CIVL 3137

Homework 7 Solution

1. A compacted asphalt concrete specimen has a mass in air of 4762 g and an apparent mass in water of 2581 g. If the theoretical maximum specific gravity (G_{mm}) of the asphalt concrete is 2.332, what is the VTM for this material?

$$G_{mb} = \frac{W_{in\,air}}{W_{in\,air} - W_{in\,water}} = \frac{4762}{4762-2581} = 2.1834 = \underline{\underline{2.183}}$$

$$VTM = \left(1 - \frac{G_{mb}}{G_{mm}}\right) \times 100\% = \left(1 - \frac{2.1834}{2.332}\right) \times 100\% = \underline{\underline{6.389\%}}$$

2. Assume the asphalt concrete specimen in the previous problem has a binder content of 6.2%. Assume, too, that the aggregate blend contains 25.2% gravel (G_s = 2.69), 45.6% natural sand (G_s = 2.61), and 29.2% manufactured sand (G_s = 2.72). What is the VMA of the specimen?

$$\frac{1}{G_{sb}} = \frac{f_1}{G_1} + \frac{f_2}{G_2} + \cdots + \frac{f_n}{G_n} = \frac{0.252}{2.69} + \frac{0.456}{2.61} + \frac{0.292}{2.72} = 0.3757 \quad \Rightarrow \quad G_{sb} = \underline{\underline{2.661}}$$

$$VMA = \left[1 - \frac{G_{mb}(1-P_b)}{G_{sb}}\right] \times 100\% = \left[1 - \frac{2.1834(1-0.062)}{2.661}\right] \times 100\% = 2.3035 = \underline{\underline{23.04\%}}$$

3. What is the VFA for the asphalt concrete in the previous two problems?

$$VFA = \left[1 - \frac{VTM}{VMA}\right] \times 100\% = \left[1 - \frac{6.389}{23.035}\right] \times 100\% = 72.264 = \underline{\underline{72.26\%}}$$

4. How much asphalt cement should you add to 1200 g of aggregate to make an asphalt concrete specimen with an asphalt content of 5.5%?

Remember, asphalt content is the mass of asphalt cement divided by the mass of asphalt concrete. The mass of the asphalt concrete is just the sum of the aggregate and asphalt cement masses.

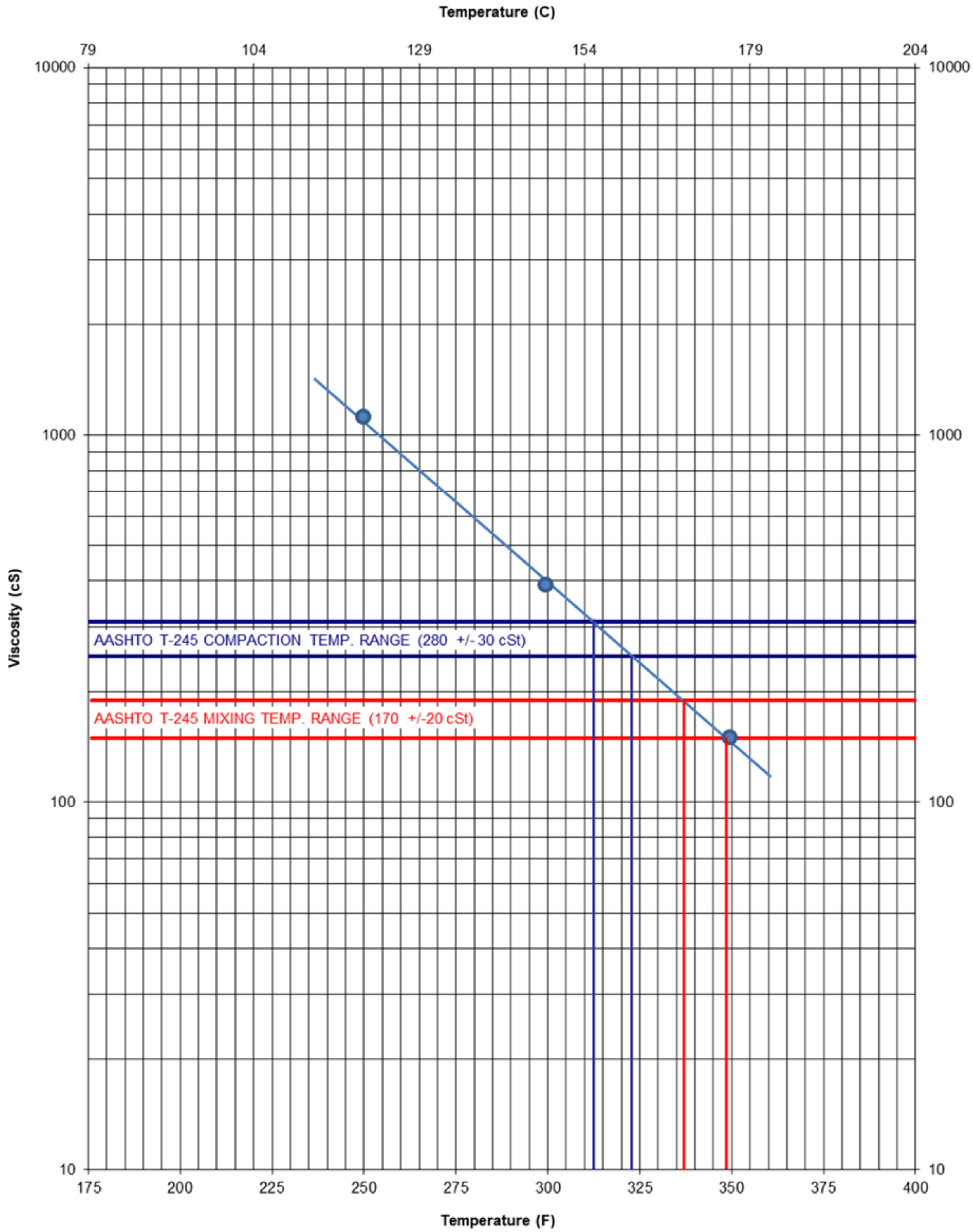
$$P_b = \frac{m_{cement}}{m_{aggregate} + m_{cement}} \times 100\%$$

$$0.055 = \frac{m_{cement}}{1200 + m_{cement}}$$

$$1200(0.055) = m_{cement}(1 - 0.055)$$

$$m_{cement} = 1200\,g\left(\frac{0.055}{0.945}\right) = \underline{\underline{69.8\text{ g}}}$$

5. Using the attached viscosity-temperature chart, determine the range of allowable mixing temperatures and the range of allowable compaction temperatures for this asphalt cement.



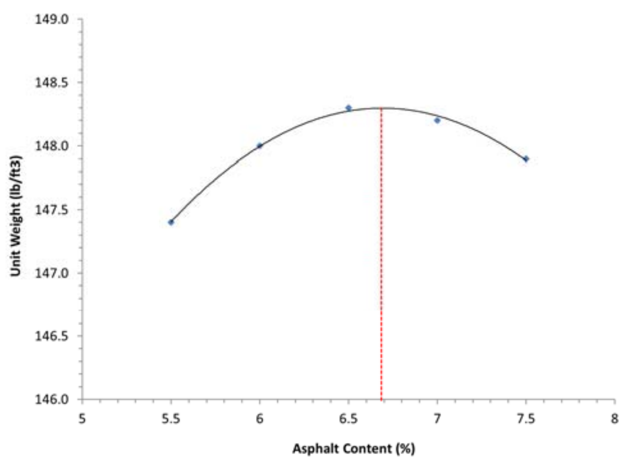
Compaction Range: 313-323°F

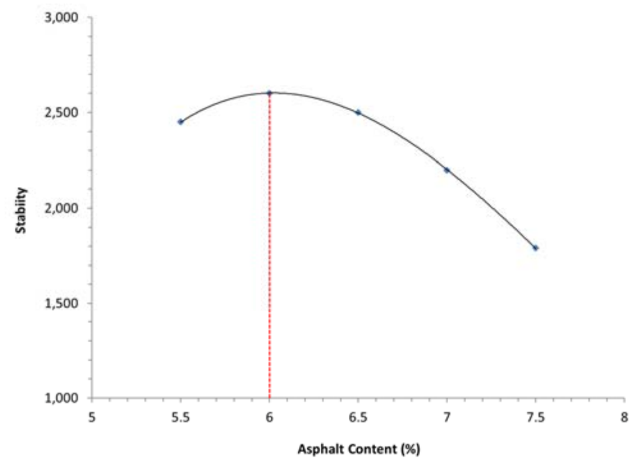
Mixing Temp Range: 337-349°F

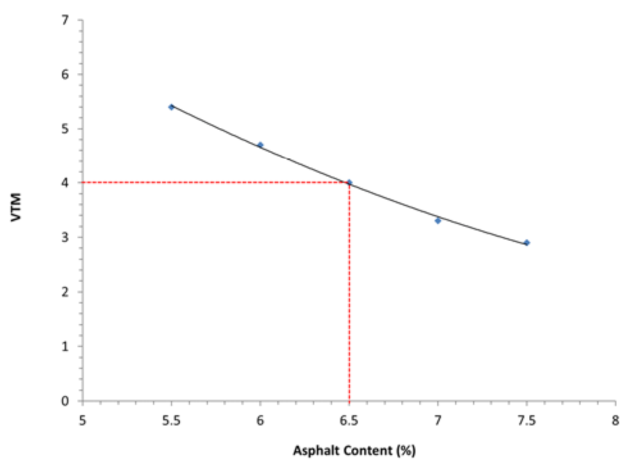
6. The table below contains the average results from a series of 15 Marshall tests (3 pats at each of 5 different asphalt contents) using a dense-graded aggregate blend with a nominal maximum aggregate size of 25 mm (1"). Plot the test results in Excel and establish the relationships between the test results and asphalt content.

	Asphalt Content (%)				
	5.5	6	6.5	7	7.5
Unit Weight (pcf)	147.4	148.0	148.3	148.2	147.9
Stability (lb)	2450	2600	2500	2200	1790
Flow	12.1	13.0	13.7	14.1	14.3
Air Voids (%)	5.4	4.7	4.0	3.3	2.9
VMA (%)	15.2	14.9	14.7	14.8	15.3
VFA (%)	64.5	68.5	72.8	77.7	81.0

7. Use the plots from the previous question to determine the optimum asphalt content based on the Asphalt Institute method. Be sure to show your work. No equation, no credit.



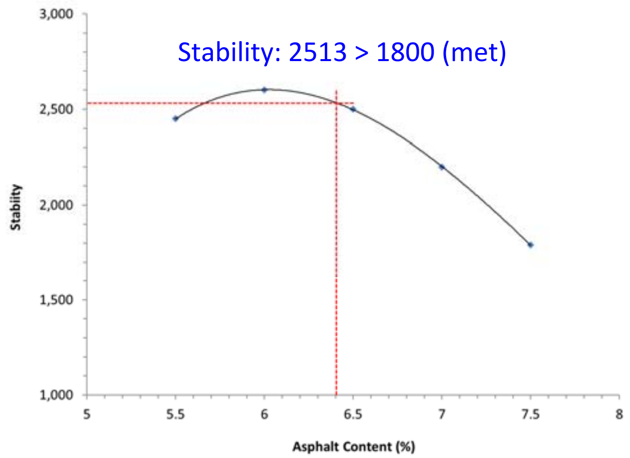


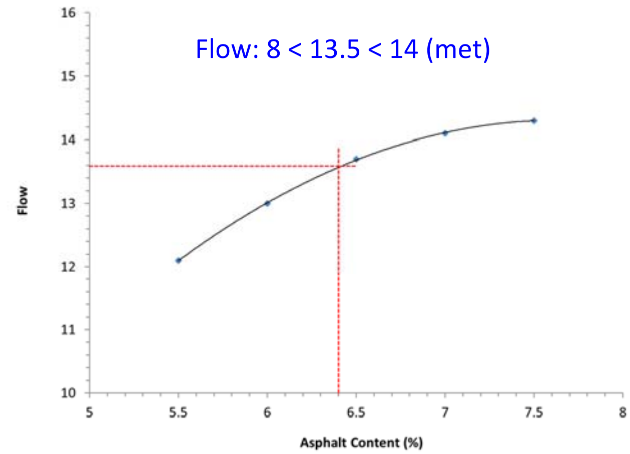


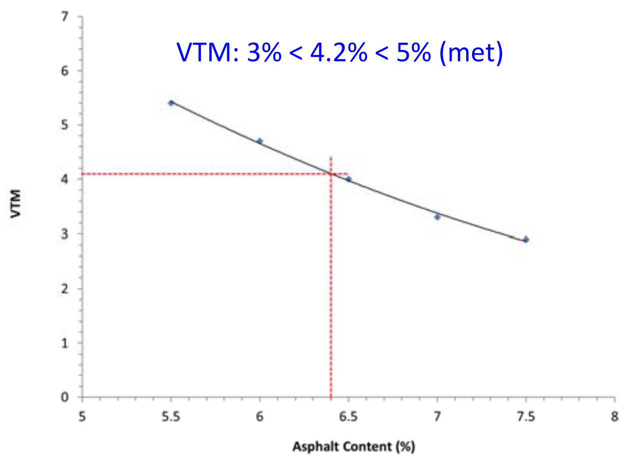
Max Density Max Stability 4% Air Voids

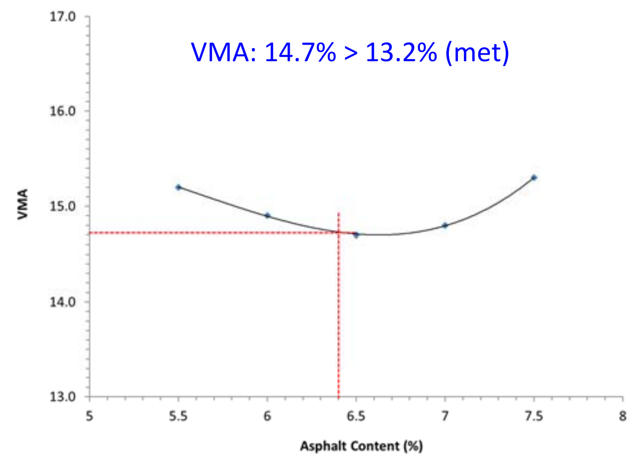
$$AC = \frac{6.7\% + 6.0\% + 6.5\%}{3} = 6.4\%$$

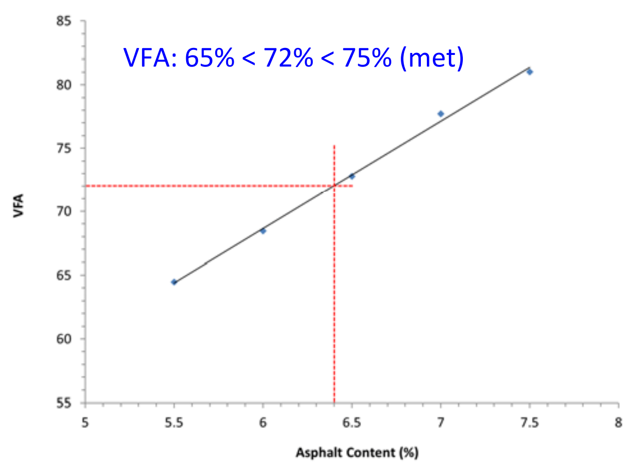
8. Use the plots from the previous two questions to estimate the stability, flow, VTM, VMA and VFA of an asphalt mix with the optimum asphalt content. State whether each value meets the Asphalt Institute requirements for a high-traffic pavement.

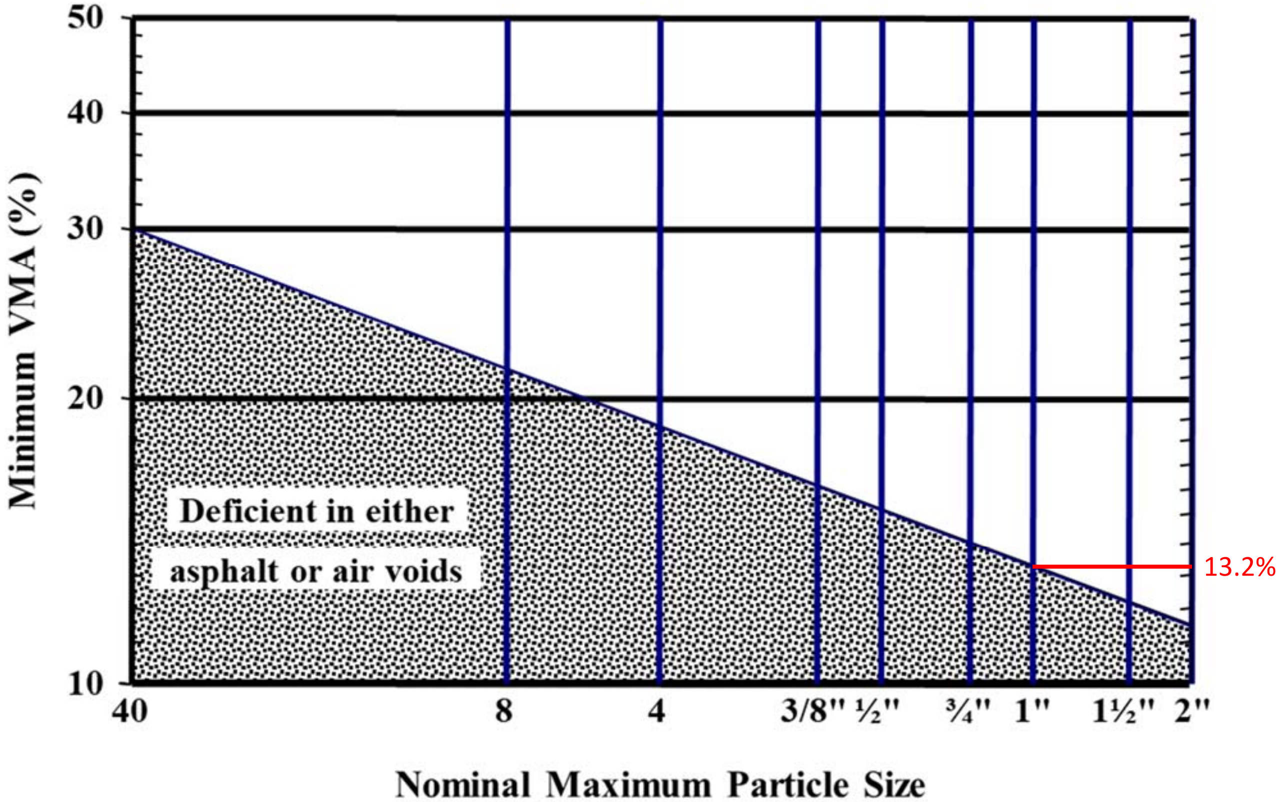











Minimum VMA (%)
50
40
30
20
10
Deficient in either
asphalt or air voids
13.2%
40
8
4
3/8"
½"
¾"
1"
1½"
2"
Nominal Maximum Particle Size