University of Technology		
Building & Construction Engineering Department		
Final Exam – Answers –2015/2016		
Subject: Methods of Construction	Class: 3rd year	
Branch: Structural Engineering	Time : 3 Hours	
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Q1-A) (15 marks)

Capacity = 1060 l/min. All pipes, fittings and valves will be (125 mm) in diameter.

1) For the (125 mm) pipes, from table (10-3), the total equivalent length of pipe will be:

No.	Item	Quantity	Equivalent Length of Pipe, m	Total Length of Pipes, m
1)	Foot valve	1	1(23.2)	23.2
2)	90° Elbow	3	3(4.1)	12.3
3)	Gate valve	2	2(0.9)	1.8
4)	Check valve	1	1(16.1)	16.1
5)	Pipes		8+7+50+10+3	78.0
				131.4

From table (10-2) the friction loss/100m of (125 mm steel pipe) and 1060 l/min flow will be: 1.38

2) The total head including lift plus heads lost in friction will be:

Item	Total Equivalent Length of Pipes, m	
Lift	3+10	13.0
Head lost in friction (125mm)	131.4(1.38)/100	1.8
	Total Head	14.8

For:

A total head of 15 m > 14.8 m A suction head of 3 m A flow of 1060 l/min	A Model 20-M self-priming pump with a capacity approximately (1098 l/min) > (1060 l/min) will be satisfactory to do the job.

Q1-B) (10 marks)

Fill the Blanks with the suitable words selected from the list below:

1) Cast-in-place
2) duplex
3) increase
4) drawbar pull
5) swell
6) Accident Prevention

Q2-A) (15 marks)

Solution:

Actual Cost		$	40000
Cost of tires	$4\times1500=$	$	6000
Remaining cost w/o Tires	$40000-6000=$	$	34000
Salvage cost		$	4000
Useful life, N		yr	5
Depreciation, Equipment	$D_{Equ.}=(P-S)/N=(34000-4000)/5=$	$	6000
Maintenance, Equipment	$M_{Equ.}=0.8\times Depreciation=$	$	4800
Average cost, $\overline{P}=\frac{P(N+1)+S(N-1)}{2N}$	$\overline{P}=\frac{34000(5+1)+4000(5-1)}{2(5)}$	$	22000
Investment	$I=10\%\overline{P}=0.10(22000)=2200$	$	2200
Total fixed cost/yr	$D+M+I=6000+4800+2200=$	$	13000
Hourly Fixed Cost, HFC	$HFC=13000/2600=$	$/hr	5.0
Depreciation, Tires	$D_{Tires}=P_{Tires}/N_{Tires}=6000/2000=$	$/hr	3.0
Maintenance, Tires	$M_{Tires}=0.6\times3=$	$/hr	1.8
Fuel cost		$/hr	8.0
Lubrication oil cost		$/hr	2.0
Total Cost, excluding labor	6.3+6+2.4+7.50+0.5=	$/hr	**19.8**

Q2-B) (10 marks)

State whether the following statements are true or false and then correct the underlined words if the statement is false:

1) One of the uses of a Tractor is opening up roads through mountains and rocky areas. F (bulldozer)
2) The term Stabilization refers to making soil firm and preventing it from moving. T
3) Preheating the water is the most effective method of providing the required temperature for placing concrete in hot weather. F (cold weather)
4) Angledozers are mounted with blades set perpendicular to the direction of travel. F (Bulldozers)
5) Round precast concrete piles are cast in horizontal forms. F (vertical)

Q3-A) (15 marks)

Lumber Quantity:	$200\ m^2 \times 2\ m^3/m^2 = 400\ m^3$
Lumber Cost:	$400\ m^3 \times 0.25\$/\ m^3 = 100\ \$$
Carpenter's Making or Erecting Time:	$200m^2 \times 4hr/\ 100m^2 = 8\ hr$
Carpenter's Making or Erecting Cost:	$8\ hr \times 5\ \$/hr = 40\ \$$
Helpers' Making Time:	$200m^2 \times 2hr/\ 100m^2 = 4\ hr$
Helpers' Making Cost:	$4\ hr \times 2.5\ \$/hr = 10\ \$$
Helpers' Erecting or Removing Time:	$200m^2 \times 6hr/\ 100m^2 = 12\ hr$
Helpers' Erecting or Removing Cost:	$12\ hr \times 2.5\ \$/hr = 30\ \$$
Total Cost $=(100+40+10)+ 5 \times (40+2\times30) = 150+500 = 650\ \$$	
Cost per one square meter $= 650/(200\times5) = 0.65\ \$/m^2$	

Q3-B) (10 marks)

Correct the underlined words with the suitable word or words in the following statements:

1) Anytime a piece of equipment pays for itself on job, it is a good business to rent it. (purchase)
2) In designing concrete forms, the largest value of (L) calculated for each category of bending, shear and deflection is used as the safe span that satisfies all conditions. (smallest)
3) It may be easy to drive timber piles into hard formations. (difficult or impossible)
4) To make soil firm and prevent it from moving is called segregate. (stabilize)
5) An incident involving multiple injuries, a fatality, and/or extensive property damage is called incident. (major accident)

Q4-A) (15 marks)

Solution:

$$Probable\ \ Output = \frac{50000}{(100)\times(8)} = 62.5\ m^3/hr$$

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

Assume that the optimum depth is equal to the actual depth
Then the % of optimum depth =100%, Angle of swing=75°
From table (6-2), $(D_{cut}\ \&\ A_{swing})_F = 1.07$

From table (6-3),
$(J\ \&\ M)_F = 0.81$

$$(Time)_F = \frac{45}{60} = 0.75$$

$$62.5 = Ideal\ Output \times 1.07 \times 0.81 \times 0.75$$

$$Ideal\ Output = 96.15\ m^3/hr$$

From table (6-1), for ideal output ≥ 96.15 m^3/hr and sand and gravel soil, choose ($0.6m^3$) power shovel, the Ideal output = 118 m^3/hr, Optimum depth = 1.6m

$$\%\,of\ optimum\ cut = \frac{2}{1.6} \times 100 = 125\%$$

From table (6-2), for 125% of optimum height and 75° angle of swing:

Optimum Depth %	Angle of Swing	$(D_{cut}\ \&\ A_{swing})_F$		$(D_{cut}\ \&\ A_{swing})_F$
D_1=120	75°	F_1=1.03	→	F_R =1.015
D_R=125	75°	F_R		
D_2=140	75°	F_2=0.97		

$$(D_{cut} - A_{swing})_F = F_1 + (F_2 - F_1)\left(\frac{D_R - D_1}{D_2 - D_1}\right)$$

$$(D_{cut} - A_{swing})_F = 1.03 + (0.97 - 1.03)\left(\frac{125 - 120}{140 - 120}\right) = 1.015$$

From table (6-3), $(J\ \&\ M)_F = 0.81$, $(Time)_F = 0.75$

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

$$Probable\ Output = 118 \times 1.015 \times 0.81 \times 0.75 = 72.76\ m^3/hr$$

$$72.76\ m^3/hr > 62.5\ m^3/hr \Rightarrow \therefore OK$$

Q4-B) (10 marks) Define five of the following:

1) **Occupational Accident**: An accident, the origins of which are from a workplace. A sudden Occupational Accident can take place either at the workplace, or while commuting between home and the workplace.
2) **Sub Grade**: The surface produced by grading native earth, or cheap imported material which serves as a base for more expensive paving.
3) **Gradability**: Gradability 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.
4) **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.
5) **Concrete Form Tie**: a tensile ready-made unit with safe load ratings having an internal tension unit and an external holding device, used to secure concrete forms against the lateral pressure of unhardened concrete.
6) **Paving mixers**: Paving mixers are used primarily to mix and place concrete for highways, streets, and airport runways. They are mounted on crawler trucks in order that they may move along with the placing of concrete.

Q5-A) (10 marks)

Solution:

Gradability is determined as follows:

$$Drawbar\ pull\ in\ 1^{st}\ gear = 10000\ kg$$

$$\begin{pmatrix} Available \\ drawbar\ pull \end{pmatrix} = 0.85 \times 10000 = 8500\ kg$$

$$Gradability = \frac{\begin{pmatrix} Drawbar\ Pull\ to \\ Overcome\ Grade \end{pmatrix}}{W_{tons} \times 10}$$

$$\begin{pmatrix} Available \\ Drawbar\ Pull \end{pmatrix} = \begin{pmatrix} Pull\ required\ to \\ overcome\ Rolling \\ Resistance \end{pmatrix} + \begin{pmatrix} Pull\ required\ to \\ overcome\ Grade \end{pmatrix}$$

$$\begin{pmatrix} Pull\ required\ to \\ overcome\ Grade \end{pmatrix} = \begin{pmatrix} Available \\ Drawbar\ Pull \end{pmatrix} - \begin{pmatrix} Pull\ required\ to \\ overcome\ Rolling \\ Resistance \end{pmatrix}$$

$$\begin{pmatrix} Pull\ available\ to \\ overcome\ grade \end{pmatrix} = 8500 - \left[Pull_{RR\text{-}crawler\ tractor} + Pull_{RR\text{-}loaded\ wheel\ scraper}\right]$$

$$\begin{pmatrix} Pull\ available\ to \\ overcome\ grade \end{pmatrix} = 8500 - [20 \times (70 - 50) + (\quad 20 + 10) \times 40]$$

$$\begin{pmatrix} Pull\ available\ to \\ overcome\ grade \end{pmatrix} = 8500 - [20 \times 20 + 30 \times 40] = 8500 - [400 + 1200] = 8500 - 1600 = 6900 kg$$

$$\begin{pmatrix} Combined\ weight \\ for\ tractor\ and \\ loaded\ scraper \end{pmatrix} = 20 + 20 + 10 = 50\ ton$$

$$Gradability = \frac{6900}{50 \times 10} = 13.8\%$$

Q5-B) (5 marks)

Solution:

Net moldboard capacity= $3 \div 1.20 = 2.5 m^3$

Probable round-trip time:

Pushing, 30m, @ 3 km/hr, $\dfrac{\frac{30}{1000} \times 60}{3} = 0.6\ min$

Returning, 30m, @ 6 km/hr, $\dfrac{\frac{30}{1000} \times 60}{6} = 0.3\ min$

Fixed time, 0.3 min

Total time= 0.6+0.3+0.3= 1.2 min

Trip per hour, $45 \div 1.2 = 37.5$

Output per hour, $37.5 \times 2.5 = 93.75\ m^3 / hr$

Q5-C) (10 marks)

Answer one of the following:

1) State the causes of construction accidents. How can these accidents be avoided?

The causes of construction accidents are:

1. Uncontrollable contact between men and equipment or materials.
2. Failure of temporary structures, such as forms, scaffolds, ladders, etc.
3. Engineering hazards, such as the use of explosives, presence of injurious gases, toxic dusts, etc.
4. Unsafe practices of individual workers or personnel hazards resulting from the carelessness of workers.

Most of the accidents could be avoided through the application of an effective safety program.

2) Explain the effect of grade in locating a borrow pit.

It is desirable, when possible, to locate a borrow pit at a higher elevation than the fill, in order that the slope down the road may help the loaded trucks or other hauling equipment by permitting them to carry larger loads or to travel at higher speeds. Since the vehicle will be empty when returning up the road from the fill to the borrow pit, the effect of the grade will be considerably less.