

NPTEL
NPTEL ONLINE CERTIFICATION COURSE

Course
On
Reinforced Concrete Road Bridges

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Lecture 19: Design of RCC T Beam Bridge (Part IV)

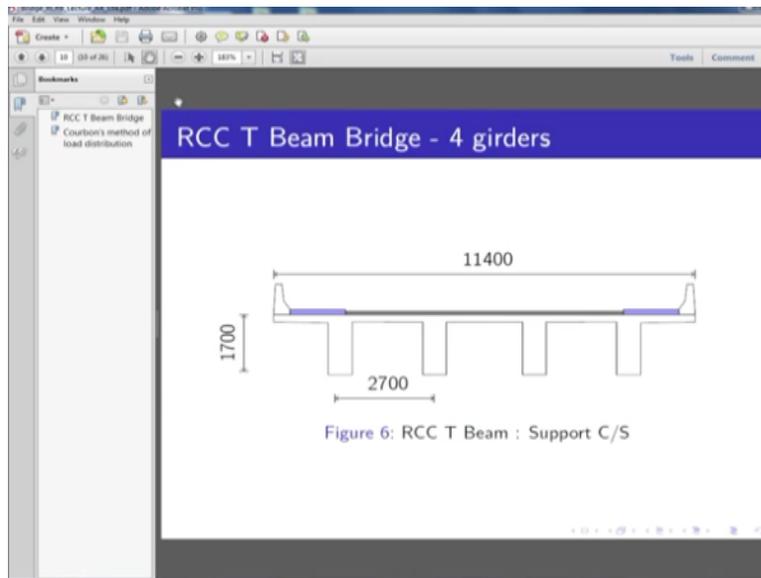
Hello everybody we shall continue with the design of RCC T beam bridges, we have given the basic principle and we have come to that one that how now we shall distribute that your saved vehicle load among all the grider, that means grider will take how much we load that we shall, it will take that we shall show.

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So this is our that load say lecture number 19, this particular one we are showing here that we would like to say that lecture number 19 that we shall continue and then let me show you that one here.

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So we shall come back to here that we shall say regarding IRC Class A loading that as we have decided.

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RCC T Beam Bridge - 4 girders

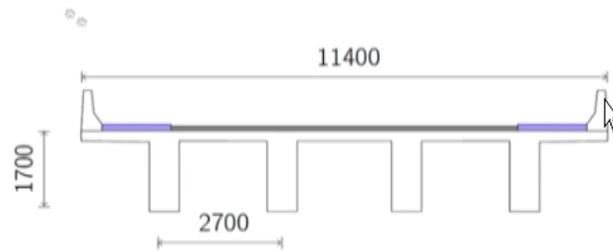
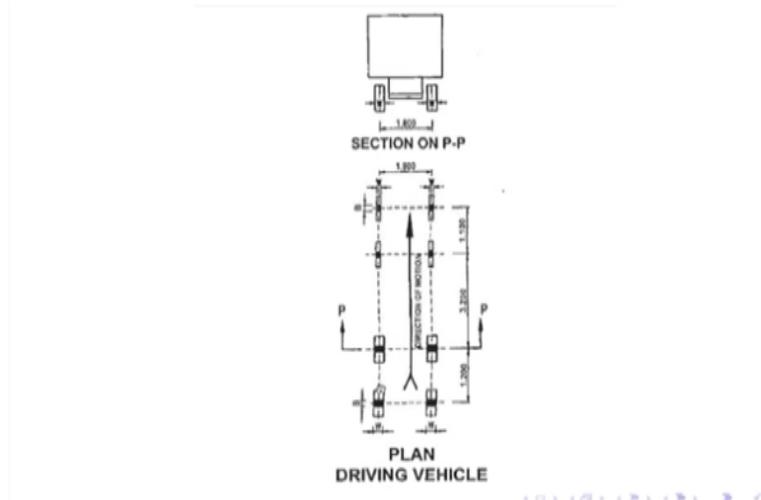


Figure 6: RCC T Beam : Support C/S

So this is the one that we have continued in the last class.

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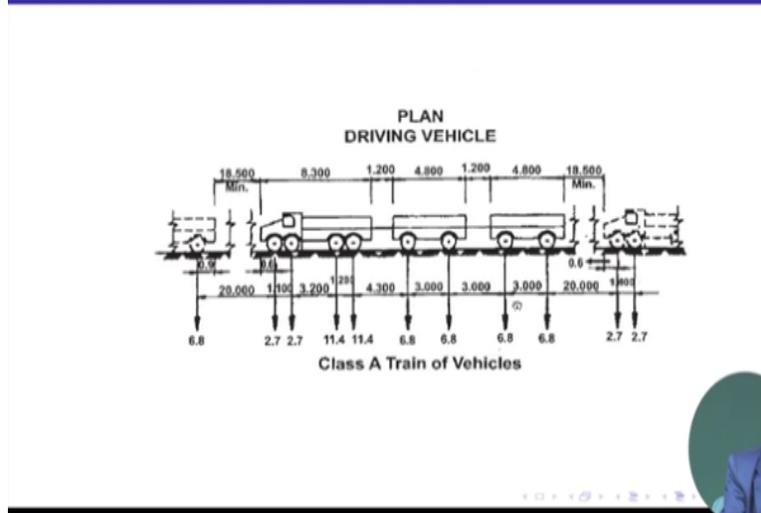
IRC Class A Loading



And then now we have that loading whatever we have shown you that is from IRC6 that particular loading we have considered this is the one that IRC Class A loading, that particular loading we are having and then this is the double length, so these double length loading that means we can keep side by side to Class A loading that we can keep.

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IRC Class A Loading



Coming to this one here, this is the loading I have taken from IRC6 here itself that which I have shown earlier also, the loading whatever we are having, we are all those things detail are there, that means here we are having four wheel side by side, two wheels for one vehicle, another two is for the other vehicle that we shall have.

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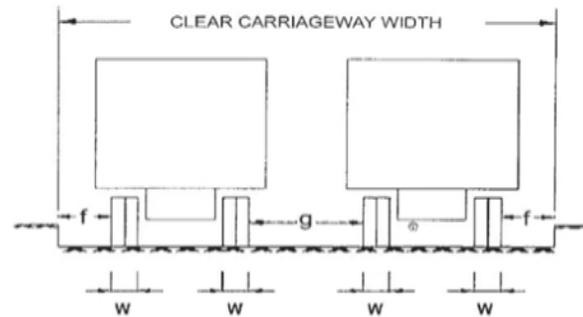
IRC Class A Loading

Axle load (tonne)	Ground contact area	
	B (mm)	W (mm)
11.4	250	500
6.5	200	380
2.7	150	200

And for each of them the impression of that.

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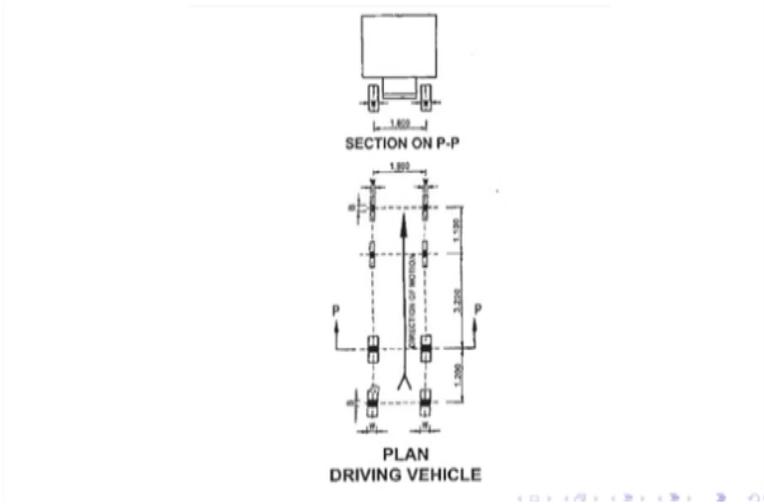
IRC Class A Loading



This is the one we say, we should know this information that f , how much will be the f from the card, what will be the corresponding w , what is the G between that, so G is very, very important here that we would like to find out how much will be the G , that means here from outer to outer we will not center to center we will, please note this one. Whereas we have this one actually center to center.

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IRC Class A Loading



This one whenever you are providing here this particular one that is center to center. So we get this one from center to center we get it, that is 1.8m, so one information we have that is 1.8m of the same vehicle between center to center wheels that particular one we can say that says, when the cross direction, this is 1.8.

Then another one we call it actually road shape, tends for similarly longitudinal direction you can consider, so that means this section PP whatever we are considering here, this is the section we are getting it here. So 1.8 and this side you are getting different values, whatever actually given here, 3.2, 1.1 like that all these things are given. So therefore, this is one cross section you are looking this vehicle from side and you are looking this one from this direction trapping direction and that one we can consider here that how much we can get that load.

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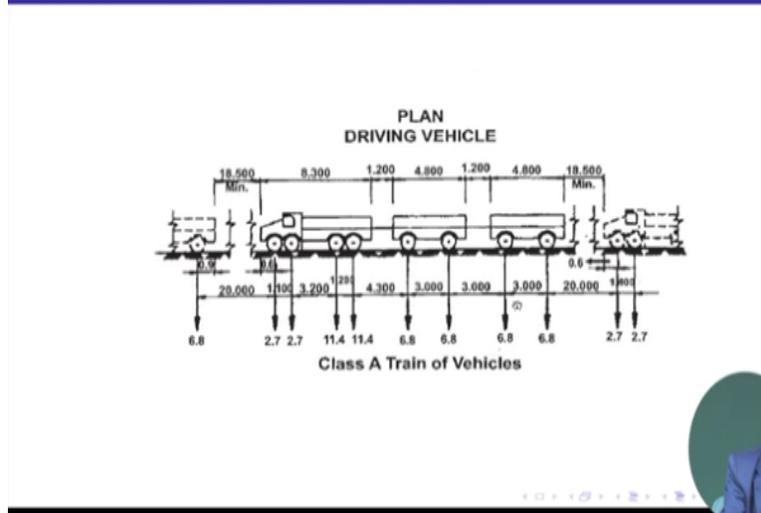
IRC Class A Loading

Axle load (tonne)	Ground contact area	
	B (mm)	W (mm)
11.4	250	500
6.5	200	380
2.7	150	200

So coming to this one here now we are having axle load 11.4, 6.5, 2.7 for these different cases we can find out 250/500, 200/380, 150.200.

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IRC Class A Loading



So we are having here 2.7, 11.4, 6.8.

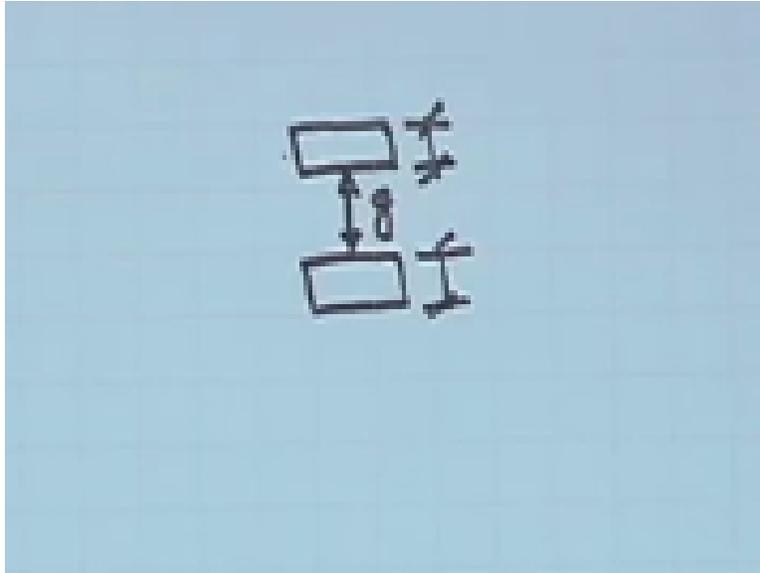
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IRC Class A Loading

Axle load (tonne)	Ground contact area	
	B (mm)	W (mm)
11.4	250	500
6.5	200	380
2.7	150	200

So this particular one here so we are having different equation.

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So that means here we can say that, if we have this one say I am going the traffic direction, this is the impression of one wheel, this is the impression of another wheel and these distance in suppose to be G . And then we are having, this one will have different value. So how much will be there for different phases you are having this is $250/500$, $200/300$, $150/200$ so these value will be different for different loading so that means along the vehicle you are having different actually interest so that means the center to center we can have so obviously in that case we can consider that load that particular one will be different for that particular one will be here.

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IRC Class A Loading

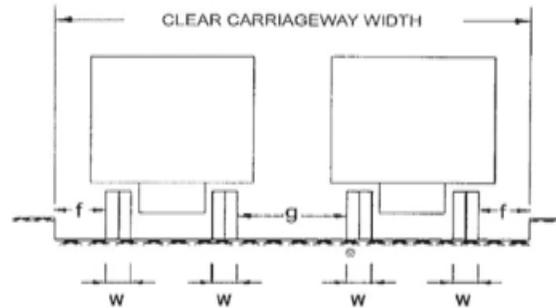
Axle load (tonne)	Ground contact area	
	B (mm)	W (mm)
11.4	250	500
6.5	200	380
2.7	150 [Ⓢ]	200



So what we shall do it here than in the case then obviously we shall take it from the maximum one we can consider and on the bases of that we shall find out that g.

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IRC Class A Loading



That mean these g we shall give for the maximum load then so then for other cases it will be little more okay no problem.

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IRC Class A Loading

Clear carriageway width	g	f
5.3 m(*) to 6.1 m(**)	Varying between 0.4 m to 1.2 m	150 mm for all carriageway width
Above 6.1 m	1.2 m	

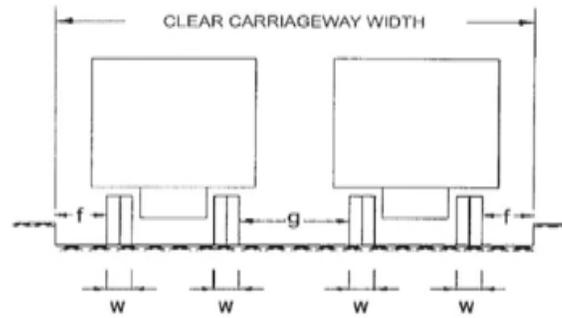


So that particular one you can consider there so our thing is that for 5.3 m to 6.1 m that one we are having so 0.4 m that is the one and then after 6.1m gradually it will go up to 1.2 for our case these more than 6.1m that is 7.5m so we are getting this one 1.2m that means we shall get this g 1.2m that is the one we can say that means in our case for line only you can say it will come gradually whatever we are having that value but even the single line also 5.3 m it will be less than that.

So that means you can consider 0.4m single line, and for double line we shall consider 1.2m that particular one we can consider now another value is there width.

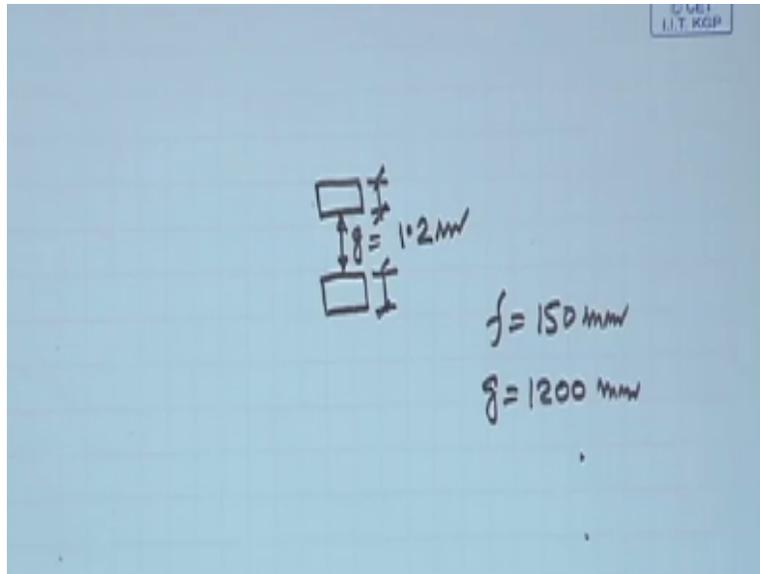
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IRC Class A Loading



And this width equal to 150 mm.

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So we are getting these cases we are getting $f = 150$ mm that we are getting here and $g =$ right we write down that one here 1200mm is what I can do actually here considering that aspect I can take it here these loading I can take it.

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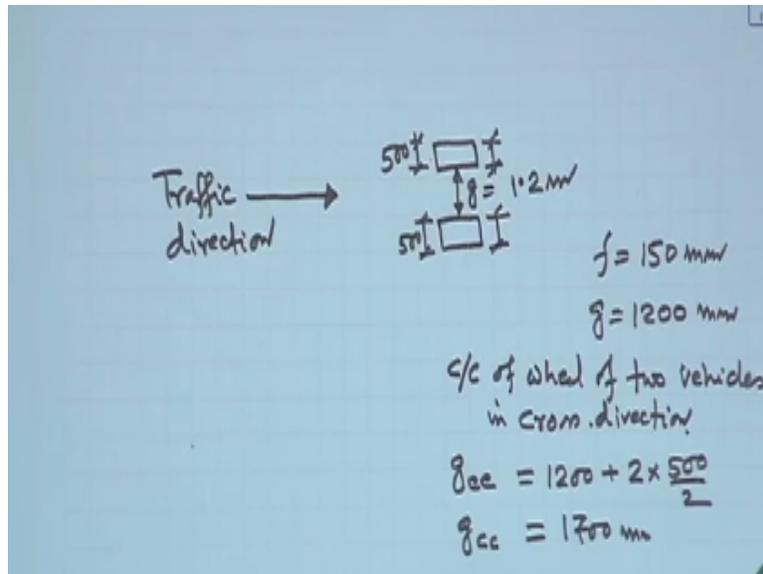
IRC Class A Loading

Axle load (tonne)	Ground contact area	
	B (mm)	W (mm)
11.4	250	500
6.5	200	380
2.7	150	200



That which is given here 11.4 tonne so 250/ 200 so I can take this one say as a 500.

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So that means here center to center of wheel of two wheels in cross direction or transfers direction not in longitudinal or traffic direction it is in cross direction, so this is the one that traffic direction, the vehicles are moving like this so coming to this particular point here then I can say let us say that term let us say g_{cc} I can say center to center I can say will be equal to then $1200 + 2 \times 500 / 2$.

So that you can have no other vehicle will have that particular one so which is coming as 1700mm, so g_{cc} that way I can say 1700mm so this is the thing that we are getting it here that particular one that one that information is required that particular one here.

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IRC Class A Loading

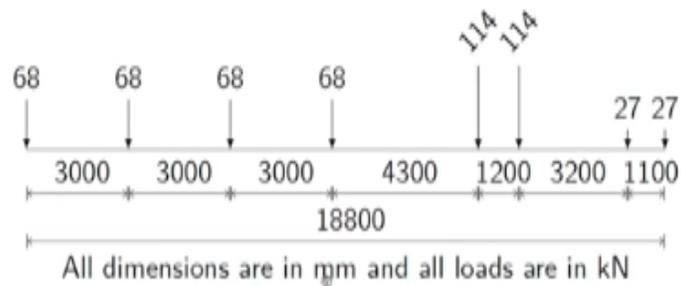
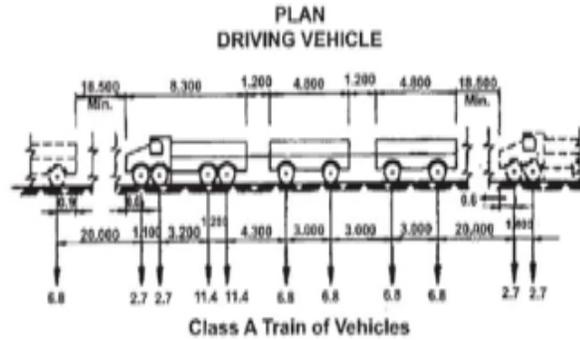


Figure 7: IRC Class A loading

So this particular one we are getting it here now this is the loading for class A whatever loading we have here that loading IRC class A loading so I have given that in kN and these all are mentioned are given in mm so from the front wheel in IRC code that is given from left to right I given that one that means that traffic direction is in this direction that way I mean to say, so this one given so this one given so 27, 27 I get all include Newton and that one from the front wheel center of front wheel to the center of rear wheel that one 18800 mm.

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IRC Class A Loading



And just wait I will show you this particular one we are getting it here so this is the one dimension we are getting here and 20 that one we just see the difference these particular one centre to centre so those things you should keep it in your mind. And 18.5 also that one also you should keep in your mind that one how much you are getting.

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IRC Class A Loading

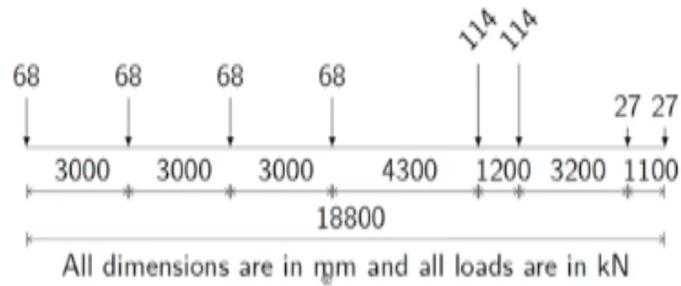


Figure 7: IRC Class A loading

So this is the loading that we are having and this loading for the whole that one say vehicles that particular one we are getting it here so that means here.

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RCC T Beam Bridge - 4 girders

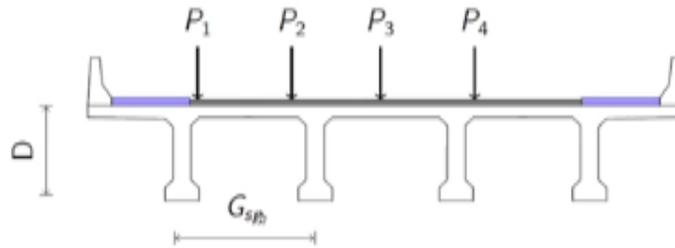
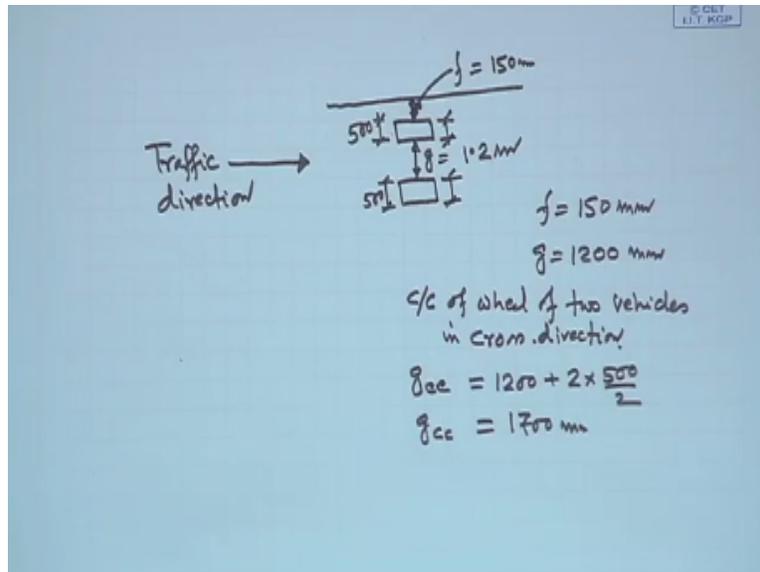


Figure 8: RCC T Beam : Span C/S

The according to the IRC 6 the combination of that either I can have 70 or loading only one because for double length we should have actually for double length we should have to 1IRC 70 are loading but for double length that we shall have this is the one we are having here that loading that is for 1IRC loading this is IRC loading, so how much is this one from this curve and that one your value is which I have told you earlier just to tell you this particular value it then this is the one from the end this one and this one.

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And this we are talking that $f = 150$ so you can come as close as the 6 inches that means you have that 150mm means see this particular one almost you can say that means you can come very close that is the one where as in your say IRCC 70 here loading you are having that is 1.2m so it is quite far but whereas in this particular one here it will come very close to that curve or footpath that is the one we can find out this is the basic difference here, now so we can find out this distance this one is how much.

This will of the same build in which is coming as 1.8m this is coming as 1.7m then you are coming as 1.8m, so that means these loading whenever we are providing this loading that loading comes here and P1 P2 P3 P4 that one we shall consider here that how much will be that let us consider this one and G1 from the let, let us consider this one in G1 let us consider G2 let us consider G3 let us consider this one G4 so there are four griders so how much this griders you want to take.

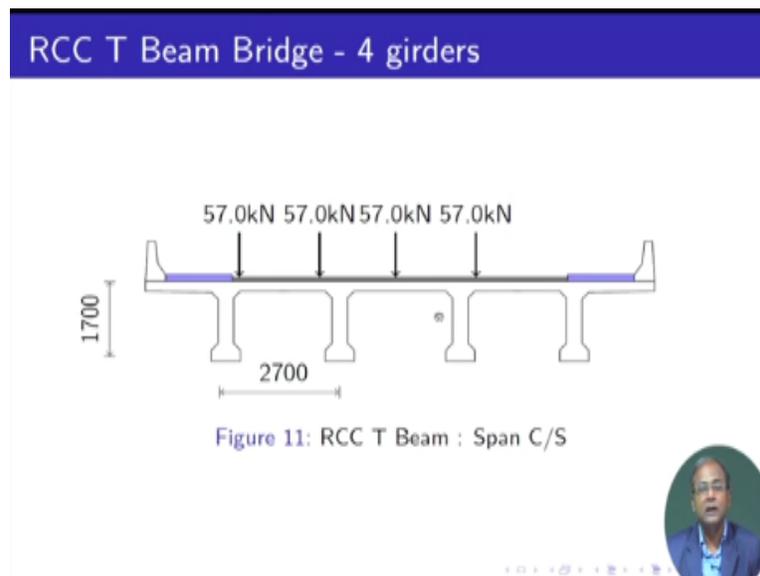
That this one will take you one P1 how it will be distinguished P2 how we will estimate P3 how we will estimate and P4 how we will estimate that we have to find out as I have told you earlier this one also now we can do the d analysis that you can make the grid of that one is your beams and then you can find out directly applying the load you can find out that the difference sections.

How much is a bending moment how much is the shear, force that we can find out, but here the method we are telling this particular one this is very, very whole method but steel which is

relevant and useful and this one gives you inside and that hoe much is that grider actually that we have to placing the load how much it will take obviously.

The we can say p1 will be taken more by this grider this way that we can find out here and which comes similar person also but whenever you are doing in the competing program that one software you are using sometimes it happy or that we you are not feeling that how the loads are coming how the loads are distributed that actually in these step.

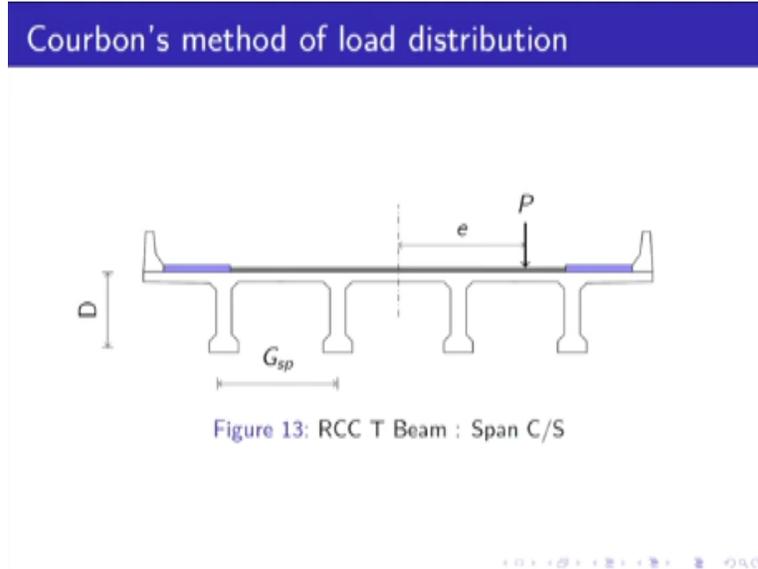
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Now the theory that is here as I have told you 2.7n ton that means 13.5km is one part is here and another one here this is 13.5 this is 13.5 that we can consider that means the load is coming along the line direct to vehicles it will come in that particular fashion, next one we are taking 34 that means 6.8 or 68kN so I can distributed here like that particular that means along the line or its direction we are having so many of wheel, four wheels that one curve one here and those will load we have to distribute.

That is our objective here similarly the other one also we can have that means I can say that piece the load for one save to the set of wheel in a 1 and 1 line so it will take by 2 and this one will take $P/2$ this one will take $P/2$ this one is $P/2$ so I can say P is how much if we can say on the basis of that we can find out here, so our objective is that these particular one whenever you are coming to that one say $P_1 P_2 P_3 P_4$ that we are getting it here.

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So that one we use that one there are many methods are there but this is the most popular method that Courbon's method of load distribution that is the 1 we do it and then.

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Courbon's Method

- According to Courbon's method, the reaction R_i of the cross beam on any girder i of a typical bridge consisting of multiple parallel beams is computed assuming a linear variation of deflection in the transverse direction
- The deflection will be maximum on the exterior girder on the side of the eccentric load
- The reaction R_i is then given by

$$R_i = \frac{P l_i}{\sum l_i} + \left[\frac{P l_i}{\sum l_i} \cdot \frac{e d_i \sum l_i}{\sum l_i d_i^2} \right] \quad (1)$$
$$R_i = \frac{P l_i}{\sum l_i} \left[1 + \frac{\sum l_i}{\sum l_i d_i^2} e d_i \right]$$

That one the objective is that if this load is be easier from the center line at a distance say e then how that load p will distributed along the all griders that is our objective.

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Courbon's Method

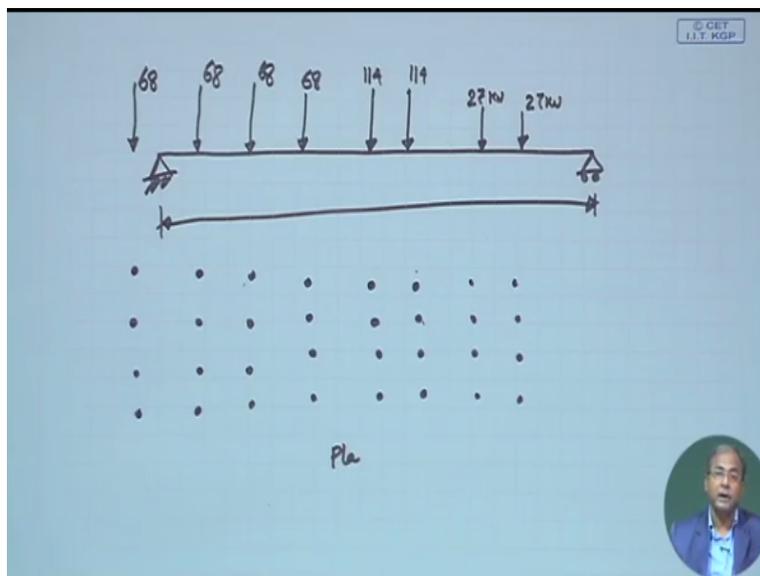
- According to Courbon's method, the reaction R_i of the cross beam on any girder i of a typical bridge consisting of multiple parallel beams is computed assuming a linear variation of deflection in the transverse direction
- The deflection will be maximum on the exterior girder on the side of the eccentric load
- The reaction R_i is then given by

$$R_i = \frac{P I_i}{\sum I_i} + \left[\frac{P I_i}{\sum I_i} \cdot \frac{e d_i \sum I_i}{\sum I_i d_i^2} \right] \quad (1)$$

$$R_i = \frac{P I_i}{\sum I_i} \left[1 + \frac{\sum I_i}{\sum I_i d_i^2} e d_i \right]$$

For that according to Courbon's method that x and R_i of the cross beam on any girder i of a typical bridge consisting of a multiple parallel beams is computed assuming a linear variation of deflection in the transverse direction. This is our assumption that deflection will be maximum on the exterior girder on the side of the eccentric load and the reaction $R_i = P / \sum I_i + P / \sum I_i * e d_i \sum I_i / \sum I_i d_i^2$ or if we take it $P / \sum I_i$ so $1 + \sum I_i / \sum I_i d_i^2 e d_i$ now if I_i is in equal then the problem will become very simple that obviously most of the cases we consider that regarded you say that second moment areas same for all of them.

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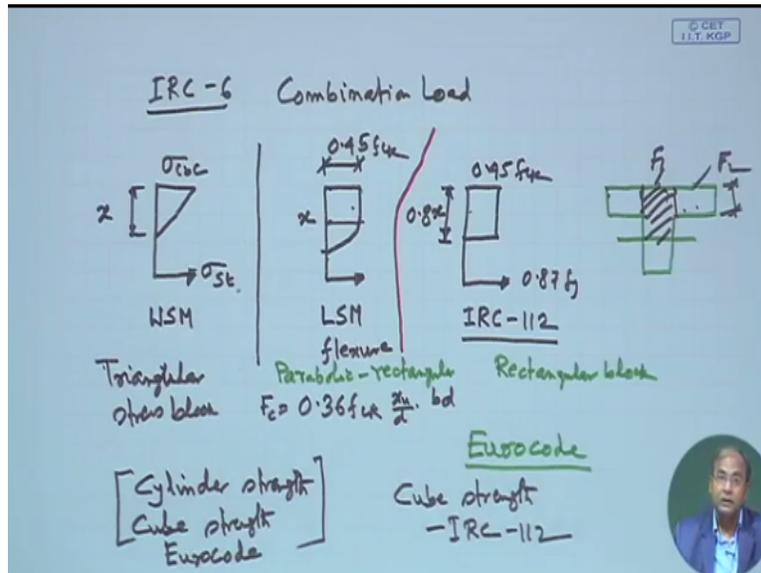


So this loading anybody can consider here along the girder so we are having certain loading here say 27 kilo Newton this is the loading then we are having say it will far away 114 please allow me to not to write kilo Newton again as soon that kilo Newton then we are having 68, 68, 68 and 68 may be outside may be inside depending on the scan of the beam you are getting this you allow then another side by side load so these 27 kilo Newton whatever it is their so we shall get the corresponding load here.

The similar load we shall get it but on the basis of distinguish we shall get another load we shall get it because 3 these $p/2$ that means here having 1, 2, 3, 4 this is our plan another set you are getting here it will look from the top this one I am getting here this one so this is the line up 27 kilo Newton this is another line 27 this is another 27 that means here we are getting a 13.5, 13.5 and 13.5 like that.

So these corresponding load for each girder I shall find it new value and that means this 27 kilo Newton that one will be replaced along the girder if I consider that this simply supported the along the girder I shall get the new value of that we shall find out and on the basis of that we have to find out the vending movement and see our force and when we shall get that particular one then we can solve that we can design it so our objectives is that we shall find out on the basis of your vending purposes.

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So now coming to this on here that according to we just let me tell you IRC that is 6 you shall get the combination of load it will not simple say 1.5 somewhere it is 1.35 1.5 that multiply in factor like that so then we have to apply that one and shear force that we will get it here. so this is thing that we do it here, just to tell you here, one is that I have told you, that this working state method, where we are having σ_{cbc} σ_{st} , here having this one say limited state method, we are having two methods available. This value is according to that, though it 4/9, let me write down here 4.5 fck and this is your x this is also x.

Now in IRC there are these method also we can use it, further very interesting is there, we consider this one has 0.45 fck but this one we consider 0.8x, the force developed here due to this, this is you say limit state method that collapse flexure. This is we are talking say your 0.87fy IRC 112. Now what we are basically doing here the area of this one you can actually say 0.36fck these particular one we consider here. Then we consider here you say something x_u/d , bd like that we find out here that force for F_c .

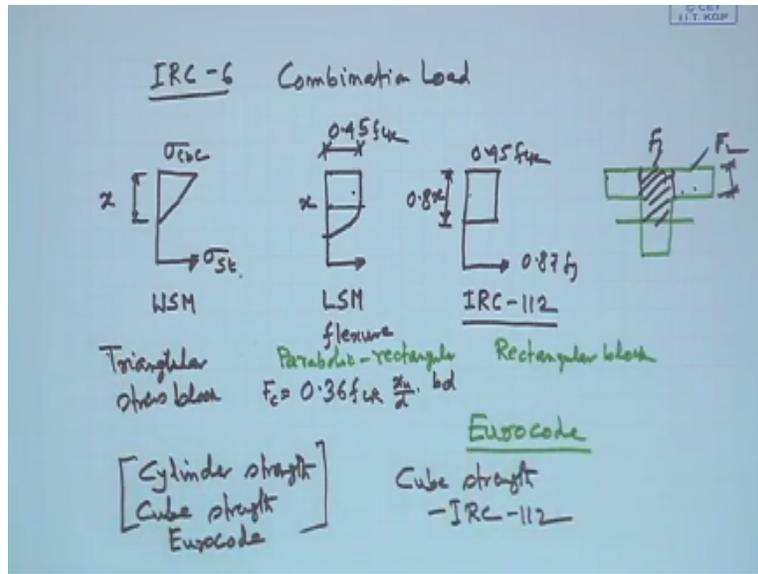
The interesting part is that we are having the formula and vector, o we call it this is triangular stress block, this one we call it parabolic rectangular block and this one we call it rectangular block. The interesting part is that, what we do it here 0.8x, so 0.36 so these area 0.36, so here if

you do it 0,8 x then you will get the same area. That means you are reducing this particular one here that will show that I will be getting the rectangular block.

What is the advantage of rectangular block? the advantage of rectangular block for your rectangular section as no such problem but whenever you are having for these case you are T, so in this case to find out you say when the out the compressive force , that will be easier to do it. Wherever you are having your neutral exceed matter but here the neutral position depending on the rectangular position, whether it will fall within the plane or not the basis of that your compressive force will be different neutral position will also differ that will change.

But in this case there portion actually over come using this particular one here, this one is also true for, I would like to say true for in euro code also , they follow the IRC code they have actually followed that euro code like that. Only thing in the euro code I can say that they give actually your cylinder strength also, that I shall say. That cylinder strength and cube strength.

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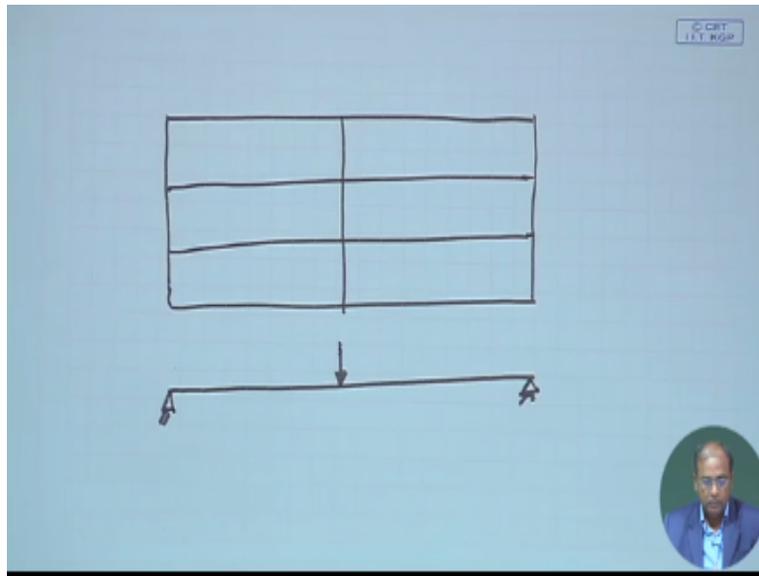


That they give actually in the cylinder strength also ,that I shall say that cylinder strength and the cube strength ,that they give when ever code we only allow the cube strength ,this is I R C and it is too far I R C 112 and it is too far I R C 4 5 6 also ,we use this particular one and this for Euro code were are different kind and allow that those things ,so it is very easy too then find out that means that we find out and this portion this one will whole thing will come and these portion whatever it will come that image will come and find out and that if I say these one is taken in the F 1 and these one is taken say F2 ,so these particular one the image will find out that the simple one multiplication we can do it and we can solve these problem .

This is the one that were make it here that you are in these in your it his code we follow these particular one here ,so that means our objective is that have told you that the all the thermometer is on the page get this one here then we can take the other one ,the another method but the things that here if you are interested that the code also say the particular one you can go in with these head also you can read all alternatively you can go this way the particular one which is same like the Euro code only the particular one will be and these way you will find out the problem then it is actually very simple that particular one here.

So we shall keep this the problem that one and we give you it that the complete solution and we can give you so that we cargo head so this is the thing that I could say that one that we can particular .one more thing axially I say now.

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As I have told you that one more thing that have to design in the cross beam also ,if you have only one here the cross beam what we Cando here in this particular case in the addition to that portion that whatever have told you that one I can consider these one adjective one in the load also I can consider here and then there are two more cross beam here and here there also we shall take it and then in the decision of that we can take it and that one these are taking one by one on this things that means independently.

We are considering each of them we are considering the out of the outer gander and the inner gadded. Now we can provide the same section for the outer gadded and the inner gadded only thing we shall make it, we shall provide the reinforcements we shall change we shall not seen may be the inner gadded the one kind of the enforcement outer gadded and the other king of the reinforcement that way we can actually go ahead, because the face that will the data idea that one the section berceuse we are bearing the other things that very important they are.

So they are over all depth we shall keep it same but inside that your reinforcement only we shall modify that why these are easy or from the construction point of view. Because the design from the view because my personal then only go for the simple design because that if you would like to save actually that your enforcement that other kind of different kind of actual geometry they will be a possibility of doing mistake actually a site.

So that one the object is that whenever they finally that whole calculation whatever we do that nothing will go the site only that drawing will go to the site. So I shall tell you something the getting the enforcement in the next class that I will tell you, so that you can get an idea what exactly you want to do. So main object is personally feel that your drawing should be such that after looking the drawing imagery want can remember those values.

That is more important rather that every time you will go to drawings and check whether the dimensions are correct or not because the many variations are enforcement will prone to make actually your say that detailing problem of a site. And then if you use the drawing the number of tends more and more then obviously the drawing will be that— it will be actually it will not in the prober shape imagery.

Because exide your having Donets other side, those things actually you have to keep it on your mind that design should be as simple as possible. Another one I would like to say a—this is not my comment, I got it this information that particular one from a very weak person that structural engineering was civilian structure was that main thing that on that if you look at he your structure and if you feel that and definitely unsafe.

So you should have that confidence in you that looking structure that should have confidence. so that is why from geometry point of view to that you may are all depth if the section other geometry all those things whenever consider in that case we find out that section should be such that do not miser that only saving few millimeters of the all those things and your are making the structure actually unsafe.

I have told you that moment of resistance that is more important here. And that one for concrete it will always move then the steel and for steel it will always move the demand whatever that to your requirement from the applied load point of view. So these I conclude this one today—that one so then we are having more module and we shall discuss little bit about your say enforcement and then we shall close our this course. Thank you very much.

