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.