National Examinations – December 2012

98-Civ-B7, Highway Engineering

3 Hour Duration

NOTES

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.

2. Any data, not given but required, can be assumed.

3. This is an **"OPEN BOOK"** examination. Any non-communicating calculator is permitted.

4. A total of **five** solutions is required. Only the first five as they appear in your answer book will be marked.

5. All questions are of equal value.

1. The following information refers to a crest vertical curve:

   g1 = + 4 %
   g2 = - 2 %
   Design speed = 110 km/h
   K = L/A = 90 m
   Chainage of PVI is 0+400.000 (Each station is 1000 m)
   Elevation of PVI is 150.000
   Compute the elevations of the high point and even 50-m stations.

2. Calculate the storage capacity of a rectangular pond given the following:

   Bottom elevation 90.000 m with cross sectional dimensions 100 m x 50 m
   Top elevation 110.000 m with cross sectional dimensions 200 m x 100 m
   Straight sloping sides.
   What are the cross-sectional dimensions at elevations 95.000, 100.000, and 105.000?
   Use this cross-sectional data to calculate the storage capacity.

3. Determine
   (a) The aggregate bulk dry specific gravity
   (b) The aggregate apparent specific gravity
   (c) The percent moisture content of the aggregate
   (d) The percent absorption, given the following:

   Mass of moist aggregate sample = 5,300 g
   Mass of oven-dried aggregate = 5,210 g
   Mass of aggregates submerged in water = 3,300 g
   Mass of saturated surface dry aggregate = 5,230 g

4. The United States Federal Highway Administration's relationship for determining the distribution of aggregates that provides maximum density is given by the "0.45 power" law. On a semi-log aggregate gradation chart provided, draw a graph showing the proportions of the various aggregate sizes for a 19 mm maximum aggregate size (19, 12.5, 9.5, 4.75, 2.36, 1.18, 0.600, 0.300, 0.150 and 0.075 mm aggregate portions)

5. (a) State the ingredients of asphalt emulsions.
(b) State the ingredients of cutback asphalts.
(c) What re the uses of asphalt emulsions?
(d) What are the uses of cutback asphalts?
(e) Why is asphalt emulsion preferred over cutback asphalt?
(f) Explain how asphalt emulsions work as a binder in asphalt mixtures.
(g) Why is it important to have optimum binder content in HMA?
(h) What would happen if less than optimum binder content is used?
(i) What would happen if more than optimum binder content is used?
(j) Why is the strength of asphalt concrete not necessarily the most important criterion in asphalt mix design?

6. A horizontal circular curve has a radius of 400 m and a deflection angle of 12^0 00' with the point of intersection at Station 240.000 (Distance between the stations is 1000 m). Calculate
(a) The station of the beginning of the circular curve
(b) The station of the end of the circular curve
(c) If the layout is to proceed at 20-m intervals, calculate the deflection angle to the first even station, deflection angle to the last even station and the deflection angles to the even 20-m stations in between.

7. (a) The Rainfall Intensity Curves for the City of Toronto are given by the equation

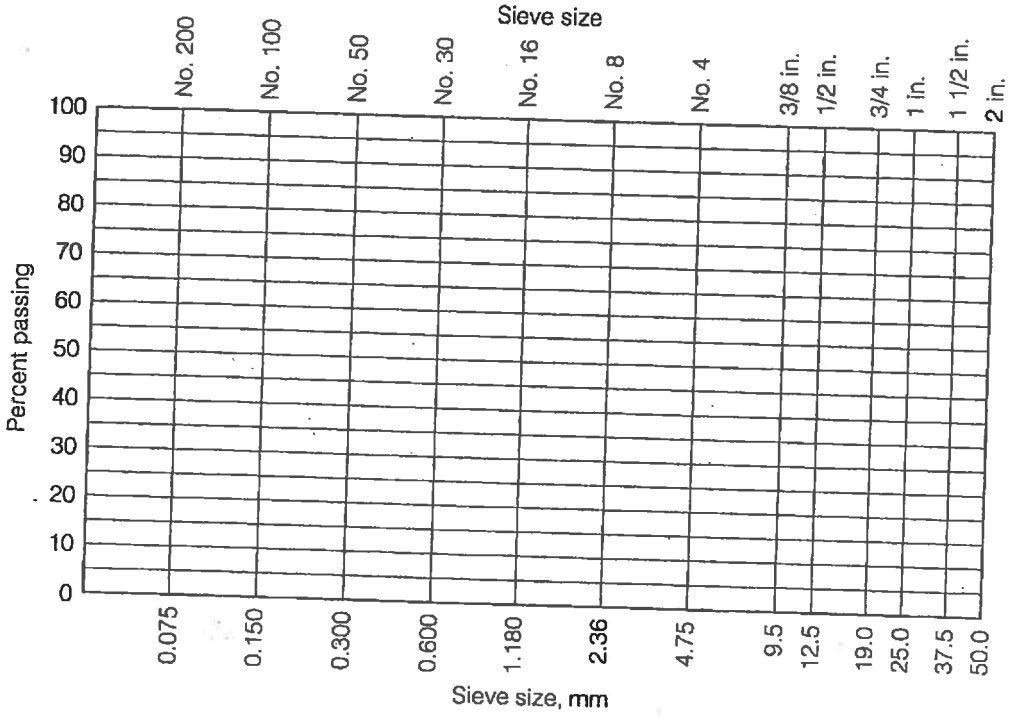
$I = A*T^c$ (i.e. A times T raised to the power of c)

I = Rainfall intensity (mm/h)
T = Time of concentration (hours)

For a return period of 100 years,
coefficient A = 59.7 and
exponent c = -0.80 (i.e., negative 0.80)

A culvert is being designed for a highway in the City of Toronto. The drainage area is 24 hectares in urban business district and the time of concentration is 30 minutes. If a water speed of 2 m/s is to be maintained, design a square culvert.

(b) A trapezoidal channel has a base of 2 m and side slopes of 1:1. A smooth asphalt lining is used and the channel slope is 3%. If the water speed is 10 m/s, determine the depth of water in the channel.



Semi-log aggregate gradation chart.