University Of Technology
Building and Construction Eng. Dept.
Exam – Final- – 2014/2015
Subject : Managemant . Equipement **Class:3**
Time : 3 Hours
Branch : Construction
Date : / 6 / 2015
Examiner :D.Raid AL-Lamy

Q1- A -A (**60000** 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)	– Working day=8 hrs.
– Angle of swing of (45°).	– Working hour=50 min.
– Job conditions are poor.	– Percentage of stops=15%.
– Management conditions are good.	– Month=30 days.

Q1-B- Determine the Factors that affect the cost of owning and operating construction equipment include?

Q2 -**A** - Determine the number of strokes per min (n) for a duplex double-acting size (150mm × 300mm) if the total pumping head including friction loss in pipe is (48) m and the efficiency of pump is 60% and the minimum horsepower is 32 hp , the weight of 1 liter of water is 1 kg. Assume a water slippage of 3%.?

Q2 –B- The owner must consider all costs related to the ownership and operation of the equipment . What are these costs?

Q3 Select the smallest power shovel required to excavate (56000 m3 bank measure) of hard, tough clay earth in 110 working days of 8hrs each. The average depth of cut will be (2.7m) and the average angle of swing will be (90o), noting that the job conditions are excellent, the management conditions are good and the working hour is 60 min.?

Q4 -A- Determine the Maximum size batch of paving mixer which Maximum output per hour is 90 m3 and it is possible to produce a batch of concrete in 60 sec.?

Q4 -B-What are the Disadvantages of owning equipment compared to renting it are?

Q5 –A- Determine the probable cost per hour for owning and operating a (20 m^3) truck with six rubber tires, using the following information:

Cost of Equipment	$92623
Cost of tires	$12113
Engine, Diesel	250 hp
Crankcase capacity	53 liter
Hours between oil changes	80 hr
Operating factor	0.6
Useful life, with no salvage value	6 years
Life if tires	4000 hrs
Repairs to tires	15% of depreciation of tires
Maintenance	60% of Depreciation
Investment	20% of Average Value
Hours operated per year	2000
Cost of fuel per liter	0.33 $/liter
Cost of oil per liter	0.53 $/liter

Q5 –B- Define the following terms:

Coefficient of Traction , Rolling Resistance , Rim Pull, Grad ability:

Q6- A tractor whose weight is (18 tons) has a drawbar pull of (2100 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 (40kg/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 (5%), what will the effective drawbar pull be, if the tractor moves:
   a) Up the road.
   b) Down the road.

Equations

Check Bending: $L = 1.29h\sqrt{\frac{fb}{w}} =$	$P = 7 + \frac{1414R}{1.8T + 32}$	$P = 7 + \frac{2079 + 440R}{1.8T + 32}$
Check Shear: $L = \frac{2vbh}{1.5w} =$	**Check Deflection:** $L = 0.787 \times \sqrt[4]{\frac{EID}{w}}$	$R = \frac{Out\ Put\ (m^3 / hr)}{b \times l}$
Fuel consumed per hour = operating factor × hp × engine consumption	$\overline{P} = \frac{P(N+1)}{2N}$	$\overline{P} = \frac{P(N+1) + S(N-1)}{2N}$
$q = \frac{hp \times f \times 0.0027(kg / hp - hr)}{0.89(kg / l)} + \frac{C}{t}$	$W = \frac{w\ Q\ h}{e}$	$Q = C \times \frac{\pi\ d^2\ l\ n}{4} \times 10^{-6}$

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	3.5 180	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

Model 5-M				
Total Head including Friction, (m)	**Capacity, (liters per min)**			
	Height of Pump above Water, (m)			
	3.0	**4.5**	**6.0**	**7.5**
5	322	-	-	-
6	318	257	-	-
8	310	254	-	-
9	299	250	186	133
12	269	227	174	125
15	233	197	155	106
18	159	151	121	83
21	83	83	75	45

Model 8-M				
Total Head including Friction, (m)	**Capacity, (liters per min)**			
	Height of Pump above Water, (m)			
	3.0	**4.5**	**6.0**	**7.5**
6	511	-	-	-
8	507	443	-	-
9	500	435	352	246
12	466	413	333	239
15	413	374	307	223
18	341	318	265	193
21	250	246	216	155
24	151	151	151	106

Model 10-M				
Total Head including Friction, (m)	Capacity, (liters per min)			
	Height of Pump above Water, (m)			
	3.0	4.5	6.0	7.5
8	628	-	-	-
9	625	530	416	-
12	598	530	416	284
15	549	492	401	265
18	477	443	367	257
21	386	379	322	227
24	280	280	257	182
27	151	151	151	121

Table (10-1) – Minimum Capacities for M-Rated Self-Priming Centrifugal Pumps Manufactured in accordance with Standards of the Contractors Pump Bureau

Model 15-M				
Total Head including Friction, (m)	Capacity, (liters per min)			
	Height of Pump above Water, (m)			
	3.0	4.5	6.0	7.5
6	980	-	-	-
9	946	795	757	-
12	912	784	670	606
15	852	765	651	530
18	746	746	640	530
21	606	606	606	522
24	473	473	473	473
27	363	363	363	363
Model 18-M				
Total Head including Friction, (m)	Capacity, (liters per min)			
	Height of Pump above Water, (m)			
	3.0	4.5	6.0	7.5
8	1139	-	-	-
9	117	965	757	-
12	1045	946	757	613
15	946	897	749	602
18	818	802	689	553
21	659	659	598	481
24	488	488	473	394
27	310	310	310	280
29	216	216	216	216
Model 20-M				
Total Head including Friction, (m)	Capacity, (liters per min)			
	Height of Pump above Water, (m)			
	3.0	4.5	6.0	7.5
9	1260	1060	890	625
12	1192	1022	871	613
15	1098	965	833	583

18	965	890	776	541
21	802	791	696	492
24	625	625	594	432
27	439	439	439	356
30	227	227	227	227

Table (10-1) – Minimum Capacities for M-Rated Self-Priming Centrifugal Pumps Manufactured in accordance with Standards of the Contractors Pump Bureau

Model 30-M				
Total Head including Friction, (m)	Capacity, (liters per min)			
	Height of Pump above Water, (m)			
	3.0	4.5	6.0	7.5
9	1893	1646	1325	946
12	1874	1628	1306	946
15	1798	1571	1287	927
18	1703	1541	1230	908
21	1571	1400	1136	871
24	1344	1230	1022	799
27	946	908	814	662
30	379	379	379	379

Model 40-M				
Total Head including Friction, (m)	Capacity, (liters per min)			
	Height of Pump above Water, (m)			
	3.0	4.5	6.0	7.5
8	2517	-	-	-
9	2498	2176	1798	1344
12	2441	2139	1760	1325
15	2347	2063	1722	1306
18	2214	1930	1647	1268
21	2025	1798	1552	1192
24	1760	1552	1382	976
27	1419	1230	1136	833
30	946	814	738	549
33	246	227	189	151

Model 90-M				
Total Head including Friction, (m)	Capacity, (liters per min)			
	Height of Pump above Water, (m)			
	3.0	4.5	6.0	7.5
8	5678	-	-	-
9	5602	4845	3974	2990
12	5413	4656	3861	2952
15	5110	4391	3672	2782
18	4637	3974	3407	2612
21	3974	3407	2933	2309

24	3028	2574	2271	1855
27	1703	1514	1382	1135
30	379	379	379	379

Table (10-2) – Friction Loss for Water, in m/100m of Clean Wrought-Iron or Steel Pipes

Flow (l/min)	Nominal Size, mm											
	25	31.5	37.5	50	62.5	75	100	125	150	200	250	300
19	1.93	0.51										
38	6.86	1.77	0.83	0.25	0.11							
53	12.8	3.28	1.53	0.45	0.19							
76	25.1	6.34	2.94	0.87	0.36	0.13						
91	35.6	8.92	4.14	1.2	0.5	0.17						
114	54.6	13.6	6.26	1.82	0.75	0.26	0.07					
151		23.5	10.79	3.1	1.28	0.44	0.12					
189		36	16.4	4.67	1.94	0.66	0.18	0.06				
284			35.8	10.1	4.13	1.39	0.28	0.12				
376			62.2	17.4	8.51	2.39	0.62	0.2	0.08			
454				24.7	10	3.37	0.88	0.29	0.12			
568				38	15.4	5.14	1.32	0.33	0.17			
643				48.4	19.6	6.53	1.67	0.54	0.22			
757				66.3	26.7	8.9	2.27	0.74	0.3	0.08		
833					32.2	10.7	2.72	0.88	0.36	0.09		
984					44.5	14.7	3.24	1.2	0.49	0.13		
1060					51.3	16.9	4.3	1.38	0.56	0.14		
1136						19.2	4.89	1.58	0.64	0.16		
1287						24.8	6.19	2	0.81	0.21		
1514						33.9	8.47	2.72	1.09	0.28	0.09	
1893						52.5	13.0	4.16	1.66	0.42	0.14	0.06
2271							18.6	5.88	2.34	0.6	0.19	0.08
2650							25	7.93	3.13	0.8	0.26	0.11
3028							32.4	10.22	4.03	1.02	0.33	0.14
3407							40.8	12.9	5.05	1.27	0.41	0.17
3785							50.2	15.8	6.17	1.56	0.5	0.21
4164								19	7.41	1.87	0.59	0.25
4542								22.5	8.76	2.2	0.7	0.3
4921									10.2	2.56	0.82	0.34
5299									11.8	2.95	0.94	0.4

Table (10-3) – Length of Steel Pipe, (m), Equivalent to Fittings and Valves

Item	Nominal Size, mm											
	25	31.5	37.5	50	62.5	75	100	125	150	200	250	300
90° Elbow	0.9	1.1	1.3	1.7	2.0	2.5	3.4	4.1	4.9	6.4	7.9	10.0
45° Elbow	0.4	0.5	0.6	0.8	0.9	1.2	1.5	1.9	2.3	3.0	4.0	4.6
Tee, Side Outlet	1.7	2.3	2.8	3.7	4.1	5.2	6.7	8.4	10.1	13.3	16.8	20.1
Close Return Bend	1.9	2.6	3.1	4.0	4.6	5.6	7.3	9.5	11.2	14.9	18.9	22.3
Gate Valve	0.2	0.2	0.3	0.4	0.4	0.5	0.8	0.9	1.1	1.4	1.7	2.1
Globe Valve	8.2	11.3	13.1	16.8	20.1	25.0	35.1	41.2	50.3	65.5	85.4	102.1
Check Valve	3.2	4.0	4.8	6.4	8.0	9.7	12.9	16.1	19.2	24.7	32.0	83.1
Foot Valve	7.3	10.1	11.6	14.0	16.8	19.5	22.9	23.2	23.2	23.2	23.2	23.2

ANS1—**A** **Solution**:

$$\text{Time required to do the job} = 3(30)(8)(1-0.15) = 612 hrs$$

$$\text{Actual Output} = \frac{60000}{612} = 98.03 \ m^3/hr$$

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

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 = $\frac{50}{60}$

$$98.03 = \text{Ideal Output} \times 1.26 \times 0.61 \times \frac{50}{60} = 153.05 \ m^3/hr$$

$$\text{Ideal Outpu} = 153.05 \ m^3/hr$$

From table (8-2), for $\text{Ideal Outpu} = 153.05 \ m^3/hr$ and hard, tough clay earth choose (1.2 m^3) power shovel.
From table (8-2), for 1.2 m^3) power shovel and hard, tough clay earth:
Ideal output= 156m^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 = $\frac{50}{60}$

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

$$\text{Actual Output} = 156 \times 1.26 \times 0.61 \times \frac{50}{60} = 99.87 \ m^3/hr$$

$$99.87 \ m^3/hr > 98.03 m^3/hr \Rightarrow \therefore OK$$

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.

Solution:Q2A

From eq. (5-4):

$$.32 = \frac{W}{4560} = \frac{w\ Q\ h}{4560\ e} = \frac{1 \times X \times 48}{4560 \times 0.6} = 1824 L/\min$$

$$1824 = 2\ (1 - 0.03) \times \frac{\pi\ (150)^2\ (300)\ (n)}{4} \times 10^{-6}$$

n=177.43rpm

Solution:Q2B

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.

Solution:Q3

$$\text{Actual Output} = \frac{56000}{(110)\times(8)} = 63.63\ m^3/hr$$

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

Assume that the optimum depth is equal to the actual depth

Then the % of optimum depth =100%, Angle of swing=90°

From table (8-3), $\left(D_{cut}\ \&\ A_{swing}\right)_F = 1$

From table (8-4), $\left(J\ \&\ M\right)_F = 0.81$

$$\text{Time factor} = \frac{60}{60}$$

$$63.63 = \text{Ideal Output} \times 1 \times 0.81 \times \frac{60}{60}$$

$$\text{Ideal Outpu} = 78.56\ m^3/hr$$

Use (0.8 m^3) power shovel

From table (8-2), for (0.8m^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 90^{o} angle of swing:

$$\left(D_{cut} \; \& \; A_{swing}\right)_F = 1$$

From table (8-4), $\left(J \; \& \; M\right)_F = 0.81$, Time factor $= \frac{60}{60}$

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

$$\text{Actual Output} = 111 \times 1 \times 0.81 \times \frac{60}{60} = 89.9 \; m^3/hr$$

$$89.9 \; m^3/hr > 78.56 \; m^3/hr \Rightarrow \therefore OK$$

Solution:Q4A

No. batches per hr = 60 × 60 sec ÷ 50 sec = 72
Maximum size batch=90 ÷ 72 = $1.25 m^3$

Solution:Q4B

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.

Solution:Q5A

Because the tires have different life than the truck, they should be treated separately to calculate the depreciation of each.

Cost to owner:	
Cost of Equipment	92623
Cost of tires	12113
Net cost less tire	80510
average value of the equipment $\overline{P} = \frac{P(N+1)}{2N} = \frac{92623(5+1)}{2(5)}$	55574

Annual Costs for truck:	
Depreciation: $D = \frac{P}{N} = \frac{80510}{5}$	16102
Maintenance: $M = 50\%D = 0.5(16102)$	8051
Investment: $I = 20\%\overline{P} = 0.2(55574)$	11115
Total Annual Fixed Cost	\$35268
Hourly Costs:	
Hourly ownership cost $35268/2000$	17.63
Fuel: $0.6 \times 250 \times 0.15(0.33)$	7.43
Lubrication Oil: $\frac{250 \times 0.6 \times 0.0027}{0.89} + \frac{53}{80} = 1.12(0.53)$	0.59
Tire depreciation: $12113/5000$	2.42
Tires repairs: 0.15×2.42	0.36
Total Cost per hour, excluding labor	\$28.43

Solution:5B

Coefficient of Traction ;The coefficient of traction may be defined as the factor by which the total load on a driving tire or track should be multiplied in order to determine the maximum possible tractive force between the tire or track and the surface just before slipping will occur.

Rolling Resistance: Rolling Resistance is a resistance which is encountered by a vehicle in moving over a road or surface. This resistance varies considerably with the type and condition of the surface over which a vehicle moves.

Rim Pull: Rim pull is a term which is used to designate the tractive force between the rubber tires of driving wheels and the surface on which they travel. Rim pull is expressed in kilograms, and it may be determined from Equation ;

$$Rim\ Pull_{(kg)} = \frac{274 \times hp \times efficiency}{speed_{(km/hr)}}$$

Grad ability: Grad ability is defined as the maximum slope (expressed as a percent) that a crawler or wheel-type tractor (or related equipment) may move up at a uniform speed.

Solution:Q6

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

$$\begin{matrix} Difference \\ Drawbar\ Pull \end{matrix} = W_{tons} \times \left(R\ R_{road} - 50\right) = 18_{ton} \times \left(40 - 50\right)_{kg/ton} = -180\ kg$$

$$Effective\ Drawbar\ Pull = 2100 - (-180) = 2280kg$$

2. 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:

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

$$Drawbar\ Pull\ to\ Overcome\ Grade = 18 \times 10 \times (+5) = 900kg$$

$$Effective\ Drawbar\ Pull = 2100 - (-180) - 900 = 1380kg$$

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

$$Drawbar\ Pull\ to\ Overcome\ Grade = W_{tons} \times 10 \times Slope = 18 \times 10 \times (-5) = -900kg$$

$$Effective\ Drawbar\ Pull = 2100 - (-180) - (-900) = 3150kg$$