University Of Technology

Building and Construction Eng. Dept.

Exam – Final- – 2015/2016

Subject : Construction Methods & Equipment Class:3

Branch : Construction& Building Time : 3 Hours

Examiner: D. Raid AL-Lamy Date : 29 / 5 / 2016

NOTE: Answer (5) Questions ONLY

Q1-(A)- A piece of equipment is available for purchase for ($20000), has an estimated useful life of (5 years, and an estimated salvage value of ($5000). Determine the depreciation and the book value for each of the 5 years using SOY method? **(12mark)**

Q1(B) What are Factors that affect the cost of owning and operating construction equipment? **(8mark)**

Q2(A) - Determine the probable cost per hour for owning and operating a diesel engine crawler power shovel, using the following information: **(12mark)**

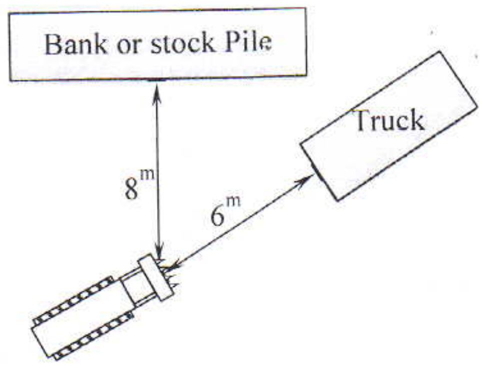
Cost of equipment	$ 60000
Shipping & unloading	$ 5000
Useful life	6 years
Salvage value at the end of its life	$ 5000
Hours operated per year	2000
Cost of fuel per hour	$3.6
Cost of oil per hour	$0.4
Maintenance cost is 60% of its depreciation	
Investment cost is 10% of its average value	

Q2(B) What are Investment costs include? ? **(8mark)**

Q3-(A The owner must consider all costs related to the ownership and operation of the equipment, and the effect which continued use will have on these costs. What are these costs to be considered ? **(8 mark)**

Q3-(B) (**50000** m^3) of hard, tough clay earth is required to be excavated during 3 months. Find the smallest power shovel that can be used to do the job, using the following information: **(12mark)**

– Actual depth of (2.7m) – Angle of swing of (45°). – Job conditions are poor. – Management conditions are good.	– Working day=10 hrs. – Working hour=50 min. – Percentage of stops=15%. – Month=30 days.



- Travel speed by gear:

Forward	Speed (m/min)	Reverse	Speed (m/min)
1st	51	1st	62
2nd	78	2nd	97
3rd	107	3rd	134

- Assume that the tractor will travel at an average of **80%** of the specified speeds in **2nd** gear, forward and reverse.
  - The fixed time should be based on time studies for the particular equipment and job (**0.4** min).
  - It's probable that the average volume will be about **90%** of this capacity for sustained loads.

Equations you my need

$$L = 0.787 \times \sqrt[4]{\frac{EID}{w}} \quad , \quad L = \frac{2vbh}{1.5w} \quad , \quad L = 1.29h\sqrt{\frac{fb}{w}}$$

ادارة معدات / مرحلة ثالث / نموذج ١

ANS1A**Solution:**

N	$R_m = \frac{N-m+1}{SOY}$	$D_m = R_m(P-S)$ (\$)	$B.V.$ (\$)
0	-	-	20000
1	$R_1 = \frac{5-1+1}{15} = \frac{5}{15}$	$D_1 = \frac{5}{15}(20000-5000) = 5000$	15000
2	$R_2 = \frac{5-2+1}{15} = \frac{4}{15}$	$D_2 = \frac{4}{15}(20000-5000) = 4000$	11000
3	$R_3 = \frac{5-3+1}{15} = \frac{3}{15}$	$D_3 = \frac{3}{15}(20000-5000) = 3000$	8000
4	$R_4 = \frac{5-4+1}{15} = \frac{2}{15}$	$D_4 = \frac{2}{15}(20000-5000) = 2000$	6000
5	$R_5 = \frac{5-5+1}{15} = \frac{1}{15}$	$D_5 = \frac{5}{15}(20000-5000) = 1000$	5000

ANSQ1B Factors that affect the cost of owning and operating construction equipment include:

1. The cost of the equipment delivered to the owner.
2. The severity of the conditions under which the equipment is used.
3. The number of hours the equipment is used per year.
4. The number of years the equipment is used.
5. The care with which the owner maintains and repairs the equipment.
6. The demand for used equipment when it is sold, which will affect the salvage value.

ANS2(A) Solution:

$$P = 60000 + 5000 = \$\ 650000$$

$$D = \frac{65000 - 5000}{6} = \$\ 10000$$

$$M = 0.6 \times D = 0.6 \times 10000 = \$\ 6000$$

$$\overline{P} = \frac{P(N+1) + S(N-1)}{2N} = \frac{65000(6+1) + 5000(6-1)}{2 \times 6}$$

$$\overline{P} = \frac{455000 + 25000}{12} = \$\ 40000$$

$$I = 0.1 \times \overline{P} = 0.1 \times 40000 = \$\ 4000$$

$$F.A.C = D + M + I = 10000 + 6000 + 4000 = \$\ 20000$$

$$F.H.C = \frac{F.A.C}{Hours\ operated\ per\ year}$$

$$F.H.C = \frac{20000}{2000} = 10\ \$ / hr$$

$$\therefore Probable\ Cost_{\ per\ hour} = F.H.C + Fuel\ Cost_{per\ hour} + Oil\ Cost_{per\ hour}$$

$$\therefore Probable\ Cost_{\ per\ hour} = 10 + 3.6 + 0.4 = 14\ \$ / hr$$

ANS2B

Investment costs which include the following:

- The interest on the money invested.
- Taxes of all types which are assessed against the equipment.
- Insurance.
- Storage.

ANS3A

The owner must consider all costs related to the ownership and operation of the equipment, and the effect which continued use will have on these costs.

The costs to be considered are:

1. Depreciation and replacement.
2. Investment.
3. Maintenance and repairs.
4. Downtime.
5. Obsolescence.

ANS3B **Solution**:

$$Time\ required\ to\ do\ the\ job = 3(30)(10)(1-0.15) = 765 hrs$$

$$Actual\ Output = \frac{50000}{765} = 65.4\ m^3 / hr$$

$$Actual\ Output = Ideal\ Output \times \left(D_{cut}\ \&\ A_{swing}\right)_F \times \left(J\ \&\ M\right)_F \times \left(Time\right)_F$$

Assume that the optimum depth is equal to the actual depth

Then the % of optimum depth =100%, Angle of swing=45°

From table (8-3), $\left(D_{cut}\ \&\ A_{swing}\right)_F = 1.26$

From table (8-4), $\left(J\ \&\ M\right)_F = 0.61$, Time factor $= \dfrac{50}{60}$

$$65.4 = Ideal\ Output \times 1.26 \times 0.61 \times \frac{50}{60} = 73.64\ m^3 / hr$$

$$Ideal\ Outpu = 102.11\ m^3 / hr$$

From table (8-2), for $Ideal\ Outpu = 102.11\ m^3 / hr$ and hard, tough clay earth choose (0.8 m^3) power shovel.

From table (8-2), for (0.8 m^3) power shovel and hard, tough clay earth:

Ideal output= 111 m^3/hr, Optimum depth= 2.7 m

$$\%\ of\ optimum\ cut = \frac{2.7}{2.7} \times 100 = 100\%$$

From table (8-3), for 100% of optimum height and 45° angle of swing:

$\left(D_{cut}\ \&\ A_{swing}\right)_F = 1.26$

From table (8-4), $\left(J\ \&\ M\right)_F = 0.61$, Time factor $= \dfrac{50}{60}$

$$Actual\ Output = Ideal\ Output \times \left(D_{cut}\ \&\ A_{swing}\right)_F \times \left(J\ \&\ M\right)_F \times \left(Time\right)_F$$

$$Actual\ Output = 111 \times 1.26 \times 0.61 \times \frac{50}{60} = 71.1\ m^3 / hr$$

$$71.1\ m^3 / hr > 65.4\ m^3 / hr \Rightarrow \therefore OK$$

ANS4A : **Advantages of purchasing equipment compared to renting it are:**

1. It is more economical if the equipment is used sufficiently.
2. It is more likely to be available for use when needed.
3. Because ownership should assure better maintenance and care, purchased equipment should be kept in better mechanical condition.

Disadvantages of owning equipment compared to renting it are:

1. It may be more expensive than renting.
2. Purchasing may require a substantial investment of money or credit that may be needed for other purposes.
3. The ownership of equipment may influence a contractor to continue using obsolete equipment after superior equipment has been introduced.
4. The ownership of equipment designed primarily for a given type of work, may induce a contractor to continue doing that type of work, whereas other work requiring different types of equipment might be available at a higher profit.
5. The ownership of equipment might influence a contractor using the equipment beyond its economic life, thereby increasing the cost of production unnecessarily.

ANS4B **Solution**:

1. For single use, assuming no salvage value for the lumber the cost will be:

Lumber Quantity:	$200\ m^2 \times 1.7\ m^3/m^2 = 340\ m^3$
Lumber Cost:	$340\ m^3 \times 0.1\$/m^3 = 34\ \$$
Carpenter's Making Time:	$200m^2 \times 3hr/100m^2 = 6\ hr$
Carpenter's Making Cost:	6 hr× 2.5 \$/hr = 15 \$
Carpenter's Erecting Time:	$200m^2 \times 6hr/100m^2 = 12\ hr$
Carpenter's Erecting Cost:	12 hr× 2.5 \$/hr = 30 \$
Helpers' Making Time:	$200m^2 \times 1hr/100m^2 = 2\ hr$
Helpers' Making Cost:	2hr× 1.25 \$/hr = 2.5 \$
Helpers' Erecting & Removing Time:	$200m^2 \times 5hr/100m^2 = 10\ hr$
Helpers' Erecting & Removing Cost:	10 hr× 1.25 \$/hr = 12.5\$
Total Cost = 34+15+30+2.5+12.5= 94 \$	
Cost per one square meter= 94/200 = 0.47 $\$/m^2$	

2. For 6 times use, assuming no salvage value for the lumber the cost will be:

From the previous part for single use:	
Lumber Cost:	= 34 $
Carpenter's Making Cost:	= 15 $
Helpers' Making Cost:	= 2.5 $
For five additional uses:	
Carpenter's Erecting Cost:	= 6×30 = 180 $
Helpers' Erecting & Removing Cost:	= 6×12.5 = 75 $
Total Cost = 34+15+2.5+180+75= 264 $	
Cost per one square meter= 264/1200 = 0.22 $/m²	

ANS5

The total load on decking will be:

Concrete	3.6 kN/m²
Live load	1.9 kN/m²
Total load	5.5 kN/m²

Design of Decking($L_{Decking}$): (spacing between joists)

Consider a 1m wide strip of decking.

$$W_{(Decking)} = P_m \times b_{(Decking)} = 5.5 \times 1 = 5.5 \ \text{kN/mL}$$

Check Bending:

$$L = 1.29h\sqrt{\frac{fb}{w}} = 1.29 \times 0.025\sqrt{\frac{12400 \times 1}{5.5}} = 1.53m$$

Check Shear: $L = \dfrac{2vbh}{1.5w} = \dfrac{2 \times 1000 \times 1 \times 0.025}{1.5 \times 5.5} = 6m$

Check Deflection: $L = 0.787 \times \sqrt[4]{\dfrac{EID}{w}}$

$$I=\frac{bh^3}{12}=\frac{1\times(0.025)^3}{12}=1.302\times10^{-6}m^4$$

$$L=0.787\times\sqrt[4]{\frac{11034.5\times1000\times1.302\times10^{-6}\times3}{5.5}}$$

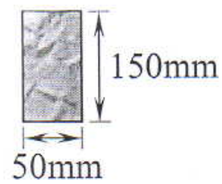
$$L=1.32m$$

Use the least number of L= 1.32m ≈ 1.3m

$L_{Decking}$**=1.3m**

Design of Joists (L_{Joists}): (spacing between Stringers)

b=50mm, h=150mm.



$$W_{(Joists)}=P_m\times L_{(Decking)}=5.5\times1.3=7.15\ \text{kN/mL}$$

Check Bending:

$$L=1.29h\sqrt{\frac{fb}{w}}=1.29\times0.15\sqrt{\frac{12400\times0.05}{7.15}}=1.8m$$

Check Shear: $L=\frac{2vbh}{1.5w}=\frac{2\times1000\times0.05\times0.15}{1.5\times7.15}=1.4m$

Check Deflection: $L=0.787\times\sqrt[4]{\frac{EID}{w}}$

$$I=\frac{bh^3}{12}=\frac{0.05\times(0.15)^3}{12}=1.406\times10^{-5}m^4$$

$$L=0.787\times\sqrt[4]{\frac{11034.5\times1000\times1.406\times10^{-5}\times3}{7.15}}$$

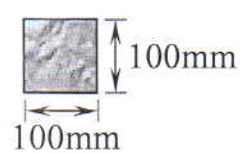
$$L=2.24m$$

Use the least number of L= 1.4m

L_{Joist} **=1.4m**

Design of Stringers ($L_{Stringers}$): (spacing between Shores)

b=100mm, h=100mm.



$$W_{(Stringer)}=P_m\times L_{(Joist)}=5.5\times1.4=7.7\ \text{kN/mL}$$

Check Bending:

$$L=1.29h\sqrt{\frac{fb}{w}}=1.29\times0.1\sqrt{\frac{12400\times0.1}{7.7}}=1.64m$$

Check Shear: $L=\frac{2vbh}{1.5w}=\frac{2\times1000\times0.1\times0.1}{1.5\times7.7}=1.73m$

Check Deflection: $L=0.787\times\sqrt[4]{\frac{EID}{w}}$

$$I = \frac{bh^3}{12} = \frac{0.1 \times (0.1)^3}{12} = 8.333 \times 10^{-6} m^4$$

$$L = 0.787 \times \sqrt[4]{\frac{11034.5 \times 1000 \times 8.333 \times 10^{-6} \times 3}{7.7}}$$

$$L = 1.93m$$

Use the least number of L= 1.64m ≈ 1.6m

$L_{Stringer}$ =1.6m

Check Load on Shores with Safe Load on Shores calculated from Eq. (7-19):

$$Load_{(Shores)} = P_m \times L_{(Joist)} \times L_{(Stringer)} = 5.5 \times 1.4 \times 1.6 = 12.32 \ kN/mL$$

$$K = 7120 \left(1 - \frac{g}{80b}\right) bh$$

$$K = 7120 \left(1 - \frac{(3.0 - 0.025 - 0.15 - 0.1}{80 \times 0.1}\right) (0.1)(0.1)$$

$$K = 7120 \left(1 - \frac{2.725}{8}\right) (0.01) = 46.95kN/mL > 12.32kN/mL$$

$\therefore$ OK

<u>ANS6A</u>

From Eq. (4-2):

$$Q = N\ C \times \frac{\pi\ d^2\ l\ n}{4} \times 10^{-6}$$

$$Q = 2\ (1 - 0.04) \times \frac{\pi\ (150)^2\ (300)\ (180)}{4} \times 10^{-6}$$

$$Q = 1832.2\ l/min$$

From eq. (5-4):

$$P = \frac{W}{4560} = \frac{w\ Q\ h}{4560\ e} = \frac{1 \times 1832 \times 48}{4560 \times 0.6}$$

$$P = 32.14\ hp$$

ANS 6B

The cycle time per load will be, in minutes:

Fixed time (load, shift, turn and dump)	$0.40\ min$	0.40
Haul time	$\frac{8+6}{0.8\times 78}=0.224\ \text{min}$	0.224
Return time	$\frac{8+6}{0.8\times 97}=0.180\ \text{min}$	0.18
Cycle time		0.804

Although the rated capacity of the bucket is ($1.72m^3$), it's probable that the average volume will be about 90% of this capacity for sustained loads.

$0.9\times 1.72=1.55\ m^3$		1.55
No. of cycles	$\frac{60}{0.804}=74.6$	
Volume	$74.6\times 1.55=115.6\ m^3$	

The material swell is 25% and the operating factor for the tractor is (45 min/hr)

Volume per hour in bank measure will be= $\frac{115.6}{1.25}\times\frac{45}{60}=69.36\ m^3/hr$

The production rate will be 69.36 m^3/hr

Table (8-2) - Ideal Output of Power Shovel, in Cubic Meter Per 60-Min Hour, Bank Measure.