

# **Solution Manual**

## **for**

# **Estimating Construction Costs**

### **Sixth Edition**

**Prepared by**

**Garold D. Oberlender, Ph.D, P.E.**

**Carisa H. Ramming, P.E.**

# Contents

|                                                            |     |
|------------------------------------------------------------|-----|
| Chapter 1 – Introduction .....                             | 4   |
| Chapter 2 – Bid Documents .....                            | 4   |
| Chapter 3 – Estimating Process .....                       | 6   |
| Chapter 4 – Conceptual Cost Estimating .....               | 8   |
| Chapter 5 – Cost of Construction Labor and Equipment ..... | 11  |
| Chapter 6 – Handling and Transporting Material .....       | 21  |
| Chapter 7 – Earthwork and Excavation .....                 | 32  |
| Chapter 8 – Highways and Pavements .....                   | 46  |
| Chapter 9 – Foundations .....                              | 59  |
| Chapter 10 – Concrete Structures .....                     | 65  |
| Chapter 11 – Steel Structures .....                        | 74  |
| Chapter 12 – Carpentry .....                               | 76  |
| Chapter 13 – Roofing and Flashing .....                    | 84  |
| Chapter 14 – Masonry .....                                 | 86  |
| Chapter 15 – Floor Systems and Finishes .....              | 91  |
| Chapter 16 – Painting .....                                | 94  |
| Chapter 17 – Plumbing .....                                | 99  |
| Chapter 18 – Electrical Wiring .....                       | 104 |
| Chapter 19 – Sewerage Systems .....                        | 109 |
| Chapter 20 – Water Distribution Systems .....              | 109 |
| Chapter 21 – Total Cost of Engineering Projects .....      | 109 |
| Chapter 22 – Computer Estimating .....                     | 110 |

## Introduction

This solution manual is intended as a guide for instructors using the textbook, *Estimating Construction Costs, 6th edition*. Estimating is not an exact science. It involves the process of forecasting the cost and/or time to perform construction operations based on assumed conditions. The assumed conditions include labor and equipment productivity, cost of materials, hourly rates of labor and equipment, and job conditions unique to each project.

Before assigning problems to the students, it is helpful for the instructor to first read the solutions contained in this manual, in particular the assumptions that are made in arriving at the final solutions. Obviously, different assumptions will produce different end results. For example, one estimator may assume a 45-min. effective hour, whereas another may assume a 50-min. effective hour. Similarly, one person may assume a 5% waste of materials, whereas another may assume 10% waste. Thus, the solutions to some of the problems appearing in this publication may differ from the solutions obtained by other persons, with both solutions being correct for the assumed conditions. For this reason the correctness of solutions to the problems should be based on the conditions assumed by the student and his or her mathematical solution of the stated problem.

## Chapter 1 – Introduction

---

Chapter 1 has no homework problems

---

## Chapter 2 – Bid Documents

---

**2.1 Review the sections of *Instructions to Bidders* and *Bid Forms* in Division 00 in the appendix of the book and prepare a list of items the estimating team must address as they prepare a bid for the project.**

- Instructions to Bidders:
  - Receipt and opening of bids
  - Bid submissions
  - Withdrawal of bids
- Bid Forms:
  - Base bid
  - Alternates

**2.2 As discussed in this chapter the bid document becomes a legal document when the owner and contractor sign the contract agreement. Prepare a list of items that are in the bid documents that are no longer applicable when the contract is signed.**

- Advertisements for bid
- Instruction to bidders
- Bid form
- Bid bond

**2.3 Obtain copies and compare the general conditions of the contract from three sources: the American Institute of Architects (AIA), the Associated General Contractors (AGC), and the Engineers Joint Contract Documents Committee (EJCDC).**

The answer to this question will vary, depending on depth of analysis by the student. Responses will likely address emphasis on building type projects in the AIA and AGC document, and infrastructure type projects in the EJCDC documents, etc.

**2.4 Obtain specifications from three sources: your local city government, your state department of transportation (DOT), and the American Association of State Transportation and Highway Officials (AASHTO). Summarize the list of major divisions of these three sources.**

The answer to this question will vary, depending on depth of analysis by students. Local city government's pertain to commercial and residential buildings, city streets, water, and sewer type projects. AASHTO and DOT pertain to infrastructure type projects in the transportation industry.

**2.5 Discuss problems that may arise during contract negotiations between the owner and contractor when the contractor's bid summary is by materials (such as concrete, metals, etc.), rather than by completed facilities (such as Building A, Building B, Parking Lot, etc).**

The owner generally is interested in the cost of major components of the project, rather than the cost of construction materials. For example, if the estimated cost exceeds the owner's permissible budget, cuts must be made by eliminating a building, or parts of a building, rather than merely reducing the cubic yards of concrete or pounds of steel. Owners think in terms of facilities and sub-facilities, rather than materials that make up the facilities. During negotiations, the contractor will likely have to reformat the estimate to enable the owner to make decisions on how to derive a contract amount that matches available funds.

**2.6 List problems that may occur for the owner during the bidding phase of a project when the estimated pay quantities in a unit-price contract are lower than the actual amount.**

The contractor may unbalance the bid by decreasing the unit price of the under estimated quantity and increasing the cost of another bid item, resulting in increased cost to the owner.

The contractor may underbid the job to win the contract, then look for change orders during construction to obtain additional money.

**2.7 List problems that may occur for the contractor during construction when the actual quantity of work is lower than the pay quantities in the bid documents.**

The reduced quantity of work may result in reduced profit for the contractor.

The contractor may have an excessive number of over-sized equipment on the job, resulting in reduced profit.

The contractor may file a claim against the owner, which will cause legal expenses.

**2.8 Sometimes "Lump-Sum Contracts" are called "Hard-Dollar Contracts" or Fixed-Cost Contracts", which infers the bid amount will equal the final cost of the project. Prepare a list of methods a contractor may use to obtain costs above the bid amount.**

The contractor may underbid the job to win the contract and then issue change orders for additional cost.

The contractor may file claims against the owner of the project.

---

## Chapter 3 – Estimating Process

---

### 3.1 List and briefly describe the important factors that should be included in estimating procedures.

#### Construction methods:

- Decision must be made on the plan of construction operations
- Operations to be performed by contractor's personnel and work to be subcontracted.
- Availability of contractor-owned equipment
- Consider skills and experience of contractor's personnel

#### Construction schedule:

- Before starting the estimate, provide a schedule based on the construction methods
- Include milestones that are established in the bid documents
- Consider weather, safety, and lead-time for procuring materials or special equipment
- Use the construction schedule to determine the required resources

#### Quantity takeoff:

- Takeoff quantities in accordance with the method of measurements for payments
- Quantity takeoff should follow the sequence of construction
- Ensure a system of quantity takeoff that does not omit items or duplicate items
- Develop periodic reviews and checks during the takeoff process

#### Estimate of cost:

- Ensure reliable historical cost records from previous jobs
- Perform periodic reality checks on the reasonableness of the cost estimate
- Prepare a well-documented summary of cost estimate
- Perform a risk assessment and risk analysis for contingency

#### Assessment of risks:

- Develop a risk assessment method appropriate to each project
- Involve both the project management team and the estimating team
- Perform a risk analysis for assigning an appropriate contingency to the estimate
- Assign contingency based on risk and level of accuracy and level of confidence

### 3.2 Describe the purpose of the kickoff meeting of an estimating team. What are typical issues that should be discussed?

#### Purpose of kickoff meeting of an estimating team:

- Ensure alignment between the customer and project team.
- Provide an orientation for team members, including goals, objectives, and requirements.
- Establish a clear understanding of customer's expectations, priorities, and use of estimate.
- Establish a clear understanding of the estimating team's responsibilities.
- Consider external requirements to assess risks vs. worth of preparing estimate.

#### Typical issues that should be discussed:

- Consider competition of other potential bidders.
- Experience with the architect, engineer, construction manager, and/or owner
- Consider availability of material suppliers and subcontractors.
- Evaluate time allowed for construction, liquidated damages, and owner's ability to pay.
- See Table 3.1 for issues to be considered at the kickoff meeting.

**3.3 Review the material in Chapter 7 on Earthwork and develop a checklist of items that should be included in a detailed estimate of the grading operation for a highway project.**

Conduct a site survey to observe underground utilities, traffic control, obstructions, etc.  
 Study the soil report to identify types of soil, rock formations, underground water, etc.  
 Determine appropriate swell and shrinkage factors based on type of soil.  
 Review plan and profile sheets, cross-sections for volume of material and haul distance.  
 Select type, size, and number of available equipment for construction operations.  
 Obtain equipment production rates from historical records of previous jobs of similar work.  
 Evaluate cycle times, production rates, and total time the equipment will be on the job.  
 Calculate labor and equipment costs based on cycle times, production rate, and time on the job.  
 Add a reasonable contingency based on risk.

**3.4 Discuss the difference between internal and external review of an estimate and describe a situation when an external review might be especially valuable.**

Internal reviews are conducted by the estimate team.  
 External reviews are conducted by parties outside the estimating team.  
 External review are especially helpful for projects that are unusual, such as projects that have work that is different than normally performed by the estimating team's company.

**3.5 What value can be obtained from documenting an estimate, other than minimizing inaccuracies?**

Improves communications between the customer, project team, and estimating team.  
 Helps the estimating team to organize the estimate.  
 Assists the estimating team in review of the estimate.  
 Provides the customer with an appreciation and understanding of the estimate.

**3.6 Review technical journal articles that pertain to risk analysis and risk assessment. Based on your review summarize methods of assigning contingency to the time and cost of construction estimates.**

The answer to this question will vary, depending on the references selected.  
 Students should cite sources of information in their responses. Typically responses will likely include simulations.

**3.7 Interview three estimators, one working for an owner, design, and contractor respectively, to identify factors that each estimator believes is important for preparing accurate estimates.**

The answer to this question will vary, depending on the persons interviewed.  
 Students should cite sources of information in their responses.