# ROAD INTERSECTIONS AND TRAFFIC CONTROL DEVICES

3.1 Basic requirements of intersections
3.2 Types of intersections and their configuration
3.3 Channelized and unchannelized intersections
3.4 Rotary intersections
3.5 Warrants for signalization and choice of traffic control devices
3.7 Traffic signals, signal design and signs
3.8 Road marking and traffic island

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## ROAD INTERSECTIONS

- Road intersection can be defined as the general area where two or more roads join or cross within which are included the road way and road side facilities for traffic movement in that area.
- Intersections are points of traffic hazards which affect safety, speed, efficiency, capacity and cost of operation of the whole road.
- Intersections should be designed to reduce crashes and delays and they should led to the orderly movements of vehicular as well as pedestrian traffic.

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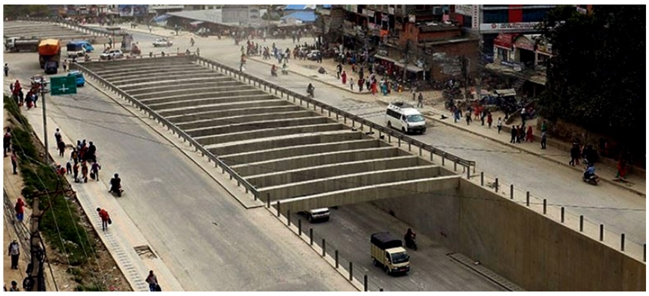
# TYPE OF INTERSECTION

- Intersection at grade or level
- Grade separated intersection



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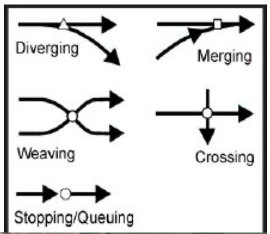
# TYPE OF INTERSECTION

- Intersection at grade or level
  - All the approaching or converging roads meet at one level.
  - Traffic maneuvers include merging, diverging, crossing and weaving.
  - The highway radiating from an intersection are referred as intersection legs.

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# TYPE OF INTERSECTION

- Intersection at grade or level
  - Basic requirements of Intersection at Grade
    - There should be adequate visibility for all the approaching vehicles on all converging roads.
    - Width of pavement at radius for turning should be sufficiently provided.
    - Area of conflict should be reduced to minimum by introducing properly designed traffic island and channelizing island.
    - Relative speed of approaching vehicles should be small.
    - Sudden change of path should be avoided.
    - Proper signs should be provided on the road approaching to warn the drivers.
    - Good lighting at night is desirable.
    - If the number of pedestrians and cyclists are large, separate provision should be made for their safe passage in intersections with high volume of fast moving traffic.

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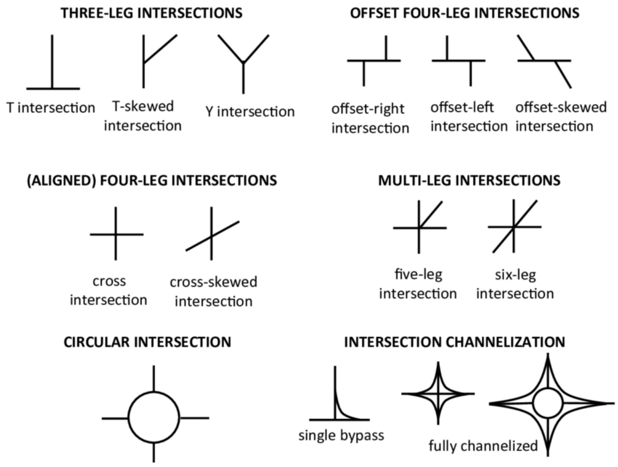
# TYPE OF INTERSECTION

- Intersection at grade or level
  - Various forms of Intersection
    - According to the system of intersecting roads at grade intersection their forms may be tee, cross, staggered T, staggered and skewed, multiple intersection.

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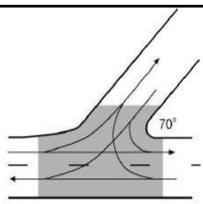
# TYPE OF INTERSECTION




Undefined vehicle path and large area of conflict

- Intersection at grade or level
  - Unchannelized Intersection
    - An unchannelized intersection is one without island for directing traffic into definite path.
    - No provision of any direction island or central island.
    - Heavy flow of traffic leads to frequent crashes and the intersection cannot perform properly.
    - Heavy traffic are controlled by traffic signals or by traffic police.
    - Most dangerous type of intersection.
    - Cheapest, easiest in design but complex in traffic operation.

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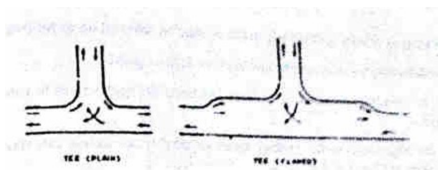
# TYPE OF INTERSECTION

- Intersection at grade or level
  - Unchannelized Intersection
    - When no additional pavement width for turning movement is provided it is called plain intersection.
    - When the pavement is widened at the intersection area by a traffic lane or more, it is known as flared intersection.



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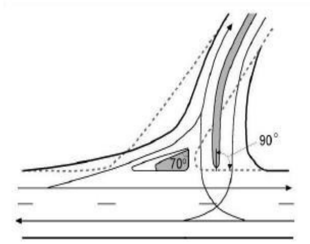
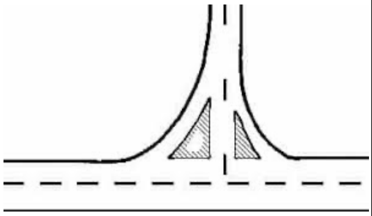
# TYPE OF INTERSECTION




Definition of vehicle paths



- Intersection at grade or level
  - Channelized Intersection
    - The direction of traffic flow at intersections to definite paths by means of traffic marking, island is known as channelization.
    - These island helps in channelizing turning traffic to control their speed and angle of approach.
    - The number of crashes decreases when an intersection is channelized.
    - Channelization may be either partial or complete with divisional and directional islands and medians.
    - Superior to other types because from traffic operation point of view there is better control on the traffic entering and leaving the intersection. However one of the crossing vehicles will have to stop while the other proceeds.

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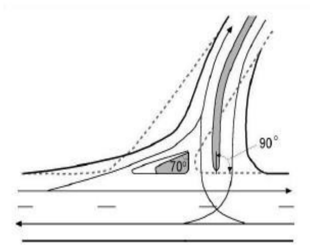
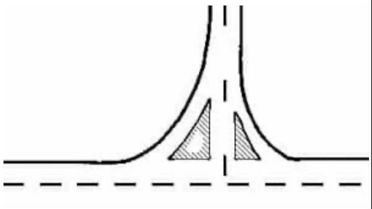
# TYPE OF INTERSECTION




Definition of vehicle paths



- Intersection at grade or level
  - Channelized Intersection
    - Advantages of Channelized Intersection
      - Vehicles can be confined to definite paths.
      - Speed control devices can be installed to force the vehicles to reduce their speed before entering the intersection.
      - Points of conflict can be separated.
      - Refugee island can be provided for pedestrian.
      - Angle of merging and diverging maneuvers can be kept minimum.
      - Proper channelization increases capacity, safety, provides maximum convenience and gradually establish confidence of the drivers.

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# TYPE OF INTERSECTION

- Intersection at grade or level
  - Rotary Intersection
    - A rotary intersection or traffic rotary is an enlarged road intersection where all converging vehicles are forced to move round a large central island in one direction (clockwise direction) before they can weave out of traffic flow into their respective directions radiating from the central island.
    - Rotaries and roundabouts are channelized intersections comprising a central circle surrounded by a one-way roadway.
    - It is a specialized form of intersection at grade.

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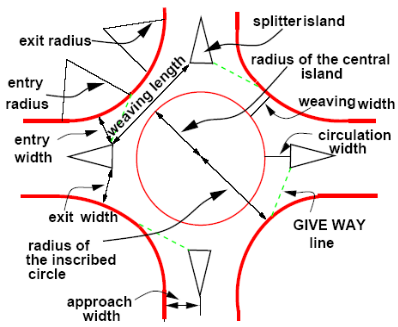
# TYPE OF INTERSECTION

- Intersection at grade or level
  - Rotary Intersection
    - The main objectives of providing a rotary are to eliminate the necessity of stopping even for crossing stream of vehicles and to reduce the area of conflict.
    - The crossing of vehicles is avoided by allowing all vehicles to merge into the streams around the rotary and then to diverge out to the desired radiating road. Thus the crossing conflict is eliminated and converted into weaving maneuver or a merging operation from the right and a diverging operation to the left.

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# TYPE OF INTERSECTION

- Intersection at grade or level
  - Rotary Intersection
    - Advantages
      - Crossing maneuvers are converted into weaving, merging and diverging operation.
      - Equal opportunity for all vehicles as those turning left.
      - Rotary could function itself, no need of traffic police or signal.
      - Number and severity of road crash is reduced.
      - Rotaries can be constructed with advantage when the number of intersecting roads is between four and seven.
      - The capacity of the rotary intersection is the highest of all other intersection at grade.
      - Operation cost at rotary is less than at signalized intersection where the vehicles have to stop and proceed.

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# TYPE OF INTERSECTION

- Intersection at grade or level
  - Rotary Intersection
    - Limitations
      - It requires large area of land.
      - With mixed traffic condition it may be complex.
      - If pedestrian traffic is high in urban area then rotary itself cannot control the traffic hence it becomes necessary to provide traffic police.
      - When the traffic volume is very low, construction of a rotary cannot be justified.

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Intersections where crossing maneuvers are made at different levels so that the movements in different directions do not conflict with each other is known as grade separated intersection.
  - In grade separated intersection roads are separated by passing one road over or below the other.
  - Grade separated intersection design is the highest form of intersection treatment.
  - At grade separated intersection normally one way traffic movements are designed and hence only left diverging, merging maneuvers are involved which has practically no hazardous effect on other traffic.

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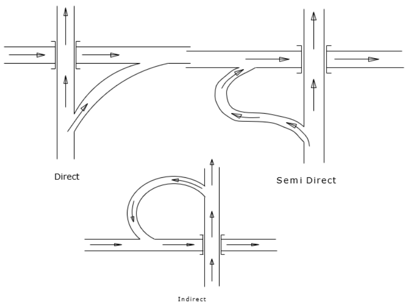
# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Interchange is a system where by facility is provided for movement of traffic between two or more roadways at different levels in the grade separated junction.
  - Interchange ramps may be classified as:
    - Direct
    - Semi-direct
    - Indirect

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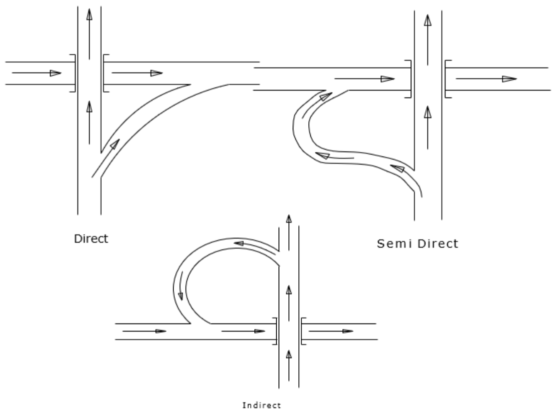
# TYPE OF INTERSECTION

- Grade Separated Intersection
  - The direct interchange ramp involves diverging to right side and merging from the right.
  - Semi-direct interchange ramp allows diverging to left but merging is from right side.
  - In the indirect method of interchange ramp, a simple diverging to the left and a merging from the left side are involved which are simple and less hazardous than diverging to the right and merging from the right. But the distance to be traversed in indirect interchange is more.





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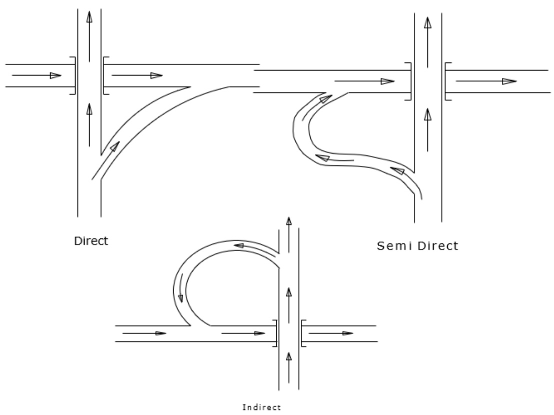
# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Different shapes of the ramps are used according to the traffic pattern, traffic volumes, design speed, topography, intersecting angle and the type of ramp terminals.
  - Ramp grade should be flat as possible to minimize driving effort in maneuvering from one road to another.
  - Access should be controlled throughout all portions of interchanges, just as for the highway between the interchanges.





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## TYPE OF INTERSECTION

- Grade Separated Intersection
  - Advantages
    - There are no crossing conflicts.
    - They provide more safety, comfort and convenience to motor traffic and affect saving in operational cost and time of travel.
    - Capacity of grade separated roads almost approaches to the full capacity.
    - They provide easy means of separation of express ways and freeways from local traffic.
    - Grade separation can be designed for any angle of intersection and any number of intersecting roads.

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## TYPE OF INTERSECTION

- Grade Separated Intersection
  - Disdvantages
    - Grade separation involves very large area.
    - It involves lot of expenditure in providing bridges under passes and interchange ramps.
    - Unnecessary rise of grade and sag are introduced in vertical alignment. It is undesirable in flat or plain terrain.

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Grade Separation Structures
    - The grade separated intersections are classified as over-pass and under-pass.
    - When the major highway is taken above by raising its profile above the general ground level by embankment and an over bridge across another highway, it is called an over-pass.
    - If the highway is taken by depressing it below the ground level to cross another road by means of an under bridge, it is known as under pass.
    - The choice of the overpass or underpass depends on topography, vertical alignment drainage, aesthetic features and preferential aspects for one of the highways.

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Grade Separation Structures
    - Advantages of an overpass
      - Troublesome drainage problems may be reduced by taking the major highway above the cross road.
      - Future expansion or lateral expansion or construction of separate bridge structure for divided highway is possible.

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Grade Separation Structures
    - Disadvantages of an overpass
      - If the major highway is to be taken over by constructing high embankments and by providing steep gradients, the increased grade resistance may cause speed reduction on heavy vehicles.
      - There will be restriction to sight distance unless long vertical curves are provided.

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Grade Separation Structures
    - Advantages of an underpass
      - There is a warning to traffic in advance due to the presence of an under-pass which can be seen from distance.
      - When the major highway is taken below, it is advantageous to the turning traffic because the traffic from cross road can accelerate while descending the ramp to the major highway and traffic from the major highway can decelerate while ascending the ramp to the cross roads.

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Grade Separation Structures
    - Disadvantages of an underpass
      - There is no possibility of stage construction for the bridge structure at the under pass.
      - Over head structure may restrict the sight distance in valley curves.

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Grade separated intersections without interchange
    - Grade separated intersections with interchange

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Grade separation without interchange is simply introduction of bridge or series of bridges which enable traffic streams on the intersecting highways to cross over each other without any vehicle conflict taking place.
    - So a structure without interchange is an over bridge or under pass or flyover, whereby the traffic at different levels moves separately without a provision for an interchange between them.
    - The different forms of grade-separated junction can be considered under the number of legs the intersection serves. Thus, the interchanges can be classified as three-leg, four legs and multiple legs.

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Three-leg Interchange
      - T Interchanges
      - Y Interchanges
      - A Partial Rotary Interchange
    - Four-leg Interchange
      - Diamond Interchange
      - Half clover leaf interchange
      - Clover leaf interchange
      - Rotary interchange
      - Directional interchange

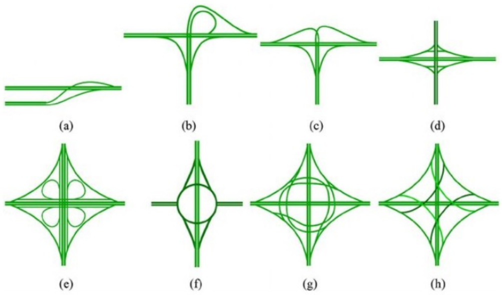


Fig. 1. Some typical interchange bridges. (a) Bifurcation type. (b) Trumpet type. (c) Y type. (d) Diamond type. (e) Cloverleaf type. (f) Roundabout type. (g) Turbine type. (h) Stack type.

Source: https://www.researchgate.net/publication/273395245_Three-Dimensional_Reconstruction_of_Large_Multilayer_Interchange_Bridge_Using_Airborne_LiDAR_Data/figures?lo=1

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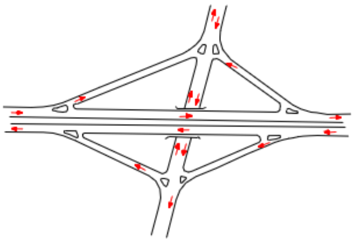
# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Diamond Interchange
        - A popular form of interchange in urban locations involving a major-minor crossing is a diamond interchange.
        - It can be designed for a relatively narrow right of way of the major road.



Diamond Intersection

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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Half cloverleaf interchange
        - When a major road crosses a minor road (not more than 3 lanes), it is possible to provide a partial cloverleaf.
    - Video Link: https://youtu.be/7GTZRSPry70


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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Cloverleaf Interchange
        - The cloverleaf interchange is a 4-leg interchange with a single structure.
        - It is used when two high volume and high speed facilities intersect each other.
    - Video Link: https://youtu.be/7GTZRSPry70


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# TYPE OF INTERSECTION





- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Cloverleaf Interchange



        - Advantages
          - Through traffic on both roads in unimpeded.
          - Only one structure is required.
          - Left turning traffic has a direct path.
          - It is very simple to use and does not confuse the drivers.


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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Cloverleaf Interchange
        - Disadvantages
          - Relatively large area is required.
          - The carriageway area required is also higher than a rotary interchange.
          - The U-turns are long and operationally difficult.
          - Right turning vehicle has to travel extra distance.
          - Weaving maneuvers are involved, some of them on the roadway of the structure and some underneath the structure.



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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Rotary Interchange
        - A rotary interchange is a form of 4 leg interchange and can be used for multi-leg interchange.



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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Rotary Interchange
        - Advantages
          - It occupies relatively less land area.
          - The carriageway area is also less than many other types.
          - U-turns are easy.
          - Suitable for most of the sites.


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# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Rotary Interchange
        - Disadvantages
          - The capacity is limited by the capacity of the roundabout itself.
          - The straight through traffic on one road is required to weave with turning traffic from the other road.


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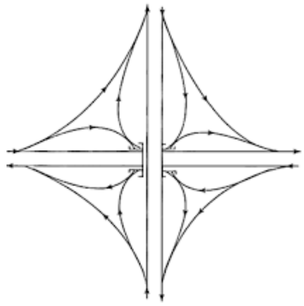
# TYPE OF INTERSECTION

- Grade Separated Intersection
  - Types of Grade Separated Intersection
    - Four-leg Interchange
      - Directional Interchanges
        - Directional interchanges generally have more than one highway grade separation with direct or semi-direct connections of ramps for the major right turning traffic.
        - These interchanges are rather complex and involve complicated multi-level structures.



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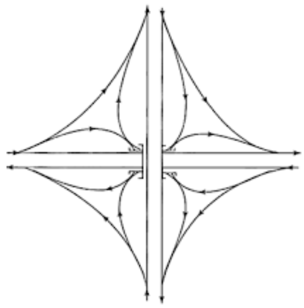

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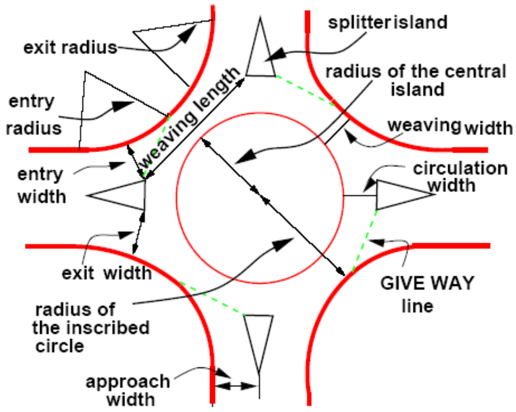
# DESIGN OF TRAFFIC ROTARY

- Speed of the traffic at rotary.
- Shape of Central Island.
- Radius of Rotary Roadway.
- Width of Rotary Roadway.
- Weaving distance and weaving angle.
- Radius of entrance and exit curves.
- Channelizing Island.
- Design of camber, super-elevation, grade, signs and lighting.
- Provision for pedestrians, cycle traffic.

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# DESIGN OF TRAFFIC ROTARY

- Speed of the traffic at rotary
  - 30 kmph for urban areas
  - 40 kmph for rural areas

- Shape of central island
  - Circular
  - Elliptical
  - Turbine
  - Tangent

  Generally, circular shape is adopted.

- Radius of Central Island

  $$R = \frac{V^2}{127 * f}$$

  f = 0.43 and 0.47 for speeds 40 kmph and 30 kmph respectively.
  Minimum radius of central island should be greater than 1.33 times radius of entry curve.

- Width of rotary roadway
  One traffic lane wider than mean width of the entry and non-weaving section.

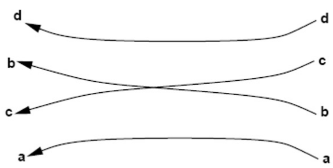
  $$w = \frac{e1+e2}{2} + 3.5$$

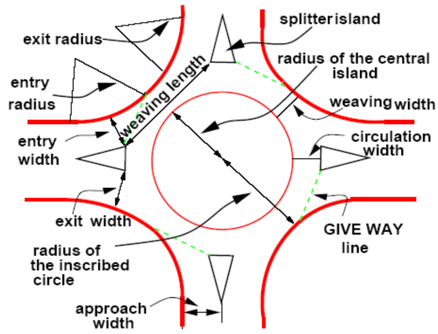
- Weaving angle and length
  Small weaving angle but should not be less than 15°.
  Weaving length at least 4 times the width of the weaving section.

  Minimum Recommended weaving length
  45-90 m for 40 kmph
  30-60 m for 30 kmph

- Entrance and Exit Curves
  For 40 kmph entry curve radius 20 – 35 m.
  For 30 kmph entry curve radius 15 – 25 m.

  Exit curves should be of a larger radius than entry curves, usually 1.5 to 2 times of radius of entry curve is considered reasonable.




**Capacity of Rotary Roadway**

$$Q_p = \frac{280W(1 + e/w)(1 - p/3)}{(1 + W/L)}$$

**Proportion of weaving traffic is given by:**

$$p = \frac{b + c}{a + b + c + d}$$

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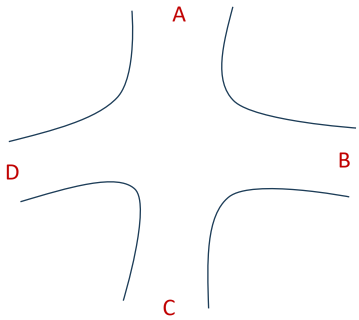
# NUMERICAL

Design a traffic rotary with given projected flow.

| Leg | Left | Straight | Right |
|---|---|---|---|
| A | 222 | 511 | 326 |
| B | 724 | 1121 | 318 |
| C | 1443 | 566 | 593 |
| D | 955 | 1968 | 929 |




**Proportion of weaving traffic is given by:**

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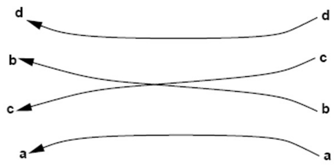
**Capacity of Rotary Roadway**

$$Q_p = \frac{280W(1+e/w)(1-p/3)}{(1+W/L)}$$




| Capacity Analysis | | | | | | | |
|---|---|---|---|---|---|---|---|
| Section | a | b | c | d | b + c | a + b + c + d | p |
| AB | 222 | 837 | 2561 | 929 | 3398 | 4549 | 0.747 |
| BC | 724 | 1439 | 1440 | 326 | 2879 | 3929 | 0.733 |
| CD | 1443 | 1159 | 1447 | 318 | 2606 | 4367 | 0.597 |
| DA | 955 | 2897 | 884 | 593 | 3781 | 5329 | 0.709 |

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# NUMERICAL

Speed of the traffic at rotary

30 kmph for urban areas
40 kmph for rural areas

Weaving length at least 4 times the width of the weaving section.

| Capacity Analysis | | | | | | | |
|---|---|---|---|---|---|---|---|
| Section | a | b | c | d | b + c | a + b + c + d | p |
| AB | 222 | 837 | 2561 | 929 | 3398 | 4549 | 0.747 |
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Entrance and Exit Curves

For 40 kmph entry curve radius 20 – 35 m.
For 30 kmph entry curve radius 15 – 25 m.

Exit curves should be of a larger radius than entry curves, usually 1.5 to 2 times of radius of entry curve is considered reasonable.

Radius of Central Island

$$R = \frac{V^2}{127*f}$$

f = 0.43 and 0.47 for speeds 40 kmph and 30 kmph respectively.
Minimum radius of central island should be greater than 1.33 times radius of entry curve.

$$p = \frac{b+c}{a+b+c+d}$$

$$e = \frac{e1+e2}{2}$$

$$w = \frac{e1+e2}{2} + 3.5$$

$$Q_p = \frac{280W(1+e/w)(1-p/3)}{(1+W/L)}$$

| Design Parameter Selected (1) | | |
|---|---|---|
| Design Speed | 30 | kmph |
| Radius of entry curve | 15 | m |
| Exit curve radius | 30 | m |
| Radius of central island | 20 | m |

| Leg | Entry Width (e1) | Exit Width (e2) |
|---|---|---|
| A | 7 | 7 |
| B | 10 | 10 |
| C | 10 | 10 |
| D | 10 | 10 |

| Design Parameter Selected (2) | | |
|---|---|---|
| Design Speed | 30 | kmph |
| Radius of entry curve | 15 | m |
| Exit curve radius | 30 | m |
| Radius of central island | 20 | m |

| Leg | Entry Width (e1) | Exit Width (e2) |
|---|---|---|
| A | 12 | 12 |
| B | 10 | 10 |
| C | 10 | 10.5 |
| D | 14 | 14 |

| Calculation (1) | | | | | | |
|---|---|---|---|---|---|---|
| Length | e = (e1+e2)/2 | w | Qp (Num) | Qp (Den) | Qp | Remarks |
| 45.00 | 7.00 | 10.50 | 3679.94 | 1.23 | 2983.73 | 0.00 |
| 55.00 | 10.00 | 13.50 | 4972.82 | 1.25 | 3992.78 | 1.00 |
| 55.00 | 10.00 | 13.50 | 5270.73 | 1.25 | 4231.97 | 0.00 |
| 55.00 | 10.00 | 13.50 | 5023.80 | 1.25 | 4033.71 | 0.00 |

| Calculation (2) | | | | | | |
|---|---|---|---|---|---|---|
| Length | e | w | Qp (Num) | Qp (Den) | Qp | Remarks |
| 65.00 | 12.00 | 15.50 | 5782.76 | 1.24 | 4669.31 | 1.00 |
| 55.00 | 10.00 | 13.50 | 4972.82 | 1.25 | 3992.78 | 1.00 |
| 65.00 | 10.25 | 13.75 | 5382.87 | 1.21 | 4443.00 | 1.00 |
| 70.00 | 14.00 | 17.50 | 6734.03 | 1.25 | 5387.22 | 1.00 |

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$R = V^2 / 127f = 15.07m$

But, 1.33*Radius of entry curve = 1.33*15 = 19.95m

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## TRAFFIC OPERATION AND MANAGEMENT

- Due to more number of vehicles on the road, it has become utmost necessary for the safe traffic operation on highways.
- Adequate regulations and controls have to be imposed.
- Traffic regulations should be made obligatory to all road users irrespective of their public positions.

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## TRAFFIC REGULATIONS

- Traffic regulations should be framed in such a way that effective control on drivers, vehicles and other road users could be exercised.
- Regulations are framed for safe and efficient movement of traffic and pedestrians.
- Regulations and laws are framed to cover or achieve:
  - Driver's Control
  - Vehicle Control
  - Flow Regulations
  - General Controls

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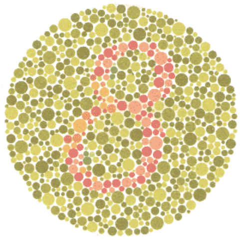
# TRAFFIC REGULATIONS

- Driver's Control
  - This control should be strictly exercised during granting driving licenses.
  - Physical conditions, eye sight, hearing power, etc should be tested.
  - Driving license for light and heavy motor vehicles.
  - Professional and Non-professional types.
  - Renew after every five year.
  - Category (11): A to K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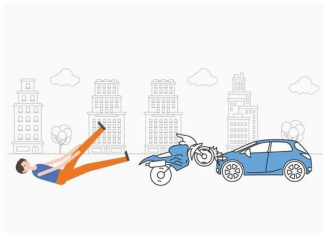
# TRAFFIC REGULATIONS

- Vehicle Control
  - Regular inspection of vehicles by traffic police.
  - Vehicle registration: zonal registration, number plate of different color for different ownerships.
  - Insurance: Third party insurance.
  - Brake, steering, lights.
  - Route control, time control for transport vehicles.



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# TRAFFIC REGULATIONS


- Flow Regulations
  - These regulations help in smooth flow of the traffic.
  - Keep to left is one such regulation.
  - Directional Control
  - Turning Control
  - Overtaking Control
  - One-way, speed limit, prohibitory signs, informatory, warning signs, pedestrian control

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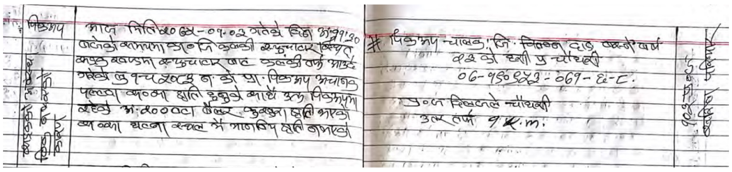
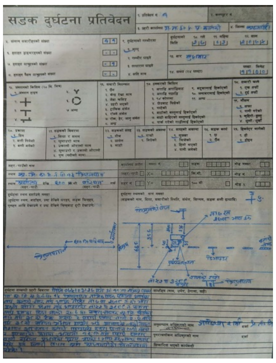
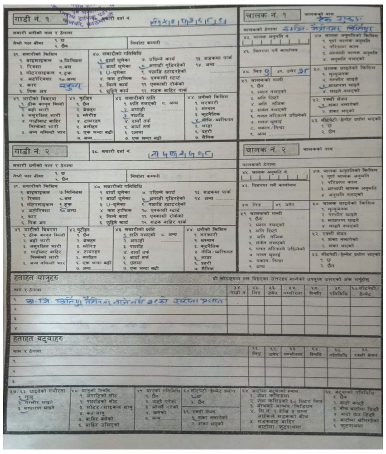
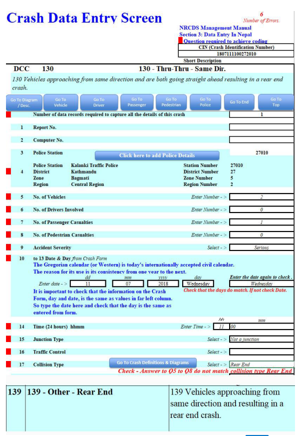
# TRAFFIC REGULATIONS



- General Controls
  - Some other regulations and provisions are made to report crashes provisions and recording and disposing traffic violation cases.



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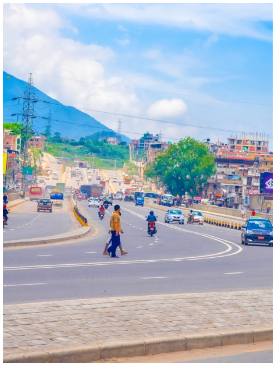
# TRAFFIC CONTROL DEVICES


- The various aids and devices used to control, regulate and guide traffic are called traffic control devices.



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# REQUIREMENTS OF TRAFFIC CONTROL DEVICES (WARRANTS FOR SIGNALIZATION AND CHOICE OF TRAFFIC CONTROL DEVICES)

- The control device should fulfill a need – Each device must have a specific purpose for the safe and efficient operation of traffic flow.
- It should command attention from the road users – For commanding attention, proper visibility should be there. Also the sign should be distinctive and clear.
- It should convey a clear, simple meaning – Clarity and simplicity of message is essential for the driver to properly understand the meaning in short time. The use of color, shape and legend as codes becomes important in this regard.
- Road users must respect the signs – Respect is commanded only when the drivers are conditioned to expect that all devices carry meaningful and important messages. Overuse, misuse and confusing messages of devices tends the drivers to ignore them.
- The control device should provide adequate time for response – The sign boards should be placed at a distance such that the driver could see it and gets sufficient time to respond to the situation. Eg: The STOP sign which is always placed at the stop line of the intersection should be visible for at least one safe stopping sight distance away from the stop line.

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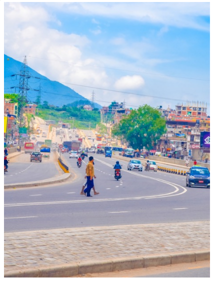
# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signs
- Traffic Signals
- Road Markings
- Traffic Island
- Access Control on Highways
- Road Lights





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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signs
  - Measure to convey specific information to the driver quite in advance, so that he/she may become careful.
  - The three main functions of traffic signs are to regulate, warn and inform as:
    - They give timely warning of hazardous situations.
    - They are of great help in regulating traffic by imparting messages to the drivers about the need to stop, give way and limit their speeds.
    - They give information as to highway a route, directions and point of interest.




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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signs
  - Traffic Sign Category
    - Regulatory/Mandatory Signs
    - Warning Signs
    - Informatory Signs




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## TYPES OF TRAFFIC CONTROL DEVICES



- Traffic Signs
  - Traffic Sign Category
    - Regulatory/Mandatory Signs
      - They indicate to the traffic an obligation to comply with statutory regulation and non-compliance of which is considered an offence.
      - These signs give orders.
      - They tell drivers what they must not do (prohibitory) or what they must do (mandatory).
      - Most of them take the form of a circular disc, although two signs, the Stop sign and the Give way sign, have distinctive individual shapes.

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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signs
  - Traffic Sign Category
    - Regulatory/Mandatory Signs
      - These signs can be further grouped as:
        - Stop and Yield Signs
        - Speed Signs
        - Movement Signs
        - Parking Sign
      - Traffic Sign Manual (Published by DOR) schedule of regulatory signs (A1 – A33) thirty three types of signs.



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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signs
  - Traffic Sign Category
    - Warning Signs
      - These warn drivers of some actual or potential danger and hazardous conditions ahead.
      - Warning signs are distinguished by their equilateral triangle shape with a red border encompassing a black symbol and white background.
      - Sometimes additional information is put onto a supplementary plate below the main sign.
      - The traffic sign manual describes about 48 warning signs (B 01 – B 48).


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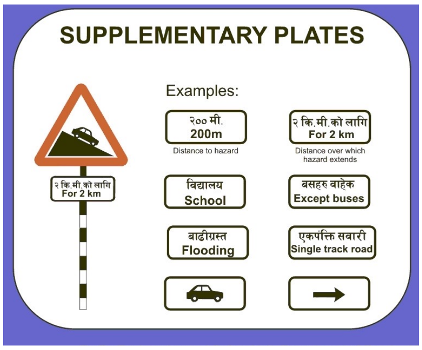
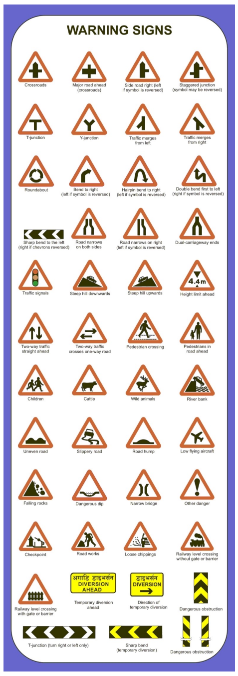
# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signs
  - Traffic Sign Category
    - Warning Signs

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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signs
  - Traffic Sign Category
    - Informatory Signs
      - Most of these signs give drivers information to enable them to find their way to their destination.
      - It is a varied group of signs, but they are all either square or rectangular in shapes.
      - Direction and place identification sign.
      - Facility information sign (location of petrol pumps, hospitals, etc).
      - Other useful information sign
      - Parking Sign, Name of streets and highways, Flood gauge, etc.

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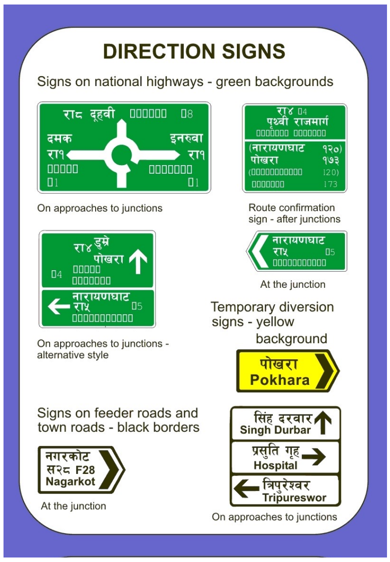
# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signs
  - Traffic Sign Category
    - Informatory Signs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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
  - Traffic signals are such control devices which can alternately direct the traffic to stop and proceed at level intersections.
  - The main requirements of traffic signals are to draw attention, provide meaning and time to response and to have minimum waste of time.
  - To control traffic at important road junctions or intersections the automatic traffic signals are installed in big cities.


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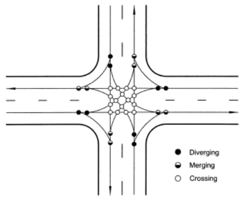
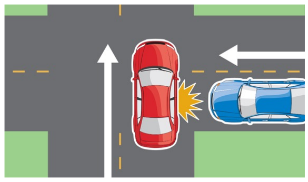
## TYPES OF TRAFFIC CONTROL DEVICES




- Traffic Signals
- Advantages of Traffic Signals
  - Movement of traffic on level intersection is more orderly and safe.
  - Traffic handling capacity of the intersection is increased.
  - Right angled collision points are reduced.
  - Traffic signals when subjected to automatic control prove more economical than manually operated signals.
  - Pedestrian can cross the roads safely at the signalized intersection.
  - Signals provide chance to crossing traffic of minor road to cross the path of continuous flow of traffic stream.



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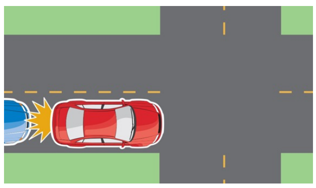
## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Disadvantages of Traffic Signals
  - In case of automatic control, failure of power may cause lot of confusion.
  - Possibilities of rear end collisions are increased.
  - In case of automatic signals, operated at fixed interval a vehicle in urgency may have to wait at intersection even if there is no traffic on crossing road, only because signal is showing red light to him.
  - Excessive delays to vehicle may be caused especially during off peak periods.



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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Categories of Traffic Signals
  - For Vehicle Control
  - For Pedestrian Crossing Movement


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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Categories of Traffic Signals
  - For Vehicle Control
    - Red Light – Traffic is prohibited from proceeding beyond the stop line.
    - Green Light – Vehicular traffic may proceed beyond the stop line.
    - Amber Light – Conveys same prohibited as red signals except where vehicles are so close to the stop line that they cannot safely stop before the stop line they should proceed.


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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Categories of Traffic Signals
  - For Pedestrian Crossing Movement
    - Red Standing Man – Pedestrians are prohibited from crossing the road.
    - Green Walking Man – Pedestrians may cross the road with care.
    - Flashing Green Man – Pedestrians are prohibited from crossing the road except where they have started to cross the road, in which case they should continue to cross the road.





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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Types of Traffic Signals
  - Traffic Control Signals
    - Fixed-time signal
    - Manually operated signal
    - Traffic actuated (automatic) signal
  - Pedestrian Signal
  - Special Traffic Signal


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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Types of Traffic Signals
  - Traffic Control Signals
    - Fixed-time signal
      - This type of signal is set to repeat regularly a cycle of red, amber and green lights.
      - The timing of each phase cycle is predetermined based on the traffic studies.
      - Simplest type of automatic traffic signals which are electrically operated.
      - Disadvantage is that sometimes the traffic flow on one road may be almost nil and traffic on cross road may be quite heavy and that volume of traffic need to be queued.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Types of Traffic Signals
  - Traffic Control Signals
    - Manually operated traffic light
      - Light signal posts are fixed on the left hand side of the approaching vehicles at all entrance points to the intersection.
      - These posts are provided with red, yellow and green light arrangements.
      - These lights are so interconnected that they can be switched off or switched on from a single common point.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Types of Traffic Signals
  - Traffic Control Signals
    - Traffic actuated Signal
      - In this type of signals, timings of the phase and cycle can be changed according to the traffic needs.
      - In fully traffic actuated signals, detectors are located on each approach which assign the right of way to various traffic movements on the basis of demand.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Types of Traffic Signals
  - Pedestrian Signal
    - This is meant to give right of way to the pedestrians to cross a road.
    - When pedestrians are crossing the road, the vehicular traffic shall remain stopped by stop or red signal on the traffic signal of the road.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals
- Types of Traffic Signals
  - Special Traffic Signal
    - Flashing Beacon
      - It is meant to give warning to the approaching traffic.
      - The drivers of vehicles shall have to stop before entering the nearest cross walk at the intersection or at the stop line when red signals are flashed.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- Definitions
  - Cycle – A signal cycle is one complete rotation through all of the indications provided.
  - Phase – It is a part of cycle length allocated for specific traffic movement.
  - Cycle Length – Cycle length is the time in seconds that it takes a signal to complete one full cycle of indications. It indicates the time interval between the starting of green for one approach till the next time the green starts. It is denoted by C.
  - Interval – This indicates the change from one stage to another. There are two types of intervals – change interval and clearance interval.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- Definitions
  - Change interval is also called the yellow time indicates the interval between the green and red signal indications for an approach.
  - Clearance Interval is also known as all red and is provided after each yellow interval indicating a period during which all signal faces show red and is used for clearing off the vehicles in the intersection.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- Definitions
  - Green Interval – It is the green indication for a particular movement or set of movements and is denoted by $G_i$. This is the actual duration the green light of a traffic signal is turned on.
  - Red Interval – It is the red indication for a particular movement or set of movements and is denoted by $R_i$. This is the actual duration the red light of a traffic signal is turned on.
  - Lost time – It indicates the time during which the intersection is not effectively utilized for any movement.

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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- General Design Data for Intersection System
  - Cycle length for two phase signal is mostly 40 to 60 seconds.
  - Time of yellow or amber color varies from 3 to 5 seconds, higher values being adopted for higher speed. This time is completed on the basis of time required to stop the vehicle at stop line and also time required to clear the intersection from the vehicles already entered before change of color.
  - Timing for green light may be nearly 20 seconds.
  - Timing for red light is slightly less than green light timing.
  - Clearance of pedestrian time is calculated on the basis of pedestrian's walking speed of 1.2 m/secs.

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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- Trial Method of Cycle Design

Let A and B are two roads intersecting at a point and it is required to design cycle length for the intersection.

1. For 15 minutes take traffic counts on road A and B, simultaneously and the same intersection.
2. Let $N_1$ and $N_2$ be traffic counts of 15 minutes A and B road respectively.
3. Assume trial cycle length of C seconds.
4. Based on assumed value of C, calculate the number of cycles in 15 minutes period as follows: $\frac{15*60}{C} = \frac{900}{C}$.
5. Assume 2.5 seconds headway time and calculate green light periods $G_A$ and $G_B$ for roads A and B as follows:

   $G_A = \frac{2.5*C*N_1}{900}$ and $G_B = \frac{2.5*C*N_2}{900}$. Assume yellow or amber period of $Y_A$ and $Y_B$ for A and B roads.
6. Calculate the cycle time $C = G_A + G_B + Y_A + Y_B$
7. If the calculated cycle length C works out approximately equals to the assumed cycle C, the cycle length is accepted as design cycle, otherwise trials are repeated.

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# NUMERICAL

The 15 minutes traffic counts on a cross roads A and B are observed as 150 and 120 vehicles per lane respectively. If the amber times required are 4 and 3 seconds respectively for two roads based on approach speeds. Design signal timings by trial cycle method. Assume an average time headway of 2.5 seconds during green phase.

- **Let $N_1$ and $N_2$ be traffic counts of 15 minutes A and B road respectively.**

  $N_1$ = 150 vpl

  $N_2$ = 120 vpl
- **Assume trial cycle length of C seconds.**

  Let Cycle Length = 40 seconds
- **Based on assumed value of C, calculate the number of cycles in 15 minutes period as follows:** $\frac{15*60}{C} = \frac{900}{C}$.

  Number of cycles = $\frac{900}{C} = \frac{900}{40}$ = 22.50
- **Assume 2.5 seconds headway time and calculate green light periods $G_A$ and $G_B$ for roads A and B as follows:**

  $G_A = \frac{2.5*C*N_1}{900} = \frac{2.5*40*150}{900}$ = 16.67 seconds and $G_B = \frac{2.5*C*N_2}{900} = \frac{2.5*40*120}{900}$ = 13.33 seconds
- **Assume yellow or amber period of $Y_A$ and $Y_B$ for A and B roads.**

  $Y_A$ = 4 seconds and $Y_B$ = 3 seconds.
- **Calculate the cycle time C = $G_A + G_B + Y_A + Y_B$** = 16.67 + 13.33 + 4 + 3 = 37 seconds.

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# NUMERICAL

The 15 minutes traffic counts on a cross roads A and B are observed as 150 and 120 vehicles per lane respectively. If the amber times required are 4 and 3 seconds respectively for two roads based on approach speeds. Design signal timings by trial cycle method. Assume an average time headway of 2.5 seconds during green phase.

- **Assume trial cycle length of C seconds.**

  Let Cycle Length = 30 seconds
- **Based on assumed value of C, calculate the number of cycles in 15 minutes period as follows:** $\frac{15*60}{C} = \frac{900}{C}$.

  Number of cycles = $\frac{900}{C} = \frac{900}{30}$ = 30
- **Assume 2.5 seconds headway time and calculate green light periods $G_A$ and $G_B$ for roads A and B as follows:**

  $G_A = \frac{2.5*C*N_1}{900} = \frac{2.5*30*150}{900}$ = 12.50 seconds and

  $G_B = \frac{2.5*C*N_2}{900} = \frac{2.5*30*120}{900}$ = 10 seconds
- **Assume yellow or amber period of $Y_A$ and $Y_B$ for A and B roads.**

  $Y_A$ = 4 seconds and $Y_B$ = 3 seconds.
- **Calculate the cycle time C = $G_A + G_B + Y_A + Y_B$** = 12.50 + 10 + 4 + 3 = 29.50 seconds.

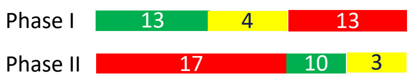
- Let Cycle Length = 25 seconds
- Number of cycles = $\frac{900}{C} = \frac{900}{25}$ = 36
- $G_A = \frac{2.5*C*N_1}{900} = \frac{2.5*25*150}{900}$ = 10.42 seconds and
- $G_B = \frac{2.5*C*N_2}{900} = \frac{2.5*25*120}{900}$ = 8.33 seconds
- $Y_A$ = 4 seconds and
- $Y_B$ = 3 seconds.
- C = $G_A + G_B + Y_A + Y_B$ = 10.42 + 8.33 + 4 + 3 = 25.75 seconds.

Take Cycle Length = 30 seconds and extra 0.5 seconds may be added to the green time of main road 1.

Therefore,

$G_A$ = 12.50 + 0.50 = 13 seconds and

$G_B$ = 10 seconds.

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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- <u>Webster's Method</u>
  - In this method the optimum signal cycle $C_o$ corresponding to least total delay at the signalized intersection is workout. The field work involves estimating:
    - The saturation flow **'s'** per unit time on each approach of the intersection.
    - The normal flow **'q'** on each approach during the design hour.
  - Based on higher value of normal flow the ratio $y_1 = q_1/s_1$ and $y_2 = q_2/s_2$ are worked out on the approach roads A and B. In case of mixed traffic, it has to be converted in terms of PCU separately for normal flow saturation flow values.
  - The saturation flow is to be obtained from field studies by noting the number of vehicles in the stream of compact flow during the green phases and corresponding time intervals precisely.

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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- <u>Webster's Method</u>

The normal flow of traffic is determined on the approach roads form the field studies for the design period (during the peak hour or off peak hour as the case may be)

The optimum signal cycle

$C_o = \frac{1.5L+5}{1-y}$

Where,

L = Total lost time for cycle, sec.

**L = nI + R**

n = Number of phases

R = All red time

$y = y_1 + y_2$

Then,

$G_1 = \frac{y_1}{y}(Co - L)$

$G_2 = \frac{y_2}{y}(Co - L)$

Similar method is used when there is more number of signal phases.

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# NUMERICAL

The average normal flow of traffic on cross roads 1 and 2 during design period are 375 and 225 pcu per hour. The saturation flow values on these roads are estimated as 1050 and 850 pcu per hour respectively. The all red time required for pedestrian crossing is 10 secs. Design two phase signal by Webster's method. Considering amber time to be 2 seconds each for clearance.

- **The saturation flow 's' per unit time on each approach of the intersection.**

  $s_1$ = 1050 pcu/hr

  $s_2$ = 850 pcu/hr

- **The normal flow 'q' on each approach during the design hour.**

  $q_1$ = 375 pcu/hr

  $q_2$ = 225 pcu/hr

- **Based on higher value of normal flow the ratio $y_1 = q_1/s_1$ and $y_2 = q_2/s_2$ are worked out on the approach roads A and B. In case of mixed traffic, it has to be converted in terms of PCU separately for normal flow saturation flow values.**

  $y_1$ = 375/1050 = 0.36

  $y_2$ = 225/850 = 0.26

- **The optimum signal cycle**

  $C_o = \frac{1.5\,L+5}{1-y}$

L = nl + R = 2n + R = 2*2 + 10 = 14 seconds
L = 2 + 2 + 10 = 14 seconds

y = $y_1$ + $y_2$ = 0.36 + 0.26 = 0.62

$C_o = \frac{1.5\,L+5}{1-y} = \frac{1.5 * 14 + 5}{1-0.62}$ = 68.50 seconds

$G_1 = \frac{y_1}{y}(Co - L) = \frac{0.36}{0.62}(68.50 - 14)$ = 31.65 secs

$G_2 = \frac{y_2}{y}(Co - L) = \frac{0.26}{0.62}(68.50 - 14)$ = 22.85 secs

Phase I: 31.65 | 2 | 24.85 | 10

Phase II: 33.65 | 22.85 | 2 | 10

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# NUMERICAL

Design two phase traffic signal using Webster's method. The flow on cross roads 1 and 2 during design period are 450 pcu/hr and 325 pcu/hr respectively. The capacity of roads 1 and 2 being 1400 pcu/hr and 1200 pcu/hr respectively. Take amber time as 3 sec for pedestrian crossing is 15 secs.

- **The saturation flow 's' per unit time on each approach of the intersection.**

  $s_1$ = 1400 pcu/hr

  $s_2$ = 1200 pcu/hr

- **The normal flow 'q' on each approach during the design hour.**

  $q_1$ = 450 pcu/hr

  $q_2$ = 325 pcu/hr

- **Based on higher value of normal flow the ratio $y_1 = q_1/s_1$ and $y_2 = q_2/s_2$ are worked out on the approach roads A and B. In case of mixed traffic, it has to be converted in terms of PCU separately for normal flow saturation flow values.**

  $y_1$ = 450/1400 = 0.32

  $y_2$ = 325/1200 = 0.27

- **The optimum signal cycle**

  $C_o = \frac{1.5\,L+5}{1-y}$

L = nl + R = 2n + R = 2*3 + 15 = 21 seconds
L = 3 + 3 + 15 = 21 seconds

y = $y_1$ + $y_2$ = 0.32 + 0.27 = 0.59

$C_o = \frac{1.5\,L+5}{1-y} = \frac{1.5 * 21 + 5}{1-0.59}$ = 89.02 seconds

$G_1 = \frac{y_1}{y}(Co - L) = \frac{0.32}{0.59}(89.02 - 21)$ = 36.89 secs

$G_2 = \frac{y_2}{y}(Co - L) = \frac{0.27}{0.59}(89.02 - 21)$ = 31.13 secs

Phase I: 36.89 | 3 | 34.13 | 15

Phase II: 39.89 | 31.13 | 3 | 15

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# NUMERICAL

The average normal flow of traffic on cross roads 1 and 2 during design period are 400 pcu/hr and 500 pcu/hr. The saturation flow values on these roads are estimated as 1200 pcu/hr and 1400 pcu/hr respectively. The all red time for pedestrian crossing is 12 sec. The amber times for road 1 is 3 secs and road 2 is 4 secs. The starting time loss for road 1 is 2 secs and for road 2 is 3 secs respectively.

- **The saturation flow 's' per unit time on each approach of the intersection.**

  $s_1$ = 1200 pcu/hr

  $s_2$ = 1400 pcu/hr

- **The normal flow 'q' on each approach during the design hour.**

  $q_1$ = 400 pcu/hr

  $q_2$ = 500 pcu/hr

- **Based on higher value of normal flow the ratio $y_1 = q_1/s_1$ and $y_2 = q_2/s_2$ are worked out on the approach roads A and B. In case of mixed traffic, it has to be converted in terms of PCU separately for normal flow saturation flow values.**

  $y_1$ = 400/1200 = 0.33

  $y_2$ = 500/1400 = 0.36

- **The optimum signal cycle**

  $C_o = \frac{1.5\,L+5}{1-y}$

L= 3+2+4+3 + 12 = 24 seconds

$y = y_1 + y_2$ = 0.33 + 0.36 = 0.69

$C_o = \frac{1.5\,L+5}{1-y} = \frac{1.5*24+5}{1-0.69}$ = 132.36 seconds

$G_1 = \frac{y_1}{y}(Co - L) = \frac{0.33}{0.69}(132.36 - 24)$ = 51.78 secs

$G_2 = \frac{y_2}{y}(Co - L) = \frac{0.36}{0.69}(132.26 - 24)$ = 56.48 secs

| | | | | | |
|---|---|---|---|---|---|
| Phase I | 2 | 51.78 | 3 | 63.48 | 12 |
| Phase II | 56.78 | 4 | 3 | 56.48 | 12 |

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# NUMERICAL

A fixed time 2-phase signals is to be provided at an intersection having four arms. The design hour traffic and saturation flow are given. The time lost per phase due to starting delays is 2 seconds. Calculate the optimum cycle time. Allocate the given times to the two phases.

| | North (N) | South (S) | East (E) | West (W) |
|---|---|---|---|---|
| Design hour flow | 800 | 400 | 750 | 600 |
| Saturation flow | 2400 | 2000 | 3000 | 3000 |

- **The saturation flow 's' per unit time on each approach of the intersection.**

  $s_N$ = 2400 pcu/hr  $s_E$ = 3000 pcu/hr

  $s_S$ = 2000 pcu/hr  $s_W$ = 3000 pcu/hr

- **The normal flow 'q' on each approach during the design hour.**

  $q_N$ = 800 pcu/hr  $q_E$ = 750 pcu/hr

  $q_S$ = 400 pcu/hr  $q_W$ = 600 pcu/hr

- **Based on higher value of normal flow the ratio $y_1 = q_1/s_1$ and $y_2 = q_2/s_2$ are worked out on the approach roads A and B. In case of mixed traffic, it has to be converted in terms of PCU separately for normal flow saturation flow values.**

  $y_N$ = 800/2400 = 0.33  $y_E$ = 750/3000 = 0.25

  $y_S$ = 400/2000 = 0.20  $y_W$ = 600/3000 = 0.20

- **The optimum signal cycle**

  $C_o = \frac{1.5\,L+5}{1-y}$

L= 2+2+2+2= 8 seconds

$y = y_N + y_E$ = 0.33 + 0.25 = 0.58

$C_o = \frac{1.5\,L+5}{1-y} = \frac{1.5*8+5}{1-0.58}$ = 40.48 seconds

$G_{NS} = \frac{y_N}{y}(Co - L) = \frac{0.33}{0.58}(40.48 - 8)$ = 18.48 secs

$G_{EW} = \frac{y_E}{y}(Co - L) = \frac{0.25}{0.58}(40.48 - 8)$ = 14 secs

| | | | | |
|---|---|---|---|---|
| Phase I | 2 | 18.48 | 2 | 18 |
| Phase II | 22.48 | 2 | 2 | 14 |

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# TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- Design on basis of Pedestrian Crossing Time

This procedure is adopted when two phase signal unit in a cross road is to be designed together with pedestrian signals.

1. Select yellow interval from 3 to 5 seconds depending upon the speed of approaching vehicles. For speed up to 50 kmph yellow preload is 3 second, 50-60 kmph speed 4 seconds and 60-80 kmph speed 5 seconds.
2. Calculate pedestrian clearance time based on 1.2 m/sec speed. This time depends upon speed of walking over the width of the carriage way.
3. Minimum red time of traffic signal is taken as pedestrian clearance time for crossing plus initial interval for pedestrian to start crossing. The red time is equal to minimum green time plus yellow time for the crossing.
4. Minimum green time is computed based on the pedestrian clearance time for cross road plus initial interval for starting the pedestrian to cross minus yellow period. This equals to the red time for cross road minus amber (yellow) period for the cross road. If pedestrian signals are installed, initial interval which is known as walk period should not be less than 7 sec. If there is no pedestrian signal this interval may be taken as minimum 5 sec.

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TYPES OF TRAFFIC CONTROL DEVICES

- Traffic Signals [Into Design]
- Design on basis of Pedestrian Crossing Time

5. Based on highest approach volume per hour, actual green time is calculated. Cycle length so computed should be adjusted for next higher 5 seconds. The extra or excess time is distributed to green light timings proportionately to approaching traffic volume.
6. The value thus obtained is computed on the basis of %, as the controller settings are in percent of cycle.
7. Times so calculated are set in the controller and operation is watch at site during peak traffic hour. If need arise, correction may be done in timing at site.

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## NUMERICAL

An isolated signal with pedestrians indication is to be installed on a right angled intersection with road A 18m wide and road B 12m wide. The heaviest volume per hour for each lane of road A and road B are 275 and 225 respectively. The approach speeds are 55 and 40 kmph, for A and B respectively. Design the timings of traffic and pedestrian signals.

- **Select yellow interval from 3 to 5 seconds depending upon the speed of approaching vehicles. For speed up to 50 kmph yellow preload is 3 second, 50-60 kmph speed 4 seconds and 60-80 kmph speed 5 seconds.**

  $A_A$ = 4 seconds   $A_B$ = 3 seconds

- **Calculate pedestrian clearance time based on 1.2 m/sec speed. This time depends upon speed of walking over the width of the carriage way.**

  For Road A = 18/1.20 = 15 seconds   For Road B = 12/1.20 = 10 seconds

- **Minimum red time of traffic signal is taken as pedestrian clearance time for crossing plus initial interval for pedestrian to start crossing. The red time is equal to minimum green time plus yellow time for the crossing.**
- **If pedestrian signals are installed, initial interval which is known as walk period should not be less than 7 sec. If there is no pedestrian signal this interval may be taken as minimum 5 sec.**

  Minimum red time for road A = 15 + 7 = 22 seconds   Minimum red time for road B = 10 + 7 = 17 seconds

- **Minimum green time is computed based on the pedestrian clearance time for cross road plus initial interval for starting the pedestrian to cross minus yellow period. This equals to the red time for cross road minus amber (yellow) period for the cross road.**

  Minimum green time for Road A = 17 – 4 = 13 seconds   Minimum green time for Road B = 22 – 3 = 19 seconds

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## NUMERICAL

An isolated signal with pedestrians indication is to be installed on a right angled intersection with road A 18m wide and road B 12m wide. The heaviest volume per hour for each lane of road A and road B are 275 and 225 respectively. The approach speeds are 55 and 40 kmph, for A and B respectively. Design the timings of traffic and pedestrian signals.

- **Based on highest approach volume per hour, actual green time is calculated.**

  Use relation, $\frac{G_A}{G_B} = \frac{n_A}{n_B}$

  where, $G_A$ and $G_B$ are green times and $n_A$ and $n_B$ are approach volume per lane.

  Here, the green time calculated is increased for road A with higher traffic volume.

  $G_B$ is taken as 19 seconds and $G_A$ is calculated.

  $G_A = \frac{n_A}{n_B} * G_B = \frac{275}{225} * 19 = 23.20$ seconds

- **Cycle length computed should be adjusted for next higher 5 seconds.**

  Total cycle length = $G_A + G_B + A_A + A_B = G_A + A_A + R_A = G_B + A_B + R_B$ = 23.20 + 4 + 19 + 3 = 49.20 seconds.

  **Adopt Cycle Length = 50 seconds.**

  **Excess Time = 50 – 49.20 seconds = 0.80 seconds**

- **The extra or excess time is distributed to green light timings proportionately to approaching traffic volume.**

  $G_A = 23.20 + \frac{n_A}{n_A+n_B} * 0.80 = 23.20 + \frac{275}{275+225} * 0.80 = 23.64$ seconds   $G_B = 19 + \frac{n_B}{n_A+n_B} * 0.80 = 19 + \frac{225}{275+225} * 0.80 = 19.36$ seconds

  $R_A = G_B + A_B$ = 19.36 + 3 = 22.36 seconds   $R_B = G_A + A_A$ = 23.64 + 4 = 27.64 seconds

  Cycle Time (C) = 23.64 + 22.36 + 4 = 50 seconds.

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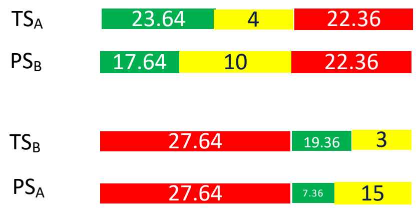
## NUMERICAL

An isolated signal with pedestrians indication is to be installed on a right angled intersection with road A 18m wide and road B 12m wide. The heaviest volume per hour for each lane of road A and road B are 275 and 225 respectively. The approach speeds are 55 and 40 kmph, for A and B respectively. Design the timings of traffic and pedestrian signals.

- **Design of Pedestrian Signal**
  - **Do not Walk (DW) period of pedestrian signal at road A ($PS_A$) is red period of traffic signal at B.**
  - **For $PS_A$, $DW_A = R_B = 27.64$ seconds**
  - **Do not Walk (DW) period of pedestrian signal at road B ($PS_B$) is red period of traffic signal at A.**
  - **For $PS_B$, $DW_B = R_A = 22.36$ seconds**
- **Pedestrian clearance intervals (CI) are of 15 and 10 seconds respectively for roads A and B for crossing. The walk time (W) is calculated from total cycle length.**
  - **For $PS_A$, $W_A = 50 – 27.64 – 15 = 7.36$ seconds**
  - **For $PS_B$, $W_B = 50 – 22.36 – 10 = 17.64$ seconds**

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## TYPES OF TRAFFIC CONTROL DEVICES

- Road Markings
  - Road marking or traffic marking are made of lines, patterns, words, symbols or reflectors on the pavement, kerb, sides of island or on the fixed objects within or near the road.
  - The road marking conveys the required information to the driver without distracting their attention from the carriageway.
  - Classified as:
    - Carriageway marking (Pavement marking)
    - Kerb Marking
    - Object Marking
    - Reflector Unit Marking.

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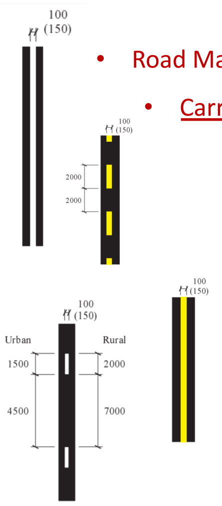
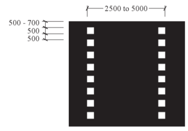
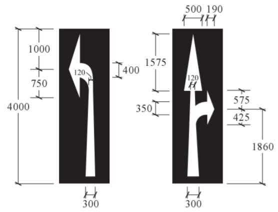
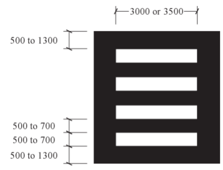
# TYPES OF TRAFFIC CONTROL DEVICES

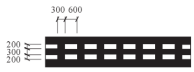


- Road Markings
  - Carriageway Marking (Pavement Marking)
    - Center Line – To separate the opposite stream.
    - Lane Line – To designate traffic lane.
    - No passing zone marking – To indicate that overtaking is not permitted.
    - Turn Marking – Used near intersection to designate proper lateral placement of vehicles before turning to different directions.
    - Stop Line – To indicate where vehicles are required to stop.
    - Cross walk lines – Places where pedestrians are to cross the road.
    - Parking Space Limit, Cyclist Crossing, Approach to obstructions, etc.









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# TYPES OF TRAFFIC CONTROL DEVICES

- Road Markings
  - Carriageway Marking (Pavement Marking)

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# TYPES OF TRAFFIC CONTROL DEVICES

- Road Markings
  - <u>Kerb Marking</u>
    - Road kerb at straight roads are marked.
    - Properly marked kerb indicate pavement limit.
    - Usually painted with alternate black and yellow or black and white colors.
    - Helpful during night times.

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# TYPES OF TRAFFIC CONTROL DEVICES

- Road Markings
  - <u>Object Marking</u>
    - Physical obstructions like bridge, signs, signals, traffic island, culvert head wall, etc are clearly marked to make the drivers alert about such hazardous objects.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Road Markings
  - Reflector Unit
    - In case of hazardous obstructions, reflector units are fixed.
    - Light of reflector unit should be visible from a distance of about 150 m.
    - Used as guide marking for safe driving during night.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Island
  - Traffic island are raised area provided at level road to avoid or minimize the areas of major and minor conflicts.
  - Island establishes physical channels through which vehicular traffic may be guided to travel and avoid conflict with other vehicular traffic.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Island
  - Functions of Island
    - They segregate vehicular traffic from pedestrian traffic.
    - They guide traffic into specific routes.
    - They reduce the conflict area.
    - They increase traffic safety.

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## TYPES OF TRAFFIC CONTROL DEVICES

- Island
  - Types of Island
    - Divisional Island or Median Island
    - Channelizing Island
    - Rotary or Central Island
    - Pedestrian Loading Island

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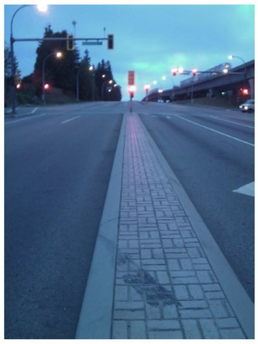
# TYPES OF TRAFFIC CONTROL DEVICES

- Island
  - Types of Island
    - Divisional Island or Median Island
      - Provided to separate opposing flow of traffic in a road having four or more lane.
      - Provided to eliminate head on collision.
      - To eliminate the head light glare during night driving, the width of this island should be quite large.
      - The height of divisional island should be enough to prevent vehicles entering into the island.



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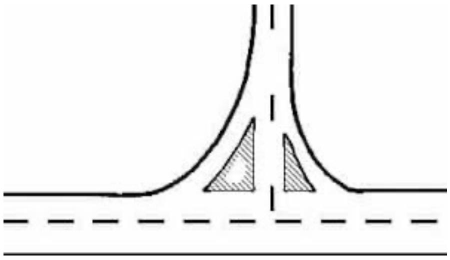
# TYPES OF TRAFFIC CONTROL DEVICES

- Island
  - Types of Island
    - Channelizing Island
      - Used to guide the motorists at turning points.
      - These are normally, triangular in shape.
      - Useful as a traffic control device, particularly at intersections having large areas.



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# TYPES OF TRAFFIC CONTROL DEVICES

- Island
  - Types of Island
    - <u>Central Island or Traffic Rotary</u>
      - It is an enlarged highway intersection where all the approaching vehicles from all the converging roads are forced to move around a large centrally situated island before they weave out into the desired radiating road.

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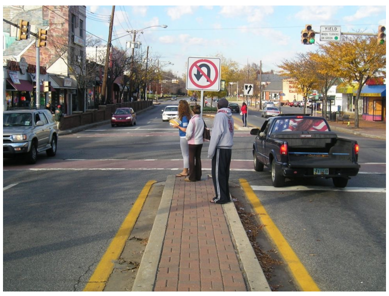
# TYPES OF TRAFFIC CONTROL DEVICES


- Island
  - Types of Island
    - <u>Pedestrian Loading Island</u>
      - Provided at regular bus stops and similar places for the safety of passenger.



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## TYPES OF TRAFFIC CONTROL DEVICES

- Access control on highways



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## TRAFFIC MANAGEMENT SCHEMES

- One-way Streets
- Restriction on turning movements
- Tidal flow operations
- Exclusive bus lanes
- Closing side streets
- Pedestrian streets
- Staggering of office hours


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