Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	PAVEMENT ENGINEERING
COURSE CODE	:	BFT 40203
PROGRAMME	:	BFF
EXAMINATION DATE	:	JULY 2020
DURATION	:	6 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) State differences between Equivalent Standard Axle Load (ESAL) and truck factor.
(3 marks)

(b) Describe a consideration in flexible pavement design procedure where the designed was primarily based on empirical or experience.
(6 marks)

(c) Flexible pavement was constructed by a bitumen and granular materials based on mechanistic-empirical method. Based on that statement, discuss method of design and sketch a loading distribution,which under wheel load to pavement structure.
(6 marks)

(d) A circular load having 6 in. (152 mm)radius and 80 psi (552 kPa) uniform pressure was applied on a two-layer system with a Poisson's ratio is 0.5 and hot mix asphalt elastic modulus 500,000 psi (3.45 GPa) as shown in **Figure Q1(d)(i).** The subgrade (soil) elastic modulus 5,000 psi (35 MPa) can support 8 psi (55 kPa) maximum vertical stress. Refer **Figure Q1(d)(ii)** in your calculation.

(i) Calculate the required thickness of a full-depth pavement.
(5 marks)

(ii) If a thin surface treatment applied on a granular base with elastic modulus 25,000 psi (173 MPa), calculate the thickness of base course.
(5 marks)

Q2 (a) Explain the mechanistic-empirical method in pavement design.
(3 marks)

(b) State how to evaluate the pavement serviceability in flexible pavement design according to the American Association of State Highway and Transportation Officials (AASHTO) design method.
(3 marks)

(c) A total load of 20,000 lb (89.0 kN) was applied on the surface of a two layer system through a rigid plate 12 in. (305 mm) in diameter as shown in **Figure Q2(c)(i).** Layer one has a thickness of 8 in. (203 mm) and layer two has an elastic modulus of 6,400 psi (44.2 MPa). Both layers are incompressible with a Poisson ratio of 0.5. If the deflection of the plate due to loading is 0.1 in. (2.54 mm), calculate the elastic modulus of layer one. Refer **Figure Q2(c)(ii)** in your calculation.
(6 marks)

(d) South-North freeway with a three lane carriageway constructed with a full-depth asphalt pavement thickness 8 in. (203 mm) carried a 9,000 lb. (940 kN) wheel load on over a set of dual tires with a center to center spacing of 11.5 in. (292 mm) as shown in **Figure Q2(d)(i).** Refer **Figure Q2(d)(ii)** and **Q2(d)(iii)** in your

calculation.
If each single wheel load contact pressure 67.7 psi (467 kPa) applied on pavement surface layer;

(i) Calculate the circular area of radius.

(5 marks)

(ii) Based on your answer in **Q2(d)(i),** estimatethe critical tensile strain in the asphalt layer.

(12 marks)

Q3 (a) Briefly discussthe causes corrosion of concrete reinforcement in rigid pavement.

(3 marks)

(b) Discuss the phenomenon of pumping and its effects on rigid pavement.

(6 marks)

(c) Rigid pavements are exposed to concrete reinforcement corrosion that damage and spalling in reinforced concrete structures and may influence the durability of concrete.

(i) With aid of a diagram, explain in details the causes of the reinforcement corrosion.

(8 marks)

(ii) Discuss on how to prevent the reinforcement corrosion in rigid pavement.

(8 marks)

Q4 (a) Hinge or warping joints is serious problem that can lead to serve roughness in a degree of flexibility concrete slab. A daily curling and warping induce critical stresses and cracking in rigid pavement slabs. With the aid of diagrams;

(i) Explain in details the curling and warping in jointed concrete pavement.

(8 marks)

(ii) Propose the most required appropriate solution how to prevent the serious warping or curling stress.

(8 marks)

(b) Increasing emissions and awareness on issues related to global climate change have forced road pavement engineers to consider reusing the materials in existing distressed pavements, rather than to open up new quarries and import material to reconstruct the road pavement. Propose and explain in details the method and typical process involves to restored the road pavement layer.

(9 marks)

- END OF QUESTIONS –

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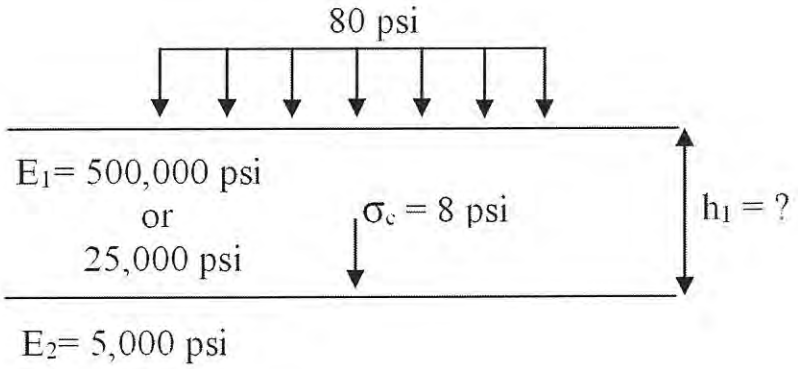

FIGURE Q1(d)(i): A two-layer pavement structure system

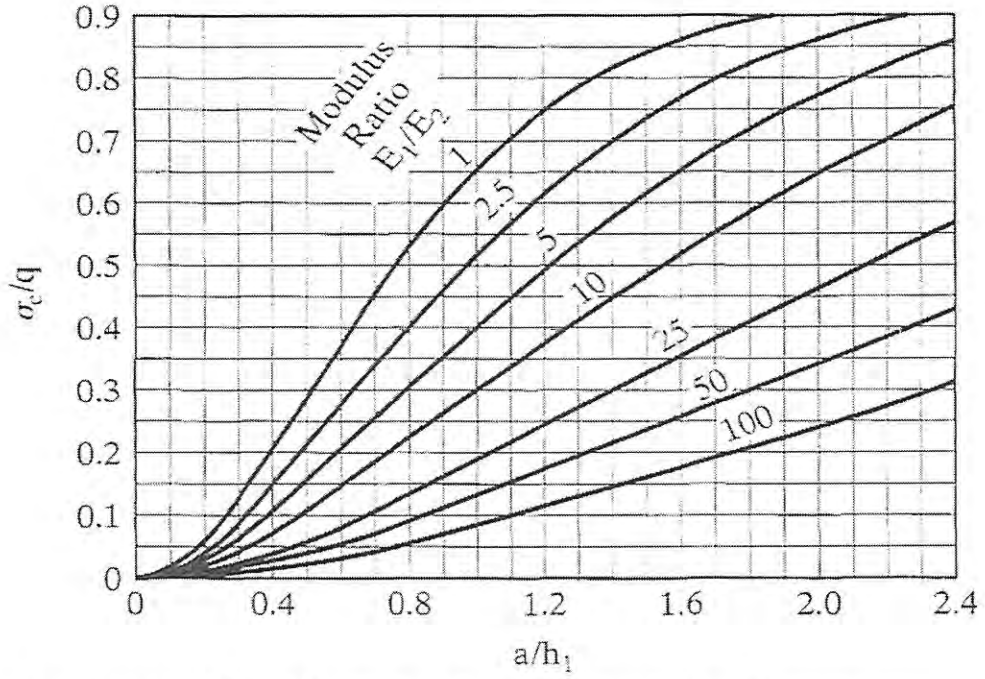

FIGURE Q1(d)(ii): Vertical surface deflection for two-layer systems (Burmister, 1943)

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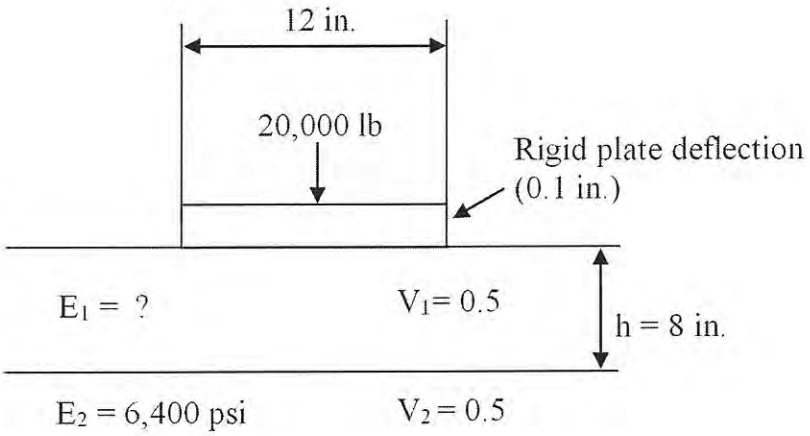

FIGURE Q2(c)(i): Load applied on the surface of a two-layer system through a rigid plate

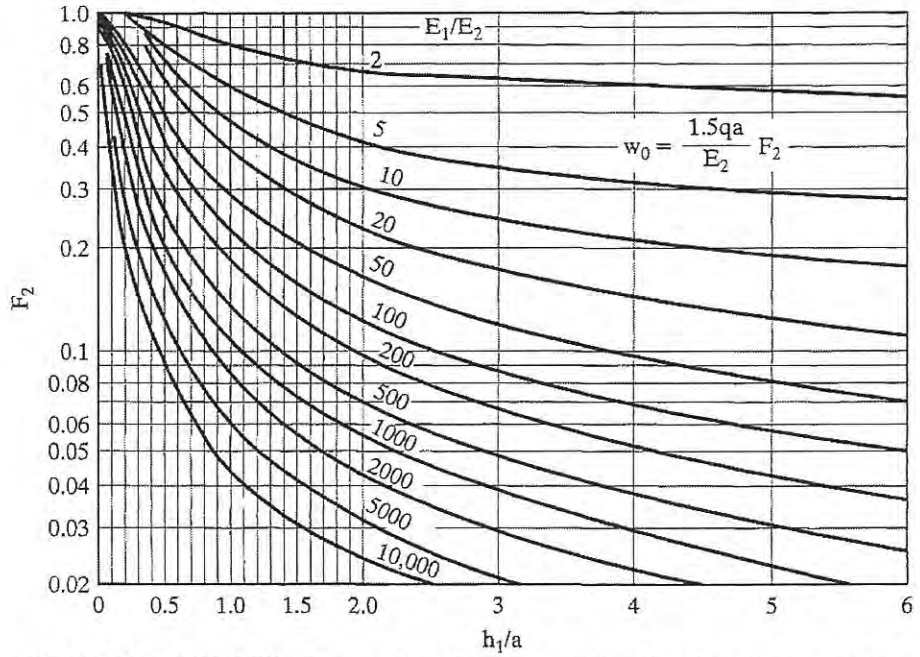

FIGURE Q2(c)(ii): Vertical surface deflection for two-layer systems

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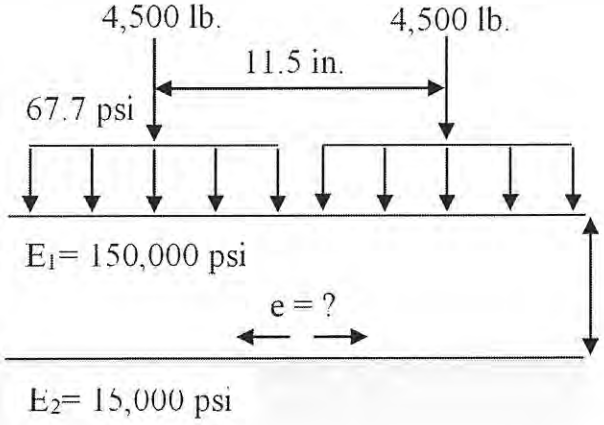
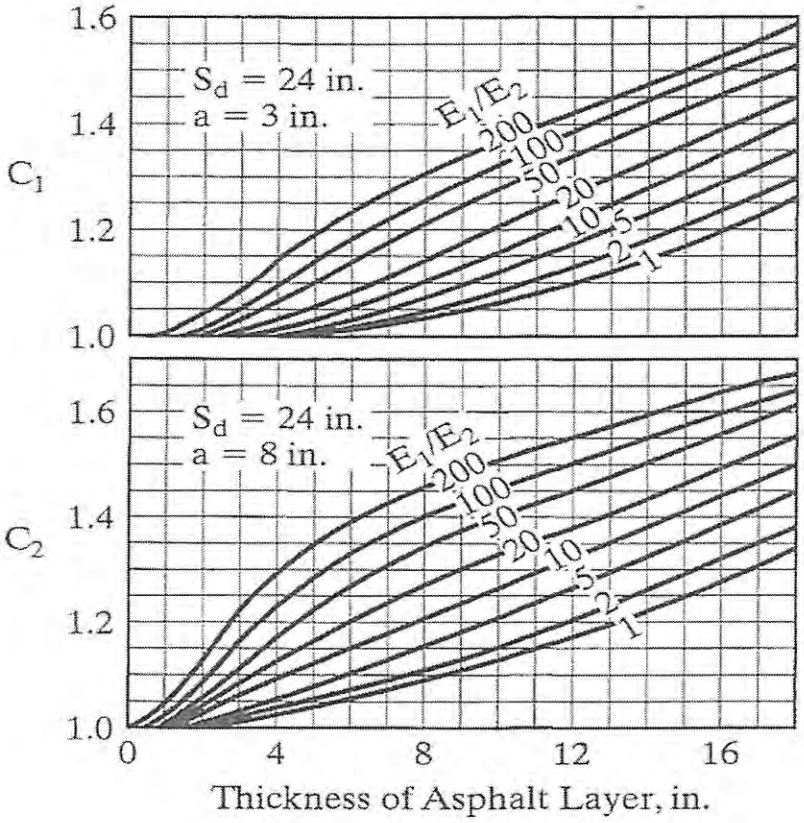


FIGURE Q2(d)(i): A two-layer pavement surface system



FIGUREQ2(d)(ii): Conversion factor for dual wheel (Huang, 1973)

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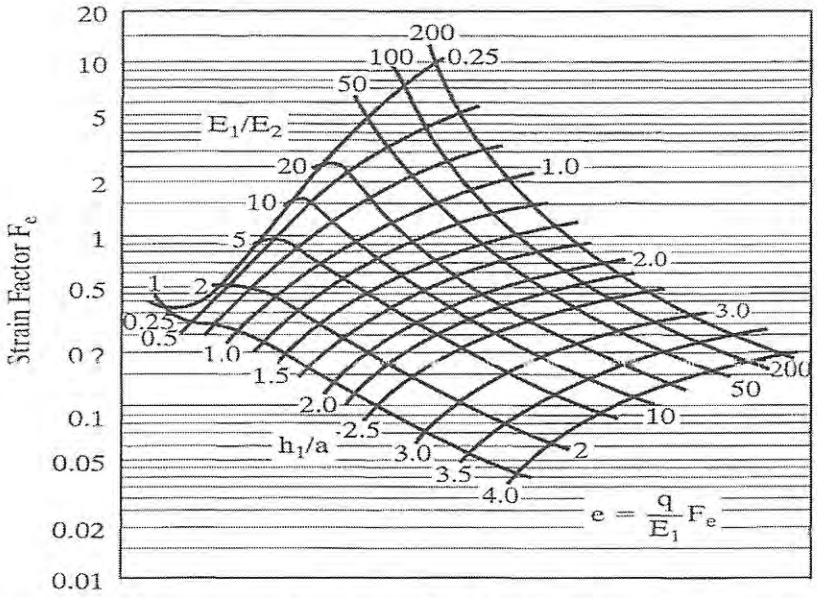

FIGURE Q2(d)(iii): Conversion factors for full depth pavementswheel (Huang, 1973)

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Formulae:

$$ESAL = (ADT)_0(T)(T_r)(G)(365)$$

$$M_r = 1500CBR$$

$$u_f = 1.18\times10^8 M_R^{-2.32}$$

$$\sigma_x = \frac{E\alpha_t\Delta_t}{2(1-v^2)}(C_x + vC_y), \quad \sigma_z = p\left[1 - \frac{z^3}{(a^2+z^2)^{\frac{3}{2}}}\right], \quad e = \frac{q}{E_1}F_e$$

$$\ell = \left[\frac{Eh^3}{12(1-v^2)k}\right]^{0.25}, \quad \frac{L_x}{\ell}, \quad w_0 = \frac{2(1-v^2)pa}{E}$$

$$a = \sqrt{\frac{P}{i\pi}}, \quad \frac{\sigma_c}{q}, \quad \frac{E_1}{E_2}, \quad q = \frac{P}{A}, \quad w_0 = \frac{1.18qa}{E_2}F_2,$$

$$\sigma = \frac{CE\alpha_t\Delta_t}{2}, \quad a' = \frac{24}{S_d}a, \quad h_1 = \frac{24}{S_d}h_1, \quad C = C_1 + 0.2\,x\,(a-3)(C_2 - C_1)$$

$$\frac{a}{h_1}, \quad h_e = \sum_{i=1}^{n} h_i C_i E_i$$