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THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY (CIVIL) - LEVEL 4
FINAL EXAMINATION - 2012/13

CEX4236 - HIGHWAY ENGINEERING

Time allowed : Three hours

Date : Sunday, 28th July 2013 **Time : 9:30 - 12:30**

Answer any five (5) questions. All questions carry equal marks. Write down your Index Number clearly on the answer script.

01. A spot speed survey was conducted at a site beyond Kottawa along Colombo Avissawella road with the view to impose a speed limit, in order to reduce the high accident rate on this stretch. Following are the spot speeds (in km/h) recorded in the vicinity. :

52	46	58	61	63	34	75	39	55	78
48	64	51	52	44	62	63	52	58	42
55	72	69	55	52	35	61	55	59	65
51	76	64	44	38	42	78	72	66	47
56	59	40	50	44	68	72	44	46	60
75	49	75	65	50	38	58	52	51	59
54	70	60	77	48	59	52	78	62	35
45	39	42	50	55	55	51	36	40	58

Group the results into 10km/h speed intervals and plot the following :

(i). The histogram and frequency distribution curve of the spot speeds. (04 marks)
(ii). Cumulative distribution curve (ie., cumulative frequency curve). (04 marks)

From the above curves calculate,

(a) the range of speeds (02 marks)
(b) the median speed. (02 marks)
(c) the 15 percentile speed. (02 marks)
(d) the 85 percentile speed. (02 marks)
(e) the mode of frequency distribution curve of spot speeds. (02 marks)
(f) the suggested speed limit, giving reasons. (02 marks)

02.

Describe the following (with sketches where necessary)

(a). 'Zoning' in origin destination surveys. (04 marks)

(b). Road pricing. (04 marks)

(c). Stopping sight distance. (04 marks)

(d). Reversible lane (or tidal flow) operation. (04 marks)

(e). Collision diagrams. (04 marks)

03. (a). When planning a road network for a particular area, there are several road patterns or layouts that may be used as guidelines. With the help of neat diagrams indicate three (3) such patterns that could be used to fit a road network in a region under consideration.

(06 marks)

(b). Let us assume that there is a region that has to be developed and two (2) road systems are proposed to suit the development plan as indicated below. Calculate the agricultural, industrial and average utility factors for the two proposals separately. Based on your results indicate which proposal should be considered for implementation.

Proposal	Total Road Length (km)	Number of Population Centres with Population of		Productivity per Year	
		0 to 5000	5000 to 10000	Agriculture (Tonne)	Industry (Tonne)
A	990	35	45	90	120
B	1050	30	50	100	80

Use the following units for your calculations:

Every 5 tonnes of agricultural produce to be assigned one unit.
Every 10 tonnes of industrial produce to be assigned one unit.
Population group - 00 to 5000, take as 0.5 unit.
Population group - 5000 to 10000, take as 1.0 unit.

(10 marks)

(c). List the main factors taken into consideration when roads are classified and briefly describe them.

(04 marks)

04.

(a). Draw a typical cross-section of a 2 lane dual carriageway (ie., 2 lanes in each direction) road in a (i) cut-section (ii) fill-section. Label all the important components of sections.

(04 marks)

(b). Describe the following elements of a highway cross-section
(i). Right of way of the road
(ii). Formation width
(iii). Width of pavement or carriageway.
(iv). Type of carriageway

(08 marks)

(c) Indicate on a neat sketch the forces acting on a vehicle travelling along a super elevated curved section of the highway by using standard notations. Write an expression for the outward force and derive an expression for the speed of the vehicle with respect to radius of the curve, super elevation and coefficient of lateral friction.

(04 marks)

(d) When a carriageway is to be widened on a curve, what are the four main considerations to be taken in to account?

(04 marks)

05. (a). Name the three (3) main types of 'time limit parking schemes' and briefly describe each type. (06 marks)

(b). When introducing 'time limit parking schemes' it should aim at achieving certain objectives. Briefly describe three (3) objectives that we should have in mind when introducing a time limit parking scheme. (03 marks)

(c). List and describe the three (3) different types of peripheral car park developments that are commonly used in developed countries. (06 marks)

(d). State five (5) factors that should be considered in locating of entrances and exits of parking areas. (05 marks)

06. 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 4%. The daily traffic is expected to be 100 passages of 4-axle vehicles with 3000 kg on the front axle, 6000 kg on the second axle, and 9000 kg each on the two rear axles; 120 passages of 3-axle vehicles with loads of 2000 kg on the front axle, and 9000 kg each on the two rear axles; and 150 passages of 2-axle vehicles with loads of 2500 kg on the front axle, and 8000 kg on the rear axle. Design the road for a life of 20 years assuming 3% annual growth of traffic. You may use the design curves indicated in Figures 1 and 2.

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 = 1.55

(c). 2-axle vehicles Equivalence factor
Front axle = 0.009, and Rear axle = 0.90 (16 marks)

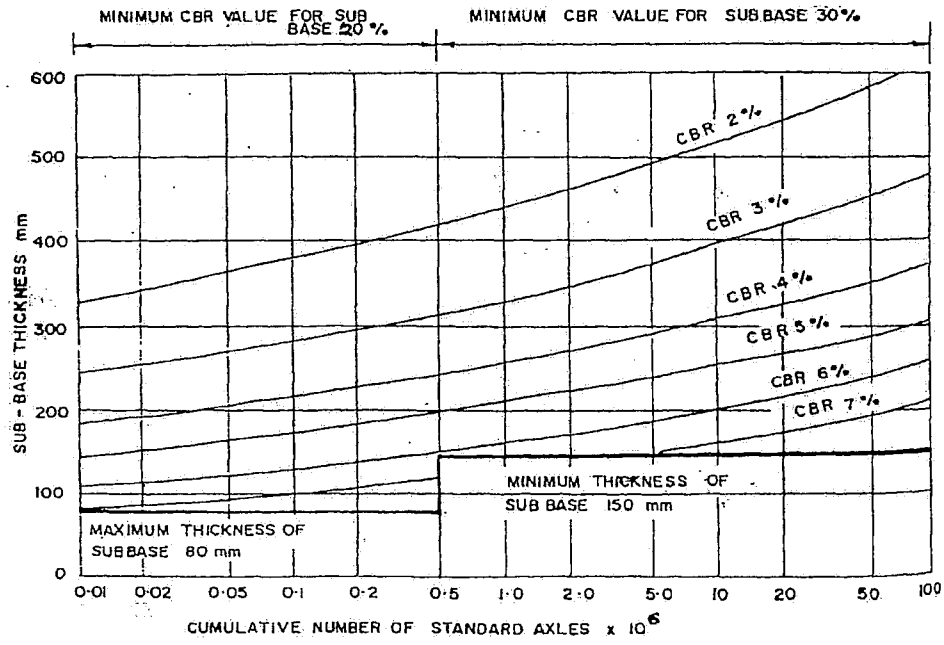

Figure 1 – Flexible Pavement Design Curves for Sub Base

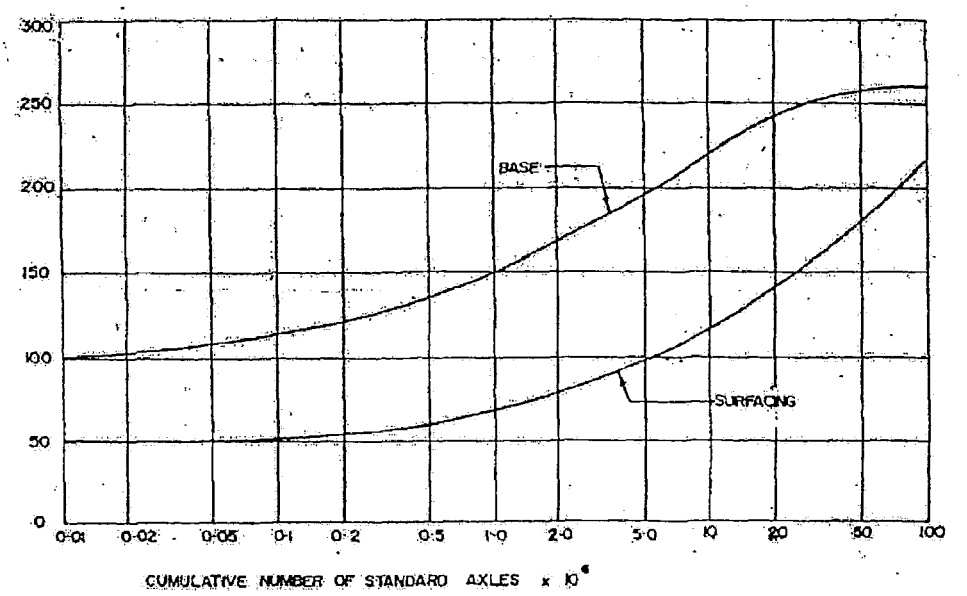

Figure 2 – Flexible Pavement Design Curves for Base and Surfacing Base Material – Wet Mix and Dry Bound Macadam

07.

(a) Distinguish between 'bitumen emulsions' and 'cut-back bitumen'. (06 marks)

(b) What do you understand by 80/100 grade of bitumen based on penetration test? (04 marks)

(c) Explain briefly the penetration test carried out to evaluate the consistency of bitumen, illustrating the type of apparatus used in the laboratory, and indicate the standard values used in the test. (06 marks)

(d) Based on a penetration test results what is indicated by (a) lower penetration value, and (b) higher penetration value? (04 marks)

08.

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

(a) List <u>six</u> (6) types of surface applications that are available in road surface construction and briefly 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. (05 marks)

(c). Discuss the advantages and disadvantages of an Asphaltic concrete surfacing when laid on a heavily trafficked road. (05 marks)

(d). Explain the difference between a 'seal coat', and a 'tack coat' as road surface treatments. (04 marks)