



UNIT-3

Construction Cost Estimating

Learning Outcomes

By the end of this unit the learner will be able to:

- ✓ Explain the components of estimates
- ✓ Explore different methods for estimation.
- ✓ Discuss the importance of estimation in Construction Projects.

Unit 3

Construction Cost Estimating

Introduction

In construction estimate means working out approximate requirement of various resources required for constructing structure. Resources for construction constitute materials, labour (human efforts), equipment and time. All these resources are closely linked with money. It is, therefore, customary to estimate the money required for constructing a structure. Estimating is, therefore, very commonly understood to be working out the approximate cost they will have to be spent for creating a structure. This cost is worked out before the construction is started, it relates to future. There being uncertainties about the future, estimate has therefore an element of approximation. The actual cost is known only after the structure is completed.

All the parties/agencies associated with the construction i.e., owner/user, architect, contractor, supervisors are all interested in estimates. Estimates are needed in different stages of the project. A good estimate should be as close to the actual cost of construction.

In this unit we shall consider different aspects of estimation of a construction work. The unit will begin with broad idea of what a construction is and the procedure of preparing an estimate. Subsequently the estimation during different stages of the construction project will be discussed.

Estimate of a Construction Project

Purpose of an Estimate

Before the construction of structures is taken up all those concerned with it want to know the cost of the work involved. The owner/user wants to know the cost;

- i) to provide necessary funds, and
- ii) to compare the offers given by tenders, if the owner intends to entrust the work to a contractor. He intends to select the most competitive as he is interested in constructing the structure at the lowest price.

A contractor is interested in the project estimates to ensure that;

- i) he can earn a reasonable profit, and
- ii) he can organise various resources to complete the construction.

The consultant and/or architect also have interest in the estimates of cost to

- i) charge appropriate consultation fee to the client,
- ii) Assist the client in selecting the contractors.

Components of an Estimate

Construction of a structure involves a number of activities e.g. construction of a building will involve excavation for foundations, masonry, concreting, timber work, plumbing for water supply and drainage, electrification etc. These activities in turn consume resources such as materials, human efforts in the

form manual work put in by skilled and unskilled work, equipment, supervision etc. All these resources cost money and hence the cost of the resources constitutes the basic cost of constructing a structure. In addition we must consider costs of related items like preliminary works before starting, winding works after completion, fees for licenses, permits, consultancy etc.

Construction projects pass through various phases and a number of agencies are associated with it. Estimate of costs is necessary for each agency and for each phase to serve a specific purpose. The estimation during different phases and different purposes is discussed in the following sections.

Estimation during Feasibility Studies

Before a construction project is taken up for execution it is necessary to establish its feasibility. Project feasibility has to be tested on both technical and financial grounds. Technical feasibility ensures that the structure can be constructed with the available technology i.e. materials, design methods, construction methods etc. Financial feasibility ensures that the money spent on construction of the structure is commensurate with utility of the project viz. service rendered or returns yielded. Feasibility studies help us to seek answers to the following questions:

- a) Should the construction project under consideration be taken up for execution or be dropped because of prohibitive costs '?
- b) If two alternative projects are available which one is preferred from economical point of view?
- c) For a project which alternative from the viewpoint of layout, materials, method of design and construction is more economical?
- d) What is the economic size of the project?

Estimate of costs help us find the answer to these questions. These estimates are known as feasibility estimates. They are done in the very early stage of the project mainly to establish its feasibility. They have to be done in a short time and are very approximate. They are therefore known as approximate estimates. No doubt an estimate always has an element of approximation but approximate estimates are not of much assistance in the execution of project.

Quick Method of Approximate Estimate

Quick method of estimating approximate cost of a new structure consists of two steps:

- 1) To work out the total units involved in the structure based either on physical parameter e.g. square metres of plinth area, cubic metres of volume of building, length of road or service/utility rendered by the project e.g. area irrigated in hectares, number of students in a school or college; number of beds in a hospital etc.
- 2) Multiply the above by the known cost of the structure per unit.

Cost Data

To enable the estimator to arrive at the reliable unit rates to be used in approximate estimating it is necessary for the site supervisors to keep cost data sheets on the work site on construction operation

(during execution of a project) detailing total cost of materials, labour, equipment etc. The resultant unit cost per structure is then worked out. In addition to being useful in checking the actual cost estimated at the starting of the project, this unit rate also serves as the basis of preparing an approximate estimation of a similar project in future. It is however, essential for an estimator to take into account.

- i) variations in the prices of materials, labour and equipment that might have taken place since the completion of the project forming the basis of unit rate,
- ii) difference in the site conditions, design methods, materials, method of construction etc for the new structure, and
- iii) Possibility of variations in the labour and equipment outputs likely to occur due to change in conditions and place when new structure will be constructed. Reliability of the approximate estimate depends on
 - a) Accuracy of cost data maintained, and
 - b) Price adjustments done to account for the change in the conditions mentioned in sub-section above.

Estimation during Project Report Stage and for Project Approval Execution Strategy

After the feasibility of the construction project is established and the project is considered for execution next stage will be preparation of a project report which includes essential details which help execution of project. They are:

- i) layout of the project,
- ii) design and drawings,
- iii) technical specifications, and
- iv) Estimates of cost.

The project report and cost estimates also help in getting the approvals of the competent authority. Before taking up estimation for the project report the layout of the works, design, drawings and technical specifications should be completed. It is therefore essential, at the stage of preparation of project report, that user/owner decides the execution strategy which decides

- a. whether the project will be taken departmentally or through contract,
- b. if by contract what type of contract will be chosen and how the contractor will be selected.

Decision regarding execution strategy helps the client in preparing the right type of estimates.

Estimating Procedure

i) Items and Units

From the drawings (and with the help of specifications) estimator prepares list of the activities to be performed. This constitutes the list of items which further forms the basis for bill of quantities, Activities could be

- a. line out,
- b. excavation for foundation,
- c. foundation concrete,
- d. masonry, and
- e. timber work RCC work, etc.

For each item a suitable unit is chosen which will be the basis of measurement for estimating and later on for the basis for tendering and making payment to the contractor. Units chosen for measurement are

- a. length/width/height for say pipe line, kerb etc.,
- b. area for plastering, painting,
- c. volume for masonry, earth work, concreting etc., and
- d. Number for items like wash hand basin, water closets.

In addition to these units provisions are made on lump sum /job basis for those items which are not on measurement wise.

ii) Taking off the Dimensions

For all the items listed as above the appropriate dimensions are taken off , the drawing and the quantities are worked out in the respective units with due allowances for deductions for the portions where the work is not done e.g. openings for doors and windows. The result of the two above steps is a list of items together with their quantities and the units. The items are further priced at the rates per unit of item which are built up on the consideration of resources required for unit of items.

Each item of the construction requires;

- a. materials, and
- b. labour and equipment.

It is necessary to build up material rate, labour rate and equipment rate for each item.

iii) Materials Rate

Estimator should know the quantity of material (of specified requirement) for each unit item. This is worked out on the basis of specifications of the item. Price of the material is obtained from the quotations from the suppliers. Over and above the price of procuring the material it is necessary to add expenditure to account for:

- a. transport of the material,
- b. loading and unloading,
- c. handling on site,
- d. storing, watch and ward, and
- e. Wastage to cover breakage, losses, inevitable pilferages etc. which may vary from 2% to about 10%.

Information on the above points enables us to build up the cost of materials required for unit item.

iv) Labour Rate

Labour rate for a unit item depends on the category and number of labour employed. Category depends on the trade (carpenter, mason, bar bender etc.). Number of labour depends on the quantity of item and output of labour per unit time -- a working day. Labour output is the most uncertain plan. It depends on the factors like skill of the worker, site organisation, weather conditions and many other factors which are often beyond the control of supervisor. Records of labour output for all the trades have to be kept on site for many years noting varying conditions under which they are observed. A comprehensive lists of unskilled, semi-skilled and skilled time are compiled. These lists are helpful in working out the labour components (in terms of labour days) for each unit item. The estimator has then to calculate cost of the labour per head per day i.e. the labour rate. This depends on the following factors:

- a. Basic wage primarily governed by the prescribed minimum wages or fair wages.
- b. Payment for inclement weather when the labour reports to work but cannot be assigned any work or can do work only for a part of the day due to unfavourable weather or heavy rains.
- c. Paid holidays.
- d. Expenditure incurred on travel, labour camps.
- e. Overtime payment.
- f. Sickness benefits.
- g. Insurance.
- h. Any other payment as per statutory requirement.
- i. Conveyance of labour.

Generally the payment for items (b) to (i) are included as a percentage of the basic wage.

v) Equipment Rate

On the lines similar to the labour rate, equipment rates are also calculated. Equipment hours required for an item depend on the quantity of the item and the output of the equipment under the conditions of use. The equipment rate can be worked out either on the basis of equipment hour or the unit output of the item. Equipment rate is based on

- a. Cost of Capital Investment.
- b. Depreciation.

- c. Cost of Fuel & Lubricants.
- d. Repairs & Maintenance.
- e. Salaries of Operators & Helpers.
- f. Allowance for possible idle time.
- g. Insurance.
- h. Any other related expenses.

On the basis of cost of materials, labour rate and equipment rate the unit rate for each item is worked out, which is then used for working out the cost of the item. For items which are not amenable to accurate measurement lump sum provision is made on the basis of past experience or the judgement of the estimator about the work content.

The cost worked out as above constitutes the cost of the work portion. To this are added the following costs:

- a. Expenditure on surveys, data collection, design, drawings and estimating.
- b. Land Acquisition.
- c. Establishment required during the execution of work.
- d. Allowance for unforeseen works that may be found necessary in the course of execution.
- e. Overhead expenses to be incurred on the site as well as in head office.

All the costs mentioned above add up to the total cost of the project.

vi) **Project Approval**

Project report together with the estimate of cost must receive the approval of the competent authority. For the construction projects two types of approvals are sought for.

a. **Administrative Approvals**

This is the first stage approval. It is obtained from the competent authority of the user department. Thus when Health Department wants to construct a hospital it approaches the **Public Works Department** to take up construction of the hospital building. PWD carries out feasibility studies. Prepares the layout and rough drawings and specifications on the basis of which approximate cost estimates are prepared as explained in the earlier paragraph. These approximate and drawings are forwarded to the user department for approval. This is known as administrative approval and is an indication of acceptance of the proposals by the user department and its commitment to make the funds for the project available by PWD.

b. **Technical Sanction**

On receipt of the administrative approval the PW Deptt takes up the work of detailed design, drawings and estimates as a first step to take up construction. Detailed report comprising designs, drawings, specification and estimates of cost have to be approved by the competent authority of PW Deptt.

Estimating for Planning Bill of Quantities

Departmental Construction

Bill of quantities is a statement showing the item/activities with their quantities and unit of measurement. This statement supported by the specification assists planning, scheduling and field execution of the project. If the construction is to be done departmentally the approved project estimates serve this purpose. These estimates will have to be supplemented detailed working drawings and estimated as and when required during the course of construction. These estimates will be, normally within the provisions of the sanctioned estimates and have to be approved by the competent authority.

Construction through Contract

For the construction work entrusted to a contractor the owner furnishes a bill of quantities if he intends to obtain offer from tenderer on item rate basis. Such a bill of quantities is prepared by the client by extracting those items from the sanctioned estimate which are proposed to be entrusted to a contractor. Tenderer will quote his rates against the items of bill of quantities.

Tenderer will, however, prepare his own bill of quantities which forms the basis of his offer and later assist him in planning, scheduling and construction of the work.

Programme of Work: As a prerequisite to the preparation of contractor's bill of quantities, he should

- i) study the tender documents very carefully,
- ii) visit the site of work and collect detailed information that will help him in preparing the bill of quantities, and
- iii) prepare a tentative construction programme. This programme shows the principal items of construction, the duration required by them and the scheduled dates of their start and completion. Such a programme is of considerable assistance in accurate pricing of material, labour, plant and equipment, scaffolding etc.

Important divisions of the contractor's bill of quantities are as below:

- i) **Contractors' Own Work**
Many contractors generally carry out only certain items of work by employing their own labour. The contractor should identify these items. He should then build up the rate for the unit item considering materials, labour and plant equipment. The items should be priced on the basis of these rates.
- ii) **Work Done by the Sub-contractor**
Certain items of the work are entrusted by the main contractor to his sub-contractors after obtaining client's approval. The main contractor obtains the sub-contractors' bids, selects the most competitive bid. To this he adds his own expenses and profit, Supervision and any other reason and adds the total amount in his own bill of quantities.

iii) Nominated Sub-contractor and/or Supplier

Main contractor has to get certain portion of the work done by sub-contractor nominated by the owner and/or obtain certain materials from suppliers nominated by the owner. These items are included under provisional sums or prime cost sums. The main contractor has to add for the work he has to do in connection with these items such as unloading, handling, storing, fixing, supervision as well as his margin of profit.

iv) Insurances

The main contractor is required to insure the works against possible damage due to fire or by other risk. Such insurances have to be priced as per the requirement of contract conditions.

General Items

In addition to the above provision has to be made for the following.

- i)** transport to and from the site; erection and dismantling of large plant and equipment.
- ii)** Scaffolding.
- iii)** Setting out works.
- iv)** Watch and ward.
- v)** Providing and maintaining access roads to the site as well as of facilities like offices, stores, canteen, roads, and latrines in the works area.
- vi)** Lighting and water and power.
- vii)** Bailing out water.
- viii)** Telephone facilities.
- ix)** Expenditure on hospitality.
- x)** Any other related expenditure.

All the expenses discussed above total up to the cost which the contractor will have to spend on the construction work. By addition of profit margin the contractor will arrive at the price he can offer to the client.

Estimating for Planning and Scheduling of Construction

When the constructor intends to start the actual construction work in the field he has to prepare construction programme which indicates planning i.e. sequence in which he would take up various activities of the project and scheduling i.e. starting and completion of each activity. Planning and scheduling enables the contractor to organise the resources required which would involve

- i)** placing orders for materials with the selected vendors,
- ii)** taking deliveries, transporting, storing of materials,
- iii)** Recruiting and selecting human resources - labour, supervisors, engineers, managers etc.
- iv)** Procurement, transport, erection and dismantling of equipment and plant, and
- iv)** Payment of wages and salaries.

Constructor has to plan the programme of expenditure. This is done with reference to the bill of quantities prepared before the commencement of the work. Activities or part thereof to be taken up on

a unit of time (say a day) is noted from the construction programme. Estimated cost of the activities or their parts is identified from cost estimates and expenditure per unit time (day or week) is worked out. Thus the estimating for planning and scheduling would involve;

- i) preparation of bill of quantities,
- ii) preparation of construction programme,
- iii) identifying the activities to be taken up as per the programme, and
- iv) splitting the costs of items identified in (iii) above.

Estimation for Variations

Variations become necessary during the construction of a structure. Variations may be necessary due to the following reasons.

- i) user intends to introduce changes in the structure, and
- ii) Changes in assumptions made at the time of design and drawing, e.g, foundation depth may differ during the construction.

Variations may take one or more of the following forms:

- i) additional work,
- ii) deletion of work, and
- iii) Alteration or replacing an existing item by a new item.

Cost of the work will change due to variation. It is necessary to estimate the change in the cost due to the introduction of variation. Construction supervisor can play a very useful role in estimation of change in the cost. This is done as follows:

- i) **Additional Work**

Cost of additional work will be extra cost to be added to the cost of the work originally approved. Items of additional work are listed and their quantities are worked out. Rates for these items are arrived at in the same manner as one do for all new item. Price of the additional work is calculated on the basis of these rates.

- ii) **Deleted Work**

Cost of the deleted work will have to be deducted from the approved cost. Items deleted are identified, the quantities which are not executed are worked out and their cost at the estimated rates is worked out.

- iii) **Alteration**

Estimation for the cost of these works comprises two points i) cost of the new item is worked out as in (i) above while the reduction in the cost due to items replaced is worked out as in (ii) above. The difference in these two will be the result of alteration. If (i) is more than (ii) alteration will increase the cost of the work. If (i) is less than (ii) alteration will reduce the cost of the work.

Estimating, for Revision of Project Budgets

Project Budget

Budget can be defined as a plan for future against which the progress actually achieved is measured. Planning for a construction project is done in the form of construction programme. It shows the sequence in which the activities will be taken up. Before starting an activity it is necessary to initiate action to organise the resources required by the activity. Thus if the date on which the concrete is to be poured is decided and it takes up a week to place orders for resources like cement, aggregates and get them on site in time to start pouring concrete on the scheduled date the procurement of the resources has to be initiated one week before the date of pouring. Expenditure on concreting activity will have to be incurred ahead of the actual - concrete. It will be obvious from this the construction programme prepared in terms of start and completion of activities will have to be translated into

- i) work related to activities in progress and the cost thereof, and
- ii) work related to activities to be taken up in future 'and costs thereof.

This can be illustrated with a case:

- i) Construction supervisor has to continue masonry work next day by employing labour. He will have to pay labour wages.
- ii) He has planned to start concreting work for which he has to convey material to the site work. He has to spend on conveyance chargeable to the item of concrete.
- iii) He has to place order for certain materials for the work to be started next week. He has to pay advance with the orders. This expenditure is chargeable materials for the concerned item.

It is thus possible to prepare detailed programme of expenditure to be incurred on any day together with the items (and sub-items) to which these items are chargeable. This constitutes the project budget for the field staff.

Revised Project Budget

Very often the project budget prepared at the beginning may need revision from time to time during the execution of work. Revision may have to be done due to the following reasons:

- i) Progress actually achieved varies when compared to the planned targets. Some of the activities may be delayed or may be finished earlier.
- ii) Variations become necessary due to either addition, deletion or alterations
- iii) Prices may undergo changes during the execution.

The net result of the above may change in the programme of works and programmed expenditure. The construction supervisor will have to evaluate the changes correctly and their effect on the budgets so on to formulate revised project budget.

Further Reading:

- ✓ *Martin Brook, (2008), Estimating and Tendering for Construction Work*
- ✓ *David J. Pratt, (2004), Fundamentals of Construction Estimating*
- ✓ *Brian Greenhalgh, (2013), Introduction to Estimating for Construction*