UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	ADVANCED FOUNDATION ENGINEERING
COURSE CODE	:	BFG 4013 / BFG 40103
PROGRAMME	:	BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **QUESTION 5** AND ANY OTHER **THREE (3)** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIFTEEN (15)** PAGES

Q1

(a) List any **TWO (2)** of the drawbacks of the finite difference method.

(4 marks)

(b) Illustrate the solution process of the finite element method.

(8 marks)

(c) As finite element solutions are not exact solutions with many assumptions and approximations, the main sources of error have been identified, namely modeling, mesh and numerical errors. Discuss the **numerical errors** with a suitable example.

(6 marks)

(d) An important rule of using finite element softwares to analyze engineering problems is to "always use a good mesh". Elaborate your understanding of the statement.

(7 marks)

Q2

(a) Sketch the **THREE (3)** types of combined footing commonly used, i.e. rectangular, trapezoidal and strap footing.

(6 marks)

(b) Referring to **FIGURE Q2(b)**, determine the dimensions of a rectangular footing using the conventional method. Both columns are square.

(10 marks)

(c) Given that the allowable bearing capacity of the soil is 180 kPa, proportion and partially design a trapezoid footing for the given data:

Column 1

- 450 mm x 450 mm
- DL = 1100 kN
- LL = 850 kN

Column 2

- 450 mm x 450 mm
- DL = 950 kN
- LL = 600 kN

(9 marks)

Q3

(a) Drilled shaft foundations are acknowledged to have a number of advantages compared to conventional piles. List **THREE (3)** of the advantages.

(6 marks)

(b) Illustrate the procedure for 'dry' method of constructing drilled shaft foundation using suitable sketches.

(8 marks)

(c) For a drilled shaft shown in **FIGURE Q3(c)**, the corrected average SPT number (N_{60}) within a distance of $2D_b$ below the base of the shaft is found to be 35. Determine

i. the ultimate load-bearing capacity.

(6 marks)

ii. the load-bearing capacity for a settlement of 10 mm.

(5 marks)

Q4

(a) A retaining structure is checked for its stability against the lateral pressure known. Using suitable sketches, briefly describe **THREE (3)** possible stability failures of retaining structures.

(6 marks)

(b) Reinforced-earth retaining walls have been widely used since the 60's. Explain the beneficial effects of soil reinforcement.

(6 marks)

(c) A geotextile-reinforced retaining wall is shown in **FIGURE Q4(c)**. By assuming T_{ult} = 50 kN/m, RF_{id} = 1.2, RF_{cr} = 2.5 and RF_{cbd} = 1.25, determine the following:

i. the vertical spacing of the layers (S_V)

(5 marks)

ii. the length of each layer of geotextile (L)

(4 marks)

iii. the lap length (l_l)

(4 marks)

Q5

(a) Foundations supporting engines or machines are subjected to vibration caused by unbalanced machine forces as well as the static weight. Discuss **THREE (3)** main design considerations for a safe and well performance of machine foundations.

(9 marks)

(b) A concrete foundation is 2.5 m in diameter. The foundation is supporting a machine. The total weight of the machine and foundation is 270 kN. The machine imparts a vertical vibration force, $Q = Q_o \sin\omega t$. Given $Q_o = 27$ kN (not frequency dependent), and the operating frequency is 150 cpm. For the soil supporting the foundation, unit weight = 19.5 kN/m^3, shear modulus = 45000 kPa and Poisson's ratio = 0.3. Determine

i. the resonant frequency

ii. the ratio of resonant frequency to the operating frequency

iii. the amplitude of vertical vibration at the resonant frequency

(16 marks)

Some useful formulas:

$$B_z = \left(\frac{1-\mu}{4}\right)\left(\frac{W}{\gamma r_o^3}\right)$$

$$f_r = \left(\frac{1}{2\pi}\right)\left(\sqrt{\frac{Gg}{W}}\right)\left(\frac{1}{r_o}\right)\sqrt{\frac{B_z - 0.36}{B_z}}$$

$$A_{z(resonance)} = \frac{Q_o(1-\mu)}{4Gr_o}\left(\frac{B_z}{0.85\sqrt{B_z - 0.18}}\right)$$

Terjemahan

Q1

(a) Senaraikan mana-mana **DUA (2)** kelemahan kaedah perbezaan terhingga.
(4 markah)

(b) Ilustrasikan proses penyelesaian bagi kaedah unsur terhingga.
(8 markah)

(c) Oleh kerana kaedah unsur terhingga bukanlah penyelesaian muktamad dengan pelbagai anggapan dan penghampiran digunakan, punca-punca ralatnya telahpun dikenalpasi, iaitu pemodelan, jaringan dan ralat berangka. Bincangkan **ralat berangka** dengan menggunakan contoh yang sesuai.
(6 markah)

(d) Satu peraturan penting dalam menggunakan perisian unsur terhingga untuk menganalisis masalah adalah untuk "sentiasa menggunakan jaringan yang baik". Terangkan pemahaman anda tentang pernyataan ini.
(7 markah)

Q2

(a) Lakarkan **TIGA (3)** jenis asas tapak gabungan yang lazim digunakan, i.e. tapak berbentuk segiempat tepat, trapezium dan jalur.

(6 markah)

(b) Merujuk kepada **FIGURE Q2(b)**, tentukan dimensi sebuah tapak berbentuk segiempat tepat dengan menggunakan kaedah biasa. Kedua-dua tiang adalah berbentuk segiempat sama.

(10 markah)

(c) Jika keupayaan galas tanah adalah 180 kPa, kadar dan rekabentuk secara separa sebuah asas tapak trapezoid dengan data yang diberikan:

Column 1

- 450 mm x 450 mm
- DL = 1100 kN
- LL = 850 kN

Column 2

- 450 mm x 450 mm
- DL = 950 kN
- LL = 600 kN

(9 markah)

Q3

(a) Asas tiang bergerudi diperakui mempunyai beberapa kelebihan berbanding dengan cerucuk biasa. Senaraikan **TIGA (3)** kelebihan ini.

(6 markah)

(b) Ilustrasikan prosedur kaedah 'kering' bagi membina asas tiang bergerudi dengan menggunakan lakaran yang sesuai.

(8 markah)

(c) Untuk tiang bergerudi yang ditunjukkan dalam **FIGURE Q3(c)**, nombor SPT yang dibetulkan (N_{60}) dalam lingkungan jarak $2D_b$ di bawah dasar tiang adalah 35. Tentukan

i. keupayaan galas muktamad.

(6 markah)

ii. keupayaan galas untuk enapan 10 mm.

(5 markah)

Q4

(a) Sebuah tembok penahan disemak kestabilannya terhadap tekanan ufuk yang diketahui. Dengan menggunakan lakaran yang sesuai, jelaskan secara ringkas **TIGA (3)** kegagalan yang mungkin berlaku pada tembok penahan.

(6 markah)

(b) Tembok penahan dengan tanah bertetulang telah diginakan secara meluas sejak tahun 60-an lagi. Jelaskan kelebihan tanah bertetulang.

(6 markah)

(c) Sebuah tembok penahan yang diperkukuhkan dengan geotekstil ditunjukkan dalam **FIGURE Q4(c)**. Dengan membuat anggapan bahawa T_{ult} = 50 kN/m, RF_{id} = 1.2, RF_{cr} = 2.5 dan RF_{cbd} = 1.25, tentukan yang berikut:

i. jarak pugak antara lapisan-lapisan (S_V)

(5 markah)

ii. panjang geotekstil setiap lapisan (L)

(4 markah)

iii. panjang tindihan (l_l)

(4 markah)

Q5

(a) Asas yang menyokong enjin atau mesin adalah terdedah kepada getaran yang disebabkan oleh daya mesin yang tak seimbang serta berat statik. Bincangkan **TIGA (3)** pertimbangan rekabentuk untuk memastikan prestasi atau perlakuan baik asas mesin.

(9 markah)

(b) Sebuah asas konkrit mempunyai diameter 2.5 m. Asas tersebut menyokong sebuah mesin. Jumlah berat mesin dan asas ialah 270 kN. Mesin tersebut memindahkan daya getaran pugak, $Q = Q_o \sin\omega t$. Diberi Q_o = 27 kN (tidak bergantung kepada frekuensi), dan frekuensi operasi adalah 150 rpm. Untuk tanah yang menanggung asas, berat unit = 19.5 kN/m^3, modulus ricih = 45000 kPa dan nisbah Poisson = 0.3. Tentukan

i. frekuensi resonan

ii. nisbah frekuensi resonan kepada frekuensi operasi

iii. amplitude getaran pugak pada frekuensi resonan

(16 markah)

Rumus-rumus yang berguna:

$$B_z = \left(\frac{1-\mu}{4}\right)\left(\frac{W}{\gamma r_o^3}\right)$$

$$f_r = \left(\frac{1}{2\pi}\right)\left(\sqrt{\frac{Gg}{W}}\right)\left(\frac{1}{r_o}\right)\sqrt{\frac{B_z - 0.36}{B_z}}$$

$$A_{z(resonance)} = \frac{Q_o(1-\mu)}{4Gr_o}\left(\frac{B_z}{0.85\sqrt{B_z - 0.18}}\right)$$

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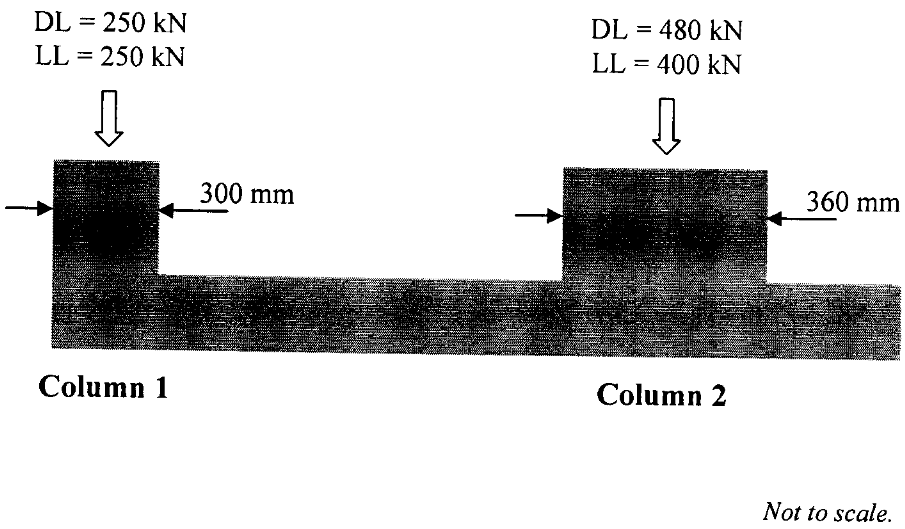

FIGURE Q2(b)

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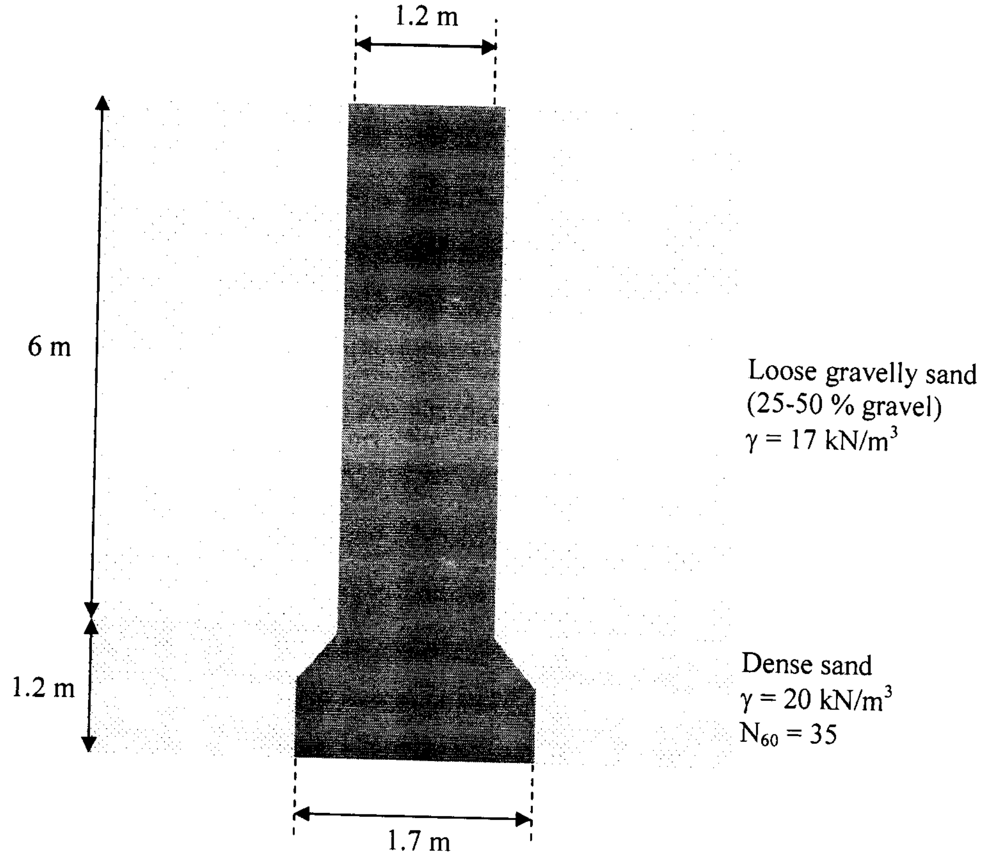

$$Q_{u(net)} = \sum_{i=1}^{N} f_i p \Delta L_i + q_p A_p$$

$f_i = \beta_1 \sigma'_{ozi} < \beta_2$

$\beta_1 = \beta_7 - \beta_8 z_i^{0.75}$ (for $0.25 \le \beta_1 \le 1.8$)

$q_p = \beta_5 N_{60} \le \beta_6$ (for $D_b < 1.27$)

For $D_b \ge 1.27$ m,

$$\Rightarrow q_{pr} = \left(\frac{1.27}{D_b(m)}\right) q_p$$

$\beta_2 = 192$ kN/m^2
$\beta_5 = 57.5$
$\beta_6 = 10$ kN/m^2
$\beta_7 = 2.0$
$\beta_8 = 0.15$

FIGURE Q3(c)i

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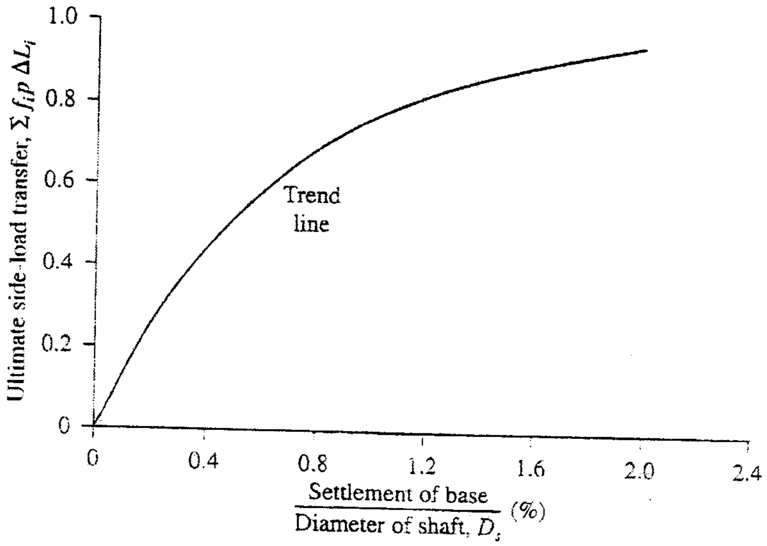
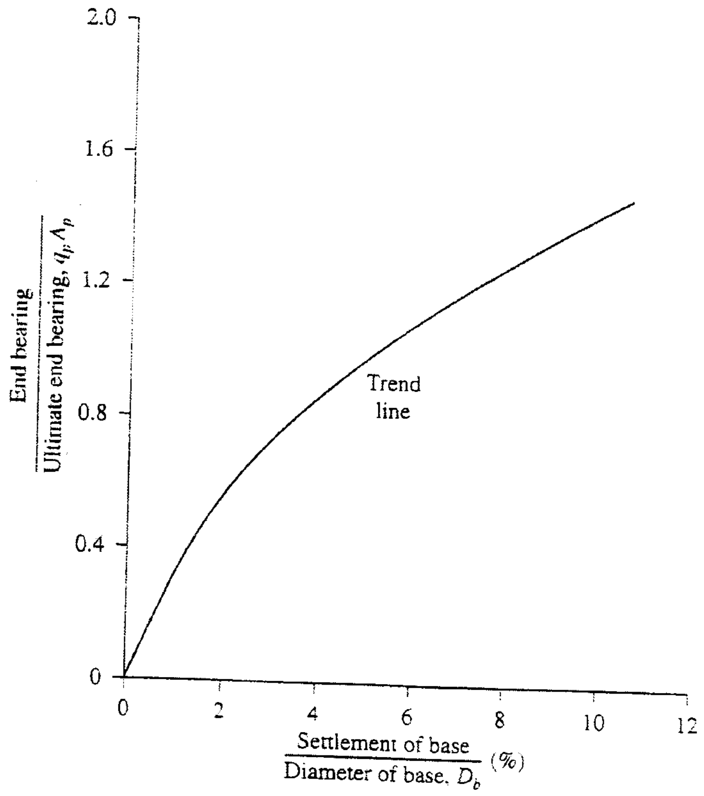


Normalised side-load transfer trend in gravelly sand.



Normalised base-load transfer trend in sand.

FIGURE Q3(c)ii

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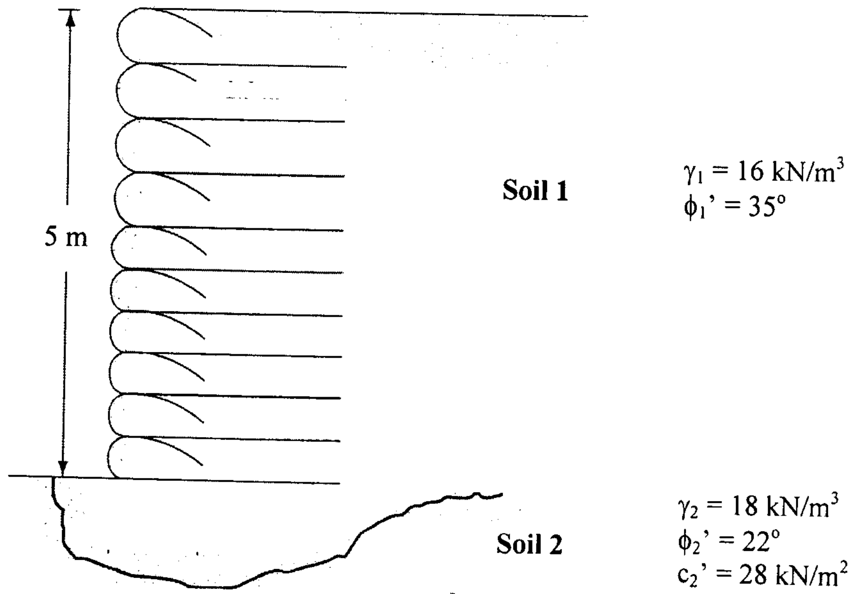

$$\sigma'_a = K_a \sigma'_o = K_a \gamma_1 z$$

K_a = Rankine active pressure coefficient $= \tan^2(45 - \phi'_1/2)$

$$T_{all} = \frac{T_{ult}}{RF_{id} \times RF_{cr} \times RF_{cbd}}$$

RF_{id}	1.1–2.0
RF_{cr}	2–4
RF_{cbd}	1–1.5

$$S_V = \frac{T_{all}}{\sigma'_a FS_{(B)}} = \frac{T_{all}}{(\gamma_1 z K_a)[FS_{(B)}]}$$

$$L = l_r + l_e$$

$$l_r = \frac{H - z}{\tan\left(45 + \frac{\phi'_1}{2}\right)}$$

$$l_e = \frac{S_V \sigma'_a [FS_{(P)}]}{2\sigma'_o \tan\phi'_F}$$

$$l_l = \frac{S_V \sigma'_a [FS_{(P)}]}{4\sigma'_o \tan\phi'_F}$$

$\sigma'_a = \gamma_1 z K_a$
$\sigma'_o = \gamma_1 z$
$FS_{(P)}$ = 1.3 to 1.5
ϕ'_F = Friction angle at geotextile-soil interface $\approx \frac{2}{3}\phi'$

FIGURE Q4(c)