CIE600 Construction Methods
Homework #2 – Solution

1)

A 2-yd (1.53-m^3) dragline is being used to excavate a canal in common earth. The average swing angle is 70°, the average depth of cut is 8.9 ft (2.7 m), and job efficiency is 50 min/h. Estimate the dragline's hourly production in loose measure.

Solution:

Ideal output = 230 BCY/h (176 BCM/h) (Table 3-7)

Optimum depth = 9.9 ft (3.0 m) (Table 3-8)

$$\% \text{ optimum depth} = \frac{8.9}{9.9} \times 100 = 90\%$$

$$\left[= \frac{2.7}{3.0} \times 100 = 90\% \right]$$

Swing-depth factor = 1.06 (Table 3-9)
(70° swing, 90% optimum depth)

Job efficiency = 50/60 = 0.83

Production = ideal output x swing-depth x job efficiency (Eq 3-3)

= 230 x 1.06 x 0.83 = 202 BCY/h

[= 176 x 1.06 x 0.83 = 155 BCM/h]

2)

A 3.5-yd (2.68 m^3, heaped) hydraulic shovel with a bottom dump bucket is excavating tough clay. The swing angle is 120°, and job efficiency is 75%. Estimate the shovel's hourly production in bank measure.

Solution:

Standard cycles/h = 150 (Table 3-6)

Swing factor (120° swing) = 0.94 (Table 3-6)

Heaped bucket volume = 3.5 LCY (2.68 LCM)

Bucket fill factor (average) = 0.80 (Table 3-2)

Job efficiency = 0.75

Load factor = 0.77 (Table 2-5)

Production (loose) = C x S x V x B x E (Eq 3-2)

= 120 x 0.94 x 3.50 x 0.80 x 0.75 = 237 LCY/h

237 x 0.77 = 182 BCY/h

[= 120 x 0.94 x 2.68 x 0.80 x 0.75 x 0.77 = 140 BCM/h]

3)

Estimate the time required to load 400 cu yd (306 m^3) of gravel into trucks using a clamshell having a heaped bucket capacity of 1 cu yd (0.75 m^3). Estimated cycle time is 25s. Job efficiency is estimated to be 80%.

Solution:

Bucket fill factor (average) = 0.95 (Table 3-2)

Bucket load = 1.00 x 0.95 = 0.95 LCY

[= 0.75 x 0.95 = 0.71 LCM]

Job efficiency = 0.80

Production = volume/cycle x cycles/h (incl efficiency) (Eq 2-1)

$$= 0.95 \times \frac{3600}{25} \times 0.80 = 109 \text{ LCY/h}$$

$$[= 0.71 \times \frac{3600}{25} \times 0.80 = 82 \text{ LCM/h}]$$

$$\text{Time required} = \frac{400}{109} = 3.7 \text{ h}$$

$$[= \frac{306}{82} = 3.7 \text{ h}]$$

4)

A small hydraulic excavator will be used to dig a trench in hard clay (bucket fill factor = 0.80). The minimum trench size is 26 in. (0.66 m) wide by 5 ft (1.53 m) deep. The excavator bucket available is 30 in. (0.76 m) wide and has a heaped capacity of ¾ cu yd (0.57 m^3). The maximum digging depth of the excavator is 16 ft (4.9 m). The average swing angle is expected to be 85°. Estimate the hourly trench production in linear feet (meters) if job efficiency is 70%.

Solution:

$$\text{Actual volume/ft of trench} = \frac{30}{12} \times 5 \times \frac{1}{27} = 0.46 \text{ BCY}$$

[Volume/m of trench = 0.76 x 1.53 = 1.16 BCM]

Load factor = 0.77 (Table 2-5)

Standard cycles/h = 160 (Table 3-7)

$$\% \text{ maximum depth} = \frac{5.0}{16.0} \times 100 = 31\%$$

$$[= \frac{1.53}{4.9} \times 100 = 31\%]$$

Swing-depth factor = 1.16 (Table 3-8)
(85° swing, 31% maximum depth)

Heaped bucket volume = 0.75 LCY (0.57 LCM)

Bucket fill factor (average) = 0.80 (Table 3-2)

Job efficiency = 0.70

Trench adjustment factor = 0.98 (Table 3-9)

Production (loose) = C xS x V x B x E (Eq 3-3)

= 160 x 1.16 x 0.75 x 0.80 x 0.70 = 78 LCY/h

78 x 0.77 = 60 BCY/h

[= 160 x 1.16 x 0.57 x 0.80 x 0.70 x 0.77 = 46 BCM/h]

$$\text{Trench production} = \frac{60}{0.46} = 130 \text{ ft/h}$$

$$[= \frac{46}{1.16} = 40 \text{ m/h}]$$

5)

A hydraulic excavator-backhoe is excavating the basement for a building. Heaped bucket capacity is 1.5 cu yd (1.15 m^3). The material is common earth with a bucket fill factor of 0.90. Job efficiency is estimated to be 50 min/h. The machine's maximum depth of cut is 24 ft (7.3 m) and the average digging depth is 13 ft (4.0 m). Average swing angle is 90°. Estimate the hourly production in bank measure.

Solution:

Standard cycles/h = 160 (Table 3-3)

$$\% \text{ maximum depth} = \frac{13}{24} \times 100 = 54\%$$

$$[= \frac{4.0}{7.3} \times 100 = 54\%]$$

Swing-depth factor = 1.08 (Table 3-4)
(90° swing, 54% maximum depth)

Heaped bucket volume = 1.5 LCY (1.15 LCM)

Bucket fill factor = 0.90

$$\text{Job efficiency} = \frac{50}{60} = 0.83$$

Load factor = 0.80 (Table 2-5)

Production (loose) = C x S x V x B x E (Eq 3-1)

= 160 x 1.08 x 1.5 x 0.90 x 0.83 = 194 LCY/h

194 x 0.80 = 155 BCY/h

[= 160 x 1.08 x 1.15 x 0.90 x 0.83 x 0.80 = 119 BCM/h]