New 2018

Civilittee

اللجنة الأكاديمية للهندسة المدنية

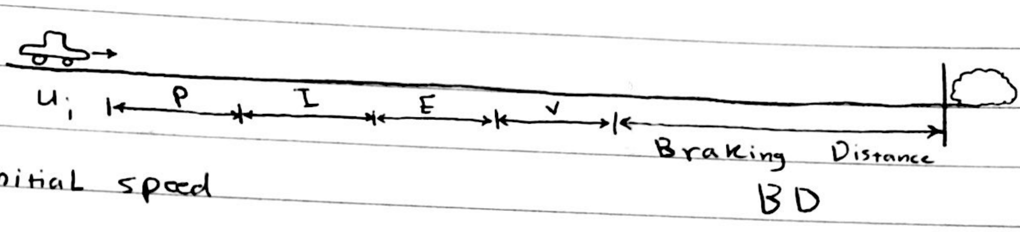
دفتر

هندسة المرور

اسامة سلهب

هندسة المرور

5/10/2017



u_i : initial speed

* PIEV process

→ time t_r = 2.5 s [avg.]

→ distance $u_i * t_r$

if one or more :

- * senior (old) Driver
- * dust
- * speed
- * Rainy, foggy, snowy
- * fatigue, Drugs
- * time of day

→ $t_r = 2.5 * 1.35$ sec.

* Rang of tr (0.5 - 7) sec.

* Stopping Sight distance :-

→ SSD = PIEV distance + BD

$$= u_i * t_r + \frac{u_i^2 - u_f^2}{2g\left(\frac{a}{g} \pm \frac{G}{100}\right)}$$

g: rate of gravitional acceleration 32.2 ft/sec^2 ($9.8\ m/sec^2$)

a: rate of deceeleration 11.2 ft/sec^2

G: grade ↗ ↘ if level → G = 0 %

→ a/g ≃ 0.35

1 mile → 5280 ft

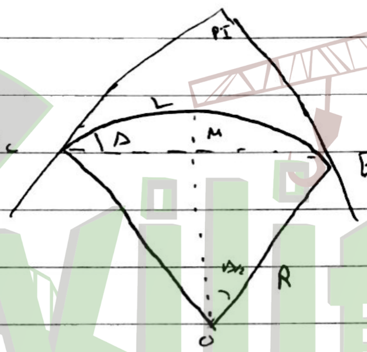
mile/hr → $\underbrace{5280/3600}_{1.47}$ ft/sec

* Force acting on vehicles :

$$\underbrace{R_a}_{\text{Resistance} \;\; \text{tractive}} + \underbrace{R_g}_{\text{Res.} \;\; \text{trac.} \;\; \text{Zero (level)}} + \underbrace{R_r}_{\text{res.}} + \underbrace{R_c}_{\text{Res.} \;\; \text{Straight (tangent) Zero}}$$

* power = $R * u$

$\hookrightarrow [1.47 * \Sigma R / 550]$ lb



$\cos\frac{\Delta}{2} = \frac{R - M}{R}$ $\quad$ * $SSD = \frac{\pi R \Delta}{180}$

$M = R - R\cos(\Delta/2)$

$\rightarrow \; SSD_{act.} = \frac{\pi R}{90}\left[\cos^{-1}\left(\frac{R - M}{R}\right)\right]$

$\rightarrow \; SSD_{design} = PIEV + DB$

* if $SSD_{act} < SSD_{des.} \longrightarrow$ Not Safe

if $SSD_{act} \geq SSD_{des.} \longrightarrow$ Safe

Example 3.5 :

Speed @ G = − 5% = Speed @ G = − 3%

$$BD = \frac{u_i^2 - 0}{2g\left(\frac{a}{g} \pm G\right)}$$

The Student needed an extra 18.5 when travelling @ G = − 5% then when travelling @ G = − 3%

BD @ G = − 5% = X

BD @ G = − 3% = X − 18.5

→ @ G = − 5% ⇒ $X = \dfrac{u_i^2}{2g\left(\frac{a}{g} - \frac{5}{100}\right)}$

→ @ G = − 3% ⇒ $X - 18.5 = \dfrac{u_i^2}{2g\left(\frac{a}{g} - \frac{3}{100}\right)}$

نفرض من رحطن

u = 51.4 mi/h

* Traffic flow :

→ flow :

no. of vehicle = N which were counted with T sec.

q → 1 hr (3600 sec.)

N → T sec.

(veh / hr) ← $q = \dfrac{N * 3600}{T}$ * dinamic

نحتاج فيديو

→ Density :

N → L (ft)

K → 1 mile (5280)

→ $K = \dfrac{N * 5280}{L}$ (veh / mile)

Ex 6.1 :

$N = 4$ veh's , $L = 300'$, $u_A = 45$ mil/hr

$u_B = 45$ mil/hr

$u_C = 40$ "

* time = T sec. $u_D = 30$ "

1) $q = \frac{N * 3600}{T} = \frac{4 * 3600}{T}$ (veh/hr)

2) $K = \frac{4 * 5280}{300} = 70.4$ (veh/mile)

3) $\bar{u}_t = \frac{45 + 45 + 40 + 30}{4} = 40$ mph

4) $\bar{u}_s = \frac{4}{\frac{1}{45} + \frac{1}{45} + \frac{1}{40} + \frac{1}{30}} = 39$ mph

* $\boxed{q = K * u_s}$

12/10/2017

$\bar{u}_s$: Space mean speed @ any density

K : Density @ any speed

u_f : free flow speed (Constant for same road characteristics)

@ $K = \emptyset$

K_j : Jammed traffic density (Constant for same road charac..)

@ $\bar{u}_s = \emptyset$

→ @ K_j or @ u_f → Boundary conditions

$\bar{u}_s = u_f\,(1 - K/K_j)$ ← inverse Linear relationship ($\bar{u}_s$ & K)

* Green shield's Model

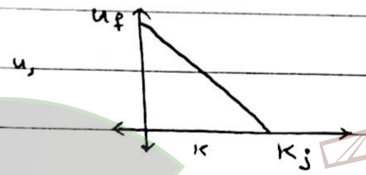
at $q_{max.}$ $\rightarrow$ $K = K_o$

$u_s = u_o$

* Macroscopic Approach :

→ Green shield's Model:

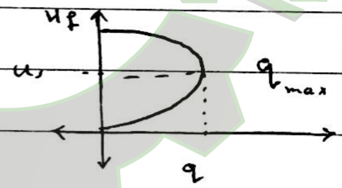
a) $\bar{u}_s = u_f - u_f \; K/K_j$ ---- ①



* Subsititute for (K) in ① :

$$\left[\bar{u}_s = u_f - u_f * \frac{q}{\bar{u}_s * K_j} \right] * \bar{u}_s$$

$$\rightarrow \bar{u}_s^{\,2} = u_f \, u_s - \frac{u_f}{K_j} * q$$



* Diffenentiating (q) with respect to $\bar{u}_s$:

$$\rightarrow 2\,\bar{u}_s = u_f - \frac{u_f}{K_j} \cdot \frac{dq}{d\bar{u}_s}$$

* Rearranging :

$$\frac{dq}{d\bar{u}_s} = (u_f - 2\,\bar{u}_s) * \frac{K_j}{u_f}$$

but , @ Capacity ($q_{max.}$) $\rightarrow$ $\frac{dq}{d\bar{u}_s} = Zero$

$(K = K_o \;,\; u_s = u_o)$

$$\rightarrow 0 = \frac{u_f \, K_j}{u_f} - \frac{2\,\bar{u}_o \, K_j}{u_f}$$

⇒

$$\rightarrow K_j = \frac{2 \bar{U}_o K_j}{U_f}$$

$$\Rightarrow \boxed{U_o = \frac{1}{2} U_f} \quad , @ \, q_{max.}$$

b) $\bar{U}_s = U_f - U_f \, K/K_j$ --- ①

* Substitute for $\bar{U}_s$ in ①

$$\left[\frac{q}{k} = U_f - U_f \frac{K}{K_j} \right] * K$$

$$\rightarrow q = U_f \, K - U_f \, K^2/K_j$$

* Differentiating (q) with respect to K :

$$\frac{dq}{dK} = U_f - 2K \frac{U_f}{K_j}$$

but, @ Capacity ($q_{max.}$) $\rightarrow$ $(dq/dK) = 0$

$[K = K_o \, , U_s = U_o]$:

$$\rightarrow 0 = U_f - 2 K_o \, U_f/K_j$$

$$\Rightarrow \boxed{K_o = \frac{1}{2} K_j} \quad , @ \, q_{max.}$$

So, $q_{max.} = K_o * U_o$

$$= \frac{K_j}{2} * \frac{U_f}{2} = \boxed{\frac{K_j \, U_f}{4}}$$

→ Greenberg Model :

$\bar{U}_s = C \ln K_j/K$ ---- ①

C : Constant that depends on the characteristic of traffic flow

⇒

* Multiply both sides with (K) :

$\rightarrow \quad q = C\,K \ln(K_j/K)$

$= C\,K \ln K_j - C K \ln K$

* Differentiate (q) with respect to (K) :

$\rightarrow \quad \frac{dq}{dK} = C \ln K_j - C(1 + \ln K)$

$= C \ln K_j - C \ln K - C$

$= C \ln(K_j/K) - C$

@ $q_{max.}$ $\rightarrow$ dq/dK = Zero

$\rightarrow \quad 0 = C \ln(K_j/K_o) - C$

$C = C \ln(K_j/K_o)$

$\Rightarrow \boxed{\ln \frac{K_j}{K_o} = 1}$, @ $q_{max.}$ ---- ②

* Subsituting ② in ① @ $q_{max.}$

$u_o = C$

Now @ $q_{max.}$ $\rightarrow$ $u_o = C \ln(K_j/K_o)$

but , $1 = \ln(K_j/K_o)$

$1 = \ln K_j - \ln K_o$

$\ln K_o = \ln K_j - 1$

$e^{\ln K_o} = e^{\ln K_j - 1}$

$\Rightarrow \boxed{K_o = e^{(\ln K_j - 1)}}$, @ $q_{max.}$

$q_{max.} = u_o * K_o$

$= C * e^{(\ln K_j - 1)}$

* Follow - The - Leader Theory :

$$X_n - X_{n+1} = p + S$$
$$= \rho \, \dot{x}_{n+1}$$

* Differentiate :

$$\dot{X}_{n+1} = \frac{d\, x_{n+1}}{d_t} \quad ; \quad S : \text{Constant}$$

$$\dot{X}_n - \dot{x}_{n+1} = \rho \ddot{x}_{n+1}$$

* Rearranging :

استجابة المركبة

$$\ddot{X}_{n+1} = (\dot{X}_n - \dot{x}_{n+1}) / \rho$$ ← Describes response of vehicle

However, researches found that at any time (t) there's a time Lag term that Corresponds to [pIEV time] = T

* Also; $\rho = 1/\lambda$

$$\lambda = a \frac{\dot{X}^{m}_{n+1}(t+T)}{[X_n(t) - X_{n+1}(t)]^L}$$

∴ a, L, m : Constant
→ change micro. → macro.

لو عوضنا بقيم

$$\boxed{\ddot{X}_{n+1}(t+T) = a \frac{\dot{X}^{m}_{n+1}(t+T)}{[X_n(t) - X_{n+1}(t)]^L} * \left[\dot{X}_n(t) - \dot{X}_{n+1}(t)\right]} \quad (1)$$

Now, derivate either green shield or green berg Models from follow - the - Leader theory.

* Substitute for $m = 0$, $L = 1$ in eq. (1) :

$$\rightarrow \ddot{X}_{n+1}(t+T) = \frac{a[\dot{X}_n(t) - \dot{x}_{n+1}(t)]}{[X_n(t) - X_{n+1}(t)]}$$

* integrating both sides :

$$\rightarrow \dot{X}_{n+1}(t+T) = a \, L_n [X_n(t) - X_{n+1}(t)] + C$$

* for Steady State Condition :

Speed of vehicle A = vehicle B

$$U_n - U_{n+1} = \text{Zero}$$

$$\dot{X}_{n+1}(t) = \dot{X}_{n+1}(T) = u$$

$$\rightarrow \quad u = a \ln \underbrace{[X_n - X_{n+1}]}_{\text{Space head way } = 1/K \rightarrow \text{density}} + C$$

Assming now that we've measured these parameters for the traffic stream :

$$u = a \ln \frac{1}{K} + C$$

Now ; using boundary condition at max. $K = K_j$

$\rightarrow$ @ K_j $\therefore$ $u = 0$

$$0 = a \ln 1/K_j + C$$

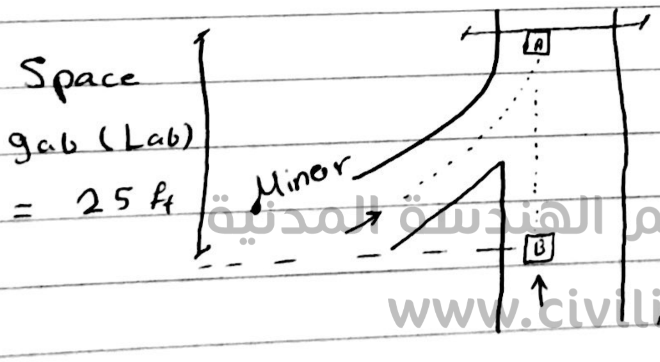
$$C = -a \ln 1/K_j$$

* substituting :

$$u = a \ln 1/K - a \ln 1/K_j$$

$$\boxed{u = a \ln K_j/K} \leftarrow \text{Green berg's Model.}$$

17/10/2017



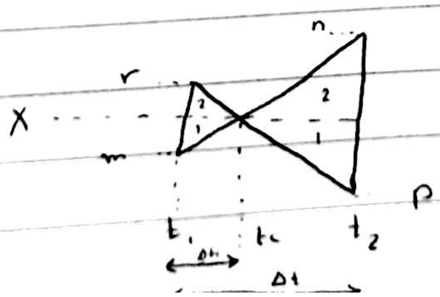
A @ 8:00

B @ 8:01

$\rightarrow$ Time gab (Lag) = 60"

* Mathematical Solution :

1) first two triangles by similar triangles :



$$\rightarrow \frac{X - p}{\Delta t - \Delta t_1} = \frac{X - m}{\Delta t_1}$$

$$2X \Delta t_1 - p \Delta t_1 = X \Delta t - m \Delta t + m \Delta t_1 \quad \text{--- equ. (1)}$$

2- Second two triangles by similar triangle :

$$\rightarrow \frac{n - X}{\Delta t_2 - \Delta t_1} = \frac{r - X}{\Delta t_1}$$

$$n \Delta t_1 - 2X \Delta t_1 = r \Delta t - X \Delta t - r \Delta t_1 \quad \text{--- equ. (2)}$$

(1) + (2) ; we get :

$$\rightarrow \Delta t_1 (n-p) + \Delta t_1 (r-m) = \Delta t (r-m)$$

$$\Delta t_1 = \frac{\Delta t (r-m)}{n - p + r - m}$$

$$t_c = \frac{\Delta t (r-m)}{n - p + r - m} + t_1 \quad ; \quad t_c = t_1 + \Delta t_1$$

M : no. of gaps accepted @ t_1

r : " " " rejected "

n : " " " accepted @ t_2

p : " " " rejected "

* using the number from the example

$$t_c = 3 + \frac{1 (38 - 32)}{57 - 19 + 38 - 32} = 3.14 \text{ sec.}$$

λ : arrival rate of vehicles

$$\mu = \lambda * t$$

$\lambda = 1000$ veh / hr
$t = 10$ Sec.
$X = 5$ veh.

$\rightarrow \mu = \lambda * t$
$= \frac{1000}{3600} * 10 = \frac{100}{36}$

$\rightarrow p(X=5) = \frac{(\frac{100}{36})^5 * e^{-\frac{100}{36}}}{5!}$

$\rightarrow p(X<2) = p(X=0) + p(X=1)$

$= \frac{(\frac{100}{36})^0 * e^{-\frac{100}{36}}}{0!} + \frac{(\frac{100}{36})^1 * e^{-\frac{100}{36}}}{1!}$

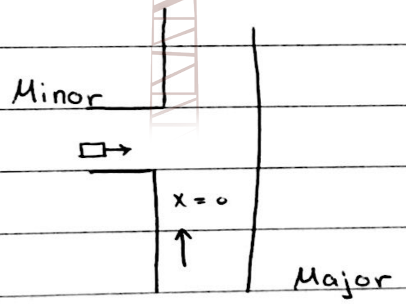
$\rightarrow p(X>2) = 1 - p(X<2)$

الخميس 19/10/2017

$p(x) = \frac{\mu^x * e^{-\mu}}{x!}$

Gap existence :

$X = 0$ arrivals



$p(x=0) = \mu^0 * e^{-\mu} / 0!$
$= e^{-\mu}$

$\lambda = 1000$ veh / hr [volume]

$\rightarrow$ Acceptance :
$p(h \geq t_c) = e^{-\mu}$ $\leftarrow$ Gap existence probability

$\rightarrow$ Rejection :
$p(h < t_c) = 1 - e^{-\mu}$ $\leftarrow$ No Gap

$\therefore t_c$ is found using RaFF's approach

* frequency of existence of Gaps : (Acceptance)

$$\rightarrow (\lambda - 1) * e^{-\mu}$$

* frequency of no existence of Gaps : (Rejection)

$$\rightarrow (\lambda - 1) * (1 - e^{-\mu})$$

Example 6.7 :

λ = 1800 veh / hr = 1800 / 3600 veh / sec. = 0.5 veh / sec.

t_c = 3.5 sec.

* Expected no. of acceptable Gaps :

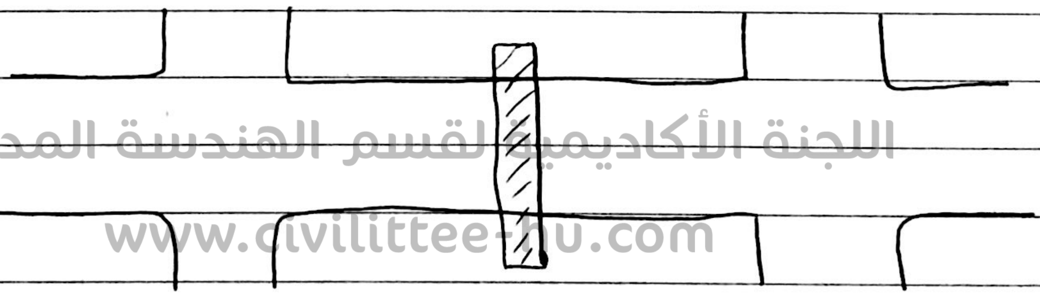
$$\text{frequency (F)} = (\lambda - 1) * e^{-\mu}$$

$$= (1800 - 1) * e^{-0.5 * 3.5} = 312 \text{ gaps}$$

[Accepted]

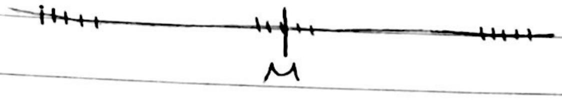
$$\rightarrow \mu = \lambda * t_c$$

urban
AND
Suburban



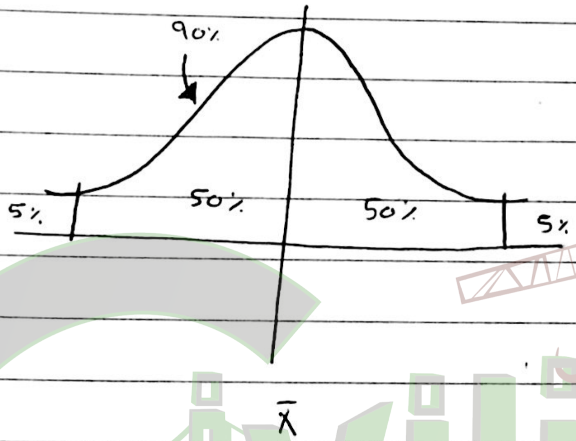
$S = \sqrt{\dfrac{\Sigma (x - \bar{x})^2}{N - 1}}$, Small

$$\sigma = \sqrt{\frac{\Sigma (x - \mu)^2}{N}} \text{ , Larg}$$



pop. → σ

Sample → S



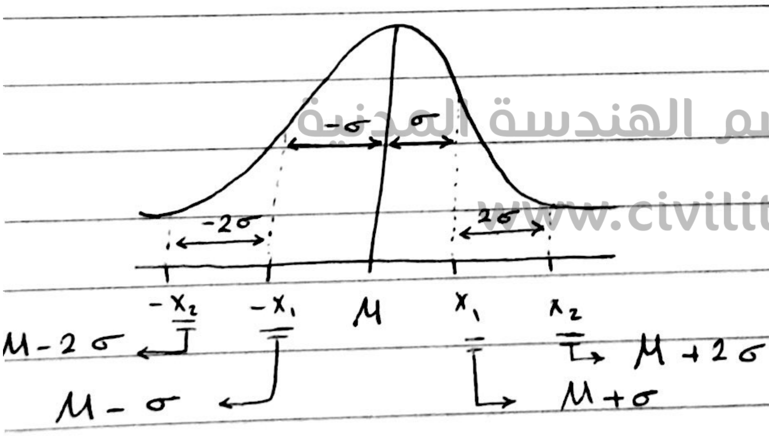
$\int f(x)\,.\,dx = 50\%$

$CL = 90\%$

$\alpha = 100\% - 90\% = 10\%$

$\alpha/2 = 5\%$

* Standardized Normal dist. – Z dist.

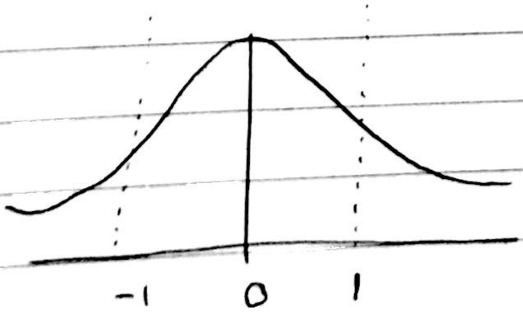


$Z = \dfrac{X - \mu}{\sigma}$

$Z_1 = [\mu + \sigma - \mu]/\sigma = 1$

$-Z_1 = [\mu - \sigma - \mu]/\sigma = -1$

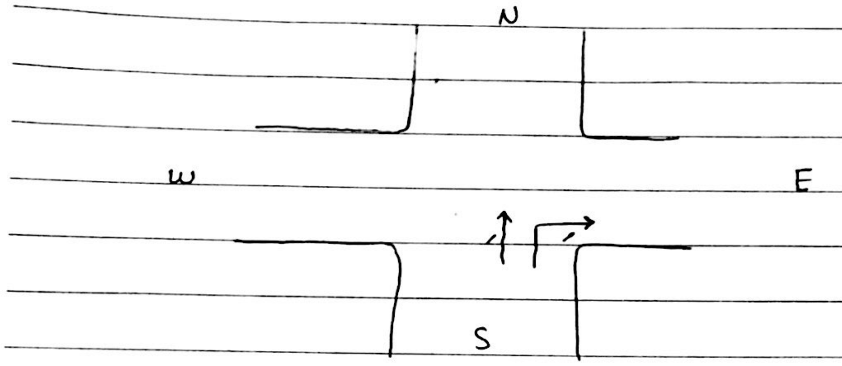
@ $\mu \longrightarrow Z = [\mu - \mu]/\sigma = \emptyset$



$Z_2 = [\mu + 2\sigma - \mu]/\sigma = 2$

$-Z_2 = [\mu - 2\sigma - \mu]/\sigma = -2$

24/10/2017



* Turning movements :

→ Through (TH)

→ Right (Rt)

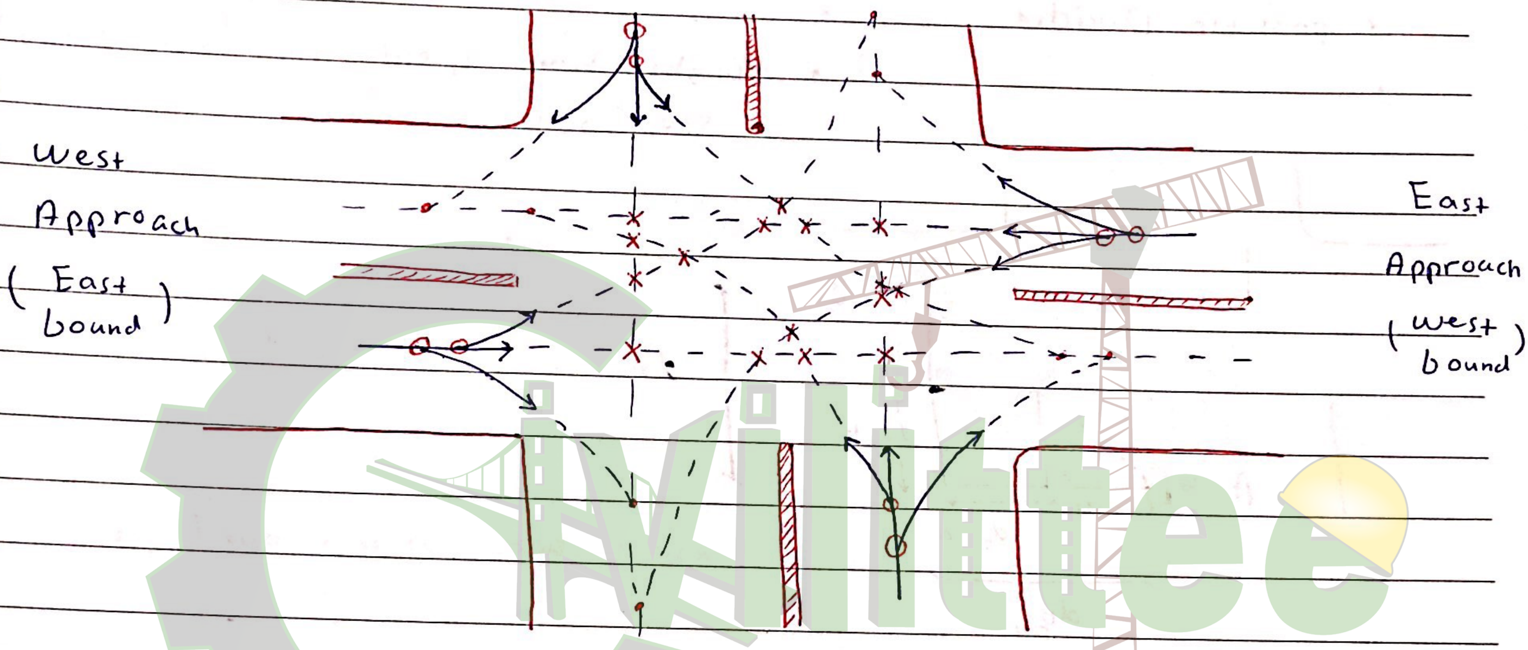
→ left (Lt)

→ U - turn (U)

29/10 الأحد

TCD's : Traffic Control Devices

North Approach (South Bound)



South Approach
(North bound)

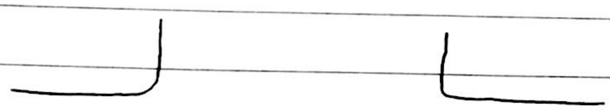
* No TCD's
* Left , Right
* No U-turn , No pedestrians

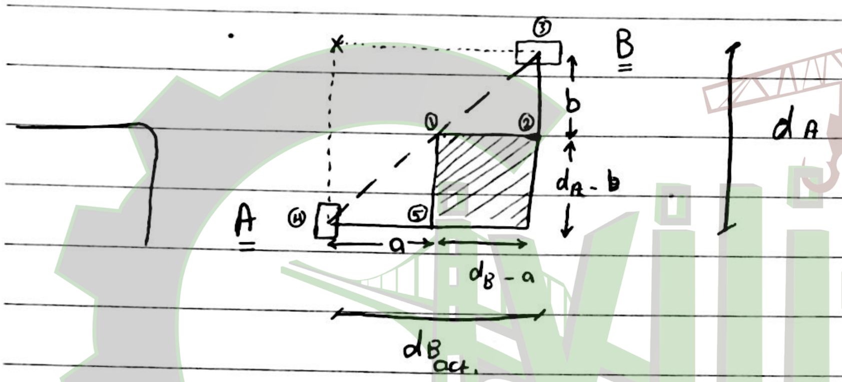
→	Merge	•	8
→	Diverg	o	8
→	Cross	x	16
			32 Conflect point.

* if U-turn allows : + 4 for Merge & Diverg
* if pedestrians allows : + 32 for cross

31 / 11 الثلاثاء

Major	Minor
* wider	*
* Higher volume	*
* possible Divided	*
*	* Might have yield sign or 2-way stop sign





$$d_A = U_{Ai} * t_r + \frac{U_{Ai}^2 - U_{Af}^2}{2g\left(\frac{a}{g} \pm G/100\right)}$$

a, b, d_A : Km

$$\frac{a}{d_A - b} = \frac{dB_{act} - a}{b}$$

$$dB_{act} = \frac{ab}{d_A - b} + a$$

$$= \frac{ab + ad_A - ab}{d_A - b} = \frac{ad_A}{d_A - b}$$

* for Safety :

$$dB_{act} \geq dB_{min}$$

Otherwise ; i.e $dB_{act.} < dB_{min.} = U_{iB} * t_r + \dfrac{U_{iB}^2 - U_{fB}^2}{2g\left(\frac{a}{g} \pm \frac{G}{100}\right)}$

$\longrightarrow$ not Safe $\longrightarrow$ passive Control is violated

* Rule 2 : (level I)

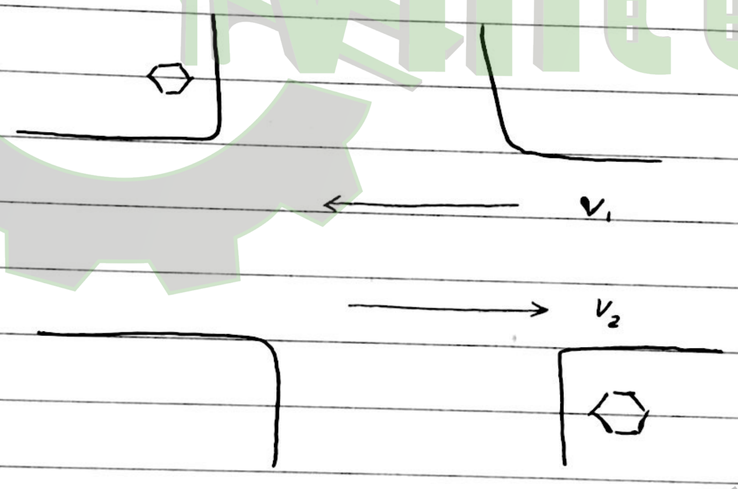
$$t_A = t_B$$

$$\frac{d_A + 18}{u_A * 1.47} = \frac{d_{B_{min}} - 12}{u_B * 1.47}$$

rule 2 $\longrightarrow$ $d_{B_{min.}} = \frac{(d_A + 18) * u_B * 1.47}{u_A * 1.47} + 12$

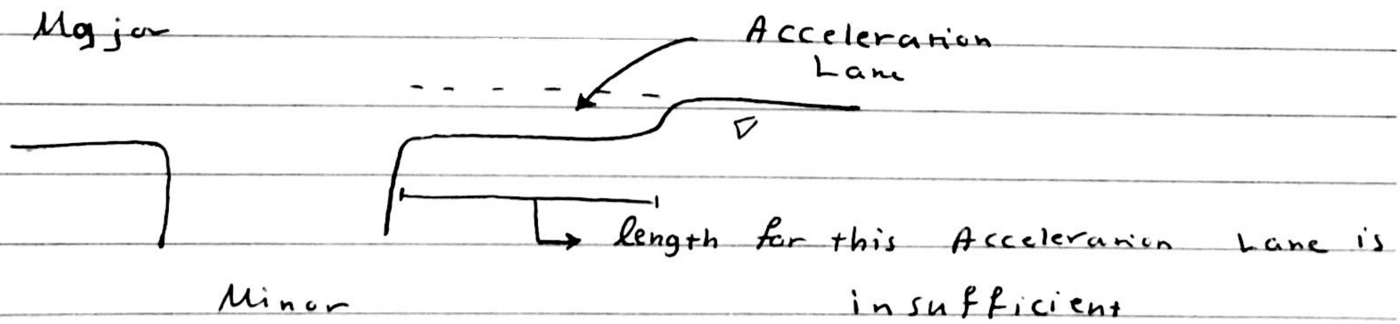
rule 1 $\longrightarrow$ $d_{B_{min.}} = 1.47 * u_B * t_r + \frac{u_{B_i}^2}{2g\left(\frac{a}{g} \pm \frac{G}{100}\right)}$

* Two - way stop sign :

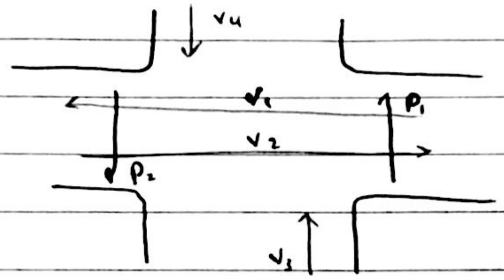


i) $V_1 + V_2 > 6,000$ veh / day

2/11 الخميس



Major



Minor

* mon. or, Tue, or wed. (3) , delay for vehicle on minor during peack-hr $> \underline{\underline{30}}$ sec.

hr	(1) $V_1 + V_2$	(2) $V_3 + V_4 + P_1 + P_2$
1	$\geq 300 * 70\%$	$\geq 200 * 70\%$
2	$\geq 300 * 70\%$	$\geq 200 * 70\%$
3	$\geq 300 * 70\%$	$\geq 200 * 70\%$
4		
⋮		
8	$\geq 300 * 70\%$	$\geq 200 * 70\%$

, any highest 8-hrs within aday, not necessiatily Consequitive متتالية

$$V_3 + V_4 = \underbrace{\text{vehicle} + \text{Byc.} + P_1 + P_2}_{\text{unit}}$$

الاحد 5/11

* if the intersection is not Controlled by any TCD and there's a sight obstruction

→ Check Level I

- Safe [No Control] $d_{B_{act}} \geq d_{B_{min}}$
- unsafe ≡ Violation (rule 1 and/or rule 2) $d_{B_{act}} < d_{B_{min}}$ → * Reduce speed on major * Remove obstruction * Check for yield or stop

→ Check for Level II

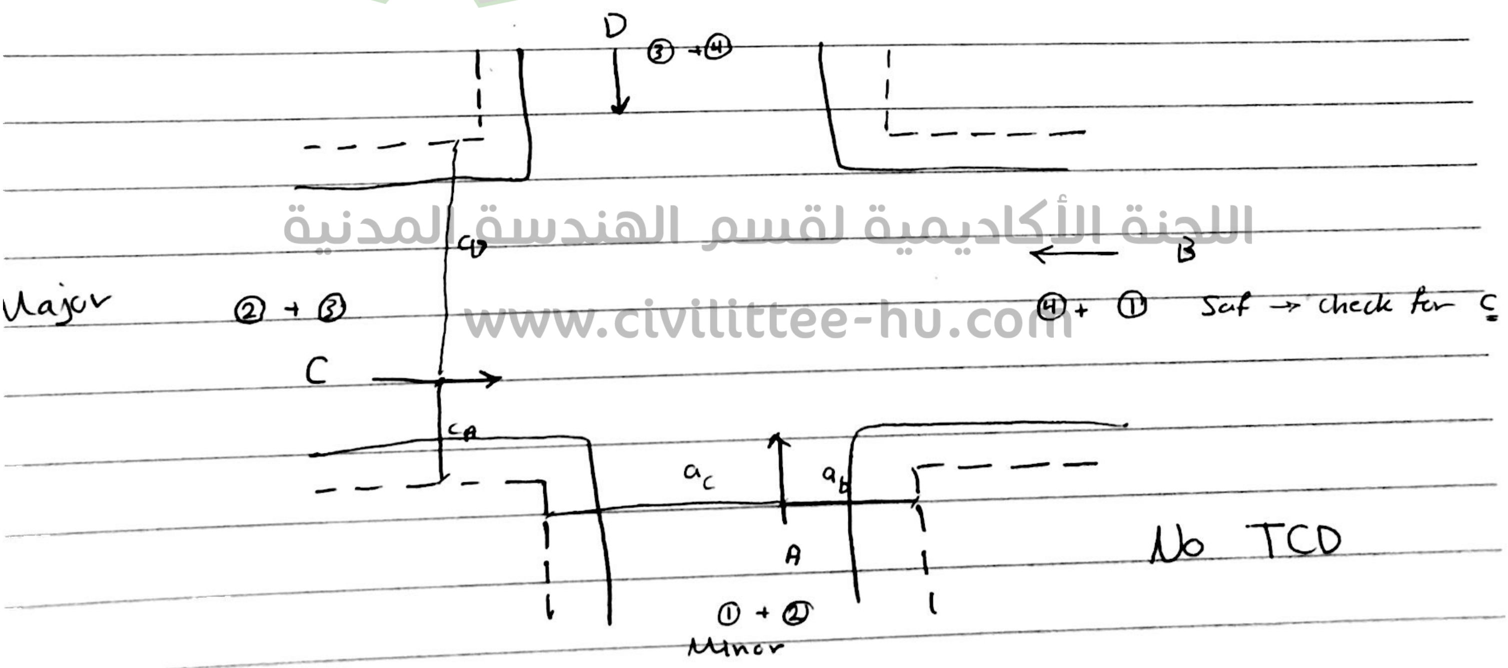
↳ two-way stop → since there's on obstruction

if Not ↓

* Check for yield — data ↓ yield is need
* check for 2-way stop — data ↓ 2-way stop needed
* Check for All-way stop — data ↓ All-way stop is needed
* check traffic signals

safe with out 2-way install

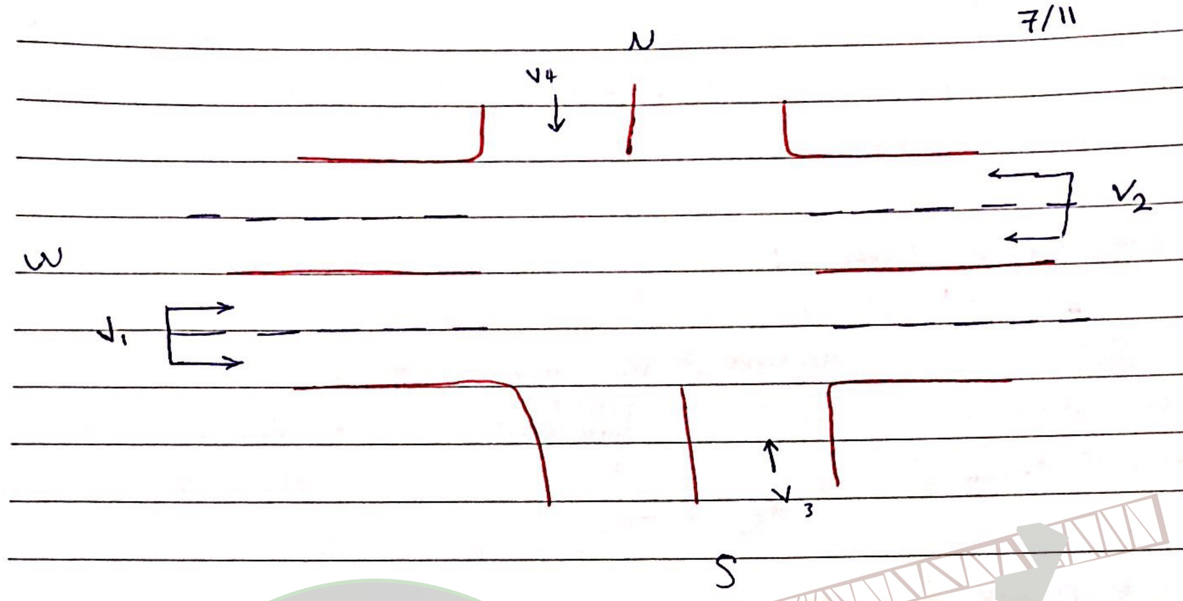
data 2-way stop needed



* if we check for ① and ② was unsafe

→ install 2-way

الثلاثاء 7/11



* 2-lanes in Major
* One Lanes in Minor

→ No. of lanes / direction.

Avg. week day traffic Volume during any 8-hrs not necessarily consequitive

Approach Vol. / Hr	Major E	Major W	Major Σ	Minor N	Minor S	
1) 6-7	300	350	650 ✓	100	200	
2) 7-8	400	300	700 ✓	110	100	
3) 10-11	300	300	600 ✓	110	120	x
4) 12-13	250	400	650 ✓	160	140	
5) 13-14	300	350	650 ✓	170	130	
6) 14-15	350	250	600 ✓	190	100	
7) 16-17	410	300	710 ✓	180	150	
8) 20-21	300	300	600 ✓	150	100	

Heighest 8-hrs Volume

2 Lanes & 1 Lanes

→ Condition A :

Major 100%	Minor
≥ 600	≥ 150

* Condition A :
from warrant 1 is not met since there's a vol. below the there shold on Minor (10h - 11h)

→ Condition B :

Major 100%	Minor
≥ 900	≥ 75

* Condition B :
from W_1 is not met → None of the hrs on Major was met

$\cancel{X}$ → if Speed on Major > 40 mph (70 Kph)
or pop. $< 10{,}000$ inhabitants

→ Condition A : **OR** → in Condition B :

Major 70%	Minor
≥ 420	≥ 105

Major 70%	Minor
≥ 630	≥ 53

← في حال لم ينطبق على 100% في Cond. A+B ولم يعطيني سرعة او عدد سكان.

→ Condition A : **AND** → Condition B :

Major 80%	Minor
≥ 480	≥ 120

Major 80%	Minor
≥ 720	≥ 60

* W_1 is not met since 80% of Condition B is not met

W1

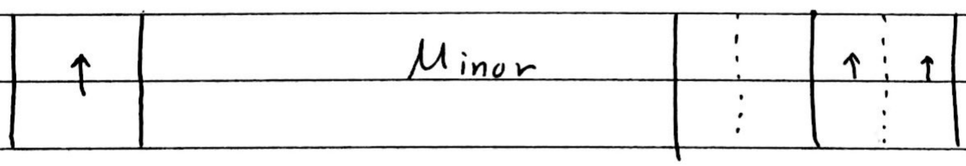
No. Speed or pop
or Speed Major > 40 mph
or pop. < 10,000
↓
Use 70% of
Cond. A or B
↓ if met
w_1 is met
otherwise ↓
w_1 is not met

No speed or pop.
or speed < 40 mph
or pop. > 10,000
↓
use 100% of
Cond. A or B
met → w_1 is met
Not met ↓
use 80% of Condition A + B (AND)
if met ↓ w_1 is met
otherwise ↓ w_1 is not met

Warrant 3: 12/11 الاحد *

1) Total Stop time delay:

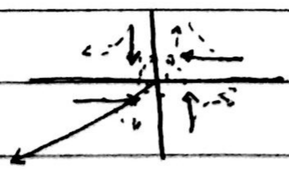
(Volume * delay /veh) Minor



4 veh-hrs 5 veh-hrs

+

2) Vol. on the Same Minor approach as in Condition 1 ≥ * 100 veh/hr
* 150.

3)  ≥ 800 veh/hr

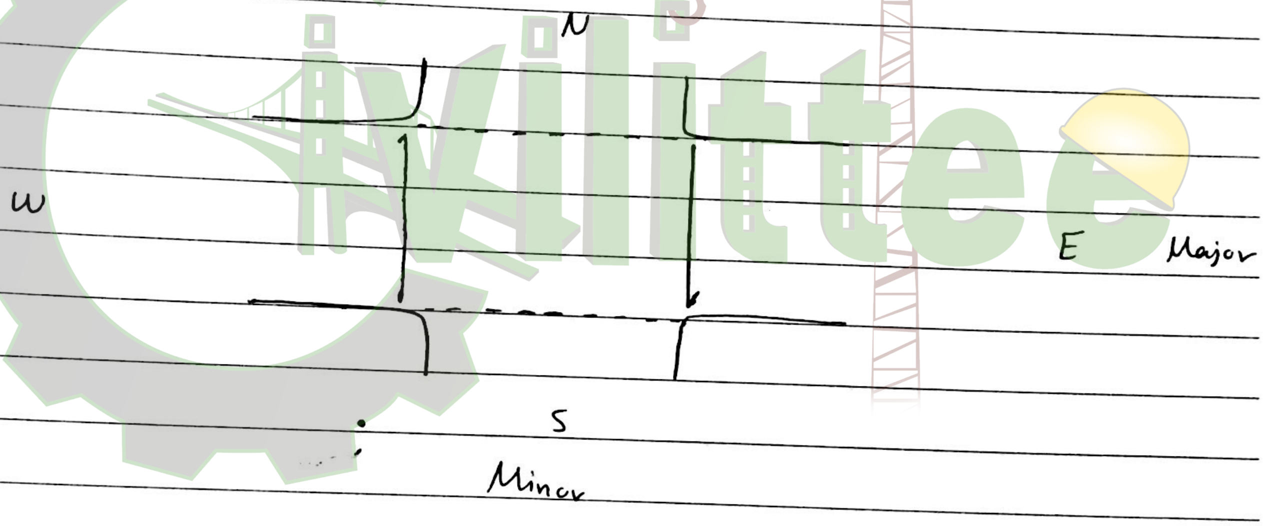
r = 250 m

	total major	highest minor
8 - 9	700	300
2 - 3	690	370

* we pick the peack hours based on Major approaches Volume

→ check all warrants (1-8).

→ check applicable warrants في حال كان معرف التقاطع ووجود معلومات



		$\underline{\underline{E}}$	$\underline{\underline{W}}$	$\underline{\underline{\Sigma}}$	
1)	8 - 9	70	30	100	
2)	10 - 11	80	50	130	✓
3)	13 - 14	60	100	160	✓
4)	14 - 15	70	90	160	✓

	E Gaps / hr	W Gaps / hr	
1)	54	60	x
2)	60	59	x
3)	59	54	✓
4)	60	50	x

* It's enough to have no. of gaps < no. of minutes for one direction for the Condition to be met

- if non of the warrant was met expect for warant 4 or 5

→ the signal should be
→ pedestrian actuated

* Many remedial measured were implemented but failed to provide safe crossing for school children.
→ Check

14/11 الثلاثاء

* Crash Out Come :

→ personal Injuries :
→ Slight injury : اصابات بسيطة
→ Severe injury : اصابة خطيرة
→ fatality
→ property Damage only (PDO) اضرار مادية

* Crash type :
* Head - on
* Side swipe
* pile - up
* Rear - end ← Can not be ~~Corr~~ Corrected using traffic Signal
* Left turn
* right turn
* pedestrian

* trials

* ≥ 5 craches

* 1- Check 80% of W_1 - A

  or 80% of W_1 - B

  or at Least we've 80% * 100 ped./hr / 4-hrs

  or 80% * 190 ped./hr / 1-hrs

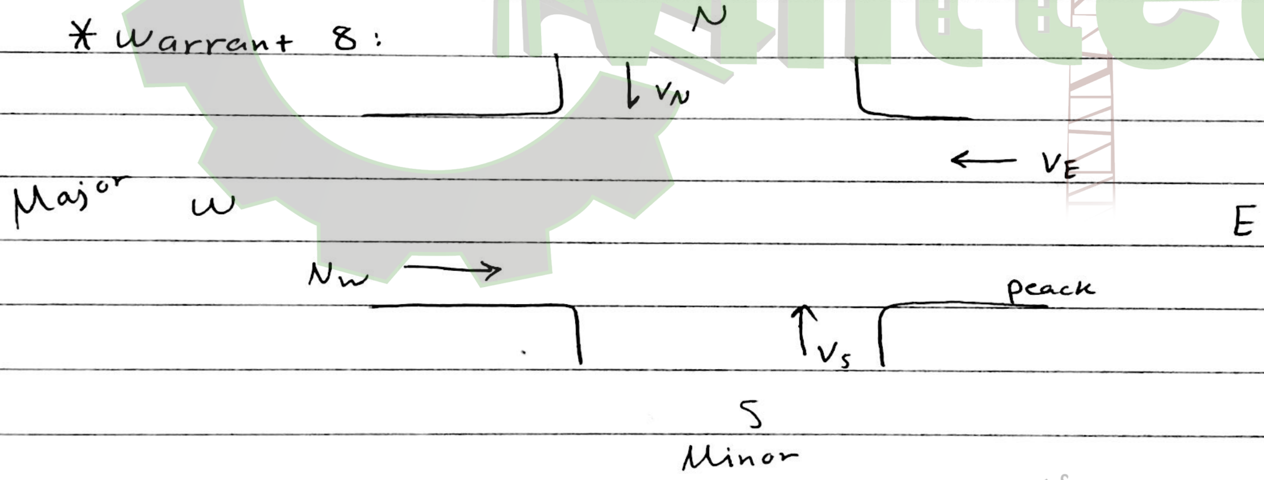
  or → if speed > 40 mph (70 kph)

  pop. < 10,000

→ check for 56% of W_1-A

  or 56% of W_1 - B

* Warrant 8 :



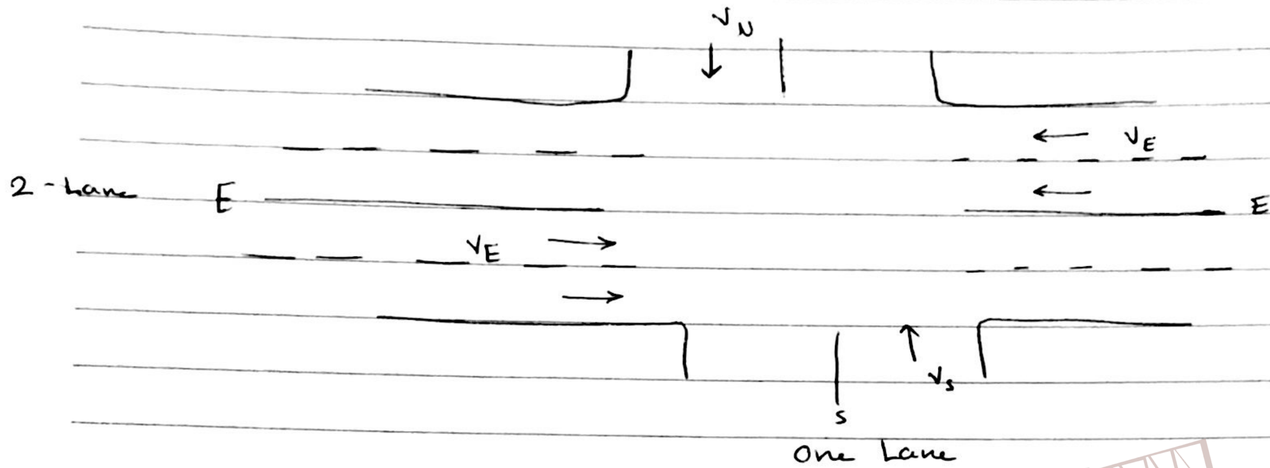
$$V_E + V_N + V_W + V_S \geq 1000 \text{ veh/hr}$$

Mon. , Tue , wed.

$$+ (V_E + V_W + \overbrace{V_{N,S}}^{\text{الاعلى بينهم}})^5 \rightarrow \text{has met} \rightarrow W_1 \text{ or } W_2 \text{ or}$$

$$F = P(1 + G\%)^{N} \rightarrow 5$$

* Ex: 8.2



$V_W + V_E = 400$ veh/hr

$V(\text{Higher})_{N,S} = 100$ veh/hr

$U_{major} = 43$ mph

$\rightarrow$ 2 Lanes Major E-W + 1 Lane minor N-S

Use 70% of warrants since $U_{major} > 40$ mph

* W_1 : Condition A.

Thersholds:

70% major	minor
420	105

Since $400 < 420 \rightarrow W_1 - A$ is not met

Since not met because of vol. on major, then W_1 is not met

* W_2 : Using fig. 4C-2 : (400, 100)

Since (400, 100) falls belows the (2 lane & 1 Lane) curve

$\rightarrow W_2$ is not met

* W_3 : using fig. 4C-4 : (400, 100)

$\rightarrow W_3$ is not met

* W_4 : ped. volume
= 200 ped / hr. > 190 ped / hr
+ no. of gaps = 52 /hr < 60

and the nearest signalized intersection
is 450′ away > 300′

→ W_4 is met.

Decision : A traffic Signal installed according to W_4

→ the traffic signal shall be of pedestrian - actuated type.

EX : page 464. 16 / 11 الخميس

W_4 : pedestrian
W_7 : Crash Experience [No speed or pop. - data]
8 - hrs , 4 - hrs , peack - hrs

	Major	Minor
1)	1,130	125
2)	1,090	100
3)	1,070	103
4)	1,050	115
5)	1,040	100
6)	1,011	95
7)	985	100
8)	975	85

	ped. Vol.	gaps
1)	135	55
2)	140	50
3)	120	52
4)	180	58

* Crash data = 4 ⊥ + 3LT + 3 ped. = 10 crashes

→ 2 way Stop Sign

→ Delay / peack - hr = 30 Sec. / Veh.

* W_1 :

- Cond. A : 100% → Thresholds : (600 , 150)

∴ Not met Since (1,130 ; 125) has the minor approach Vol. < 150

- Check Cond. B : 100% → Thresholds : (900 , 75)

∴ Cond. B is met

* W_2 :

using fig. 4C-1 and Curve (2 Lanes ; 1 lane)

point (1,090 ; 100) Lies below the curve

→ W_2 is not met.

* W_3 :

- Craterion A : (1,130 ; 125)

1) Total - Stopped time delay

$$= 125 * \frac{30}{3600} = 1.04 \text{ veh-hrs} < 4 \text{ veh-hrs}$$

→ Craterion A is not met

- Craterion B : using fig. 4C-3

Since (1,130 ; 125) Lies below Curve (2 & 1 La

→ craterion B is not met

∴ W_3 is not met

* W_4 : is met.

→ because all peak vol. > 100 & Gaps < 60.

* W_7 :

A) 2way stop sign already exists

B) 10 crashes > 5 crashes

c) Since W_1 was met at 100% ; then it's met at 80%

→ W_7 is met

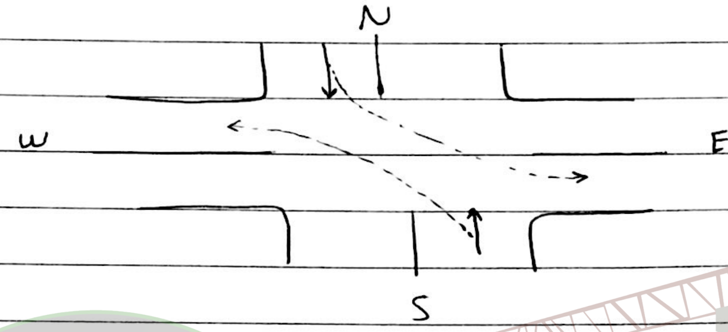
→ Decision :

A traffic Signal Can be installed since the following warrants are met (W_1 , W_4 , W_7)

الاحد ١٩/١١

$\frac{g_i}{C} \neq 1$

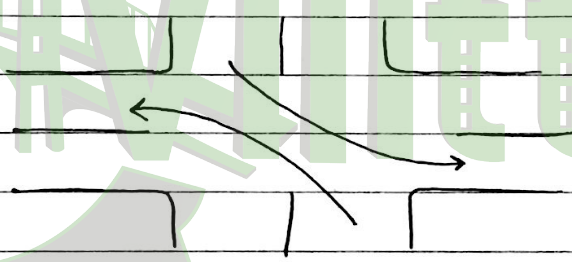
$\frac{g_i}{C} = 1 \rightarrow$ No intersection exists.



* permitted to make the LT in case there's a gap of an adequate Length

→ Can not be found in Jordan

protected LT



→ has it's own or shared phase (has green time) without any Conflicting movement

Design ⟷ Analysis

Geometry Traffic

Design

↓

Collect data to Calculate : C, g_i, S_i, L, y_i

↓

Check LOS

* Compute no. of Lane groups

Analysis

↓ observes

S_i, g_i, C

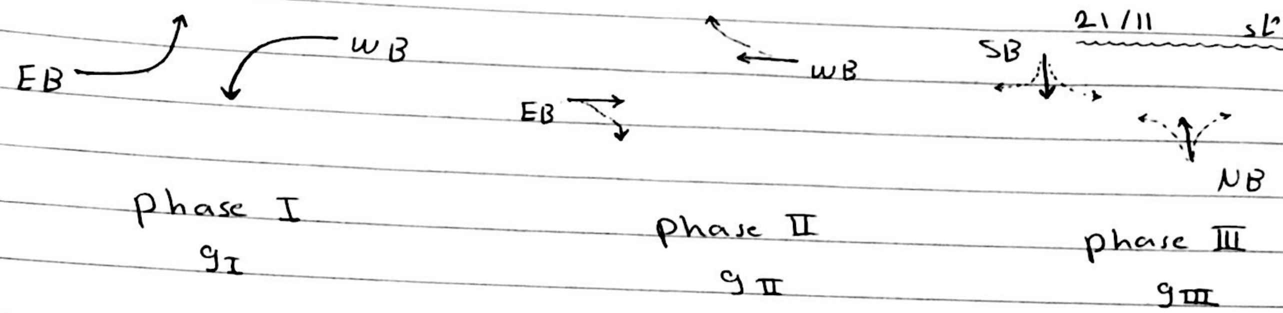
y_i, L

↓

Calculate LOS

* observe Lane groups

الثلاثاء 21/11



Exclusive $\equiv$ protected

* max. no. of Lane groups / Approach :

= no. of Lanes

= no. of Lanes − 1 → > 1

* table 16.7 :

→ V_g : summation of flow rate in Lane group without divide by PHF

90 ↰ ↑ 110

→ $P_{LT} = \frac{90}{90+110} * 100\%$

الخميس 23/11

t_L : Lost time / phase

$l_1 + l_2$

start-up ↲ ↳ Clearance

L : total Lost time in a cycle

* $C = S_i * g_i/C$

$\frac{v}{c} = X_c$ is assumed for design purposes

$X_c = 1.0 \rightarrow y_c \geq 0.9$

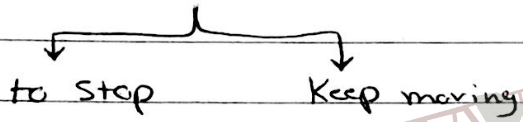
or

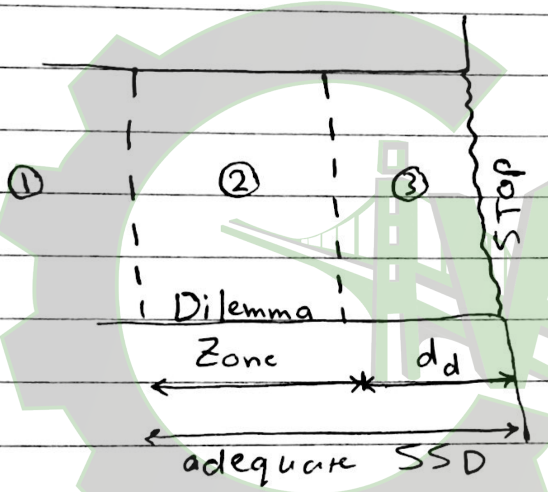
$X_c = 0.9 \rightarrow y_c < 0.9$

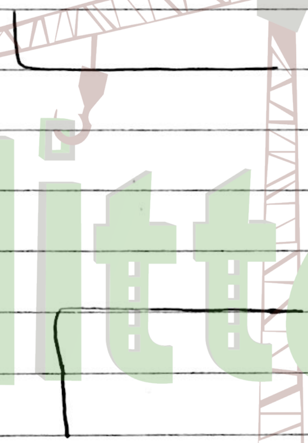
26/11 الاحد

Dilemma Zone: if a safe stop before the intersection can't be accomplished at constant speed, the vehicle will enter the intersection during a red indication

→ if there's a dilemma zone:
↳ Driver's decision is always incorrect







① if the vehicle is before SSD:
→ it can stop safety before the Stop Line

② if the vehicle is located after SSD and after d_d
→ the driver will : → Enter during red in the intersection, if decided to keep moving
→ stop after the stop line if decided to stop

③ if the vehicle is located in d_d:
→ the driver can enter the intersection before AR

36'

Vine

$u = 35$ mph , $G = $ Zero

* Checking for G_p :

→ To Cross maple (green is given to pedestrians and red is given for vehicles on Maple and green for vehicles is given on Vine) G_{III}

$C = 65$ sec.

$g_I = 12.5$ sec. } mapple

$g_{II} = 24.7$ sec.

$g_{III} = 15.8$ sec. } Vine

$N_{ped.} = 15$ ped.

L : width of vine

* G_p (mapple) $= 3.2 + \frac{60}{4} + 0.27 * 15$

$= 22.25$ sec. > 15.8 sec. $+ 4$ NOT Safe

→ To Cross Vine (green is given to pedestrians and red is given to vehicles on vine and green is given to vehicles on mapple) G_{II}

* G_p (Vine) $= 3.2 + \frac{36}{4} + 0.27 * 15$

$= 16.25$ sec. < 24.7 sec. Safe

$\rightarrow$ adjust g_{III} to be $G_p - t_L$

$= 22.25 - 4 = 18.25$ sec.

Maintaining ratio between green times :

$$\left(\frac{g_{II}}{g_{III}}\right)_{before} = \left(\frac{g_{II}}{g_{III}}\right)_{after}$$

$$\frac{24.7}{15.8} = \frac{g_{II}}{18.25}$$

$\Rightarrow$ $g_{II} = 28.53$ sec.

$$\left(\frac{g_{I}}{g_{III}}\right)_{before} = \left(\frac{g_{I}}{g_{III}}\right)_{after}$$

$$\frac{12.5}{15.8} = \frac{g_{I}}{18.25}$$

$\Rightarrow$ $g_{I} = 14.44$ sec.

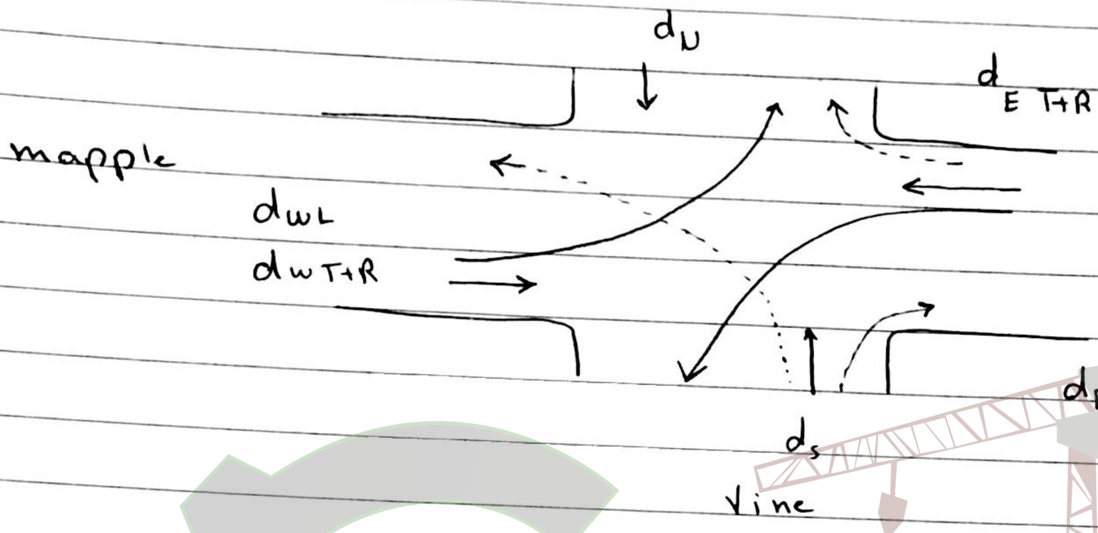
$C_{new} = 14.44 + 25.53 + 12 + 18.25$

$= 70.22$ sec.

$$C_i = S_i * \frac{g_i}{C}$$

28/11 الثلاثاء

$d_{E\,T+R} = d_1 + d_2 + d_3$



$d_{E\,L} = d_1 * PF + d_2 + d_3$

$$d\ (\text{East Appraach}) = \frac{d_{EL} * V_L + d_{E(T+R)} * V_{(T+R)}}{V_L + V_{(T+R)}}$$

$$d\ (\text{intersection}) = \frac{d_E * V_E + d_W * V_W + d_N * V_N + d_S * V_S}{V_E + V_W + V_N + V_S}$$

– sec / veh –

↓

Get LOS : Level of service

3/12 الاحد

* V = DHV : Design hour volume
  = AADT * K%

* $PHF = \dfrac{\text{total Volume}}{4 * \text{peak volume (15 min.)}}$

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

→ $P_T = P_T + P_B$

Ex. 1 : 1) $\frac{1600}{PHF} = \frac{1600}{0.95} = 1684$ 5/12 الثلاثاء

use the range > 1200 p_c/hr to get f_G, E_T, E_R

ATS : $f_G = 0.99$ [Ex 20-7] , $E_T = 1.5$, $E_R = 1.1$ [Ex. 20-9]
PTSF : $f_G = 1.00$ [Ex. 20-8] , $E_T = E_R = 1$ [Ex. 20-10]

$$FFS = BFFS - F_{LS} - F_A$$
$$= 60 - 1.7 - 5$$
$$= 53.3 \text{ mph}$$

* Access/mile = 20/mile

$f_{np} = 0.8$ using [Ex 20-11]

Example 1: one segment of a class I two-lane highway is on rolling terrain and has an hourly volume of 500 veh/hr with PHF = 0.94 and the traffic stream contains 5% Large trucks, 2% buses and 6% recrational vehicles for these conditions determine: 7/12 الخميس

Analysis flow rate for ATS and PTSF

V = 500 veh/hr ; %T = 5% + 2% = 7% (rolling)
$\%R_v = 6\%$; PHF = 0.94

$$V_p = \frac{V}{PHF * f_G * f_{HV}}$$

$$\frac{V}{PHP} = \frac{500}{0.94} = 532 \text{ veh/hr}$$

* using the range below 600 pc/hr get for ATS ,

→ $f_G = 0.71$, $E_T = 2.5$, $E_R = 1.1$

$$F_{HV} = \frac{1}{1 + 0.07(2.5-1) + 0.08(1.1-1)} = 0.9$$

ATS: $V_p = \frac{500}{0.94 * 0.71 * 0.9} = 832$ pc/hr

* find the new adjustment factor using rang between (600-1200)

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

$F_{HV} = 0.935$

$V_p = 612$ pc/hr ✓

Example 2: A class I two-Lane highway is no Level terrain. with passing permitted through hout (np% = zero)

* Lane width = 11 ft , sholder width = 4 ft
* Access/mi. = 16/mile , BFFS = 60 mph

Highway is oriented north & south and during the peack hour 440 vehicles go north bound
360 " " South " → V = 800 veh/hr

PHF = 0.87 , %T = 4% ; % Buses = 3% ⇒ %T = 7%
%Rv = 1%

⇒ LOS ??

Direction % = $\frac{440}{800} * 100\% = 0.55$

ATS: $\frac{V}{PHF} = \frac{800}{0.87} = 919.54$ veh/hr

$f_G = 1$; $E_T = 1.2$, $E_R = 1$

⇒ $f_{HV} = 0.986$

$$\Rightarrow V_p = \frac{800}{0.87 * 1.0 * 0.986} = 932.414 \text{ pc/hr}$$

$$FFS = BFFS - f_{LS} - f_A$$
$$= 60 - 1.7 - 4 = 54.3 \text{ mph}$$

$f_{np} = 0.0 \rightarrow$ Since passing is permitted throughout

$$\therefore ATS = FFS - 0.000776\, V_p - f_{np}$$
$$= 54.3 - 0.000776 * 932.414 - 0$$
$$= 47 \text{ mph}. \quad [LOS \rightarrow C]$$

PTSF: $\underbrace{E_T = 1.1 \; , \; E_R = 1}$

$\underbrace{f_{HV} = 0.993 \; ; \; f_G = 0.94}$

$V_p = 925.977$ pc/hr

$$BPTSF = 100\left(1 - e^{-0.00879 * 925.977}\right)$$
$$= 55.689 \%$$

f_{dnp} = Zero

PTSF = 55.689 + Zero = 55.689 % $\Rightarrow$ [Los C]

$\therefore$ Two-way $\rightarrow$ LOS = C

Example 3: 2 way highway is corrently Operating at its two way Capacity Rolling terrain Consists of Car & trucks only.
A recent traffic Con't revealed that 720 vehicles (Total in both direction) arrive in the most Congested 15 minutes interval
What is the % Trucks in traffic Stream based On ATS measure?

$V_{15} = 720$ veh
$V_p = 3200$ pc/hr (at Capacity)

$$PHF = \frac{V}{V_{15} * 4}$$

$$= \frac{2880}{720 * 4} = 1$$

$$V_p = \frac{V}{PHF * f_G * f_{HV}}$$

ATS
- $f_G = 0.99$
- $E_T = 1.5$

$$3200 = \frac{2880}{1 * 0.99 * \frac{1}{1 + P_T(1.5-1)}}$$

$\Rightarrow$ $\boxed{P_T = 20\%}$

MLH:

* interrupted flow: flow in a traffic stream with a specific Speed and density, that meets another traffic stream with a different Speed and density.

الاحد

$T_{LC} = L_{CL} + L_{CR}$

undivided $\rightarrow L_{CL} = 1.8$ m

$L_{CL} = 1.8$ m

TWLT's

$V = DDHV$

$= DHV * D\%$

$= AADT * K\% * D\%$

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

$f_p = (0.85 - 1)$

<u>Ex:</u> AADT = 60,000 veh / hr

u = 80 Km / hr $\rightarrow$ BFFS = 80 + 8 = 88 Kph

K% = 10%

D% = 55%

P_T = 5%

A/km = 6 , PHF = 0.9

$\rightarrow$ LOS D $\rightarrow$ # N = ??

$\hookrightarrow V_{p\,max.}$

$FFS = BFFS - F_{LW} - F_{LC} - f_m - f_A$

$\Rightarrow$ Assume : $L_W = 3.6$ m , M : Divided } for design

$L_C = 3.6$ m

$\Rightarrow V_{p_{max.}} = 1775$ pc ph pL

$\downarrow$

Using Ex: 21-3

$DDHV = 60{,}000 * 10\% * 55\% = 3{,}300$

$$f_{HV} = \frac{1}{1+0.05\,(2.5-1)} = 0.93$$

$$V_p = \frac{DDHV}{PHF * f_{HV} * f_p * N}$$

$$\Rightarrow N = \frac{3300}{0.9 * 0.93 * 1 * 1775} = 2.2$$

use 3

Ex 2: $FFS = BFFS - F_{LW} - F_{LC} - F_A - F_M$

$= (80+8) - 2.1 - 0.6 - 2.9 - 2.6$

$= 79.8$ km/hr

$T_{LC} = L_{CL} + L_{CR}$

$= 1.8 + 1.2$

$= 3$

Ex 4: Using Ex: 21-2 or fig. 21-3

$V_{T\,(before)} = 8\% * 3000$

$= 240$ Trucks

Capacity $= V_{p_{max.}}$ before LOS F $= 2030$ pc ph pL

* assume the new volume of trucks to be V_{NT}

$$V_p = \frac{DDHV}{PHF * f_p * N * f_{HV}}$$

$\Rightarrow$

$\Rightarrow V_{RV}$ (before) $= 2\% * 3000$

$= 60$ RV

$$f_{HV} = \frac{1}{1 + P_{TN}(2.5-1) + P_{RVN} * (2-1)}$$

$$P_{TN} = \frac{240 + V_{NT}}{3000 + V_{NT}} * 100\% \qquad P_{RVN} = \frac{60}{3000 + V_{NT}}$$

$$\Rightarrow V_p = 2030 = \frac{3000 + V_{NT}}{0.8 * 0.95 * 3 * f_{HV}}$$

Solving for V_{NT} :

$\Rightarrow V_{NT} = 483$ trucks / hr

* Composit Grades: الطلاقات

Some time it is necessary to determine the cumulative effect on operations of saveal significant grades in succession. for this situation a distance-weighted average may be used if all grades are less than 4% OR the total combinal length of the grades is less than 4000 ft (1220 m)

Example: A 2% upgrade for a 1000′ (305 m) is followed immediately by at 3% grade for 2000′ (610 m) then, Composite grade applies

$$\rightarrow \text{Equivalency factor} = \left[\frac{2 * 1000 + 3 * 2000}{1000 + 2000}\right] * 100\%$$

find using these values; E_T, E_R ← $= 2.67\%$

using specific grades Exhibits | length of up grade $= 3000'$

الخميس

* Hypotheses :
  * Null Hypothesis : $H_0 = \mu_1 = \mu_2$ العينة الاولى لها نفس avg. للعينة الثانية
  * Alternate Hypothesis :

H_1 :
* $\mu_1 \neq \mu_2$ → 2-tailed test
* $\mu_1 > \mu_2$
* $\mu_1 < \mu_2$

$\left.\begin{matrix}\mu_1 > \mu_2 \\ \mu_1 < \mu_2\end{matrix}\right\} \rightarrow$ 1-tailed test

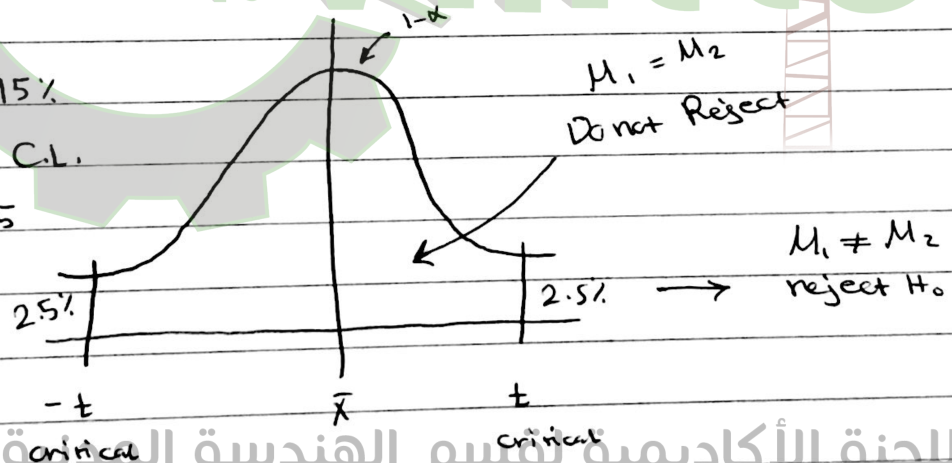
H_0 : There's no Statistical Significant difference

H_1 :
* There's a statistical significant difference
* Avg. of crashes occuring on Location 1 are staticitically Significant Higher than those occuring on Location 2.
* Avg. of crashes occuring on Location 1 are staticitically Significant Lower than those Occeuring on Location 2.

C.L. = 95%

α = 100% − C.L.

= 0.05



$(\alpha/2, dF)$ $(\alpha/2, dF)$

↳ $dF = n_1 + n_2 - 2$

Using table

Compare with → $T_{calculated}$

Reject H_0 → $\mu_1 \neq \mu_2$

Do not Reject H_1 → $\mu_1 = \mu_2$