Design of Reinforced Concrete Structures
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Lecture –14
Design of Slabs

Today, we shall start design of slabs. So, we have a few more lecturers, so today we shall start part 1. And this is your lecture number 14, design of slabs part 1.

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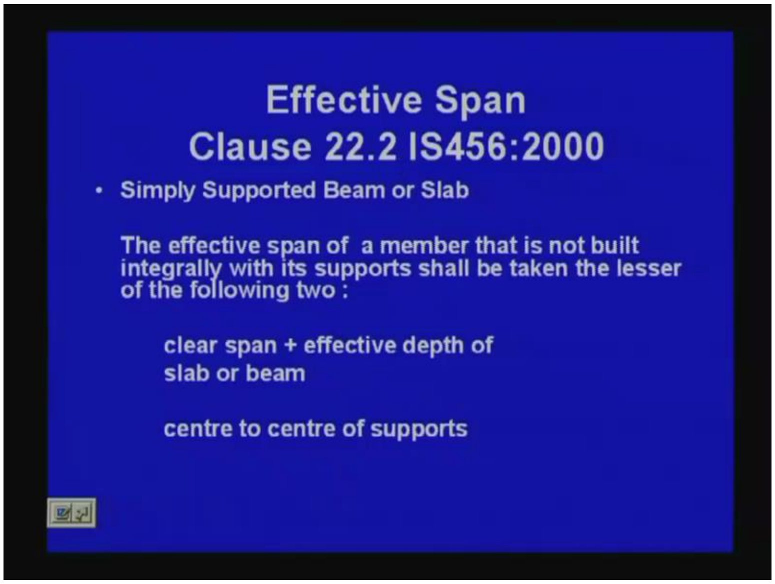

Before we start the design of slabs, let us see what our words says related to your effective span.

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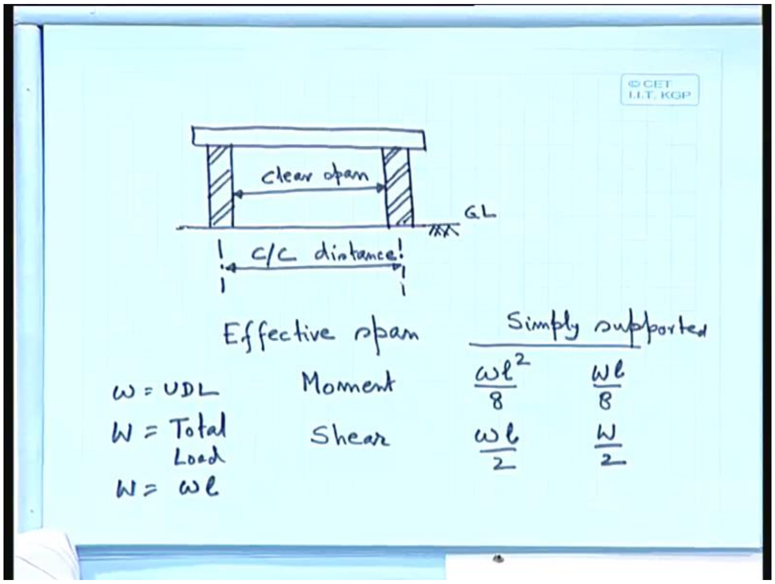

We have, say a masonry wall. This is our ground level; it may be a beam or a slab. We can take as if it is supported by 2 masonry walls. So, we have different spans. This is your ground level, we have foundation but we are not interested right now. This may be a beam or a slab, we have this is your clear span like clear cover, we can say clear span. And let us see the centre line of the supports; here this is masonry wall or brick wall. This is called that centre to centre distance, but this is not the effective span. Our interest here; we have to find out that effective span, like say effective depth, here also we can consider that effective span. Where we have to use this effective span? We have to use this effective span, to calculate moment.

So, you can say for simply supported case, let us say WL square by 8. You have find out the other way also; WL by 8, w is the total load or w is the uniformly distributed load. Similarly, we can take say, for let us be specific simply supported. We can specify 1 of the ways; whether you are specifying w udl or w the total load, whatever way we specify. Similarly, for shear; WL by 2 or simply we can write down w by 2 because, you will find out in codes either it is in a total load. Total load is nothing but, w I can say, in this case which is nothing, but w times l; total load.

So, our interest here, what we have to find out; what is the effective span? Or in the other way what is the value of l? For this case, if you take the simply supported case what is the value of l that effective span, that we have to find out. Now, let us see that what our quote says is 456 what our quote says.

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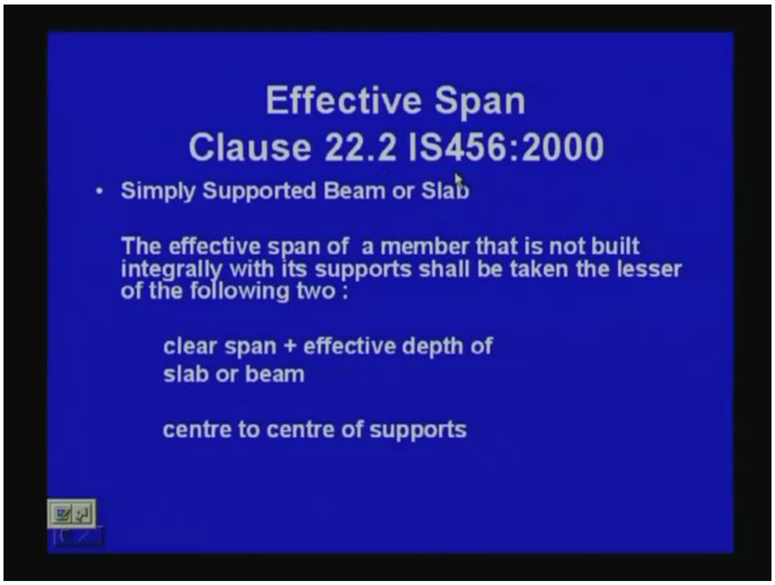

We can take the effective span and we shall get it in clause 22.2 is 456 2000. In design classes, we most of the time we Refer that code because, wherever you have any dispute or another thing, that is the code it will help us to solve that problem. So, if it is simply supported beam or slab, the effective span of a member that is not built integrally with its supports that means: there is no movement developed in the support, shall be taken the lesser of the following 2. That means: you are having 2, out of that which 1 will be the lesser, that we you have to take.

So, that means: you have to calculate that clear span plus effective depth of slab or beam. That means: which are the case you are considering. In our case, in few next few days, we shall design slabs, so we shall take here slab only. So, clear span plus effective depth of slab or beam. So, that we have to take, that is 1 case that is our effective span shall get.

The other 1 is centre to centre of supports. Out of these 2, which 1 will be minimum; that we shall take it as effective span, for that problem.

So, here if we take, say 250 is the width of the wall brick wall, then we can find out centre to centre distance, if the slab gets 124 millimeter is the overall depth. So, you can calculate, we can assume certain depth and on the basis of that, we can go for calculation or replacement. If, it is 125 millimeter or 150 millimeter that is, the thickness of the slab then, you can calculate effective depth and you can find out the effective span.

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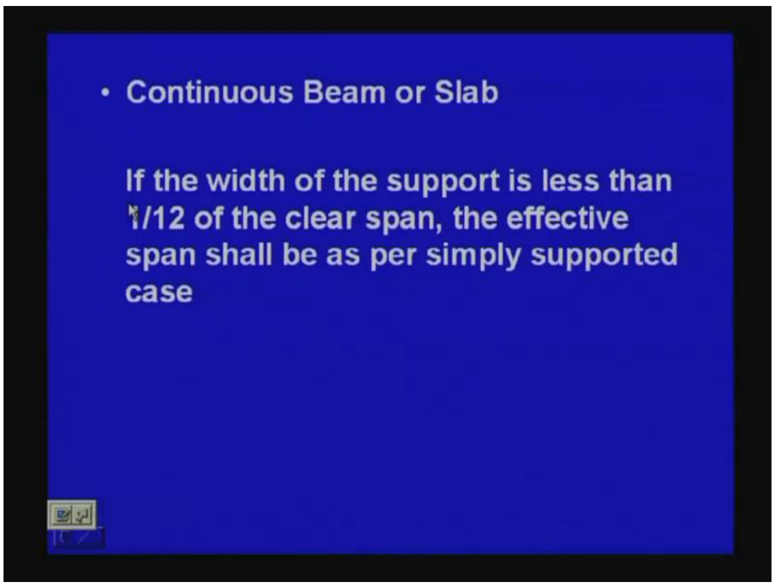

But, if it is continuous beam or slab, so we have the code says; it is in the same clause. If, the width of the support is less than one- twelfth of the clear span, then it is dependent on the support width. The effective span shall be as per simply supported case, the 1 which I have already told, so it will be according to that. Then it is dependent on the width of that wall or the support but, it is not we do not stop it here, there are further clarification.

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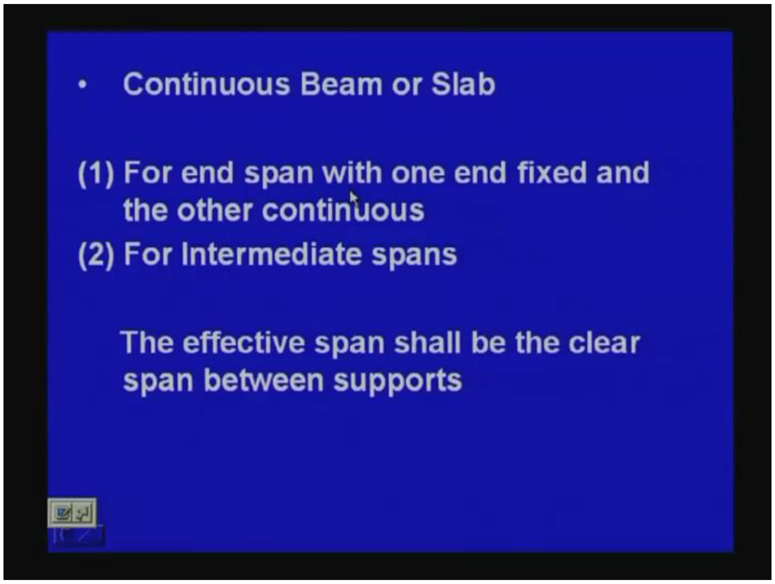

Continuous beam if it is the other way, for end span with 1 end fixed and the other continuous, what is continuous? We can start in this way that means: the slab, we are specifying the slab or beam whatever you specify, if we take it as a say simply supported, it can move like this. So, you can go like this; let us say stop it here. Let us say there is a column here, we can put it like this just to make it there is a column here, a column this side so that means: I can say this side is fixed.

So, our case in this case we can say for end span with 1 end fixed and the other continuous or for the intermediate spans, the effective span shall be the clear span between supports. So this is the case, so you will simply take that clear span between supports.

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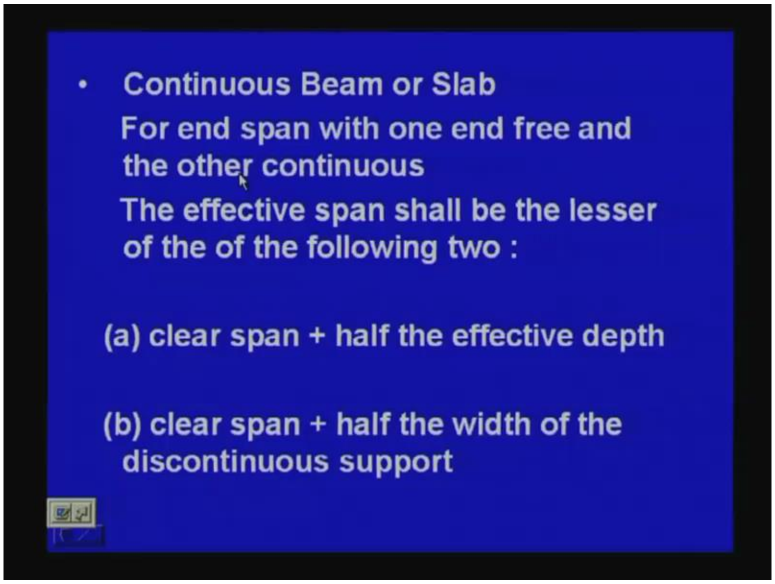

So, we can say for this case; this is the clear span and also it is told that for intermediate supports, the intermediate span. These are the intermediate span but, so we shall take the clear span. What about the other case? For end span with 1 end free and the other continuous, the effective span shall be the lesser of the following 2; clear span plus half the effective width, note half the effective width depth, clear span plus half the width of the discontinuous support. That means: here in this case we are talking this problem.

So, what should be the effective span? Because, this side is free discontinuous support and we shall get for this case, your effective span will be different. And that 1 will contribute, in calculating your moment shear other things; that is why it is so important. Because, if you consider moment, so it becomes a l square. So obviously; the effective span it will little bit crucial.

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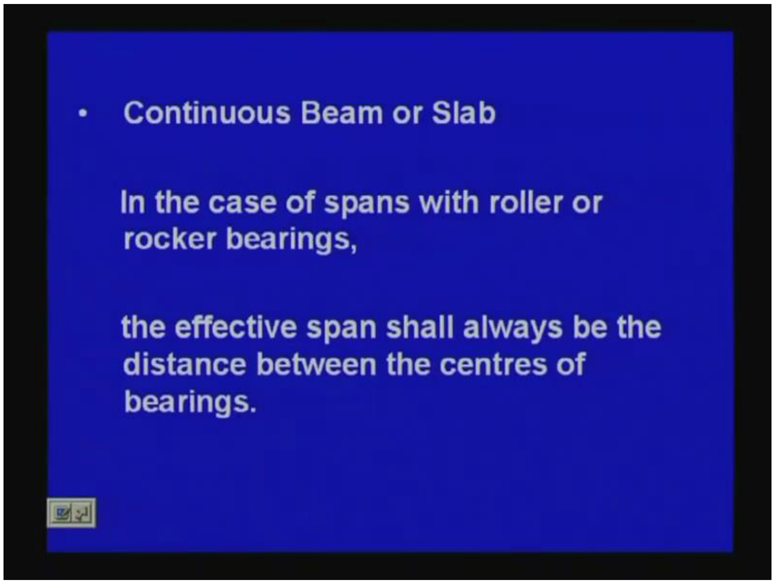

Now, we have 1 more case: continuous beam or slab. In the case of spans with roller or bearings, the effective span shall always be the distance between the centers of bearings, so this is very simple. So, when you are talking say bearings, so then it will be just you take the centre to centre distance between 2 bearings. So, that all of them you will get in the is 456, but I think this is required to know with examples.

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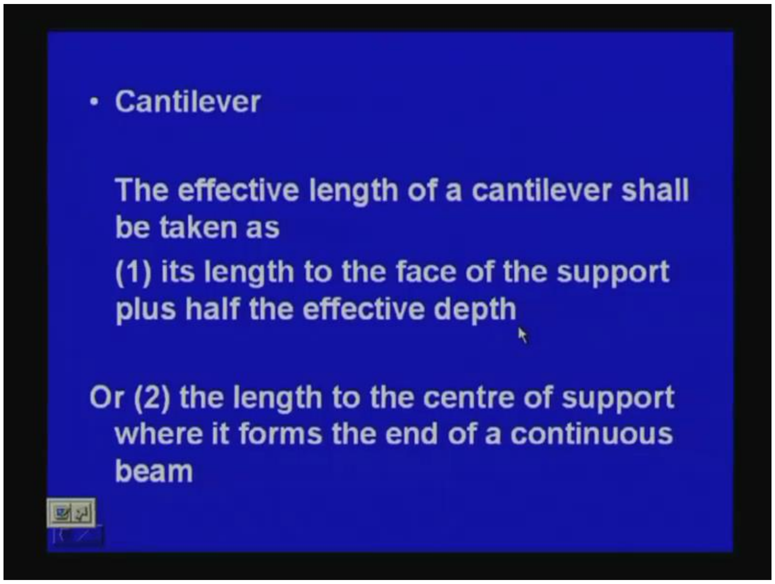

Now, what about the cantilever? For cantilever, the effective length of a cantilever shall be taken as 1, its length to the face of the support plus half the effective depth, note in few cases you are taking effective depth and few cases you are taking half of the effective depth, so that you please note. Or the length to the centre of support, where it forms the end of a discontinuous beam, then this is the case where it is a discontinuous; it is the end of a continuous beam.

So, when it is continuous beam that means: here if we take like this this problem, it goes. So, in this case what will happen, then we shall take that these portion we shall take it as say your, we are talking this, as I say continuous beam. This is a continuous beam we are considering say and at the end we are talking say you say as slab, so there we shall take the second case, the length of the centre of support while it forms the end of a continuous beam. That we shall take for that problem.

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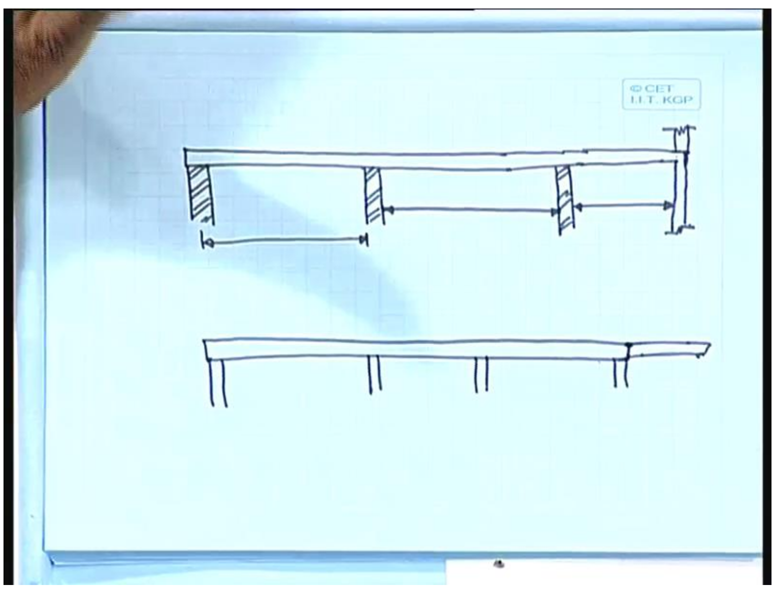

So, according to this effective span, we shall decide which is the case? What is the support condition? And on the basis of that we shall find out the effective span.

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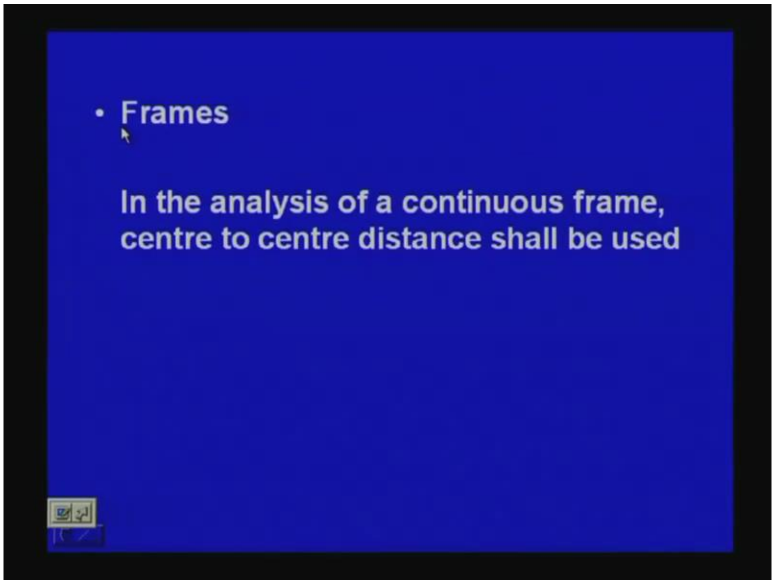

But, what about frames because we have to analysis say your problem, we need this 1 for analysis purpose. If, it is a frame structure, that which you can analysis it with some say 1 say method different methods by say any program is still now a days we do it.

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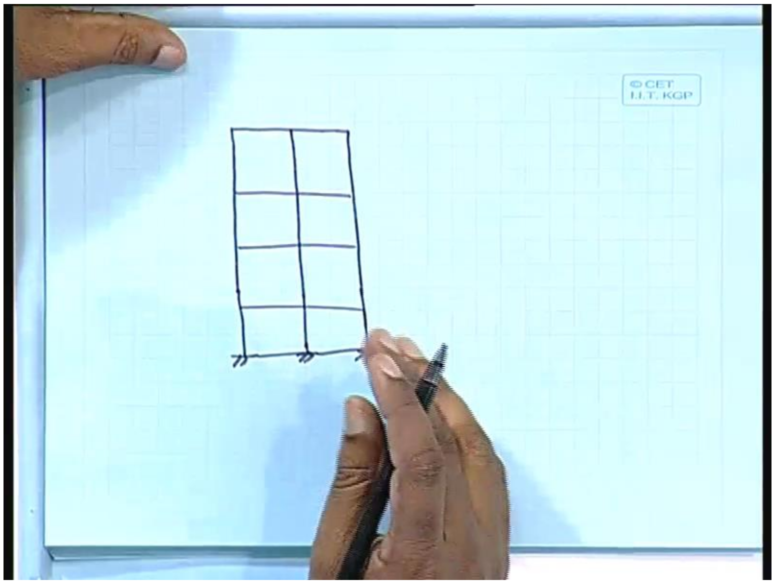

So, in this case what will happen? In the analysis of a continuous frame, centre to centre distance shall be used. So, you shall not go of any experiment on anything on the effective depth or anything. So, we shall do the analysis for frames; multiple frames for say seismic analysis, dead load live load, different load cases, we have to take and accordingly we have to solve it. In that case, we shall take that effective span, simply the centre to centre distance.

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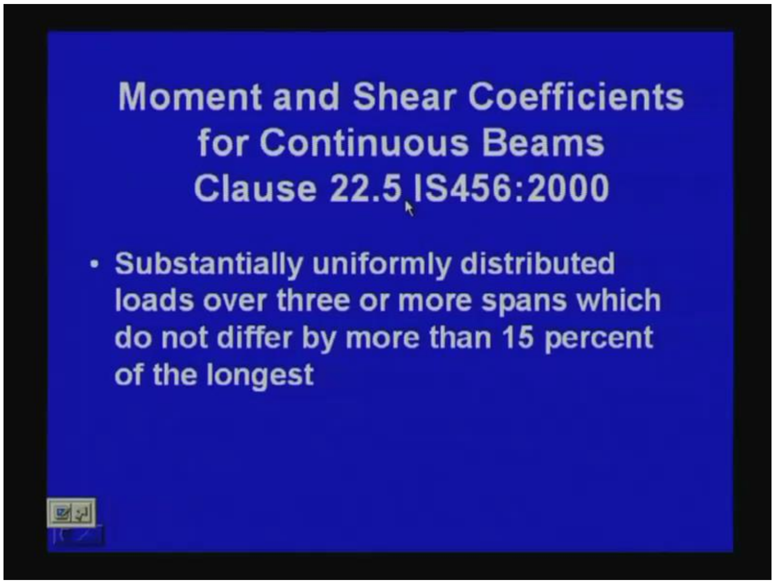

We do that, our code says; that moment and shear coefficients for continuous beams, which we can get it in clause 22.5 I think because, I always Referring this clauses, so at least you should note down so that, you can refer those clauses. So, where shall we use this? Our code gives few coefficients so substantially uniformally distributed loads over 3 or more spans. This is for continuous beams or slabs when you shall take, substantially uniform, it is not exactly but, it will be take 10 percent or 15 percent that way we say.

So, if it is a more than over 3 or more spans, which do not differ by more than 15 percent of the longest. There is a longest span out of that and if you find that, not within more than 15 percent, then we can use these coefficients.

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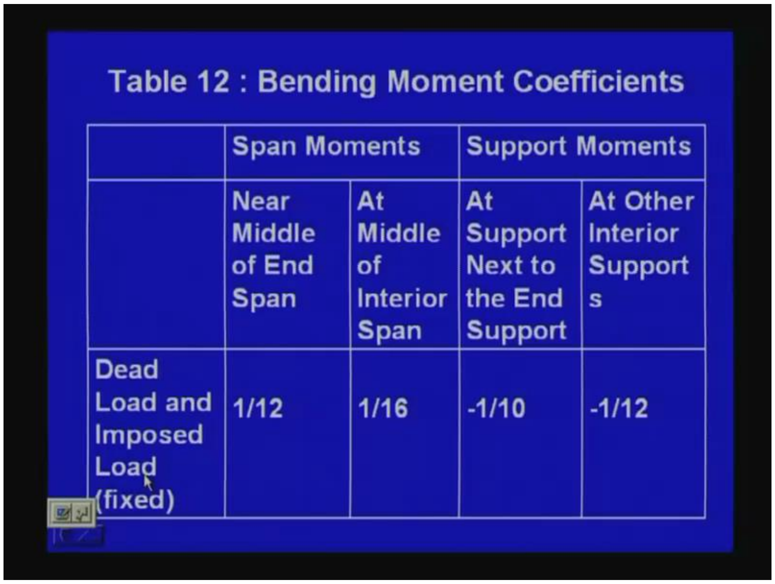

Table 12 : Bending Moment Coefficients

	Span Moments		Support Moments	
	Near Middle of End Span	At Middle of Interior Span	At Support Next to the End Support	At Other Interior Support s
Dead Load and Imposed Load (fixed)	1/12	1/16	-1/10	-1/12

So, 1 table 12 that simply, I have copied that 1 that is; bending moment coefficients. But, we have to use the different coefficients, we have to use. So, for span moments and for support moments; there is 1 span moment and there is support moment; so near middle of end span, for span moment. And we are talking this 1 say dead load and imposed load fixed, dead load and imposed load fixed.

So, loading which are say you shears or any machine that is fixed in its position, then we take it as a fixed imposed load. So in that case, near middle of end span what does it mean? It means: so you can take this problem. So, near middle of end span, why near middle of end span? Because, when in diagram may be sometimes, it will be say something like that, for uniformity distributed load, so it will go like this and here it thins because, at this end we do not have any end 1.

So, it will be near middle of not exactly in the middle, so to the near middle of end span and that 1 we shall get and have to take that 1 by 12 that coefficient. So, that coefficient what is that coefficient? It means: the movement equal to, if I takes a total load, so 1 by 12, w is the total load and l.

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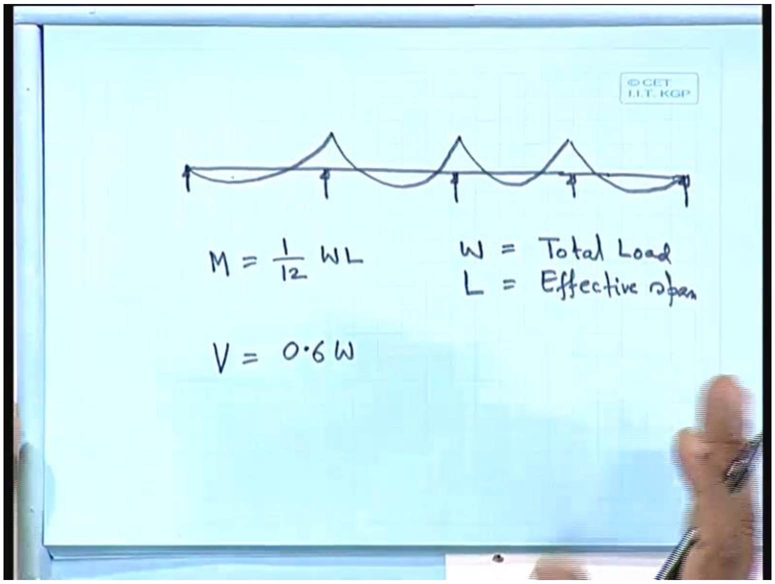

So, let us write down w total load on that span, where which 1 you are considering and l effective span. So, M equal to 1 by 12 WL here that is, the coefficient we are taking. At the middle of interior span, at middle of interior span that means; this is the interior spans, these are called interior spans, this is called interior span. So, we shall get in the middle of the interior span; here, here and that how much you shall get? That is 1 by 16 times that WL.

Now, what about your supports? At support next to the end support because, we are at the end support there is no movement, so at support next to the end support, that 1 will be even minus 1 by 10 and at other interior support we shall get minus 1 by 12. So, here we shall get; here we shall get that you say support next to the end support and this is your interior support, in this particular problem. So, this is your case, we are considering dead load and imposed load fixed.

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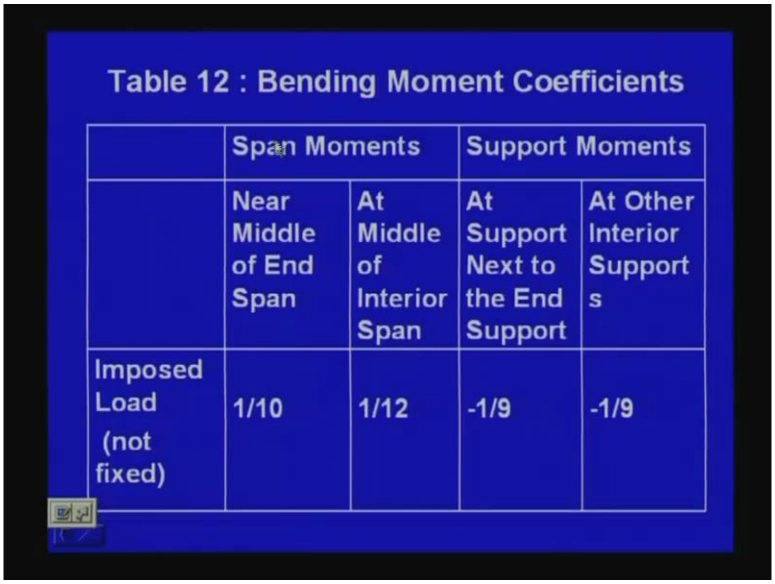

Table 12 : Bending Moment Coefficients

	Span Moments		Support Moments	
	Near Middle of End Span	At Middle of Interior Span	At Support Next to the End Support	At Other Interior Supports
Imposed Load (not fixed)	1/10	1/12	-1/9	-1/9

Now, this 1onethat imposed loads not fixed, which is movable that means; today at this time you are say, you are in the bedroom itself, you can say that you say dressing table then, you are say cot and so many other things almirah, all those things you just move around . So, that way we can say this is not fixed. So in that case, we have to take these coefficients.

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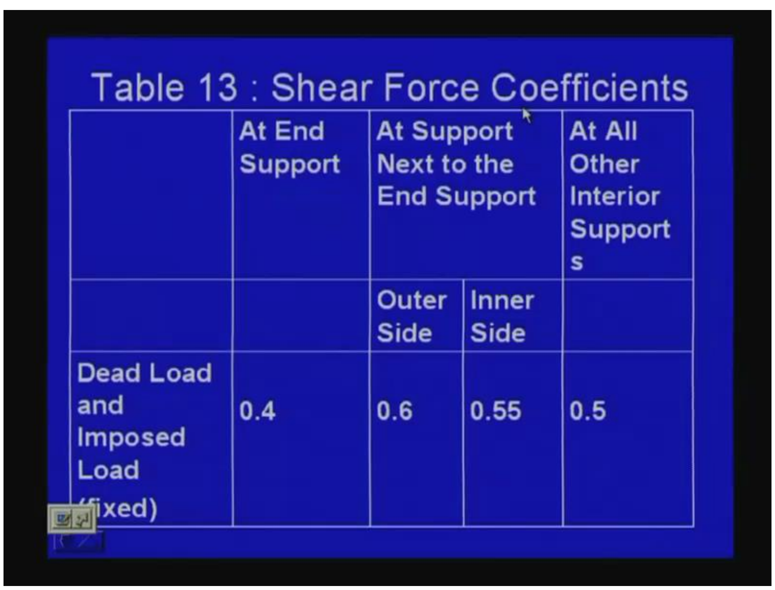

Table 13 : Shear Force Coefficients

	At End Support	At Support Next to the End Support		At All Other Interior Supports
		Outer Side	Inner Side	
Dead Load and Imposed Load (fixed)	0.4	0.6	0.55	0.5

Now, what about your other part? There is 1 shear force coefficients. This shear force coefficients here, again the similar fashion, that dead load and imposed load that is fixed, at end support and at support next to the end support and at all other interior supports. So, you shall get and we are having that, next to the end support we have 2 positions; 1 is the outer side other 1 in the inner side. What does it mean? It means: this is your outer site and this is your inner site. And that v, that 1 will be equal to say 0.6W, W is the total load.

If, it is simply supported beam say then, W by 2 that is 0.5 instead were, we are having 0.4 0.55 0.5 0.6 like that. And that we have to take it, the moment and shear force you shall get it, so that means; if the spans are uniform, that we say almost constant, all the spans same and load also does not differ much then, we can use the table 12 and table 13. These 2 tables we can immediately we can use it and we can find out the moment and shear force.

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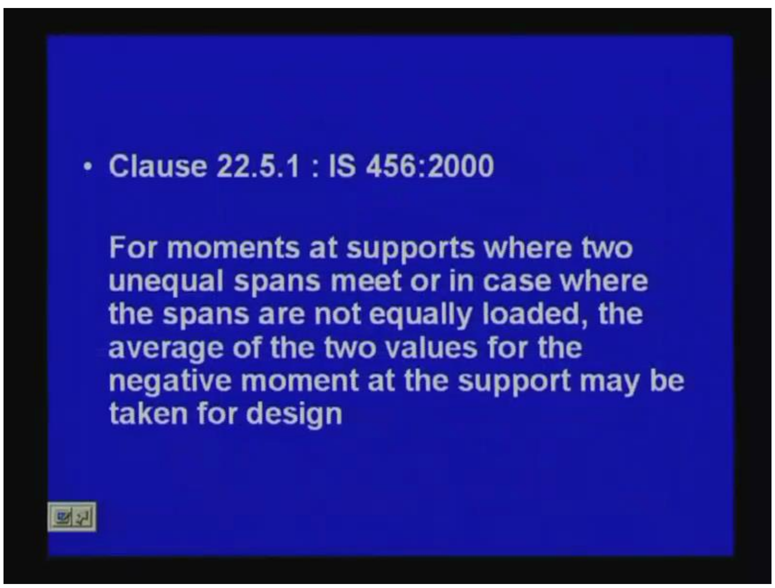

Now, our quote says that for moments at supports, where 2 unequal spans meet or in case where the spans are not equally loaded. It may be the either case, that means: the spans are equal and but loading is different, so that is why you will get for in 1 side you will get

1 moment, considering the other side you will get the other movement, in the same point same junction, same support. If the spans are different then also, you shall get the different movement. In that case, our quote says that, the average of the 2 values for the negative moment because, we are talking say support at the support, may be taken for design. In that case we simply, we shall take the average value. Because, at each and every level, there should not be any confusion or dispute and that is dissolved in this quotes. That is why this quote is so important.

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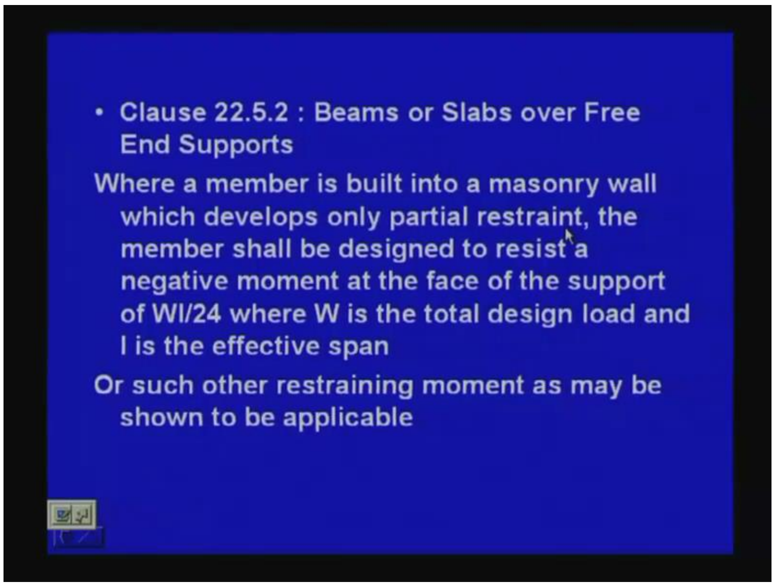

So, this is another clause where, a member is built into a masonry wall. So far, we have taken that masonry wall that mean; simply supported, but it may happened that you are say beam or slab that is interiorly, that is inserted in the embedded in the masonry wall itself. In that case, certain partial fixity may occur and our quote says; where a member is built into a masonry wall, which develops only partial restraint, not full that you, not WL squared by 12.

The member shall be designed to resist a negative moment, at the face of the support, at the face of the support of WL by 24. Instead we are having to say, WL by 12 w is the total load l in this case and l is the effective span. So WL by 12 24 that mean: we are taking half of that. So, per shelf fixed effected you can say half that means, it is semi rigid you can say in 1 since or such other restraining moment as may be shown to be applicable or you can argue, this is a very determinant problem. So, you have personally fix it you know, from other some other sources or measurement. So, you can take that 1 also, so our quote says; that is what you can take, but there should be only taken if the client of both sides that agree.

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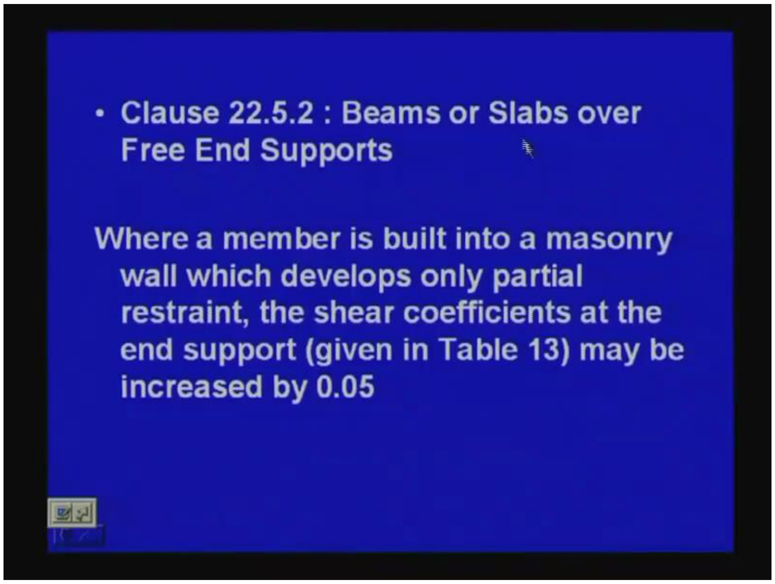

Beams or slabs over free end supports, where a member is built into a masonry wall, which develops only partial restraint, the shear coefficients at the end support, that is which is given in table 13 that is a shear coefficients, may be increased by 0.05 that means: you can add 0.05 that, if it is 0.4 then, you add 0.45. If, it is 0.55 then, you add 0.6. So that way you can take, that is for shear and the other 1 for moment.

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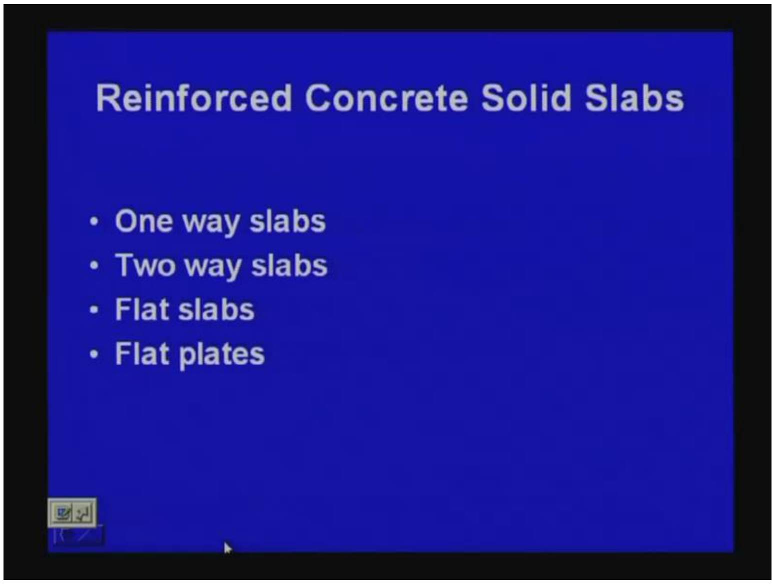

Now, let us come to our problem that, so far we know that what is the support condition, what should be the effective span, how to calculate shear and bending movement, how to calculate shear force and that we shall follow. So but, what are the different kinds of slab? If we take, there are reinforced concrete solid slabs. Mainly, we shall take say 1 way slabs, 2 way slabs, then flat slabs and flat plates. These are the 4 different we shall use it.

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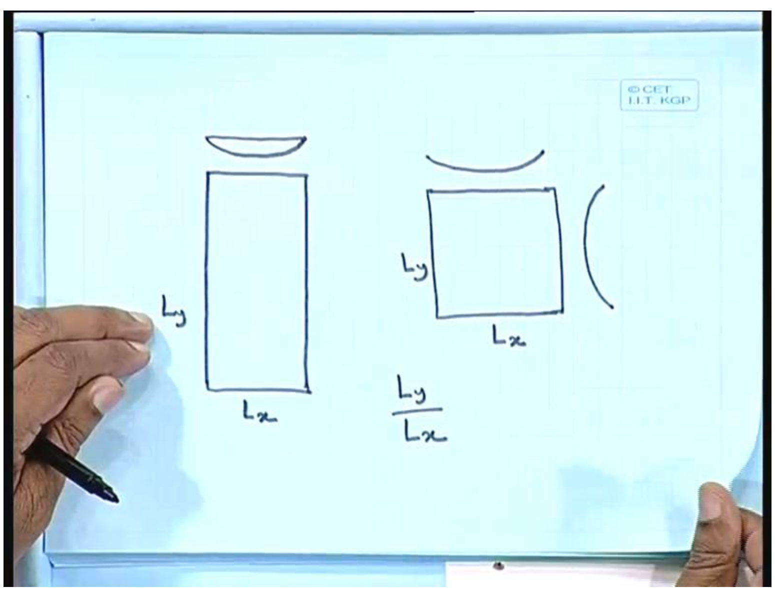

If, we say, let us say this is 1 hall what will happen this 1? You will find out that bending, you can take a piece of paper or you can take say your any type of say, thin membrane type of thing, if it is just a plastic also, you keep it over this type say arrangement, what will find out? You see that it is bending like this. If, we make it says almost a square then, we can find over that you will see that both sides; this side as well as this side.

Now, depending on these let us say Lx and this is say Ly; the span in both sides. Depending on the situation Ly by Lx, we find out that whether if it is 1 way or 2 ways. How to design that means; whether we shall consider only 1 side movement or whether we shall consider the movement both sides. So, in our case 1 way; if Ly by Lx greater than 2, then we shall take it as say 1 way, if it is say within less than equal to 2, then we shall take that 1 in this problem we shall take 2 ways. We shall count the other 2 flat slabs and flat plates that, we shall not design but that 1, we shall come later stage. At least, I shall show 1 or 2 examples how to design that 1.

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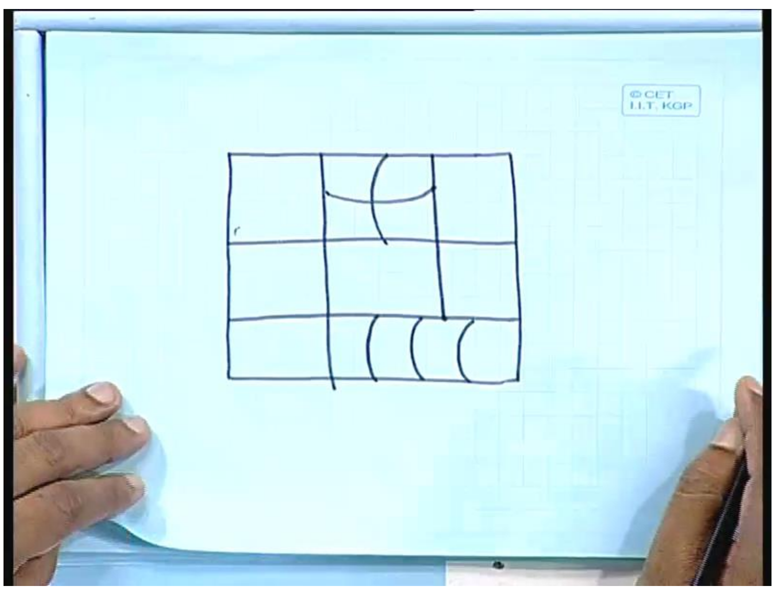

Here what happens, we are talking say frames structures; if you take a grid, if you take a grid say like this say something like this; which is coming, these are all beams these. And over that, we have the slab. So these are all slabs and that you have to design. Now, for this problem if I discontinue the beam here, then we can get this is 1 panel and here we can design it, as if it will beamed like this, this side.

So, we have to design that 1, as I say 1 way. Whereas this 1, it will bend this way as well as this way. So you have to design this 1 as I said 2 slabs that, I should will show you, that in the next few classes, how to design that 1. Now, what about you say but that means it is supported by the beams or may be walls.

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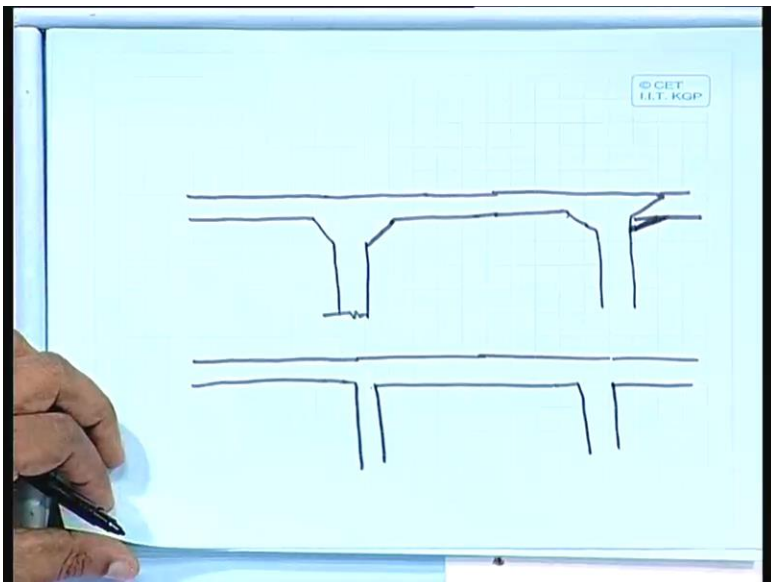

Whereas, it may happen just to show you that flex slabs. It may happen that it is like this. This is your beam column, so this is your, we can design it as I said flat slab. We can also take it as, simply say flat plate as if it is supported by that columns only. There is no beam, it is just supported by as if that is there are different say prop, there are different supports and over that, you are keeping 1 plate, whereas here you are just making little bit bigger and then what that you have keeping the slab or plate. So this is your flex slab, this one is talking that say here that flat plate.

So, these are the 4 different types of say your slab part, we generally design. But in our case, we shall only concentrated in this class that is; 1 way slab and 2 way slabs, which we mainly generally use.

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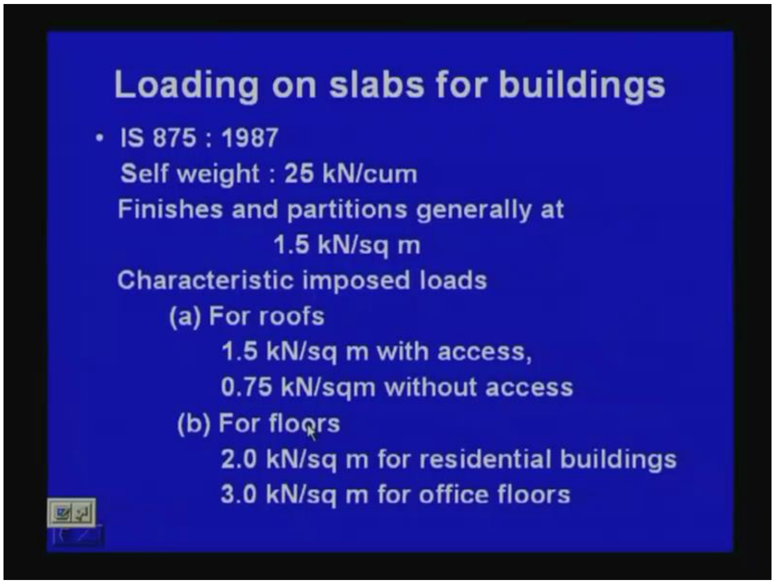

The other portion, at least we should remember, that is, loading on slabs for buildings. Let us say, at least we should remember this 1 and what our is 875 1987 that 1 says, obviously; we have to take self weight for reinforced concrete, already we have used this 1 25 kilometer per cubic meter, finishes and partitions. We use finishes and partitions generally at 1.5 kilo Newton per square meter. Note use cubic meter and here we are using 1.5 kilo Newton per square meter.

So, you finish and partition also that we say, partition wall that 1 it is distributed, say may be say 125 millimeter thick, say your brick wall. So, you can place it anywhere so that, we shall distribute that load and that is your coming on that 1.5 kilometer per square meter. The other 1 that imposed loads for roofs, this is 1.5 kilo Newton per square meter with access, that means: if you access the roof, if you have access then, we take it 1.5 kilo Newton per square meter.

If, it is not accessible, possibly your hall possibly that your roofs are not accessible, so in that case, we have to take say 0.75 kilo Newton on per square meter. For floors, we are having 2 different 1 that, if it is say residential buildings, so you take 2 kilo Newton on per square meter. If, it is office floors then, you take 3 kilo Newton on per square meter. So, we should remember these few and if it is not mentioned then, we shall assume on the basis of this that means: if it is a office building, if it is not mentioned the load, then we have to take that 3 kilo Newton on per square meter.

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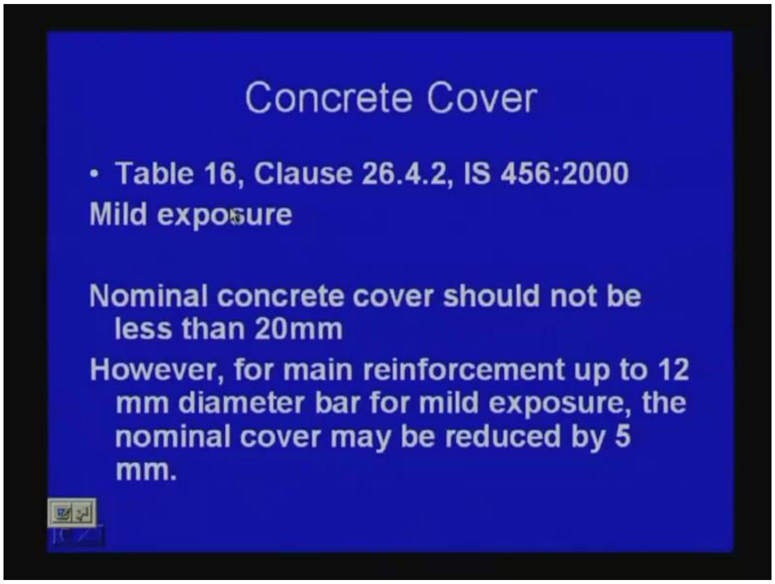

What about the concrete cover? That you will find out in table 16. We have already used clear cover, that is, 25 millimeter for beam. So, you will find out in table 16 clause 26.4.2 is 456 2000. And I have just given say mild exposure because, severe there are so many other exposure environmental 1. So, nominal concrete cover should not be less than 20 millimeter. It says it should not be less than 20 millimeter.

However, for main reinforcement up to 12 millimeter diameter bar, for mild exposure, the nominal cover may be reduced by 5 millimeter. That means: if it is say mild exposure and the body you are using for slabs; if it is less than 12 millimeter or upto 12 millimeter then, you can use we can reduce that 20 millimeter to 15 millimeter, that means: we can use 15 millimeter.

So, for slabs we shall use 15 millimeter. If, it is not mentioned any other say in your environmental condition and your exposure condition or any you are using that within 12 millimeter, then we shall use this 15 millimeter.

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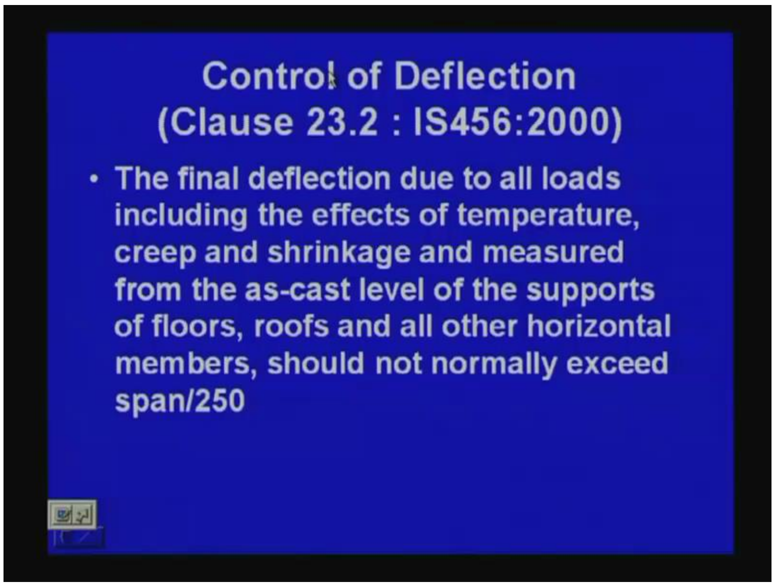

Then one more part that is; very important because, this is the one that which will be giving the serviceability. I have already told this is the 1 that, so far whatever I am talking, that is called actually you limit state of collapse. We are talking flexure here; for beams as well as for slabs. But, there is a 1 more part, that is you say serviceability limit state so that, the users will not feel any discomfort. And that 1 obviously; that you say deflection, that if you have say; deflection that if you say that you have slab or the 1 where your are supporting structure, if it is vibrating too much, if you are having deflective more, then obviously; that you will feel it will be scary.

So, at least it should be serviceable and that 1 obviously 1 part that is you say control of deflection, that even say crack section. The crack section if you find out cracks, then what will happen, that also it may be scary. But, even if you give guarantee but unfortunately or fortunately that our assumption is that, it is based on crack section. The design you are doing that is; you would actually crack section design that only the assumption. So, that means even if you find cracks then you can say, even then it is safe but, the users who are using that 1 residence of that building, obviously; that it may be scary. So, it is little bit irony also you can say and that is true for all of us also, even if you design.

So, this control of deflection, you will find out in clause 23.2. The final deflection due to over loads, but how shall we find out? Because, you are not going to calculate that deflection, so we do it on the basis of something say span. So the final deflection due to all loads, including the effects of temperature, due to temperature also the deflection may occur, creep it occurs and shrinkage, this will be are measured from the as-cast level of the supports.

So, from one, you can take 1 say bench mark point, that is, the support of floors or roofs and all other horizontal members, should not normally exceeds span by 250, it should not exceed span by 250. That means: if we know span, so effective span say you are say 3000, so you can take say divide by 3000 divided by 250, that you should take it as I say you, say maximum deflection allowed.

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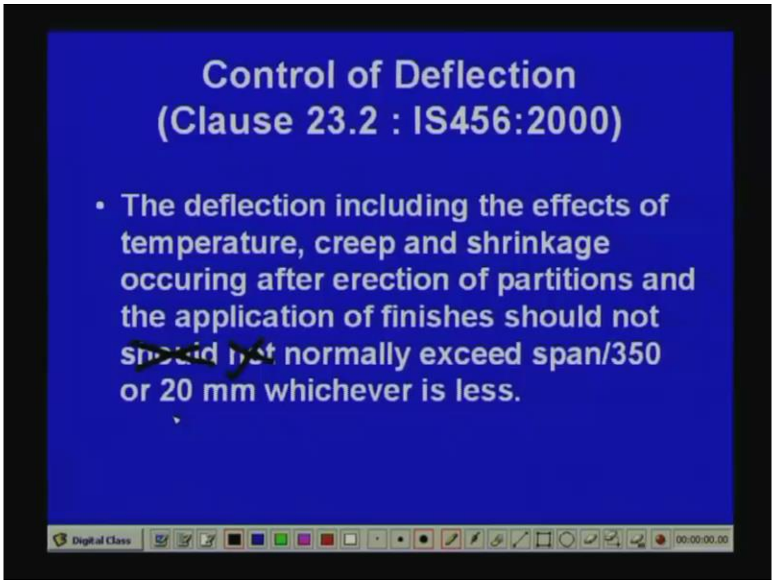

The deflection, including the effects of temperature creep and shrinkage occurring, occurring after erection of partitions and the application of finishers, that means: partition or any other that final 1 and finishers, should not, so normally exceeds span by 350 or 20 millimeter whichever is less. So, you should remember that span by 350 that is, the maximum allowed that may deflection or 20 millimeter that is, it specified that in our case it should not be more than 20 millimeter.

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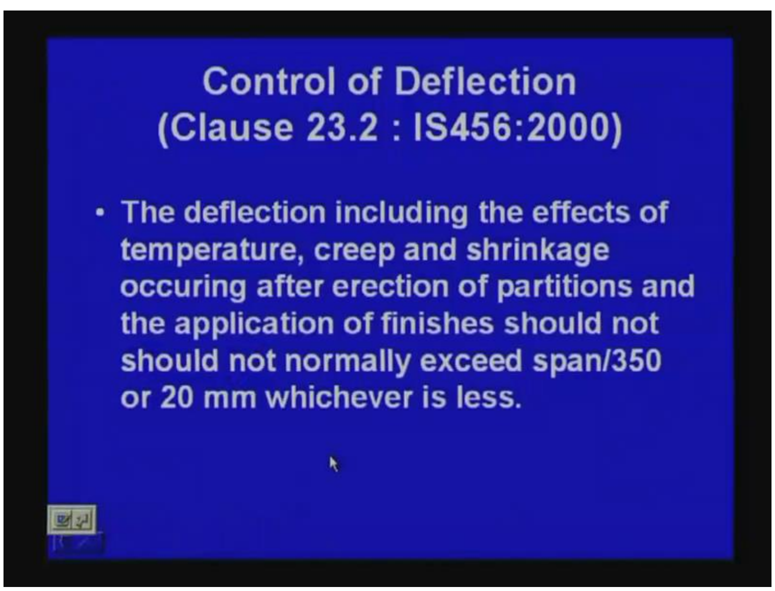

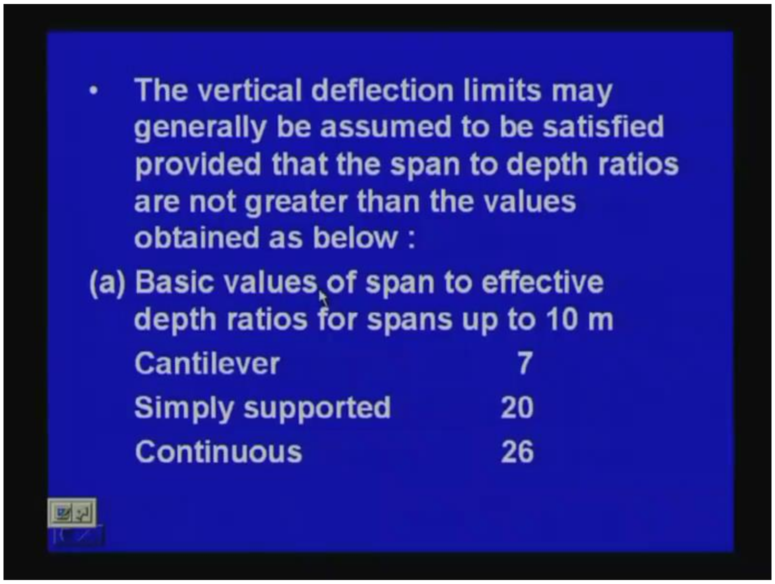

Now, let us see the vertical deflection limits, may generally be assumed to be satisfied, provided that the span to depth ratios are not greater than the values obtained as below. We can satisfy that 1 in other way; indirect way. We take that certain span to depth ratios span by depth ratio l by d, l is the effective span and effective depth d. So, if we take certain ratio which we can find out, the code says; if it is cantilever and then our code says that means: here we can get cantilever l by d, we will getting that 1 say 7. And here this is your basic values of span to effective depth ratios, for spans up to 10 meter. That means: if the span is up to 10 meter then, we shall take, for cantilever span by depth ratio that is 7, because it will give us that to choose the, it will also give us to choose the effective depth.

In other way, we shall use these value 720 or 26, 7 for cantilever, 20 for simply supported and 26 for continuous beam. So, what we can do, what is the when you are starting the design, then effective depth I have to find out. That we calculate on the basis of because, I know span or effective span. So, effective span, that too I know, so effective span divided by these value basic value, it will give me to select you are say effective depth and also the overall depth, which we can use it for the calculation of load and other things also.

So, this one also will help us to take that you are say, clearly assumption of you say, effective depth as well as overall depth. So, we are getting cantilever 7 simply supported 20 continuous 26, this is basic values.

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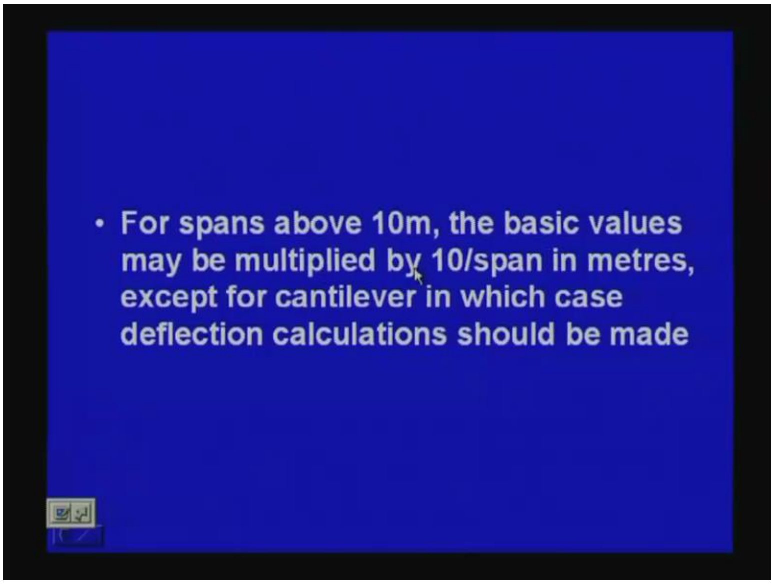

But, one more that for spans above 10 meter, the basic values may be multiplied by 10 by span. So, if it is more than 10 meters or 10 by span, so it will be further reduced in meters, except for cantilever in which case, the special calculation should be made. That means: for cantilever beam for the slab, if it is more than 10 meter, then in that case you have to calculate your deflection. Otherwise, you can use that coefficient or that value, we can multiply with that 10 by span and then we can find out the new value and that we can use it.

So, you have started with some basic value, then we are modifying according to the span that is 1, we can say that 1 say your q 1.

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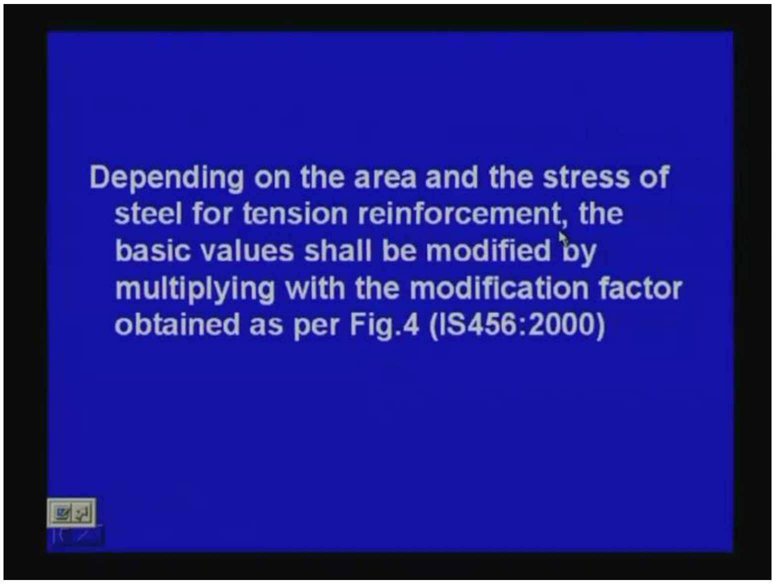

Now, depending on the area and the stress of steel for tension reinforcement, the basic values that means, the first 1 that which are given or the second 1 depending on the that span by 10 by span multiplying that 1, shall be modified multiplying with the modification factor obtained as per figure 4. There is 1 figure so that, we can take it and that 1 what is the case? Area and the stress of steel, that from there we shall find out and we can further modify the basic value and let us see that figure 4.

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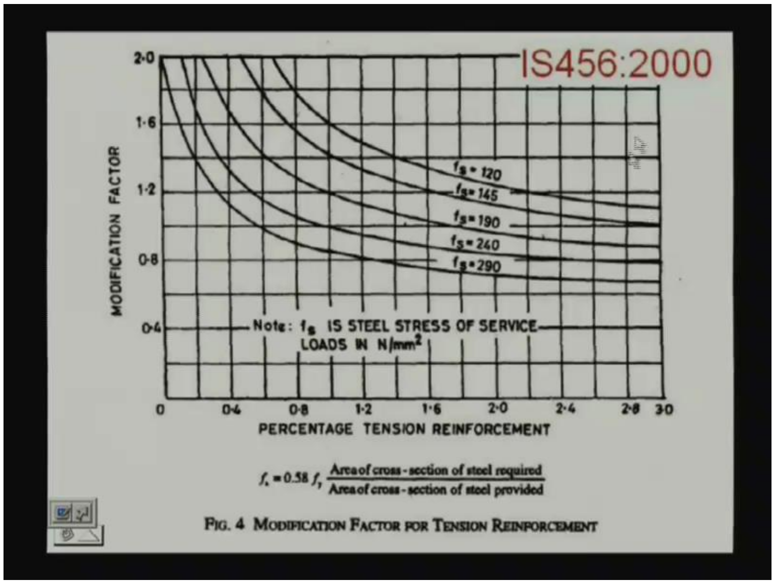

So, this is your that figure 4, for different grid different stress we can take it and this is 1 say service load in Newton per square millimeter, from there that is the modification. We can use this figure and from there from the percentage of steel, we can further we can modify. Now, how do I know that initially if we start with some say simply supported beam 20?

So, here we can have to modify the value, but how do I know? That means; it will come from our experiments, that what is the percent of steel generally we use for slabs. So, on the basis of that, we can find out certain factor. Or in other way, we have to redesign it. We have to start with basic value then, you do the whole process again you do it, but that we generally don’t do it because, if you are express if you know that 1 so the very first trial itself we can go.

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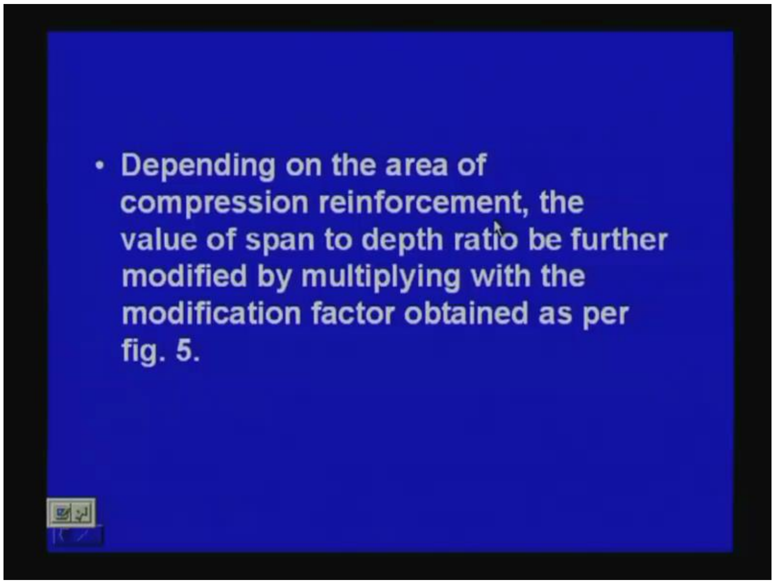

Depending on the area of compression reinforcement, the value of span to depth ratios be further modified by multiplying with the modification factor, obtained as per figure 5. There is 1 more figure in that is 456, from there we can get another modification.

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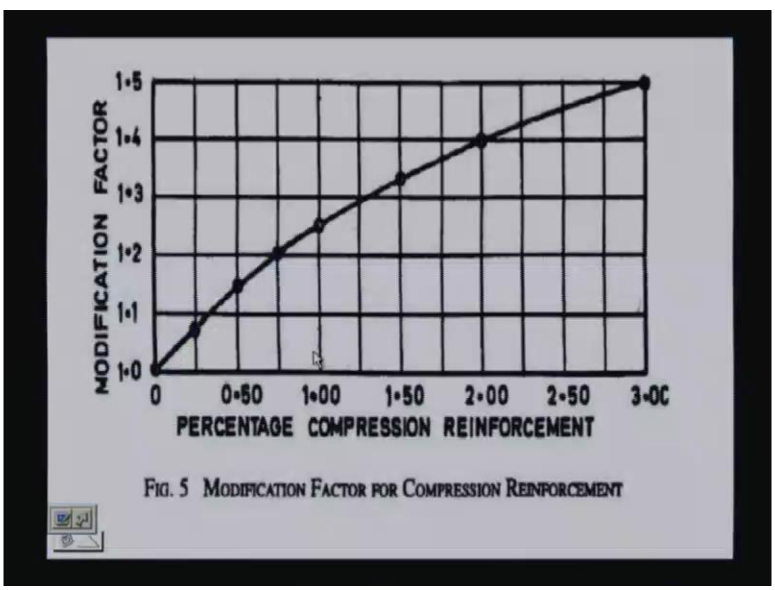

So, this is your depth depending on the compression reinforcement. The first 1 figure 4 that is, on the tension reinforcement and the other 1 on the basis of the compression reinforcement. So, our basic value will be modified with the tension reinforcement also on the basis of compression reinforcement.

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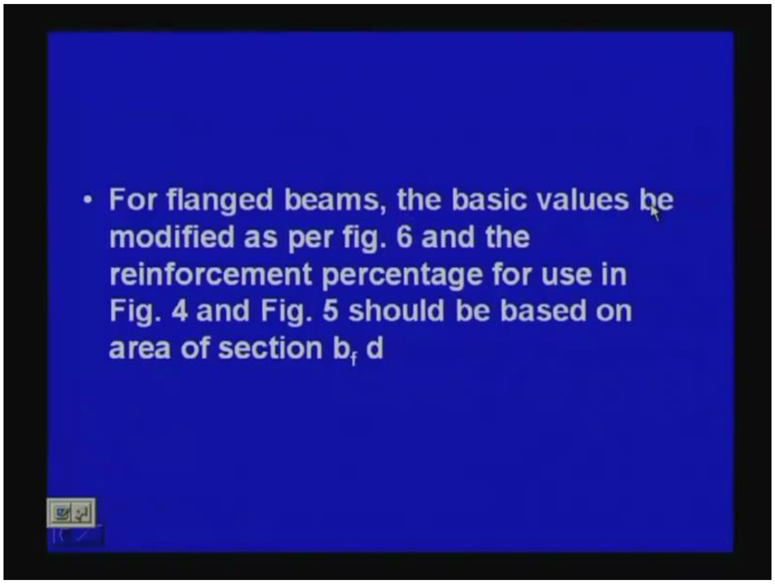

Now, for flanged beams, the basic values be modified as per figure 6 and the reinforcement percentage for use in figure 4 and figure 5 should be based on area of section b and d, note that this is b and d that way we have to take.

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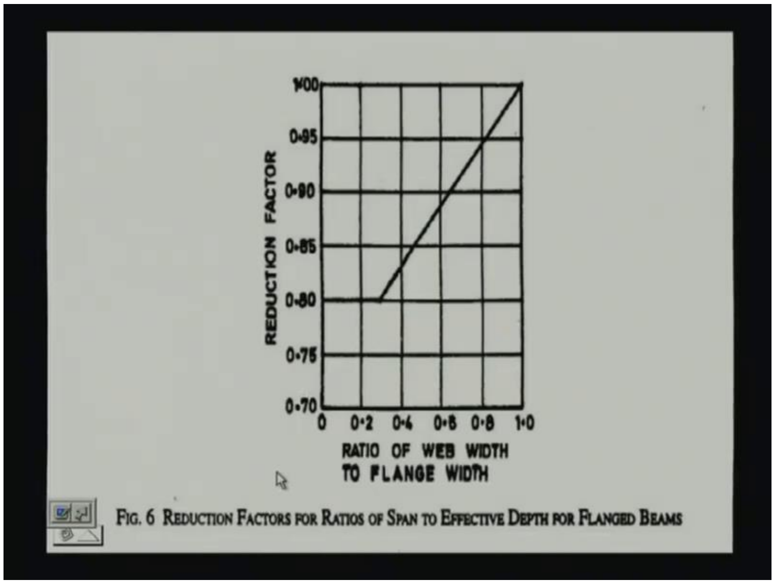

And this is that figure 6. So for slab design or also for beam design, we have to take all those things that which, I have not given previously, because I thought at least we should concentrate on that formulas, that which we are using say nv equal to 0.138 fck bd square like that and now we are slowly we are coming to that codes and other things that how to how to design it.

So, the beam slab design is nothing but you can say, beam design itself. Only thing that, in the slab design, we take that width of the slab that is 1000 millimeter, that is we take 1 meter width and that is so we are doing the same beam design. Only thing that, here we are taking that 1 meter and here also that, another by simple thing that we are taking only rectangular 1. So, now let us at least start the problem, in which we shall continue in the next class. So, our problem let us start with 1 example, design of 1 way slab.

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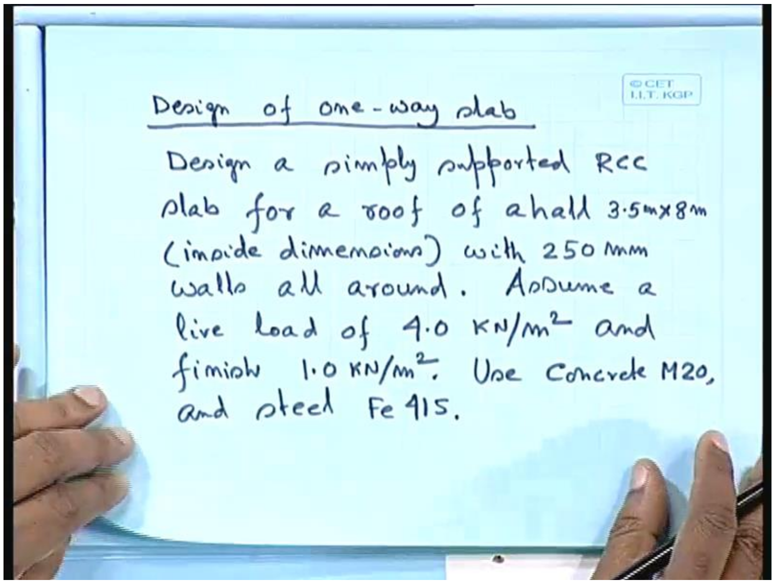

Design a simply supported RCC slab for a roof of a hall 3.5meter into 8 meter. And this is a inside dimensions with 250 millimeter walls all around, which is supported by 250 millimeter walls around. Let us assume a live load of 4 kilo Newton per square meter and finish, because there is no partition finish 1.0 kilo Newton square meter. Use concrete M20 and steel Fe 415.

So, we have to design of 1 way slab, design a simply supported RCC slab for a roof of the hall 3.5 meter into 8 meter that is the inside dimension. So, clear span here 3.5 meter in 1 side and another side 8 meter, as increase 1 way, so we have to take 3.5 meter with 250 millimeter wall around. Assume a live load of 4 kilo Newton per square meter, though it is quite high but any way just for problem check let us take it and finish 1 kilo Newton per square meter. I have given 1.5, but here we are not using any partition. Use concrete M20 and steel Fe 415. So this is the problem.

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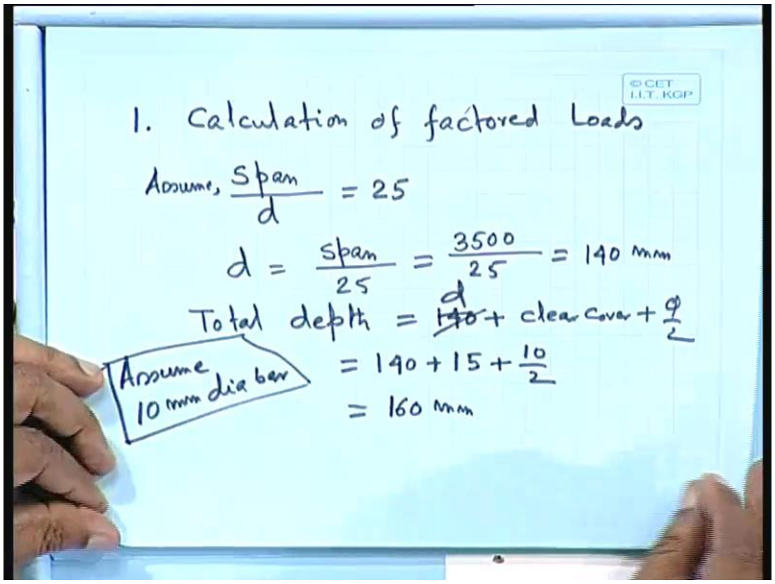

So, let us do the first step, that is, the calculation of factored loads. Let us take we shall assume span by d is equal to say 25, simply supported here it is 20, but constantly say the reinforcement other things you have taking say you say 25. So, you can find out d equal to span by 25. And we have not yet calculate the effective span because, this is after all some preliminary, that estimate to find out your loading other things. So, you can take it here directly say 3500, that we are taking this much and on the basis of that, we shall get 140 millimeter. Total depth equal to 140 plus clear cover let us write down clear cover plus phi by 2. I think, I should write down here d, d plus clear cover plus phi by 2, d equal to here 140, clear cover how much we have take? Let us take assume 10 mm dia bar. For slab, we shall generally use that 8 mm 10 mm or 12 mm, generally we use.

So, in our case we can use the clear cover, even for mild exposure, we are getting say 15. So, for mild exposure we are getting 15 because, we are using less than or equal to 12 millimeter plus 15 by 2 and we get 160 millimeter.

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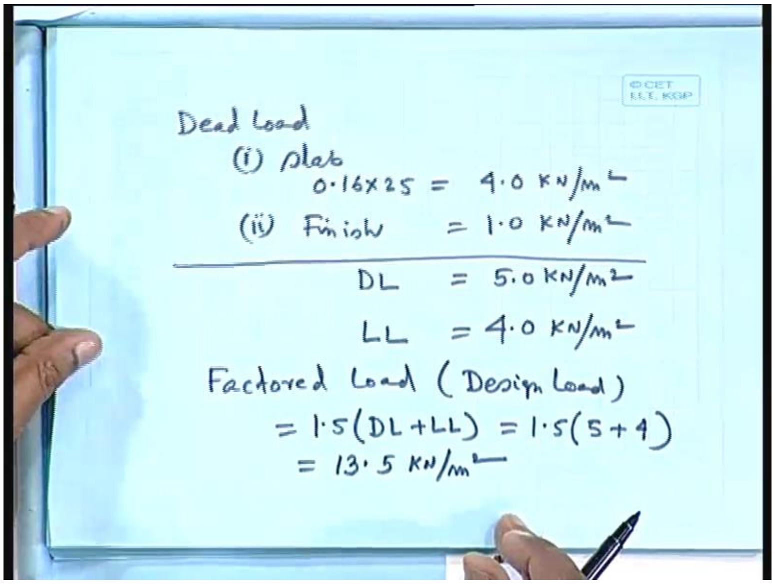

So, we can now we can calculate the dead load. Dead load; so slab 0.16 times 25 4 kilo Newton per square meter, finish 1 kilo Newton per square meter which already given, dead load 5 kilo Newton per square meter, live load already specified 4 kilo Newton per square meter. So, factored load or we call it as design load. So, we are talking dead load live load only, so let us multiply with 1.5 only. So, it comes as equals 13.5 kilo Newton per square meter. What about the effective span? So, we know factored load or design load that is 13.5 kilo Newton per square meter.

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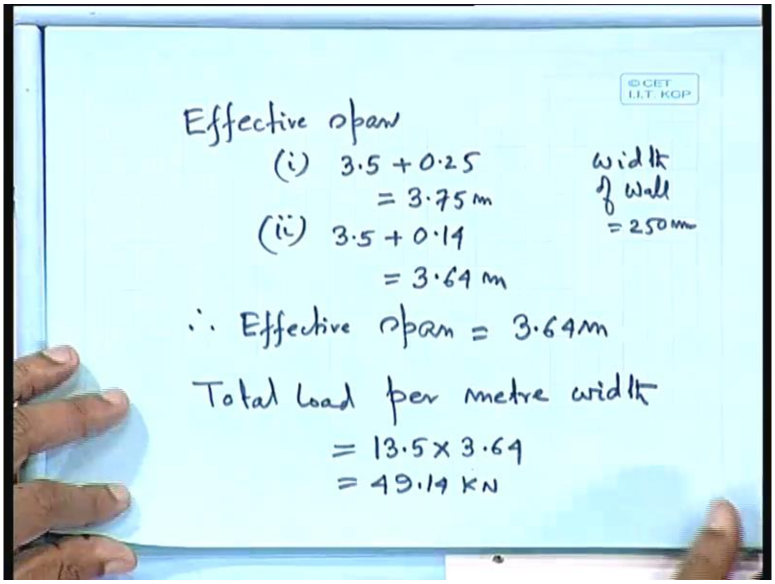

Effective span, let us write down 1 3.5 plus 0.25, that width of wall 250 millimeter which comes as 3.75 meter. The other 1, 3.5 plus effective depth, effective depth we have computed, effective depth we have computed 140 millimeter. So, you can take it as 0.14 and this comes as 3.64 meter. Therefore, effective span equal to 3.64 meter, total load per meter width equal 13.5 times 3.64 which comes as 49.14 kilo Newton. We are talking the total load; so 3.64 is the span and 13.5 kilo Newton per square meter, that is effected load or design load. So 13.5 times 3.64 which comes as 49.14 kilo Newton.

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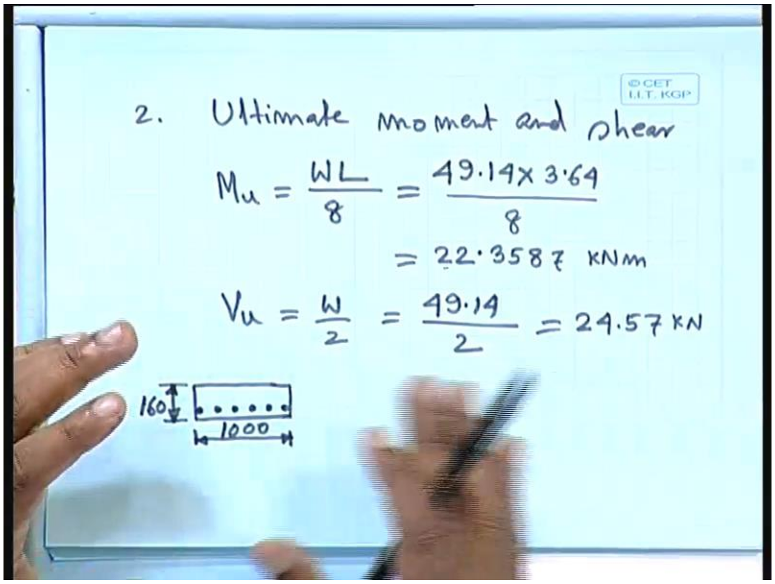

So, ultimate, now let us calculate ultimate moment and shear. Mu equal to total load times effective span divided by 8 equals 49.14 times 3.64 divided by 8 equals to 22.3587 kilo Newton, Vu that is equal to W by 2 equals 49.14 divided by 2 equals 24.57 kilo Newton. This is your Mu and the other 1 is Vu. Now, we know what we shall do it; we shall take a beam, a rectangular beam and we have the width 1000 millimeter, 1000 millimeter is the width and if and then, we shall solve this problem taking that Mu and Vu.

So, we shall find out and we have to check, whether we have and how to provide the reinforcement that reinforcement, so all ready we have done that, overall depth we have already computed. So, we have to find out that, so this is 160 little bit higher side. So, you have to check it taking 160, whether this is sufficient whether it can resist this moment. And we have to provide their reinforcement, so we have to provide their reinforcement. In this case what we provide actually, we do not provide the reinforcement their number of bars. These are the reinforcement this 1 normal to the paper I say, longitudinal reinforcement, but we do not provide it as a number of bars.

The one we have done it for say your beams, that say 2 times 2 20 320 or 31 like that. But, here what we do, we take it say the diameter of the bar say 10 millimeter at the rate of the spacing, we provide the spacing here. So that we have to find out, that means: we have already taking that say overall depth and also know the effective depth. So, you have to check that taking this moment; whether that effective depth is coming less than the computed figure less than the provided effective depth.

If it is okay, then we can go for that we can accept that. And then, you have to find out the area of steel. Then we have to check that, Vu generally we don't check it, but we shall check for this problem; whether that V that shear stress we have computed on the basis of this Vu, whether we are getting that 1 less than that c. Whether you are getting less than the 0.15 percent as per the table 19 of is physics, so that it less than. If it is less than, then we shall not provide any reinforcement, then we do not need any shear and for slabs we do not provide any stirrups. And that shall we continue in the next class.