Cost Estimating

WSDOT Unit Bid Analysis
Outline

• Construction organizations (review)
• Construction contracts (review)
• Contract documents
  – Standard specifications
  – Standard specifications for DOTs
• Unit prices
  – Unit bid items
  – WSDOT Unit bid items
  – Short in-class exercise
• Quality control/acceptance
• Price adjustments
Construction Organizations

**Construction Using Owner Forces**

- Owner
  - Construction Staff
    - Project Director
      - Construction Forces

**Owner-Managed Construction**

- Owner
  - Construction Staff
    - Project Director
      - Hired Forces
      - Contractors
Construction Organizations

**General Contractor**
- Owner
  - Design Firm
  - Prime Contractor
    - Subcontractors
    - Contractor Work Force

**Design/Build**
- Owner
  - Design/Build Firm
    - Design Force
    - Construction Force
    - Subcontractors
Construction Organizations

Construction Management

- Owner
- Construction Manager
  - Design Firm
  - Construction Firms
Construction Contracts

• Method of award
  – Formally advertised contracts
  – Negotiated contracts

• Method of pricing
  – Fixed-price
    • Lump sum contract
    • Unit price contract
  – Cost-plus
    • Cost plus percentage of cost
    • Cost plus fixed fee
    • Cost plus fixed fee with a guaranteed maximum cost
    • Cost plus incentive fee
Contract Documents

- General conditions
  - Defines responsibilities and rights
- Supplementary conditions
  - Types:
    - Modification of general conditions
    - Additional information beyond general conditions Plans
- Technical Specifications
- Drawings
Contract Documents : What You Might See

• Standard Specifications
  – General conditions
  – Technical specifications

• Contract Provisions
  – Bid proposal forms and regulations
  – Required contract provisions (bond, DBE, etc.)
  – Amendments to the standard specifications
  – Special provisions
  – Wage rate documentation

• Plans
  – Project drawings
  – Standard plans
Standard Specifications

• Construction Specifications Institute
  – MasterFormat 2004 Edition
    • 50 Divisions of construction information
    • Specifications-writing standard for most construction
Example

32 12 16.13 Plant-Mix Asphalt Paving

32 = Level 1 = Division 32: Exterior Improvements
12 = Level 2 = Flexible Paving
16 = Level 3 = Asphalt Paving
13 = Level 4 = Plant-Mix Asphalt Paving
Standard Specifications for DOTs

• Typically do not use MasterFormat 2004
• Generally use 9 Divisions:
  – General Requirements
  – Earthwork
  – Production from Quarry and Pit Sites and Stockpiling
  – Bases
  – Surface Treatments and Pavements
  – Structures
  – Drainage Structures, Storm Sewers, Water Mains, and Conduits
  – Miscellaneous Construction
  – Materials

http://www.wsdot.wa.gov/eesc/design/projectdev/gsppage1.htm
Unit Prices

- Standard Units
  - Defined in Standard Specifications

5-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

- “HMA Cl. ___ PG ___”, per ton.
- “HMA for Approach Cl. ___ PG ___”, per ton.
- “HMA for Preleveling Cl. ___ PG ___”, per ton.
- “HMA for Pavement Repair Cl. ___ PG ___”, per ton.
- “Commercial HMA”, per ton.

The unit contract price per ton for “HMA Cl. ___ PG ___”, “HMA for Approach Cl. ___ PG ___”, “HMA for Preleveling Cl. ___ PG ___”, “HMA for Pavement Repair Cl. ___ PG ___”, and “Commercial HMA” shall be full compensation for all costs incurred to carry out the requirements of Section 5-04 except for those costs included in other items which are included in this sub-section and which are included in the proposal.
Unit Bid Items

http://www.wsdot.wa.gov/biz/contaa/uba/bid.cfm
Some Extremely General Rules-of-Thumb

- **Density**
  - Gravel borrow, aggregate, soils: 1.85 tons/yd$^3$
  - HMA, PCC: 2.05 tons/yd$^3$

- **Mobilization**
  - 5 to 15% of construction cost

- **Traffic control**
  - 5 to 25% of construction cost
  - Urban freeway work costs more (up to 30%)

- **Design and construction engineering**
  - Usually not included in bid
  - Can be 5 to 15% of construction cost

- **Clearing, grubbing, demolition**
  - $5,000/acre
Some Extremely General Rules-of-Thumb

- **Right-of-way**
  - Cost is per square foot ($20 to $50/ft^2 in urban areas)
  - Administration cost for each take
  - Relocation costs

- **Detention and water treatment**
  - $6/ft^2 of roadway surface
  - $10/ft^2 of roadway surface in pond area is purchased

- **Environmental permits and mitigation**
  - $150,000/acre or $31/yd^2

- **Temporary water pollution and erosion control**
  - 2% of construction cost

- **Traffic signals**
  - Variable...but basic ones can cost in the neighborhood of $200,000

- **Survey**
  - Construction survey: 1.5% of construction costs
  - Design survey: 1.5% of construction costs
Quality Control

Definition
Actions and considerations necessary to assess production and construction processes so as to control the level of quality being produced in the end product.

- Measuring output
- Using results to adjust process
Acceptance

**Definition**
Formal procedure used to decide whether work should be accepted, rejected, or accepted at a reduced payment.

- Three forms:
  - Accept with no inspection
  - 100 percent inspection
  - Acceptance sampling
Acceptance Density Testing
Truck Bed Sampling

Lakeside Industries, Night Paving
Truck Bed Sampling

Dividing sample for an ignition oven asphalt content test
Truck Bed Sampling – Automatic
PCC Smoothness Testing
Methods of Price Adjustment: HMA

• Statistical evaluation
  – Jobs over 2,500 tons of HMA
  – Most strict tolerance limits

• Nonstatistical evaluation
  – Smaller jobs (City, County)
  – Less strict tolerance limits

• Commercial evaluation
  – Minor areas (e.g. sidewalks, paths, gores)
  – Least strict tolerance limits
Statistical Evaluation

- Calculate a “pay factor” (PF)
  - For each item measured
- Calculate a “composite pay factor” (CPF)
  - Each item measured is weighted by “f” factor

\[
CPF = \frac{f_1 (PF_1) + f_2 (PF_2) + \ldots + f_i (PF_i)}{\sum f_i}
\]
Price Adjustments: HMA

- **Mixture**
  - Gradation
  - Asphalt content
  - Laboratory air voids

- **Compaction**
  - Density

- **Others**
  - Cyclic density (temperature differentials)
  - Smoothness

\[
JMCIF = 0.60(CPF - 1.00)
\]

\[
CIPAF = 0.40(CPF - 1.00)
\]

Total Pay = Tons \times \text{Unit Price} \times \text{Pay Adjustment Factor}
Methods of Price Adjustment: PCC

- **Statistical evaluation**
  - WSDOT jobs over 1,500 yd$^3$
  - Most strict tolerance limits

- **Nonstatistical evaluation**
  - Smaller jobs
  - All contracts not administered by WSDOT
  - Less strict tolerance limits
Statistical Evaluation

• Calculate a “pay factor” (PF)
  – For each item measured

• Calculate a “composite pay factor” (CPF)
  – Each item measured is weighted by “f” factor

\[ CPF = \frac{f_1(PF_1) + f_2(PF_2) + \ldots + f_i(PF_i)}{\sum_{i} f_i} \]
Price Adjustments: PCC

• Mixture
  – 28-day compressive strength (mean of 5 sets of 28-day compressive strength cylinders or 3,000 psi, whichever is higher)
  – Air content (3.0 to 7.0%)

• In-place
  – Thickness
  – Smoothness

Total Pay = Tons × Unit Price × Pay Adjustment Factor
HMA Demonstration

• Hot Mix Database
  – ????

• HMA View
  – http://hmaview.ce.washington.edu/wsdot
  – http://hmaview.ce.washington.edu/mdsha
Engineer’s Estimate Exercise

- Repaving my street in Ballard
  - Street is 500 ft long, 40 ft wide
  - Pavement is PCC, 6 inches thick
  - Replace with PCC, 8 inches thick
  - Replace curb and gutter
  - No storm sewer system
  - There are gas and sewer utilities under the pavement (deep enough that you do not have to relocate them)
Primary References

