Design of Reinforced Concrete Structures

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Lecture - 09
Design of Doubly Reinforced Beam Flexure – II

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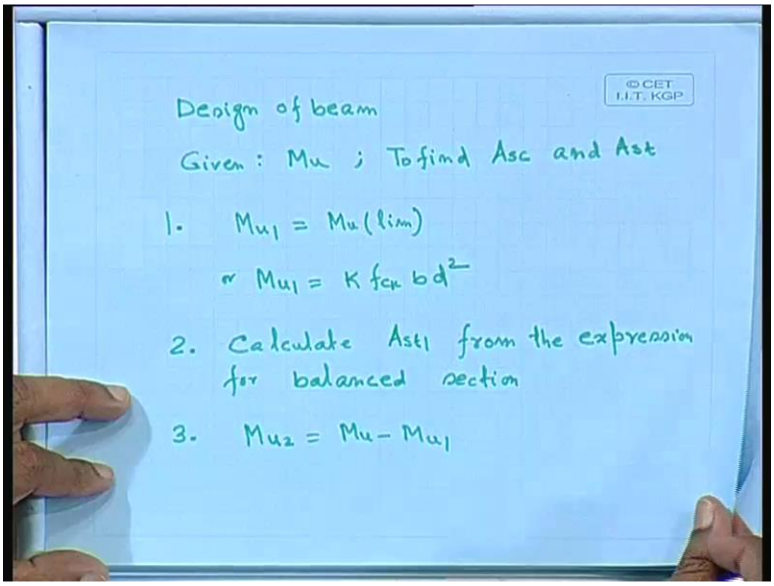

Let me continue, the part 2 of design of doubly reinforced beam. Let us check the procedure of design of beam. We have done the analysis, here given Mu and we have to find to find Asc and Ast area of steel in the composite side, area of steel in the tensile side. So, the steps find Mu1 equal to say Mu lim the limiting moment that balanced moment.

We can further write down or Mu1 equal to k fck bd square you can check with the last that note. Number 2: calculate Ast1 from the expression for balanced section that also you check, it we have already written explicitly in detail in the analysis of beam. Number 3: Mu1 if it is say greater than Mu, Mu1, if it is greater Mu; that means, we do not go we need to go for design of doubly reinforced section, it is singly reinforced section we have to check Mu2 equal to Mu minus Mu1.

We can write down in the next page I think.

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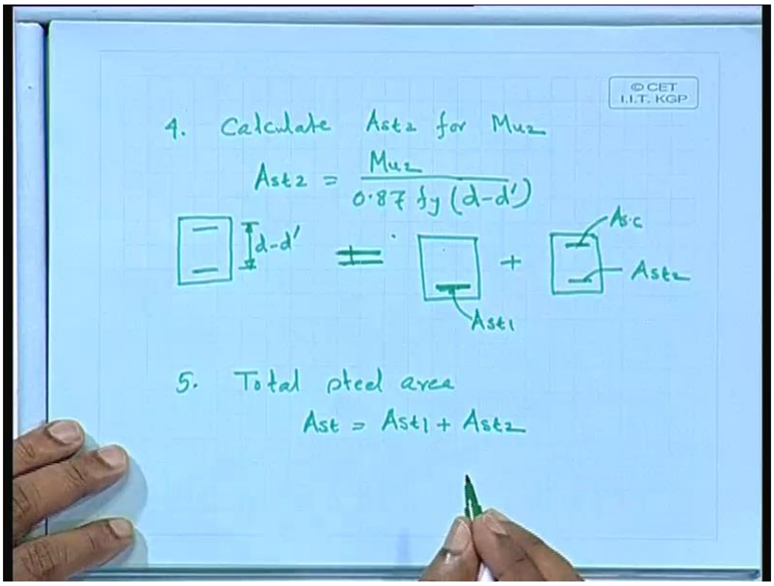

Number 4: Calculate Ast2 for Mu2 Ast2 equal to Mu2 divided by 0.87 fy and the lever arm d minus d dash for your reference again we are taking the section and d minus d dash. Ast2 means total area of steel that you are providing out of that you have 1 portion due to your balanced section. So, a section this section I can make it as let us say equal to this is equal I can consider, a section of same width and depth, but, having only tensile reinforcement here.

Let us say, this is as Ast1 and in this case we are not considering the concrete that concrete any more, we are taking only the steel part Asc and Ast2 where from you are getting Ast1 , Ast1 is nothing but, the balanced section due to balanced section whatever reinforcement you are getting computing that is Ast1 . And why Asc and Ast2 is different that I have already told because the stress at this level is different and stress at this level different.

Since it has to be in equilibrium, this is an equilibrium because your compression and tension in equilibrium and again what you are doing slowly you are adding reinforcement here and reinforcement here, the reinforcement will different because of your say stress level. So, reinforcement area different, but, force forces are equal. And this your Ast 2. So, that is why Ast2 equal to Mu2 the balanced remaining your moment of resistance remaining moment divided by 0.87 fy d minus d dash.

We can find out a total steel area. Ast equal to Ast1 plus Ast2.

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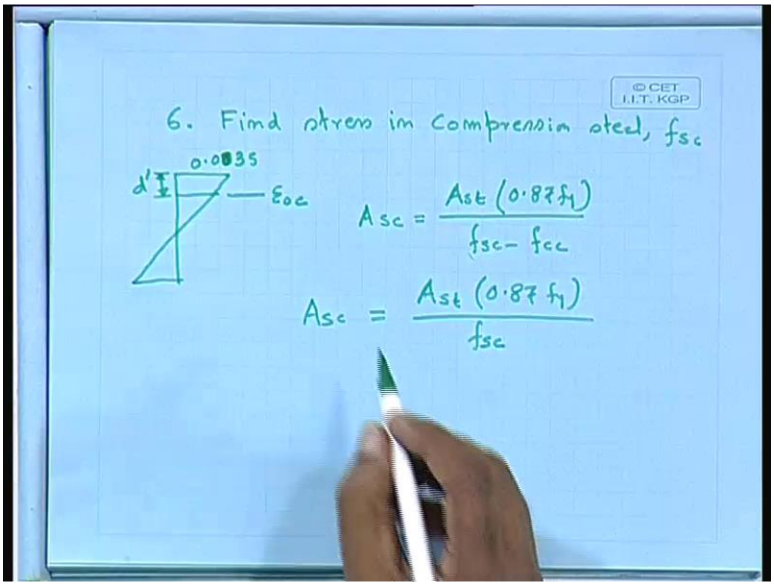

Number 6: find stress in compression steel. Let us say, that is fsc, we can find the fsc how shall we find out. This is at a distance d dash this is 0.0035. We can get the corresponding strain in the steel level epsilon sc, we can get the corresponding steel level in epsilon sc when we shall we get epsilon sc either from the carve either from the carve or from the table there where you have made it from there we can find out the corresponding stress fsc.

If we can get fsc we can get the area of steel. So, we can write down Asc equal to Ast2 times 0.87 fy this is the tensile force fsc minus fcc. You can further write down fsc minus fcc. Fsc is the stress in steel minus fcc because already we have taken that portion. So, that is why you can deduct in other way our code says that no need of taking you can simply ignore this fcc.

So, you can write down as Ast 0.87 fy divided by fsc. So, we know Ast now and we can get Asc also. Now let us do at leAst2 examples, if we can manage it.

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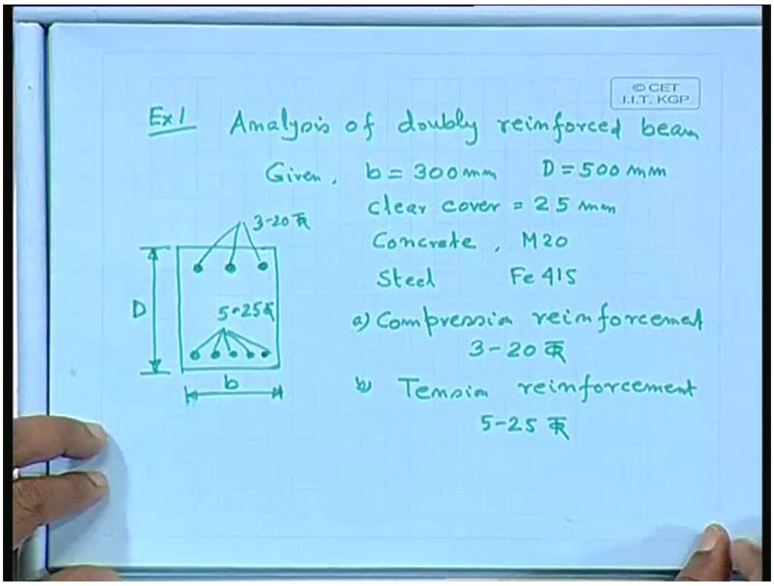

Example 1 analysis of doubly reinforced beam given b equal to 300 millimeter d 500 clear cover 25 millimeter concrete m 20 steel Fe 415 compression reinforcement 320 tor tension reinforcement 525 tor. Let us draw the section b D 320 525. So, this is your problem and you have to find out the moment of resistance that how much moment of resistance moment it can take.

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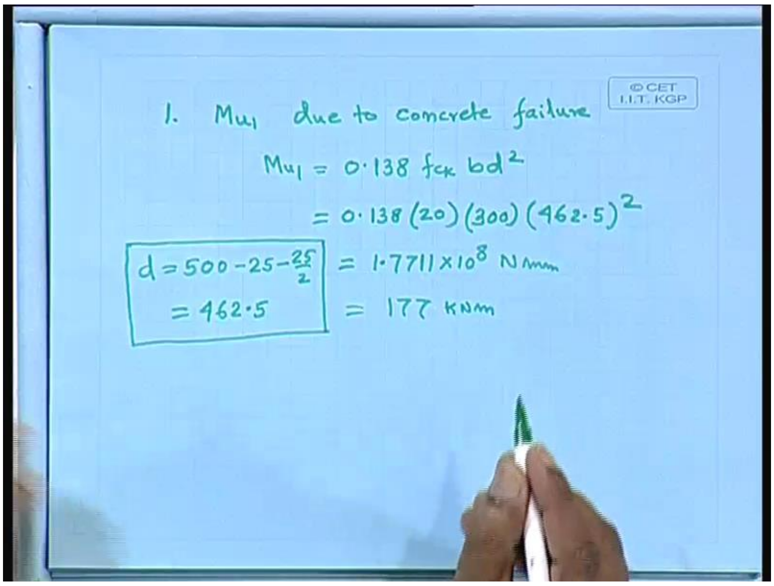

Number 1: Mu1 due to concrete failure. Mu1 equal to 0.138 fck bd square equal to 0.138 multiplied by 20 times 300 that is: the b what about d let us calculate d. D equal to capital D minus clear cover minus 25 by 2, which comes as 462.5 The top and bottom

reinforcement diameter different please note 462.5 whole square equal to 1.7711 10 to the power 8 newton millimeter. Let us say, 177 kilo newton meter. We shall find out the balanced steel we shall get now the balanced steel.

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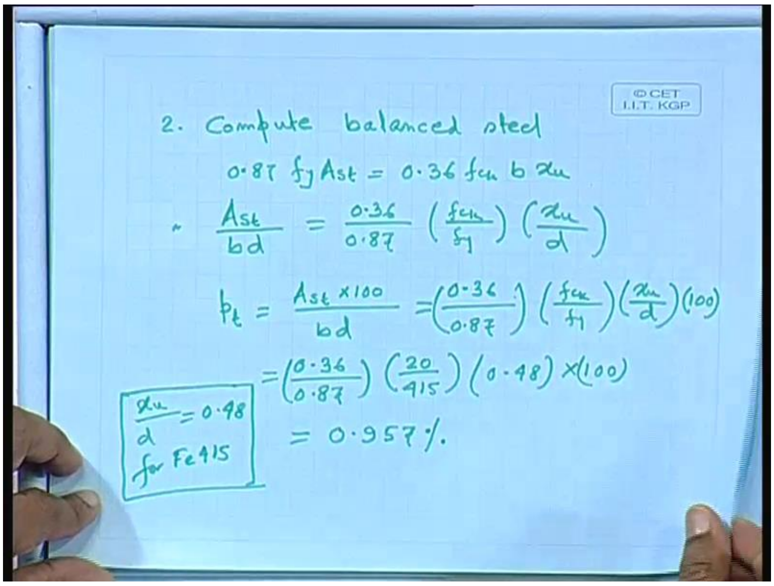

Number 2: compute balanced steel. Let us start from the beginning 0.87 fy Ast equal to 0.36 fck b xu. or Ast by bd equal to 0.36 by 0.87 fck by fy times xu by d; pt Ast times 100 divided by bd equal to I can simply write down 0.36 by 0.87 multiplied by fck by fy multiplied by xu by d times 100 times hundred equal to 0.36 by 0.87 times 20 by 415 times 0.48; xu by d equal to 0.48for Fe 415 times 100 equals to 0.978 percent. So, balanced steel that is 0.957 percent.

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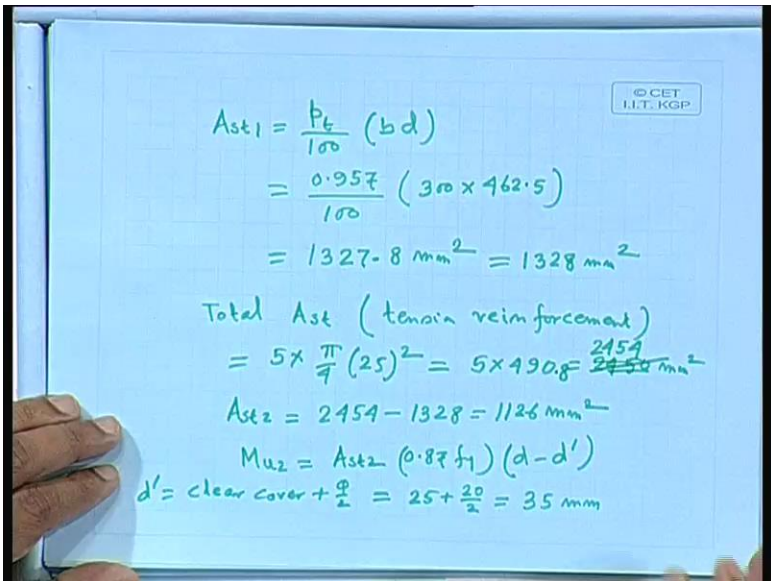

We can write down Ast1. Let us continue, Ast1 equal to pt by 100 times bd 0.957 by 100 times 300 into 462.5 effective depth already, we computed equal to 1327 millimeter square. Let us say 1328. What about area of steel? Ast that means, tension reinforcement equal to 5, I think I can write down. So, 5 into pi by 425 whole square which comes as: 25 into pi divided by 4 into 5. So, I can write down as 5 into 490.

So, if we write down we can get little more of course. Ast2 equal to I think I have taken little more. So 25 so, I can write down here as instead of that 490.8. So, 490.86 say into 5 which is coming as 2454. Let us write down as 2454 write down as 2454 Ast2 equal to 2454 minus 1328 equal to 1126. Mu2 will be equal to Ast2 times 0.87 fy times d minus d dash. D dash equal to clear cover plus let us say, 5 by 2 which comes as 25 plus and the top 3 numbers of 20 dia bar 3 numbers of 20 dia bar at the top.

So, 20 by 2 which comes as 35 millimeter.

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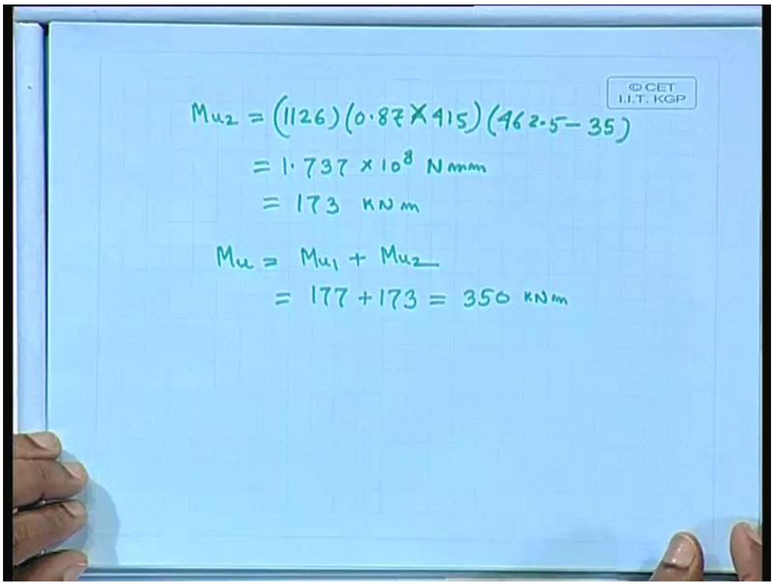

We can write down then Mu2; Mu2 will be equal to 1126 times 0.87 into 415 multiplied by 462.5 minus 35 which comes as 1.7378 equal to 100 say 73 kilo newton meter. Mu we can write down as Mu1 plus Mu2 equal 177 plus equal 173 equals to 350 kilo newton meter.

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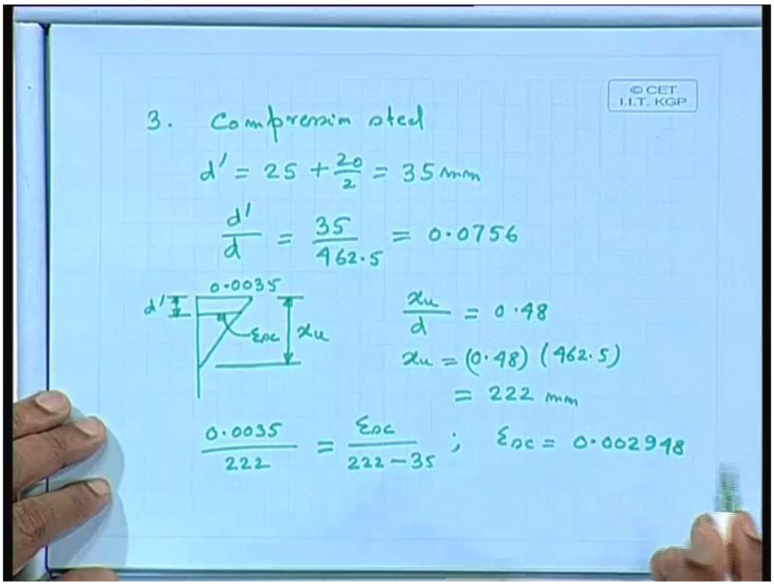

Number 3: compression steel d dash equal to 25 clear cover plus 20 by 2 35 millimeter. D dash by d 35 by 462.5 equals 0.0756. We can also write down as: this is d dash and the strain is 0.0035 xu, xu by d 0.48 xu equal to 0.48 times multiplied by d which is 462.5 which comes as 222 millimeter. What about epsilon sc then; epsilon sc will be this is

epsilon sc, epsilon sc will be 0.0035 divided by 222 equal to epsilon sc divided by 222 minus 35 xu minus d.

We can write down epsilon sc equal to 0.002948.

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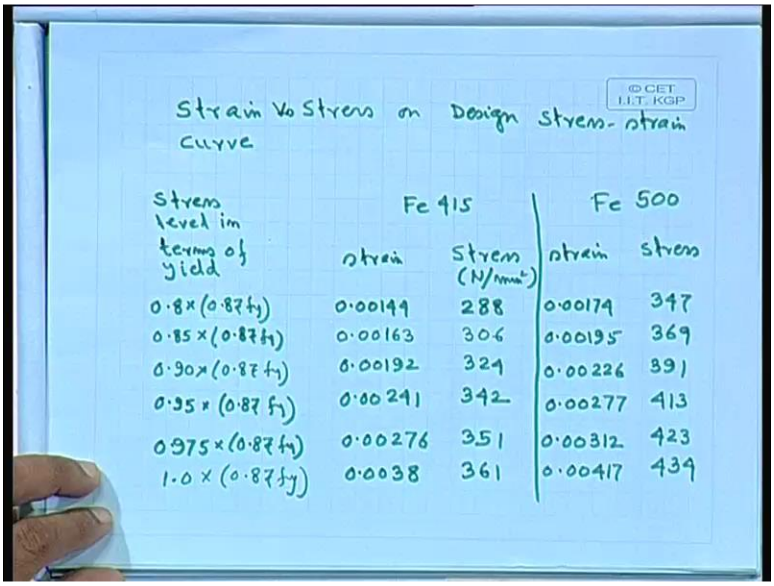

Strain Vs Stress on Design stress-strain curve

Stress level in terms of yield	Fe 415 strain	Fe 415 Stress (N/mm²)	Fe 500 strain	Fe 500 stress
0.8 × (0.87 fy)	0.00144	288	0.00174	347
0.85 × (0.87 fy)	0.00163	306	0.00195	369
0.90 × (0.87 fy)	0.00192	324	0.00226	391
0.95 × (0.87 fy)	0.00241	342	0.00277	413
0.975 × (0.87 fy)	0.00276	351	0.00312	423
1.0 × (0.87 fy)	0.0038	361	0.00417	434

So, if we can check, yes if you can check either from this table.

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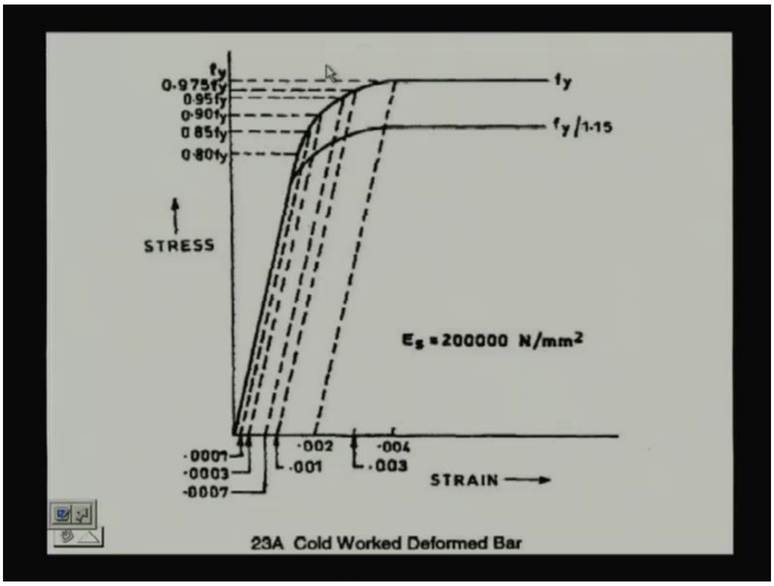

Or we can go back to this curve or we can go back to this curve from here also we can directly we can get from this graph the corresponding stress instead of that, it is better to use this table and in our case 0.002948 it means which is coming in this interval. So, we can find out the corresponding stress in compression steel you can get that 1 in IS 456 also it is in IS 456. SV 16 is the design head that is special publication, but, IS 456 that is that it will help you to design, but, IS 456 is the actual code which you have to follow.

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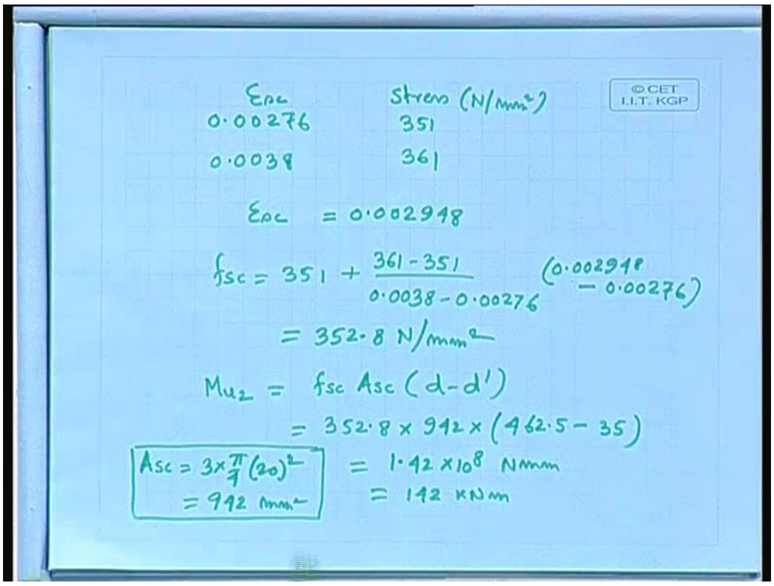

So, we can write down epsilon sc 0.00276 strain, stress 351 0.0038 361 therefore, epsilon sc computed 0.002948 fsc equal to 351 plus 361 minus 351. Let us, make it multiplied by 002948 minus equals 352.8 newton per square millimeter. Mu2 equal to fsc Asc d minus d dash fsc is the force in the compressive steel multiplied by the lever arm which comes as 352.8 multiplied by Asc what about Asc; Asc equal to 3 times pi by 420 square which comes as 942 square millimeter. This is the area of steel in the (( )) 320 number of bars provided into 942 into 462.5 minus 35 equal to 1.42 into 10 to the power 8 newton millimeter equals 142 kilo newton meter.

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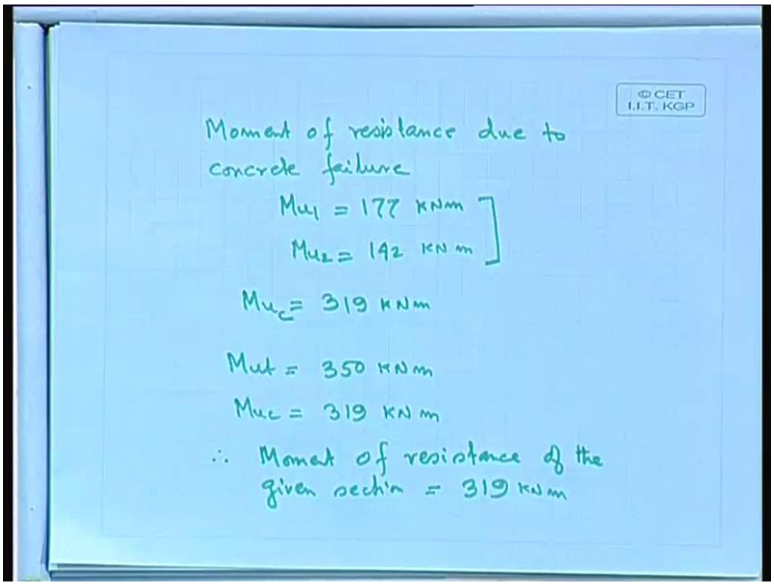

So, we have got 142 kilo newton meter Mu1 how much moment of resistance moment of resistance due to concrete failure Mu1 equal to 177 kilo newton because this is a balanced section and Mu2 we have computed 142. Mu 319 the sum of 2 this 2 sum of these 2 177 plus 1042, which comes as 319 kilo newton meter 1 we have got, we have got 2 values. So, we have got 2 values 177 plus 173 350. So, we can write down as say mut equal to 350 kilo newton meter.

Let us say, Mu c 319 kilo newton meter therefore, moment of resistance of the section of the given section 319 kilo newton meter that is, what we have to find out. There is 1 more thing I should say that why do you need to provide compression reinforcement from the ductility point of view also we can say that, we need that say steel in the compression side particularly, for say earthquake resistance structures that compression steel adequate compression steel it will help us to make it ductile.

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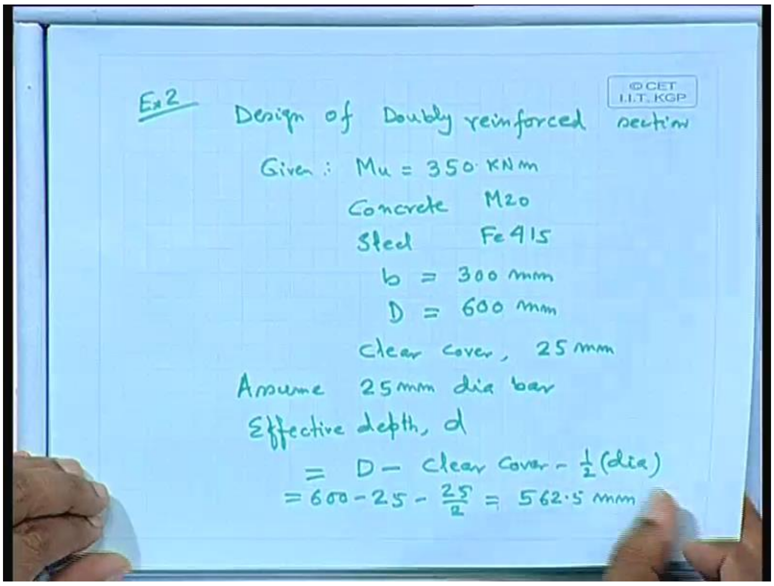

Then next problem let us solve 1 I think we have time example 2 design of doubly reinforced section concrete given Mu equal to 350 kilo meter, concrete M 20, steel Fe 415 b weight of the beam 300 millimeter D overall depth 600 millimeter clear cover 25 millimeter. Let us assume, we shall use 25 millimeter dia bar assume 25 millimeter dia bar we shall provide. So, effective depth d equal to D minus clear cover minus half of dia equal 600 minus 25 minus 25 by 2 comes as 562.5 millimeter 562.5 millimeter.

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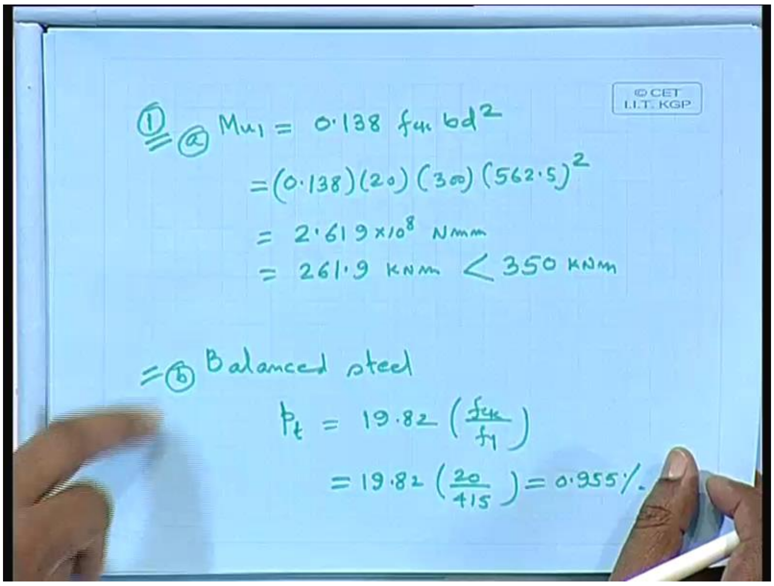

Mu1 what is Mu1 due to concrete failure Mu1 equal to 0.138 fck bd square Mu1 equal to 0.138 fck bd square due to concrete failure. It comes as 0.138 times 20 times 300 times

562.5 equals equals to 261.9 kilo newton meter less than the applied moment 350 kilo newton meter. 261.9 due to concrete failure, we are getting 261.9; that means, the balanced moment we have to provide steel compression steel. What about balanced steel, you can start with the same first principle instead of that I am using pt equal to 19.82 fck by fy equals 19.82 times 20 by 415 comes as 0.955 percent or you can start doing the same thing from the first principle. Let us do, I think it is better to keep this 1 as a number 1; number 1 I can say this 1 as say and this 1 as say b 1 a 1 b. So, we are getting for the balanced section.

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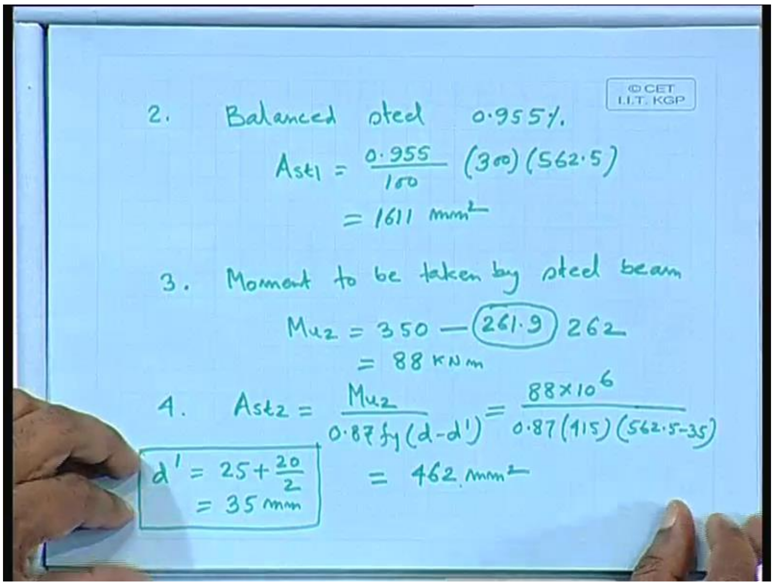

Number 2: balanced steel 0.955 percentage already we have computed. Therefore, Ast1 area of steel equal to 0.955 by 100 times 300 times the effective depth which comes as 1611 square millimeter. Moment to be taken by steel beam or in other way you have to provide the reinforcement now because, we are doing it to separate way 1 is that only isolated case of single reinforce section.

Now, we are adding reinforcement in the compression side and in the tension side both of them again will be in equilibrium, but, since the stress level is different that is why you will get 2 different steel area. So, Mu2 equal to 350 minus I can say 261.9 equals this 1 I can consider as say 262. So, we can write down as eighty-eight kilo newton meter. What about the area of steel 2. Ast2 will be equal to Mu2 divided by 087 fy d minus d dash equal to 88 10 to the power of 6 0.874155 92.5 minus 35 562.5 minus 35 d dash equal to 25.

Let us say, again we shall provide the 20 millimeter dia bar at the top which comes as 35 millimeter, we are assuming that we shall provide 20 millimeter dia bar at the top like the previous 25 diameter at the bottom and 25 diameter at the top. We can provide the same of course, which comes as 462 square millimeter. So, if we compute then we shall get 462 square millimeter.

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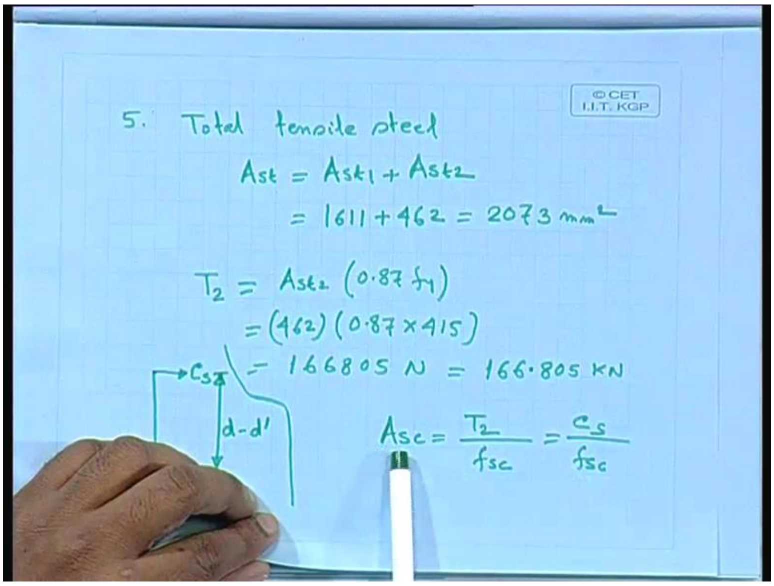

What about the total tensile steel; total tensile steel, Ast equal to Ast1 plus Ast2 1611 plus 462 equals 2073 square millimeter.. We know 462; 462 is the area of steel. What is the corresponding force. Let us say, tensile force T2; tensile force T2 equal to Ast2 times 0.87 fy equal to 462 times 0.87 into 415. This is the force. So, 462 times 0.87 times 415 comes as 166805 newton equals 166.805 kilo newton this is the force.

This force if I say T2 we are talking the steel beam Cs what is the distance between this 2 d minus d dash. So, T2 I know because we are assuming that steel will reach the yield stress and that is why, it is simpler we can even eventually we can calculate the Ast2 and since, we are already computed Ast 2. So, we can find out the tensile force. The already we have done the balanced part that may be concrete failure and tensile 1 Ast1 and the concrete failure that already, it is balanced we have done it and it is in equilibrium.

Now, we are providing the tensile reinforcement which is Ast2 So, corresponding force T2 166.805 kilo newton in this problem. We have to provide the reinforcement in the compression side such a way. So, that it will be in equilibrium. So, we have to find out that cs; cs should be equal to T2 but, the strain at this level is different than the strain at this level because in this case the strain is coming from the top fiber concrete failure that is 0.0035.

So, the compression side, the steel will never reach the yield stress 0.87 fy it will never reach yield stress. We shall find out the yield stress getting the strain at that level and the corresponding stress. So, we have to find out the strain and stress, but, your force will be equal to 166.805. In other way, I can say Asc will be equal to t 2 by fsc or in other way cs by fsc, but, we do not know fsc at this moment we do not know fsc, but, we know the strain and from the strain we can get the corresponding stress and if we can find out the stress we can get the Asc.

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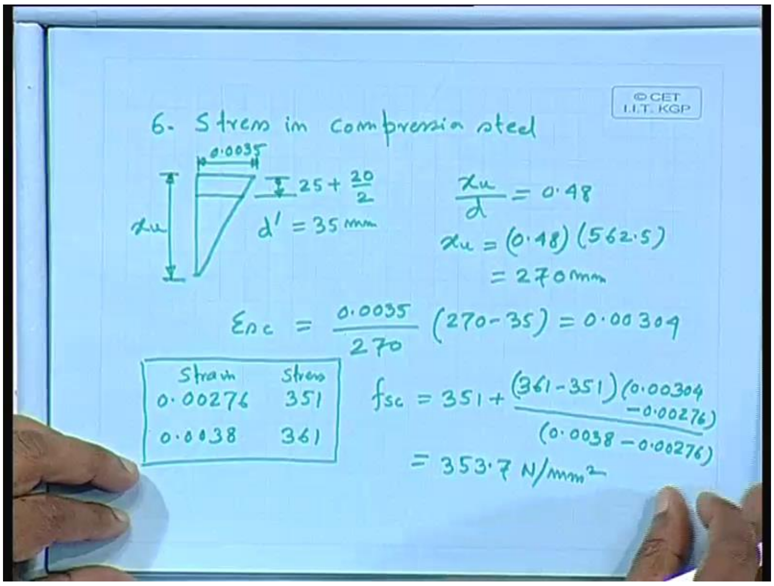

So, number 6: stress in compression steel. So, xu 0.0035 we are assuming, we shall provide 20 millimeter dia bar. So, clear cover 25 plus diameter twenty millimeter diameter equals 35 millimeter this is your the d dash; xu by d 0.48 xu equal to 0.48 times 562 .5 270 millimeter. Epsilon sc equal to 0.0035, which will be always less than this 0.0035 minus 35 equal to 0.00340.

From the table again, we are getting the same integral 0.00276, which comes as 351 stress, strain 0.0038 361 from the table the 1 which we have given in the last class last lecture. So, fsc equal to 351 plus 361. Let us, make it in a in detail 0.00304 minus 0.00276 divided by 0.0038 minus 0.00276 equals 353.7 newton per square millimeter.

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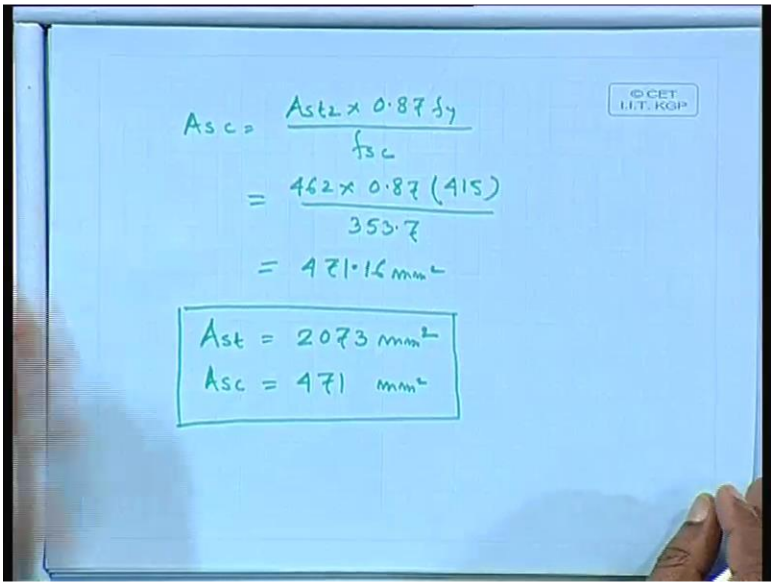

So, we have got fsc we can calculate Asc; Asc equal to in other way, I can write down Asc equal to Ast2 times 0.87 fy divided by fsc equal to 462 into 0.87 415 divided by 353.7 equals 471.6 square millimeter. Area of steel Ast equal to 2073 square millimeter; Asc equal to let us say, 471 square millimeter. So, this is your design and we can finally, provide the reinforcement also that it may come again that 525 and 220 something like that, it may come. So, you can provide the actual reinforcement also you can provide.

So, we have done 2 problems: 1 that analysis of beam and the other 1 the design of doubly reinforced section.

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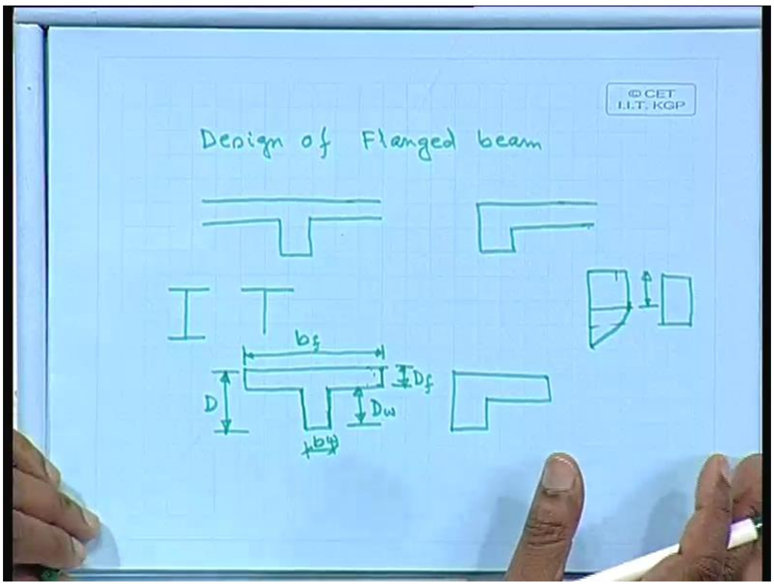

We shall do in the next class, since we have time little bit, we shall do the design of flanged section, flanged beam as I have mentioned, this is your slab and beam that the support at the end it generally comes we can call it as inverted L. We take whenever, it bends we take certain portion from both sides or from this side we take that is called flange, you can say that you say wave type of thing T beam like this.

Now, what we shall do, we shall take the width of the flange also not only wave so, for we have done the rectangular section. So, shall take these portion also that width as well as the flange for these case we shall take certain portion up to this. What we shall do, we have to find out say bw. Let us say, certain dimension bw width of the web overall depth Df depth of the flange, width of the flange and depth of the web, we can get what we have to we have to find out the we can do the design as well as we can do the analysis.

Moment of resistance we can find out for these sections. Here what happen only thing I shall mention today, there could be 3 different cases, depending on the stress block this is your stress block, what we can get this is from here to here constant, it is possible the whole stress block within flange, it is possible that whole stress block within flange that would be 1 case. The other case could be the slab portion of the flange within these zone; that means, we are having the constant stress in the whole problem, but, other alternative with third 1 possible that we are having in between here.

So, this is the most difficult 1. The first 1, it is easier that it is nothing but, a simple rectangular section 1 is of using b we shall use the bf. The other case also we shall have 2 parts 1 part is the rectangular portion, other part is the flanged portion, but, it is having the constant stress. So, we can get the force easily, but, the third part where you are having somewhere in between the flange.

So, then it is difficult portion how much will be the force, that also we can find out. So, this are the 3 different cases and we shall continue, in the next class. So, thank you.

DESIGN OF REINFORCED CONCRETE STRUCTURES

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LECTURE # 13

Design of Shear

Last class, we have started design for shear and today, we shall continue design for shear because, we have started 1 problem solving. So in this lecture, design for shear that, we shall continue today .

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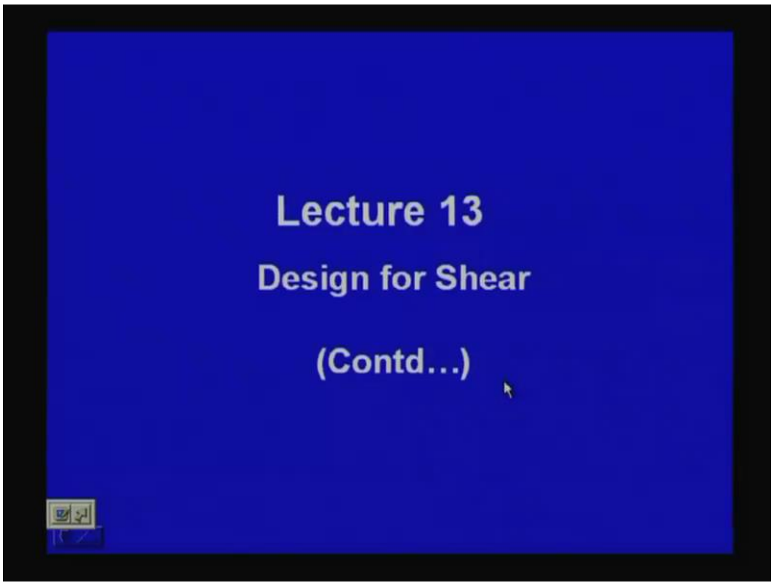

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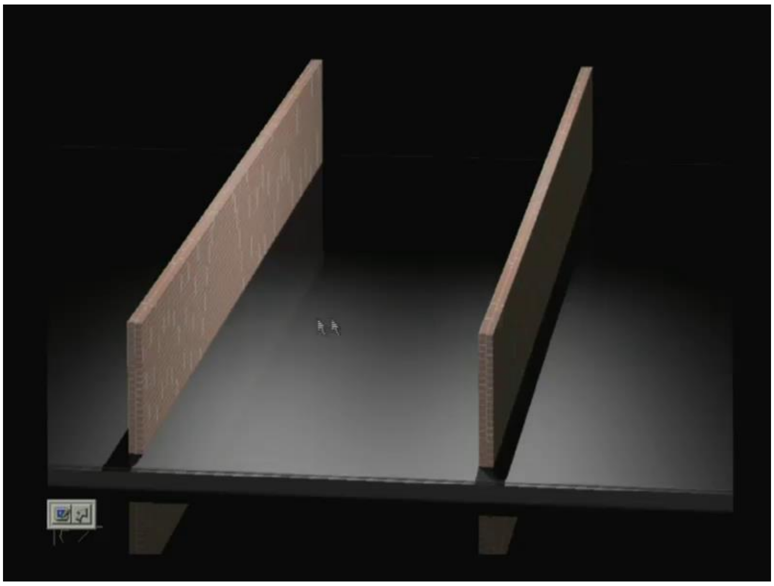

Let us, just review the problem which, we have started and just review it. So, we have 2 brick walls; 2 brick walls, we can take it this 1 say 250 mm width, having so many just for clarification, we have made it like this there are so many beams 3 meter spacing.

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Covered by the roof slab. So, this is your different beams but, we have constructed these beams integrally with the slab. So, we can take action of the t-beam.

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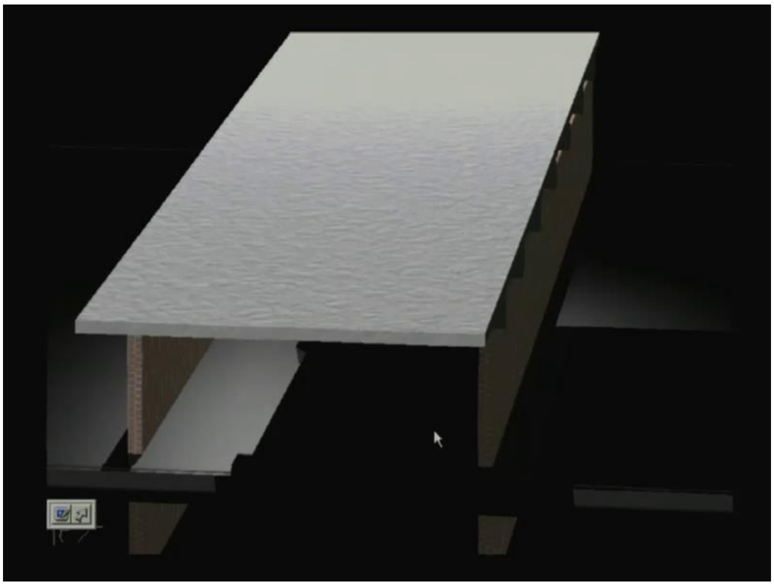

So, each of them will be t-beam and which has width of the web, depth of the flange, width of the flange and depth of the web also okay.

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So, before we come to that; let us see, that few what we have done already you have in your note book but anyway I think it is worth to for mentioning.

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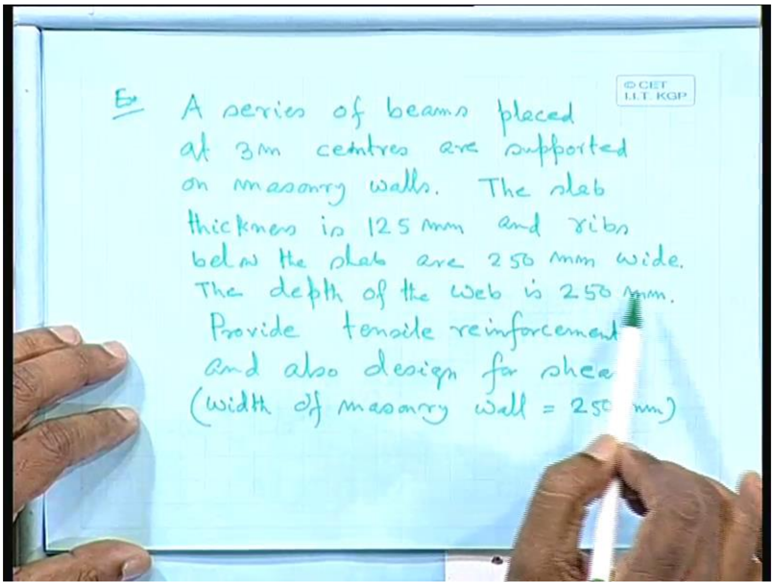

A series of beams placed at 3 meters centers, are supported on masonry walls which we have already shown. The slab thickness is 125 millimeter and the ribs below the slab are 250 millimeter wide the depth of the web is 250 millimeter provide tensile reinforcements then also design for shear. Because we do not, want to do it separately, for flexure and shear, we want to do the same problem for flexure as well as shear the width of the masonry wall that is 250 millimeter that we have done. We have calculated loading.

So, dead load we have calculated taking 250 kilo Newton per meter cube for the concrete unit rate 6 meter ceiling, we are taken ceiling plaster that is at the bottom of the slab and 30 millimeter thick floor finish that is at the top of the slab taking that; we are getting dead load 3.989 kilo Newton per square meter. And live load that we have taken 4 kilo Newton per square meter which we can get for a specific purpose.

Since, it is not mentioned we have taken 4 kilo Newton per square meter but, for the specific purpose for the particular building then we can get the appropriate loading from is 875 okay.

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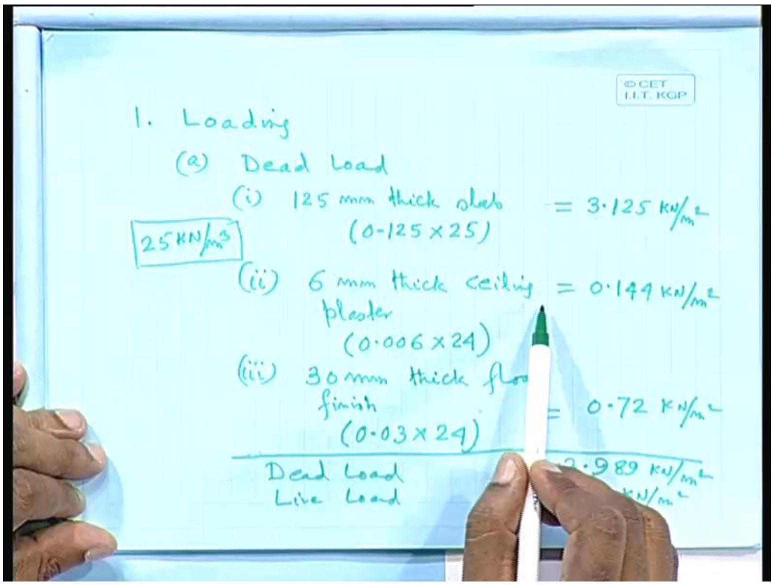

So, next 1 load on beam. So, we are getting this 1 that kilo Newton per square meter that is on the slab.

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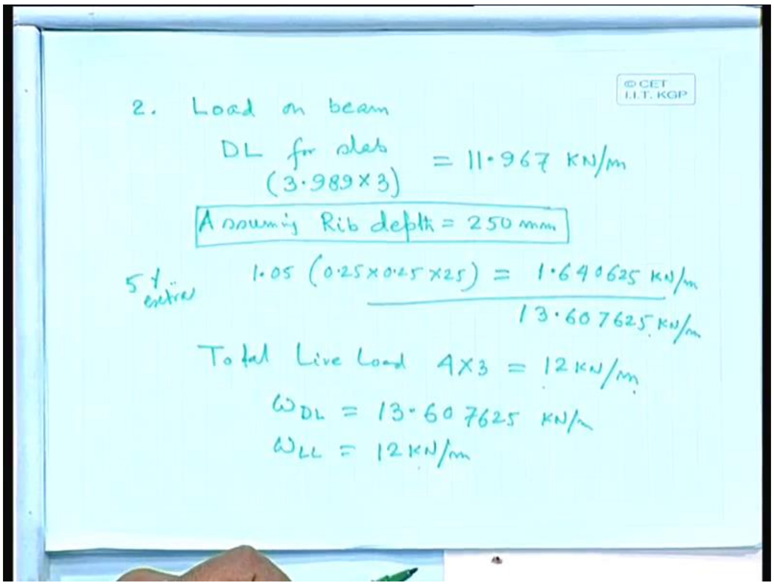

Now, we shall take that load on beam, individual beam that means; if we go back.

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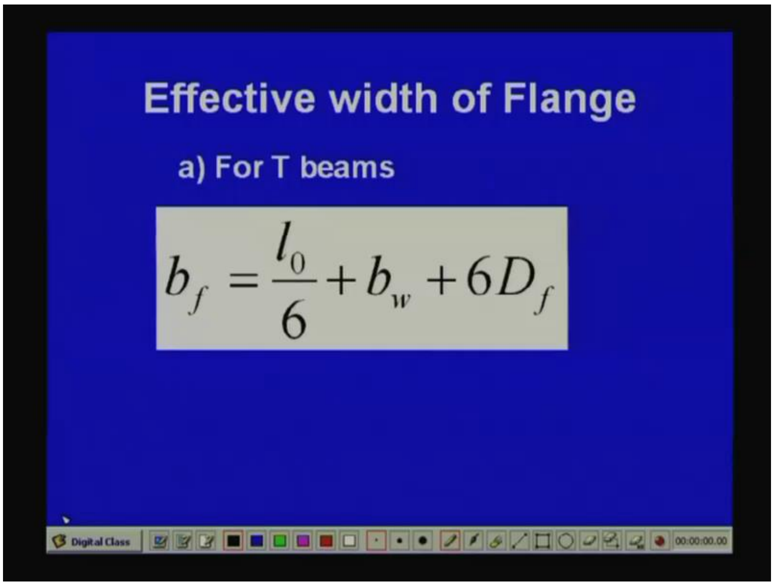

So, if we come with this problem, that means; we shall get the 1.

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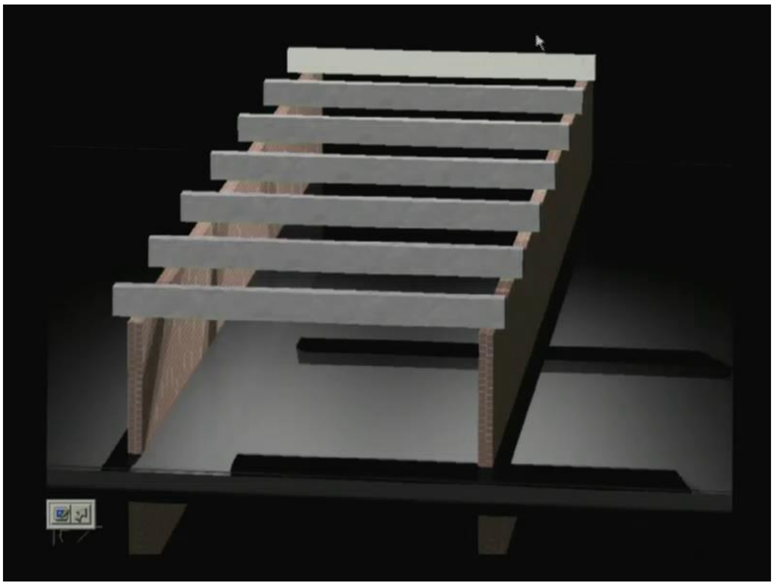

So, we shall get. So, this is the square area for on the slab unit square and we have that load from both sides.

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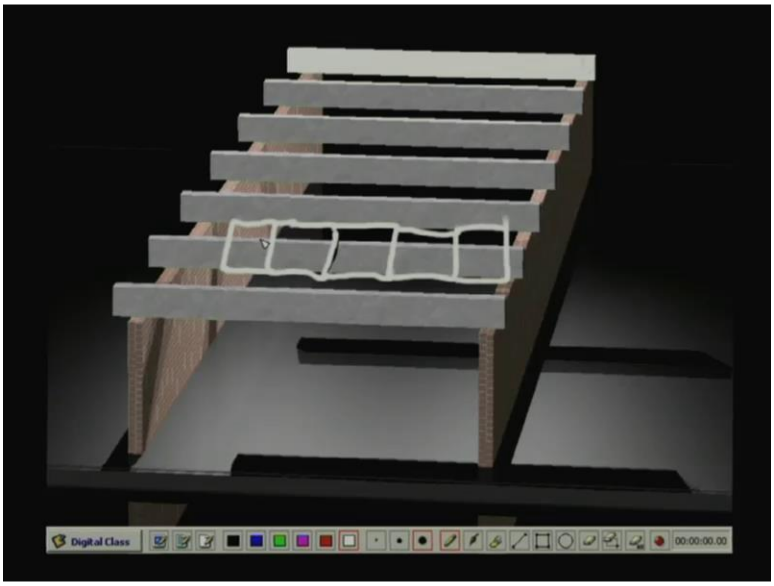

So, if we take this 1 you can get the load 3.898 kilo Newton per square meter for dead load and for live load 4 kilo Newton per square meter and which you are getting within this area within this area you are getting this load. So, now where to take the loading on the beam load on beam. So, how much is the load on beams. So, dead load for slab that we have already computed and that we are assuming and here we are assumed certain rib depth rib 250 millimeter.

So, we are getting an 5 percentage extra for plastering and lot of other things. So, we can get 13.607 kilo Newton per meter; total live load 4 into 3 because, spacing of beams 3 meter so 4 into 3 12 kilo Newton per meter. So, you can get along this length we are getting that; how much 12 kilo Newton per meter and 13.607625 kilo Newton per meter for dead load and we have done up to this.

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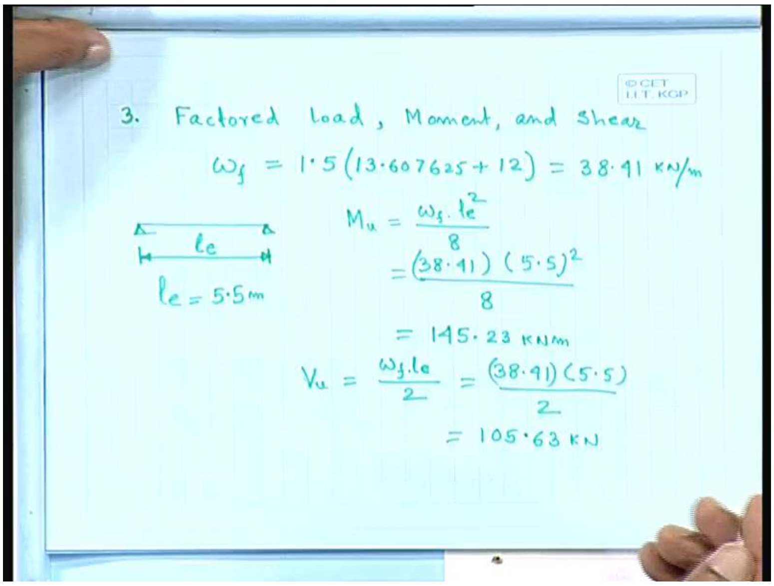

Let us, continue the number 3: now, we have to take the factored load and we have to calculate also factored load, then moment, bending moment and shear; how much will be the factored load. Let us say, wd or f you can take wf the design load, that factored load which will be equal to now, we shall {mul} multiply because hence, it is not mentioned because we are {talking} taking only the dead load and the live load. So, we shall multiply by with 1.5.

So which comes as plus live load equals 38.41 say kilo Newton meter. Our what about moment, our beams are simply supported on the masonry wall there is no moment on 2 supports because, it is just simply supported this is a case of simply supported beam. So, we can take the moment at the mid span and we need the effect we call it effective span instead of taking this 1 we call it say effective span.

What is that 1, our code says even though we know say here, even though we know what should be the your effective span that you have to find out because it is dependent on that not only that your say centre to centre of the beam but, if it is dependent also effective depth also so, out of that minimum 1 we take it and here we are we are taking this 1 unless otherwise specified it is not mentioned we shall take it as centre to centre of the wall. Centre to centre of the wall that, we shall take.

So, we shall get moment that mu equal to wf times le square by 8. So, le will be equal to this 1 is given here 5. I think we have missed it right. So, that better let us, take that 1 say 5.5 meter that 5.5 meter is the space that your distance centre centre between 2 walls and that is the span effective span, we shall take it here. So equals 38.41 times 5.5 whole square by 8 equals 145.23 kilo Newton meter. What about vu that shear force design shear force we shall take w le by 2, equals 38.41 times 5.5 by 2 it comes as 105 505.63 kilo Newton.

So, this is your moment for which you have to design and this is your shear force after the factored load this is the design load after multiplication of 1.5. If it is if you have sysmic load (( )) load wind load then appropriate factor we have to use. Next 1 number 4: that effective width and depth

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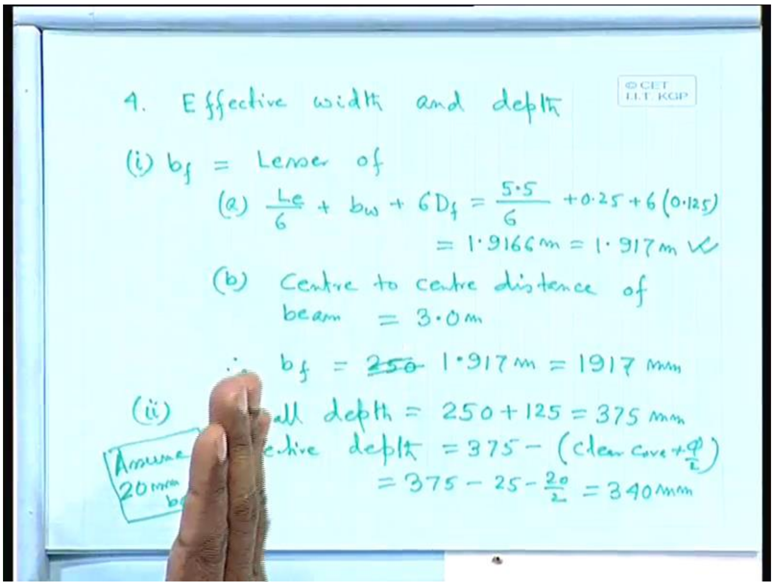

Now, we have to mention that, what is the effective width of this flange that we have to mention, where from shall we get it already, we have mention for t beam. So, we shall use this formula if it is t beam that we shall use it and that is available in the code.

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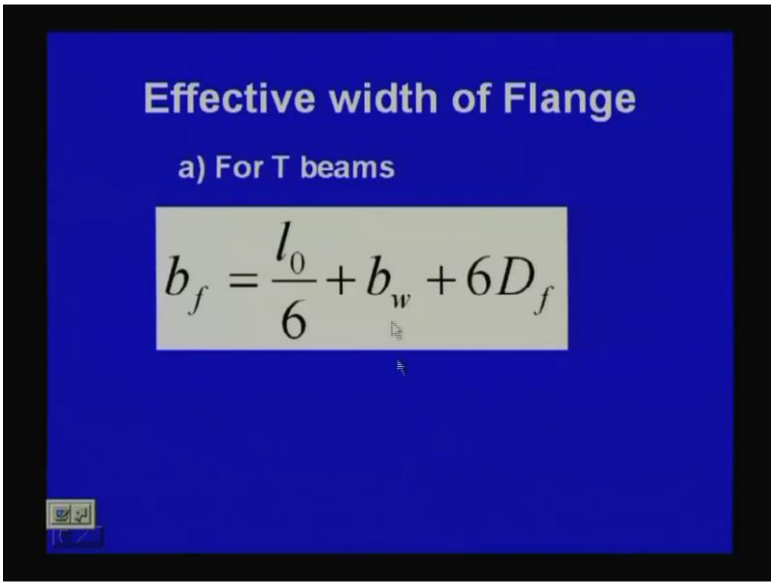

If, it is l-beam we shall use this 1

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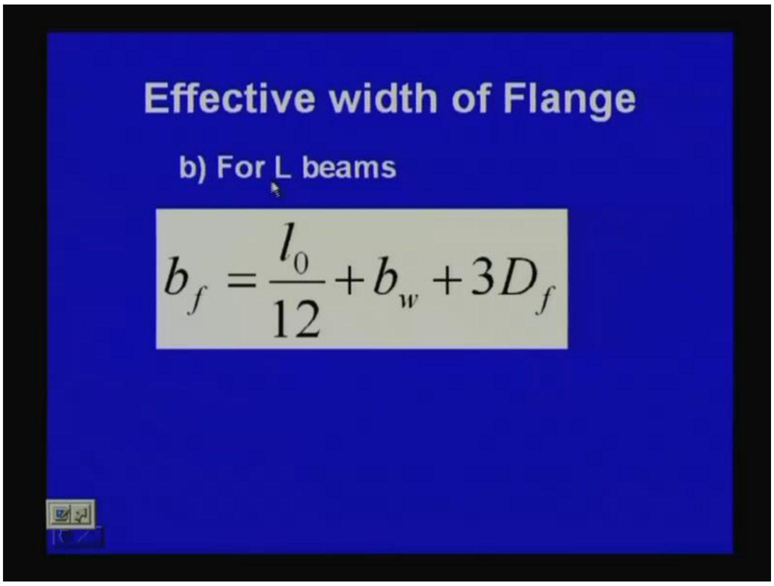

If, it is isolated say beams as per our code for t-beam, we shall get this formula.

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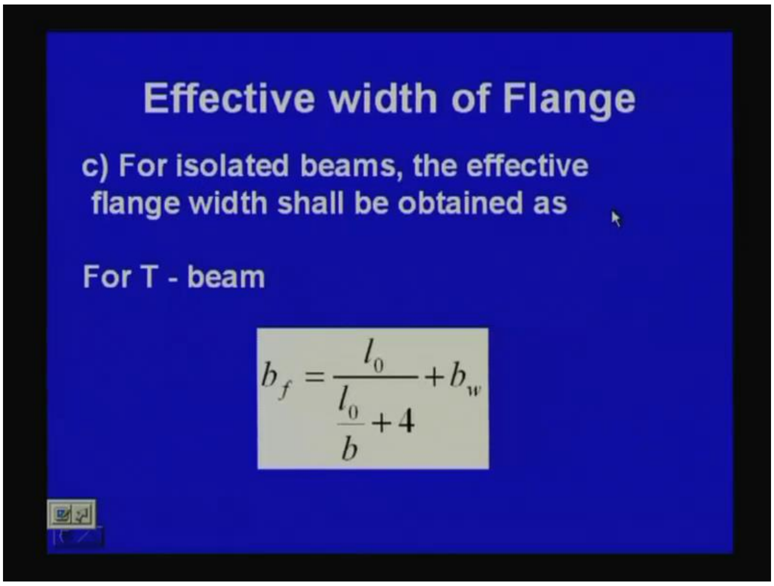

Let me, mention the other 1 for l-beam.

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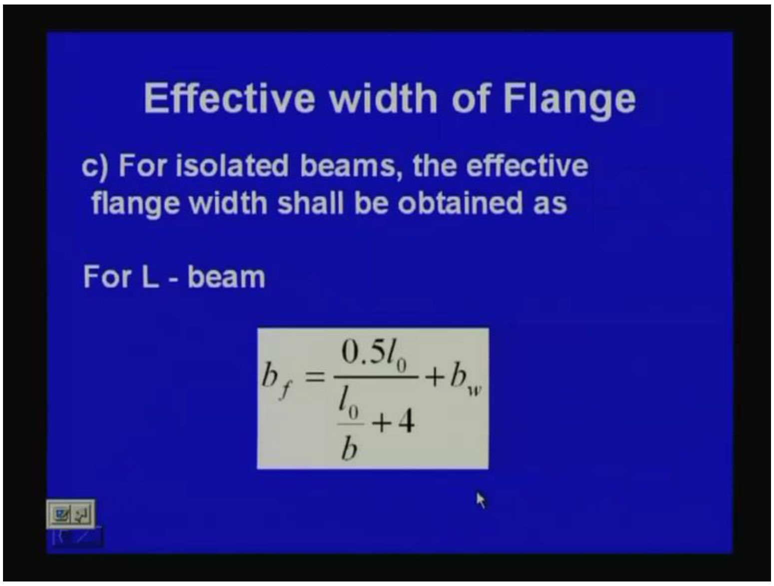

So, here in our case already I have shown while design the t-beam in our case, we shall use this formula.

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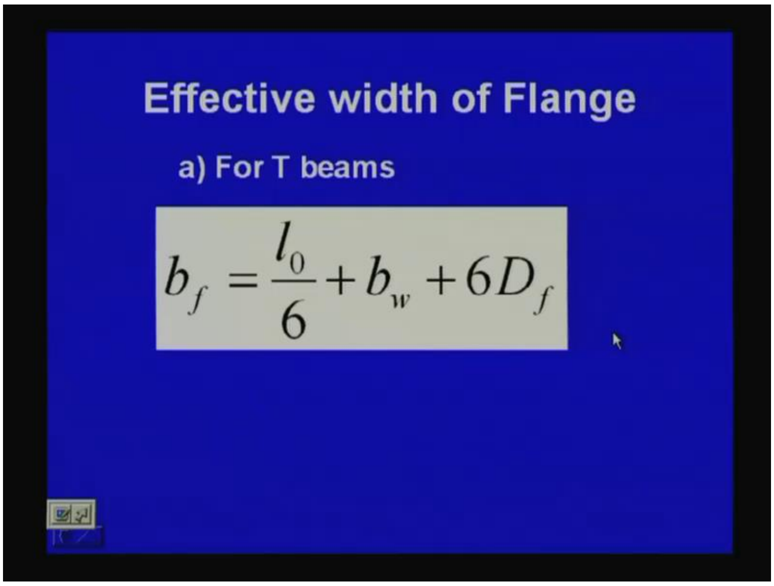

So, what is bf; bf equal to lesser of l by 6 plus bw plus 6 df, which comes as 5.5. Let us say e here divided by 6 plus 0.25 plus 6 times slab thickness 125 millimeter, which comes as 1.9166 meter. Let us take, 1.917 meter; b: centre to centre distance of beam and which equal to spacing that is 3 meter and we have to take out of this lesser of this 1; that which 1 is the minimum.

So, bf equal to 250 equal to 1.917 this 1 meter equal to 1917 say millimeter. Let us, write it down what about your overall depth, this is say 1 this is the effective width number 2, we are interested to find out the effective depth. So, overall depth equal to let us take, we have assumed 250 millimeter is the web depth plus 125 millimeter is the slab thickness which comes as 375 millimeter effective depth.

If we assume, that we shall provide 20 mm dia bar; assume, 20 mm dia bar that, we shall provide so, effective depth equal to 375 minus clear cover plus pie by 2 which comes as 375 minus 75 minus 20 by 2 equals 340 millimeter in this case, what we can do I am always mentioning this the other way in books also you can find that they are directly they are assuming the effective depth that, also you can assume instead of assuming that overall depth and then coming to the effective depth you can also assume that, effective depth and then go to the overall depth.

But why I prefer this 1 because finally we have to provide overall depth and overall depth should be some say regular number that is why I prefer let us assume, overall depth and let us also assume that, we shall provide which type of bar which diameter bar, we shall provide on the basis of that let us, calculate the your effective depth because effective depth can be any number but whereas, overall depth should be at least I prefer say multiple of 25 or may be multiple of 10 also it is dependent on the designer.

So, if we assume that, we shall provide overall depth in multiple of 25. So, let us assume overall depth and come to the effective depth. So, you have got that say overall depth then what about your mu then.

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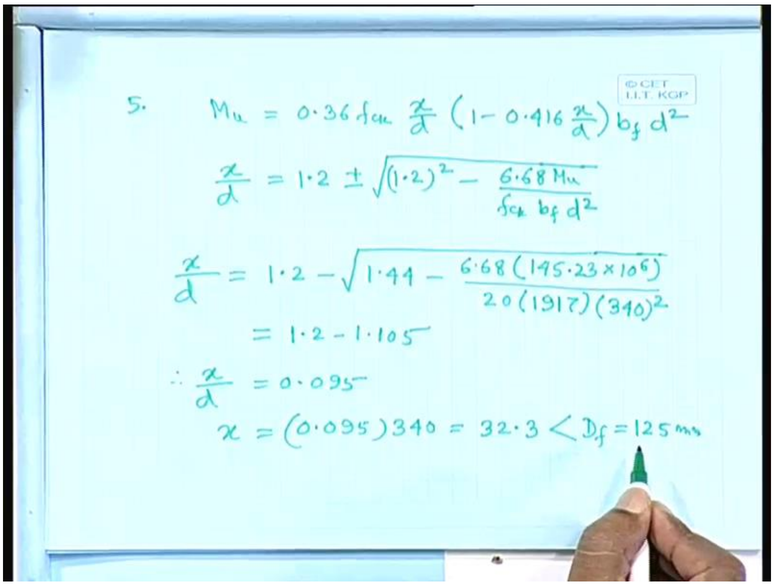

We know that mu equal to 0.36 fck x by d 1 minus 0 point four 1 six x by d bf here, in this case bf because we are talking say your that t-beam bf times d square. If we rearrange this 1 then we can get this formula. So, if you like to remember this also you can remember plus minus root over 1 point 2 whole square minus 6.68 mu divided by fck of bf d square there are so many other ways also 1 can remember directly instead of coming from the first principal always using this formula you can remember this formula also if you like.

So, you can write down x by d equal to 1.2 minus 6.68. Let us write down the full thing 145.23 into 10 to the power of 6; we are making everything in Newton millimeter divided by 20 times the width of the flange 1917 millimeter times the effective depth computed which; we are going to provide so that is the 340 which comes as: therefore, x by d 1 case x by d equal to 0.095 and x equal to 0.095 times 340 equals to 32.3 less than df depth of the flange or slab which equal to 125 millimeter.

So, in our case it is that as if, it is a rectangular beam. So, you can take this 1 say your x 32.3. So, it is less that it is within the flange it is nothing but your we can say, it is a case of rectangular beam only though; we have taken t-beam. So, we can use the formula. So, how much will be the steel provided number 6 say steel to be provided, area of steel equal to mu divided by 0.87 fy the stress in steel d minus 0.42 xu or x that is the 1 lever arm which comes as 145.23 into 10 to the power of 6 divided by 0.87 times 145 that fe 415 that steel 340 minus 0.42 times 32.3 is the that your neutral axis depth which comes as 1232 square millimeter.

So, we can provide 4 numbers of 20 tor and so, what is the ast provided area of steel this is area of steel computed this 1. So, area of steel actually provided equals 1256 square millimeter. So, you have provided 1256 square millimeter little more so, I think this is acceptable what about you your; so, we can provide that percentage equal to 1256 into 100 divided by here, we shall take it not on the basis of width either; we will take it on the basis of not on the basis of flange we shall take it here that web width of the web.

So, 250 times 340; when we shall take the percentage of steel, we shall take width of the web equals 1.47 percent our code says: then minimum steel that should be 0.85 into 100 divided by fy. So, this our code says: so, 0.85 times 100 divided by 415, which comes as a say 0.2 percent. So, our that steel provided that is 1.47 percent greater than the minimum steel required.

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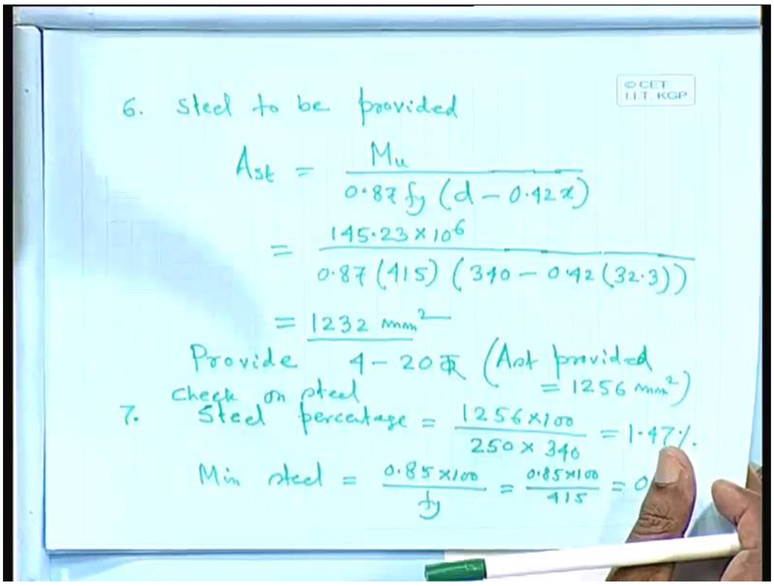

What about the shear reinforcement, I think we can this 1 we can take it as a check. Let us, take this 1 as a check so, number 7 say check on the reinforced steel that; how much your are providing and whether, it is permissible or whether it is within the limit. So, that we are checking in this case number 8. Let us come to the same problem the shear reinforcement how much is our is our vu that is 105.63 kilo Newton percentage of tensile reinforcement already, we have just computed 1.47 percent.

What is our that 2c max; maximum shear stress and that where from we shall get it that we shall get it refer table 20 is 456 and you should always mention that whenever, you are mentioning that code you also mention the year because, it differential year say 1978 is 456 says (( )) that 1 you have to mention the year also otherwise, it is not complete because there are so many revisions; so, 1978 may have other say number. So, that is why you should mention the year of publish that is when, it is revised.

So, maximum stress test we are getting 2.8 Newton per square millimeter that means; that if our nominal stress say, it comes more than that then we have to change the section. So, 2 v equal to vu by b times d what about this b; b is the width of the web though we are taking, we are talking say your t-beam that here, you have to take b as the width of the web vu equal to 105.63 into 10 to the power of 3 divided by 250 times 340. And it comes as 1.2427 Newton per square meter.

So, it is less than 2.8. So, no need of changing the section. Now, what about whether, we need shear reinforcement, what about the shear reinforcement that; we have to find out. We can get it that 100 ast by bd and we have tow c and that we shall get it in table 19 is 456. So, let us write down table 19 is 456 2000. When you do the design you always mention that, the reference clause or table of the code; that always you have to mention and we generally we do it in this side.

In the right hand side generally, we refer all these things. So, we can get it because, it is 1.47. So, 1.25 if, it is the tensile reinforcement percentage, which comes as 0.67 and if, it is 1.25 then it is 0.72. This 1 the part of the table 19. So, appropriate that values 1.25 1 .5 because, you have to take it 1.47. So, tow c you will take it linear equal to 0.67 plus 0.72 minus 0.67 by 0.25 times 1.47 minus 1.25 which, comes as 0.714 Newton per square millimeter.

So, this is the tow c which, will be taken care of by concrete the shear stress this portion that tow c times bd whatever, shear force we shall get that 1 will be taken care of by the concrete, which will be due to the that aggregate interlocking and compression of the concrete zone, and also the double action of the reinforcement steel. The tensile reinforcement steel so, that composition total we shall get it from table 19. How much we shall get and that is coming here, to tow c equal to 0.4714 Newton per square millimeter. And which is less than tow v the 1 we have computed.

So, this is your tow v which, we have computed which is coming as 1.2427, which is greater than 0.714. So, we need shear reinforcement.

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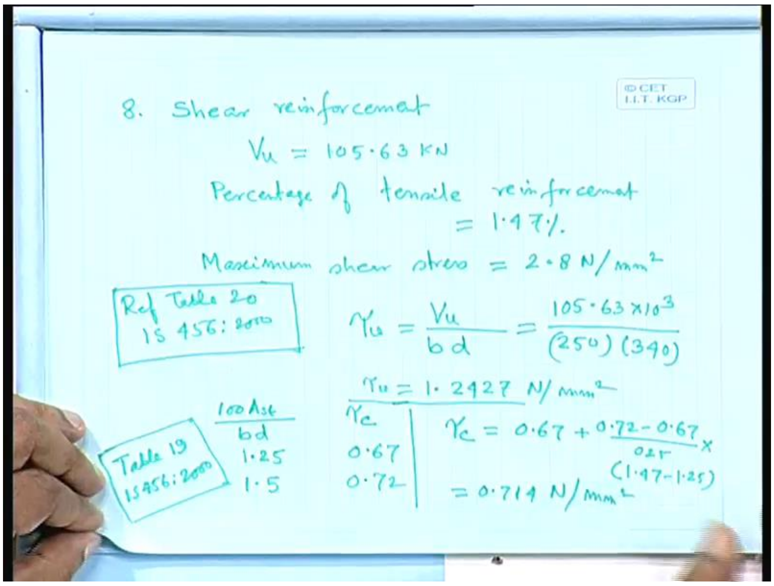

So, in our case; we can write down that tow v greater than tow c, but and tow v less than tow c max. So, no need of changing the ah your say section, but we have to provide shear reinforcement. So, shear the concrete due to concrete say and let us say, that 1 vc so, vc equal to 0.714 times, 250 times, 340, which comes as 60.69 kilo Newton. Shear to be taken by steel vs say equal to vu minus vc 105.63 kilo Newton minus 60.69 kilo Newton equals 44.94 kilo Newton.

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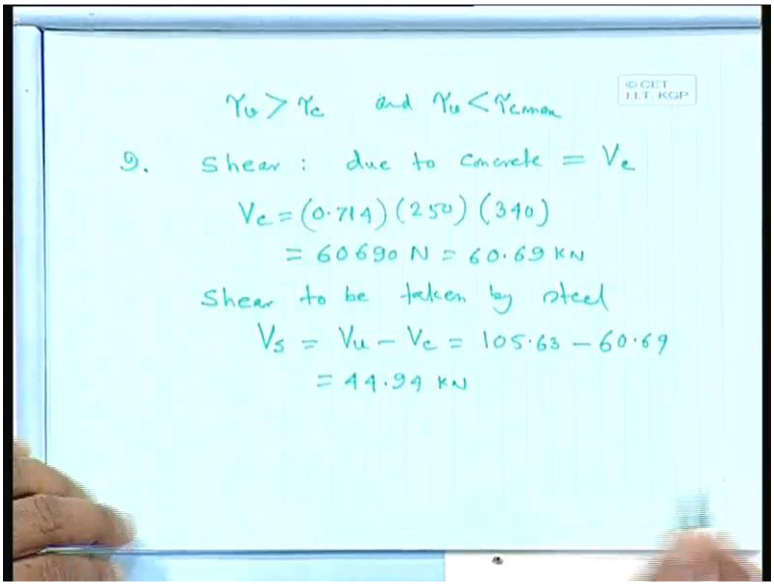

What about vus. Let us go the next page then vus that is: as per the code 0.87 fy times, asv times d divided by sv the spacing asv by sv equal to vus in our case divided by 0.87 fy d or asv by sv equal to 44.94 into 10 to the power of 3 divided by 0.87 415 times, 340 equals 0.366. This the 1 asv by sv we can get 0.366. If we use. Let us say, use eight mm tor. So, asv and we shall use 2 legged therefore, asv equal to 2 which will be equal to say 2 into 50 equal to say 100 square millimeter.

We can write down asv by sv equals 0.366. So, sv equal to asv by 0.366 equal to 100 by 0.366 equal to 273 millimeter sv equal to 273 millimeter.

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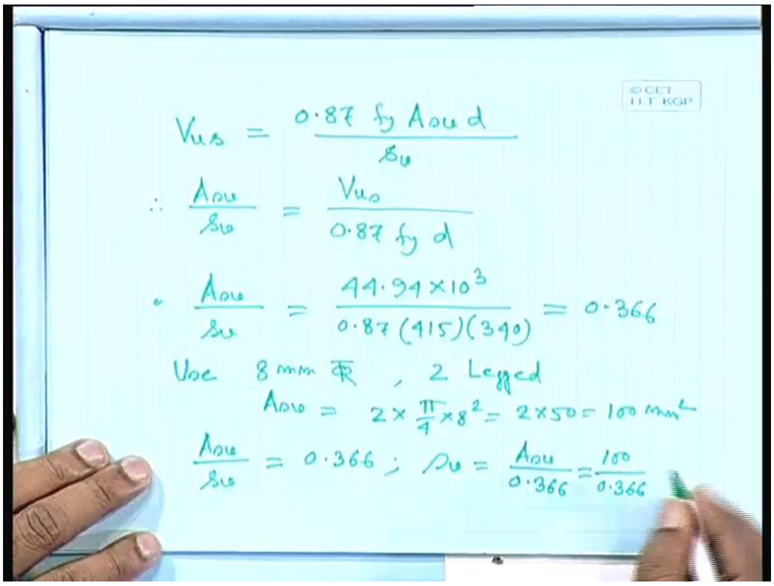

So, let us write down the spacing sv 273 millimeter. We are using 8 mm tor 2 legged. What our code says that: maximum spacing a 0.75 d 0.75 times 340 equals 255 millimeter b not greater than 300 millimeter output says. So, minimum of this minimum or I can say, lesser of the above 2 equal to 255 millimeter. So, it is governed by this 1. So, we can provide though it is maximum spacing here 273, here 255, here 300. So, we can specify use 8 tor 2 legged at the rate of 250 millimeter center to center.

So, this is the 1 that we are providing, it is always better that after this, it is always better to summarize our result, it is always better to summarize our result. So, what we can do then.

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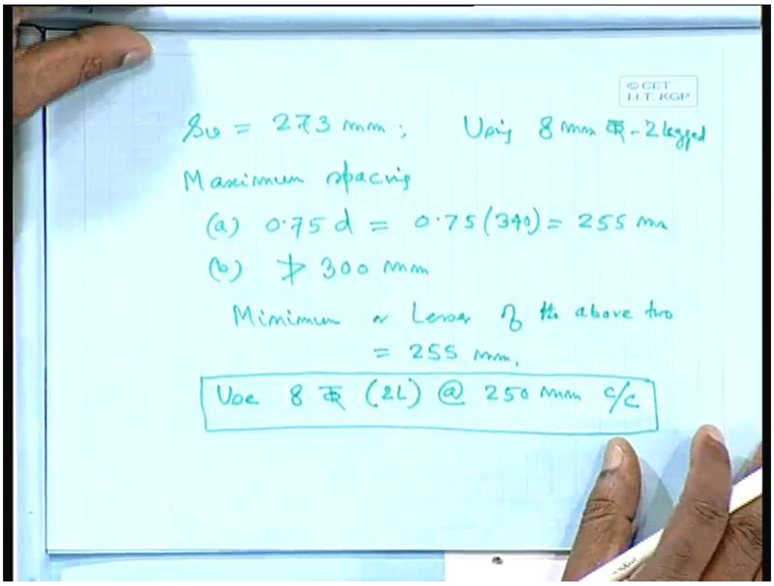

We shall provide the t-section, we are here 125. And this 1 250; we have 4 420 and the stirrup other 2 bar, we are ah just providing say: that we need not specify here, but anyway because for our design we shall not specify. So, we shall get 250, 420 tor 8 tor 2 legged at the rate of 250 millimeter centre to centre. Concrete m 20 steel fe 415; that only we have taking fe 415. So, anyway so, that we have used this 1; clear cover.

Let us mention, 25 millimeter main longitudinal tensile reinforcement 420 tor, stirrup 8 tor, at the rate of 2 legged (( )) 2 legged at the rate of 250 millimeter center to center. So, this your the summary of the results it should be at the end you should summarize the whole thing. Because finally that; this 1 only will go for drawing or to the draftsman because, they dont need any calculation all those things, it should be very clear. And though, it is not mentioned.

So, we can provide let us, complete this 1 that hanging bars. Let us take here, that 2 10 torque. This is not in our calculation; it is not mentioned to complete this figure. Let us take, this is 2 10 toque because, it is not you are just providing the minimum 1. So, we can provide 2 10 torque. So, this is that your whole design that step by step that you have to make it that whole design step by step you have to make it for your say flexure as well as for shear.

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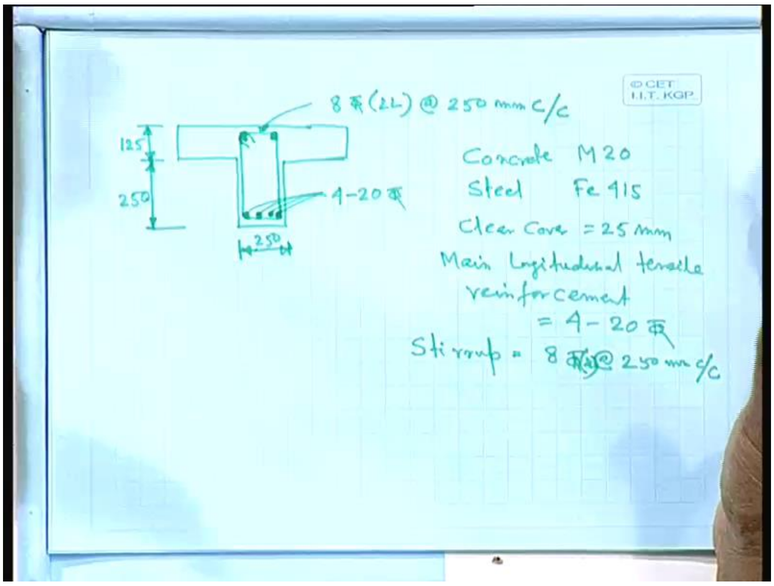

Let us, solve 1 more problem I think that 1 will give you; that your for the nominal shear here. So, design of stirrups for nominal shear. Let us, take b equal to 250 millimeter, d equal to 450 millimeter longitudinal, tensile reinforcement that is: 520 tor, vu that shear force that is: the factored 1 60 kilo Newton concrete m 20 steel fe 415. So, what is the effective depth. Effective depth equal to 450 minus 25 is the clear cover minus the 20 by 2 that is: the diameter of the bar, half of the diameter which comes as 415 millimeter. Area of steel ast equal to 5 into pie by 20 square equals 1.570 square millimeter.

Let us, write down here percentage of steel p 1.570 into 100 divided by 250 times 415; 415, is the effective depth please not this is 415 is the effective depth, which we have computed here, it comes as 1.513 percentage; 1.513 percentage okay this p, we shall take it for our that tow c to calculate the tow c.

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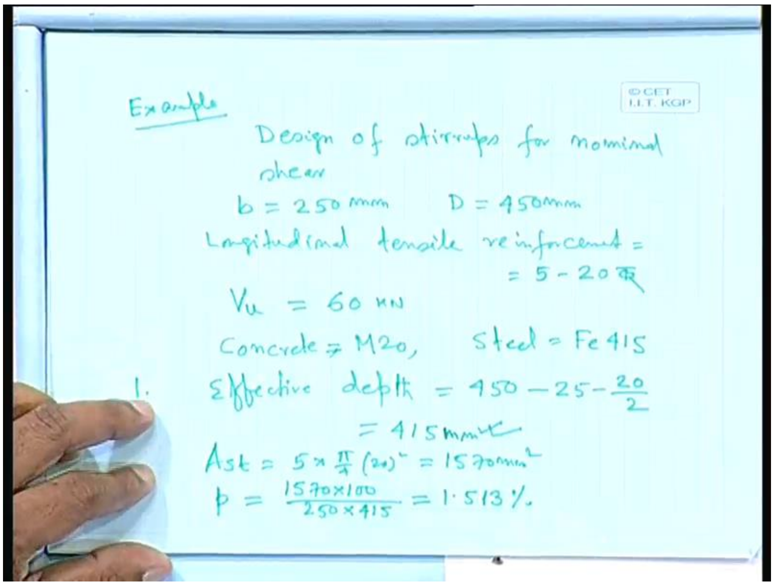

What about the shear force number 2: the that tow v equal to vu by bd v u equal to 60 into 10 to the power of 3 divided by 250 times 415 this 415 is effective with depth please note that the 1 the steel 0.578 Newton per square millimeter tow c max from table 20 of is 456; 2000, which comes as 2.8 Newton per square millimeter less than tow c max. From table 19, we shall get 100 ast by bd and tow c that we shall get 1.5 we are getting 0.72 this is in Newton per square millimeter, 1.75, 0.75.

So, tow c equal to 0.72 plus 0.75 minus 0.72 divided by 0.25 1.513 minus 1.5 percentage of steel, which comes as 0.722 Newton per square millimeter. So, tow c we shall get as 0.722 Newton per square millimeter and tow v 0.578 Newton per square millimeter.

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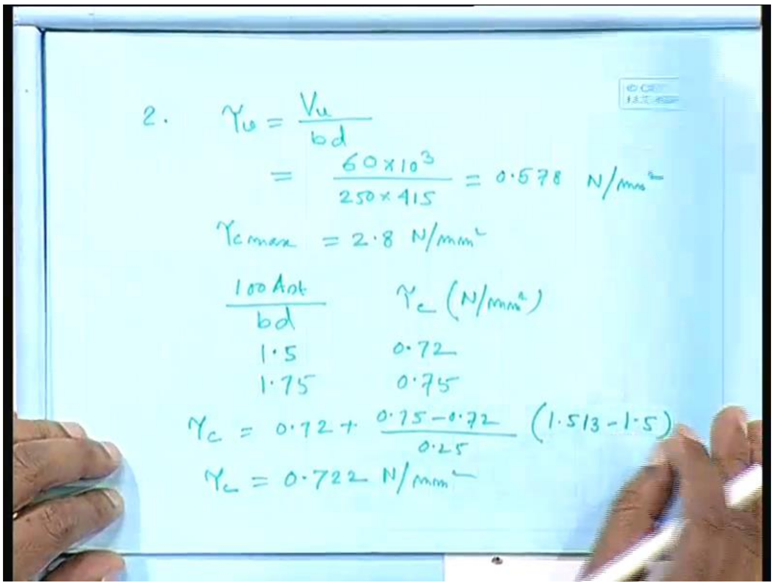

So, if we write down tow v 0.578 Newton per square millimeter tow c computed 0.722 Newton per square millimeter; tow c max 2.8 Newton per square millimeter. So, we can write down tow v is less than tow c and less than tow c max. So, we can write down only nominal shear reinforcement is required what our code says: our code says that: what will be the nominal shear reinforcement

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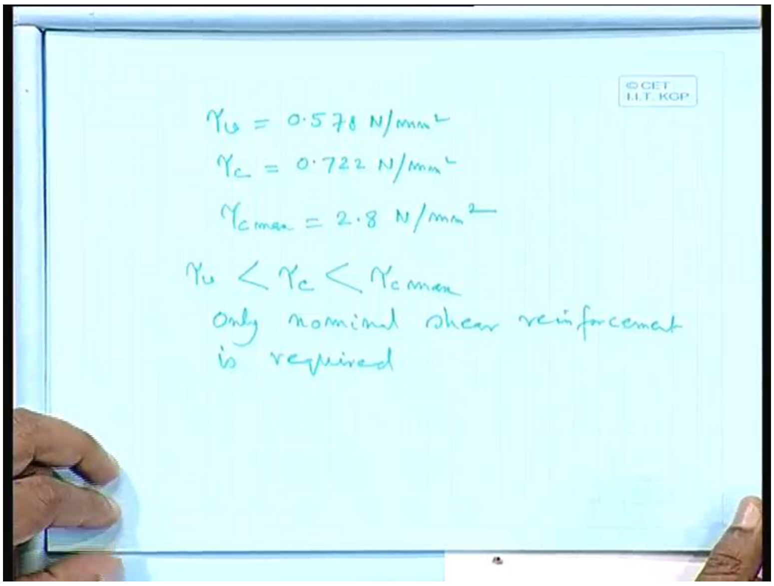

We can get it in clause 26.5.1.6 that, we shall get it 26.5.1.6 of is 456, 2000 here, that asv by bsv 0.4 divided by 0.87 fy 0.4 by 0.87 fy you can get, this value or asv by sv equal to 0.4 b times 0.87 times 415 equals 250 times. So, 0.87 asv equal to again s 0.87 times 415. So, you can get it. Let us, provide use 8 tor 2 legged. So, asv equal to again 2 equal to 100 square millimeter sv equal to asv by how much is this value asv by sv, which comes as 0.276.

So, asv by sv so, from there we can find out 0.276 equal to 362 millimeter. what about the spacing, maximum spacing a 0.75 d equal to 0.75 times 415 comes as 311 millimeter, b not greater than 300 millimeter that is: a numerical value mention in our code. So we are we can provide, we have to provide, the shear reinforcement stirrup 8 tor, 2 legged, at the rate of 300 centre to centre. Because we are taking 300 that is the 1 minimum and here 311.

So, we have to provide 300. So,8 tor 2 legged at the rate of 300 centre to centre that, we have to provide and that you can get it that is the 1 minimum that nominal reinforcement. So in your problem that, we have given so, there you have to take this you have to calculate according to this steps.

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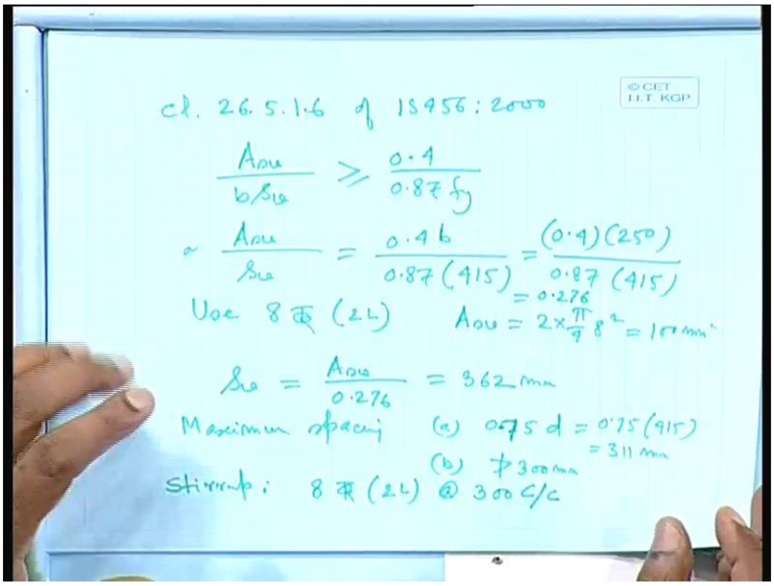

So, this is all regarding your say uh beam design that your flexure as well as say shear and it should be complete and it should follow that steps. And you should not keep everything in your calculated only then only in the final result not that 1 because sometimes you have produce your design calculation also. And there is another 1 say: the designer has done, it sometimes it has to be proof checked that means; that calculation everything done according to is codes, according to the analysis methods design.

So, that is again proof checked so, it should be rated by somebody else so, that is why your calculation all those thing if you do everything in your say only calculator and put the result then, it will be difficult may be it will be difficult for you also even after say may be 1 month or 2 months also or if it is more than it will be more difficult so, that is why it is a good practice that you have to refer your clause of is 456 or any other code which, you are using that is number 1.

Number 2: that your calculation you write your formula firs,t equation first and what are the if you remember everything fine if the say asv, that is the convention if you follow that asv is for the shear or shear your say area of steel ast that is, the area of steel for the tensile reinforcement if you mention that way and if you can have in the very beginning of your report. The list of that your say symbols used so, that is fine and otherwise you have to mention what is that ast asv all those things that you have to mention that is number 1.

So, what you have to do, you have to use your formulas you have to write your formulas first and then you put your numerical values in the corresponding position wherever, you are used that formula that your say different variables and then you write down the final result; not the 1 you have used your formula, written your formula and then finally your writing that you say equation and final in result then, it will be difficult for you to check it; if it is required.

This is that always you do it and you use and you write down your that clause tables whatever, you are using say for example, in table 19 whenever, you are using I am writing that 1 your say your that percentage of steel and corresponding tow c again percentage of steel and corresponding tow c that I am mentioning and then I am again writing that 1 because it helps in future otherwise in the calculation itself, I can do it but in result sometimes if you do any mistake then again, it will be too much confusing so that you have to avoid.

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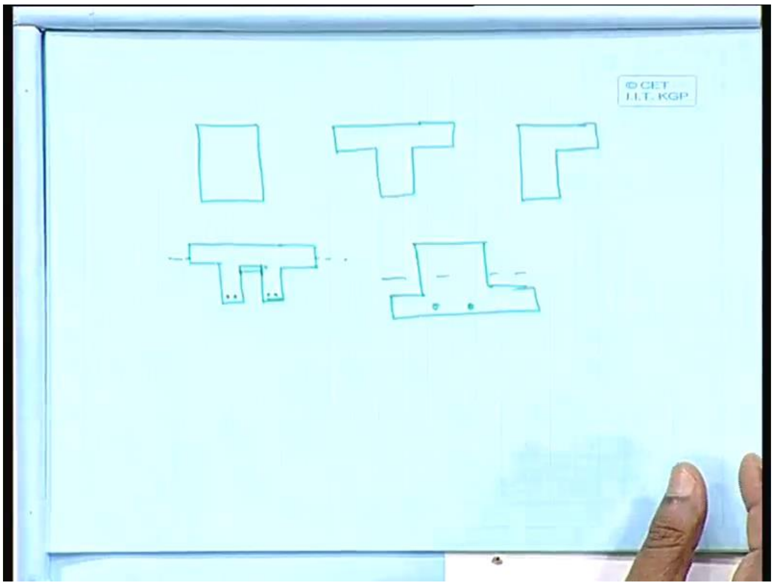

This is 1 part the second part that not necessarily that your section will be simple rectangular or t-beam or l-beam not like, that sometimes you have to design your section which, may be some say your different shape say it may happen like this also, if we take this 1 up to this may be due to from the architectural point of view or may be from some other view say, we would like to provide your say tables all those thing through that. So, whatever you have this is also another section.

So, here gain it is nothing but the t -section because that your neutral axis if it comes within, if you can provide within the flange then there is no problem because then, it is the simple say rectangular 1 only. And the another part the concrete is not taking any load or anything any moment. So, whatever reinforcement you are providing here so, that is the 1 your area of steel. So, it is nothing but again you can say this nothing but your t-beam or again you can come back to that 1 otherwise if it comes the other option the neutral axis. So, then you have to do that your calculations.

So, in this case, it is always preferable that I shall keep the neutral axis that is 1 way of tricky solution, that your providing the solution within that limit. So, our calculation and other things will be easy. So, this is this is your 1 problem, it may happen say sometime, it may happen though, it is not 1 but sometimes, it may happen that it can be something like this also the other way. But even then your reinforcement whenever, your are providing the reinforcement here, but this 1 will not come into picture when that your neutral axis is within this limit.

So that way you can solve your different problems that you can solve. So, your problem for example, purpose other things that this type of cross section may come so, that also you can consider.

Thank you.