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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017**

COURSE NAME : HIGHWAY ENGINEERING
COURSE CODE : BFC31802
PROGRAMME CODE : BFF
EXAMINATION DATE : JUNE 2017
DURATION : 2 HOURS 30 MINUTES
INSTRUCTIONS : ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

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- Q1 (a) Asphalt concrete is widely used as road structure component.
- (i) Describe contents of asphalt concrete. (4 marks)
 - (ii) Characterize **THREE (3)** important properties of asphalt concrete. (6 marks)
- (b) **Table 1** contains the results from a binder course aggregate gradation test, while **Figure Q1(b)** provides the gradation requirement. Comment on the suitability of the aggregate as a binder course material. (9 marks)
- (c) Indicate the purpose of asphalt mix concrete design. (2 marks)
- (d) Marshall Method is one the most common methods to evaluate trial mixes of asphalt concrete. Results of trial mix have been plotted in **Figure Q2(d)**. The mix is to meet the JKR Specification in **Table 2** for surface course subjected to medium traffic 14 mm maximum sized aggregates. From graphs, determine the optimum bitumen content (OBC) of the mixture. (4 marks)

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Q2 (a) The most important factor contributed in pavement performance is loading condition. Therefore the effect of loading on the pavement structure was discussed thoroughly in the ATJ/5-85 (Amendment 2013) to ensure the pavement is well designed.

(i) List the traffic data that are considered in the manual. (4 marks)

(ii) Calculate the Equivalent Standard Axle Load (ESAL) of different commercial vehicles (CVs) with total numbers of 120, 210, 150 and 120, if the equivalent factors are 0.001, 0.18, 1.56 and 7.21 respectively. (6 marks)

(b) A rigid pavement was designed with the conditions below:

- Modulus of subgrade reaction of combination subbase /subgrade = 30 MPa/m
- Concrete flexural strength = 4.5 MPa
- Load safety factor = 1.1
- Thickness of concrete slab = 20m

For a single axle load of 130 kN and 6300 expected repetition during the design life, determine its contribution to fatigue and erosion for the following types of pavement.

(i) Slab with dowel joint and concrete shoulder. (3 marks)

(ii) Slab with dowel joint without concrete shoulder. (3 marks)

(iii) Slab with aggregate interlock joint and concrete shoulder. (3 marks)

(iv) Slab with aggregate interlock joint without concrete shoulder. (3 marks)

(v) What conclusion regarding the effect of type of joint and shoulder may be drawn from your answer on the question above? (3 marks)

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- Q3** (a) Describe the main objective of earthwork in a road construction. (2 marks)
- (b) Degree of compaction is dependent on various factors. Lists and briefly discuss **TWO (2)** of the factors. (6 marks)
- (c) The road embankment requires 233000 m³ of soil. The borrow soil has an average moisture content of 8.3% and bulk density of 1.6 Mg/m³. The embankment will be compacted to an average relative compaction of 95% based on a maximum dry unit weight of 1.83 Mg/m³ and optimum moisture content of 12.9% obtained. Compute the volume of water that will be required to bring these soil to the optimum moisture content. (6 marks)
- (d) A contractor needs to haul 70000m³ (before excavate) of soil to highway construction site. The method of hauling is by using wheel loader at a borrow site to load the soil into dump trucks. Each dump truck has a capacity of 10 m³, and one loader will be required to service every 3 dump trucks. The same loaders will be used everyday. The dump trucks will then haul the soil to the construction site and deposit it there, which require a cycle time of 30 min. The labor and equipment cost for wheel loader is RM180.00 per hour and dump truck is RM175.00 per hour. The soil has a bulking factor of 30%. The hauling needs to be completed within 20 working days, using 8 hours shift per day. Using the situations;
- (i) Determine number of loaders and dump trucks will be needed to complete the hauling in the required time. (7 marks)
- (ii) Compute the cost of the works. (4 marks)

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- Q4** (a) State **THREE (3)** categories of road maintenance. (3 marks)
- (b) List **FOUR (4)** factors of road failures. (4 marks)
- (c) A rutting is a depression or groove worn into a road or path by the travel of wheels. Rutting in asphalt pavement can be filled with asphalt, then overlaid with another layer of asphalt. In accordance:
- (i) List **THREE (3)** causes of rutting. (3 marks)
- (ii) Discuss briefly **THREE (3)** reasons for rutting maintenance. (6 marks)
- (d) Cold in-place recycling (CIPR) is the processing and treatment with bituminous and/or chemical additives of existing HMA pavements without heating to produce a restored pavement layer. List **THREE (3)** and discuss briefly the typical process involves in this method. (9 marks)

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- Q5** (a) Elaborate **THREE (3)** objectives of road drainage. (6 marks)
- (b) One of the consequences of high precipitation on the road surface is hydroplaning. In accordance;
- (i) Define hydroplaning. (2 marks)
- (ii) Discuss the effect of hydroplaning (2 marks)
- (c) By using diagram, discuss the process of mud-pumping failure in rigid pavement (5 marks)
- (d) By using diagram, explain **THREE(3)** characteristics of free/gravitational water and capillary water. (6 marks)
- (e) Outline **TWO (2)** examples for each surface drainage and their roles. (4 marks)

–END OF QUESTIONS–**CONFIDENTIAL**

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TABLE 1: Gradation test results

Sieve Opening (mm)	Mass Retained On Sieve (g)
37.5	0
25	0
19	145.4
12.5	135.2
9.5	214.5
4.75	169.3
2.36	198.7
1.18	56.3
0.6	89.5
0.3	198.3
0.15	72.8
0.075	132.4
Pan	187.6

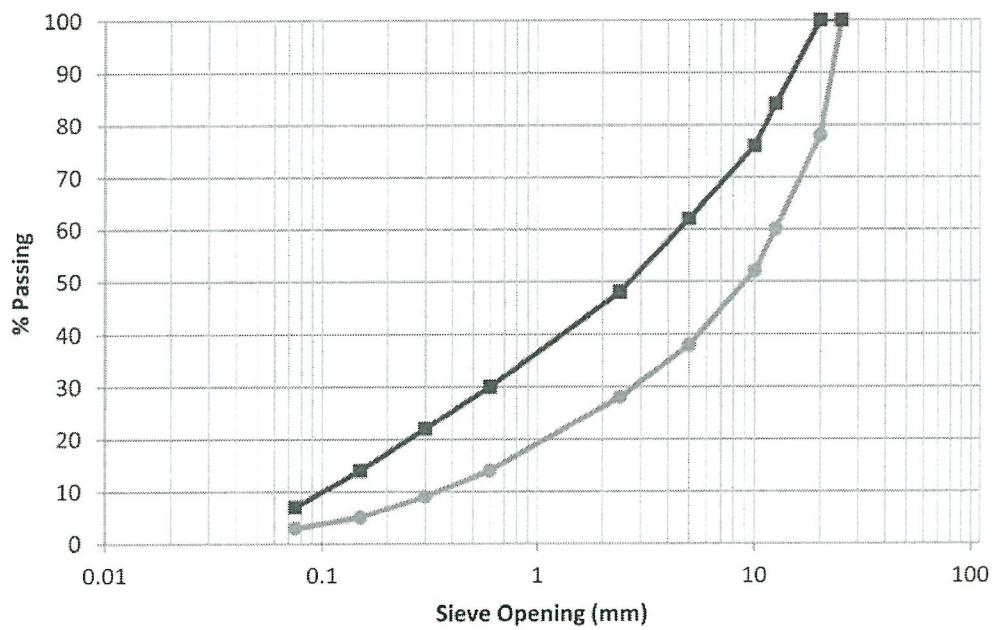
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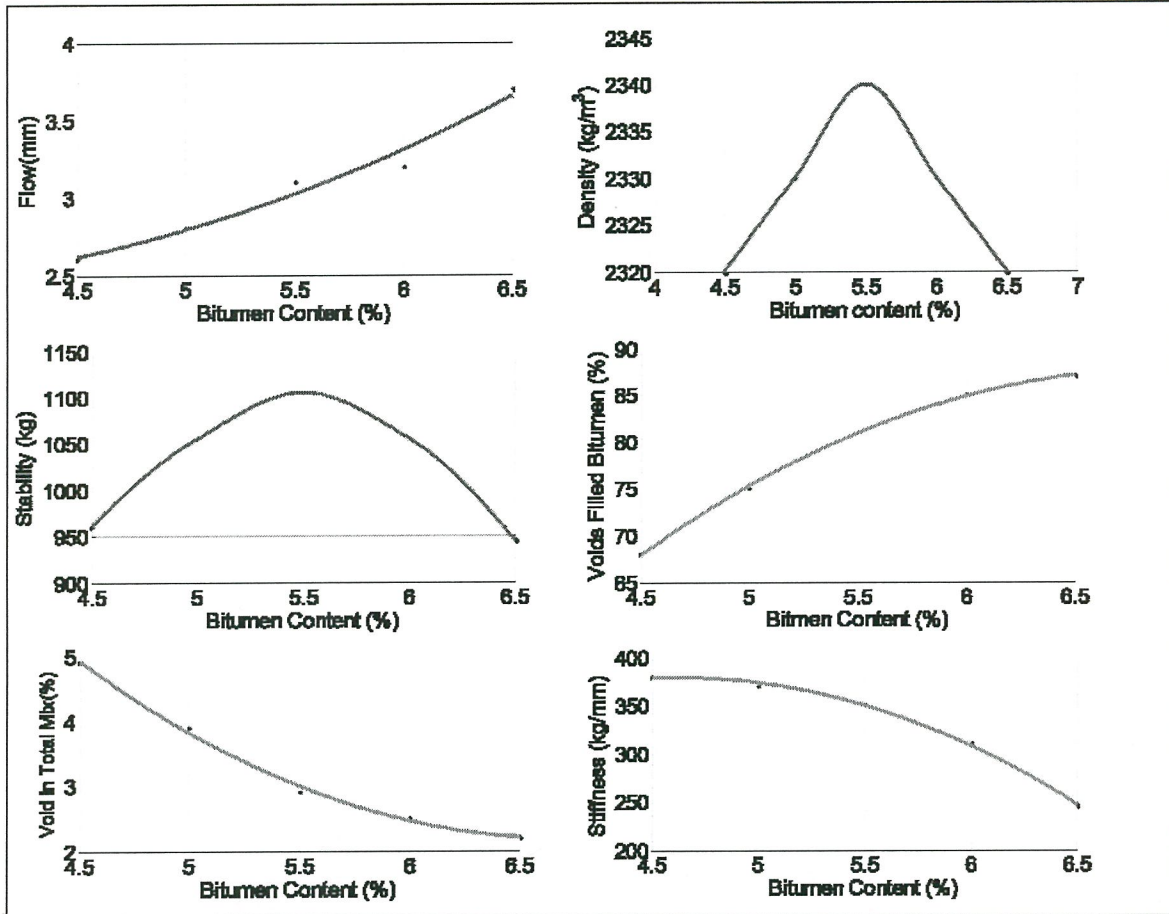
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Table 2: Test and Analysis Parameter

Parameter	Wearing Course	Binder Course
Stability	>8000 N	>8000 N
Flow	2.0 – 4.0 mm	2.0 – 4.0 mm
Stiffness	>2000 N/mm	>2000 N/mm
Air voids in mix (VTM)	3.0%-5.0%	3.0%-7.0%
Voids in aggregates filled with bitumen (VFB)	70 – 80 %	65 – 75 %

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

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

$$\text{Degree of Compaction} = \frac{\rho_d}{\text{Max. dry density}} \times 100$$

$$ESAL = EF \times \sum Trucks$$