University of Technology
Building & Construction Engineering Department
Final Exam –2014/2015

Subject: Methods of Construction **Class: 3rd year**
Branch: Structural Engineering **Time : 3 Hours**

(Note: Attempt Four Questions Only)

Q1) (25 marks)

A) In selecting a tractor several factors should be considered, List five factors only. **(10 marks)**

B) In designing a slab form, it was found that the spacing between joists ($L_{Decking}$) was (1.5 m), and the spacing between stringers (L_{Joist}) was (1 m), calculate the maximum spacing between shores ($L_{Stringer}$) then check the safe loads on shores using the following information: **(15 marks)**

- P_m=6.5 kN/m^2.
- Lumber used for decking, 25 mm.
- Lumber used for joist, (b×h), 50 mm ×150 mm.
- Lumber used for stringers, (b×h), 100 mm ×100 mm.
- Lumber used for shores, (b×h), 100 mm ×100 mm.
- g= Unsupported height of shore, 3m
- Extreme fiber in bending (f=12400 kN/m^2).
- Horizontal Shear (v = 1000 kN/m^2).
- Modulus of Elasticity (E = 11.035×10^{6}kN/m^2)
- $D_{Allowable}$= 3mm.

Q2 (25 marks)

A) A piece of equipment is available for purchase for ($15000), has an estimated useful life of (5 years), and an estimated salvage value of ($3000). Determine the depreciation and the book value for each of the 5 years using the SOY method. **(10 marks)**

B) Depending on the following information find the size of power shovel that can be used: (15 marks)

- Good common earth.
- Depth of cut (2.5 m)
- Percent of optimum depth is (86.2%)
- The depth of cut & angle of swing factor is (1.11)
- The job-management factor is (0.71)
- The probable output (162.35) m^3/hr.

Q3 (25 marks)

A) Fill the blanks with the suitable words: **(10 marks)**

1- The equipment that can be used economically on more than one project may be defined as ------------- equipment.

2- ------------------is the resistance which is encountered by a vehicle in moving over a road or surface.

3- If the unit is used to haul ready mixed concrete, which requires agitation en route to the project only to prevent segregation, the unit is called an------------.

4- Curing should prevent the loss of ----------- moisture, or replace the moisture that evaporates.

5- Square and octagonal precast concrete piles are cast in -----------forms, while round piles are cast in -----------forms.

6- Long concrete piles should be picked up at several points to reduce the ------ lengths.

7- The size of single-acting steam hammer is designated by------------------, expressed in (m.kg).

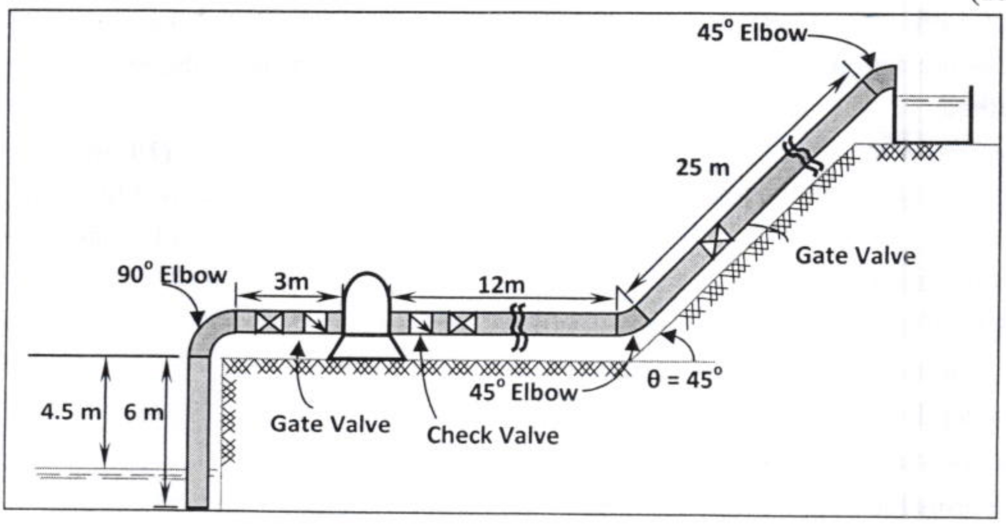
8- --------------------- steam hammer has the advantages of a single and double-acting steam hammers.

9- ------------- batching is much more dependable and more commonly used in concrete.

10- The major property of importance to the constructor in the production of fresh concrete is the------------------.

B) Select a self-priming centrifugal pump, with a capacity of (1136) l/min, for the project shown in following Fig. All pipes, fittings and valves will be (125 mm) in diameter.

(15 marks)



Q4 (25 marks)

A) List the advantages of Cast-in-Place Concrete Piles. **(10 marks)**

B) Determine the quantity of materials required per batch and the probable output for a (0.45 S) construction mixer, the quantity of materials per cubic meter are:

Cement 7.6 Bags

Sand 850 kg

Gravel 1100 kg

Water 195litters

Operating Factor is 50- min hour

If the mixer discharges the entire batch of concrete into five wheelbarrows, the time per cycle should be about as follow: **(15 marks)**

Charging mixer	0.25	min
Mixing concrete	1.00	min
Discharging mixer in each wheel- barrows	0.2	min
Lost time	0.10	min

Q5 (25 marks)

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 4%? **(10 marks)**

B) Determine the probable cost per hour for owning and operating a (25 m^3) truck with six rubber tires, using the following information: **(15 marks)**

Cost of Equipment	$92000
Cost of one tire	$2000
Engine, Diesel	250 hp
Crankcase capacity	55 liter
Hours between oil changes	80 hr
Operating factor	0.6
Useful life, with no salvage value	5 years
Tires useful Life	5000 hrs
Repairs to tires	12% of depreciation of tires
Maintenance	60% of Depreciation
Investment	20% of Average Value
Hours operated per year	2000
Cost of fuel per liter	0.5 $/liter
Cost of oil per liter	0.95 $/liter

$q = \frac{hp \times f \times 0.0027\ (kg/hp-hr)}{0.89\ (kg/l)} + \frac{C}{t}$	$\overline{P} = \frac{P\,(N+1) + S\,(N-1)}{2N}$

$P_m = 7 + \frac{1414R}{1.8T + 32}$	$P = 7 + \frac{2079 + 440R}{1.8T + 32}$	$P_m = \gamma_c \times h$
$L = 1.291 \times h \times \sqrt{\frac{fb}{w}}$	$L = \frac{2vbh}{1.5w}$	$L = 0.526 \times \sqrt[4]{\frac{EID}{w}}$
$L = 0.787 \times \sqrt[4]{\frac{EID}{w}}$	$K = 7120\left(1 - \frac{g}{80b}\right) bh$	$R = \frac{Out\ Put\ (m^3/hr)}{b \times l}$

Table (6-1) - Ideal Output of Power Shovel,

Class of material	**Size of Shovel, (cubic meter)**								
	0.3	**0.4**	**0.6**	**0.8**	**1**	**1.2**	**1.4**	**1.6**	**2**
Moist loam or high sand clay	1.1	1.4	1.6	1.8	2.0	2.1	2.2	2.4	2.6
Sand and gravel	1.1	1.4	1.6	1.8	2.0	2.1	2.2	2.4	2.6
Good common earth	1.4	1.7	2.1	2.4	2.6	2.8	2.9	3.1	3.4
Hard, tough clay	1.8	2.1	2.4	2.7	3.0	3.3	3.5	3.7	4.1
Well-blasted rock	—	—	—	—	—	—	—	—	—
Wet, sticky clay	1.8	2.1	2.4	2.7	3.0	3.3	3.5	3.7	4.0
Poorly blasted rock	—	—	—	—	—	—	—	—	—

Table (6-2) Conversion Factor for Depth of Cut and Angle of Swing

Angle of swing , degrees							Percent of Optimum Depth, %
180	**150**	**120**	**90**	**75**	**60**	**45**	
0.59	0.65	0.72	0.80	0.85	0.89	0.93	**40**
0.66	0.73	0.81	0.91	0.96	1.03	1.10	**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**
0.70	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 (6-3) 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

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

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

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
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

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
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

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
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

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
Close Return	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
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

Building & Construction Engineering Department
Final Exam - Answers –2014/2015

الموضوع/ الإجابات النموذجية
السادة/ المرسل
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Subject: Methods of Construction
Branch: Structural Engineering

Class: 3rd year
Time : 3 Hours

Q1A) In selecting a tractor several factors should be considered such as the following:

1. The size required for a given job.
2. The kind of job for which it will be used.
3. The type of footing over which it will operate.
4. The firmness of the haul road.
5. The smoothness of the haul road.
6. The slope of the haul road.
7. The length of the haul road.
8. Finally, the type of work it will do after this job is completed.

Q1-B)

Design of Stringers ($L_{Stringers}$): (Spacing Between Shores)

b=100mm, h=100mm.

$$W_{(Stringer)} = P_m' \times L_{(Joist)} = 6.5 \times 1 = 6.5 \ kN/mL$$

Check Bending:

$$L = 1.29h\sqrt{\frac{fb}{w}} = 1.29 \times 0.1\sqrt{\frac{12400 \times 0.1}{6.5}} = 1.78m$$

Check Shear: $L = \frac{2vbh}{1.5w} = \frac{2 \times 1000 \times 0.1 \times 0.1}{1.5 \times 6.5} = 2.05m$

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

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

$$L = 0.787 \times \sqrt[4]{\frac{11.035 \times 10^6 \times 8.333 \times 10^{-6} \times 3}{6.5}} = 2.01m$$

Use the least value, L= 1.78m ≈ 1.75m

$L_{Stringer}$ =1.75m

Check Load on Shores:

Safe Load on Shores:

$$Load_{(Shores)} = P_m \times L_{(Joist)} \times L_{(Stringer)} = 6.5 \times 1 \times 1.75 = 11.375 \ kN/mL$$

$$K = 7120\left(1 - \frac{g}{80b}\right)bh = 7120\left(1 - \frac{3}{80(0.1)}\right)(0.1)(0.1) = 44.5 \ kN/mL > 11.375 \ kN/mL \Rightarrow \therefore OK$$

Q2-A)Solution:

Using Eq. (2-6): $SOY = \frac{N(N+1)}{2} = \frac{5(5+1)}{2} = 15$, or

$SOY = 1+2+3+4+5 = 15$

Using Eq. (2-5):

$$R_m = \frac{N-m+1}{SOY} = \frac{5-m+1}{15}$$

Using Eq. (2-7):

$$D_m = R_m(P-S) = \frac{5-m+1}{15}(15000-3000)$$

$$D_m = \frac{5-m+1}{15}(12000)$$

$$D_m = R_m(12000)$$

Then tabulate the results as follows:

year	R_m	D_m (\$)	BV_m (\$)
0		*0*	***15000***
1	$\frac{5-1+1}{15} = \frac{5}{15}$	$R_m(12000) = 4000$	$15000 - 4000 = 11000$
2	$\frac{5-2+1}{15} = \frac{4}{15}$	$R_m(12000) = 3200$	$11000 - 3200 = 7800$
3	$\frac{5-3+1}{15} = \frac{3}{15}$	$R_m(12000) = 2400$	$7800 - 2400 = 5400$
4	$\frac{5-4+1}{15} = \frac{2}{15}$	$R_m(12000) = 1600$	$5400 - 1600 = 3800$
5	$\frac{5-5+1}{15} = \frac{1}{15}$	$R_m(12000) = 800$	$3800 - 800 = 3000$

Q2-B) Ideal output will be:

162.35 (1.11×0.71)= 206 m^3/hr.

the optimum depth is

$\frac{2.5}{x} \times 100 = 86.2\%$

$x = 2.9$m

From table (6-1) the ideal output will be 206 m^3/hr., the optimum depth is 2.9m. YOU can use 1.4 cubic meter shovel

Table (6-1) - Ideal Output of Power Shovel, in Cubic Meter Per 60-Min Hour, Bank Measure.

Class of material	Size shovel, cubic meter								
	0.3	0.4	0.6	0.8 x	1	1.2	1.4	1.6	2
	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

Solution:Q3A)

1- standard equipment.

2- Rolling Resistánce

3- agitator mixer

4- initial

5- horizontal , vertical

6- unsupported

7- energy per blow

8- differential-acting

9- Weight

10- workability

Q3-B)

1) For (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)	90^{o} Elbow	1	1(4.1)	4.1
2)	45^{o} Elbow	2	2(1.9)	3.8
3)	Check Valve	2	2(16.1)	32.2
4)	Gate Valve	3	3(0.9)	2.7
5)	Pipes		6+3+12+25=	46
				88.8

2) From table (10-2) the friction loss per 100m of (125 mm steel pipe) and 1136/min flow will be: 1.58

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

Item	Total Equivalent Length of Pipes, m	
Lift	4.5+25×sin45	22.17
Head lost in friction	88.8 (1.58)/100	1.4
	Total Head	23.57

For a total head of 24 m>23.57, a suction head of 4.5m and a flow of 1136 l/min, a model 30-M self-priming pump with a capacity approximately (1230 l/min) will be satisfactory to do the job. ((1230 l/min) > (1136 l/min)).

Q4-A)

Advantages of Cast-in-Place Concrete Piles:

1. The lightweight shells may be handled and driven easily.
2. The length of a shell may be increased or decreased easily.
3. The shells may be shipped in short lengths and assembled at the job.
4. The danger of breaking a pile while driving is eliminated.
5. Additional piles may be provided quickly if they are needed.

Q4-B) Solution:

If the batch is $0.45m^3$ the required volume of cement will be:

$0.45 \times 7.6 = 3.42$ bags

Instead of mixing $0.45m^3$ per batch which required a fractional bag of cement (3.42 bags), reduce the quantity to (3 bags), and the quantity of other materials, in the same proportion.

So the proportion of reduction per batch will be (volume per batch):

$$\frac{3(bags/batch)}{7.6(bags/1m^3)} = 0.39 \ (m^3/batch)$$

So the quantity of material per batch will be as follows:

Cement, 3bags

Sand, $850(\text{kg/m}^3) \times 0.39(m^3/Batch) = 331.5 \ kg/Batch$

Gravel, $1100 \times 0.39 = 429 \ kg/Batch$

Water, $195 \times 0.39 = 76.05 \ lt/Batch$

$$\text{Total Time per Cycle} = 0.25 + 1.00 + (0.2 * 5) + 0.10 = 2.35 \ \text{min}$$

$$\text{No. of Batches per Hour} = \frac{60}{2.35} = 25.53 \ \ Batches / hr$$

The volume per batch will be:

$$\frac{3}{3.42} \times 0.45 = 0.39\, m^3/Batch < \mathbf{0.45} m^3/Batch$$

$$\text{Output per Hour} = 25.5 \times 0.39 = 9.945 \ \ m^3 / hr$$

$$\text{Output per 50 - min Hour} = 9.945 \times \frac{50}{60} = 8.29 \ \ m^3 / hr$$

Or:

$$\text{No. of Batches per Hour} = \frac{50}{2.35} = 21.27 \ \ Batches / hr$$

$$\text{Output per 50 - min Hour} = 21.27 \times 0.39 = 8.29 \ \ m^3 / hr$$

<u>Q5-A)</u>

From eq. (5-4):

$$32.14 = \frac{W}{4560} = \frac{w\, Q\, h}{4560\ e} = \frac{1 \times X \times 48}{4560 \times 0.6} = 1832 L / \min$$

$$1832.2 = 2\ (1 - 0.04) \times \frac{\pi\ (150)^2\ (300)\ (n)}{4} \times 10^{-6}$$

n=180 rpm

Q5-B) **Solution**:

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	92000
Cost of tires =6x2000	12000
Net cost less tire	80000
average value of the equipment $\overline{P} = \frac{P(N+1)}{2N} = \frac{92000(5+1)}{2(5)}$	55200

Annual Costs for truck:	
Depreciation: $D = \frac{P}{N} = \frac{80000}{5}$	16000
Maintenance: $M' = 60\% D = 0.6(16000)$	9600
Investment: $I = 20\% \overline{P} = 0.2(55200)$	11040
Total Annual Fixed Cost	$36640
Hourly Costs:	
Hourly ownership cost 36640/2000	18.32
Fuel: $0.6 \times 250 \times 0.15(0.5)$	11.25
Lubrication Oil: $\frac{250 \times 0.6 \times 0.0027}{0.89} + \frac{55}{80} = 1.142(0.95)$	1.08
Tire depreciation: 12000/5000	2.4
Tires repairs: 0.12×2.4	0.288
Total Cost per hour, excluding labor	$33.33