

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2022 SESSION

Open-book examination
Calculators: only authorized models
Duration : 3 hours

16-CI-A6 PAVEMENT DESIGN, CONSTRUCTION AND MAINTENANCE

This is a three hours exam. It includes five (5) questions for a total of 100 points. Structure and detail your answers clearly.

Question 1: (12 points)

Describe the characteristics of pavement condition used to evaluate whether a pavement should be rehabilitated, and if so, determine the appropriate treatment required.

Question 2: (13 points)

Describe the techniques used to repair flexible pavements and their effectiveness for the following treatment types:

- a) Patching;
- b) Crack maintenance;
- c) Overlay.

Question 3: (25 points)

A flexible pavement is constructed with 225 mm (8.86 inches) wearing surface of hot-mix asphalt with high rut resistance, 275 mm (10.83 inches) of recycled mixture base (MR5 with emulsion) and 1075 mm (42.32 inches) of crushed stone (MG112) subbase.

The subgrade has an effective roadbed soil resilient modulus of 20 MPa (2900 psi), and m_2 and m_3 are equal to 0.8 for the base and subbase.

The overall standard deviation is 0.45, the initial PSI is 4.25 and the TSI (terminal serviceability index) is 2.5.

The materials properties are as follows:

- Resilient modulus of HMA = 3 592 MPa (or 521 000 psi);
 - Resilient modulus of base (MR5 with emulsion) = 146 MPa (or 21 175 psi);
 - Resilient modulus of subbase (MG-112) = 74 MPa (or 10 700 psi);
- a) How many 18-kip (80-KN) single-axle loads can be carried before the pavement reaches its TSI (terminal serviceability index) if you wanted to be 90% confident that your estimate was not too high.
- b) Considering a total average daily 18-kip ESAL of 3 215, how many years would you estimate this pavement would last (how long before its PSI drops below a TSI of 2.5).
- c) How many years would you estimate this pavement would last if you wanted to be 99% confident.

Question 4: (25 points)

An equal-tangent vertical curve is to be constructed between grades of -1% (initial) and +2% (final). The PVC (the initial point of the curve) is at station 1+000.00 and at elevation 100.00 m.

Due to a street crossing the roadway, the elevation of the roadway at station 1+100.00 must be at 99.50 m.

- a) Determine the length of curve required.
- b) Determine the elevation and stationing of the PVT (the final point of the vertical curve) and the low point.

Question 5: (25 points)

Two drivers each have a reaction time of 2.5 seconds. One is obeying a 90 km/h speed limit, and the other is travelling illegally at 108 km/h.

How much distance will each of the drivers cover while perceiving/reaction to the need to stop, and what will the total stopping distance be for each driver (using practical stopping distance and assuming roadway grade $g = -2.5\%$).

Longitudinal friction coefficient (f_L) can be calculated by the equation $f_L = 1.0371 * V^{-0.2729}$ where V vehicle speed in km/h.