

Capacity and Level of Service

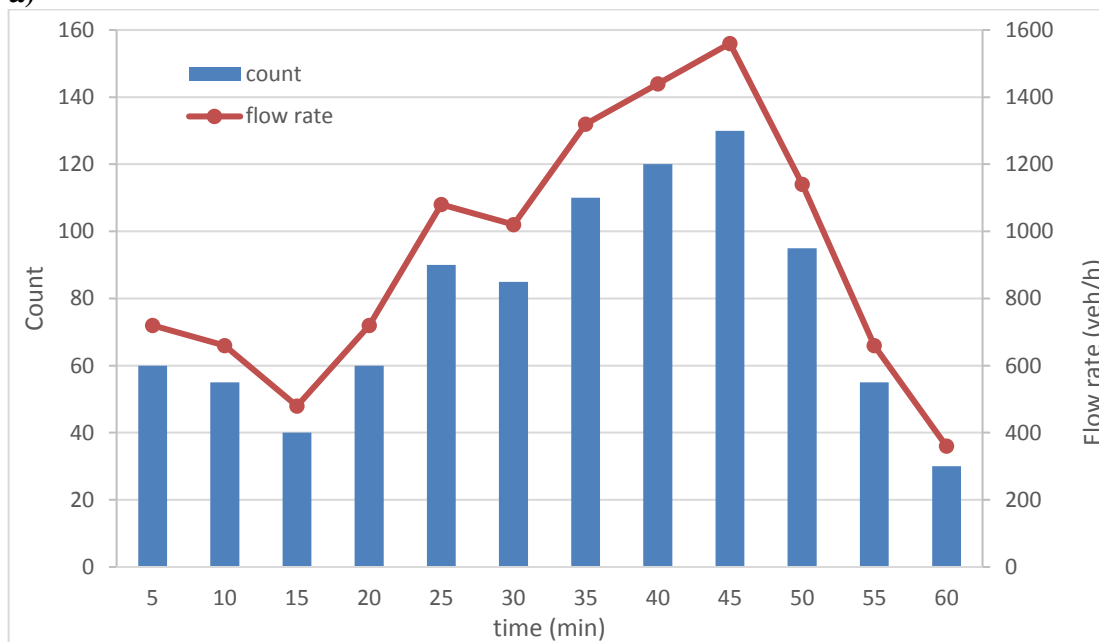
Q1. The following 12 consecutive 5-min vehicle counts were taken on a highway:

60 55 40 60 90 85 110 120 130 95 55 30

- Plot the histogram of these counts and the histogram of the flow rates computed on the basis of the preceding counts
- Calculate the hourly volume and the PHF.
- Show that for $t = 15$ min the PHF can theoretically range from 0.25 to 1.00 using the data given.

Q1 Solution:

a)



b)

$$V = \sum N_i = 930 \text{ veh/hr}$$

$$\text{PHF} = 930 / (12 * 130) = 0.596 \quad \text{Based on Max. 5 min. flow}$$

$$\text{OR: PHF} = 930 / (4 * 360) = 0.646 \quad \text{Based on Max. 15 min. flow}$$

c)

For a perfectly uniform flow, one fourth of the hourly count occurs during any 15 minute period. Hence:

$$\text{PHF} = V / (4 * (V/4)) = 1.00$$

For an extremely peaked demand, the entire hourly counts occurs in the peak 15 minute interval. Hence: $PHF = V/(4V) = 0.25$

Q2. Determine the LOS on a regular weekday on a 0.65-km section of a six-lane freeway (three-lane each) with a grade of 2 percent, using the following data:

Hourly volume: $V = 3000$ veh/hr
 $PHF = 0.85$
 Traffic Composition:
 Trucks = 10 percent
 RVs = 2 percent
 Lane width = 3.5 m
 Terrain = Level
 Base free-flow speed = 110 km/hr
 Shoulder width = 2 m
 Interchange spacing = 1 km
 Driver population adjustment factor $f_p = 0.95$

Q2 Solution:

Step 1. Compute heavy vehicle factor

Determine the correction factors for extended general freeway segments (3 percent grade and 0.65 km long):

PCEs:

$$E_T = 1.5$$

$$E_R = 1.2$$

$$\begin{aligned} f_{HV} &= \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)} \\ &= \frac{1}{1 + 0.10(1.5 - 1) + 0.02(1.2 - 1)} \\ &= 0.95 \end{aligned}$$

Step 2. Determine the peak 15-minute passenger-car equivalent flow rate.

$$\begin{aligned} v_p &= \frac{V}{PHF \times N \times f_{HV} \times f_p} \\ &= \frac{3000}{0.85 \times 3 \times 0.95 \times 0.95} \\ &= 1303.57 \text{ pc/hr/ln} \end{aligned}$$

Step 3. Compute the free-flow speed and density.

$$FFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID}$$

$$= 110 - 1.0 - 0 - 4.8 - 9.2$$

$$= 95 \text{ km/hr}$$

$$D = v/S = 1303.57/95 = 13.72 \text{ pc/km/ln}$$

Step 4. Determine level of service.

LOS = C (Since 13.5 lies between 11 and 16 pc/km/ln.)

Q3. A Class I two-lane highway has a base free-flow speed of 110 km/h. Lane width is 3.35 m and shoulder width is 0.6 m. There are 5 access points per km. The roadway is located in rolling terrain with 40% no-passing zones. The two-way traffic volume is 600 veh/hr with PHF = 0.86. The directional split is 60/40. Traffic includes 8% trucks and 2% recreational vehicles. Determine the level of service (LOS).

Q3 Solution:

$$FFS = BFFS - f_{LS} - f_A = 110 - 4.9 - 3.3 = 101.8 \text{ km/hr}$$

$$\text{Estimated } v_p = V/PHF = 600/0.86 = 697.67 \text{ pc/hr}$$

Assuming $600 < v_p < 1200$

$$f_G = 0.93, E_T = 1.9, E_R = 1.1,$$

$$P_T = 0.08, \text{ and } P_R = 0.02$$

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$

$$= \frac{1}{1 + 0.08(1.9 - 1) + 0.02(1.1 - 1)}$$

$$= 0.93$$

$$v_p = \frac{V}{PHF \times f_{HV} \times f_G}$$

$$= \frac{600}{0.86 \times 0.93 \times 0.93}$$

$$= 806.65 \text{ pc/hr/ln}$$

$$600 < 806.65 < 1200 \quad (\text{O.K.})$$

$$806.65 < 3200 \quad (\text{O.K.}) \rightarrow \text{LOS is not F}$$

$$0.6 * 806.65 = 483.99 < 1700 \quad (\text{O.K.})$$

Average Travel Speed (ATS)

$$ATS = FFS - 0.0125v_p - f_{np}$$

$$f_{np} = 3.08 \text{ (Interpolation)}$$

$$ATS = 101.8 - 0.0125 \cdot 806.65 - 3.08 = 88.6 \text{ km/hr} \rightarrow LOS = B$$

Determining v_p for percent time spent following, *PTSF*

$$600 < v_p < 1200$$

$$f_G = 0.94, E_T = 1.5, E_R = 1.0$$

$$\begin{aligned} f_{HV} &= \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)} \\ &= \frac{1}{1 + 0.08(1.5 - 1) + 0.02(1.0 - 1)} \\ &= 0.96 \end{aligned}$$

$$\begin{aligned} v_p &= \frac{V}{PHF \times f_{HV} \times f_G} \\ &= \frac{600}{0.86 \times 0.96 \times 0.94} \\ &= 773.13 \text{ pc/hr/ln} \end{aligned}$$

$$600 < 773.13 < 1200 \text{ (OK)}$$

Determining *PTSF*

$$PTSF = BPTSF + f_{d/np}$$

$$f_{d/np} = 10.96 \text{ (Interpolation)}$$

Determining *BPTSF*

$$\begin{aligned} BPTSF &= 100[1 - \exp(-0.000879v_p)] \\ &= 100[1 - \exp(-0.000879 \times 773.13)] \\ &= 49.32 \end{aligned}$$

$$PTSF = BPTSF + f_{d/np} = 49.32 + 10.96 = 60.3\% \rightarrow LOS = C$$