Q1:

From Question : 3 lanes in each direction.

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

$f_p = 0.8$

(1) FFS

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

Lane width=3.6m $\Rightarrow f_{LW} = 0$ (Chapter 4.Part 1.Page 55,Table 2)

3 lanes, &Right-Shoulder Lateral clearance=1.5m $\Rightarrow f_{LC} = 0.7$ (Chapter 4.Part 1.Page 55,Table 3)

3 lanes in each direction. $\Rightarrow f_N = 4.8\, km/h$ (Chapter 4.Part 1.Page 55,Table 4)

Interchanges per Kilometer: $\frac{1}{2} = 0.5 \Rightarrow f_{ID} = 2.1\, km/h$ (Chapter 4.Part 1.Page 55,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.Part 1.Page 39)

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

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

By using figure 1: (Chapter 4.Part 1.Page 54)

For $FFS = 102.4\, km/h$ and $V_P = 1415\, pc/h/lane$

LOS is C.

Q2:

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

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

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

Determine $f_G = 1.00$ (Chapter 4.Part 2-Page 42,Table 5b)

Determine $E_T = 1.00$ and $E_R = 1.00$ (Chapter 4.Part 2-Page 29)

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

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

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

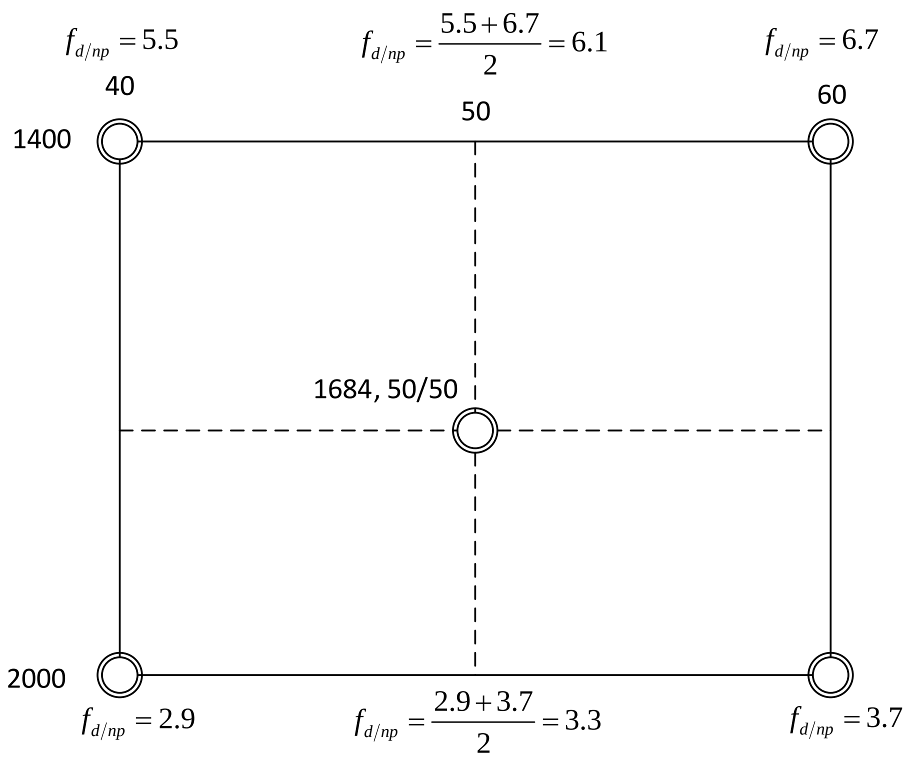
Note: Since 1684<3200, this section is operating below capacity.

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

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

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

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



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

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

Q3. Solution

$BFFS = 96.6\,km/h$; Lane width=3.36m

shoulder width=1.22; 12 access points per km

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

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

$f_{LS} = 2.8\,km/h$ (Chapeter 4.Part 2-Table 3)

$f_A = 8\,km/h$ (Chapeter 4.Part 2-Table 4)

$$FFS = 96.6 - 2.8 - 8 = 85.8\,km/h$$

Step 2. Compute average travel speed

$$ATS = FFS - 0.0125v_p - f_{np}$$
$$FFS = 85.8\,km/h$$

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

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

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

Since $v > 1200$ & rolling terrain

$f_G = 0.99$ (Chpater 4.Part 2-Page.42,Table 5a)

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

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

$E_T = 1.5$; $E_R = 1.1$ (Chpater 4.Part 2-Page:28)

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

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

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

$f_{np} = 1.35\,km/h$ (Since $v_p = 1827$ and percent no-passing zones=50) (Chpater 4.Part 2-Page.44,Table 7a)

$$ATS = FFS - 0.0125v_p - f_{np}$$
$$= 85.8 - 0.0125(1827) - 1.35 = 61.3\,km/h$$