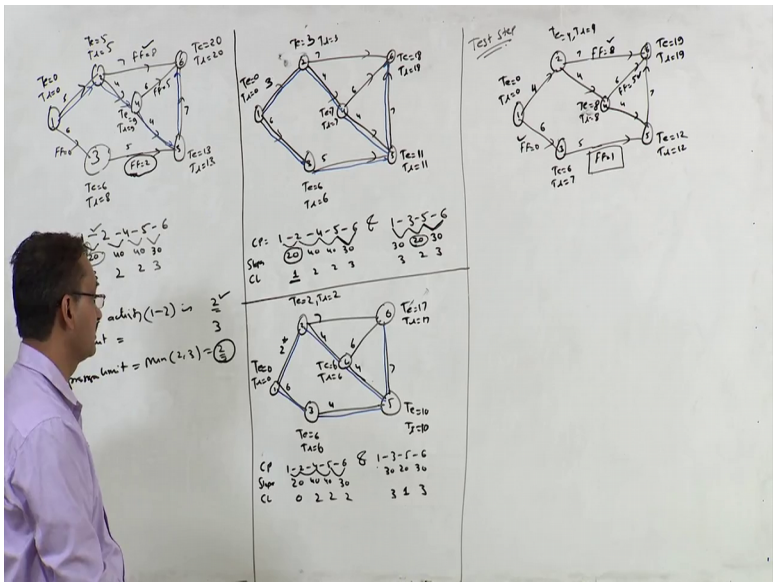
**Project Management for Managers**
**Dr. M.K. Barua**
**Department of Management**
**Indian Institute of Technology, Roorkee**

**Lecture - 50**
**Crashing of Networks-III (Free Float Method)**

Hello friends, I welcome you all in this session. In previous session we were discussing about how to reduce duration of a project using free float method. And we were solving this particular question. So, let us continue with that question. So, what we have done so far is, we have calculated critical paths in this network.

(Refer Slide Time: 00:39)



And we have found 2 critical paths, this slopes are here for this particular path and for second path the least slope is for activity 3 5.

So, what we should do? We should select activity 1 2 and 3 5 for compression right. And our direct cost will increase by 40 rupees. Why there is no need of going for test step because crash limit is one right. And let us look at how the duration of this project and gets reduced right, 3 4 5 and 6 right. So, we have to reduce duration of activity 1 2 and 3 5. So, this is a now 2, and this 2 star right. It means we cannot reduce it further right. For activity 3 5 3 5 is this 4.

In fact, what you should do? You should you should calculate free float for this network also, but let us ignore for the time being if required we will calculate right. So, other durations are same, 7 4 4, 7 4 4 this is 6 and 7 this is 6 right. Let us see; what is the effect of these 2 changes in this network right. So, T e here is a 0, T e here is 2 T e here is 6, T e here is 6. T e here is 10 from this side and from this side also T e is 10. This is now 17. So, T e here is 17. T e is 17.

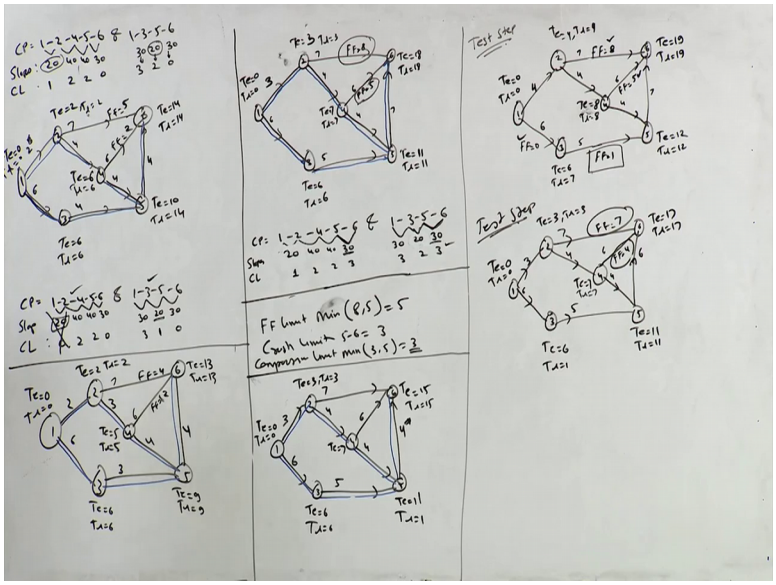
Let us look at T l values 17 10 right. T l would be 6 here, T l would be 6 here, T l would be 2 here and T l would be 0 here right. How many critical paths? Just look at critical paths here right. So, this is your critical path, this is another activity and this first critical path right. Second critical path is this right. So, you have got 2 critical paths. Let us look at their slopes. So, critical paths are so, you have got 2 critical paths critical path first is 1 2 4 5 6. And second is 1 3 5 and 6 right. Slope of course, you know slope. In fact, there is no need to write for activity 1 2, because we have exhausted that, but even for simplicity let me right. So 20, 40, 20, 40, 40 and 30 crash limit of course, this is now 0 2 2 2 similarly for this 30, 20 and 30, crash limit is now one here this is 3 and 3 right.

So, this is what we have obtained and the duration is now 15 days right, 17 days right. And let us look at what are the activities you should select now for crashing. Now you have to take a decision to crash this particular project, if you look at this particular these 2 paths here 1 2 4 5 6 and 1 3 5 6, when you reduce 1 2 and 3 5 the cost will reduced by 40 rupees, right? But if you take this common path 5 6, then the cost will increased by 30 rupees.

So, rather than reducing 1 2 and 3 5 we should have reduced common activity 5 6. So, common activity is 5 6. So, do not select 1 2 1 2 and 3 5, select common activity 5 6 and reduce is duration by 1 day. And before reducing this duration by 1 day let us calculate free float of non critical activities also. So, free float would be 18 minus 3 15 minus 7 8 right. Here 18 minus 7 11, 11 minus 6 free float is 5 right.

So, we have selected what? We have selected activity 5 6 for compression right. So, this is 1 2 3 4 5 and 6 right.

(Refer Slide Time: 07:20)




So, 1 2 3 4 5 and 6 right; so these are different nodes right. So, these durations will remain as it is 3 6 7 4 5 4 6 and this will come down by 1 day. In fact, you should do one more thing here, since you are selecting, since you are selecting 5 6 and it is crash limit is 3 right. It is crash limit is 3.

So, you need to go for test step, before reducing it by 1 day right. So, let us go for test step let us see because in this part of the board we are doing test steps right. So, test step this is 1 2 3 4 5 and 6 right. So, this is 3 this is 3 6 this is 7 4 5, this is 4 this is 6 and this is 6 right. We are going for test step. Why we are going for test step here, because crash limit is more than 1 right. And we will see how the reduction in duration of 5 6 by 1 day affects non critical activities right.

So, let us find out T e and T l for this question. This is 0 this is 3 T e at this point is 6 T e at this point is 7 right; 3 plus 4 7. 7 plus 4 11 and this is 11, this is 17: T l 11, T l 11 T l 7 right. And at this point T l is equal to 3 and T l is equal to 0. Let us find out change in free float of non critical activity; so this 2 a non critical activities right. So, non critical activity 4 6 let me write numbers also 1 2 3 4 5 and 6 right.

So, let us find out free float for this. So, 17 minus 7 10, 10 minus 6 this is 4, earlier it was 5. Free float here is 17 minus 3 14 14 minus 7, 7. So, if you look at these 2 free floats have come down earlier this was 8, now this is 7. Earlier this was 5 now this is 4. It means that when we reduce duration of activity 5 6 by 1 day free float came down from

5 to 4 if you had reduced it by 2 days it would have come down by 3. If you had reduced it by let us say. So, for every one unit reduction in 5 6 this is coming down by one unit right.

So, had we reduced it by let us say what since we reduced it by 1 day it is it is become 4, then had we reduced it by 2 days it would have become 3, 3 days 2 4 days 1 5 days 0. So, had we reduce this duration, this the duration of this activity by a 5 days it would have become a critical activity right. So, let us now take a decision for how many days we should compress this right. So, for this let us look at there is something called free float limit. And free float limit is minimum of, minimum of what; these 2 8 and 5. Do not look at the reduced free float limits; look at the earlier limit is right.

In fact, the same thing we did in earlier test step also right. This was the free float initially this was this got reduced to 1 and where looked at this. So, crash free float limit was 2. See is free float limit of this did not change we considered only free float of this activity which was 2 right. Since here you have got you are you know these 2 free floats have come down right? In fact, these 2 free float have come down here 8 5 now 7 4. So, will take the earlier free float limit is. So, minimum of these 2 is 5. Crash limit crash limit of 5 6 is what 3 right, this 3.

So, compression limit, compression limit, compression limit is minimum of these 2 minimum of free float limit and mini and crash limit. So, 3 and 5 minimum is 3. So, compression limit is 3. So now, we should take a decision to reduce this activity by 3 days right. So, this is now our final decision right. So, what you can do you can directly reduce it by 3 days right. So, let me write it here 1 2 3 4 5 and 6 1 2 3 4 5 and 6 right.

So, this is 3, this is 6 this is 5, this is 7 this is 4 this is 6 this is 4 and this would become 4 right. So, we have decided to reduce it by 4 days right. Not by 4 days up to 4, because crash limit is. So, calculate all these values T e here is 0 T e here is 3 T e here is 6 T e here is 7 T e here is 11 T e here is 15. And you can In fact, do one more thing since you have achieved crash limit for activity 1 2 and for this also right. So, you can put a star over here right.

So, T l 15 T l 11 T l 6 T l 0 and of course, T l is 3 here right. You can do In fact, reverse calculation right. So, all these activities are in this direction right. So, T e is 15. And critical paths are this is your critical path. So, again you have got 2 critical paths right, so

now, this is your network and you reduced activity 1 2 and 5 6 2 there fullest level right. Now what? Since you have got 2 critical paths here, critical path you have got 1 2 4 5 and 6, and what; 1 3 5 6, 1 3 5 and 6. Find out slopes and crash limit is right.

So, slopes are 20 40 20 40 again 40 40 and 30 right; this 40 this 30 right. For second critical path this loops are 30 20, and 30. And crash limit it is one it is. In fact, we did not have you know consume the total crash limit of 1 2 right. Is still there is one more day left right. So, this is 1 for 2 4 it this 2 2 for 5 6 we have consumed for activity 1 3 this is 3 2 and 0 right. So, what to do now? Shall we go for test step? And which 2 activities should be chosen from this critical path? Choose activity this right. Least slope and least slope here. Is there any need of going for test step here? No, because crash limit is one right. Why we had gone for test step here, because crash limit was 3 for this particular common path.

So, we will reduce activity 1 2 and 3 5; so activity 1 2 and 3 5: 1 2 3 4 5 and 6. So, let us look at activity 1 2 this is now 2, and 3 5 3 5 is this 4 right. And 1 3 will remain same 6 this is 7 this is 4 this is also 4 this is 6 this is 4 right. So, we have reduced again activity 1 2 which was 3 here now 2 and 3 5 which was 5 here now 4. Let us look at all T e's and T l values T e here is 2 T e here is 6. T e here is 2 plus 4 6. And this is 10 and this is 14 isn't it?

Let us calculate T l values. So, T l here is 14 T l is 14, T l is 6 T l is 6 T l is 2 right. And T l here is T l is T l at node one is 0. Now which are critical activities same; so this path this path. So, these are critical activities. Now there are 2 non critical activities let us find out their floats. This 14 minus 2 12 minus 7, free float is 2. Free float for this is 14 minus 6, 8 8 minus 6 2 right. So, free float here is 14 minus 14 minus 2 is 12, 12 minus 7 5 right.

So, free float is 5 and for this activity 14 minus 6 is 8, 8 minus 6 is equal 2. So, free float is 5 and 2 right. Now let us again look at which are the activities to be selected for compression right. So, you have got critical path is equal to 1 2 4 5 6 and 1 3 5 6 right. So, you have got slope just write down slope values. So, you have got 20 40 40 and 30 right. And for this you have got 30 20 and 30. Crash limit is are 0 2 2 0 this is 3 1 and 0 right.

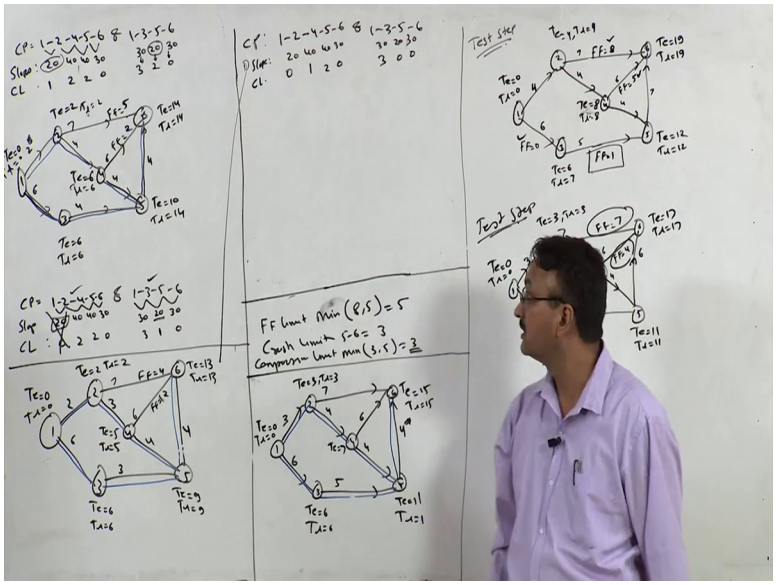
So, which 2 activities should be selected for crashing? For compression? This is the least slope here, but we cannot do it right. So, this is gone right. Now you have got only one option right. Select 3 5 from here and any of these 2 activities. So, either you select 2 4 or 4 5 one and the same thing, because cost will increased by 40 days, 40 rupees in each of these 2 cases right. So, since crash limit is one here, is there any need of going for test step no right isn't it?

So, let us select activity 3 5 and 2 4. You could have. In fact, you could have selected 4 5 also, but sees this is the first activity let us do it right. So, let us select 1 3 sorry 3 5 and 2 4 this is 1 2 3 4 5 and 6 right. So, what we are doing? Let us reduce duration of activity 2 4 2 4 is here right. So, this is 4. So, make it 3, and 3 5 3 5 is where this. So, let us make it 3 5 right. So, make it 3. All others will remain same right.

So, this is 2 6 2 6 this is 7 7 this is 6 right. This is 6 this is 4 and this is 4. Let us find out critical path. And for critical path you just calculate T e and T l values. So, T e 0 T e is 2 T e is 6 T e is 5 T e is 9 right. And T e is 13 again T l 13 T l 9 T l 6 T l, T l at this is 5 T l is 2 and T l is 0 right. Critical path is critical path is it will remain same right. So, critical path is this right.

Now, which 2 activities should be selected for compression? But before this let us also find out free float limit is of non critical activities. 13 minus 2 11, 11 minus 7 this is 4. So, free float is 4 and for this activity 13 minus 5 is 8, 8 minus 6 this is 2. So, free float for activity 4 6 is 2 right. And let us select activities for compression right. So, what to do you have got 2 critical paths here. So, from here we will write critical paths here right.

(Refer Slide Time: 27:11)




So, for this network right: so critical paths are 1 2 4 5 6 and 1 3 5 6. And their slopes and crash limits are this is so, slope is 20 40 40 and 30 for this slopes are 30 20 and 50 it is this is 30.

Now, what we need? We need crash limit is right. Crash limit; so crash limit, let me write crash limit and then will stop here. So, crash limit for this is of course, for this we have already exhausted it for this one for this 2 and for 5 6 also we have exhausted and then you have got for this is 3 and for these 2 other activities we have already exhausted right. So now what to do? We will select one of the activities from these 2 critical paths for reduction.

So, we will continue with this example in next session. And I hope that you would have understood whatever I have done in last 2 sessions of course, it is it is very, very complex method, but once you know this method you can do problems like this. In short time if you even if you write computer programs.

So, thank you very much for watching this session.

Thanks a lot.