Homework 4

3-11 Determine the horsepower developed by a passenger car traveling at a speed of 60 mph (60 km/h) on an upgrade of 4% with a smooth pavement. The weight of the car is 4500 lb (2000 kg) and the cross-sectional area of the car is 4 m².

3-12 Repeat Problem 3-11 for a 11000 kg truck with a cross-sectional area of 10 m² and coefficient of drag of 0.5 traveling at 50 mi/h (50 km/h).

3-13 A 1100 kg passenger vehicle originally traveling on a straight and level road gets onto a section of the road with a horizontal curve of radius = 250 m. If the vehicle was originally traveling at 55 mi/h (55 km/h), determine (a) the additional horsepower on the curve the vehicle must produce to maintain the original speed, (b) the total resistance force on the vehicle as it traverses the horizontal curve, and (c) the total horsepower. Assume that the vehicle is traveling at sea level and has a front cross-sectional area of 3 m².

3-14 A horizontal curve is to be designed for a section of a highway having a design speed of 60 mi/h (60 km/h).

(a) If the physical conditions restrict the radius of the curve to 150 m, what value is required for the superelevation at this curve?
(b) Is this a good design?

3-15 Determine the minimum radius of a horizontal curve required for a highway if the design speed is 70 mi/h (70 km/h) and the superelevation rate is 0.08.

3-16 The existing posted speed limit on a section of highway is 55 mi/h (55 km/h) and studies have shown that the current 85th percentile speed is 65 mi/h (65 km/h). If the posted speed limit is to be increased to the current 85th percentile speed, what should be the increase in the radius of a curve that is just adequate for the existing posted speed limit? Assume superelevation rate of 0.08 for the existing curve and for the redesigned curve.

3-17 The radius of a horizontal curve on an existing highway is 250 m. The superelevation rate at the curve is 0.08, and the posted speed limit on the road is 65 mi/h (65 km/h). Is this a hazardous location? If so, why? What action will you recommend to correct the situation?

3-18 A section of highway has a superelevation of 0.05 and a curve with a radius of only 300 ft (100 m). What speed limit will you recommend at this section of the highway?

3-19 A curve of radius 75 m and $e = 0.08$ is located at a section of an existing rural highway, which restricts the safe speed at this section of the highway to 50% of the design speed. This drastic reduction of safe speed resulted in a high crash rate at this section. To reduce the crash rate, a new alignment is to be designed with a horizontal curve. Determine the minimum radius of this curve if the safe speed should be increased to the design speed of the highway. Assume $f_s = 0.17$ for the existing curve, and the new curve is to be designed with $e = 0.08$.

3-20 What is the distance required to stop an average passenger car when brakes are applied on a 2% downgrade if that vehicle was originally traveling at 40 mi/h (40 km/h)?

3-21 A driver on a level two-lane highway observes a truck completely blocking the highway. The driver was able to stop her vehicle only 20 ft (6 m) from the truck. If the driver was driving at 60 mi/h (60 km/h), how far was she from the truck when she first observed it?

3-22 A temporary diversion has been constructed on a highway of +4% gradient due to major repairs that are being undertaken on a bridge. The maximum speed allowed on the diversion is 10 mi/h (10 km/h). Determine the minimum distance from the diversion that a road sign should be located informing drivers of the temporary change on the highway.
Maximum allowable speed on highway = 70 mi/h (70 km/h)
Letter height of road sign = 4" (10 cm)
Perception-reaction time = 2.5 s

Assume that a driver can read a road sign within his or her area of vision at a distance of 40 ft (15 m) for each inch of letter height.

3-23
Repeat Problem 3-22 for a highway with a down grade of –3.5% and the speed allowed on the diversion is 15 mi/h (15 km/h).
Assume that a driver can read a road sign within his or her area of vision at a distance of 40 ft (12 m) for each cm of letter height.

3-24
An elevated expressway goes through an urban area and crosses a local street as shown in Figure 3.10. The partial cloverleaf exit ramp is on a 2% downgrade, and all vehicles leaving the expressway must stop at the intersection with the local street. Determine (a) minimum ramp radius and (b) length of the ramp for the following conditions:

Maximum speed on expressway = 60 mi/h (100 km/h)
Distance between exit sign and exit ramp = 260 ft (80 m)
Letter height of road sign = 3" (8 cm)
Perception-reaction time = 2.5 sec
Maximum superelevation = 0.08
Expressway grade = 0%

Assume that a driver can read a road sign within his or her area of vision at a distance of 50 ft (15 m) for each inch of letter height, and the driver sees the stop sign immediately on entering the ramp.

3-25
Calculate the minimum passing sight distance required for a two-lane rural roadway that has a posted speed limit of 45 mi/h (70 km/h). The local traffic engineer conducted a speed study of the subject road and found the following: average speed of the passing vehicle was 47 mi/h (75 km/h) with an average acceleration of 1.43 mi/h/sec (2.3 km/h/sec), and the average speed of impede vehicles was 40 mi/h (64 km/h).

![Figure 3.10 Layout of Elevated Expressway Ramp, and Local Street for Problem 3-24](image-url)