1. A driver takes 3.5 s to react to a complex situation while traveling at a speed of 60 mi/h. How far does the vehicle travel before the driver initiates a physical response to the situation (i.e., putting his or her foot on the brake)?

Solution:

$$d_r = 1.47 * S * t = 1.47 * 60 * 3.5 \text{ (ft)} = 308.7 \text{ (ft)}$$

2. A driver traveling at 65 mi/h rounds a curve on a level grade to see a truck overturned across the roadway at a distance of 350 ft. If the driver is able to decelerate at a rate of 10 ft/s^2, at what speed will the vehicle hit the truck? Plot the result for reaction time ranging from 0.50 to 5.00 s in increments of 0.5 s. Comment on the results.

Solution:

$d_r = 1.47 * S * t$

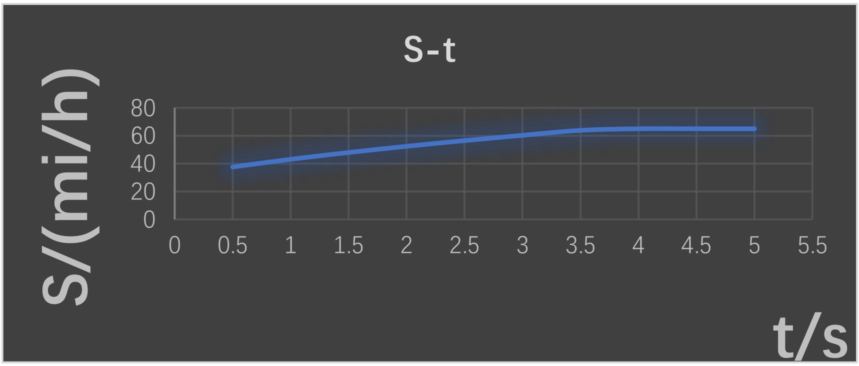
$d_b = 1.075 * S^2 / a$

$d = d_r + d_b$

t/s	S/(mi/h)	d_r/ft	a/(ft/s^2)	d_b/ft	d/ft
0.50	65	47.775	10	454.1875	501.9625

Comment: No matter what the reaction time is, the driver traveling at 65 mi/h will hit the truck. Moreover, the brake distance (d_b=454.1875ft) is more than 350 ft.

t/s	S/(mi/h)	dr/ft	a/ft/s2	db/ft	d/ft
0.5	37.59794	47.775	10	302.2249	349.9999
1	43.1048	95.55	10	254.45	350
1.5	47.98377	143.325	10	206.675	350
2	52.41049	191.1	10	158.9001	350.0001
2.5	56.49141	238.875	10	111.125	350
3	60.29675	286.65	10	63.34999	350
3.5	63.87579	334.425	10	15.57499	350
4	65				350
4.5	65		Hit!		349.9998
5	65				350



Comment: The larger the reaction time is, the smaller the initial speed is and the smaller the brake distance is. It is important to travel under the limited speed. Especially, when the reaction time ranges from 4 s to 5 s, the vehicle will hit the truck at the initial speed (65 mi/h). Drugs or alcohol will enlarge the reaction time to cause more accidents.

3. A car hits a tree at an estimated speed of 25 mi/h on a 3% upgrade. If skid marks of 120 ft are observed on dry pavement (F=0.35) followed by 250 ft (F=0.25) on a grass-stabilized shoulder, estimate the initial speed of the vehicle just before the pavement skid began.
Solution:

$$d_b(shoulder) = \frac{S^2(\text{shoulder}) - S^2(\text{hit})}{30(\text{F(shoulder)} + 0.01\text{G})}$$

$$S^2(shouler) = 250 * 30 * (0.25 + 0.03) + 25 * 25(\text{mi/h})^2 = 2725\ (\text{mi/h})^2$$

$$d_b(pavement) = \frac{S^2(\text{pavement}) - S^2(\text{shoulder})}{30(\text{F(pavement)} + 0.01\text{G})}$$

$$\text{S(pavement)} = \sqrt{120 * 30 * (0.35 + 0.03) + 2725} = 63.98\ (mi/h)$$

4. How long should the "yellow" signal be for vehicles approaching a traffic signal on a 2% downgrade at a speed of 40 mi/h? Use a standard reaction time of 1.0 s and the standard AASHTO deceleration rate.
Solution:

$$\text{t(yellow)} = \text{t} + \frac{S}{15(0.348-0.01\text{G})*1.47} = 1.0 + \frac{40}{15*(0.348-0.01*2)*1.47}\ \text{s} = 6.53\ (\text{s})$$

5. What minimum radius of curvature may be designed for safe operation of vehicles at 70 mi/h if the maximum rate of superelevation (e) is 6% and the maximum coefficient of side friction (f) is 0.10?
Solution:

$$R = \frac{S^2}{15(0.01\text{e}+\text{f})} = \frac{70^2}{15(0.01*6+0.10)}\ \text{ft} = 2041.67\ (\text{ft})$$

6. Plot the relationship between the approach speed v_0 and the length of dilemma zone for the following data: a_1=0.5g, d=1sec, w=65ft, L=15ft, and t=4.5sec.

Solution:

$X_C - X_0$: ft

v_0: mi/h

$$X_C - X_0 = \left[v_0 d + \frac{{v_0}^2}{2a_1}\right] - [v_0 t - (w + L)]$$

$$X_C - X_0 = \left[1.47 * v_0 + \frac{1.47 * 1.47 * {v_0}^2}{2 * 0.5 * \frac{1}{0.3048}}\right] - [4.5 * 1.47 * v_0 - (65 + 15)]$$

$$X_C - X_0 = 0.65864232{v_0}^2 - 5.145v_0 + 80$$