Principles of safe intersection design

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Road Safety INTERNATIONAL

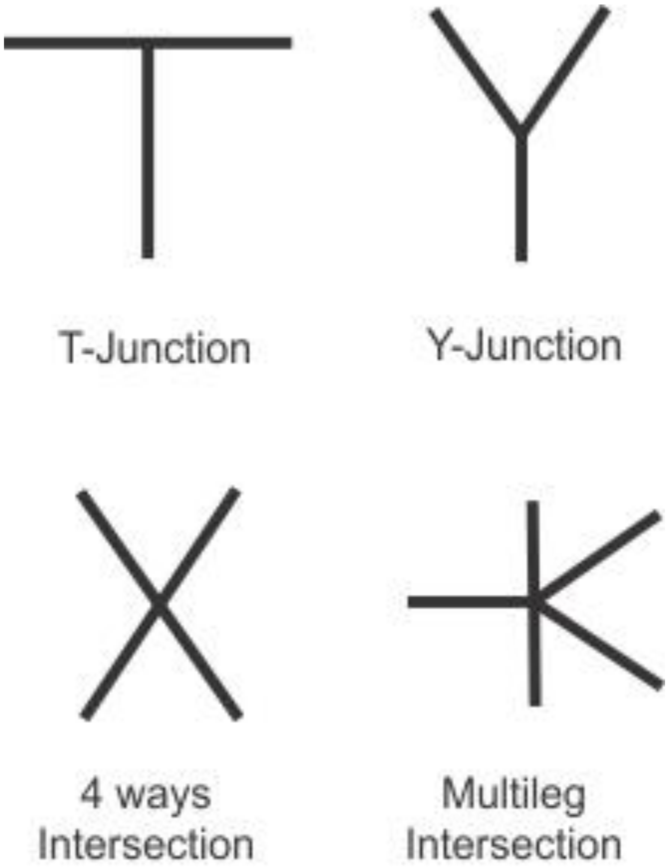
Objectives of this presentation

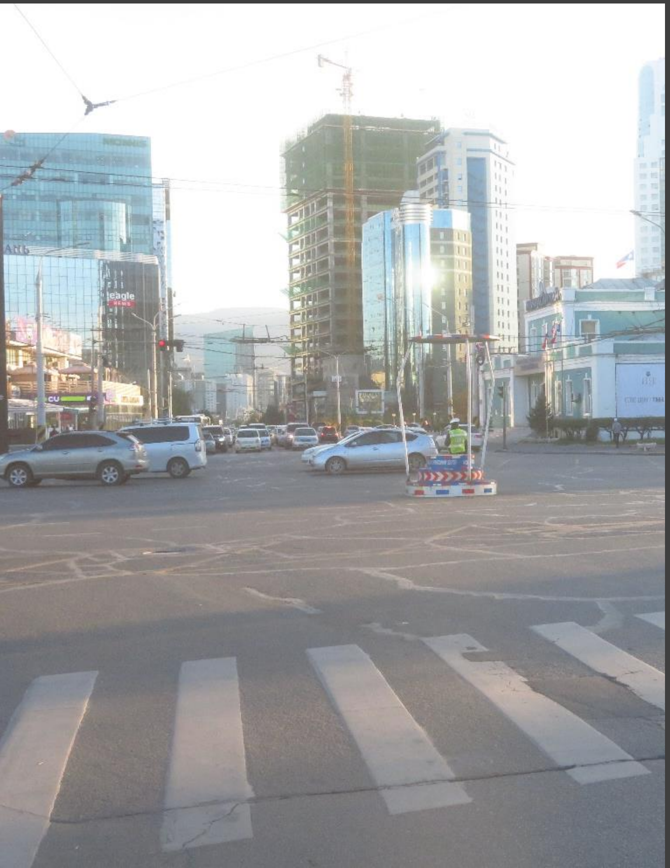
- To explain why safety at intersections is important.
- To give some details of what to look for – and how to improve safety at - your intersections (new and existing).

An intersection is defined as :

“a place where two or more roads meet at grade”.

Intersections are high risk locations because different road users (trucks, buses, cars, pedestrians, motorcycles) are required to use the same space.



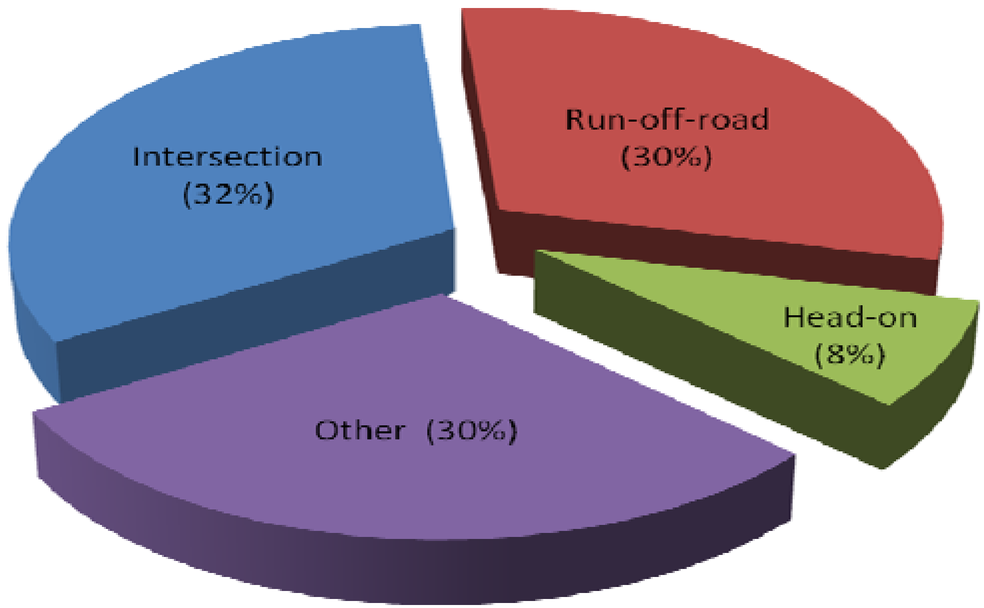


Intersections are critical locations in the road network in terms of capacity, level of service and safety.

They are the place where opposing streams of traffic have to compete for space and time.

They are high risk locations for crashes because road users on conflicting paths in intersections are required to use the same space; a collision is only avoided if they are separated in time!

SERIOUS CASUALTY CRASHES – AUSTRALIA



YOUR COUNTRY?

Intersections also present a risk of serious injury or death when a crash occurs because of the potential for high relative impact speeds.

Intersections are the location of up to 50% of reported *urban* crashes in most countries.

They are the location of between 10-20% of reported *rural* crashes in most countries.

Intersections – the basics

- Safe geometry is an essential starting point.
- Traffic control is then critical.

The main forms of control at intersections are:

- Road Rules (no physical control and relying on a priority rule to indicate right of way).
- Priority road designated by ‘Give Way’ (Yield) or ‘Stop’ signs.
- Roundabout.
- Traffic signals (Fixed time or vehicle activated).

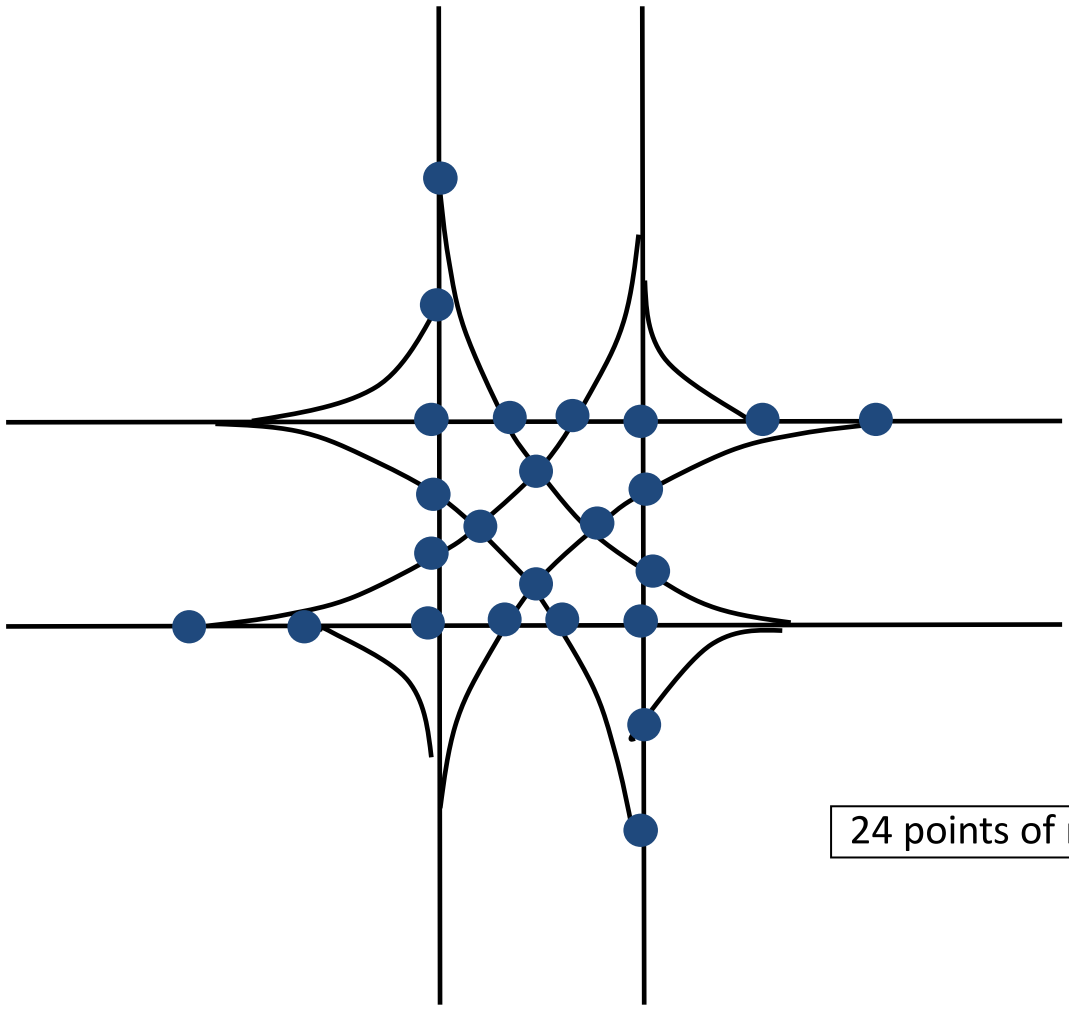
The basic principles of safe intersections are:

- Priority to major traffic.
- Clear “right-of-way”.
- Separate conflicts (in space and time).
- Minimise conflict areas.
- Minimise difference in relative speeds between vehicles
- Defined vehicle paths
- Provisions for all vehicular and non-vehicular traffic.
- A design which is “simple” and consistent.

In line with these objectives we will discuss:

- Minimum number of conflict points
- Relative impact speeds
- Visibility to/from the intersection
- Intersection control - roundabouts and traffic signals
- The need for sheltered left turn lanes

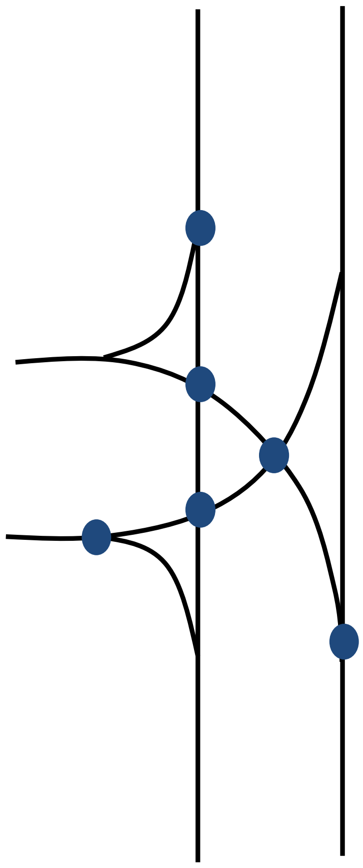
1 Conflict points at intersections



The fewer conflict points – the safer!

24 points of major conflict

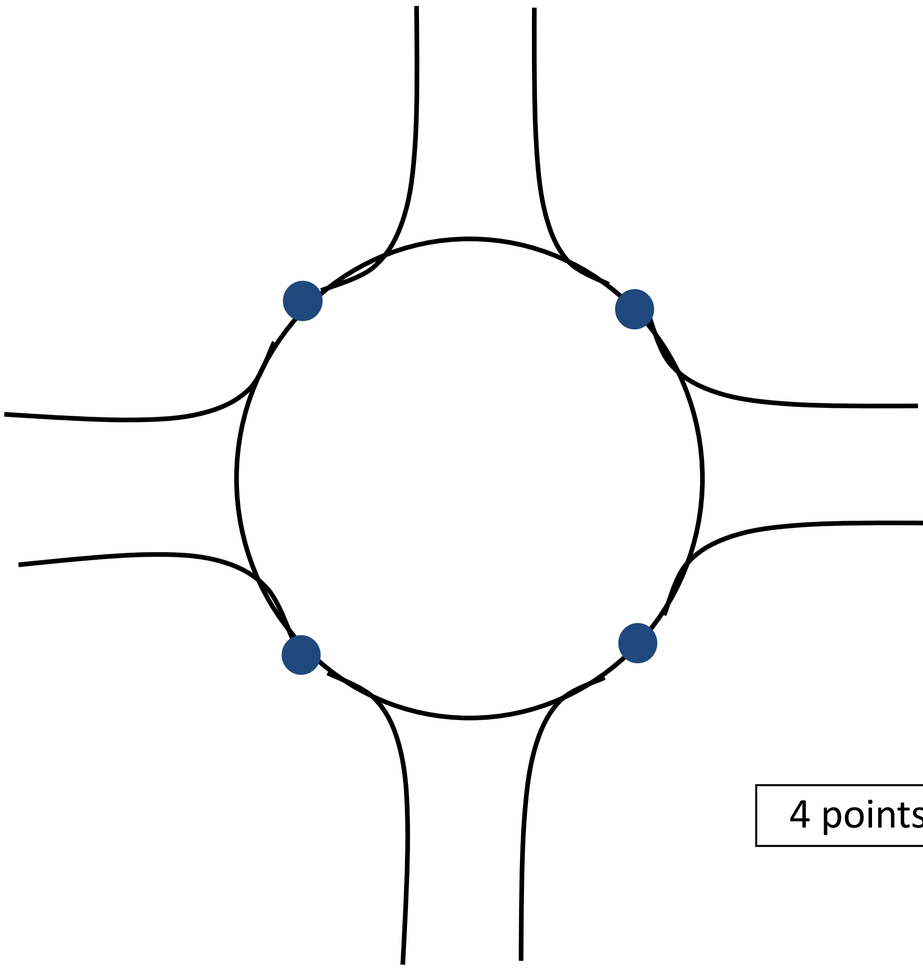
1 Conflict points at intersections



The fewer conflict points – the safer!

6 points of major conflict

1 Conflict points at intersections



The fewer conflict points – the safer!

4 points of major conflict

2 Relative impact speeds

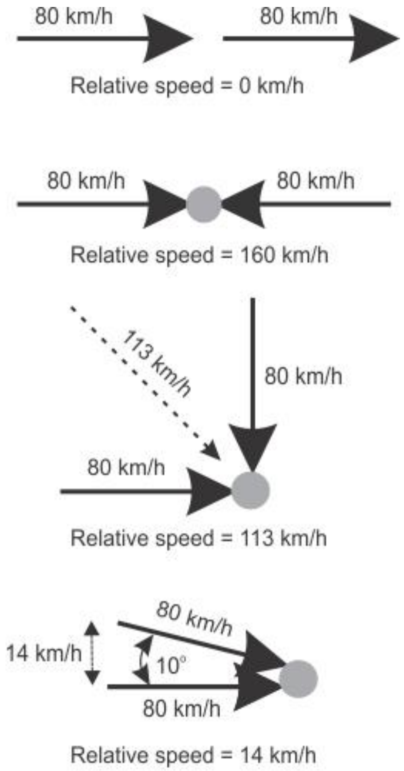


Figure 2.8 Relative Speed

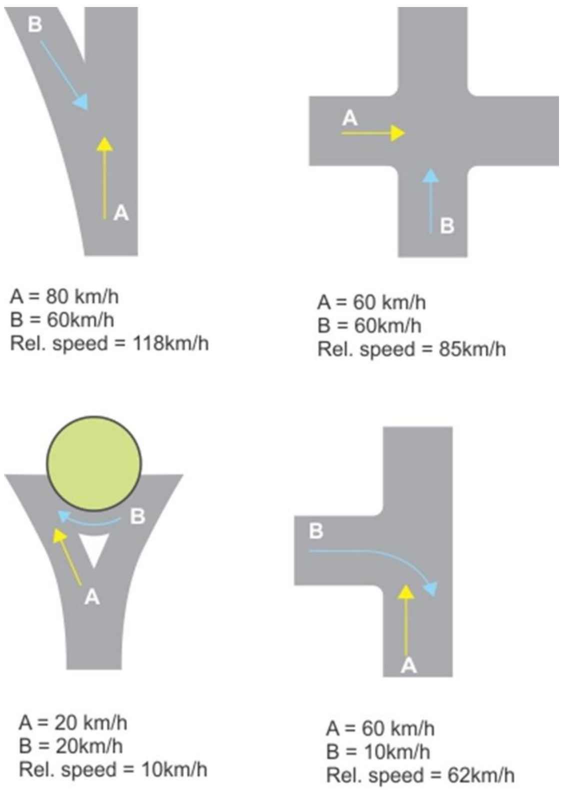


Figure 2.9 Relative Speed at Intersections

Y junctions are very dangerous

Y junctions are very dangerous

Try to eliminate each Y-junction by…

- Converting to a T-junction
- Converting to a roundabout
- Signalizing (urban areas)
- Closing one approach

T-junctions are safer because they:

- Control the turn speed
- Reinforce priority
- Enhance sight lines

Conversion of Y junction to a T junction in a rural area

Because the side road intersects the main road on the outside of a curve, make sure drivers on the side road can see the intersection in sufficient time (ASD)

3 Visibility to/from the intersection

Each driver/rider needs to recognise the intersection in sufficient time to be able to react safely.

Every approaching driver/rider needs to be able to recognise and understand the priority that applies at the intersection.

Providing Approach Sight Distance (ASD) is the best way to ensure this.

ASD is the minimum level of sight distance which should be provided at an intersection.

It is defined as “the distance travelled by a vehicle between the time when the driver receives a stimulus indicating a need to stop, and the time that the vehicle does come to a stop”.

This distance is sufficient for drivers/riders to be able to see the line marking at the intersection.

Basic elements of intersection safety

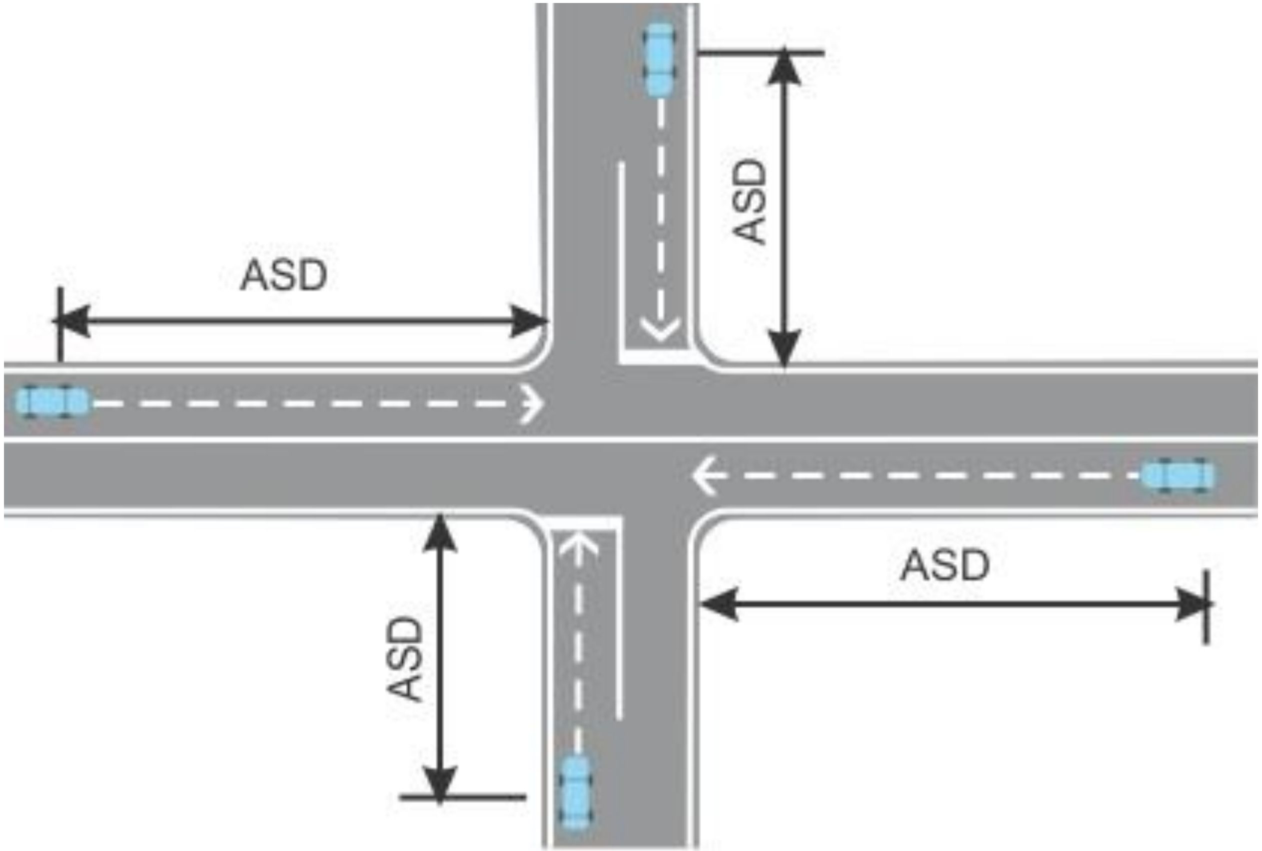


Figure 2.2 Approach Sight Distance

For driving on left side of road

- ASD – approach sight distance
- SISD – safe intersection sight distance
- ASD addresses overshoot crashes
- SISD addresses restart problems

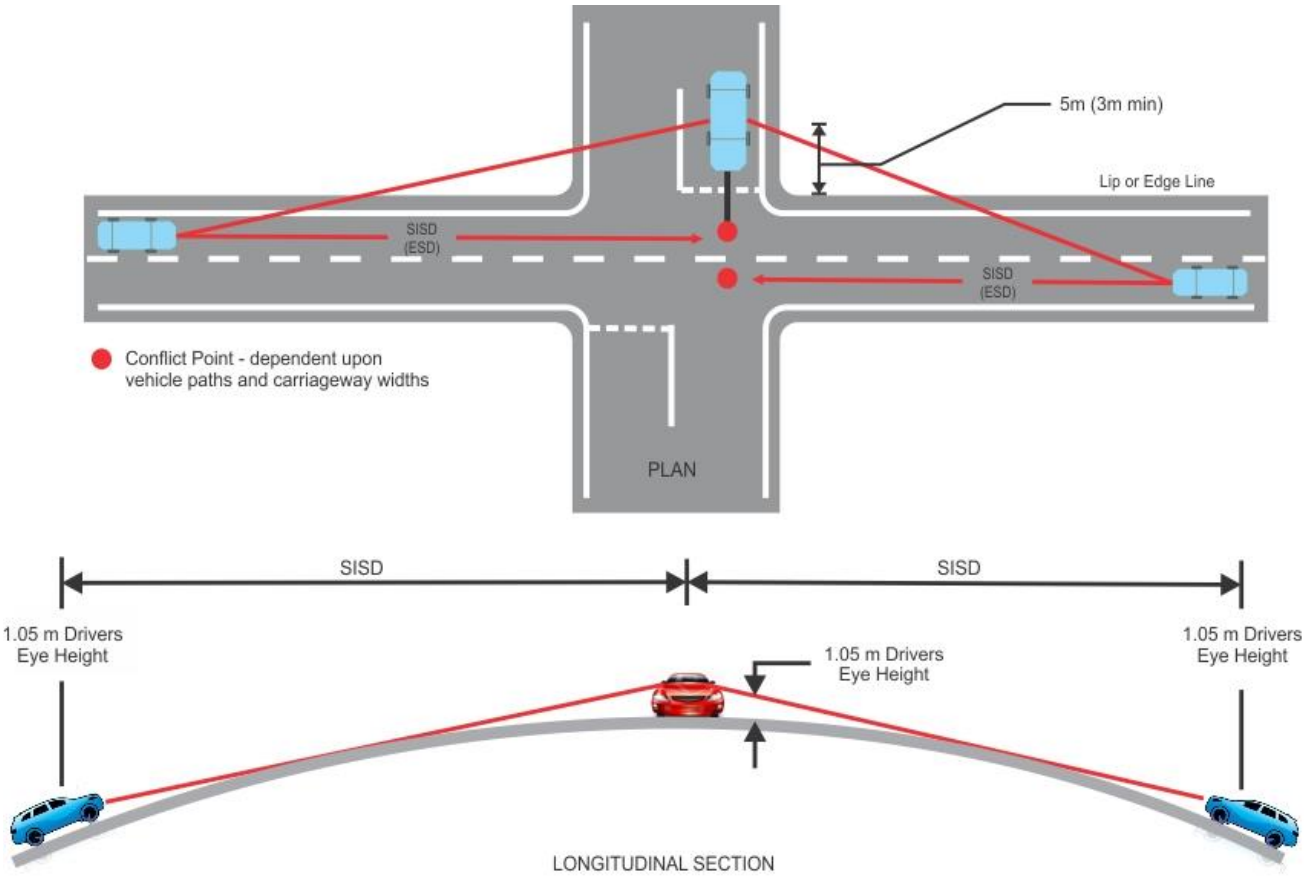
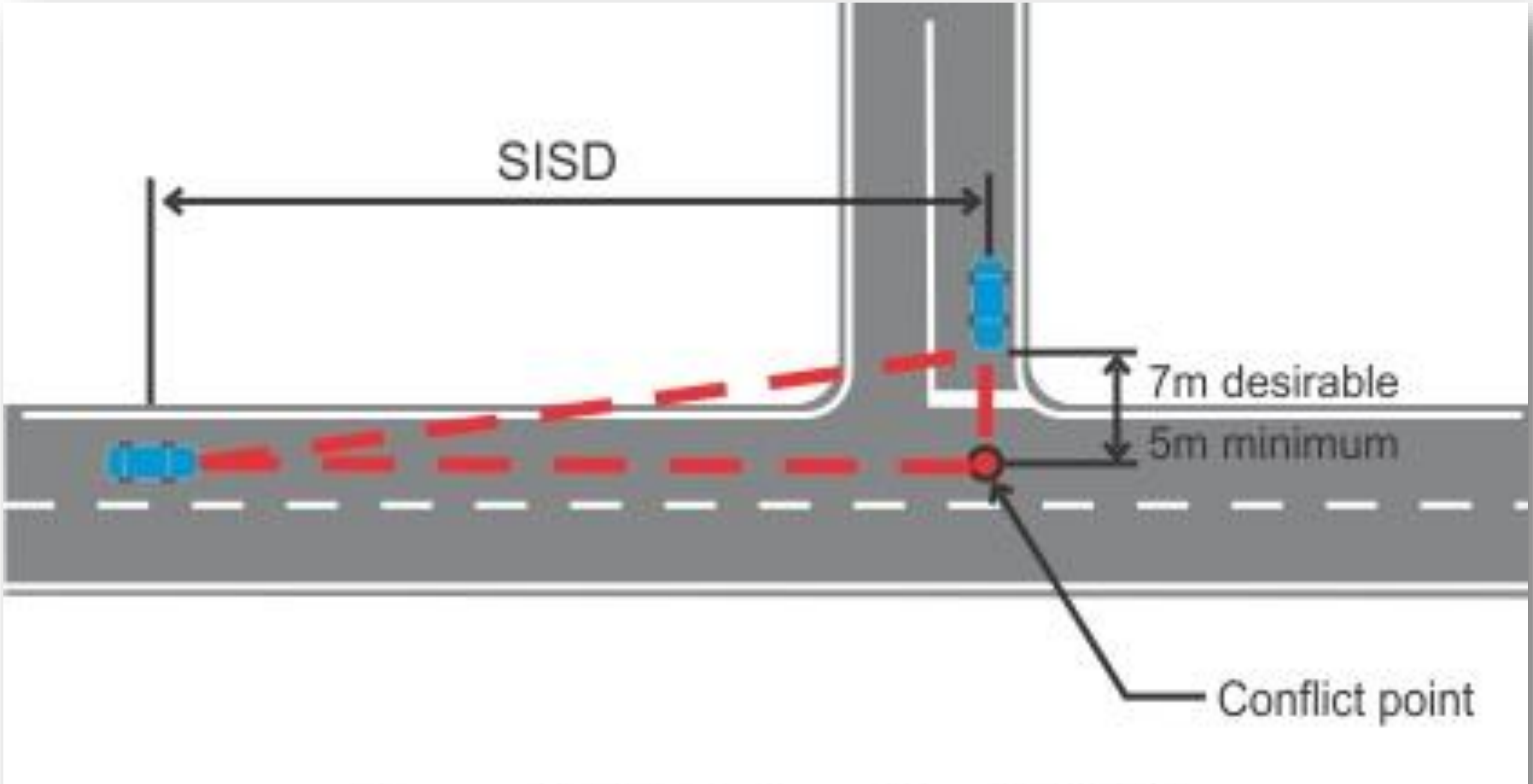


Figure 2.3 Safe Intersection Sight Distance

For driving on left side of road



Figures 2.4 Safe Intersection Sight Distance

For driving on left side of road

Table 2.2 Safe Intersection Sight Distance

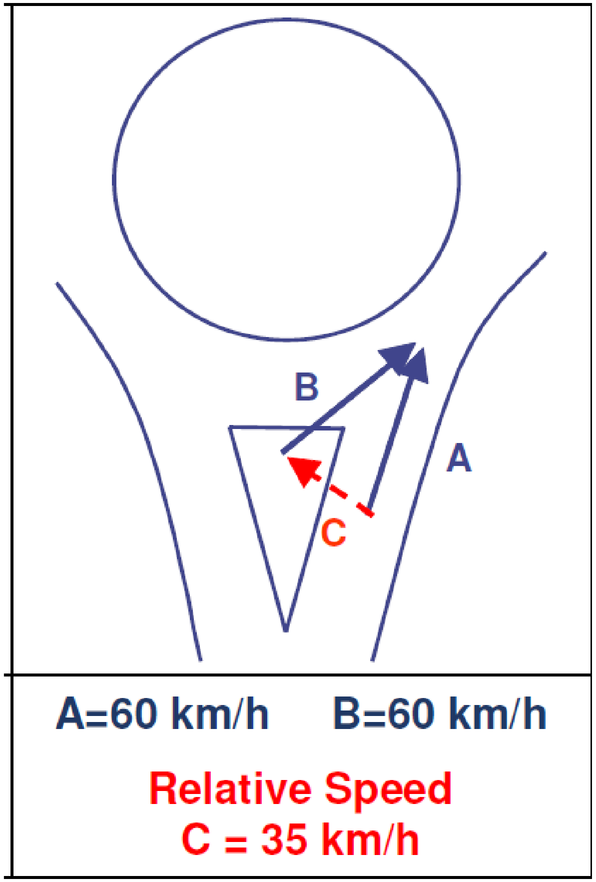
SPEED ON MAIN ROAD (km/h)	SAFE INTERSECTION SIGHT DISTANCE (m)
40	66
50	89
60	113
70	140
80	170
90	203
100	240

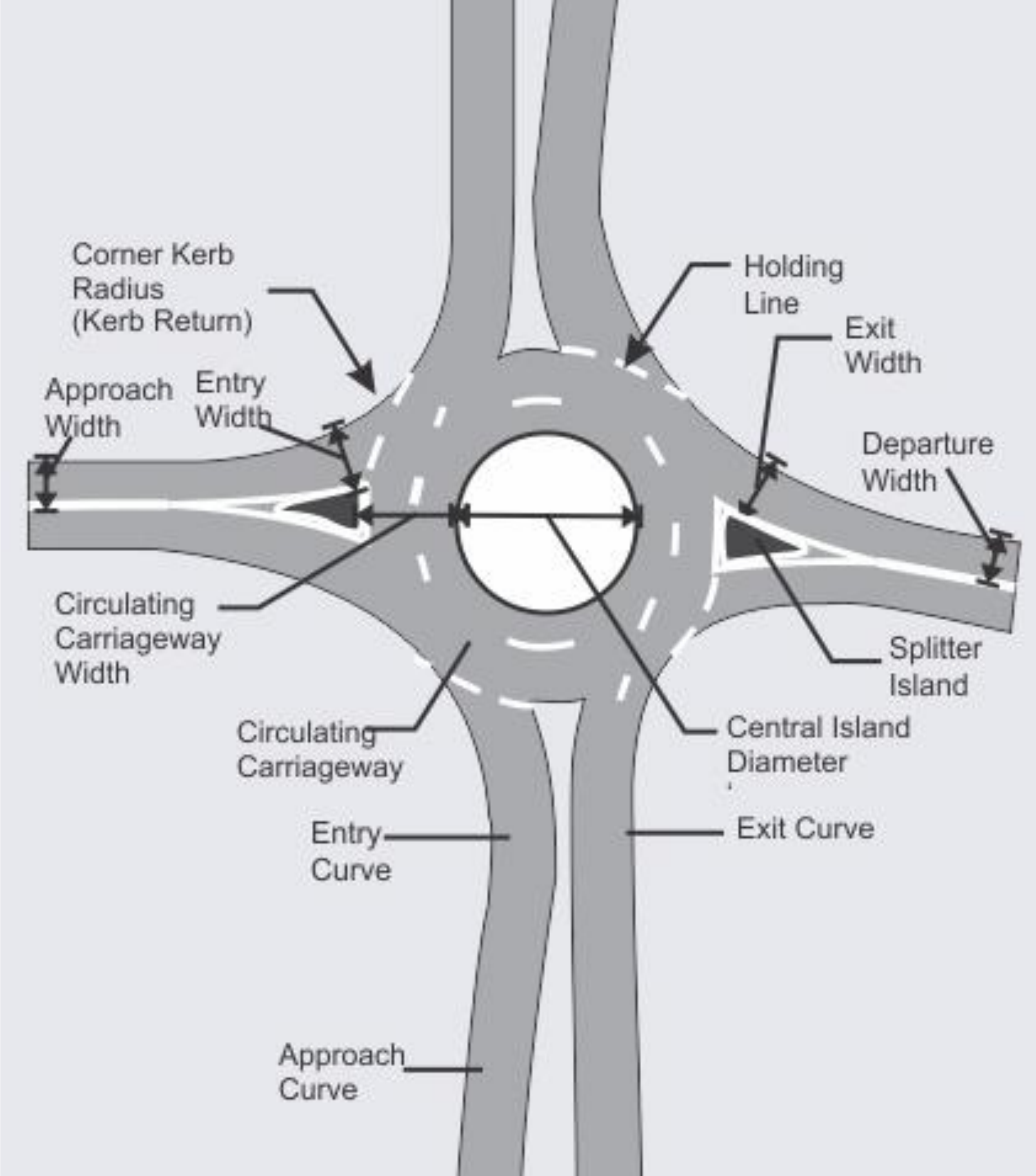
4 Intersection control

Roundabouts are the safest form of intersection control. Why?

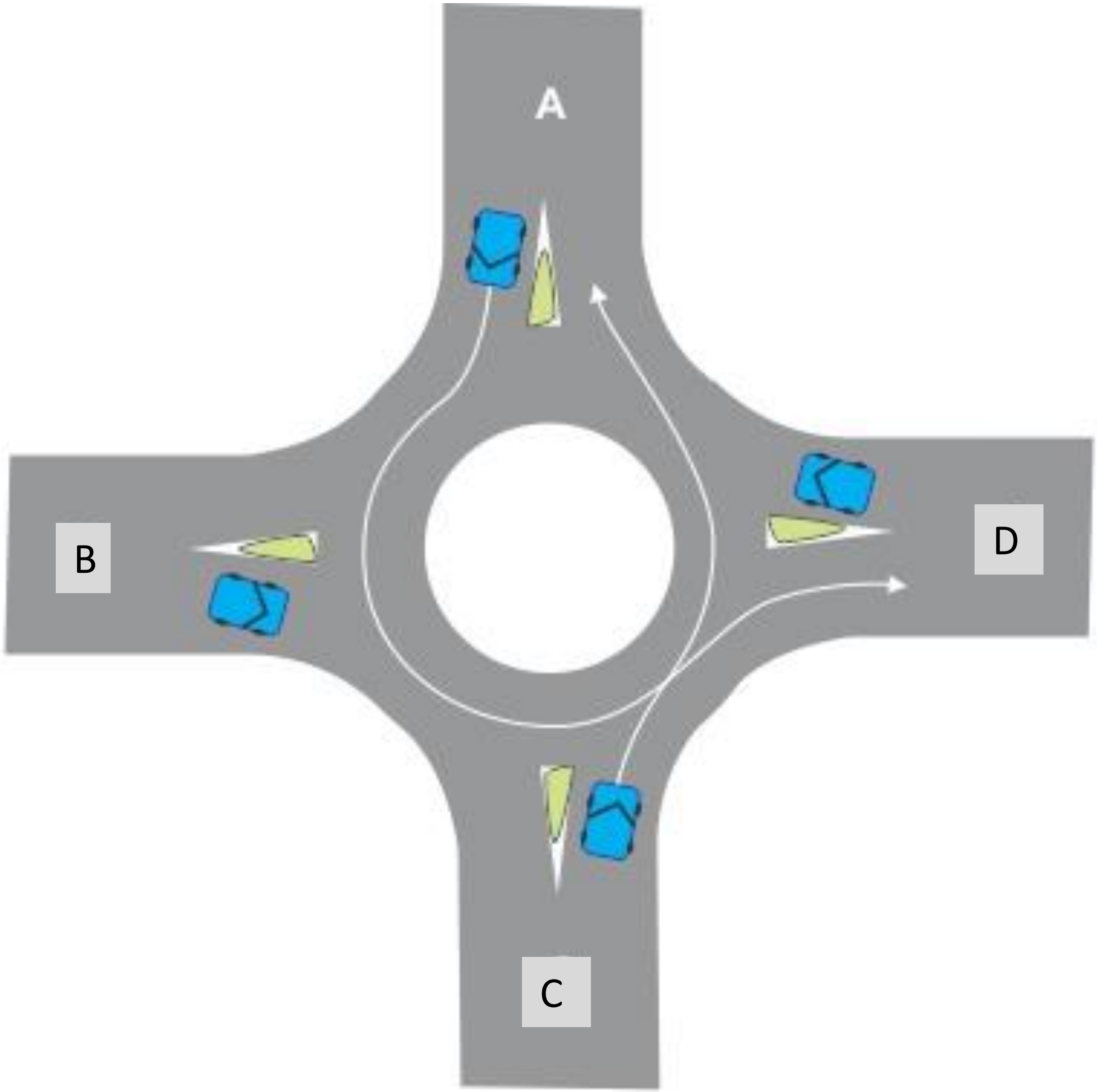
Why are roundabouts "safe"?

- Few conflict points (only four)
- Good geometry induces slow entry speeds
- Clearly defined "right of way"
- Simple decision making process for drivers/riders
- Low relative impact speed (if collisions do occur)





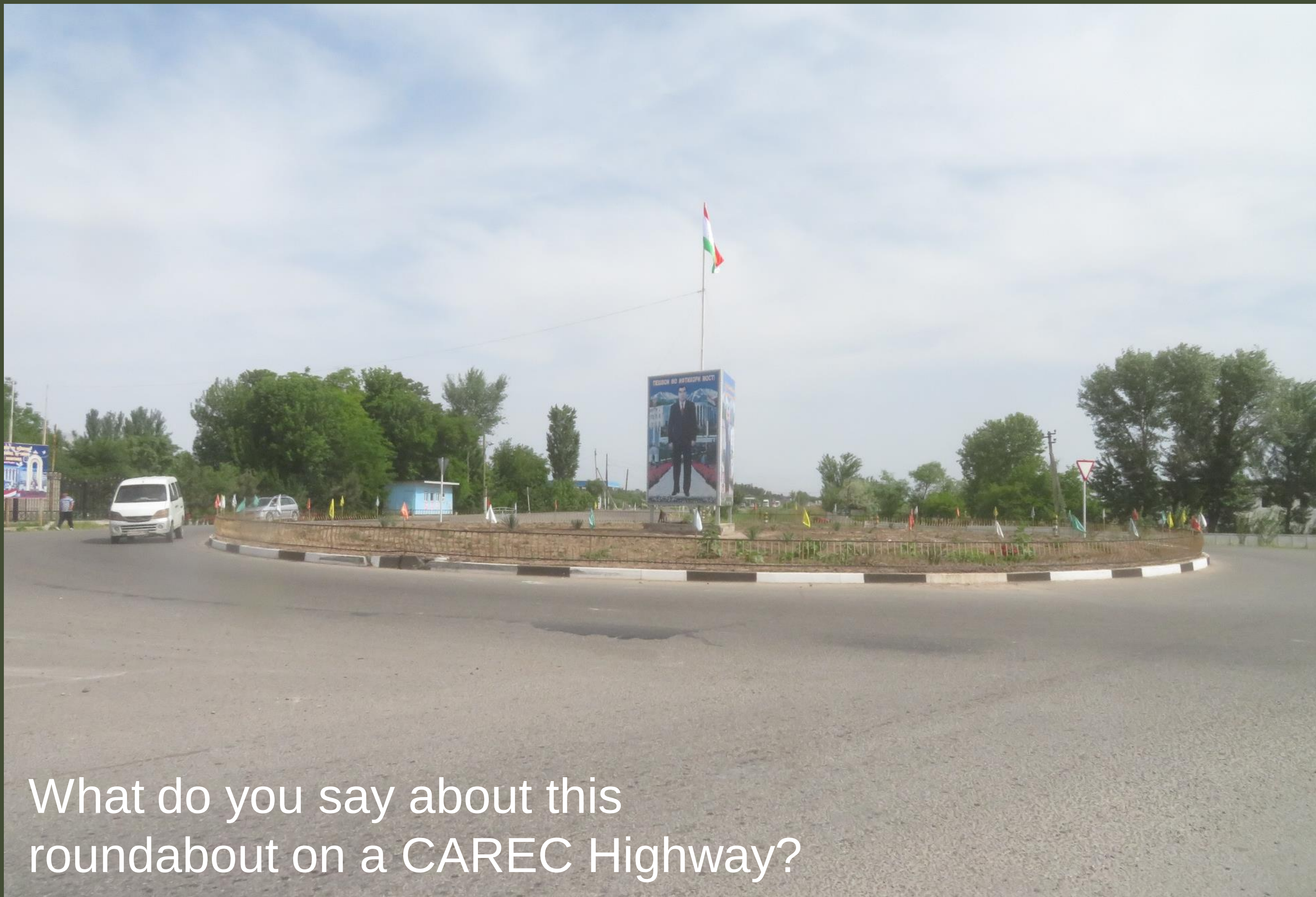
For driving on left side of road



Roundabouts only function well with “balanced flows”

Roundabouts only function well with adequate deflection (good geometry)

What do you say about this roundabout on a CAREC Highway?



What do you say about this
roundabout on a CAREC Highway?


What do you say about this
roundabout on a CAREC Highway?

Appropriate sites for roundabouts include:

- where stop/give way sign control causes unacceptable delays
- where traffic signals would result in greater delays
- where there is a high proportion of left turning traffic
- intersections with more than 4 legs

Appropriate sites for roundabouts include:

- cross intersections where there is a history of crossing or turning crashes
- rural intersections where speeds are high
- local street intersections
- at intersections where the major movement is a turning movement (eg. in small towns where a highway takes a left turn)

Appropriate sites for roundabouts include:

- Y or T intersections (these tend to have a lot of left turn vehicles)
- where traffic growth is expected to be high but patterns are uncertain
- local roads and collector roads where priority for one route is not desirable (for traffic calming reasons)

Intersection safety

Inappropriate sites for roundabouts include:

- where a satisfactory geometric design cannot be achieved
- where traffic flows are “unbalanced”
- major/minor road intersections
- sites with considerable pedestrian activity #
- at an isolated site within a linked traffic signal network #

- this is variable and should not automatically discount a site

Inappropriate sites for roundabouts include:

- where peak hour reversible lanes are needed
- where *very* large vehicles are common
- where nearby traffic controls may cause queuing back into the roundabout

Roundabouts are good for safety

Safety performance of roundabouts

- Safe because of reduced numbers of conflict points.
- Safe because of the general reduction in traffic speeds.
- Safe because high angles of conflict are eliminated.
- Safe because of the relative simplicity of decision making at the entry.

Roundabouts are good for safety

- Safe because long splitter islands at high speed locations give good warning of the presence of an intersection.
- Safe because splitter islands give a refuge for pedestrians.
- Safe because roundabouts require a “conscious action” by motorists as they pass through, regardless of the presence of other vehicles.

Most significantly, roundabouts REDUCE the types of crashes where people are seriously hurt or killed by 78-82% when compared to conventional stop-controlled and signalized intersections, per the AASHTO Highway Safety Manual.

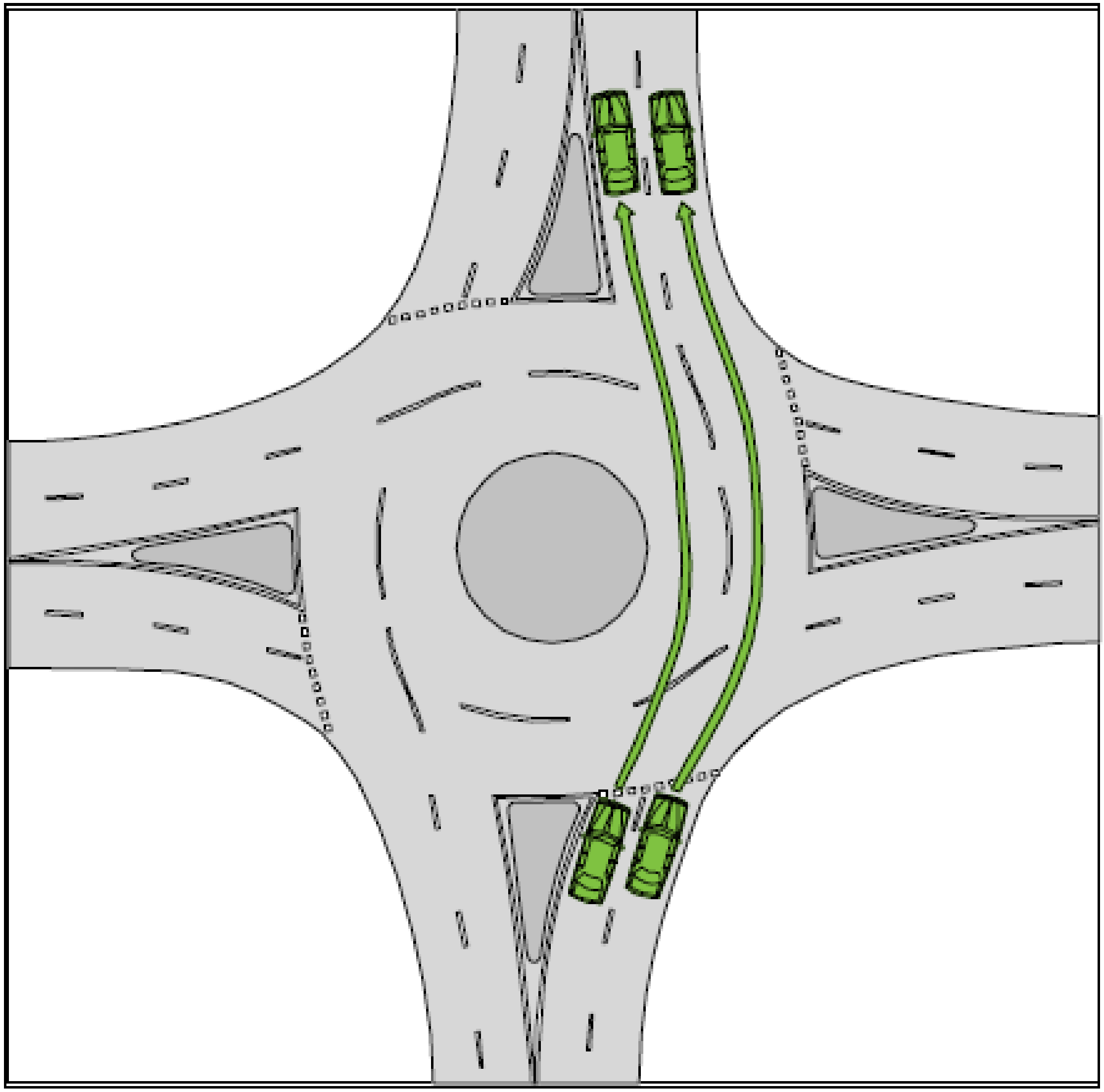
Roundabouts are good for safety

But your roundabouts will only work well when…

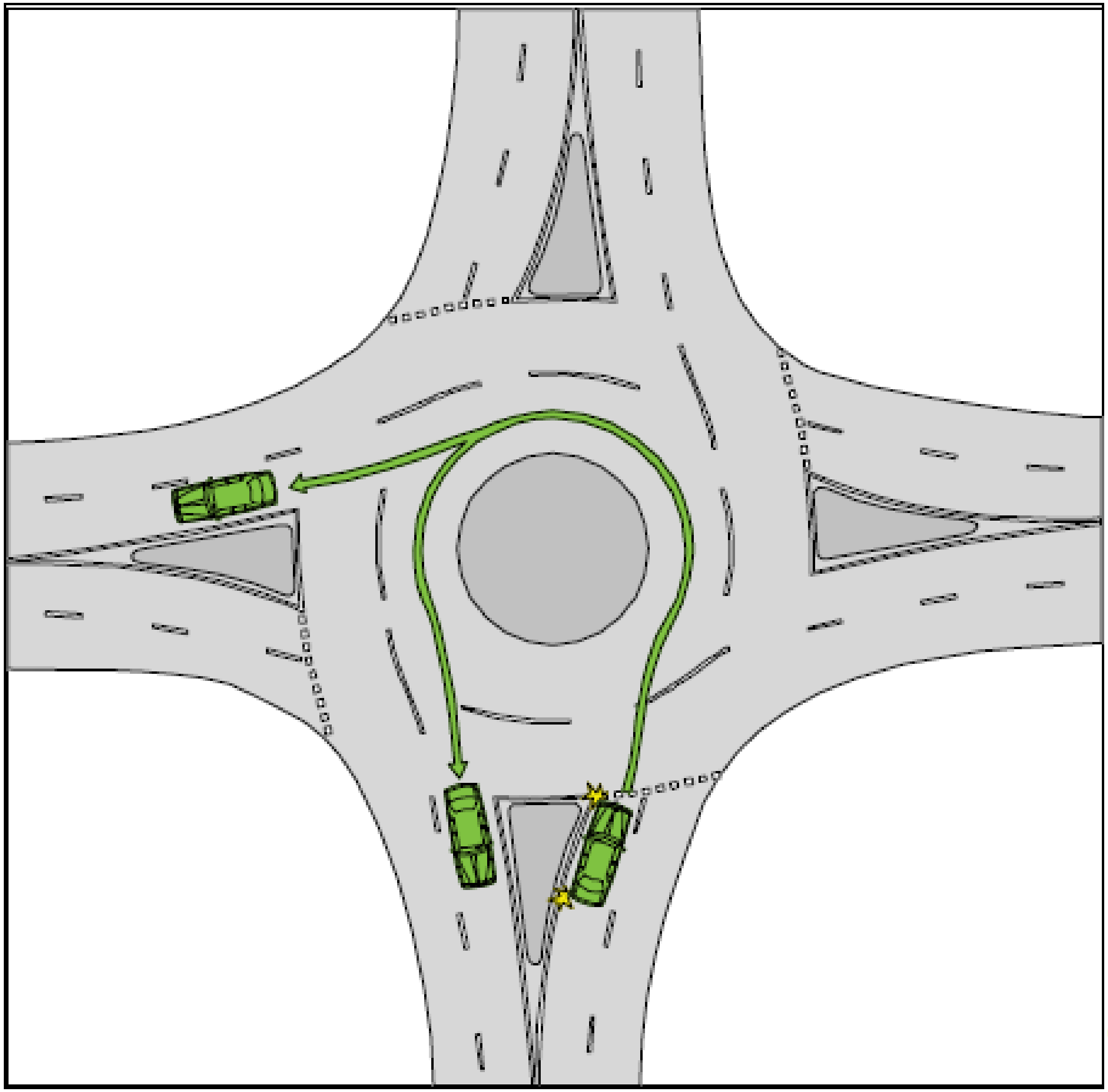
- They are designed with suitable geometric deflection for all approaches.
- Drivers slow down and give way before entering.
- Traffic Police enforce the Road Rules for roundabouts.
- In the early days, public awareness campaigns may be needed to make users aware of how to correctly use the roundabouts.

Most significantly, roundabouts REDUCE the types of crashes where people are seriously hurt or killed by 78-82% when compared to conventional stop-controlled and signalized intersections, per the AASHTO Highway Safety Manual.

Exit line marking for multi-lane roundabouts



Exit line marking for multi-lane roundabouts



This multi-lane roundabout would benefit from “Exit” line marking

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This multi-lane roundabout would
benefit from geometric deflection

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benefit from geometric deflection

Traffic signals

Traffic signals reduce crashes by 45%

(Victoria CRF)

Vehicle activated signals are safer, more efficient. They need vehicle detectors

- Detectors on each approach tell the controller when a vehicle approaches.
- The controller decides which approach has most vehicles waiting and turn it to green.
- Signal phasing permits full control of agreed turns (usually left turns).

Fixed time signals are cheaper, but can encourage “red-light running

- Fixed time signals may have several plans that operate across the day/week.
- But they cannot recognise occasions when traffic builds up on one approach.
- Frustrations can increase when lots of vehicles are help up, and few are moving.


40

For maximum efficiency traffic signals should be vehicle activated.

These have detectors on each approach.

The detectors tell the controller which approach has vehicles on it, and gives more time to that approach.

More efficient than fixed time signals – and also safer!

Why? Because drivers/riders know they will get short delays and some will disobey the red signals.

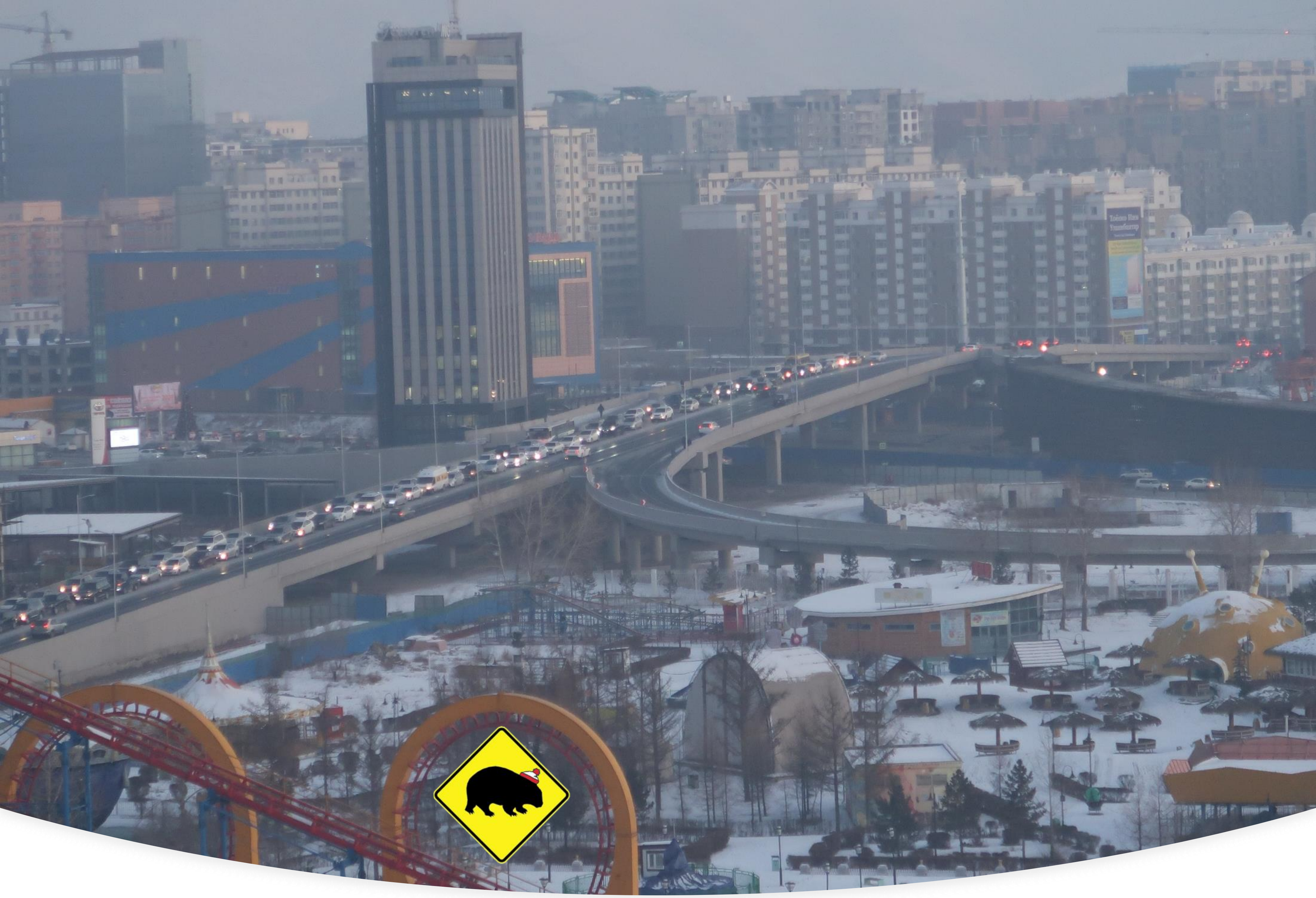
Traffic signal hardware, civil works, and signal timings

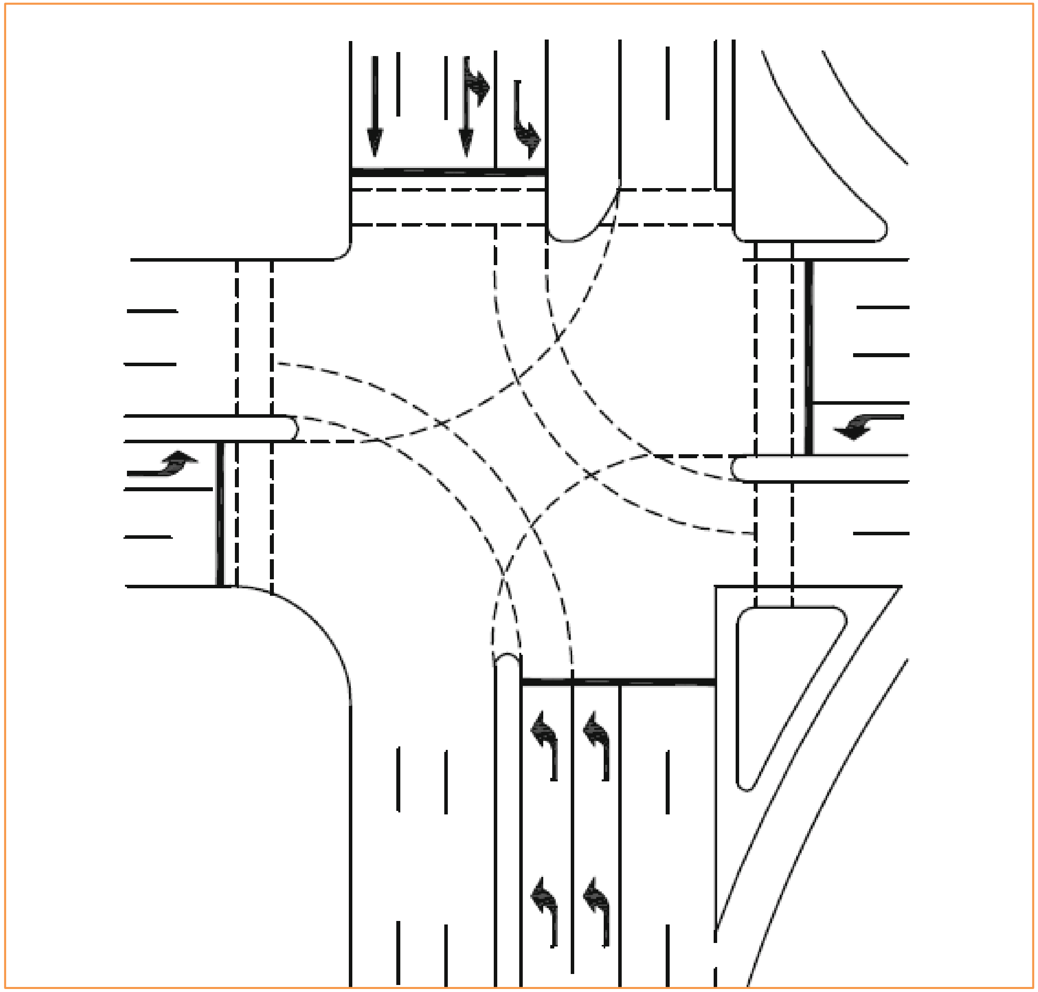
Hardware:

- Conspicuous
- Clear
- Pedestrian and vehicle detectors
- Clear line marking
- Dropped kerbs for pedestrians
- Large islands

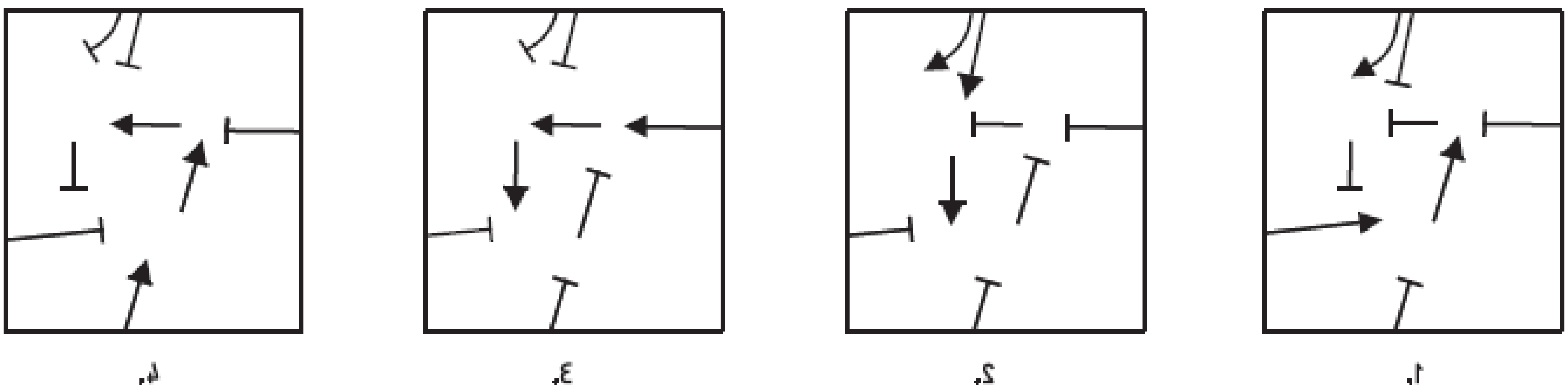
Timing

- No conflicts between opposing flows
- Sufficient time for the volumes
- Clearance time between phases
- Clearance time for pedestrians
- Fully controlled turns





Turn lines assist left turners to more safely negotiate large intersections



Check the traffic signal phasing

Arrow – traffic can move
Stem – traffic cannot go

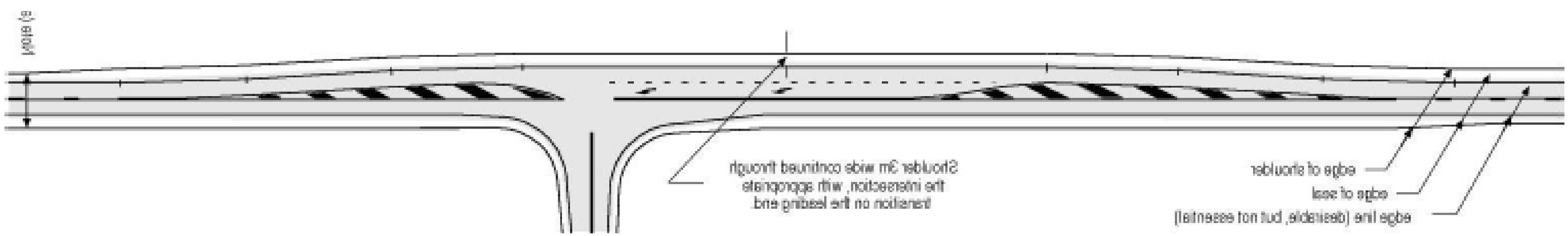

WEBB DOCK DR
Webb Dock East


WALK
WITH
CARE
DO NOT CROSS
CROSS WITH CARE
FLASHING
COMPLETE CROSSING
DO NOT START
TO CROSS
vicroads

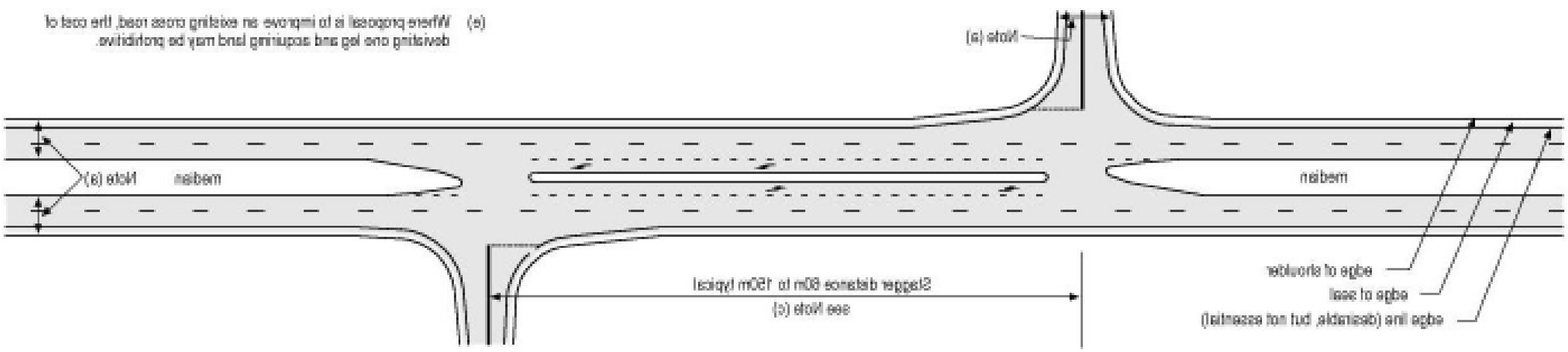
5 Provide sheltered left turn lanes, especially on high speed roads

- Reduce the risk of rear-end collisions
- Give a safe storage area
- Needs a median 5m+ wide
- Needs sufficient length for easy deceleration plus storage

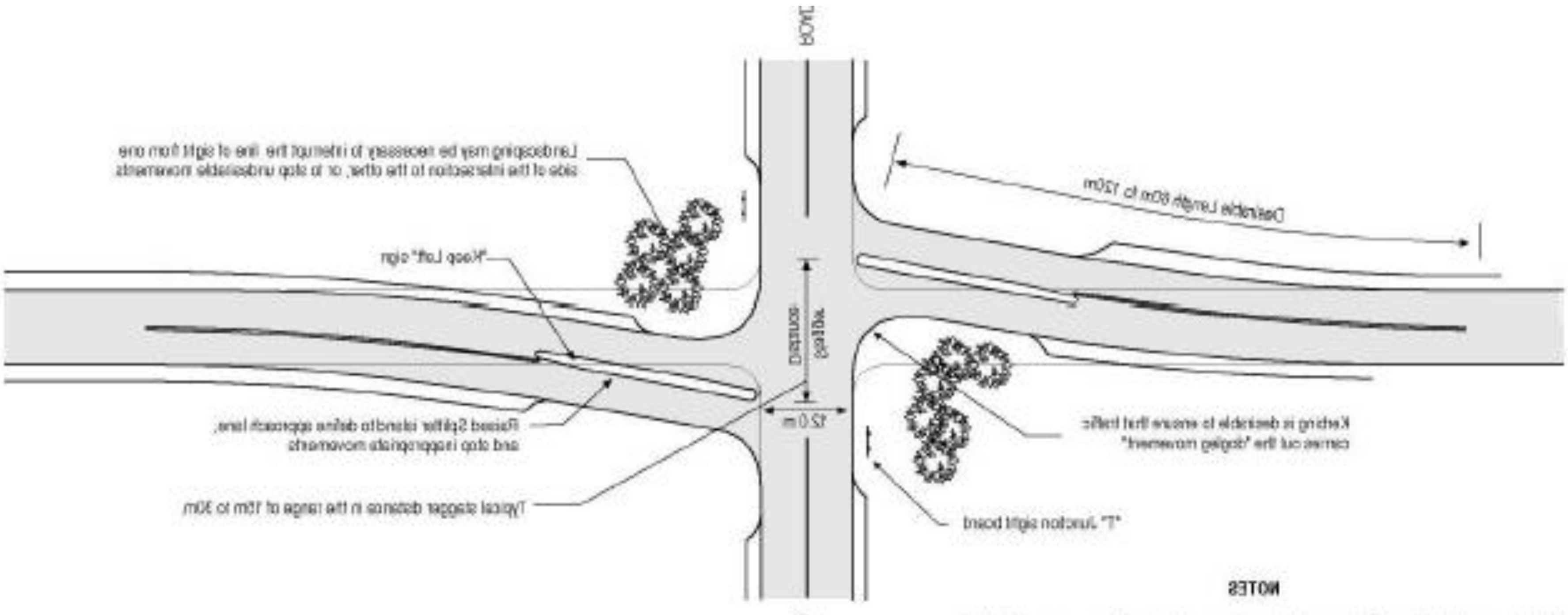
SHELTERED LEFT TURN LANE



RIGHT LEFT STAGGER – DIVIDED ROAD



LEFT RIGHT STAGGER - UNDIVIDED

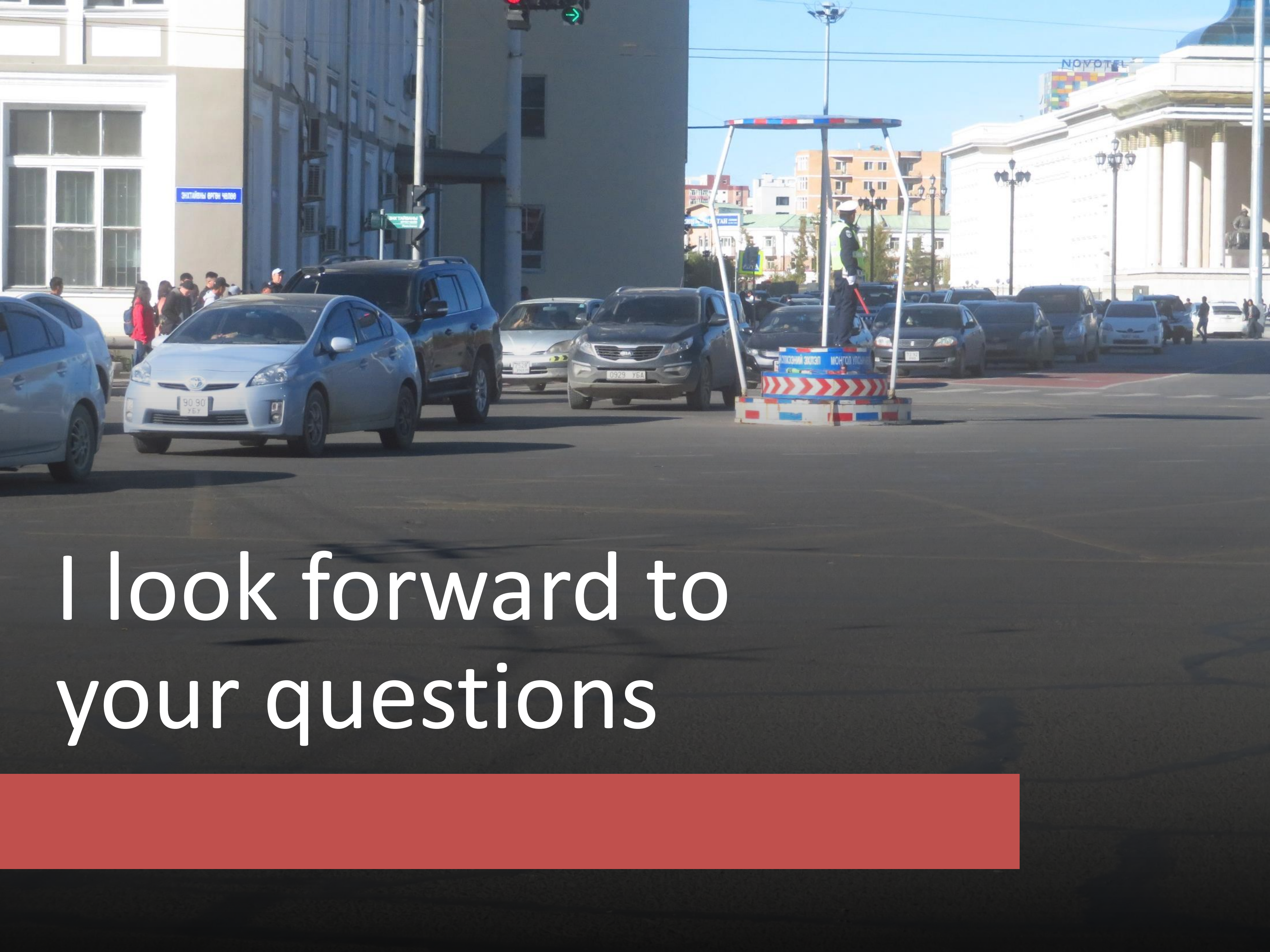


Very high risk median opening

Very high risk median opening


公安
WAW
110


Low risk sheltered left turn lane



I look forward to your questions