THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY (CIVIL) - LEVEL 4
FINAL EXAMINATION - 2015/16

00042

CEX4236 - HIGHWAY ENGINEERING

Time allowed : Three hours

Date : Tuesday, 22nd November 2016   Time : 9:30 - 12:30

Answer any <u>five</u> (05) questions. All questions carry equal marks. Write down your Index Number clearly on the answer script.

01. Traffic accidents cost our nation largely in both human and financial terms.

(a). Describe the following in relation to road safety, using sketches where necessary. Accidents due to (i) poor pedestrian behaviour, (ii) poor mechanical condition of vehicles, and (iii) bad road conditions.

(06 marks)

(b). Name the <u>four</u> (04) categories of road accidents, briefly explaining each of them.

(08 marks)

(c). Briefly explain what a 'collision diagram' means, and describe how it can be used to reduce accidents on a particular stretch of road.

(06 marks)

02. Write down the formula that can be used to determine the cumulative number of standard axles used for pavement design, explaining each of the terms involved.   (04 marks)

Design a flexible pavement with 'wet mix and dry bound macadam' surfacing for a two-lane road leading to a warehouse complex where the subgrade has a CBR value of 3%. The daily traffic is expected to be 80 passages of 4-axle vehicles with 3000 kg on the front axle, 5000 kg on the second axle, and 8000 kg each on the two rear axles; 100 passages of 3-axle vehicles with loads of 2500 kg on the front axle, and 10000 kg each on the two rear axles; and 120 passages of 2-axle vehicles with loads of 3000 kg on the front axle, and 7000 kg on the rear axle. Design the road for a life of 20 years assuming 4% annual growth of traffic. You may use the design curves indicated in Figures 1 and 2 given in next page.

Find the required thicknesses of (i) sub base, (ii) base, and (iii) surfacing.

Assume the following equivalence factors for different axles in the three types of vehicles.

(a). 4-axle vehicles Equivalence factor
   Front axle = 0.015,   Second axle = 0.65, and Two rear axles = 2.00

(b). 3-axle vehicles Equivalence factor
   Front axle = 0.004, and Two rear axles = 1.50

(c). 2-axle vehicles Equivalence factor
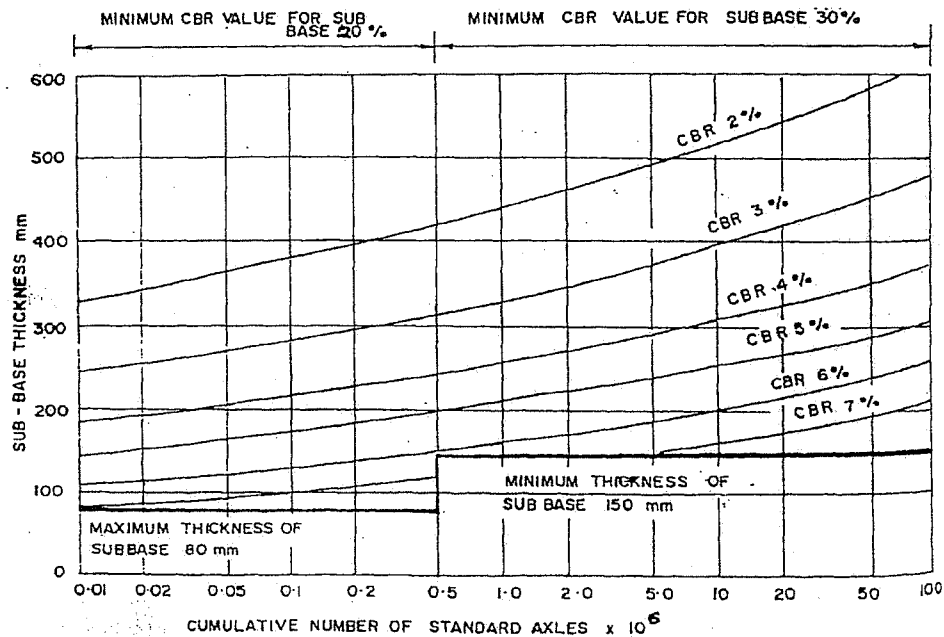   Front axle = 0.009, and   Rear axle = 0.90

(16 marks)

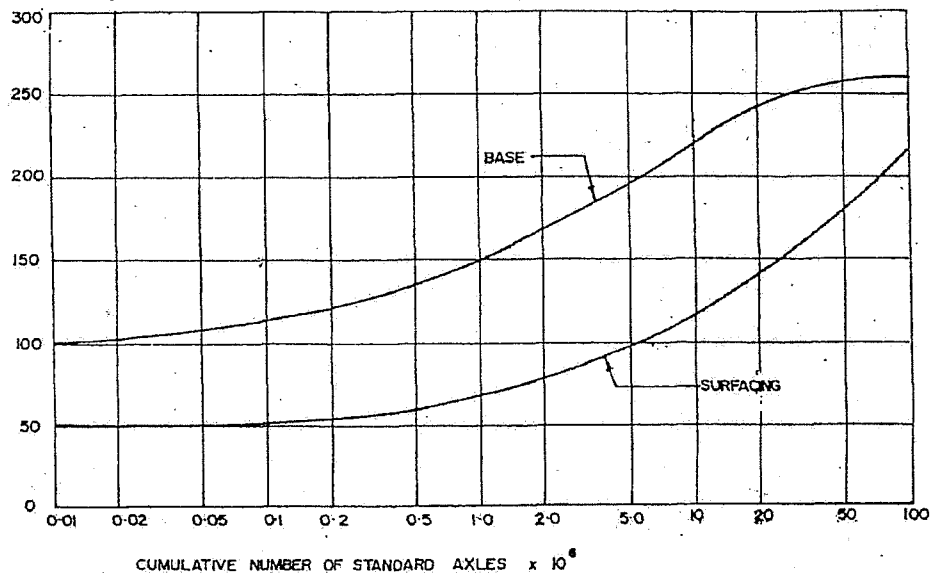**Figure 1** – Flexible Pavement Design Curves for Sub Base

Figure 2 – Flexible Pavement Design Curves for Base and Surfacing Base Material – Wet Mix and Dry Bound Macadam

03.

(a) Describe what is meant by:
(i)Time Mean Speed (TMS) and (ii) Space Mean Speed (SMS)

The spot speeds of vehicles at a location on a road in open country were measured with the help of a radar gun. Following spot speeds were measured of 10 vehicles passing a particular observation point.
40 km/h, 45 km/h, 42 km/h, 38 km/h, 48 km/h, 48 km/h, 35 km/h, 50 km/h, 52 km/h, 35 km/h.

Calculate (i) Time Mean Speed (TMS) and (ii) Space Mean Speed (SMS) of these 10 vehicles at this site.

(08 marks)

2

(b). Another survey of Spot speeds was conducted on a road under free flowing conditions. The results of 100 vehicles are shown in table below.

Speed Range (km/h)		Number of
Greater or equal to	Less than or equal to	Vehicles observed
30	39	05
40	49	09
50	59	16
60	69	26
70	79	24
80	89	17
90	99	03

Draw the (i) histogram and frequency distribution curve, and (ii) cumulative distribution curve (ie., cumulative frequency curve) for above results.

(06 marks)

From the above curves find the (i) modal speed, (ii) average speed, (iii) 15% and 85% percentile speeds.

(06 marks)

04.

(a). Level of service is associated with different operating conditions that occur on a road when it accommodates various traffic volumes. List five (05) factors which might be considered in evaluating level of service.

(05 marks)

(b). Draw a neat sketch indicating the relationship between the operating speed and volume/capacity envelope. Also indicate the six (06) levels of service inside this envelope.

(05 marks)

(c). Describe what is meant by 'Service volume' for a particular level of service.

(04 marks)

(d). Explain what is meant by (i) Sight distance, and (ii) Stopping site distance.

(06 marks)

05.

(a). Culverts are structures used to facilitate passing drainage water under the roadway when water paths cross it. With the help of a clear diagram indicate all the important features, both up-stream and down-stream, of a culvert.

(06 marks)

(b). Explain the terms (i) outlet control, and (ii) inlet control conditions that are considered in design of culverts. You may draw clear illustrations to explain the difference.

(08 marks)

(c). A culvert has to be designed to discharge 3.0 m³/s. The inlet is submerged, while the outlet is free. The headwater level should not rise more than 1.2 m from the centre of the culvert inlet. Determine the size of a suitable precast concrete pipe. You may consider coefficient of discharge as 0.62 and acceleration due to gravity as 9.81 m/s²

(06 marks)

06.

As a person working in a road rehabilitation project, you are required to have an adequate knowledge of the modern surface laying methods, equipment that are used, and their proper usage, depending on the type of construction and expected function of the road.

(b) List different types of surface applications that are available in modern day road surface construction and discuss for what purposes they can be used. (06 marks)

(b). Explain the steps involved in carrying out a (i) Single Base Surface Treatment (SBST), and (ii) Double Base Surface Treatment (DBST) dressing for a road surfacing process.

(07 marks)

(c). Explain the difference between a 'seal coat', and a 'tack coat' as road surface treatments. Discuss also the advantages and disadvantages of the two types of coats.

(07 marks)

07.

(a). What are the main factors taken into consideration when roads are classified?

(05 marks)

(b). Explain the main differences between an 'expressway' and a 'main arterial road'.

(05 marks)

(c). Discuss the advantages and disadvantages of the three-wheeler as an urban passenger-carrying vehicle in a developing country. (05 marks)

(d). Discuss suitable measures that can be used to enhance cycling as a proposed mode of transport for short trips (less than 20km) in flat terrain coastal areas.

(05 marks)

08.

(a). Briefly discuss the various types of bridges that are available for river crossings and connecting hilly areas, explaining their suitability to different conditions such as terrain, river width, river depth, ground conditions, bed rock levels, high flood level and river usage.

(12 marks)

(b). Explain the basic concept of composite beams, used in bridges.

(08 marks)