

CONTENTS

About the Authors vi

Preface xv

Computer Applications 18

Forms for Preparing Estimates 20

CHAPTER 1 Introduction 1

Purpose of This Book	1
Estimating	2
Importance of the Estimator and the Estimating Team	3
Purpose of Estimating	3
Types of Estimates	4
Approximate Estimates	5
Detailed Estimates	6
Organization of Estimates	7
Building Construction Projects	8
Heavy Engineering Construction Projects	9
Quantity Takeoff	11
Labor and Equipment Crews	12
Checklist of Operations	12
Bid Documents	13
Addenda and Change Orders	14
Overhead	14
Material Taxes	15
Labor Taxes	15
Workmen's Compensation Insurance	15
Labor Burden	16
Bonds	16
Insurance	16
Representative Estimates	17
Instructions to the Readers	17
Production Rates	17
Tables of Production Rates	18

CHAPTER 2 Bid Documents 22

Bid Documents and Contract Documents	22
Contract Requirements	23
Arrangement of Contract Documents	23
Building Construction Specifications	24
Heavy/Highway Specifications	25
Bidding Requirements	25
Negotiated Work	32
Addendum	32
Alternates	32
Change Order	32
Warranties	33
General Conditions of the Contract Documents	33
Bonds	33
Insurance	35
Heavy/Highway Drawings	36
Building Construction Drawings	37
Symbols and Abbreviations	42
Problems	43

CHAPTER 3 Estimating Process 44

Decision to Bid	44
Estimating Process	44
The Estimating Team	46
Estimate Work Plan	47

Methods and Techniques	49
Preparing Estimates	50
Estimating Procedures	51
Estimate Checklists	52
Documentation of Estimate	53
Estimate Reviews	54
Risk Assessment	57
Risk Analysis	57
Contingency	57
Traditional Methods of Assigning Contingency	58
Estimate Feedback for Continuous Improvement	62
Problems	63

CHAPTER 4

Conceptual Cost Estimating 64

Accuracy of Conceptual Estimates	64
Liability of Conceptual Cost Estimates	65
Preparation of Conceptual Estimates	65
Broad-Scope Conceptual Estimates	66
Time Adjustments for Conceptual Estimates	67
Adjustments for Location	68
Adjustment for Size	69
Combined Adjustments	69
Unit-Cost Adjustments	70
Narrow-Scope Conceptual Cost Estimates	72
Factors Affecting Cost Records	72
Conceptual Costs for Process Industry	72
Problems	79

CHAPTER 5

**Cost of Construction Labor and
Equipment** 81

<i>Construction Labor</i>	81
Sources of Labor Rates	81

Cost of Labor	82
Social Security Tax	82
Unemployment Compensation Tax	82
Workers' Compensation and Employer's Liability Insurance	83
Public Liability and Property Damage Insurance	83
Fringe Benefits	84
Production Rates for Labor	85

<i>Construction Equipment</i>	88
Sources of Equipment	88
Equipment Costs	88
Ownership Costs	90
Operating Costs	93
Problems	99

CHAPTER 6

**Handling and Transporting
Material** 101

Introduction	101
Cycle Time and Production Rate Calculations	102
Handling Lumber	106
Transporting Sand and Gravel	108
Handling and Transporting Bricks	112
Unloading and Hauling Cast-Iron Pipe	115
Problems	116

CHAPTER 7

Earthwork and Excavation 119

Job Factors	119
Management Factors	119
Methods of Excavating and Hauling Earth	120
Physical Properties of Earth	120
Excavating by Hand	123
Excavating with Trenching Machines	125

Wheel-Type Trenching Machines	127
Ladder-Type Trenching Machines	127
Excavating with Draglines	129
Handling Material with a Clamshell	131
Excavating with Hydraulic Excavators	132
Front Shovels	133
Hauling Excavated Materials	136
Backhoes	138
Excavating and Hauling Earth with Scrapers	141
Shaping and Compacting Earthwork	146
Drilling and Blasting Rock	149
Cost of Operating a Drill	151
Problems	154

CHAPTER 8

Highways and Pavements 158

Operations Included 158

<i>Clearing and Grubbing Land</i>	158
Land-Clearing Operations	158
Rates of Clearing Land	160
Disposal of Brush	164
Demolition	165

Concrete Pavements 165

General Information	165
Preparing the Subgrade for Concrete Pavements	166
Construction Methods Used	167
Batching and Hauling Concrete	167
Placing Concrete Pavements	168
Concrete Pavement Joints	170
Curing Concrete Pavement	172

Asphalt Pavements 179

Aggregates	179
Asphalts	180
Asphalt Plants	181

Transporting and Laying Asphalt Mixes	183
Compacting Asphalt Concrete Mixes	185
Equipment for Hot-Mix Asphaltic-Concrete Pavement	186
Cost of Hot-Mix Asphaltic-Concrete Pavement	186
Computer Estimating of Highway Projects	191
Problems	191

CHAPTER 9

Foundations 193

Types of Foundations	193
Footings	194
Sheeting Trenches	194
Pile-Driving Equipment	196
Sheet Piling	200
Wood Piles	202
Driving Wood Piles	203
Prestressed Concrete Piles	204
Cast-in-Place Concrete Piles	205
Steel Piles	206
Jetting Piles into Position	209
Drilled Shaft Foundations	209
Problems	213

CHAPTER 10

Concrete Structures 215

Cost of Concrete Structures	215
Forms for Concrete Structures	215
Materials for Forms	216
Labor Required to Build Forms	220
Forms for Slabs on Grade	220
Materials for Footings and Foundation Walls	220
Quantities of Materials and Labor-Hours for Wall Forms	223

- Prefabricated Form Panels 228
 - Commercial Prefabricated Forms 229
 - Forms for Concrete Columns 230
 - Material Required for Concrete Column Forms 232
 - Quantities of Materials and Labor-Hours for Column Forms 234
 - Economy of Reusing Column Forms 236
 - Column Heads, Capitals, and Drop Panels 238
 - Shores and Scaffolding 238
 - Material and Labor-Hours for Concrete Beams 240
 - Forms for Flat-Slab Concrete Floors 243
 - Patented Forms for Floor Slabs 246
 - Material and Labor-Hours Required for Metal-Pan Concrete Floors 247
 - Corrugated-Steel Forms 248
 - Cellular-Steel Floor Systems 249
 - Concrete Stairs 249
 - Reinforcing Steel* 251
 - Types and Sources of Reinforcing Steel 251
 - Properties of Reinforcing Bars 252
 - Estimating the Quantity of Reinforcing Steel 252
 - Cost of Reinforcing Steel 253
 - Labor Placing Reinforcing Steel Bars 254
 - Welded-Wire Fabric 256
 - Concrete* 256
 - Cost of Concrete 256
 - Quantities of Materials for Concrete 257
 - Labor and Equipment Placing Concrete 258
 - Lightweight Concrete 260
 - Perlite Concrete Aggregate 260
 - Tilt-Up Concrete Walls* 261
 - Problems 262
-
- CHAPTER **11**
 - Steel Structures** 263
 - Types of Steel Structures 263
 - Materials Used in Steel Structures 263
 - Estimating the Weight of Structural Steel 264
 - Connections for Structural Steel 264
 - Estimating the Cost of Steel Structures 264
 - Items of Cost in a Structural-Steel Estimate 265
 - Cost of Standard Shaped Structural Steel 265
 - Cost of Preparing Shop Drawings 265
 - Cost of Fabricating Structural Steel 267
 - Cost of Transporting Steel to the Job 267
 - Cost of Fabricated Structural Steel Delivered to a Project 268
 - Erecting Structural Steel 270
 - Labor Erecting Structural Steel 275
 - Field Painting Structural Steel 277
 - Problems 278
-
- CHAPTER **12**
 - Carpentry** 279
 - Introduction 279
 - Classification of Lumber 279
 - Plywood 282
 - Cost of Lumber 283
 - Nails and Spikes 283
 - Bolts and Screws 284
 - Timber Connectors 287
 - Fabricating Lumber 288
 - Rough Carpentry Houses* 289
 - House Framing 289
 - Sills 290
 - Floor Girders 290
 - Floor and Ceiling Joists 291
 - Studs for Wall Framing 293

Framing for Window and Door Openings	295
Rafters	295
Prefabricated Roof Trusses	298
Roof Decking	299
Wood Shingles	300
Subfloors	300
<i>Exterior Finish Carpentry</i>	302
Fascia, Frieze, and Corner Boards	302
Soffits	303
Wall Sheathing	303
Aesthetic Exterior Siding	303
<i>Heavy Timber Structures</i>	304
Problems	305

CHAPTER 13

Interior Finish, Millwork, and Wallboards 307

Interior Finish Carpentry	307
Labor-Hours Required to Set and Trim Doors and Windows	307
Wood Furring Strips	308
Gypsum Wallboards	309
Wall Paneling	309
Interior Trim Moldings	310
Finished Wood Floors	310
Problems	312

CHAPTER 14

Roofing and Flashing 314

Roofing Materials	314
Area of a Roof	314
Steepness of Roofs	315
Roofing Felt	315
<i>Roofing Shingles</i>	315
Wood Shingles	315
Asphalt Shingles	316

Slate Roofing	319
Clay Tile Roofing	319

Built-Up Roofing 320

Felt for Built-Up Roofing	320
Pitch and Asphalt	320
Gravel and Slag	320
Laying Built-Up Roofing on Wood Decking	321
Laying Built-Up Roofing on Concrete	321
Labor Laying Built-Up Roofing	322

Flashing 323

Metal Flashing	323
Flashing Roofs at Walls	324
Flashing Valleys and Hips	324
Labor Required to Install Flashing	326
Problems	326

CHAPTER 15

Masonry 327

Masonry Units	327
Estimating the Cost of Masonry	327
Mortar	328

Bricks 329

Sizes and Quantities of Bricks	329
Pattern Bonds	329
Types of Joints for Brick Masonry	331
Estimating Mortar for Bricks	331
Quantity of Mortar for Brick Veneer Walls	332
Accessories for Brick Veneer Walls	333
Cleaning Brick Masonry	333
Solid Brick Walls	334
Labor Laying Bricks	335

Concrete Masonry Units 338

Labor Laying Concrete Masonry Units	339
--	-----

Stone Masonry 342

Bonds for Stone Masonry	342
Mortar for Stone Masonry	342
Weights of Stone	342
Cost of Stone	343
Labor Setting Stone Masonry	344
Problems	345

CHAPTER 16 Floor Systems 347

<i>Steel-Joist System</i>	347
General Description	347
Floor and Ceiling	347
Bridging	348
Metal Decking	349
Ceiling Extensions	349
Joist End Supports	349
Size and Dimensions of Steel Joists	349
Cost of Steel Joists	350
Labor Erecting Steel Joists	350
Labor Installing Metal Decking	351
Labor Placing Welded-Wire Fabric	351
Concrete for Slabs	352
<i>Combined Corrugated-Steel Forms and Reinforcement for Floor System</i>	355
Description	355
Installing Corrugated Sheets	355
Labor Installing Corrugated Sheets	356

CHAPTER 17 Floor Finishes 359

<i>Concrete-Floor Finishes</i>	359
Monolithic Topping	359
Separate Concrete Topping	360
Labor Finishing Concrete Floors with a Power Machine	361
<i>Terrazzo Floors</i>	363
Terrazzo Topping Bonded to a Concrete Floor	364

Terrazzo Placed on a Wood Floor	364
Labor Required to Place Terrazzo Floors	364

<i>Vinyl Tile</i>	366
Laying Vinyl Tile on a Concrete Floor	366
Laying Vinyl Tile on a Wood Floor	366
Labor Laying Vinyl Tile	366
Problems	367

CHAPTER 18 Glass and Glazing 368

Glass	368
Glass for Steel and Aluminum Sash	369
Putty Required to Glaze Steel and Aluminum Sash	369
Labor Required to Install Glass	369
Problems	371

CHAPTER 19 Painting 372

Materials	372
Covering Capacity of Paints	373
Preparing a Surface for Painting	374
Labor Applying Paint	375
Equipment Required for Painting	375
Cost of Painting	375
Problems	377

CHAPTER 20 Plumbing 378

Plumbing Requirements	378
Plumbing Code	379
Sizes of Soil and Waste Pipe	380
Steel Pipe	380
Brass and Copper Pipe	381
Copper Tubing	382

Labor Required to Lay Cast-Iron Pipe with Mechanical Joints	430
Labor Required to Lay Push-on Joint Cast-Iron Pipe	431
Cost of a Cast-Iron Pipe Water Distribution System	433
Horizontal Directional Drilling	436
Procedure for Horizontal Directional Drilling	437
Production Rates	440

CHAPTER 24

Total Cost of Engineering Projects 441

Cost of Land, Right-of-Way, and Easements	441
Legal Expenses	442
Bond Expense	442
Cost of Construction	442
Engineering Expense	442
Interest during Construction	443
Contingencies	444
Example Estimate for Total Cost of an Engineering Project	444

CHAPTER 25

Computer Estimating 445

Introduction	445
Importance of the Estimator	446
Use of Computers in Estimating	446
Electronic Media	448
Evolution of Computer Programming	448
Fundamentals of Spreadsheets	449

Commercially Available Estimating Software	451
Management of Data	454
Starting an Estimate	456
Biditems	458
Quantity Takeoff	460
Resource Types	460
Resources	462
Labor Resources	463
Precision in Labor Costing	466
Equipment Resources	467
Material	469
Crews	470
Structuring the Estimate	471
Entering the Estimate	473
Copying from Past Estimates	475
Checking Estimates for Reasonableness	477
Inquiries	478
Turning a Cost Estimate into a Bid	479
Bid Pricing	482
Quote Solicitation	484
Taking Quotes	485
Turning in the Bid	486
Loading HeavyBid/Express from the CD Included with This Book	488
Problems	489

APPENDIX

Example Bid Documents 498

Index 549