CE 417 Equations

Chapter 2

Production = Volume per cycle X Cycles per hour

$$\text{Cost per unit of production} = \frac{\text{Equipment cost per hour}}{\text{Equip. prod. per hour}}$$

$$\text{Moisture content (\%)} = \left(\frac{\text{Moist weight} - \text{Dry weight}}{\text{Dry weight}}\right) \times 100$$

$$\text{Swell (\%)} = \left(\frac{\text{Weight/bank volume}}{\text{Weight/loose volume}} - 1\right) \times 100$$

$$\text{Shrinkage (\%)} = \left(1 - \frac{\text{Weight/bank volume}}{\text{Weight/compacted volume}}\right) \times 100$$

$$\text{Load factor} = \frac{\text{Weight/loose unit volume}}{\text{Weight/bank unit volume}}$$

$$\text{Load factor} = \frac{1}{1 + \text{swell}}$$

$$\text{Shrinkage factor} = \frac{\text{Weight/bank unit volume}}{\text{Weight/compacted unit volume}}$$

Shrinkage factor = 1- shrinkage

Triangular spoil bank

$$Base\ weidth = \left(\frac{4\ x\ volume}{pile\ length\ x\ \tan\left(angle\ of\ \ repose\right)}\right)^{1/2}$$

$$\text{Pile height} = \frac{\text{base width x tan (angle of repose)}}{2}$$

Conical Spoil pile

$$\text{Volume} = \frac{\text{base area x height}}{3}$$

$$Diameter\ of\ \ pile\ base = \left(\frac{7.64\ x\ volume}{\tan\left(angle\ of\ \ repose\right)}\right)^{1/3}$$

$$\text{Pile height} = \frac{\text{Diameter of pile base x tan (angle of repose)}}{2}$$

Chapter 2 (continued)

Pit excavation: Volume = Horizontal area x Average depth

Trench excavation: Volume = Cross-sectional area x length

Large area: $$\text{Average depth} = \frac{\text{Sum of products of depths x weight}}{\text{Sum of weights}}$$

Chapter 3

1- Shovel

Production (LCM/h)= Cycles/h x Swing factor x heaped bucket vol.(LCM) x Bucket fill factor x job eff.

2- draglines

Expected Production (BCM/h) = Ideal output x Swing depth factor x Effic.

3- Backhoes

Production (LCM/h)= Cycles/h x Swing depth factor x heaped bucket x Vol.(LCM) x Bucket fill factor x job eff..

4. Clamshells

Production (LCM/h)= Cycles/h x heaped bucket vol.(LCM) x Bucket fill factor x job eff.

Chapter 4

Cycle time = fixed time + variable time

Total resistance = Grade resistance + rolling resistance

Rolling resistance factor (kg/t) = 20+ (6 x cm penetration)

Grade resistance factor (kg/t) = 10 x grade (%)

Grade resistance (kg) = vehicle wt (t) x grade resistance factor (kg/t)

Grade resistance (kg) = vehicle wt (t) x grade

Effective grade (%)= Grade (%) + (Rolling resistance factor (kg/t)) /10

Derating factor (%)= (Altitude (m) – 915) /102

Maximum usable pull = Coefficient of traction x weight on drivers

1- Dozer

Blade load (LCM)= 0.375 x height (m) x Width (m) x Length (m)

Production (LCM/h)= blade capacity (LCM) x (60 / cycle time (min)) x job eff.

2- Loader

Production (LCM/h)= bucket size (LCM) x bucket fill factor x(60 / cycle time (min))x job eff

Chapter 4 (continued)

3- Scraper

Production (LCM/h)= capacity (LCM) x (60 / cycle time (min)) x job eff. factor

Number of scrapers served = scraper cycle time / pusher cycle time

Number of pushers required = no. of scrapers / (no. of scrapers served by one pusher)

$$\text{Production} = \frac{\text{No. of pushers x no. of scrapers x production of per scraper}}{\text{Required number of pushers}}$$

4- Trucks and Wagons

load time = (haul unit capacity) / Loader production at 100% eff.

Load time = number of bucket loads x excavator cycle time

Number of haulers required (N) = (haul unit cycle time) / (Load time)

Expected production (theoretically) = excavator production at 100% eff. x job eff. factor

$$\text{Expected production} = \frac{\text{Actual no. of units}}{\text{N}} \text{ x excavator prod. at 100\% eff. x job eff. factor}$$

(no. of units < N)

Chapter 5

1. Compactor production (CCM/h)

$$= \frac{\text{10 x width per pass (m) x speed (km/h) x lift thickness (cm) x job eff.}}{\text{Number of passes required}}$$

2. Motor grader

$$Time(h) = \left[\sum \frac{No.\ of\ \ passes\ x\, section\ length\ (km)}{average\ speed\ \ for\ section\ (km/h)} \right] x \frac{1}{efficiency}$$

Chapter 12

Lateral pressure P = 7.2+ 785 R /(T+18) ($R \le 2.1$ m/h)

P = 7.2 + (1154/ (T+18)) + (244 R /(T+18)) (R = 2.1 to 3.27 m/h)

P = 150 h (R > 3.27 m/h)

Lateral force H = 0.02 X *dl* X ws

Bending (wood) $l = (40.7/1000)\ d\ ((F_b\ b) / w)^{1/2}$

$= (100/1000)\ ((F_b\ S) / w)^{1/2}$

(plywood) $l = 3.16\ ((F_b\ KS) / w)^{1/2}$

Shear (wood) $l = (1.11/1000)\ (F_v\ A / w) + 2d$

$l = (1.11/1000)\ (F_v\ bd / w) + 2d$

(plywood) $l = 1.67\ (F_s\ (lb/Q)) / w) + 2d$

Deflection

$\Delta = 1/180$ $l = (93 / 1000)\ (EI / w)^{1/3} = (93 / 1000)\ (Ebd^3 / 12w)^{1/3}$

$\Delta = 1/240$ $l = (84.7 / 1000)\ (EI / w)^{1/3} = (84.7 / 1000)\ (Ebd^3 / 12w)^{1/3}$

$\Delta = 1/360$ $l = (73.8 / 1000)\ (EI / w)^{1/3} = (73.8 / 1000)\ (Ebd^3 / 12w)^{1/3}$

Compression f_c or $f_{c\perp} = P/A$

Tension $ft = P/A$

Chapter 17

Straight line method: D_n= (Cost – Salvage – tires) / N

Sum of the years digit method:

D_n= ((N - (n-1)) * amount to be depreciated) / Sum of years digit

Double Declining Balance Method:

D_n= (2/N) * Book value at beginning of year

Average Investment= (Initial cost + Salvage) / 2

$$\text{Hourly repair cost} = \frac{\text{year digit * lifetime repair cost}}{\text{Sum of year digit * Hours operated}}$$

$$\text{Tire cost} = 1.15 * \frac{\text{cost of a set of tires}}{\text{Expected tire life (h)}}$$