# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESI 2011/2012

| | | |
|---|---|---|
| COURSE NAME | : | FOUNDATION ENGINEERING |
| COURSE CODE | : | BFC 4043 |
| PROGRAMME | : | 4 BFF |
| EXAMINATION DATE | : | JANUARY 2012 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER QUESTION **Q1** AND OTHER **THREE (3)** QUESTIONS |

THIS PAPER CONSISTS OF **TWELVE (12)** PAGES

**Q1** (a) Ground improvement is defined as the controlled alteration of the state, nature or mass behaviour of ground materials in order to achieve an intended satisfactory response to existing or projected environmental and engineering actions. Discuss:

(i) **TWO (2)** types of ground improvement for cohesive soil

(ii) **TWO (2)** types of ground improvement for cohesionless soil

(12 marks)

(b) An earth fill has to be carried out for a housing project at Parit Raja. After completion, it will occupy a net volume of 200,000m$^3$. The borrow material is a stiff clay imported from Air Hitam. In its "bank" condition, the borrow material has a bulk unit weight, $\gamma_b$ of 17 kN/m$^3$, water content (w) of 15%, and an in-place void ratio (e) of 0.60. The fill will be constructed in layers of 200 mm in depth, loose measure, and compacted to a dry unit weight ($\gamma_d$) of 19kN/m$^3$ at a water content of 17.5%.

(i) Determine the required volume of borrow pit excavation in m$^3$ from Air Hitam.

(ii) What is the shrinkage factor due to compacting the fill?

(13 marks)

**Q2** (a) A school building is proposed to be constructed at a rather flat site. As the engineer in-charge of the project, you had decided to use the seismic refraction method to check the subsoil condition. Briefly describe the principles on which seismic refraction studies for subsurface explorations are based and the type of subsurface information that the method can provide.

(10 marks)

(b) A thin-walled Shelby tube sampler was pushed into soft clay at the bottom of a borehole a distance of 600 mm. When the tube was recovered, a measurement down inside the tube indicated a recovered sample length of 400 mm.

(i) What is the recovery ratio of the sample?

(ii) What (if anything) happened to the sample?

(iii) If a tube having external diameter of 89 mm and internal diameter of 80 mm was used, what is the probable sample quality?

(iv) If a Shelby tube sampler was not available during a site investigation work, name any other **TWO (2)** samplers that can be used to obtain soil sample that has almost the same quality as sample retrieve from a Shelby tube sampler.

(15 marks)

**Q3** (a) Explain in details the concept of settlement of shallow foundation with suitable illustrations.

(5 marks)

(b) An eccentrically loaded 2 m X 2 m foundation is shown in **Figure Q3(b)**.

(i) Using Meyerhof's effective area method, determine the ultimate bearing capacity if e/B= 0.09 (one-way eccentricity).

(15 marks)

(ii) Use FS=3.5 and determine the allowable bearing capacity.

(5 marks)

**Q4** (a) Briefly describe:

(i) Pile Load Tests

(ii) Negative skin friction

(4 marks)

(b) Explain in details any **THREE (3)** types of piles and their structural characteristics.

(6 marks)

(c) **Table 1** show the variation of $N_{60}$ with depth in a granular soil deposit. A concrete pile 9 m long (0.350 m x 0.350 m in cross section) is driven into the sand and fully embedded in the sand. Estimate the allowable load-carrying capacity of the pile ($Q_{all}$). Use FS = 4 and Meyerhof's equations.

**Table 1**

| Depth (m) | $N_{60}$ |
|---|---|
| 1.5 | 4 |
| 3.0 | 8 |
| 4.5 | 6 |
| 6.0 | 4 |
| 7.5 | 16 |
| 9.0 | 18 |
| 10.5 | 21 |
| 11.0 | 24 |
| 12.5 | 20 |
| 14.0 | 19 |

(15 marks)

**Q5** (a) Explain in detail different type of retaining structure:

(i) Retaining wall

(ii) Reinforced earth

(iii) Sheet pile

(iv) Braced cut.

(8 marks)

(b) Figure **Q5(b)** shows cantilever sheet pile penetrating into saturated clay. Determine:

(i) The theoretical and actual depth of penetration. Use $D_{actual} = 1.6\ D_{theory}$

(ii) Maximum moment

(17 marks)

**S1** (a) Pembaikan tanah adalah pengubahan keadaan, sifat semulajadi dan ciri tanah secara terkawal bagi memenuhi kehendak sesuatu projek yang sedia ada ataupun yang sedang dirancang.

(i) **DUA (2)** jenis pembaikan tanah yang bagi tanah yang berjelekit

(ii) **DUA (2)** jenis pembaikan tanah yang bagi tanah yang tidak berjelekit

(12 markah)

(b) Suatu kerja penambakan tanah perlu dijalankan untuk sebuah projek perumahan di Parit Raja. Setelah siap, tambakan ini akan meliputi isipadu bersih sebanyak 200,000$m^3$. Tanah tambakan yang digunakan adalah tanah liat padat yang diambil dari Air Hitam. Pada keadaan asal, tanah liat padat itu mempunyai berat unit pukal,$\gamma b$ bernilai 17kN/$m^3$, kandungan air (w %) 15%, dan nisbah lompang in-situ (e) 0.60. Tanah tambakan itu akan dipadatkan secara berlapisan di mana setiap lapisan adalah setebal 200mm, diletak secara longgar, dan dipadat kepada berat unit kering ($\gamma d$) 19kN/$m^3$ dengan kandungan air 17.5%.

(i) Tentukan isipadu tanah yang perlu dikorek daripada Air Hitam dalam $m^3$

(ii) Apakah nilai faktor pengecutan akibat daripada pemadatan?

(13 markah)

**S2** (a) Sebuah bangunan sekolah telah dicadangkan untuk dibina di atas sebuah tapak bina yang rata. Sebagai jurutera yang mengendalikan projek tersebut, anda telah membuat keputusan untuk menggunakan kaedah pembiasan seismik bagi menyiasat keadaan tanah di bawah tapak tersebut. Terangkan dengan ringkas prinsip asas penyiasatan tapak menggunakan kaedah pembiasan sesismik dan jenis maklumat atau keterangan mengenai sub-permukaan yang akan diberikan oleh kaedah tersebut.

(10 markah)

(b) Satu tiub Shelby berdinding nipis telah ditekan masuk ke dalam tanah liat lembut di bawah satu lubang jara sedalam 600 mm. Apabila tiub tersebut ditarik naik didapati panjang sampel di dalam tiub tersebut cuma 400 mm.

(i) Apakah nisbah perolehan sampel tersebut?

(ii) Apakah (jika ada) yang telah berlaku kepada tanah tersebut?

(iii) Jika satu tiub yang mempunyai garispusat luar 89 mm dan garispusat dalam 80 mm telah digunakan , apakah tahap kualiti sampel yang akan diperolehi?

(iv) Jika tiub Shelby tidak ada ketika kerja-kerja penyiasatan tapak dijalankan, namakan dua (2) jenis tiub pencontoh yang lain yang boleh digunakan bagi mendapatkan sampel tanah yang mempunyai kualiti yang sama seperti yang diperolehi dengan menggunakan tiub pencontoh Shelby.

(15 markah)

**S3** (a) Terangkan dengan mendalam konsep enapan terhadap asas cetek dengan menggunakan gambarajah yang sesuai.

(5 markah)

(b) Suatu asas cetek berdimensi 2 m X 2 m yang terbeban secara sipi ditunjukkan seperti pada Rajah **Q3(b)**.

(i) Dengan menggunakan kaedah Meyerhof, tentukan keupayaan galas menyeluruh untuk asas ini sekiranya e/B= 0.09 (kesipian dalam satu arah).

(15 markah)

(ii) Tentukan keupayaan galas yang dibenarkan untuk kes di atas. Pertimbangkan FS=3.5.

(5 markah)

**S4** (a) Nyatakan dengan ringkas bagi perkara berikut:

(i) Ujian Pembebanan Cerucuk

(ii) Geseran Kulit Negatif

(4 markah)

(b) Terangkan dengan jelas **TIGA (3)** jenis asas cerucuk serta ciri-ciri strukturnya.

(6 markah)

(c) **Jadual 1** menunjukan nilai $N_{60}$ mengikut kedalaman bagi tanah berbutir. Satu asas cerucuk konkrit 9 m panjang (0.350 m x 0.350 m garisrentas) dipacu ke dalam lapisan pasir dan ditanam sepenuhnya. Tentukan keupayaan galas yang dibenarkan bagi asas cerucuk tersebut ($Q_{all}$). Gunakan FS = 4 dan persamaan Meyerhof's.

**Jadual 1**

| **Kedalaman (m)** | $N_{60}$ |
|---|---|
| 1.5 | 4 |
| 3.0 | 8 |
| 4.5 | 6 |
| 6.0 | 4 |
| 7.5 | 16 |
| 9.0 | 18 |
| 10.5 | 21 |
| 11.0 | 24 |
| 12.5 | 20 |
| 14.0 | 19 |

(15 markah)

**S5** (a) Terangkan perbezaan di antara struktur penahan:

(i) Tembok penahan

(ii) Tanah bertetulang

(iii) Cerucuk keping

(iv) Tembok korekan berembat

(8 markah)

(b) Rajah **Q5(b)** menunjukkan cerucuk keping yang ditanam dalam tanah liat tepu. Kirakan :

(i) kedalaman teoritikal dan kedalaman sebenar sebuah cerucuk keping. Diberi $D_{sebenar} = 1.56D_{teori}$

(ii) Maksimum momen

(17 markah)

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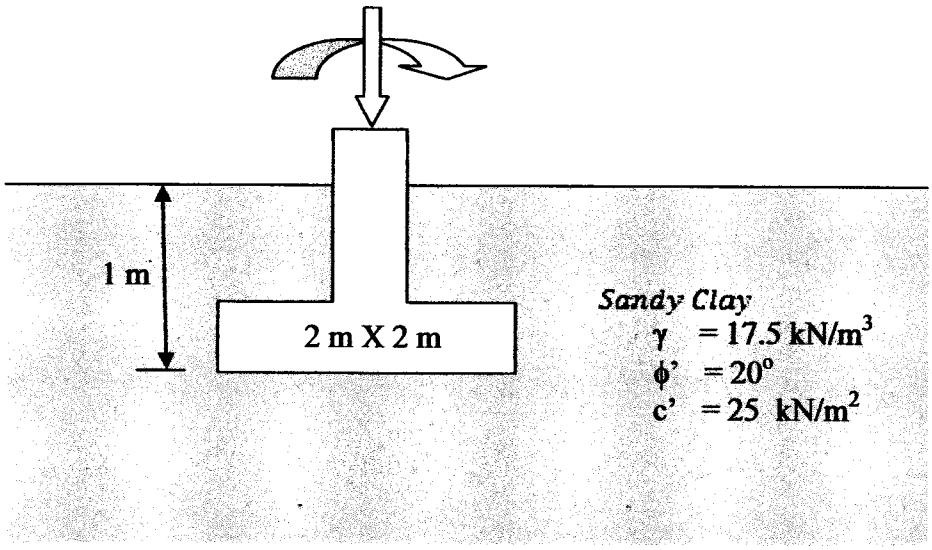


**FIGURE Q3(b)**

**FINAL EXAMINATION**

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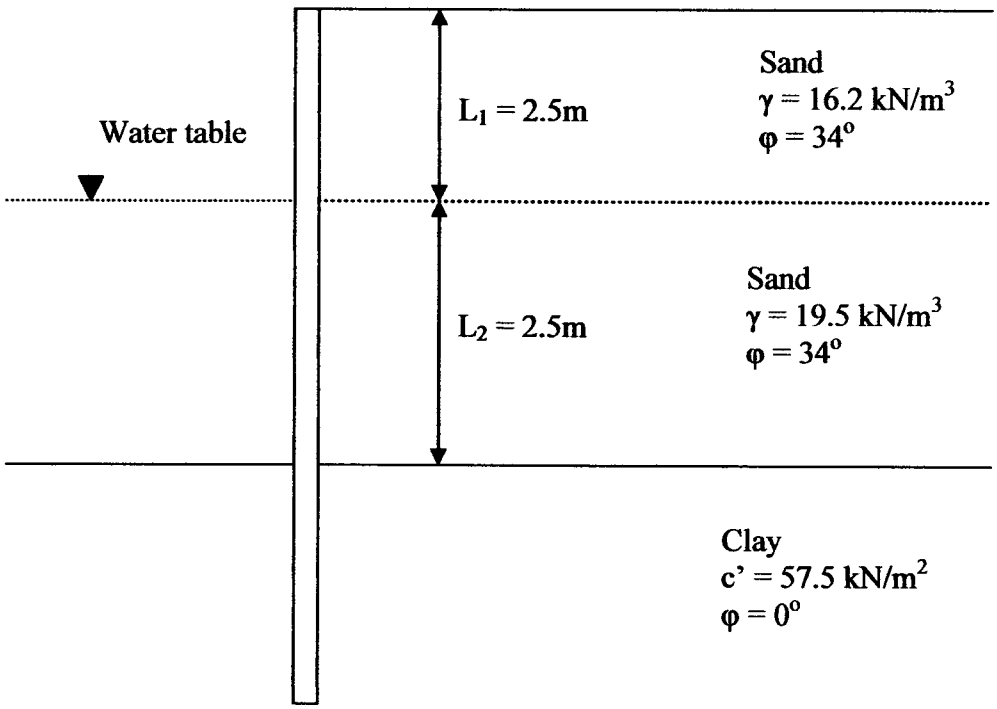


**FIGURE Q5(b)**

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Shape, Depth and Inclination Factors (DeBeer (1970); Meyerhof (1963); Meyerhof and Hanna (1981)

| Factor | Relationship | Reference |
|---|---|---|
| Shape | $F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$<br>$F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi'$<br>$F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$ | DeBeer (1970) |
| Depth | $\frac{D_f}{B} \le 1$<br>For $\phi = 0$:<br>$F_{cd} = 1 + 0.4\left(\frac{D_f}{B}\right)$<br>$F_{qd} = 1$<br>$F_{\gamma d} = 1$<br>For $\phi' > 0$:<br>$F_{cd} = F_{qd} - \frac{1 - F_{qd}}{N_c \tan\phi'}$<br>$F_{qd} = 1 + 2\tan\phi'(1 - \sin\phi')^2\left(\frac{D_f}{B}\right)$<br>$F_{\gamma d} = 1$<br>$\frac{D_f}{B} > 1$<br>For $\phi = 0$:<br>$F_{cd} = 1 + 0.4 \underbrace{\tan^{-1}\left(\frac{D_f}{B}\right)}_{\text{radians}}$<br>$F_{qd} = 1$<br>$F_{\gamma d} = 1$<br>For $\phi' > 0$:<br>$F_{cd} = F_{qd} - \frac{1 - F_{qd}}{N_c \tan\phi'}$<br>$F_{qd} = 1 + 2\tan\phi'(1 - \sin\phi')^2 \underbrace{\tan^{-1}\left(\frac{D_f}{B}\right)}_{\text{radians}}$<br>$F_{\gamma d} = 1$ | Hansen (1970) |
| Inclination | $F_{ci} = F_{qi} = \left(1 - \frac{\beta^\circ}{90^\circ}\right)^2$<br>$F_{\gamma i} = \left(1 - \frac{\beta}{\phi'}\right)^2$<br>$\beta$ = inclination of the load on the foundation with respect to the vertical | Meyerhof (1963); Hanna and Meyerhof (1981) |

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## Meyerhof's Bearing Capacity Factors

| $\phi'$ | $N_c$ | $N_q$ | $N_\gamma$ | $\phi'$ | $N_c$ | $N_q$ | $N_\gamma$ |
|---|---|---|---|---|---|---|---|
| 0 | 5.14 | 1.00 | 0.00 | 26 | 22.25 | 11.85 | 12.54 |
| 1 | 5.38 | 1.09 | 0.07 | 27 | 23.94 | 13.20 | 14.47 |
| 2 | 5.63 | 1.20 | 0.15 | 28 | 25.80 | 14.72 | 16.72 |
| 3 | 5.90 | 1.31 | 0.24 | 29 | 27.86 | 16.44 | 19.34 |
| 4 | 6.19 | 1.43 | 0.34 | 30 | 30.14 | 18.40 | 22.40 |
| 5 | 6.49 | 1.57 | 0.45 | 31 | 32.67 | 20.63 | 25.99 |
| 6 | 6.81 | 1.72 | 0.57 | 32 | 35.49 | 23.18 | 30.22 |
| 7 | 7.16 | 1.88 | 0.71 | 33 | 38.64 | 26.09 | 35.19 |
| 8 | 7.53 | 2.06 | 0.86 | 34 | 42.16 | 29.44 | 41.06 |
| 9 | 7.92 | 2.25 | 1.03 | 35 | 46.12 | 33.30 | 48.03 |
| 10 | 8.35 | 2.47 | 1.22 | 36 | 50.59 | 37.75 | 56.31 |
| 11 | 8.80 | 2.71 | 1.44 | 37 | 55.63 | 42.92 | 66.19 |
| 12 | 9.28 | 2.97 | 1.69 | 38 | 61.35 | 48.93 | 78.03 |
| 13 | 9.81 | 3.26 | 1.97 | 39 | 67.87 | 55.96 | 92.25 |
| 14 | 10.37 | 3.59 | 2.29 | 40 | 75.31 | 64.20 | 109.41 |
| 15 | 10.98 | 3.94 | 2.65 | 41 | 83.86 | 73.90 | 130.22 |
| 16 | 11.63 | 4.34 | 3.06 | 42 | 93.71 | 85.38 | 155.55 |
| 17 | 12.34 | 4.77 | 3.53 | 43 | 105.11 | 99.02 | 186.54 |
| 18 | 13.10 | 5.26 | 4.07 | 44 | 118.37 | 115.31 | 224.64 |
| 19 | 13.93 | 5.80 | 4.68 | 45 | 133.88 | 134.88 | 271.76 |
| 20 | 14.83 | 6.40 | 5.39 | 46 | 152.10 | 158.51 | 330.35 |
| 21 | 15.82 | 7.07 | 6.20 | 47 | 173.64 | 187.21 | 403.67 |
| 22 | 16.88 | 7.82 | 7.13 | 48 | 199.26 | 222.31 | 496.01 |
| 23 | 18.05 | 8.66 | 8.20 | 49 | 229.93 | 265.51 | 613.16 |
| 24 | 19.32 | 9.60 | 9.44 | 50 | 266.89 | 319.07 | 762.89 |
| 25 | 20.72 | 10.66 | 10.88 | | | | |

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**Given formula:**

$$q_{ult} = c' N_c F_{cs} F_{cd} F_{ci} + q N_q F_{qs} F_{qd} F_{qi} + 0.5 B \gamma N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$$

$$q_{max} = \frac{Q}{BL} + \frac{6M}{B^2 L}$$

$$q_{min} = \frac{Q}{BL} - \frac{6M}{B^2 L}$$

$$If\ e < \frac{B}{6},\quad q_{max} = \frac{Q}{BL}\left(1 + \frac{6e}{B}\right)\ and\ q_{min} = \frac{Q}{BL}\left(1 - \frac{6e}{B}\right)$$

$$If\ e > \frac{B}{6},\quad q_{max} = \frac{4Q}{3L\,(B - 2e)}$$

$$FS = \frac{Q_{ult}}{Q_{all}}$$

$q_p = 0.4\ p_a\ N_{60}\ (L/D) \leq 4\ p_a\ N_{60}$

$10D$ above and $4D$ below

$Q_p = A_p\ (q_p)$

$Q_s = pLf_{av}$

$f_{av} = 0.02\ p_a$ (average $N_{60}$)

$$D^2[4c - (\gamma L_1 + \gamma' L_2)] - 2DP_1 - \frac{P_1(P_1 + 12c\bar{z}_1)}{(\gamma L_1 + \gamma' L_2) + 2c} = 0$$

$$P_1 = \tfrac{1}{2} p_1 L_1 + p_1 L_2 + \tfrac{1}{2}(p_2 - p_1) L_2 \qquad \bar{z}_1 = \frac{\sum M_E}{P_1}$$

$$M_{max} = P_1\left(z' + \bar{z}_1\right) - \frac{p_6 z'^2}{2}$$

$$z' = \frac{P_1}{p_6} = \frac{P_1}{4c - (\gamma L_1 + \gamma' L_2)}$$

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2011/2012

| | | |
|---|---|---|
| COURSE NAME | : | STRUCTURE REPAIR AND REHABILITATION |
| COURSE CODE | : | BFP 4043 |
| PROGRAMME | : | 4 BFF |
| EXAMINATION DATE | : | JANUARY 2012 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **FOUR (4)** QUESTIONS ONLY |

THIS PAPER CONSISTS OF FIVE (5) PAGES

**Q1** The use of vehicle bombs to attack a targeted building has been a feature of campaigns by terrorist organizations around the world.

(a) Discuss **five (5)** effects of explosion on structure of building.

(10 marks)

(b) With aid of sketches, explain the nature of explosions and the mechanism of blast waves in free air.

(15 marks)

**Q2** The method of strengthening concrete structures with Fiber Reinforced Polymer (FRP) composites has existed for over a decade.

(a) Discuss **three (3)** types of FRP available in the market.

(12 marks)

(b) If the application of FRP laminates is to be used for strengthening of a reinforced concrete beam. List the surface preparation process needed before the laminations started.

(8 marks)

(c) Completely sketch the diagram of the strengthening works for reinforced concrete beam.

(5 marks)

**Q3** There are several methods available in repairing crack.

(a) If the epoxy pressure injection technique is decided to rehabilitate reinforced concrete beam-column joints damaged by earthquakes. Discuss the process involved before the epoxy injection started.

(10 marks)

(b) If extremely high injection pressures needed, the crack can be cut out to a certain depth. Explain **three (3)** methods can be applied before injecting the epoxy.

(15 marks)

**Q4** A spall in a concrete surface may be resulting of localized distress or the symptom of a more widespread distress in the concrete element. In either case, an attempt should be made to determine the causes of the distress prior to selecting a remedy.

(a) Discuss **four (4)** possible of causes of spalling.

(12 marks)

(b) Explain the surface preparation process in concrete removal before the repairing technique was applied.

(13 marks)

**Q5** In a reinforced concrete bridge, the pier has been damaged with severe cracks and internal steel reinforcement was also corroded due to the increase of age and adverse environmental condition.

(a) Discuss **five (5)** importance of visual inspection in repairing and monitoring the deterioration of bridge structure.

(10 marks)

(b) Many types of non destructive (NDT) method have been carried out to check the structural integrity of concrete bridge. Propose **five (5)** NDT method of rehabilitating the reinforced concrete structural components of bridge. Justify your answer.

(15 marks)

**Q6** A residential complex will be developed over a hilly terrain and site formation is a challenge when bore pile crane is to be brought in an already heavily congested site. A temporary reinforced fill structure is proposed to extend and widen a working platform.

(a) Propose a method and suitable design for temporary reinforced fill. Provide complete sketches and labeling in your diagram.

(15 marks)

(b) Discuss **five (5)** possible requirements of temporary work in site.

(10 marks)

**Malay translation.**

**If there existed any contradiction of statement, the English translation will be considered.**

S1 Penggunaan bom berkenderaan untuk memusnahkan bangunan sasaran telah menjadi lumrah oleh organisasi pengganas di seluruh dunia.

(a) Bincangkan **lima (5)** kesan letupan ke atas struktur bangunan.

(10 markah)

(b) Terangkan keadaan letupan dan mekanisme gelombang letupan di udara dengan bantuan lakaran.

(15 markah)

S2 Kaedah pengukuhan struktur konkrit dengan 'Fiber Reinforced Polymer' (FRP) telah wujud sepanjang dekad yang lalu.

(a) Bincangkan **tiga (3)** jenis FRP yang ada di pasaran.

(12 markah)

(b) Jika penggunaan balutan FRP digunakan untuk mengukuhkan rasuk konkrit tetulang. Senaraikan proses penyediaan permukaan yang diperlukan sebelum balutan.

(8 markah)

(c) Dengan bantuan gamabarajah, lakarkan bagaimana pengukuhan berfungsi dalam rasuk konkrit tetulang.

(5 markah)

S3 Terdapat beberapa kaedah untuk membaiki retakan.

(a) Jika teknik epoxy suntikan bertekanan digunakan untuk membaikpulih konkrit tetulang antara sambungan rasuk-tiang. Bincangkan proses yang terlibat sebelum suntikan epoxy dimulakan.

(10 markah)

(b) Jika suntikan epoxy yang memerlukan tekanan sangat tinggi, retak perlu dipotong pada kedalaman tertentu. Terangkan **tiga (3)** kaedah yang diperlukan sebelum menyuntik epoxy.

(15 markah)

S4 Pecahan kepingan permukaan konkrit mungkin disebabkan kerosakan pada tempat yang tertentu atau simpton kerosakan yang merebak di dalam elemen konkrit. Dalam kes tertentu, uasaha perlu dilakukan untuk mengenalpasti punca kerosakan sebelum memilih kaedah untuk memperbaiki keadaan itu.

(a) Bincangkan **empat (4)** kemungkinan punca pecahan kepingan konkrit.

(12 markah)

(b) Terangkan proses penyediaan permukaan dalam membuang konkrit sebelum teknik membaikpulih dijalankan.

(13 markah)

**S5** Pada jambatan konkrit tetulang, tiang jambatan telah rosak disebabkan retakan sederhana dan bar keluli juga mengalami karatan akibat usia yang meningkat dan keadaan persekitaran.

(a) Bincangkan **lima (5)** kepentingan pemeriksaan visual dalam membaikpulih dan mengawasi kerosakan struktur jambatan.

(10 markah)

(b) Banyak jenis kaedah 'non destructive' (NDT) telah dijalankan untuk memeriksa struktur konkrit jambatan. Cadangkan **lima (5)** kaedah NDT dalam membaikpulih komponen struktur jambatan konkrit bertetulang. Berikan alasan anda dalam pemilihan kaedah-kaedah tersebut.

(15 markah)

**S6** Komplek residensi akan dibangunkan di sepanjang teres bukit dan pembinaan tersebut mencabar apabila 'bore pile crane' akan dibawa ke pembinaan yang sesak. Struktur pengisian tetulang yang sementara telah dicadangkan untuk membesarkan platform bekerja.

(a) Cadangkan kaedah dan rekaan yang bersesuaian untuk pengisian tetulang yang sementara dengan menggunakan lakaran dan label yang relevan.

(15 markah)

(b) Bincangkan **lima (5)** kemungkinan keperluan kerja sementara di tapak pembinaan.

(10 markah)

**SOALAN TAMAT**