## 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
$=[(\mathrm{c}-\mathrm{f}) \mathrm{a}] /(4 * 27) \mathrm{CY}$ (cubic yards)
$c=$ cut in feet $f=$ fill in feet $a=$ area (sq. ft)
- Shrinkage and swell values:
$\mathrm{L}=\left(1+\mathrm{S}_{\mathrm{w}} / 100\right) \mathrm{B}$
$\mathrm{C}=\left(1-\mathrm{S}_{\mathrm{h}} / 100\right) \mathrm{B}$ (Eqns 7.1,2)
$\mathrm{S}_{\mathrm{w}}$ : \% swell, $\mathrm{S}_{\mathrm{h}}$ : \% shrinkage (Table 7.1)
L: volume of loose soil
C: volume of compacted soil
B: volume of undisturbed soil


## Excavating Basements and Structural Foundations

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


F

## Division 3: Concrete

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


Figure 10.2 in Text book

## Contd.

- Concrete volume estimation:

Volume in $\mathrm{CY}=[(\mathrm{X}$ area in sq ft .)(length in ft$)($ waste factor) $] / 27$

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

| Concrete Mixture <br> by Volume | Sacks of <br> Cement | Fine Aggregate <br> (CY) | Coarse Aggregate <br> $(\mathbf{C Y})$ |
| :--- | :---: | :---: | :---: |
|  |  |  |  |
| $1: 1: 1.75$ | 10.00 | 0.37 | 0.63 |
| $1: 2: 2.25$ | 7.75 | 0.56 | 0.65 |
| $1: 2.25: 3$ | 6.25 | 0.52 | 0.70 |
| $1: 3: 4$ | 5.00 | 0.56 | 0.74 |
|  |  |  |  |
| Source: 1998 R.S. Means Building Construction Cost Data |  |  |  |

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

## Contd.

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

| Bar <br> Number | Bar Diameter <br> $(\mathrm{in})$ | Weight <br> $(\mathbf{b b / L F})$ | Minimum Overlap <br> Recommended |
| :---: | :---: | :---: | :---: |
|  |  |  |  |
| 2 | $1 / 4$ | 0.167 | $1^{\prime}-0^{\prime \prime}$ |
| 3 | $3 / 8$ | 0.376 | $1^{\prime}-0^{\prime \prime}$ |
| 4 | $1 / 2$ | 0.668 | $1^{\prime}-0^{\prime \prime}$ |
| 5 | $5 / 8$ | 1.043 | $1^{\prime}-3^{\prime \prime}$ |
| 6 | $3 / 4$ | 1.502 | $1^{\prime}-6^{\prime \prime}$ |
| 7 | $7 / 8$ | 2.044 | $1^{\prime}-9^{\prime \prime}$ |
| 8 | 1.0 | 2.670 | $2^{\prime}-0^{\prime \prime}$ |
| 9 | 1.128 | 3.400 | $2^{\prime}-4^{\prime \prime}$ |
| 10 | 1.270 | 4.303 | $2^{\prime}-7^{\prime \prime}$ |
| 11 | 1.410 | 5.513 | $2^{\prime}-10^{\prime \prime}$ |

## Contd.

- 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

|  | Filling Rate | Concrete Temperature ( F) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 50 | 60 | 70 | 80 | 90 | 100 |
| " | 1 | 330 | 300 | 279 | 262 | 250 | 240 |
|  | 2 | 510 | 450 | 409 | 375 | 350 | 330 |
|  | 3 | 690 | 600 | 536 | 487 | 450 | 420 |
|  | 4 | 870 | 750 | 664 | 600 | 550 | 510 |
|  | 5 | 1,050 | 900 | 793 | 712 | 650 | 600 |
|  | 6 | 1,230 | 1,050 | 921 | 825 | 750 | 690 |
|  | 7 | 1,410 | 1,200 | 1,050 | 933 | 850 | 780 |
|  | 8 | 1,466 | 1,246 | 1,090 | 972 | 877 | 808 |
|  | 9 | 1,522 | 1,293 | 1,130 | 1,007 | 912 | 836 |
|  | 10 | 1.578 | 1,340 | 1,170 | 1,042 | 943 | 864 |

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

Pressure exerted by alt. Conc $=(\mathrm{P})(\mathrm{Wa}) / 150$
P: Pressure exerted by $1501 \mathrm{l} / \mathrm{CF}$ conc.
Wa: Weight of the alternative concrete in lb/CF


## 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 $2 \times 4$ (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:
- $1 \mathrm{bf}=\left(1^{\prime \prime}\right.$ thick x $1^{\prime}$ wide $) \times 1$ ' long $=1 / 12 \mathrm{CF}$
" A 2"thick x 4 "wide lumber $=8 / 12 \mathrm{bf} / \mathrm{ft}=$ 0.67bf/ft
" A 2 "thick x 8 "wide lumber $=16 / 12 \mathrm{bf} / \mathrm{ft}=$ $1.33 \mathrm{bf} / \mathrm{ft}$
- If we need 120 linear ft of $2 \times 4$ 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) If
- Braces: [(WL)/(HS)][(WH)/(\#U)](W) if
- Nails: (101b/1000 fbm)(total fbm)(\#U)
- Ties: [(lf of Wales)(\#U)/4]/(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

