So, this slide shows the project network diagram of a particular project with activities from A to K. So, the activity duration is represented here as you can see A refers to the activity and 8 refers to the activity duration. So, above the arrow, you can see the numbers are indicating the earliest start time earliest finish time and below the arrow the numbers are indicating the latest start time and later finish time of the particular activity.

So, earliest start time is how early an activity can be started. And later start time is how delayed an activity can be started without affecting the project completion time. So, that means this particular activity A it start can be delayed by 3 days, but this one affect the project completion time. So this has a float of 3 ways. So, how much delay an activity you can accommodate without affecting the project completion time that is called as a float of the activity.

So, this particular activity A has a float of 3 days, that means the difference between the latest start time and the earlier start time is the total float of the particular activity. Similarly, you can see the earliest start time earliest finish times indicated for all the activities. So, now, let us see how the resource allocation has to be done for this particular project. So, for this particular project, first the network diagram is drawn, I mean, the scheduling is done assuming that resources are unlimited.

But everyone knows this cannot be real case in every project site there will be a constraint of resource, resources are never unlimited. So, there will be always a limitation for the resource. So, first it is drawn assuming that it is unlimited. And now the project completion time you can see it is 20 days. So, this project is getting completed in 20 days, if you assume there is no constraint on resources, resources are unlimited.

So, the critical part of this project is B, E and I, the critical path is nothing but the longest path in a particular project which decides the project completion time. So, for this project, that the critical path is B, E, I and its duration is 20 days. Now, for this project, apply the resource constraint. So, what is the resource constraint? So, for this project, for every activity, we need the crane for the completion of the activity, but the actual availability of the crane is there are only 2 cranes available with us, that is a resource constraint.

So, there are 2 cranes, each activity requires 1 crane for the completion, but in our project site, we have only 2 cranes available C 1 and C 2. So, now, how to allocate these 2 cranes for this

particular project, making sure that the idle time for the crane should be less as well as the project completion time should not be significantly delayed, because of this resource constraint, definitely, there will be some delay, but the delay should not be very significant, that we have to take care.

So how to allocate the resources on what criteria we are going to allocate the resources. So, we will go by the simple approach, which is commonly followed in many construction project sites that is least total float approach. So, least total float approach is a common approach followed. So, we are trying to identify the activities which are more critical. So, whichever activities have least total float, those activities are more critical, I mean, as I told you, the activities which have 0 float, they are called as critical.

So the activities which have less float, they are close to critical. So generally, first we have to allocate the resources to those activities which are critical that is whichever have 0 float, then that is least so, allocate the resources to those activities, which have least float then allocate the resources to those activities, which have second least float. So, we are allocating resources in the order of criticality of the activities, instead of float, I can also go by the least latest start time.

So, both are going to give you the same result only it is more convenient to use least latest start time approach. Now, let us start with the allocation, at the start of this project, you can see that there are 3 activities. So, you have this activity A, B, and C. So, there are 3 activities, which are the starting activities, beginning activities, and you can see that all the 3 activities require the crane, but you have only 2 cranes with you.

So now on what basis we can allocate the resource to these activities. So based on whichever activity is more critical, we have to allocate the crane to the particular activity. So this activity has the least float, we have to allocate. So, it means which activity has the least latest start time, we have to allocate the crane first. So, let us see for activity A, activity B and activity C. So, let us see the latest start time. So, activity A, the latest start time is 3, activity B the latest start time is 0, it is a critical activity.

So, activity C the latest start time is 9 so, 3, 0 and 9. So, whichever activity is having the least latest start time we have to allocate first. So, we are going to allocate a crane first to activity B,

we have 2 cranes. So, now, we can allocate the next crane to the second least latest start time so, second least latest start time is your activity A. So, in the beginning you can see the crane C 1 is allocated to A and the crane C 2 is allocated to B.

So, as of now I do not have a crane to allocate to C, I mean the activity C is waiting for the allocation of the crane. So, now, let us see the next allocation now activity B is getting completed in 7 days. So, you can see the duration of activity B is 7 days it is getting completed in the 7 days so, after this after 7 days, the crane C 2 is available for allocation now we have to allocate the crane C 2 to the next activity.

So, now see which are all the next eligible activities for allocation, so, which are all the next eligible activities for allocation? So, generally the activities for which all the preceding activities are completed then the succeeding activities become eligible for the allocation. So, after B since B is completed the eligible activities for allocation of E, F and G now after B so, what are all the eligible activities for allocation E, F, G as well as C because C is also not completed now so, C is also now eligible for the allocation.

So, now, after the completion of B which are all the eligible activities we can see E, F, G and C the latest start time is for E is you can see latest start time is 7 and for F latest start time is 12 and G latest start time is 8 and C latest start time is 9 now for whichever activity which is having minimum latest start time that is more critical we are going to assign now the crane will be allocated to E. So, after B you can see the crane is allocated to E. Now you can see the activity A is completed after 8 days.

So, now the crane C 1 is ready for the next allocation. So, now after A which one to allocate we have to see now. So, now let us mark which are all the activities completed A is completed, B is completed E is completed. So, now after A now we are going to see the allocation. So, which are all eligible after A obviously your D is eligible for allocation then so, this is already waiting, F is waiting, ready for allocation G is ready for allocation C is also waiting for the allocation.

So, let us see D, F, G and C are ready for allocation what is the latest start time let us see for D it is 11 then for F it is 12 and G it is 8 and C it is 9. Now look for activity which is having least latest start time it will be G. So, you can see after E, G gets allocation because it is more critical.

Similarly, after completion of G, G is getting completed first because the duration of G is only 6 days. Now, after G which are all the eligible activities you can see.

So, now, after G which are all the eligible activities, we have to see let us mark the activities which are completed A is completed so, B is completed your G is completed and E is completed. So, now, after G which is eligible, you can see that and already C is waiting F is also waiting, D is also waiting. So, now compare the latest start time C the latest start time is 9 and F the latest start time is 12 and D the latest start time is 11. So, the minimum you can see now it is for C so now do the allocation for C.

So on a similar basis you are going to do the allocation for all the activities based on whichever is critical. Suppose if there is a tie in the latest start time, then you have to go for the activity whichever has the minimum duration, why we go for minimum duration means, because, when the activity duration is minimum, the other activity waiting time will be less, because the usage of crane will be completed fast and the crane will be easily released to the next activity.

So, the waiting time of the other activities can be reduced when you go for the allocation of shorter duration activities. So, this is the basis on which the allocation is being done based upon the least latest start time or least total float approach. So, this is called the equipment loading chart. So, by looking at this equipment loading chart, you can see that the equipment is utilized in a very effective way there is no idle time for the machine.

So, now, you can see that reschedule because of rescheduling of activities, the revised project completion time is 29 days. So, the earlier we thought considering the resource constraint, the project completion time was 20 days, now, it is 29 days. So, whenever there is a resource constraint basically there will be a delay in the project completion, but we should try our level best to make the allocation to the critical activities first, so, that the project delay is not very much significant.

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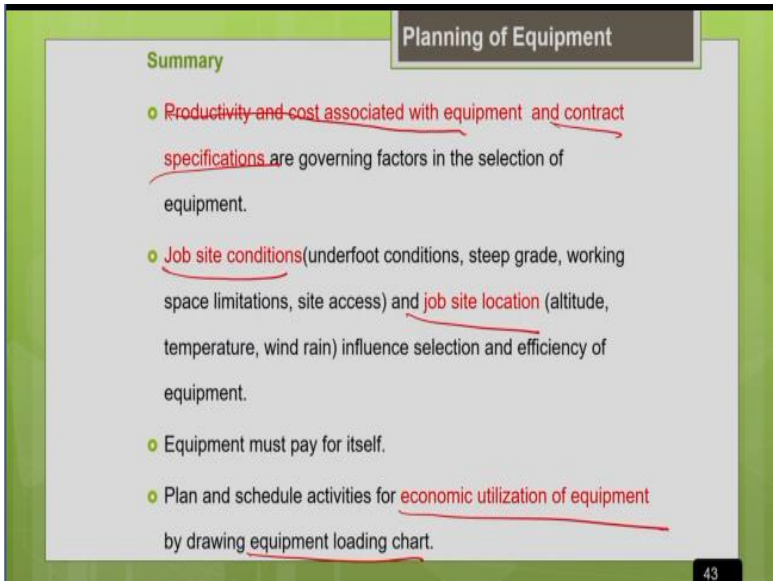

So, with this we are coming towards the end of this lecture, let me summarize whatever we discussed in this first lecture on planning of equipment. So, we discussed about the different equipment selection factors, and we found the productivity and the cost associated with the machine and the contract specifications are the important guidelines in the selection of the machine.

So, apart from that, your job site conditions or the job site location also will influence the selection of the machine to a greater extent. So, after selecting the machine after purchasing the machine, we have to plan for its economic utilization of the equipment that by discussing about resource constraint sharing and how to use the equipment loading chart for the economic utilization of equipment also we have discussed.

So, with this I have come to the end of the planning of equipment and as I mentioned in the beginning, the replacement analysis of the equipment will be discussed in the upcoming lectures. There is a separate lecture dedicated for the replacement analysis of the old machine with the new machine. So, in that particular lecture, we will discuss that particular topic.

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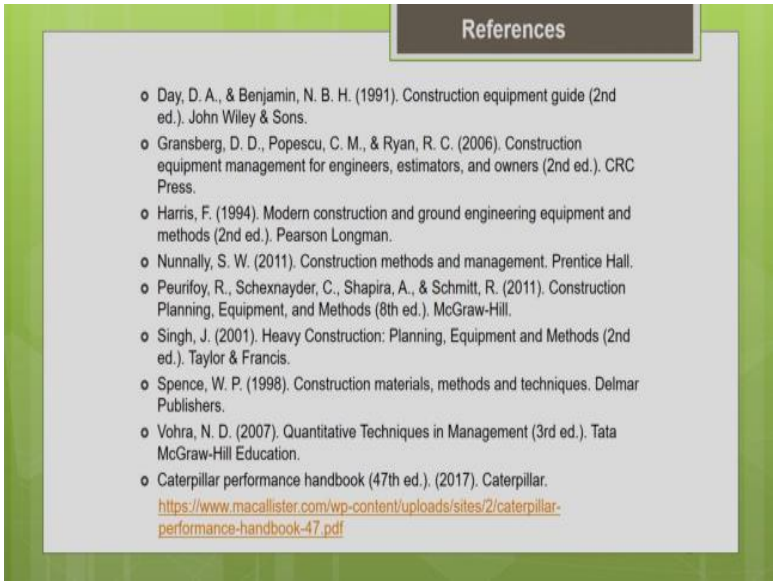

So, these are the reference textbooks. So, I advise you that you should refer some of these textbooks so that it will be easier for the course preparation. Thank you.