Cost Estimation of Construction Projects

An Online Continuing Education Course for Engineers

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Cost Estimation of Construction Projects

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I. Introduction

The purpose of this course is to enable the student to gain fundamental knowledge of estimating the cost of construction projects. The information contained in this course presents the basic concepts to assist the student in understanding the estimating process and procedures.

Estimation is not an exact science. Knowledge of construction, common sense, and judgment are required. The estimator and his team play a vital role in preparing estimates. The estimator must review and check all parts of an estimate to ensure realistic costs. He must also document the estimate so that it can be used for cost control during the construction process.

The aim of estimation is to determine the costs required to complete a project in accordance with the contract plans and specifications. For a given project, the estimator can determine the direct costs for labor, materials, and equipment. The bid price can then be determined by adding the costs for overhead (indirect costs), contingencies (costs for any potential unforeseen work), and profit to the direct cost. Because the estimate is prepared before the project is constructed, the estimate is, at best, a close approximation of the actual cost. Estimates are performed throughout the life of the project.

Estimates are classified as approximate estimates and detailed estimates. Approximate estimates are also called feasibility, screening, authorization, preliminary, conceptual, order-of-magnitude, equipment-factored, or budget estimates. Detailed estimates are also called final, bid/tender, or definitive estimates. Approximate estimates are sufficiently accurate for the evaluation of design alternatives or the presentation of preliminary construction estimates to the owner. Detailed estimates are prepared by determining the costs of materials, labor, equipment, subcontract work, overhead and profit. The detailed estimate is important to both the owner and the contractor. A significant amount of work is performed by subcontractors who specialize in a particular type of work. Examples include clearing, drywall, painting, roofing, guard rails, striping, signs, and fences, etc. Estimate includes both direct and indirect costs. Direct cost comprises of material, labor, equipment, and subcontractor costs. The quantity of material in a project can be accurately determined from the drawings and the different cost of material can be obtained from material suppliers. Multiplying the total quantity of work with the corresponding unit cost of the material gives the total cost of the material. If equipment is used, a similar procedure is adopted to get the equipment cost. Adding labor, material and equipment costs gives the direct cost total. Indirect cost comprises of mobilization, field office expenses, taxes, bonds, insurance, final

cleanup, and overhead expenses required to complete the project. Taxes on labor and material vary depending on the location. Besides, social security tax and unemployment tax must be added. These taxes vary from year to year and they must be ascertained to include in the estimate. Bonds include bid bond, material and labor payment bond, and performance bond. The bid bond ensures the owner that the contractor will sign a contract for the bid amount. Usually it is about 5 percent of the construction cost of the project. The performance bond ensures the owner that the contractor will perform all work in accordance with the contract documents. The payment bond ensures the owner that all material labor and material will be paid. The above two bonds will be usually about 100 to 200 percent. Insurance requirement includes workmen's compensation, contractor's public liability & property damage, and builder's risk insurance. The base estimate is the total of direct and indirect costs. An appropriate contingency is added to the base estimate to account for risk and uncertainties in pricing, escalation of prices, schedule changes, and unintended omissions and errors. Contingency is a real and necessary component of an estimate. Finally, a profit is added and it depends upon numerous factors such as size and complexity of project, accuracy and completeness of design documents, competition for work, availability of money, and volume of construction activity in the project area. It ranges from 5 percent for large projects to 30 percent for small high risk projects.

Section II of the course describes, in general terms, the estimating process and procedures while Section III describes in detail the conceptual cost estimating process with numerical illustrations. Section IV shows how to estimate the cost of labor and equipment used in a project. Section V to IX details cost estimating of projects in the areas of transportation of material, earth excavation, foundation, concrete structures, and masonry supported by numerical examples. Section X shows a typical example for a total cost of a project. It includes, in addition to the construction costs, all other indirect costs.

II. Estimating Process And Procedures

Estimating is a process. Information must be assembled, evaluated, documented, and managed in an organized manner. People involved in preparing the estimate must know their role, responsibility, and authority. Effective communications among members of the estimating team are essential to selecting the estimate methodology, collecting project data, confirming historical cost information, organizing the estimate to the desired format, reviewing and checking the estimate, and documenting the estimate after it is complete. Figure II.1 shows Estimating work progress.

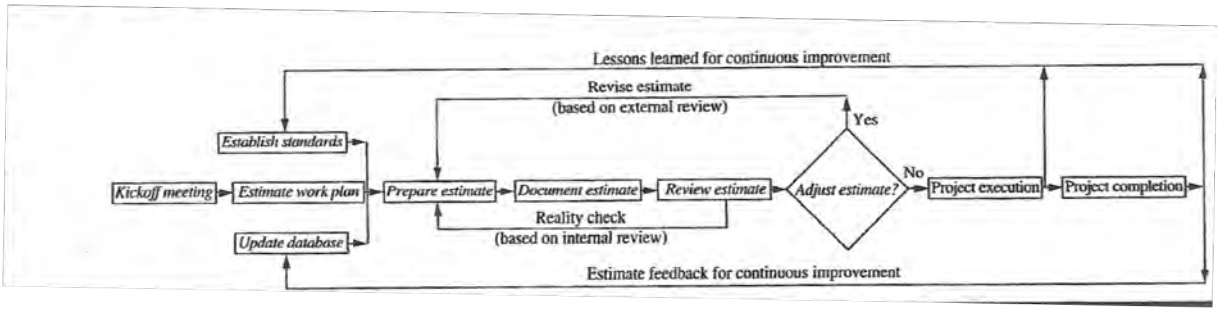

Figure II.1 Estimating work progress

The first step is the kickoff meeting which provides background information about the project to the estimating team, expectations of the team, and any pertinent information that may be needed to prepare the estimate. The next step is to establish a work plan prior to starting the estimating process. The work plan identifies the work that is needed to prepare the estimate, including who is going to do it, when it is to be done, and the budget for preparing the estimate. The work plan should contain sufficient detail to enable all members of the estimating team to understand what is expected of them.

Selection of the method of preparing an estimate depends upon the level of scope definition, time allotted to prepare, desired level of accuracy, and intended use of the estimate. As the estimate is being prepared, it is important to perform "reality checks" to make sure the costs developed are within reason.

The quality of an estimate is governed by the following considerations:

1. Quality and amount of information available for preparing the estimate.
2. Time allocated to prepare the estimate.
3. Proficiency of the estimator and the estimating team.
4. Tools and techniques used in preparing the estimate.

The preparation of an estimate involves the following:

1. Development of construction methods.
2. Preparation of the construction schedule.
3. Material quantity takeoffs.
4. Assessment of risks for contingency.

For accuracy, an investigation of the physical characteristics of the project site must be conducted. The schedule is an integral part of the estimate. Estimate documentation is essential as it improves communication between the estimating team and management, establishes a mechanism for estimate reviews, and forms a basis for early project cost control.

Once the estimate is complete, a detailed review should be made. The number of reviews will vary depending on the size of the project, type of estimate and, the length of time allowed for preparing the estimate. For any estimate there should be at least two reviews, one during the development of the estimate and the other at or near the completion of the estimate. The final estimate review is more a structured process and the review meeting may be lengthy.

A final project cost report must be prepared and it is an extremely valuable document to capture lessons learned for improving future estimates. It provides a real feedback to compare with the original cost estimate. Estimate feedback is an integral part of the estimating process.

III. Conceptual Cost Estimating

Always owners want to know the approximate cost of a project in order to evaluate the economic feasibility for proceeding with the project. A conceptual cost estimate provides such approximate cost of the project. A conceptual cost estimate is identified by the information from which the estimate is compiled and is classified into three levels as shown below:

1. Level 1 –It is an estimate prepared from the description of the project scope where there is little or no design. The accuracy of this estimate falls between +40 and -10 percent.
2. Level 2 – It is an estimate prepared upon completion of preliminary design and the accuracy of which falls between + 25 and -5 percent.
3. Level 3 – It is an estimate prepared upon completion of the final design and the accuracy of which falls between +10 and -3 percent.

The conceptual estimate is generally prepared by the owner as part of economic feasibility analysis or by the designer during the design phase for selecting the design alternatives or by the contractor for negotiated work between owner and a contractor. The preparation of conceptual cost estimates requires knowledge and experience with the work required to complete the project. Cost information from previous projects of similar type and size is essential. From the cost records of previous projects, the estimator can develop unit costs to forecast the cost of future projects. The unit cost is developed from weighting of the data that emphasizes the average value, yet it accounts for the extreme maximum and minimum values. The following equation is used for weighting cost data from previous projects:

$$UC = (A + 4B + C)/6 \quad \text{.....Eq.(III.1)}$$

where UC = forecast unit cost

A = minimum unit cost of previous projects

B = average unit cost of previous projects

C = maximum unit cost of previous projects

Problem III.1 illustrates the weighting of the cost data from previous projects to forecast the unit cost of a proposed project.

Problem III.1.

Cost data from eight previously constructed parking garage projects is shown in Table III.1.

Project	Total Cost	No. of Car Spaces
1	$466,560	150
2	$290,304	80
3	$525,096	120
4	$349,920	90
5	$259,290	60
6	$657,206	220
7	$291,718	70
8	$711,414	180

Table III.1 Cost data of previously constructed projects

Use the weighted unit cost to determine the conceptual cost estimate for a proposed parking garage that is to contain 135 parking spaces.

Solution:

From the data provided in the Ta… …ce is calculated for each project by dividing t… …d the result is shown in Table III.2 below:

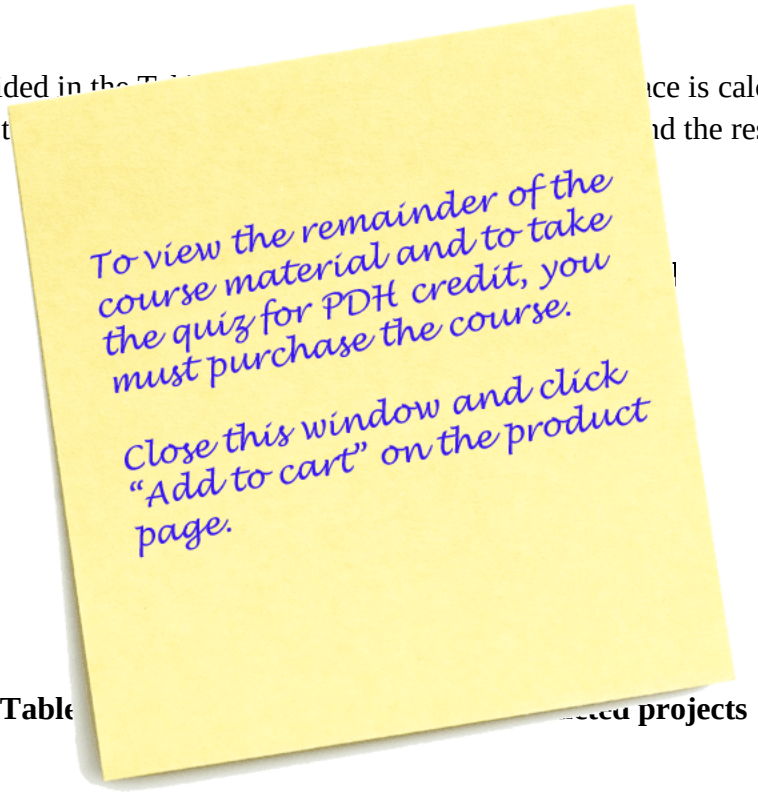

Table … …ted projects