

Q1:

From Question : 3 lanes in each direction.

volume=3000veh/h ; PHF=0.95; $BFFFS = 110 km/h$

$$f_p = 0.8$$

(1) FFS

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

$$\text{Lane width}=3.6m \Rightarrow f_{LW} = 0$$

(Chapter 4.Page 55,Table 2)

$$3 \text{ lanes, \&Right-Shoulder Lateral clearance}=1.5m \Rightarrow f_{LC} = 0.7$$

(Chapter 4.Page 55,Table 3)

$$3 \text{ lanes in each direction.} \Rightarrow f_N = 4.8 km/h$$

(Chapter 4.Page 56,Table 4)

$$\text{Interchanges per Kilometer: } \frac{1}{2} = 0.5 \Rightarrow f_{ID} = 2.1 km/h$$

(Chapter 4.Page 56,Table 4)

$$FFS = 110 - 0.0 - 0.7 - 4.8 - 2.1 = 102.4 km/h$$

(2) Flow rate V_p :

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_p} = \frac{3000}{0.95 \cdot 3 \cdot f_{HV} \cdot 0.8}$$

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

$$P_T = 10\% + 2\% = 12\% ; P_R = 8\%$$

For level terrain:

$$E_T = 1.5 ; E_R = 1.2 ;$$

(Chapter 4.Page 57. Table 6)

$$f_{HV} = \frac{1}{1 + 0.12(1.5 - 1) + 0.08(1.2 - 1)} = 0.93$$

$$V_p = \frac{3000}{0.95 \cdot 3 \cdot 0.93 \cdot 0.8} = 1415 pc/h/lane$$

By using figure 1:

(Chapter 4.Page 54)

For $FFS = 102.4 km/h$ and $V_p = 1415 pc/h/lane$

LOS is C.

Q2:

$$V = 1600 \text{ veh/h} ; P_T = 14\% ; P_R = 4\% ; PHF = 0.95$$

Step 1: Compute peak 15-min hourly passenger car equivalent v_p

$$\text{Train value for } v_p \text{ is } V/PHF = 1600/0.95 = 1684 \text{ pc/h}$$

$$\text{Determine } f_G = 1.00$$

(Chapter 4, Page 100, Table 5b)

$$\text{Determine } E_T = 1.00 \text{ and } E_R = 1.00$$

(Chapter 4, Page 101, Table 6b)

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

$$f_{HV} = \frac{1}{1 + (0.14)(1.0 - 1.0) + (0.04)(1.0 - 1.0)} = 1.00$$

$$v_p = \frac{v}{(PHF)(f_G)(f_{HV})} = \frac{1600}{(0.95)(1.00)(1.00)} = 1684 \text{ pc/h}$$

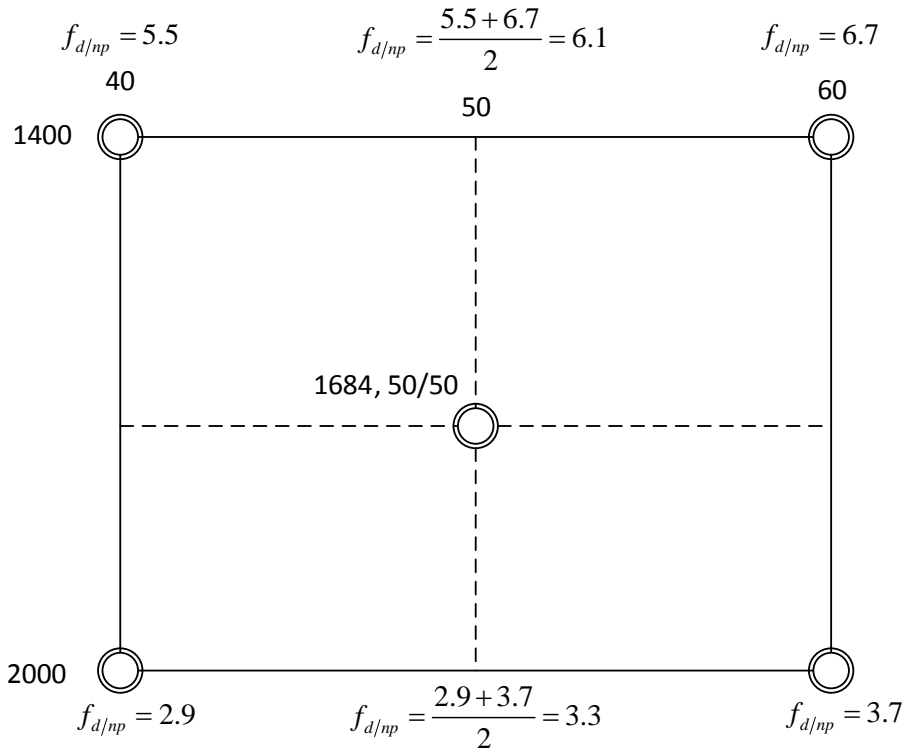
Note: Since $1684 < 3200$, this section is operating below capacity.

Step 2. Compute base percent time-spent-following (BPTSF)

$$\begin{aligned} BPTSF &= 100 \left[1 - e^{-0.000879 v_p} \right] \\ &= 100 \left[1 - e^{-0.000879(1684)} \right] \\ &= 77.2\% \end{aligned}$$

Step 3. Compute percent time-spent-following ($PTSF$)

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



$$f_{d/np} = 3.3 + \frac{2000 - 1684}{2000 - 1400} (6.1 - 3.3) = 4.8$$

$$PTSF = 77.2 + 4.8 = 82.0\%$$

Q3. Solution

$$BFFS = 96.6 \text{ km/h} ; \text{ Lane width} = 3.36 \text{ m}$$

shoulder width = 1.22; 12 access points per km

Step 1. Compute the free-flow speed under the given conditions

$$FFS = BFFS - f_{LS} - f_A$$

$$f_{LS} = 2.8 \text{ km/h} \quad (\text{Chapter 4, Page 99, Table 3})$$

$$f_A = 8 \text{ km/h} \quad (\text{Chapter 4, Page 99, Table 4})$$

$$FFS = 96.6 - 2.8 - 8 = 85.8 \text{ km/h}$$

Step 2. Compute average travel speed

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

$$FFS = 85.8 \text{ km/h}$$

$$\text{Calculate } v_p : v_p = \frac{v}{(PHF)(f_G)(f_{HV})}$$

$$1. \text{ Set } v_p = \frac{V}{PHF} = \frac{1600}{0.95} = 1684$$

2. Determine the value of f_G f_{HV} with approximate value of v_p ;

Since $v > 1200$ & rolling terrain

$$f_G = 0.99 \quad (\text{Chapter 4, Part 2-Page 42, Table 5a})$$

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

$$P_T = 14\% ; P_R = 4\%$$

$$E_T = 1.5 ; E_R = 1.1 \quad (\text{Chapter 4, Part 2-Page:28})$$

$$f_{HV} = \frac{1}{1 + (0.14)(1.5 - 1.0) + (0.04)(1.1 - 1.0)} = 0.931$$

$$v_p = \frac{v}{(PHF)(f_G)(f_{HV})} = \frac{1600}{(0.95)(0.99)(0.931)} = 1827 \text{ pc/h}$$

Check the value, whether the value of v_p within the flow limits for $f_G; E_T; E_R$ were calculated.

$f_{np} = 1.35 \text{ km/h}$ (Since $v_p = 1827$ and percent no-passing zones=50) (Chapter 4, Page.102, Table 7a)

$$\begin{aligned}ATS &= FFS - 0.0125v_p - f_{np} \\ &= 85.8 - 0.0125(1827) - 1.35 = 61.3 \text{ km/h}\end{aligned}$$