MODULE – 5

REPLACEMENT 0041ND MAINTENANCE ANALYSIS:

INTRODUCTION

Organizations providing goods/services use several facilities like equipment and machinery which are directly required in their operations. All such facilities should be continuously monitored for their efficient functioning; otherwise, the quality of service will be poor. Besides the quality of service of the facilities, the cost of their operation and maintenance would increase with the passage of time. Hence, it is an absolute necessity to maintain the equipment in good operating conditions with economical cost.

There are two basic reasons for considering the replacement of an equipment

- Physical impairment of the various parts or obsolescence of the equipment.
- Obsolescence is due to improvement of the tools of production, mainly improvement in technology.

Sometimes, the capacity of existing facilities may be inadequate to meet the current demand. Under such situation, the following alternatives will be considered.

- Replacement of the existing equipment with a new one.
- Augmenting the existing one with an additional equipment.

TYPES OF MAINTENANCE

Preventive maintenance (PM): is the periodical inspection and service activities which are aimed to detect potential failures and perform minor adjustments or repairs which will prevent major operating problems in future.

Breakdown maintenance: is the repair which is generally done after the equipment has attained down state.
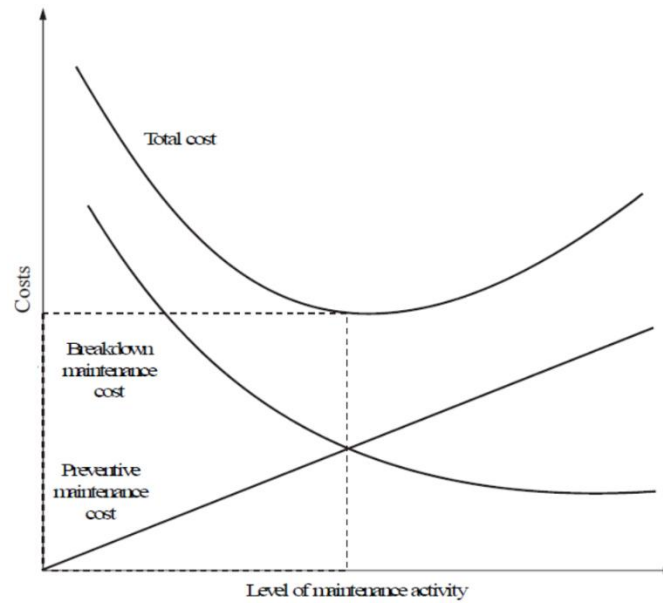
TYPES OF REPLACEMENT PROBLEM

Replacement study can be classified into two categories:

(a) Replacement of assets that deteriorate with time (Replacement due to gradual failure, or wear and tear of the components of the machines).

This can be further classified into the following types:

- Determination of economic life of an asset.
- Replacement of an existing asset with a new asset.

(b) Simple probabilistic model for assets which fail completely (replacement due to sudden failure).

DETERMINATION OF ECONOMIC LIFE OF AN ASSET

Any asset will have the following cost components:

- Capital recovery cost (average first cost), computed from the first cost (purchase price) of the machine.
- Average operating and maintenance cost (O & M cost)
- Total cost which is the sum of capital recovery cost (average first cost) and average maintenance cost.

A typical shape of each of the above costs with respect to life of the machine is shown in Fig
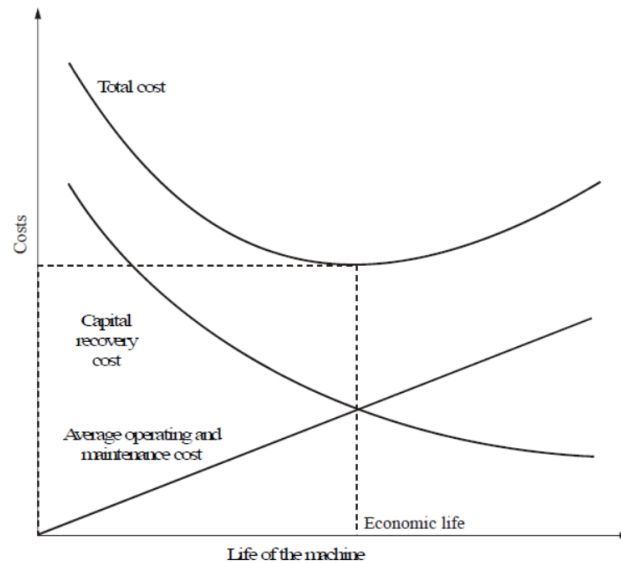
From Fig. it is clear that the capital recovery cost (average first cost) goes on decreasing with the life of the machine and the average operating and maintenance cost goes on increasing with the life of the machine. From the beginning, the total cost continues to decrease up to a particular life and then it starts increasing. The point where the total cost is minimum is called the economic life of the machine. If the interest rate is more than zero per cent, then we use interest formulas to determine the economic life.

EXAMPLE 8.1. A firm is considering replacement of an equipment, whose first cost is Rs. 4,000 and the scrap value is negligible at the end of any year. Based on experience, it was found that the maintenance cost is zero during the first year and it increases by Rs. 200 every year thereafter.

(a) When should the equipment be replaced if $i = 0\%$?

(b) When should the equipment be replaced if $i = 12\%$?

(a) When $i = 0\%$. In this problem,

(i) First cost = Rs. 4,000

(ii) Maintenance cost is Rs. 0 during the first year and it increases by Rs. 200 every year thereafter.

This is summarized in column B of Table.

End of year (n)	Maintenance cost at end of year	Summation of maintenance costs	Average cost of maintenance through year given	Average first cost if replaced at year end given	Average total cost through year given
		ΣB	C/A	4,000/A	D + E
A	B (Rs.)	C (Rs.)	D (Rs.)	E (Rs.)	F (Rs.)
1	0	0	0	4,000.00	4,000.00
2	200	200	100	2,000.00	2,100.00
3	400	600	200	1,333.33	1,533.33
4	600	1,200	300	1,000.00	1,300.00
5	800	2,000	400	800.00	1,200.00
6	1,000	3,000	500	666.67	1,166.67*
7	1,200	4,200	600	571.43	1,171.43

*Economic life of the machine = 6 years

Column C summarizes the summation of maintenance costs for each replacement period. The value corresponding to any end of year in this column represents the total maintenance cost of using the equipment till the end of that particular year.

(b) When interest rate, i = 12%. When the interest rate is more than 0%, the steps to be taken for getting the economic life are summarized with reference to Table

End of year (n)	Maintenance cost at end of year	P/F, 12%, n	Present worth as of beginning of year 1 of maintenance costs	Summation of present worth of maintenance costs through year given	Present worth of cumulative maintenance cost & first cost	A/P, 12%, n	Annual equivalent total cost through year given
			(B × C)	ΣD	E + Rs. 4,000		F × G
A	B (Rs)	C	D (Rs.)	E (Rs.)	F (Rs.)	G	H (Rs.)
1	0	0.8929	0.00	0.00	4,000.00	1.1200	4,480.00
2	200	0.7972	159.44	159.44	4,159.44	0.5917	2,461.14
3	400	0.7118	284.72	444.16	4,444.16	0.4163	1,850.10
4	600	0.6355	381.30	825.46	4,825.46	0.3292	1,588.54
5	800	0.5674	453.92	1,279.38	5,279.38	0.2774	1,464.50
6	1,000	0.5066	506.60	1,785.98	5,785.98	0.2432	1,407.15
7	1,200	0.4524	542.88	2,328.86	6,328.86	0.2191	1,386.65*
8	1,400	0.4039	565.46	2,894.32	6,894.32	0.2013	1,387.83
9	1,600	0.3606	576.96	3,471.28	7,471.28	0.1877	1,402.36
10	1,800	0.3220	579.60	4,050.88	8,050.88	0.1770	1,425.00

*Economic life of the machine = 7 years

The steps are summarized now:

1. Discount the maintenance costs to the beginning of year 1.

Column D = Column B _ [1 / (1 + i) n] = Column B _ (P/F, i, n) = Column B _ Column C.

2. Find the summation of present worth of maintenance costs through the year given

(Column E = ∑Column D).

3. Find Column F by adding the first cost of Rs. 4,000 to Column E.

4. Find the annual equivalent total cost through the years given.

Column H = Column F (A/P, 12%, n) = Column F x Column G

5. Identify the end of year for which the annual equivalent total cost is minimum.

EXAMPLE2. The following table gives the operation cost, maintenance cost and salvage value at the end of every year of a machine whose purchase value is Rs. 20,000. Find the economic life of the machine assuming interest rate, i = 15%.

End of year (n)	Operation cost at the end of year (Rs.)	Maintenance cost at the end of year (Rs.)	Salvage value at the end of year (Rs.)
1	3,000	300	9,000
2	4,000	400	8,000
3	5,000	500	7,000
4	6,000	600	6,000
5	7,000	700	5,000
6	8,000	800	4,000
7	9,000	900	3,000
8	10,000	1,000	2,000
9	11,000	1,100	1,000
10	12,000	1,200	0

Solution

First cost = Rs. 20,000

Interest rate = 15%

End of year (n)	Operation cost at the end of year	Maintenance cost at the end of year	Sum of operation and maintenance costs at the end of year	P/F, 15%, n	Present worth as of beginning of year 1 of sum of operation & maintenance cost	Cumulative sum of column F through year designated	Salvage value at the end of year	Present worth as of beginning of year 1 of salvage value	Total present worth	A/P, 15%, n	Annual equlant. total cost through year given
			B + C		D × E	ΣF		H × E	G + 20,000 − I		J × K
A	B (Rs.)	C (Rs.)	D (Rs.)	E	F (Rs.)	G (Rs.)	H (Rs.)	I (Rs.)	J (Rs.)	K	L (Rs.)
1	3,000	300	3,300	0.8696	2,869.68	2,869.68	9,000	7,826.40	15,043.28	1.1500	17,299.77
2	4,000	400	4,400	0.7562	3,326.84	6,196.52	8,000	6,048.80	20,147.72	0.6151	12,392.86
3	5,000	500	5,500	0.6575	3,616.25	9,812.77	7,000	4,602.50	25,210.27	0.4380	11,042.01
4	6,000	600	6,600	0.5718	3,773.88	13,586.65	6,000	3,430.80	30,155.85	0.3503	10,563.59
5	7,000	700	7,700	0.4972	3,828.44	17,415.09	5,000	2,486.00	34,929.09	0.2983	10,419.35 *
6	8,000	800	8,800	0.4323	3,804.24	21,219.33	4,000	1,729.20	39,490.13	0.2642	10,433.29
7	9,000	900	9,900	0.3759	3,721.41	24,940.74	3,000	1,127.70	43,813.04	0.2404	10,532.66

(First Cost = Rs. 20,000, Interest Rate = 15%)

*Economic Life = 5 years

Total annual equivalent cost = [Cumulative sum of present worth as of beginning of year 1 of operation and maintenance + Present worth as of beginning of year 1 of salvage value] X (A/P, 15%, n)

Column L = (Column G + 20,000 – Column I) _ Column K = Column J _ Column K

In Column L, the annual equivalent total cost is minimum for n = 5. Therefore, the economic life of the machine is five years.

MODULE – 5

COSTING

INTRODUCTION

Cost accounting is recently used in every sphere of modern day business. Cost means the resources sacrificed for the production of a commodity and accounting refers to the financial information system. Cost accounting system can be described as measurement and reporting of resources used in monetary terms.

Costing and cost accounting

Costing refers to the technique and process of ascertaining cost. The technique consists of the principles and rules for the determining the costs of products and services. Cost accounting is defined as the process of accounting for cost from the point at which expenditure is incurred or committed. It is that specialised branch of accounting which involves classification, accumulation, allocation, absorption and control of costs. The concept of cost accounting is bit wider than costing and cost accounting. It includes several subjects like costing, cost accounting, cost control, budgetary control, and cost audit.

a) Cost ascertainment: Ascertaining the cost of goods produced and services rendered has been the chief function of cost accounting. This purpose is sometimes referred to as product costing or cost accumulation,

b) Cost Analysis: Cost analysis is one of the important function of cost accounting.' Because cost accounting helps in decision making. When making decision, we require information about cost, revenue and other information.

c) Cost control: To control the cost, is the chief motive of every management. Cost information shows the performance of the organization. There are two types of cost control method: Standard Costing and Budgetary Control. Actual costs are compared on the budgeted cost. This help in controlling the cost. Cost forms the subject matter of cost accounting which are the resources scarified to achieve specific objectives.

Objectives of cost accounting

- The cost accounting helps in ascertaining the cost of production of every units, job, operation process, department and service.
- It indicate to management any inefficiency and the extent of various forms of waste, whether as material, time, expense or in the use of machine, equipment and tools.

- It disclose profitable and unprofitable activities so that steps can be taken to eliminate or reduce those from what, little or no profit is obtained or to change the method of production or incidence of cost in order to render such activities more profitable.
- It provides actual figures of cost for comparison with estimates and to assist the management in their price fixing policy.
- It present comparative cost data for different periods and different volumes of production and those by assist the management in budgetary control.
- It record and report to the concerned manager how actual costs compare with standard cost and possible causes of differences between them.
- It indicates the exact cause of increase or decrease in profit or loss shown by the financial accounts.
- It also provides data for comparison cost within the firm and also between similar firms.

Cost classification

The cost can be classified according to their common characteristics as listed below.

1. Behavioural classification
2. Direct and indirect cost
3. Product cost and period cost
4. Relevant and irrelevant cost
5. Real cost
6. Opportunity cost

Behavioural classification

The behavioural classification shows how the cost behaves when production change. According to behavioural classification, there are three types of cost, fixed cost, variable and semi-variable cost.

- **Fixed costs**

Fixed cost is independent of output. Whatever may the output, they remain constant. They are generally time-based. Some typical examples are rent, insurance, taxes, salaries etc. Fixed cost is of two types, committed fixed cost and discretionary fixed cost. The shape of fixed cost curve is presented below: