Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	HIGHWAY ENGINEERING
COURSE CODE	:	BFC31802
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE/JULY 2019
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Briefly describe **THREE (3)** physical properties which are commonly used to characterize the strength of a subgrade.

(6 marks)

(b) Sand cone replacement test method was conducted to determine the density during the construction of road base layer. The result of the test is shown in **Table Q1(b)(i)** and **Table Q1(b)(ii).** According to the Public Work Department (PWD) Specification for Road Work(SPJ 2008), the road base layer must be compacted at least 95% of Maximum Dry Density. Determine whether the compaction effort for the road base layer construction comply with the Specification. Give your comment on the results.

(8 marks)

(c) Selection of suitable soils to be used as subgrade for pavement is primary importance in the design and construction of highway.

(i) Explain **FOUR (4)** characteristics of soils that are considered as unsuitable material for subgrade. For each mentioned characteristic explain why the soils shall not be used as subgrade material.

(8 marks)

(ii) If the subgrade materials in cut area are found to have California Bearing Ratio (CBR) values of less than that required by the PWD Specification for Road Work (SPJ 2008), what shall be done to the top 300 mm of the subgrade.

(3 marks)

Q2 (a) An in-situ testing report for subgrade is received from ABC Sdn. Bhd. The summary results for California Bearing Ratio (CBR) values are shown in **Table Q2(a)**.

(i) Determine the CBR value according to ATJ/5-85.

(3 marks)

(ii) Give a justification of the subgrade strength according to the Standard Specification for Road Works (SPJ 2008).

(2 marks)

(b) A rigid pavement was initially designed with a 203 mm slab, a 4.8 MPa concrete modulus of rupture, a 34.5 MPa/m subbase-subgrade, k value. The initial PSI is 4.6 and the TSI is 2.5. The pavement was conservatively designed to last for 20 years. From a traffic study, the current ADT is 12,900, annual growth rate is 4% and ADTT is 19% of ADT. In accordance;

(i) Complete **Table Q2(b)**. Then determine the slab thickness.

(17 marks)

(ii) Consider the condition in **Q2(b)(i).** Suppose all of the parameters are the same, but further soil tests found that the modulus of subgrade reaction was lower. In light of this new soil finding, discuss briefly how would the design life of the pavement change?

(3 marks)

Q3 (a) Earthwork is needed in the early stage of road construction. List and describe **THREE (3)** activities involved in the earthwork.

(6 marks)

(b) **Figure Q3** shows the longitudinal profile of a site for a proposed highway. The distance and corresponding volume of soil to be cut or filled are indicated in the figure. Assume that the shrinkage and bulking factors are equal to 1.0.

(i) Draw a Mass Haul Diagram.

(6 marks)

(ii) Determine the volumes and direction of haul using the table in **Figure Q3.**

(6 marks)

(iii) Determine the volume of borrow or waste (if any).

(1 marks)

(iv) Given the following cost estimates, calculate the cost of this particular earthwork:

Cost of cutting, hauling and filling = RM 15 per cubic meter
Cost of removing unwanted soil (waste) = RM 6 per cubic meter
Cost of acquiring, hauling and filling of borrow soil = RM 10 per cubic meter

(6 marks)

Q4 (a) What are the basic purposes of a Pavement Management System?

(2 marks)

(b) Explain briefly categories of road maintenance.

(5 marks)

(c) Briefly discussed **TWO (2)** types of pavement distresses.

(6 marks)

(d) After conducting a pavement condition survey to Route F050, it can be concluded that the average Pavement Condition Index (PCI) value is 50 and considered as fair, mainly due to the surface defects. As an engineer, propose **TWO (2)** techniques of rehabilitation methods to treat the road. Give your justification for each technique chosen.

(12 marks)

Q5 (a) The serviceability of a highway is greatly dependent on the adequacy of its drainage system. Adequate and proper drainage is important for protection of road structure and safety of the road users. Briefly explain effects of water ponding on highway structure and road users.

(6 marks)

(b) The present of water often results in premature failure of pavement influences the strength and shortens its design life. What are the **TWO (2)** sources of water which highway engineer is primarily concerned with? Briefly describe each source.

(6 marks)

(c) Entrances of water into the road sub-grade can seep from the slope, unpaved shoulder, percolates down through the pavement structure itself, natural water table rise and fall during the rainy day. Based on that statement, using an appropriate diagrams propose and describe the suitable drainage system to prevent the effects of water destruction on road pavement.

(13 marks)

–END OF QUESTIONS–

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Table Q1(b)(i): Density test result

Bulk density, ρ_b	1939.67 kg/m^3
Maximum Dry Density (MDD)	1760.00 kg/m^3

Table Q1(b)(ii): Moisture content test results

Mass of tray	1.65 gram
Mass of tray + soil	2.65 gram
Mass of tray + dry soil	2.50 gram

Table Q2(a): Summary result of subgrade CBR value for 1 m depth

Depth (cm)	CBR value (%)
0-50	1.56
51-60	2.13
61-90	3.10
91-100	2.1

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Note: If you are answering **Q2**, please submit this sheet along with your answer script.

Table Q2(b): Calculation of Pavement Thickness

Trial Thickness		**Doweled joints**	**Yes**	
Modulus of Rupture, MR		**Conrete shoulder**	**Yes**	
Load Safety factor, LSF	1.2	**Design period**	20	years

Axle load (kN)	**Multiplied by LSF**	**Expected repetitions**	**Fatigue analysis**		**Erosion analysis**	
			Allowable repetitions	**Fatigue percent**	**Allowable repetitions**	**Damage, percent**
1	2	3	4	5	6	7

8. Equivalent stress :
9. Stress ratio factor :
10. Erosion factor:

Single Axle

Axle Load, kN						
125						
107						
98						
80						

11. Equivalent stress :
12. Stress ratio factor :
13. Erosion factor:

Tandem Axle

Axle Load, kN						
231						
213						
178						
142						

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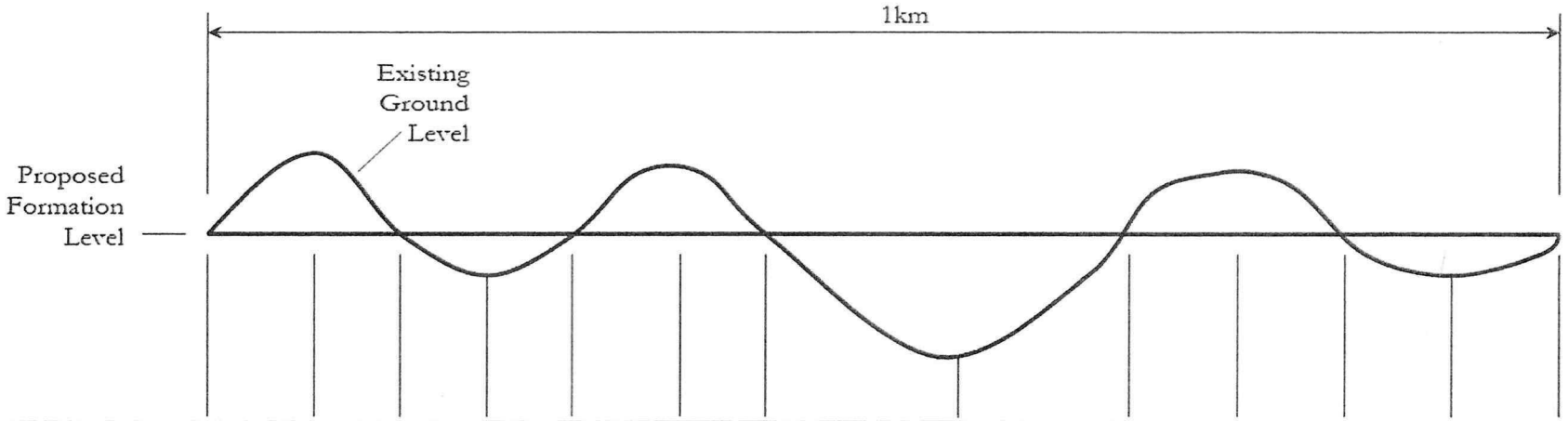

Distance (m)	100	70	80	70	75	80	100	130	70	90	85	50
Volume (m^3)	7,062	3,364	3,665	3,266	4,485	4,628	9,365	5,672	4,386	3,332	2,127	3,720
Cut (m^3)												
Fill (m^3)												
Haul (m^3)												
Borrow (m^3)												
Waste (m^3)												

Figure Q3: Longitudinal profile of a site for a proposed highway

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The following information may be useful. The symbols have their usual meaning.

$$CBR = \left(\frac{h_1 CBR_1^{1/3} + h_2 CBR_2^{1/3} \ldots + h_n CBR_n^{1/3}}{100} \right)$$

$$ESAL = ADTT \times Design\ years \times 365$$

$$Stress\ Ratio\ Factor = Equivalent\ Stress\ /\ M_R$$

$$\rho_d = \frac{\rho_b}{1 + w}$$