CE 3500: Homework 5
Due Monday, April 18

Problem 1. Design a rigid pavement by specifying the slab thickness, given the following information: daily roadway volume consists of 25,000 passenger vehicles (two axles with a load of 2000 kips each) and 10,000 semi-tractor trailers (assume each semi has a single axle with an 8000 kip load and two tandem axles, each with a 20 kip load), and is expected to grow by 3% per year. The subbase elastic modulus is 100,000 psi; the roadbed soil resilient modulus is 10,000 psi; the concrete elastic modulus and modulus of rupture are 5,000,000 psi and 650 psi, respectively; the load transfer coefficient is 3.2; and the overall standard deviation is 0.29. The pavement is saturated with moisture 5% of the time, and it takes a week for water to drain from beneath the pavement. Bedrock lies 5 ft below the surface of the road. Design the pavement to last 15 years (expecting its PSI to degrade from 4 to 2.5 in that time) with 95% reliability, assuming that the subbase is 10 inches thick.

Problem 2. Estimate the number of vehicle-pedestrian crashes at an urban signalized intersection between two roads, each with an AADT of 5000 vehicles and a total of 750 pedestrians crossing per day. There are four alcohol sales establishments within 1,000 feet of the intersection (CMF 1.12) as well as two bus stops (CMF 2.78). The safety performance function for vehicle-pedestrian crashes at urban four-leg signalized intersections with equal volume on each approach is

$$N_{SPF} = \exp\left(-9.45 + 0.40\ln(AADT) + 0.45\ln(PedVol)\right)$$

where $AADT$ is the total AADT on all approaches and $PedVol$ is the total number of pedestrian crossings.

Bonus Question. For the design of vertical curves, we assumed that the curve length was evenly split, half before PI and half afterwards. Show that this is always a valid technique: given any two points on a parabola, the lines tangent to these points intersect exactly halfway between them. Mathematically, consider the parabola x^2 without loss of generality. Given any two lines tangent to this parabola at the points (x_1, x_1^2) and (x_2, x_2^2), show that their point of intersection has x-coordinate $(x_1 + x_2)/2$.