Indian Institute of Engineering Science and Technology, Shibpur
ME (Civil) Second Semester Examinations, April-May, 2014
Advanced Pavement Design (CE-1039)\

Time: 3 hours Full Marks: 70

Answer **Five** Questions
*Taking at least **one** from Group-A, at least **one** from Group-B, and, at least **two** from Group C*

Group-A

1.(a) It is proposed to widen an existing two-lane National Highway section to 4-lane divided road. Calculate the cumulative number of standard axles to be catered for in the design with the following data :
Initial traffic in each direction in the year of completion of construction: MAV = 100 per day, 3-Axle Truck = 150 per day, 2-Axle Truck = 200 per day, Bus = 50 per day, Design life is 15 years, Traffic growth rate: MAV = 4%, 3-Axle Truck = 8%, 2-Axle Truck = 6%, Bus = 9%, VDF: MAV = 4.5, 3-Axle Truck = 4.0, 2-Axle Truck = 3.5, Bus = 2.5
(b) An axle load survey was carried out on a two lane state highway using static axle weigher on a typical working day. The field data is tabulated below. Obtain the axle load spectrum. Also, find the expected repetitions of the different single axle and tandem axle if the total two-way traffic is 2500 commercial vehicles per day at the end of the construction period. Assume any other data suitably. (7+7)

Axle Configuration	1st Axle(kg)	2nd Axle(kg)
1.2	7700	13100
1.2	6700	18400
1.2	8300	18200
1.2	7300	18700
1.2	7600	7500
1.2	7200	17100
1.2	6600	18800
1.2	6600	10600
1.2	5400	19900
1.2	6600	10800
1.2	7500	16500
1.2	6500	12300
1.2	6700	13000
1.2	7000	8400
1.2	6700	11000
1.2	7200	9900
1.2	7000	10100
1.2	5600	7300
1.2	7000	8400
1.2	6700	11000
1.2	7200	9900

Axle Configuration	1st Axle(kg)	2nd Axle(kg)	3rd Axle(kg)
1.22	7380	8500	9400
1.22	7200	11700	12600
1.22	7200	10300	10300
1.22	7200	9300	9800
1.22	6000	9600	10400
1.22	7200	9900	9200
1.22	9800	10000	9700
1.22	8600	8500	6800
1.22	7000	9600	7100
1.22	6800	7200	7700
1.22	7000	8900	7900
1.22	6400	10200	9000
1.22	5400	9500	9200
1.22	7500	10100	9900
1.22	6600	11400	9900
1.22	5800	9100	7700
1.22	6100	10600	10000
1.22	7600	7800	7600
1.22	6600	10100	9400
1.22	5800	10400	9300
1.22	7400	10000	10300

2.(a) An inter-urban highway pavement composed of a Hot Mix Asphalt (HMA) surface course, a cement treated base course, and a sand-gravel subbase is to be designed for an ESAL of 1.2×10^6. The quality of drainage is considered fair because water can be removed from the subbase within a week. The material properties are as follows: effective roadbed soil resilient modulus = 5500 psi, resilient modulus of subbase = 15,000 psi, resilient modulus of base 35,000 psi, and resilient modulus of HMA = 4.3×105 psi. Determine the thickness of the surface, base, and subbase courses required. Assume any other data suitably.
(b) List the distresses for asphalt pavements along with their causes. What is the difference between pavement rutting and depression? Are the alligator cracks basically fatigue cracks by origin? (7+4+2+1)

Group-B

3.(a) Define Transportation Asset Management? Discuss on various steps of Highway Asset Management system with an example.
(b) What do you mean by asset performance measure? Discuss on various performance measures of highway assets.
(c) State the major characteristics of management of private assets and public assets. (2+4 +2x4)

4.(a) Explain why Pavement Management is considered as the history of serviceability.

4.(b) Discuss the important issues in decision making process of pavement performance management at i) administrative level and ii) technical level.
(c) Enumerate the general data requirement in Pavement Management system. (4+5+5)

Group-C

5.(a) "A complete slope stability computation based on limit equilibrium method of slices can be split up into two parts."--- Elaborate on the 'two parts' mentioned in this statement.
(b) Describe how you would determine the factor of safety of a finite slope (i) when the slope is partially or fully submerged; (ii) when there is a water-filled tension crack running parallel to the crest of the slope; and (iii) when the slope is subjected to a pseudostatic horizontal acceleration. (2+3 x 4)

6.(a) Define an 'infinite slope'. Can a real slope be analysed based on the concept of 'infinite slope'?
(b) Show a typical failure surface in an infinite slope and give reasons for such a shape.
(c) Show that in an infinite slope a conjugate stress relationship exists between the vertical pressure on a plane parallel to the surface of the slope and the lateral pressure on a vertical plane.
(d) Using Mohr circles, derive an expression for the conjugate stress ratio between the minimum lateral pressure and the vertical pressure. (4+2+4+4)

7.(a) Derive an expression for the factor of safely of an infinite slope of inclination β in a dry cohesive (c, ϕ) soil.
(b) Hence show that (i) for a stable slope in cohesionless soil, β cannot exceed ϕ; (ii) however, for a stable slope in cohesive soil, β can exceed ϕ, but only upto a critical depth $z = z_c$. (iii) Also derive an expression for z_c.
(c) Derive an expression for the factor of safely of a long hill slope subjected to steady seepage parallel to the slope surface and occurring throughout the slope. (3+6+

8.(a) In the slope stability analyses of finite slopes based on the limit equilibrium approach, how dose it help to discretize the sliding mass into a number of slices?
(b) With a neat sketch show the complete system of forces on a typical slice. Determine whether the problem is statically determinate. If not, what is the degree of indeterminacy? How would you handle the indeterminacy to obtain a solution?
(c) Using the notation in (b) above, derive a general expression for the factor of safely common to all approximate methods. Is there any assumption involved here? (2+2x6)

9.(a) Starting from the common expression for factor of safely for all approximate methods, derive expression for factors of safely using.(i) the Ordinary Method of Slices, and (ii) the Bishop Simplified Method.
(b) Why are the above methods called 'approximate methods'? With reference to 'rigorous' methods how accurate are the above two methods? (4+8+2)

10. What are the usefulness of stability charts? Describe Taylor's stability charts and give the steps for the determination of 'true factor of safety' from this chart. (14)

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