Project Planning & Control

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Lecture – 22

Lesson - 04

Two-Span Bridge: Activity Identification and Duration Estimation

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We now go to the pile driving operation, which you can see these are the pre cast piles are driven in, you can push it into the soil and you will find that depending on where you reach the capacity or you know the push resistance that you will find it at different heights and the driving operation, again if you want to visualize the driving operation, you go to YouTube.

There are plenty of videos on, you know different types of pile driving and different operations, I did not I am show you can refer to it, so I did not want to show it as the part of this lecture, but I strongly encourage you to see what the driving includes. So, really it depends on soil type and the driving rig characteristics, we will just assume one pile per day.

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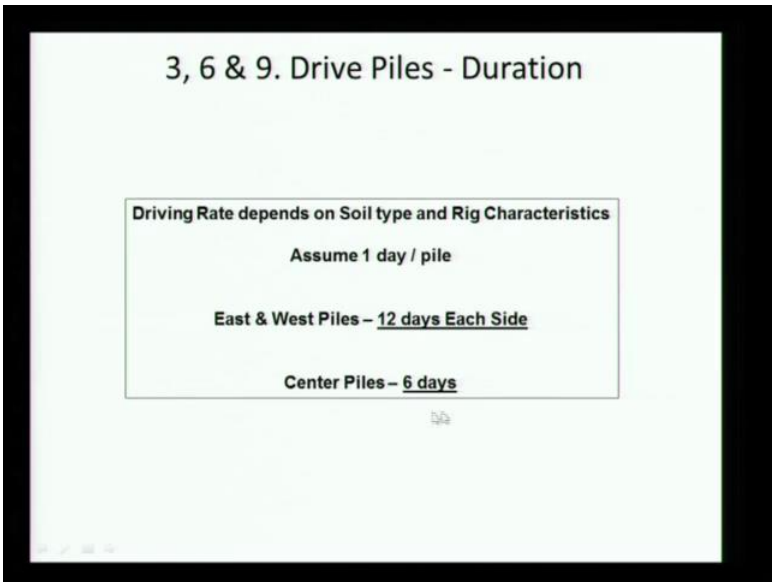

So, on the east and west pile, just think you have 12 piles, so 12 days for each side, in the middle you are assuming 6 days. Let say, we are taking it as a very direct estimate of duration.

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Now, we come to pile cap construction. So, you can see we have a pile group like this, , you need to tie the pile; only then the load is transferred to all. So, when you finish a piling operation you have piles at different heights, you might have to cut some of them, you have something like this. You have to do and you have to excavate, you have to provide a flat base like a PCC base here, you have to chip these piles, so that reinforcement is exposed and that reinforcement has to tie in with the pile cap

reinforcement, it has to be embedded in the pile cap with the pile cap reinforcement.

So, then there is a good transfer of whatever load you have to do, then you have the final reinforcement like this, you put form work around this and you pour the pile cap and it would look something like this. So, that is the operation for the constructing the pile cap and we have three sets of pile caps as you can, as we discussed.

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So, again we come in with the pile cap operations, so we have excavation and PCC bed we are giving 1 day, chipping 1 day, reinforcement placing 1 day, form work 1 day, concreting we are taking a day, form removal we deciding the removal the form after 1 day. The time to remove the form, it probably could be done in less than 1 day, but I am giving 1 day time and back filling of 1 day and we as saying that, we need to cure it for 3 days before, anything can be done over it, before we consider it complete.

So, here we have east and west pile cap, we are saying it is 5 days before we can, use it for anything else. Now, how do we get 5? 5+3, so here you have 1, 2, 3, 4, 5; concreting is done and then, whether this is done and not the curing is taking place. And then, you have the 1, 2, 3 is any way happening, so we have 8 days and a similar approach to this. So, we have taken 8 days for the pile cap and 7 days for the center pile cap.

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Now, we come to the abutment side, so here is a kind of what an abutment looks like. So, these are the ends of the bridge, so you can see here is the picture of finished abutment and you have, you can see there is an abutment here, there is an earth fill here, so over this there will be sloped embankment from the road to be built on and on the side, there will be some kind of retaining of wall, so the earth does not slip.

So, when you take a wall like this of course, these are different pictures, they are not pictures with same abutment, but I just put it as, so that you visualize what an abutment is and how it goes up. So, you have reinforcement that is tied, you have form work that is put up, concrete that is pour and form work is then striped, cured and then, over the abutment you will have capping, so that you can and then we can put the barring plates and things like that.

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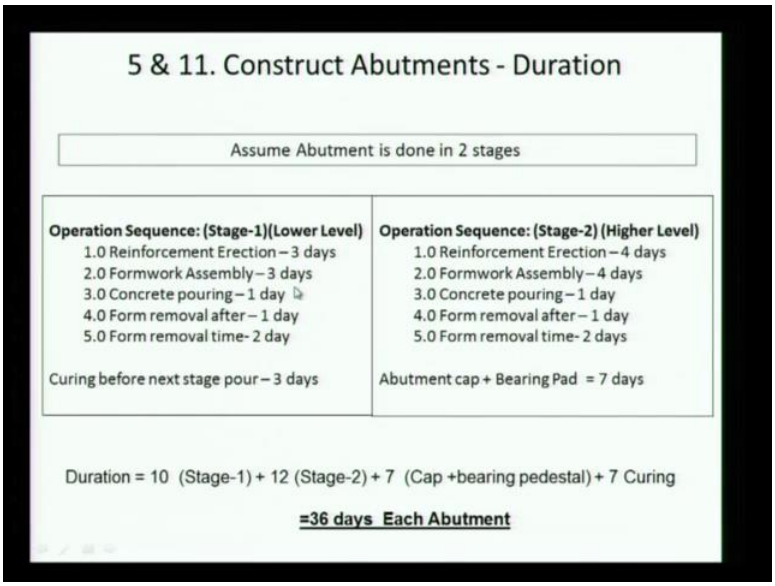

So, this is what the abutment looks like and so this is and we are also going to one more assumption here. here you see form work for a or abutment which is almost, it seems to be the full abutment. But, we are assuming that the abutment is going to be poured into two stages, they are not slip form work. Basically we have a form work level one, we will pour it, remove the forms, take it to the next level and do a second pour. A pier or something can be done, very tall piers can be done in slip forming, but again I encourage you to look at slip forming in YouTube, it is something which you will understand, a construction method. This is just two stages, why would you use two stage?.

Student: To save formwork.

One is formwork, availability of formwork.

Student: In order to complete and to prevent segregation issues.

Segregation, because the depth can be so high, if it is that there will be segregation and things like that, there will also be the form design. Your pressure of the concrete will be so high if it is so deep, you know that you will have to design your form for that. So, for all of this makes, you know makes two staging more economical, but time will be more. So, again it is a balance between cost and time, this is the sequence we are taking here, reinforcement direction.

So, we have stage 1 and stage 2, reinforcement direction we taking it as 3 days, form work assembly also 3 days, concrete pouring, form removal after at one day and form removal time we taking 2 days to remove the form. And curing before the next base is

giving it 3 days, which we say that after concrete is poured 3 days should allow, we should allow for the before the next stage of not starting with next stage of pouring of concrete .

So, here we go in, so we take this stage we go to the second stage, now you will notice reinforcement direction here is 4 days. Why?

Student: It may be because of we are going in soft soil.

We are working, remember we talked about productivity and how it drives duration. So, here we assume, because it is a higher level there is a lower productivity of reinforcement. So, again 4 days for erection, 4 days for formwork assembly, 1 day again for the pour, 1 day for the removal and 2 days, 1 day for after which the removal can start and 2 days for the removal.

And we are also making an assumption that the abutment cap plus the bearing pad will take 7 days after this and there will be again a 3 days curing require before this is done. So, if you total up, I think you will get 10 days for stage 1, 12 days for stage 2+7 days for the bearing pedestal and the cap and 7 days for curing, so totally we get 36 days for each abutment.

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Now, we come to the center pier, which again I got a mix of photograph to show you, what I know what pier consists of. Here you have basically form work, here you can see a pier again in two stages, thus the stage out, different stages of form work for a pier, people climbing up. You know if the pier height is very high, if the formwork height is

high, you have to pour concrete from all the way here, there are issues with that.

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What we are assuming here is again stage 1 and stage 2 and this is the sequence, with which we are going, where we have again I am not going to repeat through all the details, but you have concrete curing, I am giving 3 days here before stage 2 starts. So, here you have 1, 2 the sequence of events and 3 days after concrete pouring here. When you go to the next level you have reinforcement direction for again at a higher level 2 days, formwork assembly 3 days, concrete pouring, curing before pier cap here is 3 days and we are assuming the pier cap and bearing pad will take 5 days of time. So, here we go with the total calculations as it shown here leading to 27 days for the center pier. You can look at the details and if there are clarifications you can ask me.

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Now, we go to the next, which is place beams Here we see a beam is transported, the crane will take the beam and as you can see it will be placed on to the, on between the abutment and the pier and you can see an example here of how beams are placed. You need a diaphragm between the beams to be able to connect and then transfer the load properly.

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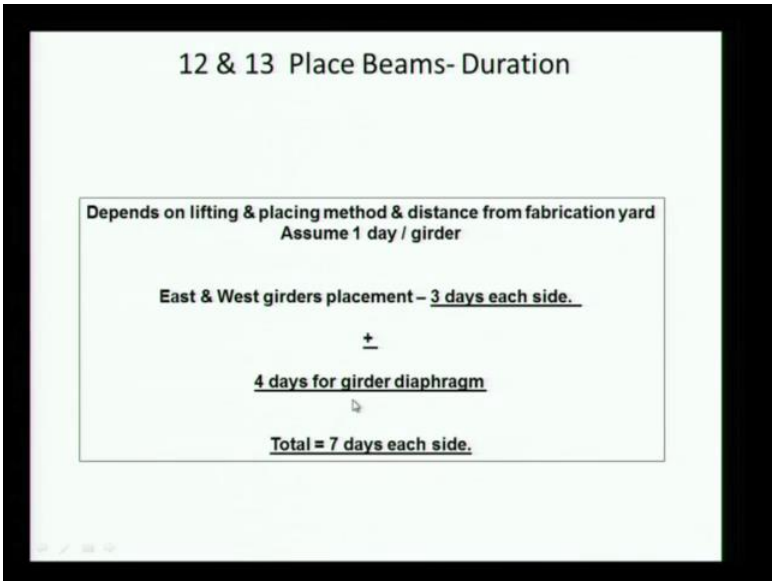

We are not, we are integrating the diaphragm into the activity and we are saying that each side will take 7 days.

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Finally, I mean the deck slab over the beams, we have to form the deck slab between the beams, we have formworks for the deck slab there will be reinforcement, there will be pouring of concrete, curing everything.

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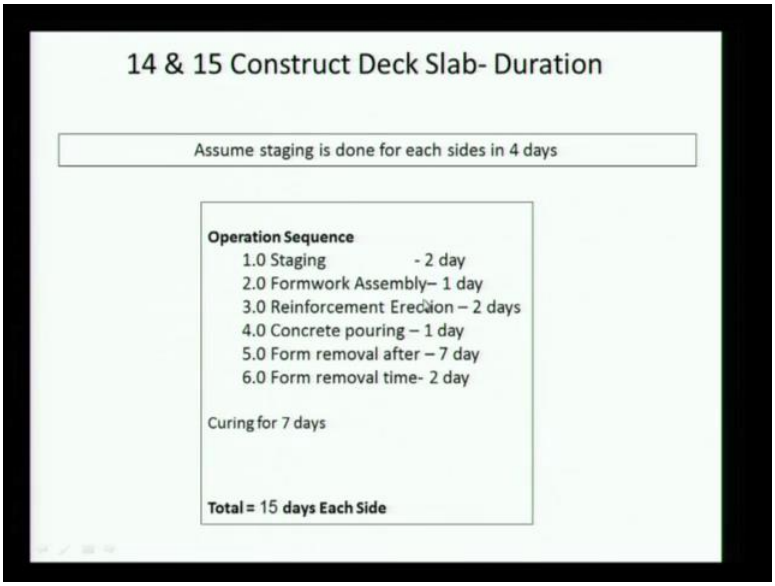

So, we are going, then we will staging to erect all of this, so staging for 2 days, formwork assembly for 1 day, reinforcement erection, concrete pouring, form removal we know after 7 days we say. We are going to allow it to be there for 7 days, because it is not supported. Once you take it down, it is not a compression member most of the others, curing for 7 and total 15 days for each side.

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Finally, the laying of the road of we have earthwork. So, here we have earthwork which gets is done we have rolling. Now, again we have earthwork and then you know this kind of a rolling is for compaction if it is not compacted to properly what happens?

Student: There will be settlement.

There will be settlement. So, this is for compaction settlement and then you have the black topping you know appropriate layering.

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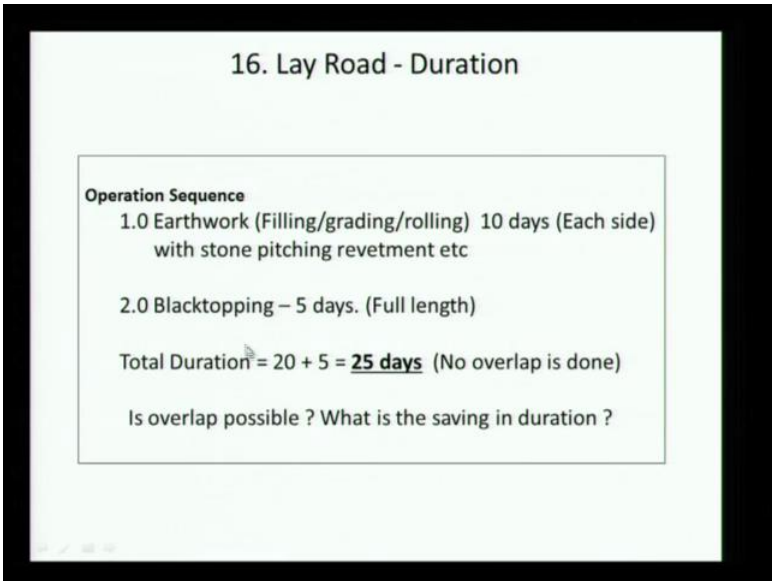

And then, the black topping done and that is what we are going through, where that assuming that the whole thing takes. So, let us get an detail here, so we are saying 10

days you know filling grading rolling each side blacktopping total length for 5 days. So, what I am done is the taken 10 plus 10 plus 5 is it or is there a shorter way I can do it?.

Student: ((Refer Time: 12:03)).

So, first I could do compaction on one side, black topping on one side

Right, so I could I could actually do 10.

Student: we start at the other one after erection is over wait So, option here is 10 +10 finish all the earthwork then start the blacktopping 25 days the second option is do my first 10 start the blacktopping when will blacktopping finish for that ten? in two in a half days , in two in a half days I will finish blacktopping while the other earthwork going which means for the next, so how many days will my blacktopping equipment be idle 7.5 days I have it Idle , then use it for the other 2.5 days, which do you think ?. So, then I reduce a duration to bring it down the 22, 22.5 days, which is preferable?.

Student: Black topping at 5 days because your equipment cost will be lesser in this case

Otherwise, I have rented the equipment I am keeping it there I am not really got any advantage or there any fluent for, is it worth it for 2 and half day. So, these are the things which you have to which you have to balance of it. So, sequencing is extremely important, but sequencing has to make sense with respect to equipment being idle expensive equipment being idle or not utilized all of it.

Student: Or I can do towards 10 days for one side , then we start the second side, but after 7 and half days I start the back topping on one side.

So, let, so again it depends on the construction method we are assuming that you know. So, we are assuming this as a linear progression to the role is that is that how works. So, in the method you are saying you are assuming that I will finish the roads section by section has I go, but it might not work that way, but then if you want to go into this micro schedule, now have to divide the road into sections and say that you know when I am taking a 10 days for each side is that the natural break is it breaking every you know every 5 days I have a section complete; that means, if two sections in the road.

Then, we are getting into finer details of the micro schedule and then, you can actually do what we can how to balance out idle time of the equipment versus synchronizing between the two activities . I brought it up in this up this particular activity, because we can discuss, because there are only two, but the same issue arises and almost all activities

and the same issue arises across all activities. Let us take those also into account has been has been go ahead , so when I mean this same issue arise across the activities what does it mean.

Student: Whether you want to start the succeeding activity between the… No it is no it is not, so much as succeeding it is like right now, we are assuming that are I am doing one set of piling and then, there are other set in the I could actually do all of it in parallel.

Student: One side of piles and one side of abutment from this.

So, is it, but there is on that is at the macro level, now these, so sequences are the micro levels sequence in the macro level really if you plan that properly with requirements to a project it will make a big difference . Now, let say this was a very important role and the 2.5 days made a, very big difference to some very big social issue in that area, then I mean say it is fine I mean I am going to keep that equipment idle for 7.5 days still go ahead with that.

So, project objective will drive all of this and keeping that in mind is a most critical issue a lot of time will find the earthwork is done everything is finish there is no blacktopping equipment available the road is left like that for months before something happens. So, that is other extreme where because of lack of equipment nothing happens. So, if we summarize other and overall questions on how we went about the duration calculations ? we went through all of these activities they some other repetitive in the nature of how we calculate.

So, I kind of went through it faster, but ultimately we did we going through the level of detail which we discussed about durations when we discussed class and duration you were at what is the level detail we want what did we consider we cannot consider parallel we consider parallel what did we consider if I go back to all of this.

Student: Could be idealized the construction as we didn't accounts for delays.

We did not account for delays, but the some of these like for example, when say concrete pouring for one day here might be little there will be you know detail half a day or little more and that, but I am give you it a buffer that is good and bad, because I am not gone to the micro detail properly.

But, there are given some kind of a buffer do you remember again recall durations what was the what was the two types of way we want about duration calculations right. So,

here what are we using this is the resource the sense that we are saying that this is what we have. So, this is the duration what level of detail did we go into resourced have been gone in the productivity levels at all here we have not even talked about resource required not even gone into the level of productivity of the resources , we have just gone in to a very broad level of sequence of operations Ive given you more of a heuristic estimate of duration at the at the sequence level and we taken that and gone the more detail doing this it would be say in a concrete pouring so many cubic meters I have a mixer which has this capacity it is.

So, many nano meters from this side it will take that person. So, much time to have travel you know get in to that level of detail I will certainly get lot more calculation to do and probably that if you have good values to support that that would be the way to go with it. Why did you say its a resource driven? How did you identify it to be resource driven? Because, here I assume that that all of this is base Ive made an assumption on that there is a certain amount of resources that have that is why it takes so many days what about labour availability ? ive made all the assumptions and given you a value what is the alternate? about what do we do in the activity I ve not told you that I have not even given you a project date we will do that also.

Also now they only found activity we found kind of what is say natural duration or default duration for activities based on some other assumptions you made. And now, you can do a network analysis and find the project duration when you tell me the project duration come back and tell you no no this is not what I want it in half the time in which case you will have to come back how would I change the time either by decreasing the duration or by more parallel more parallel at the network level yeah at the at the macro level.

So, these are the ways we can will have to come about in terms of when you going to the duration level. So, will take a look at both, but again just to reiterate in all of this we have taken a resource driven approach , but we made of very broad level assumption that the resource available can do this in this much time we should go to more a detail productivity level of a estimation it is values are available and if you have accurate information from your site .