University Of Technology

Building and Construction Eng. Dept.

Exam – Final- – 2013/2014

Subject : Construction Methods&Equipement **Class:3**
Branch : Construction& Building **Time : 3 Hours**
Examiner :D.Raid AL-Lamy **Date : / / 2014**

NOTE: Answer (5) Questions ONLY

Q1-(A) A crawler tractor weight is (20 tons), has a drawbar pull of (3000 kg) in 1st gear, is operating on a road having a slope of (3%) and a rolling resistance of (75 kg/ton); what will the effective drawbar pull be if the tractor moves up the road?

Q1-(B)- 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, and then draw the relationship between useful life and book value---

Q2 - Determine the probable cost per hour for owning and operating a diesel engine crawler power shovel, using the following information:

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	

Q3-(A) A tractor whose weight is (15 tons) has a drawbar pull of (2000 kg) in sixth gear when operated on a level road having a rolling resistance of (50 kg/ton); if the same tractor is operated on another level road having a rolling resistance of (30kg/ton) then:

1. Will the drawbar pull of the tractor be reduced or increased, find the effective drawbar pull?
2. If the road have a slope of (3%), what will the effective drawbar pull be, if the tractor moves:
   a) Up the road.
   b) Down the road.

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:

– 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.

Q4-A Find the cost of using a (**1.4** m^3) power shovel to excavate (**150000** m^3) of sand and gravel soil, using the following information:

– Actual depth of (2m) – Angle of swing of (125°). – Job conditions are good. – Management conditions are fair. -Working day=8 hrs.	– Working hour=50 min. – Percentage of stops=15%. – Month=30 days. – Cost of power shovel per day= ID 20000.

Q4-B Compare the cost of lumber and labor for (**200** m^2) of forms to construct concrete columns based on using the form once versus using them **6** times. The forms will be assembled with adjustable clamps, dressed and matched (D and M) sheathing is used; it will **require 1.7** m^3 of lumber per square meter of exposed surface; make use of the following information:

Carpenter's fees (for making & erecting): 2.5 \$/hr Carpenter's time (for making): hr/100m^2 Carpenter's time (for erecting): 6hr/100m^2	Helpers' fees (for making & erecting):1.25 \$/hr Helpers' time (for making): 1hr/100m^2 Helpers' time (for erecting & removing): 5hr/100m^2

Q5 (A)- Design the form for a concrete slab having a thickness of (**150mm**), whose net width between beam facesis (**4.7m**), use 25mm lumber for decking and **50**mm lumber for joists, type of lumber used is Douglas fir whose stresses are shown below:

The total load on decking will be:

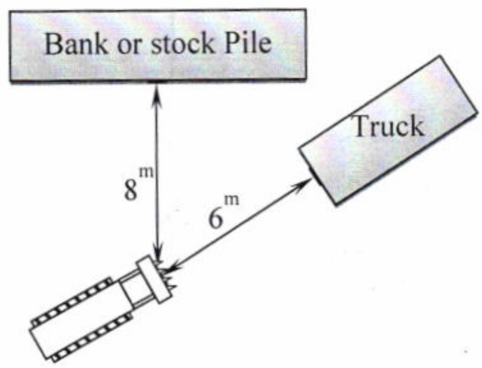
Concrete	3.6 kN/m^2
Live load	1.9 kN/m^2
Total load	5.5 kN/m^2

Kind of Lumber	Safe working stresses, (kN/m^2) ×1000				
	Extreme Fiber in Bending (f)	Compre-ssion Perpen d-icular to Grain	Compre-ssion Paralle l to Grain	Horizon-tal Shear (v)	Modulus of Elastic ity (E)
Douglas Fir,No.1 Grade	12.4	3.4	10.3	1.0	11034.5

Q5(B How many liters of fresh water will be pumped per minute by a duplex double-acting **size (150mm × 300mm)**, driven by a crankshaft making **(90 rpm)**? If the total head is (**48**m) and the efficiency of the pump is **60%,** what is the minimum horsepower required operating the pump? The weight of water is **1kg per** liter. a water slippage of **4%.?**

Q6 Find the production rate of the crawler-tractor-mounted loader shown in Figure, using the following information:

- Bucket capacity, 1.72 m^3
- Swell, 25%
- Tractor operating factor, 45 min/hr



- 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.

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

Class of material	Size shovel, cubicmeter								
	0.3	0.4	0.6	0.8	1	1.2	1.4	1.6	2
Moist loam or high sand clay	1.1 65	1.4 88	1.6 126	1.8 157	2.0 190	2.1 218	2.2 245	2.4 271	2.6 310
Sand and gravel	1.1 61	1.4 84	1.6 118	1.8 153	2.0 178	2.1 206	2.2 229	2.4 252	2.6 298
Good common earth	1.4 54	1.7 73	2.1 103	2.4 134	2.6 160	2.8 183	2.9 206	3.1 229	3.4 268
Hard, tough clay	1.8 38	2.1 57	2.4 84	2.7 111	3.0 137	3.3 156	3.5 18.	3.7 202	4.1 236
Well-blasted rock	— 30	— 46	— 72	— 95	— 118	— 137	— 156	— 175	— 210
Wet, sticky clay	1.8 19	2.1 30	2.4 53	2.7 73	3.0 91	3.3 110	3.5 125	3.7 141	4.0 175
Poorly blasted rock	— 11	— 19	— 38	— 57	— 73	— 88	— 107	— 122	— 149

Table (8-3) Conversion Factor for Depth of Cut and Angle of Swing

Angle of swing , deg							Percent of Optimum Depth
180	150	120	90	75	60	45	
0.59	0.65	0.72	0.8	0.85	0.89	0.93	40
0.66	0.73	0.81	0.91	0.96	1.03	1.1	60
0.69	0.77	0.86	0.98	1.04	1.12	1.22	80
0.71	0.79	0.88	1.00	1.07	1.16	1.26	100
0.7	0.77	0.86	0.97	1.03	1.11	1.20	120
0.66	0.73	0.81	0.91	0.97	1.04	1.12	140
0.62	0.67	0.75	0.85	0.90	0.96	1.03	160

Table (8-4) Coefficient Related to Management and Job Conditions*

Job Conditions	Management Conditions			
	Excellent	Good	Fair	Poor
Excellent	0.84	0.81	0.76	0.70
Good	0.78	0.75	0.71	0.65
Fair	0.72	0.69	0.65	0.60
Poor	0.63	0.61	0.57	0.52

اجابات / ادارة المعدات / الدور الاول
2014

Dr. Raid Saleem

ANS1A Solution:

$$Effective\ Drawbar\ Pull = \begin{matrix} Original \\ Pull \end{matrix} - \left(\begin{matrix} Pull\ Required \\ to\ Overcome\ Rolling \\ Resistance \end{matrix} + \begin{matrix} Pull\ Required\ to \\ Overcome\ Grade \end{matrix} \right)$$

Or:

$$Effective\ Drawbar\ Pull = \begin{matrix} Original \\ Pull \end{matrix} - \left(\begin{matrix} Difference\ in \\ Drawbar\ Pull \end{matrix} \right) - \left(\begin{matrix} Pull\ Required\ to \\ Overcome\ Grade \end{matrix} \right)$$

$$Effective\ Drawbar\ Pull = 3000 - 20(75 - 50) - (20 \times 10 \times 3)$$

$$Effective\ Drawbar\ Pull = 3000 - 500 - 600 = 1900\ kg$$

ANS1B 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

ANS2 Solution:

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

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

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

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

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

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

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

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

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

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

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

ANS3A The drawbar pull will be increased because the rolling resistance is lower than the tested road.

$$Difference\ Drawbar\ Pull = W_{tons}\times (R\ R_{road} - 50) = 15_{ton}\times (30-50)_{kg/ton} = -300\ kg$$

$$Effective\ Drawbar\ Pull = 2000 - (-300) = 2300kg$$

1. If the tractor was moving ona sloped road, then:
   a) If the tractor was moving up the sloped road, the drawbar pull used to overcome the grade must be reduced from the original drawbar pull:

$$Drawbar\ Pull\ to\ Overcome\ Grade = W_{tons}\times 10\times Slope$$

$$Drawbar\ Pull\ to\ Overcome\ Grade = 15\times 10\times (+3) = 450kg$$

$$Effective\ Drawbar\ Pull = 2000 - (-300) - 450 = 1850kg$$

   b) If the tractor was moving down the sloped road, then the drawbar pull will be added to the original drawbar pull:

$$Drawbar\ Pull\ to\ Overcome\ Grade = W_{tons}\times 10\times Slope = 15\times 10\times (-3) = -450kg$$

$$Effective\ Drawbar\ Pull = 2000 - (-300) - (-450) = 2750kg$$

ANS3B **Solution**:

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

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

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

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

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

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

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

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:

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

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

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

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

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

ANS4A **Solution**:

From table (8-2), for (1.4m^3) power shovel and sand and gravel soil
Ideal output= 229 m^3/hr, Optimum depth= 2.2 m

$$\%\ of\ optimum\ cut = \frac{2}{2.2} \times 100 = 90.91\%$$

In table (8-3), there is no 90.91% of optimum height and no 125° angle of swing, therefore, interpolation must be donethree times, twice for 90.91 between 120° and 150°, then for 125° between 120° and 150°.

From table (8-3), for 90.91% of optimum height and 120° angle of swing:

80	→	0.86	→	X_1=0.871
90.91	→	X_1		
100	→	0.88		

From table (8-3), for 90.91% of optimum height and 150° angle of swing:

80	→	0.77	→	X_2=0.781
90.91	→	X_2		
100	→	0.79		

From table (8-3), for 90.91% of optimum height and 125° angle of swing:

120°	→	0.871	→	X_3=0.856
125°	→	X_3		
150°	→	0.781		

$$\left(D_{cut} \,\&\, A_{swing}\right)_F = 0.856$$

From table (8-4), $\left(J \,\&\, M\right)_F = 0.71$, Time factor = $\frac{50}{60}$

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

$$Actual\ Output = 229 \times 0.856 \times 0.71 \times \frac{50}{60} = 115.98 \approx 116\ m^3/hr$$

Days required to do the job= $\frac{150000}{(116)\times(8)} = 161.64 \approx 162$

$$\therefore Cost\ of\ shovel = 162 \times 20000 = 3\ 240\ 000\ ID$$

ANS4B **Solution**:

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

Lumber Quantity:	200 m^2× 1.7 m^3/m^2= 340 m^3
Lumber Cost:	340 m^3× 0.1$/ m^3= 34 $
Carpenter's Making Time:	200m^2× 3hr/ 100m^2= 6 hr
Carpenter's Making Cost:	6 hr× 2.5 $/hr = 15 $
Carpenter's Erecting Time:	200m^2× 6hr/ 100m^2= 12 hr
Carpenter's Erecting Cost:	12 hr× 2.5 $/hr = 30 $
Helpers' Making Time:	200m^2× 1hr/ 100m^2= 2 hr
Helpers' Making Cost:	2hr× 1.25 $/hr = 2.5 $
Helpers' Erecting & Removing Time:	200m^2× 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 \$/m^2	

The total load on decking will be:

ANS5A

Concrete	3.6 kN/m^2
Live load	1.9 kN/m^2
Total load	5.5 kN/m^2

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:

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

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

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

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

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

$$L=1.32m$$

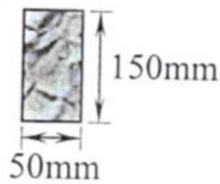
Use the least number of L= 1.32m ≈ 1.3m

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

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

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

$$L=2.24m$$

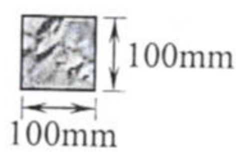
Use the least number of L= 1.4m

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):

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

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

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

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

$\therefore$ OK

ANS5B

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 6

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.

$\boldsymbol{0.9\times 1.72=1.55\ m^3}$		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