HIGHWAY ENGINEERING

GEOMETRIC DESIGN

3 G

The Driver, The Vehicle & The Road

Components of highway Transportation :

1. The Driver
2. The Pedestrian
3. The Vehicle
4. The Road
5. The Cyclist

- Reaction must be carried out within avery short time.
- most of the information received by a driver is visual.

- يتمتع معظم الناس برؤية واضحة داخل زاوية مخروطية من 3 ← 5 درجات ورؤية ضعيفة اذا كانت من 10 ← 12 درجة وما زاد تكون الرؤية خارج هذا النطاق غير واضحة والالوان المقبولة هي خليط بين الاربعة والاحمر والاخضر

Visual Acuity

- most people have clear vision within a conical angle of 3 → 5 degrees and fairly clear vision within a conical angle of 10 to 12 degrees. Vision beyond this range is usually blurred - peripheral vision.

(Color Vision) - Glare Vision and Recovery

- Color blindness (عمى الالوان) → Shapes can compensate for it.
- Combinations of black and white or yellow are most clear.
- for Glare vision and recovery about 3 seconds when moving from dark to light, can be up to 6 seconds or more when moving from light to dark

Perception – Reaction Process

• Perception

the driver sees a control device, warning sign or object on the road.

رؤية السائق لعائق أو إشارة على الطريق

• Identification

the deriver identifies the object or control device and thus understands the stimulus.

• Emotion

The deriver decides what action to take in response to the stimulus - to step on the brakes, to pass - etc

• Reaction

The driver actually executes the action decided on [PIER] time ranges from 1.25 → 3 seconds.

(PIER) → Perception - Identification - Emotion - Reaction

Visual Preception الإدراك البصري

عندما يرى السائق اي عائق على الطريق أو اشارة مثلاً يحتاج وقت إدراك ورد فعل بين الرؤية وعند اخذ القرار وهذا الزمن يتراوح بين

1.5 ⟶ 3 sec

✓ (2.5) sec

Example

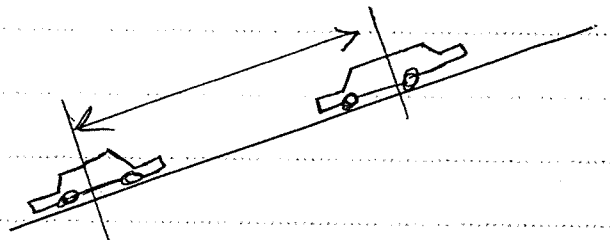
A driver with a preception-reaction time of (2.5) sec is driving at 100 km/hr When she observes that an accident has blocked the road ahead. Determine the distance the vehicle would move before the driver could activate the brakes ?

* Sol *

Distance (D) = Velocity * time

$$D = 100 * \frac{1000}{60 * 60} * 2.5 = (69.4)\ m$$

Braking Distance



$$D_b = \frac{(V_1^2 - V_2^2)}{254\,(f \pm S')} = \checkmark \quad m$$

D_b is braking distance (horizontal) in meters
V_1 and V_2 are initial and final speed (km/hr)
(f) is a coeff of longitudinal friction $= (0.3 \rightarrow 0.4)$
(S) is longitudinal slope

Example

A motorist traveling at 100 km/hr on an expressway intends to leave the expressway using an exit ramp with a maximum speed of 60 km/hr.
at what point on the expressway should the motorist step on her brakes in order to reduce her speed to the maximum allowable on the ramp just before entering the ramp. if this section of the expressway has a downgrade of 3%. 2

* SOL *

$V_1 = 100$ km/hr , $V_2 = 60$ km/hr $S' = 3\%$

$$D_b = \frac{(V_1^2 - V_2^2)}{254 * (f \pm S')} = \frac{(100^2 - 60^2)}{254 * (0.35 - 0.03)}$$

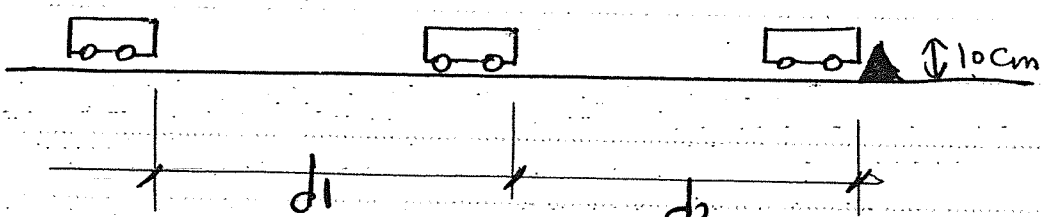
$= 78.8$ m. //

[مسافة الرؤية Sight Distance]

(A) Stopping Sight distance

- مسافة الرؤية الإيقاف وتسمى ايضاً
Non Passing Sight distance

هي أقل مسافة تسمح بوقوف وتوقف سير مسير بسرعة منتظمة
تصميمية قبل الاصطدام بعائق يقل ارتفاعة عن ١٠ سم



مسافة الادراك ورد الفعل
Perception & reaction distance

مسافة الايقاف
Stopping distance

$$SSD = \frac{V * t}{3.6} + \frac{V^2}{254 (f \pm S)}$$

(t) أي ورد الفعل (٢.٥ ثانية)

مسافة رد الفعل — مسافة الوصلة

initial Speed (Km/hr) — (V)

(S+) لو صاعد

(S-) لو هابط

Example

A motorist travilling at 100 km/hr a downgrade of 5% on a highway observes a crash ahead of him. If the motorist was able to stop his vehicle 10 m from the overturned truck what was his distance from the truck when he first observed the crash?

assume Preception reaction time is (2.5) sec

* SOL *

$$SSD = \frac{V * t}{3.6} + \frac{V^2}{254 * (f \pm S)}$$

$$= \frac{100 * 2.5}{3.6} + \frac{(100)^2}{254 * (0.35 - 0.05)}$$

$$= 200.7 \text{ m}$$

∴ Total distance from crash is

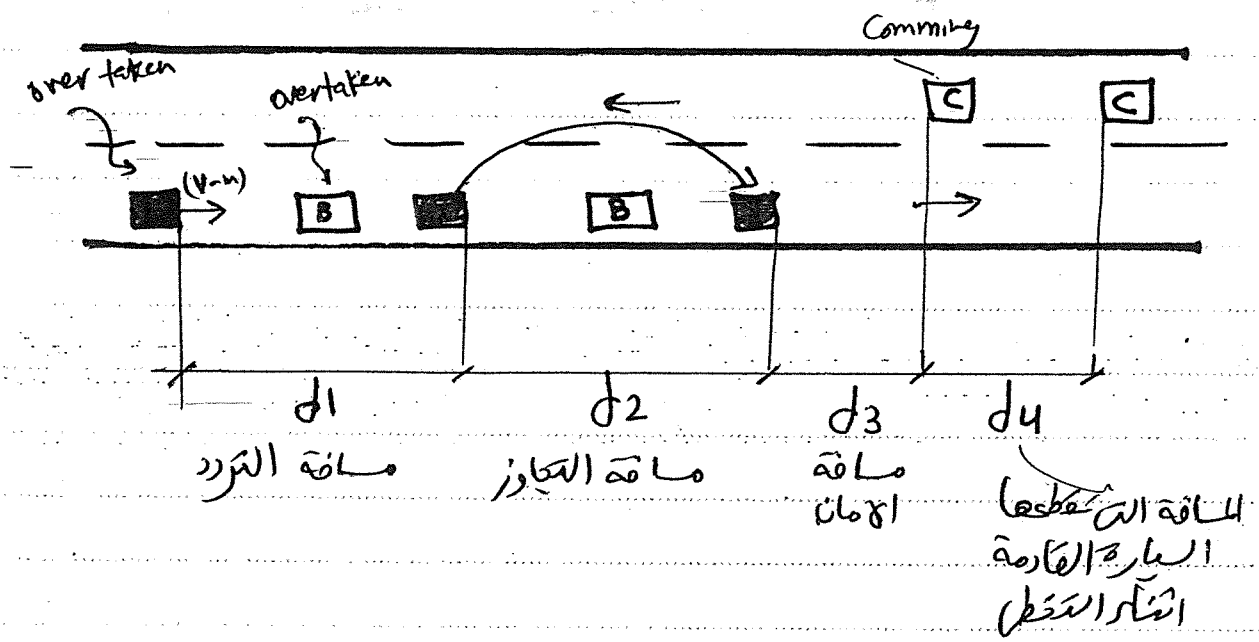
$$200.7 + 10 = (210.7) \text{ m}$$

(B) Passing Sight distance

• مسافة الرؤية التخطي

هي اقل مسافة تسمح بخروج وضع السير تسير بسرعة منتظمة والانتقال الى الاتجاه الآخر والعودة إلى نفس الاتجاه دون خطر الاصطدام بوضع السير القادمة من الاتجاه الآخر

(هام) هي لا توجد الا في الطرق الـ 2lane



$$PSD = d_1 + d_2 + d_3 + d_4$$

(d_1) Perception and reaction time distance

$$d_1 = \frac{(V-m) * t_1}{3.6} \quad = \checkmark \ m$$

take $t_1 = (3.5)$ sec زمن التردد

(d_2) distance passing vehicle occupies left lane (overtaking distance.)

$$d_2 = \frac{V * t_2}{3.6} \quad = \checkmark \ m$$

take $t_2 = (7 \rightarrow 9)$ sec
overtaking time.

(d_3) Clearance distance between the passing vehicle and the opposing vehicle after passing (safe distance)

$$d_3 = \frac{2 * V * t_3}{3.6} = \quad \checkmark \ m$$

take $(t_3 = 1.5)$ sec Safety time

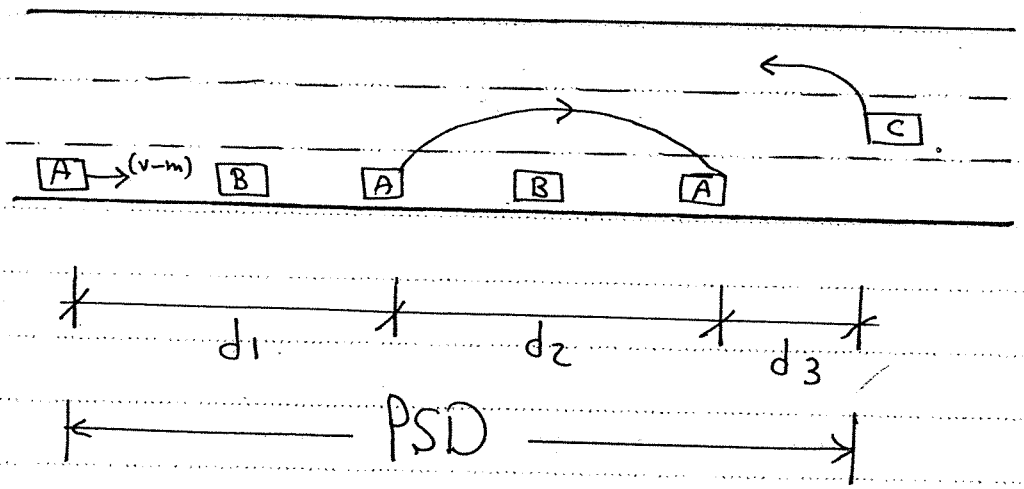
(d_4) distance traversed by an opposing vehicle

$$d_4 = \frac{2}{3} * \frac{V * t_2}{3.6} = \left(\frac{2}{3} * d_2\right)$$

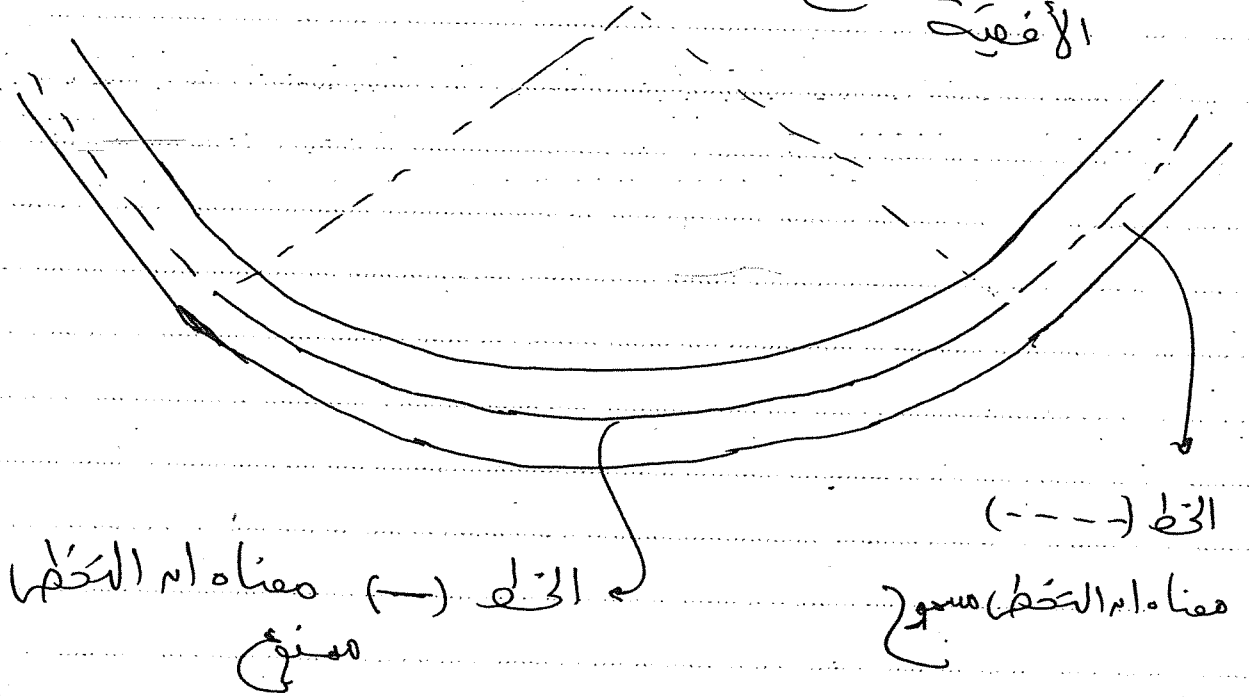
Passing Sight distance = PSD = $d_1 + d_2 + d_3 + d_4$

For 2 lane

لاحظ لوكان طريق 3- lanes



- لاحظ انه يُمنع التخطي على الطرق ذات المنصات الأفقية



Ex

A vehicle is travelling at 90 km/hr what will be the minimum passing sight distance if $m = 12$ km/hr, and overtaking time is 7 sec.

$$d_1 = \frac{(V-m)*t_1}{3.6} = \frac{(90-12)*3.5}{3.6} = 75.83 \text{ m}$$

$$d_2 = \frac{V*t_2}{3.6} = \frac{90*7}{3.6} = 175 \text{ m}$$

$$d_3 = \frac{2*V*t_3}{3.6} = \frac{2*90*1.5}{3.6} = 75 \text{ m}$$

$$d_4 = \frac{2}{3}*d_2 = \frac{2}{3}*175 = 116.67 \text{ m}$$

For 2 lanes

$$PSD = d_1+d_2+d_3+d_4 = 442.5 \text{ m}$$

For 3 lanes

$$PSD = d_1+d_2+d_3 = 325.83 \text{ m}$$

Home work

- Calculate the minimum passing sight distance required for 2-lane & 3 lanes under the following road way conditions

  → Design speed = 80 km/hr

  → Speed of vehicle to be overtaken = 60 km/hr
  ↳ (V-m)

  → overtaking time = 8 sec