National Examinations – May 2015

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 required, but not given, 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.

Grading Scheme:

Question 1: (15+5) marks

Question 2: (12+2+4+2) marks

Question 3: (20) marks

Question 4: (8+12) marks

Question 5: (6+14) marks

Question 6: (20) marks

Question 7: (20) marks

1. (a) Given the end areas below, **calculate the volumes of cut and fill** between station 250+00 and Station 251+50 by the average end area method or the pyramidal volume as appropriate. The distance between the stations is **100 m**.

(b) If the material shrinks 10 percent, **how much excess cut or fill is there**?

Station	End area, m^2	
	Cut	Fill
250+00		60
250+50		50
250+75	0	25
251+00	10	5
251+15	15	0
251+50	35	

2. (a) **Write an essay on transverse joints, dowel bars, longitudinal joints, expansion joints, construction joints and tie bars with reference to unreinforced jointed concrete pavements.**

(b) **Write a paragraph on pumping of joints in concrete pavements.**

(c) **Write a paragraph each on the four different forms of asphalt –cutback asphalts, asphalt emulsions, asphalt primers and modified asphalts.**

(d) **What are the advantages of adding tire rubber to asphalt paving mix?**

3. **Design a flexible pavement for a four lane divided highway, given the following data:**

ESALs per day per direction = 900
Lane distribution = 80% outside lane and 20% inside lane
Design period = 20 years
Traffic growth factor = 3.5 %
Initial serviceability = 4.3
Terminal serviceability = 2.5
Reliability = 90%
Overall standard deviation = 0.40
Effective roadbed resilient modulus = 30 MPa

4. Given the following with respect to a horizintal curve:

PI = 12+78.230
R = 500 m
$\Delta = 86^0$

(a) **Detrmine the stationing of PC and PT.**

(b) **Calculate the deflection angles at full stations to layout the curve in the field.**

5. (a) A sample of wet aggregate weighed 310.0 N and its oven-dry weight is 280.0 N. If the absorption of the aggregate is 4.0%, **calculate the percent of free water in the original wet sample.**

(b) A concrete trapezoidal channel has a bottom width of 6 m and side slopes of 1 vertical to 2 horizontal. The channel has a 3-percent longitudinal slope and is flowing at a constant depth of 3 m throughout its length. **Using Manning's equation, calculate the volume of flow in cubic metres per day.**

6. A 300-m sag parabolic vertical curve has a PVC at station 2+600.000 and elevation 320.000 m. The initial grade is -4.0% (minus four percent) and the final grade is +1.0% (plus one percent).

Determine the stationing and elevation of PVI, PVT and the lowest point on the curve. Also calculate the stationing and elevation of the curve at -3%, -2%, -1 % and 0% grades.

7. 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.