CV3014 S1 2015 – 2016

1(a). Trip distribution estimate the target-year trip volume that interchange between all pairs of zones I and J, where I is the trip producing zone, J the trip attracting zone.

- all trip-attracting zones J are competing with other J's to attract trips produced by each zone I. More trips attracted to zones with higher levels of attractiveness.
- There are also other factors affecting the number of trips going J or coming from I: such as distance between zone I and J, impedance, and other socio-economic factors. The further the distance, the lower chance people likely to go.
- Types of distribution models are: growth factor models and gravity model.

b) $V = c\ln\left(\frac{k_j}{k}\right)$

$q = Vk = ck\ln\left(\frac{k_j}{k}\right)$

$\frac{dq}{dk} = ck\left(\frac{k}{k_j}\right)\left(\frac{-k_j}{k^2}\right) + c\ln\left(\frac{k_j}{k}\right) = c + c\ln\left(\frac{-k_j}{k}\right) = c\left(1+\ln\left(\frac{-k_j}{k}\right)\right)$

$\frac{dq}{dk} = 0$

$1 = \ln\left(\frac{k_j}{k}\right)$

$e = \frac{k_j}{k}$

$k = \frac{k_j}{e}$ //

q_{max} is achieved when $k = k_o = \frac{k_j}{e}$

$q_{max} = ck_o\ln\left(\frac{k_j}{k_j/e}\right) = ck_o$ where $c = V_o = V_{optimum}$ to achieve q_{max}

c) ① check the t-statistics for each independent variable and intercept A. to ensure that they are values other than 0, if it is 0, $t > 1.65$ (90% significance level), so that the corresponding x disappears

② check the correlation between independent variable, if it is close to 1, means they are correlated and y would be overestimated if they appears in the same equation.

③ Quality of fit (R) is determined by multiple linear regression analysis is indicated by the multiple regression coefficient (goodness of fit). The closer R is to 1 or −1, the better is the linear relationship between the variables.

④ choose the one with low MSE which is a measure of the deviation between observed trips from predicted values.

⑤ choose the one with comparable less number of variables as it is less costly

2a)

b) $P_{bus} = \frac{e^{-0.1(T+3)}}{e^{-0.1(T+3)} + e^{-0.1(T+10)}} = \frac{e^{-0.1T-0.3}}{e^{-0.1T-0.3} + e^{-0.1T-0.3-0.7}}$

$= \frac{e^{-0.1T-0.3}}{e^{-0.1T-0.3}(1+e^{-0.7})} = \frac{1}{1+e^{-0.7}} = 0.6682$

$Q_{bus} = 0.6682 \times 20000 = 13363.76 = 13364$

$Q_{car} = 20000 - 13364 = 6636.$

$q = 6636 + 150 = 6786$ veh/hr

$T = 30 + 2\times10^{-6}(6786)^2 = 122.1$ min

c) bus service fare $= Q_{bus} \times P_B$ Let bus service fare be y

$y = Q_{bus} \times P_B$

$y = \left[\frac{e^{-0.1(T+P_B)}}{e^{-0.1(T+P_B)} + e^{-0.1(T+P_c)}}\right] \times P_B \times 20000$

$y = \left[\frac{e^{-0.1T} \cdot e^{P_B}}{e^{-0.1T}(e^{P_B} + e^{P_c})}\right] \times P_B \times 20000.$

$y = \frac{P_B e^{P_B}}{P_B(e^{P_B}+e^{P_c})} \times 20000$

$\frac{dy}{dP_B} = \frac{(e^{P_B} + P_B e^{P_B}) - [(e^{P_B} + P_B e^{P_B}) + e^{P_c}]}{P_B^2 (e^{P_B} + e^{P_c})^2}$

$= \frac{e^{P_c}}{P_B^2 (e^{P_B}+e^{P_c})^2}$

//

a) $x_4 = 5$ $x_3 + x_2 = x_4 = 5$ — ①

Route 1: Link 1: $T_1 = 24 + 2x_1$ — ②

Route 2: Link 2 + Link 4 $T_2 = 12 + 2x_2 + 8 + x_4 = 20 + 2x_2 + x_4$ — ③

Route 3: Link 3 + Link 4 $T_3 = 10 + x_3 + 8 + x_4 = 18 + x_3 + x_4$ — ④

① into ④

$10 + 5 - x_2 + 8 + x_4 = 23 - x_2 + x_4$ — ⑤

③ & ⑤

$23 - x_2 + \cancel{x_4} = 20 + 2x_2 + \cancel{x_4}$

$3 = 3x_2$

$x_2 = 1$

$x_3 = 4$

$T_2 = 20 + 2 + 5 = 27 = T_1$

$24 + 2x_1 = 27 \Rightarrow x_1 = \cancel{3}\ 1.5$

Total demand $= \cancel{3}\ 1.5 + 5 = \cancel{8}\ 6.5$

b) $t_4 = 8 + 2 + x_4 = 10 + x_4$ $x_1 + x_4 = 10$ $x_2 + x_3 = x_4$

$T_1 = 24 + 2x_1$ $x_1 + x_2 + x_3 = 10$

$T_2 = 12 + 2x_2 + 10 + x_4 = 22 + 2x_2 + x_4$

$T_3 = 10 + x_3 + 10 + x_4 = 20 + x_3 + x_4$

~~$20 + 4 + x_4 - x_2 = 22 + 2x_2 + x_4$~~

$20 + 10 - x_1 - x_2 + x_4$

$20 + 10 - (10 - x_4) - x_2 + x_4$

$\Rightarrow 20 + 2x_4 - x_2 = 22 + 2x_2 + x_4$

$x_4 - 3x_2 = 2$

$x_4 = 2 + 3x_2$

$24 + 2x_1 = 22 + 2x_2 + x_4$

$24 + 2(10 - x_4) = 22 + 2x_2 + x_4$

$24 + 20 - 2x_4 = 22 + 2x_2 + x_4$

$44 - 3x_4 = 22 + 2x_2$

$44 - 3(2 + 3x_2) = 22 + 2x_2$

$44 - 6 - 9x_2 = 22 + 2x_2$

$16 = 11x_2$

$x_2 = 16/11$ $x_1 = \frac{40}{11}$

$x_4 = 2 + 3(16/11) = 70/11$

$x_3 = \frac{54}{11}$

c) $x_1 + x_2 + x_3 = 10$

$x_1 + x_4 = 10$

$x_2 + x_3 = x_4$

$T_1 = 24 + 2x_1$

$T_2 = 12 + 2x_2 + 8 + 20 - 0.5t + x_4 = 40 + 2x_2 - 0.5t + x_4$

$T_3 = 10 + x_3 + 8 + 20 - 0.5t + x_4 = 38 - 0.5t + x_3 + x_4$

$T_2 = T_3$

$40 + 2x_2 - 0.5t + x_4 = 38 - 0.5t + x_4 - x_2 + x_4$

$2 + 3x_2 = x_4 = x_2 + x_3 \Rightarrow 2 + 2x_2 = x_3$

$x_1 + 3x_2 + 2 = 10$

$x_1 = 8 - 3x_2$

$8 - 3x_2 + x_4 = 10$

$x_4 - 3x_2 = 2$

~~$x_1 + x_2 + x_4 - x_2 = 10$~~

~~$x_1 + x_4 = 10$~~

~~$24 + 2(10 + x_4) = 40 + 2x_2 - 0.5t + x_4$~~

$T_1 = 24 + 2(8 - 3x_2)$

$= 24 + 16 - 6x_2$

$= 40 - 6x_2$

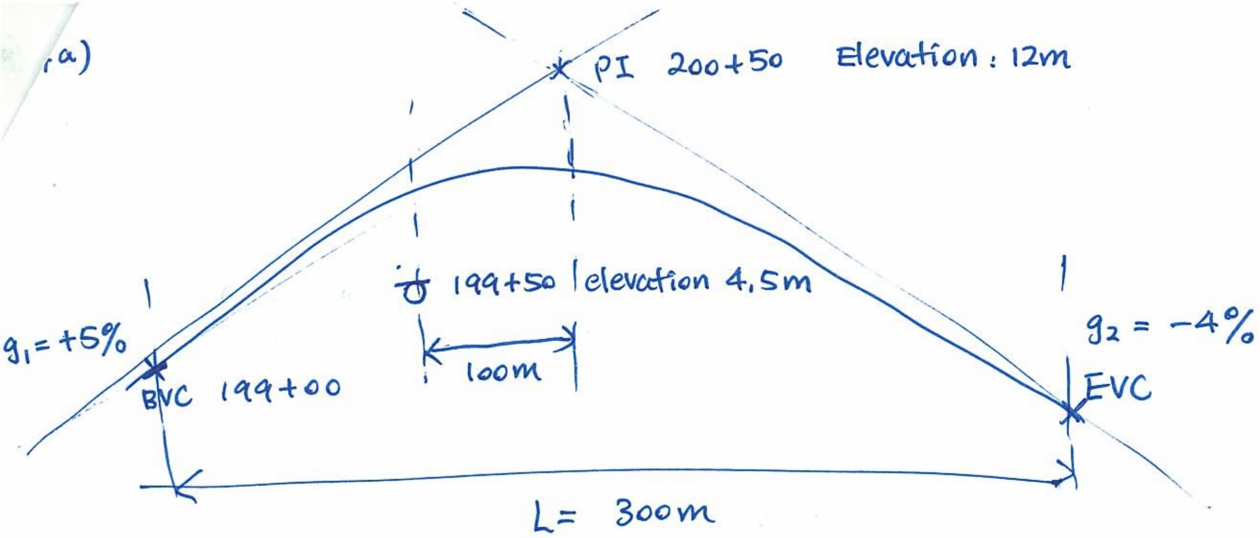
~~$x_1 + 2 + 2x_2 + x_2 = 10$~~

~~$10 - x_4 + 2 + 3x_2 = 10$~~

$T_2 = T_3$

$40 + 2\left(\frac{8 - x_1}{3}\right) - 0.5t + x_4 = 38 - 0.5t +$

a)



$r = \frac{(-4-5)}{3} = -3$

Elevation of tangent $= -3(1) + 12 = 9$ m

Elevation of pipe $= 4.5$

Elevation of road surface @ 199+50 $= \frac{Rx^2}{2} = \frac{3(0.5)^2}{2} = 0.375$ m

$\Rightarrow 9 - 0.375 = 8.625$ m

$8.625 - 4.5 = 4.125\text{ m} > 2$

b) must have adequate stopping sight distance (SSD) for safety
~ short curves do not look good; long vertical curves more pleasing appearance.
~ comfort criterion: tolerable vertical acceleration.

b) $m = 300\left[1 - \cos\left(\frac{28.65(150)}{300}\right)\right] = 9.33 \Rightarrow$ Required setback distance

$\Rightarrow < 8$ m

∴ Inadequate setback distance
∴ increase Radius of horizontal curve

$(e+f) = \frac{v^2}{gR}$ $\quad$ 90km/h = 25 m/s

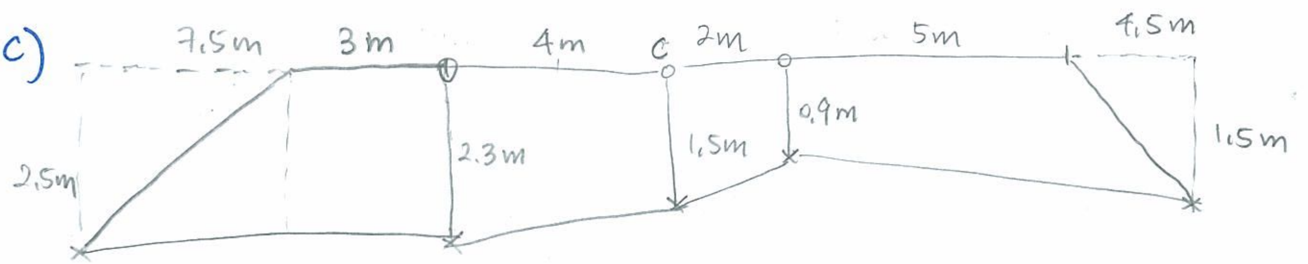
$e = \frac{25^2}{9.81(300)} = 0.13 = 0.0824 > 5\%$

∴ superelevation is not enough.
∴ decrease speed limit or increase radius of horizontal curve

$\frac{Rg(e+f)}{v^2} = 1$ $\quad$ $R = \frac{v^2}{(e+f)g} = \frac{25^2}{(0.13+0.05)9.81} = 354$ m

∴ radius is not enough.
∴ increase design speed or decrease superelevation angle

c)



side slope : 3 or 1/3

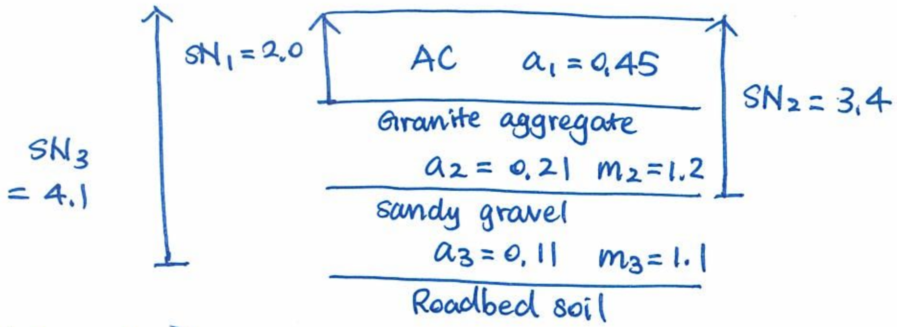
$(2.5+2.3)\times 10.5\times 0.5 + (2.3+1.5)\times 4\times 0.5 + (1.5+0.9)\times 2\times 0.5 + (0.9+1.5)(9.5)(0.5)$
$-(2.5\times 7.5\times 0.5 + 4.5\times 1.5\times 0.5)$
$= 33.85 m^2$

5a) ∘ controls S/G volume change ; S/B holds down S/G and absorbs some of the expansion

- ∘ improves drainage of water from surface joints or variable water table
- ∘ controls mud pumping which caused by 3 factors heavy load, water accumulation; unsuitable soils.
- ∘ Controls frost damage which softens S/G
- ∘ forms a working surface

b) $SN_1 = a_1 D_1$

$D_1 = \frac{2}{0.45} = 4.44 \quad D_1^* = 4.5m$



$D_2 = (SN_2 - a_1 D_1^*)/(a_2 m_2)$
$= [3.4 - 0.45(4.5)]/(0.21\cdot 1.2)$
$= 5.456m \quad D_2^* = 5.5m$

$D_3 = (SN_3 - a_1 D_1^* - a_2 D_2^* m_2)/(a_3 m_3)$
$= [4.1 - 0.45(4.5) - (0.21)(5.5)(1.2)]/(0.11\cdot 1.1)$
$= 5.69\ m \quad D_3^* = 6m.$

;)① Reliability ~ a predetermined level of assurance eg. 98% sure that the structure will perform in design life.
2) Standard deviation S_o ~
3) Serviceability index from 0 to 5 ~ initial serviceability which represent the condition of pavement immediately after construction. terminal serviability ~~rep~~ which has the lowest quality tolerated before reconstruction (ΔPSI)
) effective resilient modulus (M_r) base on recoverable strain under repeatable loads
) structural Number (SN) represents overall structure requirement needed to sustain the design traffic loadings