VRU Safety & Traffic Calming Measures in Urban & Rural Areas
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
Essence of the Traffic Calming techniques

Road design and engg. measures that REDUCE adverse effect of motorized traffic on built up areas by

- Reducing vehicle speeds and direction
- Reserving more space for pedestrians and cyclists

Value

- Self-enforcing measures that produce benefits >> costs
- Potential to reduce accident levels by 40%
Need for adapting TC techniques to Indian conditions

• Heterogeneity of traffic in urban areas / intercity roads

• Passage of Highways through townships and villages
Conditions prevailing on Highways: urban like?

Mixing of local traffic with high speed through traffic

Highway passing through towns/village
~1.5 km highways through the village
Speed variation and Mixed traffic

- High speed variations due to presence of NMT, small vehicles on highways.

- Presence of Motorized two wheelers and non motorized vehicles.
Traffic movement and crash patterns

- Proportion of pedestrians and MTW in fatalities 20-40%
- Highway shoulders used by parked vehicles, slow moving vehicles (tractors, bicycles, animal carts)
- Right most lane used by heavy vehicles
- Overtaking maneuver from passenger side

![Traffic Movement and Crash Patterns Diagram]
Injury Producing Systems

- Accident is a failure in a subsystem, or the system as a whole that damages one or more unit
Systems Approach

• Structural analysis of injury producing systems

• Focus is on the injury causing properties of systems rather on the errors of owners, designers, operators.

• Moving away from conventional explanations which are myopic overlooking the interrelationships between the various components of the system.
Traffic safety principles/the corner stones for developing safe highways in LMICs.

- Principle 1 Recognition of human frailty
- Principle 2 Acceptance of human error
- Principle 3 Creation of a forgiving environment and appropriate crash energy management.

Principle 1 and 2 must recognize that highways in LMICs will have presence of NMVs and pedestrians along with motorized traffic. Principle 3 becomes the operational principle for setting appropriate speed limits for ensuring a forgiving environment for all road users.

*Pedestrians will make mistakes in judging the possible risk in the system whereas, drivers can make mistakes in adopting an appropriate speed.*
Discussion on a paradigm shift

MoRTH continues emphasis on driver’s fault ~ 78%
Based on police reports
SAFE SYSTEM APPROACH

- Forgiveing roads/streets
- Speed management by design
- Forgiving roads/streets
• Higher level of service implies higher speeds—i.e. higher probability of fatality
Sustainable Safe traffic system

a road environment with an infrastructure adapted to the limitations of the road user;

vehicles equipped with technology to simplify the driving task and provided with features that protect vulnerable and other road users; and

road users that are well informed and adequately educated.
<table>
<thead>
<tr>
<th>ACCIDENT SEVERITY</th>
<th>TYPES OF ACCIDENTS AFFECTED</th>
<th>BEST ESTIMATE</th>
<th>95% CONFIDENCE INTERVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed humps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury accidents</td>
<td>All accidents on roads with speed humps</td>
<td>-41</td>
<td>-57; -34</td>
</tr>
<tr>
<td>Injury accidents</td>
<td>All accidents on nearby roads with speed humps</td>
<td>-7</td>
<td>-14; 0</td>
</tr>
<tr>
<td>Raised junctions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury accidents</td>
<td>Accidents at junctions</td>
<td>+5</td>
<td>-34; +68</td>
</tr>
<tr>
<td>Property damage only accidents</td>
<td>Accidents at junctions</td>
<td>+13</td>
<td>-55; +183</td>
</tr>
<tr>
<td>Rumble strips in front of junctions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury accidents</td>
<td>Accidents at junctions</td>
<td>-33</td>
<td>-40; -25</td>
</tr>
<tr>
<td>Property damage only accidents</td>
<td>Accidents at junctions</td>
<td>-25</td>
<td>-45; -5</td>
</tr>
<tr>
<td>Unspecified</td>
<td>Accidents at junctions</td>
<td>-20</td>
<td>-25; -5</td>
</tr>
<tr>
<td>Speed zones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury accidents</td>
<td>All accidents</td>
<td>-27</td>
<td>-30; -24</td>
</tr>
<tr>
<td>Property damage only accidents</td>
<td>All accidents</td>
<td>-16</td>
<td>-19; -12</td>
</tr>
</tbody>
</table>
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
Circular Hump

**Geometric Details of Road Hump**

**DESIGNED SPEED (KMPH) | RADIUS (METER) | CHORD LENGTH (METER) | BUS SPEED DURING PASSAGE (KMPH)**
--- | --- | --- | ---
20 | 11 | 3 | 5
25 | 15 | 3.5 | 10
30 | 20 | 4 | 15
35 | 31 | 5 | 20
40 | 53 | 6.5 | 25
45 | 80 | 8 | 30
50 | 113 | 9.5 | 35

Note: Refer Figure 31.1 of IRC:35:2015 for marking details
Trapezoidal Hump

Geometric Details of Road Hump

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

Note: Refer Figure 11.1 of IRC 35 2015 for marking details
H- Hump
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
Horizontal deflections

• Staggering - horizontal deviation of vehicles on the road, restricting them to known turning radii at different speeds for different vehicle types.

• Chicanes
Mini-roundabouts
Effective solution for residential areas with single carriageway roads where the vehicle speeds should not exceed 30 km/h
Horizontal Deflections
Horizontal Deflections
Suggested treatment for Mid-Block crossing (Fig 2-33) and Road junctions (Fig 2-34) with raised areas for pedestrians
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
## 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>
</tr>
</thead>
<tbody>
<tr>
<td>Speed hump</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 1(parabolic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Speed hump</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Type 2(flat top)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rumble strips</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Texture change (uncut stones)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Raised paint markings (audible markers)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Paint markings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
4-Traffic Calming on Rural Roads (Highways)

Safe environment for the vulnerable road users within local communities.

Unhindered and swift movement of the pass-through traffic.
Urban Roads
Speed Zones on NH/SH passing through village (Fig 4-1)

![Diagram of speed zones on NH/SH passing through village]

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) Checklist

**Low**

- **Desolate Agricultural Fields**
  - No treatment

- **Villages (Figure 5.6)**
  - Paint a 150mm wide continuous yellow line in the centre of the carriageway preceded by warning centre line

- **Industrial Areas (Figure 5.7)**
  - Paint a 150mm wide continuous yellow line in the centre of the carriageway preceded by warning centre line
  - Provide road studs at 6m intervals, on no-overtaking section and 9m interval on warning section, on both centre line and edge line.

- **Residential & Commercial >3m Setback (Figure 5.8)**
  - Provide gates at both ends of the corridor passing through residential or commercial areas.
  - Provide signage showing name of the area and the length of the corridor.
  - Provide 40 km/h speed limit sign and proceeded by transition speed limit sign.
  - Provide Speed limit signs, and warning signs for merging roads and physical traffic calming devices.
  - Provide other warning and informative sign as necessary

- **Residential & Commercial <3m Setback (Figure 5.9)**
  - Provide gates at both ends of the corridor passing through residential or commercial areas. Zig zag marking in the congested section. Also, provide signage showing name of the area and the length of the corridor.
  - Provide 40km/h Speed limit signs and 70 or 60km/h as transition speed limit.
  - Provide psychological traffic calming measures on main corridor.
  - Provide other warning and informative sign as necessary.
  - Provide warning signs for merging roads and physical traffic calming devices on side roads.
  - Provide a pedestrian friendly surface, that would cause discomfort for through vehicular movement, could of paver block at same level of carriageway.

- **Schools, Hospitals & Institutional Areas (Figure 5.10)**
  - Provide gates at both ends of the corridor passing through highly congested Schools, Hospitals & Institutional Areas. Zig zag marking in the congested section. Also, provide signage showing name of the area and the length of the corridor.
  - Provide 40km/h Speed limit signs and 60km/h as transition speed limit.
  - Provide physical traffic calming on main corridor to curtail the speed.
  - Provide warning signs for merging roads and physical traffic calming devices on side roads.
  - Provide other warning and informative sign as necessary.
  - Provide a pedestrian friendly surface, that would cause discomfort for through vehicular movement, could of paver block at same level of carriageway.
Rural Roads (Highways)

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

5.9 Hill Roads

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

As population density increases

Blind Bends With Or Without Steep Drops /Climbs (Figure 5.33)
- Post adequate speed limit sign posts
- Provide adequate signage indicating "steep drop/climb ahead".
- 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

High
Hill Roads

Hairpin Bend

Figure 5-32 Schematic Diagram - Hill Roads (c)