AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

STRUCTURAL ENGINEERING DEPARTMENT

كلية الهندسة

Fourth Year Civil

January, 2015 *Time : 3.00 Hrs*

CES 451 Foundation Engineering

The exam consists of *six* questions in *Six* pages. Maximum Mark = 140

Reasonably assume any missing data.

Question 1 (40 MARKS)

1-A) It is required to design an isolated footing, assuming equal contact stress, to support a rectangular column (40 cm x 100 cm) carrying a net working compression load of 210 ton and a working <u>permanent</u> moment of 70 m.t. The net bearing capacity of the foundation soil is 16 t/m^2. The thickness of the plain concrete footing is 10 cm. Draw neat sketches showing the concrete dimensions and the reinforcement details in both plan and cross sectional elevation (using scale 1 :50).

Data :

Materials: Concrete f_{cu} = 300 kg/cm^2, Steel 40/60, f_y = 4000 kg/cm2

Working stress: f_c=100 kg/cm^2, f_s = 2200 kg/cm^2, q_c=7 kg/cm^2, q_{cp}=10 kg/cm^2, local bond stress = 12 kg/cm^2

Ultimate stress: q_{cu} = 9 kg/cm^2, q_{cpu}=14.5 kg/cm^2, q_{bu}= 18 kg/cm^2

C_1 min. = 3.0 , j = 0.74
C_1 = 3.5 , j = 0.78
C_1 = 4.0 , j = 0.80
C_1 = 4.85 , j = 0.826

Area of different reinforcement steel bars:

Φ12: area = 1.13 cm^2; Φ16: area = 2.00 cm^2;
Φ18: area = 2.84 cm^2; Φ20: area = 3.14 cm^2;
Φ22: area = 3.80 cm^2; Φ25: area = 4.91 cm^2

$d = C_1 \, (M_u / (f_{cu} \cdot b))^{1/2}$ $As = M_u / f_y \cdot d \cdot j$

1-B) For the two columns shown in Figure (1), it is required to:

i) Suggest a suitable type of shallow foundation to support the two columns (the net bearing capacity of the foundation soil is 10 t/m^2).

ii) Without any calculations, sketch the reinforcement details of the selected shallow foundation system in plan.

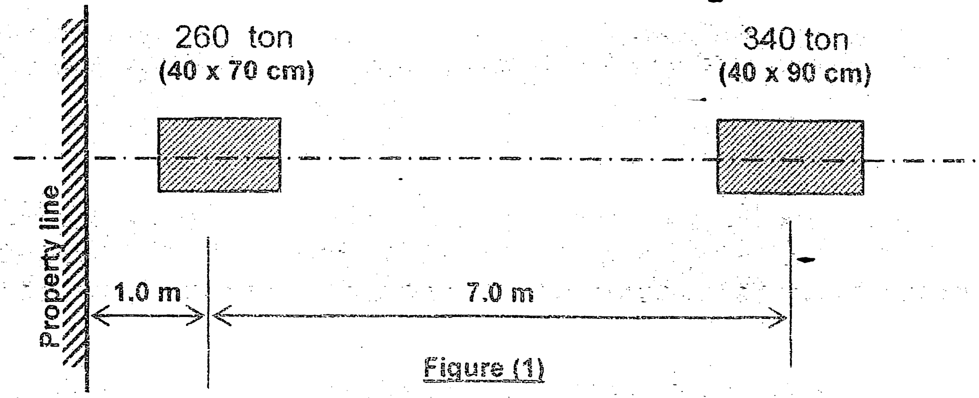


Figure (1)

Question 2 (35 MARKS)

2-A) Evaluate the following statements (right or wrong) and comment on your evaluation (Any answer without comments is not accepted):

1. Driven piles are the most suitable piling technique in city centers beside historical buildings.
2. Nicking cannot be happened by Continuous Flight Auger (CFA) piles if the concrete slump is less than 16.
3. Post grouting can increase the pile capacity.
4. Settlement criterion does not control the allowable pile capacity of large diameter bored piles.
5. Factor of safety of pile capacity is related to the risk assessment considering materials and loads.
6. Dynamic formulas to detect the pile capacity are very accurate and can be applied for all pile types in all soils.
7. Static pile load tests is the most accurate method to get realistic values of pile load-settlement performance considering the construction methodology as well as the real site conditions.
8. The cone penetration test is a very useful method to get accurate information on the in-situ soil parameters that can lead to realistic pile design.
9. Mobilization of pile skin friction needs small relative settlement between pile and surrounding soil.
10. The accuracy of Chin's method to evaluate the pile capacity from results of the pile load test depends on the measured settlement during the load test.
11. The pile group action leads to decrease of pile settlement compared with the settlement of corresponding single pile under the average applied load.
12. In a pile group under tension loads, the own weight of soil between the piles can govern the pullout resistance of the pile group.

2-B) Results of geotechnical investigation at a site showed that the soil profile, as shown in Figure (2.a), consists of a thick layer of very dense sand down to 20.0 m followed by rock formations. A bridge pier has working load (dead and live loads including the weight of the pile cap) of 10000 kN is to be founded on CFA piles with pile diameter of 0.6 m in the sand layer. The pile length is 12 m. The foundation depth is just at the ground water table that lies 2.0 m below the ground surface.

According to the conducted pile load test on a non-working pile, the ultimate pile skin friction is 80 kPa and the pile base resistance is 3000 kPa. It is required to:

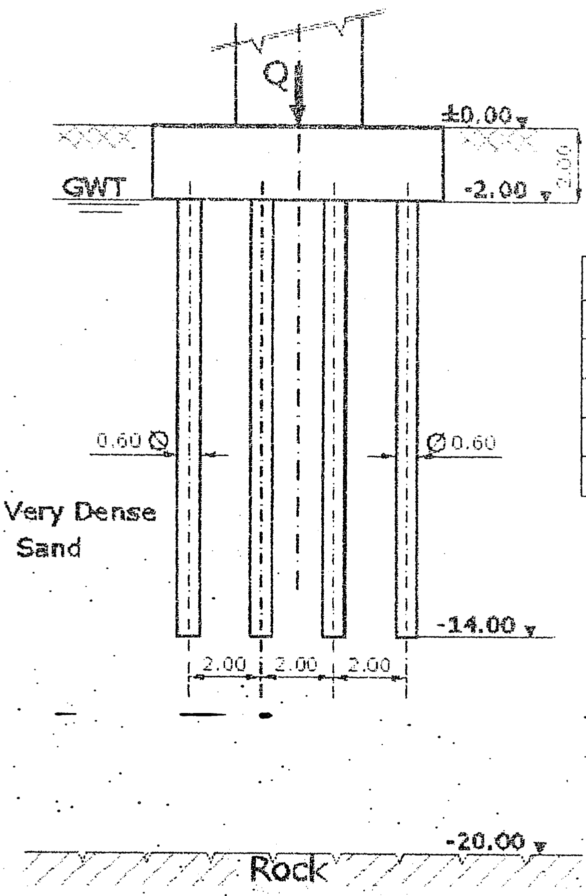
1) Calculate the allowable pile capacity under tension and compression loads considering a factor of safety equals 2.5 for both tension and compression.

2) If twelve (12) piles were arranged below the pile cap as shown in Figure (2.b), calculate the average vertical load per pile and the corresponding factor of safety.

3) If the applied working loads on the pile cap are as follows:
- Q = 10000 kN = Dead and live loads including the weight of pile cap;
- Mx = 1500 kN.m; and
- My = 4000 kN.m

i) Determine the loads taken by corner, edge and center piles no. P1, P2 and P3, respectively.

ii) Determine the factor of safety of piles no. P1, P2 and P3 under the above mentioned loading conditions.



Soil Parameters

Soil parameter	Sand
E [MN/m²]	100
ν [-]	0.3
γ / γ´ [kN/m³]	20/10
c´ [kN/m²]	0.0
φ´ [°]	36

E = Primary loading stiffness
ν = Poisson's ratio
γ / γ' = Total / Effective unit weight of soil
c' = Cohesion
φ' = Angle of internal friction

Figure (2.a): Cross Sectional Elevation & Soil Profile

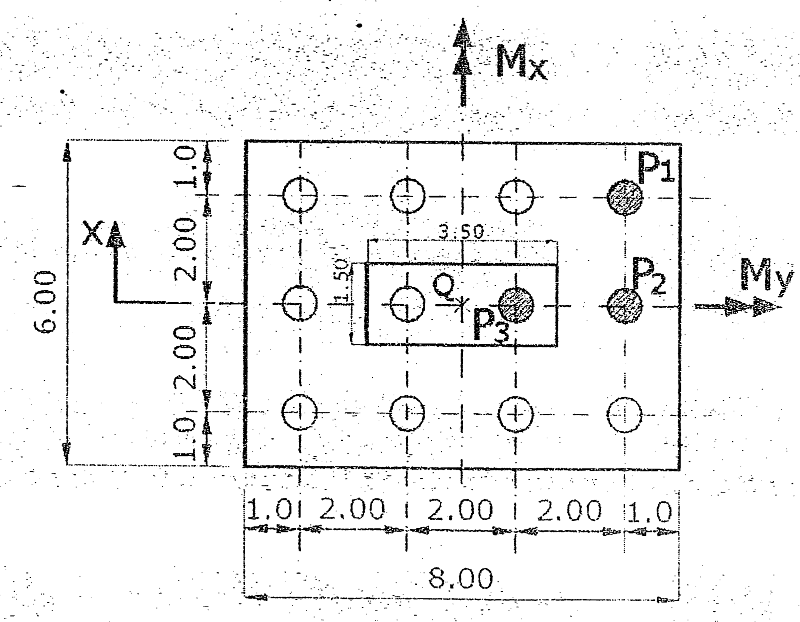


Figure (2.b): Plan of Pile Cap

Question 3 (25 MARKS)

3-A) Draw neat sketches to illustrate each of the following:

i) Details of the connection between grouted tieback and waling beam in a tangent pile wall.
ii) Details of the connection between an RC roof slab and a diaphragm wall.

3-B) Compare between the following shoring systems:

- Steel sheet pile wall
- Soldier piles
- Tangent piles

with respect to:

- Wall lateral stiffness;
- Induced vibration during construction; and
- Water tightness.

3-C) A cantilever SPW was driven across a water canal to allow for the construction of a new irrigation structure. The high water level in the canal is 4.0 m above the bed level. The subsoil below the canal bed consists of a thick layer of sand with a saturated unit weight of 20 kN/m^3 and an internal friction angle of 35°. If the water level on one side of the SPW was lowered by 4.0 m to reach the bed level, determine the safe penetration depth of the SPW and the maximum bending moment on the wall.

Question 4 (20 MARKS)

Draw neat sketches to illustrate each of the following:

i) Why does the ground settle above any tunnel constructed through soft ground?
ii) Comparison between stability of the tunnel face using Bentonite Slurry TBM and Earth Pressure Balanced TBM.
iii) Role of the TBM tail-seal in reducing ground loss.
iv) Effect of each of the following on the average soil pressure acting on a tunnel lining (illustrate using ground and support reaction curves):
   a) Stiffness of the soil.
   b) Size of overcut teeth of an Open Face TBM.

Question 5 (20 MARKS)

5-A) Explain the following using neat sketches:

i) The main zones of earth and rock fill dams.
ii) The laboratory tests and field tests required for controlling the construction of the dam.

5-B) For the homogeneous earth dam shown in Figure (3), draw the flow net under steady seepage condition.

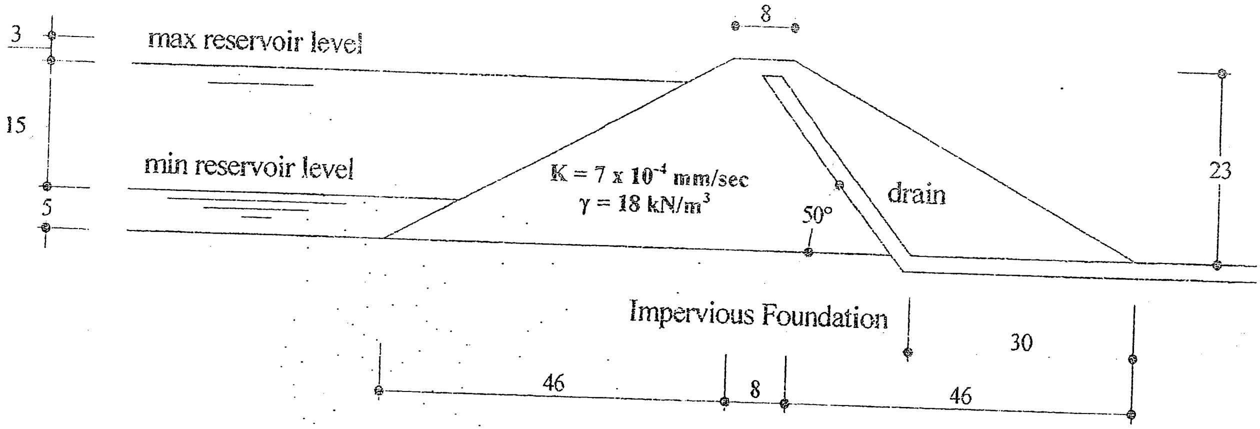


Figure (3)

Question 6 (20 MARKS)

6-A) The following table shows results of a CBR test conducted in the laboratory.

Load (kN)	0	0.26	1.12	3.36	6.83	10.70	14.52	18.02	21.25	24.14	26.76
Penetration (mm)	0	1	2	3	4	5	6	7	8	9	10

It is required to:

i) Find the CBR value for the above tested soil.
ii) Using the ACI-360 chart, find the subgrade reaction modulus for a plate 12-inch in diameter.
iii) What is the possible classification of the tested soil.

6-B) The R.C. slab on grade shown in Figure (4) is 1.50 x 6.0 meters and carries two columns, 3.0 meters center to center. Each column is subjected to: N = 1000 kN and M = 50 kN.m at opposite directions. The slab thickness is 100 cm and E_c = 20 GPa. The slab is divided into 6 elements.

If the slab on grade is constructed on the soil described above in problem (6-A), determine the contact stress below the slab on the basis of Winkler assumptions. (Assume the soil is homogeneous for great depth for K_s adjustment).

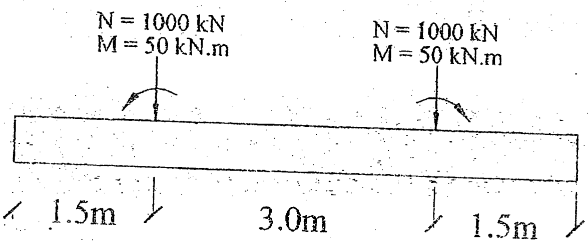
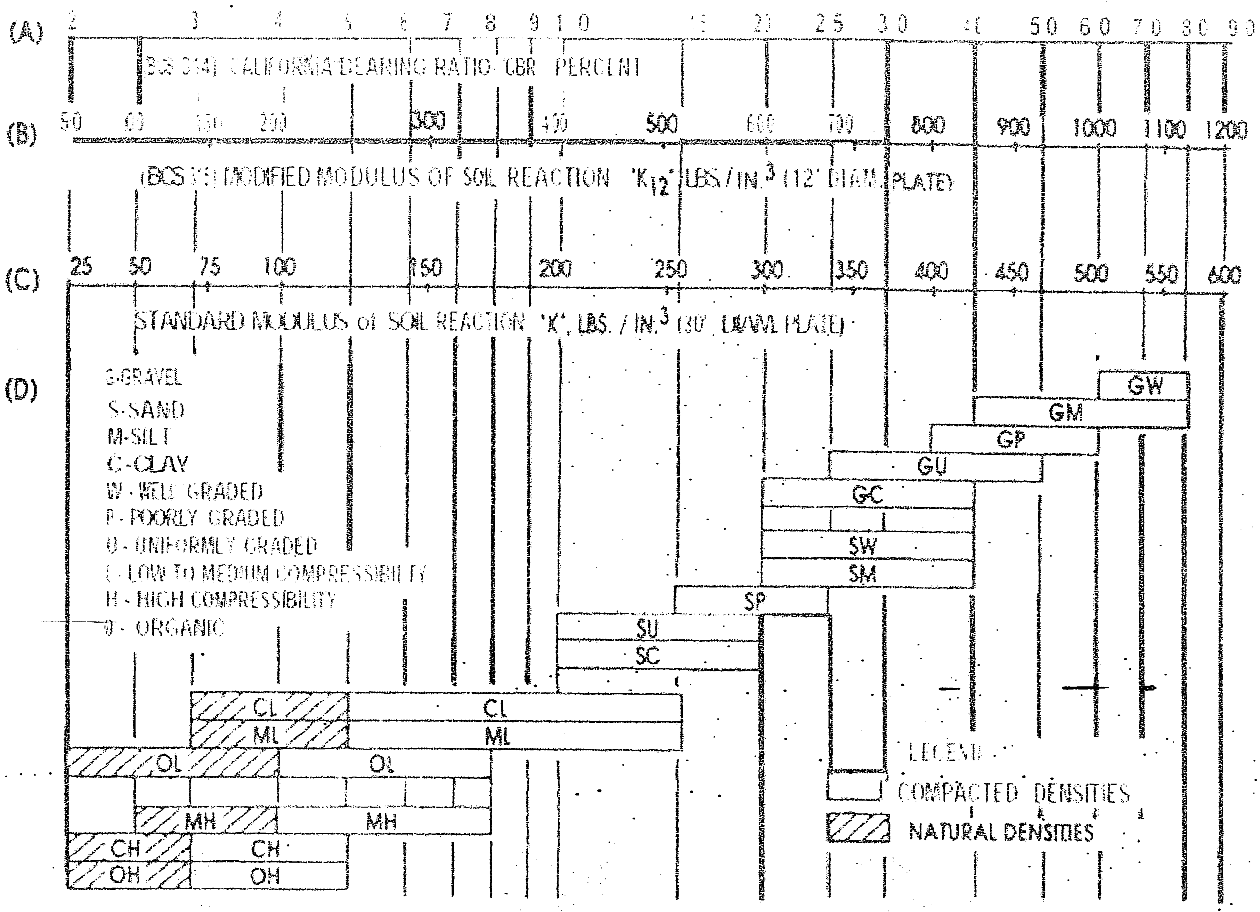


Figure (4)



Note: Comparison of soil type to 'K', particularly in the Land Hm Groups, should generally be made in the lower range of the soil type.

$K_{s(sq)} = K_{s(0.3m)} \times [(B+0.3)/(2B)]^2$	Sand, and Gravel
$K_{s(sq)} = K_{s(0.3m)} \times [0.3/B]$	Clay
$K_{s(rect)} = (K_{s(sq)}/1.5) \times (1+0.5B/L)$	Rectangular

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AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

STRUCTURAL ENGINEERING DEPARTMENT

كلية الهندسة

Fourth Year Civil

December, 2013 *Time : 3.00 Hrs*

CES 451 Foundation Engineering

The exam consists of ***six*** questions in ***Five*** pages. Maximum Mark = 140

Reasonably assume any missing data.

Question 1 (35 MARKS)

A) Explain using neat sketches the purposes of tie beams.

B) For the two columns shown in Figure (1), suggest a suitable type of shallow foundation, then give a complete design of the suggested foundation system (dimensions and reinforcement). Thickness of plain concrete footing is 25 cm, and the allowable net soil bearing capacity is 12 ton/m^2. Draw neat sketches showing concrete dimensions and reinforcement details in plan and elevation,(scale 1 :50).

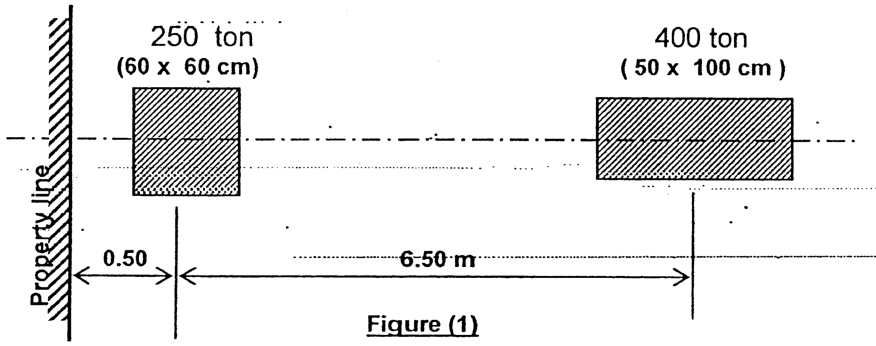


Figure (1)

Data :

Materials: Concrete f_{cu} = 300 kg/cm^2, Steel 40/60, f_y = 4000 kg/cm2

Working stress: f_c=100 kg/cm^2, f_s =2200 kg/cm^2, q_c=7 kg/cm2, q_{cp}=10 kg/cm^2, local bond stress = 12 kg/cm^2

Ultimate stress: q_{cu} = 9 kg/cm2, q_{cpu}=14.5 kg/cm2, q_{bu}= 18 kg/cm2

C_1 min. = 3.0 , j = 0.74
C_1 = 3.5 , j = 0.78
C_1 = 4.0 , j = 0.80
C_1 = 4.85 , j = 0.826

Area of different reinforcement steel bars:

Φ12: area = 1.13 cm^2 ; Φ16: area = 2.00 cm^2 ; Φ18: area = 2.84 cm^2 ; Φ20: area = 3.14 cm^2 ; Φ22: area = 3.80 cm^2 ; Φ25: area = 4.91 cm^2

$d = C_1 \, (M_u / (f_{cu} \cdot b))^{1/2}$ $As = M_u / f_y \cdot d \cdot j$

Question 2 (25 MARKS)

For the shown combined footing In Figure (2), the columns (55 x 55cm) are spaced by 2.25 m, the footing width is 2.0m and the thickness is 1.0 m. Draw the bending moment along the footing longintundal direction using the following methods:

i) Ohde method (C_0 = 1.5, C_1 = 0.65, C_2 = 0.35, C_3 = 0.25, C_4 = 0.18, C_5 = 0.13, C_6 = 0.09), E_c = 2100 kN/cm^2, E_s = 80 MN/m^2;

ii) Winkler method (K_s =50000 kN/m^3); and

iii) Pseudo-Coupled method.

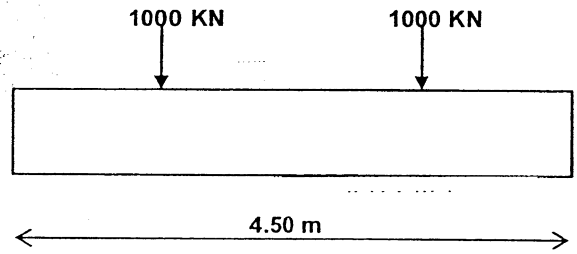


Figure (2)

Question 3 (30 MARKS)

A) Evaluate the following statements (right or wrong) and comment on your evaluation (Any answer without comments will not be accepted):

1. Driven piles are the most suitable piling technique in off-shore structure
2. Bentonite slurry increases the bearing capacity of bored piles in clayey soil.
3. Pile integrity test is a quick and economic way to determine ultimate pile capacity.
4. Pile group action increases pile capacity and decreases pile stiffness.
5. In a pile group under tension loads, the own weight of soil between the piles can govern the pullout resistance of the pile group.
6. In a pile group that is connected with a rigid pile cap and subjected to horizontal loads, the horizontal loads are distributed equally among all piles.
7. In piled raft foundation, all loads are taken only by piles.
8. Applying multiple Osterberg cells to conduct the pile load test can lead to adequate estimation of pile skin friction and end bearing resistance.

B) Results of geotechnical investigation at a site showed that the soil profile consists of a layer of very soft clay followed by very dense sand down to greater depth, as shown in Figure (3). Micro piles with pile diameter of 0.2 m are used to support the planned structure. Load tests on single pile and pile group of (4 x 4) piles are conducted to investigate the pile capacity and the pile group action. The results of the conducted pile load tests are shown in Figures (4.a & 4.b).

1) If the average working load per pile is 60 kN, determine the pile group action according to the conducted pile load tests.

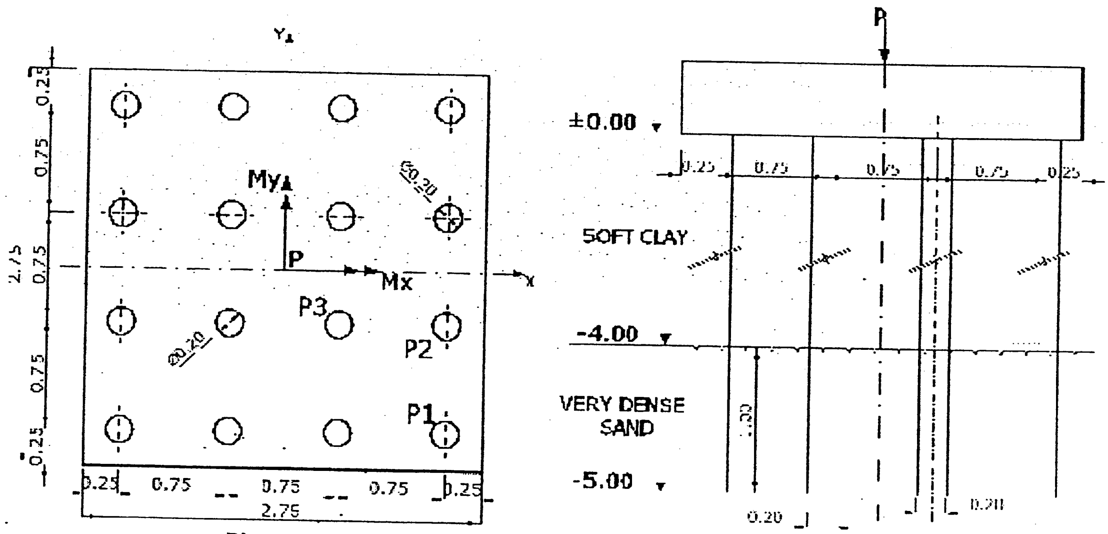
2) If the working loads on the 4 x 4 piles are as follows:

- Dead and live loads including the weight of pile cap P = 800 KN;
- Mx = 400 kN.m
- My = 100 kN.m

i) Determine the vertical loads taken by piles no. P1, P2 and P3.

ii) Determine the factor of safety for piles no. P1, P2 and P3, if the ultimate pile capacity is 100 kN.

iii) Comment on the results of point (ii).



Plan

Cross sectional Elevation & Soil Profile

Figure (3)

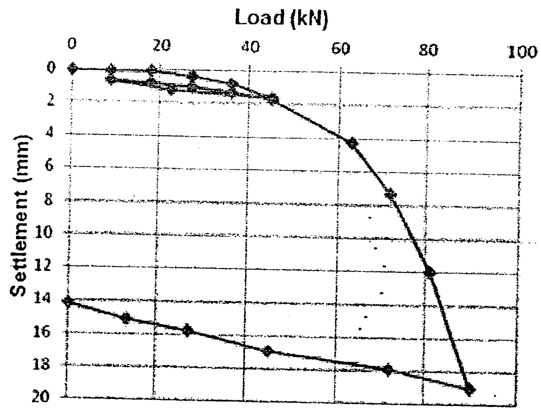


Figure (4.a): Results of pile load test on single pile

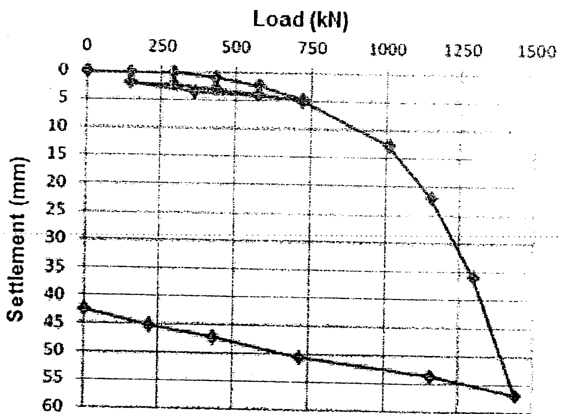
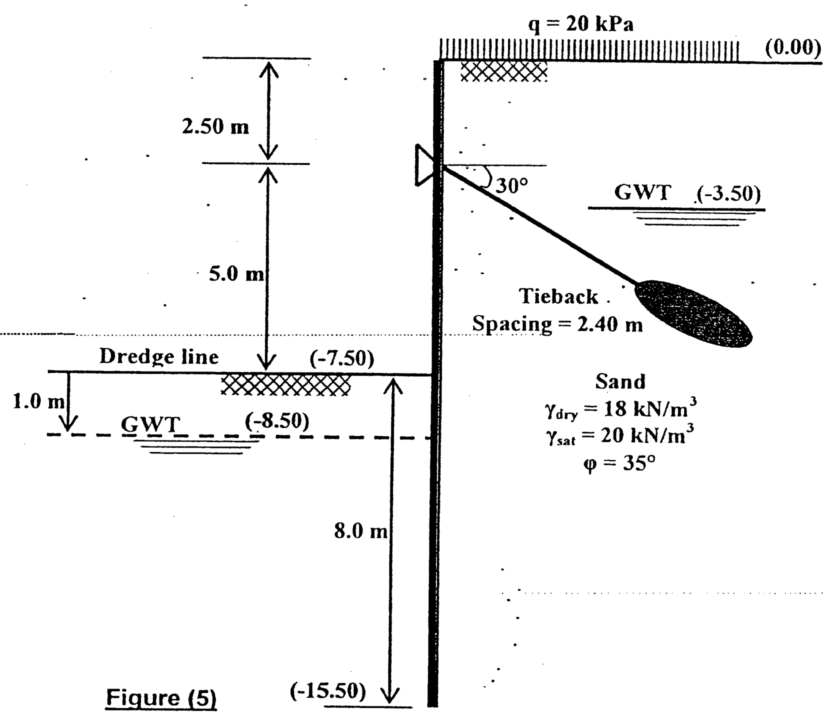


Figure (4.b): Results of pile load test on pile group (4 x 4 piles)

<u>Question 4</u> (25 MARKS)

Figure (5) shows a **<u>free-earth support diaphragm wall</u>** with a designed safe penetration depth of 8.0 m. The wall is anchored by a row of grouted tiebacks at a depth of 2.50 m from the ground surface. The tiebacks are spaced at 2.40 m out-of-plane. Because of site modifications, the dredge line is to be lowered by 1.0 m to reach the lower ground water table at level (-8.50). It is required to:

1. Check the safety of the remaining penetration depth of the wall after lowering the dredge line.
2. Check the safety of the diaphragm wall cross-section after lowering the dredge line, if the bending capacity of the wall cross-section (maximum allowed bending moment) is 700 kN.m/m.
3. Check the safety of tiebacks after lowering the dredge line, if the pullout capacity of tieback (maximum allowed pullout force) is 500 KN.
4. Comment on the results of items 1 to 3.



<u>Figure (5)</u>

<u>Question 5</u> (20 MARKS)

Draw neat sketches to illustrate each of the following:

i) Longitudinal cross section through the Bentonite Slurry (BS) TBM showing its main elements ~~(Cutting Head, BS Chamber, Overcut Teeth, Tail Seal, Tail Grouting).~~

ii) Explain why was an Open Face (OF) TBM used for constructing the large diameter Ahmed Hamdi tunnel while OF-TBMs with Compressed Air were utilized for constructing the smaller diameter sewer tunnels under Cairo?

iii) Using the Ground and Support Reaction Curves, explain how does the size of the overcut teeth affect the load carried by the tunnel lining?

iv) Effect of the distance between the centerlines of three parallel tunnels on the shape of settlement troughs at ground surface.

Question 6 (20 MARKS)

A) Explain the following using neat sketches:

i) Main zones of earth dam.
ii) Main items of construction monitoring.

B) For the shown earth dam in Figure (6), it is required to:

i) Draw the flow net and determine the rate of seepage.
ii) Draw the distribution of water pressure along the dam base.
iii) If the foundation of the dam is a layer of soft clay (6.0 m in thickness) overlying an impervious layer. **List the main points that should be implemented in the design of the dam.**

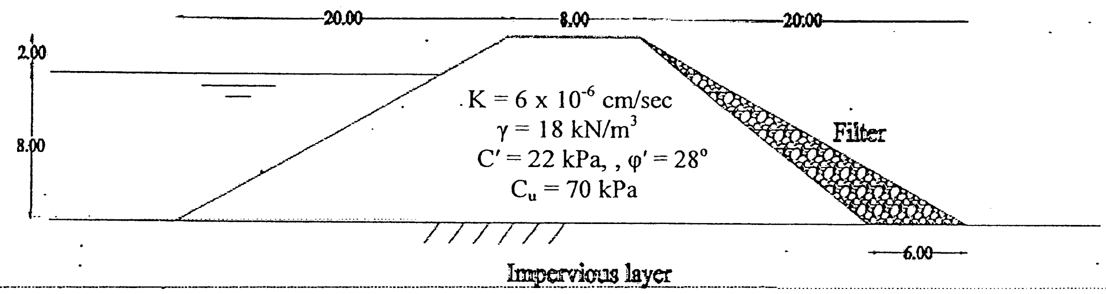


Figure (6)

BEST WISHES

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

STRUCTURAL ENGINEERING DEPARTMENT

Fourth Year Civil

December, 2012 *Time : 3.00 Hrs*

Foundation Engineering

The exam consists of *six* questions in *Six* pages. Total Marks = 140

Reasonably assume any missing data.

Question 1 (40 MARKS)

1.1 Explain using neat sketches the purposes of tie beams.

1.2 For the two columns, shown in Figure (1), it is required to:

i. Suggest a suitable foundation type.

ii. Give a complete design of the foundation (dimensions and reinforcement). Thickness of plain concrete is only 10 cm. The allowable net bearing capacity is 20 t/m².

iii. Draw neat sketches showing the concrete dimensions and reinforcement details in both plan and elevation (using scale 1:50).

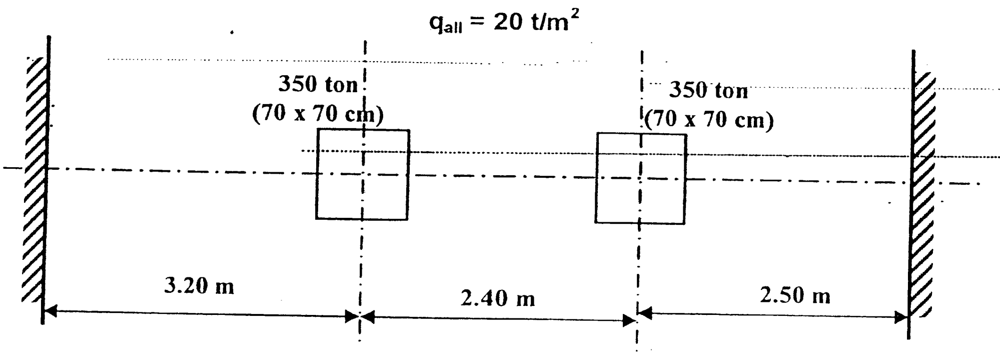


Figure (1)

Data :

Materials: Concrete $f_{cu} = 300$ kg/cm², Steel 40/60, $f_y = 4000$ kg/cm²

Working stress: f_c=100 kg/cm², f_s =2200 kg/cm², q_c=7 kg/cm², q_{cp}=10 kg/cm², local bond stress = 12 kg/cm²

Ultimate stress: q_{cu} = 9 kg/cm², q_{cpu}=14.5 kg/cm², qbu= 18 kg/cm²

$C_{1\,min.}$ = 3.0 , j = 0.74

C_1 = 3.5 , j = 0.78

~~C_1 = 4.0 , j = 0.80~~

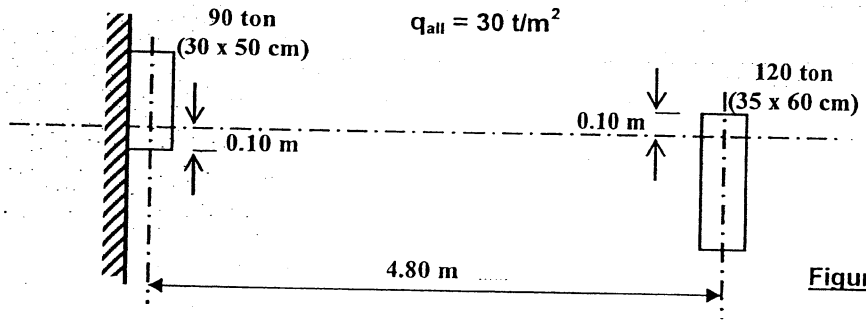
C_1 = 4.85 , j = 0.826

Area of different reinforcement steel bars:

Φ12: area = 1.13 cm²; Φ16: area = 2.00 cm²; Φ18: area = 2.84 cm²; Φ20: area = 3.14 cm²; Φ22: area = 3.80 cm²; Φ25: area = 4.91 cm²

$d = C_1\ (M_u / (f_{cu} . b))^{½}$ $As = M_u / f_y . d . j$

1.3 For the two columns, shown in Figure (2), suggest a suitable foundation type. Sketch the foundation concrete dimensions and reinforcement details in plan using suitable scale (1:50 or 1:100). Full design <u>is not</u> required.



<u>Figure (2)</u>

<u>Question 2</u> (35 MARKS)

2.1 Evaluate the following statements (right or wrong) and comment on your evaluation *<u>(Any answer without comments will not be accepted)</u>*:

i. Bored piles are the most suitable piling technique in off-shore structure
ii. Bentonite slurry is suitable to be used to stabilize the drilling hole during construction of large diameter bored piles in sandy soil.
iii. Pile integrity test is a quick and economic way to determine ultimate pile capacity.
iv. Pile skin friction is mobilized under relatively small displacements where pile base resistance needs relatively large displacements to be mobilized.
v. In a pile group under tension loads, the own weight of soil between the piles can govern the pullout resistance of the pile group.
vi. In a pile group that is connected with a rigid pile cap and subjected to horizontal load, the horizontal loads are distributed equally among all piles.
vii. Settlement of pile group under vertical compression load is smaller that the settlement of the single pile under average load.

2.2 Results of geotechnical investigation at a site showed that the soil profile consists of a thick layer of very dense sand down to 25.0 m followed by rock formations, as shown in Figure (3). A bridge pier has working load (dead and live loads including the weight of the superstructure, pier and pile cap) of 36000 KN is to be founded on large diameter bored piles with pile diameter of 1.0 m in the sand layer. Horizontal forces due to braking and wind loads in both X and Y directions are as follows: Hx = 1000 KN and Hy= 400 KN. The pile length is 15 m. The foundation depth is just at the ground water table that lies 1.5 m below ground surface. Nine piles were arranged below the pile cap, as shown in Figure (3). The following are required:

i. Calculate the settlement of the pile group, neglecting the applied moments.

ii. ~~If the settlement of the single pile under a working load of 4000 KN is 6 mm~~, calculate the pile group action.

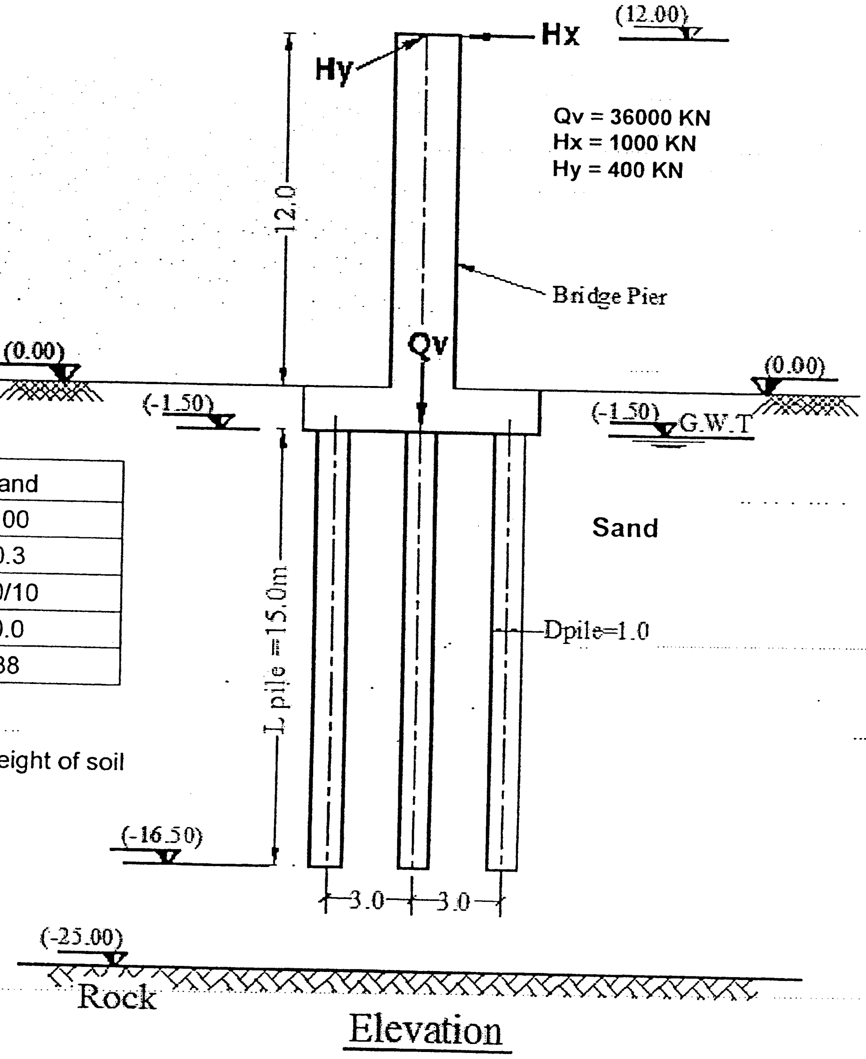
iii. Determine the vertical loads taken by piles no. P1, P2 and P3.

iv. Determine the factor of safety of piles no. P1, P2 and P3 using the following data taken from a pile load test on a nonworking pile:

a) The average ultimate pile skin friction along the pile shaft = 180 kPa

b) The ultimate pile base resistance = 3000 kPa.

v. Comment on the results of point (iv).

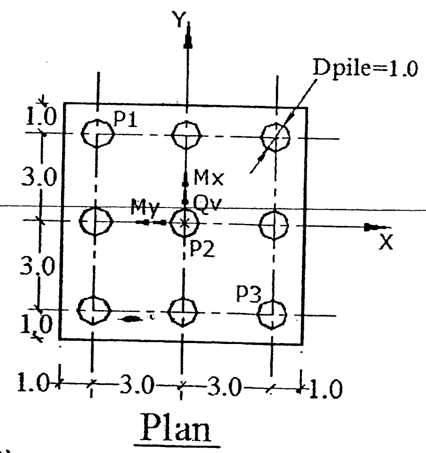


Elevation

Soil Parameters

Soil parameter	Sand
E [MN/m²]	100
ν [-]	0.3
γ / γ´ [kN/m³]	20/10
c´ [kN/m²]	0.0
φ´ [°]	38

E = Primary loading stiffness
ν = Poisson's ratio
γ / γ´ = Total / Effective unit weight of soil
c´ = Cohesion
φ´ = Angle of internal friction



Plan

Figure (3)

Question 3 (15 MARKS)

The R.C. combined footing shown in Figure (4.a) is 1.50 x 6.00 m, and carries two columns 3.00 m center to center. Each column is subjected to N vertical load. The footing is divided into 6 elements. The footing thickness is 100 cm. The expected settlement profile below the footing due to the columns loads is shown in Figure (4.b). It is required to determine:

i. The contact stress under the footing assuming the soil is elastic, homogenous, isotropic and semi-infinite. (C_o=1.33, C_1=0.52, C_2=0.30, C_3=0.20, C_4=0.16, C_5=0.12), E_c= 2000 kN/cm^2, E_s = 20000 kN/m^2.

ii. The Value of N.

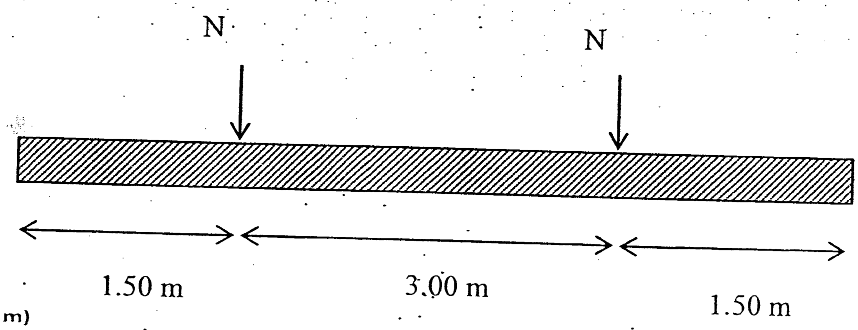


Figure (4.a)

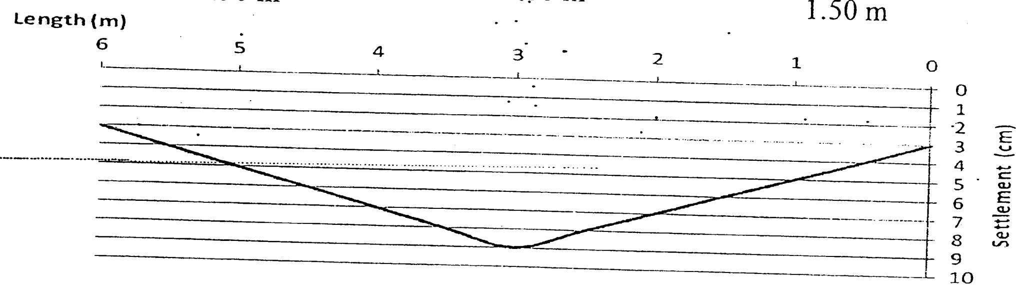


Figure (4.b) "settlement profile"

Question 4 (25 MARKS)

4.1 State briefly **using neat sketches**:

i. The main zones of earth fill dams.
ii. The laboratory tests and field tests required for controlling the construction of the dam.
iii. The main field instrumentation for main zones of the dam **in operation stage** (مرحلة التشغيل) and the purpose of it.

4.2 For the earth dam shown in Figure (5), it is required to:

i. Draw the flow net and determine the rate of seepage.
ii. Show graphically the pore water pressure distribution over the impervious foundation layer.
iii. Suggest measures to reduce the rate of seepage through the dam and determine the rate of seepage.

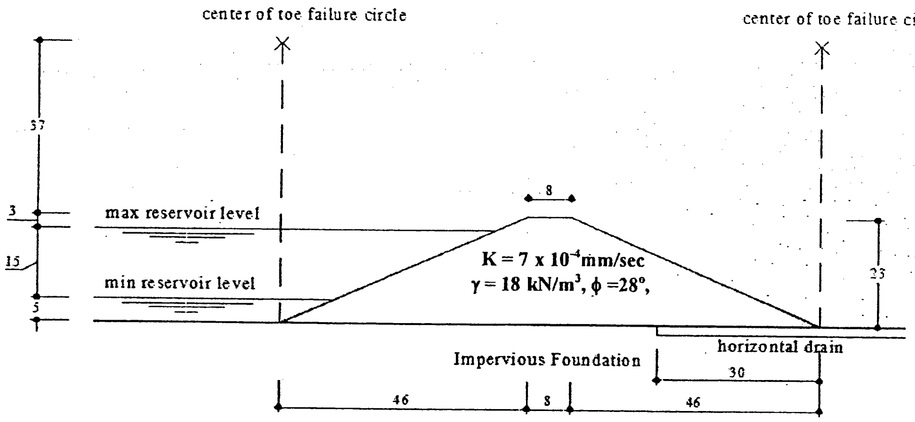


Figure (5)

Question 5 (20 MARKS)

Draw **neat sketches** to illustrate each of the following:

i. Development of ground surface settlement along a longitudinal section during the construction of a tunnel.

ii. Comparison between stability of the tunnel face using Open Face TBM with Compressed Air or Bentonite Slurry (BS) TBM.

iii. Two different types of tunnel lining for soft ground tunnels.

iv. Effect of lining pressure on the settlement trough of a tunnel constructed in a clayey soil.

Question 6 (30 MARKS)

6.1 Draw neat sketches to illustrate each of the following:

i. Details of connection between a tieback anchor and a waling beam for tangent pile wall.

ii. Details of connection between an RC roof slab and a diaphragm wall.

6.2 Figure (6) shows a **cantilever secant pile wall** that is planned to be installed during a project of widening a water canal section. The secant piles consist of R.C. pile 0.8 m in diameter, plastic concrete pile 0.6 m in diameter, with an overlap of 0.15 m. Considering the most critical condition of the water table level on the excavation side, it is required to:

i. Estimate the wall safe penetration depth.

ii. Determine the maximum bending moment per each R C. pile.

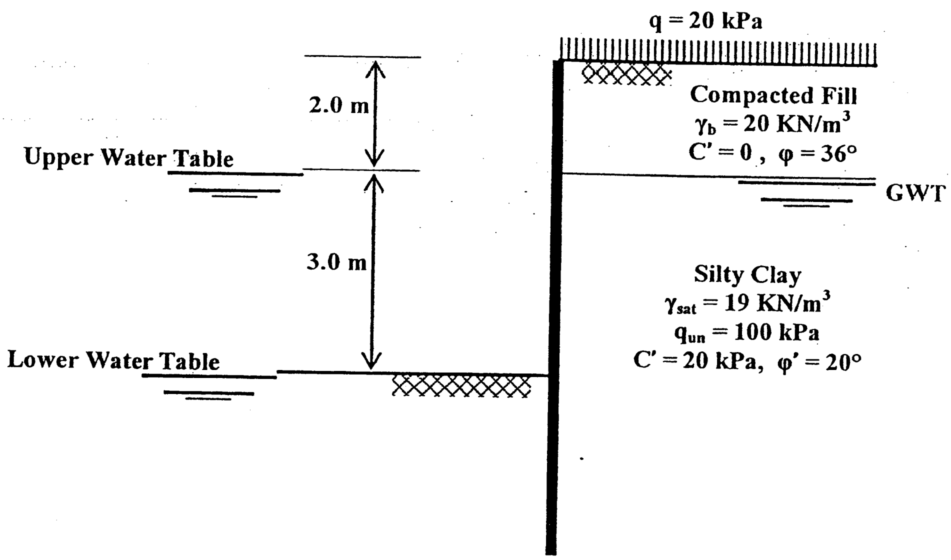


Figure (6)

☺ ☺

BEST WISHES

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

STRUCTURAL ENGINEERING DEPARTMENT

Fourth Year Civil

January, 2012 *Time : 3.00 Hrs*

Foundation Engineering

The exam consists of *six* questions in *four* pages. Total Marks = 140 1/5

Reasonably assume any missing data.

Question 1

A) Compare between the modulus of subgrade reaction and the elastic modulus of soil.

B) For the two columns shown in Figure (1), suggest a suitable type of shallow foundation, then give a complete design of the suggested foundation system (dimensions and reinforcement). Thickness of plain concrete footing is 25 cm, and the allowable net soil bearing capacity is 12 ton/m^2. Draw neat sketches showing concrete dimensions and reinforcement details in plan and elevation, (scale 1 : 50).

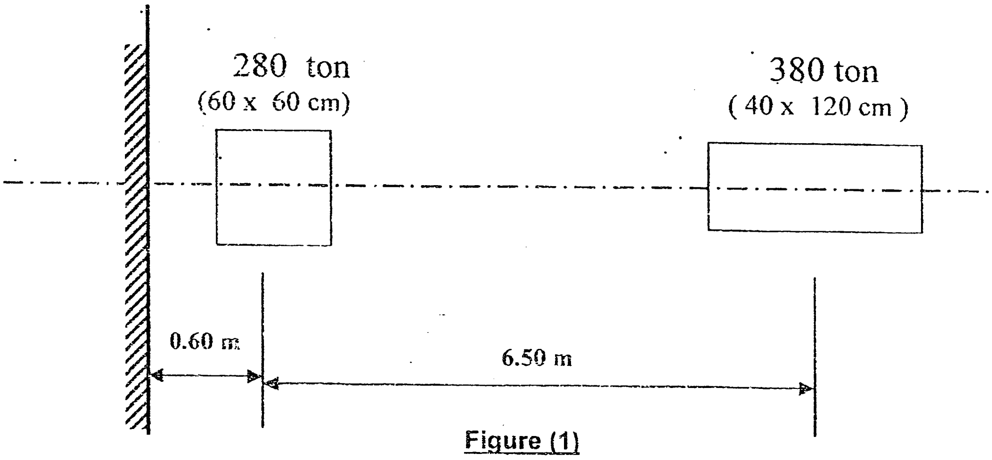


Figure (1)

Data :

Materials: Concrete f_{cu} = 300 kg/cm^2 , Steel 40/60 f_y = 4000 kg/cm2

Working stress: f_c=100 kg/cm^2, f_s =2200 kg/cm^2, q_c=7 kg/cm2, q_{cp}=10 kg/cm^2, local bond stress = 12 kg/cm^2

Ultimate stress: qcu = 9 kg/cm2, qcpu=14.5 kg/cm2, qbu= 18 kg/cm2

C_1 min. = 3.0 , j = 0.74

C_1 = 3.5 , j = 0.78

C_1 = 4.0 , j = 0.80

C_1 = 4.85 , j = 0.826

$d = C_1 \left(M_u / (f_{cu} . b) \right)^{1/2}$

$As = M_u / f_y . d . j$

Area of different reinforcement steel bars:

Φ12: area = 1.13 cm^2 ; Φ16: area = 2.00 cm^2 ; Φ18: area = 2.84 cm^2 ; Φ20: area = 3.14 cm^2 ; Φ22: area = 3.80 cm^2 ; Φ25: area = 4.91 cm^2

Question 2

The R.C. strip footing shown in Figure (2) is 2.0 x 6.0 meters and carries two columns 3.0 meters center to center. Each column is subjected to: N = 1000 kN and M = 50 kN.m at opposite directions. The footing is divided into 6 elements. It is required to:

a) Determine the contact stress below the footing on the basis of **Winkler** assumptions. (K_{so} = 2500 kN/m^3, thickness of footing is 120 cm).
b) Determine the contact stress under the footing, assuming the soil to be elastic, homogenous, isotropic and semi-infinite. (C_0=1.33, C_1=0.52, C_2=0.30, C_3=0.20, C_4=0.16, C_5=0.12), E_c= 2000 kN/cm^2, E_s=1200 kN/m^2, thickness of footing is120 cm.
c) Compare between the two solutions and explain the differences.

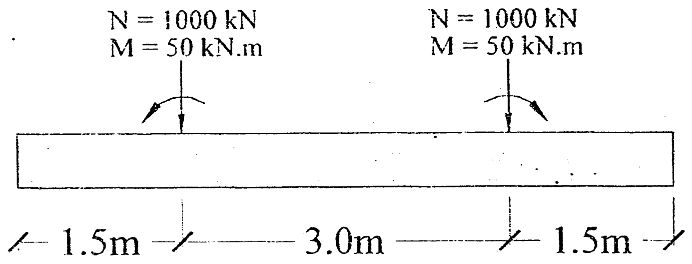


Figure (2)

Question 3

A) Evaluate the following statements (right or wrong) and comment on your evaluation **(Any answer without comments is not accepted):**

1. Bored piles are the most suitable piling technique in city centers beside historical buildings.
2. Bentonite slurry is suitable to be used to stabilize the drilling hole during construction of large diameter bored piles in sandy soil.
3. Static pile load tests should be performed at least on 50% of working piles.
4. Mobilization of more than 80% of pile skin friction needs large settlement.
5. In a pile group under tension loads, the own weight of soil between the piles can govern the pullout resistance of the pile group.
6. In a pile group that is connected with a rigid pile cap and subjected to horizontal load, the front piles have smaller load than the rear piles.

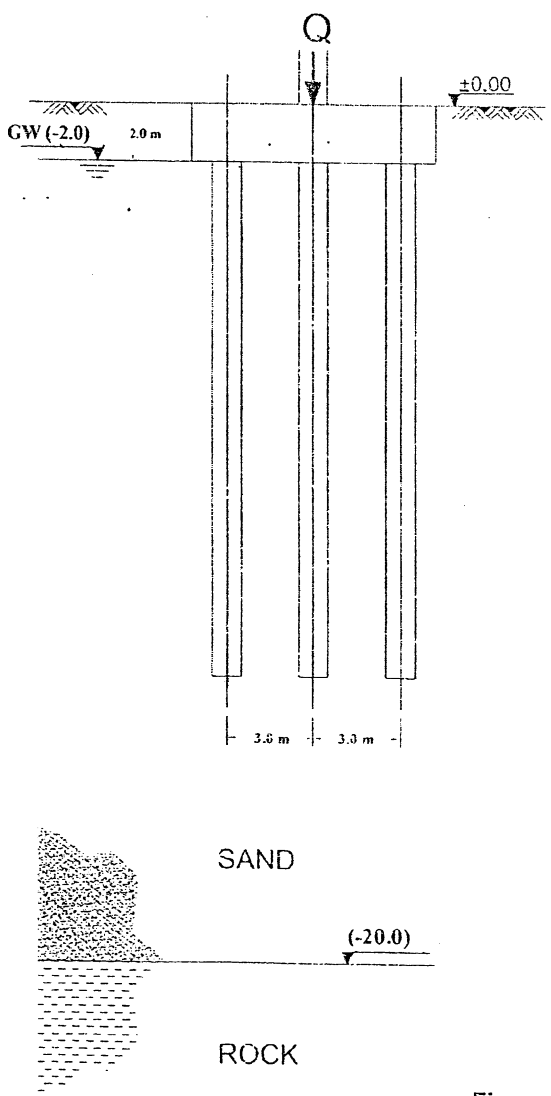
B) Results of geotechnical investigation at a site showed that the soil profile, as shown in Figure (3), consists of a thick layer of very dense sand down to 20.0 m followed by rock formations. A bridge pier has working load (dead and live loads including the weight of the pile cap) of 40500 kN is to be founded on large diameter bored piles with pile diameter of 1.20 m in the sand layer. The pile length is 15 m. The foundation depth is just at the ground water table that lies 2.0 m below ground surface. Nine piles were arranged below the pile cap, as shown in Figure (3). The following are required:

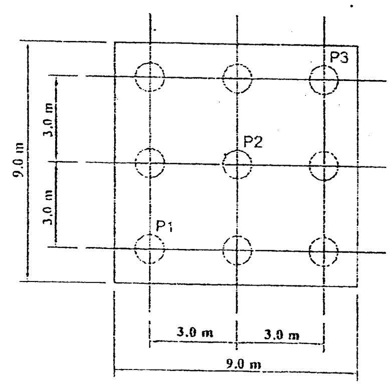
1. Calculate the settlement of the pile group.
2. If the settlement of the single pile under a working load of 4500 kN is 8 mm, calculate the pile group action.

3. If the applied working loads on the pile cap are as follows:
   $Q = 40500.0$ kN
   $M_x = 54000.0$ kNm
   $M_y = 45000.0$ kNm
   Q: dead loads including the weight of the pile cap, live loads and wind loads
   Determine the loads taken by piles No. P1, P2 and P3.
4. Determine the factor of safety of piles No. P1, P2 and P3 under the above mentioned loading conditions (in item c) using following data taken from pile load test on a nonworking pile

   The average ultimate pile skin friction along pile shaft = 240 kPa

   The ultimate pile base resistance = 5000 kPa





Soil Parameters:

Soil parameter		Sand
E	[MN/m^2]	120
ν	[-]	0.3
γ / γ'	[kN/m^3]	20/10
c'	[kN/m^2]	0.0
φ'	[°]	38

E Primary loading stiffness
γ / γ' Total / Effective unit weight of soil
c' Cohesion
φ' Angle of internal friction

Figure (3)

Question 4

Draw neat sketches to illustrate each of the following:

a) Distribution of stresses around a shallow unlined tunnel constructed through dry elastic soil having $K_o < 1$.

b) Comparison between stability of the tunnel face using Bentonite Slurry (BS) TBM or Earth Pressure Balanced (EPB) TBM.

c) Effect of each of the following on the ground settlement trough above a tunnel:
   - i. Depth of the tunnel below ground surface.
   - ii. Magnitude of pressure acting on the lining.

d) Effect of each of the following on the average soil pressure acting on a tunnel lining using ground and support reaction curves:
   - i. Stiffness of the lining.
   - ii. Magnitude of pressure acting on the face of EPB-TBM.

Question 5

The zoned earth fill dam, shown in Figure (4), has six zones. Choose the suitable material for each zone from the following list:

Material	Size (mm)
Sandy Clay	------------
Rock stone	150 to 300
Sound Sand stone	300 to 450
Grouting	------------
Oversize Rock	600 (max size)
Crushed Weathered Sand stone	100 to 200

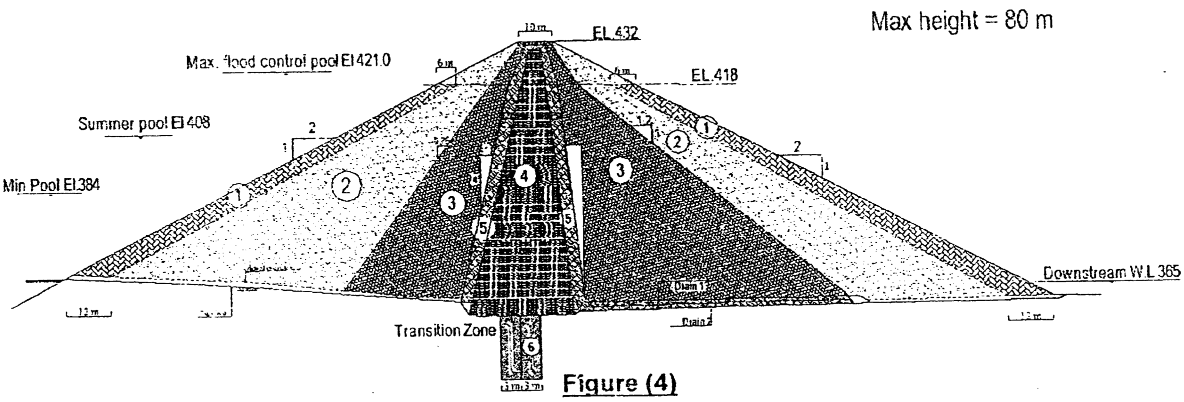


Figure (4)

A) Redraw the dam cross –section in the answering sheet, showing the following:
   - i) Choice for each zone in term of geotechnical design of the dam from the listed material.
   - ii) For each zone, the required instrumentation to check the validity of the dam design.

B) State briefly **using neat sketches** the Laboratory tests and field tests required for controlling the construction of the dam.

Question 6

A) Compare between the following types of in-situ walls:

- Steel sheet pile wall
- Soldier pile wall with timber lagging
- Tangent pile wall
- Diaphragm wall

with respect to:

- Induced Vibration during construction
- Water Tightness
- Lateral Stiffness

B) Figure (5) shows two sides of excavation [side A and side B], which are planned to be supported using **anchored-free secant pile walls** with grouted tiebacks. For the secant piles, the diameter of the R.C. pile is 0.8 m and the diameter of the plastic concrete pile is 0.6 m, with an overlap of 0.15 m. It is required to:

1. Determine the relatively more critical side (which is more critical: wall condition on side A or wall condition on side B?)
2. For the critical side wall:
   i) Estimate the safe penetration depth;
   ii) Calculate the maximum moment per each R.C. pile
   iii) Estimate the tension force in each tieback
   iv) Determine the maximum moment on the wale
   v) Determine the free length of the tieback
   vi) Draw neat sketch showing the connection between the tieback, wale and the wall

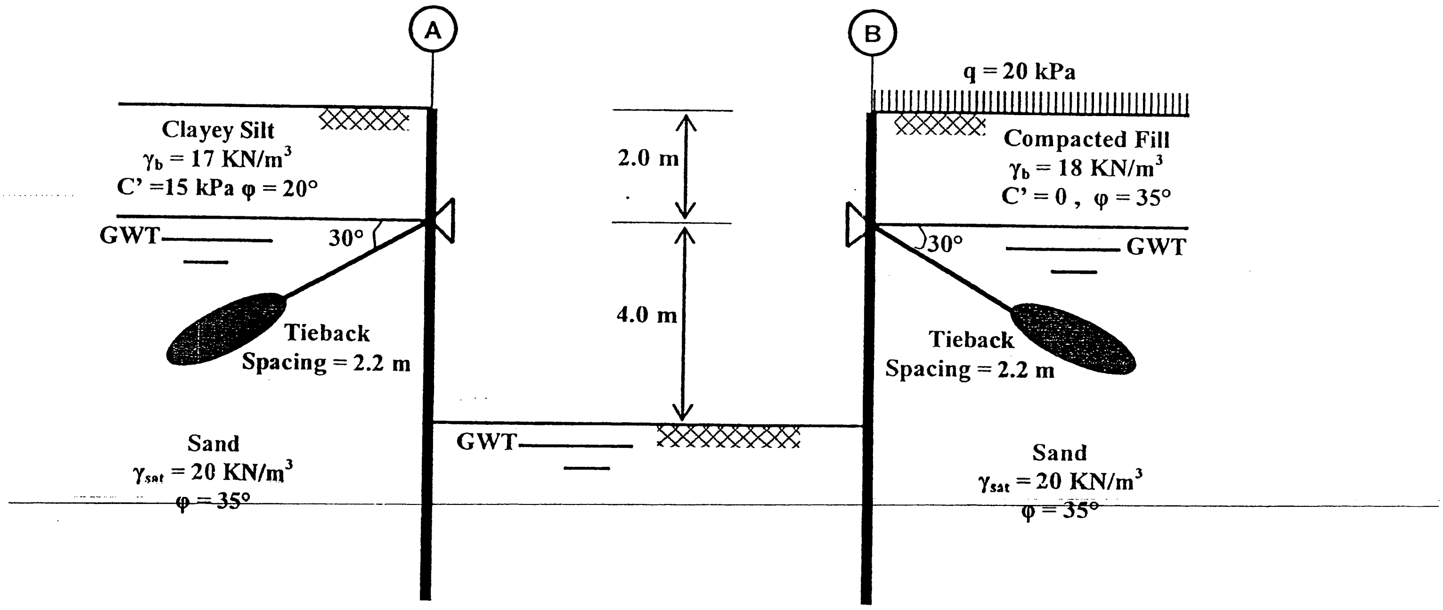


Figure (5)

BEST WISHES

Ain Shams University-Faculty of Engineering
Structural Engineering Department
Geotechnical Engineering & Foundations
4th Year Civil-Structure Division – 2010/2011
Foundation Engineering – CES 451
Time : Three Hours

جامعة عين شمس – كلية الهندسة
قسم الهندسة الإنشائية
الهندسة الجيوتقنية والأساسات
رابعة مدنى – طلبة شعبة الإنشاءات-2011/2011
هندسة الأساسات – مدن 451
الزمن : ثلاث ساعات

The exam consists of **Five Questions in Four Pages.**
Assume any missing data.

Question 1

1-1 Explain briefly, using neat sketches, each of the following:

1. The main principles and applications of floating raft.
2. The main features of modeling a shallow foundation using the Finite Element Method.
3. The limitations of using the plate load test for estimating the coefficient of subgrade reaction.

1-2 Figure (1) shows an isolated R.C. footing supports a rectangular column (50 x 100 cm). The column is designed to resist two different cases of loading (Case 1 and Case 2). Each case of loading incorporates a normal load and a single temporary moment, as follows:

Case no.	N (KN)	M_x (KN.m)	M_y (KN.m)
1	3000	380	-------
2	3000	-------	400

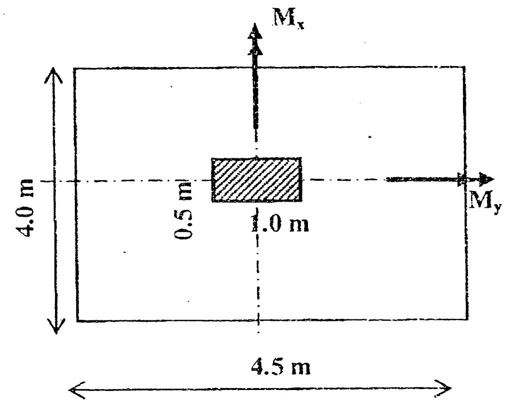


Figure (1)

It is required to:

1. Calculate and draw the diagram of contact pressure below the footing **for each case of loading**.
2. Estimate the minimum factor of safety against bearing capacity failure **in each case of loading**, if the value of the ultimate bearing capacity of the subsoil is 400 kPa.
3. Design the isolated R.C. footing shown in Figure (1) **considering only the case of loading no. 1** (full design is required).
4. Draw the details of the designed footing in both plan and cross sectional elevation using scale (1:50).

Data:

- R.C. footing dimensions: {L_{RC} = 4.5 m ; B_{RC} = 4.0 m}
- t_{PC} = 15 cm
- f_{cu} = 30 N/mm^2 ; f_y = 360 N/mm^2
- Cross sectional area of reinforcing steel bars:

Steel bar diameter	Cross sectional area (mm^2)	Steel bar diameter	Cross sectional area (mm^2)
Φ10	78.5	Φ18	254.5
Φ12	113.1	Φ20	314.2
Φ16	201	Φ25	490.9

Question 2

Figure (2) shows the subsurface soil profile at a site and the geotechnical parameters of the soil layers in that site. Groups of driven piles (50 cm in diameter and 15 m long) were proposed to support a bridge foundation in this site. The foundation depth of the pile cap is 3 m below the ground surface.

i) Calculate the allowable pile compression load, applying a factor of safety of 3.0.
ii) Determine the required number of piles if the pier load is Q_v = 12000 kN.
iii) Draw the pile cap with arrangement of the estimated number of piles beneath it.
iv) Calculate the pile group settlement,
v) Calculate the pile group action assuming that the settlement of the single pile, under its working load, is 1% of the pile diameter.
vi) Re-calculate the required number of piles if the column loads are as follows:

Vertical normal load	Q_v = 12000 kN,
Moments	M_x = 4000 kN.m

vii) Arrange the required number of piles and check the factor of safety of the maximum loaded pile.
viii) Check the horizontal force distribution among the pile group piles under following force combination :

Vertical normal load	Q_v = 12000 kN,
Moments	M_x = 4000 kN.m
Horizontal force	H_y = 1500 kN

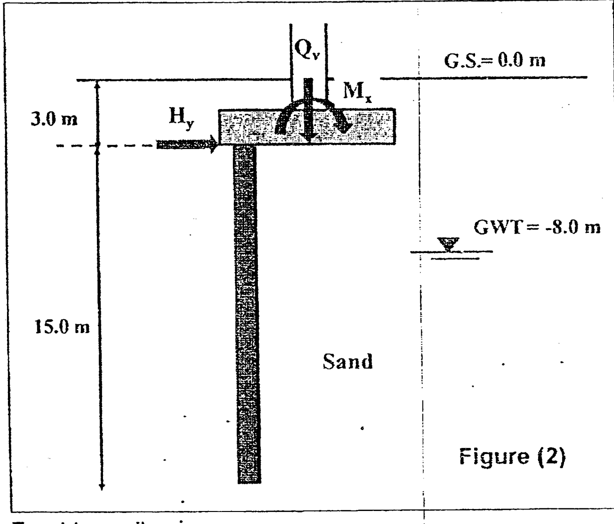


Figure (2)

Soil Parameters

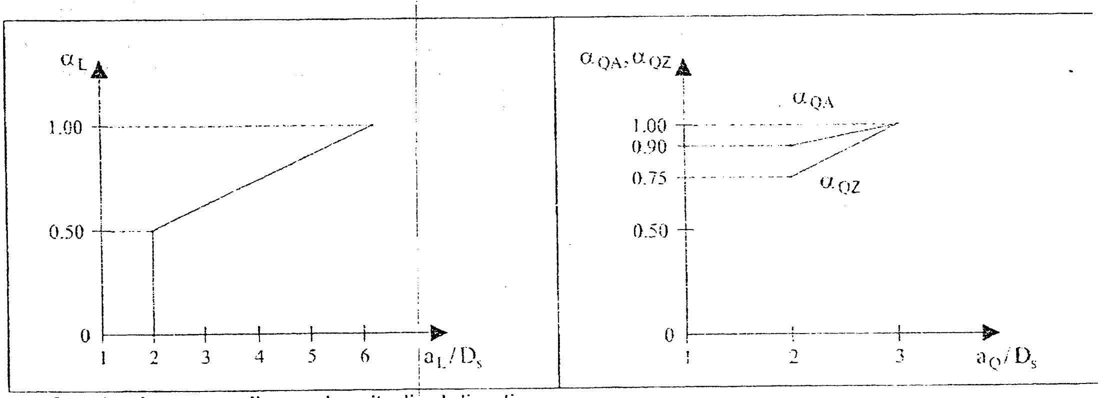
Soil parameter		Sand
E	[MN/m2]	60
ν	[-]	0.3
γ / γ′	[kN/m³]	20/10
c′	[kN/m²]	0.0
φ′	[°]	35

E	Soil deformation modulus
ν	Poisson's ratio
γ / γ′	Total / Effective unit weight of soil
c′	Cohesion
φ′	Angle of internal friction

E concrete = 30000 MPa

For driven piles:
K_{HC} = 1.0
δ = ¾ φ
N_q = 75

$$Q_{ult} = P_b\, N_q\, \pi\, R^2 + \sum_{H=0}^{H=L} K_{HC}\, P_o\, (\tan\delta)\, 2\,\pi\, R\, \Delta H$$



a_L : Spacing between piles on longitudinal direction
a_Q: spacing between piles in transverse direction
Please assume any missing data reasonably

Question 3

3-1 Using neat sketches, propose a connection between the following:

i) Secant pile wall and horizontal tie rods.
ii) Diaphragm wall and inclined grouted anchors.
iii) Soldier piles with timber lagging and horizontal struts.

3-2 For the cantilever tangent pile wall shown on Figure (3):

i) Calculate the safe penetration depth.
ii) Determine the maximum bending moment assuming the pile diameter is 0.9 m.
iii) Using neat sketches, **without further calculations,** discuss the different alternative statical systems that can be used to optimize the wall design if "h" was increased to 8 m.

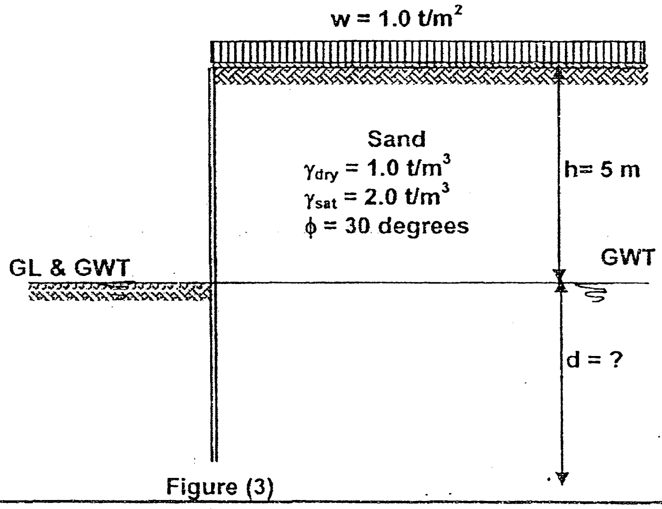


Figure (3)

Question 4

4-1 For the earth dam shown in Figure(4), it is required to:

i) Draw the flow net and determine the rate of seepage.
ii) Show graphically the pore water pressure distribution over the impervious foundation layer.
iii) Determine the factor of safety against sliding assuming that $c_a = 0.8$ c and $\delta = 0.75\ \phi$.

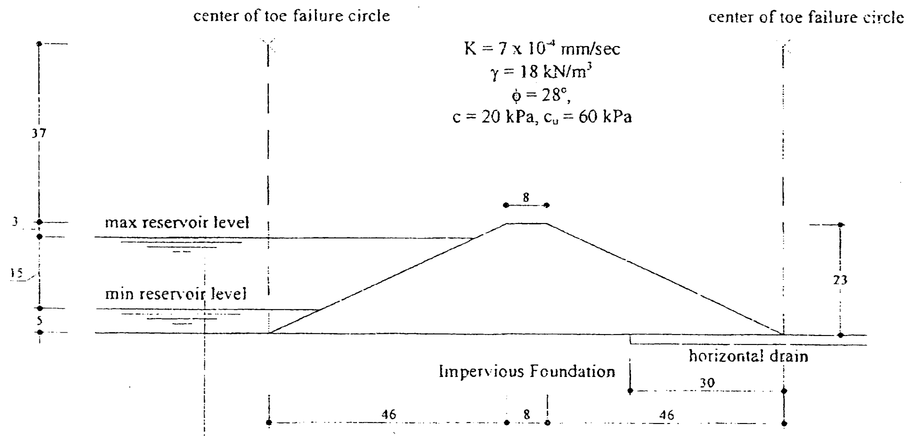


Figure (4)

4-2 The zoned earth fill dam shown in Figure (5) has six zones. Choose the suitable material for each zone from the following list:

Material	Size (mm)
Sandy Clay	----------
Rock stone	150 to 300
Sound Sand stone	300 to 450
Grouting	----------
Oversize Rock	600 (max size)
Crushed Weathered Sand stone	100 to 200

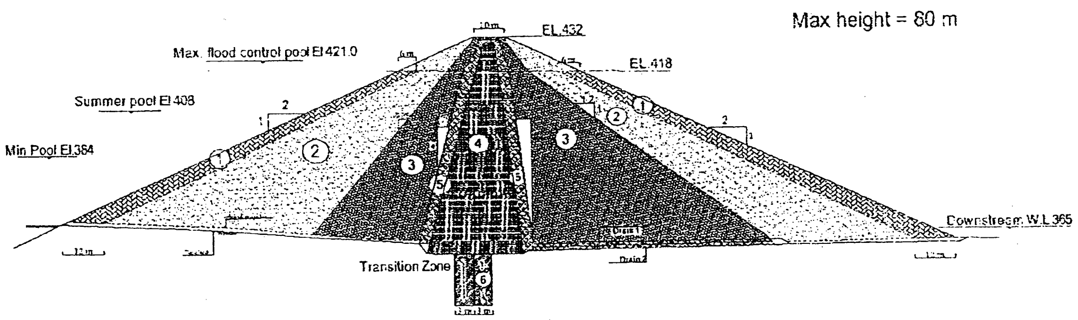


Figure (5)

Redraw the dam cross –section in the answer sheet, showing the following:

i) Choice for each zone in term of geotechnical design of the dam from the listed material.
ii) For each zone, the required instrumentation to check the validity of the dam design.

Question 5

5.1 Draw neat sketches to illustrate each of the following:

i) Stability of tunnel face when using bentonite slurry TBM of Cairo Metro tunnels.
ii) Details of the *Tail seal* of a bentonite slurry TBM and its role on reduction of ground loss in Cairo Tunnels.
iii) Use Ground Reaction Curves of the Ancient Egyptian tunnels in Luxor and of Cairo Metro tunnels.

5.2 Sketch the combined settlement trough above two parallel tunnels for the following Cases:

i) The two tunnels have the same diameter and depth below ground surface with large distance between their centerlines.
ii) The two tunnels have the same diameter and depth below ground surface with small distance between their centerlines.
iii) The two tunnels have different diameters and the same depth below ground surface with small distance between their centerlines.

BEST WISHES

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Ain Shams University-Faculty of Engineering
Structural Engineering Department
Geotechnical Engineering & Foundations
4th Year Civil-Structure Division – 2009/2010
Foundation Engineering – CES 451
Time : Three Hours

ين شمس – كلية الهندسة
سة الإنشائية
الجيوتقنية والأساسات
مدني – طلبة شعبة الإنشاءات –
2010,
الأساسات – مدن 451
ثلاث ساعات :

The exam consists of **Five Questions in Four Pages.**
Assume any missing data.

Question 1

1-1 It is required to design an isolated footing assuming equal contact stress. The footing supports a rectangular column 40 cm X 90 cm carrying net working load 190 ton, and a working <u>permanent</u> moment 80 m.t. The net allowable bearing capacity of soil is 18 t/m^2. The plain concrete footing is 30 cm in thickness.

<u>Materials :</u>
Concrete f_{cu} = 300 kg/cm^2 , **Steel 40/60** f_y = 4000 kg/cm^2,
Working stress: f_c = 100 kg/cm^2 , f_s = 2200 kg/cm^2 ,
q_c = 7 kg/cm^2 , q_{cp} = 10 kg/cm^2, local bond stress = 12 kg/cm^2
Ultimate stress: q_{cu} = 9 kg/cm^2 q_{cpu} = 14.5 kg/cm^2 , q_{bu} = 18 kg/cm^2

C1 min. = 3.00 , j = 0.740
C1 = 3.50 , j = 0.780
C1 = 4.00 , j = 0.800
C1 = 4.85 , j = 0.826

Draw neat sketches showing concrete dimensions and reinforcement details.

1-2 For the two columns shown in Figure 1, suggest a suitable type of shallow foundation, and sketch the concrete dimensions and reinforcement details. q_{all} = 10 t/m^2.

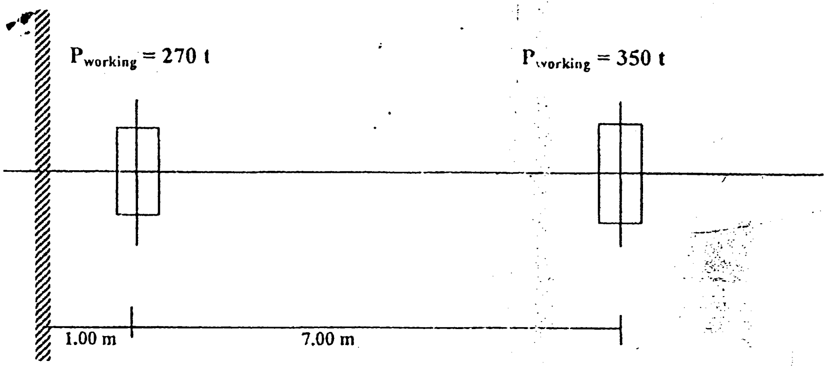


Figure 1

Question 2

2-1 Evaluate the following statements (right or wrong) and comment on your evaluation ***(Any answer without comments is not accepted)***:

a) Driven piles are the most suitable piling technique in city centers beside historical buildings.
b) Bentonite slurry is used to stabilize the drilling hole during construction of large diameter bored piles in sandy soil.
c) Low strain Integrity tests can be used to estimate the bearing capacity of piles.
d) Pile load tests (static and/or dynamic) should be performed at least on 50% of working piles.
e) Pile skin friction is fully mobilized at small settlement.
f) The structural loads are carried completely by the piles of a piled raft foundation.
g) In a pile group under tension loads, the own weight of soil between the piles can govern the pullout resistance of the pile group.
h) In a pile group that is connected with a rigid pile cap and subjected to horizontal load, the horizontal load is distributed uniformly among all piles in the pile group.

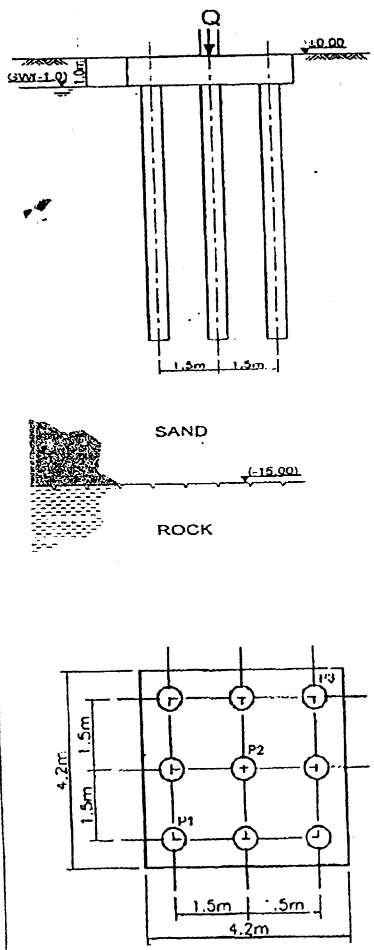
2-2 Results of geotechnical investigation at a site showed that the soil profile, as shown in Figure 2, consists of a thick layer of medium to dense sand down to 15.0 m followed by rock formations. A column with working load (dead and live loads) of 5000 kN is to be founded on driven piles with pile diameter 0.5 m in the sand layer. The pile length is 9 m. The foundation depth is just at the ground water table that lies 1.0 m below ground surface. Nine piles were arranged below the pile cap as shown in the Figure 2. The following is required:

a) Calculate the settlement of the pile group.

b) If the settlement of the single pile under working loads is 3 mm, calculate the pile group action.

c) If the applied working loads on the pile cap are as follows:
$Q = 3600$ kN
$M_x = 2700$ kNm
$M_y = 1800$ kNm
Determine the loads taken by piles No. P1, P2 and P3.

d) Determine the factor of safety of piles No. P1, P2 and P3 under the above mentioned loading condition. Comment on the results.



Soil Parameters:

Soil parameter		Sand
E	[MN/m²]	50
ν	[-]	0.3
γ / γ'	[kN/m³]	20/10
c'	[kN/m²]	0.0
φ'	[°]	33

E Primary loading stiffness
ν Unloading/reloading Poisson's ratio
γ / γ' Total / Effective unit weight of soil
c' Cohesion
φ' Angle of internal friction

Pile diameter D = 0.5 m
Pile length L = 9 m
$E_{concrete}$ = 30000 MPa

For driven piles:
$K_{HC} = 1.0$
$\delta = \frac{3}{4}\varphi$
$N_q = 60$

$$Q_{ult} = P_b N_q \pi R^2 + \sum_{H=0}^{H=L} K_{HC} P_o (\tan\delta)\, 2\pi R\, \Delta H$$

Figure 2

Question 3

3-1 Using a neat sketch, illustrate an empirical method to determine the minimum length of a tie rod (connected to a deadman) to laterally support a steel sheet pile wall. Explain how the factor of safety of the tie length can be checked using the overall block stability.

3-2 Figure 3 shows an anchored fixed earth supported Secant Pile Wall. Each R.C. pile is 80 cm in diameter and each plastic concrete pile is 50 cm in diameter, with 10 cm overlap. The point of zero bending moment in the wall can be assumed at 0.8 m below the dredge line. Ignoring the effect of seepage, the following is required:

a) Calculate the bending moment in the waling beam.
b) Calculate the maximum bending moment in each R.C. pile above the dredge line.
c) Without further calculations, draw a neat sketch (in plan and elevation) to illustrate the connection between the grouted tie back anchor and the wall.

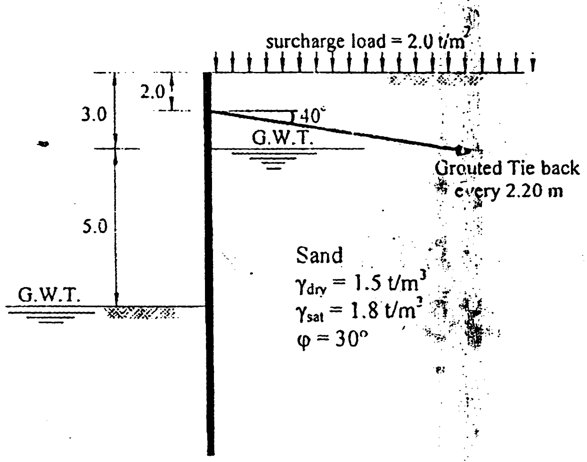


Figure 3

Question 4

4-1 For the earth dam shown in Figure 4, it is required to:

a) Draw the flow net and determine the rate of seepage.
b) Show graphically the pore water pressure distribution over the impervious foundation layer.

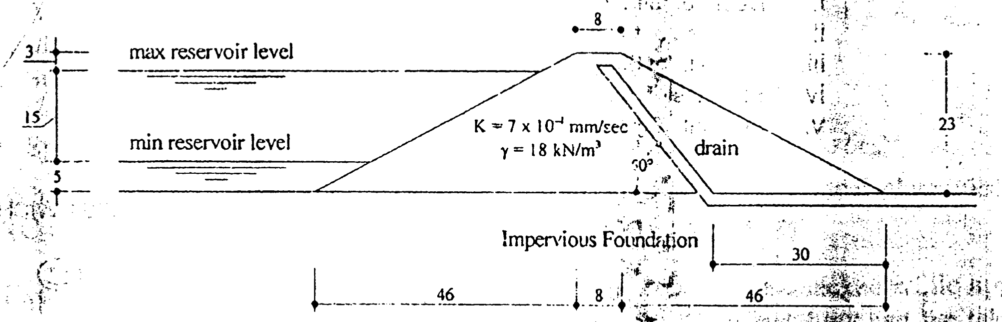


Figure 4

4-2 The zoned earth fill dam shown in Figure 5 has six zones. Choose the suitable material for each zone from the following list:

Material	Size (mm)
Sandy Clay	-----------
Rock stone	150 to 300
Sound Sand stone	300 to 450
Grouting	-------------
Oversize Rock	600 (max size)
Crushed Weathered Sand stone	100 to 200

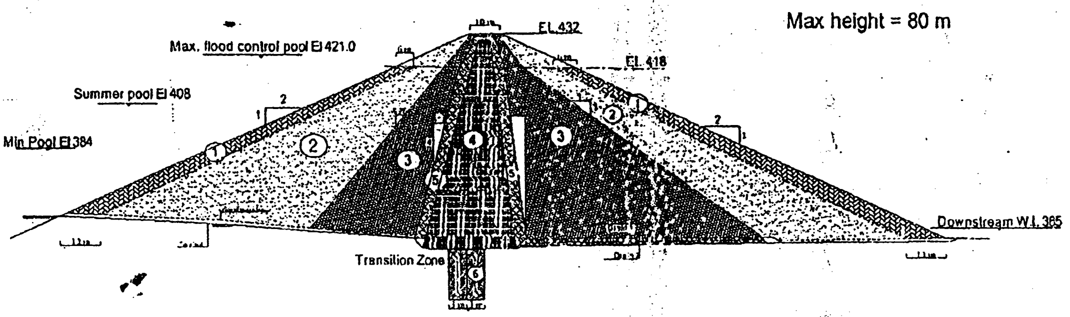


Figure 5

State briefly the main reasons behind your choice for each zone in term of geotechnical design of the dam and the precautions (الاحتياطات) that should be followed for each zone during the construction of the dam.

Question 5

Draw neat sketches to illustrate each of the following:

a) A bentonite slurry TBM in elevation, showing the following parts: *(Cutting head, Overcut teeth, Tunnel lining, Advancing hydraulic jacks, and Tail seal)*
b) Combined settlement trough above two parallel twin tunnels.
c) Use Ground Reaction and Support Reaction Curves to illustrate the effect of each of the following on the magnitude of soil pressure acting on tunnel lining:
   i. Depth of the tunnel below ground surface.
   ii. Stiffness of the ground.
   iii. Strength of the ground.
   iv. Stiffness of the lining.
   v. Amount of ground loss before lining activation.

BEST WISHES

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Ain Shams University-Faculty of Engineering
Structural Engineering Department
Geotechnical Engineering and Foundations
4^{th} Year Civil-Structure Division – 2008/2009
Foundation Engineering – CES 451
Time : Three Hours

قسم الهندسة الإنشائية
الهندسة الجيوتقنية والأساسات
رابعة مدني – طلبة شعبة الإنشاءات – 2009/2008
هندسة الأساسات – هدن 451
الزمن : ثلاث ساعات

The Exam Consists of Six Questions In Four Pages.
Use neat sketches to illustrate your answer.
Assume any missing data:

QUESTION 1

1.a. An isolated footing is supporting (1.20 X 1.20 m) column. The column is carrying a net working load of 1500 ton. A complete design and drawings of concrete dimensions and reinforcement are required for the isolated footing (Scale 1:50 or 1:100 is suggested) based on the following data:

- Net allowable bearing capacity = 24 ton/ m^2.
- Plain concrete footing thickness = 40 cm.
- Reinforced concrete footing data:

Materials:
Concrete f_{cu} = 300 kg/cm^2 ,
Steel 40/60 f_y = 4000 kg/cm^2

Working stress:
f_c = 90 kg/cm^2 , f_s = 2000 kg/cm^2 ,
q_c = 6 kg/cm^2 , q_{cp} = 8 kg/cm^2 , and local bond stress = 10 kg/cm^2 .

Ultimate stress:
q_{cu} = 9 kg/cm^2 , q_{cpu} = 12.5 kg/cm^2 , and q_{bu} = 15 kg/cm^2 .

1.b. For the two columns shown in Figure 1, suggest a suitable type of shallow foundation. Explain the statical system and draw the concrete dimensions. Net allowable bearing capacity of soil is120.0 kN/m^2 .**Without further calculations sketch the reinforcements arrangment**

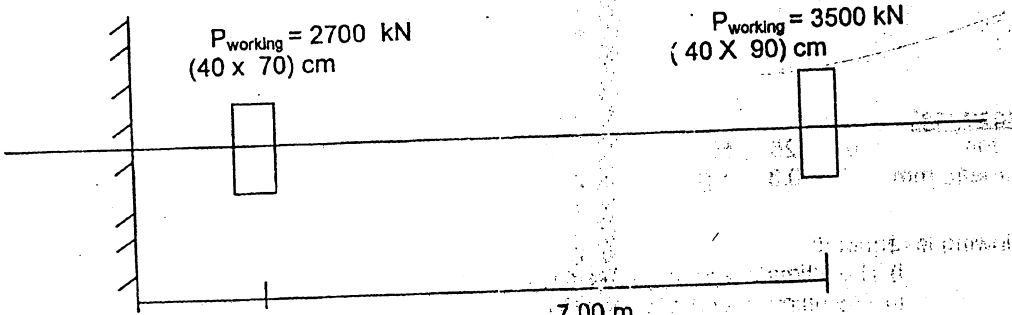


Figure 1

1.c. Resolve problem 1.b using pile caps and 60 cm diameter piles. The allowable pile working load is 100 ton. Draw the pile arrangement, and the pile cap concrete dimensions. **Without further calculations sketch the reinforcements arrangment**

Ain Shams University-Faculty of Engineering
Structural Engineering Department
Geotechnical Engineering and Foundations
4th Year Civil-Structure Division – 2008/2009
Foundation Engineering – CES 451
Time : Three Hours

امعة عين شمس – كلية الهندسة
م الهندسة الإنشائية
هندسة الجيوتقنية والأساسـات
ابعة مدنى – طلبة شعبة الإنشاءات – 2009/2008
دسة الأساسات – هدن 451
من : ثلاث ساعات

QUESTION 2

2.a. For the soil profile shown in Figure (2), it is decided to construct (CFA) pile foundation; the diameter and length of each pile are 0.5 m and 15 m, respectively. The results of pile load test are as follows:

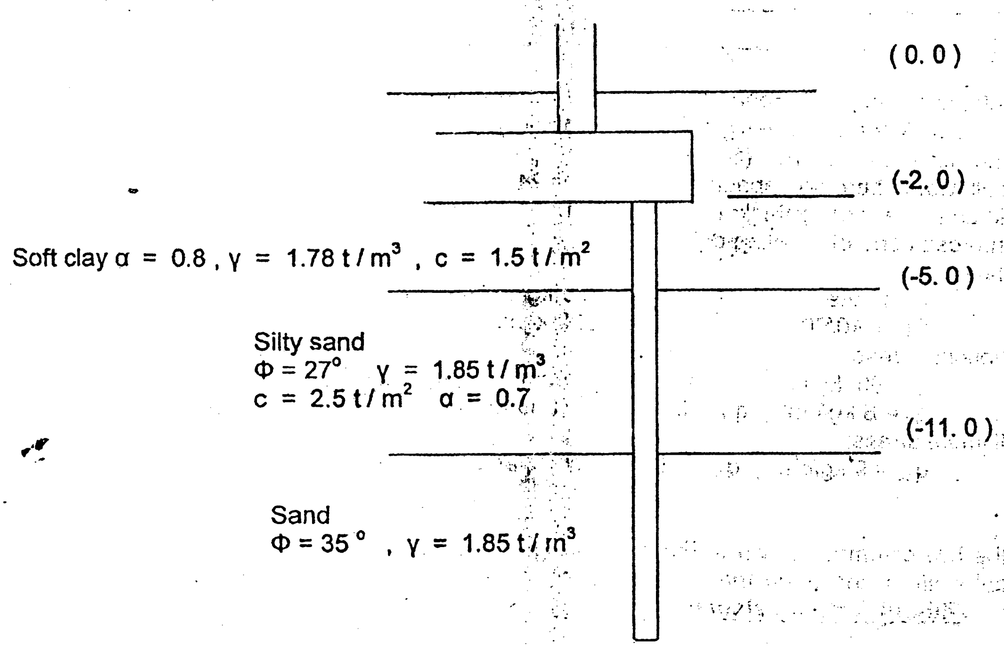


Figure 2

<u>**Pile load test**</u> :

Load, ton	0	25	50	75	100	125	150	175	225	275	0.00
Settlement, mm	0	0.3	1.0	1.7	2.6	3.5	5.0	6.9	15	39	20

The following is required:

i) The ultimate and allowable pile load using the pile load test results.
ii) The ultimate and allowable pile load using the static formula.
(Negative skin friction could be taken into consideration)
iii) Compare between the results of (i) and (ii) and comment.

Φ	Nq
25	15
30	30
35	75
40	150

<u>Data</u>

E_c = 210 t/cm^2.
K_{HC} = 1.0.
δ = ¾ Φ .

2.b. If the above pile is replaced by a driven pile installed using hammer 4.0 ton which falls from 100 cm. Calculate the maximum allowable penetration for the pile in the last 10 blows. (Efficiency of hammering is 0.95 and factor of safety is 3.0, C_c= 3.0 mm, C_p= 4.0 mm, C_q = 3.5 mm)

QUESTION 3

A reinforced concrete footing is designed to carry a masonry wall. The dimensions of the footing are (1.00 wide X 0.60 thick X 9.00 long) m, resting on overconsolidated clay deposit 10 m thickness. The imposed load on the footing is 200KN/m². Use Ohde method to determine the following:

i) The contact pressure distribution.

ii) The settlement profile.

<u>Input Data:</u>

Modulus of elasticity of clay = 20 MN/m².

Modulus of elasticity of R C = 2100 kN/cm².

The footing is divided into six elements.

C_0 = 1.60

$$C_i = \frac{C_0}{\left[1+1.2(i)^{1.4}\right]}$$

QUESTION 4

4.a. Using neat sketches, explain the main factors governing the design of the earth fill dam shown in Figure 3.

4.b. For the earth dam shown in Figure 3, it is required to:

i) Draw the flow net and determine the rate of seepage.

ii) Show graphically the pore water pressure distribution over the impervious foundation layer.

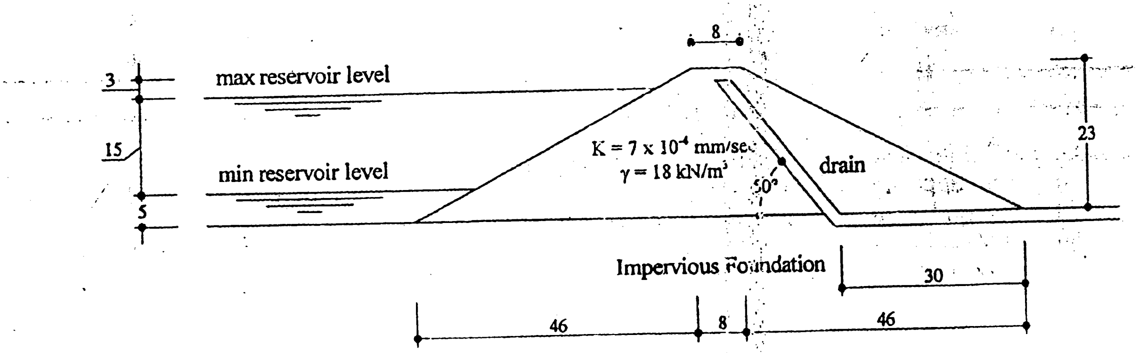


Figure 3

Ain Shams University-Faculty of Engineering
Structural Engineering Department
Geotechnical Engineering and Foundations
4th Year Civil-Structure Division – 2008/2009
Foundation Engineering – CES 451
Time : Three Hours

جامعه عين شمس – كلية الهندسة
قسم الهندسة الإنشائية
الهندسة الجيوتقنية والأساســـات
رابعة مدنى – طلبة شعبة الإنشاءات – 2009/2008
هندسة الأساسات – هدن 451
الزمن : ثلاث ساعات

QUESTION 5

5.a. Describe the advantages and disadvantages of each of the following lateral support systems:

i) Strut.
ii) Grouted anchor.
iii) Tie-back and dead man.

5.b. An anchored fixed earth supported steel sheet pile is shown in Figure (4). Calculate the force in the tie back if it is spaced 2.5 m horizontally for the following cases:

i) The clay is undrained (C_u=55 kN/m^2), and the point of zero moment is 1.5 m depth below the dredge line.
ii) The clay is drained (C'=8 kN/m^2, Φ' = 22^o), and the point of zero moment is 1.0 m depth below the dredge line.
iii) Compare between the results of (i) and (ii) and comment.

No further calculations are required.

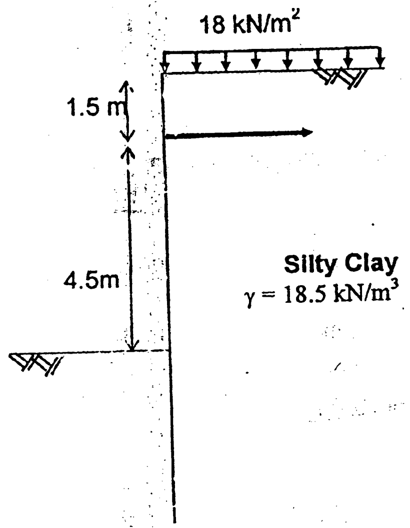


Figure 4

QUESTION 6

Describe each of the following (use neat sketches wherever possible):

i) Two applications of tunnelling in Cairo.
ii) Cut and cover tunnelling using sloped excavation.
iii) Horizontal stresses distribution along a vertical axis passing through a circular tunnel centre just after excavation and before lining activation.

BEST WISHES

Ain Shams University
Faculty of Engineering
January 2007
CES 451: **Foundation Engineering**

4th Year, Civil Engineering
Students of Struct. Eng. Div
Time: 3 hours
End of Term Final Exam

The examination consists of 5 questions in 4 pages.
Answer all questions and make a reasonable assumption of any missing data.
All sketches should be neatly drawn and properly dimensioned.

Question 1

1.a) Draw neat sketches to illustrate each of the following:

i) Classification of shallow foundations.
ii) Different types of raft foundations.

1.b) Design a reinforced concrete isolated footing for an R. C. column 100 cm in diameter. The proposed configuration of the footing is shown in Figure 1. The column is carrying net working load of 850 ton. The net bearing capacity of supporting soil is 12 t/m^2.

Data :

Materials: Concrete f_{cu} = 300 kg/cm^2 , Steel 40/60 f_y = 4000 kg/cm^2

Working stress: fc=100 kg/cm^2, fs =2200 kg/cm^2, qc=7 kg/cm^2, qcp=10 kg/cm^2, local bond stress = 12 kg/cm^2

Ultimate stress: qcu = 9 kg/cm^2, qcpu=14.5 kg/cm^2, qbu= 18 kg/cm^2

C1 min. = 3.0 , j = 0.74
C1 = 3.5 , j = 0.78
C1 = 4.0 , j = 0.80
C1 = 4.85 , j = 0.826

$$d = C_1 \, (M_u \, / \, (f_{cu} \, . \, b))^{1/2}$$
$$As = M_u \, / \, f_y \, . \, d \, . \, j$$

Draw neat sketches showing concrete dimensions and reinforcement details in plan and elevation, (scale 1 : 100). Thickness of plain concrete is 10 cm

Area of different reinforcement steel bars:

Φ12: area = 1.13 cm^2,
Φ16: area = 2.00 cm^2,
Φ18: area = 2.84 cm^2,
Φ20: area = 3.14 cm^2,
Φ22: area = 3.80 cm^2,
Φ25: area = 4.91 cm^2

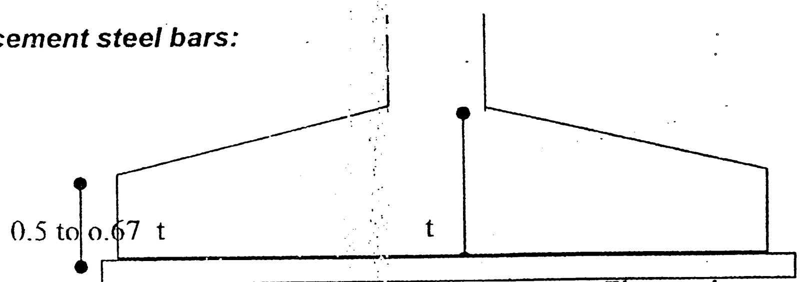


Figure 1

Question 2

2.a) Draw neat sketches to illustrate each of the following:

i) Construction of two different types of bored piles.
ii) Construction of two different types of driven piles.
iii) Settlement of a pile group.
iv) Configuration of the set-up of a pile load test.

2.b) For the two columns shown in Figure 2, suggest a suitable type of pile foundation. Each pile is 50-cm in diameter and carrying a working load of 90 t. Without design calculation, draw sketches in plan and elevation (scale: 1:50) showing the concrete dimensions and reinforcement arrangement. Minimum clear distance between the piles and adjacent property line is 90 cm.

See next page

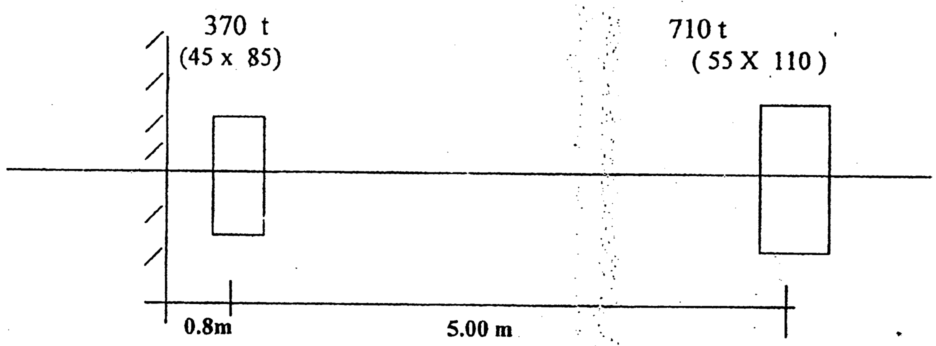


Figure 2

Question 3

It is decided to design the R.C. combined footing shown in Figure 3 considering the soil elasticity. The footing is 1.5 X 5.4 m and carries two columns 2.70 m center to center. Each column is subjected to: N=800 kN, M=60 kN.m. The footing is 100 cm in thickness and can be divided into 6 elements.

The following is required:

(a) Determine the contact stress under the footing using Winkler assumption (Ks_o= 2000 kN/m^3).

(b) Determine the contact stress under the footing assuming the soil is elastic, homogeneous, isotropic and semi-infinite. Use (C_o =1.33, C_1 =0.52, C_2=0.3, C_3 =0.2, C_4 =0.16, C_5 =0.12), E_c = 2000 kN/cm^2 and E_s = 1000 kN/m^2.

(c) Compare between the two solutions and explain the difference.

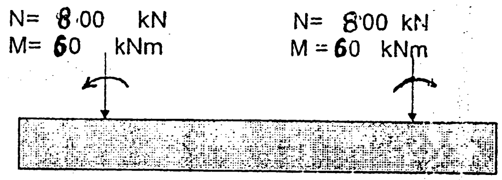


Figure 3

Question 4

4-a) Choose the most appropriate answer for each of the following:

i- Earth dams can be used efficiently on relatively weak foundation conditions due to

a) their relatively steep slopes
b) their relatively gentle slopes
c) the use of clay core
d) their flexible structure

ii- Greater fetches of earth dam reservoirs would usually result in

a) smaller free board requirement
b) greater free board requirement
c) larger core width
d) smaller core width.

iii- The core width in earth dams is usually governed by

a) core material permeability
b) head difference between dam upstream and downstream
c) available compaction equipment.
d) all of the above

iv- Setting a lower limit for the particle size of the material used in the construction of transition zones in embankment dam aims at

a) meeting the minimum filter permeability requirement
b) minimizing erosion of dam upstream slopes
c) minimizing piping of protected soil
d) decreasing seepage loss

v- short term stability analyses for the upstream slopes of rockfill dams are usually carried out using shear parameters obtained from:

a) field vane shear test
b) unconfined triaxial test
c) slow direct shear test
d) quick direct shear test

vi- The highest excess pore pressure in earth dam foundations are usually developed

a) below the dam toe immediately after construction
b) below the dam centerline immediately after construction
c) below the dam centerline at rapid drawdown
d) below the dam toe at rapid drawdown

vii- Prefabricated drains are used in the foundations of earth dams to

a) accelerate excess pore pressure dissipation
b) control seepage flow resulting from the dam reservoir
c) decrease the value of the maximum excess pore pressure
d) all of the above

viii- Stability of earth dam foundation against shear failure is usually assessed using:

a) slope stability analyses with target factor of safety of 3
b) bearing capacity analyses
c) settlement analyses
d) slope stability analyses with target factor of safety of 1.5

ix- Empirical design of earth dam crest width is based on:

a) numerical analyses of case histories
b) slope stability analyses
c) regression analyses of case histories
d) slope stability combined with seepage analyses

x- Rapid draw down in the upstream of embankment dam is usually analyzed assuming:

a) no change in pore pressure outside the dam
b) no change in pore pressure in the dam material
c) significant change in pore pressure in the dam material
d) empty dam reservoir

See next page

4-b) For the earth dam shown in Figure 4, the phereatic line associated with long term seepage through the dam material is presented in addition to the most critical slip surface for the upstream slope. It is required to:

i- Show using neat sketches (without calculation) the design water levels (phereatic lines) both inside and outside the dam body immediately after construction, at full dam operation, and at complete rapid drawdown, knowing that the groundwater table was located at ground surface prior to dam construction.

ii- Explain how the value of the factor of safety can be used to evaluate dam safety (stability).

iii- Calculate the different forces acting on slices A and B during complete rapid drawdown, knowing that the saturated unit weight of soil is about 20 kN/m^3.

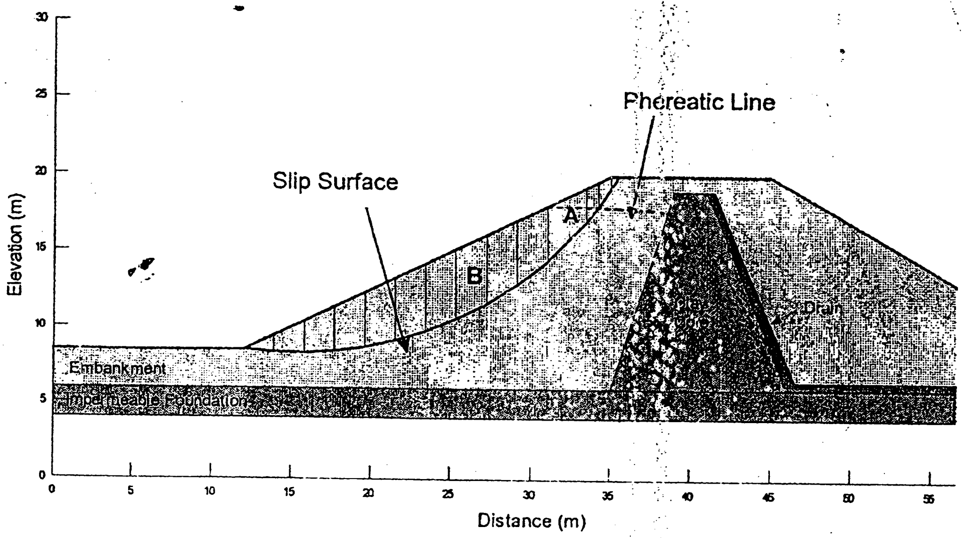


Figure 4

Question 5

a) Describe using neat sketches whenever it is required:

i) Construction of an underground metro station using cut and cover technique.

ii) Tie back anchorage system for retaining structures.

iii) Construction of tunnels using TBM.

b) A cantilever steel sheet pile wall is driven across a water channel to allow for the construction of a new irrigation structure. The water level in this channel ranges between 3.7 to 4.2 m above the bed level. Soil below the bed consists of a thick layer of silty sand (Φ=32°, saturated unit weight = 18.8 kN/m^3). It is required to calculate the maximum bending moment only acting on the sheet pile wall when the water level on one side of the sheet pile wall is lowered to the bed level.

Best Wishes ☺

Ain Shams University
Faculty of Engineering
December 2007
CES 451: Foundation Engineering

4th Year, Civil Engineering
Students of the Structure Div.
Time: 3 hours
End of Term Final Exam

The examination consists of 5 questions in 4 pages.
Answer all questions and make a reasonable assumption of any missing data.
All sketches should be neatly drawn and properly dimensioned.

Question 1

1-a) Draw neat sketches to illustrate each of the following:

i- Different types of shallow foundations.

ii- Types of structures designed using the beam on elastic foundation theory.

1-b) For the group of columns shown in Figures 2(a) and 2(b), suggest a suitable type of shallow foundation in each case. Explain the statical system and sketch the concrete dimensions and reinforcement details using an allowable bearing capacity of soil is120.0 kN/m^2. Scale 1:50 or 1:100 is suggested for the foundations plot.

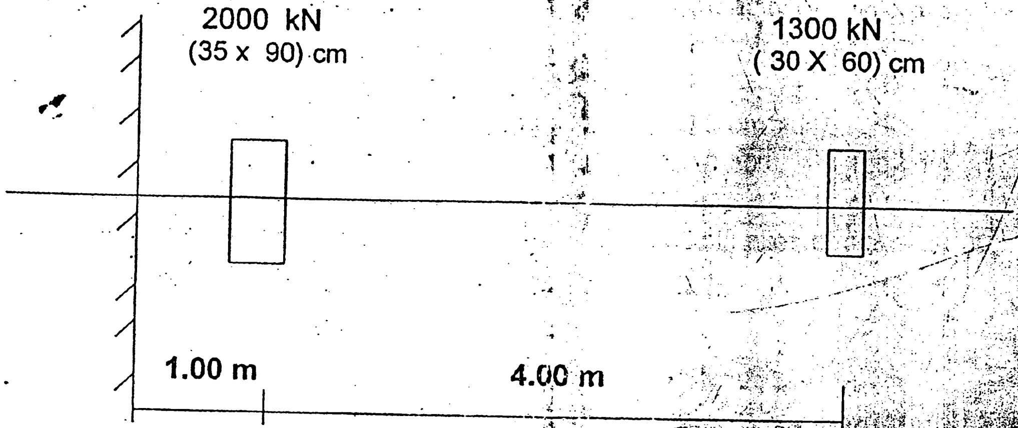


Figure 1-a

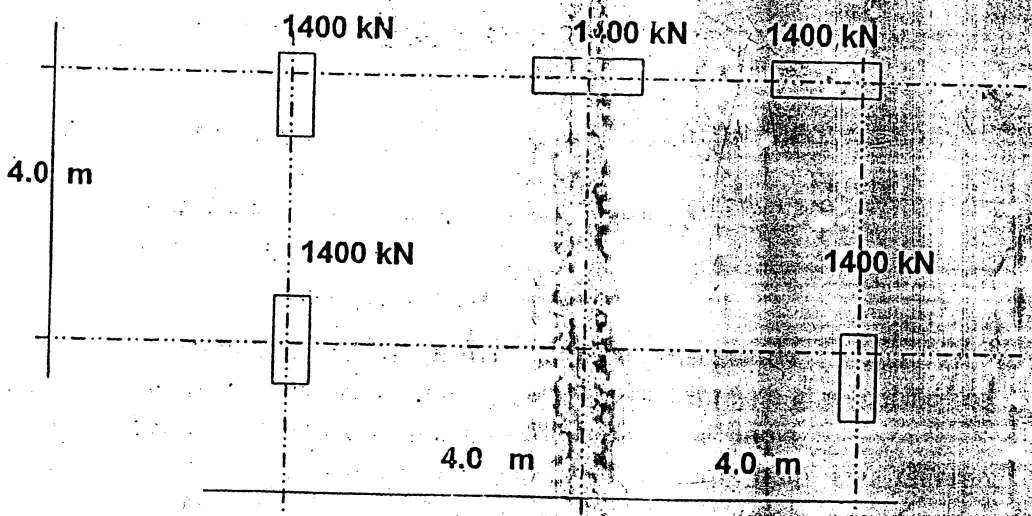


Figure 1-b

Question 2

2-a) Draw neat sketches to illustrate each of the following:

i- Construction of two different types of bored piles.

ii- Determination of pile capacity using dynamic formula.

iii- Configuration of the set-up of a pile load test

2-b) A group of 25 precast piles is driven to a depth of 7.5 m in a silty clay deposit. The piles are square in cross section (25 X 25 cm) and spaced at 0.75 m center to center. The undrained shear strength varies with depth from 34 kN/m^2 at ground level to 111 kN/m^2 at depth of 12 m below that level.

Calculate the followings:

a) The allowable compression and tension capacity of single pile.

b) The allowable load on pile group for the following cases:

- Factor of safety = 2.5.
- Allowable settlement = 25 mm (m_v = 0.8 cm^2/kN).

c (kN/m^2)	0-12.5	12.5 - 25	25-50	50-100	100-200
c_a(kN/m^2)	0-12.5	12.5 - 24	24-37.5	37.5-47.5	47.5-65

2-c) Design (complete design) the pile cap supported by six piles of diameter 60 cm as shown in Figure 2. **See design data in page 4**.

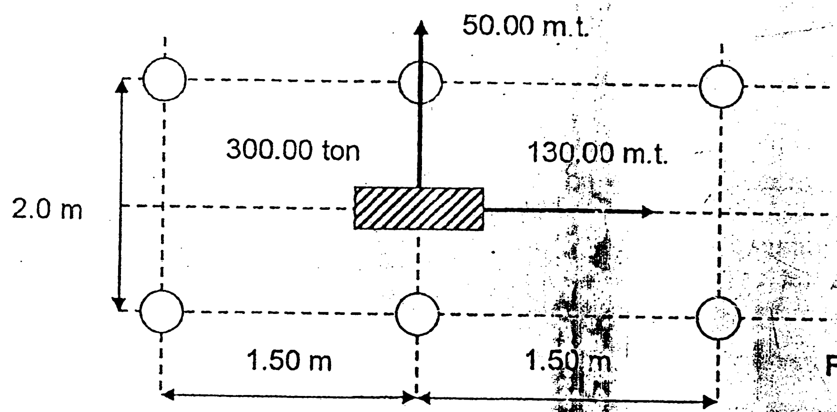


Figure 2

Question 3

3-a) Explain the following using neat sketches where necessary:

i- The factors governing the selection of dam type at a specific site.

ii- The main components of earth and rock fill dams.

iii- Seepage control measures in the earth dam and different foundation types.

3-b) For the earth dam shown in Figure 3, it is required to:

a) Draw the flow net and determine the rate of seepage.

b) Show graphically the pore water pressure distribution over the impervious foundation layer.

c) Determine the factor of safety against sliding assuming that c_a = 0.8 c and $\delta = 0.75\ \phi$.

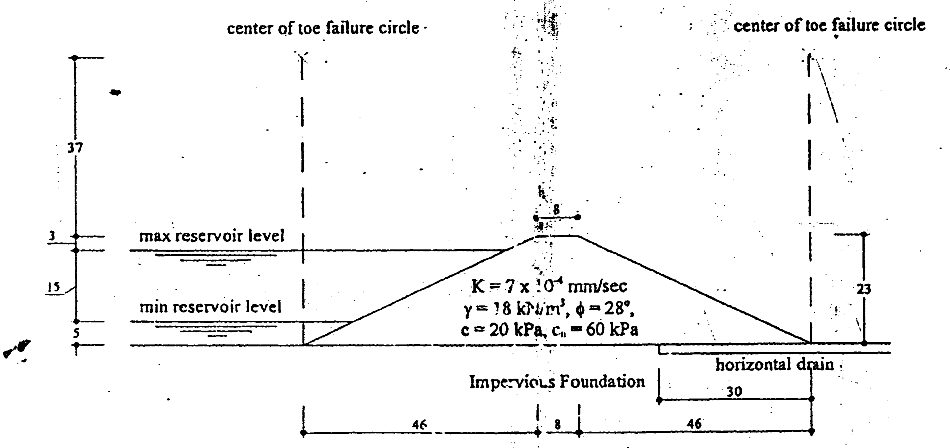


Figure (3)

Question 4

4-a) For the anchored free earth supported steel sheet pile shown in Figure 4:

a) Calculate the required embedment.

b) Calculate the force in the tie back for spacing 2.5 m horizontally.

c) If it is required to lower the water inside the excavation area to the bottom of excavation. Compare without calculation between the effects of dewatering inside or outside the excavation area.

d) Without calculation describe the requirements for determining the length of the grouted tie back.

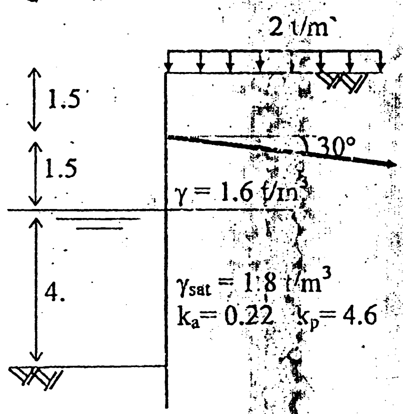


Figure (4)

Ain Shams University
Faculty of Engineering
December 2007
CES 451: Foundation Engineering

4th Year, Civil Engineering
Students of the Structure Div.
Time: 3 hours
End of Term Final Exam

Question 5

5-a) Describe using neat sketches the different parts of the TBM and the functions of each part.

5-b) Calculate and draw the ground reaction curve of a tunnel constructed through cohesive soil using the following data:

Depth to tunnel centerline	= 25 m,
Tunnel diameter	= 8 m,
Undrained shear strength	= 220 kPa,
Young's modulus of soil	= 150 MPa
Possion's ratio of soil	= 0.45,
Soil unit weight	=20 kN/m³,

The estimated radial displacement before lining activation is 8mm. The tunnel lining is precast segments with thickness of 20cm and the modulus of elasticity of the lining is 2000 kN/cm². Determine the expected average soil pressure acting on this lining.

$$R = a.e^{\frac{1}{2}\left(\frac{P_o - P_r}{c} - 1\right)}$$

$$\text{For } R \le a \ : \ U_a = (P_o - P_r).a.\frac{1+\upsilon}{E}$$

$$\text{For } R > a \ : \ A = 2.C.\left(\frac{1+\upsilon}{E}\right)e^{\left(\frac{P_o - P_r}{c} - 1\right)}, \qquad \frac{U_a}{a} = 1 - \left(\frac{1}{1+A}\right)^{0.5}$$

$$K_S = \frac{4E_l t}{D^2}$$

DATA for structural design of foundations

Concrete: f_{cu} = 300 kg/cm2 ,
Steel: grade 40/60 f_y = 4000 kg/cm²
Working stress: f_c = 100 kg/cm² , f_s = 2200 kg/cm² ,
q_c = 7 kg/cm² , q_{cp} = 10 kg/cm² , q_{bond} = 12 kg/cm²,
Ultimate stress: q_{cu} = 9 kg/cm² q_{cpu} = 14.5 kg/cm², q_{bu} = 18 kg/cm²

C1 min.	= 3.00	, j = 0.740
C1	= 3.50	, j = 0.780
C1	= 4.00	, j = 0.800
C1	= 4.85	, j = 0.826

$d = C_1 (M_u / (f_{cu} . b))^{½}$
$As = M_u / f_y . d . j$

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Eng. Dept.)

January 2015 — *Time: 3.00 hrs.*

RC Structures Design (3)-CES 421

The Exam consists of three Questions in Four Pages. 1/4

Systematic arrangement of calculations and clear neat drawings are essential.

Question (1): (60% of maximum credit)

Figure 1 shows the plan and elevation of a factory with overall dimensions of 32x24 meters where the columns are only allowed on axes A and B. The slab is hollow core units with self-weight of 3.0 kN/m². It carries a superimposed dead load of 2.5 kN/m² and a live load of 3.0 kN/m². The slab in supported by a number of post-tensioned two-hinged frames as shown in figure 1. The frame girder and the columns are both post-tensioned, **it is required to:**

1. Estimate the concrete dimensions of an intermediate frame
2. Choose appropriate cable profiles for the columns and the girders.
3. Calculate the bending moment and normal force diagrams at the transfer and working stages.
4. For the Girder only, check stresses at both the transfer and working stages and draw the stress distribution at the critical sections.
5. Determine the required number of prestressing strands for the girder only. (Area of one 15 mm strand = 140 mm²)
6. Draw to a convenient scale half sectional elevation for the frame showing all the details of reinforcement and cable profiles.

Use f_{cu} = 50 MPa, f_{cui}= 40 MPa, prestressing steel of f_{pu} = 1860 MPa, Jacking stress = 0.75 f_{pu}, Concrete cover to c.g. of prestressing steel = 100 mm, initial losses = 10%, total losses = 20%.

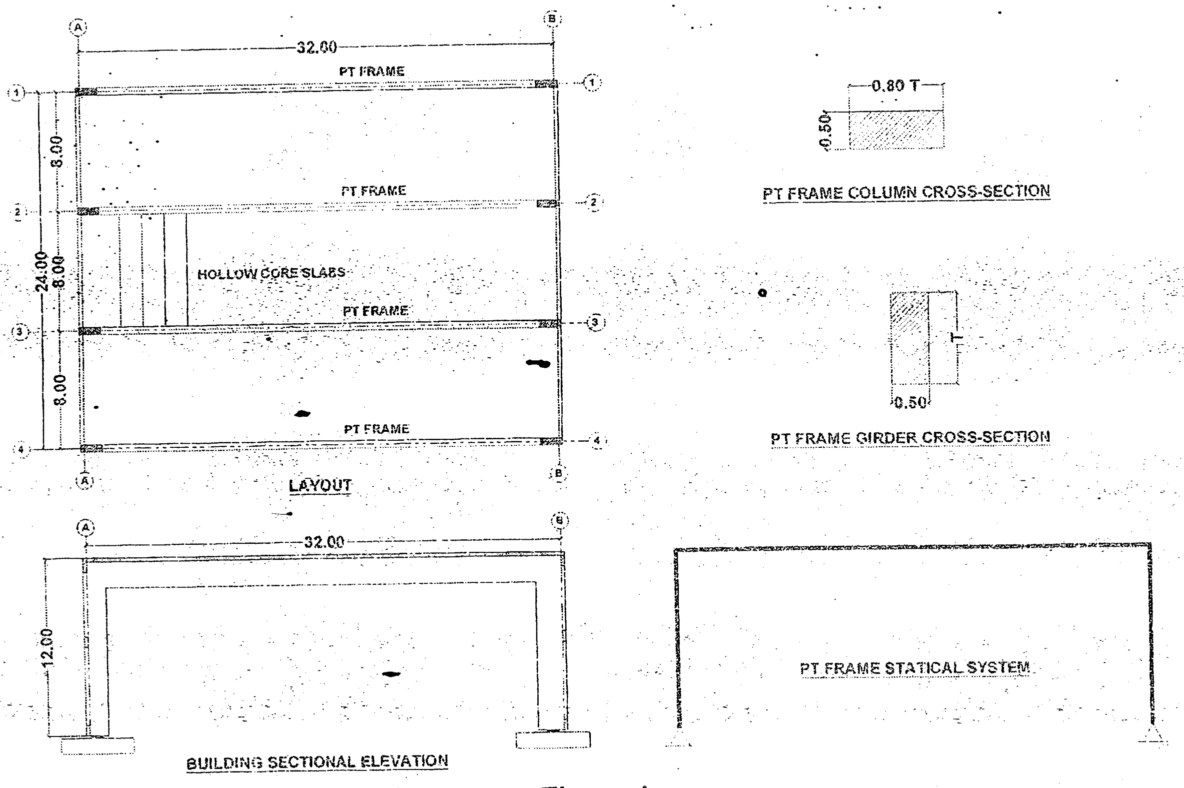
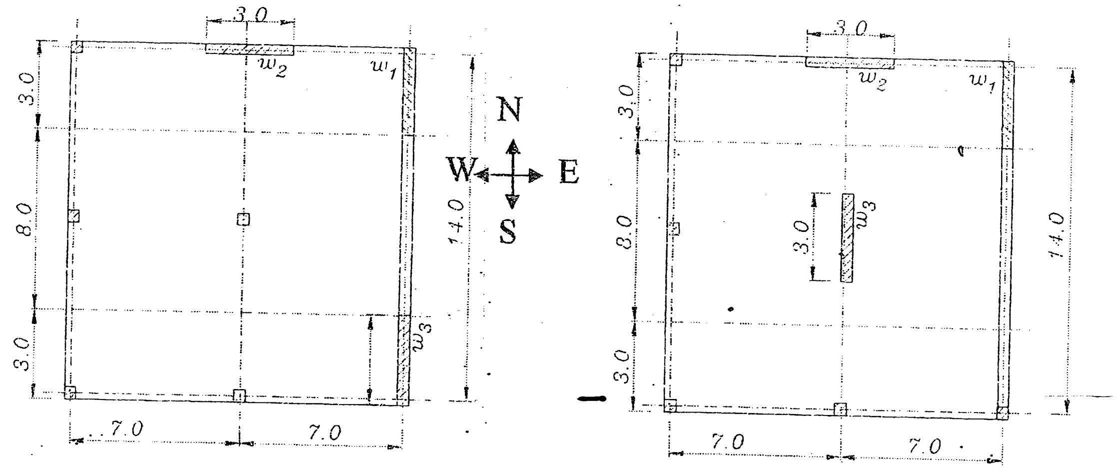


Figure 1

Question (2): (25% of maximum credit)

The plans shown are for a typical floor in a 12-storey Administrative building located in Central Egypt (zone 3). The building is constructed on dense sand (type B). Flat slab of thickness 220 mm supported by 500 mm square columns constitute the structural system carrying gravity loads. A set of shear walls is to be used as the lateral resisting element.

Floor cover and live load can be taken equal to 1.5 kN/m² and 5.0 kN/m², respectively. Wall partitions can be assumed equivalent to 2.0 kN/m². Story height is 3m and shear wall thickness = 300 mm



Building A Building B

1- Calculate the base shear acting on each building assuming seismic loads are acting in the N-S directions
2- Discuss the capability of building A and building B to resist twist due to lateral loads
3- Assume lateral load in N-S direction at the 6th floor is 600 kN, determine loads on lateral resisting elements W1, W2 and W3 of the building "B" only.
4- If you are allowed to add two more walls to each building to enhance their response under earthquakes, where in plan would you add them, and why ?

Question (3): (15% of maximum credit)

Without any calculations, draw elevation and cross-section, showing the statical system and concrete dimensions of the two bridges with the given layout in Figure 3.

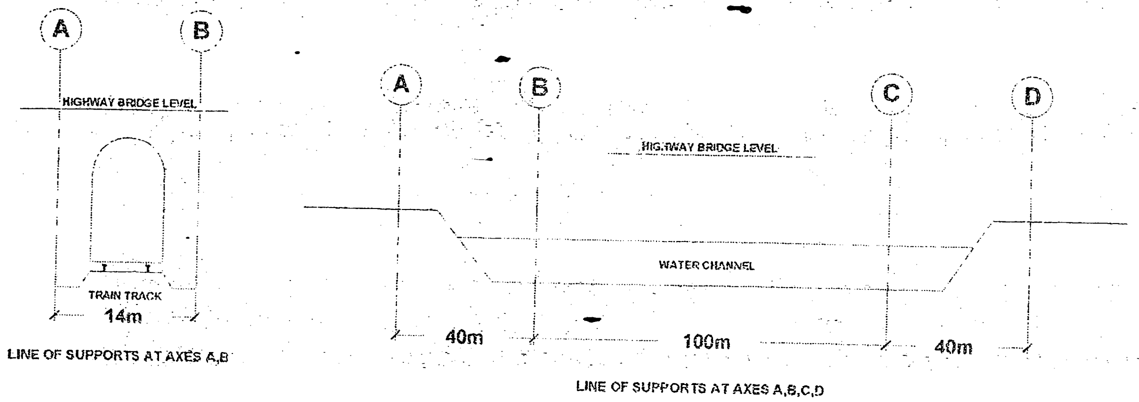


Figure 3

Equations for Earthquake Design

$$0 \le T \le T_B \quad : S_d(T) = a_g\, \gamma_1\, S \left[\frac{2}{3} + \frac{T}{T_B}\left(\frac{2.5\,\eta}{R} - \frac{2}{3} \right) \right] \quad (8\text{-}11)$$

$$T_B \le T \le T_C \; : S_d(T) = a_g\, \gamma_1\, S\, \frac{2.5}{R}\,\eta \quad (8\text{-}12)$$

$$T_C \le T \le T_D \; : S_d(T) = a_g\, \gamma_1\, S\, \frac{2.5}{R} \left[\frac{T_C}{T} \right] \eta \quad (8\text{-}13)$$

$$\ge [\,0.20\,]\; a_g \gamma_1$$

$$T_D \le T \le 4\ \text{sec} : S_d(T) = a_g\, \gamma_1\, S\, \frac{2.5}{R} \left[\frac{T_C\, T_D}{T^2} \right] \eta \quad (8\text{-}14)$$

$$\ge [\,0.20\,]\; a_g \gamma_1$$

Type (1) النوع الأول من منحنى طيف التجاوب : (أ)

Subsoil Class	S	T_B	T_C	T_D
A	1.0	0.05	0.25	1.2
B	1.35	0.05	0.25	1.2
C	1.5	0.10	0.25	1.2
D	1.8	0.10	0.30	1.2
E	1.6	0.05	0.25	1.2

Type (2) النوع الثاني من منحنى طيف التجاوب : (ب)

Subsoil Class	S	T_B	T_C	T_D
A	1.0	0.15	0.4	2.0
B	1.2	0.15	0.5	2.0
C	1.15	0.20	0.6	2.0
D	1.35	0.20	0.80	2.0
E	1.4	0.15	0.5	2.0

$\lambda = 0.85 \longrightarrow T_1 \le 2\,T_C$

$\lambda = 1.00 \longrightarrow T_1 > 2\,T_C$

$T_1 = C_t\, H^{3/4}$

Structural System	C_t
Steel moment resisting frames المنشآت المعدنية	0.085
Reinforced concrete moment resisting frames (Space frames) → Ductile frames (beams & columns) → Non-ductile frames (flat slabs)	0.075
All other buildings → Cores or Shear walls → Combinations of (cores or shear walls) & frames	0.050

α	نوع المنشأ
0.25	المباني السكنية
0.50	المنشآت والمباني العامة مثل المخازن غير الرئيسية-الاسواق التجارية-المدارس-المستشفيات-المسارح-جراجات السيارات الملاكى.....الخ
1.00	الصوامع-خزانات المياه-المنشآت المحملة بأحمال حية لفترات طويلة ومتصلة مثل المكتبات-المخازن الرئيسية-جراجات-عربات الركوب والعربات والأتوبيسات....الخ

النظام الإنشائي	نظام مقاومة الأحمال الأفقية	R
* حوائط حاملة : أغلب الحمل الرأسي ينتقل عن طريق الحوائط الحاملة والإعتماد على حوائط القص في مقاومة القوة العرضية الكلية	(أ) حوائط قص من الخرسانة المسلحة (ب) حوائط قص من المباني المسلحة (جـ) حوائط قص من المباني غير المسلحة	٤,٥٠ ٣,٥٠ ٢,٠٠
* إطارات فراغية بسيطة : الحمل الرأسي ينتقل عن طريق عناصر الإطار والإعتماد على حوائط القص أو إطارات مزودة بشكالات في مقاومة القوة العرضية الكلية	(أ) حوائط قص من الخرسانة المسلحة (ب) حوائط قص من المباني المسلحة (جـ) إطارات مزودة بشكالات	٥,٠٠ ٤,٥٠ ٤,٥٠
* إطارات فراغية مقاومة للعزوم : الحمل الرأسي والقوة العرضية الكلية الناتجة عن الزلازل تنتقل بالكامل عن طريق عناصر الإطار بدون إستخدام حوائط القص أو شكالات	منشآت (معدنية – خرسانية مسلحة – مركبة) : (أ) إطارات ذات مطولية كافية* (ب) إطارات ذات مطولية محدودة	 ٧,٠٠ ٥,٠٠
* نظام مركب من إطارات فراغية مقاومة للعزوم وحوائط القص (أو إطارات مزودة بشكالات) ويتم تصميم النظام طبقاً لما يلي : ١ – الإطارات أو حوائط القص (أو الإطارات المزودة بشكالات) تقاوم مشاركة بينها القوة العرضية الكلية وذلك طبقاً لجساءتها النسبية. ٢ – حوائط القص** : (أو إطارات مزودة بشكالات) تقاوم بمفردها القوة العرضية الكلية وذلك طبقاً لجساءتها النسبية. ٣ – الإطارات المقاومة للعزوم تقاوم بمفردها ٢٥٪ من القوة العرضية الكلية.	إطارات وحوائط – إطارات وشكالات : (أ) إطارات ذات مطولية كافية* (ب) إطارات ذات مطولية محدودة	 ٦,٠٠ ٥,٠٠
* المنشآت الأخرى :	(أ) – الأبراج الشبكية (ب) المآذن والمداخن والصوامع	٣,٠٠ ٣,٥٠

مجموعة الأهمية	المنشآت	معامل الأهمية γ_I
I	المنشآت التي يجب أن تعمل بكفاءة تامة أثناء وبعد حدوث الزلازل والمستخدمة لأغراض الطوارئ والتي تمثل أهمية كبيرة للأمان العام مثل : المستشفيات، محطات الإطفاء، محطات الكهرباء، أقسام الشرطة، مراكز الطوارئ، والإتصالات ... الخ	1.40
II	المنشآت التي لها أهمية وجود مقاومة زلزالية بالنسبة لما يترتب على إنهيارها من خسائر في الأرواح مثل : المدارس، صالات التجمع، المراكز الثقافية، الخزانات، المداخن والصوامع، دور العبادة .. الخ	1.20
III	المنشآت العادية وغير المرتبطة بأية مجموعة أخرى	1.0
IV	المنشآت ذات أهمية قليلة للأمان العام مثل : المنشآت الزراعية ، المنشآت المؤقتة .. الخ	0.80

Type of Structure	η
Steel with Welded Connections	1.20
Steel with Bolted Connections	1.05
Reinforced Concrete	1.00
Prestressed Concrete	1.05
Reinforced Masonry Walls	0.95

Examination Committee

Prof. Amr Abdelrahman	*Prof. Ahmed Ghallab*	*Asoc. Prof. Osama Al-Nesr*
Dr. Hussein Okail	*Dr. Marwan Shedid*	

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Eng. Dept.)

January 2014 — *Time: 3.00 hrs.*

RC Structures Design (3)-CES 421

The Exam consists of two Questions in Four Pages.

Systematic arrangement of calculations and clear neat drawings are essential.

Question (1): (60% of maximum credit)

Figure 1 shows the structural plans of the ground and first floors ceilings and a cross-sectional elevation of a warehouse building. The slabs of all floors carry a superimposed dead load of 3.5 kN/m^2 and a live load of 5.0 kN/m^2. Due to the difference in function, the columns on axes B and D cannot be extended to the ground floor and has to be carried by the post-tensioned concrete transfer beams on axes 1, 2, 3 and 4 in the ground floor ceiling. **It is required to:**

1. Determine the cross-section thickness (T) and the total number of prestressing strands for an intermediate transfer beam with the given cross-section. (Area of one 15 mm strand = 140 mm^2). Take into account that the transfer beam will be shored until the first floor is constructed (self-weight of the slab of the ground and first floors exits on the beam at the transfer stage).
2. Check stresses at both the transfer and working stages for the above case.
3. Check the ultimate limit state of flexure at the critical negative section of the transfer beam.
4. Carry out the design for the end anchorage block.
5. Draw to a convenient scale the beam in elevation and cross-section showing all the details of reinforcement and cable profiles.
6. If the shoring of the main girder does not exist when casting the first floor, describe without calculations the difference between the two cases and the loads to be used when checking the stresses in the beam.

Use f_{cu} = 50 MPa, f_{cui}= 40 MPa, prestressing steel of f_{pu} = 1860 MPa, Jacking stress = 0.75 f_{pu}, Concrete cover to c.g. of prestressing steel = 120 mm, initial losses = 10%, total losses = 20%.

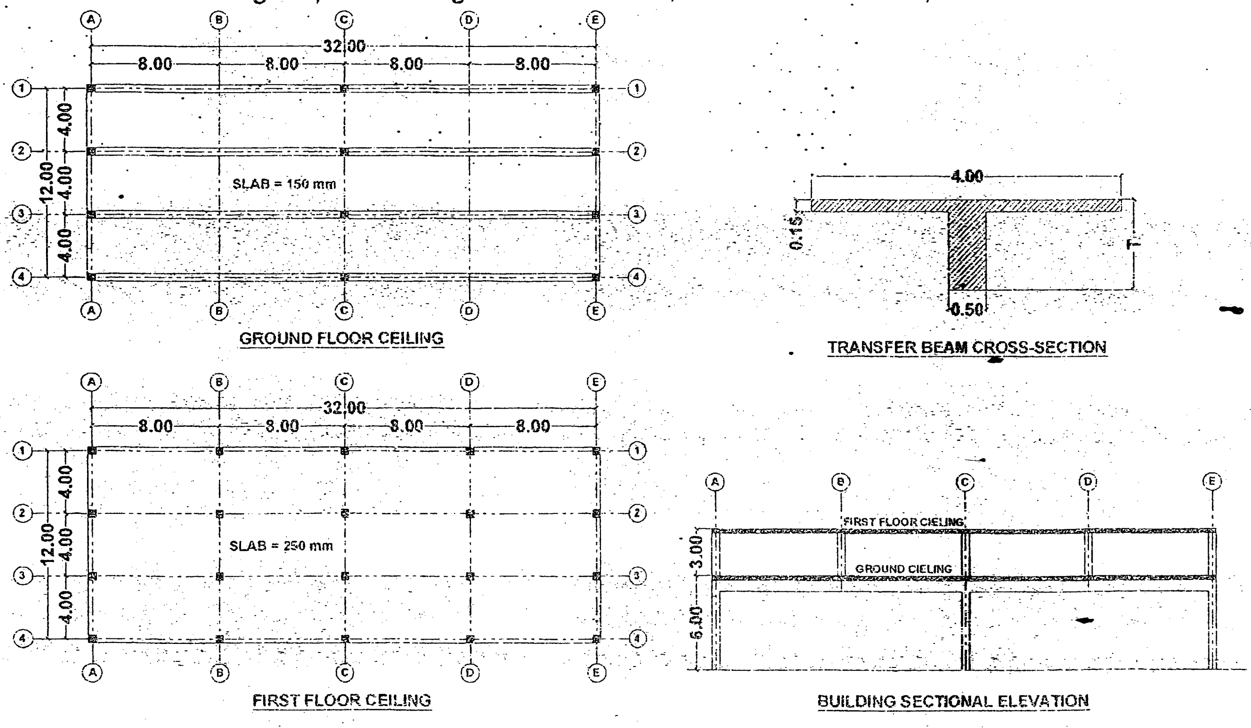


Figure 1

Hint: You can estimate each column load by the area carried by it.

Question (2): (25% of max credit)

The plan shown in figure (2) is for a typical floor in an 8-floors administrative building located in Alexandria (zone 2). The building is constructed on dense sand (type B). Flat slabs of thickness 220 mm supported by 500 mm square columns constitute the structural system carrying gravity loads. A set of shear walls is to be used as the lateral resisting element.

Floor cover and live load can be taken equal to 1.5 kN/m² and 4.0 kN/m², respectively. Wall partitions can be assumed equivalent to 1.5 kN/m². Story height is 3m and wall thickness = 300 mm.

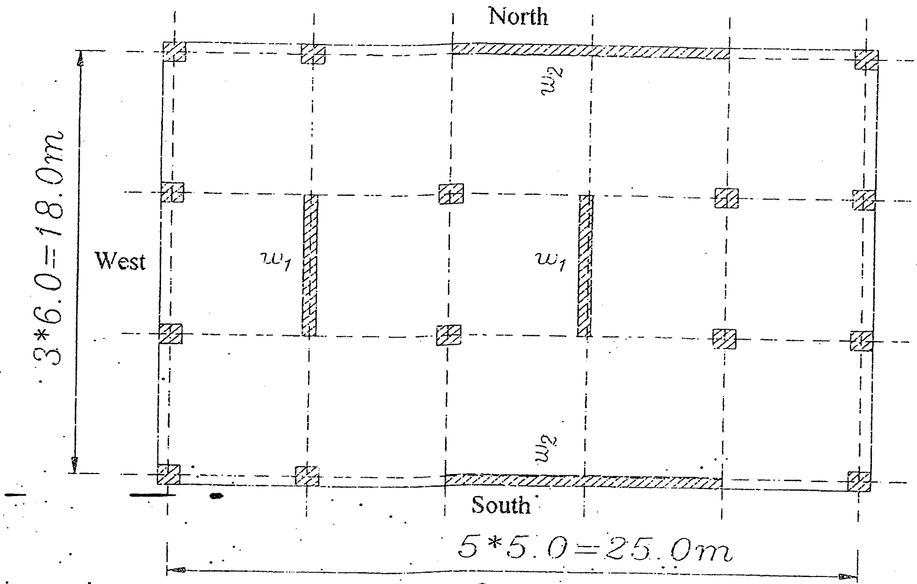


Figure 2

For the lateral load in North-South direction, it's required to:

1. Calculate the design base shear on the building due to seismic load.
2. Determine load on each story due to seismic load
3. Determine the load on each shear wall due to seismic load at the base taking into account torsion effect.

Question (3): (10% of max credit)

Typical detail (A) in figure 3 shows a part of reinforced concrete frame. It is required to draw reinforcement details of Detail (A) to satisfy the earthquake requirement code, assuming the following:

1. The frame is of limited ductility.
2. The frame is with enough ductility.

Reasonable values of longitudinal steel and distance between stirrups should be shown on drawings. Column dimension (300x900) mm, beam dimensions (300x900) mm.

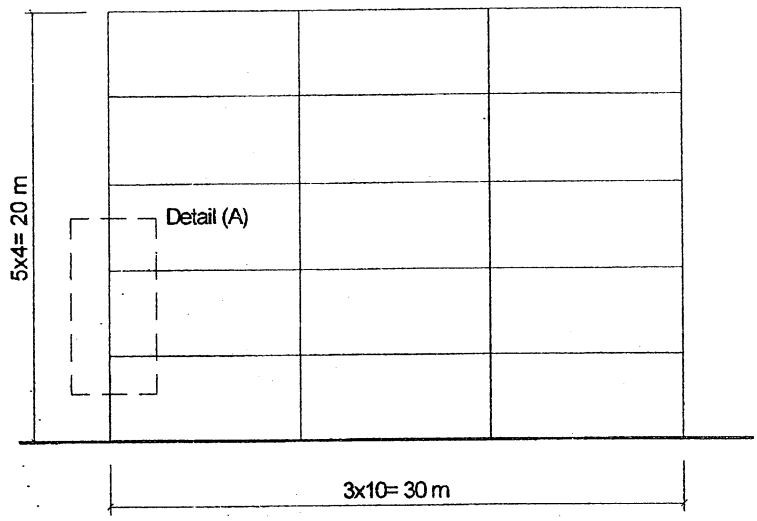


Figure 3

Equations for Earthquake Design

$$0 \leq T \leq T_B : S_d(T) = a_g\ \gamma_1\ S \left[\frac{2}{3} + \frac{T}{T_B}\left(\frac{2.5\eta}{R} - \frac{2}{3}\right)\right] \quad (8\text{-}11)$$

$$T_B \leq T \leq T_C : S_d(T) = a_g\ \gamma_1\ S\ \frac{2.5}{R}\eta \quad (8\text{-}12)$$

$$T_C \leq T \leq T_D : S_d(T) = a_g\ \gamma_1\ S\ \frac{2.5}{R}\left[\frac{T_C}{T}\right]\eta \quad (8\text{-}13)$$

$$\geq [0.20]\ a_g\gamma_1$$

$$T_D \leq T \leq 4\ \text{sec} : S_d(T) = a_g\ \gamma_1\ S\ \frac{2.5}{R}\left[\frac{T_C\ T_D}{T^2}\right]\eta \quad (8\text{-}14)$$

$$\geq [0.20]\ a_g\gamma_1$$

Type (1) النوع الأول من منحنى طيف التجاوب : (أ)

Subsoil Class	S	T_B	T_C	T_D
A	1.0	0.05	0.25	1.2
B	1.35	0.05	0.25	1.2
C	1.5	0.10	0.25	1.2
D	1.8	0.10	0.30	1.2
E	1.6	0.05	0.25	1.2

Type (2) النوع الثانى من منحنى طيف التجاوب : (ب)

Subsoil Class	S	T_B	T_C	T_D
A	1.0	0.15	0.4	2.0
B	1.2	0.15	0.5	2.0
C	1.15	0.20	0.6	2.0
D	1.35	0.20	0.80	2.0
E	1.4	0.15	0.5	2.0

$\lambda = 0.85 \longrightarrow T_1 \leq 2\,T_C$

$\lambda = 1.00 \longrightarrow T_1 > 2\,T_C$

$$T_1 = C_t\ H^{3/4}$$

النظام الإنشائي	نظام مقاومة الأحمال الأفقية	R
* حوائط حاملة : أغلب الحمل الرأسي ينتقل عن طريق الحوائط الحاملة والإعتماد على حوائط القص في مقاومة القوة العرضية الكلية	(أ) حوائط قص من الخرسانة المسلحة (ب) حوائط قص من المباني المسلحة (جـ) حوائط قص من المباني غير المسلحة	٤,٥٠ ٣,٥٠ ٢,٠٠
* إطارات فراغية بسيطة : الحمل الرأسي ينتقل عن طريق عناصر الإطار والإعتماد على حوائط القص أو إطارات مزودة بشكالات في مقاومة القوة العرضية الكلية	(أ) حوائط قص من الخرسانة المسلحة (ب) حوائط قص من المباني المسلحة (جـ) إطارات مزودة بشكالات	٥,٠٠ ٤,٥٠ ٤,٥٠
* إطارات فراغية مقاومة للعزوم : الحمل الرأسي والقوة العرضية الكلية الناتجة عن الزلازل تنتقل بالكامل عن طريق عناصر الإطار بدون إستخدام حوائط القص أو شكالات	منشآت (معدنية – خرسانية مسلحة – مركبة) : (أ) إطارات ذات مطولية كافية* (ب) إطارات ذات مطولية محدودة	 ٧,٠٠ ٥,٠٠
* نظام مركب من إطارات فراغية مقاومة للعزوم وحوائط القص (أو إطارات مزودة بشكالات) ويتم تصميم النظام طبقاً لما يلي : ١ – الإطارات أو حوائط القص (أو الإطارات المزودة بشكالات) تقاوم مشاركة بينها القوة العرضية الكلية وذلك طبقاً لجساءتها النسبية. ٢ – حوائط القص** : (أو إطارات مزودة بشكالات) تقاوم بمفردها القوة العرضية الكلية وذلك طبقاً لجساءتها النسبية. ٣ – الإطارات المقاومة للعزوم تقاوم بمفردها ٢٥% من القوة العرضية الكلية.	إطارات وحوائط – إطارات وشكالات : (أ) إطارات ذات مطولية كافية* (ب) إطارات ذات مطولية محدودة	 ٦,٠٠ ٥,٠٠
* المنشآت الأخرى :	(أ) – الأبراج الشبكية (ب) المآذن والمداخن والصوامع	٣,٠٠ ٣,٥٠

Structural System	C_t
Steel moment resisting frames المنشآت المعدنية	0.085
Reinforced concrete moment resisting frames (Space frames) → Ductile frames (beams & columns) → Non-ductile frames (flat slabs)	0.075
All other buildings → Cores or Shear walls → Combinations of (cores or shear walls) & frames	0.050

نوع المنشأ	α
المباني السكنية	0.25
المنشآت والمباني العامة مثل المخازن غير الرئيسية-الاسواق التجارية-المدارس-المستشفيات-المسارح-جراجات السيارات الملاكي ......الخ	0.50
الصوامع-خزانات المياه-المنشآت المحملة بأحمال حية لفترات طويلة ومنطقة مثل المكتبات-المخازن الرئيسية-جراجات عربات الركوب والعربات والأتوبيسات.....الخ	1.00

مجموعة الأهمية	المنشآت	معامل الأهمية γ_I
I	المنشآت التي يجب أن تعمل بكفاءة تامة أثناء وبعد حدوث الزلزال والمستخدمة لأغراض الطوارئ والتي تمثل أهمية كبيرة للأمان العام مثل : المستشفيات، محطات الإطفاء، محطات الكهرباء، أقسام الشرطة، مراكز الطوارئ والاتصالات ... الخ	1.40
II	المنشآت التي لها أهمية وجود مقاومة زلزالية بالنسبة لما يترتب على انهيارها من خسائر في الأرواح مثل : المدارس، صالات التجمع، المراكز الثقافية، الخزانات، المداخن والصوامع، دور العبادة .. الخ	1.20
III	المنشآت العادية وغير المرتبطة بأية مجموعة أخرى	1.0
IV	المنشآت ذات أهمية قليلة للأمان العام مثل : المنشآت الزراعية ، المنشآت المؤقتة .. الخ	0.80

Type of Structure	η
Steel with Welded Connections	1.20
Steel with Bolted Connections	1.05
Reinforced Concrete	1.00
Prestressed Concrete	1.05
Reinforced Masonry Walls	0.95

Examination Committee
Prof. Amr Abdelrahman *Prof. Ahmed Ghallab* *Asst. Prof. Osama Al-Nesr*
Dr. Hussein Okail *Dr. Marwan Shedid* *Dr. Mahmoud El-Kateb*

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Eng. Dept.)

January 2013 *Time : 3.00 Hrs*

Design RC Structures (3)-CES 421

The Exam consists of three Questions in Four Pages.

Systematic arrangement of calculations and clear neat drawings are essential.

Question (1): (60% of maximum credit)

Figure 1 shows the plan and elevation of a warehouse with overall dimensions of 32x40 meters. The top slab is post-tensioned in the Y-direction and supported on four continuous frames as shown in the figure. The slab has a thickness of 200 mm. It carries a superimposed dead load of 1.5 kN/m^2 and a live load of 1.0 kN/m^2. **Only for the case of total load on the entire slab, it is required to:**

1. Calculate the bending moment at the transfer and working stages.
2. Check stresses at both the transfer and working stages and draw the stress distribution at the critical sections.
3. Determine the required number of prestressing strands (Area of one 15 mm strand = 140 mm^2)
4. Check the ultimate limit state of flexure at the critical negative section of the slab.
5. Draw to a convenient scale half sectional elevation and quarter plan for the slab showing all the details of reinforcement and cable profiles.

Use f_{cu} = 50 MPa, f_{cui}= 40 MPa, prestressing steel of f_{pu} = 1860 MPa, Jacking stress = 0.75 f_{pu}, Concrete cover to c.g. of prestressing steel = 40 mm, initial losses = 10%, total losses = 20%.

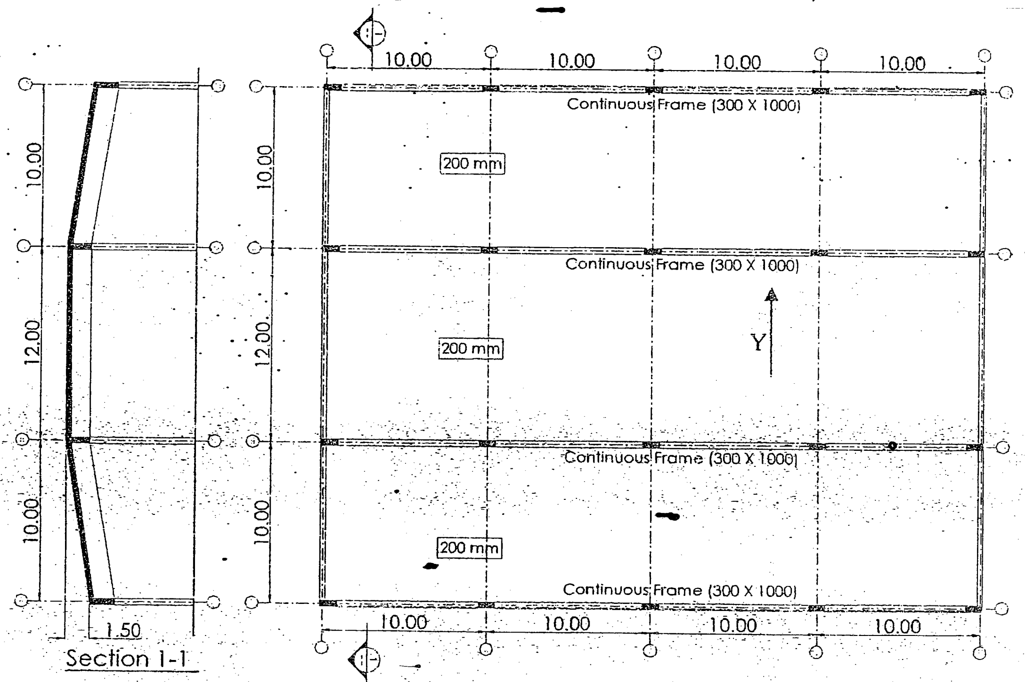


Figure 1

Question (2): (25% of maximum credit)

Figure 2 shows the plan for a typical floor in a 12-story Administrative building located in Alexandria (zone 2). The building is constructed on dense sand (type B). Flat slabs of thickness 220 mm supported by 500 mm square columns constitute the structural system carrying gravity loads. A set of shear walls is to be used as the lateral resisting element.

Floor cover and live load can be taken equal to 1.5 kN/m^2 and 5.0 kN/m^2, respectively. Wall partitions can be assumed equivalent to 2.0 kN/m^2. Story height is 3m and shear wall thickness = 300 mm.

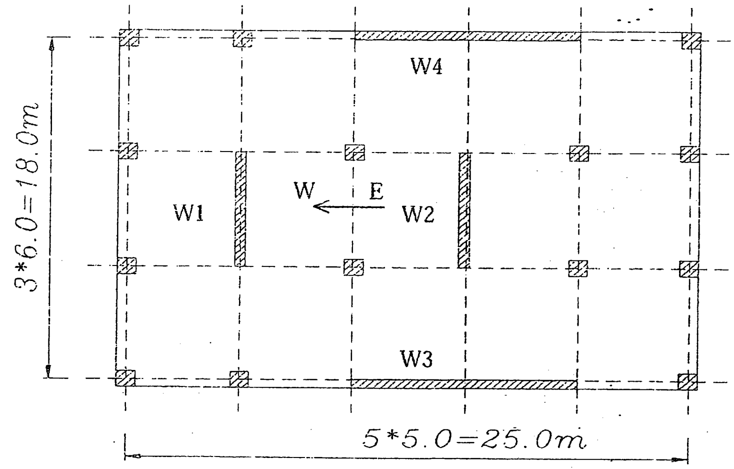


Figure 2

a- Construct the design response spectrum for the location indicated
b- Calculate the design base shear on the building in the E-W direction due to seismic loads.
c- Determine loads on each story due to the seismic loading
d- Assume lateral load at the 6th floor due to seismic loading is 600 kN, determine the loads on the shear walls taking into account any possible torsion in the structure
e- If the building was analyzed in the N-S direction, would the base shear in part "b" of this question and the wall shear forces in part "d" be the same. Justify using sketches (no calculation needed).
f- If the building consists of only one wall in each direction (W1 and W4 only), comment on the resistance to torsion (rotational stiffness) of the building and its capability to resist torsion. Justify using sketches (no calculation needed)

Question (3): (15% of maximum credit)

Figure 3 shows the elevation of a 35 meters bridge crossing a water channel. The bridge is supported on two end abutments and one intermediate supporting frame. It is required to:

1- Propose a structural system for the bridge deck and choose suitable concrete dimensions.
2- Draw to a convenient scale the bridge deck in plan and cross-sections.

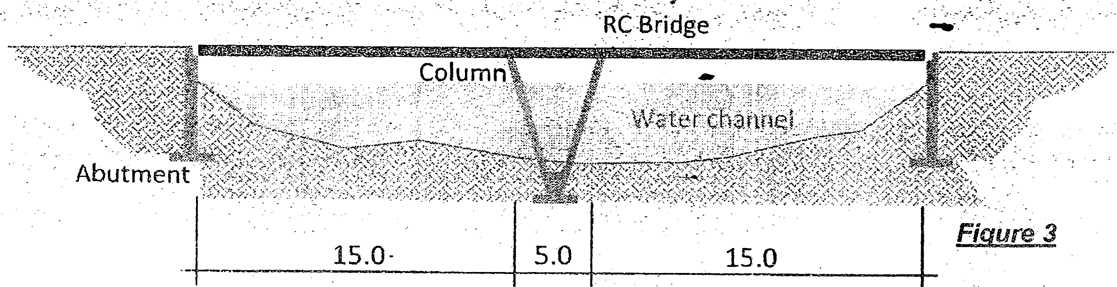


Figure 3

Seismic loads in Egyptian code

Ultimate Base Shear Force

$$F_b = S_d(T_1).\lambda\, W/g \qquad (8\text{-}16)$$

λ ... معامل تصحيح وتحدد قيمته طبقاً للآتي :

$\lambda = 0.85 \quad \text{if} \quad T_1 \le 2\,T_c$
or
$\lambda = 1.0 \quad \text{if} \quad T_1 > 2\,T_c$

وعدد أدوار المنشأ أكثر من دورين

٨-٤-٢-٥ طيف التجاوب التصميمي الأفقي للتحليل الإنشائي المرن

Horizontal Design Spectrum for Elastic Analysis

١ – تتحدد قيمة طيف التجاوب التصميمى S_d (T) لزمن عودة قياسي بواسطة المعادلات التالية :

$$0 \le T \le T_B \quad : S_d(T) = a_g\,\gamma_I\,S\left[\frac{2}{3} + \frac{T}{T_B}\left(\frac{2.5\eta}{R} - \frac{2}{3}\right)\right] \qquad (8\text{-}11)$$

$$T_B \le T \le T_C \quad : S_d(T) = a_g\,\gamma_I\,S\,\frac{2.5}{R}\eta \qquad (8\text{-}12)$$

$$T_C \le T \le T_D \quad : S_d(T) = a_g\,\gamma_I\,S\,\frac{2.5}{R}\left[\frac{T_C}{T}\right]\eta \ge [0.20]\,a_g\gamma_I \qquad (8\text{-}13)$$

$$T_D \le T \le 4\,\text{sec} : S_d(T) = a_g\,\gamma_I\,S\,\frac{2.5}{R}\left[\frac{T_C\,T_D}{T^2}\right]\eta \ge [0.20]\,a_g\gamma_I \qquad (8\text{-}14)$$

جدول (٨-٧) نسبة الحمل الحى (ψ_{EI})

(ψ_{EI})	توصيف المنشأ
1.0	* الصوامع * خزانات المياه * المنشآت المحملة بأحمال حية لفترات طويلة متصلة (المكتبات – المخازن الرئيسية – جراجات عربات الركوب والعربات السياحية والأوتوبيسات ... الخ)
0.5	* المنشآت والمبانى العامة مثل : المخازن غير الرئيسية – الاسواق التجارية – المدارس – المستشفيات – المسارح – جراجات السيارات الملاكي – الأستادات – دور العبادة ... الخ
0.25	المنشآت السكنية

جدول (٨- ٤) قيم معامل الاضمحلال التصحيحى η ، η_v

η	η_v	نوع المنشأ
١,٢	١	صلب ذو وصلات ملحومة
١,٠٥	٠,٧٥	صلب ذو وصلات بمسامير البرشام أو وصلات بمسامير القلاووظ
١,٠٠	٠,٧	خرسانة مسلحة
١,٠٥	٠,٧٥	خرسانة سابقة الاجهاد
٠,٩٥	٠,٥	حوائط من المباني المسلحة

جدول (٨-٣) قيم المعاملات T_B, T_C, T_D & S

(أ) : النوع الأول من منحنى طيف التجاوب Type (1)

Subsoil Class	S	T_B	T_C	T_D
A	1.0	0.05	0.25	1.2
B	1.35	0.05	0.25	1.2
C	1.5	0.10	0.25	1.2
D	1.8	0.10	0.30	1.2
E	1.6	0.05	0.25	1.2

(ب) : النوع الثانى من منحنى طيف التجاوب Type (2)

Subsoil Class	S	T_B	T_C	T_D
A	1.0	0.15	0.4	2.0
B	1.2	0.15	0.5	2.0
C	1.15	0.20	0.6	2.0
D	1.35	0.20	0.80	2.0
E	1.4	0.15	0.5	2.0

* يتم تعديل قيم (S) عند وجود المبنى على جرف بناء على دراسات خاصة.

جدول (٨-٩) مجموعات الأهمية ومعاملات الأهمية γ_I

معامل الأهمية γ_I	المنشآت	مجموعة الأهمية
1.40	المنشآت التى يجب أن تعمل بكفاءة تامة أثناء وبعد حدوث الزلزال والمستخدمة لأغراض الطوارئ والتي تمثل أهمية كبيرة للأمان العام مثل : المستشفيات، محطات الإطفاء، محطات الكهرباء، أقسام الشرطة، مراكز الطوارئ، والاتصالات ... الخ	I
1.20	المنشآت التي لها أهمية وجود مقاومة زلزالية بالنسبة لما يترتب على انهيارها من خسائر فى الأرواح مثل : المدارس، صالات التجمع، المراكز الثقافية، الخزانات، المداخن والصوامع، دور العبادة ... الخ	II
1.0	المنشآت العادية وغير المرتبطة بأية مجموعة أخرى	III
0.80	المنشآت ذات أهمية قليلة للأمان العام مثل : المنشآت الزراعية ، المنشآت المؤقتة .. الخ	IV

Examination Committee Course

Prof. Amr Abdelrahman
Dr. Hussein Okail
Asst.Prof. Ahmed Ghallab
Dr. Marwan Shedid
Asst. Prof. Osama Al-Nesr

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Eng. Department)

January 2012 (Term 1)

Time : 3.0 Hrs

Design RC Structures (3)-CES 421

The Exam consists of three Questions in two Pages.

Systematic arrangement of calculations and clear neat drawings are essential.

For Questions1 and 2, Use f_{cu} = 50 MPa, f_{cui}= 40 MPa, prestressing steel of f_{pu} = 1860 MPa, Jacking stress = 0.75 f_{pu}, Area of one 15 mm strand = 140 mm^2
Concrete cover to c.g. of prestressing steel = 50 mm for slabs and 150 mm for beams, initial losses = 10%, total losses = 20%.

Question (1): (35% of maximum credit)

Figure 1 shows the plan and the cable profile of a one-way prestressed concrete slab with overall dimensions of 27 x 30 meters. The slab is prestressed in the x-direction and supported on four beams and four lines of columns as shown in the figure. The slab has a thickness of 300 mm. It carries a superimposed dead load (floor cover + walls) of 2.0 kN/m^2 and a live load of 2.0 kN/m^2.

Only for the case of total load on the entire slab, it is required to:

1. Calculate the bending moment at the transfer and working stages.
2. Check stresses at both the transfer and working stages and draw the stress distribution at the critical sections. Comment if the slab is safe.
3. Check the ultimate limit state of flexure of the slab.
4. Calculate the max permissible live load that the slab can carry safely.

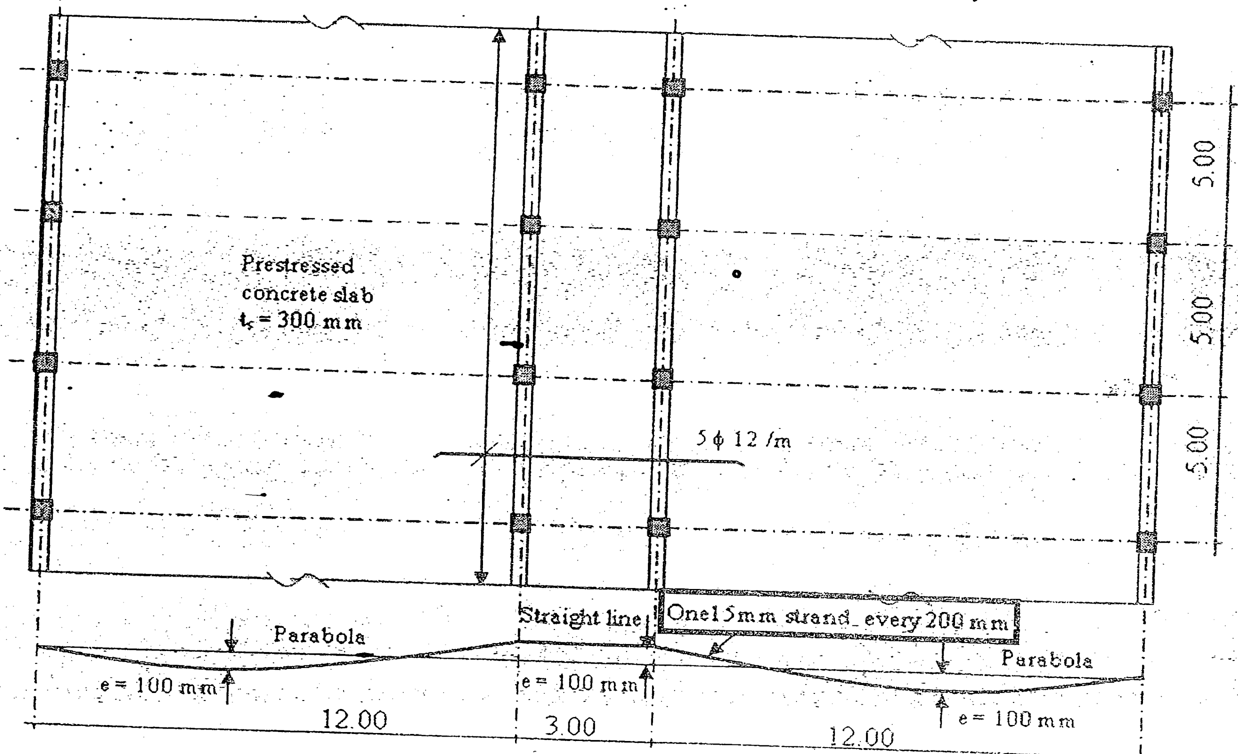


Figure 1

Question (2): (55% of maximum credit)

Figure 2 shows a plan and a cross section of a simple prestressed concrete girder-type highway bridge. The bridge has 6.0-m width carriageway and 0.5-m cantilever sidewalk at each side. The span of the bridge is 30.0 meters. It is required to:

1. Calculate and draw the BMD and SFD on the main girder due to dead and live loads.
2. Estimate the minimum required prestressing force.
3. Check stresses at both transfer and working stages.
4. Design the critical section for shear.
5. Design the end anchorage zone.
6. Draw elevation and sections showing concrete dimensions and details of reinforcement.

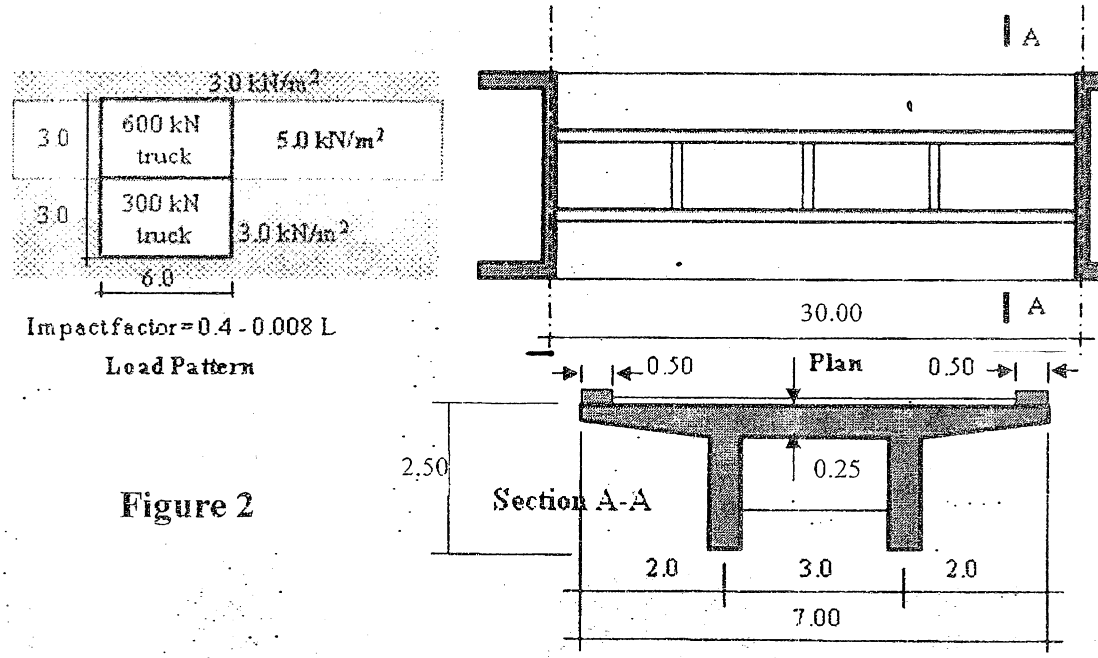


Figure 2

Question (3): (10% of maximum credit)

Figure 3 shows a reinforced concrete prism, which will be subjected to a gradually increasing tensile force from zero up to 180 kN. It is required to:

1. Assuming average crack spacing, calculate the expected number of cracks to occur during loading.
2. Calculate the maximum expected crack width.
3. Describe – using sketches - the contribution of concrete in the section capacity during all stages of loading.

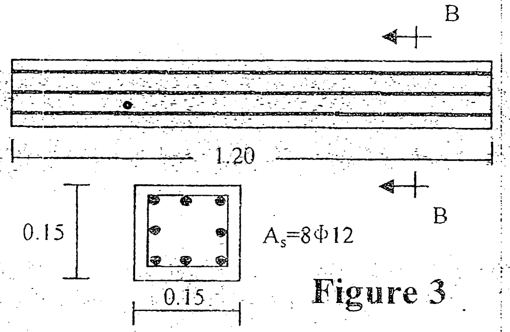


Figure 3

Use f_{cu} = 30 MPa; St 40/60; Cover to c.g of steel = 50 mm

$w_{max} = 2\,T_{cr}/(f_{cb}\,u_s) * [T/E_s A_s - 0.5T_{cr}/E_s A_s - 0.5\, f_{ctr}/E_c]$

$f_{cb} = 0.3\,(f_{cu}/\gamma_c)^{0.5}$ MPa; $f_{ctr} = 0.6\,(f_{cu})^{0.5}$ MPa;

E_c=4400 $(f_{cu})^{0.5}$ MPa; E_s=200000 MPa.

Course Examination Committee
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Date: 21.01.2012
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AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Eng. Dept.)

January. 2011 — *Time : 3.0 Hrs*

Design RC Structures (3)

The Exam consists of three Questions in three Pages.

Systematic arrangement of calculations and clear neat drawings are essential.

Used materials in all Questions: Concrete: f_{cu} = 35 MPa and Steel 40/60.

Question (1): (35% of maximum credit)

The shown bridge shall be built in an industrial area. A special truck of 480 kNs capacity shall be crossing the bridge. The dimensions and load distribution of the truck are shown in the attached sketch. **No uniform live load** shall accompany the truck when passing the bridge. It is required to:

1. Calculate the maximum bending moment and shearing force on the bridge due to dead loads and weight of the truck.
2. Design the bridge for the given dead and live loads.
3. Draw details of reinforcement in plan and cross section.
4. If the span of the bridge was 50 meters, show schematically the structural system of the bridge in elevation and cross section.

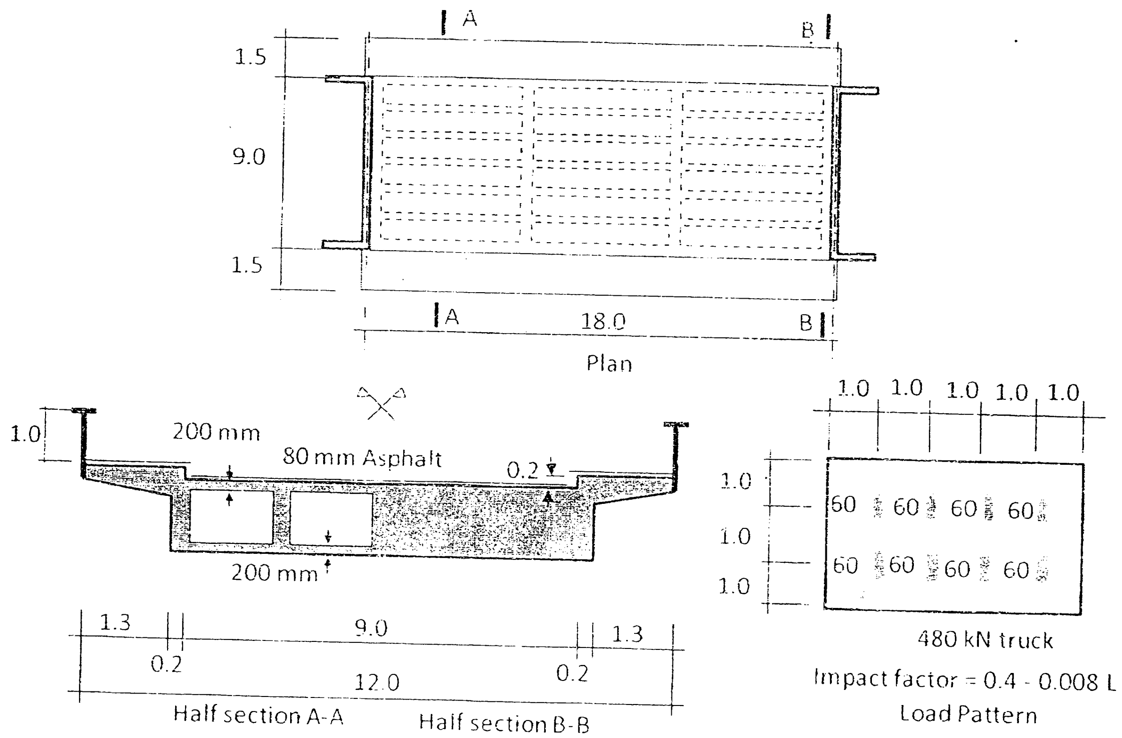

Figure 1

Question (2): (40% of maximum credit)

Figure 2 shows a swimming pool consisting of two surfaces 1 and 2 rotating about the axis "A". The water retaining part (Surface1) is covered by surface 2 with the dimensions given in the figure. It is required to:

1) Calculate the internal forces at sections (1-6).
2) Calculate the internal forces of the supporting beams B1 & B2.
3) Design the Beam B2 and draw its details of reinforcement in elevation (1:50).
4) Design the critical sections of the surface of revolution.
5) Draw the details of reinforcement of the water retaining part in plan (1:100) and in sections (1:25).

L.L. = 0.5 kN/m^2 ; F.C.=0.5 kN/m^2

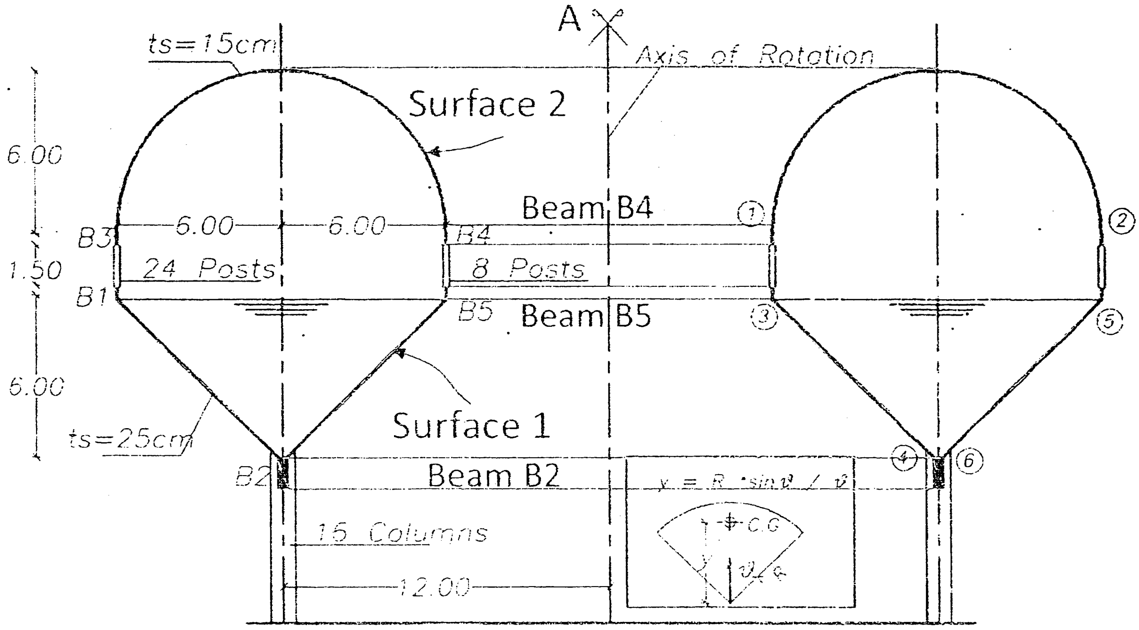

Figure 2

Question (3): (25% of maximum credit)

Figure (3-A) shows a residential building (γ_I = 1.0) located in Cairo (Zone 3; a_g = 0.15g). The building consists of 6 typical flat slab floors (ground and 5 floors) and rested on very dense sand (soil type B). The lateral loads are resisted by reinforced concrete cores. Neglecting the effect of columns on the lateral load resistance of the building and considering the earthquake force in **X-direction only**, it is required to:

a) Calculate the lateral force due to the earthquake (shear at base).
b) Calculate the lateral force at each floor and draw its distribution.

Course Examination Committee
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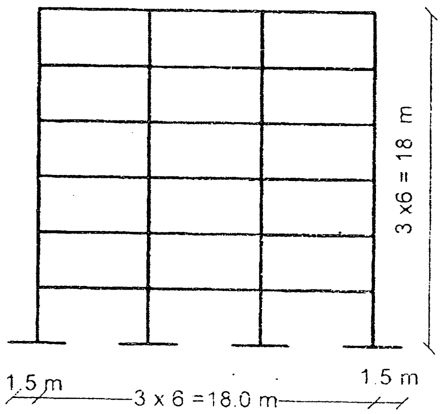
c) Calculate the lateral force on the cores above the ground floor only.

d) If the cores were relocated as shown in Figure (3-B), which case has a better resistance to lateral loads and why.(equations can be shown without calculation)

Data:

Slab thickness = 200 mm, Live load = 2 KN/m^2 , floor cover and walls = 4 KN/m^2.

Columns dimensions = 0.5 x0.5 m, Core thickness = 0.25 m.



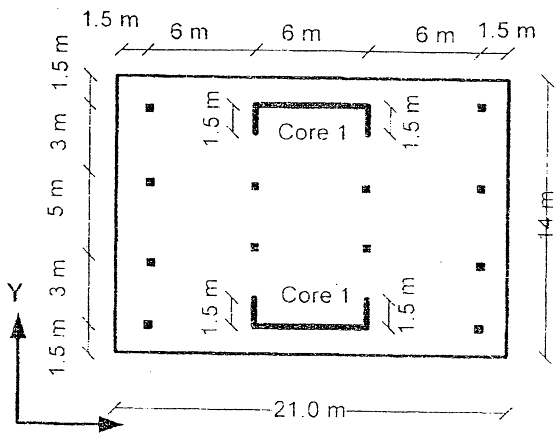


Figure (3-A): Building dimensions

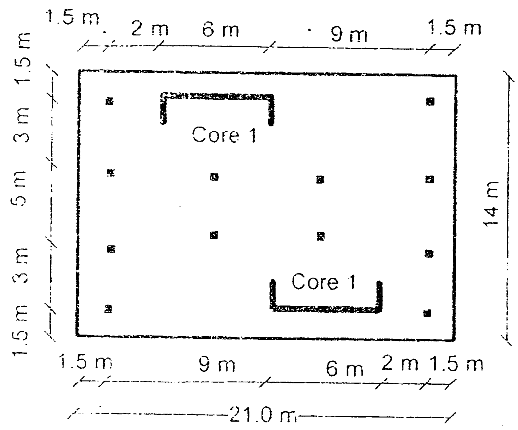


Figure (3-B): Cores locations

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Division)

Jan 2010 *Time: 3:00 Hrs*

Design of Reinforced Concrete Structures (3)

The Exam Consists of three Questions in four Pages.

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

Used materials in all Questions: Concrete: f_{cu} = 40 MPa and Steel 40/60.

Question (1a) (25% of maximum credit)

Figure 1 shows a sectional elevation of a reinforced concrete hall with an overall diameter of 43.30m. The hall is covered with an upper non-spherical dome and a part of a cone having 120 mm thickness and a part of cone with 160mm thickness. The hall is supported on (B1) and 20 columns. It is required to :-

1) Calculate the internal forces at the critical sections 1, 2, 3, and 4 of dome and cones.
2) Design the critical sections.
3) Draw a half section elevation (1:25) and a quarter plan (1:100) showing the details of reinforcement of the hall.

Design Data: Floor cover = 1 kN/m^2 and live load = 0.5 kN/m^2.

Question (1b) (30% of maximum credit)

Figure 1 also shows a structural sectional elevation of a circular flat slab shed of 43.30 m inner diameter and 53.30 m outer diameter. The shed is supported at the inner perimeter on the beam B1 in addition to 20 inclined struts of 400x400 mm dimensions as shown in the figure. The slab thickness is 250 mm.

It is required to:

1) Calculate the internal forces (BMD) of the equivalent frames in the meridian direction **(Case of total load only is required)**, using the shown statical system. (Hint: use average frame width)
2) Calculate the internal forces (BMD and NFD) in the ring direction using the **empirical method**.
3) Design the critical sections of the slab in both directions.
4) Draw a part plan showing clearly the details of the slab reinforcement in both directions (1:100).
5) Calculate the internal forces in the ring beam (B1), taking the loads from the surface of revolution into consideration.

Design Data for flat slab: Floor cover = 1.5 kN/m^2 - L.L = 1.5 kN/m^2

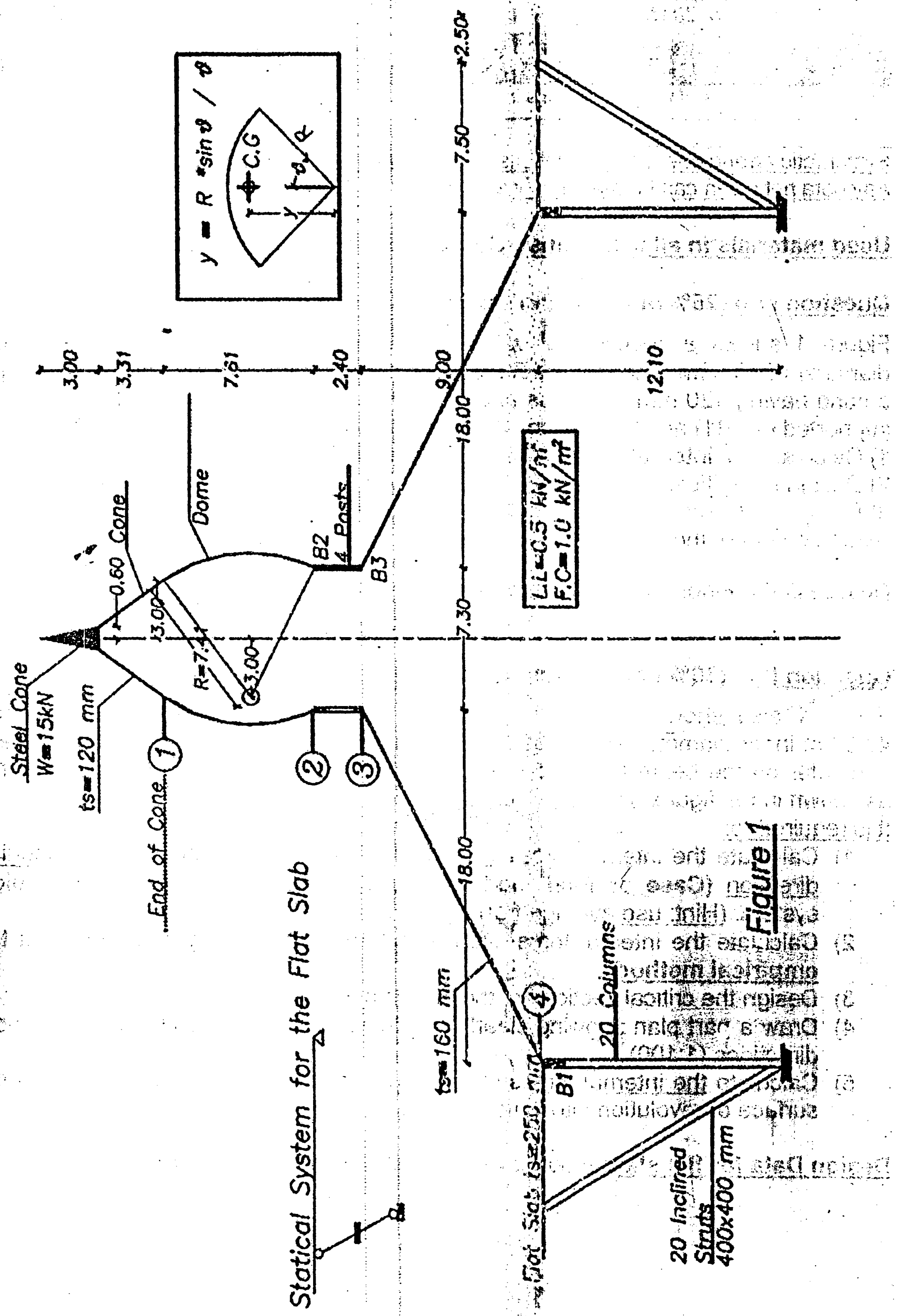

y = R *sin θ / θ
C.G
Steel Cone
W=15kN
ts=120 mm
End of Cone
0.60
Cone
Dome
3.00
R=7.4
3.00
B2
4 Posts
B3
3.00
3.31
7.61
2.40
9.00
12.10
2.50
7.50
18.00
7.30
18.00
L.L=0.5 kN/m²
F.C=1.0 kN/m²
ts=160 mm
20 Columns
B1
Flat Slab ts=250 mm
20 Inclined Struts 400x400 mm
Statical System for the Flat Slab

Figure 1

Question (2) (25% of maximum credit)

Figure 2 shows the layout of a girder type bridge of 9.0 meters carriage way and 1.5 m side walks at each side of the bridge. The deck slab is supported on 4 girders, which are supported on two abutments at axes A and D and two piers at B and C. It is required to:

1. Calculate the bending moments on the external main Girder (1) **due to the given case of loading (Trucks at mid-span of the intermediate bay).**
2. Design the main Girder (1) at mid-span of the intermediate bay.
3. Draw half sectional elevation of the main Girder (1) showing the reinforcement details using an appropriate scale.
4. If the piers on axes B and C are removed, suggest a statical system of the bridge using "single line diagram" sketches.

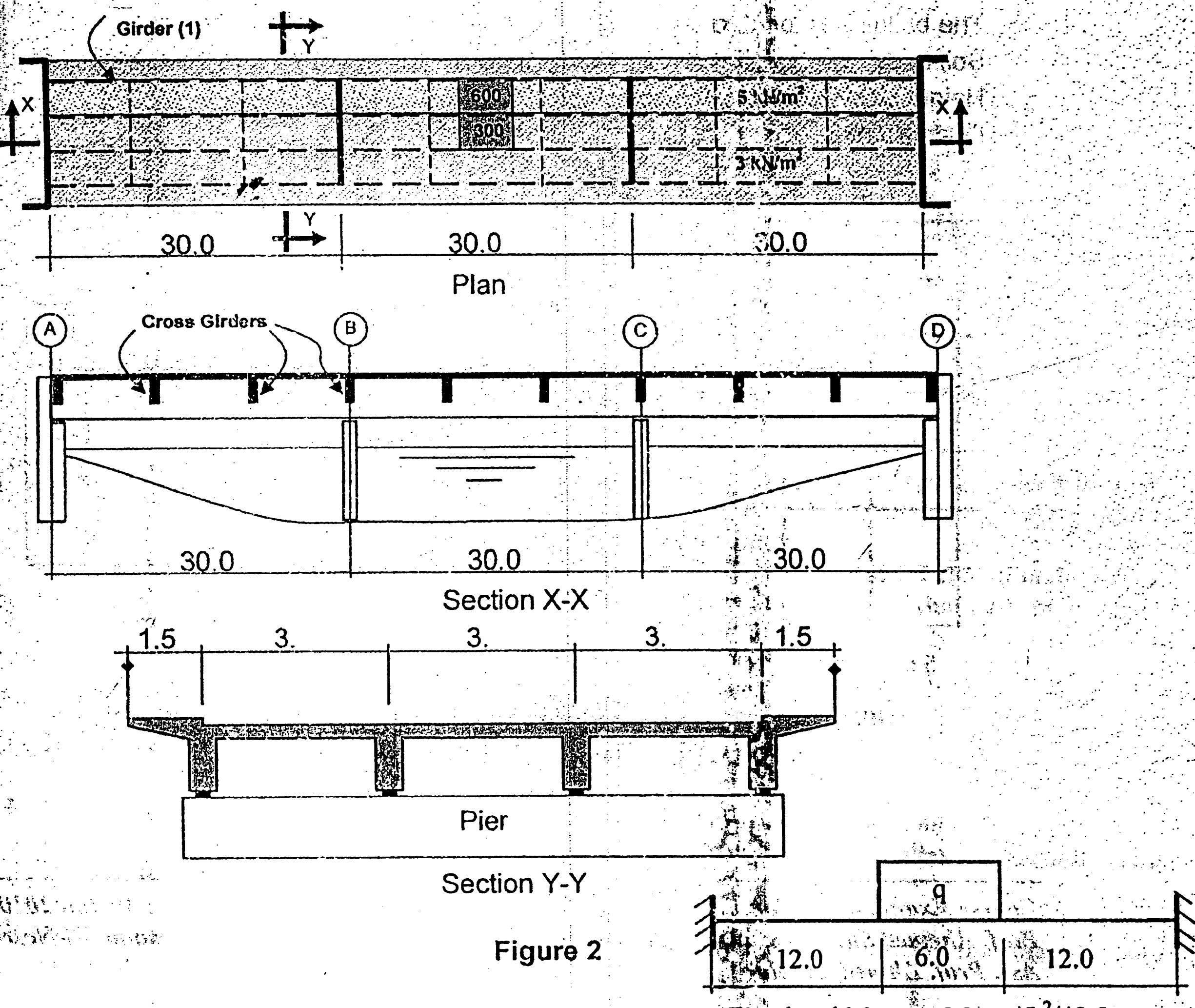


Figure 2

Fixed end Moment $M = q*L^2/40.5$

Question (3) (20% of maximum credit)

Figure (3 -a) shows a typical plan of a residential building. If the building consists of 7 typical floors as shown in figure (3-b) and subjected to horizontal earthquake force (Base shear force = V) in the Y-direction. Assuming a uniform dead load (including own weight, floor cover and walls' loads) on each floor equals to (15 kN/m^2).

If the earthquake force is resisted only by the two shear walls (W1), it is required to:

1. Calculate the base shear force (V), neglecting live load.
2. Calculate the lateral force on each wall (W1) at each floor.
3. Design the shear wall (W1) due to bending moment and normal force (use area method to calculate the normal force)
4. Draw cross section of wall (W1) showing the reinforcement details.

Data:

The building is located in **zone 4,**
Soil under the building is **weak soil (type D)**
Height between floors = 3 m
Dimensions of shear walls (250 x 4000 mm^2)

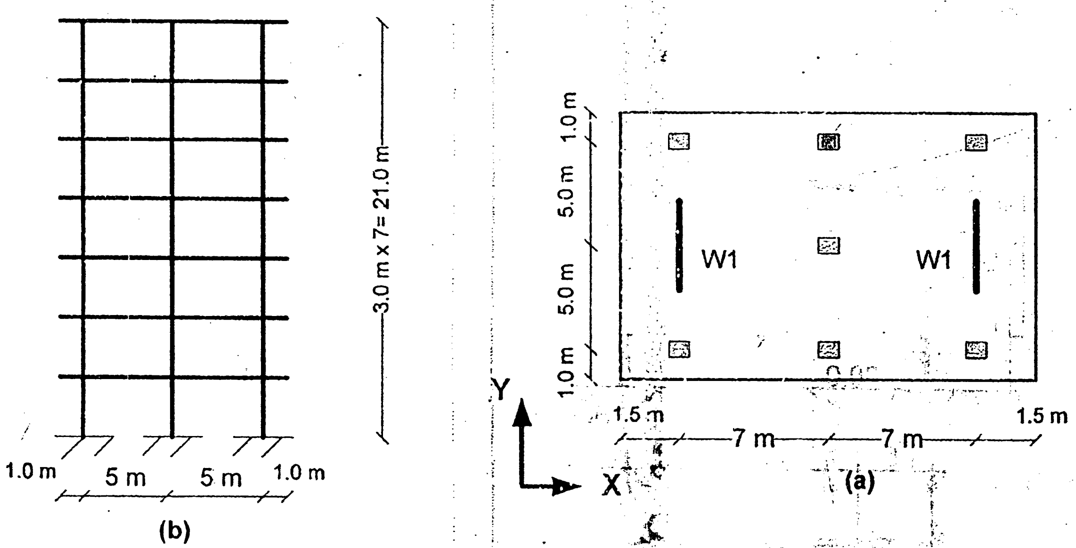


Figure. 3

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Division)

Jan 2009 *Time : 3:00 Hrs*

Design of Reinforced Concrete Structures (3)

The Exam Consists of Four Questions in five Pages.

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

Used materials in all Questions: Concrete: f_{cu} = 40 MPa and Steel 40/60.

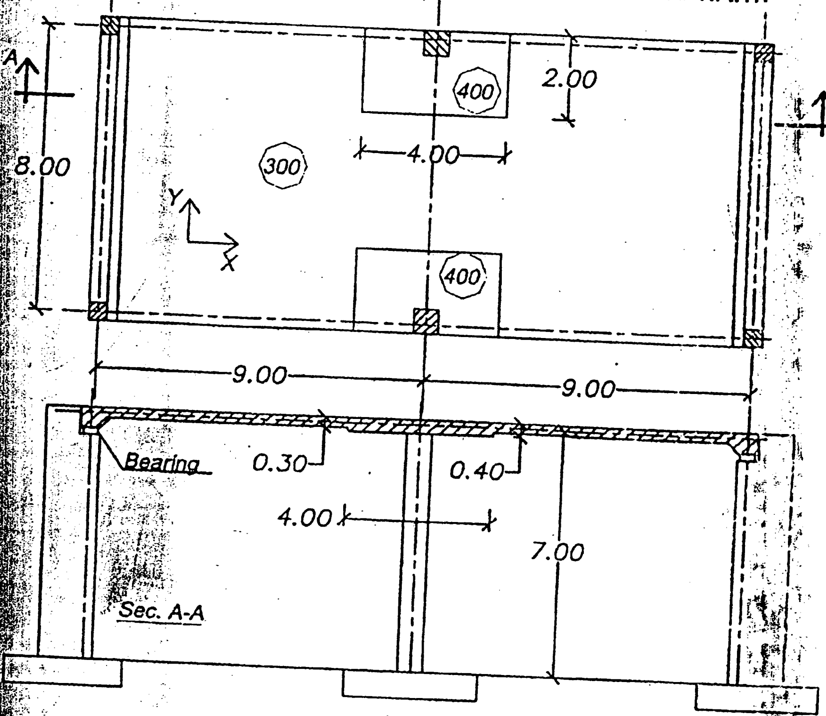
Question (1) (30% of maximum credit)

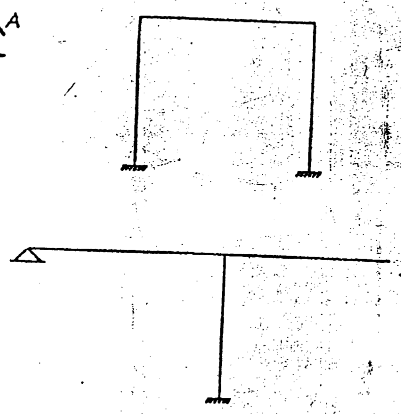
Figure 1 shows a structural plan of a footbridge with overall dimensions of 18.0x8.0m. The bridge deck system is a flat slab which is cast monolithically with the intermediate **square** columns. The slab is free to rotate at the four bearings at its edges. The slab thickness is 300 mm and is provided with 400 mm thick drop panels at the intermediate columns.

It is required to:

1) Calculate the internal forces (BMD and NFD) of the equivalent frames in X- and Y-directions (**Case of total load only is required**), ignoring the effect of the drop panel on the slab stiffness.
2) Design the critical sections of the slab in both directions.
3) Calculate the minimum column dimensions to satisfy the punching requirements.
4) Draw to a convenient scale a part plan showing clearly the details of the slab reinforcement in both directions.

Design Data: Floor cover = 3.0 kN/m^2 - L.L = 5.0 kN/m^2





Structural System in X- and Y- directions

Figure 1

Question (2) (20% of maximum credit)

Part (2-a): (14% of maximum credit)

Figure (2-a) shows a typical plan of a residential building consisting of 7 typical floors. If the building is subjected to horizontal earthquake force (Base shear force = V) in the Y-direction. The earthquake force is resisted only by the two shear walls (W1 & W2). It is required to:

A: Calculate the following in terms of "V":

1- Distribute the base shear force (V) on each floor (assuming total uniform load including slab weight and floor cover weight on each floor = w, and F_{top} =zero).
2- Calculate the lateral earthquake force on each wall taking effect of eccentricity into consideration (stiffness of wall 2 = **twice** the stiffness of wall 1)
3- Calculate the maximum moment at base of each wall.

B: Calculate the maximum base shear force (V) that the building can resist knowing that

a. maximum moment of resistance of wall W1 = 3500 kN.m
b. maximum moment of resistance of wall W2 = 5000 kN.m

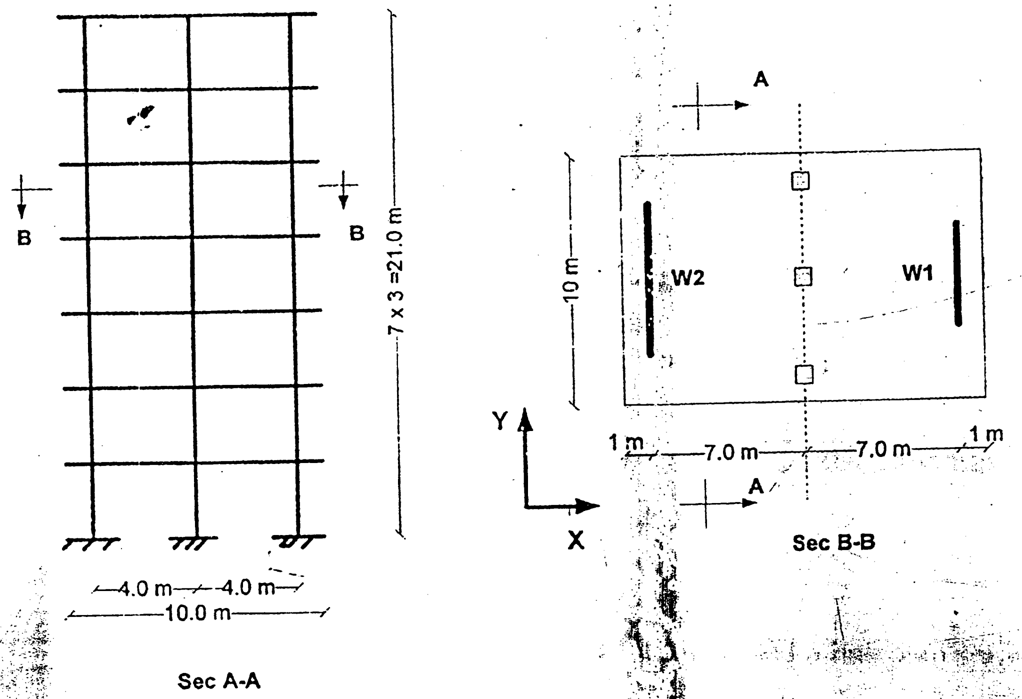


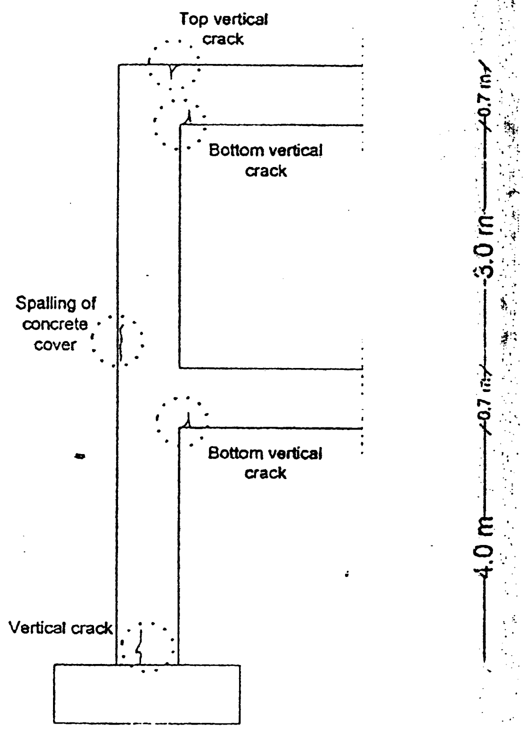
Figure 2-a

Part (2-b): (6% of maximum credit)

Figure (2-b) shows part of a residential building after earthquake. During inspection of the building, several cracks at different locations were noticed as shown in the figure. Without any calculations, it is required to:

1- Identify the reasons of the cracks at each location.
2- Redraw the same figure showing the proper details of reinforcement considering the effect of earthquakes.
(Column and beam dimensions are 250 x 700 mm).

Figure 2-b



Question (3) (40% of maximum credit)

Figure 3 shows a sectional elevation of a reinforced concrete hall with an overall diameter of 30.00m. The hall is covered with two domes having 200 mm and 140 mm thickness and a part of cone with 140mm thickness. The hall is supported on (B2) and 10 columns. It is required to :-

1) Calculate the internal forces of the critical sections 1, 2, 3, and 4 of domes and cone.

2) Design the critical sections.

3) Design the supporting beams (B1) and (B2).

4) Using a convenient scale, draw a half section elevation and a half plan showing the details of reinforcement of the hall.

Design Data: Floor cover = 1 kN/m^2 and live load = 0.5 kN/m^2.

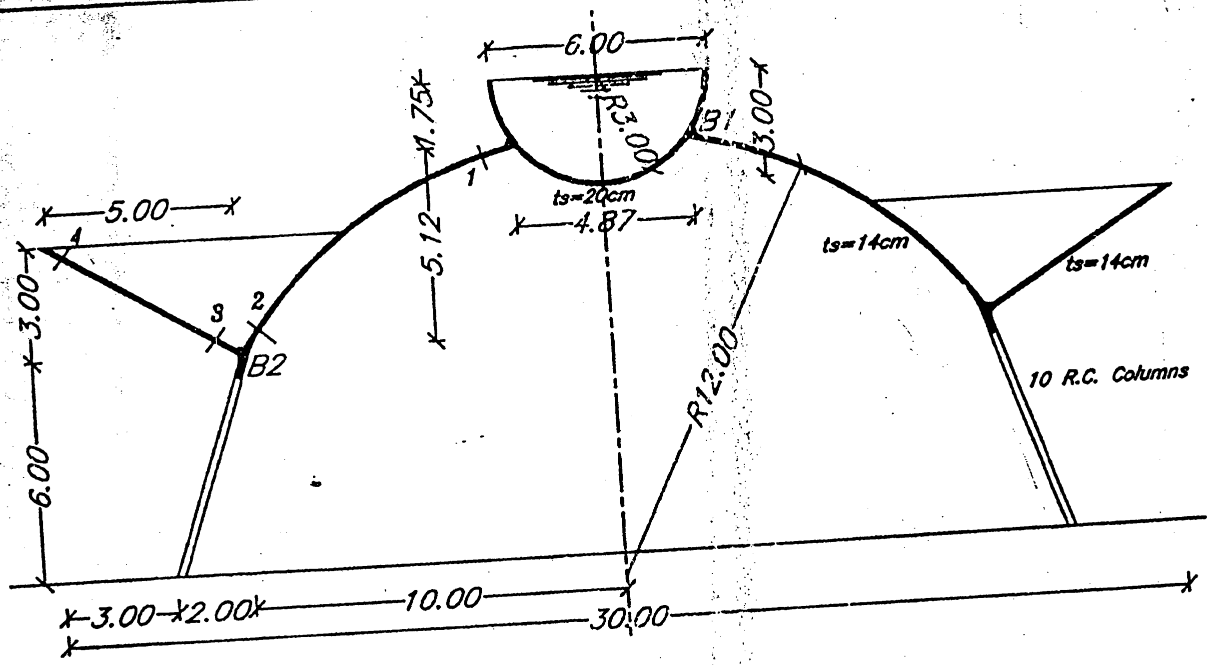


Figure 3

Question (4) (10% of maximum credit)

Figure 4 shows the structural system of a single-span reinforced concrete highway bridge. The total width of the bridge is 12.0 meters with 8.0 m roadway, while its span is 14.0 meters.

It is required to:

1. Estimate the dimensions of the bridge and draw its concrete dimensions in plan, and cross section to convenient scale.
2. Design the critical section at point **P1** at the mid-span **for the given load case only**.
3. Draw details of reinforcement of the bridge in half plan and section to convenient scale.

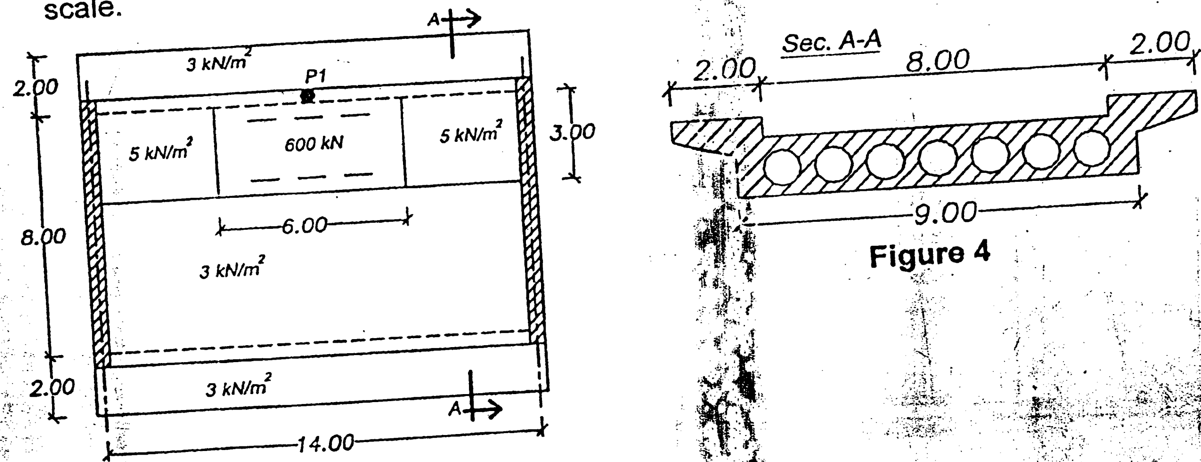
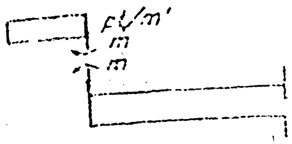
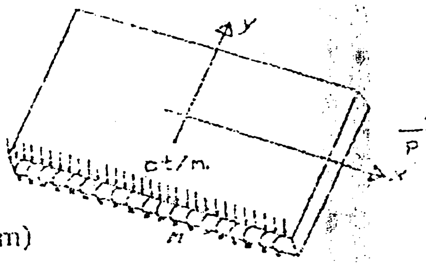
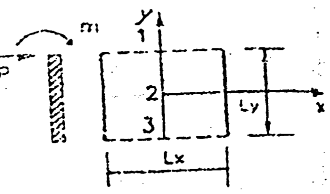


Figure 4





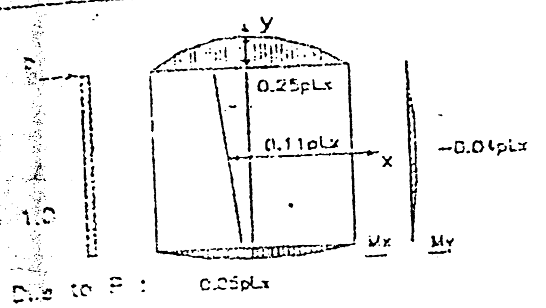


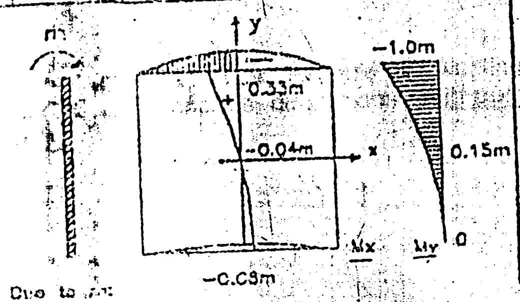
Line Load at free edge : p(t/m)
Moment at free edge : m(mt/m)

1. *Plate free at two opposite sides & simply supported at the other sides*

L_y/L_x	due to	M_x at middle of span			M_y at middle of span			Factor
		M_{x1}	M_{x2}	M_{x3}	M_{y1}	M_{y2}	M_{y3}	
3.0	p	+.25	+.01	0	0	-.01	0	pL_x
	m	+.33	-.01	0	-1.0	0	0	m
2.0	p	+.25	+.03	0	0	-.01	0	pL_x
	m	+.33	-.04	-.01	-1.0	-.01	0	m
1.6	p	+.25	+.05	+.01	0	-.02	0	pL_x
	m	+.33	-.05	-.02	-1.0	-.03	0	m
1.2	p	+.25	+.09	+.03	0	-.03	0	pL_x
	m	+.33	-.06	-.05	-1.0	-.10	0	m
1.0	p	+.25	+.11	+.05	0	-.04	0	pL_x
	m	+.33	-.04	-.08	-1.0	-.15	0	m
0.8	p	+.26	+.15	+.08	0	-.04	0	pL_x
	m	+.32	-.05	-.12	-1.0	-.22	0	m
0.5	p	+.32	+.25	+.19	0	-.04	0	pL_x
	m	+.29	-.03	-.20	-1.0	-.39	0	m
.25	p	+.53	+.50	+.47	0	-.03	0	pL_x
	m	+.25	0	-.25	-1.0	-.49	0	m

Example $\frac{L_y}{L_x} = 1.0$





Exam. Date : 03 Jan 2009

Course Examination Committee
Prof. Ahemed Sherif
Ass. Prof. Osama El-Nesr

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Division)

Jan 2008 **Time : 3:00 Hrs**

Design of Reinforced Concrete Structures

The Exam Consists of **Four** Questions in **three** Pages.

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

Used materials in all Questions: Concrete: f_{cu} = 40 MPa and Steel 40/60.

Question (1) (25% of maximum credit)

Figure 1 shows a structural plan of a 12-story office building with an overall dimensions of 16.0x28.0m. The slabs of ground and all typical floors are flat slabs. The floor slabs are supported on 9 columns and 6 shear walls. The dimensions of all columns in last floor are 400x350mm, the dimensions of all shear walls are 300x3000 mm and the floor height is 3.75m.

For the last Floor flat slab, It is required to:

1) Calculate the internal forces of the flat slab (without drop panel) for the last floor in X-direction (intermediate panel only is required).
2) Design the critical sections of the slabs in the same direction.
3) Draw to a convenient scale a part plan showing clearly the details of the slab reinforcement in both directions (the reinforcement in y-direction may be assumed).
4) What is the effect of the shear walls on the distribution of the reinforcement for the outer panels in X-direction. Schematic steel reinforcement distribution in plan is required.
5) Check punching of the slab around column C5.

Design Data: Floor cover + Partitions = 3.0 kN/m² - L.L = 4.0 kN/m²

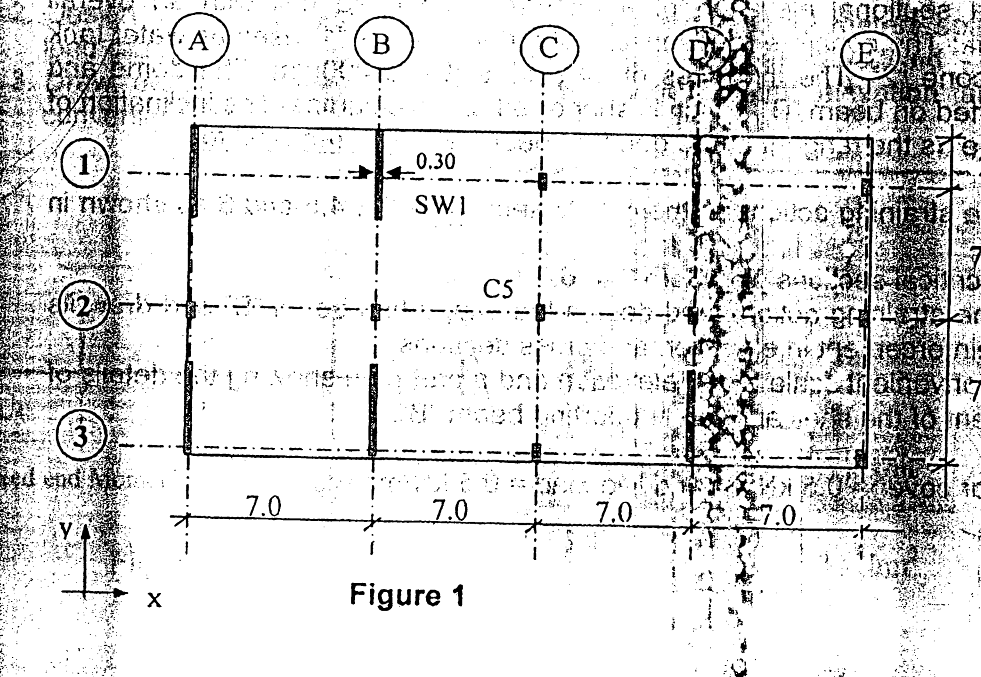


Figure 1

Question (2) (25% of maximum credit)

Assuming that the office building in Figure 1 is located in Alexandria on a medium soil. The contribution of columns in resisting seismic load in Y-direction may be neglected.

Due to earthquake loads in the Y direction only, it is required to:

1) Calculate the equivalent static loads at foundation level (Base shear and torsion moment).
2) Calculate and draw the distribution of the equivalent static load, the shear force diagram and bending moment diagram over the height of the building.
3) Check the global overturning and sliding of the building at foundation level.
4) Neglecting the coupling of the shear walls, calculate the percentage of the base shear "V" carried by the shear wall (SW1) on axis "B".

Design Data:

$$V = (Z\,I\,K\,C\,S)\,W \qquad Z = 0.3$$

$$C = \frac{1}{15\sqrt{T}} \qquad T = 0.09\frac{H}{\sqrt{B}}$$

$$K = 1.33 \qquad I = 1.0 \qquad S = 1.15$$

$$F_i = \frac{W_i H_i (V - F_t)}{\sum_{i=1,N} W_i H_i}$$

$$F_t = 0.07\,TV \le 0.25\,V \quad (for\,T > 0.7)$$

$$F_t = 0 \quad (for\,T \le 0.7)$$

Question (3) (35% of maximum credit)

Figure 2 shows a sectional elevation of a reinforced concrete hall with an overall diameter of 26.0 m. The concrete roof consists of a dome, cone "1" used as water tank and a cantilever cone "2". The thickness of all shell slabs is 200mm. The dome and cone 2 are supported on beam "B", which is supported on 10 columns. The inclination of the column is same as the tangent of the dome at beam "B". It is required to:

1. Calculate the straining actions at the critical sections 1,2,3,4,5 and 6 as shown in the figure.
2. Design the critical sections only from 3 to 6.
3. Calculate the straining actions and design the supporting beam "B" and draw its details of reinforcement in elevation and cross sections.
4. Draw to a convenient scale a half elevation and a part plan showing the details of reinforcement of the shell and the supporting beam "B".

Design Data: Floor cover = 0.5 kN/m^2 and live load = 0.5 kN/m^2.

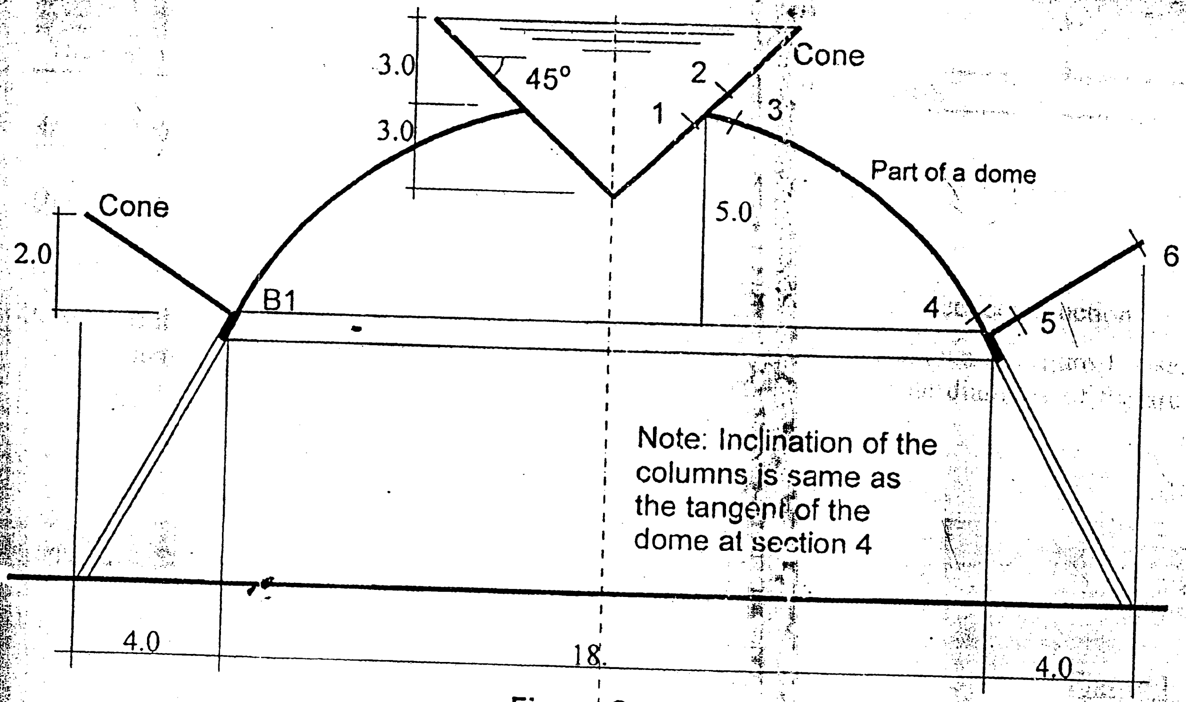


Figure 2

Question (4) (25% of maximum credit)

Figure 3 shows the statical system of a 3-span reinforced concrete highway bridge. The bridge has no sidewalks and has 3 lanes of 3.0 meters width each. Therefore, the total width of the bridge is 9.0 meters, while its spans are 6, 12 and 6 meters.

It is required to:

1. Estimate the dimensions of the bridge and draw its concrete dimensions in plan, and cross sections to convenient scale.
2. Design the critical sections (+ve & -ve) of the middle 12 meters span for the given load case. (Assume the statical system of the main span to be fixed – fixed)
3. Draw details of reinforcement of the bridge in half elevation and sections to convenient scale.

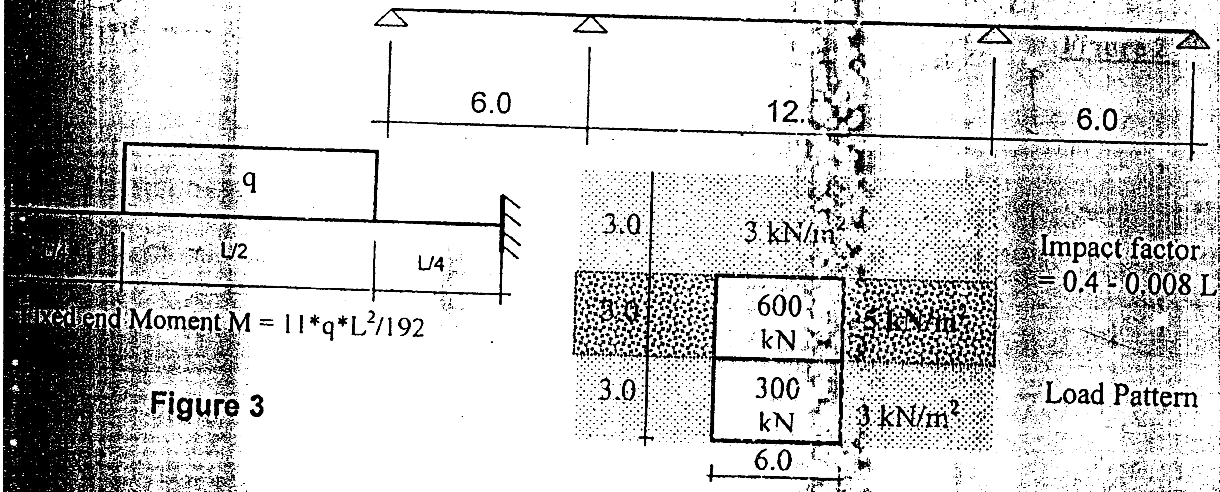


Figure 3

Jan 2007 **Time : 3:00 Hr**

Design of Reinforced Concrete Structures

The Exam Consists of Four Questions in **three** Pages.

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

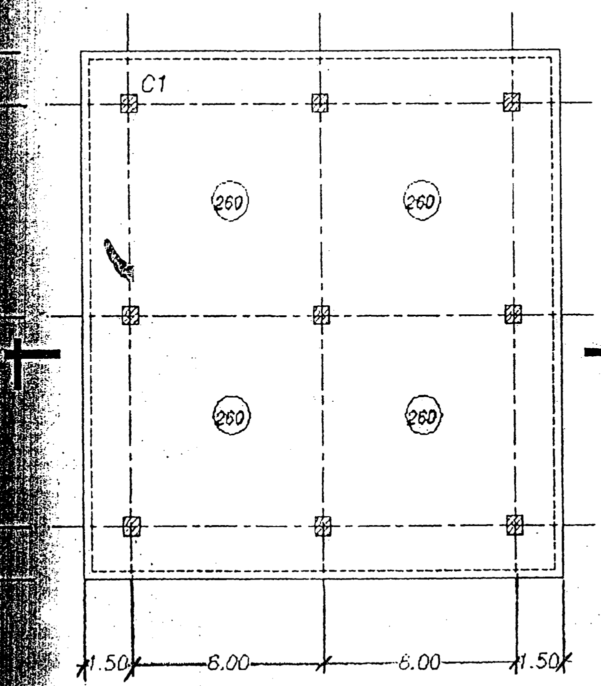
Used materials in all Questions: Concrete: f_{cu} = 30 MPa and Steel 36/52.

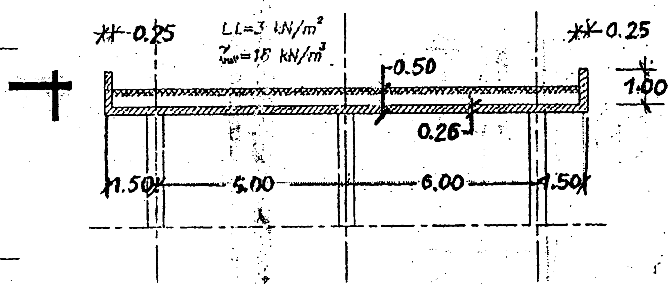
Question (1) (30% of maximum credit)

Figure 1 shows a structural plan of a roof garden supported on a flat slab. The structure has overall dimensions of 15.0x15.0m and contains no interior beams. The floor slabs are supported on 9 columns of dimensions 350x350 mm and 4.0-m height. It is required to:

1) Calculate the internal forces and design the reinforced concrete flat slab.
2) Draw to a convenient scale a half plan and section showing clearly the details of the slab reinforcement.
3) Check punching of the slab around column C1. If it is unsafe, suggest without any calculations possible modifications required to satisfy the punching shear design.

Design Data: Floor cover = 2.0 kN/m^2 - L.L = 3.0 kN/m^2 - γ_{soil} = 18 kN/m^3





Question (2) (25% of maximum credit)

Figure 2 shows a structural plan of a typical floor of a10-stories office building located in Aswan on weak soil. The building has overall dimensions of 39.0x24.0m and contains no interior beams. The floor slabs are supported on a combination of shear walls and rectangular columns and the floor height is 4.5-m. Due to earthquake loads in the Y direction only, it is required to:

1) Calculate the equivalent static load at foundation level (Base shear).
2) Calculate and draw the distribution of the equivalent static load, the shear force diagram and bending moment diagram over the height of the building.
3) Check the global overturning and sliding of the building at foundation level.
4) Calculate the percentage of the base shear "V" carried by the shear wall (W1) on axis "E". The stiffness of the columns may be ignored.

Design Data:

L.L = 6.0 kN/m² & F.C. = 1.0 kN/m²

$V = (Z\ I\ K\ C\ S)\ W \qquad Z = 0.3$

$C = \dfrac{1}{15\sqrt{T}} \qquad T = 0.09\dfrac{H}{\sqrt{B}}$

$K = 1.33 \qquad I = 1.0 \qquad S = 1.3$

$$F_j = \frac{W_j H_j (V - F_t)}{\sum_{i=1,N} W_i H_i}$$

$F_t = 0.07\,TV \le 0.25V \ldots\ldots\ldots\ (for\ T > 0.7)$

$F_t = 0 \ldots\ldots\ldots\ (for\ T \le 0.7)$

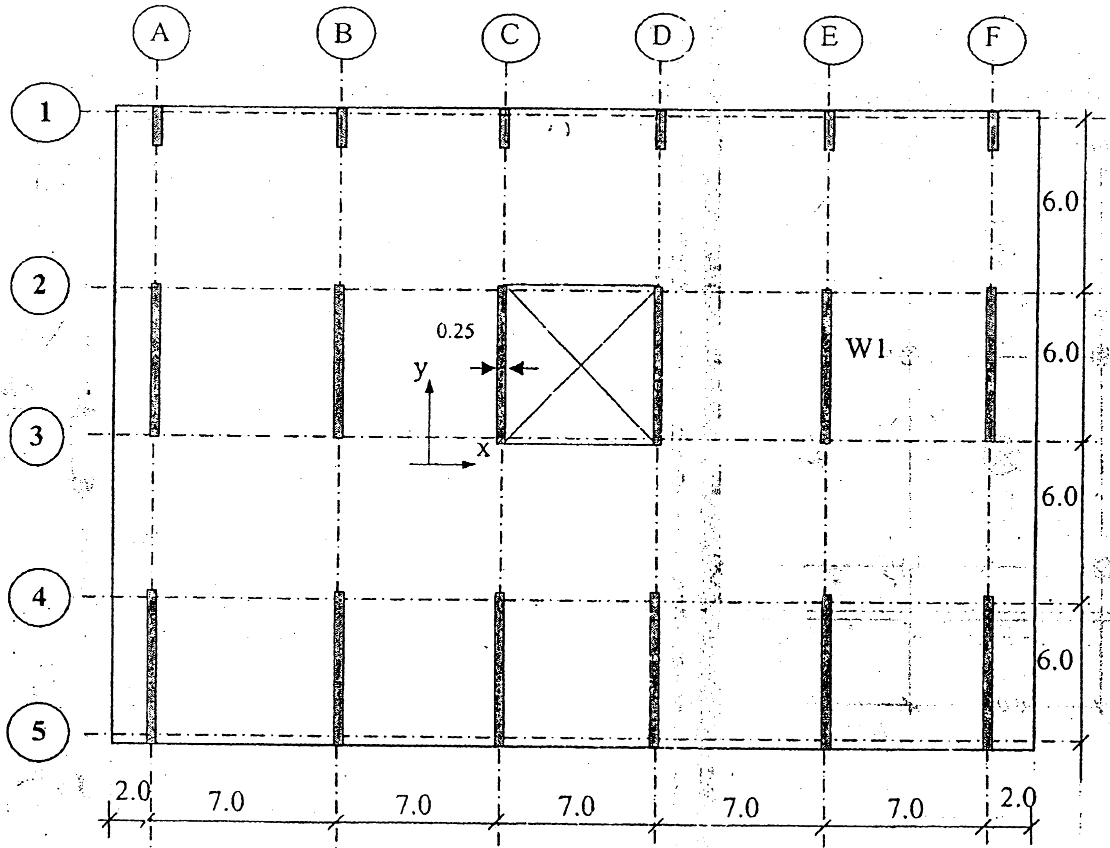


Figure 2

Question (3) (12% of maximum credit)

For a two-span concrete bridge having width of 15 meters and spans of 22 meters each, without any calculation, it is required to:

1. Choose concrete dimensions of a girder-type bridge deck and draw its cross section to a convenient scale.
2. For the bridge deck in question 1, explain briefly how to calculate the reaction on each longitudinal girder due to a single concentrated load at the mid-span of the external girder in the following cases:
   Case A): the deck has no cross girders
   Case B): the deck has stiff cross girders

Question (4) (40% of maximum credit)

Figure 3 shows a sectional elevation of a hotel reception hall. The roof of the hall has a circular dome supported by 12 columns on its outer perimeter with a diameter (d=24m) and has a central opening with a diameter of 6.0m. The roof is subjected to floor cover of 1.5 kN/m^2 and live load of 1.0 kN/m^2 in addition to its self weight. The central part of the dome is covered by a steel-glass structure supported on a conical concrete surface, which is connected to the dome at Beam B1. The hall is connected to the hotel building with a ring corridor covered with horizontal slab at level 6.5m. This horizontal slab is supported on the hotel building all around. Assuming a total weight of the steel-glass structure of 200 kN, it is required to:

1) Design the critical sections 1,2, 3 and 4.
2) Calculate the design loads and internal forces on the ring beams B1 and B2.
3) Design the ring beam B2 (total column no. = 12) and draw its cross sections showing dimensions and reinforcement details.
4) Draw the details of reinforcement of the dome and cone shells in half sectional elevation and quarter plan to a convenient scale.
5) Without any calculation, show how to design the slab of the ring corridor.

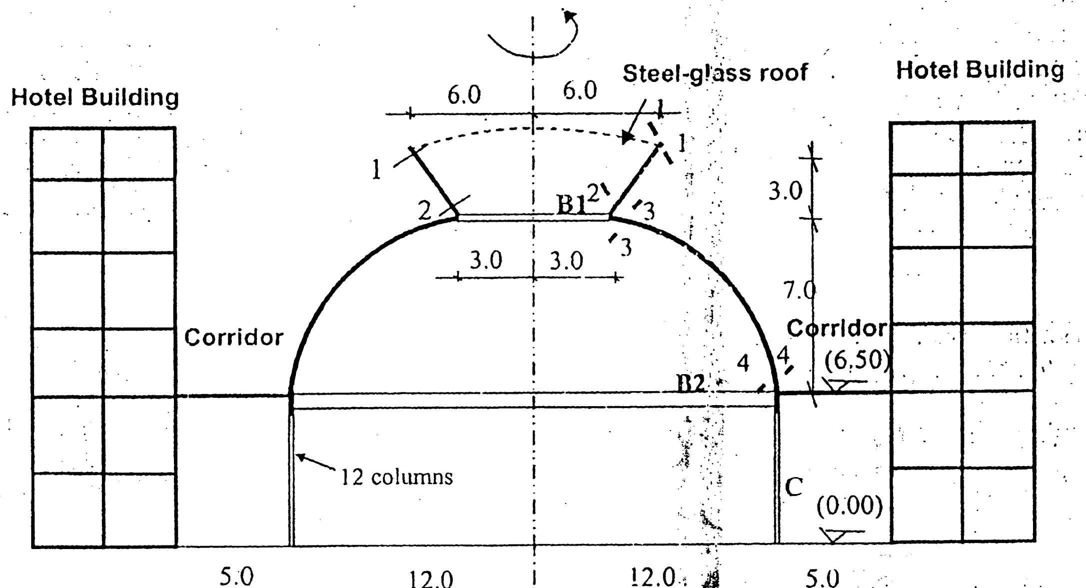


Figure 3

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING
DEPARTMENT

DESIGN OF STEEL BRIDGES
Fourth Year Civil – (Structural Eng. Sec.)
COURSE NO. CES 452
1st Term, December 2014
Time : 3 Hrs

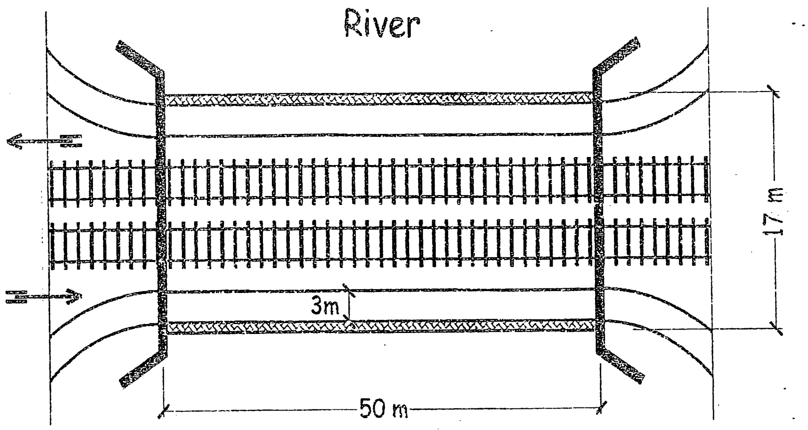
الصف الرابع ٢٠١٥م

المادة: تصميم منشآت معدنية (٣)

Material of construction is steel 52 and Live load is according to the Egyptian Code of Practice.
Data not given may be reasonably assumed./

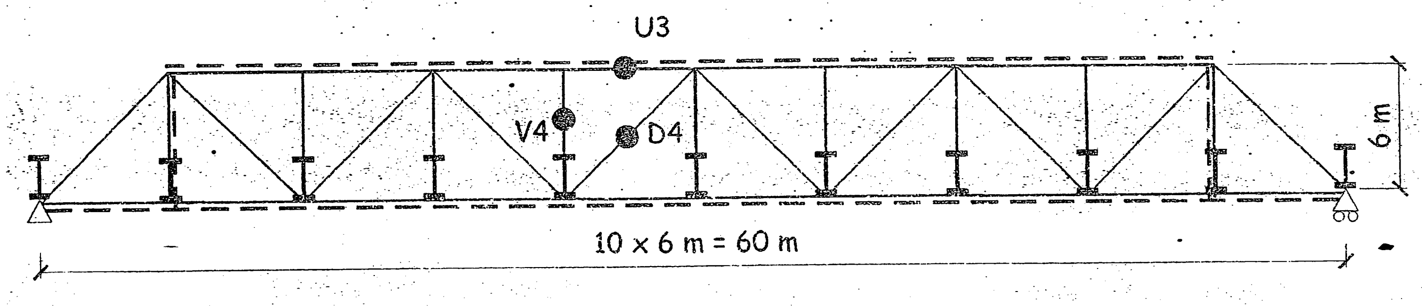
Question (1): 35%

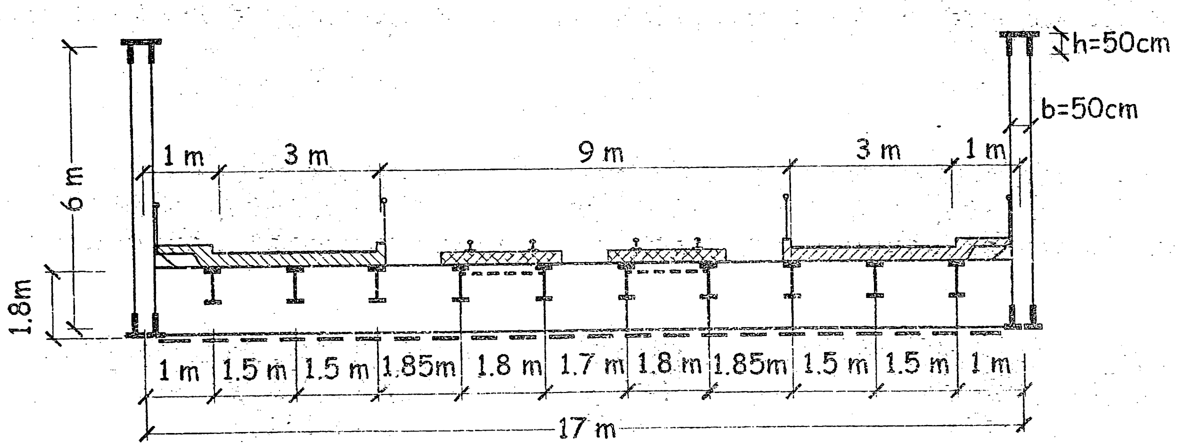
A combined road-railway bridge is to be constructed to cross a river of width 50 m. The total bridge width is 17 m including 1.0 m side walk at each side. The high water levels of the river is (+40.0). Top level of the roads is (+51.0). The minimum clearance required for navigation at the river is 5.0 m. Using a suitable scale, draw a complete general layout (for the 50 m span between the piers) showing the arrangement of the main elements of the bridge, floor beams and bracing systems in different views.



Question (2): 80%

A combined rail-roadway pony welded truss bridge of the shown cross section has a span of 60 m and is divided into 10 equal panels 6.0 m each. The main trusses are spaced 17 m apart. Depth of the main truss is 6.0 m. The inner spacing between the gusset plates is 50 cm, and depth of the upper and lower truss chords is taken as 50 cm. Depth of the welded cross girder is taken as 1.8 m. It is required to;





AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING D

DESIGN OF STEEL BRIDGES
Fourth Year Civil – (Structural Eng. Sec.)
COURSE NO. CES 452
1st Term, December 2014
Time : 3 Hrs

1- Calculate the maximum B.M. and maximum S.F. of in intermediate cross-girder due to live load and impact only. $I+1 = 0.73 + \frac{2.16}{\sqrt{L_i - 0.2}}$, where L_i = Effective Length for designed member **(15%)**

2- Design a welded built-up section for an intermediate cross-girder knowing that;

$M_{D.L.} = 110$ m.t $\quad Q_{D.L.} = 32$ t $\quad F_{sr} = 1.26$ t/cm^2 **(15%)**

3- Check the tendency of web buckling due to pure shearing stresses in the critical panel of the cross girder (Consider $Q_{Mid\text{-}Panel} = 0.94\ Q_{D+L+I}$).

[k_q=5.34+ ($4/\alpha^2$), for $\alpha>1$ & k_q=4+ ($5.34/\alpha^2$), for $\alpha<1$, $\lambda_q = \frac{d/t_w}{57}\sqrt{\frac{F_y}{k_q}}$ for $\lambda_q \le 0.8$ $q_b = 0.35F_y$,

for $0.8 < \lambda_q < 1.2$ $q_b = (1.5 - 0.625\ \lambda_q)\ 0.35F_y$, and for $\lambda_q \ge 1.2$ $q_b = (0.9/\lambda_q)\ (0.35F_y)$]. **(5%)**

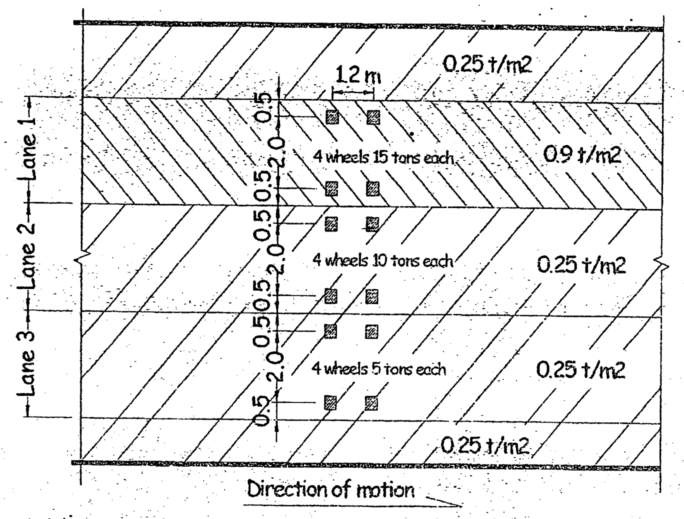
4- Design an intermediate transverse stiffener for the welded cross girder, consider $Q_{stiffener} = 0.9\ Q_{D+L+I}$

where: $C_s = 0.65\ [(0.35F_y/q_b)-1]\ Q_{stiffener}$ **(5%)**

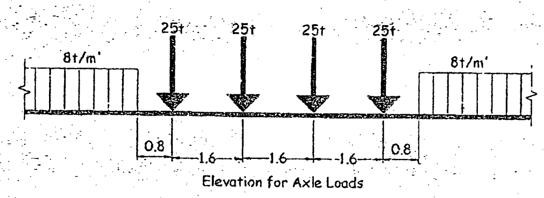
5- Find maximum and minimum forces in marked members U3, D4 and V4 due to live loads and impact only. **(20%)**

6- Design suitable sections for the marked members U3, D4 and V4, knowing that;
For U3: F_D= -527 t (Comp.), D4: F_D= -31 t (Comp.),
Note: for member (U3), consider the flexibility of U-frame action δ= 0.08 cm/ton **(20%)**

Roadway Load Pattern



Railway Load Pattern



--- GOOD LUCK ---

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT

4th Structure

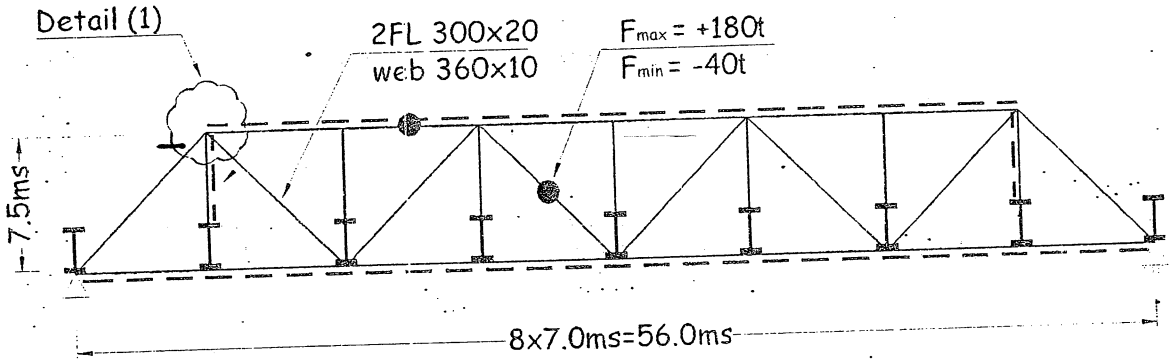
Jan. 2013 **Course Code: CES431** ***Time : 3.00 Hrs***

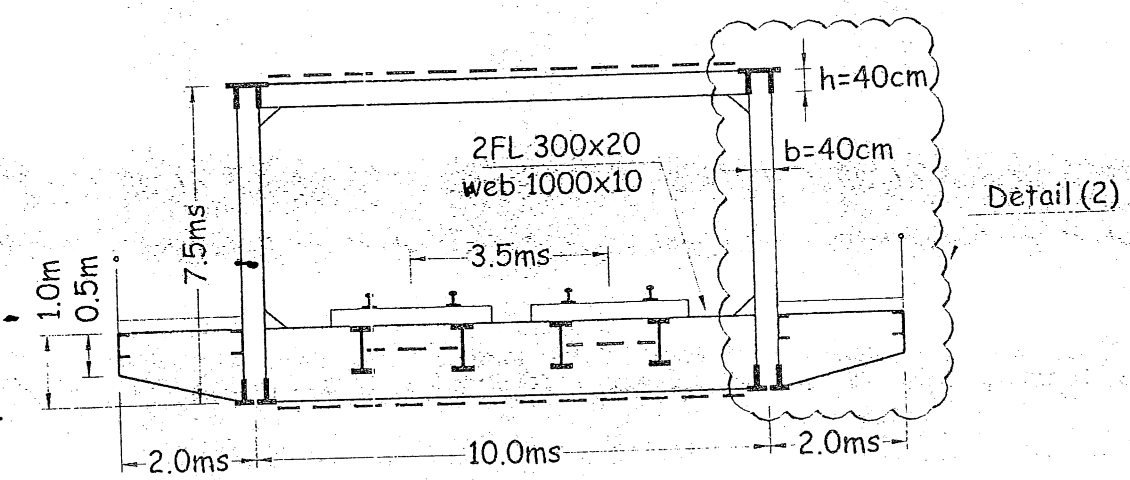
Steel Structures Design (2)

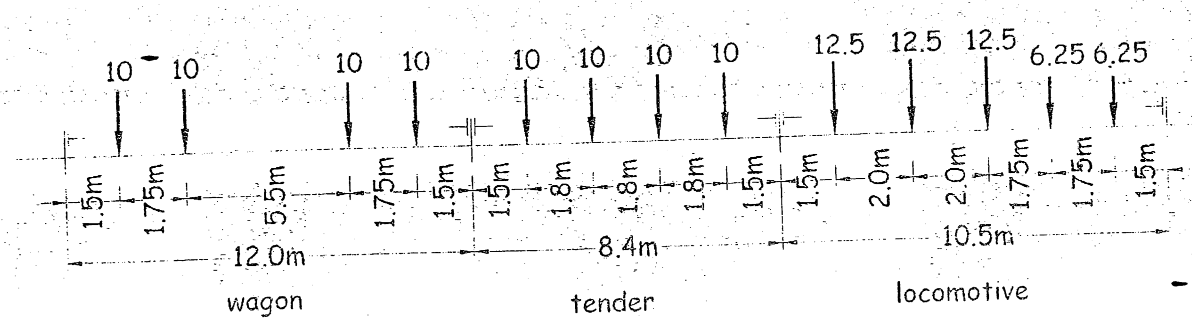
The Exam Consists of Two Questions in Two Pages. ***Total Marks: 70 Marks*** 1/2

- **Any missing data may be reasonably assumed**
- **Material of construction is Steel 52 with $F_y = 3.6$ t/cm^2 and $F_u = 5.2$ t/cm^2**

As shown in the below figures, a double-track railway truss girder bridge with double side-walk for pedestrians has a span of 56.0 ms. divided into 8 equal panels 7.0 ms. each. The main girders are spaced 10 ms. apart and have a depth of 7.5 ms. The side-walk is 2.0 ms width and the depth of cross girder is taken equal to 1.0 m. The bridge is provided with upper wind bracing as well as lower bracing along with braking force bracing system. The depth of truss chord members, h, as well as the inner spacing between gusset plates, b, is taken equal to 40 cm.







AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT

4th Structure

Jan. 2013 | **Course Code: CES431** | *Time : 3.00 Hrs*

Steel Structures Design (2)

The Exam Consists of Two Questions in Two Pages. **Total Marks: 70 Marks**

QUESTION (I): (50%)

1. Using scale 1:200, **Draw** complete bracing system of the bridge including: upper wind bracing, lower wind bracing, stringer bracing, and braking force bracing. (15%)

2. **Calculate** wind loads on both upper and lower wind bracing; **Design** the critical members for both bracing systems. (12%)

3. **Calculate** the braking force acting on the bridge bracing system; **State** using neat sketches, how to transmit braking force from stringer level to the bearings. (12%)

4. **Calculate** and **Draw** the straining action diagrams (M, N & Q) for the portal wind frame for the following two cases:
   - The portal frame is vertical "as shown in the figure",
   - The portal frame is inclined.

   Using welded I-section 2FL 350x25 / web 350x10, **Check** safety of the rafter of the portal wind frame based on the critical case of the previous two cases. (12%)

QUESTION (II): (50%)

1. Due to live load plus impact, **Calculate** the maximum normal force acting on the marked upper chord (take live load plus impact for pedestrian side-walk 500 kg/m^2); **Design** a suitable welded built-up section for the member taking F_D = -320 t. (15%)

2. **Design** the marked diagonal member considering the maximum force F_{max} = +180 t (tension) and the minimum force F_{min} = -40 t (compression), take F_{sr} = 1.26 t/cm^2. (12%)

3. **Design** the truss connection clouded as detail (1) using High strength bolt M24 (10.9) taking Ps = 6.94 t; **Draw** the connection to scale 1:10. (12%)

4. **Draw** the bridge side view clouded as detail (2) using scale 1:10. (12%)

--- GOOD LUCK ---

Course Examination Committee
Prof. Dr. Imam Soliman
Dr. Sherif Abdelbasset
Dr. Ahmed Matloub

Exam Date: *12 Jan. 2013 9.00 am*

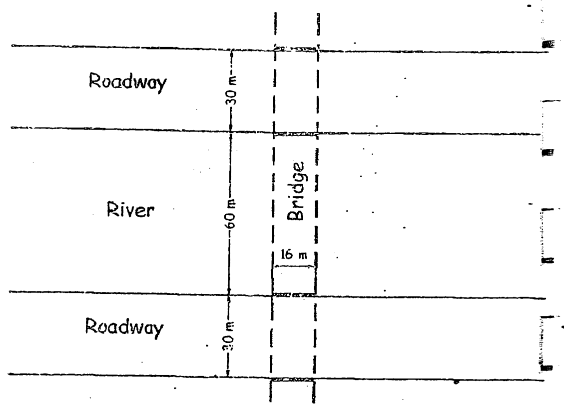
AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT

DESIGN OF STEEL BRIDGES
Fourth Year Civil – (Structural Eng. Sec.)
COURSE NO. CES 452
1st Term, January 2014
Time : 3 Hrs

Material of construction is steel 52 and Live load is according to the Egyptian Code of Practice.
Data not given, may be reasonably assumed.

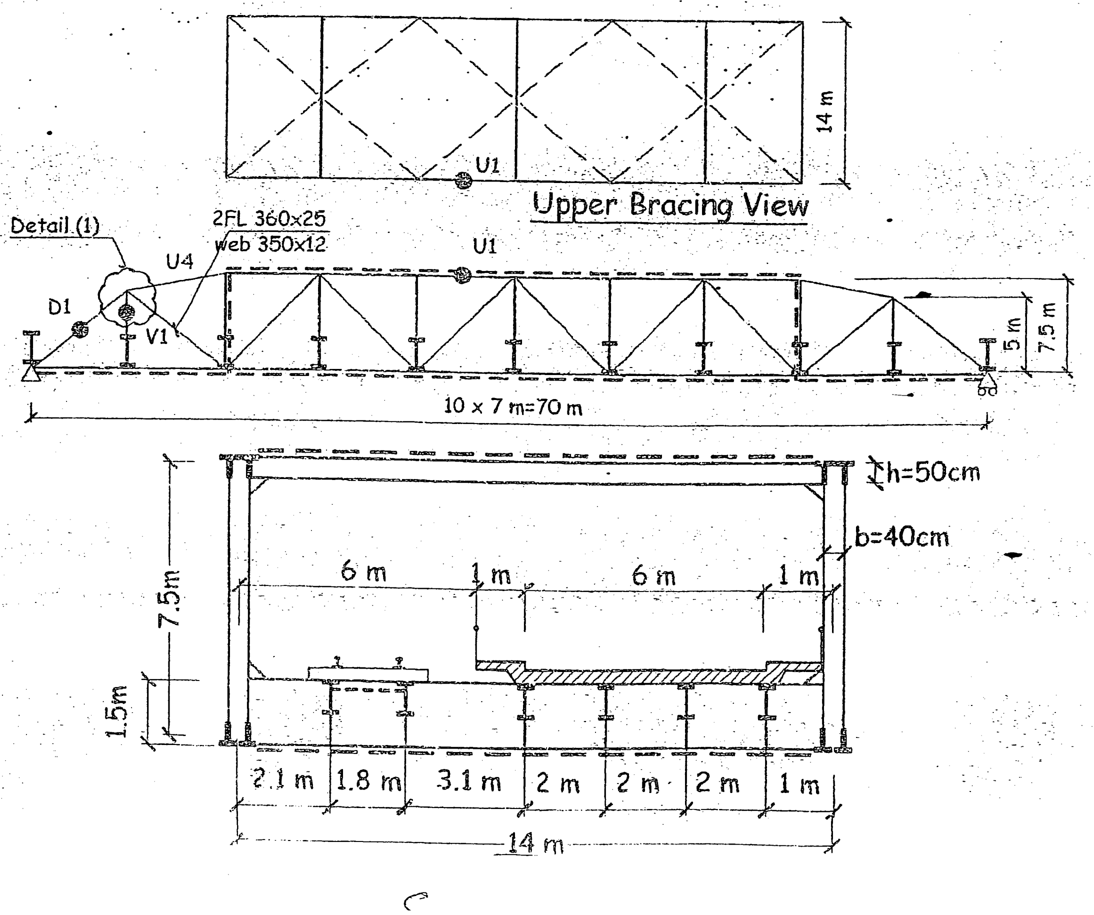
Question (1): 35%

A roadway bridge is to be constructed to cross a river of width 60 m and two roads of width 30 m at each side of the river. The roads are parallel to the river. The total bridge width is 16.0m including 2.00m side walk at each side. The high and low water levels of the river are (+350.0) and (+347.5), respectively. Top level of the roads is (+357.50). The minimum clearance required for navigation at the river is 5.0 m and 6 m for the roads. The R.C. slab thickness is 150mm, and asphalt thickness is 50mm. Maximum slop for vertical ramp at the bridge-approaches should be less than 1:10. Using a suitable scale, draw a complete general layout showing the arrangement of the main elements of the bridge, floor beams and bracing systems in different views.



Question (2): 80%

A combined rail-roadway through welded truss bridge of the shown cross section has a span of 70 m and is divided into 10 equal panels 7.0 m each. The main trusses are spaced 14 m apart. Depth of the main truss is 7.5 m. The inner spacing between the gusset plates is 40 cm, and depth of the upper and lower truss chords is taken as 50 cm. The bridge is provided with partially upper as well as lower wind bracings as shown in the figure. Depth of the welded cross girder is taken as 1.5 m. It is required to;



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING
DEPARTMENT

DESIGN OF STEEL BRIDGES
Fourth Year Civil – (Structural Eng. Sec.)
COURSE NO. CES 452
1St Term, January 2014
Time : 3 Hrs

1- Calculate the maximum B.M. and maximum S.F. of in intermediate cross-girder due to live load and impact only. $I+1 = 0.73 + \frac{2.16}{\sqrt{L_i - 0.2}}$, where L_i = Effective Length for designed member **(15%)**

2- Design a welded built-up section for an intermediate cross-girder knowing that;
$M_{D.L.} = 100$ m.t $Q_{D.L.} = 33$ t $F_{sr} = 1.26$ t/cm^2 **(10%)**

3- Check the tendency of web buckling due to pure shearing stresses in the critical panel of the cross girder (Consider $Q_{Mid\text{-}Panel} = 0.94\ Q_{D+L+I}$).

[k_q=5.34+ (4/α2), for α>1 & k_q=4+ (5.34/α2), for α<1, $\lambda_q = \frac{d/t_w}{57}\sqrt{\frac{F_y}{k_q}}$ for $\lambda_q \le 0.8$ $q_b = 0.35F_y$,

for $0.8 < \lambda_q < 1.2$ $q_b = (1.5 - 0.625\ \lambda_q)\ 0.35F_y$, and for $\lambda_q \ge 1.2$ $q_b = (0.9/\lambda_q)\ (0.35F_y)$]. **(5%)**

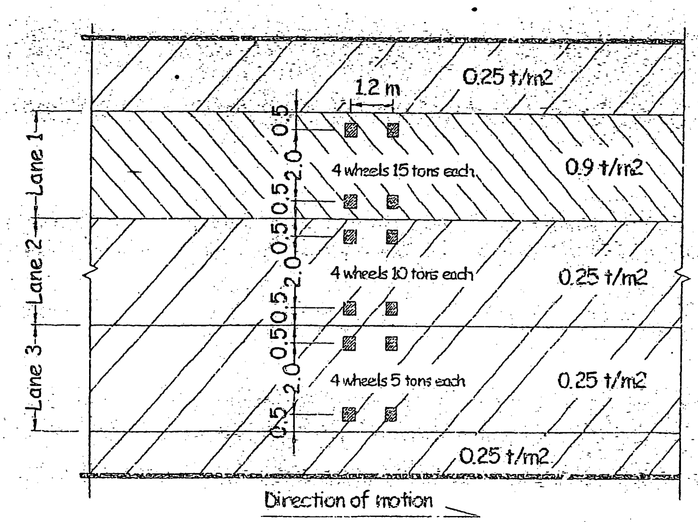
4- Design an intermediate transverse stiffener for the welded cross girder, consider $Q_{stiffener} = 0.9\ Q_{D+L+I}$
where: $C_s = 0.65\ [(0.35F_y/q_b) - 1]\ Q_{stiffener}$ **(5%)**

5- Find maximum axial forces in marked members U1, D1 and V1 due to live loads and impact. **(15%)**

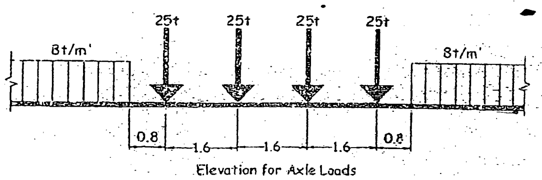
6- Design suitable sections for the marked members U1, D1 and V1, knowing that;
For U1: F_D= -550 t (Comp.), D1: F_D= -420 t (Comp.), V1: F_D= +50 t (Tens.)
Note: for member (D1), consider the flexibility of U-frame action <u>δ= 0.07 cm/ton</u> **(15%)**

7- Design the truss connection clouded as detail (1) using High strength bolt M27 (10.9) taking Ps = 7.22 t. Draw the connection to scale 1:10. Consider member U4 same as D1. **(15%)**

<u>Roadway Load Pattern</u>



<u>Railway Load Pattern</u>



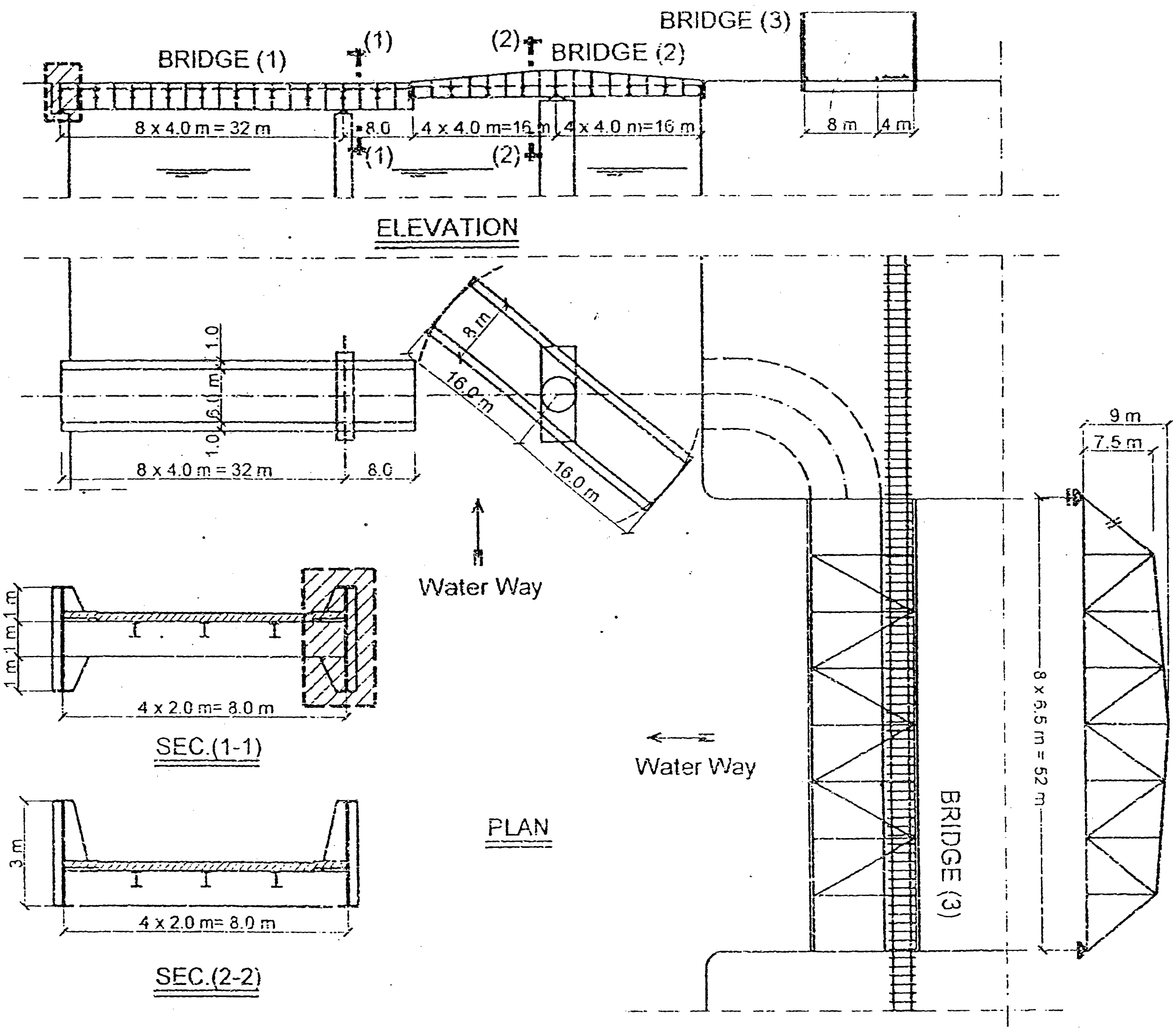
--- **GOOD LUCK** ---

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT

Fourth Year Civil – (Structural Section)
DESIGN OF STEEL BRIDGES
COURSE NO. CES 452
1st Semester, 2011-2012
Time : 3.00 hrs

Exam consists of One Question in Two Pages.

STEEL USED IS 36/52, DATA NOT GIVEN MAY BE REASONABLY ASSUMED



The above drawings contain 3 types of bridges as shown in the figure. The first one is a roadway plate girder bridge with cantilever. Span of bridge is 32 m and the cantilever length is 8 m. The bridge width is 8 m as shown in section (1-1). The spacing between cross girders is 4 m. Spacing between stiffeners of main girder is 2 m apart. The second bridge is a continuation of the same roadway using a swing bridge type with double cantilever, 16 m each, as shown in plan. The swing bridge cross section is shown in section (2-2). The third bridge is a combined road-railway truss bridge as shown in the figure. This bridge is through type divided into 8 equal panels with 6.5 m each. The total width of the bridge is 12 m.

The road way live load is taken as a distributed load of 500 Kg/m^2 only, plus impact, and including the walk ways as well. It is required to:

1- Suggest suitable system of bracing for bridges (1) and (2). Draw a plan for these bracings to scale 1:200. **(Mark: 10%)**

2- Design a cross-section for the main plate girder of bridge (2) in the "Case Open bridge", knowing that, Dead load +Floor cover =1200 Kg/m^2. Check deflection of that cantilever bridge. **(Mark: 15%)**

3- Check the safety against lateral torsional buckling of the compression flange for the cantilever of bridge (1) at section (1-1), knowing that δ =0.03 cm/ton, and plate girder cross section is composed of flange plate 500x25 mm and web plate 3000 x12 mm. C_b= 2.1

M (Dead) = 600 m.t M (Live+ Impact) = 450 m.t **(Mark: 15%)**

4- Check buckling of web plate and flexure strength of cross section of the cantilever part of bridge (1) at section (1-1), knowing that, Q (Total) = 180 ton.

If the section is unsafe against web buckling, what do you suggest to increase its strength? Use neat sketches. **(Mark: 15%)**

5- Design a field splice for the main plate girder of bridge (1), knowing that Q=60 t. Draw elevation and cross-section of the splice to scale 1:10, Indicate where is the best location of the field splice for this bridge. **(Mark: 15%)**

6- Design an end-bearing stiffener for bridge (2), at the supporting pier. Consider case open with full live load. **(Mark: 10%)**

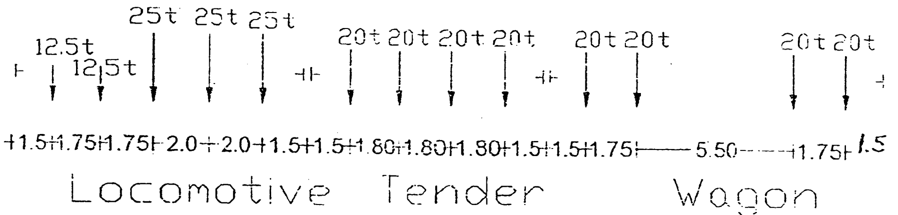
7- For truss bridge (3), draw general layout, elev. Plan, bracings,...etc., to scale 1:200. **(Mark: 10%)**

8- Draw the influence line and calculate the maximum force due to live load +impact only for the marked member (//), the first diagonal of truss bridge (3). **(Mark: 10%)**

9- Draw parts enclosed in dotted rectangles to scale 1:10. **(Mark: 10%)**

[kq=5.34+(4/α2), for α>1 & kq=4+(5.34/α2), for α<1, $\lambda_q = \frac{d/t_w}{57}\sqrt{\frac{F_y}{k_q}}$, for λq≤0.8 qb=0.35Fy,

for 0.8< λq <1.2 qb=(1.5-0.625 λq)0.35Fy , and for λq ≥1.2 qb=(0.9/ λq)(0.35Fy)].



Live Loads on Railway Bridges

- For shallow thick flanged sections: F_{ltb1}= 800/(L_u.d/A_f). C_b ≤ 0.58 F_y

- For deep thin flanges sections: $L_u/r_T < 84\sqrt{\frac{C_b}{F_y}}$ F_{ltb2}= 0.58 F_y

- When $84\sqrt{\frac{C_b}{F_y}} \le L_u/r_T \le 188\sqrt{\frac{C_b}{F_y}}$ F_{ltb2}=[0.64-{($L_u/r_T)^2$ F_y/(1.176x10^5 C_b)}] ≤ 0.58 F_y

- When $L_u/r_T > 188\sqrt{\frac{C_b}{F_y}}$ F_{ltb2}=12000. C_b /$(L_u/r_T)^2$. ≤ 0.58 F_y

GOOD LUCK

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

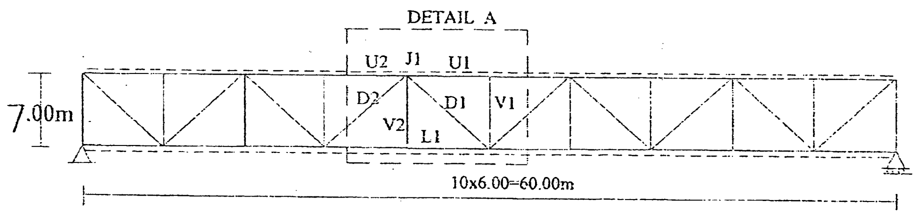
STRUCTURAL ENGINEERING DEPARTMENT

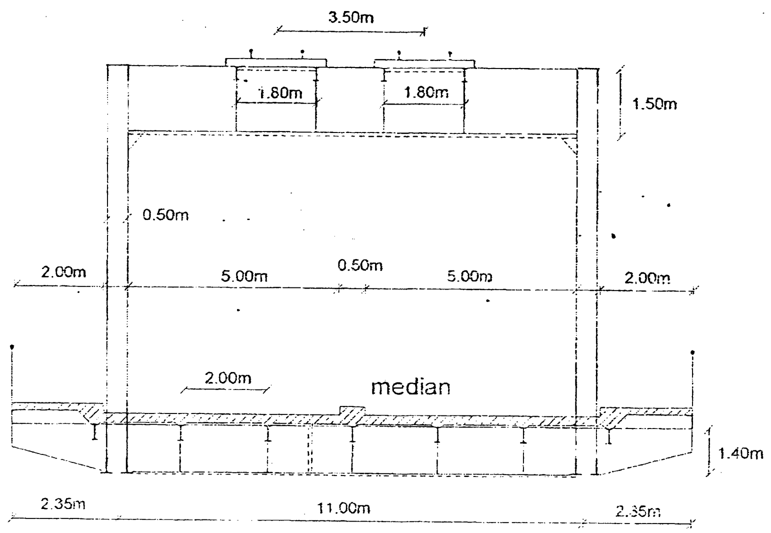
Fourth Year Civil – (Structural Section)
DESIGN OF STEEL BRIDGES
COURSE NO. CES 452
1st Semester, 2010-2011
Time : 3.00 Hrs

One Question in Two Pages.

Material of construction is **Steel 52** and Live load is according to the Egyptian Code of Practice.
Data not given may be reasonably assumed.

QUESTION (I) (100%):





Bridge Cross Section

A rail-roadway through welded truss bridge of the shown cross section has a span of 60.0 ms and is divided into 10 equal panels 6.0 ms each. The main trusses are spaced 11.0 ms apart. Depth of the main truss is 7.0 ms. The inner spacing between the gusset plates is 50.0 cm, and depth of the upper and lower truss chords is taken as 50.0 cm. The bridge is provided with upper as well as lower wind bracings. Depth of the lower roadway cross girder is taken as 1.40 m, while is taken as 1.50 m for the upper railway cross girder.

Required:

1- Draw to suitable scale the different bracing systems for the shown bridge (wind, stringer, and breaking force bracing). Calculate the forces on the breaking force bracing members (without design of members).

2- Design a suitable section for an intermediate simply supported lower stringer (only for roadway).

3- Design a welded built up section for an intermediate lower cross girder (roadway) (f_{sr}=1.12 t/cm2).

4- Design and draw (to scale 1:10 in elevation & plan) a bolted field splice for the cross girder section at 1.0 m from its mid-span (as shown in figure). Take the corresponding shearing forces at that section equal to 18.0t. Use M24 H.S. Bolts, quality 10.9, Ps = 5.55t

5- Check the tendency of web buckling due to pure shearing stresses in the critical panel of the cross girder (Consider Qmid-panel = 0.94 $Q_{D.L+L.L+I}$).

[$k_q=5.34+(4/\alpha^2)$, for $\alpha>1$ & $k_q=4+(5.34/\alpha^2)$, for $\alpha<1$, $\lambda_q = \frac{d/t_w}{57}\sqrt{\frac{F_y}{k_q}}$, for $\lambda_q \leq 0.8$ $q_b=0.35F_y$,

for $0.8<\lambda_q<1.2$ $q_b=(1.5-0.625\,\lambda_q)0.35F_y$, and for $\lambda_q \geq 1.2$ $q_b=(0.9/\lambda_q)(0.35F_y)$].

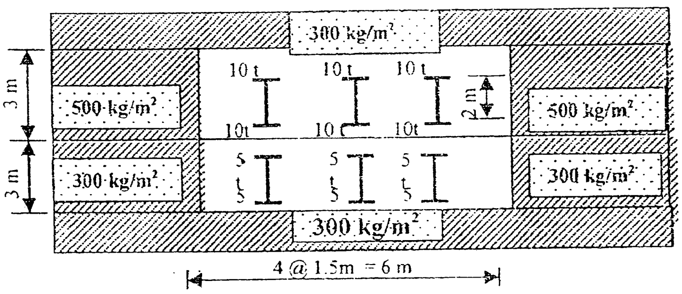
6- Design an intermediate bearing stiffener for the welded lower cross girder (Consider $Q_{stiffener}$ = 0.88 $Q_{D.L+L.L+I}$).

7- Find the maximum axial forces in the vertical members V1 and V2 **due to live loads and impact only.**

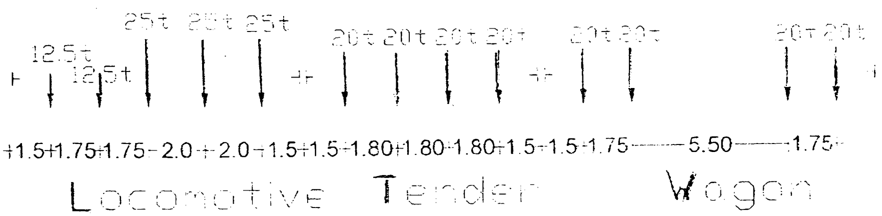
8- Design a suitable section for the upper chord member U1, lower chord member L1, diagonal member D1, and vertical member V1, given that the maximum forces are as shown in the following table. Find, without check, a suitable section for the upper chord member U2, diagonal member D2, and vertical member V2.

MEMBER	MINIMUM FORCES	MAXIMUM FORCES
U1	- 400 t	- 1200 t
U2	- 330 t	- 900
L1	+ 375 t	+ 1100 t
D1	- 60 t	+ 140 t
D2	- 25 t	- 230 t
V1	- 20 t	- 80 t
V2	+ 30 t	+ 65 t

9- Design the joint J1, using M27 H.S. Bolts, quality 10.9, Ps = 7.22t. Draw the part A to scale 1:10.



Live Loads on Roadway Bridges



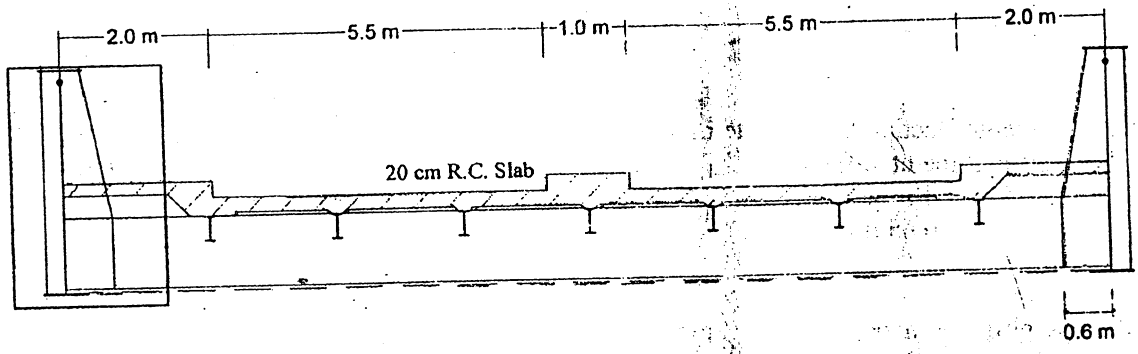
Live Loads on Railway Bridges

GOOD LUCK

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPT.
Fourth Year Civil – (Structural Division)

DESIGN OF STEEL BRIDGES
COURSE NO. CES 452
Jan. 2009
Time : 3 Hrs

Material of construction is steel 44.
Data not given may be reasonably assumed.



A plate girder, roadway, pony bridge of span 27 m has the cross-section shown in figure. The bridge supports a roadway of width 12.0m (containing a median of 1.0 m) and two side-walks 2.0 m each. The bridge floor beams consist of stringers each 2.0 m supported over cross girders as shown in figure. The spacing between cross girders is taken 4.5 m. The bridge floor consists of R.C. slab of thickness 20 cm in road and 16 cm in sidewalks. Flooring is 180 kg/m^2. Live load is taken according to Egyptian code.

<u>It is required to:</u>

1- Calculate the maximum bending moment affecting an intermediate cross girder due to live load and impact only.

2- If the maximum straining actions affecting the main girder are; "M_{D+L+I} = 1500 m.t." and maximum shear "Q_{D+L+I} = 190 t" and M_D= 700 m.t., design a welded plate girder and the necessary web-to-flange fillet welds. Assume h_w = 2700 mm , t_w = 14 mm, and, f_{sr} = 1.25 t/cm^2.

3- Suggest suitable location for the field splice of the main girder. Design and draw (to scale 1:20 in elev. & plan) the bolted field splice for the main girder. Take the corresponding shearing forces at that section equal to 60t. Use M27 H.S. Bolts (grade 10.9).

4- Design a diagonal member of the horizontal bracing of the bridge, and draw its connection with the cross girder; using HSB - M24 (8.8) Ps = 4.86 t.

5- Check buckling of the main girder web plate due to pure shearing stresses ;given:

- Q_{D+L+I} =188 t at the middle of the critical panel.

- $K_q = 5.34 + (4/\alpha^2)$ for $\alpha > 1$ & $K_q = 4 + (5.34/\alpha^2)$ for $\alpha \leq 1$,
- $\lambda_q = (d/t_w)/57 \cdot \sqrt{F_y/K_q}$,
- For $\lambda_q \leq 0.8$ $q_b = \underline{0.35\ F_y}$,
- For $0.8 < \lambda_q < 1.2$ $q_b = \underline{(1.5-0.625\ \lambda_q)\ 0.35\ F_y}$,
- and for $\lambda_q \geq 1.2$ $q_b = \underline{(0.9/\lambda_q)(0.35\ F_y)}$

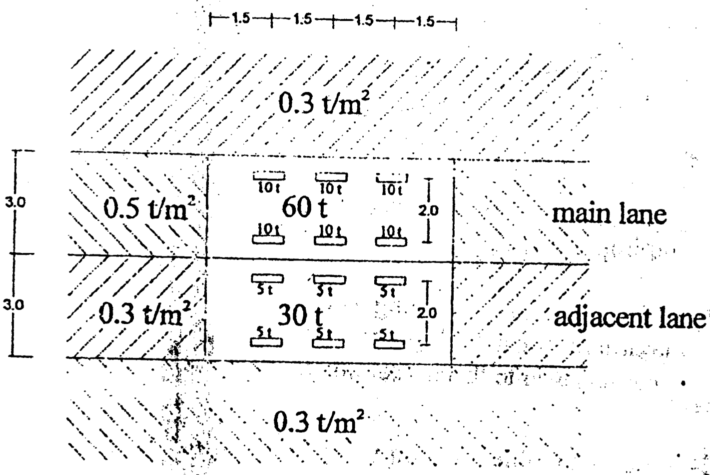
6- Design a suitable section of an intermediate stiffener of the main girder, given that the maximum shear force at stiffener $Q_{actual} = 185$ t. Design also a cross section for the horizontal stiffener provided at the one fifth of the web height from the compression flange.

- $C_s = 0.65\ [(0.35F_y/q_b) - 1]\ Q_{actual}$

7- If the cross girder is a plate girder composed of two flange plates 350x30 mm and a web 1350x12 mm, Design the connection between the cross girder and main girder using M24 pre-tensioned bolts grade (10.9). Draw part of the bridge enclosed by the rectangular to scale 1:10.

8- For web plate panel subjected to combined bending and shear, explain (using neat sketches) how check buckling is performed?

Live Loads for Roadway Bridges



GOOD LUCK

Prof. Dr. Mohamed El Aghoury
Dr. Sherif K. Hassan

سيناريو

ا/ المعمارات الحوارية
المنشآت الجديدة

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Public Works)

Jan. 2008

Design of Reinforced Concrete Structures ***Time : 3:00 Hrs***

The Exam Consists of three Questions in four Pages.

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

Used materials in all Questions: Concrete: f_{cu} = 35 MPa and Steel 36/52.

Question (1) (50 % of maximum credit)

Figure 1 shows a sectional elevation and two sectional plans of an underground water tank with lower and upper compartments. The tank is 10.0x 10.0 meters in plan with a total height of 8.0 m. The outer walls of the upper compartments are supported by a horizontal beam "B1" at top.

For only the case of upper compartment is full of water, it is required to:

1. Estimate the dimensions of the slabs and walls and draw the load diagram for section A-A and horizontal sections B-B and C-C at ¾ height of the wall.
2. Calculate and draw the bending moments and normal forces for the three sections A-A, B-B and C-C (corner effect should be considered).
3. Design the critical sections of walls and slabs (five sections are only required).
4. Draw, to a convenient scale, half-sectional elevation A-A and half-sectional plan C-C showing the concrete dimensions and details of reinforcement.
5. Calculate the internal forces acting on the horizontal beam B1.

Question (2) (30 % of maximum credit)

Figure (2) shows the structural plan of a typical floor in an industrial building. The floor has overall dimensions of 23x 23 m^2 and contains no beams. The typical floor height is 4 meter and the column dimensions at the top floor are (400 x 400) mm^2. it is required to:

1- Design the reinforced concrete slab (Drop panel is not allowed).
2- Draw to a convenient scale a 1/4 plan showing clear dimensions and reinforcement details of the slab and at the opening.
3- Check punching at the column C1.
4- Design the column C1 at ground floor (No. of floors=10) and draw its section (1:25).

Question (3) (25 % of maximum credit)

Figure (3) shows the structural plan of a typical and first floor in a residential building. The ground and first floors are used as a shopping mall. The building is composed of 8 floors and located in Cairo (**seismic zone 2, Z = 0.2**). The building is constructed on medium soil. The overall dimensions of the building are (35x 24 m^2). Floors are supported on shear walls and columns as shown in Figure (3).
Assuming the average floor thickness (t_s) = 200 mm (including weight of beams, columns and shear walls); and floor cover & partition loads = 3 kN/m². Assuming the building is

subjected to earthquake **in the Y- direction only** (neglect columns in the calculations) it is required to:

1. Calculate the total base shear force acting on the building.
2. Calculate and draw the distribution of the shear forces and bending moments over the height of the building.
3. Calculate the horizontal forces on the shear wall W1 at the foundation level taking the torsional effect into consideration.

$$V = (Z\ I\ K\ C\ S)\ W \qquad Z = 0.2$$

$$C = \frac{1}{15\sqrt{T}} \qquad T = 0.09\frac{H}{\sqrt{B}}$$

$$K = 1.33 \qquad I = 1.0 \qquad S = 1.15$$

$$F_j = \frac{W_j H_j (V - F_t)}{\sum_{i=1..N} W_i H_i}$$

$$F_t = 0.07\,TV \le 0.25V \ldots\ldots (for\ T > 0.7)$$

$$F_t = 0 \ldots\ldots (for\ T \le 0.7)$$

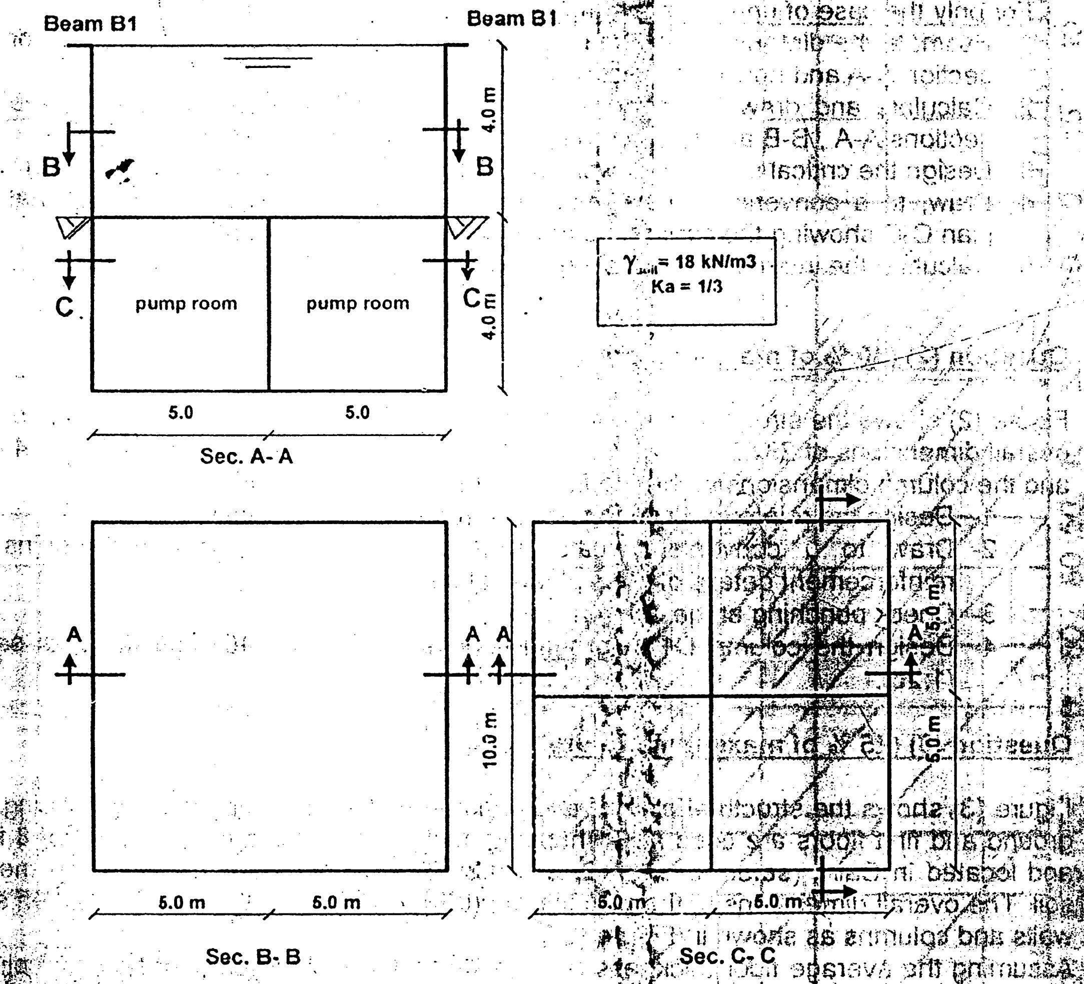


Figure 1

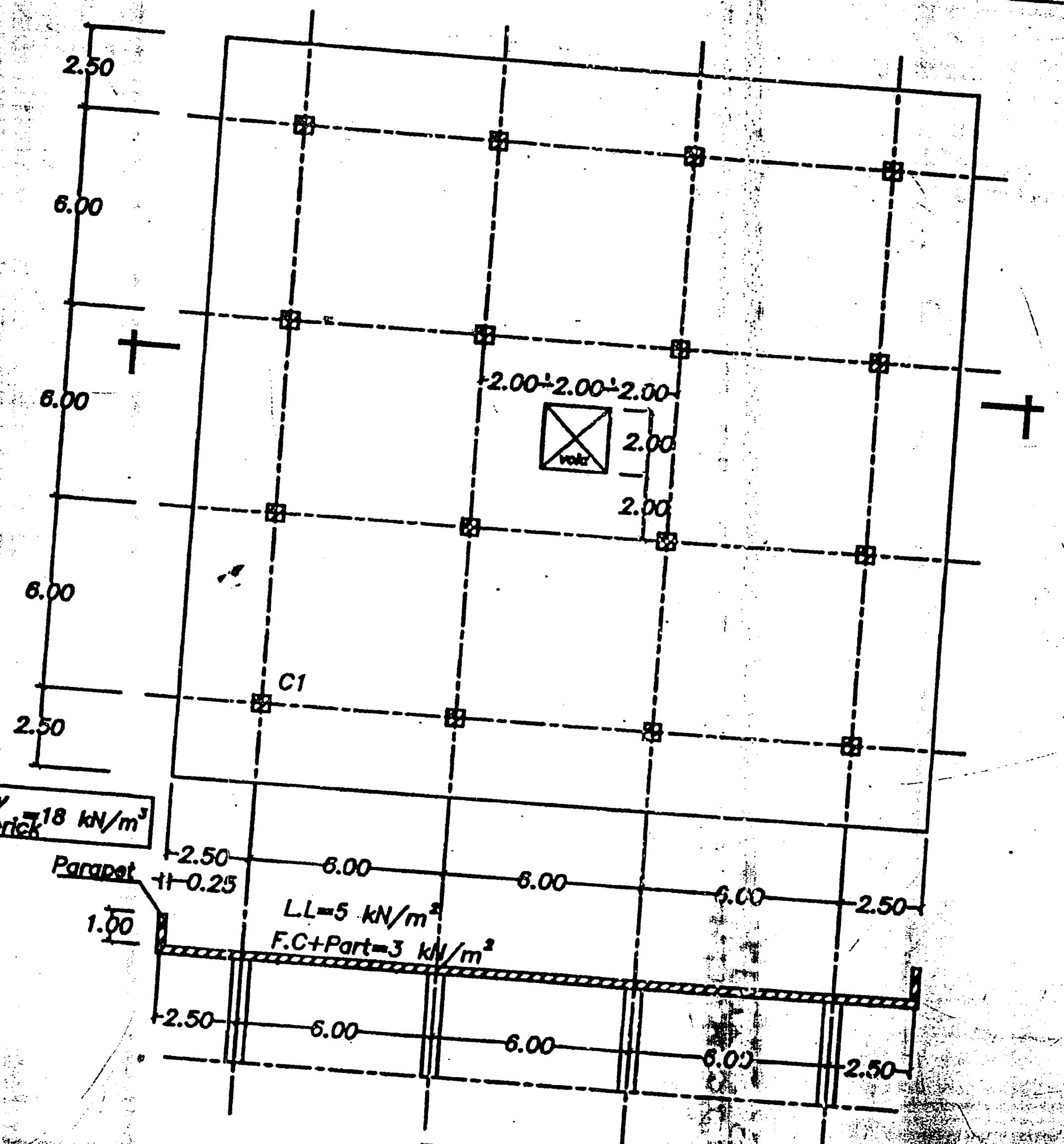
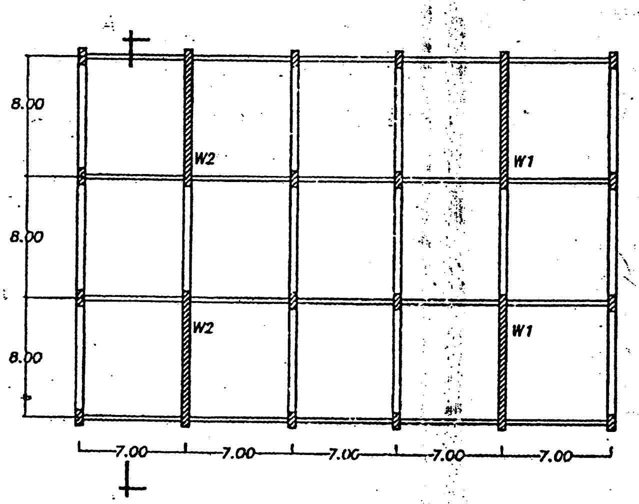
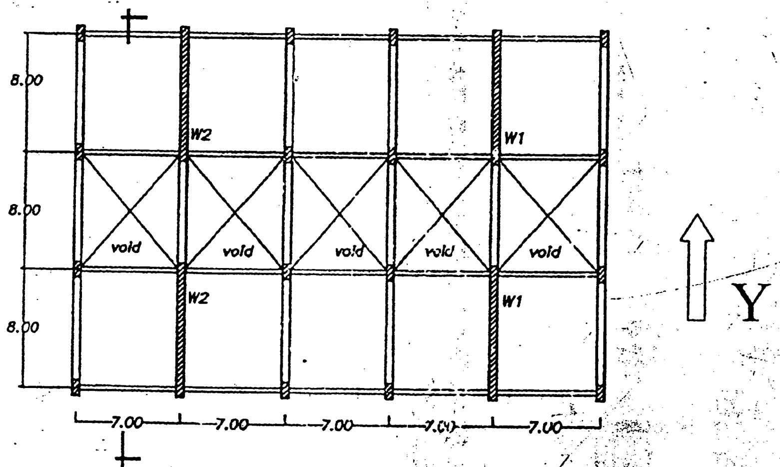

2.50
6.00
6.00
6.00
2.50
2.00
2.00
2.00
2.00
2.00
void
C1
γ_{brick}=18 kN/m³
Parapet
0.25
1.00
2.50
6.00
6.00
6.00
2.50
L.L=5 kN/m²
F.C+Part=3 kN/m²
2.50
6.00
6.00
6.00
2.50

Figure 2

Typical Floor Ceiling



Ground Floor Ceiling



Section A-A

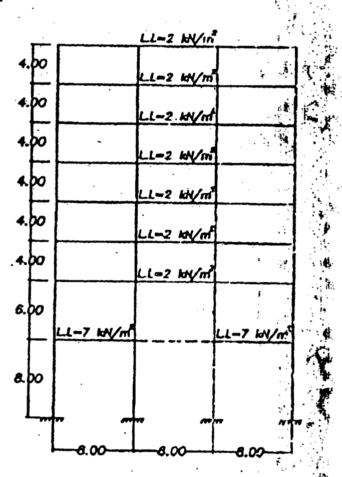


Figure 3

AIN SHAMS UNIVERSITY-FACULTY OF ENGINEERING

STRUCTURAL ENGINEERING DEPARTMENT

Fourth Year Civil (Structural Division)

January 2007 | OPEN CODE | *Time : 3.00 Hrs*

DESIGN OF STEEL BRIDGES
COURSE NO. CES 452

The Exam Consists of Three Questions in Three Pages.

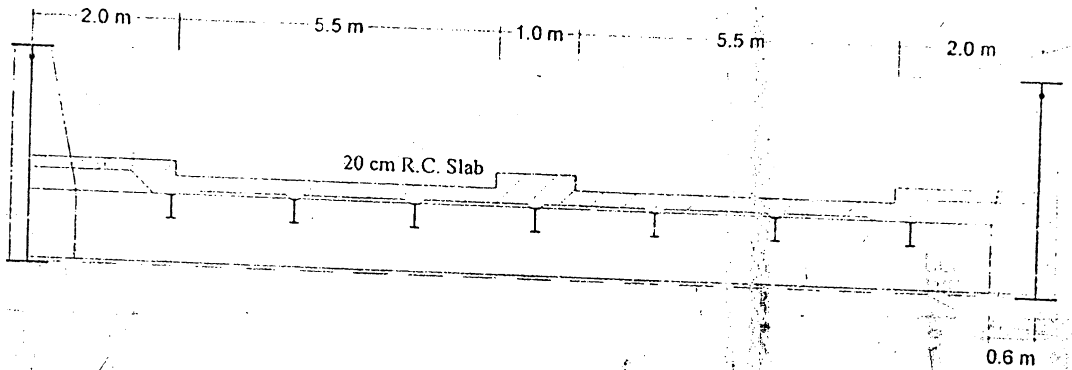
Material of construction is steel 44.
Data not given may be reasonably assumed.

Question I (25%):

The main girders of a double-track open timber floor railway bridge are composed of warren trusses having a span of 66 ms. Width of the bridge is 9.0 ms. The spacing between stringers is 1.8 ms. Height of construction is 2.5 ms.

1. Draw to scale 1:200 a fully dimensioned layout for the bridge (elevations, plans, and cross section) showing all the necessary bracings.
2. Mention all the horizontal loads and forces acting on the given bridge, and explain how these forces will be transferred to the bearings.
3. Discuss the effect of removal of braking force bracing on the design of bridge elements, use sketches if necessary.

Question II (65%):



A plate girder, roadway, pony bridge of span 27 m has the cross-section shown in figure. The bridge supports a roadway of width 12.0m (containing a median of 1.0 m) and two side-walks 2.0 m each. The bridge floor beams consist of stringers each 2.0 m supported over cross girders as shown in figure. The spacing between cross girders is taken 4.5 m. The bridge floor consists of R.C. slab of thickness 20 cm in road and 16 cm in sidewalks. Flooring is taken 175 kg/m^2. Live load is taken according to specifications. It is required to:

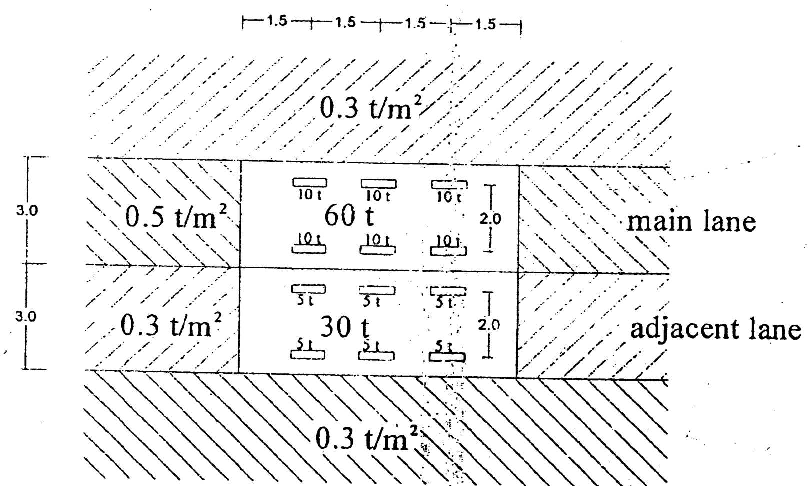
1. Calculate the maximum bending moment affecting an intermediate cross girder due to live load and impact only.
2. If the maximum straining actions affecting the main girder are; "M_{D+L+I} = 1500 m.t." and maximum shear "Q_{D+L+I} = 190 t" and M_D= 700 m.t., design a welded plate girder. (given that : flexibility of the compression flange δ=0.045 cm/t)

3-Check the tendency of web buckling due to pure shearing stresses in the critical panel of the main girder (Consider $Q_{mid\text{-}panel} = 0.94\ Q_{D.L+L.L+I}$). [$k_q$=5.34+(4/$\alpha^2$), for α >1 & k_q= 4+(5.34/α^2), for α <1, $\lambda_q = \frac{d/t_w}{57}\sqrt{\frac{F_y}{k_q}}$, for $\lambda_q \le 0.8$ q_b=0.35F_y, for 0.8< λ_q <1.2 q_b=(1.5-0.625 λ_q)0.35F_y and for $\lambda_q \ge 1.2$ q_b=(0.9/ λ_q)(0.35F_y)].

4-If the cross girder is a plate girder composed of two flange plates 350x30 mm and a web 1350x12 mm, design the connection between the cross girder and main girder using M24 pretensioned bolts grade (10.9). Bending moment due to U-frame is 14 m.t. Draw the connection to scale 1:10.

5-Design a suitable section for the end load-bearing stiffener of the main girder, given that the maximum reaction of the main girder is $Q_{D.L+L.L+I}$ = 190 t.

6-Suggest a suitable location for the field splice of the main girder, design the splice using M27, pretensioned bolts (grade 10.9) and draw it to scale 1:10 in different views.



Live Loads for Roadway Bridges

AIN SHAMS UNIVERSITY, FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT, Fourth Year Civil (Structural Division)

January 2007 | OPEN CODE | *Time : 3.00 Hrs*

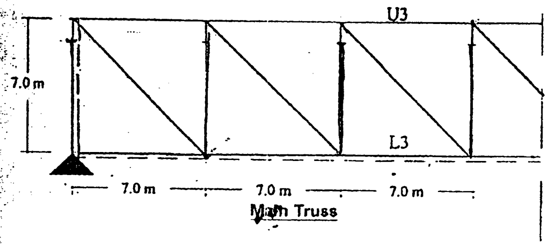
DESIGN OF STEEL BRIDGES
COURSE NO. CES 452

The Exam Consists of Three Questions in Three Pages.

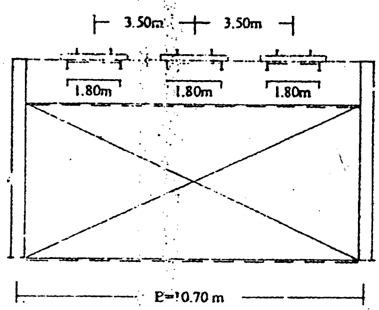
Question III (20%):

A triple-track, open timber floor, railway, through bridge of span 70.0 ms is shown in figure. The main girders of the bridge are N-trusses of depth 7.0 ms., as shown in figure. The live load affecting the bridge is train type "D". It is required to:

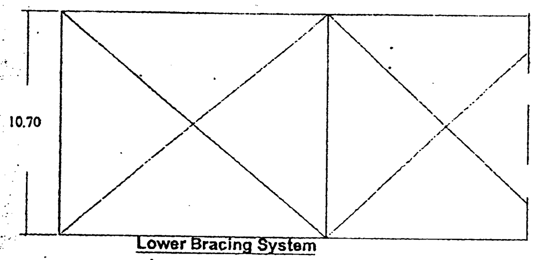
1- Draw the influence line of the maximum force of member U3 and then calculate the maximum force affecting this member.
2- Design a suitable section for the member L3, if the maximum forces in the member are; ($F_{D.L.}$ = + 150 ton, $F_{L.L+I}$ = +750 ton)
3- Discuss briefly the function of batten plates or lacing bars and diaphragms in truss chord members.



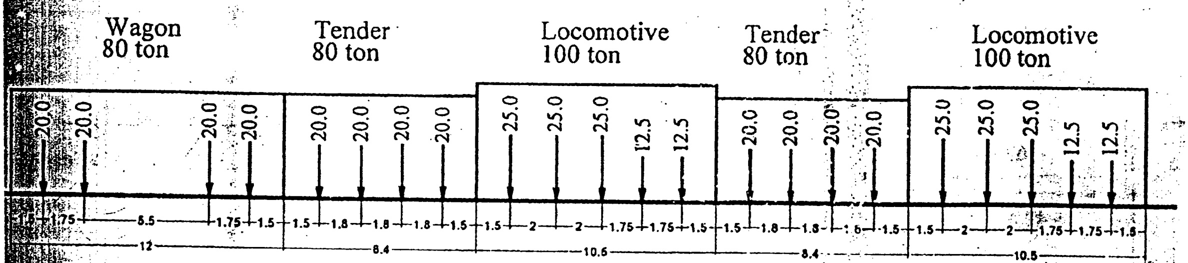
Main Truss



Bridge Cross-Section



Lower Bracing System



Train Type "D"

Ain Shams University
Faculty of Engineering
Structural Engineering Department
4th year Structural Engineering
January 2015

Course Code : CES 441

Time: 3 hours

Repair & Strengthening of Structures

The Exam Consists of Three Questions in Three Pages

Total Max. Marks:70 Marks

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

Question (1) (25 Marks)

1. What are the main differences between repair and strengthening of concrete structures?
   - Draw relationships show the effect of each of the following on the predicted service life of structures:
     Repair – Strengthening - Maintenance – Protection.
2. What are the objectives of the evaluation of concrete structures? Describe using clear sketches only **two** different methods used for in situ evaluation of concrete structures showing the objectives and the outcomes from each of them.
3. Define the term "**compatibility**". Discuss the compatibility of the following repair mortars with base concrete?. Which one can be chosen as a suitable repair material for an industrial building? Give your reasons.

Mechanical or Physical Property	Base concrete	Cementitious Mortar	Polymer modified Mortar	Resinous Mortar
Modulus of Elasticity (G.Pa)	20	25	20	15
Coefficient of Thermal Expansion ($C^{-1} \times 10^{-6}$)	11	10	13	28
Maximum Service Temperature (°C)	200	> 300	200	60
Drying shrinkage (micro-strain)	-----	1500	600	150

4. State main factors affect the bond strength between repair materials and base concrete. Discuss briefly how to increase the bond between repair and strengthening materials and base concrete.
5. Differentiate between each of the following techniques used for base concrete surface preparation:
   Push hammers, Water-jetting, Sand-blasting.
6. During the evaluation of a reinforced concrete structure, visual inspection and tension pull-off test were carried out for beams and columns using steel target with diameter 50 mm to obtain concrete tensile strength. The following results were obtained:
   - From visual inspection flexure tension and shear cracks were observed in beams due to over load and line vertical cracks in columns due to corrosion.
   - Failure loads obtained from tension pull-off test on concrete beams were 2.5, 3.0, 2.9 kN and for concrete columns were 1.5, 1.7, 1.5 kN.

   a. Draw clear sketches for the observed cracks.

   b. Calculate the average tensile strength of concrete beams and columns and draw sketch for test set-up and mode of failure.

   c. Estimate the average compressive strength of concrete beams and columns.

   d. Using clear sketch, describe the most suitable methods, materials, techniques and steps for the repair of the evaluated concrete beams and columns.

7. Tension core pull-off test was carried out to estimate the bond strength between repair mortar and base concrete, four steel targets of diameter 50 mm were glued to repair surface using a suitable adhesive material. Test results were as follow:

Test No.	Failure load (kN)	Mode of failure
1	7.0	Base failure
2	6.3	Interface failure
3	7.4	Base failure
4	5.5	Repair failure

a. Estimate each of tensile strength of base concrete and the average bond strength between repair mortar and substrate concrete.

b. Using neat sketch, show the mode of failure for each test.

Question (2) (25 Marks)

1. Choose the most suitable repair/strengthening technique for each of the following defects in concrete elements:

   a. Map cracks in RC slab
   b. Single narrow crack in RC beam
   c. Wide and very deep straight cracks
   d. ~~Doubling the~~ load carrying capacity of RC columns

2. What are the objectives of non-structural repair technique? Give a practical application for each objective

3. Cracks in reinforced concrete structures greater than approximately 0-3 mm may require sealing to prevent ingress of moisture.

   a. Note down the desirable qualities for epoxy injection resins
   b. Compare between the most used resins for crack injection in view of strength, hardening time and applications.
   c. State down the two types of injection points and the applicability of each type.

4. What are the main advantages of the vacuum polymer impregnation repair technique compared with other techniques used for filling narrow cracks?

5. Mention the possible alternatives used for each of the following processes in concrete replacement repair technique:

   a. Removal of surface deteriorated concrete
   b. Cleaning of rusted reinforcing bars
   c. Enhancing the bond between old and new concrete

6. What is the most common recommendation of the technical report for shotcrete repair technique which contradicts with the recommendations of the ACI Manual for this technique? Write a list of the possible materials for use in shotcrete application technique

7. Mention the required precautions to avoid the drawbacks of crack stitching technique

8. What are the major defects that may be repaired using the application of FRP products? Explain, with sketches, the shape and location of FRP laminates in each case

Question (3) (23 Marks)

["a"= 2 Mark, "b"= 3 Marks, "c"= 10 Marks & "d"= 8 Marks]

a. Draw the stress-strain curve for confined and unconfined concrete in compression.

b. State the basic six assumptions of flexural strengthening of RC beams using FRP?

c. A 400×500 mm rectangular concrete column is reinforced with 10Φ16 (f_{cu} = 17.5 MPa and f_y = 360 MPa). The column is retrofitted with a steel jacket which consists of four angles 80×80×8 mm and steel cage (depth of batten = 80 mm; thickness of batten = 8 mm; center-to-center spacing of battens = 280 mm, and yield strength = 220 MPa). It is required to:

- Calculate the axial load capacity of the retrofitted column.
- Determine the increase percent in the axial load capacity.
- Calculate the maximum usable strain of confined concrete.
- Draw with a convenient scale the elevation and cross section of the retrofitted column.

d. A simply supported RC beam of rectangular cross section 250×700 mm is reinforced with 4Φ16 in tension side (f_{cu} = 17.5 MPa, Steel grade 400/600 & Concrete cover = 50 mm). The beam was strengthened with two layers of GFRP (t_f= 0.30 mm; b_f= 250 mm; ε_{fu}= 0.010; E_f= 75 GPa) externally-bonded to the tension side of the beam, it is required to:

- Calculate "M_u" before and after strengthening assuming ductile failure (γ_c=1.5, γ_s=1.15 & γ_f =1.5).
- Check the stresses and strains in both FRP and reinforcing steel.

Confined Concrete Compressive Strength

$$f_{cc} = f_{cu}\left[2.25\sqrt{1+9.875\frac{f_l}{f_{cu}}} - 2.5\frac{f_l}{f_{cu}} - 1.25\right]$$

Confining Pressure for Rectangular Sections (Partially Confined)

$$f_l = \alpha_1\,\alpha_2\,\frac{t_b\,.\,b_b\,.\,(b+t)\,.\,\frac{f_y}{\gamma_s}}{b\,.\,t\,.\,S} \qquad \alpha_1 = \frac{\left(b-\frac{S_b}{2}\right)\left(t-\frac{S_b}{2}\right)}{b\,.\,t} \qquad \alpha_2 = 1 - \frac{(b-2c)^2+(t-2c)^2}{3(b\,.\,t)(1-\mu_s)}$$

Maximum Usable Compressive Strain

$$\varepsilon_{cc} = \frac{1.37\,(5\,f_{cc} - 4\,f_{cu})}{E_c} \;\&\; E_c = 4400\sqrt{f_{cu}}$$

Best Wishes

Exam Date: January 10, 2015

Course Examination Committee

Dr. Yehia Abd El-Zaher *Dr. Khalid Morsy* *Dr. Ahmed Rashad*

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year Structural Engineering

1st Semester, 2013-2014 Course Code: CES 441 Time : 3.00 Hrs

Repair and Strengthening of Structures

The Exam Consists of *Four* Questions in *Two* Pages **Total Marks: 70 Marks** 1/2

Answer all Questions (The Exam. Consists of 4 Questions)

Question (1):

1) What are the main differences between repair and strengthening of concrete structures? Draw relationships show the effect of each of the following on the predicted service life of structures:

repair – strengthening - maintenance – protection.

2) Define the term "**compatibility**". Discuss the compatibility of the following repair materials with base concrete? Which one can be chosen as a suitable repair material for an industrial building? Give your reasons.

Mechanical or Physical Property	Base concrete	Material (1)	Material (2)	Material (3)
Modulus of Elasticity (G.Pa)	20	25	25	35
Coefficient of Thermal Expansion ($C^{-1} \times 10^{-6}$)	11	11	11	32
Maximum Service Temperature (°C)	200	800	300	120
Drying shrinkage (micro-strain)	-----	900	500	250

3) During the evaluation of a reinforced concrete structure, visual inspection and tension pull-off test were carried out for beams and columns using steel target with diameter 50 mm to obtain concrete tensile strength. The following results were obtained:

- From visual inspection flexure tension and shear cracks were observed in beams due to lake of reinforcement and line vertical cracks in columns due to corrosion.
- Failure loads obtained from tension pull-off test on concrete beams were 1.1, 1.3, 1.7 kN and for concrete columns were 2.6, 2.5, 2.3 kN.

a) Draw clear sketches for the observed cracks.

b) Calculate the tensile strength of concrete beams and columns and draw sketch for test set-up and mode of failure.

c) Using clear sketch, describe the most suitable methods, materials, techniques and steps for the repair of the evaluated concrete beams and columns.

Question (2):

1) Show how to increase the live load capacity for footings, columns, beams and slabs as structural elements:

- With increasing the resistance of structural elements.

2) Discuss how to increase the bond between repair and strengthening materials and base concrete.

3) Slant shear test was carried out to estimate the shear bond strength between new concrete and old base concrete. Four composite specimens of total dimensions (100 × 100 ×400 mm) were cast and tested in compression. If you know that the angle of inclination between the new and the old base concrete was 60 ° with respect to the horizontal surface. Test results were as follow:

Test No.	Failure load (kN)	Mode of failure
1	260	Splitting
2	220	Sliding
3	245	Splitting & sliding
4	225	Sliding

a) Calculate the value of the average shear bond strength.
b) Using neat sketch, show the different obtained modes of failure.

Question (3):

1) Choose the most suitable repair/strengthening technique for each of the following defects in concrete elements:

   a) Preventing the seepage of oil from heavily cracked concrete tanks
   b) Doubling the load carrying capacity of RC columns
   c) Repair of deep honeycombing in under-water supporting elements
   d) Thorough holes in RC walls
   e) Splitting crack in RC column

2) On a sketch for vertically arranged injection nipples, show the components used in crack injection technique and the direction of injection.

3) Explain, briefly, the main steps of vacuum polymer impregnation repair technique for narrow cracks in RC slabs.

4) In case of using internal injection nipples, what are the requirements for the nipple configuration and for the fixing procedure?

Question (4):

1) State down the major definition for both of "Dry back" and "Prepacked aggregate concrete" repair techniques.

2) What is the most common recommendation of the technical report for shotcrete repair technique which contradicts with the recommendations of the ACI Manual for this technique? Write a list of the possible materials for use in shotcrete application technique.

3) Discuss the steps of concrete replacement repair technique for RC elements. State down the materials and tools needed for this procedure.

4) Using neat sketches only, explain the following:

   a) The technique of form and cast in the concrete replacement repair method
   b) Direction of crack injection along the line of crack
   c) Deep inter-connected voids in RC column
   d) Deep inter-connected cracks in RC beam
   e) Active cracks in pavement concrete slab

Best Wishes

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year Structural Engineering

1st Semester, 2012-2013 Course Code: *CES 441* *Time : 3.00 Hrs*

Repair and Strengthening of Structures

The Exam Consists of ***Four*** Questions in ***Two*** Pages ***Total Marks: 70 Marks*** 1

Answer all Questions (The Exam. Consists of 4 Questions)

Question (1):

1) What are the main differences between repair and strengthening of concrete structures? Draw relationships show the effect of each of the following on the predicted service life of structures:

repair – maintenance – protection.

2) Using neat sketches show how to increase the bearing capacity of reinforced concrete roofs without increasing the resistance.

3) Define the term "**compatibility**". Discuss the compatibility of the following repair mortars with base concrete?. Which one can be chosen as a suitable repair material? Give reasons.

Mechanical or Physical Property	Base concrete	Cementitious Mortar	Polymer modified Mortar	Resinous Mortar
Modulus of Elasticity (G.Pa)	20	25	20	15
Coefficient of Thermal Expansion ($C^{-1} \times 10^{-6}$)	11	10	13	28
Maximum Service Temperature (^oC)	200	> 300	200	60
Drying shrinkage (micro-strain)	-----	1500	600	150

Question (2):

1) During the evaluation of a reinforced concrete structure, visual inspection and tension pull-off test were carried out for beams and columns using steel target with diameter 50 mm to obtain concrete tensile strength. The following results were obtained:

- From visual inspection flexure tension and shear cracks were observed in beams due to over load and line vertical cracks in columns due to corrosion.
- Failure loads obtained from tension pull-off test on concrete beams were 2.5, 3.0, 2.9 kN and for concrete columns were 1.5, 1.7, 1.5 kN.

a) Draw clear sketches for the observed cracks.

b) Calculate the average tensile strength of concrete beams and columns, give your comments on test results and draw sketches for test set-up and mode of failure.

c) Using clear sketches, describe the most suitable methods, materials, techniques and steps for the repair of the evaluated and concrete beams and columns.

2) Give some applications (using clear sketches if possible) for each of the following materials which used in repair and strengthening works:

a) Carbon Fiber Reinforced Polymer Laminates. b) Silica fume.
c) Glass Fiber Reinforced Polymer Sheets. d) Shear Connectors.

3) **Slant shear** test was carried out to estimate the shear bond strength between new concrete and old base concrete. Four composite specimens of total dimensions 100 × 100 × 400 mm were casted and tested in compression. The angle of inclination between the new and the old base concrete was 60 ° with respect to the horizontal surface. Test results were as follow:

Test No.	Failure load (kN)	Mode of failure
1	240	Splitting
2	200	Sliding
3	220	Splitting
4	215	Splitting

a) Calculate the value of the average shear bond strength between new and old concrete.
b) Using neat sketches show the different obtained modes of failure. Give your comments.

Question (3):

1) Choose the most suitable repair/strengthening technique for each of the following defects in concrete elements:
   a) Surface inter-connected voids in RC column
   b) Wide and very deep straight cracks
   c) Deep narrow cracks
   d) Easy access of corrosive materials.
   e) Repair of deep inter-connected voids in RC abutments under water level.
2) What are the main differences between crack injection and crack grouting techniques?
3) In case of using internal injection nipples, what are the requirements for the nipple configuration and for the fixing procedure?
4) Explain, using neat sketches, the precautions to accommodate the movements of active cracks when using blanketting repair technique.

Question (4):

1) Give the differences between concrete replacement and jacketing techniques.
2) Mention the required precautions to avoid the drawbacks of crack stitching technique.
3) Sketch for the possible failure modes of a reinforced concrete member strengthened with carbon fibers.
4) Using neat sketches only, explain the following:
   a) Examination of the activity of structural cracks in concrete structures
   b) Repair of cracks by Blanketing repair technique
   c) Arrangement of injection nipples along a vertical crack showing the direction of injection
   d) Set-up of crack grouting technique using neat cement
   e) The technique of manual application of repair material in the concrete replacement repair method

Best Wishes

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year. Structural Engineering Students

1st Semester, 2011-2012 | Course Code: *CES 441* | *Time : 3.00 Hrs*

Repair and Strengthening of Structures

The Exam Consists of ***Four*** Questions in ***Two*** Pages | *Total Marks: 70 Marks* | 1/

Atempet all Questions

Question (1): (25 %)

1- What are the differences between **rpair** and **strengthening** of concrete structures. Using neat sketches only, discuss the different strengthening methods for reinforced concrete beams and slabs.

2- *"In the majority of concrete structures, cracks do not result in structural failure, but they can result in definite loss of performance of structures".*

Discuss this statement. Using clear sketches; show the crack pattern due to each of the following:

a- Over loading for R.C slabs.

b- Settlement of plastic concrete in forms.

c- Over torsional moments for concrete beams.

3- What are the objectives of the evaluation of concrete structures?. Describe using clear sketches the following non destructive tests:

Ultrasonic pulse velocity test – Core test - Loading test

What are the results obtained from each test.

4- Discuss the effect of each of the following properties on the **compatibility** of new concrete to an old base concrete:

a- Early drying shrinkage.

b- Modulus of elasticity.

c- Thermal expansion.

d- Poisson's ratio.

Question (2): (25%)

1- Explain the main factors affect the bond strength between repair materials and substrate concrete.

2- What are the differences between direct loading bond tests and patch tests for repair works.

3- **Slant shear** test was carried out to estimate the shear bond strength between new concrete and old base concrete. Four composite specimens of total dimensions 100 × 100 × 400 mm were cast and tested in compression. If you know that the angle of inclination between the new and the old base concrete was 60^{o} with respect to the horizontal surface. Test results were as follow:

Test No.	Failure load (kN)	Mode of failure
1	240	Splitting
2	200	Sliding
3	220	Splitting & sliding
4	215	Sliding

a- Calculate the value of the average shear bond strength.

b- Using neat sketches, show the different obtained modes of failure.

4- During the evaluation of a reinforced concrete structure it was concluded that some reinforced concrete columns in the basement floor (embedded in soil) needs strengthening.

4th Year Structural Engineering Students

1st Semester, 2011-2012 | **Course Code: CES 441** | **Time : 3.00 Hrs**

Repair and Strengthening of Structures

The Exam Consists of ***Four*** Questions in ***Two*** Pages | ***Total Marks: 70 Marks*** |

a- State and explain briefly possible methods can be used for the strengthening of this element.
b- Compare between each of strengthening methods taking the following into consideration:

- All used materials
- Elapsed time to finish work.
- Durability and protection needed
- All over cost.

Question (3): (25%)

1. Choose the most suitable repair/strengthening technique for each of the following defects in concrete elements:
   a. Limited number of very narrow cracks.
   b. Large number of hair ceacks in RC slab
   c. Protecting steel reinforcement from access of corrossive media.
   d. Deep inter-connected voids in RC column
   e. Deep inter-connected cracks in RC beam
2. State down the main measures controlling the choice of repair techniques for concrete elements.
3. Cracks in reinforced concrete structures greater than approximately 0-3 mm may require sealing to prevent ingress of moisture.
   a. Compare between the most used resins for crack injection in view of strength, hardening time and applications.
   b. What are the factors affecting the choice of injection pressure.
   c. State down the two types of injection points and the applicability of each type.
4. Compare between vacuum polymer impregnation repair technique and polymer injection technique for narrow cracks in RC slabs in view of: materials used, mechanism of air removal, value of applied pressure, and need for entry ports.

Question (4): (25%)

1. Using neat sketches only, explain the following:
   a. Different geometries of RC jackets for concrete footing
   b. Both of Rooting and Sealing of cracks
   c. Deep active crack in RC slab on grade repaired with and without bond breaker
   d. External prestressing of RC beam to control existing bending cracks
   e. Different geometries of RC jackets for concrete footing
2. In a tabulated form, illustrate the major drawbacks of shotcrete repair technique and the corresponding precautions to overcome them.
3. What are the problems associated with the technique of bonded steel plates used for repairing RC beams? On sketches, show how these problems may be solved
4. Explain with sketches the possible methods to apply the repair material to existing old concrete during the concrete replacement technique.

Ain Shams University
Faculty of Engineering
4th Year - Structural Engineering Department

Repair and Strengthening of Structures
January, 2010
Time Allowed : 3 hours

Atempet all Questions (The Exam. Consists of 4 Questions)

Question (1):

1. What are the differences between rehabilitation and strengthening of concrete structures. Using neat sketches only, discuss the different strengthening methods for reinforced concrete columns.

2. *"In the majority of concrete structures, cracks do not result in structural failure, but they can result in definite loss of performance of structures".*

   Discuss this statement. Using clear skeches, show the crack pattern due to each of the following:

   Over loading for R.C beams – Settlement of plastic concrete in forms – Alkali Silica Reaction.

3. What are the objectives of the evaluation of concrete structures. Discuss each of the following for loading test carried out to evaluate a reinforced concrete flat slab with span 7m in long direction and 5m in short direction given that:

   slab thickness = 25 cm, floor cover load =150 kg/m^2, live load = 500 kg/m^2.

   a. Test load
   b. Test procedure
   c. Measurements
   d. Results obtained & final conclusion

4. Define the term "compatibility".Discuss the compatibility of the following repair materials with base concrete? Which one can be chosen as a suitable repair material for the repair of concrete floors of an industrial meat plant. Give your reasons.

Mechanical or Physical Property	Base concrete	Cementitious Material	Polymer modified Material	Resinous Material
Modulus of Elasticity (G.Pa)	20	25	20	15
Coefficient of Thermal Expansion ($C^{-1} \times 10^{-6}$)	11	10	13	28
Maximum Service Temperature (°C)	200	> 300	200	60
Drying shrinkage (micro-strain)	-----	1500	600	150

Question (2):

1. Torsion pull-off test was carried out to estimate the shear bond strength between a polymer modified repair mortar and base concrete. Four steel targets of diameter 50 mm were glued to repair mortar surface using a suitable adhesive material. Test results were as follow:

Test No.	Torsional moment at failure (N.mm)	Mode of failure
1	260	Substrate failure
2	230	Interface failure
3	280	Substrate failure
4	240	Interface failure

   a. Estimate each of the torsional shear strength of base concrete and the average shear bond strength between repair mortar and base concrete.
   b. Using neat sketches, show the mode of failure for each test. Give your comments.

2. What are the differences between direct loading bond tests and patch tests for repair works. Discuss test method carried out to estimate the bond strength between carbon fiber reinforced polymers (CFRP) and substrate concrete.

3. Explain the main factors affect the bond strength between repair materials and substrate concrete. Differentiate between each of the following ~~techniques for~~ base ~~concrete~~ surface preparation:

Push hammers – Water jetting – Sand blasting

Question (3):

1. Mention the different methods to repair concrete cracks of both active and dormant types. Explain the suitability of each method
2. In case of using internal injection nipples, what are the requirements for the nipple configuration and for the fixing procedure?
3. Note down the advantages of vacum polymer impregnation method compared with traditional pressure injection method to seal very narrow cracks in RC elements
4. Mention the different materials and tools necessary for concrete replacement technique
5. Explain with sketches the possible methods to apply the repair material to existing old concrete in the concrete replacement technique

Question (4):

1. Using neat sketches only, explain the following:
   - a. Different geometries of RC jackets for concrete beams
   - b. The technique of form and cast in the concrete replacement repair method
   - c. Method of compaction followed in the drypack method
   - d. Mechanizm of air removal during epoxy injection technique
2. Choose the most suitable repair/strengthening technique for each of the following defects in concrete elements:
   - a. A single narrow crack in RC beam.
   - b. A straight, deep, wide crack in RC wall.
   - c. Map cracks in RC slab.
   - d. Surface inter-connected voids in RC column.
   - e. Bending cracks in an isolated RC footing.
   - f. Splitting crack in RC column.
3. What are the problems associated with the technique of bonded steel plates used for repairing RC beams? On sketches, show how these problems may be solved
4. Explaining the technique on sketches, what are the items to be checked while applying the span shortening technique for strengthening flexural members? Also, how can we take advantage of <u>the moving prob</u> which may be used in this technique? What are the possible alternatives for the intermediate support?

Good Luck

Atempet all Questions (The Exam. Consists of 4 Questions)

Question (1):

1) What is the difference between **maintenance** and **protection** of concrete structures. Using neat sketches only, discuss the different strengthening methods for concrete structures using additional bonded materials.
2) What are the objectives of the evaluation of concrete structures. Discuss each of the following for the loading test carried out for a reinforced concrete cantiliver slab of free length = 2.0 m, thickness 20 cm, floor cover 150 = kg/cm^2, live load = 300 kg/cm^2 ;
   a) Test load
   b) Test procedure
   c) Measurements
   d) Results obtained & final conclusion
3) Discuss the effect of each of the following properties on the compatibility of new concrete to an old base concrete:
   a) Early drying shrinkage and creep.
   b) Modulus of elasticity.
   c) Thermal expansion.
   d) Poisson's ratio

Question (2):

1) Rewrite each of the following statements and Put sign (√) or (X) beside each of them. If the statement is wrong; put it in the right form:
   a) In the majority of concrete structures, cracks result in structural failure.
   b) Repair can be defined as to replace or correct deteriorated, damaged, or faulty materials, components, or elements of a structure.
   c) Increasing the cross section of concrete column is more significant strengthening method than increasing the cross section of concrete beam.
   d) Placing additional reinforcement in the tension zone of a reinforced concrete beam (protected by an additional concrete cover by shotcrete) is a very effective strengthening method.
   e) In the case of structural repair, loaded in compression, the repair material must possess very high creep potential.
   f) When selecting a non-structural repair material, designers should ensure that repair material has a higher value of modulus of elasticity than base concrete.
   g) Cementitious based materials has similar coefficient of thermal expansion.
   h) Creep of repair material increase stresses due to shrinkage at the interface between it and base concrete.
2) Slant shear test was carried out to estimate the shear bond strength between new concrete and old base concrete. Four composite specimens of total dimensions 100 × 100 × 400 mm were cast and tested in compression. The angle of inclination of the interface to the horizontal surface was 60 ° with respect to the horizontal surface. Test results were as follow:

Test No.	Failure load (kN)	Mode of failure
1	180	Splitting
2	150	Sliding
3	160	Splitting
4	145	Sliding

   a) Calculate the value of the average shear bond strength.
   b) Using neat sketches, show the different obtained modes of failure.

3) Using neat sketches, discuss some applications for each of the following materials used in repair and strengthening works:
   a) Carbon Fiber Reinforced Polymers Laminates.
   b) Bonding Coats.
   c) Fiber reinforced concrete.
   d) Shear Connectors.

Question (3):

1) Answer the following questions:
   a) What are the main differences between ***crack injection*** and ***crack grouting*** techniques.
   b) Compare between the most used resins for crack injection in view of ***strength, hardening time and applications.***
   c) Give the differences between ***concrete replacement*** and ***jacketing*** techniques.
   d) State down the two types of ***injection points*** and the applicability of each type.
2) On a sketch for vertically arranged injection nipples, show the components used in crack injection technique and the direction of injection.
3) Choose the most suitable repair/strengthening technique for each of the following defects in concrete elements:
   a) Wide and very deep straight cracks
   b) Deep narrow cracks
   c) Limited number of very narrow cracks
   d) Insufficient stiffness
   e) Easy access of corrosive materials
   f) Large number of hair ceacks in RC slab.

Question (4):

1) Using neat sketches only, explain the following:
   a) Examination of the activity of structural cracks in concrete elements
   b) Shape of joint after blanketing of active cracks with and without bond breaker.
   c) Both of rooting and sealing of cracks.
2) Explain, using neat sketches, the precautions to accommodate the movements of active cracks when using blanketting repair technique.
3) Explain, briefly, the main steps of vacuum polymer impregnation repair technique for narrow cracks in RC slabs.
4) A ground floor column in a residential building was affected by the deficiency in construction workmanship that manifests honycombing of the lower portion of the column. The field tests showed that the honycombing infiltrated through the entire cross section of the column. The figure illustrates the condition of the column. Suggest a remedy procedure for the column.

Good Luck

in Shams University
aculty of Engineering
th Year - Structural Engineering
Department

Repair and Strengthening of Structures
CES 441
December, 2006
Time Allowed : 3 hours

Atempet all Questions (The Exam. Consists of 4 Questions)

Question (1):

1. What are the differences between repair and strengthening of concrete structures. Draw relationships to show the effect of each of :

repair – maintenance – protection

on the service life of structures.

2. **Core** and **loading tests** were carried out for the evaluation of a reinforced concrete flat slab of thickness 25 cm and span 7 m (in both directions). Tests were carried out and the following results were obtained:

a. Three cores of diameter 10 cm and height after capping 12.3 cm were drilled, and then tested in compression. Failure loads were 13 – 12.4 – 11.8 ton respectively. The required characteristic compressive strength of concrete after 28 days = 250 kg/cm^2.

b. Loading test was carried out for the slab and deflections were recorded in three positions. Test results were as follows:

Position		1	2	3
Deflection (mm)	After 24 hours of loading	6.6	7.1	18.30
	After 24 hours of unloading	1.32	1.65	4.47

i- Discuss the safety of the tested slab according to the requirements of the Egyptian Code for concrete structures.

ii- **If** the tested slab failed to satisfy the requirements of the Egyptian Code for concrete structures, state the possible ways to make it safe.

3. Using neat sketches, discuss some applications for each of the following materials used in repair and strengthening works:

a. Carbon Fiber Reinforced Polymers Laminates.
b. Bonding Coats.
c. Glass Fiber Reinforced Polymers Sheets.
d. Shear Connectors.

Question (2):

1. Differentiate between each of the following techniques used for base concrete surface preparation:

Push hammers – Water jetting – Sand blasting.

2. Define the term "compatibility". Discuss the compatibility of the following repair materials with base concrete?. Which one can be chosen as a suitable repair material for the repair of concrete floors of an industrial meat plant?

Mechanical or Physical Property	Base Concrete	Cementitious Material	Polymer modified Material	Resinous Material
Modulus of Elasticity (G.Pa)	20	25	20	15
Coefficient of Thermal Expansion ($C^{-1} \times 10^{-6}$)	11	10	13	28
Maximum Service Temperature (^oC)	200	> 300	200	60
Drying shrinkage (micro-strain)	-----	1500	600	150

Discuss the effect of the use of each of the three repair materials on the predicted service life of the repaired structure.

3. Slant shear test was carried out to estimate the shear bond strength between new concrete and old base concrete. Four composite specimens of total dimensions 100 × 100 × 400 mm were cast and tested in compression. The angle of inclination of the interface to the horizontal surface was 60 ° with respect to the horizontal surface. Test results were as follow:

Test No.	Failure load (kN)	Mode of failure
1	180	Splitting
2	150	Sliding
3	160	Splitting
4	145	Sliding

a. Calculate the value of the average shear bond strength.
b. Using neat sketches, show the different obtained modes of failure.

Question (3):

1. Compare between each of the following:
   a. Injection and grouting repair techniques.
   b. Concrete replacement and concrete jacketting techniques.
   c. Wet process and dry process in the shotcrete technique.
   d. Configuration of strengthening RC columns using FRP strips for Flexural or FRP wraps for confinement.
2. What is the most common recommendation of the technical report for shotcrete repair technique which contradicts with the recommendations of the ACI Manual for this technique?. Write a list of the possible materials for use in shotcrete application technique.
3. Using neat sketches only, explain the following:
   a. Different geometries of RC jackets for concrete beams.
   b. External prestressing of RC beam to control existing bending cracks.
   c. Deep active crack in RC slab on grade repaired with and without bond breaker.
4. Give examples for the most common materials used in crack injection. Note down the desirable qualities for epoxy injection resins.

Question (4):

1. Choose the most suitable repair/strengthening technique for each of the following purposes:
   a. Rehabilitation of limited active cracks in RC road slab.
   b. Remedy of crazing of RC slab.
   c. Protecting steel reinforcement from access of corrossive media.
   d. Repair of surface inter-connected voids in RC column.
   e. Repair of deep inter-connected voids in RC abutments under water level.
2. Outline the basic features of the drypack repair technique. Explain the type of deteriaration to be repaired using this technique.
3. Sketch for the possible failure modes of a reinforced concrete member strengthened with carbon fiber laminates.
4. Compare between vacuum polymer impregnation repair technique and polymer injection technique for narrow cracks in RC slabs in view of: materials used, mechanism of air removal, value of applied pressure, and need for entry ports.

GOOD LUCK

مواد الانشاء الحديثة

Ain Shams University
Faculty of Engineering
Structural Engineering Department
4th Year Structural Engineering

January 2012 Course Code: ***CES 414*** Time: 3 hours

Advanced Construction Materials

The Exam Consists of **Four** Questions in **Two** Pages + **Two** Pages for Equations Total Marks:70 Marks **1/4**

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

Question (1) (25%)

1. What are the possible failure modes of a lamina along the fibers direction subjected to tensile loading? Which mode do you think it is better? Why?
2. How many independent material constants used to calculate deformations for Isotropic, Orthotropic, and Anisotropic materials?
3. Draw the relationships between the following for a unidirectional lamina :
   - - Fiber volume fraction (V_f) and elasticity moduli (E_1 & E_2).
   - - Fiber volume fraction (V_f) and Shear modulus (G_{12}).
   - - Fiber volume fraction (V_f) and Major tensile strengths (S^+_L).
   - - Fiber orientation (θ) and elasticity modulus (E_θ).
   - - Fiber tensile strength (S) and fiber diameter (d).
4. A unidirectional lamina was fabricated using Glass fibers of the following properties: Elasticity modulus = 350 GPa, Poison's ratio = 0.10, Shear strength = 15 MPa, Ultimate tensile strain = 1.0 % and vinyl ester matrix of the following properties :
   Elasticity modulus = 50 GPa, Compressive strength = 60 MPa, Shear strength = 10 MPa, Poison's ratio = 0.20, Ultimate tensile strain = 2.0 %.
   If you know that the fiber volume fraction = 48%, the stress strain relationship is linear for both fibers and matrix materials, and both fibers and matrix materials can be considered as isotropic homogeneous materials. Calculate the following:
   1. Stiffness Characteristics of the lamina (E_1 & E_2 & G_{12} & υ_{12} & υ_{21})
   2. Strength Characteristics of the lamina (S^+_L & S^+_T & S^-_L & S^-_T & S_{LT})
   3. Stresses in the material axes "σ_1, σ_2, σ_{12}" if you know that the applied stresses in X-Y axes are "σ_x = 12 MPa, σ_y = 10 Mpa, σ_{xy} = 4 Mpa". ($\theta = 45^o$)

Question (2) (25%)

RC simple beam of rectangular cross section (25×70 cms) is reinforced by four steel bars (25mm diameter) in tension side and strengthened by one unidirectional lamina (width w=25cm and thickness t=3mm and properties E_f =250 GPa, ε_{fu} = 0.03) strongly bonded to the tension side of the beam. Calculate the following:

1) The ultimate bending moment "Mu" before strengthening in (KN.m) assuming ductile failure (γ_c=1.5 & γ_S=1.15)
2) The ultimate bending moment "Mu" after strengthening in (KN.m) assuming brittle failure (γ_c=1.7 & γ_S=1.32 & γ_F=1.7)
3) Check the stress in FRP & Stress in Steel

- Concrete characteristic strength f_{cu} = 25 MPa
- Reinforcing steel used is HTS Steel of grade 400/600
- Concrete cover = 5 cms, C_E=0.95, K_m=0.85

Question (3) (30 %)

1. State the general characteristics of FRP.
2. State the primary role of the fibers in the composites.
3. Compare between the advantages and disadvantages of glass and carbon fibers (tabulate your answer).
4. What is meant by "tow, mats, thermoplastic polymers, and glass transition temperature".
5. State the primary roles of the polymer matrix in the composites.
6. State the main advantages and disadvantages of Epoxy resins.
7. Draw the following relationships:
   a. The tensile stress-strain curve for braided fibers.
   b. The tensile stress as function of time at different temperatures for glass fibers.
   c. Variation of stiffness with temperature for typical polymer matrix.
   d. Stress-strain curve for confined and unconfined concrete.
8. Complete the following:
   a. Selection of the matrix has a major influence on the ...., ... as well as ....
   b. In .... individual molecules are linear without any .... while, the molecules of .... are ....
   c. The .... of the concrete jacketed elements is the .... of concrete jackets.
   d. The additional FRP shear strength is based on ...., ... and ....

Question (4) (20%)

1. The 400×550 mm rectangular column, shown in Figure (1), is retrofitted with three layers CFRP full wraps. The properties of the section and the CFRP system are reported as follows:

   $A_c\ (gross) = 217854\ mm^2$ $f_{cu} = 20\ MPa$
   $A_s = 2545\ mm^2$ $f_y = 360\ MPa$
   $t_f = 0.20\ mm$ $E_f = 300\ GPa$
   $\varepsilon_{fu} = 0.014$ $C_E = 0.85$

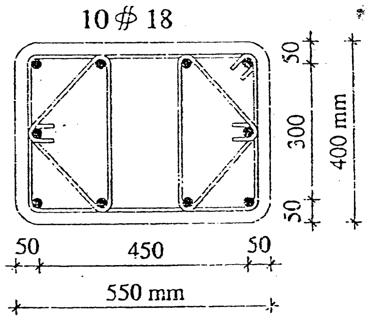


Figure (1)

   a. Calculate the axial load carrying capacity.
   b. Determine the increase percent in the axial load carrying capacity.
   c. Calculate the maximum usable strain of confined concrete.

2. For the beam cross-section shown in Figure (2), $f_{cu} = 20$ MPa, and $f_y = 240$ MPa. Assume 2-side wrap configuration using three layers discrete GFRP inclined strips ($\alpha = 60°$) 100 mm wide @ 200 mm center-to-center ($t_f = 0.60$ mm, $\varepsilon_{fu} = 0.035$, $C_E = 0.75$, and $E_f = 60$ GPa). Estimate the shear force contribution of FRP (Q_{fu}) and total shear capacity (Q_u).

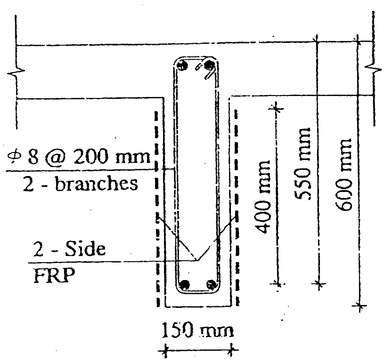


Figure (2)

Best Wishes

Exam Date : January 24, 2012

Course Examination Committee
Dr. Mohamed Abdel Moaty   Dr. Ahmed Rashad

Ain Shams University
Faculty of Engineering
Structural Engineering Department
4th Year Structural Engineering

January 2011 | Course Code: *CES 414* | Time: 3 hours

Advanced Composite Materials

The Exam Consists of **Five** Questions in **Two** Pages + **One** Page for Equations   Total Marks:70 Marks   **1/3**

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

Question (1) (10%)

1. What are the factors which the Environmental Reduction factor "C_E" depends on?
2. Explain the different factors which the fire resistance of RC structures depends on?
3. Using neat sketches only What are the possible failure modes of a lamina along the fibers direction subjected to tension loads?
4. Draw the relationships between the following for a unidirectional lamina:
   - Fiber volume fraction (V_f) and elasticity moduli (E_1 & E_2).
   - Fiber volume fraction (V_f) and Minor tensile strengths (S^+_T).
   - Fiber orientation (θ) and elasticity modulus (E_θ).
   - Fiber tensile strength (S) and fiber diameter (d).

Question (2) (20%)

A unidirectional lamina was fabricated using carbon fibers of the following properties:
Elasticity modulus= 300 GPa, Poison's ratio= 0.15, Shear strength= 150 MPa, Ultimate tensile strain = 2.0 % and vinyl ester matrix of the following properties:
Elasticity modulus = 35 GPa, Compressive strength = 250 MPa, Shear strength = 120 MPa, Poison's ratio = 0.20, Ultimate tensile strain = 4.0 %.
If you know that the transverse tensile strength of the lamina (S^+_T = 560 MPa), the stress strain relationship is linear for both fibers and matrix materials, and both fibers and matrix materials can be considered as isotropic homogeneous materials. Calculate the following:

1. Stiffness Characteristics of the lamina ($E1$ & $E2$ & G_{12} &υ_{21})
2. Strength Characteristics of the lamina (S^+_L & S^-_L& S^-_T)
3. If the lamina is safe or not under this state of stresses "σ_x = 160 MPa, σ_y= 120 Mpa, σ_{xy} = 90 Mpa" using Tsai-Hill Failure Criterion. ($\theta = 45^o$)

Question (5) (20%)

RC simple beam of rectangular cross section (25×70 cms) is reinforced by four steel bars (25mm diameter) in tension side and strengthened by one unidirectional lamina (width w=25cm and thickness t=4mm and properties E_f=250 GPa, ε_{fu} = 3%) strongly bonded to the tension side of the beam. Calculate the following:

1) The ultimate bending moment "Mu" before strengthening in (KN.m) assuming ductile failure (γc=1.5 & γS=1.15)
2) The ultimate bending moment "Mu" after strengthening in (KN.m) assuming brittle failure (γ_c=1.7 & γ_S=1.32 & γ_F=1.7)
3) Check the stresses and strains in FRP & Stresses in Steel
   - Concrete characteristic strength = f_{cu} = 25 MPa
   - Reinforcing steel used is HTS Steel of grade 400/600
   - Concrete cover = 5 cms, C_F=0.90, K_m=0.90

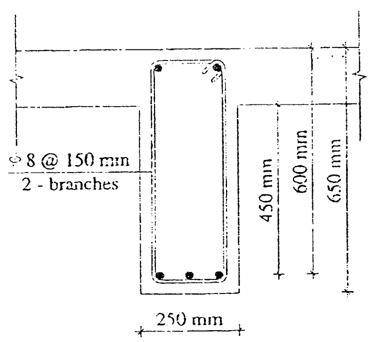
Question (4) (30 %)

1. State the general characteristics of FRP.
2. Material selection is one of the most important and critical steps in the structural design process. What are the main knowledge that required for proper selection?
3. Compare between the advantages and disadvantages of carbon and Aramid fibers (tabulate your answer).
4. What is meant by "Fiber Sizing"? State the primary functions of fiber sizing.
5. State the primary roles of the polymer matrix in the composites.
6. What is meant by "Thermosetting Polymers", and "Glass Transition Temperature"?
7. State the main advantages of polyester and epoxy resins.
8. Draw the following relationships:
   a. The tensile stress-strain curve for braided fibers.
   b. Variation of stiffness with temperature for typical polymer matrix.
   c. Stress-strain curve for confined and unconfined concrete.
   d. The relation between the confined compressive strength and confining pressure for circular concrete columns (according to Richart et al.).
9. The material of a tension member is changed from steel (E = 200 GPa, f_t = 600 MPa, and $\rho = 7.80 \times 10^3$ kg/m^3) to a CFRP (E =250 GPa, f_t =2400 MPa, and $\rho = 1.95 \times 10^3$ kg/m^3). Calculate the ratio of the cross-sectional areas, axial stiffnesses, and weights of these two members for equal load-carrying capacities. (Load = Strength × Cross-Sectional Area and Axial Stiffness = Modulus × Cross-Sectional Area).

Question (5) (20%)

1. A 400 mm diameter column with 8Φ16 bars and 8 mm spiral stirrups. The column is partially confined with discrete strips 100 mm wide @ 200 mm center-to-center. The confinement consists of three layers of GFRP. Assume t_f = 0. 6 mm, ε_{fu} = 0.035, E_f = 60 GPa, C_E = 0.75, f_{cu} = 20 MPa, and f_y = 360 MPa. Calculate the axial load carrying capacity and the maximum usable strain.

2. For the beam cross-section shown in the adjacent figure, f_{cu} = 25 MPa, and f_y = 240 MPa. The beam is subjected to an increase in its live load carrying capacity. If the total shear capacity (Q_u) increased to 200 kN. Assume 2-side wrap configuration using two layers discrete CFRP strips 50 mm wide (t_f = 0.15 mm, ε_{fu} = 0.012, C_E = 0.75, and E_f = 250 GPa). Design the shear strengthening, if warranted.



Best Wishes

Exam Date : January 25, 2011

Course Examination Committee
Dr. Mohamed Abdel Moaty Dr. Ahmed Rashad

Useful Equations

Sub-region model Equations:

$$E_2 = E_m\left[\left(1-\sqrt{\nu_f}\right)+\frac{\sqrt{\nu_f}}{1-\sqrt{\nu_f}\left[1-\frac{E_m}{E_f}\right]}\right] \quad \& \quad G_{12} = G_m\left[\left(1-\sqrt{\nu_f}\right)+\frac{\sqrt{\nu_f}}{1-\sqrt{\nu_f}\left[1-\frac{G_m}{G_f}\right]}\right]$$

Transformation Matrices:

$$[T]=\begin{bmatrix} C^2 & S^2 & 2CS \\ S^2 & C^2 & -2CS \\ -CS & CS & C^2-S^2 \end{bmatrix} \quad \& \quad [T]^{-1}=\begin{bmatrix} C^2 & S^2 & -2CS \\ S^2 & C^2 & 2CS \\ CS & -CS & C^2-S^2 \end{bmatrix}$$

Stress-Strain relationships in 1&2 and in X&Y co-ordinates:

$$\begin{Bmatrix}\sigma_1\\ \sigma_2\\ \sigma_{12}\end{Bmatrix}=\begin{bmatrix} \frac{E_1}{1-\upsilon_{12}\upsilon_{21}} & \frac{\upsilon_{21}E_1}{1-\upsilon_{12}\upsilon_{21}} & 0 \\ \frac{\upsilon_{12}E_2}{1-\upsilon_{12}\upsilon_{21}} & \frac{E_2}{1-\upsilon_{12}\upsilon_{21}} & 0 \\ 0 & 0 & G_{12} \end{bmatrix}\begin{Bmatrix}\varepsilon_1\\ \varepsilon_2\\ \varepsilon_{12}\end{Bmatrix} \quad \& \quad \{\sigma\}_{1\&2}=[Q]_{1\&2}\{\varepsilon\}_{1\&2}$$

$$\{\sigma\}_{x\&y}=[T]^{-1}[Q]_{1\&2}[T]\{\varepsilon\}_{x\&y}=[Q]_{x\&y}\{\varepsilon\}_{x\&y} \quad \& \quad \{\sigma\}_{1\&2}=[T]\{\sigma\}_{x\&y} \quad \& \quad \{\varepsilon\}_{1\&2}=[T]\{\varepsilon\}_{x\&y}$$

Longitudinal compressive strength of a unidirectional lamina:

1) In Phase Bukling of Fibers : $S_L^- = \frac{G_m}{1-\nu_f}$
2) Out of Phase Bukling of Fibers : $S_L^- = 2\nu_f\sqrt{\frac{\nu_f E_m E_f}{3(1-\nu_f)}}$
3) Splitting Failure : $S_L^- = \frac{E_1 S_T^+}{E_2 \upsilon_{12}}$
4) Shear Failure : $S_L^- = 2(S_{f12}\nu_f + S_{m12}\nu_m) \le 2S_{m12}$

Tsai-Hill Interaction failure criterion:

$$\frac{\sigma_1^2}{S_L^2}-\frac{\sigma_1\sigma_2}{S_L^2}+\frac{\sigma_2^2}{S_T^2}+\frac{\sigma_{12}^2}{S_{LT}^2} \le 1$$

Concrete Confined Compressive Strength:

$$f_{cc}=f_{cu}\left[2.25\sqrt{1+9.875\frac{f_l}{f_{cu}}}-2.5\frac{f_l}{f_{cu}}-1.25\right]$$

Confining Pressure for Circular Columns (Partial Confined):

$$f_l = K_e\frac{\mu_f \cdot E_f \cdot \varepsilon_{fe}}{2\gamma_f} \quad \& \quad \mu_f=\frac{4\,b_f\,n\,t_f}{S\,D} \quad \& \quad K_e=\left(1-\frac{(S-b_f)}{2D}\right)^2 \le 1.0$$

مواد الانشاء الحديثه

Ain Shams University
Faculty of Engineering
Structural Eng. Department
4th year structural Engineering

Properties & Testing of Materi
Advanced Composite Materi
Academic year 2009 / 20
Time allowed : 3 Hrs.

Exam consisted of "6" questions in "2" pages + "1" page for equations
Answer all the following questions :

Question (1) (15%)

1) What are the possible failure modes of a lamina along the fibers direction subjected to tensile loading? Which mode do you think it is better? Why?
2) How many material constants used to calculate deformations for Isotropic, Orthotropic, and Anisotropic materials?
3) Draw the relationships between the following for a unidirectional lamina :
   - Fiber volume fraction (V_f) and major elasticity modulus (E_1).
   - Fiber volume fraction (V_f) and minor elasticity modulus (E_2).
   - Fiber volume fraction (V_f) and Shear modulus (G_{12}).
   - Fiber volume fraction (V_f) and Major tensile strengths (S^+_L).
   - Fiber volume fraction (V_f) and Minor tensile strengths (S^+_T).
   - Fiber tensile strength (S) and fiber diameter (d).

Question (2) (20%)

unidirectional lamina was fabricated using Glass fibers of the following properties:
lasticity modulus = 350 GPa, Poison's ratio = 0.10, Shear strength = 20 MPa, Ultimate tensile strain = 1%
nd vinyl ester matrix of the following properties :
lasticity modulus = 80 GPa, Compressive strength = 60 MPa, Shear strength = 40 MPa, Poison's ratio = 20, Ultimate tensile strain = 2%
you know that the fiber volume fraction = 45%, the stress strain relationship is linear for both fibers and atrix materials, and both fibers and matrix materials can be considered as isotropic homogeneous aterials. Calculate the following :

1. Stiffness Characteristics of the lamina (E_1 & E_2 & G_{12} & υ_{12} & υ_{21})
2. Strength Characteristics of the lamina (S^+_L & S^+_T & S^-_L & S^-_T & S_{LT})
3. Stresses in the material axes "σ_1, σ_2, σ_{12}" if you know that the applied stresses in X-Y axes are "σ_x = 20 MPa, σ_y = 15 Mpa, σ_{xy} = 6 Mpa". $\theta = 60°$
4. If the lamina is safe or not under this state of stresses "σ_x = 30 MPa, σ_y = 50 Mpa, σ_{xy} = 15 Mpa" using both Max. Stress Failure Criterion and Tsai-Hill Failure Criterion.

Question (3) (15%)

C simple beam of span 5 m and rectangular cross section 25×40 cms is reinforced by two steel bars 2mm diameter) mm in tension side and strengthened by one unidirectional lamina (width w=20cm and ickness t=1mm and properties given in the previous question) strongly bonded to the tension side of the am. Calculate the ratio between Ultimate bending moment "Mu" of the beam cross section after and fore strengthening if you know that :

- Concrete characteristic strength = f_{cu} = 25 MPa
- Reinforcing steel used is HTS Steel of grade 360/520
- Concrete cover = 4 cms

Question (4) (15%)

1. What are composite materials?
2. Wood is a naturally occurring composite material. Can you explain?
3. State three general characteristics of FRP.
4. Material selection is one of the most important and critical steps in the structural design process. What are the main knowledge that required for proper selection?
5. Draw the following relationships:
   a. The tensile stress-strain curve for braided fibers.
   b. The tensile stress as function of time at different temperatures for glass fibers.
   c. Effects of loading rate and temperature on the stress-strain behavior of polymer matrix.
   d. Variation of stiffness with temperature for typical polymer matrix.
   e. Stress-strain curve for confined and unconfined concrete.

Question (5) (15%)

1. What is meant by "Filament, Yarn, Mats, Braids, and Fabrics"?
2. What are the main types of glass fibers commonly used in FRP?
3. State four advantages and four disadvantages of carbon fibers.
4. What is meant by "Fiber Sizing"? State the primary functions of fiber sizing.
5. State the primary roles of the polymer matrix in the composites.
6. What is meant by "Thermoplastic polymers", and "glass transition temperature"?
7. State the main advantages of epoxy resins.
8. State the primary functions of the fillers in ACM. What are the most commonly used fillers?

Question (6) (20%)

1. A 500 mm diameter column with 10Φ18 bars and 8 mm tie stirrups. The column is fully confined with three layers of CFRP. Assume $t_f = 0.20$ mm, $\varepsilon_{fu} = 0.016$, $E_f = 300$ GPa, $C_E = 0.85$, $f_{cu} = 25$ MPa, and $f_y = 360$ MPa. Compute the axial force capacity and the maximum usable strain.

2. For the beam cross-section shown in Fig. (1), $f_{cu} = 25$ MPa, and $f_y = 240$ MPa. Assume U-wrap configuration using three layers discrete GFRP strips 100 mm wide @ 200 mm center-to-center ($t_f = 0.6$ mm, $\varepsilon_{fu} = 0.03$, $C_E = 0.65$, and $E_f = 50$ GPa). Estimate the shear force contribution of FRP (Q_{fu}) and total shear capacity (Q_u).

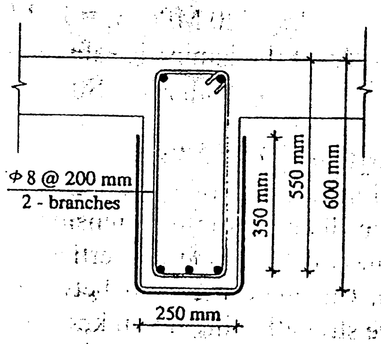


Fig. (1)

Useful Equations

- **Transformation Matrices**

$$[T]=\begin{bmatrix} C^2 & S^2 & 2CS \\ S^2 & C^2 & -2CS \\ -CS & CS & C^2-S^2 \end{bmatrix} \quad \& \quad [T]^{-1}=\begin{bmatrix} C^2 & S^2 & -2CS \\ S^2 & C^2 & 2CS \\ CS & -CS & C^2-S^2 \end{bmatrix}$$

Where : S=Sinθ & C=Cosθ

- **Stress-Strain relationships in 1&2 and in X&Y co-ordinates**

$$\begin{Bmatrix} \sigma_1 \\ \sigma_2 \\ \sigma_{12} \end{Bmatrix}=\begin{bmatrix} \frac{E_1}{1-\upsilon_{12}\upsilon_{21}} & \frac{\upsilon_{21}E_1}{1-\upsilon_{12}\upsilon_{21}} & 0 \\ \frac{\upsilon_{12}E_2}{1-\upsilon_{12}\upsilon_{21}} & \frac{E_2}{1-\upsilon_{12}\upsilon_{21}} & 0 \\ 0 & 0 & G_{12} \end{bmatrix}\begin{Bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_{12} \end{Bmatrix} \quad \& \quad \{\sigma\}_{1\&2}=[Q]_{1\&2}\{\varepsilon\}_{1\&2}$$

$$\{\sigma\}_{x\&y}=[T]^{-1}[Q]_{1\&2}[T]\{\varepsilon\}_{x\&y} = [Q]_{x\&y}\{\varepsilon\}_{x\&y}$$

- **Longitudinal compressive strength of a unidirectional lamina**

1) In Phase Bukling of Fibers : $S_L^- = \frac{G_m}{1-\nu_f}$

2) Out of Phase Bukling of Fibers : $S_L^- = 2\nu_f\sqrt{\frac{\nu_f E_m E_f}{3(1-\nu_f)}}$

3) Splitting Failure : $S_L^- = \frac{E_1 S_T^+}{E_2 \upsilon_{12}}$

4) Shear Failure : $S_L^- = 2(S_{f12}\nu_f + S_{m12}\nu_m)$

- **Confined compressive strength**

$$f_{cc} = f_{cu}\left[2.25\sqrt{1+9.875\frac{f_l}{f_{cu}}} - 2.5\frac{f_l}{f_{cu}} - 1.25\right]$$

..hams University	Advanced Construction Materials - CES 414
Faculty of Engineering	Tuesday 27-January-2009
Structural Engineering Department	4th Year - Time Allowed : 3 hours

The exam consists of Five (5) questions in two pages + One page for Equations.
Answer all questions.

Question 1 (18%)

1. State in points the two main constituents in composites and their primary roles in the composites. Explain briefly the factors affecting the properties of FRP Sections. State three advantages and disadvantages of FRP Sections.
2. State the row materials used, the manufacturing process and a sketch showing the chemical composition of ***only one*** type of fibers "i.e. Glass, Carbon, or Aramid fibers."
3. Why are Uni-directional fabrics possess higher tensile strength than other types of fabrics? Compare -using neat sketches *only*- between two different methods of production of multi-axial fabrics.
4. Draw a sketch between
   a) the axial tensile stress and axial tensile strain for different types of fibers compared with the epoxy resin on the same sketch.
   b) the stress-strain curve for typical resin system showing the elastic and plastic zones.
   c) the effect of thermal exposure on the UTS and Tensile modulus of different thermosetting resins.

Question 2 (20%)

1. What is meant by "Drawing Fibers"? Why it is carried out on Glass fibers?
2. What is meant by "Sizing Fibers"? Why it is carried out on Carbon fibers?
3. What is meant by "Hybrid Fabrics"? What type of hybrid fibers would you recommend for the production of FRP reinforcing bars used in reinforced concrete elements? and Why?
4. What is meant by "Tissue Fabric (chopped mat)"? Where, and Why, is it essential to use these fabrics in the production of FRP sections?

Question 3 (18%)

1. What is meant by "Thermo-plastic resin", "Thermoset resin", "gel time", "heat transition temperature" and "elevated temperature curing"?
2. Explain the raw materials, production method and main properties of Unsaturated polyester Resin. What is the difference between the "Catalyst" and the "Hardener"
3. What are the roles of "wax", "gel coat", "external mould release agents EMRA" in the procedures of mould preparation of FRP section production?
4. State the advantages and disadvantages of Pultrusion and VARTM production methods.

Question 4 (27%)

1. What are the possible failure modes of a lamina along the fibers direction subjected to *tensile* loading? Which mode do you think it is better? Why?
2. What are the possible failure modes of a lamina along the fibers direction subjected to *compressive* loading? (Use neat sketches whenever possible).
3. Discuss briefly the meaning of Coupling in two levels (*Lamina* level and *Laminate* level).
4. A unidirectional lamina was fabricated using carbon fibers of elasticity modulus = 500 GPa, Poison's ratio = 0.20, ultimate tensile strain = 2.0% and vinyl ester matrix of elasticity modulus = 50 GPa, Poison's ratio = 0.30, and ultimate tensile strain = 2.0%. If you know that the fiber volume fraction = 45%, the stress strain relationship is linear for both fibers and matrix materials, and both fibers and matrix materials can be considered as isotropic homogeneous materials.
   Calculate the following for the lamina:
   a) Major and Minor elasticity moduli.
   b) Major and Minor Poison's ratios.
   c) Shear modulus.
   d) Major and Minor tensile strengths.
   e) Theoretical tensile strengths for fibers and matrix materials.

Question 5 (27%)

A unidirectional lamina was fabricated using *Glass fibers* of the following properties: Elasticity modulus = 500 GPa, Poison's ratio = 0.15, Shear strength = 25MPa, Ultimate tensile strain = 1.0 %
and *vinyl ester matrix* of the following properties : Elasticity modulus = 40 GPa, Compressive strength = 60 MPa, Shear strength = 20 MPa, Poison's ratio = 0.20, Ultimate tensile strain = 2.0 %
If you know that the fiber volume fraction = 50%, the stress strain relationship is linear for both fibers and matrix materials, and both fibers and matrix materials can be considered as isotropic homogeneous materials.

Calculate the following:

1. Stiffness Characteristics of the lamina (E_I & E_2 & G_{12} & υ_{12} & υ_{21})
2. Strength Characteristics of the lamina (S^+_L & S^+_T & S^-_L & S^-_T & S_{LT})
3. Stresses in the material axes "σ_1, σ_2, σ_{12}" if you know that the applied stresses in X-Y axes are "$\sigma_x = 20$ MPa, $\sigma_y = 10$ MPa, $\sigma_{xy} = 5$ MPa", ($\theta = +30^o$).
4. Check if the lamina is safe or not under this state of stresses "$\sigma_x = 20$ MPa, $\sigma_y = 10$ MPa, $\sigma_{xy} = 5$ MPa", ($\theta = +30^o$) using both *Max. Stress Failure Criterion* and *Tsai-Hill Failure Criterion.*
5. Determine the stiffness matrix for the symmetric laminate [+30/0/+30] consisting of 3 laminae each of 0.50 mm thickness.

Useful Equations

Sub-region model Equations :

$$E_2 = E_m\left[\left(1-\sqrt{\nu_f}\right)+\frac{\sqrt{\nu_f}}{1-\sqrt{\nu_f\left(1-\frac{E_m}{E_f}\right)}}\right] \quad \& \quad G_{12} = G_m\left[\left(1-\sqrt{\nu_f}\right)+\frac{\sqrt{\nu_f}}{1-\sqrt{\nu_f\left(1-\frac{G_m}{G_f}\right)}}\right]$$

Transformation Matrices

$$[T]=\begin{bmatrix} C^2 & S^2 & 2CS \\ S^2 & C^2 & -2CS \\ -CS & CS & C^2-S^2 \end{bmatrix} \& \quad [T]^{-1}=\begin{bmatrix} C^2 & S^2 & -2CS \\ S^2 & C^2 & 2CS \\ CS & -CS & C^2-S^2 \end{bmatrix} \&$$

S=Sinθ & C=Cosθ

Stress-Strain relationships in 1&2 and in X&Y co-ordinates

$$\begin{Bmatrix}\sigma_1\\ \sigma_2\\ \sigma_{12}\end{Bmatrix}=\begin{bmatrix} \frac{E_1}{1-\upsilon_{12}\upsilon_{21}} & \frac{\upsilon_{21}E_1}{1-\upsilon_{12}\upsilon_{21}} & 0 \\ \frac{\upsilon_{12}E_2}{1-\upsilon_{12}\upsilon_{21}} & \frac{E_2}{1-\upsilon_{12}\upsilon_{21}} & 0 \\ 0 & 0 & G_{12}\end{bmatrix}\begin{Bmatrix}\varepsilon_1\\ \varepsilon_2\\ \varepsilon_{12}\end{Bmatrix} \quad \& \quad \{\sigma\}_{1\&2}=[Q]_{1\&2}\{\varepsilon\}_{1\&2}$$

$$\{\sigma\}_{x\&y}=[T]^{-1}[Q]_{1\&2}[T]\{\varepsilon\}_{x\&y} = [Q]_{x\&y}\{\varepsilon\}_{x\&y}$$

Longitudinal compressive strength of a unidirectional lamina

$$S_L^- = \frac{G_m}{1-\nu_f} \quad \& \quad S_L^- = 2\nu_f\sqrt{\frac{\nu_f E_m E_f}{3(1-\nu_f)}}$$

$$S_L^- = \frac{E_1 S_T^+}{E_2\upsilon_{12}} \quad \& \quad S_L^- = 2(S_{f12}\nu_f + S_{m12}\nu_m)$$

Ain Shams University
Faculty of Engineering
Structural Engineering Department

Advanced Construction Materials
BSc.- CES 414
Jan 2008 - Time : 3 hours

The exam consists of "Six" questions in "Two" pages

Answer All Six Questions

Question (1)

1. State in points the two main constituents in composites and their primary roles in the composites.
2. State the row materials of glass fiber and its manufacturing process. Clearly using neat sketch show the chemical composition of the glass fiber.
3. Why are Uni-directional fabrics possess higher tensile strength than other types of fabrics?
4. Resins are classified into two major groups, Compare between both groups stating the mechanical and physical properties of both types.
5. What are the roles of "wax", "Gel Coat", "external mould release agents EMRA", "surface tissue" in the procedures of mould preparation of FRP section production?
6. Draw a sketch between "the axial tensile stress" and "axial tensile strain" for different types of Fibres compared witrh the epoxy resin on the same sketch

Question (2)

1. Explain briefly the factors affecting the properties of FRP Sections.
2. State the row materials of Carbon fiber and its manufacturing process. Clearly using neat sketch show the chemical composition of the Carbon fiber.
3. State two different methods of production of multi-axial fabrics using neat sketches only. Compare between the mechanical and physical properties of both methods.
4. State the raw materials, production method and main properties of Unsaturated polyester Resin. Clearly show the polymerization process of the resin using "Peroxide" catalyst.
5. What is meant by "Tissue Fabric (chopped mat)"? Where, and Why, is it essential to use these fabrics in the production of FRP sections?
6. Draw a sketch showing the stress – strain curve for typical resin system stating the elastic and plastic zones on the sketch.

Question (3)

1. State few advantages and disadvantages of FRP Sections.
2. What is meant by "Drawing Fibers" and "Sizing Fibers". How theses operations are carried out on different types of fibers and Why?
3. What is meant by "Hybrid Fabrics". Give reasons for the use of such fabrics.
4. What are meant by the "gel time", "heat transition temperature", "natural curing" and "elevated temperature curing" of Resins.
5. State the advantages and disadvantages of Pultrusion and VARTM production methods.
6. Draw a sketch showing the effect of thermal exposure on the UTS and Tensile modulus of different thermosetting resins.

Ain Shams University
Faculty of Engineering
Structural Engineering Department

Question (4)

1) *Discuss* using neat sketches the possible modes of failure of a unidirectional lamina subjected to compressive stresses along the fibers direction.
2) *Drive* an equation to express the theoretical perfect tensile strength of a homogeneous isotropic material? Compare this strength with that of imperfect material with a sharp edge crack of size "2a" based on both Inglis and Griffith approaches. Which approach do you think it is better? Why?.
3) *Calculate* the maximum stress in a thin plate with infinite dimensions subjected to a uniform tensile stress 15 Kg/mm^2 in the following cases :
- The plate is perfect (i.e. there is no internal imperfections).
- The plate contains a circular hole of a diameter 40 mm.
- The plate contains an elliptic hole of a major diam. 40 mm and a minor diam. 20 mm.
- The plate contains a sharp edge crack of size 6 mm (i.e. 2a = 6mm) and the distance between atoms at equilibrium = 10 Angestrom.

Question (5)

A unidirectional lamina was fabricated using carbon fibers of elasticity modulus = 800 GPa, Poison's ratio = 0.12, ultimate tensile strain = 2% and vinyl ester matrix of elasticity modulus = 80 GPa, Poison's ratio = 0.28, and ultimate tensile strain = 4% . If you know that the fiber volume fraction = 42%, the stress strain relationship is linear for both fibers and matrix materials, and both fibers and matrix materials can be considered as isotropic homogeneous materials :

1) *Calculate* the following properties for the given lamina:

1. Major and Minor elasticity moduli.
2. Major and Minor Poison's ratios.
3. Shear modulus
4. Major and Minor tensile strengths.
5. Theoretical tensile strength for fibers and matrix materials.

2) *Calculate* the normal stresses along the fibers direction and perpendicular to it (i.e. σ_1 and σ_2) if you know that the applied stresses in the X-Y plane are : σ_x = 30 MPa, σ_y = 40 Mpa and σ_{xy} = 12 Mpa and fibers make an angle $\theta = 30°$ with x-axis.

3) *Calculate*, using both the "Tsai-Hill" interaction failure criterion and the maximum stress failure criterion, if this lamina will be failed under this state of stresses or not.

Question (6)

1) *What* are the 4 independent stiffness characteristics and the 5 independent strength characteristics of a unidirectional lamina?.

2) *Discuss* (using the necessary equations whenever possible) the physical meaning of Normal/Shear coupling of a unidirectional lamina subjected to in-plane loading.

3) *Draw* the relationships between the following for *a unidirectional lamina* :

- Fiber angie (θ) with x-axis and elasticity modulus in x-direction (E_x).
- Stresses along fiber direction (σ_1) and stresses perpendicular to it (σ_2) for the maximum stress failure criterion and the "Tsai-Hill" quadratic interaction failure criterion .
- Fiber diameter (d) and fiber tensile strength (S).
- Fiber volume fraction (V_f) and major elasticity modulus (E_1).
- Fiber volume fraction (V_f) and minor elasticity modulus (E_2).
- Fiber volume fraction (V_f) and Transverse tensile strength (S_T).
- Fiber volume fraction (V_f) and Longitudinal tensile strength (S_L).
- Longitudinal modulus of Elasticity (E1) vs. Transverse modulus of Elasticity (E2).

مع أطيب التمنيات بالتوفيق

Ain Shams University		Advanced Co[illegible]tion Materials
Faculty of Engineering		B.Sc.- Structural Engineering
Structural Engineering Department		January 2007 - Time: 3 hours

Answer All Six (6) Questions in Two (2) Pages

Question (1)

1) What are the main constituents of FRP sections. State in points the primary roles of each constituent in the composites.
2) Explain ***briefly*** the factors affecting the properties of FRP Sections.
3) State three advantages and three disadvantages of FRP Sections.
4) Draw a sketch ***only*** representing the relationship between:
   - The axial tensile stress and axial tensile strain for different types of Fibres compared with the epoxy resin on the same sketch Draw a sketch between:
   - The stress–strain curve for typical resin system stating the elastic and plastic zones on the sketch.

Question (2)

1) State the row materials of Glass Fibers and the manufacturing process. Clearly using neat sketch ***only*** show the chemical composition of the glass fibers.
2) What is meant by "Drawing Fibers" and "Sizing Fibers". Why theses operations are carried out on different types of fibers?
3) Why are Uni-directional fabrics possess higher tensile strength than other types of fabrics.
4) Draw sketches of three types of bi-directional woven fabrics showing the knitting method clearly.
5) What is meant by tissue fabric (chopped mat). Where and Why it is essential to use these fabrics in the production of FRP sections.

Question (3)

1) State the two major groups of Resins. Compare between both groups stating the mechanical and physical properties of both types.
2) State the raw materials, production method and main properties of Unsaturated polyester Resin. Clearly show the polymerization process of the resin using "Peroxide" catalyst.
3) What are meant by the "Gel time", "Heat transition temperature", "natural curing" and "elevated temperature curing" of Resins.
4) State the advantages and disadvantages of VARTM production method.
5) Using - **neat sketches only** - state the different methods of production of multi-axial fabrics using neat sketches only.

Question (4)

1) What is the theoretical perfect tensile strength of a homogeneous isotropic material based on the atomic model? Compare this strength with the imperfect tensile strength of the same material with a sharp tip crack of a size = 2a based on both Inglis and Griffith models. To how much do you trust Inglis and Griffith approaches to predict the imperfect material tensile strength? Why?
2) Draw the diagrams representing the relationships between:
   - Distance between atoms (b) and the resultant stress (σ).
   - Tensile strength of a material (S) and the crack size (a).
3) Calculate the max. stress in a thin steel plate with infinite dimensions subjected to uniform tensile stress of 15 Kg/mm^2 in the following cases :

- The plate is perfect.
- The plate contains a circular hole of a diameter 5 mm.
- The plate contains an elliptic hole of a major diameter 10 mm and a minor diameter 5 mm.
- The plate contains a sharp edge crack of size 2mm if the distance between atoms at equilibrium = 12 Angstrom. (Hint: Angstrom = 10^{-10} m).

Question (5)

1) For an orthotropic lamina of unidirectional fibers, discuss briefly the following properties using neat sketches whenever possible:
   - Major & Minor Poison's ratios.
   - Major & Minor moduli of Elasticity
2) Draw the relationships between the following for a unidirectional lamina :
   - Fiber volume fraction (Vf) and elasticity moduli (E1 & E2).
   - Fiber angle (θ) with x-axis and elasticity modulus in x-direction (E_θ) for uni-directional lamina, bi-directional lamina, and randomly chopped fibers lamina.
3) A unidirectional lamina was fabricated using carbon fibers of elasticity modulus = 400 GPa, tensile strength = 3000 MPa, Poison's ratio = 0.10 and vinyl ester matrix of elasticity modulus = 50 GPa, tensile strength = 200 MPa, Shear strength = 150 Mpa, Poison's ratio = 0.30. If you know that the fiber volume fraction = 40%, the stress strain relationship is linear for both fibers and matrix materials up to failure, and both fibers and matrix materials can be considered as isotropic homogeneous materials. Calculate the following for the lamina :
   a) Stiffness Characteristics (E1, E2, G12, υ12, υ21).
   b) Longitudinal and Transverse tensile strengths (S_L^+ & S_T^+).

Question (6)

1) Discuss briefly the following for a uni-directional lamina (use neat sketches whenever possible):
   a) The four independent stiffness characteristics and five independent strength characteristics.
   b) Coupling between normal and shear stresses if fibers make an angle (Θ) with the applied stresses.
2) For the unidirectional lamina given in question (5-(3)), if the fibers make an angle θ = 60° with x-axis.
   a) Calculate the stresses in the material axes system (i.e. σ1, σ2 , σ12) if you know that the applied normal and shear stresses are σ_x = 150 MPa, σ_y = 160 Mpa, q_{xy} = 100 Mpa.
   b) Calculate using Tsai-Hill failure quadratic interaction criterion if this lamina will be failed under this state of stresses or not.

Good Luck

الترجمة الصخور والتربة في المناطق الجافة

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURALENGINEERING DEPARTMENT

4 [th] year, Structural Div. students

26- january, 2010-2011 Course Code: HDN 455 Time: 3.00 Hrs

ROCKS & SOIL IN ARID ZONES

The Exam. consists of 6 questions in 2 pages.	Total Marks: 70 Marks
Assume any missing information.	Page 2/2

Question no. 4: (10 marks)

a- Explain, how can you distinguish between the different types of rocks using the property of texture and hardness? Give examples of each.
b- Compare between discolored and decomposed rocks.
c- Compare between essential minerals, secondary minerals and accessory minerals.
d- Compare between sandstone, oolitic limestone and pisolithic limestone.
e- Compare between claystone, marl, shale, siltstone.
f- A dry sample of claystone 500 gm in weight was tested in the slake durability apparatus. The weight of retained inside the sieve mesh drum (2 mm opening) after turning 200 revolution in a water path was 420 gm. An identical dry sample of the same rock 600 gm in weight after immersion in water for two hours its weight becomes 690 gm. The liquid limit and plastic limit of the considered claystone is 102%, and 59% respectively. It is required to classify the rock according to: slake durability, amount of slaking, and rate of slaking.

Question no. 5: (15 marks)

A- Put the correct sign (✓) or the incorrect sign (X) on the following sentences:
1. Angle of shearing resistance of sandstone is must be higher than the angle of shearing resistance of dense sand.
2. Shear strength of jointed rock mass is always lower than the shear strength of the intact one.
3. Shale is considered as an example for isotropic rock.
4. Claystone may increase in volume when subjected to water flooding.
5. Oolitic limestone always slaked in water.

B- During boreholing and sampling at a certain site using core sampler 100 cm in length, the recovered rock lengths at the second and third meters are as follows :
Third meter: (11, 8, (19 cm friable sediments), 5, 9, 8, 9, 10, 12, and 9 cm).
Fourth meter: (14, 10, 9 , 13, 5, 10, 8, 12, 7, and (12 cm friable sediments)).
It is required to:
i- Calculate the recovery for the third and fourth meters. Comment on the results.
ii- Calculate the RQD of the rock at the two depths. Comment on the results

C- Explain, how can you determine the rock mass rating (RMR) to evaluate the rock mass at a certain site. Discuss the importance of RMR in dealing with the jointed rock. In case of :
i- Jointed limestone, ii- Jointed claystone which slaked in water

Question no. 6: (10 marks)

A- Explain the different cases of rock joint condition.
B- A reinforced concrete footing (2.00 m X 1.80 m X 0.6 m) is embedded in a bedrock layer having R.M.R 75 %, and unit weight of 23.8 KN/m3. The unconfined compressive strength of the rock is 200 kg/cm2, and angle of shearing resistance is 32°. Depth of foundation is 1.5 m below ground surface. **It is required to:**
Determine the allowable compression force that can be carried by the footing based on bearing capacity shear failure. Draw the expected failure shape.

$Nc = 2 N_\phi^{1/2} (N_\phi + 1)$, $N\gamma = 2 N_\phi^{1/2} (N_\phi^2 - 1)$, $Nq = 2 N_\phi^2$, $N_\phi = \tan^2 (45 + \phi/2)$

$C = q_u \cdot s / \{2 \cdot \tan (45 + \phi/2)\}$, $s = \exp (RMR - 100)/9$

Ain Shams University
Faculty of Engineering

4th year, Structural De
Soils in arid zones & I
Time: 3 hours

Assume any missing information
Examination consists of 7questions in 3 pages.

Question no. 1

a- Explain the effect of water flow direction on the pore water pressure in expansive soil.

b- A square footing (2.0 X2.0 m) is founded on expansive soil at a level (-1.5m) and carried a normal load of 40 ton. The unit weight of soil is equal to 2.0 gm/cm^3. The level of ground surface is (0.00) and the level of ground floor is (+ 1.50m). The initial void ratio e_o = 0.52. The result of oedometer test carried out on expansive soil sample is given in the following table:

Stress kg/cm^2	0.25	0.5	1.0	2.0	4.0	8.0	16.0	8.0	4.0	2.0
Void ratio	.52	0.52	0.52	0.51	0.47	0.44	0.40	0.42	0.44	0.46

Calculate:

1. The corrected swelling pressure, and
2. The expected heave.
3. The expected heave in case of treated soil using replacement with thickness 1.0m and its unit weight 1.80 gm/cm3.

Question no. 2

a- Explain how can you determine the collapsibility potential experimentally?

b- Discuss the effect of the following properties on the collapsibility potential:

- Clay content
- Natural water content
- Natural density

Question no. 3

Multiple choice and state the reason.

1- The collapsibility potential increases as

a- Initial water content decreases.
b- Initial unit weight decreases.
c- Clay content increases.

2- The critical degree of saturation depends on

a- Initial water content
b- Initial unit weight
c- The size of the soil grains

3- The rate of settlement for collapsible soil is affected by

a- Clay minerals
b- Clay content
c- Shape of particles

4- The collapsibility potential can be determined using
a- Oedometer test
b- Double oedometer test
c- Field test

5- The most effective technique for construction on collapsible soil
a- Soil replacement
c- Flooding the soil
d- Compaction the soil and flooding

Question no. 4

An oedomerter test was performed on a collapsible soil, the results were:

Stress (kg/cm^2)	0.5	1.0	2.0	2.0	4.0	8.0
Dial reading	188	221	252	730	760	783

The initial dial reading was 100 divisions, and its sensitivity is 0.002 mm. The sample thickness was 18 mm and its initial void ratio was 0.78. Draw e-log stress curve and determine the degree of collapsibility and comment on the result.

Question no. 5

a- Using tabulated definite points and sketches if possible, Compare between:
1. Essential , Secondary mineral and accessory minerals
2. Oolitic limestone, sandstone, calcareous sandstone
3. Marl, Shale, Siltstone, Claystone.
4. Decomposed, and disintegrated rock.

b- Discuss the shear strength of jointed rock and shear strength of intact rock.
c- Explain the different forms of stress strain curve of rock. Draw sketches showing the difference of curve shape in case of intact and jointed rock. Show how can you estimate the elastic modulus of rock mass.
d- Draw a typical stress strain curve for rock sample in which $E_{t50} < E_{ti}$, comment.
e- Differentiate between ductile and brittle failure in rock samples, give examples.

Question no. 6

A- Put the correct sign (✓) or the incorrect sign (X) on the following sentences:
1. Angle of shearing resistance of sandstone is must be higher than the angle of shearing resistance of dense sand.
2. Shear strength of jointed rock mass is always lower than the shear strength of the intact one.
3. Shale is considered as an example for isotropic rock.
4. Oolitic limestone slaked in water.

B- During boreholing and sampling at a certain site using core sampler 100 cm in length, the recovered rock lengths at the third and fourth meters are as follows:

Third meter: (7, 8, 45 cm friable sediments, 8, 9, 8, 9, and 6 cm).
Fourth meter: (11, 10, 6, 9, 13, 10, 12, 12, 10, and 15 cm friable sediments).

It is required to:

i- Calculate the recovery for the third and fourth meters. Comment on the results.

ii- Calculate the RQD of the rock at the two depths. Comment on the results

C- Explain the items that affect the value of the rock mass rating (R.M.R) for the rock mass at a certain site.

D- Discuss the importance of RMR in dealing with the jointed rock. In case of :

i- Jointed limestone, ii- Jointed claystone which slaked in water

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Question no: 7

A- Discuss the different modes of bearing capacity shear failure for isolated footing carries normal vertical load rested on rock.

B- A reinforced concrete footing (1.80 m X 1.80 m X 0.8 m) is embedded in a bedrock layer having R.M.R 78%, and unit weight of 24.8 KN/m3. The unconfined compressive strength of the rock is 210 kg/cm2, and angle of shearing resistance is 24°. Depth of foundation is 1.5 m below ground surface. **It is required to:**

Determine the allowable compression force that can be carried by the footing based on bearing capacity shear failure. Draw the expected failure shape.

$Nc = 2\, N_\phi^{1/2}\, (N_\phi + 1)$, $N\gamma = 2\, N_\phi^{1/2}\, (N_\phi^2 - 1)$, $Nq = 2\, N_\phi^2$, $N_\phi = \tan^2 (45 + \phi/2)$

$C = q_u \cdot s / \{2 \cdot \tan\ (45 + \phi/2)\}$, $s = \exp\ (RMR - 100)/9$

Ain Shams University
Faculty of Engineering
January, 2009

4 th year, Civil Dept.
Structure Div. students
Time : **3.0 hours**

Soil in arid zones & Rock mechanics

Assume any missing information & answer all questions. The examination consists of 2 pages. All sketches should be neatly done and properly dimensioned.

Question no. 1

a- Compare between essential minerals, secondary minerals and accessory minerals.

b- Compare between Marl, Shale, Claystone.

c- Mention the names of probable essential mineral in the following rocks :
Limestone, sandstone, claystone, Granite, Marble, oolitic limestone.

d- A dry sample of rock 450 gm in weight was tested in the slake durability apparatus. The weight of retained inside the sieve mesh drum (2 mm opening) after turning 200 revolution in a water path was 420 gm. An identical dry sample of the same rock 500 gm in weight after immersion in water for two hours its weight becomes 520 gm. The liquid limit and plastic limit of the considered rock is 50%, and 30% respectively. It is required to classify the rock according to: slake durability, amount of slaking, and rate of slaking.

QUESTION no. 2

a- Discuss the shear strength of jointed rock and shear strength of intact rock.

b- Explain the different forms of stress strain curve of rock. Draw sketches showing the difference of curve shape in case of intact and jointed rock. Show how can you estimate the elastic modulus of rock mass.

c- Draw a typical stress strain curve for rock sample in which $E_{t50} > E_{ti}$, comment.

d- Differentiate between ductile and brittle failure in rock samples, give examples.

e- Explain the items that affect the value of the rock mass rating (R.M.R) for the rock mass at a certain site.

f- Discuss the importance of RMR in dealing with the jointed rock. In case of :
i- Jointed limestone, **ii- Jointed claystone which slaked in water**

QUESTION no. 3

a- Discuss the different modes of bearing capacity shear failure for isolated footing carries normal vertical load rested on rock.

b- A reinforced concrete footing (1.50 m X 1.50 m X 0.6 m) is embedded in a bedrock layer having R.M.R 72%, and unit weight of 23.8 KN/m3. The unconfined compressive strength of the rock is 240 kg/cm2, and angle of shearing resistance is 22°. Depth of foundation is 1.5 m below ground surface. **It is required to:**
Determine the allowable compression force that can be carried by the footing based on bearing capacity shear failure. Draw the expected failure shape.
$Nc = 2 N_\phi^{1/2} (N_\phi + 1)$, $N\gamma = 2 N_\phi^{1/2} (N_\phi^2 - 1)$, $Nq = 2 N_\phi^2$, $N_\phi = \tan^2 (45 + \phi/2)$
$C = q_u . s / \{ 2 . \tan (45 + \phi/2)\}$, $s = \exp (RMR - 100)/9$

See next page

Question no. 4

Define the following terms:

1. Expansive soil, free swelling and swelling pressure.
2. Direct and indirect identification of expansive soils.
3. The dependency of swelling pressure on the measuring procedure.
4. The mechanism of swelling of expansive soil deposits.
5. The factors affecting the swelling behaviour of expansive soils.
6. The different techniques used to damp or eliminate the swelling characteristics of expansive soils.

Question no. 5

The results of the different pressure procedure is as follows;

Trail No.	1	2	3	4
Applied load (kg)	5.5	11	22	44
Dial gauge reading (0.002mm/div.)	765 (heave)	385 (heave)	180 (heave)	160 (compression)

The sample dimensions are; 44 mm (diameter) and 19 mm (height). Determine the swelling pressure. If we decide to re-determine the swelling pressure using the pre-swell test arrangement, what you expect for the measured swelling pressure, why?

Question no. 6

A footing (2.5x2.5m) is founded on a successive deposit of expansive soil having bulk unit weight of 1.85 t/m^3 and initial void ratio of 0.55. The footing carrying load is 85 ton and located 1.5m below ground surface. The variations of the soil void ratio with respect to loading and wetting is as follows;

Applied pressure (kg/cm^2)	.26	.52	1.04	2.08	4.16	8.32	16.64	8.32	4.16	2.08
Void ratio	0.52	0.52	0.52	0.51	0.47	0.44	0.40	0.42	0.44	0.46

Determine; the swelling pressure and the expected footing movement.

Best wishes

سيناريث

د/ اسعداث بريك
التربة والصخور

Ain Shams University
Faculty of Engineering
Structure Eng. Dept.

4th Structure Eng.
Rocks and Dry soil
Time: 3 hours

Examination consists of Three questions in Three pages

Question No 1

A) Put (☑) or (☒) on the shown statements and correct the answer above each one

Important Note: If you do not state the reason, the answer will not be accepted.

1- The water content of soil at final swelling is equal to liquid limit.
2- The active depth of swelling soil is equal to swelling potential/ unit weight of soil.
3- The swelling potential increases as the footing stress decreases.
4- The swelling potential of saturated swelling soil can be determined using direct tests.
5- The swelling potential of unsaturated soil decreases as initial voids ratio increases.
6- The swelling pressure increases as the initial water content decreases.
7- The swelling pressure is constant value for variable initial water content.
8- The swelling pressure of unsaturated soil can be determined using indirect measurement tests.
9- The swelling pressure of unsaturated soil increases as the unit weight of soil increases.
10-The swelling of saturated soil increases as the thickness of soil sample increases.
11- The soil replacement is the most affective method for treatment of saturated swelling soil.
12- The final water content of saturated swelling soil increases as the soil depth increases in case of downward water flow.
13- The pore water pressure is negative above foundation level.
14- The effective stress of soil after swelling is bigger than the total stress of soil in case of downward water flow.
15- The activity of swelling soil is equal to clay content/ plastic limits.

B) Predict the expected heave for square footing (2.0m x2.0m) resting directly on untreated and treated expansive soil using soil replacement. The footing depth is 2.0 m. The liquid limit, plastic limit, and shrinkage limit are 120%, 50%, and 9% respectively. The footing stress is 1.0kg/cm^2, initial void ratio is 0.5, final void ratio is 1.00, soil sample depth is 4.00m, swelling pressure is 1.00kg/cm^2 and initial unit weight of soil is 2.0t/m^3. The thickness of soil replacement is 0.75 m. Compare between the loaded and unloaded area results for treated and untreated soil using direct measurement tests.

Question No.2

A) Multiple choice and state the reason.

1- The soil replacement is the most affective method for treatment
   a- Collapsible soil
   b- Loose sand

2- The collapsibility decreases as
   a- Initial voids ratio increases.
   b- Initial water content increases.

3- The critical degree of saturation decreases as
   a- The grain size of soil increases.
   b- The initial water content decreases.

4- The collapsibility of unsaturated soil can be determined using
   a- Plate load test.
   b- permeability test.

5- The active depth of collapsible soil is equal to
   a- twice footing width and footing width.
   b- 6.00m.

B) i-Compare between the collapsible and swelling soil tests in the b
   ii- Compare between the consolidation and swelling test.

C) Calculate the movement of square footing (1.0x1.0m) resting on treated and untreated collapsible soil. Thickness of treated soil is 2.00m under footing depth. The active depth of soil is 4.00m. The footing depth is 2.0m. The footing stress is 1.00 kg/cm^2. The collapsibility of soil is 5%.

Question no. 3

A- i) Differentiate between rock mass and intact rock.
ii) Explain how to classify the rock with respect to state of weathering.
iii) Compare between claystone, marl, and shale.
iv) Explain the different forms of stress strain curve of rock. Draw sketches showing the difference of curve shape in case of intact and jointed rock. Show how can you estimate the elastic modulus of rock mass.

B - During boreholing and sampling at a certain site using core sampler 120 cm in length, the recovered rock lengths at the third and fourth meters are as follows:
Third meter: (9, 13, 10 cm friable sediments, 7, 15, 29, 15, 5, 7, and 10 cm).
Fourth meter: (15, 9, 6, 7, 15, 10, 22, 8, 12, 10, and 6 cm friable sediments).
It is required to:
i- Calculate the recovery for the third and fourth meters. Comment on the results.
ii- Calculate the RQD of the rock at the two depths.

C - A dry sample of claystone 630 gm in weight was tested in the slake durability apparatus. The weight of retained inside the sieve mesh drum (2 mm opening) after turning 200 revolution in a water path was 490 gm. An identical dry sample of the same rock 550 gm in weight after immersion in water for two hours its weight becomes 650 gm. The liquid limit and plastic limit of the considered claystone is 120%, and 60% respectively. It is required to classify the rock according to: slake durability, amount of slaking, and rate of slaking.

D – i) Explain how can you determine the rock mass rating.
ii) Discuss the importance of RMR in dealing with the jointed rock. In case of :
1- Jointed limestone, 2- Jointed claystone which slaked in water
iii) Discuss the different modes of bearing capacity shear failure for isolated footing carries normal vertical load rested on rock.
iv) A reinforced concrete footing (1.70 m X 1.80 m X 0.6 m) is embedded in a bedrock layer having R.M.R 85 %, and unit weight of 22.8 KN/m3. The unconfined compressive strength of the rock is 200 kg/cm2, and angle of shearing resistance is 24°. Depth of foundation is 1.5 m below ground surface.
It is required to:
Determine the allowable compression force that can be carried by the footing based on bearing capacity shear failure. Draw the expected failure shape.

$N_c = 2\, N_\phi^{1/2}\,(N_\phi + 1)$, $N_\gamma = 2\, N_\phi^{1/2}\,(N_\phi^2 - 1)$, $N_q = 2\, N_\phi^2$;
$N_\phi = \tan^2\,(45 + \phi/2)$
$C = q_u \cdot s / \{2 \cdot \tan\,(45 + \phi/2)\}$, $s = \exp\,(RMR - 100)/9$.

Best wishes

AIN SHAMS UNIVERSITY-FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
Fourth Year Civil - Structural Section

January 2012 | **Final Exam** | ***Time : 3:00 Hrs***

STEEL PLATED STRUCTURES
COURSE NO. CES 435

The Exam Consists of Four Questions in **Seven** Pages.

ANY MISSING DATA MAY BE REASONABLY ASSUMED.

QUESTION (I): (22 Marks)

1. What are the types of arc welds generally used in cold-formed steel construction?
2. Design the welded connection shown in Figure 1 for the applied load of 3 t. Consider the eccentricity of the applied load. Steel used is St. 37 of yield stress equals 2.40 t/cm^2.

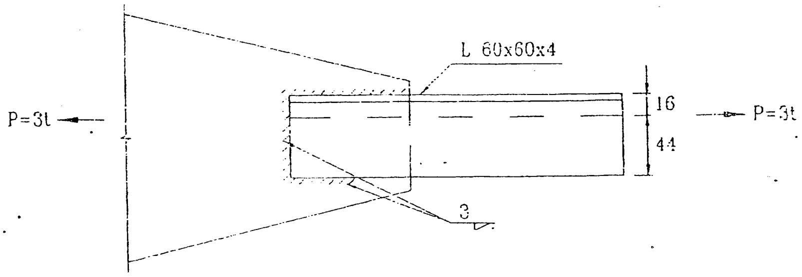


Figure 1

3. What are the types of failure usually occuring in the cold-formed steel bolted connections?
4. Check the safety of the connection shown in Figure 2. Use four 14 mm diameter non-pretensioned grade 4.6 ordinary bolts, and St. 37 of yield stress equals 2.40 t/cm^2 . Assume that washers are used under bolt head and nut and use standard holes.

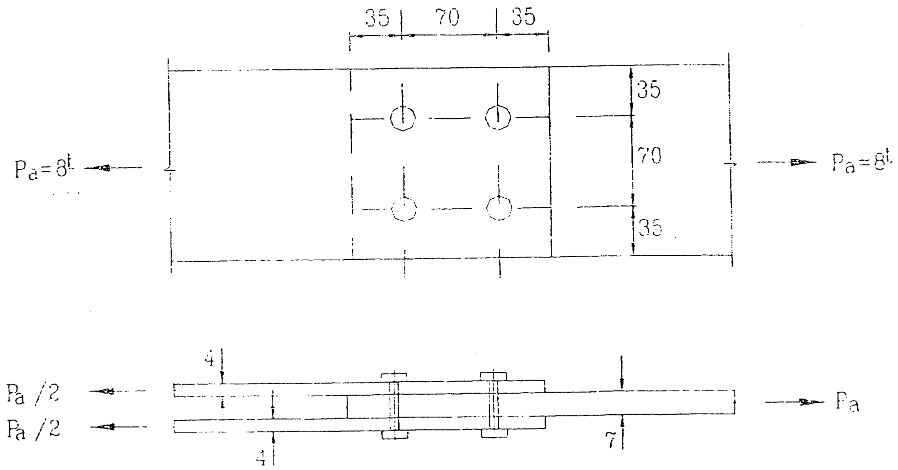


Figure 2

FILLET WELDS

i- Allowable load based on shear capacity of weld

$P_a = 0.2\ F_u\ (s\ L)$

ii- Allowable load based on strength of connected sheets

a- Longitudinal loading

when $L/t < 25$ $\quad P_a = 0.4\ F_u\ (1 - 0.01\ L/t)\ t\ L$

when $L/t \geq 25$ $\quad P_a = 0.3\ F_u\ (t\ L)$

b- Transverse loading $\quad P_a = 0.4\ F_u\ (t\ L)$

FLARE GROOVE WELDS

i- Allowable load based on shear capacity of weld

$P_a = 0.3\ F_u\ L\ s$

ii- Allowable load based on strength of connected sheets

a- Transverse loading

$P_a = t\ L\ F_u\ /\ 3$

b- Longitudinal loading

If $t \leq t_w < 2\ t$ or if the lip height is less than the weld length,

$P_a = 0.3\ t\ L\ F_u$

If $t_w \geq 2\ t$ and the lip height is equal to or greater than L,

$P_a = 0.6\ t\ L\ F_u$

ALLOWABLE TENSILE STRESS ON NET SECTION OF CONNECTED PARTS

With washers under both bolt head and nut

$F_{tt} = (1.0 - 0.9\ r + 3\ r\ d\ /\ g)\ 0.58\ F_y \leq 0.58\ F_y$

$F_{tt} = (1.0 - r + 2.5\ r\ d\ /\ g)\ 0.58\ F_y \leq 0.58\ F_y$

ALLOWABLE BEARING STRESS BETWEEN BOLTS AND CONNECTED PARTS

$F_b = \propto F_u$

ALLOWABLE SHEAR STRESS ON BOLTS

i) the allowable shear stress q_b for the bolt grades 4.6 , 5.6 and 8.8 shall be taken $q_b = 0.25\ F_{ub}$

ii) for bolt grades 4.8 , 5.8 , 6.8 and 10.9 the allowable shear stress q_b is reduced to $q_b = 0.2\ F_{ub}$

ALLOWABLE TENSILE STRESS ON BOLTS

$F_{tb} = 0.33\ F_{ub}$

QUESTION (II): (10 Marks)

1-Explain briefly (using neat sketches), what do you know about? :

a- Advantages and disadvantages of orthotropic deck bridges.
b- Comparison between the structural efficiency of orthotropic deck bridges versus conventional and composite girders bridges.
c- How orthotropic steel plate girder bridges can be analyzed using different separated components.
d- Different types of ribs and floor beams commonly used for orthotropic deck bridges.

2- Write the equilibrium equation controlling the behavior of orthotropic plate and discuss the meaning of each term comprising the equation.

QUESTION (III): (22 Marks)

1- Check the following box girder bridge of span = 100 ft. as shown in Figure 3 according to AASHTO.

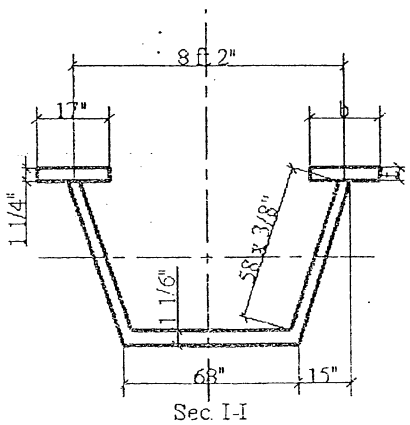


Figure 3

b = 17"
t = 1 1/4"

Given that:-

- Loads

M_{max} = 4300 ft.kip and $Q_{max} = V_v = 300$ kp

- Properties of X-section

I = 87.310 in^4 - $S_{Top} = 2813\ in^3$ - $S_{Bottom} = 3184\ in^3$

- Limitation of stresses according to AASHTO

- If $(b/t) \leq (6140/\sqrt{fy})$ Then $Fb \leq 0.55$ Fy (without stiffeners)
- If $(6140/\sqrt{fy}) \leq (b/t) \leq 60$

Then $Fb = 0.55\,Fy - 0.224\,Fy\,[\,1 - \sin(\tfrac{1}{2}\pi\,\{[13300 - (b\sqrt{Fy}/t)] / 7160\})] \;\&\; b/t \leq (13300/\sqrt{fy})$

- If $(b/t) \geq 45$ (longitudinal stiffeners must be used)

$V_w = V_v / \cos\theta$

$A_t = 2\,A_w$

$F_v = V_w / A_t$

$tw \geq (D\sqrt{Fb}) / 23000$ (for web without longitudinal stiffeners)

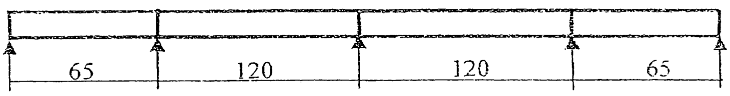
$d_o \leq D\,(260/(d/tw))^2$ or 3D

$K = 5 + [5/(do/D)^2]$

- if $D/t_w < [6000\sqrt{K}]/\sqrt{Fy}$ Then $C = 1.0$
- If $[6000\sqrt{K}]/\sqrt{Fy} \leq D/t_w \leq [7500\sqrt{K}]/\sqrt{Fy}$.Then $C = [6000\sqrt{K}] / [(D/t_w)\sqrt{Fy}]$
- If $D/t_w > [7500\sqrt{K}]/\sqrt{Fy}$). Then $C = [4.5 \times 10^7 \times K] / [(D/t_w)^2 \times Fy]$

$F_{v\,max} = (Fy/3)\,[C + (0.87 \times (1-C)/(\sqrt{1+(d_o/D)^2})]$

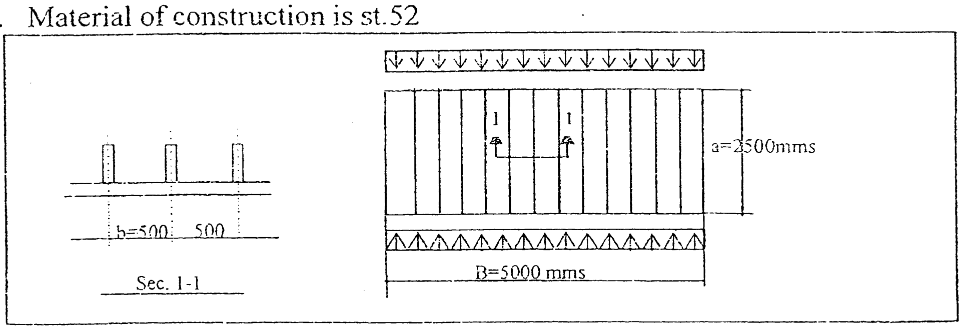
2-Draw to reasonable scale layout (X-section & plan) of box girder bridge where the width of the bridge is 25m.



i-What is the main part that governs the ultimate strength of this bridge, give reasons.

ii- Design the longitudinal ribs of the stiffened lower panel (as shown in fig.) at intermediate support of a continuous box girder, given the following:

a. Thickness of plate=12mms
b. Spacing between longitudinal ribs= 500mms.
c. Actual normal stress= $\sigma_{actual} = 1800$ kg/cm^2
d. Material of construction is st.52



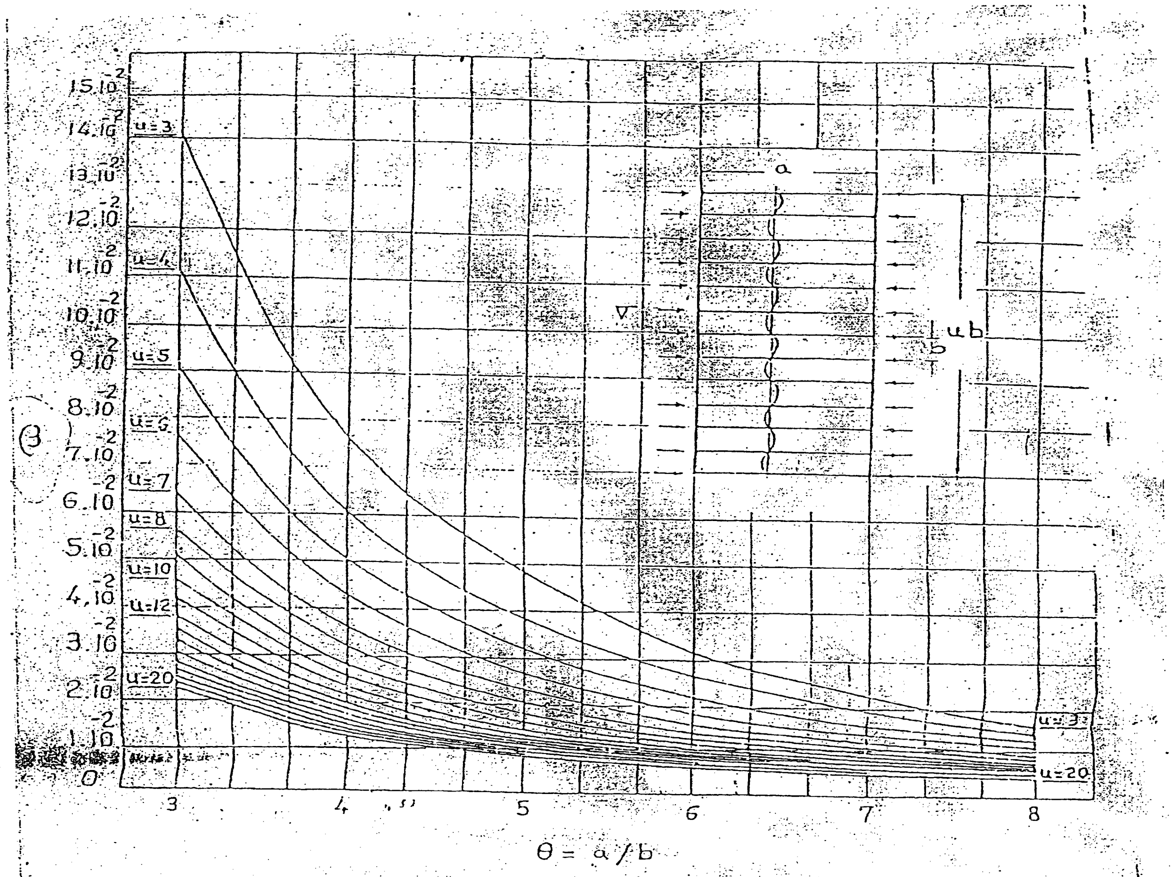
Given that:

$\delta = As / ubt$ and $\theta = a/b$

Formula $\gamma^* = \beta\,(\theta)^4 + 4\,\delta\,\theta^2$

$\gamma^* = (E\,I^*s)/(u\,b\,D)$

$D = (E\,t^3)/(12\,(1-\upsilon^2))$ where υ = poisson's ratio = 0.3



VALUES OF β FOR VARIOUS NUMBER OF SUB-PANELS

QUESTION (IV): (22 Marks)

1- Calculate the average yield stress of box section 250 x 250 x 8mm taking into consideration the effect of cold working given that:

$F_{y\text{-avarage}} = f_y + (knt^2 / A) . (f_u - f_y) < f_u$ or 1.2 f

K = 7 steel used is 36/52 A of the given section = 100 cm^2

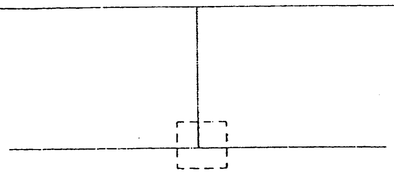
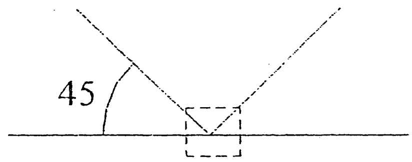
AIN SHAMS UNIVERSITY, FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT, Fourth Year Civil (Structural Section)

January 2012	Final Exam	Time : 3:00 Hrs

STEEL PLATED STRUCTURES
COURSE NO.: CES 435

The Exam Consists of **Four** Questions in **Seven** Pages.

2- Draw the following connections in <u>elevation only</u> using scale 1:10

 All sections are box 250x250x10	 All sections are pipes 108 x 5
Figure "a"	Figure "b"

a- <u>Three different shapes</u> of vierendeel rigid connection shown in figure "a"

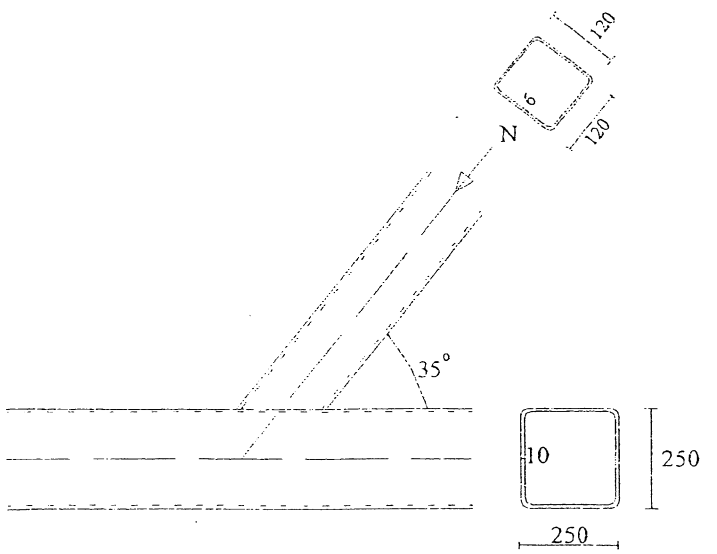
b- <u>Two different shapes</u> of planar truss joint shown in figure "b"

c- The rigid bolted connection between column (box 300x300x12) and rafter (box 250x250x10)

d- The fixed base of a sign board with pipe column 159 x 8mm (plan of connection is also required)

e- The hinged connection between composite column (box 300x300x12) and beam (IPE 300) to ensure the transmission of load to concrete (plan of connection is also required)

3- For the welded joints shown, it is required to determine the joint strength, taking into consideration <u>five</u> different possible models of failure of the joint. Assume that the bracing member is SHS of dimensions (120 x 120 x 6 mm) with yield stress 235 N/ mm^2 and that the chord member is (250 x 250 x 10 mm) with yield stress is 355 N/ mm^2.



Given that:

Section	Rectangular
Plastic design sections	$\frac{b}{t} \leq 33\varepsilon$
Compact sections	$\frac{b}{t} \leq 38\varepsilon$
Elastic design sections	$\frac{b}{t} \leq 42\varepsilon$
$\varepsilon = \sqrt{235/F_y}$	

1- YIELD LINE MODEL: $N = \frac{t_o^2 x F_{yo}}{1-\beta}\left[\frac{2h_1}{b_o x \sin\theta_1} + 4\sqrt{1-\beta}\right] x \frac{1}{\sin\theta_1}$

2- PUNCHING SHEAR MODEL: $N = \frac{t_o x F_{yo}}{\sqrt{3}}\left[\frac{2h_1}{\sin\theta_1} + 2b_{ep}\right] x \frac{1}{\sin\theta_1}$

3- EFFECTIVE BRACING WIDTH MODEL: $N = f_{y1} \cdot t_1 (2h_1 - 4t_1 + 2b_{eff})$

4- SHEAR FAILURE: $V = \frac{F_{yo}}{\sqrt{3}} x A_v$

5- CHORD WALL LOCAL BUCKLING: Deduce the equation assuming as if $\beta = 1$

Assume $b_{eff} = b_{ep} = 0.4b$

Course Examination Committee		Exam. Date : 17 January 2012
Prof. Abdelrahim Khalil Dessouki	Prof. Mohamed El Aghoury	
Prof. Nahla Kamal Hassan	Dr. Rimon Aziz	Best wishes

AIN SHAMS UNIVERSITY – FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
Fourth Year Civil (Structural Division)

January 2010 **Design of steel bridges** **Tim**

STEEL STRUCTURES (?)
COURSE NO.: CES 4??

The Exam Consists of Ten Questions in Two Pages.

Material of construction is Steel 52 ***(Any missing data may be reasonably assumed)***

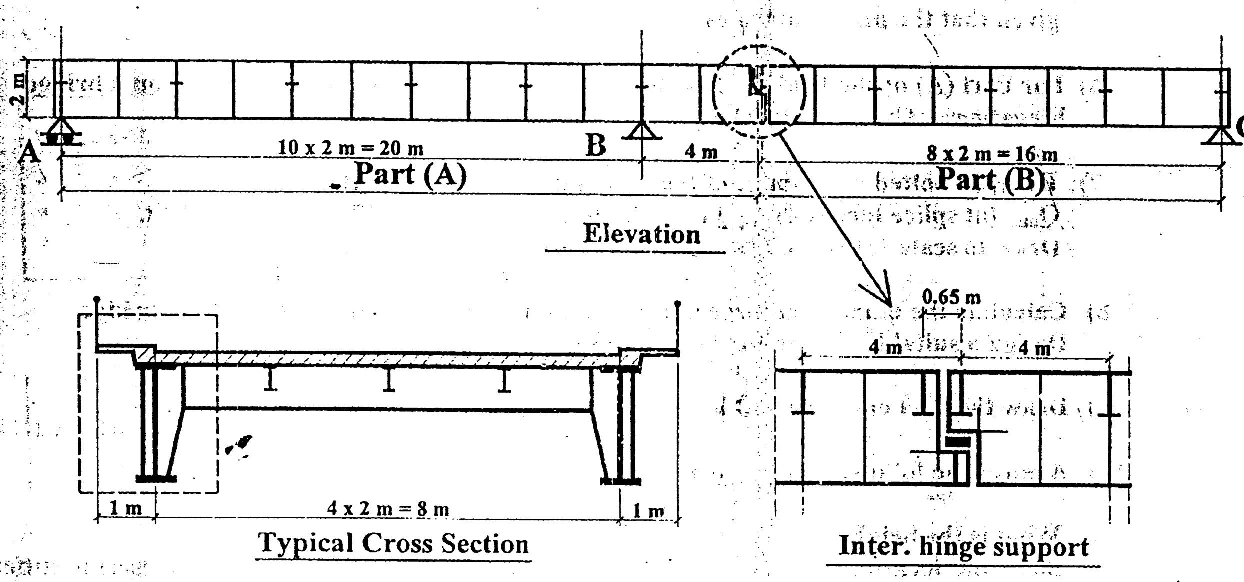


Figure (1)

Max. Credit = 110 %

A roadway deck bridge with inverted U-frame is constructed using the cross section shown in Figure (1). The plate girder bridge has 2 spans 20 m each. The whole bridge is divided into two parts, (A) and (B), as shown in the Figure. Part (B), with a length of 16 m, is resting on the overhanging cantilever of Part (A) as shown in the detailed Figure.
The bridge has a roadway width of 8.0 m and two sides walks 1.0 m each. The two main girders have 2000 mm web height and 14 mm web thickness. Vertical stiffeners of the main plate girder are provided every 2000 mm.

It is required to:-

1) Draw to scale 1:50 a structural Plan for Part (A) ONLY of the bridge.

2) If three main girders were to be used instead of the two main girders of the shown bridge, draw to scale 1:100 a general layout of the whole bridge showing (Plan, Elevation, cross section, required bracings ....etc).

3) Design a suitable cross-section of the main plate girder for Part (A) knowing that the mid-span straining actions are : $M_D = 200$ m.t $M_{L+I} = 400$ m.t $F_{cr} = 1.26$ t/cm^2.

4) Calculate the maximum negative bending moment of the main girder for Part (A). Check the stresses of the chosen section of the main girder (the designed sec. from Question 3).

AIN SHAMS UNIVERSITY – FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
Fourth Year Civil (Structural Division)

January 2010 | **Design of steel bridges** | ***Time : 3.00 Hrs***

STEEL STRUCTURES (2)
COURSE NO. [illegible]

The Exam Consists of Ten Questions in Two Pages.

5) **Design a suitable section of the end bearing stiffener of the main girder at support "A", given that the maximum shear Q_{actual} = 130 t.**

6) **For Part (A) of the bridge, show the arrangement of shop and field splices on a bridge Elevation. (Use neat sketches).**

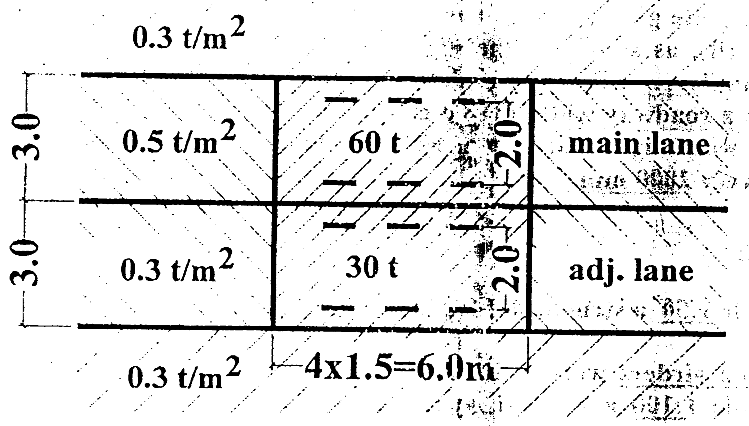
7) **Design a bolted field splice of the main girder knowing that:**
Q_{max} (at splice location) = 40 t. Use pretensioned bolts M27 (10.9), P_s= 9.03 t.
Draw to scale 1:10 an elevation and a section of the field splice.

8) **Calculate the maximum force in the lateral wind bracing of part (A) of the bridge. Design a suitable section for the horizontal bracing members.**

9) **Draw the part enclosed by the dotted rectangle to scale 1: 10.**

10) **<u>Answer the following using neat sketches</u>:-**

a- **What is the height of construction for a bridge ?**
b- **State the locations of curtailment used in plate girder's flange plates. Describe different methods to achieve these changes in the flange plate areas.**
c- **Determine the actual unsupported length of the compression flange for Part (A) of the bridge.**



Best wishes

Prof. Dr. Mohamed El Aghoury | Prof. Dr. Sherif Kamal Hassan | Dr. Sherif Abdel Basset

EGYPTIAN CODE OF PRACTICE FOR STEEL CONSTRUCTION AND BRIDGES Code No. (205) - 2001

Interaction Eq. : $\frac{f_{ca}}{F_c} + A_1 \frac{f_{bx}}{F_{bcx}}$

Stresses for St. 52 - (For t ≤ 40 mm) :

- for $\lambda < 100$ $\quad Fc = 2.1 - 0.000135\,\lambda^2$ t/cm^2
- for $\lambda \geq 100$ $\quad Fc = 7500/\lambda^2$ t/cm^2
- $fy = 3.6\ t/cm^2$

$L_{u\,max}$ = The least of

$$\frac{20\,b_f}{\sqrt{F_y}} \quad \text{OR} \quad \frac{1380\,A_f\,C_b}{F_y\,d}$$

Limits for Compact sec.

$$\frac{d_w}{t_w} \leq \frac{127}{\sqrt{F_y}} \qquad \frac{c}{t_{FL}} \leq \frac{15.3}{\sqrt{F_y}} \text{ for built-up I section}$$

$$\frac{c}{t_{FL}} \leq \frac{16.9}{\sqrt{F_y}} \text{ for hot-rolled I section}$$

F_{box} = The larger of F_{ltb1} or F_{ltb2}

$$F_{ltb1} = \frac{800\,A_f\,C_b}{L_{u\,act}\,d} \leq 0.58\,F_y$$

$$F_{ltb2} = 0.58\,F_y \qquad \text{IF} \quad \left(\frac{L_{u\,act}}{r_T}\right) < 84\sqrt{\frac{C_b}{F_y}}$$

$$F_{ltb2} = F_y\left(0.64 - \frac{\left(\frac{L_{u\,act}}{r_T}\right)^2 F_y}{1.176 \times 10^5\,C_b}\right) \leq 0.58\,F_y \qquad \text{IF} \quad 84\sqrt{\frac{C_b}{F_y}} \leq \left(\frac{L_{u\,act}}{r_T}\right) \leq 188\sqrt{\frac{C_b}{F_y}}$$

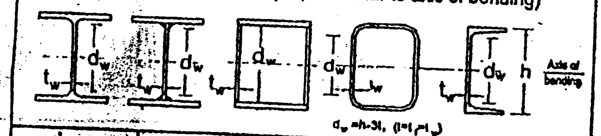
$$F_{ltb2} = \frac{12000\,C_b}{\left(\frac{L_{u\,act}}{r_T}\right)^2} \leq 0.58\,F_y \qquad \text{IF} \quad \left(\frac{L_{u\,act}}{r_T}\right) > 188\sqrt{\frac{C_b}{F_y}}$$

Best wishes

Prof. Dr. Mohamed El Aghoury | Prof. Dr. Sherif Kamal Hassan | Dr. Sherif Abdel Basset

Table (2.1a) Maximum Width to Thickness Ratios for Stiffened Compression Elements

(a) Webs: (Internal elements perpendicular to axis of bending)



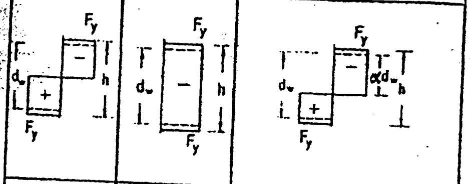
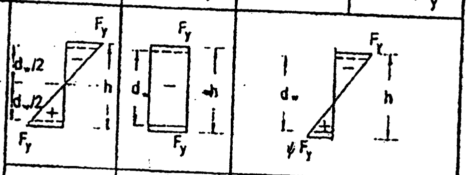
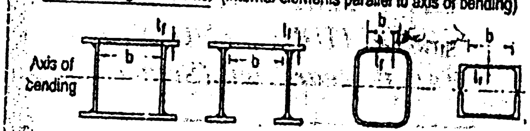
Class / Type	Web Subject to Bending	Web Subject to Compression	Web Subject to Bending and Compression	
1. Compact Stress distribution in element (Not for single channel)				
	$\alpha = 0.5$	$\alpha = 1.0$	$\alpha > 0.5$	$\alpha \leq 0.5$
	$\frac{d_w}{t_w} \leq \frac{127}{\sqrt{F_y}}$	$\frac{d_w}{t_w} \leq \frac{58}{\sqrt{F_y}}$	$\frac{d_w}{t_w} \leq \frac{699/\sqrt{F_y}}{13\alpha - 1}$	$\frac{d_w}{t_w} \leq \frac{63.8/\alpha}{\sqrt{F_y}}$
2. Non-Compact Stress distribution in element.				
	$\psi = -1$	$\psi = 1$	$\psi > -1$	$\psi \leq -1$
	$\frac{d_w}{t_w} \leq \frac{190}{\sqrt{F_y}}$	$\frac{d_w}{t_w} \leq \frac{64}{\sqrt{F_y}}$	$\frac{d_w}{t_w} \leq \frac{190/\sqrt{F_y}}{2+\psi}$	$\frac{d_w}{t_w} \leq \frac{95(1-\psi)\sqrt{-\psi}}{\sqrt{F_y}}$

Table (2.1b) Maximum Width to Thickness Ratios for Stiffened Compression Elements

(b) Internal Flange Elements: (Internal elements parallel to axis of bending)



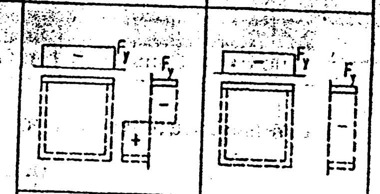
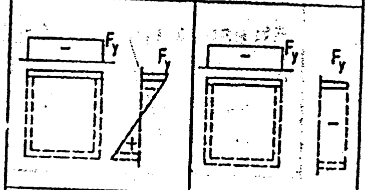
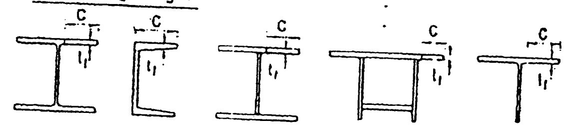
Class / Type	Section in Bending	Section in Compression
1. Compact Stress distribution in element and across section.		
	$\frac{b}{t_f} \leq \frac{58}{\sqrt{F_y}}$	$\frac{b}{t_f} \leq \frac{64}{\sqrt{F_y}}$
2. Non-Compact Stress distribution in element and across section.		
	$\frac{b}{t_f} \leq \frac{64}{\sqrt{F_y}}$	$\frac{b}{t_f} \leq \frac{64}{\sqrt{F_y}}$

Table (2.1c) Maximum Width to Thickness Ratios for Unstiffened Compression Elements

(c) Outstanding Flanges:



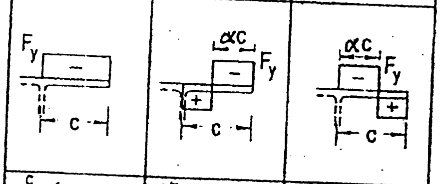
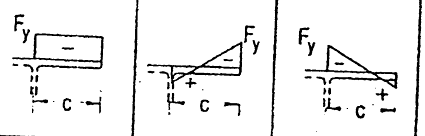
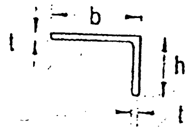
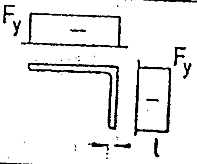
Class / Type	Flange Subject to Compression	Flange Subject to Compression and Bending	
		Tip in Compression	Tip in Tension
1. Compact Stress distribution in element.			
Rolled	$\frac{c}{t_f} \leq 16.9/\sqrt{F_y}$	$\frac{\alpha c}{t_f} \leq 16.9/\sqrt{F_y}$	$\frac{\alpha c}{t_f} \leq 16.9/\sqrt{\alpha F_y}$
Welded	$\frac{c}{t_f} \leq 15.3/\sqrt{F_y}$	$\frac{\alpha c}{t_f} \leq 15.3/\sqrt{F_y}$	$\frac{\alpha c}{t_f} \leq 15.3/\sqrt{\alpha F_y}$
2. Non-Compact Stress distribution in element.			
Rolled	$\frac{c}{t_f} \leq 23/\sqrt{F_y}$	$\frac{c}{t_f} \leq 35\sqrt{k_\sigma/F_y}$	
Welded	$\frac{c}{t_f} \leq 21/\sqrt{F_y}$	$\frac{c}{t_f} \leq 32\sqrt{k_\sigma/F_y}$	

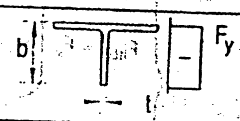
Table (2.1d) Maximum Width to Thickness Ratios for Compression Elements

(d) Angles:

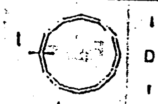


(Does not apply to angles in continuous contact with other components)

Class	Section in Compression
Stress distribution across section	
Non-compact	$b/t \leq 23/\sqrt{F_y}$; $(b+h)/2t \leq 17/\sqrt{F_y}$ (*)

Class	Section in Compression
(e) T-Section:	
Non-compact	$b/t \leq 30/\sqrt{F_y}$

(f) Tubular Section:



Class	Section in Bending and/or Compression
1. Compact	$D/t \leq 165/F_y$
2. Non-Compact	$D/t \leq 211/F_y$

AIN SHAMS UNIVERSITY-FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
Fourth Year Civil - Structural Section

January 2009	Final Exam	Time : 3:00 Hrs

STEEL PLATED STRUCTURES
COURSE NO. CES 435

The Exam Consists of Four Questions in Five Pages.

ANY MISSING DATA MAY BE REASONABLY ASSUMED.

QUESTION (I): (12 Marks)

1. What are the types of arc welds generally used in cold-formed steel construction?
2. Design the welded connection shown in Figure 1 for the applied load of 3 t. Consider the eccentricity of the applied load. Use St. 37.

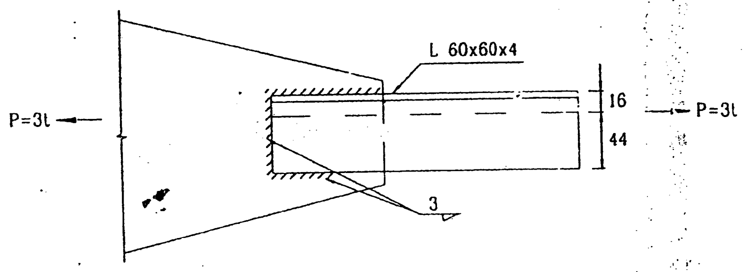


Figure 1

3. What are the types of failure usually occuring in the cold-formed steel bolted connections?
4. Check the safety of the connection shown in Figure 2. Use four 14 mm diameter non-pretensioned grade 4.6 ordinary bolts, and St. 37. Assume that washers are used under bolt head and nut and use standard holes.

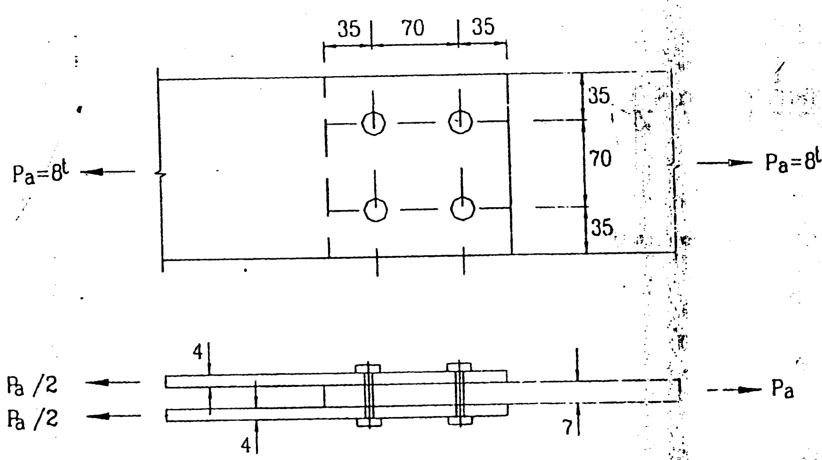


Figure 2

FILLET WELDS

i- Allowable load based on shear capacity of weld

$P_a = 0.2\, F_u\ (s\, L)$

ii- Allowable load based on strength of connected sheets

a- Longitudinal loading

when $L/t < 25$ $\quad P_a = 0.4\, F_u\,(1 - 0.01\, L/t)\, t\, L$

when $L/t \geq 25$ $\quad P_a = 0.3\, F_u\,(t\, L)$

b- Transverse loading $\quad P_a = 0.4\, F_u\,(t\, L)$

FLARE GROOVE WELDS

i- Allowable load based on shear capacity of weld

$P_a = 0.3\, F_u\, L\, s$

ii- Allowable load based on strength of connected sheets

a- Transverse loading

$P_a = t\, L\, F_u / 3$

b- Longitudinal loading

If $t \leq t_w < 2t$ or if the lip height is less than the weld length,

$P_a = 0.3\, t\, L\, F_u$

If $t_w \geq 2t$ and the lip height is equal to or greater than L,

$P_a = 0.6\, t\, L\, F_u$

ALLOWABLE TENSILE STRESS ON NET SECTION OF CONNECTED PARTS

With washers under both bolt head and nut

$F_{tt} = (1.0 - 0.9\, r + 3\, r\, d / g)\, 0.58\, F_y \leq 0.58\, F_y$

$F_{tt} = (1.0 - r + 2.5\, r\, d / g)\, 0.58\, F_y \leq 0.58\, F_y$

ALLOWABLE BEARING STRESS BETWEEN BOLTS AND CONNECTED PARTS

$F_b = \alpha\, F_u$

ALLOWABLE SHEAR STRESS ON BOLTS

i) the allowable shear stress q_b for the bolt grades 4.6 , 5.6 and 8.8 shall be taken

$q_b = 0.25\ F_{ub}$

ii) for bolt grades 4.8 , 5.8 , 6.8 and 10.9 the allowable shear stress q_b is reduced to

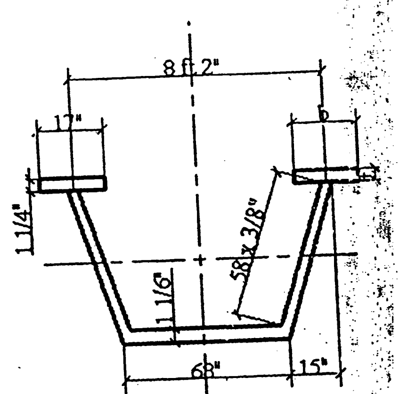
$q_b = 0.2\ F_{ub}$

ALLOWABLE TENSILE STRESS ON BOLTS

$F_{tb} = 0.33\ F_{ub}$

QUESTION (II): (20 Marks)

1) Check the following box girder bridge of span = 120 ft. according to AASHTO



Sec. I-I

b = 17"

t = 1 1/4"

Given that:-

- Loads

M_{max} = 4200 ft.kip and $Q_{max} = V_v = 209$ kp

- Properties of X-section

I = 87.310 in^4 - $S_{Top} = 2813\ in^3$ - $S_{Bottom} = 3184\ in^3$

- Limitation of stresses according to AASHTO

- If $(b/t) \leq (6140/\sqrt{fy})$ Then $Fb \leq 0.55\ Fy$ (without stiffeners)
- If $(6140/\sqrt{fy}) \leq (b/t) \leq 60$

  Then $Fb = 0.55\ Fy - 0.224\ Fy\ [1 - \sin(\frac{1}{2}\pi\ \{[13300 - (b\sqrt{Fy/t})] / 7160\})]$

  & $b/t \leq (13300/\sqrt{fy})$
- If $(b/t) \geq 45$ (longitudinal stiffeners must be used)

$V_w = V_v / \cos\theta$

$A_t = 2\ A_w$

$F_v = V_w / A_t$

$tw \geq (D\sqrt{Fb}) / 23000$ (for web without longitudinal stiffeners)

$d_o \leq D\ (260 / (d/tw))^2$ or 3D

$K = 5 + [5 / (do/D)^2]$

For $D/t_w < [6000\sqrt{K}] / \sqrt{Fy}$ Then C = 1.0

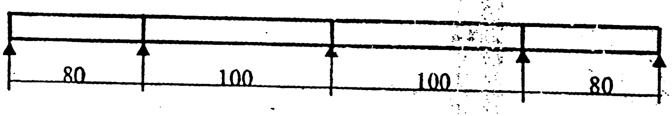
- If $[6000\sqrt{K}] / \sqrt{Fy} \leq D/t_w \leq [7500\sqrt{K}] / \sqrt{Fy}$

  Then $C = [6000\sqrt{K}] / [(D/t_w)\sqrt{Fy}]$

- If $D/t_w > [7500\sqrt{K}]/\sqrt{Fy})$

  Then $C = [4.5 \times 10^7 \times K] / [(D/t_w)^2 \times Fy]$

2) Draw to a reasonable scale the layout (X-section, elevation & plan) of a box girder bridge where the width of the bridge is 20 ms.



Comment on the design of the compression flange .

QUESTION (III): (20 Marks)

1) Explain using adequate sketches a comparison between hollow and open sections with respect to: a) the resistant bending and torsional moment and b) the design philosophy of the joint in lattice girders.
2) State briefly, using neat sketches, the different modes of failure which may occur for K- and N- types of RHS truss connections.
3) Design a circular elevated water tank with conical bottom for a capacity of 400,000 liters. The height of the suspended conical bottom plate is 4 m. The height of the tank bottom above the ground level is 15 m. A circular girder of channel section is provided at the junction of the cylindrical shell and suspended bottom. The tank is supported over twelve columns and is situated at the railway station in Alexandria. The cover of the tank is of conical shape and is to be considerd as an accessible roof with total dead and live loads equal 0.30 t/m^2 and with slope 1:5. Steel used is St. 52 of yield stress equals 3.60 t/cm^2. The design should contain all the items of the tank (Cylindrical shell plate, suspended conical bottom plate, circular girder) considering also the effect of wind load on the shell plate.

Table (1): Forces in Circular Girder (where W is the total vertical load)

Number of Columns	Load on Columns	Maximum Shear (N)	Bending Moment		ϕ'	Maximum Torsion (Nm)
			at column (N.m)	at centre (N.m)		
4	W/4	W/8	-0.03415WR	+0.01762WR	19°20'	0.0053WR
6	W/6	W/12	-0.01482WR	+0.00751WR	12°44'	0.00151WR
8	W/8	W/16	-0.00827WR	+0.00416WR	9°33'	0.00063WR
12	W/12	W/24	-0.00365WR	+0.00190WR	6°21'	0.000185WR

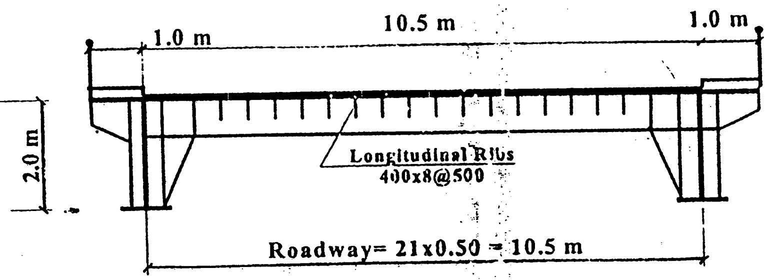
For the conical bottom of thichness (t) and at any section of diameter (b) and water hieght (h):

Meridional stress: $$f_m = \frac{W}{\pi \cdot b \cdot t \cdot \cos\theta}$$

Tangential stress: $$f_t = \frac{\gamma \cdot h \cdot b}{2 \cdot t \cdot \cos\theta}$$

QUESTION (IV): (24 Marks)

Steel used is St. 52, F_y= 3.6t/cm^2 (3.35 t/cm^2 for t >40mm)



1) A roadway deck bridge is to be constructed having the shown cross section, using Orthotropic-Steel-Deck. The main girders are simply supported with 40.0 m span. The bridge has a roadway of 10.5.0 m wide and two side walks 1.0 m each. Web of the main plate girder is 2000 mm height and 14 mm thickness. The main girders are provided with vertical stiffeners every 1667 mm together with horizontal stiffeners at one fifth of the web height from the compression side. Longitudinal ribs of 400x8 mm are used at spacing of 500 mm (center to center). Cross ribs are provided every 5000 mm. Steel decking plate of 12 mm is used. Live loads (including impact) are assumed to be 800 kg/m^2. Own weight of steel structure is to be taken as 200 kg/m^2.

It is required to:-

a) Draw a complete general layout for the bridge to scale 1:100 (Plan, Elevation, and cross section) showing the different structural elements of the bridge.
b) Design a suitable cross-section of the main girder (neglecting the additional stresses due to the floor decking-system II).
c) Check the deflection of the steel-deck-plate.

2) Using neat sketches, explain briefly the following:

a) Different types of the longitudinal ribs.
b) Function of the longitudinal and cross ribs of an Orthotropic Steel Plate Deck Bridge, to transmit the applied bridge loads.
c) The structural component systems of an Orthotropic Steel Plate Deck Bridge.
d) Stress superposition in main and floor elements of an Orthotropic Steel Plate Deck
e) Comparison of deflections and B.M. in an Isotropic and an Orthotropic Steel Plate.

Course Examination Committee		*Exam. Date : 13 January 2009*
Prof. Abdelrahim Khalil Dessouki	*Prof. Emam Soliman*	
Prof. Nahla Kamal Hassan	*Dr. Ahmed Hassan Yousef*	*Best wishes*

بسم الله الرحمن الرحيم

جامعة عين شمس - كلية الهندسة
السنة الرابعة مدني - إنشاءات
امتحان نهاية الفصل الدراسي الأول

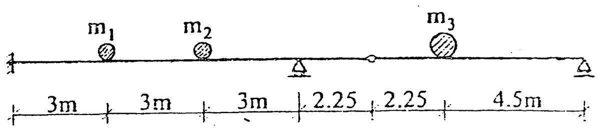
نظام قديم وحديث

تحليل منشآت متقدم
يناير ٢٠١٢
الزمن : ٣ ساعات

على الطالب استخدام القلم الرصاص في الحل وكتابة جميع التعويضات بالتفصيل

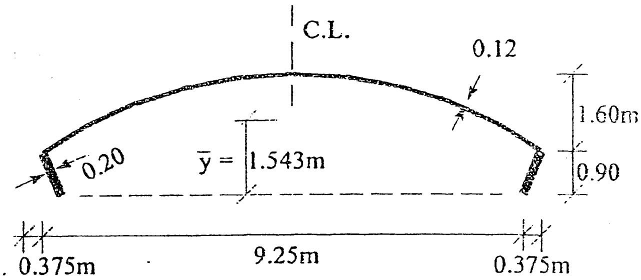
---

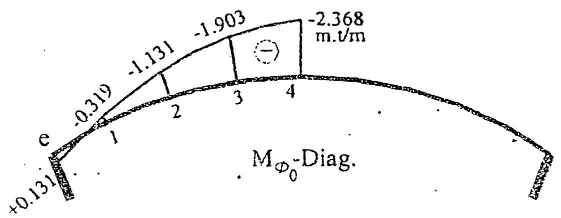
1. For the shown beam, find and draw at least two of the natural modes of vibration. Check the fundamental frequency using Rayleigh's Principle.
   $m_1 = m_2 = 1000$ kg
   $m_3 = 1500$ kg
   $EI = 0.1 \times 10^6$ m^2.kN

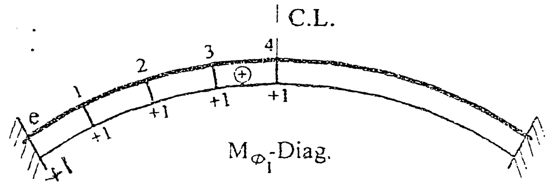


2. The figure shows the cross section, $M_{\varnothing 0}$ –Diagram, and $M_{\varnothing 1}$ –Diagram for a cylindrical long shell slab with inclined thick edges. The system is continuous in the transverse direction. It is required to find and draw the transverse BMD for the shell slab.

DATA:
g_0 = 0.700t/m = weight of each inclind thick edge, including plaster;
g = 0.450t/m^2 = total (D.L. + L.L.) on the curved surface;
R = 8.6125m; L = 25m; $\bar{y}$ = 1.543m;
δ_{10} = (-11.928) / ($EI_{N.A}$);
and δ_{11} = (+10.669) / ($EI_{N.A.}$)

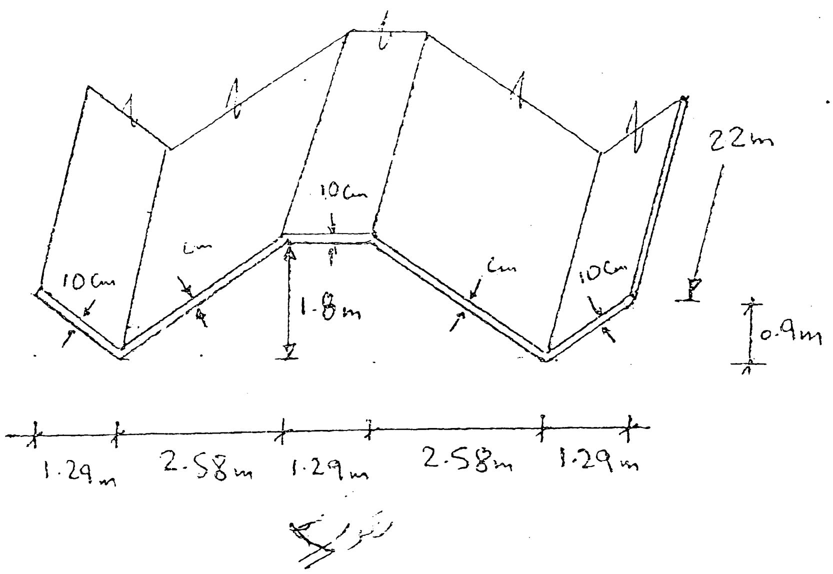






Problem no. 3

The shown concrete folded plate roof is supported on two diaphragms spaced 22m apart. The thicknesses of the plates are as shown. The unit weight of concrete is 25 kN/m^3. Assume the live load is 0.5 kN/m^2. Roof cover and insulation is 1 kN/m^2. Find the distribution of longitudinal stresses and transverse moments at the mid span section neglecting the effect of ridge displacements. Compute the area of the longitudinal reinforcement at the mid span section.



FACULTY OF ENGINEERING
STRUCTURAL ENG. DEPT.

Undergraduate, 4th Year
TIME: 3 HOURS
January 2010

MANAGEMENT OF RESOURCES

Any data not given may be reasonably assumed

1 page, 4 problems

Problem No. 1:
Motivating project teams is part of management's function. Explain methods used to achieve this.

Problem No. 2:
Develop a *project organizational structure* for a large scale construction company that was recently awarded a new contract for the construction of a residential compound in 6th October. The company is based in Kuwait and this is its first project in Egypt. The construction company needs to use a local Egyptian construction company for part of the project. The project cost is $500 million over 4 years.

Problem No. 3:
The following information was obtained from a construction company:

Activity	Normal Time (Days)	Total Normal Cost (LE)	Crash Time (Days)	Total Crash Cost (LE)	Resources (Units/Day)
1-2	4	5,000	3	6,000	3
1-3	4	4,700	3	5,500	3
1-4	5	5,600	5	5,600	4
2-5	5	5,100	4	6,000	4
3-5	4	2,400	3	3,500	3
4-6	7	3,450	5	5,750	3
5-7	7	2,700	5	4,700	3
5-8	7	3,000	5	5,000	5
6-11	11	8,800	10	9,800	9
7-9	5	3,300	4	3,500	3
8-7	2	1,200	1	2,600	3
8-10	5	3,300	4	4,350	2
8-11	6	4,500	5	5,650	4
9-12	6	3,300	4	4,400	4
10-12	6	4,000	5	5,000	5
11-12	5	3,600	4	4,900	4

a- Draw the network and find the critical path, normal time and normal cost.
b- Find the crash cost per day for each activity.
c- Which activities should be crashed to shorten the schedule by 1 day? Find the critical path and min. total crash cost.
d- Which activities should be crashed to shorten the schedule by a total of 3 days? Find the critical path and min. total crash cost.

Problem No. 4:
From the information provided in problem 3;
a- Draw the resource load diagram using the normal schedule.
b- Level the load diagram without changing the normal schedule.

Examiner: Dr. M. El-Mikawi

سيد ياسر   ١٢ / ٥ / ٢٠١٠ إدارة المشروعات

FACULTY OF ENGINEERING STRUCTURAL ENG. DEPT.	4th Year Structural Engineering TIME: 3 HOURS January 2009

MANAGEMENT OF RESOURCES

Any data not given may be reasonably assumed
2 pages, 5 problems

Problem No. 1:

Explain the following using figures where applicable:

a. Construction Project Life Cycle
b. Construction Project Stages

Problem No. 2:

An Egyptian consulting (design) firm was recently awarded a contract to design a luxury hotel. Develop the organizational chart for the design phase of the project taking into consideration the following:

- Assume that a local consulting firm specializing in landscape design will become a sub-consultant on the project to the main consultant.
- The owner has hired an international consultant specializing in building systems to be part of the design team.

Problem No. 3:

Calculate the time and cost of transporting 900 m^3 of lumber from a lumberyard to the construction site. Three trucks are available to transport the lumber; each truck's capacity is 3 m^3. The site is 17.5 km from the lumberyard, and the average speed of the truck is 40km/hr. Two workers are available on each end to load and unload the material, and they can handle 6 m^3/hr.

Assume the following:

- Each truck costs EGP 350/day
- Each laborer cots EGP 35/day
- Each driver costs EGP 60/day
- 7.0 work hours per day

Is this an efficient operation? How can you improve efficiency? Re- calculate the time and cost required.

Problem No. 4:

The following information was obtained from a construction company:

Activity	Normal Time (Days)	Total Normal Cost (LE)	Crash Time (Days)	Total Crash Cost (LE)	Resources (Units/Day)
1-2	4	5,000	4	5,000	3
1-3	4	4,700	3	5,500	3
1-4	5	5,600	4	6,600	4
2-5	5	5,100	4	6,000	4
3-5	4	2,400	3	3,500	3
4-6	7	3,450	5	5,750	3
5-7	7	2,700	5	4,700	3
5-8	7	3,000	5	5,000	5
6-11	11	8,800	10	9,800	9
7-9	5	3,300	4	3,500	3
8-7	2	1,200	2	1,200	3
8-10	5	3,300	4	4,350	2
8-11	6	4,500	5	5,650	4
9-12	6	3,300	4	4,400	4
10-12	6	4,000	5	5,000	5
11-12	5	3,600	4	4,900	4

a- Draw the project network and find the critical path, normal time and normal cost.
b- Find the crash cost per day for each activity.
c- Which activities should be crashed to shorten the schedule by 1 day? Find the critical path min. total crash cost.
d- Which activities should be crashed to shorten the schedule by a total of 3 days? Find the c path and min. total crash cost.

Problem No. 5:

From the information provided in problem 4 above;
a- Draw the resource load diagram using the normal schedule.
b- Level the load diagram without changing the normal schedule.

Examiner: Dr

يناير ٢٠٠٨

رابعة مدني انشاءات
ادارة موارد المشروعات

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

STRUCTURAL ENGINEERING DEPARTMENT

4rd year Civil Eng. Dept.

January, 2008 — **Resource management** — ***Time : 3.0 Hrs***

Construction project management

Answer the following question

<u>Assume any missing data with a reasonable numbers</u>

Question (1)

Define the following terms:-

a-Resource allocation
b-Depreciation cost
c-Labor utilization
d-Non productive time
e-Grade resistance
f- Aggregate Material planning
g- Resource management
h- Level capacity plan
i- Coefficient of traction

Question (2)

Estimate the total direct cost and the cost per 1,000 fbm of lumber for transport 50,000 fbm of lumber from a lumberyard to a job which is 3 mi from the yard. A truck will haul 3,000 fbm per load. The trucks can average 25 mi/h loaded and 40 mi/h empty.

One laborer plus the truck driver will load lumber onto the truck at the lumberyard, and another laborer plus the truck driver will unload the truck and stack lumber at the job. Each worker will handle 1,200 fbm/h when working.

Assume that the laborers and the trucks operate 50 min/h. Determine the most economical number of trucks to use.

Will placing an additional laborer at the yard and at the job reduce the cost of handling and hauling the lumber?

Labor and truck costs per hour will be

-Trucks $16.40 -Truck drivers 9.25 -Laborers 7.30

<u>Question (3)</u>

A piece of equipment is available for purchase for $ 12000 has an estimated useful life of 5 years, and has an estimated salvage value of $ 2000. Determine the depreciation and the book value for each of the 5 years using the straight-line method and the declining-balance method? (Compare)

<u>Question (4)</u>

What are the difference between owning and operating cost and what are the elements of each?

Question(5)

Determine the probable cost per hour for owning and operating a bottom-dump wagon with six rubber tires. The following information will apply.

- Initial cost = $ 120000
- Engine: 200 hp. Diesel
- Crankcase capacity, 15 gal.
- Time between oil changes, 100 hrs.
- Operating factor, 0.70
- Useful life, 5 years, with no salvage value
- Inv. + Tax. + Insurance = 15%
- Fuel cost $ 1 2/gal.
- Oil cost is $ 6/ gal.
- Estimating working hours per year is 1800 hrs.
- Maintenance & repairs is 50% of depreciation cost.

Question (6)

A total of 140,000 bricks is to be hauled from a brickyard by 5-ton gasoline-engine- powered stake-body trucks to a project 4 mi from the yard. A truck, which can haul 3,000 bricks per load, will average 30 mi/h loaded and 40 mi/h empty. Assume that the trucks operate 45 min/h.

Determine the total cost and the cost per 1,000 bricks for each of the stated conditions.

(a) Three laborers plus a truck driver will each load 450 bricks per hour onto a truck, and three other laborers plus a truck driver will unload the bricks from a truck at the job at the same rate

(b) Three laborers plus a truck driver will each load 450 bricks per hour onto a truck; then the truck driver and the three laborers will ride on the truck to the job, where they and the truck driver will unload the bricks at the same rate as at the yard. The costs per hour will be : - Truck, each = $15.75 -Truck driver =$9.50 -Laborers, each =$7.25

Question(V)

A company produces 4 types of different products A, B, C, and D. The demand (number of units) from each type is as follows:-

Demand per month	A	B	C	D
1	100	50	80	70
2	40	60	100	30
3	90	70	50	90
4	80	20	30	100

Demand of raw material for each type is as follows:-

Product type	Raw material demand per unit
A	10
B	15
C	8
D	12

a-Draw the aggregate demand plan that exactly matches the raw material

b- Calculate the ending inventory of each month based on the following:

Time (month)	1	2	3	4
Delivered material	3500	2300	2700	2700

- Ending inventory at time 0 = zero
- Comment on the result. (Do you need sub-contractor)

Question (8)

Analyze the production for a scraper is operating according to the following conditions:-

The material to be hauled is a sandy clay 2800 Ib/c.y

The expected rolling resistance for the haul road is 100 Ib/t.

The total length of haul when moving for the cut to the fill is 3200 ft. and has an Effective grade of 4 %

-Empty weight = 60000 Ib

Material weight = 50000 Ib.

-Assume an average fixed time is 5 min.

Note :- 1 m.p.h = 88 ft/min.

-Assume an operating factor = 50 min. per hr.

Question (9)

Draw the bar chart and level the labor required to no more than 8 workers per day, draw the histogram for your solution

Activity	Dependences	Duration(day)	Normal crew size	Min. crew siz
A	-	8	6	6
B	A	10	3	3
C	A	5	4	2
D	A	15	5	2
E	B&C	15	3	3
F	C	5	4	2
G	E&F&D	3	7	7

Question (10)

Find out the number of truck-trips required to construct a road using a certain earth based on the following data:

- Road thickness = 1ft "Compacted"
- Road area = 10 ft x 5000ft
- Truck capacity = 400 cu ft
- Swelling factor = 1.19
- Shrinkage factor = 0.85
- Density of loose soil = 100 Ib/cu ft

GOOD LUCK EXAMNER: DR. IBRAHIM ABDEL RASHID NOSAIR

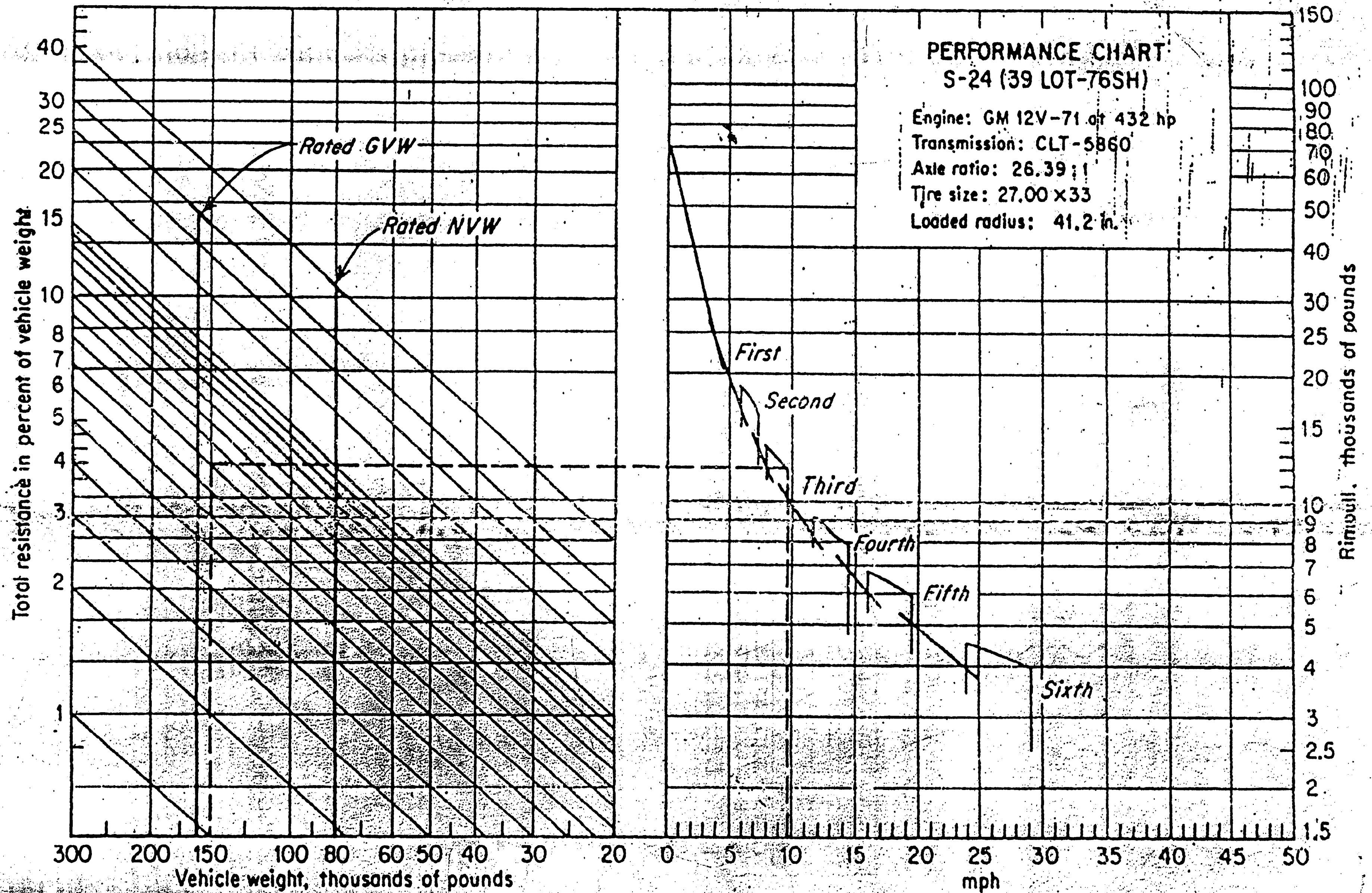


Figure 6-5 Performance chart for wheel tractor and scraper.

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th Year, Civil Engineering (Structural Division)

January 2012 — ***Time : 2:00 Hrs***

Advanced Design of Concrete Bridges (CES-427)

The Exam Consists of **Three** Questions in **Four** Pages. **1/4**

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

Used materials in all Questions: Concrete: f_{cu} = 40 MPa and Steel 40/60.

Question (1) (60% of maximum credit)

Figure 1 shows a road-way bridge layout with a total length of 120 m and a total width of 12 m. The bridge will be constructed using the shown prestressed concrete box section. It is required to:

1. Draw to a reasonable scale the bridge elements concrete dimensions in half plan, half elevation and cross sections.
2. Draw the absolute BMD, SFD and TMD for the longitudinal direction using the given loading scheme.
3. Choose the cable profile and calculate the minimum required prestressing forces P1 and P2 at the critical sections (only three sections).
4. Check the ultimate limit flexural capacity of one critical section.
5. Calculate the transverse reinforcement of the deck slab (only two cases of loading are required; the web and bottom slab reinforcement are to be assumed reasonably).
6. Draw to a reasonable scale, the details of reinforcement of the box girder deck in half elevation and cross sections.

Calculate the design ultimate limit internal forces for the following cases:

- 1.35 DL + 1.35 LL (Deck)
- Available tendon types are of 12, 15 and 19- 15 mm strands. Area of each strand = 140 mm^2; f_{pu} = 1860 MPa; Jacking stress = 0.75 f_{pu}; initial losses = 8 %; final losses = 18%.

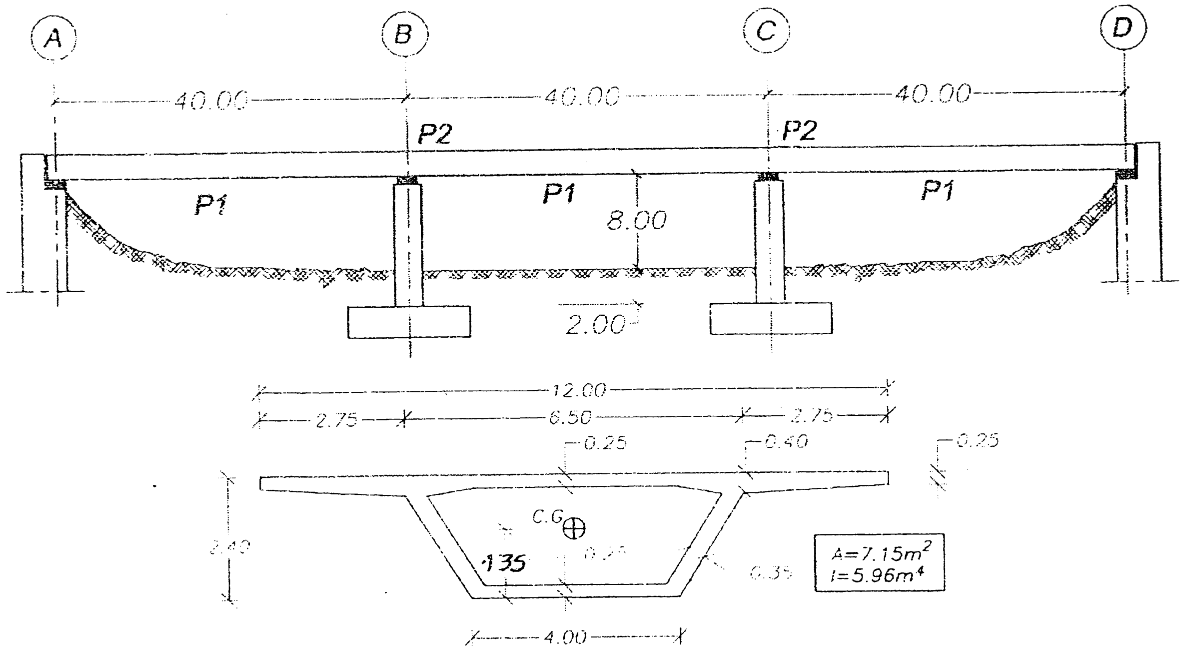
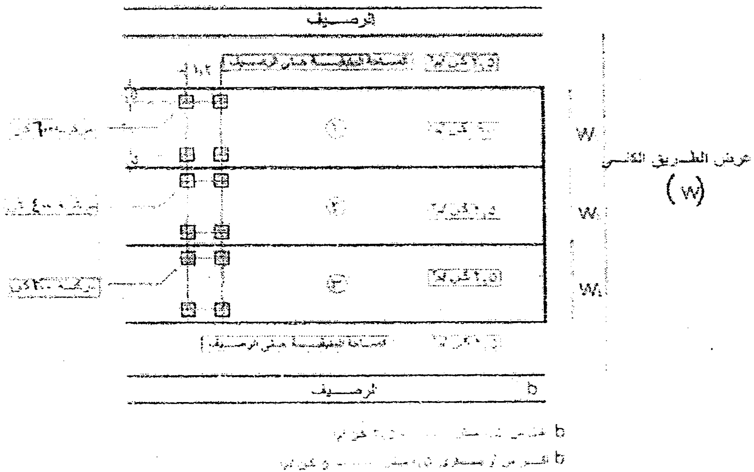


Figure 1

Advanced Design of Concrete Bridges



Question (2) (25% of maximum credit)

Figure 2 is showing the elevation and cross section of a pedestrian arch-bridge with a main span of 52m and side spans of 5m. The bridge is subjected to a uniformly distributed live load of 5 kN/m². It is required to:

1. Choose the suitable bearings at connections A, B, C and D
2. Draw to a reasonable scale the bridge elements concrete dimensions in half elevation.
3. Design the **arch girder** cross section taking buckling into consideration.

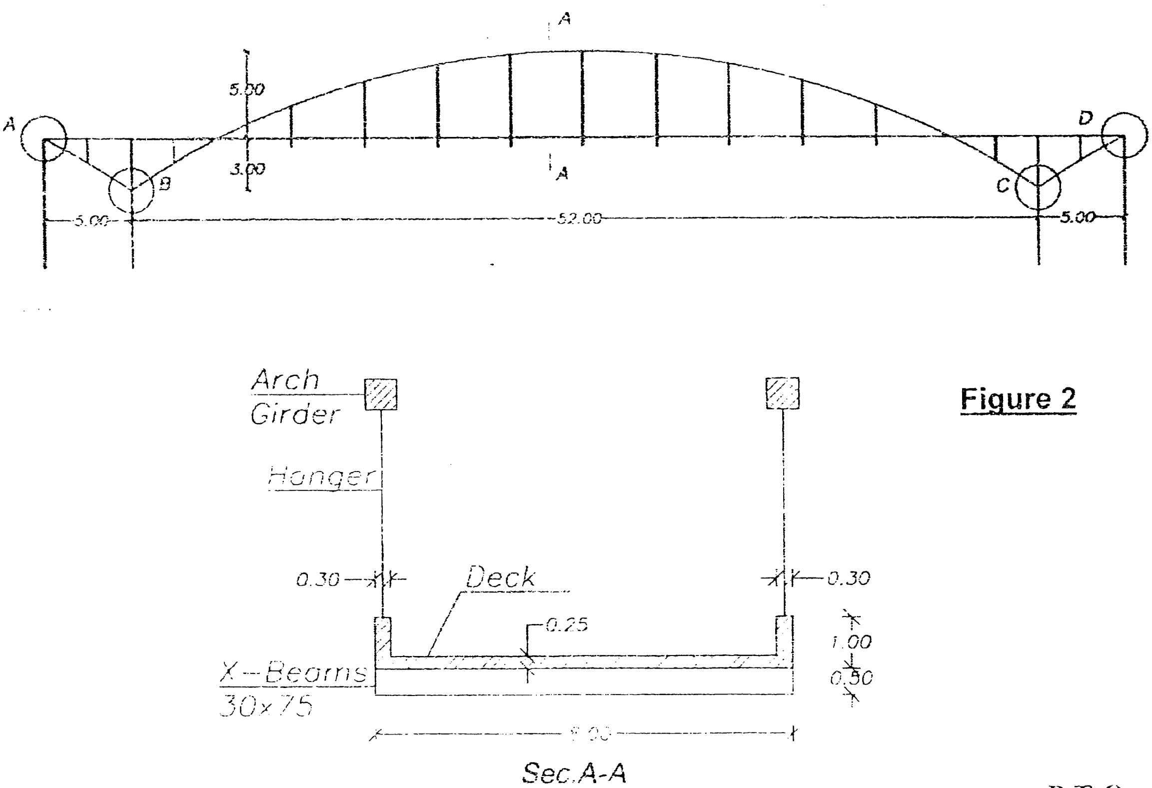


Figure 2

AIN SHAMS UNIVERSITY, FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT, 4th Year Civil (Structural Division)

January 2012 *Time : 3:00 Hrs*

Advanced Design of Concrete Bridges

The Exam Consists of Three Questions in Four Pages.

Question (3) (35 % of maximum credit)

Figure 3 is showing the elevation and cross section of a curved road-way box girder bridge with a main span of 40 m and width of 12 m (side walk width = 0.5 m each side). The radius of curvature of the bridge is 350 m. The total bridge length is 150 m. The bridge is subjected to the loading scheme given in Question 1. It is required to:

1. Choose the suitable expansion joints at the bridge edges.
2. Draw a sketch showing the bearing layout.
3. Using the given equations, calculate the centrifugal force acting on the bridge.
4. Design the critical **bridge pier** assuming the seismic load = 10 % of the bridge dead load.
5. For the alternative pier shape state if the chosen bearing layout is possible, explain why using sketches.

Load Combination: DL+0.2LL+EQ

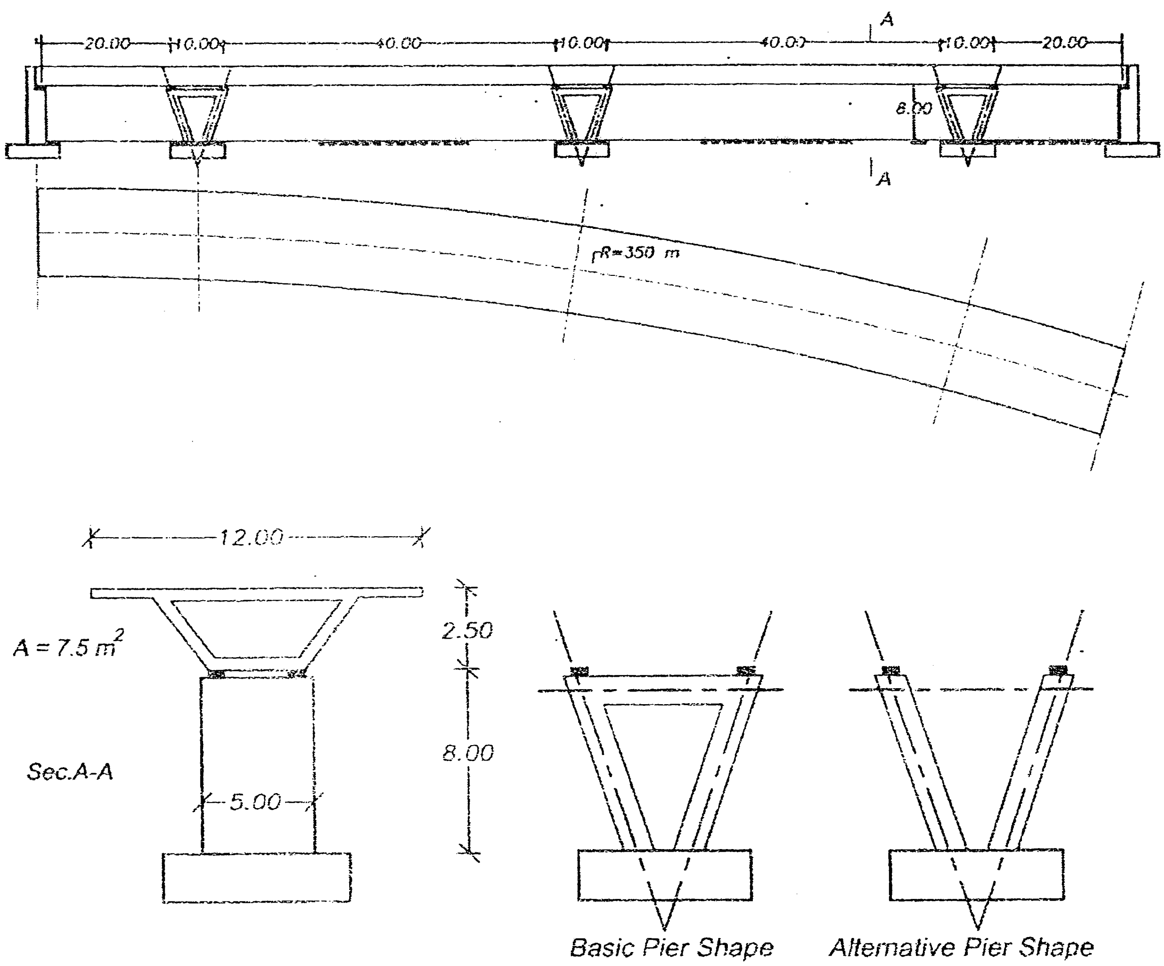


Figure 3

Advanced Design of Concrete Bridges

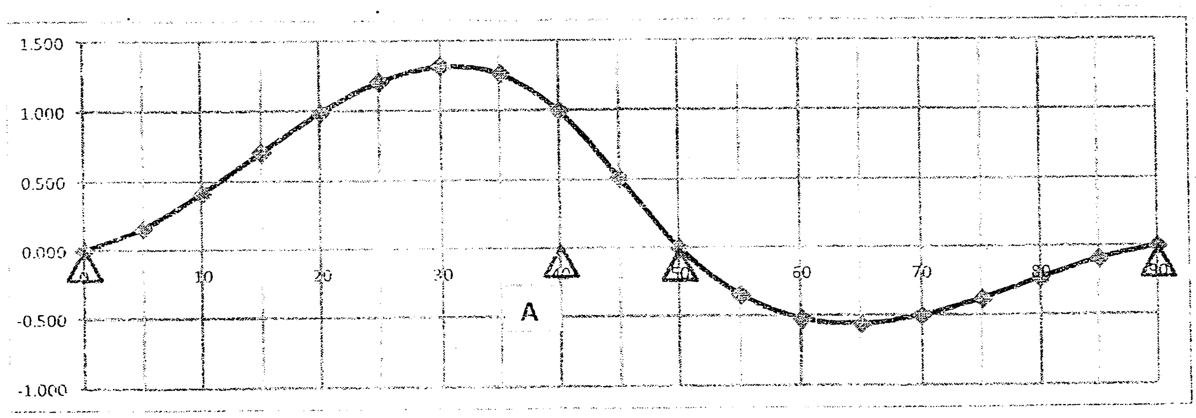
جدول (٥ – ٢) قيم قوى الطرد المركزية (Q_t).

نصف قطر الانحناء	قيم قوى الطرد المركزية
$r \le 200$ m	$Q_t = 0.2\ Q_v$ (kN)
$200 < r \le 1500$ m	$Q_t = 40\ Q_v/r$ (kN)
$r > 1500$ m	$Q_t = 0$

حيث:

r نصف قطر الانحناء الأفقي لمحور الطريق (بالمتر).

Q_v مجموع أوزان عربات التحميل المستخدمة بنموذج التحميل رقم (١) (kN).



x (m)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
IL_RA	0.00	0.16	0.41	0.70	0.99	1.21	1.32	1.27	1.00	0.51	0.00	-0.35	-0.52	-0.56	-0.50	-0.38	-0.23	-0.09	0.00

Influence Line for Reaction at Support (A)

Examination Committee
Prof. Dr. Fathy Saad
Dr. Khaled Hilal

Date: 24th January 2012

P.T.O

٤ انشاءات . المنشآت ذات الحوائط الحاملة

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Structural Engineering Department
Fourth Year – Structures Section

January, 2012 — *Time : 3.00 Hrs*

WALL BEARING STRUCTURES 336

The exam consists of *two* questions in *two* pages. Total Marks = 70 1/2

ATTEMPT ALL QUESTIONS

Systematic arrangement of calculations and clear neat drawings are essential.
Any data not given can be reasonably assumed.

QUESTION 1

١– ما هى مزايا وعيوب وحدات البناء الطينية والطفلية، وما هى أهم العوامل التى تؤثر أثناء عملية التصنيع على خواص الوحدات الناتجة، ،اذكر التحديات التى تواجه صناعة الطوب الطفلى محليا.

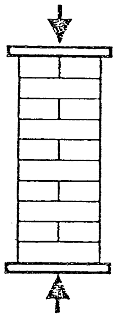
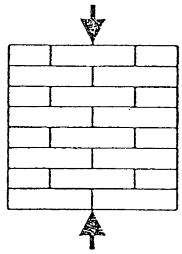
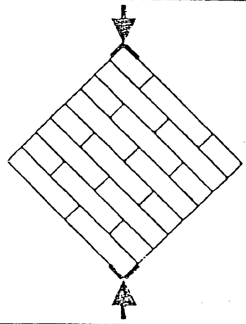
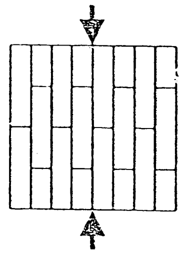
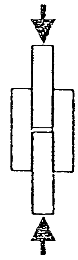
٢– للجير تأثير ايجابى على معظم خواص المونة الا أنه تأثير سلبى على بعض الخواص الأخرى، ويتوقف تأثير الجير على نسبة تواجده بالخلطة، ناقش باختصار تأثير الجير ومحتواه على خواص المونة المختلفة فى الحالة الطازجة والمتصلدة.

٣– هناك علاقة عكسية بين معامل التشبع (coefficient of saturation) ومقاومة الصقيع والعوامل الجوية، فسر ذلك باختصار.

٤– يجب عند إعداد عينات اختبار الضغط للحقين (grout) عدم استخدام قوالب (molds) غير منفذة للماء من البلاستيك او الصلب، لماذا؟. ما هى توصياتك بخصوص طريقة اعداد عينات اختبار الضغط للحقين وشكل وابعاد ونسبة الارتفاع للعرض للعينات.

٥– تعتبر حوائط المبانى مادة لها خواص مختلفة فى الاتجاهات المختلفة "(anisotropic material)"، لماذا؟ وكيف يمكن تقليل هذا الاختلاف.

٦– اذا استخدم طوب طفلى بابعاد ٢٥×١٢×٦ فى احد المشاريع واجرى اختبارات على عينات من المبانى طبقا لما هو موضح بالشكل وكانت أحمال الاختبار كما هى معطاه بالجدول، احسب مقاومة الضغط للمبانى (f'_m) ومقاومة الشد فى المستوى فى اتجاه عمودى وموازى وقطرى لمراقد المونة الأفقية، ومقاومة القص، احسب مقاومة القص اذا تعرضت المبانى لاجهادات ضغط مقدارها ٥ كجم/سم٢

شكل العينة					
متوسط حمل الاختبار (كجم)	٦٠٠٠٠	١٧١٩٠	١٧٤٧٠	٧٥٠٠	١١٧٥

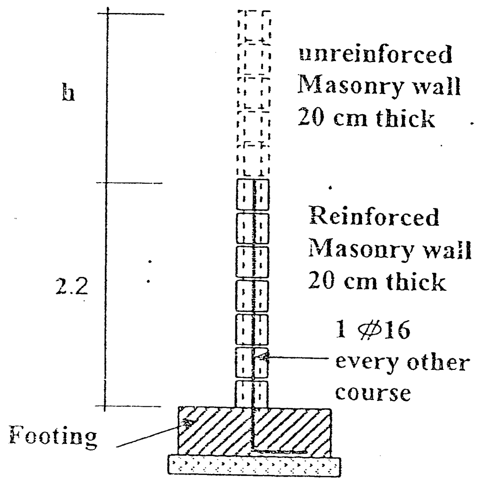
WALL BEARING STRUCTURES 336

QUESTION 2

1. The shown figure shows a 2.2-meter high fence of an industrial building. The fence is constructed of 200-mm reinforced concrete block masonry wall with 1 bar of 16 mm diameter every other course (every 40 cm). It is required to increase the height of the fence with fully grouted unreinforced 200-mm block masonry wall. If the fence is subjected to wind load of 100 kg/m^2, it is required to:

   a) calculate the maximum safe height of the fence.
   b) Draw cross sections of the wall at the reinforced and unreinforced parts.

   Use f'_{cm} = 150 kg/cm^2, steel 36/52.



2. A singly-reinforced masonry beam of 3.0 meters span is constructed from three courses of 200 mm nominal thickness concrete blocks. The beam is reinforced by 2 steel bars of 14 mm diameter as longitudinal reinforcement and 1 steel bar of 10 mm diameter every 200 mm as stirrups (single branch). It is required to calculate the safe uniform load on the beam if f'_{cm} = 150 kg/cm^2, steel 36/52.

Ain Shams University

Faculty of Engineering

Structual Eng. Dept.

بسم الله الرحمن الرحيم

Fourth year Civil

Time Allowed : 3 hours

December 2014

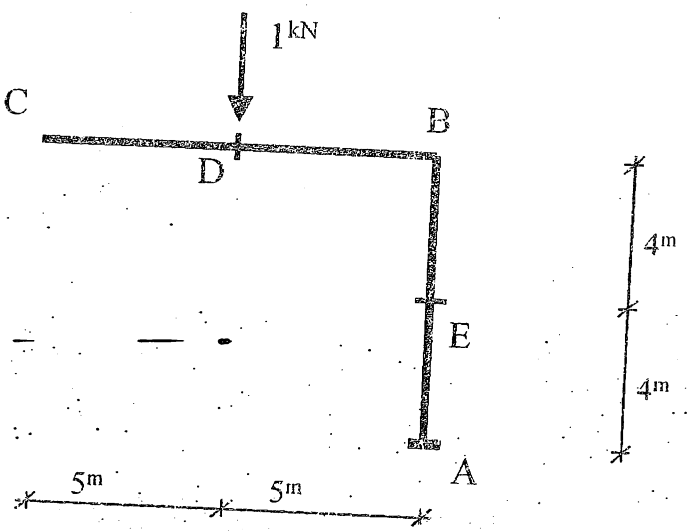
اختيارى 2 - منهاجية استخدام النماذج

EXAM IS OPEN BOOK , OPEN NOTES.
EXAM IS COMPOSED OF 6 QUESTIONS IN 5 PAGES
Maximum Grade is (100%)

PROBLEM 1

(30% of Max. Grade)

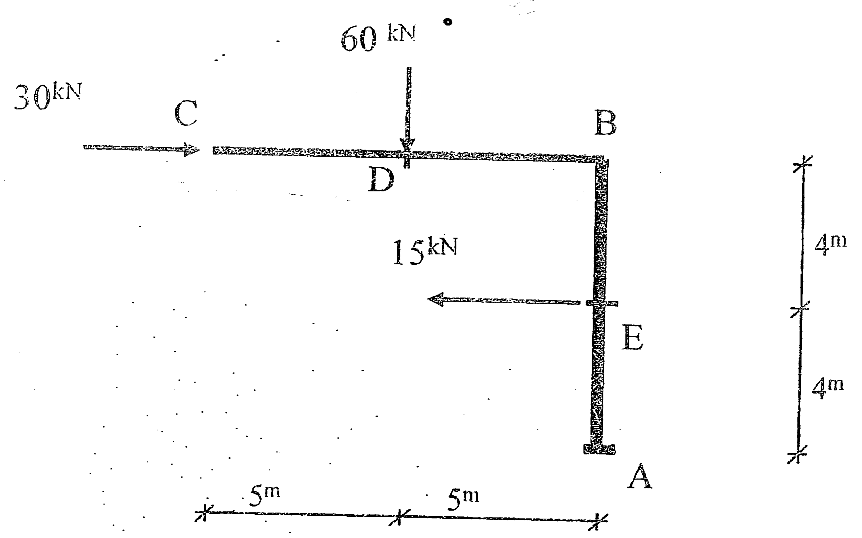
In a lab test, the shown frame is subjected to a concentrated load at point D as shown. The deformations at specific points were measured, and are given in the shown table.



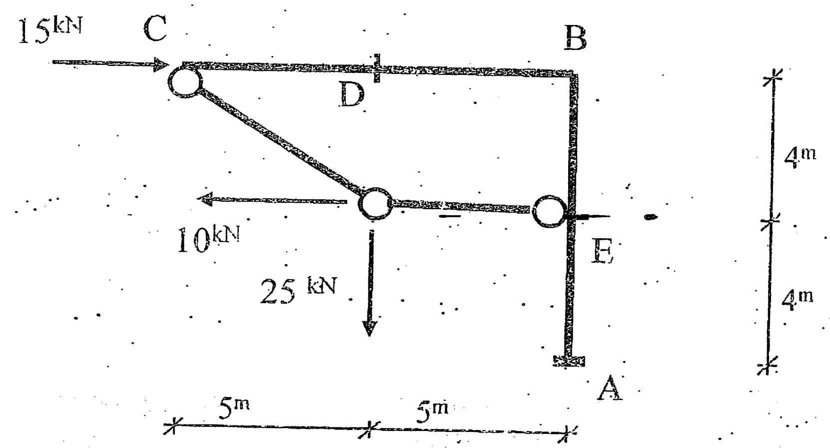
	Horizontal movement	Vertical movement
Movements at point (B)	4 mm ←	0 mm ↓
Movements at point (C)	4 mm ←	14.8 mm ↓
Movements at point (D)	4 mm ←	6.5 mm ↓
Movements at point (E)	1.7 mm ←	0 mm ↓

Determine the vertical displacement at point D due to the loads shown below for load case [1] & [2].

LOAD CASE [1]

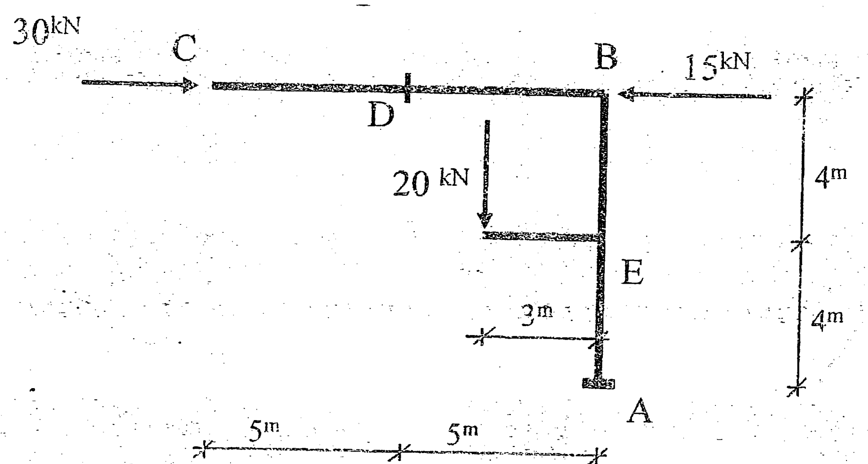


LOAD CASE [2]

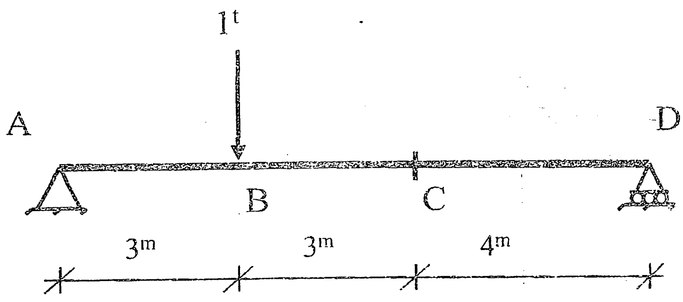


For LOAD CASE [3] shown below, is it possible to calculate the vertical displacement at point D using Maxwell's recipro^ al theorem, and the results of the lab test described above? If possible, determine its value. If not possible, what other measurements do you need to measure from the test in order to use to detrmine its value?

LOAD CASE [3]



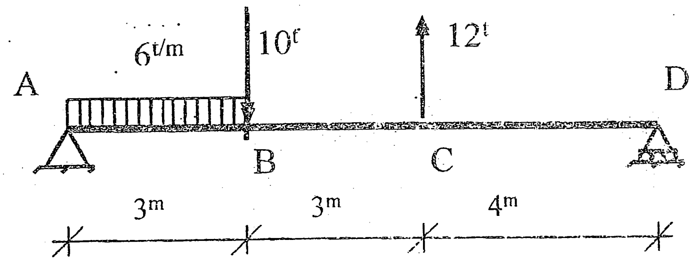
PROBLEM 2 (30% of Max. Grade)



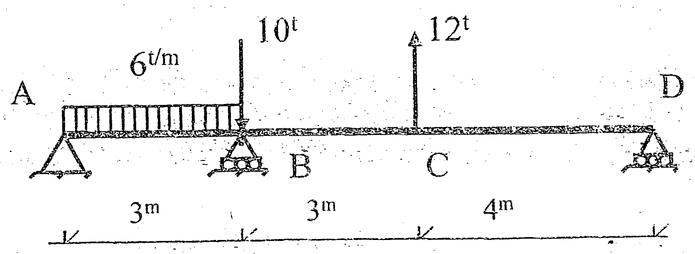
Point	X(m)	y(m)
A	0.00	0.000000
	0.50	0.003276
	1.00	0.006492
	1.50	0.009548
	2.00	0.012343
	2.50	0.014779
B	3.00	0.016754
	3.50	0.018175
	4.00	0.019022
	4.50	0.019337
	5.00	0.019164
	5.50	0.018546
C	6.00	0.017524
	6.50	0.016142
	7.00	0.014444
	7.50	0.012471
	8.00	0.010266
	8.50	0.007873
	9.00	0.005335
	9.50	0.002693
D	10.00	0.000000

The shown beam is subjected to a concentrated load at point B as shown. The deformed shape is computed for several points along the beam length and is given in the shown table.

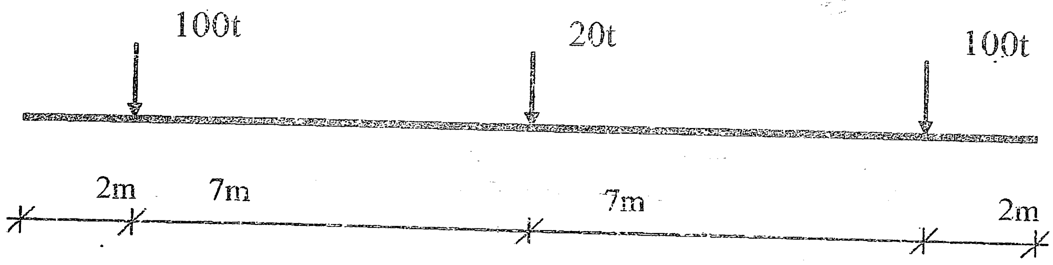
[A] If the same beam is subjected to the shown set of loads, use Maxwell's reciprocal theorem to determine the deformations at point B.



[B] If a roller support is added at point B as shown below, and the beam is subjected to the same vertical loads as shown, determine all support reactions, and draw the shear force and bending moment diagrams along the beam.



PROBLEM 3 (30% of Max. Grade)



The above figure shows an elevation of a long strip footing (2m wide), and loaded with the shown concentrated loads. A design engineer formed a 2-D model of the footing, rested on flexible springs modeling the soil reactions. He input the actual values of Young's modulus (200 t/sq.cm), footing thickness (80 cm), and soil bulk modulus (1500 t/cu.m) into the model, and specified that the own weight of the footing is to be NEGLECTED.

[A] For the above case, draw a sketch showing the shape of the stresses under the footing, which would result from a flexible FE model. Draw also sketches of the displacement shape, and the bending moment diagram you would expect to obtain from this model's results. (NO VALUES ON THE SKETCHES).

[B] Explain 2 methods you can use to make this model a "RIGID FOUNDATION" model.

[C] Repeat part [A] for the case of a rigid model. Draw sketches of stresses, displacements, and bending moments. (CALCULATE VALUES AND PUT THEM ON THE SKETCHES)

[D] Compare between the results of parts [A] & [C], showing which values of stresses, displacements, and moments you would expect to be higher in the 2 cases.

[E] If you were using the above results for preparing a calculation report, explain which values obtained from the 2 models you would use for design of sections, and for check of stresses on soil.

PROBLEM 4 (20% of Max. Grade)

If you were to prepare a model for a reinforced concrete floor, which includes level drops of 10 cm at bathroom areas, explain using neat sketches, how you will model this drop for each of the following cases:

[A] Bathroom area surrounded by drop beams from all sides.

[B] Bathroom area is in the middle of a flat slab, and the bending moment values require that the slab thickness in this area is not reduced.

For each of the above cases, show clearly the relation between your model, the statical system, and the corresponding steel reinforcement.

PROBLEM 5 (15% of Max. Grade)

It has been noted in the design community in Egypt that the analysis results obtained using most commercial software packages produce small values for bending moments in beams, compared to hand calculations. Explain the scientific reasons behind this observation, and propose a solution for this problem. Illustrate your answer with drawings.

PROBLEM 6 (15% of Max. Grade)

Explain why some designers prefer to modify the models of "beam and slab" floors, to reduce the torsional rigidity of beams.

[A] Show with sketches the problem these designers are trying to solve with this modification

[B] Explain different methods you could use in a structural software to perform the required modification.

[C] Draw neat sketches to show the difference in Bending Moments obtained

Ain Shams University	بسم الله الرحمن الرحيم	Dec, 2013
Faculty of Engineering		Fourth year Civil
Structual Eng. Dept.		Time Allowed: 3 hours

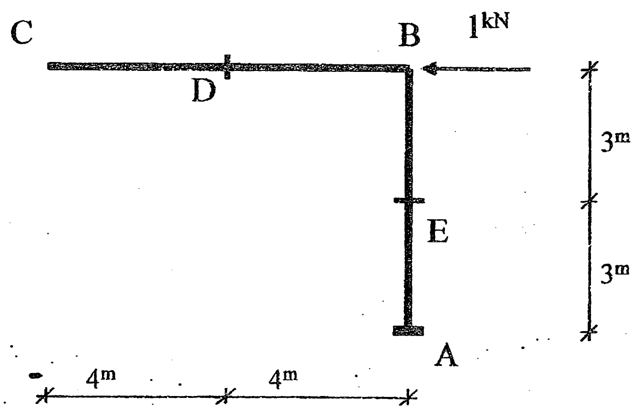
منهاجية استخدام النماذج

اختيارى 2

Exam consists of 4 problems in 4 pages. — *Page 1*

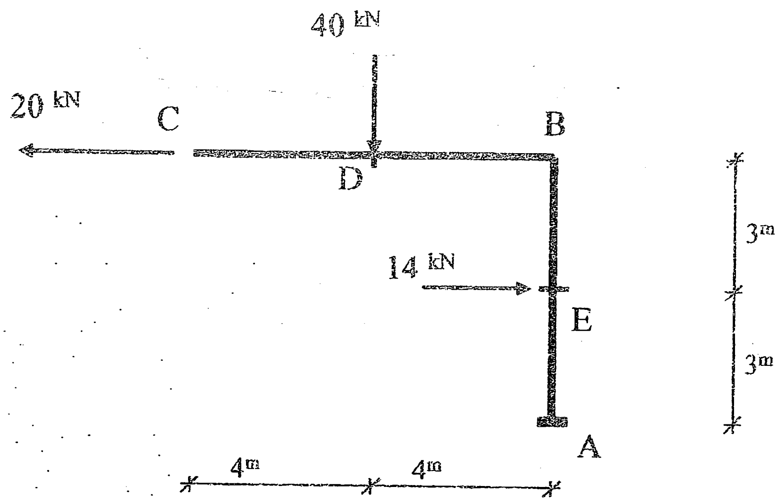
PROBLEM 1

The shown frame is subjected to a concentrated load at point B as shown. The deformations at specific points were measured, and are given in the shown table.

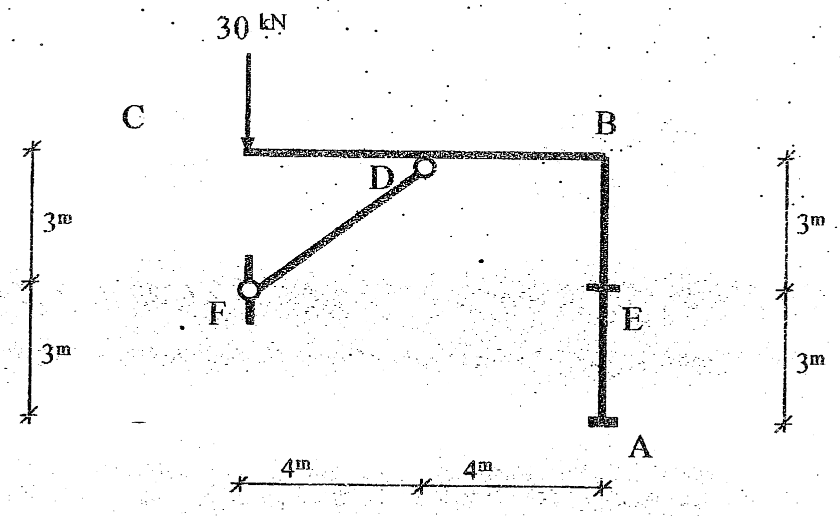


	Horizontal movement	*Vertical movement*
Movements at point (B)	*5 mm* ←	*0 mm* ↓
Movements at point (C)	*5 mm* ←	*12 mm* ↓
Movements at point (D)	*5 mm* ←	*6 mm* ↓
Movements at point (E)	*2 mm* ←	*0 mm* ↓

[I] For the same frame, determine the horizontal displacement at point B due to the loads shown below.



[II] For the same frame, if the force in link-member [DF] is 90^{kN} (compression), determine the horizontal displacement at point B due to the loads shown below.



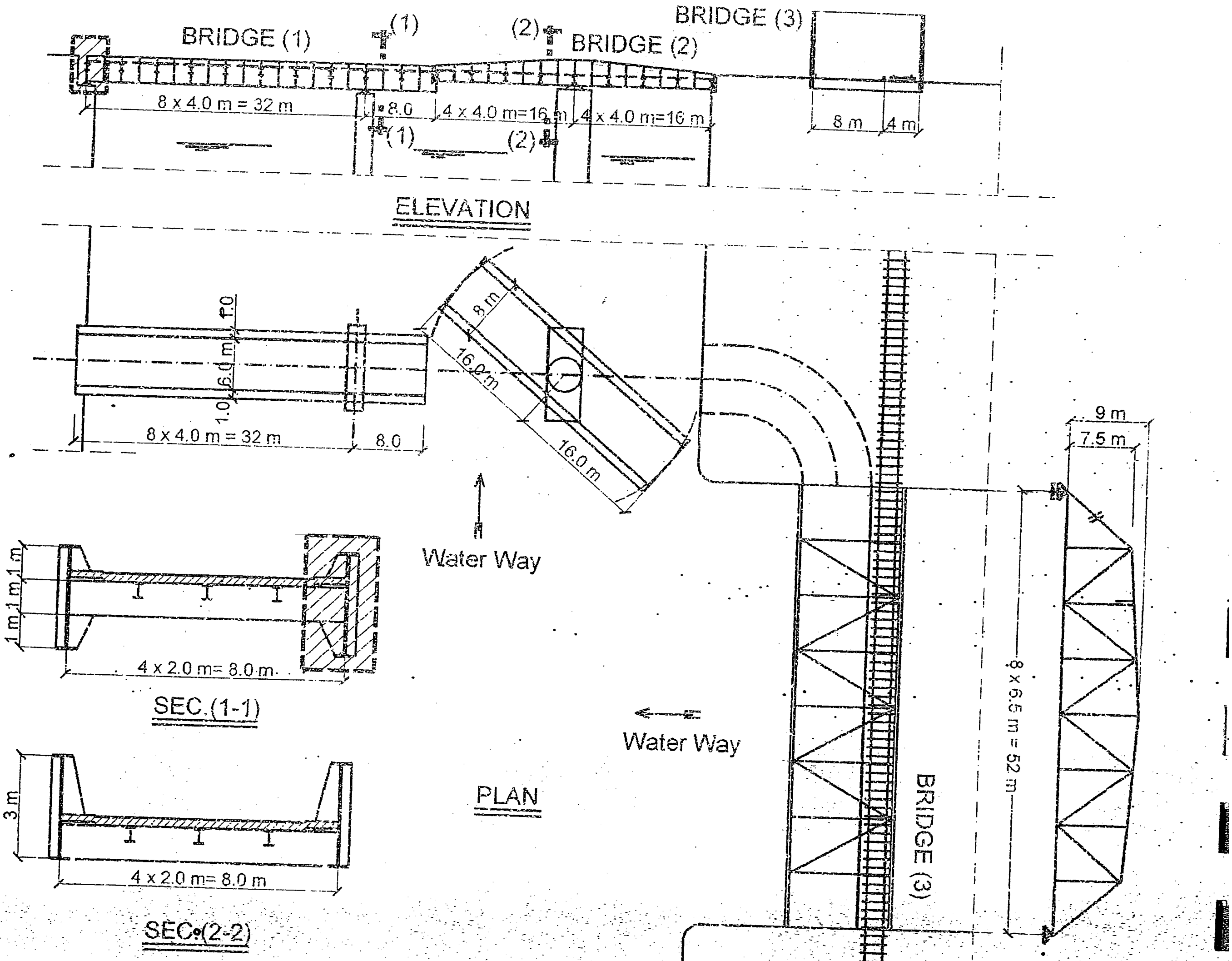
[III] Mention the name of the theorem which you used to solve parts [I] & [II] above, and explain with a sketch what this theorem states.

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT

Fourth Year Civil - (Structural Section)
DESIGN OF STEEL BRIDGES
COURSE NO. CES 452
1st Semester, 2011-2012
Time : 3.00 hrs

Exam consists of One Question in Two Pages.

STEEL USED IS 36/52, DATA NOT GIVEN MAY BE REASONABLY ASSUMED



The above drawings contain 3 types of bridges as shown in the figure. The first one is a roadway plate girder bridge with cantilever. Span of bridge is 32 m and the cantilever length is 8 m. The bridge width is 8 m as shown in section (1-1). The spacing between cross girders is 4 m. Spacing between stiffeners of main girder is 2 m apart. The second bridge is a continuation of the same roadway using a swing bridge type with double cantilever, 16 m each, as shown in plan. The swing bridge cross section is shown in section (2-2). The third bridge is a combined road-railway truss bridge as shown in the figure. This bridge is through type divided into 8 equal panels with 6.5 m each. The total width of the bridge is 12 m. The road way live load is taken as a distributed load of 500 Kg/m^2 only, plus impact, and including the walk ways as well. It is required to:

1- Suggest suitable system of bracing for bridges (1) and (2). Draw a plan for these bracings to scale 1:200. **(Mark: 10%)**

2- Design a cross-section for the main plate girder of bridge (2) in the "Case Open bridge", knowing that, Dead load +Floor cover =1200 Kg/m^2. Check deflection of that cantilever bridge. **(Mark: 15%)**

3- Check the safety against lateral torsional buckling of the compression flange for the cantilever o bridge (1) at section (1-1), knowing that δ =0.03 cm/ton, and plate girder cross section is compose of flange plate 500x25 mm and web plate 3000 x12 mm. C_b= 2.1

M (Dead) = 600 m.t M (Live+ Impact) = 450 m.t **(Mark: 15%)**

4- Check buckling of web plate and flexure strength of cross section of the cantilever part of bridge (1 at section (1-1), knowing that, Q (Total) = 180 ton.

If the section is unsafe against web buckling, what do you suggest to increase its strength? Use nea sketches. **(Mark: 15%)**

5- Design a field splice for the main plate girder of bridge (1), knowing that Q=60 t. Draw elevation an cross-section of the splice to scale 1:10, Indicate where is the best location of the field splice for thi bridge. **(Mark: 15%)**

6- Design an end-bearing stiffener for bridge (2), at the supporting pier. Consider case open with fu live load. **(Mark: 10%)**

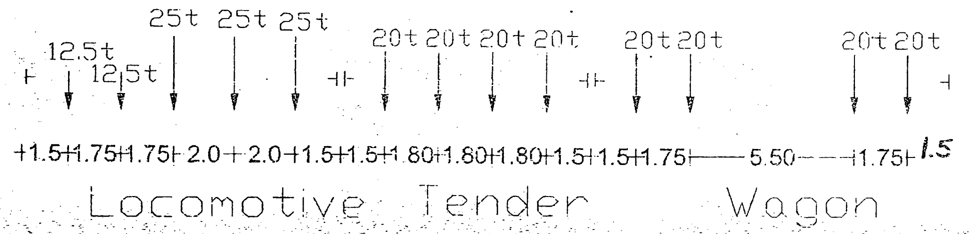
7- For truss bridge (3), draw general layout, elev. Plan, bracings,...etc., to scale 1:200. **(Mark: 10%)**

8- Draw the influence line and calculate the maximum force due to live load +impact only for th marked member (//), the first diagonal of truss bridge (3). **(Mark: 10%)**

9- Draw parts enclosed in dotted rectangles to scale 1:10. **(Mark: 10%)**

[kq=5.34+(4/α2), for α>1 & kq=4+(5.34/α2), for α<1, $\lambda_q = \frac{d/t_w}{57}\sqrt{\frac{F_y}{k_q}}$, for λq≤0.8 qb=0.35Fy,

for 0.8< λq <1.2 qb=(1.5-0.625 λq)0.35Fy , and for λq ≥1.2 qb=(0.9/ λq)(0.35Fy)].



Live Loads on Railway Bridges

- For shallow thick flanged sections: F_{ltb1}= 800/(L_u.d/A_f). C_b ≤ 0.58 F_y

- For deep thin flanges sections: $L_u/r_T < 84\sqrt{\frac{C_b}{F_y}}$ F_{ltb2}= 0.58 F_y

- When $84\sqrt{\frac{C_b}{F_y}} \le L_u/r_T \le 188\sqrt{\frac{C_b}{F_y}}$ $F_{ltb2}=[0.64-\{(L_u/r_T)^2 F_y/(1.176\times10^5 C_b)\}] \le 0.58 F_y$

- When $L_u/r_T > 188\sqrt{\frac{C_b}{F_y}}$ $F_{ltb2}=12000. C_b /(L_u/r_T)^2. \le 0.58 F_y$

GOOD LUCK

بيانات الامتحان — راسبة ثالثة

Ain Shams University
Faculty of Engineering
Structural Engineering Department

4th Year Structural Eng
Date: January 2008
Time: 3 hours

٢٠٠٨

Durability of Concrete

Answer All Questions *(Use illustrative schematic diagrams whenever possible)*

Question (1) *(50% of maximum mark)*

- Discuss the different factors that may lead to concrete deterioration?
- State what are the main phases that could be identified in the cement paste on the micro and macro structure levels?
- What are the factors that affect the amount of anhydrous clinker in cement paste?
- Show the five reaction stages of cement hydration and what is the relevance of each stage to concrete properties?
- What are the reasons for the high porosity around aggregate particles in concrete?
- How does the transition zone form? What are the general characteristics of the aggregate-paste interfacial region? How can the transition zone be improved?
- State the factors that affect the morphology of ettringite.
- What is meant by microfilling effect and the pozzolanic effect of SCM?
- What is meant by the following:
  - Friedel's Salt
  - Hadely Grain
  - Grain Size Refinement
  - Mobile Water
- Draw the relationships (only) for the following:
  - Capillary voids and f_c
  - Capillary voids and permeability
  - Entrained air voids and durability
  - *w/c* ratio and gel pores

Question (2) *(25% of maximum mark)*

- What are the different transport mechanisms through concrete? What is the main factor upon which the transport mechanisms are classified?
- Draw a sketch for a water permeability cell showing the main components. Explain how the sealing of the sides of the specimen is achieved?
- Draw the relationships (only) to show the effect of the following on water permeability:
  - w/c ratio
  - Curing time
  - Curing Temperature
  - N.M.S.
- A concrete wall separates between two spaces with different relative humidity. The relative humidity on both sides is 0.85 and 0.4, the flow rate per unit area of the wall is $3x10^{-12}$ *$m^3/sec/m^2$*, and the vapor diffusion coefficient of the concrete is $3x10^{-12}$ m/sec. Determine the thickness of the concrete wall?
- The carbonation depth for a 20 year old concrete structure is 28 mm. If the steel is located at a depth of 60 mm. What is the expected service life of the structure ($T_{service}$) and the service life left (T_{left}) before steel corrosion will be initiated.

Ain Shams University
Faculty of Engineering
Structural Engineering Department

4^th^ Year Structural Eng
Date: Jan. 2007
Time: 3 hours

Durability of Concrete

Question (3) *(30% of maximum mark)*

1. List the most common deterioration mechanisms of concrete?
2. What is meant by chemical sulphate attack and what is the difference between its action and the action of seawater on concrete?
3. Carbonation results when ambient air reacts with concrete. Discuss the carbonation reactions, the effects of carbonation on hardened concrete and a method for carbonation detection.
4. How can efflorescence cause both aesthetic and actual damage to concrete structures?
5. What are the effects of relative humidity and rate of evaporation on efflorescence? What is the difference between the action of a sulfate solution and of sea water on concrete? State the measures required to prevent adverse effects of sea water on reinforced concrete.
5. What are the three necessary components for ASR damage to occur in concrete structures? Using diagrammatic sketches, illustrate the effect of alkali content, cement content and relative humidity on the concrete expansion due to ASR. Can ASR damage be repaired? And what are the precautions taken to minimize this attack?

Concrete surfaces may be subjected to wear due to sliding, scraping or percussion. What is the difference between abrasion and erosion? And what: are the factors influencing abrasion resistance of concrete.

BEST WISHES

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th year civil

1st Semester, 2014-2015 | Course Code: CES 425 | Time : 3:00 Hrs

Course Title: Special Types of Concrete.

The Exam Consists of Two Questions in Two Pages.

Attempt all questions

Question No. 1 (52 Marks)

1- "Fiber Reinforced Concrete FRC" **(10 marks)**

1. Describe two important fiber parameters, then, illuminate its effect on the behavior of both fresh and hardened concrete.
2. Propose a suitable fiber type for the use in the following concrete applications:
   - Pavements and parking areas
   - Blast resisting structures
   - Utility boards and pipes
   - Architectural cladding panels
3. Illustrate some of the developing technologies in the field of FRC.
4. Describe those special requirements that should be considered in the preparation of FRC for:
   - Preventing segregation of fibers.
   - Measuring concrete workability
   - Improving fiber pull-out

2- "Light Weight Concrete LWC" **(10 marks)**

1. Define "Light weight aggregate concrete"?.
2. Classify the types of lightweight aggregates according to their unit weight and use? Mention some available types of light weight aggregate.
3. Describe the benefits of employing light weight concrete in constructions.
4. Draw a sketch representing the relation between the following parameters for both normal weight concrete and light weight concrete:
   - Compressive strength versus concrete density
   - Bond stress at failure versus cube compressive strength.
5. Many multistory structures were designed from the foundations up, taking advantage of reduced dead weight using lightweight concrete. Explain? Then calculate the possible reduction of weights result from replacing 4 stories by structural light weight concrete?.

3- "Radiation Shielding Concrete" **(8 marks)**

1. Comment on the shielding ability of heavy weight concrete with regard to other materials employed for the same purpose.
2. Compare between HWC and conventional concrete with regard to:
   - Shielding purposes efficiency
   - Important properties
   - The main differences in materials and mix proportions
3. What are the important effects of adding borate ores to concrete with regard to:
   - Radiation shielding properties
   - hardening of concrete.
4. Strength is considered of principal concern in the design of heavyweight concrete mixtures suitable for use in pre-stressed concrete reactor vessels (PCRV).

4- "Mass concrete" **(8 marks)**

1. Define the factors that influence temperature rise in mass concrete.
2. How to control internal concrete temperature.
3. Limiting the maximum temperature differential between the interior and exterior surface of the concrete is very important. Explain.

Course Examination Committee *Exam. Date : January 2015*

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4. Describe the important factors in mix proportioning of mass concrete?
5. Explain the effect of the following parameters on mixtures for concrete dams
   - Aggregate content and mineralogy - Type of used cement

5- "Self Consolidating Concrete SCC" **(8 marks)**

1. What are the advantages of SCC?
2. State the necessary ingredients for making SCC
3. Explicate the work of viscosity-modifying admixtures
4. Since SCC is characterized by special fresh concrete properties, many new tests have been developed. Classify 3 new tests specified for SCC.
5. What are the application fields of SCC? Is it economic if compared with conventional concrete?

6- "Shotcrete" **(8 marks)**

1- What is meant by: "rebound and overspraying in shotcreting".
2- State three advantages and disadvantages in using coarse aggregate in shotcreting.
3- Specify the major tests that should be done during construction by shotcrete.
4- Give five applications for shotcrete process.

Question No. 2 (18 Marks)

1- Shrinkage-Compensating Concrete **(9 marks)**

1. What is meant by shrinkage-compensating concrete?
2. What are the application fields of shrinkage-compensating concrete?
3. Give a sketch representing typical length change characteristics over time for both conventional and shrinkage-compensating concrete
4. Explain the mechanism of expansion of shrinkage-compensating concrete made with either expansive cement or CaO-based expansive agent.
5. What is the significance of curing process on shrinkage-compensating concrete? What are the most preferred curing methods?

2- High Strength Concrete **(9 marks)**

1. What are the general considerations taken into account for designing high strength concrete?
2. What is the effect of aggregate shape, texture, size and grading on concrete strength?
3. Explain the cementitious and pozzolanic reactions of mineral admixtures when used in concrete.
4. Draw a sketch representing the stress-strain relationship for high strength concrete and normal strength concrete.
5. Briefly discuss the design considerations for ultra-high strength concrete.

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AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT
4th year Students.

1st Semester, 2013-2014 Course Code: CES 425 *Time : 3:00 Hrs*

Course Title: Special Types of Concretes.

The Exam Consists of **Six** Questions in **Three** Pages.
Answer all questions

Any data not given can be reasonably assumed.

Question (1) Self Compacting Concrete

1. What is meant by Self Compacting Concrete?
2. State the principal difference of properties between ordinary concrete and SCC.
3. State the necessary ingredients for making SCC. Then, classify the SCC mixtures. Give an example for SCC mixture.
4. Explicate the work of viscosity-modifying admixtures (VMA)?
5. How could you measure the workability of SCC. Does slump value represent a good measure for such concrete mixtures? Why?
6. What are the application fields of SCC? Is it economic if compared with conventional concrete?

Question (2) Heavy Weight Concrete

1. What is meant by Heavy Weight Concrete?
2. Explain two different applications for Heavy Weight Concrete.
3. Which type of additives is used to improve the neutron shielding properties of concrete?
4. Give a HWC mixture for use in a nuclear power plant.
5. Explain why both high strength and high density are sought in concrete for PCRV (Pre-stressed concrete reactor vessels).

Question (3) Fiber Reinforced Concrete

1. What are the different types of fibers for use in Fiber Reinforced Concrete?
2. Clarify the effect of addition of fibers on slump as measured by ASTM C 143 for fiber reinforced concrete. What are the factors that affect slump value?. Is there any corresponding loss of workability? Explain.

4. Draw a sketch representing the load versus deflection curves for unreinforced matrix and fiber reinforced concrete
5. Describe some of the improvements that are continually being made by industry to optimize fibers to suit applications.
6. Explain the reason of:
   - Using alkali resistant glass fiber for FRC products.
   - The wide use of FRC in runways, pavements and parking areas.
   - Use of FRC in blast resistant structures.

Question (4) Structural light weight aggregate concrete

1. What is meant by: - "structural light weight aggregate concrete"
   - "Strength ceiling"
2. Compare between LWC and conventionally reinforced concrete with respect to the economic point of view?
3. How could you explain the increased usage of processed lightweight aggregates.
4. Each of the properties of lightweight aggregates may have some bearing on the properties of the fresh and hardened Concrete. Describe the effect of both particle shape & surface texture and relative density of LWA.
5. Specify general rules to be applied during pumping of LWC?
6. There is a special considerations adopted through codes for designing structural lightweight aggregate concrete. Explain some of the general considerations for the following parameters:
   - Modulus of elasticity
   - Deflection
   - Creep and shrinkage
   - Cover requirements

Question (5) mass concrete

1. Define mass concrete.
2. Identify the factors that influence temperature rise for mass concrete.
3. Describe how to control the internal concrete temperature rise?
4. Estimate the maximum temperature rise of a concrete element contains 500 kg of Type I cement per cubic meter and the least dimension of the member is 2.0 m and cast at 30°C?
5. Aggregate content and mineralogy have a great influence on properties of concrete mixtures for dams. Give explanation.

Question (6) Shotcrete

1. What is meant by Shotcrete? Then, classify shotcreting processes.
2. Specify the major tests that should be done during construction by shotcrete
3. What are the special problems you are going to face in shotcreting?
4. One of its very useful advantages is its "Limitless shape possibilities and ease of handling in areas of difficult access. Explain giving examples.
5. Shotcrete will be used to repair a concrete box culvert that has some minor spalling. Do we need to apply a bonding agent before applying the shotcrete?.

Best wishes

Course Examination Committee:
Dr. Ahmed Fathy Abdel-Aziz

Exam. Date :
14 January 2014

Ain Shams University
Faculty of Engineering
Structural Engineering Department
Fourth Year Civil

1st Semester, 2012-2013 **Course Code: CES 425** ***Time : 3.00 Hrs***

Special Types of Concrete

The Exam Consists of 3 Questions in 3 Pages

Answer the following questions:

Question (1): (35% of Max. Credit)

Green Building

1- What are the main principles of green building?
2- Are green buildings cost effective? Briefly discuss.
3- What is meant by green building rating systems? Give examples.
4- Concrete may be considered a green building material. Explain why?
5- What are the drawbacks of using cement as a construction material?

Recycled Aggregate Concrete

1- Construction and demolition wastes (CDW) cover a wide range of materials. Give examples of (CDW) and how can "On-Site Recycling" help in minimizing such waste?
2- Can recycled concrete aggregates be used in structural concrete? Explain. What are the other applications of recycled aggregate concrete?
3- Compare between the absorption of recycled aggregate concrete and conventional concrete. Explain the effect of the maximum nominal size of recycled aggregate on absorption of recycled aggregate concrete.
4- Discuss the effect of using recycled fine aggregate on the fresh and hardened properties of concrete.
5- Explain schematically the steps performed in a recycling plant to achieve 40 mm maximum nominal size recycled aggregates.

Architectural Concrete

1- How can architectural concrete be defined?
2- What are the different types of architectural concrete.
3- What is meant by white Portland cement concrete? What are its constituents and how does its production differ from that of ordinary concrete?
4- What is the effect of the colour type, colour content, cement colour, water content and curing conditions on coloured Portland cement concrete?
5- What are the maintenance methods of coloured concrete surfaces?

Course Examination Committee
Ass. Prof. Dr. Fatma Ahmed Shaker
Ass. Prof. Dr. Ahmed Fathi Abdel Aziz

Exam. Date : 15 January 2013

Question (2): (35% of Max Credit)

High Strength Concrete

1- Explain why there is no standard criterion for the strength in high strength concrete?

2- What are the advantages and disadvantages of high strength concrete?

3- Why is the transition zone between the aggregate and the cement paste important in high strength concrete? Explain how the use of mineral admixtures may help improve its properties.

4- Explain why the use of superplasticizers is necessary in high strength concrete.

5- Discuss the effect of the following on high concrete strength

a- Maximum nominal size of coarse aggregate

b- Fineness modulus of fine aggregate

c- Water absorption of coarse aggregates

d- Cement composition

e- Cement fineness

6- Compare between the stress-strain behaviour of normal strength concrete and high strength concrete.

7- How can the shrinkage of high strength concrete be minimized?

Concrete Containing Polymers

1- What are the advantages and disadvantages of using polymers in concrete?

2- Briefly explain the different types of concrete containing polymers and their applications.

3- How does polymer impregnation affect the mechanical properties concrete?

4- Explain how can concrete be fully impregnated with a low viscosity monomer.

5- Why is it recommended to use latex modified concrete for bridge and floor overlays?

Course Examination Committee
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Question (3): (35% of Max Credit)

Light weight Concrete

1- What is meant by: Strength ceiling for light weight aggregate concrete".
2- Describe the production methods of lightweight aggregate, giving details about the raw material, preparation procedures, required additions, and the processing methods.
3- "With light weight concrete, the water cement ratio is not generally used". Why?
4- Specify general rules to be applied during pumping of LWC?
5- Explain some of the codes general considerations adopted for designing structural lightweight aggregate concrete for the following parameters: Modulus of elasticity- Deflection- Creep and shrinkage- Cover requirements

Fiber Reinforced Concrete

1- Define the following: Fiber Reinforced Concrete (FRC), Fiber Aspect Ratio, Toughness
2- Draw a graph representing the behavior of FRC specimen when loaded in flexure. Then, indicate the first crack strength and the ultimate strength on the load-deformation curve.
3- State the main parameters influencing toughness.
4- Does slump represent a good measure of the workability of fibrous concrete? Clarify and describe other existing methods appropriate for FRC –if any-.
5- Illustrate some of the areas of application of FRC.

Self-Compacting Concrete

1- What are the advantages of SCC?
2- State the necessary ingredients for making SCC. Then, classify the SCC mixtures?
3- Explicate the work of viscosity-modifying admixtures (VMA)?
4- State the principal difference of properties between ordinary concrete and SCC.
5- What are the application fields of SCC? Is it economic if compared with conventional concrete?

Course Examination Committee
Ass. Prof. Dr. Fatma Ahmed Shaker
Ass. Prof. Dr. Ahmed Fathi Abdel Aziz

Exam. Date : 15 January 2013

Ain Shams University		Special Types of Concrete - CES 425
Faculty of Engineering		January-2012
Structural Engineering Department	AIN SHAMS UNIVERSITY	4th Year - Time Allowed: 3 hours

The exam consists of nine (5) questions in two pages. Answer all questions.

Question 1

1. What is meant by Self Compacting Concrete?
2. State the principal difference of properties between ordinary concrete and SCC.
3. State the necessary ingredients for making SCC. Then, classify the SCC mixtures?
4. Explicate the work of viscosity-modifying admixtures (VMA)?
5. The advent of superplasticizers made it possible to get very fluid fresh concrete mixtures (to achieve high slump values). But, the use of flowing concrete mixtures presents many risks. What are these risks?
6. What are the application fields of SCC? Is it economic if compared with conventional concrete?

Question 2

1. What is meant by Heavy Weight Concrete?
2. Explain two different applications for Heavy Weight Concrete
3. Which type of additives is used to improve the neutron shielding properties of concrete?
4. Give some high-density aggregates types, used in the production of high-density concrete.
5. Explain why both high strength and high density are sought in concrete for PCRV (Pre-stressed concrete reactor vessels).

Question 3

1. What are the different types of fibers for use in Fiber Reinforced Concrete?
2. Clarify the effect of addition of fibers on slump as measured by ASTM C 143 for fiber reinforced concrete. What are the factors affect slump value?. Is there any corresponding loss of workability? Explain.
3. State the main parameters influencing toughness of FRC.
4. Draw a sketch representing the load versus deflection curves for unreinforced matrix and fiber reinforced concrete
5. Describe some of the improvements that are continually being made by industry to optimize fibers to suit applications.
6. Explain the reason of:
   - Using alkali resistant glass fiber for FRC products.
   - The wide use of FRC in runways, pavements and parking areas.
   - Use of FRC in blast resistant structures.

Question 4

1. What is meant by: - "structural light weight aggregate concrete"
   - "Strength ceiling"
2. Compare between LWC and conventionally reinforced concrete with respect to the economic point of view?
3. "With light weight concrete, the water cement ratio is not generally used". Why?
4. How could you explain the increased usage of processed lightweight aggregates
5. Each of the properties of lightweight aggregates may have some bearing on the properties of the fresh and hardened Concrete. Describe the effect of both particle shape & surface texture and relative density of LWA.
6. Specify general rules to be applied during pumping of LWC?
7. There is a special considerations adopted through codes for designing structural lightweight aggregate concrete. Explain some of the general considerations for the following parameters:
   - Modulus of elasticity
   - Creep and shrinkage
   - Deflection
   - Cover requirements

Question 5

1. Define mass concrete.
2. Define the factors that influence temperature rise for mass concrete.
3. How to control internal concrete temperature?
4. Estimate the maximum temperature rise of a concrete element contains 500 kg of Type I cement per cubic meter and the least dimension of the member is 2.0 m and cast at 30°C?
5. Aggregate content and mineralogy have a great influence on properties of concrete mixtures for dams. Give explanation.

Best Wishes.