CEE 320
Fall Quarter 2009

Instructor:
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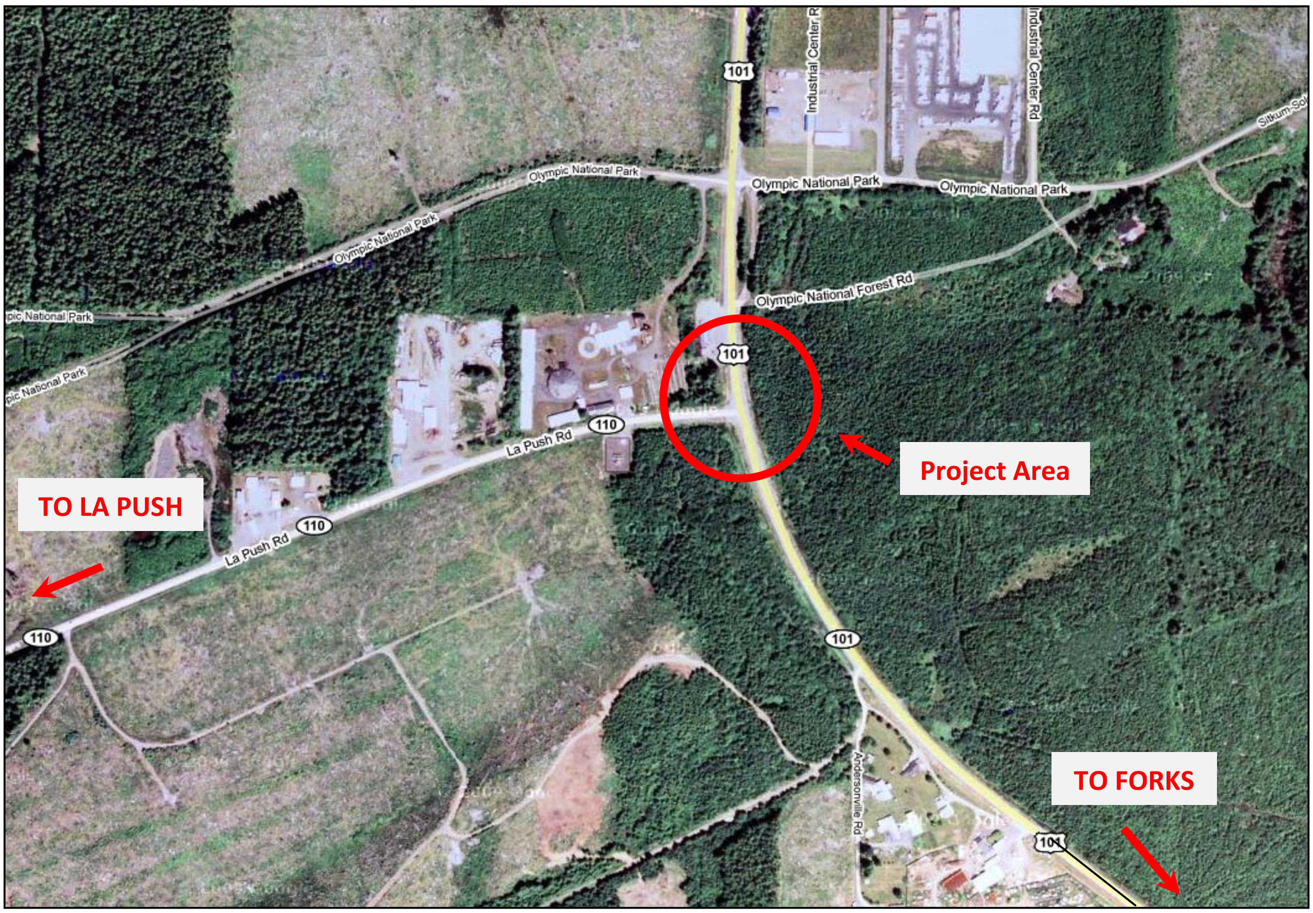
Geometric & Pavement Design (Individual Assignment)

Due to the overwhelming success of the Twilight franchise, the town of Forks has seen a large increase of visitors, and therefore a large increase in vehicle volumes (see NY Times article). This increased volume has made an impact at the intersection of US Route 101 and WA Route 110, where vehicles turn to travel between the town and the beach at LaPush, another destination of Twilight fans.



WSDOT is planning to replace the T-intersection with a small interchange consisting of 2 at-grade ramps (ramps at ground level) and 2 flyover ramps (elevated ramps). Both existing roads shall remain 22-feet wide (one 11-foot lane in each direction) and the speed limit on both is 50 mph. Your job to complete the interchange design and answer questions related to your design. You may answers the questions in the space provided in the assignment or on a separate sheet(s) of paper.

Part 1: Horizontal Design

In order to simplify the design, it has been assumed that both US 101 and SR 110 at straight (as seen in Figure 1) within the area of interest.

The ramps are designated by numbers as labeled on the figure below. Ramps 1 and 2 are at-grade ramps connecting southbound US 101 to westbound SR 110 and eastbound SR 110 to southbound US 101, respectively. WSDOT has determined that these ramps will consist of a single curve and be designed for a design speed of 50 mph and with a superelevation of 6%.

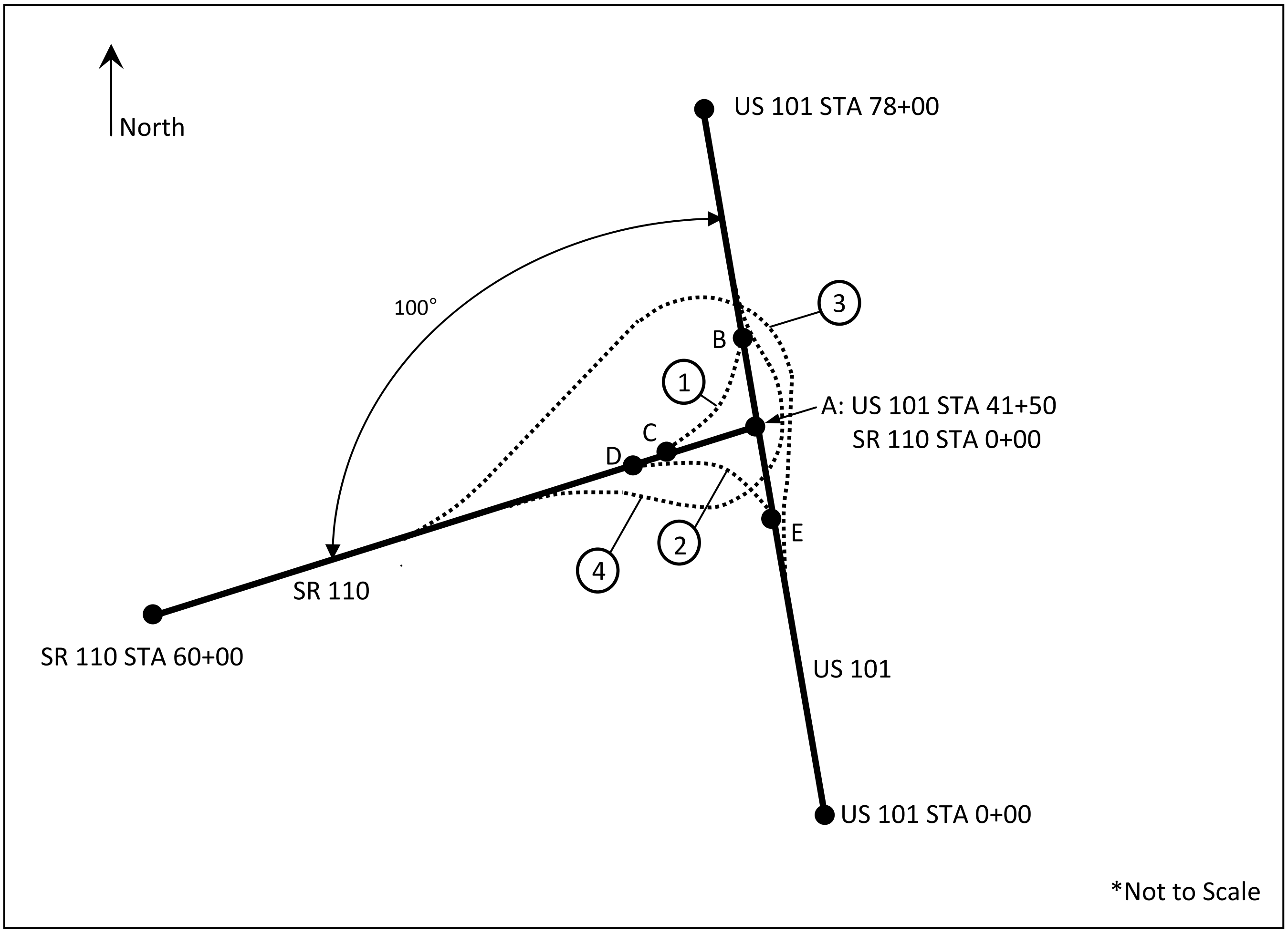


Figure 1: Intersection Plan View

<u>Problem 1:</u>

Determine the curve radius (R), tangent length (T), and length of curve (L) for ramp 1 and ramp 2. Identify the PC and PT for each curve. Be sure to identify which roadway, US 101 or SR 110, the stationing corresponds to (for example: *(SR 110) STA 32+50*). Enter the PC and PT values calculated into Table 1.

Ramp/Curve 1:

Ramp/Curve 2:

Table 1: PC & PT Stationing

Point	Description	US 101 STA	SR 110 STA
A	Curve 1&2 PI	41+50	0+00
B	Curve 1 PC		-
C	Curve 1 PT	-	
D	Curve 2 PC	-	
E	Curve 2 PT		-

Problem 2:

Assuming Ramp 1 consists of 1-11 ft lane, what is the required distance which must be cleared from the *inside edge of the lane* to provide a sufficient stopping sight distance? Use the curve information calculated previously.

Problem 3:

If the allowable superelevation was increased to 8%, would the curve length for ramp 2 increase or decrease? What would happy to the PC and PT locations of Ramp 2?

Problem 4:

Ramp 3, between northbound US 101 and westbound SR 110, will be designed as a flyover ramp. It will consist of 3 horizontal curves connected by 2 straight roadway segments, all designed for 45 mph and with a superelevation of 8%. **If the PIs of 2 adjacent curves are at 4+50 and 41+30 (stations are along the ramp alignment) and the delta angles (Δ) for the curves are 38° and 53°, respectively, what is the distance of the straight segment of ramp between these 2 curves?**

Problem 5:

Ramp 4, between eastbound SR 110 and northbound US 101, will also be designed as a flyover ramp and consist of 3 horizontal curves connected by 2 straight roadway segments, similar to Ramp 3. **If one the curves has a radius of 900 feet and its PC at station 17+00 and its PI at station 24+30 (stations are along the ramp alignment), what is the station of the PT?**

Part 2: Vertical Design

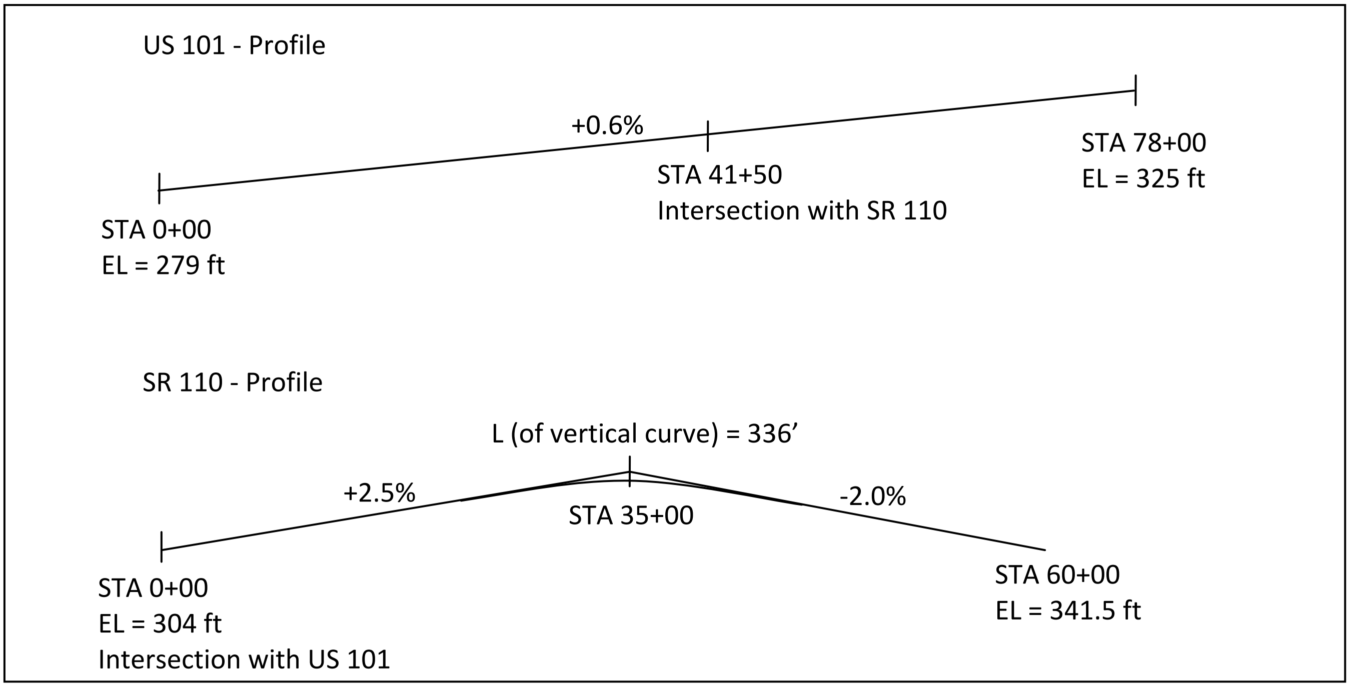


Figure 2: Existing Roadway Profiles

Problem 6:

What is the offset of the existing curve along SR 110 at the PVI?

Problem 7:

Ramps 1 and 2 are at grade. **Based upon the profiles of the existing roadways, determine the elevations of points A through E (using the stations previously calculated in Table 1). Enter the elevation values calculated into Table 2.**

Table 2:

Point	Description	Elevation
A	Curve 1&2 PI	
B	Curve 1 PC	
C	Curve 1 PT	
D	Curve 2 PC	
E	Curve 2 PT	

<u>Problem 8:</u>

The start of ramp 3 intersects US 101 at station 24+10 (on US 101), and the end of ramp 3 intersects SR 110 at station 37+20 (on SR 110). The ramp is 8455 feet in length and crosses over US 101 at station 39+95 (along the ramp), which corresponds with station 63+20 (along US 101). The ramp is designed for 45 mph. A minimum of a 20 ft clearance between the existing roadway and the new ramp is required and the depth of the ramp is 6 feet for a distance of 26 feet required between profiles. **Design the profile needed to connect the ramp start elevation to the ramp end elevation, and also meets the clearance requirements over US 101. Determine the lengths of curves, PVC, PVI, and PVT stations, PVI elevations, and grades between curves.** Hint: there should be 3 vertical curves connected by 2 constant grade section used in the profile. Assume for curve 1 that the PVC is located at station 0+00 (on the ramp) and G1 = 0.6% (grade of US 101 at ramp intersection). Assume for curve 3 that the PVT is located at 84+55 (on the ramp) and G2 =-2.0% (grade of SR 110 at ramp intersection). Remember that there is an offset between PVI elevation and curve elevation.

Problem 9:

Along ramp 4, a crest vertical curve of 515 feet is used to connect grades of +3.5% and -2.0%. **Does this curve meet stopping sight distance requirements for a design speed of 45 mph?**

Problem 10:

The ramps must be designed to allow for potential tour bus loads. A full tour bus holds 78 passengers plus a driver. Bus axle weights for an empty and full bus are shown in the table below. **Using the 4th power load equivalency approximation, determine how much more damage a full bus does to the pavement than an empty one (only driver).** Express this quantity as a multiple of the empty bus damage. For instance, “the full bus causes XX times more damage than the empty one”.

Condition	Front Axle Weight	Rear Axle Weight
Empty Bus	11,600 lb	17,400 lb
Full Bus	17,450 lb	23,250 lb