



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER 1
SESSION 2015/2016**

COURSE NAME : HIGHWAY ENGINEERING
COURSE CODE : BFC 31802
PROGRAMME : BACHELOR OF CIVIL
ENGINEERING WITH HONOURS
EXAMINATION DATE : DECEMBER 2015/JANUARY 2016
DURATION : 2 HOURS AND 30 MINUTES
INSTRUCTION : ANSWER **FOUR (4)** QUESTIONS
ONLY

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

- Q1** (a) All road base materials shall fulfill the California Bearing Ratio (CBR) test. Explain how the CBR value been determined using the following equation:

$$\text{CBR} = \frac{\text{Test Unit Stress}}{\text{Standard Unit Stress}} \times 100 \%$$

(3 marks)

- (b) Selection of the suitable soils is important for the highway foundation. List **THREE (3)** properties that can be considered as good sub-grade.
(3 marks)
- (c) Describe the process of production of the emulsion bitumen. Explain the advantages of using emulsion bitumen in bituminous mixture.
(5 marks)
- (d) Describe the purpose of Marshall mix design of asphalt concrete. Simplify the process of Marshall mix design by using the suitable diagram.
(14 marks)

- Q2** (a) A rigid pavement was designed with the condition given below:

- Modulus of Subgrade Reaction of combined subbase/subgrade = 30 MPa/m
- Concrete flexural strength = 4.5 MPa
- Load Safety factor = 1.1
- Thickness of concrete slab = 20 cm

For a single axle load of 130 kN and 7300 expected repetitions during the design life, analyze its contribution to fatigue and erosion for the following type of pavement:

- i. Slab with dowel joint and concrete shoulder.
(5 marks)
- ii. Slab with dowel joint without concrete shoulder.
(5 marks)
- iii. Slab with aggregate interlock joint and concrete shoulder.
(5 marks)
- iv. Slab with aggregate interlock joint and without concrete shoulder.
(5 marks)
- (b) Based on **Q2 (a) (i-iv)**, classify the effect of the type of joint and shoulder to the rigid pavement which may be drawn from your answers.
(5 marks)

- Q3** (a) Explain the importance of having site investigation for road construction process. (6 marks)
- (b) List **THREE (3)** treatments which can be conducted to the weak soil and compare the characteristics of each treatment method. (12 marks)
- (c) Compaction is an important process in the preparation of the road surface.
- i. Describe what does compaction do to the Hot Mix Asphalt (HMA) layer? (2 marks)
- ii. List **TWO (2)** pavement distresses which may occur due to inadequate compaction. (2 marks)
- iii. List **THREE (3)** types of compaction equipment which are commonly used and their function in the construction of asphalt layers. (3 marks)
- Q4** (a) Elaborate the basic purposes of a Pavement Management System? (2 marks)
- (b) Surface deformation is one type of pavement distress. Examine about the cause and select the appropriate treatment method for the following surface deformation categories:
- i. Rutting. (2 marks)
- ii. Depression. (2 marks)
- iii. Corrugation. (2 marks)
- iv. Shoving. (2 marks)
- (c) Describe in detail **ONE (1)** of Non-destructive Deflection Testing (NDT) method for pavement structural evaluation. (5 marks)
- (d) The average value of Pavement Condition Index (PCI) of surveyed road is 50. This PCI value is considered as fair condition. As an engineer, categorize **TWO (2)** techniques of rehabilitation method most suitable for this road together with their characteristics. (10 marks)

- Q5** (a) The strength of subgrade largely depends on moisture content and compaction efforts. Discuss **FOUR (4)** sources of water that will increase moisture content on existing subgrade layer. (8 marks)
- (b) As a Project Engineer of a new road construction, you have been reported that the underground water level of your construction site is high. This situation will expose your subgrade to have an excessive water from the underground. There are many methods available to be conducted to solve this problem. Classify **TWO (2)** methods which are suitable to overcome this problem. (6 marks)
- (c) Discuss with sketches, how the function of sub-surface drainage system in controlling seepage flow on sloping ground. (6 marks)
- (d) The main function of surface drainage is to remove rain water from road surface and road shoulder. Design a minimum cross section of the drain with when allowable velocity of flow is 0.5 m/sec, and quantity of water expected to flow in an open channel is 1.5 m³/sec. (5 marks)

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