Vulnerable Road Users Safety in Urban & Rural Areas

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Safety Principles for VRU Safety

• VRU presence in travel & Crashes
• Data shortcomings
• Risk Factors
• VRU Safety principles
• Traffic calming principles
• Urban examples
• Rural Example
### Travel to work in India (Census, 2011)

<table>
<thead>
<tr>
<th>Mode</th>
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<table>
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<td>Any Other</td>
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</table>
States: GSDPPC (contd..)

- Walk is predominant means of traveling to work in all economies
- Mode share of bicycle is higher in states of low per capita output
- Mode share of buses is around 20 percent in all economies, except in those with lowest GSDPPC
Risk factors

- Who are the victims? (AGE, GENDER, SOCIO ECONOMIC status)
- Where do the crashes occur? (Midblock, crossing, near PT Stops, near grade separated facilities)
- Impacting vehicle type? (Trucks, Buses, cars, MTW)
- Lack of pedestrian facilities in roadway design and land-use planning
- Motorised vehicle speed
  - The risk a pedestrian fatality reaches 5% at an estimated impact speed of 30 km/h.
  - Speed limits of 30–40 km/h are recommended in areas with high pedestrian traffic
  - The undisputed issue is that speed is an important risk factor for pedestrian injury and that impacts of above 30 km/h increase the likelihood of severe injury or death.
Disaggregate data for targeted policies

Under reporting pedestrians
Motorcyclists

Hsiao, M. et al. (2013) estimate

Dandona et al. estimate (2017)
Risk factors

- Inadequate visibility of pedestrians
- Pedestrian–vehicle conflict at pedestrian crossing points;
- Reduced reaction time and reduced walking speed for the elderly;
- Inability of children to gauge vehicle speed and other relevant information in order to cross the street safely alone;
- Lack of supervision of children who are too young to make safe judgements;
- Pedestrian distraction, including mobile phone use (see Box 1.3);
- Attitudes of drivers and pedestrians;
- Failure of drivers to respect right-of-way for pedestrians, including failure to yield at pedestrian crossings;
- Vehicle condition and defects (e.g. brakes, lighting, windscreen); and
- Quiet (electric) vehicles, whose presence cannot be detected by normal auditory means.
RISK Factors

- Roads are not safe or improving for pedestrians. Globally pedestrian deaths have increased at nearly twice the rate of other road crash deaths (12.9% increase from 2013 to 2016, vs. a 6.6% increase for other road users.

- While pedestrian collisions occur more in urban areas than rural settings in high-income countries, the proportion of pedestrian victims in road traffic crashes in rural areas may be higher in low- and middle-income countries as compared to high income countries.

- Pedestrian facilities such as footpaths, safe crossing facilities are not present in most Indian cities. Even when present, their poor maintenance and poor construction quality make them unusable. As a result, pedestrians are forced to share the road space with motorized vehicles and to cross the roads where there is no safe pedestrian crossing.

- Night-time travel is one of the greatest risk factors for pedestrians.
There is no fundamental difference between injuries and the occurrence of any other disease.

Injury can be defined as a disease that results from an acute exposure of the human body to transfer of energy from the environment around it.

“Accidents” and injuries are not acts of God.

All injuries cannot be prevented.
Application of Key Principles of Safe System Approach (Vision Zero(1997)) for VRU safety

• 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.
Pedestrian vulnerability

Figure 1.4 Distribution of injuries on the body of a pedestrian in a frontal car–pedestrian collision

Head trajectories

Small car
40 km/h

Big car
20 km/h

WAD

WAD: wrap-around distance

Source: 49
Urban speed limits should not exceed 50 km/h.

Local authorities should be able to reduce speeds where necessary.
IRC Classification

- Urban Expressway
- Arterial Road
- Sub Arterial Road
- Collector Street
- Local Street
- Non-Motorized Transport (NMT) Streets and Greenways
Road Typology

<table>
<thead>
<tr>
<th>Road Typology</th>
<th>Right of Way-ROW (m)</th>
<th>Design speed (km/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial Roads</td>
<td>50-80</td>
<td>50</td>
</tr>
<tr>
<td>Sub Arterial Roads</td>
<td>30-50</td>
<td>50</td>
</tr>
<tr>
<td>Collector Roads</td>
<td>12 - 30</td>
<td>30</td>
</tr>
<tr>
<td>Access Streets</td>
<td>6 - 15</td>
<td>15</td>
</tr>
</tbody>
</table>

...different roads are to be designed differently
Main roads (arterial) are usually 20-25% of the total network (speeds-50-70km/h)
Highway passing through the city (Elevated)
Collector Roads
15 m and above ROW

Access Roads
15 m ROW
Principle 2: Acceptance of human error

• Red light violation (long wait time)
• Error in judgement (short gap acceptance)
• Comfort and convenience over safety (low risk perception, NMV users)
• Travel behavior impacted by road environment (absence of pedestrian/NMV path)
Pedestrian facility design principles

- **Safety** – Well-designed and inclusive pedestrian infrastructure ensures physical safety to all age groups, gender and persons with physical disabilities while traveling in urban areas. It includes safe footpaths, safe intersections, safe crossings, shared streets, traffic calming elements, etc.

- **Security** – Pedestrian facilities that are active, well-lit and have a good mix of users belonging to different age groups and gender are perceived to be secure especially by women groups, elderly, caregivers and children.

- **Continuity** – Continuous pedestrian infrastructure provides safe movement, especially to persons on wheelchair, visually impaired persons, caregivers with prams, elderly, and tourists with trolley luggage. It includes at-grade crossings, access ramps, escalators, lifts, etc.

- **Comfort** – Shade, seating spaces, even surface, etc. improves one’s comfort. A comfortable pedestrian infrastructure provides seamless travel and connectivity to pedestrians without much effort.

- **Liveability** - A liveable pedestrian infrastructure is attractive and enjoyable. Children play elements, on-street vendors, spaces for recreation, landscape elements etc. invite pedestrians to enjoy the space for long time.
Impact angle, Kinetic energy and travel speed

At 50 deg impact angle
90 km/h Transferable energy is 4 times more than 50 km/h

Transferable energy 6-10 times more for impact angle from 20 deg. To 90 deg.
Patiala, Punjab

- Petrol Pump Area
- 4&2 Wheelers parked and Vendors are standing
- Stadium Road
  - ROW – 18-20m
  - Two way, Divided Road
- Lower Mall Road
  - ROW – 24m
  - Two way, Divided Road
- Patiala
  - Mall Road
  - ROW – 36m
  - Two way, Divided Road
- Rajbhara Road
  - ROW – 30 m
  - Two way, Divided Road

Proposed design

- A. Provided segregated area for the Vendors
- B. Median for dividing Road and slowing down/diverting vehicular traffic
- C. TSR Parking Bay for Auto rickshaws
- D. Parking Bay for 6 wheelers
- E. TSR Parking Bay for Auto rickshaws
- F. Parking Bay for 2 wheelers
- G. Raised crossing for the pedestrian crossing

Existing situation

Pilot corridor – key map
KALA AAM JUNCTION

Issues
No provision for current activities such as hawking and parking
No safe/segregated infrastructure for pedestrians
No safe pedestrian crossings
Poor traffic circulation and conflicts due to missing junction geometry

Activity Survey

Delhi Road
ROW – 20-24m
Two way, Divided Road

DM Road
ROW – 14m
Two way, Divided Road

Police Line Road
ROW – 10m
Two way, Un-Divided Road

Preet Vihar Road
ROW – 16-20m
Two way, Divided Road

Existing Roundabout

Delhi Road
ROW – 21m
Two way, Divided Road

Bulandshahr – Sayana Road
ROW – 24m
Two way, Divided Road

Type | Number
--- | ---
2W | 199
4W | 23
Bicycle | 68
E Rick | 13
TSR | 5
Hawkers | 32
Proposal 1

Because of central structure, junction already works as an unplanned rotary – better geometry can convert this to a modern roundabout increasing efficiency and safety

Planned and designated 2-wheeler and 4-wheeler bays all around the junction to reduce congestion due to friction with parked vehicles

Provision of raised crossing nearer to junction ensure the safety of crossing pedestrians.
Safety by design 1
Pedestrians Road Crossing Preferences in Delhi, India
Pedestrian overhead bridges: What have we learnt?

- pedestrian bridges should only be considered in extreme cases, as they seem to be a non-effective crossing facility. To solve conflicts between traffic and pedestrian flows it is preferable to propose at level signalized crossings.

- Raised Underpass as second best option

- Overpasses as least preferred option.

- Pedestrians prefer at grade crossing
Cross Section (45 m ROW)

Cross Section – Half Subway
Guiding Principles

• Road geometric standards from Buses/VRUs (pedestrians, bicyclists, public transport users) perspective
• Traffic management policies that enable safe mobility of VRUs
• Road side vendors/ informal sector to be viewed as service providers
Traffic Safety around schools
School education?

• Counterintuitive results: Traffic education for young children (Sandels 1974) may increase injury rates.
• Young children should always be accompanied with adults/older children.
• Many countries have “walking” school bus.
• Older children have to be explained the risk of high speed and benefits of helmets.
Traffic Safety around schools

Safe Environment?

• Low speed limit zones near schools (20km/h)
• Introducing traffic calming techniques near school zones for better speed management and compliance.
• Making bicycling and walking options (safe routes to schools).
• Encourage bus transport instead of cars or two wheelers.
Pedestrian facility Traffic Signals

Following pedestrian crossing speeds should be considered -

• 15th percentile speed (approximately 0.95 m/s) should be used for the design of signal timings.

• If older pedestrians are high in volume, a crossing speed of 0.8 m/s should be used.

• If young children accompanied by caregivers are high in volume, a crossing speed of 0.5m/s should be used. This will also be helpful to persons with reduced mobility and physical disabilities.

• School, recreation, and hospital zones should consider a crossing speed of 0.5m/s.
Principle 3 – important principle – physically separate vulnerable road users or provide travel speeds <30 km/h

• Vulnerable road users, defined here as pedestrians and two wheeler users (Australian Government Standing Committee on Planning Environment and Territory and Municipal Services, 2014; SWOV – Institute for Road Safety Research, 2012), are particularly affected by the potential levels of kinetic energy at intersections.

• The absence of any vehicle protection leaves vulnerable road users open to the full force of a crash. In fact, the safest means of ensuring Safe System compatibility with respect to vulnerable road users is to physically separate them from other road users.

• Temporal separation of vulnerable road users from vehicles is less effective in meeting Safe System ideals as this still relies on road user compliance and avoidance of error.

• For this reason, temporal separation has not been defined within Principle 4 as it still leaves open the possibility of serious injury.
### Effectiveness of Measures for Improving Pedestrian Safety

<table>
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<tr>
<th>Key Measures</th>
<th>Examples of Interventions</th>
<th>Effectiveness</th>
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<td>Proven, Promising, Insufficient evidence</td>
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<tr>
<td>Provide sidewalks</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Install and/or upgrade traffic and pedestrian</td>
<td>Yes</td>
<td></td>
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<tr>
<td>signals</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Reduce pedestrian exposure to vehicular traffic</td>
<td></td>
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<tr>
<td>Construct pedestrian refuge islands and raised</td>
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<td></td>
</tr>
<tr>
<td>medians</td>
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<tr>
<td>Construct enhanced marked crossings</td>
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<td>Provide vehicle restriction/diversion measures</td>
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<tr>
<td>Install overpasses/underpasses</td>
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<td>Improve mass transit route design</td>
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<td>Reduce traffic volumes by switching journeys from</td>
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<td>the car to public transport, walk and cycle for</td>
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<td>distances and purposes where these options work</td>
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## Effectiveness of Measures to improve Pedestrian Safety

<table>
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<tr>
<td><strong>Reduce speed limit</strong></td>
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<tr>
<td>Implement area-wide lower speed limit programmes, for example, 30km/hr</td>
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<tr>
<td><strong>Reduce Vehicle Speeds</strong></td>
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<tr>
<td>Implement road-narrowing measures</td>
<td>Yes</td>
</tr>
<tr>
<td>Implement speed management measures at road sections</td>
<td></td>
</tr>
<tr>
<td>Install speed management measures at intersections</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Provide school route improvements</strong></td>
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<tr>
<td><strong>Provide crossing enhancements</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Implement lighting/crossing illumination measures</strong></td>
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</tr>
<tr>
<td><strong>Improve sight distance and/or visibility between motor vehicles and pedestrians</strong></td>
<td>Yes</td>
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<tr>
<td>Reduce or eliminate obstruction by physical objects including parked vehicles</td>
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</tr>
<tr>
<td>Install signals to alert motorists that pedestrians are crossing</td>
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</tr>
<tr>
<td>Improve visibility of pedestrians</td>
<td>Yes</td>
</tr>
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</table>
Helmets and motorised two wheeler safety

• 30-40% fatal crash victims are two wheeler riders.
• Helmets can reduce head injury.
• Helmets are effective in low as well as high speeds.
• Helmets are essential for driver as well as riders.
• Day light head lights improves visibility and therefore reduces chances of crash.
Motorcycle helmets

Wearing a good quality motorcycle helmet can reduce the risk of death by 40% and severe head injury by >70%. Strict enforcement by police improves compliance.

Most cities have less than 40% compliance
Helmet: Aims to reduce the risk of serious head injury and brain injuries by reducing the impact of a force or collision to the head

It reduces the deceleration of the skull, and hence the brain movement, by managing the impact. The soft material incorporated in the helmet absorbs some of the impact and therefore the head comes to a halt more slowly. This means that the brain does not hit the skull with such great force. It spreads the forces of the impact over a greater surface area so that they are not concentrated on particular areas of the skull. It prevents direct contact between the skull and the impacting object by acting as a mechanical barrier between the head and the object.
2 What is Traffic Calming?

Road engineering approaches aimed at bringing the design of the road in accordance with the desired speeds of the vehicles plying on them

- reduce the negative effects of motor vehicle use
- alter driver behavior
- improve conditions for non-motorized street users
Influencing Driving Behavior

• Signs
• Markings
• Gates
Lane Narrowing
Humps

Types of Speed Humps

- Circular Hump
- Trapezoidal Hump
- Sinusoidal Hump

Figure 2-8 Types of speed humps

Profile

Cross-section

Circle Shaped humps

Sinusoidal humps

Dome Shaped Humps

Trapezoidal humps
Circular Hump

**Geometric Design**

**Details of Transition**

**Geometric Details of Road Hump**

**Chord Length of Road Hump**

<table>
<thead>
<tr>
<th>Desired Speed (KMPH)</th>
<th>Radius (Meter)</th>
<th>Chord Length (Meter)</th>
<th>BUS Speed During Passage (KMPH)</th>
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<tr>
<td>20</td>
<td>11</td>
<td>3</td>
<td>5</td>
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<tr>
<td>25</td>
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<td>45</td>
<td>80</td>
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<td>30</td>
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<tr>
<td>50</td>
<td>113</td>
<td>9.5</td>
<td>35</td>
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</table>

**Note:** Refer Figure 11.1 of IRC 35 2015 for marking details
Trapezoidal Hump

Cross Section Y-Y

Cross Section X-X

<table>
<thead>
<tr>
<th>Desired Speed (kmph)</th>
<th>Length of Ramp (m)</th>
<th>Gradient of Ramp (%)</th>
<th>Bus speed during passage (kmph)</th>
<th>Length of Flat portion</th>
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</thead>
<tbody>
<tr>
<td>20 km/h</td>
<td>0.7 m</td>
<td>14.0%</td>
<td>-</td>
<td>Minimum 2.5 m</td>
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<tr>
<td>25 km/h</td>
<td>0.8 m</td>
<td>12.5%</td>
<td>5 km/h</td>
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</tr>
<tr>
<td>30 km/h</td>
<td>1.0 m</td>
<td>10.0%</td>
<td>10 km/h</td>
<td></td>
</tr>
<tr>
<td>35 km/h</td>
<td>1.3 m</td>
<td>7.5%</td>
<td>15 km/h</td>
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<tr>
<td>40 km/h</td>
<td>1.7 m</td>
<td>6.0%</td>
<td>20 km/h</td>
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<tr>
<td>45 km/h</td>
<td>2.0 m</td>
<td>5.0%</td>
<td>25 km/h</td>
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</tr>
<tr>
<td>50 km/h</td>
<td>2.5 m</td>
<td>4.0%</td>
<td>30 km/h</td>
<td></td>
</tr>
</tbody>
</table>

Note: Refer Figure 11.1 of IRC 35 2015 for marking details
Feedback signs
Textured paving over raised crossings
Uneven road surface
Thermoplastic bar markings

Thermoplastic Marking of 300mm wide and 5mm height, at 600mm apart (one set is of 6 Strips)

5mm height is achieved through two applications of thermoplastic, applied at an interval not less than 1 hour for the 1st layer to be solidified

Thermoplastic Marking of 300mm wide and 15mm height, at 1000mm apart (one set is of 6 Strips)

15mm height is achieved through six applications of thermoplastic, applied at an interval not less than 1 hour for the previous layer to be solidified
3 Traffic Calming Measures in Urban Areas

Vertical deflections - Vertical shifts in the carriageway are the most effective and reliable of the speed reduction measures currently available.

Circular Hump in IIT Delhi (Figure 3-2)

Speed Bumps
Suggested treatment for Mid-Block crossing (Fig 2-33) and Road junctions (Fig 2-34) with raised areas for pedestrians

Design to facilitate mid-block crossing (Rehman, et al., 2009)
Residential & Commercial >3m Setback, Residential & Commercial <3m Setback
Schools, Hospitals & Institutional Areas

Hump - 3.6 m wide, circular top, 10 cm high at its peak, located 10-14 m in advance of the pedestrian crossing.

Zebra crossing

Raised Zebra crossing - Flat top, 5 m wide, 10 cm high, 1 m ramp

Residential & Commercial >3m Setback, Residential & Commercial <3m Setback
Schools, Hospitals & Institutional Areas
Urban Roads
## Eligibility criteria & Area of Application

### TC techniques for RESIDENTIAL ROADS

<table>
<thead>
<tr>
<th>Speed limit &lt;20 km/h</th>
<th>Pedestrian crossing</th>
<th>Left Turns</th>
<th>Intersections</th>
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<tbody>
<tr>
<td>Speed hump</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 1 (parabolic)</td>
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<td></td>
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<tr>
<td>Speed hump</td>
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<td></td>
<td>✓</td>
</tr>
<tr>
<td>Type 2 (flat top)</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Rumble strips</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texture change</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(uncut stones)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raised paint markings</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>( audible markers)</td>
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<td></td>
</tr>
<tr>
<td>Paint markings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Speed Zones on NH/SH passing through village (Fig 4-1)

Figure 4-1 Speed Zones on NH/SH passing through village

Table 4-1 Recommended Speed as per distance from boundary of speed zone

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Length (m)</th>
<th>Recommended Speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Heavy vehicles</td>
</tr>
<tr>
<td>1</td>
<td>260 from the boundary</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>220 from the boundary</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>180 from the boundary</td>
<td>35</td>
</tr>
<tr>
<td>4</td>
<td>150 from the boundary</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>Within boundary</td>
<td>20</td>
</tr>
</tbody>
</table>
Rural Roads (Highways)

Figures

Figure 5-6 Schematic diagram for Highway Corridors without Central Medians (a)

Figure 5-7 Schematic diagram for Highway Corridors without Central Medians (b)

Figure 5-8 Schematic diagram for Highway Corridors without Central Medians (c)
Rural Roads
(Highways)

Figure 5-9 Schematic diagram for Highway Corridors without Central Medians (d)

Figure 5-10 Schematic diagram for Highway Corridors without Central Medians (e)
Hill Roads

Checklist

Low

- Normal Drops or Climbs (Straight Stretch) *(Figure 5.31)*
  - Post speed limits signs
  - Provide centre and edge line markings with road studs

- Steep Drops/ Climbs On Straight Stretches *(Figure 5.32)*
  - Post adequate speed limit sign posts
  - Provide adequate signage indicating “steep drop/climb ahead”.
  - Provide adequate lane markings

- Blind Bends With Or Without Steep Drops /Climbs *(Figure 5.33)*
  - Post adequate speed limit sign posts
  - Provide Centre line Marking
  - Provide reflector studs on centre line markings
  - Provide psychological Rumble strips
  - Provide Triple chevron signs indicating the direction of bends.
  - Provide convex mirror to see oncoming vehicle
  - Provide adequate crash/ deflection barrier

As population density increases

High
Hill Roads Checklist

Figure 5-32 Schematic Diagram - Hill Roads (c)
IRC Standards recommended (Flat top hump/speed table)
Locations close to habitation/ pedestrian traffic
IRC Standards recommended
Creation of Speed calming zones within the settlement
IRC Standards recommended (Rumble strips) in locations away from settlements where speed control is unavoidable on highways and arterial roads. (Clause 2.3.3.3, IRC: 99-2018)

Length: Width of carriageway + Width of shoulder (if any)
C-C width: 1000 mm
Height: 20-30 mm
Width: 200-300 mm

Material for in situ cast: Cement concrete or premix bituminous material.
IRC Standards recommended
Transverse bar Markings are used to alert approaching hazard and reduce the speed. The number of a set of bar marking shall be based on approach speed as given in the table. (Clause 2.3.3.4, IRC: 99-2018)

Each set of bar marking comprise six bars.

Dimensions

Width: 200-300 mm
C-C width: 600 mm
Height/thickness: 5 mm
### Blackspots Typology

<table>
<thead>
<tr>
<th>BS Type</th>
<th>BS Type based on location typology</th>
<th>Major Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Midblock</td>
<td>Midblock section</td>
</tr>
<tr>
<td>Type 2</td>
<td>Midblock (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 3</td>
<td>Midblock (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 4</td>
<td>Staggered junction</td>
<td>Staggered junction</td>
</tr>
<tr>
<td>Type 5</td>
<td>Staggered junction (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 6</td>
<td>Staggered junction (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 7</td>
<td>T-junction</td>
<td>T-junction</td>
</tr>
<tr>
<td>Type 8</td>
<td>T-junction (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 9</td>
<td>T-junction (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 10</td>
<td>Y-junction</td>
<td>Y-junction</td>
</tr>
<tr>
<td>Type 11</td>
<td>Y-junction (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 12</td>
<td>Y-junction (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 13</td>
<td>Intersection</td>
<td>Intersection</td>
</tr>
<tr>
<td>Type 14</td>
<td>Intersection (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 15</td>
<td>Intersection (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 16</td>
<td>Multi-leg junction</td>
<td>Multi-leg junction</td>
</tr>
<tr>
<td>Type 17</td>
<td>Multi-leg junction (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 18</td>
<td>multi-leg junction (near settlement)</td>
<td></td>
</tr>
</tbody>
</table>
## Blackspot typology with maximum blackspots

<table>
<thead>
<tr>
<th>BS Type No.</th>
<th>Typology</th>
<th>No. of audited blackspots</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>T-junction (through settlement)</td>
<td>96</td>
</tr>
<tr>
<td>14</td>
<td>Intersection (through settlement)</td>
<td>66</td>
</tr>
<tr>
<td>11</td>
<td>Y-junction (through settlement)</td>
<td>47</td>
</tr>
<tr>
<td>2</td>
<td>Midblock (through settlement)</td>
<td>40</td>
</tr>
<tr>
<td>9</td>
<td>T-junction (near settlement)</td>
<td>35</td>
</tr>
<tr>
<td>7</td>
<td>T-junction</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>Midblock (near settlement)</td>
<td>21</td>
</tr>
<tr>
<td>5</td>
<td>Staggered junction (through settlement)</td>
<td>20</td>
</tr>
</tbody>
</table>
Dubanga (BS-40) T junction (Type-8)

Location Map

Crash Details (last three years data)

Total Fatal crashes = 10
Non Fatal Crashes = 11
Total fatalities = 10
Grievous injuries = 12
Minor injuries = 3
Dubanga (BS-40) T junction (Type-8)

**Activities:**

- The BS-40 Dubanga is primarily located in the urban area where 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.

Activities Drawing showing Plan and Cross-section
Dubanga (BS-40) T junction (Type-8)

Recommendations

OPTION A

OPTION B

Bus stop (with in 30 m from junction)

Bus stop (with in 30 m from junction)
Edge marking and chevron Markings on Bends
Central lane marking and Crash Barrier on a Bend
Truck Arrester Ramp
CODE OF PRACTICE FOR URBAN ROADS

Institute of Urban Transport, Delhi
WWW.IUTINDIA.ORG
www.iutindia.org/Capacity Building/Toolkits.aspx
GEOMETRIC DESIGN STANDARDS FOR URBAN ROADS AND STREETS

(First Revision)

GUIDELINES FOR TRAFFIC CALMING MEASURES IN URBAN AND RURAL AREAS

(First Revision)