

Chapter 39

Traffic intersections

39.1 Overview

It is the most complex location on any highway. Conflicts are common at the intersections. This is because vehicles moving in different direction want to occupy same space at the same time. In addition, the pedestrians also seek same space for crossing. Intersection is an area shared by two or more roads. It is some area designated for the vehicles to turn to different directions to reach their desired destinations. Its main function is to provide channelization of route direction. Drivers have to make split second decision at an intersection by considering his route, intersection geometry, other vehicles, their speed, direction etc. A small error in judgement can cause severe accidents. It also causes delay and it depends on type, geometry and type of control. Overall traffic flow depends on the performance of intersection. It also affects the capacity of the road. Especially in the case of an urban scenario, both from the accident perspective and the capacity perspective, the study of intersection is very important for the traffic engineers.

39.2 Conflicts at an intersection

Conflicts in an intersection are different for different types of intersection. Consider a typical four-legged intersection as shown in figure. The conflicts for competing through movements are 4, those between right turn and competing through movements are 8. The conflicts between right turn traffics are 4, and between left turn and merging traffic is 4. The conflicts created by pedestrians come to 8 taking into account all the four approaches. Diverging traffic also produces about 4 conflicts. Summing up all the conflicts in the intersection, it comes to 32.

The essence of the intersection control is to resolve these conflicts at the intersection for the safe and efficient movement of both vehicular traffic and pedestrians. Two methods of intersection controls are there. They are the time sharing approach and the space sharing approach. The type of intersection control that has to be adopted depends on the traffic volume, road geometry, cost involved, importance of the road etc.

39.3 Levels of intersection control

The control of an intersection can be exercised at different levels. They can be either passive control, semi control, or active control. In passive control, there is no such direct strict rules on the driver. In semi control, some amount of control on the driver is there from the traffic agency. Active control means the movement of the traffic is fully controlled by the traffic agency and the drivers cannot simply maneuver the intersection

according to his choice.

39.3.1 Passive control

Some of the intersection control that are classified under passive control are as follows:

1. No control: If the traffic coming to an intersection is low, then by applying the basic rules of the road like driver on the left side of the road must yield and that through movements will have priority than turning movements, the driver itself can manage to traverse the intersection.
2. Traffic signs: With the help of warning signs, guide signs etc. it is able to provide some level of control at an intersection.
3. Traffic signs plus marking: In addition to the traffic signs, road markings also complement the traffic control at intersections. Some of the examples are stop line marking, yield lines, arrow marking etc.
4. GIVE WAY control: This control requires the driver in the minor road to slow down to a minimum speed and allow the vehicle on the major road to proceed.
5. Two way stop control: In this case, the vehicle drivers on the minor streets should see that the conflicts are avoided.
6. All-way stop control: This is usually used when it is difficult to differentiate between the major and minor roads in an intersection. In such a case, STOP sign is placed on all the approaches to the intersection and the driver on all the approaches are required to stop the vehicle. The vehicle at the right side will get priority over the left approach.

39.3.2 Semi control

Channelization and traffic rotaries come under semi control.

1. Channelization: The traffic is separated to flow through definite paths by raising a portion of the road in the middle usually called as islands distinguished by road markings. The conflicts in traffic movements are reduced to a great extent in such a case.
2. Traffic rotaries: It is a form of intersection control in which the traffic is made to flow along one direction round a traffic island. This completely avoids through-conflicts.

39.3.3 Active control

Active control means the road user will be forced to follow the path suggested by the traffic control agencies. He cannot maneuver according to his wish. Traffic signals and grade separated intersections come under this classification.

1. Traffic signals: This control is based on time sharing approach. At a time with the help of appropriate signals, certain traffic movements are restricted where as certain other movements are permitted. Two or more phase signals may be provided depending upon the traffic conditions of the intersection.
2. Grade separated intersections: It is an intersection where crossing movements at different levels is permitted. It is very expensive and is usually used on high speed facilities like expressways, freeways etc.

39.4 Types of intersection control

The intersections are of two types. They are at-grade intersections and grade-separated intersections. In at-grade intersections, all roadways join or cross at the same vertical level. Grade separated intersections allows the traffic to cross at different vertical levels. Sometimes the topography itself may be helpful in constructing such intersections. Otherwise the initial construction cost required will be very high. But it increase the road capacity because vehicles can flow with high speed and accident potential is also reduced by such vertical separation of traffic.

39.4.1 At grade intersection control

: Different types of intersection control provided at 'at-grade' are as follows.

1. Uncontrolled or passive control: The traffic control at 'at-grade' intersection may be uncontrolled in cases of low traffic. Here the road users are required to obey the basic rules of the road. Passive control like traffic signs, road markings etc. are used to complement the intersection control.
2. Semi controlled or channelized intersections: In channalized intersections, as the name suggests, the traffic is directed to flow through different channels and this physical separation is made possible with the help of some barriers in the road like traffic islands, road markings etc.
3. Rotary/Round about: It is a form of 'at-grade' intersection laid out for the movement of traffic such that no through conflicts are there. Free-left turn is permitted where as through traffic and right-turn traffic is forced to move around the central island in a clock-wise direction in an orderly manner. Merging, weaving and diverging operations reduces the conflicting movements at the rotary.
4. Signalized control: When the vehicles traversing the intersection is very large, then the control is done with the help of signals. The phases provided for the signal may be either 2 or more than 2 . If more than two phases are provided, then it is called multiphase signal.

The signals can operate in several modes. Most common are fixed time signals and vehicle actuated signals. In fixed time signals, the cycle time, phases and interval of each signal is fixed. Each cycle of the signal will be exactly like another. But they cannot cater to the needs of the fluctuating traffic. i vehicle actuated signals, vehicle detectors will be placed on the streets approaching the intersection, and when the vehicle arrives, the detector will detect the vehicle and pass the information to the controller. The controller then sets the cycle time and adjusts the phase lengths according to the prevailing traffic requirements.

39.4.2 Grade separated intersection control

As we discussed earlier, grade-separated intesections are provided to separate the traffic in the vertical grade. But the traffic need not be those pertaining to road only. When a railway line crosses a road, then also grade separators are used. Different types of grade-separators are flyovers and interchange. Flyovers itself are subdivided into overpass and underpass. When two roads cross at a point, if the road having major traffic is elevated to a higher grade for further movement of traffic, then such structures are called overpass. Otherwise, if the major road is depressed to a lower level to cross another by means of an under bridge or tunnel, it is called under-pass.

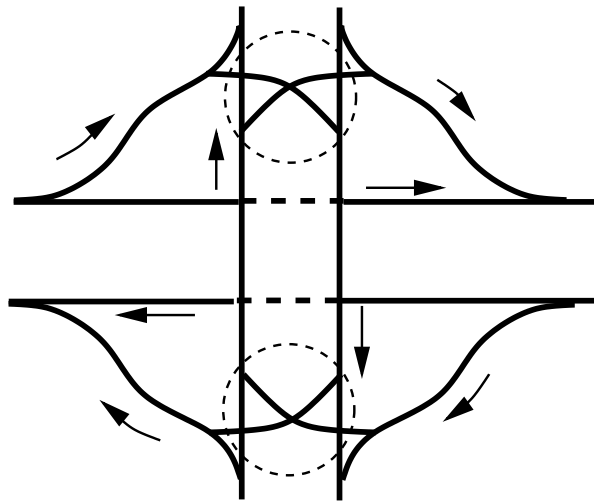


Figure 39:1: Diamond interchange

39.4.3 Interchange

Interchange is a system where traffic between two or more roadways flows at different levels in the grade separated junctions. Different types are

1. Diamond interchange: It is the most popular form of four-leg interchange found in the urban locations where major and minor roads cross. The important feature of this interchange is that it can be designed even if the major road is relatively narrow.
2. Clover leaf interchange: It is also a four leg interchange and is used when two highways of high volume and speed intersect each other. The main advantage of cloverleaf intersection is that it provides complete separation of traffic. Also high speed at intersections can be achieved. But the disadvantage is that large area of land is required.
3. Trumpet interchange: It is a three leg interchange. If one of the legs of the interchange meets a highway at some angle but does not cross it, then the interchange is called trumpet interchange.

39.5 Channalized intersection

The vehicles approaching the intersection are directed to definite paths by islands, markings etc. and this process is called channelization. There can be channalized or unchannalized intersection but channalized intersection provides more safety and efficiency. It reduces the number of possible conflicts by reducing the area of conflicts available in the carriageway. If no channalizing is provided, the driver will have less tendency to reduce the speed while entering the intersection from the carriageway. The presence of traffic islands, markings etc. makes the driver to reduce the speed and becomes more cautious while maneuvering the intersection. A channalizing island serves as a refuge for pedestrians and makes pedestrian crossing safer. Channalization of traffic through a three-legged intersection and a four-legged intersection is shown in the figure.

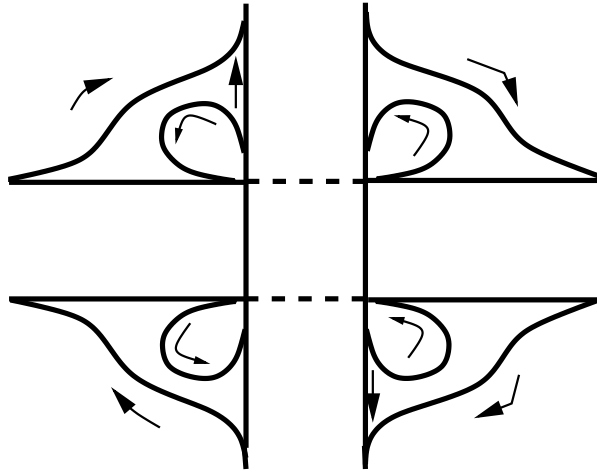


Figure 39:2: Cloverleaf interchange

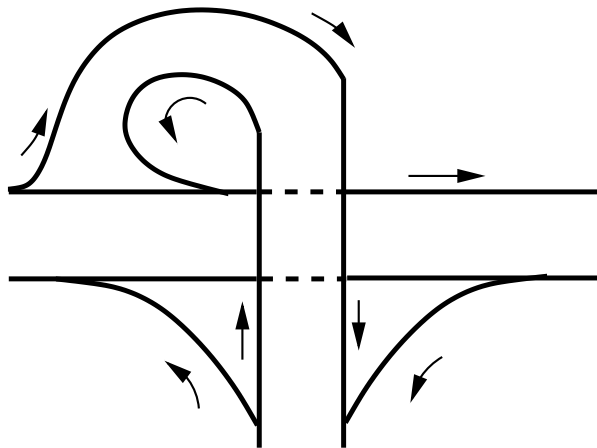


Figure 39:3: Trumpet interchange

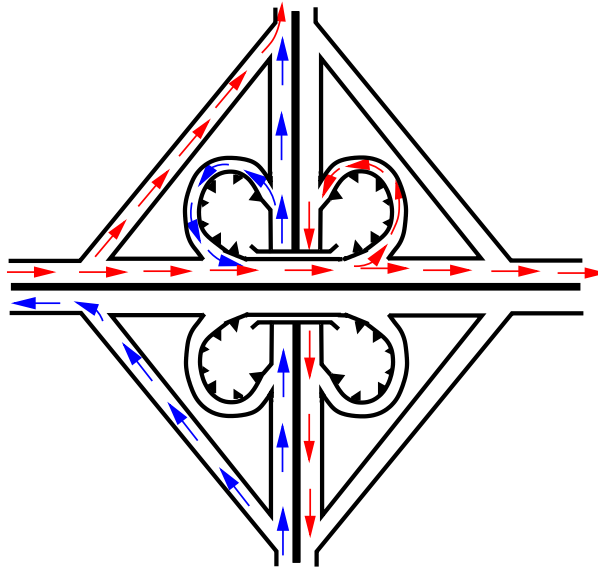


Figure 39:4: Cloverleaf interchange

39.6 Clover-leaf intersection

It is also a four leg interchange and is used when two highways of high volume and speed intersect each other. The main advantage of cloverleaf intersection is that it provides complete separation of traffic. Also high speed at intersections can be achieved. But the disadvantage is that large area of land is required.

39.7 Summary

Traffic intersections are problem spots on any highway, which contribute to a large share of accidents. For safe operation, these locations should be kept under some level of control depending upon the traffic quantity and behaviour. Based on this, intersections and interchanges are constructed, the different types of which were discussed in the chapter.

39.8 Problems