

King Fahd University of Petroleum & Minerals
College of Environmental Design
Construction Engineering & Management Department
CEM 511
Construction Estimating
Fall 2005/2006



Detailed cost estimating

Requirements:

- Finalized working drawings and specifications are available.
- Complete and detailed survey of work quantities.
- Identification, compilation, and analysis of many items of cost that will enter into the construction process.
- Intimate knowledge of the prices, availability, and characteristics of material, equipment, and labor.



Highway bridge

Serves as a basis for discussion of project estimating

- Single span vehicular bridge.
- Deck-girder type, and composite steel-concrete construction.
- Two reinforced concrete abutments, each consists of a breast wall and two wing walls.
- Each abutment rests on a heavy concrete footing supported by twenty-eight, 40-foot long H-section steel piles.



Highway bridge

- The ten-inch-thick reinforced concrete paving slab is supported by seven, W36×150 steel floor girders.
- A steel guardrail is required along each side.
- All exposed structural concrete is to be given a rubbed finish.
- Certain bridge surfaces are to be painted.



Highway bridge

- The owner of the project is a public agency.
- Competitive bid on the basis of unit prices.
- Bidding documents including finalized drawings and specifications are in the hands of the bidding contractors.
- Final estimate and presented is prepared by the prime contractor for bidding purpose



Quantity takeoff

- Bid items cannot be priced without breaking the work down into smaller subdivisions.
- The contractor intends to subcontract the painting and thus did not take off its quantities.



Management inputs

- Decisions on how construction operations are to be conducted.
- Includes proposed project manager, the field superintendent, and company personnel who have the authority to make decisions.
- Decisions regarding field supervision, construction methods, general time schedule, and construction equipment are made.



Field supervision

The pricing of a project must take into account the special abilities of key field personnel

- Most supervisors do better in terms of construction costs on some portions of the project than on others.
- Identifying the top supervisors who will be assigned to the project.



Construction methods

Principal construction procedures must be identified before project can be priced.

- Custom, company equipment and experience make most of such choices.
- Choice between feasible alternatives is made after evaluating time and cost characteristics.
- Examples include procedures to be followed in underpinning an adjacent structure, how best to brace an excavation, what method of scaffolding to be used, how to dewater the site.



General time schedule

An approximate construction schedule is important for pricing purposes.

- Many items of job overhead expense are almost directly dependent on the duration of the construction period.
- equipment and labor productivity are affected by the time periods the work items are implemented.



Construction equipment

Detailed pricing of equipment cannot proceed until equipment selections are made in fairly specific terms.

Equipment of the highway bridge:

- Transit-mix concrete obviates need for concrete plant.
- 50-ton crane with an 80-foot boom will be used for pouring concrete, placing structural steel, and driving steel piles.
- A 7200-foot-pound double-acting hammer and a 900 cubic foot per minute air compressor will be used for the pile driving.



Construction equipment

- A low-boy truck trailer and a 25-ton crane will be needed for transport and assembly of the pile driving rig.
- A crawler tractor with bulldozer blade will do the unclassified excavation.
- A 1-cubic yard backhoe will be used for the structural excavation.
- A flat bed truck, troweling machine, and concrete saw.
- Concrete vibrators and assorted small tools.



Project costs

- **Project direct costs:**

Material, Labor, Equipment, and Subcontractors.

- **Project indirect costs:**

Overheads (Project, Office), bonds, and tax.



Material costs

- If the quantity survey has been done with some exactness, materials can usually be priced quite accurately.
- Written quotations for materials are solicited to know the prices, freight charges, taxes, delivery schedule, and guarantees.
- On the highway bridge, the contractor will receive price quotations covering material such as transit-mix concrete, structural and reinforcing steel, steel pilings, and guardrail.



Material costs

- **Material costs when entered on the summary sheets must all be on a common basis:**
for example, delivered to the job site and without sales tax.
- **When owners provides material to contractors, contractors need not add this material price into cost estimates. But handling and inspection costs are added.**



Labor costs

- Labor costs are inherently variable and difficult to estimate.

- Proper labor cost estimate necessitates:

Job analysis.

Historical data.

Decisions on how to conduct operations.

- Labor costs can be estimated either by labor production rates or labor unit costs.



Labor costs

- Labor production rates

concrete placement rate of 10 cy/hr is the production rate for the prescribed concrete crew.

Costs equal the time required to pour concrete (32 hrs) multiplied by the direct hourly wage of the crew (\$145.43) giving total direct labor cost of \$4,654.

The most reliable source of labor productivity information is obtained from cost-accounting reports compiled from completed projects.



Labor costs

- Labor unit costs

It is the direct labor expense per unit of production of a work type.

Labor unit cost to prefabricate abutment forms is \$1.10/sf., multiplying by the total quantity of 1,810 gives the total labor direct costs of \$1,991.

Must be based on the appropriate levels of work productivity and the proper wage rates.

For concrete example, given that the production rate is 10 cy/hr, and direct hourly wage of the crew (\$145.43), the unit expense would be $\$145.43/10 = \14.5 per cy



Equipment costs

Refers to equipment that the contractor uses to construct the project.

For major items of equipment such as earth-moving machines, concrete plants, and truck cranes, detailed studies are made.

For minor items such as power tools, concrete vibrators and buggies, a lump sum allowance for such items is added to total project costs.

Like labor are inherently variable and difficult to estimate.



Equipment costs

Acquiring construction equipment:

- Purchase all new or renovated equipment and sell at the end of the project. The difference between the purchase cost and estimated salvage is entered in the estimate.
- Rent can be advantageous for satisfying temporary peak demand or for providing specialized equipment.
- Leasing is a long term renting is an alternative to equipment ownership.
- Leasing avoids having the contractor's funds tied up in fixed assets.



Equipment costs

- Many leases provide that at the end of the lease period the contractor has purchase option.
- Lease or rental rates are applied to the work items that the equipment will be needed.
- Operating costs such as fuel, oil, grease, filter, repairs and parts, tire replacement and repairs, and maintenance labor and supplies must be included in cost estimate.
- Like labor, equipment expenses such as scraper and excavators is computed by combining production rates with the equipment hourly rate.



Equipment costs

- **Cost of prefabricated concrete forms might be better spread over an estimated number of re-usages.**
- **Cost of towers and scaffolding are best expressed in terms of calendar months.**
- **Cost of concrete-mixing plants, and asphalt-paving plants are expressed as per unit of material produced.**
- **Mobilization and demobilization costs are separately computed for inclusion in the estimate.**



Equipment costs

- **Equipment expense rates**

The sum of Ownership and Operating expense expressed as a cost per unit of time is often referred to as internal rental rate or budget rate.

Use of historical equipment cost records.

O&O costs can be computed by setting up an account that maintain record of all equipment expenses. This data constitute a basic resource for reducing O&O cost to total equipment cost rate.



Equipment costs

- Equipment production rates

Cost-accounting records from past projects is a reliable source.

Production information provided by the equipment manufacturer can be of assistance.

Stopwatch time studies made to obtain productivity of specific equipment is another source of production rates.



Equipment costs

- **Equipment unit costs**

**Driving rate of piles is 70 ft/hr (production rate),
equipment expense rate is \$177.38 per hr.**

Equipment charge per linear foot of pile driven (Equipment unit costs) is $\$177.38/70$, which equals \$2.53.



Subcontractor costs

- The general contractor is completely responsible by contract with the owner for all subcontracted work.
- On the highway bridge, the contractor has made an advance decision to subcontract painting works.
- The contractor does not compile painting costs. Rather, the lowest subcontract bid with the contractor other expenses.
- Subcontractors are evaluated based on past experience, history of reliability and financial stability, and experience and equipment.



Subcontractor costs

- Reinforcing steel

The contractor estimated direct costs as \$42,705.

The contractor received a subbid for \$40,275.

The contractor judges the subcontractor to be honest, reliable, and of good reputation.

The subbid is complete and does not require the contractor to provide specific job-site services.

The use of this subbid will reduce the contractor's bid by a significant amount.

The contractor decided to use the subbid to prepare his bid



Summary sheets

- After the quantity take off has been completed and management inputs have been made.
- On a unit-price job, each summary sheet lists the work types necessary to accomplish the total quantity of a single bid item.
- All quantities pertaining to concrete are transferred to and priced on concrete summary sheets.
- Quantities of other work items are transferred from the quantity sheets to summary sheets for pricing purposes.



Project budget

- Assume that our contractor is the successful bidder.
- Cost estimate must be restructured into a more suitable format for subsequent cost control.
- Project budget is the detailed schedule of expenses that the project manager will use for cost control during the construction phase.
- The work quantities and prices have been extracted from the bid item summary sheets.
- The actual construction expenses of the highway bridge are compared with the programmed costs in the project budget.

