Material Take-off

Week 3
CEE4333

Agenda

• Division 1: Earthwork / Excavation
• Division 2: Concrete foundation wall
Earthwork: Cut and Fill

- Division 2 CSI Format
- Volume of displaced soil
  \[ V = \frac{[(c - f) a]}{(4 \times 27)} \text{ CY (cubic yards)} \]
  \( c = \text{cut in feet} \)
  \( f = \text{fill in feet} \)
  \( a = \text{area (sq. ft)} \)
- Shrinkage and swell values:
  \[ L = (1 + \frac{S_w}{100})B \]
  \[ C = (1 - \frac{S_h}{100})B \] (Eqns 7.1, 2)
  \( S_w: \% \text{ swell, } S_h: \% \text{ shrinkage (Table 7.1)} \)
  \( L: \text{volume of loose soil} \)
  \( C: \text{volume of compacted soil} \)
  \( B: \text{volume of undisturbed soil} \)

Excavating Basements and Structural Foundations

- Called mass excavations
- Angle of repose and working space driven by safety considerations
- \[ V = \frac{[(F + 2W + D \times \tan \alpha) (D) (L)]}{27} \]
  \( V = \text{undisturbed volume in CY} \)
  \( L = \text{Linear foot of footing} \)

![Diagram](image)
Division 3: Concrete

- Grade beam footings
- Basement walls for buildings
- Retaining walls
- Vertical walls for water reservoirs

Figure 10.2 in Text book
• Concrete volume estimation:
  Volume in CY = \([X \text{ area in sq ft.}](\text{length in ft})(\text{waste factor})]/27

• Concrete aggregate estimation (use this table and table 10.10 in text book):

<table>
<thead>
<tr>
<th>Concrete Mixure by Volume</th>
<th>Sacks of Cement</th>
<th>Fine Aggregate (CY)</th>
<th>Course Aggregate (CY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1.75</td>
<td>10.00</td>
<td>0.37</td>
<td>0.03</td>
</tr>
<tr>
<td>1:2.25.25</td>
<td>7.75</td>
<td>0.36</td>
<td>0.05</td>
</tr>
<tr>
<td>1:2:25:3</td>
<td>6.25</td>
<td>0.32</td>
<td>0.10</td>
</tr>
<tr>
<td>1:3:4</td>
<td>5.00</td>
<td>0.36</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Source: 1998 R.S. Means Building Construction Cost Data

Amounts of aggregate and sacks of cement required to produce 1CY of concrete.

• Estimating Reinforcing steel (use following table and table 10.6 in text book)

<table>
<thead>
<tr>
<th>Bar Number</th>
<th>Bar Diameter (in)</th>
<th>Weight (lb/lf)</th>
<th>Minimum Overlap Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1/4</td>
<td>0.167</td>
<td>1&quot; - 0&quot;</td>
</tr>
<tr>
<td>3</td>
<td>3/8</td>
<td>0.376</td>
<td>1&quot; - 0&quot;</td>
</tr>
<tr>
<td>4</td>
<td>1/2</td>
<td>0.608</td>
<td>1&quot; - 0&quot;</td>
</tr>
<tr>
<td>5</td>
<td>5/8</td>
<td>1.043</td>
<td>1&quot; - 3/4</td>
</tr>
<tr>
<td>6</td>
<td>3/4</td>
<td>1.502</td>
<td>1&quot; - 6&quot;</td>
</tr>
<tr>
<td>7</td>
<td>7/8</td>
<td>2.670</td>
<td>1&quot; - 9&quot;</td>
</tr>
<tr>
<td>8</td>
<td>1.0</td>
<td>2.670</td>
<td>2&quot; - 0&quot;</td>
</tr>
<tr>
<td>9</td>
<td>1.125</td>
<td>3.400</td>
<td>2&quot; - 4&quot;</td>
</tr>
<tr>
<td>10</td>
<td>1.270</td>
<td>4.303</td>
<td>2&quot; - 6&quot;</td>
</tr>
<tr>
<td>11</td>
<td>1.510</td>
<td>5.513</td>
<td>2&quot; - 10&quot;</td>
</tr>
</tbody>
</table>
• Estimating reinforcing steel;
  - Estimated by the pound/ton
  - Minimum overlapping distance: guarantees structural integrity in reinforced concrete structures when splicing is used
  - Adjustment: Add 10% for wastage due to overlapping and cut related wastage

Formwork

• Talk about bf
• About studs
• About nails
• Each formula
• Then go on to the problem
Formwork

- Not included in drawings: Temporary, therefore reuse wherever possible
  - Complicated formwork: multiple reuse (steel, aluminum)
  - Typically 2-4 uses (lumber, plywood, plyform)
- Functionality: To support the pressure imposed by fresh concrete
  - Pressure (rate of filling, temperature of concrete)
  - See table for Pressure
  - Allows decision on formwork design

Maximum pressure exerted on forms by fresh concrete in lb/SF for concrete weighing 150lb/CF

Pressure exerted by alt. Conc = (P)(Wa)/150

P: Pressure exerted by 150lb/CF conc.
Wa: Weight of the alternative concrete in lb/CF
Form design information

Formwork

- Plywood, Plyform
  - Comes in sheets 4’ wide x 8’, 10’ 12’ long
  - Use available dimensions or incur wastage
- Lumber
  - Measured and priced in board feet (bf) [foot board measure]
  - Lumber sawed lengthwise at the mill and finished: usually there is a loss in size
  - Thus 2 x 4 (nominal size) is 1.5” thick and 3.5” wide (actual size)
  - S4S: Surfaced on all 4 Sides
Calculating Foot Board Measure

• 1 bf (board foot) is lumber with dimension:
  - 1 bf = (1” thick x 1’ wide) x 1’ long = 1/12 CF
  - A 2” thick x 4” wide lumber = 8/12 bf/ft = 0.67 bf/ft
  - A 2” thick x 8” wide lumber = 16/12 bf/ft = 1.33 bf/ft
  - If we need 120 linear ft of 2 x 4 studs:
    • 120’ x 2” x 4” /12 = 80 bf

Estimating Foundation Walls

• WL: Wall Length
• WH: Wall Height
• W: Waste Factor
• HS: Horizontal Spacing
• VS: Vertical Spacing
• #L: Number of Layers
• #U: Number of uses of Lumber
The Account

- **Horizontal Reinforcement:**
  - \((WL)[(WH)/(VS)](#L)(W)\) (linear feet: \(lf\))
- **Vertical Reinforcement:**
  - \((WH)[(WL)/(HS)](#L)(W)\) (linear feet: \(lf\))
- **Formwork:**
  - Amount of plywood: \((WL)(WH)(2)(W)/(#U)\) \(sf\)
  - Studs: \((WH)[(WL)/(HS)](2)(W)/(#U)\) \(lf\)
  - Wales: \((WL)[(WH)/(VS)](2)(W)/(#U)\) \(lf\)
  - Sills: \((WL)(4)(W)/(#U)\) \(lf\)
  - Braces: \([(WL)/(HS)][(WH)/(#U)](W)\) \(lf\)
  - Nails: \((10lb/1000 \text{ fbm})(\text{total fbm})(#U)\)
  - Ties: \([(lf \text{ of Wales})(#U)\div 4]/(\text{Tie Spacing})\)

The Method

- **Calculate Undisturbed Volume of earth to be removed:** Factor in swellage
- **Calculate amount of earth to be disposed**
- **Estimate concrete**
  - Use information about mixture to estimate coarse, fine and sacks of cement
- **Estimate reinforcing (in tonnage)**
- **Estimate formwork**
  - What is the concrete pressure temp. being used?
    - Decide on spacing for studs, wales and ties
  - Convert total linear footage of lumber to bfm