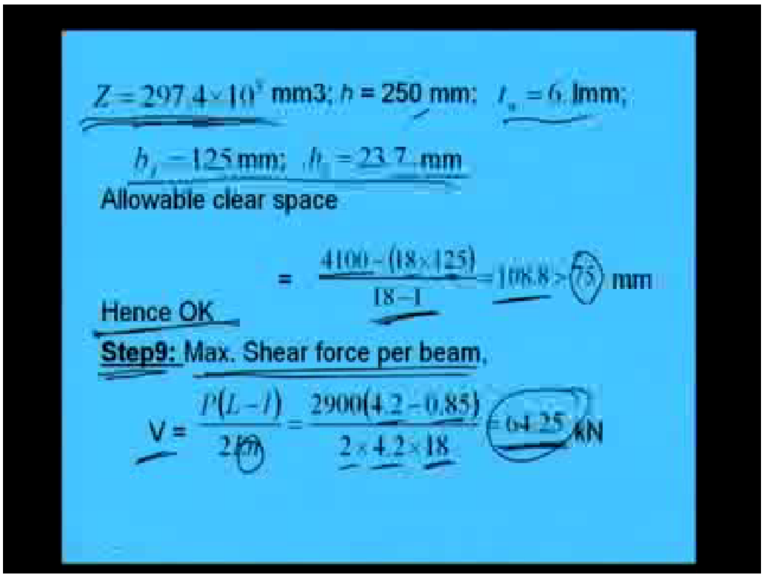

So, j d is giving 297. We need Z is 316, Z required and here almost similarly we have given 297, very close to that, h is 250, t w is 6.1 millimeter these are giving in the code for that particular Z, b f 125 millimeter and h 2 is 23.7 millimeter. So, allowable clear space will become how much 4100 minus 18 into 125 by 18 minus 1 that is 108. So, so spacing is given 108.8 which is greater than 75 millimeter as per the (( ))it should be greater than 75 millimeter. So, this is okay from spacing point of view, the number of beam whatever will be (( )) for lower tier is completely okay.

Now, in step 9 what to do will check for the shear force. First, you find out the maximum shear force. We know from the formula there maximum shear force will become p into L minus L by 2 L into n for num n number of beam. So, if you put the value p as 2900 into 4.2 minus 0.85 by 2 into 4.2 into 18. So, 64.25 kilo Newton. So, maximum shear force for beam we are going to get as 64.25 kilo Newton. So, maximum shear force we are getting. Now, what will we do?

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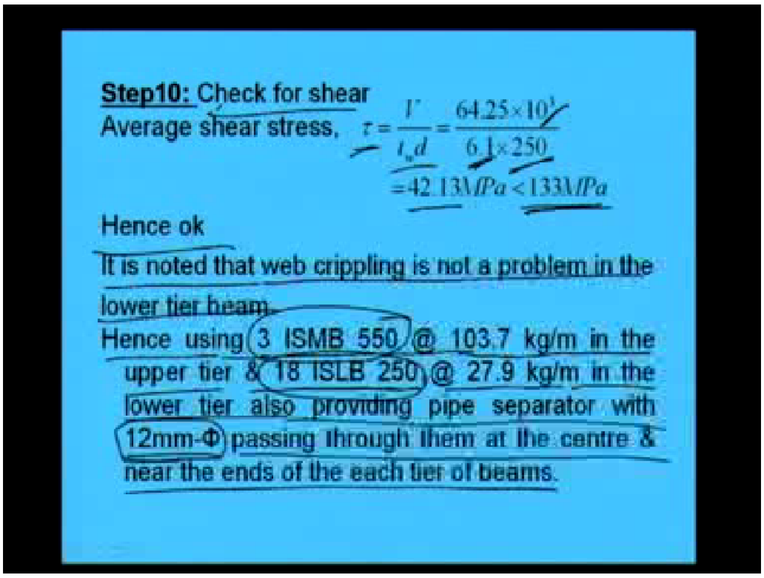

Now, will go for check for shear. Now, average shear stress will become tau is equal to b by t w into d. So, b was giving b you calculate from here that is 64.25 kilo Newton. So, 64.25 kilo Newton that is 64.25 into 10 cube Newton by 6.1 is t w and d is 250 . So, after calculating these we are going to get as 42.13 M P a which is less than 133 M P a, which is less than 133 M P a hence we can said this is okay. So, from shear stress point of view the beam whatever we are consider the number of beam and the size of beam is quite okay. Now, it is noted that web crippling is not a problem in the lower tier beam because the shear force and other all the things are going to distribute.

So, it will be very less, the concept is force coming to the lower tier beam is very less that is where we do not need to check. If the upper tier is okay then what tier will be automatically okay. So, we can use 3 I S M B 550 at 103.7 k g per meter in the upper tier and 18 I S L B 250 at 27.9 k g per meter in the lower tier and also providing pipe separator with 12 m m phi passing through them at the centre and near the ends of the each tier of beams. So, beam what beam we are going to provide 3 number of I S M B 550 for upper tier, 3 numbers of I S M B 550 and for lower tier 18 number of I S L B 250 and we are providing some pipe separator of 12 m m diameter just to keep their spacing in a fixed distance.

So, in this way you can design. Now, design picture means if you see this will be something like this. So, here will see that we have providing here the upper tier 3 numbers of 550 I S M B 550 and the lower tier beam we are provided I S L B, how much we are provided I S L B 250, here we are provided 3 numbers and here we are providing 18 numbers and what else you know we have calculated the base split size, the display to where we have calculated, say we calculate to the base plate. So, width of place 715, 850 let the width of base plate is 850 and length of top tier is 4.2 meter. So, this is what we found, let just I am recalling.

So, over all dimension is actually these will be 4.25 by 4.2 actually we are going to consider and you saw the this okay also. 4.2 now base plate is width is 850. So, we can go width. So, this will be 850 and other to like connection etcetera will be standard connection you have to do that will know.

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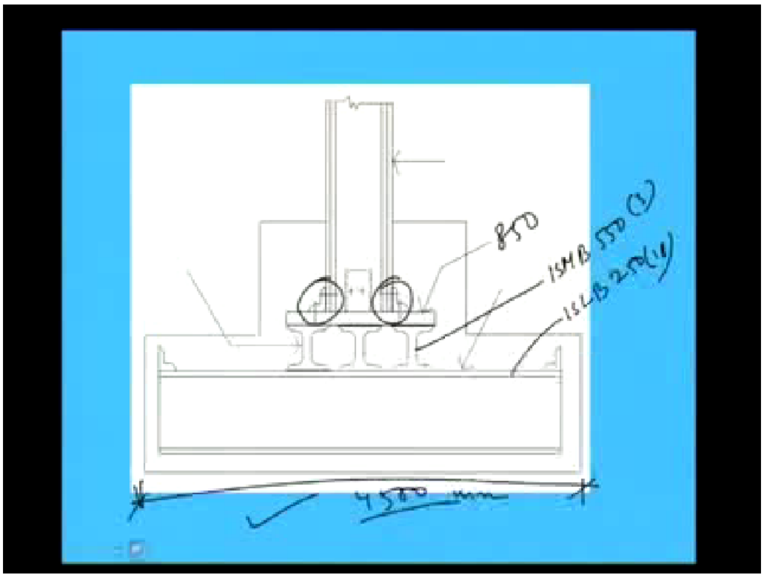

So, in this way we can find out the details of the grillage foundation, these also you can find out twice giving (( )) Remember form the calculation I think you can find out, 4.5 meter that is 4500 millimeter . So, this length also you know. So, in this way you can find out. Now, the remaining part of that previous lecture I like to complete as we have time. Remaining part means in last day we have discussed about the design procedure of the gusset base. So, the example what about we have discussed is in last lecture will solve now.

So, before going to solve just by want me I will just replace this steps because unless we remember the steps you may not be able to find out properly means we may be in trouble to go step by step just to replace.

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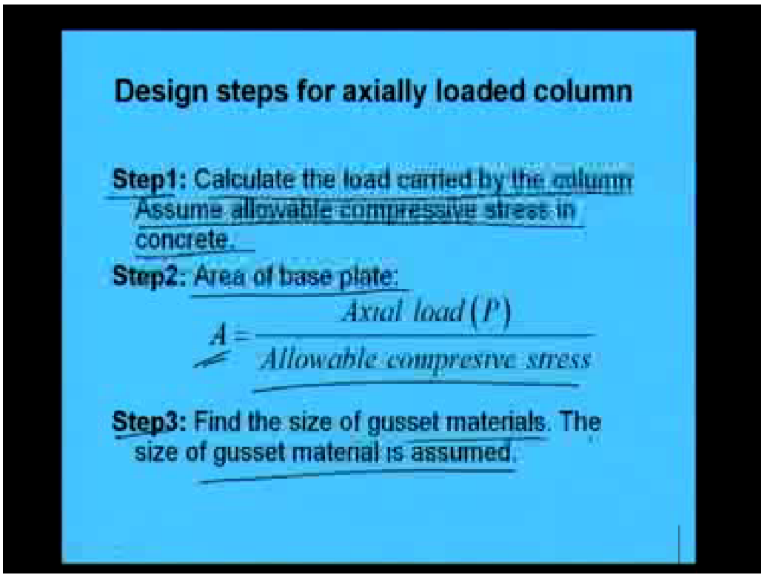

Just I am re writer it is (( )) that is first step what will you do that calculate the load carried by the column and will assume allowable compressive stress in concrete specification, then area base plate will be find out that is axial load by allowable compressive stress in step 2. Step 3 will find out the size of gusset materials and that will be assumed.

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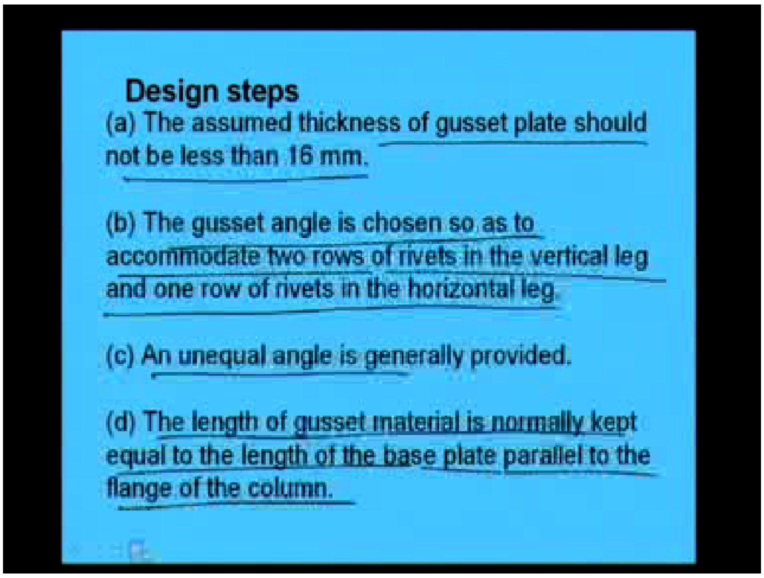

According to the some (( ))that like the assume thickness of gusset plate should not be less than 16 m m, this is 1. The gusset angle is chosen. So, as to accommodate 2 rows of rivets in the vertical leg and 1 row of rivets in the horizontal leg and regionally huge an unequal angle the length of gusset material is normally kept equal to the length of the base plate parallel to the flange of the column.

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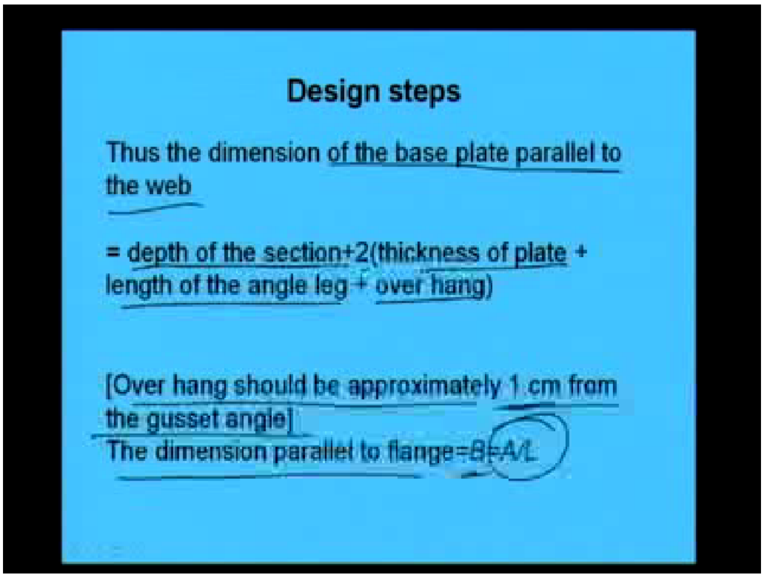

Then the dimension of the base plate parallel to the web can be calculate from this that is depth of the section plus 2 into thickness of plate plus length of the angle plus over hang. Over hang should be approximately 1 centimeter from the gusset angle and the dimension of parallel to flange B will become A by L, A is the total means area.

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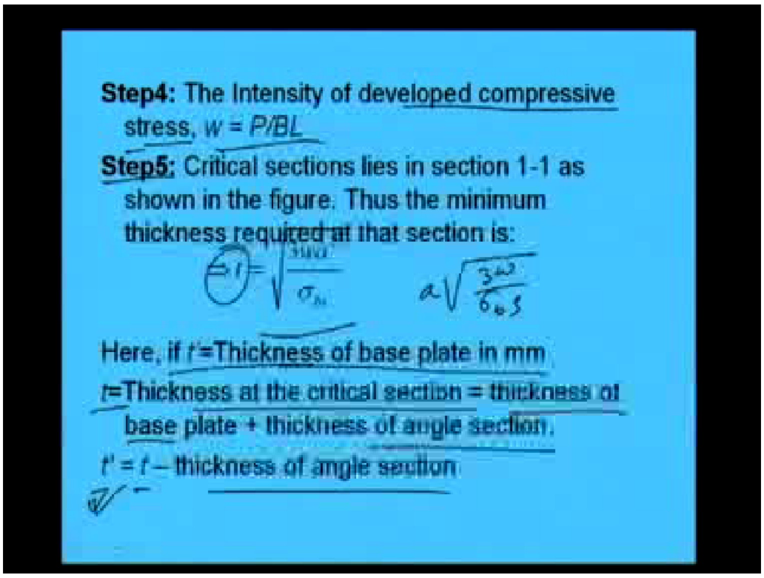

And the intensity develop means the intensity of developed compressive stress W can be return as P by B L, P by B L and in step 5 we can find out the value of minimum thickness equal at the critical section, at the critical section as you know we can find out these value as a into square root of 3 W by sigma b s. Now, if t dash is the thickness of the base plate and t is the thickness of the critical section which is thickness of base plate for thickness of the angle then t dash will become t minus thickness of angle. So, in this way you can find out the thickness of base plate.

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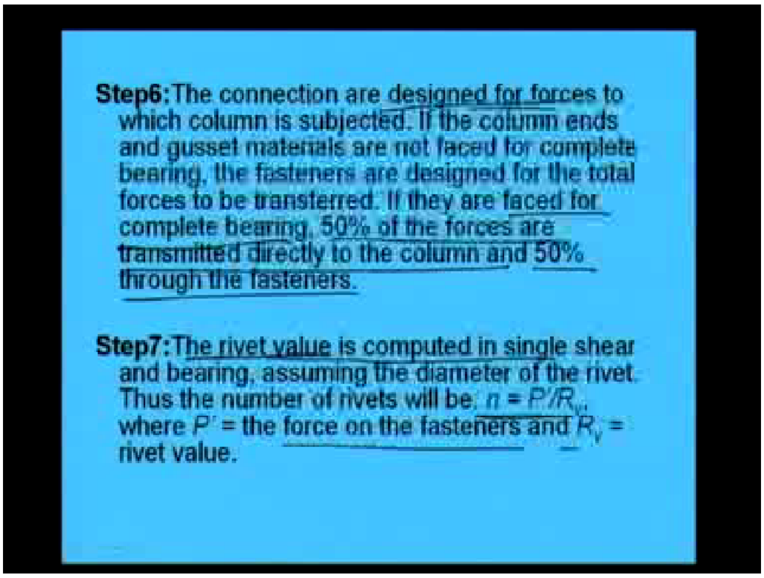

Then the connections are designed, then the and this connection are designed in decision of that 50% of the forces will be transmitted directly to the column and 50% through the fasteners, if they are faced for complete bearing otherwise whole. And we can find out the rivet value for a particular diameter of the rivet and blood thickness there you can find out the number of rivet. On the basis of force on the fasteners and rivet value.

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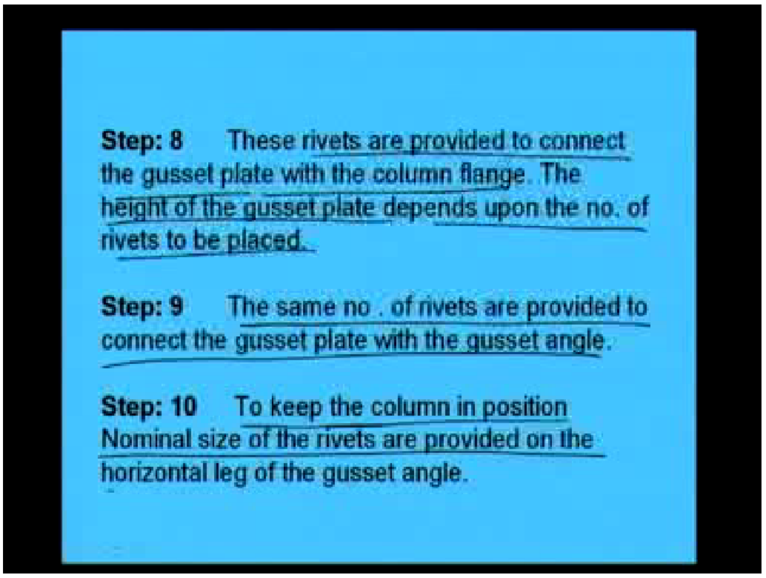

So, this are the state and rivets will be provided to connect the gusset plate with the column flange, the height of the gusset plate depends upon the number of rivets, the same number of rivets are provided to connect the gusset plate with the gusset angle and took column to keep the column in position, nominal size of the rivets are provided on the the horizontal gusset plate.

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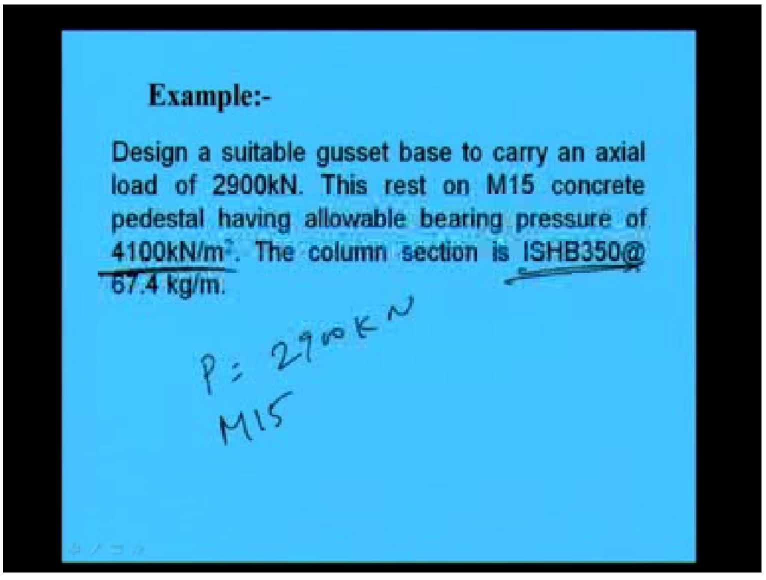

These are the thing and we have seen the example that load was 2900 kilo Newton and M15 grade of concrete was used bearing pressure of 4100 kilo Newton kilometer square and I S H B 350 where used. So, let us see.

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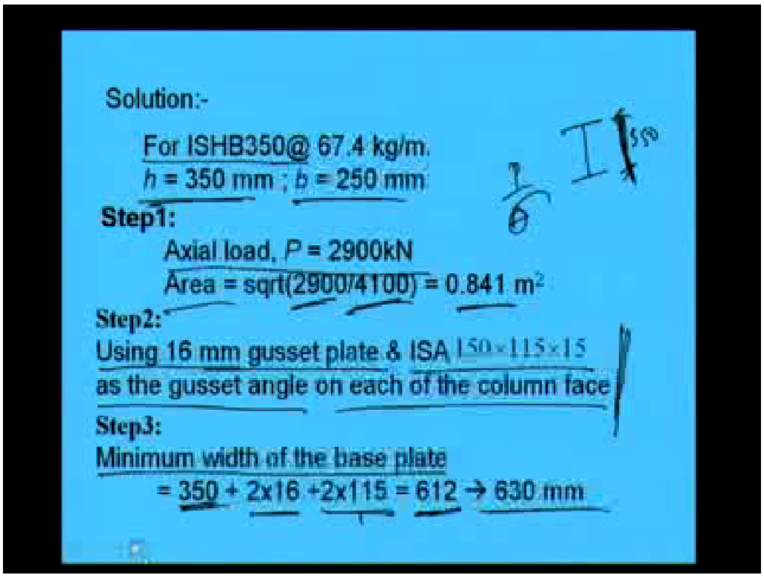

So, for I S H B 350 we know h is 350 and b is 250. Now axial load was giving this. So, area we can find out P by a. So, P is 2900 sorry area will find out. So, P by sigma and sigma is 4100. So, 0.841 meter square. Now, let use 16 m m gusset plate and I S A 150 by 150 by 15 as the gusset angle on each of the column face. So, this we are going to assume. So, from this we can find out the minimum width of the base plate, minimum width of the base plate will be what? The 350 which we got earlier this h because this will be the 350. So, 350 last 2 into 16 plus 2 into 115 this is the angle. So, 612 now let us provides is 630 millimeter base plate width.

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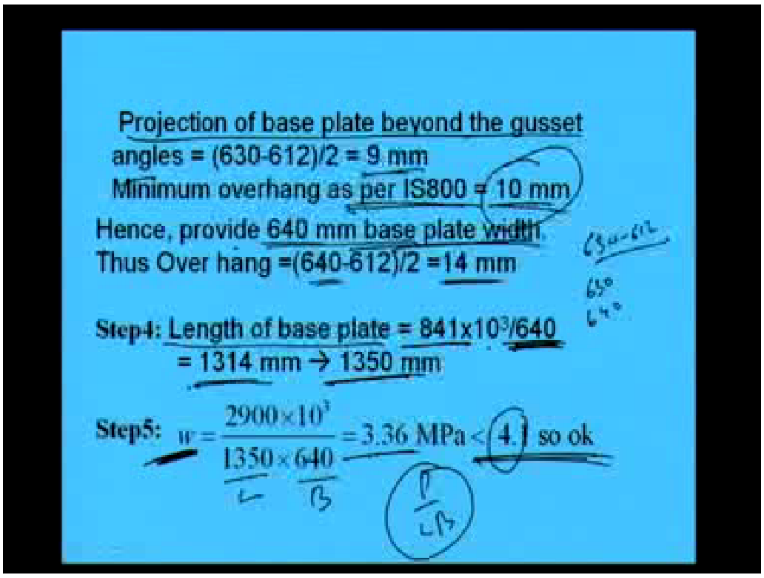

So, projection of the base plate beyond the gusset angles will become how much 630 was total minus 612 was actual. So, 630 minus 612 by 2 is equal to 9 m m and as per I S code minimum over hang should be 10 m m. So, we are providing is 10 m m. So, let us increased from 630 to 640 m m base plate width. We are used IS 630 now we are going to use 640 because to make minimum over hang more than or equal to 10 m m. So, if you make 640 we are going to get over hang as 640 minus 612 by 230 40 m m. So, over hang we are getting 40 m m which is less than 10 m m.

Now, length of base plate will become this 841 into 10 cube by 640, 841 was the total means area, area by length 841 into 10 cube is the total area. So, a by length is equal to sorry width is equal to length. So, 13, 14 millimeter. So, let us use 1350. So, the steps are whatever it is coming in to low intensity that is 2900 by length into width 1350 into 640 P by L into b that is becoming 3.36 M P a which is less than 4.1 because in the example in the question it was given that allowable this I was 4100 kilo Newton per meter square or 4.1 Newton per millimeter square. So, this is the table of one 3.36 is less than 4.1. So, it is right.

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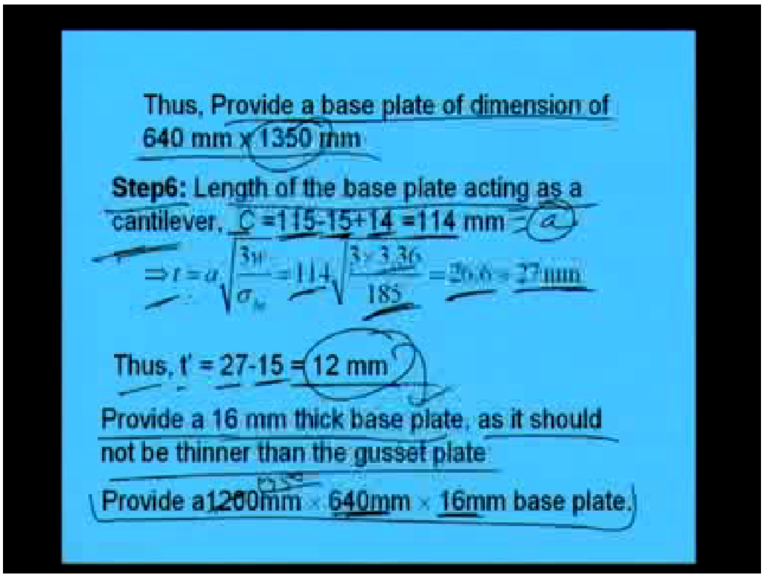

So, now, will go for the dimension what about we have arrived that is 640 by 1350. So, in this way we had (( )) dimension 640 by 1350 millimeter. Now, in step 6 what will do length of the base plate acting as cantilever that C value will be getting 115 minus 15 plus 14, 14 involves the (( )). 115 plus 14 minus 15. So, 114. So, now, we can find out t. t is equal to a into square root of 3 w by sigma base this is basically a or C whatever you can say. So, 114 into square root of 3 into w was 3.36 by 185, this is going 26.6 or 27 m m. So, thickness is coming 27 m m there.

So, thickness of the base plate will become 27 minus the angle of the thickness of the angle. So, this is 12 m m. So, 12 m m we are going to get. Now, what to do? Now, let us provide 16 m m thick base plate means influence of 12 m m, let we are encouraging as it should not be thinner than the gusset plate, in coded provision that told that it should not be thinner than the gusset plate. So, thickness of the base plate will be minimum 16. So, the finally, we are the deciding the dimension of the gusset plate as like this that is 1200 by 1640 by 16. Not 1200 sorry 1350 by 640 by 16, 1350 by 1350 we got, we got 1350 here. So, 1350 by 640 by 16.

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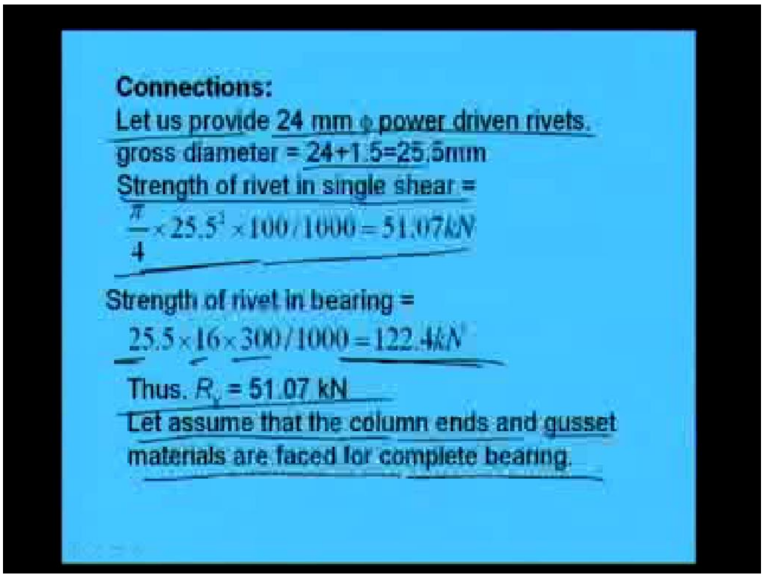

So, in this way base plate dimension has been faced. Now, let us go to the connection. Let us provide 24 m m power driven rivets. So, the gusset diameter will become 24 plus 1.5 that is 25.5 millimeter and strength of the rivet in single shear will become as you know tau (( )) into pie by 4 into d square. So, 51.0 and strength in bearing that is sigma p f into d into t. So, finally, we are getting debate value as 51.07 kilo Newton. Now, let us assume that the column ends and gusset material are faced for complete bearing. If it is faced for complete bearing.

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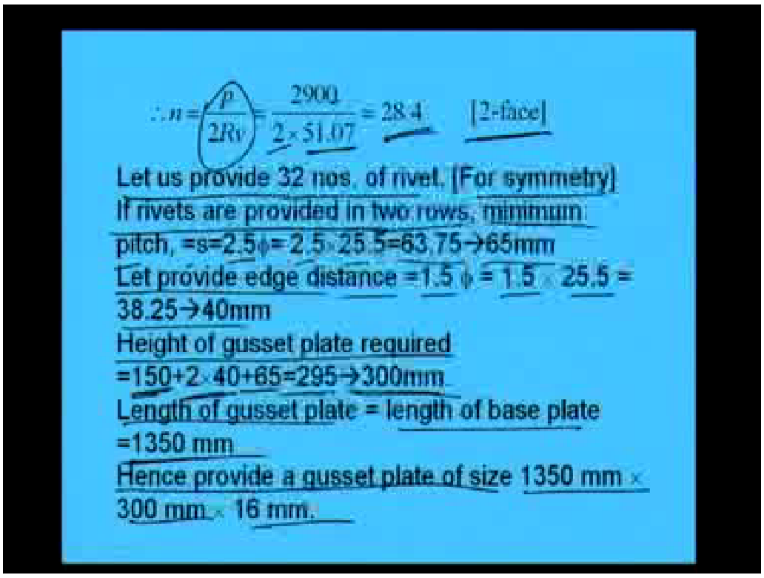

Then, we can find out that 50% is going to taken by that. So, P by 2 into this r b. So, 28.4 and into 2 face. So, let us provide 32 numbers of rivet to make it symmetry, if rivets are provided in 2 rows minimum pitch s will become 2.5 into 5 that is 2.5 into this that is 63.75 that is 65 millimeter. Now, let us provide edge distance of 1.55 that is 1.5 into 25.5. So, that is becoming 40. So, height of gusset plate can be found, angle length that is 150 plus 2 into 40 last 65, 65 is the minimum page. So, 295. So, let us provide 300. So, height of gusset proceed also decided. Now, length of the gusset plate is equal to length of base plate that is 1350 millimeter. So, let us provide a gusset plate of size of 1350 by 300 by 16 m m. So, in this way we can find out the gusset plate size.

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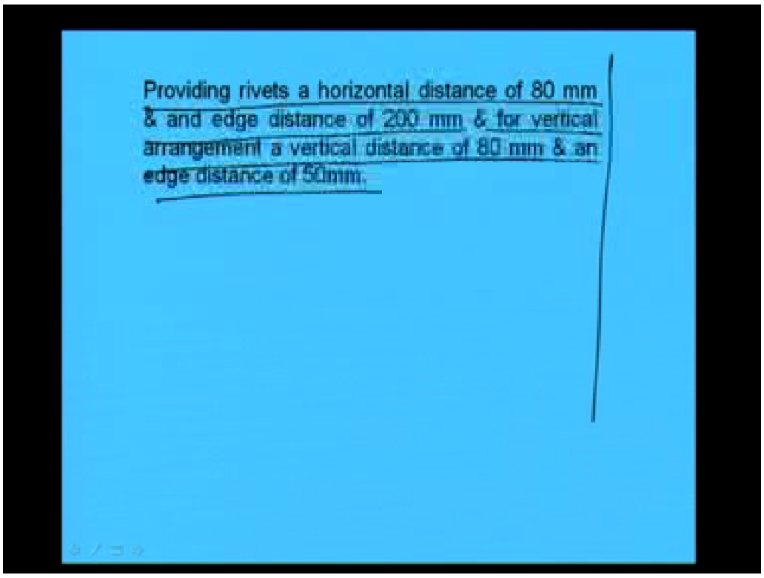

So, providing rivets a horizontal distance of 80 m m and edge distance of 200 m m and for vertical arrangement, a vertical distance of 80 m m and a distance of 50 m m. So, in this way we can provide. So, because of shortage of time I am not going to discuss much. So, I hope you will be able to calculate the details in proper way. So, with this I like to conclude today lecture as well as the last lecture means this is the last lecture which I supposed to deliver. So, thank you very much for your attention. I hope with this you will be able to get some idea about the design of this structure and further if you have any confusion please let us know.

So, that we can clear it. In fact, certain mistake you may find out in my lecture and you people mean those who are viewing this video lecture at the right percent to review. So, if you find any mistake kindly let us known. So, that we can overcome those mistake and we can modify the things because of shortage of time we have done very highly. So, let us know if we have done some mistake in calculation of the workout example excetera. So, that we can modify it. So, thank you very much for your patience to listen to all the lectures of design of steel structures. Thank you.