MODULE 2

Crashing and time –cost trade off

Resource smoothing and resources levelling

Construction, equipment, material and labour schedules

Preparation of job layout.

Codification of the planning system:

- Codification approach
- Work package and activities identification code
- Resource codes
- Cost and Finance accounting codes
- Technical document codes

Ref: 13.4

Amit Gupta

PROJECT COST ANALYSIS

Cost Versus Time

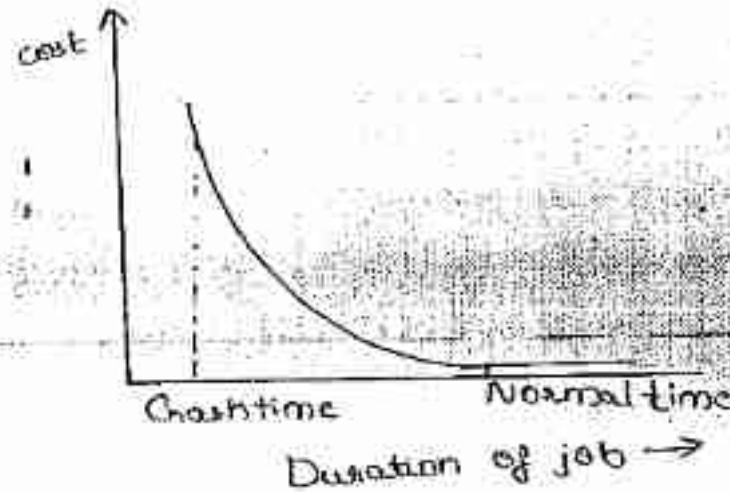
The ultimate objective of network technique is not only bring improvement in planning, scheduling and control of Pjt but also to assist the possibility of arriving at a feasible and desirable time-cost relation. Very often, it will be necessary to accelerate the completion of work. This can be done by reducing the duration of critical activities by increasing the resources provided to these activities. E.g. war time repair of air field, road work, in the want of national security. Here cost is less important and time/duration is important.

Project cost depend on available time for completing the work. Also the time in which a project may be completed depends upon the cost that the owner is prepared to bear. Thus the cost & time are interrelated.

It has been observed that by increasing the duration, cost is reduced. On the other hand if the duration is reduced, the cost will increase. e.g. double or triple. Thus a decision has to be taken whether it would be worth while to deploy additional resources to reduce the duration. The duration for the completion of Pjt most economically is called Optimum duration.

In CPM network technique for each activity there are two time and cost estimate as follow:

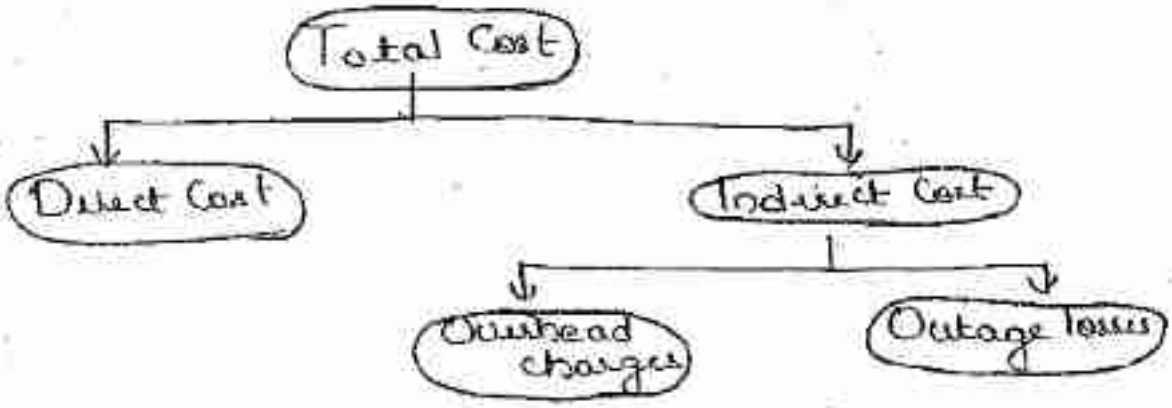
1. Normal estimate: The emphasis is laid on cost, time being associated with minimum cost.
2. Crash estimate: The emphasis is given to absolute minimum time required to complete the job. The necessary cost required to complete the Pjt in minimum time is provided.



Project Cost

For any Pjt, total expenditure incurred in terms of manpower, equipment, machinary and material and time to achive a particular goal is known as total cost of pjt. The cost of pjt can be broadly divided into two

① Direct Cost ② Indirect Cost



Direct Cost Cost which are directly attributed to Pjt

Direct cost consist of expenditure which are directly chargeable to the execution of activity of project. Material cost, labour cost are examples Direct cost depends on completion time of Pjt. Normally for any Pjt there will be an optimum duration for which the direct cost is minimum. Usually this duration is called as called Normal Duration

is needed the duration of the project can be shortened below normal duration by deploying additional resources

Variation of Cost with Time

- The curve is non linear.
- The direct cost of project is minimum at some optimum (normal duration) project duration
- The direct cost increases on either side of optimum (normal) duration
- There is a point beyond which the duration cannot be reduced irrespective of increase in direct cost. This duration is known as crash duration & corresponding cost is known as crash cost

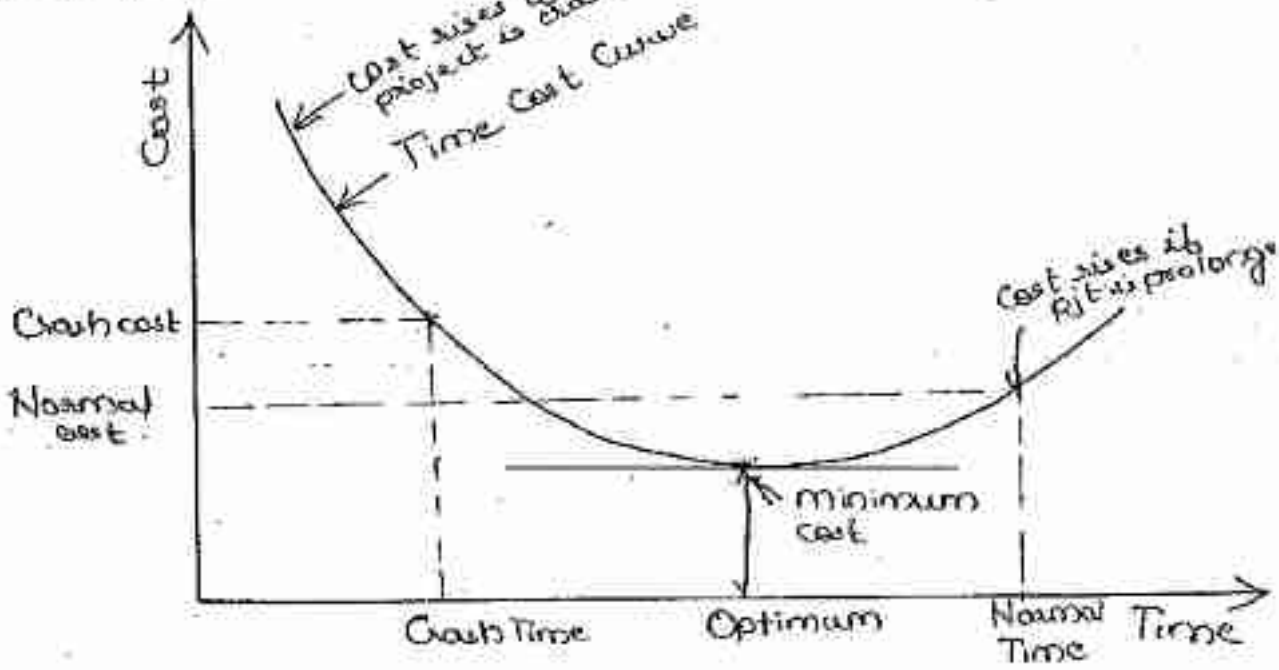
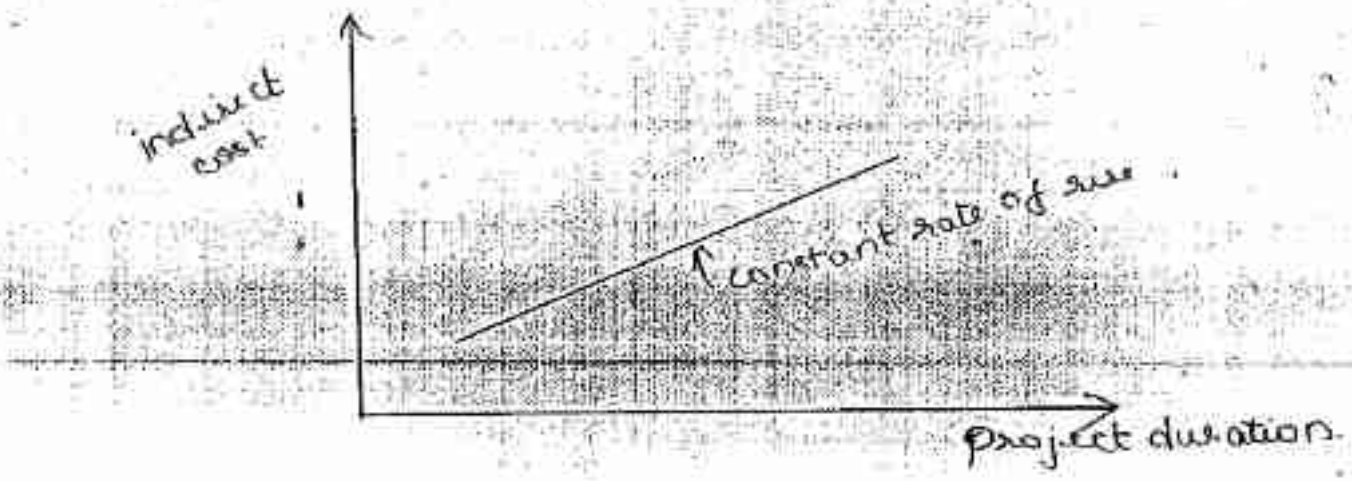


Fig: Variation of Direct Cost of an Activity

Indirect Cost

Indirect cost consist expenditure which cannot be clearly allied to individual activities of pjt. Overhead cost such as establishment charges, management charges, administration charges, insurance charges etc are examples of indirect cost of pjt. These indirect costs are directly varying with duration of pjt.

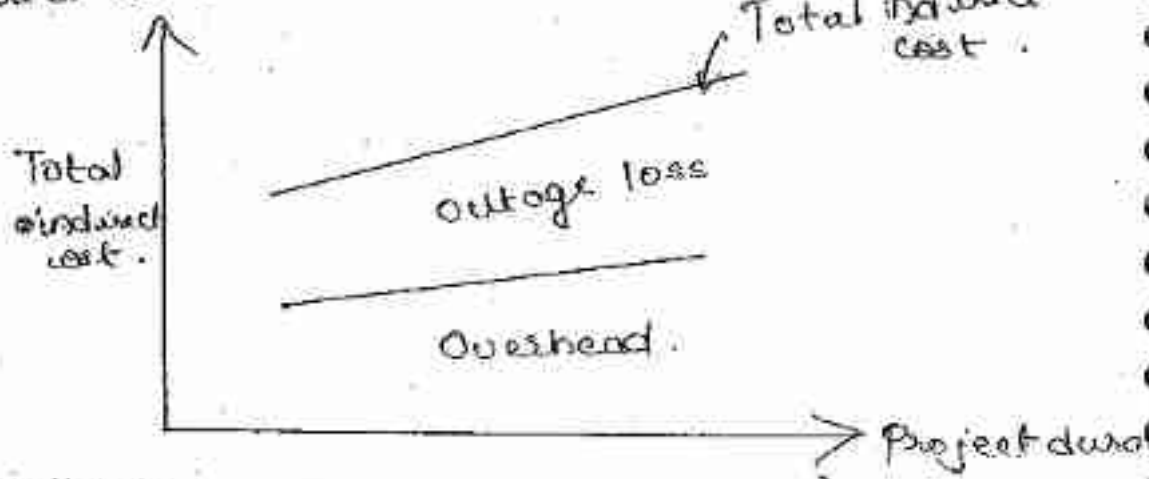


But when there is a loss in profit due to inability to meet the demand or due to penalty due to delay etc, the corresponding increase in cost must be added to overhead cost. Such a loss is known as outage loss.

It may be noted that the direct cost associated with individual activities will increase if the activities are speeded up or expedited. This process is known crashing of activities. Only critical activities are selected for crashing as this process should reduce the time

If the crashing of a pjt where variation of direct & indirect cost are linear → simple compression

If we are crashing a pjt where the variation of direct & indirect cost is non linear → Complex Comp



Definitions

Normal time: The time allotted for an activity by estimator. (t_n)

Crash time: The minimum possible time in which an activity can be completed by deploying extra resources is known as crash time (t_c)

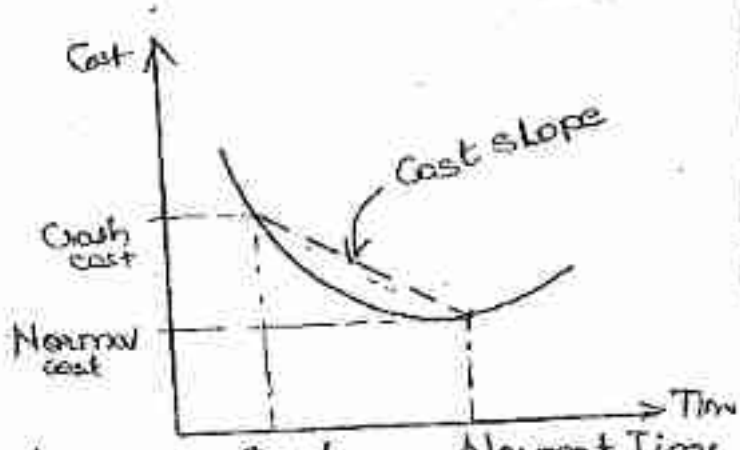
Normal cost: The direct cost required to complete the activity in normal duration is normal cost (C_n)

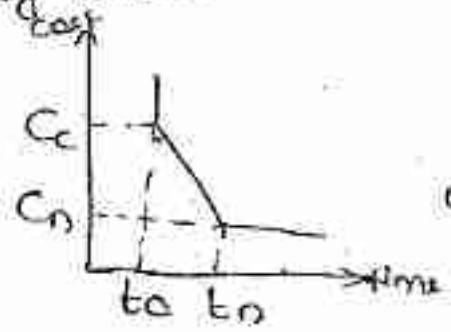
Crash cost: The direct cost corresponding to crash time of completing an activity (C_c)

Cost slope

direct cost

This curve can be approximated to a straight line or more than one straight line depending on feature of curve.





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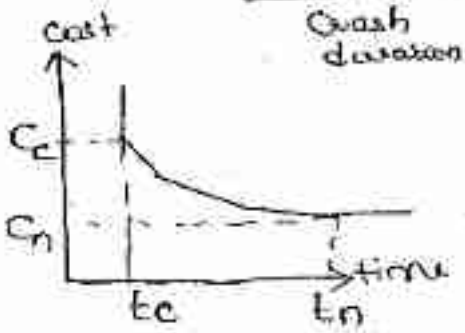


The slope of this straight line is known as ~~cost~~ Cost slope

$$\text{Cost slope} = \frac{\text{Crash Cost} - \text{Normal Cost}}{\text{Normal time} - \text{Crash time}}$$

$$CS = \frac{C_c - C_n}{t_n - t_c}$$

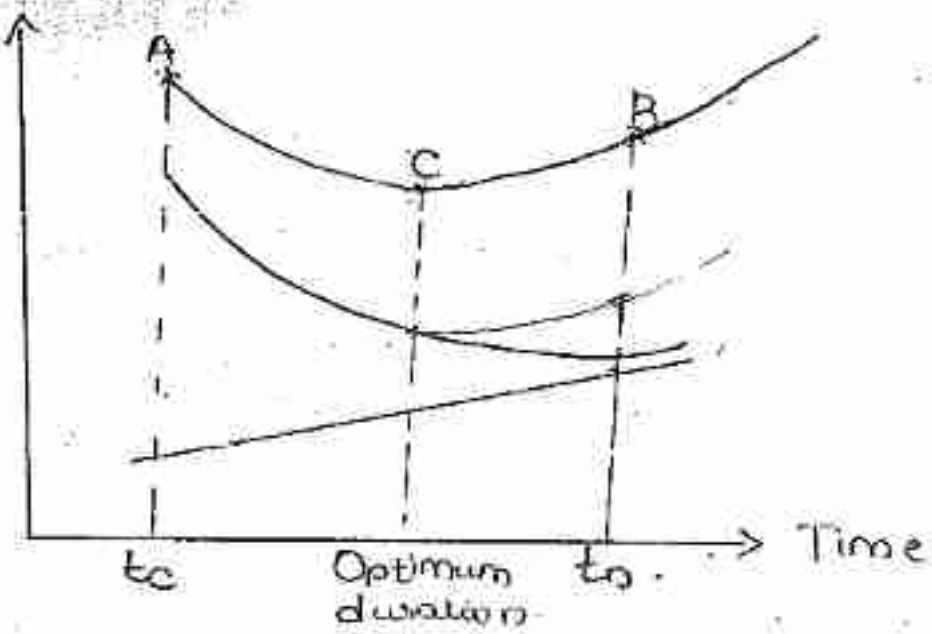
Minimum duration: The duration obtained after crashing all activities is minimum duration.

Total Cost of Project

Total cost = Direct Cost + Indirect Cost.

The total cost of a pjt with assigned duration of various activities is given by the sum of D.Cost of all activities & indirect cost of Project.

Direct cost → Non linear Curve
In Direct cost → Linear Curve
∴ Total cost → Non linear Curve



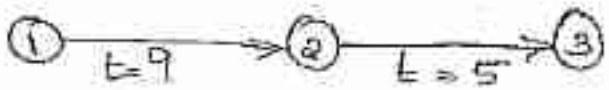
From Curve ACB, the total cost of pjt is min for cetain time duration. This duration is optimum duration for minimum cost.
Further increase in duration ⟹ Increase in T.Cost.
Also the pjt duration is decreased, then also T.Cost increases. Optimum duration is less than Normal duration. Both D.Cost & I.Cost increase beyond tn. Below tn indirect cost ~~duration~~ decrease but D.Cost increases.

Steps in Optimising Cost

1. Analyse pjt & establish a direct cost-time relationship for various activities.
2. Determine cost slope for network with normal duration of activities.
3. Compute direct cost with Normal duration for activities.

with critical activity having least Cash/slope
5 Continue crashing of critical activities in the ascending order of cash slope
6 Crash the parallel non critical activities which have become critical due to reduction of critical path duration by step 4 & 5
7 Crashing of activities is continued till a stage is reached beyond which no further crashing is possible
8 Determine total cost of pjt by adding direct & indirect cost.
9. Draw T. Cost - duration curve
10. Optimum duration corresponding to min total cost is obtained.

4. Table give the information about various activities of network



Activity	Normal Duration t_n (days)	Normal Cost C_n (Rs)	Crash duration t_c (days)	Crash Cost C_c (Rs)
1-2	9	8000	6	9500
2-3	5	5000	3	5500

The pjt overhead cost is @ Rs 300/day.

Determine :-
(a) Direct cost-duration relationship
(b) Total cost - duration relationship
(c) Corresponding least cost plan (network)

Ans: Step 1: Cost slope

Activity	$\frac{\Delta C}{C_c - C_n}$ (Rs)	Δt $t_n - t_c$ (days)	Cost slop - $\frac{\Delta C}{\Delta t}$ (Rs/day)
1-2	1500	3	500
2-3	500	2	250

Step 2:

Normal duration of Rjt = 9+5 = 14 days

Normal cost of Rjt = 8000+5000

= 13000 rupees

Step 3:

Activity 2-3 has least slope. ∴ Crash it first

Duration by which 2-3 can be crashed = 2 days

Extra cost of crashing activity = 250×2

= 500 rupees

Project duration = 9+3 (14-2) = 12 days

= 12 days

∴ D. Cost = 13000+500 = 13500

Step 4:

Crash 1-2.

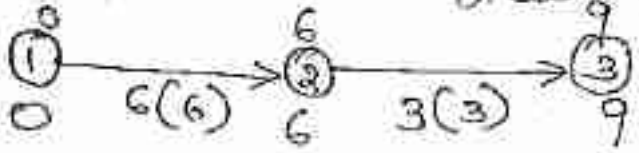
Δt = 9-6 = 3 days (12-3) = 9 days

Extra cost of crashing = 3×500

= 1500 rupees

D. Cost = 13500+1500

= 15000

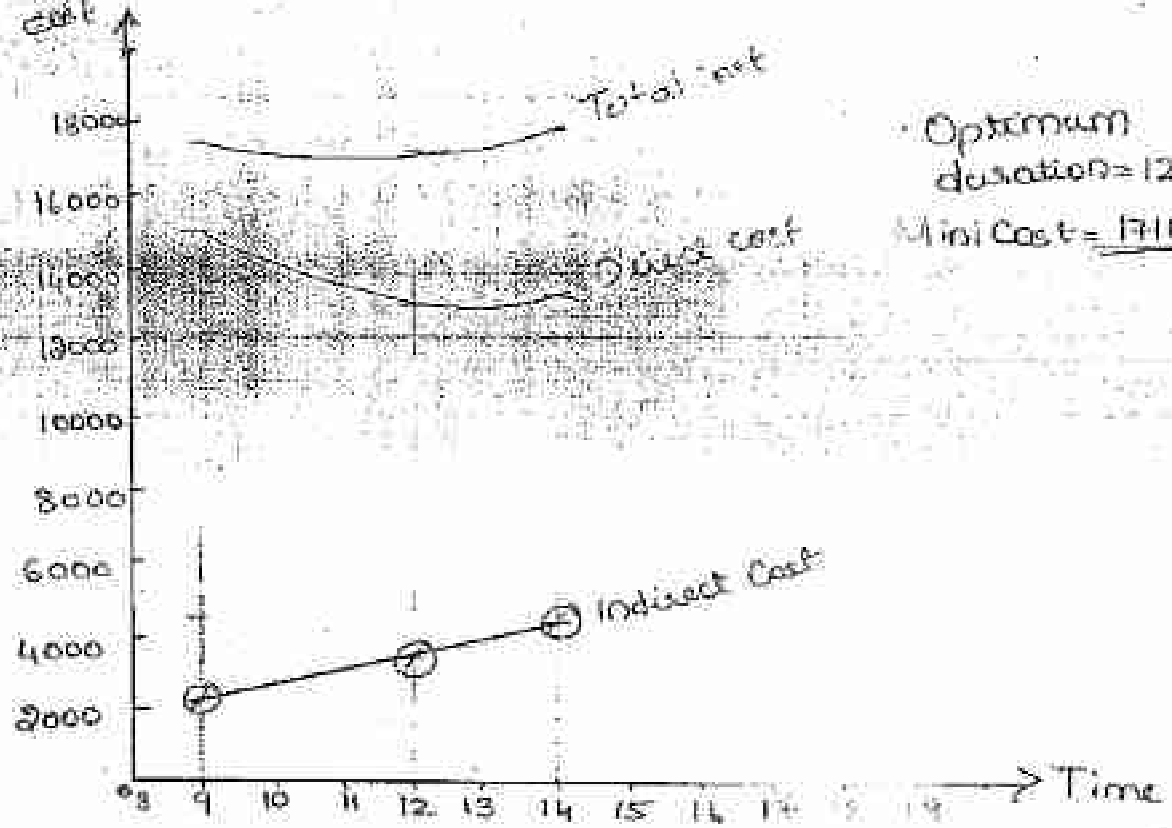


Project Duration = 12-3

= 9 days.

Step 5: Total cost of Project

Duration days	14 (Normal)	12 (first crash)	9 (second crash)
Direct cost	13000	13500	15000
Indirect cost	4500 (14×300)	3600 (12×300)	..... (9×300)



Optimum duration = 12d

Mini Cost = 1710c

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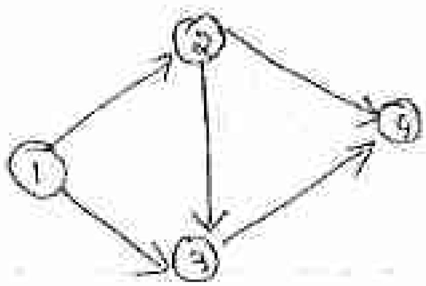
Following table shows cost & d... of each activ... The indirect cost is Rs 3150/ week. Determine optimum duration of pjt & min cost

Activity	Normal Duration	Normal Cost	Crash Duration	Crash Cost
1-2	7	8000	4	5000
1-3	9	5000	6	9500
2-3	5	7000	2	10,000
2-4	6	9000	4	16,000
3-4	6	6000	4	9,000



Extra cost = 2 × 1500
= Rs 3000/-

Total direct Cost = Rs 49000

Duration = 16 − 2
= 14 ~~days~~ weeks

3 week
E.C = 3 × 1500
= 4500
TDC = 38000 + 4500
42500

Duratn = 12 days
15 − 3 = 12 weeks

Next 1−2

Let crash by 2 week

Extra Cost = ~~Rs~~ 2 × 2500
= Rs 5000

Total direct Cost = Rs 45,000

Duration = 14 − 2
= 12 ~~days~~ weeks

by 3 week
E.C = 3 × 2500
= 7500
TDC = 50,000
Duratn = 9 week
12 − 3

Next 3−4

Crash by 2 weeks

Extra cost = 2 × 3000
= Rs 6000

Total D.C = 45000 + 6000
= Rs 51000/-

Duration = 12 − 2
= 10 ~~days~~ weeks

2 week
EC = 6000
50000 + 6000
TDC = 56,000
9 − 2
Duratn = 7 week

Next 2−4

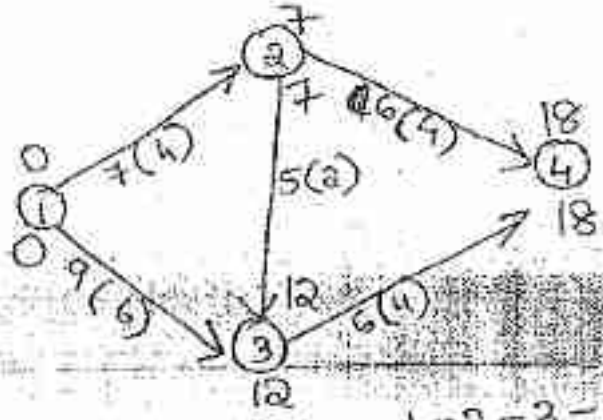
Crash by 2 weeks

Extra Cost = 2 × 3500
= Rs 7000/-

T.D.C = Rs 58000/-

Duration = 8 days

2 week 2 × 3500
EC = 7000
56000 + 7000
TDC = 63000
7 − 2 = 5 weeks
Duratn = 5 weeks



1-2-4 = 13
1-2-3-4 = 18
1-3-4 = 15

Critical path → 1-2-3-4

Project duration = 18 days weeks.

Project cost = 8000 + 17000 + 10000

= 35000/-

Activity	AC $C_c - C_n$	Δt $t_o - t_c$.	$\frac{\Delta C}{\Delta t}$
1-2	15500-8000 = 7500	7-4 = 3	2500 7500/3 III
1-3	9500-5000 = 4500	9-6 = 3	1500 4500/3 II
2-3	10000-7000 = 3000	5-2 = 3	1000 3000/3 I
2-4	16000-9000 = 7000	6-4 = 2	3500 7000/2 IV
3-4	12000-6000 = 6000	6-4 = 2	3000 6000/2 III

Normal duration → 18 days weeks.

Direct cost = sum of all Normal cost

= 8000 + 5000 + 7000 + 9000 + 6000

= Rs 35000/-

Least slope for activity 2-3

∴ Crash activity 2-3 by 2 weeks.

3 day → crashed

7+2+6 = 15

7+3+6 = 16

Extra cost for crashing 2-3 = 2 × 1000

= Rs 2000/-

Crash by 3rd = 3×1000 = 3000.

∴ Total direct cost = 35000 + 3000

= Rs 37000/-

TDC = 38000

Project duration	18	16	14	12	10	8
Direct Cost	35000	37000	40000	45000	51000	58000
Indirect Cost	56700	50400	44100	37800	31500	25200
T. Cost	91700	87400	84100	82800	82500	83200

Pjt duration = 10 weeks.
T Cost = R.82500/-

Pjt duratn	18	15	12	9	7	5
DC	35000	38000	42500	50000	56000	63000
IC	56700	47250	37800	28350	22050	15750
TC	91,700	85250	80300	78350	78050	78750

Pjt duration = 7 week.
T. Cost = R.78050/-

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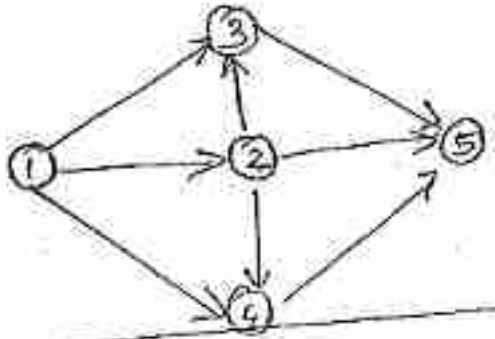
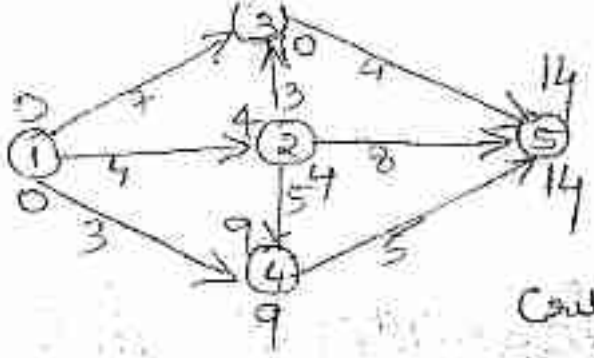


Indirect cost = 2500/day

Activity	Cost		Time	
	Normal	Crash	Normal	Crash
1-2	8000	12000	4	2
1-3	12000	14000	7	6
1-4	9000	12000	3	2
2-3	10,000	13000	3	2
2-4	7000	8500	5	4
2-5	10000	12000	8	6
—	4000	12000	4	2



1-2-5 = 12
1-2-4-5 = 14
1-4-5 = 8

Critical path = 1245
Duration = 14

Activity	ΔE	Δt	$\frac{\Delta C}{\Delta t}$	Days shortened				
1-2	4000	2	2000		1	1		
1-3	2000	1	2000				1	
1-4	3000	1	3000					
2-3	3000	1	3000					
2-4	1500	1	1500	1				
2-5	2000	2	1000					
3-5	6000	2	3000					
4-5	4000	2	2000				1	

Days cut	0	1	1	1	2
Pjt duration	14	13	12	11	10
Direct Cost	73000	74500	76500	78500	82500
Indirect cost	35000	32500	30000	27500	25000
Total cost	108000	107000	106500	106000	107500

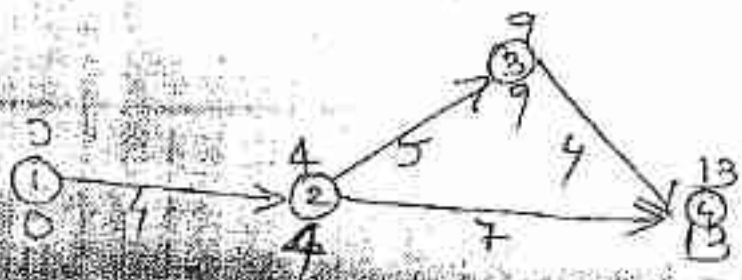
Optimum duration 11

Minimum Cost = R106000

(6)

Activity	Normal duration	Normal Cost	Crash duration	Crash Cost
1-2	4	4000	2	12000
2-3	5	3000	2	7500
2-4	7	3600	5	6000
3-4	4	5000	2	10000

I.C = 200 d



Critical path → 1-2-3-4

Duration = 13 days.

Activity	ΔC	Δt	$\frac{\Delta C}{\Delta t}$
1-2	8000	2	4000
2-3	4500	3	1500
2-4	2400	2	1200
3-4	5000	2	2500

Direct cost will be equal to sum of normal cost of all activities.

∴ Direct cost = 4000 + 3000 + 3600 + 5000

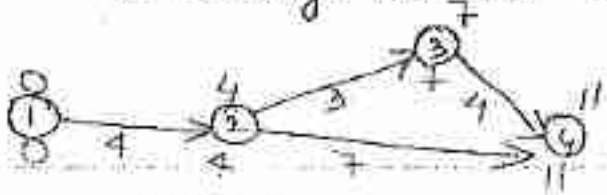
= Rs 15600/-

For crashing start with critical activity having minimum cash slope.

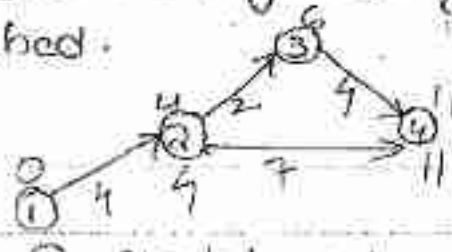
Critical Activity	Cash slop
1-2	4000
2-3	1500
3-4	2500

∴ Crash Activity 2-3 first.

It can be crashed upto from 5 day to 8 day i.e 3 days can be crashed.



Crash by 3 days.



Crash by 3 days.

will affect non critical activity 2-4, which has a float of 2 days. Hence let us restrict the crashing of 2-3 by 2 days only in first stage

Now duration of project = 13 - 2
= 11 days

Extra cost of crashing = 2 × 1500
= Rs 3000

∴ Direct cost of project of 11 day duration
= 15600 + 3000
= Rs 18600

Activity 2-4 is lying on the parallel path, hence it become critical, though activity 2-3 has still one de crashing left. However activity 2-3 cannot be crashed along with 2-4 is also crashed. Let us ∴ crash 2-3 by 1day & 2-4 by 1day simultaneously. However this combined crashing will be useful only if the combined cost slope of these two activities is less than the cost slope of ~~these~~ any of remaining critical activity. or combined cost slope of critical activities on parallel path.

Further crashing can be done with 3 alternatives

① Crashing activities 2-3 & 2-4 simultaneously.
Combined cost slope = 1500 + 1200
= 2700/-

② Crashing activities 3-4 & 2-4 simultaneously having combined cost slope = 2500 + 1200
= 3700/-

③ Crashing 1-2 alone
Cost slope = 4000/-

Out of these first alternative has minimum

cost slope

∴ Crash 2-3 & 2-4 simultaneously

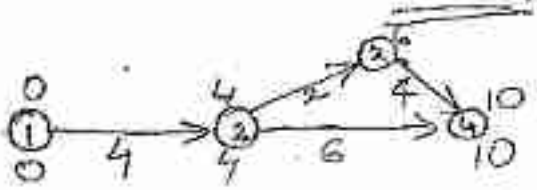
Extra cost of crashing = 2700 × 1

= Rs 2700

Direct Cost = 18600 +

2700

= Rs 21300/- Duration = 10day



The remaining activities to be crashed are 1-2, 2-4, 3-4. Out of these activities 2-4 & 3-4 are to be crashed together with combined slope of 2500 + 1200 = 3700

Activity 2-4 has only 1day crashing remaing.

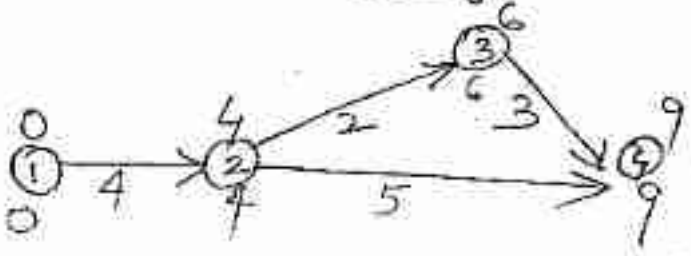
∴ Cost of crashing - 3700 × 1

= 3700

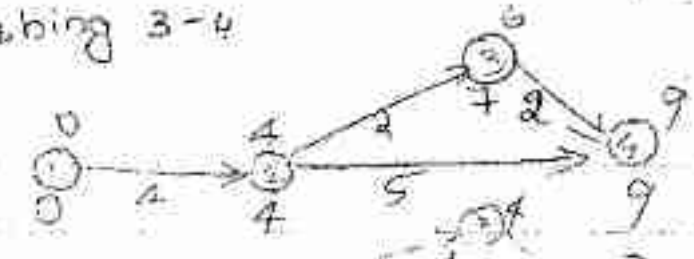
Direct cost = 21300 + 3700 = Rs 25000

Duration = 10 - 1

= 9 days.



Crashing 3-4



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1-2-4 durati

1-2 & 3-4, activity 3-4 cannot be further crashed as its further path since it will affect activity 2-4 which is already crashed

∴ only remaining activity 1-2 is to be crashed

∴ Extra cost = 2 × 4000

= Rs 8000

Duration → 9 - 2 = 7 days

Direct Cost = 25000 + 8000

= Rs 33000

Pick duration	13	11	10	9	7
D.C.	18600	18600	21300	25000	33000
I.C	26000	19000	20000	18000	14000
T.C	41600	40600	41300	43000	47000

Optimum Project Duration is 11 days & Optimum Cost is 40600

RESOURCES ALLOCATION

Resources include manpower, materials, money, machines and equipments, space, time etc that are required to complete various activities of a project. In an analysis it is assumed that resources are available at all stages of activities. But in actual practice, all the necessary resources are not available in unlimited quantities i.e resources are always limited and this will significantly affect the initiation, performance and completion of activities in time. Thus various activities of Pjt should be scheduled in such a manner that the available resources may be utilised in the best possible manner.

The availability of certain resources may fluctuate from time to time. If skilled technicians and specified equipment is restricted, then they have to be employed on a permanent or semi permanent basis and equipments must be hired in advance, resulting in increased pjt cost. Thus fluctuation in resources should be utilised in an optimal manner.

To carry out the Pjt smoothly & to complete it on schedule, it is necessary that required resources will be made available in specified quantity at desired moment.

The planning of resources should be done in such a manner that no increase or decrease in resource demand may occur. For a good resource plan, it is essential that the pjt may be completed during the stipulated period. To achieve this objective some time it becomes essential to make changes in earliest start time of some critical activities.

Methods of Resource Allocation

There are basically two approaches in solving a problem.

* Resource smoothing
* Resource levelling

Resource Smoothing

In resource smoothing, the total p/t duration is maintained to a minimum level. The resource smoothing is applied such that the total p/t duration remains the same, ie there is no change in duration of p/t. The start times of some of the activities are so shifted within their available floats that uniform demand is created for resource.

First the periods of minimum demand for resource are determined and activities are shifted according to availability of float & requirement of resource. Thus the intelligent use of floats can smoothen the demand to maximum possible extent. This type of resource allocation is known as resource smoothing.

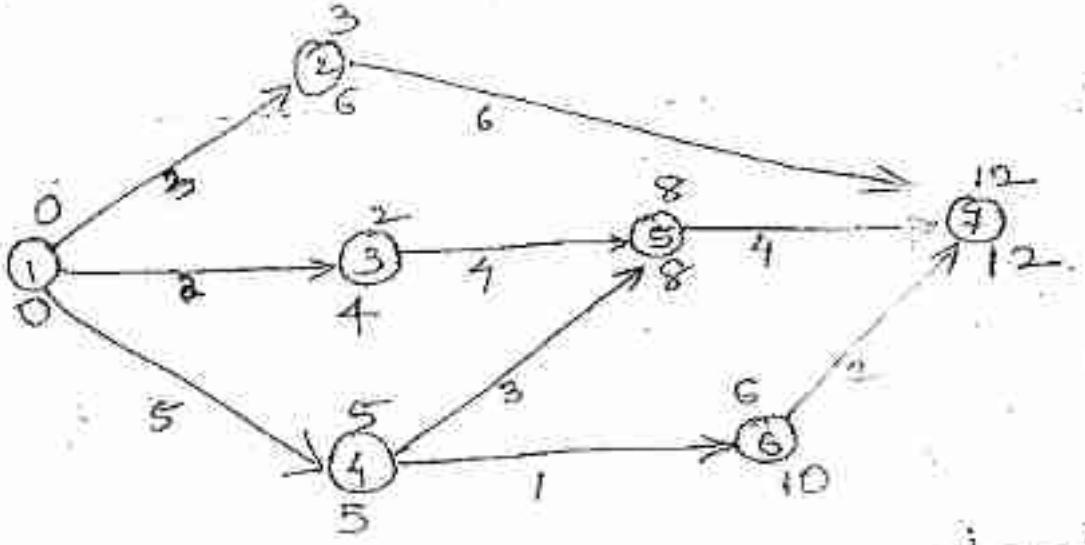
Steps in Resource Smoothing:

1. List out resources required for diff. activities and important activities are identified.
2. Resource profile are prepared.
3. Time period of peak & low demand is identified
4. If there is no restraint on availability of resource, the demand of resources should be made as uniform as possible. This can be done by changing the time ~~and~~ of start & finish of non critical activity in first instance. These activities have some float hence available float can be used for doing adjustments.

finish each activity of a project in the
Smoothen the requirement of resources so that
project is completed in schedule duration.

Activity	Expected time (t)	No of labours
1-2	3	4
1-3	2	5
1-4	5	7
2-7	6	6
3-5	4	2
4-5	3	4
4-6	1	2
5-7	4	5
6-7	2	3

Step 1:- Draw Network diagram of given data



Step 2: From the data, determine T_E^i & T_L^j

Step 3: Using T_E & T_L calculate EST, EFT, LST & LFT. Also determine total float for each activity

Step 4: From Total float, determine critical path

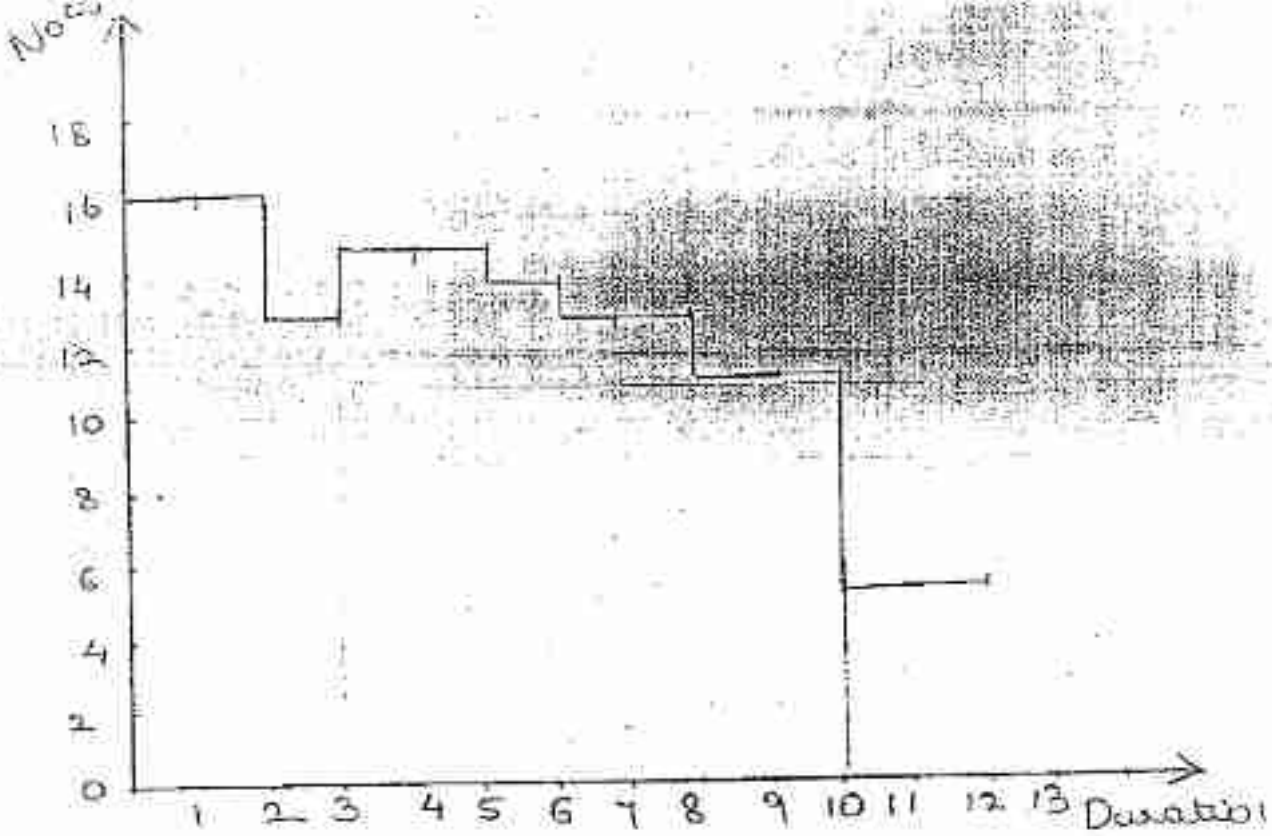
Activity	EST	EFT	LST	LFT	Total Float
1-2	0	3	3	6	3
1-3	0	2	2	4	2
1-4	0	5	0	5	0 Critical
2-7	3	9	6	12	3
3-5	2	6	4	8	2
4-5	5	8	5	8	0 Critical
4-6	5	6	9	10	4
5-7	8	12	8	12	0 Critical
6-7	6	8	10	12	4

Critical activity 1-4-5-7

Project duration is 12 days.

Steps:- Show realist start time of each activity on bar chart & determine the value of T. resource required for each day.

Duratn → / Activity ↓	1	2	3	4	5	6	7	8	9	10	11	12
1-2	4	4	4									
1-3	5	5		7	7							
1-4	7	7	7	6	6	6	6	6	6			
2-7						2						
3-5			2	2	2	4	4	4				
4-5						2						
4-6												
5-7					8	8	8	8	5	5	5	5
6-7							3	3				
	16	16	13	15	15	14	13	13	11	5	5	5



It is clear that demand of labours varies from 5 to 16. The max. demand of 16 labours is for two days only.

To smoothen situation we adjust the activity having float

The activities are rewritten having float in decreasing order.

Activity	EST	EFT	LST	LFT	Float	Remark
		8	10	12	4	Non Cri.
6-7	6	6	9	10	4	"
4-6	5	9	6	12	3	"
2-7	3	3	3	6	3	"
1-2	0	2	2	4	2	"
1-3	0	6	4	8	2	"
3-5	2	5	6	8	0	Criti
1-4	0	8	5	8	0	"
4-5	5	12	8	12	0	"
5-7	8					

6-7, 4-6 → Maximum float of 4 days

2-7, 1-2 → Float = 3 days.

The float is so subjected that the requirement of resource may remain practically constant

	1	2	3	4	5	6	7	8	9	10	11	12	2 days shift
1-2			4	4	4	—							
1-3	5	5											
1-4	7	7	7	7	7								3day shift
2-7					6	6	6	6	6	6	6		
3-5			2	2	2	2							
4-5						4	4	4	1				
4-6									2				
5-7									5	5	5	5	
6-7							3	3					
	12	12	13	13	13	12	13	13	13	11	11	5	

Resource Levelling

In a PJT there are many activities which need varying resources. The demand on a specific resource should not increase beyond the prescribed limit. If the demand of resource increase more than its availability, then only alternative is to delay the activity having max float. This process is called Levelling. It is a process by which we are aiming at a stabilized work force. Here the resources are limited. The PJT may get extended

Need for Resource Allocation

Fixed crew size is needed for resource allocation

startup problem - On starting day problem

completion day - employ more workers.

- any workers can do any
- No of days needed to complete the activity is fixed
- an activity one started will continue till its end

Rules for Resource Levelling

CPM Logic should be maintained
Activities on critical path must use a normal crew size otherwise PJt get extended

Planned crew size must be blw & including the minimum & normal crew size.

Steps in Resource Levelling

① The peak requirement of resource is lowered by staggering the resource input on non critical activities thus the completion of PJt may be delayed.

② Either some of concurrent activities may be placed in series or duration of critical activities may be increased to reduce the peak demand. This will increase the duration of PJt.

Following procedure may be adopted.

1. First the high peak of resource demand should be lowered utilizing the free float of activities.
2. Non critical activities may be rescheduled to the required extent utilizing float, starting with activity having larger float. If necessary critical activity may also be tackled.

Simplify

Calculate Es, EF.

Full the daily allocation for critical activities

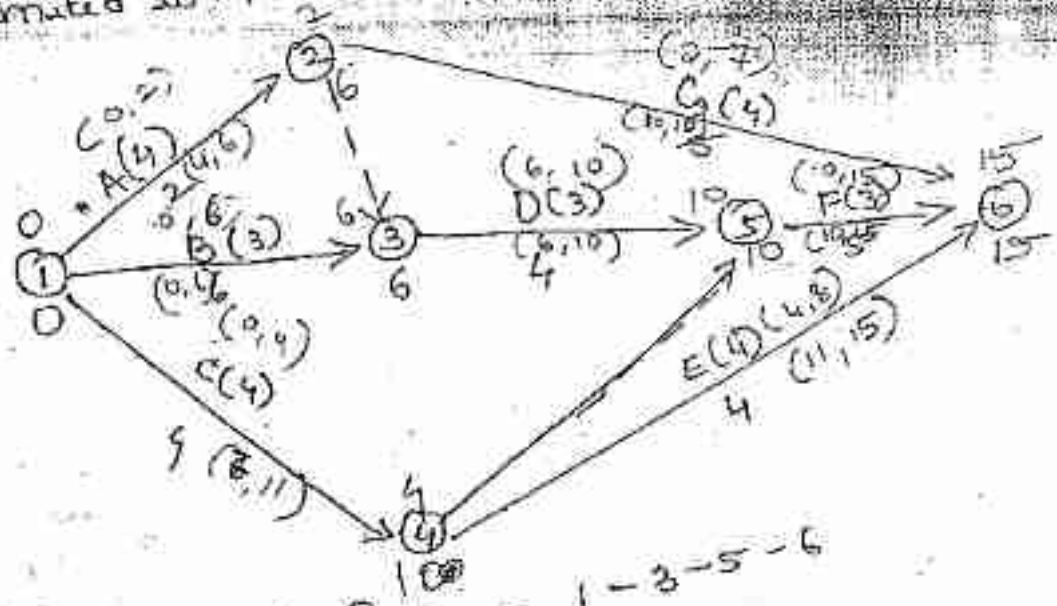
Try diff combination of labour allocation to find the best fit for the hierarchy of importance & check that:

All daily allocation are within the - max/min

Network logic is maintained

sum of daily allocation = total mjt labour requirement

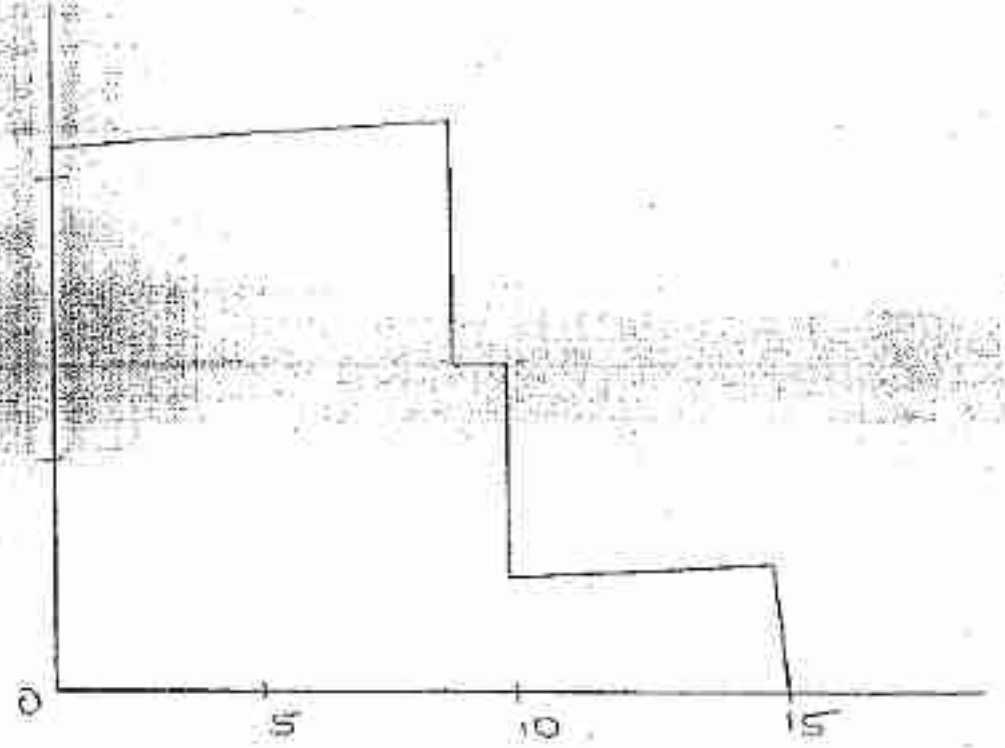
Q. Level out the requirement of resource, if the max. no of masons on any day has to be limited to 7



Critical Path = 1 - 3 - 5 - 6

duration = 15 days

Activity	Requirement	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1-2	4	4	4												
1-3	3	3	3	3	3	3	3								
1-4	4	4	4	4	4			3	3	3	3				
3-5	3			4	4	4	4	4							
2-6	4					4	4	4	4			3	3	3	3
4-6	4														
5-6	3														
		11	11	11	11	11	11	11	4	3	3	3	3	3	3



The demand varies blw 11 & 3

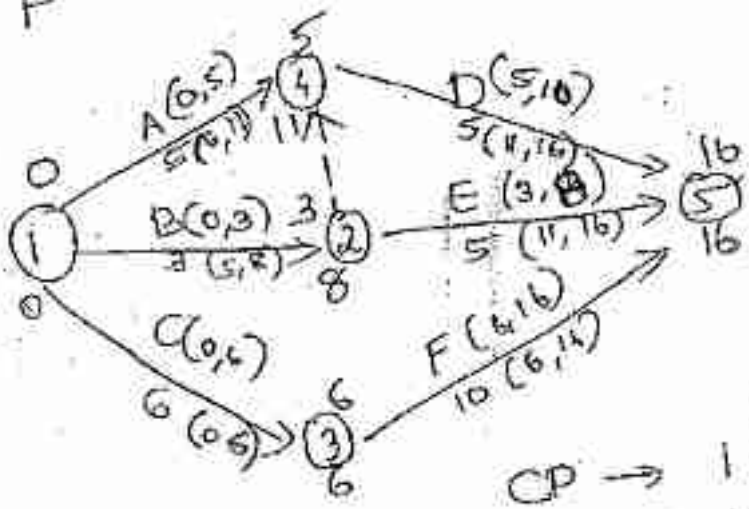
Activity G has a float of 8 days. We can shift it by 8 days.

Limit per day mason to 4.

Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-2	4	4													
1-3	3	3	3	3	3	3									
1-4			4	4	4	4									
3-5							3	3	3	3					
2-6							4	4	4	4	4				
4-6											4	4	4	4	4
5-6											3	3	3	3	3
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

Allocate the daily workforce for a network schedule for max crew size of 19 workers/day. Level & smooth labour requirement

Activity	Normal dur	Crew size Normal	Crew size Mini
A	5	5	1
B	3	4	2
C	6	8	8
D	5	6	3
E	5	4	2
F	10	4	4



CP → 1 – B – 3 – E – 5

duration 16 days

Activity	Duratn	Crew N	Crew M	Required work done	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	5	5	1	5×5 = 25	(5	1	1	1	1	1	5	5	5	5	)				
B	3	4	2	3×4 = 12	(2	2	2	2	2	2	)								
C	6	8	8	6×8 = 48	(8	8	8	8	8	8)									
D	5	6	3	30						(					5	5	5	5	5
E	5	4	2	20				(				2	2	2	2	2	2	2	2
F	10	4	4	40							(4	4	4	4	4	4	4	4	4
	Total				10	11	11	11	11	11	11	11	11	11	11	11	11	11	11

5

Scheduling

5.1. INTRODUCTION

All construction works consist of a sequence of different activities, which usually start with the preparation and setting out of the sites. After site preparation, foundation, sub structure, super structure fittings, finishing and a number of other activities are taken up. Most probably the last activity is demolishing the temporary structures, removing the construction machinery and clearing up the site. The number of activities increases with the progress of work and decreases as the work reaches completion stage. The sequence of activities depends upon the method of construction adopted. Some of the activities may be of critical nature and if the scheduled of programme is not adhered, then the construction programme may be seriously disrupted and delayed. Thus to have control over the work, different techniques are adopted. For the construction of a small building the general sequence of activities are as follows:

1. Earth work in excavation
2. Lime concrete and brick work in foundation
3. Damp proof course
4. Precasting of R.C.C. lintels
5. Casting of R.C.C. columns
6. Preparation of chowkhats
7. Brick work in super structure
8. Earth work in filling
9. Sanitary work
10. R.C.C. roof slab
11. Preparation of door panels
12. Glazed windows
13. Preparation and fixing window grils
14. Lime concrete in roof etc.
15. Plastering
16. Flooring
17. Electric work
18. Sanitary work
19. Colour and white washing
20. Painting of doors and windows
21. Sanitary and electric fittings
22. Cleaning up the site etc.

5.2. SCHEDULING

A construction schedule is a graphic representation which shows the phasing rate of construction with the starting and completing dates of each activity and the sequential relationship among various operations in a construction project.

In other words, scheduling can also be defined as the mechanical process for setting various planned activities in order by fixing the starting and finishing dates for each activity of the work to execute the whole work in a systematic and orderly manner.

Thus a schedule is a time table for the execution of a project assigning definite timings for individual constructional activities leading to the completion of the work.

5.3. USE OF SCHEDULING

Following are the use of scheduling:

1. The quantity of work involved, labour, material, equipment and money required at each stage of work can be determined by scheduling.
2. The actual progress of the work can be checked from time to time by scheduling.
3. The project can be carried out in a systematic manner by the use of scheduling.

5.4. ADVANTAGES OF SCHEDULING

For any important construction work the planning and scheduling is indispensable. Following are the advantages of scheduling:

1. By studying the schedule of the work, alternative methods of execution can be examined and the most economical method can be selected. Further the effect of likely constraints can be evaluated at the planning stage only.
2. It gives clear picture of quantity and type of materials, man power and equipment required at different stages of execution of work and duration of supply of material.
3. As the time of starting of each activity is known, the arrangement of adequate resources as man power, material, money and equipment etc. can be done in advance.
4. The resource utilisation can be optimised and the available resources can be directed to various activities to the best advantage.
5. The actual progress of each activity can be monitored with reference to the planned programme. If there is any delay in any activity the remedial measures can be taken to speed it up before it can cause difficulty in the other related activities.
6. As the inter relationship of various activities at different stages is known, their priorities can be fixed properly to the best advantage.
7. The effect of any change such as modification in original plan or weather conditions can be properly evaluated and the programme of construction can be suitably amended.
8. Total time of completion of the work can be known from scheduling.
9. The last but the most important advantage of scheduling is that the work may be executed in a most efficient way with out wastage of time and any input, resulting in maximum possible economy.

5.5. PREPARATION OF CONSTRUCTION SCHEDULES

The procedure of preparing construction schedule is as follows:

1. The work or project is divided into a number of operations and their inter dependence or relationship is studied. After the carefull study of their interdependence the sequence of operation is decided.
2. The quantity of work involved in each operation is to be determined.
3. The time required for the completion of each operation as well as the completion of total project is determined. This can be done by knowing the quantum of work involved and the rate of performing each activity.

5.6. CLASSIFICATION OF SCHEDULING

Schedules can be classified into groups according to the requirement for which it is required as follows:

1. Construction schedule
2. Materials schedule
3. Labour schedule
4. Equipment schedule
5. Financial schedule
6. Control schedule
7. Organisational schedule
8. Summary schedule

5.6.1. Construction Schedule

It is a roaster prepared for the construction of different activities or items of work for the completion

of a certain project. Before preparing the construction schedule following informations must be known.

1. Various operations to be done in a particular project.
2. Quantum of work to be done in each operation.
3. Unit of measurement.
4. Rate of progress or rate of completing the work with due allowance for weather conditions.
5. Number of labourer required (both skilled and unskilled).
6. Number and type of machines and equipment required.
7. Date of starting the work.
8. Date of completing the work.
9. Correlation between different operations.

On the top of each schedule following information should be clearly written on the left hand side:

(*a*) Name of the project

(*b*) Name of the Owner/Contractor/Engineer

(*c*) Location of the project

Use of Construction Schedule. Same as advantages of the scheduling.

Example 5.1. *Prepare a construction schedule for the construction of a road project with the following data:*

(*a*) Length of the road = 1200 km

(*b*) Width of the road = 30 m

(*c*) Construction of culverts = 12 Nos.

(*d*) Earth work for filling = 15×10^4 m^3

(*e*) Area of 8 m wide and 0.25 cm thick road surface is 12.5×10^4 m^2

(*f*) For the above road project an area of 65 hectare is to be cleared.

Note. In the execution of the above project only tentative values of different quantities have been assumed. For the execution of the project, following works will be done.

1. Moving on the site. Under this head following works are to be done:

(*a*) Erection of silos for stroing aggregate at site.

(*b*) Erecting silos for storing cement at site.

(*c*) Arrangements for storing equipment and machines.

(*d*) Arrangement for suitable office work.

(*e*) Arrangement for establishing testing labouratory.

(*f*) Servicing arrangements of equipment and machines near the site of work.

(*g*) Arrangements for other miscellaneous works etc.

Let time required for above actives be one weak.

2. Clearing and grubbing the site. Let buldozers employed for this task, complete the work in 8 weeks.

3. Construction of drainage work. Let 12 weeks are required to complete 12 culverts on the road site.

4. Earth filling. Let earth filling can be completed in 27 weeks.

5. Concreting the rod. Let 15 weeks are required for concreting work.

6. Clearing the site. After the completion of the project, let two weeks are require to move the equipment and machines from the site.

The construction schedule of this work is shown in Fig. 5.1.

5.6.2. Equipment use schedule

To decide the type, number and dates on which a particular equipment will be needed, equipment use schedule has to be prepared before the start of the project, so that it is arranged well in advance and brought

Job No. _____ Year _____

Project _____ Date _____

Owner _____

Location _____

ESTIMATED PROGRESS

ACTUAL PROGRESS

S. No	OPERATION	QTY.	UNIT	RATE PER WEEK	TIME IN WEEKS
1	MOVING IN	ALL			1
		ALL			1.5
2	SITE CLEARANCE	65	HAC	10	8
		65	HAC		9
3	DURATION STRUCTURES	12	No.		12
		9	No.		10
4	EARTH FILLING	15,10	cu. m.	54000	27
		648.10	cu. m.	5000	12
5	CONC. ROAD	125.10	Sq. m.	53000	12
6	MOVING OUT	ALL			2
		ALL			

APRIL MAY JUNE JULY AUG. SEP. OCT. NOV.

Fig. 5.1. Construction Schedule

(Equipment use report)

JOB NO. _____

PROJECT _____

OWNER _____

LOCATION _____

DATE OF CLOSING WEEK _____

YEAR _____

WORKING

IDLE

UNDER REPAIR

EQUIPMENT	MON.	TUE.	WED.	THU.	FRI.	SAT.	SUN.
POWER SHOVEL No. 5							
DRAG LINE No. 7							
TRUCK No. 16							
TRUCK No. 14							
TRUCK No. 12							
TRACTOR No. 3							
SCRAPER No. 1							
TRUCK No. 1							

Fig. 5.2. Equipment use Schedule

at site as and when needed. The aim of this schedule is to derive maximum advantage of the equipment when at site and remove it from the site when its job is over. This will save money. *Fig. 5.2.*

5.6.3. Labour schedule

The aim of this schedule is to decide the number of skilled and unskilled labour required for the execution of different operations on different dates. With the help of this schedule required labour can be arranged well in time. It is difficult and costly to arrange skilled labour as and when required. It helps in reducing the labour cost. A labour schedule can be prepared from the construction schedule.

5.6.4. Material schedule

This schedule should be prepared well in advance of the start of the work. This schedule may be prepared from the construction schedule. To avoid delay in the execution of the work, all construction materials should reach the site of work well in advance, at least before the start of the work. In case materials stored at site long before its use, it is likely to deteriorate in its quality. For example cement will lose its strength by 50% if stored for six months. Thus at the time of preparing material schedule following points must be kept in mind.

1. The materials should be delivered at site at least one week earlier than its use.
2. Materials at site should not remain un used for long. If they allowed to remain unused for long they will detoriate.

5.6.5. Financial schedule

The estimated amount of money which the owner or contractor has to provide to finance the project can be obtained from construction schedule. In most of the cases of construction contracts, it is specified that the owner will pay about 90% cost of the completed work during each month for each job to the contractor.

5.6.6. Control schedule

At the end of a fixed date the incharge of the project has to send the progress report of the project to the head quarter. In order to complete the project with in specified time limits, the chief executive plans to provide resources as equipment, machines and money etc.

5.6.7. Equipment use schedule

After the purchase of the equipment for a particular project, the owner gets a mark punched or painted on the equipment or machine to identify it from others. The owner should have full knowledge of the equipment purchased by him. Usually following information is sent to the owner.

1. Cost of the equipment
2. Efficiency of each equipment or machine
3. Record of their repair
4. Details of expenditure on repair
5. Duration of effective use of the equipment.
6. Details of fuel consumption by the equipment.
7. Details of servicing of the equipment.

With the above information, the efficiency and working capacity of the equipment can be compared with the figures supplied by its manufacturers. This schedule is useful at the time of purchase new equipment. The specimen of a equipment use schedule is shown in Fig. 5.2.

14
Job Layout

14.1. INTRODUCTION

The construction of a project is carried out in the form of a camp. It should be so designed that the work progresses efficiently with minimum interruption. Every project must be organised and executed in the most economical and safest way. The arrangements made for the smooth execution of the project is known as job layout. A job layout is a scaled drawing of the proposed construction site showing all relevant features such as entry and exit points to the site, storage areas for materials and other necessary aminities such as contractor's offices, space for keeping equipments, and labour housing etc. The basic input of a construction job, namely men, materials and machines must be controlled and placed at the site in such a way that.

(*a*) The materials are stored as near as possible to the place of their utilisation.

(*b*) The machines are positioned in such a way that they are fully utilised.

(*c*) Adequate storage and other accommodation must be available.

A job lay out that provides maximum efficiency is known as optimum job layout. Actually the activities at construction site go on changing with the progress of the work. Hence the job layout should be reviewed periodically and modified to suit the changed needs of the site activities.

Thus in order to prepare a job layout, an over all idea of the type, extent of work and the way in which it is to be carried out must be studied before hand from the construction plans, specifications and other contract documents. The knowledge of principles of storing and stacking of materials and placing of equipments is essential for preparing a good job layout.

14.2. OBJECTIVES OF PREPARING A JOB LAYOUT

Generally a job lay out is prepared for the following objectives:

1. To save time in delivering the construction material at the site of construction.
2. To safe guard construction material from damage and deterioration.
3. To keep the lead of cartage minimum, so that certage expenses may be minimum.
4. To adopt the best mode of working.
5. To complete the work with the minimum use of equipment and machinery.
6. To take maximum out put from labour and machines.
7. To provide safety to workers and passer by etc.
8. To avoid damage due to construction activities to the nearby properties.
9. The common use materials as fine and coarse aggregates should be stored near to each other.
10. To store construction materials as near the place of their utilisation as possible.

FACTORS AFFECTING THE JOB LAYOUT

following factors have been found to affect the job layout:

1. **Nature and type of work.** Nature and type of work plays an important role in the preparation of job lay out. For example the job lay out for a Earthen dam or canal lining will be quite different from that of a multi-storeyed building as the nature and extent of requirements of supporting facilities are quite different in each case. In case of a multi storeyed building project, the job layout should be located centrally, where as in case of lining of canal or high way construction project a number of construction centres at suitable locations will be required. Availability of materials, labour also affect the site arrangements to a great extent.

2. **Access to site.** The access to the site of construction must be easy as it will facilitate the transportation of equipment and construction material at minimum cost. If the facilities for transportation of equipment and materials are not available, it will affect the job layout badly. Hence to complete any project economically and with in time schedule it is essential that the access to site must be easy.

Site having different routes for entrance and exit is ideal. In case there is only one route for entrance and exit both, then near the main entrance, a sign post must be erected to indicate the position of the store. It will also help in avoiding accidents.

3. **Nature of the ground.** For the movement and fixing the machinery, strong and solid ground is essential. In case the site soil is soft, then for erecting heavy machinery, preparation of solid foundation will be essential. Pucca roads will also be required for the easy movement of heavy machines. Sites having high water table, some times require de-watering for lowering the water table of the site.

4. **Temporary roads.** If the soil is loose then to transport the heavy machinery and equipment, construction materials etc. from the main road or railway station pucca road is essential. In such situations road construction work should be completed before the start of the project.

5. **Construction methods.** The construction can be either cast in situ or pre cast elements. In case it is to be completed by pre cast elements, then the provision for casting yard should be included in the job layout.

6. **Availability of materials.** If the construction materials are available locally, then there storage problem will be less, other wise it will affect the job layout, as storage space for materials is to be included in job layout at suitable location. The location of material storage should be such that their cross movement is avoided and their lead time is minimum. Materials should be well protected from damage due to atmospheric and weathering effects. Pilferage of materials should never be tolerated.

7. **Miscellaneous factors.** Non availability of the following facilities will also affect the job layout.

1. **Accommodation for administrative block and residences.** To achieve a faster progress of work, it is essential that the administrative block and residences of officers and workers should be nearer to the site of work. During the full duration of the project, the residential accommodations should be permanent.

While selecting the site for accomadations following points should be kept in mind.

(a) The location of manager's, residence should have an easy approach. It should be easy to locate.

(b) To residential site should be away from work shop etc., where noise pollution should be minimum.

(c) As far as possible, the residential accommodation of all officers should be nearer to each other.

(d) The residential site should be such, that it may not be very use full for other works.

2. **Medical facilities.** The field medical facilities should be provided to workers and officers at site colony. There should also be following facilities.

3. Public health amenities

4. School facility for the children of the staff and workers.

5. Electricity, Telephone and water supply.

6. Daily necessity of life etc.

14.4. RECORD TO BE STUDIED BEFORE PREPARING A JOB LAYOUT

For preparing a good job layout following records should be studied carefully

1. Site plan
2. Working drawings
3. Specifications

1. Site plan. It is a scaled drawing indicating the orientation, shape, and dimensions of the site and relationship to the surrounding areas. The site plan shows the following details:

(*a*) The boundaries of the construction site.
(*b*) The boundaries of the adjacent area owned by the owner.
(*c*) The position of the site in relation to the adjacent road indicating name and width etc.
(*d*) The location and size of any built up work at site.
(*e*) The location and size of any existing building proposed to be demolished.
(*f*) The location of any service utility as existing water mains, sewers, electric lines etc.
(*g*) The presence of physical features such as natural drains, wells, river etc.
(*h*) The location of all proposed building works indicating their distances from the roads adjacent to buildings and boundaries with in 12 metres of the site and number of stories in each building.
(*i*) The location and width of all approach roads or passages from the existing roads or passages of all buildings to be constructed.
(*j*) North direction.
(*k*) Any other information considered necessary.

2. Working drawings. Working drawings include the plans of buildings and other works to be constructed at the site. Usually working drawings consist of the following items.

(*a*) Floor plans of the buildings and other works showing the position and dimensions of walls, structural members, openings such as doors and windows, size of the room, stair cases, lift if any and other essential services. The north direction and usage of all areas also is indicated.
(*b*) Elevations of all works from all open sides indicating the ground level, the height and depths of all salient features or points.
(*c*) Sections passing through walls, stair cases/lift wells etc., showing the details of structural members such as foundations, walls, columns, floors, roofs, parapet etc.
(*d*) Tarrace plan showing the slope of the roof and drainage etc.
(*e*) Service plan showing the plans of water supply, sewage disposal, air conditioning or any other special services that have been planned to be provided.

3. Specifications. Specifications serve to guide the bidder at the time of tendering and the contractors to prepare job layout and executing the work.

14.5. CLASSIFICATION OF SPECIFICATIONS

Specifications can be classified based on use as follows:

(*a*) **Standard specifications.** These specifications are standardized for the general use of the trade. Indian standard Institution prepares standards for the general use. These standards are known as *Indian Standard Specifications.*

(*b*) **Outline specifications.** These are preliminary specifications and provide basic information. These are usefull at the time of bidding and are accompanied with the preliminary drawings of the work. These are further developed later at the planning stage of the project. They are also known as *guide specifications.*

(*c*) **Project specifications.** These are detailed specifications prepared taking into account the special requirements of the particular job.

(*d*) **Manufacture's specifications.** These are prepared by the manufacturers to indicate the quality of the products manufactured by them.

14.6. STORING AND STACKING OF MATERIALS AT SITE

Usually large quantities of construction materials have to be stored at the sites of construction. Thus to prepare a proper job layout at site, it is necessary to know the correct method of storing materials at site.

14.6.1. Points to be Considered while storing materials at site

Following points should be kept in mind while storing materials at site:

1. Materials should be stored in such a way that they are not affected by impurities or by atmospheric agencies such as sun, wind or moisture etc.
2. Cement should be stored in covered sheds. The plinth level of the shed should be at least one metre higher than the adjoining ground. The cement bags should be stacked on a raised platform of bricks or on planks about 15 to 20 cms above the shed floor. The space between the walls and cement bags alround should be at least 30 cms.
3. The inflammable materials must be stored separately from other combustible materials. This area should be specially protected from fire hazards. In such areas smoking should be prohibited.
4. Explosives should be stored in a safe place, away from combustible and inflammable materials under lock and key. The statutory requirements of explosives acts must be followed.
5. Materials of common use must be stored near the place of their use to minimise the handling.
6. As far as possible materials used for similar purposes must be stored close together.
7. Heavy items must be kept near the crane or hoist for ease in handling.
8. As far as possible, heavy items should be stored away from trenches, soft ground or improper support to prevent accidents and subsistances.
9. Materials which deteriorate with the passage of time such as cement and lime should not be stored for long. They should be used in such a way that the earliest supply is consumed first. To control the pilferage and theft of materials, they should be stored in secure place under watch and ward.

14.7. LOCATION OF MACHINERY AND EQUIPMENT

Now a days on construction projects a large variety of construction machinery and equipment is used. The use of equipment and machinery has been found economical both in cost and duration. The list of equipment commonly used is given below:

1. **Machinery for transportation of materials.** For this purpose different capacity of trucks, and wagons are employed for moving construction materials to the site and removing away overburden and surplus materials.
2. **Earth moving machinery.** For levelling and moving earth for short distances bulldozers, tractors, scrapers and grader etc. are employed.
3. **Excavating equipment.** For excavating the earth, shovels, drag lines and clam shells etc. are used.
4. **Lifting devices.** For lifting the materials cranes and winches are used.
5. **Conveyor system.** For moving or transporting materials such as concrete this system is used.
6. **Drilling equipment including air compressors.** This equipment is used for rock drilling.
7. **Rock blasting equipment.** For breaking rocks this equipment is used.
8. **Grouting equipment.** For making the rock more impervious, grouting equipment is used.
9. **Pile driving equipment.** For driving piles under under or on land pile driving equipment is used.
10. **Pump and well point equipment.** For draining out water this equipment is used.
11. **Equipment for concrete works.** For concrete works, concrete mixers, vibrators, polishing and grinding equipment is used. For transporting concrete dumpers and other equipment is also used.

14.8. STACK SIZE OF COMMON BUILDING MATERIALS

The stacking size of common building materials is shown in Table 14.1 below:

Table 14.1. Size of stacks

Name of material	*Method of stacking*	*Size of stack*
Cement	Cement bags should be placed on bricks or planks about 15 cm higher than the floor of the shed or store. There should be a minimum distance between the walls and cement bags of 30 cms alround.	In one stack not more than 12 bags should be placed one over the other
Lime	Hydraulic lime should be stored in such a way that it remains unaffected by moisture.	
Bricks	The bricks should be stacked at ground level. The height of the stack should not be more than 1.5 to 1.7 m. The height of tiles stacks should not be more than 1 m, but the height of concrete block stacks may be upto 2 m.	
Aggregate	Different aggregates as coarse and fine aggregates must be stored separately on hard and clean ground.	The size of stack may be $2 \times 2 \times 0.5$ m
Timber	Timber should be stacked on concrete blocks or well seasoned timber planks at least 15 cms higher than the store floor. Timber of different lengths and size should be stacked separately. In two consecutive layers there should be a gap of about 2.5 cms for free circulation of air. There should be a minimum distance of 50 cms between two stacks.	Breadth of stack should be 1.5 m and height 2 m
Steel	The steel used for reinforcement should be stacked in such a way that it is not affected by moisture, oils and lubricants. For preventing it from rusting it should be given a cement paste coating.	

14.9. POINTS TO BE CONSIDERED AT THE TIME OF PREPARING LAYOUT OF EQUIPMENT

At the time of preparing equipment layout, following points should be kept in mind:

1. The equipment should be placed near the place of its use as well as near the place of materials it is supposed to utilise. For example a concrete mixer should be placed near the stack of aggregates and the mixed concrete may not have to be carried for long distances.
2. For costly equipment, temporary sheds should be provided to safe guard them from weather effects.
3. Arrangements for essential repairs, maintenance, oiling, lubricating and petrol filling should be made at the construction site.
4. The layout should be such that the safety of machinery can be ensured by the security staff.
5. Sufficient space should be available for erection of scaffolding and removal and shifting of equipment to places where it can be utilised fully.
6. For transport vehicles there should be adequate space for parking.
7. The main office of the establishment should be near the main entrance, so that visitors for bussiness need not to have to cross the work site.
8. Security check posts should be so located that no material could pass in or out with out proper check.
9. Adequate safety measures and fire prevention equipment should be provided in the layout.

14.10. PREPARATION OF JOB LAYOUT

To get the idea of the nature and extent of the work, the construction plans, specifications, contract documents and other available material describing the job should be studied carefully and a scaled drawing at a scale of 1 in 100 should be prepared showing the out lines of the work or job to be constructed. The entry and exit points as well as the areas of temporary facilities should be marked. From the above study following information should be collected.

1. Area needed for accommodation. This area includes the area required for offices, stores and

residential accommodation for officers, staff and labour.
2. Area required for machines sheds, repair shops and workshop etc.
3. Area for miscellaneous amenities such as canteen, toilets, dispensary etc.
4. Areas for security and fire fighting facilities.
5. Area required for construction work.
6. For how much period the area may be available.

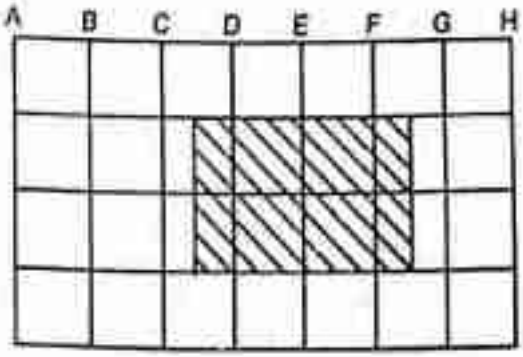


Fig. 14.1.

In deciding the location of each area, the principle of storage of materials and equipment as well as the factors which affect the job layout should be kept in mind. The problem of allocating the space for men, materials and machines has to be tackled separately for each site.

(*a*) From the data collected, a plan is prepared. On this plan natural features such as river, drainages, and other such obstacles should be marked.

(*b*) On the same plan different requirements of space as discussed above should be marked in the form of grid as shown in Fig. 14.1.

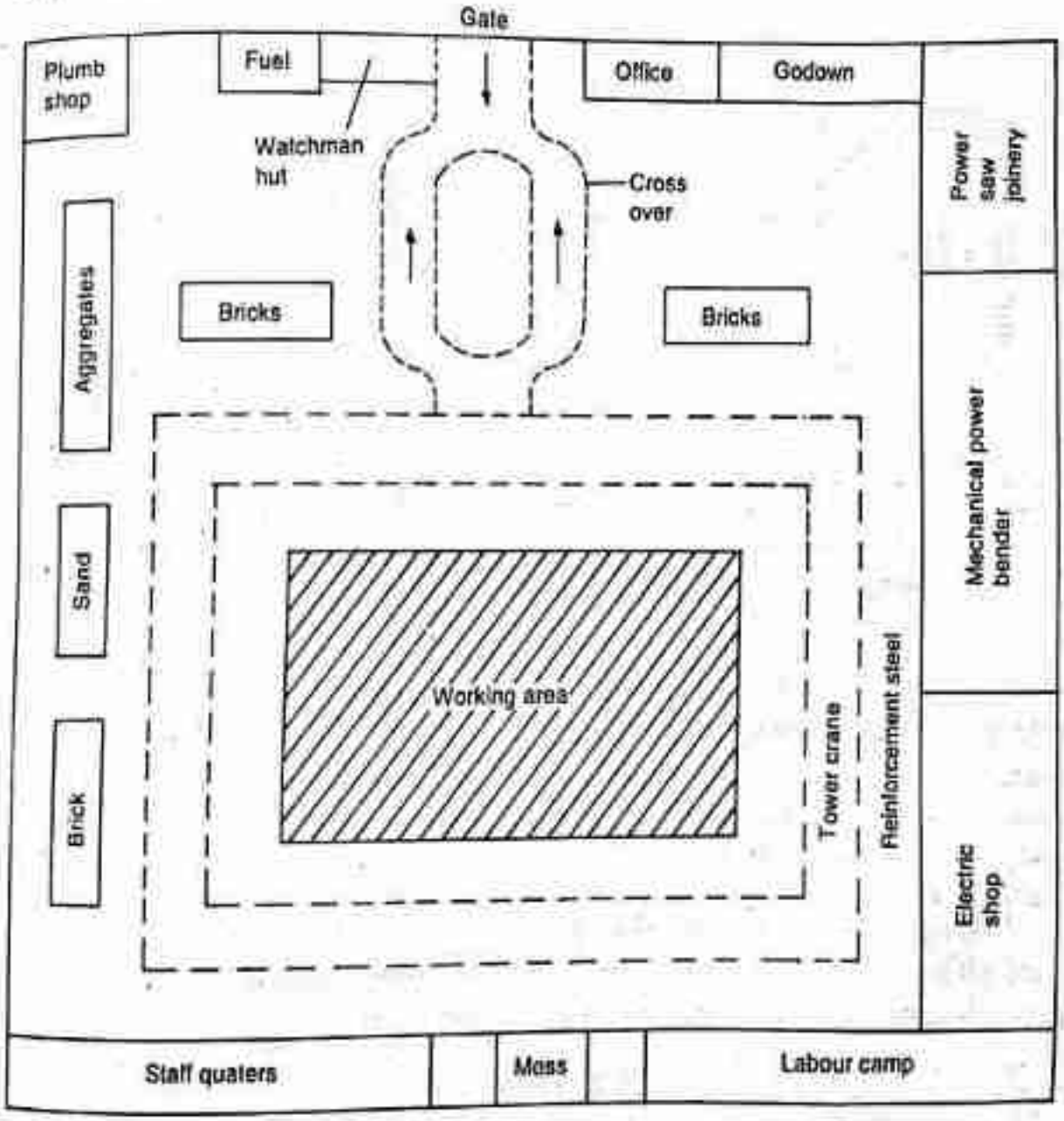


Fig. 14.2.

(c) Areas required for storing different materials are shown in a tabular form.
(d) Charts of different stocks of different materials and machines are prepared using the standard symbols.
(e) The chart of working conditions of different equipment and machines and duration for which the equipment has been used on the project are prepared.

Actually at site many activities go side by side. Hence the storage of materials at exact place and repair of equipment at its working place is not possible. Thus alternative most economical job lay outs should be prepared. A typical job layout is shown in Fig. 14.2. The job lay out of a multi-storyed Building is shown in Fig. 14.3.

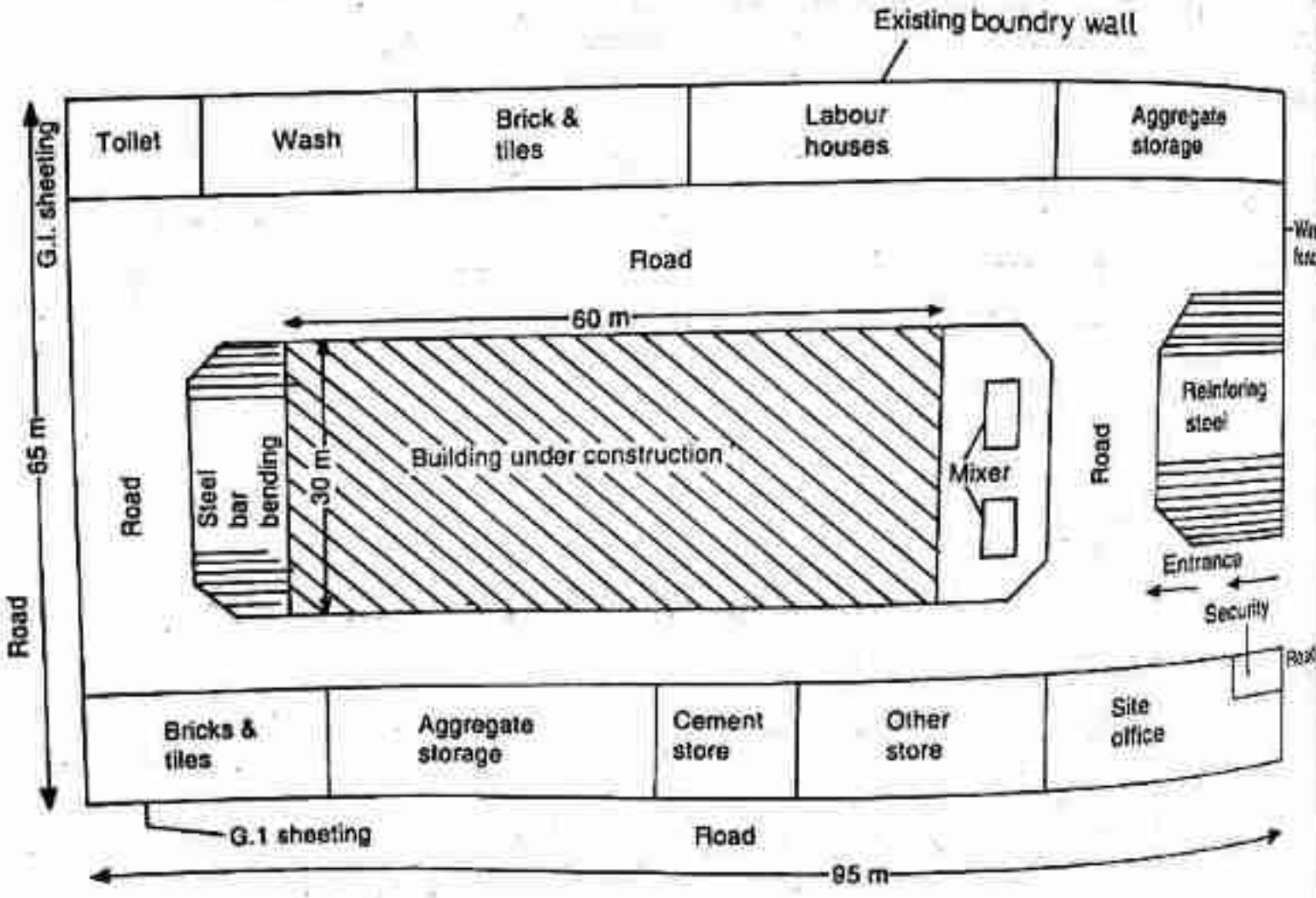


Fig. 14.3. Job layout for multi storyed building

14.11. ADVANTAGES OF A GOOD JOB LAYOUT

The advantages of a good job layout are found as follows:

1. A good job layout provides smooth and economical working of the project.
2. A good job layout reduces the completion time of the project.
3. A good job layout provides more safety in the working of the project.
4. A good job layout reduces the material wastage and deterioration.
5. A good job layout affords easy, speedy and economical transportation of materials.
6. A good job layout increases the output of man and machinery.

Codification of planning System :-

Coding is the allocation of symbols which places an object or subject in its correct classification whereas Codes are simply a particular identification mark symbols or references

Codes may consist of letters or numbers, punctuation marks or a combination of all. The length of code may largely depend upon the complexity of specification of system.

Purpose:-

* An organized control of a major project is not possible without the proper codification of project data
* Codes enable identification, classification and quick retrieval of data
* Codes abbreviate data and expressions used in natural language.
* Short length data code reduces storage space and costs.

Codification Approach

Purpose

A project organization handles large varieties of data The data includes activities, resources, costs and documents A simple approach to describe these items is to assign suitable names This process may result in several different names being assigned to each item by different persons handling the same item It is therefore essential to develop a code to identify each frequently occurring item

The item code is built up by using alphabets, numerals, symbols or combination of these It may be noted that a code consists of a string of alphanumeric characters and that these are not the arithmetic numbers or functions used for making calculations.

Data Needing Codification

There is no end to the demand for the codification of data from the various departments within a project But unnecessary codes can create confusion and may defeat the very purpose for which they are designed Some of the aspects which may need codification are listed below:

→ Activity, work package, sub-group and group identification
→ Bill of quantities
→ Cost accounting system
→ Drawings and specifications.
→ Equipment Identification

→ Finance accounting system
→ General and administrative accounts
→ Head office expenses
→ Indexing system
→ Jobs, sub contracts
→ Labour categories
→ Material types
→ Numbering activities, areas, building locations etc.
→ Overhead charges.
→ Project Codes
→ 'K' to represent kilos and thousands in large sized numerical data

In construction projects, the codes used can be broadly divided into three categories a project interfacing codes or simply project codes (codes used for developing an interdepartmental database) and departmental specialized codes

The project interfacing codes composed of a number of divisions or components, can be broadly grouped into work package and connected activities identification codes, resource codes, cost and sales accounting codes and technical document codes

activity identification code

Eg:- In a building construction project, consider the steel reinforcement fixing activity of wall foundation workpackage of residential building no 13 under the foundation responsibility centre. This activity can be represented by the code RB13011OFD

where
RB → type of building ie residential building
13 → building location ie, building number

(4) 01 → identifies wall foundation work package
10 → stands for steel reinforcement fixing activity of wall foundation work package
FD → code for foundation responsibility center

The alphabets and numberals used in the above eg: are not assigned at random, but they follow a systematic labelling approach.

Labelling Approach

Label types:- Codes can be labelled using alphabets or numerals or a combination of both

→ Alphabet Codes

Alphabet letters A to Z, single or combined, can be used to represent a code. An alphabet (capital or small) in a single character space can represent 26 variations as compared to numerals 0 to 9, which can depict maximum of 10 variations. In some cases, codes can be best be represented by abbreviating them
Eg: Carpenter can be coded as CARP.

→ Numerical Codes

It is the most important form of coding.
In numerical codes, each character can be represented by a numerical varying from 0 to 9.
These numericals when used in combinations, can create a

large number of variations

Numerical codes are easy to comprehend, those requiring analysis by computers

→ Alphanumeric Codes

It is used in combinations of alphabets and numerals to develop a code

Each character in an alphanumeric code can represent upto 36 distinct variables

eg: 0 to 9 and A to Z

Importance of 'zero' in a code

In some codification systems '0' has a special significance. Zeroes when used on the right side of a non-zero character, indicate summary level information.

Eg:- B1 00 00 stands for all residential buildings

B1 13 00 Represents the residential building number 13

B1 13 01 Indicates the foundation work package of building number 13

In some codes, zero is used to represent 'not applicable'

Significant Code

A code is termed significant if it can be easily understood by applying certain sets of simple rules to each of its components.

For eg: if a is based mnemonic features, it can help the users to memorize the code.

Further accounting becomes simple if the code includes numeric digits

Generally significant code consist of two or more alphanumeric components

Eg:- BW013 represent activity blockwork of building number 13

BW → block work
013 → building number

Generally numeric codes are non-significant.

It is not necessary that all codes should be significant in nature.

Eg. Corporate level, Bulldozer code = BD012
Project level = DZ01

Here project level is more significant with less characters.

Workpackage and Activities Identification Code.

Code composition for identifying a work package.

Eg: Excavation can be identified as 'excv' in small project, but in major project with different number & type of excavations, workpackage identification may need certain prefixes and suffixes. For proper identification include codes of the project and subprojects to which the workpackage belong.

A workpackage is a group of related tasks within a project. subproject within a large project

Eg:- Workpackage and activity identification code

Subproject Code	Workpackage Code	Activity No	Other related Code.

Alternate arrangement :-

Activity code	Workpackage Code	Subproject Code	Other related Codes.

Workpackage is smallest unit of work that a project can be broken down to when creating work breakdown structure (WBS)

Subproject Codes: A project can be divided into a number of subprojects or group tasks or facilities.

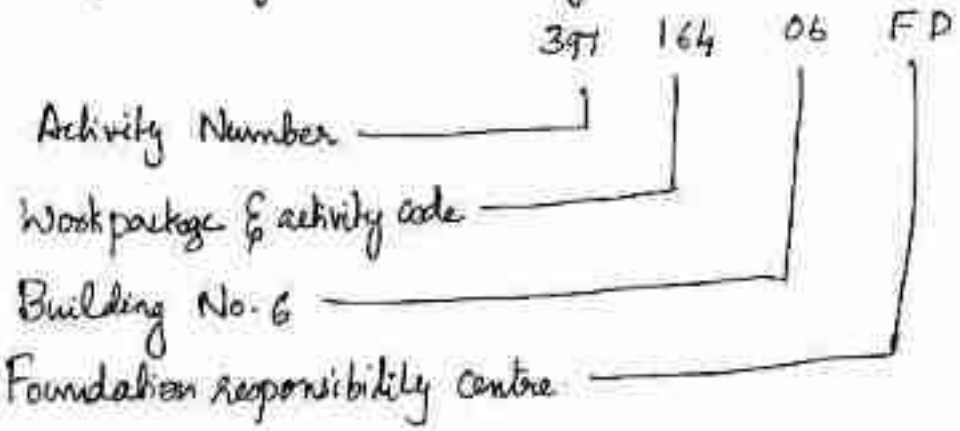
Eg:- Residential building RB
Public Building PB
Educational building EB.

Generally each primary division can represent a work package of small projects, whereas for large projects, each sub division of its further breakdown may be used to denote a workpackage.

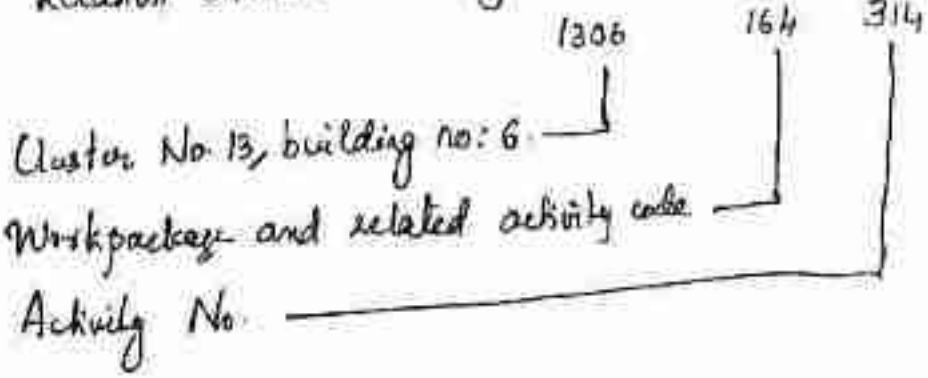
Activity Identification Code

* An activity number is assigned for identifying an activity.
* It can be an alphanumeric code or it can be derived from schedule of work.
* Activity numbers are primarily used by planners.
* These numbers correlate w/w logic, activity description and activity sub-group codes.

Eg:- Responsibility Oriented Activity Code.



Location Oriented Activity Code.



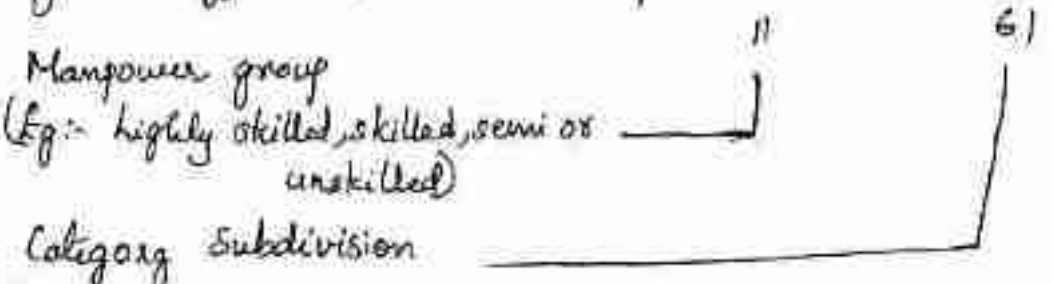
Resource Codes

* Resource codification at the project site is necessary to identify, locate, account & monitor each item of resource.
* From the moment it is indented to the time it is finally disposed off.

→ Construction manpower Code.

* Manpower is planned, indented, accounted & controlled by categories

Eg:- A typical 4 character manpower code.



* Manpower at project site can be grouped to various numbers like administrative staff, construction worker, technical staff etc

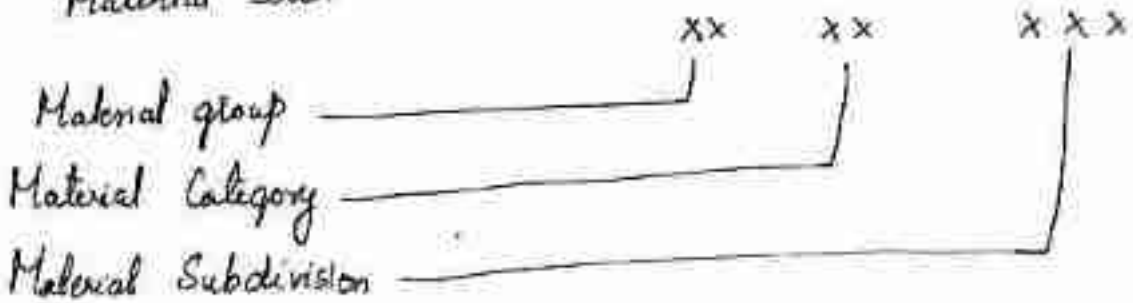
→ Construction Material Code

* Project inventory of bulk stores, finishing materials, electrical and mechanical components etc run into thousands of items.
* These materials vary in many ways such as use and purpose, supply source, stocking methodology, procurement date, location in warehouse, site requirement date and so on..
* A common practice is to identify the materials by individual names.
* But these material names or descriptions go on changing, while passing through various processes, departments or transit agencies.

It is therefore necessary that all concerned use the same unique label to identify and describe the materials.

* Ideally material code should describe the type of material, material specifications and its location in warehouse
* Generally codification can be restricted to category A & B materials

Eg: Material Code.



Material Group:-

* The materials can be grouped using 2 characters code in many ways:-
  → Using divisions of standard specifications
  → Using classifications of materials into main divisions like fast moving bulk materials, repetitive materials, one time use materials, equipment related materials etc
  → Using 4 digit numerical group from 0001 to 9999.

Materials Category:-

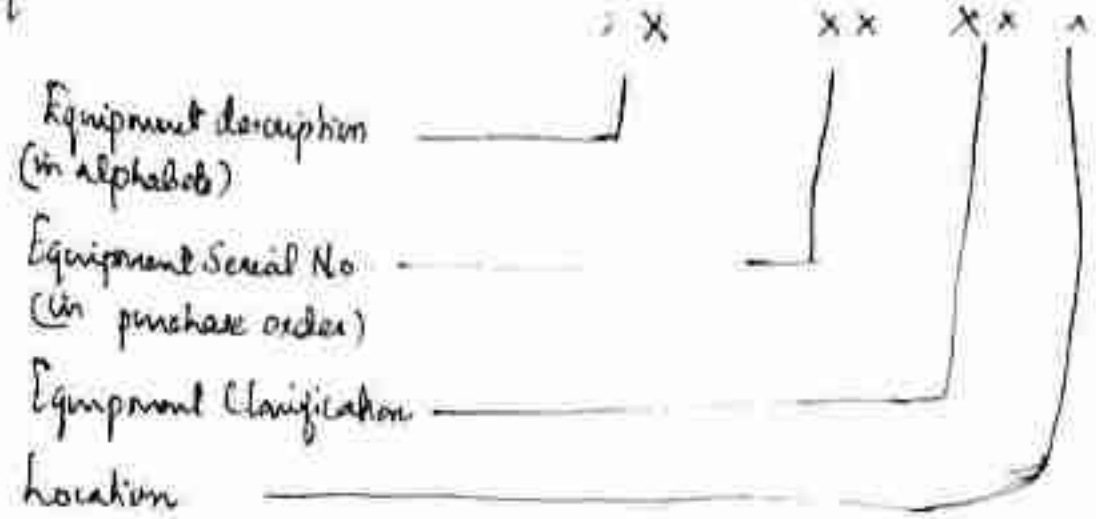
* It shows split up of the group of materials like cement into types (ordinary or sulphate resistance) and its further sub divisions like bulk cement or bagged cement.

→ Equipment Code

* An equipment is a high cost long life item of machinery.
* Equipment is fixed asset, and is capitalized for accounting purposes.
* Generally its performance is measured in terms of hours utilized

* Plant and equipment is codified to facilitate its identification for recording purchase costs and depreciation value, locating and processing spares, updating maintenance and repair documents, monitoring performance and accounting operating costs

Eg:-



→ Other Expenses Code

* In addition to manpower costs, material costs and equipment costs, numerous miscellaneous expenses are incurred during the execution of a project.
* Some of them are directly related to the work package.
* These expenses include costs relating to designs and drawings, investigations and trials, sub contracts, equipment hiring and share of indirect costs.

Typical Construction equipment group Identification codes.

Equipment Group No.	Equipment Group Description	Equipment Item	Item Identification Code
01	Earth moving plant	Dozers	DR
		Loaders	LR
		Excavators	XR
		Scrappers	SR

02	Concreting Equipment	Batching Plant	BP
		Concrete Pump	CP
		Concrete mixers	CH
		Transit Mixers	TH
03	Materials Handling Equipment	Mobile Cranes	MC
		Tower Cranes	TC
		Overhead Cranes	OC
		Forklifts	FL
		Gantry Cranes	GC
04	Transportation Fleet	Tippers	TR
		Dumpers	DR
		Water tankers	WT
		Fuel tankers	FT
05	Utility Services Equipment	Power Supply Equipment	PS
		Water supply Equipment	WS
		Sewage disposal Equipment	SD
		HVAC Equipment	HC

Cost and Finance Accounting Codes.

→ Cost Accounting Codes

* A cost accountant means the cost management information system of the project and accounts for all the costs.
* These cost include standard or budgeted costs, actual costs, and future costs.
* Its database is workpackage.
* Develops each workpackage construction cost.
* Identifies the nature and type of each transaction involving direct costs and classifies them into fixed overheads and variable overheads.
* Split ups each workpackage production cost into elemental costs such as:

✓ Direct labour cost
✓ Direct material cost
✓ Direct equipment cost
✓ Direct other expenses
✓ Indirect apportioned variable overheads
✓ Indirect apportioned fixed overheads
✓ Production cost
✓ Production direct cost
✓ Production indirect cost
✓ Earned value

Cost Accountant Work package Cost Codes

Type of Cost	Cost Category Code
Direct labour cost	FD 040 21 - L
Direct material cost	FD 040-12 M
Direct equipment & other expenses	FD 040-04-E
Indirect apportioned variable overheads	FD 040 - V
Indirect apportioned fixed overheads	FD-040 - F
Production Cost	FD 040 21 1204 P
Production direct cost	FD 040 21 12 04 D
Production Indirect Cost	FD 040 - I
Work done value	FD 040 - V

→ Sales or Earned Value Accounting Code

* Split up each work package into work items as listed in BOQ.
* Generally adopt BOQ sequential code to account for the sale value of each saleable item.
* Correlate costs with sales of each workpackage as well as each item of BOQ

Eg:

Responsibility Centre Code	TD
Work package code	164
BOQ serial/reference	A20
Activity identification code	125
Cost Code	B

Represents work done value of activity 125 of workpackage no 164 which is priced in BOQ serial A20.

→ Finance Accounting Code

* Finance accounts the expenses and revenue with their debtors and creditors
* Conforms to corporate policy which is formulated in line with the statutory requirements.

Integrated Finance and Resources Accounting Code.

Finance Accounting Head	Code Label
Revenue account heads	0001 to 0999
Manpower expenses	1000 to 1999
Material expenses	2000 to 2999
Equipment Expenses.	3000 to 3999
Other production expenses	4000 to 4999
General & administration cost of project	5000 to 5999
Fixed assets account.	6000 to 6999
Individual debtors accounts.	7000 to 7999
Individual creditors account.	8000 to 8999
Balance sheet heads of accounts	9000 to 9999

→ Drawings Code

* There are two approaches to handling the drawing preparations
* There are traditional unstructured approach and structured systematic approach.
* In traditional unstructured approach, drawings are divided into two categories ie, general arrangement drawings and detailed working drawings with each showing the whole building or its parts in plan, elevation and sections.
* The traditional group of drawings are numbered serially in the group, as they are produced.

→ Specifications Code.

* Specifications describe the types characteristics and method of installation of materials and equipments as per drawings and schedules.
* Project specifications are covered in the last of the contract documents and these can be generally extracted from specification standards such as Bureau of Indian Standards, other national building specifications (NBS) like British Standard Specifications.
* The code used for labelling specifications such as, Construction Specifications Institute (CSI), Washington DC and British Standard Specifications can also provide guidelines for developing own specification codes by construction companies.

→ Bill of Quantity (BOQ) Code

* Bill of quantity (BOQ) itemize the quantity of work and the contractual costs to complete the project.
* BOQ links scope of work with drawings and specification to facilitate pricing
* Element headings and subdivisions codes of CI/SFB enable systematic preparation of BOQ. Construction Project manuals
* This enables direct cross reference b/w work items and specifications.