

**CARLETON UNIVERSITY**  
Department of Civil and Environmental Engineering

**Highway Engineering CIVE 4209A**

**Winter 2016**

**Assignment (5)**

1. The following results were obtained in a sieve analysis for three different soils. Classify the soils according to the AASHTO classification system.

Soil	Percent passing			L.L.	P.L.
	No. 10	No. 40	No. 200		
1	47	23	14	---	N.P.
2	75	45	38	37	29
3	79	62	48	43	35

2. An asphaltic concrete surface course mixture is being designed by the Marshall method. The aggregate combination in a trial mixture contains 41% coarse aggregates, 52% fine aggregates, and 7% mineral filler; specific gravities of these materials are 2.62, 2.68, and 2.94, respectively. Asphalt cement to be used has a specific gravity of 1.02. Results of tests on specimens prepared from this aggregate combination and various percentages of asphalt (by weight of total mixture) are as follows:

Percentage of Asphalt	Mass of Specimen (g)		Stability (lb)	Flow (0.01 in)	$G_{mm}$
	In Air	In Water			
5.0	1318.00	767.00	1175	13	2.68
5.5	1320.00	787.00	1352	12	2.66
6.0	1336.00	805.00	1381	12	2.64
6.5	1326.00	797.00	1325	14	2.60
7.0	1330.00	792.00	1250	18	2.57

The mixture is to be designed for medium traffic and for a nominal maximum particle size of 2.5 inches. Determine the optimum asphalt content for this mixture. Is the mixture satisfactory?

3. The predicted traffic mix of a proposed four-lane urban non-interstate freeway (all axles are single axles):

Passenger cars = 78%

Single-unit trucks:

2-axle, 5,000 lb/axle = 12%

2-axle, 9,000 lb/axle = 4%

3-axle or more, 23,000 lb/axle = 3%

Tractor semitrailers and combinations:

3-axle, 20,000 lb/axle = 3%

The projected AADT during the first year of operation is 3900 (both directions). If the traffic growth rate is estimated at 3% and the CBR of the subgrade is 75, determine the depth of a full-asphalt pavement using the AASHTO method and design life of 20 years. The resilient modulus of the asphalt ( $E_{AC}$ ) is 320,000 lb/in<sup>2</sup>. Assume  $m_i$  for the subgrade is 1 and the percent of traffic on the design lane is 42%,  $p_t = 2.5$  and SN (for calculating ESAL) = 4. Use a reliability level of 90%, a standard deviation of 0.45, and a design serviceability loss of 2.0. Assume the design lane factor  $f_d$  is 0.42.

4. Use the PCA design method to check the total fatigue percent and damage percent for an 8.0-inch thick concrete pavement of a two-lane highway. The pavement has doweled joints and no concrete shoulders. The modulus of subgrade reaction is 200 pci and the concrete modulus of rupture is 650 psi. Assume a load safety factor of 1.1 and a design period of 20 years. The average daily traffic during the design period is 2500, of which 35% are trucks. Truck weight distribution data for single and tandem loads are tabulated below.

Single Axles		Tandem Axles	
Axle loads (kip)	No. axles per 1000 trucks	Axle loads (kip)	No. axles per 1000 trucks
16	130.9	24	80.2
18	110.8	28	34.4
20	65.4	32	24.0
22	15.6	36	17.2
24	2.3	40	16.8
26	1.9	44	10.5

**Due Date: April 8, 2016**

**(No assignments will be accepted after 12:00 noon on the due date)**