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NPTEL ONLINE CERTIFICATION COURSE

Course
On Reinforced Concrete Road Bridges

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Lecture 14: Design of Slab Bridges (Part - VI)

Hello everybody, so we shall conclude today with the design of Slab Bridge, already we have done in detail for IRC 70 unloading; now we shall take another problem on Slab Bridge only to give you idea.

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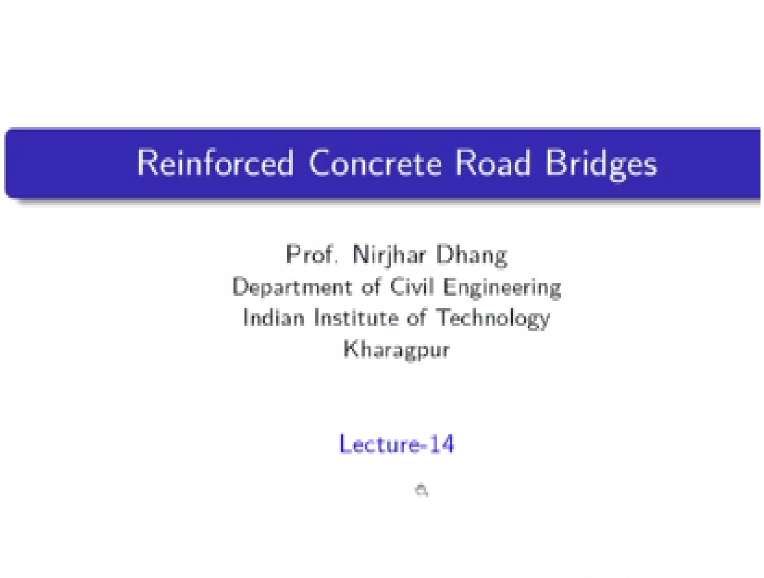

This is actually your lecture number 14 and that one we are considering here.

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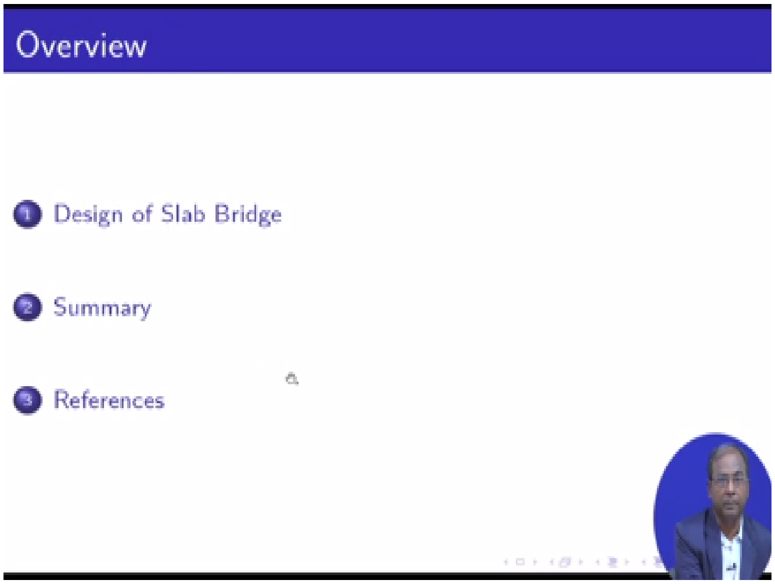

The same set bridge but we shall take a different problem we shall consider and that one.

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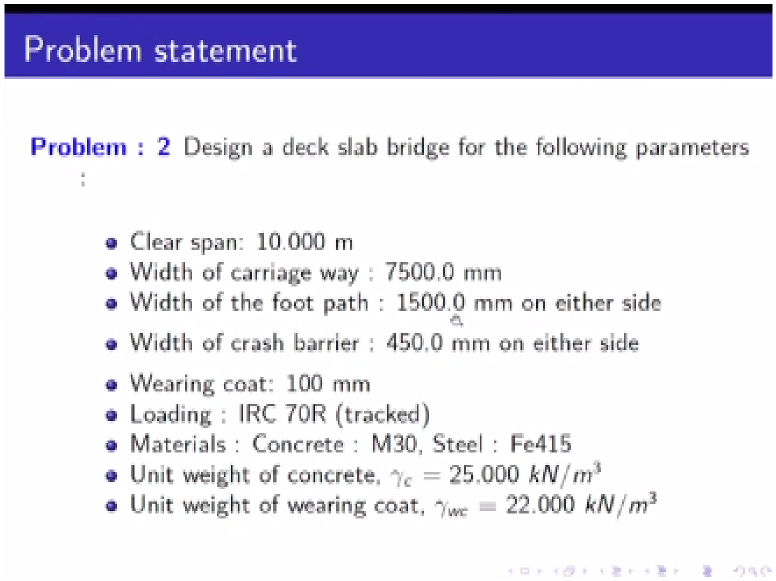

Here so let us consider this one as a problem 2 and what we are doing here, just let me give you before coming to that, I am Telling You.

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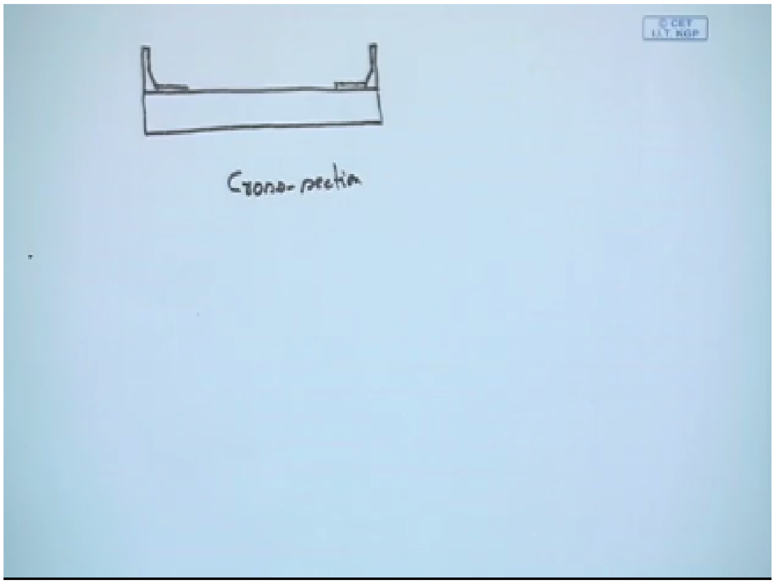

So this is your that slab cross section and we are having here the class barrier and then footpath, this one we are considering here and for this we shall find out that we have changed the span. So this one now coming to this one, so let us see the clear span, so same problem we are doing 10 meter with the carriage way 7500 the for double length, weight of the footpath we have taken it to 1500 millimeter on either side, with the class barrier that with the bottom there one we are having 450 millimeter, we are having 100 millimeter.

Our accessibility loading, we have change the grade of concrete that a M30, Steel Fe415 unit weight earlier we took it 24 and now we have taken 25, wearing coat that is 22 the kN/m3. So this is your the data whatever we are getting.

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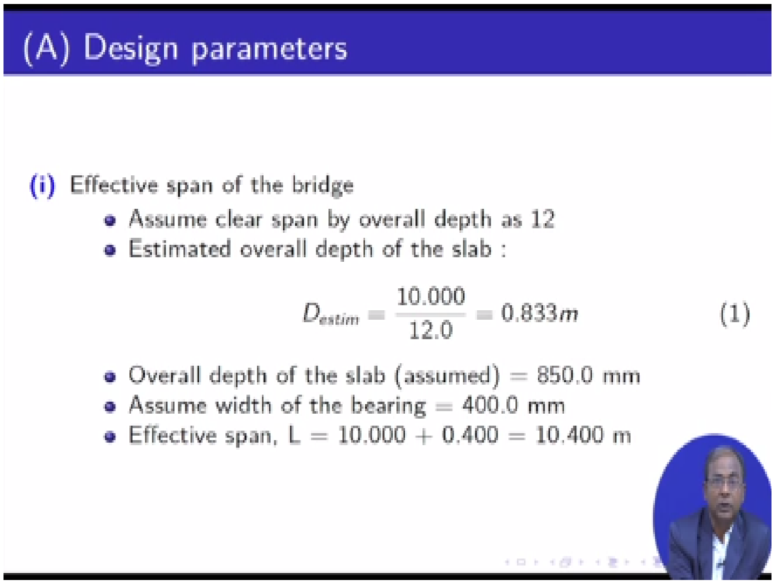

Mixed we are considering that again we are depth we have taken this is the 12 we have taken, we can consider 13 also, we can consider 14 also, that also you can find out on the basis of that you can find out the estimated depth and over all depth we are getting here, so that means here what I have done basically here this I added 833 mm and then added another 25mm and rounded off, so we are getting 2/25 divided, so 815m we are getting here. Depth of the width of the bearing as usual we are taking 400mm, so effective square 10.4, so we are getting this one 10.4.

This is the one for solid slab we are considering here and we would like to see that what is happening, the it looks like the same problem only the spam is changed and I have change that unit weight of the concrete to 25, which is the usual case we should take it.

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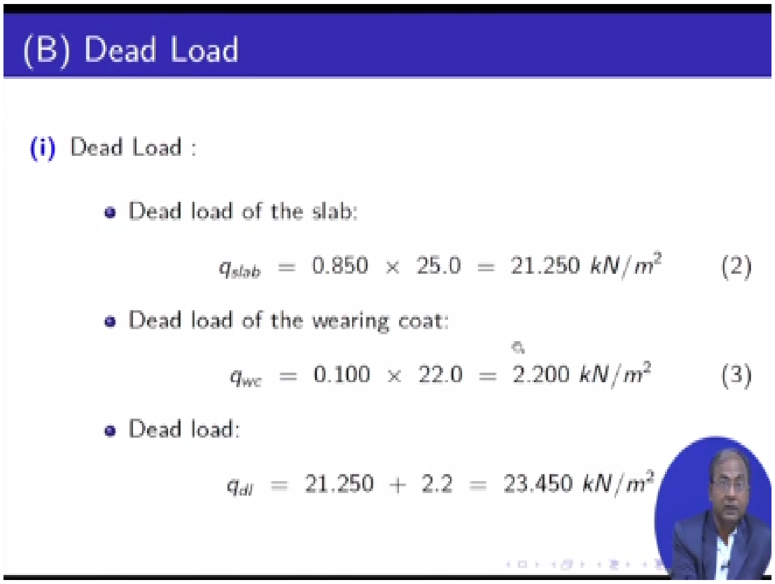

So as usual that q slab for the dead weight, so we are getting 201.25 kN /m^2 and then we are in code for that to point to and read load we are getting to the 3145 kN/m^2, that I mean to say that per square meter you can get this much of load it is coming here.

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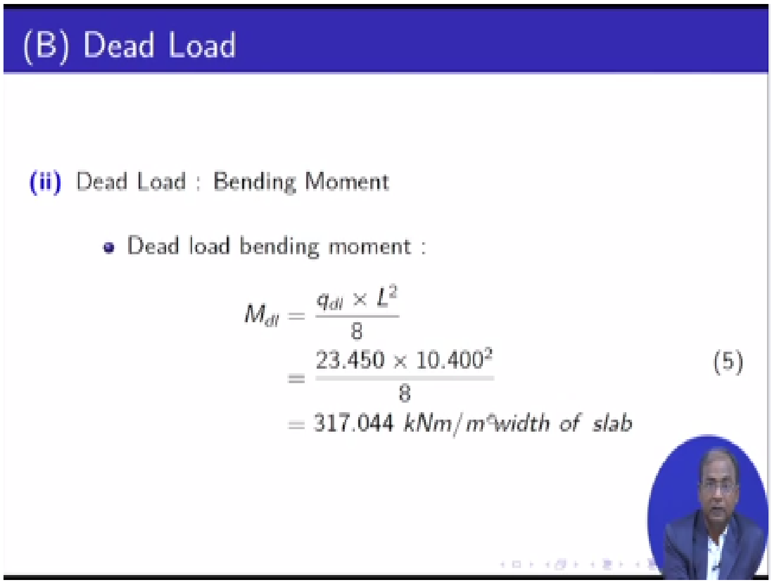

So you can find out that 317 it looks like quite high per meter width of slab, we are getting here 23.45 and this we are getting here.

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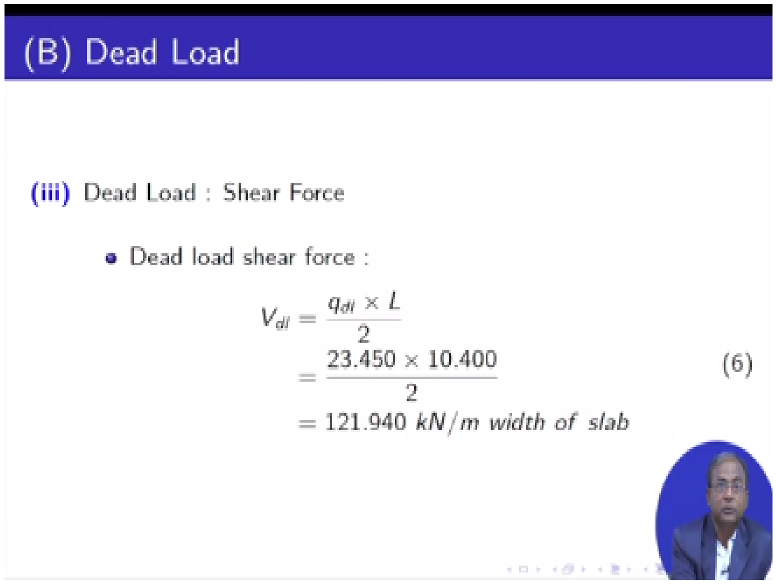

So what we can do here that for the dead load shear force 23.45 x $10^{0.42}$, so 121.94 kN /m so that we can get it by meter width of the slab, so we have got that one as usual we can get that for the bending moment and for the shear force that we can find out when that is coming here in this particular one we can get it here.

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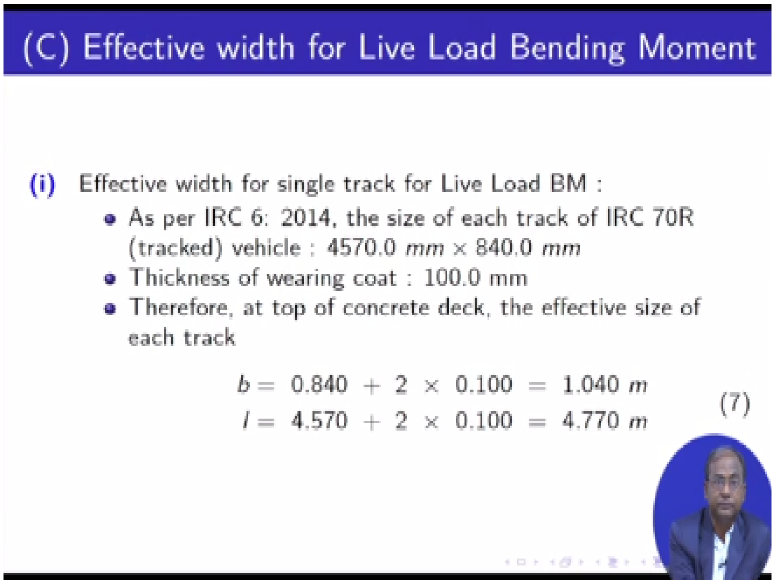

The next question is coming into picture, this part there is no problem because we are going from the top of the viewing quote to the bottom one, that on the top of concrete so that one we shall get the same one we are getting for IRC loading that we can get it

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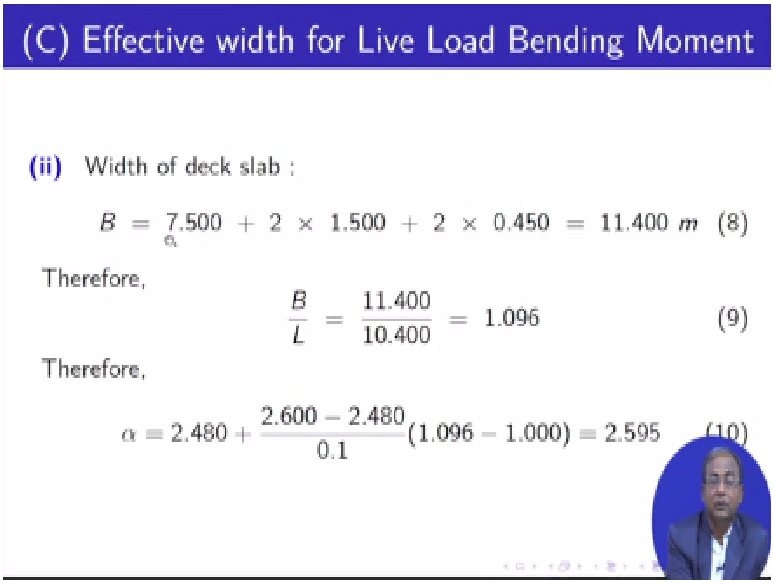

And as usual that B now it will be chain B means total B now we are considering here just to give you idea that we are talking this one as our B we are considering here.

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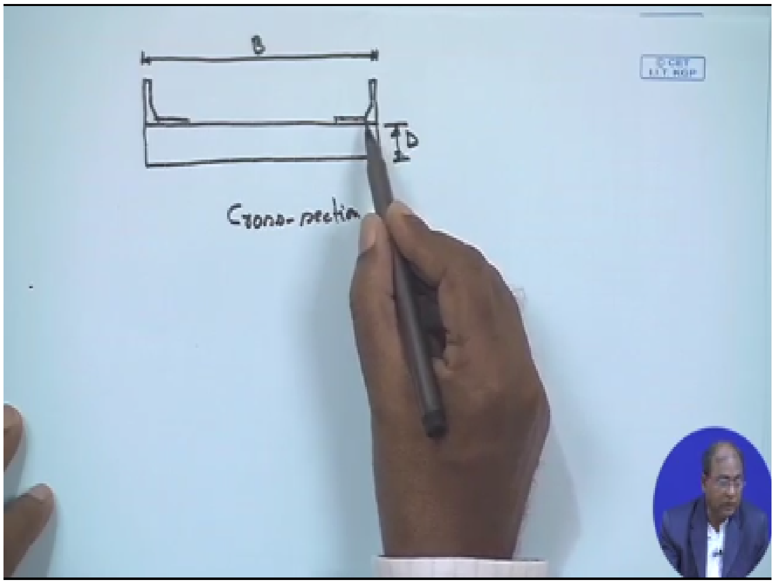

Okay so sorry so this one we are considering here that B we can get it here and then this is our depth D, so class barrier generally as per IRC pipe we can get this one we take 450, this one also 450. So what we can do it here we can find out now that your B total B which is coming at 11.4m and B/ L 1.096 so we can get the α value which is coming this one we can get it here, that α value we can get it the 2.59, that we can get it from the table that we can find out.

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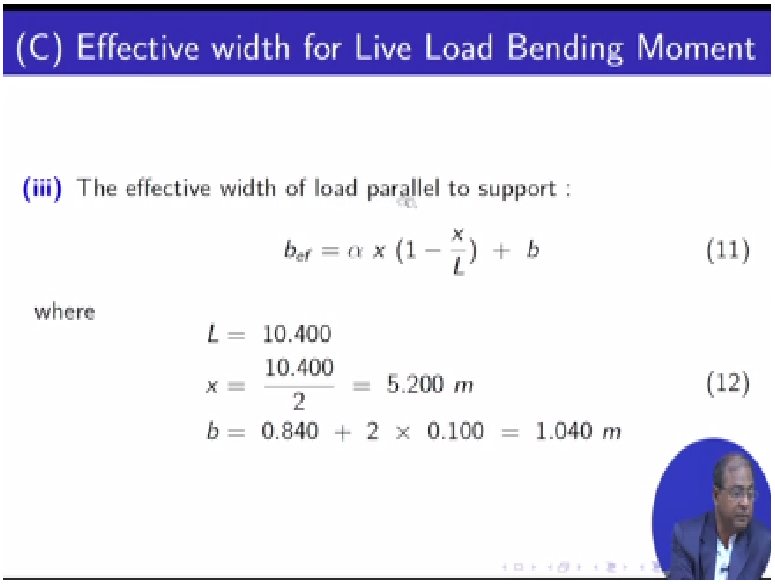

Effective depth again we can calculate that one on the basis of that Lx because we are considering at the middle the load is given at the middle, so and B so we are getting here the same value will get it here there will be no change here. Only thing because that we got other things with x value because of this one will be changed and L also. So we have got this particular on here 7.788m, that effective that for a single load that means for the one track that we are getting 7.788m.So we can compare that one earlier one you can compare and you can see that how much is the difference you are getting here.

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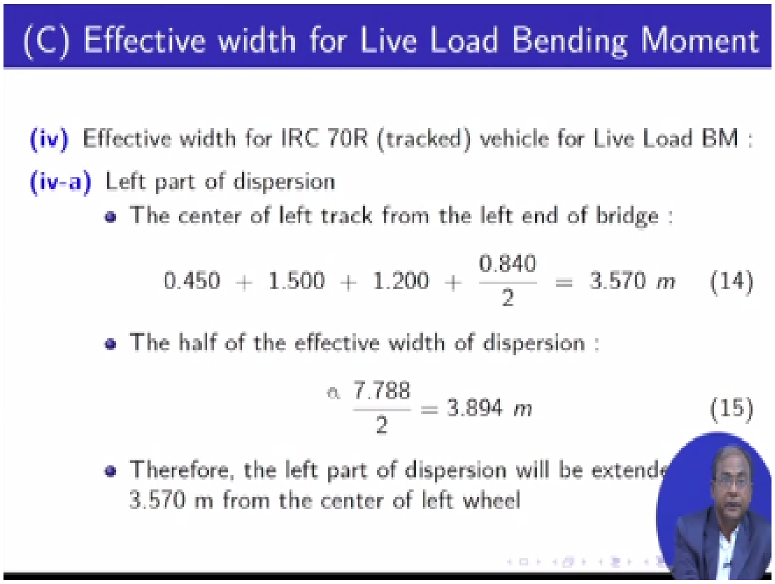

So coming to this particular one here center of left rack the breakage here, so let me give you the vehicle, the vehicle is here so this is our left track and from the left track we can get the center line of that. So we can find out from here to here you can find out from here to here if I can do it that means other we also can find out so that from there we can get, that how much this length will come? That we can find out, this particular one we can find out here. That is the one we are doing this particular on here.

So whatever we can do it here the center of left track from the left in a bridge so 0.45 that is the class barrier +1.5 that is the footpath, then we are having that we do the end the footpath to the in outer of the track and then the centerline of the track which is covering where 3.57, half of the effective width of the dispersions because already I have got 7.788m which is coming at 3.894. So that will be 3.894 code we are getting it here, so obviously we have to go up to these so 3.57 we have got it here.

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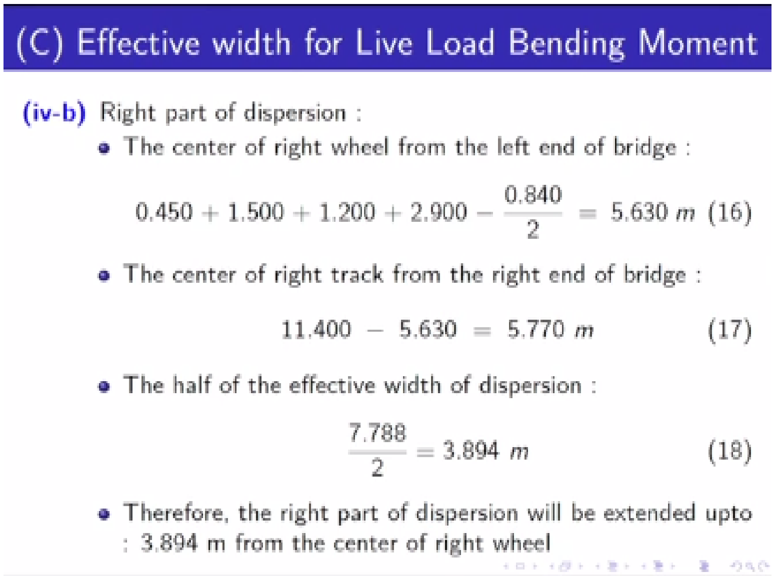

Next one right part again we shall do it so 0.45 so this the particular we are getting it under the right wheel from the left end of grade 5.63 and the width of the bridge that be 11.4 – 5, so that means from the right side we are getting 5.7 right end we are getting 5.77. So it is coming 3.894 that is less than this so that means I can take the pool this person on the right side 3.894 we can take it.

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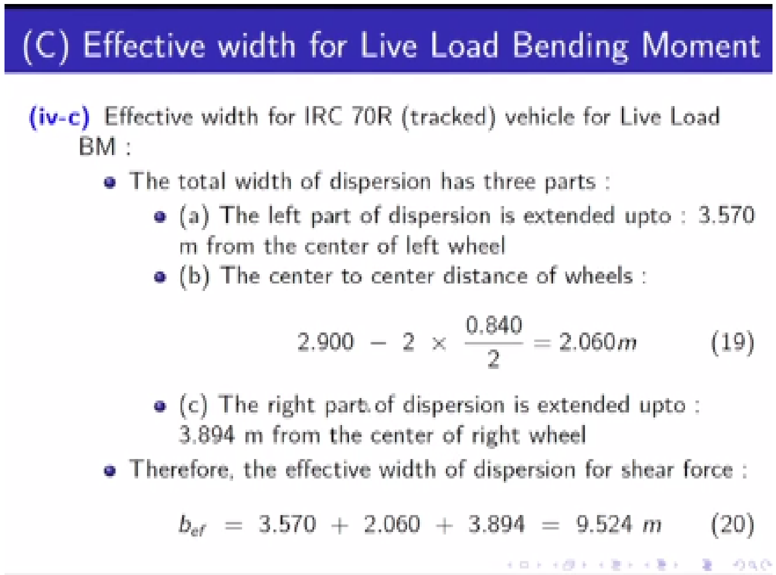

And which we have taken this value that we can get it so which is we are getting here 9.52 for that effective width that we are getting for that, this is for the bending wind because the verb ending event that as you have told earlier that we have kept that load at the middle and on the basis of that we have got this value.

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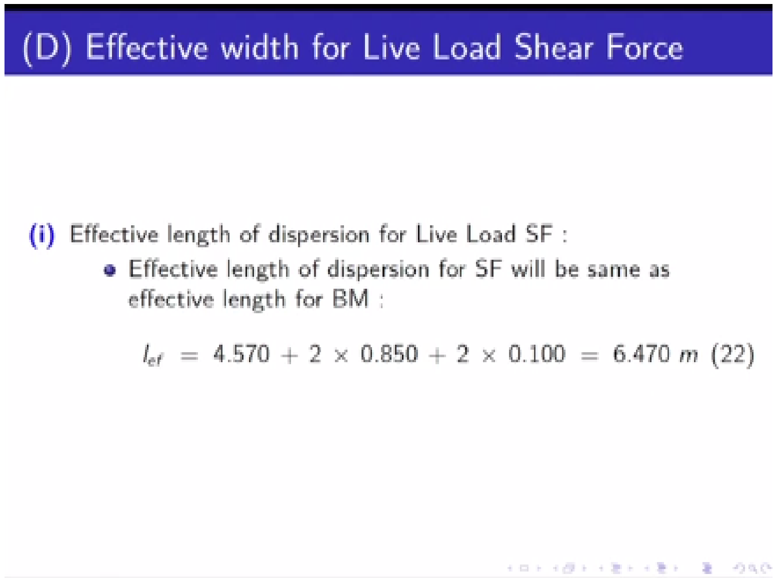

So effective length you can again find out which is coming at 6.47 that perk alone we are getting that a similar fashion order a little bit ago so this is for the shear force the same value will get for shear force also 6.47m we shall get it here that we can find out and then we can do this particular one problem.

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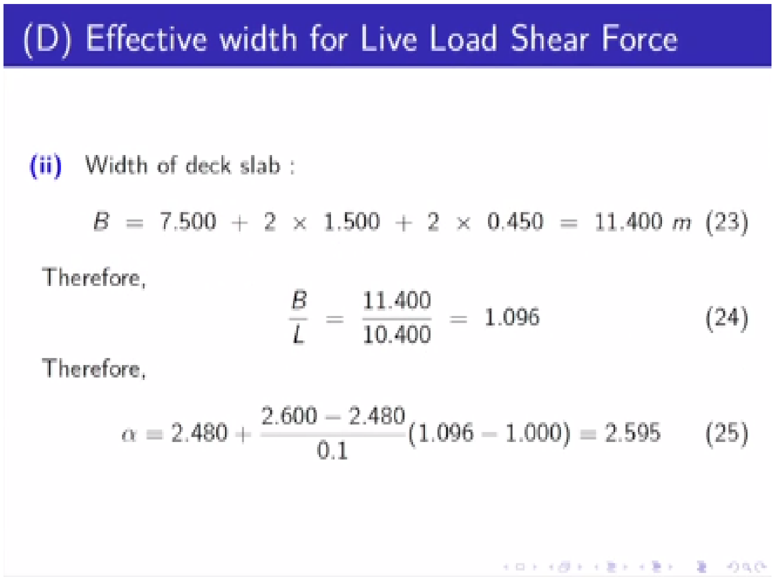

So again the same way we have got it for the shear force also.

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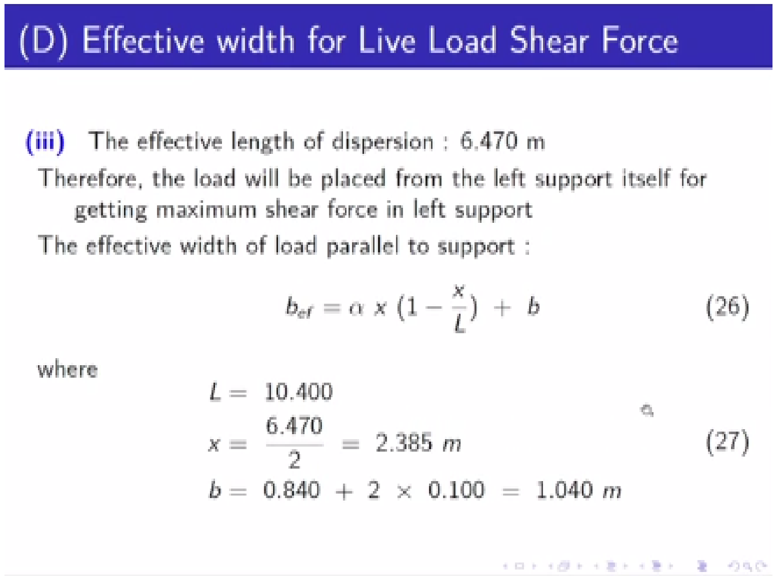

The same way the same fashion we are getting this one also.

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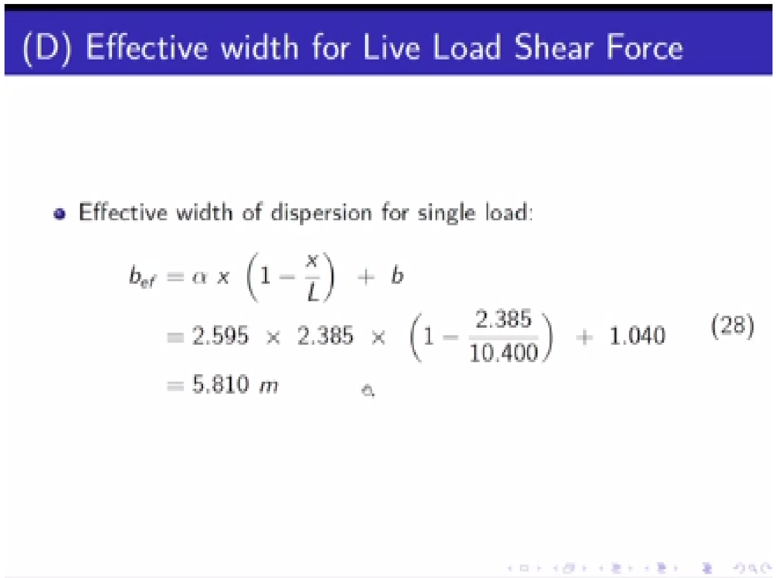

That your this percent that 5.81m we have got it for single load and then.

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(D) Effective width for Live Load Shear Force

(iv) Effective width for IRC 70R (tracked) vehicle for Live Load SF:

(iv-a) Left part of dispersion

- The center of left track from the left end of bridge :

$$0.450 + 1.500 + 1.200 + \frac{0.840}{2} = 3.570\ m \quad (29)$$

- The half of the effective width of dispersion :

$$\frac{5.810}{2} = 2.905\ m \quad (30)$$

- Therefore, the left part of dispersion will be extended upto : 2.905 m from the center of left wheel

Similar fashion we have got it for the for the both the track for the pool vehicle you have to consider and which you can find out here the3.57 and 2.9905 so we can take this purpose on here that we can find out.

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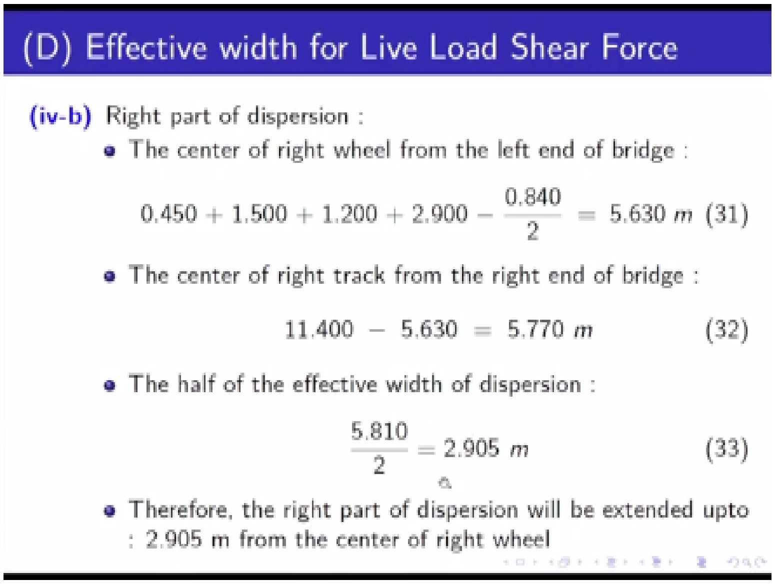

So then we can find out this one similarly for the right but also you can find out.

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(D) Effective width for Live Load Shear Force

(iv-c) Effective width for IRC 70R (tracked) vehicle for Live Load SF :

- The total width of dispersion has three parts :
  - (a) The left part of dispersion is extended upto : 2.905 m from the center of left wheel
  - (b) The center to center distance of wheels :

$$2.900 - 2 \times \frac{0.840}{2} = 2.060m \quad (34)$$

  - (c) The right part of dispersion is extended upto : 2.905 m from the center of right wheel
- Therefore, the effective width of dispersion for shear force :

$$b_{ef} = 2.905 + 2.060 + 2.905 = 7.870\ m \quad (35)$$

And then we are getting that effective depth with that one we are getting 7.87 that we are getting it here. So we can find out this one we can find out because why I am showing a difficult single problem because we would like to see that one that what happens actually with that increasing that slab because, otherwise one can say that voice I will go for other type of bridge only we can go for the actualities means all we all can be slam only.

That is the one so this problem I would like to show that one that whether really that all bridge scan be made white slab bridge only. Definitely that since there is so many bridges so it means that we require that other type of bridges also. Coming to this one here I can say

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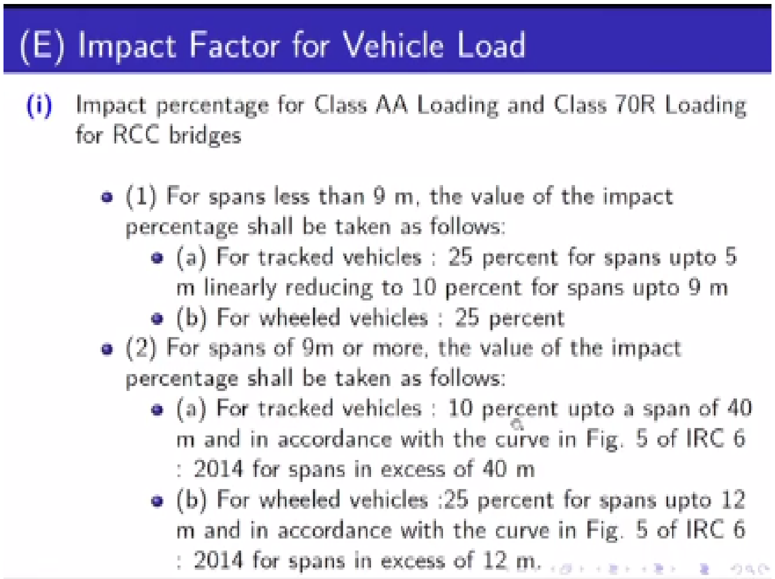

Again already we have discussed all those things because just I have repeated because this particular one made through computer to them that is why it has come again we are giving this so that you can immediately you can find out that whether that proper value is. So here for spans of 9meter or more for at various 10% up to span of 40m, that which it will be 10% here. So these are the cases so these for con one you can get it for all our 61 this is sufficient for the impact one you can get it.

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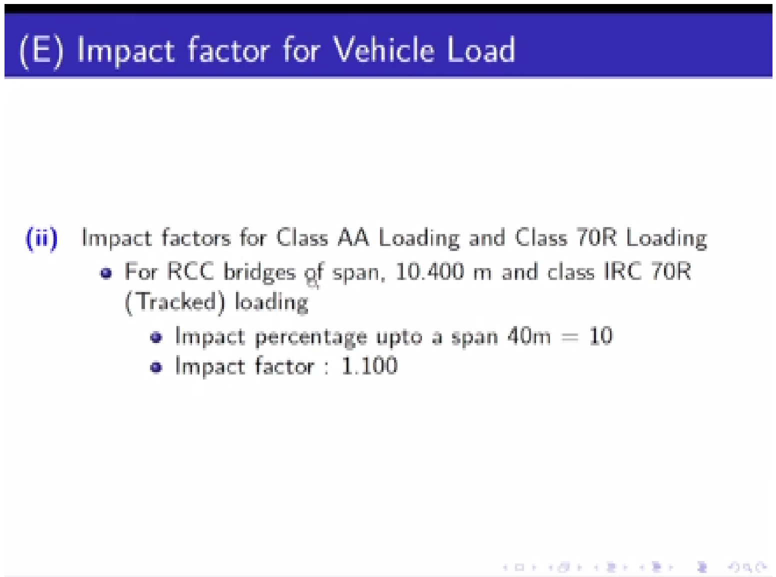

So on the basis of that immediately you can find out for RCC bridges of 17.4m and class IR 370 attract loading we are getting impact percentage gain and so impact factor we are getting here 1.1.

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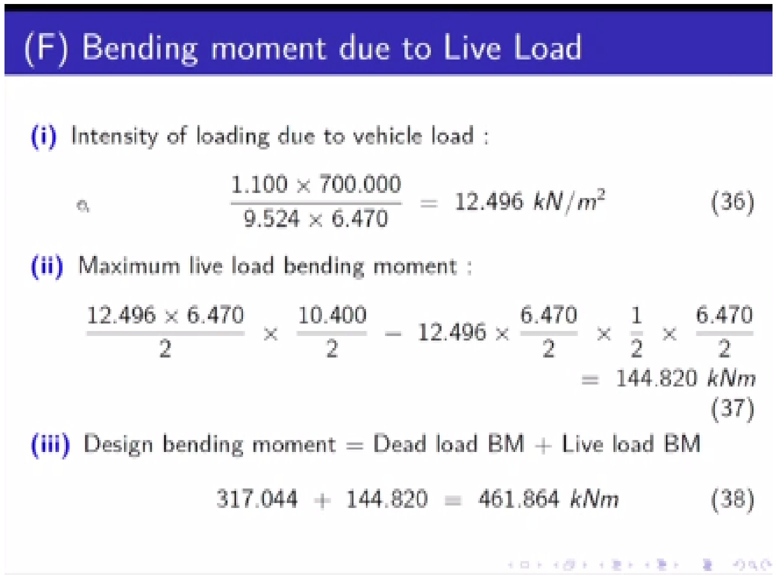

So we can find out the density of loading which is coming very less because you would say that this person with actually more so we can find out 12.496 next in line load bending moment 12.496 x 6.47/2 x 10.4, this one in the last one possibly that there is a certain kind of that value we change little bit better please check that one. I shall give it on the slide the corrected one we will find out and that you can compare. These are been the moment here which I mean to say these particular these are the two values you are getting.

So you can imagine whenever you are considering that dead load and live load the objective is that our objective for bridge design or provide the properties, there is something that instructional design also you can say, that you live load is your requirement that means the vehicles to be passed in this case over the bridge. That one we have to consider here now considering that aspect whenever the vehicles moving because of that that whatever bending moment you are getting and to take care back load you are giving actually more.

That you have two supporting system actually require more bending moment so that is not at all so desirable say for example if we consider the dead load + live load, if you consider this one as 100%, so obviously you can consider that if dead load is < 50% that dead to bending when dead to dead load is < 50% then you can say, that is optimizing anyway for argument is sake that is not possible that to get say less than 50%. I mean to say that let us say 40 you are getting for dead load and 60 you are getting for live load.

That means you can take care that your say supporting system can you light that we can say, for argument is sake okay that it may be difficult to let us say 50 that is also quite acceptable but if we go towards more that means subject having 60% actually or dead load and live load is actually say 40% and long span 1 you can find out, that 1 also far that actually that for the dead load it will be hard that actually what been limiting to dead load will be furthermore compared to the live load of the due to vehicle.

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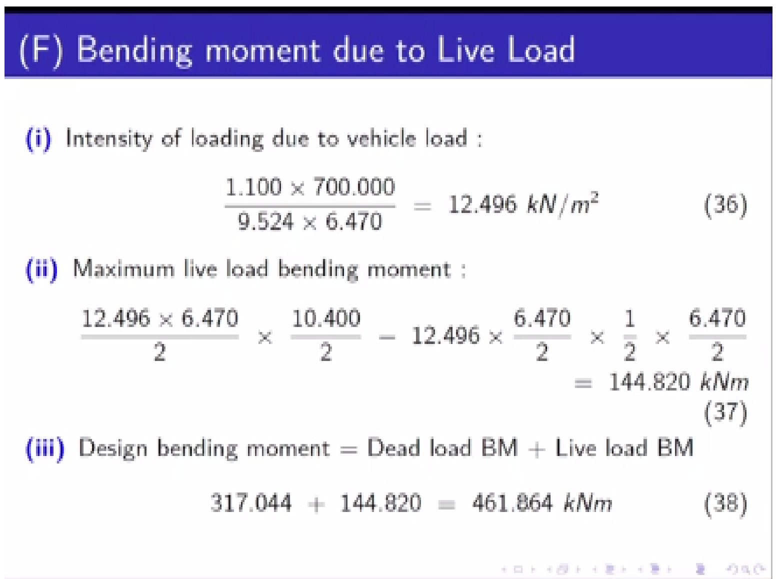

That will so here you can imagine the second one almost it is more than because only 1/3,2/3 in that particular way you can get it that means we have to find out the section for this, this is actually this is our requirement but this one to get this one to achieve this one we have to provide this much of bending over then only we can achieve. That is the one what I would like to say that why you will go for actually new one, the other one we shall go that we can find out here. So this is the one that bending moment that way you can consider here.

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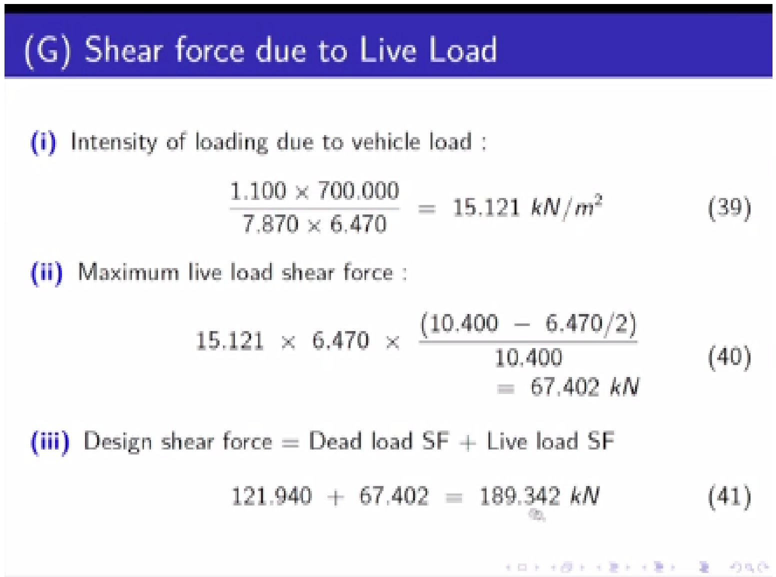

Similarly we can find out that your say for shear force due to live load that we can find out here dead load and live load so total we are getting 189, so you have to check this one with that particular section.

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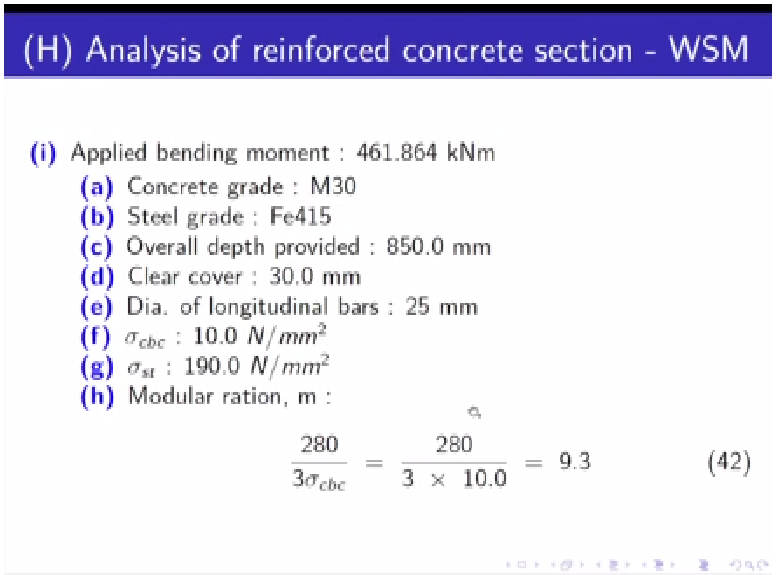

So now we have to design we have taken working stress method but I can give you other problems also that one we shall and give you for limited other problems, the same problem we shall do it and but just we shall finish that one part our CCTV also so and then we shall give that problem as well as we shall give that own the solution also, we shall give them so that you can also go through it also that whole thing we can go through other than your video that we can do it.

So this problem we shall do it by because first we are doing working stress method that is thus cutting point because if you do not if you just only use one method then obviously you cannot compare. So here whatever we are doing here it 5025, so this particular one we can find out and that we can, we can solve this problem and then

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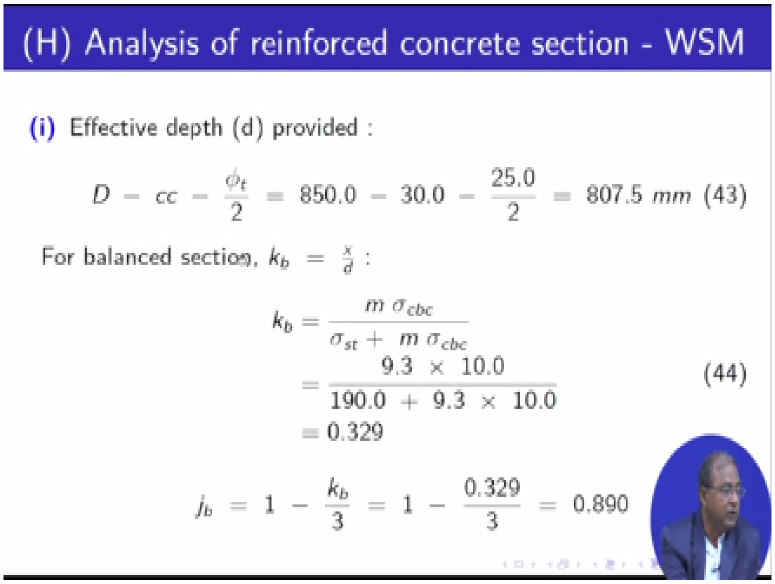

We are getting here 807.5, 850 + on a 32 and number 2 and KB we have got this1gb also you got the simulators on the same slide almost similar slide you can find out there also in that you can find out

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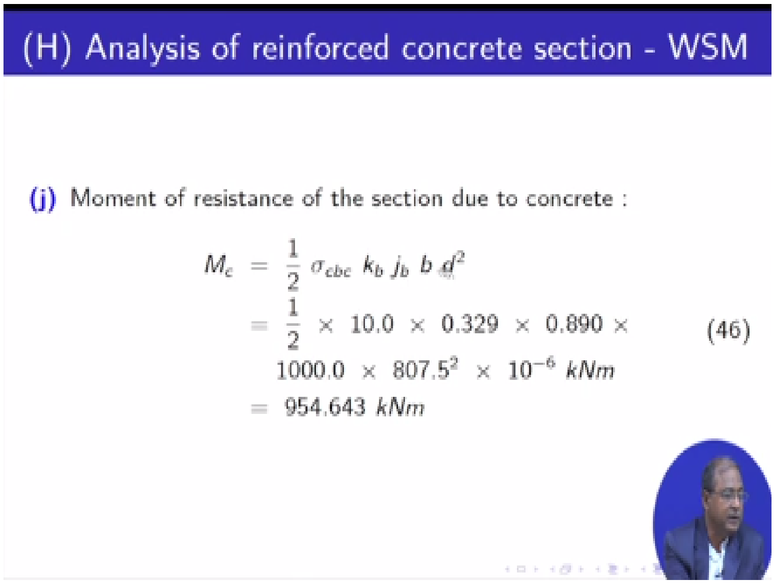

And then half $\sigma_{cbc}\ k_b\, j_b\, b\ d^2$ so we can get this particular element that and you can find out here so this is the one we can find out that 954 and requirement is 461so that one now whether as I told earlier also that build value is that is very modest is our resistance due to concrete and that one should be more because, we do not want that concrete will fail fast that is the thing that, we do not want, so effective depth provided this one.

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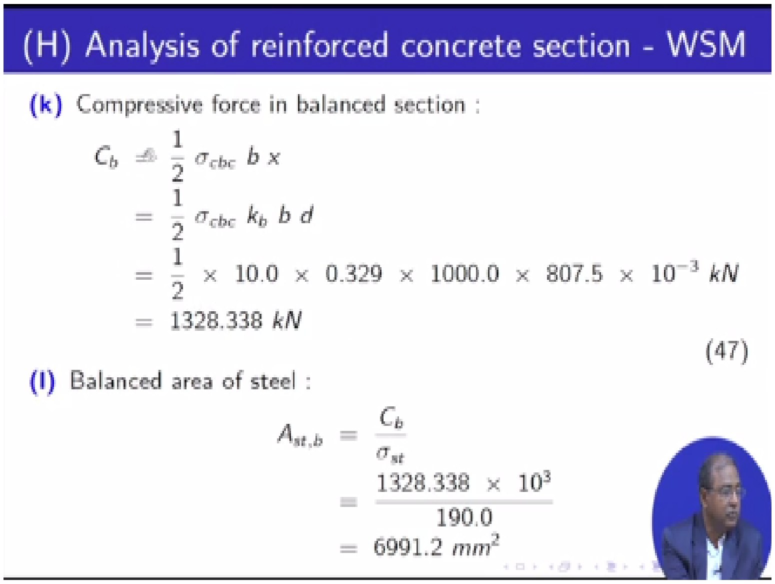

And this is the one that compressive force and on the basis of that we can find out that balanced area of Steel that is 6991, that means this one also will resist this much of bending moment but our requirement is very less for 61so we shall provide on the basis of that we shall provide so we can find out this one here on the basis of that.

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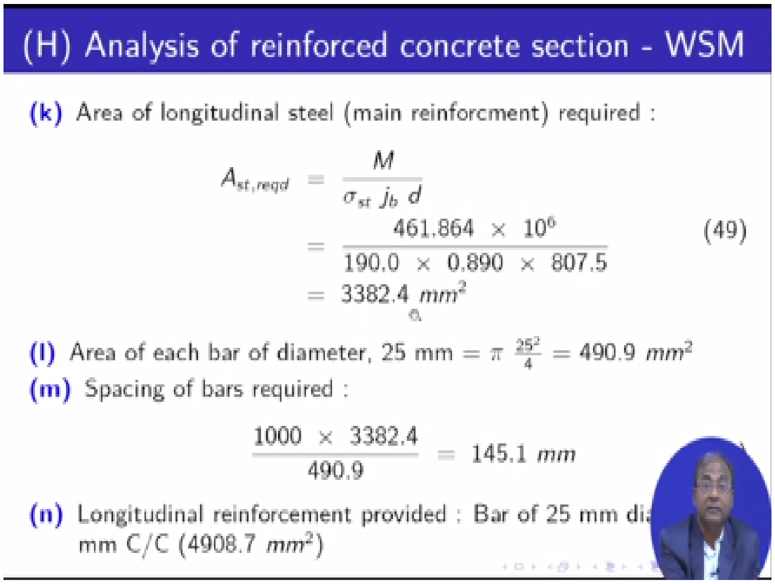

We require only 300 cut L 3000 382 and which is coming actually we are providing for 9:08 that means, we are actually in between that is the thing with like I would like to say and that I am going to actually emphasize that one that how to design that particular one ? That one you have to consider here. So coming to this one here just let me give you this particular one problem what actually we are doing?

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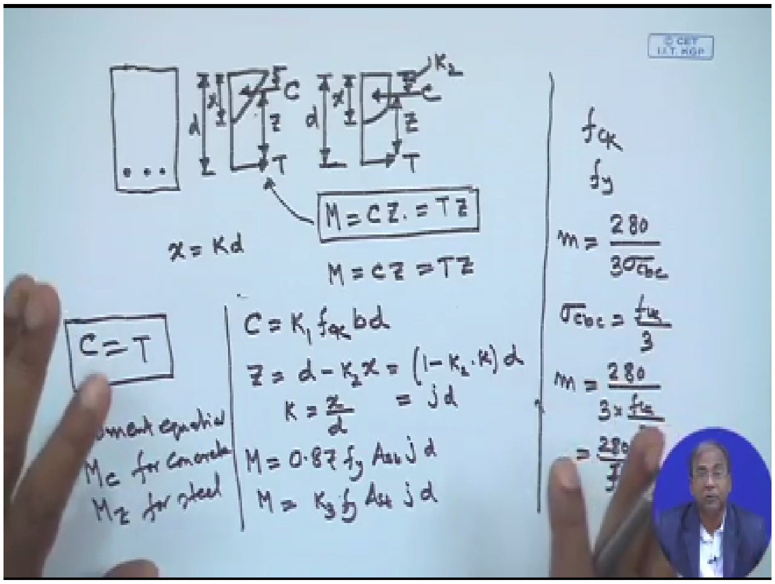

The basic philosophy that what we are doing basically here that if we consider that let us consider, any arbitrary section okay let us consider are rectangular section only and it has a for this case, we have solved this problem and we have a live arm. This is d and this one X, so x = Kd, then we can find out here X = we can say Kd this is your C and this is your T. So what we can do that M = CZ = TZ, this one we do not know how much it is? So what we shall say again I am telling this one section again I am telling this once is C.

This one again for this case also D this is your x and this one we call it as k2, so what I mean to say that whenever you are solving this problem here, then we are giving a specific values Z that = -1k /3 all those things write down this is our Z so our objective here in general whatever we can consider here again M = CZ that is your say again we are telling TZ for this case that is the one which is which you have told you from this particular one here and this one also the same thing.

I will variants and then we can say C = k1 f_{ck} BD that particular one we can consider here similarly we can say Z= D - k2 x =1 this particular 1-K 2 x Kd because k = X/ D, so that means here whatever we are talking this one here x this particular on here the same way we can dependent, the what I mean to say that whether you work with the working stress method whether you work with the limit method that these values are only going to change, but basic equation remains same.

That is what actually we consider here the basic equation actually remains same, so coming to this particular here we can find out on the basis of that we can find out the solution and which will be again say for example, for this case whenever we are talking this one say M = we consider say 0.87 f_y as then jd so this one we can write down here jd, so then what I can say that M = a3 say f_y as t jd, this k3 means whatever the value you can service.

I can always say that parameter I can say and on the basis of that we can actually find out and on the basis of that we can solve, that means your main thing that here I mean to say that f_{ck} and your f_y as I have told you earlier that m = 280/ 3 σ_{cbc} and as you all know $\sigma_{cbc}$is nothing but f_{ck} /3 this is down 1we get it, so that means we can say m = 280/ 3 into f_{ck} / 3which comes as 280 /3 only so sorry f_{ck} . So that means here we can write down this parameter in terms of f_{ck} that we can write down to 80.

So that means here what I mean to say we can write down all of them in terms of f_{ck} and f_y and on the basis of that we can solve. So in general that you are having only two equations one is called that equilibrium equation and the other one is the moment equation and these two equation that means one for the m is C for concrete, another one we shall get it four for concrete. Let us write down and this is for steel. So we can write down this one we can do it and on the basis of that we can found.

This is our whole objective that I am trying to say that I shall give you one problem with that one we shall give you because then it will be easier to know that one that how much is the difference we are getting, another one important factor that is your safe partial safety factor that is also there and that partial safety factor will be that with the different kind of loading other things that one also, we shall give and that one we shall take it with that IRC 112 that we can consider that we shall do it here. So this is the thing we do it here coming to this particular one.

Here we have got these 3382.4 that is our requirement and then we are covering 25 millimeter, so this one we are providing here and so we can get 25mm at that 100mm x the center support, now the thing is that why we shall go for it I have told earlier also once more let me repeat, that we would like to make this one here, the whatever moment is required then concrete.

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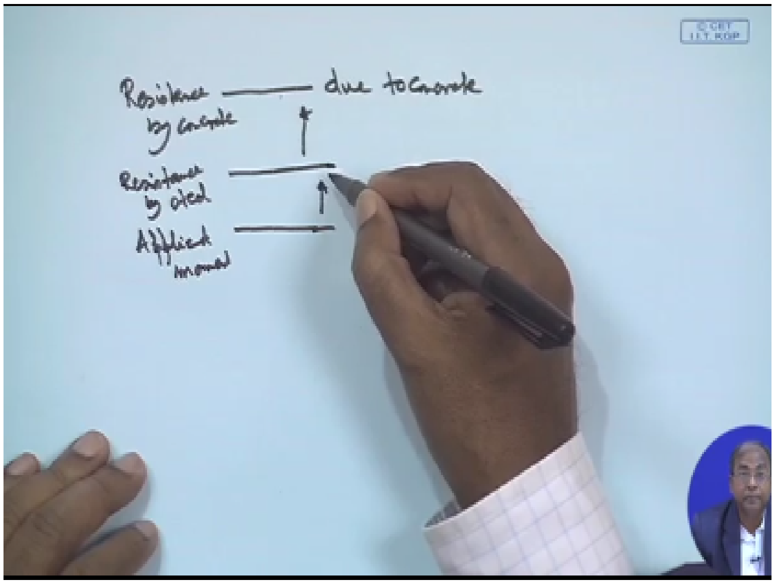

Should be at the top this is the resistance by concrete this is your say applied moment and steel will come here, so this one the steel we come here so that we can find out this one in between so we can always give guarantee that it is actually we can be under enforced. So this is the one we are getting it here so let us see that how much we are getting due to your say shear force

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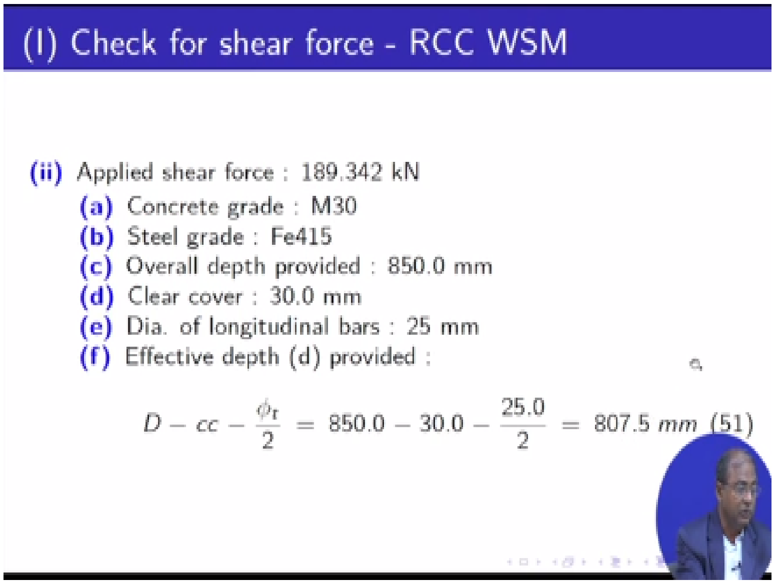

So I have taken this M30 so steel gate is a Fe415 that one we have consider and so we are getting D which is = 850 that particular one we are getting 807.5mm. That way we have already calculated.

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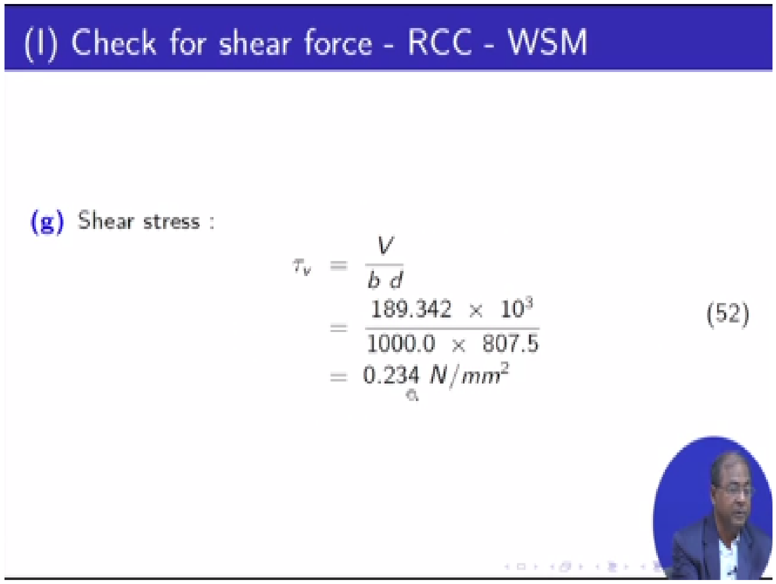

So this is coming very late so that means here no reinforcement regret and for shear over we provide certain reinforcement you know to hold that your set of bars that also we do it and that one will give you the nominal reinforcement if you require that one as but the cuddle provision that also can be. So this is the whole thing we can do it now we shall give you problem on this remaining one we shall give that different problems we shall give you and that, so that you can understand that because whatever we are giving that one with the limited time only we are considering that.

You are the main criteria we are going, so we can compare that and also that I have not given your CIRC class a loading also and IRC 70 are loading also that also we shall consider and that we shall take care in your say our RCCTV that one we shall do it and one more thing, that we shall we consider that only also your say abutment also that one at least I should introduce that one that one also. So with this we shall conclude that one say your design of that slab beach which is very common and this last problem I have shown you that one just to give you idea.

That why we restrict our self or that one with that with certain and that we can consider here that I can say that again I am telling this particular one here

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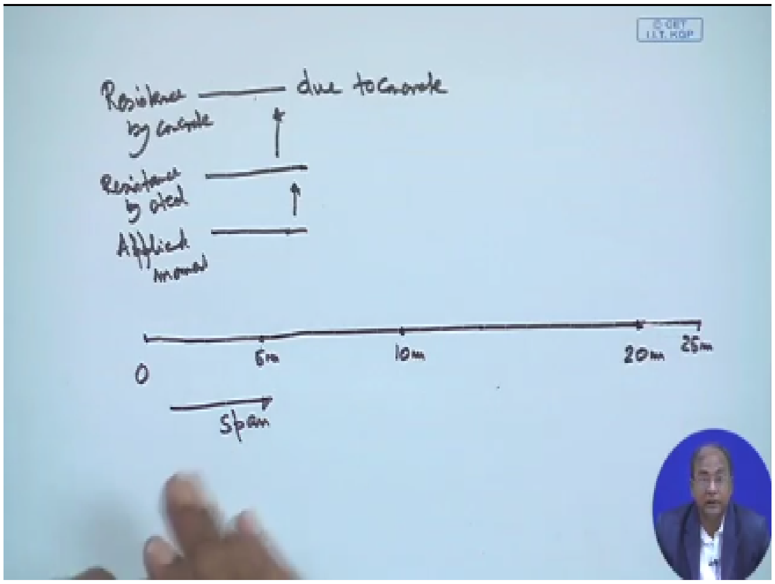

We have taken that one if this is your gos span and so we are going here up to say 10m and then another one we are getting, it here say 20 meter, that means here our boundary we can go little bit more, let us say maximum say something say 25 meter. That is our scope of this the scores that we shall go that means initially we have started with say 5m then we have gone to that 10m then we shall approach towards 20 meter and mainly we have considered that one.

Your super structure now we shall consider that once a superstructure, we have considered and then we shall go for it actually here another one that you are saying how we shall do the abutment, so let us conclude with this one with the design of slab we shall come in detail in other part also it shall come thank you very much.