Urban and Rural Junction

Sandeep Gandhi Ph.D.
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• Intersection planning principles
• Difference between urban and rural junction environment
• Types of intersections
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Background

Urban and Rural Junctions
What are intersections?

The intersection is the area where two or more roads meet each other. Intersections facilitate change in the direction of movement of vehicle and people. Direction of movement of multiple travel modes or multiple vehicles from the same travel mode can intersect resulting in conflicts. These conflicts need to be through planning to achieve a safe junction environment.
What is an accident blackspot

• Blackspot is a road section of 300-500m length that has an abnormally high number of road crashes showing a pattern of road crash types due to some underlying local risk factors.

• Volume of traffic in most of the NHs/SHs are substantially high and hence the crash frequency and fatalities are high; the above classes of highways (including expressways) continue to account for the 55-60% of the overall crashes and deaths in the last decade.

Most black spots are found at or near intersections. Therefore, careful design of intersections is a critical requirement to ensure a safe road environment.
Intersection Planning Principles

Urban and Rural Junctions
Key Principles of Safe System Approach (SSA)

• Principle 1 : Recognition of human frailty
• Principle 2 : Acceptance of human error
• Principle 3 : Creation of a Forgiving environment and appropriate crash energy management.

Thus, design of roads play an important role in road safety and **improved geometric design** of road infrastructure could in turn improve road safety.
Proven Measures to enhance road safety

• Speed control
• Containment
• Protection from road side hazards
• Information through markings, signage
• Traffic Management
Difference between urban and rural junction environment

Safety at Urban and Rural Junctions
Difference and similarities between urban and rural junction environment

**Rural**
- Intersecting carriageways with no segregated footpath or cycle track, but a shoulder
- Activities around junction include, IPT informal bus stops and vendors
- Low volume high speed observed
- Missing lighting
- Junctions are unsignalized
- Traffic calming is avoided on NH

**Urban**
- Intersecting carriageways with segregated footpath on all roads and cycle tracks on urban roads, cycle lanes on distributor/collector roads
- Activities at junctions include IPT, informal bus stops and vendors
- High volume and moderate speeds observed
- Lighting at junctions
- Major junctions are signalized
- Traffic calming on minor junctions
Type of Intersections

Urban and Rural Junctions
Major and minor intersections

- **Major Junctions**
  - Signalized Crossing – provide storage bays/refuge at int.
  - Roundabouts – provide peripheral path with raised crossings
  - Unsignalized Crossings – provide traffic calming, safe raised crossings

- **Minor Junctions/property entrance**
  - Provide raised crossings, at footpath and cycle track level (or common at footpath level)

**Major Junction**
- All turns, High Volume even on cross roads
- Design –
  - **Signalized Intersection**
  - **Signalized pedestrian crossing**

**Moderate Junction**
- All turns, Low Volume on cross roads
- Design -
  - **Modern roundabouts** with 2 phase signal
  - **Signalized pedestrian crossing** on corridor, raised crossing on side roads

**Minor Junction**
- Only left turns, low volume
- Design –
  - **Raised crossing design**; Right of way, pedestrians and cyclists
Intersections Typologies

1. Road Typology (Rural)
   • National Highway (NH)
   • State Highway (SH)
   • Major District Road (MDR)
   • Other District Road (ODR)
   • Village Road (VR)

2. Road Typologies (Urban)
   • Arterial (6-8 lane divided), Speed = 50 km/h
   • Sub arterial (4 – 6 lane divided), speed = 50 km/h
   • Collector/distributor (4 lane divided) speed = 30 km/h
   • Access/Local – (1-2 lane undivided), speed = 15 km/h

Types of at grade Junctions

<table>
<thead>
<tr>
<th>Junction categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Intersection (X)</td>
</tr>
<tr>
<td>T Junction</td>
</tr>
<tr>
<td>Y Junction</td>
</tr>
<tr>
<td>Staggered Junction</td>
</tr>
<tr>
<td>Multi-leg</td>
</tr>
</tbody>
</table>
Safe intersection design elements

What we will cover

- Geometric design
- Traffic calming + surface treatment
- Signages
- Pavement marking
- Lighting and drainage

Major Junctions

At Grade Intersections
- Signalized intersection
- Unsignalized intersection

Roundabouts
- 2 lane roundabouts
- Single lane roundabouts
- Mini roundabouts
Intersection design approach

Urban and Rural Junctions
Step by step method of planning the intersection

• Step 1 – Record activities in the vicinity of the intersection through observations – include vendors, parking, bus/IPT stops, etc.
• Step 2 – Record the type of intersecting roads, and the typology of the junction (X, T, Y, etc.)
• Step 3 – Establish the design speed (IRC SP-73 suggests 60% of approach speed – approach design speed should be approach posted speed)
• Step 4 – Data collection including total station surveys, traffic counts, etc.
• Step 5 – Assess the relevant intersection solution based on the intersecting road type, context, grade, traffic volume of junction, etc.
• Step 6 – Finalize the geometric designs and layout plans of the intersection
• Step 7 – Detail the intersection, determine location and designs of signage, pavement marking, traffic calming, light poles, signal poles, etc.
At grade vehicular junctions – roundabout or intersections

<table>
<thead>
<tr>
<th>Roundabouts</th>
<th>Intersections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pros</strong></td>
<td></td>
</tr>
<tr>
<td>• Reduce the number of conflicts to eight as against 32 in un-signalized intersections.</td>
<td>Signalized intersections can handle high traffic volumes. This can be achieved by accommodating wider carriageway with more number of lanes.</td>
</tr>
<tr>
<td>• Ensures safety through speed reduction by design. This is particularly useful at late night hours when speeds are high and compliance of signals and traffic rules is low.</td>
<td></td>
</tr>
<tr>
<td>• Minimal or no delays for all road users including cyclists.</td>
<td></td>
</tr>
<tr>
<td><strong>Cons</strong></td>
<td></td>
</tr>
<tr>
<td>Roundabouts are <strong>not very effective for more than two circulatory lanes</strong>. They have capacity limitations and may not be able to handle very high volume of traffic.</td>
<td>• Four times the number of conflicts than the roundabout.</td>
</tr>
<tr>
<td>• Safety is ensured by eliminating conflicts through signalization – high dependence on enforcement.</td>
<td>• Higher delays for all road users including cyclists.</td>
</tr>
</tbody>
</table>
Why Roundabouts

NHRP Report 572, Roundabouts in the United States, Foreword – states ...

• "Although traffic circles have been used in the United States since 1905, their use has been limited since the 1950s because many were found to work neither efficiently nor safely.

• The modern roundabout was developed in the United Kingdom in the 1960s to address these problems.

• Two key characteristics of the modern roundabout are
  • (1) entering traffic that yields to circulating traffic and
  • (2) geometric constraints that slow entering vehicles.

• Many studies have shown that modern roundabouts are safe and effective, and they are now widely used internationally".

“Because of enhanced junction safety (especially at off peak hours) modern roundabouts are referred to as the sleeping policemen”
Urban Intersections

Urban and Rural Junctions
<table>
<thead>
<tr>
<th>Arterial Roads</th>
<th>Distributor Roads</th>
<th>Access Streets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial Roads</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Distributor Roads</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Access Streets</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Arterial roads have higher speeds and flow than access streets. Therefore grading from 1 to 6 represents expected severity and frequency of conflicts – 1 being highest and 6 being lowest.
Arterial to arterial junction (signalized)

- Left turns at junctions
- Cycle tracks at junctions
- Cycle crossing type at junctions
- Storage
- Delays
- Conflicts

a : arterial road (24m to 60m)
b : length of cycle lane leading upto cycle track (minimum 30m)
c : distance for entry/exit on side roads from junction (minimum 60m)
## Segregated left turning lanes at junctions

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic calming and signalization of segregated left turning lane makes it a controlled (and not signal free) left turn which allows safe gaps for pedestrians and cyclists to cross</td>
<td>Segregated left turning lanes introduce at least two more stages for crossing cyclists and pedestrians, making the crossing more complex and adding to their delays, and adversely effecting their directness (in time and distance)</td>
</tr>
<tr>
<td>Staged crossing ensures that smaller road widths or distances require to be crossed at a given time, making it safer for cyclists and pedestrians and also allowing a smaller and more efficient crossing phase in the signal.</td>
<td>Segregated left turn lanes with non-coordinated signals can result in conflicts between straight moving and left turning motorized traffic (on far side of the junction), resulting in reduced efficiency of signal plan.</td>
</tr>
<tr>
<td>Segregated left turn lanes with signal co-ordination for cyclists, can reduce delays for straight moving cyclists as they can be allowed to mode unobstructed with straight motorized traffic even if they arrive in the middle of the green phase.</td>
<td>Segregated left turn lanes with coordinated signals (between left turning and intersection signal, i.e. straight and left move together in one phase), does not significantly benefit motorized vehicles and may be counterproductive at junctions where left turning traffic volume is high. Such Co-ordination of signals also denies the cyclists, who approach the junction during the green phase, to move straight along with vehicular traffic.</td>
</tr>
</tbody>
</table>
# Un-segregated left turning lanes at intersections

<table>
<thead>
<tr>
<th><strong>Advantages</strong></th>
<th><strong>Disadvantages</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Left turning phase is not signal free allowing cyclists and pedestrians to make a safe crossing and turning at junction during designated phases.</td>
<td>Such designs are generally accompanied by provision of an extra left turning lane or left turning pocket on the near side of the junction. This increase the crossing distance for pedestrians requiring longer pedestrian phase time.</td>
</tr>
</tbody>
</table>

Controlled left turns ensure that conflicts between straight and (left) turning vehicles can be avoided during specific phases ensuring higher efficiency and throughput during the straight phase. | Where very high left turning traffic is expected (higher than 30%), provision of a non-segregated and signalized left turn may contribute to some delays for vehicular traffic. |

Non-segregated left turning lanes reduce crossing delays for cyclists and pedestrians, as segregated left turns require staged and thus more number of crossings (separately across left turning lane and other traffic lanes) leading to accumulation of wait time at each crossing red light. | At junction where very high left turning traffic is expected, it may not be possible to separate left turning phase from straight phase on a traffic arm. Here cyclists arriving in the middle of the green phase may not be able to move with the motorized traffic for fear of conflicts with left turning vehicles. |

At junctions where left turning traffic percentage is expected to significantly minor, a left turning pocket may allow introduction of left turning phase, independent of straight traffic on a traffic arm. This allows cyclists arriving in the middle of a vehicular green phase to safely move straight across the junction with motorized traffic. | |
Planning Segregated cycle tracks at intersections (arterial roads)

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cyclists moving straight at an intersection.</strong></td>
<td>Segregated left turning motorized vehicular lanes cannot be provided without reducing directness for straight moving cyclists. In which case they would need to turn left with motorized traffic and then cross at a safe distance to come back to the intersection.</td>
</tr>
<tr>
<td>Segregate NMV tracks leading up to the stop line of the junction allow the cyclists to move ahead of the vehicular queue and access a storage area generally located ahead of the vehicular stop line. This helps in reducing their delays and increasing their directness considerably.</td>
<td></td>
</tr>
<tr>
<td><strong>Cyclists Turning Left at an Intersection.</strong></td>
<td></td>
</tr>
<tr>
<td>Segregated NMV tracks extending up to the junction allow them to bypass long MV queues and related delays.</td>
<td></td>
</tr>
<tr>
<td><strong>Cyclists Turning right at an intersection.</strong></td>
<td></td>
</tr>
<tr>
<td>In combination with a Bicycle holding area it allows cyclists to position themselves to make a right turn ahead of the vehicular traffic</td>
<td>This only works well if there is not too much head on vehicular traffic.</td>
</tr>
</tbody>
</table>
### Bicyclists crossing design at signalized intersections

<table>
<thead>
<tr>
<th>Bicyclists crossing along with or as vehicular traffic</th>
<th>Bicyclists crossing along with or as pedestrian traffic</th>
<th>Bicyclists crossing independent of vehicular and/or pedestrian traffic (separate signal phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Direct route across the intersection;</td>
<td>• Usually very uncomfortable and indirect;</td>
<td>• Intersection design can contribute to clearer position of cyclists;</td>
</tr>
<tr>
<td>• At busy intersections with high speeds potentially very dangerous.</td>
<td>• Inducing conflicts between cyclists and pedestrians;</td>
<td>• Conflict points can be indentified and thus conflicts can be managed;</td>
</tr>
<tr>
<td></td>
<td>• Denial of vehicular characteristics of cycling.</td>
<td>• Usually these intersections will be more complicated and more spacious.</td>
</tr>
<tr>
<td></td>
<td>• This solution is often chosen by lack of other feasible options.</td>
<td></td>
</tr>
</tbody>
</table>
Arterial to distributary junction (signalized)

Junction Type: Arterial to Distributory (Signalised Junction, free left turning)

- Bicycle lane
- Raised crossing
- Free left turn

Junction Type: Arterial to Distributory (Signalised Junction, no free left turning)

- Bicycle lane
- Footpath
- Bicycle Track
- Cycle box

a: arterial road (24m to 60m)
b: distributary road (12m to 30m)
c: offset for cycle track start from junction (minimum 30m)
Distributary to distributary (signalized)

Junction Type: Distributary to Distributary
(Signalised Junction, no free left turning)

a: distributory road (12m to 30m)
b: junction width (minimum 40m)
Distributary to Access

Junction Type: Distributary to Access
(Non-Signalised Raised Junction)

- Mini roundabout
  - Over-runnable, curved with max height of +150, in rough texture
- Raised intersection

a: distributory road (12m to 30m)
b: access road (6m to 15m)
c: raised junction crossing

Junction Type: Distributary to Access
(Non-Signalised Junction)

- Mini roundabout
  - Over-runnable, curved with max height of +150, in rough texture
- Raised crossing

a: distributory road (12m to 30m)
b: access road (6m to 15m)
c: raised crossing on every arm after turning
Access to access junction

Junction Type: Access to Access
(Non - Signalised Raised Junction)

Mini roundabout
Over-runnable, curved with max height of +150, in rough texture

Raised intersection

Footpath

a : access road (6m to 15m)
b : raised junction crossing

Junction Type: Access to Access
(Non - Signalised Junction with raised crossings)

Raised crossing

Mini roundabout
Over-runnable, curved with max height of +150, in rough texture

a : access road (6m to 15m)
b : raised crossing

Footpath
### Roundabouts - Arterial to arterial

<table>
<thead>
<tr>
<th>Inscribed Circle Diameter</th>
<th>Minimum Circulatory Lane Width*</th>
<th>Central Island Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>45m</td>
<td>9.8m</td>
<td>25.4m</td>
</tr>
<tr>
<td>50m</td>
<td>9.3m</td>
<td>31.4m</td>
</tr>
<tr>
<td>55m</td>
<td>9.1m</td>
<td>36.8m</td>
</tr>
<tr>
<td>60m</td>
<td>9.1m</td>
<td>41.8m</td>
</tr>
<tr>
<td>65m</td>
<td>8.7m</td>
<td>47.6m</td>
</tr>
<tr>
<td>70m</td>
<td>8.7m</td>
<td>52.6m</td>
</tr>
</tbody>
</table>

*Inscribed circle dia. To be equivalent or more than the total carriageway width of the wider arm

- NMV lanes
- Inscribed circle
- Central Island
- Circulatory roadway
- Left turns
- Entry/exit radius

**Diagram Notes:**
- **Free left turning lane with raised crossing**
- **Tighter entry radius** – 10-20m
- **Gentler exit radius** – 30-50m
- **Greater entry deflection**
- **Smaller exiting deflection**
- **Circulatory lane width**
- **Inscribed circle**
- **Central Island**
- **Circulatory roadway**
- **Left turns**
- **Entry/exit radius**
- **Footpath**
- **Bicycle Track**
<table>
<thead>
<tr>
<th>Junction</th>
<th>Roundabout Components</th>
<th>Bicycle Infrastructure along the roundabout</th>
<th>Bicycle and pedestrian crossing Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial with Arterial Road junction (6 – 8 lane divided carriageway)</td>
<td>Roundabouts with segregated left turning lane</td>
<td>Segregated track on the periphery</td>
<td>Grade separated access to inner circle, or Raised crossing across traffic arms</td>
</tr>
<tr>
<td>Arterial with Distributor Road junction</td>
<td>Roundabouts with segregated left turning lane or Two Lane Roundabout</td>
<td>Segregated track on the periphery</td>
<td>Raised crossing across traffic arms</td>
</tr>
<tr>
<td>Distributor to Distributor road junction (D6.3-17)</td>
<td>Two Lane Roundabout</td>
<td>Segregated track on the periphery or Painted lanes along the carriageway</td>
<td>Raised crossing across traffic arms</td>
</tr>
<tr>
<td>Distributor to Access Road Junction (D6.3-18)</td>
<td>Two Lane Roundabout or One Lane Roundabout</td>
<td>Painted lanes along the carriageway</td>
<td>Raised crossing traffic arms or Pavement Marking (on raised junctions) across traffic arms</td>
</tr>
<tr>
<td>Access to Access road Junction</td>
<td>One Lane Roundabout or Mini Roundabout</td>
<td>Mixed NMV traffic with motorists</td>
<td>Pavement Marking (on raised junctions) across traffic arms or Raised crossing across traffic arms</td>
</tr>
</tbody>
</table>
Roundabouts - Distributary to distributary

- Tighter entry radius – 10-20m
- Gentler exit radius – 30-50m
- Smaller exiting deflection
- Greater entry deflection
- Inscribed circle

Inscribed circle dia. To be equivalent or more than the total carriageway width of the wider arm
Roundabouts - Distributary to access roundabout

Inscribed circle dia. To be equivalent or more than the total carriageway width of the wider arm

- Tighter entry radius – 10-20m
- Gentler exit radius – 30-50m
- Circulatory lane width
- Smaller exiting deflection
- Greater entry deflection
- Inscribed circle
- Circulatory dia.
Modern roundabout - step by step design approach

1. Aligning the center lines of the approach roads, in order to locate the roundabout at the intersection point.

2. Roundabouts at the urban roads work efficiently for not more than 2 lanes. Demarcating 2 lanes of the carriageway to go inside the roundabout and 1 lane for free left turn lane.

3. Diameter of the Central Island should be at least as much as the total carriageway width. Apron and Inscribed Circle dimensions to be referred from the table below.

4. For the Entry Width to increase from the carriageway down to the Circulatory Roadway width. Tangential Circle is introduced between Inscribed Circle and Carriageway. With Average Effective Flare Length of 20-30mts.
Modern roundabout - step by step design approach

5. Offset the entry curve towards the median by the width of MV Lane going in the roundabout.
   Make a tangential curve between the median edge and apron edge.

6. Exit Curve right edge: make a curve tangential to the MV Lane edge and Inscribed Circle, after the junction.
   The radius of the Exit curve should be greater than the entry radius curve so as to avoid vehicle to vehicle path overlap.

7. Exit Curve left edge: Make tangential curve between median and apron with radius as the right edge curve minus MV lane widths exiting roundabout.

8. Left Turning lane right edge - Make a tangential circle between left turning MV lane edges of both the arms of junction.
   Radius of the Left turn lane should not be significantly larger than the entry curve radius to avoid overspeeding by left-turning vehicles.
   Another determining factor is to achieve min. 3.5 mts of space at the designated pedestrian crossing area of the left-turning island.
Modern roundabout - step by step design approach

9. Left Turning lane left edge - Offset the curve by distance as much as the left turning lane (refer Step 2.)

10. Exit Curve Lane widening. For the turning vehicles it is mandatory to provide lane widening at the left turning lane, with reference to the turning radius Refer ASVV Table 4.37, page 124. Fillet the vertices of the left turning islands by minimum 0.5mts radius.

11. Lane widening at the splitter island - at entry:
   • Offset 0.0m down to 0.3mts.
   Offset the central island circle by 0.3mts.
   Make tangential curve between the offset of apron and median edge.

12. Lane widening at the splitter island - at exit:
   • Offset 1.0m down to 0.0mts.
   Offset the central island circle by 1.0mts.
   Make a tangential circle between the median edge and central island offset.
Modern roundabout - step by step design approach

13. Lane Widening at the Splitter Island - at circulatory roadway side.

Minimum distance between the circulatory roadway edge and the splitter island edge should be 0.5mts (towards the roundabout entry).

Fillet the edges of the splitter island by radii 0.5mt and 1.0mts minimum at the entry and exit sides of the roundabout, respectively.

14. Pedestrian Crossing - at least 7.5mts away from yield line.

Free Left turn ramp at least 3mts away from the pedestrian crossing ramp.

Before the pedestrian crossing ramp begins, the minimum standing space to be provided for pedestrians should be 1.8mts wide.

15. Align the edges of the unpaved, to make refuge of minimum 1.8mts width.

Demarcate space for crossing pedestrian traffic.

Refuge - 1.8mts wide at least.

16. Put bollards at a clear distance of 1.4mts.
Roundabout with BRT

- Three phase signal – buses, pedestrians, other motor vehicles
- 2 lane roundabouts
## Minor intersections – common raised crossing

<table>
<thead>
<tr>
<th>Common Raised Crossing</th>
<th>Split Raised Crossing</th>
</tr>
</thead>
<tbody>
<tr>
<td>All vehicles slow down at the raised area with cyclists to face minimal level change resolved by a ramp of</td>
<td>Vehicles slow down due to two ramps and cyclists do not attend any kind of level change promising a comfortable and safe ride.</td>
</tr>
<tr>
<td>Priority given to cyclists after pedestrians.</td>
<td>Equal priority given to pedestrian and cyclists over motorists.</td>
</tr>
</tbody>
</table>
Minor intersections – split raised crossing

300 x 100mm and 60mm thick dotted warmer tarmac, with 30 hit top darne of 25mm dia x 5mm thickness as per specification.

DRIVEWAY ENTRY TO BUILDING

PROPERTY EDGE

FOOTPATH
  LVL: X+150mm

RAISED CROSSING
  LVL: X+150mm

CYCLE TRACK
  LVL: X+100mm

 RAISED CROSSING
  LVL: X+100mm

M.V. Lane
  LVL: X mm

FOOTPATH
  LVL: X+150mm

RAISED CROSSING
  LVL: X+100mm

CYCLE TRACK
  LVL: X+100mm

M.V. Lane
  LVL: X mm

Section AA

= The perpendicular distance between Compound Wall & MV Lane edge.
= width of the Gate or Road.
if R ≤ 6M then
WIDTH of Raised Crossing= x + 2R
if R > 6M then
WIDTH of Raised Crossing= 
x + (2R - 12)

= The perpendicular distance between Compound Wall & MV Lane Unpaved.
x = 4.50M
R = 5.20W
WIDTH of Raised Crossing= x + 2R
= 4.50 + 2 x 5.20 = 14.10M
Rural intersections

Urban and Rural Junctions
Arterial roads have higher speeds and flow than access streets. Therefore grading from 1 to 6 represents expected severity and frequency of conflicts – 1 being highest and 6 being lowest.

Design choices and detailing will depend on whether intersections are in the settlement or not.

<table>
<thead>
<tr>
<th></th>
<th>Express-way/ NH</th>
<th>SH/ MDR</th>
<th>ODR/ Village Rd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Express-way/ NH</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>SH/ MDR</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>ODR/ Village Rd.</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

1. Grade separated crossing for motor vehicles
2. Large rotaries
3. Grade separated crossing for motor vehicles
4. No right turns – traffic calmed merging/diverging lanes
5. Roundabouts
6. Unsignalized/Traffic Calmed Crossing
7. Mini Roundabouts
8. Traffic Calmed Crossing
9. Mini Roundabouts
10. Unsignalized/Traffic Calmed Crossing
11. Mini Roundabouts
Major design concerns and remedies

- **Edge drop** – safety edge treatment required
- **Missing shoulder** – provision of 2m wide shoulder or crash barrier required
- **Missing markings** – Markings as per IRC 35-2015 required
- **Missing signs** – Signs as per IRC 67-2021 required
- **Unsignalized/uncontrolled junctions** – Traffic calming including, pre-warners (rumble strip), trapezoidal or circular humps, raised crossings, texture change (rough texture, required).
- **Informal bus stops** – formalized bus stops within 50m of intersection required.
- **Vending activity and IPT parking on carriageway or shoulder** – Defined vending spaces and IPT bays at observed locations or near bus stops to be provided, with edge protection and traffic calming.

*The Safety Edge is an effective solution to reduce pavement edge-related crashes, by shaping the edge of the pavement to 30 degrees using a commercially available device (called a shoe) that can be attached to the paver. The asphalt is extruded under the shoe, resulting in a durable edge that resists edge raveling.*
“T” Junction

- The predominant land use in the vicinity of this blackspot is commercial, barren and residential.
- Major landmark around this blackspot is the petrol pump. Pedestrians were crossing and walking along the road.
- Buses were boarding and deboarding the passengers at informal stops.
- The shoulder was occupied by the vendor shops, M2W, M3W and other parked vehicles.
**Major Road Recommendations Tondan Road (NH-230):**

**Speed control and driver alerting measures:**
- Provide sets (one set has six strips) of bar markings (5 mm thick) before the Trapezoidal speed table both sides of the junction on the major road.
- Provide Trapezoidal speed tables before the junction on the Major road as per across the whole carriageway, and it should have markings as per standard.
- Edge drop shall be treated with a safety edge. For details of the safety, edge treatment.
- Provide Six-metre-wide textured patch on approach lanes of the major road after Bar marking.

**Road markings as per IRC:35-2015:**
- Provide road markings.
- Hazardous roadside objects shall be highlighted with hazard makers.

**Road signage’s as per IRC:67-2021:**
- Provide speed table and T- junction signs before the junctions of the major road.
- Provide Speed limit sign before the junctions of the major road.
”X” Junction

- Predominant land use in the vicinity of this blackspot is commercial and residential.
- Pedestrians were crossing and walking along the road.
- There is a canal across the road.
- Buses were boarding and deboarding the passengers at informal stops.
- Vehicles were over speeding at the location.
Major Road Recommendations Tondan Road (NH-230):

Speed control and driver alerting measures:
- Provide sets (one set has six strips) of bar markings (15 mm thick) before the Trapezoidal speed table both sides of the junction on the major road.
- Provide Trapezoidal speed tables before the junction on the Major road as per across the whole carriageway, and it should have markings as per standard.
- Edge drop shall be treated with a safety edge. For details of the safety, edge treatment.
- Provide Six-metre-wide textured patch on approach lanes of the major road after Bar marking.

Road markings as per IRC:35-2015:
- Provide road markings.
- Hazardous roadside objects shall be highlighted with hazard markers.

Road signage’s as per IRC:67-2021:
- Provide speed table and X-Intersection signs before the junctions of the major road.
- Provide Speed limit sign before the junctions of the major road.
- Provide hazard markers for hazardous objects.
“Y” Junction

• This junction is primarily located in the urban area where the predominant land use in the vicinity of this blackspot is residential and commercial.
• Pedestrians were crossing and walking along the road.
• There is a curved section on the road.
• Buses were boarding and deboarding the passengers at informal stops.
• Temporary barricades were present at the junction for restricting the incoming vehicles to the junction from minor road and AR.
• Vehicles were over speeding at the BS location.
• Unsafe edge drop
Major Road Recommendations Mangal Pandey Marg (ODR):

**Speed control and driver alerting measures:**
- Provide sets (one set has six strips) of bar markings (5 mm thick) before the Trapezoidal speed table both sides of the junction on the major road.
- Provide Trapezoidal speed tables before the junction on the Major road as per across the whole carriageway, and it should have markings as per standard.
- Edge drop shall be treated with a safety edge. For details of the safety, edge treatment.
- Provide Six-metre-wide textured patch on approach lanes of the major road after Bar marking.

**Road markings as per IRC:35-2015:**
- Provide road markings.
- Hazardous roadside objects shall be highlighted with hazard makers.

**Road signage’s as per IRC:67-2021:**
- Provide speed table and Y-junction signs before the junctions of the major road.
- Provide Speed limit sign before the junctions of the major road.
- Provide hazard markers for hazardous objects.
Staggered junction

- The BS-323 Behati Area is primarily located in the urban area where the predominant land use in the vicinity of this blackspot is residential, commercial and agricultural.
- Pedestrians were crossing and walking along the road.
- The shoulder was occupied by the vendor shops, M2W, M3W and other parked vehicles.
- Buses were boarding and deboarding the passengers at informal stops.
- Vehicles were over speeding at the BS location.
Staggered junction

**Major Road Recommendations Kursi Road (MDR-77C):**

**Speed control and driver alerting measures:**
- Provide sets (one set has six strips) of bar markings (5 mm thick) before the Trapezoidal speed table both sides of the junction on the major road.
- Provide Trapezoidal speed tables before the junction on the Major road as per across the whole carriageway, and it should have markings as per standard.
- Edge drop shall be treated with a safety edge. For details of the safety, edge treatment.

**Road markings as per IRC:35-2015:**
- Provide road markings.
- Hazardous roadside objects shall be highlighted with hazard makers.

**Road signage’s as per IRC:67-2021:**
- Provide speed table and T- junction signs before the junctions of the major road.
- Provide Speed limit sign before the junctions of the major road.
- Provide hazard markers for hazardous objects.
Other Intersection Elements

Urban and Rural Junctions
Design elements to ensure safe junctions

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Safety Provisions</th>
<th>IRC Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Refuge Island</td>
<td>IRC: 103- 2012</td>
</tr>
<tr>
<td>2</td>
<td>Kerb Ramp</td>
<td>IRC: 103- 2012</td>
</tr>
<tr>
<td>3</td>
<td>Bollards</td>
<td>IRC: 103- 2012</td>
</tr>
<tr>
<td>4</td>
<td>Road Markings</td>
<td>IRC: 35- 2015</td>
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<tr>
<td>5</td>
<td>Warning Signages</td>
<td>IRC: 67- 2012</td>
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<tr>
<td>6</td>
<td>Pedestrian path</td>
<td>IRC: 103- 2012</td>
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<tr>
<td>7</td>
<td>Zebra Crossing</td>
<td>IRC: 35- 2015</td>
</tr>
<tr>
<td>8</td>
<td>Rumble Strip</td>
<td>IRC: 35- 2015</td>
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<tr>
<td>9</td>
<td>Transverse Bar Marking</td>
<td>IRC: 99- 2018</td>
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<td>10</td>
<td>Speed Breaker</td>
<td>IRC: 103- 2012</td>
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<tr>
<td>11</td>
<td>Delineators</td>
<td>IRC: 79- 2019</td>
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<tr>
<td>12</td>
<td>Raised Crossing</td>
<td>IRC: 99- 2018, Pg. No 12</td>
</tr>
<tr>
<td>13</td>
<td>Box Marking</td>
<td>IRC: 35- 2015, Pg. No. 107</td>
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<tr>
<td>14</td>
<td>Cycle Track</td>
<td>IRC: 11- 2015, Pg. No. 07</td>
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<tr>
<td>15</td>
<td>Tree or Vegetation pruning</td>
<td>IRC: SP 88- 2019</td>
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<td>16</td>
<td>Chevron Marking</td>
<td>IRC: 35- 2015</td>
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<td>17</td>
<td>Bus Box Marking</td>
<td>IRC: 35 2015, Pg. No. 79</td>
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<tr>
<td>18</td>
<td>Turning Radius</td>
<td>IRC: SP -41 Pg. No. 23</td>
</tr>
</tbody>
</table>
Other junction design elements

Audible signals

Vending spaces

Entrance to cycle track

Cycle box
Thank you

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