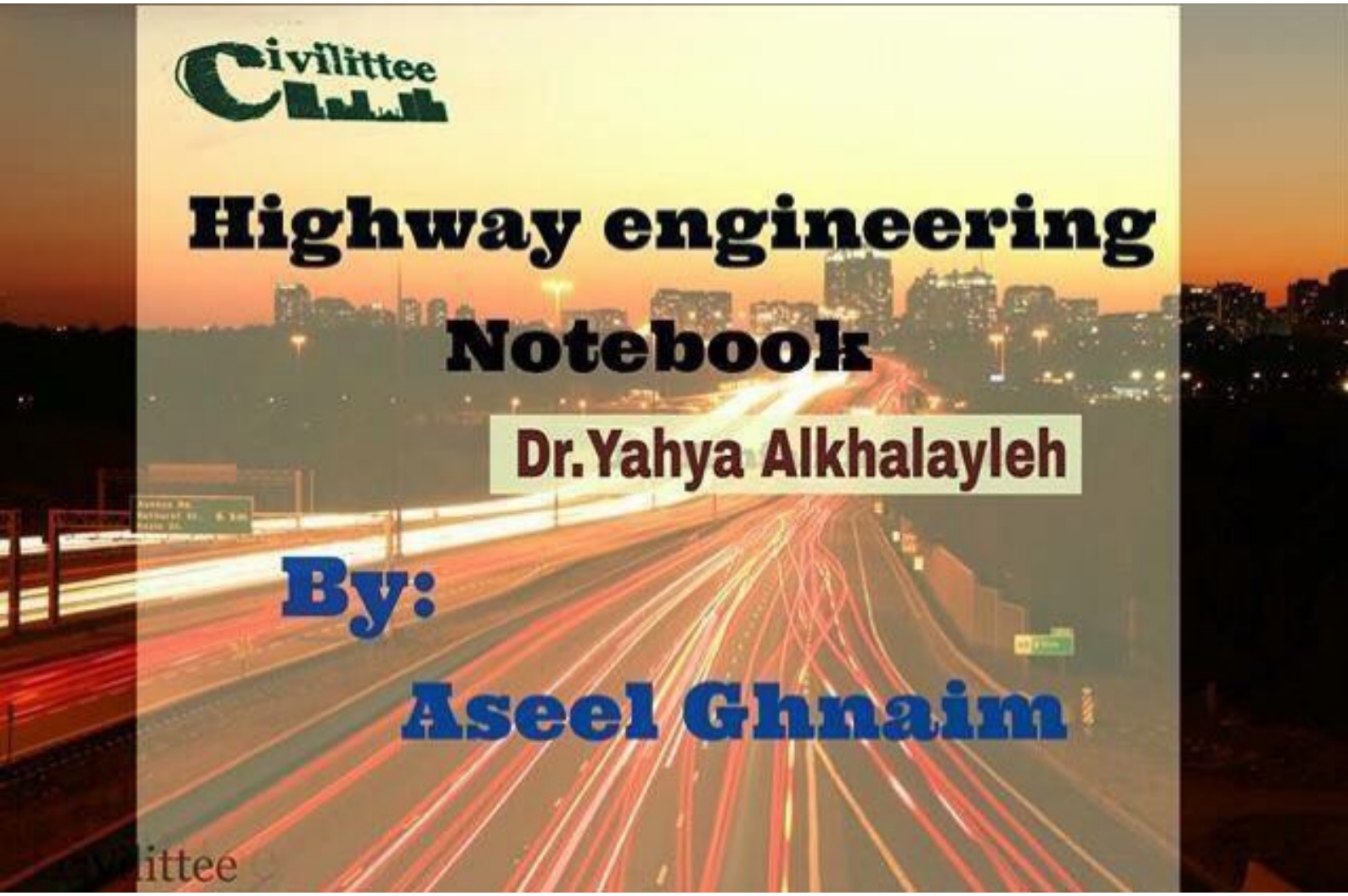
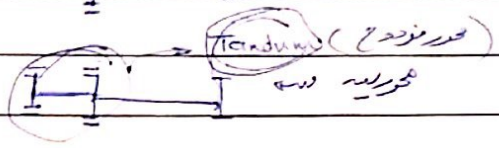


* Design standards *

- Vehicles are classified by AASHTO into four categories.

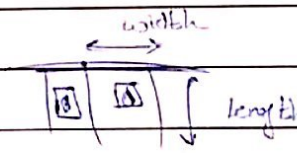
1. passengers cars 
2. Buses 
3. Trucks :-
   a) single unit 
   b) semi trailer 
4. Recreational vehicle.

* There are some design standards the engineer should be familiar with:-

1. Vehicle characteristics :-

design vehicles, it is a certain charactaristics in the vehicle which is important for the geometric design :

- weight → - structural design of bridges.
  - structural design pavement.
- Vehicle Length → 1. parking store Length
  2. plat Form Length.

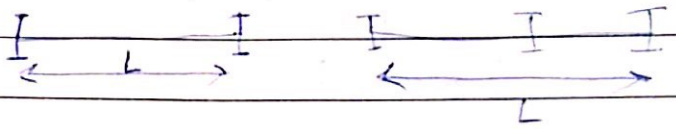


c) width → 1. lane width
2. parking store width.
3. Lateral clearance.

d) Hight → • vertical clearance.
• Bridges store vertical

* follows :

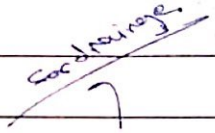
* Wheel Base =



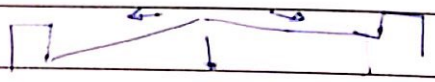
1- Lateral clearance on curves

* Design standards for HWY.

1. Minimum Grade : it is limited by the need to provide drainage



2. Minimum Length of v. curves . it is limited by SSD , appearance and comfort.



3. Minimum radius of horizontal curves for a given design speed - minimum radius is limited by Maximum side friction , which is base on Max. superelevation

4. Max. super elevation :- it is limited by side friction to prevent slipping vehicle from sliding

* Cross-section element of Hwy *

* The Cross-section consist of followed:-

1- Travel Lanes

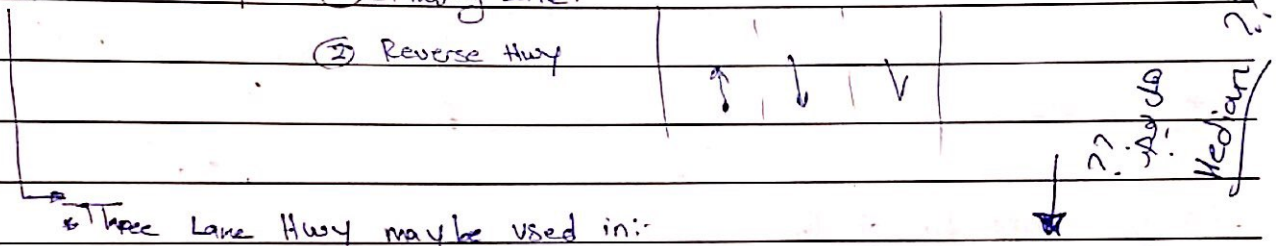
2- standard width. [max = 3.6m] , [min = 2.7 m = 9 ft] , where Number of Lanes & width depends on:- 1. Design speed.
2. volume of traffic.

* Categories of Hwy:-

1- Two Lane Hwy (width 7.2m) with shoulders on both sides.

2- Three Lane Hwy — (1) climbing Lane.

(2) Reverse Hwy



* Three Lane Hwy may be used in:-

(1) 2-Lane in one direction and one Lane is in the other [permanent].

(2) The third Lane may be used alternatly.

(3) For climbing Lane.

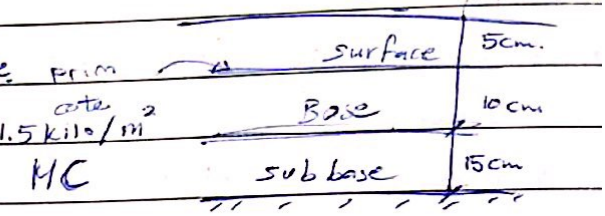
(4) For Left turnings only [urban areas].

3- Four Lane Hwy:- it should be divided (medium), should be between (1.2-20) m

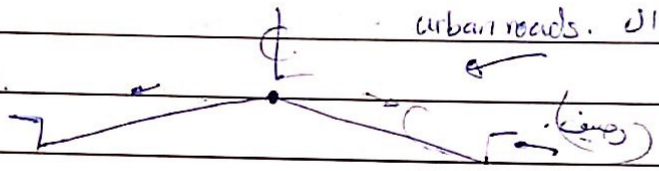
* Project *

Item	Unit (m)	Price / m =	Quantity Estimate	Price
Leveling	m^2	-		
Cut	m^3	3 JD		
FILL	m^3	3.5 JD		
sub base	m^2 or m^3	2 JD	35600	Jd/m^2
Base	m^2 or m^3	2.5 JD	44500	Jd/m^2
Hot mix asphalt. - weight - m^2, - m^3		.5 JD	8900	Jd/m^2
Prime Coat kg/m^2	kg	.5 JD	133500	Jd/kg

prim rate 1.5 kilo/m^2 MC



* Pavement Crown:-



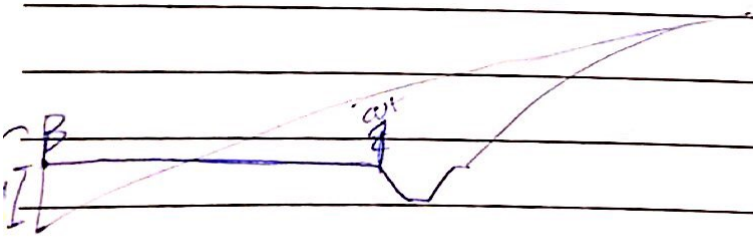
- Raising the center line of the road way above the pavement for drainage perpose.

- Recommended value. = (1.5 - 2)%

Min .5%.

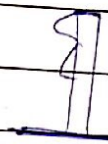
* Gaurd ~~Gate~~ Rail:-

- a guard ~~rail~~ rail should be ~~divided~~ provided when:- 1) Fill > 2.4 m in Hig
2) sudden change in alignm
3) In locations where d road side ditch.

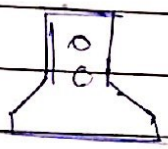


* Followed:-

Type of Gaurd rail :-

1- W - Beam.  → Flixible.

← for Rural roads.

2- Concrete :-  → rigid.

- Properties :-
① Flixible to absorbe

3- Cables :-

* Gaurd rails should be flixible to reduce damage if there is a collision, also to absorb energy.

* In urban areas curbs are used, the highets should be between 15 - 20 cm

* Right of Way :-

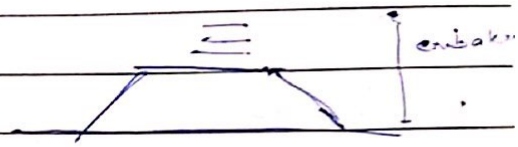
- It is the Land required along the road alignment by the Hwy organisation.

1- The right of the road depends on the importance of the road, sufficient right of way should be required in order to avoid the expence of purchasing developed properties.

* Followed:-

2- To provide drainage system

3- For height of embankment or depth of cutting [side slopes & Back slo



4- Visibility consideration on curves.

5 - width of land required for future development.

* example:-

if → 4 Lane Hwy → 3m / lane

Median → 2m

shoulder → 3m

Fill = 5m → S.S = 4:1

Cut = 5 → S.S = 2:1

Sol:-

for Cut	for fill
→ 4*3 = 12	12
→ T2	2
→ 6	6
→ 40	20
60m	40m

??

take larger.

* followed *

* Recommended values of R.W :-

(40-60 ft) for 2 Lane urban collector.

- 84 ft of minimum for arterial 2 Lane

(64-100) ft, 4-Lane devided arterial.

- 120 - 300, devided arterial

* Shoulders → For Rural Roads.

- They are provided for 1) safe operation

2) They increase site distance on H. curves.

3) Provide refuge for stalled vehicles or emergency.

4) Improve capacity (increase effective width)

- Width should be greater than 3 meters.

> 1.2m in mountary areas.

- slope > 3%

- surface should be rough compared to the main road.

* Median :-

- The section of a devided H.way that separate the Lanes in oppesing direction

- The function of Median :-

1. provides a recovery area for out of control vehicles.

2. seperate oppising traffic

3. provide storage area for left tanning & U-turning

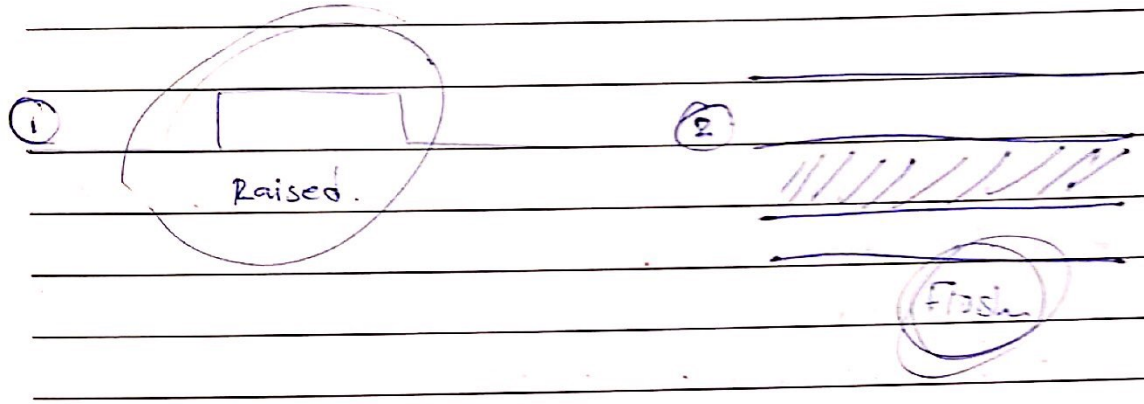
4. Provide refuge for pedestrians.

5. Reducing the effect of head Light glare.

* Followed:-

* 3- Types of Medians:-

1. Raised
2. Flush.
3. depressed.

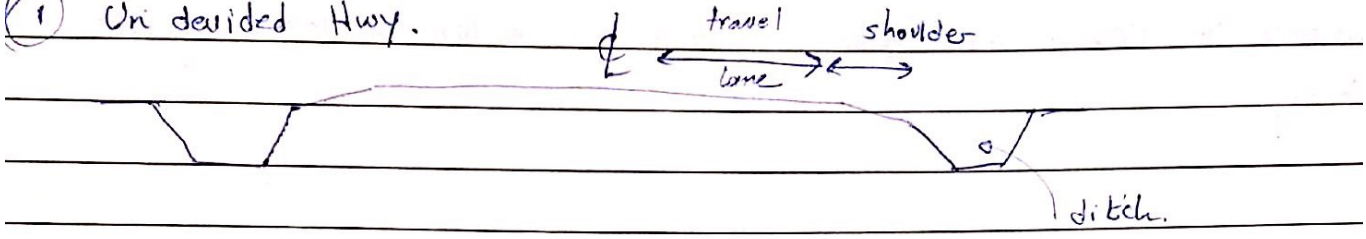


3 Depressed:-

- Raised Medians used in urban roads.
- Flush Medians used in urban & free ways.
- Depressed used in Free ways.

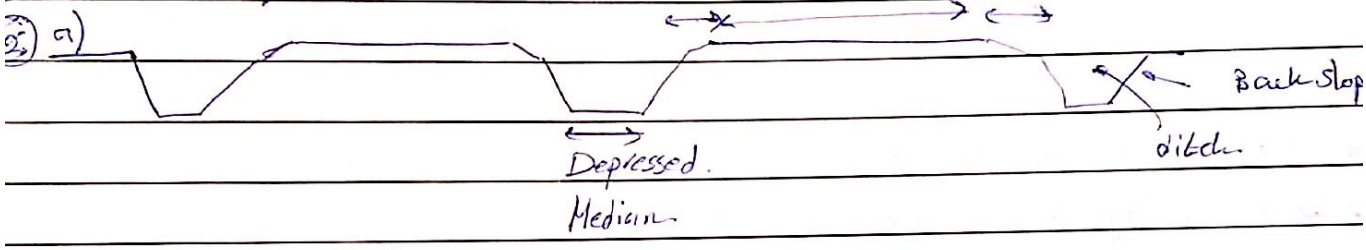
* Followed:-

(1) Uni devided Hwy.

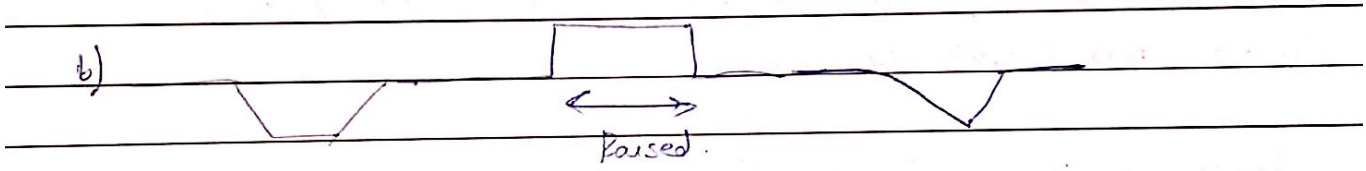


2). Devided Hwy.

a)



b)



* For Residintial Areas in Urban roads side walks are used.

↳ Side walks :-

- provided in roads for urban areas.
- they are also provided when pedestrian traffic is high.

* The Minimum width is (1.2 m) (4 ft) in residintial areas and (4-8) ft in commercial areas.

* Parking studies *

* One of the important considerations in traffic operation is the park because the veihcles which operate on Hwy have a terminal point requir Parkings.

* The parking facilities can be grouped in the following two types:-

1. on-street Parking — [Kerb Park].
2. off-street parking.

* kerb or on street Parking:-

- The disadvantage of on street parking:-

1. The safety of various classes of road users. is adversly affected (increas road accidents particulary pedistrians).

2. Imped traffic flow & reduce their speed.

3- Decrease road Capacity.

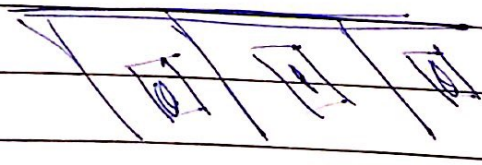
4- Increase Journey time (Increase delay).

* The on street Parking kerb either:-

1. parallel

1- wide
2. one way
3 - local
4 - low flow

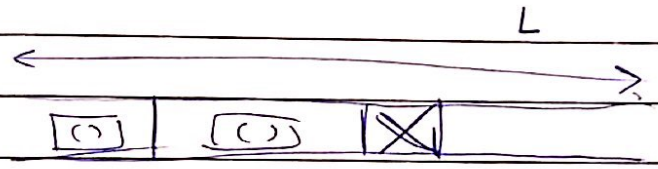
2. Angular.



* Followed*

* Angular parking is designed under the following conditions:-

1. wide streets having good sight distance.
2. Local road.
3. One way streets.
4. Low traffic volume.



*

*if L = 1000 m , width = 58 ft , find the maximum number for 2 Lane Hwy if the width of the Lane = 12'

① 58 - 24 = 34' ——— for Maximum ① if parallel → $\frac{1000}{22}$ = ...

+

30° → $\frac{1000}{17}$ = ...

* Parking applications *

* Example:- [Parking duration].

parking garage have 200 parking spaces, Parking duration time = 2 hrs, 7am-7

→ find the Number of veihcles can park in the garage.

- sol:-

space.hr = 200 × 12 = 2400 space.hr

$N = \frac{2400}{2}$ = 1200 veihcle.

* Example [Parking turnover]:-

parking garage have 200 parking spaces, number of veihcles use the garag is 450 veihcles, parking turn over = ??

*sol:-

$P.T.O = \frac{450}{200}$ = 2.25 vehcles/spaces.

* Parking duration = $\frac{\text{Parking Load}}{\text{Parking volume}}$

* Parking Turnover = $\frac{\text{P. volume}}{\text{\# of bays}}$

* followed *

* Example:-

Parking garage have capacity of 300 Parking spaces, and open from 7am - 7Pm, There are 480 vehicles park daily. 30% of the parked vehicles park 8 hrs, 50% park for 6 hrs., and 20% Park 4 hrs. Determine whether there is a need to provide for additional parking spaces for the garage.

* Sol:-

480 * 30% = 144 ⟶ for 8 hours.

↳ space - hour required = 144 x 8 = 1152 sp-hr.

50% * 480 = 240 ⟶ for 6- hour.

↳ 240 * 6 = 1440 space-hr.

20% * 480 = 96 vehicle ⟶ for 2-hours.

↳ 2 * 96 = 192 sp-hr.

- Total space hour = 192 + 1440 + 1152 = 2784 sp-hr

* space-hr available = 12 * 300 = 3600 sp-hr. ⟶ 3000 > 2784

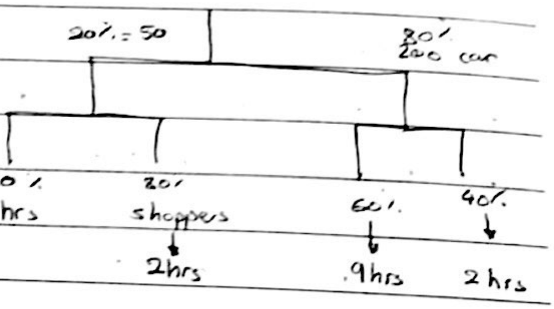
↳ There is no need for additional spaces.

* Example :- 4.7 → من الورقة

* sol :-

80% → 200 نصف

20% → 50 cannot park.



→ The space - hour required for 20% ??

1- $\frac{20}{100} * 50 = 10$ vehicles park 9 hrs

→ space - hr req = $9 \times 10 = 90$ space - hr

2- $\frac{80}{100} * 50 = 40$ vehicles.

→ space_hr = $40 * 2 = 80$ sp-hr.

* Total space - hr = $90 + 80 = 170$ space-hr.

↳ $\frac{170}{10} = 17$ spaces required.

- if effeciency = .8 → $\frac{170}{.8 * 10} = 22$ spaces.

اذا رسمت ال accumalation curve ، وكان في ساعات بوصل فيها لل capacity خلال فترة بسيطة ، مش مشكلة
الزمن اللي وصل فيه لل capacity ونحسب على اساس الزمن الجديد.

* Parking generation + Supply needs *

* The issue in parking is to determine How many parking spaces are required for a particular development; [Hospitals, Hotels, residential areas, etc...]

* The need for parking spaces Depends upon many factors :-

1- size of Land.

2- public transport accessibality.

* The table below shows some of the parking generation specification needs:-

Type of Land use	preffered unit	alternative	Parking demand
1. Residential	Per dwelling	—	1.2
2. Shopping center	Per 1000 ft^2	—	3.79 / 1000 ft^2
3- offices	Per 1000 ft^2	—	2.52 / 1000 ft^2
4- Industrial	Per employee	Per 1000 ft^2	1
5- Hospitals	Per employee	Per bed.	1.71 / bed.
6- Restureats	Per seet	Per 1000 ft^2	15.8 / 1000 ft^2
7- Bank	Per 1000 ft^2		3.3 / 1000 ft^2
8- Hotels	Per unit	Per Bed.	.81 / bed

* followed *

- Example :-

if office Area = 25000 ft^2 , Parking = ??

* sol :-

2.52 * 25 = 63 spaces.

* Intersection Design *. (التقاطعات)

- The general term junction or intersection is where two or more needs cross on another at the same or different elevation.

- Types of intersection:-

1- At - grade int.

2- Grade seperation → a) with ramp → Free اذا في free و

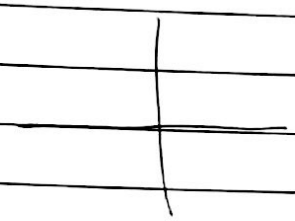
b) without ramp. → free way اذا كان في Local عنا ال

1* At - Grade intersection :-

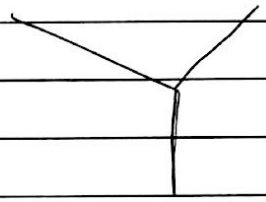
- this is the most common type of Int. , and it indicate the road junction @ the same elevation traffic movement are @ the same Level.

* Followed :-

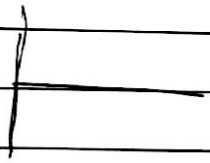
a) Cross - int.



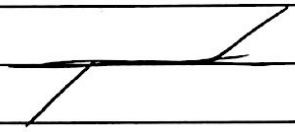
c) Y- int.



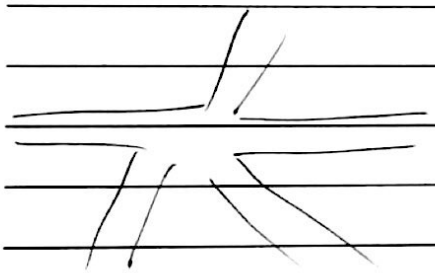
b) T- int



d) skewed int

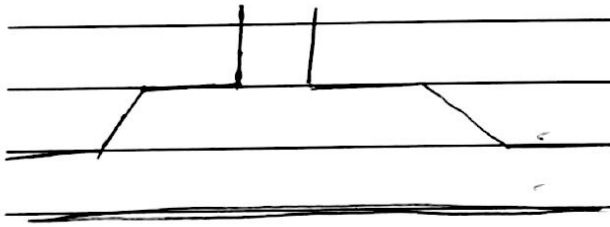


e) Multi - Leg int.



f) Flared - int.

H) T- flared.



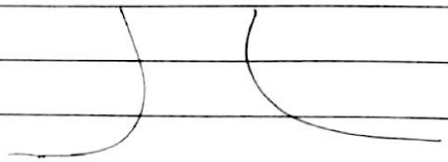
* Followed *

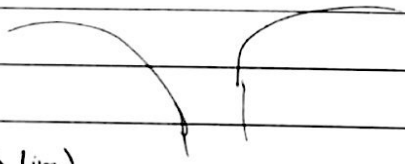
* There are three types of grade int:-

1- All paved or unchemelled int.

2. channelle zed int.

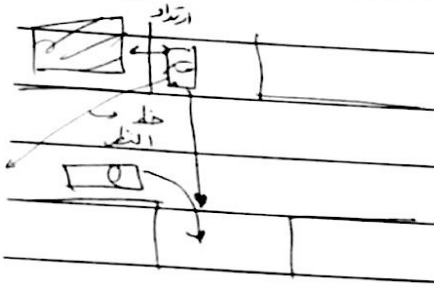
3. Round int.

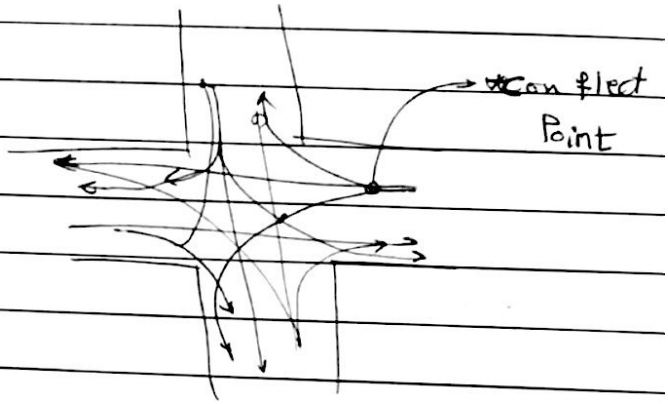




* The design of intersection of the (curve line) depends on the following:-

1. sight Dist.

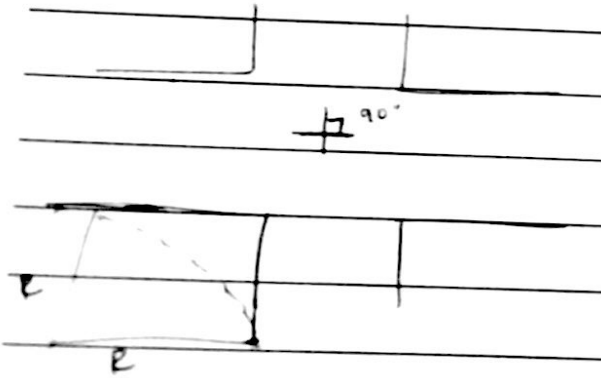




- if the sight distance is Limited or short, a stop ~~sight~~ sign or give way sign should be installed. [stop sign for less important road].

2- Turning radius @ intersection.

- depends on the compisition of the traffic.

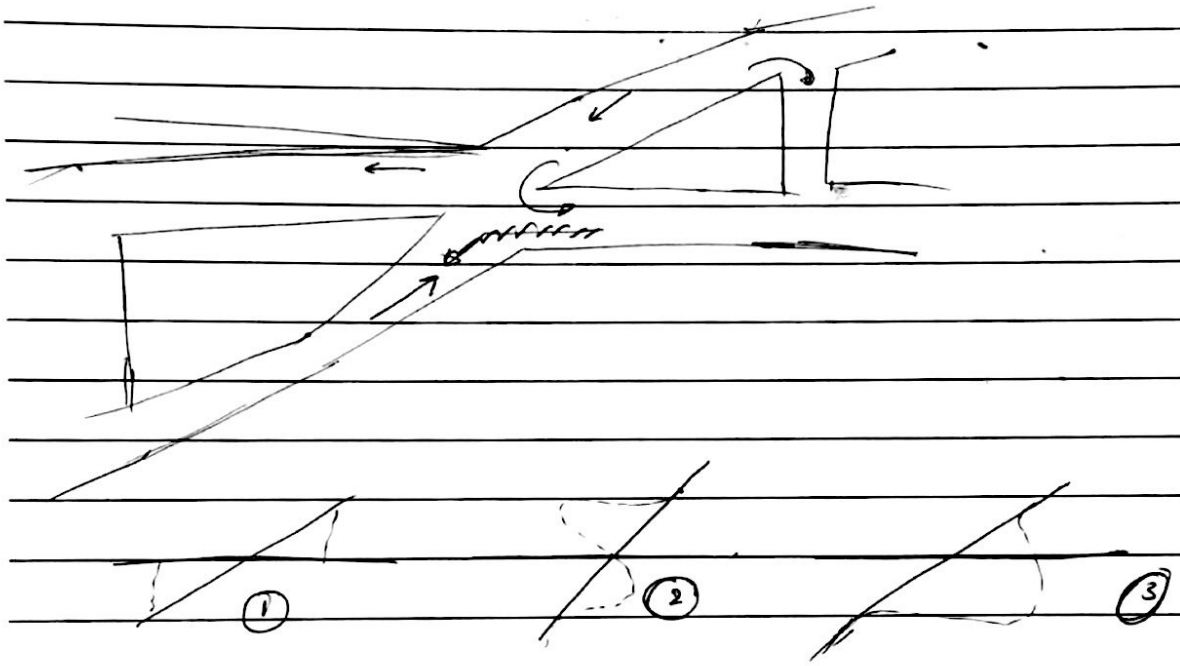


* Followed*

3- Pedestrian Movement.

4- Reducing accidents [safety consediration]:-
- reducing conflict points.

5- Angle of crossing [cute angle]:-
- a cute angle should be avoided :



6- Types of Intersecting roads.

* If the traffic volume is Low and the crossing roads are minor , Simple or all - paved int. is used.

* If the traffic volume increases , flared intersection is used.

* If the volume increase More, there is a delay , Use chanalized int.

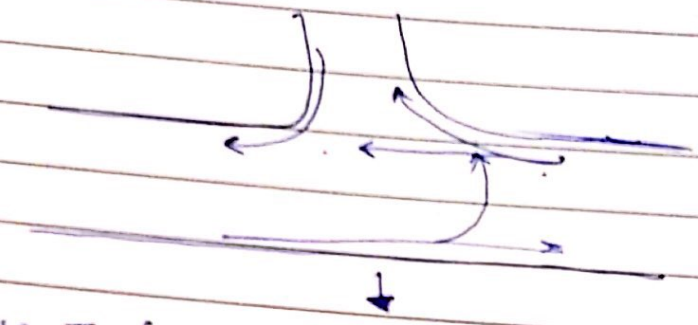
* If the volume increase More , Use round about.

* followed *

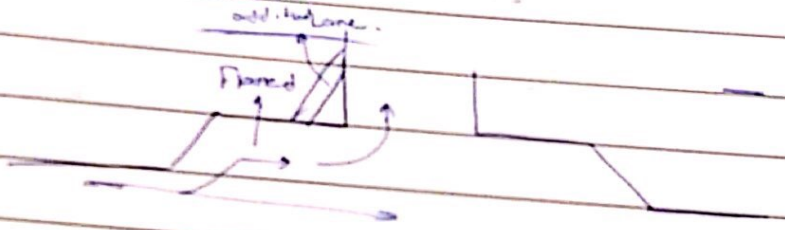
* If the round about fails, Use traffic signals.

* If all that fails, use grad separeted.

* T- Intersection [Plane], Used for Minor roads:-



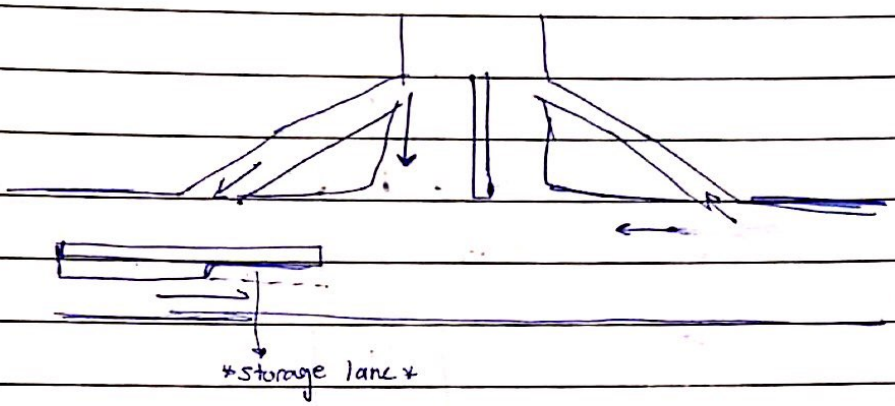
* We use T- flared:-

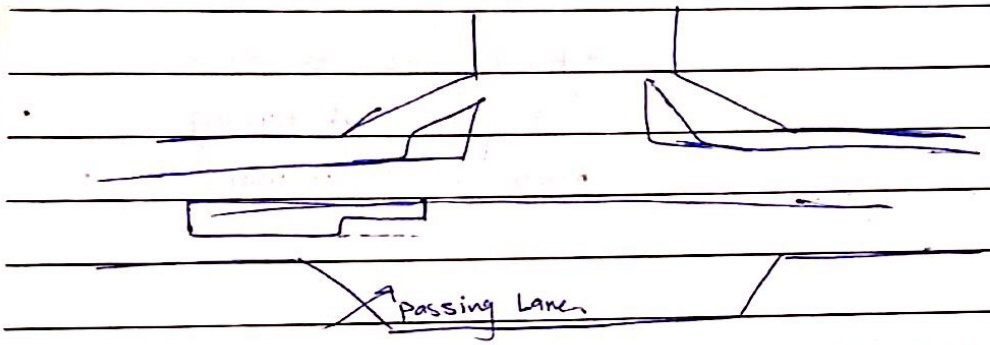


* T- int. with right turn lane additional lane is provided to seperate right turning vehicles from through traffic.

* Followed *

* Channaleized T- intersection:- [with two intersection islands]





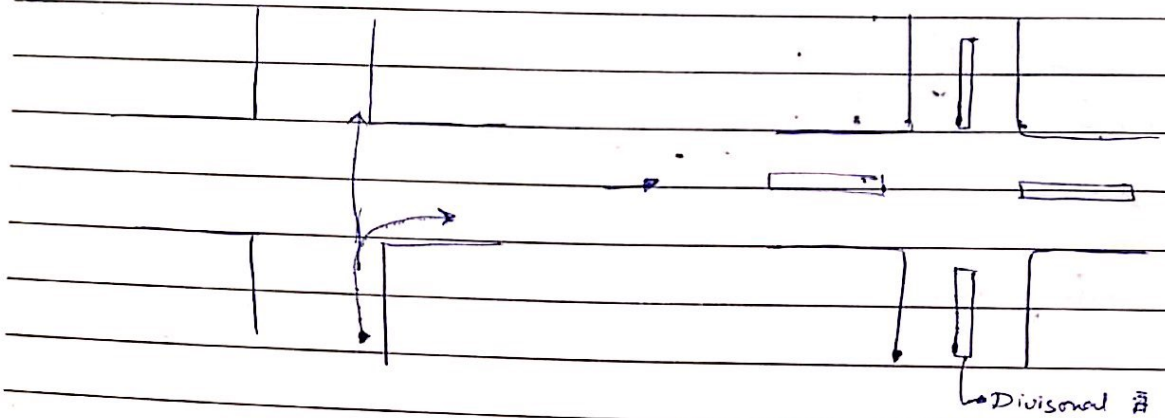
* Channalized T- int -with right turning Lane, storage Lane and passing Lane. For through traffic and storage Lane for left turning.

* Followed *

* Cross intersection:-

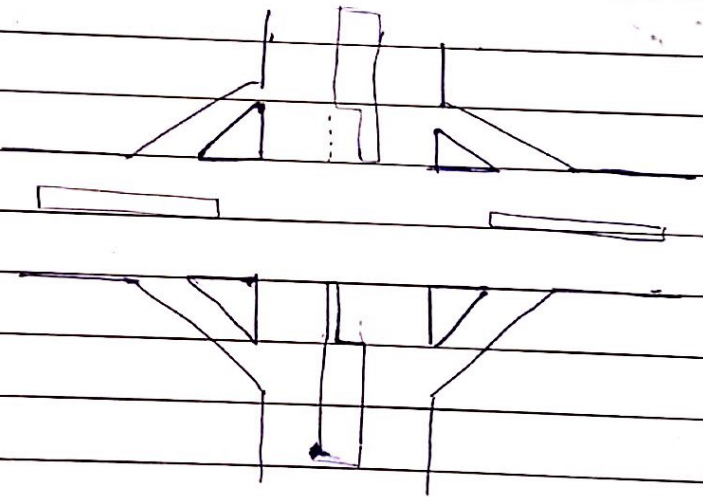
cross -

① Plan - int.



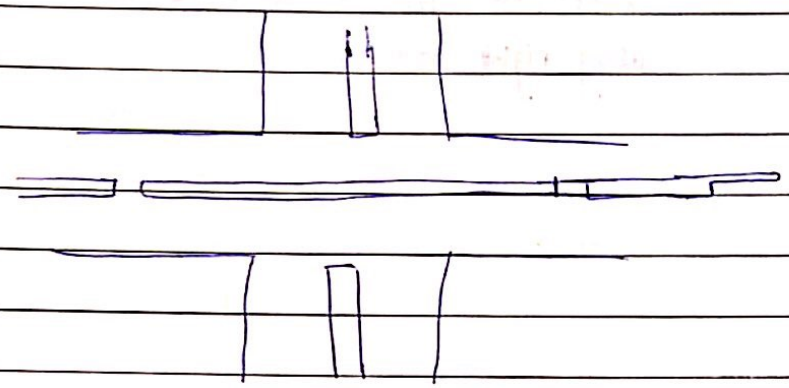
* Four Leg int with divisonal island for high turning movement of pedistrians.

نفل حركة السير في ال [cross intersection.] في حالة التقاطعات العشرة.



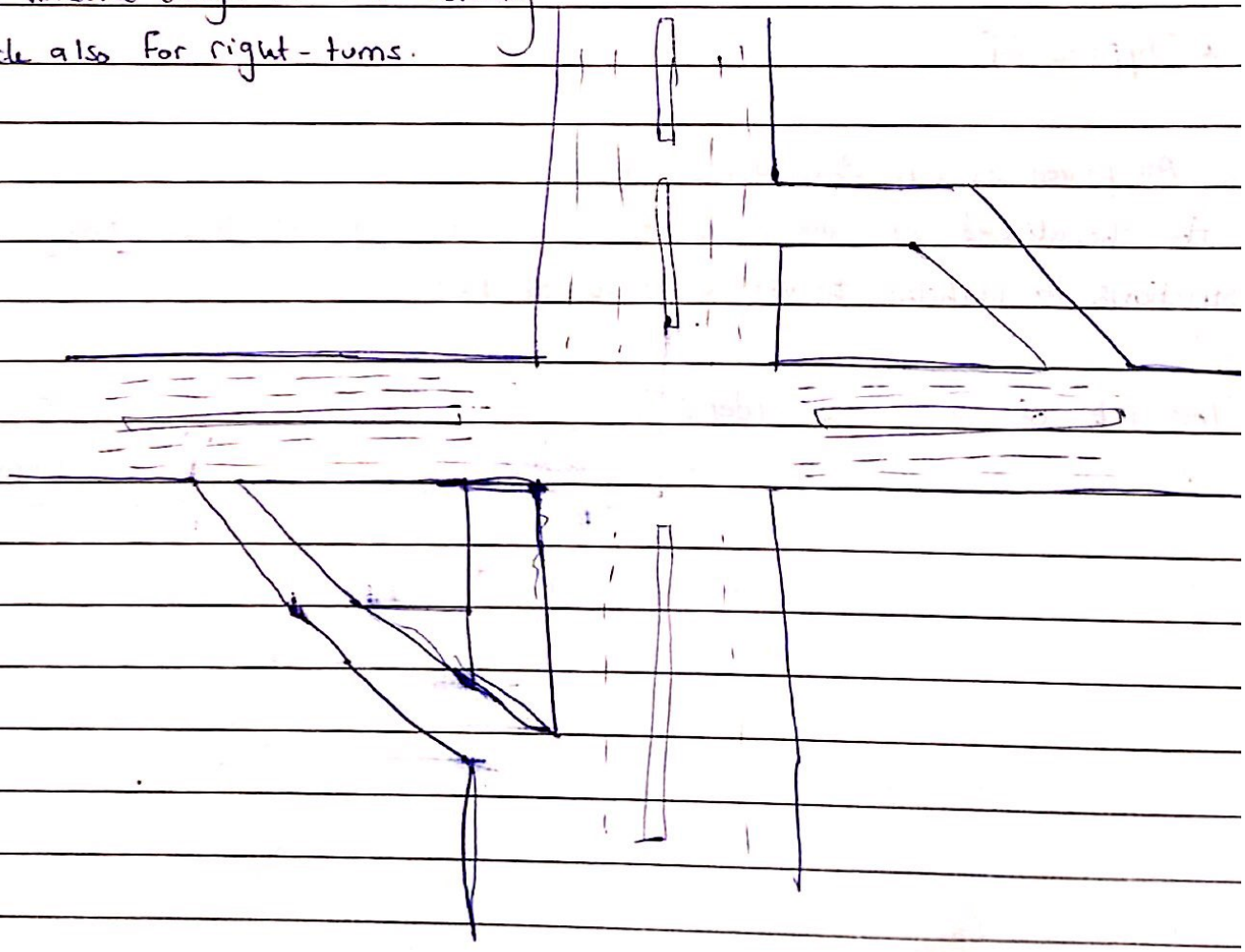
* Local مع local X
* Arterial مع Arterial ✓
* collectors ✓
* Hways X
  - في ال Hway بكون seperated.

(3) * Cross intersections:-



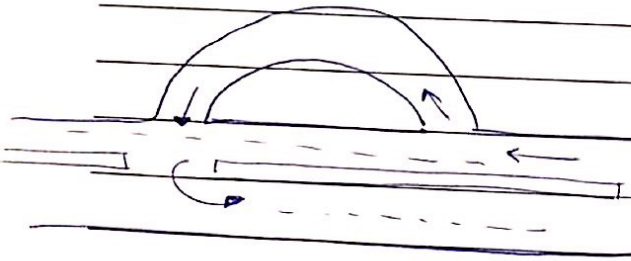
• Four Leg intersection → turning Left as U-turn * [left turn handeled as a U-turn]

* Jug handeled design for left-turning vehicle also for right-turns.



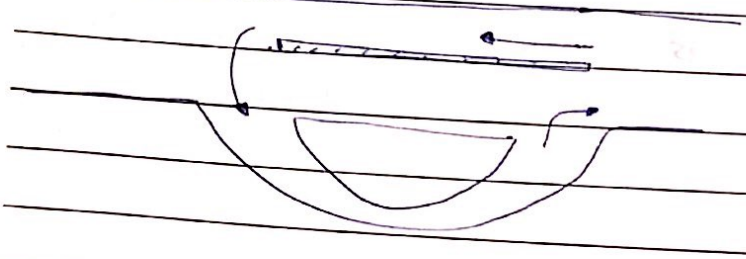
Five A

* followed *



* left turn handeled as a U-turn using right side.

or



* right turn handeled as a U-turn using sight.

* ~~Types of~~

1* All paved or un chanalized int.

- the chanalized int. are paved the whole area and as such there is n restrictions to veihcles to use any part of the int.

- This int. of the lowest order.

* followed *

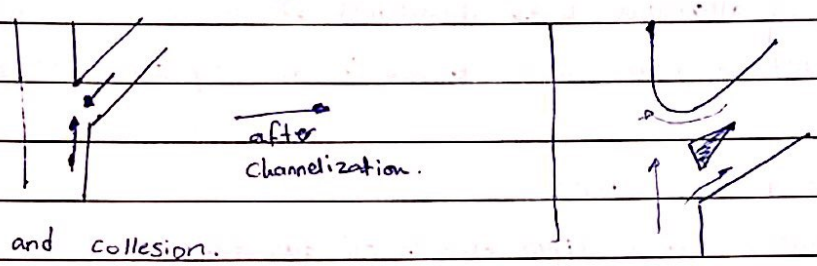
2* Channelized int.:-

The purpose of channelization is:-

a) Increase safety

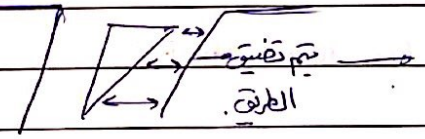
b) Increase capacity.

c) Angle between intersecting roads can be maid more favorable.



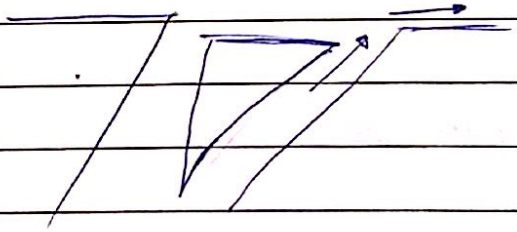
head and collesion.

d) speed control can be established over veihcles entering an intersections by Funneling the vehicles into narrow openning.



e) prohibited turns may be prevented. → عشان

one way



* followed *

f) refuge may be provided for turning or crossing vehicles and pedistrians.

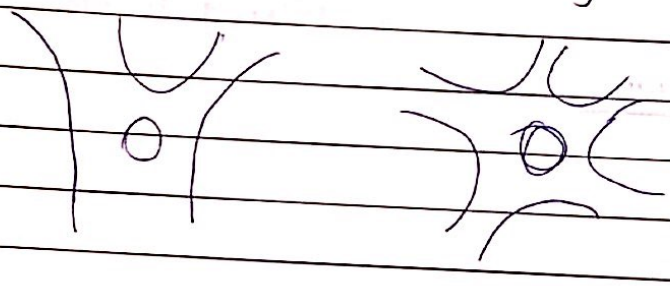
* Round abouts :-

- Round about is being alternative to the conventional of (at - grade) intersection, it consist of central island where vielcles travel in one-way counter clockwise

- They are reffered to be used when :-

1- There's equal traffic volume approaching in all directions.

2- When the design hourly volume approaching the intersection does not exceed 3000 veh/hr



* Following the advantages are for round about :-

1- It Provides simple solution for road junctions where more than four roads meet and it proves to be advantages when the number of intersecting road is between 4 and 7

2- It regulate traffic and there's a continuous flow of traffic through the round about.

3- It is cheep to construct than suprated int.

* followed

4- It is self controlled traffic avoiding the necessity of traffic policemen

* The disadvantages are:-

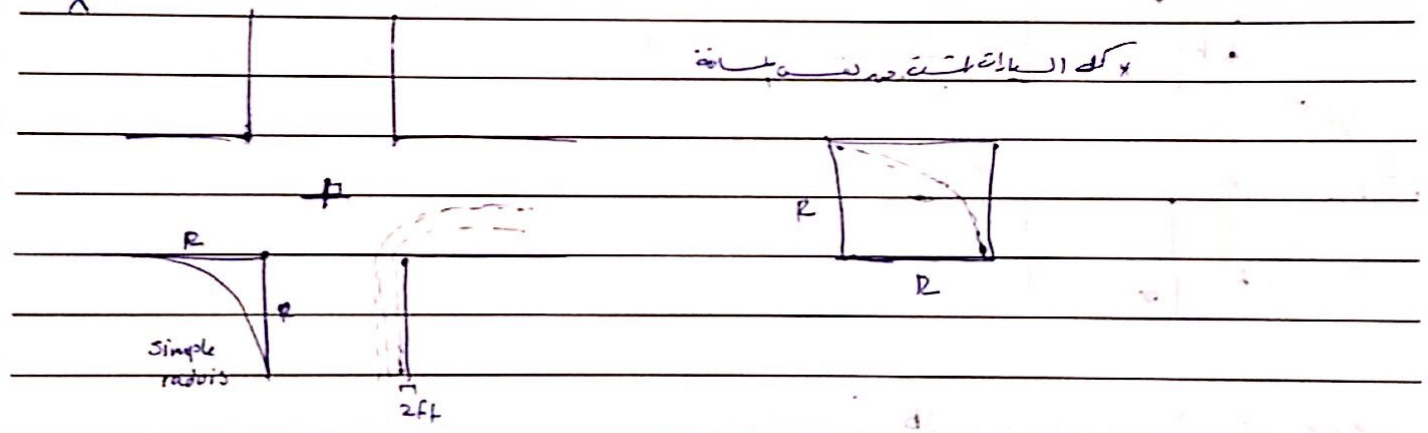
1. it does not function effectivly of all approaches have similar traffic vol.

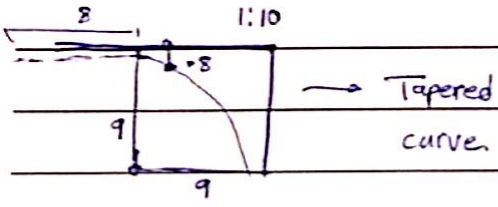
2. It requires large are of flat land.

3- Difficult for pedistrians

4- It requires not suitable for high speed roads

*

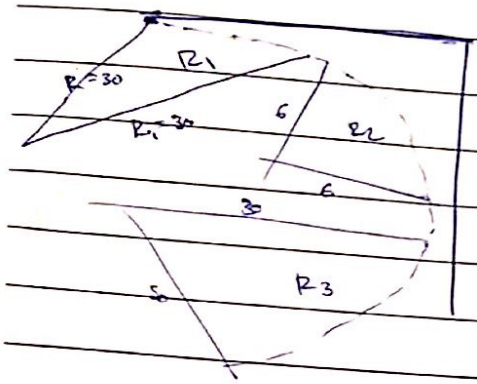




→ Tapered curve

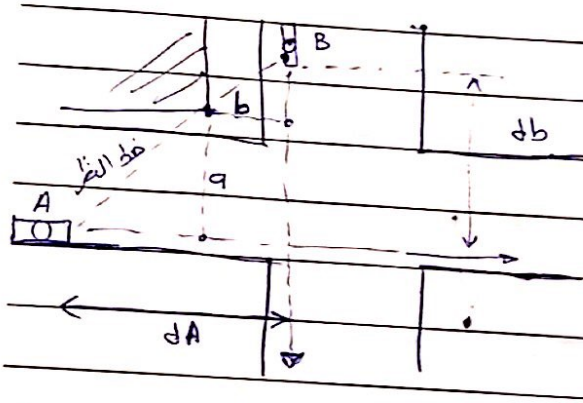
* followed *

* Three centered compound curve



$R_1 = R_3 \neq R_2$ ↖
$> R_2$ ↙

* Sight distance at intersections:-



المسافة من السيارة
إلى أقرب عائق

$$* \frac{db}{db} = \frac{a}{da-b} \longrightarrow db = a\left(\frac{da}{da-b}\right)$$

SSD

* followed *

10 mile/hr = 10 * 5280 / 3600 = ___ ft/sec

1 mile = 5280 ft

* Example:-

A tall building is located 45 ft from the center line of the right lane of a local road (b in the figure), and 65 ft from the center lane of the right lane of an intersecting road (a in the figure), the maximum speed limit on the intersecting road is 35 mile/hr, what should be the speed limit on the local road such the minimum sight distance is provided to allowe the drivers to approaching vehicles to avoid immenent collision by adjusting their speed.

- Sol:-

a = 65 , b = 45 , Max Speed Limit = 35 mile/hr.

$$d_b - a\left(\frac{d_a}{d_a - b}\right) = 65\left(\frac{155}{155-45}\right) = 91.6 \text{ ft.}$$

SSD = 1.47 * Vtr

= 1.47 * 35 * 3 = 155 ft → da

* SSD = 1.47 Vtr

91.6 = 1.47 * 3 * V → V = 20.8 mile/hr.

* Followed *

* Grade seperation :-

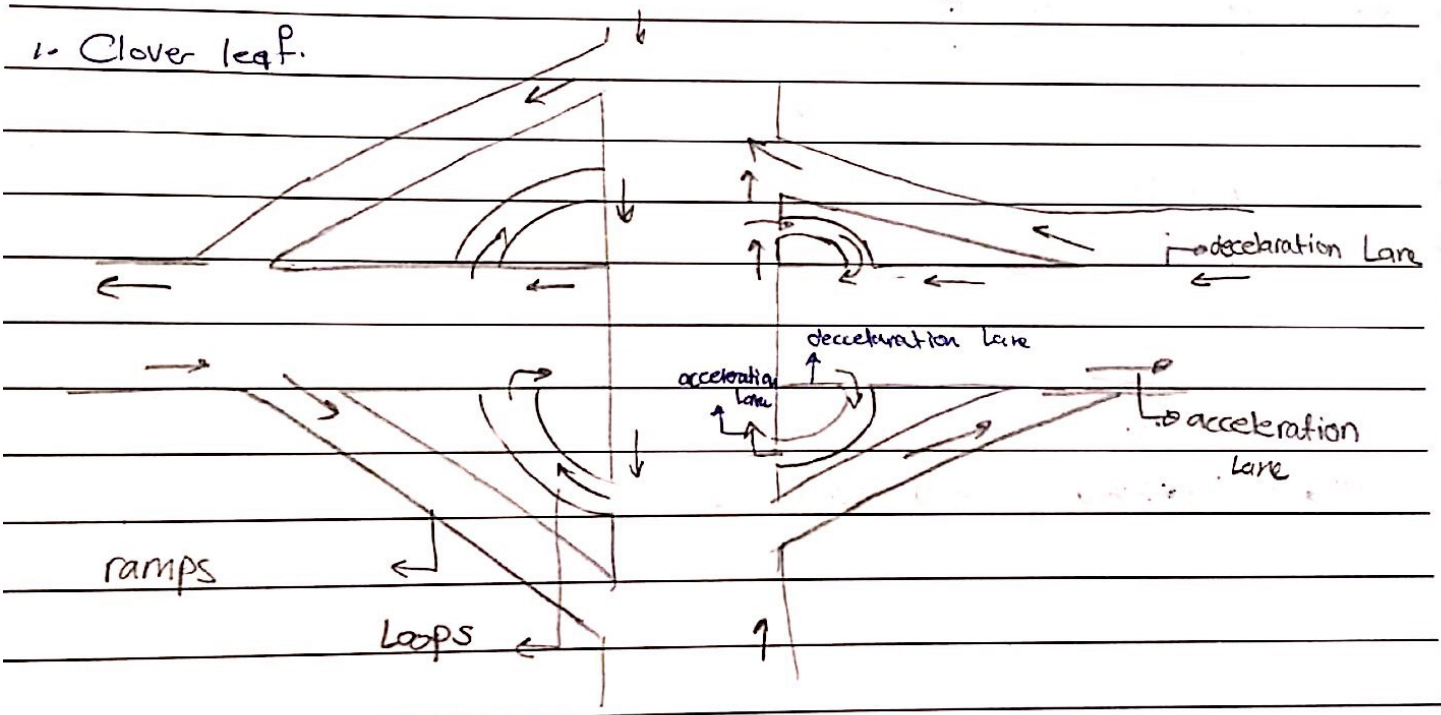
- a grade seperation is the arrangement of taking one road over the or under another by mean of a bridge, it's also known as a flyover junction.

- The grade seperation at interchanges maybe warranted if:-

1. It was decided to have limited access (cross roads)
2. to eleminate bottle necks (@ grade roads).
3. to increase safty.
4. If the topography is such that the other type of design are not feasible.
5. If there was a high traffic volume.

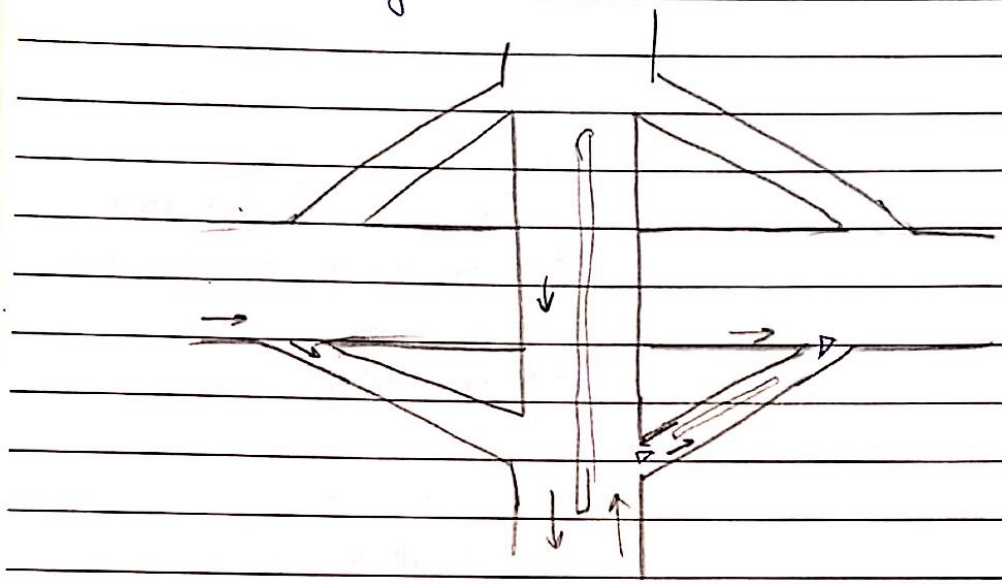
* An interchange in grade seperation in which vehicles moving in one direction
* An interchange maybe of various types but the common ones are :-

1- Clover leaf.



+ followed:-

2. Diamond Interchange:-

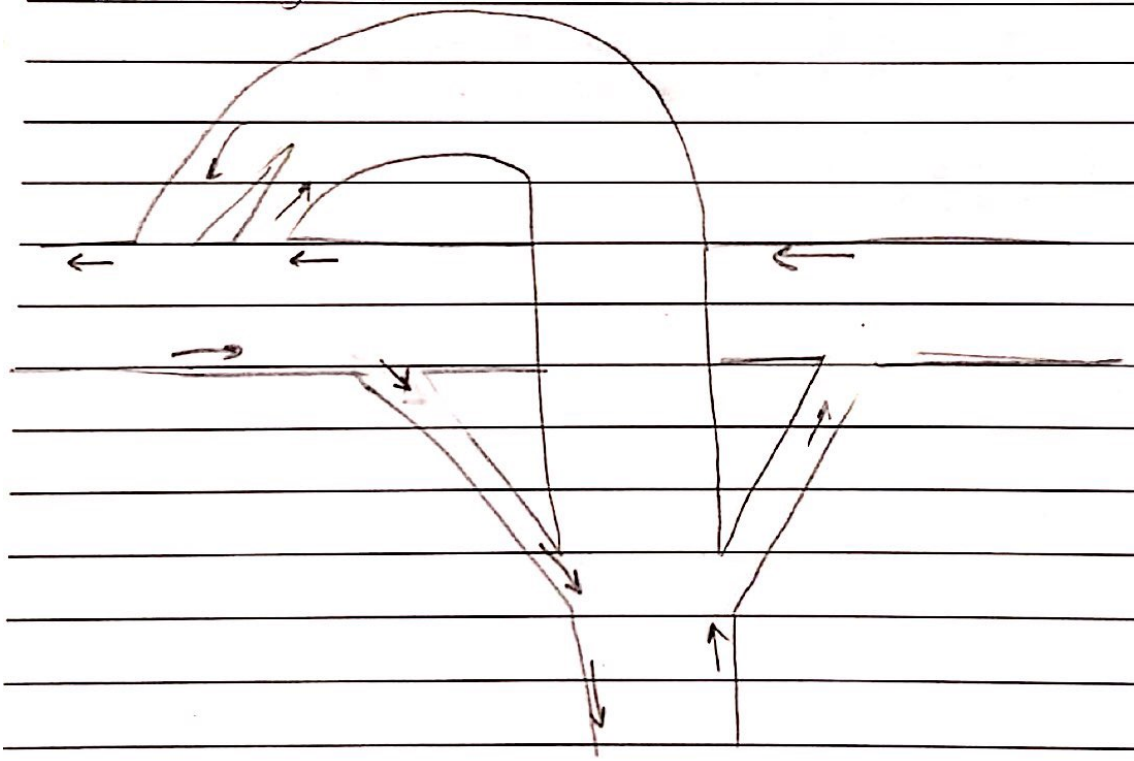


* very simple
* Most common
* Least costly
* Smaller Right of way than clover leaf

* Ramp بنزل
* Loop. بنزل

3. Trumpet.

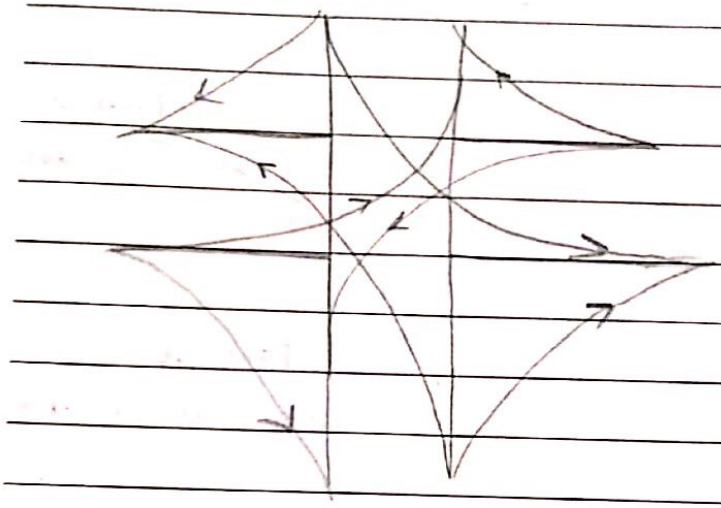
- Used @ T- junction.



* Little Right of way
* inexpensive.

* followed:-

4- ALL directional interchange.



* The name implies that travel is directional towards your distenction.

* Multiple Level structure

* very high cost

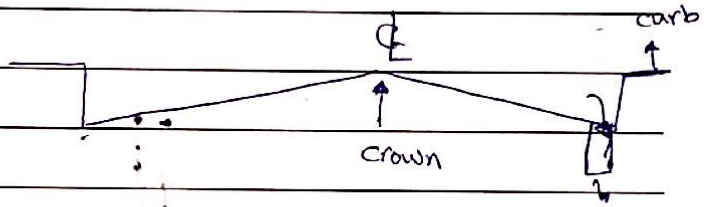
* High speed

* high volume situation

* Used for free way with free way.

* Drainage of City Streets *

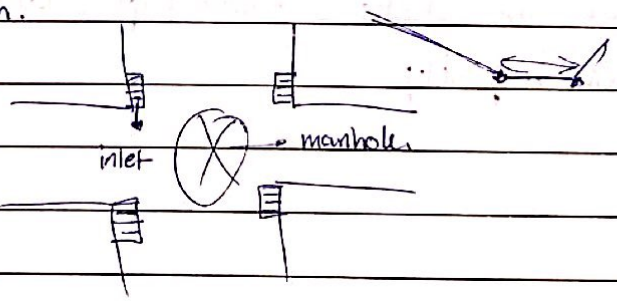
- The surface drainage of city street is different from Rural Hwy.
- Open drains cannot be used, they are: 1- un sightly
  2- occupy more space.
  3- serve as a source of dangerous.
- therefore under ground drains and sewers are used.
- The surface water drainage system in a city composed of the following:-
  1. pavement crown
  2. curb and gutter.
  3. storm drains
  4. inlets - catch basin - manholes.



* The Longitudoral grade of the gutter must be sufficient to facilitate rapid removal of the water. at sags where water collected an inlet must be provided.

(1) Inlet:-

- They are usually provided at intersection.
- Inlets are located at the side of the road (30-60) m - connected by Manhole.

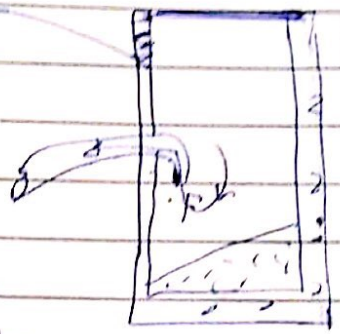


- The purpose of inlet is to collect storm water in short period, and there is no flooding.
- The inlet is simply a concrete box, it may have openings in vertical or Horizontal direction.

* Inlet have only an outlet pipe placed at the bottom of the inlet they are subjected to clogging, the object, which cause trouble at the openning are sticks, waste paper, leaves, depries, so they must be cleaned frequently

* Followed :-

* Catch basin :-



- They are similer to inlets in their function & design the difference in the outlet pipe - it's placed at some distance above the bottom of the chamber

~~- The bottom of~~

- The purpose of the catch basin is that deprties flushed from the streets is trapped in the bottom of the catch basin so that it does not enter the storm sewer.

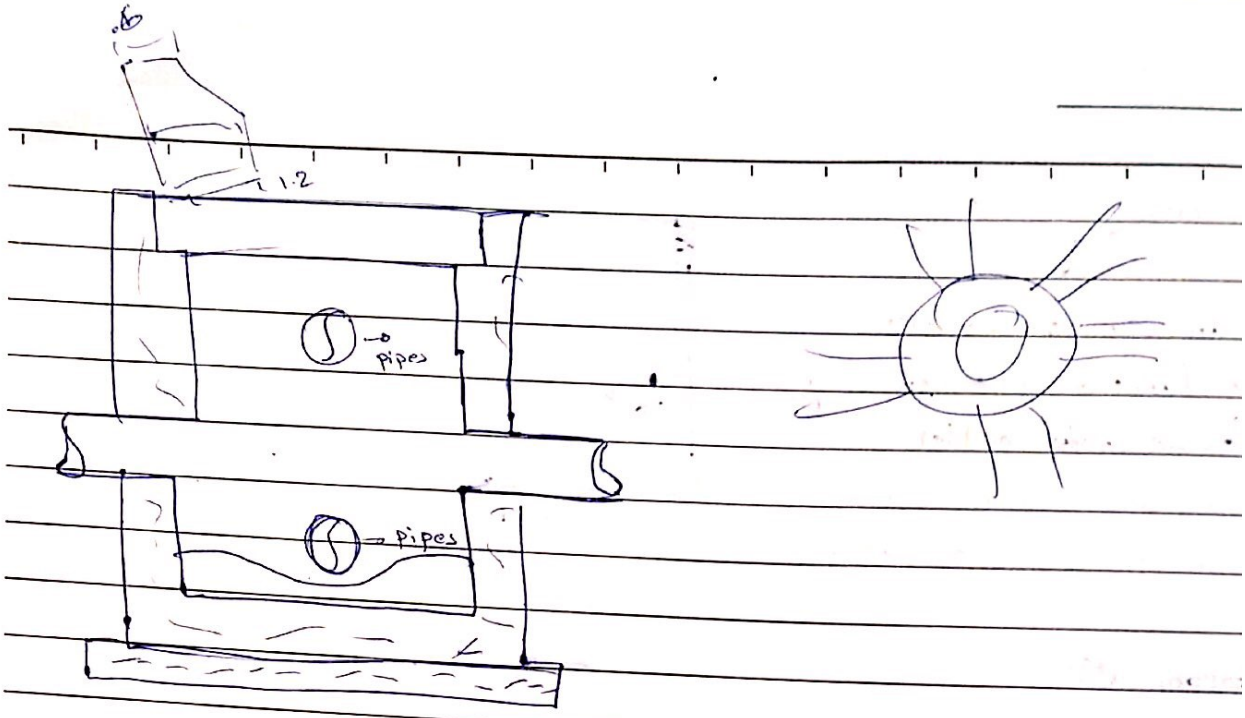
* Manholes :-

storm sewer system are subjected to partial are complete clogging and facilites must be provided for cleening.

- Manholes are provided at points where :-
  1. Where sewer change direction
  2. Grade
  3. at junctions
  4. at intersection points (90 - 150)

* The openning should be large enough to permit a man to enter the chambers a room in which he can work 1.2 m.

- Manhole ~~covers~~ covers are cast iron circular shape .6m diameter.



* Drainage & Drainage structure:-

- Surface Drainage:-

1) Roadway crown.
2) Shoulder & side slopes
3) Longitudinal ditches
4) Catch basin, inlets & Manholes.

Urban

Rural.

* Culverts & Bridges :-

- The difference between culvert & bridges is the span Length.
- span < 20 → culverts
  - > 20 → Bridge.

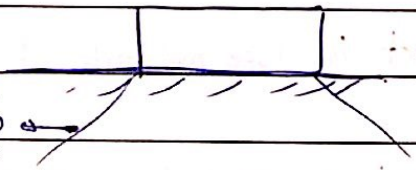
* Culverts are found in three locations:-
  1. at the bottom of depression.
  2. Where natural streams intersect the road way
  3. at Location required for passing surface drainage carried in side ditches.

* Shapes :-
  1. Box
  2. Circular
  3. Arch.

* Culverts are installed either @ right angle or on skew.

* Cullverts if possible should cross at right angle to reduce cost.

* The grade of the culvert should comfort to the existing grade of the streem.
  - if the grade is reduced → velocity may be reduced ; this will cause sedment in the water deposited in the culvert. [capacity will be reduced].
  - Increasing slope → velocity increased ; hense it will cause erosion, theref protective measures is needed at the outlet.



بنعمل حماية العبارة بصب الأرضية concrete حتى ما يصير في erosion ←
وتقل السرعة.

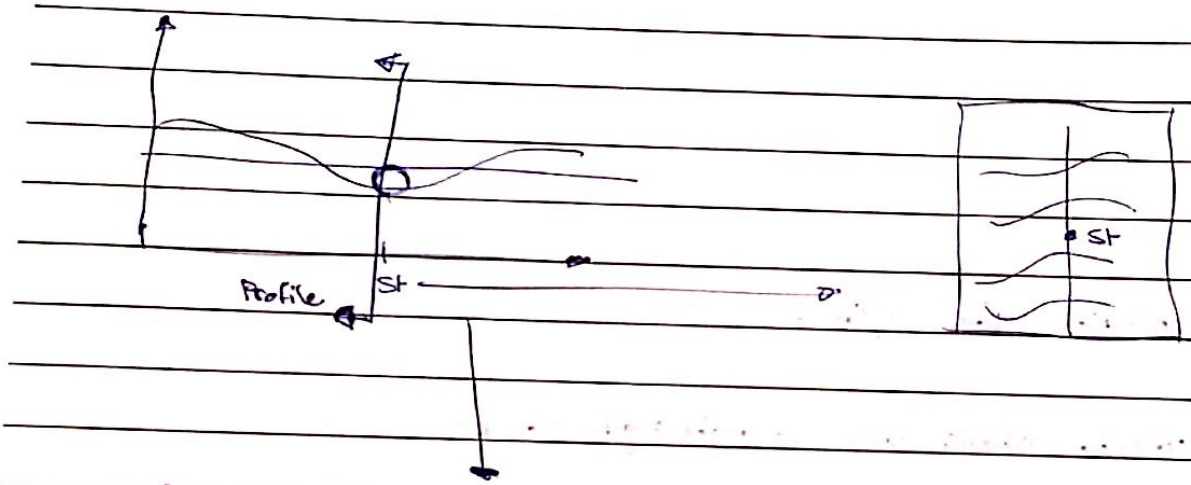
* ~~S~~ followed

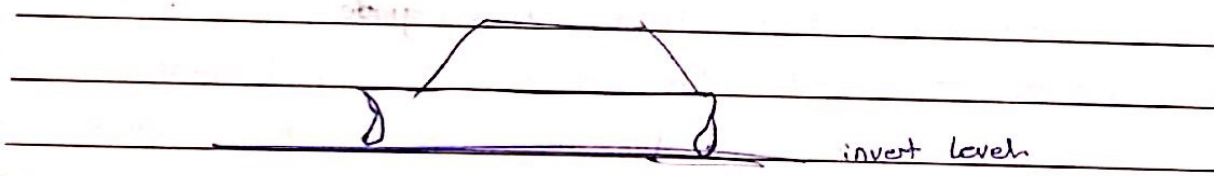
* 2% slope for culvered in the average , it will keep the culvert clean while at the same time the water speed is keep at measurable level [speed of water = 1.5 m/s to 3m/s).

* Hydrulic design of the culvert :-

- The design involves the following procedure

1. obtain all site data and plot a road way cross section at the culvert side including the profile of the streem channel





cross section of profile

2. Establish the culverts invert elevation at the inlet and outlet and determine the culvert lengths and slope.

3- Select the type and site of culvert and the design features.

3- Examin the need for energy dissipator and where needed. (Provide protective devices to prevent erosion)

* followed *

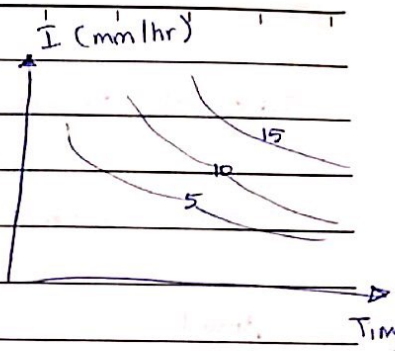
* Design of surface drainage :-

- the design procedure is devided into 3- Phases :-

1- Estimate of the quantity of wate.

2. The Hydrulic design of each element.

3. comparison of alternative. (choose the cheepest)



* Estimation of the quantity of water:-

1. perform statical Analysis on the recorded stream flow to provide an estimated peak design flow for a given return ~~flow~~ period.

- Return period refers to the estimated frequency of rare events such as floods. depends on experimence & judgment.

* * Rain Entinsity :-

the estimation of peak run off for drainage design is accomplished by consideration of severe storms that occur at interval which greater than the other timer.

* Surface run off :-

- The infiltration depends on:-

1. Type of soil
2. soil covers
3. Temprature.
4. slope of surface.-

x Following are

Type of drainage surface	Coeff. of runoff.
cement or asphalt surface	.75 - .95
gravel	.35 - .6
sandy soil cultivated.	.15 - .3
clay soil cultivated.	.3 - .7.5
Urban Bussiness district	.6 - .8
Urban residential	.5 - .7
Rural residential	.35 - .6
~~Wood land~~	

* Average Runoff water speed over surface condition for time consideration (m/s):

Surface condition	slope			
~~wood land~~	0-3	4-7	8-10	11-15
Wood Land	.15	.3	.45	.6
Pavement	1.5	3.65	4.7	5.5
Soil cultivated.	.25	.45	.65	.8

* The rational Method *

* $Q = C I A$ → Q = runoff (m^3/sec)

C = coeff. of runoff.

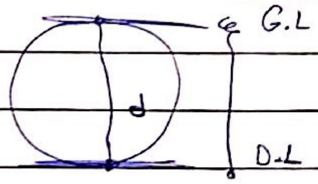
I = Intensity of rainfall. (mm/hr)

A = Area in Hectar. = $10000\ m^2$

* $C_w = \frac{C_1 A_1 + C_2 A_2 + \cdots}{\Sigma C}$ → اذا الترب مختلفة.

* $Q = VA$ → A = cross section of culvart. →

V = speed @ pipe or channel



* Example:-

الورقة اللي وزعها الدكتور آخر محاضرة