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NPTEL ONLINE CERTIFICATION COURSE

Course
on
Reinforced Concrete Road Bridges

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Lecture 09: Design of Slab Bridges (Part I)

Hello everybody last class we completed with the general overview that reinforced concrete structures particularly your slab bridges general element and that we have discussed the three methods working stress method as per IRC21, as well as, as per IS456 also. Next one as per IS456, and then IRC112 that is the new code and I like to sell that one that is also similar to eurocode also.

What I would like to say regarding these different codes you will find out certain similarity, because we all live in the same earth, so how do feel that it will be different to different country. There are certain specific thing will be different for different countries, and that way I would like to mention here before we start that today's program that eurocode they have made saturate that few more, few closets which will be country Pacific.

Similarly, here also that way also we can think of it in our country also that like say your different zones of earth that is one particular common example true for everybody. So that way we can find out that the clauses which are supposed to be change according to the geography that if we can identify and it can be changed. So the code can be like that, here also I would like to mention here in this case there, since I am taking that one instead of taking only one method I would like to compare that.

Because it is not the one formula we would like to understand that how that formula works that is the beginning. So we are not carrying over that same whatever we have done in the reinforced concrete structures elements last class that we are not moving with the same one rather let us take one problem and that problem on design of solid slab bridges.

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So with considering that aspect today we are starting with the lecture number nine.

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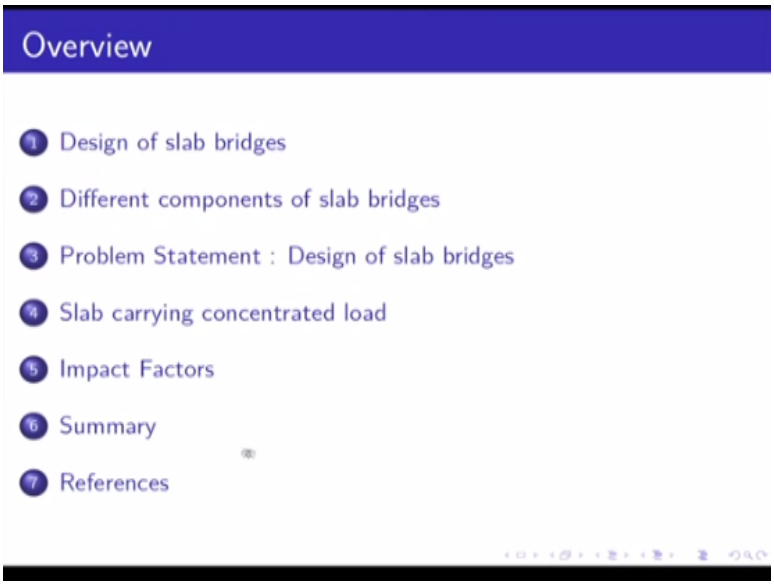

And there we shall take different views, obviously it is not only it will not be one particular say within half an hour it is not possible, so it will be carried over to other sessions also, other modules also, other lecture session also, maybe it will go up 10, 11 like that lecture number 10, lecture number 11 also. So this is the general guideline so far we shall try to accommodate up to say impact factors and bending moment and shear force, because we are talking this one here the slab bridge that is mainly to it has to be resisted by say shear force and bending moment considering that aspect.

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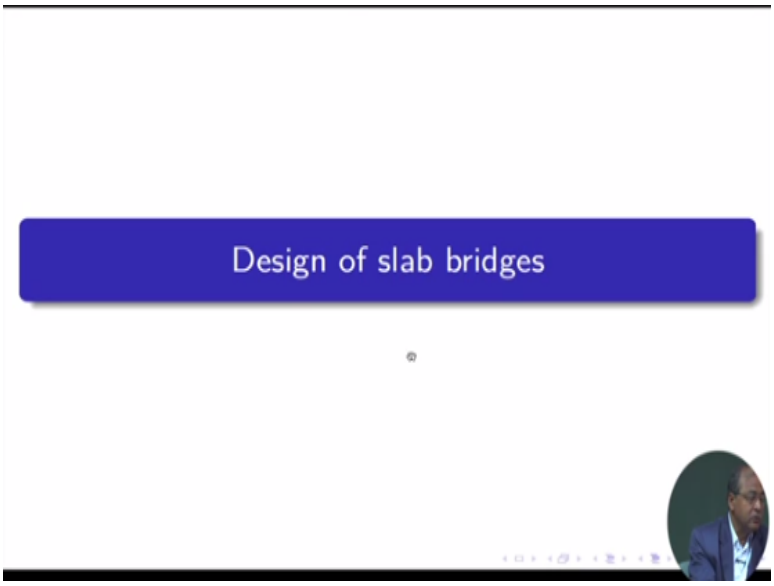

So our topic today we shall start now with a problem before that let us introduce that slab bridge and order the very specific design principle for that, that we shall discuss. And then we shall move to a particular problem, because our main objective of this course that you understand that how to design you can design on your own also. And also you can understand that the required one the dimension whatever you are giving that how far it is correct.

So that also would like to understand that particular aspect, rather I would like to say that we would like to feel it, rather just only simple computation for bridge engineering or for a particular bridge it is not just a number, the structure itself you have to feel if you can understand that and then it will be easier to get your confidence.

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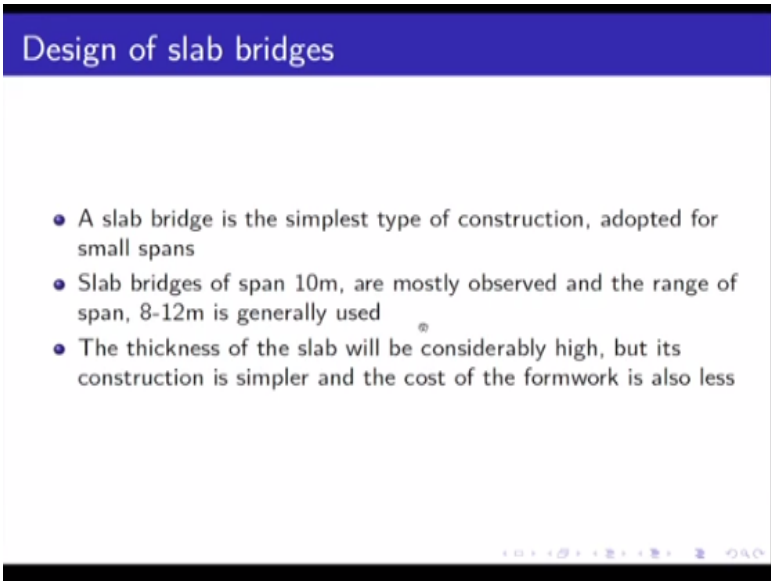

A slab bridge obviously the simplest type of construction adopted for small spans. Slab bridges of span 10m that is generally we observe. And the range of span that generally I have told you 8-12m you can start from 5m also or 3m also that way also I am depending on. But what I mean to say whenever you are talking say slab bridge generally it comes in that range. Otherwise, we go for some kind of say alpha type rope that one we call.

So we call several specific name, the thickness of the slab will be considerably high, but its construction is simpler and the cost of formwork also is that less. So this is the one that first one we are introducing that in bridging particularly in reinforced concrete road bridges this is the first one you can consider. Because we would like to follow a journey, and in the journey this is your first step.

And then we shall go to next step there where we shall fill yes, now I require different formwork that slab bridge is not sufficient, rather it will not at all will be economic.

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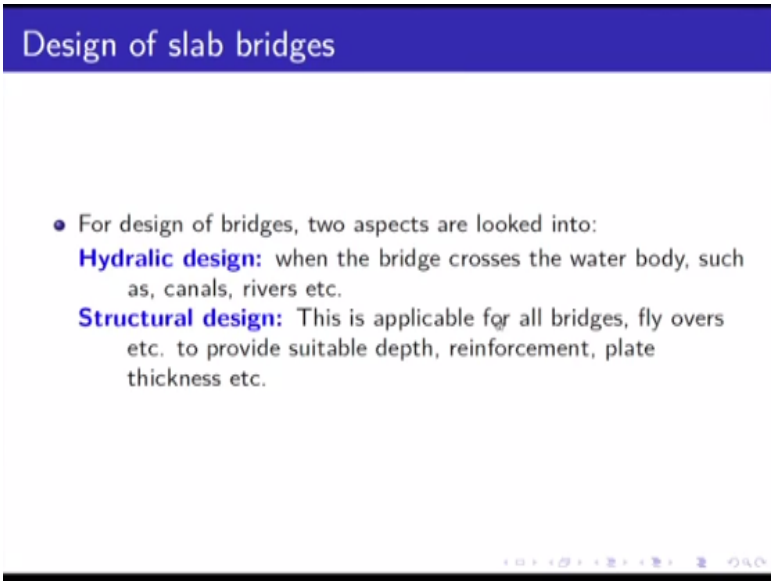

There are two aspect, so that is U is missing here hydraulic U is missing whenever I shall give that more to there I shall corrected U is hydraulic design. When the bridge crosses the water body such as canals, rivers like that. So obviously we are having for a canal or for a river we are having certain natural flow, natural slope that one is there. And now you are obstructing that, and in normal situation there will be no problem.

But in abnormal situation like say high flat that level that time it may happen that one that, since already you have obstructed that one, so you have to give certain natural flow. So on the basis of that you have to decide what will be the height of the socket of the, that the bottom of the bridge whatever you do the height that one should be from the water level. So that there should not many problem or rather I can say the bridge will never be submerged.

So that is our objective that we have to take care. Considering that aspect and that aspect we consider that one from the hydraulic design, and that we generally do it before that before actually your design. So that one is decided at the time of general people are some general arrangement of drawing that one. So these portion definitely you could start that required one if we get time we shall come back to that required problem how to make it.

But before that mainly say fly over other things where that water body is not there, there is no such flow. So we can directly we can consider certain kinds of span and that span which will fit for your that slab bridge that we can decide. So we shall consider our second aspect first that is your structural design, and this is applicable for all bridges that is fly overs etc. to provide

suitable depth, reinforcement, plate thickness like that that is obviously for the steel structure if you consider plate thickness here.

But anyway, so this particular aspect we shall consider here that is a one we shall consider the structural design.

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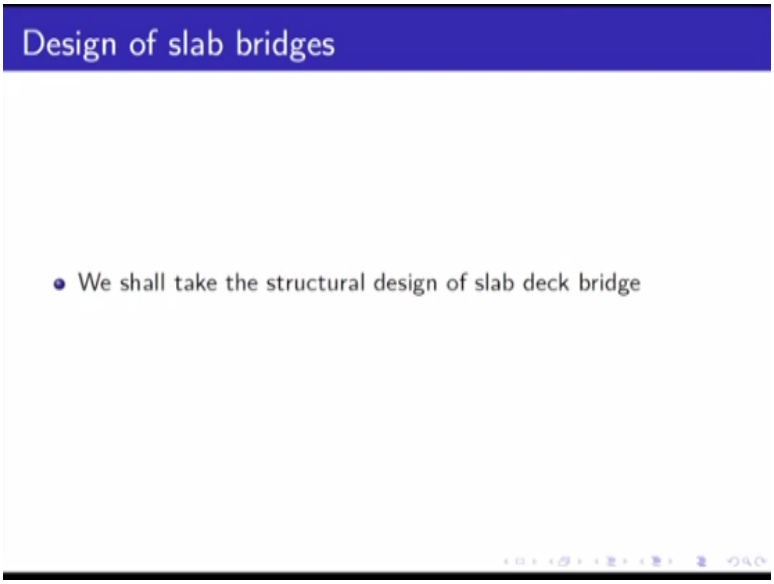

So as usual I can take that we shall take the structural design of slab deck bridge that is a very, very simple one, as if you are giving a piece of paper and that piece of paper should be we are putting that piece of paper or a cloth that one you are spanning from one support to another support that one. Now the question is that what will be the thickness of that cloth, or what will be the thickness of that paper that is our objective.

And that we would like to find out to do that what you have to find out, you have to find out what will be the bending moment, and obviously this particular one that is your simply supported bridge. So bending moment obviously will be maximum at the median, and shear force that definitely that one will be in the support. So these are the two aspects we have to find out these two one that bending moment and shear force you have to find out.

And then we shall solve and then we shall see that whether the section provided that is perfectly alright or not.

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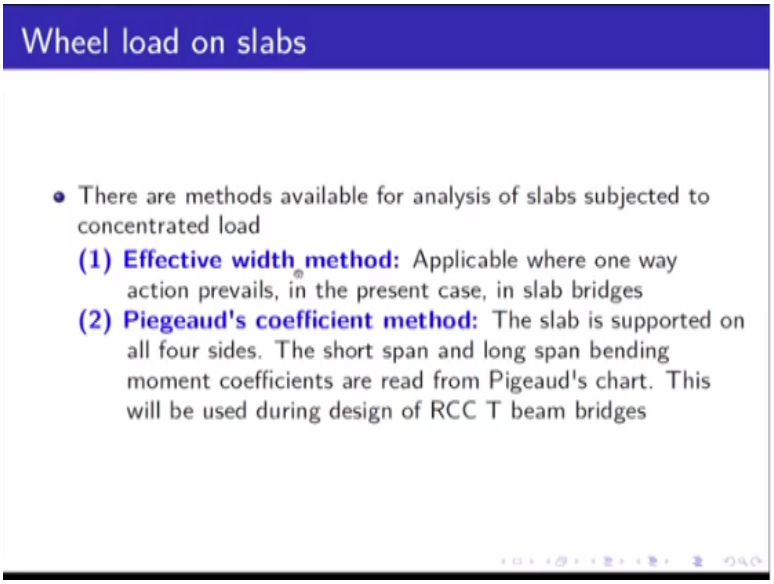

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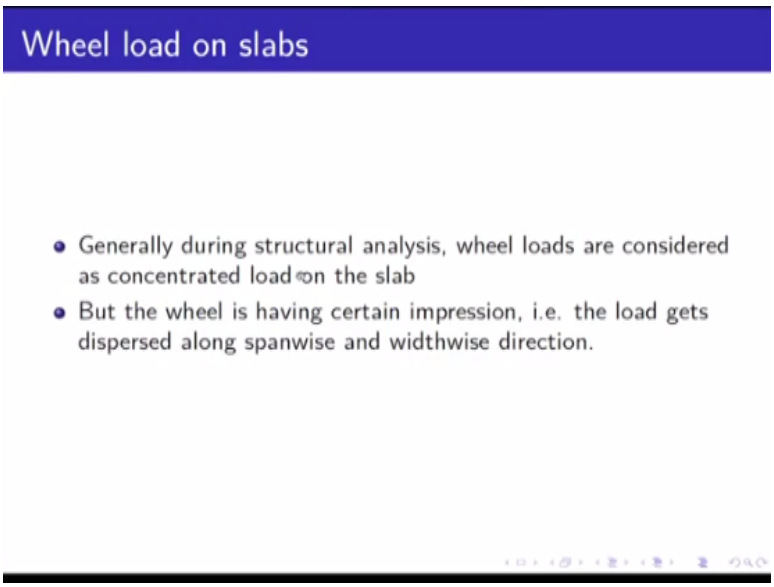

Now this particular aspect is very important that so far those who are actually did betaken and also still studying in colleges in our Institute that you have done structural analysis, and you have

seen that your loads which are coming as say your wheel load that one coming as a concentrated load that is a one we considered. But the wheel obviously we are having certain impression that is the load gets dispersed along span wise, and also with widthwise.

So this particular impression wither and also it will be dispersed that particular load also will be dispersed. So that load also you have to find out that how much load will come. So that means whatever it is you can consider that you can definitely can consider as a concentrate load without about it, but at the same time we can consider this one as a just area load and on the basis of that we can find out.

So that the load, the stress will come seeing any certain kind of say, your certain level of one say, scale list. So that is also based to help us to make an economic design.

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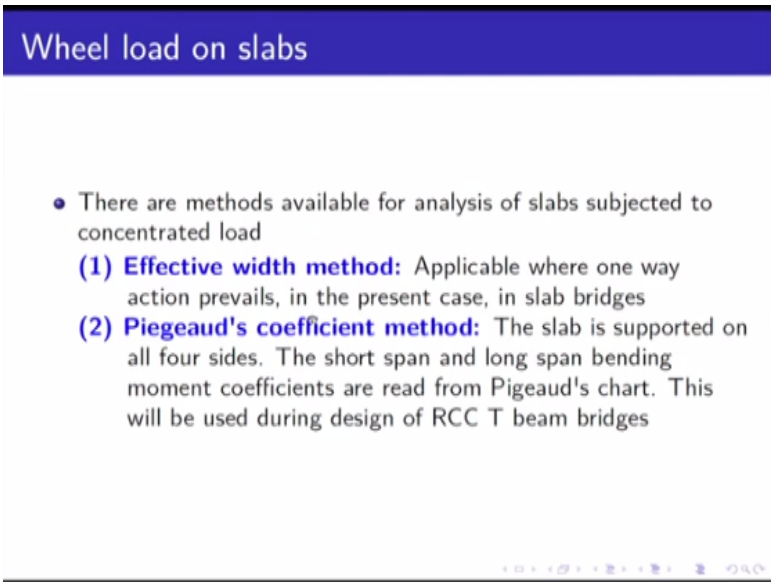

For that case there are actually many more methods actually there is one more method actually here I have just to give you idea that effective width method, Piegeaud's coefficient method, there is another method actual Westergaard's method also available, but whatever the methods commonly used that we are actually describing here, because the main objective another objective of this course to introduce in this whole area and so that because the thing is that you should also know the domain.

The domain where you will get that information one can say okay now we shall do the Google and then I shall find out, but you will find out so much enormous information from there to get you know that you say, that important one and also relevant one it will take another 10 hours. So that means it is almost equivalent of this course itself. So coming to that particular one here, we would like to introduce that whatever actually methods available commonly used that we are going to describe.

Coming to this particular one here that effective width method, and this one we can say applicable where one way action prevails in the present case in slab bridges. So this is the one actually we shall use it here, that means whatever load we are having that load will having have certain kind of effective width that means that apparently it looks like the contact area on the surface of the deck, that one you can say finally you can say certainly it is dispersed and then that dispersed area is coming more than the contact area.

So obviously your stress will be less and accordingly, obviously that your bending moment, shear force that one also will come, that we shall see that is our objective that one we like to do it. And then Piegeaud's coefficient method slab is supported on all four sides, the short span and long span bending moment coefficients are read from Piegeaud's chart. This chart I am not introducing now, but later on in our RCC T beam bridges that time we shall introduce this one just I am referring this one that is another method whatever available.

And this will be used, based I have told you that our RCC T beam bridges that one. So what we are going to do now that effective width method this particular method we shall use it, and that those we have done that RCC design that I think that you have used that say your IS456 where you are having certain concentrated load if it is on the floor and how that load will give you that moment and that you can calculate that one, that is there also you calculate that effective width there is a formula.

And the same formula we shall use it here also, so what I am trying to say here whenever we are having this reinforced concrete design generally we use it one that road which goes towards building design. And another one it goes towards bridge design particularly reinforced concrete base that is the one and obviously there are certain other aspects also that bunker, silo, water tank that also you have to do it separately that is.

So generally the basic one reinforced concrete design that which I have told you that IS456 or IRC21 or standard 12 that particular one we are having and then from there we have to find out certain kinds of things applicable for bridges particularly reinforced concrete bridges that we have to move, so that we can directly apply that reinforced concrete design.

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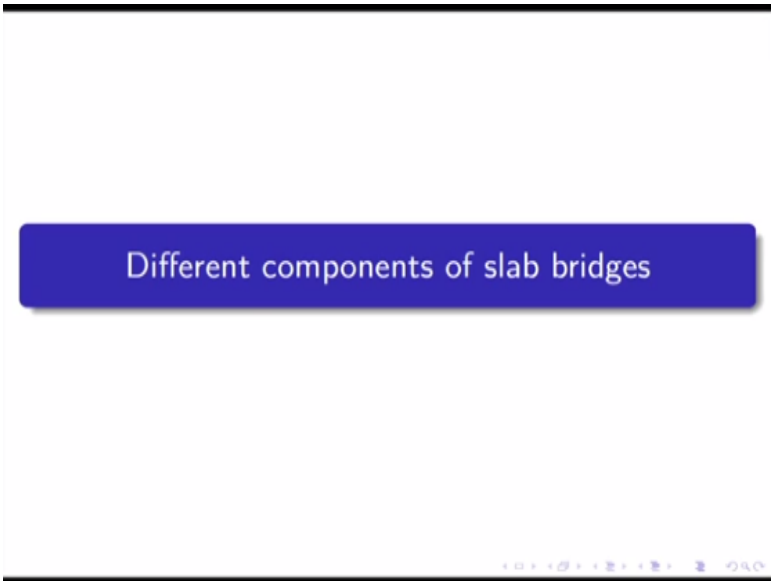

So coming to this second one here let us see that different components of slab bridges are of this particular one already I introduced in that your say that introduction of this particular course, but again let us just take a part of it, so that we can discuss in detail.

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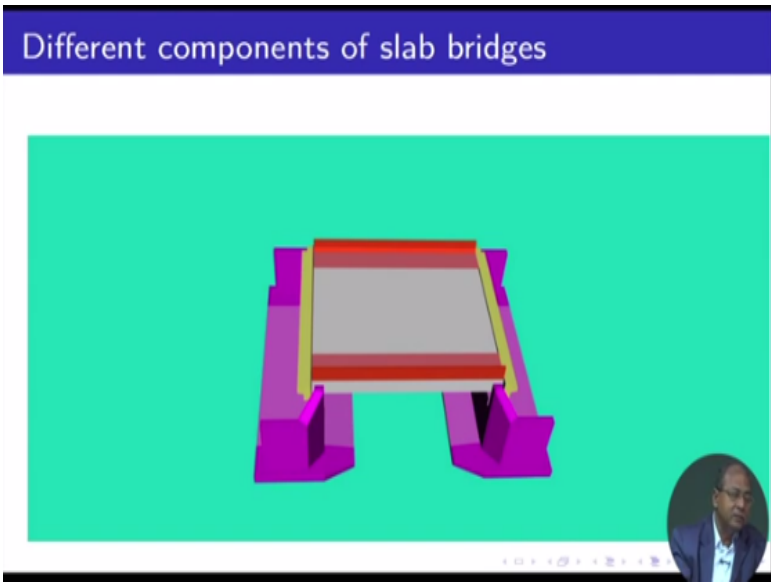

And that one we can find out here so this is the complete that bridge which comes here and then this one let us say this particular bridge can move to that traffic can move, vehicles can move from this direction to this direction, and this direction restriction that one you can say that you are having actually that both ways step is actually you are having, and then we can find out this thickness also and then, and this is the one that actually the thing is that all made of concrete, so it should be actually that same color but we have given this color separate only to identify that different components otherwise it may be difficult to understand that which one you are.

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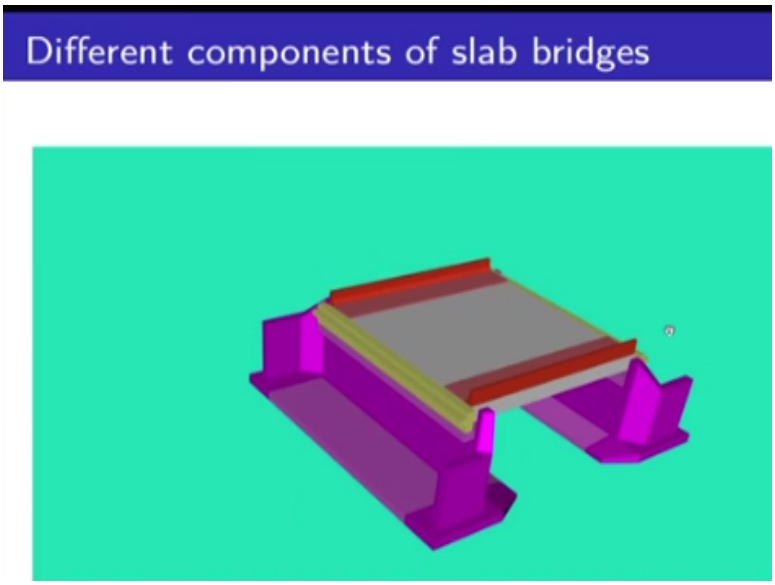

So here we are having say as failure this is another view you can see so obviously there pattern we are talking actually now superstructure this is the slab deck that is the one our superstructure and this superstructure supported by two abutments these abutments are also made of reinforced concrete, so that way you can say that enforce concrete so we shall go just we shall introduce that some introductory thing we shall give it for sub structure particularly abutments.

So that you can understand that what will be the thickness of abutment other things so then on it will this particular course will be complete in all respects we shall not be able to go to full design of that one that one you can see from that but I hope I shall introduce a few books also so that actually can understand that wire phone will get the rest of the information but anyway but mainly we are talking our safe slab superstructure.

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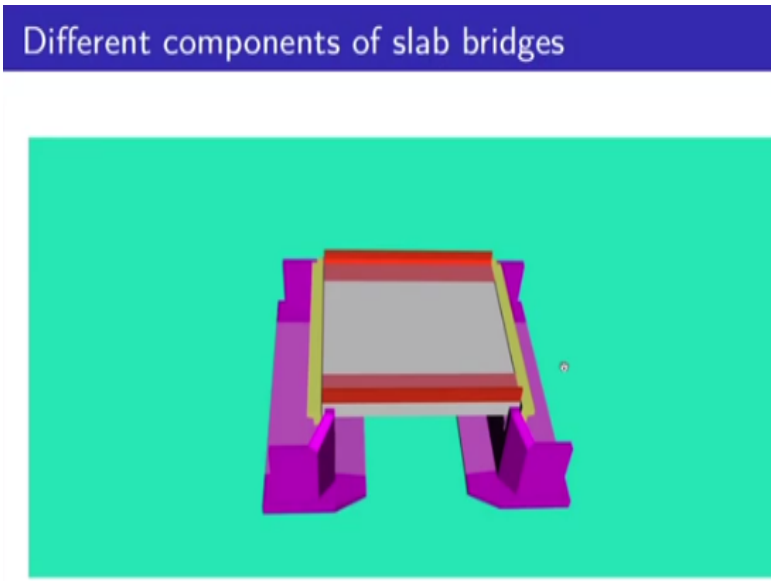

So this is your another view we have given this a curved view.

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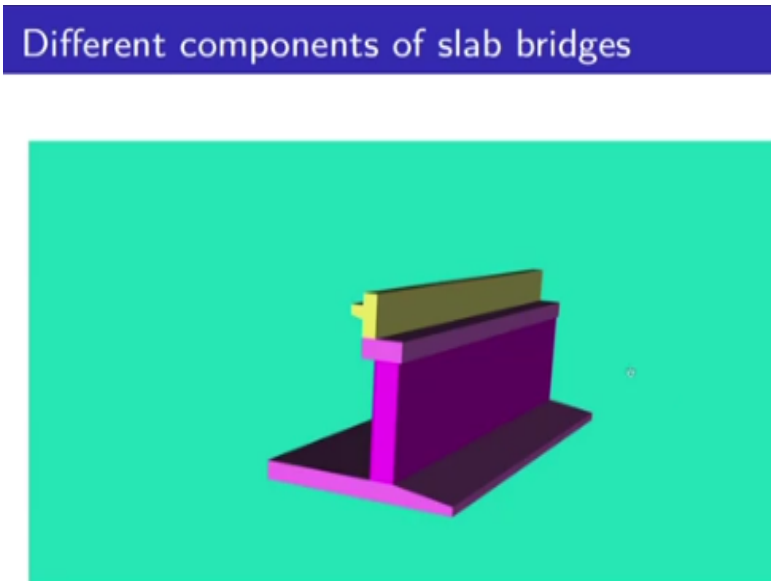

Now you can see this particular one here this is the abutment, so whenever you are talking abutment then we are having that base and base and then we are having steam then we are having abutment cap and this one this is sufficient actually this portion but we have given this one so that you know that you are say soil other things all those things will not also that you are say road if we do not give here that here we are having that say for example.

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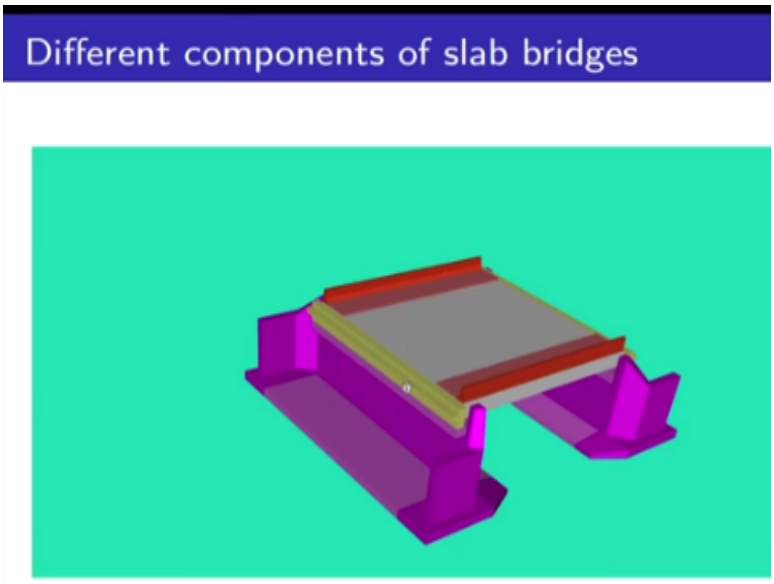

This particular one that bridge will be there the slab now from there here art will be there so that art that particular portion so it will go in this particular different place it will come, so to avoid that one we can actually we keep this dark wall here.

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So this is the one that one you can consider this one abutment and always for a bridge you will have two abutments one in the beginning you can say that and another one in the other side these are the two abutments you will have and obviously that abutment we designed separately the two abundance because it made for a whenever you are talking say fly over and fly over let us say it is one kilometer long safe fly over.

Or more than that so obviously when the abutment in one place say for example I have started that one say 100 kilometer chain edge generally whenever we specify a particular bridge that we call it with the chain age, chain age that particular one just let me write down this one.

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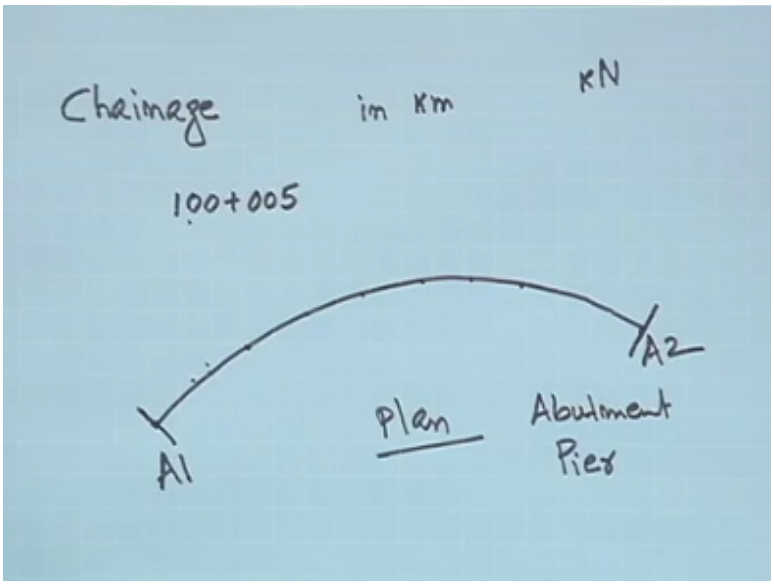

Say chain age and this one we mentioned in kilometer, please note kilometer K should be small kilometer K always it is small, similarly kilo Newton K in capital but K is small that is Kilo Newton, so coming to this one here chain age that one generally specified in kilometer and meter say for example we are I am just giving some number say 100 + 005 so this means that hundred kilometer divisible generally starts from a particular city.

So that from the main city it will go and from that particular location it will start one kilometer 00, 1002, 003 and then this chain age means actually from that particular city that one it is at 100 km, 5 m away this is the one general chain age we keep, so whenever you are having something like this it may happen that one you are having fly over I am talking the plan, so you are starting from here and you are ending here.

So you require one abutment here another abutment here, so this one let us say we are conditioning A1 and this one you are considering A2, so this is the one and you are having more number of actually your say pier we call it just to give it here Pier, so abutment and pier and these are made of reinforced concrete.

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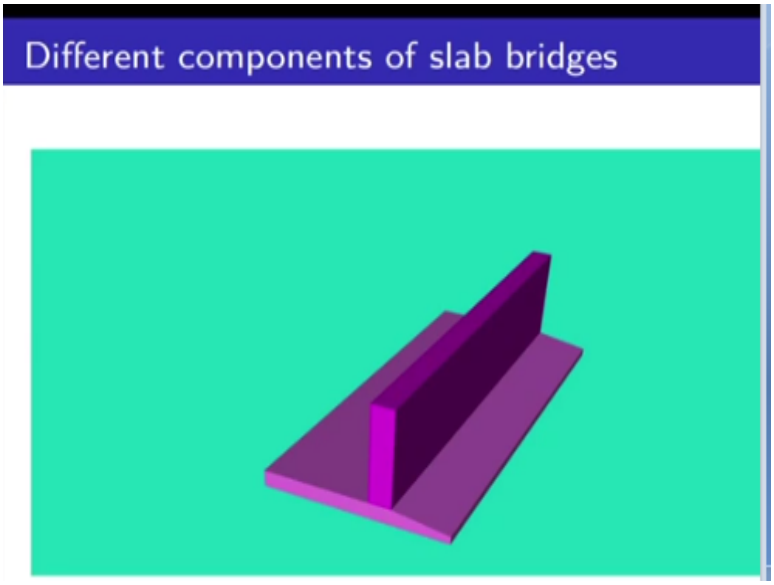

Now coming to this one here I would like to say this that you are having that base over that your steam will come so obviously you have to find out what will be the thickness of this stage, this height other things there are two aspect one is ewe call it say substructure another one we call it say foundation, so here we can say that we can consider these particular one say 14 that abutment itself actually you can consider this sub structure.

Because below that if you are having pilings other things that way you can consider as a foundation that we can consider, now coming to this particular one here, we are having that we have to know this thickness how far it will go from the ground level those things you will find out from the geotechnical investigation, so that information from there we shall find out how far below it will come so that we are getting the proper bearing capacity.

And so that we can transfer the load whatever coming to the superstructure that load can be transferred to the ground.

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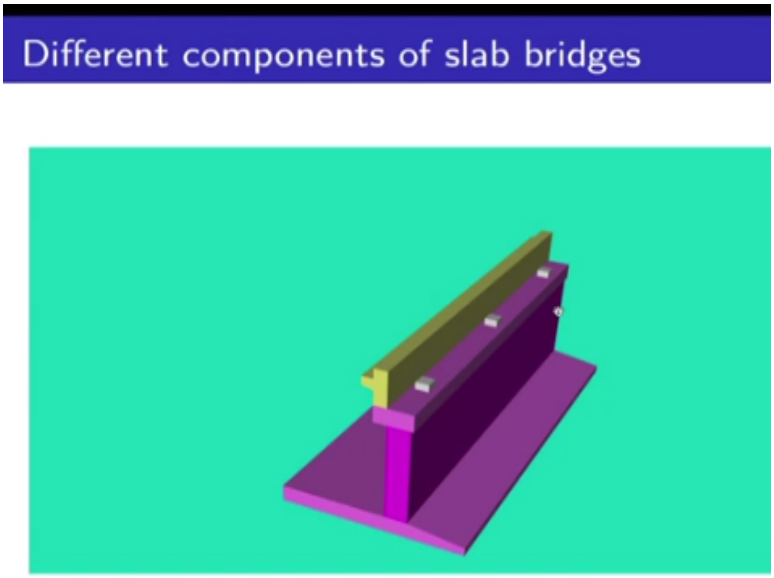

Then we are having that one the same thing whatever you have the discussed, so here that slab will come we can give few bearings here we are giving the particular one here.

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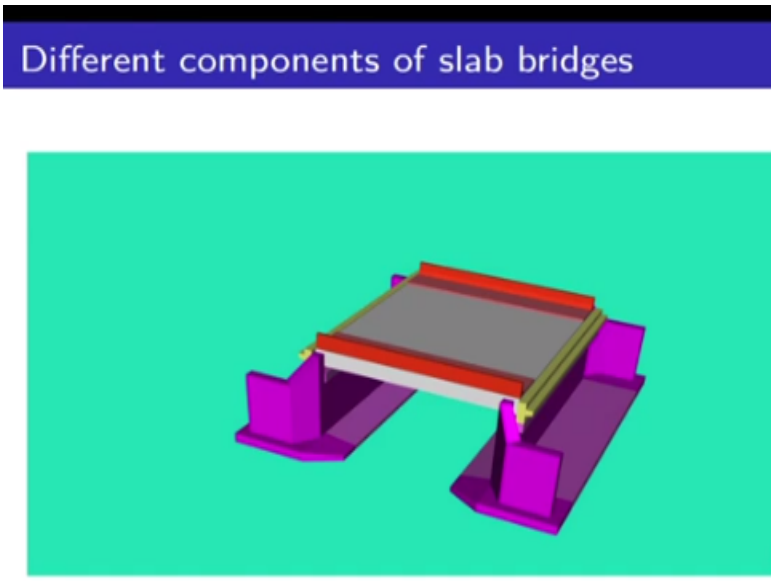

Then we are having another side, we are giving that wing wall and then the slab the slab we have to design this is our main thing that means first thing we should know what will be the length there is one more thing I can say there is one if you see that particular one from this end to other end that is called actually clear, so what will be the clear span that we can see and then you can calculate that you will say effective span.

So this is our deck slab that we have then we are providing that your say class barrier that we are providing that class barrier and footpath also.

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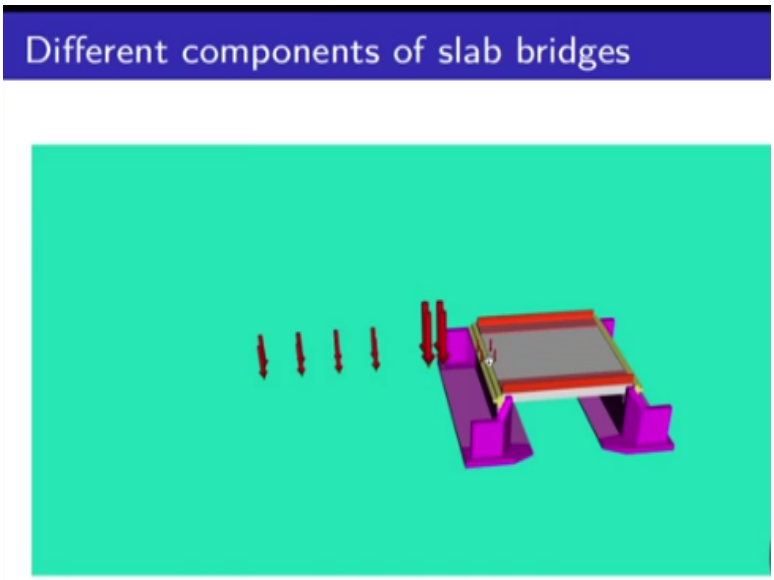

And so this particular one say load means here that over that what load is coming that is this is of course I give an IRC say A loading that whatever we have discussed in earlier lecture that one will discuss, so this is your say that loading that we are having here the greatest this particular one here we are having and then this load will come there is another load is called IRC class 70R loading that also there.

So how many loads we shall consider other things we have discussed and that one will be followed as per IRC 6, so as per IRC 6 you can actually find out that which load to be taken that all those things we can consider here. Now whenever we are having this particular one here just to make that one.

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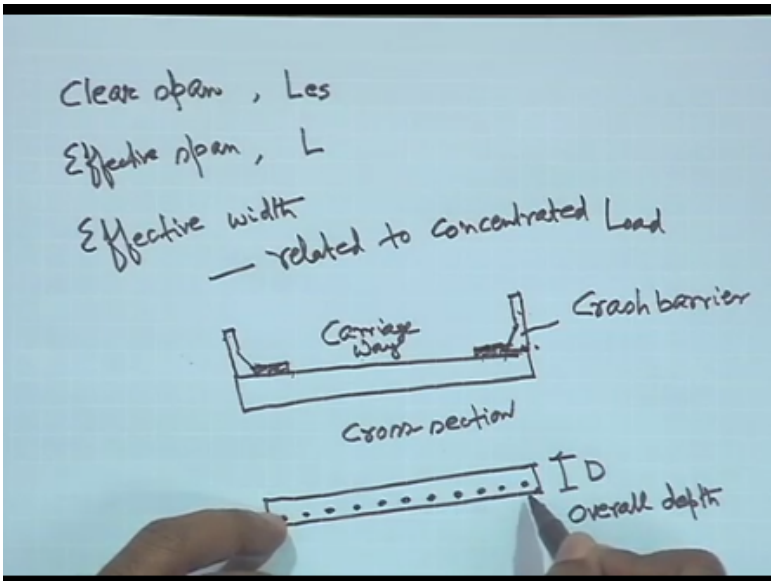

We require something that is called say one term we have given that is it say clear span, another one we call it say effective span. Generally we mentioned this one in meteor generally if you find out the dimensions whenever we specified that parameters of our say, you are the bridge for a structure you will find out that we give the dimension in a particular unit whenever it talks expand generally we mentioned that one say you are in meter though you can mention everything in one unit say for example in meter or millimeter like that.

Say for example whenever you are talking say you say slab thickness we never say something say 1 to 0.1 to 5 meter or say 0.2 meter we always say 200 millimeter, 120 millimeter like that but whenever you talk to span then we talk that particular one in meter so that is the one general generally we follow on that particular one here. Now we have also discussed with that effective width, we have also discussed that effective width.

And this is related to this is related to concentrated load, so we have to find out that also that effective with that particular one to find out, now what is our objective, out of that I have shown you a picture that and that one we have I have shown you the question is that particular one here what I am going to find out, so there are few things first that what will be the carriage way that means so far I know a very simple thing this is the bridge actually cross section.

And then we have shown the one like this cross mediate and then we are having footpath in both sides say it can be one side also so these for some carriage way, the vehicle will move so this is the one you know so that one obviously it will be dependent on our requirement that how much

we shall give whether you shall give a single lane whether it shall be double lane or triple lane and that we shall follow from IRC 5.

So this is the one we have to then we have to give say what will be the footpath we are giving 1.5 meter like that we give but sometimes we give one meter also sometimes 0.7 though it is because they were because of hand crowns other things it happens like that, this is called crash barrier I have shown it but I am writing that particular one so that it is easier to understand that one, so our objective here this one that will say very simple thing this cross section this width we know carriageway, how much we have to find out from the IRC5.

Footpath width if this both sides fine if it is one side that we also fine and then you are having say your crash barrier you can consider this one say 500 like that you can consider here and then you can find out the total width of this, the next question is coming how much shall we provide this say D and this one we are talking overall depth this is our next one that one that we have to first now as I have told you in the very beginning of this course in the class today.

That as if you are giving a cloth the cloth is actually moving from one support to another support or you are having a piece of paper or a made of paper the thickness that we are to provide so that we can actually use it, so this is your that overall depth D that we have to find out and on the basis of that we have to move and since it is reinforced concrete so we have to provide the reinforcement also.

And as I have told you so these are this is your main consideration that whenever you are talking that particular one here this is your main consideration that these you have to provide the next other things will come into picture that you would say I can say crash barrier or other things that design also we have to do lot of other things but first thing that one if it if it is fine this particular one here because you will find out so many other reinforcements that I shall show you.

But the thing is the main thing that overall depth D and this, the enforcement because these are the main reinforcement that we have to provide, since it is simply supported beam so reinforcement will be at the bottom.

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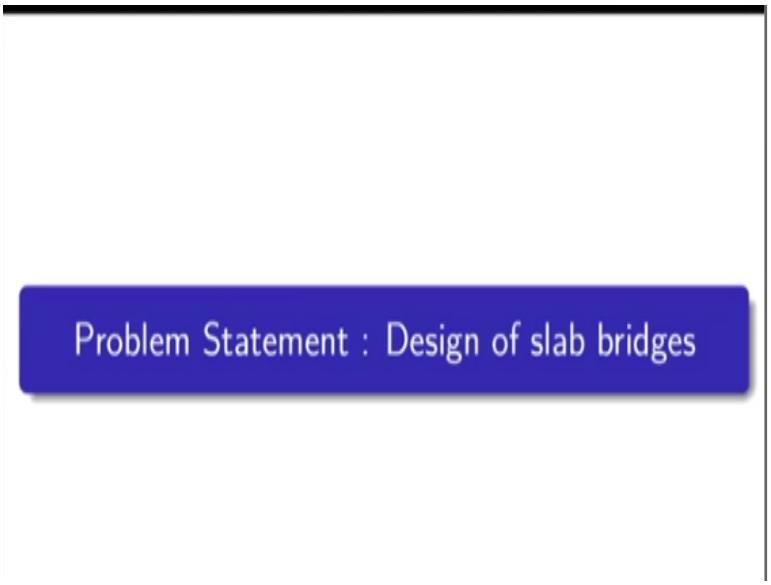

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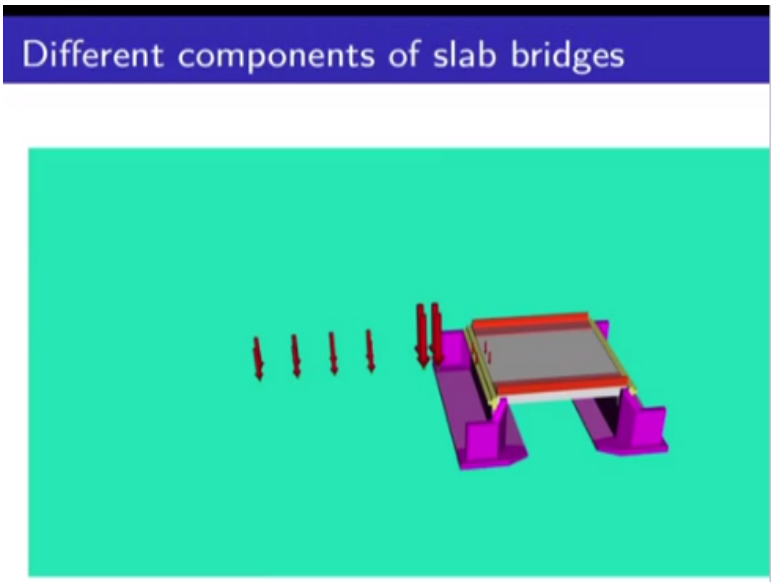

So that particular one let us conclude this session up to this and then we shall start with the problem statement, thank you very much.