

**National Examinations – December 2014**  
**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+8) marks

Question 3: (20) marks

Question 4: (10+10) marks

Question 5: (10+10) marks

Question 6: (6+14) marks

Question 7: (5+15) marks

1. (a) Given the end areas below, calculate the volumes of cut and fill between station 351+00 and Station 352+50. The distance between the stations is 100 m.

(b) If the material shrinks 12 percent, how much excess cut or fill is there?

Station	End area, m <sup>2</sup>	
	Cut	Fill
351+00		57.93
351+50		52.28
351+75	0	23.58
352+00	8.40	3.73
352+14	13.80	0
352+50	33.34	

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 an essay on pumping of joints in concrete pavements.

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

ESALs per day per direction = 888

Lane distribution = 85% outside lane and 15% inside lane

Design period = 20 years

Traffic growth factor = 3%

Initial serviceability = 4.2

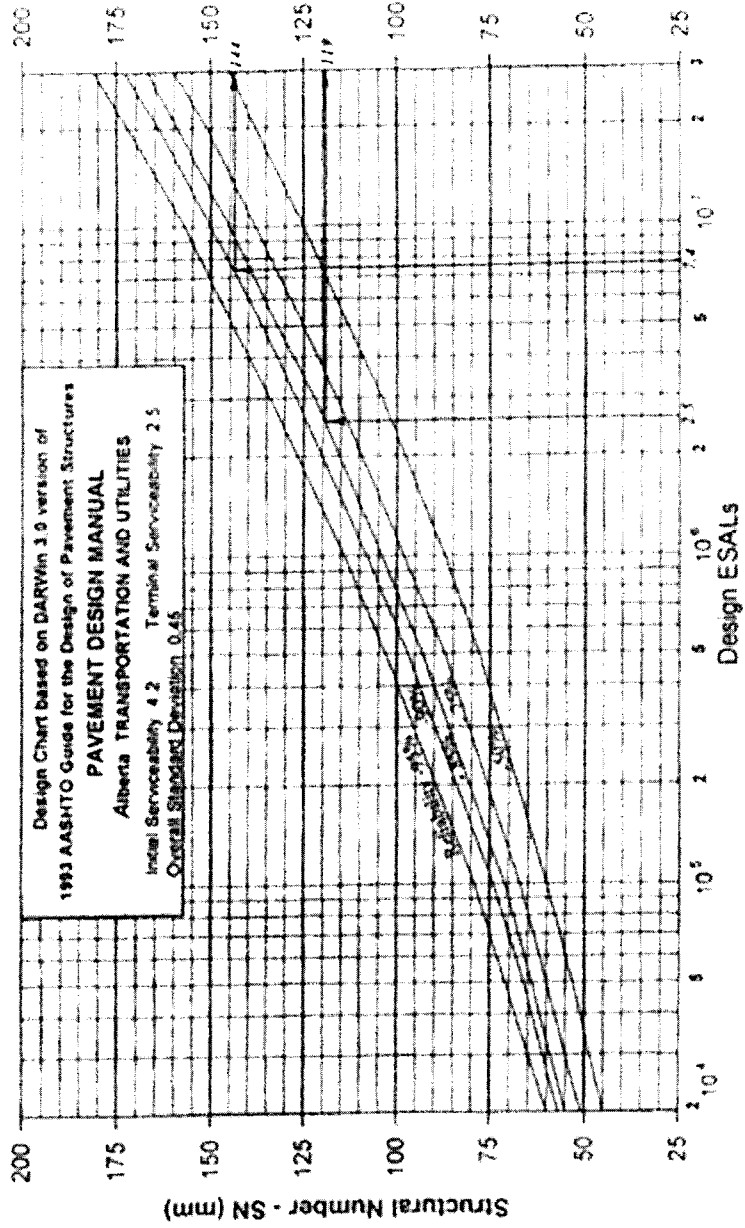
Terminal serviceability = 2.5

Reliability = 90%

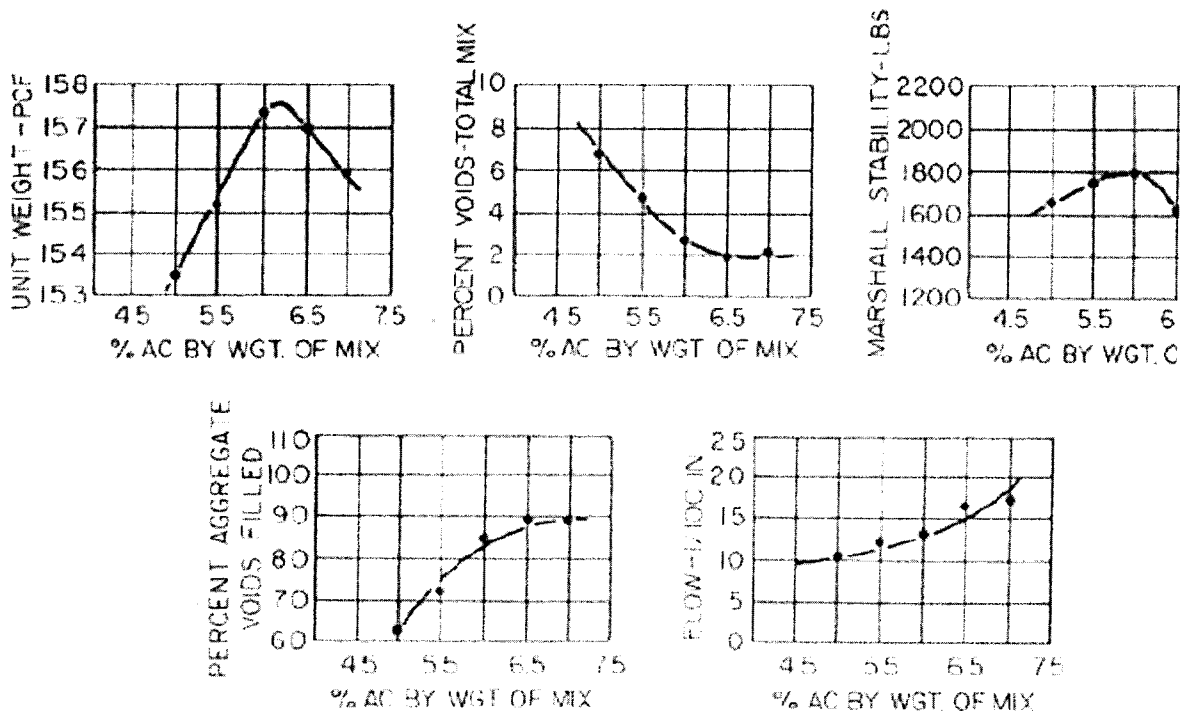
Overall standard deviation = 0.45

Effective roadbed resilient modulus = 30 MPa

Structural Number for Effective Roadbed Resilient Modulus of 30 MPa



4. (a) List the merits and limitations of
- (i) the Marshall Mix Design Method
  - (ii) the Hveem Mix Design Method, and
  - (iii) the Superpave Volumetric Mix Design Method.
- (b) State the advantages and disadvantages of the following three types of Hot-mix Asphalt mixes:
- (i) Dense graded asphalt mix
  - (ii) Open graded (or uniformly graded) friction course mix
  - (iii) Stone mastic Matrix) asphalt mix
5. (a) Assume the data shown below represent laboratory test results on a dense-graded asphalt mix. Compute the optimum asphalt content as per Marshall method of mix design and check whether it satisfies mix design criteria.



- (b) Write an essay on the different forms of asphalt –Cutback asphalts, asphalt emulsions, asphalt primers and modified asphalts.

6. Given the following with respect to a horizontal curve:

$$PI = 12+78.230$$

$$R = 500 \text{ m}$$

$$\Delta = 86^{\circ} 28'$$

(a) Determine the PC and PT stationing.

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

7. (a) A sample of wet aggregate weighed 300.0 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) The following are the properties of the aggregate and compacted HMA. Calculate the density, air voids, VMA, VFA and dust proportion.

Effective specific gravity of the aggregate = 2.724

Specific gravity of the binder = 1.028

Bulk specific gravity of the mix = 2.346

Maximum specific gravity of the mix = 2.516

Binder content = 5.5 percent of the weight of total mix.

Aggregate passing 0.075  $\mu\text{m}$  (No. 200) sieve = 4.0%