Prepared by Nabil Al-Dmaidi
CHANGING PROJECT DELIVERY SYSTEMS

by

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Traditional Method (Design_then_Build)

- Also known as Design_Bid_Build or hard money or Competitive bid contract.
- Has three sequential phases
  Design - Bid - Construction

Design Phase → Bid/Award → Construction Phase

Architect-Engineer hired

Single Construction Contract
Traditional Organization of Construction

Feasibility

- Specialist and consultants
  - Build the project on paper

- In-house and consulting services
  - Engineering and design
  - Contract documents

- Project approval and selection of A/E

Contract

- Contract design and supervision
- Call for bids
- Single bid package
- Bid acceptance and notice to proceed

Contracting

- Industry participation bidding
- A/E general supervision
  - Planning, engineering, and management
  - Concentration

Use of facility

- Owner user
  - Project completion and acceptance

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Traditional Organization

Owner

A/E

General Contractor

Sub Contractor

Sub Contractor

Sub Contractor

Sub Contractor

Sub Contractor
Estimating Needs for Design-Bid-Build

- Complete set of drawings
- Specification
- Other contract documents
  - General conditions
  - Special conditions
  - Addenda
- Others (soil report)
Hierarchy of Contract Document

- **Addenda**
- **Special Conditions**
- **General Conditions**
- **Specification**
- **Drawing**
Fast Track or Phased Construction Method

Concepts → Working Drawing

Design Phase

CM and A/E or DB hired

Construction Phase

Variable separate construction contracts
Level of Influence

![Graph showing the relationship between influence and project cost over time. The graph illustrates that as influence decreases, project cost increases over time.](image-url)
1. Design Build

- Single firm responsible for both design and construction.
Form of Design_Build Organization

- Owner → Design-Build (Architect/Engineer) → Contractor
- Owner → Design-Build (Contractor) → Architect/Engineer
- Owner → Design-Build (Joint Venture) → Architect/Engineer
- Owner → Design-Build (DB Firm) → Architect/Engineer
Advantages of Design & Build for Owners

- Owner only has to communicate with one entity
- Total project duration can be reduced.
- Integration of construction planning and design phases
- Claims reduction.
- Innovation in design and construction can be encouraged
- Risk assigned to party best able to manage that risk
- Reduce change orders
Disadvantages of DB for Owners

- Fewer checks and balances, owner must rely on integrity of the design-build firm
- Reduced owner involvement in the design process may result in less than expected results
- All your eggs in one basket
Advantages to a design-build organization

- Improved constructability
- A specialized organization can be developed
- Reduction of negligence claims between the Architect/Engineer and the construction contractor since they are under one umbrella firm
- Ability to react rapidly to change in scope
Disadvantages for the design-build firm

- Acceptance of additional project risk
- Possible premature release of bid packages (when using fast track) which can lead to increased errors in the plans and extras
- Scope of work changes can be difficult to identify under DB/ fast track construction
- Heavy overhead due to large multi-disciplined staff requirements
2. Engineer/Procure/Construct (EPC)

EPC Model #1

Owner

Pure CM

In-House Design or Eng.. Firm

CM

Specialty Contractors and Vendor

Specialty Contractors and Vendor

Specialty Contractors and Vendor

Specialty Contractors and Vendor
By soliciting more bids and by passing the savings directly to the owner, the owner saves $15,000 compared to the best general contractor price. This example illustrates four bid packages. Typical commercial building projects may have thirty or more bid packages.
2. Engineer/Procure/Construct (EPC) (cont.)

General Contractor acting as CM

Owner

Engineer/Procure Construct

Specialty Contractors and Vendor
Specialty Contractors and Vendor
Specialty Contractors and Vendor
Specialty Contractors and Vendor

EPC Model #2

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Other Models of Single Source Delivery Systems

- A/E acting as CM

```
  Owner

  A/E and CM

  Prime Contractor

EPC Model #3
```
Other Models of Single Source Delivery Systems (cont.)

CM acting as Contractor

A/E

Owner

Prime Contractors

CM

Contractor

EPC Model #4
Others

Owner

Design Department

Construction Department

Contractors

Optional Own Force Work

CM Owner

Prime Contractors

Subs

A/E

Owner Builder

Owner C.M.

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Estimating Needs for Single Source Delivery

- Conceptual Design
- Assemblies cost data
- Update your estimate as the design develops
- Value engineering studies
Design-Build Issues

1. Prequalification

- The reduction of the number of possible bidders to a small group of serious, qualified bidders improves the effectiveness of the selection process.
Design-Build Issues (cont.)

2. Proposal Evaluation
   - Cost only
   - Cost and time
   - Multiparameter (quality, safety...etc.)
Innovative Contracting Methods

- Multiparameter Bidding (A+B+C)

Multiparameter bidding is a bidding system within the competitive bidding concept where a successful bidder is selected based on the combined cost, time and quality.
Example of Multi-parameter Bidding

<table>
<thead>
<tr>
<th>Contractor</th>
<th>&quot;A&quot;</th>
<th>Bid Contract Time (Days)</th>
<th>&quot;B&quot;</th>
<th>Facility User Cost @ $4000 per Contract Day</th>
<th>&quot;A+B&quot; Cumulative Bid</th>
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</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
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<td>$3,942,724</td>
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<td>$3,231,006</td>
<td>95</td>
<td>$380,000</td>
<td>$3,611,006</td>
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</tbody>
</table>

Lowest Cumulative Bid Cost
Design-Build Issues (cont.)

3. Legal

   a. Insurance and Bonding

      ■ The contractor should have the proper insurance to cover design deficiencies or cover construction errors.

   b. Conflict of Interest

      ■ Design-build eliminates the checks and balances of the traditional methods.
Innovative Contracting Methods (cont.)

- Construction Warranties (DBW)

A warranty is a guarantee of the integrity of a project and of the maker responsibility for the replacement or repair of deficiencies for a period longer than the traditional 1-year warranty.

- It is different than project maintenance warranties that provide routine maintenance
Estimating is not an Exact Science.

It is a group of:

* **Skills** and **experiences**
* knowledge of construction
* knowledge of prices curry
* Common sense
* The judgment required
Estimating material costs can be accomplished with a relatively high degree of accuracy.

Accurate estimating of labor and equipment cost is considerably more difficult to accomplish.
But

- The quantity of materials for a particular job can be accurately calculated from the dimensions on the drawings for that particular job.

- After the quantity of material is calculated, the estimator can obtain current unit prices from the supplier and then multiply the quantity of material by the current unit price to estimate the cost of materials.
Importance of the Estimator and the Estimating Team

- Whether using computer or not.
- The estimator and his or her team play a vital role in preparing estimates.
Information must be:

- Assembled, organized, and stored.
- Cost records from previously completed projects and cost quotes from suppliers, vendors, and subcontractors must be gathered.
- Assessment of job conditions and evaluation labor and equipment and productivity rates must be performed.
Note:

The estimator must also document the estimate so to be used for cost control during the construction process.
Purpose of estimating:

1. To determine the forecast costs required to complete a project in accordance with the contract plans and specifications.

2. Determining the probable real cost and determining the probable real time to build a project.
Types of estimate:

1. **Approximate Estimate**

2. **Detailed Estimates**
Organization of Estimates:

Two basic approaches have evolved to organize work items for estimating:

One approach is to identify work by the categories contained in the projects written specifications. (such as CSI of building construction project).
The other approach uses a work breakdown structure (WBS) to identify work items by their location on the project.
Quantity takeoff

1- Calculate the quantity of material and record the amount and unit of measure on the appropriate line item in the estimate.

2- Each estimator must develop a system of quantity takeoff that ensure that the quantity is not omitted or calculated twice.
3- Will organized and careful check will reduce the chance of omitted an items and detect those items that counted twice

4- Adding appropriate percentage of waste must be done for items that may be waste during construction
Labor and equipment crews

- To estimate the quantity take off an assessment of how the project will be constructed must be made.

- The assessment should include an analysis of the job conditions, labor and equipments crews.
Checklist of operation:

- Checklist include all operations necessary to construct the project

- Check must be done to ensure that no operations have been omitted
Material taxes

- The taxes rate for materials will vary depending on the location.

- Generally the tax on materials will range from 3 to 6 percent.

- The estimator should include the appropriate amount of tax in the summary of the estimate.
Representative Estimates

- Direct cost: labor, material, equipment
- Indirect cost: overhead, profit

- Estimating is not an exact science, it depends upon experience, judgment, and care
Production rates

- Is the number of units of work produced by a unit of equipment or a person in a specified unit of time (usually one hour).
When preparing an estimate for a project, if access is available to production rates obtained from actual jobs constructed under similar conditions, the estimator should use them instead of the general tables.
[Chapter Two]

Bid Documents
BID DOCUMENTS AND CONTRACT DOCUMENTS

- The difference between bid and contract documents.

The bid document applies to before the contract is signed, whereas the contract document applies to after the contract agreement is signed by the owner and contractor.

*The bid documents consist of:

- The invitation to bid.
- Bid forms.
- Drawings.
- Specifications.
- Requirements of bonds and insurance.
- Addenda.
* Why we need the bid documents?
The contractor used it in prepare an estimate and submit a bid.

- It’s legal documents for construction and completion of the project.

* Who writes the bid documents?
Architect Engineer.
Contract Requirements:

1) Competitive contract.
2) Negotiated contract

In most municipal, state, and federal projects are awarded by competitive bidding.

-- Competitive bidding involves:
  _ Advertisement for bids in public media.
  _ Bid opening is performed in the open public.
  _ Contractor performs a detailed estimate and submits a bid price accordance with the contract documents.
The owner and engineer perform the evaluation of bids at a later date.

Most governments award contract to the lowest bidder, provided all conditions of the contract have been met.

Private owners are not required to award the contract to the lowest bidder but may select to the contractor deemed most desirable for the project.

**Negotiated contracts**: Awarding of the contract is made to the contractor who the owner feels can provide the best total performance. This bid may or may not be lowest initial cost.
Arrangement of contract documents:

1- Legal matters:
   - Bid forms.
   - Bond requirements.
   - Insurance requirements.
   - General condition.
   - Supplementary conditions of the contract.
2) Technical matters:

- Plans (drawings).

- Specifications that describe the material, workmanship, and methods of construction that are required to build the project.

* Where conflicts exist between the drawings and written specifications, it is common practice that the written specifications govern.
Building Construction Specifications:

It’s defined:

1) The quality of material.
2) Performance rating of equipment.
3) Level of workmanship.
4) Warranty requirements.

Construction Specification Institute (CSI) Master format organizes project information into major divisions.
A list of the CSI numbers and titles includes:

0-Introductory Information Bidding and Contracting Requirements.
1-General Requirements.
2-Site Construction.
3-Concrete.
4-Masonry.
5-Metals.
6-Wood and Plastics.
7-Thermal and Moisture Protection.
8-Doors and Windows

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Heavy/Highway Specifications:

1-General Provisions.
2-Excavation and Embankment.
3-Base Courses.
4-Surfaces Courses: bituminous, concrete pave’s.
5-Structures: steel, concrete bridges.
6-Materials: aggregate, asphalt.
7-Traffic Control: signals, signs.
8-Incidental Construction: guard rails, fences.
Bidding requirements

- The information contained in this section of the contract documents is extremely important to the estimating team. Typical information in the bidding requirements includes:
The bidding solicitation sometimes called the invitation to bid contain the time that bids must be submitted. The estimator must establish a plan to complete all work to meet the deadline of the bid date, otherwise the bid will be disqualified. The bid solicitation also gives the name and address of the owner and design organization with instructions on how to obtain the bid documents.
The instruction to bidders section describes vital information that is required to submit a bid. For example, that may appear in the instruction to is a statement that the contractor must make a provision during execution of the contract document to allow the owner to take advantage of the owner's contract documents to allow the owner to take advantage of the owner's tax exempt status for materials and equipment purchased for the project.
The information available to bidders section may include such items as referencing a subsurface exploration report that has been prepared for the project, but is not shown in contract documents. The information available to bidders may include information about the project from a material testing laboratory.
Bid forms

The bid form defines the format that is required for submission of the bid. The format of the bid form impacts the assembly and summary of costs in the final estimate. The owner may request the bid as lump sum, unit prices based on predefined pay quantities in the bid documents, or combination of both.
For construction project the work may be priced by several methods or combination of the pricing method. The method selected depends on distribution of risk between the owner and contractors.
Types of Contract

- Single fixed cost or Lump-sum
- Negotiated Cost-plus-a-fee contract
- Guaranteed maximum price
Single Fixed Cost or Lump-sum

- Contractor agrees to perform the work for a predetermined price that includes profit.
- Same as unit price contract
TYPES OF CONTRACT
Advantages of Fixed Cost Contract

- Historically supported with well-established legal and contractual procedures.
- Overall cost is predetermined.
- Minimal involvement by the owner.
- Owner may benefit from price competition.
- Incentive for contractors to reduce costs.
Disadvantages of Fixed Cost Contract

- Long procedure
- The owner and designer is in adversarial position with the general contractor
- Does not benefit from highly qualified contractor on technological advancements
- Pass much of the risk to the contractor
Negotiated Cost-Plus-A-Fee Contract

- Contractor agrees to perform the work for a fixed or variable fee to cover overhead cost and profit.
- Fee can be flat dollar sum or % of cost estimate.
- Incentive fees are now increasingly popular.
Advantages of Negotiated Cost-Plus-A-Fee Contract

1. Minimal adversarial position
2. Preferred for unknown technology
3. No official change order procedure
Disadvantages of Negotiated Cost-Plus-A-Fee Contract

1. May not be the most economical price
2. System can be abused
3. Owner or designer involvement are increased
4. Additional administrative cost
5. No incentive for contractors to reduce cost
6. Pass the risk to the owner
Guaranteed Maximum Price

- The contractor agrees for a fixed fee and profit at a cost not to exceed pre-established max. price.
- Costs above the guarantee are absorbed by the contractor.
- Savings may be reverted to the owner or in most cases shared by the owner and the contractor.
Advantages of Guaranteed Maximum Price

1. Guarantee maximum price.
2. Owner may pass some of the risk to the contractor.
3. Sharing the savings can reduce the cost.
4. Minimum owner involvement
Disadvantages of Guaranteed Maximum Price

1. Generate disputes in case of poor initial scope.
2. Change orders negate the advantage of guarantee.
Lump-sum Contract

(Price is fixed at $10,300)

- **a =** If final cost is $9,500, contractor profit is $800 (8.42%)
- **b =** If final cost is $10,000 (as expected), contractor profit is $300 (3%)
- **c =** If final cost is $10,500, contractor loss is $200 (-1.9%)
Time-and-Materials Contract

(Price = cost plus 5%)

Final Price

Final Cost

$11,025

$10,500

$9,975

$9,500

$10,000

$10,500

a = If final cost is $9,500, contractor profit is $475 (5%)
b = If final cost is $10,000, contractor profit is $500 (5%)
c = If final cost is $10,500, contractor loss is $525 (5%)

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Time-and-Materials Contract

(Price = cost of work plus fixed fee of $500 with a maximum price of $10,500)

a = If final cost is $9,500, contractor profit is $500 (5.26%)
b = If final cost is $10,000, contractor profit is $500 (5%)
c = If final cost is $10,500, contractor loss is $0 (0%)

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## Degree of Risk for Owner and Contractor

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<td>RISK</td>
</tr>
</tbody>
</table>

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The building code of Hammurabi, founder of the Babylonian empire, is the earliest known code of law. Translated:

228: If a builder build a house for a man and complete it, that man shall pay him two shekels of silver per sar (approximately 12 square feet) of house as his wage.

229: If a builder has built a house for a man and if the house he has built falls in and kills the householder, that builder shall be slain.

230: If the child of the householder be killed, the child of that builder shall be slain.

231: If the slave of the householder be killed, he shall give slave for slave to the householder.

232: if goods have been destroyed; and because the house was not made strong, and it has fallen in, he shall restore the fallen house out of his own material.

233: If a builder has built a house for a man, and his work is not done properly and a wall shifts, then that builder shall make that good with his own silver.
Negotiated work

- It is used when the owner wants to start construction at the earliest possible date to benefit from an early completion and use of the project.

- A representative of the owner works with the contractor to evaluate alternatives to obtain a project configuration that meets the needs of the owner, yet with a cost within the owner’s allowable budget.

- The final contract agreement usually is a cost plus a fixed fee with a guaranteed maximum amount. If the cost is above or below the guaranteed maximum amount, then the owner and the contractor agree to a splitting of the difference.
Addendum

- It is a change in the contract documents during the bidding process, before a ward of the contract.
- Addenda are issued to correct errors in the contract documents or clarify an issue. May concern addition to the work at the request of the owner.
- The estimating team must be certain that the costs of all addenda are included in the estimate.
Alternate

- It is an addition or subtraction to a base bid price for substitutions requested by the owner during the bidding process.
- Each alternate is listed and numbered separately in the bid documents.
- For example:
  An alternate No.1 may be add the parking lot.
  An alternate No.2 may be deduct the sidewalks.
Change order

- It is issued by the designer but signed by the owner and contractor.

- Making a change in the contract documents during construction.

- Upon approval by the owner change orders become a part of the contract documents.
Warranties

- They are guarantees by the contractor that specific components of the project will be free from defects due to materials or workmanship for a specified warranty period.

- They cover specific items, such as a roofing warranty or an equipment warranty that are part of the construction project.

- The type of warranty and warranty periods are defined in the written specifications of the contract documents.
Bonds

- Bidders submit bonds as qualifications for submitting a bid for a project.

- The contractor secures bonds from a bonding company or a bank on behalf of the owner as financial and legal protection for the owner.
Three type of bonds are commonly required in construction contracts (as the book):

1. Bid bond.
2. Performance bond.
3. Payment bond.
4. Maintenance Bond
If the contractor:

default,
or fails to complete the project,
or fails to pay labor and material cost
the bond company or the bank agrees to fulfill the contract agreement.
Insurance

- The contractor must secure insurance, because there are many risks involved in construction.
- The precise losses that are reimbursable from insurance are based on predetermined losses named in the insurance policy.
Types of Available Insurance for Construction Projects

2. Public Liability and Property Damage Insurance.
3. Workmen’s Compensation Insurance.
Basic Builder's Risk Insurance

- General Builder's Risk which covers damages to the project due to fires, wind, and hail.
- Insurance is based on the estimated completed value of the project, so the premium rate usually is set at 60% of the complete value.
- Basic Builder's Risk Insurance varies with the type and location of the structure.
Public Liability and Property Damage Insurance

- It protects the contractor against injuries to the general public or public property due to actions of the employees while performing works.
- The cost of this insurance depends on the type of work and the safety record of the contractor.
- It is range from (2-8)% of the base cost of the labor.
Workmen’s Compensation Insurance

- To protect workers as a result of injury or death on a project.
- It provides medical expenses and payment of lost wages during the period of injury.
- The cost can range from (10-30)% of the base cost of the labor, depending on the type of work that is performed by each worker.
Contractor’s Equipment Floater

- It provides protection against loss or damages to equipment because of fire, tornado, flood, perils of transportation, and theft.
- The cost varies with location, it is about $1.50 per $100.00 of equipment value per year.
Work Breakdown Structure (WBS)

- A hierarchical system which sub-divides larger elements of the project into smaller elements.
- The smallest unit of the WBS is the work package.
<table>
<thead>
<tr>
<th>Level</th>
<th>Level Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Total Project</td>
</tr>
<tr>
<td>2</td>
<td>Subproject</td>
</tr>
<tr>
<td>3</td>
<td>Category of Work</td>
</tr>
<tr>
<td>4</td>
<td>Work Package</td>
</tr>
<tr>
<td>5</td>
<td>Resources</td>
</tr>
</tbody>
</table>

**Work Breakdown Structure**

- **Warehouse**
  - Administration
  - Mobilization/Demobilization
  - Masonry Wall
  - Steel Columns & Joints
  - Roof System
  - Roof System
  - Interior Finishes
  - Roof System
  - Interior Finishes

- **Sitework**
  - Footing
  - Floor Slab
  - Masonry Wall
  - Steel Columns & Joints
  - Roof System

- **Excavate Footings**
  - Form & Reinforce Footings
  - Place Footings

- **Labor**
  - Material
  - Equipment

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Work Breakdown Structure (cont.)

- The scope of work in each work package should be defined to avoid overlaps and omissions between work packages.
- Work packages should be defined in terms of design, construction methods, and completion requirements, with associated performance dates.
Scope of Work Packages

Each work packages should be:

1. Manageable
   - Specific authority and responsibility can be assigned.

2. Independent
   - With minimum interfacing or dependence on other elements.

3. Measurable
   - In terms of progress.
The Project Cost System

Objectives of Establishing Project Cost System.

1. Keep the construction costs of the project within the established budget

2. Develop labor and equipment productivity information for estimating the cost of future work.
<table>
<thead>
<tr>
<th>Project Number</th>
<th>Area Code</th>
<th>Work Type Code</th>
<th>Distribution Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0908B</td>
<td>05</td>
<td></td>
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</tr>
<tr>
<td>03157.20</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cost Code for stripping concrete formwork for bridge deck (Labor).
Project Number

0908B  05  03157.20  3

Eighth project in 1997 (Bridge)
Area Code

9708B 05 03157.20 3

- Geographic location

OR

- Associate Field Cost to Specific Supervisor or Management
<table>
<thead>
<tr>
<th>Work Type Code</th>
<th>Description</th>
</tr>
</thead>
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<tr>
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<td>0315</td>
<td>Concrete Formwork</td>
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<tr>
<td>03157</td>
<td>Wood Concrete Formwork</td>
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<tr>
<td>03157.20</td>
<td>Wood Concrete Formwork for Deck</td>
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<tr>
<td>03157.30</td>
<td>Wood Concrete Formwork for Abutment</td>
</tr>
</tbody>
</table>

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Distribution Code

9708B  05  03157.20  3

1. Total
2. Material
3. Labor
4. Equipment
5. Sub-Contract

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Cost Code and Cost Control

- All items of expense are charged to the project where they are incurred.
- "General" or "miscellaneous" cost accounts should not be used, are poor practice, and should be avoided.
- The cost code is to serve its basic purpose, it must be understood and used consistently by all company personnel.
Cost Accounting Reports

- Cost report intervals are a function of the project size, nature of the work, and type of contract involved.
- There must be a balance between the cost of generating the reports and the value of the management information received.
The most widely used cost codes are:
- Masterformat, CSI (Construction Specifications Institute)
- Uniformat, UCI (Uniform Construction Index).

Masterformat is widely used by software companies and government agencies.
Most contractors match their cost control system to their payroll periods and to their time-monitoring system.
COST CODES (cont.)

- **Masterformat**
  - Has 16 divisions
  - Divisions were developed according to trades

- **Uniformat**
  - Has 12 divisions
  - Tends to follow the progress of construction
Relationship Between UNIFORMAT & MASTEFORMAT

<table>
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<tr>
<th>Design Uniformat</th>
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<tr>
<td>01 General Requirements</td>
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<td>02 Site Work</td>
<td>012 Spec. Foundation Cond.</td>
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<td>03 Concrete</td>
<td>021 Slab on Grade</td>
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<td>04 Masonry</td>
<td>022 Basement Excavation</td>
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<td>05 Metals</td>
<td>031 Floor Construction</td>
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<tr>
<td>06 Wood &amp; Plastic</td>
<td>032 Roof Construction</td>
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<tr>
<td>07 Therm. &amp; Moisture Protect.</td>
<td>033 Stair Construction</td>
</tr>
<tr>
<td>08 Doors &amp; Windows</td>
<td>041 Ext. Doors &amp; Windows</td>
</tr>
<tr>
<td>09 Finishes</td>
<td>042 Ext. Closure</td>
</tr>
<tr>
<td>10 Specialities</td>
<td>05 Roofing</td>
</tr>
<tr>
<td>11 Equipment</td>
<td>06 Int. Closure</td>
</tr>
<tr>
<td>12 Furnishings</td>
<td>061 Partitions</td>
</tr>
<tr>
<td>13 Special Construction</td>
<td>062 Interior Finishes</td>
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<td>14 Conveying Systems</td>
<td>063 Specialties</td>
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<tr>
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<td>081 Plumbing</td>
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<tr>
<td>16 Electrical</td>
<td>082 H.V.A.C.</td>
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<td>11 Equipment</td>
<td>083 Fire Protection</td>
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<td>12 Site Work</td>
<td>084 Spec. Mechanical Syst.</td>
</tr>
<tr>
<td>13 Site Preparation</td>
<td>091 Services &amp; Distribution</td>
</tr>
<tr>
<td>14 Site Utilities</td>
<td>092 Lighting &amp; Power</td>
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<tr>
<td>15 Site Work</td>
<td>093 Spec. Electrical Syst.</td>
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DR. Nabil Dmaidi
## UNIFORMAT Level A and B

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<th>0120 Special (level B)</th>
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DR. Nabil Dmaidi
Drawings
What’s “Drawings”? 

Plans are a set of two-dimensional diagrams or drawings used to describe a place or object, or to communicate building or fabrication instructions. Usually plans are drawn or printed on paper, but they can take the form of a digital file.

Latécoère 28

Laté 28-3 Comte-de-la-Voué
The Importance of Drawings:

1- They are a form of communication better than words.

2- Many drawings can be done searching for what looks best.

3- The design tells us what we want to achieve in the final appearance.

4- The drawings guide the estimators in bidding phase.
The Importance of Drawings/cont.

5- It shows the contractors the project dimensions and a lots of information.

6- It guides the consultant engineer how the work is going on.

7- It considered as reference if any problems appeared.
Advantages of drawings:

1. Clearly define aspects of engineered items.
2. Conform to standards.
3. Minimize confusion.
Pre - Drawing Activities:

* Bidding and construction information conveyed by two major devices:
* Specifications (written material).
* Drawing (graphic presentation).
Preliminary Activities:

1- Provide design concept schematics.
2- Preliminary drawings prepared to the degree that owner can visualize the total project.
3- Anything that can contribute to a more complete understanding of the client shall be considered.
Types of drawings:

1- Contract drawings.
2- Working drawings.
3- Shop drawings.
4- As-built drawings.
Contract drawings:

* The contract drawings are used as an essential part of the contract.
* Keep a set on the job with all changes and revisions posted.
* Assign someone this responsibility.
Working drawings:

A working drawing is a type of technical drawing, which is part of the documentation needed to build an engineering product or architecture. Typically in architecture these could include civil drawings, architectural drawings, structural drawings, mechanical drawings, electrical drawings, and plumbing drawings.
Shop drawings:

A shop drawing is a drawing or set of drawings produced by the contractor, supplier, manufacturer, subcontractor, or fabricator.

Shop drawings are typically required for pre-fabricated components. Examples of these include: elevators, structural steel, trusses, pre-cast, windows, appliances and cabinets.

The shop drawing is the manufacturer’s or the contractor’s drawn version of information shown in the construction documents.
The shop drawing normally shows more detail than the construction documents. It is drawn to explain the fabrication and/or installation of the items to the manufacturer’s production crew or contractor's installation crews.

The style of the shop drawing is usually very different from that of the architect’s drawing.
As-built drawings:

Revised set of drawing submitted by a contractor upon completion of a project or a particular job. They reflect all changes made in the specifications and working drawings during the construction process, and show the exact dimensions, geometry, and location of all elements of the work completed under the contract. Also called record drawings.
Building construction drawings

- Title sheet (This sheet contains the name of the project, owner, designer, and other pertinent information related to the project).
CONSTRUCTION AND REHABILITATION OF AUSTRALIAN WATER NETWORK
Building construction drawings

- **Index sheet** (which provides a summary of all the remaining sheet in the drawings, Its shows the list of drawing. For building type project, the remaining sheets generally follow this arrangement: civil, architectural, structural, mechanical, electrical, plumbing, and fire protection.)
<table>
<thead>
<tr>
<th>Bid Documents</th>
<th>Nabil Dmaidi</th>
</tr>
</thead>
<tbody>
<tr>
<td>129</td>
<td></td>
</tr>
</tbody>
</table>
Building construction drawings

- Plans, elevations, and section.

  - Plan views (Views looking vertically down on the object).

  - Elevation views (Views looking horizontally at an object).
Plane views
Building construction drawings

- Perspective views (Views looking at an object from a point that is not perpendicular to any face of the object).
- A section view (view of the object as seen by passing a cutting plane through the object).
- A detail (is an enlargement of a specific area of a project. Connections of structural components are generally sown as details).
Building construction drawings

- Isometric or pictorial drawings. It is a common practice to show the routing in three-dimensional pictorial drawings.)
Building construction drawings

Line Work:

Several types of line work that are used in preparing drawings include:

- Thick lines-outline edges of objects (plans and elevations).
- Thin lines with short dashes—denote the centerline of an object.
- Phantom lines—show the path of moving parts.
- Broken lines—denote the object is longer than shown.
- Short dashed lines—denote edges on the object that cannot be seen from the near side surface of the object.
Building construction drawings

- Scales
  - Usually the type of scale used is identified at the bottom of the page on the drawings.
Building construction drawings

Scales

Two types of scales are used in construction drawings, the architect’s scale and the engineer’s scale.

The architect’s scales that are commonly used for plans and elevations include 1/32 in. = 1 ft and 1/16 in. = 1 ft. Complicated areas often use the ¼ in. = 1 ft, or ½ in.

The engineer’s scale, graduated in tenths of an inch, is often used for civil, structural, and mechanical drawings. The scales are 10, 20, 30, 40, 50, and 60.
Building construction drawings

Schedules

To simplify the presentation of repetitious items (such as footings, columns, doors, windows, room finishes, etc.) a schedule is frequently used. Likewise, a footing schedule is a listing of all footings in the foundation, showing the diameter, depth, type, size, and number of reinforcing bars.
Building construction drawings

- **Symbols and abbreviations**
- Symbols are used on the drawings to identify the types of materials and work required during construction.
- Abbreviations of organization that produce technical information and standards for materials are frequently referenced in the specifications of contract documents.
Specification
The Most Important thing you will ever build will be your **Reputation**!
Specifications

Specifications are written instructions to be used in conjunction with the drawings so that together they fully describe and define the work that is to be accomplished along with the method and quality that will be required. They supplement the Drawings and show information that cannot be easily shown in graphic form.
Purpose Of Specifications

- Guide the bidders in cost estimates for their proposals

- Guide the Contractor during the:
  - Construction Phase
  - Erections and Installations
  - Ordering of materials
  - Performance of work
Relationship To The Drawings

- Normally the Drawings provide a physical description of the project and the Specifications provide information regarding:

  - Quality of materials
  - Quality of workmanship
  - Erection and installation methods
  - Test and Inspections
Users of Specifications

1. During bidding process
   - Estimators for G.C.
   - Subcontractors
   - Material suppliers

2. Pre Construction process
   - Planning and zoning department
   - Permit issuing authority
   - Various government agencies
Users of Specifications

3. During construction phase
   · Project manager
   · Project superintendent
   · Crew foremen
   · Individual workers
   · Inspectors
   · Schedulers
   · Cost control personnel
   · Shop drawing checkers
   · Fabrication and installation persons
Technical Specifications

- Spell out the technical requirements of the project. Have restricted application, usually to only a limited or specific part of the project.

- Provisions make it possible and practical to assign the responsibility for each of these provisions to the proper party, which is important contract system of construction.
Reference Sources For Specifications

Specs writing requires tremendous amount of

- Knowledge
- Information

Specification writer should have:

- An extensive personal library
- All time ready access to reference information (additional)

Remembering where to get information is more important than remembering the information sources
Codes exist in cities

- Building Codes
- Plumbing Codes
- Electrical Codes

Construction shall conform with applicable codes and ordinances.

- There may be occasions when codes overlap. In such case, highest or most demanding will prevail.
- Where there are no local codes, “accepted standards of good practice” must be observed.
Continued.....

- Model codes have national distribution and use.

Examples of model codes:

- UBC (Uniform Building Code)
- NBC (National Building Code)
- SSBC (Southern Standard Building Code)
- BBC (Basic Building Code)
- NPC (National Plumbing Code)
- NEC (National Electric Code)
- LSF (Life Safety Code)
continued...

- Specification standards by
  - Professional and industry associations
- Recommended specifications by
  - Materials manufactures
- Guide specifications by
  - Government agencies
  - Municipalities
  - County, States, and Cities
While one person or department is responsible for their preparation, the specifications are ultimately done by all those involved in the project.
Approaches To Writing Specifications

- Performance or Results Specifications
- Methods or Prescription Specifications
QUALIFICATIONS for SPEC WRITER

- A thorough knowledge of the construction process and design process
- A good understanding of construction materials and construction methods
- Be skillful with written English and adapt a sense of fairness

Nabil Dmaidi
Use Of Standard Forms

Specifications should be presented:

- In standard forms
- In understandable language

4 C’s

- CLEAR
- CONCISE
- CORRECT
- COMPLETE
MOTTO: “SKILL, RESPONSIBILITY, AND INTEGRITY”
AGC
Associated General Contractors of America
PERFORMANCE or RESULTS SPECIFICATIONS

Describe in detail the required performance or service characteristics of the finished product or system.

Methods used to achieve desired results is left to the discretion of the Contractor but **must** be guaranteed.

Methods of testing and measurement, to evaluate the results, should be spelled out in the specifications.

Avoid drastic changes from performance standards.
PREFORMANCE or RESULTS
SPECIFICATIONS

- Present specifications in an orderly fashion to guard against errors and omissions including:
  - General description of product / system
  - Design and installation requirements
  - Product/systems operation conditions
  - Test / measurements information detailed
  - Guaranties / warranties required
1) Advantages:
   - Provides wide competition among products and systems.
   - Contractor improves its experience and knowledge in its specialized field.
   - Specs writer does not need to have an extensive knowledge of products and systems as would be required under prescription specs.

2) Disadvantages
   - Devising adequate testing / measuring systems by which results can be evaluated is difficult.
   - Used in connection with equipment and machinery requirements only.
PRESCRIPTION OR METHODS SPECIFICATIONS

Specifications describe in detail:

- The methods to be used
- The procedures to be followed

If the material is specified by brand name or manufacturer, the specifications writer has the advantage of knowing the performance characteristic of the material/system because of its past performance on other projects.

- Also used when outside appearances will not necessarily disclose defects. (e.g., brick masonry and concrete)
- A Specifications writer assumes more responsibility with Prescription Specifications.
The Specifications writer warrants the performance of the products/systems and not the Contractor.

The Specifications writer should make sure the requirements are realistic.

The Specifications writer should be fully aware of the materials and field methods he is specifying.

Impractical requirements lead to extra costs to the Owner.
OPEN vs CLOSED SPECIFICATIONS

OPEN SPECIFICATIONS
- Open to all qualified bidders
- Encourages competition among firms/manufacturers
- A must for publicly funded projects

CLOSED SPECIFICATIONS
- Available to only one firm
- The use of only one product brand
APPROVED “OR EQUAL” PHRASE

- Restricted specification is the combination of Performance and Prescription Specifications.
  - Minimum 2 brand names listed followed by the phrase “or approved equal.”

- The phrase “or equal” is interpreted to mean approved as equal by the Design Professional.

- Contractor’s request for another brand to be added to the list, must be done at the bidding stage. If the Design Professional is in agreement, an addendum will be issued.
DISADVANTAGES of RESTRICTED SPECIFICATION

- Restricted specs does not violate the law prohibiting closed specs on public projects.
- Sometime difficult to find products that are equal and that meet specification writers approval. (Use performance specs in this case).
- In situations where only one manufacturer’s product will give desired results, then,
  - If manufacturer is aware of absence of competition, it may increase price.
  - Costs more to owner (Use closed specs in this situation)
STANDARD FORMAT

- Single standard format
- Avoid confusion
- Assures effective communication

C.S.I. FORMAT
by Construction Specification Institute

Goals

- Improved quality of Construction Specifications.
- Achieve uniformity in specification writing by furnishing a standard arrangement of material.
THREE PART SECTION FORMAT

PART I  GENERAL
- Scope of work
- Submittals for approval
- Delivery
- Job conditions
- Guaranties

PART II  PRODUCTS
- Technical specifications for material or equipment

PART III  EXECUTION
- Quality of workmanship
- Installation or erection procedures
- Finishes
- Provisions for testing and inspections
C.S.I. FORMAT

ADVANTAGES

- Increase bidding accuracy
- Greater control for contractor
- Assisting design professional in producing more complete specifications.
- Facilitates the transition from estimating quantities/costs to bidding to scheduling to cost accounting to data base.

INTENDED FOR:

- Buildings
- Adopted by AGC, AIA, USCE, & NSPE
- Whenever a job does not use certain division it is skipped, but the numbers of the remaining divisions remain the same.
<table>
<thead>
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<th>CSI Divisions</th>
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<tbody>
<tr>
<td>0. Bidding and contract requirements</td>
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<tr>
<td>1. General Requirements</td>
</tr>
<tr>
<td>2. Site Work</td>
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<tr>
<td>3. Concrete</td>
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<td>4. Masonry</td>
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<td>5. Metals</td>
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<td>6. Wood and Plastics</td>
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<tr>
<td>7. Thermal and Moisture Protection</td>
</tr>
<tr>
<td>8. Doors and Windows</td>
</tr>
<tr>
<td>9. Finishes</td>
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<td>10. Specialties</td>
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<td>14. Conveying Systems</td>
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<tr>
<td>15. Mechanical</td>
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<tr>
<td>16. Electrical</td>
</tr>
</tbody>
</table>
Other Standard Formats

- AASHTO - American Association of State Highway and Transportation Officials
  
  For use with Highway construction, Major structures, and Bridges.

- AASHTO Format has 7 sections
ESCAPE CLAUSES

- In attempt to protect the owner's interest, some specifications writers make use of exclamatory clauses, also referred to as “escape” or “weasel” clauses.

- These are clauses that shift the responsibility from the responsible party to the contractor.

- They thus enable either the owner or the design professional to avoid responsibility.
Contracts

Chapter Three (A)
A Philosophy on Contracts

- If you can’t do a job on the basis of a handshake, you don’t want the job.

- Always back up the handshake with a water-tight explicit contract
Hammurabi’s Code
Definitions

- **Contract**: An agreement, usually between two parties, that is enforceable by law.
  - Unilateral – one side makes a promise, expecting performance from the other
  - Implied – terms not clearly stated
  - Written contract – terms specifically stated on paper
  - Verbal contract – spoken agreement
  - Estoppel – contract becomes binding in spite of the fact that no formal agreement has been made.
  - Entire vs. Severable – Partial compensation for partial performance
  - Subcontract – contract between one contract party and a third party to perform some part of primary contract
Elements of Contracts

- Offer and Acceptance (counteroffer)
- Meeting of the minds – parties agree at time of contract on basic meaning and implications
- Consideration – something of value
- Lawful subject matter
- A contract is *executed* when both parties have fully performed in accordance with the contract.
- Defaults and Remedies
  - Damages
  - Specific performance
  - Liens
Writing an effective contract

- The more explicit and detailed, the better
- Include physical, demonstrable deliverables
- Include deadlines as contract requirements
- Specifically address remedies for failure to perform
- Specifically address issues of severability
- Specifically address subcontract issues
- Specifically address confidentiality terms
- Specifically address bonding and insurance requirements
- Specifically address grievance procedure
- Get it checked by a contract lawyer
Project Structure

- Owner’s option, subject to procurement and other regulations
- Should provide incentives to meet owner’s objectives
- Determines owner’s level of control and oversight
Considerations in Project Structure

- Experience, involvement level of owner
- Objectives – cost, quality
- Relationship between owner and engineer/architect
- Preferences of engineer/architect
- Managing the interests of involved parties
Methods of Contracting

- Open Competitive Bidding
- Selected Competitive Bidding
- Negotiation
The Players

- Owner
- Engineer/Architect
- General Contractor
- Subcontractors
- Laborers
- Regulators
Architects and Engineers

- **Architect:** One whose occupation is the utilization of expertise in the formulation of designs, detailed plans, and specifications used by a contractor on the erection or alteration of a building. May include supervision of construction.

- **Professional Engineer:** A person engaged in the professional practice of rendering service or creative work requiring education, training, and experience in engineering sciences and the application of special knowledge of mathematical, physical, and engineering sciences in such professional or creative work as consultation, investigation, evaluation,
Traditional Contract Agreement

Owner → Engineer/Architect

General Contractor

Subcontractor → Worker

Subcontractor → Worker

Worker
Separate Contracts Arrangement (Construction Project Management)
Design-Build
Outline:

- Introduction to Risk Management
- Bonds, purposes of bonds, and types of bonds
- Construction Insurance, its requirements and general insurance topics
- Construction safety and safety programs
Introduction to Risk Management

• Risk in the construction industry is highly unpredictable and extreme.

• In construction projects, risk is a major concern for the engineer, the contractor and the owner.

• Owners have instituted risk management concepts to preclude losses resulting from natural causes, accidents, and mismanagement.

• **Risk management** is a comprehensive approach to handling exposures to loss.
Introduction to Risk Management, cont.

• Exposure is the potential for liability and claims.

• Three ways to manage exposure:
  – Minimize exposure (not for construction projects)
  – Bonding and insurance
  – Make yourself an unattractive target for claims
Introduction to Risk Management, cont.

- Three types of losses:
  - Losses from physical means can be minimized through construction insurance.
  - Losses from mismanagement can be minimized through specialty bonds.
  - Losses due to accidents can be minimized though the implementations of an intensive safety program.
Contract Bonds

- A contract bond is a guarantee by contractors that they are financially capable of performing the work identified in the construction contract.

- Three main types of contract bonds:
  - Bid Bonds
  - Performance Bonds
  - Labor & Material Payment Bonds
Some definitions

Principal: the party who is responsible to perform the undertaken being bonded, (usually the contractor).

Surety: the party who is guaranteeing the performance of the principle, (the bonding company).

Obligee: the party for whose benefit the bond is written (the owner).

Surety Bond: the written document given by the surety and the principle to the obligee to guarantee a specific obligation.
Indemnity Agreement: the contract between the principle and the surety (the principle guarantees the bonding company that no loss would happen due to providing the bond).

Penal Amount: the face value of the guarantee, usually 100% of the contract amount.

Claimant: the party who is filing a claim against the bond to recover expenses or costs due to nonperformance of the principal.

Lien: the legal right of a party to control the property of another or have it sold in order to recover payments of a claim by the injured party.
Purposes and advantages of bonds

- Bonds are used to guarantee completion of a project as specified and that it will be free of liens when completed.

Main advantages of bonds:
- The owner is protected against the withdrawal of a favorable bid by a contactor through bid bond.
- Suppliers and subcontractors are protected against non-payment by a contractor with a labor & material payment bond.
- The owner receives protection against default, breach of contract or nonperformance by the contractor through a performance bond.
Disadvantages of bonds

- Bonding requirements may restrict bidding.
- Owners may not be aware of the magnitude of the surety’s obligations or services.
- Owners with large construction budgets may not be able to pre-qualify contractors.
1) Bid Bonds:

- A surety issues a *bid bond* to guarantee the contractor will, within a specified period of time, enter into a contract at the price submitted in the bid.
- The price of bid bonds vary, but 10% of the bid amount is generally accepted.
- If the bidder has failed to execute a contract, and the owner has made a claim to recover the difference in the two low bids from the surety, the surety has to pay the guaranteed amount to the owner.
Three possible defenses a surety can make:

- The low bidder can prove they made a mistake in the preparation of their bid.
- The owner delays too long in making a contract award.
- The owner tries to change the terms and the conditions of the contracts between the award and execution dates.
Types of Bonds, cont.

2) Performance Bonds:

*Performance Bonds* provide the most important protection for the owner.

- They guarantee the work will be completed in accordance with the contract document.
- In case of a breach or default by the contractor, the surety has several options:
The surety can finance the project by providing funds to the defaulting contractor to complete the work. The surety can pay the face amount of the bond to the owner. The surety can wait for termination of the contract with the original contractor, then complete the work with another contractor of their choice.
The surety does have some possible defenses against the claims made by the owner, such as the following:

Breach of Contract – If the owner has breached the contract through wrongful delays, nonpayment of invoices and change orders.

Overpayment – If the owner overpaid the contractor for the completed work at the time of the default.

Material Alternation – In case of significant alternation without written notice to the surety.
Types of Bonds, cont.

3) Labor & Material Payment Bonds:

They guarantee the project’s suppliers, subcontractors, and other providers of labor, materials, goods, and services will be paid.

This bond is also beneficial to the owner. It provides protection from unpaid parties filing mechanics liens against the project property.

A payment bond might generally cover:

- Equipment rental
- Freight and transportation fees
- Repair charges for tools and equipment
- Temporary structures, fuels, and union benefits.
Items not generally covered under a payment bond include:

- Insurance premiums
- Workers compensation
- Financial loans and taxes.

Most payment bonds carry certain limitations to claims, which may vary from one jurisdiction to another.
Construction Insurance

Construction Insurance provides protection for the proposed project and its participants (the owner, contractor and the architect/engineer) from physical damage and liabilities due to project losses.

Each participant must carry adequate insurance coverage to protect themselves.

Insurance requirements:
- Owners insurance requirements.
- Contractors insurance requirements.
- Design professional insurance requirements.

More details about construction insurance are in the following references:
Owners insurance requirements

- Property Insurance: damage to one’s own property from diverse causes as fire and theft is commonly insured against.
  - AIA Document A201 (paragraph 11.3) describes the types of loss protection typically carried by an owner on a construction project.

- Owners Liability Insurance: the owner is responsible for obtaining and maintaining their own general liability policies that apply to their normal operations and protect them against negligent acts by their employees or agents.
Liabilities are an obligation imposed by the law through either litigation or arbitration. Liability insurance protects the owner in disputes over claims of wrong doing or acts of negligence. Loss of Use Insurance: owners may wish to consider securing protection of their premises in case they become unusable due to fire or other hazardous causes.
Contractors insurance requirements

Property Insurance. Contractual requirements do not usually address the contractor’s obligation to carry adequate property insurance (for their personal properties), but it is a good business practice.

Contractor’s Liability Insurance: A contractor may incur liability for damages in different situations, such as:

- Liability to injured employees
- Direct responsibility for injury or damage to the person (not employee) or property of third parties, caused by acts or omissions of the contractor
- Liability that may involve the contractor as a result of the operation of their motor vehicles.
- Contingent liability: involves the direct liability of the contractor for acts of parties for whom they are responsible, such as suppliers and subcontractors.
Design professional insurance requirements

Professional Liability Insurance: often overlooked by an owner is the need for adequate insurance coverage by the design professional.

- The engineering function carries major liability if done incorrectly and should, therefore, be required to carry and maintain professional liability insurance.

There are two types of this kind of insurance:

- “claims made”: covers the engineer only for claims made, while the policy is in effect. (common)
- “occurrence”: covers the engineer when acts occurs, while the policy is in effect. (unavailable)
Insurance Certificates.

Owner-Controlled Insurance Program:
- These types of programs are often referred to as “wrap-up” insurance coverage.
- The owner provides all of the insurance for the project except design professional and contractor professional liability insurance.

Construction Insurance Checklist:
- Project Property Insurance.
- Property Insurance on Contractors Own Property
- Liability Insurance
- Employee Insurance
- Automobile Insurance
- Business, Accident and Life Insurance
Construction Safety

Construction is a hazardous business.

Due to its inherent dangers, construction safety has always been a dominant concern of all parties associated with the industry.

Legislation enacted in 1970 as the Occupational Safety and Health Act (OSHA) addresses safety requirements in all businesses.

In the 1980s, the government started to fine the owners (not only the contractors) found violating any of the provisions of the law.

Safety has now moved from the arena of good business practices into the criminal courts.
Safety programs on construction projects should be part of the overall risk management procedures of the owner and the contractor.

Reduction in construction accidents has several good benefits associated with it:
- It is humanitarian to be concerned about safety.
- It makes good business sense to reduce costs and losses due to accidents.
- It makes for good public relations.

Safety can be defined as an attitude.

Management has the responsibility to establish an environment in which unsafe work practices are not tolerated.
The Importance of construction safety

- The construction industry employs about 5% of the total labor force.
- It has accounted for about 11% of the occupational injuries and 20% of the fatalities resulting from on-the-job accidents.
- At an annual cost estimated at about $10 Billion.
- When an injury results from an accident, not only the workers suffers physical damage or disability, but their families are directly affected as well.
- The owner and/or the contractor do have social responsibilities to the injured workers and their families and to the general public to operate a safe workplace.
- Management is only now becoming fully aware of the total cost of accidents on construction sites.
Safety Programs

- Owners and contractors alike need to plan and manage carefully a safety program established for a construction project to reduce the probability of accidents.
- The primary obstacle to safety program implementation in construction has traditionally been upper management’s lack of support.
- A safety program can begin with the identification of problems encountered on other similar projects or through experiences of the workers.
- An effective safety program can prevent accidents and increase worker productivity.
- Not only does a safe workplace lend itself to a productive atmosphere, but it also proclaims management’s commitment to the welfare of its employees and suppliers.
Claims

“Potential claim” applies to any difference arising out of the performance of the work that might reasonably lead to the later filing of a claim by the contractor, if the differences cannot be resolved in the field.

To become a claim:

- Protest and potential claim have not been resolved during the process of the work and have been restated with the return of the “Final Estimate.”

- First Notice with “Final Estimate.”
Claims

CONTRACTOR

OWNER OR AE REP. OR CM OR GOV’T/KO

Resolve at lowest level

CONTRACT

DISAGREEMENT

In writing, letter to owner

POTENTIAL CLAIMS

REVIEW:
- Facts
- Timeliness of submittal
Claims

**REVIEW:**
- a. Facts
- b. Timeliness of submittal

**CLAIMS HAS MERIT**

**BECOMES A CHANGE ORDER**

**RESOLVED NO ISSUE**

Disagreement

- **FILE CLAIM**
- **SETTLE CLAIM**

**HOW TO SETTLE IT IN CONTRACT?**

**CONTRACTS ROUTINELY INCLUDE PROCEDURES ON HOW TO SETTLE**
Settlement of Disputes by Arbitration

What is Arbitration?
Voluntary submission of a dispute to one or more impartial persons for final decision and determination

- Private
- Informal
- Quick
- Practical
- Inexpensive settlement
Settlement of Disputes by Arbitration

Most used: American Arbitration Association
- Arbitrators are quasi-judicial officers.
  - Usually 3, majority rules
- Not lawyers, but experts in the field of construction
- Rules of evidence do not apply
- Hear all evidence
- Hear no arguments or evidence from one side without comment from other side
- Arbitrator judgment is final in decision and award
- No written opinion required.
- Award written single sheet
- Courts will not review the Arbitrators decision
Claims When Government is the Owner

COR - Resolve with contractors representatives (Lowest level)

CO - Receive letter of potential claim

CO - Write contracting officer decision after reviewing the facts

Contractor has 30 days to resubmit claim

Government contracts have disputes procedures:

Contractors

CO - Review, CO decision

CO’s Boss

Office Chief of Engineers

Engineer’s Board of Contract Appeals (Decision Final)

Contractor
# Check List

## I. Prebid

- A. Invitation, notice, Dodge or other reports
- B. Meetings - minutes
- C. Site visits - notes/minutes/photographs
- D. Proposed schedules and sequences
- E. Estimates and back-up work sheets

## II. Bid

- A. Copy all papers submitted or issued (bid or proposal)

## III. Post-Bid/Precontract

- A. Negotiations meetings - notes and Minutes
- B. Scheduling sessions - notes and minutes
- C. Cost-reduction calculations
- D. Bonds - payment and performance

## IV. Contract Signing

- A. Check all contract documents

## V. Construction
Write

A. If no minutes are prepared, prepare memos for your own files. Confirm decisions, instructions or orders.

B. Read the minutes

If you do not agree, write your own

C. Answer all correspondence

D. Maintain chronological & subject files
Preparation for Claims Defense

ORIENTATION

A. Owner / Consultant / construction manager / general contractor / subcontractor / controlling agency correspondence files

B. Schedules

C. Job meetings and conference - notes and minutes

D. Oral instruction

E. Fields orders
F. Drawing logs
G. Submittal logs
H. Change estimates - including all calculations
I. Extra work costs
J. Field survey book and computations
K. Cost records
L. Job diaries/logs
M. Photographs
Estimating Processes

(B)

[Chapter Three]

Estimating Processes
Factors affect on how to choose the project to bid:

- The Project type
- Skills and availability of labor and equipment
- The experience in building & bidding
- Owner and Designer
Decision to Bid

Contractor should compare the investment of time and money to prepare the estimate with:

- Probability for winning the bid
- The risk during the construction
- Profit.
Estimating Process

- Kickoff meeting
  - Establish standards
  - Estimate work plan
  - Update database
- Prepare estimate
- Document estimate
- Review estimate
  - Reality check (based on internal review)
  - Revise estimate (based on external review)
- Adjust estimate
- Project execution
- Project completion

Yes

Lessons learned for continuous improvement

No

Estimate feedback for continuous improvement

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The Kickoff meeting is the first meeting of the estimating team.

- To ensure alignment between the customer and the estimating team before starting an estimate.
- To understand the customer expectation and the estimating team’s ability.
Kickoff meeting

Check of issues for the estimate kickoff meeting

- What are the owner expectations?
- What is the required specifications?
- What is availability of the material suppliers and subcontractors?
- What is availability of the labor at the construction site?
- What is the time allowed for construction?
- Are there liquidated damages?
- Have similar projects been developed previously?
Estimate work plan

The work plan is a **document to guide** the team in preparing the estimate and **improving** the estimating process.

- Identify the work, the team, the time, and the cost.
- Identify the tools and techniques to meet the level of scope definition and the accuracy of the estimate.
- The estimate work plan is unique for each project.
Preparing Estimate

A- Site investigation
B- Estimating procedure
C- Risk analysis “contingency”
Site visit

- To investigate the physical characteristics of the project site.
- To collect information and evaluate any constraints or limitation observed during the investigation, including capacity of roads and bridges for transporting material and equipment to the job, available storage space.
Estimating procedure

Development of construction methods:

- The construction method affect all other aspect of the estimate, so it should be selected early.
- Prepare a preliminary estimate for each construction method to select the most economical one.
Estimating procedure

Material quantity takeoffs

- Breakdown the project to evaluate the required cost and time to reduce errors.
Estimating procedure

Preparation of the construction schedule:
- The duration depends on the productivity rates and resources limitations.
- Milestone should be considered in preparing schedule.
Estimating procedure

The estimate of the costs

- Direct and indirect costs can be calculated after the breakdown.
Documentation of Estimate

Estimate documentation is essential for presentation, review and future use of the estimate (database)
Review estimate

Include:

- the backup materials
- assumptions
- Unit prices
- Productivity rates
Reality Checks

- to make sure the costs developed are within reason.
- This can include:
  - Simple checks for reasonableness.
  - Comparisons with similar projects
  - Comparisons with industry data (dollars/square foot, indirect/direct costs, …)
  - Check ratio (lighting/fixtures, fire protection/sprinkler, …)
The quality of any estimate is governed by these major considerations:

- Quality and amount of information available for preparing the estimate (the old database)
- Time allocated to prepare the estimate
- Proficiency of the estimator used in preparing the estimate
[Chapter Four]

Conceptual Cost Estimating
Table of contents:

- Introduction
- Preparation of Conceptual cost estimate
- Conceptual cost for process industry
Introduction

- **Cost estimates have two main parts:**
  - Conceptual (approximate) Estimates
  - Detailed Estimates

- **Why we need conceptual cost estimates?**
  - For owner: part of economic feasibility study.
  - For engineer: used in selection of design alternatives, to keep the owner of forecast costs, and to keep the design within the authorized budget.
Introduction continues

- Conceptual estimates have many levels of accuracy:
  1. level 1: accuracy within 40%
  2. level 2: accuracy within 25%
  3. level 3: accuracy within 10%

- This estimate requires:
  - Knowledge and experience.
  - Cost information from previous similar projects.
  - Considerable engineering judgment.
Preparation of Conceptual cost estimate

Broad-scope of conceptual cost estimate:
Prepared prior to the design.

1. Developing unit cost:

\[ u_c = \text{forecast unit cost} \]
\[ A = \text{min. unit cost of previous projects} \]
\[ B = \text{avg. unit cost of previous projects} \]
\[ c = \text{max. unit cost of previous projects} \]

\[ u_c = \frac{A + 4B + c}{6} \]
Preparation continues

2. Adjustments

- Time Adjustment:
  - Represents the relative inflation or deflation of costs with respect to time/indices for economic trends.

\[
\text{Forecasted cost (FC)} = \text{previous cost (PC)} \times (1 + i)^n
\]

- \(i\) = equivalent compound interest rate
- \(n\) = number of years
Preparation continues

- **location Adjustment:**
  - Represent relative differences in costs of materials, equipments and labor/indices for location changes.
  - $\text{FC} = \text{PC} \times \frac{\text{location index of proposed project}}{\text{location index of previous project}}$

- **Size adjustment (unit cost adjustment)**
  - The estimator has to adjust the unit cost according to number of units, by developing an equation that represent the changes of unit costs with number of units.
Narrow-scope of conceptual cost estimate:

Prepared during the design phases, where more information is known about various components.

Prepared in the same manner to that broad scope estimate, except the project is subdivided into parameters, such as cubic yards of concrete foundations, square feet of furnished floors, tons of structural steel, etc.
Conceptual Costs For Process Industry

- Selection of the methods for preparing early estimates depends on:
  - Level of scope definition.
  - Desired accuracy.
  - The intended use of the estimate.
Methods used to find the cost in the process industry:

- Cost capacity curve.
- Capacity ratios, raised to an exponent.
- Plant cost per unit of production.
- Computer-generated estimates.
Cost capacity curves: is a graph that plots cost on the vertical axis and the capacity on the horizontal axis.
Example:
Capacity ratios raised to an exponent:

- It is a mathematical solution to the cost capacity curves, which is a graphical technique.
Cost of Process Unit A = (Cost of Process Unit B) * (capacity of process unit A/capacity of process unit B)^x

X: factor between 0.55 and 0.88 depending on the type of process unit (usually 0.6 is used)
Example:

- Cost of a 320(cf/hr) process unit=$675,000
  Capacity ratio \( x = 0.72 \)

Estimate the cost of a similar process unit with a capacity of 450 cf/hr

Solution:

Cost of Process Unit A = \( (675,000) \times \left(\frac{450}{320}\right)^{0.72} \)

\[ = 862,797 \]
Plant cost per unit of production:

- It is used to estimate the total plant cost based on the average per unit of production based on previously completed projects.

This method is simple and approximate estimating technique.
Example:

From cost records:

average cost per unit for co-generation facilities is ($1,000/kW) of production.

For a future 300-megawatt (300MW) co-generation facilities.

Solution:

The estimate cost = ($1,000/kW * 300MW * 1000 kW/MW)

=$300,000,000

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This method assumes that the relationship between plant cost and production capacity is linear.
Computer Generated Estimates:

- These computer software packages are available to assist the estimator in generating conceptual estimates.
- They can be used for detailed material quantities such as:
  1. Equipment and material costs
  2. Construction work hours and costs.
  3. Indirect field costs and engineering work hours and costs.
The detailed quantities:

- The detailed quantity and cost output enables early project control, which is essential in the preliminary phases of a project before any detail engineering has started.
The accuracy of an estimate can be improved because the systems allow vendor costs, takeoff quantities, project specifications, site conditions to be introduced in the program.
To maximize benefits of these software program, the use of system default should be minimized and replaced with definitions as follows:

- Specifications, standards, basic practices, and procurement philosophy.
- Engineering policies.
- Preliminary plot plans (if available) and information relating to pipe rack, structures, buildings, automation, and control philosophy.
- Adequate scope definition.
- Site and soil conditions.
- Local labor conditions relating to cost, productivity, and indirect costs.
- Subcontract philosophy.
[Chapter Five]

Cost of Construction Labor and Equipment
Cost of construction labor
The importance of labors

- They influence every part of a project.

- They operate equipment, fabricate and install materials and make decisions that have a major effect on the project.

- Most persons involved in construction agree that people are the most important resources on a project.
The cost of labor

1- The straight –time wage plus any over time pay
2- social security tax.
3- unemployment compensation tax.
4- workers compensation insurance
5- public liability and property damage insurance.
6- fringe benefits
Labor wages

Wage rate vary considerably with the location of project and the various type of crafts and it determine by one of three means:

1-union wage
2-open-shop wage
3-prevailing wage
Labor wages

- Wage rate within 40 hr/week, 8 hr/day and 5 day/week is called base rate.

- For work in excess of 8 hr/day or 40 hr/week the base rate is generally increased to (1.5-2) times the base rates
Social security tax

- Federal Government Requires Employers to be taxed for providing retirement benefits for employees

- The Rate = 7.65% of Total Earnings (Avg. Wage) up to $76,000/Year of Employee wage

- The Employee Contributes an Equal Amount Through the Employer
Unemployment compensation tax

- This tax is Collected by the State to compensate workers during period of Unemployment.

Paid by Employers. -

- Usually 3% of Total Earnings (Avg. Wage) of the Employees.
Workers compensation insurance

- To provide financial assistance to the employee or to his or her family in the event of an injury or death.

- Insurance Paid by Employers.

- Premium Rate is Specified in $s per $100 of Base Wage and vary Depending on Company's record of accidents.
Public liability and property damage

- This Insurance Protects the Contractor against injuries to the general public or damage to public property due to actions of the employee while working during construction.

- Premium is Specified in $s per $100 of Base Wage and vary Depending on Company's record of accidents.
Fringe benefits

The contractor often Pay Benefits in Terms of :
- Health insurance.
- Pension Plans.
- Training program.
- Paid holiday.
- Vacations.

Generally the costs is a percent of base wage.
Productivity rates for labor

- A production rate is defined as the number of units of work produced by a person in a specified time, usually an hour or a day.

- Productivity rates depend on:
  1- labors.
  2- projects.
  3- climatic condition.
  4- job supervision.
  5- complexities of the operation.
Cost of construction equipment
Construction equipment

- All projects involve the use of construction equipment to some extent.
- Any estimate must include the cost of equipment on the project.
Sources of Equipment

- Construction equipment can be purchased or rented. Choice between purchased and rental usually depend on the amount of time the equipment will be used in the contractors operations. If extensive use of equipment is required the equipment is often purchased. If the equipment is not to be used a limited amount of time it is typically rented.
Equipment costs

- When equipment is purchased, it is necessary to determine the two types of the cost:
  1) Ownership cost
  2) Operating cost
Equipment costs!(con.)

- Ownership cost include:
  - Investment
  - Depreciation
  - Taxes and insurance

- Operating cost includes:
  - Maintenance and repairs
  - Fuel and lubricating oil
Investment Costs

- The purchase of the construction equipment requires a significant investment of money.

- The money on purchase the equipment will be either borrowed from a lender or it will be taken from reserve fund of the contractor.
Depreciation Costs

- Depreciation is the loss in the value of equipment resulting from use and age.
Taxes and Insurance Costs

- The amount of the tax varies by geographic location.
- The construction contractor must secure insurance for owning and operating equipment.
- The cost of equipment insurance varies, depending on the type and size of equipment, and the safety record of the contractor.
Operating cost

- Operating cost occurs when the unit of equipment is being used which include maintenance and repairs, fuel, oil and lubricants.
- Maintenance and repairs may be defined as major or minor, major are often included in ownership costs and minor are included in operating costs.
- Fuel and lubricating oil should be considered as an operating cost.
The cost for maintenance and repairs include costs for replacement part and labor required to keep the equipments in good working conditions. These costs vary with the type of equipment, skills of operator, times of services. For example: If an excavator is used to excavate soft earth, the replacement parts will be less than when the same excavator is used to excavate rock.
Fuel consumptions

- When operating under standard condition (barometric pressure 29.9 inch.Hg and 68°F) gasoline engine will consume approximately 0.06 gal/(hp.hr) of fuel. And for diesel engine will consume approximately 0.04 gal/(hp.hr) of fuel.
Lubricating oil consumed

- The quantity of lubricating oil consumed by an engine will vary with the size of engine, the condition of the pistons and the numbers of hours between oil changes.
Many type of construction equipment use rubber tires, whose life usually will not be the same as the equipment on which they are used for example a unit of equipment may have an expected useful life of 6 years, but the tires may last only 2 years so the new set of tires should be placed every 2 years, and the cost for this operation should be estimated separately from the equipment.
[Chapter six]

Handling and transporting material
* Material suppliers or contractor deliver the material to the job site for the construction.

*The contractor using his or her laborers and equipment to handling and transporting the material.
* The contractor can handling the material by using truck.
Regardless of the method used in the transfer of materials, must take into account the elements of time and cost estimates and work schedules of the project.

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* When estimating the time required by a truck for around trip.

* The estimator should divide the round-trip into four elements.

* These four elements define the cycle of time.
The element of the round – trip time

Return, empty → Load → Un load → Haul → Return, empty
Hauling and Returning Depend on

- Speed of vehicle
- Distance

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Speed of vehicle

Depend on

Traffic congestion

Condition of road
Given 175 ton of sand with a density of 100 Ib/cf that must be transported 7mi using a 12-cy dump truck. Tow laborers and a driver, at a rate of 1.5 cy/hr each will load the truck. Assume a haul speed of 30mph, return speed of 40mph, and 3 min to dump the load. The cost of the truck is $25/hr, the driver is $18/hr, and laborers cost $15/hr each.

What is the total time, and the total cost for transporting the material?
**Solution:**

**Quantity of work:**

Volume of sand =

\[
(175 \text{ ton} \times 2000 \text{ Ib/ton}) / (100 \text{ Ib/cf} \times 27 \text{ cf/cy})
\]

\[
= 130 \text{ cy}
\]

**Cycle time:**

Load = 12cy / (3*1.5cy/hr) = 2.667hr

Haul = 7mi / 30mph = 0.233hr

Dump = 3 min / (60min / hr) = 0.05hr

Return = 7mi / 40mph = 0.175hr

Total cycle time = 3.125hr/trip
Production rate:

Number of trips per hour = $1.0/(3.125 \text{hr/trip}) = 0.32 \text{ trip/hr}$

Quantity hauled per trip = $12 \text{cy/trip} \times 0.32 \text{trips/hr}$

= $3.84 \text{ cy/hr}$

Assuming 45 min/hr as productivity,

Production rate = $3.847 \text{cy/hr } \times (45/60) = 2.88 \text{cy/hr}$

Time:

Using 1 truck and 2 laborers = $130 \text{cy} / (2.88 \text{cy/hr})$

= $45.1 \text{hr}$
Cost:

Truck = 45.1hr * 1 truck * $25/hr = $1127.5
Driver = 45.1hr * 1 driver * $18/hr = $ 811.8
Laborers = 45.1 * 2 laborers * $ 15/hr = $1353.00

Total cost = $3292.3
Example 2

Assuming a small tractor loader can be rented at cost of $50/hr with load production rate of 95 cy/hr. The loader operation costs $21/hr. Assuming the cost of transporting the loader to the job is $400.

What is the total time, and the total cost for transporting the 175 ton of sand?
Solution:

Quantity of work:

\[
\text{Volume of sand} = \frac{(175 \text{ ton} \times 2000\text{Ib/ton})}{(100 \text{ Ib/cf} \times 27 \text{ cf/cy})} = 130 \text{ cy}
\]

Cycle time:

\[
\text{Load} = \frac{12 \text{ cy}}{95 \text{ cy/hr}} = 0.126 \text{ hr}
\]

\[
\text{Haul} = \frac{7 \text{ mi}}{30 \text{ mph}} = 0.233 \text{ hr}
\]

\[
\text{Dump} = \frac{3 \text{ min}}{60 \text{ min/hr}} = 0.05 \text{ hr}
\]

\[
\text{Return} = \frac{7 \text{ mi}}{40 \text{ mph}} = 0.175 \text{ hr}
\]

Total cycle time = 0.584 hr/trip
Production rate:

Number of trips per hour = $1.0 / (0.584 \text{hr/trip}) = 1.71 \text{trip/hr}$

Quantity hauled per trip = $12 \text{cy/trip} \times 1.71 \text{rips/hr}$

$= 20.5 \text{cy/hr}$

Assuming 45 min/hr as productivity,
Production rate = $20.5 \text{cy/hr} \times (45/60) = 15.4 \text{cy/hr}$

Time:

Using 1 truck and 2 laborers = $130 \text{cy} / (15.4 \text{cy/hr})$

$= 8.4 \text{hr}$
Cost:

Loader = 8.4 hr * $50/hr = $420.00
Operator = 8.4 hr * $21/hr = $176.4
Truck = 8.4 hr * 1 truck * $25/hr = $210
Driver = 8.4 hr * 1 driver * $18/hr = $151.2

Laborers and equipment = $957.60
Add transporting loader = $400.00

Total cost = $1357.6
The time and cost using the equipment loader are actually lower than using the laborers in example 1

Time cost money
Lumber is usually loaded onto flatbed trucks by a forklift or laborers at the lumberyard and hauled to the job. At the jobsite, the lumber is unloaded and stacked according to size.
A laborer should be able to handle lumber at a rate of 2000 to 4000 board feet per hour (bf/hr). A reasonable average rate should be about 3000 bf/hr. For lumber one board foot is 1in, thick by 12in, wide by 1ft long.
Trucks of the type generally used will haul 2 to 6 ton, corresponding to 1000 to 3000bf per load. The average speed will vary with the:

- Distance
- Type of road
- Traffic congestion
- Weather
Estimate the cost of transporting 40000bf of lumber from a lumberyard to a jobsite.

Trucks that can carry 2000bf per load will transport the lumber, the jobsite is 2mi from the lumberyard.

An examination of the haul road indicates an average speed of 20mi/hr for the trucks, including necessary delays.
Assume that a labor will handle 3000bf/hr of lumber, based on using 2 workers, a truck driver and a laborer, and 1 truck the time and cost of the job can be determined as

**Quantity of work:**
- lumber to be handled = 40000bf

**Cycle time:**
- Assume both the truck driver and a labor will load a truck.
- Rate of loading a truck = 2*3000 = 6000bf/hr
- Time to load a truck = 2000/6000 = 0.33hr
- Travel time = 4/20 = 0.2hr
- Time to unload a truck = 2000/6000 = 0.33hr

*Total cycle time = 0.86hr/trip*
Production rate:
   Number of trips per hour = 1/0.86 = 1.16 trips/hr
   Quantity hauled per trip = 2000/1.16 = 2320bf/hr

Time:
   Total time = 40000/2320 = 17.2hr
   An alternative method of determining the time to perform the work is
   Number of truckloads required = 40000/2000 = 20 truckloads
   Round-trip per load (cycle time) = 0.86 hr/trip
   Total time for the job = 20 * 0.86 = 17.2hr

Cost:
   Truck (17.2 hr @ 25.32$/hr) = 432.5$
   Truck driver (17.2 hr @ 18.17$/hr) = 312.52$
   Laborer (17.2 hr @ 15.56$/hr) = 267.63$
   Total cost = 1012.65$
   Cost per 1000bf = 1012.65/40 = 25.32$
Sand and gravel are trip mind by companies and stockpiled for use on construction projects. Sand is generally excavated from riverbeds by draglines, loaded into trucks, and transported to a central location for later distribution to prospective buyers. Similarly, gravel is trip mind from a rock quarry, crushed in a rock-crushing machine, screened and transported by trucks to a central gravel yard. Several types of equipment, such as clamshells, front-end loaders, or portable conveyors can handle sand and gravel. Common laborers can handle small quantities.
Bricks are loaded and hauled to a jobsite by forklifts or cranes fixed on trucks. The capacity is 2,000 to 3,000 bricks per load. At the jobsite the bricks are unloaded and 4-wheel tractors are used. Laborers with tongs are carrying 6-10 bricks layer. Each trip takes the labor 1/2 -1 minute. This depends on the conditions at each project.
Estimate the time and cost of hauling 60,000 bricks from the brickyard of a supplier to a jobsite 15 mi away. Each truck hauls 3000 bricks, travel at 40 mph loaded and 50 mph empty, 3 laborers load the truck another 3 unloaded it, assume each laborer carry 8 brick at 3/4 min per trip.
Quantity of work:
Material to be transported = 60,000 bricks

Production rate of laborers:
Laborers: 3 workers * 8 bricks / trip / 3/4 min per trip = 32 bricks / min.

Rate of loading a truck: 32 bricks / min * (60 min / hr) = 1,920 bricks / hr.
Cycle time:

Loading truck: 3,000 bricks / 1,920 bricks / hr = 1.56 hr

Hauling to jobsite: 15 mi / 40 mph = 0.38 hr

Unloading truck: 3,000 bricks / 1,920 bricks / 1,920 bricks / hr = 1.56 hr

Returning to yard: 15 mi / 50 mph = 0.30 hr

_______

Total cycle time = 3.80 hr / trip
Production rate of construction operation:

Number of trips per hour: $1.0 / (3.80 \text{ hr / trip})$

$= 0.26 \text{ trips / hr}$

Quantity hauled per trip: $3.000 \text{ bricks / trip} \times 0.26 \text{ trip / hr}$

$= 780 \text{ bricks / hr}$

Required number of trucks to haul $1.920 \text{ bricks / h}$

$= 1.920 / 780 = 2.5$

It will be necessary to use either 2 or 3 trucks.
The total labor crew will consist of the following persons:

At the loading site:
1- crane operator
2- laborers with the crane
3- laborers on the truck

At the unloading site:
1- Tractor operator
2- laborers helping to unload pipe
Any cost of moving the equipment to the job and back to the corage yard should be prorated to the total length of pipe handled, and added to the unit cost just determined to obtain the total cost per unit length.
Determine the number of trucks and the direct cost per foot for transporting the pipe.

- Cycle time for (1) truck:
- Loading a truck: $14 \times 3 \text{ min/joint} = 42 \text{ min/60}$
  = $0.70\text{hr}$
- Hauling to the job: $5 \text{ min/25 mph}$
  = $0.20\text{hr}$
Unloading a truck: 14 joints * 3 min/joint = 42 min / 60 min/hour = 0.70 hr
Returning to the supplier: 5 min / 30 mph
= 0.17 hr
Total cycle time = 1.77
Production rates:

- Number of trips per hour: \( \frac{1.0}{(1.77 \text{ hr/trip})} = 0.56 \text{ trips/hr} \)
- Number of joints hauled per hour per truck: \( 0.56 \text{ hr/trip} \times 14 \text{ joints/trip} = 7.9 \text{ joints/hr} \)
- Number of joints unloaded per hour: \( 14 \text{ joints/0.7 hr} = 20 \text{ joints/hr} \)
- Number of truck required:
- Required number of trucks = \( \frac{20 \text{joints/hr}}{7.9 \text{joints/hr}} = 2.5 \)
- An alternative solution is \( \frac{\text{total cycle time}}{\text{load time}} = \frac{1.77}{0.70} = 2.5 \)
- Hourly cost of labor and equipments: using 3 trucks the hourly cost for labor and equipment for this job will be
- **Crane:** 1 hr @ $73.40/hr = $73.40
- **Operator:** 1 hr @ $21.6/hr = 21.67
- **Trucks:** 1 hr*3 trucks @ $34.30/hr = 102.90
- **Trucks drivers:** 1 hr*3 drivers @ $15.56/hr = 93.36
- Foreman: 1 hr @ $2.50/hr = $25.00
- Total crew cost = $370.84/hr
- Cost per lineal foot = $370.84/hr / (20 joints/hr * 18 ft/joints) = $1.03/ft
[Chapter Seven]

*Earth work and Excavation*
Most projects involve excavation to some extent.

It may be few cubic yards for footings and trenches or may be millions of cubic yards for large earth-filled dams.
Factors that affect the production rate of excavating equipments

Job factors:
Job factors involve:
* Type and classification of soil
* Extent of water present
* Weather conditions
* Freedom of workers and equipment to operate on the job.
* Size of the job
* Length of haul for disposal
Before estimating!!!

- Evaluate the soil investigation report
- Visit the job site
- Study the specifications and plans

Now...........!

*The contractor can determine time and cost of the work that he has to do.*
Management factors:

These factors involve:

- Organizing for the job
- Maintaining good morale (الروح المعنوية) among workers
- Selecting and using suitable equipment and construction methods.
- Exercising care in servicing (تصليح) equipment
- Establishing good field supervisory personnel
Methods of excavating and hauling earth

- Hand digging and shoveling for small jobs.

- Excavation done by backhoes, front shovel, draglines, clamshells, scrapers, bulldozers, loaders, trenching machines, boring machines, and dredges.
Front shovel
Trenching machine
Boring machine
dredges
How we select the suitable excavation equipment??!!

It depends on:
1. Type of soil
2. job-site conditions
3. Depth of excavation
4. The amount of ground water in the construction area
5. The space available for the equipment.
For example

To excavate water way channel where extensive water is present we use:

A dragline
Another example

To excavate rock material that have been loosened in the excavation pit

A front shovel

Nabil Dmaidi
The soil is excavated from its natural state
Placed in hauling unit
And is transported to the disposal area

The earth material can be measured as excavated, hauled, or compacted

For example:

1cy of soil that is excavated from the ground may occupy 1.25 cy after it is loosened and placed in the hauling unit, after the soil is compacted in place may occupy .9 cy.
Swelling and shrinkage

- **swell**, happens when the soil is excavated from the earth so its **volume** will increase and **weight per unit volume** will decrease.

- **Shrinkage**, happens when the soil is compacted with compaction equipment, so the **volume** will decrease and **weight per unit volume** will increase.
Correlation between unit weights, volumes, swell, and shrinkage

\[ L = (1 + \frac{S_w}{100}) \times B \]
\[ L = (1 - \frac{S_h}{100}) \times B \]

Sw: percentage of swell
Sh: percentage of shrinkage
L: volume of loose soil
B: volume of undisturbed soil
C: volume of compacted soil
Generally, it’s preferable to use excavating equipment instead of excavating by laborers, but at some job sites the space is not sufficient for equipment to operate.

Or in area with old or ancient buildings

Or if there are water networks or telephone lines or any infrastructure element near to surface.
Excavating with trenching machines

Trenching machine is used to make trenches in the ground that required for telephone lines, water pipes, or electricity lines. These machines can be purchased or rented. **Economically**, even though it may be economical to excavate short sections of shallow trenches with hand labor, trenching machine is more economical for larger jobs.
But,

Savings in excavating costs resulting from using machine as compared with hand excavating must be sufficient to offset the cost of transporting the machine to the job and back to the storage after the work is complete.
Wheel –type trenching machines
Wheel–type trenching machines

<table>
<thead>
<tr>
<th>Depth of trench, ft</th>
<th>Width of trench, in.</th>
<th>Digging speed, ft/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2–4</td>
<td>16, 18, 20</td>
<td>150–400</td>
</tr>
<tr>
<td></td>
<td>22, 24, 26</td>
<td>90–300</td>
</tr>
<tr>
<td></td>
<td>28, 30</td>
<td>60–180</td>
</tr>
<tr>
<td>4–6</td>
<td>16, 18, 20</td>
<td>40–120</td>
</tr>
<tr>
<td></td>
<td>22, 24, 26</td>
<td>25–90</td>
</tr>
<tr>
<td></td>
<td>28, 30</td>
<td>15–40</td>
</tr>
</tbody>
</table>
EXCAVATING WITH DRAGLINES

- the dragline is used for excavating for drainage channels and levees where water is present.
- It can operate on wet ground and can dig earth out of pits containing water, because it does not have to go into the pit or hole to excavate.
- The dragline is designed to operate below the level of the machine.
- It is preferred when earth is removed from a ditch, canal, or pit containing, and cannot excavate rock.
- It is possible to use a dragline with a long boom to dispose of the material in one operation if the material can be deposited along the canal or near the pit. This eliminates the need for hauling units, thus reducing the cost of handling the material.
EXCAVATING WITH DRAGLINES
Clamshells are used primarily for handling loose materials such as loam, sand, gravel, and crushed stone.

They are also used for removing material from pier foundations, sewer manholes, or sheet-lined trenches.

They are especially suited for lifting materials vertically from one location to another, such as depositing material in hoppers and overhead bins, they are not effective in loosening solid earth, such as compacted earth, clay, and other solid materials.

The output of the clamshell is affected by looseness of the materials being handled, type of material, height of lift, angle of swing, method of disposing of the materials, and skill of operator.
EXCAVATING WITH HYDRAULIC EXCAVATOR

- The are two basic types of hydraulic excavators, depending on their type of digging action.
- hydraulic excavators that have their digging action in an upward direction are called front shovels, and that have their digging action in downward are called by several names, such as hoe, backhoe, or trackhoe.

FRONT SHOVELS
- Front shovels maneuver on tracks, similar to bulldozers, because they are used mostly in pit excavation of rock quarries.
FRONT SHOVELS excavator
They are excavating machines that can handle all classes of earth without prior loosening, but in excavating solid rock it is necessary to loosen the rock first, usually by drilling holes and discharging explosives in them.

In estimating the output of a shovel, it is necessary to know the class of earth to be excavated, the height of cut, the ease with which hauling equipment can approach the shovel, the angle of swing from digging to emptying the bucket, and the size of the bucket.
Hauling Excavated Materials:

Any project of different type we needed to excavation and this part is importance to calculate time and cost.

To explain what rode down we have example touchable.
Example:

Land in JNIEAD reign that have area = 300m², the land shape is triangle (fig. 1) we needed excavation to built multi story building, the type of the soil is Sedimentary rocks, we used CAT machine to excavation, it excavated 6.5 m³/hr, and the cost of 1 hr are 550 NIS.

Calculate the time and cost of excavation?

We known have 6-weel truck the capacity of it is 20 m³, and the cost of one trip = 220 NIS, and we working 10 hr in day.
fig show the shape of land

Nabil Dmaidi
Solution:

The volume of cut = Volume of triangle shape = 1016 m³

# hr of CAT working = 1016 / 6.5 = 156.4 hr.
# of day = 15.6 day.
# of truck trip = 1016 / 20 = 51 Trip.

Cost:

Cost of CAT = # of hr work cost of 1 hr = 156.4 x 550 = 84920 NIS.

Cost of Truck trip = # of trip x cost of 1 trip = 51 x 220 = 11220 NIS.

Cost of CAT transport in truck = One way = 500 x 1 = 500 NIS.

The total cost = Σ of all cost = 84920 + 11220 + 500 = 96640 NIS.
Scrapers can be used for excavating and hauling earth for highway projects. Scrapers are capable of loading, hauling, and distributing the soil in the compacted fill area.
Production rate of a scraper depends on:

- time to load
- accelerate and decelerate
- turn

...the haul distance must be known because of:

- As the length of the haul distances increase, the production rate of a scraper will depend on the time to haul and return.
- Estimate the cost of excavation by scraper for particular job.
Before rock can be excavated it must be broken into small pieces to be handled by the excavating equipment. So we must use drills.
The type of drills are:

**jackhammers drills**: used for holes up to about 2.5 in in diameter and 15-18 ft deep.

**wagon drills**: use for holes 2-4.5 in in diameter and depth more than 40 ft.

**drifter drills**: used for holes up to 4 in in diameter it used for horizontal holes.
✓ churn drills: used for holes up to 12 in in diameter and more than 100 ft of depth.

✓ rotary drills: used for holes 3-8 in in diameter and depth excess of 100 ft.
Always ANFO is used for explosives

ANFO is: Ammonium nitrate-fuel oil, blasting agents represent the largest industrial explosive manufactured (in terms of quantity).

Dynamite is available in stick of varying sizes, which are placed in the hole, it usually exploded by a blasting cap, which is detonated by electric current.

The amount of ANFO required loosening rock depending on:

- Type of rock.
- Spacing of haul.
- Degree of breakage desired.
Cost of operating a drill:

- Items of cost in an operating drill is:
  - Equipment and labor

Equipment cost will include:

1. The drill
2. Drill steel
3. Bits (القطع)
4. Air compressor
5. Hose (الخرطوم)
[Chapter Eight]

Highways & pavement
Highways & pavement
Clearing & Grubbing Land

- It can be divided into several operations, depending on:
  - 1. The type of vegetation to be removed.
  - 2. The type and condition of the soil and topography.
  - 3. The Amount of clearing required.
  - 4. The purpose of clearing.
Cleaning Machine
Purpose of clearing

- 1. complete removal of all trees and stumps including tree roots.
- 2. removal all vegetation above the surface only.
- 3. disposal of the vegetation by staking and burning it.
Type of clearing:

- **Light clearing**: removal of vegetation up to 2 inch (above ground level).
- **Intermediate**: for vegetation from (2-8 inch) using bulldozer blade.
- **Large**: more than 8 inch using bulldozer with special (excavate the earth around the trees to cut the main roots)
Rates of clearing land depend on:

- Type and number and size of trees.
- Density of vegetation.
- Type of soil and topography.
- Rainfall.
- Type of equipment used and skill of equipment.
Production rate:

- Production rate = width of cut (ft) \times \frac{\text{speed (mph)}}{10}
Disposal of brash:-

- When brush is to be disposal of by burning, it should be piled in stacks and windrows with a minimum amount of earth included.
Demolition :-

- For remodels of buildings or replacement of infrastructures (remove apportion or all existing structure).
- The time and cost to perform this work is difficult to estimate because there are many factors that can affect the work.
For example:

- Removal of an existing concrete pavement depends on the thickness of slab.
- Amount of reinforcement
- Job condition
- Skills of operator
- Type and size of demolition equipment
Type of pavements

- Flexible Pavements.
- Rigid Pavements
- Composite Pavements
Types of flexible pavements

- Conventional Flexible Pavement
- Full-Depth Asphalt Pavement
- Contained Rock Asphalt Mats-CRAM
Concrete pavement joints

- It's common practice to install joints at regular intervals to reduce the danger of irregular and unsightly cracks across and along concrete pavements.

Joints
- control the location of cracks.
- allow expansion and contraction of the concrete.
- and provide a method of separating concrete placement in the construction operation.
Types of pavement joints

- Construction joints
- Transverse joints
- Longitudinal joints
Missing Contraction Joint
The middle lane contraction joint was not sawed resulting in a transverse slab crack. The outer lanes have proper contraction joints and therefore, no cracking
Construction Joint
Joint roller
The cost of hot mix asphaltic concrete

- The initial expense of setting up:
  - A plant.
  - The aggregates
  - Liquid asphalt
  - Burner fuel
  - Electricity (if no generator is used)
  - Quality control
  - All the labor and equipment costs associated with laying and compacting the mix
  - Additional costs which include site rent and railroad spur for delivery of aggregates and liquid asphalt
Asphalt can be divided to:

- Cut-back asphalt
- Emulsified asphalt
- Asphalt cement
Asphalt plants

- Hot-mix asphalt is produced in plants that proportion the aggregates, dry them and combine them asphalt cement that has been heated from 275°F to 375°F.
The cost of concrete pavement place includes:

- The cost of fine-grading
- Sub grade
- Steel reinforcing (if required)
- Aggregate, cement, mixing
- Placing, finishing and curing concrete
The cost of Preparing the sub grade for concrete pavements

We must calculate the cost of:

- Excavation
- Cleaning
- Compacting after the fine – grade is complete
Construction method used

- Two methods are used to place concrete pavements:

1) Side forms: is used for small projects, as city streets or parking lots of businesses.

2) Slips forms: commonly is used for large project, such as long highway pavements or airport runways.
Placing concrete pavements

- After the fresh concrete arrives at the job site, it must be removed to its final position without segregation of the mix and before it has achieved an initial set.
- For efficiency and economy, the production rate should be balanced between the batch plate, hauling units, and the paving equipment.
There are two types of concrete mixing operations:

1) Central-batch concrete: used for projects that required large volume of concrete.

2) Job-batch concrete: is typically used for low-volume projects, such as streets, city, and parking.
For small paving projects

- The concrete may be placed from the chute of the concrete truck into the hopper of the paving machine that places the concrete labor's hand finish the concrete.
For large paving projects

- A paving train of equipment is used to place concrete pavements.
  - A paving train consists of three types of equipment:
    - Concrete placer spreader.
    - Slip-form paver.
    - Tine and cure machine.
[Chapter Nine]

Foundations
Foundations (Definition)

It is a part of the structure that support and transmit (distribute) the loads from the structure to the wider areas of the soil.
Types of Foundations

- Foundations
  - Shallow Foundations
    - Footings
  - Deep Foundations
    - Piles
    - Drilled Shaft
      - May be Steel, Timber, or concrete
Methods of construction

- (Footings): are constructed by excavating the soil from the ground and then installing reinforced concrete, usually at depth less than 5ft.

- (Piles): are driven into the ground by the hammer of pile-driving equipment, and usually driven from (30-200)ft, depends on the magnitude of the load that comes from the structure.

Continue>>>
Methods of construction (Cont.)

- (Drilled shaft): are installed by drilling holes to depths (usually from 5-60 ft) in the soils that have sufficient strength to support the loads from the structure above the foundation.
Sheeting Trenches

- A trench is excavated into the soil to construct continuous footing, if the earth is so unstable that it must be restrained for the full area of the wall of a trench, it will be necessary to install a trench box.
Pile-Diving equipment

- Equipment used to drive piles usually consists of:
  1. A truck-mounted or
  2. Crawler-mounted crane.
  3. Leads.
  4. A hammer.
  5. And a source of compressed air or
  6. Steam of drive the hammer.
\[ V_c = \frac{\pi (d_s)^2 (D_f - h)}{4} + \frac{\pi h (d_s^2 + d_s d_b + d_b^2)}{12} \]

Where:

- \( V_c \): total volume of concrete in the shaft, (cf)
- \( D_f \): depth of foundation, (ft)
- \( h \): depth from the bottom of shaft to top of bell, (ft)
- \( d_s \): diameter of shaft, (ft)
- \( d_b \): diameter of bell, (ft)
Chapter Ten

[Concrete Cost Analysis]
Concrete structure

Cost of concrete structures:-
1. Forms.
2. Concrete.
3. Reinforcing steel
4. Finishing, if required.
5. Curing.

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The cost of concrete includes:
Sand, aggregate, cement, water, admixtures, mixing, transportation and placing the concrete.

Ready mix concrete cost depends on:
1- Size of the job
2- Location
3- Quality of concrete
The quantities of materials for concrete:
the estimator should determine the cubic yard of each class of concrete in the job. A reasonable amount should be induced for waste, such as 10% loss for small job and 5% for big.

Concrete structure are designed for concrete having specified strengths, usually 28 days after it is placed in the structure. To produce a concrete with a specified strength, it is common practice to employ a commercial laboratory to design the mix.

Concrete crew includes a finisher and not more than five laborers to place, spread, vibrate and finish the surfaces.
The labor hours required to place concrete vary with:
1. Rate of delivery
2. Type of structure
3. Location of structure

Three types of concrete:
1. Below ground
2. On the ground
3. Above ground

Rate of pacing concrete

Table 10.11: labor-hours required to place concrete, hr/cy
<table>
<thead>
<tr>
<th>Type of work</th>
<th>Method of handling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct chute</td>
</tr>
<tr>
<td>Continuous footings</td>
<td>0.3-0.4</td>
</tr>
<tr>
<td>Spread footings</td>
<td>0.6-0.7</td>
</tr>
<tr>
<td>Grade beams</td>
<td>0.3-0.4</td>
</tr>
<tr>
<td>Slabs on grade</td>
<td>0.3-0.4</td>
</tr>
<tr>
<td>Walls</td>
<td>0.4-0.5</td>
</tr>
<tr>
<td>Beams and girders</td>
<td>-</td>
</tr>
<tr>
<td>Columns</td>
<td>-</td>
</tr>
<tr>
<td>Elevated slabs</td>
<td>-</td>
</tr>
</tbody>
</table>
The light weight concrete is used when:

1. Strength is not a primary factor
2. Reduction in weight depends on the type of aggregate used as example PERLITE Aggregate.

Tilt up concrete walls are walls that are casted as slabs horizontally then up lifted vertically

Advantages of tilt up walls:

1. Low cost of forms
2. Low cost of placing reinforcing steel
3. Low cost of placing concrete
Forms for concrete structure

It is usually measured in square feet of contact of area (SFCA).
-SFCA : is the surface area that concrete will be in contact with the forms.
-Price of complicated shapes of forms is higher than simple one because :-
1. Extra material.
2. Labour cost.
3. Reduced potential to reuse.
4. Low salvage value after use.
-Lumbers economical when it is used only a few times than steel or aluminum

-Cost of Material for forms includes:
1. The cost of form.
2. Finishing.
- Plywood or metal forms has low mark effect.
- The cost of forms included the cost of nails, bolts, ties, labors, erecting, oil, removing & cleaning & pour equipment like saw & drills.
-Material used in forms are:-

1. Lumber.
2. Plywood.
3. Steel.
4. Aluminum
5. Composit.
- Lumber is economical when it is used only a few times than steel and aluminum.

-Cost of Material for forms includes:

1. The cost of form.
2. Finishing.

- Play wood or metal forms has low mark effect.
- The cost of forms included the cost of nails, bolts, ties, labors, erecting, oil, removing, cleaning, pour equipment like saw & drills.
There are three types of nails used:-

2. Box nails.
3. Double headed nails.

-The required of nails is taken as:-
10-20 lb/1000bf lumber
Forms liners are used to create any texture on the concrete surface they are expensive to use depending on the type selected.

Factors that determine the amount of labor required:

1. Size of the form.
2. Kind of material used.
3. Shape of structure.
4. Location of form.
5. The extent to which prefabricated form panels or sections can be used.
6. Rigidity of dimension requirements.
7. The extent to which the forms can be prefabricated in shop & transported to the job.
For prefabricated forms it is better to estimate labor separately.

Shape & kinds of forms:

1. For on grade slab a side forms are fastened at the perimeter

Table (10.1) shows quantities of play wood, lumber, form ties & the labour-hours required for 100SFCA of wall form:
<table>
<thead>
<tr>
<th>Wall height</th>
<th>Plywood (sf)</th>
<th>Lumber (bf)</th>
<th>Forms ties</th>
<th>Carpenter</th>
<th>Helper</th>
<th>Carpenter</th>
<th>Helper</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>100-110</td>
<td>120-135</td>
<td>12</td>
<td>2-2.5</td>
<td>1.5-2</td>
<td>2.5-3</td>
<td>2-2.5</td>
</tr>
<tr>
<td>6</td>
<td>100-110</td>
<td>135-155</td>
<td>14</td>
<td>2-2.5</td>
<td>1.5-2</td>
<td>3-3.5</td>
<td>2.5-3</td>
</tr>
<tr>
<td>8</td>
<td>100-110</td>
<td>155-175</td>
<td>14</td>
<td>2-2.5</td>
<td>1.5-2</td>
<td>3.5-4</td>
<td>3-3.5</td>
</tr>
<tr>
<td>10</td>
<td>100-110</td>
<td>175-205</td>
<td>16</td>
<td>2-2.5</td>
<td>1.5-2</td>
<td>4-4.5</td>
<td>3.5-4</td>
</tr>
<tr>
<td>12</td>
<td>100-110</td>
<td>205-245</td>
<td>18</td>
<td>2-2.5</td>
<td>1.5-2</td>
<td>4.5-5</td>
<td>4-4.5</td>
</tr>
<tr>
<td>14</td>
<td>100-110</td>
<td>245-305</td>
<td>18</td>
<td>2-2.5</td>
<td>1.5-2</td>
<td>5-5.5</td>
<td>4-4.5</td>
</tr>
<tr>
<td>16</td>
<td>100-110</td>
<td>305-325</td>
<td>20</td>
<td>2-2.5</td>
<td>1.5-2</td>
<td>5.5-6</td>
<td>5-5.5</td>
</tr>
</tbody>
</table>
2. Forms of columns are made of:

1. Fiber tube ........ only once
2. Fiber glass.......... 4 times use.
3. Steel ........ many times.

- Number of clumps depend on:
  1. Height.
  2. Pressure of concrete.
If it is not necessary to rebuild the forms for each use, the estimator should separate the labor into 2 operations:

1. Making the forms.
2. Erecting & removing them.

Considerable saving can be achieved by reusing concrete forms.
The opportunity to reuse forms is reduced when multiply size of columns are required in a project.

The cost to remake forms is higher than the saving in concrete cost.

Forms for drop panels are built of lumber and pay wood, consisting of flat surfaces where as columns capitals consist of cylindrical conical surface.
3. above ground slab forms:

- The cost of forms varies with the thickness of the slab and the height of the slab above the lower floor.
- The form builder has considerable freedom in selecting the size and spacing of joist and stingers.
- The lumber required for metal pan construction consists of centering strips, stringers, shores and braces.
Metal or fiber glass patented forms are available from commercial suppliers.

1. Metal pans are placed end to end to provide one way slab action.
2. Fiberglass domes are available for forming a two-way floor system (waffle slab).

- When using commercial pans or domes the total quantity of concrete is less than flat slab.

- Contractors rent pans to an agreed price per square foot per use for minimum number of uses.
Approximate quantities of material and labor-hours required to build, erect and remove 100 SFCA of metal-pan concrete floors

<table>
<thead>
<tr>
<th>Ceiling height, ft</th>
<th>Floor thickness, in.</th>
<th>Lumber, bf</th>
<th>Labor-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Carpenter</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>120</td>
<td>3.5-4.0</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>130</td>
<td>4.0-4.5</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>140</td>
<td>4.0-4.5</td>
</tr>
<tr>
<td>14</td>
<td>10</td>
<td>130</td>
<td>3.5-4.0</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>140</td>
<td>4.0-4.5</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>150</td>
<td>4.1-4.5</td>
</tr>
<tr>
<td>16</td>
<td>10</td>
<td>140</td>
<td>3.5-4.0</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>150</td>
<td>4.0-4.5</td>
</tr>
<tr>
<td>10</td>
<td>16</td>
<td>160</td>
<td>4.0-4.5</td>
</tr>
</tbody>
</table>
4. beams shores and scaffolding:

- Vertical shores or posts and scaffolding are used to support concrete beams girders, floor slabs, roof slabs, bridge decks, and other members until the concrete has gained sufficient strength to be self-supporting.

- Many types and sized shoring and scaffolding are available and made from wood, steel are combination of the two and aluminum.
Tabular scaffolding is available to support high and heavy loads.

The contractor often rents scaffolding for a particular job.

For concrete beam forms the amount of time for carpenters is significantly greater and for helpers compares to walls and column.

The quantities of material and labor-hours to build 100 SFCA of forms for concrete beams of various sizes are showing table 10.3
## Approximate quantities of material and labor-hours required for 100 SFCA of concrete beams.

<table>
<thead>
<tr>
<th>Beam width, in.</th>
<th>Number of uses</th>
<th>Plywood, sf</th>
<th>Lumber, bf</th>
<th>Form ties</th>
<th>Labor-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>carpenter</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>100-110</td>
<td>260-290</td>
<td>12</td>
<td>13.5-14.5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>45-55</td>
<td>135-150</td>
<td>12</td>
<td>11.5-12.5</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>35-45</td>
<td>105-115</td>
<td>12</td>
<td>9.5-10.5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>25-35</td>
<td>90-100</td>
<td>12</td>
<td>8.5-9.5</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>100-110</td>
<td>210-235</td>
<td>15</td>
<td>12.5-13.5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>50-60</td>
<td>120-135</td>
<td>15</td>
<td>10.5-11.5</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>35-45</td>
<td>100-110</td>
<td>15</td>
<td>9.5-10.5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>25-35</td>
<td>75-85</td>
<td>15</td>
<td>9.0-10.0</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>100-110</td>
<td>190-210</td>
<td>20</td>
<td>11.5-12.5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>55-65</td>
<td>100-110</td>
<td>20</td>
<td>10.5-11.5</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>35-45</td>
<td>75-85</td>
<td>20</td>
<td>9.5-10.5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>25-35</td>
<td>65-70</td>
<td>20</td>
<td>9.0-10.0</td>
</tr>
</tbody>
</table>
The costs per unit of volume or area varies greatly in concrete stairs depending on the:

1. Length of tread
2. Width of tread
3. The height of the rise
4. The shape of the supporting floor for the shores

Two carpenters should be used to build the forms for the stairs, each one should fabricate and install about 25 bf/hr of lumber.
REINFORCING STEEL

- The unit of measure for reinforcing steel is pound of weight.

- Types of Reinforcing steel:
  1. Deformed bars
     Lb, Ton. →
  2. Welded wire fabric
     Sq Ft or Lb →
The most important properties of Reinforcing steel are:-

- **Size**, **Area**, **weight**

- Available strength 40Ksi, 50, 75,

- Epoxy-coated bars are used when deicing salts or sea water can effect the bars

  (Table 10.6)

  Shows size & weights of reinforcing steel
<table>
<thead>
<tr>
<th>Bar no.</th>
<th>Diameter, in</th>
<th>Area, in^2</th>
<th>weight, lb/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.375</td>
<td>0.11</td>
<td>0.376</td>
</tr>
<tr>
<td>4</td>
<td>0.5</td>
<td>0.20</td>
<td>0.668</td>
</tr>
<tr>
<td>5</td>
<td>0.625</td>
<td>0.31</td>
<td>1.043</td>
</tr>
<tr>
<td>6</td>
<td>0.75</td>
<td>0.44</td>
<td>1.502</td>
</tr>
<tr>
<td>7</td>
<td>0.875</td>
<td>0.60</td>
<td>2.044</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>0.79</td>
<td>2.670</td>
</tr>
<tr>
<td>9</td>
<td>1.128</td>
<td>1.00</td>
<td>3.400</td>
</tr>
<tr>
<td>10</td>
<td>1.27</td>
<td>1.27</td>
<td>4.303</td>
</tr>
<tr>
<td>11</td>
<td>1.41</td>
<td>1.56</td>
<td>5.313</td>
</tr>
<tr>
<td>14</td>
<td>1.693</td>
<td>2.25</td>
<td>7.650</td>
</tr>
<tr>
<td>18</td>
<td>2.257</td>
<td>4.00</td>
<td>13.600</td>
</tr>
</tbody>
</table>
- Rebar schedule:
  Each size and length or bars is listed separately for each project

(Table 10.7)
<table>
<thead>
<tr>
<th>Bar mark</th>
<th>No. required</th>
<th>Bar size</th>
<th>Length</th>
<th>Weight Lb/ft</th>
<th>Total weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>120</td>
<td>4</td>
<td>30ft 0in</td>
<td>.068</td>
<td>2405</td>
</tr>
<tr>
<td>B</td>
<td>56</td>
<td>4</td>
<td>20ft 0in</td>
<td>.668</td>
<td>749</td>
</tr>
<tr>
<td>C</td>
<td>116</td>
<td>5</td>
<td>24ft 0in</td>
<td>1.043</td>
<td>2900</td>
</tr>
<tr>
<td>D</td>
<td>42</td>
<td>6</td>
<td>12ft 4in</td>
<td>1.502</td>
<td>780</td>
</tr>
<tr>
<td>E</td>
<td>36</td>
<td>6</td>
<td>14ft 8in</td>
<td>1.502</td>
<td>794</td>
</tr>
<tr>
<td>F</td>
<td>28</td>
<td>6</td>
<td>19ft 8in</td>
<td>1.502</td>
<td>826</td>
</tr>
<tr>
<td>G</td>
<td>16</td>
<td>7</td>
<td>22ft 3in</td>
<td>2.044</td>
<td>604</td>
</tr>
<tr>
<td>H</td>
<td>72</td>
<td>7</td>
<td>22ft 3in</td>
<td>2.044</td>
<td>3280</td>
</tr>
<tr>
<td>I</td>
<td>84</td>
<td>7</td>
<td>18ft 8in</td>
<td>2.044</td>
<td>3200</td>
</tr>
<tr>
<td>J</td>
<td>24</td>
<td>8</td>
<td>24ft 0in</td>
<td>2.670</td>
<td>1535</td>
</tr>
<tr>
<td>K</td>
<td>18</td>
<td>8</td>
<td>21ft 6in</td>
<td>2.670</td>
<td>1037</td>
</tr>
</tbody>
</table>
And each size and length should be assigned a number or a letter of the alphabet (bar marks). To estimate the cost or R.S total weight of all size and length should be found.

Factors that affected the cost of R.S delivered a project:

1. Base cost of bars at the fabricating shop.
2. Cost of preparing shop drawings.
3. Cost of handling, cutting, bending, etc.
4. Cost of shop overhead and profit.
5. Cost of transporting from the shop to the job.
6. Cost of specialties, such as spacers, saddles, chairs, ties, etc.
The rates at which workers will place reinforcing steel bars will vary with these factors:

1. Size & length of bars.
2. Shapes of bars.
3. Complexity of structure.
4. Distance & height the steel must be carried.
5. Allowable tolerance in spacing bars.
6. Extent of tying required.
7. Skill of the workers.
Table 10.8: rates of placing reinforcing steel

<table>
<thead>
<tr>
<th>Type of work</th>
<th>Bar size 0.625 and less</th>
<th>Bar size 0.75 and over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beams &amp; girders</td>
<td>19-21</td>
<td>11-12</td>
</tr>
<tr>
<td>Columns</td>
<td>20-22</td>
<td>13-15</td>
</tr>
<tr>
<td>Elevated slabs</td>
<td>10-12</td>
<td>10-12</td>
</tr>
<tr>
<td>Footings</td>
<td>14-16</td>
<td>8-9</td>
</tr>
<tr>
<td>Slab on grade</td>
<td>13-15</td>
<td>13-15</td>
</tr>
<tr>
<td>Spirals &amp; stirrups</td>
<td>12-14</td>
<td>12-14</td>
</tr>
<tr>
<td>Walls</td>
<td>10-11</td>
<td>8-9</td>
</tr>
</tbody>
</table>
*For projects like sidewalls, pavements, floors, and canal linings, it is more economical to use welded wire fabric.

*It is made of cold drawn steel wire electrically welded at intersections.

*Quantity equal are ... to be reinforced with 5-10% of the area.

*is placed by unrolling it over the area, cutting it to a required length, lapping the edges and ends, and tying it at equal spaces.

Rate:-

Regular shape 0.25hr/100sl
Irregular 0.5hr/100sl
[Chapter Eleven]

Steel Structures
Steel structures used for:

- Multistory Building
- Theaters
- Industrial Building
- Roof Truss
- Stadium
- Bridges
- Others
Usually steel structures given in standard form such as:

- W-section
- C-channel
- Tubes
- Plates
- Angles
Note:

Standard forms in steel structures is more economical than as built sections.
Weight is usually used as unit of Measurement In steel structures

$/\text{ton}$
Steel structures cost include:

1) Cost of Standard Structural Shapes
2) Cost of preparing Drawing
3) Cost of Fabricating the steel shapes into finished members
4) Cost of transporting the steel
5) Cost of erecting the steel

6) Cost of field painting the steel structure

7) Cost of job over head, general overhead, Insurances, taxes and profit
Cost of standard shaped structural steel

Materials cost is function of:

1) Steel Grade
2) Shape
3) Weight
4) Total quantity
Cost of Preparing Shop drawing

- The engineer or architect does not furnish drawing in sufficient details

- The steel suppliers must prepare shop drawing before the steel can be fabricated

* Steel suppliers maintain engineering and drafting departments which prepare shop drawing in sufficient details to enable their shops to fabricate the members
Cost of fabricating structural steel

Fabricating includes:
Cutting
Punching
Milling
Planning
marking
* Fabricating structural steel function of operational performed
  * size of member
  * Operations that can be duplicated on similar members
The estimator should determine the fright or truck cost per unit weight for the particular project to include the correct amount in the estimate.
Erection structural Steel

1) The columns are erected first
2) The beams are installed to the building
Equipment for Erection structural steel

- Depends on:
  - Type of structure
  - Size
  - Height
  - Location
Types of Connection

- Types of Connection & how to install connection depend on the design criteria
Connections

- Bolted Connections:
  - it is more easy but increase construction cost

- Welded Connections:
  - more difficult and needs experience
Field Painting Structural Steel

- Sometimes necessary to perform limited field painting
- The cost will vary depending on
  - Type of structure
  - Size
  - Access to member
Rate of applying a field coat of paint to steel structure

<table>
<thead>
<tr>
<th>Member of structure</th>
<th>square ft/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam</td>
<td>200-250</td>
</tr>
<tr>
<td>Girder</td>
<td>125-200</td>
</tr>
<tr>
<td>columns</td>
<td>200-250</td>
</tr>
<tr>
<td>Roof Truss</td>
<td>275-350</td>
</tr>
<tr>
<td>Bridge</td>
<td>200-250</td>
</tr>
</tbody>
</table>
EXAMPLE

Structural Steel, consisting of beams, columns, angles, and plates, is used for a framed building. All members are to be fabricated at a shop for high-strength bolted connections. Wide flange beams will be used for beams and columns.

A list of members and details is given in accompanying table. The small-size beams are used for short spans and larger-size beams will be used for longer spans. The larger column sizes will be used for the lower floors. Where as the smaller column sizes are used for the upper floors. Angles are used as seats and clips for beam to column connections for joining together the structural members. Steel plates are used for columns base plates and splicing of column members.
Based on current economic condition, the base price of steel quoted from the supplier is 24.96$/cwt for beams and columns, 28.43$/cwt for plates and 22.17$/cwt for angles.

The steel will be delivered by 20-T trucks from the steel supplier a distance of 134mi to the job at a rate of 2.75$/mi.

An illustrative breakdown of the base, fabrication and delivery cost of the steel is shown in this example. The percentage values given in the preceding of this book are used for fabrication, shop drawings and painting.
<table>
<thead>
<tr>
<th>Number of pieces</th>
<th>Description</th>
<th>Length each</th>
<th>Weight Lb/lin ft</th>
<th>Total weight, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Columns W10x89</td>
<td>24 ft 9 in</td>
<td>89</td>
<td>39,649</td>
</tr>
<tr>
<td>12</td>
<td>Columns W10x112</td>
<td>24 ft 9 in</td>
<td>112</td>
<td>33,264</td>
</tr>
<tr>
<td>18</td>
<td>Columns W10x54</td>
<td>21 ft 6 in</td>
<td>54</td>
<td>20,898</td>
</tr>
<tr>
<td>12</td>
<td>Columns W10x72</td>
<td>21 ft 6 in</td>
<td>72</td>
<td>18,576</td>
</tr>
<tr>
<td>Total weight of columns</td>
<td></td>
<td></td>
<td></td>
<td>112,387</td>
</tr>
<tr>
<td>30</td>
<td>16x16x1 ½-in base plates</td>
<td></td>
<td></td>
<td>3,267</td>
</tr>
<tr>
<td>120</td>
<td>6x18x3/4 –in splice p</td>
<td></td>
<td></td>
<td>2,763</td>
</tr>
<tr>
<td>120</td>
<td>3x3x(3/8)</td>
<td>0 ft 8 in</td>
<td>7.2</td>
<td>575</td>
</tr>
<tr>
<td>420</td>
<td>21/2x2x(3/16)</td>
<td>0 ft 8 in</td>
<td>2.75</td>
<td>577</td>
</tr>
<tr>
<td>Total weight of column details</td>
<td></td>
<td></td>
<td></td>
<td>7,182</td>
</tr>
</tbody>
</table>

Nabil Dmaidi
<table>
<thead>
<tr>
<th>Beams W14x48</th>
<th>17 ft 6 in</th>
<th>48</th>
<th>57,120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beams W14x34</td>
<td>19 ft 9 in</td>
<td>34</td>
<td>36,261</td>
</tr>
<tr>
<td>Beams W14x32</td>
<td>16 ft 6 in</td>
<td>32</td>
<td>12,672</td>
</tr>
<tr>
<td>Beams W14x28</td>
<td>22 ft 6 in</td>
<td>28</td>
<td>11,340</td>
</tr>
<tr>
<td><strong>Total weight of beams</strong></td>
<td></td>
<td></td>
<td><strong>117,393</strong></td>
</tr>
<tr>
<td>3x3x(3/8)</td>
<td>1 ft 0 in</td>
<td>7.2</td>
<td>3,542</td>
</tr>
<tr>
<td>3x3x(1/4)</td>
<td>0 ft 10 in</td>
<td>4.9</td>
<td>670</td>
</tr>
<tr>
<td><strong>Total weight of angles</strong></td>
<td></td>
<td></td>
<td><strong>4,212</strong></td>
</tr>
<tr>
<td><strong>Total weight of fabricated steel, lb</strong></td>
<td></td>
<td></td>
<td><strong>241,174</strong></td>
</tr>
<tr>
<td><strong>Total weight, tons</strong></td>
<td></td>
<td></td>
<td><strong>120,59</strong></td>
</tr>
</tbody>
</table>
The Total cost will be:

- **Base cost of steel:**
  - Columns: 1.123.87 cwt @ $24.96/cwt = $28.051.80
  - Beams: 1,173.93 cwt @ $24.96/cwt = $29,301.29
  - Plates: 60.30 cwt @ $28.43/cwt = $29,301.29
  - Angles: 3 in .. 47.87 cwt @ $22.17/cwt = $1,061.28
  - Angles: 2 1/2 in .. 5.77 cwt @ $22.17/cwt = $127.92
  - Total base cost of steel = $60,256.62

- **Fabricating costs:**
  - Column: 1.123.87 cwt @ 85% x $24.96/cwt = $23,884.03
  - Beams: 1,173.93 cwt @ 85% x $24.96/cwt = $24,906.10
  - Plates: 60.30 cwt @ 95% x $28.42/cwt = $1,628.04
• Angles: 3 in. 47.87 cwt @85% x $22.17/cwt = $902.09
• Angles: 21/2 in. 5.77 cwt @90% x $22.17/cwt = $115.13
• Total fabricating cost = $51,435.39

• Shop painting:
  • 7.5% x $60,256.62 = $4,519.25
• Shop drawings:
  • 10.0% x $60,256.62 = $6,025.66
• Shipping steel to job:
• Number of trucks needed: 120.59 T/(20 T/truck) = 6 trucks required
• Total cost: 6 trucks x 134 mi @ $2.75/mi = $2,211.00
- Subtotal of direct costs:
- Base price of steel = $60,256.62
- Fabricating costs = $51,435.39
- Shop painting = $4,519.25
- Shop drawings = $6,025.66
- Shipping costs = $2,211.00
- Total direct costs = $124,447.92
- Overhead and profit:
  - 12% x $124,447.92 = $14,933.75
- Total cost of fabricated steel delivered to job:
  - $124,447.92 + $14,933.75 = $139,441.67....
Summary of costs:

- Cost per pound: $139,441.67 / 241.174 lb = 0.58/lb.
- Cost per hundred weight: $139,441.67 / 2,411.74 = $57.79/cwt
- Cost per ton: $139,441.67 / 120.59 T = $1,156/T.
[Chapter Fourteen]
Masonry
Masonry
1. Masonry units that are commonly used for construction include brick, concrete masonry units, and stone, either natural or artificial.

2. Masonry units are available in several sizes, grades and textures.
1. In estimating the cost of a structure to be constructed entirely or partly of masonry units, the estimator should determine separately and the cost of each kind of unit required.

2. The quantities of masonry units should include an allowance for waste.
1. Mortar for masonry units is made by mixing Portland cement with lime or masonry cement, and sand.

2. Mortar is designated as ASTM types M, S, N, O and Pl. The M type is high-strength, the S type used for structures requiring high flexural bond strength, the N type mortar is used in medium-strength, the type O is used in low strength.

**NOTE:** If fine sand is used the workability of the mortar will be much better than if coarse sand is used.
Pattern bonds

Types of pattern bonds:

- Running
- Common or American
- Flemish
- English
- Stack
- English Cross or Dutch
Types of joints for brick masonry

- Concave
- Vee
- Flush
- Raked
- Extruded
- Beaded
- Struck
- Weathered
Brick masonry can be cleaned by several methods, including bucket and brush by hand, high pressure water cleaning, or sandblasting.
The labor-hours required to lay bricks vary with a number of factors, such as the quality of work, type of bricks, kind of mortar used, shape of the walls, kind of bond pattern used, and weather conditions.
Concrete masonry units (CMUs) are concrete blocks that are manufactured in various sizes from Portland cement, sand, and gravel, or cement and lightweight aggregates.
Several kinds of stone, both natural and artificial are used in structures such as buildings, walls,....etc. Natural stones used for construction includes sandstone, limestone, dolomite, marble,....etc.
The cost of stone depends so much with kind of stone, methods of cutting stone, and location of use.
[Chapter Seventeen]

Carpentry
Carpentry deals with the processing of wood to obtain desired shapes and sizes.
Hand tools

Large number of hand tools are used for processing the wood

1. Marking and measuring tools
2. Cutting and parting tools
3. Boring tools
4. Striking tools
5. Holding tools
Measuring tools

- Steel rule or engineer’s rule
- Wooden folding rule
- Steel tape
Steel rule
Wooden folding rule

(b) Four-Fold Rule
Steel tape
Important marking tools are
1. Straight edge
2. Try square
3. Marking gauge
4. Divider
5. Marking knife
Straight edge
Try square
Gauges

Gauges are used for cutting parallel lines at a given distance from the edge

Types of gauges
1. Marling gauge
2. Mortise gauge
3. Panel gauge
4. Cutting gauge
5. Wing compass
6. Trammel
7. divider
8. Caliper
9. spirit level
10. Nabil Dmaidi
Panel gauge

It is similar to marking gauge, but it has a long stem which enables to mark the width of wide boards such as door panels.
Cutting gauge

- Cutting gauge similar to marking gauge but it has sharp cutter instead of a pin
- It is used to cut lines across the grains
- It is particularly adapted for dovetail joints
Hand saw

Hand saw is used for cutting wood to the desired shape and size

Parts of hand saw
1. Handle
2. Blade

Specifications of hand saw
1. Length of blade— 600mm to 700mm
2. Pitch--- 2.5mm to 8mm
Types of hand saw

1. Rip saw
2. Cross-cut saw
3. Panel saw
4. Tenon saw
5. Dovetail saw
6. Bow saw
7. Coping saw
8. Key hole saw
9. Compass saw
<table>
<thead>
<tr>
<th>Name</th>
<th>Length of blade, mm</th>
<th>Pitch mm</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rip saw</td>
<td>700</td>
<td>5-8</td>
<td>Sawing along the grains of large pieces of wood</td>
</tr>
<tr>
<td>Cross-cut saw</td>
<td>600</td>
<td>2.5-3.0</td>
<td>Sawing across the grains of large pieces of wood. It can also cut along the grains but not as effective as rip-saw</td>
</tr>
<tr>
<td>Panel saw</td>
<td>500</td>
<td>2.5</td>
<td>Similar to cross-cut saw but used for finer works such as sawing plywood and large joints.</td>
</tr>
<tr>
<td>Tenon saw</td>
<td>250, 300, 350 and 400</td>
<td>1.5</td>
<td>Sawing small pieces of wood and for making joints</td>
</tr>
<tr>
<td>Dovetail saw</td>
<td>200</td>
<td>1.25-1.75</td>
<td>For the smallest and most accurate work, particularly for making small dovetail joints.</td>
</tr>
</tbody>
</table>
chisels

Chisels are used for cutting excess wood for making joints

They are also used for shaping different profiles in wood work

Parts of chisels

1. handle  2. blade
3. tang     4. shoulder
5. neck
Firmer

- Capable of doing heavy work
- Used for joining and shaping the wood
- Blade rectangular section with beveled edge
- Length of blade—125mm
- Width—3 to 50mm
(a) Firmer Chisel

(b) Bevelled Edge Firmer Chisel

(c) Paring Chisel
Types of planes

1. Jack plane
   (a) wooden    (b) metal
2. Trying plane
3. Smoothing plane
4. Rebate plane
5. Plough plane
6. Router plane
7. Spoke shave
8. Special planes
[Chapter Twenty]

Water distribution systems
Water distribution systems

The cost of water distribution systems will include the material, equipment, labor, and supervision to accomplish some or all of the following:

1. clear the right-of-way for the trench
2. remove and replace pavement
3. relocate utility lines
4. install pipe
5. excavate and backfill trenches
6. install fittings
7. install valves and boxes
8. install fire hydrants
9. install service connection, meter, and meter boxes
10. drill holes under roads and pavement, and install casings for pipeline
11. test and disinfect water pipe
The following types of pipes are used for water systems:

1. Cast iron
   a. Bell and spigot
   b. Mechanical joint
   c. Push–on joint, or gasket–seal joint
   d. Threaded
   e. Cement-lined

2. Steel
   a. Threaded, black or galvanized
   b. Welded, plain or cement-lined

3. Reinforced concrete
   a. Prestressed
   b. Nonprestressed

4. Brass and copper

5. Lead

6. Plastic
Tests of water pipes

Specifications usually require the contractor to subject the water pipe to a hydro-static test after it has been to backfilling the trenches if any joints show excessive leakage they must be recalled. It is common practice to lay several blocks of pipe, install a valve temporarily and subject the section to a test. If a test satisfies the specifications, the valve is removed and the trench is repeated until the system is completed.
Cost of cutting cast-iron pipe

Cast-iron pipe may be cut with chisels or with chain cutters. Chisel cutting is done by two or more laborers using a steel chisel with a 6 to 8-lb hammer. Chain cutters can be operated by hand for pipes up to 12 in diameter but for larger pipes, a power-driven cutter should be used.

Machines are available that can cut 10- to 60-in.-diameter pipe. It requires 60 to 70 cf/min of air at a pressure of 85 lb/sq in. The saw is a portable milling machine on wheels which travels around the pipe under two silent type chains which hold the machine to the pipe and act as a flexible ring gear for the feed sprockets. The machine moves while the chins remain stationary. A complete cut is made in 1 revolution (r) around the pipe. It will require 1 min of cutting time for each inch of pipe diameter. Thus a 24-in. pipe is cut in 24 min of cutting time. An experienced crew of two individuals can install the machine on a pipe in approximately 15 min.

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The total time allowed for cutting cast-iron pipe should include measuring supporting on skids if necessary and cutting in cutting pipe larger than 24 to 30 in it may be necessary to use a crane to handle the pipe table 23.4 gives the approximate time in hours required to cut various sizes of cast-iron pipe the time given includes measuring setting up and cutting for average conditions.
Labor required to lay cast-iron pipe

The installation of bell-and-spigot cast-iron pipe will include some of or all the following operation:
1. cutting the pipe if necessary
2. lowering the pipe into the ball
3. inserting the spigot into the bell
4. yarning the bell
5. attaching a runner and pouring the lead
6. removing the runner and caulking the lead

Each joint of pipe is lowered into the trench by hand or with an excavator crane tractor-mounted side boom or other suitable equipment after the spigot end is forced into the bell to full depth two or more strands of yarning which completely encircle the pipe are caulked into the bell to center the pipe and to prevent molten lead from flowing into the pipe a runner is placed around the pipe against the bell with an opening near the top to enable molten lead to be poured into the joint the lead for a joint should be poured in one continuous operation without interruption after the lead cools to the temperature of the pipe the runner is removed the lead is caulked by hand or with a pneumatic caulking hammer.
The size of crew required to lay the pipe and the rate of laying will vary considerably with the following factors:

1. Class of soil
2. Extent of groundwater present
3. Depth of trench
4. Extent of shoring required
5. Extent of obstruction such as utilities, sidewalks, pavement
6. Size of pipe
7. Method of lowering pipe into trench
8. Extent of required for fittings and valves
Often, water lines are installed above sewer lines. The depth of water lines are placed below the frost line. Since water lines are under pressure they can be routed up or down rather than following grade to ensure gravity flow like sewer lines.

The crew required to dig the trenches lay the pipe and backfill the trenches for 12-in. pipe furnished in 18-ft lengths using a tractor-mounted side boom to lower the pipe into the trench. In trench 3 to 6 ft deep in firm earth with no groundwater and no shoring needed might include:

- Trenching machine operator
- Laborers on bell holes
- Tractor operator
- Laborers on pipe
- Workers centering pipe and installing yarning
- 1. person melting and supplying lead
- 1. person installing runners and pouring lead
- 2. workers caulking lead joints by hand
- 1. driver for utility truck
- 1. bulldozer operator backfilling trench
- 1. foreman

A crew should install four to six joints per hour either pipe or fitting the length of pipe laid will vary from 72 to 108 ft/hr. 90 ft/hr a fair average for the conditions specified.

Table 23.5 gives representative labor-hours required to lay cast-iron pipe in trenches 3 to 6 ft deep in firm soil with litter or on shoring required and no groundwater using caulked lead joints for pipe laid under other conditions the labor-hours should be altered to fit the conditions for the particular project if a crane is used to lower the pipe replace the tractor operator with a crane operator.
The crew might include:

- 1 trenching machine operator
- 2 laborers cleaning trench and digging bell holes
- 1 tractor operator lowering pipe into trench
- 1 laborer assisting tractor operator
- 2 laborers in trench handling pipe
- 1 pipe layer with pipe and fittings
- 2 laborers backfilling trench
- 1 laborer operating tamper
- 1 bulldozer operator backfilling trench
- 1 foreman

In some locations it may by necessary to reclassify some of the individuals of the crew into semiskilled or skilled ratings.
[Chapter 24]

Total Cost of Engineering Projects
The total cost to the owner may include:

1. Land, right of way, easements.
2. Legal expense.
3. Bond expense, or cost of obtaining money to finance the project.
5. Engineering and/or architect’s expense.
6. Interest during construction.
7. Contingencies.
Cost of Land, Right of Way, and Easements

- The owner of the project must provide money to purchase land or to use land in constructing an engineering project.

- Easement is the right for which the owner of the project may pay the owner of the land to maintain certain facilities (as construction of pipelines, power lines, telephone lines, etc...) without actually purchasing it.
Legal Expenses

They are the legal fees paid for the following services:

1. Acquisition of land and easements.
2. Printing and obtaining approval of bonds for:
   a. providing money to finance the project
   b. assistance to a private corporation.
3. employment.
Bond Expense

Charging to the project the costs of the following services:

1. Printing
2. Registering
3. And selling the bonds.

That is usually done through a qualified underwriting broker, who charges a fee for these services.
Cost of Construction

- The cost of construction a project is usually an estimate only, made in advance of receiving bids from contractors, prepared by an engineer or an architect.
- The estimate may be a lump-sum cost, or a unit-price estimate.
Engineering Expense

- It is the cost of the following engineering services:
  1. Surveys and studies.
  2. Prepare the plans and specifications.
  3. Assist in securing bids for the construction.
  4. Acts as the owner’s representative during construction.
Engineering Expense (Continue)

The cost of engineering surveys is by one of the following methods:

1. Lump-sum.
2. Salary cost times a multiplier.
3. Cost plus a fixed payment.
4. Percentage of construction.
Single Lump-sum Payment

- It is used for simple or small projects.
- It applies only when the work to be performed is well defined & the project has no unusual requirements.
Salary times a Multiplier Method

- It is used for complex projects or for projects that don’t have a well-defined scope of work.
- A multiplier (usually 2-3) is applied to direct salary cost to compensate for overhead, contingencies, & profit.
Cost Plus a Fixed Payment Method

- Used when an engineering design is required to start before the cost and the scope of work can be accurately determined.
- Used if the owner wants to accelerate the design process, analyze special problem, or prepare estimates for alternate types of construction.
- The fixed fee is 10% (large projects), and 25% (small projects).
Percentage of Construction Cost Method

- It is used when the design procedure, construction method, & type of material are well known.
- The percentage is on sliding scale that decreases as the construction cost increases.
- It ranges from 5-12% of the anticipated construction cost.
Interest During Construction

- The owner pay to the contractor at the end of each month during the period of construction a specified percentage of the value of the work completed during a month, usually 90%.
Providing funds to cover any additional costs that may occur during construction, if the cost of the project is not known in advance of raising funds to finance it.
Example Estimate for Total Cost of an Engineering Project

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimated cost($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Land &amp; easements</td>
<td>86000</td>
</tr>
<tr>
<td>2. Legal expenses</td>
<td>12000</td>
</tr>
<tr>
<td>3. Bond expenses</td>
<td>8100</td>
</tr>
<tr>
<td>4. Cost of construction</td>
<td>589964 (a+b+c+d+e+f)</td>
</tr>
<tr>
<td>a. Water wells (3@106.625$)</td>
<td>319.875</td>
</tr>
<tr>
<td>b. Pump houses (3@4500$)</td>
<td>13500</td>
</tr>
<tr>
<td>c. Electric power lines (9420@11.36$)</td>
<td>107011</td>
</tr>
<tr>
<td>d. Ductile iron pipe (8780@15.63$)</td>
<td>137231</td>
</tr>
<tr>
<td>e. Cast-iron fittings</td>
<td>8667</td>
</tr>
<tr>
<td>f. 12 in. Gate valve (4@920$)</td>
<td>3680</td>
</tr>
<tr>
<td>Total cost of construction</td>
<td>696064</td>
</tr>
<tr>
<td>5. Eng. expense (7% of construction cost)</td>
<td>48724</td>
</tr>
<tr>
<td>6. Interest (10 months @8%/year)</td>
<td>696064/2<em>0.08</em>10/12 = 23202</td>
</tr>
<tr>
<td>7. Contingencies (5% of 696064$)</td>
<td>34803</td>
</tr>
<tr>
<td>8. Estimated total cost</td>
<td>802793</td>
</tr>
</tbody>
</table>

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[Chapter 25]

Computer Estimating
Introduction

- To assemble complete estimate, the estimator must combine knowledge of construction methods & cost calculations.
- This takes too much time, information, & numerous calculations, so, it is an ideal task for the computer to prepare a detailed estimate.
- The estimator should NEVER accept everything that comes out of the computer as being totally correct.
Importance of the Estimator

1. The estimator must know the software being used.
2. The estimator has the capability to judge the results of the software.
3. The estimator perform “what if” analysis.
4. The estimator manage the exchange of information to ensure it is correctly entered into the computer.
Tasks of Computer Used in Estimating

1. Maintaining master checklists.
2. Maintaining an inventory of subcontractors, vendors, & suppliers.
3. Maintaining bidding records of competitive bidders.
4. Performing material quantity takeoffs.
5. Storing & retrieving historical cost data.
6. Storing & retrieving labor & equipment productivity.
Tasks of Computer Used in Estimating (continue)

7. Establishing codes for labor & equipment resources.
8. Extending prices & summarizing costs at various levels.
9. Distributing overhead & indirect costs.
10. Analyzing risk & assessing contingency for markup.
11. Preparing & delivering the bid or proposal in electronic form.
12. Sharing information within an office or company.
Electronic Media

- It is the use of the internet & other electronic media (CAD & word processing software) to operate drawings & specifications.
- Intranet is an internet site set up for private use of company & controls access of information.
- Extranet is an internet set up by a company for shared use with others.
Fundamentals of Spreadsheets

- A spreadsheet is an electronic file consisting of hundreds of columns & rows. The intersection of a column & a row is called a cell.
- Numerical data, formulas, & calculations can be entered into cells.
Advantages of Spreadsheets

1. Practically effective in reducing repetitious arithmetic.
2. They are a duplicator for paper & calculator.
3. They enable the estimator to precisely duplicate the format & appearance of manual reports that were used before the computers, since managers are more comfortable with printouts that look exactly like handwritten reports they’ve used for many years.
Disadvantages of Spreadsheets

1. Only the developer of the spreadsheet knows all the features that are in the spreadsheet.
2. They may have errors in the logic that no one discovers.
3. Only the developer of a complex sheet can use it.
4. One estimator can make changes to the spreadsheet without the knowledge of other estimators.
5. Cost items missing in a bid because of the addition of a line & forgetting to adjust the sum formula to include the line.
Management of Data

- Most data is stored on hard disks since vast amounts of data may be used in computer estimating, and data must be created, stored, retrieved, & continually updated.
Contactors typically categorize costs by the following cost categories:

1. Labor (L).
2. Material (M).
3. Equipment (E).
4. Subcontractors (S).

Note that knowing the quantity of earth excavated is not enough to estimate the cost of estimation, it’ll also depend on the size of crew & type of equipment.
Labor Resources

- It is estimated by craft rather than by individual people.
- In computer estimating, they are selected from selection lists.
- There are three methods for costing labor resources:
  1. All labor factors.
  2. Prepare all combinations
  3. Simple historical rate.
All Labor Factors Costing Method

- Enter all of the burden factors into the estimating software & let the system compute labor rates.
- Factors used in the labor calculations fall into the categories of:
  1. Taxes.
  2. Fringes.
  3. Workmen’s compensation insurance.
  4. Overtime.
Prepare all Combinations Method

- Prepare spreadsheets of all possible combinations from which companies can select the variations they need for each particular estimate.
- This method is not preferred.
Simple Historical Rate Method

- This method is valid only if all jobs are similar.
- It uses the same tax on all labor crafts of previous year for this year.
Precision in Labor Costing

- Too much precision in the rate makes little practical sense.
- Working days & working hours should be rounded to a whole integer number of days or complete number of working hours/day (that is usually 8 hours/day).
Equipment Resources

- The equipment rates can be broken down into two components:
  1. Ownership costs.
  2. Operating expenses.
The technical specifications

(Divisions 0 through 16)
Division 0_bidding requirements, contract forms, and conditions of the contract
Section 00001 Advertisement for bids

It include the type of project, the office at which bids will be received, the latest day for delivery…etc
Section 0002
Instructions to bidders
Receipt & Opening of bids

- Bids form included in the contract documents
- Bids will be received by the owner at the time and place set forth in the advertisement & then at said place
- Publicly opened & read aloud
- The owner may reject any bid not suitable
Bid submission

- Each bid must be submitted in a sealed envelop bearing on the outside the name of the bidder, his address, the name of the project for which the bid is submitted, and addressed as specified in the bid form.
Special bidding documents

- Affidavit of nondiscrimination, nonsegregated facilities, noncollusion, and business relationships.
- Bid bond
- Power of attorney
Subcontract

Any person, firm, or other party to whom it is proposed to award a subcontract under this contract must be acceptable to the owner.
Telegraphic modification

- Any bidder may modify his bid by telegraphic or facsimile communication at any time prior to the scheduled closing time for receipt of bids.
- The telegraphic or facsimile communication should not reveal bid price, but should provide the addition or subtraction to the owner until the sealed bid is opened.
Withdrawal of bids

- Bids may be withdrawn on written or telegraphic or facsimile request received from bidders prior to the time fixed for opening.
Basis of bid

- The bidder must include all unit cost items and all alternatives shown on the bid forms; failure to comply may be cause for rejection.
Qualification of bidder

The owner may make such investigation to determine the ability of the bidder to perform the work, and the bidder shall furnish to the owner all such information and data for this purpose as the owner may request.
Bid security

- each bid must be accompanied by a certified check made payable to the owner in the sum of not less than 5% of the base bid, plus add alternates if any, or a bond with sufficient sureties, to be approved by owner.
Bid default

- if the successful bidder fails or refuses to enter into a contract as required by the owner or fails to provide the required bonds and insurance to the owner, within the time limited, said bidder shall forfeit to the owner the difference between the low bid of said defaulting bidder and the amount of the bid of the bidder to whom the contract is subsequently awarded.
Time of completion

- Bidder must agree to commence work on or before a specified date
Conditions of the work

- Each bidder must inform himself fully of the conditions relating to the construction of the project and employment of labor hereon.
Addenda & interpretations

- No interpretation of the meaning of the plans, specifications or other contract documents will be made to any bidder orally.
- And to be given consideration must be received at least ten days prior to the date fixed for the opening of bids.
Power-of- attorney

The attorney-in- fact who signs bid bonds or contract bonds must file with each bond a certified and effectively dated copy of the power-of- attorney.
Laws and regulations

- all applicable state laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout.
Obligation of bidder

- At the time of the opening of bids, each bidder will be presumed to have inspected the site and to have read and to be thoroughly familiar with the plans and contract documents (including all addenda).
Substitutions and product options

- Where material is mentioned in the specifications by trade name or manufacturers name, the same is not a preference for said material, but the intention of using said name is to establish a type or quality of material. Material of other trade names or of other manufacturers which is equivalent or better in type or quality shall be submitted for approval 10 days prior to bidding and shall be accompanied by actual full sized samples.
Bidders shall note that bids must be made on a specified form. Amounts of the bids shall be completely filled in, both in figures and in writing.

Enclose the bid form in a sealed envelope plainly marked and addressed.
Section 00004_ Affidavit off nondiscrimination, nonsegregated facilities, noncollusion, and business relationships

Section 00005_ bid bond

Section 00006_ contract
- Section 00007_affidavit
- Section 00008_performance payment bond
- Section 00009_statutory bond
- Section00010_warranty bond
- Section 00011_release of liens affidavit
- Section 00012_certificate of approval
- Section 00013_general conditions
- Section 00014_suplementary conditions
Change Orders

- Change Orders are part of every project.
- Designs are not perfect.
- Owners insert changes during the work.
- Site conditions are sometimes different than expected.
- Learn how to manage Change Orders.
Change order

- In project management, a change order is a component of the change management process whereby changes in the Scope of Work agreed to by the Owner, Contractor and Architect are implemented.

- Change orders are common to most projects, and very common with large projects.
After the original scope (or contract) is formed, complete with the total price to be paid and the specific work to be completed, a client may decide that the original plans do not best represent his definition for the finished project. Accordingly, the client will suggest an alternate approach.
Common causes for change orders to be created are:

- The project's work was incorrectly estimated
- The customer or project team discovers obstacles or possible efficiencies that require them to deviate from the original plan
- The customer or project team are insufficient or incapable of completing their required deliverables within budget.
and additional money, time, or resources must be added to the project.

During the course of the project, additional features or options are perceived and requested.
A project manager then typically generates a change order that describes the new work to be done (or not done in some cases), and the price to be paid for this new work. Once this change order is submitted and approved it generally serves to alter the original contract such that the change order now becomes part of the contract.
A Change Order is work that is added to or deleted from the original scope of work of a contract, which alters the original contract amount or completion date.
The Change Clause Provides:

- Means by which the owner can adjust plans and specifications
- Means by which the contractor may incorporate suggestions
- A outline for organizing and presenting claims for additional compensation
- Coordination with dispute clause for serious problems
Problems Of Change Clauses:

Does it fall within the scope of the project?

Must the change be in writing?

Who has the authority to make the change?

Is the consent of the surety needed?

Is there a resolution available if a price cannot be agreed upon?

Is the time requirement appropriate?
Contract Changes Do More Than Alter The Scope Of The Work, They:

- Disrupt orderly sequences
- Interfere with planned deliveries
- Void prior coordination
- Change schedule logic
- Change methods for work not otherwise addressed by the change
- Cause a contractor to remain mobilized on site longer than originally planned
- Continue to add administrative costs resulting from
Three Distinct Change Order Categories Are:

1. Owner-acknowledged
   - Payment for actual work
   - Indirect costs
   - Consequential costs

2. Constructive changes
   - Defective specs
   - Change in method of performance
   - Misinterpretation of specs
   - Rejection of conforming work
   - Rejection of “or equal” submissions
Three Distinct Change Order Categories Are:

- 3. Consequential changes
  - Direct cost of additional changed work
  - Interference costs, re-sequence, work, rework
  - Impact costs - delay. extended overhead, opportunity costs
Defective Specifications

Cuts and Paste

Silly specifications

Old age

Inconsistencies

Impossibilities
Reasons For Issuing Change Orders

- Owner has secured additional financing
- Emergence of unforeseen conditions during construction
- Material nonconformance with original specifications
- Correct errors or omissions in the original documents
- Changes requested by the owner, contractor, or design professional
Information Required On Change Orders

- Name, Title or Number of the Project
- Date of the Change Order
- Number of Change Order
- Changes Required under this Order
- Change in the Contract Price
- Change in Time of Completion
Bid Submission Documents

A LATE BID IS NO BID

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Bid Submission Documents

THE PROPOSAL

- Constitutes the first part of an “offer and acceptance”
- Submitted on a proposal form that is furnished to each bidder
- Permits the owner to more easily compare the bids that are submitted
THE PROPOSAL
Should include the following information:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Name and address of owner</td>
</tr>
<tr>
<td>2.</td>
<td>Title of project</td>
</tr>
<tr>
<td>3.</td>
<td>An opening statement</td>
</tr>
<tr>
<td>4.</td>
<td>Date of proposal</td>
</tr>
<tr>
<td>5.</td>
<td>Names, addresses, and signatures of the firm submitting bids</td>
</tr>
<tr>
<td>6.</td>
<td>Receipt of addenda</td>
</tr>
<tr>
<td>7.</td>
<td>Alternate bids</td>
</tr>
<tr>
<td>8.</td>
<td>Time of completion</td>
</tr>
<tr>
<td>9.</td>
<td>Subcontractor listing</td>
</tr>
<tr>
<td>10.</td>
<td>Unit prices</td>
</tr>
</tbody>
</table>
Ethics and Bid Considerations

There is no right way to do a wrong thing!!!

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To Withdraw a Bid

A contractor must satisfactorily establish the following:

- A mistake was made
- Written notice given to agency
- Specify how mistake occurred
- Mistake made bid materially different than intended

Mistake was made in filling out the bid and was not due to an error in judgment or carelessness in inspecting the site of the work or in reading the plans and specifications.
Bid Errors

Bid errors can be divided into two categories:

Errors of fact

&

Errors of judgment

An error of fact is generally excusable:

An error of judgment is not
Contract Clauses - Frequent Disputes

- Work scope definitions
- Supporting & included documents
- Design changes
- Construction changes
- Definition of cost
- Price
- Cost reporting and control
- Schedule reporting and control
- Design rework
Attached Documents

A number of other documents are often required to be attached to the proposal.

These include:

- Prequalification statements
- Federal Government forms
- Listing of subcontractors
Important Steps in Preparing Bid Proposal

- Analyze the Contract Documents for items to be included in the bid
- Schedule site trip to investigate for potential problems
- Order bid bond early
- Schedule estimating properly
- Develop and use uniform estimating standard
- Do not bid to get job, bid to make $$$
Bid Substitutions

- A substitution is a suggested change to the base bid, which has been volunteered by the bidding firm, not the owner or the design professional.

- One disadvantage to substitutions is that there are no comparative prices available.
Low Bidder Determination

- Under a lump sum price process a direct comparison of the base bids is all that is required.

- Under the unit price proposal system, the method used is that of “equivalent lump sum”
Opening, Acceptance, & Documentation of Bids

- Private Sector - No rigid procedures
- Public Sector - following “inflexible” rules apply:
  - Receipt of sealed bids at the designed time and place
  - Confirmation that all bids are responsive
  - Acceptance and logging of name and amount for all responsive bidders
  - Summary of all line and unit price items

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Bid Alternatives

- Alternates and Substitutions are changes to the base bid
- Used to compare different products or methods
- Too many alternatives have a tendency to increase the chances of bid errors
Lump-Sum Proposals

Proposals under the competitive bidding system are usually submitted as a Lump-Sum or Unit-Price Bid.

Lump sum bids are used for most building projects, where the scope and requirements of the project are well defined.

The Proposal form must provide spaces for only one amount to be given in words and figures.
Unit-Price Proposals

- Requested when the scope of the work cannot be well-defined
- The project consists of a relatively small number of activities
- Bidders are given estimated quantities and asked to supply unit-price
Quotations Request

- One of the first actions that a general contractor takes after the decision to bid has been made is to send out quotations requests to various subcontractor and material supply firms.

- The request should contain the following information:
  1. The name of the project for which quotations are requested.
  2. The place where plans and specifications and other bidding documents may be examined.
  3. How quotations are to be submitted.
Quotations Request

4. Any unusual requirements in the particular branch of the work that the general contractor is already aware of.

5. Date by which quotations are desired.

6. Whether or not the general contractor requests the use of a standard quotation request form.
Reducing Bid Shopping and Bid Peddling

Methods Of Reducing The Practice Of Bid Shopping & Bid Peddling

- Owner may require the general contractor to submit a list of all subcontractors and major material suppliers on the bid proposal form.

- The use of a bid depository.
Two practices that cause a lot of ill will within the construction industry are bid peddling and bid shopping.

In practicing bid shopping, the general contractor takes the low bid in a branch of the work (which was used in the preparation of the bid) and goes “shopping for lower prices”.
Bid Peddling

_bid peddling takes place during the bidding phase and bid shopping after the general contract has been awarded

The practice of bid peddling involves the disclosure of the quotations of other bidders to a favored subcontractor

The net result of both of these practices, bid shopping and bid peddling, is to reduce the quality of the owner’s project